



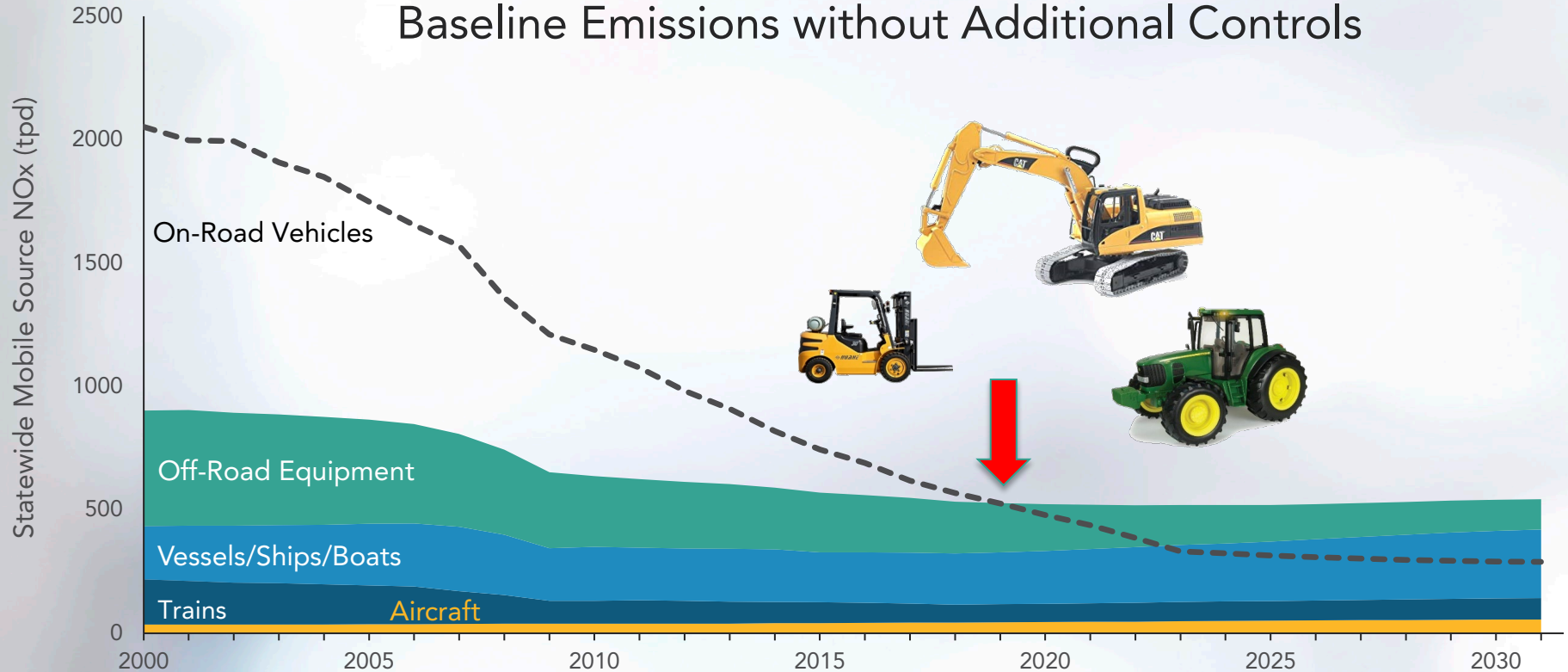
2022 Large-Spark Ignition Equipment Emissions Inventory

Air Quality Planning & Science Division

April 2022

Growing Importance of Off-Road

Baseline Emissions without Additional Controls



What is an Emissions Inventory?

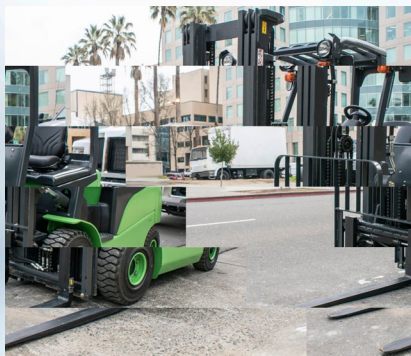
An emissions inventory for an industry sector accounts for:

- *Population* of equipment
- How often it is used (*activity*)
- The equipment *model year* (newer equipment is generally cleaner)
- The region where the equipment is used (generally by *county*)
- The total resulting *emissions* from the equipment

CARB uses emissions inventories to understand where air pollution comes from and to create strategies for emission reductions.

Overview

- Large-spark ignition (LSI) equipment are natural gas and gasoline-powered forklift, sweeper/scrubber, and industrial tow tractor equipment
- New inventory with base year 2020 integrates CA sales data, DOORS LSI database, and fleet average age turnover forecasting



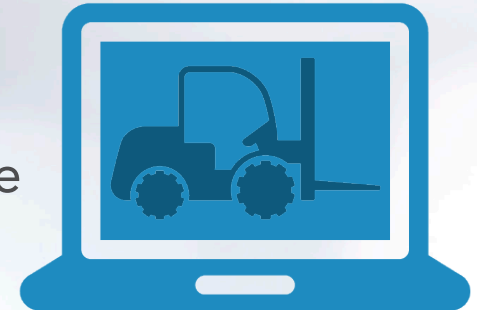
Data Sources

Data Input	Source
Population, Large Fleet and Engine Characteristics	DOORS LSI Database, 2020
Population, Small Fleets (3 units and under)	Fullerton Survey
Population, Electric Fleet and New Forklifts	ITA California Forklift Sales, 2020
Activity Hours	DOORS Fleet Survey, 2020
Emission Factors	CARB Certification Database
Regional Allocation	CARB Industrial Warehouse Space

DOORS Reporting Database

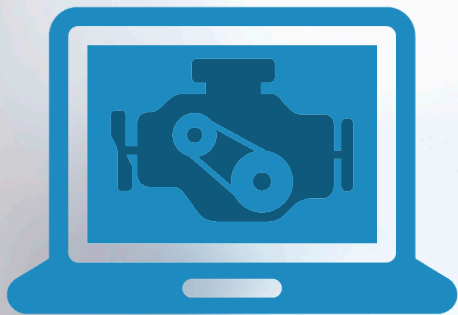
DOORS is an online tool designed to help fleet owners report off-road equipment inventories and actions taken to reduce equipment emissions as required by the [In-Use Off-Road Fleets Regulation](#) and the [Large Spark-Ignition Engine Fleet Requirements Regulation](#), as amended in 2016.

- Annual reporting is required for large fleets operating more than 3 units of fueled equipment over 25 HP or more than 19 kW for MY2005+ engines.
- Most fleets with over 4 units of equipment are required to report, but a challenge remains where many equipment are not reported into DOORS.



Engine Certification & Emissions Factors

Engine manufacturers are required to submit annual certification and compliance testing reports to the US EPA and CARB. These reports detail engine emissions testing compared to applicable engine standards. Emissions factors (EFs) are updated based on an average of reported engines by fuel, model year, horsepower, and equipment type across all manufacturers. CARB updated off-road engine emissions factors in 2017.



Emissions inventories use emissions factors to estimate emissions statewide based on the following equations:

Emission Factor, g/hphr

= Zero Hour Emissions + (Deterioration Rate * Accumulated Hours)

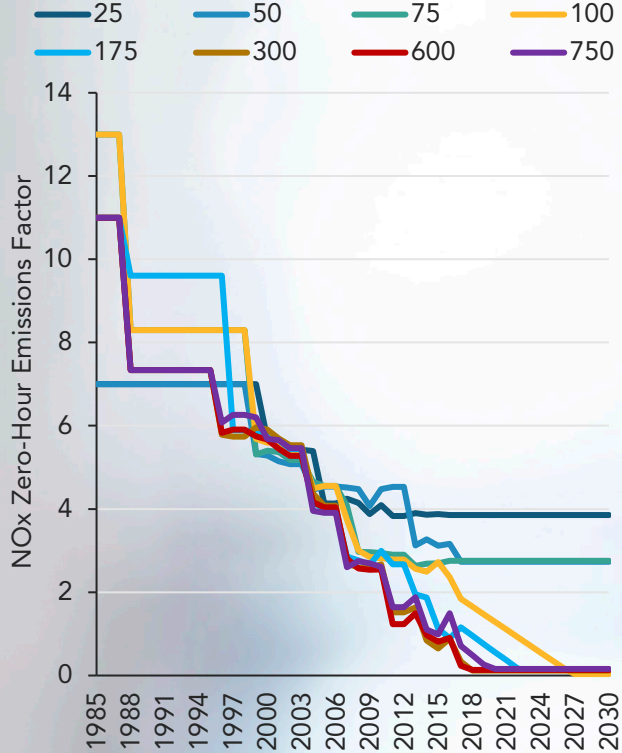
Equipment Emissions

= Population * Activity Hours * Engine Horsepower * **Load** * **EF**

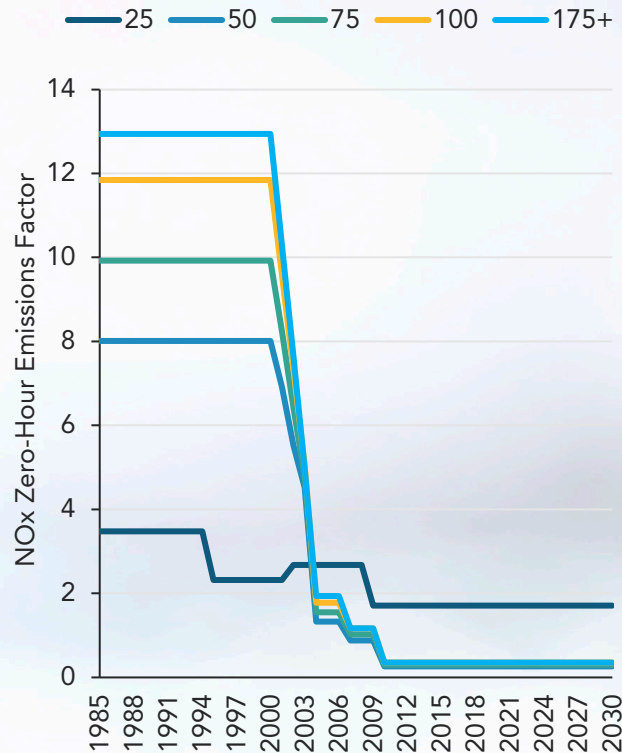
Loads are being used from OFFROAD2007 as we evaluate available data.

Zero-Hour Emissions Factors

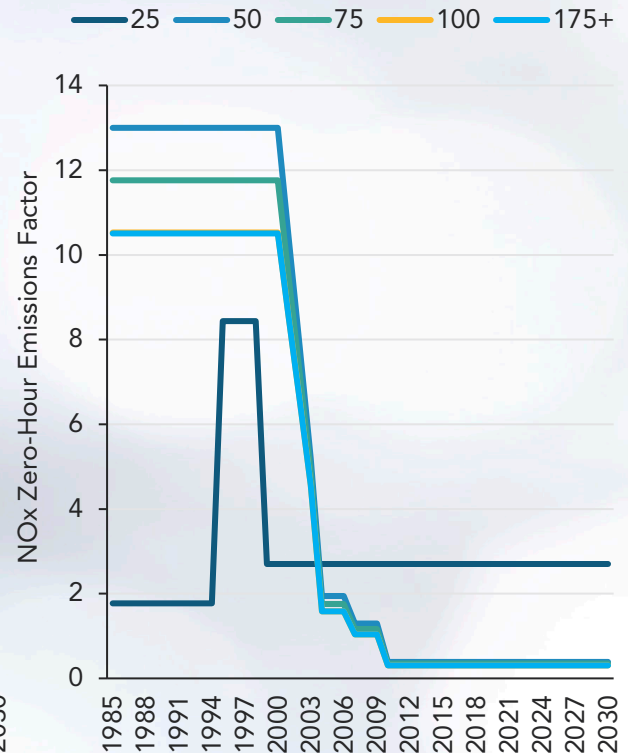
Diesel Equipment



Gasoline Equipment

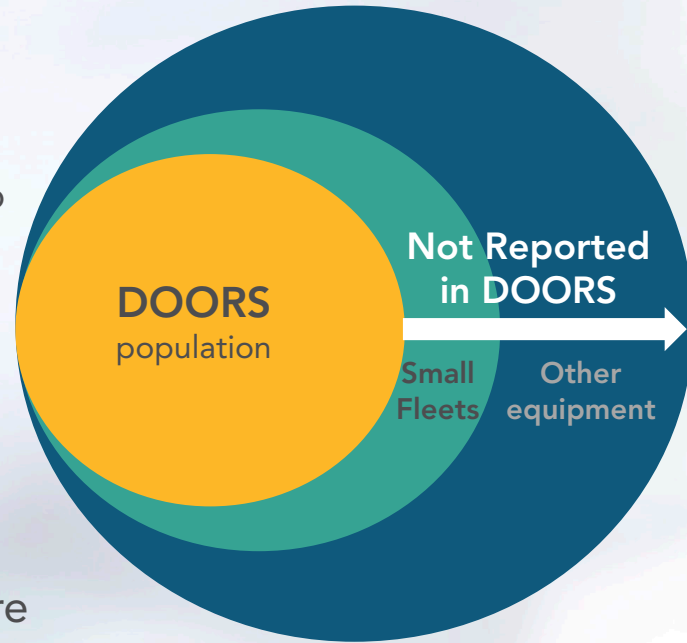


Natural Gas Equipment



Population Scaling

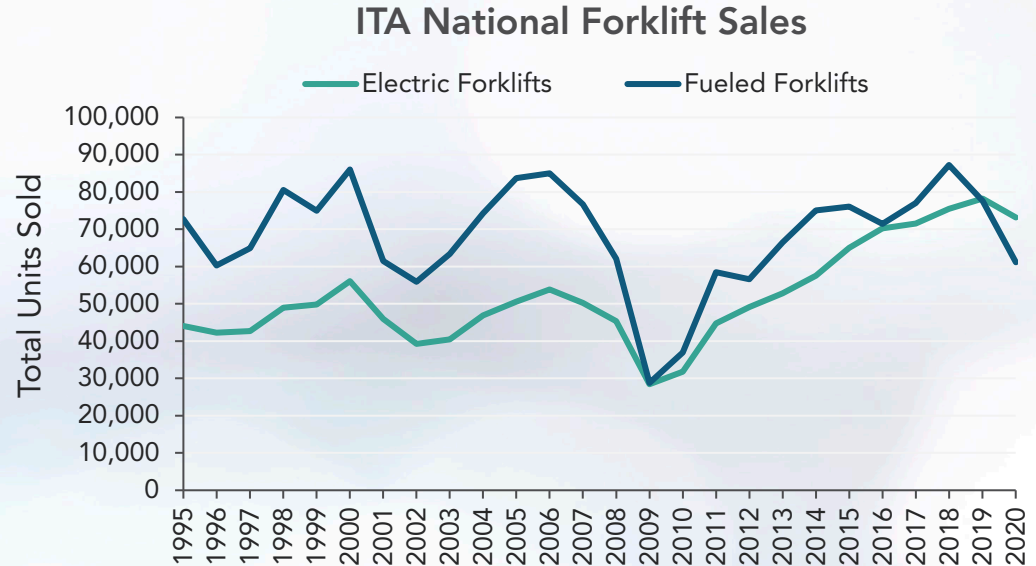
- Small fleets and electric equipment are not required to report into the DOORS database.
 - Based on a survey of over 1,200 businesses with over 8,000 equipment, small fleets that did not have to report made up **18 percent** of equipment
 - This suggests that large fleets (ones required to report in DOORS) represents **82 percent** of all equipment
 - The survey did not provide equipment details (horsepower, model year, etc)
- To model small fleets, DOORS fleets from 4 to 10 equipment were randomly sampled to model the small fleets statewide, based on assumption they were using similar equipment (compared to scaling up all DOORS fleets, including fleets with 1,000+ pieces)



Statewide Population After Scaling

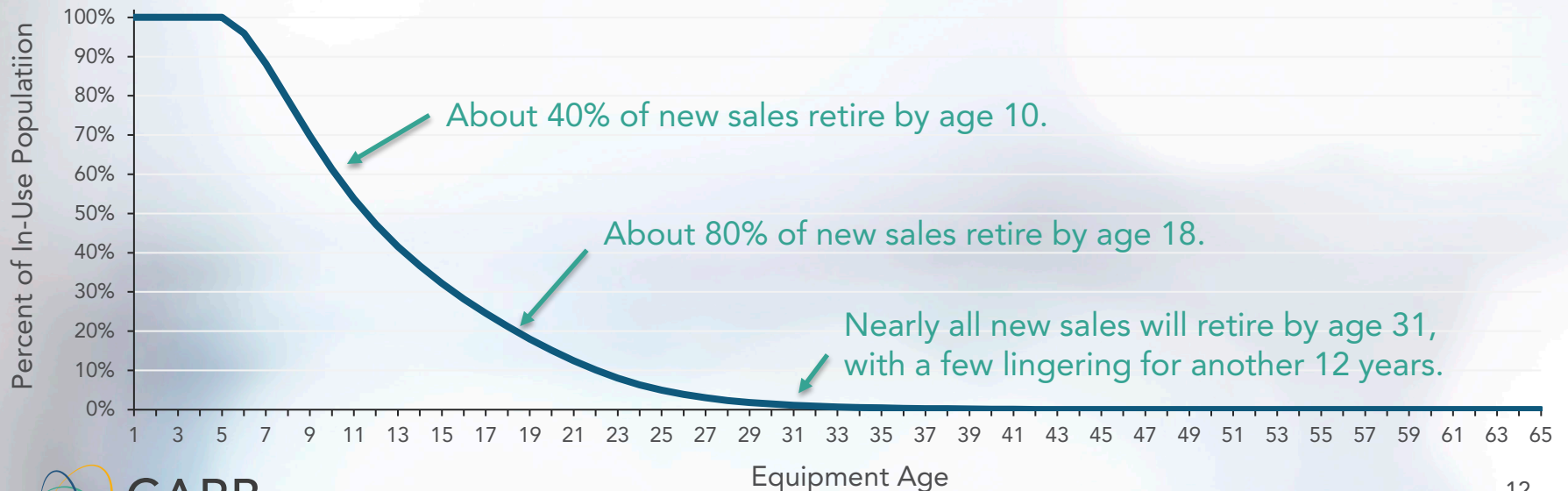
Population Scaling 2

- All equipment was scaled up to target Statewide equipment populations by age, based on equipment sales in California with survival curve from DOORS reporting.
- Electric equipment based on the percent of electric sales vs LSI forklift sales from national equipment sales



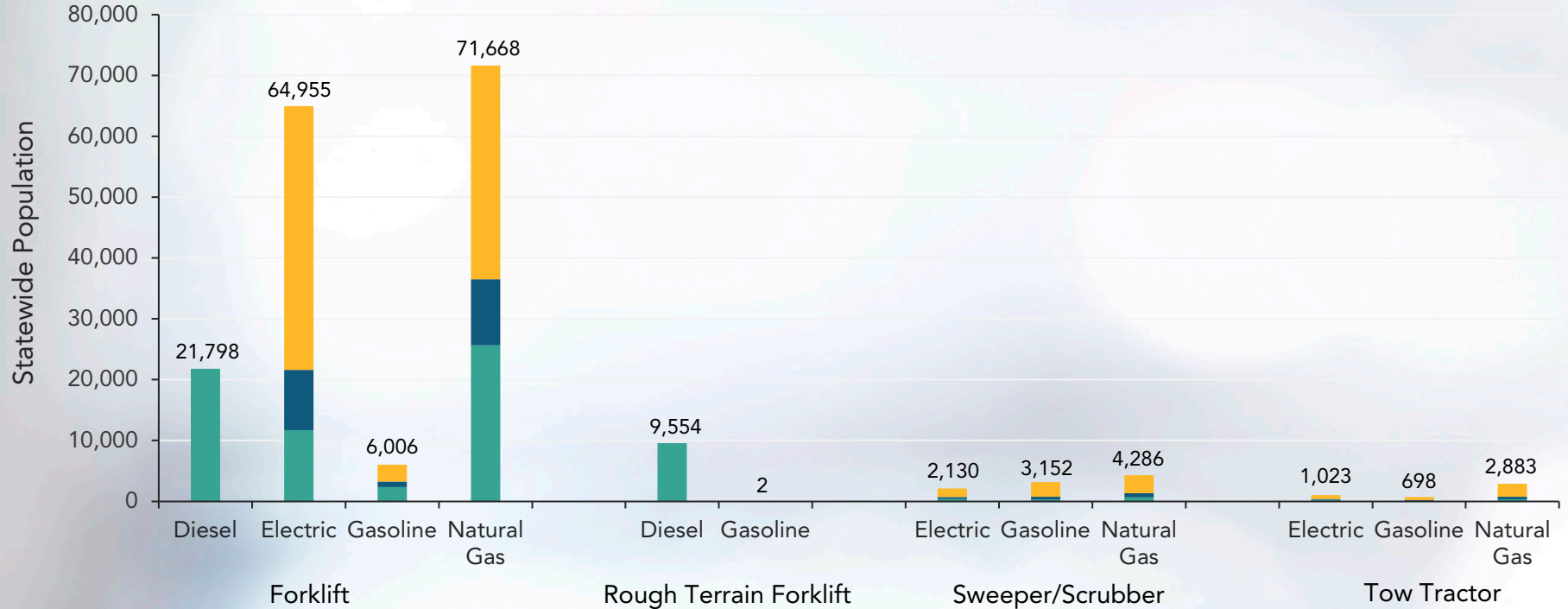
Example Survival Curve: Natural Gas-Powered Forklifts

This example represents the survival curve used to estimate target statewide natural gas forklift equipment population based on California sales. Survival rates are derived from DOORS population characteristics in base year 2020.

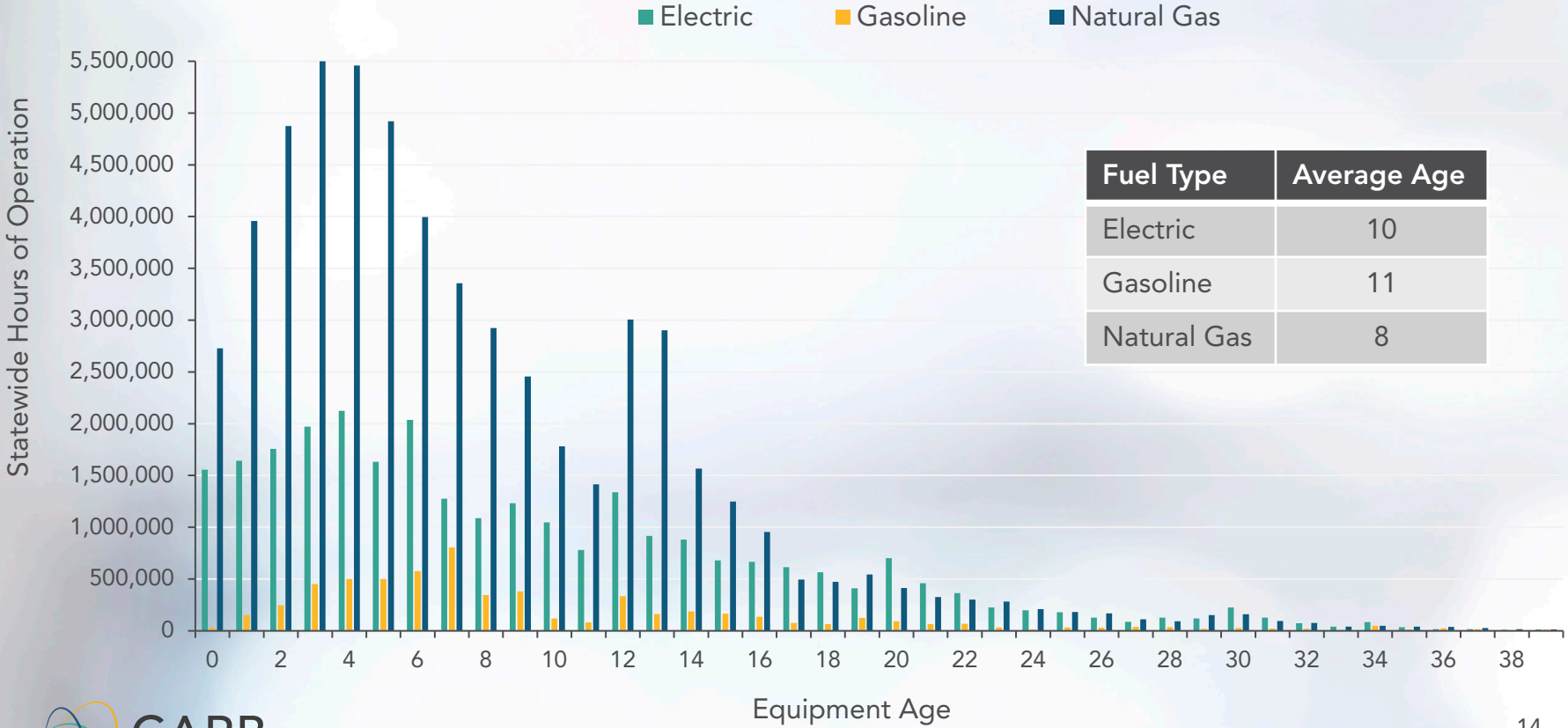


Statewide Population, 2020 Base Year

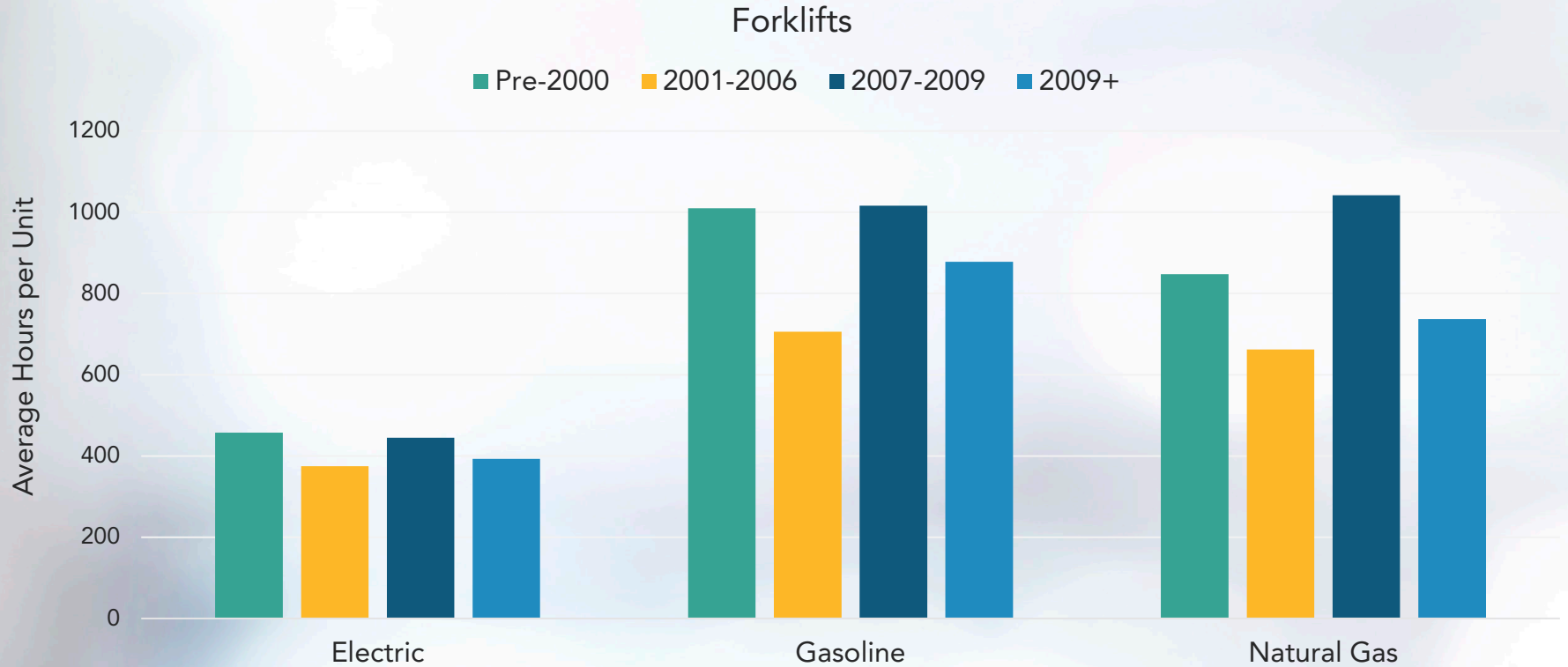
■ DOORS Reported
 ■ Small Fleets Scaled Population
 ■ Non-Reporting Scaled Population



2020 Base Year Age Distribution by Fuel Type



2020 Hours by Model Year and Fuel Type








Forecasting Equipment Replacement

Future year equipment is projected by fleet purchasing habits observed in base year 2020

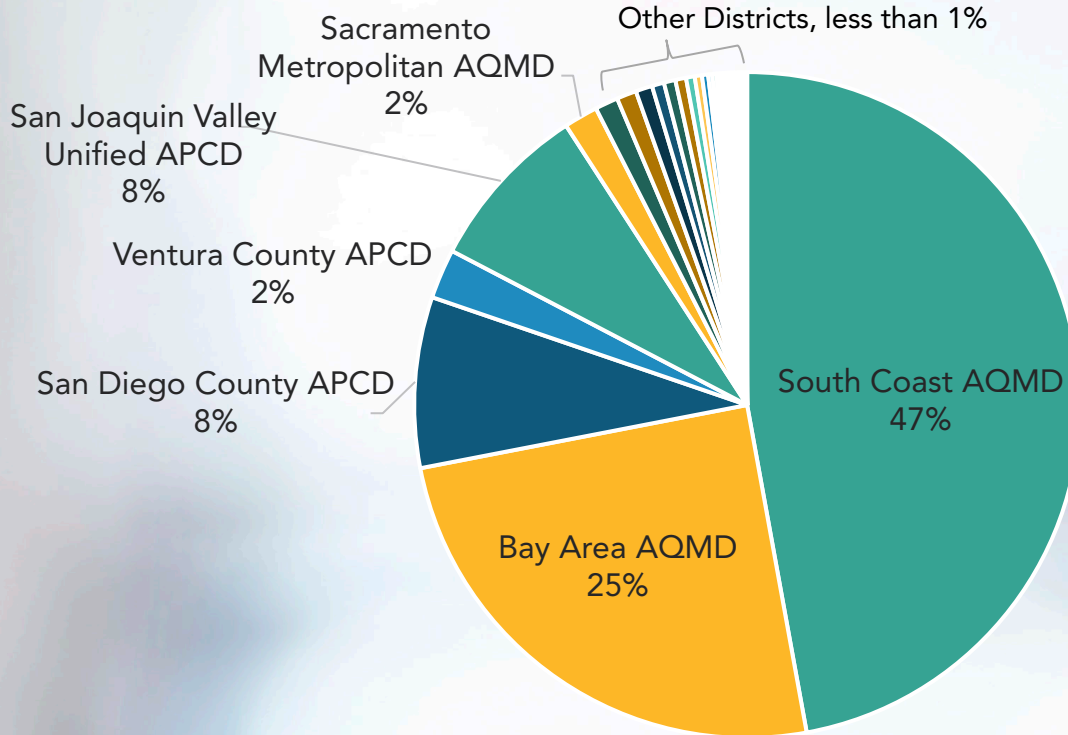
1. Fleets maintain base year average age
2. When a fleet exceeds the current average age, the oldest equipment is replaced
3. Fleets purchase only as new as their youngest equipment in the base year
 - Young fleets continue to purchase newer equipment
 - Older fleets continue to purchase used equipment

Example Fleet Replacement:

Fleet operator of 5 forklifts, **12 years old on average**, with an age 7 forklift as the youngest equipment observed in the base year 2020.

Calendar Year						Average Before Turnover	Average After Turnover
2020	Age 7	Age 9	Age 12	Age 16	Age 16	12	-
2021	Age 8	Age 10	Age 13	Age 17	Age 17 7	13	11
2022	Age 9	Age 11	Age 14	Age 18	Age 8	12	12
2023	Age 10	Age 12	Age 15	Age 19 7	Age 9	13	10.6
2024	Age 11	Age 13	Age 16	Age 8	Age 10	11.6	11.6
2025	Age 12	Age 14	Age 17 7	Age 9	Age 11	12.6	10.6

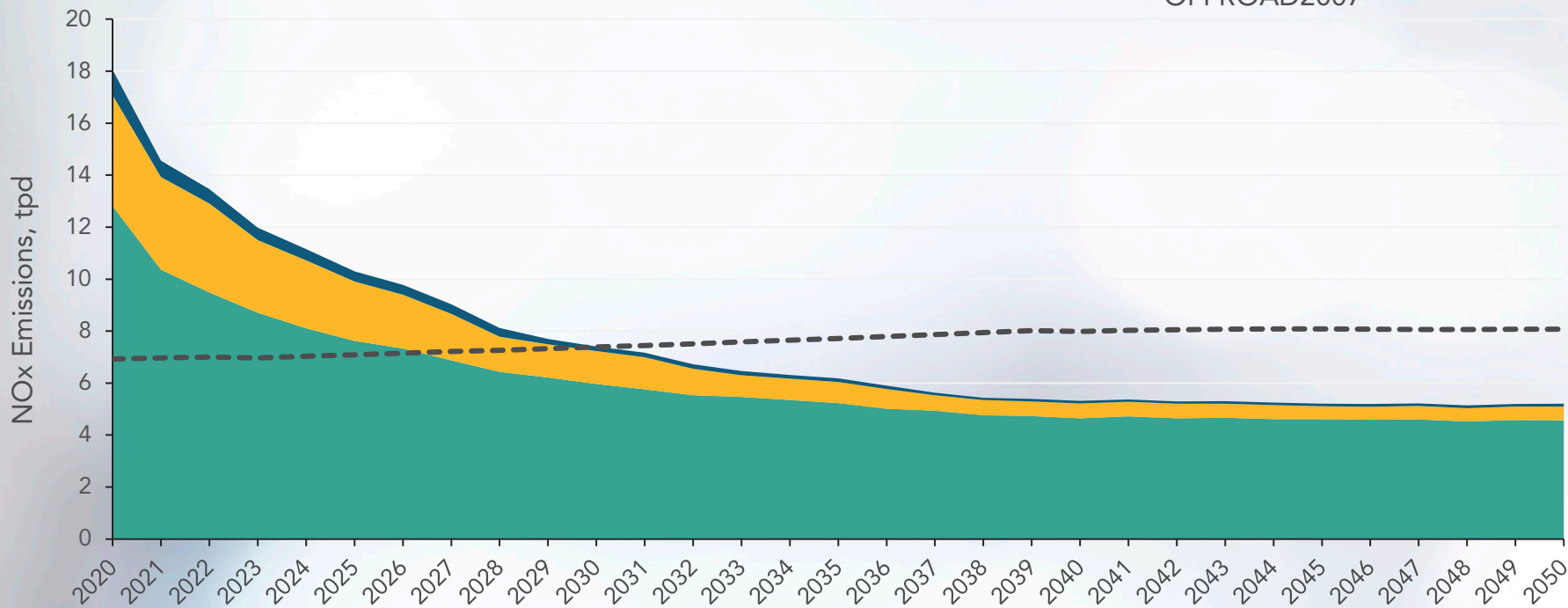
Regional Spatial Allocation



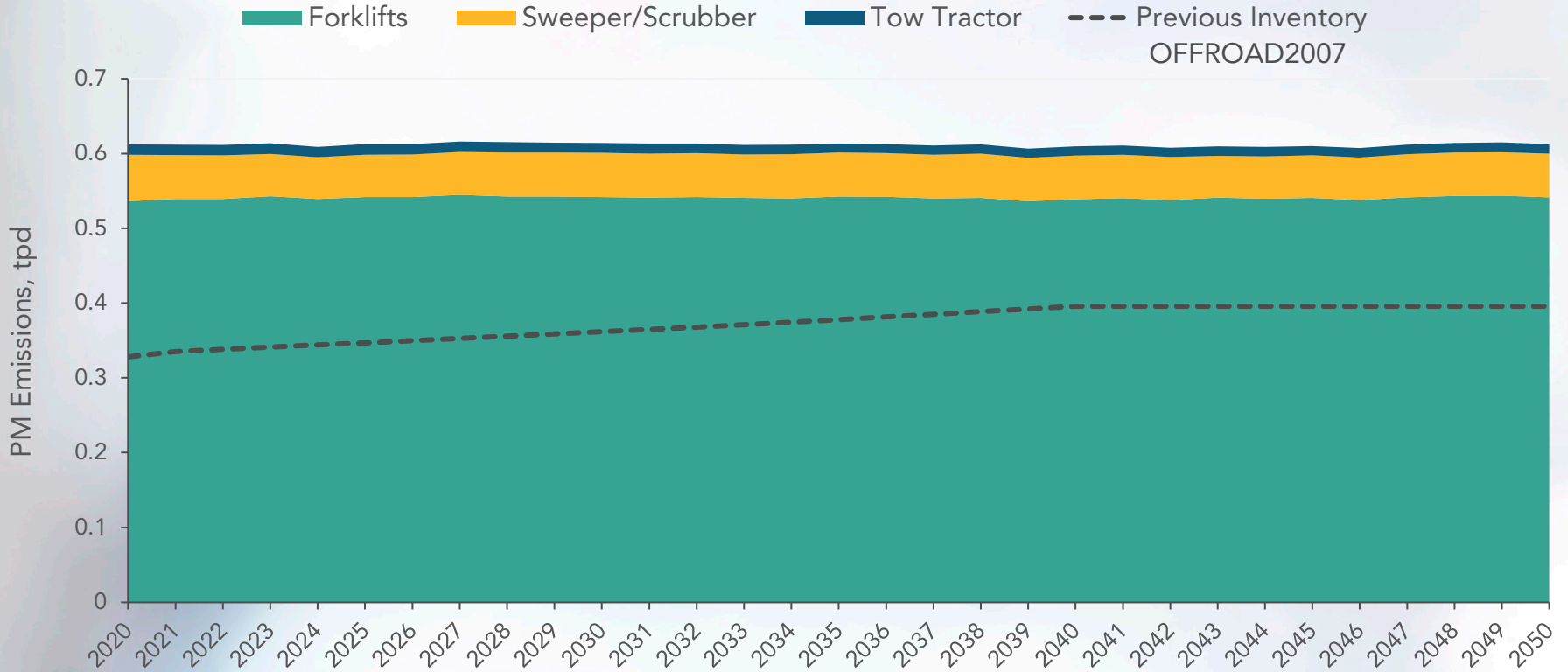
Statewide LSI emissions were allocated based on industrial warehouse square footage within each air district. Parcel information was originally sourced from the Census Longitudinal Employer-Household Dynamics Survey.

Statewide Results: NOx

Forklifts Sweeper/Scrubber Tow Tractor - - - Previous Inventory OFFROAD2007



Statewide Results: PM



Next Steps



Today: Gather Public Feedback and Ideas on Draft Inventory Updates

June 2022:
Accepting comments to the Draft Inventory Updates until June 1st.

Summer 2022:
2nd Zero-Emission Forklifts Workshop to Discuss Potential Regulatory Concepts

Following Summer 2022:
Release updated baseline inventory and rule concept benefits (emissions impact) and take further comments

2023:
Board Consideration of Zero-Emission Forklift Regulation

Questions?

- Please use Zoom's "raise hand" feature in the webinar window to comment verbally or use the "Q&A" or "Chat" feature on Zoom to type your comments and questions.
- For those joining via conference call, press *9 to raise your hand, then *6 to toggle unmute.

The image shows a Zoom meeting control bar with three callout boxes. The first callout points to the 'Unmute' and 'Start Video' buttons, explaining that users should leave audio muted and video off. The second callout points to the 'Participants' button, explaining that it opens a box for nonverbal feedback. The third callout points to the 'Chat' button, explaining that it opens a chat box for messaging.

Unmute Start Video Invite Participants Share Screen Chat Record Leave Meeting

Please leave your **audio muted** and **video off** (both indicated by a red slash).

Click to open the **Participants** box. This will allow you to give nonverbal feedback.

Click to open the **Chat** box. This will allow you to chat with Hosts and Participants.

raise hand yes no go slower go faster

To: Everyone More ▾
Type message here...

What are your thoughts?

- Please send your comments and suggestions to:

Cory Parmer
Manager

Off-Road Diesel Analysis Section

Cory.Parmer@arb.ca.gov

Off-Road Inventory Development
Helpdesk

Off-Road Diesel Analysis Section

OffRoadInventory@arb.ca.gov

- **Useful Links:**

- Off-road Equipment Emissions Inventory Documentation, <https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/msei-road-documentation-0>
- Large Spark-Ignition Fleet Requirements Regulation, <https://ww2.arb.ca.gov/our-work/programs/large-spark-ignition-lsi-engine-fleet-requirements-regulation>
- Zero-Emission Off-Road Strategies Fact Sheet, https://ww2.arb.ca.gov/sites/default/files/2020-11/ZEV_EO_Off-Road_Fact_Sheet_111820.pdf
- Zero-Emission Forklifts Measure, <https://ww2.arb.ca.gov/our-work/programs/zero-emission-forklifts>