The California Air Resources Board

Public Hearing to Consider the Proposed Advanced Clean Fleets Regulation

Staff Report: Initial Statement of Reasons

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A. List of Appendices

B. List of Acronyms and Abbreviations

AB	Assembly Bill
ACC	Advanced Clean Cars
ACF	Advanced Clean Fleets
ACT	Advanced Clean Trucks
APS	Air Pollution Specialist
AQIP	Air Quality Improvement Program
ARE	Air Resources Engineer
ARS	Air Resources Supervisor
ART	Air Resources Technician
ASB	Zero-Emission Airport Shuttle Bus
BACT	Best Available Control Technology
BAU	Business-as-Usual
BEV	Battery-Electric Vehicle
CAISO	California Independent System Operator
Caltrans	California Department of Transportation
CARB or Board	California Air Resources Board
CCR	California Code of Regulations
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CI	Confidence Interval
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalents
CPUC	California Public Utilities Commission
CTA	California Trucking Association
DAC	Disadvantaged Community
DEF	Diesel Exhaust Fluid
DMV	Department of Motor Vehicles
DOF	Department of Finance
EER	Energy Efficiency Ratio
EIA	Energy Information Administration
EMFAC	Emission Factor Inventory Model
EPA	Environmental Protection Agency
ER	Emergency Room
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
FCEV	Fuel Cell Electric Vehicle
FY	Fiscal Year
GHG	Greenhouse Gas
GM	General Motors
GO-Biz	Governor's Office of Business and Economic Development
GDP	Gross Domestic Product
GSP	Gross State Product
GVWR	Gross Vehicle Weight Rating
HD I/M	Heavy-Duty Inspection and Maintenance
HVIP	Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project

ICCT	International Council on Clean Transportation
ICE	Internal Combustion Engine
ICT	Innovative Clean Transit
IOU	Investor-Owned Utility
IPT	Incidence-per-Ton
ISOR	Initial Statement of Reasons
IWG	Interagency Working Group
kW	Kilowatt
kWh	Kilowatt-Hour
lbs.	Pounds
LCFS	Low Carbon Fuel Standard
LER	Large Entity Reporting
MMT	Million Metric Tons
MY	Model Year
NAAQS	National Ambient Air Quality Standards
NOx	Oxides of Nitrogen
NZEV	Near-Zero-Emission Vehicle
OAL	Office of Administrative Law
OBD	On-Board Diagnostics
OEM	Original Equipment Manufacturer
PG&E	Pacific Gas and Electric
PHEV	Plug-In Hybrid Electric Vehicle
PM	Particulate Matter
PM2.5	Fine Particulate Matter
POAK	Port of Oakland
POLA	Port of Los Angeles
POU	Publicly Owned Utility
PPB	Parts per Billion
PSPS	Public Safety Power Shutoff
PTO	Power Take-Off
PY	Personnel Year
RD	Renewable Diesel
REMI	Regional Economic Models, Inc.
RNG	Renewable Natural Gas
SB	Senate Bill
SC-CO_2	Social Cost of Carbon
SCE	Southern California Edison
SDG&E	San Diego Gas and Electric
SIP	State Implementation Plan
SLCP	Short-Lived Climate Pollutant
SoCalGas	Southern California Gas Company
SRIA	Standardized Regulatory Impact Assessment
SWCV	Solid Waste Collection Vehicle
TE	Transportation Electrification
TCO	Total Cost of Ownership
tpd	Tons per Day
TRU	Transport Refrigeration Unit
TTW	Tank-to-Wheel

VMT	Vehicle Miles Traveled
ZE	Zero-Emission
ZEB	Zero-Emission Bus
ZEV	Zero-Emission Vehicle

Executive Summary

Mobile sources and the fossil fuels that power them are the largest contributors in California to the formation of ozone, greenhouse gas (GHG) emissions, fine particulate matter (PM2.5), and toxic diesel particulate matter (PM). In the State, the transportation sector alone accounts for 41 percent of total GHG emissions (50 percent when upstream emissions from fuel is included) and is a major contributor to oxides of nitrogen (NOx) and PM emissions. Medium- and heavy-duty vehicles contribute a quarter of the transportation sector's GHG emissions and a third of the transportation sector's NOx emissions, a disproportionately high share considering these vehicles represent only about 1.8 million trucks among the 30 million registered vehicles in the state. The proposed Advanced Clean Fleets (ACF) regulation, or "proposed ACF regulation," would contribute to achieving the State's criteria pollutant and GHG reduction goals as well as cleaner technology targets needed to protect communities. Implementing this proposed ACF regulation is expected to save over 5,000 Californian lives between 2024 and 2050. These avoided premature mortalities and other avoided adverse health benefits have an estimated value of over $57 billion dollars.

The proposed ACF regulation is part of a comprehensive strategy that would, consistent with public health needs, accelerate the widespread adoption of zero-emission vehicles (ZEV) in the medium- and heavy-duty truck sector and in light-duty package delivery vehicles. The proposed ACF regulation would require certain fleets to deploy ZEVs starting in 2024 and would establish a clear end date of new medium- and heavy-duty internal combustion engine (ICE) vehicle sales in 2040.

The proposed ACF regulation builds on other policies to continue reducing emissions, including the Advanced Clean Trucks (ACT) regulation.[1] It would be the next significant step in accelerating towards a zero-emission (ZE) transportation system as well as a more equitable future in California. With the adoption of the ACT regulation in 2020, the California Air Resources Board (CARB or Board) took a major step in securing a ZE future. The ACT regulation covers everything from heavy-duty pickups or work trucks to the semi-trucks used in drayage and long-haul applications, and requires truck manufacturers, beginning with the 2024 model year (MY), to produce and sell ZEVs into California's market in growing numbers. The proposed ACF regulation and the ACT regulation together are expected to result in about 510,000, 1,230,000, and 1,590,000 ZEVs in California in 2035, 2045, and 2050, respectively. These quantities of ZEVS are in turn projected to significantly reduce criteria and GHG pollutants when compared to Legal Baseline as shown *in* Table 1.

Table 1: Estimated ACF Emission Reductions in 2040 and 2050

Year	NOx	PM2.5	GHG
2040	47%	24%	41%
2050	57%	37%	62%

The proposed ACF regulation establishes aggressive, but achievable, emissions targets, and would comprise the next installment of policies to help transform the medium- and heavy-

[1] The ACT regulation is comprised of California Code of Regulations (Cal. Code Regs.) title 13, sections 1963, 1963.1, 1963.2, 1963.3, 1963.4, 1963.5, 2012, 2012.1, and 2012.2.

duty sector and light-duty package delivery vehicles to ZE by focusing on specific fleets where accelerated ZE transitions are feasible and critical to these goals. It is one of a range of policies – including potential commitments in the State Implementation Plan (SIP), incentive spending, infrastructure installations, and land use policies – that jointly can achieve a full transition to a ZE transportation system. Other policies, which are not the subject of this rulemaking, are cleaning up the remaining combustion fleet, including CARB's Heavy-Duty Omnibus Regulation and Heavy-Duty Vehicle Inspection and Maintenance Regulation (HD I/M). [2,3] Thus, vehicles powered by internal combustion engines are not in the ambit of this proposal, but CARB has established a comprehensive set of rules and policies aimed at all portions of the vehicle fleet in order to protect public health. The primary objectives of this proposal include the following:

- Achieve criteria pollutant and GHG emissions reductions consistent with the goals identified in the SIP Strategy and Scoping Plan, including supporting compliance with state and federal ambient air quality standards.
- Provide criteria pollutant and toxic air contaminant emissions reductions in disadvantaged communities (DAC), which is consistent with CARB's statewide strategy to reduce these emissions in communities affected by a high cumulative exposure burdens under Assembly Bill (AB) 617.[4]
- Support the 100 percent ZE transition targets set by the Board in Resolution 20-19 which calls for:
  - Drayage trucks, last mile delivery, and government fleets to be ZE by 2035.
  - Refuse trucks, local buses, and utility fleets to be ZE by 2040.
  - All trucks and buses to be ZE, where feasible by 2045.
- Support the goals of Executive Order N-79-20, which calls for accelerated ZEV deployment with these targets:
  - 100 percent ZE drayage by 2035.
  - 100 percent ZE trucks and buses where feasible by 2045.
- Ensure requirements, such as ZEV deployment schedules and related infrastructure build-out, are technologically feasible, cost-effective, and support market conditions.
- Lead the transition away from petroleum fuels and towards electric drivetrains.
- Contribute towards achieving carbon neutrality in California pursuant to Senate Bill (SB) 100,[5] and in accordance with Executive Order B-55-18.
- Complement the ACT regulation to enhance widespread ZEV deployment.
- Mindfully set requirements to allow time for public ZE infrastructure buildout for smaller fleets or for regional haul applications who would be reliant on a regional network of public chargers.

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[2] The Omnibus regulation is comprised of Cal. Code Regs., title 13, sections 1900, 1956.8, 1961.2, 1965, 1968.2, 1971.1, 1971.5, 2035, 2036, 2111 through 2119, 2121, 2123, 2125 through 2131, 2133, 2137, 2139, 2139.5, 2140 through 2149, 2166, 2166.1, 2167 through 2170, 2423, and 2485; and Cal. Code Regs., tit. 17 sections 95662 and 95663.

[3] The rulemaking action for the HD I/M regulation has not yet been completed; the proposed HD I/M regulation is comprised of Cal. Code Regs., tit. 13, sections 2193, 2195, 2195.6, 2196 through 2196.8, 2197 through 2197.3, and 2198 through 2199.1.

[4] Assembly Bill 617 (C. Garcia, Stats. 2017, ch. 136).

[5] Senate Bill 100 (De León, Stats. 2018, ch. 312).

- Ensure manufacturers and fleets work together to place ZEVs in service suitably and successfully as market expands.
- Complement current and existing programs to achieve emissions reductions that are real, permanent, quantifiable, verifiable, and enforceable.
- Establish a fair and level playing field among fleet owners.
- Craft requirements in a way that ensures institutional capacity for CARB to manage, implement, and enforce requirements.

The proposed ACF regulation provides a ZEV phase-in approach which provides initial focus where the best fleet electrification opportunities exist, sets clear targets for regulated fleets to make a full conversion to ZEVs, and creates a catalyst to accelerate development of a heavy-duty public infrastructure network. In addition, it aggressively pushes drayage trucks to be ZE, given the suitability of their duty cycles, outsized impact on disproportionately impacted communities, and ability to maximize emissions reductions in heavily impacted communities. This approach gives fleets the flexibility to phase in ZEVs in the most suitable applications first and focuses initial ZEV infrastructure development to support community health around ports and railyards.

The proposed ACF regulation attempts to strike a balance between moving the market quickly to ZE while recognizing fleets more suited for electrification should lead the way for smaller fleets. Staff recognizes the complexities of applying purchase mandates to fleets affected by the proposed ACF regulation and acknowledges that additional tools may be needed to meet the 100 percent ZE by 2045 goal set in the Governor's Executive Order N-79-20. For instance, it is important that manufacturers continue to have strong reasons to set competitive prices, especially for small fleet owners who may experience more economic constraints on vehicle purchases; simply requiring ZEV purchases for these fleet owners could result in elevated prices for a key sector of the small business economy. Thus, CARB continues to investigate a range of tools that can address this portion of the fleet as well, in an equitable and effective way.

In addition to accelerating the deployment of ZEVs, the proposed ACF regulation states that 100 percent of manufacturer sales of all Class 2b-8 vehicles must be ZE by 2040, which sends a clear signal regarding the end of ICE powered truck sales in California. This end point for sales of new ICE vehicles in California ensures accelerated improvements in the economics of ZEVs and the investments needed to expand the market quickly. This increases confidence for infrastructure providers and ZEV components suppliers to invest in and supports a rapidly growing market, ensuring that ZEV technology advancements continue. It also provides more air quality benefits to our communities as well as more choices to fleets and consumers.

A. Purpose of The Proposed ACF regulation

The purpose of the proposed ACF regulation is to accelerate the widespread adoption and usage of ZEVs in the medium- and heavy-duty truck sector and light-duty vehicles used in mail and package delivery, to reduce harmful emissions generated from on-road mobile sources.

A number of policy, planning, and regulatory actions have led to the development of the proposed ACF regulation and the need to accelerate ZEV deployments everywhere feasible. In 2018, the Governor issued Executive Order B-55-18, which set a target to achieve carbon neutrality in California no later than 2045, and to achieve and maintain net negative emissions thereafter. In 2020, Executive Order N-79-20 set specific targets to transition the truck fleet to ZE technology by 2045. In January 2021, the ACT regulation was adopted by CARB as a key part of the holistic approach to accelerate a large-scale ZEV transition of medium- and heavy-duty trucks. The ACT regulation's ZEV sales requirement establishes a supply of medium- and heavy-duty ZEVs, while the ACT regulation's one-time fleet reporting requirement provided detailed information about fleets and how they use their vehicles. In October 2021, CARB released the 2020 Mobile Source Strategy, a top-down analysis of policy options and emissions reductions needs, which identified the proposed ACF regulation as part of a comprehensive strategy to achieve a ZE truck and bus fleet by 2045 everywhere feasible, and significantly earlier for certain well-suited market segments.[6] In addition, CARB released the 2022 State SIP Strategy (draft) which builds on 2020 Mobile Source Strategy, and includes ACF as well as a proposed commitment to accelerate the number of medium- and heavy-duty ZEV beyond the ACT and proposed ACF regulation.[7] Additionally, the 2022 Scoping Plan Update (draft) lists the proposed ACF regulation as a necessary policy to achieve climate change goals and includes it in the modeling. [8] The proposed ACF regulation directly supports achieving these goals through the regulatory transition of medium- and heavy-duty ZEVs in California.

B. Summary of Proposed ACF regulation

The proposed ACF regulation would require State and local government fleets, drayage trucks, high priority fleets, and federal fleets to phase in medium- and heavy-duty ZEVs over time. The proposed ACF regulation additionally sets a clear end date for new internal combustion-powered medium- and heavy-duty vehicle sales in California. The proposed ACF regulation includes four components: three sets of fleet requirements on State and local government fleets, drayage trucks, and high priority and federal fleets, and a ZEV sales requirement on medium- and heavy-duty truck manufacturers. The following provides information on each of the proposed components.

1. State and Local Government Fleets

- Applies to California cities, counties, public utilities, special districts, local agencies or districts, and State government agencies that own a Class 2b-8 vehicle.
    - Excludes federal agencies, which are regulated under the high priority and federal fleet requirements.
- When adding vehicles to their California fleet, affected fleet owners must only add ZEVs per the following schedule.

[6] California Air Resources Board, *2020 Mobile Source Strategy*, October 28, 2021 (web link: https://ww2.arb.ca.gov/sites/default/files/2021-12/2020_Mobile_Source_Strategy.pdf, last accessed August 2022).
[7] California Air Resources Board, *2022 State Strategy for the State Implementation Plan (2022 State SIP Strategy)*, 2022 (web link: https://ww2.arb.ca.gov/resources/documents/2022-state-strategy-state-implementation-plan-2022-state-sip-strategy, last accessed August 2022).
[8] California Air Resources Board, *The AB 32 Scoping Plan (draft)*, 2022 (web link: https://ww2.arb.ca.gov/our-work/programs/ab-32-climate-change-scoping-plan/2022-scoping-plan-documents, last accessed August 2022).

  - Fleets outside designated low-population counties: 50 percent of the total number of vehicle additions must be ZEVs beginning January 1, 2024, increasing to 100 percent beginning January 1, 2027.
  - Fleets in designated low-population counties: 100 percent of the total number of vehicle additions must be ZEVs beginning January 1, 2027.
- Compliance exemptions for backup vehicles, daily usage, infrastructure construction delays, ZEV unavailability, and mutual aid assistance.
- Annual reporting, starting April 1, 2024, with recordkeeping requirements.

2. Drayage Trucks

- Applies to Class 7-8 heavy-duty trucks transporting containerized, bulk, or break-bulk goods, empty containers or chassis' to and from California's intermodal seaports and railyards.
- All trucks added to CARB's Online System must be a ZEV beginning January 1, 2024.
  - All drayage trucks must visit a regulated seaport or intermodal railyard at least once each calendar year to remain in CARB's Online System.
  - Existing ICE drayage trucks may not exceed their minimum useful life to remain in the CARB's Online System.
  - All drayage trucks entering seaports and intermodal railyards would be required to be ZE by 2035.
- Compliance exemptions for dedicated use uni-body vehicles (e.g., auto transports), infrastructure construction delays, and ZEV vehicle delivery delays.
- Annual reporting starting January 1, 2024, with reporting or recordkeeping requirements for truck owners, seaports, railyards, and marine terminals.

3. High Priority and Federal Fleets

- Applies to fleets that meet the following criteria:
  - Any fleet owner who owns, operates, or directs 50 or more Class 2b-8 vehicles or off-road yard tractors including vehicles under common ownership and control, that operates at least 1 vehicle in California.
  - Any entity with $50 million or more in annual revenue and owns or operates at least 1 affected vehicle that is operated in California.
  - Federal government agencies that own, operate, or direct one or more affected vehicles in California.
- Affected vehicles include all Class 2b-8 on-road vehicles, off-road yard tractors, and light-duty package delivery vehicles in the fleet.
- High priority and federal fleets must meet the Model Year Schedule, or opt-in to the ZEV Milestones Option.
  - Model Year Schedule: Beginning January 1, 2024, all additions to the fleet must be ZEVs, and all ICE vehicles must be removed from the California fleet at the end of their useful life.
  - ZEV Milestones Option: ZEV phase-in requirement where a portion of the fleet must be ZE based on the schedule laid out in Table 2.

Table 2: High Priority and Federal Fleet ZEV Phase-In Schedule

Group	Percentage of Fleet that Must be ZEVs	10%	25%	50%	75%	100%
1	Box trucks, vans, two-axle buses, yard trucks, light-duty delivery vehicles	2025	2028	2031	2033	2035
2	Work trucks, day cab tractors, three-axle buses	2027	2030	2033	2036	2039
3	Sleeper cab tractors and specialty vehicles	2030	2033	2036	2039	2042

- Compliance exemptions for backup vehicles, daily usage, infrastructure construction delays, vehicle delivery delays, ZEV unavailability, declared emergency events, and mutual aid assistance.
- Annual reporting starting February 1, 2024, and recordkeeping requirements.

4. 100 Percent ZEV Sales Requirement

- Beginning 2040 MY, all new medium- and heavy-duty vehicles sold by manufacturers in California must be ZEV.
    - This requirement does not apply to authorized emergency vehicles.
- This requirement impacts all fleets and individuals who purchase medium- and heavy-duty vehicles in California.

C. Potential Impacts and Benefits of Proposed ACF regulation

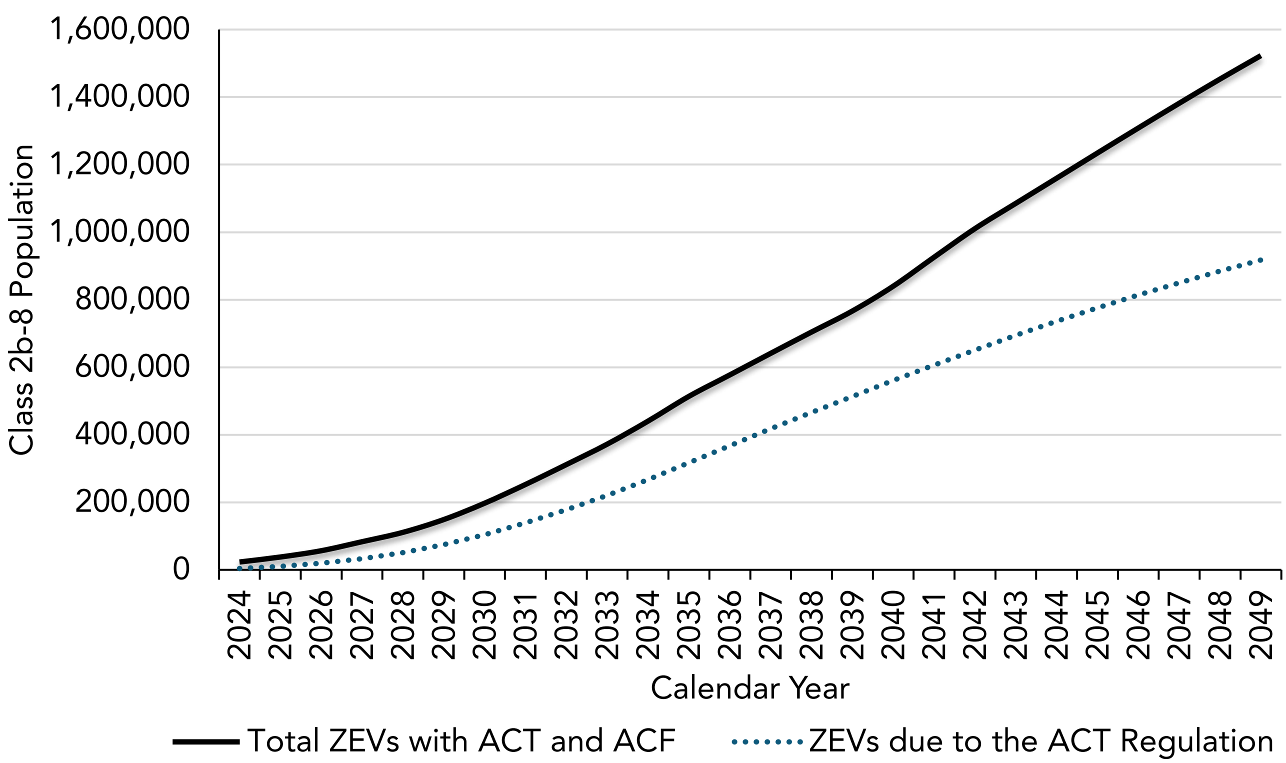
The proposed ACF regulation would help reduce emissions from fleets that pose acute health risks to local communities in which they operate and would contribute towards achieving CARB's emissions reductions goals for attaining federal health-based air quality standards and the State's GHG reduction goals. The proposed ACF regulation would result in cost-savings and reductions in criteria pollutants, toxic air contaminants, and GHG emissions at the statewide, regional, and local levels. This is a part of California's holistic plan to meet challenging federal air quality mandates and State climate goals, as well as protect the public health of all Californians. Table 3 enumerates the cumulative statewide benefits for emissions, cost-savings, and avoided premature deaths expected from full implementation of the proposed ACF regulation through calendar year 2050. The overall direct cost of the proposed ACF regulation to fleets is expected to be a savings of $22.2 billion, with additional health benefits savings of $57.8 billion, and social cost of carbon savings ranging from $9.4 billion to $36.4 billion. All costs are in 2021 constant dollars.

Table 3: Statewide Cumulative Benefits of Proposed ACF Regulation to 2050

Benefit Criteria	Cumulative Benefit by 2050
NOx Reduction	418,943 tons
PM2.5 Reduction	8,638 tons
GHG Reduction	307 MMT CO_2
Avoided Cardiopulmonary Mortalities	5,519
Health Benefits Savings	$57.8 billion
Social Cost of Carbon Savings	$9.4 to $36.4 billion
Net Fleet Cost-Savings	$22.2 billion

The proposed ACF regulation is projected to significantly increase the number of medium- and heavy-duty ZEVs in California beyond the ZEV sales expected from the ACT regulation as shown in Figure 1. The estimated number of ZEV would increase from about 320,000 to about 510,000 in 2035, from about 780,000 to about 1,230,000 ZEVs by 2045, and from about 950,000 to about 1,590,000 ZEVs by 2050.

Figure 1: Statewide Population Forecast with the Proposed ACF Regulation



The proposed ACF regulation is projected to result in significant NOx, PM2.5, and GHG emissions reductions above and beyond the ACT regulation. ZEVs produce no tailpipe emissions, reduce brake wear, PM emissions, and have lower upstream emissions. Table 4 summarizes the expected criteria pollutant emission benefits from 2031 through 2050. These emissions reductions, in tons per day (tpd), would contribute to the SIP Strategy and Climate Change Scoping Plan.

Table 4: Projected Emissions Reductions of the Proposed ACF Regulation

Calendar Year	NOx (tpd)	PM2.5 (tpd)	CO_2 (MMT/yr.)
2031	19.99	0.33	4.55
2037	51.99	0.95	10.91
2040	68.59	1.31	14.26
2045	83.89	1.86	19.89
2050	97.24	2.29	24.27

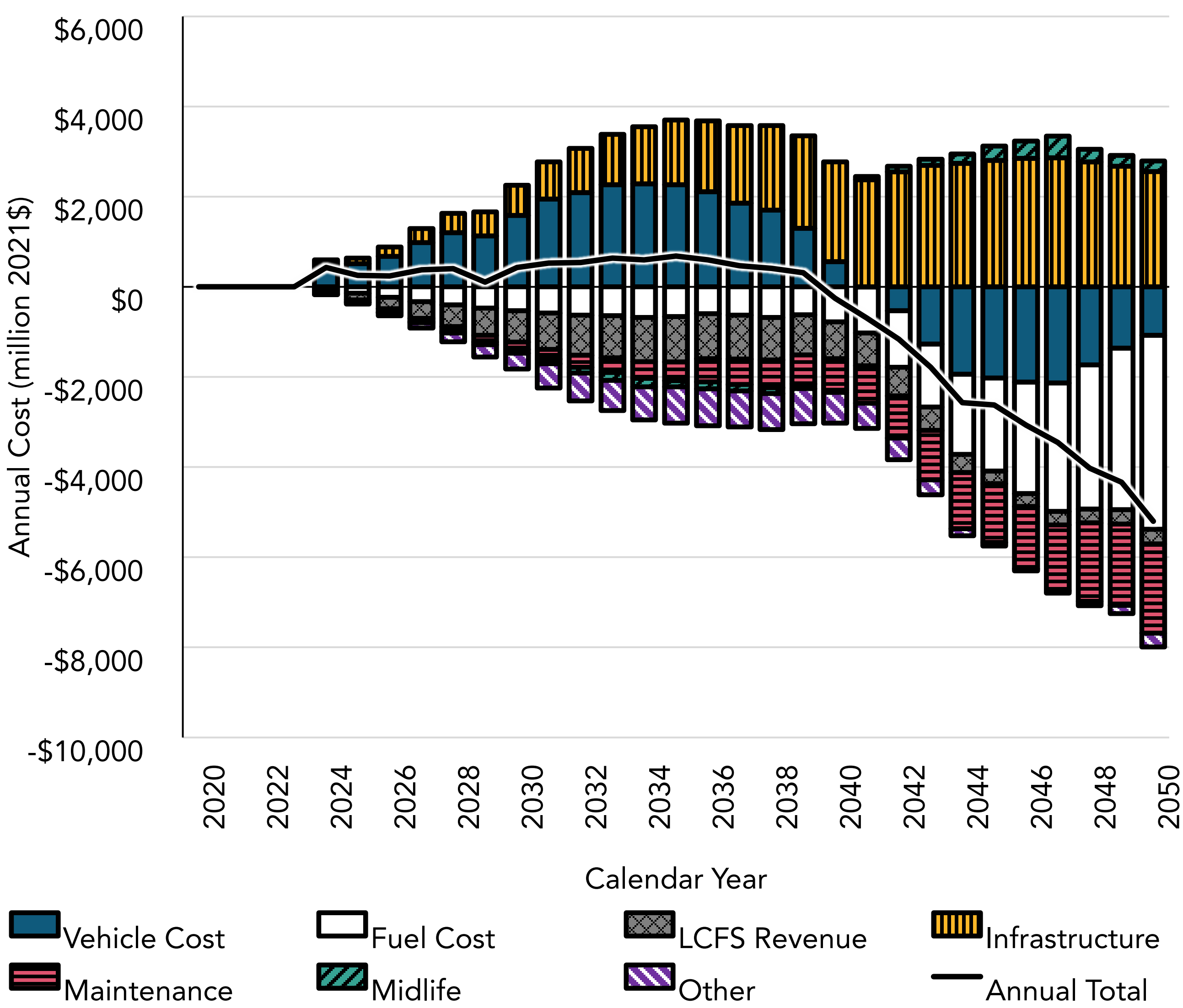
The proposed ACF regulation would also result in health benefits for individuals in California. The value of health benefits calculated for this regulation is due to fewer instances of premature mortality and hospital or emergency room (ER) visits. Table 5 displays the total cumulative number of avoided mortality and morbidity events and the total valuation to 2050.

Table 5: Estimated Cumulative Avoided Mortality and Morbidity Events and Total Valuation of Health Benefits to 2050

Cardiopulmonary Mortality	Hospitalizations for Cardiovascular Illness	Hospitalizations for Respiratory illness	ER Visits	Total Valuation
5,500	870	1,040	2,500	$57.7 Billion

Currently, ZEVs cost more than their combustion-powered counterparts due to higher vehicle costs and additional infrastructure expenses. However, due to a combination of lower fuel costs, maintenance cost-savings, and Low Carbon Fuel Standard (LCFS) revenue, ZEVs are expected to provide a positive total cost of ownership (TCO) for several use cases now and for most applications by 2030. Overall, the proposed ACF regulation is expected to result in a net savings to the California fleet. The proposed ACF regulation is expected to result in a net cost savings of $22.2 billion as illustrated in Figure 2. These costs do not include grants or rebates, so additional vehicle incentives, utility investments, and other investments will provide additional savings to fleet owners. This $22.2 billion in cost-savings are in addition to the $57.7 billion in health savings to the State.

Figure 2: Total Estimated Direct Costs of the Proposed ACF Regulation Relative to the Legal Baseline Scenario (Million 2021$)



D. Challenges and Long-Term Outlook

For over 50 years CARB has been ratcheting down on criteria and toxic pollution and more recently has been taking steps to reduce climate pollution. Pollution from black carbon and smog forming pollutants still impact Californians daily. For 5 decades, CARB has established a multitude of policies and plans and implemented numerous control measures and regulations to control and limit on- and off-road sources of emissions. However, trucks emit a disproportionate amount of air pollution. Additionally, trucks often operate in clusters centered around distribution warehouses, railyards, and ports which further exacerbates the air quality problem in these overburdened communities. A number of policies to reduce pollution from engines and their fuels have made significant progress, but more needs to be done, especially considering the long-life of trucks and the urgency of climate action. CARB found that expected efficiency gains from electrification of trucks and buses are better than previously estimated, especially for low-speed duty cycles.[9] Today, ZE trucks cost more upfront to purchase than their ICE counterparts and are in the early stages of a market transformation, but the ZEV service and support networks need to be expanded, along with charging and hydrogen fueling infrastructure. However, the efficiency of ZE trucks coupled with no tailpipe emissions means a win-win for all Californians who are disproportionately impacted by truck exhaust–including truck drivers. ZEVs have no tailpipe emissions and also have reduced PM associated with reduced brake wear, compared to conventionally fueled trucks. ICE truck exhaust emissions also increase with age which does not happen with ZEVs. In addition, ZEVs and associated lifecycle emissions from fuel and energy use are expected to continue to decline over time as the electrical grid gets even cleaner and as technology improves. Making this transition to ZE is critical to meet the State's air quality and climate change goals.

Some near-term challenges include the incremental cost to purchase the ZEV along with building-out chargers to recharge vehicles overnight at the fleet's yard, also known as depot chargers, and hydrogen fueling infrastructure, as well as the learning curve associated with adopting new technology. Most fleet vehicles travel relatively short distances each day and have operations that are suitable for electrification, but issues due to unknowns from using a new technology from the fleet perspective may exist. A mid-term challenge facing a long-haul and intrastate trucking operation is the need for publicly available charging and hydrogen fuel network. Faster chargers with capacities up to 350 kilowatts (kW) are being deployed in the field today and work is underway to develop and demonstrate chargers that exceed 1 megawatt that would allow even the largest vehicles to recharge in well under an hour. In addition, longer range trucks need supplemental storage capacity for batteries or hydrogen tanks, which can add more weight to the truck. State law allows ZEVs and near-zero-emission vehicles (NZEV) to exceed California maximum weight limits by 2,000 pounds (lbs.) which addresses some of the vehicle weight and payload capacity concerns of zero-emission technology for weight limited loads. [10] However, weight may only be an issue for a about 10 percent of the largest trucks on the road and may only affect about 2 percent of the most common dry van tractor trailer combination at maximum weight.[11] Additionally, payload capacity concerns are expected to diminish over time as battery energy densities improve and emphasis is placed on vehicle light-weighting. Weight is less of a concern for fuel cell electric vehicles (FCEV) as they have comparable range to combustion vehicles and weigh less than long-range BEVs with bigger batteries.[12] Staff anticipates these challenges to diminish with technology improvements and scale as BEVs and FCEVs become more commonplace.

Concerns have been raised around the availability and rollout of public and private ZEV infrastructure, including both charging and hydrogen stations, and the grid's ability to meet

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[9] California Air Resources Board, *Battery Electric Truck and Bus Energy Efficiency Compared to Conventional Diesel Vehicles,* 2018 (Web Link: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2019/act2019/appg.pdf, last accessed August 2022).
[10] Assembly Bill 2061 (Frazier, Stats. 2018, ch. 580).
[11] North American Council for Freight Efficiency, *Lightweighting*, 2021 (Web link: https://nacfe.org/technology/lightweighting-2/, last accessed August 2022).
[12] North American Council for Freight Efficiency, *Making Sense of Heavy-Duty Hydrogen Fuel Cell Tractors*, 2021 (Web link: https://nacfe.org/wp-content/uploads/2020/12/NACFE-Guidance-on-Hydrogen-Fuel-Cell-Tractors-FINAL-121620.pdf, last accessed August 2022).

the steadily growing electrical demand generated by the proposed ACF regulation and other rules promoting electrification. CARB staff have closely collaborated with multiple State agencies on this issue including the California Energy Commission (CEC), California Public Utilities Commission (CPUC), Governor's Office of Business and Economic Development (GO-Biz), and others. Robust modeling efforts by CEC have estimated that 157,000 chargers will be necessary by 2030 to support heavy-duty vehicle electrification.[13] This charging need will initially be focused "behind the fence" through depot charging, but publicly accessible options will be needed to enable a widespread charging network for long-range and interstate travels.

To meet the projected charging and refueling infrastructure needs, expanded incentive programs were launched by CEC. CPUC has directed the investor-owned utilities (IOU) to offer infrastructure support programs and incentives for fleet owners to install infrastructure in their territories. This includes funding programs such as the CEC's Energy Infrastructure Incentives for Zero-Emission Commercial Vehicles (EnergIIZE) program which is providing funding to support ZEV infrastructure as well as programs the CPUC has approved which authorize investor-owned utilities (IOUs) to invest in medium- and heavy-duty infrastructure.[14,15] Federal investments in charging and hydrogen stations are starting to takeoff through the Infrastructure Investment and Jobs Act. In addition, private companies are also making significant investments in ZE vehicles and infrastructure with billions of dollars in announcements.[16] Private efforts often target ZE vehicle fleet integration, charging needs, as well as to gather data to improve future products offerings. Private investments in hydrogen stations have also increased significantly in recent years as discussed on page 5 of the Assembly Bill 8 report.[17] In addition, Nikola Corporation has announced plans to build three hydrogen fueling stations for the fuel cell truck market in Colton, Ontario, and one serving the Port of Long Beach in collaboration with the Travel Centers of America.[18]

California's electric grid is designed to meet the highest demand, which in California occurs between 4 p.m. and 9 p.m. during the hottest days in summer. Fleet owners may opt to charge vehicles outside of these "peak hours." In addition, electric vehicles (EV) have the potential to serve as secondary storage to absorb excess renewable power from the grid and avoid curtailment. Work is ongoing to support the development of vehicle to load or back feeding into the grid. Other concerns have been raised about the impact public safety power

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[13] California Energy Commission, *Assembly Bill 2127 Electric Vehicle Charging Infrastructure Assessment*, 2021 (web link: https://efiling.energy.ca.gov/getdocument.aspx?tn=238853, last accessed August 2022).

[14] California Public Utility Commission, *Clean Energy and Pollution Reduction Act of 2015 (SB 350)*, 2022 (web link: *https://www.cpuc.ca.gov/sb350/*, last accessed August 2022).

[15] California Energy Commission, EnergIIZE Commercial Vehicles, 2022 (web link: *https://energiize.org/*, last accessed August 2022).

[16] Environmental Defense Fund, *Charged-Up Analysis of the Jobs, Investments and Companies in the Zero Emissions Medium and Heavy Duty Vehicle Supply Chain Economy*, 2021 (web link: https://www.edf.org/sites/default/files/documents/National%20MHD-ZEV-Supply-Chain-Analysis%2010.27.21_0.pdf, last accessed August 2022).

[17] California Air Resources Board, *2021 Annual Evaluation of Fuel Cell Electric Vehicle Deployment and Hydrogen Fuel Station Network Development*, 2021 (web link: https://ww2.arb.ca.gov/sites/default/files/2021-09/2021_AB-8_FINAL.pdf, last accessed August 2022).

[18] Nikola, *Nikola Announces Locations of Three California Hydrogen Dispensing Stations, Continued Scaling of Infrastructure*, 2022 (web link: https://nikolamotor.com/press_releases/nikola-announces-locations-of-three-california-hydrogen-dispensing-stations-continued-scaling-of-infrastructure-192, last accessed August 2022.

shutoff (PSPS) events may have on ZEV operations. The recent CPUC Decision 20-06-017 has potential to build support for distributed generation using localized microgrids that provide resiliency during power loss events, such as PSPS events and other declared emergencies.[19]

CARB staff is confident that the proposed ACF regulation targets fleets best suited for electrification while allowing flexibility over a longer time horizon for the more challenging use cases. The proposed ACF regulation is structured to phase in ZEV deployments where they are best suited to begin accelerating the transition to ZEVs in all truck market segments. This approach also considers infrastructure planning and network development strategies that will complement market expansion.

Implementation of both the existing ACT regulation and the proposed ACF regulation is expected to transition a vast majority of heavy-duty trucks to ZEVs. Shifting the remaining fleet to ZE technology requires additional policy tools to cost-effectively complete the transition for remaining fleets that are more dependent on purchasing trucks on the secondary market. The 2022 SIP Strategy identifies a Zero-Emission Truck Measure which would use targeted market signal tools, or a similar proposal that would start in 2030. Placing regulatory requirements on fleets is only one way to help accelerate the transition to ZE; for example, given the rapidly accelerating state of the truck market and working with State partners, it may also make sense to examine the current truck manufacturer requirements as they exist under ACT, as these requirements may be too low relative to public health needs and in light of accelerating technology deployments. Ensuring that manufacturers are motivated to partner with fleets and utilities to ensure that their product, ZE trucks, are being priced competitively and being used successfully is a critical underpinning of ensuing a successful accelerated transition to zero.

Federal action is also very important to support California's clean air policies. Federal adoption of cleaner NOx truck standards as well as an ACT regulation (or its CO_2 regulatory equivalent) will help California communities, but, critically, will also ensure that communities throughout the nation benefit from a robust clean truck market. National policies will help increase scale and further accelerate deployment of ZE technologies. The proposed ACF regulation is necessary to ensure California leads the nation in a shift to ZE and in meeting the State's air quality and climate targets.

I. Introduction and Background

This document summarizes staff's proposed ACF regulation to reduce emissions from light-duty delivery vehicles and Class 2b and larger medium- and heavy-duty vehicles with a manufacturer's gross vehicle weight rating (GVWR) greater than 8,500 lbs. that operate in California. The proposed ACF regulation is part of a holistic effort of achieving a ZE truck and bus California fleet by 2045 everywhere feasible and significantly earlier for certain market segments such as last mile delivery, State and local government fleets, and drayage applications. The initial focus is on drayage trucks, which have the largest impact in DACs, and on high priority fleets, with vehicles that are most suitable for early electrification. The

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[19] California Public Utilities Commission, *Decision 20-06-017: Actions to Accelerate Microgrid Deployment and Other Resiliency Solutions*, June 11, 2020 (web link: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M340/K748/340748922.PDF, last accessed August 2022).

goal of this effort is to accelerate the number of medium- and heavy-duty ZEV purchases to help achieve a full transition to ZEVs in California as soon as possible.

Mobile sources and the fossil fuels that power them are the largest contributors to the formation of ozone, GHG emissions, PM2.5, and toxic diesel PM. In California, the transportation sector alone accounts for 41 percent of total GHG emissions (50 percent when upstream emissions from fuel are included) and is a major contributor to ground level ozone and PM2.5. Statewide, about 12 million Californians live in 19 areas where levels of ozone and PM2.5 exceed the National Ambient Air Quality Standards (NAAQS) for ozone and PM2.5, (non-attainment areas). Exposure to PM2.5 and ozone is associated with increased risk of premature mortality, which has been estimated to contribute to 7,500 premature deaths each year in California.[20] The South Coast and San Joaquin Valley Air Basins have the most critical air quality challenges. These regions experience some of the nation's highest PM levels and are the only two areas in the nation with an "extreme" classification for non-attainment with the federal ozone standard. In addition, seven other areas in California are in serious or severe nonattainment with the federal ozone standard. Achieving federal air quality standards in these regions, as well as across California, provides essential public health protection by reducing hospitalizations for heart and lung related causes, decreasing ER visits, and reducing incidences of asthma.

In California, climate change is contributing to an escalation of serious problems along with worsening air quality challenges, including raging wildfires, coastal erosion, extreme weather, disruption of water supply, threats to agriculture, spread of insect-borne diseases, and continuing health threats from air pollution. Reducing GHG emissions helps put California on a trajectory to avoid the worst impacts of climate change and supports a growing clean energy economy.

In addition to regional air pollutant levels, many communities in the state experience measurable harm in the form of negative health impacts from high levels of localized pollution. There is an immediate need to reduce emissions and exposure in these highly impacted, low-income[21], and DACs throughout the state. Heavy-duty vehicle activity is often concentrated in and near these communities. This is not a coincidence. Decades of racist and classist practices, including red-lining and siting decisions, have concentrated heavy-duty vehicle and freight activities in these communities, with concomitant disproportionate pollution burdens. For instance, communities in and around ports move much of the nation's freight, and so experience pollution on a national scale in their neighborhoods. CARB has legal and moral obligations to lessen these burdens.

In light of all these needs, the proposed ACF regulation, in concert with existing State regulatory and incentive programs, seeks to accelerate the market transition to ZEVs. ZEV technologies eliminate all tailpipe emissions of criteria pollutants and greenhouse gases from the operation of vehicles, which positively affects our air quality and climate challenge. The proposed ACF regulation would help reduce emissions from fleets that pose acute health risks to local communities in which they operate and contribute towards achieving CARB's emissions reductions goals for attaining federal health-based air quality standards. The

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[20] California Air Resources Board, *Revised Proposed 2016 State Strategy for the State Implementation Plan*, 2017 (web link: https://ww3.arb.ca.gov/planning/sip/2016sip/rev2016statesip.pdf, last accessed August 2022).
[21] "Low-income communities" is defined in Health and Safety Code section 39713(d)(2) (added by Assembly Bill 1550 (Gomez, Stats. 2016, ch.369)).

proposed ACF regulation would result in reductions in criteria pollutants, toxic air contaminants, and GHG emissions at the statewide, regional, and local levels. This proposed ACF regulation is part of California's holistic plan to address challenging federal air quality mandates, protect the public health of all Californians, and meet climate change goals.

Medium- and heavy-duty ZEVs available today are already capable of meeting the average needs of local and regional trucking operations and a variety of vocational uses. Several data sources show the majority of trucks operating in California average less than 100 miles per day, except for semi-trucks where most average less than 200 miles per day.[22,23] Collected by CARB in 2021, recent Large Entity Reporting (LER) survey responses on daily mileage showed similar results for trucks that are owned by the responding entities. [24] Today's medium- and heavy-duty ZEVs have energy storage systems that can meet most of these daily operational requirements.

ZEVs also have unique advantages that eventually lead to shifts in fleet operational behaviors. Some of the advantages include quiet vehicle operation that improves safety on work sites, and enables later work shifts during times with less traffic and more efficient delivery schedules. Other benefits include less time spent on scheduled maintenance or out-of-service time due to the mechanical simplicity of ZEV systems. Over time, continued technology improvements, cost-reductions, and infrastructure growth would allow the ZEV market to continue expanding into all transportation service applications, including long-haul trucking.

Although medium- and heavy-duty ZEVs currently have higher upfront capital costs than vehicles powered by ICEs, they have lower fuel and maintenance costs that are expected to result in a positive TCO in most applications where they are suitable. Economic analyses by CARB and numerous third parties have found that medium- and heavy-duty ZEVs result in a

[22] United States Census Bureau, *2002 Vehicle Inventory and Use Survey*, 2002 (web link: https://www2.census.gov/library/publications/economic-census/2002/vehicle-inventory-and-use-survey/ec02tv-us.pdf, last accessed August 2022).

[23] California Department of Transportation, *CalTrans Truck Survey*, 2018 (web link: http://www.scag.ca.gov/committees/CommitteeDocLibrary/mtf012319_CAVIUS.pdf, last accessed August 2022).

[24] California Air Resources Board, *Large Entity Reporting Data*, 2021 (web link: https://ww2.arb.ca.gov/our-work/programs/advanced-clean-trucks/large-entity-reporting, last accessed August 2022).

lower TCO when compared to purchasing new gasoline or diesel counterparts in some applications today, and in nearly all applications by 2030.[25,26,27,28,29,30,31,32]

Increasing public pressure to address our climate crisis is pushing governments and businesses to reduce California's carbon footprint through the development of sustainability plans and the adoption of carbon reducing incentive programs and regulations. As a result of such climate focused policies and other long economic drivers, the medium- and heavy-duty ZEV market has developed rapidly over the past several years in the United States.

Staff analysis shows there are more than 148 models in North America where manufacturers are accepting orders or pre-orders and more than 130 models are actively being produced and are being delivered to the customer. Currently, all major manufacturers have announced upcoming medium- and heavy-duty ZEV plans and all but one has ZEV models in development with plans to launch them commercially prior to 2024. In addition, companies like Amazon, DHL, and the U.S. Postal Service have commissioned or self-manufactured purpose-built ZEVs in quantity for their own delivery business use.[33,34,35,36] Finally, several companies including major truck parts suppliers have a variety of EV components and drivetrain solutions for vehicle manufacturers to use in their vehicles. Appendix J provides a

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[25] California Air Resources Board, *Draft Advanced Clean Trucks Total Cost of Ownership Discussion Document*, 2019 (web link: https://ww3.arb.ca.gov/regact/2019/act2019/apph.pdf, last accessed August 2022).
[26] Atlas Public Policy, *Assessing Financial Barriers to Adoption of Electric Trucks*, 2020 (web link: https://atlaspolicy.com/wp-content/uploads/2020/02/Assessing-Financial-Barriers-to-Adoption-of-Electric-Trucks.pdf, last accessed August 2022).
[27] Hydrogen Council, *Path to Hydrogen Competitiveness – A Cost Perspective*, 2020 (web link: https://hydrogencouncil.com/wp-content/uploads/2020/01/Path-to-Hydrogen-Competitiveness_Full-Study-1.pdf, last accessed August 2022).
[28] ICF International, *Comparison of Medium-Duty and Heavy-Duty Technologies in California*, 2019 (web link: https://caletc.aodesignsolutions.com/assets/files/ICF-Truck-Report_Final_December-2019.pdf, last accessed August 2022).
[29] North American Council for Fuel Efficiency, *Regional Haul*, 2019 (web link: https://nacfe.org/regional-haul/, last accessed August 2022).
[30] North American Council for Fuel Efficiency, *Viable Class 7/8 Electric, Hybrid, and Alternative Fuel Tractors*, 2019 (web link: https://nacfe.org/future-technology/viable-class-7-8/, last accessed August 2022).
[31] University of California Los Angeles, *Zero-Emission Drayage Trucks – Challenges and Opportunities for the San Pedro Bay Ports*, 2019 (web link: https://innovation.luskin.ucla.edu/wp-content/uploads/2019/10/Zero_Emission_Drayage_Trucks.pdf, last accessed August 2022).
[32] Union of Concerned Scientists, *Ready to Work – Now is the Time for Heavy-Duty Electric Vehicles*, 2019 (web link: https://www.ucsusa.org/sites/default/files/2019-12/ReadyforWorkFullReport.pdf, last accessed August 2022).
[33] New York Times, *Can Anyone Satisfy Amazon's Craving for Electric Vans?*, 2022 (web link: https://www.nytimes.com/2022/01/18/technology/amazon-electric-vans.html, last accessed August 2022).
[34] Lightning eMotors, *DHL Express Deploys Nearly 100 New Lightning Electric Delivery Vans in U.S.*, 2021 (web link: https://lightningemotors.com/dhl-express-deploys-lightning-electric-vans-in-us/, last accessed August 2022).
[35] Reuters, *U.S. Postal chief commits to 10% of new delivery fleet as electric vehicles*, 2021 (web link: https://www.reuters.com/technology/us-postal-chief-commits-10-new-delivery-fleet-electric-vehicles-2021-02-24/, last accessed August 2022).
[36] CNN, *U.S. Postal Service says at least 40% of new delivery trucks will be electric*, 2022 (web link: https://www.cnn.com/2022/07/20/business/usps-electric-vehicle/index.html, last accessed August 2022).

partial list of medium-and heavy-duty ZEVs that are currently available or that can be ordered.

California is not alone in adopting regulations that will accelerate the ZE market. Five other states have already completed adoption of the ACT regulation (Massachusetts, New Jersey, New York, Oregon, and Washington) and two more states (Colorado and Maine) are currently in the public process required to adopt. New York has signed legislation, including the same ZE deadlines as California Executive Order N-79-20 for heavy-duty, light-duty, and off-road vehicles. The multi-state Medium- and Heavy-Duty ZEV Memorandum of Understanding continues to grow with Quebec and Virginia joining in 2021 to now include 17 states, one province and the District of Columbia.[37] Additionally, five other states (Illinois, Indiana, Michigan, Minnesota, and Wisconsin) have created a Regional Electric Vehicle Midwest Coalition Memorandum of Understanding (MOU) to accelerate medium- and heavy-duty ZE technology deployment via collaboration on infrastructure, manufacturing, and equity actions.[38] In addition, a Memorandum of Cooperation signed in June 2022 lays the foundation for potential collaboration on medium- and heavy-duty ZE policy and regulation between California and Canada.[39] This builds on Canada's commitment to decarbonize the transportation sector that has already seen actions including the path to 100 percent sales of light duty trucks by 2035 and over a half a billion dollars in MHD ZEV incentive funding.[40] Figure 3 shows regions with commitments to MHD ZEV deployment. California is also collaborating with the 16 countries and numerous regional, city and private entities of the Global Commercial Vehicle Drive To Zero's 100 percent in 2040 goals, currently chairing the Transportation Decarbonisation Alliance of countries, regions, cities and companies, and promoting the goals of the Zero Emission Vehicle Transition Council with membership spanning from Mexico to Canada and Europe to Asia. [41,42,43] As more jurisdictions pass ACT regulations and supporting policies, the ZE supply chains will grow, prices will continue to drop (benefitting consumers and fleets), new economic opportunities for electric vehicle supply equipment (EVSE) providers will continue to expand, and growing numbers of communities will benefit from air quality improvements.

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[37] *Multi-State Medium- and Heavy-Duty Zero Emission Vehicle Memorandum of Understanding.* (web link: https://www.energy.ca.gov/sites/default/files/2020-08/Multistate-Truck-ZEV-Governors-MOU-20200714_ADA.pdf, last accessed August 2022).

[38] Regional Electric Vehicle Midwest Coalition, *Memorandum of Understanding Between Illinois, Indiana, Michigan, Minnesota, and Wisconsin*. (web link: https://www.michigan.gov/-/media/Project/Websites/leo/REV_Midwest_MOU_master.pdf?rev=6dd781b5a4eb4551b3b3a5b875d67fb9#:~:text=THIS%20MEMORANDUM%20OF%20UNDERSTANDING%20(%E2%80%9CMOU,the%20%E2%80%9CParticipating%20States%E2%80%9D), last accessed August 2022).

[39] *Memorandum of Cooperation between the Government of Canada and the Government of the State of California of the United States of America concerning Climate Action and Nature Protection*. (web link: https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/reduce-emissions/memorandum-cooperation-canada-california-climate-action-nature-protection.html, last accessed August 2022).

[40] Transport Canada, *Zero-emission vehicles*, 2022, (web link: https://tc.canada.ca/en/road-transportation/innovative-technologies/zero-emission-vehicles, last accessed August 2022).

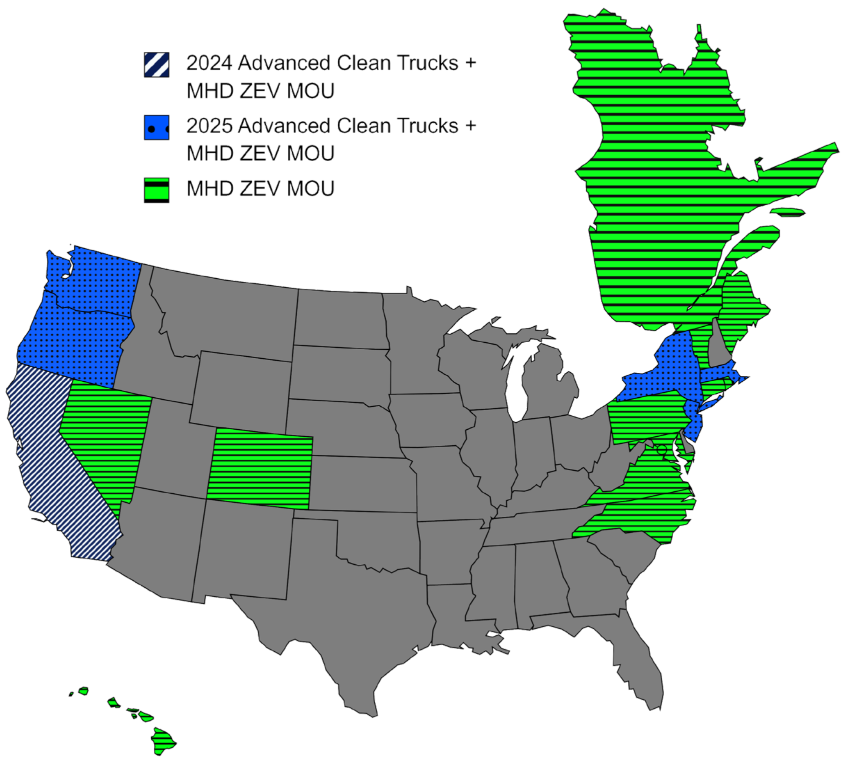
[41] Drive to Zero, *Pledge Partners*, 2022, (web link: *https://globaldrivetozero.org/about/pledge-partners/*, last accessed August 2022).

[42] Transportation Decarbonisation Alliance, *TDA Members*, 2022 (web link: https://tda-mobility.org/tda-members/, last accessed August 2022).

[43] ZEV Transition Council, 2022 (web link: *https://zevtc.org/the-council/members/*, last accessed August 2022).

According to CALSTART's Zero-Emission Technology Inventory analytics, it is estimated that there will be more than 590 ZE truck and bus models available internationally by the end of 2022.[44] This shows that the ZEV market is expanding rapidly internationally, and these same drivetrains or configurations could be brought to California and United States market. For a market growth example beyond just models available, the monthly 2021 sales in China for "New Energy" heavy trucks (battery, battery swap and fuel cell) rose smoothly from a couple hundred per month initially to over three thousand a month by year's end totaling over 10,000 and poised to follow the rapid bus electrification trajectory already seen there.[45] ACEA and the major truck manufacturers supplying the European market (many of which are also suppliers to North America) have committed to all truck sales being fossil-free by 2040, underscoring the widespread and long term commitment to bringing ZEVs to market.[46]

Figure 3: Map of North American Regions with Commitments to Medium- and Heavy-Duty ZEV Deployment



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[44] CALSTART, *Zero-emission Technology Inventory (ZETI) Analytics*, 2020 (web link: https://globaldrivetozero.org/tools/zeti-analytics/, last accessed August 2022).
[45] Bloomberg, *China's New Energy Heavy Trucks Will See More Growth in 2022*, 2022 (web link: https://www.bloomberg.com/news/articles/2022-02-01/china-s-new-energy-heavy-trucks-will-see-more-growth-in-2022 last accessed August 2022).
[46] ACEA, *All new trucks sold must be fossil free by 2040, agree truck makers and climate researchers*, 2020 (web link: https://www.acea.auto/press-release/all-new-trucks-sold-must-be-fossil-free-by-2040-agree-truck-makers-and-climate-researchers/, last accessed August 2022).
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A. Overview of Proposed ACF regulation

The proposed ACF regulation is part of CARB's portfolio of regulations already working to decarbonize the transportation sector. For the medium- and heavy-duty market, ZE focused regulations began with the Innovative Clean Transit (ICT) regulation adopted by CARB in 2018, which will transition the State's transit fleet to ZE by about 2040.[47] The Zero-Emission Airport Shuttle Bus (ASB) regulation and the Zero-Emission Powertrain Certification regulations were approved in 2019. [48,49] In January 2021, the ACT regulation was adopted by CARB and became effective under state law on March 15, 2021. It is a key part of the holistic approach to accelerate a large-scale ZEV transition of medium- and heavy-duty trucks. The ACT regulation requires manufacturers who certify Class 2b–8 chassis or complete vehicles with combustion engines to sell medium- and heavy-duty ZEVs as an increasing percentage of their annual California sales from 2024 to 2035. By 2035, ZEV sales would need to be 55 percent of Class 2b–3 truck sales, 75 percent of Class 4–8 straight truck sales, and 40 percent of truck tractor sales.

The proposed ACF regulation would continue CARB's efforts to decarbonize the transportation sector by requiring State and local government fleets, drayage trucks, high priority fleets, and federal fleets to phase in medium- and heavy-duty ZEVs over time. As a backstop, the proposed ACF regulation sets a clear end date for new combustion-powered Class 2b-8 vehicle sales in California. The following is a summary of the proposed ACF regulation:

- State and local government fleets: Phased-in requirement for newly added medium- and heavy-duty vehicles to be ZEVs starting with 50 percent in 2024 and 100 percent in 2027. Municipalities in designated low-population counties would be excluded until 2027.
- Drayage trucks: ZEV registration requirements for newly added drayage trucks starting in 2024, while allowing useful life for legacy trucks. All trucks conducting drayage operations must be ZEVs by 2035.
- High priority and federal fleets: Fleets may only add ZEVs to their California fleets and must remove vehicles at the end of a minimum useful life. Optionally, fleets may choose a phased-in schedule with increasing ZEV targets as a percentage of the total vehicle fleet. High priority fleets include entities with more than $50 million in annual revenues, or those fleets that own, operate, or direct at least 50 medium- and heavy-duty trucks and buses under common ownership and control.
  - Affected vehicles include on-road medium- and heavy-duty vehicles, light-duty package delivery vehicles with GVWR equal to or less than 8,500 lbs., and off-road yard tractors that operate in California.
- Vehicle sales: 100 percent of all new Class 2b-8 vehicles vehicle sales into California must be ZE starting in 2040.

[47] The ICT regulation is comprised of Cal. Code Regs., tit. 13, sections 2023 to 2023.11.

[48] The ASB regulation is comprised of Cal. Code Regs., tit. 17, sections 95690.1 to 95690.8.

[49] The Zero-Emission Powertrain regulation is comprised of Cal. Code Regs., tit. 13, section 1956.8. and tit. 17 section 95663.

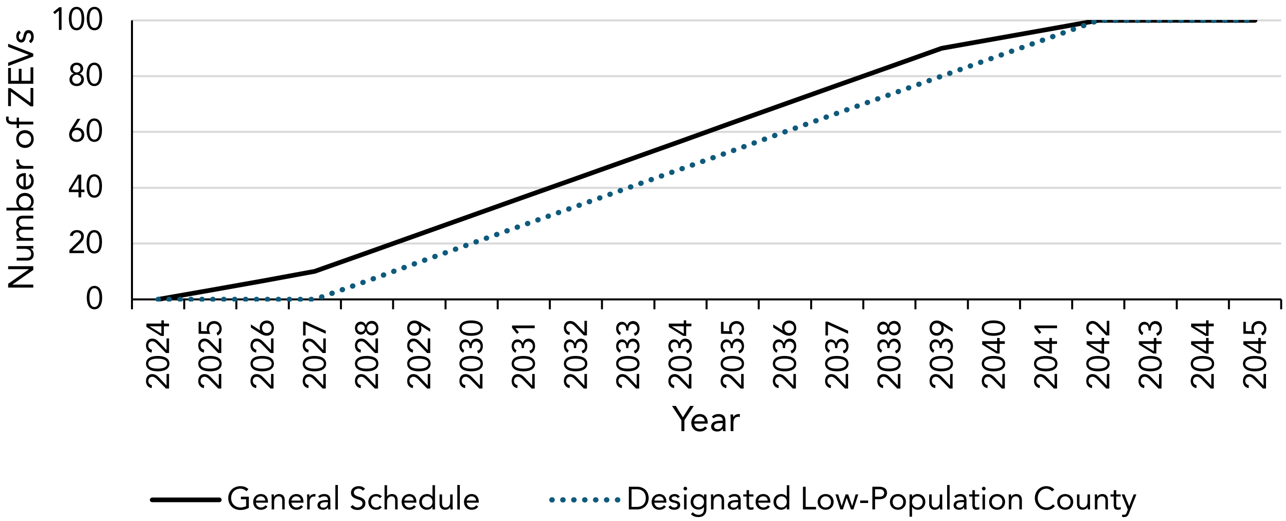
The proposed ACF regulation excludes certain vehicles with two-engines, military tactical vehicles, historical vehicles, heavy cranes, emergency vehicles, and dedicated snow removal vehicles. The proposed ACF regulation also does not apply to transit buses subject to the ICT regulation nor school buses. Staff has listened to stakeholder concerns and has designed several provisions for fleet owners who are complying with the regulation. The provisions have been designed for edge use cases that can serve as guardrails for fleets and are described in more detail in the following sections.

1. State and Local Government Fleet Requirements

State and local government agency fleet requirements were designed with the special needs and circumstances of these agencies in mind. The proposed requirements would apply to cities, counties, public utilities, special districts, local agencies and districts, and the State fleet, but excludes federal agencies. A ZEV purchase requirement at normal time of vehicle replacement was chosen as the appropriate framework to allow enough flexibility for budget fluctuations and cycles. State and local government agencies would not be required to retire trucks nor required to purchase additional vehicles to comply. However, when purchases are made, they would need to be ZEVs or NZEVs capable of ZE operation if a ZE version of a needed vehicle is not commercially available.

The proposed ACF regulation would require 50 percent of new vehicle additions to the fleet to be ZEV starting January 1, 2024, and 100 percent starting on January 1, 2027. Additional time would be provided to fleets based in designated low-population counties by exempting them from ZEV purchase requirements until 2027. Designated low-population counties include the counties of Alpine, Amador, Butte, Calaveras, Colusa, Del Norte, Glenn, Humboldt, Inyo, Lake, Lassen, Mariposa, Mendocino, Modoc, Mono, Nevada, Plumas, Shasta, Sierra, Siskiyou, Sutter, Tehama, Trinity, Tuolumne, and Yuba. Many of these areas have fewer air quality challenges than other parts of the state and the fleets based in these areas tend to have fewer vehicles, operate in remote areas that are expected to take longer for ZEV infrastructure and support networks to be developed, and tend to have more limited budgets. Figure 4 illustrates a compliance example showing the number of ZEVs in the fleet for two government fleets with 100 trucks each. One fleet meets the general requirements and would start adding ZEVs as 50 percent of their planned purchases starting in 2024. The other fleet represents one that is in a designated low population county and begins adding ZEVs in 2027. Both examples assume a business-as-usual 15-year replacement cycle. In this example, these fleets exceed 50 percent ZEVs in 2033 and 2035, respectively and complete the transition to all ZEVs in 2042.

Figure 4: 100 Truck Fleet Examples for State and Local Government Requirements



Annual reporting and recordkeeping would be required starting April 1, 2024. The proposed ACF regulation also includes exemptions and extensions to address certain situations as summarized below.

- Backup Vehicle Exemption. Allow fleet owners to purchase a new ICE vehicle and exclude it from the ZEV addition requirement if it operates less than 1,000 miles per year. Mileage accrued while operating in support of a declared emergency event would be excluded.
- Daily Usage Exemption. Fleet owners may receive a one-year exemption to purchase a new ICE vehicle if a comparable ZEV is available but cannot be placed anywhere in the California fleet while meeting the daily usage needs of any existing ICE vehicle.
- Infrastructure Construction Delay Extension. Excuses the fleet owner from taking immediate delivery of ordered ZEVs for one year due to a construction delay beyond the fleet owner's control.
- ZEV Unavailability Exemption. Allows fleet owners to purchase a new ICE vehicle if no ZEV nor NZEV of the needed configuration is commercially available. A list of vehicles that are not available as ZEVs or NZEVs will be kept on the CARB website.
- Mutual Aid Assistance. Allows a fleet owner to apply for an exemption to purchase ICE vehicles for up to 25 percent of the fleet if the vehicles are needed to provide emergency response services to fulfill the terms of a signed mutual aid agreement.

The exact regulatory language, and purpose and rationale for these provisions as they apply to State and local government fleets are provided in Appendix A-1 and Appendix H-1 of the Staff Report, respectively.

2. Drayage Truck Requirements

The proposed drayage truck requirements would apply to Class 7-8 drayage trucks operating at intermodal seaports and railyards. These drayage trucks would be required to transition to ZEVs by 2035. The proposed requirements include a phased-in approach for drayage trucks. All drayage trucks would be required to register in CARB's Online System, starting in late

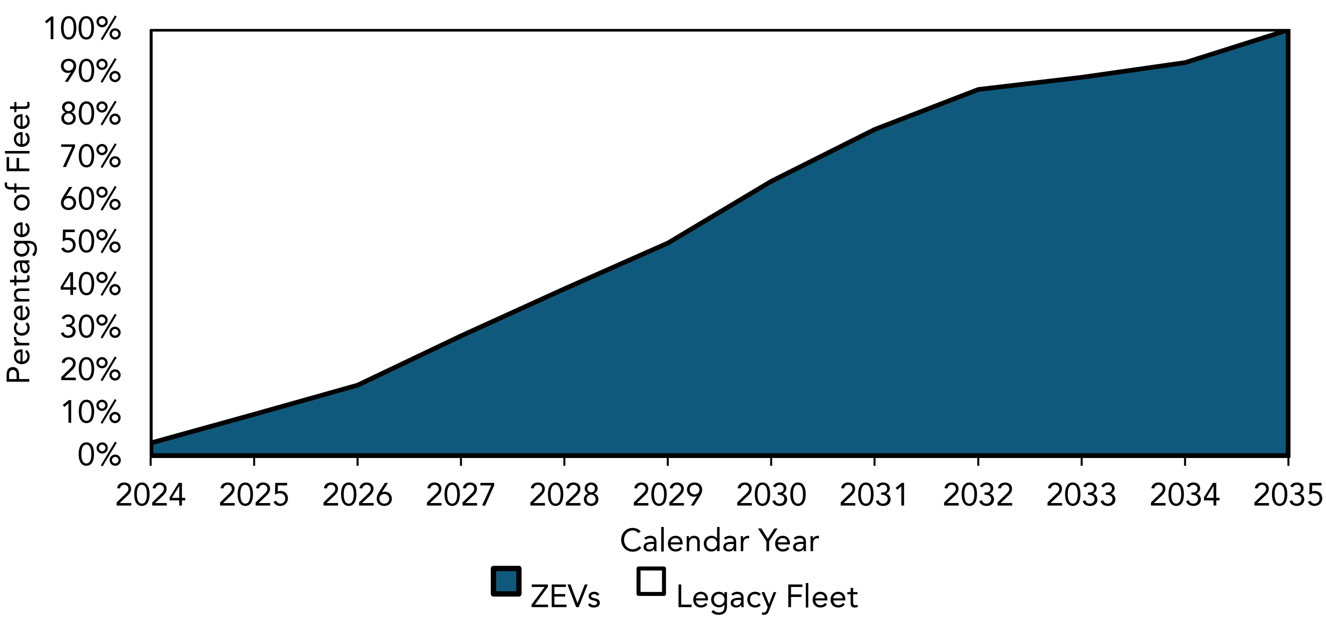
2023. Existing drayage trucks with ICEs, could remain in drayage service for a minimum period, defined as the later of the following two conditions:

- Thirteen (13) years from the MY that the engine and emissions control systems are first certified by CARB or the U.S. Environmental Protection Agency (U.S. EPA); or
- When the vehicle reaches 800,000 vehicle miles traveled (VMT) or 18 years from the MY that the engine and emissions control systems are first certified by CARB or the U.S. EPA, whichever is earlier.

Drayage trucks 12 years and older would be required to report their mileage annually. Beginning in 2024, any truck added to CARB's Online System must be a ZEV. All drayage trucks entering seaports and intermodal railyards must be ZEVs by 2035. To address infrastructure construction delays and vehicle delivery delays that are beyond the control of regulated entities, limited one-year compliance extensions provisions would be included. All drayage trucks must also visit a regulated seaport or intermodal railyard at least once each calendar year to remain in CARB's Online System. All regulated intermodal seaports and railyards would be required to report drayage truck visits annually. This approach builds on the structure of the existing drayage truck regulation and meets the goal of a complete transition of California's drayage fleet to ZE by 2035.

Figure 5 shows the projected portion of vehicles in the drayage fleet which will be zero-emission over time. ZEVs enter the drayage fleet beginning in 2024, reach 50 percent of the fleet in 2029, and reach 100 percent in 2035.

Figure 5: Drayage Fleet Over Time



Annual reporting and recordkeeping would be required before December 31, 2023. The proposed ACF regulation also includes exemptions and extensions to address certain situations as summarized below.

- Dedicated Use Vehicle Exemption. These include dedicated use or uni-body vehicles that do not have separate tractor and trailers or are vehicles using a power take off (PTO) with a hydraulic motor or blower, attached to the trailer that needs the PTO to load or unload. These vehicle types include but are not limited to (e.g., auto transport, fuel delivery vehicles, concrete mixers, on-road mobile cranes).
- Infrastructure Construction Delay Extension. Drayage truck owners may receive a one-year extension from the requirements and delay delivery of the ordered zero-emission vehicle(s) that would be reliant on the fueling infrastructure for one year.
- ZEV Vehicle Delivery Delay Extension. Drayage truck owners may exclude an existing legacy drayage truck from the requirements if the zero-emission vehicle is ordered one year in advance of the compliance date for the legacy drayage truck being replaced and the newly purchased zero-emission vehicle will not be delivered by the compliance deadline for reasons beyond the drayage truck owner's control.

The exact regulatory language, and purpose and rationale for these provisions as they apply to drayage fleets are provided in Appendix A-3 and Appendix H-3 of the Staff Report, respectively.

3. High Priority and Federal Fleet Requirements

High priority and federal fleets would be required to either add only ZEVs to their California fleets while retiring ICE vehicles at the end of minimum use life, or may opt to phase-in ZEVs as a percentage of the total fleet that operates in California. Affected California fleets would include all truck owners or controlling parties with an annual revenue greater than $50 million that operate at least 1 medium- or heavy-duty truck in California, or those who own, operate, or direct 50 or more medium- or heavy-duty trucks under common ownership and control and at least 1 of those trucks operates in California. The affected vehicles include all medium- and heavy-duty vehicles as well as any light-duty package delivery vehicles, as defined in the regulation. Controlling parties include the motor carrier, broker, or entity that directs or otherwise manages the day-to-day operation of multiple fleets under common ownership or control to serve the customers or clients of the controlling party. Controlling parties must include all vehicles in their fleet that are operated under common ownership or control in addition to their own vehicles that operate in California when determining compliance. In addition, all entities that hire and direct or hire and operate vehicles subject to portions of the proposed ACF regulation must verify that the fleets they hire comply with the regulations by looking them up on the CARB website to maintain consistency with other existing fleet rules which have similar requirements.

a) Model Year Schedule

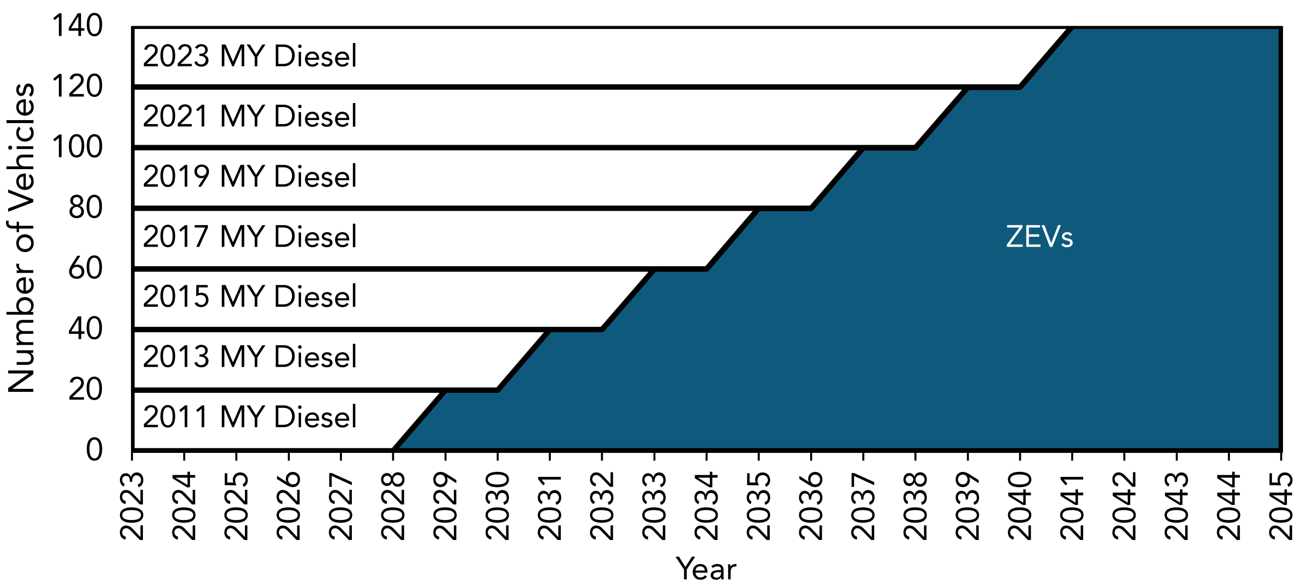
The proposed Model Year Schedule requires affected entities to add only ZEVs to their California fleets beginning in the 2024 calendar year and requires existing ICE vehicles to be removed from the California fleet at the end of their minimum useful life. Minimum useful life is defined as the latter date of two conditions:

- Thirteen (13) years commencing from the year the original engine and emissions control system in a vehicle was first certified for use by CARB or U.S. EPA; or

- The date that the vehicle exceeded 800,000 VMT or 18 years from the year the original engine and emissions control system of that vehicle was first certified for use by CARB or U.S. EPA, whichever is earlier.

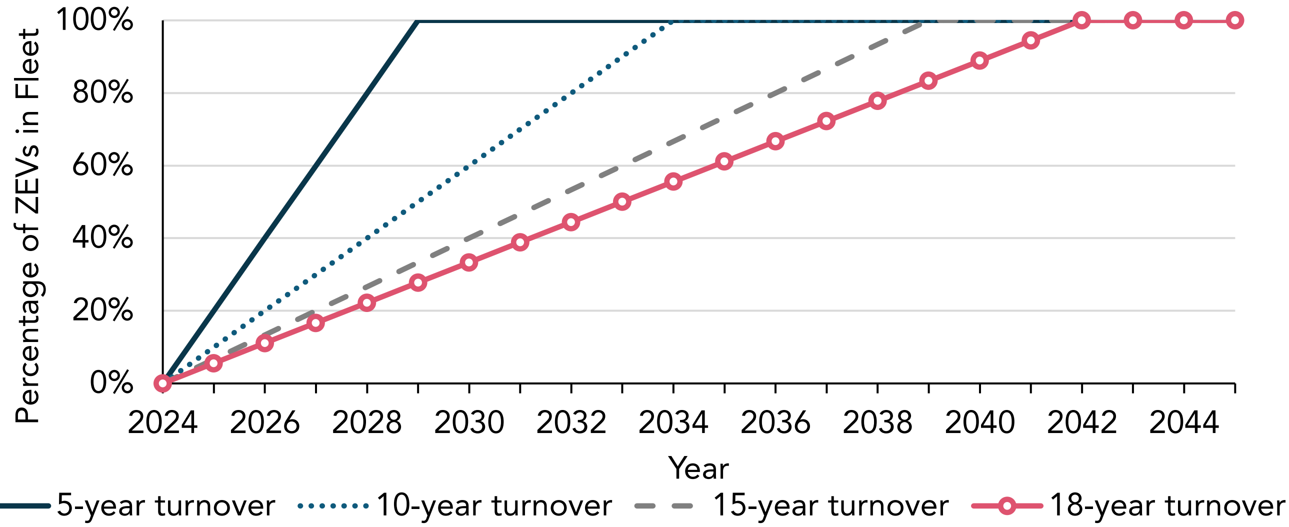
Vehicles that are 12 years and older would be required to report their mileage annually to determine when the vehicle is beyond its useful life. With this schedule, compliance is simply determined by the age and mileage of the existing ICE vehicles in the fleet. Figure 6 illustrates an example of a 140 vehicle fleet following the Model Year Schedule who purchases 20 new diesel vehicles every 2 years and keeps them for a full useful life of 18 years. The fleet would need to begin replacing their diesel-powered vehicles in 2029 when the first two vehicles become 18 years old and would make a full transition to ZEVs in 2041.

Figure 6: Model Year Schedule Fleet Example



However, fleet owners that replace their vehicles in shorter period would be required to add more ZEVs to their fleet at a faster rate with this schedule. Figure 7 illustrates how a fleet's replacement rate will affect how quickly they transition to ZEVs under the Model Year Schedule with their normal vehicle replacement cycle. The solid line shows that a fleet with a 5-year turnover cycle would need to be all ZEVs by 2029, a fleet with a 10-year turnover cycle would be all ZEVs by 2034, a fleet with a 15-year turnover cycle would be all ZEV by 2039, and a fleet with an 18-year turnover cycle would be all ZEVs by 2042.

Figure 7: Model Year Schedule Fleet Example Illustrating Impact of Turnover Rate



The proposed ACF regulation also includes exemptions and extensions for the Model Year Schedule to address certain situations as summarized below.

- Backup Vehicle Exemption. Allows a fleet owner to keep an existing ICE vehicle beyond its useful life if the vehicle is operated less than 1,000 miles per year. Mileage accrued while operating in support of a declared emergency event may be excluded.
- Daily Usage Exemption. A fleet owner may receive a one-year exemption to purchase a new ICE vehicle of a given configuration if a comparable ZEV is available but cannot be placed anywhere in the California fleet while meeting the daily usage needs of any existing ICE vehicle in the fleet.
- Infrastructure Construction Delay Extension. Allows a fleet owner to continue operating an existing vehicle up to one year beyond the end of its useful life and to delay delivery of the ordered ZEVs that would be reliant on the charging or hydrogen fueling infrastructure for one year due to construction delays beyond the control of the fleet owner.
- Vehicle Delivery Delay Extension. A fleet owner may continue operating an ICE vehicle beyond its useful life if a new ZEV is ordered to replace it one year in advance of its compliance date and the newly purchased ZEV is not be delivered by the compliance deadline for reasons beyond the fleet owner's control.
- ZEV Unavailability Exemption. Allows fleet owners to purchase a new ICE vehicle if no ZEV nor NZEV of the needed configuration is commercially available. A list of vehicles that are not available as ZEVs or NZEVs will be kept on the CARB website.
- Mutual Aid Assistance. Allows a fleet owner to apply for an exemption to purchase ICE vehicles for up to 25 percent of the fleet if the vehicles are needed to provide emergency response services to fulfill the terms of a signed mutual aid agreement.
- Declared Emergency Event Exemption. Allows any vehicle to be used to support an emergency event declared by the governor or other public official.

Beginning in 2024, affected fleets would need to report and keep records for eight years on certain information about the vehicles they operate or control in California. Reported vehicle information includes details necessary to enforce and track compliance with the proposed ACF regulation. The exact regulatory language, and purpose and rationale for these provisions as they apply to high priority and federal fleets are provided in Appendix A-2 and Appendix H-2 of the Staff Report, respectively.

b) ZEV Milestones Option

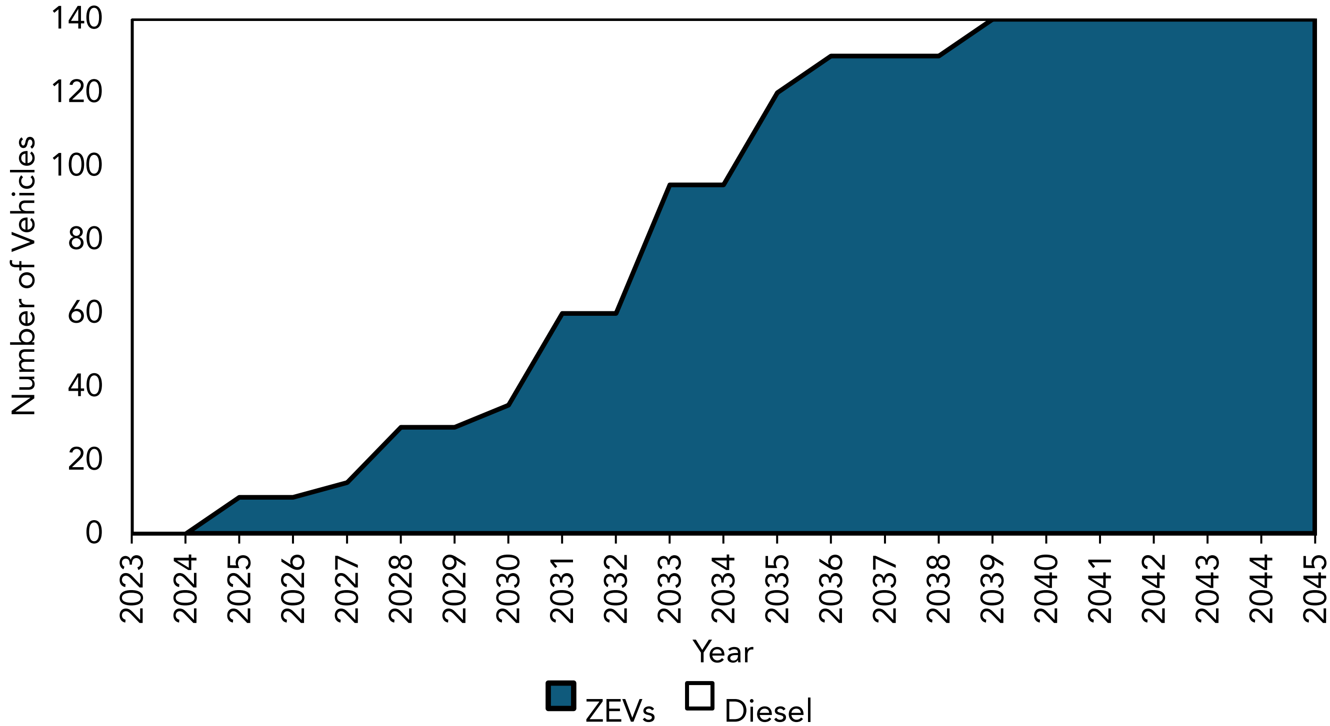
Under the optional ZEV Milestones Schedule, high priority and federal fleets must phase-in ZEVs as a percentage of their total California fleet starting at 10 percent and increasing to 100 percent based on vehicle body type as shown in Table 6. Vehicles in Group 1 are commonly used for local and regional delivery or passenger transportation and are already suitable for electrification. With this proposed schedule, all covered delivery vans and box trucks that operate in urban areas and frequent warehouses and distribution centers would be ZEVs by 2035, except for the expected small percentage of vehicles using exemptions. Vehicles in Group 2 and Group 3 are given more time because they are expected to have higher daily mileage needs, have more varied use cases and fewer of these ZEV models are available today.

Table 6: High Priority and Federal Fleet Zero-Emission Vehicle Phase-In Schedule

Group	Percentage of Fleet that Must be ZEV	10%	25%	50%	75%	100%
1	Box trucks, vans, two-axle buses, yard trucks, light-duty delivery vehicles	2025	2028	2031	2033	2035
2	Work trucks, day cab tractors, three-axle buses	2027	2030	2033	2036	2039
3	Sleeper cab tractors and specialty vehicles	2030	2033	2036	2039	2042

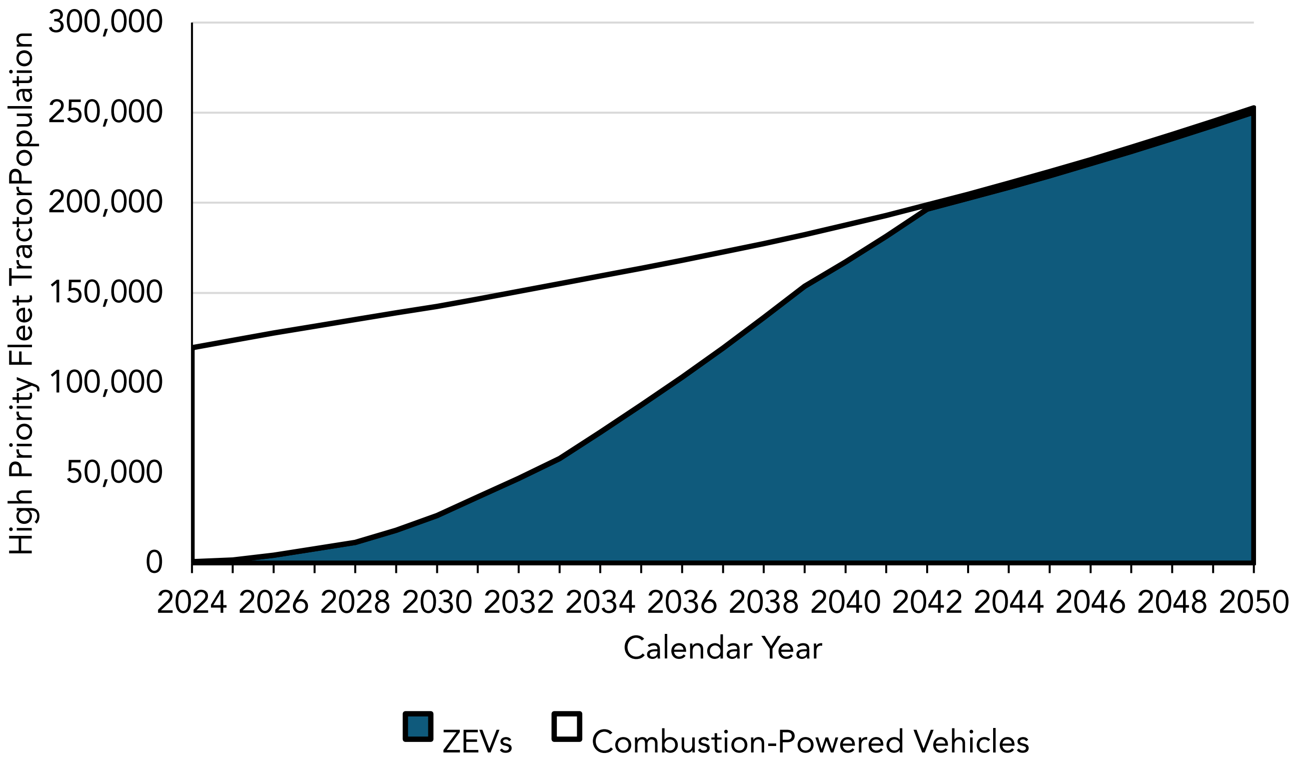
Fleet owners would have the flexibility to meet the ZEV milestones with any medium- or heavy-duty ZEVs in their fleet regardless of body type. For example, a mixed fleet with 100 box trucks and 40-day cab tractors would need 10 ZEVs to comply in 2025. The number of ZEVs required to meet the 2025 target is calculated as 10 percent of the 100 box trucks in this example. The tractors are not counted in 2025 because there is no ZEV target for day cab tractors in that year. However, fleet owners would have the flexibility to meet the 10 ZEV requirement with any combination of medium- and heavy-duty vehicles in the fleet. This means the fleet owner could meet the 2025 requirement with 10 ZEV tractors, 10 box trucks, or any combination that totals 10 ZEVs. Figure 8 illustrates the number of ZEVs this example fleet must have within their fleet to meet the ZEV Milestones Option.

Figure 8: ZEV Milestones Option Fleet Example with 100 Group 1 Vehicles and 40 Group 2 Vehicles



On these timelines, the majority of tractors that go to warehouses and transport products throughout the state would be ZEVs by 2035 and completely transition by 2042 as shown in Figure 9. This would result in direct health benefits to communities most impacted by warehouses, distribution centers, and high traffic corridors.

Figure 9: Tractor Population Over Time for High Priority and Federal Fleets



The proposed ACF regulation also includes exemptions and extensions for the ZEV Milestones Option to address certain situations as summarized below.

- Backup Vehicle Exemption. Allows fleet owners to exclude a vehicle from the ZEV milestone calculation if it operates less than 1,000 miles per year excluding any mileage accrued while operating in support of a declared emergency event.
- Daily Usage Exemption. Fleet owners may receive a one-year exemption to purchase a new ICE vehicle and exclude it from the ZEV milestone calculation if a new ZEV is available but cannot be placed anywhere in the California fleet while meeting the daily usage needs of any existing vehicle in the fleet.
- Infrastructure Construction Delay Extension. This extension applies to construction delays for ZE infrastructure that are beyond the fleet owners' control that were started at least one year ahead of the next ZEV compliance deadline. It allows the fleet owner to delay delivery of ordered ZEVs and count the existing ICE vehicle to be replaced as a ZEV when determining compliance with the ZEV milestone calculation until the ZEV is delivered.
- Vehicle Delivery Delay Extension. Fleet owners may count a vehicle to be replaced as a ZEV when determining compliance with the ZEV milestone calculation if a new ZEV is ordered one year in advance of the compliance date for the ICE vehicle being replaced and the newly purchased ZEV is not delivered by the compliance deadline for reasons beyond the fleet owner's control.
- ZEV Unavailability Exemption. Allows a fleet owner to purchase a new ICE vehicle and exclude it from the ZEV milestone calculation if all the remaining ICE vehicles in the fleet (that are not already using an exemption or extension) cannot be replaced with a ZEV or NZEV of the needed configuration because they are not available to purchase.

Additionally, if the remaining ICE vehicles in the fleet cannot be replaced with a ZEV or NZEV of the needed configuration because they are not available to purchase, those ICE vehicles may be excluded from the ZEV milestone calculation.

- Exemptions Pursuant to Declared Emergency Events. Fleet owners may purchase a new ICE vehicle and exclude it from the ZEV milestone calculation for up to 25 percent of the fleet if the vehicles are needed to provide emergency response services.
- Rental Vehicle Provision. Provides interstate rental fleet owners the options to report the average number of rental vehicles that are operated in California in lieu of counting all rental vehicles that operate in California when using the ZEV Milestones Option.

Beginning in 2024, affected fleets would need to report and keep records on certain information about the vehicles they operate or control in California. Reported vehicle information includes details necessary to enforce and track compliance with the proposed ACF regulation. The exact regulatory language, and purpose and rationale for these provisions as they apply to high priority and federal fleets are provided in Appendix A-2 and Appendix H-2 of the Staff Report, respectively. Annual reporting and recordkeeping would be required starting January 1, 2024.

c) Selecting the Appropriate Compliance Method

Both compliance options offer potential benefits for a given fleet situation. The Model Year Schedule ensures fleets can use their vehicles for their full useful life, is simple to understand, but it treats all existing vehicles the same based on age and mileage. This compliance method may present challenges for fleets, with high turnover rates (such as long-haul fleets), fleets with most vehicles already beyond their useful life, and would limit the ability of controlling parties to manage their fleet. With the Model Year Schedule, a control party cannot add or switch to another subhauler as part of their California fleet starting 2024 unless all of the vehicles in the newly added subhauler's fleet are ZEVs. The Model Year Schedule allows for a gradual transition to ZEV based on a percentage of the total California fleet regardless of vehicle age and mileage. The schedule more closely aligns projected ZEV feasibility and infrastructure buildout with the compliance requirements. The ZEV Milestones Option provides more flexibility for controlling parties to add and remove vehicles from the California fleet provided the fleet average continues to be met.

Figure 10 and Figure 11 illustrate two examples comparing the Model Year Schedule and optional ZEV Milestones Option. For a fleet with only Group 1 vehicles, they are able to keep their existing vehicles longer by using Model Year Schedule if they intend to keep all of their vehicles for the full useful life. For a mixed fleet with Group 1, Group 2, and Group 3 vehicles, the ZEV Milestones Option generally allows the fleet more time to transition to ZEVs while maintaining their normal vehicle purchase cycles because Group 2 and Group 3 vehicles have a delayed transition period.

Figure 10: Comparison Between Model Year Schedule and ZEV Milestones Option for a Fleet with 100 Group 1 Vehicles

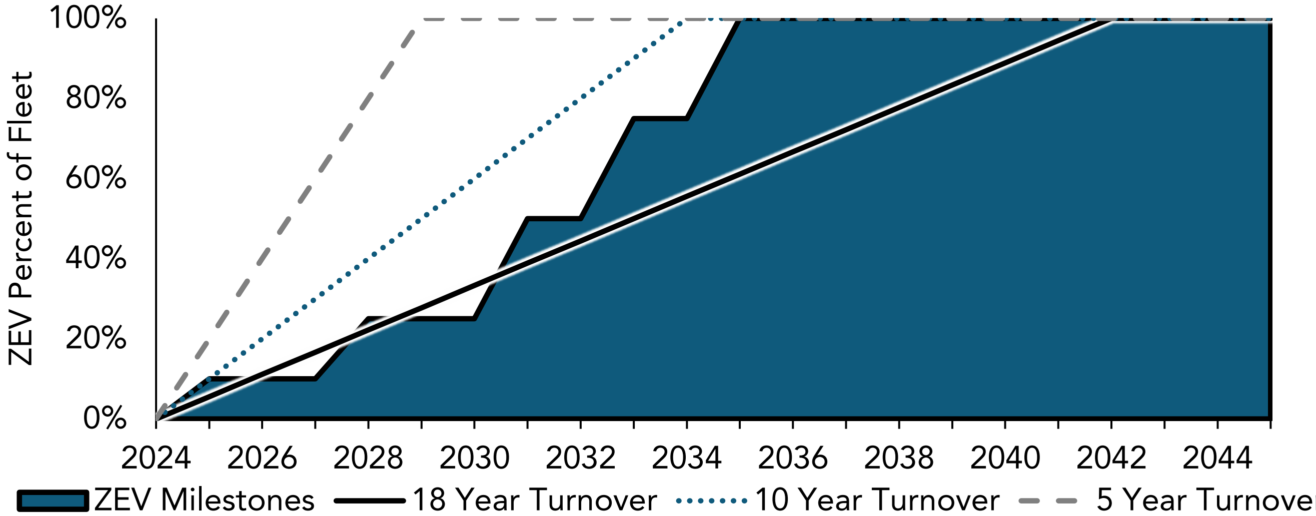
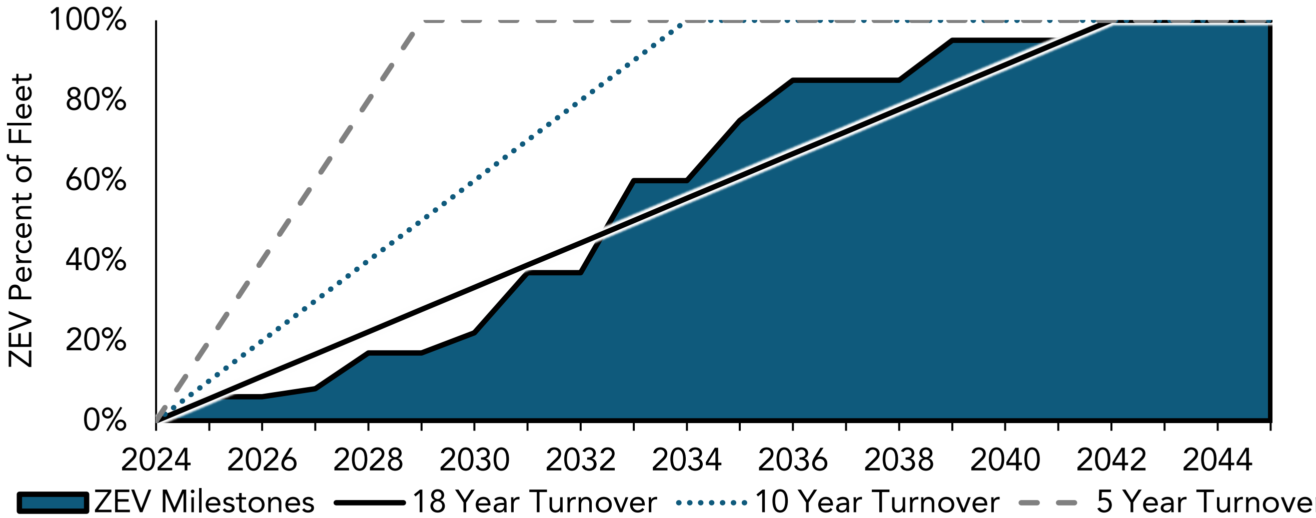


Figure 11: Comparison Between Model Year Schedule and ZEV Milestones Option for a Fleet with 60 Group 1, 20 Group 2, and 20 Group 3 Vehicles



d) Light-Duty Package Delivery Vehicles

The population of package delivery vehicles is expected to grow rapidly with expanding e-commerce deliveries. The inclusion of light-duty delivery vehicles in the high priority and federal fleets requirements is necessary to ensure emissions reductions in this last mile delivery operations. In general, package and mail delivery fleets are well-suited for electrification because they primarily return to base daily, they operate on fixed or predictable routes in cities and neighborhoods, and have frequent stops. Several major delivery companies have begun the process of incorporating ZE light-duty package delivery vehicles into their fleets with 100,000 ordered by Amazon, 10,000 ordered by UPS, 4,500 ordered by Walmart, 500 ordered by FedEx, and over 10,000 ordered by the U.S Postal

Service for placement throughout the United States.[50,51,52,53,54] These strides towards electrification demonstrate clear operational and technological feasibility for integration into fleet applications. The proposed ACF regulation includes flexibility for fleets to make an orderly transition to ZEVs by selecting the compliance method and includes provisions to ensure feasibility of deploying ZEVs where they are suited.

4. 100 Percent Manufacturer Sales Requirement

Finally, the proposed ACF regulation would include a new requirement on all vehicle manufacturers that 100 percent of all new Class 2b-8 vehicle sales in California must be ZEV starting in 2040. The requirement would not apply to emergency vehicles. The exact regulatory language, and purpose and rationale for these requirements are provided in Appendix A-4 and Appendix H-4 of the Staff Report, respectively.

B. Crossover with Other Requirements

CARB is responsible for protecting the public from the harmful effects of air pollution and developing programs and actions to fight climate change. Meeting these public health goals has resulted in a suite of regulations to control the harmful emissions of various air pollutants emitted from the operation of medium- and heavy-duty ICE vehicles. The following is a summary of existing regulations and key requirements that apply to fleets that would be affected by the proposed ACF regulation including existing laws.

1. Public Agencies and Utilities Regulation

In 2005, the rule for On-Road Heavy-Duty Diesel-Fueled Public and Utility Fleets was approved by CARB to reduce diesel PM emissions from fleet vehicles operated by public agencies and utilities.[55] The rule required affected owners to equip their heavy-duty vehicles with Best Available Control Technology (BACT) by December 31, 2012, with later

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[50] Amazon, *Amazon's custom electric delivery vehicles are starting to hit the road*, February 3, 2021 (web link: https://www.aboutamazon.com/news/transportation/amazons-custom-electric-delivery-vehicles-are-starting-to-hit-the-road, last accessed August 2022).

[51] United Parcel Service, *UPS invests in Arrival, accelerates fleet electrification with a commitment to purchase up to 10,000 electric vehicles*, January 29, 2020 (web link: https://about.ups.com/ca/en/newsroom/press-releases/sustainable-services/ups-invests-in-arrival-accelerates-fleet-electrification-with-order-of-10-000-electric-delivery-vehicles.html, last accessed August 2022).

[52] Walmart, *Walmart To Purchase 4,500 Canoo Electric Delivery Vehicles To Be Used for Last Mile Deliveries in Support of Its Growing eCommerce Business*, July 12, 2022 (web link: https://corporate.walmart.com/newsroom/2022/07/12/walmart-to-purchase-4-500-canoo-electric-delivery-vehicles-to-be-used-for-last-mile-deliveries-in-support-of-its-growing-ecommerce-business, last accessed August 2022).

[53] FedEx, *Charging Ahead: FedEx Receives First All-Electric, Zero-Tailpipe Emissions Delivery Vehicles from BrightDrop*, December 17, 2021, (web link: https://newsroom.fedex.com/newsroom/brightdropev600/, last accessed August 2022).

[54] United States Postal Service, *USPS Places Order for 50,000 Next Generation Delivery Vehicles; 10,019 To Be Electric, March 24, 2022* (web link: https://about.usps.com/newsroom/national-releases/2022/0324-usps-places-order-for-next-gen-delivery-vehicles-to-be-electric.htm, last accessed August 2022).

[55] The On-Road Heavy-Duty Diesel-Fueled Public and Utility Fleet regulation is comprised of Cal. Code Regs., tit. 13, sections 2022 and 2022.1.

requirements for designated low-population counties. Many of the same parties would be included in the proposed ACF regulation.

2. Drayage Truck Regulation

In 2007, the Drayage Truck regulation was adopted as part of CARB's efforts to reduce PM and NOx emissions from diesel-fueled engines, improve air quality associated with freight movement, and reduce near-source health risk from facilities where drayage trucks congregate.[56] Drayage trucks are on-road, heavy-duty trucks that transport containerized bulk or break-bulk goods, empty containers, and chassis to and from seaports and intermodal railyards. The Drayage Truck regulation will sunset at the end of 2022. At that time, the drayage fleet will be incorporated into the Truck and Bus regulation and must meet or exceed 2010 or newer engine emissions standards like all other diesel trucks. Drayage trucks would be included in the proposed ACF regulation.

3. Truck and Bus Regulation

In 2008, the Truck and Bus regulation was adopted by CARB as the final prong of the Diesel Risk Reduction Plan to reduce emissions of PM and NOx from heavy-duty trucks and buses over 14,000 lbs. GVWR.[57] The Truck and Bus regulation affects all vehicles travelling in California that are owned or operated by businesses, individuals, or federal entities. It requires retrofit, replacement, or repowering of older diesel vehicles, eventually ensuring that all affected vehicles meet or exceed 2010 or newer MY engine emissions by January 1, 2023. Federal fleets and a subset of fleets affected by the Truck and Bus regulation would be included in the proposed ACF regulation. Staff estimate that 36,900 California registered trucks and up to 192,000 trucks registered in other states will need to be upgraded to 2010 or newer MY engines by the end of 2023.[58]

4. Innovative Clean Transit Regulation

In December 2018, the ICT regulation was adopted by CARB which was the first medium- and heavy-duty ZEV fleet rule of its kind and it replaced the existing fleet rule for transit agencies. The ICT regulation requires all public transit agencies to gradually transition to a 100 percent zero-emission bus (ZEB) fleet where most will be ZE by 2040. The ICT regulation includes various exemptions and compliance options to provide safeguards and flexibility for transit agencies through the transition. The proposed ACF regulation would include some of the same public agencies that are subject to the ICT regulation if they also operate vehicles that are not transit buses such as a city that provides road maintenance or waste hauling services. The proposed ACF regulation builds upon the structure of the ICT purchase requirements for State and local government fleets.

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[56] The Drayage Truck regulation is comprised of Cal. Code Regs., tit. 13, section 2027.

[57] The Truck and Bus regulation is comprised of Cal. Code Regs., tit. 13, section 2025.

[58] California Air Resources Board, *Truck and Bus Regulation Final Compliance Deadline*, 2022 (web link: https://ww2.arb.ca.gov/sites/default/files/2022-06/tbcompliancedeadline_ADA.pdf, last accessed August 2022).

5. Zero-Emission Airport Shuttle Bus Regulation

In June 2019, the ASB regulation was adopted by CARB. It promotes the development and use of ZE technologies in medium- and heavy-duty airport shuttles that operate on fixed routes at 13 California airports.[59] The ASB regulation requires airport shuttle operators to transition their vehicles to ZEVs beginning in 2027, with a complete transition by the end of 2035. The ASB regulation provides compliance extensions and other flexibilities to ensure service continuity as operators transition to ZE shuttles. The proposed ACF regulation could include some fleet operators that are also subject to the ASB regulation.

6. California and Federal Phase 2 Greenhouse Gas Regulation

CARB staff worked jointly with U.S. EPA and National Highway Traffic Safety Administration staff on the next phase of federal GHG emissions standards and fuel efficiency standards, respectively, for medium- and heavy-duty engines and vehicles. The federal Phase 2 GHG emissions standards build on the Phase 1 GHG emissions standards and represent significant further GHG reductions for 2018 (2021 in California) and later MY heavy-duty vehicles.[60] The Phase 2 GHG emissions standards are structured to provide a range of options to manufacturers to reduce emissions for medium- and heavy-duty vehicles using a wide range of technologies, including aerodynamics, more efficient engines, and others. Additionally, the Phase 2 GHG emissions standards provide an opportunity to average, bank, and trade credits, as well as recognize advanced technologies that would apply to plug-in hybrid electric vehicles (PHEV), all-electric vehicles, and FCEVs. In 2018, CARB adopted the California Phase 2 program, which generally aligns with the federal Phase 2 GHG standards with minor changes.[61] The existing California Phase 2 GHG regulation provides an incentive to build lower emitting GHG vehicles, but these regulations have no specific requirement for medium- and heavy-duty manufacturers to build ZEVs. There are some synergies in costs and emissions benefits between California Phase 2 GHG and the proposed ACF regulation, because ZEVs could be used to comply with both regulations. The California Phase 2 GHG regulation also includes a temporary credit multiplier for ZEVs through 2027.

7. Advanced Clean Trucks Regulation

In January 2021, the ACT regulation was adopted as part of a holistic approach to accelerate a large-scale ZEV transition of medium- and heavy-duty vehicles.[62] Like the proposed ACF regulation, the goal of the ACT regulation is to achieve NOx and GHG emissions reductions through advanced clean technology, and to increase the penetration of the first wave of ZE heavy-duty technology into applications that are well suited to its use. The ACT regulation has two components consisting of a manufacturer sales requirement and a one-time large entity reporting (LER) requirement for fleet owners.

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[59] The ASB regulation is comprised of Cal. Code Regs., tit. 17, sections 95690.1 to 95690.8.

[60] The federal Phase 2 GHG regulations are comprised of Title 40, Code of Federal Regulations, Parts 85, 86, 600, 1033, 1036, 1037, 1039, 1065, 1066, and 1068) (81 Federal Register 73478 (October 25, 2016).

[61] The California Phase 2 GHG regulation is comprised of Cal. Code Regs., tit. 13, sections 1956.8, 1961.2, 1965, 2036, 2037, 2065, 2112, and 2141, and tit. 17, sections 95300 to 95311, 95662 and 95663.

[62]The ACT regulation is comprised of California Code of Regulations (Cal. Code Regs.) title 13, sections 1963, 1963.1, 1963.2, 1963.3, 1963.4, 1963.5, 2012, 2012.1, and 2012.2.

The manufacturer sales requirement applies to manufacturers that certify incomplete chassis or complete vehicles greater than 8,500 lbs. GVWR (i.e., Class 2b-8). Manufacturers are required to sell ZEVs as a percentage of their annual total sales. By 2035, required ZEV sales percentages will be as follows: 55 percent of Class 2b–3 truck sales, 75 percent of Class 4–8 truck sales, and 40 percent of tractor sales. Compliance is based on a credit and deficit system and provides some flexibility for manufacturers to sell more ZEVs in one weight category and fewer in another; credits may also be banked and traded. Small manufacturers with fewer than 500 annual sales in California are exempt but may opt-in to the regulation and report to claim ZEV credits.

Beginning in 2021, manufacturer sales reporting commenced to demonstrate compliance, earn credits, and to report details about credit trade transactions. ACT reporting applied to any vehicle manufacturer that produced and delivered for sale more than 500 on-road vehicles with a GVWR over 8,500 lbs. into California or into any state that adopted the ACT regulation. Manufacturers that produce vehicles below the 500-vehicle threshold have the option to voluntarily report to generate ZEV credits and NZEV credits.

The other component of the ACT regulation is the one-time LER requirement. Large entities (fleet owners, businesses, government agencies, municipalities, brokers, etc.) had to report information about their vehicles if, in 2019, they operated a facility in California and met any of the following criteria:

- Had more than $50 million in revenues in the 2019 tax year from all related subsidiaries, subdivisions, or branches, and have at least 1 vehicle that operated in California;
- Owned 50 or more vehicles that operated in California in 2019;
- Dispatched 50 or more vehicles into or throughout California in 2019; or
- Government agencies (federal, State, local, and municipalities) with at least 1 vehicle in California in 2019.

LER reporting was completed in 2021 and results of the data collected are posted on the *LER webpage*. Information collected through the survey was used to assist CARB in developing policies and recommendations, such as the proposed ACF regulation, to accelerate the transition to ZE medium- and heavy-duty vehicle fleets. The proposed ACF regulation seeks to align its requirements as closely as possible with the ACT regulation.

8. Heavy-Duty Omnibus Regulation

In September 2021, the Heavy-Duty Omnibus regulation was adopted by CARB which requires manufacturers to comply with more stringent exhaust emissions standards, test procedures, and other emissions control requirements for 2024 MY and newer California certified heavy-duty engines.[63] The combined requirements will reduce real world in-use emissions, and key elements of the regulation include:

[63]The Omnibus regulation is comprised of Cal. Code Regs., title 13, sections 1900, 1956.8, 1961.2, 1965, 1968.2, 1971.1, 1971.5, 2035, 2036, 2111 through 2119, 2121, 2123, 2125 through 2131, 2133, 2137, 2139, 2139.5, 2140 through 2149, 2166, 2166.1, 2167 through 2170, 2423, and 2485; and Cal. Code Regs., tit. 17 sections 95662 and 95663.

- Lowering NOx and PM emissions standards on existing regulatory cycles as well as a new NOx standard on a new low-load certification cycle, such that NOx standards are about 75 percent below current standards beginning in 2024 and 90 percent below current standards in 2027;
- Revamping the heavy-duty in-use testing program;
- Improving warranty, useful life, and emissions warranty information and reporting requirements;
- Strengthening the heavy-duty durability demonstration program;
- Improving the emissions averaging, banking, and trading program; and
- Creating powertrain certification test procedures for heavy-duty hybrid vehicles.

The Heavy-Duty Omnibus regulation provides emissions credits to manufacturers that certify the cleaner engines to a specific set of emissions standards. In addition, the Heavy-Duty Omnibus regulation provides an allowance for heavy-duty ZEVs to generate temporary NOx credits (2022 MY to 2026 MY) in order to incentivize the development, production, and sales of heavy-duty ZEVs in the California market. New diesel, compressed natural gas (CNG), and other engines sold in California will need to meet the compliance requirements of the Heavy-Duty Omnibus regulation and manufacturers may average, bank, and trade emissions credits for the pool of engines sold each MY. Fleets to be included in the proposed ACF regulation would be the same that purchase combustion vehicles impacted by the Heavy-Duty Omnibus regulation.

9. Transport Refrigeration Unit Regulation

In February 2022, CARB approved amendments to achieve additional health risk and emissions reductions in the regulation titled Airborne Toxic Control Measure for In-Use Diesel-Fueled Transport Refrigeration Units (TRU), TRU Generator Sets, and Facilities Where TRUs Operate.[64] The amendments include the transition of diesel-powered truck TRUs to ZE, a PM emission standard for newly manufactured non-truck TRU engines, the use of lower global warming potential refrigerants, facility registration and reporting, expanded TRU reporting and labeling, and fees. Some fleets affected by the TRU regulation would also be affected by the proposed ACF regulation.

10. Advanced Clean Cars Regulation

The Advanced Clean Cars (ACC) I regulation combines the control of smog-causing criteria pollutants and GHG emissions into a single coordinated package of light-duty vehicle regulations: the Low-Emission Vehicle regulation for criteria and GHG emissions and a technology forcing regulation for ZEVs that contributes to both types of emissions reductions.[65] The ACC I regulations were adopted in 2012 to address MY 2015-2025. The draft proposed ACC II regulations would increase ZEV sales requirements for MYs 2026-

[64] The TRU regulation is comprised of Cal. Code Regs., tit.13, sections 2477 through 2477.24.

[65] The ACC1 regulation is comprised of Cal. Code Regs. tit. 13, sections 1900, 1956.8, 1960.1, 1961, 1961.4, 1962.1 through 1962.8, 1965, 1968.2, 1968.5, 1969, 1976, 1978, 2037, 2038, 2062, 2112, 2139, 2140, 2145, 2147, 2235, and 2317.

2035. [66] ZE light-duty delivery vehicles that are required to be purchased by high priority fleets earn credit under the ACC I regulation as well as the upcoming ACC II regulation. The ACT regulation is similar to the ACC manufacturer sales requirements but for medium- and heavy- duty ZEV. The scope of the high priority and federal fleet requirements of the proposed ACF regulation would include light-duty delivery vehicles, that are subject to the ZEV sales requirements of the ACC II regulations (rather than ACT) because of their weight class. These requirements ensure manufacturers sell ZE light-duty delivery vehicles and fleets purchase them.

11. Zero-Emission Vehicle Purchases Required by Assembly Bill 739

In October 2017, California's Governor signed AB 739, which requires heavy-duty ZEV purchases by State agencies.[67] Beginning in 2025, at least 15 percent of new vehicle purchases with a GVWR of more than 19,000 lbs. must be ZEVs and at least 30 percent of such purchases must be ZEVs beginning in 2030. These same agencies would be affected by the proposed ACF regulation, and ZEVs purchased could be used to comply with both the proposed requirements and AB 739 requirements. The sales to comply with the legislation are already reflected in the BAU Baseline.

12. Heavy-Duty Inspection and Maintenance Regulation

The Heavy-Duty Inspection and Maintenance (HD I/M) regulation was approved by the Board in December 2021 to control emissions more effectively from non-gasoline on-road heavy-duty vehicles with a GVWR greater than 14,000 lbs. operating in California.[68] The regulation requires affected heavy-duty vehicles to perform periodic emissions testing twice a year to show compliance at specified intervals to ensure that the emissions control systems maintain the same efficiency as the vehicle ages. Not yet finalized, the regulation's requirements would be implemented in 3 phases with initial compliance certificate requirements beginning in 2023 and periodic testing requirements beginning in January 2024. Fleets to be included in the proposed ACF regulation would be the same that deploy vehicles subject to the HD I/M regulation.

C. Crossover with Funding Programs

CARB's incentive and regulatory programs work together to accelerate the market for ZEVs. California's Climate Change Scoping Plan and SIP Strategy, the State's blueprints for meeting climate change goals and the health-based NAAQS, call for emissions reductions from both regulations and incentives and recognize the importance of each. Financial incentives primarily support early commercialization and market development prior to regulatory requirements. Incentives help to drive early adopter purchase decisions by reducing

[66] The rulemaking action for the proposed ACC II regulation is not yet complete. The proposed ACC II regulation would be comprised of Cal. Code Regs., tit. 13, sections 1900, 1961.2 through 1961.8, 1962.2, 1962.3, 1965, 1968.2, 1969, 1976, 1978, 2037, 2038, 2112, 2139, 2140, 2147, 2317, and 2903.

[67] AB 739 (Chau, Stats. 2017, ch. 639); Public Resources Code section 25722.11.

[68] The rulemaking action for the HD I/M regulation has not yet been completed; the proposed HD I/M regulation is comprised of Cal. Code Regs., tit. 13, sections 2193, 2195, 2195.6, 2196 through 2196.8, 2197 through 2197.3, and 2198 through 2199.1.

incremental costs and supporting vehicle cost reductions over time by building manufacturer economies of scale. Incentives for vehicles and infrastructure are critical, particularly in the early market development years and to help smaller fleets and owner-operators. As regulatory requirements approach, the incentive strategy shifts toward a focus on financial assistance for smaller fleets, often in DACs, that are challenged to qualify for traditional financing programs. For some incentive programs where the primary objective is achieving surplus emissions benefits, limited incentives are available while regulations are in effect unless the upgrade or purchase is beyond the minimum requirements of the regulations. California continues to dedicate increasing levels of financial resources to reduce criteria and climate pollutant emissions from the transportation sector. The State allocates billions of dollars annually to a multitude of programs with different, but complementary goals. CARB's incentives portfolio places an emphasis on technology advancement, deployment of ZE heavy-duty vehicles, and turning over the legacy fleet. These efforts to incentivize new technologies complement CARB's regulatory efforts that ensure these technologies are deployed in strategic and impactful ways that support the State's climate and low carbon transportation goals.

Incentives play a critical role supporting the State's climate change, air quality, ZE deployment, and petroleum reduction goals. They accelerate the transition of fleets to ZE as well as support equitable, community-driven clean transportation and multi-sector approaches. Incentives promote economic growth, job training, and apprenticeship opportunities and continue to build on the successes of previous investments.

CARB's incentive and investment programs work together. There is a natural progression of support for technologies starting in the precommercial demonstration phase all the way through to financing assistance for small businesses who are unable to qualify for conventional financing for cleaner trucks. As technologies become more established and demand continues to grow, CARB is beginning to shift from broad purchase incentives to more targeted strategies that support lower-income consumers and small fleets. CARB anticipates this shift will continue to accelerate in the coming years, helping to create an equitable transition to a clean transportation future. To date, 56 percent of CARB's Low Carbon Transportation funding has supported projects benefiting priority populations. For some heavy-duty solicitations, all of the projects benefit priority populations. Projects include pilots of large-scale deployments of ZE drayage trucks, deployments of ZE transit and school buses in urban and rural settings, and projects to support ZE technologies at freight facilities.

1. CARB's Zero-Emission Truck Incentives

CARB administers a portfolio of funding that improves air quality, enhances community protection, and reduces GHG emissions. Each of these programs have their own distinct goals that support the State's broader strategy and vison of a ZE economy. Details are provided below for each funding programs/projects. Additionally, CARB has conducted focused programs or initiatives aimed to promote certain vehicle types or sectors. While some of these funding programs/projects do or can fund buses (including transit and school buses), there are additional programs/projects which provide incentive funding only for buses. Another example includes refuse vehicles. Refuse vehicles operate within communities, and their impacts are felt particularly strongly by communities located near waste transfer stations, therefore emissions reductions from these vehicles would be directly beneficial. There are ZE refuse vehicles available from several manufacturers.[69] The route length and duty cycle of refuse vehicles make this sector well primed for electrification. ZE refuse vehicles are relatively new to the market, but well-suited for it, and are poised to benefit from additional incentives in this early stage. In recognition of this, CARB is beginning an initiative to encourage agencies to purchase ZE refuse vehicles by providing higher incentives in advance of this regulatory program.

2. Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project

SB 1403 guides CARB's heavy-duty vehicle investments funded with Cap-and-Trade auction proceeds, and extended the California Clean Truck, Bus, and Off-Road Vehicle and Equipment Technology Program created under SB 1204.[70,71] Funding allocations are subject to appropriations by the Legislature, and Board approval of the annual Funding Plan for Clean Transportation Incentives. Historically, most funding for ZE trucks has been provided through the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP), which began in 2009. Since its inception in 2010, HVIP has allocated more than $700 million to support the purchase of 3,4000 ZE trucks, and nearly 2,400 ZEBs which have similar components and technology as trucks. An additional $10 million through HVIP has been allocated to charging infrastructure for these trucks and buses. These numbers are as of June 2022. Response for HVIP voucher funding, especially in the last few years, has been so large that funding is often completely reserved within a few days and sometimes within a few hours. When this occurs, the program must close to applicants until new funding becomes available and the program can reopen, which at times has been more than 1 year. HVIP reopened March 30, 2022, for funding from 2021-22 fiscal year (FY), with $430 million available for voucher funding. More than 60 percent of the funding was requested the first day. As ZE technologies gain market acceptance, HVIP is shifting to focus on small and medium fleets that operate in DACs.

Within HVIP, the upcoming Innovative Small e-Fleets Project is a new pilot project that will provide incentives for ZE trucks geared towards small and disadvantaged fleets using innovative mechanisms such as flexible leases, peer to peer truck sharing, truck as a service, individual owner planning assistance and more. Lessons learned from this pilot are expected to influence future funding policies geared toward supporting smaller disadvantaged fleets.

3. Carl Moyer Program

The Carl Moyer Memorial Air Quality Standards Attainment Program is a grant program that funds the incremental cost of cleaner-than-required engines, equipment, and other sources of air pollution. The Carl Moyer Program complements California's regulatory program by providing incentives to obtain early or extra emissions reductions, including from emission sources in minority and low-income communities and areas disproportionately impacted by

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[69] California HVIP, ZE Refuse vehicles available in HVIP, 2022 (web link: https://californiahvip.org/vehicle-category/refuse/, last accessed August 2022).
[70] SB 1403 (Lara, Stats. 2018, ch. 370). Health and Safety Code Section 39719.2.
[71] SB 1204 (Lara, Stats. 2014 Ch. 524). Health and Safety Code Section 39719.2.

air pollution. The program is currently authorized at $130 million for FY 2022-2023 from smog abatement and tire fees.

The Carl Moyer Program has been successfully implemented through the cooperative efforts of CARB and California's air pollution control and air quality management districts (air districts). Emissions reductions resulting from the Carl Moyer Program are critical for enabling CARB and the air districts to fulfill their obligations under the SIP, to attain State and federal health-based air quality standards and to reduce exposure to toxic air pollutants. The Health and Safety Code section 44275 et seq. directs CARB to oversee the program by managing and distributing funds; developing and revising guidelines, protocols, and criteria for covered vehicle projects; and determining methodologies to evaluate project cost-effectiveness. Air districts follow the Board-approved Guidelines to select, fund, and monitor specific clean air projects in their areas, providing grants to public and private entities for the incremental cost of cleaner-than-required engines and/or equipment. The Board approved changes to the Carl Moyer Program in November 2021 to better support the electrification of the on-road heavy-duty sector in general, including an increase in the cost-effectiveness limit and funding caps for these cleaner vehicles.[72] The Board also streamlined the Carl Moyer Program to better ensure program participation and provide more funding opportunities for on-road heavy-duty electrification. In April 2022, the Carl Moyer Program increased eligible zero-emission on-road heavy-duty options, including expanding engine model year eligibility and providing additional flexibilities. In addition, in April 2022, the Incentive Program Advisory Group (IPAG) was convened to provide a public process to further accelerate equity work and zero-emission heavy-duty vehicle adoption, specifically for small fleets within the Carl Moyer Program and its On-Road Heavy-Duty Voucher Incentive Program (VIP).

4. Community Air Protection Program

The Legislature has appropriated Greenhouse Gas Reduction Fund moneys annually since 2017 for incentives supporting the Community Air Protection Program, established through AB 617.[73] The initial appropriation of Community Air Protection Program incentives included legislative direction to fund on-road heavy-duty projects pursuant to the Carl Moyer Program (see above) and the Proposition 1B Goods Movement Emission Reduction program, with a broad focus on zero-emission technologies and priority populations.[74] Legislative direction in subsequent appropriations expanded funding options to include zero-emission medium- and heavy-duty vehicle charging infrastructure (also handled through the Carl Moyer Program), new incentives to address stationary sources of pollution, and new incentives to address strategies identified in air district Community Emissions Reductions Programs created

[72] California Air Resources Board, *Carl Moyer Program*, 2022 (web link: https://ww2.arb.ca.gov/resources/fact-sheets/carl-moyer-program, last access August 2022).
[73] AB 617 (C. Garcia, Stats. 2017 ch. 136). Health and Safety Code Sections new sections 39607.1, 40920.6, 40920.8, 42411, 42705.5,44391.2, amendments to sections 42400, 42402.
[74] California Air Resources Board, *Proposition 1B: Goods Movement Emission Reduction Program*, 2022 (web link: https://ww2.arb.ca.gov/our-work/programs/proposition-1b-goods-movement-emission-reduction-program, last accessed August 2022).

pursuant to AB 617.[75] The program is currently authorized at $250 million for FY 2021-2022 from the Greenhouse Gas Reduction Fund.

5. Volkswagen Environmental Mitigation Trust

The Volkswagen Environmental Mitigation Trust and the resulting Beneficiary Mitigation Plan for California includes $90 million for ZE Class 8 freight and port drayage trucks, with a maximum incentive of up to $200,000 per truck. The first statewide installment of $27 million has been allocated, and the remaining $63 million will be available beginning in late 2022 or early 2023. The Beneficiary Mitigation Plan contains the eligible mitigation actions, or project funding categories, that CARB will fund from the State's $423 million allocation of the Volkswagen Environmental Mitigation Trust.

6. Truck Loan Assistance Program

Launched in 2009, the Truck Loan Assistance Program utilizes Air Quality Improvement Program (AQIP) funds to help small-business fleet owners, affected by CARB's In-Use Truck and Bus Regulation, to secure financing for upgrading their fleets with newer trucks.[76] The program is implemented in partnership with the California Pollution Control Financing Authority through its California Capital Access Program and leverages public funding with private funding from participating lending institutions. The program is available for small fleets with 10 or fewer trucks at the time of application. It creates financing opportunities for truck owners, who fall below conventional lending criteria and are unable to qualify for traditional financing at reasonable rates, giving them an opportunity to improve their credit rating and build their business. Lenders use their traditional underwriting standards to establish loan terms; however, the program currently includes an interest rate cap of 20 percent. About $187 million in Truck Loan Assistance Program funding had been expended to small-business truckers to help purchase more than 36,000 cleaner trucks.

7. CARB and California Energy Commission Joint Solicitation

In late 2020 CARB and CEC issued the joint solicitation "Zero-Emission Drayage Truck and Infrastructure Pilot Project". The funding available for the original solicitation was $44.1 million. As part of the FY 2021 22 allocation, the Legislature also provided $40 million to CARB and $25 million to CEC to fund all remaining eligible zero-emission drayage truck and infrastructure projects that were received during the joint solicitation release.

8. Complementary California Incentives for Zero-Emission Infrastructure

CARB regularly coordinates with CEC, GO-Biz, CPUC, and the California State Transportation Agency. Additionally, the programs are complemented by local air district programs, as well as actions taken by other local government entities to support a sector-wide low carbon

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[75] California Air Resources Board, *Community Air Protection Program Communities*, 2022 (web link: https://ww2.arb.ca.gov/capp-communities, last accessed August 2022).

[76] California Air Resources Board, *Truck Loan Assistance Program*, 2022 (web link: https://ww2.arb.ca.gov/our-work/programs/truck-loan-assistance-program, last accessed August 2022).

heavy-duty vehicle and off-road technology transition. CARB coordinates closely with CEC to ensure that vehicle investments are complemented by investments in infrastructure. Each program has its own statutory and policy direction, but collectively they fit together to support California's multiple public health, air quality, and climate change goals.

In October 2015, California adopted SB 350, the Clean Energy and Pollution Reduction Act, which established GHG reduction targets and requires CPUC to direct the 6 IOUs in the state to "accelerate widespread transportation electrification (TE)."[77] The resulting programs developed by the electric utilities due to SB 350 from CPUC Decisions of 2018 and 2019, for which $740 million has been authorized, promote the deployment of medium- and heavy-duty ZEVs through incentivizing infrastructure upgrade projects that offset most or all the costs for electrical service upgrades. Additionally, CPUC IOU programs from that time forward have the intent to meet SB 350 goals, even when not called out directly. As shown in Table 7, this amounts to $1.8 billion supporting light-, medium-, and heavy-duty (on-road and off-road) charging infrastructure development, including direct current fast charging. CARB coordinates with CPUC for electric utility infrastructure upgrades to accommodate TE.

Table 7: Authorized Funding for Utility Electric Vehicle Programs

Year	Program Description	Funding
2016	SCE's Charge Ready Pilot	$22M
	SDG&E's Power Your Drive	$45M
	PG&E's EV Charge Network	$130M
2018	SCE's Charge Ready Bridge	$22M
	SB 350 Small IOU Programs	$7.6M
	SB 350 Priority Review Pilots	$42.8M
2019	SB 350 Standard Review Projects	$615M
	PG&E's EV Empower	$4M
	SDG&E's Power Your Drive Fleets Program and Vehicle-to-Grid School Bus Pilot	$109.13M
2020	AB 1082/1083 Schools, Parks & Beaches	$54.5M
	SCE's Charge Ready 2	$436M
	SB 676 Vehicle Grid Integration Pilots	$38.7M
2021	SDG&E's Power Your Drive Extension	$43.5M
	Transportation Electrification Framework Near-Term Priorities	$240M

Finally, CEC recently launched the EnergIIZE program, which provides incentives for fueling infrastructure to support battery-electric and fuel cell commercial vehicles.[78] EnergIIZE is part

[77] SB 350 (De León, Stats. 2015, ch. 547). Health and Safety Code new section 44258.5. Labor Code new sections 25302.2 and 25327. Public Utilities Code section new sections 237.5, 400, 454.51, 454.52, 454.55, 454.56, 9621, and 9622. Amendments to Labor Code sections 1720, 25310, and 25943; amendments to Public Utilities Code 337, 352, 359, 359.5, 365.2, 366.3, 399.4, 399.11,399.12,399.13, 399.15, 399.16, 399.18, 399.21, 399.30, 701.1,740.8,740.12, 9505, and 9620.

[78] California Energy Commission, *Energy Commission Announces Nation's First Incentive Project for Zero-Emission Truck and Bus Infrastructure*, 2021 (web link: https://www.energy.ca.gov/news/2021-04/energy-commission-announces-nations-first-incentive-project-zero-emission-truck, last accessed August 2022).

of CEC's FY2020-2023 Clean Transportation Investment Plan to invest $129.8 million in medium- and heavy-duty ZEV infrastructure by 2023.[79]

9. State Budget and Future Funding Availability

The ZEV budget package for FY 2021-22 included $3.9 billion dollars to multiple State agencies over 3 FYs to build on the investments in ZEVs and ZEV infrastructure the State has made over the past decade. The investments are designed to accelerate an equitable ZEV transition in both the light- and heavy-duty sectors. The budget also included initial funding commitments for 1,150 ZE drayage trucks, 1,000 ZE transit buses, and 1,000 ZE school buses, along with corresponding infrastructure, over 3 FYs, which provides strong incentives for early adopters, complementing CARB's regulations. The ZEV budget package for FY 2021-22 includes the nearly $570 allocated to HVIP as described above.

California's Budget Act for this fiscal year (FY 2022-23) appropriates funding for the ZE transformation. This fiscal year's budget includes $6.1 billion over 5 years to accelerate the State's transition to ZEVs.[80] The ZEV package builds on last year's $3.9 billion over 3 years ($1.8 billion in 2021-22), for a total of $10 billion. This is applied across a wide variety of sectors including light-, medium-, and heavy-duty vehicles, maritime, aviation, rail, and other off-road applications, as well as the necessary infrastructure and charging stations. The $3.9 billion includes approximately $1.2 billion to CEC to support infrastructure and ZEV manufacturing grants, in addition to other State agencies for categories such as the ZEV Market Development Strategy and to demonstrate and deploy ZEBs and rail equipment and infrastructure.

D. Background on Existing Trucks

This section describes the diverse array of on-road vehicles typically used by fleets operating in California that would be subject to the proposed ACF regulation. It includes an overview of affected vehicle classes, vehicle descriptions, manufacturing practices, as well as an overview of vehicle populations and characteristics.

1. Overview of Truck Classifications and Manufacturing

Medium- and heavy-duty trucks operate throughout California in numerous vocations and are an essential part of the State's economy. On-road vehicles are grouped by their GVWR, which is the manufacturer's rated weight capacity of the vehicle and ranges from Class 1-8. Class 1-2a are considered light-duty vehicles and have a GVWR at or under 8,500 lbs. Class 2b-8 are vehicles with a GVWR over 8,500 lbs. and are considered medium- and heavy-duty vehicles. Under California regulations, heavy-duty vehicles are those vehicles with a gross vehicle weight rating (GVWR) greater than 8,500 pounds, while medium-duty vehicles are a

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[79] California Energy Commission, *CEC Approves $384 Million Plan to Accelerate Zero-Emission Transportation*, 2020 (web link: https://www.energy.ca.gov/news/2020-10/cec-approves-384-million-plan-accelerate-zero-emission-transportation, last accessed August 2022).
[80] State Of California, *California State Budget FY 2022-23*v, 2022 (weblink: https://www.ebudget.ca.gov/FullBudgetSummary.pdf, last accessed August 2022).

subcategory of heavy-duty vehicles with a GVWR between 8,500 and 14,000 pounds. [81,82] Table 8 shows the weight classifications as defined by the U.S. Department of Transportation.[83]

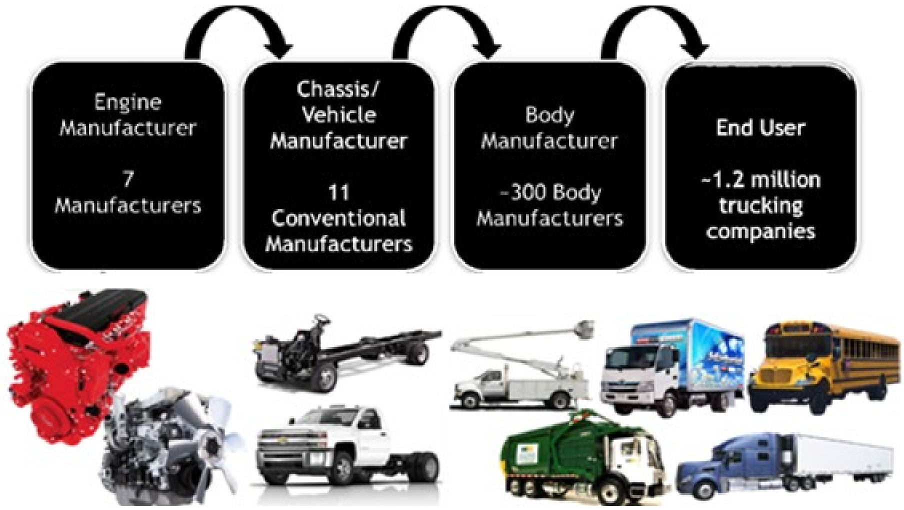
Table 8. Truck Weight Classifications (lbs.)

Category	Lower Weight	Upper Weight
Class 1	0	6,000
Class 2a	6,001	8,500
Class 2b	8,501	10,000
Class 3	10,001	14,000
Class 4	14,001	16,000
Class 5	16,001	19,500
Class 6	19,501	26,000
Class 7	26,001	33,000
Class 8	33,001	80,000 and up

Light-duty vehicles are typically manufactured as complete vehicles delivered from the factory. Medium- and heavy-duty vehicles can be produced as a complete vehicle or through multiple stages of assembly by multiple manufacturers. A truck tractor, or semi-truck, is produced as a complete vehicle and is designed primarily for the purpose of pulling trailers. Vocational trucks, however, originate as a cab-and-chassis which is typically fitted with a body and will be finished into one of many final configurations depending on use. Examples include box trucks, construction trucks, dump trucks, refuse trucks, and school buses. The majority of Class 4-8 (and some Class 3) vehicles, excluding tractors, are built by one or more manufacturers that are not vertically integrated, which means the manufacturer that produces the drivetrain and chassis likely does not produce the body. The incomplete chassis is built out, or upfitted, to the final configuration. Figure 12 illustrates the fragmented nature of the typical truck manufacturing process.

[81] Cal. Code Regs. tit. 13, section 1900(b)(6).
[82] Cal. Code Regs. tit. 13, section 1900(b)(13).
[83] Advanced Fuels Data Center, *Vehicle Weight Classes & Categories*, 2012 (web link: https://afdc.energy.gov/data/10380, last accessed August 2022).

Figure 12: Typical Truck Manufacturing Process

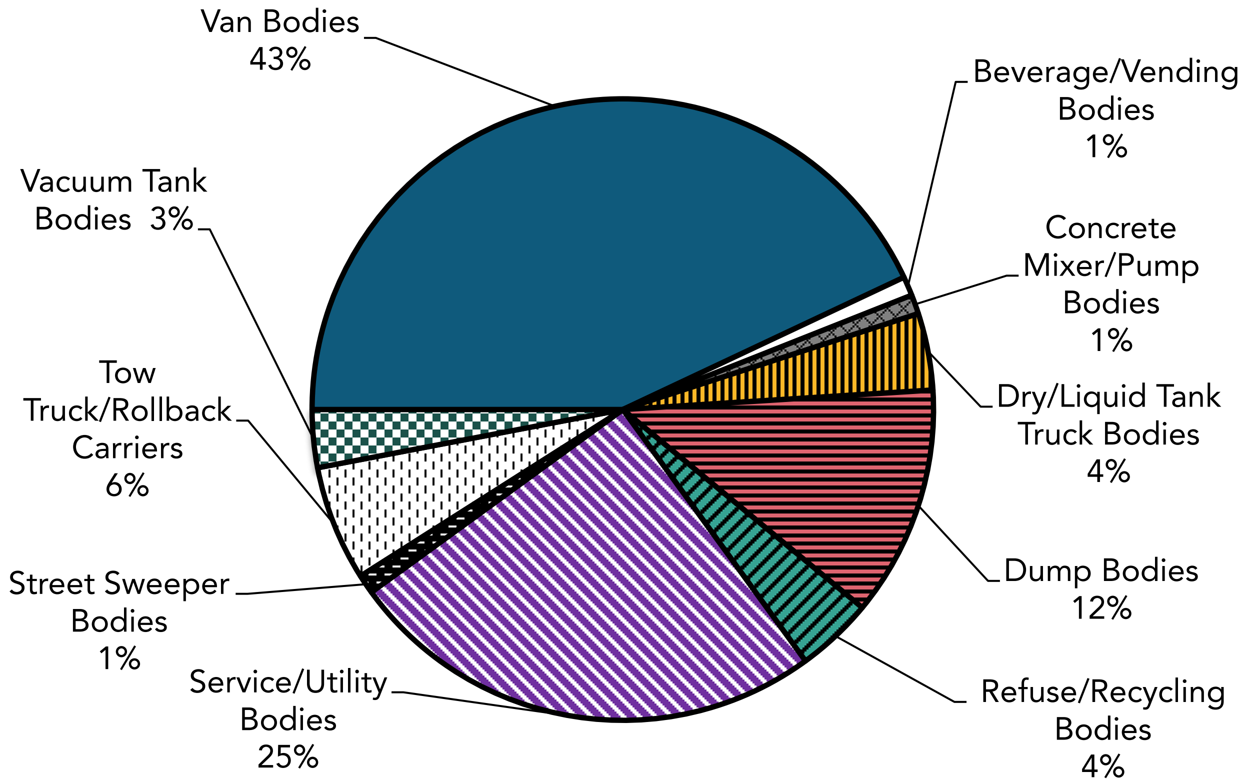


All Class 2 and most Class 3 medium-duty trucks and vans are manufactured as complete vehicles with fully integrated bodies. Full-size vans, chassis cabs and cutaways, and heavy-duty pickup trucks comprise most of the Class 2b sales. Examples of full-size vans include the Ford Transit, Mercedes Sprinter, and Chevrolet Express, and examples of heavy-duty pickup trucks include the Ford F-250 and RAM 2500. Class 3 includes the same types as Class 2b with a higher payload, but also includes a higher fraction of incomplete vehicles and stripped chassis vehicles (with a frame and engine but has no cab or body) that often become walk-in vans and box trucks with final assembly by a body manufacturer.

Class 4-8 trucks mainly function in vocational applications as urban delivery vehicles, work site trucks, and numerous other fields. The majority of these trucks are manufactured in segments and not in a vertically integrated process. For instance, vocational vehicle manufacturers such as Hino, Navistar, Ford, and General Motors (GM) produce the powertrain and chassis of the vehicles in a vertically integrated process, but do not produce or assemble the final body to the vehicle.

Vocational trucks can be configured as a flatbed, box truck, a passenger shuttle or a wide range of other configurations. The body elements are manufactured by a variety of companies and assembled based on the specifications of the end user for the primary intended function of the vehicle. Thus, the number and types of vocational bodies are highly varied. Figure 13 shows the market share by body type in 2011 for vocational trucks and does not include tractors.

Figure 13: Vocational Truck Body Types by Market Share 2011



There are over 280 individual body manufacturers engaged in the production of truck bodies in North America. The industry is highly disaggregated with hundreds of small body manufacturers competing in the same market as large national body manufacturers. Most body manufacturers produce less than 1,000 body units annually, with 74 percent manufacturing less than 500 body units annually.[84]

Class 7-8 tractors are typically manufactured as complete vehicles, though like most heavy-duty trucks, are assembled as custom orders and with parts from a variety of suppliers, which can often be mixed and matched for a given truck model depending on the customer needs. Several manufacturers supply their own engines, but also accept engines from other manufacturers.[85]

Ten major original equipment manufacturers (OEM) and their subsidiaries make up the majority of Class 2b-8 vehicles sold in the United States. Figure 14 breaks down the ten major manufacturers and shows which vehicles they produce by each weight class. These major manufacturers have largely been absent from the ZEV market until recently. Manufacturers have dedicated more resources towards ZEV technologies in part due to upcoming requirements such as the ACT regulation. Many of these manufacturers have announced plans or have already released commercial ZEVs.

[84] SpecialtyResearch.net, Truck Body Manufacturing in North America, 2018 (web link: https://www.specialtyresearch.net/, last accessed August 2022).
[85] Oak Ridge National Laboratory, *2016 Vehicle Technologies Market Report*, 2017 (web link: https://tedb.ornl.gov/wp-content/uploads/2019/04/2016_Vehicle_Technologies_Market_Report.pdf, last accessed August 2022).

Figure 14: Truck and Engine Manufacturers by Class

	Class 2b	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8
Nissan	■						
FCA	■	■	■	■			
Isuzu		■	■	■			
GM		■	■	■	■		
Ford	■	■	■	■	■	■	
Daimler	■	■					
Daimler Trucks			■	■	■	■	■
Navistar/International			■	■	■	■	■
Hino			■	■	■	■	■
Paccar				■	■	■	■
Volvo							■

In addition to the 10 major manufacturers listed above, there are more than 40 truck manufacturers developing and producing medium- and heavy-duty ZEVs. Figure 15 shows a list of all manufacturers that have ZEVs commercially available and the weight class of their products.

Figure 15: Zero-Emission Vehicle Manufacturers by Class

Manufacturer	Class 2a	Class 2b	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8
Blue Bird								
BYD Motors								
Canoo								
EVTV								
Ford								
Freightliner								
GILLIG								
General Motors								
GreenPower Motor								
Kenworth								
Kalmar								
Lightning eMotors								
Lion								
Lonestar SV								
May Mobility								
Micro Bird								
Motiv Power Systems								
Navistar (IC Bus)								
NFI Group (MCI)								
Nikola Motors								
Optimal EV								
OrangeEV								
Peterbilt								
Phoenix Motorcars								
Proterra								
REV-Collins Bus								
Rivian								
ROUSH CleanTech								
SEA Electric								
US Hybrid								
Van Hool NV								
Volvo								
Workhorse								
XOS Trucks								

2. Overview of Truck Configurations and Operating Characteristics

Trucks are differentiated and categorized by a number of factors, including physical features, operating characteristics, configurations, and the types of fleets they're utilized in. By identifying and distinguishing these factors, electrification suitability is more easily realized amongst vehicle types. This section illustrates a sampling of the vehicle types and categories that would be affected by the proposed ACF regulation and also incorporates a brief truck inventory and operation synopsis. Table 9 provides an illustration of the different truck types and configurations, by truck class, and is presented in four distinct truck groups.

Table 9: Illustration of Various Truck Configurations by Truck Class Affected by the Proposed ACF regulation

Class 1-2a	Class 2b-3	Class 4-8	Class 7-8 Tractors
 	   	  	  

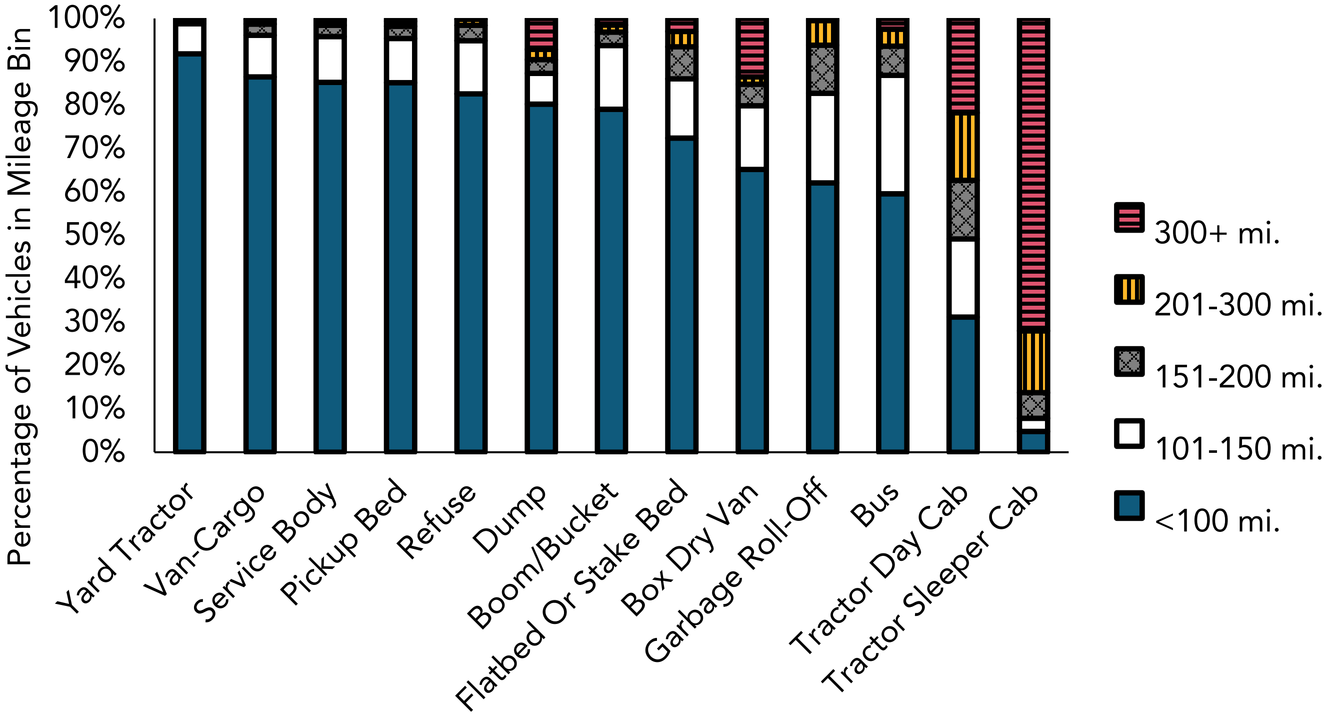
Each classification contains vehicle types with varying truck operating characteristics. Class 8, for example, contains truck tractors as well as an array of specialty vehicles that are designed for a specific job function. Their operating characteristics differ and are distinguished by a number of factors, including local vs long-haul application, stationary work capability, and utilitarian attributes. Truck configurations within these four groups tend to have relatively similar truck operating characteristics as these configurations suit the intended work function of the vehicle.

Collected by CARB in 2021, the LER data describes detailed fleet, vehicle life, operating, and facility characteristics of specific entities that met the required reporting criteria. In this section, the LER data illustrates population estimates and truck operating characteristics such as daily mileage of identified common vehicle types that fall under these classifications and whether they are regularly parked onsite at their respective facility.[86] These characteristics are quantified by the LER data for a sample of targeted vehicle populations in California.

[86] California Air Resources Board, *Large Entity Reporting Data*, 2021 (web link: https://ww2.arb.ca.gov/our-work/programs/advanced-clean-trucks/large-entity-reporting, last accessed August 2022).

Figure 16 demonstrates an overview of the estimated daily mileage percentages for the top ten vehicle types with the largest surveyed populations in the LER.[87]

Figure 16: Estimated Average Daily Mileages for Select Vehicle Categories in Large Entity Reporting



The following sections provide more detailed information on truck configurations and their operational characteristics within each of the four truck groups outlined in Table 9 above. This information is being presented because all trucks discussed below provide a sampling of the trucks that would be affected by the proposed ACF regulation.

3. Class 1-2a Light-Duty Parcel Delivery Vehicles

Light-duty delivery vehicles categorized under Class 1-2a are typically manufactured as complete vehicles delivered from the factory and are designed to transport goods directly to customers or businesses. The proposed ACF regulation would include light-duty vans used for mail and package delivery. Figure 17 provides examples of Class 1-2a light-duty parcel delivery vehicles.

[87] California Air Resources Board, *Large Entity Reporting Data*, 2021 (web link: https://ww2.arb.ca.gov/our-work/programs/advanced-clean-trucks/large-entity-reporting, last accessed August 2022).

Figure 17: Examples of Class 1-2a Light-Duty Parcel Delivery Vehicles

Light-duty package delivery vehicles are defined as having a GVWR less than 8,501 lbs. with enclosed cargo space equal to or greater than 100 cubic feet of that is used to deliver packages, parcels, or mail to the final destination from the last point of distribution.

These vehicles are small enough to traverse narrow city streets and traffic compared to larger trucks, which make them popular as delivery vehicles in metropolitan areas. Light-duty package delivery vehicles are frequently used for small package and post delivery services, most commonly part of delivery fleets such as Amazon and the U.S. Postal Service.

4. Class 2b-3 Pickup Trucks, Service Trucks, and Cargo/Delivery Vans

Class 2b-3 vehicles include larger pickup trucks, service trucks, small box trucks, cargo and delivery vans. They can carry increased payloads and towing, which are significant needs for many fleets that purchase these vehicles. Typical Class 2b-3 vehicles may include full-size pickup trucks and lower tier commercial trucks. Route and range needs are less predictable for pickup trucks in this category but are less of a concern for vans that are typically not purchased to tow loads.

a) Pickups and Service Trucks

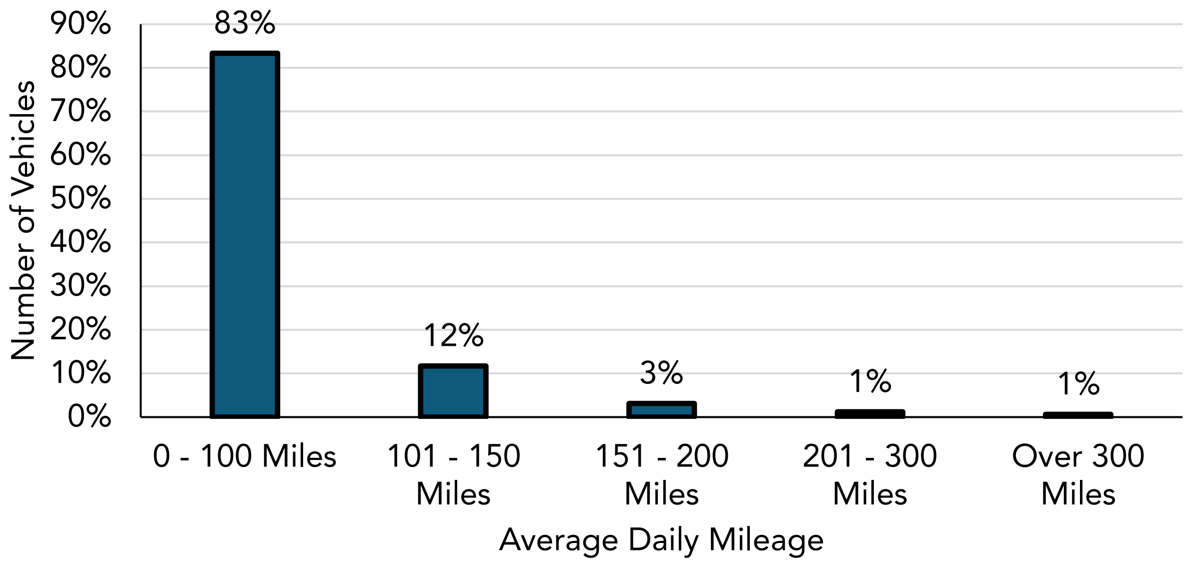
Pickups are light- and medium-duty vehicles characterized by their open bed. Service trucks are similar to pickups but have storage cabinets installed which offer more storage space and versatility to the fleet. Both vehicles are commonly equipped with towing hitches. Class 2b-3 pickups and service trucks are built with significantly higher towing and payload capacity than their light-duty counterparts. Many Class 2b-3 pickups are sold and used for personal use that would not be subject to the proposed ACF regulation until 2040. Figure 18 illustrates typical pickup and service trucks.

Figure 18: Typical Pickup and Service Trucks

These trucks are used by a variety of fleets including government, utility, commercial, and individual fleets. Pickups and service trucks are used for transporting passengers, towing, and hauling cargo, such as construction materials or waste for disposal. They are also commonly used to transport large goods, such as household appliances, and are favored by farmers, tradesmen, outdoor enthusiasts, and the like due to their versatility and capabilities for hauling equipment and tools.

Figure 19 illustrates the mileage distribution of pickup trucks in the LER data. Most notably, of the surveyed pickups, 83 percent drove an average of 100 miles or less daily. Additionally, 71 percent were regularly parked onsite at their respective facility at least 8 hours of the day.

Figure 19: Estimated Average Daily Mileage of Pickup and Service Trucks Surveyed in Large Entity Reporting



b) Cargo/Delivery Vans and Step Vans

Class 2b-3 delivery vans and trucks are designed to transport larger packages and goods directly to customers or other businesses and incorporate a variety of vehicle types, including full-size cargo vans and step vans. Parcel delivery vans such as those used by FedEx and UPS operate on regular routes with more than 100 stops per day and return to a depot at the end of the shift. Figure 20 shows an example of delivery and step vans.

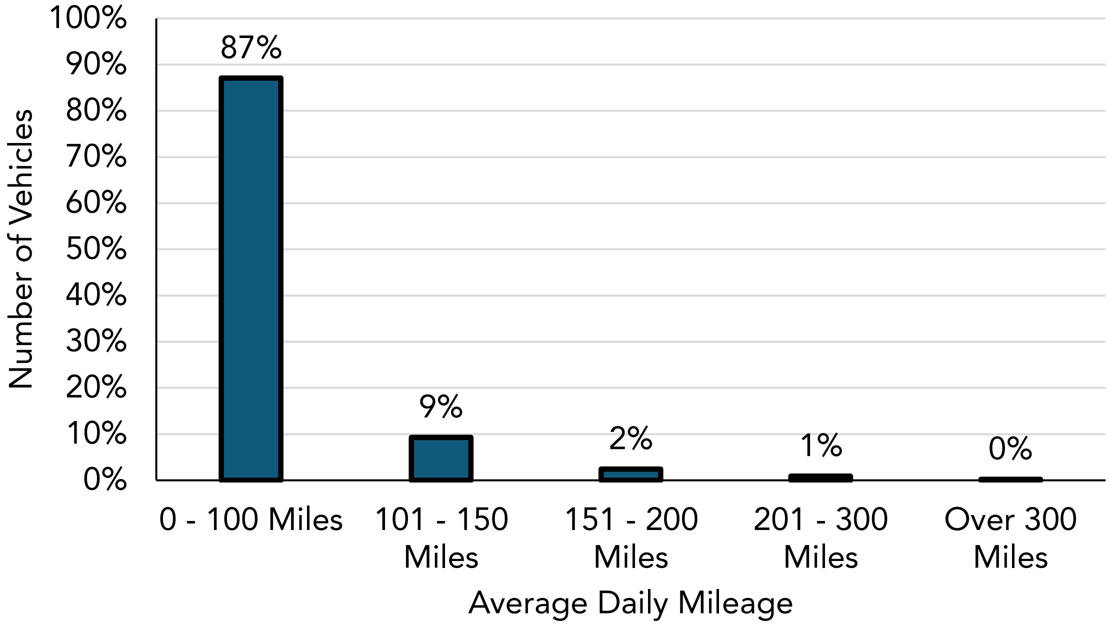
Figure 20: Example of Delivery and Step Vans

Cargo vans have a cargo area that can be accessed from the inside of the vehicle and commonly have a sliding side door and rear doors to load and unload cargo. Step vans are more rectangular in shape and are designed so the driver can easily enter the cargo area from inside the vehicle enabling frequent stops.

Generally, delivery vans and trucks are utilized in high priority and federal fleets as well as State and local government fleets to transport goods and for many businesses are the "last mile" delivery of goods in urban areas in the supply chain. Cargo vans are frequently used to transport household goods, tools and equipment, food or catering supplies, and more. Primarily used by non-public fleets, they are small enough to traverse narrow city streets and traffic compared to larger trucks, which make them popular as delivery vehicles in metropolitan areas. Step vans are frequently used for small package and parcel delivery services, most commonly part of delivery fleets such as Amazon, FedEx, and UPS.

Based on LER data, cargo and step vans account for approximately 4.5 percent of the surveyed vehicle types in the LER. Of the surveyed cargo and step vans, 87 percent drove an average of 100 or less miles daily, 10 percent drove an average of between 100 and 150 miles daily, 2 percent drove an average of between 150 and 200 miles daily and 1 percent drove an average of over 200 miles daily as shown in Figure 21. Additionally, about 63 percent were regularly parked onsite at their respective facility at least 8 hours of the day.

Figure 21: Estimated Average Daily Mileage of Cargo and Step Van Surveyed in Large Entity Reporting



5. Class 4-8 Vocational Trucks

Class 4-8 vocational trucks include a variety of vehicles purpose built to their application such as box trucks, refuse haulers, buses, and more. Many of these vehicles have operational characteristics that are more favorable for electrification, such as predictable routes, less concern regarding payload, short daily range needs, stop-and-go operations, and returning to a centralized location daily where they can be refueled. Additionally, vocational trucks, primarily service and boom trucks, are often used by State and local governments.

a) Box Trucks

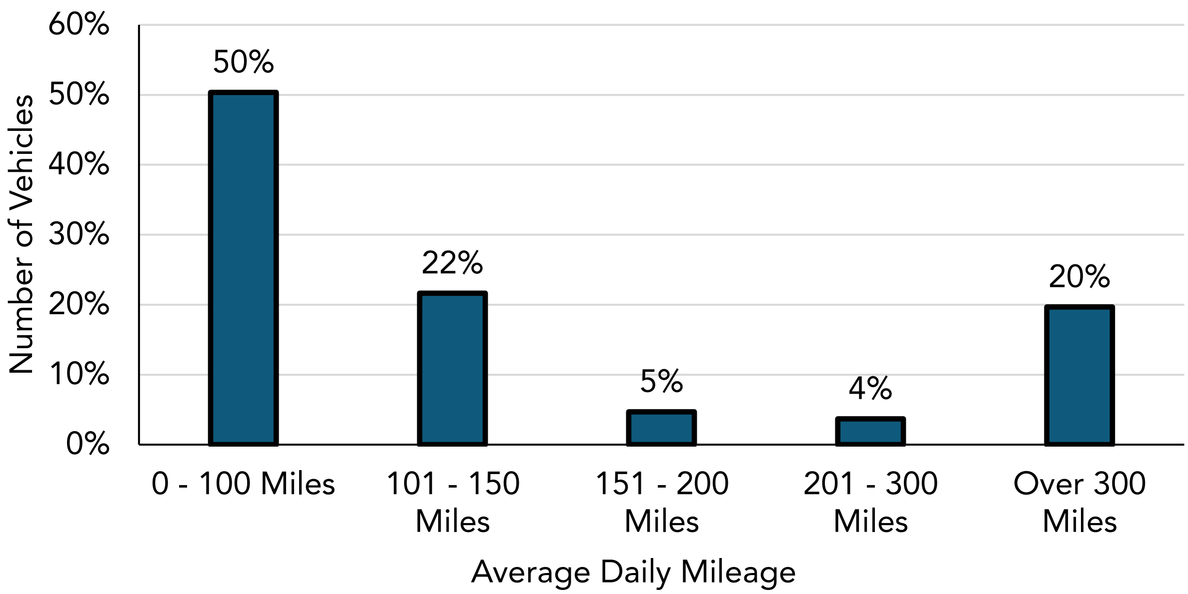
A box truck is a commercial vehicle wherein the box-shaped cargo area and cab are separated. The cargo box most commonly can only be accessed from the rear or side doors, as opposed to accessing it from the cab, which distinguishes box trucks from step or delivery vans. Common types of box trucks include reefers, box dry vans, and beverage trucks as shown in Figure 22.

Figure 22: Common Types of Box Trucks

Dry vans are another type of box truck in which the cargo box is not temperature-controlled and are used to haul dry goods, such as furniture, electronics, and non-perishable food. Reefer vans are another type of box truck that contain a temperature-controlled refrigerated cargo box with the purpose of hauling perishable goods, such as food, medicine, and cosmetics. Box dry vans are another type of box truck in which the cargo box is not temperature-controlled and are used to haul dry goods, such as furniture, electronics, and non-perishable food. Beverage trucks have a cargo box divided into bays for transport of various bottled beverages and are often refrigerated. Generally, box trucks are most widely deployed in urban areas, as their smaller size allow them to navigate narrower roads more easily compared to larger Class 8 vehicles.

Of the surveyed box trucks, 65 percent drove an average of 100 miles daily, 15 percent drove an average of 150 miles daily, 5 percent drove an average of 200 miles daily, and 15 percent drove an over an average of 200 miles daily. Additionally, 47 percent were regularly parked onsite at their respective facility at least 8 hours of the day. Figure 23 shows the estimated average daily miles of box trucks.

Figure 23: Estimated Average Daily Mileage of Box Trucks Surveyed in Large Entity Reporting



b) Vocational Trucks with Power Take-Off

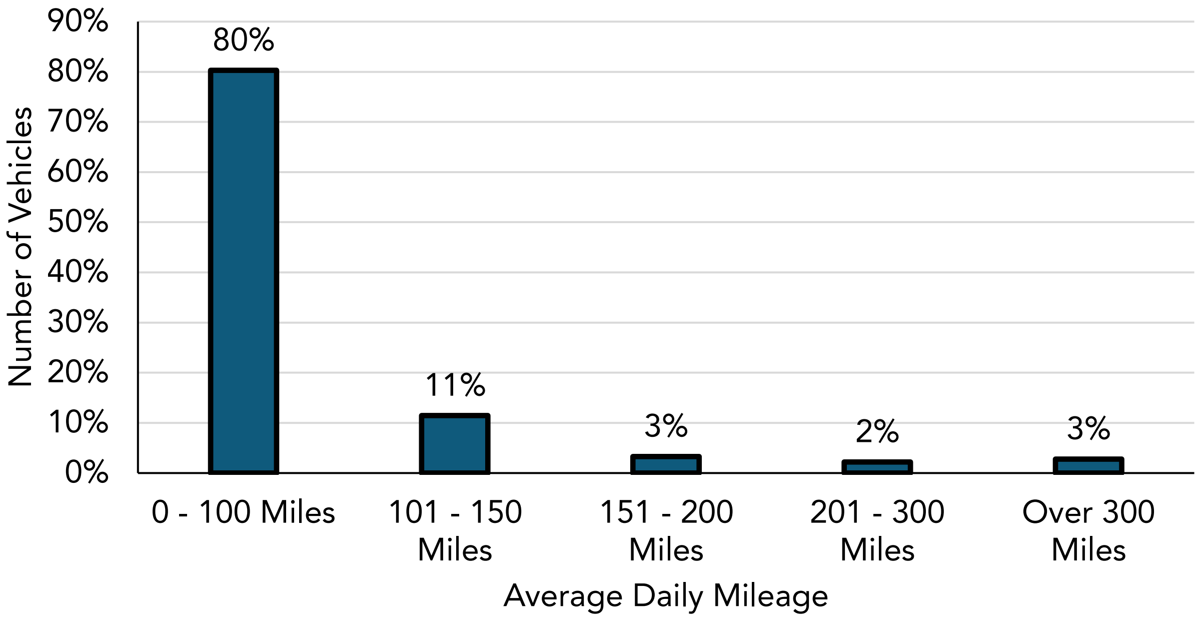
Vocational, or work, trucks are commonly built to handle a specific task or job, such as concrete mixing, dumping, sweeping, towing, etc. These trucks are often equipped with a power take-off (PTO) to operate auxiliary equipment and perform work while stationary. As shown in Figure 24, vocational trucks can use a PTO to tilt the bed or for lifting workers in a bucket.

Figure 24: Images of Trucks Equipped with a Power Take-Off

The most common types of PTO vocational vehicles are tow trucks and dump trucks, but this classification also incorporates cranes, concrete mixers, vacuum trucks, and more. For example, dump trucks consist of an open-box bed placed on the rear chassis and are operated by hydraulic lifts that dump waste at the rear through a hinged flap or door. Flatbed tow trucks utilize hydraulics to tilt the bed into a ramp and employ machine-powered winches that attach to a car and pull it onto the flatbed. Vehicles with service bodies or flatbeds are common types of non-PTO vocational trucks, but the category also extends to those with stake beds, utility beds, and more.

Of the trucks surveyed in the LER, 29 percent were identified as PTO and 71 percent were identified as non-PTO. As shown in Figure 25, 81 percent of these vehicles drove an average of 100 miles daily, 11 percent drove an average of 150 miles daily, 3 percent drove an average of 200 miles daily, and 5 percent drove an average of over 200 miles daily. Daily mileage alone, however, underrepresents the energy a PTO vehicle requires. Additionally, 73 percent were regularly parked onsite at their respective facility at least 8 hours of the day. Figure 25 shows the estimated daily mileages of vocational trucks in the LER.

Figure 25: Estimated Average Daily Mileage of Vocational Trucks Surveyed in Large Entity Reporting



c) Buses and Motorcoaches

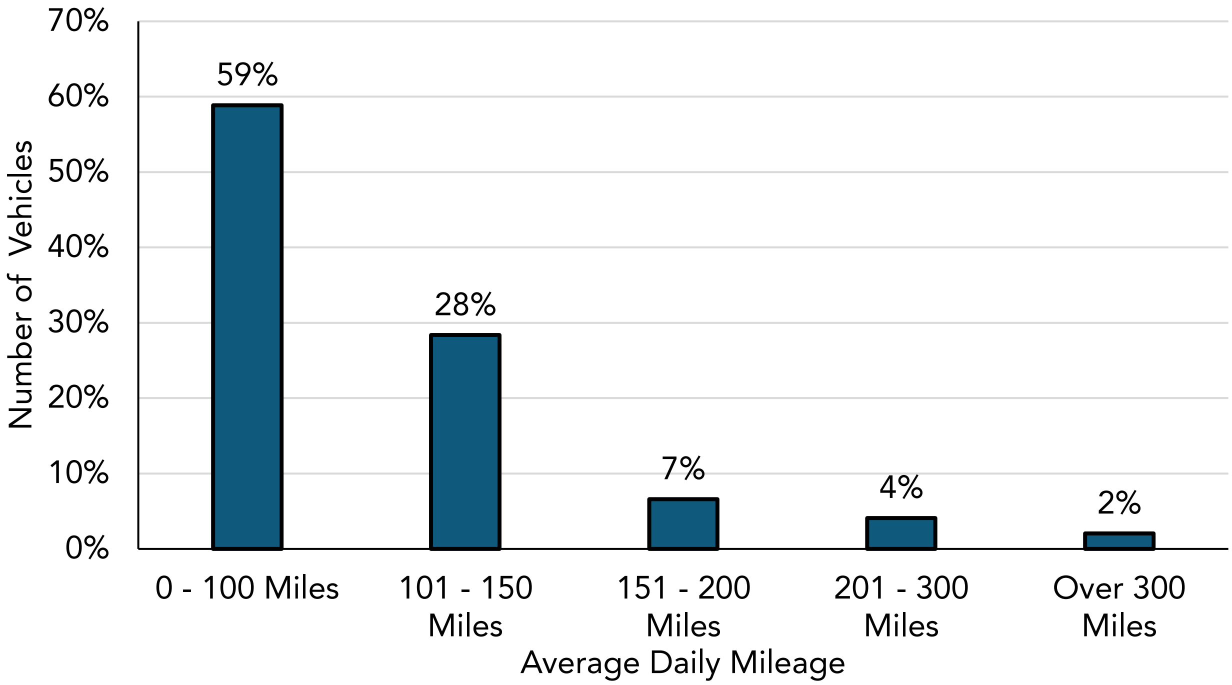
Buses range from Class 4-8 and are distinguished by their long bodies equipped with several seats or benches for passengers. Most buses range from 20-45 feet in length with some as long as 60 feet, and normally have multiple entry doors that are in the front, side, or back of the vehicle. Some have capacities as high as 300 passengers, but most usually carry between 30 and 100. There are different types of buses, such as motorcoaches and tourism buses, shown in Figure 26, with varying characteristics suited to their designated uses, but are often similar in shape and style.

Figure 26: Motorcoach and Tourism Buses

A motorcoach is a specific type of bus in which the differences in both use and travel distance distinguish it as a separate form of transportation compared to other buses. Motorcoaches are designed with an elevated passenger deck located over a baggage compartment and prioritize comfort on the interior, whereas other buses typically have more standing room to maximize passenger capacity. Buses primarily used for tourism or mass transportation can also have multiple decks. In general, buses are most widely used for transportation in urban areas, or to and from the suburbs to population centers in which they operate on fixed routes and multiple stops are taken. Motorcoaches are utilized for longer-distance travelling.

Of the surveyed buses, 59 percent drove an average of 100 miles daily, 28 percent drove an average of 150 miles daily, 7 percent drove an average of 200 miles daily, and 6 percent drove an average over 200 miles daily. Figure 27 illustrates the estimated average daily miles of buses from LER survey. Additionally, 87 percent were regularly parked onsite at their respective facility at least 8 hours of the day.

Figure 27: Estimated Average Daily Mileage of Buses Surveyed in Large Entity Reporting



d) Refuse Trucks

Refuse trucks are used for the collection and/or transport of solid waste. Common types of refuse vehicles include garbage front loaders, garbage packers, garbage roll-offs, and garbage side loaders. Some examples of battery electric models as shown in Figure 28.

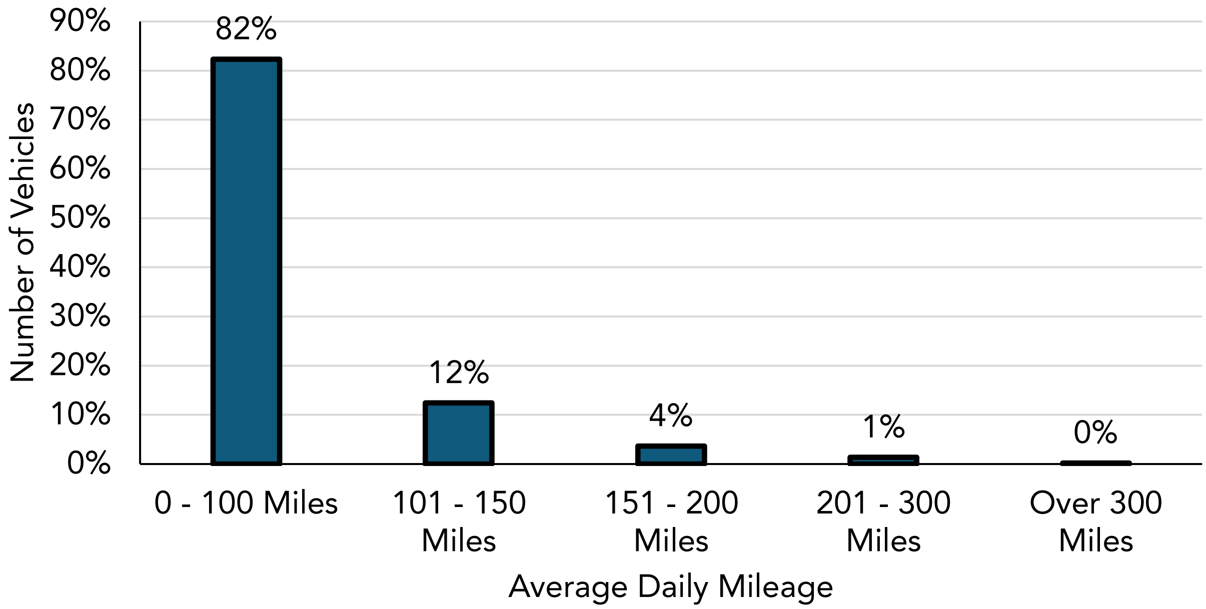
Figure 28: Example Refuse Vehicles

Garbage packers compact waste after it has been loaded into the hopper by a hydraulic moving wall that moves forwards and backwards to push the waste towards the rear of the vehicle. Garbage roll-offs transfer open top containers to local landfills and recycling centers through the use of a hydraulic bed that lifts up and down, which allows these containers to roll on and off the truck. Garbage side loaders load waste from the side of the vehicle either manually or through the use of a retractable and often articulated arm with a grappling hook or jaw that lifts and tips waste bins to empty waste into the hopper.

Refuse vehicles are generally used in the collection of residential and commercial solid waste for disposal by utilities. The route and area of service largely affects the type of refuse vehicle used. Garbage side loaders are most commonly used in residential areas for the removal of household waste. Garbage front loaders mainly collect waste from businesses that use dumpsters, typically from industrial and commercial properties, and garbage packers are deployed for both household and commercial waste removal. Additionally, due to the significant number of stops as part of the duty cycle, refuse vehicles have high energy use per mile.

Of the surveyed refuse vehicles, 83 percent drove an average of 100 miles daily, 12 percent drove an average of 150 miles daily, 4 percent drove an average of 200 miles daily, and 1 percent drove an average of over 200 miles daily as shown graphically in Figure 29. Additionally, 98 percent were regularly parked onsite at their respective facility at least 8 hours of the day

Figure 29: Estimated Average Daily Mileage of Refuse Trucks Surveyed in Large Entity Reporting



e) Specialty Trucks

There are a small number of specialty trucks that are larger than a typical vocational truck and built for a unique purpose. All specialty trucks are Class 8, usually have a heavy front axle, and are configured to perform work that can only be done while the vehicle is stationary. The auxiliary mechanism to perform this work is an integral part of the vehicle design. Examples of specialty vehicles include vehicles commonly known as vacuum trucks, digger derricks, and concrete pump trucks, but the category further extends to concrete mixers, heavy cranes, and more. Figure 30 shows an example of two types of specialty trucks: a vacuum truck (left) and a heavy-duty crane (right).

Figure 30: Specialty Truck Types

The body types of specialty vehicles vary significantly depending on the specific function they were designed for. For example, vacuum trucks feature a powerful pump that creates a vacuum inside the vehicle by removing the air from the holding tank, which allows for liquids and sludges to be drawn up. Digger derricks contain an auger powered by hydraulics that allow for large holes to be drilled into the ground and other surfaces or materials. Further, a concrete pump truck contains a hopper with an auger to churn concrete as well as a valve system that draws concrete from the hopper in intervals until it reaches the end of the concrete hose for dispersal.

Also part of the specialty truck category, two-engine vehicles are specially constructed Class 8 vehicles designed to be equipped with two engines integrated into the design of the vehicle to perform a specific function, which includes providing auxiliary power to attachments, performing special job functions, or providing additional motive power. These vehicles have unique duty cycles and low manufacturing volumes which are factors that make them unlikely candidates for early electrification or ZE conversion.

Specialty vehicles are primarily utilized in construction and for public works and maintenance projects. Concrete pumps and mixers primarily assist with road work and in concrete distribution in construction sites. Also mainly used in construction, cranes have the ability to transport heavy loads, machines, goods, and materials for various purposes. Digger derricks are commonly operated for electrical work, telephone pole installation, road work, and tree trimming. Other applications for specialty vehicles extend to sewer sanitation or storm drain cleaning, lifting and moving ships in shipyards, sample extraction from mineral deposits, and more.

6. Class 7-8 Truck Tractors

Categorized under Class 7-8, truck tractors, or tractors, are primarily designed for the purpose of pulling trailers and commonly have a single or tandem rear axle. They are a combination of a tractor unit and one or more semi-trailers, which attach through a hitch called a fifth wheel. Gross combination weights of these vehicles are typically up to 80,000 lbs. but can be higher depending on State law. Tractors are often characterized by hauling heavy loads with long and unpredictable routes, but increasingly more Class 8 vehicles are operated on short and predictable routes from centralized locations. Figure 31 shows common types of truck tractors include day cab tractors and sleeper cab tractors.

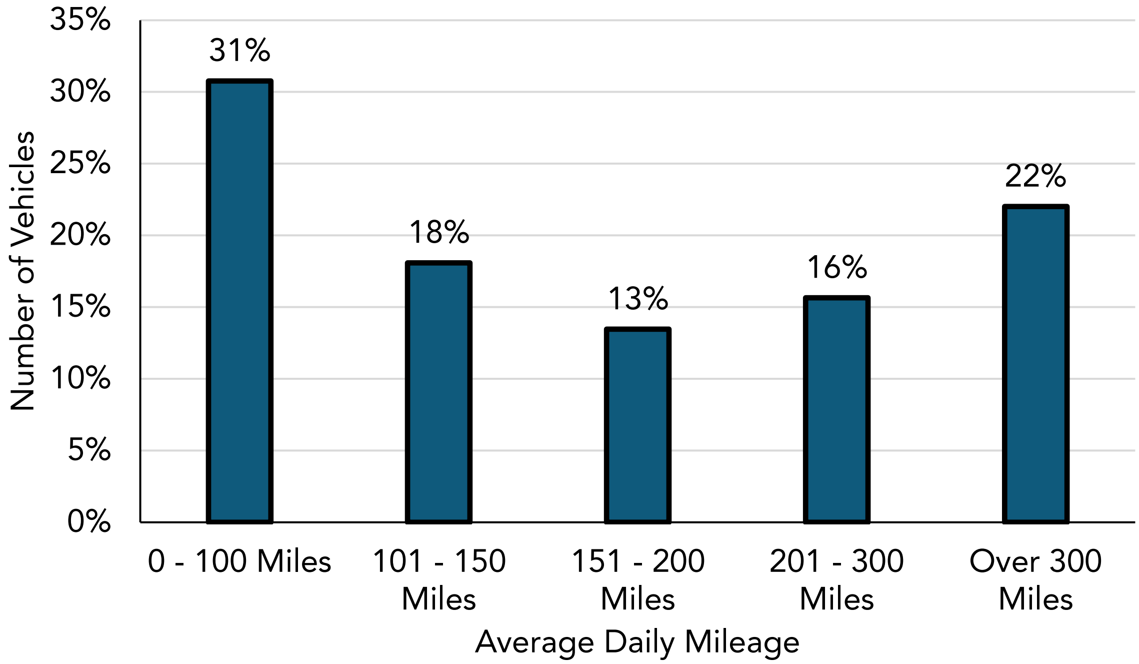
Figure 31: Common Types of Tractors

Used to transport trailers and equipment, tractors have large, high horsepower engines, heavy frame and axle construction, and a high-geared transmission. Depending on the climate and cargo, the large trailers pulled by the tractor unit vary in length, shape, and style, and may be heated, refrigerated, pressurized, or ventilated. Day cab tractors are on-road tractors without a berth designed for resting or sleeping at the back of the cab. These vehicles are deployed to haul large loads on short trips within the same day. Sleeper cab tractors are tractors with a berth designed for resting or sleeping at the back of the cab and are generally deployed in long-haul applications.

Typically, tractors are purchased new for use in both short- and long-haul operations and then high mileage tractors are commonly sold on the secondary market for regional or local operations after 4-6 years. Once in local service, annual mileage drops. Similarly, food and beverage delivery tractors typically use hub-and-spoke operations and do not travel long distances each day, returning to a home base at the end of the shift. In the early ZE market transition staff expect these vehicles to be used in short-distance operations where infrastructure can be installed at a home base location. Long-haul applications are expected to be served through a mixture of depot charging and high-speed public ZE infrastructure (charging and hydrogen fueling), both of which are expected to become commonplace over time.

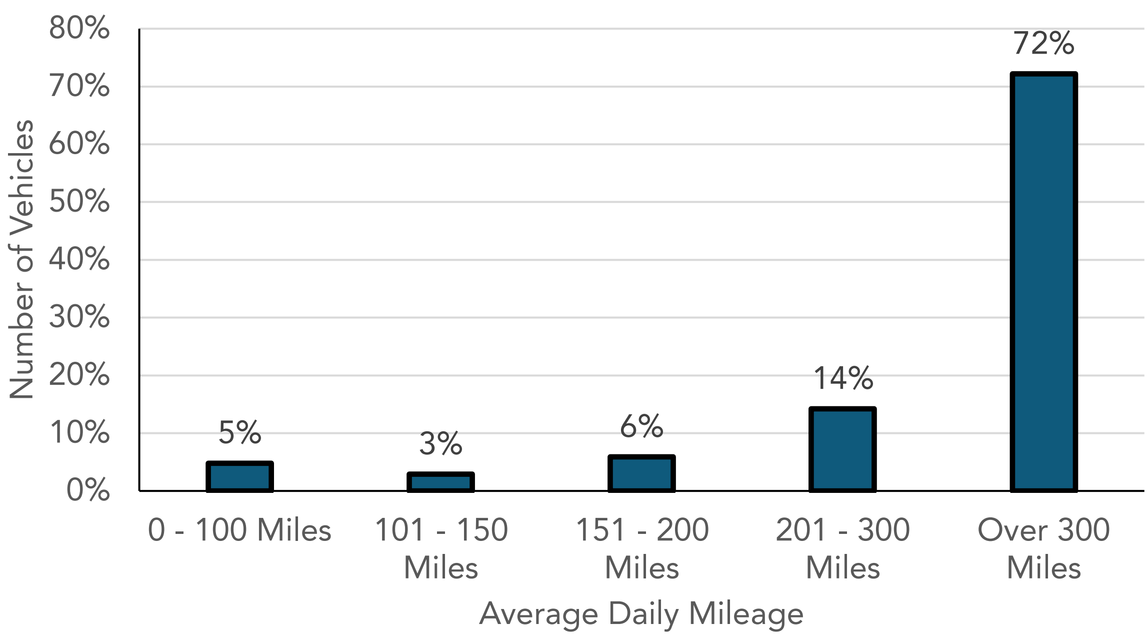
Of the surveyed day cab tractors, 31 percent drove an average of 100 miles daily, 18 percent drove an average of 150 miles daily, 13 percent drove an average of 200 miles daily, and 28 percent drove an average of over 200 miles daily as displayed in Figure 32. Additionally, 58 percent were regularly parked onsite at their respective facility at least 8 hours of the day.

Figure 32: Estimated Average Daily Mileage of Day Cab Tractors Surveyed in Large Entity Reporting



Of the surveyed sleeper cab tractors, 5 percent drove an average of 100 miles daily, 3 percent drove an average of 150 miles daily, 6 percent drove an average of 200 miles daily, and 86 percent drove an average of over 200 miles daily as displayed in Figure 33. Additionally, 10 percent were regularly parked onsite at their respective facility at least 8 hours of the day.

Figure 33: Estimated Average Daily Mileage of Sleeper Cab Tractors Surveyed in Large Entity Reporting



a) Yard Trucks

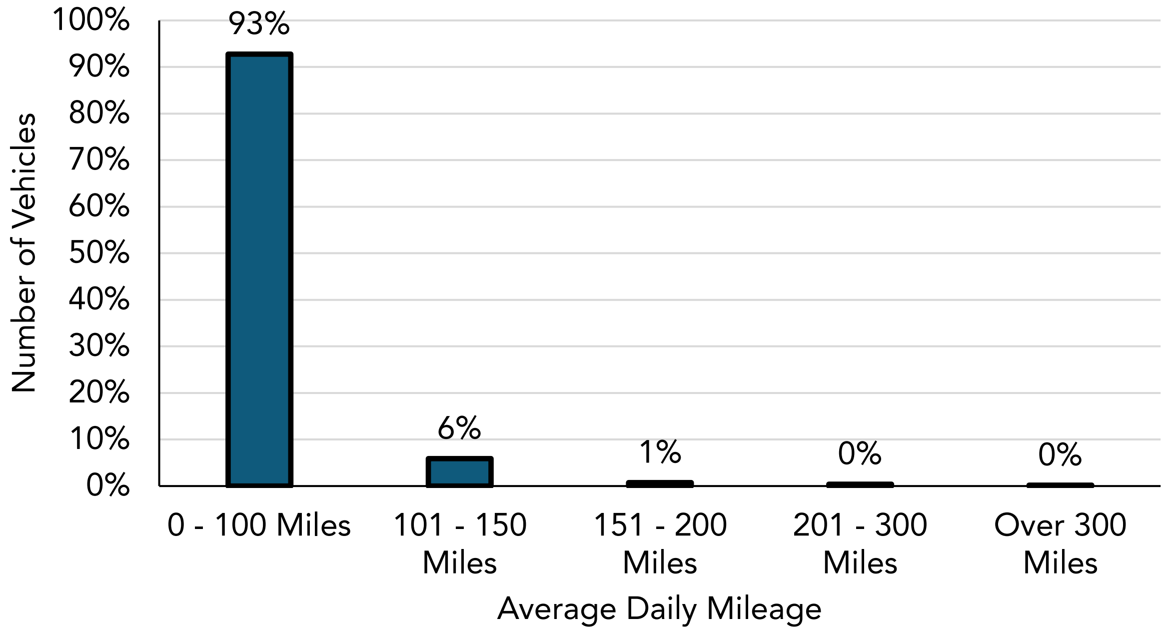
A yard truck is a vehicle with an off-road or on-road engine that is specifically designed for moving trailers and containers over short distances in or around commercial freight yards. These vehicles feature an offset single-person cab that allows for greater visibility during operation and most also have a sliding door with a catwalk on the back of the cab to provide for better trailer connection accessibility. Additionally, these vehicles have a shorter wheelbase for a small turning radius to optimize maneuvering in congested areas. Figure 34 provides examples of yard trucks.

Figure 34: Examples of Yard Trucks

Yard trucks also feature an integrated lifting mechanism and a movable fifth wheel for lifting and moving trailers. These vehicles fall under Class 7-8 and are additionally known as yard goats, trailer spotters, terminal/port tractors, stevedoring tractors, utility tractor rigs, or jockeys in the industry.

Of the surveyed yard trucks in the LER, 9 percent were classified as off-road, and 14 percent were classified as on-road. Additionally, 93 percent drove an average 100 miles daily, 6 percent drove an average of 150 miles daily, and 1 percent drove an over 150 miles daily. A graphical illustration of the estimated average daily miles is shown in Figure 35. Further, 66 percent were regularly parked onsite at their respective facility at least 8 hours of the day.

Figure 35: Estimated Average Daily Mileage of Yard Trucks Surveyed in Large Entity Reporting

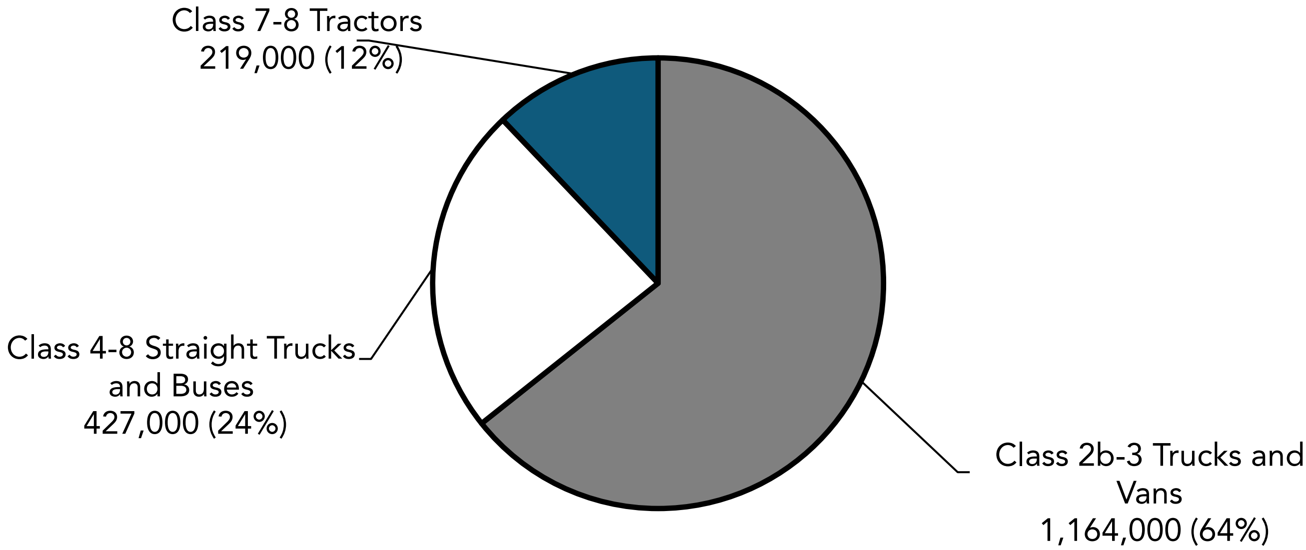


E. Characteristics of Regulated Fleets

This section provides an overview of the inventory of trucks and summary information about the regulated fleet vehicles and operating characteristics. Based on Emission Factor Inventory Model (EMFAC) 2021 data, there are approximately 1.8 million trucks operating in California on a daily basis. These trucks encompass a diverse range of vehicle types, including tractors, utility vehicles, vocational trucks, vans and pickup trucks. Figure 36 provides an overview of the population distribution of van, truck, bus, and tractor vehicle types from Class 2b-8.[88] This distribution includes in-state and out-of-state International Registration Plan trucks, but excludes motorhomes, transit buses, and school buses.

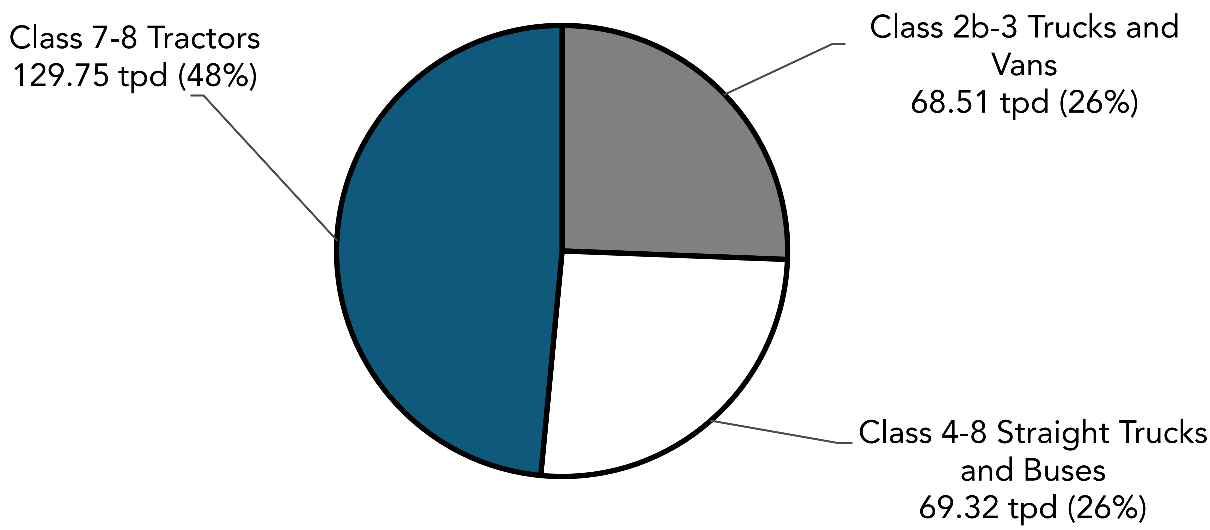
[88] California Air Resources Board, *EMFAC 2021 Database*, 2021 (web link: https://arb.ca.gov/emfac/, last accessed August 2022).

Figure 36: California Medium- and Heavy-Duty Vehicle Population, 2021



Although only roughly 12 percent of vehicles fall within Class 7-8, they account for almost half of California's NOx emissions in the medium- and heavy-duty space, as shown in Figure 37. They also make up a significant portion of PM2.5 and GHG emissions.

Figure 37: California Daily NOx Emissions of Medium- and Heavy-Duty Vehicles, 2021



Due to the disproportionate contribution of emissions from Class 7-8 vehicles compared to their population, the proposed ACF regulation prioritizes vehicles falling under this weight class. As shown in Figure 38 and Table 10, the majority of Class 7-8 vehicles would be affected under the proposed ACF regulation, including the 100 percent ZEV sales requirement.

Figure 38: Breakdown of Vehicles Affected by Proposed ACF Regulation by Vehicle Group and Fleet Type

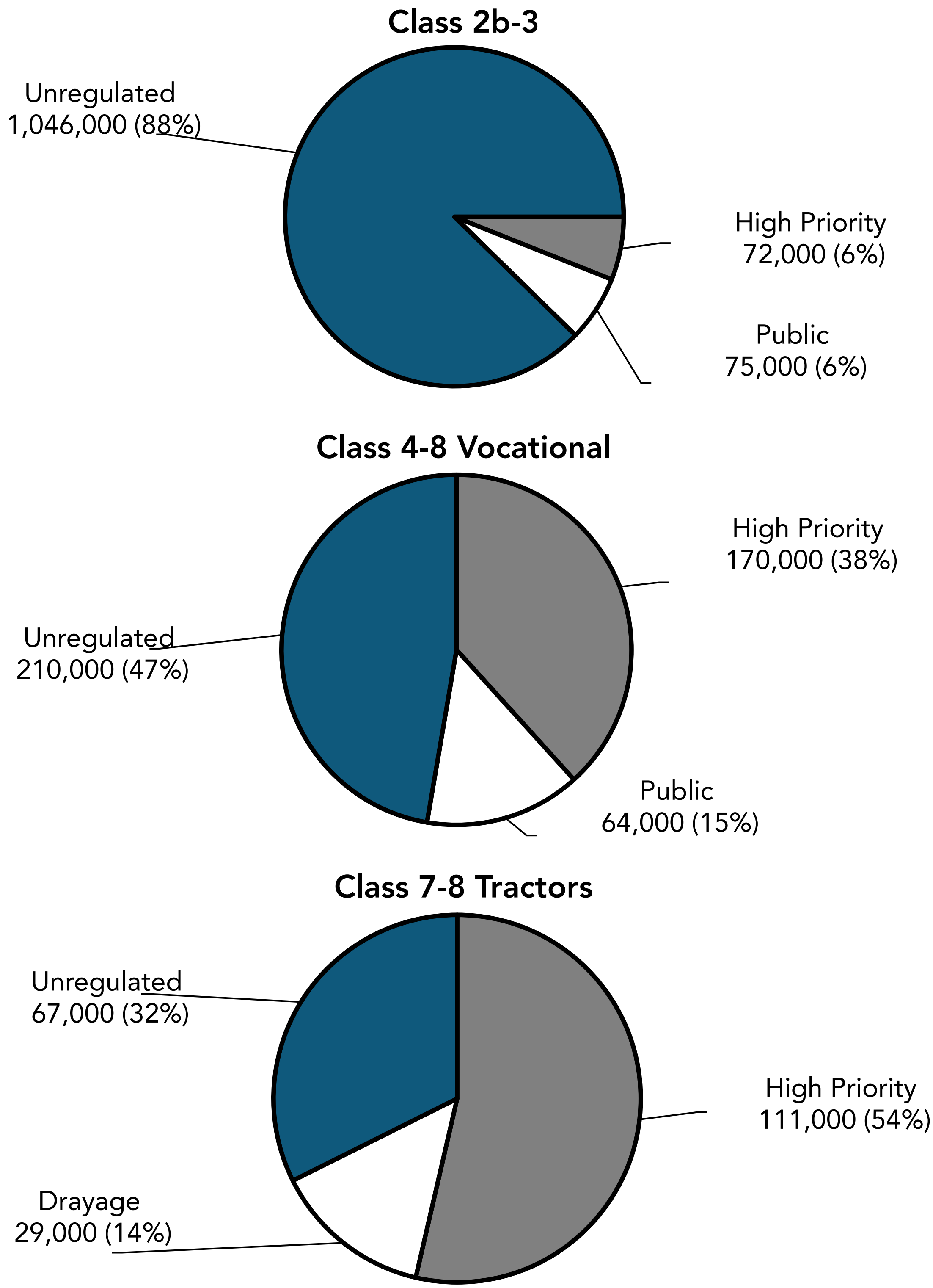


Table 10: Projected Percentage of Vehicles Affected by Proposed ACF Regulation

Vehicle Group	Total Vehicles	Subject to Regulation	Percentage Affected
Class 2b-3	1,193,000	147,000	12%
Class 4-8 Vocational	444,000	234,000	53%
Class 7-8 Tractor	204,000	137,000	68%

Targeting the disproportionate emissions of Class 7-8 vehicles means that the proposed ACF regulation also targets fleets that have been identified as major emitters of GHG and NOx within the State of California. In general, these are a relatively small number of larger fleets operating 50 or more Class 7-8 vehicles with a high number of miles travelled. As such, the high priority portion of the proposed ACF regulation affects fleets who own or dispatch 50 or more vehicles under common ownership or control.

While generally larger fleets would be subject to the proposed ACF regulation, this is not always the case. Due to the nature of how companies and fleets operate, the high priority requirements of the proposed ACF regulation take into account subsidiaries, hired fleets, and other combinations of service vehicles which total 50 or more vehicles, including vehicles and fleets under common ownership and control. The proposed high priority requirements also target companies with total gross annual revenues of at least $50 million that operate at least 1 vehicle as larger corporate bodies are more able to absorb the early impact of transitioning to a ZE fleet.

Alongside high priority fleets, State and local government fleets that operate medium- and heavy-duty vehicles, regardless of size, would have to comply with the proposed ACF regulation. Similarly, all federal fleet and drayage vehicles operating in California would be subject to the proposed ACF regulation. A breakdown of the projected number of vehicles subject to each of the high priority and federal, State and local government, and drayage fleet portions of the proposed ACF regulation is shown in Table 11. The affected fleet composition and characteristics are further discussed in the sections below.

Table 11: Breakdown of Vehicles Affected by Proposed ACF Regulation by Vehicle Group and Fleet Type

Vehicle Group	Number of State and Local Government Vehicles	Number of Drayage Vehicles	Number of High Priority and Federal Vehicles	Number of Vehicles Subject to ACF Fleet Requirements
Class 2b-3	75,000	0	72,000	147,000
Class 4-8 Vocational	64,000	0	170,000	234,000
Class 7-8 Tractor	0	29,000	108,000	137,000
Total	139,000	29,000	350,000	518,000

1. State and Local Government Fleets Overview

This section provides an overview of the many types of State and local government fleets as well as the vehicles owned or leased by municipalities and public utilities. A municipality is a city, county, city and county, special district, or a public agency of the State of California, and any department, division, public corporation, or public agency of this State, or two or more entities acting jointly. Public agencies include public schools and universities, local governments, county landfills, municipal utilities, wastewater treatment facilities, defense, military installations, public works departments, and transportation agencies. Publicly owned utilities (POU) in California provide water, electric, and gas and oil services to agricultural, urban, desert, and mountain communities.

These fleets have a diverse range in vehicle classes, operational uses, and vehicle body types. State and local government fleets consist of a variety of vehicle types, such as buses, trucks and vans, that are distributed amongst Class 2b-8 and are widely used across the different areas of the transportation sector, including public transportation and public works services.

State and local government fleets perform a wide variety of functions with diverse purposes, which include intercity and urban transport, public land management, public infrastructure construction and maintenance, and more. These fleets encompass a range of vehicle types that extend from pickups and vans to special function vehicles, such as buses, street sweepers, and vacuum trucks. Local cities and counties, for example, incorporate refuse vehicles for the collection of solid waste for disposal. Public utility fleets might use vocational trucks to fulfill water and electric service needs, but also extend to other vehicles for the purposes of passenger transportation and cargo hauling.

a) Types of Vehicles Owned/Used, Usage Characteristics Based on Large Entity Reporting

State and local government fleets consist of a variety of different body types, ranging from Class 2b pickups to Class 8 garbage packers, and are used for several different purposes. The reported State and local government vehicle type distribution is shown below in Table 12.

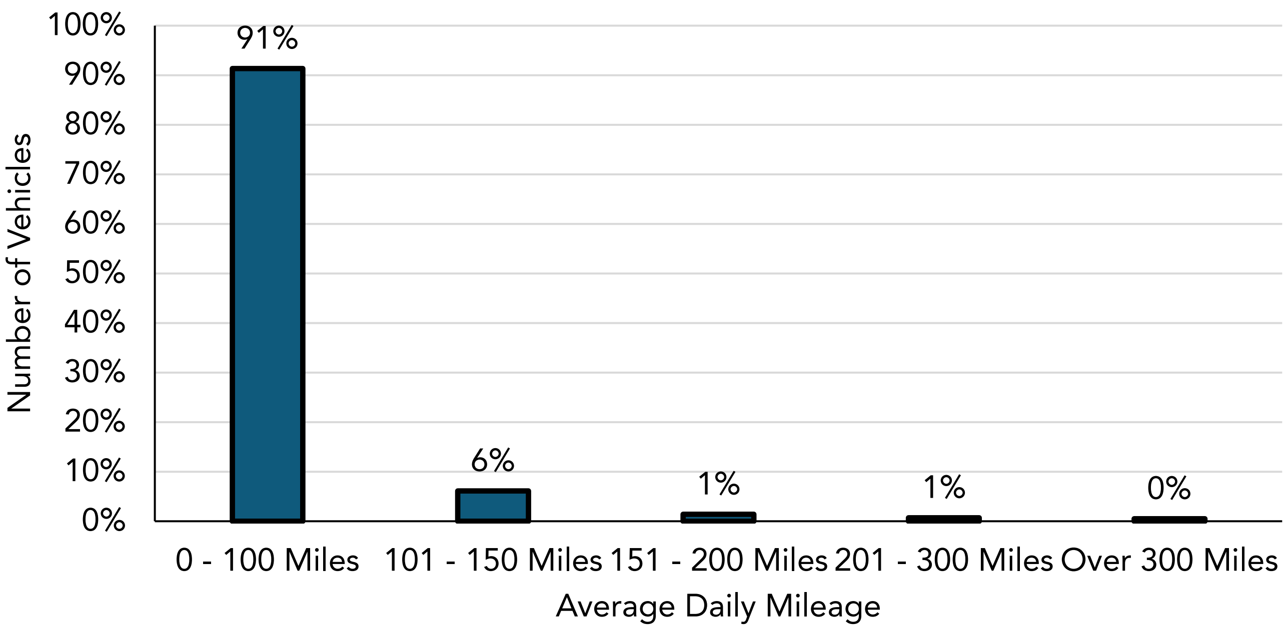
Table 12: Large Entity Reporting State and Local Government Vehicle Type Distribution

Vehicle Type	Percent of Vehicles
Service Body	25%
Pickup	20%
Dump	9%
Flatbed or Stake Bed	7%
Cargo Van	7%
Passenger Van	4%
Other Bus	4%
Garbage Side Loader	3%
Boom/ Bucket	3%
Box Dry Van	2%

According to the LER distribution, more than half of vehicles operating under State and local government fleets are either service body vehicles (25 percent) or pickup trucks (20 percent). Dump trucks (9 percent), flatbed or stake bed (7 percent), and cargo vans (7 percent) compose another 23 percent of the fleet. Passenger vans (4 percent), other buses (4 percent), garbage side loaders (3 percent), boom/bucket trucks (3 percent), and box dry vans (2 percent) constitute the remainder of State and local government fleets. The majority of the service body populations falls under Class 2b-3.

Based on the results of the LER, a 92 percent majority of State and local government fleet vehicles are estimated to operate for 100 miles per day or less, 6 percent are estimated to operate between 101 and 150 miles per day, 1 percent operate less than 200 miles daily and the remaining 1 percent are estimated to operate for more than 200 miles per day. Accounting for 88 percent of the reported State and local government fleet population in the LER, most vehicles are regularly parked at the home base facility for more than 8 hours each day and 51 percent of the vehicles typically return to their home base facility on a daily basis. Additionally, these vehicles are typically owned for 11-15 years and primarily operate less than 10,000 miles annually, according to the LER. Figure 39 shows the LER distribution of the estimated average daily mileage of vehicles in State and local government fleets.

Figure 39: Estimated Average Daily Mileage of State and Local Government Vehicles Surveyed in Large Entity Reporting



2. Federal Fleets

Federal entities located in California have a wide range of functions, including courthouses and post offices, and additionally incorporate public-domain land, military reservations, national parks, and national wildlife refuges.

Federal fleets have a variety of different body types, ranging from Class 2b cars and SUVs to Class 8 tractor day cabs, and are used for several different purposes. The U.S. Postal Service largely incorporates step vans to accomplish delivery services, but also uses other vehicles, such as cargo vans, and box trucks. Federal fleets also utilize specialty and vocational trucks as part of forestry service, for example, such as boom trucks and water trucks.

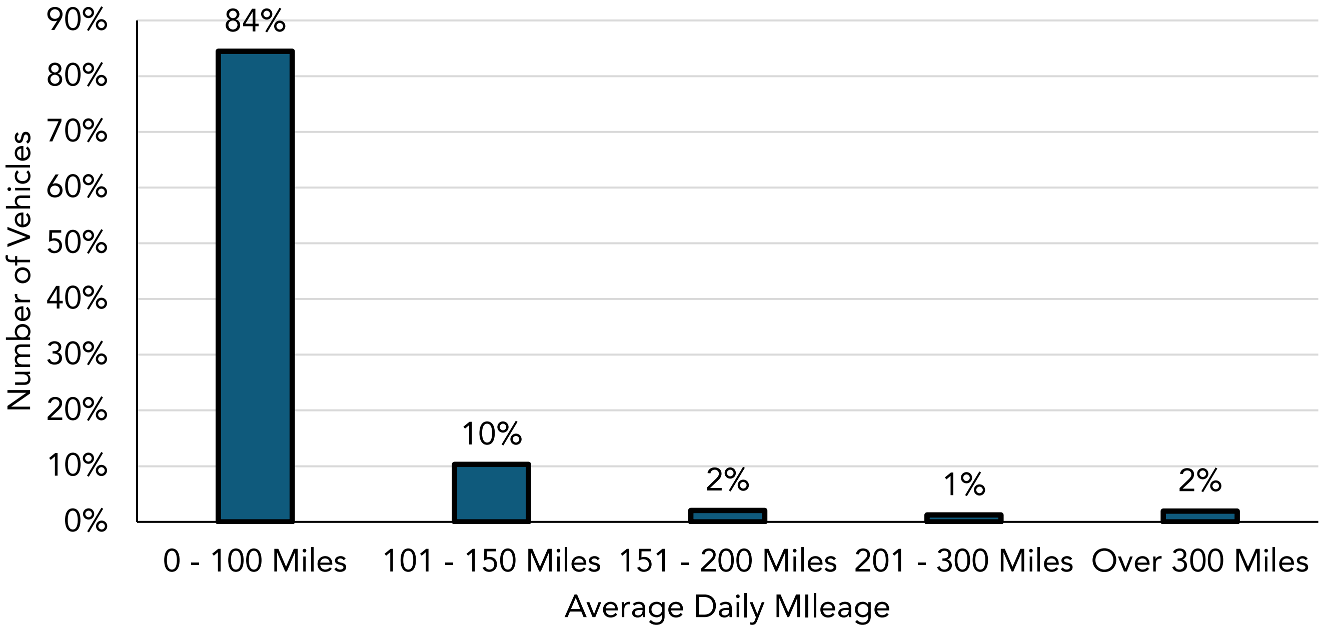
Table 13 demonstrates the ten largest LER populations amongst federal fleets across Class 2b-8, organized by vehicle type. Pickups are estimated to be the most widely used vehicle type amongst the federal fleets with the majority of the pickup populations falling under Class 2b-3.

Table 13: Large Entity Reporting Federal Fleet Vehicle Type Distribution

Vehicle Type	Percent of Vehicles
Pickup Bed	28%
Service Body	13%
Cargo Van	12%
Passenger Van	9%
Car/ SUV	7%
Flatbed or Stake Bed	5%
Tractor Day Cab	4%
Tractor Sleeper Cab	2%
Step Van	1%
Shuttle Bus	1%

The LER data also estimates that approximately 85 percent of reported federal fleet vehicles operate 100 miles per day or less, 10 percent of these vehicles average 150 miles per day or less, 2 percent average less than 200 miles per day, and the remaining 3 percent operate for more than 200 miles per day. It is also estimated that on a daily basis, about 10 percent of the vehicles reported in the LER return to their home base facility. Accounting for 50 percent of the reported federal fleet population in the LER, most vehicles are regularly parked at the home base facility for more than 8 hours each day. Additionally, these vehicles are reported to be typically owned for 11-15 years or 16-20 years and primarily operate for less than 5,000 miles annually, according to LER data. Below, Figure 40 shows the LER distribution of the estimated average daily mileage of vehicles in federal fleets.

Figure 40: Estimated Average Daily Mileage of Vehicles in Federal Fleets Surveyed in Large Entity Reporting



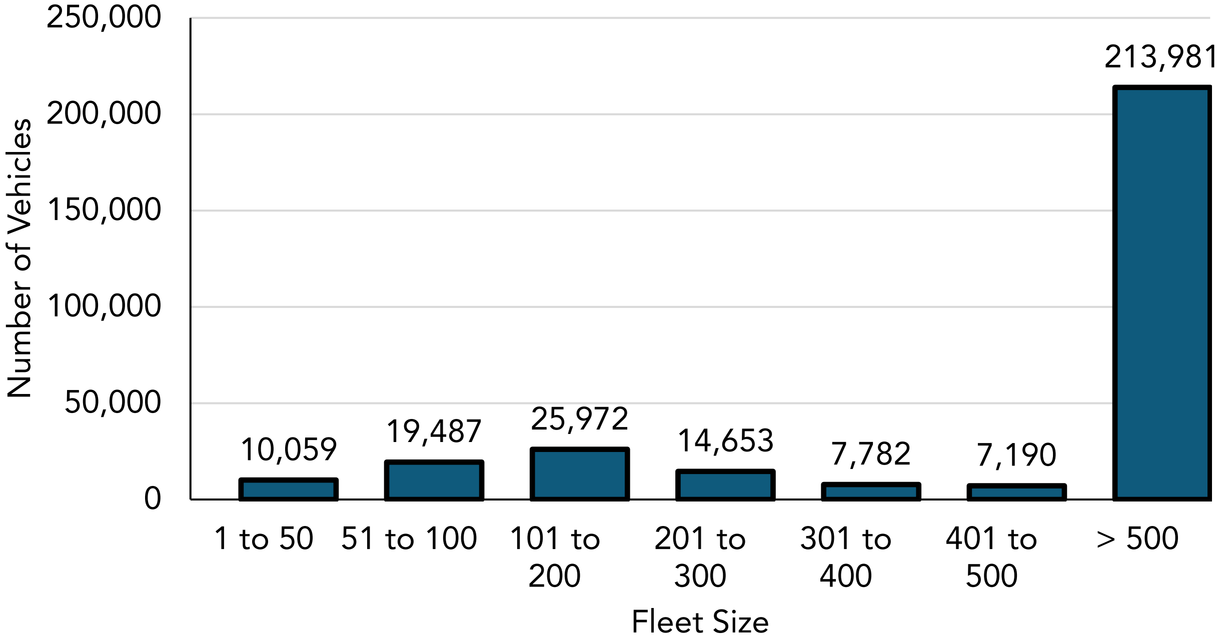
3. High Priority Fleets Commercial Fleets

High priority fleets are owned and operated by large commercial entities. Large commercial fleets typically fall into two categories: for-hire carriers and private carriers. For-hire carriers, such as FedEx and UPS, are fleets that provide goods transportation services for another company, whereas private carriers (e.g., Walmart, Pepsi Co.) transport their own cargo. The industries serviced by commercial fleets include, but are not limited to, grocery, petroleum, construction, manufacturing, retail and wholesale trade, household goods, waste management, beverage, and agriculture. Commercial fleet vehicles include a mix of trucks of different classes and various body types to meet the needs of the market segment. Body types can range from Class 2b delivery vans to Class 5 box trucks to Class 8 tractor-trailers and include many other truck types in between.

a) High Priority Fleet Representation Based on Large Entity Reporting

According to LER data, 1,170 entities (63 percent of all participants) reported as a non-governmental agency which accounted for approximately 300,000 vehicles or 77 percent of vehicles reported. LER data shows that 85 percent of the vehicles reported were comprised of fleets with 100 or more vehicles and 70 percent of the vehicles were made up of fleets of 500 or more vehicles. This data shows that large fleets account for a majority of the vehicles subject to ACF, with most of these fleets falling under the high priority fleet segment. Below, Figure 41 shows the LER distribution of the number of vehicles by fleet size for non-governmental fleets.

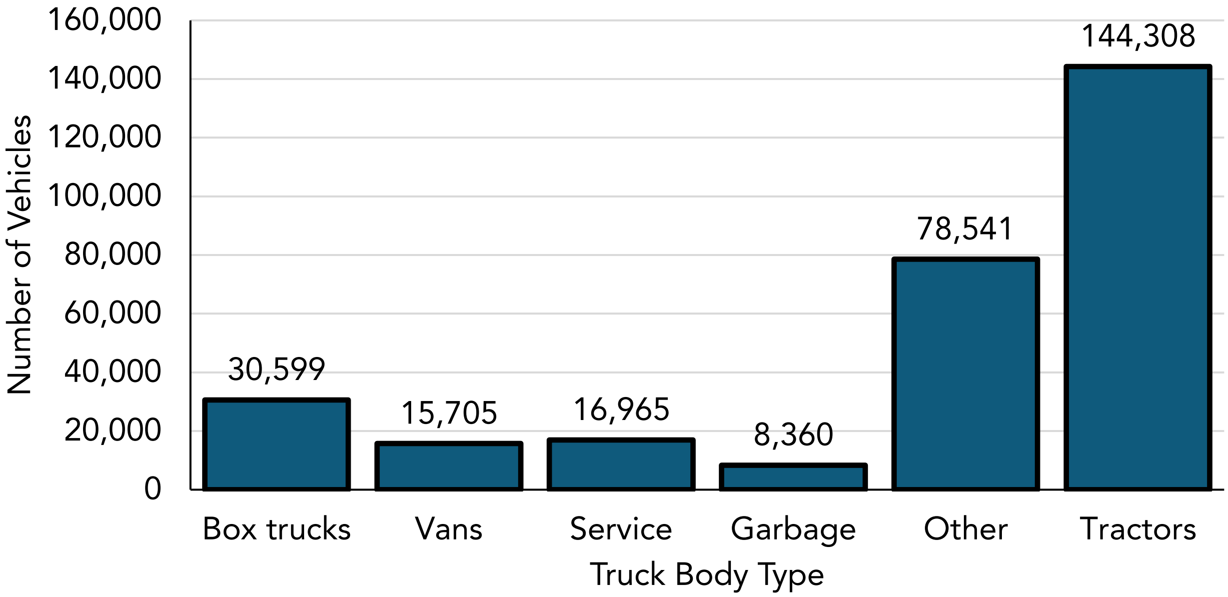
Figure 41: Number of Vehicles by Fleet Size (Non-Governmental)



b) Truck Body Type of High Priority Fleets Based on Large Entity Reporting

As described above, the industries serviced by commercial fleets are numerous which require several different truck body types to meet the specific needs of the market segment. Based on LER data, the various body types used by high priority fleets include vans, box trucks, dump trucks, garbage trucks, car carriers, water trucks, concrete mixers, and many more. However, Class 7-8 tractors make up the largest percentage (about 49 percent) of all the truck body types used by high priority fleets. Below, Figure 42 shows the LER distribution of the number of vehicles by vehicle type for non-governmental fleets.

Figure 42: Number of Vehicles by Truck Body Type (Non-Governmental)



c) Mileage by Truck Body Type Based on Large Entity Reporting

The truck types and market segments of vehicles included in the high priority fleet segment vary greatly across the many industries. As a result, the daily mileage of a truck is largely dependent on the market segment a fleet is servicing. Based on LER data, tractors are the group of trucks that have the highest daily mileage with about 44 percent of tractors traveling over 300 miles per day. However, long distance travel is not the norm for most truck operations. As shown in Table 14 below, most truck operations require travel of less than 150 miles per day.

Table 14: Daily Mileage by Truck Body Type

Truck Body Type	Percentage of Trucks Traveling 100 Miles or Less	Percentage of Trucks Traveling 150 Miles or Less
Pickup and Utility	83%	95%
Cargo and Step Van	87%	96%
Box Truck	50%	72%
Vocational	80%	91%
Refuse	82%	94%
Truck Tractor	19%	30%
Yard Truck	93%	99%

4. Drayage Fleets

Drayage trucks are defined as in-use on-road Class 7-8 trucks (trucks with a GVWR of greater than 26,000 lbs.) that are used for transporting cargo, such as containerized bulk, or break-bulk goods, that (1) operate on or transgress through seaport of intermodal railyard property for the purpose of loading, unloading, or transporting cargo, including transporting empty containers and chassis; or (2) operate off seaport or intermodal railyard property transporting cargo or empty containers or chassis that originated from or is destined to a seaport or intermodal railyard property.

Drayage trucks are typically part of a specialized fleet that primarily moves cargo to and from seaports and intermodal railyards to near-dock, local, or regional transloading facilities or warehouses to be stored or re-packaged before the cargo moves to the next destination. Staff estimates that approximately 57 percent of drayage fleet owners have 4 or more trucks. This percentage is based on CARB's analysis of drayage trucks registered at the San Pedro Bay and Oakland seaports, and California Department of Motor Vehicles (DMV) registration data. Most drayage truck owners work with and are dispatched by licensed motor carriers. Licensed motor carriers act as an intermediary business connection between the shippers and customers for which most drayage trucks are dispatched.

To estimate the number of drayage trucks subject to the proposed regulatory requirements, staff used data from the CARB Drayage Truck Registry, seaports, and intermodal railyards. The estimated population was then divided into an active or inactive fleet category. Staff assumed a truck to be a part of the active fleet if they visited an average of 2 or more times per week or 112 times per year. This visit frequency threshold provides a conservative baseline estimate of the number of active drayage trucks to ensure appropriate costs, infrastructure, and trucks are considered for current and future planning efforts.

From this analysis, staff estimates that approximately 33,310 drayage trucks service California seaports and intermodal railyards annually. Of those trucks approximately 28,700 actively service California seaports and intermodal railyards. Table 15 shows the estimated active drayage truck population in calendar year 2019, which serves as the baseline for the emissions and economic analysis.

Table 15: Active Drayage Truck Population 2019

Vehicle Category	Port of Oakland (POAK)	Port of LA/LB (POLA)	Other Seaports*	Intermodal Railyards**	Total
Instate Class 8† Active Trucks* **	4,200‡	14,000‡	1,500‡	9,000	**28,700**
Instate Class 8 Inactive Trucks* **	n/a***	2,800	n/a	n/a	**2,800**
Instate POAK Class 8 already in POLA	140	n/a	n/a	n/a	**140**
Out of State	820	850	n/a	n/a	**1,670**
Total	**5,160**	**17,650**	**1,500**	**9,000**	**33,310**

‡ T7 Port of Los Angeles and Port of Long Beach (POLA) Class 8, T7 Port of Oakland (POAK) Class 8, and T7 Other Ports Class 8 in EMFAC2021
* Estimate based on past surveys.
** Estimated based on information provided by Union Pacific Railroad and Burlington Northern Santa Fe Railway.
*** POLA trucks with more than an average 2 visits/week or 112 visits/year are considered as "active truck The 112 visit/year was determined based on POLA monthly active truck counts. POAK did not prov monthly visit data and therefore all POAK Class 8 in-state trucks were considered active.

a) Drayage Fleet Operational Characteristics

Drayage trucks generally travel a limited number of miles daily and then return to a home base. The 2018 Feasibility Assessment for Drayage Trucks, an operator survey, found that approximately 72 percent of trucks park overnight at a motor carrier home base, lot, or facility.[89] In addition, most drayage trucks typically perform 3 types of services or duty cycles:

- near-dock (6-8 miles one way),
- local or intermodal railyard (8-20 miles), and
- regional (20-120 miles).

Drayage trucks are generally part of a dedicated fleet that typically operate within these duty cycles. Table 16 shows the average operational parameters from the feasibility assessment.

[89] San Pedro Bay Ports, *2018 Feasibility Assessment for Drayage Trucks*, 2020 (web link: https://cleanairactionplan.org/download/222/other-documents/5029/final-drayage-truck-feasibility-assessment.pdf, last accessed August 2022).

Table 16: San Pedro San Pedro Bay Ports, 2018 Feasibility Assessment for Drayage Trucks Average Drayage Truck Operational Parameters

Operational Parameter	Units	Value
Average Shift Distance	Miles	160
Average Shift Duration	Hours	9.9
Average Shifts Per Day	#/day	1.6
Average Daily Operating Time	Hours	14.8
Average Daily Mileage	Miles	238

According to the I-710 Project Key-Performance Parameters for Drayage Trucks CALSTART 2013 survey, approximately 81 percent of drayage trucks that visit California's seaports report most trip distances under 60 miles.[90] This is consistent with other studies that have found that most drayage trucking companies being located within 10 miles of the port complex.[91] Truck operators also reported that they typically complete 3 roundtrips per day with 85 to 90 percent reporting only 1 shift per day. Table 17 shows the percentage of reported trip distances.

Table 17: I-710 Project Key-Performance Parameters for Drayage-Trucks, CALSTART 2013: Drayage Typical Trip Distance

Trip Distance	% of Trips	% Total
<10 miles	13%	13%
10-20 miles	23%	36%
20-40 miles	23%	59%
40-60 miles	22%	81%
60-100 miles	15%	96%
100+ miles	5%	100%*

*Exception due to rounding.

Currently available commercial ZE heavy-duty trucks can meet the average daily operations for drayage trucks based the findings from both the San Pedro Bay 2018, and CALSTART 2013 studies. Below, Section F provides an overview for both the current and anticipated availability of Class 7-8 ZE trucks and includes details for make, type, and commercial availability. The proposed ACF regulation provides a phase-in approach which provides opportunity for the longer or regional drayage trips to utilize the legacy fleet as both the technology and infrastructure develop.

[90] CALSTART, *Performance Parameters for Drayage Trucks Operating at the Ports of Los Angeles and Long Beach*, 2013 (web link: https://calstart.org/wp-content/uploads/2018/10/I-710-Project_Key-Performance-Parameters-for-Drayage-Trucks.pdf, last accessed August 2022).

[91] Port of Long Beach, *Fueling the Future Fleet: Assessment of Public Truck Charging and Fueling Near the Port of Long Beach*, 2021 (web link: https://polb.com/download/379/zero-emissions/12744/final-polb-charging-study-12-sep-2021.pdf, last accessed August 2022).

F. Medium- and Heavy-Duty Zero-Emission Vehicle Market

The ZEV market continues to rapidly evolve. A wide variety of ZE trucks and buses are available today with continued growth expected to expand options. Innovative start-up manufacturers have led the way for ZEV market development with major manufacturers also entering and contributing to the market. Major parts suppliers continue to introduce commercial components with a wave of prominent initial public offerings, mergers, and acquisitions in the industry. Both start-ups and mainstream equipment manufacturers have announced significant investments in new vehicle lineups. This section highlights the advances in the ZEV market and provides an overview of the ZEVs that are already manufactured and available in the market today.

BEVs and FCEVs are the most common examples of currently available ZEVs and are the foundation of staff's proposed ACF regulation. BEVs utilize batteries with an on-board charger to store energy from the electrical grid to power electric motors. Currently, medium- and heavy-duty BEVs with nominal ranges of 100-200 miles per charge are commonly available. A few models are available with a range over 300 miles. More longer-range BEVs are expected to become available as technology continues to improve.[92]

FCEVs use hydrogen stored on-board the vehicles to generate electricity for electric motors. The range and fueling time of these vehicles are comparable to conventional ICE technologies. FCEVs have demonstrated the feasibility of being integrated into regular fleet operations as they can provide similar capacity, range, and fueling capabilities as conventional vehicles. However, they tend to have higher curb weight compared to conventional vehicles and near-term costs are still high.

NZEVs are defined in the proposed ACF regulation as vehicles capable of operating as a ZEV for a certain number of miles as established in title 13, CCR section 1963(c)(16). Essentially, these vehicles are PHEVs powered by both an internal combustion and battery-electric powertrain that are capable of operating like a ZEV for a limited time. NZEVs are considered a bridge technology, which will assist in the development of the full ZEV market as they have the same electric drivetrain components. These vehicles provide flexibility to meet applications that are not well-suited for full ZEVs and promote the development of ZE component supply chains, training, and education as well as provide an opportunity for fleets to gain experience with electric drivetrains without range anxiety. Hybrid vehicles that cannot operate part-time as ZEVs, or vehicles powered solely by engines that do not allow the vehicles to comply with the proposed performance standards of emitting zero exhaust emissions of either criteria or greenhouse gases, i.e., vehicles powered only by internal combustion engines fueled by diesel, CNG, or gasoline, are not considered to be "near-zero."

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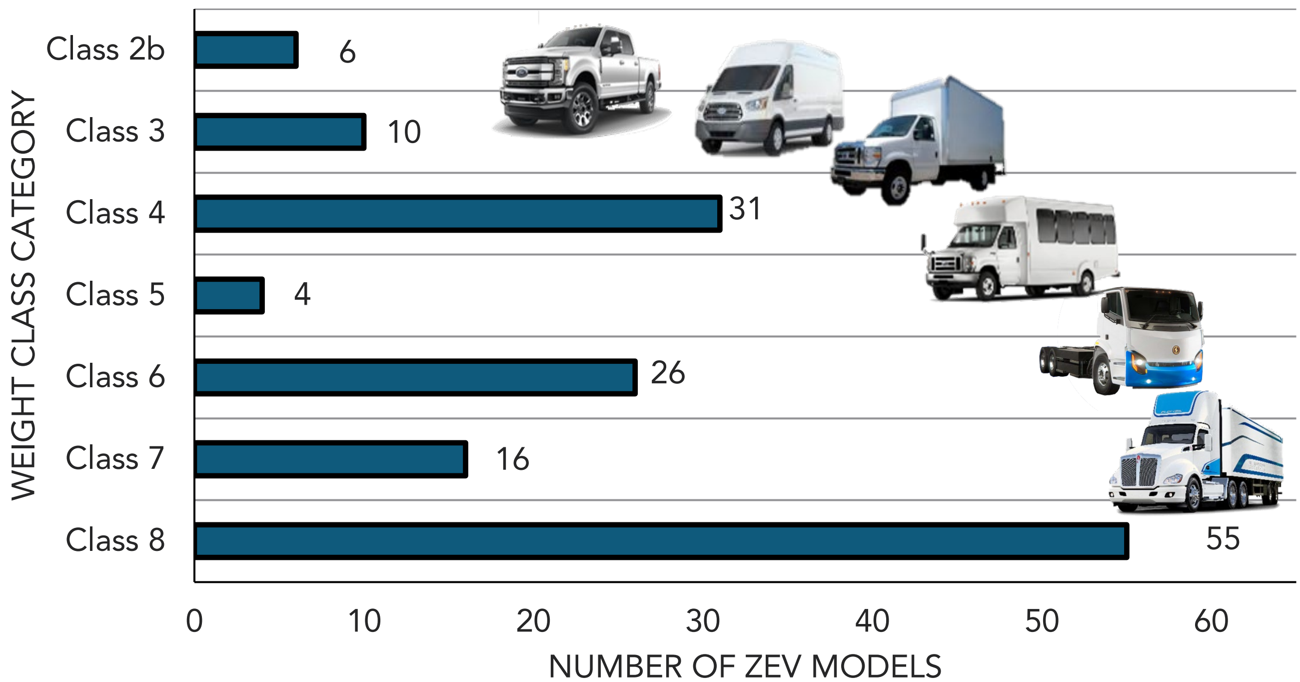
[92] CALSTART, *How Zero-Emission Heavy-Duty Trucks Can Be Part of the Climate Solution*, 2021 (web link: https://globaldrivetozero.org/site/wp-content/uploads/2021/05/How-Zero-Emission-Heavy-Duty-Trucks-Can-Be-Part-of-the-Climate-Solution.pdf, last accessed August 2022).

1. Currently Available ZEVs and Manufacturers

Technology developments as well as the number of participating manufacturers for BEVs and FCEVs have rapidly progressed over the last decade, which has led to the market introduction of ZEVs in every weight class. Within these weight classes, a wide range of vehicle configurations exist that can perform a variety of functions. Staff analysis shows there are 148 models in North America where manufacturers are accepting orders or pre-orders; 135 models are actively being produced and are being delivered to the customer. Figure 43 illustrates available ZEVs across every weight class category and each includes a considerable range of truck configurations. CARB staff verified the list by reviewing manufacturer press releases, articles, and in communicating with the manufacturer directly.

Figure 43: Number of Commercially Available ZEVs



There are currently 6 van models and 3 pickup trucks in Class 2b-3 that are commercially available, in which they are available to order or have had at least one model delivered to a customer. In addition, 2 other pickup truck model and at least 3 more vans are to be released by the end of 2022. In Class 4-5, there are 14 commercially available single-unit truck and 7 van models. In Class 6-7, there are 18 truck models and 3 van models that are commercially available. In Class 7 and 8, there are 28 truck models available. Of those, 8 tractor models are commercially available with another 5 tractors coming available by the end of 2023. Additionally, multiple new and existing truck parts suppliers have developed a variety of ZE drivetrain components including electric motors, batteries, and e-axles that are being deployed in ZEVs today.

In addition to options that are currently commercially available, the ZEV market is already expanding to include more models. California adopted the ACT regulation to ensure that manufacturers sell ZEVs as an increasing part of their total truck sales in California starting with the 2024 MY. At present, all major truck manufacturers have announced new ZEV models for North America, and most have plans to launch them prior to 2024. Other states are following suit and are adopting the same ZEV sales requirements. As ZEV sales increase with scale, the incremental costs are expected to decline faster ultimately resulting in greater ZEV attainability.

a) Manufacturers of Zero-Emission Vehicles

The number of available and announced models of new medium- and heavy-duty ZEVs is expected to grow. There are many manufacturers that have made investments in ZEVs with ZEV offerings in the market today that extend across each weight class in an array of configurations. Table 18 and Appendix J provides a current list of manufacturer and model of medium- and heavy-duty ZEVs that are commercially available.

Table 18: Vehicles Produced by Weight Class and Manufacturer

Parent Company	Class
Arrival	2b
Blue Bird	6, 7, 8
BYD Motors	4, 5, 6, 7, 8
Canoo	2b, 3
Daimler Trucks	4, 6, 7, 8
Envirotech Vehicles	3, 4
Ford	2b, 3
GILLIG	8
GM	2b
GreenPower Motor	4, 5, 6, 8
Hyundai	8
Kalmar	8
Lightning eMotors	3, 4, 5, 6, 8
Lion	6, 7 ,8
Lonestar SV	8
Motiv Power Systems	4, 5, 6
Navistar	6, 7, 8
NFI Group	8
Nikola Motors	3, 8
Optimal EV	4, 8
OrangeEV	8
PACCAR	6, 7, 8
Phoenix Motorcars	4, 8
Proterra	8
REV-Collins Bus	5-6
Rivian	2B
ROUSH CleanTech	6
SEA Electric	4, 5, 6, 7, 8
Tesla	2B, 8

Parent Company	Class
US Hybrid	3, 4, 8
Van Hool NV	8
Volvo	7, 8
Workhorse	3
XOS Trucks	6, 7, 8
Zeus	4, 5, 6, 7

Due to a higher ZEV demand from the ACT and proposed ACF regulation, production of ZEVs by businesses in California would likely expand, leading to increases in ZEV manufacturing, supply chains, and workforce development.

G. Zero-Emission Vehicle Infrastructure

This section discusses how the State is assessing the future demand and availability of ZE vehicle fueling stations including the electricity and hydrogen required. In addition, this section includes a discussion on how fleets and facilities may approach charging strategies and typical infrastructure costs. A discussion on hydrogen fueling in the context of production, distribution, and standardization is also included. Finally, this section discusses timeframes for infrastructure planning, development and deployment as well as other State agency actions and private investments.

CARB, in partnership with GO-Biz, CEC, CPUC and California Independent System Operator (CAISO) initiated a series of infrastructure-focused workgroup meetings to collaborate with fleets, facility owners, electric utilities, and fueling providers regarding the rollout and requirements of ZE refueling infrastructure. CEC is predicting the need for 157,000 chargers by 2031 in California and up to 258,000 by 2037.[93,94] CARB and CEC continue to collaborate to ensure that modeling is refined to better represent growth in ZE truck populations, both geographically and over time. Ongoing agency collaboration will ensure sufficient infrastructure is available for fleets.

1. ZEV Infrastructure Planning and Deployment

1. Depot and public charging options

Commercial vehicles engage in a wide variety of daily operations and the two most common types of operations include a hub and spoke operation where vehicles return to a home base or a long-haul operation where vehicles tend to be more transient. Different types of vehicles and infrastructure are required to address this variety.

Depot or home-base refueling is ideal for fleets that utilize a hub and spoke operation where vehicles return to a home base at the end of the shift. Postal delivery operations, last mile and regional delivery operations, bus operations, and governmental organizations fit this

[93] California Energy Commission, *2127 Report*, 2021 (web link: https://efiling.energy.ca.gov/getdocument.aspx?tn=238853, last accessed August 2022).
[94] California Air Resources Board, *Draft 2022 State Strategy for the State Implementation Plan*, 2022 (web link: https://ww2.arb.ca.gov/sites/default/files/2022-01/Draft_2022_State_SIP_Strategy.pdf, last accessed August 2022).

usage model where fleets can park their vehicles at a depot when off-shift. These situations are well suited for initial electrification because infrastructure for overnight charging operations can be centralized and managed. Fleets may also augment daily operations with an opportunity charge at a public or private charger during the day.

Fleets operating longer distances and those without access to home base charging, will benefit from high-speed public charging infrastructure of up to 350 kW capable of charging a vehicle in 1-3 hours. Staff is assuming that non-tractor trucks traveling under 200 miles per day will rely solely on depot charging until 2030, while Class 7-8 tractor trucks will rely on depot charging for 25 to 75 percent of the time, depending on vehicle range, duty cycles, and access to infrastructure both at home and away. The proposed ACF regulation provides flexibility for fleets to initially target the best suited use cases.

Today commercial high powered public charging is still developing and will eventually play a role in enabling longer-range battery-electric trucks (e.g., sleeper cabs). Freight and drayage truck drivers may want to rely on solutions that emulate what they are accustomed to—a public truck stop model. Conventional fuel suppliers are working with industry to develop fast charging solutions at/or near truck stops, and hydrogen station developers are currently adding hydrogen fueling to several retail heavy-duty diesel stations.[95,96] As more fuel cell trucks become commercially available, they will likely rely solely on publicly accessible high-speed hydrogen refueling infrastructure.

California Department of Transportation's (Caltrans) ongoing parking study work will inform and assist funding programs to identify priority locations for new charger investments that will support publicly accessible charging and increase operator safety. In addition, improving signage to help drivers locate charging facilities is also being addressed.

Technological improvements like mobile applications also have the potential to assist fleets to identify and potentially reserve charging locations that are suitable for commercial vehicles, such as by having driver facilities and room for vehicles to comfortably navigate. CARB is piloting a program designed to assist small fleets in successful ZEV deployment and lessons learned will help shape charging strategies.

a) High-Powered Public Charging

An extreme high-powered charging system is under development with the promise of up to 3.75 megawatt of charging capacity that could greatly reduce charging times to well under an hour and enable ZE adoption in some of the most demanding duty cycles. The majority of the major truck OEMs and infrastructure providers are participating in a Megawatt Charging System Task Force led by the Charging Interface Initiative.[97] The Task Force was formed to create a common solution for high-power charging of fully commercial heavy-duty EVs and is

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[95] California Energy Commission, *See projects awarded through GFO-20-605 BESTFIT Innovative Charging Solutions*v, 2020 (web link: https://www.energy.ca.gov/solicitations/2020-08/gfo-20-605-bestfit-innovative-charging-solutions, last accessed August 2022).
[96] California Air Resources Board, *2021 Annual Evaluation of Fuel Cell Electric Vehicle Deployment and Hydrogen Fuel Station Network Development*, 2021 (web link: https://ww2.arb.ca.gov/sites/default/files/2021-09/2021_AB-8_FINAL.pdf, last accessed August 2022).
[97] CHARIN, *CharIN and the Megawatt Charging System*, 2022 (web link: https://www.charin.global/technology/mcs/, last accessed August 2022).

working out the requirements for connectors, EVSEs, vehicles, communications, safety and related hardware. The promise of a global high-powered charging standard would ensure widespread compatibility and minimize any stranded assets in vehicles, connectors and chargers. CEC has funded two high powered charging demonstration projects that are currently under development via the Research Hub for Electric Technologies in Truck solicitation.

b) Rural Charging Infrastructure

Rural parts of California, with their lower population densities and dispersed geography, have unique challenges when it comes to fueling infrastructure. The State has recognized these challenges and taken multiple actions to ensure reliable and affordable infrastructure access. CEC continues to study the availability of public chargers across California and examine the location and distance vehicle owners would need to travel to publicly charge. This ongoing work overlaps with both the light-duty and heavy-duty focus and serves as a foundation to inform rural investment needs. In addition, significant new federal funding targets rural infrastructure improvements that can assist with State efforts.

The dispersed nature of stations can make service more challenging, and rural electrical distribution often lacks the redundancy of urban centers where distribution costs and benefits can be more widely shared. Assembly Bill 841 requires investor owner utilities to provide certain utility upgrades to customers free of charge which ensures that rural projects will not face potentially expensive utility grid upgrade costs for their projects.[98] In response to station uptime concerns, CEC is working to include minimum station reliability standards in all funded projects with a potential 97 percent uptime requirement.

Rural communities continue to face significant power outages due to public safety power shutoff (PSPS) events, which are planned grid outages designed to mitigate fire hazards. CPUC has directed impacted utilities to implement mitigation strategies during outages and a detailed discussion is included in the grid resiliency section below. CARB staff will continue to monitor the situation as grid hardening continues.

c) Border Ports of Entry

Infrastructure issues at ports of entry at the Southern border are similar to those in all areas of California with the exception of the potential for availability on the Mexican side of the border. In addition, many of the fleets that operate at, and across the border are small fleets, and will need to rely on public charging.

Cross-border commerce is an important part of the economies of both Mexico and California. In addition, the two border crossings, one in Otay Mesa and one in Calexico, lie on or near the major East/West and North/South goods movement corridors of Interstate 8 and Interstate 5, respectively. Given the needs for infrastructure at these locations, CARB staff has worked with the Otay Mesa Chamber of Commerce, as well as other State agencies, including, GOBIZ, CPUC, CEC, and Caltrans, as well as with the San Diego Area

[98] AB 841 (Ting, Stats, 2020, ch. 372). Public Utilities Code new sections 740.18, 740.19, 740.20, 1600, 1601, 1610 through 1618, 1620 through 1627, 1630 through 1633, 1640. Amendments to Public Utilities Code section 740.12.

Governments local planning agency, on possible assistance and solutions, including discussions of available funding for infrastructure in the area.

d) Infrastructure Cost

CARB staff has extensively analyzed cost data from a multitude of pilot and demonstration projects as well as published reports to determine accurate cost data. Individual fleet costs may vary because each has a different set of conditions based on their own unique situation.

Staff's analysis assumes that the majority of fleets using BEVs will install chargers at their facilities. This analysis includes the cost of the charger itself plus the necessary upgrades on the customer's side of the meter, which includes the charger, trenching, laying conduit, and other site upgrades. Data on these costs has been gathered from a variety of sources including various CARB-funded projects and published reports, including the International Council of Clean Transportation (ICCT) 2019 report, which assesses the cost of installing chargers at a variety of power levels across the United States.[99] Generally, infrastructure and charging costs vary proportionally based on how much power the vehicle(s) needs to recharge.

In many cases a local fleet can utilize overnight charging using a level 2 charger (up to 19.2 kW) that can add about 200 miles of range overnight and then occasionally top off at public fast charging stations. Only in higher mileage situations like a regional or long-haul tractor would high powered charging be required. A level 2 charger and installation costs approximately $25,000 while a 150 kW direct current fast charger costs roughly $88,000 and extreme high powered charging significantly higher. However, a high-powered charger is capable of refueling multiple vehicles a day while a lower powered charger is limited.

Programs from the utilities and the State are available to cover the cost of installing infrastructure. CARB does not include these programs in our regulatory analyses, but they can help fleets install infrastructure at a lower cost to them. Costs are not incorporated on the utility's side of the meter as those are the responsibility of the utility as specified in Assembly Bill 841 and are implemented by each IOU. In addition to retail charging, staff's analysis assumes a portion of the battery-electric trucks and all hydrogen FCEVs will use retail refueling. In these instances, staff assumes the infrastructure cost is included within the fuel cost the fleet pays at the retail charger or pump. A detailed accounting on infrastructure costs and assumption can be found in the Chapter VIII cost analysis.

e) Future Cost Reductions

There are several factors that staff believes will lead to reductions in infrastructure costs over time. While the cost of labor, basic construction materials, and electrical equipment are not expected to decline, as more ZEV deployments take place, learning from past experiences will inform more efficient site design and improved economies of scale. Staff expects charging stations and storage technologies to continue to fall in price as demand increases and economies of scale improve. In addition, significant work is underway to streamline project design and permitting processes. For example, pre-planning for full fleet

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[99] International Council on Clean Transportation, *2019 Annual Report*, 2019 (web link: https://theicct.org/sites/default/files/ICCT-AnnualReport-2019.pdf, last accessed August 2022).

deployments will allow construction to be intelligently planned where trenching only occurs once or electrical panels are oversized initially with load catching up over time. Recently approved CalGreen building code requirements for certain new warehouses, retail stores, and commercial stores with off-site loading zones will be required to have additional minimum electrical capacity installed during construction to help ensure the site is prepared for ZE vehicles, which lowers infrastructure costs significantly.[100]

Creative and innovative technologies like smart charging and fleet management software will also give more flexibility to adjust power demands, which may allow the sizing of smaller equipment and fewer upgrades, while still meeting the fleet needs. In addition, some fleets may choose to use on-site solar and storage to minimize the need for costly upgrades. Finally, the Draft 2022 Scoping Plan recommends that the Agency provide capacity credits for heavy-duty ZEV refueling within the LCFS program. If such a provision was adopted in a future LCFS rulemaking, these capacity credits could also play a role in reducing costs for building out public hydrogen refueling or fast charging infrastructure.[101]

f) Infrastructure Installation Timing

CARB staff have worked with the utilities to understand the general timeframes and schedules for infrastructure installation. However, each installation is unique to the facility and dependent on site-specific factors, such as the existing electric panel capacity and installation location. California law requires permitting agencies to meet minimum processing standards to ensure timely approval.

CARB staff has learned from many demonstrations, pilot projects, webinars, workshops and outreach efforts that allowing sufficient time for a project to be envisioned and completed is key. The entire process, which includes planning, developing, and deploying zero-emission fueling stations, can often take from 6-18 months. The amount of required infrastructure may vary with the fleet size as small deployments of a couple vehicles may need minor facility upgrades whereas major expansions may need extensive facility rework or relocation. Ultimately a strong team and utility partnership is critical for success.

A general timeline for charging infrastructure and hydrogen station installations is as follows: (1) Planning and permitting: 3-12 months; (2) Site preparation, construction, installation, and commissioning: 3-12 months or longer; and (3) Deployment and vehicle integration: 1-3 months.

Installing charging infrastructure requires planning and early discussions with the local utilities, many of which have set up dedicated staff to assist. Infrastructure upgrades may require service line extensions, power line reconductoring, or distribution substation upgrades which should be considered early in the planning process. However, utilities have indicated that project phasing and temporary service commonly allows fleets to deploy initial

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[100] California Department of Housing and Community Development, *2019 California Green Building Standards Code, Title 24, Part 11, California Code of Regulations*, 2019 (web link: *https://www.hcd.ca.gov/calgreen*, last accessed August 2022).

[101] California Air Resources Board, *The AB 32 Scoping Plan (draft)*, 2022 (web link: https://ww2.arb.ca.gov/our-work/programs/ab-32-climate-change-scoping-plan/2022-scoping-plan-documents, last accessed August 2022).

ZEVs quickly using existing infrastructure and that transmission upgrades can be made while a fleet expands ZEV deployments over time.

Facility leasing agreements may complicate site upgrades, but staff believes the clear regulatory and policy signals from the proposed ACF regulation, along with other ZEV related policies and executive orders issued by the Governor, would provide assurance to facility owners that site upgrades to support electrification are sound investments.

2. Electricity Supply Impact and Reliability

Concerns have been raised around the availability and rollout of public ZEV infrastructure, including both charging and hydrogen stations, and the grid's ability to meet the steadily growing electrical demand generated by the proposed ACF regulation and other rules promoting electrification. This section assesses the impact that transportation electrification (TE) will have on the State's electrical power grid and the established processes in place for planning future growth in demand on the electrical system over time, including that from demand from light-, medium-, and heavy-duty vehicles. It also discusses how electrical utilities are working to minimize disruptions to customers during unplanned outages and PSPS events.

a) Electric Grid Load Expansion

California's electric grid is in a period of transition, with several thousand megawatts of firm and dispatchable resources currently slated to be retired over the next few years, including the gas-fired once-through cooling coastal power plants and the Diablo Canyon Nuclear Power Plant. At the same time, the State continues to rapidly expand deployment of renewables and plans for greater electrification – which, paired with Senate Bill 100's[102] clean electricity grid target[103] – is designed to help achieve carbon neutrality no later than 2045. Because the State is proposing to lean heavily on the electricity sector to transition away from fossil fuels in the transportation, buildings, and industrial sectors, the demand for electricity will be increasing between now and 2045.[104] This load increase must be supported by sustained and significant build-out of electricity infrastructure in the form of generation, energy storage, and transmission and distribution infrastructure. At the same time, the integration of greater amounts of variable renewable resources (e.g., wind, solar photovoltaic) and the increasing and unpredictable extreme-weather impacts of *climate change* mean that strategies for ensuring grid reliability are also needed. New dispatchable capacity, storage and other zero-carbon resources, as well as demand-side management, can be utilized to maintain grid reliability with high concentrations of renewables. Vehicle smart charging systems can also help manage load to ensure that only critical charging is done during peak demand hours. At the individual project level, charging must be analyzed on a neighborhood distribution circuit specific basis to understand the specific and cumulative

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[102] SB 100 (De León, Stats. 2018 ch. 312). Public Utilities Code new section 454.53, amendments to Public Utilities Code sections 399.11,399.15, and 399.30.

[103] California Energy Commission, *2021 SB 100 Joint Agency Report, Achieving 100 Percent Clean Electricity in California: An Initial Assessment*, 2021 (web link: https://www.energy.ca.gov/publications/2021/2021-sb-100-joint-agency-report-achieving-100-percent-clean-electricity, last accessed August 2022).

[104] California Air Resources Board, *The AB 32 Scoping Plan (draft)*, 2022 (web link: https://ww2.arb.ca.gov/our-work/programs/ab-32-climate-change-scoping-plan/2022-scoping-plan-documents, last accessed August 2022).

impact locally. The potential for vehicle-to-grid technology, where vehicles can support electricity load, hold the promise to support grid resiliency in the future.

b) Electric Grid Planning

The State's process to plan for future electricity demand is robust. CPUC has a comprehensive Integrated Resource Plan and Long-Term Procurement Planning process that evaluates electricity needs on a ten-year time horizon and then authorizes the procurement. The process evaluates reliability needs of the overall electric system, local reliability needs specific to areas with transmission limitations, and flexibility needs like the resources required for renewable energy integration. Using inputs from the CEC's Energy Demand Forecast and the California Independent System Operator, new needs are identified, and additional procurement is authorized. Each IOU then solicits and eventually contracts for the required resources. The process is ongoing and in February 2022, CPUC approved under the 2021 Preferred System Plan procurement of potentially $49 billion in electric system upgrades by 2032.[105]

The CEC's Energy Demand Forecast is updated annually as part of the Integrated Energy Policy Report and uses various data sources such as CARB's Mobile Source Strategy, vehicle inventory, approved electrification regulations, and CEC forecasting from the AB 2127 EV Charging Infrastructure Assessment.[106] The CEC's HEVI Load model was developed in conjunction with Lawrence Berkeley National Laboratory to analyze demand for heavy-duty charging infrastructure in support of the AB 2127 assessment and is a critical input to inform the Integrated Energy Policy Report. CARB collaborates closely with CEC to ensure that data is supplied to the HEVI-Load model to capture changes in vehicle populations both geographically and over time. In addition, each utility creates an Integrated Resource Plan, which is a comprehensive planning document for the utility, that also feeds into the procurement planning process. All these inputs allow for a comprehensive assessment and a better understanding of grid impacts and infrastructure needs at the regional and local level.

c) Grid Reliability

Staff recognizes that as wildfire risk in California has grown, CPUC and IOUs have implemented a significant number of power outages to mitigate the risk of accidental ignition from damaged utility equipment. While CPUC considers PSPS outage events as safety-related (as opposed to an unplanned outage from an equipment failure or traffic accident), all grid outages create uncertainty for fleets considering adoption of ZEVs. Therefore, understanding how utilities are addressing and mitigating supply disruptions is critical.

CPUC has directed the establishment of PSPS event policies to guide the behavior of the major IOUs, such as Pacific Gas and Electric (PG&E), Southern California Edison (SCE), and San Diego Gas and Electric (SDG&E). Efforts are underway at the major IOUs to address PSPS impacts on charging infrastructure, including:

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[105] California Public Utilities Commission 2022, *Decision Adopting 2021 Preferred System Plan Rulemaking 20-05-003*, 2021 (web link: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M449/K173/449173804.PDF, last accessed August 2022).

[106] AB 2127 (Ting, Stats. 2018 ch. 365).Public Resources Code section 25229.

a. Improving communication both before and during potential or active de-energization events regarding the location and accessibility of charging stations near impacted areas;
b. Studying the feasibility of grid-independent EV charging stations (e.g., mobile charging stations), which can be used to charge EVs during PSPS and other emergency events; and
c. Coordinating with EV charging providers to reinforce EV charging networks with backup generation.

The expectation is that the frequency and duration of planned PSPS events will gradually diminish as the grid is hardened to wildfires. Outside of PSPS events, the utility industry follows reliability, outage, and resource adequacy standards from various regulators like the North American Electric Reliability Council, broadly known as NERC, as well as CPUC and other sources. Following these resource adequacy standards to ensure outages do not occur, the utilities must keep a minimum 15 percent buffer between supply and demand at all times in case of an unexpected shortfall.[107]

In addition, utilities have adopted short-term reliability standards to help monitor unscheduled power outages locally, such as from a storm, car-pole accident or equipment failure. These reliability standards are stringent and allow for an acceptable outage risk of typically one to two hours per year. In addition, CPUC uses a Loss of Load Expectation standard for determining and evaluating acceptable risk, which is currently one day per ten years.[108] Overall, electrical service is extremely reliable and it is worth noting that conventional fueling stations also cannot pump fuel during power outages.

d) Grid and Fleet Resiliency

Grid resiliency is generally the ability to adapt to changing conditions; withstand disruptions, and to rapidly recover from an adverse event. Due to the ongoing risk of wildfires and other natural disasters, summer supply shortages, as well and the rapidly evolving grid, significant work is ongoing to improve grid resiliency.

The electrical grid is actively managed by balancing authorities on a minute-to-minute basis to ensure supply and demand remained balanced at all times. The introduction of intermittent distributed energy resources like wind, solar and storage into the system are managed by ever evolving smart grid technologies that allow balancing authorities to better segment, control and optimize the system. Utilities and municipalities are looking at microgrids as a way to improve resiliency during major power disruptions because they can isolate from the main grid and manage energy resources at a local level. Microgrids can operate on a variety of power sources, including renewables, multi-fuel reciprocating engines and even stationary fuel cells—plus energy storage like batteries are often integrated to improve reliability and provide flexibility. This landscape provides both opportunities and

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[107] California Public Utilities Commission, *Resource Adequacy Homepage*, 2022 (web link: https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/resource-adequacy-homepage, last accessed August 2022).
[108] California Public Utilities Commission, *Electric System Reliability Annual Reports*, 2022 (web link: https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/electric-reliability/electric-system-reliability-annual-reports, last accessed August 2022).

challenges for improving system resiliency and ZEVs hold great potential to support grid resiliency through smart charging and vehicle to grid (or load) applications.

In addition to the potential ability for ZEVs to support grid resiliency, at the fleet level, similar on-site microgrid technology can ensure that vehicles stay fueled during power disruptions. The latest smart chargers can help the resiliency of fleet facilities as well as potentially tap onsite renewable generation, like solar and storage, to effectively manage energy costs.

Insulating fleets from safety-related de-energizing events can be accomplished with robust energy storage systems both within the utility distribution systems and at fleet sites. Designing charging infrastructure to include energy storage and clean back-up power generation can play an important role during emergencies.[109] CPUC with CEC support, leads ongoing efforts to develop standards, protocols, guidelines, methods, rates, and tariffs that serve to support and reduce barriers to microgrid deployment. In addition, similar to how conventional fleets do not keep every vehicle fully fueled at all times, ZEV fleets will also have ZEVs at various states of charge each day and advanced fleet management software can help lower outage risk by ensuring that fully charged ZEVs are always available or even by having mobile charges available.

3. Hydrogen Fueling

Heavy-duty hydrogen fuel cell vehicles hold the promise of range and refueling times consistent with today's conventional vehicles. Similar to how diesel is provided at truck stops, in most cases, drivers of fuel cell trucks will rely solely on public fueling stations. Today, thirteen dual-use fueling stations with light- and heavy-duty capabilities are under development utilizing CEC grant funding and will augment the existing demonstration and pilot stations. However, for a successful fuel cell truck market, high flow rate stations must reach commercial deployment and continued funding for station construction is needed to ensure sufficient refueling infrastructure will be in place when more trucks reach commercial availability. Focusing funding for heavy-duty hydrogen refueling infrastructure along high-use freight corridors and committing to build these stations ahead of projected demand sends the right signals to OEMs and their fleet customers.

a) Hydrogen Production

Increasing demand for hydrogen use as a transportation fuel is creating a strong business case for building hydrogen production facilities to supply the California ZEV market. Strong State policy signals via the Governor's Executive Order N-79-20, new electrification regulations, and the LCFS incentivizing low carbon fuels, are increasing demand for hydrogen with lower carbon intensity. Today, the limited number of in-state hydrogen producers for use in fuel cell vehicles means that product may occasionally be delivered to distant fueling stations at higher costs, especially during supply disruptions. In addition, most of today's demand is met by existing producers of merchant hydrogen that employ steam methane reformation processes and need to purchase renewable natural gas (RNG) at a premium to satisfy California's renewable hydrogen requirements. This creates intermittent market

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[109] California Public Utilities Commission, *Resiliency and Microgrids*, 2022 (web link: https://www.cpuc.ca.gov/resiliencyandmicrogrids, last accessed August 2022).

disruptions where renewable hydrogen supplies do not meet current demand from light-duty fuel cell vehicles and transit buses.

The cost of clean electrolytic hydrogen is projected to decrease over the coming decade due to falling electrolyzer and renewable energy costs, coupled with inexpensive curtailed electricity.[110] Today, the approximately $15 per kilogram retail price of hydrogen (associated with light-duty fueling) limits the business case for fuel cell trucks; however, producers of renewable hydrogen believe that as production scales up, hydrogen can be offered at price parity with the historical cost of conventional fuels. Similarly, the high cost to develop public heavy-duty hydrogen fueling infrastructure will require some public support, which is available through CEC's EnergIIZE program.

b) Renewable Hydrogen

CEC has increased supply by funding 100 percent renewable hydrogen production facilities in recent years, and as the heavy-duty market grows more plants will be needed. State efforts to increase demand through vehicle incentives and LCFS credits will foster a self-sustaining industry where renewable hydrogen producers have sufficient business demand to justify the significant financial investment in new capacity thereby lowering the need for on-going financial assistance.

CEC's Investment Plan update for Clean Transportation each year includes funding for zero- and near-zero-carbon fuel production and supply, and CEC has funded in-state renewable hydrogen production in recent funding cycles. The 2021 Annual Evaluation of FCEV Deployment and Hydrogen Fuel Station Network Development report produced pursuant to Assembly Bill 8 identifies demand for renewable hydrogen exceeding supply in the near term and emphasizes the need to increase and maintain a consistent supply of renewable hydrogen. [111,112] Findings in the AB 8 report describe the value of annual funding for renewable hydrogen production in the CEC's Clean Transportation Investment Plan updates. In addition, the Governor's approved budget for FY 2021-22 includes $100 million for production of green hydrogen over 2 years.

c) Hydrogen Distribution

Today, hydrogen is either delivered to fueling sites as a compressed gas or as cryogenic liquid. With increasing demand and higher station throughput, station operators and suppliers are trending more towards liquid delivery, which equates to significantly fewer truck trips and miles traveled. Limited hydrogen pipelines exist in the state and are associated with

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[110] Rocky Mountain Institute, *Fueling the Transition: Accelerating Cost-Competitive Green Hydrogen*, 2021 (web link: https://rmi.org/insight/fueling-the-transition-accelerating-cost-competitive-green-hydrogen, last accessed August 2022).

[111] AB 8 (Perea, Stats. 2013, ch. 401). Health and Safety Code new section 43018.9, repeal section 44299, amendments to Health and Safety Code sections 41081, 44060.5,44125, 44225, 44249, 44270.3,44271,44272, 44273, 44274, 44275,44280, 44281,44282,44283,44287,44299.1, and 44299.2; amendments to Public Resources Code section 42885 and 42889; amendments to Vehicle Code sections 9250.1, 9250.2, 9261.1, and 9853.6.

[112] California Air Resources Board, *2021 Annual Evaluation of Fuel Cell Electric Vehicle Deployment and Hydrogen Fuel Station Network Development*, 2021 (web link: https://ww2.arb.ca.gov/sites/default/files/2021-09/2021_AB-8_FINAL.pdf, last accessed August 2022).

supply lines to industrial facilities like petroleum refineries. A project proposed by Southern California Gas Company (SoCalGas) dubbed Angeles Link, if approved, would support production of electrolytic hydrogen from solar and wind resources in the high desert and transported via pipeline to commercial and industrial centers in Southern California.[113] Pipeline delivery would help lower costs, but significant development hurdles exist and, until then, most hydrogen will continue to be delivered by truck—with some producers actively planning to use ZE delivery trucks. In addition, some companies are considering large-scale solar electrolytic hydrogen production near stations along highway corridors, which would help mitigate or minimize the need for trucking hydrogen.

In rural, less populated regions of the state, it is anticipated that most rural truckers' hydrogen refueling needs can be met at truck stops located along California's key freight highway corridors because of the projected range of FCEVs—up to 500 miles with the Hyundai XCIENT.[114] The California Fuel Cell Partnership produced the Fuel Cell Electric Trucks Vision Document that focuses specifically on the infrastructure and support needed for a successful Class 8 fuel cell truck market. [115] The report states, "with adequate policy support, by 2035, an interim milestone of 70,000 fuel cell electric trucks on the road supported by 200 heavy-duty hydrogen stations could be achieved." As a follow up to this vision, the California Fuel Cell Partnership is working on a heavy-duty hydrogen roadmap to determine and prioritize which of the freight corridors and existing diesel truck stop sites to target first for hydrogen infrastructure.

d) Hydrogen Fueling Standardization

While hydrogen refueling infrastructure and fueling protocols for light-duty cars and transit buses have been standardized, heavy-duty fuel cell truck and refueling technology is still under development. Truck OEMs are now working with national labs and standards organizations to culminate around performance standards to meet the on-board H2 storage needs, tank pressures, and refueling times that heavy-duty fleets will require. The standards organizations are focusing on a fueling rate target of 10 kg/minute, 350 and 700 bar storage systems, nozzles and receptacles, and operational characteristics including safety guidelines and communication hardware. At this time, the standards community is working toward harmonizing ISO standards with SAE and completing standards development in 2023.

4. Zero-Emission Infrastructure Coordination and Buildout

Electric vehicles rely on the electric grid to provide consistent, on-demand power to charge vehicles. The electric grid will have to expand and adapt to meet a new and more extensive demand of light-, medium-, and heavy-duty ZEVs.

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[113] SoCal Gas, *Angeles Link Shaping The Future With Green Hydrogen*, 2022 (web link: https://www.socalgas.com/sustainability/hydrogen/angeles-link, last accessed August 2022).
[114] Hyundai, *Hyundai's XCIENT Fuel Cell Hitting the Road in California*, 2021 (https://www.hyundainews.com/en-us/releases/3362, last accessed August 2022).
[115] CaFCP, *Fuel Cell Electric Trucks – A Vision for Freight Movement in California and beyond*, 2021, (web link: https://cafcp.org/blog/california-fuel-cell-partnership-envisions-70000-heavy-duty-fuel-cell-electric-trucks-supported#:~:text=Sacramento%2C%20California%E2%80%94Today%2C%20the,by%20200%20heavy%2Dduty%20truck, last accessed August 2022).

Historically, the state's electric grid has expanded and evolved as consumer demand for electricity services has grown, including with the recent emergence of plug-in electric vehicles. California's existing grid and approved investments occurring now will allow the state to handle millions of electric vehicles in the near-term, and projections show the broader western grid can handle up to 24 million electric vehicles without requiring any additional power plants.[116] However, electrification of California's entire transportation sector, particularly when combined with increased electrification of the state's building stock, will require further investments in transmission and local distribution systems and coordinated grid planning efforts.

Longer term, vehicle electrification is achievable with a gradual build out of clean energy resources - more gradual than during times of peak electricity sector growth in the past given electric vehicle loads can be distributed over non- peak hourly periods. Several studies have shown no major technical challenges or risks have been identified that would prevent a growing electric vehicle fleet at the generation or transmission level, especially in the near-term.[117,118] Additionally, based on historical growth rates, sufficient energy generation and generation capacity is expected to be available to support a growing electric vehicle fleet.[119]

State agencies and electric utilities have begun proactively planning for electrical distribution upgrades and new load for electric vehicles via statewide energy system planning processes, including CEC's Integrated Energy Policy Report forecasting, CAISO transmission planning, and CPUC's Integrated Resource Plan proceeding for ten-year grid enhancement strategies. Additionally, recent policy changes allow investor-owned utilities in California to establish rules and tariffs under general rate case proceedings for electrical distribution infrastructure on the utility side of the meter to support transportation electrification charging stations.[120] CPUC has already approved utility investments for upgrading the electric grid along with electricity rate changes to fund those investments. CPUC approved time-of-use rates which provides signals to electricity rate changes at different times of the day that would impact the cost to fuel for electric vehicle drivers that charge at home. This decision was made to optimize grid resources, maintain grid reliability, and provide reasonable rates for residential EV charging.[121] CPUC also opened a new proceeding to modernize and prepare the grid in

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[116] PNNL 2020. Kintner-Meyer, Michael, et al, *Electric Vehicles at Scale – Phase I Analysis: High EV Adoption Impacts on the Western U.S. Power Grid. Pacific Northwest National Laboratory*, 2020 (web link: https://www.pnnl.gov/sites/default/files/media/file/EV-AT-SCALE_1_IMPACTS_final.pdf, last accessed August 2022).

[117] US DRIVE 2019, *Summary Report on EVs at Scale and the U.S. Electric Power System. U.S. Driving Research and Innovation for Vehicle Efficiency and Energy Sustainability (DRIVE)*, 2019 (web link: https://www.energy.gov/sites/prod/files/2019/12/f69/GITT%20ISATT%20EVs%20at%20Scale%20Grid%20Summary%20Report%20FINAL%20Nov2019.pdf, last accessed August 2022).

[118] Muratori et al 2021. Matteo Muratori et al, *"The rise of electric vehicles—2020 status and future expectations,"* 2021 (web link: https://iopscience.iop.org/article/10.1088/2516- 1083/abe0ad/pdf, last accessed August 2022).

[119] DOE 2019.

[120] AB 841 (Ting 2020).

[121] CPUC, *"Electricity Rates and Cost of Fueling." California Public Utilities Commission*, 2022 (web link: https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/transportation-electrification/electricity-rates-and-cost-of-fueling, last accessed August 2022).

anticipation of multiple distributed energy sources.[122] With this new proceeding, the CPUC aims to evolve grid capabilities to integrate distributed energy sources including electric vehicle charging, electric vehicle charging forecasts to improve distribution planning, and community input to optimize infrastructure investments for the grid.[123]

One of the key goals of this proceeding is to improve distribution planning, including charging infrastructure forecasting to support cost-effective and widespread transportation electrification. In parallel, CEC staff is developing the EVSE Deployment and Grid Evaluation tool, which currently uses the IOUs' Integration Capacity Analysis map data to understand existing grid conditions and capacity. This tool will not only help stakeholders identify suitable locations for charger deployments, but also act as an early warning system for utilities and grid planners to identify locations where grid upgrades may be required to support high charging demand. In most circumstances, electric vehicles do not draw energy at the same time they are operating, and charging time is usually much shorter than vehicle dwell time. This provides electric vehicles with the flexibility to charge at times that are less impactful to the grid and at times of abundant renewable generation availability.

Innovative solutions are emerging to help support charging infrastructure and manage loads at the local grid level. Since ZEVs are a unique electric load and are potentially advantageous compared to other types of load, State agencies and utilities are also actively planning for vehicle-to-grid integration services. These vehicle-to-grid services range from bi-directional charging to one-directional passive load shifting by price signals or rate design. Load shifting is valuable to the state to control peak loads by shifting a large portion of charging loads to hours that are less impactful to the grid. Load shifting strategies are also easy to implement for electric utilities and for vehicle owners and allow for better integration of renewable energy. Models suggest that electric vehicle charging can reduce renewables curtailment, which is when the output of a renewable energy resource is intentionally reduced below what it could produce, anywhere from 25 to 90 percent.[124,125] As vehicle-to-grid services move into bi-directional charging, where the power can flow to and from the vehicle battery, the benefit to the grid is greater with the potential to offset grid upgrades and further reduce overall strain at peak usage times. Bi-directional services can also provide emergency backup services in the event of grid shutoffs or general power failures. Overall, vehicle-to-grid services create opportunities to reduce system costs and facilitate renewable energy

[122] CPUC, *California Public Utilities Commission. Proposed Decision: Order Instituting Rulemaking to Modernize the Electric Grid for a High Distributed Energy Resources Future*, 2022 (web link: https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/transportation-electrification/electricity-rates-and-cost-of-fueling, last accessed August 2022).
[123] CPUC, *CPUC Takes Action to Modernize Electric Grid for High Distributed Energy Resources Future*, 2022 (web link: https://www.cpuc.ca.gov/news-and-updates/all-news/cpuc-takes-action-to-modernize-electric-grid-for-high-distributed-energy-resources-future, last accessed August 2022).
[124] CalISO, "*Impacts of renewable energy on grid operations*," 2017 (web link: https://www.caiso.com/documents/curtailmentfastfacts.pdf, last accessed August 2022).
[125] PNNL 2020.

integration, and electric vehicle resource adequacy can be doubled with these managed charging strategies.[126,127,128]

With the benefits electric vehicles can provide to the grid, State agencies in California have continued to collaborate on policies and programs to enable this integration. CEC, CAISO, CPUC, CARB, and other stakeholders are working to update the State's roadmap to integrate electric vehicle charging needs with the needs of the electrical grid. The update will reflect advancements in vehicle-to-grid technology and include actions the State can take to advance California's transportation electrification goals. Separately, in December 2020, CPUC adopted a decision on vehicle-to-grid which created metrics and strategies for advancing vehicle-to-grid and authorized almost $40 million for the investor-owned utilities to spend piloting vehicle-to-grid technologies and programs. In November 2021, CPUC adopted a resolution creating a pathway for alternating current interconnection for vehicle-to-grid and allowing some electric vehicles to enable bi-directional mode more easily. CPUC is continuing to consider streamlining procedures for both charging and bi-directional interconnections.

As the electric vehicle market expands, electricity demand will increase to provide the charging needs for these vehicles. To meet this anticipated demand, State agencies and electric utilities have begun planning and putting in place programs for electrical distribution upgrades. Although an increase in electricity demand is anticipated with the widespread adoption of electric vehicles, electric vehicles can aid in managing grid resources and can improve resilience of the grid.

To meet the demand for charging stations and hydrogen fueling as well as to ensure fueling will be conveniently located and available, significant coordination is occurring between California's agencies. CARB, CEC, and CPUC are the three primary California agencies responsible for early electric and hydrogen refueling infrastructure while a number of additional agencies also have important roles. Federal investments in charging and hydrogen stations are underway through the Infrastructure Investment and Jobs Act and the National Electric Investment Program. Ensuring requirements, such as related infrastructure build-out rates are technologically feasible, cost-effective, and support market conditions is a top priority for the implementation of the proposed ACF regulation.

a) State Agency Efforts

The following contains key actions by State agencies to address the growing need for ZE fueling infrastructure in California. While CARB engages in a number of actions aimed at expanding new and used ZEV markets and increasing access to clean mobility, CEC is the primary agency tasked with supporting infrastructure. CARB closely collaborates with sister agencies and assists in infrastructure development where appropriate to support ZE rule

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[126] Ibid.

[127] International Renewable Energy Agency, *Innovation Outlook: Smart charging for Electric Vehicles (Abu Dhabi: International Renewable Energy Agency*, 2019 (web link: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/May/IRENA_Innovation_Outlook_EV_smart_charging_2019.pdf, last accessed August 2022).

[128] Zhang et al 2018a. Zhang J, Jorgenson J, Markel T and Walkowicz K, "*Value to the grid from managed charging based on California's high renewables study" IEEE Trans. Power Syst. 34 831–40*, 2019 (web link: https://www.osti.gov/pages/servlets/purl/1494793, last accessed August 2022).

development and implementation. CARB also partners with CEC via an interagency agreement to focus on ZEV workforce training and development to promote these activities in priority communities. The program supports career pathway development projects, including curriculum, ZEV manufacturing, pre-apprenticeship training, train-the-trainer activities, and more with an emphasis on priority communities.

(1) Governor's Office of Business and Economic Development

GO-Biz serves as the first point of contact for ZEV related businesses to engage with State government. California law requires permitting agencies to meet minimum processing standards and GO-Biz is the lead agency in the effort to streamline ZEV infrastructure development permitting and has published guidebooks on hydrogen station permitting and EV charging station permitting. The guidebooks are intended to help provide the resources necessary to alleviate the remaining development barriers and to encourage cities, counties, and developers to share information to streamline the development process.[129]

(2) California Energy Commission

CEC is the State agency primarily tasked with incentivizing development to meet the charging and refueling infrastructure needs and has launched multiple efforts to support those directives. CEC developed the State's ZEV Infrastructure Plan, which initiates a long-range planning through coordination with other State agencies. The ZEV Infrastructure Plan focuses on decision-making in the public and private sectors by documenting plans and strategies to deploy ZEV infrastructure for all Californians in an equitable manner as well as the public support needed. Additional efforts include, but are not limited to:

- The Clean Transportation Program provides funding to accelerate the development and deployment of advanced transportation and fuel technologies. The 2021-2022 State Budget included $500 million to deploy charging and fueling infrastructure for medium- and heavy-duty vehicles. One example of a successful project is the Joint CARB/CEC Zero-Emission Drayage Truck and Infrastructure Pilot program that funded Class 8 port trucks and infrastructure. Clean Transportation Program funding has historically been the primary means to fund hydrogen station projects.
- The EnergIIZE program provides funding for charging and hydrogen infrastructure to support medium- and heavy-duty battery-electric and hydrogen fuel cell commercial vehicles in California. The project provides a streamlined process with targeted incentives and specialized assistance. The program received $50 million in FY 2021-2022 to launch the program and is anticipated to receive additional funding in future years. EnergIIZE offers incentives through 4 funding lanes:
    - EV Fast Track provides charging infrastructure funding for commercial fleets that have already procured battery-electric trucks or have trucks on order.
    - EV Jump Start provides charging infrastructure funding for commercial fleets operating in disadvantaged communities, transit and school bus fleets, small fleet owners, and small business enterprises.

[129] Governor's Office of Business and Economic Development, *Electric Vehicle Charging Station Permit Streamlining Fact Sheet*, 2022 (web link: https://business.ca.gov/industries/zero-emission-vehicles/plug-in-readiness/, last accessed August 2022).

- EV Public Charging Station lane provides competitive funding for publicly accessible charging infrastructure for commercial vehicles.
  - Hydrogen funding lane provides competitive funding for hydrogen fueling infrastructure for commercial fuel cell vehicles.
- BESTFIT Innovative Charging Solutions solicitation funds projects to demonstrate charging solutions for light- and heavy-duty vehicles and to accelerate commercial deployment. Heavy-duty funded projects have a greater than 1 to 1 private match.
- CEC's analytical work in forecasting and modeling is critical to ensure there is sufficient electricity and that infrastructure investments are made wisely. The 2020 Integrated Energy Policy Report provided an assessment that included a report on transportation trends, an update to the electricity demand forecast, and an assessment of microgrids. The 2021 Integrated Energy Policy Report included updates on electricity demand forecast, decarbonization, resilience and to further assess infrastructure requirements.
- AB 2127 required CEC to biennially assess EV charging infrastructure needed to support the States' 2030 goals. The CEC's initial August 2021 report indicated that 157,000 high powered chargers were needed by 2030 to support 181,000 medium- and heavy-duty vehicles.[130]
- Senate Bill 643[131] requires CEC, in consultation with CARB and CPUC, to prepare a statewide assessment of the FCEV fueling infrastructure and fuel production needed to support the adoption of ZE trucks, buses, and off-road vehicles, and complete the assessment by the end of 2023.
- Integrated Resource Plan review—Integrated Resource Plans are key electricity system planning documents that ensure utilities lay out their demand growth, resource needs, policy goals, physical and operational constraints, and proposed resource choices in the 10 to 20-year time horizon. SB 350, requires certain POUs to develop and submit an Integrated Resource Plan to CEC.
- 2020 Vehicle Grid Integration Roadmap identifies key next steps for advancing vehicle grid integration over the next 10 years. CEC is leading the effort to update the state's roadmap to integrate EV charging needs with the needs of the electrical grid.
- CEC's Load Management Standard rulemaking will improve demand-flexibility on the electricity grid by promoting a dynamic rate environment. By aggregating all utility rates, the database provides an accurate signal to appliances (including chargers) to conserve, or alternatively operate, at certain times of the day. This will support a reliable renewable and decarbonized electricity grid, as well as potentially lower charging costs.

(3) California Public Utilities Commission

The CPUC regulates California's 3 largest IOUs Pacific Gas and Electric Company (PG&E), Southern California Edison Company (SCE), San Diego Gas and Electric Company (SDG&E) and 3 smaller IOUs that operate in rural and/or unincorporated territories (Liberty Utilities, Pacificorp and Bear Valley). It has the authority over the cost and design of the IOUs' TE investment programs, the rates the IOUs establish to provide electricity as a transportation fuel, and other IOU expenditures associated with their TE programs such as pilots,

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[130] California Energy Commission, *Assembly Bill 2127 Electric Vehicle Charging Infrastructure Assessment*, 2021 (web link: https://efiling.energy.ca.gov/getdocument.aspx?tn=238853, last accessed August 2022).
[131] SB 643 (Archuleta, Stats. 2021 ch. 646). Health and Safety Code section 43871.

marketing, outreach, and education initiatives. Planning efforts include, but are not limited to:

- CPUC's 2020 draft TE Framework is a comprehensive long-term planning document intended to define the IOU role in deploying TE infrastructure and provide guidance and a structured process for IOUs to develop ten-year strategic TE Plans. This framework will streamline processes and accelerate TE growth, with a focus on DACs and addressing equity barriers.
- CPUC oversees the IOU adoption of TE Plans. IOUs will be required to adopt a TE Plan within one year of TE Framework finalization and focus on how IOUs will achieve State targets, overcome barriers and include long-term strategy for addressing medium- and heavy-duty sectors. TE Plans will include projected infrastructure needs in the IOU service territories, investment strategies, estimated budgets, as well as targets based on priority market segments and program descriptions.
- Recent CPUC decisions approved continued support of TE programs and the offering of subscription-based rates that remove direct demand charges.

(4) California Building Standards Commission

The California Building Standards Commission is the primary agency overseeing building standards in the state and works in conjunction with the Housing and Community Development Agency and others. CARB has assisted the Commission in the adoption of minimum infrastructure requirements for heavy-duty vehicles in new warehouses over 20,000 sq. ft. and new retail and grocery stores over 10,000 sq. ft. The new requirements would provide sufficient conduit and panel capacity to support a 200 to 400 KVA increase in load from future electrification.

(5) California Infrastructure and Economic Development Bank

The California Infrastructure and Economic Development Bank has broad authority to enable and increase financing opportunities for ZEV projects and bring more private capital into the market to stimulate ZEV market development and improve the viability of ZE investments. The Bank operates several programs, including the Catalyst Fund that provides low-interest loans, financial guarantees, and other economic tools to promote accelerated investment in ZEV infrastructure. To increase investments in Priority Communities the Bank will attempt to stimulate investment in ZEV infrastructure by leveraging its network of local lending partners. In addition, the Catalyst Fund was established as the state's counterpart, and recipient, to any federal climate stimulus funding that may become available.

(6) Strategic Growth Council

The Strategic Growth Council (SGC) provides California Climate Investments funding to support job development, mobility improvement, and create opportunities to enable ZEV adoption in priority communities. The SGC's Affordable Housing and Sustainable Communities Program targets 50 percent of significant funding to DACs, low-income communities, and low-Income households by increasing the accessibility to affordable housing, employment centers, and key destinations via low carbon transportation. The program typically funds ZEV transit vehicles, ZEV fueling infrastructure, and ZEV car sharing that serve low-income and DACs. The Program also emphasizes fewer VMT through reduced vehicle trip length as well as mode shift to transit, bicycling, or walking. This program is funded by the California Climate Investments Program and at least 50 percent of funds are dedicated to projects in DACs.

(7) California Department of Transportation

Caltrans is supporting local jurisdictions' transition to ZEVs by encouraging local transportation agencies to develop and adopt regional ZEV infrastructure plans and policies in their transportation plans. Locally, Caltrans is encouraging fueling efficiency via the joint use of ZEV fleets with transit agencies by coordinating efforts to identify opportunities to share charging or fueling infrastructure facilities.

Caltrans is developing a ZEV Infrastructure Handbook to establish processes and procedures for implementing workplace and public ZEV infrastructure. The Handbook will consider pricing signals and identify areas of responsibilities for workplace charging and fleet charging prioritization and builds off the experience gained in developing charging stations at its own facilities.[132] Caltrans is also collaborating with CEC to identify and address key gaps in DC charging and hydrogen fueling networks. The updated Truck Parking Survey identifies the operational characteristics of heavy-duty vehicles, such as downtime and routing, and helps inform the development of freight fueling corridors. Additional work includes development of a Dig Smart policy in order to advance best practices to lower the capital cost of infrastructure deployment and minimize disruptions caused by ongoing or duplicate construction.

b) Private Entity Infrastructure Investments

In addition to State efforts to accelerate the deployment of publicly available ZEV infrastructure, private companies have also advanced infrastructure rollout, sometimes as part of wider efforts to help fleets with the integration of ZE trucks as well as gathering data to improve their product offerings.

Industry partners are planning a network of charging sites on critical freight routes in three regions (West, East, and Texas) by 2026 with construction set to begin in 2023.[133] The initial funding is approximately $650M and will focus primarily on medium- and heavy-duty battery-electric charging infrastructure before expanding to hydrogen fuel cell and light-duty vehicles.

Hydrogen station developers including Chevron and Iwatani, who have been building hydrogen stations for light-duty vehicles with CEC funding assistance, are also committing to build stations without government funding.[134] While Chevron and Iwatani are initially focused on retail fueling or light-duty vehicles, they are retaining flexibility to service heavy-duty vehicles over the long-term. Over the past few years, the amount of private investment into

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[132] California Department of Transportation and California Energy Commission, *Final Project Report: "Installation of Electric Vehicle Charging Stations," January 2020, Document No. CEC-2020-014*, 2020 (web link: https://www.energy.ca.gov/sites/default/files/2021-05/CEC-600-2020-014.pdf, last accessed August 2022).

[133] HartEnergy, NextEra Energy, BlackRock Pitch $650 Million EV Charging Network, 2022 (web link: https://www.hartenergy.com/exclusives/nextera-energy-blackrock-pitch-650-million-ev-charging-network-198664, last accessed August 2022).

[134] Chevron, *Iwatani Agreement 30 Hydrogen Stations in CA — Chevron.com,* 2022 (web link: https://www.chevron.com/newsroom/2022/q1/chevron-iwatani-announce-agreement-to-build-30-hydrogen-fueling-stations-in-california, last accessed August 2022).

hydrogen stations has increased significantly. Information on the current status of all hydrogen stations in the state can be found at the California Fuel Cell Partnership's station map, including those that are operating, under some phase of development, and planned for future construction.[135]

In addition, several hydrogen producers are committing to develop renewable hydrogen production for the California market. While most are seeking government funding, Plug Power is planning to build a renewable hydrogen production facility in Mendota, California, without government funding. This 30-metric ton per day electrolysis plant will produce hydrogen from on-site solar power and recycled water from the city's wastewater treatment plant.[136] The plant will supply liquid hydrogen to their fuel cell forklift fleet customers and sell the surplus to the transportation market. Plug Power indicates that, due to zero carbon intensity associated with hydrogen production and the ability to earn LCFS credits, they will be able to offer hydrogen at a price competitive with diesel.

H. Fleet considerations for ZEV Deployment

The transition to ZEVs requires entities to consider a number of factors in order to accommodate the unique needs of each fleet, including upfront costs, availability, and operating characteristics, which are discussed in this section. This section also describes electricity rate structures in consideration of the influence electricity costs have on battery-electric recharging costs as well as provides a greater discussion on weight and payload capacities of ZEVs within each vehicle weight class category. Staff acknowledges these significant factors and illustrates solutions that are additionally contained within the section, along with supplemental discussion on the flexibility that the ZEV phase-in option offers for range and vehicle weight barriers.

1. Upfront Cost of ZEVs

Today and for the foreseeable future, BEVs and FCEVs will cost more upfront than their combustion-powered counterparts. This is due to a combination of higher vehicle prices as well as additional infrastructure costs. While operational savings are expected to offset these upfront costs over the lifetime of most vehicles, the increased capital expenditure associated with ZEVs will have an impact on fleets during this transition.

New vehicle prices for ZEVs are expected to be higher than their combustion counterparts for the near future due to the more costly components needed for their manufacture. BEVs require a battery and FCEVs require hydrogen tanks and fuel cell stacks, both of which increase the vehicle's overall price. However, while these prices are higher today, cost declines are occurring and are expected to continue. The price of batteries and other ZEV components continue to decline due to increased volume and economies of scale. For example, Bloomberg estimates the price of batteries has declined from $1,200/kilowatt-hour

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[135] CAFCP, *California Fuel Cell Partnership Hydrogen Stations map*, 2022 (web link: https://cafcp.org/stationmap, last accessed August 2022).
[136] Plug Power Inc., *Plug Power to Build Largest Green Hydrogen Production Facility on the West Coast*, 2021 (web link: https://www.ir.plugpower.com/press-releases/news-details/2021/Plug-Power-to-Build-Largest-Green-Hydrogen-Production-Facility-on-the-West-Coast-2021-9-20/default.aspx, last accessed August 2022).

(kWh) in 2010 to $132/kWh in 2021, a decrease of nearly 90 percent.[137] In some vocations, there is already evidence of cost parity between diesel and battery-electric vehicles. For example, Thomas-Built Buses recently announced a letter of intent which would deliver battery-electric school buses at cost parity with diesel school buses.[138] Similarly, the Ford F150 Lightning is being offered at a similar price versus an ICE Ford F150 with a similar configuration.[139] However, for vehicles with limited production, ZEV prices continue to be substantially higher than their combustion counterparts and we expect it to take more time before the incremental price for ZEVs to decline. For these reasons, staff foresees that incremental vehicle prices will become less of an issue over time.

Transitioning fleets to ZEVs would also require new infrastructure construction, which adds additional upfront costs. Initially, ZEVs will require the construction of new infrastructure for battery-electric and FCEVs. Many of the State's utilities have set up infrastructure investment programs that can offset the cost of installing infrastructure, as discussed in previous sections. As the ZEV market expands, more publicly accessible recharging and refueling networks will develop, providing fleets more refueling options and fewer concerns about range anxiety.

Financing can also alleviate these issues by spreading these upfront costs overtime. Because ZEVs have lower operating costs than combustion-powered vehicles, a fleet can spread out the higher upfront cost over the initial years of the deployment and then offset those costs with operational savings. This will allow the fleet's cashflow to remain neutral despite the higher cost of deploying ZEVs. To accelerate this process, the State is establishing programs to increase financing availability for ZEV replacements pursuant to Senate Bill 372.[140] In some instances, manufacturers themselves are setting up financing and infrastructure packages that can offer further support to fleets.[141,142] Additionally, new trucks-as-a-service business models are also appearing that allow fleets to operate trucks with minimal or no capital expenditure, resulting in increased flexibility and reduction in the needed commitment of ZEVs.[143] The combination of these programs will ease entry into the ZEV market in the upcoming years, especially for smaller fleets.

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[137] Bloomberg, *Battery Pack Prices Fall to an Average of $132/kWh, But Rising Commodity Prices Start to Bite*, 2021 (web link: https://about.bnef.com/blog/battery-pack-prices-fall-to-an-average-of-132-kwh-but-rising-commodity-prices-start-to-bite/, last accessed August 2022).

[138] Thomas-Built Buses, *Highland Electric Fleets and Thomas Built Buses Sign Agreement to Make Electric School Buses an Affordable Option Today*, 2022 (web link: https://thomasbuiltbuses.com/resources/news/highland-electric-fleets-and-thomas-built-2022-03-17/, last accessed August 2022).

[139] Inside EVs, *Ford F-150 Lightning Is Priced Much Like Gas F-150, But How?, 2021*. (web link: https://insideevs.com/news/520495/ford-f150-lightning-pricing-interview/, last accessed August 2022).

[140] SB 372 (Leyva, Stats. 2021 ch. 369). Health and Safety Code sections 44274.10 to 44274.15.

[141] Charged, *Volvo Trucks' Next-Gen VNR Electric Offers Enhanced Range and Additional Configurations*, 2022 (web link: https://chargedevs.com/newswire/volvo-trucks-next-gen-vnr-electric-offers-enhanced-range-and-additional-configurations/, last accessed August 2022).

[142] PACCAR, *PACCAR Extends Zero Emissions Leadership with Schneider Electric and Faith Technologies to Provide Comprehensive Battery Charging Solutions*, 2020 (web link: https://www.paccar.com/news/current-news/2020/paccar-extends-zero-emissions-leadership-with-schneider-electric-and-faith-technologies-to-provide-comprehensive-battery-charging-solutions/, last accessed August 2022).

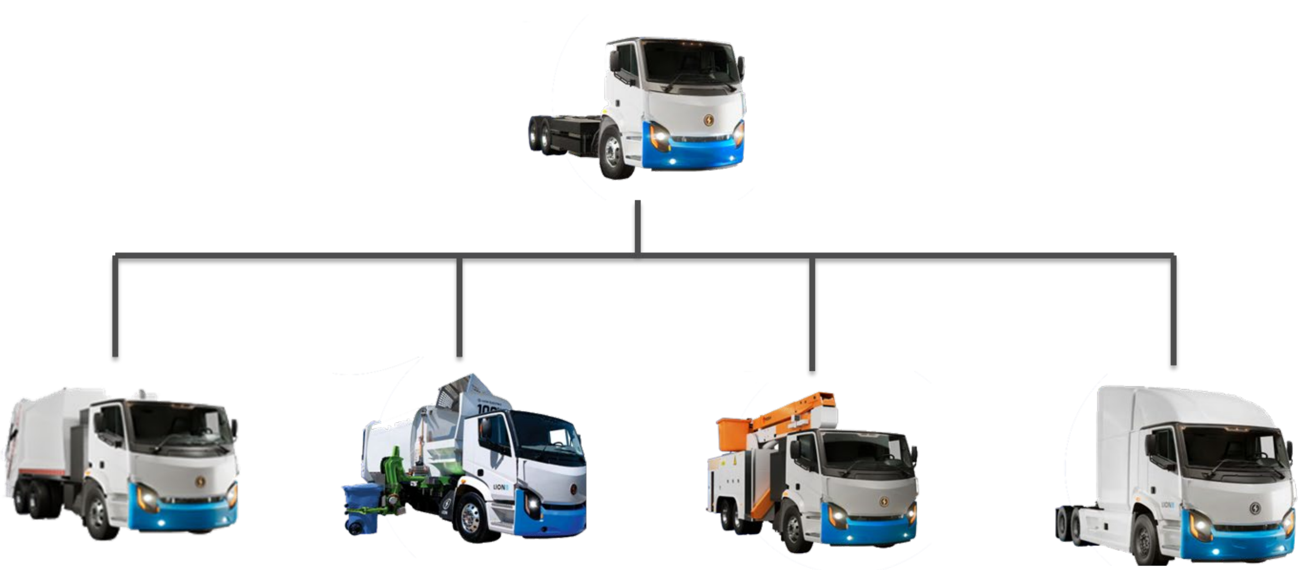
[143] WattEV, *WattEV Orders 50 Volvo VNR Electric Trucks*, 2022 (web link: https://www.wattev.com/post/wattev-orders-50-volvo-vnr-electric-trucks, last accessed August 2022).

2. Vehicle Availability from a Fleet Perspective

In consideration of highly varying fleet demands, truck manufacturers work closely with their customers to provide a vehicle model capable of meeting fleets' needs. As a result, vehicles in Class 4 and above are typically manufactured in stages, beginning with a common cab-and-chassis configuration that is then upfitted with a unique body based on a fleet's unique specifications. This process can take up to a year or more depending on the complexity of the manufacturing process. This timeline may be amplified for ZEVs.

Additional complexity may be introduced when a fleet owner or operator considers key operational needs of their potential ZEV fleet including, but not limited to, charging or fueling location (on site or otherwise), charging or fueling time (overnight or periodically throughout the day), and projected energy expenditure. Considering these factors, a manufacturer may work with fleets through dealerships to "spec out" vehicles in order to identify the ideal base configuration that best suits the needs of the fleet. This procedure requires fleets to work closely with manufacturers so that they can be apprised of what ZEVs are available for purchase as well as production lead times. Similar to the process for conventional vehicles, the body manufacturer or a post-purchase upfitter will then place the appropriate body type on the vehicle after a base cab-and-chassis is chosen. Figure 44 illustrates an example of how different bodies can be fitted on the same base cab-and-chassis, resulting in a diverse range of configurations that are able to fulfill an assortment of job functions.

Figure 44: Example of Multiple Bodies Fitted to Base Cab-and-Chassis



There are currently 158 models of ZEVs where manufacturers are accepting orders or pre-orders in every vehicle weight class category in the United States that exist in a wide variety of configurations. Manufacturers continue to make announcements for new product offerings and as technology advancements are made, staff anticipates a greater expansion in available

ZEV configurations and capabilities. A list of current internationally available ZEVs may be found on CALSTART's Zero-Emission Technology Inventory website. [144]

3. Zero-Emission Vehicle Operational Characteristics and Considerations

ZE technologies possess some operating characteristics that differ from ICE vehicles. Fleet owners or operators will need to consider which ZE technologies are best suited to meet their operational needs as well as how these vehicles will be fueled or charged.

Fleets must consider daily operating characteristics as they transition to a ZEV fleet. BEVs are already commercially available but have greater range limitations than ICE vehicles and require access to charging. FCEVs do not have the same range limitations as BEVs but there are fewer FCEVs available today and fueling infrastructure is still under development.

The LER data indicates that most vehicles operate less than 100 miles per day. Class 3-8 BEVs that are already commercially available have a nominal daily range of 100 miles. Although range application in a real-world setting is affected by factors such as heating and air conditioning, suitability is expected to improve with manufacturers currently demonstrating models with range capabilities of over 200 miles per charge.[145,146,147]

Figure 45 illustrates the estimated average daily mileage for a number of vehicle types that were surveyed in the LER. This figure demonstrates that, within the sample population, the majority of these vehicles operate for less than 100 miles per day. This is largely consistent with prior data collected from the Vehicle Inventory and Use Survey and indicates that truck electrification is achievable based on ZE trucks available today. [148]

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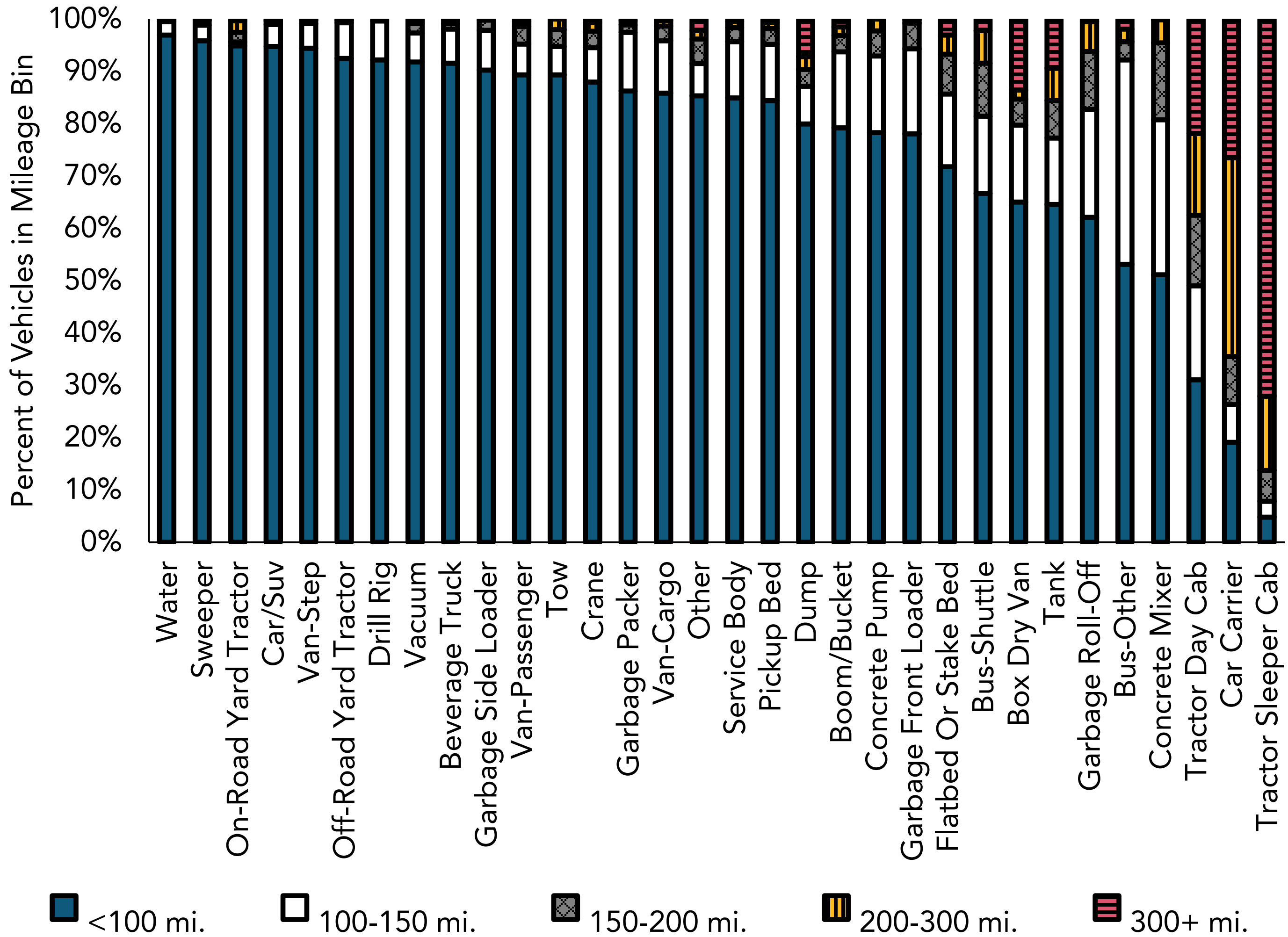
[144] CALSTART, *Zero-Emission Technology Inventory*, 2021 (web link: https://globaldrivetozero.org/tools/zero-emission-technology-inventory/, last accessed August 2022).
[145] Volvo Trucks, *The Volvo VNR Electric*, 2022. (weblink: https://www.volvotrucks.us/trucks/vnr-electric/, last accessed August 2022).
[146] Ford, *2022 Ford F-150 Lightning*, 2022. (web link: https://www.ford.com/trucks/f150/f150-lightning-electric-truck/, last accessed August 2022).
[147] Freightliner, *eCascadia*. (web link: https://freightliner.com/trucks/ecascadia/specifications/, last accessed August 2022).
[148] United States Census Bureau, *2002 Vehicle Inventory and Use Survey*, 2002 (web link: https://www2.census.gov/library/publications/economic-census/2002/vehicle-inventory-and-use-survey/ec02tv-us.pdf, last accessed August 2022).

Figure 45: Chart of the Estimated Average Daily Mileages for Select Vehicle Categories in Large Entity Reporting



For some applications that require high idling or the use of PTO, daily operational mileage may not be the best measure of a truck's duty cycle and other factors may affect a fleet's ability to electrify. Other measurement methods such as hour of operation would be appropriate in these applications.

Future expansion of the medium- and heavy-duty ZEV market must take into account applications that suit current and future ZEV technology. The most suitable market segments for electrification are ones where weight or space utilization are not overly constrained with relatively short, predictable routes operated from a centralized location. Appendix E of the ACT ISOR identified that just over 70 percent of Class 4-7 vehicles are good fits for electrification today while roughly 30 percent of Class 2b-3 and Class 8 vehicles are currently best suited for electrification. Further advances in technology will increase this portion of the medium- and heavy-duty truck population that is suitable for electrification.[149]

[149] California Air Resources Board, *Advanced Clean Trucks Regulation – Appendix E: Zero Emission Truck Market Assessment,* 2019 (web link: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2019/act2019/appe.pdf, last accessed August 2022).

4. Electricity Rate Structures

The cost of electricity influences ZE refueling costs for BEVs. Electricity is needed to recharge batteries and to create renewable or electrolytic hydrogen necessary for fuel cell operation. Electricity is provided to customers in California primarily by 6 IOUs, and 46 POUs. These utilities strive to set rates low that balance policy goals and equity concerns. The CPUC governs rates for the IOUs whereas the local utility board oversees rates for POUs. The 3 largest IOUs (PG&E, SCE, and SDG&E) provide over 75 percent of the state's electricity.

Rates have a direct impact on BEV and FCEV operating costs. Rate barriers vary by sector but revolve around similar themes comprising intermittent or inflexible use leading to charging peaks and higher rates. These barriers may inhibit fleets' abilities to electrify by increasing costs beyond conventional fuels. Monthly utility bills vary by utility, customer type, and rate schedule, but generally consist of three charge components that include:

a. Fixed: The fixed charge is a flat dollar ($) amount per billing cycle. The fixed charge is included for all customer classes and is a standard method of cost recovery for utilities located in the United States.
b. Volumetric: The volumetric component is based on the volume of energy consumed in the month and is measured in kWh. This component is subdivided into two factors, which include the total amount of energy used in the billing cycle and when the energy was used (time-of-use). The volumetric charge components are determined by multiplying the energy usage (kWh) by the dollar per kWh ($/kWh) of energy consumed resulting in a dollar amount.
c. Demand: Demand charges assess the costs associated with being able to transmit power to a customer at a specific maximum level. This is priced in dollars per kW of peak power required. Non-coincident and coincident prices are contained within the demand charge and are based on the maximum energy usage in the United States standard interval period of 15 minutes. Non-coincident demand charge uses the peak 15-minute interval during the billing cycle, whereas coincident demand charge uses the peak from the peak (or semi-peak) time of use period. The complexity of calculating demand charges makes it difficult for heavy-duty vehicles and freight equipment to budget their electricity fueling costs.

Since the 1980's, California utilities have offered time of use pricing plans for commercial rates that vary according to the time of day, season, and day type (weekday or weekend). Higher rates are charged during the peak demand and lower rates during off-peak times. Most rates include three different time of use windows that, in addition to the peak and off-peak windows, includes a super off-peak within the 24-hour clock with different price schedules for weekends and holidays. Generally, pricing includes a winter and a summer season schedule. Recently, a new rate with increased granularity has been offered to commercial customers with four windows and three seasons, including a new schedule for the spring months when renewable generation is the highest.

Early demonstration projects found that, in some situations, demand charges could account for half of electricity fueling costs. While the cost for EV operation was still lower than the diesel equivalent, fleets learned that demand charges could be a significant barrier. Generally, demand charges are highest when EVSE utilization rates are low and become a smaller bill component as fleets utilization rates increase with more adoption. In response to early challenges, CPUC and IOUs have instituted new rates that eliminate demand charges through a combination of demand charge holidays and subscription rates. For PG&E, it is the BEV1 and BEV2 Rate; SDG&E EV-HP; SCE TOU-EV-7, TOU-EV-8 and TOU-EV-9. Some fleets, however, may decide to stay on existing commercial rates instead of switching to new EV rates.

Many IOUs and POUs now offer electricity cost calculators for fleets to estimate their fueling costs. Many niche businesses have arisen to provide sophisticated software to manage charging for fleets that will optimize electricity fueling costs with technology to dampen the peaks to reduce demand charges.

AB 841 authorizes IOUs to pay for more EV charging infrastructure costs on the utility side of the meter, among other infrastructure installation costs. The law helped to resolve the need for the utility to recover costs of providing the infrastructure directly from customers pursuing the TE project. The law is being implemented into utility rules as well. For example, SCE's Rule 29 lays out the new policies on cost borne by the utility versus the customer for system upgrades. Some studies indicate that large-scale TE will lead to a decline in electricity costs due to higher utilization of generation assets, reducing electricity costs for all ratepayers.[150,151]

Fleets that work with utilities in the planning stage of ZEV infrastructure deployment to estimate their electricity demands and estimate such demands in light of existing local distribution capacity would be ideally situated in identifying how charging strategies and rate structures can be utilized to minimize their electrical rate costs. There are a number of free rate calculator tools to model fleet make and charging needs.

From the fleet perspective, implementing a smart charging strategy is an effective way to avoid charging the BEVs at peak or mid-peak hours and instead charge vehicles during off-peak hours as much as possible to manage electricity bills more effectively, resulting in a lower total operating cost of BEVs. As fleets electrify, smart charging should be considered and incorporated from the beginning to maintain low operational costs and support both grid flexibility and sustainability. Fleet operators can kickstart this process by engaging with manufacturers and exploring EV fleet service providers who may offer fleets a one-stop shop for navigating the electrification process, such as implementing managed charging systems and facilitating relationships with charger manufacturers, software vendors, and utilities.

5. Weight and Payload Capacity

Government Code section 11343.3 requires CARB to account for "vehicle weight impacts and the ability of vehicle manufacturers or vehicle operators to comply with laws limiting the weight of vehicles." The proposed ACF regulation seeks to accelerate ZEV adoption in the medium- and heavy-duty truck sector using battery or fuel cell technology. However, a concern among fleet owners and operators is that the heavier ZE trucks, when compared to

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[150] E3, *EVGrid: Electric Vehicle Grid Impacts Model*, 2019 (web link: https://www.ethree.com/tools/electric-vehicle-grid-impacts-model-2/, last accessed August 2022).

[151] M.J. Bradley and Associates, *MJB&A Analyzes State-Wide Costs and Benefits of Plug-in Vehicles in Five Northeast and Mid-Atlantic States*, 2017. (web link: *https://www.mjbradley.com/reports/mjba-analyzes-state-wide-costs-and-benefits-plug-vehicles-five-northeast-and-mid-atlantic*, last accessed August 2022).

their diesel counterparts, will result in reductions in cargo capacity in weight limited applications. However, as described in this section, most medium- and heavy-duty vehicles travel relatively short distances and don't need the largest available battery for battery electric vehicles ,and fuel cell vehicles may have advantages in certain applications where long distance travel is needed. Weight is not a major concern for ZEVs that are below Class 7 because most lighter vehicle operate less than 150 miles per day and don't need large batteries, and they can be upsized to the next higher weight class if a high mileage is needed. For Class 7 and 8 tractors, weight is potentially an issue for about 10 percent of tractor trailers that operate at their weight limits. Some of the weight concerns are partly addressed by Assembly Bill 2061[152] that allows for an additional 2,000 lbs. for alternative fueled vehicles, and as technology improves weight concerns are expected to diminish for the few trucks that are weight limited.

Battery electric vehicle weight depends on the size of the battery needed for the application. Lithium-ion batteries are the most commonly used rechargeable battery because they have one of the highest energy densities of any current battery technology. Battery systems have significantly improved over the past decade because of increases in energy density at the cell, module, and system levels.[153] Energy density has increased by more than 30 percent from the period of 2011 to 2018 across different lithium-ion chemistries and designs.[154] New chemistries that offer higher theoretical energy density limits are being researched, developed, and tested. In the near term, technologies that will outperform current lithium-ion batteries involve new cathode, anode, and electrolyte materials that increase the amount of energy stored. These include lithium-sulfur chemistries and solid-state batteries which are anticipated to be introduced into the marketplace by 2025.[155]

Recently, BEVs have employed weight saving measures such as lighter materials through the replacement of vehicle components that offer weight savings and offset the differential between ICEVs and BEVs operating at maximum payload capacities. As a result, battery energy density improvements and lightweighting are creating weight parity for many truck applications across Class 3-8 vehicles, particularly for operations that have daily ranges of 150 miles or less, or for operations that are not weight sensitive.

Hydrogen has relatively high energy density and is suited for longer range applications. Hydrogen's greater energy density allows FCEVs to have lower vehicle weights when compared to BEVs with substantially more than 150-mile range.[156] It should also be noted that weight saving advancements combined with AB 2061, that allows for an additional 2,000

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[152] AB 2061 (Frazier, Stats. 2018 ch. 580). Amendments to Business and Professions Code section 12725, and Vehicle Code section 35551.

[153] World Electric Vehicle Journal, *From Cell to Battery System in BEVs: Analysis of System Packing Efficiency and Cell Types*, 2020 (web link: https://www.mdpi.com/2032-6653/11/4/77, last accessed August 2022)

[154] European Commission, *Circular Economy Perspectives for the Management of Batteries used in Electric Vehicles*, 2019 (web link: https://publications.jrc.ec.europa.eu/repository/handle/JRC117790, last accessed August 2022).

[155] European Commission, *Circular Economy Perspectives for the Management of Batteries used in Electric Vehicles*, 2019 (web link: https://publications.jrc.ec.europa.eu/repository/handle/JRC117790, last accessed August 2022).

[156] US Department of Energy, *Fuel Cell and Battery Electric Vehicles Compared*, 2014 (web link: *https://www.energy.gov/sites/default/files/2014/03/f9/thomas_fcev_vs_battery_evs.pdf*, last accessed August 2022).

pounds, may result in class 8 BEVs and FCEVs having equal cargo payloads to ICE vehicles in the near future. [157]

a) Class 7-8 Tractors

Progress in increasing battery energy densities has greatly improved the performance and decreased the weight of batteries over the past decade. However, battery technology still requires further maturing to meet the range and weight requirements of long-haul operations, particularly those operations that regularly reach the maximum GVWR limit of 80,000 lbs. While the current state of battery technology is capable of meeting most fleet applications, such as those with stable routes, short haul, and return-to-base operations, the technology has also progressed enough to meet uses cases involving drayage and regional operations. And for operations that are not weight sensitive, as technology continues to improve BEVs with a range up to 300 miles are not expected to compromise payload capacity in the near future.[158]

The sensitivity to weight is dependent on the market segment (e.g., bulk haulers, refrigerated haulers, dry van general freight operation). For example, bulk haulers (petroleum products, chemicals, aggregates) are the most weight-sensitive market segment, but only account for 2 percent of the total trucks on the road. Refrigerated haulers represent about 10 percent of the trucks on the road, but only is weight-sensitive on a small portion (10 percent) of their trips. The majority of tractors (i.e., dry van general freight operation), about 88 percent, never travel at maximum weight because their trailers will reach the volumetric capacity "cube out" before reaching weight capacity "gross out," or because their routes and cargo patterns are not conducive to traveling with a full trailer.[159] This information is supported by data provided by U.S. EPA, which estimates that the typical average freight weight of a Class 8 tractor is 38,000 lbs. and the average total weight of a Class 8 tractor with trailer and freight is about 67,300 lbs.[160] Similarly, data from the North American Council for Freight Efficiency (NACFE) show that 50 percent or more of the loads of Class 7-8 vehicles across three operational segments (i.e., city, regional, and long-haul tractors), were below a freight weight of 39,500 lbs. This data also shows that the 90th percentile of Class 8 trucks have a GVWR less than 55,000 lbs. and the 95th percentile have a GVWR below 65,000 lbs.[161]

Class 7 and 8 FCEV and BEV tractor weight parity and performance parity may arrive much sooner than previously anticipated. According to the 2020 Tesla Impact Report, Tesla claims

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[157] California Legislature, *Assembly Bill No. 2061*, 2022 (web link: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202120220AB2061, last accessed August 2022).

[158] Lawrence Berkeley National Laboratory, *Why Regional and Long-Haul Trucks are Primed for Electrification Now*, 2021 (web link: https://eta-publications.lbl.gov/sites/default/files/updated_5_final_ehdv_report_033121.pdf, last accessed August 2022).

[159] NACFE, *Confidence Report: Lightweighting,* 2021 (web link: https://nacfe.org/wp-content/uploads/2021/02/Lightweighting-Confidence-Report-Feb2021.pdf, last accessed August 2022).

[160] U.S. EPA, *Greenhouse Gas Emissions Model (GEM) User Guide*, 2011 (web link: https://nepis.epa.gov/Exe/ZyPDF.cgi/P100BOPV.PDF?Dockey=P100BOPV.PDF, last accessed August 2022).

[161] NACFE, *Guidance Report: Electric Trucks-Where They Make Sense*, 2018 (web link: https://nacfe.org/downloads/full-report-electric-trucks/, last accessed August 2022).

that their semi-truck is capable of a 500-mile range and can handle the equivalent payload of a diesel truck, after considering the increased weight allowances for ZE technology.[162]

b) Class 3-8 Vocational Trucks

Payload capacity and range concerns are much less of a factor for Class 3-8 vocational trucks using existing battery technology. This is because typical payloads in many applications are well below the truck's maximum GVWR. For most operations in the medium-duty truck sector, freight tends to "cube out" before weight overload becomes a constraint. According to NACFE, vehicle weight for Class 3-6 medium-duty EV applications do not present a significant risk for fleet operators because they have sufficient freight weight margins or have alternate choices in vehicle designs and GVWR ratings.[163] In addition, most Class 3-8 vocational trucks have operations characterized by stable routes and home base locations that work well with the current state of battery technology. Data from NACFE shows that 75 percent of Class 3-8 vehicles are operated on shift schedules where they are parked for more than 6 hours per day. This data also suggests that 98 percent of Class 3-6 trucks travel between 50 and 150 miles a day.[164] The NACFE daily mileage data corresponds well with data collected through the LER requirement of the ACT regulation. The LER daily mileage data for Class 3-8 vocational trucks shows that 90 percent of these trucks travel less than 150 miles a day and 78 percent travel less than 100 miles per day.[165] As a result, existing data shows that BEVs with daily ranges up to 150 miles match well with expected Class 3-8 vocational duty cycles without compromising payload.

Similar to the availability of EV tractors described above, there are multiple EV medium-duty and heavy-duty non-tractors capable of a 100 to 200-mile range on a single charge available through HVIP.[166] These ZEVs include truck types such as straight trucks, flat beds, utility trucks, pickup trucks, step vans, refuse trucks, and many more. Most of the Class 3-8 vocational ZE trucks available through HVIP meet the range and weight requirements for a majority of the market segments, but for weight-sensitive vocations, there are several solutions available to address this issue.

c) Solutions for Weight Sensitive Operations

For operations that require larger battery capacities to meet longer ranges, or for vocations that are weight-sensitive, such as medium-duty beverage delivery and linen services, owners of Class 3-7 trucks considering the purchase of ZEVs using current battery technology have the option to move up a vehicle weight class if necessary. For Class 6 vehicles moving up a

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[162] Tesla, *2020 Impact Report*, 2020 (web link: https://www.tesla.com/ns_videos/2020-tesla-impact-report.pdf, last accessed August 2022).

[163] NACFE, *Guidance Report: Medium-Duty Electric Trucks Cost of Ownership*, 2018 (web link: https://nacfe.org/wp-content/uploads/2018/10/medium-duty-electric-trucks-cost-of-ownership.pdf, last accessed August 2022).

[164] NACFE, *Guidance Report: Electric Trucks-Where They Make Sense*, 2018 (web link: https://nacfe.org/downloads/full-report-electric-trucks/, last accessed August 2022).

[165] California Air Resources Board, *LER statewide aggregated data*, 2022 (web link: https://ww2.arb.ca.gov/sites/default/files/2022-02/Large_Entity_Reporting_Aggregated_Data_ADA.pdf, last accessed August 2022).

[166] California HVIP, *HVIP Eligible Vehicles*, 2022 (web link: https://californiahvip.org/vehiclecatalog/, last accessed August 2022).

weight class to Class 7, drivers are required to have either a Commercial Class A or Class B driver's license to operate the higher GVWR trucks, which may be a consideration for some fleets. In addition to moving up a vehicle weight class, reducing the vehicle's curb weight through light-weighting is an option for both medium- and heavy-duty vehicles to accommodate a larger battery pack. Lightweighting replaces heavier vehicle components with lighter weight materials, such as converting steel frames, roof hoods, side compartments, floor pans, and doors to aluminum or a lighter composite material. Also, tractors can use light-weighted trailers to provide additional and significant weight savings. Another promising option for reducing a vehicle's weight is the introduction of advanced system components. For example, Meritor is developing a fully scalable electric powertrain for Class 5-8 trucks that eliminates the need for conventional driveshafts and can provide weight savings of up to 800 lbs.[167] The flexibility in the proposed ACF regulation gives fleet owners additional time for long-haul applications and options to deploy ZEVs where most suited before needing to upgrade vehicles with more challenging applications.

d) Flexibility of the Zero-Emission Vehicle Phase-in Schedule

The proposed ACF regulation is structured in a way that provides flexibility for fleet owners to meet the ZEV phase-in requirements based on a fleet's mix of vehicle types and extends the compliance timeframe for high mileage vehicles. The ZEV phase-in schedule allows fleet owners/operators to be able to identify the trucks that are best suited for the technology available at that time. For example, the first ZEV phase-in requirements (10 percent of fleet in 2025) are in line with the current state of technology of vehicles that typically have daily ranges of 50 to 150 miles without compromising payload capacity. These vehicles include box trucks and vans which generally have stable routes and return-to-base operations, such as last mile delivery. Other vehicle types such as day cab tractors, work trucks are phased in starting 2027. The specialty truck and sleeper cab tractor phase-in requirement start in 2030, and by this time, ZEV technology is expected to have advanced to the point that range and vehicle weight are no longer barriers.

II. The Problem that the Proposed ACF regulation is Intended to Address

Transitioning to ZE technology for every on- and off-road mobile sector is essential for meeting near- and long-term emissions reductions goals mandated by statutes and policies established by various Governor-issued Executive Orders and Board directives. ZEVs are needed to reduce emissions of criteria pollutants and greenhouse gases, and especially the emissions of such pollutants that disparately impact disadvantaged communities. Diesel trucks emit a disproportionate amount of air pollution including PM, NOx (a precursor to smog), GHGs, and toxic air pollutants. Additionally, diesel vehicles often operate in clusters centered around distribution warehouses, railyards, and ports which further exacerbates the poor air quality in these overburdened communities. The sections below on the need to address State policy can be used to quickly reference the 18 statutes, Board resolutions, strategies and plans, Executive Orders, and a Memorandum of Understanding used to

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[167] HDT Trucking Info, *Meritor to Begin Commercial Electric Powertrain Production*, 2021 (web link: https://www.truckinginfo.com/10136025/meritor-to-begin-commercial-electric-powertrain-production, last accessed August 2022).

support the proposed ACF regulation. The sections that follow on the need to reduce exposure and risk, as well as need to reduce NOx, PM and GHG emissions put the State policy framework into context. Finally, the section on need to reduce emissions generated from internal combustion engines provides an overview of CARB's ongoing efforts to reduce emissions generated from internal combustion engines and the fuels used to power them, the role of biofuels in the on-road medium- and heavy-duty transportation sector, and finally how ZEVs are the solution moving forward.

In January 2021, the ACT regulation was adopted by CARB as a key part of the holistic approach to accelerate a large-scale ZEV transition of medium- and heavy-duty trucks. Alone, the ACT regulation is insufficient for achieving the significant emissions reductions that are needed on the time scale required, especially given the long lifetimes of these vehicles. The proposed ACF regulation would build on the ACT regulation. The initial focus is on drayage trucks, which have the largest impact in overburdened communities, and high priority and federal fleets, as well as State and local government fleets, whose vehicles are most suitable for electrification. CARB staff is confident that the proposed ACF regulation targets fleets best suited for electrification while allowing flexibility over a longer time horizon for the more challenging use cases to transition to ZEVs.

A. Need to Address State Policy

CARB staff reviewed and considered air quality attainment goals established by the federal government, the laws passed by the California State Legislature, the SIP, and the Executive Orders issued by Governors of California to develop the regulation. The following is a chronological summary of key supporting and existing policies used to guide the development of the proposed ACF regulation:

1. Assembly Bill 32

In 2006, California's Governor signed Assembly Bill 32, (AB 32) the California Global Warming Solutions Act of 2006[168] to address global climate change. AB 32 directed CARB to develop a scoping plan identifying integrated and cost-effective regional, national, and international GHG reductions programs. CARB adopted the AB 32 Scoping Plan in 2008, with subsequent updates in 2013 and 2017, and is currently undertaking the public process to update it for 2022. California's 2017 Climate Change Scoping Plan outlines the State's strategy to achieve its 2030 GHG targets.

2. Executive Order B-16-2012

In March 2012, Governor Brown issued Executive Order B-16-2012 directing California agencies to establish benchmarks for key milestones to help support and facilitate the ZEV market in California.[169] One of those milestones includes deploying over 1.5 million light-, medium-, and heavy-duty ZEVs and PHEVs on the road by 2025. As a result of this Order, multiple State agencies, including CARB, worked to develop and release the 2013 ZEV

[168] AB 32 (Núñez, Stats. 2006, ch. 488); Health & Saf. Code sections 38500 et seq.

[169] Office of Governor Edmund G. (Jerry) Brown Jr., *Executive Order B-16-2012*, 2012 (web link: https://www.ca.gov/archive/gov39/2012/03/23/news17472/index.html, last accessed August 2022).

Action Plan.[170] The 2013 ZEV Action Plan identified over 100 strategies to meet the milestones of the Executive Order and included 4 broad goals to advance the overall light-, medium-, and heavy-duty ZEV market. These 4 goals are:

- Complete needed ZEV infrastructure and planning;
- Expand consumer awareness and demand of ZEVs;
- Transform fleets; and
- Grow jobs and investment in the private sector.

3. Senate Bill 605 and Senate Bill 1383

Senate Bill 605 required CARB to develop a plan to reduce emissions of short-lived climate pollutants (SLCP), and Senate Bill 1383 required the Board to approve and begin implementing the plan by January 1, 2018. [171,172] SB 1383 also sets targets for statewide reductions in SLCP emissions of 40 percent below 2013 levels by 2030 for methane and hydrofluorocarbons, and 50 percent below 2013 levels by 2030 for black carbon. Reductions in GHGs from trucks, including SLCPs like black carbon, are needed to achieve the State's multiple GHG emissions reductions targets and related climate goals.

4. Board Resolution 14-2

In April 2015, CARB released the "Sustainable Freight Pathways to Zero and Near-Zero Discussion Document" in response to Board Resolution 14-2, which directed CARB to engage with stakeholders to identify and prioritize actions to move California toward a sustainable freight transport system.[173,174] The Discussion Document set out CARB's vision of a clean freight system and listed immediate and potential near-term CARB actions that staff would develop for future Board consideration. The CARB measures identified in the Discussion Document included developing and implementing strategies to accelerate the deployment of heavy-duty zero-emission technologies.

5. Executive Order B-32-15

In July 2015, Governor Brown signed Executive Order B-32-15 directing the California State Transportation Agency, California Environmental Protection Agency (CalEPA), and the Natural Resources Agency to lead other relevant State departments in developing an integrated action plan by July 2016 that "establishes clear targets to improve freight

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[170] Governor's Interagency Working Group on Zero-Emission Vehicles, *2013 ZEV Action Plan: A roadmap toward 1.5 million zero-emission vehicles on California roadways by 2025*, 2013 (web link: http://opr.ca.gov/docs/Governors_Office_ZEV_Action_Plan_(02-13).pdf, last accessed August 2022).

[171] SB 605 (Lara, Stats. 2014, ch. 523); Health & Saf. Code section 39730.

[172] SB 1383 (Lara, Stats. 2016, ch. 395); Health & Saf. Code sections 39730.5 through 39730.8, and Public Resources Code sections 42652 through 42654.

[173] California Air Resources Board, *Sustainable Freight Pathways to Zero and Near-Zero Emissions Discussion Document*, 2015 (web link: https://ww2.arb.ca.gov/sites/default/files/2020-09/Sustainable%20Freight%20Pathways%20to%20Zero%20and%20Near-Zero%20Emissions%20Discussion%20Document.pdf, last accessed August 2022).

[174] California Air Resources Board, *Board Resolution 14-2*, 2014 (web link: https://www.arb.ca.gov/board/res/2014/res14-2.pdf, last accessed August 2022).

efficiency, transition to ZE technologies, and increase competitiveness of California's freight system."[175] The 2016 California Sustainable Freight Action Plan included recommendations such as strengthening existing freight regulations as a State agency action to advance the objectives of the Executive Order.

6. Senate Bill 350

SB 350, the Clean Energy and Pollution Reduction Act, establishes GHG reductions targets and orders the CPUC to direct the 6 IOUs in the state to "accelerate widespread TE." The resulting programs developed by the electric utilities, for which $740 million has been authorized, promote the deployment of medium- and heavy-duty ZEVs through incentivizing infrastructure upgrade projects that offset most or all the costs for electrical service upgrades.

7. Senate Bill 32

In 2016, Senate Bill 32 was signed into law, which requires CARB to ensure that California's GHG emissions are reduced to at least 40 percent below the 1990 GHG level by 2030.[176]

8. Revised 2016 State Strategies

In March 2017, CARB adopted the Revised Proposed 2016 State Strategies document as part of the SIP which identified several sectors that are key to launching ZE technologies in the on-road, heavy-duty sector: transit buses, delivery trucks, and airport shuttles.[177] The proposed ACF regulation continues implementation of these strategies to increase heavy-duty ZEV deployments.

9. Senate Bill 1

In April 2017, Senate Bill 1, also known as the Road Repair and Accountability Act of 2017 was signed into law, which provides specified commercial vehicles over 10,000 lbs. GVWR a "useful life" period before such vehicles can be retired, replaced, retrofitted, or repowered through new or amended regulations.[178] The useful life period is specified as the later of

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[175] State of California Executive Order signed by Governor Edmund G. (Jerry) Brown Jr., *Executive Order B-32-15*, 2015 (web link: https://www.ca.gov/archive/gov39/2015/07/17/news19046/index.html, last accessed August 2022).

[176] SB 32 (Pavley, Stats. 2016, ch. 249); Health & Saf. Code section 38566.

[177] California Air Resources Board, *Revised 2016 State Strategy for the State Implementation Plan*, 2016 (web link: https://ww3.arb.ca.gov/planning/sip/2016sip/rev2016statesip.pdf, last accessed August 2022).

[178] SB 1 (Beall, Stats. 2017, ch. 5). Govt. Code: repeal Sections 63048.66, 63048.67, 63048.7, 63048.75, 63048.8, 63048.65, and 63048.85; add new sections 14033, 14110, 14526.7, 14556.41, 14460, 14461, 14526.7, 14556.41, 16321, and 63048.65; amend section 14526.5; Health & Saf. Code add Section 43021; Public Utilities Code: amend Section 99312.1, and add Sections 99312.3, 99312.4, and 99314.9; Revenue & Taxation Code amend Sections 6051.8, 6201.8, 7360, 8352.4, 8352.5, 8352.6, and 60050; to add Sections 7361.2, 7653.2, 60050.2, and 60201.4 to, and to add Chapter 6 (commencing with Section 11050) to Part 5 of Division 2 of, the Revenue and Taxation Code; Streets and Highways Code: amend Sections 2104, 2105, 2106, and 2107, add Sections 2103.1 and 2192.4, add Article 2.5 (commencing with Section 800) to Chapter 4 of Division 1 of, and to add Chapter 2 (commencing with Section 2030) and Chapter 8.5 (commencing with Section 2390) to Division 3 of, the Streets and Highways Code; Vehicle Code: amend Section 4156, add Sections 4000.15 and 9250.6.

either (a) 13 years from the MY that the engine and emissions control systems are first certified or (b) (when the vehicle travels 800,000 VMT or 18 years from the MY that the engine and emissions control systems are first certified for use, whichever is earlier). SB 1 also empowered the California DMV to enforce the Truck and Bus regulation through vehicle registrations.

10. Assembly Bill 617

In July 2017, California's Governor signed AB 617 into law. The bill requires new community-focused and community-driven action to reduce air pollution emissions and exposures and improve public health in communities that experience disproportionate burdens from cumulative exposure to toxic air contaminants and criteria air pollutants. To implement AB 617, CARB established the Community Air Protection Program. The Program's focus is to reduce exposure in communities most impacted by air pollution. CARB, air districts, and communities around the State are working together to develop and implement new strategies to measure air pollution, develop plans for localized emissions and exposure reductions, improve community engagement, and reduce health impacts. In addition to funding incentive projects and technical assistance for organizations participating in the program, a significant implementation activity involves air districts developing Community Emissions Reduction Programs (CERPs) and Community Air Monitoring Plans (CAMPs) for high cumulative exposure communities selected by the Board, in consultation with community steering committees of community stakeholders. All community steering committees for communities selected to date have identified air pollution from heavy-duty diesel vehicles as a concern in their communities and air districts have adopted CERPs identify strategies to respond to these vehicle emissions community concerns.

11. Title VI of U.S. Civil Rights Act of 1964

The U.S. Civil Rights Act of 1964, Title VI,[179] requires entities receiving federal assistance from discriminating on the basis of race, color, or national origin in their programs or activities. Historically, there was a common practice of denying access to federally funded services, programs, and activities based on certain people's race, color, or national origin, which Title VI intended to prevent going forward. As a recipient of funding from U.S. EPA, CARB complies with Title VI. Both discrimination and causing disparate impacts are prohibited by Title VI.

12. Executive Orders B-48-18 and B-55-18

In January 2018, Governor Brown issued Executive Order B-48-18 building on past efforts by increasing California's goal to introduce 5 million light-, medium-, and heavy-duty ZEVs on the road by 2030 and setting a target of 250,000 chargers by 2025.[180] Also in 2018, Governor Brown issued Executive Order B-55-18, which sets a target to achieve carbon neutrality in

[179] 42 U.S.C. § 2000d et seq.
[180] Office of Governor Edmund G. (Jerry) Brown Jr., *Governor Brown Takes Action to Increase Zero-Emission Vehicles, Fund New Climate Investments*, 2018 (web link: https://www.ca.gov/archive/gov39/2018/01/26/governor-brown-takes-action-to-increase-zero-emission-vehicles-fund-new-climate-investments/index.html, last accessed August 2022).

California no later than 2045 and achieve and maintain net negative emissions thereafter.[181] The proposed ACF regulation directly supports achieving these goals through the required transition to medium- and heavy-duty ZEVs in California in local government, drayage, and high priority and federal transportation sector fleets.

13. Governor Brown's August 2018 Letter to CARB

In August 2018, Governor Brown sent a letter to CARB directing it to pursue conversion of public and non-public fleets to ZEVs in categories including large employers, delivery vehicles, and transportation service fleets.[182] The proposed ACF regulation addresses this direction by requiring medium- and heavy-duty ZEV purchases for State and local government fleets, conversion of the drayage fleet to heavy-duty ZEVs, and upgrading to medium- and heavy-duty ZEVs in high priority and federal fleets.

14. Executive Order N-19-19

In September 2019, Governor Newsom issued Executive Order N-19-19, which requires every aspect of State government to redouble efforts to reduce GHG emissions and mitigate the impacts of climate change while building a sustainable and inclusive economy.[183] The Executive Order specifically calls for CARB to propose new strategies to increase demand in the primary and secondary markets for ZEVs, and to consider strengthening existing regulations or adopting new regulations to achieve necessary GHG reductions in the transportation sector. The proposed ACF regulation would support these goals by achieving GHG emissions reductions from the deployment of medium- and heavy-duty ZEVs. Additionally, ZEVs deployed early in the proposed regulatory timeline would be expected to be resold, thereby supporting a robust secondary market.

15. Board Resolution 20-19

As part of adopting the ACT regulation in June 2020, the Board also approved Resolution 20-19. The resolution required staff to come back to the Board in 2021 with requirements ensuring fleets, businesses, and public entities purchase and operate medium- and heavy-duty ZEVs.[184] The resolution set goals for the fleet requirements to be implemented on a timeline consistent with the ACT regulation and to achieve a smooth transition of California's fleet to ZEVs by 2045 everywhere feasible. The resolution also directs staff to ensure these upcoming regulations emphasize emissions reductions within DACs to the maximum extent

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[181] State of California Executive Order signed by Governor Edmund G. (Jerry) Brown Jr., *Executive Order B-55-18*, 2018 (web link: https://www.ca.gov/archive/gov39/wp-content/uploads/2018/09/9.10.18-Executive-Order.pdf, last accessed August 2022).

[182] Signed by Edmund G. (Jerry) Brown Jr., *Governor's Letter to Chair Nichols*, 2018 (web link: https://ww2.arb.ca.gov/sites/default/files/2020-06/zero_emission_fleet_letter_080118_ADA.pdf, last accessed August 2022).

[183] State of California Executive Order signed by Governor Gavin Newsom, *Executive Order N-19-19*, 2019 (web link: https://catc.ca.gov/-/media/ctc-media/documents/ctc-codes/execorder-n-19-19-a11y.pdf, last accessed August 2022).

[184] California Air Resources Board, *Resolution 20-19*, 2020 (web link: https://ww3.arb.ca.gov/regact/2019/act2019/finalres20-19.pdf, last accessed August 2022).

feasible. The resolution set the following clear goals for transitioning sectors of California's transportation industry to medium- and heavy-duty ZEVs where feasible:

- 100 percent ZE drayage, last mile delivery, and government fleets by 2035;
- 100 percent ZE refuse trucks and local buses by 2040;
- 100 percent ZE-capable vehicles in utility fleets by 2040; and
- 100 percent ZE everywhere else, where feasible, by 2045.

Staff's proposed ACF regulation largely meets the overall goals laid out by the Board with implementation starting in 2024 to align with ACT as originally planned. It would achieve 100 percent ZE drayage trucks by 2035 and most regulated delivery vehicles by 2035 as well, although the proposed ACF regulation will be brought to the Board in 2022. This proposed ACF regulation is a part of a comprehensive strategy to transition all trucks to ZE where feasible.

16. Memorandum of Understanding to Accelerate Zero-Emission Vehicle Market

After the ACT regulation was adopted by the Board, 16 states, the District of Columbia, and Province of Quebec signed a Memorandum of Understanding to work collaboratively to advance and accelerate the market for electric medium- and heavy-duty vehicles.[185] The states agreed to work together to set and meet medium- and heavy-duty ZEV sales targets and develop action plans that accelerate vehicle electrification. As of January 2022, 5 states have adopted the ACT regulation, with more expected in this year.[186]

17. Executive Order N-79-20

In September 2020, Governor Newsom signed Executive Order N-79-20, which establishes a goal that 100 percent of California sales of new passenger car and trucks be ZE by 2035.[187] In addition, the Governor's Order set a goal to transition all drayage trucks to ZEVs by 2035, all off-road equipment to ZE where feasible by 2035, and the remainder of medium- and heavy-duty vehicles to ZEVs where feasible by 2045. Under the Order, CARB is tasked to work with our State agency partners to develop regulations to achieve these goals considering technological feasibility and cost-effectiveness, which the proposed ACF regulation seeks to fulfill.

18. Revised 2020 Mobile Source Strategy

The 2020 Mobile Source Strategy was heard by the Board on October 28, 2021, and will be forwarded to the appropriate policy and fiscal committees of the Legislature as required by

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[185] California Air Resources Board, *Press Release 20-18 15 states and the District of Columbia join forces to accelerate bus and truck electrification*, 2020 (web link: https://ww2.arb.ca.gov/news/15-states-and-district-columbia-join-forces-accelerate-bus-and-truck-electrification, last accessed August 2022).
[186] Washington, Oregon, New York, New Jersey, and Massachusetts have all adopted the ACT regulation.
[187] State of California Executive Order signed by Governor Gavin Newsom, *Executive Order N-79-20*, 2020 (web link: https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-Climate.pdf, last accessed August 2022).

Senate Bill 44.[188,189] The strategy document looks at existing and emerging technologies to reduce emissions from California's transportation sector, including cars, trucks, trains, ships, and other on-road and off-road sources. These strategies illustrate the technology mixes needed for the State to meet its various clean air goals, including attaining the NAAQS, community risk reductions, and ambitious mid- and long-term climate change targets. To meet these goals, the Mobile Source Strategy found it is necessary for California's transportation sector to rapidly increase use of ZE technologies everywhere feasible.

19. Draft 2022 State Strategy for the State Implementation Plan

In January 2022, CARB released the Draft 2022 SIP Strategy for public comment.[190] The Draft 2022 State SIP Strategy focuses on emission reductions needed to meet the health-based 70 parts per billion (ppb) federal ozone standard. It will be considered by the Board in Fall 2022. Given that the document indicates California will be short of needed tons of emissions reductions needed for attainment, there is a need to push for more ZEV deployments beyond the proposed ACF regulation in future measures.

The 2022 SIP Strategy builds on the 2020 Mobile Source Strategy, and ACF as well as a proposed commitment to accelerate the number of medium- and heavy-duty ZEV beyond the ACT and proposed ACF regulation by upgrading remaining ICE vehicles to new or used ZEVs. The 2022 SIP Strategy and the upcoming legislatively mandated SB 1 report will further evaluate the potential advantages associated with additional authorities in accelerating this transition.

B. Need to Reduce Exposure and Risk in Impacted Communities

Many of the communities located near facilities where trucks operate bear a disproportionate health burden due to their proximity to emissions from the combustion engines that power trucks. There are several occurrences across the state where communities contain "groups" or "clusters" of facilities where trucks operate. In many cases, these facilities are in or near communities classified as disadvantaged by the CalEPA by using the California Communities Environmental Health Screening Tool to rank California communities based on environmental pollution burden and socio-economic indicators.[191] Exposure to diesel PM is a main contributor to these metrics for many communities ranked in the top 10th percentile statewide. Under AB 617, all community steering committees for communities selected to date have identified air pollution from heavy-duty diesel vehicles as a concern in their communities, including communities in the Bay Area, South Coast, San Joaquin Valley and San Diego air district regions. listing emissions from ports and/or railyards as a top

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[188] SB 44 (Skinner, Stats. 2019, ch. 297) (weblink: *https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201920200SB44*, last accessed August 2022).

[189] California Air Resources Board, 2020 Mobile Source Strategy, April 23, 2021. (web link: https://ww2.arb.ca.gov/sites/default/files/2021-12/2020_Mobile_Source_Strategy.pdf, last accessed August 2022).

[190] California Air Resources Board, *Draft 2022 State Strategy for the State Implementation Plan*, 2022 (web link: https://ww2.arb.ca.gov/sites/default/files/2022-01/Draft_2022_State_SIP_Strategy.pdf, last accessed August 2022).

[191] Office of Environmental Health Hazard Assessment, *CalEnviroScreen 4.0*, 2021 (web link: https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30, last accessed August 2022).

community concern. Adopted air district Community Emissions Reduction Program (CERPs) identify strategies to respond to these community concerns.

The proposed ACF regulation would assist California by simultaneously contributing to achieve the state's criteria pollutant and GHG reduction goals and cleaner technology targets. The California 2016 Mobile Source Strategy states that mobile sources and the fossil fuels that power them are the largest contributors to the formation of ozone, GHG emissions, PM 2.5 and toxic diesel PM.[192] In California, the transportation sector alone accounts for 41 percent of total GHG emissions (50 percent when upstream emissions from fuel is included) and is a major contributor to NOx and PM emissions.[193] The proposed ACF regulation is needed to accelerate the transition to ZE in the medium- and heavy-duty vehicle sector and to eliminate tailpipe emissions that disparately impact the DACs located in areas that are especially impacted by truck operations. Aligning with the Governor's Executive Order N-79-20, the deployment of ZEVs meets goals identified in Resolution 20-19, which calls for fleet requirements to be implemented on a timeline consistent with the ACT regulation and to achieve a smooth transition of California's fleet to ZEVs by 2045 everywhere feasible.

C. Need to Reduce NOx and Particulate Matter Emissions

Progress has been achieved in reducing PM2.5 and NOx emissions from mobile sources statewide through implementation of CARB's existing programs. These programs are expected to continue to provide further emissions reductions, helping the State to meet air quality standards. However, challenges remain in meeting the ambient air quality standards for ozone and PM2.5. California continues to experience some of the worst air quality in the nation. The South Coast and San Joaquin Valley Air Basins are designated as extreme non-attainment with the ozone NAAQS areas while 7 other areas are in serious or severe non-attainment with the ozone NAAQS. The near-term targets for these areas are a 2023 deadline for attainment of the 80 parts per billion (ppb) 8-hour ozone standard, 2024 for the 35 microgram per cubic meter ($\mu g/m^3$) 24-hour PM2.5 standard, and 2025 for the 12 $\mu g/m^3$ annual PM2.5 standard. There are also attainment years of 2031 and 2037 for the more recent 8-hour ozone standards of 75 ppb and 70 ppb, respectively. NOx is a precursor to both ozone and secondary PM2.5 formation. Consequently, reductions in NOx emissions provide benefits to help meet both the ozone and the PM2.5 standards. Additional PM2.5 and NOx reductions from all freight sources, including trucks, are essential to meeting these air quality standards as described in the recent Draft 2022 SIP Strategy.[194]

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[192] California Air Resources Board, *2016 Mobile Source Strategy*, 2016 (web link: https://ww3.arb.ca.gov/planning/sip/2016sip/2016mobsrc.pdf, last accessed August 2022).
[193] California Air Resources Board, *California Greenhouse Gas Emission Inventory*, 2022 (web link: https://www.arb.ca.gov/cc/inventory/data/data.htm, last accessed August 2022).
[194] California Air Resources Board, *2022 State Strategy for the State Implementation Plan (2022 State SIP Strategy)*, 2022 (web link: https://ww2.arb.ca.gov/resources/documents/2022-state-strategy-state-implementation-plan-2022-state-sip-strategy, last accessed August 2022).

D. Need to Reduce Greenhouse Gas Emissions

To date, California has made significant progress towards meeting the goals of SB 32. SB 32 requires California to reduce GHG emissions to at least 40 percent below 1990 levels by 2030. Significant progress has been made, however more needs to be done.

SLCPs such as black carbon, methane, nitrous oxide, and other compounds are emitted from transportation sources, including from burning fuels such as diesel or natural gas. These are powerful climate forcers that remain in the atmosphere for a much shorter period than longer-lived climate pollutants, such as CO_2, but are more potent when measured in terms of Global Warming Potential, which can be tens, hundreds, or even thousands of times greater than CO_2.

1. Low Carbon Fuels

The use of low carbon fuels contributes towards the reduction of GHG emission from the transportation sector. The LCFS program is based on the principle that each fuel has "life-cycle" GHG emissions that include CO_2, CH_4, N_2O, and other GHG contributors. This life cycle assessment examines the GHG emissions associated with the production, transportation, and use of a given fuel. The life cycle assessment includes direct emissions associated with producing, transporting, and using the fuels, as well as significant indirect effects on GHG emissions, such as changes in land use for some biofuels. The LCFS standards are expressed in terms of the "carbon intensity" of gasoline and diesel fuel and their respective substitutes.

In 2011, CARB's LCFS was implemented, with the carbon intensity set to just below the 2010 benchmark value calculated for fuels produced from California refineries. In 2018, the Board amended the LCFS program to harmonize with SB 32 by adjusting the annually declining carbon intensity benchmarks and extending them to 2030, and by adding new crediting opportunities to promote ZEV adoption. The 2018 LCFS amendments also consider the fuel use, or the energy efficiency ratio (EER) of the fuel-vehicle system. EER shows that BEVs are four to five times more efficient than comparable internal combustion powered technologies.[195] Electricity and hydrogen are currently the primary fuels for ZEVs, and both fuels must be produced using low carbon technology and feedstocks to minimize upstream emissions as the LCFS calculates life-cycle carbon intensity of fuel-vehicle systems. The 2018 LCFS amendments also added ZEV infrastructure crediting provision designed to support the deployment of light-duty public ZEV infrastructure. The ZEV infrastructure provision covers light-duty public hydrogen refueling infrastructure and direct current fast charging infrastructure. In addition to generating LCFS credit for dispensed fuel, the eligible hydrogen station, or direct current fast charger can generate infrastructure credits (also referred to as "capacity credits") based on the capacity of the station or charger minus the quantity of dispensed fuel.[196] LCFS Infrastructure Capacity Credits provide a revenue stream for fueling

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[195] California Air Resources Board, *LCFS Guidance 20-04 Requesting EER-Adjusted Carbon Intensity Using a Tier 2 Pathway Application Energy Efficiency Ratio*, 2020 (web link: https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/guidance/lcfsguidance_20-04.pdf, last accessed August 2022).

[196] California Air Resources Board, *LCFS ZEV Infrastructure Crediting*, 2022 (web link: https://ww2.arb.ca.gov/resources/documents/lcfs-zev-infrastructure-crediting, last accessed August 2022).

stations until ZEVs become more commonplace. Medium-duty ZEVs may be able to take advantage of these hydrogen fueling stations.

a) Renewable Natural Gas

The use of RNG as a transportation fuel has the potential to reduce GHG emissions. RNG made from organic waste counts avoided methane emissions from landfills and has a lower carbon intensity score than natural gas from fossil sources. California has the potential to produce approximately 90.6 billion cubic feet per year of RNG from dairy, landfill, municipal solid waste, and wastewater treatment facility sources[197] which represents only 4 to 5 percent of California's total annual consumption[198]. Currently, about half of the refuse trucks that operate in California are fueled by natural gas and the other half are fueled by diesel.[199] The number of CNG vehicles projected for 2024 is one percent of California's statewide fleet affected by the proposed ACF regulation.

SB 1383 established organic-waste diversion targets to achieve a 50 percent reduction of landfilled organic waste by 2020, and a 75 percent reduction by 2025 when compared to 2014-levels.[200] CalRecycle's SLCP regulation is expected to result in organics recycling infrastructure development and expanded markets for the products generated by organics recycling facilities to assist in meeting the targets set by SB 1383.[201]

Refuse companies fear if the State electrifies all sectors of the transportation sector too quickly, then the State's organic waste product procurement goals will conflict with the State's vehicle electrification policies, and they want CARB to create a long-term strategy that accounts for the SB 1383 induced circular economy. The wastewater industry comments suggest they will accept large amounts of municipal organic waste to co-digest at wastewater treatment plants, and they intend to invest in CNG vehicles and fueling infrastructure to make use of this bio-CNG. Both waste and wastewater industries have claimed new source review requirements are limiting RNG combustion at new onsite electricity generating units.

However, the limited availability of California made RNG can be directed towards harder to decarbonize sectors than transportation, or as a feedstock for energy and materials. In fact, CPUC's decision implementing Senate Bill 1440 directs RNG away from the transportation sector and creates RNG procurement targets for the IOUs.[202] SB 1440 also prohibits IOUs from procuring bio-CNG from facilities that do not commit to exclusively purchase and/or lease either NZE or ZE Class 8 trucks. Furthermore, SB 1440 states that, "It is the intent of

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[197] STEPS Program UC Davis, *Jaffee et al. "The Feasibility of Renewable Natural Gas as a Large-Scale, Low Carbon Substitute Contract No. 13-307*, 2016 (web link: https://ww2.arb.ca.gov/sites/default/files/classic/research/apr/past/13-307.pdf, last accessed August 2022).
[198] US EIA website on data for natural gas consumption by end use. (web link: *https://www.eia.gov/dnav/ng/ng_cons_sum_dcu_SCA_a.htm*, last accessed August 2022).
[199] CARB, *EMFAC*, 2021 (web link: https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/msei-modeling-tools-emfac-software-and, last accessed August 2022).
[200] California Legislative Information, *SB-1383 Short-lived climate pollutants: methane emissions: dairy and livestock: organic waste: landfills*, 2016 (web link: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SB1383, last accessed August 2022).
[201] CalRecycle, *California's Short-Lived Climate Pollutant Reduction Strategy*, 2016 (web link: https://calrecycle.ca.gov/organics/slcp/, last accessed August 2022).
[202] SB 1440 (Hueso, Stats. 2018 ch. 739). Pub. Utilities Code sections 650 and 651.

the Commission that NZE Class 8 trucks will be allowed only as long as ZE vehicles are not commercially available."[203] CPUC's definition of NZE in this context is not the same as used by CARB in this regulation and as defined in title 13, California Code of Regulations, section 1963(c)(16). CPUC considers NZE vehicles for the purposes of SB 1440, as those that meet CARB's ultra-low or optional low NOx standard and that only combust bio-CNG rather than fossil gas. CPUC's decision implementing SB 1440 will be re-evaluated in 2025 as a Renewable Gas Standard. The 2025 review will consider adopting a Renewable Gas Standard for IOUs, as well as when to require a jurisdiction's prospective purchases and/or leases of Class 8 trucks to be exclusively ZE in order to enter into RNG procurement contracts with IOUs.

The proposed ACF regulation does not conflict with the organic waste product procurement targets established by enacting SB 1383. Recovered organic waste product procurement target for jurisdictions does not require jurisdictions to purchase RNG for use directly as a transportation fuel. Moving forward, CPUC's Renewable Gas Standard may be a viable alternative to CARB's LCFS for RNG purchased by utilities and used in the residential sector.

b) Scoping Plan 2022 Update

CARB's AB 32 Scoping Plan (2022 Update) systematically evaluates and identifies feasible clean energy and technology options that will not just bring near-term air quality benefits, but also deliver on longer-term climate goals. The proposed ACF regulation takes a long view as well, by recognizing that bridging technology like NZEV as defined in title 13, CCR section 1963(c)(16), will need to play a larger role than CNG vehicles in transforming the transportation sector to ZE. Importantly, given the pace at which we must transition away from fossil fuels, we absolutely must identify and address market and implementation barriers to be successful. Given that ICE vehicles from legacy fleets will likely remain on the road for some time, even after all new vehicle sales have transitioned to ZEV technology, low carbon liquid fuels may continue to be used during this period of transition especially for more challenging use cases, and sectors such as aviation, locomotives, and marine applications. RNG or bio-CNG, currently displaces fossil fuels in transportation and will largely be needed for hard-to-decarbonize sectors but will likely continue to play a targeted role in some fleets while the transportation sector transitions to ZEVs.

E. Need to Reduce Emissions Beyond Combustion

Over the past 50 years combustion engines have gone through many upgrades as innovative vehicle emission control strategies have been adopted.[204] The primary policies implemented to address truck exhaust emission emissions have been adopting increasingly stringent engine emissions standards along with a variety of in-use fleet measures, and fuel standards. However, for California to achieve federally mandated ozone NAAQS and provide clean air for all Californians, more must be done. ZEVs have no tailpipe emissions, and have lower PM

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[203] California Public Utilities Commission, *Decision Implementing Senate Bill 1440 Biomethane Procurement Program*, 2022 (web link: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M454/K335/454335009.PDF, last accessed August 2022).

[204] California Air Resources Board, *History of CARB*, 2022 (web link: https://ww2.arb.ca.gov/about/history, last accessed August 2022).

emissions from reduced brake wear than even the cleanest ICE vehicles. The following is a summary of some of California's more significant emission control measures and their impact on emissions reductions from combustion engines.

CARB first began regulating heavy-duty engine exhaust emission standards for 1969 MY vehicles. Since the 1970s, California's regulations to control heavy-duty engine pollutant emissions have become more rigorous, continuing in the 1990s through 2010, with increasingly stringent emissions standards and test procedures for CO, HC, NOx and PM emissions. In 2004, a combined standard for smog-forming emissions for HC and NOx was implemented to further reduce the combined emissions by 40 percent. In 2007, NOx and non-methane hydrocarbon (NMHC) standards of 0.20 and 0.14 grams per brake horsepower-hour (g/bhp-hr), respectively, were phased in, reaching full compliance in 2010. An approximate reduction of 90 percent in NMHC and NOx emissions was achieved in 2010. Overall, heavy-duty engine emissions have been significantly reduced compared to uncontrolled levels.

California is already experiencing a significant decline in NOx emissions reductions from 2010 or newer MY diesel trucks. California's Truck and Bus regulation is now in its last replacement phase with a final deadline of January 1, 2023, for truck owners to upgrade to 2010 or newer MY engines.[205] By 2031, CARB's Heavy-Duty Omnibus regulation will dramatically reduce NOx emissions by another 90 percent from truck exhaust through a comprehensive suite of emissions-related requirements for 2024 and subsequent MY California-certified heavy-duty engines.[206] Figure 46 shows the steep decline in NOx emissions from now (2010 MY engines are labeled as "2020"), through full implementation of the Heavy-Duty Omnibus regulation engine certification standards for NOx (labeled as "2024" and "2027").[207] HD Omnibus certified engines will not only need to meet the 0.05 g/bhp-hr (2024) and 0.02 g/bhp-hr (2027) NOx standards, but they will also be subject to an in-use limit of 0.1 g/bhp-hr (2024), 0.04 g/bhp-hr (2027), and 0.03 g/bhp-hr (2030) NOx emissions standards.

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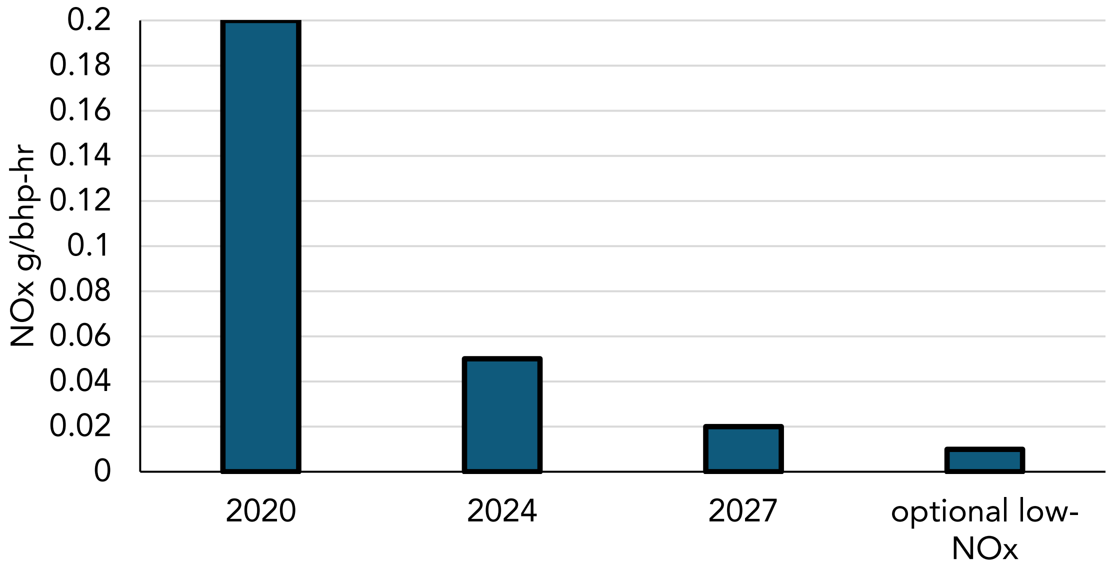
[205] California Air Resources Board, *Truck and Bus Regulation*, 2022 (web link: https://ww2.arb.ca.gov/our-work/programs/truck-and-bus-regulation, last accessed August 2022).
[206] California Air Resources Board, *Heavy-Duty Omnibus Regulation*, 2022 (web link: https://ww2.arb.ca.gov/rulemaking/2020/hdomnibuslownox, last accessed August 2022).
[207] California Air Resources Board, *Facts about the Low NOx Heavy-Duty Omnibus Regulation*, 2022 (web link: https://ww2.arb.ca.gov/sites/default/files/classic/msprog/hdlownox/files/HD_NOx_Omnibus_Fact_Sheet.pdf, last accessed August 2022).

Figure 46: Bar Chart Showing Heavy-Duty Omnibus Regulation Engine Certification Standards for NOx in 2024 and 2027 When Compared to the Current (2020) Standard



Inspection and maintenance programs for light to medium-duty vehicles started in 1988 with on-board computers, check engine lights and smog checks. Finally, starting in 2023, a similar program being proposed would be phased in for the heavy-duty sector. In 2037, the proposed HD I/M program is projected to cut statewide NOx emissions by 81.3 tpd and PM emissions by 0.7 tpd.[208]

CARB and the U.S. EPA also establish fuel certification standards which help lower exhaust emissions from combustion vehicles. Starting in 1975 lead was reduced in gasoline to enable the use of the catalytic converter. Then diesel fuel standards were established to reduce tailpipe NOx and PM, and to enable the use of PM filters and other exhaust emissions control technology. Adopted in 1988, California diesel fuel regulations set limits on aromatic hydrocarbon and sulfur content. These regulations, in effect since 1993, reduce emissions from diesel engines and equipment: 7 percent NOx, 25 percent PM, 80 percent sulfur oxides, as well as several toxic substances, such as benzene and polynuclear aromatic hydrocarbons. Volatile organic compound emission and evaporative emission controls for motor vehicle fuels and dispensers started in 1990's which helped improve air quality even more. The California Reformulated Gasoline program was implemented in 1991, which eliminated lead from gasoline and set regulations for deposit control additives and Reid vapor pressure.

The proposed ACF regulation would ensure California's fleets lead the shift towards a ZE pathway, meeting the State's goals and leading the nation in a widespread move towards carbon neutrality. A suite of new regulations, including CARB's Heavy-Duty Omnibus regulation and the proposed HD I/M program, will work to ensure that ICE vehicles operate as intended in the real world. Those regulations work in harmony with the ACT regulation

[208] California Air Resources Board, *Heavy-Duty Inspection and Maintenance Program*, 2022 (web link: https://ww2.arb.ca.gov/our-work/programs/heavy-duty-inspection-and-maintenance-program, last accessed August 2022).

and this proposed ACF regulation as the medium- and heavy-duty on-road transportation sector transitions to ZE everywhere feasible.

1. Compressed Natural Gas Vehicles

CNG vehicles operate at a 15 to 20 percent lower fuel economy than their diesel counterparts and after factoring in upstream methane emissions, natural gas trucks are more harmful to the climate than diesel trucks. [209,210] Recent studies demonstrate real-world emissions from CNG vehicles do not perform as laboratory certification standards suggest. Additionally, the potential to create low carbon fuels from California's organic waste products is limited and these fuels need to be directed towards harder to decarbonize sectors than transportation. Finally, CPUC's decisions implementing SB 1440[211] and SB 1477[212] send a clear signal that state policies supporting natural gas and distribution infrastructure must also align with key strategies to reach carbon neutrality by 2045.

One key strategy to meet California's climate neutrality target identified in the Scoping Plan Update (2022) is electrification in almost all sectors.[213] As discussed in the previous section on Renewable Natural Gas, SB 1440 directs RNG towards harder to decarbonize sectors than transportation by requiring IOUs to procure SB 1383 generated RNG. This decision goes further by requiring IOUs to procure RNG only from organic waste diversion facilities that commit to exclusively purchase or lease ZE Class 8 trucks.[214] Recently, CPUC aimed to phase out gas usage in the building sector by eliminating gas line extension allowances, ten-year refundable payment option, and fifty percent discount payment option under gas line extension rules as part of SB 1477 (Phase III). CPUC states that ending subsidies to extend gas lines "will send a price signal that building new gas infrastructure is more expensive, thus making dual fuel new construction less desirable and financially riskier". They further claim that ending gas line extension subsides beyond existing use areas will prevent stranded assets given the decade or longer lifetime of residential gas appliances.[215] Expanding CNG fueling infrastructure for CNG vehicles after the ZEV requirements take effect would have a similar risk of being stranded assets. The number of Class 2b-8 CNG vehicles projected for 2025 is relatively small at approximately one percent of California's statewide heavy-duty vehicles. Staff have also analyzed scenarios which evaluate the cost and emissions impact of

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[209] CEC Energy Almanac, *Transportation Natural Gas in California*, 2016 (web link: https://ww2.energy.ca.gov/almanac/transportation_data/cng-lng.html, last accessed August 2022).

[210] International Council on Clean Transportation, *A comparison of NOx emissions from heavy-duty diesel, natural gas, and electric vehicles*, 2021 (web link: https://theicct.org/sites/default/files/publications/low-nox-hdvs-compared-sept21.pdf, last accessed August 2022).

[211] SB 1440 (Hueso, Stats. 2018 ch. 739). Pub. Utilities Code sections 650 and 651.

[212] SB 1477 (Stern, Stats. 2018, ch. 378). (web link: *https://legiscan.com/CA/text/SB1477/id/1819922*).

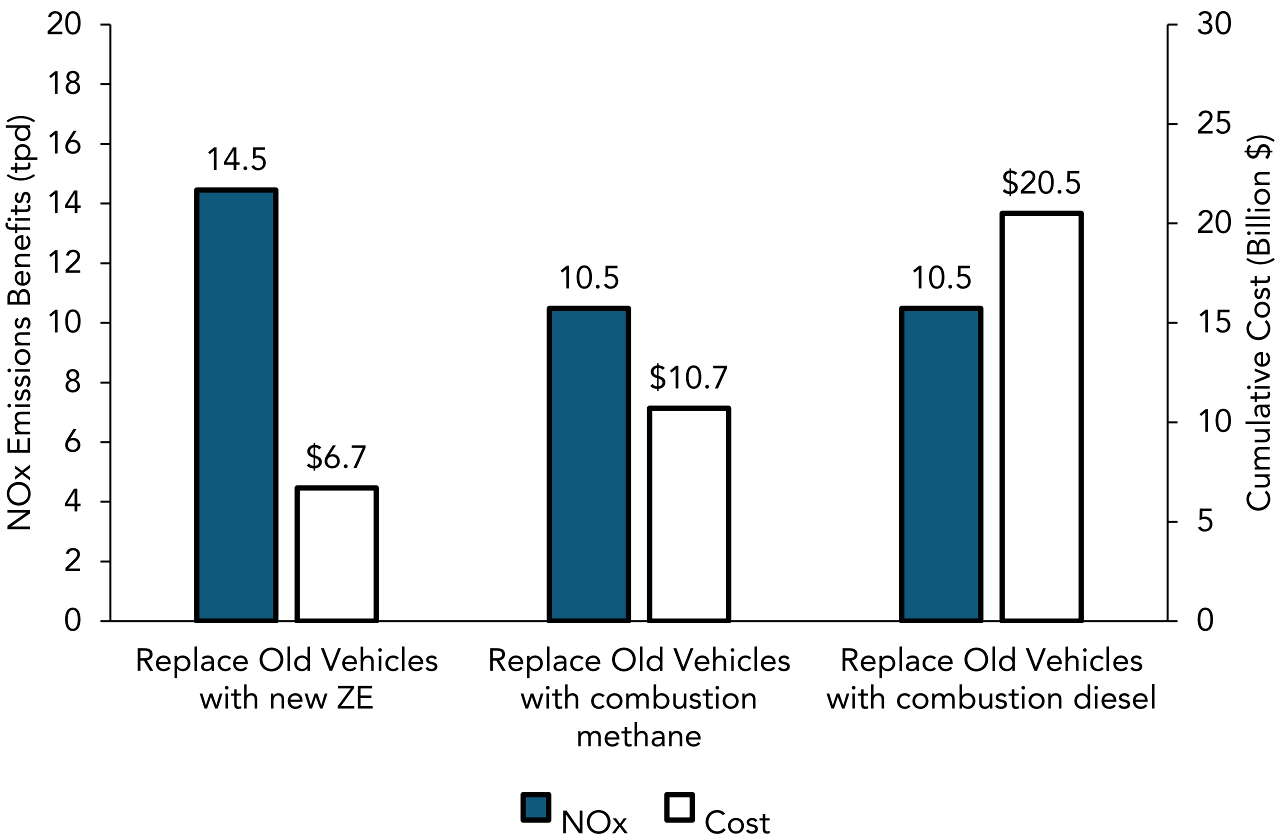
[213] California Air Resources Board, *California's 2017 Climate Change Scoping Plan*, 2017 (web link: https://ww2.arb.ca.gov/sites/default/files/classic//cc/scopingplan/scoping_plan_2017.pdf, last accessed August 2022).

[214] California Public Utilities Commission, *Decision Implementing Senate Bill 1440 Biomethane Procurement Program*, 2022 (web link: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M454/K335/454335009.PDF, last accessed August 2022

[215] California Public Utilities Commission Rulemaking 19-01-011, Phase III decision eliminating gas line extension allowances, ten-year refundable payment option, and fifty percent discount payment option under gas line extension rules. (web link: *https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M496/K415/496415627.PDF*)

transitioning older heavy-duty vehicles to new diesel, natural gas, and battery-electric vehicles.[216,217] Staff found that when comparing these different options, ZEVs offer the lowest cost and the greatest NOx emission benefits versus both combustion fuels as shown in Figure 47. This comparison illustrates how moving forward with a ZEV focused policy offers the greatest benefits to California for both health and economic reasons.

Figure 47: Statewide NOx Reductions and Cumulative Cost of Replacing Old Vehicles with ZEVs, Natural Gas, and Diesel



Furthermore, if California is to meet its health-based ambient air quality standards, we need to reduce levels of NOx emissions from on-road heavy-duty trucks by 85 percent. This will help achieve the 2008 75 ppb ozone standard required by 2031 in the South Coast region. Heavy-duty trucks and buses powered by CNG have been the "clean air" solution to help solve California's ozone problems for decades. Unfortunately, vehicles certified to the optional low NOx standard do not perform as expected within real-world applications as was

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216 California Air Resources Board, *Technical Analysis of End of Useful Life Scenarios – Statewide*, 2022 (web link: https://ww2.arb.ca.gov/resources/documents/technical-analysis-end-useful-life-scenarios-statewide, last accessed August 2022).

217 California Air Resources Board, *Technical Analysis of End of Useful Life Scenarios – South Coast*, 2022 (web link: https://ww2.arb.ca.gov/resources/documents/technical-analysis-end-useful-life-scenarios-south-coast, last accessed August 2022).

demonstrated by a recent study conducted by South Coast Air Quality Management District, CEC, CARB, and SoCalGas.[218]

This study measured emissions from 30 0.2-certified and fifteen 0.02-certified natural gas engines during controlled laboratory tests on a chassis dynamometer, and in real world applications using an on-board vehicle emissions testing device, or Portable Emissions Measuring System. This study measured the in-use emissions of 0.02-certified engines at much higher levels than certified under regular daily driving conditions in real-world applications.[219] Almost all the 0.02-certified engines produced NOx emissions greater than this certification standard, with an average NOx emission of 0.07 g/bhp-hr and some NOx emissions as much as three times higher. In addition, HD Omnibus requires more stringent test procedures such as the three-bin moving average window and the Low-load Cycle to limit emission rates during in-use operation.[220] Data on 15 tested vehicles suggest that optional low NOx engines are no cleaner than engines that will need to be certified under HD Omnibus. HD Omnibus has expanded warranty and On-Board Diagnostics requirements aimed at ensuring real-world emissions performance.

Even though the HD Omnibus has an optional pathway for even lower NOx engines, these optional low NOx engines have not been certified or tested in the real world and have some potential for a higher level of emissions while in use, especially after the end of the regulatory engine useful life period. Early conclusions point to real-world operational characteristics, such as idle time and duty cycles, as well as emission control systems deteriorating as a result of natural degradation or mal-maintenance as vehicles age and accumulate mileage, all of which can lead to real-world ICE vehicle emissions that are often much higher than their certification standard. In contrast, ZEVs have zero tailpipe emissions to guarantee that air quality benefits can be achieved throughout engine lifetimes regardless of operation and duty cycles.

The 2022 State Implementation Strategy (draft) air quality modeling indicates NOx emissions will need to decline by approximately 126 tpd from 2037 levels to provide for attainment in the remaining portions of the South Coast region that do not yet meet the preliminary 70 ppb ozone standard. Measures including the proposed ACF regulation and other policies described further in Next Steps will provide an estimated 73 tpd of NOx emission reductions in 2037 for the South Coast.[221]

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[218] Contractor's report will be made available during the 15-day changes since the estimated release date is just beyond the September 2, 2022 release of this ISOR. For background, the 200 vehicle in-use study is an extramural contract funded through the California Energy Commission and Southern California Gas Company ($2.5 million) with minor funding provided by the South Coast Air Quality Management District ($0.6 million) and California Air Resources Board ($0.25 million).

[219] California Air Resources Board, *In-Use Emission Performance of Heavy-Duty Natural Gas Vehicles Lessons Learned from 200 Vehicle Project,* 2021 (web link: https://ww2.arb.ca.gov/sites/default/files/2021-04/Natural_Gas_HD_Engines_Fact_Sheet.pdf, last accessed August 2022).

[220] California Air Resources Board (CARB), *Title 13 Final Regulation Order*, 2020 (web link: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2020/hdomnibuslownox/froa-1.pdf, last accessed August 2022).

[221] California Air Resources Board, *2022 State Strategy for the State Implementation Plan (2022 State SIP Strategy)*, 2022 (web link: https://ww2.arb.ca.gov/resources/documents/2022-state-strategy-state-implementation-plan-2022-state-sip-strategy, last accessed August 2022).

By definition, ZEVs produce no exhaust emissions of criteria pollutants or greenhouse gases under any possible operational mode. BEVs and FCEVs are the most common examples of ZEVs and both technologies utilize batteries to store energy and to power electric motors. These EVs have instant torque response, low noise, regenerative braking from energy recovered by the motor that greatly reduces brake wear and associated emissions, and generally have a simplified mechanical drivetrain, often without a transmission. Electric motors produce maximum torque and smooth acceleration from a full stop, which can be especially useful when hauling heavy loads. Additionally, some vehicles can even serve as an energy source for off-board equipment such as power tools or lights, providing several kilowatts of electricity through multiple electrical outlets.[222] Heavy-duty EVs in on-road applications across multiple vocations, weight classes, and drive cycles are more efficient than similar combustion-powered vehicles, with an efficiency ratio of 3.5 for highway speed duty cycles to greater than 7 for slow speed duty cycles when compared to similar combustion vehicles.[223]

City driving conditions have more frequent stops, which maximize the benefits of regenerative braking. Our expectation that the early battery-electric truck and bus market is more likely to be supported by centrally operated and maintained fleets that are expected to primarily be charged in the yard. Shorter range applications present less operational risk, have lower upfront cost with smaller battery packs and have a better near-term potential for a payback period more attractive for fleets. The ZEV market is expected to continue to expand to all types of vehicle operations as more ZEVs are deployed and publicly accessible infrastructure is built out.

III. The Specific Purpose and Rationale of Each Adoption, Amendment, or Repeal

California Government Code section 11346.2(b)(1) requires a description of the specific purpose for each proposed adoption, or amendment, the problem the agency intends to address with the proposed ACF regulation, and the rationale for determining that each proposed adoption and amendment is reasonably necessary to both carry out the purposes of CARB staff's proposed ACF regulation and to address the problems for which it is proposed.

The overarching purpose of the proposed ACF regulation is to reduce harmful emissions from motor vehicles. The problems these emissions cause are described above in Chapter II. Appendix H: Purpose and Rationale Description, presents the summary of each proposed amendment and describes its purpose and rationale for its role reducing emissions from motor vehicles.

[222] U.S. Department of Energy, *All-Electric Vehicles*, 2022 (web link: https://afdc.energy.gov/vehicles/electric_basics_ev.html, last accessed August 2022).
[223] California Air Resources Board, *Advanced Clean Trucks Regulation – Appendix G: Battery Electric Truck and Bus Energy Efficiency Compared to Conventional Diesel Vehicles*, 2019 (web link: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2019/act2019/appg.pdf, last accessed August 2022).

IV. Benefits Anticipated from the Regulatory Action, Including the Benefits or Goals Provided in the Authorizing Statute

A. Health Benefits

Diesel-powered mobile sources emit a complex mixture of air pollutants, including diesel PM, volatile organic compounds, and NOx which can lead to the formation of ozone and the secondary formation of PM.

The proposed ACF regulation would reduce NOx and PM2.5 emissions, resulting in health benefits for individuals in California. The value of health benefits calculated for this regulation is due to fewer instances of premature mortality and fewer hospital and ER visits. The evaluation method used in this analysis is the same as the one used for CARB's LCFS 2018 Amendments, Heavy-Duty Vehicle Inspection Program, and Periodic Smoke Inspection Program.

1. Non-Cancer Health Impacts and Valuation

The proposed ACF regulation's reduction of NOx and PM2.5 emissions would result in health benefits for individuals in California. CARB analyzed the value associated with four health outcomes in the Legal Baseline, Modified Baseline, proposed ACF regulation, and alternatives: cardiopulmonary mortality, hospitalizations for cardiovascular illness, hospitalizations for respiratory illness, and ER visits for asthma. These health outcomes and others have been identified by U.S. EPA as having a causal or likely causal relationship with exposure to PM2.5 based on a substantial body of scientific evidence.[224] U.S. EPA has determined that both long-term and short-term exposure to PM2.5 plays a causal role in premature mortality, meaning that a substantial body of scientific evidence shows a relationship between PM2.5 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. 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 PM2.5 exposure. These outcomes lead to hospitalizations and ER visits and are included in this analysis.

CARB staff evaluated a limited number of statewide non-cancer health impacts associated with exposure to PM2.5 and NOx emissions from medium- and heavy-duty vehicles. NOx includes nitrogen dioxide, a potent lung irritant when inhaled, which can aggravate lung diseases such as asthma.[225] However, the most serious quantifiable impacts of NOx emissions occur through the conversion of NOx to fine particles of ammonium nitrate aerosols through chemical processes in the atmosphere. PM2.5 formed in this manner is termed secondary PM2.5. Both directly emitted PM2.5 and secondary PM2.5 from medium- and heavy-duty

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[224] U.S. EPA, *Integrated Science Assessment for Particulate Matter (Issue EPA/600/R-19/188)*, 2019 (web link: https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=347534, last accessed August 2022).

[225] United States Environmental Protection Agency, *Integrated Science Assessment for Oxides of Nitrogen – Health Criteria, EPA/600/R-15/068*, 2016 (web link: http://ofmpub.epa.gov/eims/eimscomm.getfile?p_download_id=526855, last accessed August 2022).

vehicles are associated with adverse health outcomes, such as cardiopulmonary mortality, hospitalizations for cardiovascular illness and respiratory illness, and ER visits for asthma. As a result, reductions in PM2.5 and NOx emissions are associated with reductions in these health outcomes.

2. Reduction in Potential Cancer Risk

Diesel PM is a toxic air contaminant composed of over 40 known cancer-causing substances and PM. Examples of these carcinogenic chemicals include: polycyclic aromatic hydrocarbons, benzene, formaldehyde, acetaldehyde, acrolein, and 1,3-butadiene. CARB listed diesel PM as a toxic air contaminant in 1998, due largely to its association with lung cancer. In 2012, additional studies on the cancer-causing potential of diesel exhaust, published since CARB's listing, led the International Agency for Research on Cancer, a division of the World Health Organization, to classify diesel engine exhaust as "carcinogenic to humans."[226] In California, about 70 percent of known cancer risks from toxic air contaminants are from diesel engine emissions.

Diesel PM is composed primarily of PM2.5. Due to its small size, inhaled PM2.5 can reach the lower respiratory tract and potentially pass into the bloodstream to affect other organs. In this way, PM2.5 air pollution contributes not only to increased cancer risk, but also to respiratory and cardiovascular diseases and even premature death; other adverse health outcomes from PM2.5 also include asthma, chronic heart disease, and heart attack.

Because the proposed ACF regulation is expected to result in the reduction of both NOx and PM2.5, it is expected that there would be a resulting reduction in incidences of cancer, though this was not quantified for the proposed ACF regulation.

3. Incidence-per-Ton Methodology

CARB uses the incidence-per-ton (IPT) methodology to quantify the health benefits of emissions reductions in cases where dispersion modeling results are not available. A description of this method is included on CARB's webpage.[227] CARB's IPT methodology is based on a methodology developed by U.S. EPA.[228,229,230]

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[226] World Health Organization, International Agency for Research on Cancer, *IARC: Diesel Engine Exhaust Carcinogenic*, 2012 (web link: https://www.iarc.who.int/news-events/iarc-diesel-engine-exhaust-carcinogenic/, last accessed August 2022).
[227] California Air Resources Board, *CARB's Methodology for Estimating the Health Effects of Air Pollution* (web link: https://ww2.arb.ca.gov/resources/documents/carbs-methodology-estimating-health-effects-air-pollution, last accessed August 2022).
[228] Fann N, Fulcher CM, Hubbell BJ., *The influence of location, source, and emission type in estimates of the human health benefits of reducing a ton of air pollution*, Air Quality, Atmosphere & Health, 2:169-176, 2009 (web link: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2770129/, last accessed August 2022).
[229] Fann N, Baker KR, Fulcher CM., *Characterizing the PM2.5-related health benefits of emission reductions for 17 industrial, area and mobile emission sectors across the U.S.*, Environ Int.; 49:141-51, 2012 (web link: https://www.sciencedirect.com/science/article/pii/S0160412012001985, last accessed August 2022).
[230] Fann N, Baker K, Chan E, Eyth A, Macpherson A, Miller E, Snyder J., *Assessing Human Health PM2.5 and Ozone Impacts from U.S. Oil and Natural Gas Sector Emissions in 2025, Environ. Sci. Technol. 52 (15), pp 8095–8103*, 2018 (web link: https://pubs.acs.org/doi/abs/10.1021/acs.est.8b02050, last accessed August 2022).

Under the IPT methodology, changes in health outcomes are approximately proportional to changes in emissions. IPT factors are derived by calculating the number of health outcomes associated with exposure to PM2.5 for a baseline scenario using measured ambient concentrations and dividing by the emissions of PM2.5 or a precursor. The calculation is performed separately for each air basin using the following equation:

$$IPT = \frac{\text{number of health outcomes in air basin}}{\text{annual emissions in air basin}}$$

Multiplying the emissions reductions from the proposed ACF regulation in an air basin by the IPT factor then yields an estimate of the reduction in health outcomes achieved by the proposed ACF regulation. For future years, the number of outcomes is adjusted to account for population growth. CARB's current IPT factors are based on a 2014-2016 baseline scenario, which represents the most recent data available at the time the current IPT factors were computed. IPT factors are computed for the two types of PM2.5: primary PM2.5 and secondary PM2.5 of ammonium nitrate aerosol formed from precursors.

4. Reduction in Adverse Health Impacts

CARB staff evaluated the reduction in adverse health impacts including cardiopulmonary mortality, hospitalizations for cardiovascular and respiratory illness, and ER visits for asthma. Staff estimates that the total number of cases statewide that would be reduced (from 2024 to 2050) from implementation of the proposed ACF regulation are as follows:

1. 5,519 cardiopulmonary deaths reduced (4,316 to 6,744, 95 percent confidence interval (CI));
2. 873 hospital admissions for cardiovascular illness reduced (0 to 1,711, 95 percent CI);
3. 1,042 hospital admissions for respiratory illness reduced (244 to 1,838, 95 percent CI); and
4. 2,537 ER visits for asthma reduced (1,606 to 3,470, 95 percent CI).

Table 19 shows the estimated avoided cardiopulmonary mortality, hospitalizations, and ER visits because of the proposed ACF regulation for 2024 through 2050 by California air basin, relative to the Legal Baseline. As shown, the proposed ACF regulation is estimated to reduce overall emissions of PM2.5 and NOx, and lead to net reduction in adverse health outcomes statewide, relative to the baseline. While this analysis does not further quantify upstream emissions benefits of criteria pollutant reductions, to the degree reduced fuel demand from this rule results in reduced liquid fuel production at California refineries, further benefits would result from criteria pollutant reductions.[231] As noted above, during the COVID-19 pandemic and the stay-at-home orders, there was a drastic reduction in demand for petroleum fuels as residents stayed home. As a result of that reduced demand, several

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[231] CARB conducted a similar analysis, incorporated here by reference, in a recent SRIA document for the large fuel demand reductions associated with the proposed Advanced Clean Cars 2 Regulation. *See* California Air Resources Board, *Advanced Clean Cars II SRIA*, 2022 (web link: https://www.dof.ca.gov/forecasting/economics/major_regulations/major_regulations_table/documents/ACCII-SRIA.pdf, last accessed August 2022).

refineries shutdown or announced the repurposing of those facilities to produce low carbon fuels.[232,233] Just as GHG reductions from these sources might be expected to result from corresponding fuel demand reductions from this regulation, criteria and toxic pollution reduction from these sources will also likely occur, further expanding the benefits of these regulations. To be conservative, and in light of the many factors affecting upstream sector behavior, CARB has opted not to include specific reductions here—and even without them very significant health benefits are expected.

It should be noted that the results presented in Table 19 are estimated at a regional scale, at the air basin level. However, it is important to consider that the proposed ACF regulation may decrease the occupational exposure to air pollution of California truck operators and other employees who work around truck traffic. Without the proposed ACF regulation, these individuals are likely at higher risks of developing cardiovascular and respiratory issues as a result of medium- and heavy-duty vehicle PM emissions. Although CARB staff cannot quantify the potential effect on occupational exposure, the proposed ACF regulation is expected to provide large health benefits for these types of workers.

Table 19: Regional and Statewide Avoided Mortality and Morbidity Incidents from 2024 to 2050 under the Proposed ACF regulation

Air Basin	Cardiopulmonary mortality	Hospitalizations for cardiovascular illness	Hospitalizations for respiratory illness	ER visits
Great Basin Valleys	3 (2 - 3) ‡	0 (0 - 1)	0 (0 - 1)	1 (1 - 1)
Lake County	2 (2 - 3)	0 (0 - 0)	0 (0 - 0)	1 (1 - 1)
Lake Tahoe	1 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Mojave Desert	94 (73 - 115)	14 (0 - 28)	17 (4 - 30)	36 (23 - 49)
Mountain Counties	46 (36 - 57)	4 (0 - 9)	5 (1 - 9)	15 (10 - 21)
North Central Coast	23 (18 - 28)	4 (0 - 8)	5 (1 - 8)	13 (8 - 18)
North Coast	8 (6 - 10)	1 (0 - 2)	1 (0 - 2)	3 (2 - 4)
Northeast Plateau	3 (2 - 3)	0 (0 - 1)	0 (0 - 1)	1 (1 - 2)
Sacramento Valley	243 (190 - 298)	31 (0 - 61)	37 (9 - 66)	90 (57 - 124)
Salton Sea	71 (55 - 87)	11 (0 - 21)	13 (3 - 23)	33 (21 - 45)
San Diego County	226 (177 - 277)	34 (0 - 67)	41 (10 - 72)	89 (56 - 122)

[232] Phillips 66, *Phillips 66 Plans to Transform San Francisco Refinery into World's Largest Renewable Fuels Plant, 2020* (web link: https://investor.phillips66.com/financial-information/news-releases/news-release-details/2020/Phillips-66-Plans-to-Transform-San-Francisco-Refinery-into-Worlds-Largest-Renewable-Fuels-Plant/default.aspx, last accessed August 2022).

[233] BiodieselMagazine.com, *Marathon proceeds with renewables conversion at Martinez refinery,* 2021 (web link: https://biodieselmagazine.com/articles/2517427/marathon-proceeds-with-renewables-conversion-at-martinez-refinery, last accessed August 2022).

Air Basin	Cardiopulmonary mortality	Hospitalizations for cardiovascular illness	Hospitalizations for respiratory illness	ER visits
San Francisco Bay	419 (327 - 513)	68 (0 - 133)	81 (19 - 142)	225 (142 - 308)
San Joaquin Valley	1,111 (870 - 1355)	141 (0 - 277)	169 (40 - 298)	393 (249 - 537)
South Central Coast	63 (49 - 76)	10 (0 - 20)	12 (3 - 21)	27 (17 - 36)
South Coast	3,207 (2,509 – 3,918)	554 (0 – 1,085)	661 (155 – 1,166)	1,610 (1,019 – 2,201)
Statewide*	**5,519 (4,316 – 6,744)**	**873 (0 – 1,711)**	**1,042 (244 – 1,838)**	**2,537 (1,606 – 3,470)**

*Note: Totals may differ due to rounding.

‡ Numbers in parentheses throughout this table represent the 95 percent confidence interval (CI).

5. Uncertainties Associated with the Mortality and Illness Analysis

Although the estimated health outcomes presented in this report are based on a well-established methodology, they are subject to uncertainty. Uncertainty is reflected in the 95 percent CIs included with the central estimates in Table 19. These CIs take into account uncertainties in translating air quality changes into health outcomes.

Other sources of uncertainty include the following:

- The relationship between changes in pollutant concentrations and changes in pollutant or precursor emissions is assumed to be proportional, although this is an approximation.
- Emissions are reported at an air basin resolution, and do not capture local variations.
- Future population estimates are subject to increasing uncertainty as they are projected further into the future.

Baseline incidence rates can also experience year-to-year variations.

6. Monetization of Health Impacts

In accordance with U.S. EPA practice, health outcomes are monetized by multiplying each incident by a standard value derived from economic studies.[234] The value per incident is shown in Table 20. The value for avoided premature mortality is based on willingness to pay, which is a statistical construct based on the aggregated dollar amount that a large group of

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[234] U.S. EPA, *Appendix B: Mortality Risk Valuation Estimates, Guidelines for Preparing Economic Analyses (240-R-10-001)*, 2010 (web link: https://www.epa.gov/sites/default/files/2017-09/documents/ee-0568-22.pdf, last accessed August 2022).

people would be willing to pay for a reduction in their individual risks of dying in a year.[235] 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. 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, lost earnings for 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).[236] These monetized benefits from avoided hospitalizations and ER visits are included in macroeconomic modeling.

Table 20: Valuation per Incident for Avoided Health Outcomes (2021$)

Outcome	Value per incident
Avoided Premature Mortality	$10,453,897
Avoided Cardiovascular Hospitalizations	$61,750
Avoided Acute Respiratory Hospitalizations	$53,862
Avoided ER Visits	$884

Statewide valuation of health benefits was calculated by multiplying the value per incident by the statewide total number of incidents for 2024-2050 as shown in Table 21. The total statewide health benefits derived from criteria emissions reductions is estimated to be $57.8 billion, with $57.7 billion resulting from reduced premature cardiopulmonary mortality and $0.1 billion resulting from reduced hospitalizations and ER visits. The spatial distribution of these benefits across the state follows the distribution of the health impacts by air basin as described in Table 21.

[235] U.S. EPA, *An SAB Report on EPA's White Paper Valuing the Benefits of Fatal Cancer Risk Reduction (EPA-SAB-EEAC-00-013)*, 2000 (web link: https://nepis.epa.gov/Exe/ZyPDF.cgi/P100JOK2.PDF?Dockey=P100JOK2.PDF, last accessed August 2022).

[236] Chestnut, L. G., Thayer, M. A., Lazo, J. K. and Van Den Eeden, S. K., *The Economic Value Of Preventing Respiratory And Cardiovascular Hospitalizations, Contemporary Economic Policy, 24: 127– 143*, 2006 (web link: https://onlinelibrary.wiley.com/doi/abs/10.1093/cep/byj007, last accessed August 2022).

Table 21: Statewide Valuation from Avoided Health Outcomes (Million 2021$)

Year	Avoided cardiopulmonary mortality valuation	Avoided hospitalizations for cardiovascular illness valuation	Avoided hospitalizations for respiratory illness valuation	Avoided ER visits valuation	Annual total valuation
2024	8	1	1	4	$83.75
2025	9	1	1	4	$94.20
2026	12	2	2	6	$125.68
2027	20	3	3	10	$209.43
2028	27	4	4	13	$282.73
2029	38	5	6	18	$397.90
2030	55	8	9	26	$575.97
2031	73	11	13	35	$764.54
2032	90	13	16	43	$942.55
2033	106	16	20	50	$1,110.17
2034	129	20	25	61	$1,351.08
2035	156	24	30	73	$1,633.92
2036	179	28	35	84	$1,874.83
2037	203	32	40	95	$2,126.25
2038	229	36	45	107	$2,398.58
2039	254	40	51	118	$2,660.45
2040	275	43	56	127	$2,880.39
2041	301	48	61	139	$3,152.78
2042	328	52	67	151	$3,435.56
2043	336	53	68	154	$3,519.37
2044	344	55	70	157	$3,603.18
2045	357	57	73	162	$3,739.37
2046	370	59	77	168	$3,875.56
2047	383	62	80	174	$4,011.81
2048	397	64	83	180	$4,158.46
2049	412	67	87	186	$4,315.62
2050	426	69	90	192	$4,462.26
Total Benefit	**$57,674.15**	**$53.91**	**$56.07**	**$2.24**	**$57,786.37**

7. Potential Future Evaluation of Additional Health Benefits

While CARB's PM2.5 mortality and illness analysis has been, and continues to be, a useful method for valuing the health benefits of regulations, it only represents a portion of those benefits. The proposed ACF regulation would result in additional health benefits beyond what CARB staff has quantified. CARB's current PM2.5 mortality and illness evaluation focuses on select air pollutants and health outcomes, and therefore captures only a portion of the health benefits of the proposed ACF regulation. For example, while the current analysis considers the impact of NOx on the formation of secondary PM2.5 particles, NOx can also react with other compounds to form ozone, which can cause respiratory problems. The proposed ACF regulation would also result in a decrease of toxic air contaminants emitted from diesel engines, which can cause cancer and other adverse health effects. In addition to the health benefits that are quantified, the proposed ACF regulation would reduce additional cardiovascular and respiratory illnesses, nonfatal and fatal cancers, and lost workdays. Also, in 2021, U.S. EPA issued a Technical Support Document for their Cross-State Air Pollution Rule that provided both health functions and health valuation for lung cancer incidence, Alzheimer's disease, and Parkinson's disease, among other health endpoints related to PM2.5 exposures.[237] Updated health impact functions and valuations for ozone are also provided in the aforementioned Cross-State Air Pollution Rule Technical Support Document provided by U.S. EPA.[238]

Expanding CARB's health evaluation and economic valuation methodology to include any of the above additional inputs and health outcomes would allow the public to reach a better understanding of the benefits from reducing air pollution by moving toward ZE technologies.

As indicated, the scientific literature has demonstrated an array of air pollutant-related health impacts, well beyond what CARB staff have quantified in Table 19. Some of these impacts are summarized in the next section.

8. Adverse Impacts to Human Health from Diesel Emissions

Diesel-powered mobile sources emit a complex mixture of air pollutants, including diesel PM and gases. The gaseous pollutants include volatile organic compounds (VOC) and NOx, which can lead to the formation of ozone and the secondary formation of PM.

a) Air Toxic Impacts

Diesel PM is a toxic air contaminant composed of PM and over 40 known cancer-causing substances, including polycyclic aromatic hydrocarbons, benzene, formaldehyde, acetaldehyde, acrolein, and 1,3-butadiene.[239] CARB listed diesel PM as a toxic air contaminant in 1998, due largely to its association with lung cancer.[240] In 2012, additional studies on the cancer-causing potential of diesel exhaust published since CARB's listing led the International Agency for Research on Cancer (a division of the World Health Organization) to classify diesel engine exhaust as "carcinogenic to humans."[241] In California,

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[237] U.S. EPA., *Technical Support Document (TSD) for the Final Revised Cross-State Air Pollution Rule Update for the 2008 Ozone Season NAAQS: Estimating PM2.5- and Ozone-Attributable Health Benefits (EPA-HQ-OAR-2020-0272)*, 2021 (web link: https://www.epa.gov/sites/default/files/2021-03/documents/estimating_pm2.5-_and_ozone-attributable_health_benefits_tsd_march_2021.pdf, last accessed August 2022).
[238] Ibid.
[239] Ibid.
[240] Ibid.
[241] International Agency for Research on Cancer (a division of the World Health Organization), *Press Release N° 213, IARC: Diesel Engine Exhaust Carcinogenic*, 2012 (web link: https://www.iarc.who.int/wp-content/uploads/2018/07/pr213_E.pdf, last accessed August 2022).

about 70 percent of known cancer risks from toxic air contaminants are from diesel engine emissions.[242,243]

b) Particle Pollution Impacts

Diesel PM is composed primarily of PM2.5.[244] Due to its small size, inhaled PM2.5 can reach the lower respiratory tract and potentially pass into the bloodstream to affect other organs.[245] In this way, PM2.5 contributes not only to increased cancer risk, but also respiratory and cardiovascular diseases and even premature death.[246] Other adverse health outcomes from PM2.5 include asthma, chronic heart disease, and heart attack.[247,248] Moreover, PM2.5 can result in respiratory, cardiac, and mortality effects over short exposure times such as days or weeks.[249] PM2.5 is well known to exacerbate asthma, bronchitis, and heart disease symptoms.[250] Exposures to PM2.5 may also lead to myriad other health outcomes, including metabolic, nervous system, reproductive, and developmental effects.[251] For example, adverse health conditions with possible links to airborne PM2.5 include high blood pressure, insulin resistance, and other risk factors for Type II Diabetes, as well as psychological/cognitive problems.[252] PM2.5 may especially impact women and children via health effects such as pre-term birth, reduced birth weight, and abnormal lung and cardiovascular development.[253]

c) Ozone Pollution Impacts

As a gaseous pollutant from mobile sources, NOx can react with other compounds to form ozone, which is the main component of smog. Based on extensive evidence from scientific studies, U.S. EPA has determined that short-term exposure from ozone is causally linked to

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242 Environmental Science & Technology, *Ambient and Emission Trends of Toxic Air Contaminants in California*, 2015 (web link: https://pubs.acs.org/doi/full/10.1021/acs.est.5b02766, last accessed August 2022).

243 California Air Resources Board, *Overview: Diesel Exhaust & Health | California Air Resources Board*, (web link: https://ww2.arb.ca.gov/resources/overview-diesel-exhaust-and-health, last accessed August 2022).

244 California Air Resources Board, *Inhalable Particulate Matter and Health (PM2.5 and PM10) | California Air Resources Board*, (web link: https://ww2.arb.ca.gov/resources/inhalable-particulate-matter-and-health, last accessed August 2022).

245 U.S. EPA, *Health and Environmental Effects of Particulate Matter (PM) | Particulate Matter (PM) Pollution | US EPA*, (web link: https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm, last accessed August 2022).

246 U.S. EPA, *Integrated Science Assessment for Particulate Matter (EPA/600/R-19/188)*, 2019 (web link: https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=347534#tab-3, last accessed August 2022).

247 World Health Organization, Regional Office for Europe. *Review of Evidence on Health Aspects of Air Pollution-REVIHAAP Project: Technical Report*, 2013 (web link: https://www.euro.who.int/en/health-topics/environment-and-health/air-quality/publications/2013/review-of-evidence-on-health-aspects-of-air-pollution-revihaap-project-final-technical-report, last accessed August 2022).

248 California Air Resources Board, *Overview: Diesel Exhaust & Health | California Air Resources Board*, (web link: https://ww2.arb.ca.gov/resources/overview-diesel-exhaust-and-health, last accessed August 2022).

249 U.S. EPA, *Integrated Science Assessment for Particulate Matter (EPA/600/R-19/188)*, 2019 (web link: https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=347534#tab-3, last accessed August 2022).

250 Ibid.

251 Ibid.

252 Ibid.

253 Ibid.

adverse respiratory effects.[254] Ozone can cause irritation and damage to lung tissue, can worsen asthma and chronic illnesses including chronic obstructive pulmonary disease, and can reduce lung function. For instance, a study conducted in the San Joaquin Valley showed that increased ozone pollution led to increased risk for asthma ER visits, especially for children and Black residents.[255] Metabolic functions are also likely to be affected by short-term ozone exposure, such as those leading to increased risk for complications and hospitalizations in diabetic individuals.[256] And, similar to PM2.5, other potential health effects from ozone exposure may include impacts on the cardiovascular, nervous, and reproductive systems, and possibly increased risk of mortality.[257]

9. Health Benefits Conclusion

Mobile sources generate criteria pollutants and toxic air contaminants that are known to cause a range of serious health impacts including premature deaths. As shown in Table 19, CARB estimates that implementation of the proposed ACF regulation would result in substantial health and economic benefits, due to reduced cardiovascular/respiratory hospitalizations, asthma ER visits, and cardiopulmonary deaths. Despite these substantive benefits, CARB's assessment is limited and thus likely an underestimation, because it does not consider the various other health outcomes that could be avoided with cleaner mobile sources. Furthermore, those who live and work around areas with high mobile source activity, especially those living in DACs, are more heavily impacted by these pollutant exposures. For these individuals, actions like the proposed ACF regulation to move to cleaner mobile sources are critically important.

B. Air Quality and Climate Benefits

This section provides background information regarding California's need to reduce ambient ozone levels and GHGs, including black carbon. The proposed ACF regulation is expected to contribute to reduction of pollutants that lead to the formation of ozone and of GHGs including black carbon.

1. Reduced Ambient Ozone Levels

Diesel-powered mobile sources emit a complex mixture of air pollutants, including diesel PM and gases. The gaseous pollutants include volatile organic compounds and NOx. NOx reacts with other chemicals in the air to form both PM and ground level ozone, both of which are identified in the federal Clean Air Act as criteria pollutants, with NAAQS set. Nineteen areas

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[254] U.S. EPA, *Integrated Science Assessment (ISA) for Ozone and Related Photochemical Oxidants*, Issue EPA/600/R-20/012, 2020 (web link: https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=348522, last accessed August 2022).
[255] Gharibi H, Entwistle MR, Ha S, Gonzalez M, Brown P, Schweizer D, Cisneros R., Ozone pollution and asthma emergency department visits in the Central Valley, California, USA, during June to September of 2015: a time-stratified case-crossover analysis, J Asthma, 2019 Oct;56(10):1037-1048. doi: 10.1080/02770903.2018.1523930. Epub 2018 Oct 9. PMID: 30299181.
[256] U.S. EPA, *Integrated Science Assessment (ISA) for Ozone and Related Photochemical Oxidants Issue EPA/600/R-20/012*, 2020 (web link: https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=348522, last accessed August 2022).
[257] Ibid.

in California are in non-attainment for the 70 ppb ozone standard. Controlling ozone precursor emissions, in particular NOx, is key to attaining the federal ozone standards.[258] Most of the NOx emissions from heavy-duty engines come from diesel-cycle engines, especially in the higher weight classes. However, gasoline and natural gas Otto-cycle spark-ignited engines are also used, to a lesser extent, in heavy-duty trucks, primarily in the lower weight classification vehicles. Even low mileage natural gas vehicles certified to the optional 0.02 g/bhp-hr NOx emissions standard pollute in the field more than expected.[259]

Substantial progress has been achieved in reducing NOx emissions in California through implementation of CARB's existing mobile source programs, and it is expected that these programs will continue to provide further reductions through 2031, contributing significantly to meeting air quality standards. However, challenges still remain in meeting the ambient air quality standards for ozone in 2 areas of the state with the most critical air quality challenges: the South Coast and San Joaquin Valley Air Basins.[260,261] The South Coast Air Basin has the highest ozone levels in the nation. Since NOx is also a precursor to secondary PM2.5 formation, reductions in NOx emissions will also provide benefits for meeting the PM2.5 standards. To meet the 2023 and 2031 ambient air quality standards for ozone, the South Coast Air Basin will require an approximate 80 percent NOx reduction by 2031. For most areas in California to attain the 70 ppb ozone standard, any and all potential reductions must be pursued, and the proposed ACF regulation is one of 4 on-road vehicle measures referenced in the Draft 2022 State Strategy for the SIP to support attainment of the 70 ppb ozone standard statewide.[262]

Mobile sources are the largest source category of NOx emissions and medium- and heavy-duty vehicles are the largest source of mobile source NOx emissions as displayed in Figure 48.

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[258] California Air Resources Board, *Draft 2022 State Strategy for the State Implementation Plan*, 2022 (web link: https://ww2.arb.ca.gov/sites/default/files/2022-01/Draft_2022_State_SIP_Strategy.pdf, last accessed August 2022).

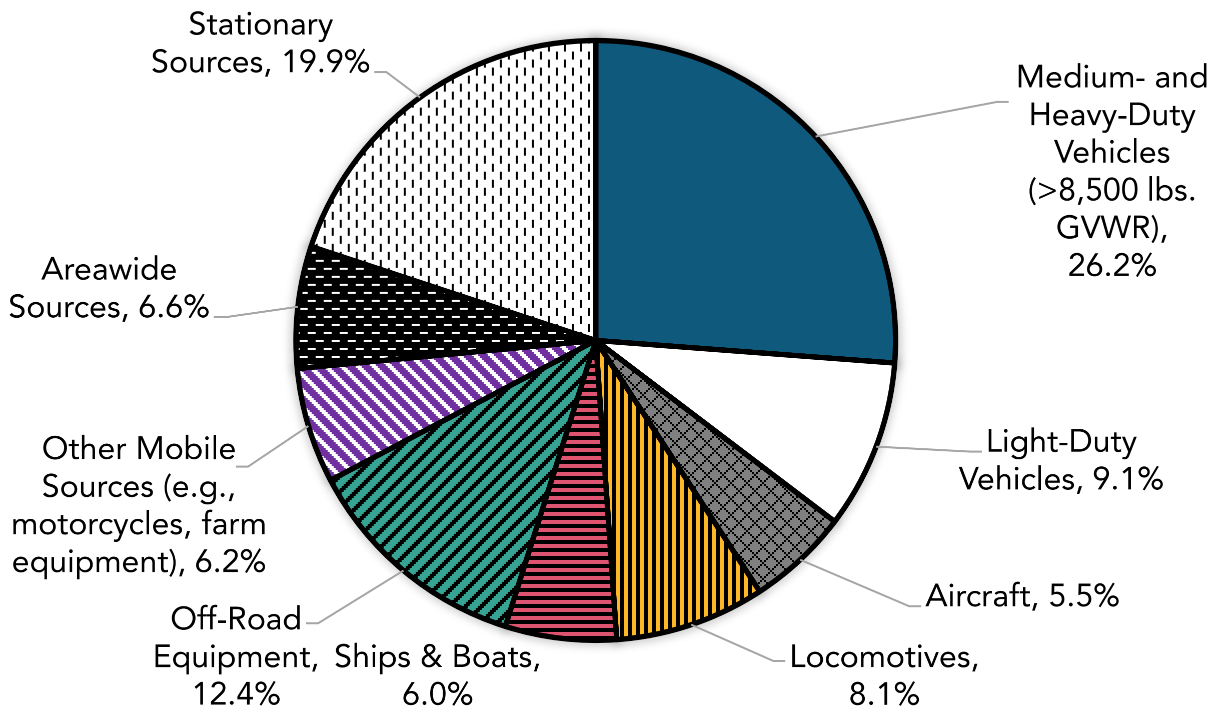
[259] California Air Resources Board, *In-Use Emission Performance of Heavy-Duty Natural Gas Vehicles: Lessons Learned from 200 Vehicle Project*, 2021 (web link: https://ww2.arb.ca.gov/sites/default/files/2021-04/Natural_Gas_HD_Engines_Fact_Sheet.pdf, last accessed August 2022).

[260] California Air Resources Board, *Staff Report: ARB Review of the San Joaquin Valley 2016 Plan for the 2008 8-Hour Ozone Standard*, 2016 (web link: https://www.arb.ca.gov/planning/sip/planarea/2016sjv/staffreport.pdf, last accessed: April 2022).

[261] California Air Resources Board, *State Implementation Plan Attainment Contingency Measures for the San Joaquin Valley 15 ug/m Annual PM2.5 Standard*, 2017 (web link: https://www.arb.ca.gov/planning/sip/sjvpm25/2017contingency/2017_sjv_conting ency_staffreport.pdf, last accessed: April 2022).

[262] California Air Resources Board, *Draft 2022 State Strategy for the State Implementation Plan*, 2022 (web link: https://ww2.arb.ca.gov/sites/default/files/2022-01/Draft_2022_State_SIP_Strategy.pdf, last accessed August 2022).

Figure 48: 2022 NOx Emissions by Source



2. Greenhouse Gases and Black Carbon

The proposed ACF regulation would result in reductions of GHGs, criteria pollutants, and toxic air contaminants, including SLCPs, from on-road medium- and heavy-duty vehicles. SLCPs are powerful climate forcers and harmful air pollutants that have an outsized impact on climate change in the near term, compared to longer-lived GHGs, such as CO_2. These pollutants include the GHGs methane and hydrofluorocarbons, and anthropogenic black carbon. Recent studies have shown that black carbon plays a much larger role in global warming than previously believed. Because SLCP impacts are especially strong over the short-term, acting now to reduce their emissions can have an immediate beneficial impact on climate change and public health.

SLCPs such as black carbon and methane are emitted from transportation sources due to the combustion of diesel and natural gas. Diesel engines emit diesel PM which is typically composed of carbon particles ("soot", also called black carbon) and numerous organic compounds, including over 40 known cancer-causing organic substances such as benzene and formaldehyde.[263] CARB estimates that about 70 percent of the total known cancer risk related to air toxics in California is attributable to diesel PM.[264] Most major sources of diesel emissions, such as ships, trains, and trucks, operate in and around ports, rail yards, and heavily traveled roadways, which are often located near highly populated and DACs. The

[263] California Air Resources Board, *Mobile Source Strategy*, 2020 (web link: https://ww2.arb.ca.gov/sites/default/files/2021-12/2020_Mobile_Source_Strategy.pdf, last accessed August 2022).
[264] California Air Resources Board, *Overview: Diesel Exhaust & Health*, 2020 (web link: https://ww2.arb.ca.gov/resources/overview-diesel-exhaust-and-health, last accessed August 2022).

proposed ACF regulation would reduce a significant amount of diesel emissions from many of these areas.

SB 1383[265] sets targets for statewide reductions in SLCP emissions of 40 percent below 2013 levels by 2030 for methane and hydrofluorocarbons, and 50 percent below 2013 levels by 2030 for anthropogenic black carbon. California's ongoing efforts to improve air quality and address climate change have already led to important reductions in SLCP emissions, and they provide a strong foundation to support further efforts to reduce emissions of these dangerous pollutants. From 2000 to 2020, California has cut black carbon from mobile sources by an estimated 75 percent. [266] CARB's ongoing efforts prevent an estimated 5,000 premature deaths in the state each year and deliver important climate benefits.[267] Reduction in GHGs, including SLCPs like black carbon and methane from ICEs are needed to achieve the State's multiple GHG reduction targets and public health goals. The proposed ACF regulation in combination with other regulations such as ACT and Heavy-Duty Omnibus that target emissions reductions from on-road diesel engines will almost eliminate black carbon emissions from on-road sources within the next ten years.

C. Benefits to Typical Businesses

The 2016 SIP Strategy identifies that "electrification and progress toward ZE is critical to address the remaining (from renewable fuels) localized risk of cancer and other adverse effects from major freight hubs, and (electrification) must play a growing role in reducing GHG emissions and petroleum use."[268] The proposed ACF regulation supports the goals of the SIP and reduces pollutants linked to multiple adverse health effects identified by the California Ambient Air Quality Standards.[269] The proposed ACF regulation also reduces GHG emissions, petroleum use, and provides the certainty needed to establish successful adoption of ZEVs, including medium- and heavy-duty vehicles. Typical businesses that own trucks and buses subject to the proposed ACF regulation may benefit financially through a lower TCO due to ZEV and/or associated infrastructure ownership. Electric utility providers would also benefit from increased electricity deliveries. Natural gas utilities can benefit by participating in the Renewable hydrogen gas market by supplying renewable natural gas to existing hydrogen producers to produce low carbon intensity hydrogen. ZEV manufacturers and component suppliers, EVSE suppliers and installers, and hydrogen fuel station suppliers may also benefit due to higher demand for medium- or heavy-duty ZEVs from the proposed ACF regulation, leading to an increase in related jobs throughout the state.

[265] (Lara, Stats. 2016, Chapter 395)

[266] California Air Resources Board, *Short-Lived Climate Pollutant Reduction Strategy*, 2017 (web link: https://ww2.arb.ca.gov/sites/default/files/2020-07/final_SLCP_strategy.pdf, last accessed August 2022).

[267] California Air Resources Board, *Short-Lived Climate Pollutant Reduction Strategy*, 2017 (web link: https://ww2.arb.ca.gov/sites/default/files/2020-07/final_SLCP_strategy.pdf, last accessed August 2022).

[268] California Air Resources Board, *2016 Mobile Source Strategy*, 2016, (web link: https://www.arb.ca.gov/planning/sip/2016sip/2016mobsrc.pdf, last accessed August 2022).

[269] California Air Resources Board, *California Ambient Air Quality Standards*, 2016(web link: https://ww2.arb.ca.gov/resources/california-ambient-air-quality-standards, last accessed August 2022).

1. Truck and Bus Owners

Individual businesses may be able to lower their TCO by taking advantage of the operational cost-savings of ZEVs like battery-electric or hydrogen FCEVs. ZEV owners that also own their charging or hydrogen fueling stations can lower costs further by taking advantage of the LCFS program. Details can be found in the Direct Costs chapter of the ACF Standardized Regulatory Impact Assessment (SRIA) in section 3.1.4.3.

Trucking companies and others that have ZEV fleets might choose to advertise themselves as being environmentally friendly and make partnerships or sign contracts with other companies that want to support the movement toward replacing fossil fuel-burning trucks and buses with those that produce no tailpipe emissions, resulting in better public health. Less vibration in the cab results in a reduced health impact to truck drivers, including a reduction in "driver's fatigue" which can lead to deadly accidents.[270, 271, 272] ZEVs reduce harmful emissions that contribute to air toxics hot spots at places such as truck mechanic shops, loading docks, and inside truck cabs, resulting in better quality air that truck drivers, including owner-operators, breathe.[273]

2. Utility Providers

a) Electric Utility Providers

The proposed ACF regulation would increase the number of medium- and heavy-duty ZEVs deployed which, in turn, would increase the amount of electricity supplied by electric utility providers, either directly or indirectly. In addition, since electric utilities also operate trucks, they would also see potential benefits like other truck owners.

The proposed ACF regulation would also help the state's IOUs meet the goals of SB 350, which includes a requirement that the state's IOUs develop programs "to accelerate widespread TE." PG&E, SCE, and SDG&E have active programs to install low-cost or free EVSE on a customer's site, and they commonly offer a voucher for the charger itself.

All three of these IOUs have established new electricity rates for commercial ZEV deployments to better align with fleet needs and to ensure affordability, which includes a variety of approaches such as demand charge holidays or a subscription-based approach. Research and development of new rate strategies is ongoing. By ensuring that vehicles would be available to make use of these utility investments and rates, the proposed ACF regulation supports the utilities' programs, the goals of SB 350, and an increase in electricity demand. In addition, other electric service providers, such as POUs and community choice aggregators,

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[270] Institute of Transport Economics, *Experiences from Battery-Electric Truck Users in Norway*, 2020 (web link: https://www.mdpi.com/601754, last accessed August 2022).
[271] Bose Corporation, *The impact of different seats and whole-body vibration exposures on truck driver vigilance and discomfort*, 2017 (web link: https://doi.org/10.1080/00140139.2017.1372638, last accessed August 2022).
[272] RAND Corporation, *Evaluating the Impact of Whole-Body Vibration (WBV) on Fatigue and the Implications for Driver Safety*, 2015 (web link: www.rand.org/t/rr1057, last accessed August 2022).
[273] National Library of Medicine, *Potential air toxics hot spots in truck terminals and cabs*, 2012 (web link: https://pubmed.ncbi.nlm.nih.gov/23409510/, last accessed August 2022).

continue to develop and deploy new programs and policies and would similarly benefit from increased electricity deliveries.

b) Natural Gas Utility Providers

The proposed ACF regulation would encourage natural gas utility providers to lower the carbon intensity of the state's natural gas grid by procuring and injecting more RNG from instate sources. Pipeline-accessible low or negative carbon intensity RNG is a valuable resource that can be used by existing hydrogen producers to produce low carbon intensity hydrogen, which has an enhanced LCFS credit value when used for transportation. Stationary fuel cells using RNG or renewable hydrogen to produce electricity can serve as a low or ZE grid resource as is being done by SoCalGas.[274] Finally, natural gas utilities have the opportunity to participate in the renewable hydrogen gas market to a fuller extent. SoCalGas realizes this potential with their proposed Angeles Link project discussed earlier.

3. Other California Businesses

The proposed ACF regulation may result in benefits to ZEV manufacturers and component suppliers, EVSE suppliers and installers, and hydrogen fuel station suppliers. Due to higher demand for medium- or heavy-duty ZEVs from the proposed ACF regulation, production of ZEVs in California would be expected to rise, leading to increases in manufacturing and related jobs throughout the state. The increase in the production and usage of ZEVs would be expected to also benefit various businesses related to the ZEV component supply chain, including those involved with batteries, fuel cells, and electric drivetrains.

The proposed ACF regulation may also benefit EVSE suppliers who would see an increase in charging equipment installation because of increased medium- and heavy-duty ZEV purchases. Most of these installations are expected to be in central depots or yards where trucks are parked overnight. Increased installation of charging infrastructure would benefit the EVSE suppliers, equipment installers, and electricians. EVSE installations would primarily be in California (though, conceivably, some businesses might also choose to operate their ZEVs in other states, resulting in additional EVSE in those states), and some of the EVSE equipment may be manufactured in California. Increased purchase of medium- and heavy-duty ZEVs under the proposed ACF regulation would also benefit various California businesses related to installing hydrogen fueling stations, supplying hydrogen, and providing associated maintenance. The proposed ACF regulation would also increase demand for renewable hydrogen, thereby motivating hydrogen producers to increase instate production of low carbon intensity hydrogen. Low carbon intensity hydrogen, such as that produced via electrolysis from wind and solar resources, will have the ability to earn significant LCFS credits driving the price of hydrogen at the pump towards parity with diesel.

Companies that contract with or use ZEV fleets would be able to tout that they are either moving towards or currently operating with a carbon neutral or carbon optimal supply

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[274] SoCalGas, *SoCalGas Highlights Successful First Year Results for Fuel Cells at Company Facilities*, 2022 (web link: https://newsroom.socalgas.com/stories/socalgas-highlights-successful-first-year-results-for-fuel-cells-at-company-facilities, last accessed August 2022).

chain.[275] Choosing to focus on a more environmentally friendly shipping method and supply chain may help some companies in their move towards carbon neutrality by compensating for other aspects of their businesses from which it is more difficult to reduce GHG emissions.

D. Greenhouse Gases—Social Cost of Carbon

The benefit of GHG emissions 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 the analysis of the SC-CO_2 for the proposed ACF regulation, 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, is in line with U.S. Government Executive Orders including 13990 and the Office of Management and Budget's Circular A-4 of September 17, 2003 and reflects the best available science in the estimation of the socio-economic impacts of carbon.[276,277]

IWG describes the SC-CO_2 as follows:

> *The 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 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 monetized value of the net impacts from global climate change that result from an additional ton of CO_2.*
>
> *Those 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.*[278]

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 as 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 ACF

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[275] University of California at Los Angeles, *Carbon-Optimal and Carbon-Neutral Supply Chains*, 2011 (web link: https://escholarship.org/uc/item/3s01b6pg, last accessed August 2022).
[276] California Air Resources Board, *California's 2017 Climate Change Scoping Plan*, 2017 (web link: https://ww2.arb.ca.gov/sites/default/files/classic//cc/scopingplan/scoping_plan_2017.pdf, last accessed August 2022).
[277] Office of Management and Budgets, *Circular A-4*, 2003 (web link: https://www.transportation.gov/sites/dot.gov/files/docs/OMB%20Circular%20No.%20A-4.pdf, last accessed August 2022).
[278] National Academies of Sciences, *Engineering, Medicine, Valuing Climate Damages: Updating Estimation of Carbon Dioxide*, 2017 (web link: http://www.nap.edu/24651, last accessed August 2022).

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 22 shows the range of SC-CO_2 discount rates developed by the IWG which reflect the societal value of reducing carbon emissions by one metric ton.[279]

Table 22: SC-CO_2 Discount Rates (in 2021$ per Metric Ton of CO_2)

Year	5% Discount Rate	3% Discount Rate	2.5% Discount Rate
2020	$16	$57	$85
2025	$19	$63	$93
2030	$22	$68	$100
2035	$25	$75	$107
2040	$29	$82	$115
2045	$32	$88	$122
2050	$36	$94	$130

The avoided SC-CO_2 from 2024 to 2050 is the sum of the annual tank-to-wheel (TTW) GHG emissions reductions multiplied by the SC-CO_2 in each year. The cumulative TTW GHG emissions reductions along with the estimated benefits from the proposed ACF regulation are shown in Table 23. These benefits range from about $9.4 billion to $36.4 billion through 2050, depending on the chosen discount rate. In Table 23, staff calculated the avoided SC-CO_2 values (Million 2021$) by applying values in Table 22 (Million 2021$ per Metric Ton of CO_2) that were adjusted with a California consumer price index inflation adjustment factor.

Table 23: Avoided SC-CO_2 (Million 2021$)

Year	GHG Emissions Reductions (MMT)	Avoided SC-CO_2 5% Discount Rate	Avoided SC-CO_2 3% Discount Rate	Avoided SC-CO_2 2.5% Discount Rate
2024	0.3	$4.7	$15.8	$23.3
2025	0.5	$8.6	$28.6	$42.2
2026	0.8	$15.8	$51.5	$76.0
2027	1.3	$27.2	$87.6	$129.1
2028	1.8	$37.3	$118.4	$174.4
2029	3.5	$54.2	$169.7	$249.7
2030	4.6	$77.5	$239.6	$352.4

[279] Interagency Working Group on the Social Cost of Carbon, *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 13990*, 2021 (web link: https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf, last accessed August 2022).

Year	GHG Emissions Reductions (MMT)	Avoided SC-CO_2 5% Discount Rate	Avoided SC-CO_2 3% Discount Rate	Avoided SC-CO_2 2.5% Discount Rate
2031	5.5	$102.9	$316.1	$461.8
2032	6.3	$128.5	$392.2	$569.4
2033	7.5	$150.9	$457.8	$660.8
2034	8.8	$183.4	$553.1	$793.6
2035	9.8	$221.1	$663.2	$946.2
2036	10.9	$253.8	$751.8	$1,068.4
2037	12.0	$290.2	$848.8	$1,202.3
2038	13.2	$330.0	$953.8	$1,346.4
2039	13.7	$371.0	$1,060.4	$1,491.9
2040	15.1	$413.4	$1,169.0	$1,639.4
2041	16.6	$473.5	$1,330.9	$1,862.0
2042	18.2	$532.5	$1,488.1	$2,077.0
2043	18.9	$564.4	$1,568.7	$2,184.4
2044	19.6	$597.5	$1,651.6	$2,294.7
2045	20.4	$636.4	$1,750.1	$2,426.3
2046	21.3	$681.0	$1,852.0	$2,566.2
2047	22.2	$727.5	$1,957.4	$2,710.9
2048	23.1	$775.6	$2,065.2	$2,858.8
2049	24.0	$824.4	$2,173.5	$3,007.2
2050	24.8	$873.9	$2,281.8	$3,155.6
Total	**307.2**	**$9,357.3**	**$25,996.4**	**$36,370.5**

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 GHGs including methane and nitrous oxide, and costs that cannot be included due to modeling and data limitations. The Intergovernmental Panel on Climate Change 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. [280,281]

E. Energy Saving and Reduction of Petroleum Fuel Dependence

Petroleum has historically been the largest major energy source for total annual United States energy consumption. California is the nation's second-largest consumer of refined petroleum products and accounts for about 9 percent of the total consumption in the United States. The transportation sector is the state's largest petroleum user accounting for about 85 percent of the total petroleum consumed.[282] As a result, the transportation sector is the largest source of GHGs in California.

In 2015, Governor Brown issued Executive Order B-30-15 establishing 6 pillars for California's climate change strategy. One of these key pillars was to reduce petroleum consumption of cars and trucks by 50 percent by 2030. California can meet this ambitious goal by building on existing efforts to improve vehicle efficiency, reduce lifecycle fuel emissions, decreasing VMT, and supporting ZEV deployment. Meeting this goal will reduce pollution, strengthen the State's economy, and will put the State on a path to meet its GHG goals. The proposed ACF regulation in combination with the implementation of the ACT Regulation would lead the way in the medium- and heavy-duty vehicle sector to enable fuel switching from petroleum-based fuels used in conventional vehicles toward hydrogen or electricity used in ZEVs.

ZEVs have 2 fundamentally superior technical features (greater upstream energy source flexibility and greater vehicle efficiency) when compared to conventional vehicles.[283] For BEVs, the greater energy source flexibility is the result of the various source types (e.g., natural gas, hydro, solar, nuclear, geothermal, and wind) that can be used to generate electricity. California's total power mix currently consists of 33 percent renewables and the State continues to target a cleaner and more sustainable electricity grid and to promote energy efficient end uses.[284] SB 350 extended California's renewable electricity procurement goal to require 50 percent renewable energy by 2030. [285] This goal was made more stringent by SB 100, which increased the 2030 target to 60 percent renewables and requires California to provide 100 percent of its retail sales of electricity from renewable and zero-carbon resources by 2045. [286] SB 350 also requires California to double statewide energy efficiency savings in electricity end uses by 2030.

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[280] Intergovernmental Panel on Climate Change, *IPCC webpage*, 2022 (web link: https://www.ipcc.ch/, last accessed August 2022).
[281] Environmental Protection Agency, *Social Cost of Carbon Fact Sheet*, 2016 (web link: https://www.epa.gov/sites/default/files/2016-12/documents/social_cost_of_carbon_fact_sheet.pdf, last accessed August 2022).
[282] U.S. Energy Information Administration, *California State Energy Profile*, 2022 (web link: *https://www.eia.gov/state/print.php?sid=CA*, last accessed August 2022).
[283] ICCT, *Transition to a Global Zero-Emission Vehicle Fleet: A Collaborative Agenda for Governments*, 2015 (web link: https://theicct.org/sites/default/files/publications/ICCT_GlobalZEVAlliance_201509.pdf, last accessed August 2022).
[284] California Energy Commission, *2021 Total System Electric Generation*, 2021 (weblink: https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/2021-total-system-electric-generation, last accessed August 2022).
[285] SB 350 (De León, Stats. 2015, ch. 547).
[286] SB 100 (De León, Stats. 2018 ch. 312).

Like electricity, hydrogen fuel provides energy source flexibility because it can be produced from several different sources such as natural gas, solar, biomass, wind, and grid electricity. Senate Bill 1505, establishes a statutory minimum of 33.3 percent renewable content for hydrogen fuel.[287] In fact, hydrogen renewable content estimates of 90 percent in 2020 and 92 percent in 2021 were achieved according to reporting from hydrogen station operators and through the LCFS program reporting.[288] CARB anticipates that the hydrogen network will maintain a minimum of 40 percent renewable content through 2027.[289] The increasing application of renewable energy sources to generate electricity and produce hydrogen is a primary catalyst for reducing California's consumption of petroleum fuel.

Another technical advantage of ZEVs in comparison to conventional petroleum-based vehicles is the greater vehicle efficiency. This is because EVs can convert over 77 percent of the electrical energy from the grid to power at the wheels whereas conventional gasoline vehicles only convert about 12 to 30 percent of the energy stored in gasoline to power at the wheels.[290] Similarly, hydrogen fuel cell vehicles have 2 to 3 times the efficiency of conventional vehicles because of the electric motor's efficient conversion of energy.[291] For conventional petroleum-fueled vehicles, the lesser vehicle efficiency is due to the inherently greater thermodynamic energy losses, fuel pumping losses, transmission losses, friction losses, and accessory loads.[292] Conversely, electric-drive vehicles have highly efficient electric powertrains which avoids most of these losses. Due to ZEVs' higher efficiencies and lower energy consumption, ZEVs reduce dependence on petroleum and reduce emissions substantially because ZEVs have no tailpipe emissions. The superior fuel efficiency and greater upstream energy source flexibility of ZEVs will help pave a low carbon future for California's transportation sector.

F. Benefits in Disadvantaged Communities and Job Creation

The proposed ACF regulation would reduce NOx and PM2.5 emissions, resulting in health benefits for Californians, and especially for Californians residing and working in disadvantaged and low-income communities. Many communities located near distribution centers, seaports, railyards, warehouses, and major roadways, bear a disproportionate health burden due to their proximity to harmful emissions from the diesel engines that power medium- and heavy-duty vehicles. ZEV deployment throughout these locations would benefit

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[287] SB 1505 (Lowenthal, Stats. 2006, ch.877). Health and Saf. Code sections 43868 and 43869.

[288] California Air Resources Board, *2021 Annual Evaluation of Fuel Cell Electric Vehicle Deployment and Hydrogen Fuel Station Network Development*, 2021 (web link: https://ww2.arb.ca.gov/sites/default/files/2021-09/2021_AB-8_FINAL.pdf, last accessed August 2022).

[289] California Air Resources Board, *2021 Annual Evaluation of Fuel Cell Electric Vehicle Deployment and Hydrogen Fuel Station Network Development*, 2021 (web link: https://ww2.arb.ca.gov/sites/default/files/2021-09/2021_AB-8_FINAL.pdf, last accessed August 2022).

[290] Department of Energy, *All-Electric Vehicles*, (web link: https://www.fueleconomy.gov/feg/evtech.shtml, last accessed August 2022).

[291] U.S. Department of Energy Hydrogen Program, *Hydrogen Fuel Cells*, (web link: https://www.californiahydrogen.org/wp-content/uploads/files/doe_fuelcell_factsheet.pdf?msclkid=3dc431a0b5fb11ecbaf6a8ab4b1ad0b4, last accessed August 2022).

[292] ICCT, *Transition to a Global Zero-Emission Vehicle Fleet: A Collaborative Agenda for Governments*, 2015 (web link: *https://theicct.org/sites/default/files/publications/ICCT_GlobalZEVAlliance_201509.pdf*, last accessed August 2022).

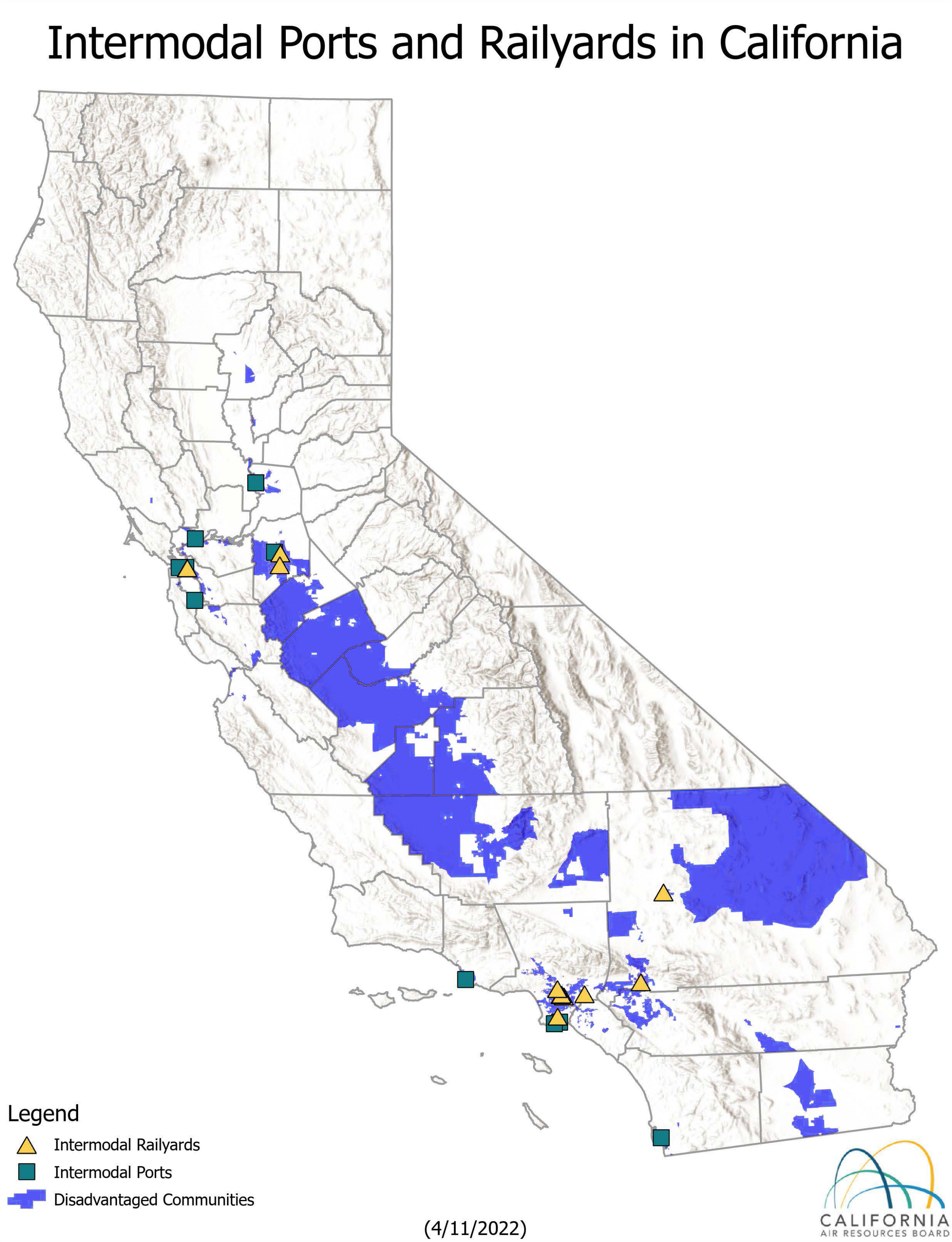
low-income and DACs. Beginning as early as 2024, the proposed ACF regulation includes ZEV phase-in requirements for trucks that travel in and out of ports and railyards. A majority of these drayage hubs are located in or within less than one mile of a community classified as disadvantaged by CalEPA.[293,294] By 2035, trucks entering the ports and railyards would need to be ZE which would greatly benefit air quality in neighborhoods surrounding these locations. Figure 49 shows the location of the major seaports and intermodal railyards and their proximity to DACs.

In addition to drayage applications, ZEV deployment would occur in other freight sectors and services where medium- and heavy-duty vehicles are deployed. Distribution centers, warehouses, and major roadways are commonly located around more densely populated urban areas, including in low-income and DACs. ZEV adoption would not only maximize NOx and PM reductions in these locations, but also help to achieve the State's GHG emissions reductions goals. Reducing GHG emissions will help stabilize the climate, which benefits all communities, including low-income and DACs.

[293] Health and Safety Code section 39711 tasks CalEPA with identifying DACs based on "geographic, socioeconomic, public health, and environmental hazard criteria." CalEPA uses CalEnviroScreen to score California communities based on environmental pollution burden and socio-economic indicators. Its updated DAC Designations, released May 3, 2022, include the twenty-five percent highest-scoring census tracts. CalEPA, *California Climate Investments to Benefit Disadvantaged Communities*, 2022 (web link: https://calepa.ca.gov/envjustice/ghginvest/, last accessed August 2022).

[294] Office of Environmental Health Hazard Assessment, *CalEnviroScreen 4.0*, 2022 (web link: https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-40, last accessed August 2022).

Figure 49: Intermodal Ports and Railyards and Disadvantaged Communities in California



As summarized above, AB 617 requires CARB to address community-scale air pollution through new community-focused and community-driven actions to reduce emissions and exposure to air pollution and improve public health in disadvantaged communities affected by a high cumulative exposure burden.[295,296] As of January 2022, 17 communities have been selected by the CARB Board based on their high cumulative exposure burden, among other relevant factors. Once selected, the regional air district for the community works with a Community Steering Committee to develop and implement a Community Emissions Reduction Program (CERP) and/or a Community Air Monitoring Plan (CAMP). The CERPs identify each community's air pollution concerns and a suite of strategies to reduce emissions from the identified sources. These strategies can include identifying new or amended air district regulations, incentive grant funding, and exposure reduction resources and tools. All AB 617 community steering committees to date have identified air pollution from heavy-duty diesel vehicle as a concern in their communities and would directly benefit from the proposed ACF regulation. Additionally, many of the AB 617 communities including those in the Bay Area, South Coast, San Joaquin Valley and San Diego air district regions have listed emissions from ports and/or railyards as a top community concern. Drayage trucks traveling to and from these locations that would be subject to the proposed ACF regulation requirements for drayage trucks.

There are currently 18 ZEV OEMs located in the state and California is currently ranked first in the United States for ZEV manufacturing jobs.[297,298] The proposed ACF regulation is expected to drive demand even higher for ZEVs and this increase may result in higher employment opportunities in California's ZEV manufacturing sector, including employment in DACs. Examples include Motiv Power and Phoenix Motorcars, two small business ZEV manufacturers located in DACs. The increase in demand for ZEVs may also benefit job creation in various businesses throughout the ZEV supply chain, including those involved in battery, fuel cell, cold plate, and solar photovoltaic technology throughout the California.

The CEC is predicting the need for 157,000 chargers by 2030 and 200 hydrogen refueling stations in California by 2030 which will result in many job opportunities beyond the ZEV manufacturing sector.[299] For example, PG&E is actively engaged in projects to expand EV charging infrastructure through a $236 million program, which has been expanded to medium- and heavy-duty fleets. The goal of the program is to install or rebate make-ready infrastructure at 700 sites by 2024 to support the adoption of 6,500 medium- and heavy-duty ZEVs. PG&E is also committing to ensure that at least 25 percent of the infrastructure portion of the budget is invested in DACs.[300] There are also plans to increase the number of hydrogen stations throughout the state. There are also plans to increase the number of hydrogen stations throughout the state. There are now 56 hydrogen retail stations open to the public in California today, with a majority located in larger cities and metropolitan

[295] AB 617 (Garcia, Stats. 2017 Ch. 136).
[296] California Air Resources Board, *Community Air Protection Program,* 2022 (web link: https://ww2.arb.ca.gov/capp, last accessed August 2022).
[297] California Air Resources Board, *Zero Emission Vehicle Manufacturing in California*, 2021 (web link: https://ww2.arb.ca.gov/sites/default/files/2021-08/MapofZeroEmissionOEMs.pdf, last accessed August 2022).
[298] EV Hub, *Where are the EV jobs?,* 2022 (web link: https://www.atlasevhub.com/weekly_digest/where-are-the-ev-jobs/, last accessed August 2022).
[299] GO-Biz, *California Zero-Emission Vehicle Market Development Strategy*, 2021 (web link: https://static.business.ca.gov/wp-content/uploads/2021/02/ZEV_Strategy_Feb2021.pdf, last accessed August 2022).
[300] PG&E, *Clean Transportation*, 2022 (web link: https://www.pgecorp.com/corp_responsibility/reports/2021/pr05_clean_transportation.html, last accessed August 2022).

areas.[301,302] The State of California is working to build 200 hydrogen refueling in the next 5 years and 13 of these new stations will also offer fueling for commercial vehicles.

Strategic planning is happening now, and opportunities are mounting for design, engineering, construction, project management firms, EVSE suppliers and installers, and hydrogen fuel station suppliers to design new and expanded infrastructure throughout California. The increase in electric charging and fueling infrastructure will also benefit electricians and other maintenance professions. Many installations will take place in California and some infrastructure equipment may be manufactured in California as well. One manufacturer, ESL Power Systems, has primary operations based in California.[303] The need for infrastructure installations will be most necessary in central depots or yards, along major transportation corridors and near ports and railyards, which are often located near DACs and other communities that bear the disproportionate burden of harmful diesel emissions.

California will also see job creation in third-party support companies and agencies who may see new opportunities for business throughout the ZEV transition. Software companies, marketing and advertising firms, roadside assistance companies, financial institutions, insurance agencies, and recyclers may all see periods of workforce growth.

These opportunities for job creation will be supplemented through the Inclusive, Diverse, Equitable, Accessible, and Local (IDEAL) ZEV Workforce Pilot. CEC's Clean Transportation Program and CARB recently allocated over $6 million in grant funds for projects that provide workforce training and development that support ZEVs, ZEV infrastructure, and ZEV-related commercial technologies in California. The projects that are rewarded will focus on supporting training in ZEV industries with an emphasis on making workforce opportunities available to DACs.[304]

G. Other Societal Benefits

ZEVs offer a number of other benefits to truck operators when compared to gasoline and diesel vehicles. ZEVs are quiet and have a smoother ride than ICE vehicles, creating a better driving experience for operators. Reduced noise at the worksite creates a safer working environment, provides additional benefits to the community in which the vehicle is operating, and do not conflict with noise ordinances which means they may be able to make more deliveries at night, therefore reducing daytime traffic congestion.

California has approved changes to grid connection rules that will open the door for the interconnection of EVs with two-way charging capabilities to the grid.[305] This vehicle-to-grid concept will allow ZEVs to turn into 'virtual power plants', where ZEVs would store and

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[301] California Air Resources Board and California Energy Commission Joint Agency Staff Report on AB 8: 2021 Annual Assessment of Time and Cost Needed to Attain 100 Hydrogen Refueling Stations in California, December 2021. (weblink: *https://www.energy.ca.gov/sites/default/files/2021-12/CEC-600-2021-040.pdf*).

[302] California Fuel Cell Partnership Station Map website: https://cafcp.org/stationmap.

[303] ESL Power Systems, Inc., *Homepage*, 2022 (web link: https://eslpwr.com/, last accessed August 2022).

[304] California Energy Commission, *IDEAL Workforce Pilot*, 2021 (web link: https://www.energy.ca.gov/solicitations/2021-10/gfo-21-602-ideal-zev-workforce-pilot, last accessed August 2022).

[305] California Public Utilities Commission, *Rule 21 Interconnection*, 2021 (web link: https://www.cpuc.ca.gov/Rule21/, last accessed August 2022).

dispatch electrical energy stored in networked vehicle batteries which together act as one collective battery for 'peak shaving' (sending power back to the grid when electricity demand is high) and 'valley filling' (charging at night when demand is low).[306] This will also help during a power outage or emergency, as ZEVs could also work as mobile power stations. For example, the F-150 Lightning and its Intelligent Backup Power, can automatically kick in to power a house if the electricity goes out. Once power is restored, the truck automatically reverts to charging its battery. Based on an average 30 kWh of use per day, a fully charged F-150 Lightning with extended-range battery provides full-home power for up to 3 days.[307] These vehicles also have the ability to be used as a portable workstation that also powers worksite tools and appliances.

Over time, advanced transportation systems and technologies have the potential to become a transformative element in the development of a cleaner, safer, and more efficient transportation system.

V. Air Quality

This chapter includes an analysis of air quality data and emissions reductions relevant to the proposed ACF regulation. This analysis may provide support for air quality discussions in chapters II, III, and IV and will provide more detailed information in support of the air quality summaries in chapters VI and VII.

A. Baseline Information

The economic and emissions impacts of the proposed ACF regulation are evaluated against the business as usual (BAU) scenario each year for the analysis period from 2024 to 2050. The BAU case for the economic and emissions analysis for the proposed ACF regulation is also referred to as the "Legal Baseline" and uses the same vehicle inventory for all analyses. The Legal Baseline reflects the implementation of all existing State and federal laws and regulations on the vehicles the proposed ACF regulation would affect. The HD I/M regulation was heard by the Board in December 2021 but was not included in the Legal Baseline because it was not approved by Office of Administrative Law (OAL) at the time this analysis was prepared.

A second baseline analysis was also prepared to show how the analysis differs if the HD I/M regulation is approved. This analysis is in the Modified Baseline Analysis Appendix of the ACF significant regulatory impact analysis (SRIA) and presents a scenario that anticipates the HD I/M regulation being finalized prior to implementation of the proposed ACF regulation. Only NOx and PM exhaust emissions are affected under the Modified Baseline because HD I/M is expected to have minimal impact on PM brake wear and GHG emissions.

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[306] ScienceDirect, *Vehicle to Grid*, 2019 (web link: https://www.sciencedirect.com/topics/engineering/vehicle-to-grid, last accessed August 2022).
[307] Ford, *F-150 Lightning ™ General Product Frequently Asked Questions*, 2022 (web link: https://www.ford.com/support/how-tos/owner-resources/f-150-lightning/f-150-lightning-product-frequently-asked-questions/#11, last accessed August 2022).

Staff used CARB's EMFAC to assess the Legal Baseline vehicle inventory, including vehicle sales and population growth assumptions, for Class 2b and larger vehicles for all fuel types.[308] EMFAC includes the effects of CARB's ASB, ICT, Truck and Bus, Heavy-Duty Omnibus, and ACT regulations, and LCFS program compliance. It is important to note that the benefits of low carbon fuels, such as RNG and renewable diesel (RD), that are part of LCFS are already included in the Legal Baseline and in all scenarios. Therefore, the economic and environmental impacts attributable to the proposed ACF regulation are solely attributable to new actions beyond those already expected. This means only ZEV deployments required by the proposed ACF regulation that exceed the ZEV sales already expected from the ACT regulation would result in new emissions benefits and costs. When compared to the Legal Baseline, the proposed ACF regulation would increase the expected number of medium- and heavy-duty ZEVs (beyond existing regulations) from about 320,000 to about 510,000 by 2035 and from about 780,000 to about 1,230,000 ZEVs by 2045. This increase in ZEVs is expected to be mainly from Class 4-8 vehicles up to 2040, then across all Class 2b-8 vehicles afterwards. The proposed ACF regulation's ZEV requirements on light-duty delivery vehicles is not expected to increase ZEVs deployed in California as the required ZEV purchases by light-duty delivery fleets does not exceed the number of ZEVs light-duty manufacturers are required to sell into California due to the Advanced Clean Car regulation. Based on recent announcements and market developments, a portion of the ZEV sales expected in the Legal Baseline for Class 2b-3 will include vehicles, such as pickup trucks sold to individuals and small businesses, that are not in the scope of the proposed ACF regulation.[309] Further discussion of vehicle population estimates is in Chapter 3 "Direct Costs," Section 3.1.1 "Vehicle Population" of the ACF SRIA. For the costs and emissions analysis, if the estimated ZEV sale can be attributed to the ACT regulation in the Legal Baseline, it will not be counted toward the proposed ACF regulation.

Staff anticipates significant sales of medium- and heavy-duty ZEVs based on the number of pre-orders which have already been placed by customers. As shown in Table 24, these near-term commercial ZEV pre-orders number over 748,000 in the United States, indicating a clear demand for the vehicles such that individuals and entities that are not subject to the proposed ACF regulation are expected to purchase them voluntarily.[310] Some of these early model sales are expected to be counted towards compliance with the ACT regulation so would not be attributed to the proposed ACF regulation. Fleets subject to the proposed ACF regulation would be expected to purchase ZEVs and some have announced pre-orders of ZEVs.

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[308] California Air Resources Board, *EMFAC 2021 Database*, 2021 (web link: https://arb.ca.gov/emfac/, last accessed August 2022).

[309] M.J. Bradley & Associates, *Electric Vehicle Market Status Update*, 2021 (web link: https://www.mjbradley.com/sites/default/files/EDF_EV_Market_Report_January_2021_Update_0.pdf, last accessed August 2022).

[310] Electrek Co, *Tesla Cybertruck pre-orders rise to over 650,000, says new report*, 2020 (web link: https://electrek.co/2020/06/22/tesla-cybertruck-pre-orders-rose-over-650000-report/, last accessed August 2022).

Table 24: Existing Medium- and Heavy-Duty Orders in North America as of November 2021

Manufacturer	Order Status
Tesla	At least 252,000 on order (250,000 Cybertruck) [311,312]
Ford	At least 160,000 on order[313]
Rivian	At least 130,000 on order[314,315]
Lordstown	At least 100,000 on order[316]
Nikola	At least 16,500 on order[317,318]
Workhorse	At least 7,900 on order[319]
Arrival	At least 10,000 on order[320]
GMC	At least 65,000 on order[321]
Bollinger	At least 6,000 on order[322]

[311] Trucks.com, *Everything We Know About the Tesla Semi Truck*, 2019 (web link: https://www.trucks.com/2019/09/05/everything-we-know-about-the-tesla-semi-truck/, last accessed August 2022).

[312] CNBC, *Elon Musk suggests Tesla has received 250,000 pre-orders for its Cybertruck*, 2020 (web link: https://www.cnbc.com/2019/11/27/elon-musk-suggests-tesla-received-250000-pre-orders-for-cybertruck.html, last accessed August 2022).

[313] Elektrek, *Ford F-150 Lightning reservations surpass 160,000 during pre-production*, 2021 (web link: https://electrek.co/2021/11/03/ford-f-150-lightning-reservations-surpass160000-during-pre-production/, last accessed August 2022).

[314] The Verge, *Amazon will order 100,000 electric delivery vans from EV startup Rivian, Jeff Bezos says*, 2019 (web link: https://www.theverge.com/2019/9/19/20873947/amazon-electric-delivery-van-rivian-jeff-bezos-order, last accessed August 2022).

[315] Inside EVs, *Reservation Numbers Reveal Rivian R1T Has 30,000 Buyers Waiting*, 2020 (web link: https://insideevs.com/news/437341/rivian-r1t-30-thousand-reservations/, last accessed August 2022).

[316] Elektrek, *Lordstown claims more than 100,000 pre-orders for its electric pickup truck*, 2021 (web link: https://electrek.co/2021/01/11/lordstown-over-100000-pre-orders-electric-pickup-truck/, last accessed August 2022).

[317] Bloomberg, *Nikola Founder Builds $7.4 Billion Fortune Off Free Truck Orders*, 2020 (web link: https://www.bloomberg.com/news/articles/2020-06-12/nikola-founder-builds-7-4-billion-fortune-off-free-truck-orders, last accessed August 2022).

[318] Nikola, *Nikola Receives Landmark Order of 2500 Battery Electric Waste Trucks from Republic Services*, 2020 (web link: https://nikolamotor.com/press_releases/nikola-receives-landmark-order-of-2500-battery-electric-waste-trucks-from-republic-services-91, last accessed August 2022).

[319] M.J. & Bradley, *EV Market Update January 2021*, 2021 (web link: https://www.mjbradley.com/sites/default/files/EDF_EV_Market_Report_January_2021_Update_0.pdf, last accessed August 2022).

[320] Arrival, *UPS invests in Arrival and Orders 10,000 Generation 2 Electric Vehicles*, 2020 (web link: https://arrival.com/news/ups-invests-in-arrival-and-orders-10000-generation-2-electric-vehicles, last accessed August 2022).

[321] CNBC, *GM looks to increase electric Hummer production as reservations top 65,000, exceeding expectations*, 2022 (web link: https://www.cnbc.com/2022/03/29/gm-looks-to-increase-hummer-ev-production-as-reservations-top-65000.html, last accessed August 2022).

[322] Biznes Alert, *Electric car for tough guys*, 2017 (web link: https://translate.google.com/translate?sl=auto&tl=en&u=https://biznesalert.pl/bollinger-b1-samochod-elektryczny/, last accessed August 2022).

Manufacturer	Order Status
Lion	At least 300 delivered, 150 on order[323,324]
Motiv	At least 128 on order[325]
BYD	At least 100 delivered, 325 on order[326,327,328]
Lightning eMotors	At least 100 on order[329]
GreenPower	At least 100 on order[330]
Phoenix	At least 56 on order[331]
Volvo	At least 15 on order[332]
Oshkosh	10,019 on order[333]

B. Emissions Inventory Methods

Staff used the EMFAC2021 model to assess the emissions reductions that would be associated with the proposed ACF regulation. EMFAC is California's official on-road (e.g., cars, trucks, and buses) mobile source inventory model that CARB uses for various clean air planning, policy development, and regulatory efforts. EMFAC2021 incorporates CARB's current understanding of statewide and regional vehicle activity and emissions and reflects the Legal Baseline of adopted medium- and heavy-duty vehicle regulations including the ACT, ICT, ASB, and Heavy-Duty Omnibus regulations. An alternative baseline is also presented in the "Baseline Information" section above to show how emissions compare if the HD I/M regulation recently adopted by the Board is approved and finalized by OAL.

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[323] Inside EVs. *Canadian National Railway Orders Lion Electric Trucks*, 2020 (web link: https://insideevs.com/news/442185/canadian-national-railway-orders-lion-electric-trucks, last accessed August 2022).

[324] Inside EVs. *Lion Electric Scores Largest Truck Order to Date*, 2021 (web link: https://insideevs.com/news/497182/lion-electric-largest-truck-order/, last accessed August 2022).

[325] Inside EVs, *Bimbo Orders More EV Trucks from Motiv After Successful Pilot*, 2020 (web link: https://insideevs.com/news/453800/bimbo-orders-more-ev-trucks-motiv/, last accessed August 2022).

[326] BYD, *BYD Delivers 100th Battery Electric Truck in the United States,* 2020 (web link: https://en.byd.com/news/byd-delivers-100th-battery-electric-truck-in-the-united-states/, last accessed August 2022).

[327] BYD, *Anheuser Busch Names BYD Sustainable Suppler of the Year*, 2020 (web link: https://en.byd.com/news-posts/anheuser-busch-names-byd-sustainable-supplier-of-the-year, last accessed August 2022).

[328] Maersk, *Maersk to deploy 300 electric trucks in partnership with Einride*, 2022 (web link: https://www.maersk.com/news/articles/2022/03/24/maersk-to-deploy-300-electric-trucks-in-partnership-with-einride, last accessed August 2022).

[329] Lightning eMotors, *Lightning eMotors Reports Financial Results for Second Quarter 2021*, 2021 (web link: *https://lightningemotors.com/20120-2/*, last accessed August 2022).

[330] GreenPower, *GreenPower Receives Order for Additional 100 EV Stars from Green Commuter*, 2020 (web link: https://greenpowermotor.com/10-100-ev-stars-green-commuter/, last accessed August 2022).

[331] Phoenix Motorcars, *Phoenix Motorcars Announces Order for 50 Zero-Emissions Utility Shuttles by LR Group of Companies*, 2016 (web link: https://www.phoenixmotorcars.com/phoenix-motorcars-announces-order-for-50-zero-emissions-utility-shuttles-zeus-by-lr-group-of-companies/, last accessed August 2022).

[332] FleetOwner, *Volvo Trucks Lands Largest VNR Electric Order*, 2021 (web link: https://www.fleetowner.com/running-green/press-release/21161426/volvo-trucks-lands-largest-vnr-electric-order, last accessed August 2022).

[333] USPS, *USPS Places Order for 50,000 Next Generation Delivery Vehicles; 10,019 To Be Electric*, 2022 (web link: https://about.usps.com/newsroom/national-releases/2022/0324-usps-places-order-for-next-gen-delivery-vehicles-to-be-electric.htm, last accessed August 2022).

The proposed ACF regulation would require affected entities to upgrade their fleets to ZEVs, thereby eliminating PM, NOx, and GHG tailpipe emissions resulting from vehicle operations. PM, NOx, and GHG emissions benefits are projected by assuming zero tailpipe emissions for the forecasted number of medium- and heavy-duty ZEVs operating in California with the proposed ACF regulation's requirements in place and assuming no change in total VMT, compared to the Legal Baseline. The PM emissions analysis also includes an estimated 50 percent reduction in PM associated with brake-wear for EVs due to regenerative braking when compared to conventional vehicles.[334] Projections, including inventory assumptions, are further discussed in Chapter 3, Direct Costs, of the proposed ACF regulation's SRIA. Staff used the latest available data on population, activity, and in-use emissions from medium- and heavy-duty truck fleets operating in California to estimate the Legal Baseline emissions.

This assessment is focused on the vehicle emissions, also known as TTW emissions, and does not include upstream emissions associated with producing and delivering the fuel or energy source to the vehicle that are addressed by other measures and policies to reduce those emissions. Similar to the proposed ACC II regulation, the proposed ACF regulation is expected to show a net reduction in upstream emissions from transitioning to medium- and heavy-duty ZEVs when compared to gasoline, diesel, natural gas, and other fossil fuels used in the Legal Baseline.[335] Light-duty BEV have an EER of 3.4 and medium- and heavy-duty vehicles have an EER of 5, therefore we expect even greater magnitude emission reductions from upstream sources by implementing this proposed ACF regulation. Additional efficiencies are gained using BEV since energy used to power them do not need to be transported by truck like other transportation fuels. The scale of emissions from short-term construction of infrastructure is expected to be trivial in the context of the total emissions reductions expected from the regulation in the next two decades. For context, staff reviewed a sample of more than 20 California Environmental Quality Act (CEQA) notices for recent medium- and heavy-duty ZEV infrastructure projects funded by CARB and sister agencies and found, for all the notices reviewed, the projects were identified as not having significant impacts on the environment. These ZEV infrastructure deployments are expected to result in substantial emissions reductions. For instance, the Volvo Low Impact Green Highway Transportation Solutions pilot project description identified the project will deploy 23 Class 8 battery-electric tractors and was expected to result in 3.57 tons of criteria emissions reductions and 3,020 metric tons of GHG reductions.[336]

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[334] National Renewable Energy Laboratory, *BAE/Orion Hybrid Electric Buses at New York City Transit*, 2008 (web link: https://afdc.energy.gov/files/pdfs/42217.pdf, last accessed August 2022).

[335] California Air Resources Board, *https://www.dof.ca.gov/forecasting/economics/major_regulations/major_regulations_table/documents/ACCII-SRIA.pdf*, 2022 (web link: https://www.dof.ca.gov/forecasting/economics/major_regulations/major_regulations_table/documents/ACCII-SRIA.pdf, last accessed August 2022).

[336] California Air Resources Board, *Fiscal Year 2017-18 Zero- and Near Zero-Emission Freight Facilities Project Solicitation - List of Applications Received and Project Summaries*, 2018 (web link: https://ww2.arb.ca.gov/our-work/programs/low-carbon-transportation-investments-and-air-quality-improvement-program/low, last accessed August 2022).

C. Emissions Inventory Results

The following section provides a discussion of the projected emissions benefits from the proposed ACF regulation of both criteria pollutants (NOx and PM2.5) and GHGs. The analyses of these statewide tank-to-wheel emissions reductions from the proposed ACF regulation are compared with the Legal Baseline and demonstrate that emissions benefits increase as the ZEV fleet phase-in requirements and the population of medium- and heavy-duty ZEVs increase.

1. Criteria Pollutant Emissions Benefits

Medium- and heavy-duty trucks are the predominant means of distributing freight and services. These trucks can be seen along distribution centers, seaports, railyards, warehouses, and major roadways, which are commonly located around more densely populated urban areas, including in low-income and DACs. Vehicles powered by both diesel and other fuels like natural gas and gasoline contribute to both PM and NOx emissions at varying rates. For example, natural gas trucks use a catalytic reduction system compared to a wall flow filter in a diesel engine, and therefore continue to emit PM and NOx emissions in quantities exceeding zero. ZEV deployment in low-income and DACs will be an important part of the solution, not only for maximizing NOx and PM reductions needed to meet SIP requirements, but also for achieving GHG emissions goals established in many statutes, or complementary to existing statutes including AB 32, SB 32, SB 350, and SB 375.

The projected statewide emissions benefits of the proposed ACF regulation from 2024 through 2050 are identified in Table 25 with respect to NOx, PM2.5, and GHGs. The emissions presented are TTW (i.e., vehicle tank to tailpipe) emissions reductions, although reductions attributable to well to wheel processes are also anticipated; consequently, the following emissions benefits comprise a conservative estimate of the emissions benefit of the proposed ACF regulation. Several critical dates represent important targets for California to meet air quality standards and GHG goals. These include 2031 and 2037 as mid-term attainment deadlines for NAAQS and 2045 and 2050 as longer-term climate goals to achieve carbon neutrality and 80 percent GHG emissions reductions below 1990 levels, respectively.

Table 25: Statewide Tank-to-Wheel NOx, PM2.5, and Greenhouse Gas Benefits of the Proposed ACF regulation Relative to Legal Baseline

Calendar Year	NOx (tpd)	PM2.5 (tpd)	CO_2 (MMT/yr.)
2024	2.39	0.03	0.26
2025	2.69	0.04	0.45
2026	3.69	0.05	0.81
2027	5.96	0.08	1.35
2028	7.78	0.11	1.79
2029	10.91	0.16	2.53
2030	15.24	0.24	3.52
2031	19.99	0.33	4.55
2032	24.42	0.41	5.54
2033	28.23	0.48	6.34
2034	34.05	0.60	7.52

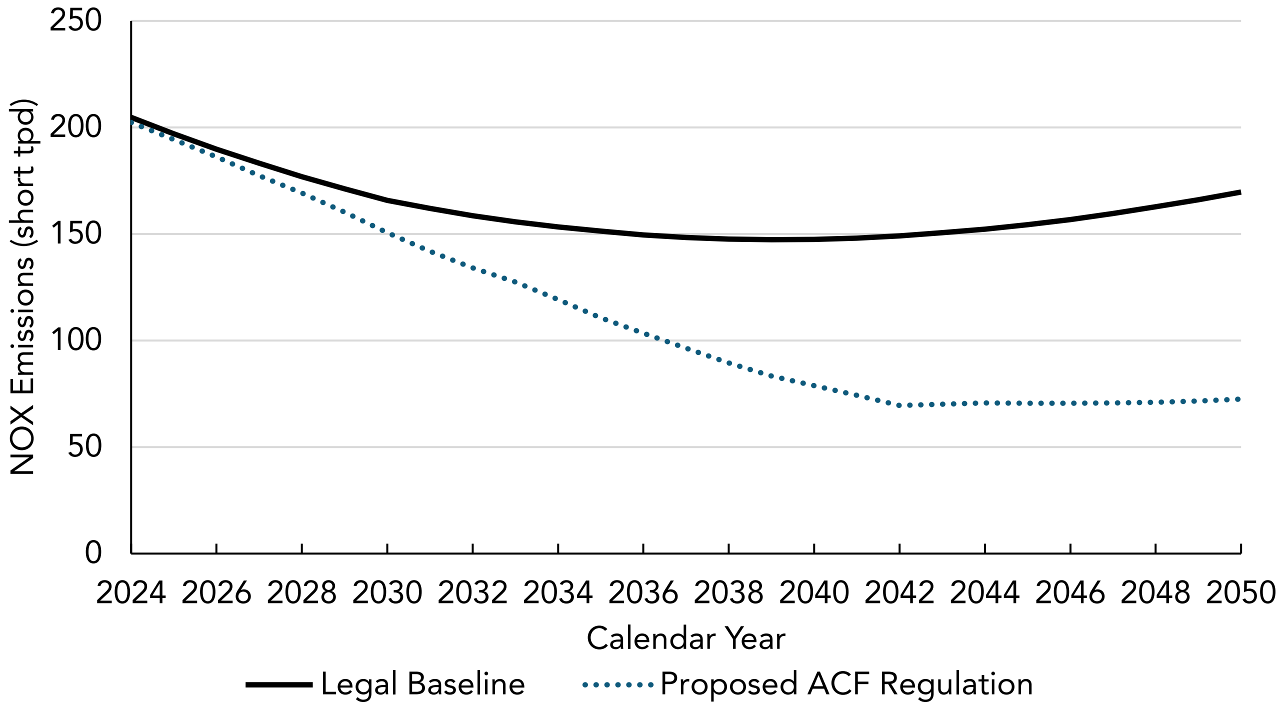
Calendar Year	NOx (tpd)	PM2.5 (tpd)	CO_2 (MMT/yr.)
2035	40.67	0.72	8.84
2036	46.12	0.83	9.84
2037	51.99	0.95	10.91
2038	58.15	1.07	12.04
2039	63.94	1.20	13.16
2040	68.59	1.31	14.26
2041	73.78	1.48	16.00
2042	79.56	1.64	17.63
2043	80.51	1.70	18.32
2044	81.65	1.77	19.02
2045	83.89	1.86	19.89
2046	86.30	1.94	20.76
2047	88.91	2.03	21.65
2048	91.66	2.12	22.55
2049	94.44	2.21	23.42
2050	97.24	2.29	24.27

Emissions benefits increase as the ZEV fleet requirements phase in and the population of medium- and heavy-duty ZEVs increase. The cumulative total emissions reductions from 2024 to 2050 is estimated to result in 418,943 tons reduction in NOx, 8,638 tons reduction in PM2.5 and 307 million metric tons (MMT) reduction of CO_2 TTW emissions, relative to the Legal Baseline.[337]

The statewide NOx and PM2.5 emissions impacts of the proposed ACF regulation are presented in the following two figures and are shown in short tpd. In the Legal Baseline, projected NOx emissions, Figure 50, decrease significantly until 2023 when the Truck and Bus regulation achieves its goal of upgrading most diesel vehicles to 2010 MY and newer engines. Beginning in 2024, the Legal Baseline for NOx emissions continues to decline as cleaner engines and ZEVs are phased in, even as VMT continues to grow, due to the normal replacement of existing vehicles with newer and cleaner ones as well as from existing regulations. However, in later years, the Legal Baseline NOx emissions begin to increase with projected VMT growth.

[337] The total cumulative emissions reductions for PM2.5 and NOx are converted from tons per day into years and assumes 312 operational days per year. Due to rounding errors, the 2024-2050 cumulative totals differ very slightly when compared to the sum values listed.

Figure 50: Projected Statewide NOx Tank-to-Wheel Emissions, Legal Baseline and Proposed ACF regulation

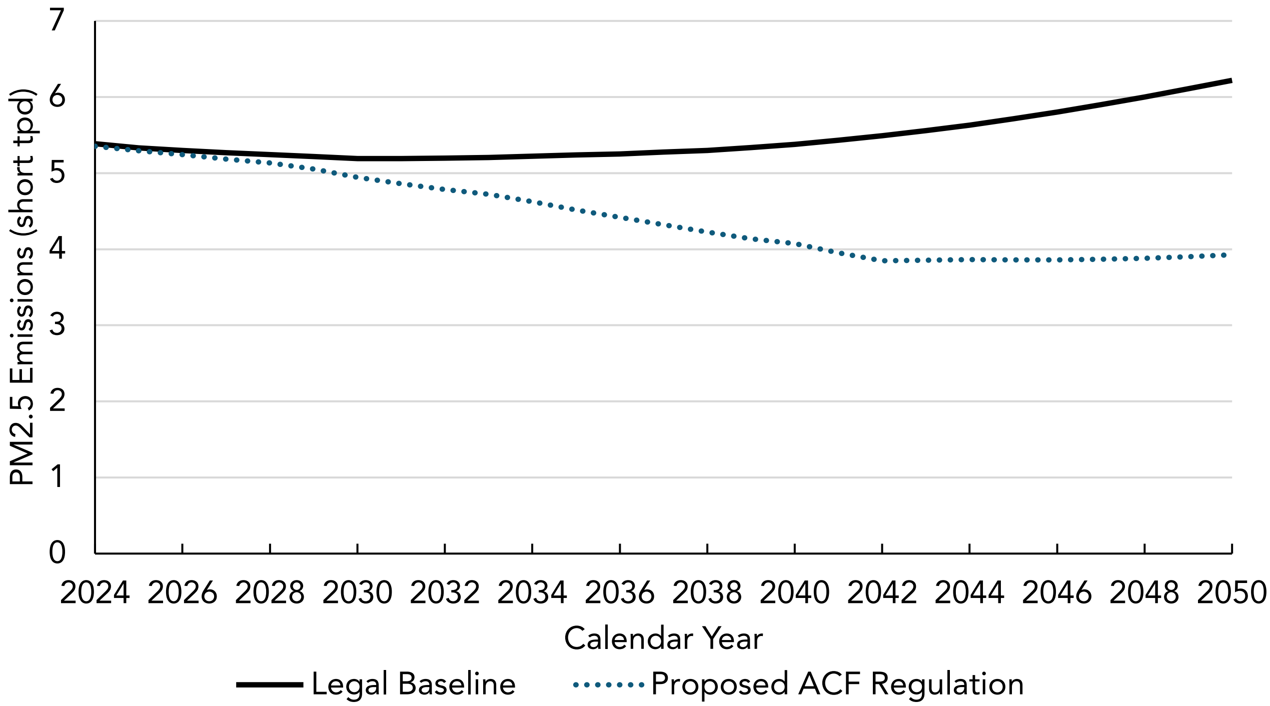


In the Legal Baseline, NOx emissions are expected to decline from 204.7 tpd in 2024 to 169.8 tpd in 2050. With the proposed ACF regulation, NOx emissions decline from 202.3 tpd in 2024 to 72.5 tpd in 2050. Although the regulated fleets will have fully converted to ZEVs by 2042, the new ZEV sales requirement will keep bringing extra emission benefits despite the predicted VMT growth and combustion vehicles emissions deterioration.

Emission and deterioration rates within this analysis followed the same methodology as in EMFAC2021. Staff applied a 50 percent reduction of PM brake wear emissions for ZEVs due to regenerative braking capability.[338] Tire wear emissions for ZEVs were assumed to be the same as ICE vehicles, and thus were not included in either the baseline or the control scenarios. For PM2.5 emissions shown in Figure 51, the Legal Baseline is initially expected to remain relatively flat as most diesel trucks already have PM filters and only limited additional reductions are expected from newer engines. Then PM2.5 emissions are expected to increase as projected VMT grows. With the proposed ACF regulation, PM2.5 emissions are expected to decline rapidly until about 2042 and then slow as more regulated fleets make a full conversion to ZEVs. Under the Legal Baseline, PM2.5 emissions are expected to increase from 5.4 tpd in 2024 to 6.2 tpd in 2050. With the proposed ACF regulation, PM2.5 emissions are expected to decrease from 5.4 tpd in 2024 to 3.9 tpd in 2050. Remaining emissions are largely due to vehicles not covered by the rule and other non-exhaust sources such as brake or tire wear.

[338] National Renewable Energy Laboratory (NREL), *BAE/Orion Hybrid Electric Buses at New York City Transit, A Generational Comparison*, 2008, (web link: https://afdc.energy.gov/files/pdfs/42217.pdf, last accessed August 2022).

Figure 51: Projected Statewide PM2.5 Tank-to-Wheel Emissions, Legal Baseline and Proposed ACF regulation



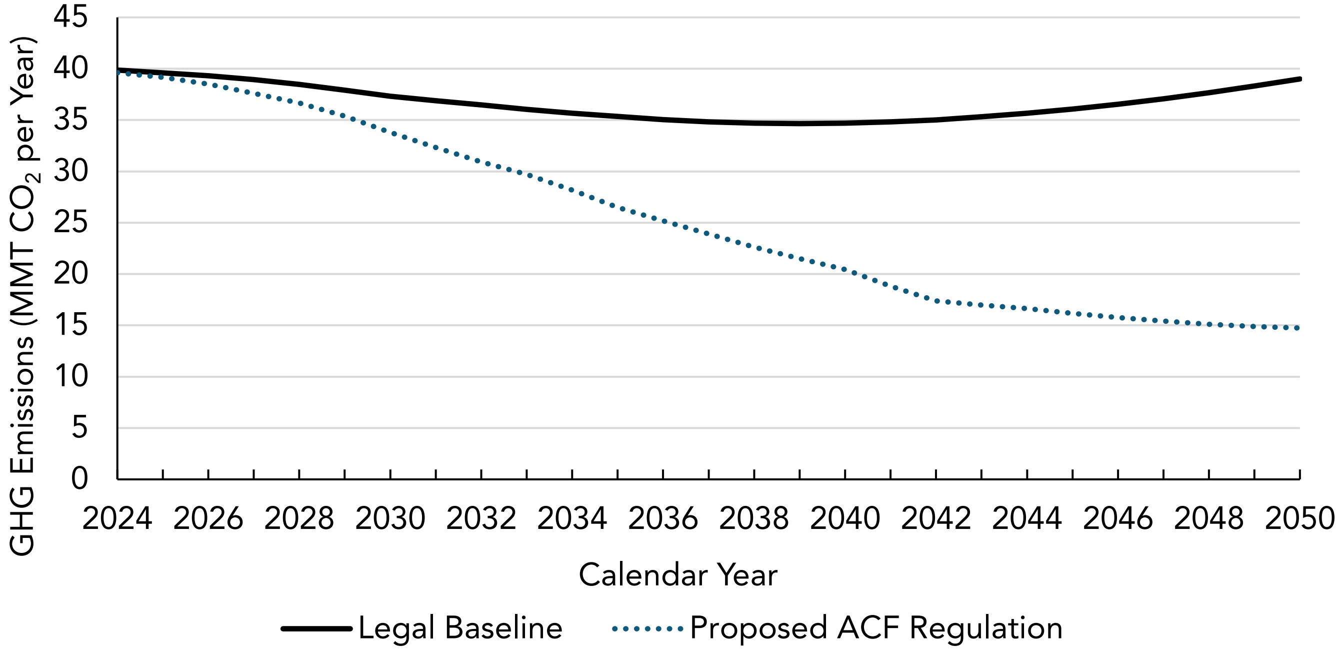
2. Greenhouse Gas Benefits

ZEV adoptions in low-income and DACs will be an important part of the solution for improvement of air quality in these areas that are so heavily impacted by truck traffic, not only for maximizing NOx and PM reductions needed to meet SIP requirements, but also for achieving the State's GHG emissions reductions goals. Reducing GHG emissions will help stabilize the climate, which benefits all communities, including low-income and DACs.

The proposed ACF regulation would be expected to result in significant GHG emissions reductions, due to replacing ICE vehicles with ZEV technologies. ZEVs produce no tailpipe emissions and have lower upstream emissions. These emissions reductions contribute to keeping California on the GHG emissions reductions path set in the Climate Change Scoping Plan.

Figure 52 summarizes the estimated TTW GHG emissions from both the proposed ACF regulation and the Legal Baseline, in units of MMT of CO_2 per year. The proposed ACF regulation would be expected to reduce cumulative TTW GHG emissions by an estimated 307 MMT of CO_2 relative to the Legal Baseline from 2024 to 2050.

Figure 52: Projected Statewide Tank-to-Wheel Greenhouse Gas Emissions of the Proposed ACF regulation



In the Legal Baseline, GHG emissions display a gradual overall decline from 2024 to 2039. The decline is the result of engine manufacturers meeting stricter emissions standards resulting in older models being replaced with more efficient models when normal replacements are made, and of the ACT regulation requiring manufacturers to build and sell a percentage of medium- and heavy-duty ZE trucks and buses. However, emissions begin to increase in about 2040, and by 2050, reach about the same annual emissions level as 2024. The GHG emissions increase is primarily due to the projected growth in medium- and heavy-duty truck VMT.

With the proposed ACF regulation, GHG emissions demonstrate a rapid decline from 2024 to 2042, reducing the annual emissions by roughly half of the 2024 estimate. The decrease in GHG emissions in comparison to the Legal Baseline is attributed to an increase in the number of ZEVs and some early retirement of medium- and heavy-duty ICE vehicles that reach the end of their useful life. The benefits are from the fact that ZEVs have no tailpipe emissions. From 2043 to 2050, GHG emissions continue to decline but at a much slower rate than in prior years.

The oil and gas and refining sector account for half of the industrial sector emissions in the State's annual GHG inventory, roughly 10 percent of the state's total GHGs. The electricity sector currently accounts for approximately 14 percent of the state's total GHGs. As the state moves away from fossil fuel combustion technology, there will be less dependence on petroleum, and this could potentially result in a reduction in petroleum industry-related GHG emissions. In addition, during the COVID-19 pandemic and the stay-at-home orders, there was a drastic reduction in demand for petroleum fuels as residents stayed home. As a result of that reduced demand, several refineries shutdown or announced the repurposing of those facilities to produce low carbon fuels. It is reasonable to expect that as fleets turnover and transition away from petroleum fuel and demand is reduced, we may see resulting upstream reductions in petroleum industry activities which could translate into additional GHG reductions.

Moreover, the transition to a cleaner fleet may also see demand increase for electricity. And, while the electricity sector is still a source of GHG emissions, there are multiple efforts to drastically decarbonize the grid even while load grows. The 2017 Scoping Plan Update, SB 350 Integrated Resource Plans, and SB 100 Report lay out the decarbonization targets and goals for 2030 and 2045. The 2017 Scoping Plan estimated a 51 to 72 percent reduction in GHG emissions relative to 1990 levels in the electricity sector while SB 100 requires planning for 100 percent zero-carbon electricity retail sales by 2045. [339] In addition to these sector specific upstream efforts to reduce GHG emissions, the 2022 Scoping Plan is currently evaluating 4 scenarios for achieving carbon neutrality no later than 2045 which either eliminates or drastically reduces the dependence on fossil fuel sourced energy.

VI. Environmental Analysis

CARB is the lead agency for the Proposed Amendments and has prepared an environmental analysis pursuant to its certified regulatory program (Cal. Code Regs., tit. 17, §§ 60000 through 60008) to comply with the requirements of CEQA. CARB's regulatory program, which involves the adoption, approval, amendment, or repeal of standards, rules, regulations, or plans for the protection and enhancement of the State's ambient air quality has been certified by the California Secretary for Natural Resources under Public Resources Code section 21080.5 of CEQA (Cal. Code Regs., tit. 14, § 15251(d)). Public Resources Code section 21080.5 allows public agencies with certified regulatory programs to prepare a "functionally equivalent" or substitute document in lieu of an environmental impact report or negative declaration, once the program has been certified by the Secretary for the Resources Agency as meeting the requirements of CEQA. CARB, as a lead agency, prepares a substitute environmental document (referred to as an "Environmental Analysis" or "EA") as part of the Staff Report to comply with CEQA (Cal. Code Regs., tit. 17, § 60005).

The Draft Environmental Analysis (Draft EA) for the proposed ACF regulation is included in Appendix D. The Draft EA provides a programmatic environmental analysis of an illustrative, reasonably foreseeable compliance scenario that could result from implementation of the proposed ACF regulation. The Draft EA states that implementation of the proposed ACF regulation could result in beneficial impacts to PM, NOx, and GHGs through the shift from operating ICE vehicles to ZEV in California.

For the purpose of determining whether the proposed ACF regulation would have a potential adverse effect on the environment, CARB evaluated the potential physical changes to the environment resulting from reasonably foreseeable compliance responses.

Implementation of the proposed ACF regulation could result in an increase in the manufacturing of ZEVs, which could require the construction and operation of new or expanded manufacturing facilities to meet the heightened demand for ZEVs, along with construction of new hydrogen-fueling stations and installation of EV charging stations to support ZEV operations. Increased deployment of ZEVs would result in a corresponding decrease in deployment of gasoline and diesel-fueled vehicles. Moreover, increased

[339] SB 100 (De León, Stats. 2018 ch. 312).

deployment of ZEVs would reduce demand for gasoline and diesel fuel, resulting in reduced rates of oil and gas extraction and refinement.

Increases in ZEV purchases may expand the production of hydrogen fuel as well as increased demand on the electrical grid requiring new electricity generation. However, California's electric grid has expanded and evolved as consumer demand for electricity services has grown, including with the recent emergence of light-duty plug-in electric vehicles. California's existing grid and approved investments occurring now will allow the state to handle millions of electric vehicles in the near-term, and projections show the broader western grid can handle up to 24 million light-duty, 200,000 medium-duty, and 150,000 heavy-duty ZEVs without requiring any additional power plants.[340] Electrification of California's entire transportation sector will require further investments in transmission and local distribution systems and coordinated grid planning efforts. The CPUC is currently in the process of evaluating and evolving grid capabilities from multiple energy sources, including renewable sources, to meet this challenge.

As a result of new ZEV demand, extraction of raw materials such as lithium and platinum and other metals may occur outside the state. This could result in increased rates of disposal of lithium-ion batteries and hydrogen fuel cells; however, disposal of these batteries would be subject to provision of California law, including, but not limited to, California's Hazardous Waste Control Law (Health and Safety Code, Division 20, Chapter 6.5; Cal. Code Regs., tit. 22, Division 4.5, Chapter 23), which restricts the disposal of used batteries to landfills. It is reasonably foreseeable that lithium-ion batteries would have a useful life at the end of vehicle life and are likely to be repurposed for a second life. To meet an increased demand for refurbishing or reusing batteries and fuel cells, new facilities or modifications to existing facilities could be constructed to accommodate recycling activities.

Implementation of the proposed ACF regulation could also result in fleet turnover. Fleets would be required to purchase and operate ZEVs, which would result in the replacement of older and less efficient fossil fuel ICE vehicles. The replaced vehicles could be sold to non-regulated entities in California or to an out-of-state party for use, junked, or sold to a salvage yard to be dismantled. As described above, disposal of any of these vehicles and the conventional batteries would be subject to comply with the applicable laws and regulations governing solid and hazardous waste.

Many of the impacts recognized as potentially significant in the EA for the proposed ACF regulation could be mitigated or reduced to less-than-significant levels through conditions of approval applied and mitigation measures to project-specific development. However, the authority to apply that mitigation lies with utilities or other agencies approving the development projects, not with CARB. Consequently, if a potentially significant environmental effect cannot be feasibly mitigated with certainty, the EA takes a conservative approach and identifies the impact as significant and unavoidable while disclosing the impact for CEQA compliance purposes. As such, reasonably foreseeable compliance responses associated with the proposed ACF regulation could result in potentially significant and

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[340] Pacific Northwest National Laboratory, *Electric Vehicles at Scale – Phase I Analysis: High EV Adoption Impacts on the Western U.S. Power Grid*, 2020 (web link: https://www.pnnl.gov/sites/default/files/media/file/EV-AT-SCALE_1_IMPACTS_final.pdf, last accessed August 2022).

unavoidable environmental impacts. Table 26 summarizes the potential environmental impacts of the proposed ACF regulation.

Table 26: Summary of Potential Environmental Impacts

Impact Number	Resource Area Impact	Significance
1-1, 1-2	Short-Term Construction-Related and Long-Term Operation-Related Effects to Aesthetics	Potentially Significant and Unavoidable
2-1	Short-Term Construction-Related and Long-Term Operation-Related Effects to Agriculture and Forest Resources	Potentially Significant and Unavoidable
3-1	Short-Term Construction-Related Effects to Air Quality	Potentially Significant and Unavoidable
3-2	Long-Term Operation-Related Effects to Air Quality	Beneficial
4-1, 4-2	Short-Term Construction-Related and Long-Term Operation-Related Effects to Biological Resources	Potentially Significant and Unavoidable
5-1	Short-Term Construction-Related and Long-Term Operation-Related Effects to Cultural Resources	Potentially Significant and Unavoidable
6-1	Short-Term Construction-Related Effects on Energy Demand	Less-than-Significant
6-2	Long-Term Operation-Related Effects on Energy Demand	Beneficial
7-1	Short-Term Construction-Related and Long-Term Operation-Related Effects to Geology, Seismicity, and Soils	Potentially Significant and Unavoidable
8-1	Short-Term Construction-Related Effects to Greenhouse Gas Emissions and Climate Change	Less-than-Significant
8-2	Long-Term Operation-Related Effects to Greenhouse Gas Emissions and Climate Change	Beneficial
9-1, 9-2	Short-Term Construction-Related and Long-Term Operation-Related Effects to Hazards and Hazardous Materials	Potentially Significant and Unavoidable
10-1, 10-2	Short-Term Construction-Related and Long-Term Operation-Related Effects on Hydrology and Water Quality	Potentially Significant and Unavoidable
11-1, 11-2	Short-Term Construction-Related and Long-Term Operation-Related Impacts on Land Use and Planning	No Impact
12-1	Short-Term Construction-Related and Long-Term Operation-Related Effects to Mineral Resources	Less-than-Significant

Impact Number	Resource Area Impact	Significance
13-1, 13-2	Short-Term Construction-Related and Long-Term Operation-Related Effects to Noise	Potentially Significant and Unavoidable
14-1	Short-Term Construction-Related and Long-Term Operation-Related Effects to Population and Housing	Less-than-Significant
15-1	Short-Term Construction-Related and Long-Term Operation-Related Effects to Public Services	Less-than-Significant
16-1	Short-Term Construction-Related and Long-Term Operation-Related Effects to Recreation	Less-than-Significant
17-1	Short-Term Construction-Related and Long-Term Operation-Related Effects to Transportation and Traffic	Potentially Significant and Unavoidable
18-1	Short-Term Construction-Related and Long-Term Operational Impacts on Tribal Cultural Resources	Potentially Significant and Unavoidable
19-1	Long-Term Operational-Related Effects on Utilities and Service Systems	Potentially Significant and Unavoidable
20-1	Short-Term Construction-Related and Long-Term Operation-Related Effects on Wildfire	Less-than-Significant

Staff prepared a Notice of Preparation and made it available for review and comment for 30 days, per the CEQA Guidelines (Cal. Code Regs., tit. 14, § 15082(b)). The comment period for the Notice of Preparation began on February 16, 2021 and ended on March 18, 2021. CARB held public workshops that also served as CEQA scoping meetings to solicit input on the scope and content of the Draft EA on March 2, 2021 and March 4, 2021. Written comments on the Draft EA will be accepted starting September 2, 2022 through October 17, 2022. The Board will consider the Final EA and responses to comments received on the Draft EA before taking action to adopt the proposed ACF regulation. If comments received during the public review period raise significant environmental issues, staff will summarize and respond to the comments. The written responses to environmental comments will be approved prior to final action on the proposed ACF regulation (Cal. Code Regs., tit. 17, § 60004.2(b)). If the proposed ACF regulation is adopted, a Notice of Decision will be posted on CARB's website and filed with the Secretary of the Natural Resources Agency for public inspection (Cal. Code Regs., tit. 17, § 60004.2(d)).

VII. Environmental Justice

State law defines environmental justice as the fair treatment and meaningful involvement of people of all races, cultures, incomes, and national origins with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies (Gov. Code, § 65040.12, subd. (e)(1)). The advancement of state and federal law on environment justice was greatly influenced by the Principles of Environmental Justice.[341] Environmental justice includes, but is not limited to, all of the following:

- The availability of a healthy environment for all people;
- The deterrence, reduction, and elimination of pollution burdens for populations and communities experiencing the adverse effects of that pollution, so that the effects of the pollution are not disproportionately borne by those populations and communities;
- Governmental entities engaging and providing technical assistance to populations and communities most impacted by pollution to promote their meaningful participation in all phases of the environmental and land use decision making process; and
- At a minimum, the meaningful consideration of recommendations from populations and communities most impacted by pollution into environmental and land use decisions (Gov. Code, § 65040.12, subd. (e)(2)).

The Board approved its Environmental Justice Policies and Actions on December 13, 2001, to establish a framework for incorporating environmental justice into CARB's programs consistent with the directives of State law.[342] These policies apply to all communities in California but are intended to address the disproportionate environmental exposure burden borne by low-income communities and communities of color. Environmental justice is one of CARB’s core values and is fundamental to achieving its mission.

Low-income and DACs have long faced disproportionate burdens from exposure to air pollution. Research shows large disparities in exposure to pollution between white and non-white populations in California, and between DACs and other communities as well, with Black and Latino populations experiencing significantly greater air pollution impacts than white populations.[343] Harmful diesel pollution from mobile sources shows some of the highest disparities, as indicated by a CARB-funded study which demonstrated that, on average, mobile sources account for over 30 percent of total PM2.5 exposures.[344] Research has shown that mobile sources are the largest sources of pollution exposure disparity for Black populations and DAC residents when compared to the average population in California. Specifically, mobile sources accounted for 45 percent of exposure disparity for the Black population, and 37 percent of exposure disparity for people in DACs.[345]

In recognition that air pollution heavily impacts DACs in California, AB 617 places additional emphasis on protecting such communities by requiring new community-focused and

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[341] Delegates to the First National People of Color Environmental Leadership Summit, *The Principles of Environmental Justice (EJ)*, 1991 (web link: https://www.ejnet.org/ej/principles.html, last accessed August 2022)
[342] California Air Resources Board, *Report: 2001-12-13 Policies and Actions for Environmental Justice (ca.gov),* 2001 (web link: https://www.arb.ca.gov/ch/programs/ej/ejpolicies.pdf?_ga=2.30332095.1878478371.1648486124-354412339.1596474861, last accessed August 2022).
[343] Office of Environmental Health and Hazard Assessment, *Analysis of Race/Ethnicity and CalEnviroscreen 4.0 Scores*, 2021 (web link: https://oehha.ca.gov/media/downloads/calenviroscreen/document/calenviroscreen40raceanalysisf2021.pdf, last updated July 2022).
[344] California Air Resources Board, *A Method to Prioritize Sources for Reducing High PM2.5 Exposures in Environmental Justice Communities in California. CARB Research Contract Number 17RD006*, 2019 (web link: https://ww2.arb.ca.gov/sites/default/files/classic/research/apr/past/17rd006.pdf, last accessed August, 2022).
[345] Ibid.

community-driven action to reduce air pollution and improve public health in areas that experience disproportionate burdens from exposure to air pollutants.[346]

Although CARB's existing regulations and incentive programs have reduced medium- and heavy-duty mobile source emissions, additional reductions are needed to protect the communities around California freight facilities that are still exposed to higher risk from diesel-powered sources. These communities bear a disproportionate health burden due to their close proximity to diesel emissions and the impacts of the resulting elevated air pollution can be measured. For example, while exposure to cancer-causing diesel particles has decreased statewide, exposure to diesel particles in DACs is on average twice than that experienced in non-DACs.[347]

Medium- and heavy-duty mobile source vehicles emit harmful pollutants both while in transit and during stationary operations across California, but frequently congregate at warehouse and distribution centers, seaports, intermodal railyards, and other locations that are commonly located near schools, hospitals, elder care facilities, and residential neighborhoods. All of California's seaports and intermodal railyards are located within approximately one (1) mile of DACs. The accelerated deployment of medium- and heavy-duty ZEVs in low-income and DACs eliminates tailpipe emissions, decreases petroleum use, reduces energy consumption, and helps California achieve its air quality and climate protection goals.

The proposed ACF regulation is consistent with CARB's environmental justice goal of reducing exposure to air pollutants and reducing adverse health impacts from toxic air contaminants in all communities. As discussed in Chapter V, the proposed ACF regulation would achieve additional emissions reductions from medium- and heavy-duty mobile source vehicles by transitioning them toward ZE technologies. The proposed ACF regulation is designed to reduce criteria pollutants, toxic air contaminants, GHG emissions, and the resulting risk from regional air pollution that can be associated with adverse health impacts. The additional reductions and associated improvements to air quality are intended to help protect all Californians and will be of particular benefit in low-income and DACs.

VIII. Economic Impacts Assessment or Standardized Regulatory Impact Assessment

This chapter describes the methodology used to determine the economic impact of the proposed ACF regulation. This includes methodology to determine the affected fleets, estimated number of ZEVs, sources used to determine the costs of various elements in the proposed ACF regulation, the total estimated incremental cost of the proposed ACF regulation versus the baseline, macroeconomic results, and fleet examples. The original SRIA

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[346] California Health and Safety Code sections 40920.6, 42 42402, 39607.1, 40920.8, 42411, 42705.5, and 44391.2, Division 26, *Assembly Bill No. 617, Nonvehicular Air Pollution: Criteria Air Pollutants and Toxic Air Contaminants*, 2017 (web link: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB617, last accessed August 2022).

[347] California Air Resources Board, *Community Air Protection Blueprint*, 2018 (web link: https://ww2.arb.ca.gov/sites/default/files/2018-08/final_draft_community_air_protection_blueprint_august_2018_1.pdf, last accessed August 2022).

document submitted to Department of Finance is in Appendix C-1, and Department of Finance's comments are in Appendix C-2 to this document.

A. Business-as-Usual Baseline

The economic and emissions impacts of the proposed ACF regulation are evaluated against the BAU scenario each year for the analysis period from 2024 to 2050. The BAU case for the economic and emissions analysis for the proposed ACF regulation is also referred to as the "Legal Baseline" and uses the same vehicle inventory for all analyses. The Legal Baseline reflects the implementation of all existing State and federal laws and regulations on the vehicles the proposed ACF regulation would affect.

The HD I/M regulation was heard by the Board in December 2021 but was not included in the Legal Baseline because it was not approved by OAL at the time this analysis was prepared. A second baseline analysis was also done to show how the analysis differs if the HD I/M regulation is approved, titled the "Modified Baseline." This analysis is in the Modified Baseline Analysis Appendix and presents a scenario that anticipates the HD I/M regulation being finalized prior to implementation of the proposed ACF regulation.

Staff used CARB's EMFAC to assess the Legal Baseline vehicle inventory, including vehicle sales and population growth assumptions, for Class 2b and larger vehicles for all fuel types.[348] EMFAC includes the effects of CARB's ASB, ICT, Truck and Bus, Heavy-Duty Omnibus, ACT regulation, and LCFS program compliance. It is important to note that the benefits of low carbon fuels such as RNG and RD that are part of the LCFS are already included in the Legal Baseline and all scenarios. Therefore, the economic and environmental impacts attributable to the proposed ACF regulation are solely attributable to new actions beyond those already expected. This means only ZEV deployments required by the proposed ACF regulation that exceed the ZEV sales already expected from the ACT regulation would result in new emissions benefits and costs. When compared to the Legal Baseline, the proposed ACF regulation would increase the expected number of medium- and heavy-duty ZEVs (beyond existing regulations) from about 320,000 to about 510,000 by 2035, from about 780,000 to about 1,230,000 ZEVs by 2045, and from about 950,000 to about 1,590,000 ZEVs by 2050. This increase in ZEVs is expected to be from Class 4-8 vehicles before 2040 and all Class 2b-8 vehicles afterwards. For the costs and emissions analysis, if the estimated ZEV sale can be attributed to the ACT regulation in the Legal Baseline, it will not be counted toward the proposed ACF regulation.

B. Direct Costs

The proposed ACF regulation would require fleets to replace their gasoline, diesel, natural gas, and other ICE vehicles with medium- and heavy-duty ZEVs. Staff assumes the total statewide costs of the proposed ACF regulation includes the upfront capital costs for the ZEVs and their associated infrastructure, changes to operating expenses, and other cost elements associated with this technology transition. This approach shows the full estimated statewide costs for deploying the number of ZEVs as required by the regulation.

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[348] California Air Resources Board, *EMFAC 2021 Database*, 2021 (web link: https://arb.ca.gov/emfac/, last accessed August 2022).

The estimated direct costs from the proposed ACF regulation and the Legal Baseline scenario include upfront capital costs of the vehicles, infrastructure, and ongoing operating costs which include fueling, maintenance, and LCFS revenues where applicable. Compared to gasoline, diesel, or natural gas powered vehicles, ZEVs generally have higher upfront capital costs today but lower operating costs, which results in an overall savings in staff's analysis over the useful life of the vehicles.

Currently, there are a number of rebate and voucher programs in California that offset some or all of the incremental costs for ZEVs and supporting infrastructure; however, none of these incentives are included in the cost analysis due to uncertainty as to which fleets may utilize funding and uncertainty in ongoing funding. Separate from CARB's incentive programs, the LCFS regulation is a market-based regulatory program that allows some fleets that dispense low carbon fuels to generate credits and sell them on the open market to generate revenue. Because of the regulatory certainty associated with the generation and use of credits by entities under the LCFS regulation, staff models credit revenue from the LCFS regulation for those entities that own and operate charging or hydrogen fueling stations. For retail stations, staff assumes a small portion of the LCFS credit value that reflects the difference in light-duty and heavy-duty credit value is passed through to the fleet. Finally, this analysis did not include any of the vehicle and infrastructure incentive and credits newly available under the recently passed Inflation Reduction Act of 2022.[349] The assumptions underlying the direct costs are detailed in the following sections. All costs discussed are in 2021 constant dollars.

1. Changes Since the Release of the Standardized Regulatory Impact Assessment

The proposed ACF regulation has been updated since the release of the SRIA on May 18, 2022.

a) Modifications to the Proposed ACF Regulation

(1) Inclusion of Light-Duty Delivery Vehicles

The scope of the high priority and federal fleet requirements has been expanded to include light-duty delivery vehicles. Staff estimates this modification would regulate an additional 40,000 light-duty vehicles. Because this modification would not increase light-duty ZEV sales beyond the requirements already set by the ACC regulations, this modification is not projected to have any direct costs on the State; instead, this would shift sales from individuals to businesses performing deliveries with light-duty vehicles. The impacts of this change are modeled through shifting costs from individuals to transportation and warehousing businesses in the macroeconomic modeling.

(2) Modifications to High Priority Fleet Requirements

The high priority fleet requirements were changed between the development of the SRIA and Initial Statement of Reasons (ISOR). As modelled in the SRIA, high priority fleets would

[349] Inflation Reduction Act of 2022, H.R. 5376, 117 Cong. (2021-2022).

comply solely though meeting the ZEV milestones. In the proposed ACF regulation, high priority fleets by default must meet the Model Year Schedule. They may opt-in to the ZEV Milestones Option as an alternative compliance pathway.

For the economic analysis, staff assumes a portion of fleets will opt into the ZEV Milestones Option based on the 3 groups of vehicles they have—50 percent of the Group 1 vehicles will opt into the ZEV Milestones Option, 75 percent of the Group 2 vehicles, and 100 percent of the Group 3 vehicles.

(3) Inclusion of Backup Vehicles in High Priority Fleet Modeling

Based on information from the ACT LER data and Truck and Bus regulation reporting, the inventory analysis models a portion of the fleet will use the backup vehicle exemption. Staff models that fleets on the Model Year Schedule will designate ten percent of their vehicles which exceed their useful life as backup vehicles. For the ZEV Milestones Option, staff models that ten percent of tractors and four percent of non-tractors will be designated as backup vehicles regardless of age.

(4) Updated CARB Staffing and Contracting Estimates

Staff have updated the projected staffing and contracting needs since the release of the SRIA. Estimated staff needs have increased from 21.75 positions to 32.5 positions. Contracting needs have increased from $200,000 in upfront costs to $2,000,000 in upfront costs and $400,000 in ongoing costs.

(5) Corrections to Fleet Reporting Costs

In the SRIA, reporting costs were erroneously modelled as continuing to 2050. Per the proposed ACF regulation, fleet reporting is required from 2024 to 2045 and ceases afterwards. The cost analysis has been updated to model fleet reporting costs up to 2045.

2. Vehicle Population

In this analysis, all estimates for annual California population and sales come from CARB's EMFAC 2021 inventory model.[350] The EMFAC model is developed and used by CARB to assess emissions from on-road vehicles including cars, trucks, and buses in California, and to support CARB's regulatory and air quality planning efforts to meet the Federal Highway Administration's transportation planning requirements. U.S. EPA approves EMFAC for use in SIP and transportation conformity analyses. EMFAC accounts for vehicle population growth, mileage accrual rates over time, vehicle fuel usage and associated emissions factors, and vehicle attrition over time.

Staff analyzed the impacts of COVID-19 on the trucking industry during development of EMFAC 2021 and as part of this analysis. Diesel fuel sales are a data surrogate to estimate diesel VMT and illustrate the general trends present in the trucking market. Data from the

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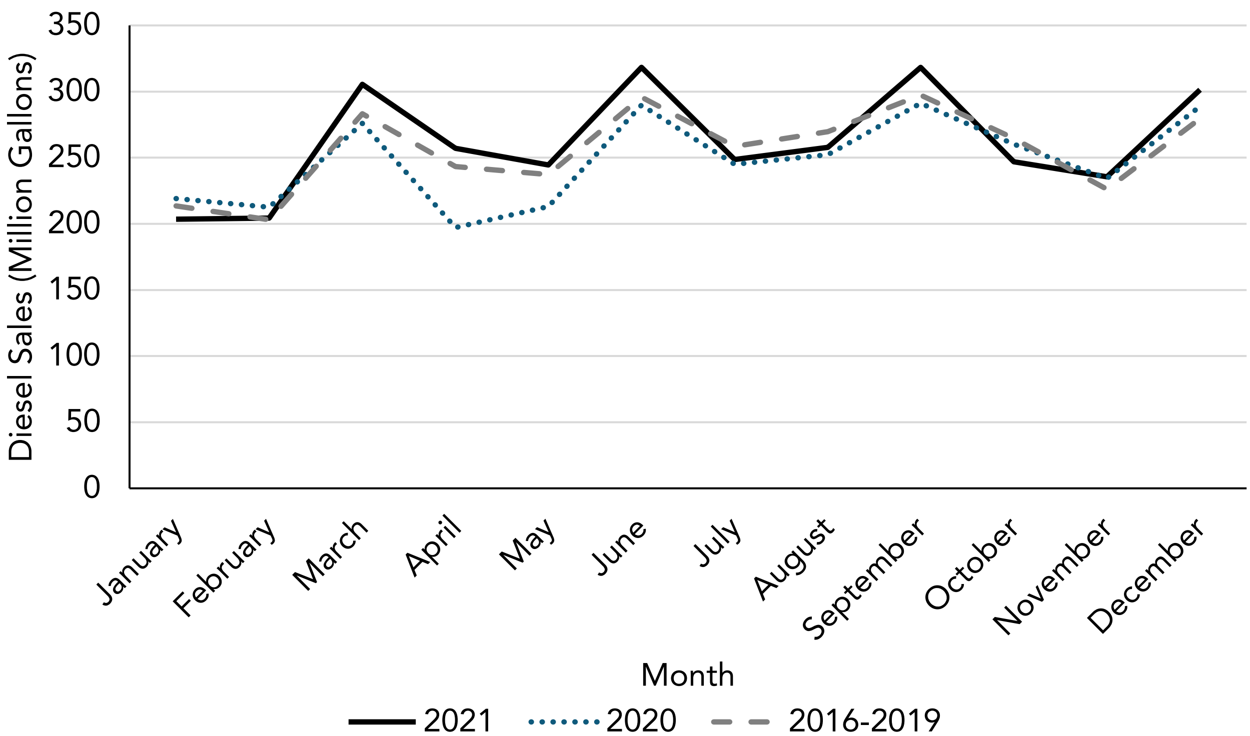
[350] California Air Resources Board, *EMFAC 2021 Web Database*, 2021 (web link: https://arb.ca.gov/emfac/emissions-inventory/, last accessed August 2022).

California Department of Tax and Fee Administration is displayed in Figure 53.[351] It shows that diesel fuel sales dropped dramatically in April 2020 and remained depressed through the second quarter of 2020. Afterwards, diesel fuel sales rebounded and returned to normal trends by the end of the year. These trends indicate that diesel fuel sales and truck mileage were not as impacted by the COVID-19 pandemic as other parts of the economy and the general trends forecasted within EMFAC 2021 remains appropriate for the purpose of this analysis.

Figure 53: Diesel Fuel Sales Data for 2021 and 2020 Versus 2016 Through 2016



The proposed ACF regulation affects a subset of the total California Class 2b-8 vehicle population. Staff used data sources including CARB's EMFAC 2021 model, DMV registration data, the CARB Drayage Truck Registry, and financial information from Dun and Bradstreet to determine which vehicles would be subject to the proposed ACF regulation.

State and local government fleet population estimates are derived from DMV information. Vehicles registered in DMV with an exempt plate were assumed to be owned by State and local government fleets. Staff estimates that roughly 128,000 trucks and buses would be subject to the proposed State and local government fleet requirements by 2024.

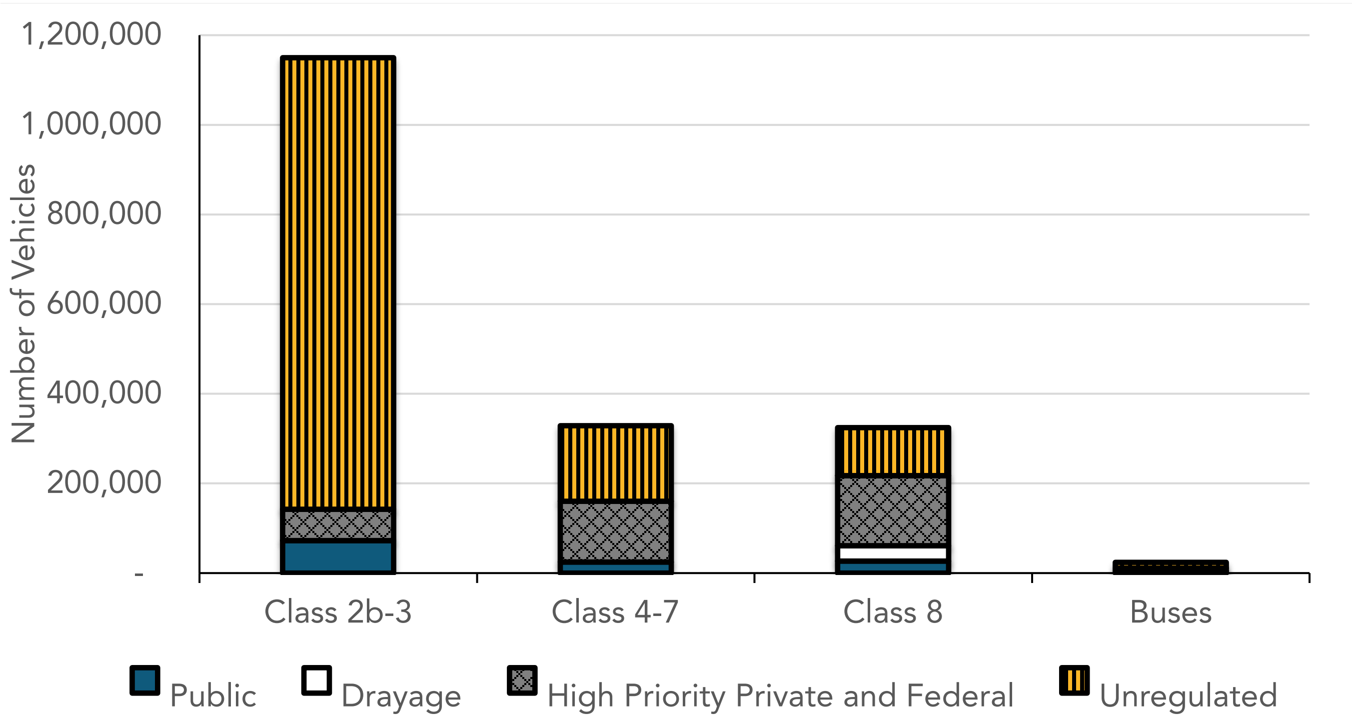
To estimate the number of vehicles subject to the drayage truck requirements, staff used the data from the CARB Drayage Truck Registry and the seaports and railyards to estimate the number of drayage trucks actively operating in California. Staff assumed a truck to be a part of the active fleet if they visited an average of 2 times per week. Staff estimates that

[351] California Department of Tax and Fee Administration, *Taxable Diesel Gallons 10 Year Report*, 2022 (web link: https://www.cdtfa.ca.gov/taxes-and-fees/Diesel-10-Year-Report.xlsx, last accessed August 2022).

approximately 34,000 trucks would be subject to the proposed drayage truck requirements by 2024.

To identify vehicles subject to the high priority and federal fleet requirement, staff first used DMV and International Registration Plan data to identify fleets with 50 or more vehicles. Staff then used Dun and Bradstreet data to determine California locations owned by businesses with greater than $50 million in annual nationwide revenue and, then used this data to match up locations owned by these businesses with vehicles registered at these locations in DMV. The data received from the ACT LER requirement aligns with the results derived from this methodology. Staff estimated the number of vehicles under common ownership and control based on data collected in the ACT one-time LER survey to be an additional 20 percent of the high priority fleet. This data was applied to EMFAC population numbers to create projections for this analysis. Figure 54 summarizes the projected proportion of vehicles subject to the proposed ACF regulation in 4 groups versus the total vehicle population in each group. Generally, vehicles in the Class 2b-3 group include pickup truck and vans that are owned by individuals and small businesses who would not be initially subjected to the proposed ACF regulation. Although the Class 2b-3 category has the highest number of vehicles, the proposed ACF regulation would include the majority of heavier vehicles operating in Classes 4 through 8 in California. Although there are fewer heavier vehicles in Classes 4 through 8, they represent the majority of criteria and GHG emissions due to their higher emission rates and mileages. Buses shown in the figure exclude transit and school buses.

Figure 54: Regulated Vehicles Versus Total Population in 2024



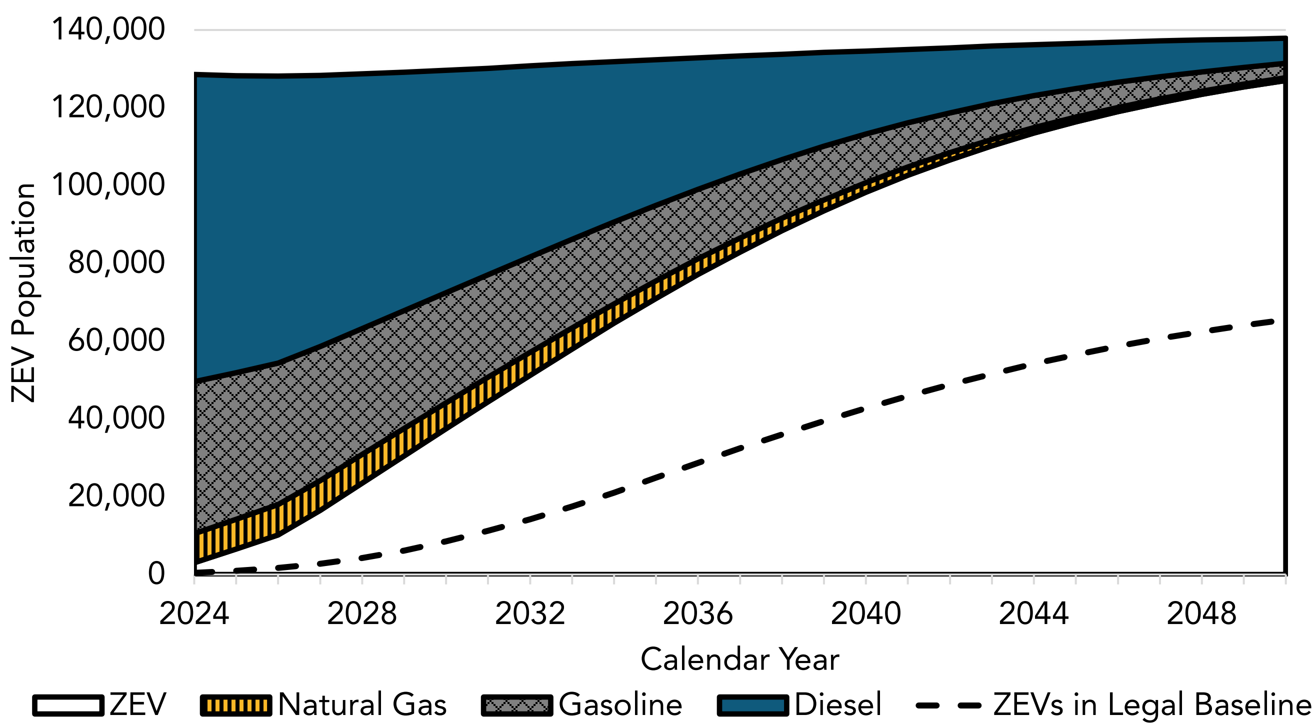
To calculate the State and local government fleet technology mixture over time, the percentage schedules shown below in Table 27 are applied to the projected State and local government fleet sales numbers to calculate the number of medium- and heavy-duty ZEVs purchased per year. Staff estimates that 3 percent of State and local government fleets operate in the designated low-population counties and 97 percent operate elsewhere.

Table 27. State and Local Government Fleets Zero-Emission Vehicle Purchase Schedule

Model Year	Designated Counties	All Other Counties
2024-2026	0	50%
2027+	100%	100%

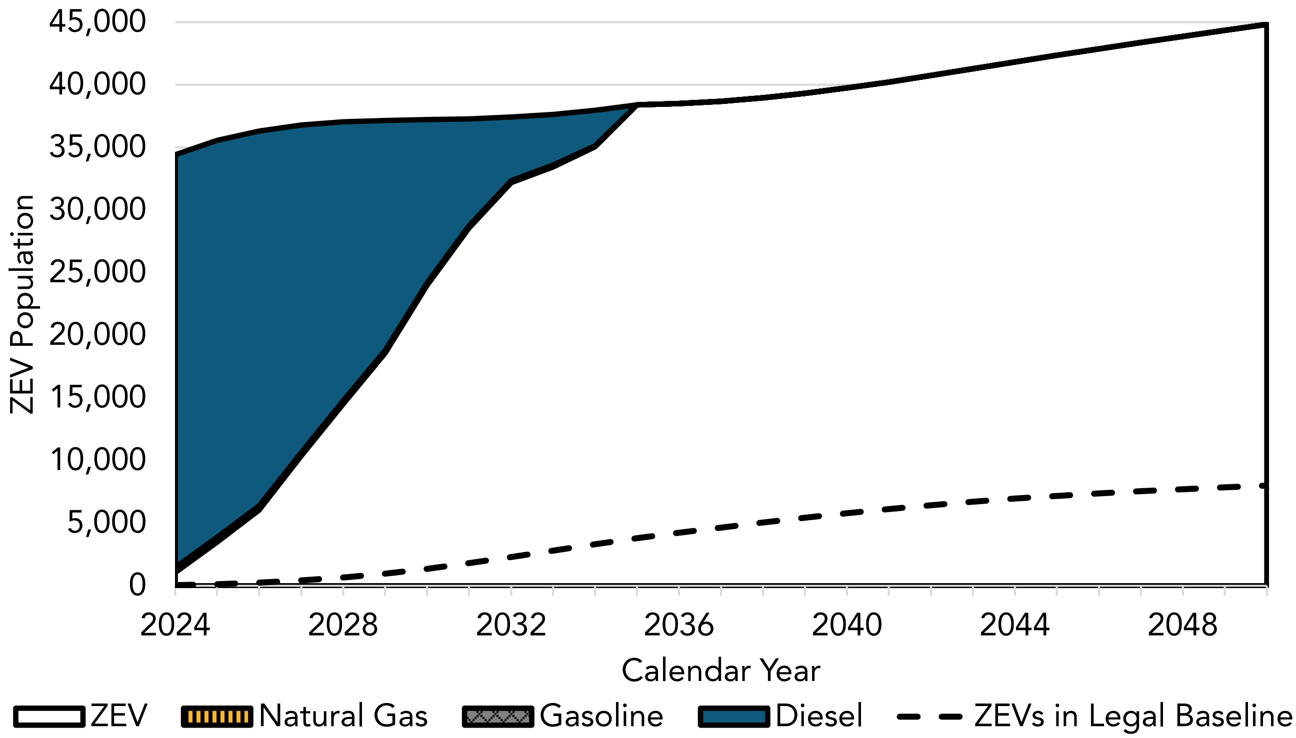
Figure 55 illustrates the projected State and local government fleet population over time by technology type using these inputs versus the medium- and heavy-duty ZEV population in the Legal Baseline scenario.

Figure 55: Projected State and Local Government Fleet Population with the Proposed ACF Regulation



To calculate the drayage truck technology mixture over time, staff assumed all additions to the drayage truck population beginning in 2024 would be ZEVs. Combustion-powered vehicles would leave the drayage truck inventory when they reach 800,000 miles which would typically be when the vehicle is 15-years-old based on mileage data. Figure 56 illustrates the projected drayage fleet population over time by technology type using these inputs versus the medium- and heavy-duty ZEV population in the Legal Baseline scenario. The natural gas population is under 300 vehicles in 2024 and is difficult to see on the figure. This figure includes drayage trucks operating at seaports as well as railyards.

Figure 56: Projected Drayage Truck Population with the Proposed ACF Regulation

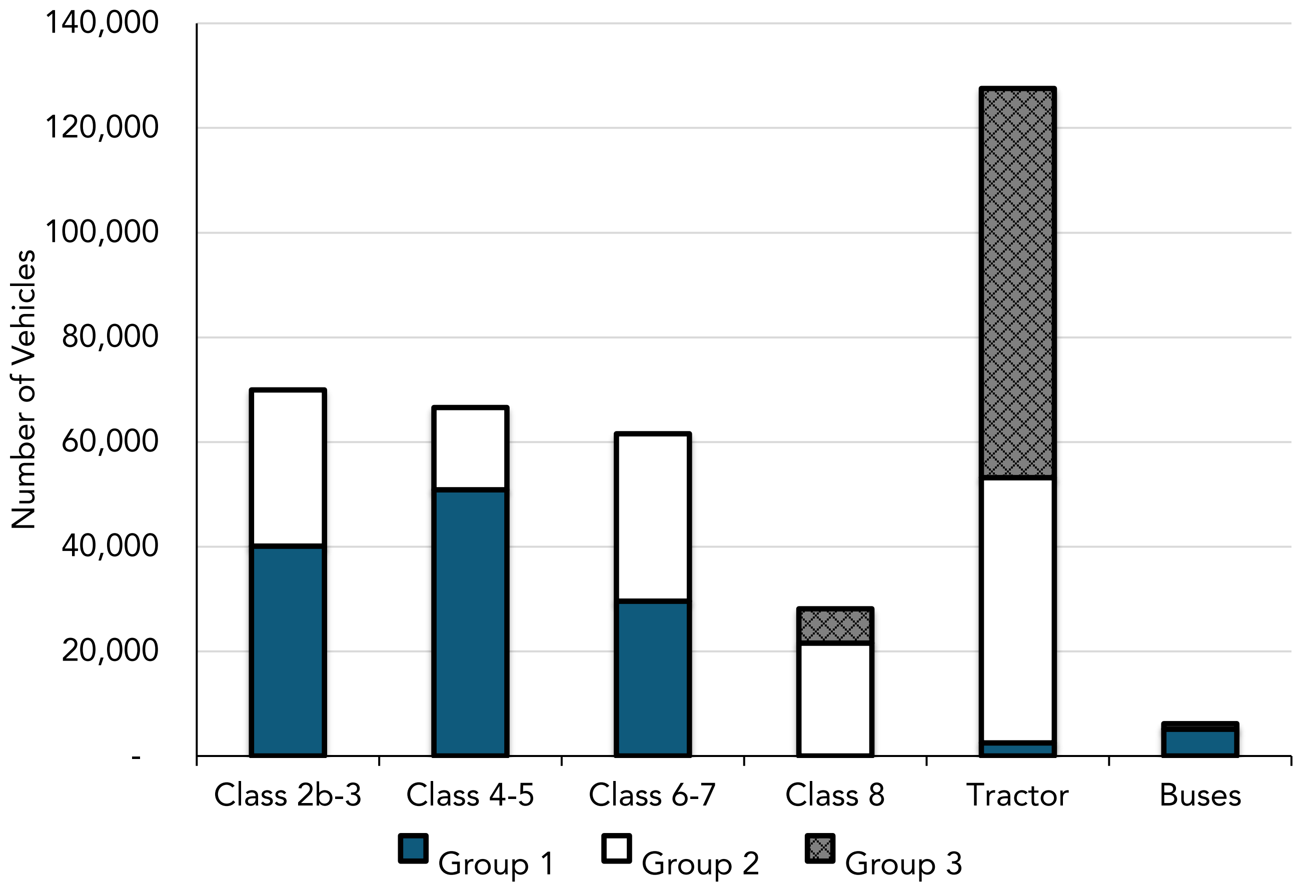


For the high priority and federal fleet requirements, fleets have two pathways to choose from: the Model Year Schedule or the ZEV Milestones Option. Fleets on the Model Year Schedule must purchase only ZEVs beginning January 1, 2024 and must retire vehicles which have exceeded their useful life. Fleets following the ZEV Milestones Option would need to meet the fleet ZEV percentage milestones outlined in Table 28. Work trucks are single-unit trucks except for specialty vehicles and vehicles already included in Group 1. A specialty vehicle is an uncommon Class 8 vocational vehicle that either has a heavy front axle or is designed to perform work while stationary with an auxiliary device which is integral to the vehicle's design e.g., a boom truck or digger derrick. For the emissions and costs analysis, fleet ZEV percentages are interpolated in years between regulatory requirements. Figure 57 illustrates the estimated 2024 population of vehicles in each vehicle category and vehicle group.

Table 28: High Priority and Federal Fleet Percentage Schedule

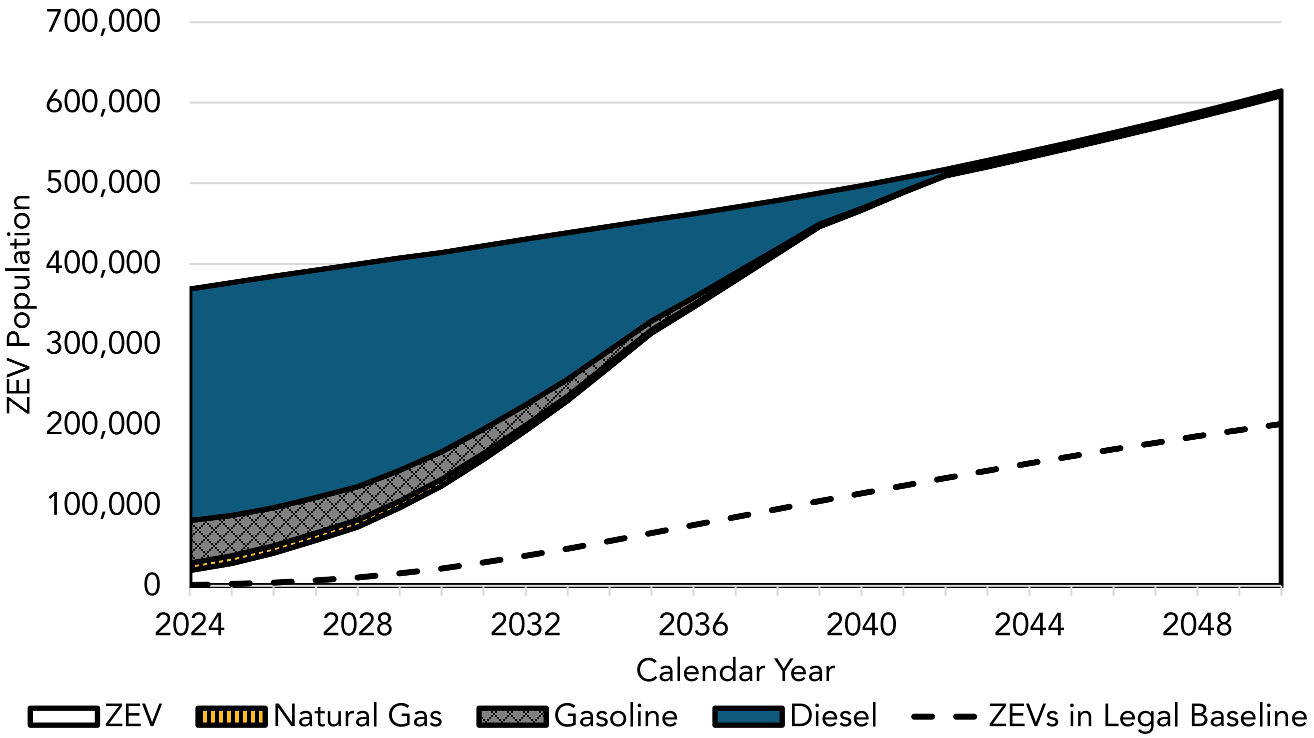
Group	**Vehicle Type**	**10%**	**25%**	**50%**	**75%**	**100%**
1	Box trucks, vans, two-axle buses, yard trucks, light-duty package delivery vehicles	2025	2028	2031	2033	2035
2	Work trucks, day cab tractors, three-axle buses	2027	2030	2033	2036	2039
3	Sleeper cab tractors and specialty vehicles	2030	2033	2036	2039	2042

Figure 57: Estimated Number of Vehicles per Vehicle Category and High Priority and Federal Fleet Grouping in 2024



For this analysis, staff assumes that 50 percent of the Group 1 vehicles will use the ZEV Milestones Option, 75 percent of the Group 2 vehicles, and 100 percent of the Group 3 vehicles. Figure 58 illustrates the projected high priority and federal fleet population over time by technology type using these inputs. Note that because a small portion of the vehicles operated by high priority and federal fleets are assumed to be designated as backup vehicles, some combustion-powered vehicles continue operating after 2042.

Figure 58: High Priority and Federal Fleet Population with the Proposed ACF Regulation



All 2040 MY and newer vehicles are assumed to be ZEVs. Nearly all new vehicles operating within California are originally sold in California; however, staff modelled that more used vehicles originally sold outside California will begin entering the state and will be purchased by regulated fleets. Table 29 shows what portion of vehicles are assumed to be originally sold in California based on their age.[352] This data was gathered using first sold data from California DMV. Instate buses and Class 2b-3 vehicles are assumed to all be sold in California, while out-of-state tractors are assumed to have all been sold outside of California. Most other vehicles newly registered in California are assumed to be purchased in California, but this fraction drops over time showing that more used trucks are being newly registered in California. For example, in 2040, 89.0 percent of 2040 MY Class 8 tractors registered within California are assumed to have been sold in California. By 2045, this fraction drops to 45.87 percent of Class 8 tractors.

Table 29: Percentage of California Registered Vehicles Originally Sold in California

Age	Class 4-6 Vocational	Class 7 Vocational	Class 8 Vocational	Class 7 Tractor	Class 8 Tractor
-1 or 0	90.97%	85.01%	89.78%	84.31%	89.00%
1	88.38%	80.35%	85.80%	82.10%	86.61%
2	85.68%	76.22%	81.86%	76.91%	79.17%
3	83.07%	72.74%	78.34%	69.92%	68.61%

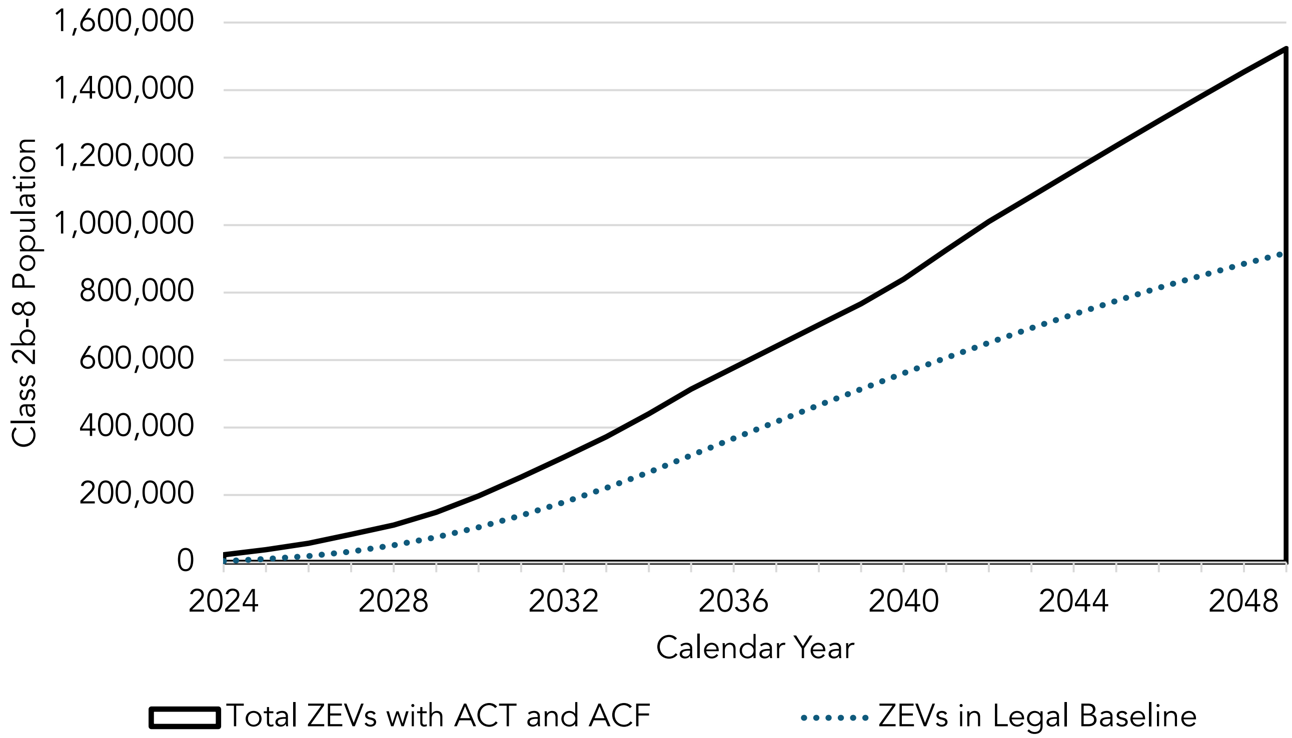
[352] California Air Resources Board, *Appendix F: Emissions Inventory Methods and Results for the Proposed Advanced Clean Trucks Regulation*, 2019 (web link: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2019/act2019/appf.pdf, last accessed August 2022).

Age	Class 4-6 Vocational	Class 7 Vocational	Class 8 Vocational	Class 7 Tractor	Class 8 Tractor
4	80.74%	70.02%	75.59%	62.30%	56.87%
5	78.90%	68.18%	74.00%	55.25%	45.87%
6	77.76%	67.35%	73.92%	49.92%	37.55%
7+	77.50%	67.35%	73.92%	47.51%	33.85%

Staff are not anticipating a prebuy situation beyond what is already expected with the Truck and Bus regulation. Most fleets that would be subject to the proposed ACF regulation are already subject to the Truck and Bus regulation. The Truck and Bus regulation requires significant turnover to 2010 or newer diesel engines prior to 2023 and accelerates vehicle purchases beyond what would be expected without that regulation. The accelerated purchases due to the Truck and Bus regulation are expected to reduce medium- and heavy-duty diesel vehicle purchases in the following years as trucks in the fleet will be newer than is typical for some fleets. This shift in fleet behavior is included in the baseline EMFAC modelling assumptions. In addition, staff are also aware of the current worldwide supply chain delays that would also dampen any short-term prebuy effects due to limited production capability from manufacturers in the immediate future.

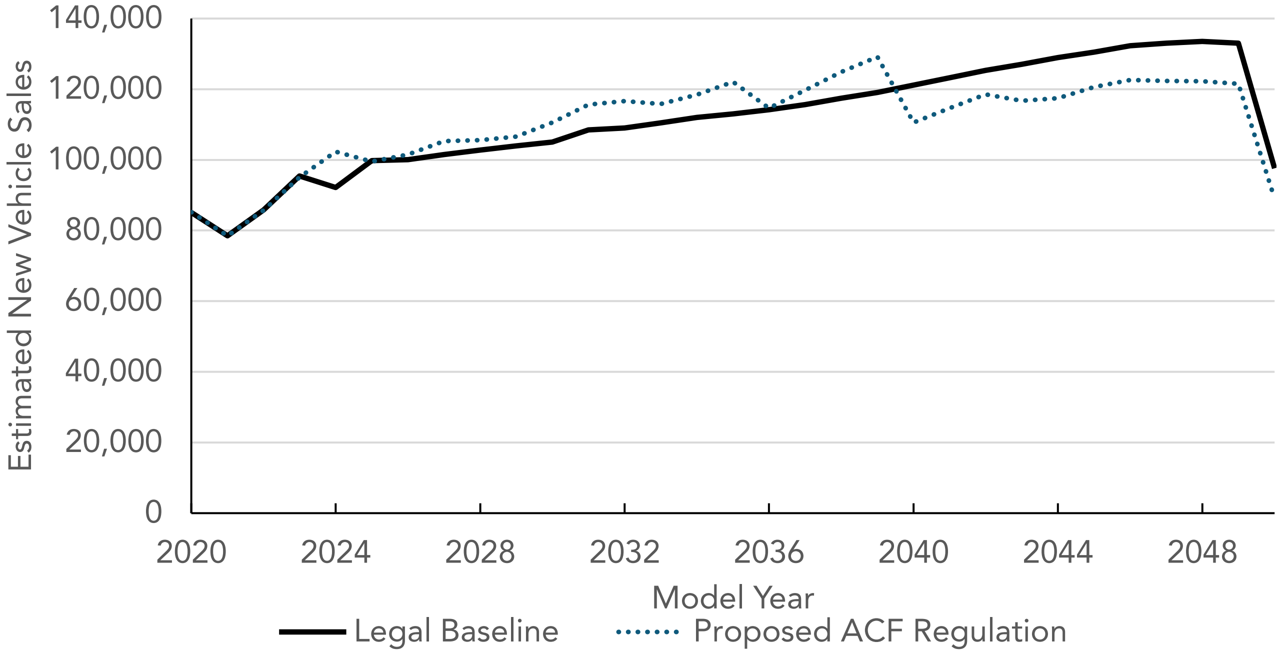
The proposed ACF regulation builds on the ACT regulation's requirement that manufacturers produce and sell increasing numbers of ZEVs in California. Figure 59 illustrates the net result of the 2 policies as well as the number of medium- and heavy-duty ZEVs each regulation would have achieved by itself. Generally, the proposed ACF regulation by itself would be expected to result in more ZEVs deployed than the adopted ACT regulation. Because ZEV sales are not all expected to be purchased by the fleets regulated under the proposed ACF regulation, the combination of the 2 would be expected to result in greater ZEV sales than each regulation achieves on its own. As a result, the proposed ACF regulation would be expected to increase the number of medium- and heavy-duty ZEVs beyond existing regulations from about 320,000 to about 510,000 by 2035, from about 780,000 to about 1,230,000 ZEVs by 2045, and from about 950,000 to about 1,590,000 ZEVs by 2050.

Figure 59: Statewide Population Forecast with the Proposed ACF Regulation



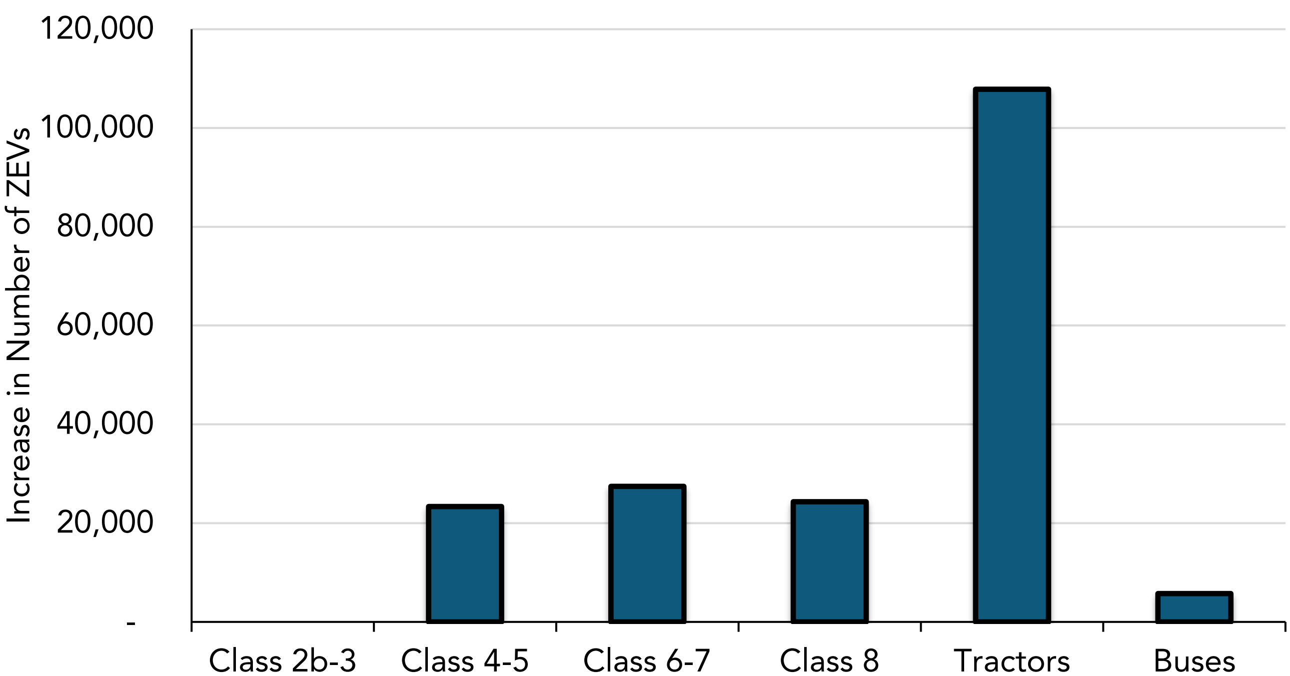
The proposed ACF regulation would result in changes to vehicle purchasing behavior. Because ZEVs are a newer commercial technology, fleets will not initially be able to purchase used ZEVs for a significant period of time. The proposed ACF regulation would also require some fleets to purchase vehicles quicker than their baseline replacement rate to keep up with regulatory milestones. As a result, the proposed ACF regulation is expected to increase new ZEV purchases by fleets. Figure 60 illustrates the projected sales per MY in the baseline and under the proposed ACF regulation. The number of new vehicle sales increases from 2024 to 2039 due to implementation of the high priority and federal fleet and drayage requirements. New vehicle sales are projected decline after 2040 when the phase-in for Group 2 vehicles end before rebounding to their baseline value near 2050.

Figure 60: Estimated New Vehicle Sales per Model Year



The projected increase in ZEVs deployed varies depending on the type of vehicles. The ACT regulation is projected to result in the largest portion of ZEVs deployed in the Class 2b-3 vehicle group and relatively fewer tractors based on that regulation's requirements and estimated sales numbers. The proposed ACF regulation generally places higher requirements on heavier vehicle classes, especially tractors, as previously noted. Figure 61 illustrates the expected increase in number of ZEVs by vehicle grouping in 2035.

Figure 61: Estimated Increase in ZEVs by Vehicle Category in 2035



Staff used the inventory analysis for cost modelling by aligning EMFAC categories into vehicle categories with available cost information. The vehicle categories in EMFAC were grouped into the following vehicle categories:

- Class 2b-3 trucks (GVWR between 8,501 and 14,000 lbs.) representing heavy-duty pickup trucks, cargo vans, and passenger vans;
- Class 4-5 trucks (GVWR between 14,001 and 19,500 lbs.) representing lighter delivery vans and service trucks;
- Class 6-7 single-unit trucks (GVWR between 19,501 and 33,000 lbs.) representing heavier delivery vans, bucket trucks, and others;
- Class 8 single-unit trucks (GVWR above 33,001 lbs.) representing a wide variety of heavy-duty vehicles including dump trucks, construction equipment, and others;
- Solid waste collection vehicles (SWCV) refer to refuse trucks used for urban waste pickup and collection;
- Tractor-trailers representing day cab tractors typically used for drayage and short to regional haul operation as well as sleeper cab tractors used for long-haul trucking; and
- Buses representing primarily cutaway shuttles and motorcoaches.

For each component of the proposed ACF regulation, staff assigned a representative vehicle for each vehicle category to calculate costs. Table 30, Table 31, and Table 32 display the different regulatory components and vehicle categories and what representative vehicle was used for that grouping.

Table 30: State and Local Government Fleet Vehicle Assumptions

Vehicle Category	Representative Vehicle
Class 2b-3	Class 3 Service Truck
Class 4-5	Class 5 Service Truck
Class 6-7	Class 6 Bucket Truck
Class 8	Class 8 Dump Truck
SWCV	Class 8 Refuse Packer
Buses	Class 5 Cutaway Shuttle

Table 31: Drayage Fleet Vehicle Assumptions

Vehicle Category	Representative Vehicle
Tractors	Class 8 Day Cab Tractor

Table 32: High Priority Fleet Vehicle Assumptions

Vehicle Category	Representative Vehicle
Group 1 - Class 2b-3	Class 2b Cargo Van

Vehicle Category	Representative Vehicle
Group 1 - Class 4-5	Class 5 Walk-in Van
Group 1 - Class 6-7	Class 6 Box Truck
Group 1 - Buses	Class 5 Cutaway Shuttle
Group 1 – Yard Tractor	Class 8 Yard Tractor
Group 2 – Class 2b-3	Class 2b Pickup
Group 2 – Class 4-5	Class 5 Service Truck
Group 2 – Class 6-7	Class 6 Bucket Truck
Group 2 – Class 8	Class 8 Dump Truck
Group 2 – SWCV	Class 8 Refuse Packer
Group 2 – Buses	Class 8 Motorcoach
Group 2 – Tractors	Class 8 Day Cab Tractor
Group 3 – Tractors	Class 8 Sleeper Cab Tractor
Group 3 – Specialty	Class 8 Bucket Truck

Throughout the body of the document, staff will refer to the cost elements of sample vehicles from the list above rather than all vehicles for brevity. A list of all vehicle-specific cost elements used in this analysis is provided in Appendix G.

3. Technology Mix Projections

Fleets currently purchase trucks powered by a variety of fuels—most commonly gasoline or diesel, and relatively low volumes of CNG, liquid natural gas, propane, E85, and other fuels. In staff's assumed Legal Baseline conditions, for simplification, Class 2b-3 vehicles and buses are split between gasoline- and diesel-powered based on existing assumptions within the EMFAC database. Class 4-8 vehicles are generally treated as diesel-powered with the exception of refuse trucks and tractors where 60 percent and 1.4 percent, respectively, are modelled to be natural gas powered. Based on EMFAC data, roughly ten percent of Class 4-8 vehicles use a fuel other than diesel, mainly gasoline.

Under the proposed ACF regulation, fleets are anticipated to meet their medium- and heavy-duty ZEV requirements using a combination of BEVs and FCEVs. Additionally, the State and local government fleet and high priority and federal fleet requirements can partly be met with NZEV technologies like PHEVs prior to 2035. It is somewhat challenging to precisely predict which ZE technologies fleets would use for complying with the proposed ACF regulation, especially as battery and fuel cell technologies have different characteristics, and such characteristics will likely change as such technologies continue to advance, and costs continue to decline. Generally, FCEVs commonly have shorter refueling times and are expected to have less sensitivity to weight concerns in long-range applications when compared to a battery-electric counterpart. BEVs can offer greater fuel cost-savings, especially for overnight charging, as electricity is generally a lower cost fuel compared to gasoline, diesel, natural gas, and hydrogen in a return to base duty cycle with sufficient dwell time to recharge the vehicles.

Based on expected manufacturer product availability and vehicle suitability analyses, staff assumes that fleets would comply with the proposed ACF regulation with a combination of battery-electric and fuel cell technologies. Currently, a wide variety of battery-electric trucks in all weight classes and configurations are commercially available. There are several commercially available battery-electric tractors now and limited small-scale deployments of fuel cell electric truck tractors by several small and major truck manufacturers. More information on current vehicle availability is discussed in Chapter I and in Appendix J. Based on manufacturer announcements, the majority of tractors commercially launched within the immediate future will be battery-electric. Manufacturers are simultaneously making investments into fuel cell electric technologies leading to commercialization in the latter half of the decade. As a result, staff is assuming 10 percent of day cab tractors will be FCEV until 2027 and 25 percent afterwards.

For sleeper cab tractors, staff is assuming an even 50:50 split between BEVs and FCEVs as they are phased in to meet 2030 compliance requirements. Both technologies face similar issues where a network of publicly accessible infrastructure is necessary to enable long-distance transportation throughout California and outside the state. For all other vehicles, staff is assuming all purchases would be battery-electric until 2026, purchases starting in 2027 onward would be 90 percent BEV and 10 percent FCEV. Currently, there are a number of medium- and heavy-duty FCEVs being demonstrated in the Class 6 and 8 weight classes.[353,354 ,355,356,357] A Class 8 fuel cell tractor produced by Hyzon Motors will be added to the HVIP catalog in August 2022.[358] Several other manufacturers including Hyundai, Volvo, Hino and Nikola are in the process of developing Class 8 fuel cell trucks or have announced plans and partnerships to do so; however in some instances, timing remains uncertain.[359,360,361]. Staff foresees a portion of regional haul and sleeper cab tractors would be fuel cell powered, but up to this point BEV technologies are the only commercially available

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[353] California Air Resources Board, *LCTI: NorCAL Zero-Emission Regional and Drayage Operations with Fuel Cell Electric Trucks*, 2022 (web link: https://ww2.arb.ca.gov/lcti-norcal-zero-emission-regional-and-drayage-operations-fuel-cell-electric-trucks, last accessed August 2022).
[354] California Air Resources Board, *LCTI: Fast-Track Fuel Cell Truck*, 2022 (web link: https://ww2.arb.ca.gov/lcti-fast-track-fuel-cell-truck, last accessed August 2022).
[355] California Air Resources Board, *LCTI: Fuel Cell Hybrid Electric Delivery Van Deployment*, 2022 (web link: https://ww2.arb.ca.gov/lcti-fuel-cell-hybrid-electric-delivery-van-deployment, last accessed August 2022).
[356] California Air Resources Board, *LCTI: Next Generation Fuel Cell Delivery Van Deployment*, 2022 (web link: https://ww2.arb.ca.gov/lcti-next-generation-fuel-cell-delivery-van-deployment, last accessed August 2022).
[357] California Air Resources Board, *LCTI: Port of Los Angeles "Shore to Store" Project*, 2022 (web link: https://ww2.arb.ca.gov/lcti-port-los-angeles-shore-store-project, last accessed August 2022).
[358] California HVIP, *Incentives for Clean Trucks and Bus*, 2022 (web link: https://californiahvip.org, last accessed August 2022).
[359] Hyundai Truck & Bus, *Hyundai Motor Details Plans to Expand into U.S. Market with Hydrogen-powered XCIENT Fuel Cells at ACT Expo*, 2022 (web link: https://trucknbus.hyundai.com/hydrogen/en/pr-center/newsroom/news-20220524?sn=BL00200410, last accessed August 2022).
[360] Volvo Group, *The Volvo Group and Daimler Truck form Joint Venture for Large Production of Fuel Cells*, 2020 (web link: https://www.volvogroup.com/en/news-and-media/news/2020/apr/news-3640568.html, last accessed August 4, 2022).
[361] Trucks.com, *Hino Debuts XL8 Fuel Cell Heavy-Duty Truck Prototype*, 2021 (website: https://www.trucks.com/2021/08/31/hino-xl8-fuel-cell-truck-prototype/, last accessed August 2022)

heavy-duty ZEVs in these segments and are proving functional for fleets that do not have high range or payload needs.

Although NZEVs are expected to have a lower upfront cost per vehicle than full ZEVs, they still require charging infrastructure and would not have as significant operational cost-savings as BEVs or FCEVs. They are not modeled in the analysis as they are expected to play a transitional role in limited use cases as existing BEVs already meet most fleet needs.

Table 33 outlines the technology assumptions for each vehicle group in the cost analysis. The Legal Baseline scenario and proposed ACF regulation scenario use the same technology distribution, but the number of ZEVs and combustion-powered vehicles will differ between the two scenarios.

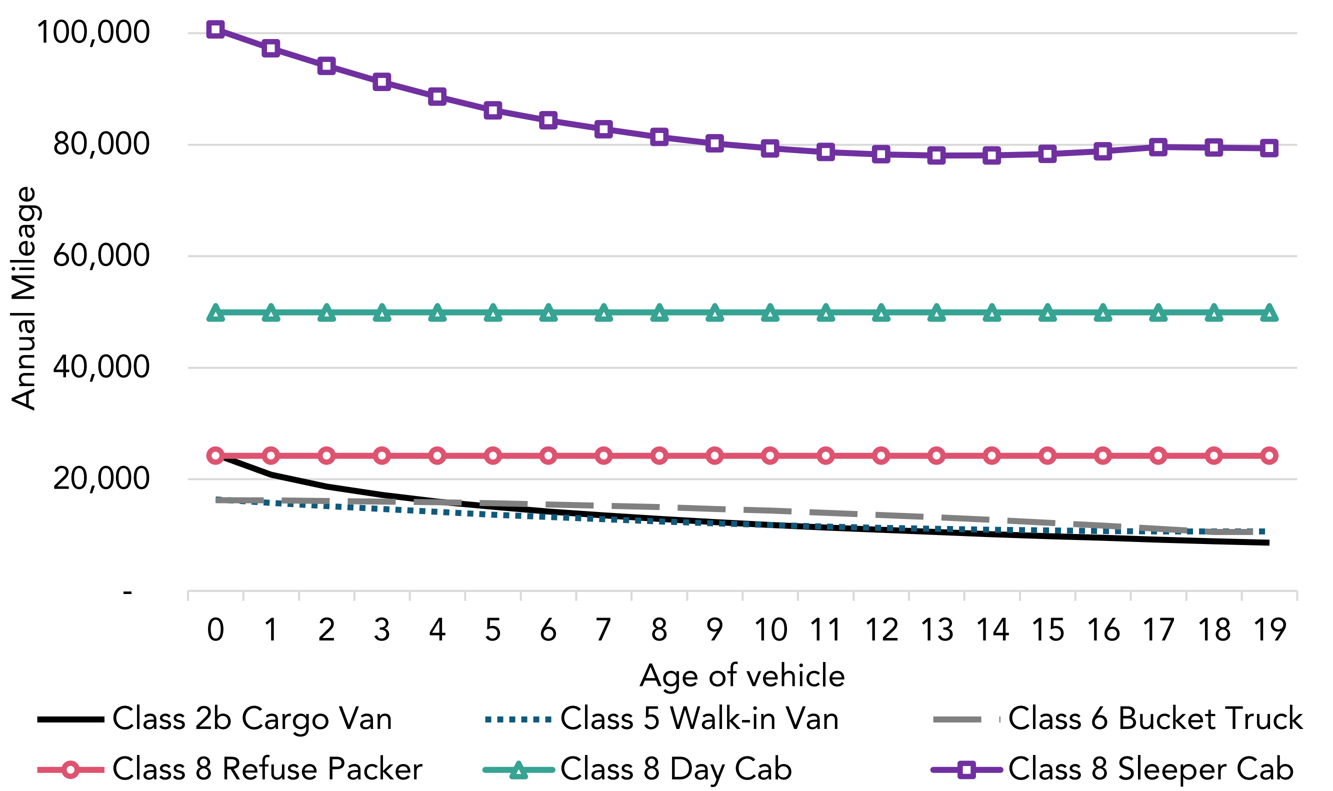
Table 33: Vehicle Groups and Technologies in the Cost Analysis

Vehicle Group	Technology Types
Class 2b-3	Diesel, Gasoline, BEV, FCEV
Class 4-5	Diesel, BEV, FCEV
Class 6-7	Diesel, BEV, FCEV
Class 8	Diesel, BEV, FCEV
SWCV	Diesel, Natural Gas, BEV, FCEV
Class 7-8 Tractor	Diesel, Natural Gas, BEV, FCEV
Buses	Diesel, Gasoline, BEV, FCEV

4. Annual Mileage

Annual mileage factors into a number of costs in this analysis including battery size, fuel costs, maintenance, and LCFS revenue. All annual mileage assumptions are based on EMFAC inventory estimates as representative of a typical vehicle within the category. For most vehicle categories, annual mileage is highest for newer vehicles and drops over time as the vehicle ages. EMFAC data was matched to the different representative vehicles. Figure 62 illustrates the mileage accrual rates for a set of sample vehicles. Mileage accrual assumptions for all representative vehicles are listed in the Vehicle Attribute Appendix within Appendix C.

Figure 62: Sample Annual Mileage Accrual Rates by Vehicle and Age



Staff has modeled an additional PTO operation by the Class 8 specialty vehicles by assuming an effective 50 percent increase in annual mileage as a surrogate for fuel use during stationary operation. A corresponding increase in battery size is modeled and is discuss later.

Staff assumes ZEVs will travel the same distance as their combustion-powered counterparts. As shown in Figure 62, the majority of single-unit trucks such as walk-in vans and refuse trucks travel under 25,000 miles per year which represents 100 miles per day. Most medium- and heavy-duty ZEVs available today can achieve this threshold and future product launches advertise higher range options. For tractors, the majority of in-state tractors travel below 200 miles per day. Manufacturers including Freightliner, Volvo, Tesla, and others have announced ZE tractor launches in 2022-2023 which would be capable of meeting these needs. As technology improves and publicly available infrastructure is built, staff anticipates fleets would be able to manage their fleets and introduce ZEVs where they are suitable to meet their daily needs. This transition to ZEV technology would occur over the course of the next 1 to 2 decades which would provide sufficient time for all vehicle types to transition to ZEV technology and perform the same duty cycle.

5. Upfront Costs

This section describes upfront costs for ICE vehicles and ZEVs. ZEVs are expected to have higher upfront costs due to increased vehicle prices and infrastructure, but these are expected to decline over time. Upfront costs include vehicle costs, infrastructure costs, taxes, and upgrades to maintenance bays.

a) New and Used Vehicle Prices

This section covers the cost to the fleet of purchasing a vehicle. Today and for the foreseeable future, purchases of most BEVs and FCEVs will cost more than their combustion-engine-powered counterparts. However, declining battery and component costs in addition to economies of scale are expected to lower the incremental costs of ZEVs as the market expands.

Base gasoline and diesel new vehicle prices are based on averages of new 2020 MY prices from manufacturers' websites and online truck marketplaces collected in early 2021. [362] New natural gas vehicle prices are derived from sources which estimate the incremental cost of upfitting a gasoline or diesel-powered vehicle to run on natural gas. Table 34 displays sample new vehicle retail prices for a variety of applications and technology types.

Table 34: Sample New Combustion-Powered Vehicle Prices (2021$)

Vehicle Group	Vehicle Price
Class 2b Cargo Van – Gasoline	$35,000
Class 2b Cargo Van – Diesel	$39,000
Class 5 Walk-in Van – Diesel	$87,000
Class 6 Bucket Truck – Diesel	$126,000
Class 8 Refuse Packer – Diesel	$226,000
Class 8 Refuse Packer – Natural Gas	$256,295
Class 8 Day Cab – Diesel	$130,000
Class 8 Day Cab – Natural Gas	$180,000
Class 8 Sleeper Cab – Diesel	$140,000
Class 8 Sleeper Cab – Natural Gas	$230,000

The Federal and California Phase 2 GHG regulations require manufacturers to build trucks that meet specified GHG emissions standards. These requirements start in 2021 MY and ramp up through the 2027 MY. U.S. EPA estimated the per vehicle costs to comply with the federal Phase 2 GHG regulation shown in Table 35.[363] These costs are added to the base cost of combustion-powered vehicles. ZEVs produce zero tailpipe emissions and do not incur increased costs due to the Phase 2 GHG regulation.

Table 35: U.S. EPA Phase 2 Greenhouse Gas Incremental Compliance Costs

Phase 2 Category	2021-2023 MY	2024-2026 MY	2027+ MY
Class 2b-3 Pickup/Van	$524	$963	$1,364
Vocational Vehicles	$1,110	$2,022	$2,662
Tractors	$6,484	$10,101	$12,442

The Heavy-Duty Omnibus rulemaking is a multi-pronged, holistic approach to decrease emissions of new heavy-duty engines sold in California beginning in the 2024 MY. The regulation lowers NOx emissions by lowering tailpipe NOx standards, establishes a new low-

[362] California Air Resources Board, New Vehicle Cost Analysis, 2021.

[363] United States Environmental Protection Agency, *Final Rule for Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles - Phase 2*, 2016 (web link: https://www.govinfo.gov/content/pkg/FR-2016-10-25/pdf/2016-21203.pdf, last accessed August 2022).

load test cycle to ensure emissions reductions are occurring in all modes of operation, strengthens durability testing requirements, lengthens emissions warranty and useful life periods, and establishes more rigorous in-use testing provisions, along with other measures. The costs to a typical fleet purchasing combustion-powered vehicles subject to the Heavy-Duty Omnibus rulemaking based on the certification type and the MY is shown in Table 36Table .[364] These costs are added to the base cost of combustion-powered vehicles, but do not change the cost for ZEVs because they do not have combustion engines and have zero tailpipe emissions. The costs associated with the Heavy-Duty Omnibus regulation are included in the Legal Baseline.

Table 36: Heavy-Duty Omnibus Estimated Increase in Purchase Price

Vehicle Category	Corresponding Weight Class	2024-2026 MY	2027-2030 MY	2031+ MY
Medium-Duty Diesel	Class 3	$1,554	$3,916	$4,354
Medium-Duty Otto	Class 3	$412	$412	$412
Heavy-Duty Otto	Class 4-8	$506	$821	$1,015
Light-Heavy-Duty Diesel	Class 4-5	$1,687	$4,741	$6,041
Medium-Heavy-Duty Diesel	Class 6-7	$2,469	$6,063	$6,923
Heavy-Heavy-Duty Diesel	Class 8/Tractors	$3,761	$7,423	$8,478

The Heavy-Duty Omnibus regulation applies to vehicles sold in California. Staff assumes State and local government fleets purchase all vehicles within California, while out-of-state fleets purchase all vehicles outside of California. Staff assumes a fraction of all other sales occur in California corresponding to the Year 0 values in Table 29. These costs are added to the base cost of combustion-powered vehicles, but do not change the cost for ZEVs because they do not have combustion engines and have zero tailpipe emissions. The costs associated with the Heavy-Duty Omnibus regulation are included in the Legal Baseline.

Staff estimated the cost of medium- and heavy-duty ZEVs for battery-electric and fuel cell powered vehicles by adding electric components costs, fuel cell component costs, energy storage costs, and body costs to a conventional glider vehicle, similar to CARB's approach used in the ACT regulation. Component costs are adjusted to account for the indirect costs associated with production volume and early market complexity. The indirect cost multipliers are derived from the 2019 Argonne National Laboratory Report "Fuel Economy and Cost Estimates for Medium- and Heavy-Duty Vehicles" and are displayed in Table 37 and are applied to the individual component costs. These multipliers are the highest in earliest years when volumes are lowest and new engineering is needed to launch electrified products. Over time, these multipliers decline as economies of scale emerge and ZEV production becomes normalized within the industry. Values for years in between are interpolated.[365] The final retail price of the ZEV is the sum of these individual total component costs. The calculated prices

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[364] California Air Resources Board, *Public Hearing to Consider the Proposed Heavy-Duty Engine and Vehicle Omnibus Regulation and Associated Amendments – Staff Report: Initial Statement of Reasons*, 2020 (web link: https://ww3.arb.ca.gov/regact/2020/hdomnibuslownox/isor.pdf, last accessed August 2022).
[365] Argonne National Laboratory, *Fuel Economy and Cost Estimates for Medium- and Heavy-Duty Vehicles*, 2019 (web link: https://publications.anl.gov/anlpubs/2021/02/165815.pdf, last accessed August 2022).

for BEVs are comparable to battery-electric trucks and vans that are available through the HVIP program today.

Table 37: Indirect Cost Multipliers Applied to Zero-Emission Vehicle Component Costs

Vehicle Category	2020 and Earlier	2025	2030	2035 and Later
Electric machine	1.95	1.55	1.29	1.20
Battery Packs	2.18	1.76	1.48	1.20
Fuel Cell System	2.18	1.76	1.48	1.20
Hydrogen Storage	2.18	1.76	1.48	1.20

Electric component costs including motors and electronic controllers are derived using assumptions from Argonne National Laboratory's 2021 Vehicle Technology Benefit Analysis for medium- and heavy-duty vehicles by averaging the low and high cases.[366] Hydrogen system component costs for the fuel cell stack and hydrogen storage are calculated using data from two Strategic Analysis reports prepared for the Department of Energy which estimated hydrogen fuel cell system costs for medium- and heavy-duty trucks.[367,368]

Generally, heavy-duty vehicles are manufactured in stages. A chassis manufacturer such as Ford or Freightliner installs a powertrain built by themselves or an outside supplier to produce a cab-and-chassis. This is then sent to a body manufacturer to install a body on the vehicle such as a box or bucket truck body. These body costs are modeled separately for ZEVs. The cost of a body can be estimated by measuring the difference between the price of a cab-and-chassis and the finished vehicle with a body. For this analysis, staff assumes bodies requiring PTO such as a bucket truck or refuse truck will cost ten percent extra up until 2030 to account for additional costs of electrifying the PTO. No increased costs are modeled for bodies without PTO.

The cost of battery storage is the largest contributing factor associated with the price of BEVs. Battery pack costs have dropped nearly 90 percent since 2010 and are projected to continue declining. [369] Battery pack costs for medium- and heavy-duty applications are currently higher than for light-duty cars due to smaller volumes and differing packaging requirements even though many use the same cells. For this analysis, staff estimate battery costs using a recent 2021 analysis from the National Academies of Sciences, Engineering, and Medicine and the indirect cost modifiers displayed in Table 37.[370] Figure 63 shows the

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[366] Argonne National Laboratory, *2021 Vehicle Technology Benefit Analysis – Medium- and Heavy-Duty Vehicles - Assumptions*, 2021 (web link: https://anl.app.box.com/s/ml0vlag8merv5xb2jjt5f901cl6rbu38, last accessed August 2022).

[367] Strategic Analysis, *Fuel Cell Systems Analysis*, 2021 (web link: https://www.hydrogen.energy.gov/pdfs/review21/fc163_james_2021_o.pdf, last accessed August 2022).

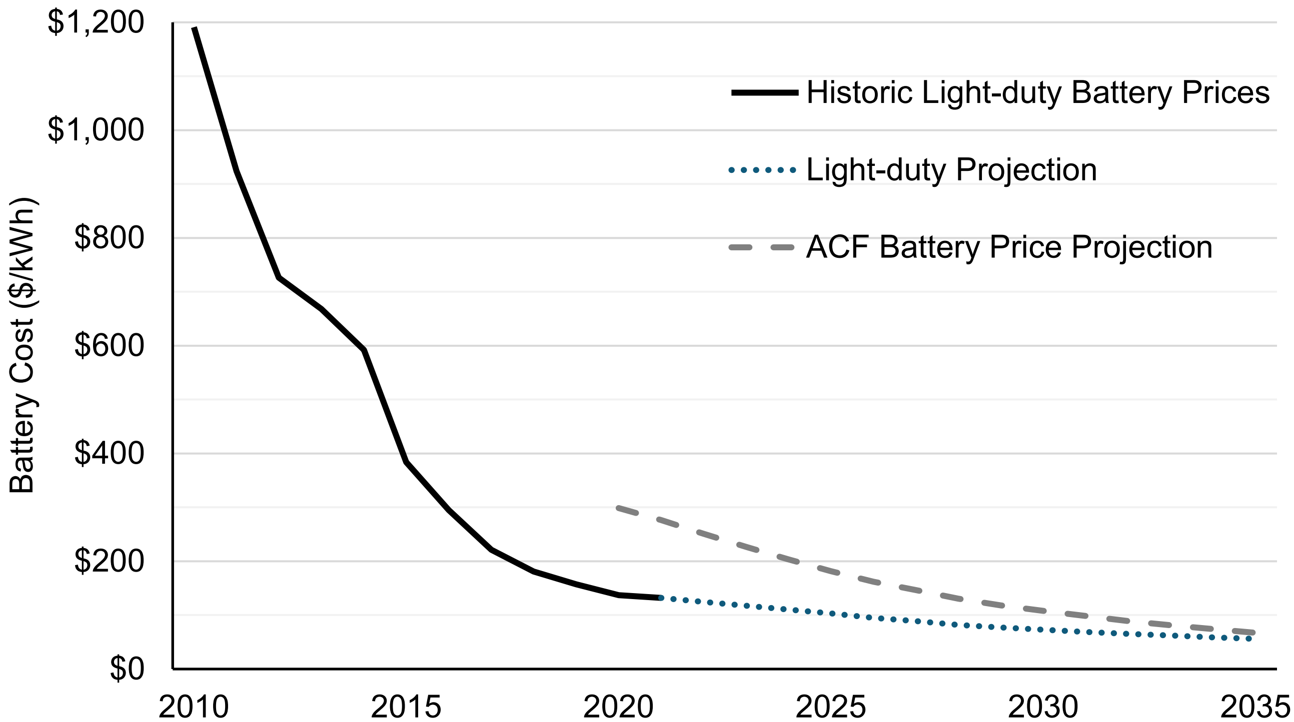
[368] Strategic Analysis, *Hydrogen Storage Cost Analysis*, 2021 (web link: https://www.hydrogen.energy.gov/pdfs/review21/st100_james_2021_o.pdf, last accessed August 2022).

[369] Bloomberg New Energy Finance, *Battery Pack Prices Fall to an Average of $132/kWh, But Rising Commodity Prices Start to Bite*, 2021 (web link: https://about.bnef.com/blog/battery-pack-prices-fall-to-an-average-of-132-kwh-but-rising-commodity-prices-start-to-bite/, last accessed August 2022).

[370] National Academies of Sciences, Engineering, and Medicine, *Assessment of Technologies for Improving Light-Duty Vehicle Fuel Economy 2025-2035*, 2021 (web link: https://www.nap.edu/read/26092/chapter/1, last accessed August 2022).

historic battery price trend and the battery price projections used in this analysis. The projections used in this analysis are shown in bold.

Figure 63: Historic Battery Price Trends and Battery Price Projections



Staff is not forecasting that this proposed ACF regulation would significantly affect commercial battery prices and ZEV technology. The proposed ACF regulation would affect a portion of California's medium- and heavy-duty trucking fleet, which is very small compared to the worldwide market for batteries in consumer electronics, light-duty vehicles, battery-storage, and other applications. To the extent that this rule increases economies of scale for general ZEV components, infrastructure, and battery production, there may be an accelerated reduction in component and vehicle prices as a result of the rule, but these effects are less certain and are not modelled. The proposed ACF regulation, along with the ACT rule and similar efforts outside California, may cause the cost for battery packs and components specifically designed for medium- and heavy-duty ZEVs to decrease as economies of scale start to emerge in this new market.

The costs for BEVs are modelled using motors and electrical components in line with an existing diesel counterpart's power needs. Battery storage is estimated using the vehicle's average daily mileage based on EMFAC data and the energy efficiency of the EV in 2020. For vehicles which EMFAC models as driving below 100 miles per day, staff assumed the battery will have a minimum capability of driving 100 miles daily. Staff then modeled a 35 percent buffer to account for battery degradation and some operational variability. For Class 2b pickups, staff modeled they will require an additional 50 percent larger battery than would otherwise be calculated to account for the towing needs of these vehicles as well as their operational variability. Similarly, staff modeled that the Class 8 specialty vehicle will require a 50 percent larger battery to accommodate expanded PTO operation as discussed previously. Table 38 lists the specifications of sample BEV.

Table 38: Battery Size Calculation

Representative Vehicle	Daily Mileage	2020 Efficiency (kWh/mi)	Battery Size (kWh)
Class 2b Cargo Van	100	0.6	80
Class 5 Walk-in Van	100	1	135
Class 6 Bucket Truck	100	1.5	205
Class 8 Refuse Packer	100	3.0	405
Class 8 Day Cab	160	2.1	455
Class 8 Sleeper Cab	320	2.1	920

The costs for FCEVs are modeled using motors and electrical components in line with an existing diesel vehicle counterpart's power needs. The battery is assumed to be 10 kWh. The fuel cell stack power output is assumed to be one half the vehicle's peak power needs. The amount of hydrogen storage depends on vehicle size, with larger vehicles requiring more storage: 10 kg for Class 2b-3 vehicles, 20 kg for Class 4-7 vehicles, 40 kg for most Class 8 vehicles and 80 kg for Class 8 sleeper cab tractors.

The estimated vehicle prices in 2021 constant dollars for sample vehicles of all fuel types are shown in Table 39. Based on these projections, ZEV costs are expected to be higher than diesel vehicle costs until at least 2030. After that point, some vehicles may see lower cost for ZEVs versus their diesel-powered counterparts as costs for ZEVs continue declining while combustion-powered costs increase over time. All costs for all MYs are available in the Vehicle Cost Attributes Appendix within Appendix C.

Table 39: New Vehicle Price Forecast (2021$)

Vehicle Group	2025 MY	2030MY	2035 MY
Class 2b Cargo Van - Diesel	$40,137	$40,611	$40,611
Class 2b Cargo Van - Gasoline	$36,137	$36,611	$36,611
Class 2b Cargo Van – Battery-Electric	$54,835	$45,167	$40,361
Class 2b Cargo Van – Fuel Cell Electric	$89,469	$63,567	$48,115
Class 5 Walk-in Van – Diesel	$91,075	$94,884	$96,184
Class 5 Walk-in Van – Battery-Electric	$107,074	$94,260	$87,552
Class 5 Walk-in Van – Fuel Cell Electric	$127,842	$106,944	$92,056
Class 6 Bucket Truck – Diesel	$130,857	$135,206	$136,066
Class 6 Bucket Truck – Battery-Electric	$165,527	$145,791	$142,076
Class 6 Bucket Truck – Fuel Cell Electric	$194,304	$161,337	$146,756
Class 8 Refuse Packer – Diesel	$232,149	$236,566	$237,621
Class 8 Refuse Packer – Natural Gas	$259,189	$260,259	$260,453
Class 8 Refuse Packer – Battery-Electric	$293,965	$257,685	$238,496
Class 8 Refuse Packer – Fuel Cell Electric	$319,852	$272,754	$240,265
Class 8 Day Cab – Diesel	$145,689	$152,115	$153,170
Class 8 Day Cab – Natural Gas	$192,434	$195,513	$195,707
Class 8 Day Cab – Battery-Electric	$204,579	$164,611	$143,371
Class 8 Day Cab – Fuel Cell Electric	$221,352	$174,254	$141,765
Class 8 Sleeper Cab – Diesel	$155,689	$162,115	$163,170
Class 8 Sleeper Cab – Natural Gas	$242,434	$245,513	$245,707
Class 8 Sleeper Cab – Battery-Electric	$295,597	$221,901	$181,883

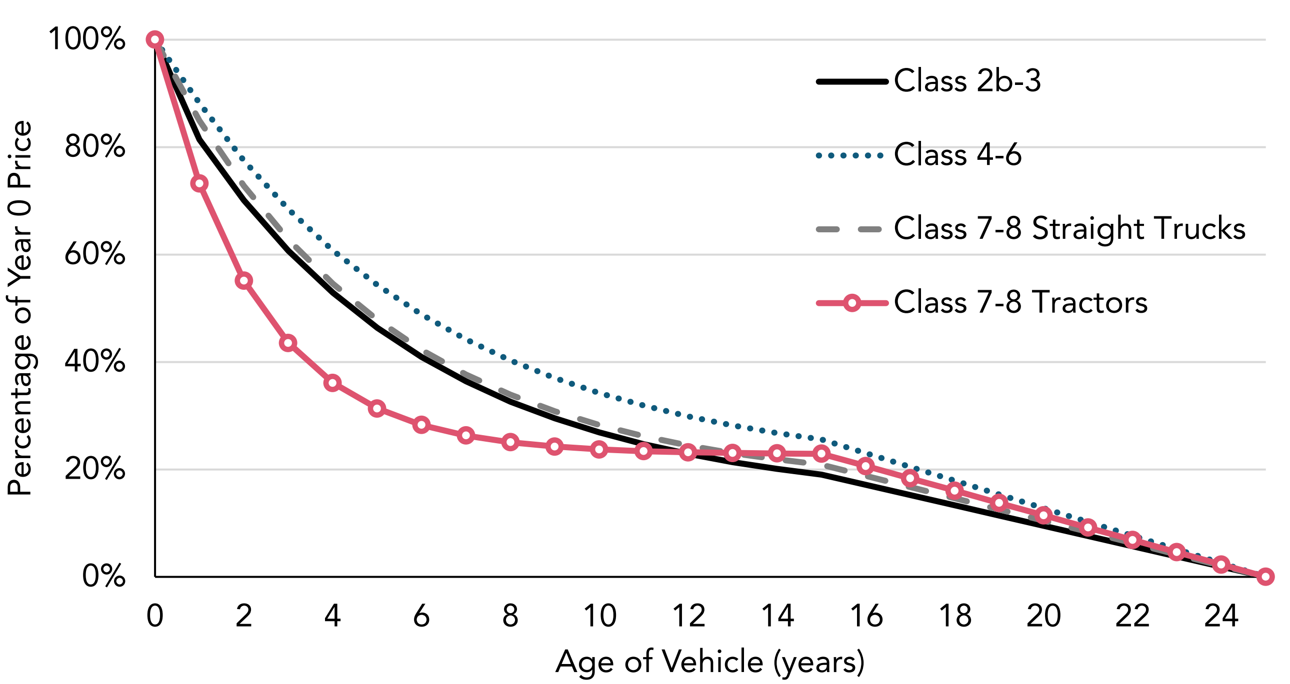
Vehicle Group	2025 MY	2030MY	2035 MY
Class 8 Sleeper Cab – Fuel Cell Electric	$254,774	$203,552	$160,833

Note that this analysis did not include the credits newly available under the recently passed Inflation Reduction Act of 2022. The Inflation Reduction Act provides substantial funding towards medium- and heavy-duty ZEVs with up to $7,500 available for commercial vehicles with a GVWR at or below 14,000 lb. and up to $40,000 for commercial vehicles with a GVWR above 14,000 lbs. These credits will further reduce the costs for ZEVs and will improve the total cost of ownership for ZEVs versus ICE vehicles. In addition, there are no restrictions on using these credits to meet regulatory requirements.

The used vehicle prices for combustion-powered trucks are calculated using major online truck marketplaces such as TruckPaper and Commercial Truck Trader by measuring the price of a given body type over several MYs and weight classes. This analysis provided up to 2,000 data points per MY to calculate the long-term residual values for medium- and heavy-duty vehicles. The trend is calculated by grouping similar trucks, performing a weighted average, then calculating an exponential curve fit for the different groups. The residual value is assumed to linearly decline from its value at 15-years-old to a value of 0 at 25-years-old to reflect that most vehicles are out-of-service or scrapped at that point.

Figure 64 displays the 4 residual value curves calculated for combustion-powered vehicles over a 25-year period. The residual value of ZEVs is assumed to decline at the same rate as combustion-powered trucks.

Figure 64: Residual Values by Vehicle Type and Age



b) Fueling Infrastructure Installation and Maintenance

Infrastructure is necessary to refuel or recharge vehicles. All vehicles need either dedicated refueling infrastructure onsite or publicly available retail stations in order to operate. There are numerous ways infrastructure expenses can be accounted for which would affect the cost to California businesses in different ways. Infrastructure expenses are generally an upfront capital investment needed prior to vehicles being deployed, but infrastructure can last multiple vehicle lifetimes and generally is amortized over its life.

For gasoline, diesel, and natural gas fueled vehicles, staff assumes the fleet is either using existing infrastructure or publicly accessible stations and the infrastructure cost is already incorporated into the fuel cost. As a result, these infrastructure costs are not separately modeled.

For this analysis, staff assumes BEVs would utilize both depot charging and recharging at publicly accessible medium- and heavy-duty retail stations and that it will vary by fleet. Staff estimated the portion of BEVs that would use depot charging versus retail refueling using data from the ACT LER requirement.[371] Vehicles that travel under 200 miles per day and either fuel at base, park at their home base 8 or more hours per day, or return to base daily are assumed to be able to depot charge. Vehicles that do not meet these criteria are assumed to require retail recharging, such as vehicles parked away from company grounds or owned by smaller operators without sufficient access to capital. Non-tractor trucks are assumed to solely depot charge until 2030, as the vast majority of these vehicles have ample opportunity to refuel at a home base during downtime. After 2030 as more vehicles transition to ZE, a portion of the non-tractor fleet is assumed to use retail charging to address more variable operations. Retail refueling assumptions are listed in Table 40. Staff acknowledges there are myriad ways fleets can choose to charge their vehicles and these assumptions are intended to be representative cost scenarios.

Table 40: Percentage of Retail Refueling for Battery-Electric Vehicles by Weight Class and Year

Vehicle Group	2023-2029	2030+
Class 2b-3	0%	15%
Class 4-5 Straight Truck	0%	15%
Class 6-7 Straight Truck	0%	15%
Class 8 Straight Truck	0%	15%
Class 7-8 Day Cab Tractor	25%	25%
Class 7-8 Sleeper Cab Tractor	75%	75%

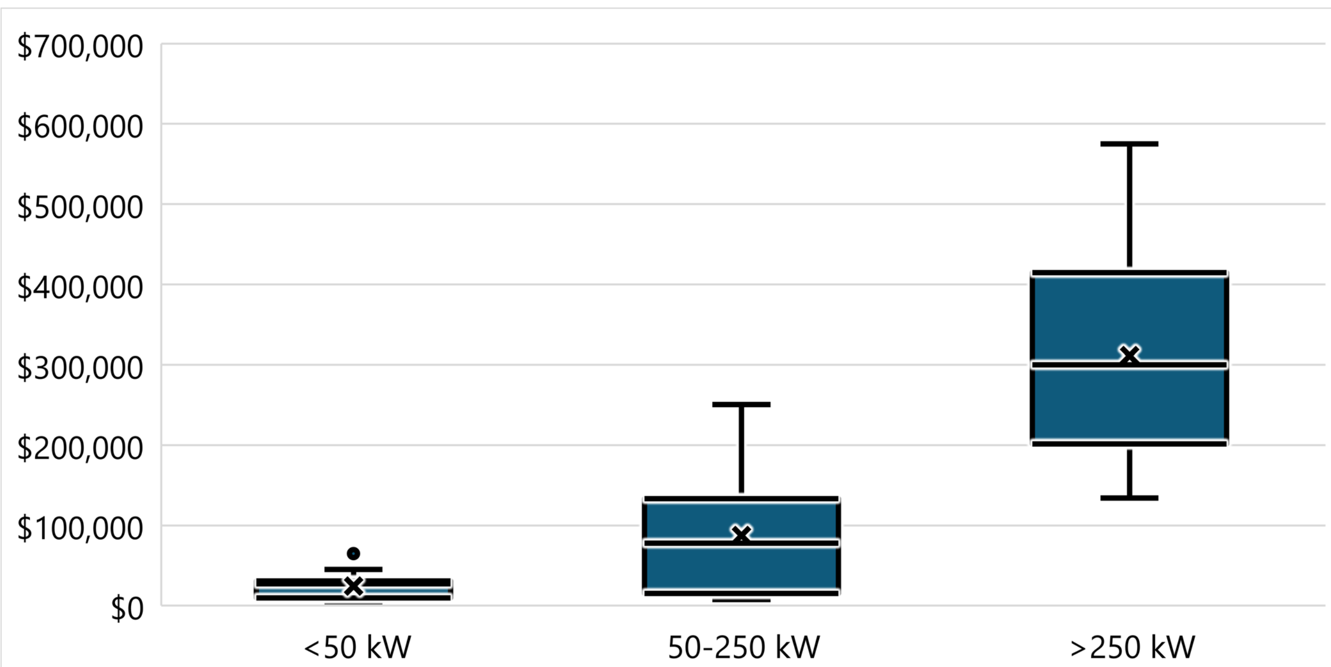
Fleets owning BEVs that do not use retail charging would set up private, behind-the-fence facility-side infrastructure to recharge their vehicles. There are two main cost components of installing charging infrastructure: the cost of the charger itself and the cost of upgrading the site to deliver power to the charger.

[371] Advance Clean Trucks, *Large Entity Reporting Results,* 2021 (web: https://ww2.arb.ca.gov/our-work/programs/advanced-clean-trucks/large-entity-reporting, last accessed August 2022).

Charger costs are derived from the ICCT working paper, "Estimating Electric Vehicle Charging Infrastructure Costs Across Major United States Metropolitan Areas."[372] Generally, smaller trucks can use Level 2 chargers that are similar to the chargers currently used by light-duty vehicles. Class 6 and heavier vehicles are assumed to require higher power direct current chargers. Class 8 vehicles and Class 7-8 tractors are assumed to use a 150 kW charger with 2 ports for each pair of BEVs.

Infrastructure upgrade costs represent costs on the customer side of the meter associated with setting up charging infrastructure at a facility and may include trenching, cabling, conduit, and panels as well as associated infrastructure costs. Staff assumes that nearly all costs associated with utility-side upgrades are the responsibility of the utility as per requirements of AB 841.[373] Soft costs including additional training costs and short-term implementation challenges, such as staff cycling vehicles between chargers, and are captured within subsection "Transitional Costs and Workforce Development". Infrastructure costs are derived from an analysis of BEV deployments conducted by CARB.[374] The data was analyzed to calculate the cost per port and results were broken into 3 groups: below 50 kW, between 50 and 250 kW, and above 250 kW. The results are shown in Figure 65 in a box-and-whisker plot. As depicted, infrastructure costs for fleets can be highly variable based on the layout of the site and the type of upgrades. The average cost is appropriate for a statewide analysis but the infrastructure cost to a given fleet may be higher or lower.

Figure 65: Infrastructure Upgrade Cost per Port and Power



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[372] International Council on Clean Transportation, *Estimating electric vehicle charging infrastructure costs across major U.S. metropolitan areas*, 2019 (web link: https://theicct.org/sites/default/files/publications/ICCT_EV_Charging_Cost_20190813.pdf, last accessed August 2022).

[373] AB 841 (Ting, Stats. 2020, ch. 372).

[374] California Air Resources Board, Infrastructure Cost Analysis, 2021.

Table 41 outlines the assumptions for charger power, charger cost, and infrastructure upgrade costs.

Table 41: Charger Power Ratings and Infrastructure Costs Per Vehicle

Vehicle Group	Charger Power (kW)	Charger Cost ($/vehicle)	Infrastructure Upgrade Cost ($/vehicle)
Class 2b-3	19	$5,000	$25,000
Class 4-5	19	$5,000	$25,000
Class 6-7	50	$25,000	$44,000
Class 8	150 kW for 2 vehicles	$37,500	$44,000
Class 7-8 Tractor	150 kW	$75,000	$88,000

Fleets are assumed to amortize their infrastructure costs over a 20-year period with an interest rate of 5 percent. The number of charger installations and infrastructure upgrades each year is based on the increase in ZEV population per year to avoid double-counting infrastructure costs in situations in later years where a ZEV is replacing another ZEV in the fleet. Fleets may be able to offset significant upgrade costs by participating in utility electrification incentives, however due to uncertain long-term availability and qualification criteria, we do not assume so in our analysis. Hydrogen infrastructure costs are incorporated into the hydrogen fuel costs and are not separately modeled here.

Depot and retail chargers for ZEVs require regular maintenance. The maintenance costs of depot chargers are estimated by considering costs for replacing charger heads, connectors, and other components, as well as labor costs for regular inspections. Charger maintenance costs are estimated at $400/year/charger.[375] Staff assume that the maintenance costs for other fueling infrastructures are reflected in the fuel price.

Backup power generation is not included in this analysis. Although some fleets may want backup generation on site, staff does not assume infrastructure costs for the use of on-site backup generation for a number of reasons. First, ZEVs would gradually enter the fleet over time and only a small portion of the fleet would be ZE. Second, power outages affect all fuel types as fuel pumps cannot work without electricity, so similar issues already exist today. Third, mobile fueling and other solutions are currently being developed and present a solution for fleets seeking additional reliability.[376] Some backup generation options such as onsite power storage, present the opportunity to offset some or all of the costs to store energy during off-peak periods to reduce peak demand charges, or by reselling the electricity onto the grid during peak times using vehicle-to-grid technology. [377]

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[375] Alternative Fuels Data Center, *Charging Infrastructure Operation and Maintenance*, 2021 (web link: https://afdc.energy.gov/fuels/electricity_infrastructure_maintenance_and_operation.html, last accessed August 2022).

[376] GM, *GM Plans to Broaden Electrification, Expanding Fuel Cells Beyond Vehicles*, 2022 (web link: https://media.gm.com/media/us/en/gm/home.detail.html/content/Pages/news/us/en/2022/jan/0119-hydrotec.html, last accessed August 2022).

[377] EDF, *California Heavy-Duty Fleet Electrification Summary Report* , 2021 (web link: http://blogs.edf.org/energyexchange/files/2021/03/EDF-GNA-Final-March-2021.pdf, last accessed August 2022).

c) Sales Tax and Federal Excise Tax

Taxes are additional costs levied on the purchase of a vehicle. Because they are based on the purchase price of the vehicle, they are higher for ZEVs due to their higher upfront costs.

Vehicles purchased in California must pay a sales tax on top of the vehicle's purchase price. The sales tax varies across the state from a minimum of 7.25 percent up to 10.50 percent in some municipalities; a value of 8.6 percent was used for staff's analysis based on a statewide average weighted by economic output.[378] This results in higher costs for fleets and higher revenue for State and local governments. Class 8 vehicles are subject to an additional federal excise tax which adds 12 percent to their purchase price.

d) Maintenance Bay Upgrades

Maintenance bays are facilities used to service vehicles. Services performed include inspections, routine maintenance, preventative maintenance, repairs, overhauls and more. Servicing EVs requires separate safety equipment, diagnostic tools, and equipment which would incur costs to the facility.

Based on transit agency data, upgrading a 15-bus maintenance bay to handle battery-electric buses would cost $25,000, and upgrading to handle fuel cell electric buses would cost $750,000.[379] For this analysis, staff assume the cost per maintenance bay is the same and a 15-bus maintenance bay could accommodate 25 trucks. Per vehicle, this works out to be $1,000 per BEV and $30,000 per FCEV. The amount of maintenance bay upgrades each year is based on the increase in ZEV population per year to avoid double-counting in situations where a ZEV is replaced by a ZEV.

6. Operating and Maintenance Costs

Operating and maintenance costs analyzed include fuel costs, diesel exhaust fluid (DEF) costs, LCFS revenue, maintenance costs, midlife costs, and registration fees.

a) Gasoline, Diesel, Natural Gas, Electricity, and Hydrogen Fuel Costs

This section describes operating costs for ICE vehicles and ZEVs. ZEVs are expected to have lower operating costs due to fuel savings, reduced maintenance cost expenses, and LCFS revenue. Operating costs include fuel costs, diesel exhaust fluid consumption, LCFS revenue, maintenance costs, midlife costs, and registration fees.

Fuel costs are calculated using total fuel consumed per year, and the cost of fuel per unit. The total fuel consumed per year is based on the vehicle population per calendar year, the annual mileage traveled by those vehicles, and the fuel economy/fuel efficiency of the vehicles. In general, ZEVs are two to five times as efficient as similar vehicles with ICE technologies and significantly reduce petroleum and other fossil fuel consumption.

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[378] California Department of Tax and Fee Administration, *California City & County Sales & Use Tax Rates*, 2022 web link: https://cdtfa.ca.gov/taxes-and-fees/sales-use-tax-rates.htm, last accessed August 2022).
[379] Transit Agency Subcommittee-Lifecycle Cost Modelling Subgroup, Report of Findings, 2017.

Fuel economy is measured in miles per gallon for gasoline and diesel fueled vehicles, and miles per diesel gallon equivalent for natural gas fueled vehicles. Gasoline, diesel, and natural gas fuel economy is derived from EMFAC inventory projections for each group. Generally, combustion-powered fuel economy is expected to increase until the 2027 MY and remain relatively constant afterwards. The energy efficiency of BEVs and FCEVs is measured in miles per kWh and miles per kg, respectively.[380]

BEV energy efficiency is derived from in-use data collected from a variety of vehicles.[381,382,383] For fuel cell vehicle efficiency, staff applied the LCFS program's EER of 1.9 to the diesel fuel economy to estimate the fuel cell fuel economy as there is limited information which measures the energy efficiency of medium- and heavy-duty FCEVs.

Staff modeled that for both BEVs and FCEVs, the efficiency will improve at the same rate the Phase 2 GHG regulation would require for combustion-powered vehicles until 2027 MY, then remain constant afterwards. This may be a conservative estimate as both technologies are less developed than ICE powertrains and reports have shown recent improvements in the technology.

Table 42 outlines the fuel economy and energy efficiency assumptions for a sample of vehicle groups and technology types over the course of the regulation. Full assumptions are in the Vehicle Attribute Appendix within Appendix C.

Table 42: Sample Vehicle Fuel Economy and Energy Efficiency

Vehicle Group	2024 MY	2027 MY	2031 MY	Unit
Class 2b Cargo Van – Diesel	19.4	19.4	19.3	mpg
Class 2b Cargo Van – Gasoline	14.1	14.1	14.0	mpg
Class 2b Cargo Van – Battery-Electric	1.9	2.0	2.0	mi./kWh
Class 2b Cargo Van – Fuel Cell Electric	42.5	42.4	42.4	mi./kg
Class 5 Walk-in Van – Diesel	9.4	9.5	9.6	mpg
Class 5 Walk-in Van – Battery-Electric	1.1	1.2	1.2	mi./kWh
Class 5 Walk-in Van – Fuel Cell Electric	16.1	17.0	17.0	mi./kg
Class 6 Bucket Truck – Diesel	8.9	9.0	9.1	mpg
Class 6 Bucket Truck – Battery-Electric	0.8	0.8	0.8	mi./kWh
Class 6 Bucket Truck – Fuel Cell Electric	15.1	15.9	15.9	mi./kg
Class 8 Refuse Packer – Diesel	3.2	3.2	3.3	mpg

[380] Fuel economy, as defined in the Energy Policy and Conservation Act of 1975 (EPCA), does not apply to BEVs. *See* 49 U.S.C. §§ 32901(10 & 11) (defining "fuel" as gasoline, diesel oil, or other "liquid or gaseous fuel" that needs conserving and defining "fuel economy" as the average number of miles traveled by an automobile per gallon of gasoline or its equivalent). Moreover, note that medium- and heavy-duty on-highway vehicles are not ''automobiles'' as defined in 49 U.S.C. § 32901(a)(3) (4-wheeled vehicles rated under 10,000 lb. GVWR, excluding work trucks (vehicles rated between 8,500 to 10,000 lb. GVWR and not medium-duty passenger vehicles as defined in 40 C.F.R. § 86.1803-01).

[381] California Air Resources Board, *Battery-Electric Truck and Bus Efficiency Compared to Diesel Vehicles*, 2018 (web link: https://ww2.arb.ca.gov/sites/default/files/2018-11/180124hdbevefficiency.pdf, last accessed August 2022).

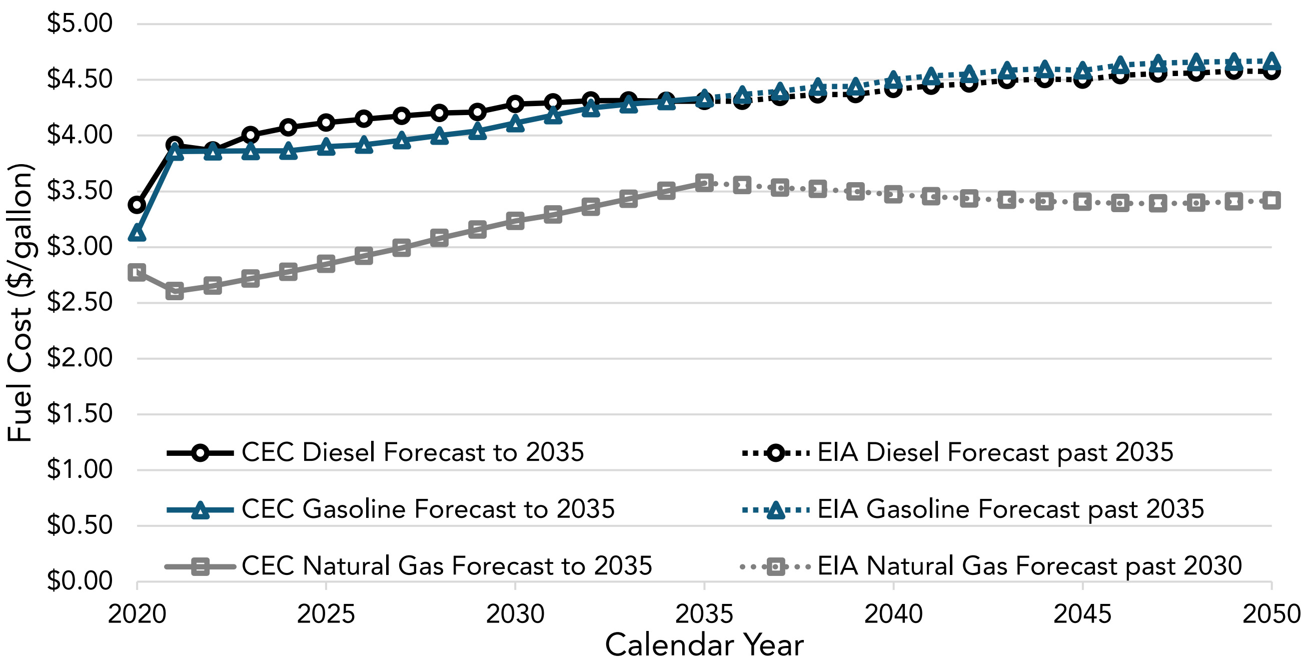
[382] Penn State LTI Bus Research and Testing Center, *Motor Coach Industries D45 CRTeLE*, 2020 (web link: http://apps.altoonabustest.psu.edu/buses/reports/522.pdf?1608733416, last accessed August 2022).

[383] Penn State LTI Bus Research and Testing Center, *GreenPower Motor Company EV Star*, 2020 (web link: http://apps.altoonabustest.psu.edu/buses/reports/515.pdf?1603821665, last accessed August 2022).

Vehicle Group	2024 MY	2027 MY	2031 MY	Unit
Class 8 Refuse Packer – Natural Gas	6.5	6.5	6.6	mpg
Class 8 Refuse Packer – Battery-Electric	0.4	0.4	0.4	mi./kWh
Class 8 Refuse Packer – Fuel Cell Electric	5.2	5.5	5.5	mi./kg
Class 8 Day Cab – Diesel	6.9	7.0	7.0	mpg
Class 8 Day Cab – Natural Gas	6.7	6.8	6.9	mpg
Class 8 Day Cab – Battery-Electric	0.5	0.6	0.6	mi./kWh
Class 8 Day Cab – Fuel Cell Electric	10.9	11.6	11.6	mi./kg
Class 8 Sleeper Cab – Diesel	7.1	7.2	7.2	mpg
Class 8 Sleeper Cab – Natural Gas	6.5	6.5	6.5	mpg
Class 8 Sleeper Cab – Battery-Electric	0.5	0.6	0.6	mi./kWh
Class 8 Sleeper Cab – Fuel Cell Electric	11.0	11.6	11.6	mi./kg

Gasoline and diesel fuel prices to 2035 are taken from the "mid-demand" scenario from CEC "Transportation Energy Demand Forecast."[384] Fuel prices past 2035 are calculated using the Energy Information Administration's (EIA) 2021 Annual Energy Outlook for the Pacific region.[385] The annual percentage change in EIA fuel prices past 2035 is applied to the 2035 CEC gasoline and diesel prices to estimate price changes past 2035. Figure 66 shows the projected prices of gasoline, diesel, and natural gas out to 2050.

Figure 66: Gasoline, Diesel, and Natural Gas Price Forecasts



Electricity costs for BEVs depend on the rate and on how they are charged and include energy costs, fixed fees, and demand fees. Vehicles charged at high power or during peak periods have higher electricity costs than if charging overnight or over an extended period.

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[384] California Energy Commission, *Transportation Energy Demand Forecast*, 2021 (web link: https://efiling.energy.ca.gov/GetDocument.aspx?tn=240934, last accessed August 2022).
[385]-Energy Information Administration, *Annual Energy Outlook 2021*, 2021 (web link: https://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO2021&region=1-9 , last accessed August 2022).

For this analysis, staff assumes the BEVs utilize both depot charging and recharging at publicly accessible medium- and heavy-duty retail stations using the same methodology as discussed previously in "Fueling Infrastructure Installation and Maintenance."

Electricity prices for depot charging are calculated using CARB's Battery-Electric Truck and Bus Charging Calculator and assumes a fleet of 20 vehicles using a managed charging strategy with the applicable rate schedule.[386] Tractors are assumed to be charged in a 4-hour shift at night with midday opportunity charging. All other trucks are assumed to charge overnight. Energy costs, monthly fees, demand rates, charger efficiency losses and local electricity taxes are incorporated into these numbers. The cost per kWh is calculated separately for each utility and a weighted average is used to determine the cost per kWh per vehicle in 2021.

Table 43 shows the depot charging electricity price per kWh for each vehicle group and major utility region as well as the weighted statewide average. In general, electricity costs are lower for larger vehicles because they tend to use more electricity which decreases the fixed costs per kWh and allows the use of lower cost rate schedules for larger utility customers. Note that SCE's newly introduced EV rates, EV-8 and EV-9, have no demand fees from 2019 to 2023 and phase them back over the following five years, with demand fees being fully reintroduced in 2029. However, to simplify the analysis, staff used the full cost of the SCE electricity rate including all demand charges from the beginning of the analysis period rather than discounting the price to reflect the transition period until the demand charges are fully reintroduced.[387]

Table 43: Depot Charging Electricity Cost Calculation for 2021 (2021$/kWh)

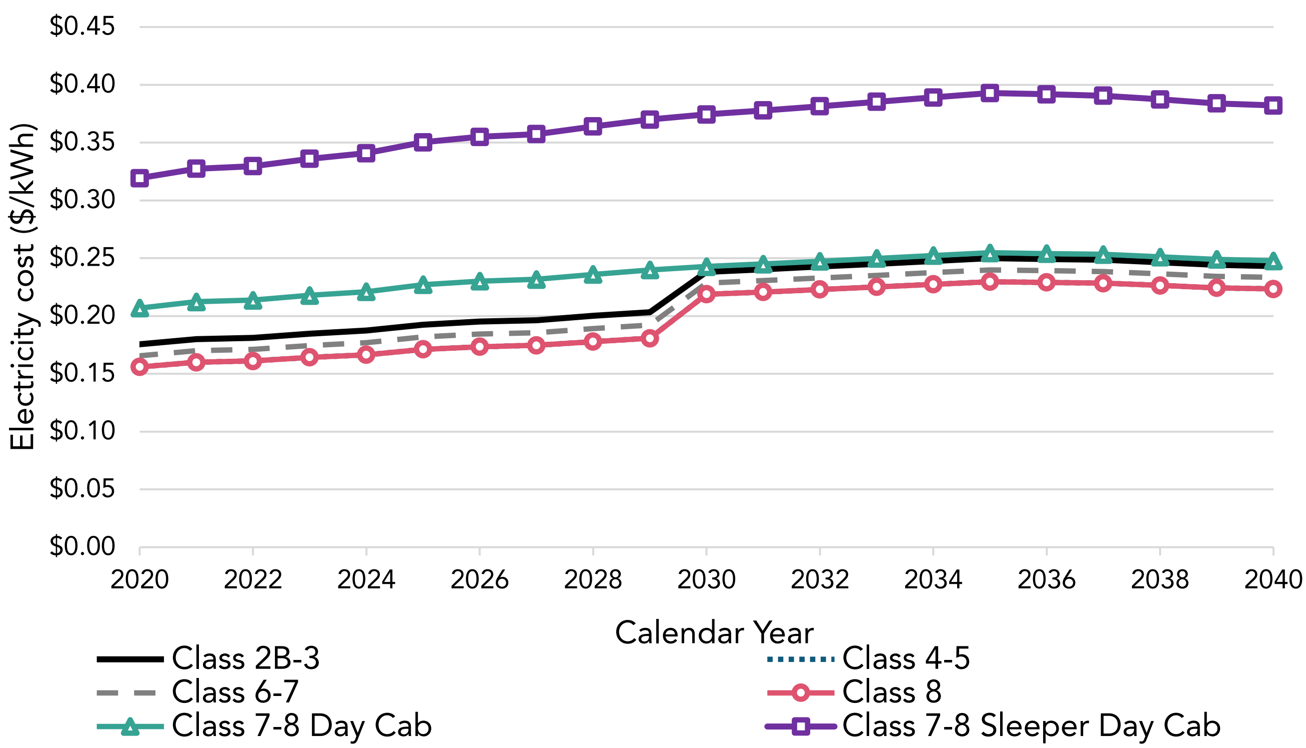
Utility Area	Class 2b-3	Class 4-5	Class 6-7	Class 8	Class 7-8 Tractor
Los Angeles Department of Water and Power	$0.11	$0.11	$0.13	$0.11	$0.17
Pacific Gas and Electric	$0.15	$0.15	$0.16	$0.15	$0.14
Sacramento Municipal Utility District	$0.17	$0.16	$0.16	$0.14	$0.14
San Diego Gas and Electric	$0.21	$0.20	$0.22	$0.20	$0.15
Southern California Edison*	$0.19	$0.15	$0.15	$0.14	$0.15
Weighted Statewide Average	**$0.18**	**$0.16**	**$0.17**	**$0.16**	**$0.16**

For retail charging, staff assumes the price for medium- and heavy-duty retail charging will be similar to current direct current fast charging costs for light-duty vehicles. Staff have used an average of charging costs offered today by Electrify America and EVgo to calculate a rate of $0.36/kWh in 2021.[388] The retail electricity charging prices have been adjusted to account for the higher LCFS credit value for heavy-duty vehicles as compared to light-duty vehicles. This adjustment is discussed further in the "LCFS" Section.

[386] California Air Resources Board, *Battery-Electric Truck and Bus Charging Calculator*, 2021 (web link: https://ww2.arb.ca.gov/resources/documents/battery-electric-truck-and-bus-charging-cost-calculator, last accessed August 2022).
[387] Southern California Edison, Communication via email with Alexander Echele in April 2019.
[388] Electrify America, *Pricing and Plans for EV Charging*, 2021 (web link: https://www.electrifyamerica.com/pricing/, last accessed August 2022).

Electricity rate changes over time are modelled using CEC's "Transportation Energy Demand Forecast."[389] CEC's rate forecast includes current and escalating revenue requirements to support ongoing investments in transmission and distribution infrastructure. Fuel prices past 2035 are calculated using the EIA 2021 Annual Energy Outlook for the Pacific region. [390] The annual percentage change in EIA electricity prices past 2035 is applied to the 2035 CEC electricity to estimate future price changes. Results per vehicle type are shown in Figure 67.

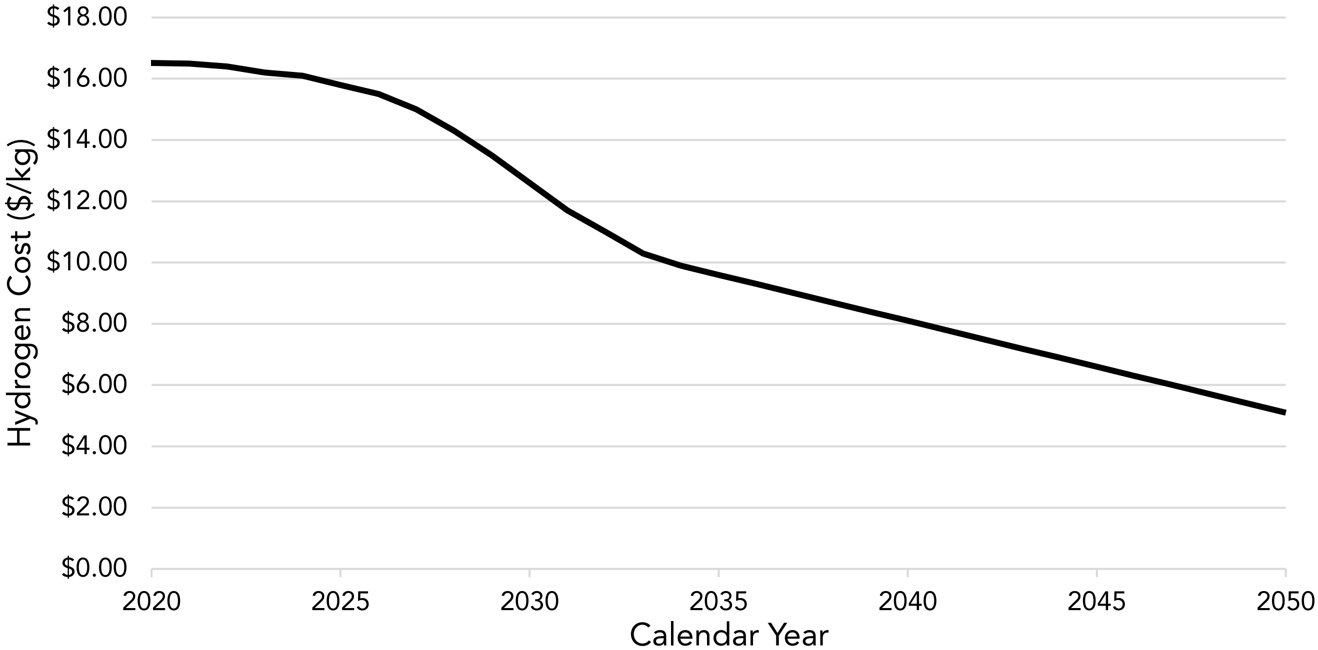
Figure 67: Electricity Price Forecasts



For this analysis, hydrogen stations are assumed to be available at strategic locations around seaports or major distribution hubs where the infrastructure costs are included in the hydrogen fuel price rather than reflecting costs for stations installed in a depot. This model is currently used for light-duty hydrogen stations and medium- and heavy-duty diesel sales and appears most appropriate for medium- and heavy-duty hydrogen fueling. Hydrogen fuel costs are modeled using CEC's "Transportation Energy Demand Forecast."[391] Past 2035, the price of hydrogen continues to decline linearly. Hydrogen costs over time are shown in Figure 68.

[389] California Energy Commission, *Transportation Energy Demand Forecast*, 2021 (web link: https://efiling.energy.ca.gov/GetDocument.aspx?tn=240934, last accessed August 2022).
[390] Energy Information Administration, *Annual Energy Outlook 2021*, 2021 (web link: https://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO2021&region=1-9 , last accessed August 2022).
[391] California Energy Commission, *Transportation Energy Demand Forecast*, 2021 (web link: https://efiling.energy.ca.gov/GetDocument.aspx?tn=240934, last accessed August 2022).

Figure 68: Hydrogen Fuel Price Forecasts



The cost of fuel displayed above includes fuel taxes. State and local taxes on fuel are listed below in Table 44.

Table 44: Local and State Taxes on Fuel

Fuel Type	Local Tax	State Tax
Gasoline	3.70% sales tax	$0.51/gal excise tax*
Diesel	4.5% sales tax	8.6% sales tax + $0.38/gal excise tax
Natural Gas	0	$0.887/gasoline gallon equivalent use tax
Electricity	3.53% utility user tax**	$0.0003/kWh
Hydrogen	0	0

*Local government portion is $0.22/gal and State government portion is $0.29/gal.
**Statewide population-weighted average

Staff acknowledge that both short-term and long-term forecasts for fuel and energy prices can change over time due to unexpected shocks in the economy. For example, The U.S. Energy Information Administration's (EIA) Short-Term Energy Outlook forecasts for Brent crude oil spot prices in 2022 have varied between $70 to $105 per barrel from the December 2021 to March 2022 forecast releases.[392,393] In the 2019, 2020, 2021, and 2022 releases of the U.S. EIA's Annual Energy Outlook, the predicted average annual real growth rate from 2021 through 2050 of transportation diesel fuel price varies from 1.0 percent, 1.5 percent, 1.5 percent, and 0.8 percent.[394] Similar patterns hold for the long-run projections on

[392] U.S Energy Information Administration, *Short-Term Energy Outlook December*, 2021 (web link: https://www.eia.gov/outlooks/steo/archives/Dec21.pdf, last accessed August 2022).
[393] U.S. Energy Information Administration, *Short-Term Energy Outlook March*, 2022 https://www.eia.gov/outlooks/steo/archives/Mar22.pdf, last accessed August 2022).
[394] U.S. Energy Information Administration, *Annual Energy Outlook 2019-2022, Table 3 Energy Prices by Sector and Sources, Pacific Region*, 2022 (web link: https://www.eia.gov/outlooks/aeo/, last accessed August 2022).

transportation gasoline prices and electricity prices, with relatively smaller adjustments for electricity prices. These different forecasts could result in changes in the cost and savings estimates for the proposed ACF regulation and the alternatives. If the realized fuel prices differ from what is forecasted, there will be proportional changes in the fuel costs and cost-savings.

b) Diesel Exhaust Fluid Consumption

Diesel-powered vehicles equipped with modern emissions control devices require diesel exhaust fluid (DEF) to reduce NOx in the exhaust stream. Argonne National Laboratory estimates DEF consumption as being 2 percent of total fuel usage in their online 2020 AFLEET tool.[395] This assumption will be applied to the fuel economy discussed previously to estimate the DEF consumption per mile. DEF is assumed to cost $2.80 per gallon per Argonne.

c) Low Carbon Fuel Standard Revenue

The LCFS regulation creates a market mechanism that incentivizes low carbon fuels, and was amended in 2018 and 2019 to increase the EER for Class 4-8 trucks from 2.7 to 5.0, reduce the carbon intensity target to 20 percent reduction by 2030, and clarify how hydrogen station operators can receive credits. The LCFS regulation now requires the carbon intensity of California's transportation fuels to decrease by 20 percent through the 2030 timeframe and maintains the standard afterwards. Electricity and hydrogen are eligible to earn LCFS credits which can be sold and used to offset the costs of these fuels. Fossil gasoline and diesel are generally not eligible for LCFS credits.

Fleets who own and operate their infrastructure generate credits based on the amount of fuel or energy they dispense. Credit values for different fuel types are calculated using the LCFS Credit Price Calculator.[396] For this analysis, staff is projecting an LCFS credit price of $200 until 2030, then declining linearly to $25 in 2045 and remaining constant thereafter. An electric Class 2b-3 vehicle would earn $0.158/kWh in 2024 using grid electricity while an electric Class 4-8 vehicle would earn roughly $0.262/kWh in 2024 at this credit price. Staff assume hydrogen is produced from 33 percent renewable feedstock as required by SB 1505.[397] This results in Class 4-8 vehicles earning $1.422/kg in 2024 at this credit price. LCFS credit revenue for a given fuel drops slightly over time as the program standards tighten and maintains upward pressure on the credit price.

For retail electricity refueling, staff conservatively assume that most LCFS credit revenue is not passed on to fleets directly, as the credit value is already incorporated into the retail price. As described previously, retail charging station costs are based off of what light-duty retail stations are charging today, which includes revenue they receive from the LCFS program. One key difference between light-duty and heavy-duty BEVs is that heavy-duty

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[395] Argonne National Laboratory, *Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool*, 2020 (web link: https://greet.es.anl.gov/afleet, last accessed August 2022).
[396] California Air Resources Board, *LCFS Credit Price Calculator*, 2021(web link: https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/dashboard/creditvaluecalculator.xlsx, last accessed August 2022).
[397] SB 1505 (Lowenthal, Stats. 2006 ch. 877).

vehicles earn substantially more LCFS credits due to their higher EER value. To reflect this, staff applied this higher EER value to the retail electricity price by calculating the difference between light-duty and heavy-duty LCFS revenue and scaling the revenue by the credit value over time. This adjustment reduces the price of heavy-duty retail charging by $0.12/kWh by 2024 declining to $0.01/kWh by 2045. This adjustment is applied to the retail charging electricity cost.

This analysis reflects that the LCFS value associated with natural gas is already included in the retail price to the fleet owner. Fossil natural gas is expected to be a deficit generator in the LCFS program for the majority of this analysis and will not generate revenue. While RNG does generate LCFS credits, the credits are typically claimed by the fuel producer and used to offset the higher cost of RNG. Therefore, the net cost to the fleet owner using RNG is essentially the same as fossil-based natural gas.

d) Maintenance Costs

Maintenance costs reflect the cost of labor and parts for routine maintenance, preventative maintenance, and repairing broken components, and does not include costs reflected in the next section "Midlife Costs" where engine rebuilds, battery replacements, or fuel cell stack refurbishments are described. Maintenance costs for EVs are generally assumed to be lower than for diesel in part due to their simpler design and fewer moving components.

Maintenance costs for combustion-powered vehicles are based on numerous studies published assessing maintenance costs for vehicles over a representative timeframe. The maintenance cost for the selected representative vehicles was calculated by identifying all sources where the maintenance cost appeared for the representative vehicles and averaging the values. All maintenance cost sources are listed in the Vehicle Attribute Appendix.

BEVs and FCEVs are assumed to have 40 percent lower vehicle maintenance costs compared to gasoline and diesel based on an aggregation of sources and data.[398] While numerous reports assume ZEVs can achieve maintenance costs of 50 percent or greater compared to gasoline or diesel, the lack of long-term data on maintenance costs presents uncertainty for modelling purposes; therefore, the staff analysis uses the more conservative estimate.

Table 45 illustrates the maintenance for a set of sample vehicles. Maintenance cost assumptions for all representative vehicles are listed in the Vehicle Attribute Appendix within Appendix C. All prices have been adjusted to 2021 dollars using a consumer price index.

Table 45: Sample Vehicle Maintenance Costs per Mile

Vehicle Group	Maintenance Cost ($/mi.)
Class 2b Cargo Van – Diesel	$0.337
Class 2b Cargo Van – Gasoline	$0.337
Class 2b Cargo Van – Battery-Electric	$0.202

[398] Argonne National Laboratory, *Comprehensive Total Cost of Ownership Quantification for Vehicles with Different Size Classes and Powertrains*, 2021 (web link: https://www.arb.ca.gov/regact/2018/ict2018/appg.pdfhttps://www.arb.ca.gov/msprog/bus/maintenance_cost.pdf, last accessed August 2022).

Vehicle Group	Maintenance Cost ($/mi.)
Class 2b Cargo Van – Fuel Cell Electric	$0.202
Class 5 Walk-in Van – Diesel	$0.210
Class 5 Walk-in Van – Battery-Electric	$0.126
Class 5 Walk-in Van – Fuel Cell Electric	$0.126
Class 6 Bucket Truck – Diesel	$0.199
Class 6 Bucket Truck – Battery-Electric	$0.119
Class 6 Bucket Truck – Fuel Cell Electric	$0.119
Class 8 Refuse Packer – Diesel	$0.943
Class 8 Refuse Packer – Natural Gas	$0.943
Class 8 Refuse Packer – Battery-Electric	$0.566
Class 8 Refuse Packer – Fuel Cell Electric	$0.566
Class 8 Day Cab – Diesel	$0.198
Class 8 Day Cab – Natural Gas	$0.198
Class 8 Day Cab – Battery-Electric	$0.119
Class 8 Day Cab – Fuel Cell Electric	$0.119
Class 8 Sleeper Cab – Diesel	$0.159
Class 8 Sleeper Cab – Natural Gas	$0.159
Class 8 Sleeper Cab – Battery-Electric	$0.095
Class 8 Sleeper Cab – Fuel Cell Electric	$0.095

e) Midlife Costs

Midlife costs are the cost of rebuilding or replacing major propulsion components due to wear or deterioration. These costs do not include general maintenance on vehicles—these are included in the "Maintenance Costs" Section. The frequency and cost of a midlife rebuild varies across the different technologies. For combustion-powered vehicles, this would be a midlife rebuild, for BEVs this would be a battery replacement, and for a hydrogen FCEV this would be a fuel cell stack refurbishment.

The frequency of a diesel engine rebuild varies based on the vehicle's weight class. Table 46 shows the anticipated diesel engine useful life based on years or miles traveled. The cost of an engine rebuild is estimated to be one quarter of the total price without a body.

Table 46: Useful Life of Diesel Engines

Vehicle/Engine Category	Useful Life (Years/Miles)
Class 4-5 (Light-Heavy-Duty)	15/270,000
Class 6-7 (Medium-Heavy-Duty)	12/350,000
Class 8 (Heavy-Heavy-Duty)	12/800,000

Data is limited for BEVs, but ZEV manufacturers are currently offering vehicles with warranties of 8 or more years and up to 500,000 miles on their products. [399,400,401,402,403] Staff estimates that the battery will be replaced every 500,000 miles and the cost of the replacement is assumed to be the size of the battery in kWh multiplied by the price per kWh at the time of the replacement.

For FCEVs, the consulting firm Ricardo has estimated that a fuel cell stack refurbishment is necessary every seven years and costs one third the cost of a new fuel cell stack at the time of refurbishment. [404]

Fleets generally do not rebuild older vehicles as there is limited return on investment when a vehicle is approaching the end of its life. Staff does not model any rebuilds occurring after the vehicle is 20 years old.

Based on the above assumptions, Table 47 shows when sample vehicles are assumed to incur midlife costs. This approach may overestimate the cost of ZEVs when compared with combustion vehicles. A table of when each representative vehicle is assumed to incur its midlife cost is shown in the Vehicle Attribute Appendix.

Table 47: Frequency of Midlife Rebuilds

Vehicle Group	Midlife Occurrence (year)
Class 2b Cargo Van - Gasoline	N/A
Class 2b Cargo Van - Diesel	N/A
Class 2b Cargo Van – Battery-Electric	N/A
Class 2b Cargo Van – Fuel Cell Electric	7, 14
Class 5 Walk-in Van – Diesel	15
Class 5 Walk-in Van – Battery-Electric	N/A
Class 5 Walk-in Van – Fuel Cell Electric	7, 14
Class 6 Bucket Truck – Diesel	12
Class 6 Bucket Truck – Battery-Electric	N/A
Class 6 Bucket Truck – Fuel Cell Electric	7, 14
Class 8 Refuse Packer – Diesel	12
Class 8 Refuse Packer – Natural Gas	12

[399] Department of Energy, *Batteries: 2020 Annual Progress Report*, 2020 (web link: https://www1.eere.energy.gov/vehiclesandfuels/downloads/VTO_2020_APR_Batteries_compliant_.pdf, last accessed August 2022).
[400] BYD, *The BYD K9*, 2019 (web link: https://en.byd.com/wp-content/uploads/2019/07/4504-byd-transit-cut-sheets_k9-40_lr.pdf, last accessed August 2022).
[401] New Flyer, *Xcelsior Charge*, 2019 (web link: https://www.newflyer.com/site-content/uploads/2019/06/Xcelsior-CHARGE-web.pdf, last accessed August 2022).
[402] Proterra, *Catalyst: 40 Foot Bus – Performance Specifications*, 2019 (web link: https://mk0proterra6iwx7rkkj.kinstacdn.com/wp-content/uploads/2019/06/Proterra-Catalyst-40-ft-Spec-Sheet.pdf, last accessed August 2022).
[403] Steinbuch, *Tesla Model S Degradation Data*, 2015 (web link: https://steinbuch.wordpress.com/2015/01/24/tesla-model-s-battery-degradation-data/, last accessed August 2022).
[404] Ricardo, *Economics of Truck TCO and Hydrogen Refueling Stations*, 2016 (web link: https://cafcp.org/sites/default/files/8_Economics-of-Hydrogen-Refueling-Stations-Ricardo_CaFCP-Bus-Team-meeting-Aug2016.pdf, last accessed August 2022).

Vehicle Group	Midlife Occurrence (year)
Class 8 Refuse Packer – Battery-Electric	N/A
Class 8 Refuse Packer – Fuel Cell Electric	7, 14
Class 8 Day Cab – Diesel	12
Class 8 Day Cab – Natural Gas	12
Class 8 Day Cab – Battery-Electric	10
Class 8 Day Cab – Fuel Cell Electric	7, 14
Class 8 Sleeper Cab – Diesel	8, 19
Class 8 Sleeper Cab – Natural Gas	8, 19
Class 8 Sleeper Cab – Battery-Electric	5, 11, 17
Class 8 Sleeper Cab – Fuel Cell Electric	7, 14

For example, the midlife costs of a 2024 MY day cab tractor would be:

- Diesel, natural gas: midlife overhaul in 2036 at a cost of $32,500;
- Battery-electric: battery replacement in 2034 at a cost of $33,717; and
- Fuel cell electric: Fuel cell stack refurbishments in 2031 and 2038 at a cost of $10,460 in 2031 and $5,544 in 2038.

f) Registration Fees

Vehicles operating and registered in California must pay an annual registration fee. The registration fee varies based on the vehicle's cost, age, and weight. These calculations are different for combustion-powered vehicles and ZEVs.

Combustion-powered vehicles and ZEVs are subject to the following fixed fees based on the DMV online calculator.[405] These are constant annual fees for every vehicle which are shown in Table 48 and Table 49.

Table 48: Fixed Registration Fees for Internal Combustion Engine Vehicles

Diesel Fee Name	Amount
Current Registration	$61
CVRA Registration Fee	$122
CVRA Service Authority for Freeway Emergencies Fee	$3
CVRA Fingerprint ID Fee	$3
CVRA Abandoned Vehicle Fee	$3
CVRA California Highway Patrol Fee	$46
Current Air Quality Management District	$6
Current Cargo Theft Interdiction Program Fee	$3
CVRA Weight Decal Fee	$3
Alt Fuel/Tech Registration Fee	$3
CVRA Auto Theft Deterrence/DUI Fee	$4
Reflectorized License Plate Fee	$1
Total	**$258**

[405] California Department of Motor Vehicles, *California New Vehicle Fees*, 2021 (web link: https://www.dmv.ca.gov/portal/dmv/detail/portal/feecalculatorweb, last accessed August 2022).

Table 49: Fixed Registration Fees for ZEVs

ZEV Fee Name	Amount
Current Registration	$61
Current California Highway Patrol	$28
CVRA Service Authority for Freeway Emergencies Fee	$1
CVRA Fingerprint ID Fee	$1
CVRA Abandoned Vehicle Fee	$1
Current Air Quality Management District	$6
Alt Fuel/Tech Registration Fee	$3
CVRA Auto Theft Deterrence/DUI Fee	$2
Reflectorized License Plate Fee	$1
Road Improvement Fee	$100
Total	**$204**

All vehicles registered in California must pay a Transportation Improvement Fee based on the retail price of the vehicle. As of 2021, the fee is $171 for vehicles priced between $35,000 and $60,000, and $192 for vehicles priced above $60,000.

All registered vehicles are assessed a Vehicle License Fee which is equal to the vehicle price multiplied by 0.65 percent and a separate percentage schedule. This separate percentage schedule is shown in Table 50.

Table 50: Vehicle License Fee Decline over Time

Year	1	2	3	4	5	6	7	8	9	10	11+
Percentage	100%	90%	80%	70%	60%	50%	40%	30%	25%	20%	15%

For commercial ICE vehicles, vehicle owners are assessed an annual weight fee based on the vehicle's potential maximum loaded weight. For EVs, the weight fee is based on its unladen weight. The estimated weight fees are shown in Table 51.

Table 51: Weight Fees for Internal Combustion Engine Vehicles and Zero-Emission Vehicles

Weight Class	Diesel Weight Fee	ZEV Weight Fee
Class 2b-3	$210	$266
Class 4-5	$447	$358
Class 6-7	$546	$358
Class 8	$1,270	$358
Class 7-8 Tractor	$2,064	$358

Overall, ZEV's pay lower registration fees over the vehicle's life although it may be higher in the initial years of registration. This difference is greater for heavier vehicles due to the large difference in annual weight fees.

7. Other Costs

This section describes costs that do not fit under upfront costs or operating costs. These include residual values, depreciation, insurance, transitional costs and workforce development, reporting costs, and battery recycling.

a) Residual Values

The residual value represents the value of the vehicle at the point where the initial purchaser sells the vehicle to another party. This value depends on numerous factors including the type of vehicle, its age, and the vehicle's propulsion technology and becomes more significant when modeling vehicle replacement cycles that are less than 12 years. The residual value for a vehicle is calculated using the same methodology described for used vehicles in the subsection titled "New and Used Vehicle Prices." For combustion-powered vehicles, this is the price of the used vehicle when it is sold out of state. This analysis reflects the net change to the initial purchaser of the vehicle. New vehicle sales in California are expected to increase and as a result more used combustion-powered vehicles are sold out of the state. The residual value represents the increase in sales out of state.

Sales between California fleets are not reflected within this analysis as such sales do not represent a net change to the State—the two fleets are exchanging cash for a vehicle asset which represents no net change.

b) Depreciation

Depreciation represents an asset's loss in value over time. This loss can be claimed as an expense and used to decrease a business's tax burden. Vehicles owned and used by businesses can have their depreciation quantified using values provided by the Internal Revenue Service Publication 946 regarding property depreciation which may be recovered when itemizing deductions from taxes.[406] These deductions are referred to as the Modified Accelerated Cost Recovery System and are considered to be cost-savings.

The cost-savings from depreciation can be calculated by multiplying the vehicle's purchase price by the Modified Accelerated Cost Recovery System depreciation rate and the corporate tax rate. Per the Internal Revenue Service Publication, most trucks follow a 5-year depreciation schedule while tractors follow a 3-year deprecation schedule. ZEVs and combustion-powered vehicles use the same depreciation rates. The amount of deprecation year-over-year is shown in Table 52.

Table 52: Depreciation Rate by Age

Age	0	1	2	3	4	5	6+
Truck	20.00%	32.00%	19.20%	11.52%	11.52%	5.76%	0%
Tractor	33.33%	44.45%	14.81%	7.41%	0%	0%	0%

The vehicle value depreciated per year is multiplied by the corporate tax rate to determine the amount of tax savings per year. The California corporate tax rate is 8.84 percent, and the

[406] Internal Revenue Service, *Publication 946 (2020), How To Depreciate Property*, 2020 (web link: https://www.irs.gov/pub/irs-pdf/p946.pdf, last accessed August 2022).

federal corporate tax rate is 21 percent.[407,408] State and local government fleets are not assumed to claim depreciation as they do not pay State or federal taxes.

c) Insurance

Fleets purchase insurance policies to protect against financial loss and a variety of unexpected events including damaging other property, damage to the vehicle, medical coverage in the event of an accident, and other situations. Because ZEVs are anticipated to cost more than their combustion-powered counterparts, vehicle coverage is anticipated to be more costly as well.

Table 53 shows the estimated cost of various insurance coverage components based on several sources staff identified.[409,410,411]

Table 53: Estimated Annual Semi-Truck Insurance Policy Costs

Types of Insurance Coverage	Policy Cost
Primary Liability	$6,000
General Liability	$550
Umbrella Policy	$600
Physical Damage	$2,000
Bobtail Insurance	$375
Uninsured/Underinsured Motorist	$75
Occupational Accident	$1,900

Physical damage is the only coverage element that depends on the cost of the vehicle being operated. The other coverage types are not dependent on the cost of the vehicle. For example, if truck were to crash into a signpost, the cost of the truck would not affect the cost of paying to replace the signpost.

By dividing the "Physical Damage" by the sleeper cab vehicle cost in Table 34, this portion is found to represent coverage costs 1/70th of the price of a new semi-truck; for the purpose of this analysis, staff assumes the "Physical Damage" insurance cost is proportional to 1/70th the cost of the vehicle when new. Insurance costs for a vehicle decline over time as the value of the vehicle decreases. Staff assumes the insurance costs decline at the same rate as shown in subsection "New and Used Vehicle Prices" on page 181.

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407 Franchise Tax Board, *Business Tax Rates*, 2021 (web link: https://www.ftb.ca.gov/file/business/tax-rates.html, last accessed August 2022).
408 Internal Revenue Service, *Publication 542, Corporation*, 2021 (web link: https://www.irs.gov/publications/p542, last accessed August 2022).
409 Forerunner Insurance Group, *What does Average semi truck insurance costs for owner operators?*, 2018 (web link: https://www.forerunnerinsurance.com/what-does-average-semi-truck-insurance-costs-for-owner-operators/, last accessed August 2022).
410 Commercial Truck Insurance HQ, *Average Semi Truck Insurance Cost*, 2019 (web link: https://www.commercialtruckinsurancehq.com/average-semi-truck-insurance-cost, last accessed August 2022).
411 Strong Tie Insurance, *Why You Need a Commercial Semi Truck Insurance Coverage*, 2021 (web link: https://www.strongtieinsurance.com/semi-truck-insurance/, last accessed August 2022).

d) Transitional Costs and Workforce Development

Transitioning to a new technology has inherent costs associated with its deployment, including shifts in operational and maintenance practices. These recurring costs include operator and technician trainings, purchasing and upgrading of software, securing additional spare parts, and others.

Limited information is available for this type of transitional cost, but discussions regarding this topic occurred during the development of the ICT regulation. Based on discussions with transit agencies, staff assumes that these "other costs" associated with ZEB deployments are equivalent to 2.5 percent of bus prices for all powertrains and should go down over time for ZEBs as they become more common.[412]

In the cost analysis for the proposed ACF regulation, staff make similar assumptions that the workforce training and transitional costs are equal to 2.5 percent of the incremental cost difference between a baseline combustion vehicle and a ZEV, given that the transitions transit agencies will be making are similar to changes made by trucking fleets. These costs continue until 2030 at which point the technology will have developed to a point where these transitional costs become BAU for trucking fleets.

e) Reporting Costs

Fleets subject to the proposed ACF regulation would need to report information annually to demonstrate compliance. Reporting would include company contact information, vehicle registration information, and engine family numbers for tractors approaching the end of their useful life. Staff estimates that to report annually, a fleet of 50 vehicles would need an average of 12.5 hours and would be proportionally longer based on the number of vehicles. Staff anticipates most fleets would already have the information requested available in databases. This time estimate includes collecting information from vehicles, placing the information into a spreadsheet, verifying the information, and reporting it into a CARB database. The hourly staffing cost is assumed to be $24.13 per hour for the employee assigned to pull the information.[413]

Staff does not expect additional reporting costs for manufacturers as a result of the 2040 100 percent medium- and heavy-duty ZEV sales requirement. Manufacturers are already required to report information to CARB under the ACT regulation. This new 100 percent sales for all Class 2b-8 vehicles requirement will not increase the amount of information reported and as a result will not have an incremental cost over the Legal Baseline.

f) Battery Recycling, Repurposing, and Disposal

The energy capacity of the batteries used in ZEVs will naturally degrade over their useful lives and require battery replacements. When battery capacity is not sufficient for meeting daily range needs for a truck or bus, it is expected that there will be a second life for the batteries.

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[412] Transit Agency Subcommittee-Lifecycle Cost Modeling Subgroup, Report of Findings, 2017.
[413] U.S. Bureau of Labor Statistics, *Occupational Outlook Handbook – Diesel Service Technicians and Mechanics*, 2021 (web link: https://www.bls.gov/ooh/installation-maintenance-and-repair/diesel-service-technicians-and-mechanics.htm, last accessed August 2022).

Used batteries can be repurposed into other applications such as stationary storage, then at the end of those battery lives can be recycled and non-recyclable materials can be disposed.

The cost for battery recycling at the end of battery life is not included here, because this cost could be offset by the residual value of the battery. The end of life may be a revenue source depending on whether the battery can be recycled and repurposed or could become a cost if it must be disposed of. Light-duty vehicle batteries are already being repurposed for second life applications including stationary storage.[414,415] Even today, some lithium-ion battery manufacturers provide an attractive residual value to customers upon the retirement of a battery. Therefore, staff believes that the residual value will offset the recycling cost and become a revenue source, but does not include a residual battery value in the economic analysis.

8. Total Costs

The proposed ACF regulation would increase the number of medium- and heavy-duty ZEVs purchased in California relative to the Legal Baseline scenario. This means that all costs would be above and beyond the costs already expected with the ACT regulation. The increased ZEVs sales have higher upfront capital costs initially for the vehicle and infrastructure investments, but lower operating costs over time resulting in net savings for truck transportation in California. When assuming all costs are borne by fleets operating in California the proposed ACF regulation results in a net cost of -$22.2 billion between 2020 and 2050 compared to the Legal Baseline scenario. This represents a substantial net decrease in costs and does not include indirect health cost-savings. In other words, the proposed ACF regulation is projected to result in net cost savings to California. Figure 69 and Table 54 illustrates the incremental difference in costs between the proposed ACF regulation and the Legal Baseline scenario. Note that the incremental cost increases and decreases are mainly due to the number of ZEVs purchased in a given time frame, the actual incremental cost of ZEVs is declining steadily over this timeframe. In Figure 69, the cost components are grouped as shown in Table 54.

Table 54: Summarized Cost Items

Cost Category	Components
Vehicle Cost	Vehicle Cost, Sales Tax, Federal Excise Tax, Residual Values
Fuel Cost	Gasoline, Diesel, Electricity, Hydrogen Fuel Cost, Fuel Taxes
LCFS Revenue	LCFS Revenue
Infrastructure	Charger Costs, Infrastructure Upgrades, Charger Maintenance
Maintenance	Vehicle Maintenance Costs, Maintenance Bay Upgrades
Midlife	Midlife Costs
Other	DEF Consumption, Registration Fees, Depreciation, Insurance, Transitional Costs, Reporting Costs

[414] Nissan Motor Corporation, *Nissan LEAF batteries to light up Japanese town*, 2018 (web link: https://newsroom.nissan-global.com/releases/180322-01-e?lang=en-US&la=1&downloadUrl=%2Freleases%2F180322-01-e%2Fdownload, last accessed August 2022).

[415] BMW Group, BMW Group, *Northvolt and Umicore join forces to develop sustainable life cycle loop for batteries* (web link: https://www.press.bmwgroup.com/global/article/detail/T0285924EN/bmw-group-northvolt-and-umicore-join-forces-to-develop-sustainable-life-cycle-loop-for-batteries, last accessed August 2022).

Figure 69: Total Estimated Direct Costs of Proposed ACF Regulation Relative to the Legal Baseline Scenario (Million 2021$)

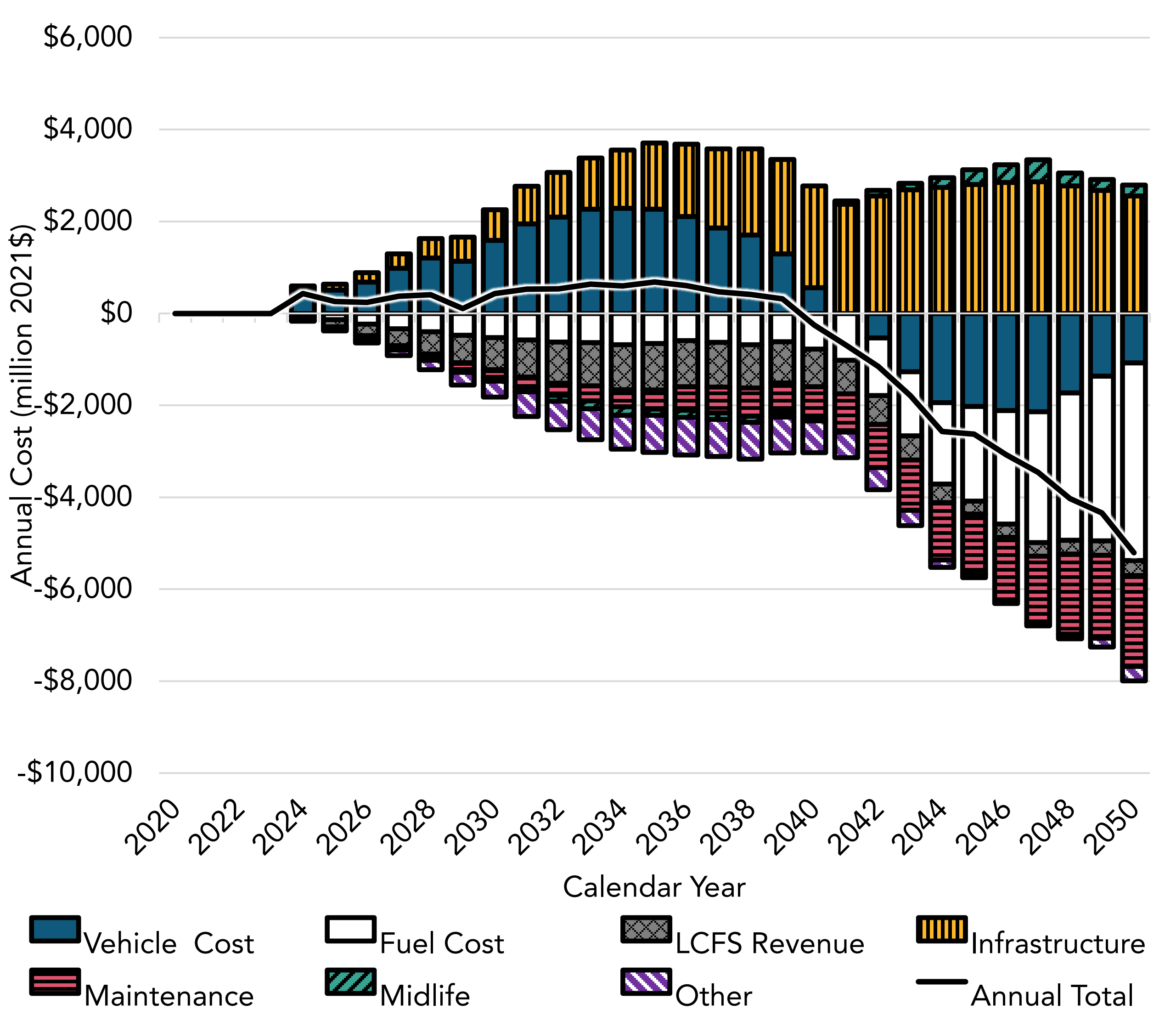

Table 55: Total Incremental Direct Costs of Proposed ACF Regulation Relative to Legal Baseline Scenario (Million 2021$)

Year	Vehicle Price	Sales and Excise Tax	EVSE & Infrastructure Installation	Maintenance Bay Upgrades	Fuel Cost	DEF Consumption	LCFS Revenue	Maintenance Cost	Midlife Costs	Registration Fees	Transitional Costs	Residual Values	Depreciation	Insurance Cost	Reporting Cost	Total Costs	Total Savings	Total*
2024	$374	$128	$68	$18	-$73	-$1	-$83	-$28	-$4	$2	$47	$0	-$33	$12	$3	$652	-$222	**$426**
2025	$447	$73	$124	$12	-$140	-$3	-$152	-$57	-$7	-$3	$31	-$9	-$79	$15	$3	$706	-$450	**$253**
2026	$612	$145	$205	$18	-$236	-$5	-$249	-$94	-$14	-$11	$40	-$79	-$119	$22	$3	$1,045	-$806	**$236**
2027	$939	$264	$311	$82	-$333	-$9	-$368	-$149	-$28	-$23	$62	-$221	-$186	$33	$3	$1,696	-$1,318	**$374**
2028	$1,104	$195	$423	$92	-$401	-$13	-$482	-$193	-$39	-$34	$63	-$94	-$256	$37	$3	$1,917	-$1,512	**$402**
2029	$1,216	$329	$530	$84	-$474	-$18	-$600	-$237	-$57	-$48	$58	-$412	-$315	$49	$3	$2,268	-$2,162	**$103**
2030	$1,620	$402	$665	$135	-$529	-$25	-$695	-$302	-$82	-$64	$76	-$435	-$404	$62	$4	$2,965	-$2,535	**$427**
2031	$2,004	$442	$822	$155	-$581	-$32	-$805	-$368	-$106	-$83	$0	-$497	-$500	$75	$4	$3,501	-$2,973	**$524**
2032	$2,183	$373	$977	$159	-$625	-$38	-$891	-$426	-$128	-$101	$0	-$463	-$566	$81	$4	$3,776	-$3,239	**$533**
2033	$2,367	$273	$1,115	$148	-$640	-$43	-$938	-$472	-$174	-$119	$0	-$371	-$591	$79	$4	$3,986	-$3,349	**$634**
2034	$2,434	$378	$1,266	$181	-$683	-$51	-$975	-$552	-$191	-$146	$0	-$526	-$622	$84	$4	$4,347	-$3,745	**$598**
2035	$2,431	$393	$1,439	$216	-$659	-$60	-$1,010	-$631	-$134	-$175	$0	-$558	-$661	$88	$4	$4,571	-$3,888	**$680**
2036	$2,102	$239	$1,572	$179	-$595	-$67	-$1,002	-$693	-$151	-$201	$0	-$230	-$638	$82	$4	$4,178	-$3,576	**$598**
2037	$1,866	$252	$1,719	$203	-$629	-$75	-$975	-$765	-$142	-$231	$0	-$259	-$578	$77	$4	$4,120	-$3,653	**$463**
2038	$1,733	$247	$1,879	$225	-$683	-$83	-$940	-$838	-$132	-$262	$0	-$277	-$534	$73	$4	$4,162	-$3,749	**$409**
2039	$1,384	$178	$2,052	$244	-$620	-$90	-$892	-$885	-$103	-$285	$0	-$265	-$474	$65	$4	$3,927	-$3,613	**$310**
2040	$539	-$170	$2,215	$294	-$779	-$97	-$815	-$995	-$45	-$310	$0	$191	-$319	$35	$4	$3,279	-$3,530	**-$256**
2041	$40	-$137	$2,375	$305	-$1,019	-$105	-$728	-$1,134	$72	-$341	$0	$93	-$132	$14	$4	$2,903	-$3,597	**-$698**
2042	-$459	-$113	$2,556	$332	-$1,253	-$114	-$633	-$1,268	$120	-$370	$0	$39	$2	-$2	$4	$3,054	-$4,211	**-$1,162**
2043	-$1,308	-$437	$2,693	$227	-$1,398	-$117	-$522	-$1,322	$138	-$380	$0	$476	$189	-$29	$4	$3,728	-$5,514	**-$1,790**
2044	-$1,978	-$373	$2,741	$170	-$1,776	-$120	-$402	-$1,416	$210	-$398	$0	$410	$402	-$47	$4	$3,937	-$6,509	**-$2,576**
2045	-$2,050	-$292	$2,806	$201	-$2,062	-$125	-$280	-$1,508	$318	-$414	$0	$317	$515	-$54	$4	$4,161	-$6,786	**-$2,629**
2046	-$2,123	-$245	$2,850	$208	-$2,473	-$129	-$287	-$1,589	$385	-$427	$0	$254	$561	-$58	$0	$4,258	-$7,333	**-$3,075**
2047	-$2,147	-$191	$2,866	$205	-$2,848	-$134	-$296	-$1,666	$478	-$439	$0	$201	$573	-$58	$0	$4,323	-$7,780	**-$3,457**
2048	-$1,751	-$149	$2,771	$0	-$3,205	-$139	-$305	-$1,738	$285	-$451	$0	$171	$541	-$56	$0	$3,768	-$7,794	**-$4,026**
2049	-$1,404	-$120	$2,679	$0	-$3,583	-$144	-$315	-$1,803	$234	-$461	$0	$158	$468	-$53	$0	$3,539	-$7,882	**-$4,343**
2050	-$1,128	-$92	$2,557	$0	-$4,302	-$155	-$329	-$1,976	$234	-$499	$0	$144	$389	-$49	$0	$3,324	-$8,530	**-$5,206**
Total*	**$11,046**	**$1,992**	**$44,275**	**$4,095**	**-$32,598**	**-$1,993**	**-$15,969**	**-$23,106**	**$937**	**-$6,274**	**$377**	**-$2,240**	**-$3,366**	**$579**	**$83**	**$63,384**	**-$85,547**	**-$22,163**

*Note: Totals may differ due to rounding.

Further detailed information on the costs of the different fleets subject to the proposed ACF regulation versus the Legal Baseline are discussed in more detail in the Additional Cost Information Appendix.

Deploying more medium- and heavy-duty ZEVs due to the proposed ACF regulation would result in a net decrease in costs to the California economy. Fleets would be expected to have higher vehicle costs and infrastructure expenses, but would also save money overall on fuel, LCFS revenue, maintenance savings, increased depreciation benefits, and other factors. Despite these potential savings, some fleets remain reluctant in shifting to ZEV technology.

The issues affecting decision-making regarding ZEVs are being analyzed in numerous reports.[416] Common themes identified include:

- **High vehicle upfront costs.** Today, a ZEV can range from 20 percent higher cost to as much as 2 to 3 times more than a similar conventional vehicle. While these costs are anticipated to decline, the higher upfront cost of ZEVs can place a barrier in vehicle purchasing patterns. These costs are often a more significant barrier to smaller fleets with limited access to capital and higher borrowing costs. A combination of declining costs, incentives, and innovative financing models can defray these upfront investments and reduce the impact of these issues.
- **Inertia of combustion-powered vehicles**. Diesel and gasoline vehicles enjoy an inherent advantage versus newer technologies solely due to their established footprint in the market. Business models, duty cycles, agreements, and other core business practices are based on the established trends of fossil fuel powered vehicles. Fleets would need to spend additional time and resources planning for a transition to ZEV technologies that does not exist when staying with the status quo.
- **Uncertainty and lack of data.** Fleets have a wealth of information available about how their existing vehicles operate based on historical data which has been gathered for decades. Information on medium- and heavy-duty ZEVs such as prices, residual values, battery deterioration, fuel economy, maintenance, and other factors are not as readily available for fleets. This information gap creates challenges in the decision-making process for fleets.
- **One-to-one replacement.** Fleets have voiced concerns that a ZEV would not be able to perform the same work as an existing combustion-powered vehicle on a one-to-one basis due to payload, mileage, or other issues for every duty cycle. However, from the fleet operational data we collected, we see that ZEVs can meet most daily needs on a one-to-one basis today provided the ZEV is placed in applications where it is suitable. The regulation is also phased-in in a manner that recognizes the vehicle types and applications that are already well suited to electrification and that technology will continue to advance. As the technology continues to improve, more applications can transition to ZE without compromise. The proposed ACF regulation schedules are designed to match projected vehicle capabilities and includes provisions to address situations where a ZEV is not available or where a given ZEV cannot meet the fleet owner's duty cycle needs.

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[416] Electrification Coalition, *Electrifying Freight: Pathways to Accelerating the Transition*, 2020 (web link: https://www.electrificationcoalition.org/wp-content/uploads/2020/11/Electrifying-Freight-Pathways-to-Accelerating-the-Transition.pdf, last accessed August 2022).

- **Electricity rate structures.** Typical commercial and industrial rate structures are not always optimized for medium- and heavy-duty electrification. These rates have been traditionally designed for steady electricity usage with high fixed loads, not the intermittent usage associated with ZEV charging. This can result in higher electricity costs for fleets that are charging their vehicles in low-duration, high-power sessions if charger utilization is low. In response to these issues, the state's three largest IOUs, PG&E, SCE, and SDG&E, have all proposed commercial ZEV electricity rates. These new rates address issues that fleets are currently facing and will lower the cost of charging for ZEVs. This makes them a more competitive option versus their combustion counterparts. Further efforts are being made by the public utilities.
- **Stranded assets.** Fleets who have made investments in combustion-powered vehicles and infrastructure installed at their facilities want to ensure they can use their assets for the time period set forth in Health and Safety Code Section 43021(a). Some fleets who have made investments into on-site fueling infrastructure include refuse fleets and public fleets who have installed CNG infrastructure. The proposed ACF regulation allows fleets to keep their vehicles for their full useful life as defined SB 1, which ensures existing vehicles and their supporting infrastructure can be used until the end of that asset's lifetime. [417] To the degree fleets opt to retire or replace vehicles early, they would be doing so because they view that course as the superior economic compliance choice. Similarly, staff does not foresee stranded assets issues for digesters built to comply with SB 1383 since the CNG vehicles and RNG fueling infrastructure can be used throughout their useful lives.[418] Similarly, for BEV charging infrastructure and consistent with other studies, a useful life of 20 years is assumed for CNG fueling infrastructure.[419,420] Additionally, CPUC's SB 1440[421] decision directs RNG towards other sectors; aligning with strategies identified in the 2022 Scoping Plan Update (draft). Finally, future revenue sources such as CPUC's potential "Renewable Gas Standard" could play an important role in providing long-term certainty for the RNG market. Therefore, economic impacts of asset "stranding" are not likely to occur as no assets would be immediately stranded. Similarly, staff does not foresee stranded assets issues for digesters built to comply with SB 1383 since the CNG vehicles and RNG fueling infrastructure can be used throughout its useful life.
- **Infrastructure planning and installation.** Switching from primarily diesel and gasoline to ZE technologies represents a significant shift for fleets. ZEVs require a different refueling strategy to fleets that can be a challenge with insufficient planning. Some issues identified include lead times for construction and interconnection, grid reliability, accommodating site layout and parking considerations, and site load management. However, numerous efforts are underway to address these issues. Under direction of SB 350, CPUC has approved applications from the state's IOUs for

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[417] SB 1 (Beall, Stats. 2017, ch. 5).

[418] SB 1383 (Lara, Stats. 2016, ch. 395).

[419] National Renewable Energy Laboratories. March 2015. Building a Business Case for Compressed Natural Gas in Fleet Applications. (web link: *https://afdc.energy.gov/files/u/publication/business_case_cng_fleets.pdf*, last accessed August 2022).

[420] Clean Fuel Connection. Permitting CNG and LNG Stations Best Practices Guide for Host Sites and Local Permitting Authorities. (web link: *https://www.baaqmd.gov/~/media/files/strategic-incentives/alt-fuels/cng-and-lng-best-practices-9-30-14-final.pdf*, last accessed August 2022).

[421] SB 1440 (Hueso, Stats. 2018 ch. 739).

nearly $700 million over 5 years to support utility investments in medium-duty, heavy-duty, and off-road vehicle electrification.[422] These programs will provide utility experience in delivering power to fleet's locations. CEC's EnergIIZE program launched in early 2022 will provide a streamlined source of funding to commercial fleets and fuel providers for charging and hydrogen fueling infrastructure over the next few years. Private companies have also formed to streamline the process of fleet electrification by offering an all-in-one package to fleets. These programs are not included in the staff cost analysis and would lower the actual cost to fleets.

9. Cost-Effectiveness

Overall, the proposed ACF regulation would result in significant emissions reductions, but the net costs are lower than the Legal Baseline. For this reason, the costs and benefits are compared as a benefit-cost ratio. Costs are all cost elements listed in Table 55 with a positive costs and cost-savings are all cost elements with a negative cost i.e., a savings. Changes to costs due to taxes and fees are removed from benefits as these savings to fleets are a cost to government, resulting in no net benefit. The benefit-cost ratio is the then calculated by taking the ratio of total benefit and total cost. Table 56 shows the estimated benefit-cost ratio for the proposed ACF regulation.

Table 56: Benefit-Cost Ratio of the Proposed ACF Regulation (billion $2021)

Regulation	Total Costs	Cost-Savings (benefit)	Health Benefits	Tax and Fee Revenue	Total Benefit*	Net Benefit**	Benefit-Cost Ratio
Proposed ACF regulation	$63.4	$85.5	$57.8	-$33.0	$110.3	$46.9	1.7

*Total benefit is the sum of cost savings, health benefits, and tax and fee revenue.
**Net benefit is the total benefit minus the total costs.

C. Fiscal Impacts

The proposed ACF regulation would impact State and local government expenditures through the purchase and operation of new vehicles and would impact revenues generated from a variety of State and local taxes and vehicle registration fee revenues that are collected.

These revenues, particularly those from State and local gasoline taxes and registration fees, are used to fund transportation projects across the state including road maintenance, construction of state highways and local streets, transit facilities and operation, and active transportation projects as described in Table 57 below. Thus, increases or decreases would impact funds available for these projects at the state, county, and local levels for use on road and transportation infrastructure improvements. We note that, though outside of this specific analysis, the transition towards ZEVs and its impacts on some of these revenues, are the subject of continued policy development given the importance of the services funded. Thus,

[422] SB 350 (De León, Stats. 2015, ch. 547).

though this analysis does not assume the creation of new specific revenue-raising measures, such measures, such as roadway pricing strategies, are not unlikely. For example, one of the key actions listed in the Climate Action Plan for Transportation Infrastructure is to convene a Roadway Pricing Working Group to create an inventory of various ongoing efforts across the state and outline state and federal statutory and administrative opportunities and barriers to equitable implementation of various roadway pricing applications currently under consideration by local and regional partners — including, but not limited to, cordon pricing, congestion pricing, and other dynamic pricing tools.[423] Additionally, the 2022 Scoping Plan Update lists actions such as permitting implementation of a suite of roadway pricing strategies by 2025 in support of adopted Sustainable Communities Strategies.[424]

Table 57: Transportation Funding Source and Purpose

Revenue Source and Account/Program	Allocation Funding Purpose
Gasoline Excise Tax—State Highway Account	highway projects and transportation maintenance and operational needs
Gasoline Excise Tax—Road Maintenance and Rehabilitation Account	prioritized road maintenance and rehabilitation projects for State and local transportation systems
Gasoline Excise Tax—Highway Users' Tax Account	local streets and roads projects
Diesel Excise Tax—Public Transportation Account	transit and intercity and commuter rail operating programs and projects.
Diesel Excise Tax—Road Maintenance and Rehabilitation Account	prioritized road maintenance and rehabilitation projects for the State and local transportation systems.
Diesel Excise Tax—State Highway Account	highway projects and transportation maintenance and operational needs.
Diesel Excise Tax—Trade Corridors Enhancement Account	trade corridor projects
State Sales Tax (Diesel)—State Transit Assistance	transit purposes as outlined in the Transportation Development Act; local transit operation and capital purposes
State Sales Tax (Diesel)—State Rail Assistance Program	intercity and commuter rail agencies for operation and capital purposes
Zero-Emission Vehicle Registration Fee—Road Maintenance and Rehabilitation Account	basic road maintenance, rehabilitation, critical safety projects and other transportation initiatives, including complete street components for the State and local transportation systems

[423] CAPTI. March 2021. Climate Action Plan for Transportation Infrastructure (web link: *https://calsta.ca.gov/-/media/calsta-media/documents/capti-2021-calsta.pdf*, last accessed August 2022).
[424] California Air Resources Board, *California's 2022 Climate Change Scoping Plan*, Appendix E: Sustainable Communities, 2022 draft (web link: *https://ww2.arb.ca.gov/sites/default/files/2022-05/2022-draft-sp-appendix-e-sustainable-and-equitable-communities_0.pdf*, last accessed August 2022).

Revenue Source and Account/Program	Allocation Funding Purpose
Motor Vehicle Registration Fees—California Highway Patrol and Department of Motor Vehicles	traffic law enforcement and regulations
Local Sales Tax Measures[425]—City/County Road Funds	Maintenance, new construction, engineering/administration, right of way, mass transit, and other
Local Sales Tax Measures—Regional Transportation Planning Agencies/Transit Operators	transit operations, transit planning

1. Fiscal Impacts to Local Government

This section describes the fiscal impact of the proposed ACF regulation to local government agencies. This includes the individual cost elements and the total fiscal impact.

a) Local Government Fleet Cost Passthrough

The local government fleet is estimated to make up roughly 81 percent of California's public fleet based the total public fleet population and information from the Department of General Services.[426] All local government fleets are subject to the proposed ACF regulation with requirements beginning for most fleets in 2024. Fleets located in designated counties would face their first requirements in 2027. A proportionate amount of the total costs outlined in Table 55 would be assumed to pass-through to local governments. Cost passthrough has been split into three categories—upfront costs, operating costs, and operating savings.

b) Utility User Taxes

Many cities and counties in California levy a Utility User Tax on electricity usage. This tax varies from city to city and ranges from no tax to 11 percent. A value of 3.53 percent was used in this analysis representing a population-weighted average.[427] By increasing the amount of electricity used, there would be an increase in the amount of the utility user tax revenue collected by cities and counties.

[425] Counties can adopt a sales tax increase for transportation programs. The passage of a local sales tax measure requires 2/3 of local voter approval, generally lasting 20 to 30 years. Twenty-five counties have implemented sales tax measures for their transportation needs; and 4 transit authorities have approved permanent local tax measures.
[426] Department of General Services, *California State Fleet, 2015-2021*, 2022 (web link: https://data.ca.gov/dataset/1b31c08e-b1a7-4459-8aef-41cfff61fc5e/resource/362ad8ca-1b50-4542-88e5-5973cf729c7f/download/fleet-asset-management-system-open-data-2015-2021.csv, last accessed August 2022).
[427] California State Controller's Office, *User Utility Tax Revenue and Rates*, 2017 (web page: https://sco.ca.gov/Files-ARD-Local/LocRep/2016-17 Cities UUT.pdf, last accessed August 2022).

c) Gasoline and Diesel Fuel Taxes

Fuel taxes on gasoline and diesel fund transportation improvements at the state, county, and local levels. Displacing gasoline and diesel with electricity and hydrogen would decrease the total amount of gasoline and diesel dispensed in the state, resulting in a reduction in fuel tax revenue collected by local governments. Natural gas is not taxed by local governments and therefore is not included in this section. The local tax on fuel is listed in Table 58.

d) Local Sales Taxes

Sales taxes are levied in California to fund a variety of programs at the State and local level. The proposed ACF regulation would require the sale of medium- and heavy-duty ZEVs in California resulting in a direct increase in sales tax revenue collected by local governments in the initial years of the regulation. Overall, local sales tax revenue may increase less than the direct increase from vehicle sales if overall business spending does not increase.

e) Fiscal Impacts on Local Government

Table 58 shows the estimated fiscal cost to local governments due to the proposed ACF regulation relative to the Legal Baseline scenario. The fiscal impact to local government is estimated to be $234 million over the first 3 years of the regulation and $3.6 billion over the regulatory analysis period to 2050. These costs are not reimbursable pursuant to Section 6 of Article XIII B of the California Constitution and Part 7 (commencing with Section 17500) of Division 4 of the Government Code. These costs are not reimbursable because this action neither compels local agencies to provide new governmental functions (i.e., it does not require such agencies to provide additional services to the public), nor imposes requirements that apply only on local agencies or school districts.[428] Instead, this regulatory action establishes requirements that apply to all individuals and entities that own or operate regulated vessels and facilities. This action also does not compel local agencies to increase the actual level or quality of services that they already provide the public.[429] For the foregoing reasons, any costs incurred by local agencies to comply with this regulatory action are not reimbursable.[430]

Table 58: Estimated Fiscal Impacts to Local Government (Million 2021$)

Year	Local Government Fleet Upfront Cost Passthrough	Local Government Fleet Operational Cost Passthrough	Local Government Fleet Operational Saving Passthrough	Utility User Tax Revenue	Local Gasoline and Diesel Fuel Taxes	Local Sales Tax	Total Fiscal Impact*
2024	-$93	-$10	$27	$4	$92	$59	$80
2025	-$95	-$10	$56	$8	$84	$19	$63
2026	-$103	-$11	$83	$14	$73	$34	$91
2027	-$164	-$21	$128	$22	$59	$61	$85

[428] County of Los Angeles v. State of California (1987) 43 Cal.3d 46, 56.
[429] San Diego Unified School Dist. v. Commission on State Mandates (2004) 33 Cal.4th 859, 877.
[430] County of Los Angeles v. State of California, 43 Cal.3d. 46, 58.

Year	Local Government Fleet Upfront Cost Passthrough	Local Government Fleet Operational Cost Passthrough	Local Government Fleet Operational Saving Passthrough	Utility User Tax Revenue	Local Gasoline and Diesel Fuel Taxes	Local Sales Tax	Total Fiscal Impact*
2028	-$165	-$21	$170	$30	$47	$39	$100
2029	-$154	-$21	$206	$41	$30	$84	$186
2030	-$148	-$20	$216	$57	$8	$99	$211
2031	-$150	-$12	$237	$75	-$15	$109	$245
2032	-$148	-$14	$255	$93	-$36	$95	$245
2033	-$146	-$15	$267	$111	-$55	$72	$233
2034	-$145	-$17	$271	$132	-$80	$96	$258
2035	-$143	-$17	$274	$158	-$107	$97	$262
2036	-$146	-$18	$292	$180	-$130	$44	$221
2037	-$149	-$19	$293	$202	-$156	$49	$220
2038	-$152	-$19	$294	$224	-$182	$46	$212
2039	-$155	-$19	$313	$247	-$204	$29	$211
2040	-$158	-$19	$310	$270	-$236	-$65	$103
2041	-$160	-$18	$303	$294	-$272	-$51	$97
2042	-$161	-$18	$299	$320	-$308	-$47	$84
2043	-$163	-$18	$295	$334	-$326	-$116	$5
2044	-$152	-$19	$288	$340	-$344	-$99	$14
2045	-$143	-$19	$280	$353	-$363	-$79	$29
2046	-$136	-$20	$284	$364	-$386	-$65	$40
2047	-$118	-$21	$285	$374	-$408	-$52	$61
2048	-$101	-$21	$289	$384	-$428	-$41	$83
2049	-$88	-$21	$294	$395	-$449	-$33	$98
2050	-$74	-$22	$298	$413	-$488	-$26	$101
Total	**-$3,708**	**-$479**	**$6,607**	**$5,439**	**-$4,577**	**$357**	**$3,638**

*Note: Totals may differ due to rounding.

2. Fiscal Impacts to State Government

This section describes the fiscal impact of the proposed ACF regulation to the State government. This includes the individual cost elements and the total fiscal impact.

a) CARB Staffing and Resources

To implement the proposed ACF regulation, CARB would require permanent staffing resources. CARB estimates 32.5 positions and $2,000,000 in contract funding would be necessary to implement the proposed ACF regulation. CARB requests 1.25 Air Resources Supervisor II (ARS II), 1.25 Office Technicians, 4 Air Resources Supervisor I (ARS I), 3 Air Resources Engineers (ARE), 9 Air Pollution Specialists (APS), 3 Air Resources Technician I (ART I), and 11 Air Resources Technician II (ART II) for a total of 32.5 new positions to carry out duties associated with the implementation of the proposed ACF regulation.

The proposed ACF regulation affects various fleets with differing requirements. It would need subject matter experts to perform tasks as follows totaling 32.5 positions. Resource needs are estimated based on past experience implementing the Truck and Bus regulation from 2010 to present.

- 1.25 ARS II to oversee section managers with staff performing ACF tasks.
- 1.25 Office Technician to provide administrative support for affected branches.
- 4 ARS I to oversee ACF program implementation.
- 1 personnel year (PY) (ART II) for funding coordination, compliance checks, and implementation of the ZEV Partner Program.
- 1 PY (APS) solely dedicated for outreach.
- 1 PY (APS) handling expert compliance assistance calls, emails, letter responses, outreach materials, presentations, training, and website updates.
  - This includes remediation to meet ADA requirements.
- 6 PYs (3 ART I and 3 ART II) to reply to reporting system emails.
  - This includes initial assessment for all extension/exemption requests.
- 4 PYs (2 ARE and 2 APS) for compliance verification, TRUCRS system improvements, maintenance, and testing.
- 1 PY (APS) for compliance tool creation and maintenance, procedure development, form creation and updates, and assigned projects.
- 1 PY (ART II) for enforcement coordination (e.g., citations, audits, registration holds, and enforcement database checks).
- 1 PY (APS) for DMV data analyses to ensure compliance and respond to data requests, including those through Public Records Act.
- 3 PY (1 ARE, 1 APS, and 1 ART II) for processing extension/exemption requests.
- 7 PY (2 APS and 5 ART II) to implement the drayage portion of the ACF regulation.
  - Assist fleet representatives with CARB registration.
  - Verify annual compliance reporting requirements for the legacy fleet.
  - Provide technical assistance, answer calls and emails.
  - Analyze reported data sets.
  - Maintain an updated CARB Online System for drayage trucks.

Table 59 shows the total number of additional positions and estimated cost per position.

Table 59: Estimated CARB Staffing Needs (Million 2021$)

Position	Number of Positions	Initial Budget Year Cost ($/year per person)	Ongoing Cost ($/year per person)
Air Resources Supervisor II	1.25	$280,000	$279,000
Air Resources Supervisor	4	$256,000	$255,000
Air Resources Engineer	3	$220,000	$219,000
Air Pollution Specialist	9	$211,000	$210,000
Air Resources Technician II	11	$105,000	$104,000
Air Resources Technician I	3	$87,000	$86,000
Office Technician	1.25	$97,000	$96,000

In addition to staffing needs, the proposed ACF regulation would require modifying two separate reporting systems to handle reporting for the new regulations to verify and track compliance as the requirements are phased in. Staff is estimating $2,000,000 in FY 2023-2024 to upgrade two existing reporting systems and to convert them to a Salesforce system (cloud) environment. Beginning FY 2024-2025 there would be an ongoing $400,000 for maintenance and ongoing fees to run the two systems. The Truck Regulations Upload and Compliance Reporting System would be updated to reflect the new requirements for fleets subject to the proposed ACF regulation requirements for high priority and federal fleets and for State and local government fleets. The upgraded drayage reporting system would be used for fleets subject to the proposed ACF regulation requirements for drayage truck fleets and regulated ports and railyards.

To the extent there are changes made to the proposed ACF regulation that increase staff resources or if the resources outlined above are not approved, additional revenue sources such as fleet owner reporting fees might be necessary to implement the proposed ACF regulation.

b) State Fleet Cost Pass-Through

The State government fleet is estimated to make up 19 percent of California's public fleet based the total public fleet population and information from the Department of General Services. [431] A proportionate amount of the total costs outlined in Table 60 would be assumed to pass-through the State governments. Cost passthrough has been split into three categories—upfront costs, operating costs, and operating savings.

c) Gasoline, Natural Gas, and Diesel Fuel Taxes

Fuel taxes on gasoline, natural gas, and diesel are used to fund transportation improvements at the state, county, and local levels. Displacing these combustion fuels with electricity and hydrogen would decrease the total amount of gasoline, natural gas, and diesel dispensed in the state. This would result in a reduction in revenue collected by the State for use in multiple levels of government. As noted above, though outside the scope of this analysis, State policy efforts continue to explore replacement revenue sources in light of the need for the ZE transition and the continuing need to fund vital services.

d) Energy Resources Fee

The Energy Resource 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 energy programs and projects deemed appropriate by the Legislature, including but not limited to, activities of CEC.

e) Registration Fees

The State collects registration fees to fund transportation improvements at the state, county, and local levels. The fee structure for ZEVs is different from diesel vehicles with some fees

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[431] Department of General Services, *California State Fleet, 2015-2021*, 2022 (web link: https://data.ca.gov/dataset/1b31c08e-b1a7-4459-8aef-41cfff61fc5e/resource/362ad8ca-1b50-4542-88e5-5973cf729c7f/download/fleet-asset-management-system-open-data-2015-2021.csv, last accessed August 2022).

such as the Vehicle License Fee being higher and others such as weight fees being lower. These differences result in lower registration fees for the ZEVs which would reduce revenue collected by the State for use in transportation services.

f) State Sales Tax

Sales taxes are levied in California to fund a variety of programs at the state and local level. This proposed ACF regulation would require the sale of medium- and heavy-duty ZEVs in California resulting in higher sales tax collected by the State government in the initial years of the regulation.

g) Depreciation

In California, the State collects corporate income tax from businesses based on their net profit for the year at a rate of 8.84 percent. Depreciation can be treated as an expense and would reduce the tax burden for a fleet and decrease tax revenue for the State.

h) Fiscal Impacts on State Government

Table 60 shows the estimated fiscal impacts to the State government due to the proposed ACF regulation relative to Legal Baseline conditions. The fiscal impact to the State government is estimated to be -$357 million over the first 3 years of the regulation and -$33.8 billion over the regulatory analysis period to 2050.

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Table 60: Estimated Fiscal Impacts on State Government (Million 2021$)

Year	CARB Staffing and Resources	State Government Fleet Upfront Cost Passthrough	State Government Fleet Operational Cost Passthrough	State Government Fleet Operational Saving Passthrough	State Fuel Taxes	Energy Resources Fees	Registration Fees	State Sales Taxes	Depreciation	Total Fiscal Impact*
2023	-$5	$0	$0	$0	$0	$0	$0	$0	$0	**-$5**
2024	-$6	-$22	-$2	$6	-$27	$0	$2	$50	-$33	**-$32**
2025	-$6	-$22	-$2	$13	-$47	$0	-$3	$16	-$79	**-$130**
2026	-$6	-$24	-$3	$19	-$76	$0	-$11	$29	-$119	**-$190**
2027	-$6	-$39	-$5	$30	-$123	$1	-$23	$52	-$186	**-$299**
2028	-$6	-$39	-$5	$40	-$164	$1	-$34	$33	-$256	**-$430**
2029	-$6	-$36	-$5	$48	-$226	$1	-$48	$71	-$315	**-$516**
2030	-$6	-$35	-$5	$51	-$308	$1	-$64	$83	-$404	**-$686**
2031	-$6	-$35	-$3	$56	-$393	$1	-$83	$92	-$500	**-$871**
2032	-$6	-$35	-$3	$60	-$471	$2	-$101	$80	-$566	**-$1,040**
2033	-$6	-$34	-$4	$63	-$535	$2	-$119	$61	-$591	**-$1,163**
2034	-$6	-$34	-$4	$64	-$628	$2	-$146	$81	-$622	**-$1,292**
2035	-$6	-$34	-$4	$64	-$732	$3	-$175	$82	-$661	**-$1,462**
2036	-$6	-$34	-$4	$68	-$817	$3	-$201	$37	-$638	**-$1,591**
2037	-$6	-$35	-$4	$69	-$911	$3	-$231	$41	-$578	**-$1,652**
2038	-$6	-$36	-$4	$69	-$1,010	$4	-$262	$39	-$534	**-$1,740**
2039	-$6	-$36	-$4	$73	-$1,095	$4	-$285	$24	-$474	**-$1,798**
2040	-$6	-$37	-$4	$73	-$1,196	$4	-$310	-$55	-$319	**-$1,850**
2041	-$6	-$37	-$4	$71	-$1,309	$5	-$341	-$43	-$132	**-$1,797**
2042	-$6	-$38	-$4	$70	-$1,426	$5	-$370	-$40	$2	**-$1,806**
2043	-$6	-$38	-$4	$69	-$1,472	$5	-$380	-$98	$189	**-$1,735**
2044	-$6	-$36	-$4	$68	-$1,516	$5	-$398	-$84	$402	**-$1,569**
2045	-$6	-$34	-$4	$66	-$1,574	$5	-$414	-$67	$515	**-$1,513**
2046	-$6	-$32	-$4	$67	-$1,642	$6	-$427	-$55	$561	**-$1,534**
2047	-$6	-$28	-$5	$67	-$1,707	$6	-$439	-$44	$573	**-$1,583**
2048	-$6	-$24	-$5	$68	-$1,772	$6	-$451	-$35	$541	**-$1,676**
2049	-$6	-$21	-$5	$69	-$1,838	$6	-$461	-$28	$468	**-$1,815**
2050	-$6	-$17	-$5	$70	-$1,985	$7	-$499	-$22	$389	**-$2,070**
Total*	**-$162**	**-$870**	**-$112**	**$1,550**	**-$25,000**	**$88**	**-$6,274**	**$301**	**-$3,366**	**-$33,845**

*Note: Totals may differ due to rounding.

D. Sensitivity Analyses

This chapter provides additional information on how the total direct costs of the proposed ACF regulation, referred to as the "main scenario", would shift by changing various inputs and assumptions. These sensitivity scenarios are not changes to the cost modelling for the main scenario but are intended to provide additional information to stakeholders. Sensitivity scenarios are presented with an increase or decrease of ten percent unless stated otherwise.

1. Higher Combustion Fuel Costs

This sensitivity analysis models a scenario where fuel costs for combustion fuels including diesel, gasoline, and natural gas are ten percent higher than modeled in the main scenario.

2. Lower Combustion Fuel Costs

This sensitivity analysis models a scenario where fuel costs for combustion fuels including diesel, gasoline, and natural gas are ten percent lower than modeled in the main scenario.

3. $6/gal Combustion Fuel Costs

This sensitivity analysis models a scenario where fuel costs for gasoline and diesel are constantly $6/gal.

4. Higher Zero-Emission Vehicle Fuel Prices

This sensitivity analysis models a scenario where fuel costs for ZE fuels including electricity and hydrogen are ten percent higher than modeled in the main scenario.

5. Lower Zero-Emission Vehicle Fuel Prices

This sensitivity analysis models a scenario where fuel costs for ZE fuels including electricity and hydrogen are ten percent lower than modeled in the main scenario.

6. Higher Zero-Emission Vehicle Prices

This sensitivity analysis models a scenario where vehicle costs for battery-electric and FCEVs are ten percent higher than modeled in the main scenario.

7. Lower Zero-Emission Vehicle Prices

This sensitivity analysis models a scenario where vehicle costs for battery-electric and FCEVs are ten percent lower than modeled in the main scenario.

8. Higher Hydrogen Fuel Cell Electric Vehicle Fraction

This sensitivity analysis models a scenario where FCEVs have ten percent higher penetration than modeled in the main scenario. The increase is reflected in Table 61.

Table 61: Modeled Fuel Cell Electric Vehicle Penetration in Higher Hydrogen Fuel Cell Electric Vehicle Fraction Scenario

Vehicle Group	2024-2026	2027 and beyond
All Class 2b-8 non-tractors	10%	20%
Class 7-8 day cab tractors	20%	35%
Class 7-8 sleeper cab tractors	60%	60%

9. Lower Hydrogen Fuel Cell Electric Vehicle Fraction

This sensitivity analysis models a scenario where FCEVs have ten percent higher penetration than modeled in the main scenario. The decrease is reflected in Table 62.

Table 62: Modeled Fuel Cell Electric Vehicle Penetration in Higher Hydrogen Fuel Cell Electric Vehicle Fraction Scenario

Vehicle Group	2024-2026	2027 and beyond
All Class 2b-8 non-tractors	0%	0%
Class 7-8 day cab tractors	0%	15%
Class 7-8 sleeper cab tractors	40%	40%

10. More Retail Refueling for Battery-Electric Vehicles

This sensitivity analysis models a scenario where retail refueling is utilized by ten percent more BEVs than assumed in the main scenario. The increase is reflected in Table 63.

Table 63: Percentage of Retail Refueling for Battery-Electric Vehicles by Weight Class and Year in More Refueling for Battery-Electric Vehicles Sensitivity Analysis

Vehicle Group	**2023-2029**	**2030+**
Class 2b-3	10%	25%
Class 4-5 Straight Truck	10%	25%
Class 6-7 Straight Truck	10%	25%
Class 8 Straight Truck	10%	25%
Class 7-8 Day Cab Tractor	15%	15%
Class 7-8 Sleeper Cab Tractor	65%	65%

11. Less Retail Refueling for Battery-Electric Vehicles

This sensitivity analysis models a scenario where retail refueling is utilized by ten percent less BEVs than assumed in the main scenario. The decrease is reflected in Table 64.

Table 64: Percentage of Retail Refueling for Battery-Electric Vehicles by Weight Class and Year in Less Refueling for Battery-Electric Vehicles Sensitivity Analysis

Vehicle Group	2023-2029	2030+
Class 2b-3	0%	5%
Class 4-5 Straight Truck	0%	5%
Class 6-7 Straight Truck	0%	5%
Class 8 Straight Truck	0%	5%
Class 7-8 Day Cab Tractor	15%	15%
Class 7-8 Sleeper Cab Tractor	65%	65%

12. Higher Low Carbon Fuel Standard Credit Price

This sensitivity analysis models a scenario where LCFS credit prices remain at a value of $200 until 2030, then decline linearly to $100 in 2045 and remaining constant thereafter.

13. Lower Low Carbon Fuel Standard Credit Price

This sensitivity analysis models a scenario where LCFS credit prices remain at a value of $100 until 2030, then decline linearly to $25 in 2045 and remaining constant thereafter.

14. Summary of Results

Table 65 describes the results of the sensitivity analysis.

Table 65: Direct Costs of Proposed ACF Regulation and Sensitivity Scenarios Relative to Legal Baseline Scenario (Million 2021$)

Year	Main Scenario	High Combustion Fuel Costs	Low Combustion Fuel Costs	$6/gal Combustion Fuel Cost	Higher ZEV Fuel Costs	Lower ZEV Fuel Costs	High ZEV Price	Lower ZEV Price	Higher FCEV Fraction	Lower FCEV Fraction	More BEV Retail Fueling	Less BEV Retail Refueling	Higher LCFS Credit Values	Lower LCFS Credit Values
2024	**$426**	$413	$440	$361	$436	$423	$531	$322	$533	$417	$440	$424	$426	$469
2025	**$253**	$227	$279	$134	$271	$247	$367	$139	$326	$225	$277	$243	$253	$332
2026	**$236**	$190	$281	$36	$267	$224	$386	$86	$315	$178	$276	$214	$236	$367
2027	**$374**	$298	$450	$50	$436	$352	$608	$141	$534	$214	$434	$338	$374	$570
2028	**$402**	$300	$504	-$23	$492	$368	$654	$151	$590	$212	$482	$351	$402	$659
2029	**$103**	-$39	$244	-$483	$233	$45	$363	-$157	$313	-$121	$208	$32	$103	$430
2030	**$427**	$231	$622	-$339	$613	$328	$730	$124	$682	$159	$564	$289	$427	$831
2031	**$524**	$273	$776	-$450	$774	$387	$857	$192	$826	$222	$697	$351	$499	$997
2032	**$533**	$230	$836	-$624	$841	$360	$875	$192	$845	$215	$739	$327	$473	$1,058
2033	**$634**	$289	$979	-$684	$994	$431	$987	$281	$926	$331	$868	$400	$530	$1,186
2034	**$598**	$192	$1,004	-$958	$1,027	$351	$984	$212	$903	$285	$864	$332	$440	$1,174
2035	**$680**	$205	$1,154	-$1,138	$1,193	$376	$1,076	$283	$970	$389	$984	$376	$455	$1,279
2036	**$598**	$69	$1,127	-$1,436	$1,177	$237	$963	$233	$846	$357	$930	$266	$301	$1,193
2037	**$463**	-$129	$1,056	-$1,752	$1,110	$51	$828	$99	$672	$247	$821	$106	$85	$1,039
2038	**$409**	-$250	$1,068	-$2,004	$1,126	-$55	$783	$35	$595	$221	$791	$27	-$61	$957
2039	**$310**	-$405	$1,024	-$2,306	$1,096	-$208	$678	-$58	$444	$173	$715	-$95	-$262	$819
2040	**-$256**	-$1,045	$533	-$3,034	$588	-$834	$73	-$585	-$143	-$377	$169	-$681	-$930	$193
2041	**-$698**	-$1,569	$174	-$3,692	$203	-$1,335	-$332	-$1,063	-$650	-$750	-$254	-$1,141	-$1,480	-$318
2042	**-$1,162**	-$2,116	-$207	-$4,391	-$202	-$1,861	-$774	-$1,549	-$1,183	-$1,144	-$700	-$1,624	-$2,063	-$861
2043	**-$1,790**	-$2,782	-$797	-$5,056	-$809	-$2,514	-$1,453	-$2,127	-$1,894	-$1,689	-$1,325	-$2,255	-$2,795	-$1,584
2044	**-$2,576**	-$3,603	-$1,549	-$5,928	-$1,600	-$3,299	-$2,238	-$2,913	-$2,754	-$2,395	-$2,119	-$3,033	-$3,671	-$2,471
2045	**-$2,629**	-$3,698	-$1,561	-$6,135	-$1,642	-$3,367	-$2,269	-$2,989	-$2,893	-$2,357	-$2,173	-$3,085	-$3,830	-$2,629
2046	**-$3,075**	-$4,196	-$1,953	-$6,626	-$2,078	-$3,826	-$2,712	-$3,437	-$3,399	-$2,748	-$2,606	-$3,543	-$4,309	-$3,075
2047	**-$3,457**	-$4,627	-$2,287	-$7,114	-$2,450	-$4,220	-$3,087	-$3,826	-$3,837	-$3,078	-$2,975	-$3,939	-$4,729	-$3,457
2048	**-$4,026**	-$5,243	-$2,809	-$7,808	-$3,008	-$4,801	-$3,609	-$4,442	-$4,501	-$3,551	-$3,530	-$4,522	-$5,341	-$4,026
2049	**-$4,343**	-$5,609	-$3,077	-$8,219	-$3,314	-$5,129	-$3,887	-$4,797	-$4,838	-$3,849	-$3,832	-$4,853	-$5,702	-$4,343
2050	**-$5,206**	-$6,572	-$3,840	-$9,400	-$4,148	-$6,019	-$4,720	-$5,692	-$5,746	-$4,665	-$4,673	-$5,739	-$6,631	-$5,206
Total*	**-$22,163**	-$38,879	-$5,445	-$78,935	-$6,292	-$33,206	-$13,257	-$31,063	-$21,438	-$22,793	-$13,846	-$30,350	-$36,719	-$14,333

*Note: Totals may differ due to rounding.

E. Fleet Examples

The following are a set of examples to illustrate the potential costs of the proposed ACF regulation to a fleet. The fleets in these examples do not purchase any ZEVs in the baseline to illustrate the maximum potential costs.

1. Delivery Fleet

Table 66 illustrates an example delivery fleet that owns 100 Class 5 walk-in vans and 100 Class 8 day cab tractors. This example can represent a fleet who moves goods to and from warehouses along freight corridors and to local distribution hubs. The costs from 2020-2050 are shown for a fleet in the Legal Baseline that only owns diesel vehicles purchased new in California, and under the proposed ACF regulation scenario where the fleet would transition all their vehicles from diesel to battery-electric. In the baseline, the fleet operates its vehicles 10 years before replacing them and as a result buys 10 box trucks and 10 day cabs tractors per year. Under the proposed ACF regulation, the fleet would meet the ZEV milestones targets set under the high priority fleet requirements and add ZEVs to the fleet. In the early years of the proposed ACF regulation, the fleet can comply by ensuring a portion of its new purchases are ZEVs, but as the fleet approaches its 100 percent requirements it will need to accelerate replacement to ensure all diesel-powered vehicles leave the fleet and are replaced by ZEVs. This scenario assumes the fleet meets the minimum compliance requirements and assumes the fleet does not purchase any ZEVs early to avoid accelerated replacement. All other mileage and cost assumptions are the same as described previously in this section.

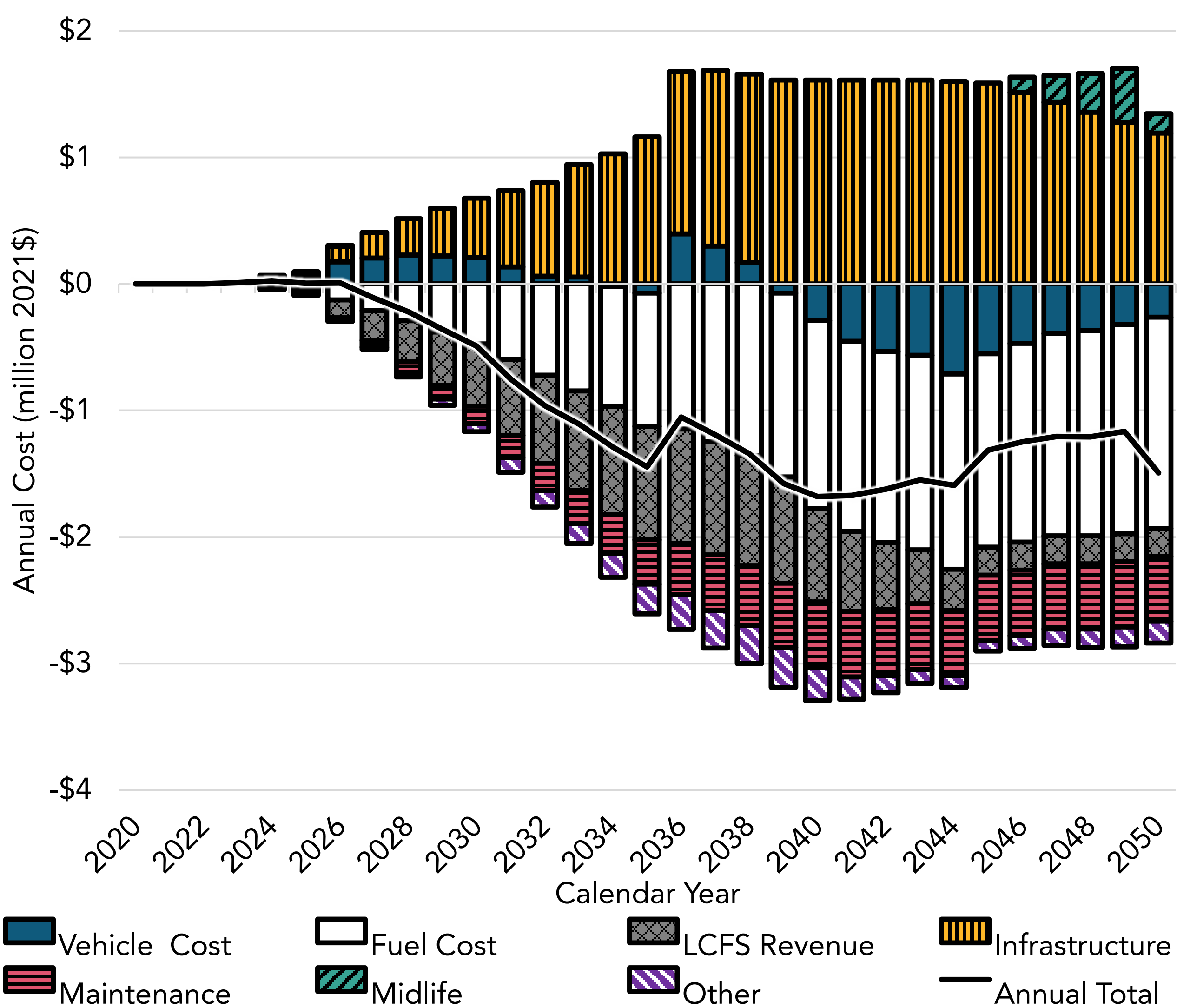
The costs over the analysis period are lower for the battery-electric fleet as compared to the diesel fleet (even with infrastructure costs included); however, the upfront capital expenses are higher initially but become lower after about 2035. Access to capital or financing will be critical for fleets to take advantage of the overall savings of medium- and heavy-duty ZEVs. Table 66 and Figure 70 shows the estimated costs for examples of a typical business.

Table 66. Typical Business Cumulative Cost Example 2024 to 2050 (2021$)

Cost Line Items	Legal Baseline 2030	Proposed ACF Regulation 2030	Legal Baseline 2040	Proposed ACF Regulation 2040	Legal Baseline 2050	Proposed ACF Regulation 2050	Difference 2050
Vehicle Price	$14,685,731	$15,642,581	$45,035,881	$47,818,215	$75,443,467	$73,298,665	-$2,144,802
Sales and Excise Tax	$2,698,173	$2,865,414	$6,655,722	$6,938,354	$10,613,271	$10,277,552	-$335,719
EVSE & Infrastructure Costs	$0	$1,521,346	$0	$13,334,088	$0	$28,131,027	$28,131,027
Maintenance Bay Upgrades	$0	$48,274	$0	$219,195	$0	$230,975	$230,975
Fuel Cost	$31,129,984	$29,577,440	$68,629,847	$56,212,495	$107,407,314	$79,251,569	-$28,155,744
DEF Consumption	$420,289	$376,413	$904,788	$509,296	$1,384,947	$509,296	-$875,651
LCFS Revenue	$0	-$1,667,673	$0	-$9,745,633	$0	-$12,987,057	-$12,987,057
Maintenance Cost	$10,338,830	$9,849,816	$23,200,191	$18,928,186	$36,061,552	$26,624,399	-$9,437,153

Cost Line Items	Legal Baseline 2030	Proposed ACF Regulation 2030	Legal Baseline 2040	Proposed ACF Regulation 2040	Legal Baseline 2050	Proposed ACF Regulation 2050	Difference 2050
Midlife Costs	$1,040,667	$1,040,667	$1,040,667	$1,040,667	$1,040,667	$2,263,707	$1,223,040
Registration Fees	$3,476,624	$3,345,371	$7,797,402	$6,338,450	$12,124,155	$8,639,178	-$3,484,977
Transitional Costs	$0	$214,835	$0	$214,835	$0	$214,835	$214,835
Residual Values	-$5,317,209	-$5,317,209	-$11,920,089	-$13,200,401	-$18,847,839	-$19,214,791	-$366,952
Depreciation	-$3,517,882	-$3,748,519	-$12,059,103	-$12,928,904	-$20,648,988	-$20,114,349	$534,639
Insurance Cost	$1,420,767	$1,463,448	$3,227,538	$3,296,439	$5,048,820	$4,898,627	-$150,193
Reporting Cost	$0	$9,652	$0	$21,717	$0	$33,782	$33,782
Total	**$56,375,973**	**$55,221,857**	**$132,512,843**	**$118,996,999**	**$209,627,367**	**$182,057,416**	**-$27,569,951**

Figure 70: Estimated Costs of Proposed ACF Regulation to the Example Typical Business (Million 2021$)



2. Drayage Owner-Operator

This example is a drayage truck owner-operator subject to the drayage truck requirements. Drayage truck owners generally own one to three tractors and represent approximately 25 percent of drayage businesses. This percentage is based on vehicle identification numbers for tractors registered at the San Pedro Bay and Oakland seaports compared to California's DMV address registration data.

In the Legal Baseline scenario, the operator purchases a 2014 MY diesel day cab tractor in 2022 and operates it for 12 years. Following that, the operator would continue the pattern of purchasing an 8-year-old diesel day cab tractor and operating it for 12 years. In this example, the drayage operator purchases 8-year-old used tractors in 2034 and 2046.

Under this proposed ACF regulation example, the operator owns a 2014 MY diesel day cab tractor purchased in 2022. The drayage operator would likely turn over their diesel tractor at the end of 2029 when the tractor is 15-years-old (average age or MY of tractors reaching 800,000 miles) and has exceeded the useful life and would replace it with a new 2030 MY battery-electric tractor which they would operate for 20 years.

Most assumptions are the same as previously described in this document; however, some modifications were made for this example to better illustrate the costs the small business would face:

- The drayage operator is assumed to finance their vehicles for 5 years at an interest rate of 15 percent;
- The drayage operator would not install infrastructure themselves and instead would rely solely on retail charging; and
- No transitional costs associated with maintenance or infrastructure planning are assumed as these are costs are associated with organizational shifts within a large business.

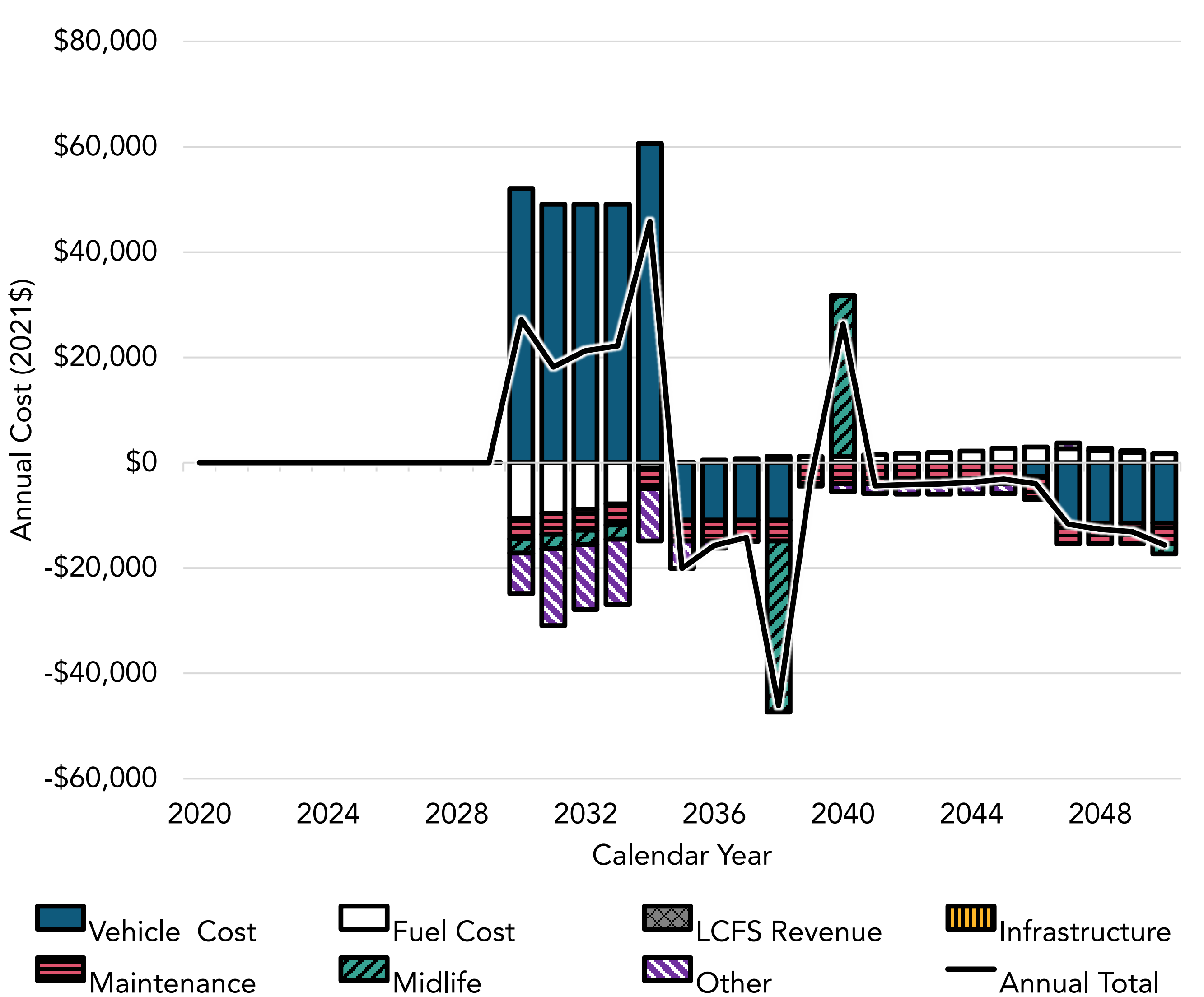
Table 67 and Figure 71 illustrate the costs for the example small business. The small business would see a net savings by 2040 and thereafter but would need to make significant upfront capital expenses in 2030 to purchase a new battery-electric tractor rather than buying another used diesel tractor. Incentives, financing assistance, and other programs offered will be helpful to support smaller operators with upfront capital expenses.

Table 67. Small Business Cumulative Cost Example 2024 to 2050

Cost Line Items	Legal Baseline 2030	Proposed ACF Regulation 2030	Legal Baseline 2040	Proposed ACF Regulation 2040	Legal Baseline 2050	Proposed ACF Regulation 2050	Difference 2050
Vehicle Price	$0	$49,106	$54,449	$245,531	$111,694	$245,531	$133,837
Sales and Excise Tax	$0	$33,745	$7,483	$33,745	$15,351	$33,745	$18,394
EVSE & Infrastructure Costs	$0	$0	$0	$0	$0	$0	$0
Maintenance Bay Upgrades	$0	$0	$0	$0	$0	$0	$0
Fuel Cost	$286,310	$275,812	$618,647	$585,387	$943,662	$932,196	-$11,466

Cost Line Items	Legal Baseline 2030	Proposed ACF Regulation 2030	Legal Baseline 2040	Proposed ACF Regulation 2040	Legal Baseline 2050	Proposed ACF Regulation 2050	Difference 2050
DEF Consumption	$3,862	$3,380	$8,157	$3,380	$12,182	$3,380	-$8,803
LCFS Revenue	$0	$0	$0	$0	$0	$0	$0
Maintenance Cost	$79,265	$75,302	$178,347	$134,751	$277,429	$194,200	-$83,229
Midlife Costs	$21,667	$18,958	$62,292	$49,534	$94,792	$80,110	-$14,681
Registration Fees	$22,732	$21,915	$49,388	$34,591	$76,134	$43,736	-$32,399
Transitional Costs	$0	$0	$0	$0	$0	$0	$0
Residual Values	$0	-$30,854	-$29,858	-$854	-$46,547	-$30,854	$15,693
Depreciation	$0	-$8,287	-$14,492	-$66,113	-$27,760	-$66,113	-$38,353
Insurance Cost	$4,431	$6,342	$9,172	$14,971	$13,697	$19,574	$5,876
Reporting Cost	$0	$48	$0	$109	$0	$169	$169
Total	$418,267	$445,466	$943,587	$1,005,031	$1,470,634	$1,455,672	-$14,961

Figure 71: Estimated Costs of Proposed ACF Regulation to the Example Small Business (2021$)



3. Pickup Truck Buyer

There are no direct costs on individuals as a result of this Proposed ACF regulation. Staff estimates that manufacturers may see increased costs as a result of this rule's 100 percent ZEV sales requirement beginning 2040 MY and will likely pass the costs through to individuals in the state through increased incremental prices. These individuals will also see increases and decreases in costs due to different costs for ZEVs versus ICE vehicles.

This example is an individual who purchases a new Class 2b-3 pickup truck in 2040. Individuals are not directly regulated by the proposed ACF regulation but will be indirectly affected by the 2040 100 percent ZEV sales requirement. A significant portion of vehicle sales in the Class 2b-3 weight classes are pickup trucks purchased by individuals for their personal usage.

In the Legal Baseline scenario, the individual would buy a 2040 MY gasoline powered Class 2b-3 pickup in 2040 and operate it for ten years. Under the proposed ACF regulation, the individual would instead purchase a 2040 MY battery-electric Class 2b-3 pickup truck and operate it for ten years.

Most assumptions are the same as in the core cost analysis; however, some assumptions have been changed to reflect differences between costs to an individual versus costs to a fleet. Information has been taken from the ACC II SRIA.[432]

- Infrastructure costs are assumed to be $200 for the charging cord and $680 to install a charging port in the individual's garage. No maintenance costs are assumed. Infrastructure costs are not amortized.
- Electricity costs have been modified to cost at $0.25/kWh in 2026 and increase over time.
- The individual does not receive any revenue from the LCFS regulation.
- No depreciation is assumed.

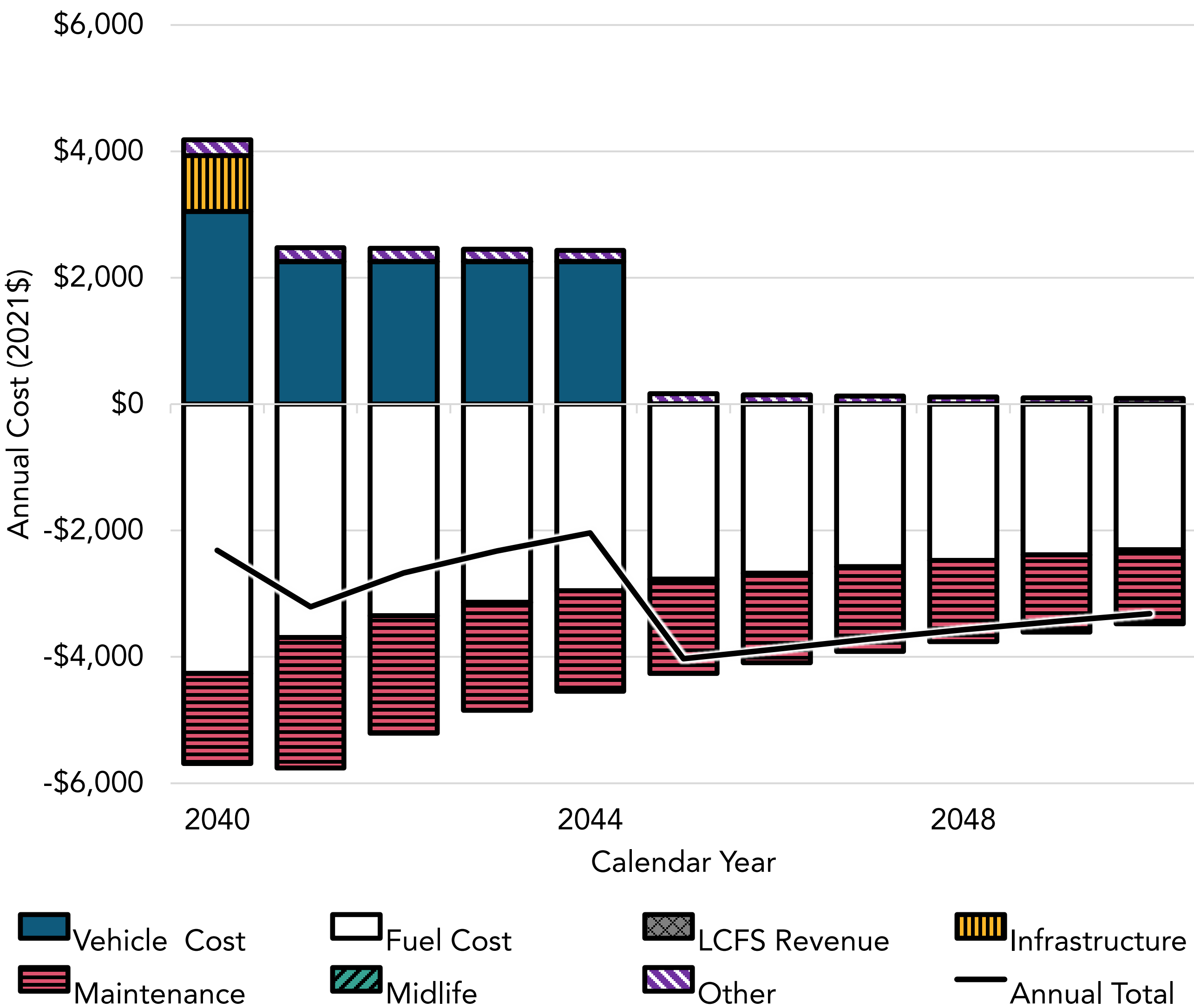
Table 68 and Figure 72 illustrate the costs for the example individual. The individual would see increased vehicle and infrastructure costs, but fuel and maintenance savings offset these costs and lead to a payback in under a year.

Table 68: Pickup Truck Buyer Cumulative Cost Example

Cost Line Items	Legal Baseline 2050	Proposed ACF Regulation 2050	Difference 2050
Vehicle Price	$45,864	$57,132	$11,268
Sales and Excise Tax	$3,235	$4,029	$795
EVSE & Infrastructure Costs	$0	$935	$935
Maintenance Bay Upgrades	$0	$1,155	$1,155
Fuel Cost	$57,862	$25,289	-$32,573
DEF Consumption	$0	$0	$0
LCFS Revenue	$0	$0	$0
Maintenance Cost	$43,937	$26,362	-$17,575
Midlife Costs	$0	$0	$0
Registration Fees	$7,831	$8,817	$986
Transitional Costs	$0	$0	$0
Residual Values	$0	$0	$0
Depreciation	$0	$0	$0
Insurance Cost	$3,092	$3,868	$775
Reporting Cost	$0	$0	$0
Total	$161,821	$127,587	-$34,234

432 California Air Resources Board, *Advanced Clean Cars II Proposed Amendments to the Low Emission, Zero Emission, and Associated Vehicle Regulations: Standardized Regulatory Impact Analysis*, 2022 (web link: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/accii/appc1.pdf, last accessed August 2022).

Figure 72: Estimated Costs of Proposed ACF Regulation to Pickup Truck Buyer (2021$)



F. Macroeconomic Analysis

1. Methods for Determining Economic Impacts

This section describes the estimated total impact of the proposed ACF regulation on the California economy. The proposed ACF regulation would result in incremental cost and cost-savings for businesses to comply with the regulation. These costs would result in direct changes in expenditures in the economy and are passed on to businesses. These changes in expenditures by businesses would indirectly affect employment, output, and investment in sectors that move freight and provide services to affected businesses.

These direct and indirect effects would lead to induced effects, such as changes in personal income that affect consumer expenditures across other spending categories. The total economic impact is the sum of these effects and is presented in this section. The total economic impact of the proposed ACF regulation is simulated relative to the baseline scenario using the cost estimates described in Section B. The analysis focuses on the changes in major macroeconomic indicators from 2022 to 2050, including employment, output, personal income, and gross state product (GSP). The years of the analysis are used to simulate the proposed ACF regulation through more than 12 months post full implementation.

Regional Economic Models, Inc. (REMI) Policy Insight Plus Version 2.5.0 is used to estimate the macroeconomic impacts of the proposed ACF 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.[433] REMI Policy Insight Plus provides year-by-year estimates of the total impacts of the proposed ACF regulation, pursuant to the requirements of Senate Bill 617 and the California Department of Finance (DOF).[434] Staff used the REMI single region, 160 sector model with the model reference case adjusted to reflect California DOF's most current publicly available economic and demographic projections.[435,436]

Specifically, REMI model's National and Regional Control was updated to conform to the most recent California DOF economic forecasts which include United States Real Gross Domestic Product (GDP), income, and employment, as well as California civilian employment by industry, released with the Governor's Budget on January 10, 2022, and DOF demographic forecasts for California population forecasts, last updated in July 2021.[437,438,439,440] After the DOF economic forecasts end in 2025, CARB staff made assumptions that post-2025, economic variables would continue to grow at the same rate projected in the REMI baseline forecasts.

2. Inputs and Assumptions of the Assessment

The estimated economic impact of the proposed ACF regulation is sensitive to modeling assumptions. This section provides a summary of the assumptions and inputs used to

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[433] REMI, *Models*, 2022 (web link: https://www.remi.com/model/pi/, last accessed August 2022).

[434] SB 617 (Calderon, Stats. 2011, ch. 496); Gov. Code section 65850.52.

[435] California Legislature, *Senate Bill 617*, October 2011(web link: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201120120SB617, last accessed August 2022).

[436] California Department of Finance, *Chapter 1: Standardized Regulatory Impact Analysis for Major Regulations – Order of Adoption*, December 2013(web link: https://dof.ca.gov/wp-content/uploads/Forecasting/Economics/Documents/Order_of_Adoption-12012013.pdf, last accessed August 2022).

[437] California Department of Finance, *Economic Research Unit. National Economic Forecast – Annual & Quarterly. Sacramento: California*, November 2021. (web link: https://dof.ca.gov/wp-content/uploads/Forecasting/Economics/Documents/United-States-Economic-Forecast-MR-2022-23.xlsx, last accessed August 2022).

[438] California Department of Finance, *Economic Research Unit. California Economic Forecast – Annual & Quarterly. Sacramento: California,* November 2021 (web link: https://dof.ca.gov/wp-content/uploads/Forecasting/Economics/Documents/California-Economic-Forecast-MR-2022-23.xlsx, last accessed August 2022).

[439] California Department of Finance, *Economic Research Unit. National Deflators: Calendar Year averages: from 1929, April 2021. Sacramento: California*, January 2022 (web link: https://dof.ca.gov/wp-content/uploads/Forecasting/Economics/Documents/Implicit-Price-Deflators-CY.xlsx, last accessed August 2022).

[440] California Department of Finance, *Demographic Research Unit. Report P-3: Population Projections, California, 2010-2060 (Baseline 2019 Population Projections; Vintage 2020 Release) Sacramento: California*, July 2021 (web link: https://dof.ca.gov/forecasting/demographics/projections/, last accessed August 2022).

determine the suite of policy variables that best reflect the macroeconomic impacts of the proposed ACF regulation. The direct costs and savings estimated in Section C and the non-mortality related health benefits estimated in Section B are translated into REMI policy variables and used as inputs for the macroeconomic analysis.[441]

The direct costs of the proposed ACF regulation, as described in Section C, would include changes in upfront costs to fleets for the increased purchase of ZEVs and decreased purchase of ICE vehicles. The net change in vehicle costs is input into the economic model as an increase in production costs for all industries in California that operate fleets anticipated to be affected by the proposed ACF regulation. Fleets which use ZEVs would realize changes in production costs related to their change in fuel mix, operations costs, and maintenance and repair costs. Fleets would also need to make investments in infrastructure to support their use of the ZEVs, which would increase their production costs. Fleets that own ZEV infrastructure to charge their vehicles would be able to generate LCFS credits and receive a direct financial benefit. Fleets required to accelerate the retirement of their non-ZEVs may see an increased residual value from resale of the vehicles on the used market, as described in the Direct Costs section of this report. This however is not expected to result in any statewide economic impact, as other fleets would also be purchasing the vehicles at the higher residual value, directly offsetting revenue received by the seller as an expenditure to the buyer. Finally, changes in fleets' vehicle purchases, fuel use, and other activities would reduce the amount paid in federal, State, and local taxes and fees. The total change in taxes and fees businesses pay are modeled as a reduction in production costs for the fleets.

Table 69: Share of Vehicles Owned and Operated by Fleets Affected by the High Priority and Federal Fleet Requirements of the Proposed ACF Regulation

Major Sectors	NAICS	Share of Vehicles
Agriculture and Natural Resources	111-115, 21	5.12%
Construction	23	9.35%
Manufacturing	31-33	4.37%
Retail and Wholesale	42, 44-45	15.44%
Transportation and Public Utilities	22, 48, 492-493	50.40%
Finance, Insurance & Real Estate	52, 53	1.13%
Services	51, 54-56, 61, 62, 71, 72, 81	14.14%
Government (Public Administration)	92	0.05%

Costs and savings incurred by fleets would result in corresponding changes in final demand for industries supplying those particular goods or services as shown in Table 70. The term "fleets" in the table includes all of the industries with businesses operating affected vehicles. As fleets' purchase of vehicles are estimated to be primarily from out-of-state manufacturers, demand changes for the corresponding ZEV supply chain cannot be directly modeled as a change in final demand in California. In order to account for this, staff estimates the share of

[441] Refer to Section G: Macroeconomic Appendix for a full list of REMI inputs for this analysis.

demand which may be fulfilled by California businesses, based on California's share of national output for the industry (electrical component manufacturing).[442] All other changes in demand are included in this analysis. The infrastructure upgrades necessary for fleet use of ZEVs is assumed to be provided by businesses in the construction sector (NAICS 23). The EVSE and maintenance is assumed to be supplied by businesses in the Other Electrical Equipment and Component Manufacturing industry (NAICS 3359). The change in demand for vehicle maintenance and midlife rebuild is realized by the automotive repair and maintenance industry (NAICS 8111). The reduction in gasoline and diesel fuel demand is assumed to be incurred by the Petroleum and Coal Products manufacturing industry (NAICS 324), while the decrease in natural gas demand occurs for the Natural gas distribution industry (NAICS 2212). The increased demand for electricity and hydrogen fuel is assumed to be provided by the Electric power generation, transmission, and distribution industry (NAICS 2211) and Basic Chemical manufacturing industry (NAICS 3251), respectively. The reporting cost and the workforce training and development are assumed to be provided by the Office administrative services (NAICS 5611, 5612) and private education services industries (NAICS 61), respectively. The change in demand for gasoline stations (NAICS 4471) selling some of the products above, is estimated based on the retail margin for that industry and entered in as change in final demand for the retail sector (NAICS 44-45).[443] Finally, the LCFS credits generated by fleets that install and use EVSE are assumed to be purchased by producers of fossil fuels, which pass those costs through in the price of fuel; this is modeled as an increase in fuel costs for individuals and businesses in California.

Table 70: Sources of Changes in Production Cost and Final Demand by Industry

Source of Cost or Savings for Fleets	Industries with Changes in Final Demand (NAICS)
Vehicle Prices	*Upfront cost:* Electrical Component Manufacturing.[a] (3363)
Infrastructure upgrades	*Upfront cost:* Construction (23)
Electric Vehicle Supply Equipment	*Upfront cost:* Other Electrical Equipment and Component Manufacturing. (3359)
EVSE maintenance	*Upfront cost:* Construction (23)
Vehicle maintenance and midlife rebuild	*One-time and recurring cost:* Automotive Repair and Maintenance (8111)
Gas and diesel fuel	*Recurring cost:* Petroleum and Coal Products Manufacturing. (324)
Natural gas	*Recurring cost:* Natural Gas Distribution (2212)
Hydrogen fuel	*Recurring cost:* Basic Chemical Manufacturing (3251)
Diesel Exhaust Fluid	*Recurring cost: Agricultural Chemical Manufacturing. (3253)*

[442] Based on REMI Policy Insight Plus (v 2.4.1), California's share of national output is 2.3 percent for motor vehicle parts manufacturing. (3,363) in 2019.

[443] A gross margin 10.5 percent is used, based on the average gross margin of small and medium gasoline stations (NAICS 4471) from *Bizminer*, 2022 (web link: https://www.bizminer.com/, last accessed August 2022).

Source of Cost or Savings for Fleets	Industries with Changes in Final Demand (NAICS)
Workforce training and education	*Recurring costs:* Education Services; Private (61)
Reporting	*One-time cost:* Office Administrative Services; Facilities Support Services (5611, 5612)
LCFS credit generation	*Recurring cost:* Fuel prices[b]

[a] The Industry Sales policy variable is used here rather than Exogenous Final Demand.
[b] Individuals and each industry share of cost resulting from increasing fuel prices is based on data from REMI v2.5 (see the Macroeconomic Appendix for the distribution).

In addition to these changes in production costs and final demand for businesses, there would also be economic impacts as a result of the fiscal effects, primarily from changes in fuel and sales tax revenue, depreciation, and registration fees, as described in Section D. The changes in fuel tax revenue would change the production costs for fleets and the corresponding change in government revenue is modeled as a change in State and local government spending, assuming this revenue reduction is not offset elsewhere. Additional CARB staff and resources in support of this regulation are modeled as changes in State government employment and spending. The change in federal excise tax revenue and depreciation is outside the scope of the economic model and not evaluated here.

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

3. Results of the Assessment

The results from the REMI model provide estimates of the impact of the proposed ACF regulation on the California economy. These results represent the annual incremental change from the implementation of the proposed ACF regulation relative to the baseline scenario. The California economy is forecasted to grow through 2050, therefore, negative statewide impacts reported here should be interpreted as a slowing of growth and positive impacts as an acceleration of growth resulting from the proposed ACF regulation. The results are reported here in tables for every four years from 2022 through 2050.

a) California Employment Impacts

Table 71 presents the impact of the proposed ACF regulation on total employment in California across all industries. Employment comprises estimates of the number of jobs, full-time plus part-time, by place of work for all industries. Full-time and part-time jobs are counted at equal weight. Employees, sole proprietors, and active partners are included, but unpaid family workers and volunteers are not included. The employment impacts represent the net change in employment, which consist of positive impacts for some industries and negative impacts for others. The proposed ACF regulation is estimated to initially result in a slightly positive employment impact through about 2026 after which the trend reverses with a negative employment impact through rest of the regulatory horizon. The results are further described at the industry level in the following paragraph. These changes in employment do not exceed 0.2 percent of baseline California employment across the entire regulatory horizon.

Table 71: Total California Employment Impacts

Metric	2026	2030	2034	2038	2042	2046	2050
California Employment	25,955,120	25,988,237	26,215,483	26,620,729	27,193,545	27,865,042	28,673,835
% Change	0.00%	-0.07%	-0.13%	-0.16%	-0.13%	-0.09%	-0.15%
Change in Total Jobs	21	-18,835	-33,107	-43,138	-34,577	-25,572	-41,990

The total employment impacts shown above are net of changes at the industry level. The overall trend in employment changes by major sector are illustrated in Figure 73 and Table 72 shows the changes in employment by industries that would be directly impacted by the proposed ACF regulation. As the requirements of the proposed ACF regulation go into effect the industries generally realizing reductions in production cost or increases in final demand would see an increase in employment growth. This initially includes the construction sector as businesses install EVSE and make other facility upgrades, and the electric power sector due to increased demand. The directly affected fleets, which primarily operate in the transportation and warehousing sector, would initially see a decrease in employment due to higher vehicle costs, but as those vehicles are operated the operational savings build up over time, reducing production costs for the industry reducing the negative impact. The reduced spending on maintenance and repair costs for ZE trucks would result in a downward trend in employment for the industry.

The largest decrease in employment results from the public sector, which is estimated to realize a decrease in fuel and sales tax revenue and registration fees. This foregone revenue may eventually be replaced by revenue from other sources, in which case these negative job impacts to State and local government would be diminished. The transition towards ZEVs and its impacts on some of these revenues are the subject of continued policy development. Although this analysis does not assume the creation of new specific revenue-raising measures, measures such as roadway pricing strategies under discussion in California have the potential to generate revenue. For example, the four largest metropolitan planning organizations in California, representing over 80 percent of the population, have proposed a suite of pricing measures in their sustainable communities strategies to meet regional GHG reduction targets set by CARB. Caltrans is convening the State Roadway Pricing Working Group to provide State leadership and support for the implementation of local, regional, and State efforts to implement such strategies. However, this is outside the scope of the proposed ACF regulation and not evaluated here. It is important to note that many of these negative job impacts represent a structural shift for these industries that directly correspond to substantial benefits to ZEV owners who would have much lower operational costs from the lower fuel expenses and reduced maintenance and repair of ZEVs.

Figure 73: Job Impacts by Major Sector

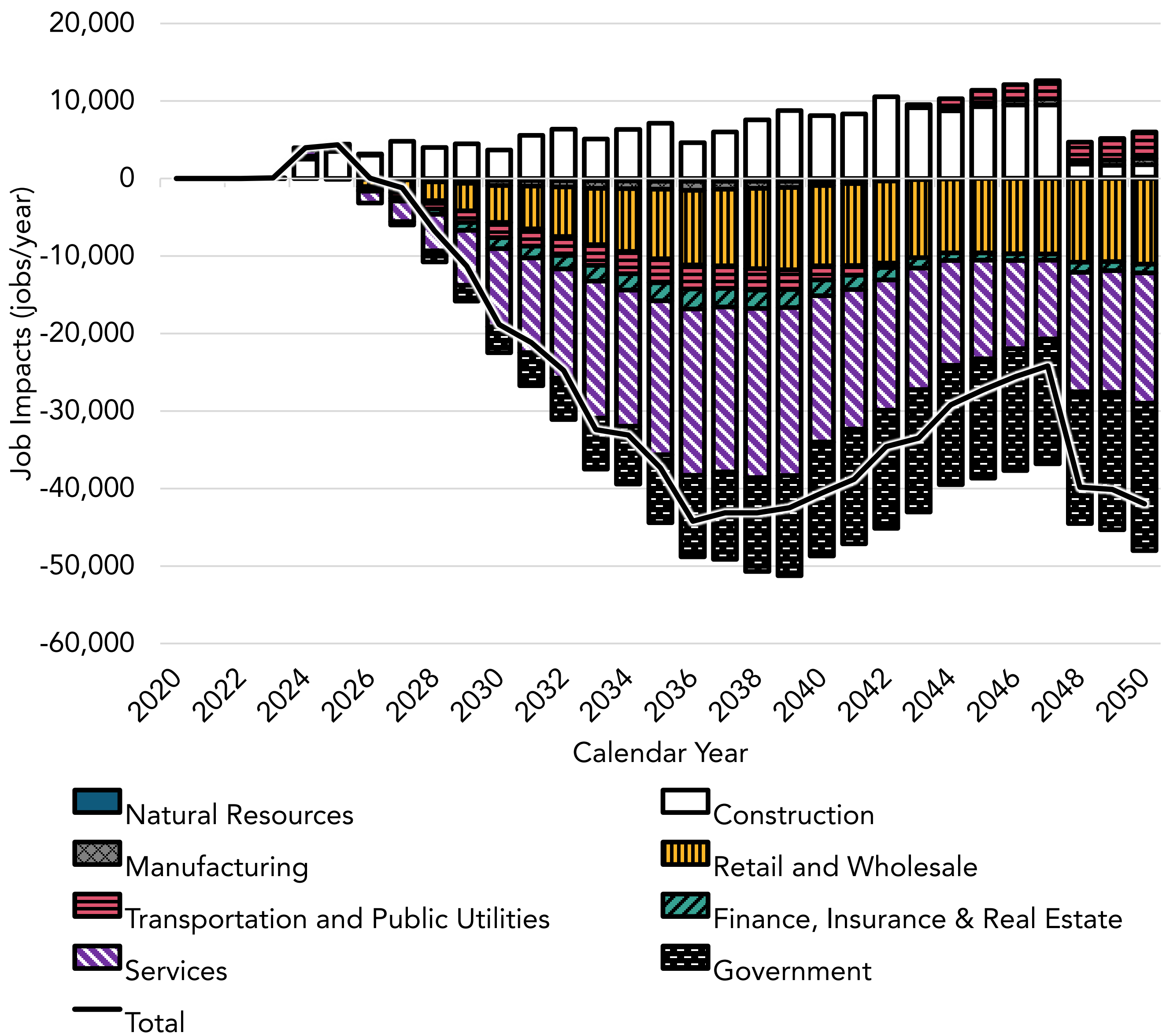


Table 72: Employment Impacts by Primary and Secondary Industries

Industry	Metric	2026	2030	2034	2038	2042	2046	2050
Transportation and Warehousing (48, 492-493)	% Change	0.00%	-0.12%	-0.22%	-0.26%	-0.14%	-0.01%	0.06%
	Change in Jobs	-70	-1,718	-3,238	-3,967	-2,229	-160	1,001
Electric power generation, transmission and distribution (2211)	% Change	0.20%	0.92%	2.30%	3.93%	5.73%	6.07%	6.66%
	Change in Jobs	75	332	791	1,302	1,819	1,882	2,013
Natural gas distribution (2212)	% Change	-0.07%	-0.35%	-0.66%	-0.95%	-1.12%	-1.15%	-1.30%
	Change in Jobs	-9	-43	-80	-112	-127	-128	-141

Industry	Metric	2026	2030	2034	2038	2042	2046	2050
Construction (23)	% Change	0.22%	0.28%	0.48%	0.57%	0.67%	0.69%	0.11%
	Change in Jobs	3,009	3,660	6,327	7,573	9,124	9,468	1,610
Petroleum and coal products manufacturing (324)	% Change	-0.16%	-0.83%	-1.62%	-2.40%	-3.07%	-3.20%	-3.62%
	Change in Jobs	-20	-100	-189	-270	-333	-340	-376
Retail trade (44-45)	% Change	-0.04%	-0.20%	-0.35%	-0.45%	-0.43%	-0.41%	-0.45%
	Change in Jobs	-829	-3,870	-6,605	-8,481	-8,438	-8,277	-9,437
Automotive repair and maintenance (8111)	% Change	-0.39%	-1.63%	-2.95%	-4.02%	-3.76%	-3.07%	-4.95%
	Change in Jobs	-903	-3,778	-6,834	-9,343	-8,750	-7,174	-11,634
State & Local Government	% Change	0.01%	-0.14%	-0.30%	-0.48%	-0.59%	-0.61%	-0.72%
	Change in Jobs	162	-3,375	-7,474	-12,132	-15,218	-15,747	-19,019

b) California Business Impacts

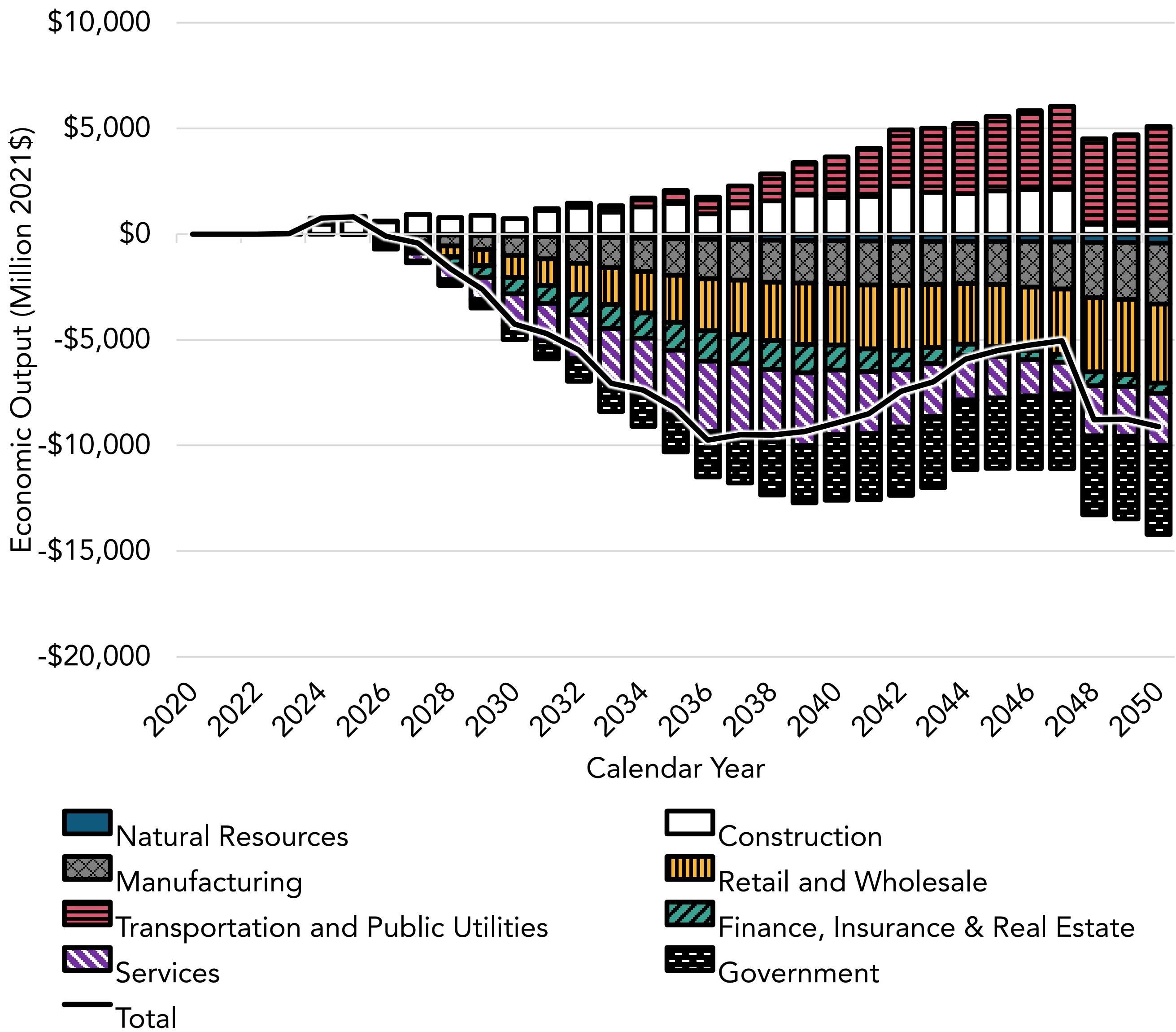
Gross output is used as a measure for business impacts as it represents an industry's sales or receipts and tracks the quantity of goods or services produced in a given time period. Output growth is the sum of output in each private industry and State and local government as it contributes to state GDP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

The results of the proposed ACF regulation show a decrease in output of $99 million in 2030 and a decrease of $5.3 billion in 2050 as shown in Table 73. The trend in output changes is illustrated by major sector in Figure 74. Similar to the employment impacts, there would initially be positive impacts on output for construction and electric power sectors, which trend towards positive impacts over time as the operational savings accumulate, leading to output growth. There would be negative impacts on output in the oil and gas extraction, automotive repair and maintenance, and public sectors. The negative output impact on manufacturing is primarily driven by the petroleum and coal products manufacturing industry, which is estimated to see a relatively large decrease in final demand for diesel and gasoline.

Table 73: Change in Output Growth in California by Industry

Industry	Metric	2026	2030	2034	2038	2042	2046	2050
California Economy	Output (2021M$)	6,064,336	6,365,917	6,725,733	7,189,243	7,777,733	8,433,448	9,169,339
	% Change	0.00%	0.00%	-0.07%	-0.11%	-0.13%	-0.10%	-0.06%
	Change (2021M$)	0	-99	-4,256	-7,379	-9,506	-7,440	-5,253
Transportation and Warehousing (48, 492-493)	% Change	0.00%	-0.01%	-0.17%	-0.31%	-0.39%	-0.30%	-0.09%
	Change (2021M$)	0	-18	-351	-685	-905	-731	-226
Electric power generation, transmission and distribution (2211)	% Change	0.00%	0.20%	0.93%	2.31%	3.96%	5.56%	6.13%
	Change (2021M$)	0	102	494	1,284	2,310	3,434	4,014
Natural gas distribution (2212)	% Change	0.00%	-0.07%	-0.35%	-0.67%	-0.96%	-1.14%	-1.15%
	Change (2021M$)	0	-7	-39	-76	-112	-138	-144
Construction (23)	% Change	0.00%	0.23%	0.28%	0.49%	0.58%	0.80%	0.71%
	Change (2021M$)	0	581	732	1,284	1,574	2,261	2,108
Petroleum and coal products manufacturing (324)	% Change	0.00%	-0.16%	-0.83%	-1.63%	-2.41%	-3.05%	-3.21%
	Change (2021M$)	0	-154	-855	-1,782	-2,800	-3,795	-4,288
Retail trade (44-45)	% Change	0.00%	-0.04%	-0.21%	-0.36%	-0.47%	-0.47%	-0.43%
	Change (2021M$)	0	-120	-624	-1,173	-1,665	-1,920	-1,985
Automotive repair and maintenance (8111)	% Change	0.00%	-0.39%	-1.66%	-3.02%	-4.13%	-3.75%	-3.20%
	Change (2021M$)	0	-103	-449	-844	-1,199	-1,133	-1,006
State & Local Government	% Change	0.00%	0.01%	-0.14%	-0.30%	-0.48%	-0.59%	-0.60%
	Change (2021M$)	0	32	-674	-1,519	-2,517	-3,237	-3,427

Figure 74: Change in Output in California by Major Sector



c) Impacts on Investment in California

Domestic private 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 ACF regulation are shown in Table 74 and shows a decrease of private investment of about $1.0 billion in 2030 which trends towards an increase of $2.49 billion in 2050. These changes in investment do not exceed 0.4 percent baseline investment across the regulatory horizon.

Table 74: Change in Gross Domestic Private Investment Growth

Metric	2026	2030	2034	2038	2042	2046	2050
Private Investment (2021M$)	547,621	571,932	605,292	646,614	693,307	742,261	795,973
% Change	-0.03%	-0.18%	-0.19%	-0.07%	0.17%	0.33%	0.31%
Change (2021M$)	-172	-1,040	-1,141	-453	1,200	2,436	2,492

d) Impacts on Individuals in California

The proposed ACF regulation would impose no direct costs on individuals in California. However, the costs incurred by affected businesses and the public sector would cascade through the economy and affect individuals.

One measure of this impact is the change in real personal income, which is income received from all sources, including compensation of employees and government and business transfer activity, adjusted for inflation. This is an aggregate statewide measure of personal income change, representing a net of income lost from jobs foregone in some sectors and jobs gained in other sectors. Table 75 estimates annual change in real personal income across all individuals in California due to the proposed ACF regulation. Total personal income growth decreases by about $3.86 billion in 2030 but the impact begins to diminish after 2040, resulting in a decrease of about $2.1 billion by 2050, not exceeding 0.2 percent of the baseline. The 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 change in personal income growth is estimated to decrease $19 per person in 2030, which trends positive over time resulting in an increase of $68 per person in 2050.[444]

Table 75: Impacts on Individuals in California

Metric	2026	2030	2034	2038	2042	2046	2050
Personal Income (2021M$)	2,861,550	3,187,013	3,477,682	3,737,691	4,040,484	4,378,592	4,745,721
% Change	-0.02%	-0.11%	-0.17%	-0.18%	-0.11%	-0.05%	-0.04%
Change (2021M$)	-764	-3,855	-6,195	-7,140	-4,745	-2,180	-2,071
Personal Income per capita (2021$)	68,996	76,178	81,152	86,202	91,813	98,550	106,058
% Change	-0.02%	-0.08%	-0.08%	-0.05%	0.03%	0.06%	0.06%
Change (2021$)	-19	-64	-71	-44	25	62	68

[444] The sign of the change in personal income per capita differs from overall personal income due to population growth changes estimated by the REMI model as a result of the proposed ACF regulation.

e) Impacts on Gross State Product

GSP is the market value of all goods and services produced in California and is one of the primary indicators of economic growth. It is calculated as the sum of the dollar value of consumption, investment, net exports, and government spending. Under the proposed ACF regulation, GSP growth would be anticipated to decrease by about $2.42 billion in 2030 and by $4.28 billion in 2050 as shown in Table 76. These changes do not exceed 0.2 percent of baseline GSP. This metric summarizes impacts discussed above, including consumer spending, investment, and government spending. This is why the results trend negative, as the decrease in consumer and government spending in California would outweigh the increase in investment resulting from the proposed ACF regulation.

Table 76: Change in Gross State Product

Metric	2026	2030	2034	2038	2042	2046	2050
GSP (2021M$)	3,666,219	3,893,045	4,161,493	4,471,810	4,822,161	5,207,097	5,630,591
% Change	0.00%	-0.06%	-0.10%	-0.12%	-0.08%	-0.04%	-0.08%
Change (2021M$)	-43	-2,420	-4,169	-5,276	-3,796	-2,293	-4,276

f) Creation or Elimination of Businesses

The REMI model cannot directly estimate the creation or elimination of businesses. However, changes in jobs and output for the California economy described above can be used to understand some potential impacts. The overall jobs and output impacts of the proposed ACF regulation would be small relative to the total California economy, representing changes of no greater than 0.2 percent. However, impacts to specific industries are larger as described in previous sections. While there would initially be negative impacts on the transportation and warehousing sector, these diminish over time. The trend of increasing demand for the construction sector to provide services related to EV charging has the potential to lead to an expansion or creation of businesses over time. While the electric power sector similarly sees large increases in demand, its services are provided by public utilities, which would not directly impact business creation. The decreasing trend in demand for gasoline and diesel fuel following from this proposed ACF regulation has the potential to result in the elimination of businesses in this industry and downstream industries, such as gasoline stations and vehicle repair businesses, if sustained over time.

g) Incentives for Innovation

The proposed ACF regulation provides flexibility for fleets to purchase ZEVs ahead of the proposed schedules. Private and public fleet owners that purchase ZEVs before they are required would be able to count them towards a future compliance requirement to gain flexibility when making future vehicle purchase. This may encourage fleets to make ZEV purchases early for vehicles that are well suited to their needs which could provide flexibility to purchase ICE vehicles in later years. High priority and federal fleets could purchase Group 1 ZEVs at any point prior to 2025, Group 2 ZEVs at any point prior to 2027, and Group 3 ZEVs at any point prior to 2030. Drayage fleets could add ZEVs to the CARB Online System at any point prior to turnover requirements or the 2035 ZEV deadline. Fleets that act early would be more likely to be eligible for incentive programs that may be available to finance costs or lower the upfront cost.

ZEVs are anticipated to lead to other unquantified benefits and operational efficiencies that may provide another incentive for fleets to use ZEVs to better serve customers. For example, ZEV may be able to make deliveries at night where noise ordinances limit deliveries, their quiet operation can also improve safety at a work site, and the ability to plug in power tools or export power at a job site or as back-up power may increase overall productivity.

Staff anticipates growth in industries that manufacture or support ZEVs, including ZEV manufacturer and component suppliers, infrastructure installers, electrical vehicle technicians, and others. This growth would strengthen the ZEV supply chain, foster a ZE market, and promote technology growth sooner than would have otherwise occurred.

h) Competitive Advantage or Disadvantage

The proposed ACF regulation has three primary regulatory components for different fleet types and each component addresses competitive advantage or disadvantage differently.

The public fleet requirement would not be anticipated to create a competitive advantage or disadvantage. Public agencies do not compete against each other, and each agency would be able to identify the strategy that allows them to comply.

The drayage truck requirement would not be anticipated to create a competitive advantage or disadvantage. The proposed ACF regulation applies equally to all drayage trucks that enter seaports and railyards within California.

The high priority and federal fleet requirement would not be anticipated to create a significant change in competitive advantage or disadvantage. First, federal agencies do not compete with other fleets and would not have a competitive advantage or disadvantage. For high priority fleets, the requirements apply to all trucks that operate in California regardless of where the truck or company is headquartered and would be phased in by truck type. This ensures that all vehicles in these fleets would be subject to the same requirements.

Fleets that do not meet the fleet size or revenue threshold would not be initially regulated by this proposed ACF regulation, but the risk of creating a competitive advantage or disadvantage is mitigated as these initially non-regulated fleets would become subject to the regulation if their revenue or fleet size increases above the thresholds established in the regulation, and ultimately, such fleets would be subject to the regulation when the 100 percent ZEV sales component of the proposed ACF regulation is fully implemented. In addition, the fleet size for determining which fleet would be subject to the regulation includes all medium- and heavy-duty vehicles that are operated under common ownership and control. This ensures a level playing field between businesses that compete for the same work regardless of their business model.

The 100 percent manufacturer ZEV sales requirement would not be anticipated to create a significant change in competitive advantage or disadvantage. This manufacturer requirement affects entities that are headquartered both within California and outside the state. However, all of the costs from deploying the number of ZEVs required by the proposed ACF regulation are assumed to be borne in California. This approach shows the full estimated cost to California for deploying the same number of ZEVs required by the regulation. As shown in the cost analysis, these proposed ACF regulation are expected to have a positive economic impact on affected entities. Fleets and California businesses are expected to see a net reduction in costs through reduced spending on fuel costs and vehicle maintenance as shown in the cost examples, Table 55, and Figure 69.

4. Summary and Agency Interpretation of the Assessment Results

The results of the macroeconomic analysis of the proposed ACF regulation are summarized in Table 77. As analyzed here, CARB estimates the proposed ACF regulation would be unlikely to have a significant impact on the California economy. Overall, the change in the growth of jobs, state GDP, and output is projected to not exceed 0.2 percent of the baseline. While the proposed ACF regulation would initially result in decreased growth in the transportation and warehousing sector in California, it trends positively over time diminishing the negative impact. Both the construction and electric power sectors would see large positive growth by providing their services to affected fleets. The diesel and gasoline fuel savings for the fleets represent decreased demand for gasoline and diesel from the industry, implying a decrease in growth for the industry and downstream industries such as gasoline stations and vehicle repair. This analysis also shows the negative impact estimated for State and local government output and employment due to tax revenue decreases, without any offsetting revenues. This foregone revenue, which supports important programs in the state, may eventually be replaced by revenue from other sources, in which case these negative impacts to State and local government would be diminished.

Table 77: Summary of Macroeconomic Impacts of Proposed ACF Regulation

Indicator	Metric	2026	2030	2034	2038	2042	2046	2050
GSP	% Change	0.00%	-0.06%	-0.10%	-0.12%	-0.08%	-0.04%	-0.08%
	Change (2021M$)	-43	-2,420	-4,169	-5,276	-3,796	-2,293	-4,276
Personal Income	% Change	-0.02%	-0.11%	-0.17%	-0.18%	-0.11%	-0.05%	-0.04%
	Change (2021M$)	-764	-3,855	-6,195	-7,140	-4,745	-2,180	-2,071
Employment	% Change	0.00%	-0.07%	-0.13%	-0.16%	-0.13%	-0.09%	-0.15%
	Change in Jobs	21	-18,835	-33,107	-43,138	-34,577	-25,572	-41,990
Output	% Change	0.00%	-0.07%	-0.11%	-0.13%	-0.10%	-0.06%	-0.10%
	Change (2021M$)	-99	-4,256	-7,379	-9,506	-7,440	-5,253	-9,117
Private Investment	% Change	-0.03%	-0.18%	-0.19%	-0.07%	0.17%	0.33%	0.31%
	Change (2021M$)	-172	-1,040	-1,141	-453	1,200	2,436	2,492

IX. Evaluation of Regulatory Alternatives

Government Code section 11346.2, subdivision (b)(4) requires CARB to consider and evaluate reasonable alternatives to the proposed regulatory action and provide reasons for rejecting those alternatives. This section discusses alternatives evaluated and provides reasons why these alternatives were not included in the proposed ACF regulation. As explained below, no alternative proposed was found to be less burdensome and equally effective in achieving the purposes of the regulation in a manner than ensures full compliance with the authorizing law.

The primary objectives of the proposed ACF regulation include the following:

1. Accelerate the deployment of ZEVs that achieve the maximum emissions reductions possible from medium- and heavy-duty vehicles to assist in the attainment of NAAQS for criteria air pollutants (Health & Safety Code sections 43000.5(b), 43018(a)).

2. Reduce the State's dependence on petroleum as an energy resource and support the use of diversified fuels in the State's transportation fleet (Health & Safety Code Section 43000(e), California Public Resources Code (PRC) section 25000.5). In addition, petroleum use as an energy resource contributes substantially to the following public health and environmental problems: air pollution, acid rain, global warming, and the degradation of California's marine environment and fisheries (PRC section 25000.5(a)).

3. Decrease GHG emissions in support of statewide GHG reduction goals by adopting strategies to deploy medium- and heavy-duty ZEV in California to support the Scoping Plan, which was developed to reduce GHG emissions in California, as directed by SB 32.[445] California's 2017 Climate Change Scoping Plan and 2020 Mobile Source Strategy aim to accelerate development and deployment of the cleanest feasible mobile source technologies and to improve access to clean transportation. Implementation of the proposed ACF regulation would also provide further GHG reductions pursuant to Assembly Bill 1493.[446]

4. Develop a regulation that is consistent with and meets the goals of the SIP, providing necessary emissions reductions from vehicular sources for all of California's non-attainment areas to meet NAAQS (Health & Safety Code sections 39002, 39003, 39602.5, 43000, 43000.5, 43013, 43018).

5. Maintain and continue reductions in emissions of GHGs beyond 2020, in accordance with SB 32 (Health & Safety Code sections 38551(b), 38562, 38562.5, 38566); pursue measures that implement reduction strategies covering the State's GHG emissions in furtherance of California's mandate to reduce GHG emissions to the 1990 level by 2020 and 40 percent below the 1990 level by December 31, 2030. In addition, target and achieve carbon neutrality in California no later than 2045, pursuant to SB 100,[447] and maintain net negative emissions thereafter in accordance with Executive Order B-55-18.

6. Lead the transition of California's medium- and heavy-duty transportation sector from internal combustion engines to ZE technology. Promote this development alongside the manufacturer sales requirements established in the ACT regulation to support ZEV sales, CARB Resolution 20-19 and Executive Order N-79-20 setting a course to transition truck and bus fleets to ZE by 2045 with earlier targets for key segments including drayage operations to ZE by 2035.

7. Complement existing programs and plans to ensure, to the extent feasible, that activities undertaken pursuant to the measures complement, and do not interfere with,

[445] SB 32 (Pavley, Stats. 2016, ch. 249).
[446] AB 1493 (Pavley, Stats. 2002, ch. 200).
[447] SB 100 (De León, Stats. 2018 ch. 312).

existing planning efforts to reduce GHG emissions, criteria pollutants, petroleum-based transportation fuels, and toxic air contaminant emissions.

8. Incentivize and support emerging ZE technology that will be needed to achieve CARB's SIP goals.

9. Achieve maximum technologically feasible emissions reductions of GHGs that are real, permanent, quantifiable, verifiable, and enforceable (Health & Safety Code sections 38560, 38562(d)(1)).

10. Provide market certainty for ZE technologies and fueling infrastructure to guide the acceleration of the development of environmentally superior medium- and heavy-duty vehicles that will continue to deliver performance, utility, and safety demanded by the market.

11. Take steps to ensure all Californians can live, work, and play in a healthful environment free from harmful exposure to air pollution. Protect and preserve public health and well-being, and prevent irritation to the senses, interference with visibility, and damage to vegetation and property (Health & Safety Code section 43000(b)) in recognition that the emission of air pollutants from motor vehicles is the primary cause of air pollution in many parts of the state (Health & Safety Code section 43000(a)).

12. Spur economic activity of ZE technologies in the medium- and heavy-duty vehicle sectors. Incentivize innovation that will transition California's economy into greater use of clean and sustainable ZE technologies and promote increased economic and employment benefits that will accompany this transition (AB 1493,[448] section 1(g); Health & Safety Code Section 38501(e)).

A. List of Alternatives

CARB's portfolio of regulations already working to decarbonize the medium-, and heavy-duty transportation sector began with the ICT regulation CARB adopted in 2018, the ASB regulation and the Zero-Emission Powertrain Certification regulation, which CARB adopted in 2019, and the Advanced Clean Trucks regulation which CARB adopted in 2021. This proposed ACF regulation seeks to build an equitable transition for businesses that works towards decarbonizing the transportation sector in California. Staff listened to stakeholder concerns that involved 19 workshops and 366 meetings over the course of 2 years. Staff considered and integrated many stakeholder's concepts into the proposed ACF regulation. However, since the proposed ACF regulation seeks an optimum balance between feasibility and progress, staff rejected some of the of the concepts that were either more burdensome than the proposed ACF regulation and/or that were not as effective as the proposed ACF regulation. Some concepts staff considered but did not perform detailed emissions and cost projections for include various exemptions and narrowed applicability requirements that could create a market imbalance or opportunities to evade ownership models. And other concepts staff did not analyze because they were financially and administratively infeasible. Staff performed a full detailed cost and benefits analysis for a few proposed alternatives as bookends for this regulatory alternatives' analysis, these include: the least stringent

[448] AB 1493 (Pavley, Stats. 2002, ch. 200).

(combustion) and most stringent (acceleration) alternatives which were analyzed as part of the SRIA and CEQA, Appendix C and D, respectively.

Table 78 provides annual criteria emissions reductions benefits of these alternatives and staff's proposed ACF regulation, when compared to Legal Baseline or BAU. Staff's proposed ACF regulation is estimated to achieve 1.7 times the NOx and 16.7 times the PM2.5 emissions reductions benefits as the least stringent alternative. However, when compared to the most stringent alternative, staff's proposed ACF regulation is estimated to achieve 60 percent of the NOx and 63 percent of the PM2.5 benefits. Table 79 shows the valuation of the health benefits attributed to the criteria emissions reductions. The total statewide valuation of health benefits of the less stringent alternative is less than half of the proposed ACF regulation at about $25.6 billion and the more stringent alternative is about $34.3 billion more in health benefits than the proposed ACF regulation at $92.1 billion.

Table 78: Criteria Pollutant Reduction Comparisons to Business-as-Usual for the Staff Proposed ACF regulation, Less (Combustion) and More (Acceleration) Stringent Alternatives

Year	Alt. 1 (Combustion) NOx (tpd)	Proposed ACF regulation NOx (tpd)	Alt. 2 (Acceleration) NOx (tpd)	Alt. 1 (Combustion) PM2.5 (tpd)	Proposed ACF regulation PM2.5 (tpd)	Alt. 2 (Acceleration) PM2.5 (tpd)
2024	0.42	2.39	5.52	0.0002	0.03	0.07
2025	1.41	2.69	7.87	0.0032	0.04	0.12
2026	2.83	3.69	12.75	0.0059	0.05	0.20
2027	5.30	5.96	19.21	0.012	0.08	0.30
2028	8.04	7.78	25.23	0.018	0.11	0.40
2029	10.59	10.91	31.01	0.024	0.16	0.52
2030	13.49	15.24	37.83	0.034	0.24	0.64
2031	16.35	19.99	46.47	0.041	0.33	0.80
2032	19.13	24.42	55.21	0.045	0.41	0.97
2033	21.37	28.23	63.46	0.045	0.48	1.13
2034	23.66	34.05	72.28	0.048	0.60	1.30
2035	26.24	40.67	81.45	0.055	0.72	1.49
2036	27.94	46.12	87.06	0.055	0.83	1.61
2037	29.67	51.99	92.91	0.058	0.95	1.79
2038	31.38	58.15	98.92	0.061	1.07	1.95
2039	33.08	63.94	104.89	0.066	1.20	2.11
2040	34.78	68.59	106.71	0.071	1.31	2.19
2041	36.47	73.78	108.78	0.077	1.48	2.26
2042	38.14	79.56	111.01	0.084	1.64	2.34
2043	39.79	80.51	113.35	0.090	1.70	2.42
2044	41.41	81.65	115.90	0.096	1.77	2.50
2045	43.01	83.89	118.70	0.10	1.86	2.58
2046	44.57	86.30	121.83	0.11	1.94	2.67
2047	46.09	88.91	125.12	0.11	2.03	2.76
2048	47.59	91.66	128.58	0.12	2.12	2.85
2049	49.09	94.44	132.17	0.19	2.21	2.94

2050	50.60	97.24	135.93	0.12	2.29	3.03
Total[449]	**231,637**	**418,938**	**673,970**	**519**	**8,627**	**13,710**

Table 79: Health Benefits Comparisons to Business-as-Usual for the Staff Proposed ACF Regulation, Less (Combustion) and More (Acceleration) Stringent Alternatives (Million 2021$)

Year	Alternative 1 (Combustion)	Proposed ACF regulation	Alternative 2 (Acceleration)
2024	$10.45	$83.75	$188.46
2025	$41.93	$94.20	$272.21
2026	$83.75	$125.68	$450.28
2027	$167.55	$209.43	$691.13
2028	$251.30	$282.73	$921.53
2029	$335.05	$397.90	$1,162.44
2030	$429.37	$575.97	$1,434.77
2031	$523.63	$764.54	$1,790.85
2032	$617.90	$942.55	$2,146.93
2033	$701.70	$1,110.17	$2,503.12
2034	$785.45	$1,351.08	$2,880.22
2035	$879.77	$1,633.92	$3,299.20
2036	$942.67	$1,874.83	$3,550.68
2037	$1,005.51	$2,126.25	$3,854.37
2038	$1,068.35	$2,398.58	$4,147.72
2039	$1,131.19	$2,660.45	$4,441.02
2040	$1,194.03	$2,880.39	$4,556.30
2041	$1,267.38	$3,152.78	$4,692.49
2042	$1,330.22	$3,435.56	$4,828.63
2043	$1,393.07	$3,519.37	$4,964.82
2044	$1,455.91	$3,603.18	$5,111.52
2045	$1,518.80	$3,739.37	$5,268.62
2046	$1,581.64	$3,875.56	$5,425.84
2047	$1,644.48	$4,011.81	$5,603.91
2048	$1,696.87	$4,158.46	$5,782.03
2049	$1,759.77	$4,315.62	$5,960.22
2050	$1,812.15	$4,462.26	$6,148.74
Total*	**$25,629.94**	**$57,786.37**	**$92,078.05**

*Totals may not add up due to rounding.

Table 80 shows the annual CO_2 emissions reductions benefits of these alternatives and staff's proposed ACF regulation, when compared to Legal Baseline or BAU. Staff's proposed ACF regulation is estimated to achieve about 307 MMT CO_2 emissions reductions benefits more

[449] The total cumulative emissions reductions for PM2.5 and NOx are converted from tons per day into years and assumes 312 operational days per year. Due to rounding errors, the 2024-2050 cumulative totals differ very slightly when compared to the sum values listed.

than both BAU and the least stringent alternative. Compared to the most stringent alternative, staff's proposed ACF regulation is estimated to achieve 65 percent of the 472 MMT CO_2 benefits. The avoided cost benefits attributed to these estimated CO_2 emissions reductions are about $9.4 to $36.4 billion through 2050 when compared to the least stringent alternative. However, the more stringent alternative avoided cost benefits attributed to the GHG emissions reductions are about $13.5 to $54.4 billion through 2050. The avoided cost benefits are the SC-CO_2 discussed in detail in GHG Benefits Section.

Table 80: Greenhouse Gas Reduction Comparisons to Business-as-Usual for the Staff Proposed ACF Regulation, Less (Combustion) and More (Acceleration) Stringent Alternatives (Million 2021$)

Year	Alternative 1 (Combustion) CO_2 (MMT/yr.)	Proposed ACF regulation CO_2 (MMT/yr.)	Alternative 2 (Acceleration) CO_2 (MMT/yr.)
2024	0	0.26	0.83
2025	0	0.45	1.57
2026	0	0.81	2.67
2027	0	1.35	4.00
2028	0	1.79	5.22
2029	0	2.53	6.55
2030	0	3.52	7.96
2031	0	4.55	9.72
2032	0	5.54	11.52
2033	0	6.34	13.16
2034	0	7.52	14.89
2035	0	8.84	16.73
2036	0	9.84	17.86
2037	0	10.91	19.42
2038	0	12.04	20.95
2039	0	13.16	22.43
2040	0	14.26	23.11
2041	0	16.00	23.83
2042	0	17.63	24.56
2043	0	18.32	25.29
2044	0	19.02	26.04
2045	0	19.89	26.84
2046	0	20.76	27.68
2047	0	21.65	28.53
2048	0	22.55	29.39
2049	0	23.42	30.26
2050	0	24.27	31.15
Total*	**0**	**307.24**	**472.16**

*Totals may not add up due to rounding.

Table 81 shows the net cost and benefits to California's economy for staff's proposed ACF regulation as well as the least and most stringent alternatives, when compared to Legal Baseline or BAU. The cost to the California economy when assuming all costs occur in

California would be $3.5 billion between 2024 and 2050 in the least stringent alternative versus the Legal Baseline. Staff's proposed ACF regulation and the most stringent alternative have the most cost-savings at $22.1 billion and $22.5 billion, respectively. The benefit-cost ratio is greater than one in all cases suggesting that other metrics need to be considered when evaluating the proposal in comparison to alternatives. The total benefits of the proposal and Alternative 2 compared to Alternative 1 results in twice the health benefits and substantial GHG benefits that are not quantified in Table 80. Finally, the net benefit is the total benefits minus the total costs. This analysis shows that Alternative 2 (Acceleration) has more benefits than costs than both the least stringent Alternative 1 (Combustion) and the proposed ACF regulation. The reasons for rejecting the alternatives are discussed in more detail below.

Table 81: Total Statewide Benefit and Cost Comparison to Business-as-Usual of the Staff Proposed ACF Regulation, Alternative 1 (Combustion) and Alternative 2 (Acceleration)

Scenario	Total Costs	Cost-Savings	Net Costs	Health Benefits	Tax and Fee Revenue	Total Benefit*	Net Benefit**	Benefit: Cost Ratio
Combustion (less)	$6.7	$3.5	$3.2	$25.6	$0.7	$29.8	$23.1	4.5
Proposed ACF regulation	$63.4	$85.5	-$22.1	$57.8	-$33.0	$110.3	$46.9	1.7
Acceleration (more)	$112.5	$135.0	-$22.5	$92.1	-$57.9	$169.2	$56.7	1.5

*Total benefit is the sum of cost savings, health benefits, and tax and fee revenue.
**Net benefit is the total benefit minus the total costs.

1. Cleaner Combustion—Less Stringent

This alternative is less stringent than the proposed ACF regulation. This alternative is based on an alternative concept suggested by the California Council for Environmental and Economic Balance and applies to the same fleets as the proposed ACF regulation. [450] This alternative is characterized as a "cleaner combustion" option that would count engines certified to the Heavy-Duty Omnibus regulation equivalent to a ZEV purchase for the same regulated fleets as the proposed ACF regulation.

Under this alternative, regulated fleets would have the option to meet compliance requirements by purchasing a combination of ZEVs or engines certified to the engine standards established by the Heavy-Duty Omnibus regulation. All medium- and heavy-duty engines sold in California need to be certified to the latter standards, regardless of fuel type. Engines certified in California to the Omnibus regulation starting in 2024 are initially certified to standards 75 percent to 90 percent lower than U.S. EPA certified engines and have

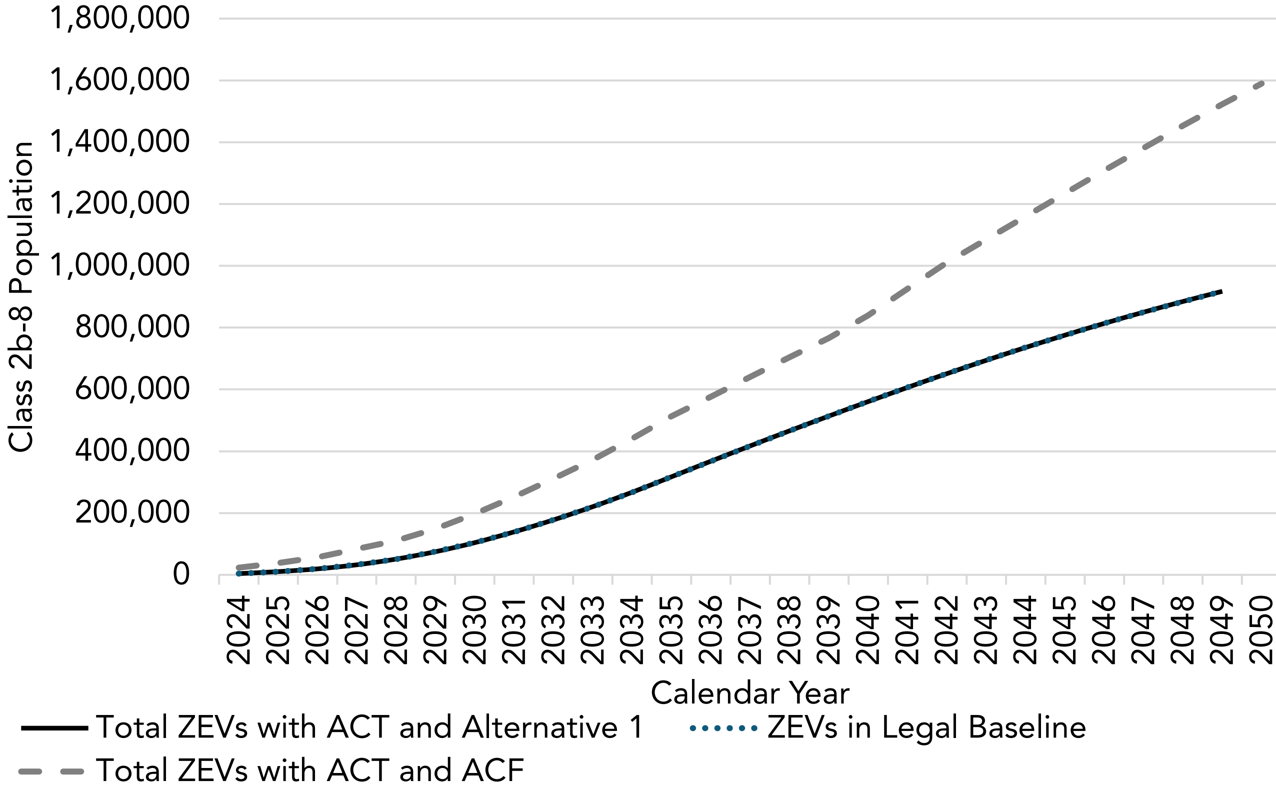
[450] California Council for Economic and Environmental Balance, *Re:Comments on Advanced Clean Fleets Proposed ACF regulation and Alternatives for the Environmental Analysis*, 2021 (web link: https://www.arb.ca.gov/lists/com-attach/29-acf-comments-ws-UDNUMVUxUGZWMlcl.pdf, last accessed August 2022).

additional requirements that ensure real world emissions remain low for a longer period of time in all modes of operation through improved test procedures, lengthened warranty, strengthened durability demonstrations, and other emissions control requirements.[451] We expect real world NOx emissions to be about 90 percent lower during the life of the vehicle than existing engines starting in 2024.

In this alternative, starting in 2024, State and local government fleets and high priority fleets would be required to purchase either ZEVs or engines certified to the California Heavy-Duty Omnibus engine standards. For State and local government fleets, this alternative is not expected to result in any changes because they already buy California certified engines. For high priority and federal fleets, this alternative is projected to result in accelerated emissions benefits and increased costs, as the fleets that would have otherwise normally purchased used federally certified engines in the baseline, would now be required to purchase new California Heavy-Duty Omnibus certified engines. For drayage fleets, pre-2024 MY trucks would be removed from the CARB drayage Online System at the end of their useful life and all vehicles added in the Online System would be either a ZEV or 2024 MY or newer engine certified to the Heavy-Duty Omnibus requirements. Under this alternative, the number of ZEVs would not increase beyond what is projected from the ACT regulation already reflected in the Legal Baseline. The Cleaner Combustion Alternative results in NOx emissions benefits relative to the Legal Baseline from the more stringent NOx standards of California certified engines compared to federal engine standards. This alternative also results in some PM2.5 emissions benefits and negligible GHG benefits. Figure 75 illustrates the ZEV population over time under combustion (Alternative 1) which results in roughly 650,000 ZEVs by 2035 and 950,000 ZEVs by 2050, the same number as in the Legal Baseline. This represents 200,000 fewer ZEVs by 2035 and 650,000 fewer ZEVs by 2050 when compared to the proposed ACF regulation. Because of the identical number of ZEVs between combustion (Alternative 1) and the Legal Baseline, the “ZEVs due to ACT” line overlaps with the “Total ZEVs” line.

[451] California Air Resources Board, *Heavy-Duty Omnibus: Appendix D – Emissions Inventory and Results for the Proposed Amendments*, 2020 (web link: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2020/hdomnibuslownox/appd.pdf, last accessed August 2022).

Figure 75: Statewide Vehicle Population Forecast over Time under Combustion (Alternative 1)



Although (Alternative 1) results in lower NOx, PM2.5, and GHG emissions compared to the Legal Baseline scenario, it is important to note that this alternative results in significantly fewer NOx, PM2.5, and GHG benefits compared to the proposed ACF regulation. Indeed, this result is readily apparent when considering the faulty underlying premise of this alternative – that the exhaust emissions generated by trucks powered by engines that emit low levels of emissions (e.g., 0.02 grams of NOx), are equivalent to emissions generated by trucks that emit zero emissions of criteria pollutants or GHGs.

Alternative 1 produces less criteria emissions reductions than the proposed ACF regulation, is less effective at meeting California's SIP obligations, and does not make progress towards meeting the State's GHG reduction targets. In addition, this alternative is not projected to result in any additional near-term emissions reductions compared to the proposed ACF regulation. Figure 76, Figure 77, and Figure 78 show the difference in GHG, NOx, and PM2.5 emissions between combustion (Alternative 1), the Legal Baseline, and the proposed ACF regulation.

Figure 76: Projected Greenhouse Gas Emissions under Legal Baseline, Proposed ACF Regulation, and Combustion (Alternative 1)

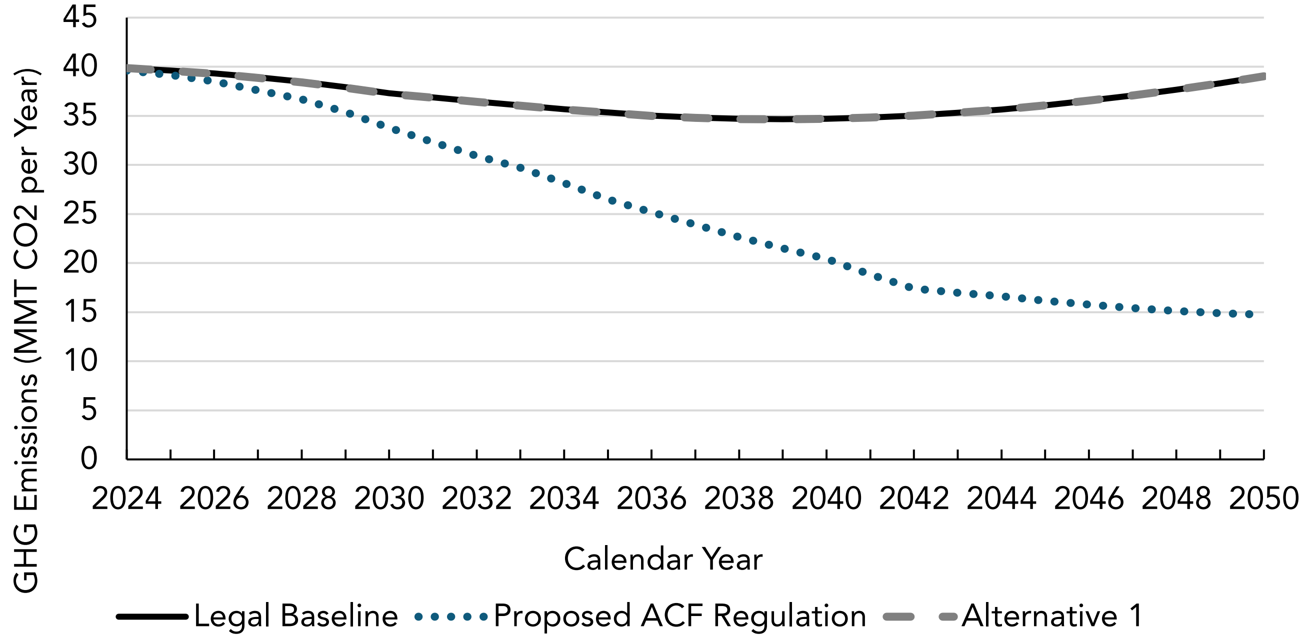


Figure 77: Projected NOx Emissions under Legal Baseline, Proposed ACF Regulation, and Combustion (Alternative 1)

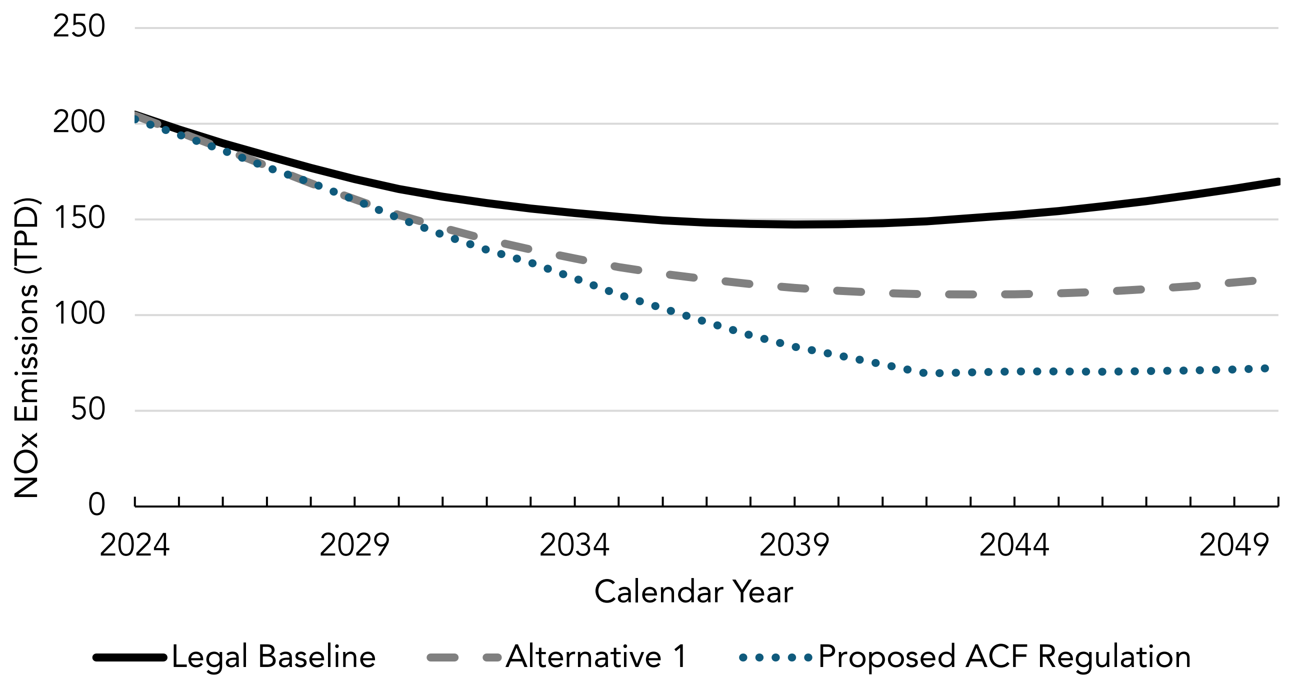
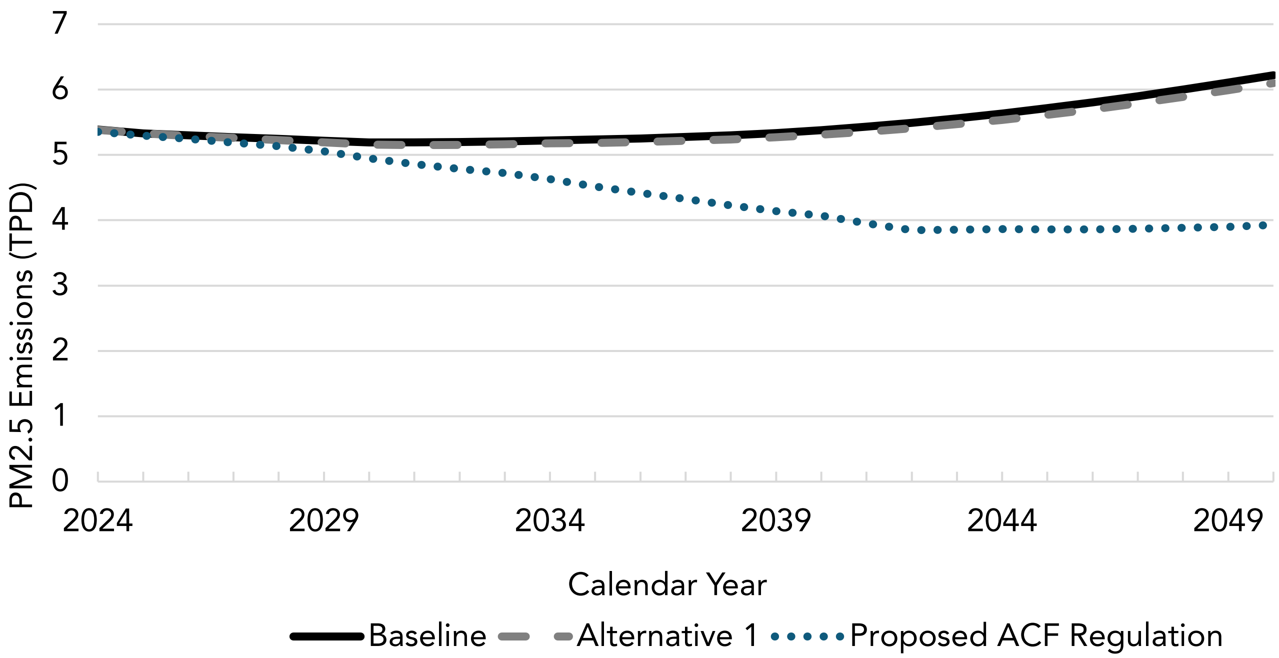


Figure 78: Projected PM2.5 Emissions under Legal Baseline, Proposed ACF Regulation, and Combustion (Alternative 1)



The Cleaner Combustion (Alternative 1) results in emissions reductions relative to the Legal Baseline leading to health benefits as shown in Table 82. The health benefits for this alternative are less than those of the proposed ACF regulation due to less emissions reductions estimated. The total statewide valuation of health benefits of the less stringent alternative is estimated to be $25.6 billion as summarized in Table 82.

Table 82: Statewide Valuation from Avoided Health Outcomes for Combustion Alternative 1 (Million 2021$)

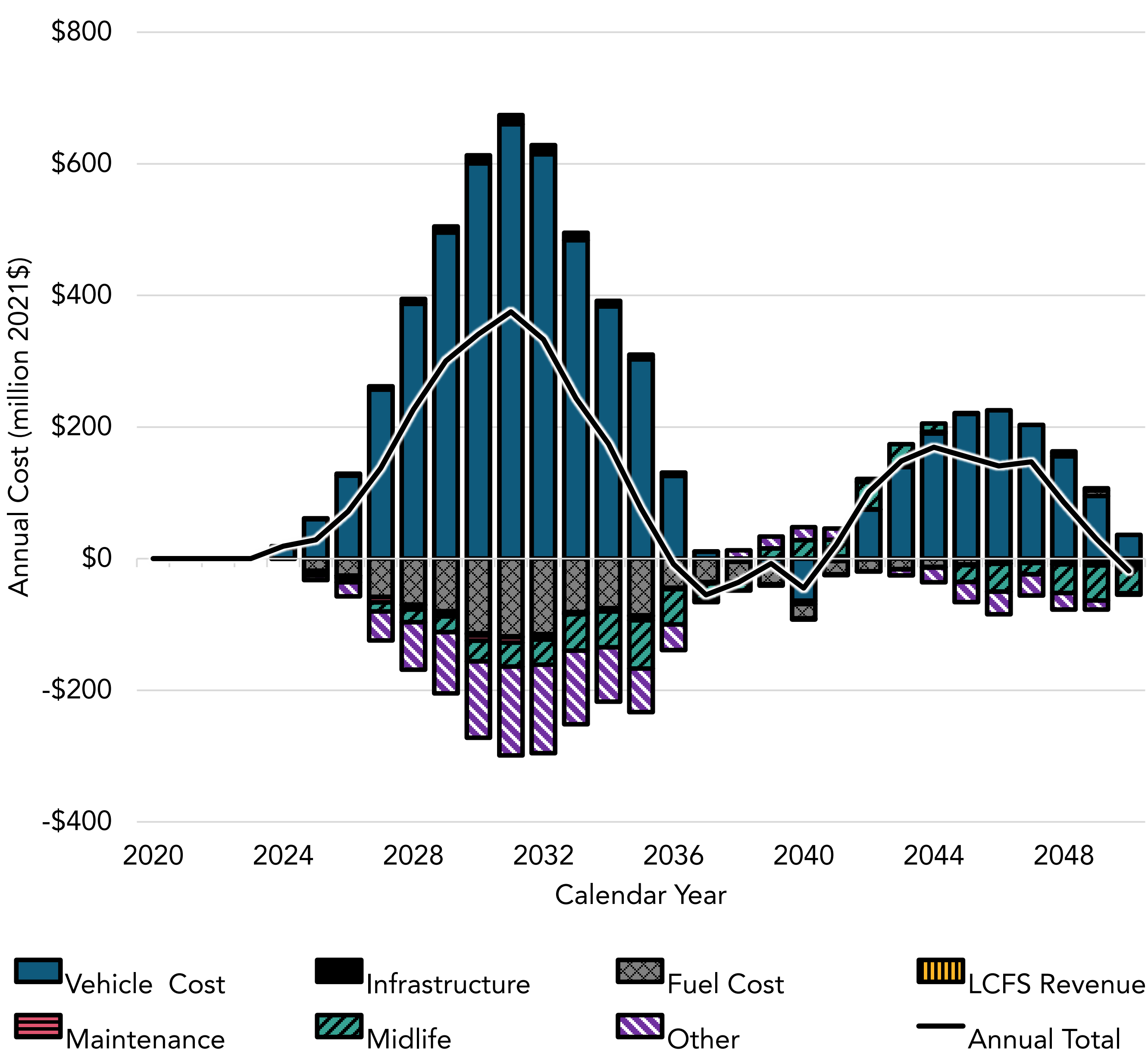
Calendar Year	Avoided Cardiopulmonary Mortality	Avoided Hospitalizations for Cardiovascular Illness	Avoided Hospitalizations for Respiratory Illness	Avoided ER Visits	**Total Avoided Annual Valuation**
2024	1	0	0	1	**$10.5**
2025	4	1	1	2	**$41.9**
2026	8	1	1	4	**$83.8**
2027	16	2	3	8	**$165.6**
2028	24	3	4	12	**$251.3**
2029	32	4	5	15	**$335.1**
2030	41	6	7	20	**$429.4**
2031	50	7	9	24	**$523.6**
2032	59	9	10	28	**$617.9**
2033	67	10	12	32	**$701.7**
2034	75	11	13	35	**$785.5**
2035	84	13	15	39	**$879.8**

Calendar Year	Avoided Cardiopulmonary Mortality	Avoided Hospitalizations for Cardiovascular Illness	Avoided Hospitalizations for Respiratory Illness	Avoided ER Visits	**Total Avoided Annual Valuation**
2036	90	14	17	42	**$942.7**
2037	96	15	18	44	**$1,005.5**
2038	102	16	19	47	**$1,068.4**
2039	108	17	20	50	**$1,131.2**
2040	114	18	21	53	**$1,194.0**
2041	121	19	23	55	**$1,267.4**
2042	127	20	24	58	**$1,330.2**
2043	133	21	25	61	**$1,393.1**
2044	139	22	26	63	**$1,455.9**
2045	145	23	28	66	**$1,518.8**
2046	151	24	29	68	**$1,581.6**
2047	157	25	30	71	**$1,644.5**
2048	162	26	31	73	**$1,698.9**
2049	168	27	33	75	**$1,759.8**
2050	173	28	34	78	**$1,812.2**
Total*	**$22,580.1**	**$23.6**	**$24.7**	**$1.0**	**$25,629.9**

*Note: Totals may differ due to rounding.

This alternative results in incremental costs of California certified engines versus federal certified engines which is partially offset by incremental savings associated with projected improved fuel economy of newer vehicles. The cost to the California economy when assuming all costs occur in California would be $3.5 billion between 2024 and 2050 in combustion (alternative 1) versus the Legal Baseline. Figure 79 illustrates the incremental difference in cost between combustion (Alternative 1) and the Legal Baseline scenario.

Figure 79: Total Estimated Direct Costs of Alternative 1 Relative to the Legal Baseline Scenario (Million 2021$)



a) Reason for Rejecting

Combustion (Alternative 1) is rejected because it is less effective at reducing emissions of criteria pollutants and greenhouse gases as the proposed ACF regulation. As shown in Table 78, Alternative 1 achieves minimal reductions of PM2.5 and greenhouse gases, and achieves significantly less reductions of NOx emissions (approximately 50 short tons less NO_X per day in 2049) than the proposed ACF regulation. This factor is critical because California needs to achieve the greatest degree of emissions reductions from criteria pollutants and greenhouse gases in order to reduce the serious risks to the health and welfare of Californians posed by such pollutants, to attain State and federal ambient air quality standards, and to address climate change-induced harms and carbon neutrality goals. Combustion (Alternative 1) also does not effectively advance the deployment of heavy-duty ZEVs as compared to the proposed ACF regulation, and is accordingly not consistent with the goals established by the Governor in multiple Executive Orders and by the Board. ZEV deployments are a key part of the SIP Strategy, and the Climate Change Scoping Plan as a necessary component needed to both improve California's air quality and to achieve the State's climate protection goals. Therefore, this alternative is rejected because it would not achieve the greatest degree of emissions reductions from criteria pollutants and GHGs that are needed to reduce the serious risks to the health and welfare of Californians posed by such pollutants, to attain State and federal ambient air quality standards, and to address climate change-induced harms and carbon neutrality goals. In addition, the alternative fails to advance the deployment of heavy-duty ZEVs, as expressed in direction by the Governor and the Board, as effectively as the proposed ACF regulation.

2. Accelerated Zero-Emission Vehicle Transition—More Stringent

Proposed by a coalition of 20 environmental, environmental justice, health, science-based advocacy, and labor organizations, this alternative proposes a more aggressive ZEV transition than the proposed ACF regulation. [452] Under this concept, the following modifications would be made to the proposed ACF regulation, all of which increase the stringency:

- Applicability for high priority and federal fleets would be expanded to include to any fleet which has ten tractors or more.
- The 100 percent manufacturer ZEV sales requirement would be accelerated to begin in 2036.
- The requirements for high priority and federal fleets would be accelerated by
    - Setting the ZEV Milestones Option for Group 2 vehicles to be the same as Group 1 which begins at 10 percent in 2025 ramping up to 100 percent in 2035; and
    - Setting the ZEV Milestones Option for sleeper cab tractors in Group 3 to be the same as the proposed Group 2 requirements which begins at 10 percent in 2027 ramping up to 100 percent in 2039.

The Accelerated ZEV Transition Alternative results in more medium- and heavy-duty ZEVs deployed than the Legal Baseline scenario and the proposed ACF regulation, and achieves more emissions benefits than the proposed ACF regulation. Figure 80 displays the alternative versus the Legal Baseline and proposed ACF regulation. The Accelerated ZEV Transition Alternative results in roughly 560,000 ZEVs by 2035 and 1,810,000 ZEVs by 2050. This is an increase of 860,000 ZEVs by 2050 versus the Legal Baseline and 230,000 more ZEVs in 2050 than the proposed ACF regulation. Criteria and GHG pollutant emissions reductions are shown in Figure 80, Figure 81, and Figure 82.

[452] 20 undersigned environmental, *Environmental justice, health, science-based advocacy, and labor organizations letter to CARB*, September 27, 2021 (web link: https://www.arb.ca.gov/lists/com-attach/64-acf-comments-ws-AGNXPlI+AD4BYgBu.pdf, last accessed August 2022).

Figure 80: Statewide Population Forecast over Time under Accelerated Zero-Emission Vehicle Transition (Alternative 2)

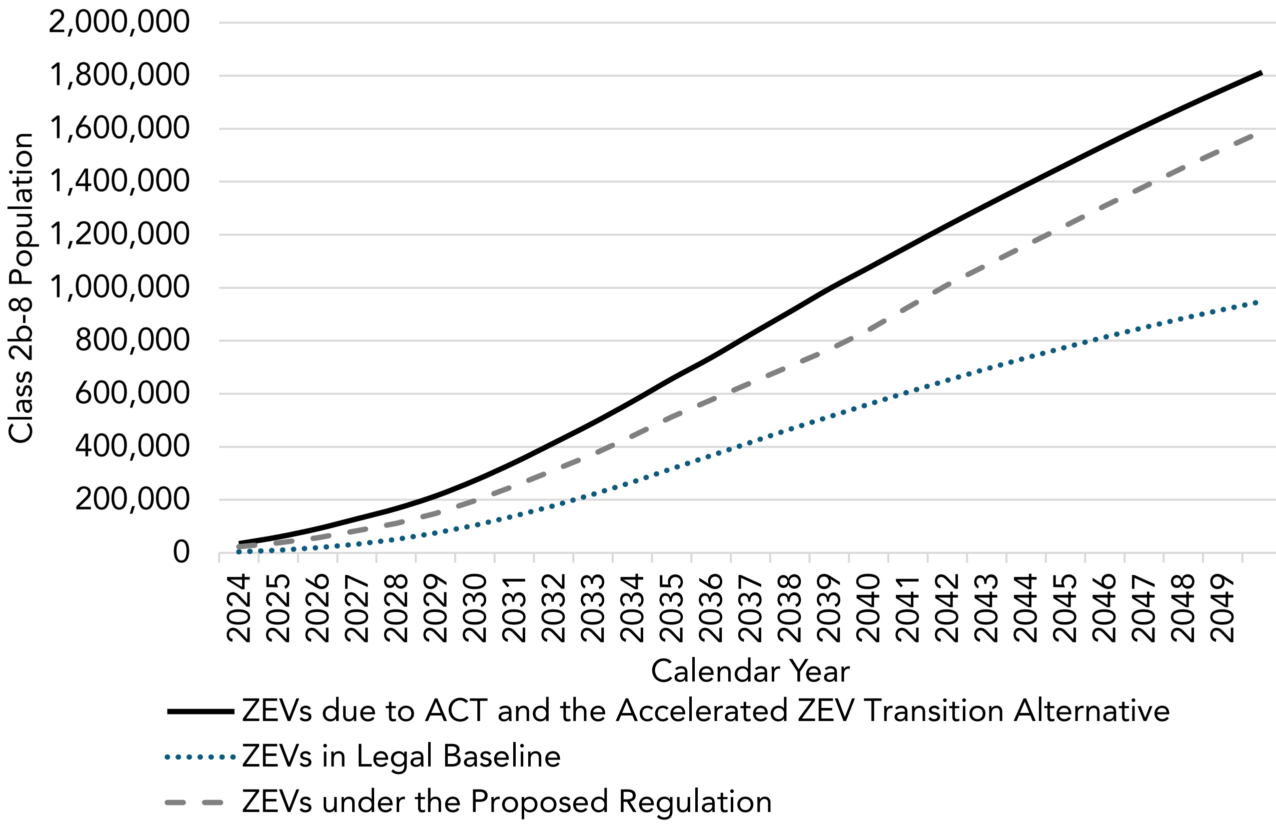


Figure 81: Projected NOx Emissions under Legal Baseline, Proposed ACF Regulation, and Accelerated Zero-Emission Vehicle Transition (Alternative 2)

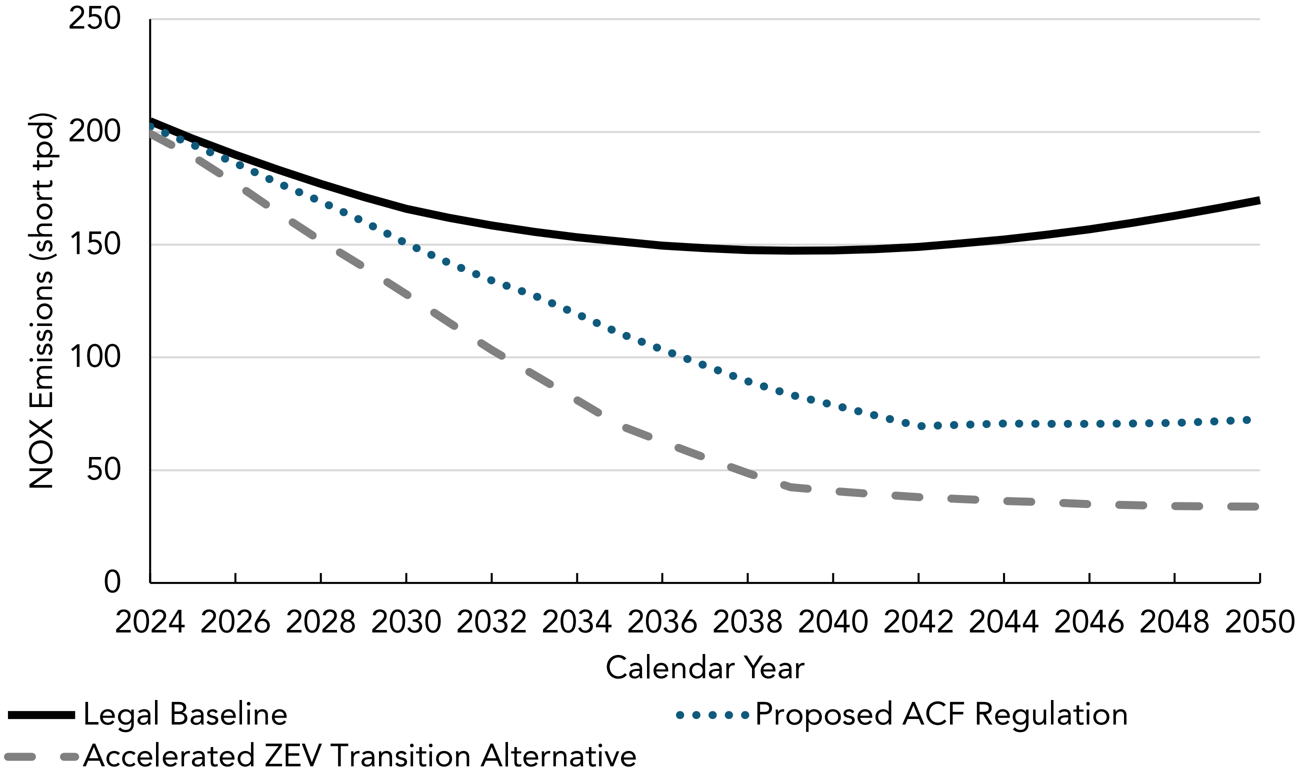


Figure 82: Projected PM2.5 Emissions under Legal Baseline, Proposed ACF Regulation, and Accelerated Zero-Emission Vehicle Transition (Alternative 2)

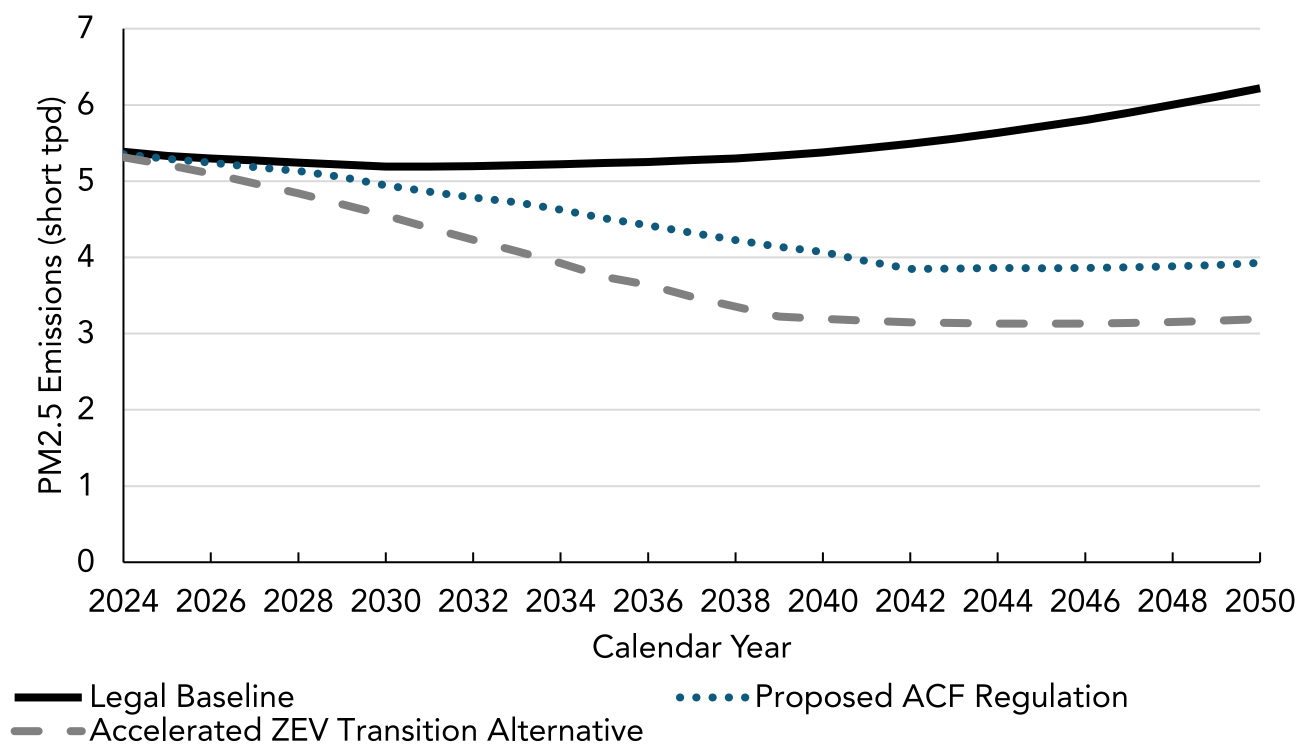
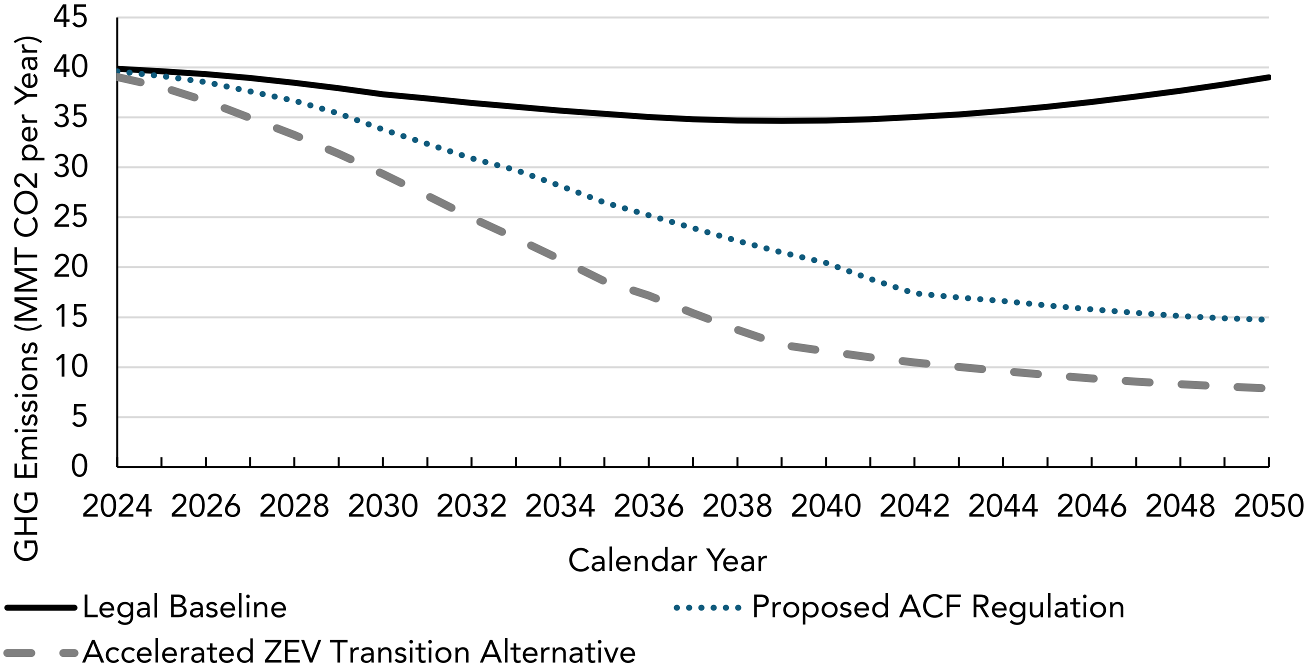


Figure 83: Projected Greenhouse Gas Emissions under Legal Baseline, Proposed ACF Regulation, and Accelerated Zero-Emission Vehicles Transition (Alternative 2)



The Accelerated ZEV Transition Alternative results in emissions reductions relative to the Legal Baseline leading to health benefits. The health benefits for this alternative are more than those of the proposed ACF regulation due to more emissions reductions estimated. The total statewide valuation of health benefits of the more stringent alternative is estimated to be $92 billion as summarized in Table 83. Totals may not add up due to rounding.

Table 83: Statewide Valuation from Avoided Health Outcomes for Accelerated Zero-Emission Vehicle Transition (Alternative 2) (Million 2021$)

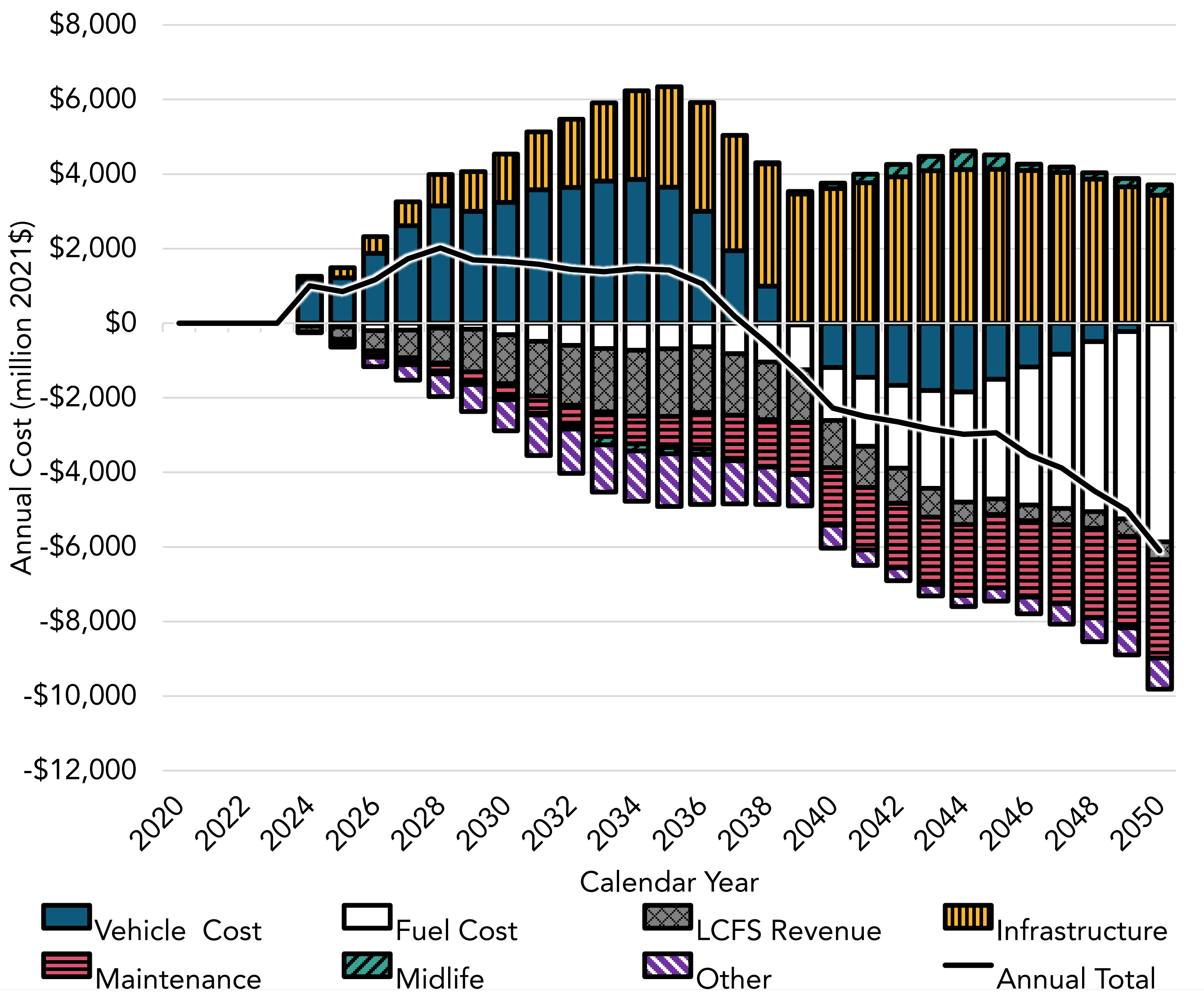
Calendar Year	Avoided Cardiopulmonary Mortality	Avoided Hospitalizations for Cardiovascular Illness	Avoided Hospitalizations for Respiratory Illness	Avoided ER Visits	**Total Avoided Annual Valuation**
2024	18	2	3	9	**$188.46**
2025	26	3	4	13	**$272.21**
2026	43	6	7	21	**$450.28**
2027	66	9	11	32	**$691.13**
2028	88	12	15	43	**$921.53**
2029	111	16	19	53	**$1,162.44**
2030	137	20	24	66	**$1,434.77**
2031	171	25	30	81	**$1,790.85**
2032	205	30	36	98	**$2,146.93**
2033	239	36	43	113	**$2,503.12**
2034	275	42	50	130	**$2,880.22**
2035	315	48	58	148	**$3,299.20**
2036	339	53	63	159	**$3,550.68**

Calendar Year	Avoided Cardiopulmonary Mortality	Avoided Hospitalizations for Cardiovascular Illness	Avoided Hospitalizations for Respiratory Illness	Avoided ER Visits	**Total Avoided Annual Valuation**
2037	368	57	68	172	**$3,854.37**
2038	396	62	74	184	**$4,147.72**
2039	424	67	79	196	**$4,441.02**
2040	435	69	82	201	**$4,556.30**
2041	448	71	85	206	**$4,692.49**
2042	461	73	87	211	**$4,828.63**
2043	474	75	90	217	**$4,964.82**
2044	488	78	93	223	**$5,111.52**
2045	503	80	96	229	**$5,268.62**
2046	518	83	100	236	**$5,425.84**
2047	535	86	103	243	**$5,603.91**
2048	552	89	107	250	**$5,782.03**
2049	569	93	111	257	**$5,960.22**
2050	587	96	114	265	**$6,148.74**
Total*	**$91,900.21**	**$85.28**	**$88.98**	**$3.59**	**$92,078.05**

*Note: Totals may differ due to rounding.

This alternative increases the number of medium- and heavy-duty ZEVs sold in California relative to the Legal Baseline. ZEV sales would also be higher than under the proposed ACF regulation. This results in higher initial costs and lower net costs to California compared to the Legal Baseline. The cost to the California economy when assuming all costs occur in California would be -$22.5 billion between 2024 and 2050 for this alternative versus the Legal Baseline. Figure 84 illustrates the incremental difference in cost between this alternative and the Legal Baseline scenario. The negative costs correspond to a net savings.

Figure 84: Total Estimated Direct Costs of Accelerated Zero-Emission Vehicle Transition Alternative Relative to the Legal Baseline Scenario (Million 2021$)



a) Reason for Rejecting

The Accelerated ZEV Transition Alternative would expand the number of tractor fleets regulated, accelerate requirements for day cabs, sleeper cabs, and work trucks, and bring the 100 percent ZEV sales requirement forward to 2036 MY. This alternative is rejected as the more aggressive timeframe raises questions about feasibility for certain fleets in the near-term while the ZEV market is still developing. Increasing the requirements further by accelerating regulatory deadlines would introduce potential market imbalances between required ZEV sales and purchases. Also, during the transition this alternative would affect more fleets and lessons learned may not be leveraged which could slow progress during early implementation. This alternative would immediately bring in a wide range of smaller businesses that could have less access to capital versus larger fleets and might face difficulty making the needed investments in zero-emission vehicles and infrastructure. Additionally, many of these smaller businesses may not operate in major transportation corridors where retail infrastructure is more likely to be sited in the early years and will need to install infrastructure. Smaller fleets may also be at a disadvantage since these small businesses may not be easily adjust their prices in comparison to high priority fleets that establish market prices. In addition, earlier requirements for work trucks, day cabs tractors, and sleeper cab tractors raise feasibility concerns regarding the availability of publicly available infrastructure as fleets operating these vehicles are more likely to rely on publicly available infrastructure. This alternative also proposes an earlier end date for combustion technologies which increases risks about feasibility for trucks with more challenging use cases, although the 2036 timeframe does provide time for ZE solutions to be identified.

With an accelerated timeframe, smaller tractor fleets would not have the opportunity to learn from the experiences of early adopters and larger fleets. For a smooth transition to ZEV technologies, sufficient time is needed to build-out maintenance, supply, and infrastructure networks to make a full transition to ZEVs. Smaller fleets are more likely to rely on publicly available charging infrastructure and independent maintenance and service technicians that is still in the process of being developed and may not be available where needed in all cases. Additionally, smaller fleets are more likely to purchase used vehicles, which may not be available as ZEVs due to this alternative's accelerated timeframe. This would as a result in more costly vehicle additions as well as an administrative burden for fleets and CARB staff with potential increases in exemption requests as well as other unintended consequences.

Additionally, market forces need to be considered in expanding the early ZEV market. The ACT regulation guarantees a supply of ZEVs in the California market. However, this alternative would result in a fast ramp-up of additional ZEV demand significantly above the expected supply of ZEVs, that may result put upward pressure on vehicle prices. Market dynamics concentrated in the hands of consumer fleets would help maintain downward price pressures and would bring ZEV costs in line with other technologies sooner. Ultimately, this alternative is rejected because it raises additional questions about timing, introduces additional uncertainty associated with the feasibility of successfully deploying ZEVs in the early market, and results in imbalanced market forces that could slow ZEV deployment. Staff will continue to analyze the rapidly evolving technical progress of these vehicle classes to determine if additional stringency or future regulation is warranted. The end date of 2040 for combustion sales in California was selected to complete a full transition to ZEV, and to meet the goals in Executive Order N-79-20. The 2040 end date provides more than ample time for a steady transition to the clean energy economy utilizing the natural rate of attrition and job sector shifts. Additionally, California endorses the Global MOU on Medium- and Heavy-Duty ZEV which established the same target of 100 percent sales by 2040 to enable a full transition.[453] Staff anticipates that critical regional corridor infrastructure will be available and higher incremental upfront cost for ZEV when compared to ICE vehicles will be overcome by 2040. However, staff will continue to investigate the pros and cons of accelerating the 100 percent ZEV date from 2040 to an earlier date.

[453] Memorandum of Understanding on Zero-Emission Medium- and Heavy-Duty Vehicles. (web link: *https://globaldrivetozero.org/site/wp-content/uploads/2021/12/Global-MOU-ZE-MHDVs-signed-20-Dec-21.pdf*, last accessed August 2022).

B. Other Concepts

1. "Legal Baseline" or Business-as-Usual Baseline

Staff examined the BAU, also referred to as the "Legal Baseline" in the CEQA analysis. In this alternative, the proposed ACF regulation is never developed. This alternative results in roughly 650,000 ZEVs by 2035 and 950,000 ZEVs by 2050, which is well below the ZEV targets established by Executive Order N-79-20 and CARB Resolution 20-19. The ACT manufacturer sales mandate jump starts the ZEV market by accelerating the ZE transition—shifting from innovation to commercialization. This proposed ACF regulation builds on ACT by establishing demand for medium– and heavy-duty trucks, and the much-needed build-out of ZE charging and hydrogen fueling infrastructure.

The No Project Alternative is included only to assist in the analysis and consideration of this portion of the proposed ACF regulation and the action alternatives. It is useful to include a "No Project Alternative" in this analysis for the same reasons that this type of alternative is called for in the State CEQA Guidelines. As noted in the CEQA Guidelines, "the purpose of describing and analyzing a no project alternative is to allow decision-makers to compare the impacts of approving the proposed ACF regulation with the impacts of not approving the proposed ACF regulation" (Cal. Code Regs., tit. 14 § 15126.6(e)(1)). The No Project Alternative also provides an important point of comparison to understand the potential environmental benefits and impacts of the other alternatives.

Beneficial impacts resulting from the proposed ACF regulation would not occur under the No Project Alternative. This would include no reduction of criteria pollutants, toxic air contaminants, and GHGs beyond what is required under existing regulations and would not protect public health. The No Project Alternative would fail to support the manufacturer sales requirements of ZEVs in the ACT regulation and other related programs.

Under the No Project Alternative, the proposed ACF regulation would not occur, and existing conditions would continue. Truck sales would continue as they have been and in line with the projected ZEV sales from the existing ACT regulation which is already expected to result in about 280,000 ZEVs by 2035.

2. Match Advanced Clean Trucks and Advanced Clean Fleets Zero-Emission Vehicle Deployments Exactly

Supported by the Truck and Engine Manufacturers Association, this concept would align ZEV deployment criteria between the proposed ACF regulation with the ACT sales requirements. [454] This concept would require fleets to purchase the same types of commercial ZEVs and in the same quantities as produced by the manufacturers in the ACT rule. To match ZEV sales with fleet demand, manufacturers would be responsible to track the usage of trucks under this alternative, which would be difficult to realistically implement, and would ultimately delay the market availability and deployment of ZEVs. Also embedded in this concept is relief for

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[454] Truck and Engine Manufacturers Association, *Letter to CARB*, October 29, 2021 (web link: https://www.arb.ca.gov/lists/com-attach/105-acf-comments-ws-V2VUYlBjVjRSC1Bh.pdf, last accessed August 2022).

the manufacturers from the ACT requirements if a fleet is awarded an exemption from the ACF purchase requirements.

This concept also proposes that manufacturers subject to the ACT regulation generate a full credit for the sale of an NZEV because NZEVs and ZEVs are treated equally under the ACF compliance requirements. To put this in context, under the current ACT regulation manufacturers receive partial ZEV credits for producing NZEVs, whereas the proposed ACF regulation would allow fleets to purchase NZEVs to meet their ZEV obligations if a ZEV is not available or if an NZEV best meets their operational needs, and would allow manufacturers to receive full ZEV credit for producing NZEVs qualifying for those exemptions However, to meet California's GHG reduction goals and move to a 100 percent ZE transportation future, a manufacturer sales requirement that assigns maximum credit to the production and sales of ZEVs over NZEVs is necessary to first ensure ZEVs are available and fully supported as fleet purchase requirements and second allow for NZEV production in the early years to be used as a bridging technology until ZEVs can be fully supported through a well-established infrastructure framework. This alternative would still result in NZEV and ZEV deployment, but it does not incentivize manufacturers to produce more ZEVs than NZEVs than what is already required by ACT.

For this concept, the net cost for ZEV deployment would not change; only the allocation of the cost to the fleet or the manufacturer would differ. As a result, the number of ZEVs would not increase compared to the proposed ACF regulation. Therefore, this alternative was rejected at this time because, compared to the proposed ACF regulation, it fails at meeting all project goals mainly due to the lack of medium- and heavy-duty ZEV deployment, delay in development of depot infrastructure, and lack of market certainty.

3. Exempt Group 2 and 3 Vehicles and Extend Timeline Six Years to Purchase Group 1 Zero-Emission Vehicles

Supported by the California Trucking Association (CTA), this alternative is less stringent than the proposed ACF regulation by proposing changes to the ZEV Milestones Option for high priority fleets and in essence would focus ZEV deployments to vehicles currently contained in Group 1 (light-duty package delivery vehicles, box trucks, vans, buses with two axles, and yard tractors). [455] This alternative would delay the ZEV milestones Group 1 purchase schedule by six years and shift the deployment strategy for new ZEVs in Group 2 (work trucks, day cab tractors, and buses with three axles) and Group 3 (sleeper cab tractors and specialty vehicles) to the public using incentive funding.

This alternative would exempt ZEV requirements for most regional or long-haul applications and fails to provide the market certainty and the needed infrastructure investments to develop a charging or hydrogen fueling network for a 100 percent transition to ZEVs. Additionally, the ZEV purchase delay for all Group 1 vehicles would hinder infrastructure build-out and is contrary to current recommended ZEV deployment strategies that show electrification of these vehicles in last mile delivery applications is feasible today.

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[455] California Trucking Association, *Letter to CARB*, October 29, 2021 (web link: https://www.arb.ca.gov/lists/com-attach/126-acf-comments-ws-AGNQIgFhBHoLbFIm.pdf, last accessed August 2022).

This alternative also recommends relying on incentive funding to spur ZEV deployments for Group 2 and 3 vehicles. To date, CARB has administered over $8 billion dollars in funding to support clean transportation. These investments have played a critical role helping advance technologies and bringing us to where we are today. Although incentives are a critical component for the demonstration phase and early adoption of emerging technologies, they are not a sustainable way for a long-term ZEV transition. This can only be accomplished through well-established goals like those in the ZEV Milestones targets for Groups 1, 2, and 3 vehicles of the proposed ACF regulation. Eliminating Group 2 and Group 3 vehicles from purchase requirements would impact California businesses unequally, and high polluters would continue operating in and around overburdened communities.

This alternative additionally has the potential to create a market imbalance and could create an incentive for fleet owners to change their operating characteristics to be excluded from the requirements. Furthermore, this alternative would achieve much fewer air quality benefits than the proposed ACF regulation and would not be as effective at advancing the adoption of medium- and heavy-duty ZE technologies and develop a self-sustaining ZEV market, which is a cornerstone of California's long-term transportation strategy to reduce localized pollution and GHG emissions.

Furthermore, this alternative would not result in any additional ZEV deployments or would result in significantly fewer ZEV deployments than the proposed ACF regulation. Therefore, this alternative is rejected at this time as it fails to meet objective 1, 4, and 10 due to the deceleration of ZEV deployment, a lack of market certainty for ZE technologies and fueling infrastructure, and failing to meet goals of the SIP, while also being less efficient in meeting objectives 2, 3, 5, 6, 8, 11, and 12 compared to the proposed ACF regulation. Additionally, this alternative would delay development of a retail fueling/charging infrastructure network, associated construction expansion, and scalability. Continuing, this alternative would delay development of a retail fueling/charging infrastructure network, associated construction expansion, and scalability and would not be as effective at meeting program objectives.

4. Exempt Small Fleets and Interstate Truckers

Supported by the Owner-Operator Independent Drivers Association (OOIDA), this alternative is less stringent than the proposed ACF regulation because it would exempt small owners of trucks registered and operated in California that are managed by, or dispatched by, a "controlling party" from meeting the ZEV purchase mandate prior to 2045.[456] This alternative would also exempt any interstate truck owner or operator that drives fewer than 7,500 miles in California in any compliance year. Under the proposed ACF regulation, "controlling parties" act like a fleet owner and are held to the same requirements to avoid shifting business practices with the intention of evading ownership models. Under this alternative, fleets managed by "controlling parties" could modify their dispatch practices to prioritize hiring interstate truck owners to circumvent the proposed ACF regulation's ZEV purchase requirements. Exempting small truck owners that are paid to deliver goods by "controlling

[456] Owner-Operator Independent Driver Association, *Comment letter to CARB*, October 29, 2021 (web link: https://www.arb.ca.gov/lists/com-attach/118-acf-comments-ws-BjRVYwY1UTMAKFBh.pdf, last accessed August 2022).

parties" subject to the proposed ACF regulation would impact California businesses unequally, and high polluters would continue operating in California's communities.

This alternative would not apply to long-haul applications and would not provide the market certainty for the needed infrastructure investments to develop a charging or hydrogen fueling network. Furthermore, in addition to potentially creating a market imbalance, this alternative concept would not be as effective at advancing the adoption of medium- and heavy-duty ZE technologies and develop a self-sustaining ZEV market, which is a cornerstone of California's long-term transportation strategy to reduce localized pollution and GHG emissions. Continuing, this alternative would not result in any additional ZEV deployments or would result in significantly fewer ZEV deployments than the proposed ACF regulation.

Therefore, this alternative was rejected because it fails to meet objective 4 and 10 due to a lack of market certainty for ZE technologies and fueling infrastructure as well as failing to meet goals of the SIP, while also being less efficient in meeting objectives 1, 2, 3, 5, 6, 8, 11, and 12 compared to the proposed ACF regulation. Additionally, this alternative would delay development of a retail fueling/charging infrastructure network, associated construction expansion, and scalability.

5. Exempt Refuse Fleets Subject to Senate Bill 1383

This alternative proposes to exempt a solid waste fleet owner until at least 2040 from ZEV requirements if they meet all of the following criteria: the fleet must be located in-state, owned by or contracted with municipalities implementing SB 1383, collecting and processing in-state organic waste into RNG or working in partnership with a facility producing in-state RNG from their organic waste, and using RNG in their own SWCVs. [457] This alternative is based on comments submitted by CR&R Incorporated and Coalition of Waste Management Providers. This alternative is less stringent because it would exempt a small class of fleet owners and qualifying vehicles, resulting in more emissions than the proposed ACF regulation.

Currently, about half of the refuse trucks that operate in California are fueled by natural gas and the other half are fueled by diesel.[458] Based on this distribution, refuse fleets would be impacted unequally under this alternative and refuse fleets that qualify for this exemption would be granted additional time to purchase and deploy ZEVs. However, refuse fleets that operate diesel-fueled vehicles would not be eligible to delay ZEV deployments. Additionally, refuse vehicles operate in and around neighborhoods with a duty cycle and usage pattern conducive to using a ZE powertrain, e.g., low speed, frequent breaking, and returning to base at night. This alternative would delay the transition to a ZE transportation system and would simply prolong the BAU conditions for these fleets.

Natural gas engine NOx emissions are no different than diesel starting in 2024 because of the Heavy-Duty Omnibus regulation as previously described. In addition, natural gas vehicles are not expected to achieve any GHG reductions and generally have a 15 to 20 percent

[457] SB 1383 (Lara, Stats. 2016, ch. 395).

[458] CARB, *EMFAC*, 2021 (web link: https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/msei-modeling-tools-emfac-software-and, last accessed August 2022).

lower fuel economy than their diesel counterparts[459] and, after factoring in upstream methane emissions, are more harmful to the climate than diesel trucks.[460] Any benefits and costs associated with the use of RNG and other low carbon transportation fuels are already reflected in the baseline due to the LCFS regulation and would not be new reductions.

Supporters of this alternative have stated that transitioning to ZEV technologies and infrastructure would result in stranded assets because the RNG recovered from the SB 1383 mandated conversion of organic waste would diminish their ability to use this RNG in their collection vehicles. However, staff believes that the proposed ACF regulation does not conflict with the organic waste product procurement targets established by enacting SB 1383 since the recovered organic waste product procurement targets for jurisdictions does not require them to purchase RNG directly for use as a transportation fuel. In fact, a recent CPUC decision that implements SB 1440 creates a viable alternative to CARB's LCFS for RNG purchased by utilities and are used in the residential sector. [461,462] Additionally, LCFS credits have a 10-year guarantee after a digester project is operational and CNG trucks have an average vehicle lifetime of 15 years and would not be required to be replaced in less than 18 years. Therefore, staff does not foresee the proposed ACF regulation's ZEV purchase mandate as a barrier for refuse fleets recovering investments in their existing CNG vehicles, or even for new vehicles purchased up until the ZEV mandates take effect. In addition to directing RNG away from the transportation sector, SB 1440 creates RNG procurement targets for the IOUs and prohibits them from procuring biomethane from organic diversion facilities that do not commit to exclusively purchasing and/or leasing Class 8 NZEVs or ZEVs. CPUC's Renewable Gas Standard will be re-evaluated in 2025 and this review includes limiting RNG procurement contracts to facilities that commit to purchasing or leasing exclusively Class 8 ZEVs. This new RNG market created by a Renewable Gas Standard could provide revenue for digesters built to comply with SB 1383.

Finally, California has the potential to produce a limited amount of RNG from dairy, landfill, municipal solid waste, and wastewater treatment facility sources.[463] This alternative would prolong CNG vehicle use that is increasingly competing with other, harder-to-decarbonize sectors than transportation. CARB's AB 32 Scoping Plan scenario number 3 (Figure 85) predicts CNG vehicle growth rate to be relatively flat and insignificant overall, which should

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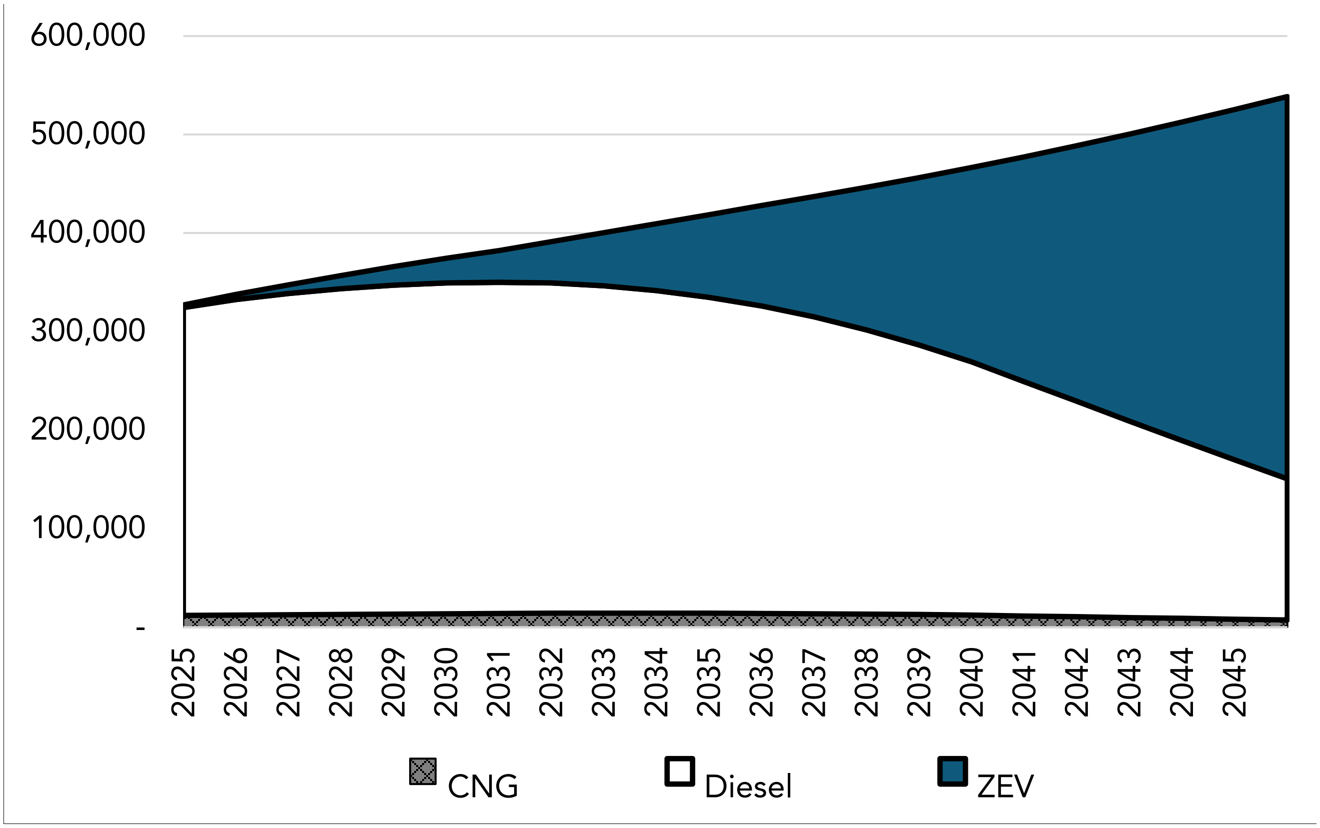
[459] CEC Energy Almanac, *Transportation Natural Gas in California*, 2019 (web link: https://ww2.energy.ca.gov/almanac/transportation_data/cng-lng.html, last accessed August 2022).
[460] International Council on Clean Transportation, *A comparison of NOx emissions from heavy-duty diesel, natural gas, and electric vehicles*, 2021 (web link: https://theicct.org/sites/default/files/publications/low-nox-hdvs-compared-sept21.pdf, last accessed August 2022).
[461] SB 1440 (Hueso, Stats. 2018 ch. 739).
[462] California Public Utilities Commission, *Decision 22-02-025 Implementing SB 1440 Biomethane Procurement Program*, 2022 (web link: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M454/K335/454335009.PDF, last accessed August 2022).
[463] STEPS Program, Institute of Transportation Studies, UC Davis, *The Feasibility of Renewable Natural Gas as a Large-Scale, Low Carbon Substitute*, 2016 (web link: https://ww2.arb.ca.gov/sites/default/files/classic/research/apr/past/13-307.pdf, last accessed August 2022).

be a clear indication of the need to utilize RNG in other, harder-to-decarbonize sectors than transportation, or as a feedstock for energy and materials.[464]

Figure 85: Stacked Area Chart Depicting Heavy-Duty Vehicle Stocks for Compressed Natural Gas, Diesel, and Zero-Emission Vehicles Projected Out from 2025 to 2045 as Predicted by Alternative 3.



Therefore, this alternative is rejected because it would be less effective than the proposed ACF regulation in meeting ZEV-related project objectives 1, 6, 8, 10, and 12 as it would result in fewer ZEVs, less ZEV infrastructure build-out, less ZEV innovation and less ZEV-related economic activity. This alternative also fails to meet 100 percent ZEV targets for refuse trucks by 2040 established in CARB Resolution 20-19.[465] In addition, this alternative is also less effective at meeting GHG-related goals described in project objectives 3, 5, and 9. Furthermore, this alternative would be less effective than the proposed ACF regulation at meeting objectives 2, 4, 7, and 11.

[464] California Air Recourses Board, *Draft AB 32 Scoping Plan. Data for this chart taken from AB 32 GHG Inventory Sectors Modeling Data Spreadsheet*, 2022 (web link: https://ww2.arb.ca.gov/sites/default/files/2022-05/2022-draft-sp-PATHWAYS-data-E3.xlsx, last accessed August 2022).
[465] CARB, *Public Hearing to Consider The Proposed Advanced Clean Trucks Regulation Resolution 20-19*, 2020 (web link: https://ww2.arb.ca.gov/sites/default/files/barcu/board/res/2020/res20-19.pdf, last accessed August 2022).

6. Focus Zero-Emission Vehicle Requirements on Return to Base Concepts

Proposed by the California Council for Environmental and Economic Balance (CCEEB), this alternative is less stringent than the proposed ACF regulation because it would limit ZEV deployments to fleets that utilize centralized depot charging as the primary BEV charging strategy and would not apply to other fleets. As an example, this alternative would impose ZEV requirements for parcel delivery trucks that operate on regular routes with more than 100 stops per day that return to a depot for charging at the end of the shift. This alternative would result in fewer ZEV purchases than the proposed ACF regulation and therefore would achieve fewer emissions reductions. This alternative also would not apply to most regional or long-haul applications and would not provide the market certainty for the needed infrastructure investments to develop a charging or hydrogen fueling network. Additionally, it would be less effective at reducing emissions from semi-trucks that are a major contributor to medium- and heavy-duty vehicle emissions around warehouses and in our communities.

This alternative has the potential to create a market imbalance as well as an incentive for fleet owners to change their operating characteristics to be excluded from the requirements. Furthermore, this alternative concept would not be as effective at advancing the adoption of medium- and heavy-duty ZE technologies as well as developing a self-sustaining ZEV market, which is a cornerstone of California's long-term transportation strategy to reduce localized pollution and GHG emissions. Therefore, this proposed alternative is rejected because it would not result in any additional ZEV deployments or would result in significantly fewer ZEV deployments than the proposed ACF regulation. This alternative would delay development of a retail fueling/charging infrastructure network, associated construction expansion, and scalability and would not be as effective at meeting program objectives.

This alternative was rejected because it fails to meet objectives 4, 8 and 10 of the proposed ACF regulation as it does not support emerging ZE technology needed to achieve CARB's SIP goals nor does it provide market certainty for ZE technologies and fueling infrastructure. Additionally, the alternative is less efficient in meeting objectives 1, 2, 3, 5, 6, 11, and 12 compared to the proposed ACF regulation.

7. Credit for Zero-Emission or Natural Gas Vehicles

Presented by the Western States Trucking Association, this alternative proposes that early action credit should be granted to early adopters of both ZE trucks and low-NOx trucks, stemming from the adoption of natural gas vehicles that have already been deployed in the construction, utility, and waste collection industries to historically offset diesel emissions. [466]

As discussed under the BACT alternative, while reducing emissions of NOx, low-NOx engines do not achieve any additional GHG reductions and would not reduce PM from tire wear, compared to existing trucks. The potential use of renewable fuels including RNG and RD procured by fleets are already covered under the LCFS program and Heavy-Duty Omnibus

[466] Western States Trucking Association, *letter to CARB*, September 27, 2021 (web link: https://www.arb.ca.gov/lists/com-attach/63-acf-comments-ws-UiVSJwB1UGIBKgIq.pdf, last accessed August 2022).

regulation while the GHG reductions from these fuels are already attributed to the LCFS and Heavy-Duty Omnibus regulations.

This alternative is rejected as it would not align with California's goal of maximizing TE while resulting in no additional NOx emissions reductions and would potentially result in less PM and GHG reduction. It also fails to meet or is less effective in meeting all program objectives compared with the proposed ACF regulation.

8. Best Available Control Technology Concept

This alternative is a modification to the proposed ACF regulation and would allow for the use of BACT for compliance. The order of BACT would be a ZEV, then NZEV, then the cleanest certified engine. This alternative was suggested by the California Natural Gas Vehicle Coalition and proposes to expand what is considered to be ZEVs that are not available based on costs, availability of reliable infrastructure, and if ZEVs are not able to be a one-to-one replacement for existing ICE vehicles and many of these are undefined or are already included in the proposed ACF regulation. For simplicity this analysis focuses on the core effect of the suggested alternative when ZEVs are not available. This concept builds on the Heavy-Duty Omnibus regulation that sets new NOx engine standards and other emission control requirements. The Heavy-Duty Omnibus regulation also includes optional certification standard and a credit average, banking, and trading system.

For drayage trucks, this alternative would potentially result in fewer ZEVs and more ICE vehicles because the proposed ACF regulation only allows for ZEVs. For high priority and federal fleets, the alternative could result in more NZEVs assuming the fleet owner would otherwise purchase a NZEV when a suitable ZEV was available because this alternative treats ZEVs and NZEVs equally. It could increase the number of cleaner combustion engines if ZEVs and NZEV are not available assuming engines certified to the HD I/M optional standards become available. For State and local government fleets there would be no change except when ZEV and NZEVs are not available because the proposed ACF regulation already requires them to purchase ZEVs before NZEVs. If either is not available, the alternative could increase the number of engines certified to the Heavy-Duty Omnibus optional standards assuming they become available.

The proposed concept could potentially result in cleaner engines in some fleets but would not achieve new NOx reductions overall, because engine manufacturers can average their emissions to comply with the Heavy-Duty Omnibus regulation for all MYs. If CNG engines are certified to the optional standards, this alternative concept could require the purchase of some CNG engines along with ZEVs. This would likely result in the need for CNG infrastructure for small number of vehicles and potentially result in poorly utilized fueling and maintenance infrastructure and concerns about stranded assets for fleets that are not already using CNG.

Overall, this alternative could result in some emission benefits from increasing ZEVs in high priority fleets that would otherwise purchase NZEVs, but could reduce the number of ZEVs in drayage. It would not achieve any new benefits from cleaner combustion engines compared to the proposed ACF regulation because manufacturers can average their emissions to comply in the Heavy-Duty Omnibus regulation.

This alternative is rejected because it adds administrative burden to account for cleaner engines that are already accounted for in the Heavy-Duty Omnibus regulation and would not achieve any new reductions by including them in the proposed ACF regulation.

This alternative also suggests that using renewable fuels such as RNG and RD would achieve additional GHG benefits. However, any requirement to use renewable fuels would not result in additional GHG benefits because low carbon fuels like RNG and RD are accounted for under California's LCFS program and the federal Renewable Fuel Standard.

The number of Class 2b-8 CNG vehicles projected for 2025 is already relatively small at approximately one percent of California's statewide heavy-duty vehicles. Allowing a narrow exemption for an extremely small percentage of California's heavy-duty vehicles could result in unnecessary financial risk and the potential for stranded assets as ZEV technology improves and ZEV infrastructure expands. Staff is also concerned that the cost to operate existing CNG fueling stations and maintenance shops will grow with declining usage. Therefore, this alternative was rejected because it fails to meet or is less effective in meeting all program objectives compared to the proposed ACF regulation.

9. Apply 100 Percent Drayage Zero-Emission Vehicle Timeline to All Regional Goods Movement

Proposed by the ACF Coalition, this alternative would apply a more stringent ZEV purchase requirement by targeting an expansion of the drayage definition to include regional secondary goods movement. The current drayage definition covers the initial movement of goods by trucks that move cargo to and from seaports to intermodal railyard facilities. This alternative would expand the drayage definition to include secondary goods movement where the cargo has been unloaded and repackaged at a local processing, cross-docking, warehouse, or transloading facility before heading to the next or final destination. This alternative would expand the scope to smaller fleets not currently affected by the high priority fleet requirements and could potentially move the 100 percent ZEV purchase timeline for some vehicle types up by 4 years, from 2039 to 2035, for high priority fleets that have opted to use the ZEV Milestones Option.

This alternative would add considerable complexity to the existing high priority fleet definition because it would be difficult to determine and differentiate which vehicles are used in drayage verses regional freight movement verses longer-haul applications. Additionally, this alternative would encourage entities to shift their business models to possess older ICE vehicles for longer than they traditionally would in order to circumvent earlier ZEV transition compared to the proposed ACF regulation, as it lacks the additional ZEV Milestones Option allowed in the proposed ACF regulation. The ZEV Milestones Option increases flexibility for fleets with a higher turnover rate while continuing to maintain a timeframe that coincides with ZEV deployment and air quality goals, as well as other program objectives. Coupled with the Model Year Schedule, the ZEV Milestones Option supports an increased and more cost-effective ZEV transition within fleets that would result in more significant air quality and health benefits, and in an earlier timeframe, than the alternative would, particularly in DACs located near ports and intermodal facilities in relation to drayage ZEV transition. Under this alternative, there would be heavy reliance on public charging that is still in development. In addition, the implementation and enforcement of this alternative presents additional costs and challenges. For example, each facility would need to develop a compliance verification system to determine if a truck meets the regulatory requirements before entering the property. This adds additional costs and complexity that could impede the movement of goods due to the number of potential facilities that would need to implement or update verification or reporting systems.

This alternative would also only provide minimal emission benefits above the currently proposed ACF regulation, as well as require significant expansion of regulatory exemptions and special provisions to achieve proper implementation and enforcement. Furthermore, this alternative conflicts with the timeline for ZEV deployment in the proposed ACF regulation, which was structured to coincide with infrastructure development, and the majority of regional trucks are already subject to the high priority and federal fleet requirements. Therefore, this alternative was rejected at this time as it is less effective in meeting objectives 1, 3, 4, 5, 6, 8, and 11 due to the anticipated decrease in early ZEV deployment within drayage fleets and resulting diminished GHG reductions compared to the proposed ACF regulation.

10. Require 100 Percent Zero-Emission Vehicle Purchases beginning in 2023 for State and Local Government Fleets

Supported by the ACF Coalition, this alternative proposes a more stringent purchase requirement for State and local government fleets. This concept modifies the proposed ACF regulation by increasing the ZEV purchases to 100 percent beginning in 2023 for State and local government fleets instead of 2027. This alternative would increase ZEV purchases by State and local government fleets from 2024 through 2026.

This alternative could be more effective at meeting program objectives; however, it also bears substantial risks. This alternative would start one year earlier than the proposed ACF regulation, move up the 100 percent ZEV purchase requirement 3 years earlier for local government fleets that operate in low-population designated counties, and increase the 50 percent ZEV purchase requirement to 100 percent for all other State and local governments. This alternative removes the additional time for smaller agencies in more remote areas to plan for infrastructure and removes their opportunity to learn from the experiences of other larger State and local government agencies. Furthermore, State and local governments additionally require lead time with a 2-3 year timeframe to approve budgets and secure contracts for infrastructure installation as well as ZEV acquisitions due to their unique funding cycle and competitive procurement practices. This alternative, as a result, would be difficult to realistically implement with the given lead time constraint. Additionally, CARB staff does not expect the rule requirements to be codified and effective until late 2023, which would not provide enough time for State and local governments to plan and implement a purchase schedule to meet the requirements of this alternative.

This alternative would likely increase the number of ZEVs deployed but would also increase administrative burden due to the higher likelihood that certain vehicle configurations may not be available as ZEVs until the market develops further. Therefore, this alternative was rejected at this time as it is financially and administratively infeasible for State and local government fleets due to a lack of lead time for infrastructure development and ZEV acquisition needed for their funding cycles and competitive procurement practices. However, given the greater emissions benefits of this alternative, staff continues to analyze the rapidly evolving technical progress of these categories to determine if additional stringency is warranted.

11. Mandate Retirement at the End of Useful Life

Supported by the South Coast Air Quality Management District, the ACF Coalition, and the California Electric Transportation Coalition, this alternative concept targets the mandatory retirement of the medium- and heavy-duty ICE vehicles subject to the proposed ACF regulation at the end of their useful life, as defined by SB 1.[467] At the end of their useful life, these older trucks are to be replaced with ZEVs under this alternative. The SB 1 useful life provision limits the retirement, replacement, retrofit, or repower of specified commercial vehicles that would have been subject to new regulations or amendments. SB 1 provides truck owners certainty of their investments by allowing truck owners to operate their existing vehicles for specified periods of time before being subject to regulations that require the retirement, replacement, retrofit, or repower of specified commercial motor vehicles. This alternative concept forces the turnover of older trucks to be replaced with ZEVs and would send a signal to the market regarding the residual value of combustion trucks.

In general, this alternative would only advance the timeline for vehicle turnover for State and local government fleets, resulting in greater ZEV purchases and associated benefits; however, it also bears some risks. This alternative would eliminate the flexibility for a State and local government fleet to keep a unique, specialized, or costly vehicle in the fleet longer while purchasing ZEV replacements and could result in higher costs. It also means that State and local government fleets may need to retire a relatively low-use vehicle and would limit their ability to purchase a ZEV that could be highly utilized, which would result in more emissions benefits and have a better TCO. This alternative could also place downward pressure on used truck prices and create additional incentive for unregulated fleets to purchase used trucks and keep them in California. This could reduce the potential air quality benefits and may shift costs from regulated fleets to unregulated fleets. For State and local government fleets, this would increase administrative burdens due to the higher likelihood that certain vehicle configurations may not be available as ZEVs until the market develops. Still, this alternative would likely be more effective at meeting program objectives, reducing criteria pollutant emissions, and reducing climate emissions relative to the proposed ACF regulation.

Therefore, this alternative was rejected at this time as it is financially and administratively infeasible for fleets already subject to the ZEV purchasing requirements of the proposed ACF regulation. However, given the potential for greater emissions benefits of this alternative, staff continues to analyze industry interest and the rapidly evolving technical progress of the ZEV market to determine if additional policies are needed. Preliminary analysis like this alternative is discussed in the 2022 SIP Strategy (draft) as a measure called, "Zero Emission Trucks Measure." The proposed draft SIP measure would use market signal tools, if given authority to implement differentiated registration fees, restrictions or fees for combustion trucks entering low or zero-emission zones, and/or indirect source rules to establish zero-emissions zones by 2035. Without new authority to use such market signal tools, these strategies would need to consider the most economical compliance options available in the secondary markets to upgrade to ZEVs, including used ZEVs, everywhere feasible.

[467] SB 1 (Beall, Stats. 2017, ch. 5).

12. Small Fleet Turnover

Proposed by the ACF Coalition, this alternative builds on the proposed ACF regulation and adds additional requirements for smaller fleets that are initially unaffected by the proposed ACF regulation until the 100 percent ZEV purchase requirement takes effect. [468] Under this alternative, these small fleets would be required to retire all ICE vehicles at the end of their useful life as defined by the criteria in SB 1 and then replace these vehicles with newer ICE vehicles or ZEVs. In considering this alternative, staff modeled that small fleets would most likely replace the vehicles that reach the end of their useful life with used combustion-powered vehicles that are typically three to five years old, which is a common practice today since the upfront costs are lower to purchase used ICE vehicles. As a result, this alternative would delay the number of ZEVs deployed when compared with the proposed ACF regulation. Replacing older trucks at the end of their useful life with newer "used" combustion trucks would produce more NOx and PM reductions in California than staff's proposed ACF regulation as shown in Table 84. The NOx emissions reductions related to accelerated fleet turnover is the most pronounced from 2024 to 2030 as the oldest combustion vehicles are retired from California's fleet.

Table 84: Pollutant Reduction Difference Between the Staff Proposed ACF Regulation and the Small Fleet Turnover Concept

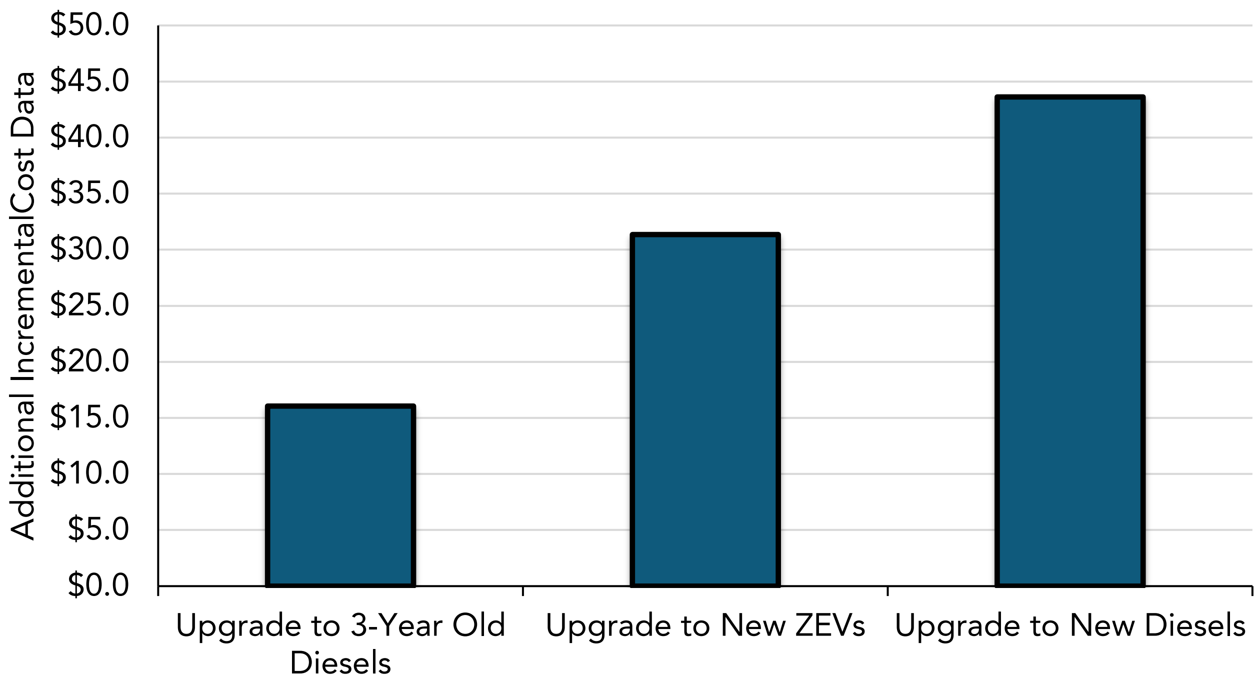
Year	NOx (tpd)	PM2.5 (tpd)	CO_2(MMT/yr)
2024	-32.05	-0.39	0.17
2025	-29.75	-0.37	0.16
2026	-27.90	-0.35	0.15
2027	-25.51	-0.31	0.14
2028	-23.13	-0.27	0.09
2029	-20.88	-0.24	0.05
2030	-19.05	-0.21	0.10
2031	-17.43	-0.17	0.14
2032	-15.59	-0.14	0.13
2033	-14.20	-0.12	0.13
2034	-13.21	-0.10	0.12
2035	-12.87	-0.09	0.15
2036	-12.16	-0.08	0.16
2037	-11.36	-0.06	0.17
2038	-10.34	-0.05	0.12
2039	-9.36	-0.04	0.06
2040	-8.54	-0.03	0.02
2041	-8.01	0.02	0.26
2042	-7.39	0.06	0.31
2043	-6.59	0.07	0.38
2044	-5.69	0.08	0.43

[468] Advanced Clean Fleets Coalition, *letter to CARB*, September 8, 2021 (web link: https://www.arb.ca.gov/lists/com-attach/47-acf-comments-ws-VCBcKAZyBzdQPQJd.pdf, last accessed August 2022).

Year	NOx (tpd)	PM2.5 (tpd)	CO_2(MMT/yr)
2045	-5.05	0.07	0.38
2046	-4.33	0.06	0.20
2047	-3.92	0.03	-0.11
2048	-3.66	0.00	-0.44
2049	-3.43	-0.02	-0.58
2050	-3.01	-0.03	-0.66
Total[469]	**-110,572**	**-840**	**2.22**

This alternative is expected to result in significant costs to affected fleets. Requiring fleets who would typically hold on to their vehicles until they cannot operate to immediately replace them with lightly used or new vehicles bears a significant incremental cost. Figure 86 illustrates a simplified cost analysis for this alternative versus the Legal Baseline as well as examples that require new ZEVs or new diesel-powered vehicles. All three examples show a significant increase in costs to these smaller fleets, with used diesels causing the smallest increase and new diesels providing the largest. Note that this analysis includes cost savings, so while the ZEV example has lower cost than new diesel vehicles, these smaller fleets may not have the capital necessary to make the necessary vehicle and infrastructure investments needed for ZEVs.

Figure 86: Increase in Total Direct Costs for Small Fleet Turnover Alternative Versus Legal Baseline By 2037



This alternative accelerates vehicle turnover for some of the oldest vehicles, resulting in some criteria emission benefits compared to staff's proposed ACF regulation; however, it also bears some risks and would create an increased burden for smaller fleets. This alternative

[469] The total cumulative emissions reductions for PM2.5 and NOx are converted from tons per day into years and assumes 312 operational days per year. Due to rounding errors, the 2024-2050 cumulative totals differ very slightly when compared to the sum values listed.

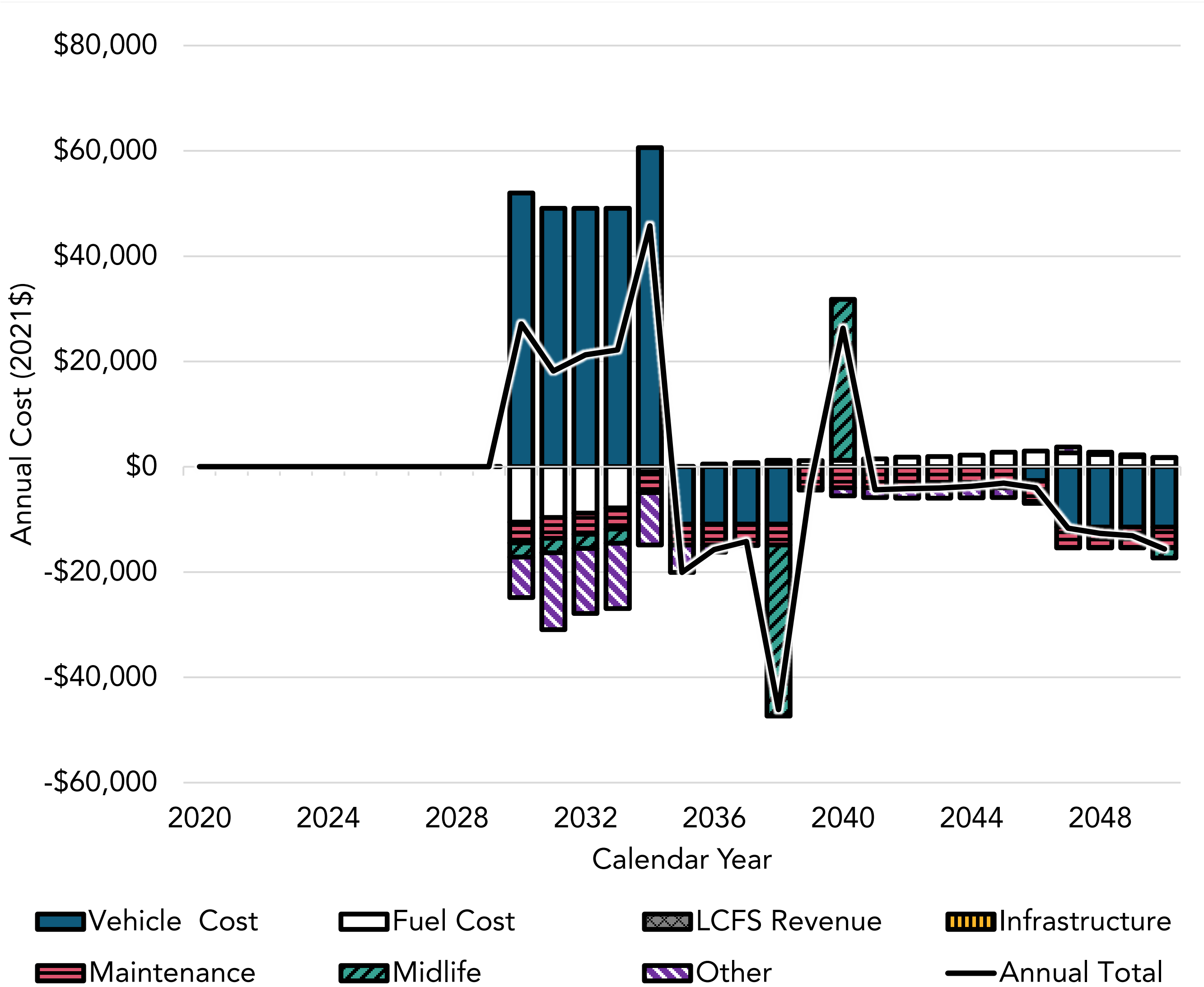
could place downward pressure on used truck prices by shifting market sales of used trucks from the larger regulated fleets to the small unregulated fleets. Under this alternative, there would also be a financial strain on small California businesses with forced turnover requirements in addition to opportunity cost related to delaying ZEV purchase. As shown by Table 84, this alternative would reduce NOx and PM emissions from smaller fleets but would not be more effective at increasing the number of ZEV deployments nor at reducing climate emissions compared to the proposed ACF regulation. Therefore, this alternative was rejected as it is financially infeasible for small fleets currently unaffected by the proposed ACF regulation. However, fleet turnover polices could become an important component of the next-generation portfolio of regulations and fiscal incentives that support our economy's transition to a ZE transportation system.

C. Small Business Alternative

The Board has not identified any reasonable alternatives that would lessen any adverse impact of the proposed ACF regulation on small businesses.

The example small business modeled is a drayage truck owner-operator subject to the drayage truck requirements. For both the "Legal Baseline" and proposed ACF regulation example, the small business owner purchases a used 2014 diesel day cab tractor in 2022. In the "Legal Baseline" scenario, the business owner operates that vehicle for 12 years until 2034. Following that, the operator would continue the pattern of purchasing an 8-year-old used diesel day cab tractor and operate that vehicle for 12 years (purchasing used ICE vehicles in 2034 and 2046). Under this proposed ACF regulation example, the drayage operator would likely turn over their diesel tractor at the end of 2029 when the tractor is 15 years old and has exceeded the useful life. The operator would replace the tractor with a new 2030 battery-electric tractor which it would operate for 20 years. In this example, the small business would buy one less used ICE vehicle than the "Legal Baseline" because they would be purchasing a new ZEV with a longer useful life instead. The drayage operator is assumed to finance its vehicles for 5 years at an interest rate of 15 percent. In the proposed ACF regulation example, the operator will see a net savings starting in 2040 which would continue to grow until 2050. The overall costs to a small business owner throughout the timeframe of this regulation is less than the "Legal Baseline" since its TCO is less for a BEV than for an ICE vehicle. However, the operator would need to make a significant upfront capital expenses in 2030 to purchase a new battery-electric tractor rather than two smaller investments spread out over a longer time. Incentives, financing assistance, and other programs offered will be helpful to support smaller operators with the onetime upfront capital expense. Staff assumed a small business would utilize public charging or fueling infrastructure rather than building depot infrastructure. For retail electricity refueling, staff conservatively assume that most LCFS credit revenue is not be passed on to fleets directly as the credit value is already incorporated into the retail price.

Figure 87: Estimated Costs of Proposed ACF Regulation to the Example Small Business (2021$)



D. Performance Standards in Place of Prescriptive Standards

Government Code section 11346.2(b)(4)(A) requires that when CARB proposes a regulation that would mandate the use of specific technologies or equipment, or prescribe specific actions or procedures, it must consider performance standards as an alternative. The proposed ACF regulation does not prescribe any specific technology or any equipment – rather, it allows regulated entities to acquire affected categories of any medium- and heavy-duty vehicles that have demonstrated that they emit zero emissions of criteria or GHG emissions; the regulation does not specify how such vehicles must comply with these standards. Currently battery-electric vehicle technology (BEV and PHEV) and fuel cell electric vehicle (FCEV) technologies have demonstrated the capability of meeting the proposed performance standards; however, the regulation does not preclude regulated entities from utilizing any other technology that meets the proposed performance standards. If entities elect to utilize BEV or FCEV technologies, the proposed ACF regulation also establishes requirements to ensure that regulated entities actually purchase and use those technologies, rather than vehicles that emit higher levels of emissions. The proposed ACF regulation encourages innovation by allowing manufacturers and fleet owners to determine the most cost-effective means of compliance given their business model or operational needs. Even if the proposed ACF regulation is considered a prescriptive standard, to the extent it establishes specific measurements, actions, or quantifiable means of limiting emissions or purchasing ZEVs, it would still be preferred over other *performance*-based alternatives. Anything less prescriptive than this proposed ACF regulation in terms of emission limits and requirements for ZEV purchases erodes the proposed ACF regulation's ability to secure the emissions reductions needed for meeting California's public health and climate goals and State and federal air quality standards because less prescriptive measures would allow, by omission, additional flexibilities on technology, valuation, fleet mixing, and assurance measures that would not achieve the same magnitude of emissions reductions or support for the nascent ZEV market. More performance-based alternatives would thus undermine the goals of this action. Furthermore, to the extent the proposed ACF regulation is determined to specify a sole means of compliance through specific actions, measures, or other quantifiable means, this means of compliance is necessary to accurately confirm compliance with the requirements to ensure that motor vehicle emissions are permanently reduced.

E. Health and Safety Code Section 57005 Major Regulation Alternatives

CARB estimates the proposed ACF regulation would have an economic impact on the state's business enterprises of more than $10 million in one or more years of implementation. CARB will evaluate alternatives submitted to CARB and consider whether there is a less costly alternative or combination of alternatives that would be equally as effective in achieving increments of environmental protection in full compliance with statutory mandates within the same amount of time as the proposed regulatory requirements, as required by Health and Safety Code section 57005.

X. Justification for Adoption of Regulations Different from Federal Regulations Contained in the Code of Federal Regulations

Currently, there are no comparable federal requirements for fleets to purchase or use ZE technologies for vehicles greater than 8,500 lbs. GVWR, and there are also no federal requirements for 100 percent sales of ZE technologies for Class 2b-8 vehicles beginning in 2040. As shown in this staff report and accompanying analyses, the cost of the State regulations is justified by the substantial benefits to the public health, and welfare, and the environment, as described above and in the accompanying materials, including California's need to achieve the greatest degree of emissions reductions from criteria pollutants and greenhouse gases in order to reduce the serious risks to the health and welfare of Californians posed by such pollutants, to attain State and federal ambient air quality standards, to address climate change-induced harms and carbon neutrality goals, and to effectively advance the deployment of heavy-duty ZEVs as consistent with the goals established by the Governor in multiple Executive Orders and by the Board in California's SIP Strategy and the Climate Change Scoping Plan.

XI. Public Process for Development of the Proposed Action

Consistent with Government Code sections 11346, subdivision (b), and 11346.45, subdivision (a), and with the Board's long-standing practice, CARB staff held public workshops and had other meetings with interested persons during the development of the proposed ACF regulation. These informal pre-regulatory discussions provided staff with useful information that was considered during development of the regulation and is now being proposed for formal public comment.

In February 2020, CARB staff began informing the public of the proposed ACF regulation and development process. Over the past 2 years of rule development, staff hosted over 24 public workgroups and workshops. CARB staff reached out directly to affected stakeholders and conducted 386 meetings with over 170 groups and individuals. CARB staff also sent over 273,000 mailers and numerous emails to the 81,944 recipients from 10 listservs, as well as 84,597 fleet contacts from the TRUCRS reporting database system. CARB staff offered engagement opportunities to receive feedback and solicit for alternatives from a variety of groups and stakeholders, including manufacturers, large fleet owners and single truck owners-operators, environmental advocacy organizations and the communities impacted most heavily by medium- and heavy-duty truck emissions. Numerous workshops, workgroup meetings, forums, and listening sessions were held via webcast. A summary of outreach activities is listed in Table 85 and a full list of meetings related to this proposed ACF regulation can be found in Appendix E Summary of Outreach Table.[470]

Table 85: List of Outreach Activities

Number	Outreach Activity
24	Workshop/Workgroups
3	Listening Sessions
386	Stakeholder Meetings
273,000	Postcard Mailers
166,541	Email Recipients
883	Training Attendees

A webpage was developed to host all information pertaining to the regulatory process. The webpage hosted all public meeting announcements, materials made available for public comment, English and Spanish language factsheets, drafted regulation language and comments, a listserv signup link, and contact information.[471] CARB's TruckStop website also hosted information on the proposed ACF regulation on the ACF webpage and the ZEV TruckStop webpage.[472,473] The ZEV TruckStop webpage includes information about all ZE

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[470] California Air Resources Board, *Advanced Clean Fleets Meetings and Events*, 2022 (web link: https://ww2.arb.ca.gov/our-work/programs/advanced-clean-fleets/advanced-clean-fleets-meetings-events, last accessed August 2022).

[471] California Air Resources Board, *Advanced Clean Fleets Regulation*, 2021 (web link: https://ww2.arb.ca.gov/our-work/programs/advanced-clean-fleets, last accessed August 2022).

[472] TruckStop, *Proposed ACF regulations, 2021* (web link: https://ww2.arb.ca.gov/sites/default/files/truckstop/azregs/futureregs.html, last accessed August 2022).

[473] TruckStop, *ZEV TruckStop, 2021* (web link: https://ww2.arb.ca.gov/sites/default/files/truckstop/zev/zevinfo.html, last accessed August 2022).

regulations in development or that are currently being implemented and all available incentive programs. It also contains information on CARB's major partners in the ZE transition and links to resources regarding ZEV market availability.

Workshops were held to discuss a variety of strategies on the potential framework for a ZE truck regulation. In 2021, several comprehensive workshops were held on the proposed ACF regulation as a whole and in September of 2021 a workshop was held to discuss draft regulation language being released to the public. Some workshops were recorded and posted for reference on the ACF website; others were not recorded to allow for frank discussions. Most were held remotely due to the Coronavirus pandemic.

Smaller workgroups were held to better capture stakeholder input from similarly affected fleets.[474] These meetings focused on different topics including drayage fleets and costs, State and local government fleets, high priority and federal fleets, and smaller fleets. This provided a dedicated space for smaller fleets to ask questions, comment on the proposed regulatory requirements and express how those requirements might affect them.[475] The small fleet workgroup meetings included both day and evening sessions to reach and receive input from the largest possible audience. A separate channel for live interpretation was provided once for Punjabi and twice for Spanish with one Spanish session recorded and posted on the ACF website. A workgroup was also held to discuss the emissions reductions associated with the proposed ACF regulation. Staff were available throughout the meetings to answer questions. All workgroups were recorded and posted for reference on the ACF website.

Separate from the workgroups focused on the proposed ACF regulation, CARB staff also hosted a series of workgroup meetings in collaboration with CEC, CPUC, and GO-Biz. Spanning from late 2021 to March 2022, these meetings focused on activities, challenges, and solutions surrounding the build-out of fueling infrastructure needed to support the fleet of ZE trucks and buses that the proposed ACF regulation would bring about. The primary objective was to gain a collective understanding of the status in each topic area, the initiatives underway at each State agency, and the opportunities presented in meeting the demands of infrastructure scale-up. Workgroup meetings were held on four topics including Business Considerations, Hydrogen, Electricity and the Grid, and Costs and Funding.

For every public event staff used notices to announce meeting events, documents, a public comment docket, translation resources, and other associated regulatory materials to encourage participation and attendance at the workgroups and workshops. The materials include staff presentations, the December 2020 Preliminary Draft Cost Data and Methodology Discussion (updated and reposted with new September 2021 data), and the proposed ACF regulation language.[476, 477] Draft regulation text was organized in sections

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474 California Air Resources Board, *Notice of Public Workshop Meeting to Discuss the Proposed Advanced Clean Fleets Regulation*, 2021 (web link: https://ww2.arb.ca.gov/resources/documents/mailout-msc-21-2103, last accessed August 2022).

475 California Air Resources Board, *Notice of Public Workshop to Discuss the Proposed Advanced Clean Fleets Regulation*, 2021 (https://content.govdelivery.com/accounts/CARB/bulletins/2f6a894, last accessed August 2022).

476 California Air Resources Board, *Cost Data and Methodology Discussion Document, 2020* (https://ww2.arb.ca.gov/sites/default/files/2020-12/201207costdisc_ADA.pdf, last accessed August 2022).

477 California Air Resources Board, *Advanced Clean Fleets Draft Regulation and Comments*, 2021 (https://ww2.arb.ca.gov/our-work/programs/advanced-clean-fleets/advanced-clean-fleets-draft-regulation-and-comments, last accessed August 2022).

including requirements for high priority and federal fleets, State and local government fleets, drayage truck fleets, and vehicle manufacturers, and was posted publicly 2 weeks prior to the September 2021 workshop. The 30-day informal comment period following this posting was extended to allow ample and additional time for input, feedback, and alternatives to the proposed ACF regulation. Staff released updated draft regulation language that included changes made based on prior comment ahead of the workshops on May 2, 4, and 6 of 2022 including the addition of requirements for light-duty package delivery vehicles.[478] Table 86 lists the number of recipients for each email list used by staff to announce document postings, public events, and other regulatory updates.

Table 86: Distribution to CARB Email Lists

Public Email List	Number of Recipients
Actruck	8,051
Zevfleet	4,098
Porttruck	6,272
Onrdiesel	33,484
Publicfleets	5,619
Swcv	4,114
Sfti	2,869
Aqip	8,931
Hvip	3,017
Hdlownox	5,489
TRUCRS	84,597
Total	166,541

Staff included input from the community beyond directly regulated stakeholders and environmental advocacy organizations. To do this, CARB hosted a community listening session focused on truck activities as well as a two-day listening session focused on freight activities. These events gave attendees a brief overview of CARB's work to reduce air pollution from California trucks and allowed interested community members the opportunity to provide their input and vision for what CARB's priorities should be going forward. In addition, staff directly reached out to over 50 environmental justice groups to offer information and time to discuss the proposed ACF regulation. This work resulted in several informational meetings and 3 webinar presentations for AB 617 Community Steering Committees. Staff also published an article in the CARB Environmental Justice blog spot to reach a wider and more diverse audience of affected parties.[479] This post was highlighted in the November 2021 Environmental Justice newsletter. To inform tribal communities, staff utilized CARB's Tribal Relations website[480] as well as the Tribal Relations email listserv.

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[478] California Air Resources Board, *Updated Draft Regulatory Text for the Advanced Clean Fleets Regulation Now Available for Public Comment*, 2022 (https://content.govdelivery.com/accounts/CARB/bulletins/3142c5f, last accessed August 2022).

[479] California Air Resources Board, *CARB Environmental Justice Blog*, 2021 (web link: http://carbej.blogspot.com/2021/10/new-zero-emission-truck-regulation-will.html, last accessed August 2022).

[480] California Air Resources Board, *CARB Tribal Relations*, 2022 (web link: https://ww2.arb.ca.gov/tribal-relations, last accessed August 2022).

Staff also explored several other avenues to inform and engage fleets who may not be tuned into CARB's workgroups or email lists. An informational postcard mailer was sent to over 273,000 fleets identified to be either directly or indirectly affected by the proposed ACF regulation. Staff also reached out to 14 trade associations and 18 metropolitan planning organizations. Several rural areas were also engaged through outreach efforts and meetings were held with the Otay Mesa Chamber of Commerce and the Imperial County Environmental Justice IVAN committee. Staff reached out by email to the Rural Counties Representatives Council. To reach State and local government fleets, staff sent several invitations to engage directly by email to the Metropolitan Planning Organizations, the San Diego Association of Governments Freight Stakeholders Working Group, Clean Cities Coalitions, and the Institute of Local Governments, who in turn included an overview in several affiliated newsletters and listservs. An overview of the proposed ACF regulation has also been incorporated into a new CARB training course that has hosted over 883 attendees in 5 separate sessions in addition to 586 attendees who received an ACF overview when CARB staff hosted the One-Stop Truck events that occurred in October 2021 and January 2022.

Another round of workgroups were held in May of 2022 when staff presented revised regulation language and encouraged further feedback. Three separate sessions were hosted to best engage with stakeholders on the three sections of the regulation. For a second time staff reached out directly to community-based organizations, industry associations, and local government organizations to encourage participation in the workgroups and offer one-on-one meetings to discuss the proposed ACF regulation. A final public workgroup was held on July 26, 2022 which focused on how to improve draft provisions for allowing exemptions and extensions of the proposed ACF regulation for high priority, federal, and State and local government fleets.

After several years of virtual meetings, staff finally had the chance to attend in-person events. Representatives from CARB attended the Great American Truck Show in Fresno April 15-16, 2022, and the Advanced Clean Transportation Expo held May 9-12, 2022. At both events staff had the opportunity to speak to attendees regarding the proposed ACF regulation and participated in several event workgroups as CARB representatives. Staff also presented the proposed ACF regulation to a national audience on the SIRIUS XM Road Dog Trucking radio program. Staff was interviewed about the regulation and California's plans for ZE transportation in two separate hour segments during the month of April 2022.

Throughout the past two years, CARB worked closely with GO-Biz, CEC, CPUC, and other agencies and utilities in the state to engage the public on upcoming TE efforts. CEC is the State's primary energy policy and planning agency working on the strategic regional planning needed to support adoption of ZEVs. GO-Biz is the State's leader for job growth, economic development, and business assistance efforts and they are leading the way for collaboration on ZE transportation. They are working to cultivate opportunities to accelerate ZEV market growth by offering consultation for incentives, site selection, compliance, and investment assistance. CEC is investing in the charging infrastructure and technologies that are driving the transition to clean ZEVs throughout the state. One example is their new EnergIIZE program which offers funding for ZE truck and bus infrastructure. CPUC and California's six IOUs are working towards accelerating widespread TE and ensuring that electric rates make EV charging cheaper than fueling with gasoline or diesel. In addition to planning and monetary assistance, new educational resources for fleets are being developed every day by several agencies and organizations. Staff is working hard to ensure fleets are finding these helpful resources and getting access to planning resources and trainings when they are being offered. Staff continue to meet with stakeholders and explore ways to inform the public about the proposed ACF regulation. The program webpage and CARB's TruckStop website will be continually updated to offer information on engagement opportunities, existing and future regulations, and the resources that would aid fleets in their transition to ZE technologies.[481]

XII. Next Steps

With implementation of both ACT and the proposed ACF regulation, only about half of the trucks operating in California would be ZE. Shifting the remaining fleet to ZE technology requires additional policy tools. As the Board looks to significantly expand ZEV deployment beyond ACF there must be careful consideration of how to do this in a manner that is economically feasible for the more than 100,000 fleets who rely on the secondary market to purchase trucks. As Senator and Board member Leyva's letter indicated, new market tools may be needed, such as differentiated registration fees, restrictions or fees for polluting trucks entering low or ZE zones, and indirect source rules may be more effective at aggressively targeting emissions reductions in heavily impacted neighborhoods.[482]

The 2022 SIP Strategy (draft), scaffolded from the recent 2020 Mobile Source Strategy, includes a proposed commitment to accelerate the number of medium- and heavy-duty ZEVs beyond ACT by upgrading remaining combustion trucks to new or used ZEVs. The 2022 SIP Strategy includes a Zero-Emission Truck Measure which would use market signal tools, if given authority to implement differentiated registration fees, restrictions or fees for combustion trucks entering low or ZE zones, and/or indirect source rules to establish ZE zones by 2035. Without new authorities, starting in 2030 the measure would require fleets to phase in ZEVs into fleets operating in California that aren't already covered by the proposed ACF regulation. The strategy would consider the most economical compliance options available in the secondary markets to upgrade to ZEVs, including used ZEVs, everywhere feasible. Another measure called out in the 2022 SIP Strategy is the On-Road Heavy-Duty Vehicle Useful Life Regulation that would involve CARB developing a regulation, potentially paired with new incentives or legislative measures, to require on-road heavy-duty vehicles that have reached the end of their useful life as defined in SB1 to retire, replace, retrofit, or repower the on-road heavy-duty vehicle or engine, and upgrade to ZE trucks.

Additional incentive programs are needed to send clear signals to the market and support new scrap and replace regulatory programs, specifically to help ensure that smaller trucking companies have more consistent access to ZE truck incentives. This concept would involve CARB working to develop incentive programs which should include consideration of policies other jurisdictions have employed such as supporting local ZE zones and/or differentiated registration fees so that dirtier trucks pay more and ZE trucks have a consistent source of incentive funding.

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[481] California Air Resources Board, *CARB TruckStop Zero-Emission Vehicles*, 2021 (web link: http://ww2.arb.ca.gov/sites/default/files/truckstop/zev/zevinfo.html, last accessed August 2022).
[482] Senator Levya, *letter to CARB*, October 27, 2021 (web link: https://ww2.arb.ca.gov/resources/documents/senator-leyva-letter-regarding-diesel-vehicle-turnover, last accessed August 2022).

Other policy levers cannot be adjusted by Californians alone. Over half of the heavy-duty VMT in California are from federally certified trucks and their NOx emissions will be significantly higher than California engines starting in the 2024 MY. The Clean Air Act requires that federal emissions standards for new heavy-duty engines and vehicles provide manufacturers a minimum of 4 years of lead time, and that such standards be applicable for a period of 3 years. Existing federal truck GHG standards already ratchet up in 2027. Federal truck rules to tighten NOx emissions standards were proposed in March 2022 and must be finalized by the end of the year, or the opportunity will be lost to include emissions reductions associated with the 2027 MY, and would also potentially jeopardize the benefits from the 2028 and 2029 MY standards. It is paramount that the U.S. EPA align the proposed federal future heavy-duty emissions standards and other emissions-related requirements with CARB's Heavy-Duty Omnibus regulation, and to also push for accelerated medium- and heavy-duty ZEV policies nationwide. From our collective experience with promulgating light-duty ZE technologies, regulations, and incentives, we know that manufacturers respond creatively when regulators inside and outside of California send strong, unified, regulatory signals. Advocating for federal adoption of cleaner NOx truck standards as well as an ACT regulation (or its CO_2 regulatory equivalent) will help California communities, but, critically, will also ensure that communities everywhere benefit from a robust clean truck market.

Staff understands more needs to be done, especially to reduce emissions in overburdened communities and to require upgrades to ZEV upon vehicle retirement. Even with the above policies to kick start the early ZEV market for high priority and public fleets, additional tools will provide the best opportunity to promote ZEV for use cases where it is more challenging to make the transition to zero.

XIII. References

The following documents references are shown on Appendix B.