



## **2023 Implementation Review: 2021 Amendments to the Small Off-Road Engine Regulations**



**August 30, 2024**

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## Acronyms

ABT – Averaging, banking, and trading

AGZA – American Green Zone Alliance

CARB or Board – California Air Resources Board

Carl Moyer – Carl Moyer Memorial Air Quality Standards Attainment Program

CO – Carbon monoxide

CORE – Clean Off-Road Equipment Voucher Incentive Project

CSUF – California State University, Fullerton

FAQ – Frequently asked questions

HC – Hydrocarbon

LSI – Large spark-ignition

NO – Nitrogen monoxide

NO<sub>2</sub> – Nitrogen dioxide

NO<sub>x</sub> – Oxides of nitrogen

PM – Particulate matter

ROG – Reactive organic gas

SORE – Small off-road engine

U.S. EPA – United States Environmental Protection Agency

ZEE – Zero-emission equipment

## Units of Measure

cc – cubic centimeters

kW – kilowatt

kWh – kilowatt hour

psi – pound per square inch

tpd – tons per day

V – volt

W – watt

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## Executive Summary

The California Air Resources Board (CARB or Board) adopted amendments to the small off-road engine (SORE) regulations in 2021 (2021 Amendments) to achieve emission reductions from SORE. The Board directed staff to annually review the status of implementation and to conduct a technology review in the 2025 to 2026 timeframe to assess the progress towards the model year 2028 zero-emission standards for pressure washers and portable generators. This document is the first implementation review.

The 2021 Amendments went into effect January 1, 2023, and the new emission standards start with model year 2024. Zero-emission standards are set in two phases. The emission standards starting with model year 2024 are zero for most SORE and more stringent for larger pressure washers and portable generators. The second phase includes zero-emission standards for pressure washers and portable generators beginning with model year 2028.

This 2023 implementation review covers outreach and compliance assistance, incentives, engine and evaporative family certification, emission reduction credit programs, compliance testing, survey of equipment population and utilization, and zero-emission equipment (ZEE) market growth.

Section 209(e) of the Clean Air Act mandates that while California may set emission standards for SORE, they require authorization by the U.S. EPA before they may be enforced. CARB submitted its request on December 20, 2022, and is waiting on U.S. EPA's decision. These amendments will provide \$8.77 billion of health benefits to Californians through 2043 upon U.S. EPA granting authorization in a timely manner.

Below are some highlights of the review:

- The appetite for commercial ZEE among landscapers is strong, as demonstrated by the expenditure of \$30 million of incentive funding in less than one year through the Clean Off-Road Equipment Voucher Incentive Project (CORE) Professional Landscaping program.
- CARB has issued 26 Executive Orders for pressure washers and portable generators meeting the more stringent emission standards for model year 2024.
- In the absence of U.S. EPA authorization, some manufacturers have elected to certify to the currently authorized model year 2023 standards with Limited Term Executive Orders. CARB has issued 54 Limited Term Executive Orders.<sup>1</sup>
- Voluntary emission reduction credit programs encourage manufacturers to produce cleaner equipment. However, very few manufacturers are using such credits to

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<sup>1</sup> California Air Resources Board. *"New Vehicle and Engine Certification: Executive Orders for Off-Road Spark-Ignited Engines and Equipment."* 2024. <https://ww2.arb.ca.gov/new-vehicle-and-engine-certification-executive-orders-road-spark-ignited-engines-and-equipment>

certify engines that emit above the standards.

- The markets for ZEE have greatly increased. For example, in 2022, residential ZEE shipped to the U.S. reached a new peak, approximately 60% of the market share.
- Landscapers continue to have concerns about the high upfront cost of ZEE, and staff agree that more incentives for professional landscapers are needed to encourage initial purchases, thereby allowing CARB to begin meeting emission reduction goals while awaiting U.S. EPA authorization.

Implementation of the 2021 Amendments has been a success through 2023. More information about these topics is provided throughout the report, and further details and background may be found in the appendices.

## Introduction

This document was prepared by CARB staff to review the status of the implementation of amendments to the SORE regulations approved by the Board for adoption in December 2021. The 2021 Amendments will provide \$8.77 billion of health benefits to Californians, when fully implemented. The Board directed staff in [Resolution 21-28](#) to “review annually the status of the implementation of the proposed amendments and to conduct a technological review in the 2025 to 2026 timeframe to assess the progress towards the [model year (MY)] 2028 zero-emission standards for portable generators and any other engine or equipment category that may be newly subject to the model year 2028 zero-emission standards.”<sup>2</sup> The 2021 Amendments were approved by the Office of Administrative Law on September 14, 2022, and became effective January 1, 2023. New emission standards apply starting with model year 2024. This is the first annual implementation review that covers the status of the 2021 Amendments now in effect. Staff will conduct a technological review, separately from this, and other annual implementation reviews, to assess the progress towards the model year 2028 zero-emission standards for pressure washers with engine displacement greater than or equal to 225 cubic centimeters (cc) and portable generators in the 2025 to 2026 timeframe.

## Background

### SORE Category

SORE are spark-ignition engines rated at or below 19 kilowatts (25.5 horsepower), that are not used to propel a licensed on-road motor vehicle, an off-road motorcycle, an all-terrain vehicle, a marine vessel, a snowmobile, a model airplane, a model car, or a model boat.<sup>3</sup> Typical examples of equipment using SORE are leaf blowers, small chainsaws, string trimmers, lawn mowers, and portable generators, as shown below in Figure 1.

Some small engines are not subject to the SORE regulations. The federal Clean Air Act, section 209(e)(1), preempts state emission standards for new engines used primarily in construction equipment or vehicles or used primarily in farm equipment or vehicles that are smaller than 175 horsepower from CARB regulation of emission standards. Approximately 11% of small off-road equipment in California may fall into these categories.<sup>4</sup> Equipment with diesel-fueled engines, stationary equipment and equipment with large spark-ignition (LSI) engines with displacement greater than one liter are not subject to SORE regulations. Displacement is the total swept volume of all the cylinders in an engine (usually expressed in cubic centimeters or liters) and is an expression of an

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<sup>2</sup> California Air Resources Board. “[Proposed Amendments to the Small Off-Road Engine Regulations: Transition to Zero Emissions, Resolution 21-28.](#)” 2021. <https://ww2.arb.ca.gov/sites/default/files/barcu/board/res/2021/res21-28.pdf>

<sup>3</sup> Cal. Code Regs., tit. 13, sec. 2401(a)(45).

<sup>4</sup> California Air Resources Board, “[2020 Emissions Model for Small Off-Road Engines – SORE2020.](#)” 2020. [https://ww2.arb.ca.gov/sites/default/files/2020-09/SORE2020\\_Technical\\_Documentation\\_2020\\_09\\_09\\_Final\\_Cleaned\\_ADA.pdf](https://ww2.arb.ca.gov/sites/default/files/2020-09/SORE2020_Technical_Documentation_2020_09_09_Final_Cleaned_ADA.pdf)

engine's size.

Figure 1. Examples of Equipment Using SORE



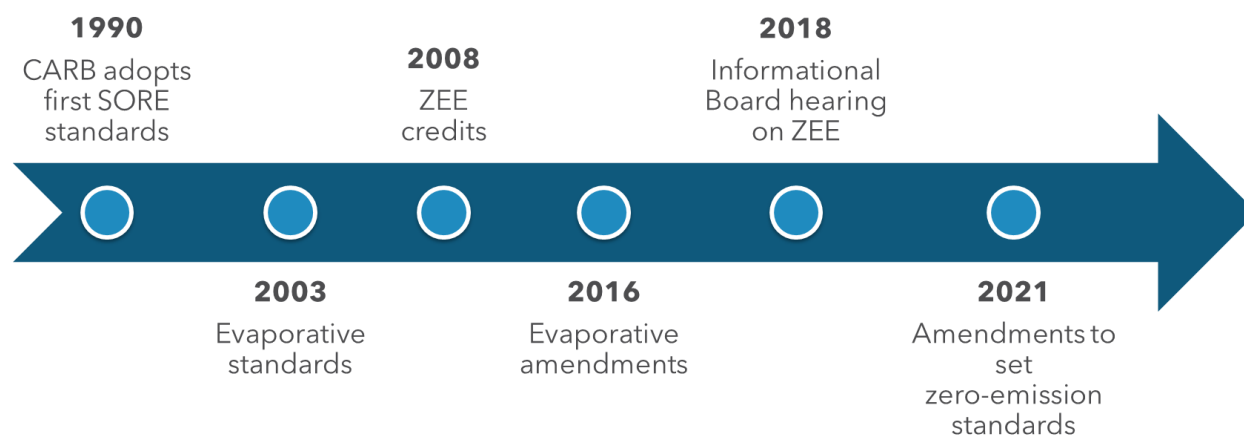
## Regulatory History

CARB regulations have provided smog-forming emission reductions from SORE for nearly 30 years, as shown in Figure 2. CARB was the first to adopt emission regulations for SORE in 1990. CARB adopted further emission standards for SORE, including the first evaporative emission standards in 2003; an emission reduction credit program for professional-level ZEE in 2008 to encourage the market development of ZEE; and amendments to the evaporative emission regulations to increase accountability for manufacturers in 2016. Staff updated the Board in 2018 on zero-emission technologies and potential pathways to 100% ZEE in California before proposing the 2021 Amendments in December 2021 to set zero-emission standards for SORE in two phases to meet expected emission reductions and other statutory mandates.

CARB submitted a request on December 20, 2022, that U.S. EPA grant California authorization to enforce CARB's 2016 as well as the 2021 amendments to the SORE regulations. U.S. EPA held a public hearing on June 27, 2023, and provided a public comment period from May 23, 2023, to July 28, 2023, to consider CARB's request. CARB is waiting on U.S. EPA's decision.

Appendix C specifies additional details regarding SORE regulatory history.

Figure 2. SORE Regulatory History



## Summary of 2021 Amendments

The Board adopted the 2021 Amendments to the SORE regulations to reduce smog-forming emissions in California to help meet our 2016 State Implementation Plan obligations, to meet the goals in Governor’s Executive Order N-79-20, and to comply with the requirements of Assembly Bill 1346 (Berman, Statutes of 2021, Chapter 753).<sup>5</sup> These amendments set SORE emission standards to zero in two phases, as summarized below in Table 1.

Table 1. New Emission Standards

<b>Equipment</b>	<b>Model year 2024-2027</b>	<b>Model year 2028+</b>
<b>Most SORE</b>	Zero	Zero
<b>Pressure washers (≥ 225 cc) and portable generators</b>	More stringent	Zero

Appendices A and B specify the exhaust and evaporative emission standards, respectively, for model year 2024 and subsequent model year engines. The first phase begins in model year 2024, when exhaust and evaporative emission standards for most engines are zero. Emission standards for pressure washer engines with displacement greater than or equal to 225 cc and portable generator engines are more stringent starting in model year 2024. The second phase begins in model year 2028 when all SORE are subject to emission

<sup>5</sup> California Air Resources Board. “2021 – Assembly Bill 1346 (Berman, Marc), Small Off-Road Engines (Chaptered).” 2021. <https://ww2.arb.ca.gov/2021-assembly-bill-1346-berman-marc-small-road-engines-chaptered>

standards of zero after the Board's considers staff technological review in 2025 or 2026.

Appendix D specifies additional details regarding the 2021 Amendments.

## Implementation Review

### Outreach and Compliance Assistance

CARB staff's commitment to engage with stakeholders, landscapers, and residential users of lawn and garden and other small off-road equipment contributes to the success of the 2023 implementation. SORE staff continuously conduct public outreach and provide compliance assistance regarding ZEE, the 2021 Amendments, and requirements in the SORE regulations. To promote ZEE, CARB loans out a trailer of equipment to professional landscapers, called the ZEE Roadshow. Staff assist stakeholders and interested parties through meetings, workshops, shows and expositions, and email communications. In 2023, we responded to more than 500 emails and participated in nearly 40 meetings and events. Staff formed a workgroup for professional landscapers to ensure landscapers are aware of the 2021 Amendments, to better understand challenges landscapers face, and to help spread awareness of available incentive programs. Staff assist engine and equipment manufacturers with certification, testing, and compliance questions. To help manufacturers and landscapers understand the impacts of the 2021 Amendments, staff developed a plain language *fact sheet*, which is posted in English and Spanish.<sup>6</sup>

### ZEE Roadshow

Since 2018, CARB has operated the successful ZEE Roadshow. Professional zero-emission lawn and garden equipment travel throughout the State, being loaned to landscaping crews who work for cities, military bases, parks and recreation districts, theme parks, colleges and universities, school districts, utility companies, and zoos. The ZEE Roadshow has visited more than 60 organizations, giving crews the opportunity to operate ZEE for free. To reach potential ZEE Roadshow participants, American Green Zone Alliance (AGZA), the contractor managing ZEE Roadshow operations, distributed flyers while delivering the ZEE Roadshow and during events for the CORE Professional Landscaping incentive program.

Operating ZEE in real-world conditions without the pressure to purchase equipment has gained positive results. Nearly every crew has found at least one piece of ZEE they prefer over SORE. The ZEE Roadshow trailer now contains six brands, 32 pieces of equipment, and 60 accessories. Figure 3 shows a sample of ZEE in the trailer in 2023.

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<sup>6</sup> California Air Resources Board, *"2021 Amendments to the Small Off-Road Engine Regulations Fact Sheet."* 2023. <https://ww2.arb.ca.gov/our-work/programs/small-road-engines-sore/2021-amendments-small-road-engine-regulations>

Figure 3. ZEE Roadshow Trailer



### **Landscaper Workgroup**

Ensuring the successful implementation of the 2021 Amendments for professional landscapers is a top priority. Therefore, staff formed a landscaper workgroup in 2023 that meets quarterly for professional landscapers to discuss the 2021 Amendments to the SORE regulations and incentives for electric landscape equipment. Attendees from CARB include program staff from SORE, CORE and the Carl Moyer Memorial Air Quality Standards Attainment Program (Carl Moyer). CORE Professional Landscaping is a multi-million-dollar incentive project intended to encourage California off-road equipment users to purchase commercialized zero-emission off-road equipment. SB 170 (Skinner, Chapter 240, Statutes of 2021), the Budget Act of 2021, provided \$30 million to fund the CORE Professional Landscaping program to incentivize small businesses or sole proprietors to purchase zero-emission equipment for their professional landscaping services. CORE Professional Landscaping is administered by CALSTART, a nonprofit organization working with businesses and governments to reduce air pollution. The Carl Moyer Program provides grant funding for cleaner-than-required engines, equipment, and other sources of air pollution through California's 35 local air districts and is another potential source of incentives for SORE equipment.

Staff publicized the workgroup through direct mail, at public events, and with the help of small engine dealers who provided flyers at cash registers. Staff also solicited participation through CARB's Office of the Ombudsperson, Environmental Justice blog, California Landscape Contractors Association, National Association of Landscape Professionals, and ZEE manufacturers. The Office of the Ombudsperson provided information and flyers regarding the workgroup to numerous chambers of commerce and business federations,



associations, panels and alliances, including at in-person events.

Lists of landscaping businesses in California were obtained from the Employment Development Department and California Contractors State License Board. These lists included businesses that have employees or hold contractor's licenses. A list of additional landscaping businesses was developed by obtaining information on licensed businesses that engage in landscaping services from counties and incorporated cities in California. Postcards inviting landscapers to join and participate in the workgroup were mailed to all businesses for which an address was available.

Between 30 and 60 landscapers attended the three workgroup meetings held in 2023. The meetings focused on compliance assistance and clarifying that the SORE regulations apply to newly produced engines and do not have requirements for end users. CARB-certified SORE may be used, maintained, and repaired for the rest of their useful life. Landscapers expressed interest in incentives to purchase ZEE. The appetite for commercial ZEE among landscapers is strong, as demonstrated by the expenditure in less than one year of all the funds allocated by the Legislature to provide incentives for landscapers to purchase ZEE. Staff tracked other potential incentives through legislation and provided updates during meetings. Unfortunately, bills that would allocate additional funding have not yet been adopted. Some larger landscaping businesses asked about costs for upgrading electrical services to keep up with charging demands. Staff explained that the regulations do not require anyone to upgrade their electrical service and that smart charging switches can alleviate electrical demand.

## **Events**

In February 2023, staff participated in the NorCal Landscape and Nursery Show in San Mateo and provided information about the 2021 Amendments, incentive programs, and other CARB regulations to attendees. Other exhibitors included AGZA and CALSTART, nurseries, equipment manufacturers, equipment dealers, and other outdoor accessory providers. There were approximately 1,100 attendees, which included landscapers, students, landscape designers and outdoor store owners, that wanted to discuss the SORE regulations and incentive programs for ZEE. Staff were able to clarify requirements in the SORE regulations for some attendees who had misunderstandings of in-use requirements for small off-road equipment and incentive programs. Many attendees expressed their support for CARB's work and appreciation for CARB's attendance at the show.

Staff attended The Anaheim Landscape Expo alongside CORE Professional Landscaping program staff and CALSTART in September 2023. There was significant interest in the CORE Professional Landscaping Program and funding opportunities. CARB staff and CALSTART offered two seminars for SORE regulation updates and incentives available to landscapers. The participants at the exposition comprised individuals from various backgrounds, such as landscapers, students, landscape designers, and owners of outdoor power equipment stores. Staff provided information on regulations, the landscaper



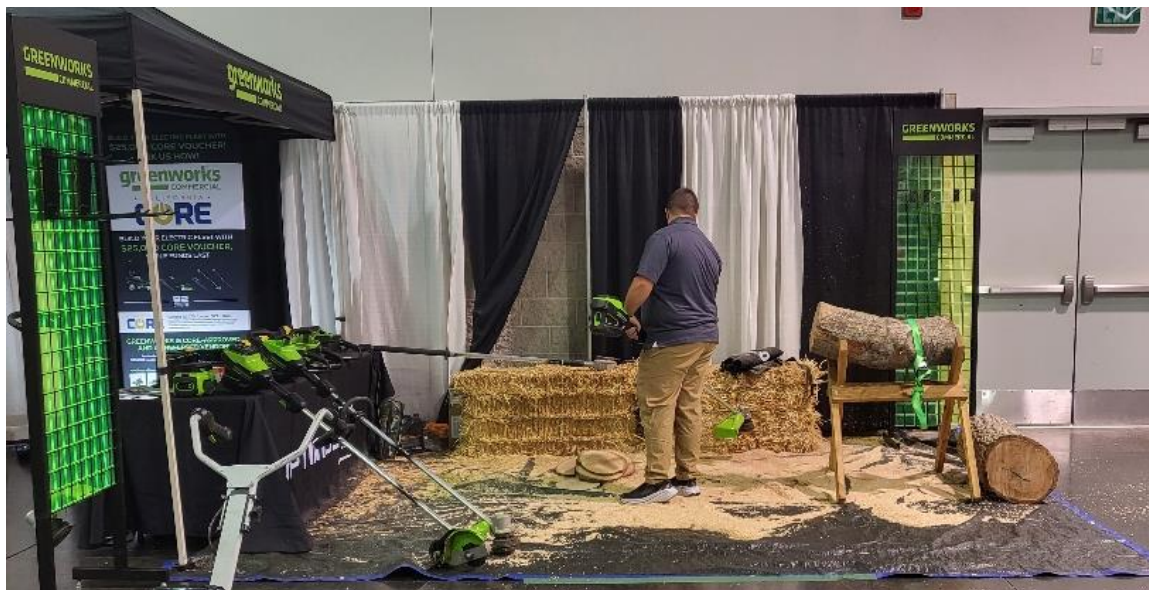
workgroup, and the ZEE Roadshow. Other exhibitors included AGZA, SORE and ZEE manufacturers and dealers, and other outdoor accessory providers. Manufacturers, including Stihl, Makita, Milwaukee, Echo, Ego, Greenworks, and Sunseeker exhibited a wide range of ZEE. Figure 4 below shows Stihl's large display of ZEE options. Some provided live demonstration shows and allowed participants to try the equipment, as shown in Figure 5.

In October 2023, staff traveled to the Equip Exposition in Louisville, Kentucky, to learn about new ZEE coming to the market. Numerous manufacturers actively endorsed ZEE, frequently highlighting its advantages over equipment powered by engines. Discussions focused on gauging public sentiment toward ZEE and the potential shift of landscaping crews to exclusively using ZEE products. Many manufacturers expressed a relatively positive outlook that professional landscapers can successfully replace their SORE equipment with ZEE. The manufacturers conveyed the positive feedback they received from expo attendees and showcased new products and innovations at outdoor demonstration areas, allowing participants to observe and test the products. Staff addressed inquiries regarding CARB's regulations and incentive programs. Manufacturers sought information on the timing of emission standard changes and the specific equipment covered by these regulations. Questions also revolved around the CORE Professional Landscaping program, including the processing timeline for orders, the availability of additional funds, and the potential expansion of the CORE Professional Landscaping program to cover other categories.

Figure 4. Stihl Exhibit at The 2023 Anaheim Landscape Expo



Figure 5. Greenworks Live Demonstration Area at The 2023 Anaheim Landscape Expo



## Frequently Asked Questions

The most common questions received through email and during meetings and events were from equipment users asking what equipment they may use starting January 1, 2024, and store owners asking what equipment they may sell starting January 1, 2024. CARB regulates the emissions from the production and sale of new SORE and does not have in-use requirements for CARB-certified SORE equipment. The SORE regulations do not prohibit the use of existing, CARB-certified equipment or specify dates by which new engines or equipment must be imported or by which new engines must be sold. Therefore, certified and labeled SORE equipment may continue to be sold in 2024 or later, depending on availability.

Another popular question is what incentives are available to help equipment users purchase ZEE. CORE Professional Landscaping provides a point-of-sale discount to help offset the incremental cost of zero-emission technology for professional landscaping services operated by small businesses or sole proprietors. The CORE Professional Landscaping program aimed to cover 70% of the manufacturer's suggested retail price. Other incentive programs, including the Carl Moyer Program, are run by local air districts, so the details of the programs vary. Staff developed a webpage for zero-emission landscaping equipment incentive programs that provides incentives by location.<sup>7</sup> It includes all air districts and the types of incentives that may be available, such as professional and residential vouchers and rebates. More information about the incentive programs may be found in section II.G. of this document. Other questions included

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<sup>7</sup> California Air Resources Board. *"Zero-Emission Landscaping Equipment Incentive Programs."* 2024. <https://ww2.arb.ca.gov/our-work/programs/zero-emission-landscaping-equipment/zero-emission-landscaping-equipment-incentive>

applicability to the SORE regulations<sup>8</sup> and clarifying questions about the pressure test and tilt test in TP-901 and TP-902.

Staff began receiving inquiries toward the end of 2023 from stakeholders seeking guidance regarding the emission standards and requirements for model year 2024 engines without U.S. EPA's authorization to enforce CARB's recent amendments. Staff explained that CARB is administering the program in a manner consistent with its existing authority. Some manufacturers have requested Executive Orders for their engines without certifying that the engines comply with all requirements of the 2021 Amendments. These manufacturers have instead elected to certify that their model year 2024 engines meet the currently authorized model year 2023 emission standards and requirements. Therefore, CARB has issued Limited Term Executive Orders to these manufacturers that will terminate on the date that U.S. EPA's authorization decision is published in the Federal Register. Any engines or evaporative emission control systems that are certified under such Executive Orders cannot be manufactured for sale, sold, offered for sale in California, or introduced, delivered, or imported into California after that date.

## Incentive Programs

Incentives for zero-emission lawn and garden equipment play a critical role in ensuring the success of implementing the 2021 Amendments. Incentives, such as tax credits or vouchers, make zero-emission lawn and garden equipment more affordable for individual consumers and landscaping businesses. This financial assistance directly addresses the cost barrier, encouraging people to opt for cleaner technologies. By offering incentives, government organizations and other entities stimulate interest among consumers to invest in environmentally-friendly equipment. Reduced upfront costs make it more attractive for both businesses and individuals to choose zero-emission options when purchasing lawn mowers, chainsaws, or leaf blowers. Incentives play a pivotal role in raising awareness about the environmental impact of engine-powered equipment. They serve as a catalyst for individuals and businesses to prioritize and actively seek out cleaner alternatives, contributing to a broader shift in consumer behavior. As more individuals and businesses choose cleaner options, manufacturers are incentivized to produce a wider range of environmentally-friendly products to meet the growing market demand. Focusing on incentives is pivotal for the success of the 2021 Amendments. These incentives make environmentally-friendly choices more accessible, affordable, and appealing to consumers and businesses, thereby increasing the adoption of zero-emission lawn and garden equipment.

There are several incentive programs available to help small off-road equipment users purchase ZEE. The California Legislature allocated \$30 million in the Budget Act of 2021 (SB 170, Chapter 240, Statutes of 2021) "to provide incentives for professional landscaping services in California operated by small businesses or sole proprietors to purchase

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<sup>8</sup> California Air Resources Board. *"SORE Applicability Fact Sheet."* 2021. <https://ww2.arb.ca.gov/resources/fact-sheets/sore-applicability-fact-sheet>

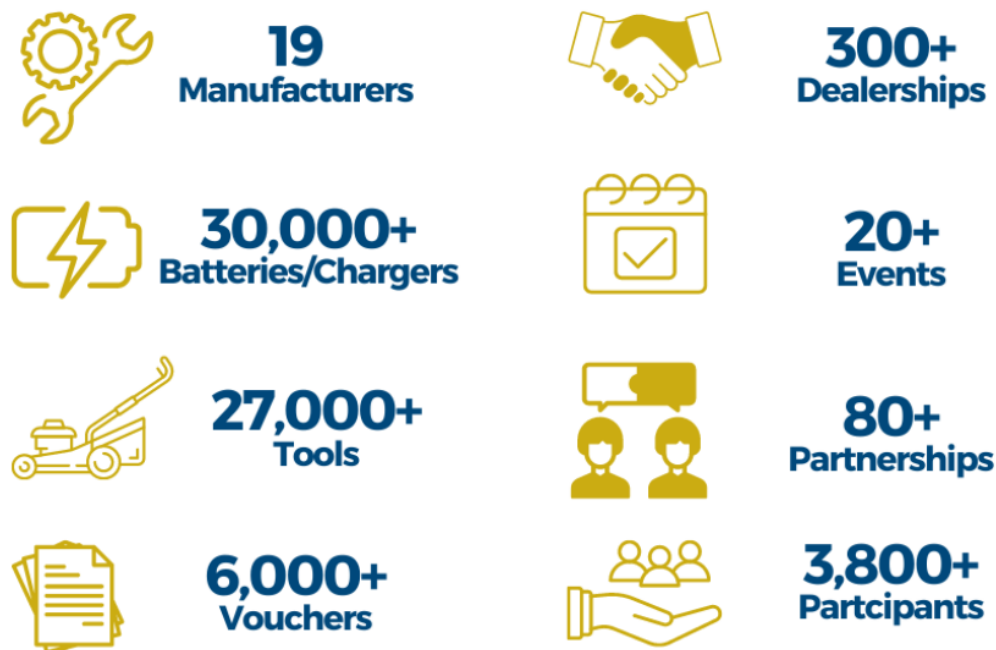
zero-emission small off-road equipment.” This funding was distributed through the CORE Professional Landscaping voucher incentive project and became available to small business professional landscapers in November 2022. However, this funding was quickly depleted by October 2023, showing an eagerness and willingness to purchase ZEE among landscapers. As shown below in **Error! Reference source not found.** and Figure 6, this program operated through approximately 300 dealers, streamlining the process for end-users to participate without any upfront financial burden. The dealers covered the costs initially and subsequently redeemed the allocated vouchers to ensure seamless and financially viable participation for end-users. Businesses seized the opportunity presented by these incentives, showing the genuine need and eagerness within the sector to purchase zero-emission equipment. Nearly 500 different equipment models were available for vouchers. More than 27,000 pieces of equipment and 40,000 batteries and chargers were purchased through the program. Among the professional landscapers who benefited from CORE Professional Landscaping funding, at least 42% identified as Hispanic or Latinx, highlighting the program's impact on supporting diversity within the landscaping industry.

Table 2. CORE Professional Landscaping Equipment Tools Funded as of February 2024

<b>Equipment Type</b>	<b>Count</b>
<b>Backpack Leaf Blower</b>	4,122
<b>Handheld Leaf Blower</b>	3,556
<b>Chainsaw</b>	3,878
<b>Edger</b>	187
<b>Hedge Trimmer</b>	5,013
<b>String Trimmer</b>	4,112
<b>Pole Saw</b>	805
<b>Ride-on/Stand-on Mower</b>	95
<b>Walk-behind Mower</b>	2,841



Figure 6. CORE Professional Landscaping Details



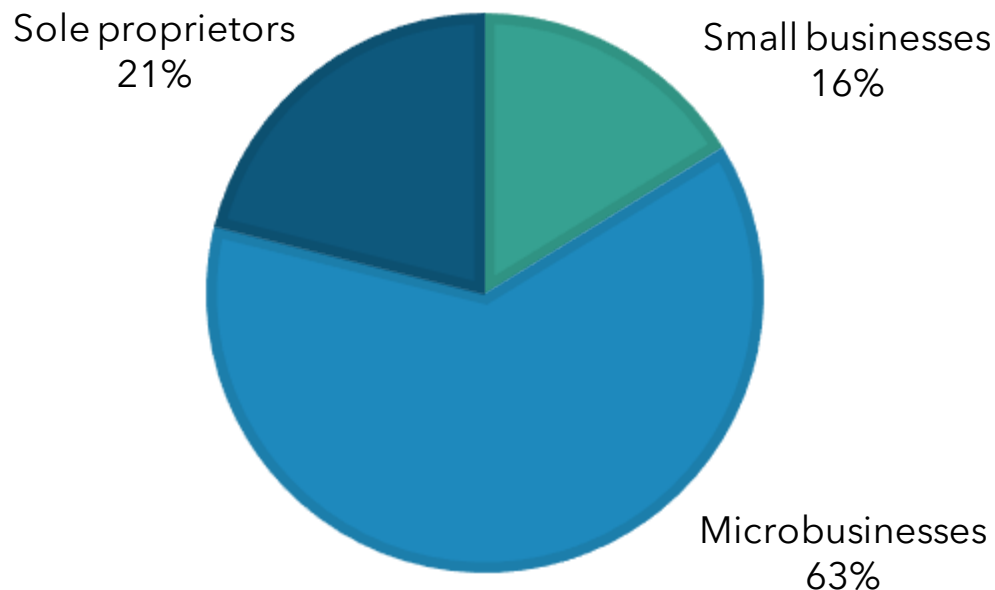
The program's commitment to outreach included a substantial outreach budget of \$600,000. Notably, half of this budget was dedicated to organizing events and initiatives in collaboration with AGZA. The other half was allocated to a strategic advertising campaign that encompassed Univision, a prominent media outlet spanning radio, television, and social media platforms. To complement the advertising efforts, direct mailings and targeted email campaigns were launched, providing interested parties with comprehensive information about CORE Professional Landscaping. This multi-pronged approach helped to ensure a wide-reaching and inclusive outreach strategy, fostering awareness and participation.

The program provided flexibility regarding battery acquisition. While participants were encouraged to purchase at least one piece of equipment, they were afforded the opportunity to procure as many batteries as needed. Understandably, much of the CORE Professional Landscaping incentive funding was used for batteries since batteries drive the upfront cost difference between SORE and ZEE.

The CORE Professional Landscaping program adhered to the small business definition in Government Code section 14837(d)(1)(A), which states in part, "Small business' means an independently owned and operated business that is not dominant in its field of operation... and which, together with affiliates, has 100 or fewer employees." Some apprehensions were voiced over the inclusion of all types of businesses under this classification, but SB 170 is very clear, to provide incentives to small businesses or sole proprietors. The allocated funds were distributed to sole proprietors of businesses, microbusinesses of 25 or fewer employees, and small businesses of 100 or less.

employees. Sole proprietors received 21% of the total funding, microbusinesses received 63%, and small businesses received 16%, as shown below in Figure 7.

Figure 7. Distribution of CORE Professional Landscaping Funding



Several local air districts, including South Coast Air Quality Management District (AQMD) and San Joaquin Valley Air Pollution Control District (APCD), have also developed their own incentive programs for residential users and businesses. Both South Coast AQMD and San Joaquin Valley APCD offer rebates for zero-emission lawn mowers to residential users when they scrap their gasoline-powered lawn mowers. For businesses, South Coast AQMD and San Joaquin Valley APCD have programs that help with purchasing commercial zero-emission equipment. The Zero-Emission Landscaping Equipment Voucher Program provides incentives for San Joaquin Valley landscapers, public agencies, and businesses that perform their own landscape maintenance, to replace their old gas-powered landscape equipment with new electric options. Small business and public agency applicants may be eligible for up to 100% of the cost of new equipment, while large businesses may be eligible for up to 85% of the cost of new equipment.

In 2023, AGZA held 11 events promoting the CORE Professional Landscaping incentives. CARB staff attended several gatherings, including an event in Sacramento on August 13, 2023, as shown below in Figure 8**Error! Reference source not found..** The events included booths from equipment manufacturers, local air districts, and CARB. Events were attended by local landscapers, both independent and from organizations like school districts.

Figure 8. Sacramento AGZA/CORE Professional Landscaping Event



In October 2023, Representative Correa introduced the Promoting Reduction of Emissions Through Landscaping Equipment Act, to create a federal tax credit to enable local small businesses, including landscaping and lawn care businesses of all sizes, to purchase zero-emission equipment. The bill provides a 40% credit on the purchase of zero-emission equipment, such as mowers, leaf blowers, hedgers, and accessories up to \$25,000 every year and up to \$100,000 over the course of 10 consecutive years. This bill has been referred to the House Committee on Ways and Means.

## Engine and Evaporative Family Certification

Manufacturers must certify and label engines and evaporative emission control systems each model year before introducing them into California commerce. New emissions standards for SORE begin model year 2024. The effective date for the 2021 Amendments was January 1, 2023. However, staff did not expect manufacturers to make extensive changes to the engine or evaporative families they certified in model year 2023 versus model year 2022. Manufacturers typically submit certification applications for a given model year several months before the beginning of the corresponding calendar year so they may receive Executive Orders of certification for their engine and evaporative families before the beginning of the calendar year. Many model year 2023 SORE Executive Orders were issued before January 1, 2023, and the amended requirements were not expected to significantly impact certification for model year 2023. The number of certified engine and evaporative families has not changed significantly in model year 2023 versus model year 2022 with less than a 10% change. For model year 2022, CARB approved 481 evaporative family and 624 engine family Executive Orders. For model year 2023, CARB approved 451 evaporative family and 613 engine family Executive Orders. Of the 87 manufacturers who certified engine or evaporative families for model year 2022, 18 manufacturers did not apply for exhaust or evaporative emission certification for model year 2023.

For model year 2024, the emission standards for most SORE are zero. Model year 2024 engines used in pressure washers with displacement greater than or equal to 225 cc and generators are required to meet more stringent emission standards. During rulemaking, concerns were raised about the ability of industry to meet the more stringent standards. Thus far, manufacturers have submitted 26 certification applications, which have been received and approved for Executive Orders for pressure washers with engine displacement greater than or equal to 225 cc and generators for model year 2024 achieving the more stringent emission standards.

The SORE regulations continue to apply to portable generators installed on RVs which will be subject to more stringent emission standards starting with model year 2024. During the 2021 rulemaking and the Board Hearing, staff received many comments about RV generators. However, in 2023, we received only a few emails asking about the requirements for RV generators. Staff met with RV industry representatives to ensure they were aware that Cummins announced plans to meet CARB's new emission standards for model year 2024. Cummins, the dominant manufacturer of RV generators, has met the new, more stringent emission standards and certified several of its generator models for model year 2024.

Pending U.S. EPA's action to grant authorization, CARB has issued 54 Limited Term Executive Orders for manufacturers that requested to certify their engines or evaporative emission control systems without meeting the 2021 Amendments.<sup>9</sup> Staff will track the emission reductions that may not be realized due to such certifications.

## **Emission Reduction Credit Programs**

### **Certification Averaging, Banking, and Trading**

The exhaust emission regulations include an emission reduction credit averaging, banking, and trading (ABT) program, in which manufacturers can generate credits with engines that emit below the emission standards and use them to produce engines that emit above the emission standards. This averaging of emissions gives manufacturers the flexibility to certify those higher-emitting engines. Exhaust emission reduction credits may be banked for up to five years, to be used later, or may be traded with other manufacturers. The previous evaporative emission reduction credit program only included averaging and banking. Starting with model year 2023, manufacturers may trade evaporative emission credits.

To increase equity in earning credits, the 2021 Amendments include flexibility for manufacturers to earn evaporative emission credits for engines with displacement less than or equal to 80 cc. Manufacturers have more exhaust emission credits banked

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<sup>9</sup> California Air Resources Board. *"New Vehicle and Engine Certification: Executive Orders for Off-Road Spark-Ignited Engines and Equipment."* 2024. <https://ww2.arb.ca.gov/new-vehicle-and-engine-certification-executive-orders-road-spark-ignited-engines-and-equipment>



compared to evaporative emission credits. This is primarily due to the option for design certification. Under this option, manufacturers may use certified evaporative emission control system components that have been tested to meet design standards rather than testing assembled engines with evaporative emission control systems to demonstrate compliance with evaporative emission standards. However, manufacturers could not earn evaporative emission credits when using design certification. Prior to model year 2023, equipment using engines with displacement less than or equal to 80 cc were required to use design certification. Manufacturers of handheld equipment (which typically use engines with displacement less than or equal to 80 cc) have had fewer opportunities to earn evaporative emission credits than manufacturers of non-handheld equipment as a result. The 2021 Amendments include a provision to allow engines with displacement less than or equal to 80 cc to certify to hot soak plus diurnal emission standards and earn evaporative emission credits for model year 2023. Manufacturers may use any credits earned in this way for their own engines or may bank them or trade them to other manufacturers.

From 2020 to 2022, the total exhaust and evaporative emission credit banks increased, showing manufacturer's ability to produce lower emitting engines and evaporative emission control systems. In this timeframe, 12 manufacturers have participated in ABT for exhaust emission credits, with the total bank reaching nearly 2.6 billion credits. Five manufacturers have participated in averaging and banking evaporative emission credits, with the total bank reaching approximately 145,000 credits. Manufacturers are required to submit end-of-year and final reports for exhaust and evaporative emission credits banked, averaged, or traded. End-of-year reports must be submitted within 90 days after the end of the model year, and final reports must be submitted within 270 days after the end of the model year. The total banks are approximately 3.5 billion exhaust and 240,000 evaporative emission credits, respectively, as of the end of model year 2023. Despite these banks, very few manufacturers are using emission reduction credits to certify engines for model year 2024.

### **Zero-Emission Generator Credit Program**

The zero-emission generator credit program became available on January 1, 2023, which allows manufacturers to earn emission reduction credits for zero-emission generators. This credit program incentivizes manufacturers to increase development and production of zero-emission generators, particularly zero-emission generators with the greatest energy storage and highest power output. The credits that might be earned in this program could be used to ease the purchase of ZEE by offsetting emissions from SORE generators. Thus far, no manufacturers have taken advantage of the program. A few manufacturers of zero-emission generators that would likely qualify for credits have made inquiries, but none has pursued certification. To help spread awareness of the new program, CARB sent out a notice to remind manufacturers of the opportunity to earn emission credits by certifying zero-emission generators through model year 2026.

## Compliance Testing

CARB staff has conducted regular SORE evaporative emission compliance testing each model year since 2015. Since January 2022, staff has conducted evaporative emission compliance testing on 21 equipment units from 17 evaporative families using TP-902, Test Procedure for Determining Diurnal Emissions from Small Off-Road Engines, amended May 6, 2019, in Sacramento's laboratory.

CARB staff will continue SORE compliance testing in Sacramento and will also begin parallel testing in the new Mary D. Nichols Campus, laboratory in Riverside to maximize efficiency. The Sacramento and Riverside laboratories are expected to test approximately 25 evaporative families each year through 2027. CARB staff will provide further updates on compliance testing in subsequent implementation reviews.

## Surveys

Between 2017 and 2019, CARB contracted with the Social Science Research Center at California State University, Fullerton (CSUF) to assess the population and utilization patterns of SORE across households, non-landscaping businesses, and landscapers. This survey evaluated the frequency and way individuals engaged with small off-road equipment. The results were used to calculate a more accurate inventory of small off-road equipment in California for emissions modeling.

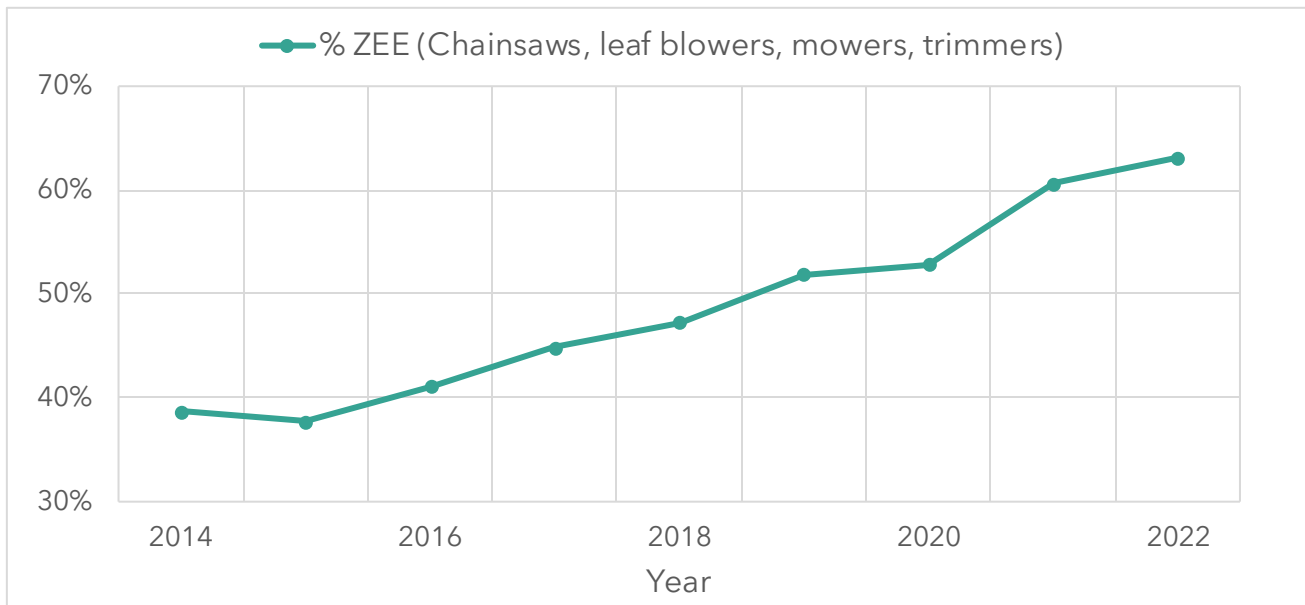
CARB has contracted with CSUF to perform another survey between 2023 and 2025. The results of the survey will be utilized to update the SORE emission inventory. An additional objective of the survey is to identify any changes in population or patterns of equipment use. CARB staff sought and received input from stakeholders on the questionnaire for the survey of landscapers. In March 2023, staff held a questionnaire-focused meeting to receive additional input. Staff then worked with CSUF to make modifications to the questionnaire based on the stakeholder input. CARB staff will provide further updates on this survey in subsequent implementation reviews.

## ZEE Market Growth

### Residential lawn and garden

ZEE have been available for many equipment types for decades. The level of performance, number of brands, and number of equipment options have increased greatly and continue to do so today. Battery and electric motor technology have advanced rapidly in recent years, while costs have declined. This progress is leading toward increasing numbers of zero-emission lawn and garden equipment being shipped each year throughout the United States. As shown below in Figure 9, more than 60% of the total residential equipment (chainsaws, handheld leaf blowers, walk-behind mowers, and trimmers) shipped throughout the U.S. in 2022 were zero-emission.

Figure 9. 50-State Total Residential Shipment Estimates



## Commercial lawn and garden

The ZEE markets for commercial lawn and garden equipment, such as riding mowers and backpack blowers, are expanding. Mean Green now offers the industry's largest electric zero turn lawn mower called the EVO. With up to 8 hours of continuous mowing time due to its 35 kWh battery, a 74" mulching rear discharge deck, 20-degree slope capability, and performance comparable to a large diesel mower, the EVO is ready for the biggest jobs and longest days.<sup>10</sup> During the 2023 Equip Exposition, Mean Green previewed a new EVO with a 96" cutting width and larger battery that has become available in 2024. Stihl's BGA 300 backpack blower offers powerful performance and commercial-grade durability. It delivers a powerful 26 Newtons blowing force and 192 miles per hour air speeds for heavy-duty clearing. When paired with the AR 3000 L backpack battery, the BGA 300 delivers up to 140 minutes of performance. Three power levels plus a boost mode improve battery efficiency for consistent, long-lasting power throughout the battery charge.<sup>11</sup> The growth of the ZEE market for commercial lawn and garden equipment, exemplified by products such as Mean Green's EVO electric zero-turn lawn mower and Stihl's BGA 300 backpack blower, signifies a significant shift towards sustainable, zero-emission options for landscaping and outdoor maintenance. CARB staff will provide further updates on commercial and residential ZEE in subsequent implementation reviews. Appendix E provides more information on ZEE market growth.

<sup>10</sup> Mean Green Electric Mowers. "[Mean Green EVO Zero-Turn Mower](https://meangreenproducts.com/evo%2074%20ztr/)." Accessed on December 4, 2023.

<sup>11</sup> Stihl. "[BGA 300 Backpack Blower](https://www.stihlusa.com/products/blowers%20and%20shredder%20vac/battery%20blowers/bga300/?aqid=83bfe1274ac71177336db448f756a815)." Accessed on December 7, 2023.

<https://www.stihlusa.com/products/blowers%20and%20shredder%20vac/battery%20blowers/bga300/?aqid=83bfe1274ac71177336db448f756a815>

## Conclusion

Implementation of the 2021 Amendments has been a success through 2023. CARB will continue to issue Limited Term Executive Orders while awaiting to receive authorization from U.S. EPA because enforcement of the model year 2024 emission standards and requirements are contingent on receiving authorization. The SORE program has made significant strides in promoting the adoption of ZEE and ensuring compliance with the 2021 Amendments and regulatory requirements through engaging outreach and extensive compliance assistance.

The success of the ZEE Roadshow and high demand for CORE Professional Landscaping incentive funding demonstrate that professional landscapers are pleased with their experience and eager to purchase additional ZEE with the help of incentives. The quarterly landscaper workgroup meetings have provided a valuable platform for landscapers and other stakeholders to stay updated on regulations and incentives. Landscapers attending the meetings advocated for commercial ZEE, including for their local air district to implement a Carl Moyer lawn and garden program, and for renewing funding each year.

CARB's active participation in industry events and expos, such as the NorCal Landscape and Nursery Show, the Anaheim Landscape Expo, and the Equip Exposition in Louisville, has allowed staff to directly engage with landscapers, equipment vendors, and stakeholders in the landscaping industry. These interactions have clarified many concerns and misconceptions surrounding the 2021 Amendments, demonstrating CARB's commitment to transparency and support for its stakeholders.

Compliance testing serves to hold manufacturers accountable and inform staff of ongoing noncompliance with emission standards. Parallel testing in Sacramento and Riverside will increase testing capacity. Surveys will provide critical data for understanding equipment usage patterns and updating the SORE emission inventory.

CARB staff will continue to support the implementation of the 2021 Amendments through the landscaper workgroup, incentive funding, surveys, meetings, and market analysis, while providing annual updates in addition to a technology review in the 2025 to 2026 timeframe to the Board. Implementation of the 2021 Amendments is impacted while waiting on U.S. EPA to grant California authorization so CARB may enforce the 2016 as well as the 2021 amendments to the SORE regulations, but options like incentivizing ZEE, allow CARB to start obtaining reduction goals in the interim.



## Bibliography

- California Air Resources Board. *"Proposed Amendments to the Small Off-Road Engine Regulations: Transition to Zero Emissions, Resolution 21-28."* 2021.  
<https://ww2.arb.ca.gov/sites/default/files/barcu/board/res/2021/res21-28.pdf>
- California Air Resources Board, *"Revised Proposed 2016 State Strategy for the State Implementation Plan."* 2017.  
[https://ww2.arb.ca.gov/sites/default/files/classic/planning/sip/2016sip/rev2016state sip.pdf](https://ww2.arb.ca.gov/sites/default/files/classic/planning/sip/2016sip/rev2016state%20sip.pdf)
- California Air Resources Board. *"SORE Applicability Fact Sheet."* 2021.  
<https://ww2.arb.ca.gov/resources/fact-sheets/sore-applicability-fact-sheet>
- California Air Resources Board. *"Zero-Emission Landscaping Equipment Incentive Programs."* 2024. <https://ww2.arb.ca.gov/our-work/programs/zero-emission-landscaping-equipment/zero-emission-landscaping-equipment-incentive>
- California Air Resources Board, *"2020 Emissions Model for Small Off-Road Engines - SORE2020."* 2020. [https://ww2.arb.ca.gov/sites/default/files/2020-09/SORE2020\\_Technical\\_Documentation\\_2020\\_09\\_09\\_Final\\_Cleaned\\_ADA.pdf](https://ww2.arb.ca.gov/sites/default/files/2020-09/SORE2020_Technical_Documentation_2020_09_09_Final_Cleaned_ADA.pdf)
- California Air Resources Board, *"2021 Amendments to the Small Off-Road Engine Regulations Fact Sheet."* 2023. <https://ww2.arb.ca.gov/our-work/programs/small-road-engines-sore/2021-amendments-small-road-engine-regulations>
- Mean Green Electric Mowers. *"Mean Green EVO Zero-Turn Mower."* Accessed on December 4, 2023. <https://meangreenproducts.com/evo%2074%20ztr/>
- Stihl. *"BGA 300 Backpack Blower."* Accessed on December 7, 2023.  
<https://www.stihlusa.com/products/blowers%20and%20shredder%20vacs/battery%20blowers/bga300/?aqid=83bfe1274ac71177336db448f756a815>

## Appendices

*Appendix A: Exhaust Emission Standards for Model Year 2024 and Subsequent Model Years*

*Appendix B: Evaporative Emission Standards for Model Year 2024 and Subsequent Model Years*

*Appendix C: SORE Regulatory History*

*Appendix D: Summary of 2021 Amendments*

*Appendix E: Zero-Emission Equipment Market Growth*

# Appendix A

## Exhaust Emission Standards for Model Year 2024 and Subsequent Model Years

Table A.1. Exhaust Emission Standards for Spark-Ignition Engines, Except Generator Engines and  $\geq 225$  cc Pressure Washer Engines (grams per kilowatt-hour)

<b>Model Year</b>	<b>Displacement Category</b>	<b>Durability Periods (hours)</b>	<b>Hydrocarbon plus Oxides of Nitrogen<sup>(1,2,3)</sup></b>	<b>Carbon Monoxide<sup>(3)</sup></b>	<b>Particulate Matter<sup>(3)</sup></b>
<b>2024 and subsequent</b>	< 50 cc	300	0.00	536	0.00 <sup>(4)</sup>
<b>2024 and subsequent</b>	50-80 cc, inclusive	300	0.00	536	0.00 <sup>(4)</sup>
<b>2024 and subsequent</b>	> 80 cc – < 225 cc	500	0.00	549	NA
<b>2024 and subsequent</b>	225-825 cc, inclusive	1,000	0.00	549	NA
<b>2024 and subsequent</b>	> 825 cc	1,000	0.00	20.6	NA

Table A.2. Exhaust Emission Standards for Generator Engines (grams per kilowatt-hour)

<b>Model Year</b>	<b>Displacement Category</b>	<b>Durability Periods (hours)</b>	<b>Hydrocarbon plus Oxides of Nitrogen<sup>(1,5)</sup></b>	<b>Carbon Monoxide<sup>(5)</sup></b>	<b>Particulate Matter<sup>(5)</sup></b>
<b>2024 through 2027</b>	< 50 cc	500	6.0	400	2.0 <sup>(4)</sup>
<b>2024 through 2027</b>	50-80 cc, inclusive	500	6.0	400	2.0 <sup>(4)</sup>
<b>2024 through 2027</b>	> 80 cc – < 225 cc	500	6.0	400	NA
<b>2024 through 2027</b>	225-825 cc, inclusive	1,000	3.0	200	NA
<b>2024 through 2027</b>	> 825 cc	1,000	0.80	20.6	NA
<b>2028 and subsequent</b>	< 50 cc	300	0.00	400	0.00 <sup>(4)</sup>
<b>2028 and subsequent</b>	50-80 cc, inclusive	300	0.00	400	0.00 <sup>(4)</sup>
<b>2028 and subsequent</b>	> 80 cc – < 225 cc	500	0.00	400	NA
<b>2028 and subsequent</b>	225-825 cc, inclusive	1,000	0.00	200	NA
<b>2028 and subsequent</b>	> 825 cc	1,000	0.00	20.6	NA



Table A.3. Exhaust Emission Standards for  $\geq 225$  cc Pressure Washer Engines  
(grams per kilowatt-hour)

<b>Model Year</b>	<b>Displacement Category</b>	<b>Durability Periods (hours)</b>	<b>Hydrocarbon plus Oxides of Nitrogen<sup>(1,6)</sup></b>	<b>Carbon Monoxide<sup>(6)</sup></b>	<b>Particulate Matter<sup>(6)</sup></b>
<b>2024 through 2027</b>	225-825 cc, inclusive	1,000	3.0	200	NA
<b>2024 through 2027</b>	> 825 cc	1,000	0.80	20.6	NA
<b>2028 and subsequent</b>	225-825 cc, inclusive	1,000	0.00	200	NA
<b>2028 and subsequent</b>	> 825 cc	1,000	0.00	20.6	NA

- (1) The Executive Officer may allow gaseous fueled (i.e., propane, natural gas) engine families, that satisfy the requirements of the regulations, to certify to either the hydrocarbon plus oxides of nitrogen or hydrocarbon emission standard, as applicable, on the basis of the non-methane hydrocarbon (NMHC) portion of the total hydrocarbon emissions.
- (2) Engines used exclusively to power products which are used exclusively in wintertime, such as snowthrowers and ice augers, at the option of the engine manufacturer, need not certify to or comply with standards regulating emissions of HC+NO<sub>x</sub> or NMHC+NO<sub>x</sub>, as applicable. If the manufacturer exercises the option to certify to standards regulating such emissions, such engines must meet such standards. If the engine is to be used in any equipment or vehicle other than an exclusively wintertime product such as a snowthrower or ice auger, it must be certified to the applicable standard regulating emissions of HC+NO<sub>x</sub> or NMHC+NO<sub>x</sub> as applicable.
- (3) Applicable to all small off-road engines, except generator engines and  $\geq 225$  cc pressure washer engines.
- (4) Applicable to all two-stroke engines.
- (5) Applicable only to generator engines. The CO emission standards for marine generator engines in all displacement categories are 4.5 g·kWh<sup>-1</sup>.
- (6) Applicable only to  $\geq 225$  cc pressure washer engines.

# Appendix B

## Evaporative Emission Standards for Model Year 2024 and Subsequent Model Years

Table B.1. Hot Soak Plus Diurnal Emission Standards for Small Off-Road Engines, Except Generator Engines and  $\geq 225$  cc Pressure Washer Engines

<b>Displacement Category</b>	<b>Effective Date Model Year</b>	<b>Hot Soak Plus Diurnal Emission Standards<sup>1</sup> (g organic material hydrocarbon equivalent·test<sup>-1</sup>)</b>
<b><math>\leq 80</math> cc</b>	2024	0.00
<b><math>&gt; 80</math> cc - <math>&lt; 225</math> cc Walk-Behind Mowers</b>	2024	0.00
<b><math>&gt; 80</math> cc - <math>&lt; 225</math> cc (except Walk-Behind Mowers)</b>	2024	0.00
<b><math>\geq 225</math> cc</b>	2024	0.00

Table B.2. Hot Soak Plus Diurnal Emission Standards for Generator Engines

<b>Displacement Category</b>	<b>Effective Date Model Year</b>	<b>Hot Soak Plus Diurnal Emission Standards<sup>1</sup> (g organic material hydrocarbon equivalent·test<sup>-1</sup>)</b>
<b><math>\leq 80</math> cc</b>	2024	0.50
<b><math>\leq 80</math> cc</b>	2028	0.00
<b><math>&gt; 80</math> cc - <math>&lt; 225</math> cc</b>	2024	0.60
<b><math>&gt; 80</math> cc - <math>&lt; 225</math> cc</b>	2028	0.00
<b><math>\geq 225</math> cc</b>	2024	0.70
<b><math>\geq 225</math> cc</b>	2028	0.00

Table B.3. Hot Soak Plus Diurnal Emission Standards for  $\geq 225$  cc Pressure Washer Engines

<b>Displacement Category</b>	<b>Effective Date Model Year</b>	<b>Hot Soak Plus Diurnal Emission Standards<sup>1</sup> (g organic material hydrocarbon equivalent·test<sup>-1</sup>)</b>
<b><math>\geq 225</math> cc</b>	2024	0.70
<b><math>\geq 225</math> cc</b>	2028	0.00

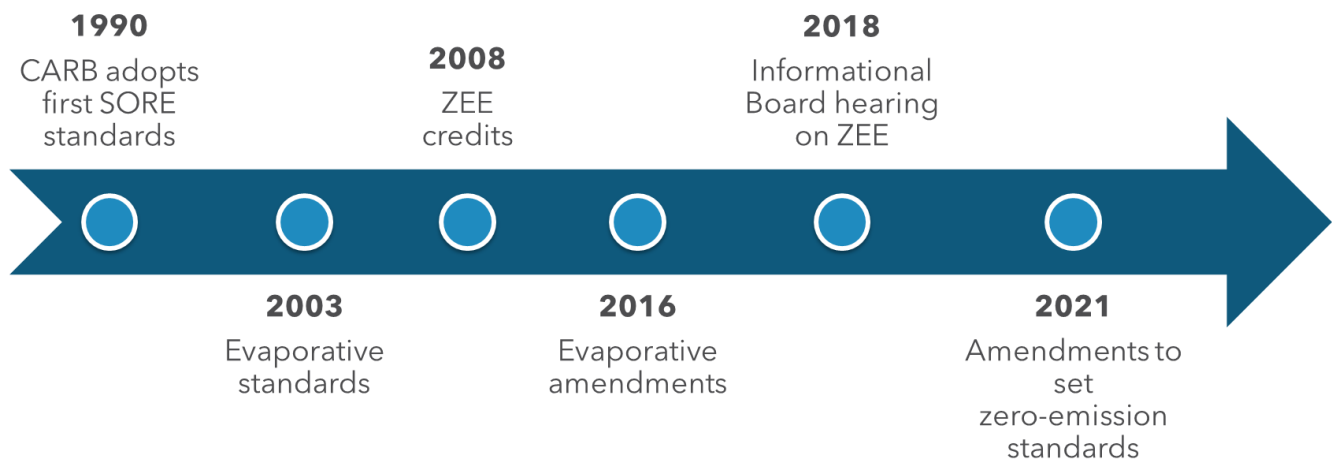
<sup>1</sup> The standards for hot soak plus diurnal emissions are measured in grams of organic material hydrocarbon equivalent per test, which includes both the hot soak test and the 24-hour diurnal test, as specified in TP-902.

# Appendix C

## SORE Regulatory History

Emissions from SORE occur both when the engine is running (exhaust and evaporative emissions) and when it is not running (evaporative emissions). Exhaust emissions contain both oxides of nitrogen (nitrogen monoxide (NO) and nitrogen dioxide (NO<sub>2</sub>), denoted NO<sub>x</sub>) while evaporative emissions contain reactive organic gas (ROG). Figure C.1., below, summarizes the SORE regulatory history.

Figure C.1. SORE Regulatory History



CARB adopted the first SORE regulations in 1990 when setting the first exhaust emission standards. The exhaust emission regulations include emission standards for hydrocarbon (HC), NO<sub>x</sub>, carbon monoxide (CO), and PM. Hydrocarbons are chemical compounds consisting of carbon and hydrogen only; many hydrocarbons are ROG. Emissions of all organic compounds are measured to verify compliance with the emission standards for hydrocarbons for gasoline fueled engines. The first CARB evaporative emission standards for SORE were adopted in 2003. CARB adopted an emission reduction credit program for professional-level ZEE in 2008. This expanded on existing emission reduction credit programs that provide flexibility for manufacturers in meeting emission standards.

Amendments to the evaporative emission regulations were adopted in 2016, following validation studies that found low rates of compliance with existing emission standards. A major purpose of these amendments was to increase compliance rates and facilitate compliance testing and enforcement actions. The evaporative amendments included the following: the requirement for one engine instead of five to be tested for an initial compliance determination, the option for the Executive Officer to purchase equipment for compliance testing, and the requirement for bonds to be posted by manufacturers without

sufficient U.S. assets to cover potential enforcement penalties. The 2016 evaporative amendments did not change the emission standards except to include fuel line permeation emission standards for engines with displacement less than or equal to 80 cc. These fuel line permeation emission standards were similar to those included in U.S. EPA regulations and implemented between model years 2012 and 2016. Staff continue to perform compliance testing to hold manufacturers accountable for achieving the certified emission levels and ensure Californians realize the air quality benefits of the current regulations. Since model year 2015, CARB has completed compliance testing of 52 evaporative families, 17 of which have failed to meet the emission standards. CARB has assessed penalties for the violations, and staff has worked with manufacturers to ensure that the causes of failure were addressed.

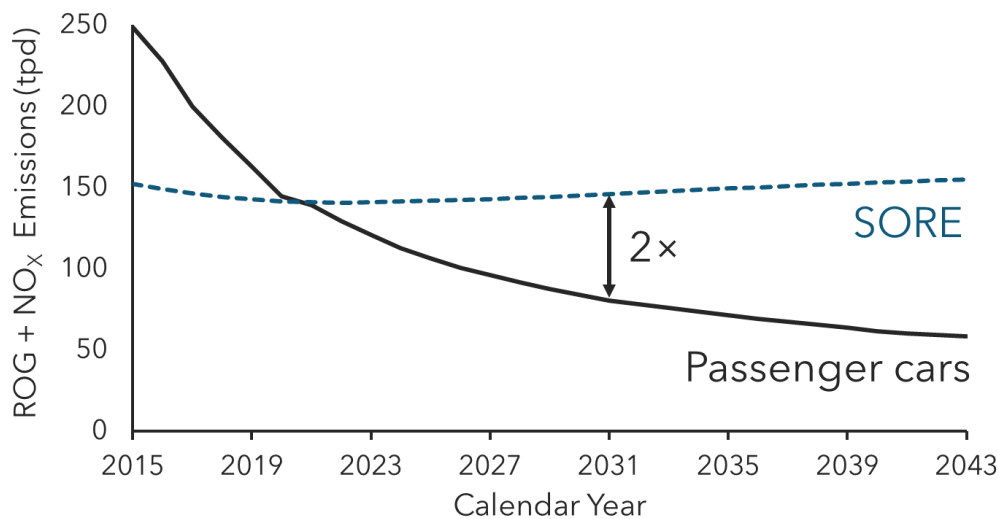
Staff presented an update to the Board during its public hearing in November 2018 titled, "Informational Update on Reducing Emissions from Small Off-Road Engines: Operator Exposure, Health Risks, and Pathways to Zero Emissions." The staff update included information about demonstration projects that provided professional landscapers an opportunity to use and test professional-grade battery-operated landscaping equipment. Additionally, staff provided information on cities in California that had already replaced their SORE municipal landscaping equipment with ZEE. Staff noted that some colleges and universities in California were also on the path to adopt ZEE to replace their SORE equipment. There was a showcase of ZEE outside the meeting room with eight manufacturers and businesses showing their newest ZEE. The Board encouraged staff to quickly propose amendments to the SORE regulations to set to zero-emission standards due to the availability of commercial-grade ZEE, in conjunction with the high noncompliance rate of engines, which leads to excess emissions and the significant health impacts to operators.

# Appendix D

## 2021 Amendments

The Board adopted the 2021 Amendments to the SORE regulations to reduce smog-forming emissions in California and meet our 2016 State Implementation Plan Strategy obligations, to meet the goals in Governor's Executive Order N-79-20, and to comply with the requirements of AB 1346. Although SORE have been regulated since 1995 and smog-forming emissions have decreased by 50% since 2000, additional emission reductions were needed to meet commitments in the 2016 State Implementation Plan Strategy. Prior to the 2021 Amendments summer emissions from SORE were forecasted to be nearly twice those from light-duty passenger cars in 2031, as shown below in Figure D.1.

Figure D.1. Need to Reduce SORE Emissions



Prior to the 2021 Amendments, summer emissions from SORE were forecasted to be nearly twice those from light-duty passenger cars in 2031.

The 2021 Amendments will result in total emission reductions of approximately 58,844 tons of NO<sub>x</sub> and 421,924 tons of ROG from 2023 through 2043, compared to the previous regulations. Such emission reductions will decrease the amount of adverse health impacts, saving Californians \$8.77 billion. The expected health benefits include 887 fewer premature deaths due to cardiopulmonary causes; 436 fewer emergency room visits for asthma; and 168 and 141 fewer acute respiratory and cardiovascular hospitalizations, respectively. SORE emission standards are set to zero in two phases, as summarized below in Table D.1.

Table D.1. New Emission Standards

<b>Equipment</b>	<b>Model year 2024-2027</b>	<b>Model year 2028+</b>
<b>Most SORE</b>	Zero	Zero
<b>Pressure washers (<math>\geq 225</math> cc) and portable generators</b>	More stringent	Zero

Appendices A and B specify the exhaust and evaporative emission standards, respectively, for model year 2024 and subsequent model year engines. The first phase begins in model year 2024, when exhaust emission standards for HC + NO<sub>x</sub> and PM for most engines are zero (0.00 grams per kilowatt hour or g·kWh<sup>-1</sup>), as shown in Table 1. Evaporative emission standards for most engines are also zero (0.00 grams per test or g·test<sup>-1</sup>) beginning in model year 2024 (Table 4). The evaporative emission standards include “hot soak” emissions (representing emissions that occur when placing a hot engine in storage after use on a hot summer day) to better evaluate emissions from real-world use of SORE equipment. These emission standards of zero apply to engines used in all equipment types except pressure washers with displacement greater than 225 cc and portable generators. Emission standards for pressure washer engines with displacement greater than 225 cc and portable generator engines are more stringent than the existing emission standards starting in model year 2024, but are not zero, as shown in Appendix A in Table A.2 and Table A.3 for exhaust emission standards and Appendix B in Table B.2 and Table B.3 for evaporative emission standards. The second phase begins in model year 2028, when the emission standards for HC + NO<sub>x</sub> and PM for pressure washer engines with displacement greater than 225 cc and portable generator engines are zero. Before emission standards are set to zero in model year 2028, staff will monitor the technological feasibility and present the review to the Board in the 2025 to 2026 timeframe.

The 2021 Amendments created the new displacement category of greater than 825 cc in order to establish the new CO emission standards for portable generator engines (except for marine generator engines) and other engines with displacement greater than 825 cc. These new CO emission standards are now aligned with the current emission standards for LSI engines with displacement greater than 825 cc, as established in § 2433(b). This ensures SORE with displacement greater 825 cc are not subject to less stringent emission standards than LSI engines with displacement greater than 825 cc. The new CO emission standards for generators with displacement less than or equal to 825 cc are based on engines already certified for sale in California. The new CO emission standards for marine generator engines are aligned with the CO emission standards for marine generator engines set by U.S. EPA in Title 40, Code of Federal Regulations, § 1054.145(n)(2). The

emission standards set by U.S. EPA have applied since model year 2013 for engine families tested with California's LEV III<sup>12</sup> certification gasoline.

The 2021 Amendments also amended existing emission reduction credit programs to improve consistency and add flexibility for manufacturers. The exhaust emission regulations include an emission reduction credit ABT program, where manufacturers can generate credits with engines that emit below the emission standards and use them to produce engines that emit above the emission standards. This averaging of emissions gives manufacturers the flexibility to certify those higher-emitting engines. Exhaust emission reduction credits may be banked for up to five years, to be used later, or may be traded with other manufacturers. The previous evaporative emission reduction credit program only included averaging and banking. Trading was added to the evaporative emission credit program in the 2021 Amendments. New zero-emission generator credit programs have been added to the ABT programs to encourage the production of zero-emission equipment, which allow manufacturers to earn emission reduction credits for zero-emission generators as well.

Other changes in the 2021 Amendments include sunseting the voluntary "Blue Sky Series" engine requirements and repealing the variance provisions in the evaporative emission regulations. The Blue Sky Standards were developed to allow manufacturers to receive recognition for certifying to lower emission standards, but CARB has no record of any manufacturer taking advantage of the program for engines. The 2021 Amendments to the evaporative emission test procedures add further instructions for a fuel tank pressure test, a new fuel cap and tether test, a tilt test to check for fuel leaks, and instructions for accelerated preconditioning of engines. The 2021 Amendments to TP-901 will ensure fuel tank testing configurations are closer to those of production fuel tanks by requiring the hole for a fuel line and grommet system to be present in the fuel tanks and requiring fuel tanks to be tested with the same production fuel cap throughout testing.

Starting with model year 2024, evaporative emission control system certification procedure CP-902 will be used for all engines, including those with displacement less than 80 cc, which previously used a different certification procedure. Most of the 2021 Amendments to the exhaust emission test procedures are intended to align them with updates to the federal test procedures that have been adopted since CARB adopted its test procedures. The 2021 Amendments also include California-specific changes necessary to maintain the stringency of California emission standards, provide internal consistency, prevent redundant effort and confusion for testers, or provide additional flexibility. For example, the requirements for exhaust emission compliance testing were changed from testing "a reasonable number of engines" to "one or more engines." Procedure text that provides examples based on equipment or fuel types that are not relevant to SORE, such as locomotives and compression-ignition engines, were removed

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<sup>12</sup> *California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles*, as last amended September 2, 2015.

to prevent confusion. References to National Institute of Standards and Technology-traceable standards were changed to Système International d'Unités-traceable standards to allow flexibility for manufacturers around the world to use other recognized international standards while still maintaining the consistency necessary to ensure test data accuracy, precision, and comparability to the emission standards.



# Appendix E

## Zero-Emission Equipment Market Growth

Zero-emission equipment (ZEE) have been available for many equipment types for decades. The level of performance, number of brands, and number of equipment options have increased greatly and continue to do so today. Battery and electric motor technology have advanced rapidly in recent years, while costs have declined for both residential and commercial lawn and garden equipment.

During the 2021 rulemaking and the Board Hearing, professional landscapers expressed concerns about the performance, run-time, durability, and high upfront cost of commercial ZEE. Battery technology advances in recent years have increased run-time and improved performance and durability providing greater confidence to professional landscapers in using only ZEE.

The availability of commercial zero-emission pressure washers was limited when the 2021 Amendments were being developed. Since then, the market has continued to develop. Cordless commercial zero-emission pressure washers are available, and more options are being developed by manufacturers. One example is by Tuffy Cleaning Systems. The Tuffy pressure washer has a 4 gallon-per-minute (gpm) flow rate operating at a pressure of 4,000 pounds per square inch (psi) and can last for 6.5 hours on a full charge,<sup>13</sup> as shown in **Error! Reference source not found.** With these new products coming to the market and manufacturers showing interest, staff expect other manufacturers to start producing more options.

Another key category of equipment is golf course maintenance equipment. An example of this is a zero-emission bunker rake, which is typically used to maintain golf courses to smooth the surface of a bunker, also known as a sand trap. Smithco now offers an industrial-grade electric bunker rake, the Sand Star E 48 volt (V) AC, that can run up to eight hours on a single charge.<sup>14</sup>

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<sup>13</sup> Tuffy Cleaning Systems. "[Zero Emissions Battery Powered Commercial Pressure Washer](https://tuffycleaningsystems.com/tuffy-cleaning-systems)." Accessed on January 31, 2024. <https://tuffycleaningsystems.com/tuffy-cleaning-systems>

<sup>14</sup> Smithco. "[Sand Star E 48V AC](https://www.smithco.com/product/sand-star-e-48v-ac)." Accessed on August 24, 2023. <https://www.smithco.com/product/sand-star-e-48v-ac>

Figure E.1. Tuffy Cleaning Systems Pressure Washer



Some equipment users have expressed concern about the availability of zero-emission log splitters. However, manufacturers are offering more options with power ratings similar to or better than gasoline-powered log splitters. Zero-emission log splitters can operate by using electricity from a standard outlet or rechargeable batteries for mobility. Some commercial operators may continue to use log-splitting devices that connect to a tractor's hydraulic system. This use is outside the scope of the SORE regulations and highlights the importance of cleaner off-road equipment in all sectors. The Boss Industrial horizontal dual-action 16-ton corded electric log splitter can split logs up to 20.5 inches long.<sup>15</sup> ELITE ENERGY 20-ton 57.6 V battery powered hydraulic log splitter is capable of splitting logs up to 16 inches in diameter and 20.5 inches in length.<sup>16</sup> Titan Attachments offers a 3-point 25-ton log splitter that attaches to a Category 1 tractor 3-point hitch to use the tractor's hydraulics to operate and can quarter wood up to 25 inches in length.<sup>17</sup> By offering these

<sup>15</sup> Boss Industrial. "[Horizontal Dual-Action 16-Ton 16.5 Amp Electric Log Splitter](https://www.homedepot.com/p/Boss%20Industrial%20Boss%20Industrial%20Horizontal%20Dual%20Action%2016%20Ton%2016%205%20Amp%20Electric%20Log%20Splitter%20ED16T21/321572748)." Accessed on December 7, 2023. <https://www.homedepot.com/p/Boss%20Industrial%20Boss%20Industrial%20Horizontal%20Dual%20Action%2016%20Ton%2016%205%20Amp%20Electric%20Log%20Splitter%20ED16T21/321572748>

<sup>16</sup> ELITE ENERGY. "[20-Ton 57.6V Battery Powered Hydraulic Log Splitter](https://www.homedepot.com/p/DK2%20ELITE%20ENERGY%2020%20Ton%2057%206V%20Battery%20Powered%20Hydraulic%20Log%20Splitter%20OPS220EV%20K/326094498)." Accessed on December 7, 2023. <https://www.homedepot.com/p/DK2%20ELITE%20ENERGY%2020%20Ton%2057%206V%20Battery%20Powered%20Hydraulic%20Log%20Splitter%20OPS220EV%20K/326094498>

<sup>17</sup> Titan Attachments. "[3 Point 25 Ton Log Splitter](https://www.homedepot.com/p/Boss%20Industrial%20Boss%20Industrial%20Horizontal%20Dual%20Action%2016%20Ton%2016%205%20Amp%20Electric%20Log%20Splitter%20ED16T21/321572748)." Accessed on December 7, 2023. <https://www.homedepot.com/p/Boss%20Industrial%20Boss%20Industrial%20Horizontal%20Dual%20Action%2016%20Ton%2016%205%20Amp%20Electric%20Log%20Splitter%20ED16T21/321572748>

different power source options, zero-emission log splitters meet a range of user needs and environmental considerations. Users can choose the power source that best suits their specific requirements, whether it's the convenience of plugging into an outlet, the portability of battery power, or the adaptability of connecting to a tractor's hydraulic system.

The zero-emission generator market is continuing to grow. More manufacturers are entering the market as consumers demand zero-emission options. Atlas Copco, a manufacturer of engine-powered construction equipment, among other products, has launched new zero-emission generators that are powered by batteries. Depending upon the application, the units can deliver more than 12 hours of power from a single charge. Some models can be charged in less than one hour. Other models may be daisy-chained together to form a microgrid supplying more power.<sup>18</sup> These zero-emission generators will likely see extensive use at construction sites, where crews frequently need portable power supplies to power their tools. The reduced noise that comes from using zero-emission generators instead of SORE or diesel-fueled generators will decrease noise pollution from construction sites and benefit construction workers and communities surrounding construction sites. Other examples include:

Firman has introduced their new line of ZERO-E portable power stations with continuous power of 2,000 watts (W) and a peak power of 4,000 W for demanding needs, as shown below in **Error! Reference source not found.**. This modular system features slide locking technology to effortlessly expand up to 10 portable power packs. The ZERO-E is expected to retain 80% or more of its original energy capacity after 4,000 charge cycles, and power may be doubled with parallel support.<sup>19</sup>

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<sup>18</sup> Julian Buckley. "[Atlas Copco introduces new battery energy storage systems.](https://www.newpowerprogress.com/news/atlas%20copco%20introduces%20new%20battery%20energy%20storage%20systems/8030148.article#:~:text=The%20Power%20and%20Flow%20division,construction%20sites%20and%20similar%20locations)" Accessed on August 24, 2023. <https://www.newpowerprogress.com/news/atlas%20copco%20introduces%20new%20battery%20energy%20storage%20systems/8030148.article#:~:text=The%20Power%20and%20Flow%20division,construction%20sites%20and%20similar%20locations>

<sup>19</sup> Firman Power Equipment. "[ZERO E Portable Expandable Power Station.](https://firmanpowerequipment.com/collections/zero-e/products/e201001)" Accessed on December 4, 2023. <https://firmanpowerequipment.com/collections/zero-e/products/e201001>

Figure E.2. Firman ZERO E Portable Power Station



Makinex has launched the Portable Power Box that offers continuous power up to 8 kilowatts (kW) with 15 kWh of battery capacity. The device provides three power outlets with a capacity of 15 amps each, along with two USB outlets delivering 5 V. Its storage capacity is derived from three 48 V lithium-ion batteries, which can be completely charged within 9 hours, either through a 240 V receptacle or using solar panels.<sup>20</sup>

Oncore Energy makes fuel cell generators with various energy storage capacities suitable for residential users and commercial applications, as shown below in a mobile trailer in **Error! Reference source not found.** Residential users have access to many scalable versions of the Oncore system to provide back-up power for homes. Utilities and municipalities are beginning to use the commercial hydrogen fuel cell generators to power telephone and internet connectivity and traffic lights. System sizes for both residential and commercial generators start at 4 kW and increment to 8 kW, 12 kW, 16 kW, and 20 kW or more. Commercial fuel cell generators may go up to 100 kW or more. These hydrogen fuel cell systems may be outfitted with an electrolyzer to convert solar or wind energy to hydrogen, adding to the energy available.<sup>21</sup>

<sup>20</sup> Makinex. "[Portable Power Box \(PPB\)](https://www.makinex.com/products/portable-power-box)." Accessed on December 11, 2023. <https://www.makinex.com/products/portable-power-box>

<sup>21</sup> Oncore Energy. "[The future of reliable, clean energy in America. Oncore Energy: Premium hydrogen fuel cell microgrid](https://oncoreenergy.com/)." Accessed on September 11, 2023. <https://oncoreenergy.com/>



Figure E.3. Oncore Energy Fuel Cell Generator

