State of California
Air Resources Board

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

Standardized Regulatory Impact Assessment (SRIA)

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A. Introduction

1. Background on Transport Refrigeration Units

Transport refrigeration units (TRU) are refrigeration systems powered by integral (inside the TRU housing) diesel engines designed to control the environment of temperature-sensitive products transported in insulated trucks, trailers, shipping containers, or railcars. TRU generator sets are diesel internal combustion engine-powered generators designed to provide electric power to electrically-driven refrigeration units of any kind. TRUs can be single-temperature or multi-temperature, in which multi-temperature units can maintain multiple temperature zones. TRUs are capable of both cooling and heating.

a. Truck TRUs

Truck TRUs are used to control the environment of temperature-sensitive products transported in straight trucks where the trailer is permanently attached to the truck cab. Truck TRUs are generally used for local and regional delivery, and return to a home base each night. Due to their daily operational characteristics, TRUs installed on trucks are well suited for zero-emission technologies, such as battery-electric. A truck TRU is shown in Figure A1.

Figure A1. Truck TRU

b. Trailer TRUs

Trailer TRUs are used to control the environment of temperature-sensitive products transported in semi-trailers that detach from the truck cab. Trailer TRUs often have longer loading times due to larger cargo capacity. Trailer TRUs are used in long-haul transport, visit other states to deliver or bring in loads, and generally do not return to a home base each night. A trailer TRU is shown in Figure A2.

Figure A2. Trailer TRU

c. Domestic Shipping Container TRUs and Railcar TRUs

Domestic shipping container (DSC) TRUs are used to control the environment of temperature-sensitive products transported in DSCs that move by truck and rail. Similar to trailer TRUs, DSC TRUs are used in long-haul transport, visit other states to deliver or bring in loads, and generally do not return to a home base each night. Railcar TRUs are used to control the environment of temperature-sensitive products transported in railcars. Railcar TRUs are generally unattended during use and trips may exceed a week. A DSC TRU and railcar TRU are shown in Figure A3 and Figure A4, respectively.

Figure A3. DSC TRU

Figure A4. Railcar TRU

d. TRU Generator Sets

TRU generator sets are designed and used to provide electric power to electrically-driven refrigeration units of any kind. This includes, but is not limited to generator sets that provide electricity to electrically-powered refrigeration systems for shipping containers when they are not plugged into ocean-going ship electric power or dock shore power. Refrigerated containers are intermodal in that they can be loaded onto ocean-going vessels for marine transport, then upon arrival at a port they can be transferred to a chassis for over-the-road truck transport, or transferred to a rail stack car or flatcar for rail transport.

There are several types of TRU generator sets, including "pin-on" and "under-slung." Pin-on TRU generator sets are pinned onto the front of refrigerated shipping containers, just above the container's all-electric refrigeration system, which is built into the shipping container. A pin-on TRU generator set is shown in Figure A5.

Figure A5. Pin-on TRU Generator Set

Under-slung TRU generator sets are clamped to the frame rails of a trailer chassis that is designed for the sole purpose of transporting shipping containers on the roadway. This arrangement is also called a "belly mount." An under-slung TRU generator set is shown in Figure A6. Both pin-on and under-slung TRU generator sets are designed to provide electric power for only one refrigerated shipping container.

Figure A6. Under-slung TRU Generator Set

A third type of TRU generator set, called a "powerpack," is designed to provide power for a number of refrigerated shipping containers, in which several diesel generators are installed on a shipping container. These powerpack containers are loaded onto railcars and connected to multiple refrigerated shipping containers on adjacent railcars. A powerpack TRU generator set is shown in Figure A7.

Figure A7. Powerpack TRU Generator Set

2. Regulatory History

The California Air Resources Board (CARB or Board) adopted the Airborne Toxic Control Measure for In-Use Diesel-Fueled TRUs and TRU Generator Sets, and Facilities where TRUs Operate (TRU ATCM; title 13, California Code of Regulations, section 2477) in 2004.[1] The purpose of the TRU ATCM is to reduce diesel particulate matter (diesel PM) from TRUs and TRU generator sets, as well as reduce near-source health risk at facilities where TRUs operate. The TRU ATCM requires that TRU engines that operate in California meet specific in-use performance standards that require diesel PM emissions to be reduced in accordance with a phased compliance schedule. The phased compliance schedule is based on the model year (MY) of the TRU engine and a seven-year operational life for the equipment. At the end of the year in which the engine becomes seven years old, compliance action shall be taken to reduce diesel PM emissions. The TRU ATCM includes two levels of stringency that were phased-in over time. The first phase, beginning in 2008, is the low emission TRU (LETRU) performance standards. The second phase, beginning in 2010, is the ultra-low emission TRU (ULETRU) performance standards. Ultimately, all TRU engines are required to meet the ULETRU performance standards and have 85 percent PM control (compared to an uncontrolled Tier 0 engine) to be fully compliant with the TRU ATCM.

CARB subsequently amended the TRU ATCM in 2010 and 2011. The 2010 amendments included additional recordkeeping and reporting requirements for TRU original equipment manufacturers (OEM) that directly or indirectly sell, or offer for sale, TRUs to the California market, as well as more stringent definitions for compliance. The 2011 amendments extended certain TRU performance standard compliance deadlines from those originally contained in the 2004 regulation and

[1] California Air Resources Board, Public Hearing to Consider the Adoption of the Proposed Airborne Toxic Control Measure for In-Use Diesel-Fueled Transport Refrigeration Units (TRU) and TRU Generator Sets, and Facilities where TRUs Operate, Staff Report: Initial Statement of Reasons, October 2003. (web link: https://ww3.arb.ca.gov/regact/trude03/isor.pdf)

included provisions to improve enforceability. The TRU ATCM is fully implemented and TRU owners have the following compliance options:

- Use a TRU equipped with an engine that meets the United States Environmental Protection Agency (U.S. EPA) Tier 4 final emission standards for 25-50 horsepower engines (meets ULETRU).
- Retrofit the existing TRU with a Level 3 Verified Diesel Emission Control Strategy (VDECS) with 85 percent PM control (meets ULETRU).
- Use an alternative technology that eliminates TRU diesel engine operation (and emissions) while at a facility. Alternative technologies include electrification, cryogenic refrigeration systems, alternative fuel systems, exclusive use of alternative diesel fuel, fuel cell-powered refrigeration systems, and other technologies that eliminate emissions while at a facility (meets ULETRU).
- Replace the existing unit (engine and refrigeration system) with a new TRU equipped with an engine that meets the U.S. EPA Tier 4 final emission standards for less than 25 horsepower engines, which would be in compliance until the seventh year after the replacement TRU's engine MY (does not meet ULETRU).

3. Proposed Regulatory Action

CARB staff are proposing amendments to the TRU ATCM, hereafter referred to as the "Proposed Amendments." The Proposed Amendments are needed to achieve additional emission reductions by transitioning diesel-powered truck TRUs to zero-emission, as well as requiring newly manufactured TRU engines in the remaining categories to meet a PM emission standard, the use of lower global warming potential (GWP) refrigerant, facility registration and reporting, expanded TRU reporting and labeling, and fees. The Proposed Amendments are designed to begin the transition of TRUs to zero-emission technology, which is part of California's holistic plan to address challenging mandates and needs for public health protection, and to meet air quality standards and climate goals. Key elements of the Proposed Amendments include the following:

By December 31, 2022:

- All newly manufactured truck TRUs, trailer TRUs, and DSC TRUs that operate in California shall use refrigerant with a GWP less than or equal to 2,200, or use no refrigerant at all.
- MY 2023 and newer trailer TRU, DSC TRU, railcar TRU, and TRU generator set engines shall meet a PM emission standard of 0.02 grams per brake horsepower-hour (g/hp-hr) or lower.
    - Note: MY 2022 and older trailer TRU, DSC TRU, railcar TRU, and TRU generator set engines would continue to operate under the current TRU ATCM requirements, in which they shall meet ULETRU by December 31st of the seventh year after the engine MY. For example, a trailer TRU equipped with a MY 2020 engine would have to meet ULETRU by December 31, 2027.

By December 31, 2023:

- Applicable Facility[2] owners shall register their facility with CARB, pay registration fees every three years, and report all TRUs that operate at their facility to CARB quarterly, or alternatively attest that only compliant TRUs (have a valid CARB compliance label or determined as compliant on CARB's website) operate at their facility.
- TRU owners shall report All TRUs that operate in California to CARB, regardless of where they are based.
- TRU owners shall pay TRU operating fees and affix CARB compliance labels to their TRU every three years, for each TRU operated in California.
- TRU owners shall turnover at least 15 percent of their truck TRU fleet (defined as truck TRUs operating in California) to zero-emission technology each year (for 7 years). All truck TRUs operating in California shall be zero-emission by December 31, 2029.

4. Statement of the Need of the Proposed Amendments

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 much needed public health protection for the millions of Californians that still breathe unhealthy air, reduce exposure to air toxics, and help to meet current health based ambient air quality standards across California. Additionally, meeting California's greenhouse gas (GHG) emission reduction targets is an essential part of the global action needed to slow global warming and achieve climate stabilization. The Proposed Amendments will achieve PM, nitrogen oxides (NOx), and GHG emission reductions from diesel-powered TRUs and increase the use of zero-emission technology in the off-road sector, which is needed to meet these complementary goals.

a. Need to Reduce Risk

Many of the communities near facilities where TRUs operate bear a disproportionate health burden due to their close proximity to emissions from the diesel engines that power TRUs. There are several occurrences across the State where communities contain "groups" or "clusters" of facilities where TRUs operate. In many cases, these facilities are located in or near communities that are classified as disadvantaged by the California Environmental Protection Agency (CalEPA). CalEPA uses the California Communities Environmental Health Screening Tool (CalEnviroScreen) to rank California communities based on environmental pollution burden and socio-economic

[2] An applicable facility is defined in the Proposed Amendments as a refrigerated warehouse or distribution center with a building size greater than or equal to 20,000 square feet, a grocery store with a building size greater than or equal to 15,000 square feet, a seaport facility, or an intermodal railyard if one or more TRUs operate within the legal property boundary of the facility.

indicators.[3] Exposure to diesel PM is a main contributor to these metrics for many communities ranked in the top 10th percentile statewide on CalEnviroScreen.

CARB staff performed a health risk assessment to evaluate the localized cancer risk impacts attributable to emissions from the diesel engines that power TRUs at cold storage warehouses (CSW) and grocery stores. The health risk assessment estimated the increase in potential cancer risk that would result under a business-as-usual scenario and emphasized the need for further emission reductions from TRUs to provide public health benefits and reduce the cancer risk burden to communities surrounding facilities where they operate. Additional details on the health risk assessment and health benefits of the Proposed Amendments are discussed in Section B.4.a.

b. Need to Reduce PM2.5 and NOx Emissions

Progress has been achieved in reducing PM2.5 and NOx emissions from mobile sources statewide through implementation of CARB's existing programs. These programs are expected to continue to provide further emission reductions, helping the State to meet air quality standards. However, challenges remain in meeting the ambient air quality standards for ozone and PM2.5 in two areas of the State with extreme air quality issues: the South Coast Air Basin and San Joaquin Valley. The near-term targets for these areas are a 2023 deadline for attainment of the 80 parts per billion (ppb) 8-hour ozone standard, 2024 for the 35 microgram per cubic meter (µg/m3) 24-hour PM2.5 standard, and 2025 for the 12 µg/m3 annual PM2.5 standard. There are also mid-term attainment years of 2031 and 2037 for the more recent 8-hour ozone standards of 75 ppb and 70 ppb, respectively.[4] NOx is a precursor to secondary PM2.5 formation. Consequently, reductions in NOx emissions also provide benefits to help meet the PM2.5 standards. Additional PM2.5 and NOx reductions from all freight sources, including TRUs, are essential to meeting these air quality standards.

c. Need to Reduce GHG Emissions

To date, California has made significant progress towards meeting the goals of Senate Bill (SB) 32 (Pavley, Chapter 249, Statutes of 2016).[5] SB 32 requires California to reduce GHG emissions to at least 40 percent below 1990 levels by 2030. Despite the progress made, more needs to be done.

Black carbon (soot) is emitted from burning fuels such as diesel. Hydrofluorocarbons (HFC) are synthetic gases that are used in a variety of applications, including refrigeration. Black carbon and HFCs are short-lived climate pollutants (SLCP) which are powerful climate forcers that remain in the atmosphere for a much shorter period

[3] Office of Environmental Health Hazard Assessment, CalEnviroScreen 3.0, June 25, 2018. (web link: https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30)
[4] California Air Resources Board, Revised Draft 2020 Mobile Source Strategy, April 23, 2021. (web link: https://ww2.arb.ca.gov/sites/default/files/2021-04/Revised_Draft_2020_Mobile_Source_Strategy.pdf)
[5] California Health and Safety Code § 38566, Division 25.5, Senate Bill No. 32, September 8, 2016. (web link: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB32)

of time than longer-lived climate pollutants, such as carbon dioxide (CO2), but are more potent when measured in terms of GWP, which can be tens, hundreds, or even thousands of times greater than CO2.[6]

SB 605 (Lara, Chapter 523, Statutes of 2014)[7] requires CARB to develop a plan to reduce emissions of SLCPs, and SB 1383 (Lara, Chapter 395, Statutes of 2016)[8] requires the Board to approve and begin implementing the plan by January 1, 2018. SB 1383 also sets targets for statewide reductions in SLCP emissions of 40 percent below 2013 levels by 2030 for methane and HFCs, and 50 percent below 2013 levels by 2030 for black carbon. Reductions in GHGs, including SLCPs like black carbon and HFC, from TRUs are needed to achieve the State's multiple GHG emission reduction targets and related climate goals.

d. Need to Address Emergence and Growth in the Number of Less than 25 Horsepower Units

The Proposed Amendments are needed to address the emergence and growth in the number of trailer TRUs equipped with engines less than 25 horsepower. The 2019 update to the statewide TRU emission inventory[9] indicates growing sales of units with less than 25 horsepower engines, which is in contrast to previous inventories where all trailer TRU engines were over 25 horsepower. The California and federal PM off-road emission standard for engines less than 25 horsepower is 15 times higher (i.e., less stringent) than the standard for engines greater than 25 horsepower. As a result, diesel PM emissions have not been reduced under the TRU ATCM as expected. Similar trends are also expected for DSC TRUs, railcar TRUs, and TRU generator sets. Based on the TRU emission inventory, the number of TRUs equipped with engines less than 25 horsepower will become responsible for the majority of PM emissions from TRUs in the near future, if current trends continue. The Proposed Amendments address this growth in emissions by requiring all MY 2023 and newer trailer TRU, DSC TRU, railcar TRU, and TRU generator set engines to meet a PM standard that aligns with the U.S. EPA Tier 4 final PM emission standard for engines greater than 25 horsepower.

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[6] California Air Resources Board, Short-Lived Climate Pollutant Reduction Strategy, March 2017. (web link: https://ww2.arb.ca.gov/sites/default/files/2018-12/final_slcp_report%20Final%202017.pdf)
[7] California Health and Safety Code § 39730, Division 26, Senate Bill No. 605, Short-lived climate pollutants, September 21, 2014. (web link: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140SB605)
[8] California Health and Safety Code § 39730, Division 30, Senate Bill No. 1383, Short-lived climate pollutants: methane emissions: dairy and livestock: organic waste: landfills, September 19, 2016. (web link: http://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SB1383)
[9] California Air Resources Board, Draft 2019 Update to Emissions Inventory for Transport Refrigeration Units, October 2019. (web link: https://ww3.arb.ca.gov/cc/cold-storage/documents/hra_emissioninventory2019.pdf)

a. Need to Address State Policy and Plans Directing CARB to Achieve Further Reductions from TRUs

The Proposed Amendments are needed to address the State policies and plans summarized below directing CARB to achieve additional diesel emission reductions.

i. Executive Order N-79-20

In September 2020, Governor Newsom issued Executive Order (EO) N-79-20,[10] which directed 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 zero-emission from off-road vehicles and equipment operations in the State by 2035. The Proposed Amendments support the directive of the EO by transitioning diesel-powered truck TRUs to zero-emission technology.

ii. 2020 Mobile Source Strategy

CARB released the Revised Draft 2020 Mobile Source Strategy (MSS)[11] in April 2021. The strategy document looks at existing and emerging technologies to reduce emissions from California's transportation sector, including cars, trucks, trains, ships, and other on-road and off-road sources. The strategies laid out in the MSS illustrate the technology mixes needed for the State to meet its various clean air goals, including federal ambient air quality standards, community risk reduction, and ambitious mid-and long-term climate change targets. The MSS includes a rapid electrification scenario for TRUs, increasing 10 percent each year beginning in 2024, highlighting the need to transition diesel-powered TRUs to zero-emission.

iii. 2017 State Strategy for the State Implementation Plan

The federal Clean Air Act requires areas that exceed the health-based national ambient air quality standards to develop SIPs that demonstrate how they will attain the standards by specified dates. In March 2017, the Board adopted the State Strategy for the State Implementation Plan (State SIP Strategy), which outlines CARB's comprehensive strategy to reduce emissions from mobile sources to meet critical air quality and climate goals over the next 15 years.[12] The State SIP Strategy includes statewide control measures CARB committed to bring to the Board for adoption to achieve the NOx reductions needed for attainment by 2023 and 2031. The Proposed Amendments are one of the control measures that is committed in the SIP.

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[10] Executive Order N-79-20, State of California Executive Order signed by Governor Gavin Newsom, September 23, 2020. (web link: https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-Climate.pdf)

[11] California Air Resources Board, Revised Draft 2020 Mobile Source Strategy, April 23, 2021. (web link: https://ww2.arb.ca.gov/sites/default/files/2021-04/Revised_Draft_2020_Mobile_Source_Strategy.pdf)

[12] California Air Resources Board, Revised Proposed 2016 State Strategy for the State Implementation Plan, March 7, 2017. (web link: https://www.arb.ca.gov/planning/sip/2016sip/rev2016statesip.pdf)

iv. 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 Assembly Bill (AB) 617 (Garcia, Chapter 136, Statutes of 2017).[13] AB 617 is a significant piece of air quality legislation that 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 Amendments are expected to reduce diesel TRU emissions and exposure statewide, and will be of particular benefit in disadvantaged communities experiencing disproportionate burdens.

v. California's 2017 Climate Change Scoping Plan

In 2006, Governor Schwarzenegger signed AB 32, the California Global Warming Solutions Act of 2006 (Núñez, Chapter 488, Statutes of 2006)[14] to address global climate change. AB 32 directed CARB to develop a scoping plan identifying integrated and cost-effective regional, national, and international GHG reduction programs. CARB adopted the AB 32 Scoping Plan in 2008 and subsequent updates in 2013 and 2017. California's 2017 Climate Change Scoping Plan[15] outlines the State's strategy to achieve its 2030 GHG target, and includes control measures for high-GWP refrigerants and diesel-powered TRUs.

vi. Executive Order B-32-15 and Sustainable Freight Action Plan

In July 2015, Governor Brown issued EO B-32-15,[16] which directed the secretaries of the California State Transportation Agency, CalEPA, and California Natural Resources Agency to lead other relevant State departments in developing an integrated action plan by July 2016 that "establishes clear targets to improve freight efficiency, transition to zero-emission technologies, and increase competitiveness of California's freight system." In response to the directive, the California State Transportation Agency, CalEPA, California Natural Resources Agency, CARB, California Department of Transportation, California Energy Commission, and Governor's Office of Business and Economic Development developed the California Sustainable Freight Action

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[13] California Health and Safety Code § 40920.6, 42400, 42402, 39607.1, 40920.8, 42411, 42705.5, and 44391.2, Division 26, Assembly Bill No. 617, Nonvehicular Air Pollution: Criteria Air Pollutants and Toxic Air Contaminants, July 26, 2017. (web link: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB617)

[14] California Health and Safety Code § 38500 - 38599, Division 25.5, Assembly Bill No. 32, California Global Warming Solutions Act of 2006, September 27, 2006. (web link: http://www.leginfo.ca.gov/pub/05- 06/bill/asm/ab_0001-0050/ab_32_bill_20060927_chaptered.pdf)

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

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

Plan.[17] The plan establishes clear targets to improve freight efficiency, transition to zero-emission technologies (deployment of over 100,000 freight vehicles and equipment capable of zero-emission operation and maximize near-zero emission freight vehicles and equipment powered by renewable energy by 2030), and increase competitiveness of California's freight system. The 2016 California Sustainable Freight Action Plan includes a measure to reduce emissions from diesel-powered TRUs as a State agency action to advance the objectives of the EO and the Sustainable Freight Action Plan.

i. Sustainable Freight Pathways to Zero and Near-Zero Discussion Document

In April 2015, CARB released the Sustainable Freight Pathways to Zero and Near-Zero Discussion Document (Discussion Document)[18] in response to Board Resolution 14-2,[19] which directed CARB to identify and prioritize actions to move California toward a sustainable freight transport system. The Discussion Document set out CARB's vision of a clean freight system, and included immediate and potential near-term CARB actions to be developed for future Board consideration. The near-term CARB measures identified in the Discussion Document included the development of a regulation to achieve additional emission reductions from diesel-powered TRUs.

5. Major Regulation Determination

Per Department of Finance regulations (title 1, California Code of Regulations, sections 2000-2004),[20] the Proposed Amendments are a major regulation requiring a SRIA because the economic impact of the regulation is projected to exceed $50 million in a 12-month period. The Proposed Amendments result in direct costs exceeding $50 million each year beginning in 2025. The Proposed Amendments will become effective October 1, 2022 and be fully implemented by December 31, 2030. The SRIA analyzes costs to comply with the Proposed Amendments from 2022 to 2034.

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[17] California Department of Transportation et al., California Sustainable Freight Action Plan, July 2016. (web link: https://dot.ca.gov/-/media/dot-media/programs/transportation-planning/documents/main-document-final-07272016v2.pdf)

[18] California Air Resources Board, Sustainable Freight Pathways to Zero and Near-Zero Emissions Discussion Document, April 23, 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)

[19] CARB Board Resolution 14-2, Sustainable Freight Strategy Update, January 23, 2014. (web link: https://arb.ca.gov/board/res/2014/res14-2.pdf)

[20] California Code of Regulations § 2000-2004, Division 3, Standardized Regulatory Impact Assessment for Major Regulations. (web link: https://govt.westlaw.com/calregs/Document/IAA1C7210595511E3BFC8D5B3615C797F?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default)&bhcp=1#co_anchor_IA8F81D2F7A734A449389719B2F838650)

6. Baseline Information

CARB staff estimated the economic impacts of the Proposed Amendments by evaluating the economic and emission impacts of the proposal relative to the baseline (Baseline) each year for the analysis period (from 2022 to 2034). The Baseline for the Proposed Amendments reflects full compliance with existing federal emission standards for off-road diesel engines and diesel fuel, as well as with the current TRU ATCM requirements.

For the SRIA, staff used the statewide TRU emission inventory model to estimate emissions under the Baseline and Proposed Amendments, as well as to forecast the number of TRUs each year from 2022 to 2034 for which there are direct costs or benefits associated with the Proposed Amendments. Detailed information on the data sources and methodology used in the statewide TRU emission inventory are described in CARB's Draft 2019 Update to the Emission Inventory for TRUs (2019 Update).[21] While the emission inventory methodology is the same as described in the 2019 Update, the emission impacts reported in the SRIA reflect full compliance with existing regulations.

The Proposed Amendments would impact approximately 8,800 truck TRUs and 269,000 TRUs in the remaining TRU categories. Approximately 95 percent of truck TRU fleets, and 90 percent of trailer TRU fleets are considered small business, respectively. The Proposed Amendments would also impose requirements on approximately 7,800 applicable facilities. Approximately 96 percent of refrigerated WHDCs, and 90 percent of grocery stores are considered small business, respectively. Impacts to these entities are discussed in detail in the Typical and Small Business sections (Section C.2 and C.3).

Figure A8 and Figure A9 show the Baseline statewide PM2.5 and NOx emissions by TRU category in tons per year from 2022 to 2034, respectively. The slight reduction in emissions during the 2027 to 2028 timeframe is because the SRIA requires an analysis of the Proposed Amendments compared to the Baseline, in which full compliance with existing regulations is assumed. The full compliance assumption causes significant turnover in 2020 to force compliance with the TRU ATCM, creating a population surge, particularly in 23 to 25 horsepower units. This population surge will hit the next compliance deadline in 2027.

[21] California Air Resources Board, Draft 2019 Update to Emissions Inventory for Transport Refrigeration Units, October 2019. (web link: https://ww3.arb.ca.gov/cc/cold-storage/documents/hra_emissioninventory2019.pdf)

Figure A8. Baseline Statewide PM2.5 Emissions by TRU Category from 2022 to 2034

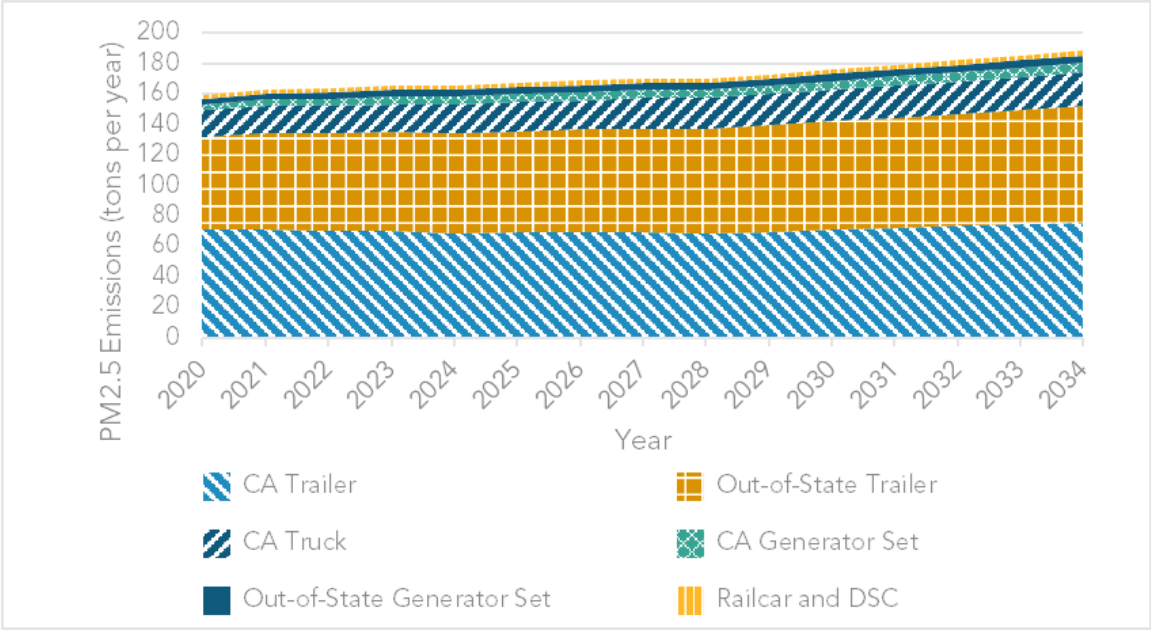
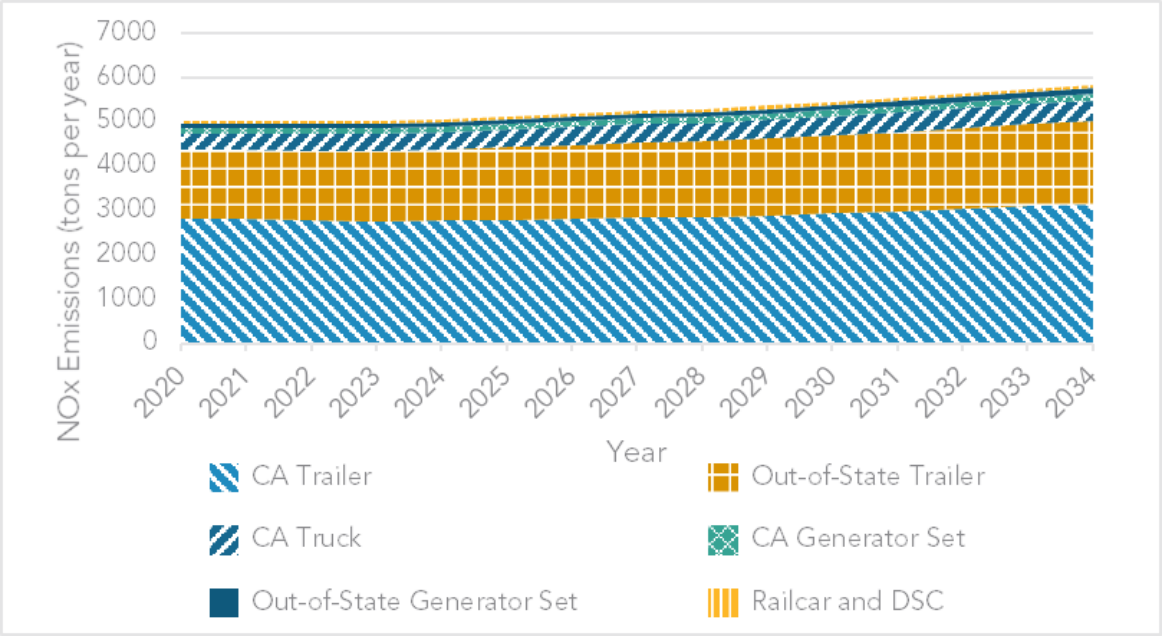


Figure A9. Baseline Statewide NOx Emissions by TRU Category from 2022 to 2034



The current economic situation may have had a slight impact on the refrigerated transport industry and the trajectory of TRU activity, as there have been changes in human activity that resulted in disruptions to the supply chain. In general, consumers shifted food consumption from restaurants to homes. However, while expenditures on food away from home decreased, expenditures on food from grocery stores and other

retail food establishments have increased. In the United States, consumer spending on food and beverages (purchased for off-premises consumption) increased by $84 billion from 2019 to 2020, the largest growth of any sector.[22] Additionally, the national average spot rates for refrigerated freight in December 2020 were at a year-to-date high and well above any level reached in 2019.[23] Staff do not anticipate the economic downturn will have a significant impact on future growth in refrigerated transport, and therefore used historical growth trends for the industry, as described in Section B.1.a.

The first regulatory compliance date that would result in costs to TRU or applicable facility owners to comply with the Proposed Amendments is December 31, 2022. Staff believe this provides adequate time for affected industry to revert to normal economic conditions. In addition, several adjustments were made to the model used to determine the macroeconomic impacts of the Proposed Amendments to reflect the current economic conditions, which are described in Section E.

7. Public Outreach and Input

CARB staff have engaged in an extensive public process since development of the Proposed Amendments began in early 2016. Staff conducted meetings with members of impacted communities, environmental justice advocates, local air districts, industry stakeholders (including TRU owners and operators, TRU dealers and service centers, truck and trailer leasing companies, trade associations, TRU OEMs, electric utilities, freight facility owners and operators, and infrastructure manufacturers), and other interested parties. Meeting formats included public workshops, work group meetings, community meetings, informal meetings, phone calls, and site visits.

a. Public Workshops

CARB staff conducted eight public workshops to solicit stakeholder feedback and discuss regulatory concepts, methodology and data used to develop the emission inventory and conduct a health risk assessment, infrastructure considerations, and compliance and enforcement mechanisms. Staff notified stakeholders of all workshops with the issuance of a public notice at least three weeks prior to their occurrence. Staff posted the notices to the TRU Regulation website[24] and distributed them through

[22] Thomas Mitterling, Nirai Tomass, and Kelsey Wu, "The decline and recovery of consumer spending in the US," December 14, 2020. (web link: https://www.brookings.edu/blog/future-development/2020/12/14/the-decline-and-recovery-of-consumer-spending-in-the-us/)

[23] Freight Waves Passport, "Reefer markets: Ending the year with a bang," December 11, 2020. (web link: https://passport.freightwaves.com/research/reefer-markets-ending-the-year-with-a-bang)

[24] California Air Resources Board, New Transport Refrigeration Unit Regulation Under Development Website. (web link: https://ww2.arb.ca.gov/our-work/programs/transport-refrigeration-unit/new-transport-refrigeration-unit-regulation)

several public list serves that include over 17,000 recipients.[25] Each of these workshops was open to all members of the public. Staff posted meeting materials, including agendas, slide presentations, and draft regulatory language, on CARB's TRU Regulation website in advance of the workshops.

Staff held an initial workshop on April 13, 2016 in Sacramento, California. During this workshop, staff discussed concepts to reduce emissions from stationary TRU operations, and solicited stakeholder feedback and suggestions on additional ideas. The workshop was webcast with the ability to submit questions online to ensure all interested parties could access the information and participate in the discussion.

Staff conducted a second set of public workshops on August 16, 2017 in Sacramento, California, and on August 18, 2017 in Riverside, California. During these workshops, staff presented a draft concept to limit the amount of time that diesel-powered TRUs operate while they are stationary, as well as require an overall zero-emission mode operating time. Staff also discussed emission inventory updates, survey results, and information on available incentive funding. During these workshops, staff introduced stationary operating time limit and electronic telematics system requirements. The Sacramento workshop included 37 participants and 80 webcast participants. The Sacramento workshop was webcast with the ability to submit questions online to ensure the opportunity for broader public participation. The Riverside workshop included 21 participants.

Staff held a third set of public workshops on August 28, 2019 in Fontana, California, on September 3, 2019 in Fresno, California, and on September 11, 2019 in Sacramento, California. In response to the high costs associated with the concept presented at the previous workshops, staff presented a revised concept to require truck TRUs to transition to zero-emission technology, trailer TRUs to utilize zero-emission operation while stationary for more than 15 minutes at applicable facilities, and applicable facilities to install infrastructure to support zero-emission operation. During these workshops, staff introduced diesel emission standards and lower GWP refrigerant requirements. Staff also discussed infrastructure considerations, enforcement and compliance mechanisms, funding opportunities, and solicited stakeholder input on the concept as well as alternatives for the SRIA and Environmental Assessment prepared for the Proposed Amendments. These workshops therefore also served as California Environmental Quality Act (CEQA) scoping meetings. The Fontana workshop included 30 participants, the Fresno workshop included 16 participants, and the Sacramento workshop included 35 participants and 101 webcast participants. The Sacramento workshop was webcast with the ability to submit questions online to ensure the opportunity for broader public participation.

[25] Number of subscribers for the following CARB lists as of January 28, 2021: Agricultural Activities, Community Air, Environmental Justice ChERRP, Commerce, Environmental Justice ChERRP, Mira Loma, Environmental Justice ChERRP, Wilmington, Goods Movement Emission Reduction Program, Port Truck, Reduction of GHG Emissions from Refrigerated Shipping Containers, Stationary Equipment Refrigerant Management Program, Sustainable Freight Transport Initiative, and Transport Refrigeration Units.

Staff held a non-regulatory workshop on October 31, 2019 in Sacramento, California, to discuss emission inventory updates and the preliminary health analyses for the draft concept of the Proposed Amendments. At this workshop, staff discussed updates to the statewide TRU emission inventory and presented draft results from these updates. Staff also presented the methodology, data inputs, and results related to the health impacts from TRUs. The workshop included 22 participants. The workshop was webcast with the ability to submit questions online to ensure the opportunity for broader public participation.

Staff conducted a final workshop on March 19, 2020 via teleconference to discuss the updated concept in response to input received on the draft concept presented at workshops in August and September of 2019. During the call, staff discussed refined regulatory concepts, draft regulatory language, and updated health risk and emission inventory estimates. The teleconference included 299 participants. To facilitate the exchange of information, staff created an informal comment submittal form available for stakeholders to submit comments on the draft regulatory language. The teleconference was open to the public and staff encouraged participation by all parties.

b. Work Group Meetings

CARB staff conducted three work group meetings to solicit stakeholder feedback and discuss regulatory concepts, costs, infrastructure considerations, and compliance and enforcement mechanisms.

Staff held a work group meeting on November 3, 2017 in Sacramento, California to discuss costs, fleet operational needs, and technology readiness to successfully deploy and expand the zero-emission TRU market, as well as enforcement and infrastructure issues identified at the August 2017 workshops. Staff invited key stakeholders. Participants included environmental justice advocacy groups, local air districts, TRU owners and operators, TRU dealers, trade associations, TRU OEMs, electric utilities, freight facility owners and operators, infrastructure manufacturers, and electronic telematics system (ETS) suppliers. During the meeting, staff again solicited stakeholder suggestions for regulatory alternatives. The work group meeting included 47 participants.

Staff held a second work group meeting on December 17, 2019 in Sacramento, California, to discuss infrastructure-related issues identified at the workshops held in August and September 2019. Staff invited key stakeholders. Participants included TRU owners and operators, trade associations, TRU OEMs, electric utilities, freight facility owners and operators, and infrastructure manufacturers. During the meeting, staff discussed the proposed timeline for infrastructure, electricity costs, potential inclusion of a plug standard, and infrastructure-related cost data and assumptions. Stakeholders indicated that CARB should not include a plug standard in the Proposed Amendments and allow the market and ongoing industry efforts to develop one. The work group meeting included 22 participants.

Staff held a third work group meeting on July 29, 2020 via webinar to discuss enforcement-related issues identified during the workshops held in August 2019, September 2019, and March 2020. The work group meeting was open to the public. During the meeting, staff outlined potential enforcement strategies for each of the requirements in the Proposed Amendments and solicited stakeholder feedback. The work group meeting included 223 participants.

c. Stakeholder Meetings and Site Visits

As of April 2021, CARB staff have conducted more than 160 informal meetings, phone calls, and site visits with a broad group of stakeholders to develop the Proposed Amendments, discuss regulatory concepts, and gather input. Stakeholders included members of impacted communities, environmental justice advocates, local air districts, TRU owners and operators, trade associations, TRU OEMs, TRU dealers and service centers, truck and trailer dealers, TRU truck and trailer leasing companies, freight brokers, forwarders, shippers, receivers, freight facility owners and operators, and other interested parties.

In addition to meeting with a wide range of stakeholders, staff also conducted targeted outreach to potential applicable facilities. This included mailing over 40,000 postcards to facilities with refrigerated operations potentially affected by the Proposed Amendments to notify them of upcoming workshops and direct them to the TRU Regulation website for more information. Staff also visited several facilities, including refrigerated warehouses, distribution centers, CSWs, port terminals, and railyards to learn more about their business operations and to better understand potential implementation challenges associated with the Proposed Amendments.

Staff also held several meetings with agriculture stakeholders to discuss the Proposed Amendments. In 2017, staff traveled to Fresno to discuss issues regarding freight facilities and TRUs. Staff held conference calls with several agricultural association representatives on August 15, 2018 and March 11, 2019 to brief them on the Proposed Amendments and received several comments regarding the industry's seasonal operations. On September 3, 2019, staff traveled to Fresno to conduct a public workshop on the Proposed Amendments. Staff also provided an update to the San Joaquin Valley Air Pollution Control District Citizens Advisory Committee at their March 3, 2020 meeting and met with stakeholders to discuss the Proposed Amendments.

d. Informational Documents

Staff developed two informational documents that were made available to the public. In August 2020, staff posted a preliminary cost document on the TRU Regulation website for public comment which outlined the cost inputs and assumptions to be used for the economic analysis of the Proposed Amendments. In January 2021, in response to stakeholder questions received, staff posted an informational document on the TRU Regulation website to provide additional clarification on the key elements included in the Proposed Amendments.

B. Benefits

The Proposed Amendments are designed to reduce toxic air contaminant, criteria pollutant, and GHG emissions by transitioning diesel-powered truck TRUs to zero-emission, as well as requiring newly manufactured TRU engines in the remaining categories to meet a PM emission standard, and the use of lower GWP refrigerant. Cumulatively, from 2022 to 2034, the Proposed Amendments are expected to reduce statewide TRU emissions by approximately 1,258 tons of PM2.5, 3,515 tons of NOx, and 1.42 million metric tonnes of carbon dioxide equivalents (MMTCO2e), relative to the Baseline. The total statewide valuation of avoided health outcomes from 2022 to 2034 is approximately $1.75 billion.

1. Emission Benefits

a. Inventory Methodology

CARB estimates TRU emissions in California using the statewide TRU emission inventory model. The data sources and methodology used in the statewide TRU emission inventory model are described in CARB's Draft 2019 Update to Emissions Inventory for TRUs.[26]

TRU populations are based on data reported in the Air Resources Board Equipment Registration (ARBER) System.[27] Under the current TRU ATCM, owners of TRUs based in California are required to report their TRUs to CARB. Owners of TRUs that are based outside California may report their TRUs to CARB to facilitate travel within the State, but are not required to do so. ARBER maintains information for all TRUs reported to CARB. The out-of-state TRU populations are scaled up based on heavy-duty truck populations from the CARB Emission Factor (EMFAC) inventory model.[28,29] Additionally, the ARBER populations are scaled up 3.7 percent to account for non-reported TRUs, which is based on CARB enforcement data.[30]

New sales population estimates also come from the statewide TRU emission inventory and are based on expected turnover and growth.[31] Turnover is dependent on the

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[26] California Air Resources Board, Draft 2019 Update to Emissions Inventory for Transport Refrigeration Units, October 2019. (web link: https://ww3.arb.ca.gov/cc/cold-storage/documents/hra_emissioninventory2019.pdf)
[27] California Air Resources Board, Air Resources Board Equipment Registration System. (web link: https://arber.arb.ca.gov/, last accessed July 2020)
[28] California Air Resources Board, EMFAC2017 Database. (web link: https://www.arb.ca.gov/emfac/2017/, last accessed June 2020)
[29] Since the TRU inventory update, a new version of EMFAC (EMFAC2021) has been released. However, the in-state versus out-of-state heavy-duty truck populations in EMFAC2021 are not significantly different from those in EMFAC2017.
[30] California Air Resources Board, Draft 2019 Update to Emissions Inventory for Transport Refrigeration Units, October 2019. (web link: https://ww2.arb.ca.gov/sites/default/files/classic//cc/cold-storage/documents/hra_emissioninventory2019.pdf)
[31] California Air Resources Board, Draft 2019 Update to Emissions Inventory for Transport Refrigeration Units, October 2019. (web link: https://ww2.arb.ca.gov/sites/default/files/classic//cc/cold-storage/documents/hra_emissioninventory2019.pdf)

number of units that will likely retire in a given year utilizing a survival curve, which characterizes the retirement behavior for different ages. The annual population growth rate is determined primarily by TRU population trends from Americas Commercial Transportation Research (ACT Research). Based on TRU population data from ACT Research, the annual population growth reflected in the TRU emission inventory is 1.6 percent.[32]

The current inventory uses a 2019 baseline and forecasts emissions for future years for each TRU category and pollutant. The emission inventory for any given year is calculated by combining the TRU population, hours of TRU engine activity, TRU engine horsepower, load factors, emission factors, and fuel correction factors, in the following equation:

$$Emissions = Population \times Activity \times Hp \times LF \times EF \times FCF$$

Where:

Population = Count of equipment population (unit-less)
Activity = Time the engine is running (hours)
Hp = Horsepower of the engine (maximum brake horsepower)
LF = Load factor (unit-less)
EF = Emission factor (grams per kilowatt-hour) specific to horsepower and MY and pollutant, and includes deterioration
FCF = Fuel correction factor based on calendar year (unit-less)

CARB staff estimated PM2.5, NOx, and GHG emissions for the Proposed Amendments compared to the Baseline. Staff quantified emission benefits from 2022 to 2034, which is consistent with the timeframe used for the cost analysis. Table B1 summarizes the assumptions staff used to model the emission reductions for each emission control requirement of the Proposed Amendments.

Table B1. Emission Inventory Modeling Assumptions

Requirement	Modeling Assumption
Zero-emission truck TRUs	Modeled by a linear reduction in the activity, fuel, and emissions from diesel-powered truck TRUs.
Newly manufactured trailer TRU, DSC TRU, railcar TRU, and TRU generator set engines meet PM emission standard	Modeled by reducing PM emissions for new sales of trailer TRUs, DSC TRUs, railcar TRUs, and TRU generator sets by 85 percent, for those TRUs that do not already meet the 0.02 PM standard.
Newly manufactured truck TRUs, trailer TRUs, and DSC TRUs use lower GWP refrigerant	Modeled by reducing the CO2-equivalent emissions resulting from the use of R-452A refrigerant (GWP=2,141) compared to the current predominantly used R-404A refrigerant (GWP=3,922) for newly manufactured truck TRUs, trailer TRUs, and DSC TRUs.

[32] Americas Commercial Transportation Research Co., LLC, U.S. Reefer Population Growth, Proprietary, 2018. (web link: http://www.actresearch.net)

b. Anticipated Emission Benefits

The Proposed Amendments are expected to reduce PM2.5, NOx, and GHG emissions from TRUs beyond levels that would be achieved under the current TRU ATCM. Staff estimate that from 2022 to 2034, the Proposed Amendments would further reduce cumulative statewide emissions by approximately 1,258 tons of PM2.5, 3,515 tons of NOx, and 1.42 MMTCO2e. PM2.5 emission reductions would begin in 2023 when newly manufactured TRU engines would be required to meet a PM emission standard, NOx emission reductions would begin in 2024 when diesel-powered truck TRUs begin to transition to zero-emission technology, and GHG reductions would begin in 2023 when newly manufactured TRUs would be required to use lower GWP refrigerant. Table B2 shows the estimated annual emission reductions that would result from the Proposed Amendments from 2022 to 2034.

Table B2. Estimated Annual PM2.5, NOx, and GHG Emission Reductions Resulting from the Proposed Amendments from 2022 to 2034

Year	PM2.5 (tons)	NOx (tons)	GHG (MMTCO2e)[33]
2022	0	0	0.00
2023	16	0	0.01
2024	32	59	0.03
2025	48	119	0.05
2026	65	181	0.07
2027	83	246	0.09
2028	115	312	0.12
2029	133	381	0.14
2030	148	430	0.16
2031	151	436	0.17
2032	153	443	0.18
2033	155	451	0.19
2034	158	458	0.20
Total	1,258	3,515	1.42

Figure B1, Figure B2, and Figure B3 show the PM2.5, NOx, and GHG emissions impact of the Proposed Amendments relative to the Baseline from 2022 to 2034.

[33] Includes GHG emission reductions from TRU engine and refrigerant.

Figure B1. Statewide PM2.5 Emissions from TRUs under the Baseline and Proposed Amendments from 2022 to 2034

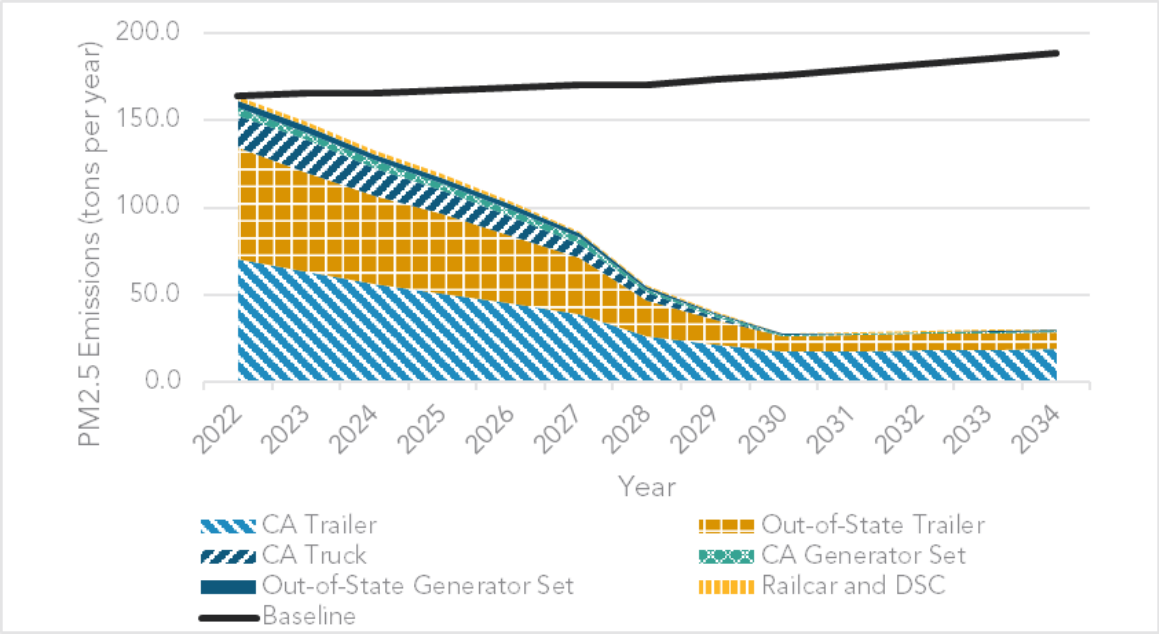


Figure B2. Statewide NOx Emissions from TRUs under the Baseline and Proposed Amendments from 2022 to 2034

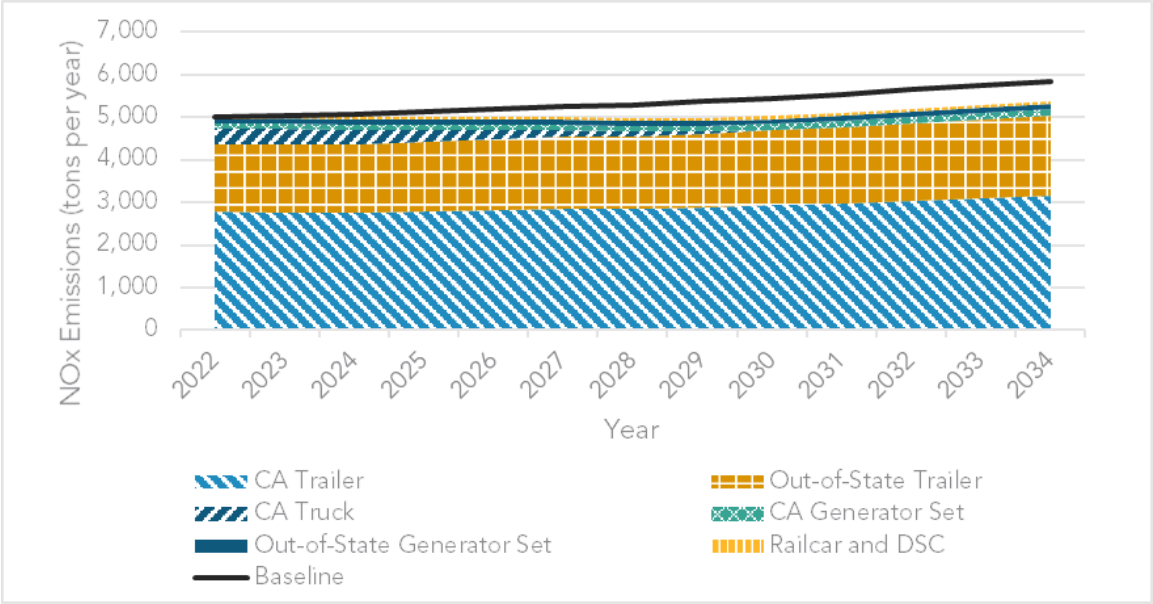
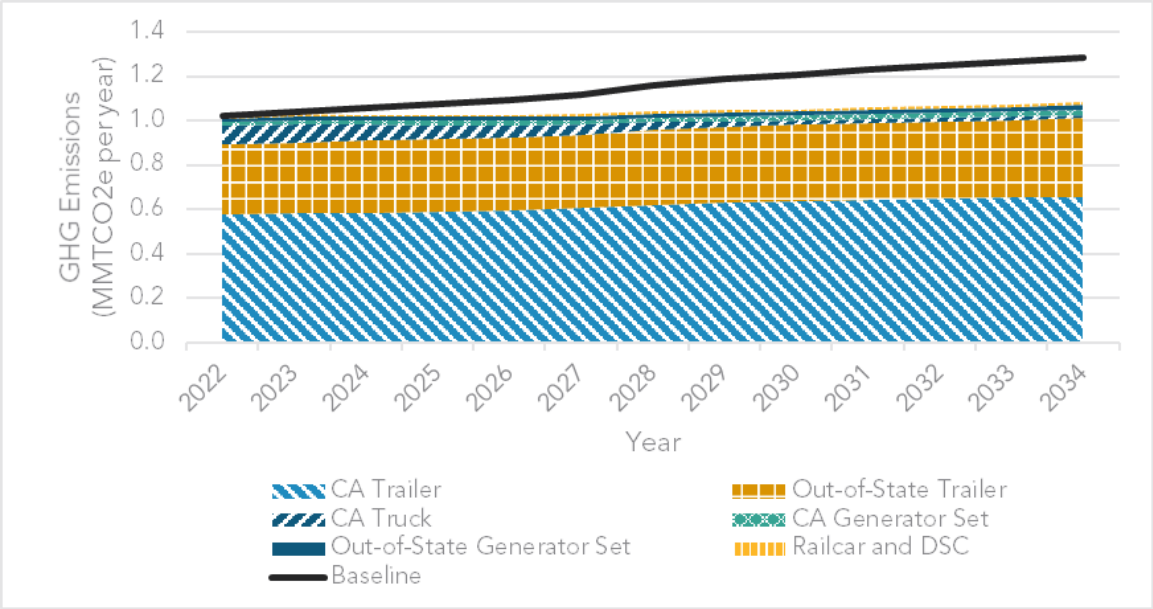


Figure B3. Statewide GHG Emissions from TRUs under the Baseline and Proposed Amendments from 2022 to 2034[34]



2. Benefits to Typical Businesses

The Proposed Amendments will provide opportunities for design, engineering, construction, and project management firms to design new and expanded infrastructure at an estimated 989 truck TRU home base facilities statewide. The increase in electric charging and fueling infrastructure will also benefit suppliers, equipment installers, and electricians. All of the installations will be in California, and some of the infrastructure equipment may be manufactured in California. One manufacturer, ESL Power Systems, has primary operations based in California.[35]

Increased purchases of zero-emission TRUs under the Proposed Amendments will also benefit zero-emission TRU manufacturers, wholesalers, and retailers, as well as various businesses in the zero-emission TRU supply chain, including those involved in battery, fuel cell, cold plate, and solar photovoltaic technology throughout the State. One zero-emission TRU manufacturer, Clean Cold Power, has indicated to staff that equipment will be assembled in California.[36] Individual businesses that own zero-emission TRUs may also be able to lower their total cost of ownership with operational and maintenance cost savings, and credits generated under the Low Carbon Fuel Standard (LCFS) program.

[34] Includes GHG emissions from TRU engine and refrigerant.
[35] ESL Power Systems, Inc. (web link: https://eslpwr.com/, last accessed May 5, 2021)
[36] Phone conversation between Brett Gipe and Michael Britt (Clean Cold Power) and Lea Yamashita (CARB) on December 10, 2020.

3. Benefits to Small Businesses

Electricians, engineering, construction, and project management companies; parts and components businesses; and others involved in designing, installing, and maintaining electric and fueling infrastructure equipment may fall into the small business category. The benefits to zero-emission TRU manufacturers and other related businesses discussed above also apply to small businesses.

4. Benefits to Individuals

The Proposed Amendments will benefit California residents by reducing cancer risk to individual residents and off-site workers near facilities where TRUs operate; reducing non-cancer health impacts by lower direct PM exposure and secondary formation of PM2.5 from NOx; improving air quality and resulting ozone exposure from reductions in NOx; and providing GHG emission reductions needed to combat climate change. Emission reductions will also reduce occupational exposure and benefit on site workers, including, but not limited to TRU operators, drivers, and other individuals who work at facilities where TRUs operate. Staff estimated the statewide value of health benefits from reduced PM2.5 and NOx emissions, as well as the value of GHG emission reductions using the social cost of carbon, as described below.

a. Health Benefits

Exposure to pollution from the diesel engines that power TRUs has both potential cancer and non-cancer health impacts. Staff conducted a health risk assessment to evaluate the benefits of the Proposed Amendments regarding potential cancer risk resulting from direct exposure to diesel PM from TRUs. Staff also estimated the non-cancer health impacts, such as cardiopulmonary mortality, hospitalizations for cardiovascular illness and respiratory illness, and emergency room visits for asthma associated with exposure to ambient levels of directly emitted PM2.5 and secondary PM2.5 formed in the atmosphere from TRU NOx emissions.

Additional information regarding the emission inputs, air dispersion modeling, and the methodology for calculating potential cancer risk can be found in CARB's 2019 Preliminary Health Analyses for the Transport Refrigeration Unit Regulation (Preliminary Health Analyses).[37] The values reported in the Preliminary Health Analyses are based on a previous draft concept for the Proposed Amendments presented at workshops in August and September 2019. While the health analysis methodology is the same as described in the Preliminary Health Analyses, the health risk, impacts, and valuations reported in the SRIA reflect the Proposed Amendments.

i. Reduction in Potential Cancer Risk

Based on staff's analysis, the facility types with the highest estimated contribution of statewide diesel PM emissions from the diesel engines that power TRUs are

[37] California Air Resources Board, Preliminary Health Analyses: Transport Refrigeration Unit Regulation, October 18, 2019. (web link: https://ww2.arb.ca.gov/sites/default/files/classic//cc/cold-storage/documents/hra_healthanalyses2019.pdf)

refrigerated WHDCs (which include CSWs) and grocery stores. Therefore, the health risk assessment evaluated the cancer risk associated with emissions from TRUs operating at CSWs and grocery stores. CSWs range in size depending on the location and type of operation. Due to the variability in size and operation, staff modeled the risk at a generic CSW and a generic grocery store.

Potential cancer risk is expressed as the chance an individual has of developing cancer if a million people were continuously exposed to a toxic air contaminant for a specified duration of exposure. Staff calculated potential cancer risk values for two exposure scenarios: individual residential exposure and off-site worker exposure.

1) Individual Residential Cancer Risk

The cancer risk to an individual resident is based on an assumed 30-year exposure duration. After full implementation of the Proposed Amendments, individual residential cancer risk from TRU operations at CSWs is estimated to be reduced by 58 percent compared to the business-as-usual scenario (BAU). Similarly, after full implementation, individual residential cancer risk from TRU operations at grocery stores is estimated to be reduced by 57 to 72 percent compared to BAU, depending on the operational scenario.

2) Off-Site Worker Cancer Risk

For the evaluation of off-site worker cancer risk, staff assumed that a worker outside a CSW or grocery store is exposed to the emission sources for 25 years, 8 hours per day, and 250 days per year. After full implementation of the Proposed Amendments, off-site worker cancer risk from TRU operations at a CSW is estimated to be reduced by 58 percent compared to BAU. Off-site worker cancer risk from TRU operations at a grocery store is estimated to be reduced by 58 to 71 percent compared to BAU, depending on the operational scenario. Although the health risk assessment only evaluated exposure to individual residents and off-site workers, the Proposed Amendments are also expected to reduce occupational exposure of on-site workers, including, but not limited to TRU operators, drivers, and other individuals who work at facilities where TRUs operate.

ii. Non-Cancer Health Impacts and Valuations

CARB staff evaluated the statewide non-cancer health impacts associated with exposure to PM2.5 and NOx emissions from TRUs. NOx includes nitrogen dioxide, a potent lung irritant, which can aggravate lung diseases such as asthma when inhaled.[38] However, the most serious quantifiable impacts of NOx emissions occur through the conversion of NOx to fine particles of ammonium nitrate aerosol through chemical processes in the atmosphere. PM2.5 formed in this manner is termed secondary PM2.5. Both directly emitted PM2.5 and secondary PM2.5 from TRUs is associated with adverse health outcomes, such as cardiopulmonary mortality, hospitalizations for

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

cardiovascular illness and respiratory illness, and emergency room visits for asthma. As a result, reductions in PM2.5 and NOx emissions are associated with reductions in these health outcomes.

1) Incidence-Per-Ton Methodology

CARB uses the incidence-per-ton (IPT) methodology to quantify the health benefits of emission reductions in cases where dispersion modeling results are not available. A description of this method is included on CARB's webpage.[39] CARB's IPT methodology is based on the methodology developed by U.S. EPA.[40,41,42]

Under the IPT methodology, 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 emission reductions from the Proposed Amendments in an air basin by the IPT factor then yields an estimate of the reduction in health outcomes achieved by the Proposed Amendments. 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.

2) Reduction in Adverse Health Impacts

CARB staff evaluated the reduction in adverse health impacts including cardiopulmonary mortality, hospitalizations for cardiovascular illness and respiratory illness, and emergency room visits for asthma. Staff estimates that the total number of

[39] CARB's Methodology for Estimating the Health Effects of Air Pollution. Retrieved February 9, 2021, from https://ww2.arb.ca.gov/resources/documents/carbs-methodology-estimating-health-effects-air-pollution

[40] Fann N, Fulcher CM, Hubbell BJ., The influence of location, source, and emission type in estimates of the human health benefits of reducing a ton of air pollution, Air Quality, Atmosphere & Health, 2:169-176, 2009. (web link: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2770129/)

[41] Fann N, Baker KR, Fulcher CM., Characterizing the PM2.5-related health benefits of emission reductions for 17 industrial, area and mobile emission sectors across the U.S. Environ Int.; 49:141-51, November 15, 2012. (web link: https://www.sciencedirect.com/science/article/pii/S0160412012001985)

[42] Fann N, Baker K, Chan E, Eyth A, Macpherson A, Miller E, Snyder J., Assessing Human Health PM2.5 and Ozone Impacts from U.S. Oil and Natural Gas Sector Emissions in 2025, Environ. Sci. Technol. 52 (15), pp 8095–8103, 2018. (web link: https://pubs.acs.org/doi/abs/10.1021/acs.est.8b02050)

cases statewide that will be reduced (from 2022 to 2034) from implementation of the Proposed Amendments are as follows:

- 177 premature deaths reduced (138 to 217, 95 percent confidence interval (CI))
- 57 hospital admissions for cardiovascular illness reduced (7 to 106, 95 percent CI)
- 87 emergency room visits reduced (55 to 119, 95 percent CI)

Table B3 shows the estimated reductions in health outcomes resulting from the Proposed Amendments from 2022 to 2034.

Table B3. Estimated Total Reductions in Health Outcomes as a Result of the Proposed Amendments from 2022 to 2034

Air Basin	Cardiopulmonary Mortality	Hospital Admissions	Emergency Room Visits
Great Basin Valleys	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Lake County	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Lake Tahoe	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Mojave Desert	2 (2 -3)	1 (0 - 1)	1 (1 - 1)
Mountain Counties	1 (1 - 1)	0 (0 - 0)	0 (0 - 0)
North Central Coast	1 (1 - 2)	0 (0 - 1)	1 (0 - 1)
North Coast	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Northeast Plateau	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Sacramento Valley	7 (5 - 8)	2 (0 - 3)	2 (2 - 3)
Salton Sea	1 (1 - 2)	0 (0 - 1)	1 (0 - 1)
San Diego County	6 (5 - 7)	2 (0 - 3)	2 (2 - 3)
San Francisco Bay Area	20 (16 - 25)	7 (1 - 12)	11 (7 - 15)
San Joaquin Valley	22 (17 - 27)	5 (1 - 9)	8 (5 - 11)
South Central Coast	2 (1 - 2)	0 (0 - 1)	1 (0 - 1)
South Coast	115 (89 - 140)	40 (5 - 74)	59 (37 - 81)
Total	177 (138 - 217)	57 (7 -106)	87 (55 - 119)

Note: The values in parentheses represent the 95% confidence intervals of the central estimate. Totals may not add due to rounding.

3) Monetization of Health Impacts

In accordance with U.S. EPA practice, CARB staff monetized health outcomes by multiplying incidence by a standard value derived from economic studies.[43] Table B4

[43] National Center for Environmental Economics et al., Appendix B: Mortality Risk Valuation Estimates, Guidelines for Preparing Economic Analyses (EPA 240-R-10-001), December 2010. (web link: https://www.epa.gov/sites/production/files/2017-09/documents/ee-0568-22.pdf)

shows the valuation per incident avoided health outcome in 2019 U.S. Dollars (2019$). The valuation for avoided premature mortality is based on willingness to pay.[44] This value 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 risk of dying in a year, such that one death would be avoided in the year across the population. This is not an estimate of how much any single individual would be willing to pay to prevent a certain death of any particular person,[45] nor does it consider any specific costs associated with mortality, such as hospital expenditures.

Unlike premature mortality valuation, the valuation for avoided hospitalizations and emergency room visits is based on a combination of typical costs associated with hospitalization and the willingness of surveyed individuals to pay to avoid adverse outcomes that occur when hospitalized. These include hospital charges, post-hospitalization medical care, out-of-pocket expenses, lost earnings for both individuals and family members, lost recreation value, and lost household protection (e.g., valuation of time-losses from inability to maintain the household or provide childcare). These costs are most closely associated with specific cost savings to individuals and costs to the health care system.

Table B4. Valuation per Incident Avoided Health Outcomes (2019$)

Outcome	Valuation per Incident
Avoided Premature Deaths	$9,864,695
Avoided Cardiovascular Hospitalizations	$58,288
Avoided Acute Respiratory Hospitalizations	$50,842
Avoided Emergency Room Visits	$834

The statewide valuation of health benefits is calculated by multiplying the number of avoided adverse health outcomes by valuation per incident. Staff quantified the annual and total statewide valuation of avoided adverse health outcomes from 2022 to 2034, as shown in Table B5 and Table B6, respectively. The statewide distribution of these benefits follow the distribution of emission reductions and avoided adverse health outcomes; therefore, most benefits to individuals will occur in the South Coast, San Joaquin Valley, and San Francisco Bay Area air basins.

[44] United States Environmental Protection Agency Science Advisory Board (U.S. EPA-SAB), An SAB Report on EPA's White Paper Valuing the Benefits of Fatal Cancer Risk Reduction (EPA-SAB-EEAC-00-013), July 2000. (web link: http://yosemite.epa.gov/sab%5CSABPRODUCT.NSF/41334524148BCCD6852571A700516498/$File/eeacf013.pdf)

[45] United States Environmental Protection Agency, Mortality Risk Valuation – What does it mean the place a value on a life? (web link: https://www.epa.gov/environmental-economics/mortality-risk-valuation#means)

Table B5. Annual Statewide Valuation of Avoided Adverse Health Outcomes as a Result of the Proposed Amendments from 2022 to 2034 (2019$)

Year	Valuation
2022	$0
2023	$16,729,000
2024	$39,549,000
2025	$61,580,000
2026	$86,590,000
2027	$113,408,000
2028	$155,747,000
2029	$183,967,000
2030	$207,522,000
2031	$213,218,000
2032	$219,004,000
2033	$224,831,000
2034	$230,766,000

Note: Values have been rounded to the nearest thousand.

Table B6. Total Statewide Valuation of Avoided Adverse Health Outcomes as a Result of the Proposed Amendments from 2022 to 2034 (2019$)

Outcome	Valuation
Avoided Premature Deaths	$1,749,747,000
Avoided Hospitalizations	$3,092,000
Avoided Emergency Room Visits	$73,000
Total	$1,752,912,000

Note: Values have been rounded to the nearest thousand.

In addition to the monetized health impacts, additional health benefits associated with emission reductions will be achieved by the Proposed Amendments. These additional health benefits, including elevated vulnerability and impacts in disadvantaged communities, work loss days, school loss days, brain and lung health, cancer risk, and birth outcomes, currently are not monetized. Staff are developing methodologies that will allow these additional benefits to be quantified in the future.

b. Social Cost of Carbon

The benefit of GHG reductions achieved by the Proposed Amendments can be estimated using the social cost of carbon (SC-CO2), which provides a dollar valuation of the damages caused by one ton of carbon pollution and represents the monetary benefit today of reducing carbon emissions in the future.

The Council of Economic Advisors and the Office of Management and Budget convened an Interagency Working Group on the Social Cost of Greenhouse Gases (IWG) to develop a methodology for estimating the SC-CO2. The methodology relies on a standardized range of assumptions and can be used consistently when estimating

the benefits of regulations across agencies and around the world.[46] Staff utilized the current 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 Revised 2017 Climate Change Scoping Plan, in line with the Office of Management and Budget Circular A-4 of September 17, 2003, and reflects the best available science in the estimation of the socio-economic impacts of carbon.[47,48]

The IWG describes the social cost of carbon as follows:

"The social cost of carbon (SC-CO2) for a given year is an estimate, in dollars, of the present discounted value of the future damage caused by a 1-metric ton increase in carbon dioxide (CO2) emissions into the atmosphere in that year, or equivalently, the benefits of reducing CO2 emissions by the same amount in that year. The SC-CO2 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 CO2.

These damages include, but are not limited to, changes in net agricultural productivity, energy use, human health, property damage from increased flood risk, as well as nonmarket damages, such as the services that natural ecosystems provide to society. Many of these damages from CO2 emissions today will affect economic outcomes throughout the next several centuries."[49]

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 future emissions cause incrementally larger damages. A higher discount rate decreases the value today of future environmental damages. This analysis uses the IWG standardized range of discount rates from 2.5 to 5 percent to represent varying valuation of future damages. Table B7 shows the range of IWG SC-CO2 values used in California's regulatory assessments.[50,51]

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[46] Additional technical detail on the IWG process is available in the Technical Updates of the Social Cost of Carbon for Regulatory Impact Analysis – Under Executive Order 12866 (by the Interagency Working Group on Social Cost of Greenhouse Gases, United States Government). (web link: https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf, and https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/scc_tsd_final_clean_8_26_16.pdf)
[47] California Air Resources Board, California's 2017 Climate Change Scoping Plan, November 2017. (web link: https://www.arb.ca.gov/cc/scopingplan/scoping_plan_2017.pdf)
[48] Office of Management and Budgets, Circular A-4. (web link: https://www.transportation.gov/sites/dot.gov/files/docs/OMB%20Circular%20No.%20A-4.pdf)
[49] National Academies of Sciences, Engineering, Medicine, Valuing Climate Damages: Updating Estimation of Carbon Dioxide. (web link: http://www.nap.edu/24651)
[50] The SC-CO2 values are of July 2015 and are available at: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis - Under Executive Order 12866, revised July 2015. (web link: https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf)
[51] The IWG SC-CO2 values are provided in 2007 dollars. Staff adjusted from 2007 to 2019 dollars by using the California Department of Finance Consumer Price Index (CPI-U), adjusting from 2007 dollars to 2019 dollars. (web link: https://www.dof.ca.gov/Forecasting/Economics/Indicators/Inflation/documents/CPI_All_Item_CY.xlsx)

Table B7. Social Cost of Carbon (2019$/Metric Ton)

Year	5 Percent Discount Rate	3 Percent Discount Rate	2.5 Percent Discount Rate
2020	$15	$54	$80
2025	$18	$59	$88
2030	$21	$65	$94
2035	$23	$71	$101
2040	$27	$77	$108
2045	$30	$83	$115
2050	$34	$89	$123

If all of the expected emission reductions projected under the Proposed Amendments are achieved and assumed to be equivalent to CO2 reductions, the avoided SC-CO2 in a given year is the total emission reductions (in MTCO2e multiplied by the SC-CO2 (in $/MTCO2e) for that year. The annual emission reductions from the Proposed Amendments and the estimated benefits are shown in Table B8. The total benefits range between $29 million to $134 million from 2022 to 2034, depending on the discount rate.

Table B8. Avoided Social Cost of CO2 from 2022 to 2034 (Million 2019$)

Year	GHG Emission Reductions (MMTCO2e)	5 Percent Discount Rate	3 Percent Discount Rate	2.5 Percent Discount Rate
2022	0.00	$0	$0	$0
2023	0.01	$0	$1	$1
2024	0.03	$1	$2	$3
2025	0.05	$1	$3	$4
2026	0.07	$1	$4	$6
2027	0.09	$2	$6	$8
2028	0.12	$2	$7	$11
2029	0.14	$3	$9	$13
2030	0.16	$3	$10	$15
2031	0.17	$4	$11	$16
2032	0.18	$4	$12	$18
2033	0.19	$4	$13	$19
2034	0.20	$5	$14	$20
Total	1.42	$29	$92	$134

SC-CO2, while intended to be a comprehensive estimate of the damages caused by carbon globally, does not represent the cumulative cost of climate change and air pollution to society. There are additional costs to society outside of the SC-CO2, including costs associated with changes in co-pollutants, the social cost of other GHGs including methane and nitrous oxide, and costs that cannot be included due to modeling and data limitations. The Intergovernmental Panel on Climate Change has

stated that the IWG SC-CO2 estimates are likely underestimated due to the omission of impacts that cannot be accurately monetized, including important physical, ecological, and economic impacts.[52]

c. Other Benefits

i. Establishing Zero-Emission Technology in the Off-Road Sector

The Proposed Amendments will transition truck TRUs to zero-emission technology. Truck TRUs provide a unique opportunity to increase zero-emission technology in the off-road sector. Truck TRUs are generally used for local and regional delivery, and return to a home base each night. Due to their daily operational characteristics and the operating range of current technologies, truck TRUs are well suited for zero-emission. As more fleets use zero-emission truck TRU technologies as a result of the Proposed Amendments, industry acceptance of advanced technologies will improve. The current state of zero-emission TRU technology will progress and expand into extended range applications, as well as other off-road sectors.

ii. Infrastructure

The Proposed Amendments will increase the installation of electric charging and fueling infrastructure needed to support the use of zero-emission truck TRUs. Advanced TRU technologies are underutilized due in part to limited access to supporting infrastructure at the facilities where TRUs operate. Additional installations of electric charging and fueling infrastructure will support the use of these technologies, as well as other advanced technology equipment and vehicles onsite.

The increased use of electric charging infrastructure will also increase the amount of electricity supplied by utility providers and help the State's investor-owned utilities meet the goals of SB 350.[53] SB 350 requires the State's investor-owned utilities to develop programs to accelerate widespread transportation electrification with goals to reduce dependence on petroleum, increase the uptake of zero-emission vehicles, help meet air quality standards, and reduce GHGs. The three large investor-owned utilities in the State, Pacific Gas & Electric, San Diego Gas & Electric, and Southern California Edison, all have programs to install make-ready charging infrastructure for TRUs. In addition, all three large investor-owned utilities have either proposed or have been approved to establish new commercial electricity rate options that make charging more affordable during certain times of the day. Although not required by SB 350, several publicly-owned utilities have taken similar action. For example, Los Angeles Department of Water and Power and Sacramento Municipal Utility District have make ready charging infrastructure programs and new commercial rates for charging. The Proposed Amendments support the utilities' programs and the goals of SB 350 by

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[52] Intergovernmental Panel on Climate Change, Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007. (web link: https://www.ipcc.ch/site/assets/uploads/2018/03/ar4_wg3_full_report-1.pdf)

[53] California Legislature, Senate Bill No. 350, signed October 7, 2015. (web link: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160SB350)

increasing the number of zero-emission TRUs in the State to make use of these utility investments and rates.

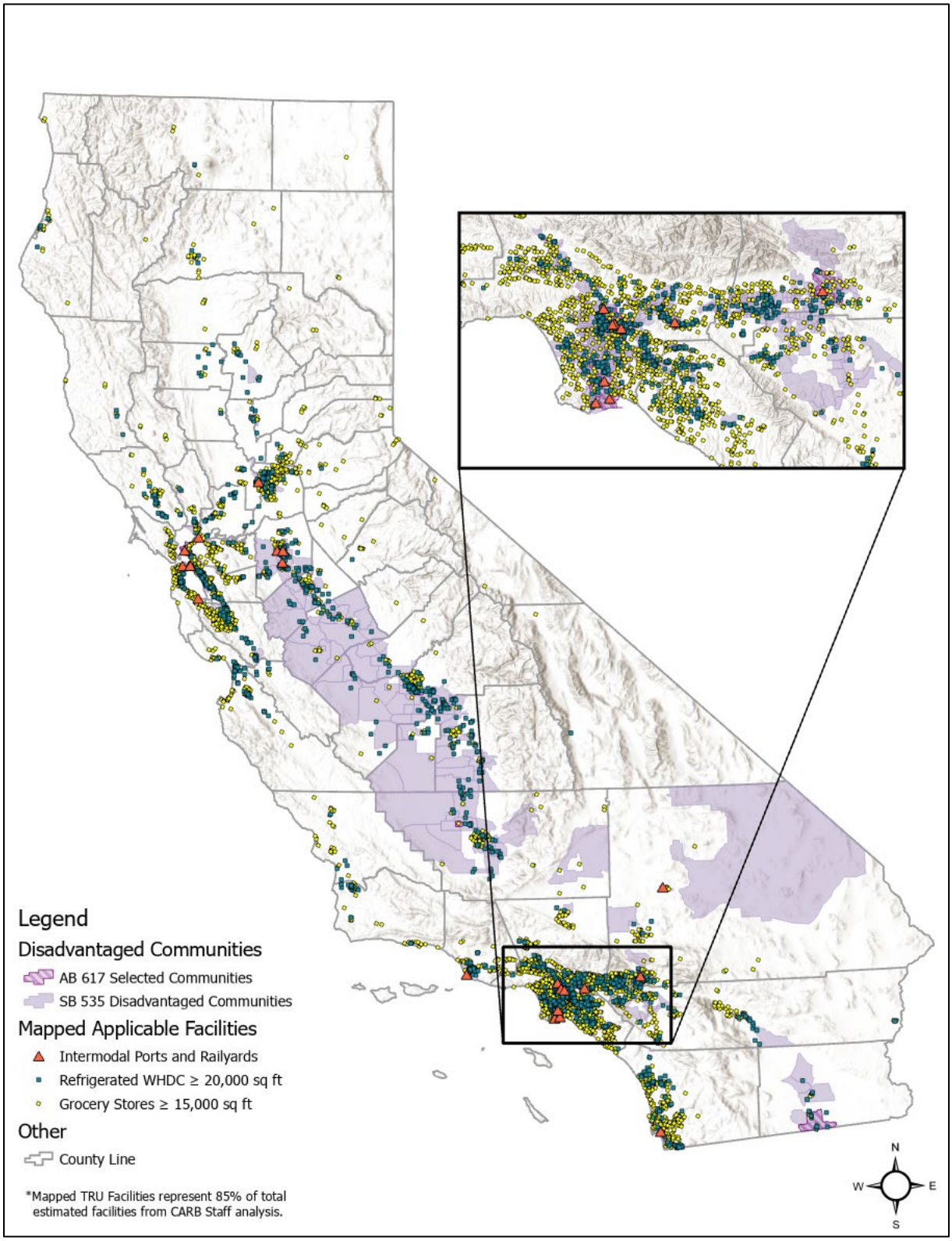
iii. Benefits in Disadvantaged Communities

The Proposed Amendments will reduce PM2.5 and NOx emissions, resulting in health benefits for Californians, including those in disadvantaged and low-income communities. Many of the communities near facilities where TRUs operate bear a disproportionate health burden due to their close proximity to emissions from the diesel engines that power TRUs. Based on staff's analysis, approximately 40 percent of the proposed applicable facilities identified are located in disadvantaged communities as designated by CalEnviroScreen.[54]

The Proposed Amendments require applicable facilities to ensure that only compliant TRUs operate on their properties. To meet this requirement, applicable facilities may collect information on all TRUs that operate at their facilities and report that information to CARB quarterly. Alternatively, facilities may provide a declaration, under penalty of perjury, that non-compliant TRUs will not be allowed to operate on their properties. Facility reporting will help CARB staff better identify non-compliant TRUs operating in California and bring them into compliance. Not allowing non-compliant TRUs to operate at an applicable facility incentivizes TRU owners to comply and achieves immediate emission reductions in impacted communities. Figure B4 shows the statewide distribution of the proposed applicable facilities, including those in disadvantaged communities.

[54] Office of Environmental Health Hazard Assessment, CalEnviroScreen 3.0, June 25, 2018. (web link: https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30)

Figure B4. Proposed Applicable Facilities (as of January 2021)



iv. Noise Reduction

The Proposed Amendments will provide an additional noise reduction benefit from diesel TRUs. Diesel-powered TRUs can produce a substantial amount of noise, which also results in adverse health impacts. This is of concern when TRUs operate near places where people live, work, and play. Staff have received several noise complaints regarding TRU activity near schools, hospitals, elder care facilities, and residential neighborhoods. The Proposed Amendments will transition diesel truck TRUs to zero-emission technology, which produces little to no noise. This will eliminate the use of diesel truck TRUs and reduce noise levels.

C. Direct Costs

The direct costs of the Proposed Amendments are estimated to be approximately $1.03 billion from 2022 to 2034. The direct costs include capital costs for new zero-emission truck TRUs and supporting infrastructure, TRUs equipped with engines that meet the PM emission standard, lower GWP refrigerant, as well as annual costs for maintenance, diesel and electricity usage, LCFS credit revenue, CARB fees, and administrative costs for registration and reporting. The direct costs in this section include costs to State and local governments, which are also quantified separately in the Fiscal Impacts section (Section D). The assumptions underlying the direct costs are detailed in the sections below.

1. Direct Cost Inputs

a. TRU Populations and New Sales

The Proposed Amendments include different requirements and associated costs for each TRU type. Staff divided the affected TRU population into five categories for this analysis, including truck TRUs, trailer TRUs, DSC TRUs, railcar TRUs, and TRU generator sets. As described in Section B.1.a, all estimates for annual TRU populations and new sales are from the statewide TRU emission inventory.[55]

i. Truck TRUs

The Proposed Amendments require TRU owners to transition a percentage of their truck TRU fleet to zero-emission technology each year starting in 2023. Table C1 shows the phase-in compliance schedule for zero-emission truck TRU fleets required by the Proposed Amendments.

[55] California Air Resources Board, Draft 2019 Update to Emissions Inventory for Transport Refrigeration Units, October 2019. (web link: https://ww3.arb.ca.gov/cc/cold-storage/documents/hra_emissioninventory2019.pdf)

Table C1. Phase-in Compliance Schedule for Zero-Emission Truck TRU Fleets from 2022 to 2034

Year	Required Zero-Emission Percentage
2022	0%
2023	15%
2024	30%
2025	45%
2026	60%
2027	75%
2028	90%
2029	100%
2030	100%
2031	100%
2032	100%
2033	100%
2034	100%

The required number of zero-emission truck TRUs in a given year is dependent on the number of truck TRUs in an owner's fleet and is calculated using the following equation:

$$Zero\text{-}emission\ truck\ TRUs = Zero\text{-}emission\ \% * Truck\ TRU\ fleet\ size$$

Where:

Zero-emission truck TRUs = required number of zero-emission truck TRUs in a given year (unit-less)

Zero-emission % = zero-emission truck TRU fleet from Table C1 for that year (percentage)

Truck TRU fleet size = total number of diesel truck TRUs in owner's fleet that operate in California (unit-less)

If the calculated number of 'zero-emission truck TRUs' is not equal to a whole number, it is rounded up to a whole number when the fractional part of the required number of truck TRUs is equal to or greater than 0.5, and rounded down if less than 0.5. For example, a fleet consisting of one truck TRU that operates in California shall contain one zero-emission truck TRU by 2026 and a fleet consisting of two truck TRUs that operate in California shall contain one zero-emission truck TRU by 2024 and two zero-emission truck TRUs by 2027.

Staff determined the annual number of zero-emission truck TRUs that would result from the Proposed Amendments based on the number of truck TRUs in each fleet

reported in ARBER.[56] Table C2 shows the annual truck TRU population and number of zero-emission truck TRUs that would result from the Proposed Amendments.

Table C2. Annual Truck TRU and Zero-Emission Truck TRU Population from 2022 to 2034

Year	Annual Truck TRU Population	Annual Zero-Emission Truck TRU Population
2022	7,268	0
2023	7,385	960
2024	7,503	2,176
2025	7,623	3,202
2026	7,745	4,802
2027	7,869	6,138
2028	7,995	7,355
2029	8,122	8,122
2030	8,252	8,252
2031	8,384	8,384
2032	8,519	8,519
2033	8,655	8,655
2034	8,793	8,793

ii. Trailer TRUs, DSC TRUs, Railcar TRUs, and TRU Generator Sets

Staff are proposing to require MY 2023 and newer trailer TRU, DSC TRU, railcar TRU, and TRU generator set engines to meet a 0.02 g/hp-hr PM emission standard, or lower. MY 2022 and older units would continue to operate under the current TRU ATCM requirements, in which they are required to meet ULETRU by December 31st of the seventh year after the engine MY.

The TRU emission inventory estimates the number of TRUs in the Baseline that are equipped with a greater than 25 horsepower engine that meets a 0.02 g/hp-hr PM emission standard. This is based on the compliance action of units under the current TRU ATCM, as reported in ARBER from 2011 to 2018.[57] Beginning in 2023, new sales that are not equipped with an engine that meets the PM emission standard would need to take compliance action. Tables C3 and C4 show the annual TRU populations and number of new TRU sales that do not meet the PM emission standard and would need to take compliance action under the Proposed Amendments, respectively.

[56] California Air Resources Board, Air Resources Board Equipment Registration System. (web link: https://arber.arb.ca.gov/, last accessed July 2020)
[57] California Air Resources Board, Air Resources Board Equipment Registration System. (web link: https://arber.arb.ca.gov/, last accessed July 2020)

Table C3. Annual Trailer TRU, DSC TRU, Railcar TRU, and TRU Generator Set Populations from 2022 to 2034

Year	Trailer TRUs	DSC TRUs	Railcar TRUs	TRU Generator Sets	Total
2022	160,937	411	3,736	30,709	195,792
2023	163,512	417	3,796	31,200	198,925
2024	166,129	424	3,857	31,699	202,108
2025	168,787	431	3,918	32,206	205,342
2026	171,487	437	3,981	32,722	208,627
2027	174,231	444	4,045	33,245	211,965
2028	177,019	452	4,109	33,777	215,357
2029	179,851	459	4,175	34,318	218,802
2030	182,729	466	4,242	34,867	222,303
2031	185,652	474	4,310	35,425	225,860
2032	188,623	481	4,379	35,991	229,474
2033	191,641	489	4,449	36,567	233,145
2034	194,707	497	4,520	37,152	236,876

Table C4. Annual Trailer TRU, DSC TRU, Railcar TRU, and TRU Generator Set New Sales Populations that Would Need to Take Compliance Action to Meet the PM Emission Standard from 2022 to 2034

Year	Trailer TRUs	DSC TRUs	Railcar TRUs	TRU Generator Sets	Total
2022	0	0	0	0	0
2023	15,206	40	366	2,344	17,956
2024	13,450	43	387	1,777	15,657
2025	15,594	66	599	2,707	18,966
2026	16,489	113	1,031	3,965	21,598
2027	29,073	121	1,101	8,715	39,010
2028	17,557	83	752	4,053	22,445
2029	17,265	65	594	3,654	21,578
2030	18,088	62	561	3,210	21,921
2031	17,518	64	579	3,034	21,195
2032	16,542	66	601	2,763	19,972
2033	18,922	77	700	3,529	23,228
2034	20,246	100	400	4,526	25,272

b. TRU Annual Activity and Activity within California

TRU annual activity and activity within California are used to calculate fuel costs, maintenance costs, and LCFS credit revenue. Annual activity values are from the TRU emission inventory and based on 2011 facility survey data and 2018 TRU telematics

reports.[58] The survey covered 54 different facilities that monitored TRU activity and provided information on their annual TRU activity. More information on the results from that survey are described in detail in the 2011 emission inventory update.[59] Staff acquired telematics data from trailer TRUs, detailing total time, time the unit (but not engine) was on, time the engine was on, whether the trailer was stationary or moving, and (in limited cases) fuel use.

The inventory assumes that truck TRUs, which are generally used for local and regional delivery, are captive to California. Therefore, all truck TRU activity is allocated to California. Trailer TRUs, DSC TRUs, railcar TRUs, and TRU generator sets have activity split between California and other states or countries and are modeled on interstate truck activity patterns from EMFAC2017.[60] Truck activity in EMFAC is distributed for the portion of time spent in-state versus out-of-state based on vehicle miles travelled (VMT) patterns from the International Registration Program for in-state versus out-of-state trucks. Table C5 provides the annual activity and activity within California for each TRU type that staff used for this analysis.

Table C5. Annual Activity and Activity within California by TRU Type

TRU Type	Annual Activity (hours)	Percentage of Activity within CA	Annual Activity within CA (hours)
Truck TRU	1,360	100.0%	1,360
California Trailer TRU	2,201	78.1%	1,719
Out-of-State Trailer TRU	2,201	12.4%	273
DSC and Railcar TRU	1,697	18.9%	321
California Generator Set	1,000	78.1%	781
Out-of-State Generator Set	1,000	12.4%	124

c. Applicable Facility Populations

The Proposed Amendments include refrigerated warehouses or distribution centers (WHDC) with a building size of 20,000 square feet or greater, grocery stores with a building size of 15,000 square feet or greater, seaport facilities, and intermodal railyards. The square feet thresholds are based on the amount of TRU activity and associated health risk relative to facility size; there are no proposed size thresholds for seaport facilities or intermodal railyards because activity is not based on facility size and TRUs operate for longer periods of time at these facility types compared to refrigerated WHDCs and grocery stores. For this analysis, staff further categorized

[58] California Air Resources Board, Draft 2019 Update to Emissions Inventory for Transport Refrigeration Units, October 2019. (web link: https://ww3.arb.ca.gov/cc/cold-storage/documents/hra_emissioninventory2019.pdf)
[59] California Air Resources Board, Public Hearing to Consider Proposed Amendments to the Airborne Toxic Control Measure for In-Use Diesel-Fueled TRUs and TRU Generator Sets, and Facilities where TRUs Operate. Staff Report: Initial Statement of Reasons, August 31, 2011. (web link: https://ww3.arb.ca.gov/regact/2011/tru2011/truisor.pdf)
[60] California Air Resources Board, EMFAC 2017 Database. (web link: https://www.arb.ca.gov/emfac/2017/)

refrigerated WHDCs into standard and high-cube and grocery stores into standard and supercenters to better estimate the costs associated with these facility types since they have varying levels of TRU activity.

To determine the number of facilities that would be subject to the applicable facility registration, registration fee, and reporting requirements in the Proposed Amendments, staff developed a refrigerated facility inventory based on datasets from various sources, including CARB, other State departments, contracted businesses, and online refrigerated business sites.[61] Staff identified seven data sources with information on approximately 80,000 facilities with potential TRU activity. To validate the data from each data source, staff reviewed the facilities using Google Maps and Google Earth to determine facility characteristics, including facility type, building size, and number of dock doors. Staff estimated the statewide number of applicable facilities by determining the number of facilities above the proposed size threshold for each facility type in the refrigerated facility inventory. Table C6 provides the estimated statewide applicable facility population by type in 2020. Staff applied a 1.6 percent[62] annual growth rate in future years.

Table C6. Estimated Statewide Applicable Facility Population in 2020

Facility Type	Population
Refrigerated WHDC - (Building size greater than or equal to 20,000)	2,167
Grocery Store - (Building size greater than or equal to 15,000 square feet)	3,918
Seaport Facility (No size threshold)	25
Intermodal Railyard (No size threshold)	9
Total	6,119

d. Equipment Capital Costs to TRU Owners

This section summarizes the equipment capital costs to TRU owners to comply with the Proposed Amendments. This includes the capital cost of new zero-emission truck TRUs and supporting infrastructure; new trailer TRUs, DSC TRUs, railcar TRUs, and TRU generator sets equipped with engines that meet the PM emission standard; and lower GWP refrigerant.

i. Zero-Emission Truck TRUs

Truck TRU owners may comply with the Proposed Amendments using a combination of battery-electric, cold plate, solar, and cryogenic zero-emission technologies. It is difficult to predict TRU owners' future plans for complying with the Proposed Amendments, especially as battery technologies improve and costs continue to decline. Although cold plate and cryogenic units are less expensive, staff assumed TRU owners would comply with the zero-emission truck TRU requirement by purchasing battery-electric truck TRUs. This is based on stakeholder input, and that many

[61] California Air Resources Board, Transport Refrigeration Unit Applicable Facility Inventory, February 2020.
[62] Americas Commercial Transportation Research Co., LLC, U.S. Reefer Population Growth, Proprietary, 2018. (web link: http://www.actresearch.net)

products require TRUs to both heat and cool in order to maintain a stable temperature while controlling humidity and promoting adequate airflow, which other technologies are not capable of.

Staff estimated the cost of a battery-electric truck TRU by adding electric component, energy storage, and additional labor costs to a conventional diesel-powered TRU. The battery cost is the largest contributing factor associated with the price of a battery-electric TRU. Truck box lengths vary between 12 and 28 feet. The required size of the battery is dependent on the size of the truck, as well as other factors specific to each operation, including the length of the route, product being transported, temperature of the load, number of door openings on the route, and outdoor temperature.

The current average battery capacity for light-duty electric vehicles is 45 kilowatt-hours (kWh),[63] which is comparable in size to current offerings of battery-electric truck TRUs ranging in size from 10 to 60 kWh. Therefore, staff used current price projections for light-duty batteries as shown in Table C7.[64] Battery costs have dropped over 80 percent since 2010 and are projected to continue to decline. Battery costs from 2031 to 2034 were extrapolated, since cost projections are not available past 2030. Staff derived costs for the remaining components, such as the battery management system, power system, controllers, and labor from cost estimates from a small scale manufacturer of battery-electric TRUs.[65] Table C8 shows the breakdown of estimated costs for each component, as well as the total estimated cost of a battery-electric truck TRU based on battery costs in 2023.

Table C7. Projected Light-Duty Battery Costs from 2022 to 2034 (2019$)

Year	Projected Battery Cost per kWh
2022	n/a
2023	$112
2024	$104
2025	$96
2026	$90
2027	$84
2028	$79
2029	$74
2030	$70
2031	$62
2032	$57
2033	$52

[63] Statista, "Estimated average battery capacity in electric vehicles worldwide from 2017 to 2025, by type of vehicle," February 5, 2021. (web link: https://www.statista.com/statistics/309584/battery-capacity-estimates-for-electric-vehicles-worldwide/)
[64] Bloomberg, "QuickTake Better Batteries," October 2019. (web link: https://www.bloomberg.com/quicktake/batteries, last accessed December 2019)
[65] Claimed confidential data obtained from an industry source that requested non-attribution.

Year	Projected Battery Cost per kWh
2034	$46

Table C8. Estimated Cost Breakdown and Total Cost of Battery-Electric Truck TRU, Based on 2023 Battery Cost (2019$)

Battery Size (kWh)	Battery Pack (wiring, components, labor)	Battery Management System	Power System (motor, controller, wiring, cables, labor)	Refrigeration System	Total
10	$16,100	$1,100	$5,400	$13,000	$35,600
20	$17,700	$1,800	$6,800	$13,000	$39,300
40	$20,900	$3,200	$7,500	$13,000	$44,600
50	$22,500	$4,000	$8,100	$13,000	$47,600
60	$24,100	$4,700	$8,800	$13,000	$50,600

The total cost of a battery-electric truck TRU (based on battery costs in 2023) ranges from $35,600 to $50,600 depending on the battery size. For this analysis, staff used the cost of a battery-electric truck TRU with a median battery size of 40 kWh. This is based on the current offerings of battery-electric truck TRUs with batteries ranging in size from 10 to 60 kWh capable of handling an 8 to 12 hour route, depending on the operational needs.[66] Staff determined this operating range to be sufficient for truck TRUs since they are generally only used for local and regional operations.

Table C9 shows the average baseline cost of a diesel truck TRU is $19,300. Table C10 shows the cost of a battery-electric truck TRU assumed over the regulation period, and accounts for the decline in battery costs shown in Table C7. Table C11 provides the incremental cost difference between a battery-electric truck TRU and a diesel truck TRU from 2023 to 2034.

Table C9. Baseline Diesel Truck TRU Cost (2019$)[67]

TRU Type	Cost
Diesel Truck TRU 1	17,690
Diesel Truck TRU 2	18,790
Diesel Truck TRU 3	19,710
Diesel Truck TRU 4	21,030
Average	$19,300

Table C10. Battery-Electric Truck TRU Cost from 2022 to 2034 (2019$)

Year	Average Battery-Electric Truck TRU Cost
2022	n/a
2023	$44,600
2024	$44,160
2025	$43,700

[66] Claimed confidential data obtained from an industry source that requested non-attribution.
[67] Claimed confidential data obtained from industry sources that requested non-attribution.

Year	Average Battery-Electric Truck TRU Cost
2026	$43,360
2027	$43,020
2028	$42,730
2029	$42,450
2030	$42,220
2031	$41,990
2032	$41,820
2033	$41,650
2034	$41,530

Table C11. Battery-Electric Truck TRU Incremental Cost from 2023 to 2034 (2019$)

Year	Incremental Cost Battery-Electric versus Diesel Truck TRU
2022	n/a
2023	$25,300
2024	$24,860
2025	$24,400
2026	$24,060
2027	$23,720
2028	$23,430
2029	$23,150
2030	$22,920
2031	$22,690
2032	$22,520
2033	$22,350
2034	$22,230

The total capital cost to comply with the zero-emission truck TRU requirement in the Proposed Amendments in a given year is calculated using the following equation:

$$Capital\ Cost = [new\ sales \times incremental\ ZE\ cost] + [in\text{-}use\ turnover \times total\ ZE\ cost]$$

Where:

Capital Cost = zero-emission truck TRU capital cost ($)

New sales = annual new zero-emission sales population resulting from natural turnover (number of units)

Incremental ZE cost = incremental cost of zero-emission truck TRU from Table C11 ($)

In-use turnover = number of in-use units replaced with a zero-emission unit to meet the annual zero-emission percentage (number of units)

Total ZE cost = total zero-emission truck TRU cost from Table C10 ($)

Staff amortized the capital cost of new zero-emission truck TRU purchases over a period of 5 years at an interest rate of 5 percent. The amortized costs result in a level cost incurred for every year until the capital cost of the TRU is fully paid and also reflect normal purchasing patterns in which businesses generally do not pay the total capital cost up front. Staff amortized the costs using the following equations:

$$Amortized\ Cost\ of\ Capital\ =\ capital\ expenditures\ \times\ capital\ recovery\ factor\ (CRF)$$

$$CRF\ =\ i\ (1+i)^n\ /\ (1+i)^{\ n}-1$$

Where:

Amortized cost of capital = uniform payment amount over the life of the capital ($)

Capital expenditures = capital cost of the equipment ($)

i = interest rate (assumed to be 5 percent)

n = life of the capital (assumed to be 5 years)

Staff used an interest rate of 5 percent, which reflects the rate of return on an inflation-adjusted 10-year treasury security (about 2 percent in the past five years), plus the CalEPA recommended 3 percent risk premium.[68] Additionally, the 5 percent is the average of what the United States Office of Management and Budget recommends (3 and 7 percent) and what U.S. EPA has used historically for regulatory analyses.[69] The 5-year timeframe reflects approximately half the expected lifetime for a TRU.

Although it was assumed that the capital cost of zero-emission truck TRUs would be amortized, staff also determined the unamortized, upfront, capital cost to TRU owners should they not have access to financing. Table C12 shows the total amortized and unamortized cost of zero-emission truck TRUs from 2022 to 2034 is estimated to be $165.7 million and $107.6 million, respectively. The cost would be incurred by truck TRU owners. The amortized and unamortized costs to truck TRU owners would be negative beginning in 2032 and 2030, respectively, since they would no longer need to take compliance action every seven years.

Table C12. Estimated Annual Zero-Emission Truck TRU Capital Costs from 2022 to 2034 (2019$)

Year	Zero-Emission Truck TRU Capital Cost (Amortized)	Zero-Emission Truck TRU Capital Cost (Unamortized)
2022	$0	$0
2023	$5,600,000	$24,300,000

[68] California Air Resources Board, Economic Evaluation Supplement
Climate Change Draft Scoping Plan Pursuant to AB 32 The California Global Warming Solutions Act of 2006, Appendix I: Modeling Assumptions for Economic Analysis of the Draft Scoping Plan, September 2008. (web link: https://ww3.arb.ca.gov/cc/scopingplan/document/economic_appendix1.pdf)
[69] United States Environmental Protection Agency, Guidelines for Preparing Economic Analyses, December 2010. (web link: https://www.epa.gov/environmental-economics/guidelines-preparing-economic-analyses)

Year	Zero-Emission Truck TRU Capital Cost (Amortized)	Zero-Emission Truck TRU Capital Cost (Unamortized)
2024	$13,700,000	$35,700,000
2025	$19,100,000	$24,500,000
2026	$31,700,000	$55,400,000
2027	$38,300,000	$30,500,000
2028	$39,600,000	$29,700,000
2029	$33,800,000	$10,300,000
2030	$23,400,000	(-$20,700,000)
2031	$6,300,000	(-$19,700,000)
2032	(-$5,200,000)	(-$20,300,000)
2033	(-$16,900,000)	(-$21,900,000)
2034	(-$23,800,000)	(-$20,400,000)
Total	$165,700,000	$107,600,000

ii. Zero-Emission Truck TRU Infrastructure

The Proposed Amendments do not include a specific infrastructure requirement. However, staff accounted for the capital cost of infrastructure needed to support operation of battery-electric truck TRUs purchased to comply with the zero-emission truck TRU requirement. Staff assumed truck TRU home base facility owners would install infrastructure on the same schedule as the truck TRUs transition to zero-emission technology to accommodate changing fleet sizes and minimize capital and maintenance costs for unused chargers.

The most common infrastructure for a battery-electric truck TRU is a vehicle charger or an electrical vehicle supply equipment (EVSE) at the Level 2 power level that requires a 208- or 240-volt wall outlet using a J1772 connector. Level 2 EVSE are already installed and operational throughout the State, primarily powering light- and medium-duty vehicles. As of May 2021, there are approximately 27,000 Level 2 charging outlets located at over 13,000 stations statewide.[70] Additional stations are in the planning, design, and construction phase and will soon be operational as part of California's Zero-Emission Vehicle Action Plan.[71] However, as a conservative cost assumption and to ensure truck TRUs are sufficiently charged after their daily operations, staff assumed truck TRU owners would not rely on publicly accessible charging infrastructure. Staff assumed that truck TRU owners would install one single-port Level 2 charger per truck TRU at their home base facility. This would allow truck TRUs to complete their daily operations and return home to their home base facility to charge overnight. Nighttime charging at the home base facility during

[70] U.S. Department of Energy, Energy Efficiency and Renewable Energy Alternative Fuels Data Center, Alternative Fueling Station Counts by State. (web link: https://afdc.energy.gov/stations/states, last accessed May 12, 2021)

[71] California Governor's Office of Business and Economic Development, 2018 ZEV Action Plan Priorities Update, September 2018. (web link: https://static.business.ca.gov/wp-content/uploads/2019/12/2018-ZEV-Action-Plan-Priorities-Update.pdf, last accessed January 2021)

off-peak times would also avoid time-of-use electricity charges. Therefore, the number of chargers needed to support operation of the approximately 8,800 battery-electric truck TRUs that would be purchased to meet the zero-emission truck TRU requirements from 2022 to 2034 is 8,800.

To estimate the number of truck TRU home base facilities, staff queried the ARBER database to determine the number of unique addresses for truck TRU fleets. For this analysis, staff assumed that each unique address represented one home base facility. Based on this information, staff estimate there are 989 truck TRU home base facilities that would need to install infrastructure to support operation of the battery-electric truck TRUs purchased to comply with the Proposed Amendments.[72]

Level 2 chargers have a variety of power outputs from 16 to 48 amps at 208- or 240-volts. The higher power output results in faster charging and meets the specifications of existing zero-emission truck TRUs. Level 2 chargers available on the market today have a variety of different features and power ratings resulting in cost variability. Given a lack of data on individual needs relative to power, and wall or pedestal mounted chargers, all types of charging units are assumed available to truck TRU home base facility owners based on individual purchase decisions. Table C13 shows the cost of a single-port Level 2 charger ranges from $608 to $2,004. This includes the Level 2 charger, the necessary outlet, and power cord. For this analysis, staff used an average cost of $1,154 per charger, which represents the average of units with power output ranging from 7.2 to 11.5 kWh, as well as wall mount and pedestal installations.

Table C13. Capital Cost of Commercial Level 2 Charger[73]

Manufacturer	Model	Installation Type	Output (kW)	Cost
ClipperCreek[74]	HCS-50 40	Wall	9.6	$608
Phillips and Temro[75]	EVSE	Wall	7.2	$621
Phillips and Temro[76]	EVSE	Wall	7.2	$669
ClipperCreek[77]	HCS-60 48	Wall	11.5	$860

[72] California Air Resources Board, Air Resources Board Equipment Registration System. (web link: https://arber.arb.ca.gov/, last accessed July 2020)
[73] Level 2 charger cost estimates were provided in 2021 dollars. Staff adjusted from 2021 to 2019 dollars by using the California Department of Finance Consumer Price Index (CPI-U). A factor of 0.96 is used to adjust from 2021 dollars to 2019 dollars. (web link: https://www.dof.ca.gov/Forecasting/Economics/Indicators/Inflation/documents/CPI_All_Item_CY.xlsx)
[74] Clipper Creek, HCS-50, 40A, L2 EVSE, 240V, w/25 ft cable. (web link: https://store.clippercreek.com/hcs-50-hcs-50P-40-amp-ev-charging-station, last accessed January 29, 2021)
[75] Email from Hector Cruz (Phillips and Temro) to Lea Yamashita (CARB) dated January 21, 2021.
[76] Email from Hector Cruz (Phillips and Temro) to Lea Yamashita (CARB) dated January 21, 2021.
[77] Clipper Creek, ClipperCreek HCS-60, 48 Amp, Level 2 EVSE, 240V, with 25 ft cable. (web link: https://store.clippercreek.com/hcs-60-48-amp-ev-charging-station, last accessed February 11, 2021)

Manufacturer	Model	Installation Type	Output (kW)	Cost
ClipperCreek[78,79]	HCS-50 40	Pedestal	9.6	$1,295
ClipperCreek[80,81]	HCS-60 48	Pedestal	11.5	$1,548
Phillips and Temro[82]	EVSE	Pedestal	7.7	$1,625
PowerCharge[83]	P20SP	Pedestal	7.2	$2,004

Installation costs also vary due to site-specific factors, such as the existing electric panel capacity, installation location, and regional labor costs. Based on a report by the International Council on Clean Transportation (ICCT), per-charger costs decline as more chargers are installed. Level 2 charger installation costs range from $2,840 for more than six chargers to $4,150 for a single charger.[84] These costs are based on installations in Southern California and include labor, materials, permits, taxes, and utility upgrades, which may or may not include costs associated with the need to bring additional power to the site. As previously discussed, staff assumed truck TRU infrastructure would be installed on the same schedule that truck TRUs are required to transition to zero-emission technology, adding enough chargers to accommodate the battery-electric truck TRU population each year to accommodate changing fleet sizes and minimize capital and maintenance costs for unused chargers.

Based on the annual zero-emission truck TRU fleet percentages in the Proposed Amendments, only fleets with more than 10 truck TRUs would be required to purchase more than one zero-emission truck TRU requiring the installation of multiple charger installations in a given year. Fleet information from ARBER indicates that less than 8 percent of truck TRU fleets have more than 10 truck TRUs.[85] Therefore, staff used the installation cost for a single charger. The ICCT report also recommends a 10 percent reduction for work place charging, which is the most similar to the truck TRU

[78] Clipper Creek, HCS-50, 40A, L2 EVSE, 240V, w/25 ft cable. (web link: https://store.clippercreek.com/hcs-50-hcs-50P-40-amp-ev-charging-station, last accessed January 29, 2021)
[79] Clipper Creek, Pedestal for ClipperCreek HCS EV Charging Station, Single Mount. (web link: https://store.clippercreek.com/mounting-solutions/ev-charging-station-mounting-equipment-hcs-pedestal, last accessed February 11, 2021)
[80] Clipper Creek, ClipperCreek HCS-60, 48 Amp, Level 2 EVSE, 240V, with 25 ft cable. (web link: https://store.clippercreek.com/hcs-60-48-amp-ev-charging-station, last accessed February 11, 2021)
[81] Clipper Creek, Pedestal for ClipperCreek HCS EV Charging Station, Single Mount. (web link: https://store.clippercreek.com/mounting-solutions/ev-charging-station-mounting-equipment-hcs-pedestal, last accessed February 11, 2021)
[82] Email from Hector Cruz (Phillips and Temro) to Lea Yamashita (CARB) dated January 21, 2021.
[83] EV Charge Solutions, PowerCharge P20SP Commercial EV Charger. (web link: https://www.evchargesolutions.com/PowerCharge-P20SP-Commercial-EV-Charger-p/p20sp.htm, last accessed January 29, 2021)
[84] The International Council on Clean Transportation, Estimating Electric Vehicle Charging Infrastructure Costs Across Major U.S. Metropolitan Areas, August 2019. (web link: https://theicct.org/sites/default/files/publications/ICCT_EV_Charging_Cost_20190813.pdf, last accessed January 20, 2021)
[85] California Air Resources Board, Air Resources Board Equipment Registration System. (web link: https://arber.arb.ca.gov/, last accessed July 2020)

application. Therefore, for this analysis, staff assumed an average installation cost of $3,733 per charger. Table C14 shows the zero-emission truck TRU infrastructure capital cost inputs used for the SRIA.

Table C14. Zero-Emission Truck TRU Infrastructure Capital Cost Inputs

	Cost (per unit)
Level 2 Charger	$1,154
Installation	$3,733

Staff determined the amortized capital cost (including installation) of charging infrastructure at truck home base facilities over a period of 5 years at an interest rate of 5 percent[86] using the same methodology used for truck TRU capital costs described in Section C.1.d.i.[87] Table C15 shows the total amortized and unamortized capital cost (including installation) of charging infrastructure at truck TRU home base facilities from 2022 to 2034 is estimated to be $48.1 million and $42.9 million, respectively. The cost would be incurred by truck TRU home base facility owners.

Table C15. Estimated Annual Zero-Emission Truck TRU Infrastructure Capital Costs from 2022 to 2034 (2019$)

Year	Truck TRU Infrastructure Cost (Amortized)	Truck TRU Infrastructure Cost (Unamortized)
2022	$0	$0
2023	$1,100,000	$4,700,000
2024	$2,500,000	$5,900,000
2025	$3,600,000	$5,000,000
2026	$5,400,000	$7,800,000
2027	$6,900,000	$6,500,000
2028	$7,200,000	$5,900,000
2029	$6,700,000	$3,800,000
2030	$5,700,000	$600,000
2031	$4,000,000	$600,000
2032	$2,700,000	$700,000
2033	$1,500,000	$700,000
2034	$800,000	$700,000
Total	$48,100,000	$42,900,000

iii. PM Emission Standard

The Proposed Amendments require MY 2023 and newer trailer TRU, DSC TRU, railcar TRU, and TRU generator set engines to meet a 0.02 g/hp-hr PM emission standard, or lower. MY 2013 and newer TRU engines in the 25 to less than 50 horsepower category

[86] Infrastructure costs were amortized over a period of 5 years at an interest rate of 5 percent, to reflect approximately half the expected lifetime for charging equipment.
[87] United States Department of Energy, Costs Associated with Non-Residential Electric Vehicle Supply Equipment, November 2015. (web link: https://afdc.energy.gov/files/u/publication/evse_cost_report_2015.pdf)

are certified to the Tier 4 final off-road engine standards and meet the 0.02 g/hp-hr PM emission standard. The baseline cost of a diesel trailer TRU, DSC TRU, railcar TRU, and TRU generator set is based on the average cost estimate for units with engines less than 25 horsepower shown in Table C16. The capital cost of a trailer TRU, DSC TRU, railcar TRU, and TRU generator set equipped with an engine that meets the PM emission standard is based on the average cost estimate for units with engines greater than 25 horsepower shown in Table C17.

Table C16. Baseline Cost of Trailer TRU, DSC TRU, Railcar TRU, and TRU Generator Set (2019$)

TRU Type	Cost
Diesel Trailer TRU/DSC TRU/Railcar TRU 1	$24,290[88]
Diesel Trailer TRU/DSC TRU/Railcar TRU 2	$25,280[89]
Diesel Trailer TRU/DSC TRU/Railcar TRU 3	$25,850[90]
Diesel Trailer TRU/DSC TRU/Railcar TRU 4	$26,000[91]
Diesel Trailer TRU/DSC TRU/Railcar TRU 5	$26,250[92]
TRU Generator Set 1	$16,710[93]
TRU Generator Set 2	$17,250[94]
TRU Generator Set 3	$17,940[95]

Table C17. Cost of Trailer TRU, DSC TRU, Railcar TRU, and TRU Generator Set Equipped with an Engine that Meets the PM Emission Standard (2019$)

TRU Type	Cost
Diesel Trailer TRU/DSC TRU/Railcar TRU 1	$27,320[96]
Diesel Trailer TRU/DSC TRU/Railcar TRU 2	$28,000[97]
Diesel Trailer TRU/DSC TRU/Railcar TRU 3	$28,830[98]

[88] Truckpaper, Carrier X4 7300 for Sale in Manheim, PA. (web link: https://www.truckpaper.com/listings/trailers/for-sale/155984105/2020-carrier-x4-7300?gtmlt=1&keeponsite=true&_ga=2.265625679.1948851531.1611953426-92742101.1593111444, last accessed January 29, 2021)
[89] Claimed confidential data obtained from an industry source that requested non-attribution.
[90] Email from Luis Chavez (Carrier) to Renee Coad (CARB) dated September 18, 2018.
[91] Claimed confidential data obtained from an industry source that requested non-attribution.
[92] Claimed confidential data obtained from an industry source that requested non-attribution.
[93] Claimed confidential data obtained from an industry source that requested non-attribution.
[94] Generator Joe, Thermo King Model SGUM 4000 Under Mount. (web link: https://www.generatorjoe.net/container-reefer-clipon-diesel-generators/containner-cllipon-thermoking/1009/, last accessed January 29, 2021)
[95] Generator Joe, Thermo King Model SGCO 4000 Clip-On. (web link: https://www.generatorjoe.net/container-reefer-clipon-diesel-generators/containner-cllipon-thermoking/1007/, last accessed January 29, 2021)
[96] Claimed confidential data obtained from an industry source that requested non-attribution.
[97] Claimed confidential data obtained from an industry source that requested non-attribution.
[98] Claimed confidential data obtained from an industry source that requested non-attribution.

TRU Type	Cost
Diesel Trailer TRU/DSC TRU/Railcar TRU 4	$29,400[99]
TRU Generator Set	$19,900[100]

The capital cost for new TRUs equipped with an engine that meets the PM emission standard in a given year is calculated by multiplying the annual new sales population that does not meet the PM emission standard (see Table C4) times the incremental cost for each TRU category shown in Table C18.

Table C18. Trailer TRU, DSC TRU, Railcar TRU, and TRU Generator Set Capital Costs (2019$)

Equipment Type	Baseline Cost	Proposed Cost	Incremental Cost
Diesel Trailer TRU/DSC TRU/Railcar TRU	$25,530	$28,390	$2,860
TRU Generator Set	$17,300	$19,900	$2,600

Staff determined the amortized capital cost of new TRUs equipped with an engine that meets the PM emission standard over a period of 5 years at an interest rate of 5 percent using the same methodology used for truck TRU capital costs described in Section C.1.d.i. Table C19 shows the total amortized and unamortized capital cost to comply with the PM emission standard from 2022 to 2034 is estimated to be $720.4 million and $754 million, respectively. The cost would be incurred by TRU owners.

Table C19. Estimated Annual PM Emission Standard Capital Costs from 2022 to 2034 (2019$)

Year	PM Emission Standard Capital Cost (Amortized)	PM Emission Standard Capital Cost (Unamortized)
2022	$0	$0
2023	$11,600,000	$50,400,000
2024	$21,800,000	$44,000,000
2025	$34,100,000	$53,300,000
2026	$48,100,000	$60,600,000
2027	$73,300,000	$109,200,000
2028	$76,200,000	$62,900,000
2029	$80,000,000	$60,500,000
2030	$81,900,000	$61,600,000
2031	$81,700,000	$59,500,000
2032	$69,400,000	$56,100,000
2033	$70,000,000	$65,200,000
2034	$72,300,000	$70,700,000
Total	$720,400,000	$754,000,000

[99] Marketbook, Thermo King Precedent S600 for Sale in Miami, Florida. (web link: https://www.marketbook.ca/listings/trailers/for-sale/155646185/2020-thermo-king-precedent-s600, last accessed January 17, 2020)
[100] Claimed confidential data obtained from an industry source that requested non-attribution.

iv. Lower GWP Refrigerant

Refrigerant capital costs would be incurred by TRU OEMs and TRU dealers to manufacture and sell new TRUs with lower GWP refrigerant as required by the Proposed Amendments, since initial refrigerant charge[101] may be done by the OEM or the dealer during final installation (particularly common for multi-temperature units). For the purpose of this analysis, staff assumed that TRU dealers would purchase refrigerant at aftermarket cost, which is usually higher than the cost to TRU OEMs. Although staff assumed refrigerant costs would be passed on to TRU owners and reflected in a higher capital cost for compliant TRUs compared to what would have been purchased in the Baseline, refrigerant capital costs were analyzed separately and are discussed below.

The incremental cost to switch to lower-GWP refrigerants would be due to the higher cost for alternative refrigerants to comply with the Proposed Amendments. Staff estimated that approximately 10 percent of new units currently use HFC-134a (GWP = 1,430). HFC-134a is generally used for medium low temperature applications, and is not suitable for very low temperatures. HFC-134a would continue to be allowed under the Proposed Amendments because its GWP value is less than the proposed threshold of 2,200. Therefore, staff assumed that 10 percent of new units would continue to use HFC-134a.

The remaining 90 percent of new units currently use R-404A. For the purpose of this analysis, staff assumed this portion of the new units would switch to R-452A (GWP = 2,141) to comply with the Proposed Amendments, since it is a "design-compatible" replacement for R-404A, suitable for both very low and medium low temperatures, commercialized in the European markets and is already being offered as an optional alternative by manufacturers in the North American markets.[102,103]

The aftermarket cost for R-404A is estimated to be $5.9 per pound, based on online vendor pricing.[104] The aftermarket cost for R-452A is not readily available in the public domain because it is not yet in wide use in the U.S. Therefore, staff calculated the online price differential between R-404A and R-452A from a European-based

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[101] Refrigerant charge or recharge is the initial filling or refilling of a TRU with refrigerant.

[102] Carrier Press Release, Carrier Transicold Strengthens Sustainability Initiatives with Lower GWP for North America Truck and Trailer Systems, December 15, 2020. (web link: https://www.carrier.com/truck-trailer/en/north-america/news/news-article/carrier_transicold_strengthens_sustainability_initiatives_with_lower_gwp_refrigerant_for_north_america_truck_and_trailer_systems.html)

[103] Fleet Owner, Thermo King offers products to help reduce emissions, July 28, 2017 (web link: https://www.fleetowner.com/running-green/emissions/article/21696418/thermo-king-offers-products-to-help-reduce-emissions)

[104] Refrigerant Guys, Price of R-404A in 24-lb disposable cylinder. (web link: https://www.refrigerantguys.com/R404a-24lb-p/111026.htm, last accessed September 4, 2020).

vendor.[105,106] Staff assumed that the same price differential would apply to the U.S. due to market demand as a result of the Proposed Amendments. Therefore, the aftermarket cost of R-452A is estimated to be $14.8 per pound.

The OEM cost for R-404A and R-452A is also not publicly available. Therefore, staff first determined the OEM cost to aftermarket cost ratios for HFC-134a and for HFO-1234yf, using publicly available information. HFC-134a is the most ubiquitous single-compound refrigerant in use, and HFO-1234yf is a leading low-GWP alternative in vehicle air conditioning and a component for R-452A and other refrigerant blends. Staff applied the average OEM cost to aftermarket cost ratios for HFC-134a and for HFO-1234yf to the aftermarket costs for R-404A and R-452A described above. The resulting OEM cost for R-404A and R-452A is estimated to be $3.7 per pound and $9.3 per pound, respectively.[107]

Based on staff communication with an OEM, about 10 percent of truck TRUs and 20 percent of trailer TRUs and DSC TRUs undergo final assembly at installation and their initial refrigerant charges are conducted by the installing dealers.[108] Aftermarket refrigerant costs are assumed to apply to these situations. The remaining TRUs are assumed to be initially charged by OEMs. Staff used the breakouts of initial refrigerant charge venues to weight-average the initial charge costs for truck TRUs, trailer TRUs, and DSC TRUs. Based on manufacturer specifications for commercially available truck TRUs, trailer TRUs, and DSC TRUs from the two main TRU OEMs, staff used a refrigerant capacity of 6.5 pounds[109,110] for truck TRUs and 16 pounds[111,112] for trailer TRUs and DSC TRUs. Therefore, an initial charge with R-452A, on average, is estimated to cost $38 more for a truck TRU and $100 more for a trailer TRU or DSC

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[105] Refrigerant Boys, Price of R-404A in 30-kg refillable cylinders for EU market. (web link: https://www.refrigerantboys.com/en/buy/r404a-fluids/r404a-cylinder-30-kg/, last accessed September 4, 2020)
[106] Refrigerant Boys, Price of R-452A in 30-kg refillable cylinders for EU market. (web link: https://www.refrigerantboys.com/en/buy/refrigerant-fluids/r452a-fluids/r452a-bottle-with-30-kg-of-gas-21-7-x-1-1-4-valve/, last accessed September 4, 2020)
[107] The aftermarket prices of HFC-134a and HFO-1234yf are estimated to be $4.8/lb and $59.9/lb, based on two vendors' online pricing (Refrigerant Guys, 2020b; Refrigerant Depot, 2020). The OEM prices of HFC-134a and HFO-1234yf are estimated to be $3.2/lb and $35.2/lb, respectively, using the midpoints of the vehicle manufacturer price ranges reported in Sherry et al. (2017). Therefore, the aftermarket cost to OEM cost ratio is 1.50 for HFC-134a and 1.70 for HFO-1234yf. Staff used the average, 1.60, and applied it to the aftermarket costs for R-404A and R-452A.
[108] Claimed confidential data obtained from an industry source that requested non-attribution.
[109] Carrier Transicold, Supra S8 Performance Specifications, December 2020. (web link: https://www.shareddocs.com/hvac/docs/2000/Public/05/62-12105.pdf)
[110] Thermo King, T-690 and T-690 Max Specifications, February 2020. (web link: https://2v0usj4e6l6t2qrqk1maqr81-wpengine.netdna-ssl.com/wp-content/uploads/2019/12/T-690-Spec-Sheet.pdf)
[111] Carrier Transicold, X4 7300 Performance Specifications, February 6, 2020. (web link: https://www.shareddocs.com/hvac/docs/2000/Public/0C/62-11663.pdf)
[112] Thermo King, Precedent S-610DE Specification Sheet, April 2017. (web link: https://2v0usj4e6l6t2qrqk1maqr81-wpengine.netdna-ssl.com/wp-content/uploads/2015/04/2020-Precedent-S-610DE-Spec-Sheet.pdf)

TRU as compared with an initial charge with R-404A. Table C20 shows the refrigerant capital costs used in the SRIA.

Table C20. Refrigerant Capital Costs (2019$)

Equipment Type	Baseline Cost	Proposed Cost	Incremental Cost
Truck TRU	$25	$64	$38
Trailer TRU and DSC TRU	$66	$166	$100

The refrigerant capital costs in a given year are calculated by multiplying the annual new sales population times the incremental cost for each TRU category shown in Table C19. Since staff assumed that refrigerant costs would be passed on to TRU owners and reflected in a higher capital cost for compliant TRUs, staff determined the amortized refrigerant capital costs over a period of 5 years at an interest rate of 5 percent using the same methodology used for truck TRU capital costs described in Section C.1.d.i. Table C21 shows the amortized and unamortized capital cost to comply with the refrigerant requirement from 2022 to 2034 is estimated to be $29.8 million and $31.2 million, respectively. The cost would be incurred by TRU owners.

Table C21. Estimated Annual Refrigerant Capital Costs from 2022 to 2034 (2019$)

Year	Refrigerant Capital Cost (Amortized)	Refrigerant Capital Cost (Unamortized)
2022	$0	$0
2023	$500,000	$2,200,000
2024	$1,000,000	$2,000,000
2025	$1,500,000	$2,300,000
2026	$2,100,000	$2,400,000
2027	$3,000,000	$4,200,000
2028	$3,100,000	$2,600,000
2029	$3,200,000	$2,500,000
2030	$3,300,000	$2,600,000
2031	$3,300,000	$2,500,000
2032	$2,900,000	$2,300,000
2033	$2,900,000	$2,700,000
2034	$3,000,000	$2,900,000
Total	$29,800,000	$31,200,000

There are likely additional OEM capital investments in manufacturing infrastructure to properly handle the new refrigerant, update labeling, operation and servicing manuals, and obtain pertinent certification, as well as additional aftermarket sector costs to purchase equipment to handle new refrigerants, and to train technicians to properly handle the new refrigerant. However, OEMs have already started the lower-GWP refrigerant transition and offer R-452A truck and trailer TRUs as an optional alternative

for the North American markets.[113,114] Therefore, staff assumed OEMs and dealers have already made needed investments and did not account for additional costs to TRU OEMs or dealers as a result of the Proposed Amendments.

v. Total Equipment Capital Costs

Tables C22 and C23 summarize the total equipment capital costs by requirement and the total equipment capital costs by TRU category relative to the Baseline from 2022 to 2034, respectively.

Table C22. Annual Equipment Capital Costs from 2022 to 2034 (2019$)

Year	Zero-Emission Truck TRUs	Zero-Emission Truck TRU Infrastructure	PM Emission Standard	Refrigerant
2022	$0	$0	$0	$0
2023	$5,600,000	$1,100,000	$11,600,000	$500,000
2024	$13,700,000	$2,500,000	$21,800,000	$1,000,000
2025	$19,100,000	$3,600,000	$34,100,000	$1,500,000
2026	$31,700,000	$5,400,000	$48,100,000	$2,100,000
2027	$38,300,000	$6,900,000	$73,300,000	$3,000,000
2028	$39,600,000	$7,200,000	$76,200,000	$3,100,000
2029	$33,800,000	$6,700,000	$80,000,000	$3,200,000
2030	$23,400,000	$5,700,000	$81,900,000	$3,300,000
2031	$6,300,000	$4,000,000	$81,700,000	$3,300,000
2032	(-$5,200,000)	$2,700,000	$69,400,000	$2,900,000
2033	(-$16,900,000)	$1,500,000	$70,000,000	$2,900,000
2034	(-$23,800,000)	$800,000	$72,300,000	$3,000,000
Total	$165,600,000	$48,100,000	$720,400,000	$29,800,000

Table C23. Annual Equipment Capital Costs by TRU Category from 2022 to 2034 (2019$)

Year	Truck TRU	Trailer TRU	DSC TRU	Railcar TRU	TRU Generator Set
2022	$0	$0	$0	$0	$0
2023	$6,700,000	$9,900,000	$0	$300,000	$1,400,000
2024	$16,200,000	$18,700,000	$100,000	$500,000	$2,500,000
2025	$22,800,000	$28,800,000	$100,000	$900,000	$4,200,000
2026	$37,100,000	$39,600,000	$200,000	$1,700,000	$6,700,000
2027	$45,200,000	$58,500,000	$300,000	$2,400,000	$12,100,000

[113] Carrier Press Release, Carrier Transicold Strengthens Sustainability Initiatives with Lower GWP Refrigerant for North America Truck and Trailer Systems, December 15, 2020. (web link: https://www.carrier.com/truck-trailer/en/north-america/news/news-article/carrier_transicold_strengthens_sustainability_initiatives_with_lower_gwp_refrigerant_for_north_america_truck_and_trailer_systems.html)

[114] Fleet Owner, Thermo King offers products to help reduce emissions, July 28, 2017. (web link: https://www.fleetowner.com/running-green/emissions/article/21696418/thermo-king-offers-products-to-help-reduce-emissions)

Year	Truck TRU	Trailer TRU	DSC TRU	Railcar TRU	TRU Generator Set
2028	$46,800,000	$60,100,000	$300,000	$2,700,000	$13,100,000
2029	$40,500,000	$62,600,000	$300,000	$2,900,000	$14,300,000
2030	$29,100,000	$64,200,000	$300,000	$2,800,000	$14,600,000
2031	$10,400,000	$64,900,000	$300,000	$2,500,000	$14,000,000
2032	(-$2,500,000)	$56,700,000	$200,000	$2,200,000	$10,300,000
2033	(-$15,400,000)	$57,600,000	$200,000	$2,100,000	$10,000,000
2034	(-$23,000,000)	$59,500,000	$300,000	$2,000,000	$10,500,000
Total	$213,900,000	$581,100,000	$2,600,000	$23,000,000	$113,700,000

e. Sales Tax

Sales tax is an additional cost levied on the purchase of a TRU. Since sales tax is based on the purchase price of the TRU, they are higher for units that would be purchased to comply with the Proposed Amendments due to their higher capital costs. TRUs purchased in California incur a sales tax on top of the purchase price. The sales tax varies across the State from a minimum of 7.25 percent up to 10.5 percent in some municipalities. For this analysis, staff used a value of 8.6 percent, which is a weighted average based on county-level output.[115, 116] Staff applied the additional sales tax cost to the capital cost for TRUs based in California. This results in higher costs for California-based TRU owners and higher revenue for local and State government (discussed in Section D.1 and D.2).

f. Maintenance and Operational Costs

i. TRU Maintenance Costs

TRU maintenance costs reflect the cost of labor and parts for routine maintenance, preventative maintenance, and repairing broken components. Maintenance costs for battery-electric truck TRUs are generally lower than diesel-powered TRUs in part due to fewer moving components. The maintenance cost for a diesel TRU is estimated at $0.95 per hour of operation, whereas the maintenance cost for a battery-electric truck TRU is estimated at $0.50 per hour of operation.[117] Annual TRU maintenance costs are calculated by multiplying the TRU maintenance rate by the annual activity within California per TRU (see Table C5) and the total TRU population per calendar year.

For trailer TRUs, DSC TRUs, railcar TRUs, and TRU generator sets, staff assumed the TRU maintenance costs would be the same in the Baseline and the Proposed Amendments since TRUs equipped with an engine that meets the proposed PM

[115] County-level output derived from Regional Economic Models, Inc. (REMI) Policy Insight Plus Version 2.4.1. Output is defined as the amount of production, including all intermediate goods purchased as well as value added (compensation and profit). Can also be thought of as sales or supply. The components of Output are Self Supply and Exports (Multiregions, Rest of Nation, and Rest of World).

[116] California Department of Tax and Fee Administration, California City & County Sales & Use Tax Rates, October 2020. (web link: https://www.cdtfa.ca.gov/taxes-and-fees/sales-use-tax-rates.htm)

[117] Claimed confidential data obtained from industry sources that requested non-attribution.

emission standard would incur the same maintenance cost as those equipped with engines that do not.

TRU refrigerant maintenance costs reflect the labor and material cost for a service technician to recharge the refrigerant in a TRU. The estimated annual maintenance cost for R-404A refrigerant is $6 per truck TRU and $14 per trailer TRU and DSC TRU. Under the Proposed Amendments, newly manufactured truck TRUs, trailer TRUs, and DSC TRUs would use the lower-GWP R-452A refrigerant, with an estimated annual maintenance cost of $14 per truck TRU and $35 per trailer TRU and DSC TRU. This is based on an assumed leak rate of 15 percent per year[118] (for all refrigerants) and the refrigerant capacity for truck TRUs, trailer TRUs, and DSC TRUs discussed previously. Table C24 shows the total estimated annual TRU and refrigerant maintenance costs from 2022 to 2034.

Table C24. Annual TRU and Refrigerant Maintenance Costs from 2022 to 2034 (2019$)

Year	Truck TRU	Trailer TRU	DSC TRU	Railcar TRU	TRU Generator Set
2022	$0	$0	$0	$0	$0
2023	$20,000	$900,000	$2,000	$0	$0
2024	(-$600,000)	$1,400,000	$2,000	$0	$0
2025	(-$1,300,000)	$1,700,000	$3,000	$0	$0
2026	(-$1,900,000)	$2,200,000	$5,000	$0	$0
2027	(-$2,900,000)	$2,600,000	$7,000	$0	$0
2028	(-$3,700,000)	$3,400,000	$9,000	$0	$0
2029	(-$4,400,000)	$3,800,000	$10,000	$0	$0
2030	(-$4,900,000)	$3,900,000	$10,000	$0	$0
2031	(-$5,000,000)	$4,000,000	$10,000	$0	$0
2032	(-$5,100,000)	$4,000,000	$10,000	$0	$0
2033	(-$5,100,000)	$4,100,000	$10,000	$0	$0
2034	(-$5,200,000)	$4,200,000	$11,000	$0	$0
Total	(-$40,100,000)	$36,200,000	$89,000	$0	$0

ii. Zero-Emission Truck TRU Infrastructure Maintenance Costs

Level 2 charger maintenance costs include the cost to replace charger heads, connectors, and other components, as well as labor costs for regular inspections. Annual maintenance costs are estimated to be $92.50 per unit.[119] Maintenance costs are calculated by multiplying the annual maintenance cost by the number of chargers.

[118] California Air Resources Board, California's High Global Warming Potential Gases Emission Inventory Methodology and Technical Support Document, April 2016. (web link: https://ww3.arb.ca.gov/cc/inventory/slcp/doc/hfc_inventory_tsd_20160411.pdf)
[119] Avista Corp, Electric Vehicle Supply Equipment Pilot Final Report, October 18, 2019. (web link: https://smartenergycc.org/wp-content/uploads/2019/10/Avista-EVSE-Pilot-Project-Review.pdf)

These costs also incorporate a 1.6 percent annual industry growth rate.[120] Table C25 shows the estimated infrastructure maintenance costs for zero-emission truck TRU infrastructure from 2022 to 2034.

Table C25. Estimated Annual Zero-Emission Truck TRU Infrastructure Maintenance Costs from 2022 to 2034 (2019$)

Year	Zero-Emission Truck TRU Infrastructure Maintenance Cost
2022	$0
2023	$0
2024	$200,000
2025	$400,000
2026	$600,000
2027	$900,000
2028	$1,100,000
2029	$1,400,000
2030	$1,500,000
2031	$1,500,000
2032	$1,600,000
2033	$1,600,000
2034	$1,600,000
Total	$12,400,000

iii. Diesel Fuel and Electricity Costs

Diesel fuel and electricity costs for truck TRUs are calculated using total fuel used per year and the cost of fuel per unit. For diesel units, fuel consumption is rated in gallons per hour (gal/hr). Staff used a fuel consumption rate of 0.55 gal/hr for diesel truck TRUs, which staff derived from the statewide TRU inventory model.[121] Annual electricity usage is based on the truck TRU battery size, number of operating days, and the total zero-emission truck TRU population per calendar year. Electricity usage also accounts for a 10 percent battery charging loss factor.[122] Table C26 shows the truck TRU diesel and electricity inputs used for the SRIA.

[120] California Air Resources Board, Draft 2019 Update to Emissions Inventory for Transport Refrigeration Units, October 2019. (web link: https://ww3.arb.ca.gov/cc/cold-storage/documents/hra_emissioninventory2019.pdf)
[121] California Air Resources Board, Draft 2019 Update to Emissions Inventory for Transport Refrigeration Units, October 2019. (web link: https://ww3.arb.ca.gov/cc/cold-storage/documents/hra_emissioninventory2019.pdf)
[122] Foothill Transit Battery Electric Bus Demonstration Results: Second Report, Eudy and Jeffers, NREL, June 2017. (web link: https://www.nrel.gov/docs/fy17osti/67698.pdf)

Table C26. Truck TRU Diesel Fuel and Electricity Cost Inputs

Input	Value
Baseline Diesel Truck TRU Fuel Consumption	0.55 gal/hr[123]
Zero-Emission Truck TRU Battery Size	40 kWh[124]

Truck TRUs generally operate 6 days a week during the early morning to afternoon, making deliveries along a fixed route, and return to a home base facility at the end of their day.[125] Since TRU operation varies widely, staff assumed that each truck TRU would deplete the battery after their daily operation and fully recharge their battery each night. Staff encourage truck TRU owners to work with TRU manufacturers to determine the adequate size battery for their specific operations to avoid the need to recharge during times that would incur additional time-of-use charges and ensure they can utilize nighttime charging during off-peak times.

The California Energy Commission (CEC) provides diesel fuel and electricity price forecasts as part of the Integrated Energy Policy Report (IEPR) process. The forecast includes three demand cases designed to capture a reasonable range of demand outcomes over the next 10 years. The "high-energy demand case" incorporates relatively high economic/demographic growth, relatively low electricity and natural gas rates, and relatively low committed efficiency program, self-generation, and climate change impacts. The "low-energy demand case" includes lower economic/demographic growth, higher assumed rates, and higher committed efficiency program and self-generation impacts. The "mid" case uses input assumptions at levels between the "high" and "low" cases.[126]

For this analysis, staff used diesel fuel and electricity prices to 2031 from CEC's Transportation Energy Demand Forecast 2020 IEPR Update.[127] Staff used diesel price projections from the mid-case scenario in the 2020 IEPR update and electricity price projections from the commercial electricity prices in the mid-case scenario in the 2020 IEPR update. Staff calculated fuel prices past 2031 by using the Energy

[123] California Air Resources Board, Draft 2019 Update to Emissions Inventory for Transport Refrigeration Units, October 2019. (web link: https://ww3.arb.ca.gov/cc/cold-storage/documents/hra_emissioninventory2019.pdf)

[124] As discussed in Section C.1.d.i, staff assumed a median battery size of 40 kWh based on the current offerings of battery-electric truck TRUs with batteries ranging in size from 10 to 60 kilowatt-hours capable of 8 to 12 hours of operation. This operating range was determined to be sufficient for truck TRUs since they are generally only used for local and regional operations and do not operate outside of California.

[125] McCormack, E., Chilan, T., Bassok, A., Fishkin, E., TransNow, Truck Trip Generation by Grocery Stores. Washington, DC: United States Department of Transportation, 2010. (web link: https://ntlrepository.blob.core.windows.net/lib/33000/33900/33993/TNW2010-04.pdf)

[126] California Energy Commission, Final 2019 Integrated Energy Policy Report, February 2020. (web link: https://efiling.energy.ca.gov/getdocument.aspx?tn=232922)

[127] California Energy Commission, Transportation Energy Demand Forecast 2020 IEPR Update, December 3, 2020. (web link: https://efiling.energy.ca.gov/GetDocument.aspx?tn=235841&DocumentContentId=68785, last accessed January 8, 2021)

Information Administration's (EIA) 2020 Annual Energy Outlook for the Pacific region.[128] Staff applied the annual percentage change in EIA diesel fuel and electricity prices past 2031 to the 2031 CEC diesel and electricity prices to estimate price changes past 2031.

Staff adjusted the CEC diesel fuel prices because TRUs are considered to be off-road equipment and are not subject to certain taxes included in the CEC values. Staff subtracted the federal excise tax rate equal to $0.385 per gallon,[129] as well as State diesel tax and local district tax estimated to be 13 percent and 1.36 percent,[130] respectively. When used off-road, diesel is taxed at the combined statewide sales tax rate, plus applicable district taxes. Therefore, staff applied the combined State and local sales tax rate used in this analysis of 8.6 percent, which is a weighted average based on county-level output, with 3.94 percent[131] going towards State sales tax and 4.67 percent[132] going towards local sales tax. The projected cost of diesel and electricity used in this analysis are outlined in Table C27.

Table C27. Diesel and Electricity Price Projections from 2022 to 2034 (2019$)

Year	Diesel Price per Gallon	Electricity Price per kWh
2022	$2.40	$0.19
2023	$2.38	$0.19
2024	$2.38	$0.19
2025	$2.35	$0.19
2026	$2.34	$0.20
2027	$2.28	$0.20
2028	$2.25	$0.20
2029	$2.19	$0.21
2030	$2.15	$0.21
2031	$2.15	$0.21
2032	$2.16	$0.21
2033	$2.20	$0.21
2034	$2.21	$0.21

[128] Energy Information Administration, Annual Energy Outlook 2020. (web link: https://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO2020&region=1-9&cases=ref2020&start=2018&end=2050&f=A&linechart=ref2020-d112119a.3-3-AEO2020.1-9&map=ref2020-d112119a.4-3-AEO2020.1-9&sourcekey=0%00, last accessed January 8, 2021)

[129] California Department of Tax and Fee Administration, Tax Rates for Motor Vehicles and Diesel Fuels, May 2020. (web link: https://cdtfa.ca.gov/formspubs/L739.pdf)

[130] California Department of Tax and Fee Administration, Sales Tax Rates for Fuels. (web link: https://www.cdtfa.ca.gov/taxes-and-fees/sales-tax-rates-for-fuels.htm, last accessed February 10, 2021)

[131] California Department of Tax and Fee Administration, Detailed Description of the Sales & Use Tax Rate. (web link: https://www.cdtfa.ca.gov/taxes-and-fees/sut-rates-description.htm, last accessed January 29, 2021)

[132] California Department of Tax and Fee Administration, California City & County Sales & Use Tax Rates, October 2020. (web link: https://www.cdtfa.ca.gov/taxes-and-fees/sales-use-tax-rates.htm)

The diesel fuel and electricity costs for truck TRUs in a given year are calculated using the following equations:

$$Diesel\ Cost = population \times activity \times fuel\ consumption\ rate \times cost\ of\ diesel$$

Where:

Diesel cost = annual diesel usage cost ($)

Population = annual diesel truck TRU population (number of units)

Activity = truck TRU activity in California (1,360 hours per unit)

Fuel consumption rate = 0.55 gallon/hour

Cost of diesel = statewide average diesel cost from Table C27 ($/gallon)

$$Electricity\ Cost = population \times battery\ size \times operating\ days \times cost\ of\ electricity$$

Where:

Electricity cost = annual electricity usage cost ($)

Population = annual zero-emission truck TRU population (number of units)

Battery size = average zero-emission truck TRU battery size (40kW)

Operating days = number of days per year truck TRUs operate (312 days/year)

Cost of electricity = statewide average electricity cost from Table C27 ($/kWh)

Table C28 outlines the total estimated annual diesel and electricity usage costs for truck TRUs.

Table C28. Estimated Annual Truck TRU Diesel Fuel and Electricity Costs from 2022 to 2034 (2019$)

Year	Annual Truck TRU Diesel Fuel Cost	Annual Truck TRU Electricity Cost
2022	$0	$0
2023	$0	$0
2024	(-$1,700,000)	$2,400,000
2025	(-$3,800,000)	$5,700,000
2026	(-$5,600,000)	$8,600,000
2027	(-$8,200,000)	$13,100,000
2028	(-$10,300,000)	$17,000,000
2029	(-$12,100,000)	$20,800,000
2030	(-$13,100,000)	$23,300,000
2031	(-$13,200,000)	$24,200,000
2032	(-$13,600,000)	$24,500,000
2033	(-$14,000,000)	$24,900,000
2034	(-$14,300,000)	$25,300,000
Total	(-$109,900,000)	$189,800,000

For trailer TRUs, DSC TRUs, railcar TRUs, and TRU generator sets, staff assumed diesel fuel costs would be the same in the Baseline and the Proposed Amendments. In general, an engine operating at higher power levels uses more fuel. Therefore, it would be expected that the purchase of units with greater than 25 horsepower engines to comply with the PM emission standard would result in higher diesel fuel costs. However, one of the two major TRU OEMs indicated that they plan to offer units equipped with a less than 25 horsepower engine that meets the 0.02 g/hp-hr PM emission standard.[133] Therefore, staff assumed the population mix of less than 25 horsepower and greater than 25 horsepower engines and resulting diesel fuel usage would remain the same.

iv. Low Carbon Fuel Standard Revenue

The LCFS Regulation is designed to reduce GHG emissions by requiring fuel producers to reduce the carbon intensity in fuel or purchase credits from those who supply low carbon fuel. The regulation incentivizes the use of low carbon fuels, including electricity, hydrogen, natural gas, and biofuels.[134] TRU owners who use electricity as a power source to charge their zero-emission truck TRUs can generate credits based on the amount of energy they use. Staff expect that all parties eligible to generate LCFS credits will take advantage of the incentive provided by LCFS. Staff determined credit values for different fuel types using the LCFS Credit Price Calculator.[135] LCFS credit revenue is projected to drop slightly over time as program standards tighten and maintain upward pressure on the credit price. Table C29 outlines the projected LCFS credit values and revenue from 2022 to 2034. These values are based on a credit price of $200 and a California grid average Carbon Intensity of 81.49 grams of carbon dioxide equivalent emissions per megajoule of fuel energy.[136]

Table C1. Projected LCFS Credit Values and Revenue from 2022 to 2034

Year	Projected LCFS Credit Value per kWh	Projected LCFS Credit Revenue
2022	$0.16	$0
2023	$0.16	$0
2024	$0.16	(-$1,900,000)
2025	$0.15	(-$4,100,000)
2026	$0.15	(-$6,000,000)
2027	$0.15	(-$9,000,000)
2028	$0.14	(-$10,700,000)
2029	$0.14	(-$12,900,000)
2030	$0.14	(-$14,200,000)

[133] Claimed confidential data obtained from an industry source that requested non-attribution.

[134] California Air Resources Board, Unofficial Electronic Version of the Low Carbon Fuel Standard Regulation, July 2020. (web link: https://ww2.arb.ca.gov/sites/default/files/2020-07/2020_lcfs_fro_oal-approved_unofficial_06302020.pdf)

[135] California Air Resources Board, LCFS Credit Price Calculator. (web link: https://www.arb.ca.gov/fuels/lcfs/dashboard/creditpricecalculator.xlsx, last accessed May 2021)

[136] LCFS staff analysis dated March 9, 2020. Values for 2031-2033 are extrapolated.

Year	Projected LCFS Credit Value per kWh	Projected LCFS Credit Revenue
2031	$0.14	(-$14,100,000)
2032	$0.13	(-$14,100,000)
2033	$0.13	(-$14,000,000)
2034	$0.13	(-$13,900,000)
Total	n/a	(-$114,900,000)

The total estimated LCFS credit revenue for truck TRU owners is estimated to be $114.9 million from 2022 to 2034. The cost savings would be incurred by TRU owners.

g. Administrative Costs

TRU owners and applicable facility owners would incur registration and reporting costs to comply with the Proposed Amendments. These costs are detailed below.

i. Registration and Reporting

1) TRUs

The Proposed Amendments require TRU owners to report all TRUs that operate in California beginning in 2023, regardless of the state they are based in. The current TRU ATCM requires that owners report California-based TRUs to CARB. Although a number of out-of-state fleets already voluntarily report to CARB, staff accounted for the costs associated with the time it would take to report out-of-state based TRUs since it is not currently a requirement in the TRU ATCM. Based on the amount of information TRU owners would be required to report, staff estimated that it would take on average 10 minutes to report each TRU at an estimated rate of $50 per hour for staffing and lost revenue from the employee assigned to pull and submit the information. The total cost to report approximately 459,000 out-of-state based TRUs to CARB from 2023 to 2034 is estimated to be $3.5 million and the costs would be incurred by TRU owners.

2) Applicable Facilities

The Proposed Amendments require applicable facility owners to register their facilities with CARB in 2023. Based on the amount of information facilities would be required to report, staff estimated that it would take on average one hour per facility to do this at a rate of $50 per hour for staffing and lost revenue from the employee assigned to pull and submit the information. The total cost to register approximately 7,800 applicable facilities with CARB from 2023 to 2034 is estimated to be $388,150 and the costs would be incurred by the facility owners.

ii. CARB Fees

The Proposed Amendments include TRU operating fees and applicable facility registration fees that would impose a direct, on-going cost to owners. The proposed fees will result in revenue to the State to offset costs needed to implement and enforce the Proposed Amendments. Reported and compliant TRUs will receive a CARB issued compliance label to facilitate quick identification of compliance status for

CARB staff and applicable facilities. TRU compliance labels will be valid for three years. Reporting every three years would help to ensure that reported information is accurate and kept up to date. Staff determined that compliance monitoring and enforcement activities related to zero-emission TRUs will be less resource intensive, and therefore have a lower operating fee. Table C30 shows the fee amounts under the Proposed Amendments. The fiscal impacts to State government are described in the Fiscal Impacts section (Section D.2).

Table C30. Fee Amounts

Type	Fee Amount per TRU or Facility
TRU Operating Fee, paid once every three years	$43
Zero-Emission TRU Operating Fee, paid once every three years	$22
Facility Registration Fee, paid once every three years	$43

The total fees from 2022 to 2034 are estimated to be $48 million. The cost would be incurred by TRU and applicable facility owners.

iii. Applicable Facility Reporting Costs

The Proposed Amendments require applicable facility owners to ensure that TRUs operating on their property are compliant. Owners may choose one of the following options:

- Reporting Option 1: Report all TRUs that operate on applicable facility property to CARB
- Reporting Option 2: Provide a declaration to CARB, under penalty of perjury, that non-compliant TRUs subject to this regulation would not be permitted to operate on applicable facility property.

1) Refrigerated WHDCs

Based on the initial compliance path chosen by facilities under CARB's Drayage Truck Regulation,[137] which includes reporting requirements for terminal operators regarding the drayage trucks that enter their facility, staff estimated that 10 percent of refrigerated WHDCs would collect and report all TRU activity to CARB (Reporting Option 1) and 90 percent would not allow non-compliant TRUs to operate (Reporting Option 2).

To estimate reporting costs, staff further categorized refrigerated WHDCs into standard refrigerated WHDCs with a building size between 20,000 and 199,999 square feet and refrigerated high-cube WHDCs (HCWHDC) with a building size greater than 200,000 square feet since the number of estimated TRU visits correlate with the building square footage. Staff applied TRU visit metrics from the 2016 South Coast Air

[137] California Air Resources Board, Public Hearing to Consider Proposed Amendments to the In-Use On-Road Diesel-Fueled Heavy-Duty Drayage Truck Regulation. Staff Report: Initial Statement of Reasons, October 2007. (web link: https://ww3.arb.ca.gov/regact/2007/drayage07/drayage07.htm)

Quality Management District and Institute of Transportation Engineers Warehouse Vehicle Trip Generation Analysis[138] to the average building square footage for a standard refrigerated WHDC and refrigerated HCHWDC to determine annual TRU activity as shown in Table C31.

Table C31. Estimated Annual Number of TRUs at Refrigerated WHDCs

Facility Type	TRUs Per Year
Refrigerated WHDC – Standard	2,496
Refrigerated HCWHDC	43,992

Collect and Report TRU Information to CARB

According to the United States Bureau of Labor Statistics, the median wage for Transportation, Storage, and Distribution Workers in California in May 2019 was $15.89 per hour[139] and the benefits amounted to $6.81 (70.3 percent of the hourly wage).[140] Benefits include insurance, which includes life, health, and short- and long-term disability, Social Security, Medicare, unemployment insurance (both state and federal), workers' compensation, as well as costs for paid vacation, holiday, sick, and personal leave. Staff used the fully-burdened labor rate of $22.70 for refrigerated WHDC workers to collect TRU information. Staff estimated it would take two minutes to collect information for each TRU. Therefore, the cost to collect TRU information at a standard WHDC and refrigerated HCWHDC is estimated to be $1,899 and $33,287 per year, respectively.

Based on the number of TRU visits and the amount of information facilities would be required to report, staff assumed it would take two hours for standard refrigerated WHDCs and four hours for HCWHDCs to retrieve, review, and report the information to CARB on a quarterly basis at a rate of $50 per hour for staffing and lost revenue from the employee assigned to submit the information. The cost to a standard refrigerated WHDC and HCWHDC to report information to CARB is estimated to be $400 and $1,000 per year, respectively. Therefore, the total cost to a standard refrigerated WHDC and HCWHDC to collect and report TRU information to CARB (Reporting Option 1), is estimated to be $2,299 and $34,287 per year, respectively.

Check for Compliance Onsite

Staff assumed 10 percent of standard refrigerated WHDCs and HCWHDCs would check for TRU compliance onsite and that it would take one minute to ensure the TRU had a valid CARB compliance label. Staff assumed the same type of workers that

[138] Institute of Transportation Engineers, High-Cube Warehouse Vehicle Trip Generation Analysis, October 2016. (web link: https://www.ite.org/pub/?id=a3e6679a%2De3a8%2Dbf38%2D7f29%2D2961becdd498)
[139] United States Bureau of Labor Statistics, State Occupational Employment and Wage Estimates California, May 2019. (web link: https://www.bls.gov/oes/current/oes_ca.htm#53-0000)
[140] United States Bureau of Labor Statistics, Employer Costs for Employee Compensation for the Regions – September 2020. (web link: https://www.bls.gov/regions/southwest/news-release/employercostsforemployeecompensation_regions.htm)

would collect and report TRU information would check for compliance and used the fully-burdened labor rate of $22.70 per hour[141] for refrigerated WHDC and refrigerated HCWHDC workers described above. Therefore, the cost to a standard WHDC and refrigerated HCWHDC to check for compliance onsite and turn non-compliant TRUs away (Reporting Option 2) is estimated to be $944 and $16,649 per year, respectively.

Only Doing Business with California-Compliant Companies

Based on the initial compliance path chosen by facilities under CARB's Drayage Truck Regulation, staff assumed that most facilities would choose the lowest cost option of only doing business with California compliant companies. Staff estimated that 80 percent of refrigerated WHDCs would require the use of compliant TRU units in their contracts and only do business with companies that are on CARB's 100 percent compliant list.[142] This would not incur any additional costs.

2) Grocery Stores

Similar to refrigerated WHDCs, based on the initial compliance path chosen by facilities under CARB's Drayage Truck Regulation, staff estimated that 10 percent of grocery stores would collect and report all TRU activity to CARB (Reporting Option 1) and 90 percent would not allow non-compliant TRUs to operate (Reporting Option 2).

Staff further categorized grocery stores into standard grocery stores with a building size between 15,000 and 89,999 square feet and supercenters with a building size greater than or equal to 90,000 square feet. Unlike refrigerated WHDCs, vehicle trip metrics for grocery stores are based on the type of store and not on the size of the building. This varies for each store depending on factors such as store hours, labor force, consumer demand, and travel time from distribution centers. However, based on environmental planning documents for various grocery stores in the State, staff assumed the average number of TRU deliveries is two per day at grocery stores and four per day at supercenters, six days per week.[143,144,145,146]

Collect and Report TRU Information to CARB

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[141] United States Bureau of Labor Statistics, Occupational Employment Statistics. (web link: https://www.bls.gov/oes/home.htm, last accessed June 2019)
[142] California Air Resources Board, 100 Percent TRU ATCM Compliant Carrier List Search Page. (web link: https://arber.arb.ca.gov/publicTCCReports.arb)
[143] City of Malibu, Whole Foods and the Park Shopping Center Draft Environmental Impact Report, February 2015. (web link: https://www.malibucity.org/DocumentCenter/View/11516/WHOLE-FOODS-AND-THE-PARK-EIR----Consolidated-Draft-EIR?bidId=)
[144] City of Oakland, Safeway Redevelopment Project Broadway at Pleasant Valley Avenue Draft Environmental Impact Report, January 2013. (web link: http://www2.oaklandnet.com/oakca1/groups/ceda/documents/report/oak039284.pdf)
[145] City of Clearlake, Clearlake Walmart Center Expansion Draft Environmental Impact Report, March 2017. (web link: https://www.clearlake.ca.us/DocumentCenter/View/668/1_Clearlake-Walmart-Center-Expansion-Draft-EIR-Volume-I-Chapters-1-410.pdf)
[146] City of Oakland, Safeway Shopping Center – College and Claremont Avenues, July 2012. (web link: http://www2.oaklandnet.com/oakca1/groups/ceda/documents/agenda/oak036885.pdf)

Staff assumed 10 percent of standard grocery stores and supercenters would check for TRU compliance onsite. Because no California specific median wage for grocery workers was available, staff used the same wage for refrigerated WHDC and refrigerated HCWHDC workers described above. Therefore, staff assumed the fully-burdened labor rate for standard grocery store and supercenter workers to collect TRU information is $22.70 per hour. Staff estimated it would take two minutes to collect information for each TRU. Therefore, the cost to collect TRU information at a standard grocery store and supercenter is estimated to be $472 and $944 per year, respectively.

Based on the number of TRU visits and the amount of information required to report, staff assumed it would take two hours for standard grocery stores and four hours for supercenters to report the information to CARB on a quarterly basis at a rate of $50 per hour for staffing and lost revenue from the employee assigned to submit the information. The cost to a standard grocery store and supercenter to report information to CARB is estimated to be $400 and $1,000 per year, respectively. Therefore, the total cost to a standard grocery store and supercenter to collect and report TRU information to CARB (Reporting Option 1), is estimated to be $872 and $1,944 per year, respectively.

Check for Compliance Onsite

Staff assumed 10 percent of standard grocery stores and supercenters would check for TRU compliance onsite and it would take one minute to ensure the TRU had a valid CARB compliance label. The same type of workers that would collect and report TRU information would check for compliance and used the fully-burdened labor rate of $22.70 per hour. Therefore, the cost to a standard grocery store and supercenter to check TRU compliance onsite and turn non-compliant TRUs away (Reporting Option 2) is estimated to be $236 and $472 per year, respectively.

Only Doing Business with California-Compliant Companies

Similar to refrigerated WHDCs, staff assumed 80 percent of grocery stores would only do business with companies that are compliant and on CARB's list. This would not incur any additional costs.

3) Seaport Facilities and Intermodal Railyards

Because seaport facilities and railyards already collect information for incoming refrigerated containers, staff assumed these facilities would collect and report all TRU activity to CARB. There are already systems in place to perform the task of gathering the required information. Therefore, the cost of submitting this information to CARB would be the cost of reviewing information and generating a report to submit to CARB. Based on annual number of TRU visits and the amount of information facilities would be required to report, staff estimated it would take one hour per week. According to the United States Bureau of Labor Statistics, the median wage for Rail Transportation Workers in California in May 2019 was $25.17 per hour and the

benefits amounted to $10.79 (70.3 percent of the hourly wage).[147] Because no California-specific median wage for seaport workers was available, staff used the same wage for workers at both facility types. Therefore, staff used the fully-burdened labor rate of $35.96 per hour for seaport and railyard workers to check collected TRU information. The cost for seaport facilities and railyards to collect TRU information is estimated to be $1,870 per year.

Based on the number of TRU visits and the amount of information required to report, staff assumed it would take four hours for seaport facilities and railyards to report the information to CARB on a quarterly basis at a rate of $50 per hour for staffing and lost revenue from the employee assigned to submit the information. The cost to a seaport facility and railyard to report information to CARB is estimated to be $1,000 per year. Therefore, the total cost to a seaport facility and railyard to collect and report TRU information to CARB (Reporting Option 1) is estimated to be $2,870 per year. Table C32 shows the reporting costs by option chosen for each of the applicable facility types.

Table C32. Estimated Reporting Costs by Applicable Facility Type and Option Chosen

Facility Type	Cost to Collect and Report TRU Information to CARB (Reporting Option 1)	Cost to Check Compliance Onsite/Turn Non-Compliant TRUs Away (Reporting Option 2)	Cost to Only do Business with Compliant Companies (Reporting Option 2)
Standard Refrigerated WHDC	$2,299	$1,899	$0
Refrigerated HCWHDC	$34,287	$33,287	$0
Grocery Store	$872	$472	$0
Supercenter	$1,944	$944	$0
Seaport Facility or Railyard	$2,870	n/a	n/a

Table C33 shows the total reporting cost to applicable facility owners from 2022 to 2034 is estimated to be $36.8 million.

Table C33. Estimated Applicable Facility Reporting Costs from 2022 to 2034 (2019$)

Year	Applicable Facility Reporting Cost
2022	$0
2023	$0
2024	$3,100,000
2025	$3,100,000
2026	$3,200,000

[147] United States Bureau of Labor Statistics, State Occupational Employment and Wage Estimates California, May 2019. (web link: https://www.bls.gov/oes/current/oes_ca.htm#53-0000)

Year	Applicable Facility Reporting Cost
2027	$3,200,000
2028	$3,300,000
2029	$3,300,000
2030	$3,400,000
2031	$3,500,000
2032	$3,500,000
2033	$3,600,000
2034	$3,600,000
Total	$36,800,000

iv. Truck TRU Owner Extension Costs

Staff have worked closely with TRU OEMs and electric utilities to ensure the regulatory compliance dates and annual zero-emission truck TRU percentages that would be required by the Proposed Amendments are feasible. Staff do not anticipate delays to the availability of zero-emission truck TRUs or the installation of charging or fueling infrastructure needed to support zero-emission truck TRUs. The costs and emission reductions presented in this analysis reflect full compliance with the Proposed Amendments. However, to be conservative, staff quantified the costs that truck TRU owners would incur to apply for an extension to the zero-emission truck TRU requirement due to unavailability of zero-emission truck TRUs or infrastructure-related delays. Truck TRU owners may apply for an extension if compliance technology is not available due to a TRU OEM delay or if infrastructure cannot be installed on time due to any of the following:

- A delay in the manufacture and shipment of infrastructure equipment
- A delay in obtaining construction permit(s)
- A delay in obtaining power from a utility
- A delay due to private financing
- A delay in the installation of infrastructure
- A natural disaster
- The discovery of archeological, historical, or tribal cultural resources under CEQA

Table C34 shows the estimated number of truck TRU extensions each year from 2022 to 2034. The TRU OEM extension estimate is based on historical data on the number of OEM related extension applications received for the current TRU ATCM. The infrastructure extension estimates are based on analysis of truck TRU home base facilities, including the number of facilities, their location, as well as the estimated number of truck TRUs and subsequent amount of infrastructure staff expect to be installed at each truck TRU home base facility.

Table C34. Estimated Number of Truck TRU Extensions from 2022 to 2034

Year	TRU OEM Delay	Infrastructure Manufacture/ Shipment Delay	Permit Delay	Utility Upgrade Delay	Utility Connection Delay	Private Financing Delay	Installation Delay	Natural Disaster, CEQA, Historical, Tribal Discovery
2022	0	0	0	0	0	0	0	0
2023	12	6	4	6	5	7	7	2
2024	23	6	4	6	5	7	7	2
2025	11	6	4	6	5	7	7	2
2026	38	6	4	6	5	7	7	2
2027	21	6	4	6	5	7	7	2
2028	15	6	4	6	5	7	7	2
2029	8	6	4	6	5	7	7	2
2030	5	1	2	2	1	1	1	1
2031	5	1	2	2	1	1	1	1
2032	5	1	2	2	1	1	1	1
2033	5	1	2	2	1	1	1	1
2034	5	1	2	2	1	1	1	1
Total	153	47	38	52	40	54	54	19

Table C35 shows the estimated time to apply for an extension depending on the type. The hourly cost is assumed to be $100 per hour.

Table C35. Estimated Time and Cost to Complete Extension Application

Extension Type	Time to Complete Each Extension Application (hours)	Cost to TRU Owner to Complete Each Extension
TRU OEM Delay	2	$200
Infrastructure Manufacture/Shipment Delay	2	$200
Permitting Delay	2	$200
Utility Infrastructure Upgrade	4	$400
Utility Connection Delay	2	$200
Financial Delay	2	$200
Installation Delay	2	$200
Natural Disaster, CEQA, Historical, Tribal Discovery	10	$1000

Table C36 shows the total cost to truck TRU owners to apply for an extension from 2022 to 2034 is estimated to be $117,000.

Table C36. Estimated Truck TRU Extension Costs from 2022 to 2034

Year	Truck TRU Extension Cost
2022	$0
2023	$12,600
2024	$14,800

Year	Truck TRU Extension Cost
2025	$12,400
2026	$17,800
2027	$14,400
2028	$13,200
2029	$11,800
2030	$4,000
2031	$4,000
2032	$4,000
2033	$4,000
2034	$4,000
Total	$117,000

h. Total Net Costs

Table C37, Table C38, and Table C39 show the total net costs, total direct costs (without netting), and total cost savings of the Proposed Amendments from 2022 to 2034, respectively. Direct costs include all capital costs, TRU refrigerant maintenance costs, truck TRU infrastructure maintenance costs, electricity usage, CARB fees, and administrative costs for registration and reporting. Cost savings include truck TRU capital costs, truck TRU maintenance cost savings, truck TRU diesel fuel savings, and LCFS credit revenue.

Table C37. Total Net Costs of the Proposed Amendments from 2022 to 2034 (2019M$)

Year	Equipment Capital Costs	Equipment Maintenance Costs	Infrastructure Capital Costs	Infrastructure Maintenance Costs	Diesel Fuel Costs	Electricity Costs	LCFS Credit Revenue	Administrative Costs	Total
2022	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
2023	$17.7	$0.9	$1.1	$0.0	$0.0	$0.0	$0.0	$10.8	$30.5
2024	$36.5	$0.8	$2.5	$0.2	(-$1.7)	$2.4	(-$1.9)	$4.3	$43.1
2025	$54.7	$0.4	$3.6	$0.4	(-$3.8)	$5.7	(-$4.1)	$4.3	$61.3
2026	$81.8	$0.3	$5.4	$0.6	(-$5.6)	$8.6	(-$6.0)	$11.0	$96.0
2027	$114.7	(-$0.2)	$6.9	$0.9	(-$8.2)	$13.1	(-$9.0)	$5.9	$124.0
2028	$118.9	(-$0.3)	$7.2	$1.1	(-$10.3)	$17.0	(-$10.7)	$6.7	$129.7
2029	$117.0	(-$0.6)	$6.7	$1.4	(-$12.1)	$20.8	(-$12.9)	$8.1	$128.5
2030	$108.6	(-$1.0)	$5.7	$1.5	(-$13.1)	$23.3	(-$14.2)	$7.0	$118.0
2031	$91.3	(-$1.0)	$4.0	$1.5	(-$13.3)	$24.2	(-$14.1)	$8.0	$100.6
2032	$67.1	(-$1.0)	$2.7	$1.6	(-$13.6)	$24.5	(-$14.1)	$7.5	$74.8
2033	$56.0	(-$1.0)	$1.5	$1.6	(-$14.0)	$24.9	(-$14.0)	$7.3	$62.2
2034	$51.5	(-$1.0)	$0.8	$1.6	(-$14.3)	$25.3	(-$13.9)	$8.5	$58.3
Total	$916.0	(-$3.7)	$48.1	$12.3	(-$109.9)	$189.8	(-$114.9)	$89.4	$1,027.0

Table C38. Total Direct Costs of the Proposed Amendments from 2022 to 2034 (2019$)

Year	Equipment Capital Costs	TRU Refrigerant Maintenance Costs	Infrastructure Capital Costs	Infrastructure Maintenance Costs	Electricity Costs	Administrative Costs	Total
2022	$0	$0	$0	$0	$0	$0	$0
2023	$17,700,000	$900,000	$1,100,000	$0	$0	$10,800,000	$30,500,000
2024	$36,500,000	$1,400,000	$2,500,000	$200,000	$2,400,000	$4,300,000	$47,300,000
2025	$54,700,000	$1,700,000	$3,600,000	$400,000	$5,700,000	$4,300,000	$70,400,000
2026	$81,800,000	$2,200,000	$5,400,000	$600,000	$8,600,000	$11,000,000	$109,600,000
2027	$114,700,000	$2,600,000	$6,900,000	$900,000	$13,100,000	$5,900,000	$144,100,000
2028	$118,900,000	$3,400,000	$7,200,000	$1,100,000	$17,000,000	$6,700,000	$154,300,000
2029	$117,000,000	$3,900,000	$6,700,000	$1,400,000	$20,800,000	$8,100,000	$157,900,000
2030	$108,600,000	$3,900,000	$5,700,000	$1,500,000	$23,300,000	$7,000,000	$150,000,000
2031	$91,300,000	$4,000,000	$4,000,000	$1,500,000	$24,200,000	$8,000,000	$133,000,000
2032	$72,300,000	$4,000,000	$2,700,000	$1,600,000	$24,500,000	$7,500,000	$112,600,000
2033	$72,900,000	$4,100,000	$1,500,000	$1,600,000	$24,900,000	$7,300,000	$112,300,000
2034	$75,300,000	$4,200,000	$800,000	$1,600,000	$25,300,000	$8,500,000	$115,700,000
Total	$961,700,000	$36,300,000	$48,100,000	$12,400,000	$189,800,000	$89,400,000	$1,337,700,000

Table C39. Total Cost Savings of the Proposed Amendments from 2022 to 2034 (2019$)

Year	Truck TRU Capital Cost Savings	Truck TRU Diesel Fuel Cost Savings	Truck TRU Maintenance Cost Savings	LCFS Credit Revenue	Total
2022	$0	$0	$0	$0	$0
2023	$0	$0	$0	$0	$0
2024	$0	(-$600,000)	(-$1,700,000)	(-$1,900,000)	(-$4,200,000)
2025	$0	(-$1,300,000)	(-$3,800,000)	(-$4,100,000)	(-$9,200,000)
2026	$0	(-$1,900,000)	(-$5,600,000)	(-$6,000,000)	(-$13,500,000)
2027	$0	(-$2,900,000)	(-$8,200,000)	(-$9,000,000)	(-$20,100,000)
2028	$0	(-$3,700,000)	(-$10,300,000)	(-$10,700,000)	(-$24,700,000)
2029	$0	(-$4,400,000)	(-$12,100,000)	(-$12,900,000)	(-$29,400,000)
2030	$0	(-$4,900,000)	(-$13,100,000)	(-$14,200,000)	(-$32,200,000)
2031	$0	(-$5,000,000)	(-$13,200,000)	(-$14,100,000)	(-$32,300,000)
2032	(-$5,200,000)	(-$5,100,000)	(-$13,600,000)	(-$14,100,000)	(-$38,000,000)
2033	(-$16,900,000)	(-$5,100,000)	(-$14,000,000)	(-$14,000,000)	(-$50,000,000)
2034	(-$23,800,000)	(-$5,200,000)	(-$14,300,000)	(-$13,900,000)	(-$57,200,000)
Total	(-$45,900,000)	(-$40,100,000)	(-$109,900,000)	(-$114,900,000)	(-$310,800,000)

2. Direct Costs on Typical Businesses

For the purposes of the Proposed Amendments, typical businesses are defined as all affected establishments in the State that are not small businesses. The estimated costs to TRU and applicable facility owners considered to be a typical business to comply with the Proposed Amendments are discussed below.

a. TRU Owners

Truck and trailer TRUs make up approximately 83 percent of the TRU population that operates in California. For this analysis, staff calculated the cost for a typical California-based truck TRU fleet and a typical California-based trailer TRU fleet to comply with the Proposed Amendments as compared to the Baseline.

i. Truck TRU Owner

Based on CARB's ARBER[148] and Dun and Bradstreet[149] databases, the average number of truck TRUs owned by companies with more than 100 employees is 8. Therefore, to illustrate the costs to a typical business, staff considered an average fleet with eight truck TRUs. All cost assumptions are the same as discussed in previous sub-sections for truck TRUs. An owner of a fleet consisting of eight truck TRUs would be required to purchase zero-emission truck TRUs beginning in 2023, as shown in Table C40.

Table C40. Annual Number of Zero-Emission Truck TRU Purchases Required by the Proposed Amendments for a Typical Business Owning Truck TRUs from 2022 to 2034

Year	Number of Zero-Emission Truck TRUs Purchased
2022	0
2023	1
2024	1
2025	2
2026	1
2027	1
2028	1
2029	1
2030	0
2031	0
2032	0
2033	0
2034	0
Total	8

[148] California Air Resources Board, Air Resources Board Equipment Registration System. (web link: https://arber.arb.ca.gov/, last accessed July 2020)
[149] Dun and Bradstreet Database, Employee data for companies that own truck TRUs, Proprietary, 2019. (web link: https://www.dnb.com/ca-en/)

To assess the costs to a typical business owning truck TRUs, staff assumed the truck TRU owner also owns the truck TRU home base facility where charging infrastructure would be installed to support operation of the battery-electric truck TRUs purchased to comply with the zero-emission truck TRU requirement. As discussed in Section C.1.d.ii, staff assumed owners would install infrastructure on the same schedule as the truck TRUs transition to zero-emission technology, adding enough chargers to accommodate the battery-electric truck TRU population each year.

Table C41 shows the annual amortized cost for a typical business owning truck TRUs to comply with the Proposed Amendments from 2022 to 2034, which ranges from -$7,600 to $65,200. The total amortized cost for a typical business owning truck TRUs to comply with the Proposed Amendments from 2022 to 2034 is estimated to be $352,100. To show the feasibility of compliance for a typical business owning truck TRUs, staff compared the maximum amortized annual cost of $65,200 to the annual revenue of a typical business in the truck transportation industry, which is $36.5 million.[150] The maximum amortized annual cost for a typical business owning truck TRUs to comply with the Proposed Amendments is less than one percent of their annual revenue.

Table C42 shows the annual unamortized cost for a typical business owning truck TRUs to comply with the Proposed Amendments from 2022 to 2034, which ranges from -$11,600 to $102,100. The total unamortized cost for a typical business owning truck TRUs to comply with the Proposed Amendments from 2022 to 2034 is estimated to be $293,900. To show the feasibility of compliance for a typical business owning truck TRUs, staff compared the maximum unamortized annual cost of $102,100 to the annual revenue of a typical business in the truck transportation industry, which is $36.5 million.[151] The maximum unamortized annual cost for a typical business owning truck TRUs to comply with the Proposed Amendments is less than one percent of their annual revenue.

[150] United States Census Bureau, 2012 SUSB Annual Datasets by Establishment Industry, 2015. (web link: https://www.census.gov/data/datasets/2012/econ/susb/2012-susb.html, last accessed March 12, 2021)
[151] United States Census Bureau, 2012 SUSB Annual Datasets by Establishment Industry, 2015. (web link: https://www.census.gov/data/datasets/2012/econ/susb/2012-susb.html, last accessed March 12, 2021)

Table C41. Estimated Annual Cost to a Typical Business Owning Truck TRUs to Comply with the Proposed Amendments from 2022 to 2034 (2019$)

Year	Equipment Capital Costs	Equipment Maintenance Costs	Infrastructure Capital Costs	Infrastructure Maintenance Costs	Diesel Costs	Electricity Costs	LCFS Credits	Administrative Costs	Total
2022	$0	$0	$0	$0	$0	$0	$0	$0	$0
2023	$11,200	$0	$1,100	$0	$0	$0	$0	$320	$12,600
2024	(-$8,300)	(-$600)	$2,300	$200	(-$1,800)	$2,600	(-$2,000)	$20	(-$7,600)
2025	$34,600	(-$1,200)	$4,500	$400	(-$3,500)	$5,200	(-$3,700)	$40	$36,300
2026	$45,500	(-$2,400)	$5,600	$700	(-$7,000)	$10,700	(-$7,500)	$170	$45,800
2027	$56,300	(-$3,000)	$6,800	$900	(-$8,500)	$13,600	(-$9,400)	$40	$56,700
2028	$55,800	(-$3,600)	$6,800	$1,100	(-$10,100)	$16,600	(-$10,500)	$70	$56,200
2029	$65,100	(-$4,200)	$6,800	$1,300	(-$11,500)	$19,800	(-$12,200)	$70	$65,200
2030	$43,100	(-$4,800)	$4,500	$1,500	(-$12,900)	$23,000	(-$14,000)	$40	$40,400
2031	$32,200	(-$4,800)	$3,400	$1,500	(-$12,800)	$23,400	(-$13,700)	$70	$29,300
2032	$21,400	(-$4,800)	$2,300	$1,500	(-$12,900)	$23,400	(-$13,400)	$70	$17,600
2033	$10,700	(-$4,800)	$1,100	$1,500	(-$13,100)	$23,400	(-$13,200)	$40	$5,600
2034	$0	(-$4,800)	$0	$1,500	(-$13,300)	$23,400	(-$12,900)	$70	(-$6,000)
Total	$367,600	(-$39,000)	$45,200	$12,100	(-$107,400)	$185,100	(-$112,500)	$1,020	$352,100

Table C42. Estimated Unamortized Cost to a Typical Business Owning Truck TRUs to Comply with the Proposed Amendments from 2022 to 2034 (2019$)

Year	Equipment Capital Costs	Equipment Maintenance Costs	Infrastructure Capital Costs	Infrastructure Maintenance Costs	Diesel Costs	Electricity Costs	LCFS Credits	Administrative Costs	Total
2022	$0	$0	$0	$0	$0	$0	$0	$0	$0
2023	$48,500	$0	$4,900	$0	$0	$0	$0	$320	$53,700
2024	(-$14,900)	(-$600)	$4,900	$200	(-$1,800)	$2,600	(-$2,000)	$20	(-$11,600)
2025	$95,100	(-$1,200)	$9,800	$400	(-$3,500)	$5,200	(-$3,700)	$40	$102,100
2026	$47,200	(-$2,400)	$4,900	$700	(-$7,000)	$10,700	(-$7,500)	$170	$46,800
2027	$46,800	(-$3,000)	$4,900	$900	(-$8,500)	$13,600	(-$9,400)	$40	$45,300
2028	$46,500	(-$3,600)	$4,900	$1,100	(-$10,100)	$16,600	(-$10,500)	$70	$45,000
2029	$46,200	(-$4,200)	$4,900	$1,300	(-$11,500)	$19,800	(-$12,200)	$70	$44,400
2030	$0	(-$4,800)	$0	$1,500	(-$12,900)	$23,000	(-$14,000)	$40	(-$7,200)
2031	$0	(-$4,800)	$0	$1,500	(-$12,800)	$23,400	(-$13,700)	$70	(-$6,300)
2032	$0	(-$4,800)	$0	$1,500	(-$12,900)	$23,400	(-$13,400)	$70	(-$6,100)
2033	$0	(-$4,800)	$0	$1,500	(-$13,100)	$23,400	(-$13,200)	$40	(-$6,200)
2034	$0	(-$4,800)	$0	$1,500	(-$13,300)	$23,400	(-$12,900)	$70	(-$6,000)
Total	$315,400	(-$39,000)	$39,200	$12,100	(-$107,400)	$185,100	(-$112,500)	$1,020	$293,900

ii. Trailer TRU Owner

Based on CARB's ARBER[152] and Dun and Bradstreet[153] databases, the average number of trailer TRUs owned by companies with more than 100 employees is 7. Therefore, to illustrate the costs to a typical business, staff considered an average trailer TRU fleet with seven trailer TRUs. Trailer TRU fleet owners would incur capital costs for new units purchased beginning in 2023 to comply with the PM emission standard. To determine the number of new trailer TRUs that would be purchased by a typical business owning trailer TRUs, staff used the current average age of the trailer TRU fleet. Based on the statewide TRU inventory, the average age of a trailer TRU is five years old. With an average useful life of 10 years,[154] and assuming that all of the TRUs were the same age and did not already meet the PM emission standard, a typical business owning trailer TRUs would turnover their fleet and purchase seven new units in 2027. All cost assumptions are the same as discussed in previous sub-sections for trailer TRUs.

Table C43 shows the annual amortized cost for a typical business owning trailer TRUs to comply with the Proposed Amendments from 2022 to 2034, which ranges from $0 to $5,500. The total amortized cost for a typical business owning trailer TRUs to comply with the Proposed Amendments from 2022 to 2034 is estimated to be $27,800. To show the feasibility of compliance for a typical business owning trailer TRUs, staff compared the maximum amortized annual cost of $5,500 to the annual revenue of a typical business in the truck transportation industry, which is $36.5 million.[155] The maximum amortized annual cost for a typical business owning trailer TRUs to comply with the Proposed Amendments is less than 1/10th of one percent of their annual revenue.

Table C44 shows the annual unamortized cost for a typical business owning trailer TRUs to comply with the Proposed Amendments from 2022 to 2034, which ranges from $0 to $22,400. The total unamortized cost for a typical business owning trailer TRUs to comply with the Proposed Amendments from 2022 to 2034 is estimated to be $24,300. To show the feasibility of compliance for a typical business owning trailer TRUs, staff compared the maximum unamortized annual cost of $22,400 to the annual revenue of a typical business in the truck transportation industry, which is $36.5 million.[156] The maximum unamortized annual cost for a typical business owning

[152] California Air Resources Board, Air Resources Board Equipment Registration System. (web link: https://arber.arb.ca.gov/, last accessed July 2020)
[153] Dun and Bradstreet Database, Employee data for companies that own trailer TRUs, Proprietary, 2019. (web link: https://www.dnb.com/ca-en/)
[154] California Air Resources Board, Draft 2019 Update to Emissions Inventory for Transport Refrigeration Units, October 2019. (web link: https://ww3.arb.ca.gov/cc/cold-storage/documents/hra_emissioninventory2019.pdf)
[155] United States Census Bureau, 2012 SUSB Annual Datasets by Establishment Industry, 2015. (web link: https://www.census.gov/data/datasets/2012/econ/susb/2012-susb.html, last accessed March 12, 2021)
[156] United States Census Bureau, 2012 SUSB Annual Datasets by Establishment Industry, 2015. (web link: https://www.census.gov/data/datasets/2012/econ/susb/2012-susb.html, last accessed March 12, 2021)

trailer TRUs to comply with the Proposed Amendments is less than 1/10 of one percent of their annual revenue.

Table C43. Estimated Annual Cost to a Typical Business Owning Trailer TRUs to Comply with the Proposed Amendments from 2022 to 2034 (2019$)

Year	PM Emission Standard Costs	Refrigerant Costs	Refrigerant Maintenance Costs	Administrative Costs	Total
2022	$0	$0	$0	$0	$0
2023	$0	$0	$0	$300	$300
2024	$0	$0	$0	$0	$0
2025	$0	$0	$0	$0	$0
2026	$0	$0	$0	$300	$300
2027	$4,900	$200	$100	$300	$5,500
2028	$4,900	$200	$100	$0	$5,200
2029	$4,900	$200	$100	$0	$5,200
2030	$4,900	$200	$100	$300	$5,500
2031	$4,900	$200	$100	$0	$5,200
2032	$0	$0	$100	$0	$100
2033	$0	$0	$100	$300	$400
2034	$0	$0	$100	$0	$100
Total	$24,500	$1,000	$800	$1,500	$27,800

Table C44. Estimated Unamortized Cost to a Typical Business Owning Trailer TRUs to Comply with the Proposed Amendments from 2022 to 2034 (2019$)

Year	PM Emission Standard Costs	Refrigerant Costs	Refrigerant Maintenance Costs	Administrative Costs	Total
2022	$0	$0	$0	$0	$0
2023	$0	$0	$0	$300	$300
2024	$0	$0	$0	$0	$0
2025	$0	$0	$0	$0	$0
2026	$0	$0	$0	$300	$300
2027	$21,200	$800	$100	$300	$22,400
2028	$0	$0	$100	$0	$100
2029	$0	$0	$100	$0	$100
2030	$0	$0	$100	$300	$400
2031	$0	$0	$100	$0	$100
2032	$0	$0	$100	$0	$100
2033	$0	$0	$100	$300	$400
2034	$0	$0	$100	$0	$100
Total	$21,200	$800	$800	$1,500	$24,300

b. Applicable Facility Owners

Applicable facilities would incur costs to comply with the facility registration, registration fee, and reporting requirements in the Proposed Amendments. The costs to applicable facilities that are considered typical businesses are not expected to be different from the costs outlined previously (see Section C.1.g).

i. Refrigerated WHDC Owner

Based on CARB's TRU Applicable Facility Inventory[157] and Dun and Bradstreet[158] databases, the average building size of a refrigerated WHDC owned by companies with more than 100 employees is 125,000 square feet and would incur reporting costs as described for a standard refrigerated WHDC in Section C.1.g.iii.1.

Table C45 shows the total cost for a typical business owning a refrigerated WHDC to comply with the Proposed Amendments from 2022 to 2034 is estimated to range from $222 to $27,810, depending on the reporting option chosen. The annual cost to comply would range from $0 to $2,392. To show the feasibility of compliance for a typical business owning a refrigerated WHDC, staff compared the maximum annual cost of $2,392 to the annual revenue of a typical business owning a refrigerated WHDC, which is $67.4 million.[159] The maximum annual cost for a typical business owning a refrigerated WHDC to comply with the Proposed Amendments is less than 1/100th of one percent of their annual revenue.

Table C45. Estimated Annual Cost to a Typical Business Owning a Refrigerated WHDC to Comply with the Proposed Amendments from 2022 to 2034 (2019$)

Year	Registration Costs	Registration Fee	Collect and Report TRU Information to CARB (Reporting Option 1)	Check Compliance Onsite/Turn Non-Compliant TRUs Away (Reporting Option 2)	Only do Business with Compliant Companies (Reporting Option 2)
2022	$0	$0	$0	$0	$0
2023	$50	$43	$2,299	$1,899	$0
2024	$0	$0	$2,299	$1,899	$0
2025	$0	$0	$2,299	$1,899	$0
2026	$0	$43	$2,299	$1,899	$0
2027	$0	$0	$2,299	$1,899	$0
2028	$0	$0	$2,299	$1,899	$0
2029	$0	$43	$2,299	$1,899	$0
2030	$0	$0	$2,299	$1,899	$0
2031	$0	$0	$2,299	$1,899	$0

[157] California Air Resources Board, Transport Refrigeration Unit Applicable Facility Inventory, February 2020.
[158] Dun and Bradstreet Database, Employee data for companies that own refrigerated WHDCs, Proprietary, 2019. (web link: https://www.dnb.com/ca-en/)
[159] Dun and Bradstreet Database, Employee and revenue data for companies that own refrigerated WHDCs, Proprietary, 2019. (web link: https://www.dnb.com/ca-en/)

Year	Registration Costs	Registration Fee	Collect and Report TRU Information to CARB (Reporting Option 1)	Check Compliance Onsite/Turn Non-Compliant TRUs Away (Reporting Option 2)	Only do Business with Compliant Companies (Reporting Option 2)
2032	$0	$43	$2,299	$1,899	$0
2033	$0	$0	$2,299	$1,899	$0
2034	$0	$0	$2,299	$1,899	$0
Total	$50	$172	$27,588	$22,788	$0

ii. Grocery Store Owner

CARB's TRU Applicable Facility Inventory[160] and Dun and Bradstreet[161] databases indicate that the average building size of a grocery store owned by companies with more than 100 employees is 52,000 square feet and would incur reporting costs as described for a standard grocery store in Section C.1.g.iii.2.

Table C46 shows the total cost for a typical business owning a grocery store to comply with the Proposed Amendments from 2022 to 2034, which is estimated to range from $222 to $10,686, depending on the reporting option chosen. The annual cost to comply would range from $0 to $965, depending on the reporting option chosen. To show the feasibility of compliance for a typical business owning a grocery store to comply with the Proposed Amendments, staff compared the maximum annual cost of $965 to the annual revenue of a typical business owning a grocery store, which is $67.4 million.[162] The maximum annual cost for a typical business owning a grocery store to comply with the Proposed Amendments is less than 1/100th of one percent of their annual revenue.

Table C46. Estimated Annual Cost to a Typical Grocery Store Owner to Comply with the Proposed Amendments from 2022 to 2034 (2019$)

Year	Registration Costs	Registration Fee	Collect and Report TRU Information to CARB (Reporting Option 1)	Check Compliance Onsite/Turn Non-Compliant TRUs Away (Reporting Option 2)	Only do Business with Compliant Companies (Reporting Option 2)
2022	$0	$0	$0	$0	$0
2023	$50	$43	$872	$472	$0
2024	$0	$0	$872	$472	$0
2025	$0	$0	$872	$472	$0
2026	$0	$43	$872	$472	$0
2027	$0	$0	$872	$472	$0

[160] California Air Resources Board, Transport Refrigeration Unit Applicable Facility Inventory, February 2020.
[161] Dun and Bradstreet Database, Employee data for companies that own grocery stores, Proprietary, 2019. (web link: https://www.dnb.com/ca-en/)
[162] Dun and Bradstreet Database, Employee and revenue data for companies that own refrigerated WHDCs, Proprietary, 2019. (web link: https://www.dnb.com/ca-en/)

Year	Registration Costs	Registration Fee	Collect and Report TRU Information to CARB (Reporting Option 1)	Check Compliance Onsite/Turn Non-Compliant TRUs Away (Reporting Option 2)	Only do Business with Compliant Companies (Reporting Option 2)
2028	$0	$0	$872	$472	$0
2029	$0	$43	$872	$472	$0
2030	$0	$0	$872	$472	$0
2031	$0	$0	$872	$472	$0
2032	$0	$43	$872	$472	$0
2033	$0	$0	$872	$472	$0
2034	$0	$0	$872	$472	$0
Total	$50	$172	$10,464	$5,664	$0

iii. Seaport Facility or Railyard Owner

Typical businesses owning a seaport facility or railyard would incur reporting costs as described in Section C.1.g.iii.3. Table C47 shows the total cost for a typical business owning a seaport facility or railyard to comply with the Proposed Amendments from 2022 to 2034 is estimated to be $34,662. The annual cost for a typical business owning a seaport facility or railyard to comply with Proposed Amendments is estimated to range from $0 to $2,963.

Table C47. Estimated Annual Cost to a Typical Business Owning a Seaport Facility or Railyard to Comply with the Proposed Amendments from 2022 to 2034 (2019$)

Year	Registration Costs	Registration Fee	Reporting Option 1 - Collect and Report TRU Information to CARB)
2022	$0	$0	$0
2023	$50	$43	$2,870
2024	$0	$0	$2,870
2025	$0	$0	$2,870
2026	$0	$43	$2,870
2027	$0	$0	$2,870
2028	$0	$0	$2,870
2029	$0	$43	$2,870
2030	$0	$0	$2,870
2031	$0	$0	$2,870
2032	$0	$43	$2,870
2033	$0	$0	$2,870
2034	$0	$0	$2,870
Total	$50	$172	$34,440

3. Direct Costs on Small Businesses

For the purposes of the Proposed Amendments, companies with 100 or fewer employees are considered small businesses.[163] Meeting the small business criteria does not relieve TRU or applicable facility owners of any requirements in the Proposed Amendments. Staff used the small business criteria for analysis purposes only. The estimated costs to TRU and applicable facility owners considered to be small business to comply with the Proposed Amendments are discussed below.

a. TRU Owners

i. Truck TRU Owner

Based on CARB's ARBER[164] and Dun and Bradstreet[165] databases, 95 percent of truck TRU fleets are considered small business. The average number of truck TRUs owned by companies with 100 or fewer employees is 5. Therefore, to illustrate the costs to a small business, staff considered an average fleet with five truck TRUs. All cost assumptions are the same as discussed in previous sub-sections for truck TRUs. A fleet consisting of five truck TRUs would be required to purchase zero-emission truck TRUs beginning in 2023, as shown in Table C48.

Table C48. Annual Number of Zero-Emission Truck TRU Purchases Required by the Proposed Amendments for a Small Business Owning Truck TRUs from 2022 to 2034

Year	Number of Zero-Emission Truck TRUs Purchased
2022	0
2023	1
2024	1
2025	0
2026	1
2027	1
2028	1
2029	0
2030	0
2031	0
2032	0
2033	0
2034	0
Total	5

[163] California Government Code, Title 2, Division 3, Part 5.5, Chapter 6.5, §14837. (web link: https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?sectionNum=14837.&lawCode=GOV)
[164] California Air Resources Board, Air Resources Board Equipment Registration System. (web link: https://arber.arb.ca.gov/, last accessed July 2020)
[165] Dun and Bradstreet Database, Employee data for companies that own truck TRUs, Proprietary, 2019. (web link: https://www.dnb.com/ca-en/)

To assess the costs to a small business owning truck TRUs, staff assumed the truck TRU owner also owns the truck TRU home base facility where charging infrastructure would be installed to support operation of the battery-electric truck TRUs purchased to comply with the zero-emission truck TRU requirement. As discussed in Section C.1.d.ii, staff assumed owners would install infrastructure on the same schedule as the truck TRUs transition to zero-emission technology, adding enough chargers to accommodate the battery-electric truck TRU population each year.

As discussed in Section C.1.d, staff assumed that the cost of new TRUs purchased to comply with the Proposed Amendments would be amortized. This is based on stakeholder input indicating that businesses generally do not pay the total capital cost up front. In addition to the amortized costs to comply with the Proposed Amendments, staff also determined the unamortized cost to TRU owners that may not have access to financing.

Table C49 shows the amortized annual cost for a small business owning truck TRUs to comply with the Proposed Amendments from 2022 to 2034, which ranges from -$4,100 to $40,400. The total cost for a small business owning truck TRUs to comply with the Proposed Amendments from 2022 to 2034 is estimated to be $223,000. To show the feasibility of compliance for a small business owning truck TRUs, staff compared the maximum amortized annual cost of $40,400 to the annual revenue of a small business in the truck transportation industry, which is $1.5 million.[166] The maximum amortized annual cost for a small business owning truck TRUs to comply with the Proposed Amendments is less than 3 percent of their annual revenue.

Table C50 shows the unamortized annual cost for a small business owning truck TRUs to comply with the Proposed Amendments from 2022 to 2034, which ranges from -$4,900 to $53,600. The total unamortized cost for a small business owning truck TRUs to comply with the Proposed Amendments from 2022 to 2034 is estimated to be $185,800. To show the feasibility of compliance for a small business owning truck TRUs, staff compared the maximum unamortized annual cost of $53,600 to the annual revenue of a small business in the truck transportation industry, which is $1.5 million.[167] The maximum unamortized annual cost for a small business owning truck TRUs to comply with the Proposed Amendments is less than 4 percent of their annual revenue.

[166] United States Census Bureau, 2012 SUSB Annual Datasets by Establishment Industry, 2015. (web link: https://www.census.gov/data/datasets/2012/econ/susb/2012-susb.html, last accessed March 12, 2021)
[167] United States Census Bureau, 2012 SUSB Annual Datasets by Establishment Industry, 2015. (web link: https://www.census.gov/data/datasets/2012/econ/susb/2012-susb.html, last accessed March 12, 2021)

Table C49. Estimated Annual Cost to a Small Business Owning Truck TRUs to Comply with the Proposed Amendments from 2022 to 2034 (2019$)

Year	Equipment Capital Costs	Equipment Maintenance Costs	Infrastructure Capital Costs	Infrastructure Maintenance Costs	Diesel Costs	Electricity Costs	LCFS Credits	Administrative Costs	Total
2022	$0	$0	$0	$0	$0	$0	$0	$0	$0
2023	$11,200	$0	$1,100	$0	$0	$0	$0	$190	$12,500
2024	$1,800	(-$1,900)	$2,300	$200	(-$3,600)	$2,600	$0	$20	$1,400
2025	$17,500	(-$1,200)	$2,300	$400	(-$3,500)	$5,200	(-$2,000)	$0	$18,700
2026	$28,300	(-$1,800)	$3,400	$400	(-$5,200)	$8,000	(-$3,700)	$90	$29,500
2027	$39,200	(-$2,400)	$4,500	$600	(-$6,800)	$10,900	(-$5,600)	$40	$40,400
2028	$38,700	(-$3,000)	$4,500	$700	(-$8,400)	$13,900	(-$7,500)	$20	$38,900
2029	$32,400	(-$3,000)	$3,400	$900	(-$8,200)	$14,100	(-$8,700)	$40	$30,900
2030	$32,400	(-$3,000)	$3,400	$900	(-$8,100)	$14,400	(-$8,700)	$40	$31,300
2031	$21,500	(-$3,000)	$2,300	$900	(-$8,000)	$14,600	(-$8,700)	$20	$19,600
2032	$10,700	(-$3,000)	$1,100	$900	(-$8,100)	$14,600	(-$8,600)	$40	$7,600
2033	$0	(-$3,000)	$0	$900	(-$8,200)	$14,600	(-$8,400)	$40	(-$4,100)
2034	$0	(-$3,000)	$0	$900	(-$8,300)	$14,600	(-$8,200)	$20	(-$4,000)
Total	$233,700	(-$28,300)	$28,300	$7,700	(-$76,400)	$127,500	(-$70,100)	$560	$223,000

Table C50. Estimated Unamortized Annual Cost to a Small Business Owning Truck TRUs to Comply with the Proposed Amendments from 2022 to 2034 (2019$)

Year	Equipment Capital Costs	Equipment Maintenance Costs	Infrastructure Capital Costs	Infrastructure Maintenance Costs	Diesel Costs	Electricity Costs	LCFS Credits	Administrative Costs	Total
2022	$0	$0	$0	$0	$0	$0	$0	$0	$0
2023	$48,500	$0	$4,900	$0	$0	$0	$0	$190	$53,600
2024	$11,300	(-$1,900)	$4,900	$200	(-$3,600)	$2,600	$0	$20	$13,500
2025	$0	(-$1,200)	$0	$400	(-$3,500)	$5,200	(-$2,000)	$0	(-$1,100)
2026	$47,200	(-$1,800)	$4,900	$400	(-$5,200)	$8,000	(-$3,700)	$90	$49,900
2027	$46,800	(-$2,400)	$4,900	$600	(-$6,800)	$10,900	(-$5,600)	$40	$48,400
2028	$46,500	(-$3,000)	$4,900	$700	(-$8,400)	$13,900	(-$7,500)	$20	$47,100
2029	$0	(-$3,000)	$0	$900	(-$8,200)	$14,100	(-$8,700)	$40	(-$4,900)
2030	$0	(-$3,000)	$0	$900	(-$8,100)	$14,400	(-$8,700)	$40	(-$4,500)
2031	$0	(-$3,000)	$0	$900	(-$8,000)	$14,600	(-$8,700)	$20	(-$4,200)
2032	$0	(-$3,000)	$0	$900	(-$8,100)	$14,600	(-$8,600)	$40	(-$4,200)
2033	$0	(-$3,000)	$0	$900	(-$8,200)	$14,600	(-$8,400)	$40	(-$4,100)
2034	$0	(-$3,000)	$0	$900	(-$8,300)	$14,600	(-$8,200)	$20	(-$4,000)
Total	$200,300	(-$28,300)	$24,500	$7,700	(-$76,400)	$127,500	(-$70,100)	$560	$185,800

ii. Trailer TRU Owner

Based on CARB's ARBER[168] and Dun and Bradstreet[169] databases, 90 percent of trailer TRU fleets are considered small business. The average number of trailer TRUs owned by companies considered to be small business is seven. This is the same number of trailer TRUs owned by a typical business.

Therefore, the cost of owning trailer TRUs for a small business would be the same as the costs described for a typical business in Section C.2.a.ii. To show the feasibility of compliance for a small business owning trailer TRUs, staff compared the maximum amortized annual cost of $5,500 and the maximum unamortized annual cost of $22,400 to the annual revenue of a small business in the truck transportation industry, which is $1.5 million.[170] The maximum amortized annual cost for a small business owning trailer TRUs to comply with the Proposed Amendments is less than 1 percent of their annual revenue, while the maximum unamortized annual cost is less than 2 percent.

The similar trailer TRU fleet size for a typical business (more than 100 employees) and small business (100 or fewer employees) may be due to the small sample size in which staff only had employee data from Dun and Bradstreet for 63 trailer TRU fleets reported in ARBER. It may also be due to the possibility that typical trucking companies may not specialize solely in refrigerated transport and their fleets may also include non-refrigerated trucks or trailers.

b. Applicable Facility Owners

i. Refrigerated WHDC Owner

Based on CARB's TRU Applicable Facility Inventory[171] and Dun and Bradstreet[172] databases, 96 percent of refrigerated WHDCs are considered small business. The average building size of a refrigerated WHDC considered to be a small business is 87,000 square feet and would incur reporting costs as described for a standard refrigerated WHDC. Therefore, the cost of owning a refrigerated WHDC for a small business would be the same as the costs described for a typical business in Section C.2.b.i. To show the feasibility of compliance for a small business owning a refrigerated WHDC, staff compared the maximum annual cost of $2,393 to the annual

[168] California Air Resources Board, Air Resources Board Equipment Registration System. (web link: https://arber.arb.ca.gov/, last accessed July 2020)
[169] Dun and Bradstreet Database, Employee data for companies that own trailer TRUs, Proprietary, 2019. (web link: https://www.dnb.com/ca-en/)
[170] United States Census Bureau, 2012 SUSB Annual Datasets by Establishment Industry, 2015. (web link: https://www.census.gov/data/datasets/2012/econ/susb/2012-susb.html, last accessed March 12, 2021)
[171] California Air Resources Board, Transport Refrigeration Unit Applicable Facility Inventory, February 2020.
[172] Dun and Bradstreet Database, Employee data for companies that own refrigerated WHDCs, Proprietary, 2019. (web link: https://www.dnb.com/ca-en/)

revenue of a small business owning a refrigerated WHDC, which is $10.1 million.[173] The average annual cost for a typical business owning a refrigerated WHDC to comply with the Proposed Amendments is less than 1/10th of one percent of their annual revenue.

ii. Grocery Store Owner

CARB's TRU Applicable Facility Inventory[174] and Dun and Bradstreet[175] databases indicate 90 percent of grocery stores are considered small business. Grocery stores considered to be small businesses have an average building size of 30,000 square feet. They would incur reporting costs as described for a standard grocery store. Therefore, the cost of owning a grocery store for a small business would be the same as the costs described for a typical business in Section C.2.b.ii. To show the feasibility of compliance for a small business owning a grocery store to comply with the Proposed Amendments, staff compared the maximum annual cost of $963 to the annual revenue of a small business owning a grocery store, which is $2.46 million.[176] The average annual cost for a small business owning a grocery store to comply with the Proposed Amendments is less than 1/10th of one percent of their annual revenue.

iii. Seaport Facility or Railyard Owner

Seaport facilities and railyards are not considered small businesses.

4. Direct Costs on Individuals

The Proposed Amendments would not result in any direct costs on individuals. However, staff anticipate the Proposed Amendments would result in indirect costs to individuals to the extent that compliance costs are passed through to consumers of refrigerated products. Assuming the total net cost of the Proposed Amendments is fully passed through to consumers, the estimated cost to California is calculated by dividing the total cost of the Proposed Amendments by 13,272,939 California households.[177] Table C51 shows the total impact of the Proposed Amendments from 2022 to 2034 is $77.38 per household with a yearly average of $5.95.

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[173] Dun and Bradstreet Database, Employee and revenue data for companies that own refrigerated WHDCs, Proprietary, 2019. (web link: https://www.dnb.com/ca-en/)
[174] California Air Resources Board, Transport Refrigeration Unit Applicable Facility Inventory, February 2020.
[175] Dun and Bradstreet Database, Employee data for companies that own grocery stores, Proprietary, 2019. (web link: https://www.dnb.com/ca-en/)
[176] Dun and Bradstreet Database, Employee and revenue data for companies that own refrigerated WHDCs, Proprietary, 2019. (web link: https://www.dnb.com/ca-en/)
[177] California Department of Finance, Demographic Research Unit, "P-4 Projected Households, Household Population, Group Quarters and Persons per Household for the Counties and State of California," June 12, 2020. (web link: https://www.dof.ca.gov/forecasting/demographics/projections/documents/P4_HHProjections_B2019.xlsx)

Table C51. Cost of the Proposed Amendments per California Household from 2022 to 2034[178]

Year	Annual Net Cost of Proposed Amendments (millions)	Cost per Household
2022	$0	$0.00
2023	$30.5	$2.30
2024	$43.1	$3.25
2025	$61.3	$4.62
2026	$96.0	$7.23
2027	$124.0	$9.34
2028	$129.7	$9.77
2029	$128.5	$9.68
2030	$118.0	$8.89
2031	$100.6	$7.58
2032	$74.8	$5.64
2033	$62.2	$4.69
2034	$58.3	$4.39
Total	$1,027.0	$77.38

Individuals may see health benefits as described in Section B.4.a. Individuals may see macroeconomic indirect and induced benefits and costs, which are discussed further in Section E.

D. Fiscal Impacts

This chapter describes costs and benefits that would be incurred by local, State, and federal government agencies due to the Proposed Amendments. Local government agencies that own TRUs or applicable facilities would be subject to the same direct costs and benefits outlined in Section C, as well as experience changes in revenue from utility user taxes, diesel fuel taxes, and local sales taxes. State government agencies that own TRUs or applicable facilities would also be subject to the same direct costs and benefits outlined in Section C, as well as experience changes in revenue from diesel fuel taxes, Energy Resources Fees, CARB fees, and State sales taxes. Costs to CARB would include staffing and resources needed to implement and enforce the Proposed Amendments. CARB does not own any TRUs or applicable facilities. Federal government agencies that own TRUs or applicable facilities would also be subject to the same direct costs and benefits outlined in Section C. In addition, the Proposed Amendments would result in health benefits to individuals in California. These benefits may translate to cost savings for local and State healthcare providers.

[178] If the net cost to comply with the Proposed Amendments is not passed through to consumers of refrigerated products, the indirect cost to individuals will be lower than the numbers presented in this table.

Staff determined the number and percentage of TRUs relative to the total population owned by local, State, and federal government using ARBER reporting data as shown in Table D1.[179]

Table D1. Number of TRUs Owned by Local, State, and Federal Government in 2019

	Privately Owned	Local Government	State Government	Federal Government
Number of TRUs	193,091	256	154	7
Percentage of Total Number of TRUs	99.780%	0.132%	0.080%	0.004%

Staff determined the number of truck TRU home base facilities and applicable facilities owned by local, State, and federal government by using ARBER[180] and the TRU Applicable Facility Inventory.[181] Table D2 includes the number of truck TRU home base facilities and applicable facilities owned by local, State, and federal government agencies, which staff used to calculate the direct costs to local, State, and federal government facility owners.

Table D2. Number of Facilities Owned by Local, State, and Federal Government in 2019

Government	Truck TRU Home Base	Refrigerated WHDC	Grocery Store	Port Facility	Railyard
Local Government	25	9	0	10	0
State Government	6	2	0	0	0
Federal Government	1	0	12	0	0

1. Local Governments

a. TRU and Facility Owner Costs

The Proposed Amendments would have a small fiscal impact to local government agencies that own TRUs or applicable facilities, relative to the total estimated cost of the Proposed Amendments. Using 2019 data from the ARBER database,[182] staff determined the percentage of TRUs owned by local governments to be 0.132 percent of the total number of TRUs (see Table D1). Staff applied this percentage to the total equipment-related direct costs in Table C22 to estimate the costs incurred by local government TRU owners. Staff determined that 25 truck TRU home base facilities and 19 applicable facilities are owned by local government (see Table D2).[183]

[179] California Air Resources Board, Air Resources Board Equipment Registration System. (web link: https://arber.arb.ca.gov/, last accessed September 2019)
[180] California Air Resources Board, Air Resources Board Equipment Registration System. (web link: https://arber.arb.ca.gov/, last accessed September 2019)
[181] California Air Resources Board, Applicable TRU Facility Inventory, February 2020.
[182] California Air Resources Board, Air Resources Board Equipment Registration System. (web link: https://arber.arb.ca.gov/, last accessed September 2019)
[183] California Air Resources Board, Applicable TRU Facility Inventory, February 2020.

The assumptions underlying the direct costs to local government agencies are identical to those identified in Section C of the SRIA. The estimated direct costs to local government TRU and applicable facility owners are summarized in Table D3.

Table D3. Total Direct Equipment and Infrastructure-Related Costs to Local Governments from 2022 to 2034 (2019$)

Year	Equipment Capital Costs	Equipment Maintenance Costs	Truck TRU Infrastructure Capital Costs	Truck TRU Infrastructure Maintenance Costs	Diesel Fuel Costs	Electricity Costs	LCFS Credit Revenue	Administrative Costs	Total
2022	$0	$0	$0	$0	$0	$0	$0	$0	$0
2023	$23,000	$1,000	$0	$0	$0	$27,000	$0	$15,000	$66,000
2024	$48,000	$1,000	(-$2,000)	$3,000	(-$3,000)	$62,000	$4,000	$82,000	$195,000
2025	$72,000	$1,000	(-$5,000)	$8,000	(-$5,000)	$91,000	$10,000	$83,000	$255,000
2026	$108,000	$0	(-$7,000)	$11,000	(-$8,000)	$137,000	$15,000	$95,000	$351,000
2027	$152,000	$0	(-$11,000)	$17,000	(-$12,000)	$175,000	$22,000	$88,000	$431,000
2028	$157,000	$0	(-$14,000)	$23,000	(-$14,000)	$182,000	$29,000	$90,000	$453,000
2029	$155,000	(-$1,000)	(-$16,000)	$27,000	(-$17,000)	$170,000	$34,000	$95,000	$447,000
2030	$144,000	(-$1,000)	(-$17,000)	$31,000	(-$19,000)	$144,000	$38,000	$93,000	$413,000
2031	$121,000	(-$1,000)	(-$18,000)	$32,000	(-$19,000)	$102,000	$39,000	$96,000	$352,000
2032	$89,000	(-$1,000)	(-$18,000)	$32,000	(-$19,000)	$68,000	$39,000	$98,000	$288,000
2033	$74,000	(-$1,000)	(-$19,000)	$33,000	(-$19,000)	$37,000	$40,000	$98,000	$243,000
2034	$68,000	(-$1,000)	(-$19,000)	$33,000	(-$18,000)	$19,000	$40,000	$101,000	$223,000
Total	$1,211,000	(-$3,000)	(-$146,000)	$250,000	(-$153,000)	$1,214,000	$310,000	$1,034,000	$3,717,000

b. Utility User Tax

Several 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. For this analysis, staff used a value of 3.53 percent, representing a population-weighted average.[184] By increasing the amount of electricity used, there would be an increase in the amount of utility user tax revenue collected by cities and counties.

c. Diesel Fuel Tax

Off-road diesel is exempt from on-road diesel taxes, but does incur sales tax.[185] Displacing diesel with electricity would decrease the total amount of diesel fuel dispensed in the State, resulting in a reduction in tax revenue collected by local governments. For this analysis, staff used the combined State and local sales tax rate of 8.6 percent, which is a weighted average based on county-level output, with 3.94 percent[186] going towards State sales tax and 4.67 percent[187] going towards local sales tax.

d. Local Sales Tax

Sales tax is levied in California to fund a variety of programs at the local and State levels. The Proposed Amendments would result in the sale of more expensive TRUs in California, which would result in a direct increase in sales tax revenue collected by local governments. However, overall, local sales tax revenue may increase less than the direct increase from TRU and infrastructure sales if overall business spending does not increase. For this analysis, staff used the combined State and local sales tax rate of 8.6 percent, which is a weighted average based on county-level output, with 3.94 percent[188] going towards State sales tax and 4.67 percent[189] going towards local sales tax.

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[184] California State Controller's Office, California Cities Utility Users Taxes Revenue and Tax Rate Fiscal Year 2018-19, November 2020. (web link: https://www.sco.ca.gov/Files-ARD-Local/LocRep/2018-19_Cities_UUT.pdf, last accessed January 2021)

[185] California Department of Tax and Fee Administration, California City & County Sales & Use Tax Rates, October 2020. (web link: https://www.cdtfa.ca.gov/taxes-and-fees/sales-use-tax-rates.htm)

[186] California Department of Tax and Fee Administration, Detailed Description of the Sales & Use Tax Rate. (web link: https://www.cdtfa.ca.gov/taxes-and-fees/sut-rates-description.htm, last accessed January 29, 2021)

[187] California Department of Tax and Fee Administration, California City & County Sales & Use Tax Rates, October 2020. (web link: https://www.cdtfa.ca.gov/taxes-and-fees/sales-use-tax-rates.htm)

[188] California Department of Tax and Fee Administration, Detailed Description of the Sales & Use Tax Rate. (web link: https://www.cdtfa.ca.gov/taxes-and-fees/sut-rates-description.htm, last accessed January 29, 2021)

[189] California Department of Tax and Fee Administration, California City & County Sales & Use Tax Rates, October 2020. (web link: https://www.cdtfa.ca.gov/taxes-and-fees/sales-use-tax-rates.htm)

e. Fiscal Impact on Local Governments

From 2022 to 2034, the cost to local governments due to the Proposed Amendments is estimated to be $3.7 million resulting from TRUs and applicable facilities owned by local governments. Local governments would also see a direct increase in utility user and local sales tax revenue of $19 million and a decrease in diesel fuel tax revenue of $4.9 million. Table D4 shows the total fiscal impact on local governments, which is estimated to be -$10.4 million from 2022 to 2034.

Table D4. Estimated Fiscal Impact on Local Governments from 2022 to 2034 (2019$)

Year	TRU and Facility Owner Costs	Utility User Tax Revenue	Local Diesel Fuel Tax	Local Sales Tax	Total
2022	$0	$0	$0	$0	$0
2023	$67,000	$0	$0	(-$1,633,000)	(-$1,566,000)
2024	$197,000	(-$84,000)	$76,000	(-$2,199,000)	(-$2,010,000)
2025	$255,000	(-$195,000)	$170,000	(-$1,731,000)	(-$1,501,000)
2026	$351,000	(-$292,000)	$250,000	(-$3,325,000)	(-$3,016,000)
2027	$431,000	(-$445,000)	$366,000	(-$2,565,000)	(-$2,213,000)
2028	$453,000	(-$580,000)	$461,000	(-$2,103,000)	(-$1,769,000)
2029	$448,000	(-$708,000)	$538,000	(-$1,086,000)	(-$808,000)
2030	$413,000	(-$796,000)	$584,000	$393,000	$594,000
2031	$352,000	(-$824,000)	$591,000	$416,000	$535,000
2032	$289,000	(-$836,000)	$605,000	$436,000	$494,000
2033	$243,000	(-$848,000)	$625,000	$447,000	$467,000
2034	$223,000	(-$863,000)	$640,000	$385,000	$385,000
Total	$3,722,000	(-$6,471,000)	$4,906,000	(-$12,565,000)	(-$10,408,000)

2. State Government

a. TRU and Facility Owner Costs

The Proposed Amendments would have a small fiscal impact to State government agencies that own TRUs or applicable facilities, relative to the total estimated cost of the Proposed Amendments. Using 2019 data from the ARBER database,[190] staff determined the percentage of TRUs owned by State government to be 0.08 percent of the total number of TRUs (see table D1). Staff applied this percentage to the total equipment-related direct costs in Table C22 to estimate the costs incurred by State government TRU owners. Staff determined that 6 truck TRU home base facilities and 2 applicable facilities are owned by State government (see Table D2).[191]

[190] California Air Resources Board, Air Resources Board Equipment Registration System. (web link: https://arber.arb.ca.gov/, last accessed July 2020)
[191] California Air Resources Board, Applicable TRU Facility Inventory, February 2020.

The assumptions underlying the direct costs to State government are identical to those identified in Section C of the SRIA. Table D5 shows the estimated direct costs to State government TRU and facility owners from 2022 to 2034.

Table D5. Total Direct Equipment and Infrastructure-Related Cost to State Government from 2022 to 2034 (2019$)

Year	Equipment Capital Costs	Equipment Maintenance Costs	Truck TRU Infrastructure Capital Costs	Truck TRU Infrastructure Maintenance Costs	Diesel Fuel Costs	Electricity Costs	LCFS Credit Revenue	Administrative Costs	Total
2022	$0	$0	$0	$0	$0	$0	$0	$0	$0
2023	$14,000	$1,000	$7,000	$0	$0	$0	$0	$7,000	$29,000
2024	$29,000	$1,000	$15,000	$1,000	(-$1,000)	$2,000	(-$2,000)	$2,000	$47,000
2025	$44,000	$0	$22,000	$2,000	(-$3,000)	$5,000	(-$3,000)	$1,000	$68,000
2026	$65,000	$0	$33,000	$4,000	(-$4,000)	$7,000	(-$5,000)	$7,000	$107,000
2027	$91,000	$0	$42,000	$5,000	(-$7,000)	$10,000	(-$7,000)	$3,000	$137,000
2028	$95,000	$0	$44,000	$7,000	(-$8,000)	$14,000	(-$9,000)	$3,000	$146,000
2029	$93,000	$0	$41,000	$8,000	(-$10,000)	$17,000	(-$10,000)	$4,000	$143,000
2030	$86,000	(-$1,000)	$35,000	$9,000	(-$10,000)	$19,000	(-$11,000)	$3,000	$130,000
2031	$73,000	(-$1,000)	$25,000	$9,000	(-$11,000)	$19,000	(-$11,000)	$4,000	$107,000
2032	$53,000	(-$1,000)	$16,000	$9,000	(-$11,000)	$20,000	(-$11,000)	$4,000	$79,000
2033	$45,000	(-$1,000)	$9,000	$10,000	(-$11,000)	$20,000	(-$11,000)	$4,000	$65,000
2034	$41,000	(-$1,000)	$5,000	$10,000	(-$11,000)	$20,000	(-$11,000)	$4,000	$57,000
Total	$729,000	(-$3,000)	$294,000	$74,000	(-$87,000)	$153,000	(-$91,000)	$46,000	$1,115,000

b. Diesel Fuel Tax

Displacing diesel with electricity would decrease the total amount of diesel fuel dispensed in the State, resulting in a reduction in diesel fuel tax revenue collected by State government. For this analysis, staff used the combined State and local sales tax rate of 8.6 percent, which is a weighted average based on county-level output, with 3.94 percent[192] going towards State sales tax and 4.67 percent[193] going towards local sales tax.

c. Energy Resources Fee

The Energy Resources Fee is a $0.0003/kWh surcharge levied on consumers of electricity purchased from electrical utilities.[194] The revenue collected is deposited into the Energy Resources Programs Account of the General Fund which is used for ongoing energy programs and projects deemed appropriate by the Legislature, including but not limited to, activities of the California Energy Commission.

d. CARB Fees

The Proposed Amendments include TRU operating fees and applicable facility registration fees that would impose a direct, on-going cost to TRU owners and applicable facility owners. The fee schedule is presented in Section C.1.g. The proposed fees would result in revenue to the State to offset costs to CARB to implement and enforce the Proposed Amendments (see Appendix A: Fee Development).

e. State Sales Tax

Sales tax is levied in California to fund a variety of programs at the local and State levels. The Proposed Amendments would result in the sale of more expensive TRUs in California, which would result in a direct increase in sales tax revenue collected by the State. However, overall, State sales tax revenue may increase less than the direct increase from TRU and infrastructure sales if overall business spending does not increase. For this analysis, staff used the combined State and local sales tax rate of 8.6 percent, which is a weighted average based on county-level output, with

[192] California Department of Tax and Fee Administration, Detailed Description of the Sales & Use Tax Rate. (web link: https://www.cdtfa.ca.gov/taxes-and-fees/sut-rates-description.htm, last accessed January 29, 2021)

[193] California Department of Tax and Fee Administration, California City & County Sales & Use Tax Rates, October 2020. (web link: https://www.cdtfa.ca.gov/taxes-and-fees/sales-use-tax-rates.htm)

[194] California Department of Tax and Fee Administration, 2020 Electrical Energy Surcharge Rate. (web link: https://www.cdtfa.ca.gov/formspubs/l725.pdf, last accessed July 2020)

3.94 percent[195] going towards State sales tax and 4.67 percent[196] going towards local sales tax.

f. Costs to CARB

i. Additional Staffing

The following additional permanent, full-time CARB staff would be needed to successfully implement and enforce the Proposed Amendments:

- 4.0 Air Resources Technician (ART) I positions beginning in Fiscal Year 2023-2024 to implement the Proposed Amendments. Duties would include assisting TRU owners and applicable facility owners with registration and reporting, providing technical assistance, and issuing compliance labels.
- 1.0 Staff Services Manager, 3.0 Air Pollution Specialist, 2.0 ART II, and 4.0 ART I positions beginning in Fiscal Year 2023-2024 to conduct enforcement activities, such as issuing and processing citations. The need for increased enforcement would result from additional requirements in the Proposed Amendments requiring out-of-state based TRU reporting, TRU operating fees, applicable facility registration, applicable facility registration fees, and applicable facility reporting.

The Fiscal Year 2022-2023 budget does not include any resources specifically for implementation or enforcement of the Proposed Amendments (the additional functions described above) because the Proposed Amendments have not yet been adopted. CARB will seek authorization to use fees collected to augment staff once the Board acts on the proposal. Table D6 shows the number of positions needed by CARB and the cost for each classification in 2021.

Table D6. Number of CARB Positions Needed and 2021 Costs

Position	Number of Positions	Initial Budget Year Cost (Annual Salary plus Benefits per Position)	Ongoing Cost (Annual Salary plus Benefits per Position)
Air Pollution Specialist	3	$195,000	$194,000
Air Resources Technician I	8	$85,000	$84,000
Air Resources Technician II	2	$101,000	$100,000
Staff Services Manager	1	$168,000	$167,000

Table D7 shows the estimated staffing costs expected to be incurred by CARB from 2022 to 2034. SB 854 authorizes CARB to assess fees to cover its reasonable costs,

[195] California Department of Tax and Fee Administration, Detailed Description of the Sales & Use Tax Rate. (web link: https://www.cdtfa.ca.gov/taxes-and-fees/sut-rates-description.htm, last accessed January 29, 2021)

[196] California Department of Tax and Fee Administration, California City & County Sales & Use Tax Rates, October 2020. (web link: https://www.cdtfa.ca.gov/taxes-and-fees/sales-use-tax-rates.htm)

with specific considerations, on all off-road and other mobile sources certification and compliance programs not currently covered under the existing fee regulation authority (Health and Safety Code section 43019).[197] The Proposed Amendments include TRU operating fees and applicable facility registration fees. CARB intends to seek authority to use the collected fees to cover program costs as allowed by SB 854.

Table D7. Estimated Annual Staffing Costs Incurred by CARB from 2022 to 2034

Year	Annual CARB Staffing Costs
2022	$0
2023	$849,500
2024	$1,692,000
2025	$1,685,000
2026	$1,685,000
2027	$1,685,000
2028	$1,685,000
2029	$1,685,000
2030	$1,685,000
2031	$1,685,000
2032	$1,685,000
2033	$1,685,000
2034	$1,685,000
Total	$19,391,500

g. Fiscal Impact on State Government

From 2022 to 2034, the cost to State government due to the Proposed Amendments is estimated to be $1.1 million resulting from TRUs and applicable facilities owned by State government, and CARB would incur costs of approximately $19.4 million. State government would also see a direct increase in revenue from Energy Resources Fees, TRU operating fees, applicable facility registration fees, and State sales tax of $59.5 million and a decrease in diesel fuel tax revenue of $22.6 million. Table D8 shows the total fiscal impact to State government agencies, which is estimated to be -$16.4 million from 2022 to 2034. CARB will seek authorization to use collected fees to offset costs incurred to implement and enforce the Proposed Amendments.

[197] California Health and Safety Code § 43019.1, Division 26, Senate Bill No. 854, July 27, 2018. (web link: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB854)

Table D8. Estimated Fiscal Impact to State Government from 2022 to 2034 (2019$)

Year	Costs to CARB	TRU and Facility Owner Costs	State Diesel Fuel Tax	Energy Resources Fee	TRU Operating Fee and Applicable Facility Registration Fee	State Sales Tax	Total
2022	$0	$0	$0	$0	$0	$0	$0
2023	$850,000	$29,000	$0	$0	(-$9,145,000)	(-$1,388,000)	(-$9,654,000)
2024	$1,692,000	$46,000	$331,000	(-$4,000)	(-$1,093,000)	(-$1,868,000)	(-$896,000)
2025	$1,685,000	$68,000	$748,000	(-$9,000)	(-$961,000)	(-$1,470,000)	$61,000
2026	$1,685,000	$106,000	$1,099,000	(-$13,000)	(-$7,567,000)	(-$2,825,000)	(-$7,515,000)
2027	$1,685,000	$138,000	$1,641,000	(-$20,000)	(-$2,330,000)	(-$2,179,000)	(-$1,065,000)
2028	$1,685,000	$145,000	$2,092,000	(-$25,000)	(-$3,224,000)	(-$1,786,000)	(-$1,113,000)
2029	$1,685,000	$143,000	$2,495,000	(-$30,000)	(-$4,569,000)	(-$923,000)	(-$1,199,000)
2030	$1,685,000	$130,000	$2,746,000	(-$33,000)	(-$3,422,000)	$334,000	$1,440,000
2031	$1,685,000	$107,000	$2,789,000	(-$34,000)	(-$4,308,000)	$354,000	$593,000
2032	$1,685,000	$80,000	$2,837,000	(-$35,000)	(-$3,849,000)	$371,000	$1,089,000
2033	$1,685,000	$63,000	$2,891,000	(-$35,000)	(-$3,512,000)	$380,000	$1,472,000
2034	$1,685,000	$57,000	$2,941,000	(-$36,000)	(-$4,598,000)	$327,000	$376,000
Total	$19,392,000	$1,112,000	$22,610,000	(-$274,000)	(-$48,578,000)	(-$10,673,000)	(-$16,411,000)

3. Federal Government

a. TRU and Facility Owner Costs

The Proposed Amendments would have a small fiscal impact to federal government agencies that own TRUs or applicable facilities, relative to the total estimated cost of the Proposed Amendments. Using 2019 data from the ARBER database,[198] staff determined the percentage of TRUs owned by the federal government to be 0.004 percent of the total number of TRUs (see Table D1). Staff applied this percentage to the total equipment-related direct costs in Table C22 to estimate the costs incurred by federal government TRU owners. Staff determined that 1 truck TRU home base facility and 12 applicable facilities are owned by the federal government (see Table D2).[199]

The assumptions underlying the direct costs to federal government agencies are identical to those identified in Section C of the SRIA. Table D9 shows the estimated direct costs to federal government TRU and facility owners from 2022 to 2034

[198] California Air Resources Board, Air Resources Board Equipment Registration System. (web link: https://arber.arb.ca.gov/, last accessed July 2020)
[199] California Air Resources Board, Applicable TRU Facility Inventory, February 2020.

Table D9. Total Direct Equipment and Infrastructure-Related Costs to Federal Government from 2022 to 2034 (2019$)

Year	Equipment Capital Costs	Equipment Maintenance Costs	Infrastructure Capital Costs	Infrastructure Maintenance Costs	Diesel Fuel Costs	Electricity Costs	LCFS Credit Revenue	Administrative Costs	Total
2022	$0	$0	$0	$0	(-$)	$0	$0	$0	$0
2023	$600	$0	$1,100	$0	(-$)	$0	$0	$1,200	$2,900
2024	$1,300	$0	$2,500	$200	(-$100)	$100	(-$100)	$1,900	$5,800
2025	$2,000	$0	$3,700	$400	(-$100)	$200	(-$100)	$1,900	$8,000
2026	$3,000	$0	$5,500	$600	(-$200)	$300	(-$200)	$2,500	$11,500
2027	$4,100	$0	$7,000	$900	(-$300)	$500	(-$300)	$2,000	$13,900
2028	$4,300	$0	$7,300	$1,100	(-$400)	$600	(-$400)	$2,000	$14,500
2029	$4,200	$0	$6,800	$1,400	(-$400)	$800	(-$500)	$2,600	$14,900
2030	$3,900	$0	$5,800	$1,500	(-$500)	$800	(-$500)	$2,100	$13,100
2031	$3,300	$0	$4,100	$1,500	(-$500)	$900	(-$500)	$2,100	$10,900
2032	$2,400	$0	$2,700	$1,600	(-$500)	$900	(-$500)	$2,800	$9,400
2033	$2,000	$0	$1,500	$1,600	(-$500)	$900	(-$500)	$2,200	$7,200
2034	$1,900	$0	$800	$1,600	(-$500)	$900	(-$500)	$2,200	$6,400
Total	$33,000	$0	$48,800	$12,400	(-$4,000)	$6,900	(-$4,100)	$25,500	$118,500

b. Fiscal Impact on Federal Government

Staff do not anticipate any additional fiscal impact on federal government agencies other than the direct costs shown in Table D9. The fiscal impact to federal government agencies from 2022 to 2034 is estimated to be $118,500.

E. Macroeconomic Impacts

1. Methods for Determining Economic Impacts

This section describes the estimated impact of the Proposed Amendments on the California economy. The Proposed Amendments would result in changes in costs to TRU fleets and applicable facilities in order to comply with its requirements. These changes in expenditures would affect employment, output, and investment in sectors that supply freight and services in support of these businesses and industries.

The direct impacts of the Proposed Amendments would lead to additional indirect and induced effects, like changes in personal income that affect consumer expenditures across other spending categories. The incremental total economic impacts of the Proposed Amendments are simulated relative to the Baseline using cost data described in Section C. The analysis focuses on incremental change in major macroeconomic indicators from 2022 to 2034 including employment, output growth, and gross state product (GSP). The years of the analysis are used to simulate the Proposed Amendments through 12 months post full implementation.

Regional Economic Models, Inc. (REMI) Policy Insight Plus Version 2.4.1 is used to estimate the macroeconomic impacts of the Proposed Amendments on the California economy. REMI is a structural economic forecasting and policy analysis model that integrates input-output, computable general equilibrium, and econometric and economic geography methodologies.[200] REMI Policy Insight Plus provides year-by-year estimates of the Proposed Amendments, pursuant to the requirements of SB 617 and the California Department of Finance.[201, 202]

CARB uses the REMI single-region, 160-sector model. Several adjustments were made to the model reference case to reflect the impacts of current economic conditions and to reflect the Department of Finance conforming forecasts. First, the REMI model's National Control was updated with a short-term national forecast based on the U.S. Economic Outlook for 2020-2022 from the University of Michigan's Research Seminar

[200] For further information and model documentation see: https://www.remi.com/model/pi/
[201] California Legislature, Senate Bill 617, signed on October 5, 2011. (web link: http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201120120SB617, last accessed March 2021)
[202] Department of Finance, Chapter 1: Standardized Regulatory Impact Analysis for Major Regulations - Order of Adoption. (web link: http://www.dof.ca.gov/Forecasting/Economics/Major_Regulations/SB_617_Rulemaking_Documents/documents/Order_of_Adoption-2.pdf, last accessed March 2021)

in Quantitative Economics (RSQE)[203] release on February 19, 2021, which was made available on the REMI website.[204] Second, the National and Regional Controls in REMI were updated to reflect the most recent Department of Finance conforming forecasts which include population projections dated March 2021 and U.S. real GDP and employment forecasts, and California civilian employment growth numbers dated November 2020. Because the Department of Finance forecasts only extended to 2024, staff made the assumption that post-2024, U.S. income and employment would continue to grow at the same rate as projected in the RSQE forecast.

2. Inputs of the Assessment

The estimated economic impact of the Proposed Amendments is sensitive to modeling assumptions. This section provides a summary of the assumptions and inputs used to determine the suite of policy variables that best reflect the macroeconomic impacts of the Proposed Amendments. The direct costs estimated in Section C and the non-mortality health benefits estimated in Section B are translated into REMI policy variables and used as inputs for the macroeconomic analysis.[205]

The direct costs of the Proposed Amendments, are described in Section C, and include capital costs for new zero-emission truck TRUs and supporting infrastructure, new TRUs equipped with engines certified to meet a PM emission standard, lower GWP refrigerants, as well as annual costs for maintenance, diesel and electricity usage, LCFS credit revenue, CARB fees, and administrative costs for registration and reporting.

Equipment, operational, and administrative costs and savings for truck, trailer, and DSC TRU fleets are input into the economic model as a change in production costs in the truck transportation industry (NAICS 484). Similar equipment, operational, and administrative costs for TRU generator set and railcar TRU fleets are input into the economic model as a change in production costs in the water transportation (NAICS 483) and rail transportation (NAICS 482) industries, respectively.

Costs borne by applicable facilities are also input into the economic model as increases in production costs. Infrastructure and maintenance costs at truck TRU home bases are input as production cost increases to the truck transportation industry, refrigerated WHDC costs are input as production cost increases to the warehousing and storage industry (NAICS 493), seaport facility costs are input into the model as increases in production costs to the scenic and sightseeing transportation and support activities for transportation industry (NAICS 487, 488), and railyard costs are input into the model as increases in production costs to the rail transportation industry (NAICS 482). For grocery stores, 99 percent of the costs are input as production cost increases to the retail trade industry (NAICS 44, 45) and the remaining 1 percent is input as production cost increases to the wholesale trade industry (NAICS 42). This

[203] U.S. Research Seminar in Quantitative Economics Forecast, February 19, 2021. (web link: https://lsa.umich.edu/econ/rsqe.html)
[204] REMI Forecast Updates (web link: https://www.remi.com/forecast-updates/, last accessed April 2021)
[205] Refer to Appendix B: Macroeconomic Modeling Inputs for a full list of REMI inputs for this analysis.

split was informed by NAICS classification data from the applicable grocery stores and supercenters.

Costs and savings incurred by TRU fleets and applicable facilities would result in corresponding changes in final demand for industries supplying those particular services or equipment. Changes in demand for TRU equipment and maintenance from the in-state portion of all the TRU fleets is assumed to be met by businesses in the refrigeration equipment and supplies merchant wholesalers' industry (NAICS 423740) and is input into the model as an exogenous change in demand to the wholesale trade industry (NAICS 42). Changes in demand for diesel fuel is input into the model as an exogenous change in demand to the petroleum and coal products manufacturing industry (NAICS 324). The additional demand for charging equipment necessary for zero emission TRUs is input into the model as increased demand to the other electrical equipment and component manufacturing industry (NAICS 3359) and the infrastructure upgrades necessary for charging is input into the model as increased demand for the construction industry (NAICS 23). Changes in demand for electricity is input into the model as an exogenous change in demand to the electric power generation, transmission and distribution industry (2211). Reporting and other administrative services is modeled as increased demand in the office administrative services and facilities support services industry (NAICS 5611, 5612).

Table E1 illustrates the sources of changes in production costs for TRU fleets and applicable facilities and corresponding changes in final demand by industry as described above.

Table E1. Sources of Changes in Production Cost and Final Demand by Industry

Source of Cost or Savings	Industries with changes in production costs[206]	Industries with changes in final demand (NAICS)
TRU Equipment and Maintenance	TRU fleets	Wholesale trade (42)
Diesel Fuel	TRU fleets	Petroleum and coal products manufacturing (324)
Electricity and Infrastructure	TRU fleets and applicable facilities	Electric power generation, transmission, and distribution (2211), construction (23), other electrical equipment and component manufacturing (3359)
Compliance Plans, Load Surveys[207]	Applicable facilities	Management, scientific, and technical consulting services (5416)
Registration and Reporting	TRU fleets and applicable facilities	Office administrative services; facilities support services (5611, 5612)

[206] TRU fleets include businesses within the truck transportation (484), water transportation (483), and rail transportation (482) industries. Applicable facilities include businesses within the truck transportation (484), warehousing and storage (493), retail trade (44, 45), wholesale trade (42), and scenic and sightseeing transportation and support activities for transportation industries (487, 488).
[207] Compliance plan and load surveys are a cost element associated with Alternative 1, but is included in this table to describe the relationships between the costs and mirrored increases in demand.

Source of Cost or Savings	Industries with changes in production costs[206]	Industries with changes in final demand (NAICS)
ETS Data Plans[208]	TRU fleets	Management, scientific, and technical consulting services (5416)

In addition to these changes in production costs and final demand for businesses, there would also be economic impacts as a result of fiscal effects. The Proposed Amendments would result in changes in diesel, electricity, and sales tax revenues. The changes in tax revenue are modeled as changes in State and local government spending, assuming that this revenue is not offset elsewhere. The additional CARB staff needed to implement the Proposed Amendments is modeled as an increase in government employment. As described in Appendix A: Fee Development, the fees collected through the Proposed Amendments will offset all employment and implementation costs of the TRU program and are not anticipated to result in additional economic impacts through increased government spending. For this reason, the increased fee revenue collected through the Proposed Amendments was not added to the REMI modeling as an increase in state government spending, nor was government spending decreased to reflect the opportunity costs of additional hires.

The health benefits resulting from emission reductions of the Proposed Amendments reduce health care costs for individuals on average. The reduction in healthcare cost is modeled as a decrease in spending for hospitals, with a reallocation of the spending towards other goods and increased savings. The GHG emission reduction benefits as valued through the SC-CO2 represent the avoided damage from climate change worldwide per MT of CO2e. These benefits fall outside the scope of the economic model and are not evaluated here.

3. Results of the Assessment

The results from the REMI model provide estimates of the impact of the Proposed Amendments on the California economy. These results represent the annual incremental change from the implementation of the Proposed Amendments relative to the Baseline. The California economy is anticipated to grow through 2034, therefore, negative impacts reported here should be interpreted as a slowing of growth and positive impacts as an acceleration of growth resulting from the Proposed Amendments.

a. California Employment Impacts

Table E2 presents the impacts of the Proposed Amendments on total employment in California and for the primary and secondary industries impacted by the Proposed Amendments, for all of the odd years of the assessment.[209] The statewide employment impacts of the Proposed Amendments are anticipated to be slightly positive in 2023

[208] ETS Data plans are a cost element associated with Alternative 1, but is included in this table to describe the relationships between the costs and mirrored increases in demand.
[209] The Proposed Amendments have no impacts in 2022. In 2034, the impacts are similar to the impacts in 2033 as evidenced in the figures that are also presented in this section.

and 2024, corresponding with demand for TRU equipment and infrastructure needed to support operation of zero-emission truck TRUs from in-state fleets. From 2025 to 2034, the employment impacts are estimated to be negative as the overall costs of the Proposed Amendments offset the positive impacts of additional in-state demand. The changes in statewide employment represent, at most, a 0.01% change relative to baseline California employment.

The overall trend in employment changes by major sector are illustrated in Figure F1. The major sectors that are estimated to have increased demand or direct increases to employment such as the retail and wholesale sector and the government sector are estimated to have increases in employment in the early years of the assessment. From 2027 to 2034, all major sectors are anticipated to have slight decreases in employment relative to the Baseline.

Industries that are estimated to have net costs, decreases in demand, or revenue loss are anticipated to have decreases in employment growth. This includes the various transportation sectors that operate TRU equipment, warehousing, retail, and petroleum and coal products manufacturing. The wholesale trade industry includes both the suppliers of TRU equipment (the refrigeration equipment and supplies merchant wholesalers' industry) and some of the applicable grocery store and supercenters that would face costs under the Proposed Amendments. On net, this industry is estimated to have positive employment impacts from 2023 to 2028, followed by a slight decline in employment growth.

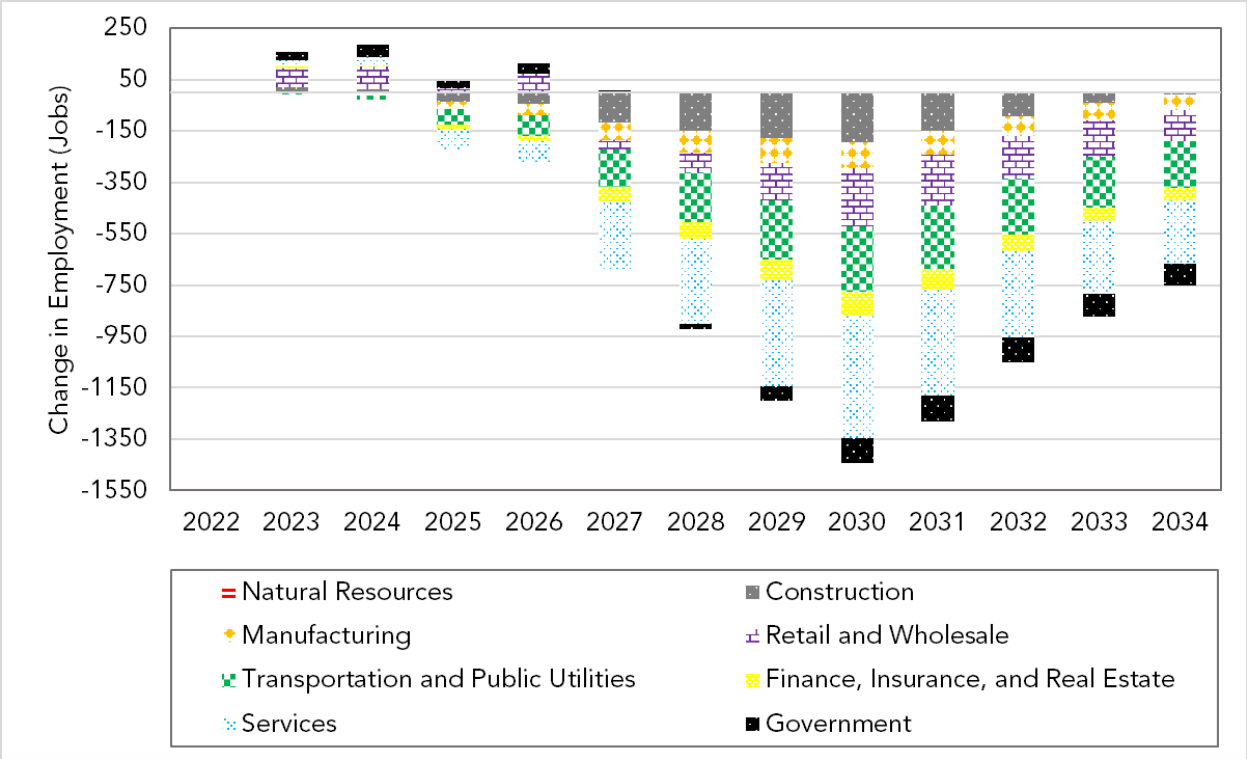
Industries that are estimated to have increased demand may see employment growth. In particular, the electric power and generation industry is estimated to see slight increases in employment growth in the latter years of the analysis associated with increased demand for electricity from truck TRUs.

Table E2. Summary of Employment Impacts Associated with the Proposed Amendments

Industry	Units	2023	2025	2027	2029	2031	2033
CA statewide	Total Employment (millions)	23.6	24.3	24.3	24.2	24.2	24.3
CA statewide	Percent change	0.00%	0.00%	0.00%	-0.01%	-0.01%	0.00%
CA statewide	Change in jobs	150	-180	-680	-1,200	-1,280	-870
Truck transportation	Percent change	0.00%	-0.02%	-0.04%	-0.05%	-0.06%	-0.05%
Truck transportation	Change in jobs	-10	-40	-100	-140	-150	-120
Water transportation	Percent change	-0.02%	-0.03%	-0.08%	-0.13%	-0.15%	-0.14%
Water transportation	Change in jobs	0	0	-10	-10	-10	-10
Rail Transportation	Percent change	0.00%	-0.02%	-0.05%	-0.08%	-0.09%	-0.09%
Rail Transportation	Change in jobs	0	0	-10	-10	-10	-10
Scenic and sightseeing trans. and support activities for trans.	Percent change	0.00%	0.00%	-0.01%	-0.01%	-0.02%	-0.01%
Scenic and sightseeing trans. and support activities for trans.	Change in jobs	0	0	-10	-20	-20	-20
Warehousing and storage	Percent change	0.00%	0.00%	-0.01%	-0.01%	-0.01%	-0.01%
Warehousing and storage	Change in jobs	0	-10	-10	-20	-30	-20
Retail trade	Percent change	0.00%	0.00%	-0.01%	-0.01%	-0.01%	0.00%
Retail trade	Change in jobs	-20	-60	-120	-150	-130	-80
Wholesale trade	Percent change	0.01%	0.01%	0.01%	0.00%	-0.01%	-0.01%
Wholesale trade	Change in jobs	90	70	90	0	-70	-60
Petroleum and coal products mfg.	Percent change	0.00%	-0.01%	-0.01%	-0.02%	-0.02%	-0.02%
Petroleum and coal products mfg.	Change in jobs	0	0	0	0	0	0
Electric power gen. and dist.	Percent change	0.00%	0.01%	0.02%	0.03%	0.04%	0.04%
Electric power gen. and dist.	Change in jobs	0	0	10	10	20	20
Construction	Percent change	0.00%	0.00%	-0.01%	-0.01%	-0.01%	0.00%
Construction	Change in jobs	20	-40	-110	-170	-150	-40
Other electrical equipment and component mfg.	Percent change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Other electrical equipment and component mfg.	Change in jobs	0	0	0	0	0	0

Industry	Units	2023	2025	2027	2029	2031	2033
Office administrative services; Facilities support services	Percent change	0.00%	0.02%	0.02%	0.01%	0.01%	0.01%
Office administrative services; Facilities support services	Change in jobs	0	20	20	10	10	10
State government	Percent change	0.00%	0.00%	0.00%	0.00%	-0.01%	-0.01%
State government	Change in jobs	20	20	10	-10	-30	-20
Local government	Percent change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Local government	Change in jobs	20	10	0	-40	-70	-60

Figure E1. Changes in Employment by Major Sector



b. California Business Impacts

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

As illustrated in Table E3, the Proposed Amendments are estimated to result in an increase in statewide output in 2023 and 2024. From 2025 to 2031, the Proposed Amendments are estimated to lead to a slight decrease in statewide output. The changes in statewide output are no larger than 0.01 percent of baseline levels.

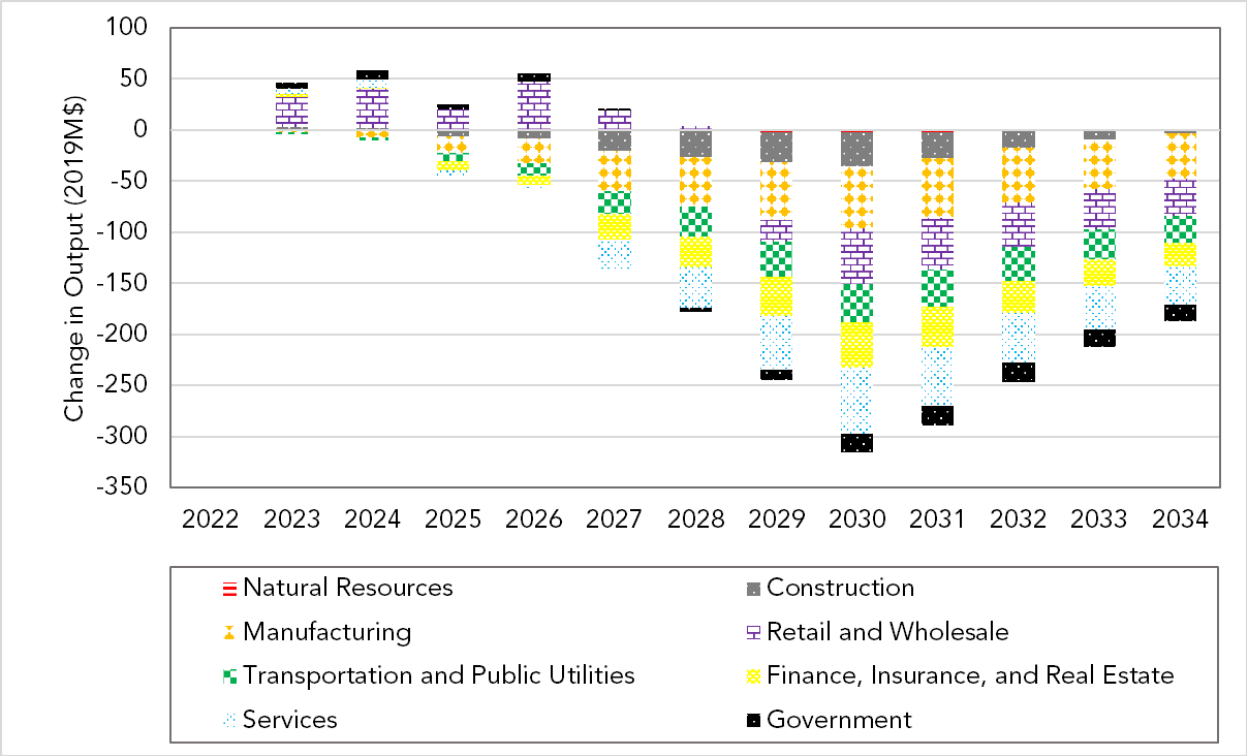
Figure E2 illustrates the impacts to output by major sector. Similar to the employment impacts, sectors and industries that are anticipated to face production cost increases, decreases in demand, or decreased revenue are anticipated to have corresponding decreases in output, while industries that are anticipated to see increases in demand are estimated to have increases in output.

Table E3. Summary of Output Impacts Associated with the Proposed Amendments

Industry	Units	2023	2025	2027	2029	2031	2033
CA statewide	Total Output (2019B$)	4,932	5,240	5,343	5,463	5,603	5,778
CA statewide	Percent change	0.00%	0.00%	0.00%	-0.01%	-0.01%	0.00%
CA statewide	Change (2019M$)	43	-21	-115	-245	-289	-212
Truck transportation	Percent change	0.00%	-0.02%	-0.04%	-0.05%	-0.06%	-0.05%
Truck transportation	Change (2019M$)	-2	-8	-19	-28	-30	-26
Water transportation	Percent change	-0.02%	-0.03%	-0.08%	-0.13%	-0.15%	-0.14%
Water transportation	Change (2019M$)	-1	-2	-5	-8	-10	-10
Rail Transportation	Percent change	0.00%	-0.02%	-0.05%	-0.08%	-0.09%	-0.09%
Rail Transportation	Change (2019M$)	0	0	-1	-2	-3	-3
Scenic and sightseeing trans. and support activities for trans.	Percent change	0.00%	0.00%	-0.01%	-0.02%	-0.02%	-0.01%
Scenic and sightseeing trans. and support activities for trans.	Change (2019M$)	0	-1	-3	-4	-5	-4
Warehousing and storage	Percent change	0.00%	0.00%	-0.01%	-0.01%	-0.01%	-0.01%
Warehousing and storage	Change (2019M$)	0	0	-1	-2	-3	-2
Retail trade	Percent change	0.00%	0.00%	-0.01%	-0.01%	-0.01%	-0.01%
Retail trade	Change (2019M$)	-2	-7	-16	-20	-18	-13
Wholesale trade	Percent change	0.01%	0.01%	0.01%	0.00%	-0.01%	-0.01%
Wholesale trade	Change (2019M$)	31	28	36	-1	-31	-27
Petroleum and coal products mfg.	Percent change	0.00%	-0.01%	-0.01%	-0.02%	-0.02%	-0.02%
Petroleum and coal products mfg.	Change (2019M$)	0	-4	-10	-14	-16	-15
Electric power gen. and dist.	Percent change	0.00%	0.01%	0.02%	0.04%	0.04%	0.04%
Electric power gen. and dist.	Change (2019M$)	0	4	10	16	18	19
Construction	Percent change	0.00%	0.00%	-0.01%	-0.01%	-0.01%	0.00%
Construction	Change (2019M$)	3	-6	-19	-30	-26	-8
Other electrical equipment and component mfg.	Percent change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Other electrical equipment and component mfg.	Change (2019M$)	0	0	0	0	0	0

Industry	Units	2023	2025	2027	2029	2031	2033
Office administrative services; Facilities support services	Percent change	0.00%	0.02%	0.02%	0.01%	0.01%	0.01%
Office administrative services; Facilities support services	Change (2019M$)	0	3	2	2	2	2
State and local government	Percent change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
State and local government	Change (2019M$)	6	5	2	-10	-19	-17

Figure E2. Changes in Output by Major Sector



c. Impacts on Investments in California

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

The changes in private investment for the Proposed Amendments, relative to the Baseline, are shown in Table E4 and show a decrease in private investment of $2 million in 2023 and a decrease of as large as $47 million in 2029. In any given year this represents changes of less than 0.01 percent of baseline investment.

Table E4. Changes in Gross Domestic Private Investment

Units	2023	2025	2027	2029	2031	2033
Private Investment (2019B$)	448	484	493	503	514	530
Percent Change	0.00%	0.00%	-0.01%	-0.01%	-0.01%	0.00%
Change (2019M$)	-2	-14	-36	-47	-39	-13

d. Impacts on Individuals in California

As modeled, the Proposed Amendments do not impose direct costs on individuals in California. However, the costs incurred by affected businesses and the public sector would cascade through the economy and affect individuals. One measure of the statewide impact is the change in real personal income.

Table **E5** shows the annual change in real personal income across all individuals in California. Total personal income decreases by $9 million in 2023, then continues a downward trend, with a decrease of $119 million in 2033. The change in personal income can also be divided the California population to show the average or per capita impact on personal income. Personal income initially decreases by less than $1 per person in 2023 and decreases by about $4 per person in 2029 and 2031, the years with the greatest impact.

Table E5. Change in Personal Income

Units	2023	2025	2027	2029	2031	2033
Personal Income (2019B$)	2,587	2,742	2,846	2,959	3,104	3,219
Percent Change	0.00%	0.00%	-0.01%	-0.01%	-0.01%	0.00%
Change (2019M$)	-9	-56	-134	-175	-166	-119
Per Capita Change (2019$)	0	-1	-2	-4	-4	-3

e. Impacts on Gross State Product (GSP)

Gross State Product (GSP) is the market value of all freight and services produced in California and is one of the primary indicators used to gauge the health of the economy. Table E6 shows the annual change in gross state product as estimated as a result of the Proposed Amendments. Under the Proposed Amendments, GSP is anticipated to increase slightly in 2023 and 2024. This primarily reflects the initial increase in demand for TRU equipment from the in-state TRU fleets. There is a slight decrease in GSP growth as the Proposed Amendments increase in costs over time. In 2031, GSP is estimated to $153 million lower than baseline levels, a 0.01 percent decrease.

Table E6. Change in Gross State Product

Units	2023	2025	2027	2029	2031	2033
Gross State Product (2019B$)	2,923	3,119	3,194	3,282	3,378	3,488
Percent Change	0.00%	0.00%	0.00%	0.00%	-0.01%	0.00%
Change (2019M$)	27	-7	-56	-128	-153	-109

f. Creation or Elimination of Businesses

The Proposed Amendments do not directly result in business creation or elimination and the REMI model cannot directly estimate the creation or elimination of businesses. However, changes in the jobs and output for the California can be used to understand some of the potential impacts. The overall jobs and output impacts are small relative to the total California economy, about 0.01 percent. However, impacts in some sectors are larger or occur at different times, as described in previous sections.

Reductions in output could indicate elimination of businesses. Conversely, increased output within an industry could signal the potential for additional business creation if existing businesses cannot accommodate all future demand. There is no threshold that identifies the creation or elimination of business. Based on the modeling of output

changes, the wholesale trade industry sees increased output in several years and increased purchases of zero-emission TRUs would benefit zero-emission TRU manufacturers, as well as businesses in the zero-emission TRU supply chain.

As discussed in Section B.2, the Proposed Amendments would also provide opportunities for design, engineering, construction, and project management firms to design new and expanded infrastructure at truck TRU home base facilities. While the net impact of the Proposed Amendments on the construction industry is estimated to be slightly negative, there will be some businesses within this industry that see additional demand that could lead to the creation of business.

The industries that house TRU fleets and applicable facilities may face infrastructure related costs and see net decreases in output growth. Many of the applicable facilities are large, and while they face compliance costs, it is unlikely that they would be eliminated. Many of the TRU fleets, however, are small businesses and face significant compliance costs. The truck transportation, rail transportation, and water transportation sectors are estimated to have decreases in output of about 0.1 percent relative to baseline levels and could potentially result in elimination of some businesses. Section C.2 and C.3 discuss the impact of the Proposed Amendments on typical businesses and small businesses. The annualized compliance costs on typical businesses is expected to be less than 1 percent of total annual revenue and would not be anticipated to lead to significant business elimination. For small business TRU fleets, annualized compliance costs are on average expected to be less than 1 percent of total revenue, but in some years could approach 3 percent of total annual revenue. Staff cannot rule out the possibility of some elimination of business.

g. Incentives for Innovation

The Proposed Amendments provide a strong signal for the development of zero-emission TRU technologies and help in building a robust market for advanced technologies. Staff anticipate growth in the industries that manufacture zero-emission TRU technologies, which would strengthen the supply chain and result in technology improvements earlier than they would have otherwise occurred. For example, improvements in battery weight and range are needed to improve market acceptance and bring overall battery-electric technology costs down. These improvements would allow advanced technologies to further expand into extended range TRU applications, as well as other off-road sectors. In addition, due to the large volume of refrigerated freight that moves through California, there is the possibility that the Proposed Amendments would compel TRU OEMs to incorporate advanced technologies and lower-GWP refrigerant into units sold outside of the State.

h. Competitive Advantage or Disadvantage

Staff do not anticipate impacts to the competitive advantage or disadvantage of businesses currently doing business in the State because the Proposed Amendments impose requirements equally on all TRUs that operate in California, whether the business that owns or operates them is based in-state or out-of-state. All businesses owning or operating TRUs would be subject to the same zero-emission truck TRU, PM

emission standard, lower-GWP refrigerant, and administrative requirements, regardless of in-state or out-of-state ownership status. Thus, the Proposed Amendments would not create any competitive disadvantage to businesses located in California.

Businesses that already use zero-emission TRU technologies may gain a competitive advantage compared to fleets that rely on diesel-powered TRUs in the Baseline. Some businesses may already be using cold plate and cryogenic TRUs in addition to battery-electric TRUs. Such businesses will not have large compliance costs associated with the Proposed Amendments and may also gain a competitive advantage compared to fleets that rely on diesel-powered TRUs in the Baseline.

Applicable facilities are required to pay registration fees and ensure that TRUs operating on their property are compliant. The applicable facilities are based on size thresholds and facilities below these specific thresholds will not face direct costs associated with the Proposed Amendments. Therefore, facilities below the threshold may gain a slight competitive advantage compared to larger facilities. Out-of-state facilities will not face the same registration fees and reporting costs. Therefore, California-based facilities may also face a competitive disadvantage to other similar-sized applicable facilities in close proximity, but in another state. Staff do not consider these impacts significant because fees and reporting costs are relatively small compared to the total cost of the Proposed Amendments, and small compared to the total revenue of these facilities.

i. Summary of Agency Interpretation of the Assessment Results

As modeled, CARB estimates the Proposed Amendments are unlikely to have a significant impact on the California economy. Table E7 summarizes the major economic indicators in California for the odd years of the analysis. Overall the change in the growth of jobs, state GDP, and output is projected to not exceed 0.01 percent of the Baseline.

Table E7. Summary of Macroeconomic Impacts of the Proposed Amendments

Economic Indicator	Units	2023	2025	2027	2029	2031	2033
GSP	Percent Change	0.00%	0.00%	0.00%	0.00%	-0.01%	0.00%
GSP	Change (2019M$)	27	-7	-56	-128	-153	-109
Personal Income	Percent Change	0.00%	0.00%	-0.01%	-0.01%	-0.01%	0.00%
Personal Income	Change (2019M$)	-9	-56	-134	-175	-166	-119
Employment	Percent Change	0.00%	0.00%	0.00%	-0.01%	-0.01%	0.00%
Employment	Change (jobs)	150	-180	-680	-1,200	-1,280	-870
Output	Percent Change	0.00%	0.00%	0.00%	-0.01%	-0.01%	0.00%
Output	Change (2019M$)	43	-21	-115	-245	-289	-212
Private Investment	Percent Change	0.00%	0.00%	-0.01%	-0.01%	-0.01%	0.00%
Private Investment	Change (2019M$)	-2	-14	-36	-47	-39	-13

F. Alternatives

1. Alternative 1

Alternative 1 is a more stringent requirement for trailer TRUs, DSC TRUs, railcar TRUs, and TRU generator sets operating in California. Under this alternative, all trailer TRU, DSC TRU, railcar TRU, and TRU generator set engines would be required to meet diesel emission standards for PM, NOx, and CO. This is in contrast to the Proposed Amendments, which only require newly manufactured trailer TRU, DSC TRU, railcar TRU, and TRU generator set engines to meet a PM emission standard. Additionally, trailer TRUs, DSC TRUs, and TRU generator sets would be required to use zero-emission operation while stationary at certain facilities in California and be equipped with an electronic telematics system. Although the PM, NOx, and CO diesel emission standards and zero-emission operation while stationary requirement would result in greater emission benefits, it would also require the purchase of more expensive TRUs, as well as the purchase and installation of approximately 38,000 plugs to support zero-emission operation at applicable facilities statewide. Railcar TRUs would not be subject to the zero-emission operation requirement. Requirements for lower GWP refrigerant, zero-emission truck TRUs, registration, reporting, and fees would remain unchanged from the Proposed Amendments. Key elements of Alternative 1 include the following:

By December 31, 2022:

- Newly manufactured truck TRUs, trailer TRUs, and DSC TRUs that operate in California shall use refrigerant with a GWP less than or equal to 2,200, or use no refrigerant at all (same as Proposed Amendments).

By December 31, 2023:

- All truck TRU fleets shall turnover at least 15 percent each year (for 7 years) to zero-emission technology. All truck TRUs operating in California shall be zero-emission by December 31, 2029 (same as Proposed Amendments).
- MY 2023 and older trailer TRU, DSC TRU, railcar TRU, and TRU generator set engines shall meet a 0.02 g/hp-hr PM emission standard (more stringent than Proposed Amendments).
- MY 2024 and newer trailer TRU, DSC TRU, railcar TRU, and TRU generator set engines, regardless of horsepower, shall meet the U.S. EPA Tier 4 final emission standards (PM, NOx, CO) for 25-50 horsepower engines (more stringent than Proposed Amendments).
- MY 2024 and newer trailer TRUs, DSC TRUs, and TRU generator sets shall use zero-emission operation when stationary for more than 15 minutes at an applicable facility and be equipped with an electronic tracking system (ETS) (more stringent than Proposed Amendments).

By December 31, 2027:

- All trailer TRUs, DSC TRUs, and TRU generator sets operating in California shall use zero-emission operation when stationary for more than 15 minutes at an applicable facility and be equipped with an ETS (more stringent than Proposed Amendments).

By December 31, 2030:

- All trailer TRU, DSC TRU, railcar TRU, and TRU generator set engines, regardless of horsepower, shall meet the more stringent U.S. EPA Tier 4 final emission standards (PM, NOx, CO) for 25-50 horsepower engines (more stringent than Proposed Amendments.

This alternative aligns with proposals from stakeholders advocating for the most stringent requirements feasible.

a. Costs

Under Alternative 1, the total direct cost to TRU owners is the summation of the cost of zero-emission truck TRUs, electric-standby or hybrid-electric TRUs (eTRU) capable of zero-emission operation, Level 3 VDECS, lower GWP refrigerant, ETS, and supporting infrastructure, as well as annual costs for maintenance, diesel and electricity usage, electronic telematics system data plans, LCFS credit revenue, CARB fees, and administrative costs for registration and reporting.

Staff used the cost estimates for battery-electric truck TRUs discussed in Section C.1.d.i and refrigerant costs discussed in Section C.1.d.iv. Compliance with the in-use PM standard in Alternative 1 would be achieved by retrofitting the TRU engine with a Level 3 VDECS.

To comply with the PM, NOx, and CO diesel emission standards and zero-emission operation while stationary requirement, staff assumed TRU owners would purchase new trailer and DSC eTRUs capable of zero-emission operation equipped with a greater than 25 horsepower engine, since these units would be fully compliant with Alternative 1. The capital cost for a new trailer TRU or DSC TRU to comply with Alternative 1 is $35,000, which is based on the current average cost of commercially available single-temperature and multi-temperature eTRUs with a greater than 25 horsepower engine. The capital cost for a new railcar TRU to comply with Alternative 1 is $28,390, which is the current average cost of commercially available units with a greater than 25 horsepower engine. The capital cost for a new TRU generator set to comply with Alternative 1 is $19,900, which is the current average cost of commercially available “pin-on” and “under-slung” units with a greater than 25 horsepower engine.

The capital cost for ETS is $1,000, which is based on estimates from TRU fleets and both major OEMs. The cost for an ETS data plan cost is $240 per year.

The cost for the purchase and installation of 30A 480V 3-phase plugs at applicable facilities is estimated to be $13,600 per plug,[210] This does not include additional site transformer or substation costs. In addition, facilities that request a significant electrical service upgrade with their electric utility may need to pay for a method of service or a load survey that is estimated to cost $50,000.[211, 212] Based on the estimated number of TRU visits for each facility type and the electrical power draw of TRUs, staff assumed this would apply to all 321 refrigerated HCWHDCs and 4 railyards. Table F1 shows the incremental costs associated with Alternative 1.

Table F1. Capital Costs for Alternative 1 (2019$)

Equipment Type	Baseline Cost per Unit	Proposed Cost per Unit	Incremental Cost per Unit
Diesel Truck TRU	$19,300	$44,600	$25,300
Truck eTRU	$20,400	$44,600	$24,200
Diesel Trailer TRU/DSC TRU <25hp	$25,530	$35,000	$9,470
Diesel Trailer TRU/DSC TRU >25hp	$28,390	$35,000	$6,610
Trailer/DSC eTRU <25hp	$31,630	$35,000	$3,070
Railcar TRU <25hp	$25,530	$28,390	$2,860
TRU Generator Set <25hp	$17,300	$19,900	$2,500
Level 3 VDECS	$0	$5,190[213]	$5,190
Electronic Telematics System	$0	$1,000[214]	$1,000
Truck TRU - Level 2 Charger	$0	$1,154	$1,154
Truck TRU – Level 2 Charger Installation	$0	$3,733	$3,733
Applicable Facility - 30A 480V 3-phase plug (including installation)	$0	$13,600[215]	$13,600

From 2022 to 2034, Alternative 1 is estimated to cost $6.56 billion compared to the Baseline versus $1.03 billion for the Proposed Amendments compared to the Baseline. The higher cost of Alternative 1 is due to the cost of trailer TRUs and DSC TRUs equipped with a greater than 25 horsepower engine and capable of zero-emission operation, as well as the purchase and installation of 38,000 plugs at applicable facilities to support the zero-emission operation of TRUs onsite. These higher costs are slightly offset by lower operating and maintenance costs and LCFS credits. Table F2, Table F3, and Table F4 show the total net costs, direct costs, and cost savings for Alternative 1, respectively.

[210] Based on the average of CARB funded projects and confidential data obtained from industry sources that requested non-attribution.
[211] If a utility customer has a service request for new load greater than six megawatts or need an additional distribution circuit, the customer will be required to pay for a method of survey.
[212] Survey costs claimed confidential data obtained from industry sources that requested non-attribution.
[213] Claimed confidential data obtained from industry sources that requested non-attribution.
[214] Claimed confidential data obtained from industry sources that requested non-attribution.
[215] Average of CARB funded projects and claimed confidential data obtained from industry sources that requested non-attribution. Does not include additional site transformer or substation costs.

Table F2. Total Projected Net Costs for Alternative 1 from 2022 to 2034 (2019M$)

Year	Equipment Capital Costs	Equipment Maintenance Costs	Infrastructure Capital Costs	Infrastructure Maintenance Costs	Diesel Fuel Costs	Electricity Costs	ETS Data Plan Costs	LCFS Credit Revenue	Administrative Costs	Total
2022	$0	$0	$0	$0	$0	$0	$0	$0	$19.6	$19.6
2023	$666.2	$0.9	$51.0	$0	$0	$0	$0	$0	$11.1	$729.2
2024	$116.7	(-$2.7)	$52.2	$2.8	(-$14.9)	$14.9	$5.8	(-$12.7)	$4.7	$166.8
2025	$170.9	(-$5.1)	$54.1	$3.1	(-$24.2)	$25.9	$10.8	(-$19.9)	$4.6	$220.2
2026	$233.7	(-$7.5)	$56.7	$3.3	(-$34.3)	$37.6	$16.7	(-$28.3)	$11.4	$289.3
2027	$788.7	(-$10.3)	$59.1	$3.6	(-$44.4)	$51.2	$23.1	(-$37.9)	$6.7	$839.8
2028	$769.8	(-$19.7)	$60.2	$3.9	(-$81.5)	$94.4	$48.3	(-$64.4)	$9.5	$820.5
2029	$770.0	(-$21.0)	$60.5	$4.2	(-$82.5)	$100.8	$50.1	(-$67.4)	$8.7	$823.4
2030	$764.9	(-$21.7)	$60.4	$4.4	(-$83.4)	$106.2	$51.7	(-$69.6)	$7.5	$820.4
2031	$751.1	(-$22.0)	$59.6	$4.5	(-$84.5)	$109.9	$53.2	(-$69.3)	$8.4	$810.9
2032	$308.5	(-$22.4)	$59.1	$4.5	(-$86.5)	$111.5	$54.0	(-$69.0)	$8.6	$368.3
2033	$263.7	(-$22.7)	$58.8	$4.6	(-$89.2)	$113.2	$54.9	(-$68.7)	$7.7	$322.3
2034	$270.6	(-$23.1)	$59.0	$4.7	(-$91.4)	$115.1	$55.8	(-$68.4)	$8.8	$331.1
Total	$5,874.8	(-$177.3)	$690.7	$43.6	(-$716.8)	$880.7	$424.4	(-$575.6)	$117.3	$6,561.8

Table F3. Total Projected Direct Costs for Alternative 1 from 2022 to 2034 (2019$)

Year	Equipment Capital Costs	Equipment Maintenance Costs	Electricity Costs	ETS Data Plan	Infrastructure Capital Costs	Infrastructure Maintenance Costs	Administrative Costs	Total
2022	$0	$0	$0	$0	$0	$0	$19,600,000	$19,600,000
2023	$666,200,000	$900,000	$0	$0	$51,000,000	$0	$11,100,000	$729,200,000
2024	$116,700,000	$0	$14,900,000	$5,800,000	$52,200,000	$2,800,000	$4,700,000	$197,100,000
2025	$170,800,000	$0	$25,900,000	$10,800,000	$54,100,000	$3,100,000	$4,600,000	$269,300,000
2026	$233,700,000	$0	$37,600,000	$16,700,000	$56,700,000	$3,300,000	$11,400,000	$359,400,000
2027	$788,700,000	$0	$51,200,000	$23,100,000	$59,100,000	$3,600,000	$6,700,000	$932,400,000
2028	$769,800,000	$0	$94,400,000	$48,300,000	$60,200,000	$3,900,000	$9,500,000	$986,100,000
2029	$770,000,000	$0	$100,800,000	$50,100,000	$60,500,000	$4,200,000	$8,700,000	$994,300,000
2030	$764,900,000	$0	$106,200,000	$51,700,000	$60,400,000	$4,400,000	$7,500,000	$995,100,000
2031	$751,100,000	$0	$109,900,000	$53,200,000	$59,600,000	$4,500,000	$8,400,000	$986,700,000
2032	$313,600,000	$0	$111,500,000	$54,000,000	$59,100,000	$4,500,000	$8,600,000	$551,300,000
2033	$280,500,000	$0	$113,200,000	$54,900,000	$58,800,000	$4,600,000	$7,700,000	$519,700,000
2034	$294,400,000	$0	$115,100,000	$55,800,000	$59,000,000	$4,700,000	$8,800,000	$537,800,000
Total	$5,920,400,000	$900,000	$880,700,000	$424,400,000	$690,700,000	$43,600,000	$117,300,000	$8,078,000,000

Table F4. Total Projected Cost Savings for Alternative 1 from 2022 to 2034 (2019$)

Year	Equipment Capital Costs	Equipment Maintenance Costs	Diesel Fuel Costs	LCFS Credit Revenue	Total
2022	$0	$0	$0	$0	$0
2023	$0	$0	$0	$0	$0
2024	$0	(-$2,700,000)	(-$14,900,000)	(-$12,700,000)	(-$30,300,000)
2025	$0	(-$5,100,000)	(-$24,200,000)	(-$19,900,000)	(-$49,200,000)
2026	$0	(-$7,500,000)	(-$34,300,000)	(-$28,300,000)	(-$70,100,000)
2027	$0	(-$10,300,000)	(-$44,400,000)	(-$37,900,000)	(-$92,600,000)
2028	$0	(-$19,700,000)	(-$81,500,000)	(-$64,400,000)	(-$165,600,000)
2029	$0	(-$20,900,000)	(-$82,500,000)	(-$67,400,000)	(-$170,800,000)
2030	$0	(-$21,700,000)	(-$83,400,000)	(-$69,600,000)	(-$174,700,000)
2031	$0	(-$22,000,000)	(-$84,500,000)	(-$69,300,000)	(-$175,800,000)
2032	(-$5,200,000)	(-$22,400,000)	(-$86,400,000)	(-$69,000,000)	(-$183,000,000)
2033	(-$16,900,000)	(-$22,700,000)	(-$89,200,000)	(-$68,700,000)	(-$197,500,000)
2034	(-$23,800,000)	(-$23,100,000)	(-$91,400,000)	(-$68,400,000)	(-$206,700,000)
Total	(-$45,900,000)	(-$178,100,000)	(-$716,700,000)	(-$575,600,000)	(-$1,516,300,000)

b. Benefits

Staff developed emission reduction estimates for Alternative 1 according to the methodology described in Section B.1.a. Alternative 1 would result in greater PM2.5, NOx, and GHG emission reductions than the Proposed Amendments. Figure F1, Figure F2, and Figure F3 show the PM2.5, NOx, and GHG emissions under the Baseline, Proposed Amendments, and Alternative 1.

Figure F1. Projected PM2.5 Emissions under the Baseline, Proposed Amendments, and Alternative 1

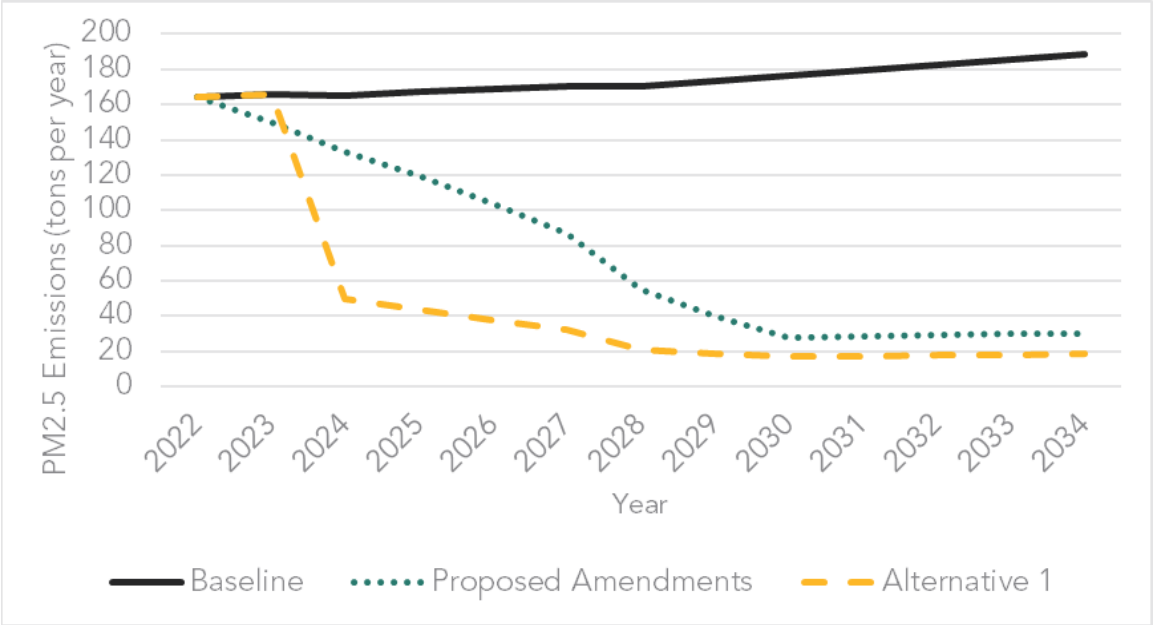


Figure F2. Projected NOx Emissions under the Baseline, Proposed Amendments, and Alternative 1

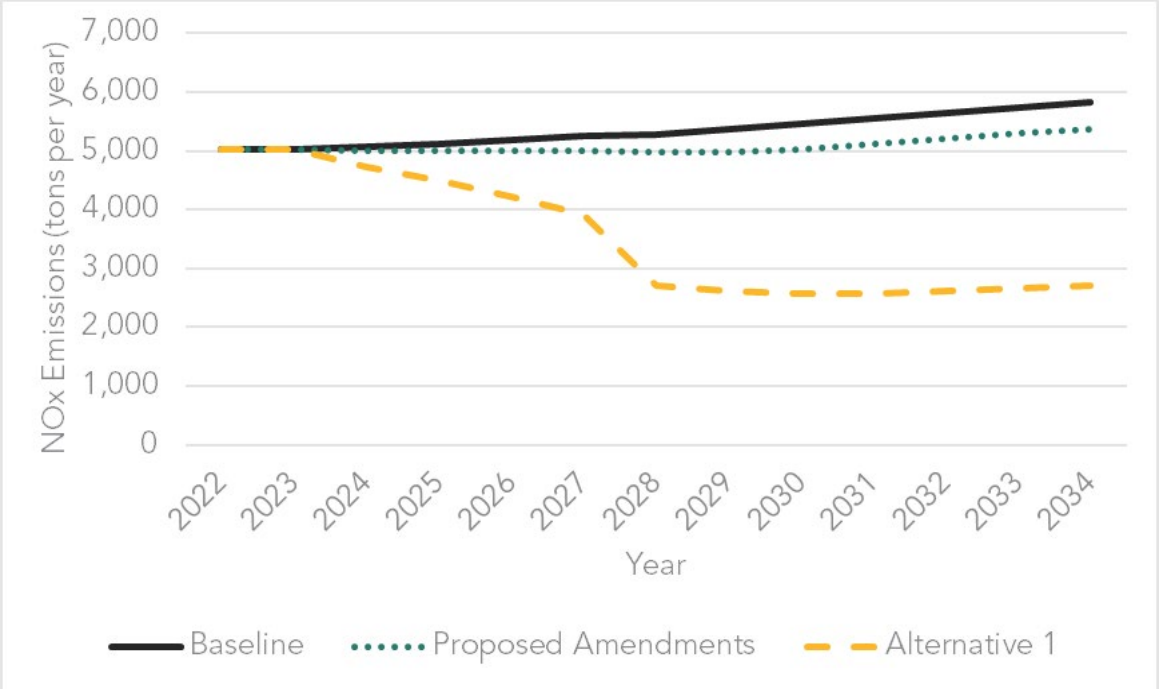
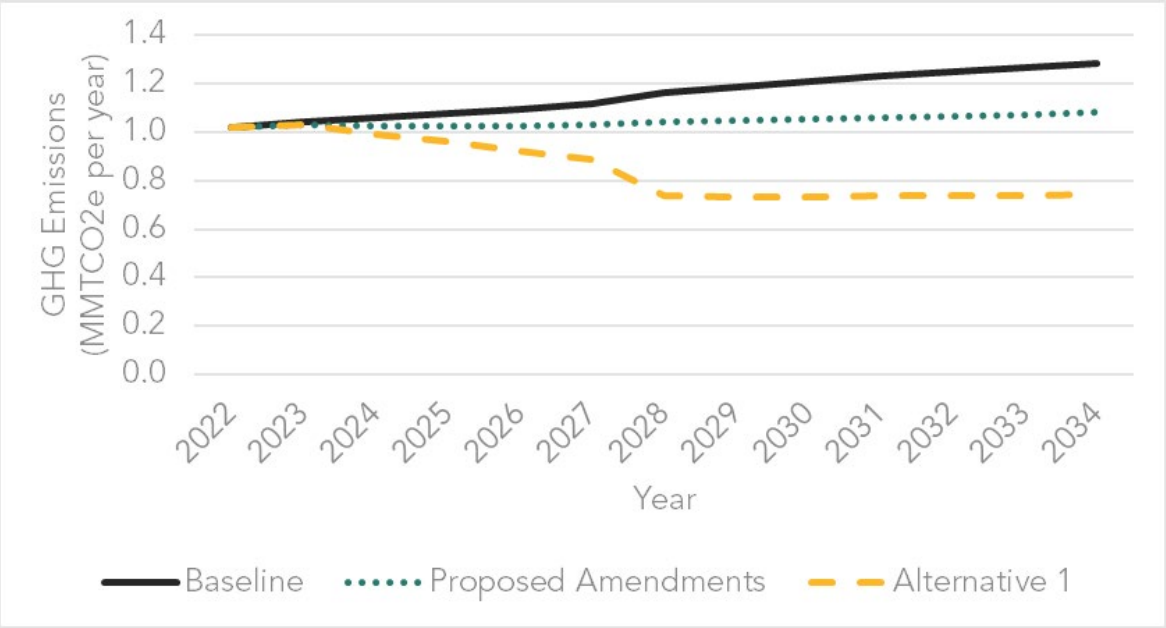


Figure F3. Projected GHG Emissions under the Baseline, Proposed Amendments, and Alternative 1



Staff used the estimation methodologies described in Section B.4.a.ii.2 to quantify avoided cardiopulmonary mortality, hospitalizations for cardiovascular illness and respiratory illness, and emergency room visits for respiratory illness and asthma that would be expected to result from Alternative 1. Staff calculated the health benefits for Alternative 1 using the methodology described in Section B.4.a.ii.3. Table F5 shows the statewide valuation of avoided health outcomes for Alternative 1. Alternative 1 results in a higher valuation of health benefits at $3.95 billion compared to the Proposed Amendments at $1.75 billion.

Table F5. Statewide Valuation of Avoided Health Outcomes for Alternative 1 from 2022 to 2034

Outcome	Avoided Incidents	Valuation
Avoided Premature Deaths	400	$3,947,125,769
Avoided Hospitalizations	128	$6,920,114
Avoided Emergency Room Visits	195	$162,941
Total	723	$3,954,208,824

c. Economic Impacts

Alternative 1 is more stringent compared to the Proposed Amendments, in which all trailer TRUs, DSC TRUs, railcar TRUs, and TRU generator sets would be required to meet diesel emission standards for NOx, PM, and CO. Additionally, trailer TRUs, DSC TRUs, and TRU generator sets would be required to use zero-emission operation while stationary at certain facilities in California and be equipped with an ETS. This results in higher incremental costs relative to the Proposed Amendments.

The macroeconomic impact analysis results, for the odd years of the analysis, are shown in Table F6. In 2023, Alternative 1 is estimated to result in a slight increase GSP, output, and employment. The increased economic activity is a result of increased demand due to purchases and installation of equipment and infrastructure by in-state fleets, as well as construction activity required to equip applicable facilities with the ability to support the zero-emission stationary requirements. After the initial boost to economic activity, the overall increased costs of Alternative 1 result in decreases in overall economic activity. In years 2029 to 2031, Alternative 1 is estimated to decrease GSP, personal income, employment, and output by 0.01 percent to 0.07 percent below baseline levels. Relative to the Proposed Amendments. These impacts are approximately 3 times as large as those estimated under the Proposed Amendments.

Table F6. Summary of Macroeconomic Impacts of Alternative 1

Economic Indicator	Units	2023	2025	2027	2029	2031	2033
GSP	Percent Change	0.01%	-0.01%	-0.01%	-0.03%	-0.03%	-0.01%
GSP	Change (2019M$)	393	-174	-324	-894	-940	-422
Personal Income	Percent Change	-0.01%	-0.01%	-0.03%	-0.04%	-0.04%	-0.02%
Personal Income	Change (2019M$)	-230	-239	-840	-1,104	-1,128	-480
Employment	Percent Change	0.01%	-0.01%	-0.02%	-0.03%	-0.03%	-0.01%
Employment	Change (jobs)	3,400	-1,730	-3,990	-7,760	-7,800	-3,130
Output	Percent Change	0.01%	-0.01%	-0.01%	-0.03%	-0.03%	-0.02%
Output	Change (2019M$)	686	-347	-656	-1,651	-1,746	-840
Private Investment	Percent Change	-0.01%	-0.02%	-0.05%	-0.07%	-0.06%	-0.01%
Private Investment	Change (2019M$)	-65	-107	-228	-343	-322	-71

Figure F4 illustrates the changes in employment by major sector associated with Alternative 1. The large increase in employment in 2023 primarily reflects a one-time short-lived increased demand for construction activities to install infrastructure in applicable facilities. From 2024 to 2034, the changes in employment closely match the pattern in overall costs for Alternative 1. The greatest decreases in overall employment occur between 2029 to 2031, directly following the years with greatest incremental costs.

Figure F4. Changes in Employment by Major Sector Associated with Alternative 1

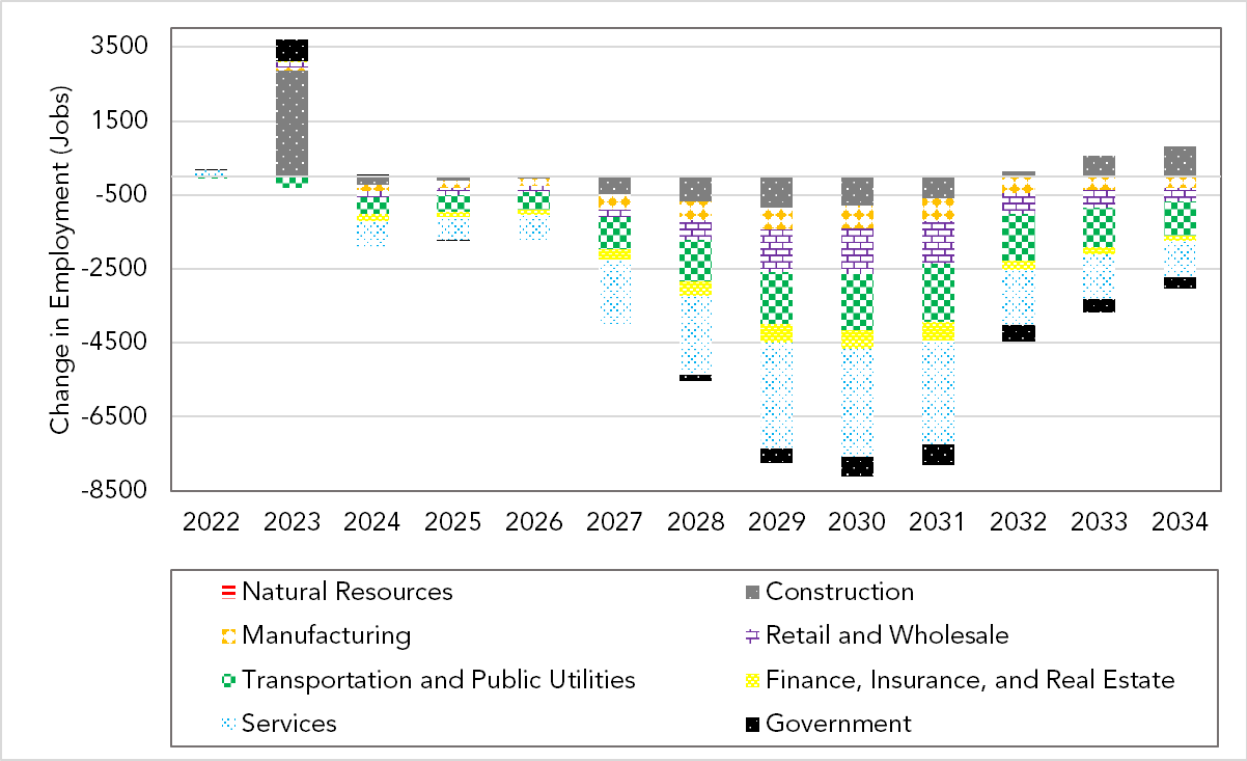
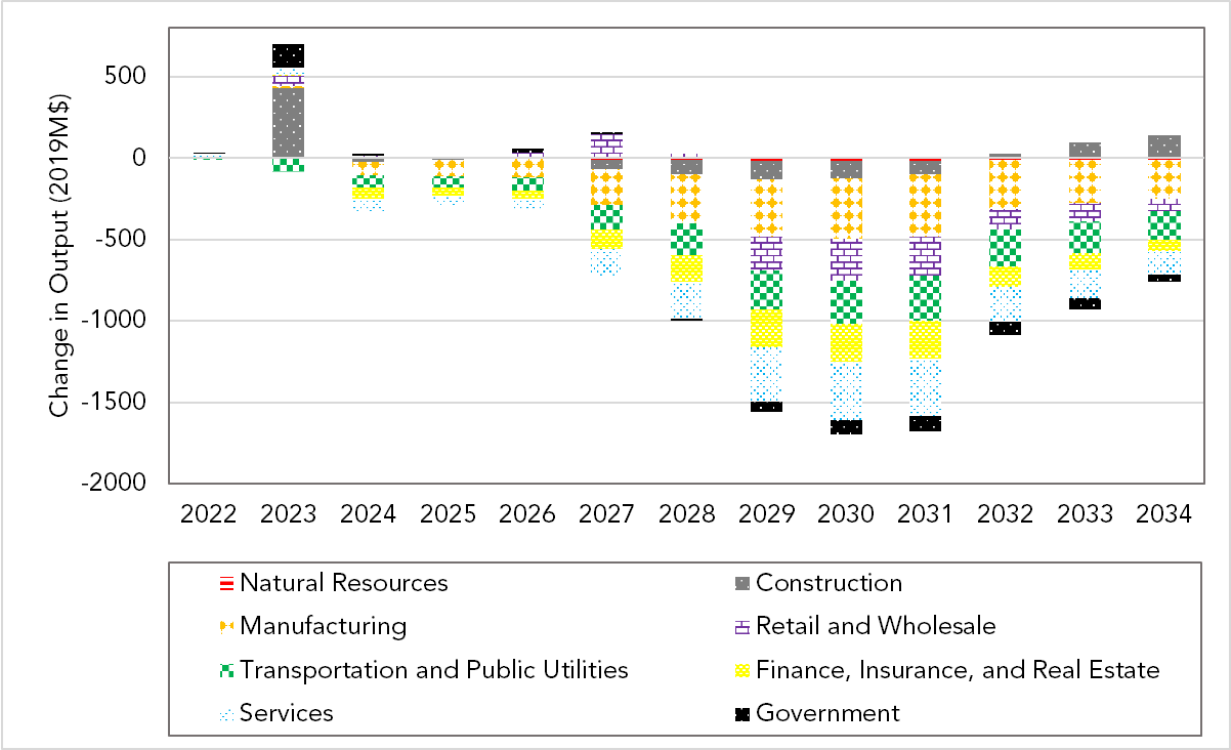


Figure F5 illustrates the changes in output by major sector associated with Alternative 1. The trends in output are similar to the trends that were observed for employment. Alternative 1 is estimated to result in increases in California output in 2023, primarily due to demand in the construction sector, followed by decreases in overall output from 2024 to 2034. The slight increase in overall output in 2027 results from the Baseline full compliance assumption that caused significant turnover in 2020 to force compliance with the TRU ATCM. This leads to a surge in demand for new equipment in 2027. See Section A.6 for more information.

Figure F5. Changes in Output by Major Sector Associated with Alternative 1



d. Cost-Effectiveness

Cost-effectiveness is a measure of the cost of a regulation per ton of expected emission reduction. There are multiple approaches to calculating cost-effectiveness. Staff calculated the cost-effectiveness of Alternative 1 (in $/weighted ton) using the cost-effectiveness method provided in the Carl Moyer Program Guidelines Appendix C by dividing the cost over a period of time by the weighted emission reductions (in tons per year) over that time period.[216] Table F7 shows the cost-effectiveness for the Proposed Amendments and Alternative 1. Staff estimated that Alternative 1 would be less cost-effective than the Proposed Amendments due to the higher direct costs.

Table F7. Cost-Effectiveness of the Proposed Amendments and Alternative 1

Proposal	Carl Moyer Program Cost-Effectiveness per Weighted Ton
Proposed Amendments	$35,828
Alternative 1	$116,361
Difference in Cost-Effectiveness	$80,533

e. Reason for Rejecting

Although Alternative 1 achieves greater emissions benefits in the early years of implementation, staff rejected Alternative 1 because it does not meet the directive of

[216] California Air Resources Board, Carl Moyer Program Guidelines, Appendix C, April 27, 2017. (web link: https://ww2.arb.ca.gov/sites/default/files/classic/msprog/moyer/guidelines/2017/2017_cmpgl.pdf)

EO N-79-20 to transition off-road vehicles and equipment operations in the State to zero-emission by 2035. In addition to the zero-emission truck TRU requirements in the Proposed Amendments, staff intend to pursue an additional rulemaking to transition the remaining TRU categories to zero-emission per the EO. Alternative 1 would impose significant costs on the TRU industry only to be subject to additional zero-emission requirements in the near future. Stakeholders have also expressed concern regarding the feasibility of the zero-emission operation while stationary requirement included in Alternative 1 because TRUs and the facilities where they operate are often not under the same ownership. There is not currently a standardized plug for electric-standby or hybrid-electric TRUs that would be used to comply with the zero-emission operation requirement. Without plug standardization, it would be difficult to ensure compatibility between TRUs and facility infrastructure owned by different entities.

2. Alternative 2

Alternative 2 is a less stringent requirement for truck TRUs operating in California. Under this alternative, all newly manufactured truck TRU, trailer TRU, DSC TRU, railcar TRU, and TRU generator set engines would be required to meet a PM emission standard. In contrast to the Proposed Amendments, Alternative 2 does not include a requirement for truck TRUs to transition to zero-emission technology. Requirements for registration, reporting, and fees would remain unchanged from the Proposed Amendments. Key elements of Alternative 2 include the following:

By December 31, 2022:

- All newly manufactured truck TRUs, trailer TRUs, and DSC TRUs that operate in California shall use refrigerant with a GWP less than or equal to 2,200, or use no refrigerant at all (same as Proposed Amendments).
- MY 2023 and newer TRU engines shall meet a PM performance standard of 0.02 g/hp-hr (less stringent than Proposed Amendments).

This alternative aligns with proposals from stakeholders advocating for elimination of zero-emission requirements.

a. Costs

Under Alternative 2, the total direct cost to TRU owners is the summation of the cost of TRUs equipped with engines certified to meet the PM emission standard, lower GWP refrigerant, CARB fees, and administrative costs for registration and reporting. A truck TRU with an engine that meets a 0.02 g/hp-hr PM emission standard is not currently available since all commercially available truck TRUs are under 25 horsepower. Therefore, staff estimated the incremental cost of a truck TRU by assuming the same cost ratio for a less than 25 horsepower trailer TRU to a greater than 25 horsepower trailer TRU would apply to truck TRUs. Staff used the cost estimates for trailer TRUs, DSC TRUs, railcar TRUs, and TRU generator sets equipped with an engine that meets the PM emission standard discussed in Section C.1.d.iii and

refrigerant costs discussed in Section C.1.d.iv. Table F8 shows the incremental costs associated with Alternative 2.

Table F8. Capital Costs for Alternative 2 (2019$)

	Baseline Cost	Proposed Cost	Incremental Cost
Diesel Truck TRU	$18,600	$20,860	$2,260
Diesel Trailer TRU/DSC TRU/Railcar TRU	$25,450	$28,540	$3,090
TRU Generator Set	$17,260	$19,900	$2,640

From 2022 to 2034, Alternative 2 is estimated to cost $919.7 million compared to the Baseline versus $1.03 billion for the Proposed Amendments compared to the Baseline. Alternative 2 would not require the purchase of zero-emission truck TRUs or supporting infrastructure. This would result in lower costs to California compared to the Proposed Amendments. Table F9 shows the total direct costs for Alternative 2.

Table F9. Total Projected Net Costs for Alternative 2 from 2022 to 2034 (2019$)

Year	Equipment Capital Costs	Equipment Maintenance Costs	Administrative Costs	Total
2022	$0	$0	$0	$0
2023	$12,900,000	$900,000	$10,800,000	$24,600,000
2024	$24,300,000	$1,400,000	$4,300,000	$30,000,000
2025	$37,900,000	$1,800,000	$4,300,000	$44,000,000
2026	$53,100,000	$2,200,000	$11,000,000	$66,300,000
2027	$80,400,000	$2,700,000	$5,900,000	$89,000,000
2028	$83,500,000	$3,500,000	$6,800,000	$93,800,000
2029	$87,500,000	$3,900,000	$8,200,000	$99,600,000
2030	$89,600,000	$4,000,000	$7,100,000	$100,700,000
2031	$89,600,000	$4,100,000	$8,100,000	$101,700,000
2032	$76,700,000	$4,100,000	$7,600,000	$88,500,000
2033	$77,300,000	$4,200,000	$7,400,000	$88,900,000
2034	$79,900,000	$4,300,000	$8,600,000	$92,700,000
Total	$792,700,000	$37,000,000	$90,000,000	$919,700,000

b. Benefits

Staff developed emission reduction estimates for Alternative 2 according to the methodology described in Chapter B.1.a. Alternative 2 would result in fewer emission reductions than the Proposed Amendments, and would not achieve any NOx emission reductions compared to the Baseline. Figure F6, Figure F7, and Figure F8 show the PM2.5, NOx, and GHG emissions under the Baseline, Proposed Amendments, and Alternative 2.

Figure F6. Projected PM2.5 Emissions under the Baseline, Proposed Amendments, and Alternative 2

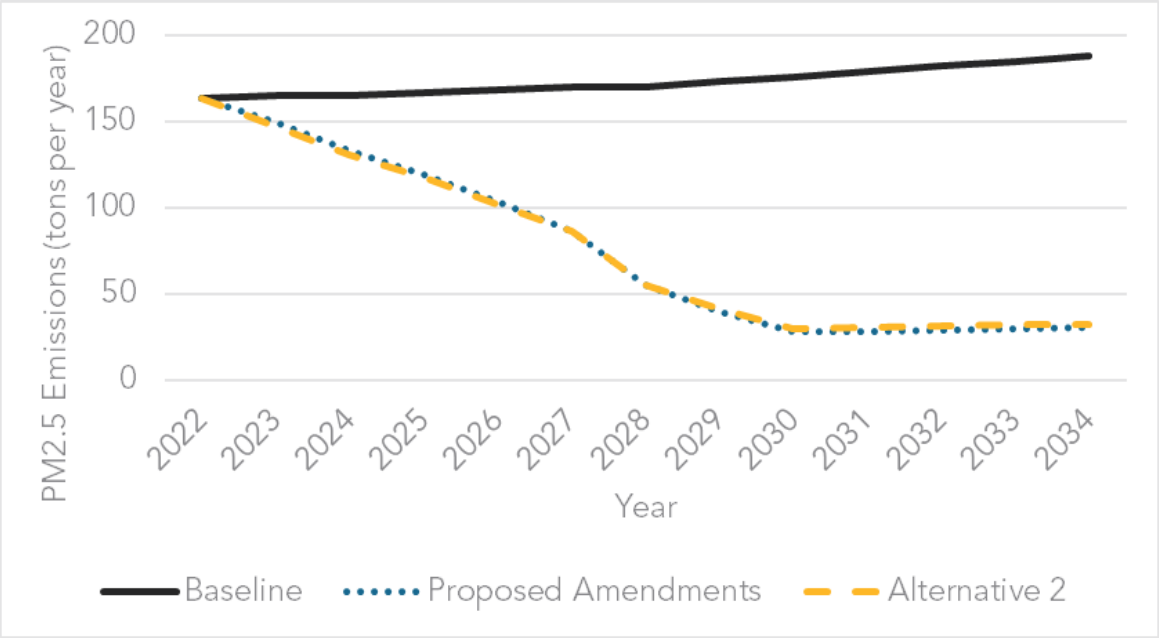


Figure F7. Projected NOx Emissions under the Baseline, Proposed Amendments, and Alternative 2

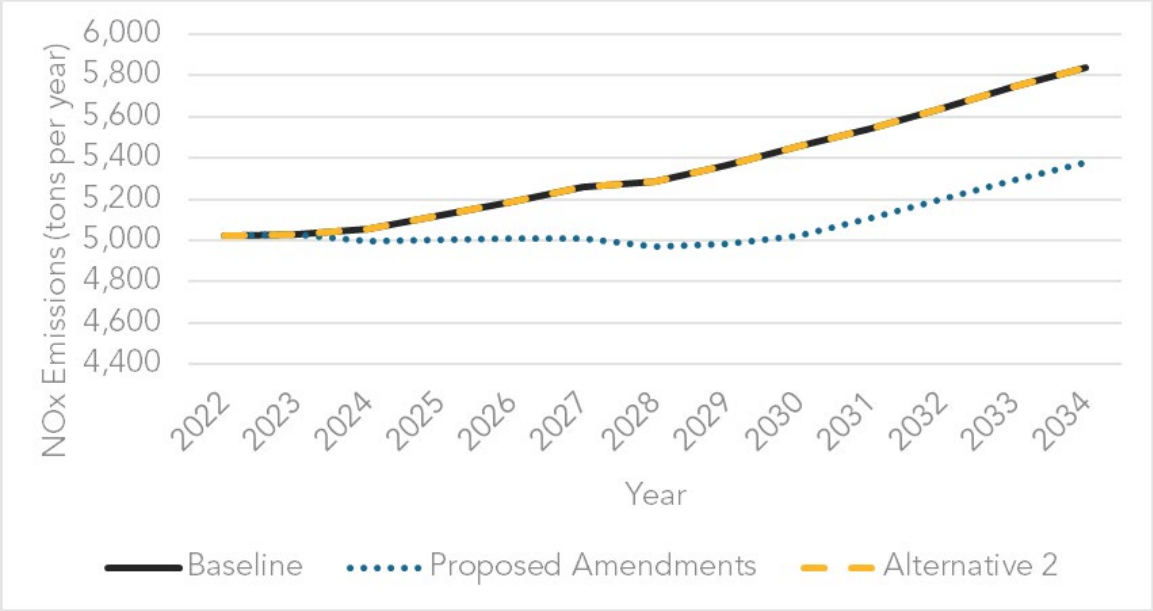
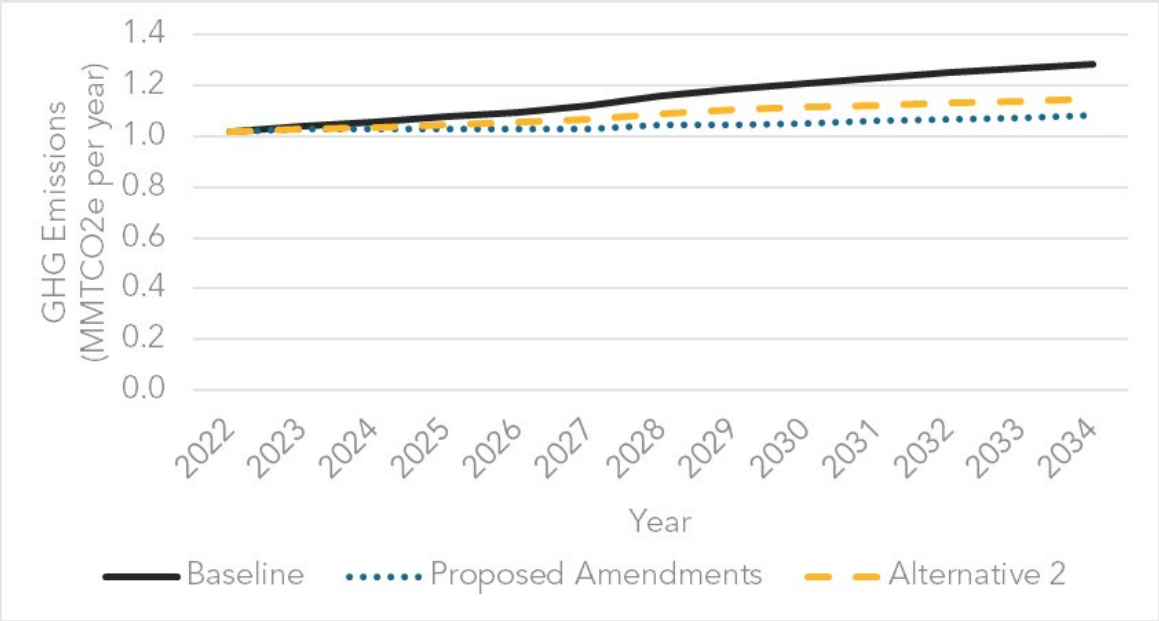


Figure F8. Projected GHG Emissions under the Baseline, Proposed Amendments, and Alternative 2



Staff used the estimation methodologies described in Section B.4.a.ii.2 to quantify avoided cardiopulmonary mortality, hospitalizations for cardiovascular illness and respiratory illness, and emergency room visits for respiratory illness and asthma that would be expected to result from Alternative 2. Staff calculated the health benefits for Alternative 2 using the methodology described in Section B.4.a.ii.3. Table F10 shows the statewide valuation of avoided health outcomes for Alternative 2. Alternative 2 results in a lower valuation of health benefits at $2.56 billion compared to the Proposed Amendments at $4.33 billion (see Table B5).

Table F10. Statewide Valuation of Avoided Health Outcomes for Alternative 2 from 2022 to 2034

Outcome	Avoided Incidents	Valuation
Avoided Premature Deaths	145	$1,434,905,310
Avoided Hospitalizations	46	$2,536,801
Avoided Emergency Room Visits	72	$59,892
Total	468	$1,437,502,003

c. Economic Impacts

Alternative 2 is less stringent compared to the Proposed Amendments, requiring truck TRUs to meet a PM emission standard instead of transitioning to zero-emission technology. As a result, Alternative 2 directly impacts fewer industries and results in lower incremental costs relative to the Proposed Amendments.

The macroeconomic impact analysis results are shown in Table F11. The overall impacts are similar to those under the Proposed Amendments. Unlike the Proposed

Amendments which are estimated to have some positive impacts to output and employment in the early years of the assessment, Alternative 2 is estimated to have slight negative impacts in all years of the assessment. This is because Alternative 2 does not have the same levels of demand for equipment from in-state fleets nor any of the infrastructure investments that would occur to support zero-emission TRUs. Alternative 2 also doesn't have costs subsequent mirrored increases in demand associated with changes diesel fuel and electricity use.

Table F11. Summary of Macroeconomic Impacts of Alternative 2

Economic Indicator	Units	2023	2025	2027	2029	2031	2033
GSP	Percent Change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
GSP	Change (2019M$)	-5	-26	-63	-108	-121	-110
Personal Income	Percent Change	0.00%	0.00%	0.00%	-0.01%	-0.01%	0.00%
Personal Income	Change (2019M$)	-22	-49	-104	-139	-154	-142
Employment	Percent Change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Employment	Change (jobs)	-80	-280	-640	-970	-1,040	-920
Output	Percent Change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Output	Change (2019M$)	-10	-49	-120	-202	-228	-210
Private Investment	Percent Change	0.00%	0.00%	-0.01%	-0.01%	-0.01%	-0.01%
Private Investment	Change (2019M$)	-6	-16	-35	-46	-46	-36

Figure F9 and Figure F10 illustrate the impact of Alternative 2 on employment and output by major sector. Alternative 2 is estimated to have progressively larger impacts to employment and output, relative to the baseline, in all years of the assessment. These impacts closely match the pattern in the overall costs of Alternative 2 which increase overtime.

Figure F9. Changes in Employment by Major Sector Associated with Alternative 2

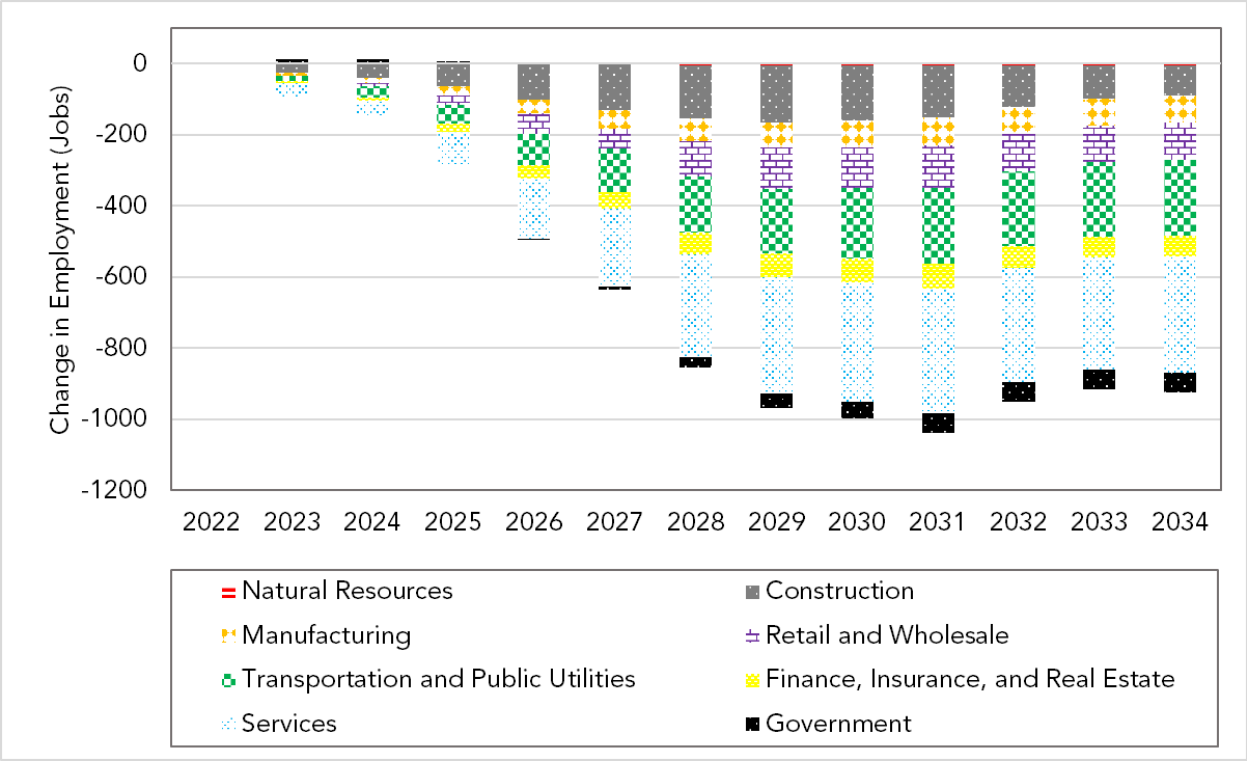
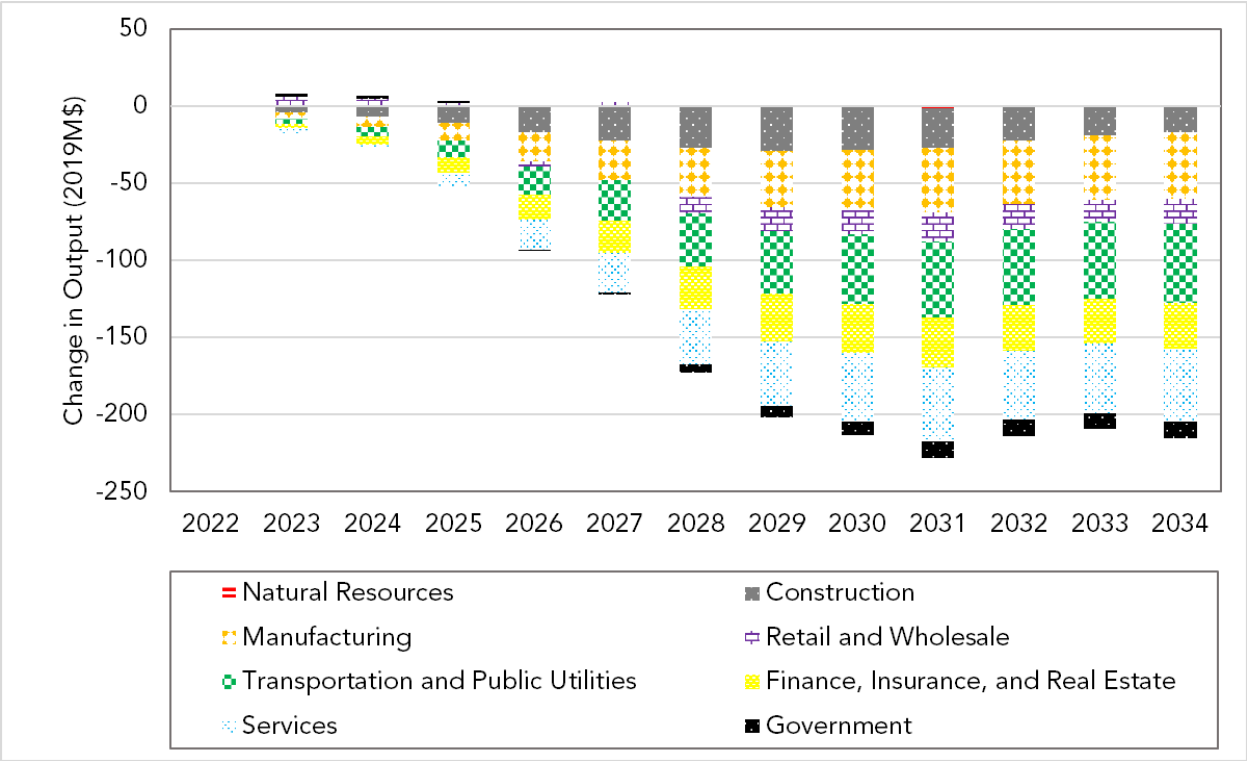


Figure F10. Changes in Output by Major Sector Associated with Alternative 2



d. Cost-Effectiveness

Cost-effectiveness is a measure of the cost of a regulation per ton of expected emission reduction. There are multiple approaches to calculating cost-effectiveness. Staff calculated the cost-effectiveness of Alternative 2 (in $/weighted ton) using the cost-effectiveness method provided in the Carl Moyer Program Guidelines Appendix C by dividing the cost over a period of time by the weighted emission reductions (in tons per year) over that time period.[217] Table F12 shows the cost-effectiveness for the Proposed Amendments and Alternative 2. Staff estimated that Alternative 2 would be slightly less cost-effective than the Proposed Amendments.

Table F12. Cost-Effectiveness of the Proposed Amendments and Alternative 2

Proposal	Carl Moyer Program Cost-Effectiveness per Weighted Ton
Proposed Amendments	$35,828
Alternative 2	$36,683
Difference in Cost-Effectiveness	$855

e. Reason for Rejecting

Staff rejected Alternative 2 because it is less cost-effective and would achieve fewer NOx and GHG reductions than the Proposed Amendments. Alternative 2 would not achieve any NOx reductions compared to the Baseline, which are needed to help meet the federal ambient air quality standards for ozone. Additionally, Alternative 2 does not include a zero-emission requirement for TRUs, failing to meet the directive of EO N-79-20 to achieve 100 percent zero-emission off-road vehicles and equipment by 2035; advance zero-emission TRU market development; and increase installation of electric or fueling infrastructure needed in California to support zero-emission technology.

[217] California Air Resources Board, Carl Moyer Program Guidelines, Appendix C, April 27, 2017. (web link: https://ww2.arb.ca.gov/sites/default/files/classic/msprog/moyer/guidelines/2017/2017_cmpgl.pdf)

Appendix A: Fee Development

This appendix describes California Air Resources Board (CARB or Board) staff's methodology for determining the fee amounts included in the Proposed Amendments.

CARB has historically used existing funds (primarily the Motor Vehicle Account) to implement and enforce the TRU ATCM. On June 27, 2018, California passed SB 854 (Committee on Budget and Fiscal Review, Chapter 51, Statutes of 2018).[218] SB 854 allows CARB to adopt a schedule of fees to cover all or part of CARB's reasonable costs associated with certification, audit, and compliance of off-road or non-vehicular engines and equipment, aftermarket parts, and emission control components sold in the State (limited to activities covered by HSC sections 38560, 43013 and 43018, on-road aftermarket parts under Vehicle Code section 27156(h)). As such, this legislation provides CARB the authority to assess fees to cover its reasonable costs, with specific considerations, on off-road and other mobile source certification and compliance programs not currently covered under the existing fee regulation authority under HSC section 43019. This new authority is housed in HSC section 43019.1. CARB will deposit fees collected into the Certification and Compliance Fund as required under HSC section 43019, used to support mobile source certification and compliance activities.

The Proposed Amendments include TRU operating fees and applicable facility registration fees. The proposed fees will enable the TRU program to be self-sustaining as allowed by SB 854. To develop the fees for the Proposed Amendments, staff determined the reasonable costs for the implementation and enforcement of the Proposed Amendments. Costs include labor and operations. Below is a description of both cost categories.

1. Labor Costs

Total labor costs include both the direct labor to implement TRU program activities (Direct Labor) and overhead costs that include administrative management, legal, and information technology costs to run the agency (Indirect Labor).

a. Direct Labor

The Direct Labor cost includes existing staff in the Transportation and Toxics Division and Enforcement Division, as well as new positions that CARB plans to request in a budget change proposal once the Board adopts the Proposed Amendments. Direct Labor costs include each staff and first level manager that would directly work on TRU program activities. Second level managers or above were not included in the calculation.

The percent time spent on TRU program activities is based on time estimates provided by current TRU program staff. The percent time was summed into a person year (PY)

[218] California Health and Safety Code § 43019.1, Division 26, Senate Bill No. 854, July 27, 2018. (web link: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB854

activity level for each classification. Each staff PY time was multiplied by the 2021 Fiscal Year Labor Budget class cost, which is a mid-range salary for each classification and includes benefits, operating expense, and equipment. Fiscal Year Labor Budget class cost is calculated annually through an administrative process which annualizes the California Department of Human Resources monthly salary by position class, adds an average of 53 percent of the salary cost for benefits, and adds an average of 20 percent of the salary cost for operating expenses and equipment for each class. Each class has its own benefit and operating expenses and equipment determination.

Table App. A-1 and Table App. A-2 show the annual Direct Labor cost for existing and new TRU program staff, respectively. The Direct Labor cost does not reflect the roughly 9.23 percent cut to labor costs across most State bargaining units as a result of negotiations in response to the current economic condition and anticipated impact on the State budget. Most of the agreements are temporary and are anticipated to have minimal impact during the effective dates of the Proposed Amendments.

Table App. A-1. Annual TRU Program Direct Labor Cost – Existing Staff

Classification	PY Time Estimate	2021/2022 FY Cost	Annual Direct Labor Cost
Air Pollution Specialist	0.75	$195,000	$146,250
Air Resources Engineer	0.5	$206,000	$103,000
Air Resources Supervisor I	0.25	$238,000	$59,500
Air Resources Technician II	4.2	$101,000	$424,200
Staff Air Pollution Specialist	0.25	$220,000	$55,000
Total	5.95	n/a	$787,950

Table App. A-2. Annual TRU Program Direct Labor Cost – New Staff

Classification	PY Time Estimate	2021/2022 FY Cost	Annual Direct Labor Cost
Air Pollution Specialist	3.0	$195,000	$585,000
Air Resources Technician I	8.0	$85,000	$680,000
Air Resources Technician II	2.0	$101,000	$202,000
Staff Services Manager I	1.0	$167,000	$167,000
Total	14.0	n/a	$1,634,000

b. Indirect Labor

Indirect Labor includes the management, administrative, legal, and information technology costs to run the agency. The Indirect Labor percentage was calculated directly for the agency using Division, Executive Office, and Chair Office management, Administrative Services Division, Legal Office, and information technology services staffing divided by the total agency labor force. The Indirect Labor percentage was calculated as 26 percent of the Direct Labor cost for CARB.

c. Total Labor Cost

Table App. A-3 shows the total annual labor cost for the TRU program.

Table App. A-3. Total Annual TRU Program Labor Cost

Annual Direct Labor Cost	Annual Indirect Labor Cost	Total Annual Labor Cost
$2,421,950	$629,707	$3,051,657

2. Operational Costs

Operational Costs are the direct costs to conduct program activity. As shown in Table App. A-4, this includes compliance labels, envelopes, and postage.

Table App. A-4. TRU Program Operational Costs

Item	Quantity Purchased Per Year	Estimated Cost Per Item	Operational Cost
Compliance Label (two per TRU)	162, 402	$2.50	$415,827
Envelope	81,201	$0.07	$5,822
Postage	81,201	$0.62	$51,563
Total	n/a	n/a	$473,211

3. Fee Calculation

CARB staff calculated the fee amounts based on TRU populations from the statewide TRU inventory[219] and applicable facility populations from the Applicable Facility Inventory.[220] Based on the TRU and applicable facility populations, staff determined the average annual number of TRUs and applicable facilities that would be expected to pay fees over a ten year period beginning in 2023 if the fees were collected every three years. The ten-year period was used to reflect the average useful life of a TRU. Staff also applied a 12 percent non-compliance rate, which is based on the average of non-reporting assumed in the statewide TRU inventory (3.75 percent) and the percentage of citations issued by CARB's Enforcement Division for non-reporting violations in 2019 (21 percent).[221] Table App. A-5 shows the cost per TRU or applicable facility and zero-emission TRU, respectively.

[219] California Air Resources Board, Draft 2019 Update to Emissions Inventory for Transport Refrigeration Units, October 2019. (web link: https://ww3.arb.ca.gov/cc/cold-storage/documents/hra_emissioninventory2019.pdf)
[220] California Air Resources Board, Transport Refrigeration Unit Applicable Facility Inventory, February 2020.
[221] California Air Resources Board, 2019 Annual Enforcement Report, June 2020. (web link: https://ww2.arb.ca.gov/sites/default/files/2020-06/2019_Annual_Enforcement_Report.pdf)

Table App. A-5. Cost per TRU or Applicable Facility (to be Collected Every 3 Years)

Total Annual TRU Program Cost	Average Annual Number of TRUs/Applicable Facilities Subject to Fees	Average Annual Number of Zero-Emission TRUs Subject to Fees	Cost per TRU/Applicable Facility (every 3 years)	Cost per Zero-Emission TRU (every 3 years)
$3,524,868	81,201	1,965	$43	$22

The fee calculation is based on estimated population numbers and compliance rates. Staff may amend the fee amounts in a future rulemaking if collected fees do not fully cover CARB's costs for activities associated with the TRU program.

Appendix B: Macroeconomic Modeling Inputs

Table App. B-1 presents the specific inputs used in the REMI modeling for the Proposed Regulation. Staff adjusted costs from 2019 to 2018 dollars when input into the REMI model.

Table App. B-1. REMI Inputs

REMI Policy Variable	Industry	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Production Cost	Truck Transportation (484)	0.00	25.75	35.72	51.34	80.49	102.77	106.74	103.89	93.74	77.52	56.21	44.54	40.09
Production Cost	Water Transportation (483)	0.00	2.92	2.60	4.20	7.66	12.11	13.33	14.51	14.71	14.33	10.53	10.24	11.00
Production Cost	Rail Transportation (482)	0.00	0.41	0.56	0.97	1.79	2.46	2.73	2.88	2.85	2.55	2.20	2.17	2.05
Production Cost	Scenic And Sightseeing Transportation And Support Activities For Transportation (487, 488)	0.00	0.00	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.09
Production Cost	Warehousing And Storage (493)	0.00	0.21	2.35	2.39	2.52	2.46	2.50	2.65	2.58	2.62	2.78	2.71	2.75
Production Cost	Retail Trade (44-45)	0.00	0.37	0.55	0.56	0.75	0.58	0.59	0.79	0.61	0.62	0.83	0.64	0.65
Production Cost	Wholesale Trade (42)	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Exogenous Final Demand	Wholesale Trade (42)	0.00	31.22	41.84	31.92	63.40	47.26	37.13	16.50	-13.11	-13.69	-14.20	-14.51	-13.23
Exogenous Final Demand	Petroleum And Coal Products Manufacturing (324)	0.00	0.00	-1.66	-3.71	-5.44	-7.96	-10.03	-11.72	-12.71	-12.87	-13.17	-13.60	-13.93

REMI Policy Variable	Industry	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Exogenous Final Demand	Electric Power Generation, Transmission, And Distribution (2211)	0.00	0.00	2.38	5.54	8.33	12.69	16.53	20.16	22.68	23.47	23.82	24.17	24.59
Exogenous Final Demand	Construction (23)	0.00	3.60	4.56	3.85	6.00	5.01	4.57	2.88	0.49	0.50	0.50	0.51	0.52
Exogenous Final Demand	Other Electrical Equipment And Component Manufacturing (3359)	0.00	0.96	1.38	1.41	2.17	2.19	2.32	2.09	1.59	1.61	1.64	1.67	1.69
Exogenous Final Demand	Management, Scientific, And Technical Consulting Services (5416)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Exogenous Final Demand	Office Administrative Services, Facilities Support Services (5611, 5612)	0.00	0.32	3.01	3.05	3.10	3.15	3.20	3.25	3.31	3.36	3.41	3.47	3.52
State And Local Government Spending	State Government Spending	0.00	1.35	1.50	0.71	1.69	0.54	-0.27	-1.50	-2.96	-3.02	-3.08	-3.14	-3.14
State And Local Government Spending	Local Government Spending	0.00	1.59	2.14	1.70	3.27	2.57	2.16	1.22	-0.18	-0.18	-0.20	-0.22	-0.16
State And Local Government Employment	State Government Employment	0.00	7.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00

REMI Policy Variable	Industry	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Consumer Spending	Reallocate Consumption: Hospitals	0.00	-0.03	-0.06	-0.10	-0.14	-0.19	-0.26	-0.32	-0.36	-0.38	-0.39	-0.41	-0.43