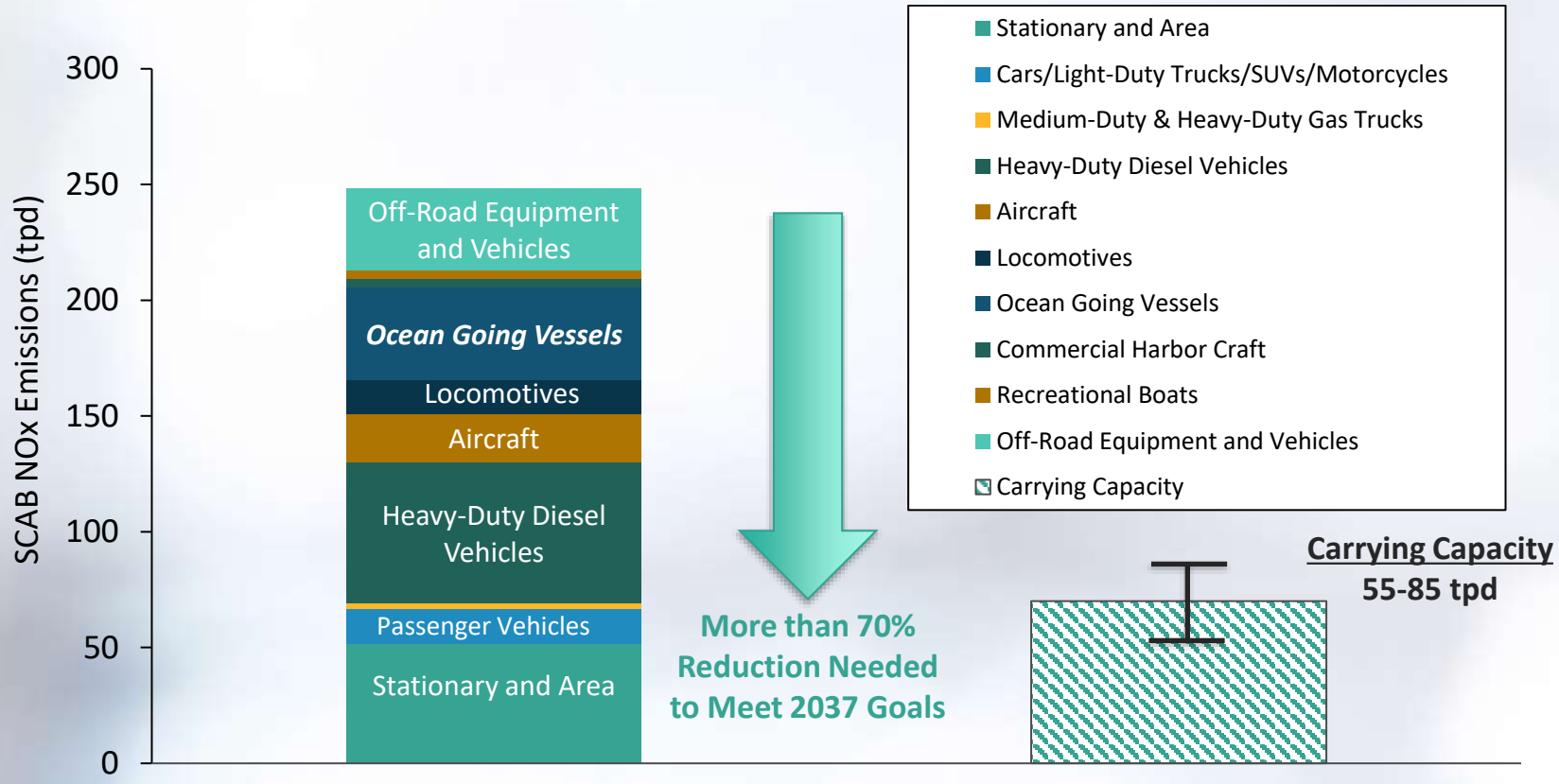
CALIFORNIA
AIR RESOURCES BOARD

Draft Update to Ocean Going Vessels (OGV) Emissions Inventory

2022 AQMP Mobile Source Working Group

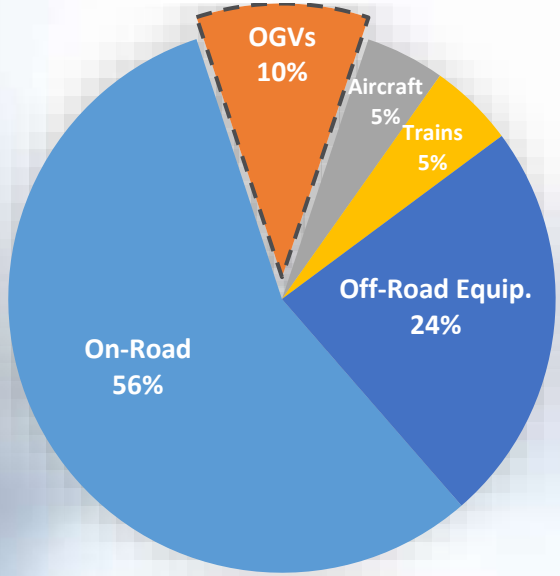
August 24, 2021

South Coast 2037 Draft Attainment Goal

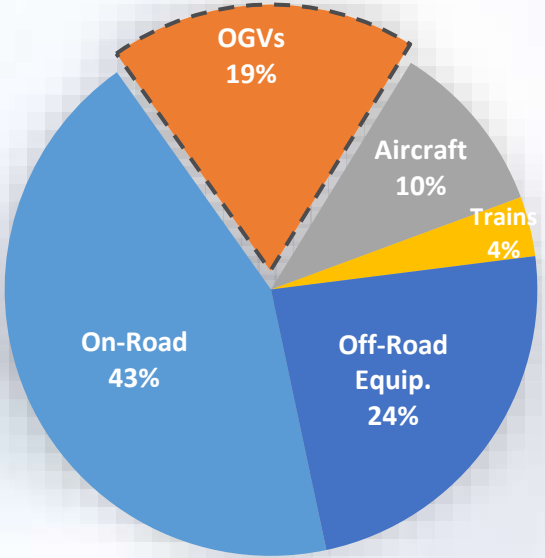


OGV NOx Emission Contribution in South Coast

- OGV emissions (out to 100 nautical miles) make up 20% of mobile source NOx emission in 2037, up from 10% in 2017



2017



2037

Source: CEPAM 2019 Summer Emissions, with 2020 At Berth Regulation amendments

OGV Inventory

- OGV inventory covers marine vessels over 400 feet, 10,000 tons, with large engine displacement
- At-Berth inventory updated in 2020
- Inventory updates for transit, maneuvering, anchorage are needed
  - Improve base year accuracy and location specificity
  - Review growth forecast and future engine Tiers for visiting vessels
  - Review literature on emission factors for main/auxiliary engines and boilers

2016 Container Vessel Tracks

Modes of Operation

- **At-Berth**: Operations while moored to a dock
- **Anchorage**: Operations when vessel drops anchor near the port
- **Maneuvering**: Slow speed vessel operations while in port areas
- **Transit**: Vessel operations between ports

Data Sources: Overview

Vessel Activity	Emission Factors	Engine Defaults	Forecasting
2020 AIS Records	2020 EPA EFs	2020 IHS Records	FAF 4.4
		2020 Starcrest	Historical Port Calls
		2019 Industry	Mercator Report

Characteristics	Control Measures
2020 IHS Records	2019 Compliance

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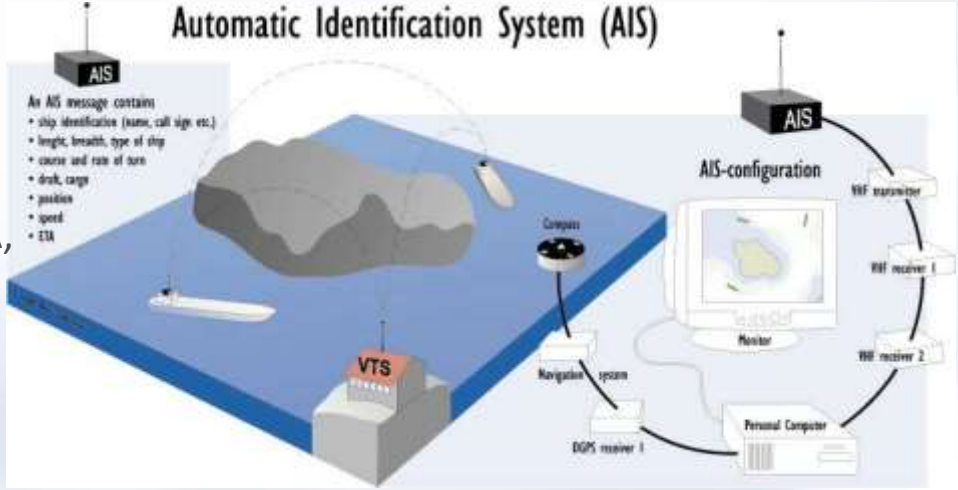
FAF: Freight Analysis Framework

Activity Data Source: AIS

- Automatic Identification System (AIS) is an onboard navigation safety device that all OGVs are required to equip for improved navigation and collision avoidance.

- AIS reports provide vessel location and movement information in US waterways.

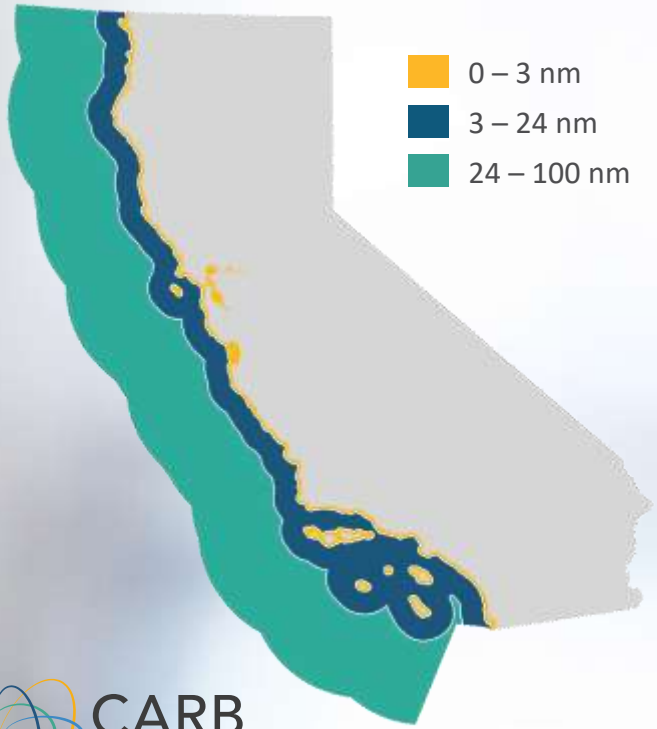
- This massive data source is made public through collaboration of the USCG, NOAA, and the Bureau of Ocean and Energy Management (BOEM) via Marine Cadastre.



https://coast.noaa.gov/htdata/CMSP/AISDataHandler/2020/index.html

Geographic Domain

Statewide



South Coast

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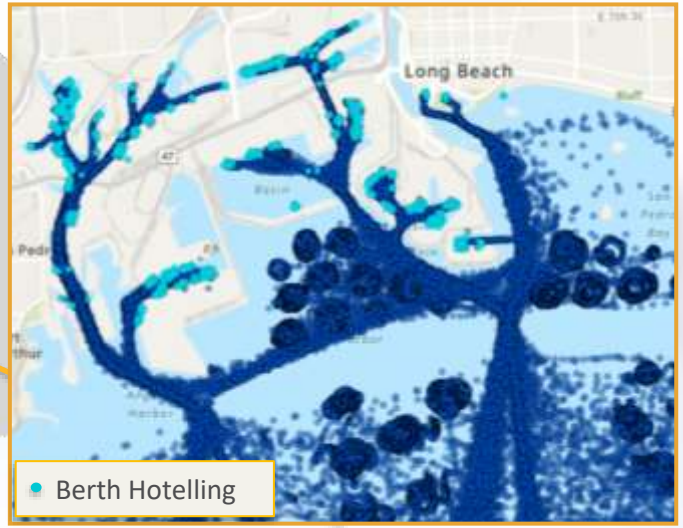
Processing AIS

- OGV records are matched with EPA emissions factors and default loads by vessel type, engine type, and activity.
- Activity defined by location and speed.



Activity Modes:

Berth Hotelling
- Within 4 km of port, not in anchorage zone, and speed of 0 kts

Anchorage Hotelling
- Within anchorage zone with speed < 1 kts

Maneuvering
- Within 3 nm, speed < 3 kts

* This figure depicts one month of cleaned AIS data for illustration purposes only.

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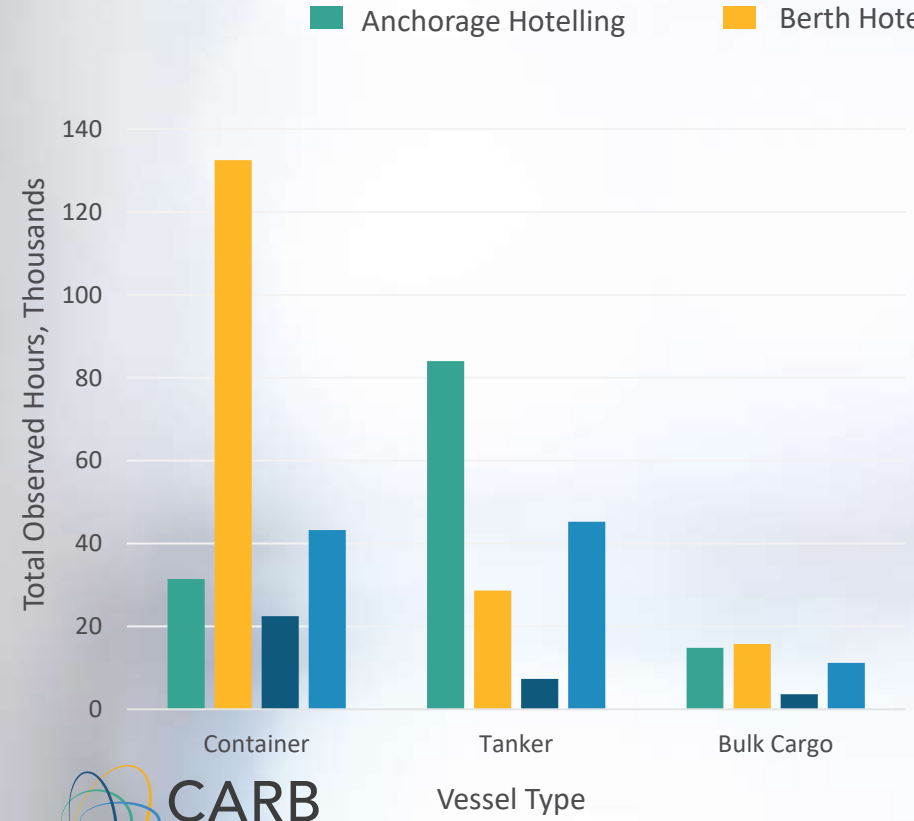
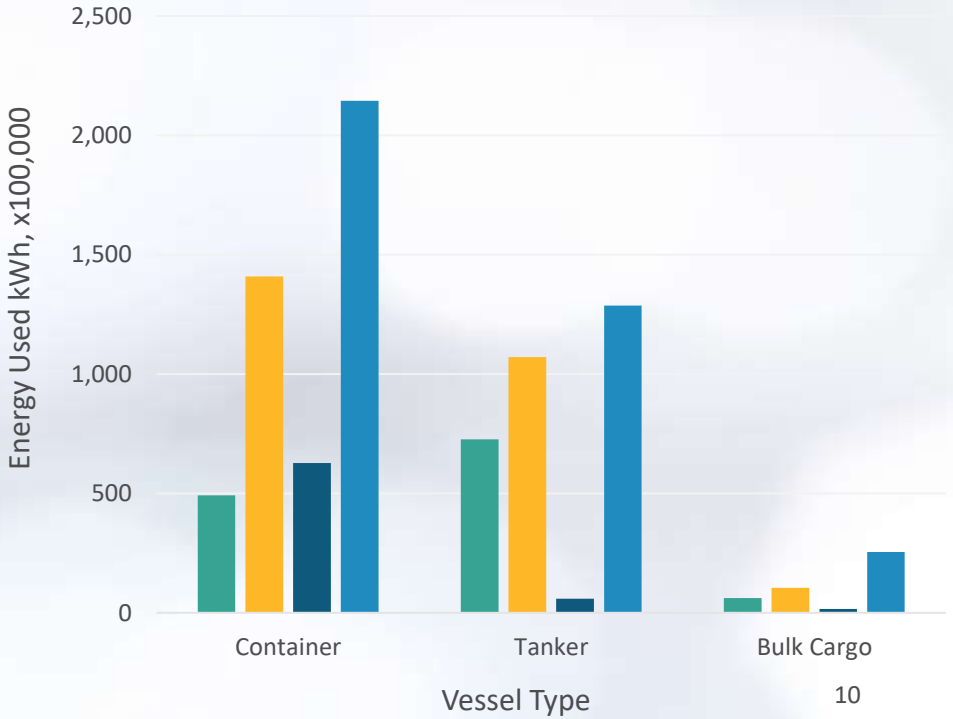
South Coast 2020 OGV by Type





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Engine Default Loads

- Boiler proposed default values from Ports' emissions inventory (developed by Starcrest) were used directly for all vessels.
- Tanker loading and discharge activities in Richmond were adjusted with custom power operations based on 2019 industry data.
- Auxiliary engine max power was derived from IHS annual averages by type and size, then combined with Starcrest loads by activity.

Operational kW = [engine load] * [Max aux power]

Example: Applying Aux Loads

On average, IHS registry shows 3180 kW max aux power for all 8,000 TEU capacity containerships identified in 2020 AIS records.

Records with known max aux power:

2020 activity record shows an 8,401 TEU capacity containership at anchor with max installed aux engine power of 3,300 kW. The estimated operational kW for aux engines for that record would be 1,298 kW.

Activity	Starcrest Default	Fractional Load = (Starcrest/IHS)
Transit	1,553	0.4885
Maneuvering	2,485.5	0.7818
Berth	1,116.5	0.3512
Anchorage	1,250.5	0.3933

Records without known max aux power:

Using default values for operating power instead of adjusting unique vessel power. In example record above, the estimated operational aux power in unknown max power case would be 1,250.5 kW.

Statewide average max power of some vessel types and sizes were lower than Starcrest reported defaults. Fractional loads were adjusted to not exceed 1 for those types and sizes, as shown in following slides.

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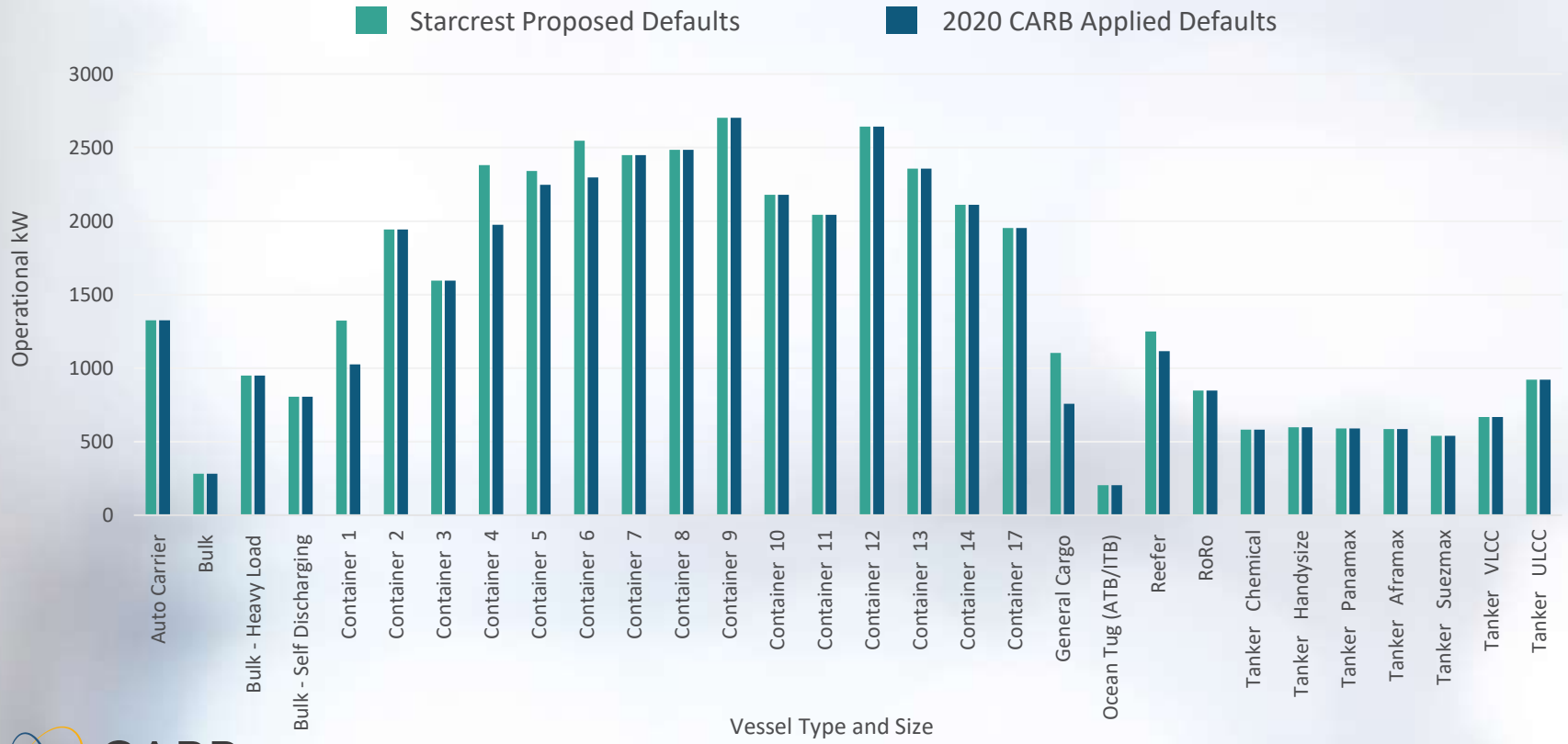
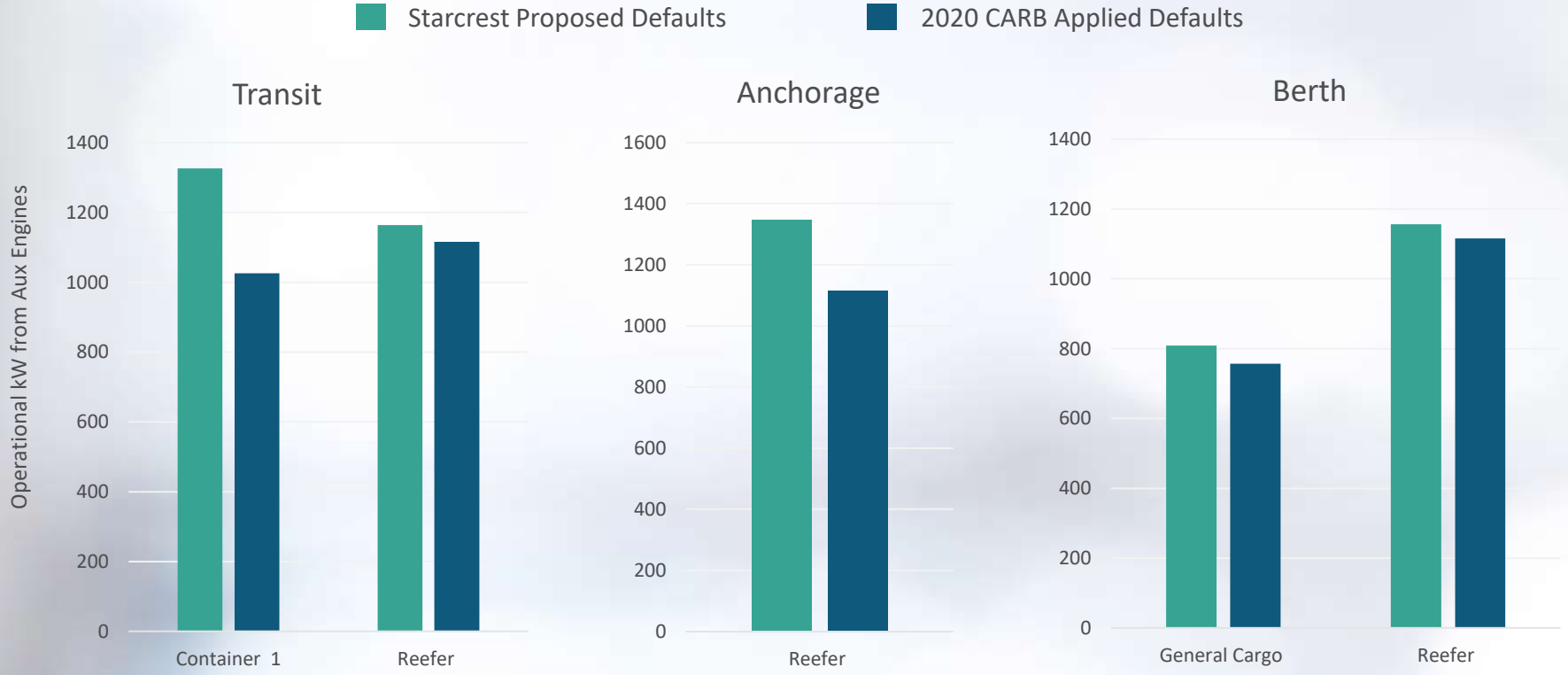
Aux Operational kW: Maneuvering

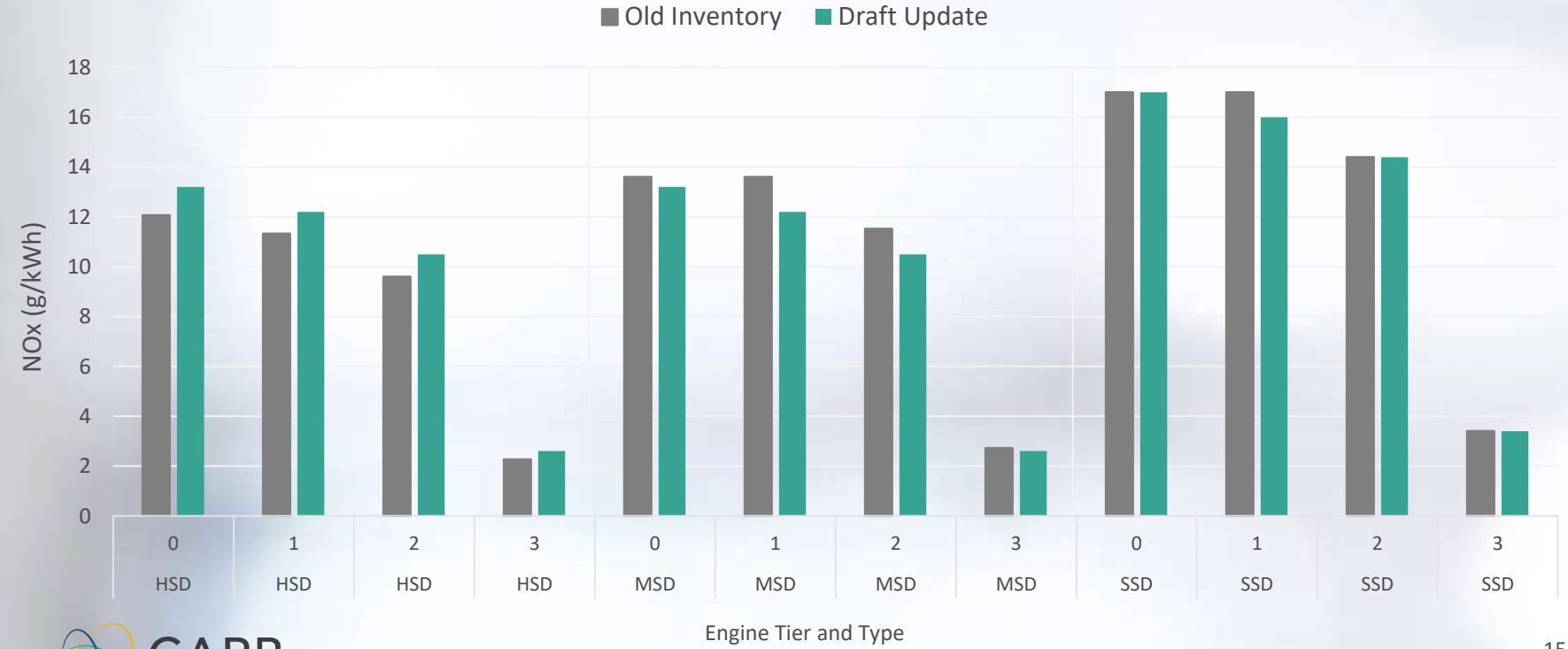


Note: Container size bins in thousand TEU capacity

Aux Operational kW: Other Modes

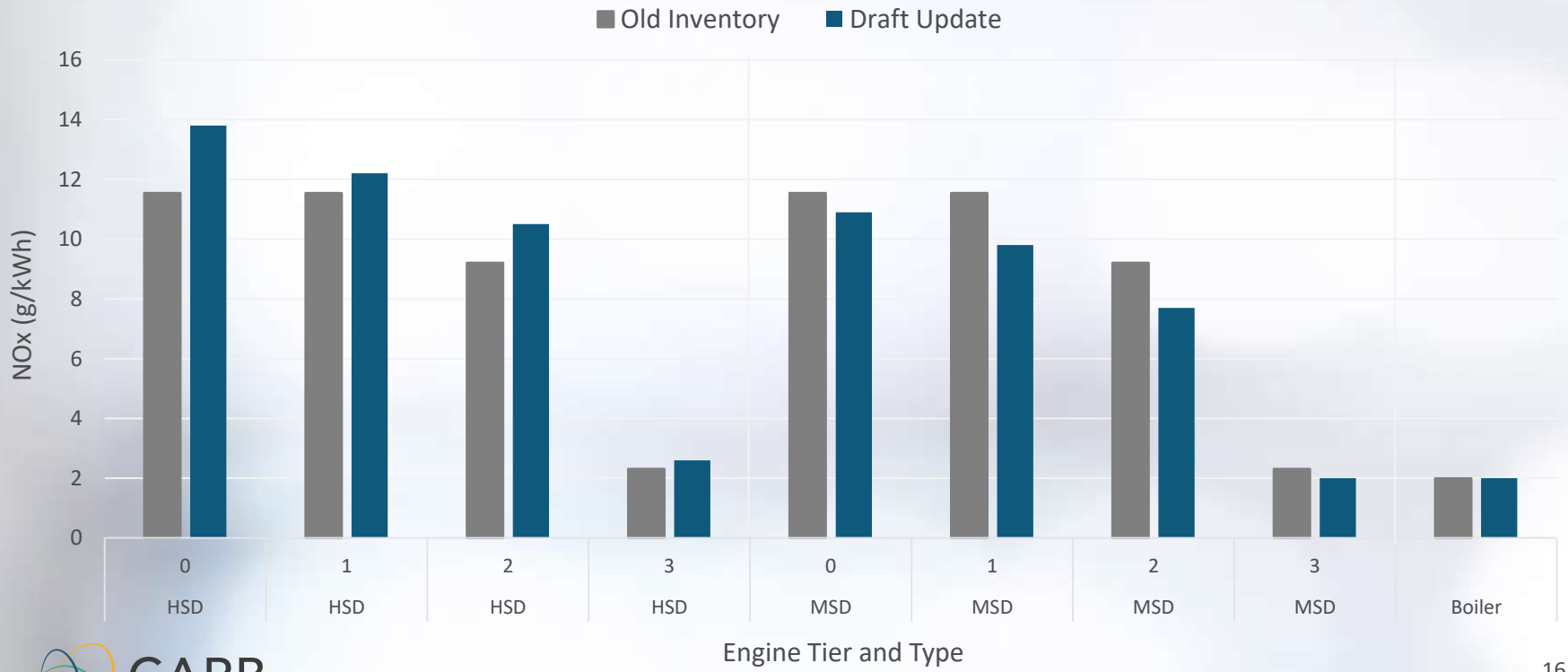


NOx Emissions Factors Comparison: Main Engines



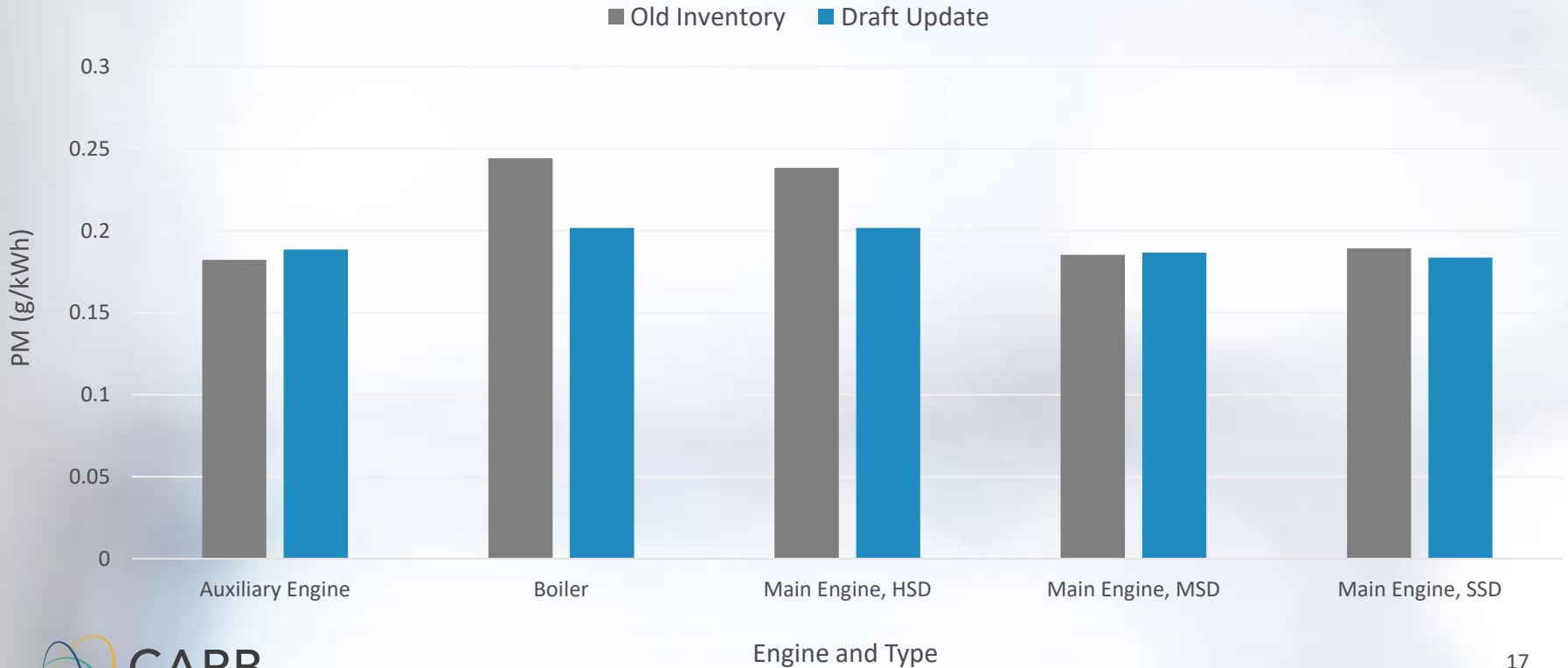
Note: High Speed Diesel (HSD), Medium Speed Diesel (MSD), Slow Speed Diesel (SSD)

NOx Emissions Factors Comparison: Auxiliary Engines and Boilers



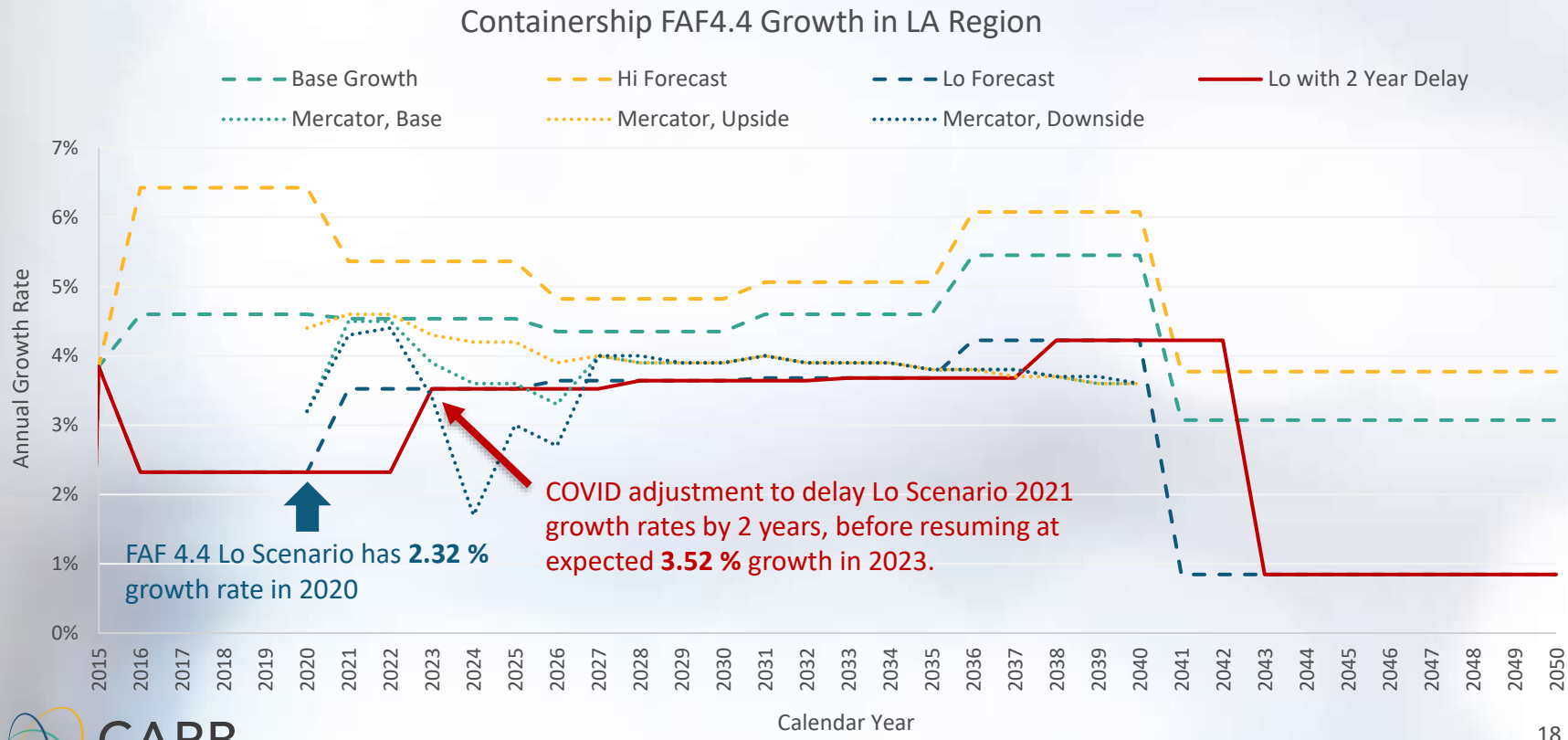
Note: High Speed Diesel (HSD), Medium Speed Diesel (MSD), Slow Speed Diesel (SSD)

PM Emissions Factors Comparison: Distillate Fueled Engines and Boilers



Note: High Speed Diesel (HSD), Medium Speed Diesel (MSD), Slow Speed Diesel (SSD)

Forecasting Data Source: FAF



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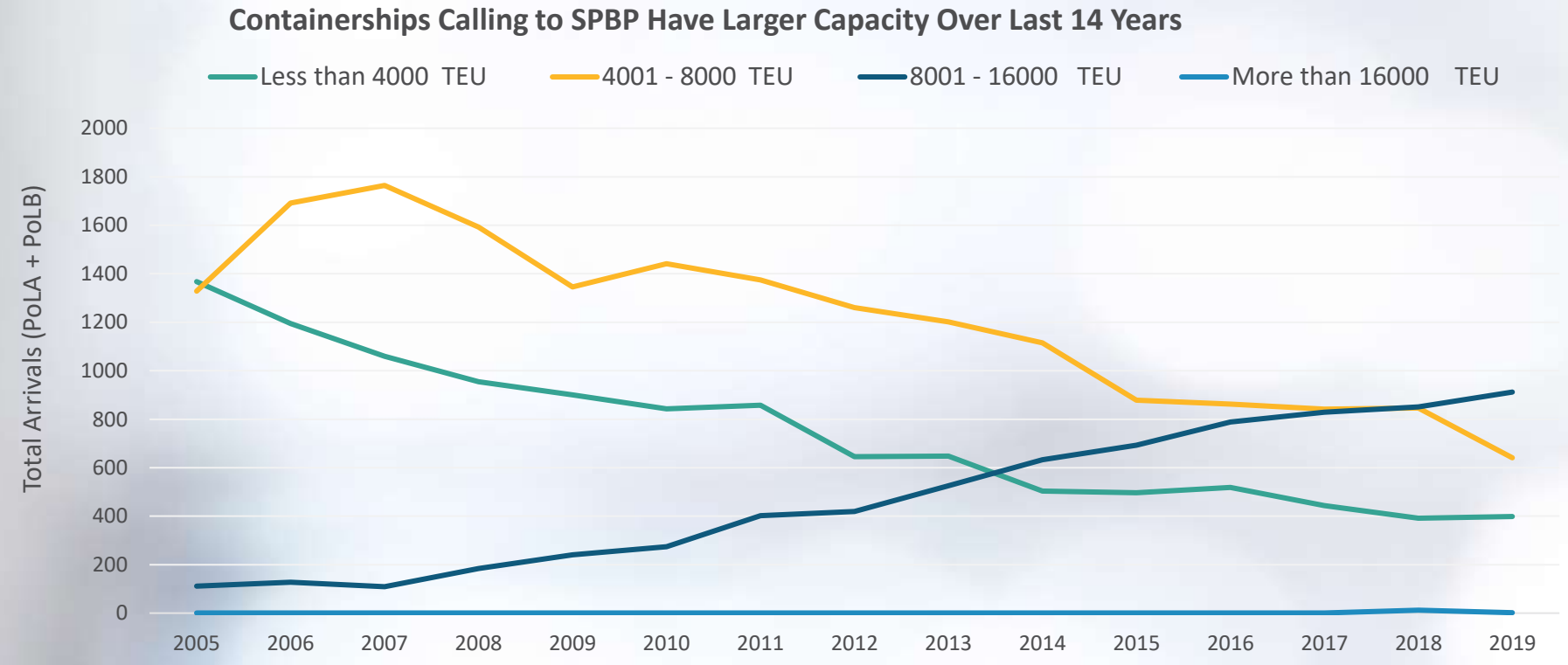
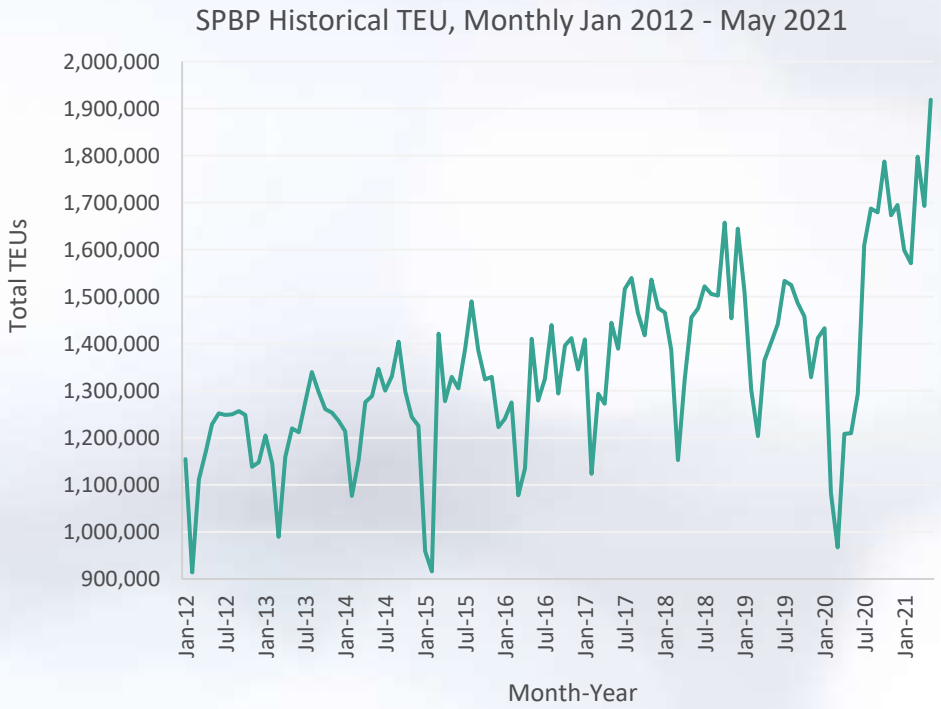
Note: Freight Analysis Framework (FAF)

Containership Capacity Trends

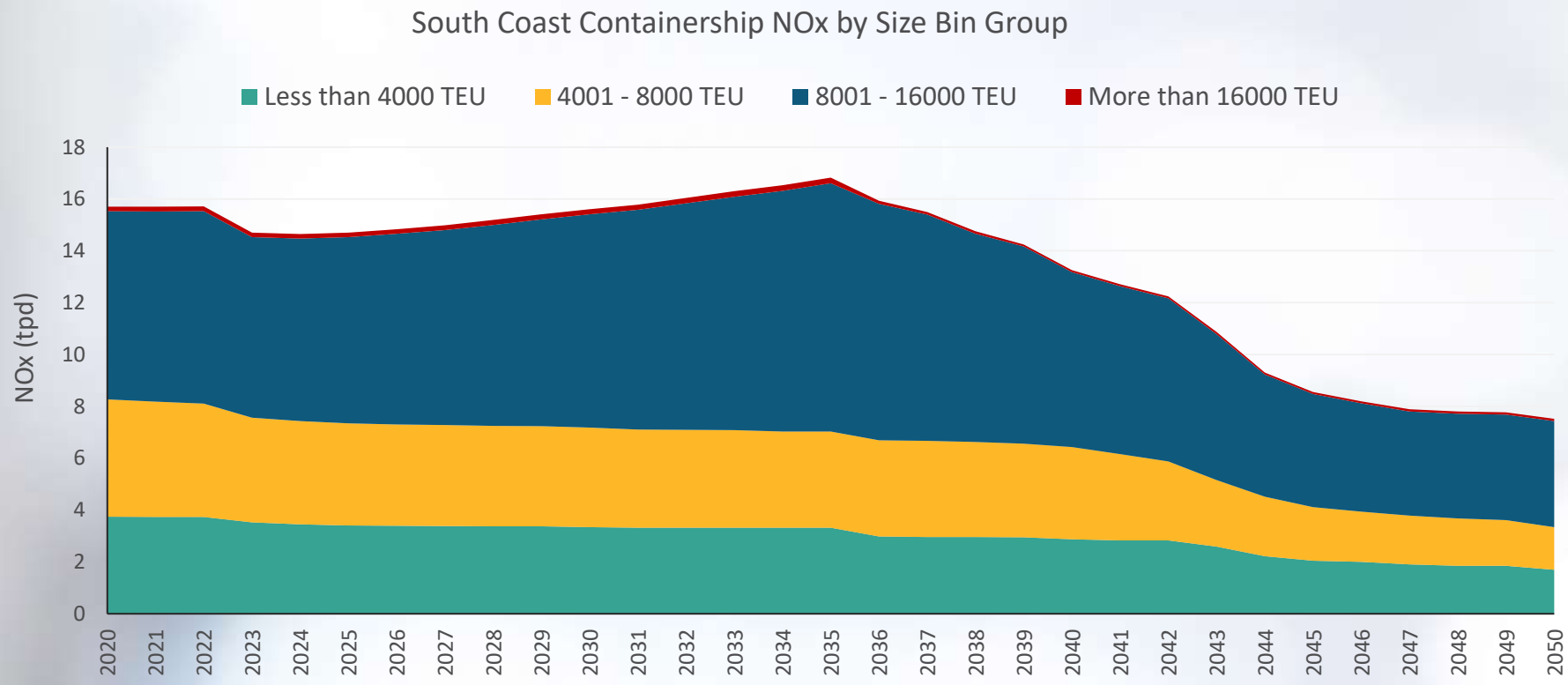


Containership Capacity Adjustment

- On average, containerships deliver about 64% of their max capacity, estimated from SPBP TEUs 2012 – 2019.
- We assume the average containerships by size bin will continue to operate as they have historically.
- Container vessels above 8000 TEU capacity were grown enough to meet increased freight forecast from FAF4.4 slow growth scenario.



Containership Capacity NOx Impacts

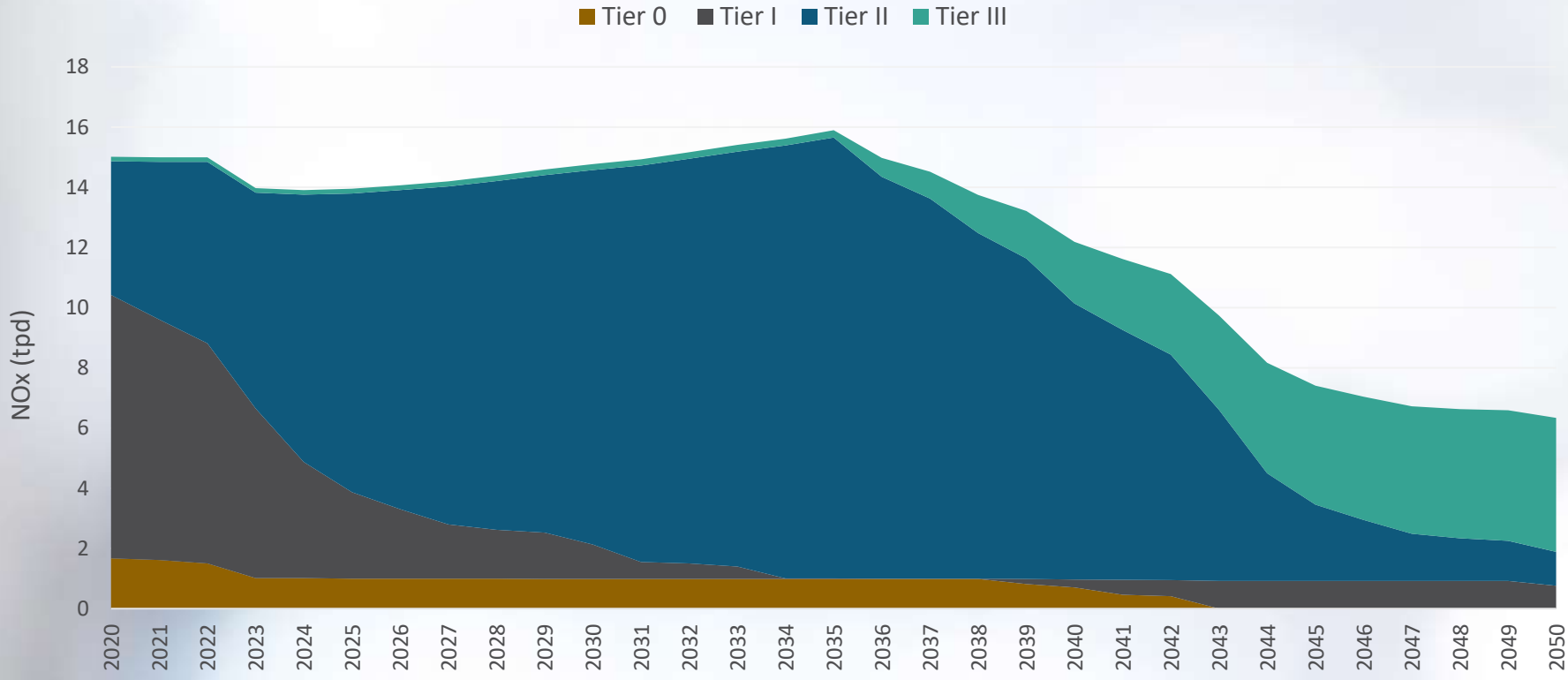


Tier Assumptions

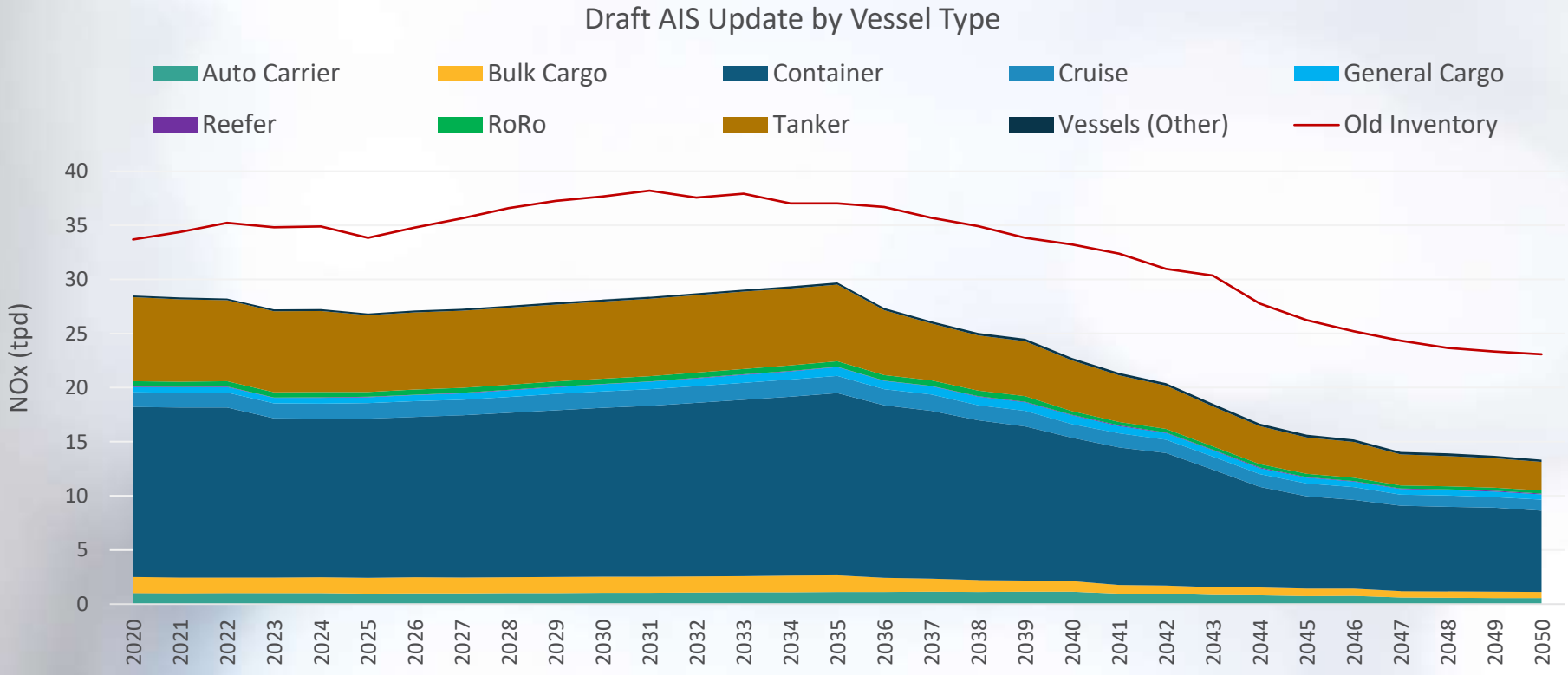
- Based on Mercator report, growth of Tier III vessels delayed until 2030.

- Main engine duty cycle adjustment: All Tier III main engines operating at less than 25% load are assumed to be operating at Tier II levels.

South Coast Containership NOx by Tier



South Coast NOx Emissions Out to 100 nm



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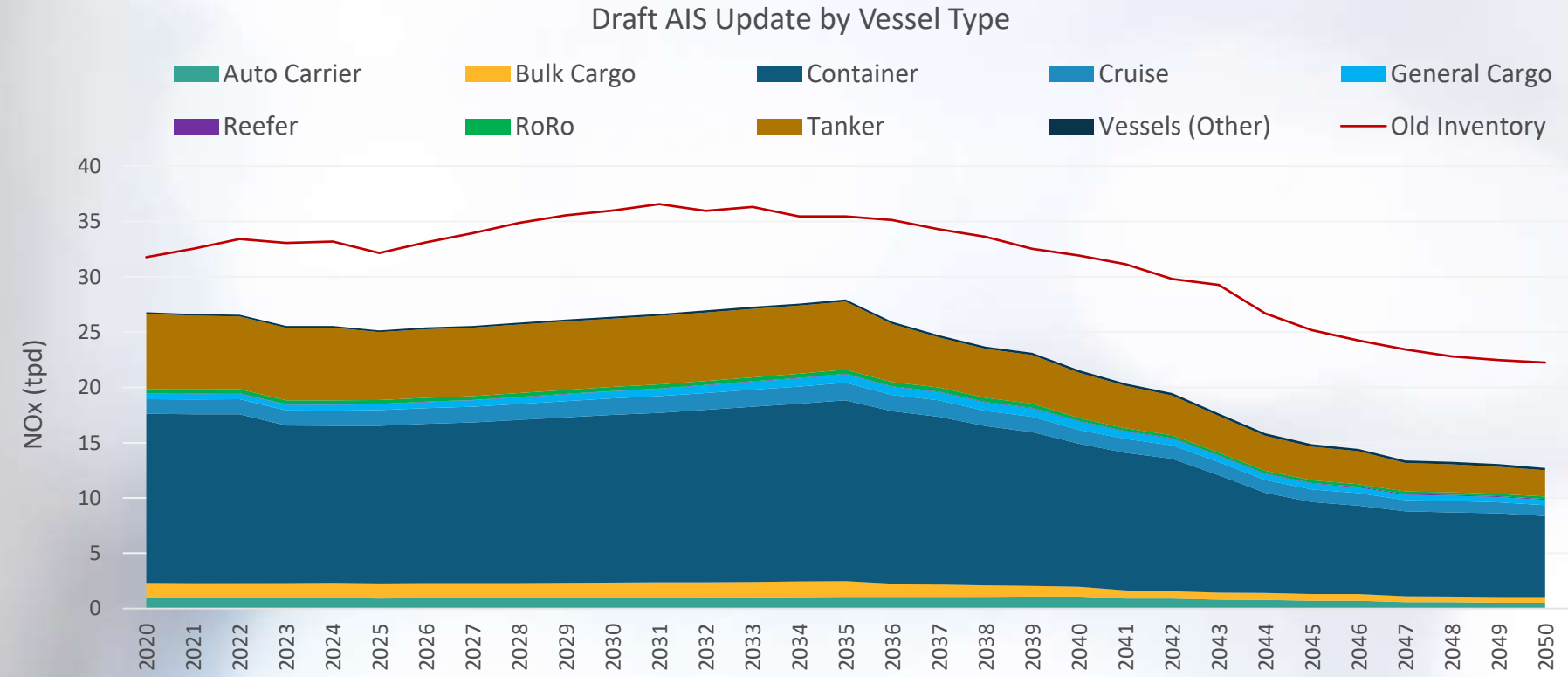
South Coast NOx Emissions Out to 24 nm



What Are Your Thoughts

- **Tier III Penetration**: Is it reasonable to assume that growth of Tier III vessels will be delayed until 2030?
- **Tier III Low Load Operation:** What do you think about the emission rate assumptions for Tier III engines operating under 25% load?
- **Forecasted Freight Growth Rates:** Considering recent congestions at the ports, what are your thoughts about the long-term growth rate assumptions embedded in this draft?

Send your comments and suggestions to: Nancy.Bui@arb.ca.gov

Next Steps


CARB Public Workshop
• More statewide level details
• **Sep 2021**
Draft Release
• Open for public comments
• **Oct 2021**
Final Release
• Inclusion in 2022 South Coast SIP emissions inventory
• **Nov/Dec 2021**

Contact Information

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  Cory.Parmer@arb.ca.gov
- Sam Pournazeri, Chief, Mobile Source Analysis Branch
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- **Useful Links:**
  - 2019 At Berth Emissions Inventory:
    https://ww2.arb.ca.gov/sites/default/files/classic/regact/2019/ogvatberth2019/apph.pdf
  - 2011 OGV Emissions Inventory:
    https://ww2.arb.ca.gov/sites/default/files/classic/regact/2011/ogv11/ogv11appd.pdf
  - 2022 State Strategy for the State Implementation Plan: https://ww2.arb.ca.gov/resources/documents/2022-state-strategy-state-implementation-plan-2022-state-sip-strategy

Ocean-Going Vessel Retrofit Water-in-Fuel Project Update

South Coast AQMP Mobile Source Working Group

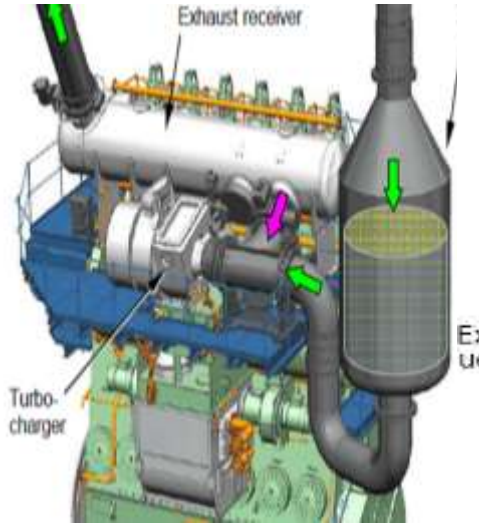
August 24, 2021

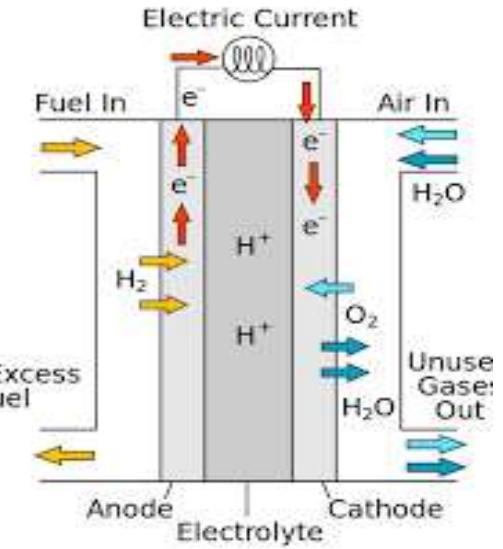
Background

- Ocean-Going Vessels (OGV) are expected to be one of largest NOx emission sources in the near future
- Forecast showed limited Tier 3 vessel calls at our local ports
- Upgrading an OGV is costly
- OGVs are designed to remain in service for over 25 years
- Need for developing retrofit technologies

Technology Assessment and Selection

- Technologies assessed:
  - Selective catalytic reduction (SCR)
  - Exhaust gas recirculation (EGR)
  - Water-in-Fuel (WiF)
  - Alternative fuel conversion
  - Battery and fuel cell
- 1st project selection- WiF
  - Easy to install on the existing ship
  - Cost-effectiveness
  - Partnership





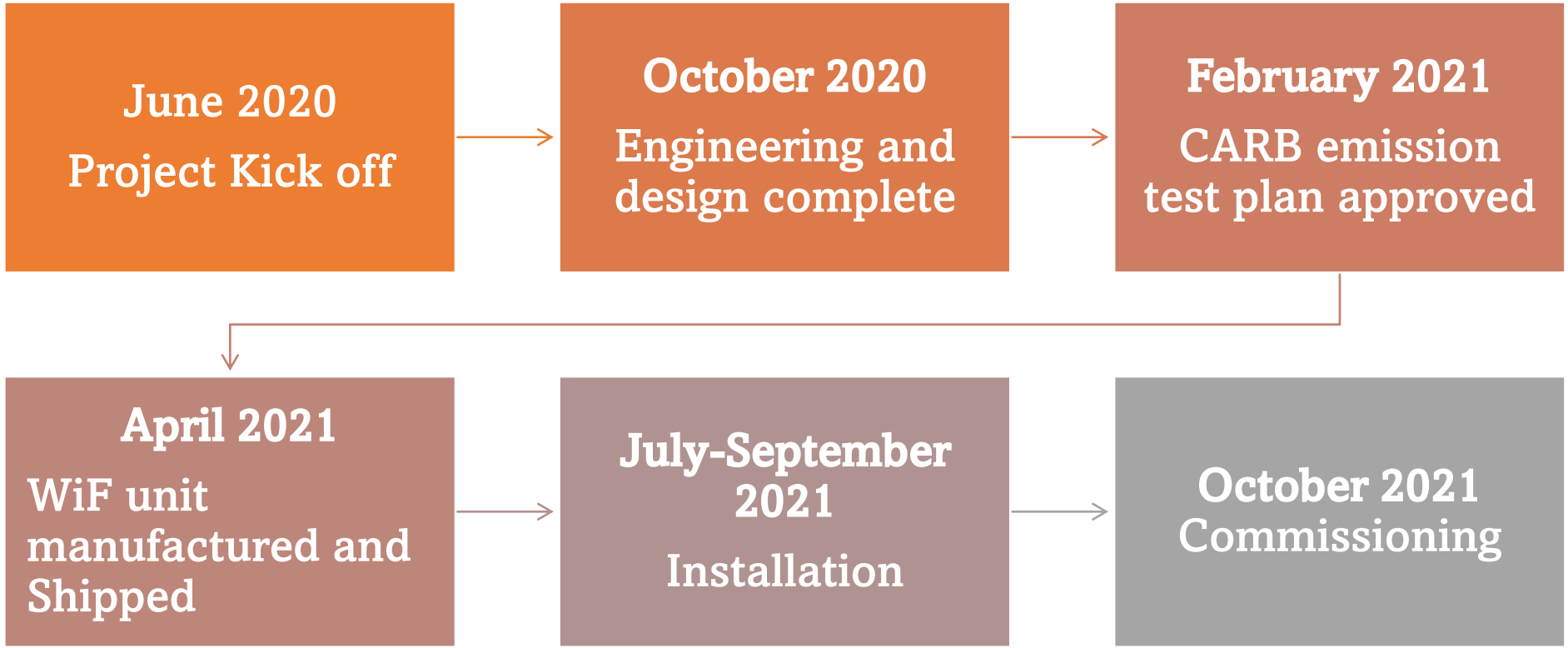
Project Partners

- Funding: SCAQMD, Port of Los Angeles and Long Beach
- MAN Energy Solutions –Technology Provider
  - Design and develop the WiF unit
  - Oversee the manufacturing of WiF
  - Supervise the installation
  - Commission and optimization
  - Emission Testing
- MSC- Demonstrator
  - Provide vessel specification, access and on-board support
  - Coordinate ship routes and schedule
  - Vessel –MSC ANZU
    - Built in 2015 Tier 2, container ship with 8800TEU capacity
    - MAN 9S90ME engine (main)

Water-in-Fuel Retrofit

- The WiF unit manufactured into 2 parts:
  - Emulsion Mixer
  - Emulsion booster
- Elevated foundation installation
- Installation time: 4-6 weeks, while vessel at berth and on route
- Commissioning and optimization
- Emission testing and verification
- Operation range: 10-50% engine load
- Total project cost: $3M
- Expected NOx reduction: 40% or 2.2 ton/call

Project status



Next Steps

- Obtain marine approval
  - DNV GL
- Installation inspection – August 15, 2021, at Antwerp
- Finalize the vessel route for Q4 2021
- Commissioning and optimization
- Emission Test and verification
- Expected project completion: June 2022
- Expected San Pedro Bay Port vessel call: 5-7 times/year

Challenges

- Uncertainties of vessel routes due to the congestion at the ports around the world

- COVID restrictions
  - Travel
  - Board the ship
  - Deliver materials to the ship