



Clean Technology Adoption in Off-Road Sector

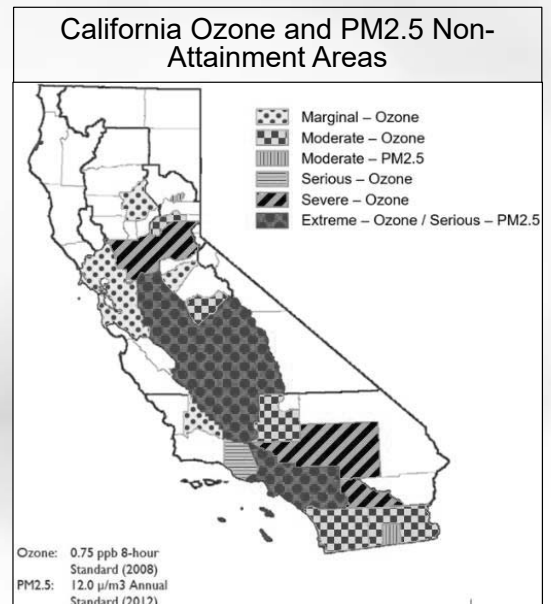
2022 AQMP Mobile Source Working Group

April 7, 2021

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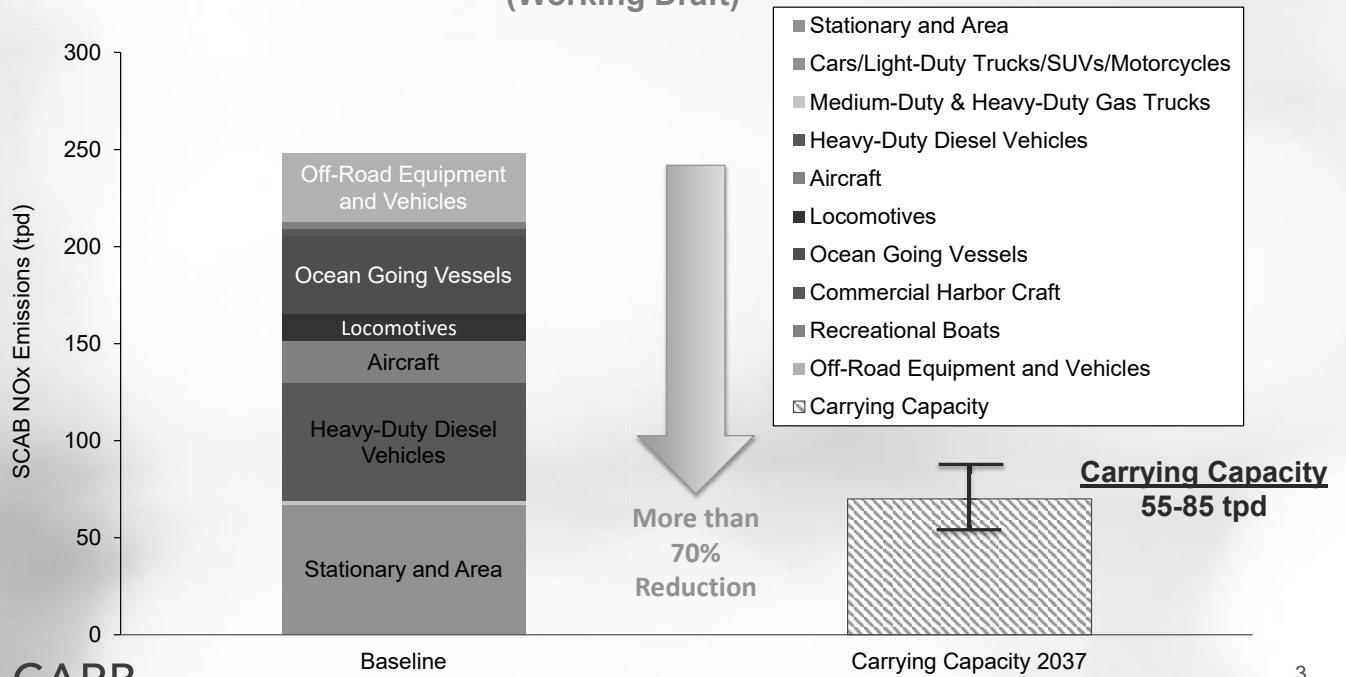
Major NO_x and PM_{2.5} Emission Reductions Needed

- California has the worst air quality in the nation
- Key challenges
 - San Joaquin Valley – PM_{2.5}
 - South Coast - Ozone
- Off-road equipment are one of the largest contributors
- Actions beyond current programs needed to meet air quality goals in various regions



South Coast 2037 Attainment

(Working Draft)



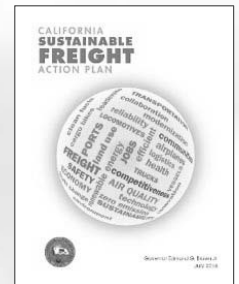
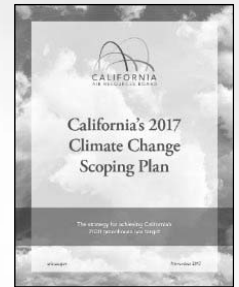
Disadvantaged Community Focus

- Assembly Bill 617 directs CARB to identify community level strategies
- Communities seek rapid transition to zero-emissions



Zero-Emission Key to California's Future

- Multiple criteria, air toxics, and climate pollutant emissions reduction plans
- Core strategies
 - Zero-emissions everywhere feasible
 - Cleaner fuels and cleaner combustion everywhere else



Executive Order N-79-20

Full transition to **ZE off-road equipment** by 2035*
 *where feasible

100% ZEV sales by 2035

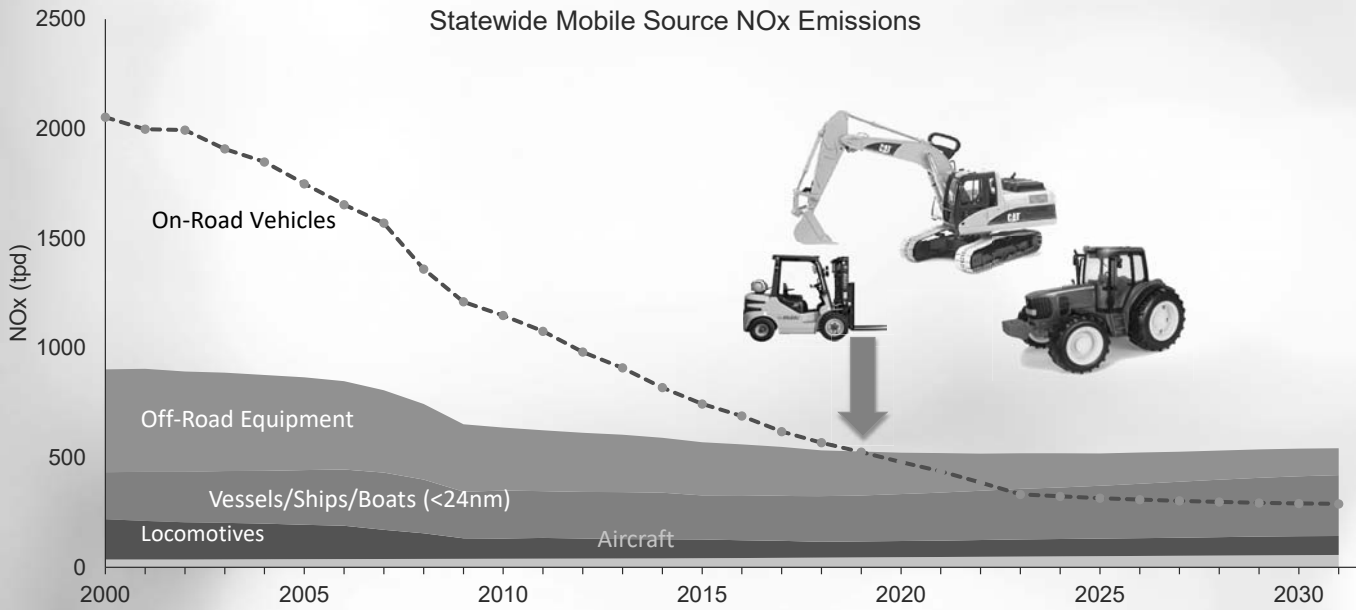
Full transition to **ZEV short-haul/drayage trucks** by 2035

Full transition to **ZEV buses & heavy-duty long-haul trucks** by 2045*

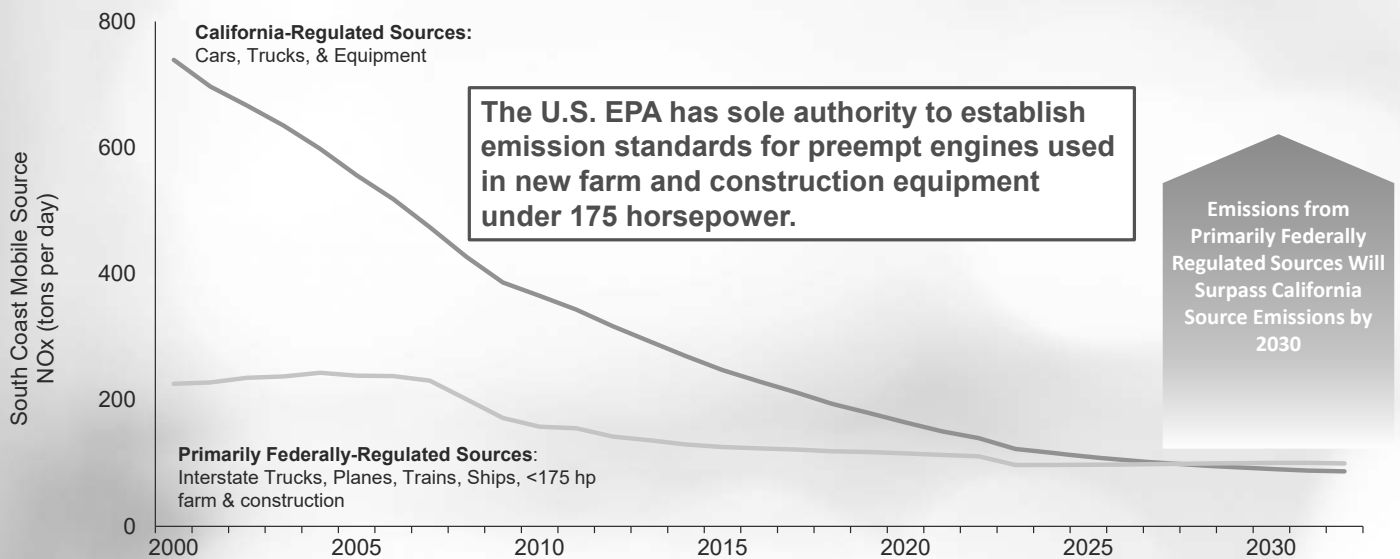
Transition of all off-road equipment operations to zero-emission where feasible by 2035

Strategies, in coordination with other State agencies, U.S. Environmental Protection Agency and local air districts, to achieve 100 percent zero-emission from off-road vehicles and equipment operations in the State by 2035.

Growing Importance of Off-Road



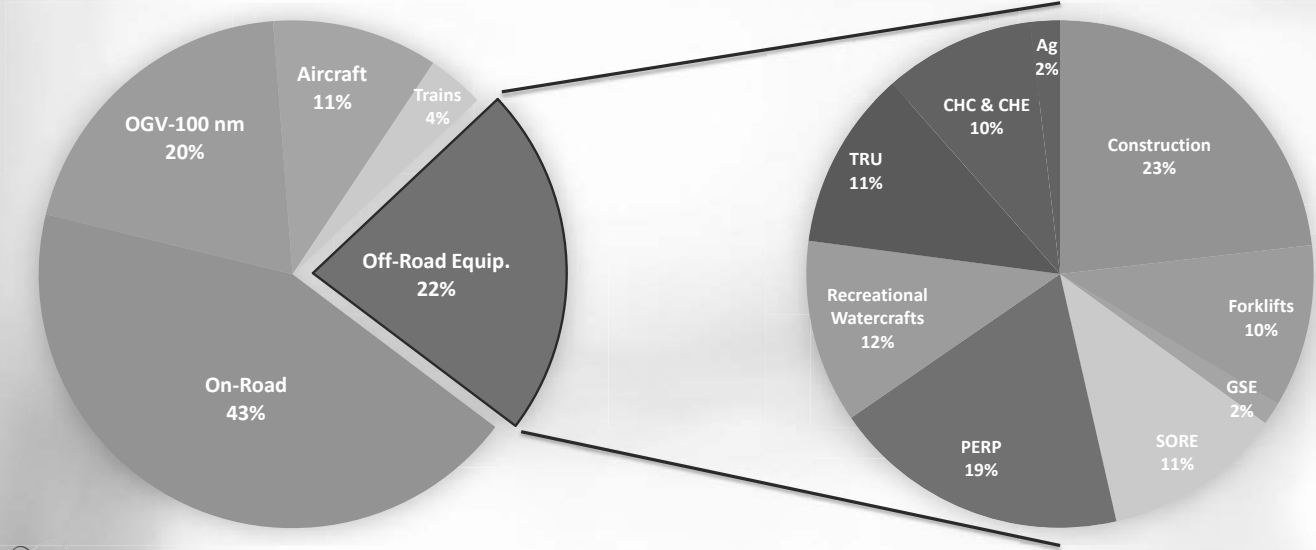
Controlling Federal Sources is Critical to Achieving our Clean Air and Climate Targets



Off-Road NOx Emission Contribution

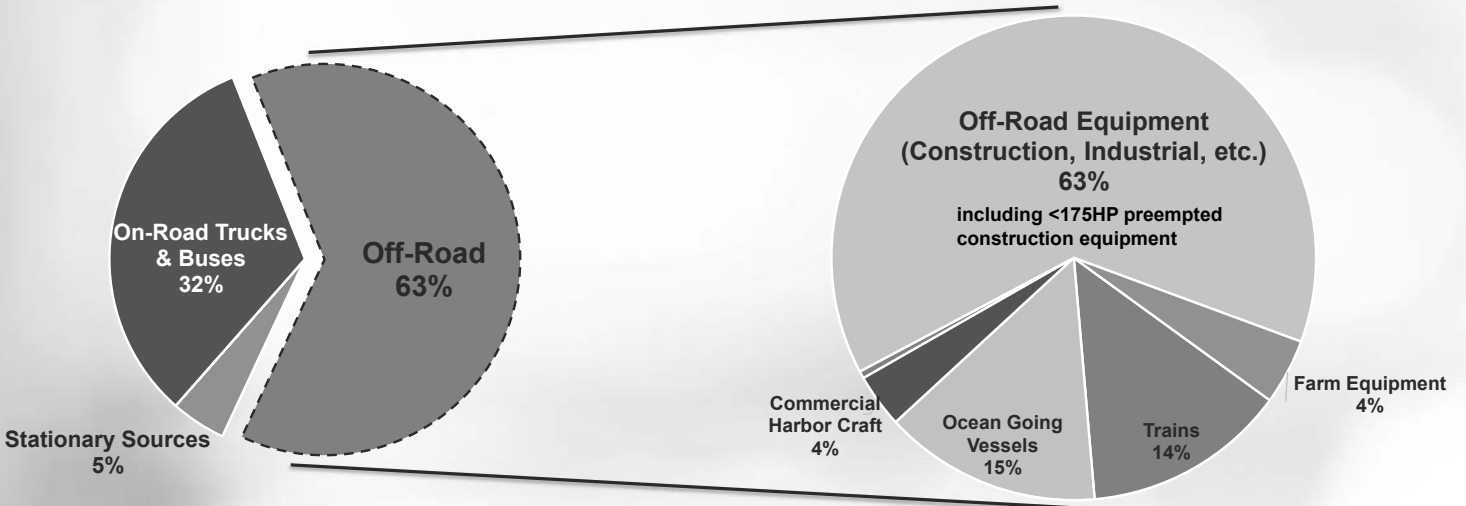
Mobile Source NOx emissions in SC in 2037

Off-Road Equipment NOx emissions in SC in 2037



Off-Road Diesel PM Emission Contribution

Diesel PM emissions in SC in 2020



Zero-Emission Technology



Low HP Construction & Agricultural equipment



- Most current commercialized electric equipment are under 150 HP

- Mobile battery solutions may play key role in solving infrastructure limits



- Under 100 hp tractors and forklifts have potential for electrification

- Federal preemption to set emission standards for preempt engines used in new farm and construction equipment under 175 horsepower.

Portable equipment



- Portable diesel-fueled engines with a rated brake horsepower of 50 and greater (≥ 50 bhp)
- Fuel cells have shown long term potential, additional research and demos needed

Cargo Handling Equipment



- Electric Top-pick and yard tractors at ports and intermodal railyards
- Battery electric forklifts
- Hydrogen fuel cell forklifts show potential as well

TRUs



- In-use emission regulation
- Full electrification of truck TRUs by 2034 (regulatory proposal)
- Full electrification of trailer TRUs (2020 MSS proposal)

Hybridization

OGVs



- Demo hybrid auxiliary engine
- If we include hybrid auto carrier and Roro vessels, the OGV sector has a potential to reduce diesel use by 35%



- Clean Off-Road Equipment Voucher Incentive Project
- Hybrid RTG cranes offer 40% fuel savings



Locomotives



- Demonstration projects for fuel cell-powered line-haul and switcher locomotives in 2025
- Battery electric demo starts in 2021 (switcher) and 2022 (line haul)
- SBCTA Fuel-cell MU passenger locomotive demo in 2022
- Caltrans aims to reduce 35% of the total fuel usage per passenger train mile by 2030

Construction & Agricultural Equipment



- Many construction and agricultural demo cases have shown common hybrid modules used with a similar range of horsepower
- On average, 25% of efficiency improvement due to hybridization
- 400 ~ 600 hp construction and agricultural equipment types may find interim solution in hybridization

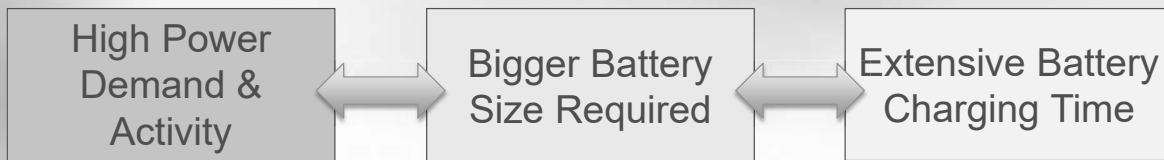
CHCs



- Hybrid Tug, Ferry, and Excursion units comprise 49% of the total diesel consumption of the sector
- In-use short run ferries become zero-emission by 2028 (9% of ferries)
- Potential for all tugs to go to diesel-electric (~20% efficiency gain) by 2030, all excursion vessels go to plug-in hybrid by 2030

Key Technical Barriers for Off-Road Electrification

- Pace of commercialization
 - Technology readily available
 - Some equipment types commercially available, others in demonstration phase
- Limited access to charging infrastructure
- Operational limitations



Existing Market Potential for Zero-Emission Construction Equipment

- Various construction equipment types have demonstrated a high potential of clean technology adoption according to previous and on-going demo projects.
- Similar horsepower ranges to electrified on-road heavy-duty applications; some transferability of technologies
 - Semi-truck HP range: 400~600HP
 - 175 HP and lower CE types → higher electrification potential
- Additional demonstration projects for higher horsepower ranges are key

Hybrid Construction Equipment Demonstrations

Caterpillar's large hybrid excavator

- Caterpillar hybrid excavator (336F H, 2014)
- 30% fuel savings compared with the similarly sized baseline machine without hybrid technology.



Volvo CE's electric hybrid wheel loader

- Volvo Construction Equipment hybrid electric wheel loader (LX1, 2016)
- 50~55% fuel efficiency improvement
- 33~35% GHG emission reduction compared to Volvo CE's diesel-powered base model.



Examples of Zero Emissions Construction Equipment (1)

- PON/CAT Z-line 323F excavator
- Full battery electric
- 164 hp
- 300 kWh energy storage
- Units in service in Norway and Netherlands
- Purchasable today



<https://www.pon-cat.com/no/pon-equipment/nyheter/z-line>

Examples of Zero Emissions Construction Equipment (2)

- JCB 220X
- Hydrogen Fuel Cell 20 ton excavator prototype
- In proving grounds testing for >18 months



<https://www.jcb.com/en-gb/news/2020/07/jcb-leads-the-way-with-first-hydrogen-fuelled-excavator>

Examples of Zero Emissions Construction Equipment (3)

- Volvo EX02
- Fully electric compact excavator prototype
- 38 KWh energy storage
- Enough to operate the machine for eight hours in an intense application



<https://www.volvoce.com/global/en/this-is-volvo-ce/what-we-believe-in/innovation/prototype-electric-excavator/>

Examples of Zero Emissions Construction Equipment (4)

- CASE Project Zeus Backhoe
- Battery powered electric backhoe
- 90 KWh energy storage
- Capable of typical 8hr workday
- Purchasable today



[Link 1: https://www.constructionequipment.com/case-580-ev-fully-electric-backhoe-loader?oly_enc_id=8464A9098134D5C](https://www.constructionequipment.com/case-580-ev-fully-electric-backhoe-loader?oly_enc_id=8464A9098134D5C)

[Link 2: https://www.casece.com/northamerica/en-us/resources/articles/media-case-unveils-project-zeus-580ev-first-fully-electric-backhoe-loader](https://www.casece.com/northamerica/en-us/resources/articles/media-case-unveils-project-zeus-580ev-first-fully-electric-backhoe-loader)

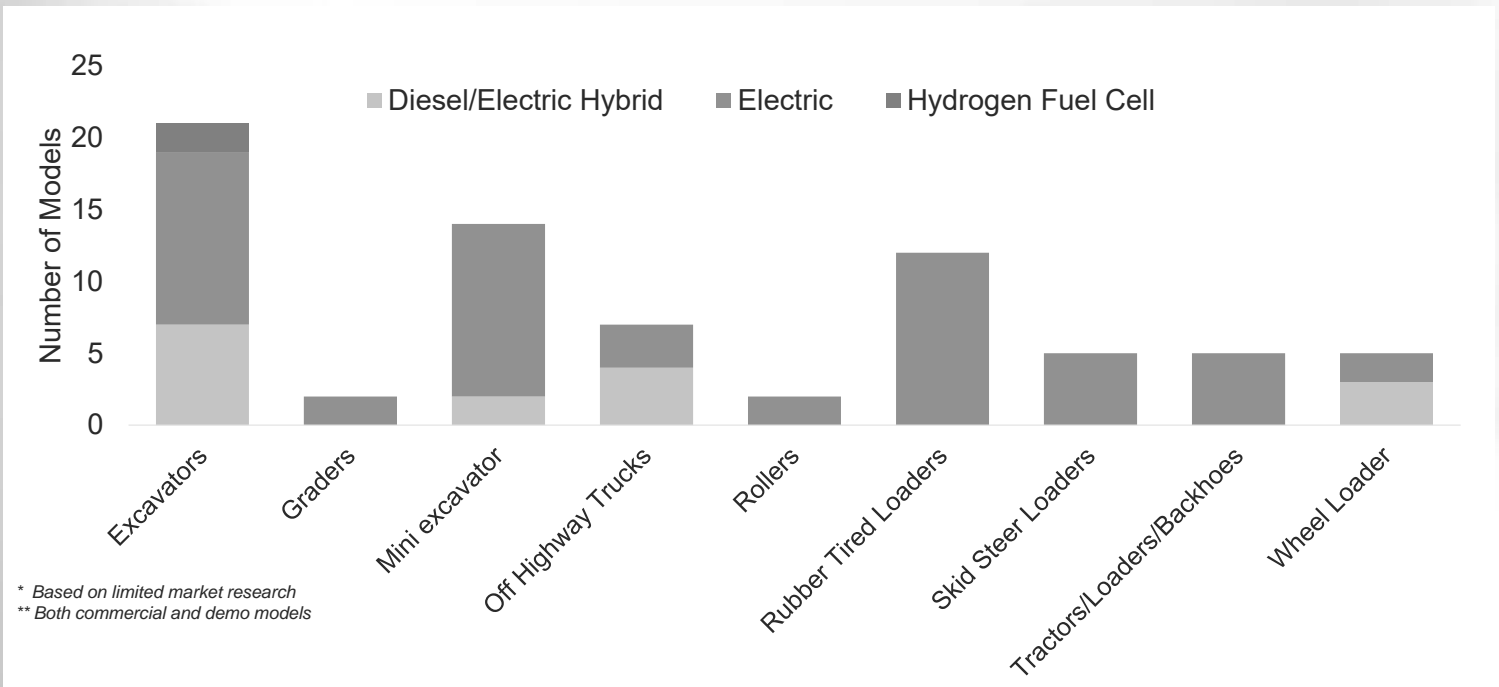
Examples of Zero Emissions Construction Equipment (5)

- Volvo L25
- Electric Compact Wheel Loader
- 39 KWh energy storage
- Enough to operate the machine for eight hours
- Expected charging time of 2 hours (Off board charging time 400 VAC 32A)



<https://www.volvoce.com/united-states/en-us/products/electric-machines/l25-electric/#overview>

Current Technology Availability: Construction



Assessing Electrification and Hybridization Potential

Hybridization

- Current commercially available technologies and demonstration projects provide application horsepower ranges

Electrification

- Horsepower ranges of currently available commercial models and demos
- Review of current battery capacity and charging times
- Research on daily and maximum power use from different construction and off-road applications
- Determining where current battery technology could meet power requirements

AN EXAMPLE OF ELECTRIFICATION FEASIBILITY ASSESSMENT

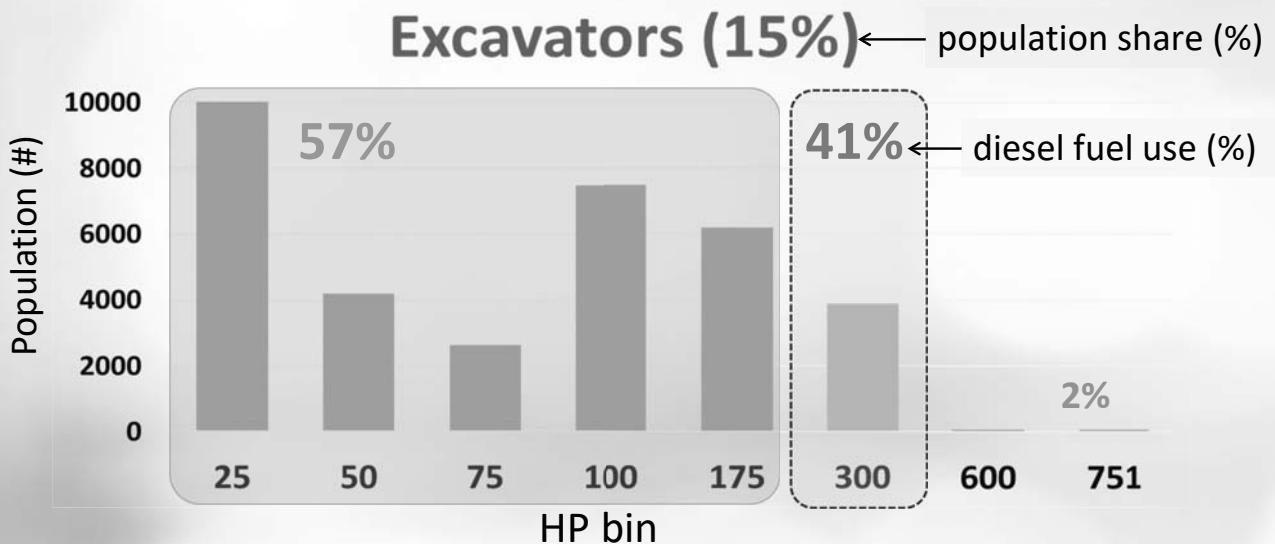
1. Assess power needs from ECU data, including peak power and daily energy use

Equipment Type	Equip. ID	HP Bin of the equipment	Total Operating Hours (hrs)	Mean Daily Fuel Use (gal/day)	Hours per Day
Excavator	3	175	256.1	20.21	1.75
Grader	4	300	13.3	0.98	0.15
Off-Highway Tractor	9	600	223.7	137.04	7.99

2. Determine battery size and charging times required to meet demand (in some cases, *current* technology has prohibitive battery size or charging needs for full electrification)

Equipment Type	Battery Size (kWh)		Charging Time with 50 kW Charger (Hour)	
	Minimum	Maximum	For Minimum Battery Size	For Maximum Battery Size
Excavator	387	420	8	8
Grader	54	60	1	1
Off-Highway Tractor	2,283	2,711	46	54

Horsepower Ranges for Existing Clean Technologies

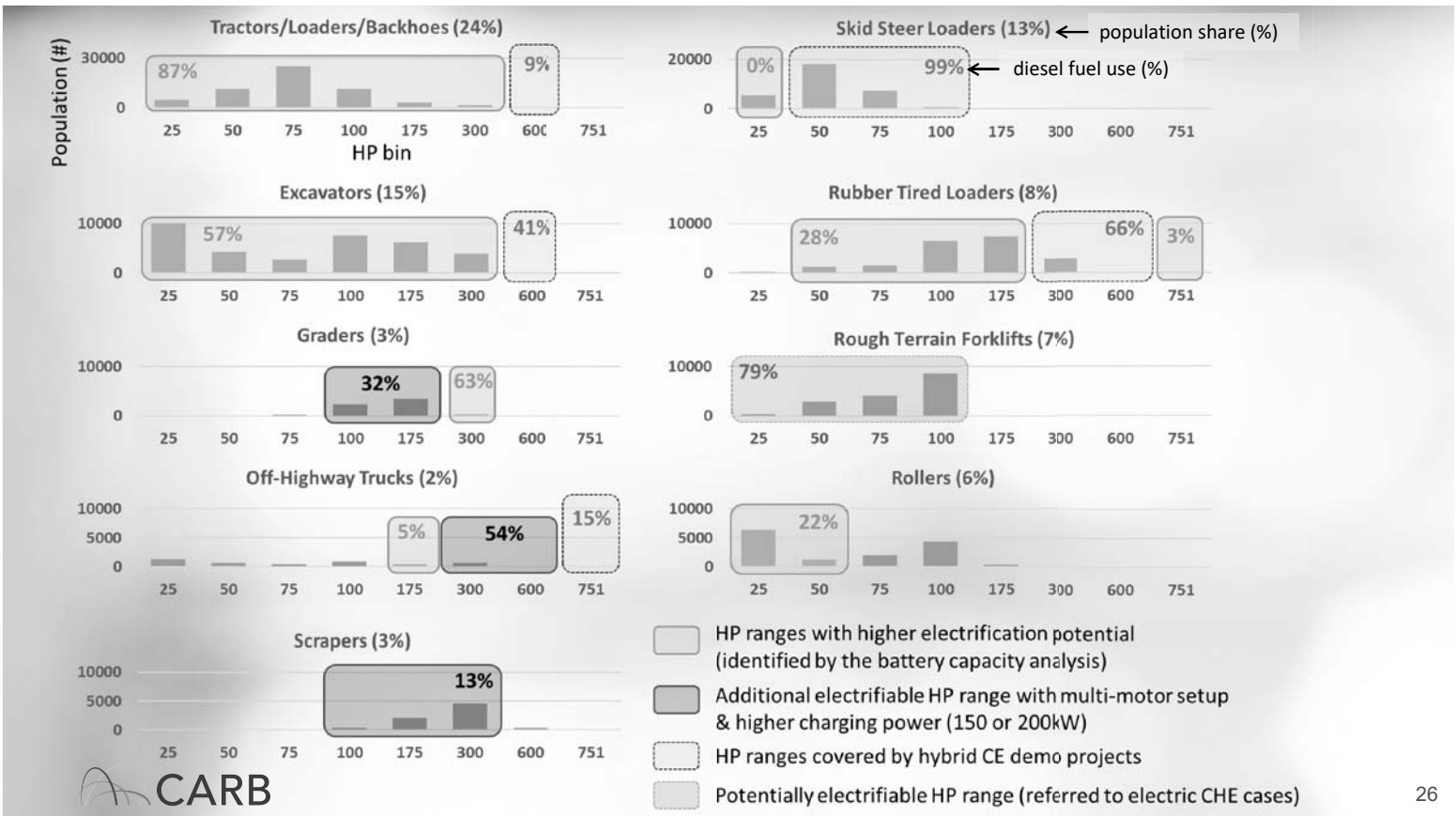
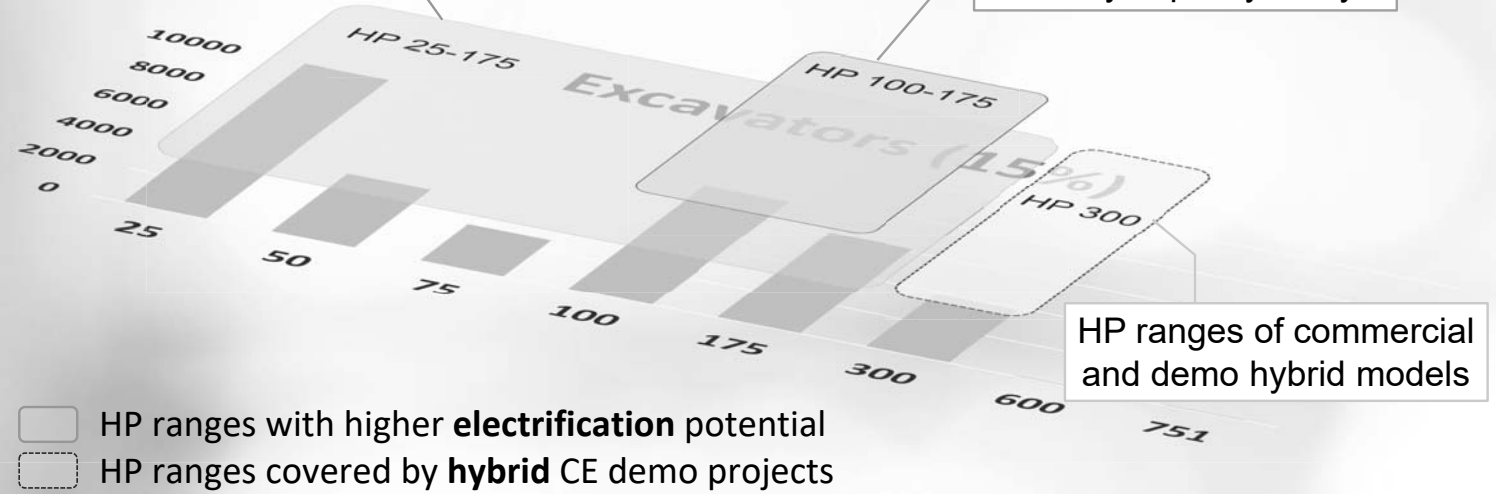


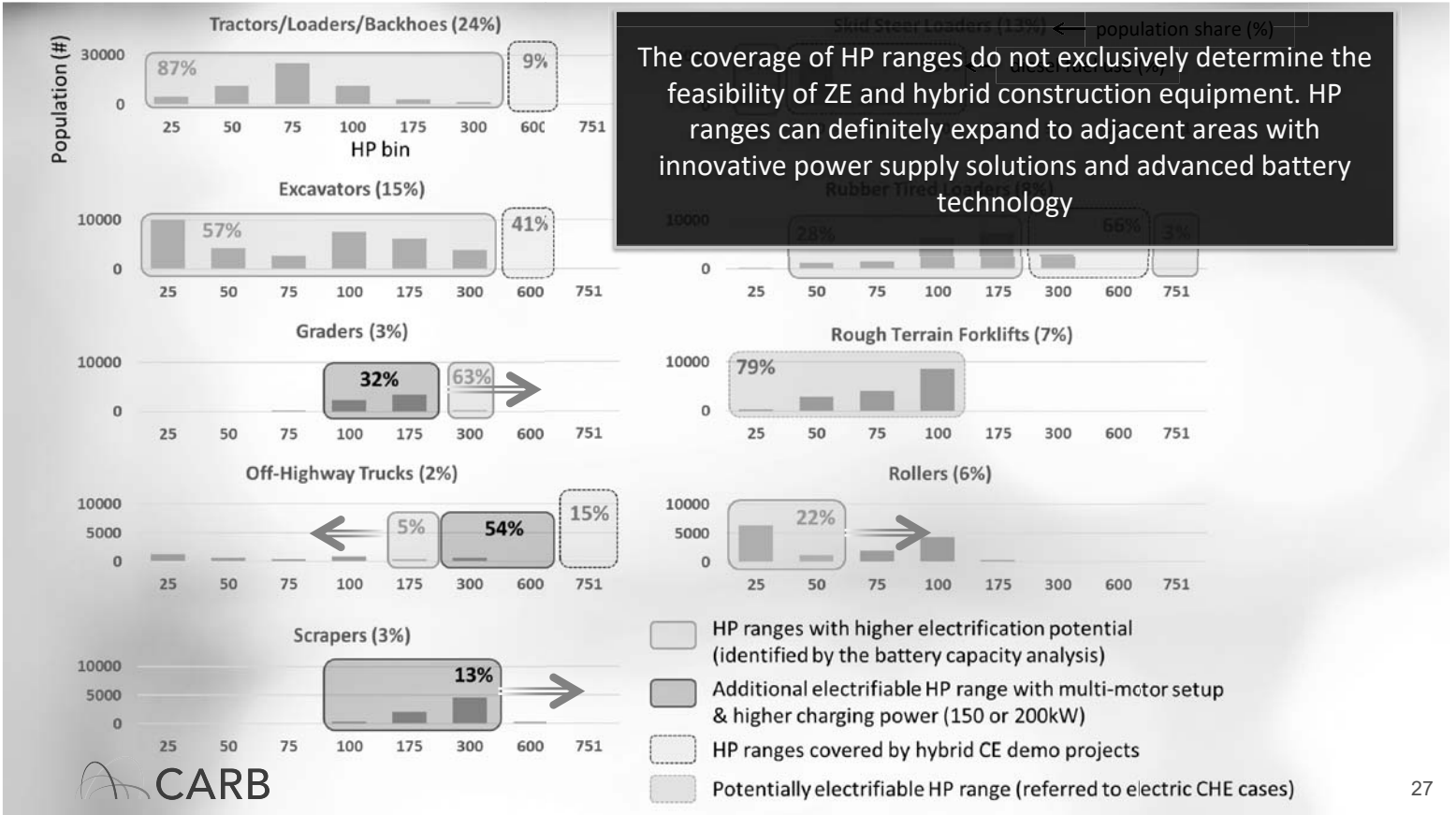
- HP ranges with higher **electrification** potential
- HP ranges covered by **hybrid** CE demo projects

Horsepower Ranges for Existing Clean Technologies

HP ranges of commercial and demo electric models

HP ranges based on the battery capacity study





Potential Fuel Savings

Construction & Mining Equipment Type	Horsepower Range		Fuel Use by Segment (gpy)		Fuel Share (%)		Baseline Fuel Use (gpy)	Alt. Fuel Use (gpy)	Fuel Reduction (gpy)	% of Reduced Fuel Use
	Electrification	Hybridization	Electrification	Hybridization	Elec.	Hybrid.				
Crawler Tractors	-	-	-	-	0%	0%	15,853,308	15,853,308	-	0%
Excavators	25-300	600	16,332,089	11,607,735	57%	41%	28,525,577	3,487,686	25,037,891	88%
Graders	300 (100-175)	-	6,708,850		95%	0%	10,731,276	572,943	10,158,333	95%
Off-Highway Tractors	175 (300-600)	751 <	7,108,569	-	59%	15%	36,179,004	10,920,025	25,258,980	70%
Rollers	25-50	-	1,071,497	-	22%	0%	4,931,572	3,860,075	1,071,497	22%
Rough Terrain Forklifts	25-100	-	4,246,152	-	79%	0%	5,353,663	1,107,512	4,246,152	79%
Rubber Tired Loaders	50-175 & 751<	300-600	13,583,010	28,796,492	31%	66%	43,489,540	8,309,160	35,180,379	81%
Scrapers	(100-300)	-	-	-	13%	0%	28,325,209	24,659,142	3,666,067	13%
Skid Steer Loaders	25	50-100	-	5,111,444	0%	99%	5,185,890	1,352,307	3,833,583	74%
Tractors/Loaders/Backhoes	50-300	600 (300-600)	34,508,455	3,743,397	87%	9%	39,626,931	2,310,928	37,316,003	94%
Diesel use of the TOP 10 equipment types (gpy) (87% of the entire sector)							218,201,971	72,433,086	145,768,885	67%
Diesel use of the entire Construction and Mining sector (gpy)							251,421,757	105,652,873	145,768,885	58%

- If the entire population of the target segments are fully electrified or hybridized (i.e., by 2050), it is expected to achieve 58% fuel savings

Need for Zero-Emission Infrastructure Planning

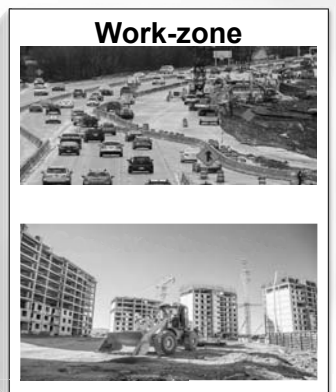
- A reliable infrastructure system is essential for zero emission technologies to achieve widespread growth
- Infrastructure needs, charging standards/connections, and power capacity needs vary widely, and are under various stages of development by source category
- In some off-road applications such as construction or agriculture, access to the grid may be nonexistent
- Innovative solutions are needed to overcome these barriers: mobile and ground power units
- Collaborate and engage facilities, utilities, and other agencies in zero-emission planning discussions

Mobile Battery Solution for Construction Equipment

- Much of the equipment is too heavy to make re-charging trips every day
- Various construction sites may not have stationary power supply
- Mobile batteries provide on-site charging solutions
- 7 mobile and ground power units are available through CORE



Mobile battery pack on wheels



Potential Mobile Power Supply Solutions

- Portable hydrogen fuel cell power generator
- Charging service van
- Portable off grid solar chargers
- Efficient fast charging strategy for peak-shaving in a limited grid connection condition
- Battery and tank swapping technologies



The Olav Vs Gate construction site in Oslo, Norway, is a zero-emissions project with ZERON ZE85US (9t) and ZE160LC (17.5t) electrified excavators built by NASTA AS. Courtesy of NASTA AS

Potential Strategies

Voucher Incentives for Clean Off-road Equipment

Expand eligibility for voucher incentives through Clean Off-Road Equipment.
Funding for zero-emission off-road construction equipment.

Zero-Emission Forklift Requirements

(Board Date: 2022)

In-Use Requirements for forklifts to transition to zero emissions. Zero emissions equipment is option for replacement.

In-Use Off-Road Diesel Vehicle Amendments

(Potential Board Date: 2023)

Focused on phasing out Tier 0 to Tier 2 equipment

Potential Strategies (continued)

Green Fleet Recognition Program

(Action by: 2025)

Voluntary program for recognition of cleanest fleets, with an emphasis on zero emissions. Would allow public agencies and partnerships to choose fleets with minimal environmental impact.

Off-Road Tier 5 Engine Standards

(Potential Board Date: 2024)

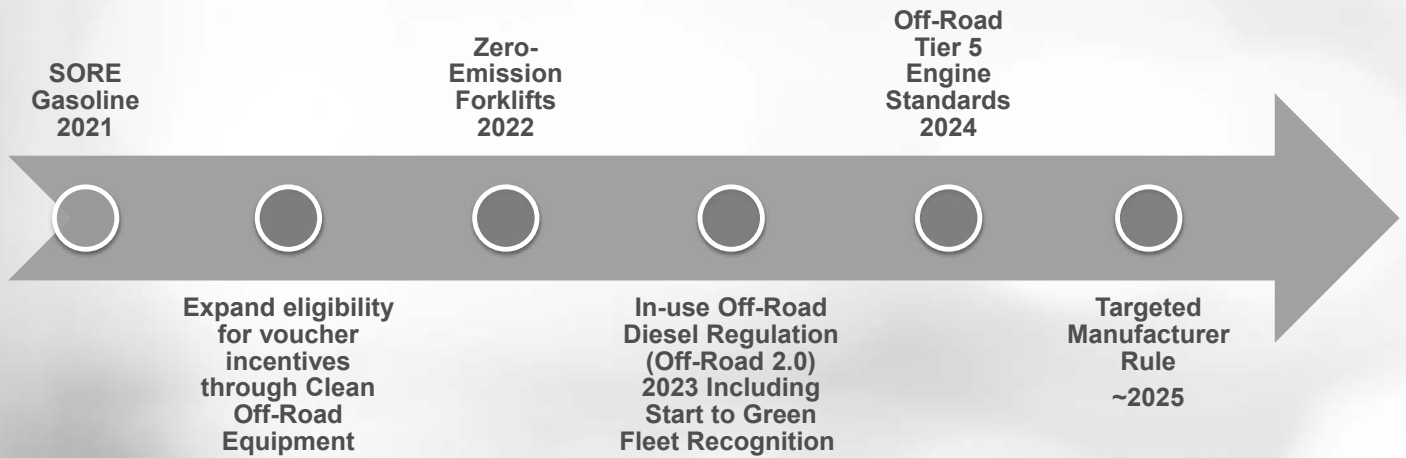
New NOx, PM, and GHG standards, and considering off-road diesel OBD requirements. May include powertrain certification, and/or credits.

Targeted Zero-Emission Off-Road Equipment Production

(Potential Board Date: 2025)

Manufacturer requirements for production of zero-emission off-road equipment. Sales/production mandate levels based on the projected feasibility of zero-emission technology in the various off-road equipment types.

Strategies Timeline



Questions, Comments, Feedback

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Metro's Green Construction Policy: Program Overview

April 7th, 2021

Shannon Walker, ENV SP
Senior Environmental Specialist, LA Metro



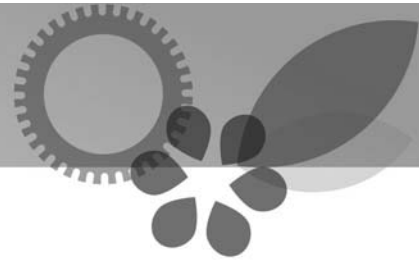
About the GCP

Why was the GCP created?

- Air quality impacts human health.
- The U.S. EPA and the International Agency for Research on Cancer (IARC) have classified diesel exhaust as a potential human carcinogen.
- Diesel engines are a major source of harmful air pollutants.
- Increased planned construction activity from passing of Measure R in 2008.



GCP Purpose and Goal



Purpose

- *To identify and mitigate diesel exhaust emission impacts on human health and the environment to the greatest extent feasible.*

Application

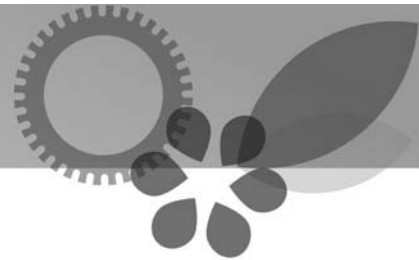
- Applies to on-road vehicles, off-road equipment, and portable generators used for Metro Construction Projects and at Metro Rights-of-Way.
- Part of the requirements for funding capital projects for other jurisdictions when applying for transportation funds.

Goal

- To reduce harmful diesel exhaust emissions such as Particulate Matter (PM), Nitrogen Oxides (NO_x), and Carbon Dioxide equivalent (CO₂e) while minimizing impact to construction project costs and schedules.



GCP Regulatory Compliance



California Air Resources Board (CARB) Compliance

- Truck and Bus Regulations
- Off-Road Diesel Regulation
- Large Spark Ignition Fleet
- DOORS Reporting
- PERP



GCP Specification Requirements



Metro Construction Specifications

- The GCP was incorporated into Metro Construction Specifications in May 2012.

Key Requirements



Off-Road Diesel-Powered Construction Equipment
≥ 50 BHP, Must Meet Tier 4 Off-Road Emission Standards



On-Road Diesel-Powered Vehicles
GVWR ≥ 19,500 lbs.
Must Meet EPA 2010 or greater On-Road Emission Standards



Portable Generators
≥ 50 BHP, Permitted/Registered w/ BACT for PM Emissions

GCP Specification Requirements



Additional Requirement: Renewable Diesel

- Mandated use of Bulk Renewable Diesel (R-99) in lieu of Petroleum Diesel (exceptions may apply based on start date of project).
- Aligned with Department of General Services (DGS) MM 15-07.

Best Management Practices

- Use electric power instead of diesel power (when available).
- Limit idling to five (5) consecutive minutes.
- Maintain 1000 feet between Truck Traffic and Sensitive Receptors.

GCP Specification Requirements



Exceptions

- Construction equipment that is part of a small fleet (less than or equal to 2,500 HP).
- Construction equipment required for use at locations defined as “gassy” per Cal/OSHA (must contain lowest emitting MSHA-approved engines or technically feasible)
- On-road equipment or vehicles part of a small fleet (fleet size of 1-3 vehicles); must comply with CARB requirements for small fleets.
- The Contractor has attempted to lease the vehicle or equipment that would comply with this policy, but that vehicle or equipment is not available for lease or short-term rental within 200 miles of the project site
- Exceptions are valid for one year from time of equipment use on-site – updated exception letters must be annually resubmitted to Metro for review.



GCP Specification Requirements



Conformance

- Metro conducts periodic inspections of sites and construction equipment.
- Metro provides assistance to help contractors to meet requirements.

Key Submittals

- Certification of Compliance
- Construction Equipment Information List
- Monthly Fuel Use Log for all equipment used on-site.
- CARB Registration or SCAQMD Permits for Portable Equipment
- Notification within 14 days of new equipment and/or vehicles



GCP Specification Requirements

GCP On-Site Inspections



CARB EIN numbers



Gross Vehicle Weight Rating



Portable Equipment
Registration Program



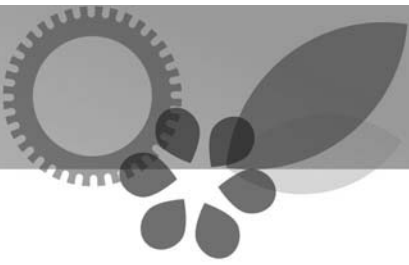
GCP Training

On-Site Training for Contractors

- Training is provided to contractors on Metro's GCP specification and applicable CARB regulations regularly and often.
- Training is always available on an as-needed basis and is determined by the project's assigned Metro Environmental PM.
- For all segments pertaining to CARB, a CARB representative conducts the training.



GCP Emissions Impacts



Emissions Calculations

- Fuel usage as reported by each project is compiled to calculate annual emissions of NO_x, PM, and CO₂e.
- Emissions are compared between baseline emissions (Tier 2) and specific/actual emissions (Tier 4).

Item	Year	City	County	Equipment	Model	HP	Use	Hours	Flow Rate (GPH)	New Specific (lb/hr)	CO ₂ e Base (lb/hr)	CO ₂ e Specific (lb/hr)	PM10 Base (lb/hr)	PM10 Specific (lb/hr)	NO _x Base (lb/hr)	NO _x Specific (lb/hr)	
1	2019	San Diego	San Diego	Tractor/Loader/Backhoes	100	107	TAI	7.62	4.28	1,045.97	0.23	0.05	0.05	1.14	0.17		
2	2019	San Diego	San Diego	Excavators	100	107	TAI	20.31	11.95	2,988.18	0.63	0.04	0.04	0.90	0.44		
3	2019	San Diego	San Diego	Excavators	200	107	TAI	8.8	5.58	1,415.75	0.30	0.02	0.02	0.35	0.18		
4	2019	San Diego	San Diego	Excavators	300	107	TAI	52.58	31.17	7,899.87	1.27	0.02	0.02	1.25	0.25		
5	2019	San Diego	San Diego	Excavators	400	107	TAI	11.39	7.95	2,044.62	0.39	0.01	0.01	0.39	0.18		
6	2019	San Diego	San Diego	Excavators	500	107	TAI	24.73	13.81	3,532.20	0.78	0.01	0.01	0.89	0.34		
7	2019	San Diego	San Diego	Excavators	600	107	TAI	27.1	15.06	3,857.25	0.86	0.01	0.01	0.99	0.39		
8	2019	San Diego	San Diego	Excavators	700	107	TAI	38.84	21.46	5,532.20	1.27	0.01	0.01	1.39	0.74		
9	2019	San Diego	San Diego	Excavators	800	107	TAI	4.60	2.48	624.11	0.14	0.01	0.01	0.64	0.10		
10	2019	San Diego	San Diego	Excavators	900	107	TAI	1.89	1.07	275.99	0.06	0.01	0.01	0.24	0.08		
11	2019	San Diego	San Diego	Excavators	1000	107	TAI	17.82	10.19	2,537.61	0.53	0.01	0.01	0.64	0.34		
12	2019	San Diego	San Diego	Tractor/Loader/Backhoes	200	107	TAI	4.84	2.75	706.87	0.15	0.01	0.01	0.17	0.09		
13	2019	San Diego	San Diego	Tractor/Loader/Backhoes	300	107	TAI	37.58	2.35	5,538.18	0.12	0.01	0.01	0.61	0.45		
14	2019	San Diego	San Diego	Tractor/Loader/Backhoes	400	107	TAI	37.58	2.55	5,538.18	0.12	0.01	0.01	0.68	0.48		
15	2019	San Diego	San Diego	Tractor/Loader/Backhoes	500	107	TAI	38.84	2.67	5,615.74	0.12	0.01	0.01	0.81	0.48		
16	2019	San Diego	San Diego	Tractor/Loader/Backhoes	600	107	TAI	18.82	1.37	2,537.61	0.09	0.01	0.01	0.49	0.22		
17	2019	San Diego	San Diego	Tractor/Loader/Backhoes	700	107	TAI	18.82	1.57	2,537.61	0.09	0.01	0.01	0.49	0.22		
18	2019	San Diego	San Diego	Tractor/Loader/Backhoes	800	107	TAI	18.82	1.77	2,537.61	0.09	0.01	0.01	0.49	0.22		
19	2019	San Diego	San Diego	Tractor/Loader/Backhoes	900	107	TAI	18.82	1.97	2,537.61	0.09	0.01	0.01	0.49	0.22		
20	2019	San Diego	San Diego	Tractor/Loader/Backhoes	1000	107	TAI	18.82	2.17	2,537.61	0.09	0.01	0.01	0.49	0.22		
21	2019	San Diego	San Diego	Skid Steer Loaders	100	107	TAI	8.8	0.87	0.88	0.04	0.01	0.01	0.04	0.03		
22	2019	San Diego	San Diego	Skid Steer Loaders	200	107	TAI	8.8	0.87	0.88	0.04	0.01	0.01	0.04	0.03		
23	2019	San Diego	San Diego	Skid Steer Loaders	300	107	TAI	8.8	0.87	0.88	0.04	0.01	0.01	0.04	0.03		
24	2019	San Diego	San Diego	Skid Steer Loaders	400	107	TAI	8.8	0.87	0.88	0.04	0.01	0.01	0.04	0.03		
25	2019	San Diego	San Diego	Skid Steer Loaders	500	107	TAI	8.8	0.87	0.88	0.04	0.01	0.01	0.04	0.03		
26	2019	San Diego	San Diego	Skid Steer Loaders	600	107	TAI	8.8	0.87	0.88	0.04	0.01	0.01	0.04	0.03		
27	2019	San Diego	San Diego	Skid Steer Loaders	700	107	TAI	8.8	0.87	0.88	0.04	0.01	0.01	0.04	0.03		
28	2019	San Diego	San Diego	Skid Steer Loaders	800	107	TAI	8.8	0.87	0.88	0.04	0.01	0.01	0.04	0.03		
29	2019	San Diego	San Diego	Skid Steer Loaders	900	107	TAI	8.8	0.87	0.88	0.04	0.01	0.01	0.04	0.03		
30	2019	San Diego	San Diego	Skid Steer Loaders	1000	107	TAI	8.8	0.87	0.88	0.04	0.01	0.01	0.04	0.03		
31	2019	San Diego	San Diego	Cranes	100	107	TAI	61.88	87.88	22,818.88	1.58	0.01	0.01	1.51	1.61		
32	2019	San Diego	San Diego	Cranes	200	107	TAI	61.88	87.88	22,818.88	1.58	0.01	0.01	1.51	1.61		
33	2019	San Diego	San Diego	Cranes	300	107	TAI	61.88	87.88	22,818.88	1.58	0.01	0.01	1.51	1.61		
34	2019	San Diego	San Diego	Cranes	400	107	TAI	61.88	87.88	22,818.88	1.58	0.01	0.01	1.51	1.61		
35	2019	San Diego	San Diego	Cranes	500	107	TAI	61.88	87.88	22,818.88	1.58	0.01	0.01	1.51	1.61		
36	2019	San Diego	San Diego	Cranes	600	107	TAI	61.88	87.88	22,818.88	1.58	0.01	0.01	1.51	1.61		
37	2019	San Diego	San Diego	Cranes	700	107	TAI	61.88	87.88	22,818.88	1.58	0.01	0.01	1.51	1.61		
38	2019	San Diego	San Diego	Cranes	800	107	TAI	61.88	87.88	22,818.88	1.58	0.01	0.01	1.51	1.61		
39	2019	San Diego	San Diego	Cranes	900	107	TAI	61.88	87.88	22,818.88	1.58	0.01	0.01	1.51	1.61		
40	2019	San Diego	San Diego	Cranes	1000	107	TAI	61.88	87.88	22,818.88	1.58	0.01	0.01	1.51	1.61		
41	2019	San Diego	San Diego	Cranes	1000	107	TAI	61.88	87.88	22,818.88	1.58	0.01	0.01	1.51	1.61		
42	2019	San Diego	San Diego	Cranes	1000	107	TAI	61.88	87.88	22,818.88	1.58	0.01	0.01	1.51	1.61		
43	2019	San Diego	San Diego	Cranes	1000	107	TAI	61.88	87.88	22,818.88	1.58	0.01	0.01	1.51	1.61		
44	2019	San Diego	San Diego	Cranes	1000	107	TAI	61.88	87.88	22,818.88	1.58	0.01	0.01	1.51	1.61		
45	2019	San Diego	San Diego	Cranes	1000	107	TAI	61.88	87.88	22,818.88	1.58	0.01	0.01	1.51	1.61		
TOTALS	2019	San Diego	San Diego							1,253.74	555.81	117,374.40	107,374.40	84.15	8.83	40.81	30.88

Emissions Impacts

- It is estimated that the use of renewable diesel across multiple construction projects in 2019 resulted in a GHG emissions reduction of **98%** compared to petroleum diesel, preventing **2,421 MTCO₂e** of GHG emissions.
- Similarly, it is estimated that the deployment of renewable diesel at Metro projects reduces PM emissions by **~25-35%** and NO_x emissions by **~10%** on projects by deploying renewable diesel, compared to petroleum diesel (based on CARB estimates).

Thank you.

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