California Air Resources Board

Public Hearing to Consider the Proposed Zero-Emission Forklift Regulation

Staff Report: Initial Statement of Reasons

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List of Acronyms

AB	Assembly Bill
APS	Air Pollution Specialist
ARE	Air Resources Engineer
ART II	Air Resources Technician II
BEV	Battery-Electric Vehicle
CARB or Board	California Air Resources Board
CAISO	California Independent System Operator
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CI	Carbon Intensity
CO_2	Carbon dioxide
COI	Cost of Illness
CORE	Clean Off-Road Equipment Voucher Incentive Project
CPUC	California Public Utilities Commission
DAC	Disadvantaged Community
DOF	California Department of Finance
DOORS	DOORS Online Reporting System
ED	Emergency Department
EER	Energy Economy Ratio
EIA	Environmental Impact Analysis
EO	Executive Order
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
FY	Fiscal Year
gCO_2e/MJ	Grams Carbon Dioxide Equivalent per Megajoule
GHG	Greenhouse Gas
GO-Biz	Governor’s Office of Business and Economic Development

HP	Horsepower
IOU	Investor-Owned Utility
IPT	Incidence-per-Ton
ISOR	Initial Statement of Reasons (i.e., Staff Report)
IWG	Interagency Working Group
kVA	Kilovolt-Amp
kW	Kilowatt
kWh	Kilowatt-Hour
GBV	Great Basin Valleys
LC	Lake County
LCFS	Low Carbon Fuel Standard
LT	Lake Tahoe
LSI	Large Spark-Ignition
MC	Mountain Counties
MD	Mojave Desert
MMBtu	Million Metric British Thermal Units
MMT	Million Metric Tons
MWh	Megawatt-Hours
MY	Model Year
NAAQS	National Ambient Air Quality Standards
NC	North Coast
NCC	North Central Coast
NOx	Oxides of Nitrogen
NP	Northeast Plateau
NREL	National Renewable Energy Laboratory
OSHA	Occupational Safety and Health Administration
PG&E	Pacific Gas & Electric
PM	Particulate Matter

PM2.5	Fine Particulate Matter
PSPS	Public Safety Power Shutoff
REMI	Regional Economic Model, Inc.
ROG	Reactive Organic Gas
RPS	Renewable Portfolio Standard
SB	Senate Bill
SC	South Coast
SC-CO_2	Social Cost of Carbon
SCC	South Central Coast
SCE	Southern California Edison
SD	San Diego County
SDG&E	San Diego Gas & Electric
SFB	San Francisco Bay
SIP	State Implementation Plan
SJV	San Joaquin Valley
SRIA	Standardized Regulatory Impact Assessment
SS	Salton Sea
SV	Sacramento Valley
TAC	Toxic Air Contaminant
TE	Transportation Electrification
tpd	Tons Per Day
TTW	Tank-to-Wheel
U.S. EPA	United States Environmental Protection Agency
VSL	Value of Statistical Life
WTP	Willingness to Pay
WTT	Well-to-Tank
WTW	Well-to-Wheel
ZE	Zero-Emission

ZEF	Zero-Emission Forklifts
ZEV	Zero-Emission Vehicle

Executive Summary

A. Why is the Proposed Zero-Emission Forklift (ZEF) Regulation needed?

Mobile sources, including off-road equipment, and the fossil fuels that power them, are the largest contributors to emissions of ozone precursors, fine particulate matter (PM2.5), diesel particulate matter, and greenhouse gases (GHG) in California. While the California Air Resources Board's (CARB or Board) mobile source programs have made significant progress in improving air quality throughout California, many areas still fail to attain the National Ambient Air Quality Standards (NAAQS) for ozone and fine particulate matter (i.e., PM2.5). Currently, there are 19 areas in California, including the South Coast Air Basin and San Joaquin Valley, that are designated as nonattainment areas for ozone. This results in approximately 67 percent of California's population, or 26 million out of 39 million people, living in areas exposed to concentrations above the federal ozone and PM2.5 standards. Further, a disproportionate number of those most impacted by high ozone levels live in low-income and disadvantaged communities (DAC).[1] In addition, climate change continues to impact California communities and the environment by increasing smog formation;[2,3,4] extending the pollen season; contributing to intense wildfires;[5] creating

[1] CARB, 2022 State Strategy for the State Implementation Plan, September 2022 (web link: *https://ww2.arb.ca.gov/sites/default/files/2022-08/2022_State_SIP_Strategy.pdf*).

[2] Reidmiller, D.R., et al., Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II, Chapter 14, Human Health, U.S. Global Change Research Program, 2018 (web link: *https://nca2018.globalchange.gov/chapter/14/*).

[3] A.J. McMichael et al. (Eds.), Climate Change and Human Health: Risks and Responses, World Health Organization, page 12, 2003 (web link: *https://apps.who.int/iris/bitstream/handle/10665/42742/924156248X_eng.pdf?sequence=1&isAllowed=y*).

[4] NRDC, Issue Brief: Climate Change and Health in California, page 3, February 2019 (web link: *https://www.nrdc.org/sites/default/files/climate-change-health-impacts-california-ib.pdf*).

[5] Singleton et al., Increasing Trends in High-Severity Fire in the Southwestern USA from 1984 to 2015, Forest Ecology and Management, Volume 433, 2019 (web link: *https://www.fs.usda.gov/rm/pubs_journals/2019/rmrs_2019_singleton_m001.pdf*).

hotter temperatures that could cause heat-related health problems;[6,7] causing weather extremes, such as drought[8] and flooding;[9] [10] and increasing prevalence of infectious diseases.[11] [12]

The Proposed Zero-Emission Forklift Regulation (Proposed Regulation) is identified in the Revised Proposed 2016 State Strategy for the State Implementation Plan (2016 State SIP Strategy)[13] as a necessary measure to meet air quality standards by deadlines established in the Clean Air Act. The federal Clean Air Act sets out requirements for adoption of air quality standards, as well as the required elements of State Implementation Plans (SIP), which must demonstrate how a nonattainment area will meet the health-based standards by the required attainment deadline. The 2016 State SIP Strategy estimated that the measure would reduce emissions of oxides of nitrogen (NOx) by 2 tons per day (tpd), PM2.5 by less than 0.1 tpd, and reactive organic gases (ROG) by 0.2 tpd in 2031. The Proposed Regulation is also identified in the 2016

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[6] Kadir et al. (Eds.), Indicators of Climate Change in California, Office of Environmental Health Hazard Assessment, August 2013 (web link: *https://oehha.ca.gov/media/downloads/climate-change/document/climatechangeindicatorsreport2013.pdf*).

[7] CARB, Health & Air Pollution (web link: *https://ww2.arb.ca.gov/resources/health-air-pollution*, last accessed August 2023).

[8] Mann, M. E. and Gleick, P. H., Climate Change and California Drought in the 21st Century, Proceedings of the National Academy of Sciences of the United States of America, March 2015 (web link: *https://www.pnas.org/doi/epdf/10.1073/pnas.1503667112*).

[9] Swain et al., Increasing Precipitation Volatility in Twenty-First-Century California, Nature, 2018 (web link: *https://www.sierraforestlegacy.org/Resources/Conservation/FireForestEcology/ThreatsForestHealth/Climate/CI_Swain_etal_2018_Increasing_Precip_Volatility.pdf*).

[10] Dettinger, M., Climate Change, Atmospheric Rivers, and Floods in California—a Multimodel Analysis of Storm Frequency and Magnitude Changes, Journal of the American Water Resources Association, June 2011 (web link: *https://ca.water.usgs.gov/pubs/2011/climate-change-atmospheric-rivers-floods-california-dettinger.pdf*).

[11] Lindgren et al., Monitoring EU Emerging Infectious Disease Risk Due to Climate Change, Science, April 2012, web link: *https://www.researchgate.net/publication/224856024_Monitoring_EU_Emerging_Infectious_Disease_Risk_Due_to_Climate_Change*).

[12] Solomon et al, Airborne Mold and Endotoxin Concentrations in New Orleans, Louisiana, After Flooding, October through November 2005, Environmental Health Perspectives, September 2006 (web link: *https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1570051/*).

[13] CARB, Revised Proposed 2016 State Strategy for the State Implementation Plan, March 2017 (web link: https://ww3.arb.ca.gov/planning/sip/2016sip/rev2016statesip.pdf).

Mobile Source Strategy,[14] 2020 Mobile Source Strategy,[15] and Sustainable Freight Action Plan[16] as a critical measure needed to achieve further emissions reductions to achieve California's clean air and climate goals. Distribution centers, and warehouses where forklifts operate in large numbers are commonly located in more-densely-populated areas, including in low-income communities and DACs. Many communities located near distribution centers, and warehouses bear a disproportionate health burden due to their proximity to harmful emissions from mobile sources. Adoption of the Proposed Regulation would reduce NOx, PM2.5, and ROG in these locations. In addition, the Proposed Regulation aligns with Governor Newsom's Executive Order (EO) N-79-20, which directed CARB and other State agencies to transition off-road vehicles and equipment to 100 percent ZE by 2035 where feasible.[17] Furthermore, staff believes the measure could help catalyze greater adoption of ZE technology in other off-road segments by increasing market awareness and supporting the overall growth of the ZE industry.

B. What will the benefits of the Proposed Regulation be?

Cumulatively, from 2026 through 2038, the Proposed Regulation is expected to reduce statewide emissions from forklifts by approximately 18,700 tons of NOx, 2,100 tons of PM2.5, 5,000 tons of ROG, and 9.4 million metric tons (MMT) or CO_2 due to the transition of propane- and gasoline-fueled forklifts to battery-electric and fuel-cell electric forklifts, which do not produce tailpipe emissions. The emission reductions are expected to reduce the concentration of criteria pollutants in the communities in which forklifts operate, benefitting the local residents and the operators of the equipment. CARB staff estimates the Proposed Regulation would reduce adverse health impacts as follows: 544 fewer cases of cardiopulmonary mortality; 115 fewer hospitalizations for cardiovascular disease; 148 fewer cases of cardiovascular emergency department (ED) visits; 62 fewer cases of nonfatal acute myocardial infarction; 17 fewer hospitalizations for respiratory disease; 321 fewer cases of

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[14] CARB, Mobile Source Strategy, May 2016 (web link: *https://ww3.arb.ca.gov/planning/sip/2016sip/2016mobsrc.pdf*).

[15] CARB, 2020 Mobile Source Strategy, October 2021 (web link: https://ww2.arb.ca.gov/sites/default/files/2021-12/2020_Mobile_Source_Strategy.pdf).

[16] Governor of the State of California, California Sustainable Freight Action Plan, July 2016 (web link: https://ww2.arb.ca.gov/sites/default/files/2019-10/CSFAP_FINAL_07272016.pdf).

[17] State of California Executive Department, *Executive Order N-79-20*, September 2020 (web link: https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-Climate.pdf).

respiratory ED visits; 42 fewer cases of lung cancer incidence; 1,295 fewer cases of asthma onset; 109,800 fewer cases of asthma symptoms; 80,635 fewer work loss days; 272 fewer hospitalizations for Alzheimer's disease; and 39 fewer hospitalizations for Parkinson's disease. These significant reductions in adverse health cases are expected to be seen across all ages in the state.

C. What will the costs of the Proposed Regulation be?

Costs associated with the Proposed Regulation were evaluated and include direct costs and cost savings for businesses in addition to costs to local, state, and federal governments. Cumulative cost-savings from full implementation of the Proposed Regulation through calendar year 2043 are estimated as follows:

- $7.5 billion in health benefit savings;
- $0.25 to $1 billion in social cost of carbon savings (SC-CO_2); and
- $2.7 billion in net fleet cost savings.

An operator of a typical spark-ignited forklift fleet that transitions to ZEFs is expected to see cost savings of approximately $30,000 per forklift.

D. What public process has been conducted to develop the Proposed Regulation?

Consistent with Government Code sections 11346, subdivision (b), and 11346.45, subdivision (a), and keeping with the long-standing practice at the Board, CARB staff held public workshops, workgroups, and other meetings with stakeholders during the development of the Proposed Regulation. To ensure an open and transparent rulemaking process, staff have engaged in an extensive public process throughout the development of the Proposed Regulation. Over the past three years of rule development, CARB staff conducted three public workshops, two workgroup meetings, and multiple individual meetings with stakeholders to gather additional information and feedback during the development of the Proposed Regulation. Attendees of these meetings included impacted community members, industry stakeholders, local air districts, consultants, equipment operators, equipment dealers and manufacturers, rental agencies, and government organizations.

In addition, a webpage was developed to host all information pertaining to the regulatory-development process, including all public meeting announcements, materials made available for public comment, draft regulation language, an email list signup link, and staff contact information. For every public event, staff used notices sent to the email list to announce meeting events, documents, translation resources, and other associated regulatory materials to encourage participation and attendance at the workgroups and workshops. Furthermore, CARB staff has also sent over 270,000 mailers to trucking fleets, over 200,000 mailers to small businesses, and email notices to over 70,000 subscribers of the Zero-Emission Forklift Rulemaking email list and other public email subscriber lists to distribute information about the rulemaking.

E. What forklifts would be covered by the Proposed Regulation?

The Proposed Regulation would require forklift fleets to transition spark-ignited forklifts (e.g., propane and gasoline forklifts) to ZE technology starting in 2026 with the oldest, highest-emitting forklifts being phased out first. Forklifts are widely used in freight, materials handling, manufacturing, and construction operations. In the freight industry, ZEFs have already achieved substantial market acceptance and deployment volumes. However, in other industries, forklifts with spark-ignited engines are still widely used.

Forklifts, part of a category of equipment referred to as "powered industrial trucks," are industrial vehicles designed to lift and move objects by using a forked lift platform that is positioned under the object to be moved. For propulsion and to power its lifting mechanism, a forklift can use a spark-ignited (i.e., gasoline, propane, or natural gas) internal combustion engine, a compression-ignited (i.e., diesel) internal combustion engine, or an electric motor.

Forklifts are used in various applications resulting in the availability of numerous commercial designs. The different designs have led to a seven-bin classification system developed by the Occupational Safety and Health Administration (OSHA) to differentiate powered industrial trucks for the purposes of implementing occupational safety standards.[18] Classes I and II represent electric-motor forklifts, which are considered ZEFs; Class III represents electric-powered pallet jacks; Classes IV and V represent two common types of forklifts that use internal-combustion engines; and

[18] Occupational Safety and Health Administration, Powered Industrial Trucks (Forklift) eTool (web link: *https://www.osha.gov/etools/powered-industrial-trucks/types-fundamentals/types/classes*, last accessed August 2023).

Class VII represents rough terrain forklifts. Class VI represents industrial tow tractors, an equipment type that is not truly a forklift but included in OSHA's industrial truck classification system.

The Proposed Regulation targets Class IV and V forklifts (as shown in Figure 1) powered by a spark-ignition engine for turnover. Class IV forklifts typically use smooth solid tires, called cushion tires, and are designed to be used on smooth, paved surfaces. A Class IV forklift is what is commonly considered a standard warehouse forklift. Class V forklifts typically use taller tires that can be pneumatic (air-filled, foam-filled, or solid), with a tread designed for use on uneven surfaces. A Class V forklift is typically used outdoors. As Class IV and V forklifts are phased out pursuant to the Proposed Regulation, they are expected to be replaced with functionally equivalent Class I ZEFs (as shown in Figure 1), or possibly Class II forklifts, which are specialized ZEFs designed to operate within very narrow aisles. Class III lift trucks, i.e., powered pallet jacks, are excluded from the Proposed Regulation and are not considered equivalent in function to a Class IV or V forklift in that the lift mechanism is only intended to lift its load slightly to facilitate lateral, not vertical, movement.

Figure 1. Types of Forklifts

Class I – Electric-Powered	Class IV – Internal Combustion Engine Cushion Tire
	

Class V – Internal Combustion Engine Pneumatic Tire	Class VII – Rough Terrain
	

Class VII forklifts (as shown in Figure 1), so-called "rough-terrain forklifts," are excluded from the Proposed Regulation because very few manufacturers currently offer a ZE equivalent to a Class VII forklift. In addition, due to the nature of their duty cycle, dirty work environments, and tendency to operate further from charging locations, fleets would face greater operational challenges incorporating ZE versions of Class VII forklifts in the near term.

The Proposed Regulation is focused on the replacement of large spark-ignition (LSI) forklifts with zero-emission forklifts and does not cover diesel-fueled (compression-ignited) forklifts. Diesel-fueled forklifts are currently subject to CARB's current In-Use Off-Road Diesel Fueled Fleets Regulation (Off-road Diesel Regulation), which bans older tier diesel-fueled equipment, and which requires emissions from fleets with diesel forklifts to be reduced dramatically over time. The Off-road Diesel Regulation also provides compliance credit for replacing diesel forklifts with ZEFs.[19] Staff intends to consider the accelerated transition to zero emissions of other off-road equipment types, including diesel-fueled and rough terrain forklifts, in subsequent regulatory efforts, including in two measures identified in the 2022 State SIP Strategy, the

[19] Title 13, California Code of Regulations, Sections 2449, 2449.1 2449.2, and 2449.3.

potential Off-Road Zero-Emission Targeted Manufacturer Rule and potential amendments to the Cargo Handling Equipment Regulation.[20]

F. What ZEF technology exists to enable success of the Proposed Regulation?

ZEFs have been available for decades and are already widely used in indoor applications, such as warehouses and distribution centers. Up until now, ZEFs have been primarily powered by flooded lead-acid battery technology. However, battery and electric motor technology continues to advance rapidly, and many new models are being offered today with innovative, new battery technologies, such as lithium-ion based batteries. Furthermore, fuel cell technology, which is currently being used in a limited number of larger fleets, continues to mature.

The flooded lead-acid battery, the most common type of forklift battery today, has been used to power battery-electric forklifts for decades. Staff estimates there are roughly 70,000 lead-acid ZEFs in operation in California today. While this battery technology is not without its drawbacks, it has been used successfully in industries, such as logistics and cold storage, due to cost savings and for other reasons, such as food safety and indoor air quality. Other industries, however, have not adopted battery-electric forklifts at the same scale due to perceptions about performance and other factors.

Today, there is strong interest and activity in lithium-ion battery technology because the industry believes the technology can address many of the historical issues associated with lead-acid battery technology. It is estimated that about seven to ten percent of new industrial batteries sold in 2021 use lithium technology[21]. This technology, while more expensive, has certain advantages over lead-acid battery technology, which are causing forklift operators to increasingly consider undertaking the larger initial investment of purchasing lithium-ion technology forklifts.

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[20] CARB, 2022 State Strategy for the State Implementation Plan, pages 89 and 87, September 2022 (web link: https://ww2.arb.ca.gov/sites/default/files/2022-08/2022_State_SIP_Strategy.pdf).

[21] Zhukov A., Review of the North American Lithium Forklift Battery Market: The 7 Most Popular Brands in the USA and Canada, OneCharge, October 2021 (web link: https://www.onecharge.biz/blog/review-of-the-north-american-lithium-forklift-battery-market-the-7-most-popular-brands-in-the-usa-and-canada/?utm_source=PR&utm_medium=Industry+Media&utm_campaign=Battery+review).

Lithium-ion batteries are able to be charged much more quickly and do not require a cooldown period after each charging event, which allows them to take advantage of opportunity charging (i.e., charging during scheduled downtime, such as employee breaks) to extend the amount of time it can be used in each day.[22] In addition, the energy density of lithium-ion batteries is much higher than lead-acid batteries, which allows operators to configure forklifts with capacities higher than has been historically possible. Lithium-ion batteries also require less maintenance, thereby reducing the amount of staff training and space required to handle and store hazardous, corrosive substances inherent to the use of flooded lead-acid battery technology. Furthermore, a lithium-ion battery is expected to last approximately double the number of cycles as a flooded lead-acid battery.

G. What would the Proposed Regulation require?

The Proposed Regulation would phase out affected Class IV and Class V LSI forklifts in nearly all applications served by those forklifts today. The Proposed Regulation includes two primary components: a restriction on the purchase of LSI Forklifts starting on January 1, 2026, and phase-out requirements starting on January 1, 2028, for existing LSI Forklifts. The Proposed Regulation would also establish requirements for forklift Manufacturers, forklift Dealers, and forklift Rental Agencies. The following bullets provide more detailed information on each component of the Proposed Regulation.

1. Scope

- The Proposed Regulation would apply to Class IV and Class V forklifts that use LSI engines ("Class IV LSI Forklifts" and "Class V LSI Forklifts," respectively). Certain types of forklifts, such as rough-terrain forklifts, diesel forklifts, combat and tactical support equipment, and others would not be addressed by the Proposed Regulation.
- Purchase restrictions and phase-out requirements would apply to Class IV LSI Forklifts of any lift capacity and Class V LSI Forklifts with a lift capacity of up

[22] Summit ToyotaLift, Forklift Battery Types, May 2021 (web link: *https://www.summithandling.com/forklift-battery-types/*).

to 12,000 pounds ("Targeted Class IV Forklifts" and "Targeted Class V Forklifts," respectively, and collectively as "Targeted Forklifts").

- Although the performance requirements of the Proposed Regulation would not apply to Class V LSI Forklifts with a lift capacity greater than 12,000 pounds, reporting of these forklifts would be required. This reporting is needed to better understand the impacts of Class V forklifts over 12,000 pounds and inform future zero-emission off-road rulemakings, such as the Off-Road Zero-Emission Targeted Manufacturer Rule mentioned above.

2. Forklift Fleet Operator Requirements

- Beginning on January 1, 2026, fleets would not be allowed to acquire or take possession of a new Targeted Forklift.
- Beginning on January 1, 2026, fleets would not be allowed to acquire or take possession of a used 2026 or subsequent Model Year (MY) Targeted Forklift.
- MY Phase-Out Schedules: Beginning January 1, 2028, Targeted Forklifts in operation prior to January 1, 2026, would be required to be phased out of the California fleet in accordance with the MY schedules set forth in Table 1.

Table 1. Targeted Forklift Phase-Out Schedule

Compliance Date	MY Phase-Out Schedule for Class IV Forklifts with a Lift Capacity of 12,000 Pounds or Less in Large Fleets (26 or more forklifts)	MY Phase Out Schedule for Class IV Forklifts with a Lift Capacity of 12,000 Pounds or Less in Small Fleets (less than 26 forklifts) and Agricultural Operations	MY Phase Out Schedule for Class IV Forklifts with a Lift Capacity Greater Than 12,000 Pounds in Large Fleets (26 or more forklifts)	MY Phase Out Schedule for Class IV Forklifts with a Lift Capacity Greater Than 12,000 Pounds in Small Fleets (less than 26 forklifts) and Agricultural Operations	MY Phase Out Schedule for Class V Forklifts in All Fleets
1/1/2028	2018 MY and older				
1/1/2029		2016 MY and older			

Compliance Date	MY Phase-Out Schedule for Class IV Forklifts with a Lift Capacity of 12,000 Pounds or Less in Large Fleets (26 or more forklifts)	MY Phase Out Schedule for Class IV Forklifts with a Lift Capacity of 12,000 Pounds or Less in Small Fleets (less than 26 forklifts) and Agricultural Operations	MY Phase Out Schedule for Class IV Forklifts with a Lift Capacity Greater Than 12,000 Pounds in Large Fleets (26 or more forklifts)	MY Phase Out Schedule for Class IV Forklifts with a Lift Capacity Greater Than 12,000 Pounds in Small Fleets (less than 26 forklifts) and Agricultural Operations	MY Phase Out Schedule for Class V Forklifts in All Fleets
1/1/2030					2017 MY and older
1/1/2031	2019 - 2021 MY				
1/1/2032		2017 - 2019 MY			
1/1/2033	2022 and 2023 MY				2018 - 2020 MY
1/1/2034		2020 and 2021 MY			
1/1/2035	2024 and 2025 MY		2025 MY and older		2021 and 2022 MY
1/1/2036		2022 and 2023 MY			
1/1/2037					
1/1/2038		2024 and 2025 MY		2025 MY and older	2023 – 2028 MY*

* 2026, 2027, and 2028 MY Class V Forklifts rented by a Fleet Operator would also be required to be phased out by January 1, 2038, along with 2023, 2024, and 2025 MY Class V Forklifts operated by the fleet.

- Although the Proposed Regulation does not specify if or how phased-out forklifts must be replaced, battery-electric or fuel-cell electric forklifts could be used in place of phased-out Targeted Forklifts.

- Until January 1, 2038, forklift fleets would still be able to purchase, lease, or rent used 2025 and previous MY Targeted Forklifts for use in California so long as said forklifts have not yet been phased out according to the applicable MY Phase-Out Schedule set forth in Table 1.
- Until January 1, 2038, forklift fleets would be able to rent 2026, 2027, and 2028 MY Targeted Class V Forklifts for use in California.
- The Proposed Regulation would include compliance exemptions for low usage, emergency operations, and temporary storage of Targeted Forklifts to be removed from the fleet as well as compliance extensions for infrastructure construction, ZEF delivery delays, and feasibility issues.
- The Proposed Regulation would allow a Fleet Operator to delay the phase-out of one Targeted Forklift until January 1, 2038, for each Class V LSI Forklift with a lift capacity greater than 12,000 pounds replaced with an equivalent ZEF.
- The Proposed Regulation includes annual reporting and recordkeeping requirements starting January 1, 2026, and labeling requirements in certain situations.
- Staff's proposal includes amendments to the LSI Engine Fleet Requirements Regulation (LSI Fleet Regulation), set forth in Title 13, California Code of Regulations, Sections 2775, 2775.1, and 2775.2. The revisions would simplify that regulation's reporting requirements, which would reduce the compliance burden for operators as well as increase clarity of the annual reporting requirements, since many of the operators that would be subject to the Proposed Regulation are currently subject to the LSI Fleet Regulation.
- Beginning January 1, 2026, a commercial or governmental entity that hires a Fleet Operator would also be responsible for the operation of an LSI Forklift that does not comply with the provisions in the Proposed Regulation.

3. Forklift Manufacturer Requirements

- The Proposed Regulation would establish a new ZE standard for engines and powertrains used in ZEFs.
- Forklift Manufacturers would no longer be allowed to produce for sale in California or offer for sale in California new Targeted Class IV Forklifts as of January 1, 2026, and no longer be allowed to produce for sale in California or offer for sale in California new Targeted Class V Forklifts as of January 1,

2029, unless the forklift engine meets the zero-emission standards set forth in Section 2433 of the Proposed Regulation.

- Beginning January 1, 2026, forklift manufacturers would be required to submit production and sales information to the Executive Officer annually for all LSI Forklifts produced for sale or sold in California.

4. Forklift Dealer Requirements

- A Dealer would not be allowed to possess the following:
  - 2026 and subsequent MY Targeted Class IV Forklifts starting January 1, 2026;
  - New Targeted Class IV Forklifts starting January 1, 2026;
  - 2025 and previous MY Targeted Class IV Forklifts that have already been phased out in accordance with the phase-out schedule for Class IV Forklifts in Small Fleets and Agricultural Operations, as shown in Table 1, below, starting January 1, 2026;
  - 2025 or previous MY Targeted Class V Forklifts that have already been phased out in accordance with the Class V Forklift phase-out schedule in Table 1, below, starting January 1, 2026;
  - 2026 and subsequent MY Targeted Class V Forklifts starting January 1, 2029; and
  - Any Targeted Forklift starting January 1, 2038.
- Starting January 1, 2026, a Dealer would not be able to sell, lease, offer for sale, offer for lease, or deliver to a Fleet Operator in California:
  - A new Targeted Forklift.
  - A used 2026 or subsequent MY Targeted Forklift.
  - A 2025 or previous MY Targeted Forklift if the MY of said forklift has already been phased out in accordance with the applicable schedule in Table 1. For Targeted Class IV Forklifts, a dealer would use the phase-out schedules for Small Fleets and Agricultural Operations to determine whether or not a Forklift has been phased out.
- Starting January 1, 2026, a Dealer would not be able to sell, lease, offer for sale, offer for lease, or deliver to a Rental Agency in California:
  - A new Targeted Class IV Forklift.
  - A used 2026 or subsequent MY Targeted Class IV Forklift.

    - A 2025 or previous MY Targeted Class IV Forklift if the MY of said forklift has already been phased out in accordance with the phase-out schedule for Class IV Forklifts in Small Fleets and Agricultural Operations, as shown in Table 1.
    - A 2025 or previous MY Targeted Class V Forklift if the MY of said forklift has already been phased out in accordance with the Class V Forklift phase-out schedule in Table 1.

- Starting January 1, 2029, a Dealer would not be able to sell, lease, offer for sale, offer for lease, or deliver to a Rental Agency in California:
    - A new Targeted Class V Forklift.
    - A used 2026 or subsequent MY Targeted Class V Forklift.
- The Proposed Regulation would include exemptions for Dealers to sell and transport new Targeted Forklifts to out-of-state purchasers and to Fleet Operators that would operate such forklifts as dedicated emergency forklifts.
- The Proposed Regulation includes recordkeeping requirements on LSI Forklift sale transactions starting January 1, 2026.

5. Forklift Rental Agency Requirements

- Rental Agencies would be subject to the same MY phase-out schedules (See Table 1) as Fleet Operators.
- Unlike Fleet Operators, between January 1, 2026, and December 31, 2028, Rental Agencies would be allowed to acquire Targeted Class V Forklifts as forklifts they offer for rent. Such forklifts would be required to be phased out by January 1, 2038.
- The Proposed Regulation would allow a Rental Agency to delay the phase-out of one Targeted Forklift until January 1, 2038, for each Class V LSI Forklift with a lift capacity greater than 12,000 pounds replaced with an equivalent ZEF.
- The Proposed Regulation includes annual reporting and recordkeeping requirements starting January 1, 2026.

I. Introduction and Background

This Staff Report: Initial Statement of Reasons (Staff Report or ISOR) and its appendices provide the basis for CARB staff's proposal to adopt the Proposed Regulation. The Proposed Regulation aims to reduce emissions from forklifts that operate in California and accelerate the adoption of ZE technology. It describes the Proposed Regulation and its associated costs and benefits. The Proposed Regulation would require California forklift fleets to transition from spark-ignited forklifts (e.g., propane and gasoline forklifts) to ZEFs. The Proposed Regulation seeks to advance ZE technology in forklifts to reduce emissions and to facilitate further technology development and zero-emission infrastructure expansion.

The following is a list of appendices of this Staff Report:

- Appendix A-1. Proposed Regulation Order for Sections 3000, 3001, 3002, 3003, 3004, 3005, 3006, 3007, 3008, 3009, 3010, and 3011;
- Appendix A-2. Proposed Regulation Order for Section 2433;
- Appendix A-2.1. Proposed Regulation Order for Section 2433 (Alternate Format);
- Appendix A-3. Proposed Regulation Order for Section 2775.1;
- Appendix A-3.1. Proposed Regulation Order for Section 2775.1 (Alternate Format);
- Appendix B-1. CARB's Original Standardized Regulatory Impact Assessment (SRIA) which was submitted to California Department of Finance (DOF) on April 5, 2023;
- Appendix B-2. DOF's Comment Letter regarding the Original SRIA;
- Appendix C. CARB's Draft Environmental Impact Analysis (Draft EIA);
- Appendix D. 2023 Large Spark Ignition Forklift Emission Inventory Document;
- Appendix E. Purpose and Rationale for Each Regulatory Provision; and
- Appendix F. List of References.

Mobile sources, such as cars, trucks, ships, locomotives, and a diverse array of off-road equipment, and the fossil fuels that power them significantly contribute to emissions of criteria pollutants and GHG in California. They account for about 80 percent of ozone-precursor emissions and approximately 50 percent of statewide GHG emissions.[23] In addition, the 2016 State SIP Strategy[24] acknowledges the need for emission reductions from the off-road sector and includes the Proposed Regulation as

[23] CARB, Mobile Source Strategy, May 2016 (web link: *https://ww3.arb.ca.gov/planning/sip/2016sip/2016mobsrc.pdf*).

[24] CARB, Revised Proposed 2016 State Strategy for the State Implementation Plan, March 2017 (web link: https://ww3.arb.ca.gov/planning/sip/2016sip/rev2016statesip.pdf).

one of the measures that will support meeting the air quality standards established in the federal Clean Air Act.[25] Further, the Proposed Regulation would help advance California's progress towards meeting the ZE goals of Governor's EO N-79-20.[26] Ultimately, for California to meet its public health and climate goals, the transition from internal combustion engines, for both on-road vehicles and off-road equipment, to ZE technology will be critical.

Forklifts that use internal combustion engines can be spark-ignited (i.e., gasoline, propane, or natural gas) or compression-ignited (i.e., diesel). LSI forklifts are spark-ignited forklifts of 25 HP or greater.

The Proposed Regulation would target LSI forklifts for use of ZE technology (i.e., battery-electric, fuel cell-electric, or other ZE technology as the only source of power for propulsion and work). Certain types of forklifts, such as rough-terrain forklifts and diesel forklifts would not be addressed by the Proposed Regulation.

Starting in 2026, the measure would both restrict the sale and purchase of most new LSI forklifts in California and require fleets to phase out most existing LSI forklifts over time through 2038. Staff is proposing this measure because many forklift applications are well-suited for ZE technology, and because transitioning spark-ignited forklifts to zero emission would reduce emissions that contribute to unhealthy regional ozone and particulate matter (PM) and to climate change. Further, due to fuel savings, an operator of a typical spark-ignited forklift fleet that phases in ZEFs is expected to see cost savings of approximately $30,000 per forklift. Converting the estimated 89,000 affected LSI forklifts in the State to ZEFs is expected to generate a cumulative cost savings of approximately $2.7 billion.

The 2016 State SIP Strategy[27] estimated that the measure would reduce emissions of NOx by 2 tons per day (tpd), PM2.5 by less than 0.1 tpd, and ROG by 0.2 tpd in 2031. Moreover, the 2022 State SIP Strategy estimated that the measure would reduce emissions of NOx by 1.7 tpd and ROGs by 0.3 tpd in 2037. The Proposed Regulation would exceed the emission reduction estimates provided in the 2016 State SIP Strategy and 2022 State SIP Strategy as it is expected to reduce NOx by 2.01 tpd, PM2.5 by 0.17 tpd, and ROG emissions by 0.46 tpd in 2031 and NOx by 3.26 tpd and ROG by 0.95 tpd in 2037. In addition, the Proposed Regulation is estimated to cumulatively reduce NOx emissions by 18,724 tons, PM2.5 emissions by 2,075 tons,

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[25] The federal Clean Air Act sets out requirements for adoption of air quality standards, as well as the required elements of SIPs, which must demonstrate how a nonattainment area will meet the standards by the required attainment deadline.
[26] State of California Executive Department, Executive Order N-79-20, September 2020 (web link: https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-Climate.pdf).
[27] CARB, Revised Proposed 2016 State Strategy for the State Implementation Plan, March 2017 (web link: https://ww3.arb.ca.gov/planning/sip/2016sip/rev2016statesip.pdf).

ROG emissions by 4,973 tons, and CO_2 emissions by 9.4 MMT from 2026 to 2043. Furthermore, over the same time period, staff estimates the Proposed Regulation would reduce adverse health impacts as follows: 544 fewer cases of cardiopulmonary mortality; 115 fewer hospitalizations for cardiovascular disease; 148 fewer cases of cardiovascular ED visits; 62 fewer cases of nonfatal acute myocardial infarction; 17 fewer hospitalizations for respiratory disease; 321 fewer cases of respiratory ED visits; 42 fewer cases of lung cancer incidence; 1,295 fewer cases of asthma onset; 109,800 fewer cases of asthma symptoms; 80,635 fewer work loss days; 272 fewer hospitalizations for Alzheimer's disease; and 39 fewer hospitalizations for Parkinson's disease. These significant reductions in adverse health cases are expected to be seen across all ages in the state.

Cumulative cost-savings from full implementation of the Proposed Regulation through calendar year 2043 are estimated as follows: $7.5 billion in health benefit savings; $0.25 to $1 billion in social cost of carbon savings; and $2.7 billion in net fleet cost savings.

A. Regulatory Objectives

Recognizing the requirements of Senate Bill (SB) 32[28], EO S-3-05, and Assembly Bill (AB) 1279 (Muratsuchi, Chapter 337, Statutes of 2022) to reduce GHG emissions as well as the need for California to attain NAAQS and California Ambient Air Quality Standards for criteria air pollutants and to reduce exposure to toxic air contaminant (TAC) emissions, the primary objectives of the Proposed Regulation include the following:

1. Accelerate the deployment of ZEFs, which achieve the maximum emissions reduction possible to assist in the attainment of NAAQS for criteria air pollutants (Health & Safety Code Sections 43000.5(b) and 43018(a)).
2. Decrease and eliminate emissions from petroleum and fossil-fuel use by forklifts by setting standards that eliminate exhaust emissions from forklifts. Emissions from petroleum use as an energy resource contribute 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 (Public Resources Code Section 25000.5(b) and (c)).
3. Decrease GHG emissions in support of statewide GHG reduction goals by adopting strategies to deploy ZEFs in California to support the Scoping Plan, which was developed to reduce GHG emissions in California, as directed by

[28] SB 32, Pavley, Stats. 2016, ch. 249); Health & Safety Code Section 38566 (web link: *http://www.leginfo.ca.gov/pub/15-16/bill/sen/sb_0001-0050/sb_32_bill_20160908_chaptered.htm*).

AB 32 (Nuñez, Chapter 488, Statutes of 2006). California's 2022 Scoping Plan[29] and 2020 Mobile Source Strategy[30] aim to accelerate development and deployment of the cleanest feasible mobile source technologies and to improve access to clean transportation.

4. Develop a regulation that is consistent with and meets the goals of the State Implementation Plan (SIP), providing necessary emissions reductions for all of California's nonattainment areas to meet NAAQS (Health & Safety Code Sections 39002, 39003, 39602.5, 43000, 43000.5, 43013, and 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, and 38566); and 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 as soon as possible, but no later than 2045, pursuant to SB 100 (De León, Chapter 312, Statutes of 2018) and AB 1279, maintain net negative emissions thereafter in accordance with AB 1279 and EO B-55-18[31], and to ensure that by 2045, statewide anthropogenic greenhouse gas emissions are reduced to at least 85 percent below the 1990 levels, pursuant to AB 1279.

6. Lead the transition of California's off-road sector from internal combustion to ZE technology. Support ZEF sales and EO N-79-20's goal to transition off-road operations to ZE by 2035.[32]

7. Complement existing programs and plans to ensure, to the extent feasible, that activities undertaken pursuant to the measure complement, and do not interfere with, existing planning efforts to reduce GHG emissions, criteria pollutants, petroleum-based transportation fuels, and TAC emissions.

8. Incentivize and support emerging ZE technology that will be needed to achieve CARB's SIP goals.

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[29] CARB, 2022 Scoping Plan for Achieving Carbon Neutrality, December 2022 (web link: *https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf*).

[30] CARB, 2020 Mobile Source Strategy, October 2021 (web link: https://ww2.arb.ca.gov/sites/default/files/2021-12/2020_Mobile_Source_Strategy.pdf).

[31] State of California Executive Department, Executive Order B-55-18, September 2018 (web link: https://www.ca.gov/archive/gov39/wp-content/uploads/2018/09/9.10.18-Executive-Order.pdf).

[32] State of California Executive Department, Executive Order N-79-20, September 2020 (web link: https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-Climate.pdf).

9. Achieve emission reductions that are real, permanent, quantifiable, verifiable, and enforceable (Health & Safety Code Sections 38560 and 38562(d)(1)).

10. Provide market certainty for ZE technologies and charging and hydrogen-fueling infrastructure to guide the acceleration of the development of environmentally superior ZEFs 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)).

12. Spur economic activity of ZE technologies in the off-road 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, Section 1(g) (Pavley, Chapter 200, Statutes of 2002); Health & Safety Code Section 38501(e)).

B. Types of Forklifts

Forklifts, part of a category of equipment referred to as "powered industrial trucks," are industrial vehicles designed to lift and move objects by using a forked lift platform that is positioned under the object to be moved. A forklift can use either an internal combustion engine, which can be spark-ignited (i.e., gasoline, propane, or natural gas) or compression-ignited (i.e., diesel), or an electric motor for propulsion and to power its lifting mechanism.

Forklifts are used in various applications resulting in the availability of numerous commercial designs. The different designs have led to a seven-bin classification system developed by the OSHA to differentiate powered industrial trucks for the purposes of implementing occupational safety standards.[33] Classes I and II represent electric-motor forklifts, which are considered ZEFs; Class III represents electric-powered pallet jacks; Classes IV and V represent two common types of forklifts that use internal-combustion engines, and Class VII represents rough terrain forklifts. Class VI represents industrial tow tractors, an equipment type that is not truly a forklift but included in OSHA's industrial truck classification system.

[33] Occupational Safety and Health Administration, Powered Industrial Trucks (Forklift) eTool (web link: https://www.osha.gov/etools/powered-industrial-trucks/types-fundamentals/types/classes, last accessed August 2023).

The Proposed Regulation targets Class IV and V forklifts (as shown in Figure) powered by a spark-ignition engine for turnover. Class IV forklifts typically use smooth solid tires, called cushion tires, and are designed to be used on smooth, paved surfaces. A Class IV forklift is what is commonly considered a standard warehouse forklift. Class V forklifts typically use taller tires that can be pneumatic, foam filled, or solid with a tread designed for use on uneven surfaces. A Class V forklift is typically used outdoors. As Class IV and V forklifts are phased out pursuant to the Proposed Regulation, they are expected to be replaced with functionally equivalent Class I ZEFs (as shown in Figure 2), or possibly Class II forklifts, which are specialized ZEFs designed to operate within very narrow aisles. Class III lift trucks, i.e., powered pallet jacks, are excluded from the Proposed Regulation and are not considered equivalent in function to a Class IV or V forklift in that the lift mechanism is only intended to lift its load slightly to facilitate lateral, not vertical, movement.

Figure 2. Types of Forklifts

Class I – Electric-Powered	Class IV – Internal Combustion Engine Cushion Tire
	

	
Class V – Internal Combustion Engine Pneumatic Tire	Class VII – Rough Terrain

Class VII forklifts (as shown in Figure 2), so-called “rough-terrain forklifts,” are excluded from the Proposed Regulation because very few manufacturers currently offer a ZE equivalent to a Class VII forklift. In addition, due to the nature of their duty cycle, dirty work environments, and tendency to operate further from charging locations, fleets would face greater operational challenges incorporating ZE versions of Class VII forklifts in the near term.

C. Summary of Proposed Regulation

The Proposed Regulation would phase out affected Class IV and V LSI forklifts in nearly all applications served by said forklifts today. The Proposed Regulation includes two primary components: a restriction on the purchase of LSI Forklifts starting on January 1, 2026, and phase-out requirements starting on January 1, 2028, for existing LSI Forklifts. The Proposed Regulation would also establish requirements for forklift manufacturers, forklift Dealers, and forklift Rental Agencies. The following bullets provide more detailed information on each component of the Proposed Regulation.

1. Scope

- The Proposed Regulation would apply to Class IV and Class V forklifts that use LSI engines (hereinafter “Class IV LSI Forklifts” and “Class V LSI Forklifts,” respectively). However, certain types of forklifts, such as rough-terrain forklifts, diesel forklifts, combat and tactical support equipment, and others would not be addressed by the Proposed Regulation.

- The performance requirements of the Proposed Regulation (i.e., purchase restriction and phase-out requirements) would apply to Class IV LSI Forklifts of any lift capacity and Class V LSI Forklifts with a lift capacity of up to 12,000 pounds (hereinafter "Targeted Class IV Forklifts" and "Targeted Class V Forklifts," respectively, and collectively as "Targeted Forklifts"). Although the performance requirements of the Proposed Regulation would not apply to Class V LSI Forklifts with a lift capacity greater than 12,000 pounds, reporting of said forklifts would be required.

2. Forklift Fleet Operator Requirements

- Beginning on January 1, 2026, fleets would not be allowed to acquire or take possession of a new Targeted Forklift.
- Beginning on January 1, 2026, fleets would not be allowed to acquire or take possession of a used 2026 or subsequent MY Targeted Forklift.
- MY Phase-Out Schedules: Beginning January 1, 2028, Targeted Forklifts in operation prior to January 1, 2026, would be required to be phased out of the California fleet in accordance with the MY schedules set forth in Table .

Table 2. **Targeted Forklift Phase-Out Schedule**

Compliance Date	MY Phase-Out Schedule for Class IV Forklifts with a Lift Capacity of 12,000 Pounds or Less in Large Fleets (26 or more forklifts)	MY Phase Out Schedule for Class IV Forklifts with a Lift Capacity of 12,000 Pounds or Less in Small Fleets (less than 26 forklifts) and Agricultural Operations	MY Phase Out Schedule for Class IV Forklifts with a Lift Capacity Greater Than 12,000 Pounds in Large Fleets (26 or more forklifts)	MY Phase Out Schedule for Class IV Forklifts with a Lift Capacity Greater Than 12,000 Pounds in Small Fleets (less than 26 forklifts) and Agricultural Operations	MY Phase Out Schedule for Class V Forklifts in All Fleets
1/1/2028	2018 MY and older				
1/1/2029		2016 MY and older			

Compliance Date	MY Phase-Out Schedule for Class IV Forklifts with a Lift Capacity of 12,000 Pounds or Less in Large Fleets (26 or more forklifts)	MY Phase Out Schedule for Class IV Forklifts with a Lift Capacity of 12,000 Pounds or Less in Small Fleets (less than 26 forklifts) and Agricultural Operations	MY Phase Out Schedule for Class IV Forklifts with a Lift Capacity Greater Than 12,000 Pounds in Large Fleets (26 or more forklifts)	MY Phase Out Schedule for Class IV Forklifts with a Lift Capacity Greater Than 12,000 Pounds in Small Fleets (less than 26 forklifts) and Agricultural Operations	MY Phase Out Schedule for Class V Forklifts in All Fleets
1/1/2030					2017 MY and older
1/1/2031	2019 - 2021 MY				
1/1/2032		2017 - 2019 MY			
1/1/2033	2022 and 2023 MY				2018 - 2020 MY
1/1/2034		2020 and 2021 MY			
1/1/2035	2024 and 2025 MY		2025 MY and older		2021 and 2022 MY
1/1/2036		2022 and 2023 MY			
1/1/2037					
1/1/2038		2024 and 2025 MY		2025 MY and older	2023 – 2028 MY*

* 2026, 2027, and 2028 MY Class V Forklifts rented by a Fleet Operator would also be required to be phased out by January 1, 2038, along with 2023, 2024, and 2025 MY Class V Forklifts operated by the fleet.

- Although the Proposed Regulation does not specify if or how phased-out forklifts must be replaced, battery-electric or fuel-cell electric forklifts could be used in place of phased-out Targeted Forklifts.

- Until January 1, 2038, forklift fleets would still be able to purchase, lease, or rent used 2025 and previous MY Targeted Forklifts for use in California so long as said forklifts have not yet been phased out according to the applicable MY Phase-Out Schedule set forth in Table 1.
- Until January 1, 2038, forklift fleets would be able to rent 2026, 2027, and 2028 MY Targeted Class V Forklifts for use in California.
- The Proposed Regulation would include compliance exemptions for low usage, emergency operations, and temporary storage of Targeted Forklifts to be removed from the fleet as well as compliance extensions for infrastructure construction, ZEF delivery delays, and feasibility issues.
- The Proposed Regulation would allow a Fleet Operator to delay the phase-out of one Targeted Forklift until January 1, 2038, for each Class V LSI Forklift with a lift capacity greater than 12,000 pounds replaced with an equivalent ZEF.
- The Proposed Regulation includes annual reporting and recordkeeping requirements starting January 1, 2026, and labeling requirements in certain situations.
- Staff's proposal includes amendments to the LSI Fleet Regulation to simplify that regulation's reporting requirements which would reduce the compliance burden for operators as well as increase clarity of the annual reporting requirements, since many of the operators that would be subject to the Proposed Regulation are currently subject to the LSI Fleet Regulation.
- Beginning January 1, 2026, a commercial or governmental entity that hires a Fleet Operator would also be responsible for the operation of an LSI Forklift that does not comply with the provisions in the Proposed Regulation.

3. Forklift Manufacturer Requirements

- The Proposed Regulation would establish a new ZE standard for engines and powertrains used in ZEFs.
- Forklift Manufacturers would no longer be allowed to produce for sale in California or offer for sale in California new Targeted Class IV Forklifts as of January 1, 2026, and no longer be allowed to produce for sale in California or offer for sale in California new Targeted Class V Forklifts as of January 1, 2029, unless the forklift engine meets the zero-emission standards set forth in Section 2433 of the Proposed Regulation.

- Beginning January 1, 2026, forklift manufacturers would be required to submit production and sales information to the Executive Officer annually for all LSI Forklifts produced for sale or sold in California.

4. Forklift Dealer Requirements

- A Dealer would not be allowed to possess the following:
    - 2026 and subsequent MY Targeted Class IV Forklifts starting January 1, 2026;
    - New Targeted Class IV Forklifts starting January 1, 2026;
    - 2025 and previous MY Targeted Class IV Forklifts that have already been phased out in accordance with the phase-out schedule for Class IV Forklifts in Small Fleets and Agricultural Operations, as shown in Table 1, below, starting January 1, 2026;
    - 2025 or previous MY Targeted Class V Forklifts that have already been phased out in accordance with the Class V Forklift phase-out schedule in Table 1, below, starting January 1, 2026;
    - 2026 and subsequent MY Targeted Class V Forklifts starting January 1, 2029; and
    - Any Targeted Forklift starting January 1, 2038.
- Starting January 1, 2026, a Dealer would not be able to sell, lease, offer for sale, offer for lease, or deliver to a Fleet Operator in California:
    - A new Targeted Forklift.
    - A used 2026 or subsequent MY Targeted Forklift.
    - A 2025 or previous MY Targeted Forklift if the MY of said forklift has already been phased out in accordance with the applicable schedule in Table 1. For Targeted Class IV Forklifts, a dealer would use the phase-out schedules for Small Fleets and Agricultural Operations to determine whether or not a Forklift has been phased out.
- Starting January 1, 2026, a Dealer would not be able to sell, lease, offer for sale, offer for lease, or deliver to a Rental Agency in California:
    - A new Targeted Class IV Forklift.
    - A used 2026 or subsequent MY Targeted Class IV Forklift.

    - A 2025 or previous MY Targeted Class IV Forklift if the MY of said forklift has already been phased out in accordance with the phase-out schedule for Class IV Forklifts in Small Fleets and Agricultural Operations, as shown in Table 1.
    - A 2025 or previous MY Targeted Class V Forklift if the MY of said forklift has already been phased out in accordance with the Class V Forklift phase-out schedule in Table 1.
- Starting January 1, 2029, a Dealer would not be able to sell, lease, offer for sale, offer for lease, or deliver to a Rental Agency in California:
    - A new Targeted Class V Forklift.
    - A used 2026 or subsequent MY Targeted Class V Forklift.
- The Proposed Regulation would include exemptions for Dealers to sell and transport new Targeted Forklifts to out-of-state purchasers and to Fleet Operators that would operate such forklifts as dedicated emergency forklifts.
- The Proposed Regulation includes recordkeeping requirements on LSI Forklift sale transactions starting January 1, 2026.

5. Forklift Rental Agency Requirements

- Rental Agencies would be subject to the same MY phase-out schedules (See Table 1) as Fleet Operators.
- Unlike Fleet Operators, between January 1, 2026, and December 31, 2028, Rental Agencies would be allowed to acquire Targeted Class V Forklifts as forklifts they offer for rent. Such forklifts would be required to be phased out by January 1, 2038.
- The Proposed Regulation would allow a Rental Agency to delay the phase-out of one Targeted Forklift until January 1, 2038, for each Class V LSI Forklift with a lift capacity greater than 12,000 pounds replaced with an equivalent ZEF.
- The Proposed Regulation includes annual reporting and recordkeeping requirements starting January 1, 2026.

D. Regulatory History

Over the past several decades, CARB has adopted several programs aimed at controlling off-road engine emissions in the State, including new engine standards and commercial in-use fleet rules. The engines used in the forklifts that would be subject to the Proposed Regulation are off-road LSI engines. For such engines, the first California new-engine emission standards were approved for adoption by the Board in 1998 (LSI Engine Regulation[34]). Beginning with MY 2001, the LSI Engine Regulation requires manufacturers to demonstrate compliance of their LSI engines with applicable emission standards before such engines (and the equipment in which the engines are installed) can be sold in California. The emission standards were established to address the fact that internal-combustion-engine use in California significantly contributes to air pollution and public-health risk.

LSI engines use an ignition device such as a sparkplug to ignite the air-fuel mixture every thermodynamic engine cycle; this is in contrast to diesel engines, which use compression and high-pressure for ignition. Some common fuels used in LSI engines are gasoline and propane. LSI engines can be found in off-road equipment, such as sweeper/scrubbers, industrial tow tractors, generator sets, small irrigation pumps, and, as mentioned above, forklifts. To ensure continued progress in the development of cleaner LSI engines, the LSI Engine Regulation was amended several times since its adoption, the latest version of which became effective with the 2010 MY.

In May 2006, the Board approved for adoption the Large Spark-Ignition Engine Fleet Requirements Regulation (LSI Fleet Regulation)[35], which applies to operators of forklifts, sweeper/scrubbers, industrial tow tractors, and airport ground support equipment that use an LSI engine. The LSI Fleet Regulation, which the Board amended in 2010, established a fleet-average emission requirement for fleets with four or more pieces of applicable equipment, which required the turnover of older, dirtier engines to newer, cleaner engines from 2009 to 2013. The use of ZE equipment was also an option fleets could employ to comply with the LSI fleet-average emission requirement. The LSI Fleet Regulation complemented the LSI Engine Regulation and further reduced emissions of NOx and hydrocarbons from LSI engines by accelerating the transition of the in-use fleet to newer, cleaner LSI-engine-powered equipment. The LSI Fleet Regulation's fleet-average emission requirements were fully phased in by 2013. Together, the LSI Engine and the LSI Fleet Regulations have reduced emissions from many mobile off-road sources, including the forklifts that would be subject to this Proposed Regulation.

Diesel-fueled engines (i.e., compression-ignition engines) are subject to separate, but similar, regulations. For new off-road diesel engines, the latest emission standards were adopted by the Board in 2004. The emission standards for diesel engines are categorized into four tiers of progressively more stringent emission levels. The first tier for diesel engines phased in between 1996 and 2000, depending on engine size. Tier

[34] Title 13, California Code of Regulations, Sections 2430-2439.
[35] Title 13, California Code of Regulations, Sections 2775, 2775.1, and 2775.2.

2 engine standards followed and were fully implemented to all engine sizes up to 750 HP by 2007. Tier 3 standards took effect between 2006 and 2011. Tier 4 Interim standards became effective for most engines between 2008 and 2012, and all off-road engines sold in California after 2015 are required to meet Tier 4 Final emission standards.[36] Further, as directed in the 2022 State SIP Strategy,[37] CARB staff are currently working on evaluating the feasibility of establishing Tier 5 emission standards, which would further reduce diesel emissions from new off-road equipment.[38]

To complement the new-engine emission standards for diesel engines, CARB adopted the Off-Road Diesel Regulation in 2007, which established fleet-average emission rates for PM and NOx for off-road diesel equipment operating in the State. Like the LSI Fleet Regulation, the regulation requires that fleets reduce their fleet-average emissions as time goes on.

The Board approved amendments to the Off-Road Diesel Regulation in late 2022. The amendments will further reduce emissions of criteria pollutants and toxics from off-road diesel vehicles operating in California, beyond the reductions being achieved via the ongoing implementation of the previous Off-Road Diesel Regulation. Off-road equipment, such as forklifts, can be subject to either the LSI Fleet Regulation, if fueled by gasoline or propane, or the Off-Road Diesel Regulation, if fueled by diesel. Both fleet regulations require operators to retire, repower, or replace higher-emitting equipment over time.

The Low Carbon Fuel Standard (LCFS) which was one of the original programs identified in the Scoping Plan, was approved by the Board in 2009. The intent of the LCFS is to reduce the carbon intensity (CI) of California's transportation fuels by increasing the availability of low-carbon and renewable alternatives. LCFS also helps reduce petroleum dependency resulting in other air quality benefits. In support of the AB 32 goals and emission-reduction regulations, such as the Proposed Regulation, LCFS provides credits for the deployment of cleaner transportation alternatives, such as electric vehicles (EV). These credits can be sold to provide a financial incentive for using clean technology by offsetting the cost of the technology. CARB staff periodically reviews the effectiveness of the LCFS program and, for example, may adjust the type of vehicles that qualify for the credits, or the number of credits earned by operating a certain type of vehicle. Since the price of LCFS credits are market-based, the value of the credits is subject to fluctuations. Currently, the LCFS program

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[36] Title 13, California Code of Regulations, Sections 2420 through 2427.

[37] CARB, 2022 State Strategy for the State Implementation Plan, September 2022 (web link: https://ww2.arb.ca.gov/sites/default/files/2022-08/2022_State_SIP_Strategy.pdf).

[38] CARB, Potential Amendments to the Diesel Engine Off-Road Emission Standards: Tier 5 Criteria Pollutants and CO_2 Standards (web link: *https://ww2.arb.ca.gov/our-work/programs/tier5/about*, last accessed October 2023).

can provide forklift Fleet Operators who choose to participate in the program, annual credits for the use of electric and other low carbon fueled forklifts. CARB staff is concurrently considering adjustments to the LCFS program, which could impact crediting for forklifts in the future.[39]

E. Technology Feasibility

Today, about half of the forklift population in California uses ZE technology largely due to advantages that the technology can provide, such as reduced indoor air pollution and lower operating costs, and because many forklift applications have duty cycles that are well-suited for its use. ZEFs are common in the logistics industry, but growth in other industries and applications has been relatively slow. Staff believes ZEFs today are capable of serving as a direct replacement for the forklifts required to be phased out by the Proposed Regulation.

1. Technology Advancements

ZEFs have been available for decades and are already widely used in indoor applications, such as warehouses and distribution centers. Up until now, ZEFs have been primarily powered by flooded lead-acid battery technology. However, battery and electric motor technology continues to advance rapidly, and many new models are being offered today with innovative, new battery technologies, such as lithium-ion based batteries. Furthermore, fuel cell technology, which is currently being used in a limited number of larger fleets, continues to mature.

The flooded lead-acid battery, the most common type of forklift battery today, has been used to power battery-electric forklifts for decades. Staff estimates there are roughly 70,000 lead-acid ZEFs in operation in California today. While this battery technology is not without its drawbacks, it has been used successfully in industries, such as logistics and cold storage, due to cost savings and for other reasons, such as food safety and indoor air quality. Other industries, however, have not adopted battery-electric forklifts at the same scale due to perceptions about performance and other factors.

A flooded lead-acid battery pack that is used in a forklift for an eight-hour shift generally requires eight hours to charge and an additional eight hours to cool down

[39] CARB, Presentation for Public Workshop to Discuss Potential Changes to the Low Carbon Fuel Standard, February 22, 2023. (web link: *https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/lcfs_meetings/LCFSpresentation_02222023.pdf*).

following a charge before it can be used again.[40] As such, lead-acid batteries can typically be used for only one full work shift per day. To work around this limitation, multiple-shift operations have historically employed the use of two or three lead-acid battery packs per forklift and a battery-swapping strategy. This type of arrangement requires a dedicated area for charging and storing battery packs, which takes away from square footage the facility could otherwise use, and additional resources to manage, maintain, and swap battery packs as necessary.

In addition, regular maintenance is also required for flooded lead-acid batteries. The acid solution within such batteries evaporates over time, so water needs to be replenished on a regular basis. The watering process requires specialized equipment and safety equipment to protect staff personnel from incidents, such as battery-acid spills.[41]

Other lead-acid based battery types that address certain issues experienced with flooded lead-acid batteries exist, but there are trade-offs. For example, gel cell batteries require less maintenance and are less susceptible to vibrations, but they require longer charging times. Both absorbed glass mat batteries and thin plate pure lead batteries require less maintenance and charge faster but have shorter life expectancies. While these alternative battery types are used by some operators, they are not as common as flooded lead-acid batteries in the forklift segment.[42]

Today, there is strong interest and activity in lithium-ion battery technology because the industry believes the technology can address many of the historical issues associated with lead-acid battery technology. It is estimated that about seven to ten percent of new industrial batteries sold in 2021 use lithium technology[43]. This technology, while having higher upfront costs, has certain advantages over lead-acid battery technology which are causing forklift operators to increasingly consider undertaking the larger initial investment of purchasing lithium-ion technology forklifts.

Lithium-ion batteries are able to be charged much more quickly and do not require a cooldown period after each charging event, which allows them to take advantage of opportunity charging (i.e., charging during scheduled downtime, such as employee

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[40] Summit ToyotaLift, Forklift Battery Types, May 2021 (web link: https://www.summithandling.com/forklift-battery-types/).
[41] Ibid.
[42] Ibid.
[43] Zhukov A., Review of the North American Lithium Forklift Battery Market: The 7 Most Popular Brands in the USA and Canada, OneCharge, October 11, 2021 (web link: *https://www.onecharge.biz/blog/review-of-the-north-american-lithium-forklift-battery-market-the-7-most-popular-brands-in-the-usa-and-canada/?utm_source=PR&utm_medium=Industry+Media&utm_campaign=Battery+review).*

breaks) to extend the amount of time it can be used in each day.[44] In addition, the energy density of lithium-ion batteries is much higher than lead-acid batteries, which allows operators to configure forklifts with capacities higher than has been historically possible. Lithium-ion batteries also require less maintenance, thereby reducing the amount of staff training and space required to handle and store hazardous, corrosive substances inherent to the use of flooded lead-acid battery technology. Furthermore, a lithium-ion battery is expected to last approximately double the number of cycles as a flooded lead-acid battery.

Lithium-ion technology also addresses a phenomenon called "voltage sag," which is much more pronounced in a lead-acid battery.[45] Voltage sag describes the drop in voltage experienced by a battery as the energy of the battery is depleted. What this means for a forklift is that performance degrades over the workday as the battery is drained, which can make a forklift perform more less optimally or feel sluggish toward the end of a shift.

Although the upfront cost of lithium-ion batteries are roughly two to three times more expensive than comparable flooded lead-acid batteries, this cost differential is expected to decline over time as more and more forklifts, as well as other vehicles, transition to ZE technology. However, staff believes, even at current upfront prices, the potential operational savings provided by lithium-ion technology would make it the preferred solution for many fleets, especially for those that are space-constrained and operate multiple shifts. That said, staff believes lead-acid technology will continue to be the dominant ZE technology in battery-electric forklifts in the near term because of its capital-cost advantage and existing support systems, although the market share of lithium-ion technology is expected to grow as lithium-ion battery prices decline.[46]

Fuel-cell forklifts currently represent approximately 10 percent of all zero-emission forklifts.[47] Fuel cell technology also addresses many of the concerns applicable to lead-acid battery forklifts, such as charging time and voltage sag. With respect to charging times, fuel-cell forklifts are even quicker to refuel than charging an equivalent lithium-ion battery forklift. However, hydrogen fueling infrastructure is costly to install, and hydrogen fuel is still a more expensive energy option relative to electricity except when it is produced, delivered, and used at scale. Therefore, fuel-cell forklifts are

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[44] Summit ToyotaLift, Forklift Battery Types, May 2021 (web link: *https://www.summithandling.com/forklift-battery-types/*).

[45] Battle Born Batteries, The Truth About Lead-Acid vs. Lithium-Ion Batteries in RVs, March 2021 (web link: https://battlebornbatteries.com/lead-acid-vs-lithium-ion-batteries/).

[46] Ziegler, M. and Trancik, J., Re-Examining Rates of Lithium-Ion Battery Technology Improvement and Cost Decline, Energy & Environmental Science, 2021 (https://pubs.rsc.org/en/content/articlepdf/2021/ee/d0ee02681f).

[47] Metzger, N. and Li, X., Technical and Economic Analysis of Fuel Cells for Forklift Applications, ACS Omega, 2022 (web link: https://pubs.acs.org/doi/epdf/10.1021/acsomega.1c07344).

generally deployed in larger fleets today, where the infrastructure costs can be spread across many units and fleets can take advantage of lower hydrogen costs.

As fleets transition to zero emissions, under this Proposed Regulation they have the flexibility to choose the ZE technology that works best for them based on financial and operational considerations. Furthermore, for most ZEFs, the transition would result in cost savings due primarily to fuel and maintenance savings. While not relied upon for staff's analysis, incentives that promote the use of ZE technology, may also help lower overall ZEF costs.

2. Availability

Class IV and Class V forklifts are well-suited to transition to ZE technology, with a wide variety of ZEFs from a number of manufacturers now commercially available. A recent online search and manufacturer survey conducted by staff of ZEF offerings identified almost 400 models, more than 130 of which were models with a lift capacity greater than 12,000 pounds.[48] As more fleets convert to ZEFs due to the Proposed Regulation, forklift manufacturers may invest in maintaining or even expanding their zero-emission product lines. Such investments could contribute to break-through technologies and lead to even broader acceptance of ZE technologies in other off-road vehicle applications

F. Zero-Emission Infrastructure

This section discusses how the State is assessing the future demand for and availability of fueling for ZE vehicles (ZEV), such as ZEFs, 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.

1. Zero-Emission Infrastructure Planning and Deployment

Fleets encompassing about half of the forklift population in California are already using ZE technology and as such have access to the necessary charging infrastructure. These fleets, in planning their transition to ZE technology, made the necessary investments to install forklift chargers, as well as any necessary electrical capacity

[48] CARB, Available Zero-Emission Forklift Models, Version 1.1, September 2023 (web link: *https://ww2.arb.ca.gov/sites/default/files/2023-09/Available%20ZEF%20Models%20.xlsx*).

upgrades at their facilities. However, as other fleets will need to make the transition as well, CARB staff took into consideration the status of charging infrastructure (both facility-side and utility-side of the meter) and coordinated with the State's lead agencies on infrastructure when crafting the Proposed Regulation.

Many Targeted Forklifts are operated in warehouse and distribution facilities where electric power and the necessary electrical generation capacity to charge equipment is already available and sufficient, while others will require upgrades to the electrical capacity prior to installing charging infrastructure. Alongside the ZEF rulemaking, other recent CARB rulemaking activities such as the Advanced Clean Fleets regulation, Advanced Clean Cars II regulation, Commercial Harbor Craft regulation, and In-Use Locomotive regulation also relate to increasing ZE equipment adoption. As part of these rulemakings, CARB staff is working with the California Energy Commission (CEC), California Public Utilities Commission (CPUC), California Independent System Operator (CAISO), utility providers, and the Governor's Office of Business and Economic Development (GO-Biz), to support electric system planning that accounts for the significant growth in infrastructure needs to further support widespread deployment of ZE technology.

a) Rural Charging Infrastructure

The dispersed nature of rural communities means that the electric grid in these regions may not currently have additional capacity beyond what is already in use. In addition, 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, and "fast trip" events, where circuits are set to trip more quickly and readily to avoid providing excessive energy to faults – which could cause an ignition. CPUC has directed impacted utilities to implement mitigation strategies during outages and a detailed discussion is included in the grid resiliency section below.

b) Future Cost Reductions

Chapter VIII, Section B details staff's Standardized Regulatory Impacts Assessment, which includes estimated costs for the installation of infrastructure. That said, there are several factors that staff believes will lead to reductions in infrastructure costs over time. The cost of labor, basic construction materials, and electrical transmission and distribution equipment are not expected to decline as more ZEV deployments take place. Staff expects charging equipment 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 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.

Creative and innovative technologies like smart charging 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.

c) Infrastructure Installation Timing

CARB staff have worked with 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, installation location, local permitting requirements, and the amount of available additional capacity on that circuit.

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 important. The entire process, which includes planning, developing, working with the utility, acquiring permits from local authorities, and deploying ZE charging and fueling stations, can take between six months to three years or more, depending on the scale of electric infrastructure work that is needed and the local requirements for building. To help speed up the electricity infrastructure installation process, California law requires permitting agencies to meet minimum processing standards to ensure timely permit approval. The amount of required infrastructure (both at the facility- and utility-side of the meter) will vary with the fleet size as small deployments of a couple vehicles may only need minor facility upgrades whereas major expansions may need extensive facility and grid work. Ultimately, a strong fleet and utility partnership and early communication is critical for success.

Installing charging infrastructure requires planning and early discussions with the local utilities, many of which have set up dedicated staff to assist. Infrastructure upgrades will likely require service line extensions at minimum, as well as power line reconductoring (i.e., replacing existing powerlines with new powerlines), distribution substation upgrades, or transmission work, which should be considered early in the planning process. However, utilities have indicated that project phasing commonly allows fleets to deploy initial ZEVs quickly using existing infrastructure and that electrical infrastructure upgrades can be made while a fleet expands its ZE deployments over time.

Facility leasing agreements may complicate site upgrades, and staff acknowledges that some fleets do not own or lease their own spaces, and those that do may have reasons for leasing only for a period of time. Staff believes the Proposed Regulation, along with other ZE-related policies and the EOs issued by the Governor, serve as clear signals to facility owners (landlords) that site upgrades to support electrification are worthwhile investments.

d) Remote Locations

Remote locations and off-the-grid facilities could experience unique challenges because of the distance between these sites to the nearest electrical circuit, difficult terrain, and/or the transient nature of forklifts operating at these sites. Whether a fleet operator decides to install infrastructure at a remote location could depend on factors, such as how often they operate at the location, the duration of said operation, and the cost of bringing in power to the site. In some instances, operators could opt to use mobile power units to charge forklifts, or alternatively, use fuel-cell forklifts, at remote worksites if infrastructure upgrades are too costly. Additionally, these facilities could participate in the remote grid programs that some California utilities offer where the utility owns and operates the remote grid for the customer.

2. Electricity Supply Impact and Reliability

Concerns have been raised around the grid's ability to meet the increased electrical demand generated by the Proposed Regulation and other rules promoting electrification. This section assesses the impact that broad electrification 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. It also discusses how electrical utilities are working to minimize disruptions to customers during unplanned outages and PSPS events.

a) Electric Grid Planning

The State's process to plan for future electricity demand is robust. System planning begins with the CEC, with the development of their annual Integrated Energy Policy Report (IEPR) and the associated Energy Demand Forecast. The IEPR demand forecast then informs the CPUC and CAISO planning processes for generation resources, distribution infrastructure, and transmission infrastructure. The CPUC's Integrated Resource Planning Process evaluates electricity generation needs, leveraging the CEC's IEPR demand forecast on a ten-year time horizon and then directs the procurement of new generation resources. The CPUC's Integrated Resource Planning process also determines the generation resource needs that will be most cost effective for ratepayers, will achieve our greenhouse gas emission goals, achieve other policy goals, and ensure system reliability. Additionally, the CPUC oversees the Resource Adequacy program for all load serving entities in its jurisdiction, which ensures sufficient electric generation is under contract to meet grid needs. Using inputs from the CEC's IEPR Demand Forecast, the CPUC establishes and enforces resource adequacy procurement requirements on a monthly basis for each jurisdictional load serving entity.

The CEC's IEPR demand forecast also informs distribution planning at the CPUC for the Investor-Owned Utilities (IOUs). This system-wide forecast of expected electric demand is disaggregated down to a more granular level by each utility for their specific territory. This is then the basis of the distribution infrastructure that each IOU will build over an approximately five-year period.

Using inputs from the CEC's IEPR Energy Demand Forecast and in coordination with the CPUC and other Local Regulatory Authorities, the CAISO establishes local reliability needs specific to areas with transmission limitations and flexible capacity to meet system ramping needs experienced with the continued growth of Distributed Energy Resources (DER).[49] Load serving entities then solicit for and eventually contract with new and existing resources to meet procurement requirements. The CPUC's Integrated Resource Planning process additionally informs transmission procurement for the state via CAISO's Transmission Planning Process.

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 emission inventory, approved and expected CARB electrification regulations, and CEC results from the AB 2127 EV Charging Infrastructure Assessment.[50] All these inputs allow for a comprehensive assessment and understanding of grid impacts and infrastructure needs at the regional and local level due to changes in electricity demand, which in part, would be caused by charging and fueling ZEFs and EVs.

b) Electric Grid Load Expansion

California's electric grid is in a period of transition, with a shift towards heavier reliance on carbon-free resources. The State continues its efforts to rapidly expand deployment of renewables and energy storage, while at the same time, planning for significant growth in electrification across various sectors of the California economy. The transition to carbon-free electric generation is driven by SB 100[51,52], which targets serving 100 percent of retail electric demand with carbon neutral sources no later than 2045.

Because the State is proposing to lean heavily on the electric sector to transition away from fossil fuels use, the demand for electricity is expected to increase significantly

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[49] Distributed Energy Resources are distribution-connected distributed generation resources such as energy efficiency, demand response, customer generation (e.g., rooftop solar), energy storage, alternative fuel vehicles (e.g., electric vehicles), and water-energy conservation.

[50] AB 2127, Ting, Public Resources Code section 25229, Electric vehicle charging infrastructure: assessment, ch. 365, 2018 (web link: *https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB2127*).

[51] SB 100, De León, Public Utilities Code new section 454.53, California Renewables Portfolio Standard Program: emissions of greenhouse gases, ch.312 (web link: *https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB100*).

[52] Gill, L. et al., 2021 SB 100 Joint Agency Report, Achieving 100 Percent Clean Electricity in California: An Initial Assessment, California Energy Commission, March 2021 (web link: *https://efiling.energy.ca.gov/EFiling/GetFile.aspx?tn=237167&DocumentContentId=70349*).

between now and 2045.[53] This load increase must be supported by sustained and significant build-out of electricity infrastructure in the form of carbon-free generation, energy storage, and transmission and distribution infrastructure. 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 impact locally. The potential for vehicle-to-grid technology, where vehicles can support electricity load by allowing the grid to pull power from vehicles when it is beneficial to the electric system, holds the promise to support grid resiliency in the future.

c) Grid Reliability

As wildfire risk in California has grown, IOUs may proactively cut power to electrical lines as a measure of last resort if the utility believes there is imminent and significant risk that strong winds may topple power lines or cause major vegetation related issues leading to increased risk of wildfires. IOUs are also employing fast trip style outages that cut power more quickly to ensure that minimal energy is provided to faults on lines in High Fire Threat Districts to reduce instances of utility-caused ignitions. While both PSPS and fast trip outage events may reduce the risk of utility-associated wildfires, outages create uncertainty for fleets considering adoption of ZEFs. Therefore, understanding how utilities are addressing and mitigating power 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 & Electric (SDG&E). Efforts are underway at the major IOUs to address PSPS impacts on charging infrastructure, including:

- Improving communication both before and during potential or active de-energization events regarding the location and accessibility of charging near impacted areas; and
- Studying the feasibility of grid-independent charging stations (e.g., mobile charging stations), which can be used to charge battery-electric vehicles (BEV) and equipment during PSPS and other emergency events.[54]

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[53] CARB, 2022 Scoping Plan for Achieving Carbon Neutrality, December 2022 (web link: *https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf*).

[54] California Public Utilities Commission, Fact Sheet: Electric PSPS Event Guidelines Update Decision, Approved May 28, 2020 (R.18-12-005) (web link: *https://www.cpuc.ca.gov/-/media/cpuc-website/files/uploadedfiles/cpucwebsite/content/news_room/newsupdates/2020/psps-phase-ii-decision-fact-sheet-20201023.pdf*).

The CPUC is also considering how to best address the use of fast trip style outages by the IOUs, though no procedural action has been taken nor have any concrete recommendations been proposed. In March 2023, CPUC's Safety Policy Division held a virtual workshop to discuss utility fast trip programs and associated reliability issues.[55] There has been no procedural action as of yet related to these programs.

The expectation is that the frequency and duration of planned PSPS events will gradually diminish as the grid is hardened to wildfires. The same cannot necessarily be said for fast trip outages, though wildfire hardening of lines may lead to a decreased instance of these types of outages. Outside of PSPS events, the utility industry follows reliability standards from the North American Electric Reliability Council, broadly known as NERC and CAISO. Following these operating reserves standards to ensure outages do not occur, the CAISO must keep a minimum six percent buffer between supply and demand at all times in case of an unexpected shortfall.[56]

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. Further, to address reliability during the summer, CPUC has initiated rule making R.20-11-003 which includes programs that encourage energy conservation during the summer and the development of new energy resources.[57] As such, electrical service is overall extremely reliable, and staff believes the probability of fleets not having the electricity necessary to charge their ZEFs and maintain operations would be low.

d) Grid and Fleet Resiliency

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

The electrical grid is actively managed by balancing authorities on a minute-to-minute basis to ensure supply and demand remain balanced at all times. The introduction of

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[55] California Public Utilities Commission, Protective Equipment and Device Settings (PEDS) (web link: *https://www.cpuc.ca.gov/industries-and-topics/wildfires/protective-equipment-device-settings*, last accessed September 2023).
[56] California Public Utilities Commission, Resource Adequacy Homepage (web link: *https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/resource-adequacy-homepage*, last accessed August 2023).
[57] California Public Utilities Commission, Summer Reliability (web link: *https://www.cpuc.ca.gov/news-and-updates/newsroom/summer-2021-reliability*, last accessed September 2023).

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 different ways to improve resiliency during major power disruptions, including hardening transmission lines, installing new distributed energy resources, and establishing microgrids. Microgrids can isolate from the main grid and manage energy resources at a local level, meaning they have the potential to improve customer reliability and resilience to grid disturbances."[58] Microgrids can operate on a variety of power sources, including renewables, multi-fuel reciprocating engines, and even stationary fuel cells. In addition, batteries can be used as energy storage in microgrids to improve reliability and provide flexibility. This landscape provides both opportunities and challenges for improving system resiliency, and ZEVs hold great potential to support grid resiliency through smart charging and "vehicle-to-grid" (or load) applications. ZEFs also hold great potential for supporting the electrical grid through forklift to grid applications since ZEFs tend to be plugging in during times of peak electricity demand and stay plugged in at the same location for many hours.

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 and equipment stay charged 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 ZEF fleets from safety-related de-energization 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.[59] CPUC, with CEC support, leads ongoing efforts to develop standards, protocols, guidelines, methods, rates, and tariffs as necessary that serve to support and reduce barriers to microgrid deployment.

3. Hydrogen Fueling

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 EO N-79-20, new zero-emission

[58] National Renewable Energy Laboratory, Microgrids (web link: https://www.nrel.gov/grid/microgrids.html, last accessed August 2023).
[59] California Public Utilities Commission, Resiliency and Microgrids (web link: https://www.cpuc.ca.gov/resiliencyandmicrogrids, last accessed August 2023).

vehicle and equipment regulations, and the LCFS incentivizing low carbon fuels, are increasing demand for hydrogen with lower CI. Today, the limited number of in-state hydrogen producers for use in fuel-cell vehicles means that hydrogen fuel 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 hydrogen that employ steam methane reformation processes and need to purchase renewable natural gas at a premium to satisfy California's renewable hydrogen requirements. This creates intermittent market disruptions where renewable hydrogen supplies do not always meet current fuel cell vehicle demand.

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.[60] Today, the approximately $15 per kilogram retail price of hydrogen (associated with light-duty fueling) limits the business case for fuel-cell technology in other vehicles, such as heavy-duty trucks and forklifts; 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.

Moreover, 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.[61] 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 CI associated with hydrogen production and the ability to earn LCFS credits, they will be able to offer hydrogen at a price competitive with conventional fuels.

4. Zero-Emission Infrastructure Coordination and Buildout

ZEFs and other ZEVs rely on the electric grid to provide consistent, on-demand power to charge. The electric grid will have to expand and adapt to increased charging as demand for ZEVs continues to grow.

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[60] Beagle, E. et al., Fueling the Transition: Accelerating Cost-Competitive Green Hydrogen, Rocky Mountain Institute, 2021 (web link: *https://rmi.org/insight/fueling-the-transition-accelerating-cost-competitive-green-hydrogen*).

[61] Plug Power Inc., Plug Power to Build Largest Green Hydrogen Production Facility on the West Coast, September 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*).

The state's electric grid expansion is driven by consumer demand, customer applications for electric service, and the statewide electric demand forecast through the CEC's IEPR, which allows utilities to build out the grid proactively. California is working to better forecast the expected growth in electricity demand from ZEVs so that it can proactively plan for the millions of EVs and equipment we expect over the coming years. Electrification of California's entire mobile-source 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.

State agencies and electric utilities have begun proactively planning for electric system upgrades and anticipated new load for EVs and equipment via statewide energy system planning processes, including CEC's Integrated Energy Policy Report forecasting, CAISO's transmission planning process, CPUC's Integrated Resource Plan proceeding, CPUC's High DER proceeding, and CPUC's staff proposal for the Freight Infrastructure Planning framework. Additionally, recent policy changes (AB 841) directed IOUs in California to establish rules for electrical distribution infrastructure on the utility side of the meter to support transportation electrification (TE) charging stations. CPUC has already approved utility investments for upgrading the electric grid along with electricity rate changes to fund those investments.

IOUs each offer time-of-use rates, which charge different prices at different times of the day for commercial and residential customers, impacting the cost to fuel for EV drivers and Fleet Operators. Time-of-use rates are designed to charge less when resources are more available, charge more when the grid is more constrained, optimize grid resources, and provide reasonable rates for EV charging.[62] Some IOUs also offer dynamic rates, which provide more real time price signals aimed at better capturing the grid conditions at that time. The CPUC has an open proceeding, the Demand Flexibility Rulemaking, which is further examining dynamic rates and demand flexibility policy. On this topic, CPUC staff issued a whitepaper "Advanced Strategies for Demand Flexibility Management and Customer DER Compensation."[63]

The CPUC also has an open proceeding, the High DER proceeding, aimed at reforms to the distribution planning process and policy to modernize and prepare the grid in

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[62] California Public Utilities Commission, Electricity Vehicles Rates and Cost of Fueling (web link: *https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/transportation-electrification/electricity-rates-and-cost-of-fueling*, last accessed August 2023).

[63] California Public Utilities Commission, Advanced Strategies for Demand Flexibility Management and Customer DER Compensation, June 2022 (web link: *https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/demand-response/demand-response-workshops/advanced-der---demand-flexibility-management/ed-white-paper---advanced-strategies-for-demand-flexibility-management.pdf*).

anticipation of multiple distributed energy sources.[64] With this new proceeding, the CPUC aims to evolve "grid capabilities and operations to integrate solar, storage, EV charging, flexible load management, and other distributed energy resources to safely and reliably meet the State's 100 percent clean energy goals."[65]

One of the key goals of this proceeding is to improve distribution planning, including planning for increased demand from charging infrastructure. In parallel, CEC staff is developing the EVSE Deployment and Grid Evaluation tool, which currently uses the IOUs' Grid Needs Assessment data to understand existing grid conditions and capacity. This tool could help stakeholders identify suitable locations for charger deployments.

Innovative solutions are emerging to help support charging infrastructure and manage loads at the local grid level. For example, State agencies and utilities are actively planning for vehicle-grid integration (VGI). VGI strategies 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 by electric utilities and vehicle owners allow for better integration of renewable energy. Models suggest that effective VGI can reduce renewables curtailment, which occurs when the output of a renewable energy resource is intentionally reduced below what it could produce.[66,67] As VGI strategies incorporate 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 provide power back to the grid when it is needed. Bi-directional services can also provide emergency backup services in the event of grid shutoffs or general power failures. Overall, VGI creates opportunities to reduce system costs and

[64] California Public Utilities Commission, Assigned Commissioner's Scoping and Ruling for Rulemaking 21-06-017, November 2021 (web link: *https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M422/K949/422949772.PDF*).

[65] California Public Utilities Commission, CPUC Takes Action to Modernize Electric Grid for High Distributed Energy Resources Future, June 2021 (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*).

[66] California Independent System Operator, Fast Facts: Impacts of Renewable Energy on Grid Operations, 2017 (web link: *https://www.caiso.com/documents/curtailmentfastfacts.pdf*).

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

facilitate renewable energy integration, and EV charging can be doubled with these managed charging strategies.[68, 69, 70]

With the benefits EVs 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 on policies to integrate EV charging needs with the electrical grid. The policies will reflect advancements in VGI strategies and technologies and include actions the State can take to advance California's electrification goals. Additionally, in December 2022, the CPUC adopted a decision to identify the key strategic focus areas of vehicle-grid integration on which the CPUC and IOUs will focus. These focus areas are—1) rates and demand flexibility programs, 2) technology enablement, and 3) planning. This builds on funding for vehicle-grid integration pilots authorized in 2020. In November 2021, the CPUC established a pathway for direct current interconnection for vehicle-to-grid and allowing some EVs to enable bi-directional mode more easily. CPUC is continuing to consider streamlining procedures for bi-directional interconnections.

As the EV and equipment markets expand, electricity demand will increase. Although a significant increase in electricity demand will occur with the widespread adoption of EVs and equipment, vehicle-to-grid integration can aid in managing load, providing grid resources, and supporting resiliency.

To meet the demand for charging and hydrogen fueling, 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[71] and the National Electric Vehicle Infrastructure Program[72].

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[68] Ibid.

[69] International Renewable Energy Agency, Innovation Outlook: Smart Charging for Electric Vehicles, 2019 (web link: *https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/May/IRENA_Innovation_Outlook_EV_smart_charging_2019.pdf*).

[70] Zhang, J. et al., Value to the Grid from Managed Charging Based on California's High Renewables Study, 2018 (web link: https://www.osti.gov/pages/servlets/purl/1494793).

[71] Infrastructure Investment and Jobs Act, H.R 3684, 117th Congress (2021) (web link: https://www.congress.gov/117/plaws/publ58/PLAW-117publ58.pdf).

[72] California Department of Transportation and California Energy Commission, National Electric Vehicle Infrastructure Program (web link: https://www.energy.ca.gov/programs-and-topics/programs/national-electric-vehicle-infrastructure-program-nevi, last accessed August 2023).

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, CARB closely collaborates with its sister agencies and assists in infrastructure development where appropriate to support ZE rule development and implementation.

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. GO-Biz has dedicated staff to help local jurisdictions streamline ZEV infrastructure permitting and development and has published guidebooks[73] and other resources on hydrogen station permitting and EV charging station permitting. These efforts 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. These efforts are expected to support the transition of LSI Forklifts to ZEFs.

2) California Energy Commission

CEC is the State agency primarily tasked with incentivizing development and supporting infrastructure to meet the charging and refueling infrastructure needs of ZEVs and has launched multiple efforts to support those directives. CEC developed the State's ZEV Infrastructure Plan, which outlines a collaborative process with other State agencies to meet State ZEV goals. 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, ZE technology manufacturing, pre-apprenticeship training, train-the-trainer activities, and more with an emphasis on priority communities. 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 CEC efforts include, but are not limited to:

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[73] California Governor's Office of Business and Economic Development, Electric Charging Station Permitting Guidebook, Second Edition, January 2023 (web link: https://business.ca.gov/wp-content/uploads/2019/12/GoBIZ-EVCharging-Guidebook.pdf).

- The Clean Transportation Program provides up to $100 million annually in funding to accelerate the development and deployment of advanced transportation and fuel technologies in various funding areas.[74]
- The EnergIIZE program[75] provides funding for charging and hydrogen infrastructure to support battery-electric and hydrogen fuel-cell commercial vehicles in California. The project provides a streamlined process with targeted incentives and specialized assistance. EnergIIZE offers incentives through 4 funding lanes:
    - EV Fast Track Lane provides charging infrastructure funding for commercial fleets that have already procured BEVs or have vehicles on order.
    - EV Jump Start Funding Lane provides charging infrastructure funding for commercial fleets operating in DACs, transit and school bus fleets, small fleet owners, and small business enterprises.
    - EV Public Charging Station Funding 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-, medium-, and heavy-duty vehicles and to accelerate commercial deployment.
- CEC's analytical work in forecasting and modeling is critical to ensure there is sufficient electricity and that infrastructure investments are made wisely.
- AB 2127 required CEC to biennially assess ZEV 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. [76]
- SB 643[77] requires CEC, in consultation with CARB and CPUC, to prepare a statewide assessment of the fuel-cell EV fueling infrastructure and fuel production needed to support the adoption of

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[74] California Energy Commission, Clean Transportation Program (web link: https://www.energy.ca.gov/programs-and-topics/programs/clean-transportation-program, last accessed August 2023).

[75] California Energy Commission, EnergIIZE Commercial Vehicles (web link: https://www.energiize.org/, last accessed July 2023).

[76] AB 2127, Ting, Public Resources Code section 25229, Electric vehicle charging infrastructure: assessment, 2018 (web link: *https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB2127*).

[77] SB 643, Archuleta, Stats. Fuel cell electric vehicle fueling infrastructure and fuel production: statewide assessment, ch. 646, 2021 (web link: *https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202120220SB643*).

ZE trucks, buses, and off-road vehicles, and complete the assessment by the end of 2023.

- 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 publicly owned utilities to develop and submit an Integrated Resource Plan to CEC for review and approval.
- 2020 VGI Roadmap update effort 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 updated Load Management Standards 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.

The Zero-Emission Vehicle Infrastructure Plan and other CEC efforts will greatly encourage and support the development of charging infrastructure for both on-road and off-road ZEVs, including ZEFs.

3) California Public Utilities Commission

The CPUC is the utility regulator over California's three largest IOUs, PG&E, SCE, and SDG&E, and three smaller IOUs that operate in rural and/or unincorporated territories (Liberty Utilities, PacifiCorp, and Bear Valley). As regulators of the IOUs, the CPUC applies its expertise and experience in electric rate design, electric system infrastructure deployment, grid management, and safety to support ZEV deployment. The CPUC's activities on transportation electrification fall into a few main categories: strategic planning on ZEV policy and investments; electric rates and cost of fueling; distribution infrastructure and planning to support charging infrastructure; vehicle-grid integration policy, pilots, and technology enablement; and IOUs' charging infrastructure investment programs. Some grid-related planning efforts include, but are not limited to:

- The CPUC's recent staff proposal on zero-emission freight infrastructure planning that addresses the need for proactive planning of long lead time electrical infrastructure needed to support the acceleration of transportation electrification.

- Oversight of the IOUs' EV Infrastructure Rules, pursuant to AB 841 (Ting, 2020), under which the IOUs began offering service in mid-2022. These rules, also known as Rule 29/45, shifted the approach to how the IOUs fund and how customers pay for certain utility-side of the meter investments associated with EV charging;

- The CPUC's 2022 adoption of a TE policy framework regarding IOU investment in chargers and make-readies, and the adoption of a rebate program for medium- and heavy-duty and targeted light-duty chargers that furthers state policy promoting decarbonization while prioritizing investment in low-income, underserved, and tribal communities;
- The CPUC's work with other state agencies, including CEC and CAISO, to ensure we are planning for accelerated transportation electrification;
- The CPUC's proceeding to advance demand flexibility through electric rates, which considers developing dynamic rates broadly available for customers, including ZEV charging and discharging; and
- The CPUC's proceeding to modernize the electric grid for a high distributed energy resources future is currently considering potential reforms to the IOUs' distribution planning process.

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 Division of the State Architect, the Department of Housing and Community Development, and others. CARB has assisted the Building Standards Commission in the adoption of minimum infrastructure requirements in new warehouses 20,000 square feet or greater and new retail and grocery stores 10,000 square feet or greater. The new requirements would provide sufficient conduit and panel capacity to support a 200 to 400 kilovolt-amps (kVA) increase in load for future electrification. In other words, the additional conduit and panel capacity would make it less costly to expand the electrical capacity of a building to accommodate ZEV charging in the future. Additionally, these vehicle infrastructure requirements were further amended as part of the 2022 CALGreen Code Intervening Code Adoption Cycle to include new manufacturing facilities and new office buildings. The minimum infrastructure requirements apply at 10,000 square feet or greater for new manufacturing facilities and 60,000 square feet or greater for new office buildings. These new requirements would also provide sufficient conduit and panel capacity to support a 200 to 400 kVA increase in load for future electrification. Staff estimates that 400 kVA would support roughly 10 to 50 ZEF chargers depending on charger rating and power factor.

5) California Infrastructure and Economic Development Bank

The California Infrastructure and Economic Development Bank (IBank) 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. IBank offers low-interest green municipal loans and green bonds for climate-smart infrastructure, credit enhancements and venture capital investment for climate entrepreneurs and investors, and debt financing for private borrowers to scale climate solutions. To increase investments in priority communities, IBank will attempt to stimulate investment in ZEV infrastructure by sourcing supportive capital from the federal government and other sources, and by leveraging its network of local lending partners.

b) Federal Inflation Reduction Act of 2022

The Inflation Reduction Act of 2022 provides substantial credit toward commercial clean vehicles, including mobile machinery with up to $40,000 for commercial vehicles with a gross vehicle weight rating above 14,000 pounds. These credits will further reduce the costs for ZEVs and will improve the total cost of ownership for ZEVs versus internal combustion engine vehicles. In addition, there are no restrictions on using these credits to meet regulatory requirements.[78]

G. Diesel-Fueled Forklifts

The Proposed Regulation is focused on the replacement of LSI forklifts with zero-emission forklifts and does not cover diesel-fueled forklifts. Diesel-fueled forklifts are currently subject to CARB's current Off-road Diesel Regulation, which bans older tier diesel-fueled equipment, and which requires emissions from fleets with diesel forklifts to be reduced dramatically over time. The Off-road Diesel Regulation also provides compliance credit for replacing diesel forklifts with ZEFs.[79] That said, staff intends to consider the accelerated transition to zero emissions of other off-road equipment types, including diesel-fueled and rough terrain forklifts, in subsequent regulatory efforts, including in two measures identified in the 2022 State SIP Strategy, the potential Off-Road Zero-Emission Targeted Manufacturer Rule and potential amendments to the Cargo Handling Equipment Regulation.[80]

When fleets phase out LSI Forklifts per the requirements of the Proposed Regulation, staff believes it is unlikely that diesel forklifts will be selected over ZEFs because, for the applications in which LSI Forklifts are used today, ZEFs are expected to be the most suitable option given multiple considerations affecting such a purchase decision, including disadvantages of selecting diesel-fueled forklifts. Indeed, according to the Industrial Trucks Association, ZEFs already represent roughly half of new forklift sales

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[78] Inflation Reduction Act of 2022, H.R. 5376, 117th Congress (2022) (web link: *https://www.congress.gov/bill/117th-congress/house-bill/5376*).
[79] Title 13, California Code of Regulations, Sections 2449, 2449.1 2449.2, and 2449.3.
[80] CARB, 2022 State Strategy for the State implementation Plan, pages 89 and 87, September 2022 (web link: https://ww2.arb.ca.gov/sites/default/files/2022-08/2022_State_SIP_Strategy.pdf).

in California, demonstrating the compelling market-driven case for ZEFs. For instance, diesel forklifts generally cannot be used indoors for extended periods of time due to emissions and noise.[81] In addition, due to the lower cost of ownership of ZEFs, fleets that use ZEFs are expected to realize savings over the long term (see Section VIII, SRIA). Moreover, diesel forklifts are more expensive than LSI forklifts and could require the installation of onsite fuel storage[82], so any upfront cost advantage of staying with internal combustion technology would be diminished for a fleet that opts to convert from LSI to diesel. Lastly, while certain duty cycles have presented ZEFs with challenges in the past, current ZEF technology (e.g., lithium-ion batteries, fuel cells, advanced lead-acid batteries) addresses most, if not all, of those challenges (see Section I.E, Technology Feasibility). In addition, for the rare instances where a fleet may not be able to identify a suitable ZE option, the Proposed Regulation includes extension provisions for feasibility issues that would allow the fleet to delay the phase-out of applicable LSI Forklifts potentially up until January 1, 2038.Any replacements of LSI forklifts with diesel forklifts that do occur would be subject to the current "Adding Vehicle" requirements in CARB's Off-Road Diesel Regulation, which are aimed at ensuring only newer, cleaner diesel vehicles can be added to fleets.[83] In addition, any diesel forklifts obtained may be subject to future requirements aimed at meeting the ZE transformation goals of EO N-79-20.

H. Well-To-Tank Criteria Emissions

CARB staff reviewed emissions related to the production of propane and the California grid that is used to charge electric forklifts to evaluate the Proposed Regulation's impact on total well-to-wheel (WTW) emissions.

Using the CA-GREET3.0 model[84], CARB staff evaluated the difference in NOx and PM emissions from the production of California liquid propane gas (LPG or propane) to instate California electricity generation emissions.[85] This analysis reflects well-to-tank (WTT) criteria emissions only. The emissions cited elsewhere in this report, such as in Chapter V, Section C. are generally tank to wheel (TTW); combined TTW and WTT

[81] Toyota Material Handling, Forklift Fuel Options and Buying Considerations, March 28, 2023 (web link: https://www.toyotaforklift.com/resource-library/blog/purchasing-decisions/forklift-fuel-options-and-buying-considerations).

[82] Atlantic Forklift Services, Pros & Cons: Electric, Propane, and Diesel Forklifts (web link: https://www.atlanticforkliftservices.com/pros-cons-electric-propane-diesel-forklifts/, last accessed July 2023).

[83] Title 13, California Code of Regulations, Sections 2449, 2449.1 2449.2, and 2449.3.

[84] CARB, CA-Greet Model: Version 3.0 Effective Jan 4, 2019 (web link: *https://ww2.arb.ca.gov/resources/documents/lcfs-life-cycle-analysis-models-and-documentation*, last accessed October 2023).

[85] Reactive Organic Gases (ROG) upstream emissions were not included in this analysis due to the lack of upstream ROG emissions data in the GREET model and other sources CARB staff reviewed.

emissions together constitute total WTW emissions. As detailed further below, CARB staff found that WTT NOx and PM emissions from electric forklifts are markedly lower than for comparable propane forklifts, as are WTW GHG emissions.

In 2022, California propane-as-fuel production had a NOx emission value of 15.9 grams per million Btu (MMBtu) and PM emission value of 1.4 grams per MMBtu, which is equivalent to 54.3 grams of NOx and 4.9 grams of PM per Megawatt-hour (MWh) of propane production. To determine the criteria emissions for instate electricity generation for 2021, which is the last year the data is currently available, staff used the California energy production listed by CEC of 194,000 gigawatts.[86] In 2021, the average emission rate for instate electricity generation was 27.1 tpd of NOx and 6.7 tpd of PM, which was determined by using the CARB CEPAM database[87, 88] for 2021, which includes cogeneration emissions. This is equivalent to 46.2 grams of NOx per MWh and 11.4 grams of PM per MWh.

While the analysis shows that the grid has higher PM per MWh produced than does propane, the electric forklift upstream emissions are lower when you include the Energy Economy Ratio (EER) per CARB's LCFS Guidelines[89]. The EER for an electric forklift is 3.8 whereas the EER for a propane forklift is 0.9. The EER is a dimensionless value that represents the efficiency of a fuel as used in a powertrain as compared to a reference fuel (in this case, diesel) used in the same powertrain. The EER reflects that electric forklifts are expected to perform roughly four times as much work as a propane forklift using the same amount of energy.

As an example, consider a baseline diesel forklift that uses 100 kWh of energy during a day of work. A propane forklift is assumed to use 111 kWh (100 kWh divided by 0.9) of energy to do the same amount of work. On the other hand, an electric forklift could achieve the same work using just 26 kWh (100 kWh divided by 3.8) of electrical

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[86] California Energy Commission, 2021 Total System Electric Generation (web link: *https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/2021-total-system-electric-generation*, last accessed September 2023).

[87] California Emission Project Analysis Model (CEPAM) Database, CEPAM2019v1.03 Standard Emission Tool, NOx Emission Data (web link: https://ww2.arb.ca.gov/applications/cepam2019v103-standard-emission-tool, last accessed October 2023).

[88] California Emission Project Analysis Model (CEPAM) Database, CEPAM2019v1.03 Standard Emission Tool, PM Emission Data (web link: https://ww2.arb.ca.gov/applications/cepam2019v103-standard-emission-tool, last accessed October 2023).

[89] California Air Resources Board, Low Carbon Fuel Standard (LCFS) Guidance 20-04: Requesting EER-Adjusted Carbon Intensity Using a Tier 2 Pathway Application, April 2020 (web link: *https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/guidance/lcfsguidance_20-04.pdf*).

energy. Assuming a charging efficiency of 85 percent[90], it would take approximately 31 kWh from the grid to recharge that forklift.

As shown in Table 3, the upstream emissions from the propane used by the forklift would amount to 111 kW multiplied by the emission rates for propane, or 6 grams of NOx and 0.54 grams of PM. The upstream emissions from the electricity needed to recharge an electric forklift completing the same work would be 31 kW multiplied by the grid emission rates, or 1.2 grams of NOx and 0.30 grams of PM, significantly lower than the emissions from the propane forklift.

Table 3. Upstream Emissions Comparison - Propane vs. Electric Forklift (for a day of work)

Energy Source	NOx (g/MWh) not including EER	PM (g/MWh) not including EER	NOx (g) including EER	PM (g) including EER
Propane	54.3	4.9	**6.0**	**0.54**
California Grid	46.2	11.4	**1.4**	**0.35**

To assess the impact of WTT emissions on GHGs, staff used the CI values and EERs per CARB's LCFS program. Carbon intensity is defined by the LCFS as "the quantity of life cycle greenhouse gas emissions, per unit of fuel energy, expressed in grams of CO_2 equivalent per megajoule (gCO_2e/MJ)." [91] Although a quantitative analysis was not performed, based on adjusted CI values, as shown in Table 4, WTW GHG emissions from a forklift using fossil-fuel-based propane are more than four times greater than such emissions from a ZEF using grid power. Additionally, while the unadjusted CI value of renewable propane is substantially lower than the CI values for both fossil-fuel-based propane and California grid electricity, when EER is taken into account, WTW GHG emissions from a forklift using renewable propane are 1.7 times greater than for a ZEF using grid power.

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[90] Pacific Gas and Electric Company, Emerging Technologies Fact Sheet: Efficient Forklift Battery Charger, November 2009 (web link: *https://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/moneybacksolutions/grocery/fb_ib/forklift_battery_charger_fs.pdf*).

[91] Ibid.

Table 4. Carbon Intensity Value Comparison – Propane vs. Electric Forklift

Fuel Pathway	Carbon Intensity (gCO_2e/MJ)	Energy Economy Ratio	EER Adjusted Carbon Intensity
Fossil-Fuel-Based Propane	83.19[92]	0.9	92.43
Renewable Propane	33.26[93]	0.9	36.96
CA Grid	81[94]	3.8	21.32

This analysis does not take into account future efforts to reduce electricity generation emissions by adopting renewable power generation such as solar and wind. These factors would mean that in the future, electric forklifts powered from the grid will have even more of an advantage in terms of lower criteria and GHG emissions than propane powered forklifts.

Incorporating the criteria emissions stemming from upstream fuel production into the analysis would yield supplementary emission benefits for the Proposed Regulation. Additionally, substantial GHG reductions would still be achieved if upstream GHG emissions were included. However, it is unknown where upstream WTT emission benefits would occur (e.g., some benefits could be outside California if propane is imported from out of state). Hence, except in this section, this ISOR focuses solely on tailpipe emission benefits, i.e., TTW, and does not consider the broader environmental or health benefits of WTT emissions.

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[92] CARB's LCFS Fuel Pathway Table, last updated September 14, 2023, (weblink: https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/fuelpathways/current-pathways_all.xlsx).

[93] Average CI based on renewable propane pathways in CARB's LCFS Fuel Pathway Table, last updated September 14, 2023, (weblink: *https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/fuelpathways/current-pathways_all.xlsx*).

[94] CARB, Low Carbon Fuel Standard Annual Updates to Lookup Table Pathways, 2023 Carbon Intensity Values for California Average Grid Electricity Used as a Transportation Fuel in California and Electricity Supplied Under the Smart Charging or Smart Electrolysis Provision, November 2, 2022 (web link: *https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/fuelpathways/comments/tier2/2023_elec_update.pdf?_ga=2.151734078.620778680.1684166454-1990257940.1569343285*).

I. Renewable Propane Carbon Intensity and Availability

Some stakeholders commented that renewable propane has a lower WTT CI than the average CI of California electricity generation. While the stakeholders' comment is true based on current fuel pathways in CARB's LCFS program, it does not represent the entire energy use process. Neglecting to account for the efficiency in which energy is converted to useable work gives an artificially high CI result for electricity used by electric forklifts. When the energy conversion is accounted for, the CI for an electric forklift is lower than a forklift that combusts renewable propane, as discussed in Chapter I, Section H, above.[95, 96]

Additionally, the CI for electricity generation is continually being reduced as mandated by the renewable portfolio standard (RPS) and other legislation.[97] For instance, SB 100 requires that retail sellers and local publicly owned electric utilities procure increasing quantities of electricity products from eligible renewable energy resources.[98] The CI for electricity in California will continue to decline until 2035 when the RPS will require the procurement of 100 percent of retail electricity sales are from renewable sources. Therefore, within the next 13 years, the CI for electricity in California is expected to be lower than the CI for renewable propane.

Further, the amount of renewable propane currently available to consumers is very small when compared to the entire California propane market. For example, the U.S. EPA estimates that 4.6 million gallons of renewable propane were produced nationally in 2021[99] (i.e., for the entire nation) whereas over 12.7 billion gallons of total propane was supplied during the same year.[100] Moreover, the NREL has stated that the

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[95] Using the CI analysis provided by United States Department of Energy for gasoline power vehicles of 12,594 pounds of CO2e per year and multiplying the number by a CI factor of 0.3 for renewable propane, gives a CI of 3,778 pounds of CO2e per year for a vehicle powered by renewable propane. However, the CI for an electric vehicle in California is 1,473 pounds of CO2e per year.

[96] United States Department of Energy, Alternative Fuels Data Center, Emissions from Electric Vehicles (web link: https://afdc.energy.gov/vehicles/electric_emissions.html, last accessed October 2023).

[97] California Public Utilities Commission, Renewables Portfolio Standard (RPS) Program (web link: https://www.cpuc.ca.gov/rps/, last accessed July 2023).

[98] SB 100, De León, Public Utilities Code new section 454.53, California Renewables Portfolio Standard Program: emissions of greenhouse gases, ch.312 (web link: *https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB100*).

[99] Whaley, Steve, The Future is Now: Renewable Propane, Advanced Clean Tech News, January 13, 2023 (web link: *https://www.act-news.com/news/the-future-is-now-renewable-propane/*).

[100] U.S. Energy Information Administration, Petroleum and Other Liquids, Release Date August 31, 2023 (web link: https://www.eia.gov/dnav/pet/pet_cons_psup_dc_nus_mbbl_a.htm).

production of renewable propane is not expected to significantly increase over the next decade.[101]

Although renewable propane has a low CI, combusting renewable propane in an LSI engine results in criteria pollutant emission such as NOx, PM2.5, and ROG. Distribution centers, and warehouses where LSI forklifts operate in large numbers are commonly located around more-densely-populated areas, including in low-income and DACs. Many communities located near distribution centers, and warehouses bear a disproportionate health burden due to their proximity to harmful emissions from mobile sources. Adoption of the Proposed Regulation would not only reduce NOx, PM2.5, and ROG in these locations and reduce adverse health impacts associated with regional air pollution but would also help to achieve the State's GHG emission reduction goals.

J. Crossover with Funding Programs

CARB's incentive and regulatory programs work together to accelerate the market for ZE vehicles and equipment. California's Climate Change Scoping Plan and State SIP Strategy, the State's blueprints for meeting climate change goals and the health-based NAAQS, respectively, 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 incremental costs and supporting vehicle cost reductions over time by building manufacturer economies of scale. As technologies become more established and demand continues to grow, technologies graduate into other incentive programs where the primary objective is achieving surplus emissions benefits. Under such programs, limited incentives are available while regulations are in effect unless the upgrade or purchase produces emission reductions beyond the minimum requirements of the regulations.

California continues to dedicate financial resources to reduce criteria and climate pollutant emissions. The State allocates funds annually to a multitude of programs with different but complementary goals. CARB's incentives portfolio places an emphasis on technology advancement, deployment of ZE vehicles and equipment, and turning over the legacy fleet. These efforts to incentivize new technologies complement CARB's regulatory efforts to ensure these technologies are deployed in strategic and impactful ways that support the State's air quality, climate, and low carbon transportation goals.

[101] Baldwin, R. M. et al., Techno-Economic, Feasibility, and Life Cycle Analysis of Renewable Propane – Final Report, National Renewable Energy Laboratory, October 2022 (web link: *https://www.nrel.gov/docs/fy23osti/83755.pdf*).

CARB administers a portfolio of funding that improves air quality, enhances community protection, and reduces GHG emissions in the off-road sector. Each of these programs has its own distinct goals that support the State's broader strategy. Details are provided below for each funding program or project.

1. Clean Off-Road Equipment Voucher Incentive Project (CORE)

Originally launched in February 2020, CORE[102] incentivizes California fleets to purchase or lease ZE off-road equipment. CORE's first year of funding focused on commercially available freight equipment that had yet to achieve a significant market foothold. CARB's Fiscal Year (FY) 2021-22 Funding Plan for Clean Transportation Incentives[103] expanded CORE's incentive assistance portfolio by adding funding for construction equipment, agricultural equipment, commercial harbor craft, and professional landscape equipment for small businesses and sole proprietors. Due to continued demand for CORE funding, CARB's FY 2022-23 Funding Plan for Clean Transportation Incentives allocated an additional $273 million to CORE.[104]

CORE encourages the purchase of heavy-duty off-road equipment powered by ZE technology over internal combustion options by providing a streamlined, point-of-sale voucher process for purchasers to receive funding to help offset the higher cost of such equipment. Because CORE is intended to encourage California off-road fleets to expand their ZE operations, it is expected to benefit the residents of California by providing immediate criteria pollutant and GHG emission reductions. Additionally, the project deploys and advances critical technologies necessary for California to meet its long-term air quality and climate change goals.

CORE vouchers are processed on a first-come, first-served basis and do not require scrappage. The program also provides enhancements for equipment deployed in disadvantaged and low-income communities, purchases made by small businesses, and infrastructure. Moreover, CORE allows for stacking of funds from other sources if those other sources also allow stacking of funds. The maximum CORE voucher cap is $500,000 for most equipment and up to $1,000,000 for rail, commercial harbor craft, and cargo handling equipment projects.

ZEFs with a lift capacity of over 8,000 pounds are currently eligible for funding through CORE.

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[102] For more information, visit *https://californiacore.org/*, last accessed October 2023.

[103] CARB, Proposed Fiscal Year 2021-22 Funding Plan for Clean Transportation Incentives, October 2021 (web link: https://ww2.arb.ca.gov/sites/default/files/2021-10/fy21-22_fundingplan.pdf).

[104] CARB, Proposed Fiscal Year 2022-23 Funding Plan for Clean Transportation Incentives, October 2022 (web link: *https://ww2.arb.ca.gov/sites/default/files/2022-10/proposed_fy2022_23_funding_plan_final.pdf*).

2. Carl Moyer Program

The Carl Moyer Memorial Air Quality Standards Attainment Program (Carl Moyer Program)[105] 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 air pollution. To date, the Carl Moyer Program has provided more than $308 million dollars in incentive funding for off-road equipment (not including agricultural equipment, marine vessels, locomotives, or lawn and garden equipment), accounting for approximately 24 percent of all Carl Moyer funding spent since 1998.[106] 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). Emission reductions resulting from the Carl Moyer Program are critical for enabling CARB and the air districts to fulfill their obligations 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.

Currently, eligibility for Carl Moyer program funding may incorporate several eligibility factors, including fleet size, hours of usage, and the type of emission-reducing technology. Regulatory compliance deadlines impact eligibility by defining the end of the surplus emission-reduction period. The Proposed Regulation would impact funding opportunities in the Carl Moyer Program due to the establishment of phase-out deadlines creating program eligibility limits. However, Carl Moyer Program funding eligibility options for ZEFs would continue, but would be dependent upon when an

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[105] For more information, please visit *https://ww2.arb.ca.gov/our-work/programs/carl-moyer-memorial-air-quality-standards-attainment-program/about*, last accessed October 2023.

[106] CARB, Carl Moyer Program Statistics: 2021 Reporting Cycle, February 24, 2023 (web link: *https://ww2.arb.ca.gov/sites/default/files/2023-02/2021%20Carl%20Moyer%20Program%20Statistics%2002-24-2023.pdf*).

applicable forklift is required to be phased out and when fleets apply for project funding.

3. Community Air Protection Program

The Community Air Protection Program[107] includes funding to support a community-focused action framework to improve air quality and reduce exposure to criteria air pollutants and TACs through emission reductions in the communities most impacted by disproportionate levels of air pollution. AB 617 directed CARB to establish the Community Air Protection Program to address the disproportionate burdens with which these communities continue to struggle. Community Air Protection incentives, first appropriated by the Legislature in 2017, with additional appropriations in 2018, 2019, 2021, and 2022, have provided hundreds of millions of dollars to community-prioritized emission-reduction measures. Like the Carl Moyer Program, Community Air Protection incentives are implemented through the cooperative efforts of CARB and California's air districts.

4. Volkswagen Environmental Mitigation Trust

The Volkswagen Environmental Mitigation Trust[108] and the resulting Beneficiary Mitigation Plan[109] for California includes $70 million for ZE freight and marine projects, with a maximum incentive of up to $210,000per forklift. ZEFs with a lift capacity greater than 8,000 pounds lift capacity are eligible for funding through this program. 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.

5. Complementary California Incentives for Zero-Emission Infrastructure

CARB regularly coordinates with the CEC, GO-Biz, CPUC, and the California State Transportation Agency on programs to facilitate the state's transition to zero emissions and a low-carbon future. For example, CARB coordinates closely with CEC to ensure that vehicle and equipment investments are complemented by investments in infrastructure. Additionally, state programs are complemented by local air district

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[107] For more information, visit *https://ww2.arb.ca.gov/our-work/programs/community-air-protection-incentives/about*, last accessed October 2023.

[108] For more information, visit *https://ww2.arb.ca.gov/our-work/programs/volkswagen-environmental-mitigation-trust-california/about*, last accessed October 2023.

[109] CARB, Beneficiary Mitigation Plan For the Volkswagen Environmental Mitigation Trust, June 2018 (web link: *https://ww2.arb.ca.gov/sites/default/files/2018-07/bmp_june2018.pdf*).

programs as well as actions taken by other local government entities. 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 six IOUs in the state to "accelerate widespread transportation electrification."[110] In response to SB 350 and due to prior TE efforts as well, the CPUC has authorized the electric utilities to spend approximately $2.4 billion on TE programs, from 2016 through the end of 2029. These programs promote the deployment of ZEVs through incentivizing charging infrastructure upgrade projects that offset most or all the costs for the make-ready infrastructure and electrical service upgrades. These programs support the objectives and intent of SB 350 and cover charging infrastructure for targeted light-duty vehicles, medium-duty vehicles, heavy-duty vehicles, and off-road equipment. Table 5 below shows the EV charging programs authorized for the IOUs.

Table 5. Authorized Funding for Investor-Owned Utility Electric Vehicle Charging Programs

Year of Program Authorization	Program Description	Funding
2016	SCE's Charge Ready Pilot	$22 Million
2016	SDG&E's Power Your Drive	$45 Million
2016	PG&E's EV Charge Network	$130 Million
2018	SCE's Charge Ready Bridge	$22 Million
2018	SB 350 Small IOU Programs	$7.8 Million
2018	SB 350 Priority Review Pilots	$42.8 Million
2018	PG&E's EV Fast Charge (SB 350 Standard Review Projects)	$615 Million

[110] SB 350, De León, Clean Energy and Pollution Reduction Act of 2015, ch. 547, 2015 (web link: *http://www.leginfo.ca.gov/pub/15-16/bill/sen/sb_0301-0350/sb_350_bill_20151007_chaptered.htm*).

Year of Program Authorization	Program Description	Funding
2018	SCE's Charge Ready Transport	4356.4 Million
2018	PG&E's EV Fleet	$245.8 Million
2019	PG&E's EV Empower	$4 Million
2019	SDG&E's Power Your Drive Fleets Program and Vehicle-to-Grid School Bus Pilot	$113.4 Million
2019	AB 1082/1083 Schools, Parks & Beaches	$64.7 Million
2020	SCE's Charge Ready 2	$436 Million
2020	SB 676 Vehicle Grid Integration Pilots	$35 Million
2021	SDB&E's Power Your Drive Extension	$43.5 Million
2021	Transportation Electrification Framework Near-Term Priorities	$240 Million
2022	Funding Cycle 1	$600 Million

Finally, CEC recently launched the EnergIIZE program, which provides incentives for fueling infrastructure to support battery-electric and fuel cell commercial vehicles and equipment.[111] EnergIIZE is part of CEC's FY2020-2023 Clean Transportation

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

Investment Plan to invest $129.8 million in medium- and heavy-duty ZEV infrastructure by 2023.[112]

6. Zero-Emission Vehicle Package

The ZEV package, which was agreed upon by the Governor and the Legislature in 2021, is a $9 billion, multi-year, multi-agency package promulgated to equitably decarbonize the transportation sector. The ZEV package builds on the investments in ZEVs and infrastructure the State has made over the past decade and is applied across a wide variety of segments including both on- and off-road applications, as well as the necessary infrastructure and charging stations.

II. The Problem that the Proposal is Intended to Address

In the coming years, California needs to continue to build upon its successful efforts to meet critical risk reduction, air quality, and climate goals. Achieving these goals will provide needed public health protection for the millions of Californians that still breathe unhealthy air, reduce exposure to air toxics in DACs, and help to meet SIP commitments. Additionally, meeting California's GHG emission reduction targets is an essential part of the global action needed to slow global warming and achieve climate stabilization. The Proposed Regulation would achieve NOx, PM2.5, ROG, and GHG emission reductions from LSI Forklifts and increase the use of ZE technology in the off-road sector, which would help to meet these complementary goals. This chapter provides a description of the problems the Proposed Regulation are intended to address.

A. Need to Reduce Criteria-Pollutant and GHG Emissions

CARB's mobile source programs have made significant progress in improving air quality throughout California. However, many areas throughout the State still fail to attain the NAAQS for ozone and fine particulate matter (i.e., PM2.5). Currently, there are 19 areas in California, including the South Coast Air Basin and San Joaquin Valley, that are designated as nonattainment areas for ozone. This results in approximately 67 percent of California's population, or 26 million out of 39 million people, living in areas exposed to concentrations above the federal ozone and PM2.5 standards.[113] Further, a

[112] California Energy Commission, CEC Approves $384 Million Plan to Accelerate Zero-Emission Transportation, October 2020 (web link: *https://www.energy.ca.gov/news/2020-10/cec-approves-384-million-plan-accelerate-zero-emission-transportation*).

[113] Based on 2021 monitored ozone and PM design values contoured over population by census tract.

disproportionate number of those most impacted by high ozone levels live in low-income and DACs.[114]

Emission reductions are needed to protect the health and welfare of all California residents. Exposure to NOx is linked to premature death, cardiopulmonary effects, decreased lung function and growth in children, respiratory symptoms, ED visits for asthma, and intensified allergic responses. In addition, NOx contributes to the formation of other airborne toxic substances, including ozone, nitric acid, and nitrate.[115] Furthermore, because PM2.5 can be deposited deep inside the lung, exposure to PM2.5 has been associated with adverse health impacts including premature mortality, increased hospital admissions for heart or lung causes, acute and chronic bronchitis, asthma attacks, ED visits, and respiratory symptoms.[116] In addition, climate change continues to impact California communities and the environment by increasing smog formation;[117,118,119] extending the pollen season; contributing to intense wildfires;[120] creating hotter temperatures that could cause heat-related health problems;[121,122]

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[114] CARB, 2022 State Strategy for the State implementation Plan, page 2, September 2022 (web link: https://ww2.arb.ca.gov/sites/default/files/2022-08/2022_State_SIP_Strategy.pdf).

[115] CARB, Nitrogen Dioxide and Health (web link: *https://ww2.arb.ca.gov/resources/nitrogen-dioxide-and-health#:~:text=In%20addition%2C%20a%20number%20of,asthma%2C%20and%20intensified%20allergic%20responses*, last accessed September 2023).

[116] CARB, Inhalable Particulate Matter and Health (PM2.5 and PM10) (web link: *https://ww2.arb.ca.gov/resources/inhalable-particulate-matter-and-health*, last accessed September 2023).

[117] Reidmiller, D.R., et al., Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II, Chapter 14, Human Health, U.S. Global Change Research Program, 2018 (web link: *https://nca2018.globalchange.gov/chapter/14/*).

[118] World Health Organization, Climate change and human health: risks and responses, p.12, 2003 (web link: *https://apps.who.int/iris/bitstream/handle/10665/42742/924156248X_eng.pdf?sequence=1&isAllowed=y*).

[119] NRDC, Climate Change and Health in California, p.13, 2019 (web link: https://www.nrdc.org/sites/default/files/climate-change-health-impacts-california-ib.pdf).

[120] Singleton, M. P., et al., Increasing Trends in High-Severity Fire in the Southwestern USA from 1984 to 2015, Forest Ecology and Management, Volume 433, 2019 (web link: https://www.fs.usda.gov/rm/pubs_journals/2019/rmrs_2019_singleton_m001.pdf).

[121] Office of Environmental Health Hazard Assessment, Indicators of Climate Change in California, 2013 (web link: *https://oehha.ca.gov/media/downloads/climate-change/document/climatechangeindicatorsreport2013.pdf*).

[122] CARB, Health & Air Pollution (web link: *https://ww2.arb.ca.gov/resources/health-air-pollution*, last accessed July 2023).

causing weather extremes, such as drought[123] and flooding;[124] [125] and increasing prevalence of infectious diseases.[126] [127]

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 particulate matter. The combustion of fossil fuel by mobile sources accounts for approximately 80 percent of smog-forming NOx emissions, 90 percent of the diesel PM emissions, and nearly 40 percent of statewide GHG emissions.[128] [129] [130] Of that, off-road equipment contributes to approximately 14 percent of the NOx emissions and 7 percent of the PM emissions attributable to mobile sources.[131] Taking action to reduce criteria-pollutant and GHG emissions is urgently needed to reduce the toll air pollution and climate change is taking on Californians. Furthermore, roughly 80 percent of forklift emissions occur in the South Coast Air Basin, San Joaquin Valley Air Basin, and the San Francisco Bay Area Air Basin, three areas that were found to be in nonattainment in the 2022 area

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[123] Mann, M. E. and Gleick, P. H., Climate Change and California Drought in the 21st Century, Proceedings of the National Academy of Sciences of the United States of America, March 2015 (web link: https://www.pnas.org/doi/epdf/10.1073/pnas.1503667112).

[124] Swain et al., Increasing Precipitation Volatility in Twenty-First-Century California, Nature, 2018 (web link: *https://www.sierraforestlegacy.org/Resources/Conservation/FireForestEcology/ThreatsForestHealth/Climate/CI_Swain_etal_2018_Increasing_Precip_Volatility.pdf*).

[125] Dettinger, M., Climate Change, Atmospheric Rivers, and Floods in California—a Multimodel Analysis of Storm Frequency and Magnitude Changes, Journal of the American Water Resources Association, June 2011 (web link: https://ca.water.usgs.gov/pubs/2011/climate-change-atmospheric-rivers-floods-california-dettinger.pdf).

[126] Lindgren et al., Monitoring EU Emerging Infectious Disease Risk Due to Climate Change, Science, April 2012, web link: *https://www.researchgate.net/publication/224856024_Monitoring_EU_Emerging_Infectious_Disease_Risk_Due_to_Climate_Change*).

[127] Solomon et al, Airborne Mold and Endotoxin Concentrations in New Orleans, Louisiana, After Flooding, October through November 2005, Environmental Health Perspectives, September 2006 (web link: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1570051/).

[128] CARB, 2022 Scoping Plan for Achieving Carbon Neutrality, December 2022 (web link: *https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf*.

[129] CARB, Mobile Source Strategy, May 2016 (web link: *https://ww3.arb.ca.gov/planning/sip/2016sip/2016mobsrc.pdf*).

[130] CARB, 2022 Scoping Plan for Achieving Carbon Neutrality, December 2022 (web link: https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf).)

[131] CARB, Staff Report for the Proposed Amendments to the In-Use Off-Road Diesel-Fueled Fleets Regulation, p.35, September 20, 2022 (web link: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/off-roaddiesel/isor.pdf).

designations for ozone and PM2.5.[132, 133] Therefore, the Proposed Regulation would help lower health risk in the areas that need it most.

B. Need to Address State Policy

1. Assembly Bill 32

In 2006, California's Governor signed AB 32, the California Global Warming Solutions Act of 2006 (Nuñez, Chapter 488, Statutes of 2006) 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, 2017, and 2022. California's 2022 Scoping Plan for Achieving Carbon Neutrality[134] outlines the State's strategy to achieve carbon neutrality by 2045 or earlier.

2. 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.[135, 136] 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 Proposed Regulation is a measure identified in the Discussion Document.

3. Executive Order B-32-15

In July 2015, Governor Brown signed EO B-32-15 directing the California State Transportation Agency, California Environmental Protection Agency , and the Natural Resources Agency to lead other relevant State departments in developing an

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[132] CARB, 2022 Area Designations for State Ambient Air Quality Standards: Ozone, last updated November 2022 (web link: *https://ww2.arb.ca.gov/sites/default/files/2023-02/State_2022_O3.pdf*).

[133] CARB, 2022 Area Designations for State Ambient Air Quality Standards: PM2.5, last updated November 2022 (web link: https://ww2.arb.ca.gov/sites/default/files/2023-02/State_2022_PM25.pdf).

[134] CARB, 2022 Scoping Plan for Achieving Carbon Neutrality, December 2022 (web link: https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf).

[135] CARB, 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*).

[136] CARB, Board Resolution 14-2, Sustainable Freight Strategy Update, 2014 (web link: https://www.arb.ca.gov/board/res/2014/res14-2.pdf).

integrated action plan by July 2016 that "establishes clear targets to improve freight efficiency, transition to ZE technologies, and increase competitiveness of California's freight system."[137] The 2016 California Sustainable Freight Action Plan[138] included recommendations, such as developing regulations as a State agency action, to advance the objectives of the EO.

4. Senate Bill 350

SB 350 (De León, Chapter 547, Statutes of 2015), the Clean Energy and Pollution Reduction Act, establishes GHG reductions targets and orders the CPUC to direct the six IOUs in the state to "accelerate widespread [transportation electrification]." The resulting programs developed by the electric utilities, for which $740 million has been authorized, promote the deployment of ZE vehicles and equipment through incentivizing infrastructure upgrade projects that offset most or all the costs for electrical service upgrades.

5. Senate Bill 32

In 2016, SB 32 (Pavley, Chapter 249, Statutes of 2016) was signed into law, which requires CARB to ensure that California's GHG emissions are reduced to at least 40 percent below the 1990 levels by 2030. To date, California has made significant progress towards meeting the goals of SB 32; however more needs to be done.

6. Assembly Bill 617

The State of California placed additional emphasis on protecting local communities from the harmful effects of air pollution through the passage of AB 617 (Garcia, Chapter 136, Statutes of 2017), which highlights the need for further emission reductions in communities with high exposure burdens. AB 617 requires CARB to pursue new community-focused and community-driven actions to reduce air pollution and improve public health in communities that experience disproportionate burdens from exposure to air pollutants. The Proposed Regulation would reduce LSI Forklift emissions and exposure statewide and would be of particular benefit in DACs experiencing disproportionate burdens.

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[137] Office of Governor Edmund G. Brown Jr., Executive Order B-32-15, 2015 (web link: https://www.ca.gov/archive/gov39/2015/07/17/news19046/index.html).
[138] Governor of the State of California, California Sustainable Freight Action Plan, July 2016, (web link: *https://ww2.arb.ca.gov/sites/default/files/2019-10/CSFAP_FINAL_07272016.pdf*).

7. Executive Order B-55-18 and Assembly Bill 1279

In 2018, Governor Brown issued EO B-55-18, which sets a target to achieve carbon neutrality in California no later than 2045 and achieve and maintain net negative emissions thereafter.[139] In 2022, AB 1279 was signed into law, which established the policy of the state to achieve carbon neutrality as soon as possible, but no later than 2045; to maintain net negative GHG emissions thereafter; and to ensure that by 2045 statewide anthropogenic GHG emissions are reduced at least 85 percent below 1990 levels. The Proposed Regulation directly supports achieving these goals through the required transition of LSI Forklifts to ZEFs in California fleets.

8. Executive Order N-79-20

In September 2020, Governor Newsom issued EO N-79-20, which directs CARB, in coordination with other State agencies, U.S. EPA, and local air districts, to develop and propose technologically feasible and cost-effective strategies to achieve 100 percent ZE from off-road vehicles and equipment operations in the State by 2035. The Proposed Regulation supports the directive of the EO by transitioning LSI Forklifts to ZE technology.

9. 2020 Mobile Source Strategy

The 2020 Mobile Source Strategy[140] was approved by the Board on October 28, 2021, and uses scenario planning to take an integrated approach to identifying the technology trajectories and programmatic concepts to meet our criteria pollutant, GHGs, and TAC reduction goals from mobile sources. It is a framework that identifies the levels of cleaner technologies necessary to meet our many goals and high-level regulatory concepts that would allow the State to achieve the levels of cleaner technology. The programs and concepts in the 2020 Mobile Source Strategy have been incorporated in other planning efforts, including the SIP, the 2022 Climate Change Scoping Plan Update, and community emissions reduction plans developed as a part of Assembly Bill 617's Community Air Protection Program. The 2020 Mobile Source Strategy identifies forklifts as one of the equipment types to rapidly transition to ZE technologies where feasible to meet the State's air quality and climate goals.

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[139] State of California Executive Department, Executive Order B-55-18, 2018 (web link: *https://www.library.ca.gov/wp-content/uploads/GovernmentPublications/executive-order-proclamation/39-B-55-18.pdf*).

[140] CARB, 2020 Mobile Source Strategy, October 28, 2021 (web link: *https://ww2.arb.ca.gov/sites/default/files/2021-12/2020_Mobile_Source_Strategy.pdf*).

10. 2016 State Strategy for the State Implementation Plan

The federal Clean Air Act requires areas that exceed the health-based ambient air quality standards to develop SIP that demonstrate how such areas will attain the standards by specified dates. In March 2017, the Board adopted the State SIP Strategy [141], which outlined CARB's comprehensive strategy to reduce emissions from over the following 15 years. The 2016 State SIP Strategy identifies the need for substantial emission reductions from mobile sources and increased penetration of ZE technology. The Proposed Regulation is an identified measure in the 2016 State SIP Strategy as one needed to meet critical air quality and climate goals.

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 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 proposal and to address the problems for which it is proposed.

The overarching purpose of the Proposed Regulation is to reduce harmful emissions from forklifts by accelerating the transition to ZEFs throughout the state to reduce emissions of NOx, fine PM, other criteria pollutants, TACs, and GHG.

Appendix E to the ISOR, Purpose and Rationale, presents the purpose and rationale of each provision of the Proposed Regulation.

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

A. Health Benefits

The Proposed Regulation would reduce NOx and PM2.5 emissions, resulting in health benefits in California. CARB staff analyzed the value of health benefits associated with 12 health outcomes, most of which were added or updated through CARB's recent

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[141] CARB, Revised Proposed 2016 State Strategy for the State Implementation Plan, March 7, 2017 (web link: *https://ww2.arb.ca.gov/sites/default/files/classic/planning/sip/2016sip/rev2016statesip.pdf*).

expansion of the health analysis[142]: cardiopulmonary mortality, acute myocardial infarction, lung cancer incidence, asthma onset, asthma symptoms, hospitalizations for cardiovascular illness, hospitalizations for respiratory illness, hospitalizations for Alzheimer's disease, hospitalizations for Parkinson's disease, cardiovascular ED visits, respiratory ED visits, and work loss days.

These health outcomes 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.[143,144] 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 (e.g., acute myocardial infarction) and short- and long-term exposure to PM2.5, a likely causal relationship between non-mortality respiratory effects (including worsening asthma) and short- and long-term PM2.5 exposure, and a likely causal relationship between non-mortality neurological effects and long-term PM2.5 exposure.143

CARB staff evaluated health impacts associated with exposure to PM2.5 and NOx emissions from the Proposed Regulation. NOx includes nitrogen dioxide, a potent lung irritant, which can aggravate lung diseases such as asthma when inhaled.[145] 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 are associated with adverse health outcomes. As a result, reductions in PM2.5 and NOx emissions are associated with reductions in these adverse health outcomes.

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[142] CARB, California Air Resources Board Updated Health Endpoints Bulletin, October 20, 2023 (web link: *https://ww2.arb.ca.gov/sites/default/files/2022-11/California%20Air%20Resources%20Board%20Updated%20Health%20Endpoints%20Bulletin%20-%20Edited%20Nov%202022_0.pdf*).

[143] U.S. EPA, Integrated Science Assessment for Particulate Matter (Issue EPA/600/R-19/188), December 2019 (web link: *https://ordspub.epa.gov/ords/eims/eimscomm.getfile?p_download_id=539935*).

[144] U.S. EPA, Technical Support Document (TSD) for the Final Revised Cross-State Air Pollution Rule Update for the 2008 Ozone Season NAAQS, March 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*).

[145] U.S. EPA, Integrated Science Assessment for Oxides of Nitrogen – Health Criteria (Issue EPA/600/R-15/068), January 2016 (web link: *http://ofmpub.epa.gov/eims/eimscomm.getfile?p_download_id=526855*).

1. 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.[146] CARB's IPT methodology is based on a methodology developed by U.S. EPA.[147,148,149]

Under the IPT methodology, it is assumed that changes in emissions are approximately proportional to changes in health outcomes. 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:

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

Multiplying the emissions reductions from the Proposed Regulation in an air basin by the IPT factor then yields an estimate of the reduction in health outcomes achieved by the Proposed 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.

[146] CARB, 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 July 2023).
[147] Fann, N., et al., 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, 2009 (web link: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2770129/).
[148] Fann, N., et al., Characterizing the PM2.5-related health benefits of emission reductions for 17 industrial, area and mobile emission sectors across the U.S., Environment International; 49:141-51, November 2012 (web link: *https://www.sciencedirect.com/science/article/pii/S0160412012001985*).
[149] Fann, N., et al., Assessing Human Health PM2.5 and Ozone Impacts from U.S. Oil and Natural Gas Sector Emissions in 2025, Environmental Science & Technology, 52, pages 8095–8103, July 2018 (web link: *https://pubs.acs.org/doi/full/10.1021/acs.est.8b02050*).

2. Updated Information on Health Impact Analysis

CARB recently initiated an expanded health analysis to include additional health endpoints in order to provide a more-comprehensive analysis of the benefits of the agency's plans and regulations. A description of the updated and new health outcomes was provided in CARB's Updated Health Endpoints Bulletin, released November 2022.[150] This expansion was based on U.S. EPA's Technical Support Document for the Final Revised Cross-State Air Pollution Rule Update for the 2008 Ozone Season NAAQS and is associated with U.S. EPA's Environmental Benefit Mapping and Analysis Program – Community Edition (BenMAP-CE) version 1.5.8.[151]

To derive the IPT factors for each of the health endpoints, the number of health outcomes associated with exposure to PM2.5 were calculated by inputting PM2.5 concentrations from air monitoring data into U.S. EPA's BenMAP-CE version 1.5.8.4 (released April 16, 2021). The baseline incidence datasets embedded in the BenMAP-CE software were used; the incidence data for mortality, hospital admissions (including myocardial infarctions), and ED visits were at the county-level, while the incidence data for work loss days was provided at the national rate in the software.[152]

For most of the health endpoints, the U.S. EPA had identified one effect estimate derived from one study to be used in the respective health impact function. However, for myocardial infarction and respiratory ED visits, the U.S. EPA had identified multiple effect estimates; thus, EPA's health impact functions for these two endpoints were estimated using pooling methods. Pooling combines multiple risk estimates to determine a summary mean value estimate and associated confidence intervals.[153] For the myocardial infarction endpoint, the results were pooled from four different epidemiological studies using the random or fixed effects pooling and sum dependent

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[150] CARB, California Air Resources Board Updated Health Endpoints Bulletin, October 20, 2023 (web link: *https://ww2.arb.ca.gov/sites/default/files/2022-11/California%20Air%20Resources%20Board%20Updated%20Health%20Endpoints%20Bulletin%20-%20Edited%20Nov%202022_0.pdf*).

[151] U.S. EPA, Technical Support Document (TSD) for the Final Revised Cross-State Air Pollution Rule Update for the 2008 Ozone Season NAAQS, March 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*).

[152] U.S. EPA, Environmental Benefits Mapping and Analysis Program - Community Edition: User's Manual, 2023 (web link: *https://www.epa.gov/sites/default/files/2015-04/documents/benmap-ce_user_manual_march_2015.pdf*).

[153] U.S. EPA, Technical Support Document (TSD) for the Final Revised Cross-State Air Pollution Rule Update for the 2008 Ozone Season NAAQS, March 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*).

pooling methods, as specified in the configuration file that U.S. EPA uses for PM quantification. For respiratory ED visits, the results were pooled from analyses across four different locations in the U.S. done in one study; this pooling used the random or fixed effects method, also as specified in U.S. EPA's configuration file.

3. Reduction in Adverse Health Impacts

CARB staff estimates that the total number of cases statewide that would be reduced (from 2026 to 2043) from implementation of the Proposed Regulation are as follows:

- 544 (301 – 777)[154] fewer cases of cardiopulmonary mortality;
- 115 (83 – 145) fewer hospitalizations for cardiovascular disease;
- 148 (-57 – 344) fewer cases of cardiovascular ED visits;
- 62 (23 – 166) fewer cases of nonfatal acute myocardial infarction;
- 17 (1 – 33) fewer hospitalizations for respiratory disease;
- 321 (63 – 668) fewer cases of respiratory ED visits;
- 42 (13 – 68) fewer cases of lung cancer incidence;
- 1,295 (1,244 – 1,344) fewer cases of asthma onset;
- 109,800 (-53,559 – 266,382) fewer cases of asthma symptoms;
- 80,635 (68,002 – 92,791) fewer work loss days;
- 272 (209 – 331) fewer hospitalizations for Alzheimer's disease; and
- 39 (20 – 55) fewer hospitalizations for Parkinson's disease.

These significant reductions in adverse health cases are expected to be seen across all ages in the state. Children in particular would benefit from the reduced cases of asthma onset and asthma symptoms due to the Proposed Regulation. This may lead to better health outcomes in these children when they become adults since studies have shown that childhood asthma puts individuals at greater risk for respiratory disease and lower respiratory function in adulthood.[155,156] Adults are also expected to benefit from the Proposed Regulation due to fewer illnesses and hospitalizations, lost workdays, nonfatal acute myocardial infarctions (heart attacks), lung cancer incidences, and cardiopulmonary mortality. Seniors may benefit from reduced cases of hospitalizations for not just cardiovascular and respiratory diseases, but also

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[154] The numbers in parentheses represent the 95 percent confidence intervals, which reflect the variation in estimated associations between air pollutants (e.g., $PM_{2.5}$) and health endpoints from epidemiological literature.

[155] Sears, M.R., et al., A longitudinal, population-based, cohort study of childhood asthma followed to adulthood, New England Journal of Medicine; 349:1414-1422, October 2003 (web link: *https://pubmed.ncbi.nlm.nih.gov/14534334/*).

[156] McGeachie, M.J., et al., Patterns of Growth and Decline in Lung Function in Persistent Childhood Asthma, New England Journal of Medicine; 374:1842-1852, May 2016 (web link: *https://www.nejm.org/doi/10.1056/NEJMoa1513737*).

neurological conditions (Alzheimer’s and Parkinson’s diseases). Additionally, there would be fewer ED visits for both cardiovascular and respiratory diseases across all ages in the population.

Table 6 shows the air basin distribution of avoided health endpoints for the Proposed Regulation, for 2026 through 2043 in California, relative to the baseline. It is important to consider that the Proposed Regulation may decrease the occupational exposure to air pollution of forklift operators and other people who work around forklifts in California. These individuals are likely at higher risk of developing health issues because of forklift PM emissions. A literature review demonstrated that occupational PM exposure may be associated with adverse cardiovascular health outcomes.[157] Although CARB staff cannot quantify the potential effect on occupational exposure, the Proposed Regulation is expected to provide larger health benefits for these individuals.

[157] Fang, S.C., et al., A Systematic Review of Occupational Exposure to Particulate Matter and Cardiovascular Disease, International Journal of Environmental Research and Public Health; 7: 1773-1806, April 2010 (web link: *https://doi.org/10.3390/ijerph7041773*).

Table 6. Avoided Mortality and Morbidity Incidents from 2026 to 2043 under the Proposed Regulation*

Air Basin**	Cardiopulmonary Mortality	Hospitalizations for Cardiovascular Disease	Cardiovascular ED Visits	Acute Myocardial Infarction	Hospitalizations for Respiratory Disease	Respiratory ED Visits	Lung Cancer Incidence
GBV	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
LC	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
LT	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
MD	1 (1 - 1)	0 (0 - 0)	0 (0 - 1)	0 (0 - 0)	0 (0 - 0)	1 (0 - 1)	0 (0 - 0)
MC	1 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 1)	0 (0 - 0)
NCC	1 (1 - 2)	0 (0 - 0)	0 (0 - 1)	0 (0 - 0)	0 (0 - 0)	1 (0 - 2)	0 (0 - 0)
NC	0 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 1)	0 (0 - 0)
NP	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
SV	6 (3 - 9)	1 (1 - 2)	1 (-1 - 3)	1 (0 - 2)	0 (0 - 0)	4 (1 - 7)	0 (0 - 1)
SS	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
SD	20 (11 - 28)	5 (4 - 6)	5 (-2 - 12)	2 (1 - 6)	1 (0 - 1)	10 (2 - 20)	2 (1 - 3)
SFB	66 (37 - 95)	14 (10 - 18)	20 (-8 - 46)	8 (3 - 22)	2 (0 - 4)	49 (10 - 102)	7 (2 - 11)
SJV	17 (10 - 24)	3 (2 - 4)	4 (-2 - 10)	2 (1 - 5)	1 (0 - 1)	11 (2 - 23)	1 (0 - 2)
SCC	6 (3 - 8)	1 (1 - 2)	1 (-1 - 3)	1 (0 - 2)	0 (0 - 0)	3 (1 - 6)	0 (0 - 1)
SC	426 (235 - 607)	89 (64 - 112)	115 (-44 - 268)	48 (18 - 129)	14 (1 - 26)	242 (48 - 504)	31 (10 - 51)
Statewide	**544 (301 - 777)**	**115 (83 - 145)**	**148 (-57 - 344)**	**62 (23 - 166)**	**17 (1 - 33)**	**321 (63 - 668)**	**42 (13 - 68)**

Table 6 – Continued.

Air Basin**	Asthma Onset	Asthma Symptoms	Work Loss Days	Hospitalizations for Alzheimer's Disease	Hospitalizations for Parkinson's Disease
GBV	0 (0 - 0)	5 (-2 - 11)	3 (3 - 4)	0 (0 - 0)	0 (0 - 0)
LC	0 (0 - 0)	6 (-3 - 16)	4 (3 - 5)	0 (0 - 0)	0 (0 - 0)
LT	0 (0 - 0)	1 (0 - 1)	1 (0 - 1)	0 (0 - 0)	0 (0 - 0)
MD	2 (2 - 2)	155 (-75 - 376)	113 (95 - 130)	0 (0 - 1)	0 (0 - 0)
MC	2 (2 - 2)	144 (-70 - 350)	110 (93 - 127)	0 (0 - 0)	0 (0 - 0)
NCC	4 (4 - 4)	329 (-160 - 800)	232 (196 - 268)	0 (0 - 0)	0 (0 - 0)
NC	1 (1 - 1)	77 (-37 - 186)	61 (51 - 70)	0 (0 - 0)	0 (0 - 0)
NP	0 (0 - 0)	5 (-2 - 12)	3 (3 - 4)	0 (0 - 0)	0 (0 - 0)
SV	13 (12 - 13)	1,102 (-537 - 2,677)	895 (755 - 1031)	2 (1 - 2)	0 (0 - 1)
SS	1 (1 - 1)	53 (-26 - 129)	41 (34 - 47)	0 (0 - 0)	0 (0 - 0)
SD	46 (45 - 48)	3,886 (-1,894 - 9,438)	3,286 (2,770 - 3,782)	16 (12 - 19)	2 (1 - 3)
SFB	232 (223 - 241)	19,397 (-9,449 - 47,116)	13,421 (11,315 - 15,449)	31 (24 - 39)	6 (3 - 9)
SJV	31 (30 - 32)	2,771 (-1,354 - 6,712)	2,155 (1,818 - 2,479)	8 (6 - 10)	1 (1 - 1)
SCC	15 (14 - 15)	1,288 (-629 - 3,124)	885 (746 - 1,018)	2 (2 - 3)	0 (0 - 1)
SC	948 (911 - 984)	80,581 (-39,319 - 195,435)	59,425 (50,119 - 68,378)	212 (163 - 257)	29 (15 - 41)
Statewide	**1,295 (1,244 - 1,344)**	**109,800 (-53,559 - 266,382)**	**80,635 (68,002 - 92,791)**	**272 (209 - 331)**	**39 (20 - 55)**

* Numbers in parentheses throughout this table represent the 95 percent confidence interval.
**List of air basin names in full: Great Basin Valleys, Lake County, Lake Tahoe, Mojave Desert, Mountain Counties, North Central Coast, North Coast, Northeast Plateau, Sacramento Valley, Salton Sea, San Diego County, San Francisco Bay, San Joaquin Valley, South Central Coast, South Coast

4. 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 confidence intervals included with the central estimates in **Table 3**. These confidence intervals consider 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 and emission reductions by county are estimated based on a surrogate (i.e., total warehouse square footage by county) and do not capture all local variations.
- Future population estimates are subject to increasing uncertainty as they are projected further into the future.
- Baseline incidence rates can experience year-to-year variation.

5. Potential Future Evaluation of Additional Health Benefits

CARB has initiated expanded health analysis to include additional health outcomes to provide a more comprehensive review of the health impacts of PM2.5 exposure for this Proposed Regulation and upcoming regulations.[158] However, note that the current PM2.5 mortality and morbidity evaluation conducted by CARB staff still focuses on select air pollutants and only captures a portion of the health benefits of the Proposed Regulation. Further updates to the methodology may be made in the future to quantify additional benefits of reducing air pollution, such as by including additional pollutants and health outcomes. For instance, the current analysis considers the impact of NOx on the formation of secondary PM2.5 particles, but only includes a portion of the secondary PM2.5 particles. In addition, NOx can also react with other compounds to form ozone, which can cause respiratory problems. Ozone impacts are not included

[158] CARB, 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 July 2023).

in this analysis. Also, CARB will continue to evaluate approaches to provide both quantitative and qualitative information on health outcomes based on the best available science, such as through current literature reviews and CARB-funded research contracts. More information on CARB's research contracts can be found on CARB's online research page (*https://ww2.arb.ca.gov/our-work/programs/research-planning/research-division-contracts*).

6. Monetization of Health Benefits

The reductions in adverse health impacts described above can be assigned monetary values so the health benefits can be directly compared to other costs and savings associated with the Proposed Regulation. These values are derived from economics studies and are based on the expenses that an individual must bear for air pollution related health impacts, such as medical bills and lost work, or willingness to pay (WTP) metrics, which in addition to capturing the direct expenses of the health outcomes also capture the value that individuals place on pain and suffering, loss of satisfaction, and leisure time.

a) Methodology

Health outcomes are monetized by multiplying each incident by a value per incident that is consistent with the IPT method described above, using the standard economic studies and data as provided in U.S. EPA's BenMAP-CE.[159,160] The value per incident is derived from BenMAP-CE using the results for the total status-quo PM-related incidence for each health endpoint used to derive the IPT and dividing them by the total valuation (or cost) as estimated in BenMAP-CE using the standard studies and data it includes to derive a per incident dollar value for an avoided incident. These value per incident estimates are derived for each of the three years considered in our air quality scenario (2014-2016); an average is taken across the three years to derive the final estimate.[161] The economic studies and data used are the same as those used in U.S. EPA's recent Revised Cross-State Air Pollution Rule Update.[162] The dollar values

[159] U.S. EPA, Environmental Benefit Mapping and Analysis Program – Community Edition (BenMAP-CE) (web link: *https://www.epa.gov/benmap*, last accessed October 2023).

[160] US. EPA, BenMAP Environmental Benefits Mapping and Analysis Program- Community Edition: User's Manual, March 2023 (web link: *https://www.epa.gov/sites/default/files/2015-04/documents/benmap-ce_user_manual_march_2015.pdf*).

[161] California Air Resources Board, Valuation Estimates Spreadsheet. March 2023.

[162] U.S. EPA, Technical Support Document (TSD) for the Final Revised Cross-State Air Pollution Rule Update for the 2008 Ozone Season NAAQS, March 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*).

per incident therefore are equivalent to those evaluated in that rule, only varying due to California-specific economic and demographic data.[163]

The value per incident for each endpoint derived by the methods described above are shown in Table 7. The value for avoided premature mortality is based on the value of statistical life (VSL),[164] a measure of WTP from economic theory, which when applied to mortality risk provides a dollar estimate of benefits for an avoided premature death. The VSL is a statistical construct based on the aggregated dollar amount that a large group of people would be willing to pay for a reduction in their individual risks, such that one death would be avoided in the year across the population.[165] Specifically, the U.S. EPA central estimate of $7.4 million (2006$) is used for VSL.[166] The estimate of VSL is adjusted for per-capita income growth using U.S. EPA's central income elasticity estimate of 0.40 and the income growth forecast included in BenMAP-CE. This income elasticity estimate for VSL follows from empirical research and indicates that for every one percent increase in per capita income the VSL increases by 0.4 percent, consistent with health risk reduction being a normal good whose demand increases with income. Finally, the value for VSL is adjusted for California inflation to present the values in 2021 dollars. While the economic benefit associated with avoided premature mortality is important to account for in the analysis, the valuation of avoided premature mortality does not directly correspond to changes in expenditures and is therefore not included in the macroeconomic modeling.

Unlike mortality valuation, the cost-savings for morbidity related endpoints such as avoided hospitalizations, ED visits, as well as disease onset and occurrence are based on the cost of illness (COI) methodology.[167] The COI methodology uses a combination of typical costs associated with hospitalization or disease occurrence to assign an economic value to avoidance of such outcomes. The types of cost that are included across the different valuation studies applied here include hospital charges, post-hospitalization medical care, out-of-pocket expenses, lost earnings for both individuals

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[163] The California specific data that cause variation from national estimates are the data on county-level median daily wages and the age distribution of the population residing in each air basin. Small variations may also arise due to BenMAP-CE's Monte Carlo simulation methods.

[164] 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*).

[165] Ibid.

[166] U.S. EPA, Mortality Risk Valuation: What value of statistical life does EPA use?, last updated March 14, 2023 (web link: https://www.epa.gov/environmental-economics/mortality-risk-valuation).

[167] The WTP method is also used for valuation of one morbidity-related health endpoint: asthma symptoms.

and family members, and lost household production (e.g., valuation of time-losses from inability to maintain the household or provide childcare).

These monetized benefits from all COI-based endpoint valuations are included in the macroeconomic modeling.

Table 7. Valuation per Incident for Avoided Health Outcomes (2021$)

Endpoint	Value Per Incident (2021$)	Valuation Methodology	Notes
Premature Mortality			
Premature Mortality	$12,483,845	WTP	Shown at 2021 income levels. The estimate will grow annually proportional to income growth using U.S. EPA's central estimate for income elasticity of 0.40, and income growth forecast from BenMAP-CE.
Hospitalizations and ED Visits			
Hospital Admissions (HA), Parkinson's Disease	$15,520	COI	Direct cost of hospitalization incident.
HA, Respiratory	$11,815	COI	Direct cost of hospitalization incident.
HA, Alzheimer's Disease	$14,539	COI	Direct cost of hospitalization incident.
HA, Cardio-, Cerebro- and Peripheral Vascular Disease	$18,696	COI	Direct cost of hospitalization incident.
ED visits, All Cardiac Outcomes	$1,403	COI	Direct cost of ED visit.

Endpoint	Value Per Incident (2021$)	Valuation Methodology	Notes
ED visits, respiratory	$1,057	COI	Direct cost of ED visit.
Health Endpoint Onset/Occurrence			
Incidence, Asthma	$53,753	COI	Present value of lifetime healthcare cost and productivity losses using a 3% discount rate.
Asthma Symptoms, Albuterol use	$253	WTP for symptoms + COI for Albuterol use	Willingness to pay plus cost of albuterol.
Incidence, Lung Cancer	$30,377	COI	Direct medical cost of lung cancer. Cost discounted to present value at 3%.
Acute Myocardial Infarction, Nonfatal	$94,334	COI	Present value of 3 years medical cost and earnings lost over a 5-year period. Using a 3% discount rate.
Work Loss Days	$204	COI	Based on county-level median daily wages.

b) Statewide Valuation of Health Benefits

Statewide valuation of health benefits was calculated by multiplying the value per incident by the statewide total number of incidents for 2026-2043 as shown in

Table 8. The total statewide health benefits derived from criteria emissions reductions are estimated to be $7.49 billion, with $7.36 billion resulting from reduced premature cardiopulmonary mortality and $0.13 billion resulting from non-mortality endpoints. The spatial distribution of these benefits across the State follows the distribution of the health impacts by air basin as described in Table 6.

Table 8. Avoided Health Outcomes and Statewide Valuation of Health Benefits

Year	Premature Mortality	HA, Parkinson's Disease	HA, Respiratory	HA, Alzheimer's Disease	HA, Cardio-, Cerebro- and Peripheral Vascular Disease	ED visits, All Cardiac Outcomes	ED visits, respiratory	Incidence, Asthma	Asthma Symptoms, Albuterol use	Incidence, Lung Cancer	Acute Myocardial Infarction, Nonfatal	Work Loss Days	Valuation (Million 2021$)
2026	0	0	0	0	0	0	0	0	0	0	0	0	$0
2027	0	0	0	0	0	0	0	0	0	0	0	0	$0
2028	6	0	0	3	1	2	4	15	1,394	0	1	939	$79
2029	5	0	0	2	1	1	3	12	1,097	0	1	753	$64
2030	13	1	0	6	3	4	8	33	2,919	1	2	2,046	$176
2031	17	1	1	8	3	5	10	43	3,720	1	2	2,659	$231
2032	18	1	1	9	4	5	11	44	3,793	1	2	2,756	$242
2033	25	2	1	12	5	7	15	61	5,202	2	3	3,812	$338
2034	25	2	1	12	5	7	15	61	5,173	2	3	3,803	$341
2035	36	3	1	18	8	10	21	86	7,320	3	4	5,396	$489
2036	36	3	1	18	8	10	21	87	7,312	3	4	5,398	$494
2037	36	3	1	18	8	10	21	85	7,212	3	4	5,335	$492
2038	54	4	2	27	11	15	32	128	10,759	4	6	7,963	$741
2039	54	4	2	27	12	15	32	128	10,764	4	6	7,963	$748
2040	54	4	2	28	12	15	32	128	10,751	4	6	7,945	$753
2041	55	4	2	28	12	15	32	129	10,852	4	6	8,008	$766
2042	54	4	2	28	12	15	32	127	10,741	4	6	7,917	$764
2043	55	4	2	28	12	15	32	128	10,791	4	6	7,942	$773
Total	544	39	17	272	115	148	321	1,295	109,800	42	62	80,635	$7,492

B. Air Quality and Climate Benefits

1. NOx, PM2.5, and ROG

The Proposed Regulation would accelerate the transition of LSI forklifts to ZE forklifts, which would achieve NOx, PM2.5, and ROG emission reductions. This would contribute toward attainment of federal ambient air quality standards and meeting the commitments outlined in the 2016 State SIP Strategy and improve public health by reducing exposure to air pollution, particularly in communities heavily impacted by mobile source emissions. Cumulatively, from 2026 to 2043, the Proposed Regulation is expected to reduce statewide forklift emissions by approximately 18,700 tons of NOx, 2,000 tons of PM2.5, and 5,000 tons of ROG, relative to the Baseline. Chapter V provides a detailed summary of the air quality benefits of the Proposed Regulation.

2. Greenhouse Gases-Social Cost of Carbon

As discussed in further detail in Chapter V, Section C., staff expects the Proposed Regulation to reduce cumulative TTW GHG emissions by an estimated 9.4 MMT of CO2 relative to the baseline from 2026 to 2043.

The benefit of these GHG emission reductions can be estimated using the social cost of carbon, which provides a dollar valuation of the damages caused by one metric ton of carbon pollution and represents the monetary benefit today of reducing carbon emissions in the future.

In the analysis of the SC-CO2 for the Proposed Regulation, CARB utilizes the current Interagency Working Group (IWG)-supported SC-CO2 values to consider the social costs of actions taken to reduce GHG emissions. This is consistent with the approach presented in the 2022 Scoping Plan for Achieving Carbon Neutrality, is in line with U.S. Government EOs, 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.[168, 169, 170]

IWG describes the social costs of carbon 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.*[171]

The SC-CO2 is year-specific and is highly sensitive to the discount rate used to discount the value of the damages in the future due to CO2. The SC-CO2 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 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.

[168] CARB, 2022 Scoping Plan for Achieving Carbon Neutrality, December 2022 (web link: *https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf*).

[169] Executive Office of the President, Executive Order 13990: Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis, January 20, 2021(web link: *https://www.federalregister.gov/documents/2021/01/25/2021-01765/protecting-public-health-and-the-environment-and-restoring-science-to-tackle-the-climate-crisis*).

[170] Office of Management and Budget, Circular A-4, September 2003 (web link: https://www.transportation.gov/sites/dot.gov/files/docs/OMB%20Circular%20No.%20A-4.pdf).

[171] National Academies of Sciences, *Engineering, Medicine, Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide* , 2017 (web link: http://www.nap.edu/24651).

Table 9 shows the range of IWG SC-CO_2 discount rates used in California's regulatory assessments, which reflect the societal value of reducing carbon emissions by one metric ton.[172]

Table 9. 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

The avoided SC-CO_2 from 2026 to 2043 is the sum of the annual TTW GHG emissions reductions multiplied by the SC-CO_2 in each year. In Table 10, staff calculated the avoided SC-CO_2 values (Million 2021$) by applying values in Table 9 that were adjusted with a California consumer price index inflation adjustment factor. These benefits range from about $254 million to $1.05 billion through 2043, depending on the chosen discount rate.

[172] Interagency Working Group on Social Cost of Greenhouse Gases, Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide - Interim Estimates under Executive Order 13990, February 2021 (web link: *https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf*).

Table 10. Avoided Social Cost of Carbon for the Proposed Regulation

Year	GHG emission reductions (MMT)	Avoided $SC\text{-}CO_2$ (Million 2021$)		
		5% discount rate	3% discount rate	2.5% discount rate
2026	0.0	$0	$0	$0
2027	0.0	$0	$0	$0
2028	0.1	$2	$5	$8
2029	0.1	$2	$6	$9
2030	0.2	$4	$13	$18
2031	0.3	$6	$19	$28
2032	0.3	$7	$22	$31
2033	0.4	$10	$32	$45
2034	0.4	$11	$33	$47
2035	0.6	$15	$47	$67
2036	0.6	$17	$49	$69
2037	0.6	$17	$50	$71
2038	0.9	$26	$75	$106
2039	0.9	$26	$76	$108
2040	0.9	$27	$78	$109
2041	0.9	$27	$79	$110
2042	0.9	$28	$79	$111
2043	0.9	$28	$80	$113
Total	**9.4**	**$254**	**$743**	**$1,050**

C. Benefits to Businesses

1. Benefits to Forklift Owners and Operators

Staff expects that many forklift owners and operators switching to ZEFs would realize net cost savings over the ZEF equipment lifetime due to the lower energy costs and lower maintenance costs of operating ZEFs. These cost savings are quantified in the Direct Cost Section (Chapter VIII, Section B). The savings could be invested back into the business, passed on to businesses that are further down the supply/service chain, or passed on to the consumer. In addition, some businesses' fleets may be able to lower their total cost of ownership by utilizing incentive funds or by owning charging or hydrogen fueling stations that would allow access to LCFS program credits. Finally, as discussed further in Chapter VIII, Section B.9.b, ZEFs require less maintenance than forklifts with internal combustion engines and hence have lower maintenance costs.

Under the Proposed Regulation, employees working on-site where LSI forklifts operate would be exposed to fewer air pollutants found in combustion exhaust fumes, such as CO, NOx, and PM2.5. Reduced exposure to combustion exhaust could reduce the number of sick days employees take and improve employee productivity.

In addition, ZEFs that fleets transition to per the Proposed Regulation are expected to provide other unquantified benefits to fleets that utilize them. For example, ZEFs run more smoothly and are cleaner and quieter than their internal-combustion counterparts, which could improve worker safety and health, and potentially reduce associated costs of worksite injuries and employee illness. Whole-body vibrations experienced by forklift operators have been associated with low back pain, the degeneration of intervertebral discs, and operator fatigue.[173, 174, 175] Operator fatigue is one of the main causes of forklift-pedestrian impacts.[176] While there are many factors that contribute to forklift vibrations, electric forklifts do not have vibrations caused by

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[173] Deshmukh, Aditya Anil, Assessment of Whole Body Vibration Among Forklift Drivers Using ISO 2631-1 and ISO 2631-5, July 2009 (web link: https://soar.wichita.edu/bitstream/handle/10057/2530/t09038.pdf?sequence=1).

[174] Rion Equipment, *The Advantages of an Electric Forklift* (web link: https://rionequipment.com/handling/blog/the-advantages-of-an-electric-forklift/, last accessed July 2023).

[175] Conger Industries Inc., *6 Health Risks for Forklift Operators and How to Prevent Them*, updated June 19, 2023 (web link: https://www.conger.com/health-risks-forklift-operators/).

[176] Conger Industries Inc., Top 10 Most Common Forklift Accidents (And How to Prevent Them), updated June 23, 2023 (web link: https://www.conger.com/forklift-accidents/).

a reciprocating engine and, therefore, are less fatiguing to operate.[177] As such, transitioning Class IV and V affected forklifts to ZE could also reduce workplace accidents, injuries, and associated costs.

Finally, companies that use ZEF fleets would be able to advertise that they are reducing their carbon footprint by utilizing a carbon-neutral or carbon-optimal supply chain.[178] In addition, environmentally friendly material handling equipment may help some companies achieve their goal of carbon neutrality by compensating for other aspects of their businesses from which it is more difficult to reduce GHG emissions.

2. Benefits to Electric Utility Providers

The Proposed Regulation would increase the number of ZEFs 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 ZEFs, they would also see potential benefits like other forklift owners and operators, as discussed above in Chapter IV, Section C.1, Benefits to Forklift Owners and Operators.

The Proposed Regulation would also help the State's IOU meet the goals of SB 350, which includes a requirement that the State's IOUs develop programs "to accelerate widespread transportation electrification." PG&E[179], SCE[180], and SDG&E[181] have active programs to install low-cost or free EV charging infrastructure on a customer's site.

All three of these IOUs have established new electricity rates for commercial deployments of ZE vehicles and off-road equipment to better align with fleet needs and to ensure affordability. Research and development of new rate strategies are ongoing. By ensuring that ZEFs would be available to make use of these utility investments and rates, the Proposed Regulation supports the utilities' programs, the goals of SB 350, and an increase in electricity demand. In addition, other electric service providers, such as publicly owned utilities and community choice aggregators,

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[177] Rion Equipment, *The Advantages of an Electric Forklift* (web link: https://rionequipment.com/handling/blog/the-advantages-of-an-electric-forklift/, last accessed July 2023).

[178] Caro, F., et. al, Carbon-Optimal and Carbon-Neutral Supply Chains, University of California at Los Angeles, 2011 (web link: https://escholarship.org/uc/item/3s01b6pg).

[179] Pacific Gas and Electric Company, EV Fleet Program (web link: *https://www.pge.com/en_US/large-business/solar-and-vehicles/clean-vehicles/ev-fleet-program/ev-fleet-program.page*, last accessed July 2023).

[180] Southern California Edison, Charge Ready Transport Program (web link: https://crt.sce.com/program-details, last accessed July 2023).

[181] San Diego Gas and Electric Company, Power Your Drive for Fleets (web link: *https://www.sdge.com/business/electric-vehicles/power-your-drive-for-fleets*, last accessed July 2023).

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

3. Benefits to Small Businesses

The Proposed Regulation would increase demand for the manufacture and distribution of ZEFs, charging equipment, and associated components as well as for the design, installation, and maintenance of electrical or hydrogen infrastructure. Small businesses would benefit from the Proposed Regulation to the extent they are involved in the industries that would be needed to fulfill the increased demand for the aforementioned products and services. Examples of small businesses that could benefit from the Proposed Regulation include electricians, engineering firms, project management companies, parts manufacturers, and construction companies. In addition, small businesses in the printing industry could benefit from the increased demand for forklift labels that the Proposed Regulation would require. Furthermore, the anticipated benefits to forklift owners and operators discussed in Chapter IV, Section C.1, such as fuel and maintenance savings, would also apply to small businesses that own forklifts.

4. Benefits to Other Entities

By increasing sales of ZEFs and associated infrastructure, the Proposed Regulation would result in financial benefits to ZEF manufacturers, ZEF component manufacturers and suppliers, electrical circuit panel manufacturers and suppliers, electrical contractors, electric utilities, material handling equipment dealers, charging station suppliers, producers of hydrogen, and hydrogen fuel station suppliers. As discussed further in Chapter VIII, Section D.2, the higher demand for ZEFs from the Proposed Regulation would likely also lead to an increase in sales and manufacturing related jobs throughout the State. Finally, to the extent that the Proposed Regulation spurs generation of on-site power to charge ZEFs, the Proposed Regulation would also benefit California fleets that sell or manufacture electrical generating equipment, energy storage, and related services, such as companies that support solar photovoltaic (PV) panels, and electrical generators.

Targeted Class IV and Class V Forklifts are well-suited to transition to ZE technology. As more fleets convert to ZEFs due to the Proposed Regulation, forklift manufacturers would be expected to maintain or even increase their investments in developing ZE technologies and expand their ZE product lines. Such investments could contribute to break-through technologies and broader acceptance of ZE technologies in off-road vehicle applications.

The increased use of electric charging infrastructure by off-road EVs would decrease the amount of fossil fuel consumed in California, helping the State meet the goals of

SB 350.[182] Furthermore, SB 350 directs IOUs to implement programs to accelerate widespread TE, including the deployment of charging infrastructure. SB 350 goals include increasing the sales of ZE vehicles, reducing air pollutant emissions to help meet air quality standards, and reduce GHGs. As a result of SB 350, the States' three large IOUs (PG&E, SDG&E, and SCE) are establishing or have established commercial electricity rate programs that reduce battery charging rates at specified times of the day. Some publicly owned utilities have developed similar TE rate programs as the IOUs. By increasing the number of ZEFs in the State, the Proposed Regulation would support the utilities' programs and help meet SB 350 goals.

Further, battery-electric forklifts could be recharged onsite, thereby eliminating the need for fuel deliveries to the fleet. By reducing fuel-delivery trips to fleet facilities, the Proposed Regulation would reduce emissions related to on-road transportation. Given the lack of available data, staff was not able to estimate with reasonable certainty the emission reductions that would be attributed to fuel delivery. Therefore, those emission reductions were not included in the analysis.

California Building Standards Code, Title 24 of the California Code of Regulations requires that all new commercial buildings built after the start of 2030 must be zero net energy (ZNE) buildings. To meet this requirement, most builders of new commercial buildings are expected to add solar PV panels. The ZNE requirement does not apply to commercial buildings built before 2030. The Proposed Regulation could prompt owners of existing commercial buildings built before 2030 to add solar PV panels, vehicle charging stations, and energy storage to their buildings to reduce the operating cost of ZEFs and reduce emissions from power generation. Because staff is not able to predict with reasonable certainty how many fleets would install solar PV panels due to the Proposed Regulation, emission reductions from renewable electrical generation have not been included in staff's emission benefit estimate.

D. Benefits of More ZE Technology in the Off-Road Sector

The Proposed Regulation would increase the deployment of ZE technology in the off-road sector. The transition of forklift fleets to zero emissions would increase market awareness and acceptance of ZE technologies and support the industries involved in the production, supply, and service of such technology. The overall growth of the ZE industry resulting of the Proposed Regulation, and others like it, is expected to help stimulate advancements that lead to more robust products and support systems as well as the advancement of ZE technology in other off-road equipment types.

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[182] SB 350, De León, Clean Energy and Pollution Reduction Act of 2015, ch. 547, 2015 (web link: *http://www.leginfo.ca.gov/pub/15-16/bill/sen/sb_0301-0350/sb_350_bill_20151007_chaptered.htm*).

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 nine percent of the total consumption in the United States.

ZEVs have two fundamentally superior technical features (greater upstream energy source flexibility and greater vehicle efficiency) when compared to conventional vehicles.[183] 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.[184] SB 350 extended California's renewable electricity procurement goal to require 50 percent renewable energy by 2030.[185] 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.[186] SB 350 also requires California to double statewide energy efficiency savings in electricity end uses by 2030.

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. SB 1505, establishes a statutory minimum of 33.3 percent renewable content for hydrogen fuel.[187] In fact, hydrogen renewable content estimates of 90 percent in 2020 and 92 percent in 2021 were achieved according to reporting from

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[183] Lutsey, Nic, Transition to a Global Zero-Emission Vehicle Fleet: A Collaborative Agenda for Governments, International Council on Clean Transportation (ICCT), September 2015 (web link: *https://theicct.org/sites/default/files/publications/ICCT_GlobalZEVAlliance_201509.pdf*).

[184] California Energy Commission, 2021 Total System Electric Generation (weblink: *https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/2021-total-system-electric-generation#:~:text=Total%20system%20electric%20generation%20is,or%205%2C188%20GWh%2C%20from%202020*, last accessed July 2023)

[185] SB 350, De León, Clean Energy and Pollution Reduction Act of 2015, ch. 547, 2015 (web link: *http://www.leginfo.ca.gov/pub/15-16/bill/sen/sb_0301-0350/sb_350_bill_20151007_chaptered.htm*)

[186] SB 100, De León, Public Utilities Code new section 454.53, California Renewables Portfolio Standard Program: emissions of greenhouse gases, ch.312 (web link: *https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB100*).

[187] SB 1505, Lowenthal, Fuel: hydrogen alternative fuel, ch.877, 2006 (web link: *http://www.leginfo.ca.gov/pub/05-06/bill/sen/sb_1501-1550/sb_1505_bill_20060930_chaptered.pdf*).

hydrogen station operators and through the LCFS program reporting.[188] CARB anticipates that the hydrogen network will maintain a minimum of 40 percent renewable content through 2027.[189] 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.[190] 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.[191] 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.[192] 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.

V. Air Quality

This chapter includes an analysis of air quality data and emissions reductions relevant to the Proposed Regulation.

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[188] CARB, 2021 Annual Evaluation of Fuel Cell Electric Vehicle Deployment and Hydrogen Fuel Station Network Development, September 2021 (web link: *https://ww2.arb.ca.gov/sites/default/files/2021-09/2021_AB-8_FINAL.pdf*).

[189] Ibid.

[190] U.S. Department of Energy, All-Electric Vehicles (web link: *https://www.fueleconomy.gov/feg/evtech.shtml*, last accessed September 2023).

[191] U.S. Department of Energy Hydrogen Program, Hydrogen Fuel Cells, October 2006 (web link: *https://www.californiahydrogen.org/wp-content/uploads/files/doe_fuelcell_factsheet.pdf?msclkid=3dc431a0b5fb11ecbaf6a8ab4b1ad0b4*).

[192] Lutsey, Nic, Transition to a Global Zero-Emission Vehicle Fleet: A Collaborative Agenda for Governments, International Council on Clean Transportation (ICCT), September 2015 (web link: *https://theicct.org/sites/default/files/publications/ICCT_GlobalZEVAlliance_201509.pdf*).

A. Baseline Information

CARB staff estimated the economic and emission impacts of the Proposed Regulation by evaluating the Proposed Regulation and comparing it to the Baseline scenario each year across the regulatory horizon (2026-2043). The Baseline for the Proposed Regulation reflects full compliance with existing CARB regulations, including the LSI Engine Regulation[193] and the LSI Fleet Regulation[194].

Staff used the statewide 2023 Large Spark-Ignition Forklift Emission Inventory, described in Section B of Chapter V, below, to estimate emissions for the Baseline and Proposed Regulation, as well as to forecast the populations of forklifts each year from 2026 through 2043, for which there would be direct costs or benefits associated with the Proposed Regulation. The Proposed Regulation would impact approximately 11,000 fleets in California, who in total own about 95,000 forklifts.

B. Emissions Inventory Methodology

To determine emission impacts of the Proposed Regulation, CARB staff developed the 2023 Large Spark Ignition Forklift Emission Inventory (LSI Emission Inventory), further described in Appendix D. The emission inventory is a detailed account of the population, activity (i.e., annual hours of use), HP, age distribution, and emissions from the forklifts covered by the Proposed Regulation. The emission inventory provides data on the emission benefits and informs the cost and health impacts analyses.

The emission inventory was updated in 2021 through 2023 to support the Proposed Regulation, with the first public workshop held in April 2022 and a second workshop in January 2023. Public comments on the emission inventory were taken throughout this process, where feedback and meetings with stakeholders on the emission inventory helped CARB staff improve key details.

Data sources for the inventory are summarized below:

- Population and the age distribution of LSI forklifts were based on the CARB reporting database for forklifts (DOORS) for fleets of four or more, and on a statewide survey of forklift owners completed by California State University, Fullerton for fleets of three or less.
- Population data were supplemented by historical forklift sales, based on information from the Industrial Trucking Association (ITA).

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[193] Title 13, California Code of Regulations, Sections 2430 through 2439.
[194] Title 13, California Code of Regulations, Section 2775 through 2775.2.

- Activity was based on a survey of equipment owners in the DOORS database.
- Emission factors (EF) were updated based on the engine certification data reported to CARB and U.S. Environmental Protection Agency (U.S. EPA) by LSI engine manufacturers.
- Forecasting is based on the historical sales trend from ITA data, as well as the current age distribution of the LSI fleet.

Table 11 provides a summary of statistics from the emission inventory.

Table 11. Summary Statistics from Baseline Emission Inventory

Statewide Population	87,412 Propane Forklifts 7,313 Gasoline Forklifts 79,143 Electric Forklifts
Average Age	8 Years (Propane) 11 Years (Gasoline)
Average Activity	1,844 Hours (Propane) 1,900 Hours (Gasoline)

- Overall, as shown in Figure 3 and Figure 4, the emission inventory showed higher emissions in the 2020s compared to the previous emission inventory, the OFFROAD2007 model. This is largely due to a much higher population. The updated model includes roughly 95,000 LSI forklifts, compared to roughly 30,000 in the previous model. (The previous model did not have the benefit of reporting or California sales numbers.) However, NOx emissions decrease faster than previously estimated due to the inclusion of updated and significantly lower emission factors for 2010 and later LSI equipment.

Figure 3. Statewide Baseline NOx Emissions from LSI Forklifts by Fuel Type

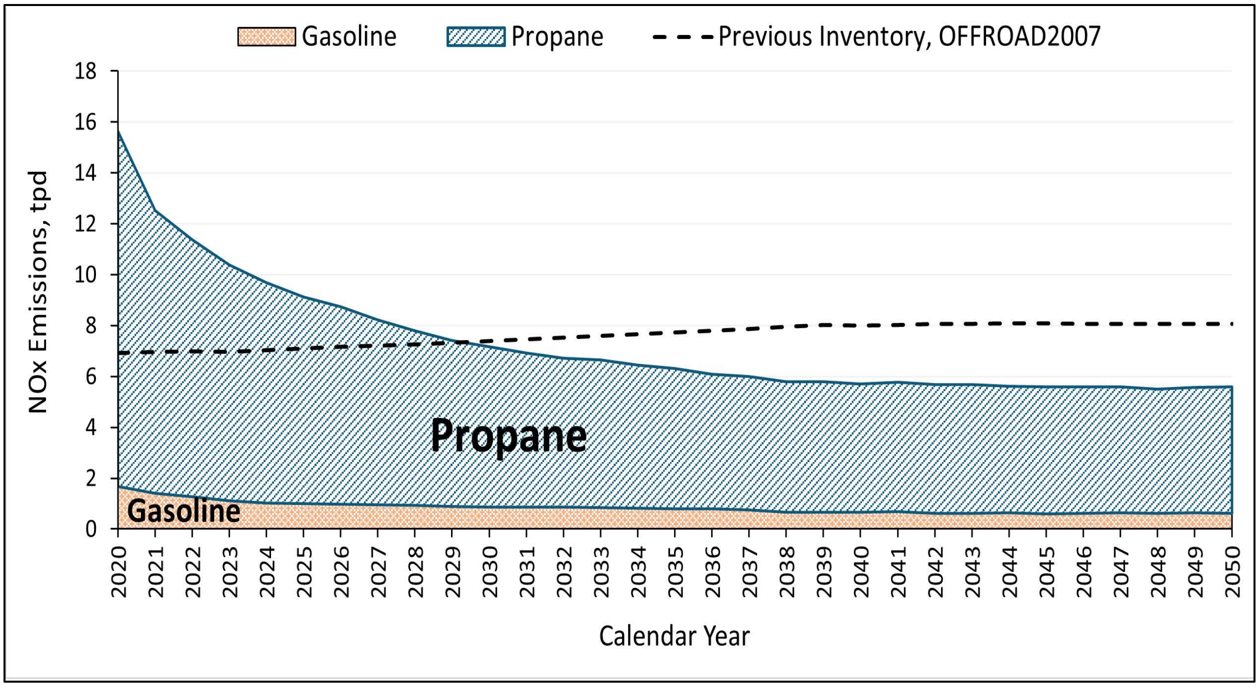
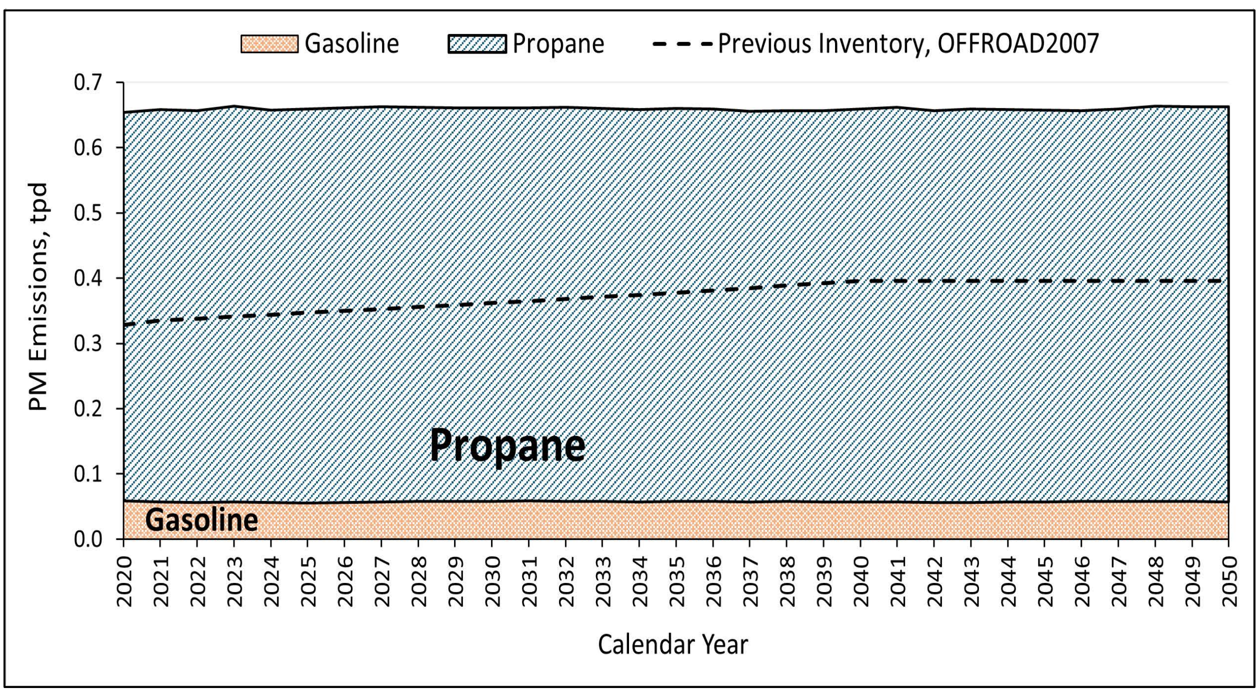


Figure 4. Statewide Baseline PM Emissions from LSI Forklifts by Fuel Type



The emissions for any given year are a function of the population, hours of engine activity, engine HP, load factors (LF), EF, and fuel correction factors (FCF), as shown in the following equation:

Emissions = Population x Activity x HP x LF x EF x FCF

Where:

Population = Count of equipment

Activity = Time the engine is running in hours

HP = Maximum brake horsepower of the engine

LF = Load Factor (Average fraction of max power rating of engine during normal operations)

EF = Emission Factor (grams per horsepower-hour) specific to horsepower, engine build year, and the specific pollutant. Includes a deterioration factor.

FCF = Fuel Correction Factor, based on calendar year

C. Emission Inventory Results

The Proposed Regulation is expected to reduce NOx by 2.01 tpd, PM2.5 by 0.17 tpd, and ROG emissions by 0.46 tpd in 2031 and reduce NOx by 3.26 tpd and ROG by 0.95 tpd in 2037. In addition, the Proposed Regulation is estimated to cumulatively reduce NOx emissions by 18,724 tons, PM2.5 emissions by 2,075 tons, ROG emissions by 4,973 tons, and CO_2 emissions by 9.4 MMT from 2026 to 2043.

The following section provides a discussion of the projected emissions benefits from the Proposed Regulation of both criteria pollutants (NOx, ROG, and PM2.5) and GHGs. The analyses of these statewide tank-to-wheel emissions reductions from the Proposed Regulation are compared with the Legal Baseline and demonstrate that emissions benefits increase as LSI forklifts are transitioned to ZEFs.

The estimated emissions benefits for the Proposed Regulation are measured relative to the Baseline scenario. Staff used the LSI Emission Inventory model to determine the emission difference between the Proposed Regulation and Baseline scenarios. Table 12 presents the estimated baseline emissions.

Table 12. Statewide TTW Baseline Emissions of NOx, PM2.5, ROG, and CO_2 from LSI Forklifts

Calendar Year	NOx (tpd)	PM2.5 (tpd)	ROG (tpd)	CO_2 (MMT/year)
2026	8.75	0.64	1.75	1.06
2027	8.22	0.64	1.72	1.06
2028	7.78	0.64	1.69	1.06
2029	7.41	0.64	1.64	1.06
2030	7.16	0.64	1.63	1.06
2031	6.91	0.64	1.63	1.06
2032	6.71	0.64	1.60	1.06
2033	6.64	0.64	1.58	1.06
2034	6.45	0.64	1.56	1.06
2035	6.30	0.64	1.56	1.06
2036	6.08	0.64	1.54	1.06
2037	6.00	0.64	1.50	1.06
2038	5.80	0.64	1.45	1.06
2039	5.79	0.64	1.45	1.06
2040	5.71	0.64	1.46	1.06
2041	5.76	0.64	1.48	1.06
2042	5.68	0.64	1.42	1.06

Calendar Year	NOx (tpd)	PM2.5 (tpd)	ROG (tpd)	CO_2 (MMT/year)
2043	5.67	0.64	1.42	1.06

This assessment is focused on the direct emissions from forklifts, also known as TTW emissions. The assessment does not include upstream emissions, also known as WTT emissions, associated with the extraction, processing, and delivery of fuel or with the generation, transmission, and distribution of electrical energy. WTT emissions are addressed by other measures and policies with the goal of reducing WTT emissions. However, as discussed further in Chapter I, Section H, if WTT emissions were included in this analysis, it is expected that GHG emission reductions would still be achieved, and there would be even greater NOx emission reductions attributed to the Proposed Regulation.

Table 13 shows the estimated NOx, PM2.5, ROG, and CO_2 emission benefits that would result from the Proposed Regulation from 2026 through 2043 in tpd for NOx, PM2.5, and ROG, and in MMT per year for CO_2. Years 2031 and 2037 are mid-term attainment deadlines for NAAQS.

Table 13. Statewide TTW NOx, PM2.5, ROG, and CO_2 Benefits of the Proposed Regulation Relative to Baseline

Calendar Year	NOx (tpd)	PM2.5 (tpd)	ROG (tpd)	CO_2 (MMT/year)
2026	0.00	0.00	0.00	0.00
2027	0.00	0.00	0.00	0.00
2028	0.90	0.05	0.20	0.08
2029	0.58	0.05	0.14	0.09
2030	1.89	0.11	0.37	0.18
2031	2.01	0.17	0.46	0.28
2032	1.91	0.19	0.48	0.30

Calendar Year	NOx (tpd)	PM2.5 (tpd)	ROG (tpd)	CO_2 (MMT/year)
2033	2.53	0.26	0.72	0.44
2034	2.42	0.27	0.71	0.45
2035	3.45	0.38	0.99	0.62
2036	3.34	0.39	0.98	0.64
2037	3.26	0.38	0.95	0.64
2038	4.90	0.57	1.28	0.95
2039	4.88	0.57	1.28	0.95
2040	4.81	0.57	1.29	0.95
2041	4.86	0.58	1.31	0.95
2042	4.78	0.57	1.24	0.95
2043	4.78	0.57	1.24	0.95

Emission benefits increase over time as Targeted Class IV and Class V Forklifts are phased out. The cumulative total TTW emission reductions from 2026 to 2043 are estimated to be 18,724 tons of NOx, 2,075 tons of PM2.5, 4,973 tons of ROG, and 9.4 MMT of CO2 relative to the Baseline scenario.

The estimated statewide NOx, PM2.5, ROG and CO2 emission reductions of the Proposed Regulation are presented relative to the Baseline scenario in the following four figures.

1. NOx Emission Reductions

Figure 5 depicts estimated NOx reductions from 2026 through 2043 of the Proposed Regulation relative to the Baseline scenario. Beginning in 2026, in the Baseline scenario, NOx emissions would continue to decline until 2038 when emissions begin to stabilize. This decline would be attributable to the expected natural turnover of pre-

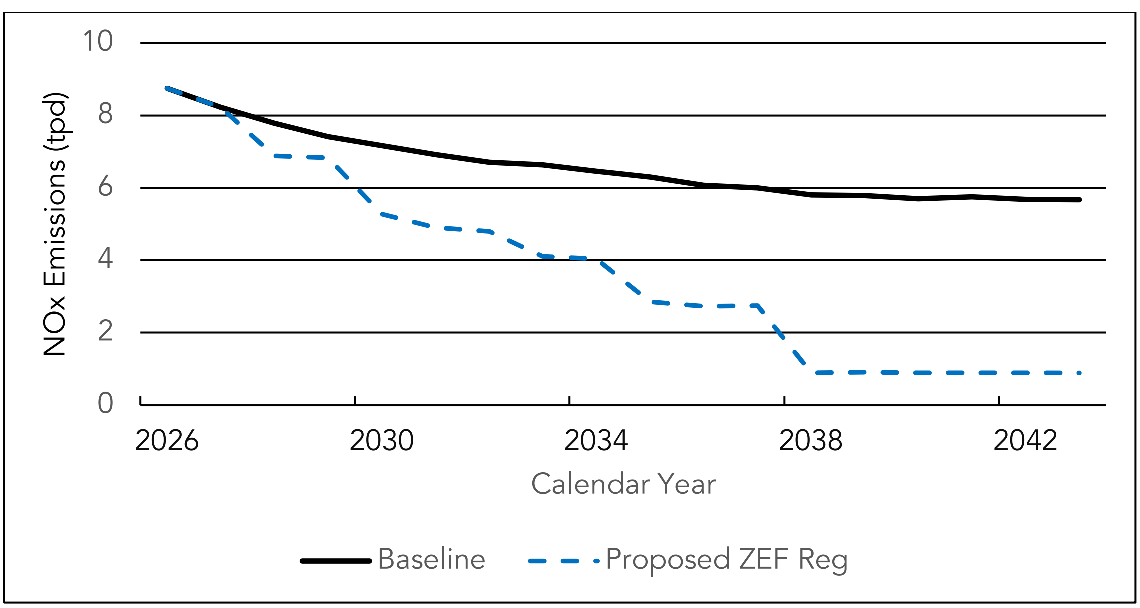
2010 MY LSI forklifts to newer, cleaner 2010 MY and subsequent LSI forklifts. In the Baseline scenario, NOx emissions are projected to decline from 8.8 tpd in 2026 to 5.7 tpd in 2043.

Under the Proposed Regulation, NOx emissions are projected to decline from 8.8 tpd in 2026 to 0.9 tpd in 2038. The first wave of phase-outs would begin in 2028 starting with 2018 MY and older Targeted Class IV Forklifts in large fleets. Then, in 2029, small fleets and agricultural operations would begin phasing out their Targeted Class IV Forklifts starting with 2016 MY and older units. For Targeted Class V Forklifts, the phase-out would begin in 2030 for all fleets starting with 2017 MY and older forklifts.

The first three years of the phase-out schedule, from 2028 through 2030, would be characterized by a decrease in NOx emissions of 1.9 tpd. This projected decline is primarily attributed to the fact that the subset of Targeted Forklifts that would be phased out by the first compliance date in each forklift category would include forklifts equipped with dirtier pre-2010 LSI engines.

Because the phase-out schedule would be staggered by forklift category (i.e., Targeted Class IV Forklifts in large fleets, Targeted Class IV Forklifts in small fleets and agricultural operations, and Targeted Class V Forklifts) and grouped MYs, NOx reductions consistently decline until the last phase-out date in 2038. Class V LSI forklifts with a lift capacity greater than 12,000 pounds remain, along with low-use LSI forklifts at microbusinesses. These forklifts are responsible for the 0.9 tpd NOx in 2038.

Figure 5. Projected Statewide NOx TTW Emissions, Baseline and Proposed Regulation



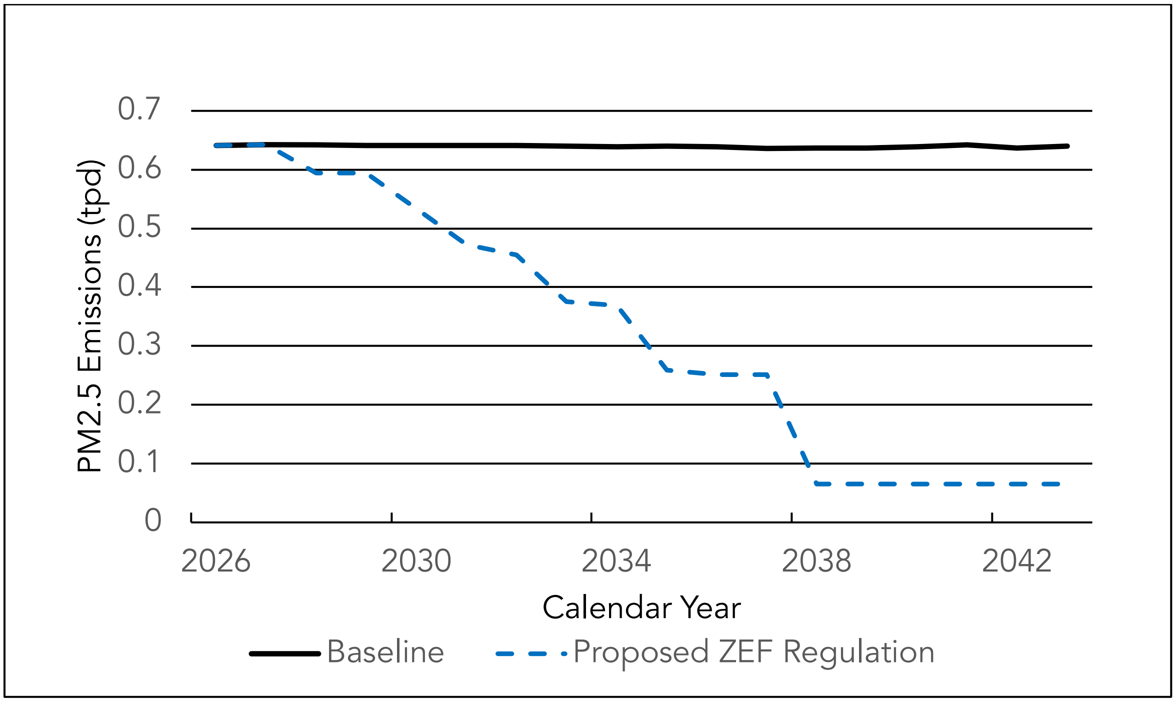
2. PM2.5 Emission Reductions

Figure 6 depicts estimated PM2.5 emission reductions from 2026 through 2043 of the Proposed Regulation relative to the Baseline scenario. Particulate matter emissions from LSI engines under the Baseline scenario are projected to remain relatively stable over the regulatory horizon. LSI engines are not subject to PM emission standards, and the LSI Emission Inventory model uses the latest available PM emission factors for propane and gasoline equipment, consistent with the OFFROAD2021 model[195] and the U.S. EPA MOVES model[196]. Based on those emission factors, there is no significant difference in PM emissions by equipment MY. As such, in the Baseline scenario, estimated PM2.5 emissions remain relatively flat from 2026 through 2043 at approximately 0.64 tpd. With the Proposed Regulation, PM2.5 emissions are projected to decline from 0.64 tpd in 2026 to 0.07 tpd in 2038 as Targeted Class IV and Class V Forklifts are phased out.

[195] California Air Resources Board, Off-Road Emissions Inventory (web link: *https://arb.ca.gov/emfac/offroad/*, last accessed October 2023).

[196] U.S. EPA, MOVES and Mobile Source Emissions Research - MOtor Vehicle Emission Simulator (MOVES) (web link: *https://www.epa.gov/moves*, last accessed August 2023).

Figure 6. Projected Statewide PM2.5 TTW Emissions, Baseline and Proposed Regulation

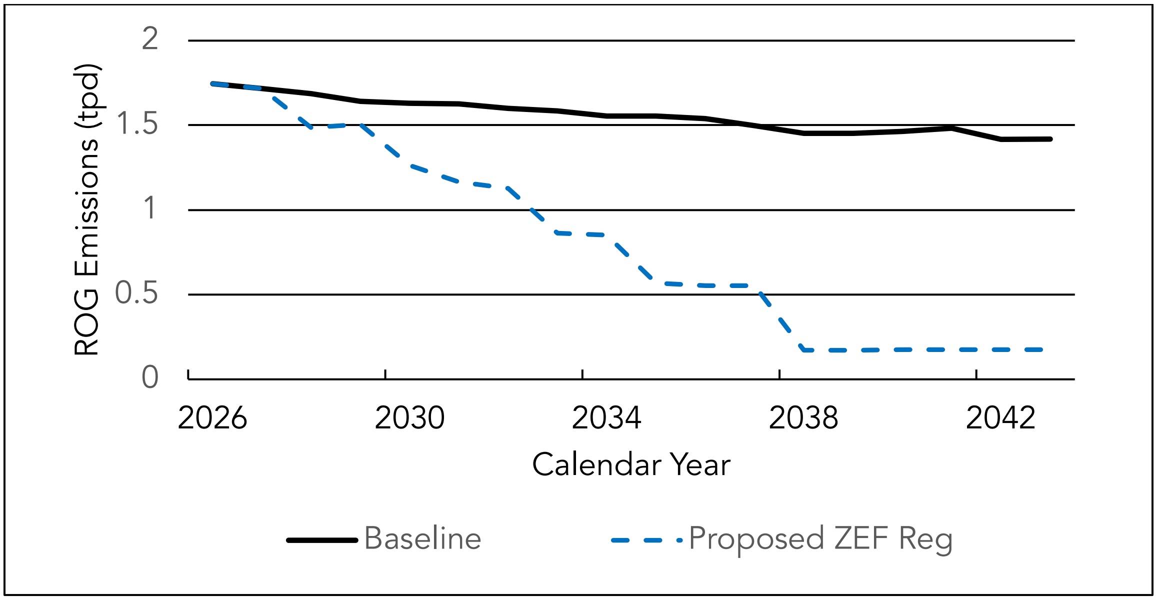


3. ROG Emission Reductions

Figure 7 depicts estimated ROG emission reductions from 2026 through 2043 of the Proposed Regulation relative to the Baseline scenario. Beginning in 2026, in the Baseline scenario, ROG emissions gradually decline until 2042 when emissions begin to stabilize. This decline is attributable to the expected natural turnover of pre-2010 MY LSI forklifts to newer, cleaner 2010 MY and subsequent LSI forklifts. In the Baseline scenario, ROG emissions are projected to decline from 1.75 tpd in 2026 to 1.42 tpd in 2043.

With the Proposed Regulation, ROG emissions are expected to drop from 1.75 tpd in 2026 to 0.17 tpd in 2038. The ROG emissions profile is similar to the NOx emissions profile for the same reasons cited above for NOx.

Figure 7. Projected Statewide ROG TTW Emissions, Baseline and Proposed Regulation



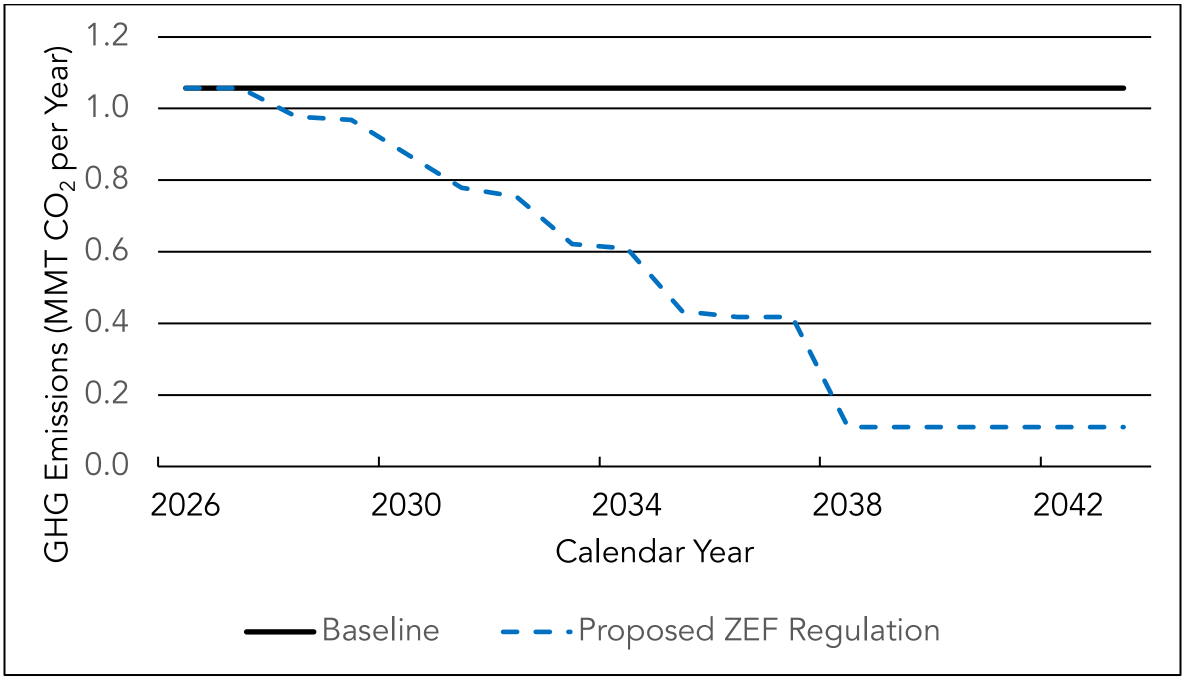
4. GHG Emission Reductions

The Proposed Regulation is expected to reduce TTW CO_2 emissions from 1.1 MMT per year in 2026 to 0.1 MMT per year by 2038. Under the Baseline scenario, GHG emissions from LSI engines are projected to remain relatively stable over the regulatory horizon. LSI engines are not subject to GHG emission standards, and the LSI Emission Inventory model uses the latest available GHG emission factors for propane and gasoline equipment, consistent with the OFFROAD2021 model[197] and the U.S. EPA MOVES model[198]. Based on those emission factors, there is no significant difference in GHG emissions by equipment MY. Figure 8 summarizes the estimated CO_2 emission reductions per year from the Proposed Regulation and the Baseline scenario.

[197]California Air Resources Board, Off-Road Emissions Inventory (web link: *https://arb.ca.gov/emfac/offroad/*, last accessed October 2023).

[198] U.S. EPA, MOVES and Mobile Source Emissions Research - MOtor Vehicle Emission Simulator (MOVES) (web link: *https://www.epa.gov/moves*, last accessed August 2023).

Figure 8. Projected Statewide CO_2 TTW Emissions, Baseline and Proposed Regulation



VI. Environmental Analysis

CARB is the lead agency for the Proposed Regulation 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 the California Environmental Quality Act (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 Impact Analysis" or "EIA") as part of the Staff Report to comply with CEQA (Cal. Code Regs., tit. 17, § 60005).

The Draft EIA for the Proposed Regulation is included in Appendix C. The Draft EIA provides a programmatic environmental analysis of an illustrative, reasonably foreseeable compliance scenario that could result from implementation of the

Proposed Regulation. The Draft EIA states that implementation of the Proposed Regulation could result in beneficial impacts through GHG reductions and air quality improvements from requiring California fleets to phase out LSI forklifts in nearly all applications served by said forklifts today.

For the purpose of determining whether the Proposed 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 Regulation would result in the purchase of new ZEFs, which would increase demand for ZEF manufacturing. An increase in manufacturing could result in the construction and operation of new manufacturing facilities, modification of existing facilities, repurposing, or closing of some existing facilities, or reopening of currently closed plants.

Increases in ZEF purchases may expand the production of hydrogen fuel as well as increase demand on the electrical grid requiring new electricity generation. Increased demand for hydrogen fuel cells, could require the development of new manufacturing facilities and/or expansion of existing manufacturing facilities. Increased demand for fuel cells could also result in an extremely small increase in platinum mining and exports from source countries or other states and a related increase in recycling, refurbishment, or disposal of hydrogen fuel cells. The use of hydrogen fuel may require transport of hydrogen to fueling locations by truck.

As for potential increased demand on the electrical grid, historically, the state's electric grid has expanded and evolved as consumer demand for electricity services has grown, including with the recent emergence of EVs. California's existing grid and approved investments occurring now will allow the state to handle millions of EVs in the near-term, and projections show the broader western grid can handle up to 24 million EVs without requiring any additional power plants.[199] Longer term, transitioning to 100 percent 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 EV 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 EV fleet at the generation or transmission level, especially in the near-term. Additionally, based on historical growth rates, sufficient energy generation and generation capacity is expected to be available to support a growing

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

EV fleet. Additionally, the increased use of battery electric and hydrogen fuel ZEFs could increase the installation of on-site charging and fueling facilities.

The Proposed Regulation may also result in increased use of lithium and lead-acid batteries, which could incrementally increase mining and imports of lithium, lead, and other minerals from countries with raw mineral supplies, with some mineral demand being met domestically. The Proposed Regulation 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. The increase in the use of batteries could also require construction and operation of new facilities and the expansion of existing facilities for recycling and disposal.

Implementation of the Proposed Regulation could result in the disposal of LSI forklifts. The replaced forklifts could be sold to an out-of-state party for use, scrapped, recycled, or sold to a salvage yard to be dismantled. As described above, disposal of any of these forklifts, as well as any included components 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 Draft EIA for the Proposed 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 Draft EIA 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 Regulation could result in potentially significant and unavoidable environmental impacts. Table 14 summarizes the potential environmental impacts of the Proposed Regulation.

Table 14. Summary of Potential Environmental Impacts

Impact Number	Resource Area Impact	Significance
1-1, 1-2	Short-Term Construction-Related and Long-Term Operation-Related Impacts on Aesthetics	Potentially Significant and Unavoidable

Impact Number	Resource Area Impact	Significance
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 Impacts on Air Quality	Potentially Significant and Unavoidable
3-2	Long-Term Operation-Related Effects to Air Quality	Beneficial
3-3	Short-Term Construction-Related and Long-Term Operational Impacts from Odors	Potentially Significant and Unavoidable
4-1	Short-Term Construction-Related Impacts on Biological Resources	Potentially Significant and Unavoidable
4-2	Long-Term Operation-Related Impacts on Biological Resources	Potentially Significant and Unavoidable
5-1	Short-Term Construction-Related and Long-Term Operation-Related Impacts on Cultural Resources	Potentially Significant and Unavoidable
6-1	Short-Term Construction-Related Effects on Energy	Less-than-Significant
6-2	Long-Term Operation-Related Impacts on Energy	Less-than-Significant
7-1	Short-Term Construction-Related and Long-Term Operation-Related Impacts on Geology and Soils	Potentially Significant and Unavoidable
8-1	Short-Term Construction-Related and Long-Term Operational-Related Impacts on GHG Emissions	Beneficial
9-1, 9-2	Short-Term Construction-Related and Long-Term Operation-Related Impacts on Hazards and Hazardous Materials	Potentially Significant and Unavoidable

Impact Number	Resource Area Impact	Significance
10-1	Short-Term Construction-Related Impacts to Hydrology and Water Quality	Potentially Significant and Unavoidable
10-2	Long-Term Operation-Related Effects to Hydrology and Water Quality	Potentially Significant and Unavoidable
11-1	Short-Term Construction-Related and Long-Term Operation-Related Impacts on Land Use and Planning	Potentially Significant and Unavoidable
12-1	Short-Term Construction-Related and Long-Term Operation-Related Effects to Mineral Resources	Less-than-Significant
13-1	Short-Term Construction-Related Impacts to Noise and Vibration	Potentially Significant and Unavoidable
13-2	Long-Term Operation-Related Effects to Noise and Vibration	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 Impacts on Recreation	Less-than-Significant
17-1, 17-2	Short-Term Construction-Related and Long-Term Operation-Related Effects to Transportation	Potentially Significant and Unavoidable
18-1	Short-Term Construction-Related and Long-Term Operational Impacts on Tribal Cultural Resources	Potentially Significant and Unavoidable

Impact Number	Resource Area Impact	Significance
19-1	Short-Term Construction-Related and Long-Term Operational-Related Impacts on Utilities and Service Systems	Potentially Significant and Unavoidable
20-1	Short-Term Construction-Related and Long-Term Operation-Related Impacts 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 March 7, 2023, and ended on April 6, 2023. CARB held a public workshop that also served as a CEQA scoping meeting to solicit input on the scope and content of the Draft EA on March 22, 2023. Written comments on the Draft EA will be accepted starting November 10, 2023, through December 26, 2023. If comments received during the public review period raise significant environmental issues, staff will respond to those comments in a separate response to comments on the Draft EA document. The Board will consider the Final EA and responses to comments received on the Draft EA before taking action to adopt the Proposed Regulation. If the Proposed 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)). Environmental justice includes, but is not limited to, all of the following:

(A) The availability of a healthy environment for all people;

(B) 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;

(C) 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

(D) 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 (Policies) on December 13, 2001, to establish a framework for incorporating environmental justice into CARB's programs consistent with the directives of State law. 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 fundamental to achieving its mission.

The impacts of climate change and air pollution affect all Californians, but residents in low-income communities and communities of color are especially vulnerable and often face the most severe impacts. Although CARB’s existing programs have reduced mobile source emissions, additional reductions are needed to protect the communities that are still exposed to air pollutants. These communities bear a disproportionate health burden due to their close proximity to emissions. By increasing the number of ZEFs, the Proposed Regulation would reduce exposure to mobile source pollution in communities throughout California, including in communities that are disproportionately exposed to such pollution, for example in communities heavily impacted by goods movement, with many warehouses and a high concentration of spark-ignited forklifts. The Proposed Regulation is anticipated to reduce emissions in California by 18,724 tons of NOx, 2,075 tons of PM2.5, 4,973 tons of ROG, and 9.4 MMT of CO_2 cumulatively by 2043. The NOx emission benefits from cleaner forklifts are important to mitigate regional ozone formation in the South Coast and San Joaquin Valley air basins, and the lower-income communities and communities of color that reside in higher ozone concentration areas.

The Proposed Regulation is consistent with CARB’s environmental justice goal of reducing exposure to air pollutants and reducing adverse health impacts from air contaminants in all communities. The Proposed Regulation would achieve emissions reductions from LSI forklifts by transitioning them to ZE technologies. The Proposed Regulation is designed to reduce criteria pollutants, GHGs, the resulting adverse health risks from regional air pollution, and the impacts of climate change. The associated improvements to air quality related to the Proposed Regulation are intended to help protect all Californians and will be of particular benefit in low-income communities and communities of color.

VIII. Standardized Regulatory Impact Assessment

Government Code sections 11346.2(b)(2) and 11346.3(c) require the preparation of a SRIA for major regulations. Major regulations are defined as having an expected economic impact that exceeds $50 million in a 12-month period. The Proposed Regulation requires a SRIA because the expected economic impact exceeds the major regulation thresholds. Therefore, a SRIA was developed for this Proposed Regulation and submitted to DOF on April 5, 2023, after which it was subsequently published on their website. The Proposed Regulation and a number of the cost assumptions have been updated since the SRIA was submitted to the DOF. This chapter provides the updated assumptions and the economic and health impacts of the revised Proposed Regulation. This includes the methodology to determine the affected fleets, estimated number of ZEFs, the total estimated incremental cost of the Proposed Regulation versus the baseline, macroeconomic results, and fleet examples. The SRIA can be found in Appendix B-1 of this document and also is available on DOF's website.

Staff's proposal and economic impact analysis has evolved in a number of ways since the SRIA was finalized and posted on April 5, 2023, as described further below.

A. Business-as-Usual Baseline

CARB staff estimated the economic and emission impacts of the Proposed Regulation by evaluating the Proposed Regulation and comparing it to the Baseline scenario each year across the regulatory horizon (2026-2043). The Baseline for the Proposed Regulation reflects full compliance with existing CARB regulations, including the Off-Road Large Spark-Ignition Engine Standards[200] and the LSI Fleet Regulation.[201]

For this analysis, staff used the statewide LSI Emission Inventory, described in Appendix D, to estimate emissions for the Baseline and Proposed Regulation, as well as to forecast the populations of forklifts each year from 2026 through 2043, for which there would be direct costs or benefits associated with the Proposed Regulation. It is important to note that LCFS credits for both fossil-based propane and renewable propane are included in the Baseline scenario and all scenarios analyzed. Therefore, the economic and environmental impacts attributable to the Proposed Regulation are solely attributable to new actions beyond those already expected.

Although incentive programs are a key part of the overall State strategy to develop and accelerate early ZE markets, staff did not assume State, federal, or local grants, rebates, or other types of funding programs would provide savings for fleets affected by the Proposed Regulation. This is because funding is limited, annual appropriations for some existing programs are uncertain, and available funding for off-road

[200] California Code Of Regulations, Title 13 (web link: *https://ww2.arb.ca.gov/sites/default/files/2020-03/Sections%202430-2439%2C%20Title%2013%2C%20California%20Code%20of%20Regulations_1999_R.pdf#:~:text=Adopt%20Title%2013%2C%20California%20Code%20of%20Regulations%2C%20Chapter,Article%204.5.%20Off-Road%20Large%20Spark-Ignition%20Engines%202430.%20Applicability*).

[201] California Code Of Regulations, Title 13 (web link: *https://ww2.arb.ca.gov/sites/default/files/classic/msprog/offroad/orspark/largesparkappa-clean.pdf*).

equipment and infrastructure is expected to be used by a wide range of fleet owners who may or may not use the funding to cover the cost of ZEFs in order to comply with requirements of the Proposed Regulation. Therefore, there would be significant uncertainty in estimating the number of applicable fleet owners who would receive incentive funding. The significant vehicle and infrastructure incentives available would reduce costs for some impacted fleets. However, the cost analysis for the Proposed Regulation and alternative scenarios compared to the baseline excludes funding assistance.

The Proposed Regulation would impact approximately 11,000 fleets in California, who in total own about 95,000 LSI forklifts, and would result in estimated cumulative direct cost savings of $2.71 billion and estimated NOx reductions of 18,724 tons from 2026 to 2043.

B. Direct Costs

The projected total direct cost of the Proposed Regulation over the implementation timeframe is estimated to be $7.71 billion. The total estimated savings is $10.42 billion, and the net cost is estimated at negative $2.71 billion (i.e., net savings of $2.71 billion). This section describes staff's direct cost analysis for the Proposed Regulation and includes assessments for State and local governments, businesses, and individuals. The methodology and assumptions used to calculate the direct costs are detailed in the sections below.

Staff's proposal and economic impact analysis has evolved in a number of ways since the SRIA was finalized and posted on April 5, 2023, as described further below.

1. Changes to the Proposal Since the Release of the SRIA

The Proposed Regulation differs from that analyzed in the SRIA that was submitted to DOF in April 2023. The changes are described below:

a) Removal of the Class IV lift capacity limit

The scope of the Proposed Regulation has been expanded to include Class IV forklifts with a lift capacity greater than 12,000 pounds. At the beginning of the regulatory development process, staff evaluated the availability of ZEFs and found that there were few ZE options commercially available with a lift capacity greater than 12,000 pounds. Therefore, staff limited the scope of the regulatory concept to only those forklifts with a lift capacity of up to 12,000 pounds. However, a more recent survey of available ZEFs has shown that several manufacturers currently offer Class-IV-equivalent ZEF with a lift capacity of more than 12,000 pounds.

b) Changes to the Phase-Out Schedule

The Proposed Regulation's phase-out schedules for 2025 MY and older LSI forklifts were changed from annual phase-out schedules starting in 2026 to grouped model-year phase-out schedules starting in 2028. The currently proposed grouped-model-year approach is shown in Chapter I.C., Summary of Proposed Regulation, above. This approach provides more lead time and flexibility, so that fleets have more time to work out potential operational challenges early in the transition and more discretion as to how they phase-out applicable LSI forklifts year-to-year, as well as greater opportunity to pursue incentive funding in the first few years. Given the additional lead time and flexibility of the grouped-model-year approach, the phase-out caps for the annual phase-out (e.g., no more than 25 percent of Class IV forklifts required to be phased out by 2026) have been removed from the proposal.

c) Removal of the Low-Use Ten Percent Cap

The regulatory approach analyzed in the SRIA would have capped the number of Low-Use Forklifts a Fleet Operator could designate to ten percent of their total fleet. Stakeholders commented that the ten-percent cap should be removed to provide additional flexibility needed for the early years of the transition to zero emissions. This cap has been removed from the proposal. Unchanged are the sunset provisions of the low-use provision. That is, after 2031, all Low-Use Forklifts would have to be phased-out except for microbusinesses, which would be allowed to keep one Low-Use LSI Forklift beyond 2031.

d) Addition of the Sales of Used LSI Forklifts

The regulatory approach analyzed in the SRIA would have restricted the sale or purchase of compliant used LSI forklifts (i.e., forklifts of a MY that has not yet been phased out) after January 1, 2026. However, the proposal was changed to allow for such sales and purchases to provide more flexibility for smaller fleets, which typically purchase used forklifts, and which could have more difficulty transitioning to zero emissions.

e) Addition of Requirement for Fleets to Report Utility Service Information

The current proposal includes a requirement that would require fleets, between January 1, 2026, and April 30, 2026, to provide to the Executive Officer either an attestation that no utility service upgrades would be necessary to transition the forklift fleet to ZE technology or documentation demonstrating that meaningful action has been taken to initiate necessary capacity upgrades (e.g., confirmation from the utility that a service upgrade application has been received). This proposed requirement is being included to help ensure necessary charging infrastructure will be available once the phase-out of LSI forklifts begins.

f) Addition of an Exemption for Dedicated Emergency Forklifts

The current proposal includes an exemption for Dedicated Emergency Forklifts, which would be forklifts maintained by a government agency or under the authority of a government agency for the primary purpose of supporting emergency operations. This proposed exemption was added to address stakeholder concerns about the potential unavailability of ZE charging/fueling infrastructure during emergency events.

g) Addition of an Extension for Delays in Infrastructure Upgrades

The current proposal includes extensions for charging/fueling infrastructure construction delays and site-electrification delays. These proposed extensions would allow fleets to continue operating non-compliant LSI forklifts in situations in which the installation of necessary infrastructure or grid upgrades is delayed due to reasons beyond the fleet's control.

h) Addition of an Extension for Technical Infeasibility

The current proposal includes an extension for situations in which replacing an applicable LSI forklift with a ZEF would be infeasible due to reasons other than infrastructure issues, such as safety issues or performance issues. This proposed extension would allow a fleet to continue operating a non-compliant LSI forklift until such a time there is a ZE model available that can adequately perform the work of the LSI forklift it would be replacing.

i) Removal of Certification Requirements

The regulatory approach analyzed in the SRIA would have required forklift manufacturers to certify ZEFs before they could be sold in California. When the proposed requirement was added, staff believed that such a requirement could help ensure manufacturers produce robust and dependable ZEFs. However, after discussions with stakeholders indicating such a requirement is unnecessary, the requirement was removed from the proposal.

j) Changes to Reporting and Labeling

The regulatory approach analyzed in the SRIA would have established requirements for fleets of any size to report information about their applicable LSI forklifts and label such forklifts with a CARB-assigned unique identifier to assist in the enforcement of the approach's requirements. However, because of the structure of the Proposed

Regulation and refinements that have been made since the development of the SRIA, staff has determined that effective enforcement of the Proposed Regulation would not need to rely on such rigorous reporting and labeling. As such, the reporting requirements in the proposal have been streamlined and the labeling requirements have been eliminated in most cases. Specifically, with respect to reporting, fleets not utilizing the small fleet phase-out schedule for applicable Class IV forklifts would not be required to report forklift information under the current proposal. Furthermore, forklift dealers would no longer be required to report information on sales and lease transactions. In addition, labeling would only be required for Low-Use Forklifts, Dedicated Emergency Forklifts, and forklifts subject to one of the delay extensions.

Because many fleets that would be affected by the Proposed Regulation are also regulated under the LSI Fleet Regulation, staff is proposing amendments to the LSI Fleet Regulation. These amendments would sunset reporting and labeling requirements for limited hours of use and specialty equipment in order to reduce the compliance burden and simplify requirements. All performance requirements of the LSI Fleet Regulation would remain in place, and the proposed amendments to the LSI Fleet Regulation would require continued maintenance of records to demonstrate compliance with the limited hours of use and specialty equipment provisions, which would also ensure that these provisions remain enforceable. Staff anticipates that the proposed amendments to the LSI Fleet Regulation would not result in adverse emissions impacts that would alter the emission benefit estimates of the Proposed Regulation. In addition, there are no costs associated with this change.

2. Changes to the Inventory Modeling Since the Release of the SRIA

Staff implemented a small number of changes in the emission inventory after the release of the SRIA for the Proposed Regulation. Staff updated the emission inventory to reflect both changes in the Proposed Regulation requirements and language, as discussed in Section VIII.B.1., above, and to update the methodology and fleet behavior assumptions and forecast. The updates of the methodology and fleet behavior assumptions and forecast are covered in greater detail in Appendix D to the ISOR, 2023 LSI Forklift Emission Inventory, and are summarized below:

- The SRIA modeling of the regulatory proposal overstated emission reduction estimates because it included all LSI forklifts regardless of lift capacity whereas the regulatory proposal used for the SRIA analysis would have only applied to LSI forklifts up to 12,000 pounds lift capacity. The modeling has been refined since the SRIA, so it now appropriately differentiates LSI forklifts with a lift capacity up to 12,000 pounds from those with a lift capacity greater than 12,000 pounds. This change alone would reduce cumulative emission benefits through 2043 by 14 percent.

- Staff updated microbusiness assumptions to reflect that 98.5 percent of the companies that own forklifts meet the definition of microbusiness, based on Dunn and Bradstreet data. The Proposed Regulation would allow microbusinesses a single Targeted Forklift as a low-use forklift indefinitely. This update showed that 11,140 companies met the definition of a microbusiness and could continue to operate a single low-use forklift 200 hours per year or less. This upper limit on operation of low-use forklifts was assumed in the modeling update. Previously, the inventory used in the SRIA estimated there were approximately 4,000 microbusinesses. While this is a significant increase in the potential population of low-use forklifts allowed under the Proposed Regulation (7,140 additional forklifts), the emission impact would be limited due to the low annual activity from the forklifts. The emissions from all low-use forklifts in the regulatory proposal in 2031 and future years is 0.2 tpd of NOx, or about 2 percent of the total NOx emissions from all LSI forklifts in California in 2023, 10.4 tpd.
- Staff updated the scenario to reflect that a fraction of businesses that currently use LSI forklifts with a lift capacity of 8,000 to 12,000 pounds could purchase LSI forklifts just over the 12,000-pound lift capacity applicability cap. This change was based on similar behavior in CARB's regulation for trailer Transport Refrigeration Units (TRUs), where approximately 40 percent of California TRU owners purchased TRUs that reduced or rerated HP, with an average reduction in HP of 32 percent. This shift in HP allowed the TRUs to meet significantly less stringent emission standards (until the TRU regulation was amended in 2022).[202]

  Based on DOORS reporting data, staff found that the average forklift with a 12,000-pound lift capacity had approximately 105 HP. Using TRUs as an example of shifting HP to avoid regulatory requirements, staff modeled that 40 percent of the forklifts between 71 and 105 HP would choose to purchase a 12,001 pound or greater lift capacity forklift to replace their forklift instead of switching to a ZEF. The cutoff of 71 HP was selected because (1) it corresponds to the median HP of an 8,000-to-9,000-pound lift capacity forklift, and (2) would result in a similar percentage shift in forklift HP to avoid regulatory requirements as was seen in the TRU population.

[202] CARB, Appendix H of the Staff Report for the Proposed Amendments to the Airborne Toxic Control Measure for In-Use Diesel-Fueled Transport Refrigeration Units (TRU) and TRU Generator Sets, and Facilities Where TRUs Operate (Approved for Adoption on February 24, 2022): 2021 Update to Emissions Inventory for Transport Reirrigation Units, July 2021 (web link: *https://ww2.arb.ca.gov/sites/default/files/barcu/board/rulemaking/tru2021/apph.pdf*).

Note that owners of smaller forklifts, under 8,000 pounds lift capacity, were not modeled as purchasing forklifts over 12,000 pounds lift capacity to avoid regulatory requirements. Although this is a possibility, the shift in size, weight, and cost of a low-capacity forklift to much higher capacity provides a barrier to this behavior. This modeling change results in owners of 4,090 forklifts between 8,000- and 12,000-pounds lift capacity avoiding the regulatory requirements by buying (or in rare cases, converting an existing forklift) to a slightly larger LSI forklift. The emission impact of this change is the loss of approximately 0.6 tpd of NOx emission reductions starting in 2028, or about 6 percent of the total NOx emissions from all LSI forklifts in 2023, 10.4 tpd.

- Due to changes in the phase-out schedule, from 2026 to 2027, non-rental fleets will not be able to purchase LSI forklifts in California, but do not have requirements to begin purchasing electric forklifts until the fleet requirements begin in 2028. Any new forklift purchases from non-rental fleets in California in that period would be electric and could produce emission benefits. However, it is not clear if fleets will advance electric purchases early or simply hold on to their existing LSI equipment until the requirements begin in 2028. Therefore, this provision was not explicitly modeled from 2026 to 2027, and no benefits were estimated prior to the first phase-out requirement in 2028.
- Evaporative emissions factors were updated to reflect the latest available data, following CARB's Small Off-Road Engine (SORE) emission inventory methodology. This update resulted in a very minor increase in the HC and organic gas emissions for gasoline forklifts only, which make up seven percent of the LSI forklift population. This implies a greater benefit to phasing them out.

3. Other Changes to the Analysis

In addition to changes made to the Inventory analysis, the following changes were also made:

- In evaluating the reduction in adverse health impacts, additional health endpoints were assessed, as covered in Chapter IV.A. (Health Benefits of the Proposed Regulation, Chapter IX.A.1.b (Health Benefits of Alternative 1), and Chapter IX.B.1.b (Health Benefits of Alternative 2).
- Direct costs:
  - Because the scope of the Proposed Regulation has been broadened to include Class IV forklifts with lift capacities greater than 12,000 pounds,

estimated costs for these forklifts were added to the analysis and are identified in Chapter VIII.B.8.a, Forklift Costs.

- There are inherent costs in transitioning to new technologies. An estimation of these costs has been added in Chapter VIII.B.10., Transitional Costs.

- Additional information was obtained on forklift maintenance costs. Based on the information, the average maintenance cost for Class IV and V propane and gasoline forklifts was adjusted from $2.63 per hour of forklift operation to $1.81 per hour. The average maintenance cost for battery-electric forklifts was adjusted from $1.77 to $1.14 per hour of forklift operation.

- Labeling costs were modified based on reduced labeling requirements described in Chapter I.C., Summary of Proposed Regulation.

- Costs associated with manufacturer certification requirements were removed from the analysis, as manufacturer certification requirements have been eliminated from the Proposed Regulation.

4. Direct Cost Inputs

Staff's direct cost analysis for the Proposed Regulation considers both upfront capital costs (such as those for purchasing ZEFs and ZEF batteries; purchasing and installing chargers; and installing and/or upgrading onsite electrical or fueling infrastructure) and on-going operational costs (such as those for fuel and electricity and forklift maintenance). The cost analysis also considers administrative compliance costs, such as the costs for reporting, recordkeeping, and labeling forklifts. Compared to LSI forklifts, ZEFs today generally have higher upfront capital costs but lower operating costs, which can result in an overall savings over the life of ZEFs.

Currently, there are several programs in California that offset some of or all the incremental costs for ZEFs and supporting infrastructure; however, none of these programs are included in the cost analysis with the exception of LCFS credits. The LCFS credit program was established by California regulations and is a market-based mechanism that increases the use of low-carbon transportation fuels in California. The assumptions underlying the direct cost analysis, including the assumed value of the LCFS credits, are detailed in Chapter VIII, Section B.5. through Section B.12.

5. Forklift Population

Staff used the LSI Emission Inventory model to determine the number of forklifts that would be subject to the Proposed Regulation as well as the number of forklifts that would be required to phase out each year. The Proposed Regulation would apply to all Class IV (LSI) forklifts, as well as to Class V (LSI) forklifts[203] with a lift capacity up to 12,000 pounds, a subset of the total California forklift population. Staff estimates that roughly 94,725 LSI forklifts from approximately 11,310 fleets would be subject to the Proposed Regulation by 2026. Of the 94,725 LSI forklifts, approximately 87,431 are propane-fueled, and 7,294 are gasoline-fueled. Based on online forklift sales listings, staff estimates that 44 percent of the total affected forklifts are Class IV forklifts and 56 percent are Class V forklifts.[204] In addition, the LSI Emission Inventory model indicates that the number of LSI forklifts and the number of fleets have not significantly changed over the past several years. Therefore, for this analysis, the LSI Emission Inventory model assumes no growth in the LSI forklift population through 2043, except for the population increase due to retention of low-use LSI forklifts, as discussed in Chapter VIII, Section B.2, Changes to the Analysis. Of the estimated 94,725 LSI forklifts, it is assumed that full regulatory implementation would result in the transition to 89,125 ZEFs. The remaining 5,600 LSI forklifts would be Class V forklifts over 12,000 pounds lift capacity, which are exempt from phase-out requirements. It was assumed that an initial population of 1,500 Class V forklifts over 12,000 pounds lift capacity would expand to 5,600 due to purchasing decisions made by fleets to avoid regulatory requirements, as discussed previously in Chapter VIII, Section B.2.

From 2026 to 2027, non-rental fleets would not be able to purchase new Targeted Forklifts in California but would not have requirements to begin phasing out existing Targeted Forklifts until the fleet requirements begin in 2028. Any new forklift purchases from non-rental fleets in California in that period would be electric and could produce emission benefits. However, it is not clear if fleets would advance electric purchases early or simply hold on to their existing LSI equipment until the requirements begin in 2028. Therefore, the emissions for this provision were not explicitly modeled from 2026 to 2027, and no benefits were estimated prior to the first compliance date of 2028. However, staff does anticipate that some fleets would turn over some volume of Targeted Forklifts to ZEFs before 2028. Therefore, for the Proposed Regulation's cost analysis, staff assumed ZEF purchases in both 2026 and 2027 at a level where the benefits of such ZEFs would offset any incremental emissions from LSI forklifts held onto longer by fleets.

The Proposed Regulation is expected to increase new forklift purchases through the phase-out period. Given that the size of the forklift population is projected to remain constant over time, the number of ZEFs purchased as result of the phase out will be equal to the number of LSI forklifts phased out. While an individual fleet could

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[203] See Section 3A for a description of Class IV and V forklifts.

[204] Search on October 29, 2022, of liquefied petroleum gas (i.e., propane) forklifts for sale on Machinery Trader website (web link: *https://www.machinerytrader.com/listings/search?Category=1036&PowerType=LPG*).

purchase a new or used ZEF to replace a phased-out forklift, at the state level the overall supply of used ZEFs is limited by the number of prior new ZEF sales. Therefore, the statewide forklift cost is best estimated based on the volume of new ZEFs sales. It is also unlikely that the used market has a sufficient volume to meet the upcoming demand and many fleets would not likely purchase used equipment. In addition, staff does not anticipate a substantive "pre-buy" situation given the current world-wide supply-chain and logistical delays that are limiting manufacturer production capabilities. A "pre-buy" is where an entity purchases an item earlier than planned to avoid or delay a regulatory requirement, emission standard, or other anticipated outcome, such as price increases or reduced availability of product due to the implementation of regulatory requirements.

While fleets could potentially opt to replace phased-out LSI forklifts with diesel-fueled forklifts, staff believes diesel replacements would be rare. Please see Chapter I, Section G for details. Currently, the estimated population of diesel forklifts in California is roughly 22,000, which staff assumes would remain unchanged through the implementation of the Proposed Regulation.

Figure 9 illustrates the projected total sales per year of spark-ignition Class IV forklifts, spark-ignition Class V forklifts, and ZEFs, combined in California in the Baseline scenario and under the Proposed Regulation. The Proposed Regulation would require an accelerated phase-out of existing Targeted Forklifts. As such, the Proposed Regulation is expected to increase overall forklift sales over most of the phase-out period from 2028 through 2038. The forklift sales increase in 2028 is a result of ZEF purchases during the first year of the phase-out for Targeted Class IV Forklifts in large fleets in combination with purchases of unaffected forklifts, i.e., those LSI forklifts that are Class V and over 12,000 pounds lift capacity.

Purchases in 2035 due to the Proposed Regulation would be almost entirely ZEFs, along with purchases of Class V forklifts over 12,000 pounds lift capacity, which are not subject to phase-out requirements. The significant number of ZEF purchases projected in 2035 is due to simultaneous phase-out requirements for multiple forklift categories. The year 2035 would be the last year of the phase-out for all Targeted Class IV Forklifts in large fleets and also a phase-out year for Targeted Class V Forklifts.

The greatest number of purchases is expected to occur in 2038, the last year of phase-out for all Targeted Class IV Forklifts in small fleets and agricultural operations and also the last year of phase-out for Targeted Class V Forklifts.

Figure 9. Projected New California Forklift Unit Sales Per MY 2026-2043 (LSI & ZEF)

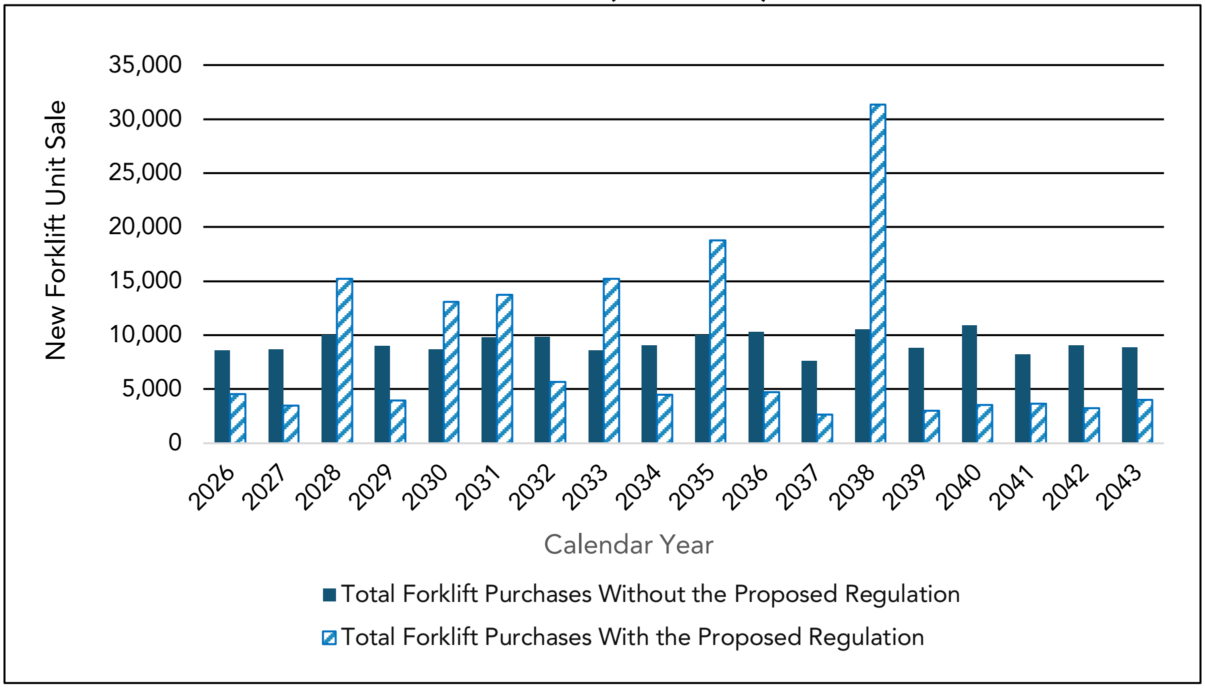
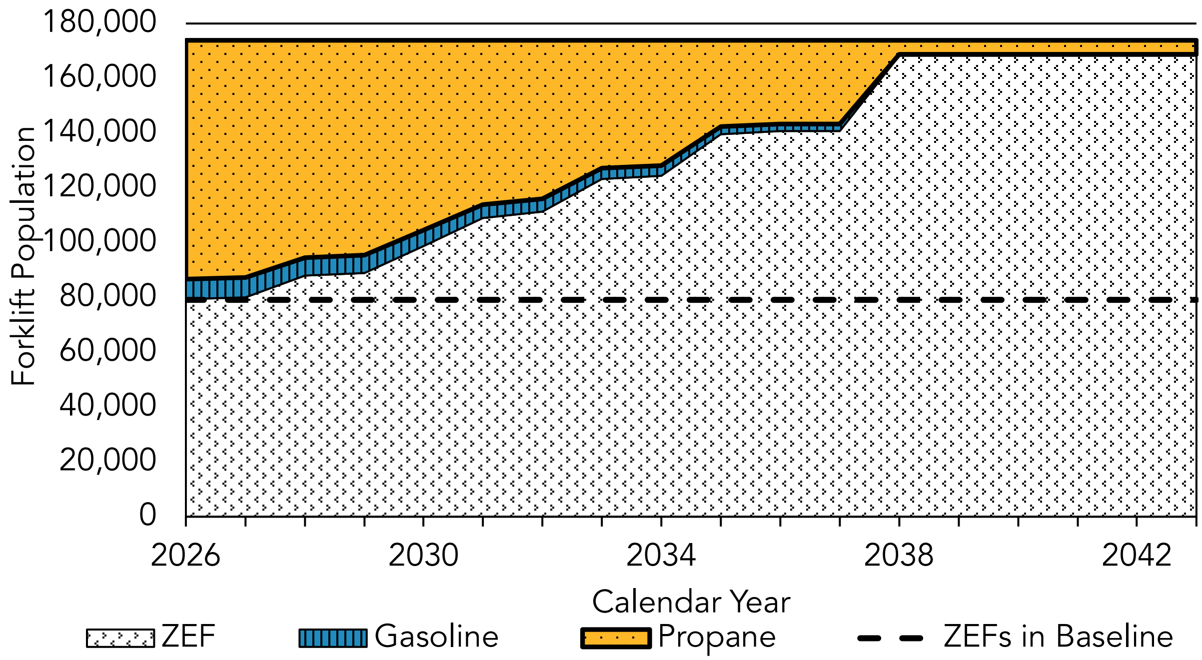


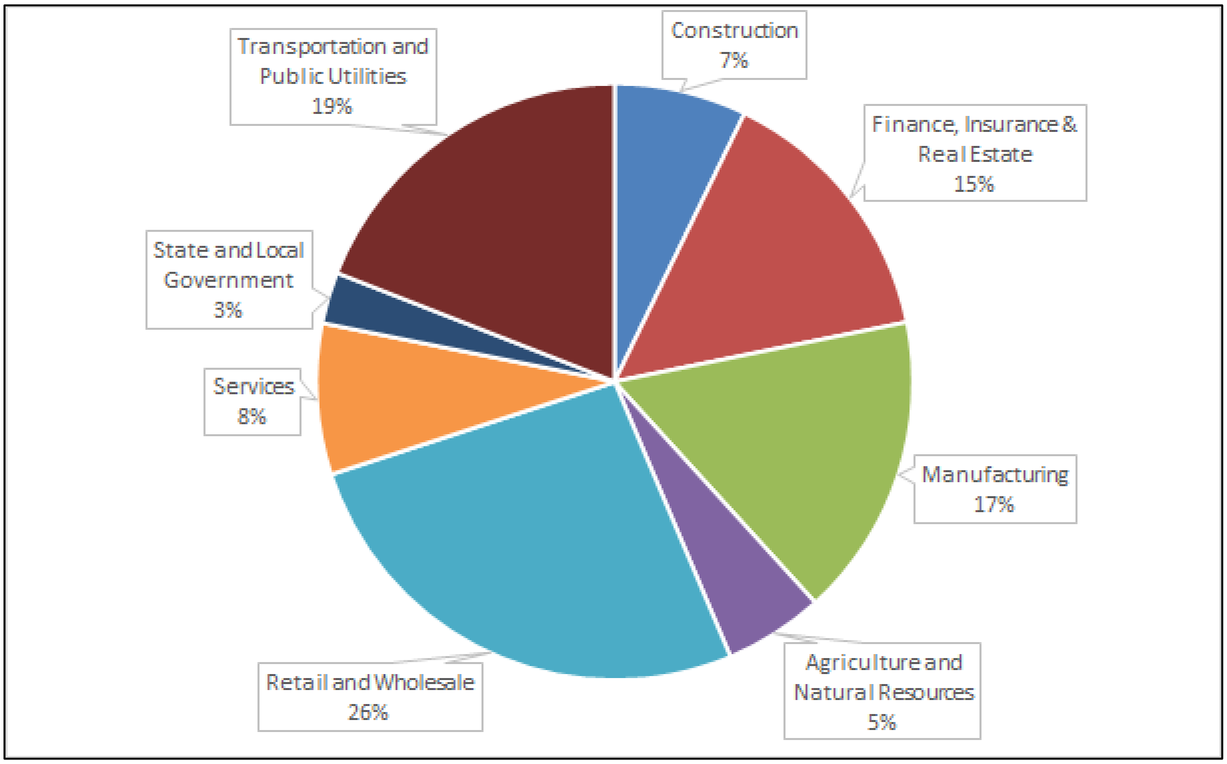
Figure 10 illustrates the projected shift in forklift population due to the Proposed Regulation. Phase-out of Targeted Class IV and Class V Forklifts would begin in 2028, and one-to-one ZEF replacements are assumed. The phase-out is discussed in more detail in Chapter I, Section C, Summary of Proposed Regulation. By 2038, all Targeted Class IV and Class V Forklifts subject to the proposed phase-out requirements would be retired from the fleet. The dashed line represents the existing population of ZEFs in the Baseline scenario (approximately 79,000 ZEFs). Based on industry forklift shipment data, the LSI Emission Inventory model assumes no growth in the forklift population through 2043, except for the population increase due to retention of low-use LSI forklifts, as discussed in Chapter VIII, Section B.2, Changes to the Inventory Modeling Since the Release of the SRIA.

Figure 10. Projected California LSI and ZE Forklift Population with the Proposed Regulation



The share of forklifts by industry are illustrated in Figure 11. These industry shares are estimated based on forklift data from CARB's DOORS database, which are then matched with the industry classification of the businesses operating fleets according to the North American Industry Classification System (NAICS) of the businesses owning the forklifts based on Dun and Bradstreet analysis.[205, 206, 207, 208]

Figure 11. Share of the Affected Forklift Population in California by Major Sector



[205] U.S. Office of Management and Budget, North American Industry Classification System, 2017 (web link: *https://www.census.gov/naics/reference_files_tools/2017_NAICS_Manual.pdf*).

[206] A more detailed table on the industry share of forklifts is included in the Macroeconomic Appendix of CARB's Proposed Zero-Emission Forklift Regulation, Standardized Regulatory Impact Assessment (SRIA), released April 2023 (web link: *https://dof.ca.gov/wp-content/uploads/sites/352/2023/04/ZE-Forklift-SRIA-to-DOF.pdf*).

[207] The DOORS database is known to underrepresent agricultural fleets; to account for this, staff used information from a 2017 agricultural-fleet survey to scale up the estimated proportion of affected agricultural forklifts relative to the total population of affected forklifts within the State (Citation: CARB, 2017 Agricultural Equipment Emission Inventory, August 2021 [web link: *https://ww2.arb.ca.gov/sites/default/files/2021-08/AG2021_Technical_Documentation_0.pdf*]); all other industry shares are scaled down proportionally.

[208] U.S. Census Bureau, North American Industry Classification System (NAICS), 2017 (web link: *https://www.census.gov/naics/reference_files_tools/2017_NAICS_Manual.pdf*).

6. Technology Mix Projections

Under the Proposed Regulation, fleets are anticipated to replace phased-out LSI forklifts with either lead-acid battery-electric forklifts, lithium-ion battery-electric forklifts, or fuel-cell forklifts. Different fleets may choose differing ZE technologies to comply with the Proposed Regulation, depending on a variety of factors and the specific circumstances of each individual fleet. In addition, as advances continue to be made in battery and fuel-cell technologies and costs continue to decline, perceived advantages that one technology may have over another today could diminish over time. Ultimately, staff expect that the choice of technology would depend primarily on cost, that state of technology at the time of purchase, and operational need.

Battery-electric forklifts have been used commercially for decades, and a large majority of ZEFs currently deployed utilize lead-acid batteries. Staff estimates there are roughly 70,000 lead-acid battery-electric forklifts in operation in California today. As such, lead-acid battery technology has achieved significant market acceptance, and there is an established support system for so-equipped forklifts. However, fuel-cell forklifts have been deployed in modest numbers, typically in large fleets, for more than several years,[209] and lithium-ion battery-electric forklifts are emerging and being deployed in significant numbers today. It is estimated that about seven to ten percent of new industrial batteries presently sold use lithium technology.[210]

Lead-acid battery technology still has substantially lower upfront purchase costs than lithium-ion or fuel-cell technology. However, the purchase costs of lithium-ion battery and fuel-cell technologies are expected to decline over time. In addition, lithium-ion and fuel-cell technologies may provide operational advantages that, for some fleets, could result in a lower total cost of ownership, such as more-consistent performance throughout the workday, shorter charging/refueling times, and less maintenance. Therefore, despite the upfront cost differential, staff's analysis assumes deployment and growth of lithium-ion battery-electric forklifts and stable deployment fuel-cell forklifts over the life of the Proposed Regulation.

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[209] Plug Power, Press Release: President Bush Views Fuel Cell Powered Lift Truck at Graftech Facility near Cleveland, July 10, 2007 (web link: *https://www.ir.plugpower.com/press-releases/news-details/2007/PRESIDENT-BUSH-VIEWS-FUEL-CELL-POWERED-LIFT-TRUCK-AT-GRAFTECH-FACILITY-NEAR-CLEVELAND-2007-7-10/*).

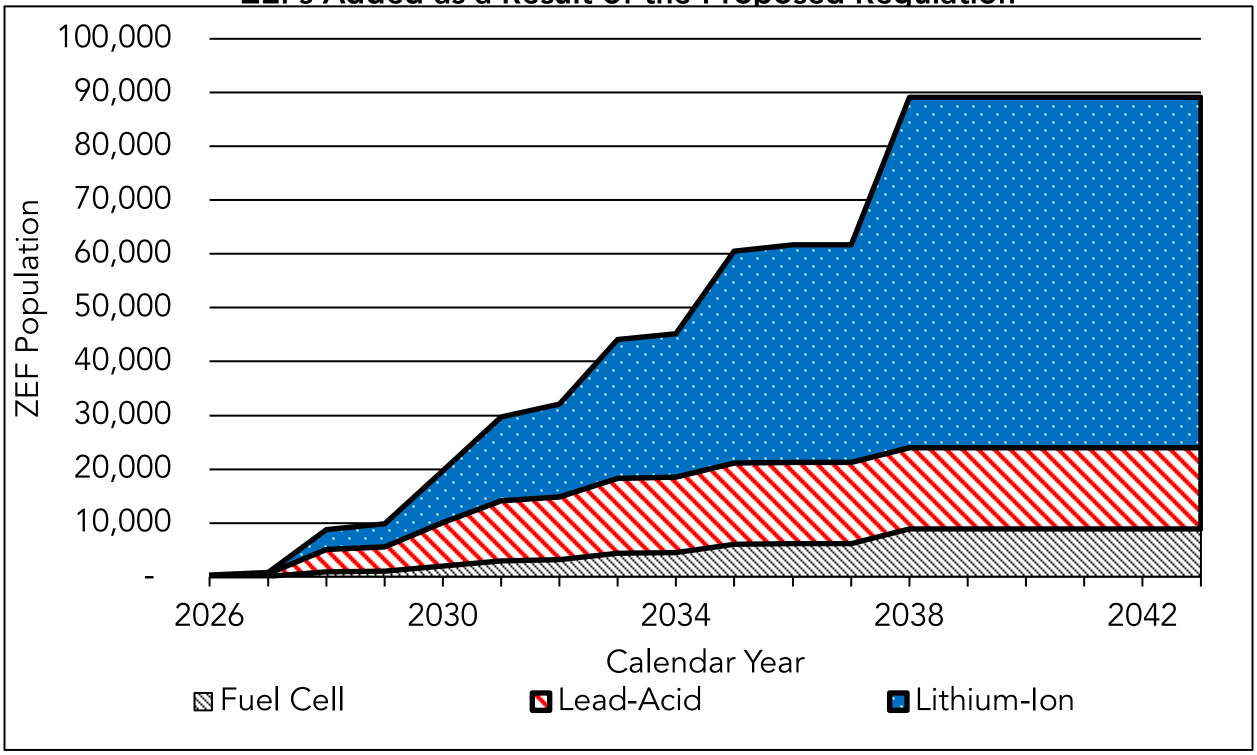
[210] Zhukov A., Review of the North American Lithium Forklift Battery Market: The 7 Most Popular Brands in the USA and Canada, OneCharge, October 11, 2021 (web link: *https://www.onecharge.biz/blog/review-of-the-north-american-lithium-forklift-battery-market-the-7-most-popular-brands-in-the-usa-and-canada/?utm_source=PR&utm_medium=Industry+Media&utm_campaign=Battery+review*).

Ultimately, staff expect fleets to choose the ZE technology that works best for them, whether that is lead-acid battery, lithium-ion battery, or fuel-cell technology. In most cases, the transition would result in cost savings over the life of the ZEF due primarily to fuel and maintenance savings. Incentives and other programs that promote the use of ZE technology, such as the LCFS program, would also help lower overall ZEF costs. Currently, a wide variety of ZEFs in all classes and lift capacities are commercially available. A recent online search conducted by staff of ZEF offerings from 11 major forklift manufacturers identified almost 250 models spanning from 2,500 to 12,000 pounds lift capacity. For ZEF forklifts above a 12,000-pound lift capacity, 28 models were identified from 5 major manufacturers covering lift capacities up to 40,000 pounds.

Figure 12 illustrates the projected technology split for ZEFs added because of the Proposed Regulation. As lithium-ion battery technology advances and prices decline, the proportion of lithium-ion battery-electric forklifts relative to lead-acid battery-electric forklifts is expected to increase. For this analysis, staff assumed that ten percent of new battery-electric forklifts in 2022 would use lithium-ion battery technology and 48 percent by 2028.[211] Using linear interpolation and extrapolation, staff estimates that 35 percent of new battery-electric forklifts sold will use lithium-ion battery technology by 2026, 61 percent by 2030, and 100 percent by 2037. It was also assumed that ten percent of ZEFs added as result of the Proposed Regulation would be fuel-cell forklifts. While the costs of lithium-ion battery and fuel-cell technologies are expected to decline over time, staff analysis assumes today's estimated full incremental cost of said technologies. The cost of various ZEFs is discussed further below in Section B.8 of this chapter.

[211] Ibid.

Figure 12. Projected Technology Distribution for ZEFs Added as a Result of the Proposed Regulation



7. Annual Hours of Operation

On average, Targeted Forklifts operate 1,848 hours per year. This figure is an average value obtained from the LSI Emission Inventory model and is based on responses to a survey conducted by CARB staff of DOORS-reported fleets in 2020 and a survey of forklift owners conducted by California State University, Fullerton.[212] In the cost analysis, the annual hours of operation is used to estimate fuel and maintenance costs as well as LCFS credit revenue.

[212] Social Science Research Center at California State University, Fullerton, Survey of Large Spark-Ignited (LSI) Engines Operating within California, January 31, 2017 (web link: *https://ww2.arb.ca.gov/sites/default/files/2020-08/ssrc_2017.pdf*).

8. Upfront Costs

a) Forklift Costs

This section covers the cost to a fleet of purchasing a forklift. Today and for the foreseeable future, battery-electric and fuel-cell electric forklifts will cost more to purchase than their internal-combustion counterparts. Declining battery and component costs, in addition to economies of scale, are expected to lower the incremental costs of ZEFs over time as the market expands. However, for this analysis, staff assumed today's full incremental cost of ZEFs for the entirety of the regulatory transition.

Forklift purchase prices were estimated based on averages of prices taken from an online forklift cost of ownership calculator supported by American Electric Power, an investor-owned electric utility in the United States (US) (AEP Calculator); online pricing estimates and information from United States forklift dealers and a warehouse-operations consultancy firm; a fuel-cell total cost of ownership report developed by NREL (Fuel-Cell Report); and information gathered through direct conversations with a California-based forklift dealer.[213, 214, 215] The AEP Calculator and online pricing estimates were used to create a distribution of prices for forklifts of different lift-capacity categories for both propane and lead-acid battery-electric forklifts. Staff assumed that prices for gasoline forklifts are the same as the prices for propane forklifts. These values were compared to pricing information from recent dealer discussions to derive a correction factor that accounts for recent cost increases due to inflation and supply-chain disruptions. The correction factor was then applied to lead-acid electric, propane, and gasoline forklifts.

Using online pricing information and information provided during dealer discussions, the price premium for lithium-ion batteries and chargers over lead-acid batteries and

[213] American Electric Power, AEP Lift truck Cost Savings Calculator, Energy Conversion Hub (web link: *https://energyconversionhub.com/content/forklift-calculator*, last accessed September 23, 2022).
[214] Conger Industries Inc., New & Used Forklift Prices: What You Can Expect to Pay in 2021, May 18, 2022 (web link: *https://www.conger.com/new-used-forklift-prices/#___How_Forklift_Pricing_Is_Determined*).
[215] Ramsden, Todd, An Evaluation of the Total Cost of Ownership of Fuel Cell-Powered Material Handling Equipment, National Renewable Energy Laboratory, April 2013 (web link: *https://www.energy.gov/eere/fuelcells/articles/evaluation-total-cost-ownership-fuel-cell-powered-material-handling*).

chargers was estimated.[216, 217] The price premium for lithium-ion batteries and chargers was added to the lead-acid battery-electric forklift prices to derive the estimated lithium-ion battery-electric forklift price.

Weighted-average prices were derived for lead-acid battery-electric forklifts, lithium-ion battery-electric forklifts, and propane and gasoline forklifts based on the expected distribution of lift capacities. These values were weighted based on data from the *Survey of Large Spark-Ignited (LSI) Engines Operating within California* conducted by California State University, Fullerton.[218]

Fuel cell forklift pricing was based on the NREL Fuel-Cell Report.[219] Today's fuel-cell forklift is most commonly found in warehouses, and the common warehouse forklift typically has a lift capacity of around 5,000 pounds. The inflation and cost increase factor was applied to the fuel-cell forklift price derived from the NREL Fuel-Cell Report to determine the final average price estimate for a fuel-cell forklift. Based on the limited information, a forklift price of $59,708 was assumed for all fuel cell forklifts up to 12,000 pounds lift capacity.

Based on battery-longevity information gathered by staff, the estimated pricing for a lead-acid battery-electric forklift includes one additional battery pack (i.e., two battery packs total). In addition, for battery-electric forklifts, charger unit costs are included in the forklift price estimates. Costs related to the installation of a charger are included in the infrastructure cost analysis described in Section B.8, below. For fuel-cell forklifts, all infrastructure costs are included in the infrastructure cost analysis described in Section B.8, below. Forklift costs to fleets are amortized at a five percent interest over five years from the year of purchase to reflect the financing of these purchases.

Purchase prices for heavy Class IV forklifts (i.e., those over 12,500 pounds lift capacity) and chargers were estimated using aggregated data from CARB's Clean Off-Road Equipment Voucher Incentive Project (CORE) for Class V diesel, lead-acid battery-

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[216] Thomas, Pete, Is a Lithium Ion Forklift Battery Worth the Extra Expense?, Toyota Material Handling Northern California, October 4, 2018 (web Link: *https://www.tmhnc.com/blog/lithium-ion-forklift-battery-cost-and-runtime*).

[217] McGuire, S., Lithium Ion vs Lead Acid Forklift Batteries: Which is Better for You?, Hy-Tek Intralogistics, January 13, 2023 (web link: *https://hy-tek.com/resources/lithium-ion-vs-lead-acid-forklift-batteries-which-is-best-for-you/*).

[218] Social Science Research Center at California State University, Fullerton, Survey of Large Spark-Ignited (LSI) Engines Operating within California, January 31, 2017 (web link: *https://ww2.arb.ca.gov/sites/default/files/2020-08/ssrc_2017.pdf*).

[219] Ramsden, Todd, An Evaluation of the Total Cost of Ownership of Fuel Cell-Powered Material Handling Equipment, National Renewable Energy Laboratory, April 2013 (web link: *https://www.energy.gov/eere/fuelcells/articles/evaluation-total-cost-ownership-fuel-cell-powered-material-handling*).

electric, and lithium-ion battery-electric forklifts. Adjustment factors were derived from online calculators[220, 221, 222] by comparing the estimated purchase price of Class IV and Class V forklifts. These factors were then applied to adjust these costs to Class IV propane, lead-acid battery-electric, and lithium-ion battery-electric forklifts. Based on CARB's LSI Emission Inventory model, Class IV forklifts greater than 12,000 pounds lift capacity account for approximately 1.3 percent of the forklifts that would be impacted by the Proposed Regulation. The costs for heavy Class IV forklifts were weighted accordingly.

The purchase price for heavy fuel-cell forklifts (i.e., those over 12,500 pound lift capacity) was estimated at $259,753 by applying an adjustment factor to the estimated $59,708 purchase price of fuel-cell forklifts not exceeding 12,000 pounds lift capacity. The adjustment factor was derived by comparing the estimated purchase price of a heavy lithium-ion battery-electric forklift to the weighted average purchase price of lithium-ion battery-electric forklifts not exceeding 12,000 pounds lift capacity.

Table 15, below, provides staff's forklift price estimates.

Table 15. Average Forklift Prices by Weight Class (2021$)

Lift Capacity Range (Pounds)	(A) Class IV or V Propane or Gasoline Forklift	(B) Lead-Acid Battery-Electric Forklift	(C) Lithium-Ion Battery-Electric Forklift	(B) – (A) Incremental Cost for Lead-Acid ZEF	(C) – (A) Incremental Cost for Lithium-Ion ZEF
3,000 and Less	$32,625	$45,911	$59,854	$13,286	$27,229
3,001 to 4,000	$36,891	$52,330	$66,274	$15,439	$29,383
4,001 to 5,000	$41,604	$58,628	$72,109	$17,024	$30,505
5,001 to 6,000	$47,292	$64,844	$78,326	$17,552	$31,033

[220] Electric Power Research Institute, Inc., Forklift: Cost Comparison Calculator, (web link: *https://forklift.epri.com/*, last accessed September 5, 2023).
[221] American Electric Power, AEP Lift truck Cost Savings Calculator, Energy Conversion Hub (web link: *https://energyconversionhub.com/content/forklift-calculator*, last accessed September 23, 2022).
[222] Hyundai Material Handling, True Cost Calculator: Is Electric Right for You? (web link: https://www.hyundaiforkliftamericas.com/true-cost-calculator/, last accessed September 5, 2023).

Lift Capacity Range (Pounds)	(A) Class IV or V Propane or Gasoline Forklift	(B) Lead-Acid Battery-Electric Forklift	(C) Lithium-Ion Battery-Electric Forklift	(B) – (A) Incremental Cost for Lead-Acid ZEF	(C) – (A) Incremental Cost for Lithium-Ion ZEF
6,001 to 7,000	$56,556	$77,520	$91,002	$20,964	$34,446
7,001 to 8,000	$58,506	$81,421	$94,902	$22,915	$36,396
8,001 to 10,000	$76,423	$85,809	$100,675	$9,386	$24,252
10,001 to 12,500	$77,520	$97,347	$112,214	$19,827	$34,694
Greater than 12,500[223]	$153,975	$256,701	$330,229	$102,726	$176,254
Weighted Average	$46,770	$70,645	$79,214	$23,875	$32,444

b) Infrastructure Costs

The cost of installing electric infrastructure for a ZEF is heavily dependent on the unique characteristics of the installation site. A report from the International Council on Clean Transportation, "Estimating Electric Vehicle Charging Infrastructure Costs Across Major U.S. Metropolitan Areas," evaluated the average cost of installing Level 2 electric car chargers at various workplace charging sites in and outside of California, including labor, materials, permits, taxes, and in some cases includes utility upgrades.[224] A Level 2 electric car charger has a typical power output ranging from 6.2

[223] Costs for Class IV forklifts only because Class V forklifts greater than 12,000 pounds lift capacity are not subject to the Proposed Regulation. The estimated cost for Class IV forklifts greater than 12,500 lift capacity is an average cost of forklifts at 15,500-, 22,000-, and 36,000-pound lift capacities.

[224] Nicholas, Michael, Estimating Electric Vehicle Charging Infrastructure Costs Across Major U.S. Metropolitan Areas, The International Council On Clean Transportation, August 2019 (web link: *https://theicct.org/sites/default/files/publications/ICCT_EV_Charging_Cost_20190813.pdf*).

kilowatt (kW) to 19.2 kW.[225] Based on forklift specifications available online and discussions with ZEF manufacturers, staff expects that chargers similar to a Level 2 electric lithium-ion car charger could support a battery-electric forklift in most operations.[226] As such, staff assumed that the cost to install a Level 2 electric car charger at a worksite would be a reasonable approximation of the cost to install a charger for a battery-electric forklift.

There are multiple infrastructure pathways that fleets could utilize to support battery-electric ZEFs. For lead-acid battery-electric forklifts operating a single shift, the cost to install supporting charging infrastructure (assuming one charger per forklift) is generally not expected to exceed that of a Level 2 electric lithium car charger because lead-acid battery charging is conducted over a longer time frame and requires lower input current than lithium battery technology. In comparison to single shift forklift operations, multiple shift operations using lead-acid battery technology would likely need to employ battery swapping techniques to ensure sufficient availability of charged batteries. This may entail additional infrastructure costs such as the development of battery swapping rooms and the purchase of battery swapping equipment.[227]

Alternatively, lithium battery technology may be particularly suitable for multiple shift operations because battery rooms and battery swapping are ordinarily not required. Lithium-ion batteries can be charged much more quickly and do not require a cooldown period after each charging event, allowing fleets to take advantage of opportunity charging (i.e., charging during scheduled downtime, such as employee breaks) to extend the duration of daily forklift operation.[228] In addition, the energy density of lithium-ion batteries is much higher than lead-acid batteries, which allows operators to configure forklifts with capacities higher than has been historically possible.

Staff assumed infrastructure installation costs for Level 2 lithium battery charging due to its versatility and the trend towards higher percentages of lithium-ion battery

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[225] EvoCharge, The Difference Between Level 1 & 2 EV Chargers (web link: *https://evocharge.com/resources/the-difference-between-level-1-2-ev-chargers/*, last accessed August 2023).

[226] High lift-capacity example: BYD Model ECB50 forklift with a lithium-ion battery pack and lift capacity of 10,700 pounds (upper end of regulatory applicability); standard charger requires a power input of 16 kW (80 volts x 200 amps); forklift specifications document: BYD, Forklifts Simplified (ECB 40,45, 50), September 22, 2023 (web link: *https://tri-lift.com/wp-content/uploads/2021/05/BYD-ECB-40-45-55-Spec-Sheet.pdf*).

[227] Conger Industries Inc., Lithium Forklift Batteries – The Complete Guide [Pros, Cons, Costs], June 19, 2023 (web link: *https://www.conger.com/lithium-forklift-battery/#lithium-ion-forklift-battery-cons*).

[228] Summit ToyotaLift, Forklift Battery Types, May 2021 (web link: https://www.summithandling.com/forklift-battery-types/).

forklifts purchased over time.[229] For further detail see Chapter I, Section E, Technology Feasibility.

In the cost analysis, the infrastructure installation costs for electric forklifts were associated with new purchases of battery-electric forklifts, but not replacement of existing battery-electric forklifts. Electrical infrastructure upgrade costs represent costs on both the facility-side and utility-side of the meter associated with setting up charging infrastructure at a facility and may include trenching, cabling, conduit, and panels as well as other associated infrastructure costs. Although staff's cost estimates for electrical infrastructure installation include utility-side upgrade costs, staff anticipates that nearly all utility-side upgrade costs would be rolled into the utility pay rates of the facility, or the customer base at large per AB 841, to be recovered over time. Estimated infrastructure costs discussed in this section do not include the cost of chargers, as those costs were included in the forklift costs that are discussed in Chapter VIII, Section B.8.a.

The estimated installation cost of the infrastructure to support hydrogen fuel-cell forklifts was based on information provided in a NREL Fuel-Cell Report[230], which examined the cost of hydrogen fueling infrastructure for a fleet of 58 forklifts. Hydrogen fueling infrastructure is often leased and paid in monthly installations.

Estimated infrastructure costs for both battery-electric and hydrogen fuel-cell forklifts have been adjusted to 2021 dollars and are shown in Table 16.

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[229] Zhukov A., Review of the North American Lithium Forklift Battery Market: The 7 Most Popular Brands in the USA and Canada, OneCharge, October 11, 2021 (web link: *https://www.onecharge.biz/blog/review-of-the-north-american-lithium-forklift-battery-market-the-7-most-popular-brands-in-the-usa-and-canada/?utm_source=PR&utm_medium=Industry+Media&utm_campaign=Battery+review*).

[230] Ramsden, Todd, An Evaluation of the Total Cost of Ownership of Fuel Cell-Powered Material Handling Equipment, National Renewable Energy Laboratory, April 2013 (web link: *https://www.energy.gov/eere/fuelcells/articles/evaluation-total-cost-ownership-fuel-cell-powered-material-handling*).

Table 16. Cost Estimates for Infrastructure Installation (2021$)[231]

	Electric Forklift Infrastructure Cost ($/forklift)	Hydrogen Forklift Infrastructure Cost ($/forklift)
Cost per Forklift	$3,375	$33,927[232]

9. Ongoing Costs

a) Fuel Costs

Propane, gasoline, hydrogen, and electricity prices were derived from a number of sources. Propane prices that represent what forklift fleets pay were based on discussions with several forklift propane suppliers that took place in June 2022. Gasoline and hydrogen prices were based on the fuel-price forecasts from the CEC (CEC Forecasts).[233]

Electricity costs were based on CARB's *Battery Electric Truck and Bus Charging Calculator*.[234] Basic inputs representing typical forklift usage were used to derive electricity cost estimates for a sample fleet of five and 25 forklifts. Example rate schedules were selected with the charging calculator to estimate electricity costs (dollar per kW) in 2019, the year in which the calculator was last updated. Staff used the CEC Forecast[235] of commercial electricity rates to scale up estimated 2019 electricity costs for 2022 and subsequent years. Energy costs, monthly fees, demand rates, charger efficiency losses and local electricity taxes are incorporated into these numbers.

[231] Note that the infrastructure costs in this table do not include cost of chargers.

[232] Calculated as the present value from a stream of monthly payments of $349 over a ten-year lifetime at a 5% discount rate.

[233] California Energy Commission, Presentation - Transportation Energy Demand Forecast: 2021 IEPR Workshop on Electricity & Natural Gas Demand Forecast, December 2021 (web link: https://efiling.energy.ca.gov/GetDocument.aspx?tn=240934).

[234] CARB, Battery-Electric Truck and Bus Charging Calculator, Version 4.0, last updated February 1, 2019.(web link: *https://ww2.arb.ca.gov/sites/default/files/2019-02/chargecalc_2.xls*).

[235] California Energy Commission, Presentation - Transportation Energy Demand Forecast: 2021 IEPR Workshop on Electricity & Natural Gas Demand Forecast, December 2021 (web link: *https://efiling.energy.ca.gov/GetDocument.aspx?tn=240934*).

Electricity cost estimates were weighted by utility company based on statewide energy consumption found in CEC's online *Electric Consumption by Entity* tool.[236]

Table 17, below, summarizes staff's electricity cost estimates for 2021.

Table 17. Electricity Cost Estimates by Utility (2021$)

Utility Company	Small Fleet	Large Fleet	Weighted Average
Los Angeles Department of Water and Power	$0.12	$0.12	$0.12
PG&E	$0.25	$0.14	$0.17
Sacramento Municipal Utility District	$0.17	$0.13	0.14
SDG&E	$0.26	$0.25	$0.26
SCE	$0.21	$0.18	$0.19
Weighted Statewide Average	$0.22	$0.16	$0.18

Staff used the average *fuel consumption rate per hour of activity* for propane and electricity from the LSI Emission Inventory model. The consumption rate for gasoline was calculated using the consumption rate for propane and adjusting it with an equivalence ratio derived from information in Argonne National Laboratory's Full

[236] California Energy Commission, Electricity Consumption by Entity (web link: *http://www.ecdms.energy.ca.gov/elecbyutil.aspx*, last accessed September 26, 2022).

Fuel-Cycle Comparison of Forklift Propulsion Systems.[237] The hydrogen consumption rate of forklifts was based on survey results discussed in the NREL Fuel-Cell Report[238].

Table 18, below, summarizes staff's fuel-cost estimates.

Table 18. Average Energy Costs to Operate Forklifts (2021$)

Fuel	Cost per Unit	Consumption Rate (Unit per Hour)	Cost per Hour of Operation
Propane (per gallon)	$2.79	1.30	$3.63
Gasoline (per gallon)	$3.86	1.17	$4.52
Electricity (per kilowatt-hour)	$0.18	7.50	$1.35
Hydrogen (per kilogram)	$16.19	0.13	$2.10

b) Maintenance Costs

Table 19 below shows average maintenance costs for forklifts. The maintenance cost estimates were based on the average costs from six online forklift cost of ownership

[237] Gaines, L.L. et al., Full Fuel-Cycle Comparison of Forklift Propulsion System, Argonne National Laboratory, October 2008 (web link: *https://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/forklift_anl_esd.pdf*).

[238] Ramsden, Todd, An Evaluation of the Total Cost of Ownership of Fuel Cell-Powered Material Handling Equipment, National Renewable Energy Laboratory, April 2013 (web link: *https://www.energy.gov/eere/fuelcells/articles/evaluation-total-cost-ownership-fuel-cell-powered-material-handling*).

calculators[239,240, 241, 242,243,244] and the NREL Fuel-Cell Report.[245] These estimates were consistent with information provided during recent discussions with forklift dealers.

One of the primary reasons for the reduced maintenance costs for electric and fuel-cell forklifts when compared to propane forklifts is that there are fewer moving parts in an electric powertrain than in an internal combustion engine. Internal combustion forklifts require regular maintenance, including oil changes, engine turn-ups, cooling system top-offs, air/fuel mixture adjustments, and filter replacements.[246] Maintenance costs for a gasoline forklift are assumed to be the same as for a propane forklift.

Table 19. Average Maintenance Costs for Forklifts (2021$)

Maintenance ($/operating hour)	Battery-Electric	Class IV or V Propane and Gasoline	Fuel Cell
Average	$1.14	$1.81	$0.86

c) Low Carbon Fuel Standard Credits

The LCFS regulation is a market-based regulatory program that incentivizes the production of low-carbon fuels. Under the LCFS program, fleets that operate forklifts that use low-carbon fuels (e.g., ZEFs and renewable propane forklifts) are able to

[239] Lean Inc., Forklift Maintenance Costs, April 11, 2021 (web link: *https://leanmh.com/forklift-maintenance-costs/*).

[240] Hyundai Material Handling, True Cost Calculator: Is Electric Right for You? (web link: https://www.hyundaiforkliftamericas.com/true-cost-calculator/, last accessed September 28, 2023).

[241] Conger Industries Inc., Forklift Maintenance: The Complete Guide for Maintenance Managers, March 10, 2023 (web link: *https://www.conger.com/forklift-maintenance-guide/#_How_Much_Does_it_Cost_to_Maintain_a_Forklift*).

[242] Raymond Intralogistics Solutions, Switching from Propane to Electric Forklifts (web link: *https://www.raymondwest.com/ic-vs-electric-forklifts*, last accessed April 2023).

[243] American Electric Power, AEP Lift truck Cost Savings Calculator, Energy Conversion Hub (web link: *https://energyconversionhub.com/content/forklift-calculator*, last accessed September 23, 2022).

[244] Electric Power Research Institute, Inc., Forklift: Cost Comparison Calculator, (web link: *https://forklift.epri.com/*, last accessed September 5, 2023).

[245] Ramsden, Todd, An Evaluation of the Total Cost of Ownership of Fuel Cell-Powered Material Handling Equipment, National Renewable Energy Laboratory, April 2013 (web link: *https://www.energy.gov/eere/fuelcells/articles/evaluation-total-cost-ownership-fuel-cell-powered-material-handling*).

[246] Conger, Electric Forklift vs. Propane: Which Is Better? January 5, 2023 (web link: Electric Forklifts vs. Propane: Which Is Better? - Conger Industries Inc.).

generate and sell credits in the open market to offset the cost of those fuels. Forklifts are an eligible equipment type to generate credits in the LCFS program. To comply with LCFS reporting requirements, entities report their forklift usage using metered electricity or with a CARB-approved estimation methodology.[247]

Staff accounted for the value of LCFS credits in the cost analysis for the Proposed Regulation. From 2018 to January 2023, the monthly average credit price has ranged from $81 to $206.[248] The modeling of LCFS credit revenue reflects assumptions by CARB staff of a $100 LCFS credit price in 2026 that declines to $35 by 2043.[249] The LCFS Credit Value Calculator[250] was used to derive the specific fuel premium estimates[251] corresponding to this credit price assumption for electricity, hydrogen, and propane. Based on this, in 2026, the estimated LCFS fuel premiums are $0.07 per gallon of propane ($0.09 per hour of operation) and $0.09 per kilowatt-hour (kWh) of electricity ($0.67 per hour of operation), which are assumed to begin to decline after 2030 as an increasing supply of credits become available due to other ZE regulations, such as the Advanced Clean Trucks Regulation.[252] Staff's LCFS fuel premium (i.e., revenue from the sale of LCFS credits) estimates from 2026 to 2043 are shown in Table 20.

Due to possible changes in the LCFS program that could remove some of the credits for forklifts, a sensitivity analysis of a scenario without the LCFS credits was completed for the Proposed Regulation in Chapter VIII, Section F. The analysis was completed because staff cannot predetermine how future amendments to the LCFS program would change LCFS credits available to Forklift owners. Providing both cost analyses can provide a more complete picture of possible costs of the Proposed Regulation.

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[247] CARB, Draft Regulatory Guidance: Low Carbon Fuel Standard Regulatory Guidance 17-02 - Methodology for Determining Electric Consumption of Electric Forklifts, 2017 (web link: *https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/guidance/regguidance_17-02.pdf*).

[248] California Air Resources Board, Credit Price Series - January 2023, last updated February 14, 2023 (web link: *https://ww2.arb.ca.gov/sites/default/files/2023-02/Credit%20Price%20Series_Jan%202023.xlsx*).

[249] CARB, Monthly LCFS Credit Transfer Activity Report for September 2022, posted on October 11, 2022 (web link: *https://ww2.arb.ca.gov/sites/default/files/2022-10/September%202022%20-%20Monthly%20Credit%20Transfer%20Activity.pdf*).

[250] CARB, The LCFS Credit Price Calculator, version 1.3, last modified March 2019 (web link: *https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fww2.arb.ca.gov%2Fsites%2Fdefault%2Ffiles%2Fclassic%2Ffuels%2Flcfs%2Fdashboard%2Fcreditvaluecalculator.xlsx&wdOrigin=BROWSELINK*).

[251] Estimated revenue per unit fuel/energy used from the sale of LCFS credits.

[252] Title 13, California Code of Regulations, Sections 1963, 1963.1, 1963.2, 1963.3, 1963.4, 1963.5, 2012, 2012.1, and 2012.2.

Table 20. Fuel Premium Estimates for LCFS Credits by Energy/Fuel Type

Calendar Year	Electricity ($/kilowatt-hour)	Hydrogen ($/kilogram)	Propane* ($/gallon)
2026	$0.09	$0.74	$0.07
2027	$0.09	$0.71	$0.06
2028	$0.09	$0.68	$0.05
2029	$0.08	$0.64	$0.05
2030	$0.08	$0.61	$0.05
2031	$0.08	$0.58	$0.04
2032	$0.07	$0.55	$0.04
2033	$0.07	$0.52	$0.04
2034	$0.07	$0.49	$0.04
2035	$0.06	$0.46	$0.03
2036	$0.06	$0.43	$0.03
2037	$0.05	$0.40	$0.03
2038	$0.05	$0.37	$0.03
2039	$0.05	$0.34	$0.02
2040	$0.04	$0.31	$0.02
2041	$0.04	$0.28	$0.02
2042	$0.03	$0.25	$0.02

Calendar Year	Electricity ($/kilowatt-hour)	Hydrogen ($/kilogram)	Propane* ($/gallon)
2043	$0.03	$0.21	$0.02

* Assumes 90:10 split between fossil-fuel based propane and renewable propane.

All LCFS fuel premium estimates provided for propane in Table 16 are weighted average values that account for a mix of both fossil-fuel based propane and renewable propane. Based on activity data from the LCFS program, staff assumed that 10 percent of all propane-powered forklifts would use renewable propane and 90 percent would use fossil-fuel based propane. On a gallon-per-gallon basis, renewable propane generates significantly more LCFS credit then fossil-fuel based propane. For example, in 2026, the LCFS fuel premium estimate for fossil-fuel based propane is $0.02 per gallon, while the estimate for renewable propane is $0.50 per gallon. Weighting the two values to account for the 90:10 propane mix results in an assumed LCFS fuel premium for propane of $0.07 per gallon in 2026.

Table 21 provides the estimated LCFS credit revenue per hour of operation for a battery-electric, fuel-cell, and propane forklift. In 2026 a battery-electric forklift is estimated to generate $0.67 per hour of operation whereas a propane forklift is estimated to generate $0.09 per hour of operation. Assuming 1,848 hours of operation per year, a battery-electric forklift would earn approximately $1,200 per year in LCFS credit revenue, while a propane forklift would earn approximately $170 per year in LCFS credit revenue.

Table 21. Estimated LCFS Revenue per Hour of Forklift Operation ($/hour)

Calendar Year	Battery-Electric Forklift	Fuel-Cell Forklift	Propane Forklift*
2026	$0.67	$0.09	$0.09
2027	$0.66	$0.09	$0.07
2028	$0.64	$0.08	$0.06
2029	$0.63	$0.08	$0.06
2030	$0.62	$0.08	$0.06

Calendar Year	Battery-Electric Forklift	Fuel-Cell Forklift	Propane Forklift*
2031	$0.60	$0.07	$0.06
2032	$0.53	$0.07	$0.05
2033	$0.53	$0.07	$0.05
2034	$0.53	$0.06	$0.05
2035	$0.45	$0.06	$0.04
2036	$0.45	$0.05	$0.04
2037	$0.38	$0.05	$0.04
2038	$0.38	$0.05	$0.04
2039	$0.38	$0.04	$0.03
2040	$0.30	$0.04	$0.03
2041	$0.30	$0.03	$0.03
2042	$0.23	$0.03	$0.02
2043	$0.23	$0.03	$0.02

* Assumes 90:10 split between fossil-fuel-based propane and renewable propane.

d) Reporting and Labeling

LSI forklift fleet operators and rental agencies subject to the Proposed Regulation would be required to report information about their fleets annually to demonstrate compliance. The first-year reporting requirements would include company information, contact information, and, as applicable, forklift identification information, forklift location, forklift age, and forklift operating hours. Reporting requirements for subsequent years would consist of updates, as applicable, to company, contact, and fleet information; hours of operation; and an attestation of compliance. Fleets would be expected to use CARB's DOORS online reporting system for reporting their company and fleet information. In addition to reporting, fleets would be required to label their Class IV and Class V forklifts in certain circumstances.

Staff expects that the reporting for the first compliance year of the Proposed Regulation would be the most labor intensive and estimates that it would take an environmental engineer one hour per forklift. The time estimate includes acquiring and verifying the required forklift information, organizing the data, entering the information into DOORS, and labeling each applicable forklift. For every year after the first year, the reporting time burden is expected to be on average one hour per forklift fleet. The one-hour-per-fleet assumption takes into account the fact that many fleets would have very few, if any, updates to enter, while others might have updates that take more than an hour to enter. This estimate also includes the time a fleet operator would need, on an annual basis, to take a photograph of the hour meter of each low-use forklift and upload it into DOORS. According to data from the United States Bureau of Labor Statistics, the median wage for an environmental engineer in California is $55.37 per hour and the engineer's benefits amount to $25.94 per hour.[253, 254] The benefits cost includes the costs for life insurance, health insurance, short- and long-term disability, Social Security, Medicare contributions, unemployment insurance, workers' compensation, holidays, and leave. Staff used the fully burdened labor rate of $81.31 in the estimated reporting cost calculation.

Staff assumes that low-use forklifts would be labeled. Purchasing and applying the label is assumed to be a one-time cost. Staff reviewed several websites of vendors that currently supply labels to fleets for use on off-road equipment subject to the LSI Fleet Regulation or the Off-Road Diesel Regulation.[255] Based on that review, staff found that a pair of equipment labels cost between $16 and $300. A total of six vendor sites were reviewed and approximately half of the vendors were selling a pair of labels for $20 or less. Therefore, for this analysis, staff assumed the cost for one label would be $10. The labor cost to apply the label to each forklift is included in staff's estimate for the labor cost.

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[253] U.S. Bureau of Labor Statistics, Occupational Employment and Wage Statistics: May 2021 State Occupational Employment and Wage Estimates - California, last modified March 2022 (web link: *https://www.bls.gov/oes/2021/may/oes_ca.htm#17-0000*).

[254] U.S. Bureau of Labor Statistics, News Release: Employer Costs for Employee Compensation – September 2022 (USDL-22-2307), for release on December 15, 2022 (web link: *https://www.bls.gov/news.release/archives/ecec_12152022.pdf*).

[255] CARB, Label Vendors for Off-Road Diesel Vehicles and Large Spark-Ignited (LSI) Equipment (web link: *https://ww2.arb.ca.gov/resources/documents/label-vendors-road-diesel-vehicles-and-large-spark-ignited-lsi-equipment*, last accessed September 2023).

To determine the total cost of reporting and labeling to fleet operators, staff used the number of Targeted Class IV and V Forklifts, the number of low-use forklifts, and the number of California fleets that would be subject to the Proposed Regulation derived from the LSI Emission Inventory model.

Although the Proposed Regulation would require forklift manufacturers to submit annual reporting of Class IV and Class V forklift sales after January 1, 2026, staff assumed only a negligible number of such sales would occur. Hence, costs for such transactions are assumed to be negligible in this cost analysis.

10. 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. In the cost analysis for the Proposed Regulation, staff made assumptions similar to those made for the Advanced Clean Fleets Regulation,[256] i.e., that the workforce training and transitional costs are equal to 2.5 percent of the incremental cost difference between a baseline combustion forklift and a ZEF. These costs continue until 2032 at which point the technology will have developed to a point where these transitional costs become business-as-usual for forklift fleets.

11. Battery Recycling, Repurposing, and Disposal Costs

The energy capacity of batteries used in battery-electric forklifts will degrade over time and, eventually, when the battery capacity is no longer sufficient for meeting daily operational needs, the batteries will need to be replaced. The lead core in expended lead-acid batteries have a market value, as the lead can be sold and recycled for reuse in the manufacture of new batteries. While the lead-core value is expected to offset a portion of the cost of replacement batteries for fleets that would be subject to the Proposed Regulation, staff did not include the value (i.e., projected savings) in this cost analysis.

[256] CARB, Public Hearing to Consider the Proposed Advanced Clean Fleets Regulation - Staff Report: Initial Statement of Reasons, August 30,2022 (web link: *https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/acf22/isor2.pdf*).

For lithium-ion batteries, it is expected that there will be a second life for the batteries. Used lithium-on 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 lithium-ion battery recycling at the end of battery life is not included here, because this cost is expected to be offset by the residual value of the battery. Light-duty vehicle lithium-ion batteries are already being repurposed for second life applications including stationary storage.[257, 258] Currently, some lithium-ion battery manufacturers provide an attractive residual value to customers upon the retirement of a battery. While staff believes that the residual value of lithium-ion batteries would eventually offset the recycling cost and become a revenue source, because the timing for and amount of this residual value are speculative, staff did not include the residual value in the economic analysis.

12. Total Costs

The Proposed Regulation would increase the number of ZEFs purchased in California relative to the Baseline scenario, as shown in Figure 10, above. Based on staff's analysis, increased ZEF sales would result in higher upfront capital costs initially due to ZEF purchases and infrastructure investments but lower operating costs over time resulting in overall net savings. Table 22 presents each category of cost considered in staff's cost analysis.

[257] Nissan Motor Corporation, Nissan LEAF batteries to light up Japanese town, March 2018 (web link: *https://global.nissannews.com/en/releases/180322-01-e#:~:text=NAMIE%2C%20Japan%20%28March%2022%2C%202018%29%20%E2%80%93%20Nissan%20and,used%20batteries%20from%20the%20Nissan%20LEAF%20electric%20car*).

[258] BMW Group, BMW Group, Northvolt and Umicore join forces to develop sustainable life cycle loop for batteries, October 15, 2018 (web link: *https://www.press.bmwgroup.com/global/article/detail/T0285924EN/bmwgroupnorthvoltandumicore-join-forces-to-develop-sustainable-life-cycle-loop-for-batteries*).

Table 22. Cost Categories Considered in the Cost Analysis

Cost Category	Costs Included in the Cost Category
Forklift Cost	Cost of forklifts, one battery and one charger for each ZEF, and a midlife battery replacement for lead-acid ZEFs
Sales Tax	Sales tax on the forklift cost
Infrastructure	Infrastructure installation
Maintenance	Forklift maintenance costs
Fuel Costs	Propane, gasoline, electricity, hydrogen fuel cost, fuel taxes
LCFS Revenue	LCFS revenue from use of electricity, hydrogen, and propane
Transitional and Reporting Costs	Transitional, workforce development, reporting, and labeling costs.

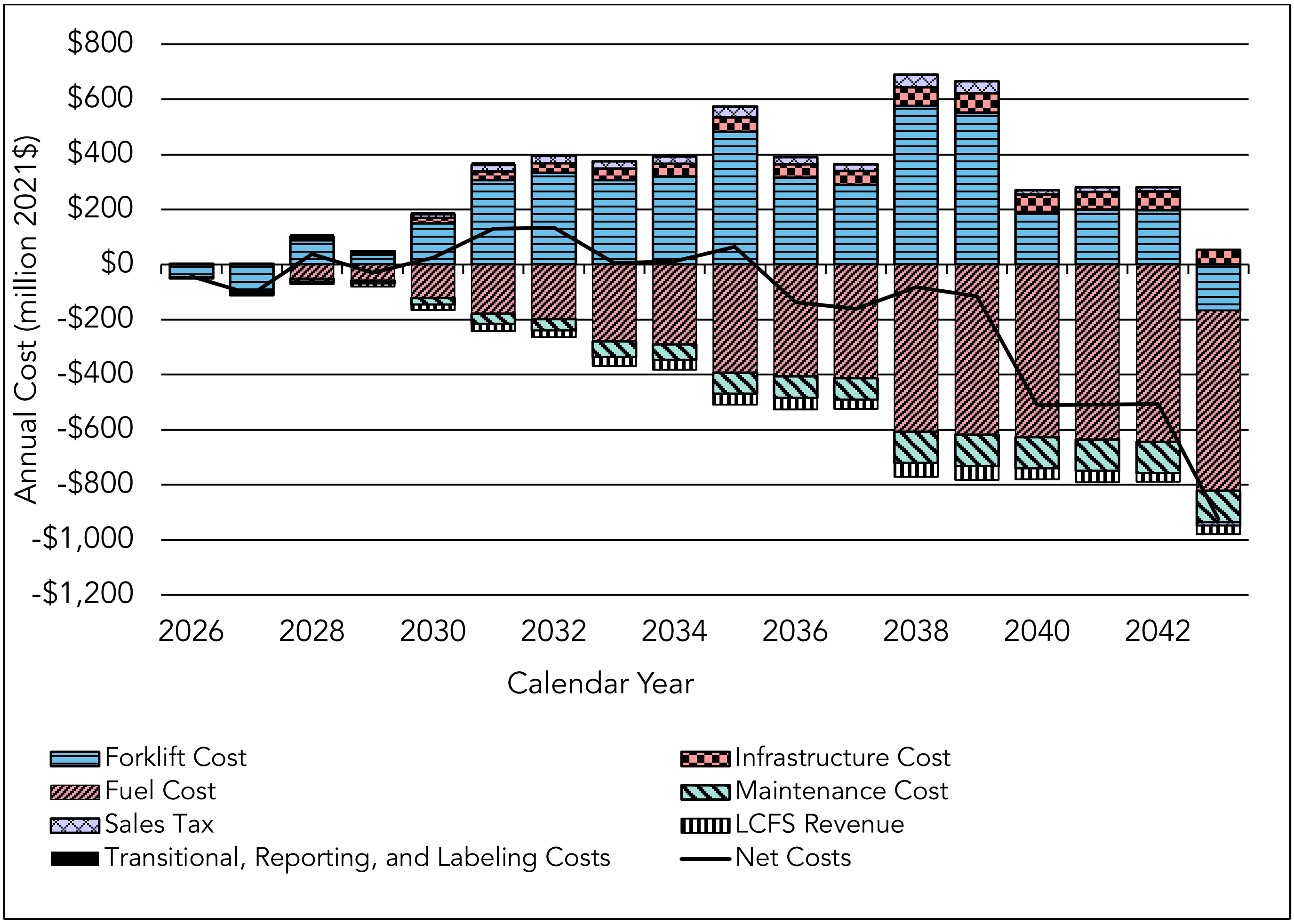
Table 23 and Figure 13 include costs for each of the categories in Table 18 and illustrate the incremental difference in costs between the Proposed Regulation and the Baseline scenario. Staff estimates that the Proposed Regulation would result in a net direct cost savings of approximately $2.7 billion between 2026 and 2043 compared to the Baseline scenario. This represents a substantial net decrease in costs and does not include indirect health benefits. Note that Table 23 also provides the present value of the incremental difference in costs between the Proposed Regulation and the Baseline scenario using a five percent discount rate. Table 23 includes costs to businesses, individuals, and state and local government. State and local government entities are estimated to own 3% of the State's forklifts, amounting to $111 million, as detailed in Section E below. Therefore, the total direct costs to only businesses and individuals is estimated to be $7.5 billion.

Table 23. Statewide Direct Cost of the Proposed Regulation (Million 2021$)

Year	Incremental Forklift Cost	Sales Tax	Infrastructure Cost	Transitional, Training, Reporting, and Labeling Costs	Maintenance Cost	Propane and Gasoline Costs	Electricity Costs	Hydrogen Cost	LCFS Credit Revenue	Total Cost	Total Savings	Net Costs
2026	-$44.8	-$3.6	$0.3	$7.9	-$0.4	-$2.4	$0.6	$0.1	-$0.3	$9.0	-$51.6	-$42.6
2027	-$96.6	-$7.8	$1.0	$1.6	-$1.1	-$7.0	$1.9	$0.3	-$0.8	$4.8	-$113.3	-$108.5
2028	$87.8	$7.1	$7.8	$7.1	-$11.4	-$73.6	$19.6	$3.1	-$8.6	$132.5	-$93.6	$38.9
2029	$35.7	$2.9	$9.6	$1.7	-$12.7	-$82.7	$22.0	$3.3	-$9.4	$75.2	-$104.7	-$29.5
2030	$150.4	$12.1	$19.1	$8.9	-$25.4	-$171.8	$44.3	$6.2	-$18.5	$241.0	-$215.7	$25.4
2031	$307.8	$24.7	$29.7	$9.2	-$37.0	-$252.1	$64.0	$8.7	-$26.0	$444.2	-$315.1	$129.1
2032	$333.6	$26.8	$34.2	$2.8	-$40.0	-$277.4	$69.7	$8.8	-$24.5	$475.9	-$341.9	$134.0
2033	$308.2	$24.8	$41.2	$0.9	-$55.5	-$388.6	$97.6	$11.3	-$34.2	$484.0	-$478.4	$5.6
2034	$321.0	$25.8	$45.0	$0.9	-$56.9	-$401.2	$100.8	$11.2	-$35.3	$504.7	-$493.5	$11.2
2035	$482.0	$38.7	$52.6	$0.9	-$76.7	-$544.0	$137.3	$14.5	-$40.5	$726.1	-$661.2	$64.9
2036	$315.2	$25.3	$49.2	$0.9	-$78.3	-$560.8	$138.9	$14.9	-$41.6	$544.5	-$680.6	-$136.1
2037	$289.4	$23.3	$50.5	$0.9	-$78.3	-$565.7	$138.4	$15.1	-$34.3	$517.6	-$678.3	-$160.7
2038	$576.1	$46.3	$66.9	$0.9	-$113.7	-$829.4	$200.1	$21.1	-$50.2	$911.4	-$993.3	-$81.9
2039	$551.1	$44.3	$70.7	$0.9	-$113.7	-$836.5	$198.5	$20.5	-$50.6	$885.8	-$1,000.8	-$114.9
2040	$191.6	$15.4	$62.8	$0.9	-$113.7	-$844.0	$196.9	$19.8	-$40.0	$487.3	-$997.7	-$510.4
2041	$199.2	$16.0	$65.0	$0.9	-$113.7	-$851.6	$196.0	$19.2	-$40.4	$496.3	-$1,005.7	-$509.4
2042	$196.7	$15.8	$68.5	$0.9	-$113.7	-$859.0	$195.9	$18.6	-$29.8	$496.5	-$1,002.5	-$506.0
2043	-$168.1	-$13.5	$53.6	$0.9	-$113.7	-$866.9	$195.4	$18.1	-$30.2	$267.9	-$1,192.4	-$924.5
Total	**$4,036.2**	**$324.4**	**$727.5**	**$49.4**	**-$1,155.5**	**-$8,414.8**	**$2,018.0**	**$214.8**	**-$515.4**	**$7,704.8**	**-$10,420.2**	**-$2,715.4**
Present Value @ 5%	**$2,176.5**	**$174.9**	**$368.8**	**$34.4**	**-$570.9**	**-$4,128.9**	**$998.2**	**$108.6**	**-$269.7**	**$4,057.6**	**-$5,165.7**	**-$1,108.1**

*Negative costs represent cost savings

Figure 13. Statewide Direct Costs of the Proposed Regulation



a) Costs to a Small Fleet

A small fleet would incur upfront and ongoing operating costs and would be expected to realize cost savings due to reduced fuel and maintenance costs and to LCFS credit revenue. However, as discussed later in this section, the rate at which cost savings would be realized by a small fleet is expected to be slower, in general, than by a typical fleet because small fleet forklifts are assumed to be operated fewer hours per year.

Staff developed an LSI fleet profile for a small fleet using the methodology explained in Chapter VIII, Section B.12.b, Costs to Typical Fleet. This process defined an assumed small fleet in California as one that would have the following characteristics:

- The fleet would have three Targeted Class IV Forklifts and four Targeted Class V Forklifts;
- Each forklift would have a lift capacity of 5,000 pounds;
- Each forklift would operate 1,044 hours per year;
- In the baseline scenario, natural turnover and replacement would occur when a forklift reaches 20 years old;
- In the Proposed Regulation scenario, each LSI forklift would be replaced with a new lead-acid battery-electric forklift; and
- Staff assumed that the small fleet would qualify as a microbusiness and retain one low-use LSI forklift that would operate 200 hours annually.

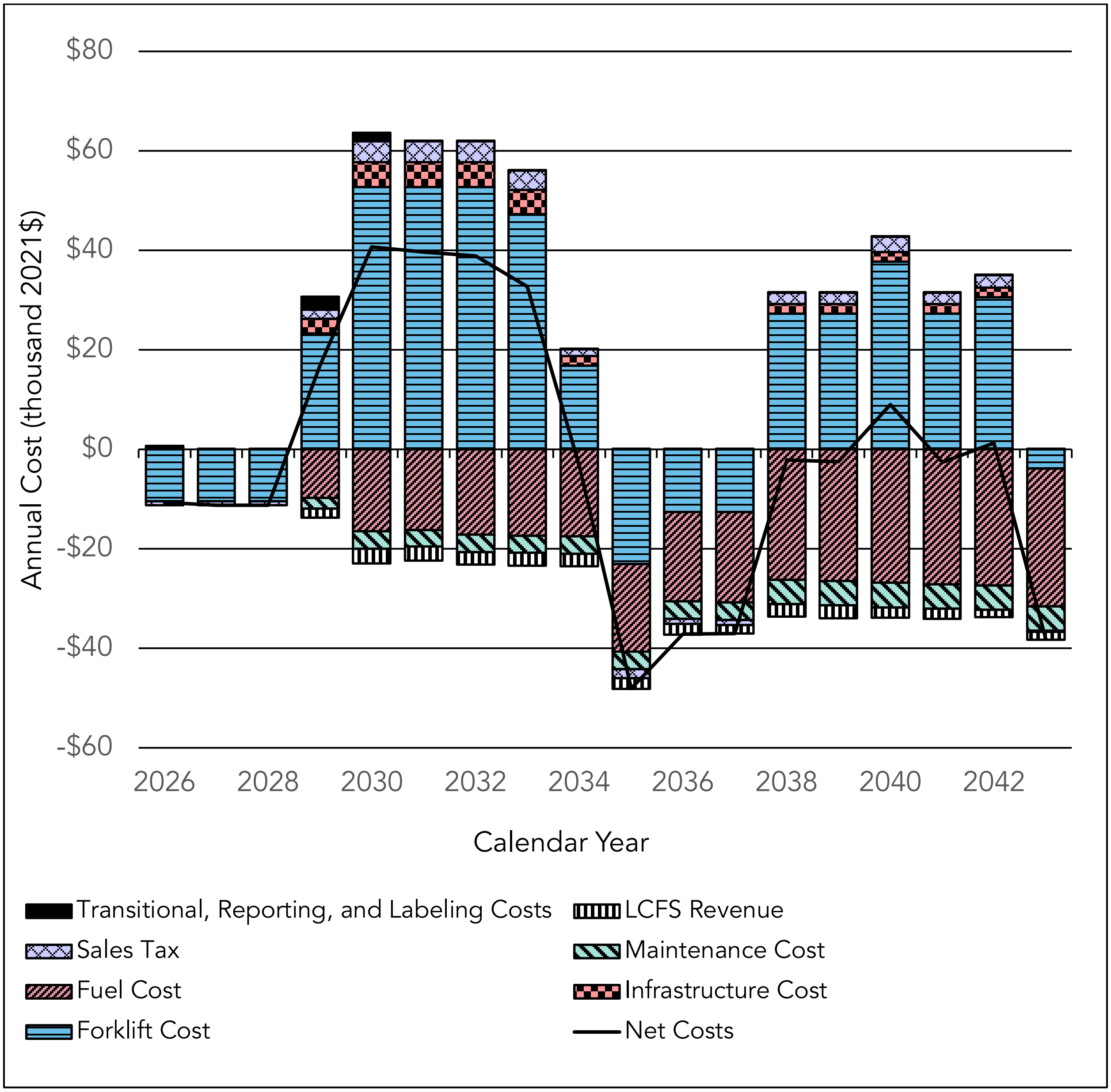
Table 24 presents estimated costs from 2026 to 2043 for a small fleet that phases out seven Targeted Forklifts in accordance with the Proposed Regulation and replaces said forklifts with comparable lead-acid battery electric forklifts. These costs are plotted in Figure 14 as well; note that costs are negative in the first few years because some LSI forklifts are held on longer than in the baseline case in the first three years. For this scenario, the overall net savings by 2043 is estimated at $24,790. Accounting for the difference in timing of costs and savings by discounting at a five percent rate to 2026 shows that a small business would see a net present value (NPV) cost of about $6,060.

Table 24. Cost Example for a Small Fleet (Thousand 2021$)

Year	Incremental Forklift Cost	Sales Tax	Infrastructure Cost	Transitional, Training, Reporting, and Labeling Costs	Maintenance Cost	Propane and Gasoline Costs	Electricity Costs	LCFS Credit Revenue	Total Cost	Total Savings	Net Costs
2026	-$10.4	-$0.8	$0.0	$0.6	$0.0	$0.0	$0.0	$0.0	$0.6	-$11.3	-$10.7
2027	-$10.4	-$0.8	$0.0	$0.1	$0.0	$0.0	$0.0	$0.0	$0.1	-$11.3	-$11.2
2028	-$10.4	-$0.8	$0.0	$0.1	$0.0	$0.0	$0.0	$0.0	$0.1	-$11.3	-$11.2
2029	$23.3	$1.9	$3.0	$2.5	-$2.1	-$15.0	$5.2	-$1.8	$35.8	-$18.9	$16.9
2030	$52.7	$4.2	$5.0	$1.7	-$3.5	-$25.2	$8.7	-$3.0	$72.3	-$31.6	$40.7
2031	$52.7	$4.2	$5.0	$0.1	-$3.4	-$24.5	$8.3	-$2.8	$70.3	-$30.7	$39.6
2032	$52.7	$4.2	$5.0	$0.1	-$3.5	-$25.9	$8.7	-$2.5	$70.7	-$31.9	$38.8
2033	$47.2	$3.8	$5.0	$0.1	-$3.5	-$26.1	$8.8	-$2.5	$64.8	-$32.1	$32.7
2034	$16.8	$1.4	$2.0	$0.1	-$3.5	-$26.3	$8.8	-$2.5	$29.1	-$32.3	-$3.3
2035	-$23.1	-$1.9	$0.0	$0.1	-$3.5	-$26.5	$8.9	-$2.2	$9.0	-$57.1	-$48.1
2036	-$12.6	-$1.0	$0.0	$0.1	-$3.5	-$26.7	$8.8	-$2.2	$8.9	-$46.1	-$37.2
2037	-$12.6	-$1.0	$0.0	$0.1	-$3.5	-$26.9	$8.8	-$1.8	$8.9	-$45.9	-$37.0
2038	$27.3	$2.2	$2.0	$0.1	-$4.9	-$38.5	$12.3	-$2.6	$43.8	-$45.9	-$2.1
2039	$27.3	$2.2	$2.0	$0.1	-$4.9	-$38.7	$12.2	-$2.6	$43.7	-$46.1	-$2.5
2040	$37.7	$3.0	$2.0	$0.1	-$4.9	-$38.9	$12.1	-$2.0	$54.9	-$45.9	$9.0
2041	$27.3	$2.2	$2.0	$0.1	-$4.9	-$39.2	$12.0	-$2.1	$43.5	-$46.1	-$2.6
2042	$30.6	$2.5	$2.0	$0.1	-$4.9	-$39.4	$12.0	-$1.5	$47.1	-$45.8	$1.3
2043	-$3.8	-$0.3	$0.0	$0.1	-$4.9	-$39.6	$12.0	-$1.5	$12.1	-$50.2	-$38.2

Year	Incremental Forklift Cost	Sales Tax	Infrastructure Cost	Transitional, Training, Reporting, and Labeling Costs	Maintenance Cost	Propane and Gasoline Costs	Electricity Costs	LCFS Credit Revenue	Total Cost	Total Savings	Net Costs
Total	**$311.9**	**$25.1**	**$34.8**	**$6.1**	**-$59.4**	**-$457.1**	**$147.5**	**-$33.6**	**$615.7**	**-$640.5**	**-$24.8**
Present Value	**$175.6**	**$14.1**	**$20.9**	**$4.3**	**-$30.9**	**-$236.2**	**$76.9**	**-$18.7**	**$349.3**	**-$343.2**	**$6.1**

Figure 14. Cost Example for a Small Fleet



As shown in Table 25, the total upfront capital cost to a small business over the regulatory horizon is estimated to be $371,794, while the cumulative of the ongoing costs are -$362,952.

Table 25. Small Fleet Example Showing Cumulative Incremental Direct Cost Over Lifetime of Proposed Regulation (2021$)

Cost line items	Cumulative to 2031	Cumulative to 2038	Cumulative to 2043
Forklift Purchase Costs	$97,381	$193,019	$311,947
Sales Tax	$7,827	$15,514	$25,073
Infrastructure Cost	$12,916	$26,826	$34,774
Upfront Costs (total)	**$118,125**	**$235,358**	**$371,794**
Transitional, Reporting and Labeling Cost	$5,151	$5,720	$6,127
Maintenance Cost	-$8,974	-$34,899	-$59,422
Propane and Gasoline Cost	-$64,629	-$261,412	-$457,138
Electricity Cost	$22,157	$87,270	$147,481
Ongoing Net Costs (total)	-$46,295	-$203,319	-$362,952
Annual Ongoing Net Costs (total/ # of years)	-$7,716	-$15,640	-$20,164

Table 26 identifies forklift replacements over time for both the baseline and Proposed Regulation scenarios. In the baseline scenario for a small business, Targeted Forklifts reaching 20 years old are replaced with LSI forklifts. This results in six replacements by 2043. Under the Proposed Regulation, turnover is earlier and Targeted Forklifts are replaced with ZEFs. The assumed useful life of ZEF is 15 years, which is shorter than the 20 years assumed for LSI Forklifts at a small business.

Table 26. Forklift Replacement Schedule for Small Fleet Example

Year	Replacement Propane Forklifts (Baseline)	Replacement ZE Forklifts (Proposed Regulation)	Net Forklifts (Proposed Regulation Minus Baseline)
2026	1	0	-1
2027	0	0	0
2028	0	0	0
2029	1	3	2
2030	0	2	2
2031	1	0	-1
2032	0	0	0
2033	1	0	-1
2034	0	0	0
2035	1	0	-1
2036	0	0	0
2037	0	0	0
2038	0	2	2
2039	0	0	0
2040	0	0	0
2041	1	0	-1
2042	0	0	0
2043	0	0	0
Total	**6**	**7**	**1**

This analysis conservatively assumes one charger would be installed for each forklift in the fleet. However, a fleet with lower forklift hours of operation may not need as many chargers per forklift as a fleet with higher activity. That is, the small fleet in this example could potentially implement more charger sharing, which would reduce costs.

In addition, existing electrical infrastructure is more likely to be able to support the addition of a smaller fleet of ZEFs without major modifications. For example, a small ZEF fleet could require only minor electrical circuit breaker upgrades as most commercial and industrial facilities have electrical panels with extra circuit capacity. Adding a larger fleet of ZEFs would likely require major electrical-panel upgrades as well as upgrades to service capacity.

Small fleets are also more likely to purchase used forklifts rather than new, which would reduce upfront capital costs, and keep forklifts for longer, which would allow for more time for operational savings to offset upfront costs. As such, it is possible that the actual net costs realized by small fleets could be lower than the values estimated in this analysis.

As indicated above, this analysis assumes that each forklift owned by a small fleet would operate an average of 1,044 hours per year. For comparison, staff assumed a forklift owned by a typical fleet would operate 1,914 hours per year. The difference in the hours of operation between small and typical fleets has been observed by CARB across many different equipment inventories. Smaller businesses consistently use their equipment fewer hours per year across many industries, including the construction, industrial, agricultural, and mining industries.[259, 260] Because the amount of fuel and maintenance savings and LCFS credit revenue is directly correlated to the number of hours a forklift operates, lower forklift usage would be expected to result in lower ongoing savings. That said, small businesses that operate forklifts more than 1,044 hours per year would likely realize greater savings than estimated by this analysis.

b) Costs to a Typical Fleet

A typical fleet that currently owns and/or operates Targeted Class IV or Class V Forklifts would incur the same types of upfront capital costs and on-going operating costs due to the Proposed Regulation as a small fleet. These costs would include, as applicable, the purchase cost of ZEFs, ZEF batteries, and ZEF chargers; costs associated with installing chargers and/or upgrading facility-side electrical or fueling infrastructure; electricity or fuel costs; maintenance costs; finance charges; and taxes. In addition, a typical fleet would also incur compliance costs, such as recordkeeping and reporting costs. A typical fleet would also be expected to realize cost savings that

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[259] CARB, *2021 Agricultural Equipment Emission Inventory*, August 2021(web link: *https://ww2.arb.ca.gov/sites/default/files/2021-08/AG2021_Technical_Documentation_0.pdf*).

[260] CARB, *2022 CARB Construction, Industrial, Mining and Oil Drilling Emissions Inventory*, August 2022 (web link: https://ww2.arb.ca.gov/sites/default/files/2022-10/2022InUseDieselInventory.pdf).

offset costs; such savings would include reduced fuel and maintenance costs and LCFS credit revenue.

To develop a fleet profile for a typical fleet, staff used DOORS data, the LSI Emission Inventory model, and data on sales revenue and number of employees from Dun and Bradstreet, Inc. For this analysis, a typical California fleet with LSI forklifts would have the following characteristics:

- The fleet would have 45 Targeted Class IV Forklifts and 45 Targeted Class V Forklifts;
- Each forklift would have a lift capacity of 8,000 pounds;
- Each forklift would operate 1,992 hours per year; and
- In the baseline scenario, natural forklift turnover and replacement occurs after 17 years of use.

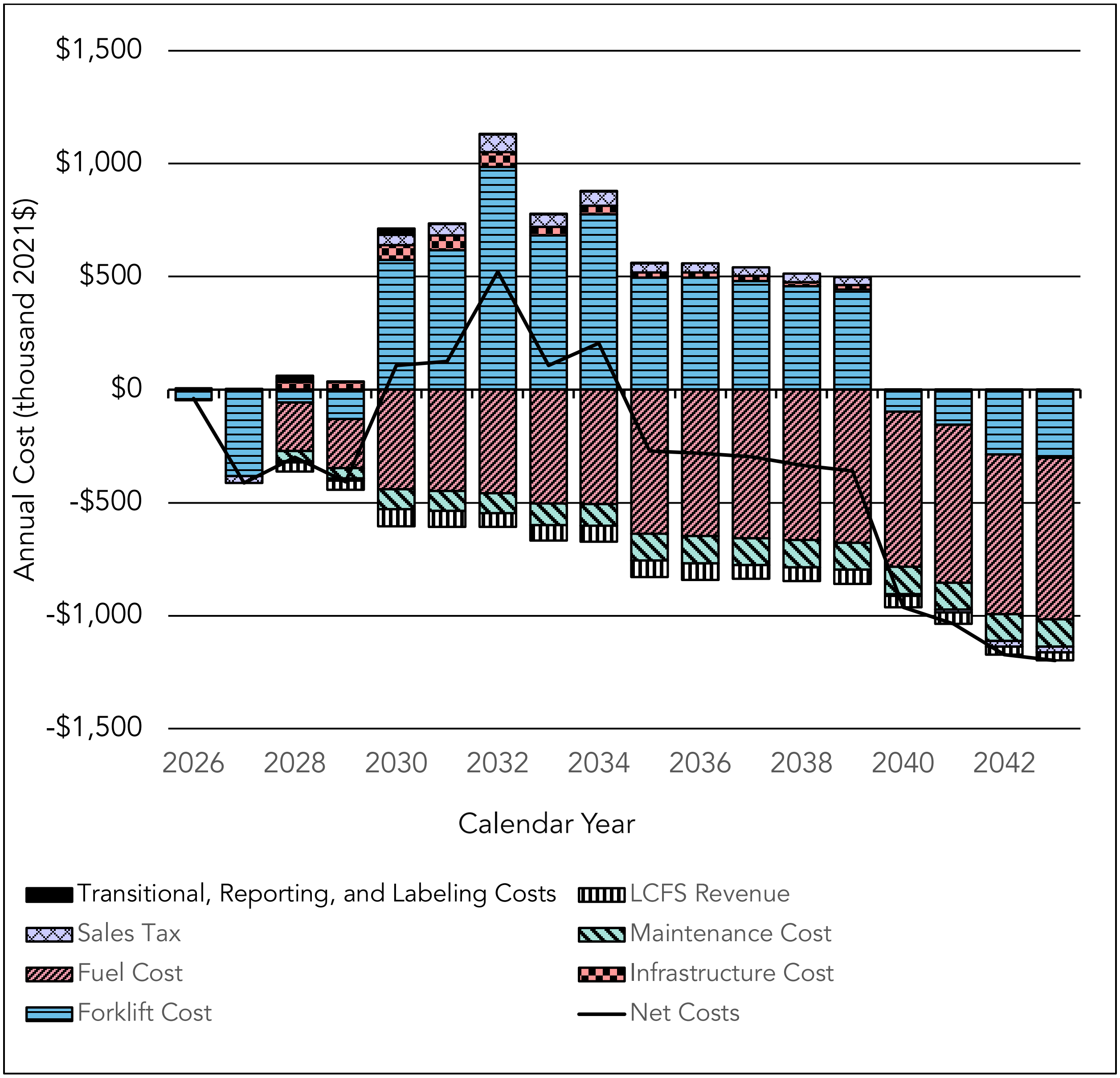
Table 27 presents estimated costs from 2026 to 2043 for a typical fleet that phases out 90 Targeted Class IV and V Forklifts in accordance with the Proposed Regulation and replaces said forklifts with comparable electric forklifts with either a lead-acid battery or a lithium-ion battery. These costs are plotted in Figure 15 as well; note that costs are negative in the first few years because some LSI forklifts are held on longer than in the baseline case in the first few years. As noted in Table 27, the initial cost to a typical fleet is higher due to the upfront costs of purchasing new ZEFs and installing charging. However, due to cost savings from lower fuel and maintenance costs and revenue from LCFS credits, overall costs decrease over time. In this example, there would be an overall cost savings of $6,005,890 by 2043. Accounting for the difference in timing of costs and savings by discounting at a five percent rate to 2026 shows that the typical fleet would receive a NPV savings of about $2,771,530. Ultimately, a typical fleet is expected to realize cost savings by switching to ZEFs.

Table 27. Cost Example for a Typical Fleet (Thousand 2021$)

Year	Incremental Forklift Cost	Sales Tax	Infrastructure Cost	Transitional, Training, Reporting, and Labeling Costs	Maintenance Cost	Propane and Gasoline Costs	Electricity Costs	LCFS Credit Revenue	Total Cost	Total Savings	Net Costs
2026	-$44.1	-$3.5	$0.0	$7.3	$0.0	$0.0	$0.0	$0.0	$7.3	-$47.6	-$40.3
2027	-$382.1	-$30.7	$0.0	$0.1	$0.0	$0.0	$0.0	$0.0	$0.1	-$412.8	-$412.7
2028	-$57.6	-$4.6	$33.8	$27.7	-$45.5	-$304.7	$90.6	-$39.6	$152.0	-$452.0	-$300.0
2029	-$131.1	-$10.5	$33.8	$0.1	-$45.5	-$307.8	$91.5	-$38.8	$125.3	-$533.7	-$408.4
2030	$574.3	$46.2	$65.6	$26.0	-$88.2	-$619.7	$178.2	-$73.9	$890.3	-$781.9	$108.4
2031	$618.4	$49.7	$65.6	$0.1	-$88.1	-$625.5	$177.7	-$71.9	$911.5	-$785.5	$126.0
2032	$985.6	$79.2	$65.6	$0.1	-$88.2	-$636.6	$179.0	-$62.5	$1,309.4	-$787.4	$522.0
2033	$682.5	$54.9	$37.8	$0.1	-$96.3	-$700.1	$196.7	-$68.5	$971.9	-$864.8	$107.0
2034	$776.7	$62.4	$37.8	$0.1	-$96.3	-$704.7	$198.1	-$68.9	$1,075.1	-$869.9	$205.2
2035	$495.7	$39.8	$23.8	$0.1	-$120.3	-$886.6	$250.1	-$73.2	$809.5	-$1,080.1	-$270.6
2036	$495.7	$39.8	$23.8	$0.0	-$120.3	-$895.5	$248.0	-$73.7	$807.4	-$1,089.6	-$282.2
2037	$479.9	$38.6	$23.8	$0.0	-$120.3	-$903.8	$247.0	-$60.8	$789.4	-$1,084.8	-$295.5
2038	$458.6	$36.9	$17.9	$0.0	-$120.3	-$912.2	$245.8	-$61.3	$759.1	-$1,093.8	-$334.7
2039	$444.1	$35.7	$17.9	$0.0	-$120.3	-$920.4	$243.7	-$61.8	$741.4	-$1,102.5	-$361.1
2040	-$97.8	-$7.9	$0.0	$0.0	-$120.3	-$928.9	$241.8	-$48.8	$241.8	-$1,203.7	-$962.0
2041	-$156.6	-$12.6	$0.0	$0.0	-$120.3	-$937.5	$240.7	-$49.3	$240.7	-$1,276.3	-$1,035.7

Year	Incremental Forklift Cost	Sales Tax	Infrastructure Cost	Transitional, Training, Reporting, and Labeling Costs	Maintenance Cost	Propane and Gasoline Costs	Electricity Costs	LCFS Credit Revenue	Total Cost	Total Savings	Net Costs
2042	-$287.6	-$23.1	$0.0	$0.0	-$120.3	-$946.0	$240.6	-$36.4	$240.6	-$1,413.4	-$1,172.8
2043	-$302.3	-$24.3	$0.0	$0.0	-$120.3	-$954.9	$239.9	-$36.9	$239.9	-$1,438.6	-$1,198.8
Total	**$4,552.4**	**$365.9**	**$447.1**	**$61.6**	**-$1,630.9**	**-$12,184.9**	**$3,309.2**	**-$926.3**	**$10,312.5**	**-$16,318.4**	**-$6,005.9**
Present Value	**$2,709.6**	**$217.8**	**$284.9**	**$46.9**	**-$864.1**	**-$6,399.0**	**$1,754.6**	**-$522.3**	**$5,911.4**	**-$8,683.0**	**-$2,771.5**

Figure 15. Cost Example for a Typical Fleet



As shown in Table 28 the total upfront capital cost to a typical business over the regulatory horizon are estimated to be $5,365,365, while the cumulative of the ongoing net costs are -$10,444,971.

Table 28. Typical Fleet Example Showing Cumulative Incremental Direct Cost Over Lifetime of Proposed Regulation (2021$)

Cost line items	Cumulative to 2031	Cumulative to 2038	Cumulative to 2043
Forklift Price	$577,827	$4,952,434	$4,552,372
Sales Tax	$46,443	$398,053	$365,898
Infrastructure Cost	$198,709	$429,211	$447,095
Upfront Costs (total)	**$822,979**	**$5,779,699**	**$5,365,365**
Transitional, Reporting and Labeling Cost	$61,257	$61,582	$61,582
Maintenance Cost	-$267,244	-$1,029,272	-$1,630,873
Propane and Gasoline Cost	-$1,857,671	-$7,497,094	-$12,184,920
Electricity Cost	$537,950	$2,102,644	$3,309,239
Ongoing Net Costs (total)	-$1,525,708	-$6,362,140	-$10,444,971
Annual Ongoing Net Costs (total/ # of years)	-$254,285	-$489,395	-$580,276

Table 29 identifies forklift replacements over time for both the baseline and Proposed Regulation scenarios. In the baseline scenario for a typical fleet, after 17 years of use, Targeted Forklifts are replaced with LSI forklifts. This results in 90 replacements by 2043. Under the Proposed Regulation, turnover is earlier and Targeted Forklifts are replaced with ZEFs. The assumed useful life of ZEFs is 15 years, which is shorter than the 17 years assumed for LSI forklifts in a typical fleet. The Proposed Regulation scenario also results in 90 forklift replacements.

Table 29. Forklift Replacement Schedule for Example of Typical Fleet

Year	Replacement Propane Forklifts (Baseline)	Replacement ZE Forklifts (Proposed Regulation)	Net Forklifts (Proposed Regulation Minus Baseline)
2026	3	0	-3
2027	23	0	-23
2028	29	34	5
2029	5	0	-5
2030	1	32	31
2031	0	0	0
2032	0	0	0
2033	8	6	-2
2034	0	0	0
2035	0	18	18
2036	0	0	0
2037	0	0	0
2038	0	0	0
2039	0	0	0
2040	8	0	-8
2041	4	0	-4
2042	8	0	-8
2043	1	0	-1

Year	Replacement Propane Forklifts (Baseline)	Replacement ZE Forklifts (Proposed Regulation)	Net Forklifts (Proposed Regulation Minus Baseline)
Total	**90**	**90**	**0**

c) Cost to Individuals

CARB staff expects that there would not be direct costs to individuals as a result of this Proposed Regulation. Individuals would realize health benefits, as described in Chapter IV, Section A, Health Benefits, from statewide, regional, and local emission benefits due to ZEFs displacing LSI forklifts. However, individuals could be impacted by indirect costs and savings realized by fleet operators, rental agencies, and manufacturers, which are further discussed in Chapter IV, Section C.

d) Share of Costs by Industry

See Figure 10, above, which illustrates the share of the affected forklift population by major sector. Costs are assumed to be proportional to the share of forklifts by industry. A more detailed breakdown of the forklift population share by industry is provided in the Macroeconomic Analysis in Appendix B-1, the SRIA.

C. Cost Effectiveness

The metric to quantify cost-effectiveness of the proposed regulation is the ratio of total monetized benefits divided by total monetized costs. A comparison of this type is an appropriate cost-effectiveness measure if the harm associated with increased emissions is fully captured in the estimates of monetized health impacts. A benefit-cost ratio greater than 1 implies that a regulation's benefits are higher than its costs. Benefits to California include both health benefits and cost savings after subtracting tax impacts to State and local governments. Table 30 indicates that the Proposed Regulation has a total cost of $7.7 billion and total benefit of $17.5 billion from 2026-2043. This results in a net benefit of $9.7 billion for the Proposed Regulation and a Benefit-Cost ratio of 2.26, indicating that the benefits are 126 percent greater than the costs.

Table 30. Benefit-Cost Ratio of the Proposed Regulation (Billion 2021$)

Total Costs	Cost Savings (benefit)	Health Benefits	Tax and Fee Revenue	Total Benefit	Net Benefit	Benefit-Cost Ratio
$7.7	$10.4	$7.5	-$0.5	$17.5	$9.7	2.26

When SC-CO_2, quantified in Chapter IV, Section B.2. is included, the total benefits of the Proposed Regulation increase up to $18.6 billion and the benefit-cost ratio to 2.62, based on a 2.41 percent discount rate.

D. Macroeconomic Impacts

1. Businesses Impacted

Consistent with other off-road fleet rules CARB has adopted, for the purposes of the Proposed Regulation, staff used fleet size as a surrogate for business size (i.e., small business versus typical business) based on an assumed correlation between fleet size and annual earnings and employee count of a business. That is, within a particular industry, the fleet size of a small business is generally expected to be smaller than the fleet size of a typical business. For that reason, in the Proposed Regulation, Class IV forklifts in small fleets and those in large fleets would be subject to different phase-out schedules, as presented in Chapter I, Section C.2. A large fleet, which would have 26 or more forklifts in its fleet, would begin phasing out its Targeted Class IV Forklift by 2028. A small fleet, which would have less than 26 forklifts, would begin phasing out its Targeted Class IV Forklift one year later by 2029. In addition, the phase-out age of Targeted Class IV Forklifts in a large fleet would be ten years while the phase-out age for a small fleet would be 13 years. The different phase-out provisions provide additional flexibility for small fleets because such fleets would be generally expected to face greater financial challenges during the transition to ZE technology. Accordingly, staff also used fleet size to determine whether a business is a small business or a typical business for the purposes of this analysis. That is, fleets with 25 or fewer forklifts are assumed to be small businesses, and fleets with 26 or more forklifts are assumed to be typical businesses.

To determine the number of businesses that would be impacted by the Proposed Regulation, CARB staff used the distribution of LSI forklift population to owners as observed on both the CARB's DOORS[261] for fleets of four or more, and the statewide survey of forklift owners completed by California State University, Fullerton for fleets of three or less[262]. These distributions were applied to the final statewide populations developed in the LSI Emission Inventory to estimate the total number of fleet operators statewide. Table 31, below, summarizes the fleet operator statistics from the LSI Emission Inventory.

Table 31. Summary Fleet Operator Statistics from Statewide Inventory

Business Size	LSI Fleet Size	Number of LSI Fleets	Percent of Fleets	Number of LSI Forklifts
Small	$\leq$ 25 forklifts	9,078	80.3%	32,415
Typical	> 25 forklifts	2,232	19.7%	62,310
Total	**All forklifts**	**11,310**	**100%**	**94,725**

Forklift manufacturers, forklift rental businesses, and forklift dealers would also be impacted by the Proposed Regulation. CARB staff is only aware of one business currently that manufactures forklifts in California, Wiggins Lift.[263] Based on feedback from the American Rental Association, it is estimated that there are up to 304 forklift rental businesses operating in California. Data for the industry which includes forklift rental businesses (Other Commercial and Industrial Equipment Rental and Leasing) shows that approximately 98 percent of establishments are small businesses.[264] Applying this distribution to the estimated 304 businesses suggests about 298 small businesses and 6 typical businesses renting forklifts in California. Forklift dealers are a subset of businesses classified in the industrial equipment merchant wholesaler industry, which has 2,634 businesses operating in California, 99 percent of them being

[261] CARB, DOORS Online Reporting Tool (web link: *https://ssl.arb.ca.gov/ssldoors/doors_reporting/doors_login.html*, last accessed September 2023).

[262] Social Research Center at CSU, Fullerton, Survey of Large Spark-Ignited (LSI) Engines Operating within California, January 31, 2017 (web link: *https://ww2.arb.ca.gov/sites/default/files/2020-08/ssrc_2017.pdf*).

[263] Wiggins Lift Co. Inc., Agricultural Equipment (web link: *https://wigginslift.com/*, last accessed September 2023).

[264] U.S. Census Bureau, Census Business Builder - Business Profile: Other Commercial and Industrial Machinery and Equipment Rental and Leasing - California (web link: *https://cbb.census.gov/cbb/#industries=532490&view=report&clusterName=Other+Commercial+and+Industrial+Machinery+and+Equipment+Rental+and+Leasing&reportType=detailed&dynHeader=undefined&geoId=06&geoType=state*, last accessed October 2023).

small businesses.[265] Adding the number forklift dealers, rental businesses, and manufacturers with the number of fleets, gives the estimated number of businesses impacted: 11,985 small businesses and 2,264 typical businesses, or 84 percent small businesses.

2. Creation of New Businesses or Elimination of Existing Businesses within the State of California.

The Regional Economic Model Inc. (REMI) model is used to model the estimated macroeconomic impacts of the proposed regulation, as described in the SRIA. REMI is a structural economic forecasting and policy analysis model that integrates input-output, computable general equilibrium, econometric and economic geography methodologies. Since the release of the SRIA, the REMI model's National and Regional Control was updated to conform to the most recent DOF economic forecasts which include U.S. Real Gross Domestic Product, income, and employment, as well as California civilian employment by industry, released with the 2023-2024 May Revision to the Governor's Budget on May 12, 2023.[266, 267, 268] After the DOF economic forecasts end in 2026, CARB staff made assumptions that post-2026, economic variables would continue to grow at the same rate projected in the REMI baseline forecasts.

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[265] U. S. Census Bureau, Census Business Builder - Business Profile: Industrial Machinery and Equipment Merchant Wholesalers - California (web link: *https://cbb.census.gov/cbb/#view=report&industries=423830&clusterName=Industrial+Machinery+and+Equipment+Merchant+Wholesalers&geoType=state&dataVariable=179&dashboardVars=15-17-33-64&centerX=-13012639&centerY=4409690&level=5&theme=default&geoId=06&dynHeader=Custom+Region*, last accessed June 2023).

[266] California Department of Finance, United States Economic Forecast – May Revision Forecast (Annual & Quarterly), April 2023 (web link: *https://view.officeapps.live.com/op/view.aspx?src=https://dof.ca.gov/wp-content/uploads/sites/352/Forecasting/Economics/Documents/United-States-Economic-Forecast-MR-2023-24-Flat-with-cpi.xlsx*).

[267] California Department of Finance, California Economic Forecast – May Revision Forecast (Annual & Quarterly), April 2023 (web link: *https://view.officeapps.live.com/op/view.aspx?src=https://dof.ca.gov/wp-content/uploads/sites/352/Forecasting/Economics/Documents/California-Economic-Forecast-MR-2023-24.xlsx&wdOrigin=BROWSELINK*).

[268] California Department of Finance, United States-California Inflation Forecast: May Revision Forecast (by calendar year), April 2023 (web link: *https://view.officeapps.live.com/op/view.aspx?src=https://dof.ca.gov/wp-content/uploads/sites/352/Forecasting/Economics/Documents/US-CA-Inflation-Forecast-MR-2023-24.xlsx&wdOrigin=BROWSELINK*).

A policy variable used in REMI to model the impacts of the Proposed Regulation has been added to account for transitional and workforce development costs as detailed in Chapter VIII, Section B.10.

The REMI model cannot directly estimate the creation or elimination of businesses. However, changes in jobs and output for the California economy described below can be used to understand some potential impacts. The overall jobs and output impacts of the Proposed Regulation are small relative to the total California economy, representing changes of no greater than 0.02 percent (Table 32). However, impacts to some specific industries are relatively larger than this. As shown below, the industrial equipment repair industry is estimated to see negative impacts, as ZEFs become a greater portion of the fleet. This trend would suggest that the number of businesses providing those services may decrease along with the reduced demand.

Table 32. Change in Output by Major Sector

Year	2026	2029	2032	2035	2038	2041	2043
% Change	0.00%	0.00%	-0.01%	0.00%	0.02%	0.00%	0.02%
Change in Output (Million 2021$)	-52	-224	-896	189	1,077	149	1,846
Natural Resources	0	-2	-11	-14	-17	-15	-7
Construction	3	1	-84	80	257	179	372
Manufacturing	3	-52	-249	-341	-407	-343	-128
Retail and Wholesale	-41	-75	-156	256	543	29	431
Transportation and Public Utilities	0	9	10	97	180	170	254
Finance, Insurance and Real Estate	1	-25	-109	38	163	127	352
Services	5	-47	-214	19	213	110	527
Commercial and Industrial Equipment Repair	0	-9	-30	-55	-80	-81	-80
Government	-23	-31	-84	54	144	-107	44
Farm	0	0	0	0	0	0	0

Additionally, the decreasing trend in demand for propane and gasoline has the potential to result in the elimination of businesses downstream of refineries, such as propane wholesalers and merchants, if sustained over time, though the overall retail and wholesale sectors are projected to expand.

3. Creation or Elimination of Jobs Within the State of California.

The Proposed Regulation is estimated to result in an initial decrease in employment growth that is less than 0.01 percent of baseline employment and begins to diminish towards the end of the regulatory horizon. Table 33 shows the impacts of the Proposed Regulation on employment in major sectors in California. The job impacts represent the net change in employment across the economy, which is composed of positive impacts for some industries and negative impacts for others. In 2043, the Proposed Regulation is estimated to result in job gains of 8,047, primarily in construction, retail and wholesale, and services, and zero jobs foregone.

Table 33. Job Impacts by Major Sector

Year	2026	2029	2032	2035	2038	2041	2043	Annual Average
% of California baseline change	0.00%	0.00%	-0.01%	0.01%	0.02%	0.01%	0.03%	0.00%
Change in total jobs	-138	-766	-3,400	1,403	5,161	1,980	8,047	633
Jobs gained	72	0	0	1,467	5,175	2,469	8,047	795
Jobs foregone	-210	-766	-3,400	-64	-14	-489	0	-163
Natural resources	1	-3	-23	-21	-14	0	29	-9
Construction	14	-1	-446	417	1,314	880	1,812	377
Manufacturing	12	-5	-170	-43	142	288	666	68
Retail and wholesale	-83	-196	-513	468	1,095	239	1,182	130
Transportation and public utilities	-9	-38	-171	110	347	223	597	82
Finance, insurance, and real estate	0	-64	-260	93	364	248	705	75
Services	45	-299	-1,401	115	1,237	590	2,861	63
Government	-118	-159	-416	264	675	-489	195	-154

4. Expansion of Businesses Currently Doing Business within the State of California.

The potential for business expansion is described above in Chapter VIII, Section D.2, Creation of New Businesses or Elimination of Existing Businesses within the State of California. The potential for business expansion is greatest in industries or sectors that are expected to see an increase in sales (output). As shown in Table 27, businesses in the construction, retail and wholesale, and services may have the largest potential for business expansion, due to the estimated increase output towards the end of the regulatory horizon.

5. Significant Statewide Adverse Economic Impact Directly Affecting Business, Including Ability to Compete

The Executive Officer has made an initial determination that the proposed regulatory action would not have a significant statewide adverse economic impact directly affecting businesses, including the ability of California businesses to compete with businesses in other states, or on representative private persons.

6. Competitive Advantages or Disadvantages for Businesses Currently Doing Business within the State

Staff does not believe the Proposed Regulation would advantage or disadvantage California fleets versus out-of-state fleets. The Proposed Regulation would apply equally to all fleets operating forklifts in California whether they are California businesses or out-of-state businesses. Furthermore, forklifts are not generally transported from one state to another in order to perform work, so staff does not expect that California forklift fleets are competing for work with out-of-state forklift fleets. Although the proposed forklift requirements could make it more expensive in the very short term to operate in California (due to the capital needed to purchase ZEFs), the Proposed Regulation is projected to result in overall net savings for fleets operating within the state.

The rental agencies near the state border could gain a competitive advantage over rental agencies out-of-state with limited ZE offerings. California rental agencies could potentially recapture the business of fleets that have historically rented forklifts from out-of-state rental agencies.

7. Increase or Decrease of Investment in the State

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

The relative changes to growth in private investment for the Proposed Regulation are shown in Table 34, which shows an increase of private investment of about $33 million in 2030, and which trends towards an increase of $563 million by 2043. Overall, there is a cumulative increase of about $1.75 billion for 2026-2043.

Table 34. Change in Gross Domestic Private Investment Growth

Year	Private Investment (2021M$)	% Change	Change (2021M$)
2026	556,685	0.00%	8
2027	568,982	0.01%	48
2028	576,585	0.01%	78
2029	586,935	0.00%	8
2030	596,028	0.01%	33
2031	606,045	-0.01%	-38
2032	616,138	-0.02%	-131
2033	627,268	0.00%	-30
2034	639,942	-0.01%	-77
2035	654,375	0.00%	16
2036	669,265	0.00%	8
2037	684,393	0.01%	56
2038	698,989	0.03%	207
2039	713,677	0.01%	63
2040	728,363	0.03%	222
2041	742,979	0.04%	298
2042	757,550	0.04%	329
2043	772,174	0.07%	563

Year	**Private Investment (2021M$)**	**% Change**	**Change (2021M$)**
Annual Average	655,354	0.01%	92
Cumulative	12,451,727	0.01%	1,755

8. Incentives for Innovation in Products, Materials, or Processes

The Proposed Regulation would provide flexibility to fleets that replace Targeted Class IV and V Forklifts with ZEFs ahead of their phase-out deadlines. Forklifts replaced ahead of compliance deadlines would provide fleet owners with the ability to reduce compliance burden in future years. Furthermore, financial incentive programs are more likely to fund compliance actions that are early or over-and-above what is required. Considering these reasons, staff believes that some fleets could opt to comply ahead of phase-out deadlines to access these incentives as well as to start reaping the operational benefits of ZE technology.

Staff anticipates growth in industries that manufacture or support ZEFs, including ZEF and ZEF-component manufacturers and suppliers, infrastructure installers, electrical powertrain technicians, and others. This growth is, in turn, expected to strengthen the ZEF supply chain, generate greater technology awareness, and foster a greater ZE market. In addition, because the Proposed Regulation would provide a strong signal of California's continued commitment to ZE technology, staff believes it would spur greater private investment, and accelerate technology innovation and market growth.

9. Benefits of the Regulation to the Health and Welfare of California Residents, Worker Safety, and the State's Environment.

Benefits of the Proposed Regulation are discussed above in Chapter IV.

E. Fiscal Impacts

The costs and savings that would be incurred by local and State governments due to the Proposed Regulation are discussed in this section. Local and State government agencies that own Targeted Class IV and Class V Forklifts would incur similar direct costs and savings as a typical fleet, as outlined in Chapter VIII, Section B.12.b. In addition, local and State governments would be impacted by changes in revenue from utility user fees or Energy Resource Fees, sales taxes, gasoline taxes, and use taxes. CARB would also incur costs of staffing to implement and enforce the Proposed Regulation.

Although not further evaluated in this analysis, federal government agencies that own Targeted Class IV and Class V Forklifts would be subject to the Proposed Regulation. Such federal government agencies would face the same types of estimated direct costs and savings as a typical fleet, as outlined in Chapter VIII, Section B.12.b.

1. Fiscal Impacts on Local Government

a) Local Government Fleet Costs

Local governments are expected to incur an incremental cost from the purchase of new forklifts, while also realizing operational savings from the use of ZEFs. State and local government fleets are estimated to make up about three percent of the State's forklift fleet (see Figure 11 in Section B.5 of this Chapter). Assuming the number of forklifts owned by State and local governments is proportional to their share of government employment, it is estimated that 2.2 percent and 0.8 percent of the statewide forklift cost and operational savings resulting from the Proposed Regulation would be realized by local government fleets and State government fleets, respectively.[269]

The Proposed Regulation would have cost impacts on local government agencies that own Targeted Class IV and Class V Forklifts since they would be subject to the same requirements as private businesses operating said forklifts in California. Using DOORS data, staff estimates that local government agencies would be required to replace approximately 1,000 Targeted Class IV and Class V Forklifts over the life of the Proposed Regulation. Local government fleets make up about 2.2 percent of the total affected forklift population in California. Local governments could also be impacted by increased or decreased utility user fees, sales tax revenue, gasoline tax revenue, and use tax revenue.

Specific impacts on individual local government fleets would depend on various factors, including fleet size and forklift age distribution. Table 35 provides a list of the largest five local government LSI forklift fleets based on fleet size (as reported in DOORS).

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[269] Based on REMI Policy Insight Plus (v3.0.0), Local governments' share of State and Local government employment is 77 percent.

Table 35. Largest Local Government LSI Forklift Fleets

Local Government Agency	Number of LSI Forklifts
City of Los Angeles (General Services)	62
City of San Diego	32
East Bay Municipal Utility District	23
City of Sacramento	21
Los Angeles County Sanitation Districts	20

b) Local Sales Tax

Sales taxes are levied in California to fund a variety of programs at the State and local level. The Proposed Regulation would result in the sale of ZEFs with higher upfront costs. The entire population of new ZEFs sold over the entire State was used for this analysis. The average tax rate in California is 8.74 percent with 4.6 percent going to local governments.[270] Overall, State sales tax revenue could increase less than the direct increase from forklift sales if overall spending does not increase.

c) Use Tax on Propane

The use of propane fuel in forklifts is subject to use the tax rate, which is equivalent to the sales tax rate described above.[271] The reduced consumption of propane fuel due to the transition to ZEFs would reduce tax revenues from this source for local governments.

d) Gasoline Fuel Tax

Taxes on gasoline include a 51.1 cents per gallon State excise tax, an 18.4 cents per gallon federal excise tax, and a State and local sales tax that averages 3.7 percent

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[270] California Department of Tax and Fee Administration, California City and County Sales and Use Tax Rates, Rates Effective July 1, 2019 through December 31, 2019, September 22, 2023 (web link: *https://cdtfa.ca.gov/taxes-and-fees/Archive-Rates-07-1-2019-12-31-2019.pdf*).

[271] California Department of Tax and Fee Administration, Laws, Regulations and Annotations: Business Taxes Law Guide – Revision 2023, Sales and Use Tax Annotations, Annotation 275.0175.500 (web link: *https://www.cdtfa.ca.gov/lawguides/vol2/suta/275-0000-all.html#275-0175-500*, last access August 2023).

across California.[272, 273] Approximately 42 percent of the State excise tax is allocated to cities and counties and are used to fund transportation improvements in the State. Displacing gasoline fuel with electricity would decrease the amount of gasoline dispensed in the State, resulting in a reduction in excise tax and sales tax revenue that is collected.

e) 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.[274] By increasing the amount of electricity used, the Proposed Regulation would cause an increase in the amount of the utility user tax revenue collected by cities and counties.

f) Fiscal Impact on Local Government

Table 36 provides the estimated fiscal impacts to local governments from 2026 through 2043 due to the Proposed Regulation. Upfront costs would include the cost of purchasing new ZEFs as well as infrastructure costs for adding forklift battery chargers, facility improvements, and electrical upgrades. Through 2043, the total upfront cost to local governments is estimated to be $109.9 million.

Local governments would also be expected to realize cost savings related to reduced ZEF energy cost, lower ZEF maintenance cost, and revenue from LCFS. In addition, local governments would be impacted by reduced gasoline and use taxes due to reduced usage of gasoline and propane, respectively, and increased sales taxes due to the sale of ZEFs and associated equipment and utility user fees. The estimated net fiscal impact to local governments is estimated to be $15.5 million over the first 3 years of the Proposed Regulation and -$168.9 million through 2043. Annual net total fiscal impact to local governments is estimated to range between a net positive budgetary impact of $49.4 million in 2038, primarily due to increased sales tax revenue, to a net negative budgetary impact of $47.7 million in 2039. A positive net budgetary or fiscal impact results when revenue gains and cost savings exceed revenue losses and costs.

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[272] California Legislative Analyst's Office, Transportation, Frequently Asked Questions, last updated November 2022 (web page: *https://lao.ca.gov/Transportation/FAQs*).

[273] Gasoline is exempt from the portion of State sales tax that supports the State General Fund and 2011 Realignment. Of the 3.7 percent, 1 percent is under State jurisdiction but goes towards various local revenue funds and is therefore included with the impacts to local government.

[274] California State Controller's Office, California Cities - Utility Users Tax Revenue and Rate, *Fiscal Year 2016-2017*, December 2018 (weblink: *https://sco.ca.gov/Files-ARD-Local/LocRep/2016-17%20Cities%20UUT.pdf*).

Accounting for both total upfront costs and total operational costs results in total costs of $157.9 million for local governments from 2026 through 2043. Over that same period, staff estimates total cost-savings of $220.2 million due to operational savings. In terms of tax and fee revenue, the Proposed Regulation would result in increases in Utility User fees revenue and sales tax revenue totaling $167.0 million and in decreases in gasoline tax revenue and use tax revenue totaling $398.1 million. Accounting for all costs and savings, the total fiscal impact is estimated to be a net negative budgetary impact (i.e., a cost) of $168.9 million from 2026 through 2043.

Table 36. Estimated Fiscal Impacts on Local Governments (Million 2021$)[275]

Year	Upfront Costs	Operational Cost	Operational Savings	Utility User Fee Revenue	Sales Tax Revenue	Gasoline Tax Revenue	Use Tax Revenue	Total Fiscal Impact (Revenue - Cost)
2026	-$0.9	$0.0	-$0.1	$0.0	-$8.6	$0.0	-$0.1	-$7.8
2027	-$2.2	$0.0	-$0.2	$0.1	-$9.9	-$0.1	-$0.3	-$7.9
2028	$2.2	$0.5	-$2.1	$0.7	$34.7	-$0.6	-$2.9	$31.2
2029	$1.1	$0.5	-$2.3	$0.8	-$10.5	-$0.6	-$3.3	-$13.1
2030	$3.9	$1.1	-$4.7	$1.5	$20.7	-$1.3	-$6.9	$13.7
2031	$7.8	$1.6	-$6.9	$2.2	$19.7	-$1.9	-$10.1	$7.5
2032	$8.5	$1.7	-$7.5	$2.4	-$6.9	-$2.0	-$11.2	-$20.4
2033	$8.1	$2.3	-$10.5	$3.3	$27.7	-$2.8	-$15.6	$12.7
2034	$8.4	$2.4	-$10.8	$3.4	-$10.2	-$2.9	-$16.1	-$25.9
2035	$12.3	$3.3	-$14.5	$4.7	$49.0	-$3.9	-$21.9	$26.7
2036	$8.4	$3.3	-$14.9	$4.7	-$14.1	-$4.0	-$22.5	-$32.8
2037	$7.8	$3.3	-$14.8	$4.7	-$13.6	-$4.0	-$22.8	-$32.0
2038	$14.8	$4.8	-$21.7	$6.8	$79.7	-$5.8	-$33.4	$49.4
2039	$14.3	$4.7	-$21.8	$6.8	-$17.7	-$5.8	-$33.7	-$47.7
2040	$5.8	$4.7	-$21.8	$6.7	-$21.5	-$5.8	-$34.1	-$43.4
2041	$6.0	$4.6	-$21.9	$6.7	-$14.4	-$5.8	-$34.4	-$36.6
2042	$6.1	$4.6	-$21.8	$6.7	-$15.8	-$5.8	-$34.7	-$38.5
2043	-$2.7	$4.6	-$22.0	$6.7	$10.0	-$5.8	-$35.1	-$4.1
Total	**$109.9**	**$48.0**	**-$220.2**	**$68.8**	**$98.2**	**-$59.0**	**-$339.1**	**-$168.9**

[275] Upfront costs include costs such as incremental forklift cost and infrastructure cost. Operational costs include costs such as reporting costs and electricity costs. Operational savings include fuel and maintenance savings.

2. Fiscal Impact on State Government

a) State Government Forklift Fleet Costs

State government is assumed to incur an incremental cost from the purchase of ZEFs, while also realizing operational savings from the use of ZEFs. State and local government fleets are estimated to make up about three percent of the California's affected forklift fleet. Based on this and the State government share of employment it is estimated that State government fleets would realize about 0.8 percent of the statewide ZEF cost and operational savings resulting from the Proposed Regulation.[276]

Specific Impacts on individual State government fleets would depend on various factors, including fleet size and forklift age distribution. Table 37 provides a list of the top five State government LSI forklift fleets based on fleet size (as reported in DOORS). CARB itself currently operates three LSI forklifts.

Table *37*. Largest State-Owned LSI Fleets

State Government Agency	Number of LSI Forklifts
California Department of Transportation	126
California Prison Industry Authority	111
California Department of Forestry	52
General Services Fleet Management	28
California Department of Parks and Recreation	22

b) State Sales Taxes

Sales taxes are levied in California to fund a variety of programs. The Proposed Regulation would result in the sale of ZEF with higher upfront costs. The entire population of new ZEFs sold over the entire State was used for this analysis. California sales tax at 8.74 percent was used in this analysis with 3.94 percent going to the State government. Overall, State sales tax revenue could increase less than the direct increase from vehicle sales if overall business spending does not increase.

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[276] Based on REMI Policy Insight Plus (v 3.0.0), State government's share of State and Local government employment is 23 percent.

c) Use Tax on Propane

The use of propane fuel in forklifts is subject to the use tax rate, which is equivalent to the sales tax rate described above. The reduced consumption of propane fuel due to the transition to ZEF, would reduce tax revenues from this source for State government.

d) Gasoline Taxes

Approximately 58 percent of the 51.1 cents per gallon State excise tax is allocated State funds such as the State Highway Account, State Highway Operation and Protection Program, State Transportation Improvement Program, and the Highway Users' Tax Account. These revenues are used to fund highway projects, prioritized road maintenance and rehabilitation projects, and local street and road projects. As discussed above, displacing gasoline fuel with electricity would decrease the amount of gasoline dispensed in the State, resulting in a reduction in excise tax and sales revenue that is collected.

e) Energy Resource Fee

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

f) Personal Income Tax

As described in Chapter VIII, Section D.1, the REMI model is used to estimate the macroeconomic impacts of the Proposed Regulation on the California economy, including impacts to personal income. Changes in personal income in California may change the amount of revenue the State of California collects in personal income tax. Table 38 shows the estimated change in personal income and personal income tax revenue over the regulatory horizon. The change in personal income tax is estimated based on a statewide average tax rate of about four percent.[277]

Table 38. California State Personal Income Tax Revenue (Million 2021$)

Year	Change in Personal Income	Change in Personal Income tax
2026	$26.6	$1.1
2027	$147.1	$5.9
2028	$194.5	$7.8
2029	-$91.2	-$3.6
2030	$98.7	$3.9
2031	-$209.1	-$8.4
2032	-$456.6	-$18.3
2033	$34.4	$1.4
2034	-$365.0	-$14.6
2035	$37.9	$1.5
2036	-$183.6	-$7.3
2037	-$3.2	-$0.1
2038	$515.7	$20.6
2039	-$354.7	-$14.2
2040	$594.1	$23.8
2041	$629.8	$25.2
2042	$673.4	$26.9
2043	$1,737.3	$69.5
Average	$168.1	$6.7

[277] The statewide average income tax rate varies over time. It averaged about four percent over the period of 2015-2022 based on historical personal income data. Specifically, statewide average income tax rate was calculated by dividing annual personal income tax revenue projections obtained from the May Revision of the California Governor's Proposed Budget for fiscal years 2017-2018 through 2023-2024, which are available through *https://ebudget.ca.gov/*, last accessed October 2023, and dividing by total personal income provided in the California Economic Forecast spreadsheet prepared by the California Department of Finance (web link: *https://dof.ca.gov/wp-content/uploads/sites/352/Forecasting/Economics/Documents/California-Economic-Forecast-MR-2023-24.xlsx*); the California Economic Forecast spreadsheet is also available through the Department of Finance's Economic Forecasts webpage at *https://dof.ca.gov/forecasting/Economics/economic-forecasts-u-s-and-california/*, last accessed October 2023).

g) CARB Staffing and Resources

To implement and enforce the Proposed Regulation, CARB would require 17 permanent staff positions. Staffing needs were estimated based on staff's experience implementing and enforcing the LSI Fleet Regulation[278] and the Off-Road Diesel Regulation[279]. CARB's staffing needs would be as follows:

- One new section consisting of one Air Resources Supervisor I, two Air Resources Engineer (ARE), three Air Pollution Specialist (APS), and one Air Resources Technician II (ART II) positions beginning in FY 2024-2025 would be needed to implement requirements of the Proposed Regulation. Staff in this new section would provide compliance assistance to affected stakeholders and conduct outreach and training activities for fleet operators, equipment dealers, rental agencies, and government agencies affected by the Proposed Regulation. In particular, the positions would be needed to identify and engage with the thousands of smaller forklift fleets in the State that are not subject to current CARB regulations affecting forklifts. Staff in this section would also develop procedures and applicable forms for extension applications and process said applications when they are received, maintain CARB's website for the Proposed Regulation to ensure all information and materials about the Proposed Regulation are up-to-date and easily accessible, and coordinate with enforcement staff on fleet audits.
- One ARE position beginning in FY2024-2025 would be needed to develop reporting database queries and analyze and evaluate reported fleet data.
- One APS and four ART II positions beginning in FY2024-2025 would be needed to answer calls and emails from stakeholders, provide technical assistance, verify annual compliance reporting requirements, and assist in the development and maintenance of the updated CARB online reporting system.
- Three APS positions beginning in FY 2024-2025 would be needed to conduct enforcement activities, including inspections, audits, issuing and processing citations, and other related activities.
- One Attorney III position beginning in FY 2024-2025 would be needed to advise program staff on issues that arise during implementation of the Proposed Regulation; advise enforcement staff on enforcement issues and litigation; provide legal counsel to and represent CARB during litigation or

[278] Title 13, California Code of Regulations, Sections 2775, 2775.1, and 2775.2.
[279] Title 13, California Code of Regulations, Sections 2449, 2449.1 2449.2, and 2449.3.

other administrative actions; and provide legal support for any future regulatory amendments to the Proposed Regulation.

Table 39 shows the total number of additional positions and estimated cost per position.

Table 39. CARB Staff Needed to Implement and Enforce the Proposed Regulation and Project Staffing Cost (2021$)

Staff Position	Number of Staff	Initial Budget Year Cost (Annual Salary Plus Benefits per Position)	Total Initial Budget Year Cost	Ongoing Cost (Annual Salary Plus Benefits per Position)	Total Ongoing Cost
Air Resources Supervisor I	1	$256,000	$256,000	$255,000	$255,000
Air Resources Engineer	3	$220,000	$660,000	$219,000	$657,000
Air Pollution Specialist	7	$211,000	$1,477,000	$210,000	$1,470,000
Air Resources Technician II	5	$105,000	$525,000	$104,000	$520,000
Attorney III	1	$251,000	$251,000	$250,000	$250,000
Total	**17**	**-**	**$3,169,000**	**-**	**$3,152,000**

h) Fiscal Impacts on State Government

State government fleets would be expected to incur the same types of upfront and ongoing operating costs as other fleets discussed in this analysis. They would also be expected to realize cost savings related to reduced energy costs, lower forklift maintenance cost, and revenue from LCFS credit. Further, the State government would also be impacted by increased or reduced revenue from sales taxes, Energy Resource Fees, gasoline taxes, and use taxes.

Table 40 presents estimated fiscal impacts of the Proposed Regulation to the State government from 2024 through 2043. Annual net total fiscal impact to the State government is estimated to range between a net positive budgetary impact of $7.2 million in 2030, primarily due to increased sales tax revenue, to a net negative budgetary impact of $49.3 million in 2040. Through 2043, the cumulative total upfront cost to the State government is estimated to be $32.8 million.

Accounting for total upfront costs, total operational costs, and total CARB staffing costs results in total costs of $108.6 million for State government from 2024 through 2043. Over that same period, staff estimates total cost-savings of $65.7 million due to operational savings. In terms of tax and fee revenue, the Proposed Regulation would result in increases in sales tax revenue and Energy Resource Fee revenue totaling $83.9 million and in decreases in gasoline tax revenue and use tax revenue totaling $321.8 million. Accounting for all costs and savings, the cumulative total fiscal impact is estimated to be a net negative budgetary impact of $159.7 million from 2024 through 2043.

Table 40. Fiscal Impacts on State Government (Million 2021$)

Year	Upfront Costs	Operational Cost	Operational Savings	CARB Staffing Cost	Sales Tax Revenue	Energy Resource Fee	Gasoline Tax Revenue	Use Tax (propane)	Personal Income Tax Revenue	Total Fiscal Impact (Revenue - Cost)
2024	$0.0	$0.0	$0.0	$1.6	$0.0	$0.0	$0.0	$0.0	$0.0	-$1.6
2025	$0.0	$0.0	$0.0	$3.2	$0.0	$0.0	$0.0	$0.0	$0.0	-$3.2
2026	-$0.3	$0.0	$0.0	$3.2	-$7.0	$0.0	$0.0	-$0.1	$1.1	-$9.0
2027	-$0.7	$0.0	-$0.1	$3.2	-$8.2	$0.0	-$0.1	-$0.2	$5.9	-$5.0
2028	$0.7	$0.1	-$0.6	$3.2	$28.5	$0.0	-$0.4	-$2.4	$7.8	$30.1
2029	$0.3	$0.2	-$0.7	$3.2	-$8.7	$0.0	-$0.5	-$2.7	-$3.6	-$18.4
2030	$1.2	$0.3	-$1.4	$3.2	$17.0	$0.1	-$1.0	-$5.7	$3.9	$11.1
2031	$2.3	$0.5	-$2.1	$3.2	$16.2	$0.1	-$1.4	-$8.3	-$8.4	-$5.6
2032	$2.5	$0.5	-$2.2	$3.2	-$5.7	$0.1	-$1.5	-$9.2	-$18.3	-$38.4
2033	$2.4	$0.7	-$3.1	$3.2	$22.7	$0.2	-$2.1	-$12.8	$1.4	$6.2
2034	$2.5	$0.7	-$3.2	$3.2	-$8.4	$0.2	-$2.1	-$13.2	-$14.6	-$41.4
2035	$3.7	$1.0	-$4.3	$3.2	$40.2	$0.2	-$2.9	-$17.9	$1.5	$17.6
2036	$2.5	$1.0	-$4.4	$3.2	-$11.6	$0.2	-$2.9	-$18.5	-$7.3	-$42.3
2037	$2.3	$1.0	-$4.4	$3.2	-$11.2	$0.2	-$2.9	-$18.7	-$0.1	-$34.8
2038	$4.4	$1.4	-$6.5	$3.2	$65.4	$0.3	-$4.3	-$27.4	$20.6	$52.2
2039	$4.3	$1.4	-$6.5	$3.2	-$14.6	$0.3	-$4.3	-$27.7	-$14.2	-$62.7
2040	$1.7	$1.4	-$6.5	$3.2	-$17.6	$0.3	-$4.3	-$28.0	$23.8	-$25.5
2041	$1.8	$1.4	-$6.5	$3.2	-$11.8	$0.3	-$4.3	-$28.2	$25.2	-$18.5
2042	$1.8	$1.4	-$6.5	$3.2	-$13.0	$0.3	-$4.3	-$28.5	$26.9	-$18.3
2043	-$0.8	$1.4	-$6.6	$3.2	$8.2	$0.3	-$4.3	-$28.8	$69.5	$47.8
Total	**$32.8**	**$14.3**	**-$65.7**	**$61.5**	**$80.6**	**$3.3**	**-$43.4**	**-$278.4**	**$121.0**	**-$159.7**

F. Sensitivity Analyses

1. No LCFS Credit

This section presents the direct costs and macroeconomic impacts under a scenario where LCFS credits are not a component of cost-savings available to fleets. As mentioned in Chapter I, Section D, staff is concurrently considering adjustments to the LCFS program,[280] which could impact crediting for forklifts in the future. As such, staff performed this sensitivity analysis to evaluate the economic impacts of the Proposed Regulation without the availability of LCFS credits. This sensitivity analysis provides a lower bound on the potential LCFS credit revenue available to forklift operators if future adjustments to the LCFS program decrease the number of credits generated by forklifts or if the LCFS credit price in future years is lower than what was described in Chapter VIII, Section B.9.c.

a) Statewide Direct Cost

Table 41 compares the cost and savings of the Proposed Regulation with and without the inclusion of LCFS credits. If anticipated revenue from LCFS credit is not included in the cost analysis, the estimated statewide savings of the Proposed Regulation would be $515.4 million less than if LCFS revenue is included. Without LCFS revenue, net cost savings of the Proposed Regulation would be approximately $2.2 billion instead of $2.7 billion.

Table 41. Impact of LCFS Credits on Statewide Direct Cost of the Proposed Regulation (Million 2021$)

LCFS Savings	Total Cost	Total Savings	Net Costs
Included	$7,704.8	-$10,420.2	-$2,715.4
Not Included	$7,704.8	-$9,904.8	-$2,200.0
Net Change	$0.00	$515.4	$515.4

[280] California Air Resources Board, Low Carbon Fuel Standard 2023 Amendments, Standardized Regulatory Impact Assessment, September 8, 2023 (web link: *https://dof.ca.gov/wp-content/uploads/sites/352/2023/09/LCFS-SRIA-to-DOF-ADA-Compliant.pdf*).

b) Typical Fleet

Table 42 compares the cost and savings to a typical fleet of the Proposed Regulation with and without the inclusion of LCFS credits. If anticipated revenue from LCFS credit is not included in the cost analysis, the estimated savings to a typical fleet under the Proposed Regulation would be $926,290 less than if LCFS revenue is included. Without LCFS revenue, net cost savings to a typical fleet would be approximately $5,079,600 instead of $6,005,890. A typical fleet is described in Chapter VIII, Section B.12.b.

Table 42. Impact of LCFS Credits on Cost Example for Typical Fleet (2021$)

LCFS Savings	Total Cost	Total Savings	Net Costs
Included	$10,312,550	-$16,318,440	-$6,005,890
Not Included	$10,312,550	-$15,392,150	-$5,079,600
Net Change if LCFS Savings Not Included	$0.00	$926,290	$926,290

c) Small Fleet

Table 43 compares the cost and savings to a small fleet of the Proposed Regulation with and without the inclusion of LCFS credits. If anticipated revenue from LCFS credit is not included in the cost analysis, the estimated savings to a small fleet under the Proposed Regulation would be $33,630 less than if LCFS revenue is included. Without LCFS revenue, net cost to a small fleet would be approximately $8,840 instead of cost savings of $24,790. A small fleet is described in Chapter VIII, Section B.12.a.

Table 43. Impact of LCFS Credits on Cost Example for Small Fleet (2021$)

LCFS Savings	Total Cost	Total Savings	Net Costs
Included	$615,690	-$640,480	-$24,790
Not Included	$615,690	-$606,850	$8,840
Net Change	$0.00	$33,630	$33,630

d) Macroeconomic Impacts

Table 44 shows the summary of economic impacts of the Proposed Regulation without the availability of LCFS credits. The results generally show a slightly more negative impacts to employment and output relative to the Proposed Regulation due to the lack of LCFS credit revenue to fleets, without which they incur higher production costs.

Table 44. Summary of Economic Impacts for the Proposed Regulation without LCFS Credits

	GSP		Personal Income		Employment		Output		Private Investment	
Year	% Δ	Δ (2021M$)	% Δ	Δ (2021M$)	% Δ	Δ Jobs	% Δ	Δ (2021M$)	% Δ	Δ (2021M$)
2026	0.00%	-32	0.00%	27	0.00%	-139	0.00%	-52	0.00%	8
2027	0.00%	54	0.00%	148	0.00%	593	0.00%	95	0.01%	48
2028	0.01%	420	0.01%	203	0.01%	2,905	0.01%	678	0.01%	79
2029	0.00%	-125	0.00%	-81	0.00%	-780	0.00%	-225	0.00%	10
2030	0.01%	204	0.00%	119	0.01%	1,448	0.00%	288	0.01%	36
2031	0.00%	-53	-0.01%	-181	0.00%	-483	0.00%	-161	-0.01%	-35
2032	-0.01%	-500	-0.01%	-429	-0.01%	-3,450	-0.01%	-904	-0.02%	-128
2033	0.00%	67	0.00%	71	0.00%	456	0.00%	-11	0.00%	-26
2034	-0.01%	-482	-0.01%	-326	-0.01%	-3,067	-0.01%	-905	-0.01%	-75
2035	0.00%	204	0.00%	82	0.00%	1,289	0.00%	168	0.00%	18
2036	-0.01%	-406	0.00%	-138	-0.01%	-2,284	-0.01%	-818	0.00%	9
2037	-0.01%	-277	0.00%	38	-0.01%	-1,377	-0.01%	-606	0.01%	55
2038	0.02%	776	0.01%	570	0.02%	4,994	0.01%	1,045	0.03%	205
2039	-0.01%	-557	-0.01%	-298	-0.01%	-3,061	-0.02%	-1,131	0.01%	60
2040	0.00%	15	0.01%	644	0.00%	833	0.00%	-183	0.03%	218
2041	0.00%	187	0.02%	681	0.01%	1,807	0.00%	114	0.04%	293
2042	0.01%	249	0.02%	719	0.01%	2,126	0.00%	226	0.04%	323
2043	0.03%	1,198	0.04%	1,785	0.03%	7,888	0.02%	1,813	0.07%	556
Average Annual	0.00%	52	0.00%	202	0.00%	539	0.00%	-32	0.01%	92

2. Higher Electrical Rate for a Typical Fleet

Individual fleets may be subject to electrical rates that are higher or lower than the estimated statewide average electrical rate. This section presents the direct costs for a typical fleet under a hypothetical scenario in which electrical rates are doubled relative to the estimated statewide average electrical rate discussed in Chapter VIII, Section B.9.a.

Table 45 compares the cost and savings of the Proposed Regulation with and without the higher electrical rate, and with the inclusion of LCFS credits. If the higher electrical rate is included in the cost analysis, the estimated savings of the Proposed Regulation for a typical fleet would be reduced by $3.3 million. With the higher electrical rate, the net cost savings of the Proposed Regulation would be approximately $2.7 million instead of $6.0 million. Similar to Table 45, the total savings and net costs of the Proposed Regulation with and without the higher electrical rate are provided in Table 46, but without the inclusion of LCFS credits.

Table 45. Impact of Higher Electrical Rate (with LCFS Credits) on Cost Example for Typical Fleet (2021$)

Higher Electrical Rate Cost	Total Cost	Total Savings	Net Costs
Higher Electrical Rate Cost Included	$13,621,790	-$16,318,440	-$2,696,650
Higher Electrical Rate Cost Not Included	$10,312,550	-$16,318,440	-$6,005,890
Net Change Due to Higher Electrical Rate Cost	$3,309,240	$0.00	$3,309,240

Table 46. Impact of Higher Electrical Rate (Without LCFS Credits) on Cost Example for Typical Fleet (2021$)

Higher Electrical Rate Cost	Total Cost Without LCFS Credits	Total Savings Without LCFS Credits	Net Costs Without LCFS Credits
Higher Electrical Rate Cost Included	$13,621,790	-$15,392,150	-$1,770,360
Higher Electrical Rate Cost Not Included	$10,312,550	-$15,392,150	-$5,079,600
Net Change Due to Higher Electrical Rate Cost	$3,309,240	$926,290	$4,235,530

3. Higher Infrastructure Costs for a Typical Fleet

Individual fleets may be subject to infrastructure costs that are significantly higher or lower than the estimated statewide average infrastructure costs. This section presents the direct costs under a hypothetical scenario in which infrastructure costs for a typical fleet are twice that discussed in Chapter VIII, Section B.8.b.

Table 47 compares the cost and savings of the Proposed Regulation with and without higher infrastructure costs, and with the inclusion of LCFS credits. If higher infrastructure costs are included in the cost analysis, the estimated savings of the Proposed Regulation for a typical fleet would be $447,090 less than without the higher infrastructure cost. With higher infrastructure costs, the net cost savings of the Proposed Regulation would be approximately $5.6 million instead of $6.0 million. Similar to Table 47, the total savings and net costs of the Proposed Regulation with and without higher infrastructure costs are provided in Table 48, but without the inclusion of LCFS credits.

Table 47. Impact of Higher Infrastructure Costs (with LCFS Credits) on Cost Example for Typical Fleet (2021$)

Higher Infrastructure Costs	Total Cost (With LCFS Credits)	Total Savings (With LCFS Credits)	Net Costs (With LCFS Credits)
Higher Infrastructure Costs Included	$10,759,640	-$16,318,440	-$5,558,800
Higher Infrastructure Costs Not Included	$10,312,550	-$16,318,440	-$6,005,890
Net Change due to Higher Infrastructure Costs	$447,090	$0.00	$447,090

Table 48. Impact of Higher Infrastructure Costs (Without LCFS Credits) on Cost Example for Typical Fleet (2021$)

Higher Infrastructure Costs	Total Cost (Without LCFS Credits)	Total Savings (Without LCFS Credits)	Net Costs (Without LCFS Credits)
Higher Infrastructure Costs Included	$10,759,640	-$15,392,150	-$4,632,510
Higher Infrastructure Costs Not Included	$10,312,550	-$15,392,150	-$5,079,600
Net Change due to Higher Infrastructure Costs	$447,090	$926,290	$1,373,380

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 proposal. 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 Board has not identified any reasonable alternatives that would lessen any adverse impact on small business.

Staff considered two primary alternatives to the Proposed Regulation: Alternative 1 (the more stringent alternative discussed in more detail in Chapter IX, Section A, below), which would accelerate the phase-out of both Targeted Class IV Forklifts and Targeted Class V Forklifts; and Alternative 2 (the less stringent alternative discussed in more detail in IX.B. below), which would apply only to Targeted Class IV and Class V Forklifts with a lift capacity of 8,000 pounds or less. Table 49 provides annual criteria emissions reduction benefits of these alternatives and staff's proposal, when compared to baseline. Staff's proposal is estimated to achieve 72 percent of the NOx, 73 percent of the PM2.5, and 73 percent of the ROG benefits as the more stringent alternative. When compared to the less stringent alternative, staff's proposal is estimated to achieve 1.9 times the NOx, 1.4 times the PM2.5, and 1.5 times the ROG emissions reduction benefits. Table 50 shows the valuation of the health benefits attributed to the criteria-pollutant emissions reductions. The total statewide valuation of health benefits of the less stringent alternative is $4.7 billion, and the more stringent alternative is about $10.2 billion.

Table 49. Criteria Pollutant Reduction Comparisons to Baseline for Alternative 1 (More Stringent), Staff's Proposal, and Alternative 2 (Less Stringent)

Year	Alt. 1 NOx (tpd)	Proposal NOx (tpd)	Alt. 2 NOx (tpd)	Alt. 1 PM2.5 (tpd)	Proposal PM2.5 (tpd)	Alt. 2 PM2.5 (tpd)	Alt. 1 ROG (tpd)	Proposal ROG (tpd)	Alt. 2 ROG (tpd)
2026	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2027	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2028	1.2	0.9	0.2	0.1	0.0	0.0	0.3	0.2	0.1
2029	1.1	0.6	0.0	0.1	0.0	0.0	0.3	0.1	0.1
2030	3.9	1.9	0.8	0.3	0.1	0.1	1.0	0.4	0.2
2031	4.0	2.0	0.8	0.4	0.2	0.1	1.1	0.5	0.3
2032	5.7	1.9	0.8	0.6	0.2	0.1	1.4	0.5	0.3
2033	5.6	2.5	1.1	0.6	0.3	0.2	1.4	0.7	0.4

Year	Alt. 1 NOx (tpd)	Proposal NOx (tpd)	Alt. 2 NOx (tpd)	Alt. 1 PM2.5 (tpd)	Proposal PM2.5 (tpd)	Alt. 2 PM2.5 (tpd)	Alt. 1 ROG (tpd)	Proposal ROG (tpd)	Alt. 2 ROG (tpd)
2034	5.4	2.4	1.1	0.6	0.3	0.2	1.4	0.7	0.4
2035	5.3	3.4	2.0	0.6	0.4	0.3	1.4	1.0	0.7
2036	5.1	3.3	1.9	0.6	0.4	0.3	1.4	1.0	0.7
2037	5.0	3.3	1.8	0.6	0.4	0.3	1.3	0.9	0.6
2038	4.9	4.9	2.8	0.6	0.6	0.4	1.3	1.3	0.9
2039	4.9	4.9	2.8	0.6	0.6	0.4	1.3	1.3	0.9
2040	4.8	4.8	2.8	0.6	0.6	0.4	1.3	1.3	0.9
2041	4.9	4.9	2.8	0.6	0.6	0.4	1.3	1.3	0.9
2042	4.8	4.8	2.7	0.6	0.6	0.4	1.2	1.2	0.9
2043	4.8	4.8	2.7	0.6	0.6	0.4	1.2	1.2	0.9
Total[281]	**25,992**	**18,724**	**9,941**	**2,856**	**2,075**	**1,440**	**6,802**	**4,973**	**3,367**

Table 50. Health Benefits Comparisons to Baseline for the Staff Proposal (Million 2021$), Alternative 1 (More Stringent) and Alternative 2 (Less Stringent)

Year	Alternative 1 (More Stringent)	Proposal	Alternative. 2 (Less Stringent)
2026	$0	$0	$0
2027	$0	$0	$0
2028	$129	$79	$42
2029	$141	$64	$31
2030	$445	$176	$103
2031	$496	$231	$133
2032	$736	$242	$141
2033	$741	$338	$202
2034	$740	$341	$202
2035	$744	$489	$323
2036	$741	$494	$326

[281] The total cumulative emissions reductions for NOx, $PM_{2.5}$ and ROG are converted from tpd into years. Due to rounding errors, the 2026-2043 cumulative totals differ very slightly when compared to the sum values listed.

Year	Alternative 1 (More Stringent)	Proposal	Alternative. 2 (Less Stringent)
2037	$742	$492	$322
2038	$741	$741	$474
2039	$748	$748	$479
2040	$753	$753	$483
2041	$766	$766	$492
2042	$764	$764	$489
2043	$773	$773	$497
Total*	**$10,198**	**$7,492**	**$4,738**

*Totals may not add up due to rounding.

A. Alternative 1: Accelerated Zero-Emission Transition - More Stringent Alternative

Alternative 1 (more stringent) would accelerate the phase-out of both Targeted Class IV Forklifts and Targeted Class V Forklifts. As discussed in the Chapter I, Section C, Summary of Proposed Rulemaking, the Proposed Regulation would phase out Targeted Class IV Forklifts between 2028 and 2038 and Targeted Class V Forklifts between 2030 and 2038. Alternative 1 would phase out both Targeted Class IV and Class V Forklifts between 2028 and 2032. Like the Proposed Regulation, Alternative 1 would phase out said forklifts by MY. Table 51 and Table 52 present the phase-out schedules of Alternative 1 relative to the phase-out schedules of the Proposed Regulation. Note that like the Proposed Regulation, Targeted Class IV Forklifts with a lift capacity greater than 12,000 pounds would be phased out on the final compliance deadline of the applicable phase out schedule, which under this alternative would be January 1, 2032. All other requirements for Alternative 1 would remain the same as the current Proposed Regulation, including recordkeeping, reporting, labeling, and exemptions.

Table 51. Comparison of Class IV Phase-Out Schedules

Compliance Date	Class IV Forklifts in Large Fleets under the Proposed Regulation	Class IV Forklifts in Small and Agricultural Fleets under the Proposed Regulation	Class IV Forklifts in Large Fleets under the Alternative 1	Class IV Forklifts in Small and Agricultural Fleets under Alternative 1
January 1, 2028	2018 MY and Older		2021 MY and Older	
January 1, 2029	---	2016 MY and Older	---	2022 MY and Older
January 1, 2030	---	---	---	---
January 1, 2031	2019 – 2021 MY	---	2022 – 2024 MY	---
January 1, 2032	---	2017 – 2019 MY	2025 MY	2023 – 2025 MY
January 1, 2033	2022 & 2023 MY	---	---	---
January 1, 2034	---	2020 & 2021 MY	---	---
January 1, 2035	2024 & 2025 MY	---	---	---
January 1, 2036	-	2022 & 2023 MY	---	---
January 1, 2037	-	---	---	---

Compliance Date	Class IV Forklifts in Large Fleets under the Proposed Regulation	Class IV Forklifts in Small and Agricultural Fleets under the Proposed Regulation	Class IV Forklifts in Large Fleets under the Alternative 1	Class IV Forklifts in Small and Agricultural Fleets under Alternative 1
January 1, 2038	-	2024 & 2025 MY	---	---

Table 52. Comparison of Class V Phase-Out Schedules

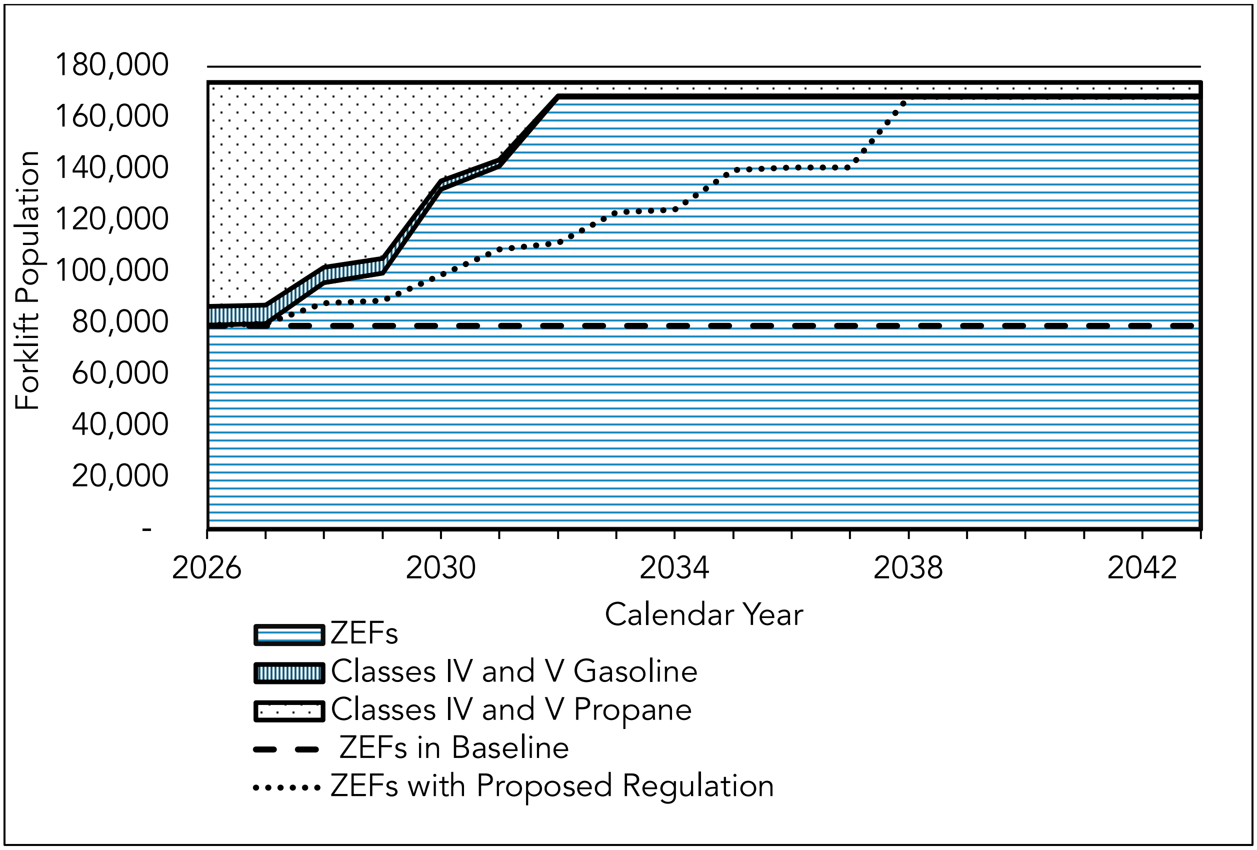
Compliance Date	Class V Forklifts under the Proposed Regulation	Class V Forklifts under Alternative 1
January 1, 2030	2017 MY and Older	2023 MY and Older
January 1, 2031	---	
January 1, 2032	---	2024 and 2025 MY
January 1, 2033	2018 – 2020 MY	---
January 1, 2034	---	---
January 1, 2035	2021 & 2022 MY	---
January 1, 2036	---	---
January 1, 2037	---	---
January 1, 2038	2023 – 2025 MY	---

When compared to the Proposed Regulation, this alternative would result in the same number of Targeted Class IV and Class V LSI forklifts phased out, but over a shorter timeframe. However, the anticipated earlier introduction of ZEFs would result in earlier and greater criteria-emission benefits, including associated health benefits; earlier and greater net cost savings; and earlier and greater climate emission reduction benefits as presented in the following sections.

1. Benefits

Alternative 1 would result in more ZEFs deployed than the Baseline scenario and earlier ZEF deployment than the Proposed Regulation. Alternative 1 would achieve more emission benefits than the Proposed Regulation. Figure 16 illustrates the ZEV population over time with Alternative 1 in comparison to the Baseline scenario and the Proposed Regulation. Alternative 1 would result in roughly 168,000 ZEFs by 2032 and this population would remain constant to 2043. The Proposed Regulation would result in an estimated 111,000 ZEFs by 2032, 141,000 by 2037, 168,000 by 2038, and a continued ZEF population of 168,000 through 2043. Alternative 1 would result in 57,000 more ZEFs by 2032 than the Proposed Regulation. Both Alternative 1 and the Proposed Regulation would result in 168,000 ZEFs by 2043, which represents an increase of 89,000 ZEFs by 2043 in comparison to the Baseline scenario.

Figure 16. Statewide Population Forecast Over Time with Alternative 1



a) Emission Benefits

Table 46 shows the estimated emission reductions that would result from Alternative 1 (more stringent alternative) from 2026 through 2043. Alternative 1 would result in greater cumulative NOx, PM2.5, ROG, and CO_2 emission reductions compared to the Proposed Regulation due to the more accelerated phase-out of Targeted Class IV and Class V Forklifts. The cumulative total TTW emission benefits from the more-stringent Alternative 1 relative to the Baseline scenario would be approximately 25,992 tons of NOx, 2,856 tons of PM2.5, 6,802 tons of ROG, and 12.9 MMT of CO_2 from 2026 to 2043. In comparison, the Proposed Regulation relative to the Baseline scenario would provide approximately 18,724 tons of NOx, 2,075 tons of PM2.5, 4,973 tons of ROG, and 9.4 MMT of CO_2 of emission reductions during the same time period. Alternative 1 would achieve approximately 39 percent more NOx benefits, 38 percent more PM2.5 benefits, 37 percent more ROG benefits, and 37 percent more CO_2 benefits than the Proposed Regulation.

Table 53. Statewide TTW NOx, PM2.5, ROG, and CO_2 Benefits of Alternative 1 Relative to Baseline

Calendar Year	NOx (tpd)	PM2.5 (tpd)	ROG (tpd)	CO_2 (MMT/year)
2026	0	0	0	0
2027	0	0	0	0
2028	1.17	0.10	0.31	0.16
2029	1.06	0.12	0.32	0.21
2030	3.85	0.33	1.02	0.54
2031	3.97	0.39	1.10	0.63
2032	5.67	0.58	1.42	0.95
2033	5.60	0.58	1.40	0.95
2034	5.44	0.57	1.37	0.95
2035	5.32	0.58	1.37	0.95
2036	5.12	0.57	1.36	0.95
2037	5.05	0.57	1.32	0.95
2038	4.89	0.57	1.28	0.95
2039	4.87	0.57	1.28	0.95
2040	4.80	0.57	1.29	0.95
2041	4.85	0.58	1.31	0.95
2042	4.78	0.57	1.24	0.95

Calendar Year	NOx (tpd)	PM2.5 (tpd)	ROG (tpd)	CO_2 (MMT/year)
2043	4.77	0.57	1.24	0.95

Figure 17, Figure 18, Figure 19, Figure 20 illustrate the NOx, PM2.5, ROG, and CO_2 emissions, respectively, under the Baseline scenario, Proposed Regulation, and Alternative 1 scenarios.

Figure 17. Projected Statewide NOx TTW Emissions Under Baseline, Proposed Regulation, and Alternative 1

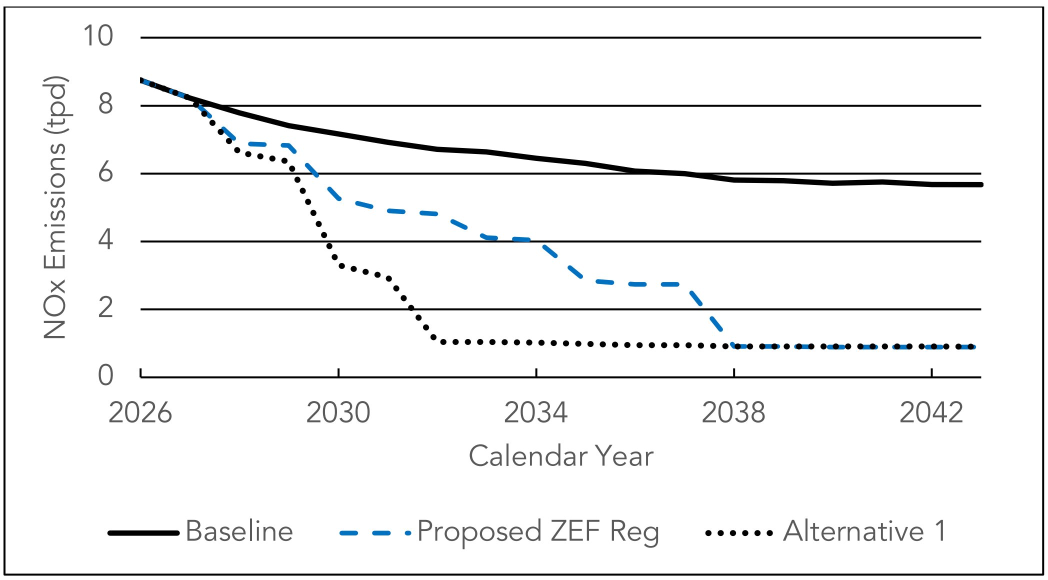


Figure 18. Projected Statewide PM2.5 TTW Emissions Under Baseline, Proposed Regulation, and Alternative 1

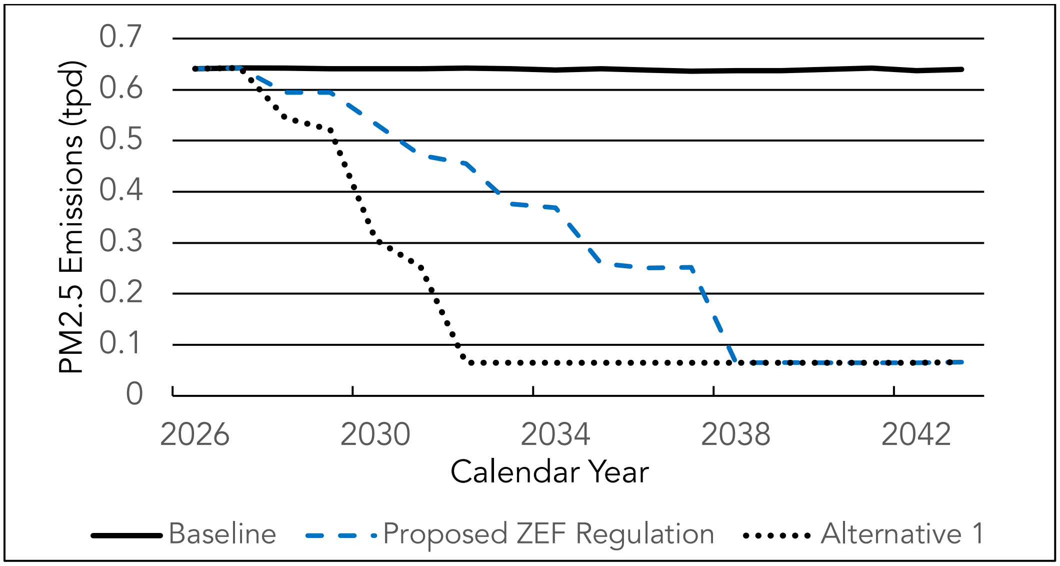


Figure 19. Projected Statewide ROG TTW Emissions Under Baseline, Proposed Regulation, and Alternative 1

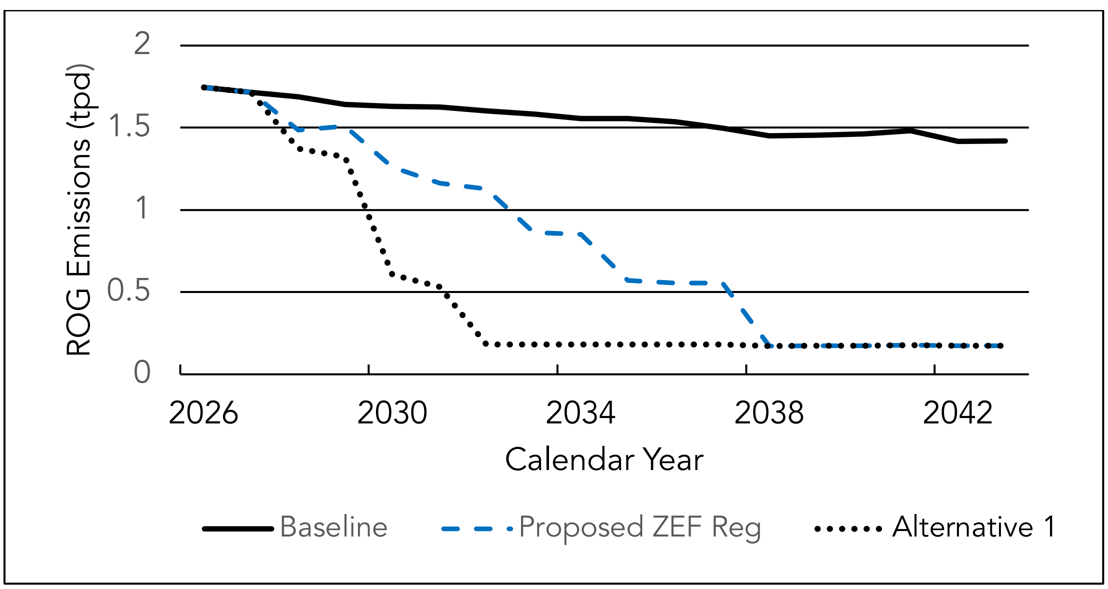
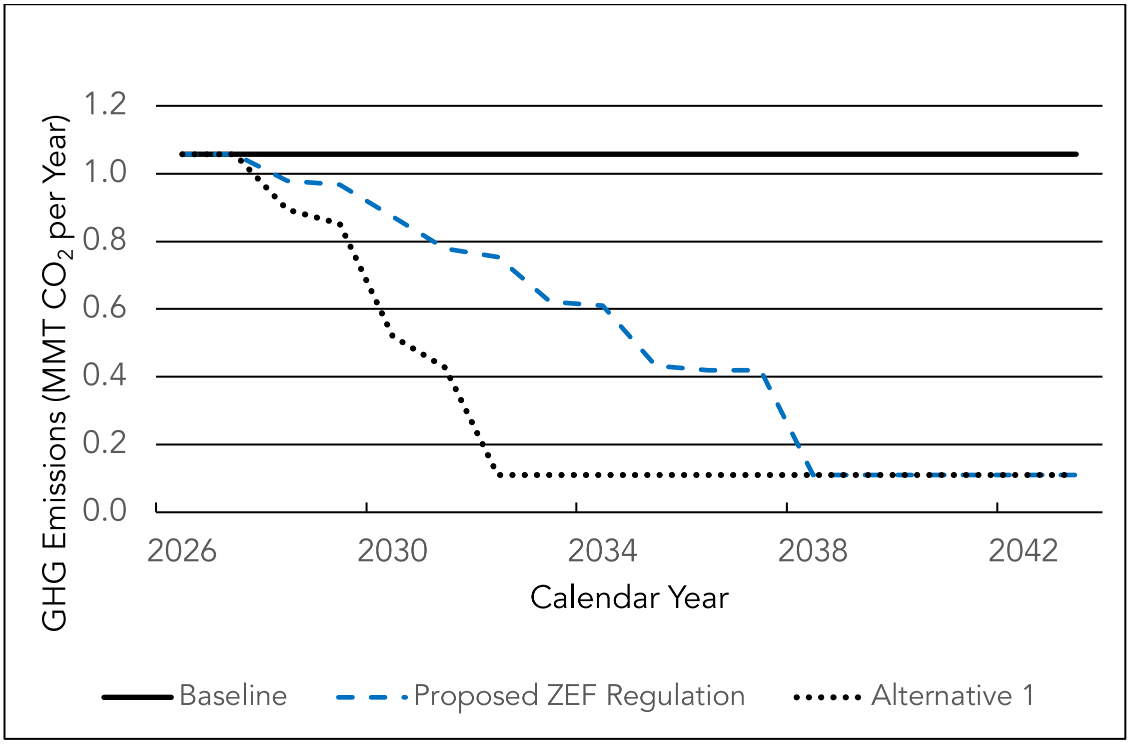


Figure 20. Projected Statewide CO_2 TTW Emissions Under Baseline, Proposed Regulation, and Alternative 1



b) Health Benefits

Staff used the methods described in Chapter IV, Section A to estimate the value of health benefits associated with 12 health outcomes that would be expected to result from implementing Alternative 1 when compared to the Baseline scenario. The avoided mortality and morbidity incidents from 2026 to 2043 of Alternative 1 are presented in Table 54 for each California air basin. As shown in Table 55, Alternative 1 has a 36 percent higher valuation of health benefits at $10.2 billion compared to the Proposed Regulation at $7.5 Billion.

Table 54. Statewide Avoided Mortality and Morbidity Incidents from 2026 to 2043 under the More Stringent Alternative Scenario*

Air Basin**	Cardiopulmonary Mortality	Hospitalizations for Cardiovascular Disease	Cardiovascular ED Visits	Acute Myocardial Infarction	Hospitalizations for Respiratory Disease	Respiratory ED Visits	Lung Cancer Incidence
SC	583 (322 - 832)	121 (88 - 153)	158 (-61 - 369)	66 (24 - 177)	19 (1 - 36)	333 (65 - 693)	43 (13 - 69)
SCC	8 (4 - 12)	2 (1 - 2)	2 (-1 - 4)	1 (0 - 2)	0 (0 - 0)	4 (1 - 9)	1 (0 - 1)
SJV	24 (13 - 34)	5 (3 - 6)	6 (-2 - 13)	2 (1 - 7)	1 (0 - 1)	15 (3 - 32)	1 (0 - 2)
SFB	91 (50 - 130)	20 (14 - 25)	27 (-10 - 63)	12 (4 - 31)	2 (0 - 5)	67 (13 - 140)	9 (3 - 15)
SD	27 (15 - 39)	7 (5 - 9)	7 (-3 - 17)	3 (1 - 8)	1 (0 - 2)	14 (3 - 28)	2 (1 - 4)
SS	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 1)	0 (0 - 0)
SV	8 (5 - 12)	2 (1 - 2)	2 (-1 - 5)	1 (0 - 3)	0 (0 - 0)	5 (1 - 10)	1 (0 - 1)
NP	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
NC	1 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 1)	0 (0 - 0)
NCC	2 (1 - 2)	0 (0 - 0)	0 (0 - 1)	0 (0 - 0)	0 (0 - 0)	1 (0 - 3)	0 (0 - 0)
MC	1 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	1 (0 - 1)	0 (0 - 0)
MD	1 (1 - 2)	0 (0 - 0)	0 (0 - 1)	0 (0 - 0)	0 (0 - 0)	1 (0 - 2)	0 (0 - 0)
LT	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
LC	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
GBV	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Statewide	**746 (412 - 1064)**	**156 (113 - 197)**	**203 (-78 - 474)**	**86 (31 - 228)**	**23 (1 - 45)**	**441 (87 - 918)**	**57 (18 - 93)**

Table 54 -- Continued

Air Basin**	Asthma Onset	Asthma Symptoms	Work Loss Days	Hospitalizations for Alzheimer's Disease	Hospitalizations for Parkinson's Disease
SC	1,307 (1,256 - 1,356)	111,390 (-54,353 - 27,0152)	81,890 (69,066 - 94,228)	289 (222 - 349)	39 (20 - 56)
SCC	20 (20 - 21)	1,785 (-871 - 4,328)	1,220 (1,029 - 1,404)	3 (2 - 3)	1 (0 - 1)
SJV	43 (41 - 45)	3,865 (-1,889 - 9,361)	2,993 (2,525 - 3,443)	11 (8 - 13)	1 (1 - 2)
SFB	320 (308 - 333)	26,749 (-13,031 - 64,975)	18,433 (15,540 - 21,218)	42 (32 - 52)	8 (4 - 12)
SD	65 (62 - 67)	5,429 (-2,645 - 13,185)	4,568 (3,852 - 5,258)	21 (16 - 26)	2 (1 - 3)
SS	1 (1 - 1)	74 (-36 - 180)	56 (47 - 65)	0 (0 - 0)	0 (0 - 0)
SV	18 (17 - 19)	1,534 (-747 - 3726)	1,240 (1,045 - 1,427)	2 (2 - 3)	1 (0 - 1)
NP	0 (0 - 0)	7 (-3 - 16)	4 (4 - 5)	0 (0 - 0)	0 (0 - 0)
NC	1 (1 - 1)	107 (-52 - 259)	84 (71 - 96)	0 (0 - 0)	0 (0 - 0)
NCC	5 (5 - 5)	454 (-221 - 1104)	319 (269 - 367)	1 (0 - 1)	0 (0 - 0)
MC	2 (2 - 2)	200 (-97 - 485)	152 (128 - 175)	0 (0 - 0)	0 (0 - 0)
MD	2 (2 - 3)	214 (-104 - 520)	156 (131 - 179)	1 (0 - 1)	0 (0 - 0)
LT	0 (0 - 0)	1 (0 - 2)	1 (1 - 1)	0 (0 - 0)	0 (0 - 0)
LC	0 (0 - 0)	9 (-4 - 22)	5 (5 - 6)	0 (0 - 0)	0 (0 - 0)
GBV	0 (0 - 0)	7 (-3 - 16)	5 (4 - 5)	0 (0 - 0)	0 (0 - 0)
Statewide	**1,786 (1,716 - 1,853)**	**151,822 (-74,058 - 368,329)**	**111,126 (93,717 - 127,878)**	**370 (283 - 449)**	**52 (27 - 75)**

* Numbers in parentheses throughout this table represent the 95 percent CI.
**List of air basin names in full: Great Basin Valleys, Lake County, Lake Tahoe, Mojave Desert, Mountain Counties, North Central Coast, North Coast, Northeast Plateau, Sacramento Valley, Salton Sea, San Diego County, San Francisco Bay, San Joaquin Valley, South Central Coast, South Coast

Table 55. Valuation of Statewide Health Benefits for Alternative 1

Year	Premature Mortality	HA, Parkinson's Disease	HA, Respiratory-2	HA, Alzheimer's Disease	HA, Cardio-, Cerebro- and Peripheral Vascular Disease	ED visits, All Cardiac Outcomes	ED visits, respiratory	Incidence, Asthma	Asthma Symptoms, Albuterol use	Incidence, Lung Cancer	Acute Myocardial Infarction, Nonfatal	Work Loss Days	Valuation (Million 2021$)
2026	0	0	0	0	0	0	0	0	0	0	0	0	$0
2027	0	0	0	0	0	0	0	0	0	0	0	0	$0
2028	10	1	0	4	2	3	6	25	2,278	1	1	1,535	$79
2029	11	1	0	5	2	3	6	27	2,419	1	1	1,661	$64
2030	34	2	1	16	7	9	20	84	7,368	3	4	5,164	$176
2031	37	2	1	18	7	10	22	92	7,987	3	4	5,711	$231
2032	55	4	2	26	11	15	33	135	11,538	4	6	8,383	$242
2033	55	4	2	27	11	15	33	134	11,404	4	6	8,357	$338
2034	55	4	2	27	11	15	33	132	11,234	4	6	8,260	$341
2035	55	4	2	27	11	15	33	132	11,143	4	6	8,214	$489
2036	54	4	2	27	11	15	32	130	10,967	4	6	8,097	$494
2037	54	4	2	27	11	15	32	129	10,870	4	6	8,040	$492
2038	54	4	2	27	11	15	32	127	10,752	4	6	7,958	$741
2039	54	4	2	27	12	15	32	128	10,756	4	6	7,958	$748
2040	54	4	2	28	12	15	32	127	10,744	4	6	7,940	$753
2041	55	4	2	28	12	15	32	129	10,845	4	6	8,003	$766
2042	54	4	2	28	12	15	32	127	10,734	4	6	7,912	$764
2043	55	4	2	28	12	15	32	128	10,784	4	6	7,937	$773
Total	746	52	23	370	156	203	441	1,786	151,822	57	86	111,126	$10,198

c) Social Cost of Carbon

Table 56 shows the avoided social cost of carbon for Alternative 1, which ranges from $337 million to $1.42 billion through 2043, depending on the discount rate. These benefits are about 35 percent greater than those of the Proposed Regulation due to the higher emission reductions of the Alternative 1.

Table 56. Avoided Social Cost of Carbon for Alternative 1

Year	GHG emission reductions (MMT)	Avoided SC-CO_2 (Million 2021$)		
		5% discount rate	3% discount rate	2.5% discount rate
2026	0.0	$0	$0	$0
2027	0.0	$0	$0	$0
2028	0.2	$3	$11	$16
2029	0.2	$4	$14	$21
2030	0.5	$12	$37	$54
2031	0.6	$14	$44	$64
2032	1.0	$22	$68	$97
2033	1.0	$22	$69	$99
2034	1.0	$23	$70	$100
2035	1.0	$23	$71	$101
2036	1.0	$25	$73	$103
2037	1.0	$25	$74	$105
2038	1.0	$26	$75	$107
2039	1.0	$26	$77	$108
2040	1.0	$27	$78	$109
2041	1.0	$27	$79	$110
2042	1.0	$29	$79	$112
2043	1.0	$29	$81	$113

Year	GHG emission reductions (MMT)	Avoided $SC\text{-}CO_2$ (Million 2021$)		
		5% discount rate	3% discount rate	2.5% discount rate
Total	**12.9**	**$337**	**$1,000**	**$1,418**

2. Costs

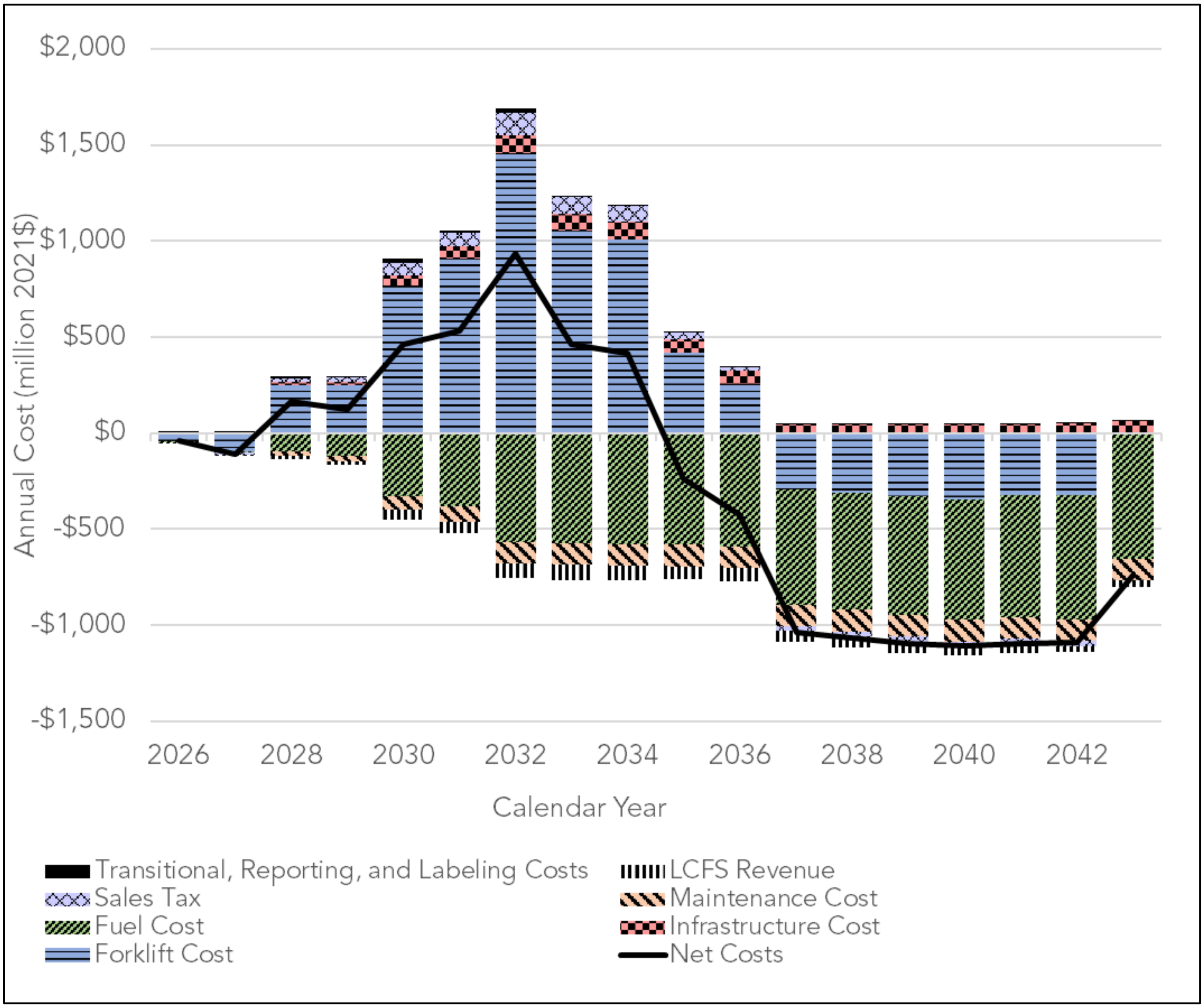
Alternative 1 would require Targeted Class IV and V Forklifts to be phased out up to six years earlier than the Proposed Regulation. The estimated cumulative net cost to the California economy would be approximately -$5.0 billion (i.e., a savings of $5.0 billion) between 2026 and 2043 under Alternative 1 relative to the Baseline Scenario. In comparison, the estimated cumulative net cost of the Proposed Regulation would be approximately -$2.7 billion over the same time period relative to the Baseline scenario. That is, Alternative 1 would provide a greater cumulative net savings (by about $2.3 billion) compared to the Proposed Regulation from 2026 through 2043. However, the cost burden of Alternative 1 from 2026 through 2030 (i.e., the first five years) would also be much greater compared to the Proposed Regulation. Alternative 1 has an estimated cumulative net cost of approximately $593 million from 2026 through 2030 whereas the Proposed Regulation has an estimated cumulative net savings of approximately $116 million over that same time period (a difference of about $709 million).

Table 57 and Figure 21 show the incremental difference in cost between Alternative 1 and the Baseline scenario.

Table 57. Statewide Direct Costs of Alternative 1 (Million 2021$)

Year	Incremental Forklift Cost	Sales Tax	Infrastructure Cost	Transitional, Training, Reporting, and Labeling Costs	Maintenance Cost	Propane and Gasoline Costs	Electricity Costs	Hydrogen Cost	LCFS Credit Revenue	Total Cost	Total Savings	Net Costs
2026	-$44.8	-$3.6	$0.3	$7.9	-$0.4	-$2.4	$0.6	$0.1	-$0.3	$9.0	-$51.6	-$42.6
2027	-$96.6	-$7.8	$1.0	$1.6	-$1.1	-$7.0	$1.9	$0.3	-$0.9	$4.8	-$113.4	-$108.6
2028	$248.2	$19.9	$15.5	$14.5	-$21.6	-$139.4	$37.2	$6.0	-$18.2	$341.2	-$179.2	$162.1
2029	$247.1	$19.9	$20.6	$4.0	-$26.5	-$173.1	$46.1	$6.9	-$21.9	$344.6	-$221.5	$123.1
2030	$770.2	$61.9	$51.0	$27.4	-$68.6	-$464.1	$119.8	$16.7	-$55.2	$1,046.9	-$588.0	$459.0
2031	$907.7	$73.0	$64.2	$8.3	-$78.8	-$537.9	$136.9	$18.1	-$61.5	$1,208.0	-$678.2	$529.9
2032	$1,458.3	$117.2	$92.5	$22.8	-$113.7	-$788.9	$198.8	$24.4	-$77.8	$1,914.0	-$980.4	$933.7
2033	$1,054.6	$84.8	$87.4	$0.9	-$113.7	-$795.9	$200.2	$22.9	-$77.7	$1,450.7	-$987.3	$463.4
2034	$1,009.5	$81.1	$91.6	$0.9	-$113.7	-$801.2	$201.7	$22.0	-$77.7	$1,406.8	-$992.5	$414.3
2035	$416.3	$33.5	$70.6	$0.9	-$113.7	-$806.4	$203.7	$21.3	-$66.7	$746.2	-$986.8	-$240.5
2036	$256.2	$20.6	$66.5	$0.9	-$113.7	-$814.7	$202.0	$21.5	-$66.6	$567.8	-$994.9	-$427.1
2037	-$295.3	-$23.7	$46.8	$0.9	-$113.7	-$821.9	$201.2	$21.8	-$55.6	$270.7	-$1,310.2	-$1,039.5
2038	-$312.7	-$25.1	$46.8	$0.9	-$113.7	-$829.4	$200.1	$21.1	-$55.5	$269.0	-$1,336.4	-$1,067.4
2039	-$329.8	-$26.5	$46.8	$0.9	-$113.7	-$836.5	$198.5	$20.5	-$55.5	$266.7	-$1,361.9	-$1,095.2
2040	-$343.6	-$27.6	$46.8	$0.9	-$113.7	-$844.0	$196.9	$19.8	-$44.4	$264.5	-$1,373.4	-$1,108.9
2041	-$322.7	-$25.9	$47.1	$0.9	-$113.7	-$851.6	$196.0	$19.2	-$44.4	$263.2	-$1,358.2	-$1,095.0
2042	-$324.2	-$26.1	$47.7	$0.9	-$113.7	-$859.0	$195.9	$18.6	-$33.4	$263.2	-$1,356.3	-$1,093.1
2043	$1.4	$0.1	$60.5	$0.9	-$113.7	-$866.9	$195.4	$18.1	-$33.3	$276.4	-$1,013.9	-$737.5
Total	**$4,299.7**	**$345.6**	**$903.7**	**$96.6**	**-$1,560.9**	**-$11,240.3**	**$2,732.7**	**$299.3**	**-$846.7**	**$10,913.6**	**-$15,883.9**	**-$4,970.3**
Present Value	**$3,105.3**	**$249.6**	**$498.9**	**$67.2**	**-$821.9**	**-$5,872.8**	**$1,440.2**	**$161.6**	**-$472.1**	**$6,582.8**	**-$8,226.8**	**-$1,644.0**

Figure 21. Statewide Direct Costs of Alternative 1



3. Cost Effectiveness

Cost-effectiveness is defined as the cost to achieve a ton of emissions reductions. However, like the Proposed Regulation, Alternative 1, has a lower net cost than the Baseline and can be more intuitively evaluated as a benefit-cost ratio. A comparison of this type is an appropriate cost-effectiveness measure if the harm associated with increased emissions is fully captured in the estimates of monetized health impacts. Benefits to California include both health benefits and cost savings after subtracting tax impacts to State and local governments. Table 58 indicates that Alternative 1 has a total cost of $10.9 billion and total benefit of $25.4 billion over the regulatory horizon.

This results in a net benefit of $14.5 billion for Alternative 1 and a Benefit Cost ratio of 2.33, indicating that the benefits are 133 percent greater than the costs. This is compared to a net benefit of $9.7 billion and benefit-cost ratio of 2.26 for the Proposed Regulation.

Table 58. Cost-Effectiveness of the Proposed Regulation and Alternative 1 (Billion 2021$)

Scenario	Total Costs	Cost Savings (benefit)	Health Benefits	Tax and Fee Revenue	Total Benefit	Net Benefit	Benefit-Cost Ratio
Proposed Regulation	$7.7	$10.4	$7.5	-$0.5	$17.5	$9.7	2.26
Alternative 1	$10.9	$15.9	$10.2	-$0.7	$25.4	$14.5	2.33

4. Reason for Rejecting

Although Alternative 1 would achieve greater emission benefits and greater cumulative net savings due to the accelerated turnover of Targeted Class IV and Class V Forklifts to ZEFs, it was rejected for the reasons discussed in this section.

The turnover rate of Targeted Forklifts under Alternative 1 would create a significantly greater cost burden for fleets during the first five years of the regulation. While using ZEFs is expected to result in cost savings over time, the upfront cost of Alternative 1 could be too challenging to overcome for fleets that are more constrained with respect to available capital. As mentioned in Chapter IX, Section A.2, Alternative 1 has an estimated cumulative net cost of approximately $593 million from 2026 through 2030 whereas the Proposed Regulation has an estimated cumulative net savings of approximately $116 million over that same period (a difference of about $709 million). From 2026 to 2043, the estimated upfront costs (forklift purchases, sales tax, and infrastructure installation) for Alternative 1 are $5.5 billion, whereas the estimated upfront costs over the same period for the Proposed Regulation are $5.1 billion. From 2026 to 2043, the present value[282] upfront costs for Alternative 1 and the Proposed Regulation are approximately $3.9 billion and $2.7 billion, respectively. Consequently,

[282] Present value accounts for the time value of money. For the purpose of this analysis, the present value is based on a five percent rate of return.

the present value upfront costs of Alternative 1 are roughly $1.2 billion (or 44 percent) higher than the Proposed Regulation.

In addition, Alternative 1's turnover rate could also pose a challenge for manufacturers to build sufficient numbers of ZEF products in the proposed timeframe. Under the baseline scenario, an estimated 9,250 ZEF and 18,470 LSI Forklift purchases (due to natural turnover) are expected during the first three years of the phase-out schedule. Under Alternative 1, in addition to the estimated 9,250 ZEF purchases needed to maintain the existing ZEF baseline population, 52,280 ZEFs would be purchased within the first three years of the phase-out schedule. By contrast, under the Proposed Regulation, 18,810 ZEFs (surplus to baseline) would be purchased during the same timeframe. Consequently, during the first three years of the phase-out schedule, Alternative 1 would require added purchases of almost three times more ZEFs than the Proposed Regulation and five times more ZEFs than the baseline scenario.

Furthermore, based on stakeholder feedback, manufacturer supply chain delays are responsible for current forklift delivery delays of an additional one to one-and-a-half years, relative to pre-pandemic delivery timelines. Especially for Alternative 1, which has a more-accelerated turnover rate, the anticipated growth in demand for certain components used in ZEFs could exacerbate delays in manufacturing and supply chain disruptions, which could further impact delivery dates of ZEFs. Difficulty in procuring necessary components could also place manufacturers in difficult competitive and financial positions in market segments where they could be required to redesign their products and retool their operations earlier than planned to accommodate parts that are available.

Alternative 1 could increase sales variation from year to year and force manufacturers to follow non-traditional and more-costly production methods, which could increase ZEF prices and impact product quality. Further, Alternative 1 could potentially result in higher prices and price spiking for ZEFs due to the expected higher demand for ZEFs relative to the Proposed Regulation, especially for Class V-replacement ZEFs for which the market is still developing.

Alternative 1 would also put more pressure on the infrastructure build-out needed to support the rapid conversion to EVs, both on- and off-road, and leave little margin for error for electricity generation and distribution planning and development. Currently, growing demand for new service connections and upgrades is already straining resources at electrical utilities in California. A comment cited in the Senate Floor Analyses of SB 410 (Becker, in committee process) states "…the growing backlog of projects…has led to frustrated customers, including affordable housing developers, local governments, and many others."[283] Furthermore, due to increased demand for electrical contractors, infrastructure components, and other related services, Alternative 1 could significantly increase the upfront cost of infrastructure improvements. Coupled with the anticipated higher cost of the ZEFs, themselves, the financial burden that Alternative 1 could impose on California businesses, and small businesses could substantially impair their profitability and competitiveness.

B. Alternative 2: Reduced Lift-Capacity Threshold – Less Stringent Alternative

Alternative 2 (less stringent) would only apply to Targeted Class IV and Class V Forklifts with a lift capacity of 8,000 pounds or less. That is, unlike the Proposed Regulation, Alternative 2 would not require the phase-out of Targeted Class IV and Class V Forklifts with a lift capacity greater than 8,000 pounds. The phase-out schedules for Alternative 2 would be the same as those in the Proposed Regulation for both forklift classes. In addition, all other requirements and provisions in the Proposed Regulation, including reporting, recordkeeping, labeling, and exemptions, would apply. The more limited scope of Alternative 2 would reduce the number of Class IV and Class V forklifts that would need to be phased out and replaced with ZEFs over the regulatory timeframe. While Alternative 2 would result in lower upfront costs, it would also result in lower emission reductions and health benefits than the Proposed Regulation.

1. Benefits

Although Alternative 2 would result in NOx, PM2.5, ROG, and GHG emission benefits relative to the Baseline scenario, the benefits would not be as great as those estimated for the Proposed Regulation. This is because Alternative 2 would be limited to only forklifts up to 8,000 pounds lift capacity, so fewer LSI forklifts would be phased out under the Alternative 2 scenario. Figure 22 illustrates the ZEF population over time under Alternative 2, the Baseline scenario, and the Proposed Regulation. Alternative 2 would result in roughly 143,000 ZEFs by 2038, and this ZEF population would remain constant into 2043. The Proposed Regulation would result in an estimated 168,000 by 2038, and the ZEF population would remain constant into 2043. Alternative 2 would result in about 25,000 less ZEFs by 2038 than the Proposed Regulation and 64,000 more ZEFs than the Baseline scenario.

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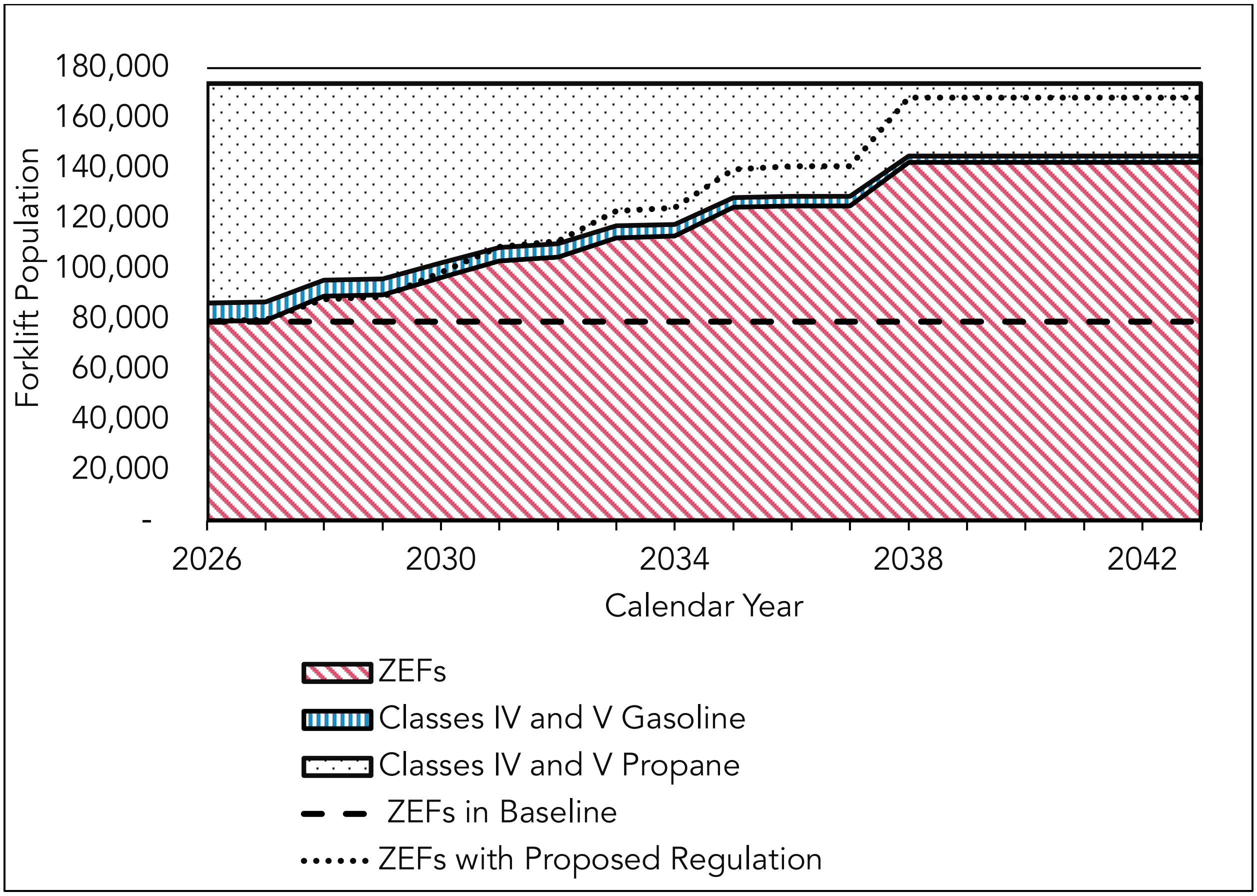
[283] SB 410, Powering Up California, Senate Floor Analyses, May 23, 2023 (web link: *https://leginfo.legislature.ca.gov/faces/billAnalysisClient.xhtml?bill_id=202320240SB410*, last accessed June 2023).

Figure 22. Statewide Population Forecast Under Alternative 2



a) Emission Benefits

Table 59 shows the estimated emission reductions that would result from Alternative 2 (less-stringent alternative) from 2026 through 2043. Alternative 2 would reduce NOx, PM2.5, ROG and CO_2 emissions compared to the Baseline scenario. However, Alternative 2 would result in reduced emission benefits compared to the Proposed Regulation due to fewer Class IV and Class V affected forklifts being phased out. As such, Alternative 2 would be less effective than the Proposed Regulation at meeting California's SIP obligations and GHG reduction goals.

The cumulative total TTW emission benefits from the less-stringent alternative relative to the Baseline scenario accounts for approximately 9,941 tons of NOx, 1,440 tons of PM2.5, 3,367 tons of ROG, and 6.1 MMT of CO2 from 2026 to 2043. In comparison, the Proposed Regulation relative to the Baseline scenario would provide approximately 18,724 tons of NOx, 2,075 tons of PM2.5, 4,973 tons of ROG, and 9.4

MMT of CO_2 of emission reductions during the same time period. Alternative 2 would achieve approximately 47 percent less NOx benefits, 31 percent less PM2.5 benefits, 32 percent less ROG benefits, and 35 percent less CO_2 benefits than the Proposed Regulation.

Table 59. Statewide TTW NOx, PM2.5, ROG, and CO_2 Benefits of Alternative 2 Relative to Baseline

Calendar Year	NOx (tpd)	PM2.5 (tpd)	ROG (tpd)	CO_2 (MMT/year)
2026	0.00	0.00	0.00	0.00
2027	0.00	0.00	0.00	0.00
2028	0.24	0.04	0.11	0.07
2029	0.05	0.04	0.05	0.08
2030	0.83	0.08	0.22	0.14
2031	0.81	0.12	0.26	0.19
2032	0.76	0.13	0.27	0.20
2033	1.13	0.18	0.44	0.28
2034	1.06	0.19	0.42	0.29
2035	1.98	0.27	0.67	0.41
2036	1.92	0.27	0.67	0.42
2037	1.85	0.27	0.64	0.42
2038	2.80	0.39	0.91	0.59
2039	2.78	0.39	0.91	0.59
2040	2.76	0.39	0.92	0.59
2041	2.79	0.39	0.94	0.59
2042	2.73	0.39	0.89	0.59
2043	2.74	0.39	0.89	0.59

Figures 23 through 26 illustrate the NOx, PM2.5, ROG, and CO_2 emissions, respectively, under the Baseline, Proposed Regulation, and Alternative 2 scenarios.

Figure 23. Projected Statewide NOx TTW Emissions Under Baseline, Proposed Regulation, and Alternative 2

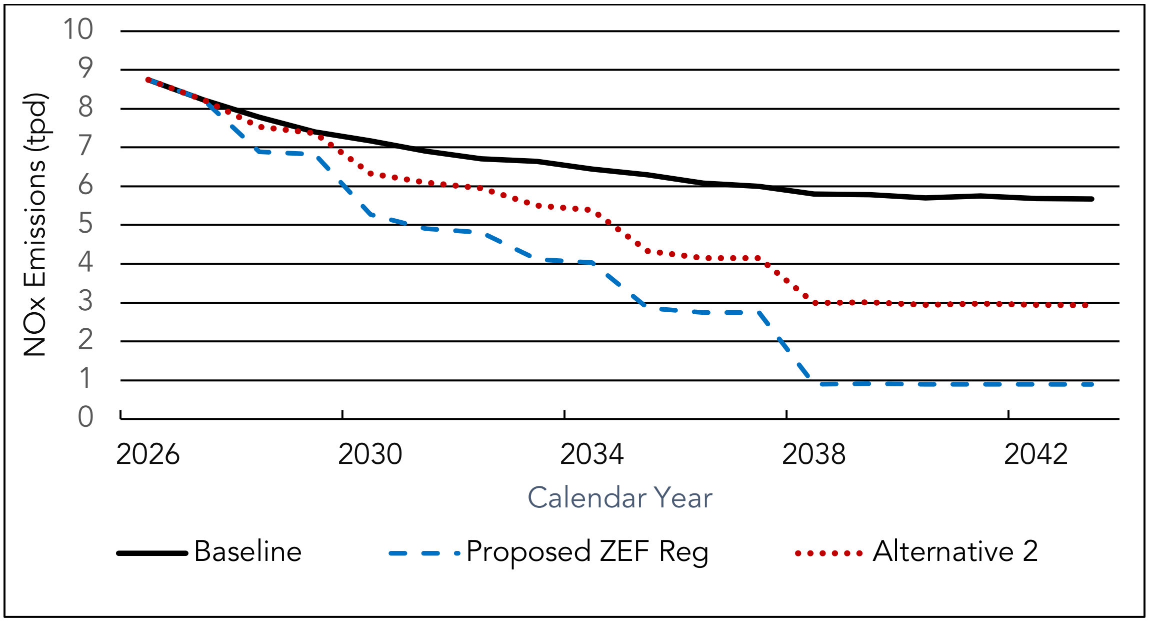


Figure 24. Projected Statewide TTW PM2.5 Emissions Under Baseline, Proposed Regulation, and Alternative 2

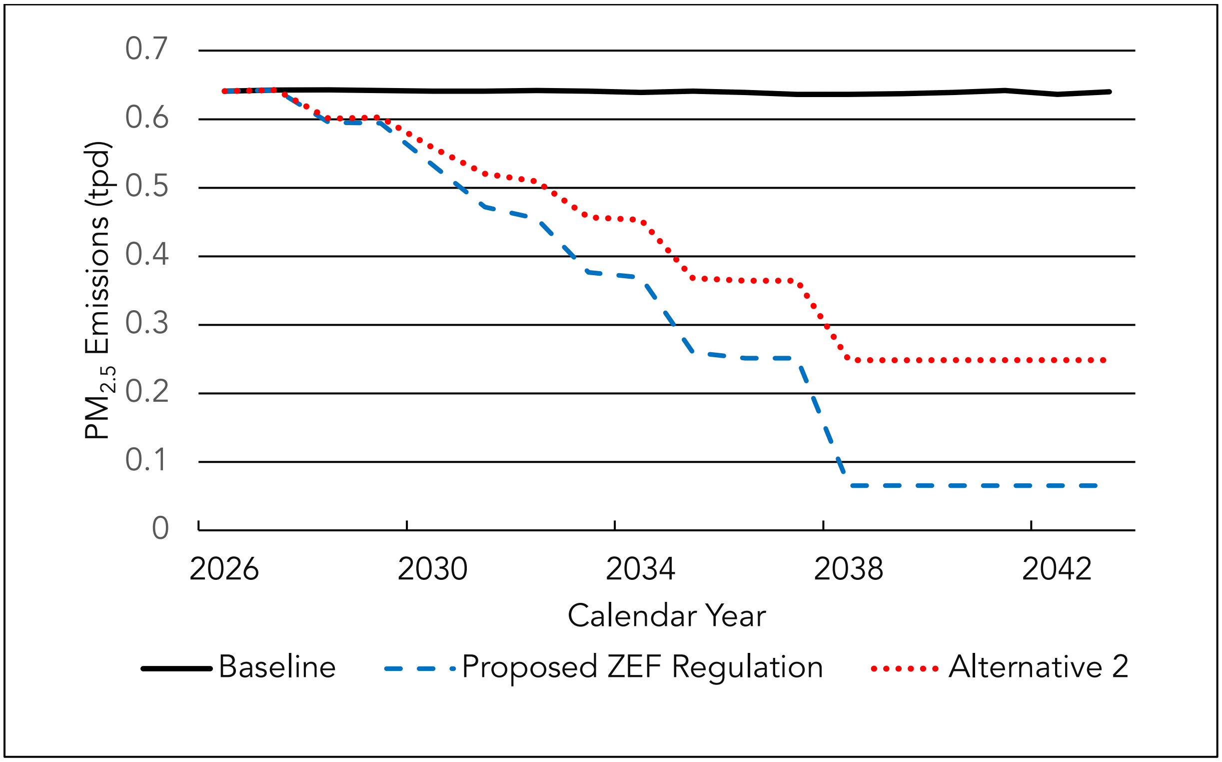


Figure 25. Projected Statewide TTW ROG Emissions Under Baseline, Proposed Regulation, and Alternative 2

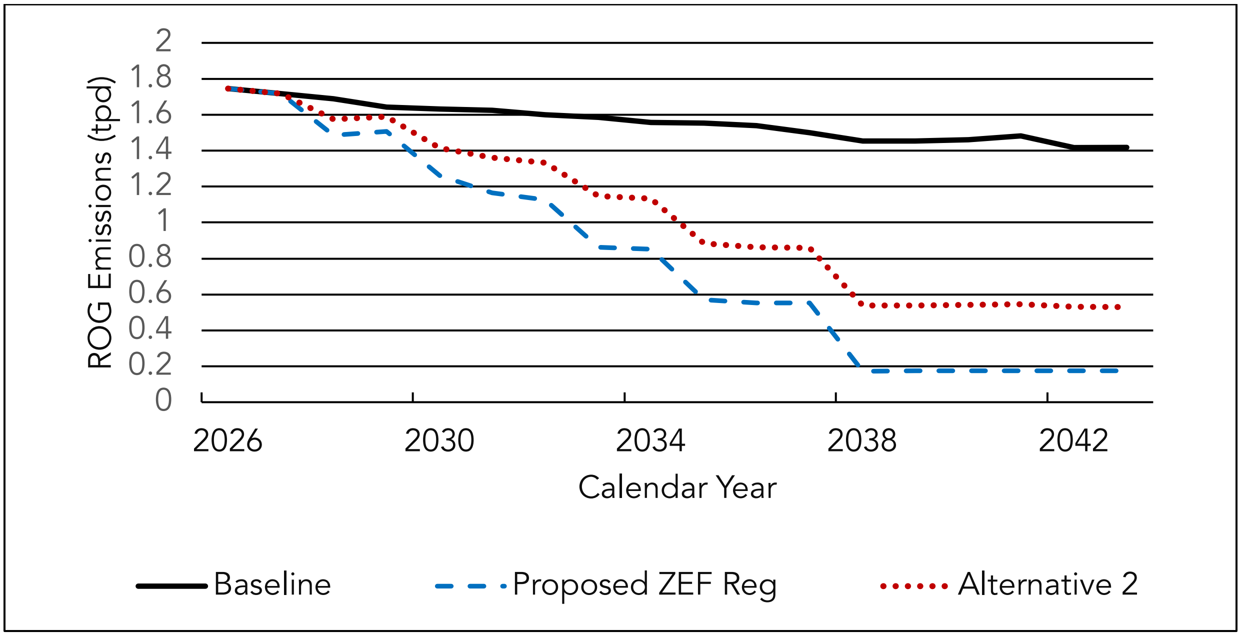
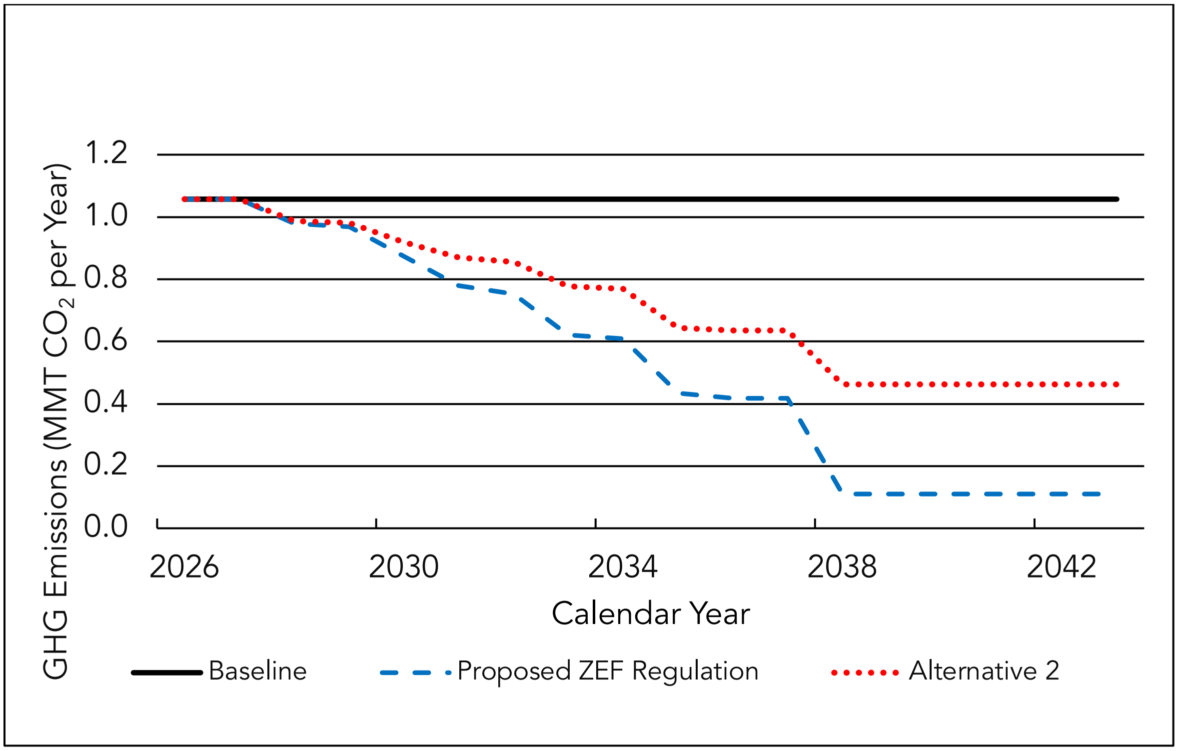


Figure 26. Projected Statewide TTW CO_2 Emissions Under Baseline, Proposed Regulation, and Alternative 2



b) Health Benefits

Staff used the methods described in Chapter IV, Section A to estimate the value of health benefits associated with 12 health outcomes that would be expected to result from implementing Alternative 2 when compared to the Baseline scenario. The avoided mortality and morbidity incidents from 2026 to 2043 of Alternative 2 are presented in Table 60. As shown in Table 61, Alternative 2 has approximately 37 percent lower valuation of health benefits at $4.7 billion compared to the Proposed Regulation at $7.5 billion.

Table 60. Avoided Mortality and Morbidity Incidents from 2026 to 2043 under the Less Stringent Scenario*

Air Basin**	Cardiopulmonary Mortality	Hospitalizations for Cardiovascular Disease	Cardiovascular ED Visits	Acute Myocardial Infarction	Hospitalizations for Respiratory Disease	Respiratory ED Visits	Lung Cancer Incidence
GBV	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
LC	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
LT	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
MD	1 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 1)	0 (0 - 0)
MC	0 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 1)	0 (0 - 0)
NCC	1 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	1 (0 - 1)	0 (0 - 0)
NC	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
NP	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
SV	4 (2 - 5)	1 (1 - 1)	1 (0 - 2)	0 (0 - 1)	0 (0 - 0)	2 (0 - 5)	0 (0 - 0)
SS	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
SD	12 (7 - 18)	3 (2 - 4)	3 (-1 - 8)	1 (0 - 4)	0 (0 - 1)	6 (1 - 13)	1 (0 - 2)
SFB	43 (23 - 61)	9 (7 - 12)	13 (-5 - 29)	5 (2 - 14)	1 (0 - 2)	31 (6 - 65)	4 (1 - 7)
SJV	10 (6 - 15)	2 (1 - 3)	2 (-1 - 6)	1 (0 - 3)	0 (0 - 1)	7 (1 - 14)	1 (0 - 1)
SCC	4 (2 - 5)	1 (1 - 1)	1 (0 - 2)	0 (0 - 1)	0 (0 - 0)	2 (0 - 4)	0 (0 - 0)
SC	269 (149 - 384)	56 (41 - 71)	73 (-28 - 169)	30 (11 - 81)	9 (0 - 17)	153 (30 - 318)	20 (6 - 32)
Statewide	**344 (190 - 491)**	**73 (53 - 92)**	**93 (-36 - 217)**	**39 (14 - 105)**	**11 (0 - 21)**	**203 (40 - 422)**	**26 (8 - 43)**

Table 60 – Continued

Air Basin**	Asthma Onset	Asthma Symptoms	Work Loss Days	Hospitalizations for Alzheimer's Disease	Hospitalizations for Parkinson's Disease
GBV	0 (0 - 0)	3 (-2 - 8)	2 (2 - 3)	0 (0 - 0)	0 (0 - 0)
LC	0 (0 - 0)	4 (-2 - 10)	3 (2 - 3)	0 (0 - 0)	0 (0 - 0)
LT	0 (0 - 0)	0 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
MD	1 (1 - 1)	101 (-49 - 246)	74 (62 - 85)	0 (0 - 0)	0 (0 - 0)
MC	1 (1 - 1)	93 (-45 - 226)	71 (60 - 82)	0 (0 - 0)	0 (0 - 0)
NCC	2 (2 - 3)	212 (-103 - 515)	150 (126 - 172)	0 (0 - 0)	0 (0 - 0)
NC	1 (1 - 1)	51 (-25 - 124)	41 (34 - 47)	0 (0 - 0)	0 (0 - 0)
NP	0 (0 - 0)	3 (-2 - 8)	2 (2 - 2)	0 (0 - 0)	0 (0 - 0)
SV	8 (8 - 8)	693 (-338 - 1685)	563 (475 - 648)	1 (1 - 1)	0 (0 - 0)
SS	0 (0 - 0)	34 (-17 - 83)	26 (22 - 30)	0 (0 - 0)	0 (0 - 0)
SD	29 (28 - 30)	2,452 (-1,194 - 5,955)	2,074 (1,749 - 2,388)	10 (8 - 12)	1 (1 - 2)
SFB	150 (144 - 155)	12,466 (-6,072 - 30,285)	8,630 (7,275 - 9,934)	20 (15 - 25)	4 (2 - 6)
SJV	19 (18 - 19)	1660 (-811 - 4,022)	1,295 (1,092 - 1,489)	5 (4 - 6)	1 (0 - 1)
SCC	9 (9 - 9)	775 (-378 - 1879)	535 (451 - 616)	1 (1 - 2)	0 (0 - 0)
SC	601 (577 - 623)	50,802 (-24,782 - 123,246)	37,498 (31,623 - 43,150)	136 (104 - 165)	18 (10 - 26)
Statewide	**821 (789 - 852)**	**69,351 (-33,820 - 168,291)**	**50,964 (42,977 - 58,650)**	**174 (133 - 212)**	**25 (13 - 35)**

* Numbers in parentheses throughout this table represent the 95 percent CI.
**List of air basin names in full: Great Basin Valleys, Lake County, Lake Tahoe, Mojave Desert, Mountain Counties, North Central Coast, North Coast, Northeast Plateau, Sacramento Valley, Salton Sea, San Diego County, San Francisco Bay, San Joaquin Valley, South Central Coast, South Coast

Table 61: Valuation of Statewide Health Benefits for Alternative 2

Year	Premature Mortality	HA, Parkinson's Disease	HA, Respiratory-2	HA, Alzheimer's Disease	HA, Cardio-, Cerebro- and Peripheral Vascular Disease	ED visits, All Cardiac Outcomes	ED visits, respiratory	Incidence, Asthma	Asthma Symptoms, Albuterol use	Incidence, Lung Cancer	Acute Myocardial Infarction, Nonfatal	Work Loss Days	Valuation (Million 2021$)
2026	2026	0	0	0	0	0	0	0	0	0	0	0	0
2027	2027	0	0	0	0	0	0	0	0	0	0	0	0
2028	2028	3	0	0	1	1	1	2	8	746	0	0	503
2029	2029	2	0	0	1	0	1	1	6	533	0	0	366
2030	2030	8	1	0	4	2	2	5	19	1,704	1	1	1,194
2031	2031	10	1	0	5	2	3	6	25	2,134	1	1	1,526
2032	2032	11	1	0	5	2	3	6	26	2,209	1	1	1,605
2033	2033	15	1	0	7	3	4	9	37	3,110	1	2	2,279
2034	2034	15	1	0	7	3	4	9	36	3,073	1	2	2,260
2035	2035	24	2	1	12	5	7	14	57	4,839	2	3	3,567
2036	2036	24	2	1	12	5	7	14	57	4,823	2	3	3,561
2037	2037	24	2	1	12	5	6	14	56	4,724	2	3	3,494
2038	2038	34	2	1	18	7	9	20	82	6,883	3	4	5,094
2039	2039	35	2	1	18	7	9	20	82	6,887	3	4	5,095
2040	2040	35	3	1	18	7	9	20	82	6,902	3	4	5,101
2041	2041	35	3	1	18	8	9	21	83	6,977	3	4	5,149
2042	2042	35	3	1	18	7	9	20	82	6,875	3	4	5,068
2043	2043	35	3	1	18	8	9	20	82	6,931	3	4	5,101
Total	344	25	11	174	73	93	203	821	69,351	26	39	50,964	$4,738

c) Social Cost of Carbon

Table 62 shows the avoided social cost of carbon for Alternative 2, which ranges from $162 million to $673 million through 2043, depending on the discount rate. These benefits are 36 percent less than those of the Proposed Regulation due to the lower emission reductions of Alternative 2.

Table 62: Avoided Social Cost of Carbon for Alternative 2

Year	GHG emission reductions (MMT)	Avoided $SC\text{-}CO_2$ (Million 2021$)		
		5% discount rate	3% discount rate	2.5% discount rate
2026	0.0	$0	$0	$0
2027	0.0	$0	$0	$0
2028	0.1	$1	$5	$7
2029	0.1	$2	$5	$8
2030	0.1	$3	$10	$14
2031	0.2	$4	$13	$19
2032	0.2	$5	$14	$21
2033	0.3	$7	$20	$29
2034	0.3	$7	$21	$31
2035	0.4	$10	$31	$44
2036	0.4	$11	$32	$45
2037	0.4	$11	$33	$47
2038	0.6	$16	$47	$66
2039	0.6	$16	$48	$67
2040	0.6	$17	$48	$68
2041	0.6	$17	$49	$69
2042	0.6	$18	$49	$69
2043	0.6	$18	$50	$70
Total	**6.0**	**$162**	**$476**	**$673**

2. Costs

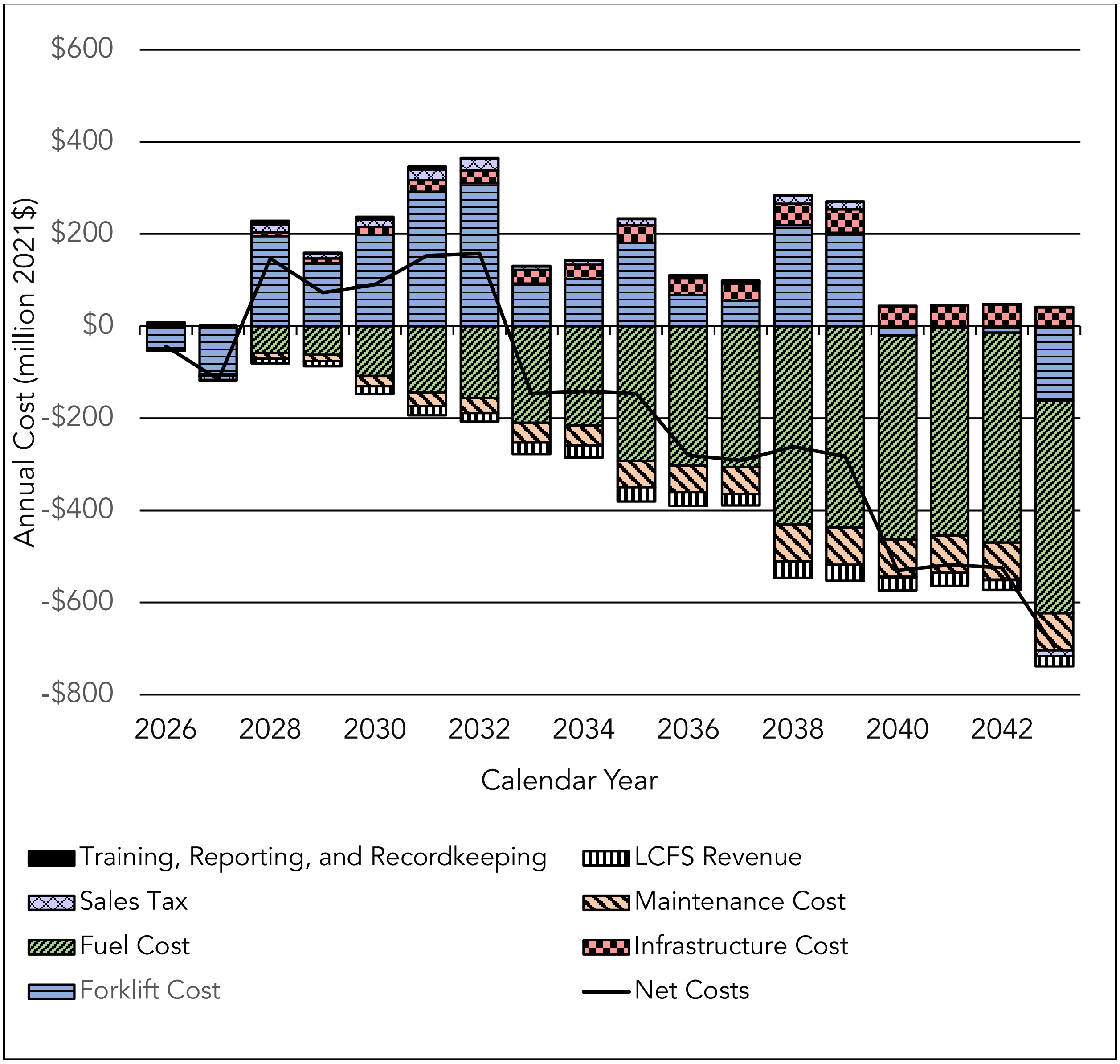
Alternative 2 would decrease the number of Class IV and Class V forklifts that would be phased out and replaced with ZEFs relative to the Proposed Regulation. The estimated cumulative net cost to the California economy would be approximately ---$3.4 billion (i.e., a savings of $3.4 billion) between 2026 and 2043 under Alternative 2 relative to the Baseline scenario. In comparison, the estimated cumulative net cost of the Proposed Regulation would be approximately -$2.7 billion over the same time period relative to the Baseline scenario.

Table 63 and Figure 27 illustrate the incremental difference in costs between Alternative 2 and the Baseline scenario.

Table 63. Statewide Direct Costs of Alternative 2 (Million 2021$)

Year	Incremental Forklift Cost	Sales Tax	Infrastructure Cost	Transitional, Training, Reporting, and Labeling Costs	Maintenance Cost	Propane and Gasoline Costs	Electricity Costs	Hydrogen Cost	LCFS Credit Revenue	Total Cost	Total Savings	Net Costs
2026	-$47.2	-$3.8	$0.1	$7.8	-$0.2	-$1.4	$0.4	$0.1	-$0.2	$8.4	-$52.7	-$44.3
2027	-$104.8	-$8.4	$0.6	$1.3	-$0.7	-$4.3	$1.1	$0.2	-$0.5	$3.3	-$118.7	-$115.4
2028	$195.4	$15.7	$8.8	$8.5	-$13.0	-$83.9	$22.4	$3.6	-$9.9	$254.3	-$106.7	$147.6
2029	$136.8	$11.0	$10.4	$1.4	-$13.8	-$90.0	$24.0	$3.6	-$10.3	$187.2	-$114.0	$73.2
2030	$197.7	$15.9	$17.5	$6.5	-$22.7	-$153.3	$39.6	$5.5	-$16.5	$282.7	-$192.5	$90.2
2031	$292.3	$23.5	$24.8	$6.3	-$29.6	-$201.8	$51.1	$7.0	-$20.8	$405.1	-$252.2	$152.9
2032	$310.2	$24.9	$28.2	$2.2	-$31.6	-$218.8	$54.9	$7.0	-$19.3	$427.4	-$269.7	$157.8
2033	$92.6	$7.4	$29.5	$0.9	-$41.7	-$291.8	$73.2	$8.6	-$25.7	$212.3	-$359.2	-$146.9
2034	$102.0	$8.2	$32.0	$0.9	-$42.6	-$299.7	$75.3	$8.4	-$26.4	$226.8	-$368.7	-$141.9
2035	$180.1	$14.5	$38.4	$0.9	-$57.2	-$405.9	$102.3	$10.9	-$30.2	$347.1	-$493.3	-$146.2
2036	$68.0	$5.5	$36.3	$0.9	-$58.1	-$416.2	$103.1	$11.1	-$30.8	$224.8	-$505.2	-$280.3
2037	$55.3	$4.4	$37.2	$0.9	-$58.1	-$419.9	$102.6	$11.3	-$25.4	$211.8	-$503.5	-$291.7
2038	$218.7	$17.6	$47.6	$0.9	-$80.5	-$587.0	$141.6	$15.0	-$35.5	$441.3	-$703.0	-$261.6
2039	$202.9	$16.3	$50.2	$0.9	-$80.5	-$592.0	$140.4	$14.6	-$35.8	$425.3	-$708.3	-$283.0
2040	-$20.0	-$1.6	$43.4	$0.9	-$80.5	-$597.4	$139.2	$14.1	-$28.3	$197.7	-$727.7	-$530.0
2041	-$4.6	-$0.4	$44.8	$0.9	-$80.5	-$602.7	$138.6	$13.7	-$28.6	$198.1	-$716.7	-$518.7
2042	-$13.3	-$1.1	$47.1	$0.9	-$80.5	-$608.0	$138.6	$13.3	-$21.1	$199.8	-$723.9	-$524.1
2043	-$160.9	-$12.9	$41.0	$0.9	-$80.5	-$613.5	$138.2	$12.9	-$21.4	$193.0	-$889.2	-$696.2
Total	**$1,701.1**	**$136.7**	**$538.0**	**$44.1**	**-$851.9**	**-$6,187.6**	**$1,486.5**	**$160.8**	**-$386.6**	**$4,446.2**	**-$7,805.1**	**-$3,358.8**
Present Value	**$1,068.8**	**$85.9**	**$276.5**	**$30.8**	**-$426.5**	**-$3,073.8**	**$744.9**	**$82.6**	**-$205.5**	**$2,509.3**	**-$3,925.7**	**-$1,416.3**

Figure 27. Statewide Direct Costs of Alternative 2



3. Cost Effectiveness

Cost-effectiveness is defined as the cost to achieve a ton of emissions reductions. However, like the Proposed Regulation, Alternative 2, has a lower net cost than the Baseline and can be more intuitively evaluated as a benefit-cost ratio. A comparison of this type is an appropriate cost-effectiveness measure if the harm associated with increased emissions is fully captured in the estimates of monetized health impacts. Benefits to California include both health benefits and cost savings after subtracting tax impacts to State and local governments. Table 64 indicates that Alternative 2 has a total cost of $4.4 billion and total benefit of $12.1 billion over the regulatory horizon. This results in a net benefit of $7.6 billion for Alternative 2 and a Benefit Cost ratio of 2.72, indicating that the benefits are 172 percent greater than the costs. This is compared to a net benefit $9.7 billion and benefit-cost ratio of 2.26 for the Proposed Regulation.

Table 64. Cost-Effectiveness of the Proposed Regulation and Alternative 2 (Billion 2021$)

Scenario	Total Costs	Cost Savings (benefit)	Health Benefits	Tax and Fee Revenue	Total Benefit	Net Benefit	Benefit-Cost Ratio
Proposed Regulation	$7.7	$10.4	$7.5	-$0.5	$17.5	$9.7	2.26
Alternative 2	$4.4	$7.8	$4.7	-$0.4	$12.1	$7.6	2.72

4. Reason for Rejecting

The projected upfront cost for Alternative 2 is lower than the Proposed Regulation, and its benefit-cost ratio is higher than for the Proposed Regulation (2.72 versus 2.26). However, Alternative 2 would also result in lower NOx, PM2.5, ROG, and CO_2 emission benefits and fewer ZEFs deployed. Although CARB's 2016 SIP commitment for ROG reductions of 0.2 tpd by 2031 would be met through Alternative 2, the commitment for NOx reductions of 2 tpd by 2031 would not be met. Alternative 2 would obtain only 0.81 tpd NOx by 2031.

The deployment of ZE vehicles and equipment is a key component of California’s long-term strategy to meet its aggressive air quality, climate, and ZE goals. Alternative 2 was rejected because it would not be as effective as the Proposed Regulation at improving air quality and protecting public health, combating climate change, and accelerating the adoption of ZE technology.

C. Small Business Alternative

The Board has not identified any reasonable alternatives that would lessen any adverse impact on small business. However, the Proposed Regulation would provide a phase-out delay option to accommodate the needs of smaller fleet operators and allow microbusinesses to keep one low-use forklift indefinitely (for others, the low-use exemption would sunset on December 31, 2030).

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 Regulation would not prescribe the use of any specific technology or equipment. Instead, regulated entities would be able to phase out Targeted Forklifts; they could then replace them with any compliant forklift or choose not to replace them at all. The Proposed Regulation would not specify how forklifts must comply with the standards. Currently, battery-electric technology and fuel-cell electric technologies have demonstrated the capability of meeting the proposed performance standards. However, the Proposed Regulation would not preclude fleets from utilizing any technology that meets the proposed performance standards.

The Proposed Regulation would provide flexibility that could encourage innovation by allowing fleets to determine their compliance path based on their business model or operational needs. Even if the Proposed Regulation is considered a prescriptive standard, to the extent it establishes specific measurements, actions, or quantifiable means of limiting emissions, it would still be preferred over other performance-based alternatives. Anything less prescriptive than the Proposed Regulation in terms of emission limits and requirements for ZEF purchases would erode the ability to secure the emissions reductions needed for meeting California's public health and climate goals and State and federal air quality standards. 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. More performance-based alternatives would thus undermine the goals of the Proposed Regulation. Furthermore, to the extent the Proposed 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 Targeted Forklift emissions are permanently reduced.

E. Health and Safety Code section 57005 Major Regulation Alternatives

CARB estimates the proposed regulation will 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.

F. Other Alternatives Considered but Rejected

This section describes additional alternatives that were considered during development of the Proposed Regulation, but ultimately rejected for the reasons provided. The regulatory objectives discussed in this section refer to those described in Chapter I, Section A of this ISOR.

1. Allow for the Use of Cleaner Spark-Ignited Forklifts

This alternative, Alternative 3, is a modification to the Proposed Regulation that would allow fleets to turn over some portion of their forklifts to the cleanest certified LSI engines rather than ZE technology. Variations of this approach have been suggested by stakeholders during the rulemaking process with the primary intent of reducing anticipated compliance costs and burden. Some advocates for this approach stated that this alternative could provide flexibility for forklift operations that may be more difficult to transition to zero emission. Some advocates have also suggested use of renewable propane in lieu of ZEFs.

Alternative 3 could result in cleaner engines in some fleets, but it would reduce the number of Class IV and Class V forklifts replaced with ZEFs over the regulatory timeframe. While Alternative 3 could result in lower upfront costs, it would also result in lower emission reductions and health benefits than the Proposed Regulation. As such, Alternative 3 was rejected. While staff understands there could be operations that are more challenging to transition to ZE technology initially, the Proposed Regulation includes provisions that would provide extensions when warranted for feasibility and other issues.

Advocates for Alternative 3 also suggested that using renewable propane would achieve additional GHG benefits. However, any requirement to use renewable fuels would not result in additional GHG benefits because low carbon fuels are accounted for under California's LCFS program.[284] In addition, as discussed further in Chapter I, Section H, NOx, GHG, and PM emission benefits of ZEFs are greater than renewable propane forklifts even when all emissions are accounted for.

Alternative 3 was rejected because it would fail to meet the primary ZEF-related objectives 1 and 6. These objectives seek to accelerate deployment of ZEFs to achieve

[284] Title 17, California Code of Regulations, Sections 95480-95503.

maximum emission reductions and transition the off-road sector to ZE technologies by 2035 where feasible. Alternative 3 would result in less ZEF deployments, less ZEF-related economic activity, and less ZEF infrastructure build-out. Additionally, Alternative 3 fails to meet the goals outlined in EO N-79-20. Furthermore, it was rejected because it would be less effective in meeting California's climate goals and GHG-related objectives 3 and 5. Alternative 3 would also be less effective at meeting criteria pollutant emissions reductions program objectives 4, 7, and 8. This alternative would achieve less NOx, PM2.5, ROG, and GHG emission benefits when compared to the Proposed Regulation. Finally, it was rejected because it would be less effective in meeting program objectives 2 and 11 compared to the Proposed Regulation.

2. Utilize Hours-of-Use as Basis for Phasing Out Affected Forklifts

Some stakeholders suggested the use of a phase-out schedule based on hours-of-use instead of forklift age. Under this alternative, Alternative 4, forklifts would be required to be phased out of a fleet after reaching a set hours-of-service threshold.

Alternative 4 presents implementation and enforcement challenges that would potentially lead to the slower deployment of ZEFs. Forklift hour meters, especially on older forklifts, cannot be relied upon for accurately determining hours-of-operation, because they can be easily replaced, malfunction, or be disconnected or tampered with in other ways. As such, staff believes Alternative 4 could create a loophole which fleets could use to delay or avoid transitioning to ZE technology.

This alternative was rejected primarily because of staff's concerns about the reliance on an hour meter for implementation and enforcement purposes, and because it provides less certainty as to when affected LSI forklifts would be required to be phased out. In addition, Alternative 4 fails to meet objective 9 of the Proposed Regulation due to enforceability challenges.

3. Extend the Availability of the Low-Use Exemption Indefinitely for All Fleets

The Proposed Regulation would establish a low-use exemption that would allow a fleet operator to use an Affected Forklift of a phased-out MY up to 200 hours per year. However, the exemption would sunset on December 30, 2030, for all fleets except microbusinesses. Microbusinesses would be able to keep one affected forklift as a low-use forklift indefinitely. Alternative 5 would allow all fleets to keep one affected forklift as low-use forklift indefinitely.

Although Alternative 5 would result in NOx, PM2.5, ROG, and GHG emission benefits relative to the Baseline scenario, the benefits would not be as great as those estimated for the Proposed Regulation. This is because Alternative 5 would allow some forklifts to be maintained as low-use forklifts that would have otherwise been removed from the fleet. In addition, this alternative either fails to meet or would be less effective in meeting program objectives 1, 2, 3, 5, 6, 7, 8, 11, and 12 of the Proposed Regulation. For the aforementioned reasons, Alternative 5 was rejected.

4. Allow Rental Fleets to Purchase New Class IV Forklifts in 2026, 2027, and 2028

During the course of regulatory development, representatives of rental agencies argued that rental fleets should be exempt from the requirements of the regulation and allowed to purchase spark ignition forklifts indefinitely. While fleet operators would be prohibited by the Proposed Regulation from purchasing new affected forklifts (both Class IV and Class V) starting January 1, 2026, rental agencies would be allowed to continue purchasing new affected Class V forklifts until January 1, 2029, to use in their rental fleet. Alternative 6 would allow rental agencies to purchase new affected Class IV forklifts as well through December 31, 2028.

This alternative was rejected because staff does not believe it would be necessary to allow the continued purchase of affected Class IV forklifts after December 31, 2028. While commercially available, ZE pneumatic-tired forklifts are still relatively new when compared to ZE solid-tired forklifts. Therefore, staff expects that there could be more operational challenges and learning for fleets deploying ZE pneumatic-tired forklifts for the first time. The allowance for rental fleets to purchase affected Class V forklifts was added so that rental agencies could maintain a newer, more-reliable Class V forklift fleet during the phase-out period in order to better serve their customer fleets facing such operational challenges. However, staff does not believe such an allowance is needed for Class IV forklifts.

Although Alternative 6 would result in NOx, PM2.5, ROG, and GHG emission benefits relative to the Baseline scenario, the benefits would not be as great as those estimated for the Proposed Regulation. This is because by allowing rental agencies to purchase new Class IV forklifts in 2026, 2027, and 2028, it would increase the overall availability of Class IV forklifts on which fleet operators could depend, which could delay their decision to transition to zero emission. In addition, this alternative either fails to meet or would be less effective in meeting program objectives 1, 2, 3, 5, 6, 7, 8, 10, 11, and 12 of the Proposed Regulation. For the aforementioned reasons, Alternative 6 was rejected.

5. Exempt Small Fleets

Alternative 7 would completely exempt small fleets, that is, fleets of 25 or fewer forklifts, from the Proposed Regulation. All other requirements in the proposal would remain the same.

Alternative 7 was rejected because staff does not believe it would not be necessary to exclude small fleets as explained below. Like larger fleets, small fleets could also achieve cost savings over time operating a ZEF. Staff acknowledges that it may be more difficult for smaller businesses to absorb the additional capital costs of ZEFs, and most small businesses would likely fall into the small-fleet category. As such, the Proposed Regulation includes elements that would help ease cost impacts on small fleets by allowing such fleets to extend the utility of existing affected forklifts and by providing more time to plan, budget, and prepare for the transition. Specifically, for small fleets, the phase-out of Class IV forklifts would be delayed one year (i.e., would start in 2029 instead of 2028), and the phase-out age of affected forklifts would be 13 years old rather than 10 years old, as proposed for large fleets. In addition, microbusinesses that only use their forklifts less than 200 hours per year on average would be allowed to maintain one affected forklift as a low-use forklift indefinitely.

Although Alternative 7 would result in NOx, PM2.5, ROG, and GHG emission benefits relative to the Baseline scenario, the benefits would not be as great as those estimated for the Proposed Regulation. This is because small fleets would not be required to turn over affected forklifts zero emission. Based on staff's estimates, roughly one-third of affected forklifts in California are in fleets of 25 or fewer units. In addition, this alternative either fails to meet or would be less effective in meeting program objectives 1, 2, 3, 5, 6, 7, 8, 10, 11, and 12 of the Proposed Regulation. For the aforementioned reasons, Alternative 7 was rejected.

X. Justification for Adoption of Regulations Different from Federal Regulations Contained in the Code of Federal Regulations

Government Code section 11346.2(b)(6) requires CARB to describe its efforts to avoid unnecessary duplication or conflicts with federal regulations that address the same issues. It also requires CARB to justify adopting regulations that are different from existing federal regulations by making either or both of these findings:

1. The differing state regulations are authorized by law.
2. The cost of differing state regulations is justified by the benefit to human health, public safety, public welfare, or the environment.

CARB has authority under state and federal law to set standards for California that reduce emissions from off-road engines and equipment to meet federal and state ambient air quality standards and climate change requirements and goals. CARB has the authority to require additional and separate reporting than required under federal law. California has plenary authority under the state and federal constitutions to protect public health and welfare. The California Health and Safety Code directs CARB to exercise this authority to reduce and eliminate harmful air emissions. These statutory obligations are identified in the authority citations for the Proposed Regulation.

Currently, there are no comparable federal requirements for fleets to phase-out LSI forklifts. As shown in this Staff Report and accompanying analyses, the cost of the Proposed Regulation is justified by the substantial benefits to the public health, welfare, and the environment, as described in the accompanying materials. ZE technology is needed to achieve the greatest degree of emission reductions of criteria pollutants and GHG to reduce the serious risks to the health and welfare of Californians posed by air pollutants. In addition, the Proposed Regulation is needed to attain State and federal ambient air quality standards, reduce climate change-induced damage, and meet carbon neutrality goals. Further, the Proposed Regulation is consistent with the goals established by the Governor in EO N-79-20, and by the Board in California's SIP Strategy and the Climate Change Scoping Plan.

XI. Public Process for Development of the Proposed Action (Pre-Regulatory Information)

Consistent with Government Code sections 11346, subdivision (b), and 11346.45, subdivision (a), and keeping with the long-standing practice at the Board, CARB staff held public workshops, workgroups, and other meetings with stakeholders during the development of the Proposed Regulation. These informal pre-regulatory discussions provided staff with useful information that was considered during development of the Proposed Regulation, which is now being released for formal public comment.

Over the past three years of rule development, staff has hosted five public workshops and workgroups. In addition, CARB staff reached out directly to affected stakeholders and conducted numerous meetings with forklift fleets, dealers, rental agencies, manufacturers, industry groups, and other stakeholders. Furthermore, CARB staff has also sent over 270,000 mailers to trucking fleets, over 200,000 mailers to small businesses, and email notices to over 70,000 subscribers of the Zero-Emission Forklift Rulemaking email list and other public email subscriber lists. A webpage was developed to host all information pertaining to the regulatory-development process, including all public meeting announcements, materials made available for public comment, draft regulation language, an email list signup link, and staff contact information. For every public event, staff used notices sent to the email list to announce meeting events, documents, translation resources, and other associated regulatory materials to encourage participation and attendance at the workgroups and workshops. Most of the stakeholder and public meetings were held using webinars and videoconference applications. Virtual workshops and meetings are more accessible than meetings at a physical location since anyone with internet service or a cellular device can attend from any location in the world without having to travel to a specific location. As a result, remote workshops usually have higher attendance than local meetings. All workgroup and workshop meetings were open to all members of the public. A summary of the workshops, workgroups, and stakeholder meetings is provided below.

Three public workshops were held on October 7, 2020, January 24, 2023, and March 22, 2023, to discuss the Proposed Regulation. During the October 7, 2020, workshop, CARB staff discussed the concept of the Proposed Regulation and solicited feedback on the regulatory approach, emission inventory methodology, and potential alternatives to the Proposed Regulation. The workshop was announced on September 14, 2020, by posting a notice to CARB's website for the Proposed Regulation and by distributing the notice to several public email subscriber lists. The total number of notice recipients were 70,421 at the time the notice was distributed. The workshop was open to all members of the public and was held virtually using a webinar application. CARB staff posted the workshop material (agenda and slide presentation) on CARB's webpage for the Proposed Regulation prior to the workshop. The approximate number of stakeholders in attendance for the workshop was 400.

On January 24, 2023, CARB staff held a second public workshop to discuss updates to the draft regulatory proposal, including those made in response to feedback received by stakeholders. Some of the topics discussed included the costs and benefits analyses, newly proposed extensions and delays, and changes to definitions. Staff also gave a presentation on the development of the inventory modeling used to estimate the benefits that would be provided by the Proposed Regulation. At the workshop, staff encouraged stakeholders to participate by providing feedback on the draft proposal. The workshop was announced on December 23, 2022, by posting a notice to CARB's website for the Proposed Regulation. The notice was also distributed to subscribers of both the Zero-Emission Forklift Rulemaking email subscriber list and Off-Road Spark-Ignition Equipment Activities email subscriber list. The workshop was open to all members of the public and was held virtually using a webinar application. CARB staff posted the workshop material (slide presentations) on CARB's webpage for the Proposed Regulation prior to the workshop. The total number of notice recipients were approximately 8450 at the time the notice was distributed. The approximate number of stakeholders in attendance for the second workshop was 350. The workshop was recorded, and the recording was posted to the Proposed Regulation's webpage after the meeting.

A third workshop was held on March 22, 2023, to discuss the environmental analysis (EA) and changes made to the draft regulatory proposal, such as added and modified language on potential delay extensions and exemptions. Staff encouraged stakeholders to participate and solicited feedback on the Proposed Regulation. As for the previous workshops, the workshop was announced in advance, by posting the notice to CARB's website for the Proposed Regulation. The notice was also distributed to subscribers of both the Zero-Emission Forklift Rulemaking email subscriber list and Off-Road Spark-Ignition Equipment Activities email subscriber list. The total number of notice recipients were approximately 8,500 at the time the notice was distributed. The workshop was open to all members of the public and was held virtually using a webinar application. CARB staff posted the workshop material (draft regulation language and slide presentation) on CARB's webpage for the Proposed Regulation prior to the workshop. The approximate number of stakeholders in attendance for the third workshop was 350. This workshop was also recorded, and the recording was posted to the Proposed Regulation's webpage after the meeting.

In addition to public workshops, staff also held more-targeted workgroup meetings. On August 17, 2021, CARB staff held morning and afternoon public virtual workgroup meetings to discuss specific elements of the draft language of the Proposed Regulation. Attendee stakeholders were a diverse group representing the agriculture industry, rental companies, equipment dealers, and small businesses. Discussion topics included the Proposed Regulation's applicability, definitions, general requirements, exemptions, and labeling and reporting requirements. After each of the topics mentioned above were discussed, staff solicited stakeholders for comments and recommended alternatives to the proposal that would result in an equivalent outcome. In addition, staff went over the next steps of the regulation development process. There were 183 stakeholders in attendance for the morning workgroup meeting and 31 for the afternoon meeting.

A second virtual workgroup meeting was held on February 22, 2022. Staff did additional public outreach for this workgroup meeting by publishing an industry bulletin through the Contractors State Licensing Board website to invite licensees to participate. The workshop was also announced by posting a notice to CARB's website for the Proposed Regulation and by distributing the notice to several public GovDelivery subscriber list, such as the subscriber list for the ZE Forklifts rulemaking and the subscriber list for LSI Forklift owners who have reported in DOORS. The two list had a total of 3,372 subscribers at the time the notice was sent out. At the workgroup meeting, CARB staff introduced a more refined and comprehensive concept of the Proposed Regulation that was based on comments provided by external stakeholders. There were 515 stakeholders registered for the workgroup and 340 stakeholders attended the meeting. The workgroup meeting was recorded and posted on CARB's website for the Proposed Regulation.

Staff also conducted informal meetings, phone calls, and site visits with stakeholders to discuss concepts, and gather input on the Proposed Regulation language. Stakeholders included members of impacted communities, environmental justice advocates, air districts, trade associations, forklift dealers, public agencies, and individual business owners.

XII. References

Document References are provided in Appendix F to the ISOR.

XIII. Appendices

The following is a list of appendices of this Staff Report:

- Appendix A-1. Proposed Regulation Order for Sections 3000, 3001, 3002, 3003, 3004, 3005, 3006, 3007, 3008, 3009, 3010, and 3011;
- Appendix A-2. Proposed Regulation Order for Section 2433;
- Appendix A-2.1. Proposed Regulation Order for Section 2433 (Alternate Format);
- Appendix A-3. Proposed Regulation Order for Section 2775.1;
- Appendix A-3.1. Proposed Regulation Order for Section 2775.1 (Alternate Format);
- Appendix B-1. CARB's Original Standardized Regulatory Impact Assessment (SRIA) which was submitted to California Department of Finance (DOF) on April 5, 2023;
- Appendix B-2. DOF's Comment Letter regarding the Original SRIA;
- Appendix C. CARB's Draft Environmental Impact Analysis (Draft EIA);
- Appendix D. 2023 Large Spark Ignition Forklift Emission Inventory Document;
- Appendix E. Purpose and Rationale for Each Regulatory Provision; and
- Appendix F. List of References.