California Zero-Emission Equipment Research Projects, Financial Programs, and Regulatory Actions List Fact Sheet

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CALIFORNIA
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Contents

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Introduction

Off-road equipment electrification is not solely driven by technological progress; it is also shaped significantly by the comprehensive policy framework in place. While technological innovations pave the way for these advancements, the state's diverse policy tools play a pivotal role. It's important to note that the introduction of new technology-enabled equipment often entails higher costs compared to conventional counterparts. Decision-making for new equipment adoption involves a complex consideration of factors such as the cost premium, payoff period, available incentive or credit programs, infrastructure expenses, energy efficiency gains, charging times, access to public charging infrastructure, and more.

In the midst of these multifaceted interests, this document serves as a guide to CARB's array of zero-emission equipment-related research projects, financial aid programs, and regulatory actions. These aspects are indispensable components in achieving the ambitious goals set forth by Executive Order N-79-20. By combining technological innovation with robust policy initiatives, the state is better positioned to realize a sustainable and thriving off-road equipment (ORE) sector that aligns with California's commitment to environmental stewardship and improved air quality.

California Policy Drivers

The California policy drivers empower the clean air agencies to shape both regulatory actions and financial assistance programs. Particularly, the presented Senate and Assembly Bills and Executive Orders directed to create the California air quality improvement strategies and regulations. These directives have spurred the commitment of CARB and other clean air agencies to reduce criteria pollutants and greenhouse gas (GHG) emissions.
Numerous air quality improvement plans and regulations have already begun to reshape the composition of the equipment fleet, supporting transitions across diverse sectors and varying horsepower ranges. The policy drivers outlined herein not only foster the momentum toward electrification within off-road sectors but also lay down the essential foundations for the state's electrification strategies and their subsequent implementation. This dynamic interplay between policy and industry is instrumental in forging a cleaner and more sustainable future for California's off-road equipment landscape.

Table 1. California Policy Drivers

California Policy	Goals and Requirements
Senate Bill 1389 (2002)	SB 1389 requires the CEC to prepare the Integrated Energy Policy Report (IEPR) biennially. The report presents CEC's integrated assessment results about the state's energy issue and provides policy recommendations to conserve resources, facilitate a sustainable energy supply chain, and protect the environment.
Assembly Bill 32 (2006)	AB 32, or the Global Warming Solutions Act of 2006, requires California to reduce GHG emissions to 1990 levels by 2020. AB32 directs CARB to adopt regulations to achieve the maximum technologically feasible and cost-effective GHG emission reductions. The Low Carbon Fuel Standard (LCFS) program was one of CARB's nine discrete early action measures to reduce California's greenhouse gas (GHG) emissions that cause climate change.

California Policy	Goals and Requirements
Senate Bill 350 (2015)	The Clean Energy and Pollution Reduction Act (SB 350) requires the California Energy Commission (CEC) to establish annual targets statewide, including reduction of GHG emissions to 40 percent below 1990 levels by 2030 and to 80 percent below 1990 levels by 2050.
Senate Bill 32 (2016)	SB 32 mandates the reduction of greenhouse gas (GHG) emissions to 40% below 1990 levels by 2030. CARB is responsible for ensuring that California meets this goal. This air quality agency publishes an Update to the Scoping Plan every five years, detailing how CARB plans to meet emission reduction targets.
Assembly Bill 617 (2017)	CARB's Community Air Protection Program aims to reduce exposure in communities highly impacted by air pollution in response to AB 617. The state agencies and local air districts are collaborating on various efforts to implement innovative air quality improvement strategies and reduce health impacts.
Senate Bill 100 (2018)	SB 100 mandates the state to achieve 100% renewable and carbon-free electricity by 2045 and 60% renewable electricity by 2030.
Assembly Bill 3232 (2018)	AB 3232 requires the CEC to assess the potential to reduce the emissions of GHG emissions from residential and commercial buildings by at least 40 percent below 1990 levels by 2030.
Executive Order B-55-18 (2018)	EO B-55-18 sets a goal for the entire California economy to achieve carbon neutrality by 2045 and achieve and maintain net harmful emissions thereafter.
Executive Order N-79-20 (2020)	EO N-79-20 aims to achieve 100% zero-emission vehicles (ZEV) for passenger cars, light-duty trucks, and drayage vehicles by 2035 and medium and heavy-duty vehicles by 2045. More importantly, it directs CARB to develop and propose "strategies, in coordination with other State agencies, U.S. EPA and local air districts, to achieve 100 percent zero-emission from off-road vehicles and equipment operations in the State by 2035".
Senate Bill 44 (2021)	SB 44 recognizes California's continuous efforts needed to reduce on- and off-road sector emissions and requires CARB to update the Mobile Source Strategy (MSS) every five years. MSS will be translated into State Implementation Plans (SIP), demonstrating how the state will attain the standards by specified dates. It is also incorporated into Climate Change Scoping Plan and Community Emissions Reduction Plans (CERPs).

ZEE-related Air Quality Improvement Measure Regulations in California

Table 2. California Air Quality Improvement Strategies, Programs, and Regulations

Regulations and Programs	Description (Goals and Requirements)
Heavy-Duty Three-Year Plan of Low Carbon Transportation Investments and Air	This long-term investment plan is a funding roadmap for the heavy-duty vehicle and equipment sectors. It provides a total of $3.9 billion to multiple State agencies for the three fiscal years to accelerate ZEV sales and ZEV infrastructure network expansion. $2.3 billion is allocated to

Regulations and Programs	Description (Goals and Requirements)
Quality Improvement Program	CARB, and it will support numerous air quality and climate goals and provide benefits to disadvantaged communities.
Low Carbon Fuel Standard (LCFS) and LCFS Electricity and Hydrogen Provisions	The LCFS Program is a critical component of CARB's efforts to reduce life cycle GHG emissions and other smog-forming and toxic air pollutants. It aims to decrease the carbon intensity of California's transportation fuel inventory and promote the use of renewable energy and low-carbon fuel types. The LCFS Electricity and Hydrogen Provisions grant incentives to entities using hydrogen or electricity as a transportation fuel. Using hydrogen to produce other transportation fuel is also eligible for LCFS credits.
2022 Scoping plan	California Global Warming Solutions Act, Assembly Bill 32 (AB 32), created a GHG emissions reduction program in 2006. Based on the identified advanced clean technologies available, this multi-year program offers a comprehensive climate change scoping plan targeting GHGs reduction by at least 40 percent below 1990 levels by 2030 and achieving carbon neutrality by 2045. CARB updates the plan every five years, and the 2022 Scoping Plan is the third version of the roadmap for the State of California's efforts to reduce emissions and build resilient communities.
California Clean Off-Road Equipment Voucher Incentive Project - Construction (CORE-Con)	The Clean Off-Road Equipment Voucher Incentive Project (CORE) is a first-come, first-served voucher program for off-road equipment that began funding equipment in 2020. It is part of California Climate Investments, a statewide initiative allocating billions of Cap-and-Trade dollars to 1) reduce criteria pollutants and greenhouse gas emissions, 2) strengthen the economy, and 3) improve public health and the environment. CORE-Con has been built upon the CORE program and aims to promote the deployment of zero-emission technology in the off-road sector, including various construction, mining, and other equipment types. CORE voucher amounts are tailored by the cost premium of new zero-emission alternatives over traditional equipment. Additional funding is available for charging infrastructure and equipment deployed in pollution-overburdened and low-income AB 1550 communities.
Funding Agricultural Replacement Measures for Emission Reductions (FARMER)	The Funding Agricultural Replacement Measures for Emission Reductions (FARMER) program aims to reduce agricultural sector emissions by providing grants, rebates, and other financial incentives for various agricultural equipment and has successfully funded the adoption of electric utility task vehicles (UTVs).
Carl Moyer Memorial Air Quality Standards Attainment Program	The Carl Moyer Memorial Air Quality Standards Attainment Program (Carl Moyer Program) has granted approximately $1 billion in monetary incentives to replace older polluting engines in California. The program aims to reduce emissions from heavy-duty on-road and off-road equipment that qualify for Moyer grants. Thirty-five local air districts in California are currently participating. The program covers a variety of vehicle and equipment types, such as on-

Regulations and Programs	Description (Goals and Requirements)
	road trucks over 14,000 lbs. gross vehicle weight, construction, marine vessels, locomotives, stationary agricultural equipment, forklifts, light-duty vehicles, airport ground support equipment, lawn and garden equipment, and emergency vehicles.
Community Air Protection Incentives	As of May 2022, 964 million dollars of Community Air Protection Incentives have been spent on the California communities most heavily impacted by disproportionate levels of air pollution since 2017. AB 617 directs local air districts spend funds through the two existing mobile source incentive programs, The Carl Moyer Memorial Air Quality Standards Attainment Program and the Proposition 1B Goods Movement Emission Reduction Program. Additional guidelines are that at least 70 percent of the funds must be spent on projects within and benefiting disadvantaged communities, and at least 80 percent of funds must be spent on projects within and benefiting a combination of disadvantaged and low-income communities.

ZEE-related Research Projects and Upcoming Datasets from Ongoing Activity Data Collection Programs

This chapter introduces relevant research projects overseen by CARB and discusses the research opportunity with the upcoming data survey deliverables from a variety of ORE types. The obtained activity profiles will help numerous researchers understand activity patterns and capture emission characteristics of various ORE types.
Corresponding to the manufacturers' effort to develop clean air equipment applications, CARB has been conducting various zero-emission (ZE) equipment-related research projects and established research and funding plans to help industry and research institutes.[1]

Hybridization and Full Electrification Potential in Off-Road Applications (Contract Number: 18RD016)

California aims to significantly reduce greenhouse gas (GHG) emissions using regulatory measures and incentives across sectors. Considering its significant contribution to GHG and criteria pollutant emissions, the off-road sector is a critical target of air quality improvement policies. The complexity of off-road equipment applications, engine sizes, and configurations presents challenges in understanding their operations, energy requirements, and duty cycles. Moreover, variations in engine and equipment manufacturers, particularly among smaller businesses, can create significant impacts from new emission regulations. To design effective regulations or incentives for a cleaner off-road sector, a comprehensive study is required to assess the feasibility of electrifying off-road equipment. This project aims to explore hybridization and electrification potential in off-road

1 Fiscal Year 2022-23 Three-Year Recommendations for Low Carbon Transportation Investments Appendix D: Long-Term Heavy-Duty Investment Strategy *https://ww2.arb.ca.gov/sites/default/files/2022-10/fy2022_23_funding_plan_appendix_d.pdf*

equipment while ensuring technical and economic viability. The study focuses on off-road equipment used in construction and agriculture.

Activity Data of Off-Road Engines in Construction (Contract Number: 17RD013)

This project aims to collect in-use engine activity data from various ORE types and assess and characterize the operating patterns of the ORE engines. The obtained real-world data includes engine control unit (ECU) parameters related to the internal combustion engine's performance and air pollution control devices. For the given project period, the research team collected data from 54 pieces of construction equipment with nine different equipment types. The obtained data can be used to 1) estimate load factor (%) and improve the emission inventory, 2) identify operational and environmental characteristics of various off-road equipment types, and 3) assess the energy demand required and project electrification potential per type.

Collection and Analysis of Agricultural Equipment Activity Data (Contract Number: 19RD002)

This research project will collect engine and after-treatment system performance data from up to 200 agriculture tractors' Engine Control Unit (ECU). The project will characterize how agricultural engines in the San Joaquin Valley operate under actual working conditions, including their activity parameters (e.g., engine speed, torque, and fuel rate) and maintenance frequency, crop and land types of agricultural operation performed, hours of operation, and cost. The results can be used to improve the emission inventories and to inform policies and incentive programs for off-road engines and equipment.

Full Cost Analysis and Business Case Study of Off-Road Zero-Emission Equipment (Contract Number: 21MSC006)

The goals of this project are 1) performing a full cost analysis of battery-electric and fuel cell technology in the ground off-road equipment sector and 2) analyzing the 175 horsepower under business case for manufacturers and operators of ZE ORE. The research team will estimate equipment production potential for each equipment type based on various measures, such as the performance of the ZE powertrain compared to the diesel counterparts, operational changes, availability of component suppliers, maintenance/fuel cost, etc.