# Attainment Demonstration for the 2015 8-hour Ozone Standard

Item #2

Scientific, Technical & Modeling Peer Review (STMPR)
Advisory Group Meeting

March 16, 2022

# Outline

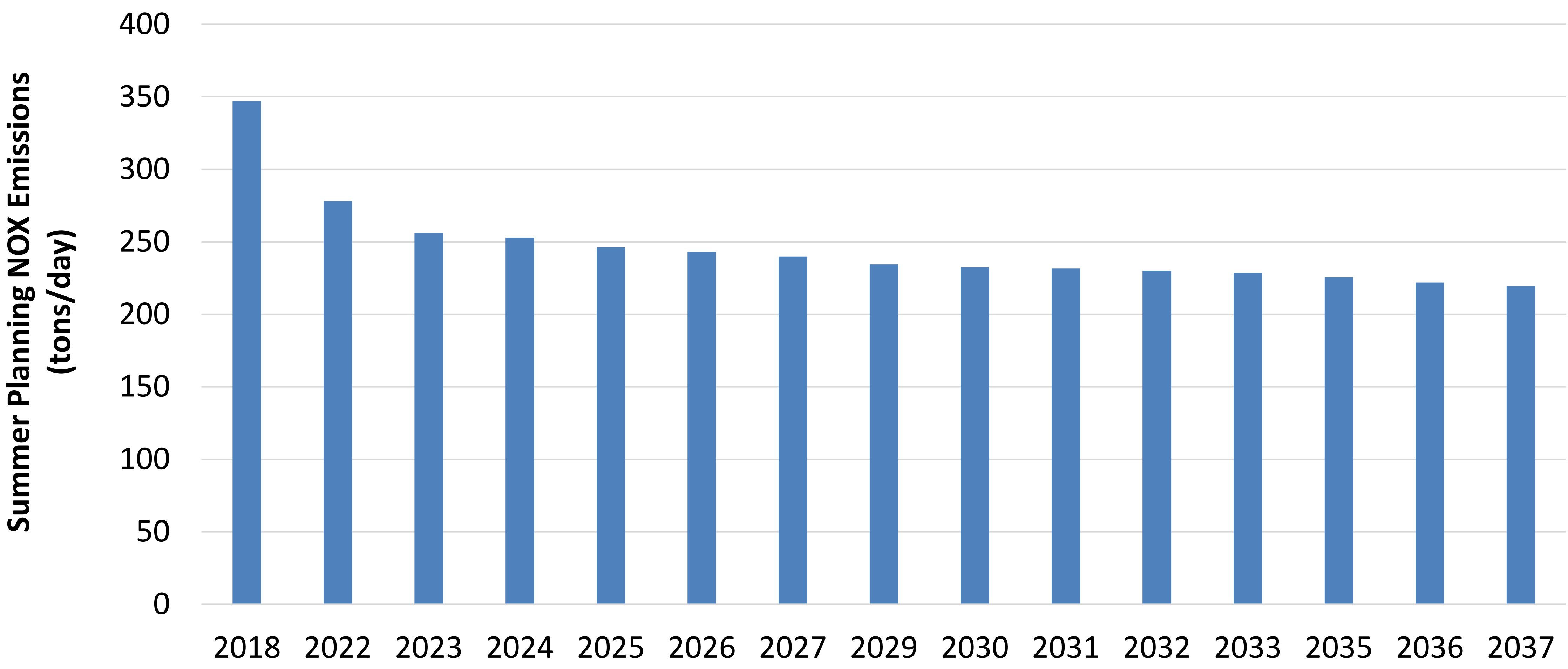
- South Coast Air Basin Attainment Demonstration
  - – Ozone Design Values
  - – Carrying capacity plots completed for 2022 AQMP
  - – Preliminary attainment scenario
- Coachella Valley Attainment Demonstration

# 2022 Air Quality Management Plan

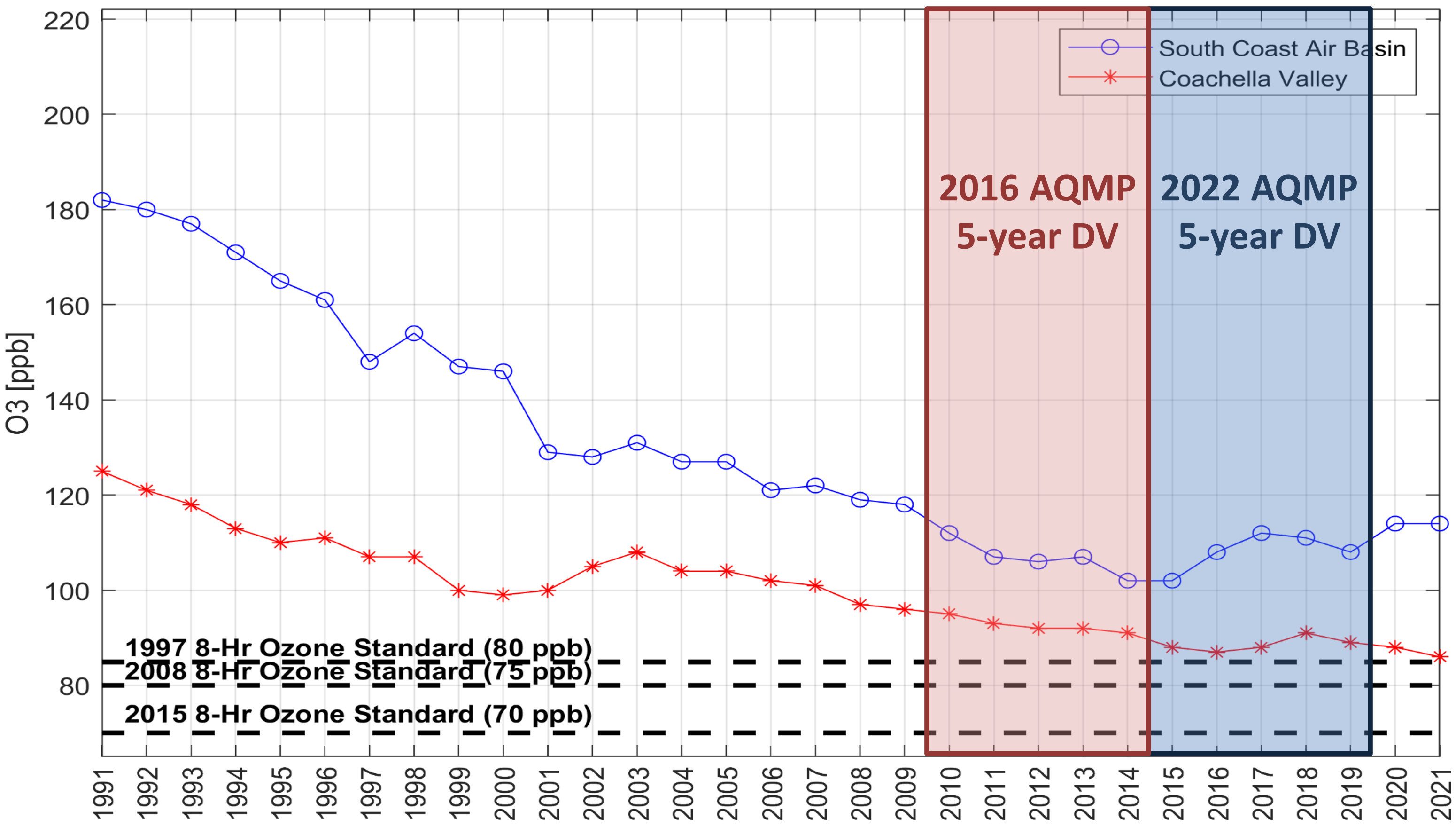
- 2022 AQMP focuses on attaining the 2015 federal 8-hour ozone National Ambient Air Quality Standard (NAAQS), 70 ppb
  - South Coast Air Basin's (SCAB) attainment due – 2037
  - Coachella Valley's attainment due – 2032
- Baseline NOx emissions in SCAB in 2037 are 220 tpd
- Preliminary NOx carrying capacity* is approximately 60 tpd to attain the 70ppb ozone standard

*Carrying capacity is the maximum allowable emissions to attain NAAQS

# South Coast Air Basin Total Baseline NOx Emissions



# Ozone Trends in the South Coast Air Basin and Coachella Valley

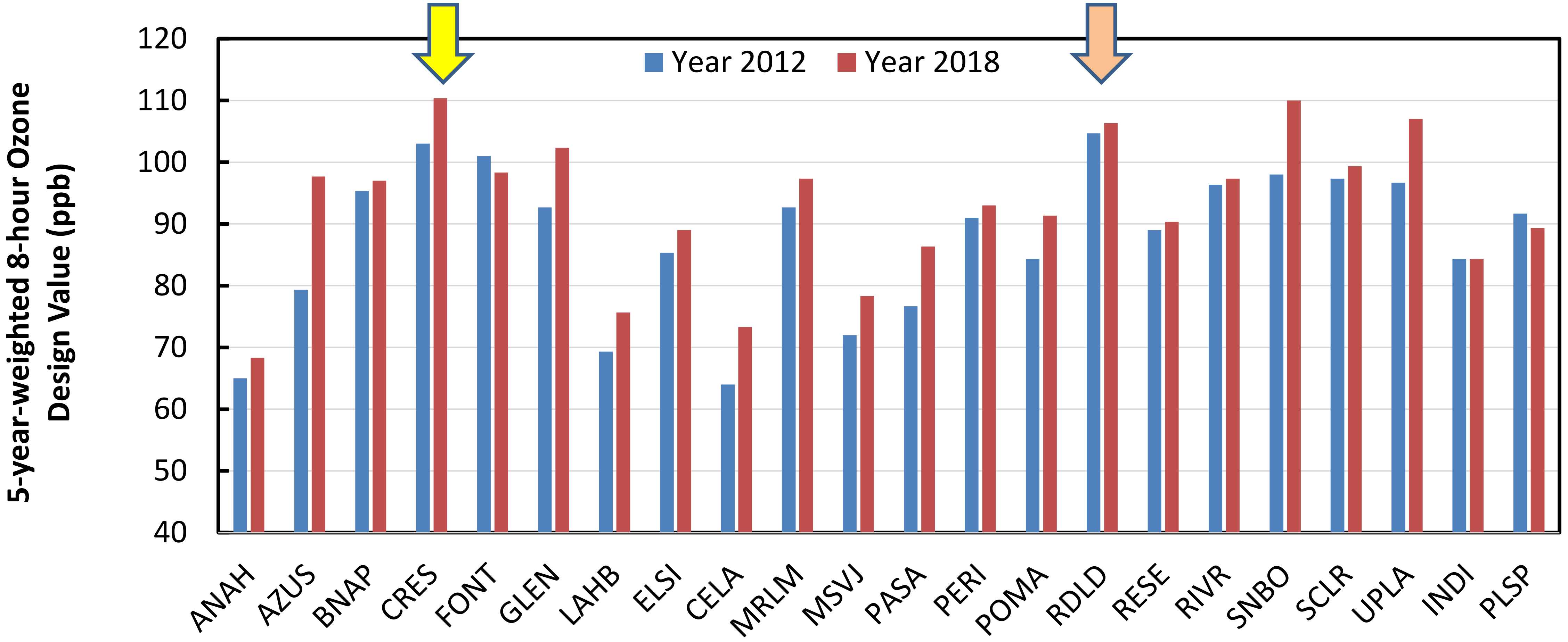



*Poor meteorology and complex photochemistry have resulted in recent poor ozone air quality despite on-going emission reductions*

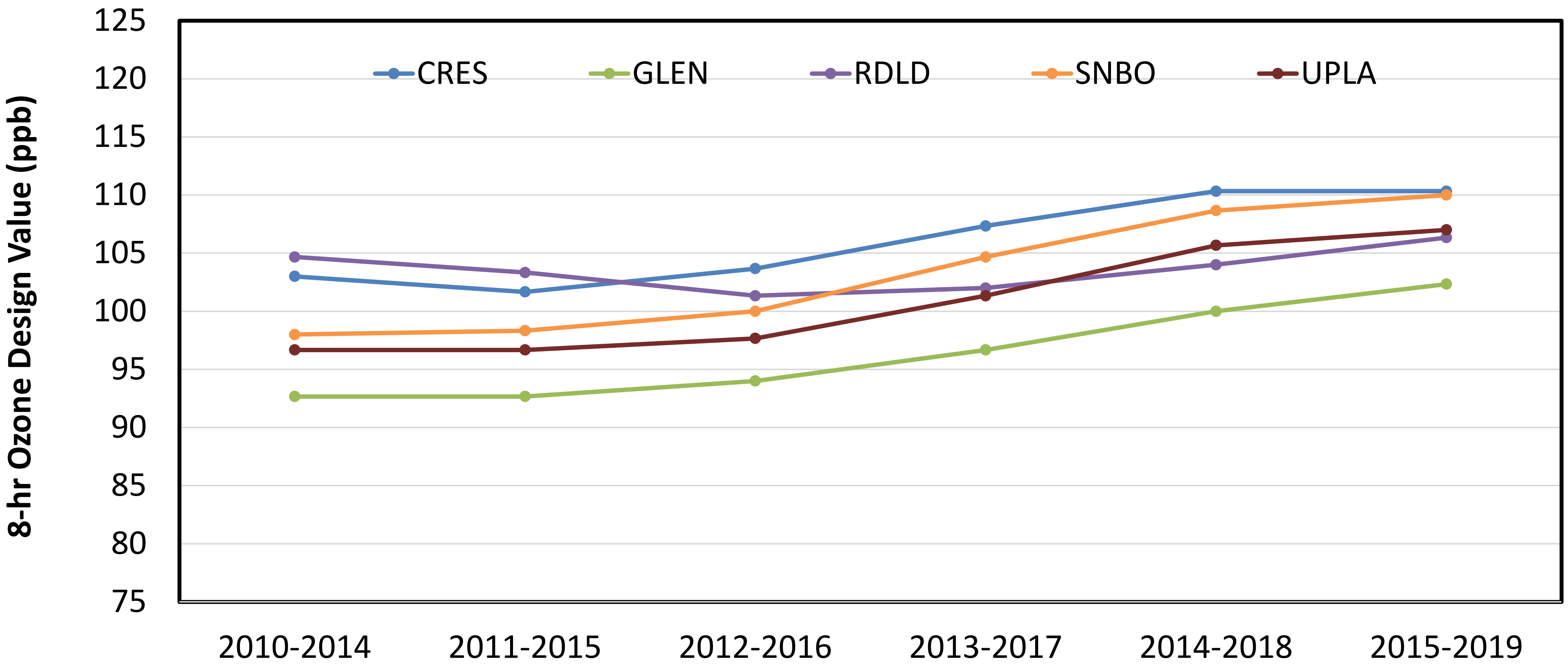


**Preliminary data for 2021*

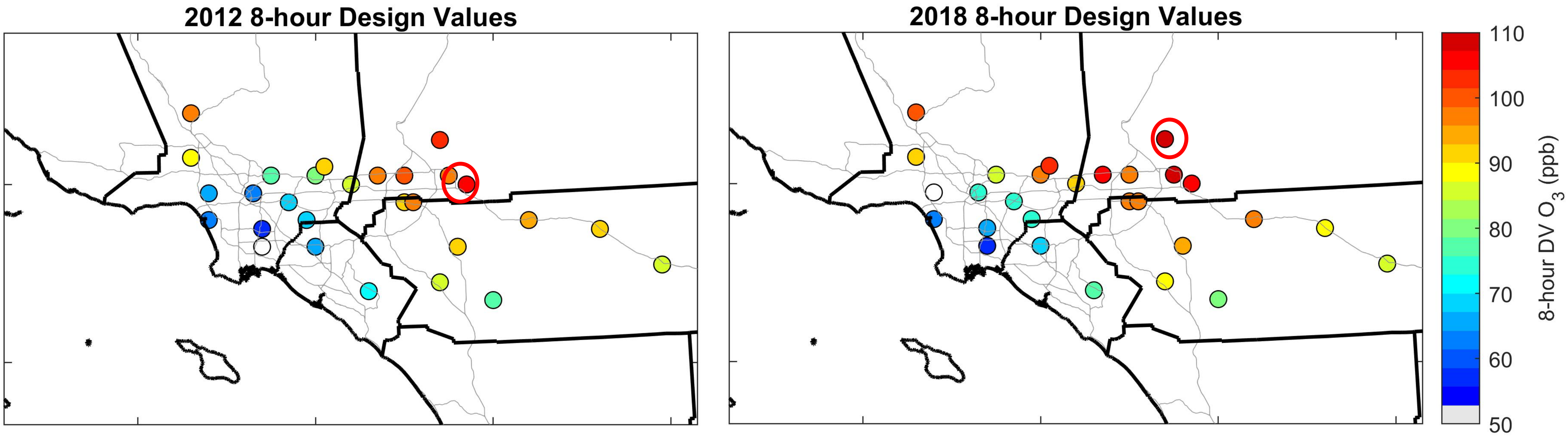
# 5-year weighted 8-hour Ozone – 2012 vs. 2018 Base Year



# 5-year weighted 8-hour Ozone Design Value Trends



# 5-year weighted 8-hour Ozone DV



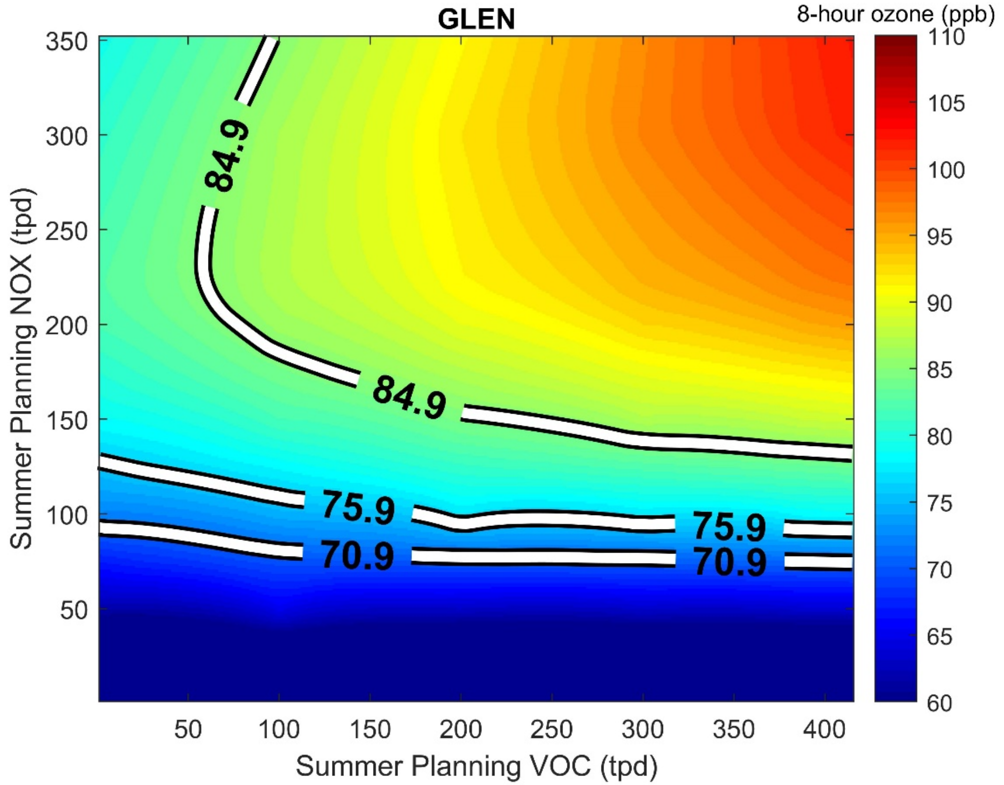
# Development of Ozone Isopleths

- CMAQ nested domains
  - 12 km including the entire California and portions of neighboring states and northern Mexico
  - 4km is the AQMP analysis domain
- Basin total anthropogenic VOC and NOx emissions used as x and y axis, respectively
- Simulations were conducted with NOx and VOC emissions in 50 tons per day (tpd) increments with MatLab spatial interpolation function
  - Emission reductions were assumed to occur equally in the entire modeling domain
- Preliminary basin total summer planning emissions

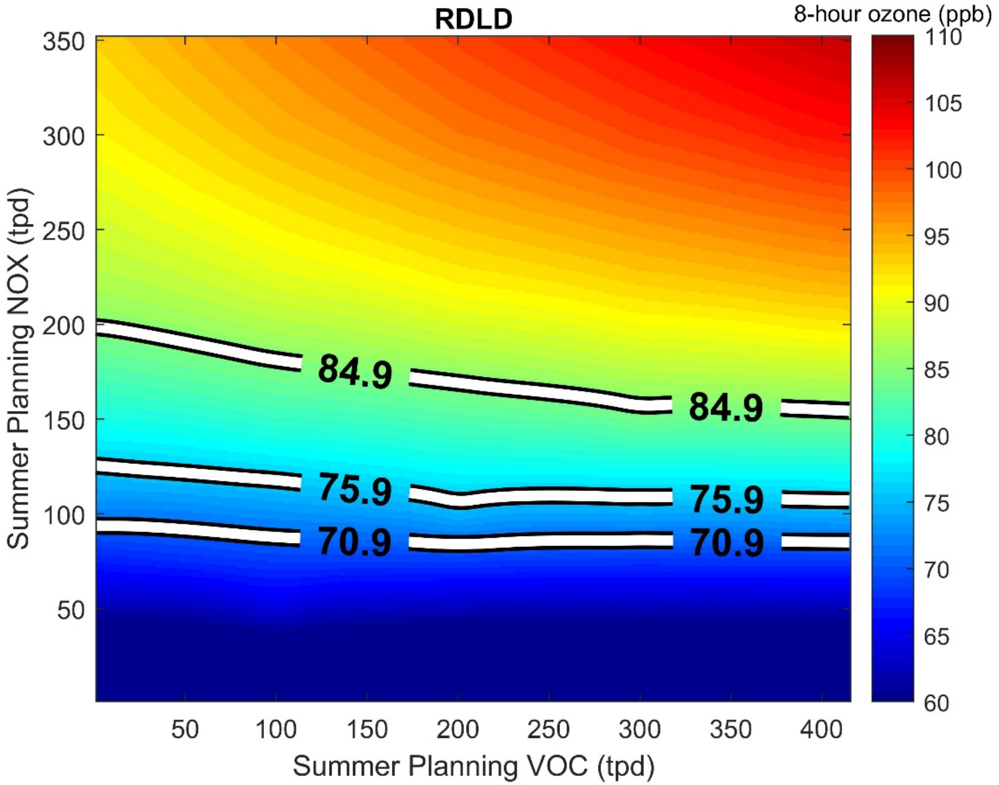
| Year | VOC (tpd) | NOx (tpd) |
|---|---|---|
| 2018 | 417 | 347 |
| 2037 | 389 | 220 |

# Carrying Capacity Plots

## Glendora

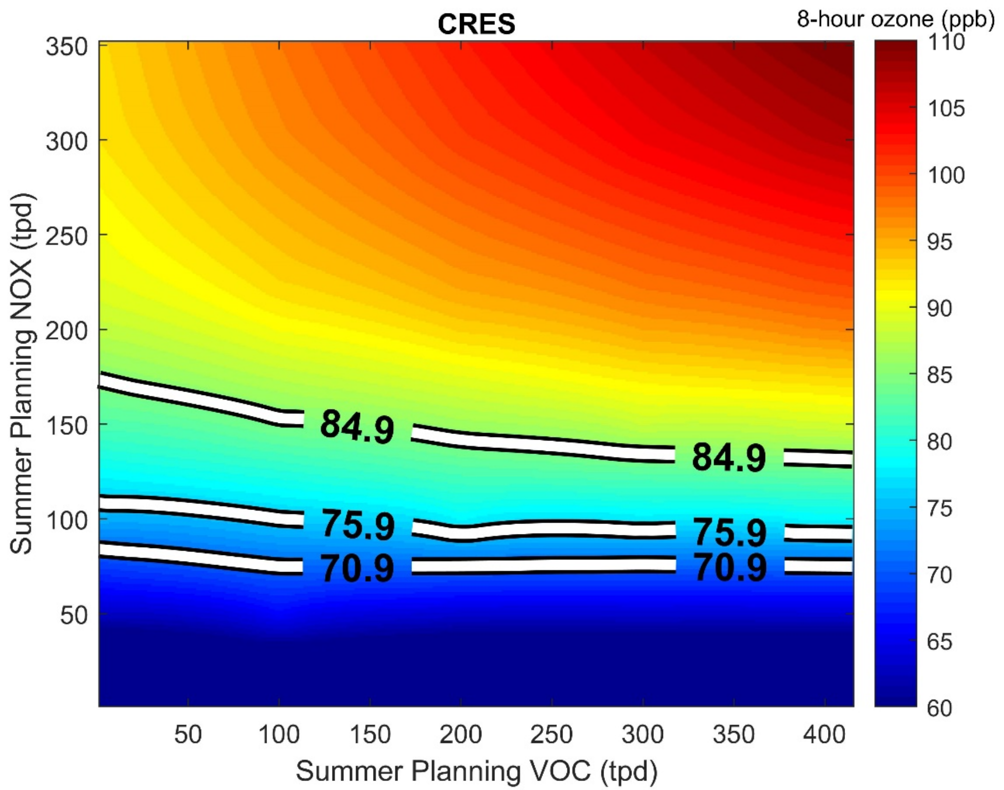



## Redlands

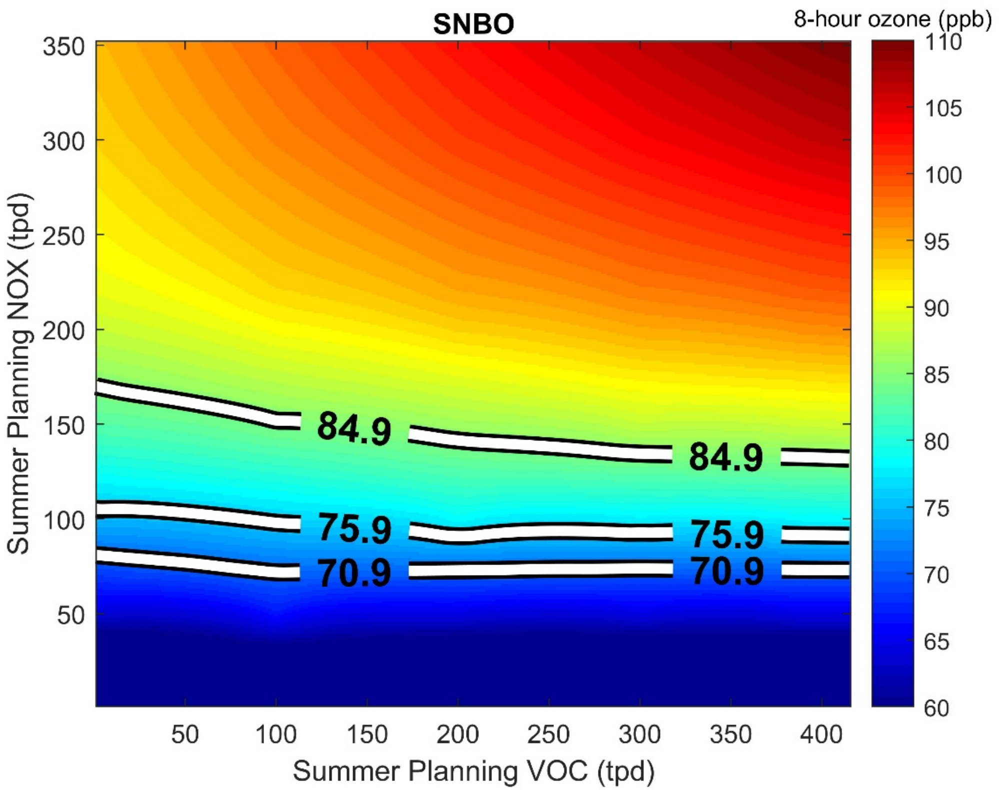


# Carrying Capacity Plots – Inland San Bernardino Stations

## Crestline

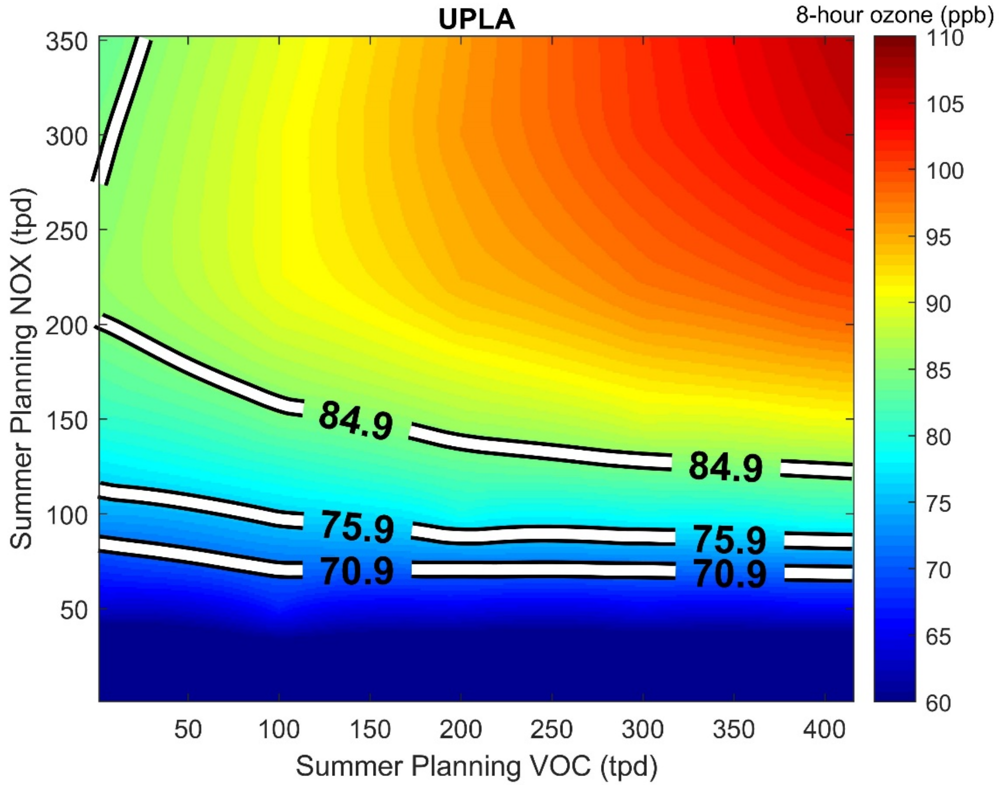



## San Bernardino

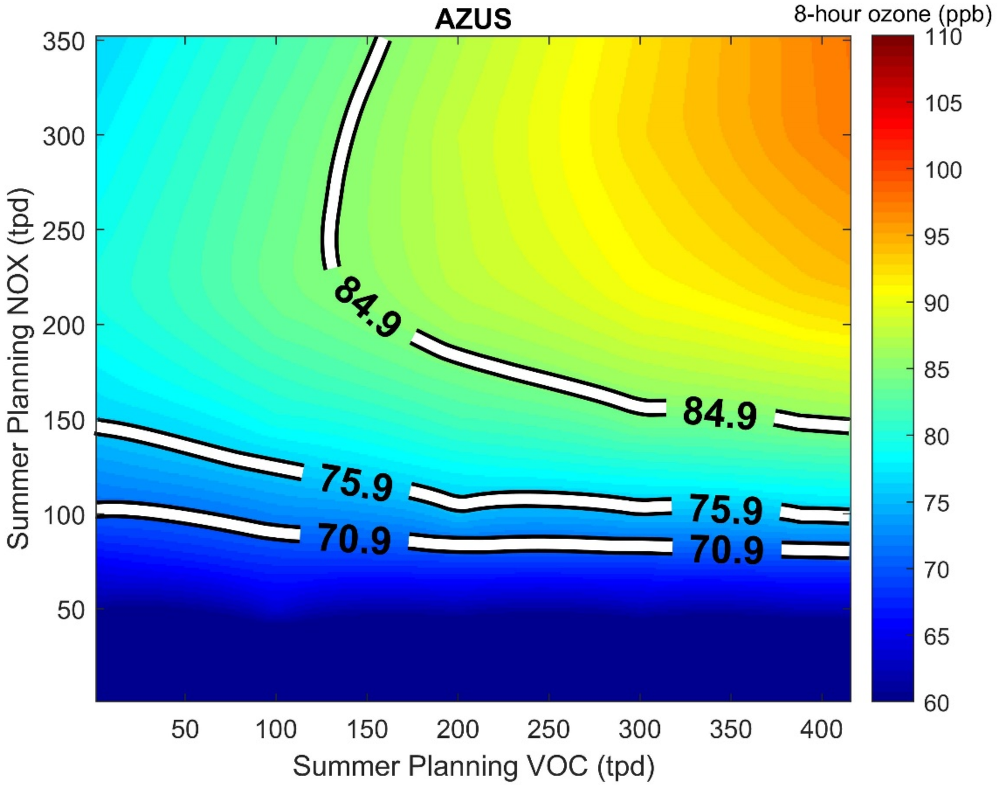


# Carrying Capacity Plots – San Gabriel Foothill Stations

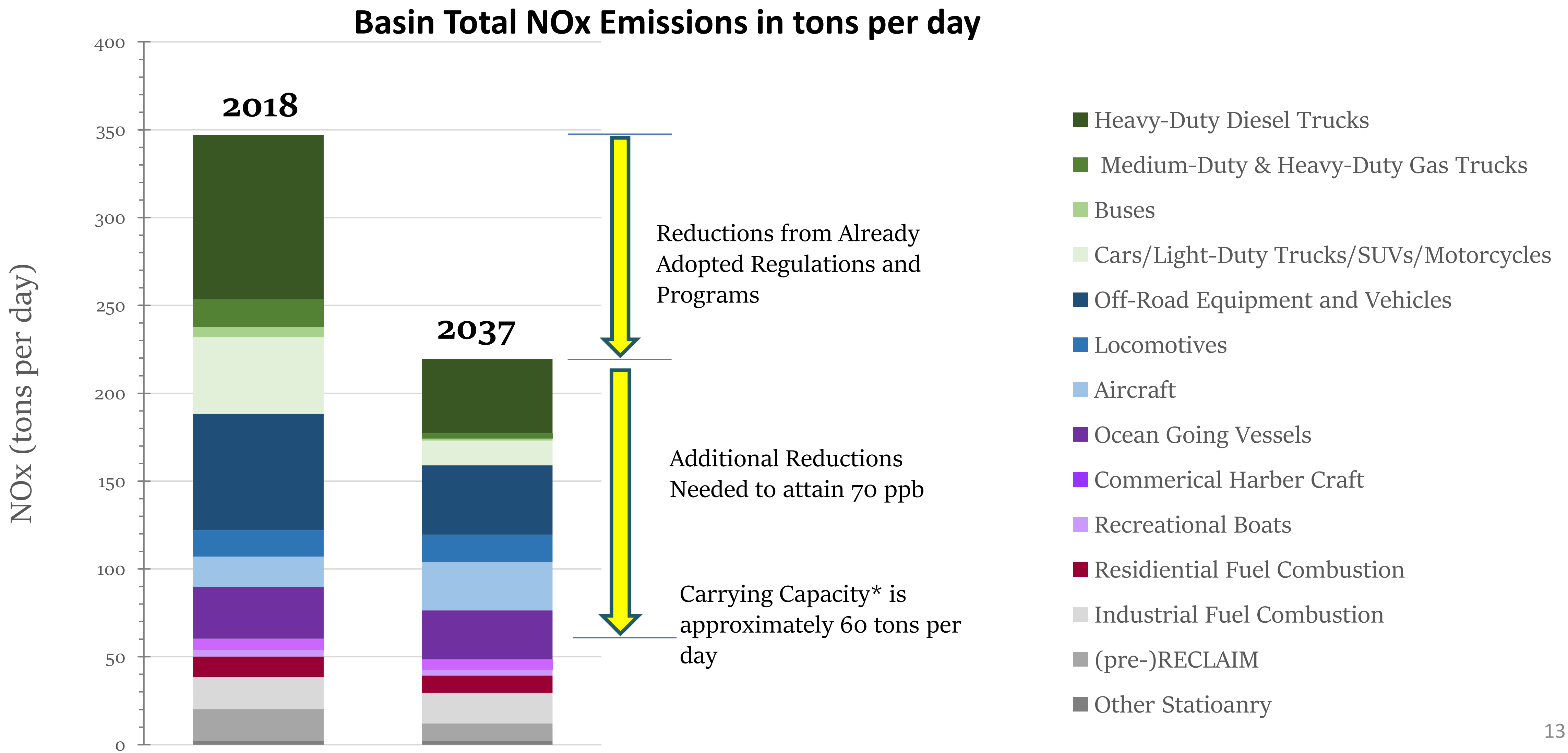
## Upland




## Azusa



# NOx Reductions Needed for Attainment



# CARB DRAFT SIP Strategy

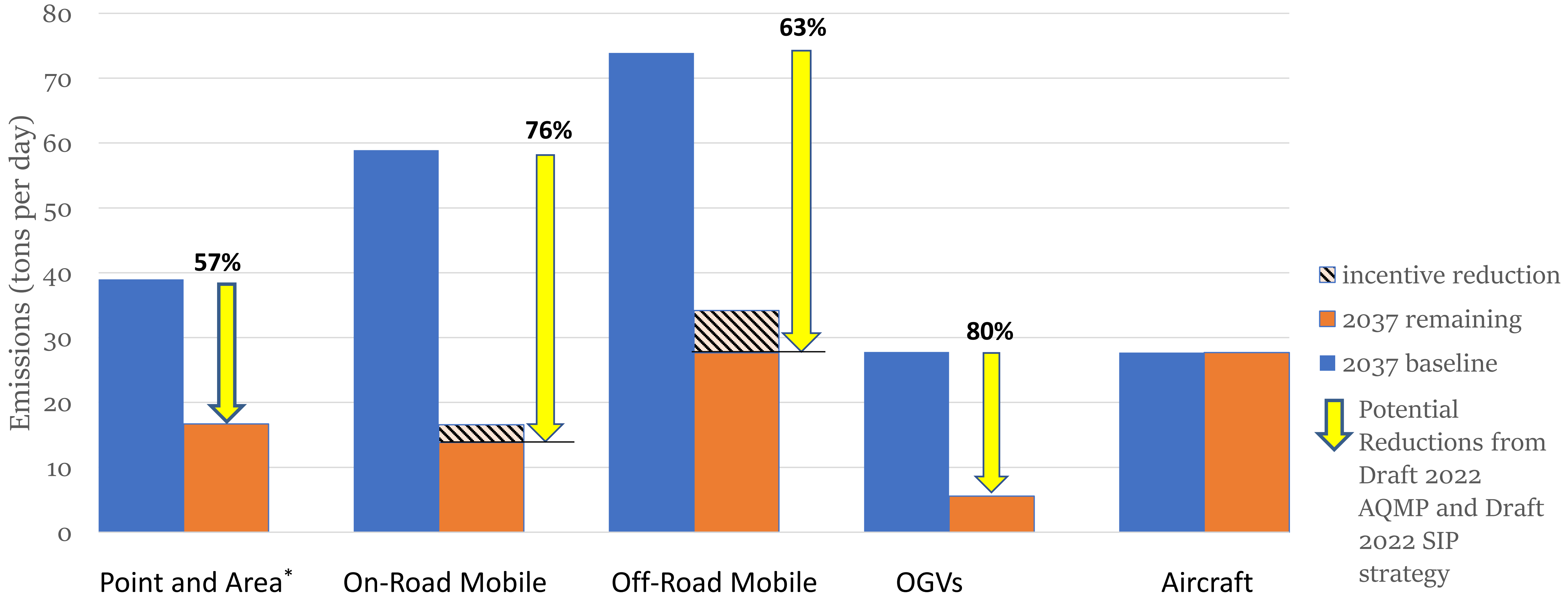
- CARB measures included in Draft 2022 SIP Strategy
- Draft 2022 AQMP will include CARB measures for the following categories
  - Area sources
  - On-Road Vehicles
  - Off-Road Vehicles and Equipment
  - CARB's measures for federally and internationally regulated sources
  - Federally and internationally regulated sources that required federal action



Table 8- South Coast Expected Emissions Reductions from the 2022 State SIP Strategy

| Proposed Measure | 2037 | |
|---|---|---|
| | NOx | ROG |
| **On-Road Heavy-Duty** | | |
| Advanced Clean Fleets Regulation | 5.3 | 0.5 |
| Zero-Emissions Trucks Measure | NYQ | NYQ |
| Total On-Road Heavy-Duty Reductions | 5.3 | 0.5 |
| **On-Road Light-Duty** | | |
| On-Road Motorcycle New Emissions Standards | 0.9 | 2.1 |
| Clean Miles Standard | <0.1 | <0.1 |
| Total On-Road Light-Duty Reductions | 0.9 | 2.1 |
| **Off-Road Equipment** | | |
| Tier 5 Off-Road Vehicles and Equipment | 1.8 | NYQ |
| Amendments to the In-Use Off-Road Diesel-Fueled Fleets Regulation | 1.3 | 0.1 |
| Transport Refrigeration Unit Regulation | 4.6 | NYQ |
| Commercial Harbor Craft Amendments | 2.6 | 0.2 |
| Cargo Handling Equipment Amendments | 1.2 | 0.3 |
| Off-Road Zero-Emission Targeted Manufacturer Rule | 1.1 | NYQ |
| Clean Off-Road Fleet Recognition Program | NYQ | NYQ |
| Spark-Ignition Marine Engine Standards | 0.3 | 1.2 |
| Total Off-Road Equipment Reductions | 12.9 | 1.8 |
| **Other** | | |
| Consumer Products Standards | NYQ | 8 |
| Zero-Emission Standard for Space and Water Heaters | 5.8 | 0.8 |
| Enhanced Regional Emission Analysis in State Implementation Plans | NYQ | NYQ |
| Total Other Reductions | 5.8 | 8.8 |
| **Primarily-Federally and Internationally Regulated Sources – CARB Measures** | | |
| In-Use Locomotive Regulation | 12.7 | 0.3 |
| Future Measures for Aviation Emission Reductions | NYQ | NYQ |
| Future Measures for Ocean-Going Vessel Emissions Reductions | NYQ | NYQ |
| Total Primarily-Federally and Internationally Regulated Sources – CARB Measures Reductions | 12.7 | 0.3 |
| **Primarily-Federally and Internationally Regulated Sources – Federal Action Needed** | | |
| On-Road Heavy-Duty Vehicle Low-NOx Engine Standards | 10.2 | NYQ |
| On-Road Heavy-Duty Vehicle Zero-Emission Requirements | NYQ | NYQ |
| Off-Road Equipment Tier 5 Standard for Preempted Engines | 2.0 | NYQ |
| Off-Road Equipment Zero-Emission Standards Where Feasible | 1.2 | NYQ |
| More Stringent Aviation Engine Standards | NYQ | NYQ |
| Cleaner Fuel and Visit Requirements for Aviation | NYQ | NYQ |
| Zero-Emission On-Ground Operation Requirements at Airports | NYQ | NYQ |
| More Stringent National Locomotive Emission Standards | NYQ | NYQ |
| Zero-Emission Standards for Switch Locomotives | NYQ | NYQ |
| Address Locomotives Remanufacturing Loophole | NYQ | NYQ |
| More Stringent NOx and PM Standards for Ocean-Going Vessels | 0.8 | NYQ |
| Cleaner Fuel and Vessel Requirements for Ocean-Going Vessels | 21.1 | NYQ |
| Total Primarily-Federally and Internationally Regulated -Federal Action Needed Reductions | 35.3 | NYQ |
| **Aggregate Emissions Reductions** | **72.9** | **13.5** |

# Summary of Potential Approach to Reducing NOx by Major Source Category



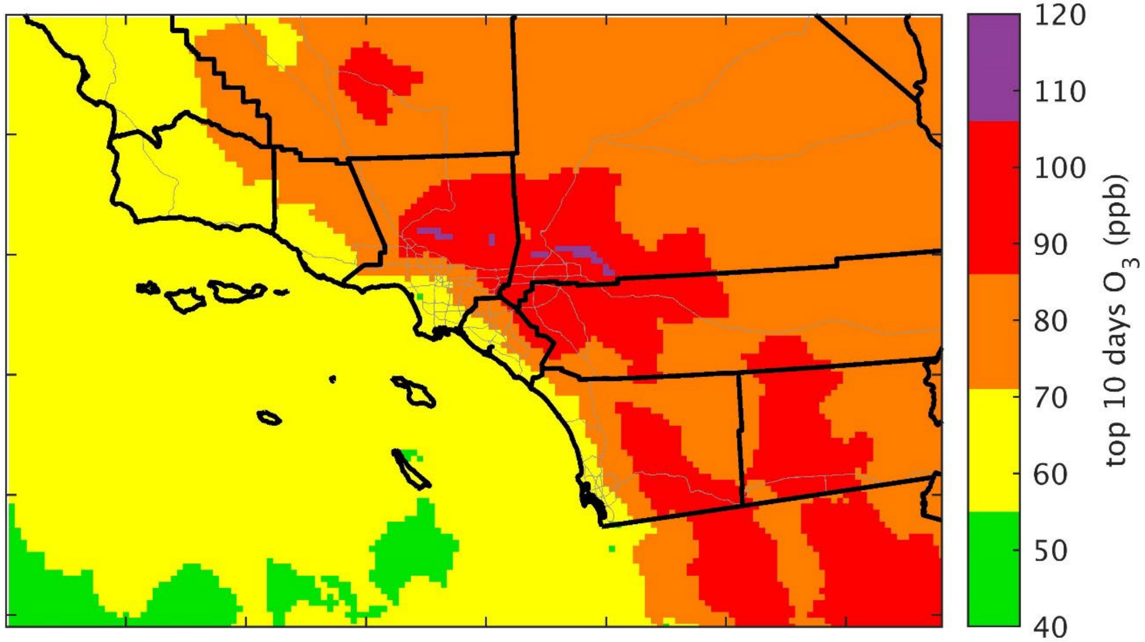



* Defined measures only

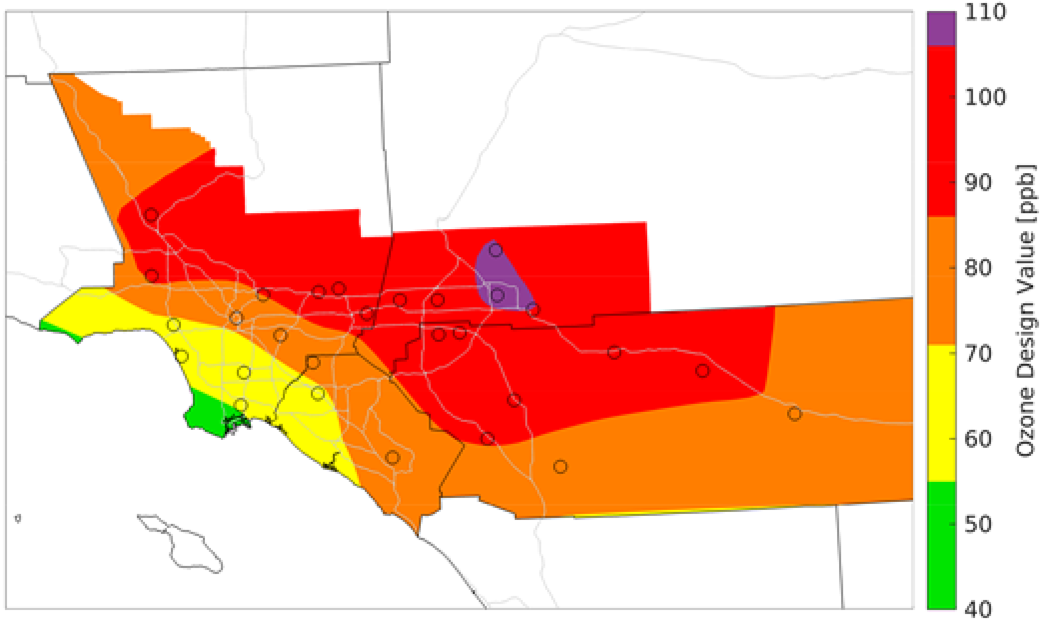
**Some incentives also anticipated for area sources, but not yet defined*

# Maximum Daily 8-hour Average (MDA8) Ozone – Base Year (2018)

## Modeled Baseline Daily 8-Hour Max 2018

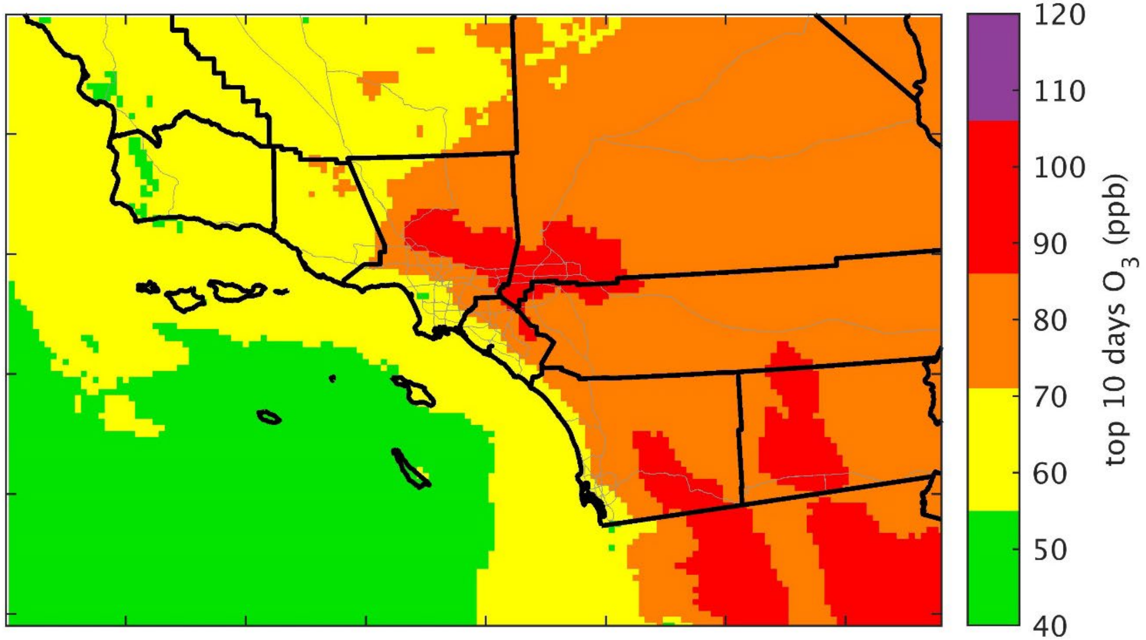



## Monitoring Data DV Baseline 2018

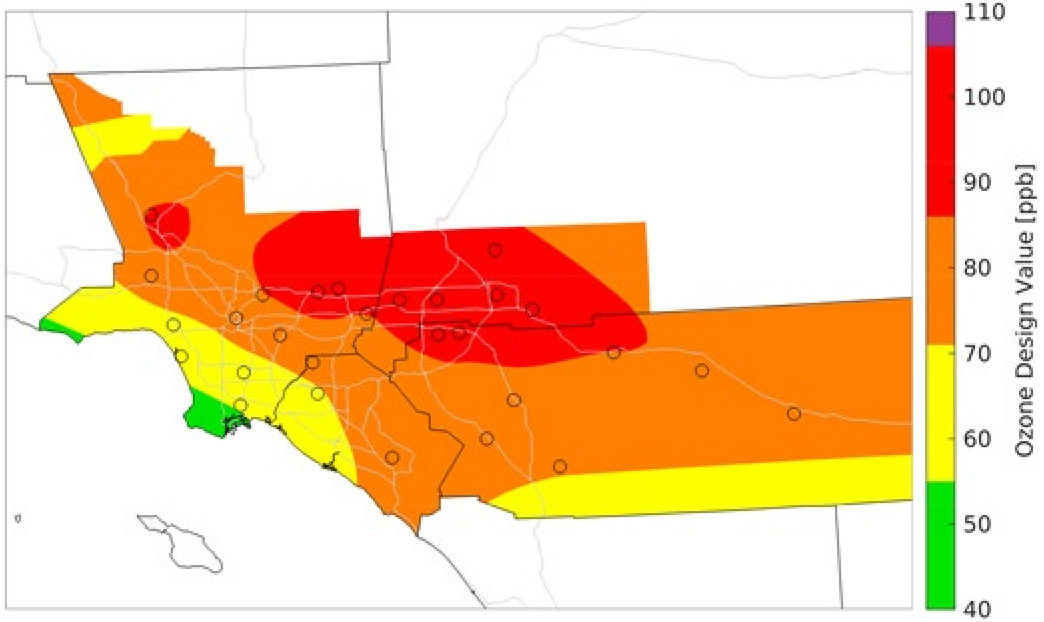


# MDA8 for 2037 Baseline (Business-as-Usual)

**Modeled Baseline Daily 8-Hour Max 2037**




**RRF-adjusted 2037 DV (Baseline)**

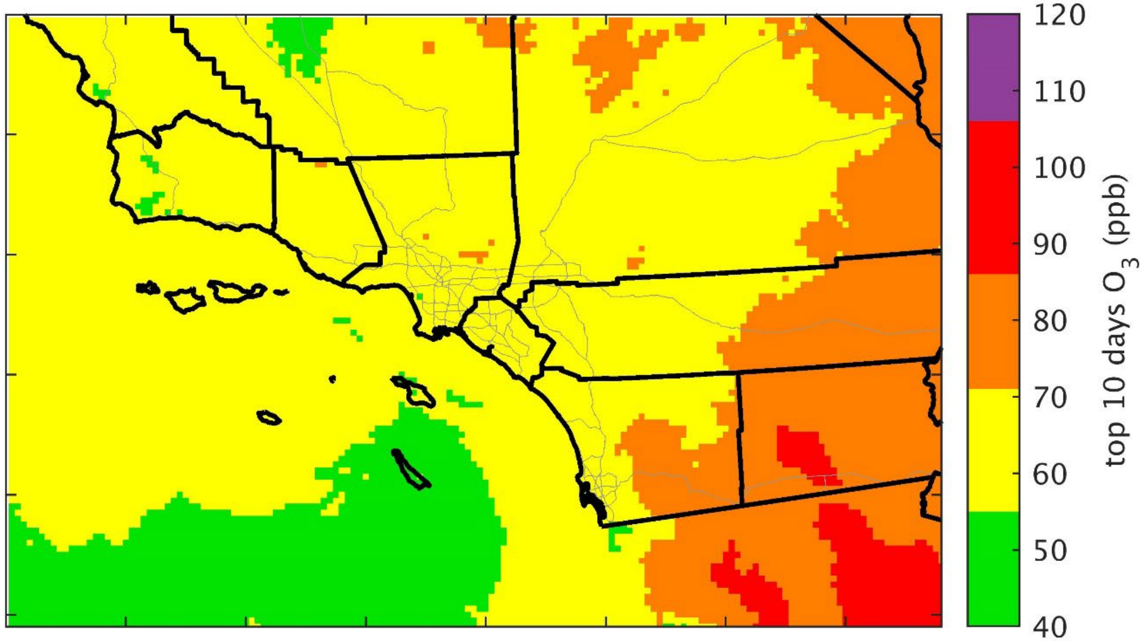



- Relative Response Factor (RRF) is calculated using the top 10 highest ozone days in the base year simulation: RRF = (average O3 in future)/(average O3 days base year)
- Future DV ($DV_{FY}$) is calculated by multiplying Base Year DV ($DV_{BY}$) times the RRF:

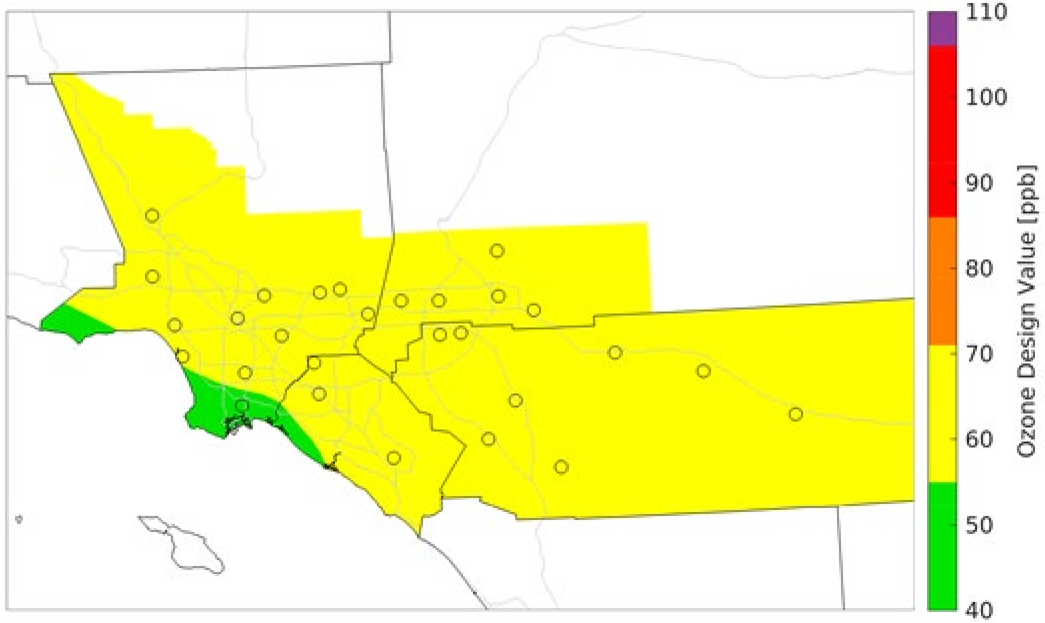
$$DV_{FY} = DV_{BY} \times RRF$$

# MDA8 – 2037 Preliminary Attainment Scenario

**Modeled Attainment 2037**

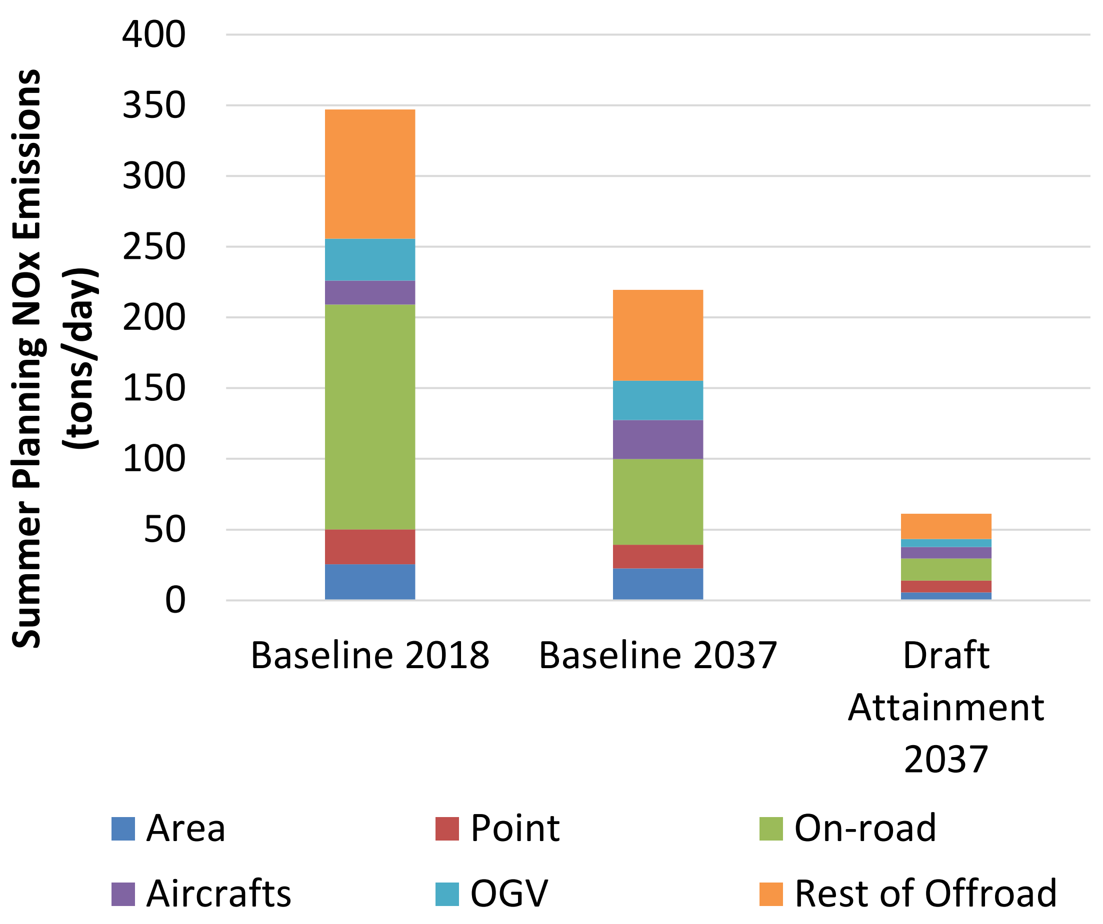


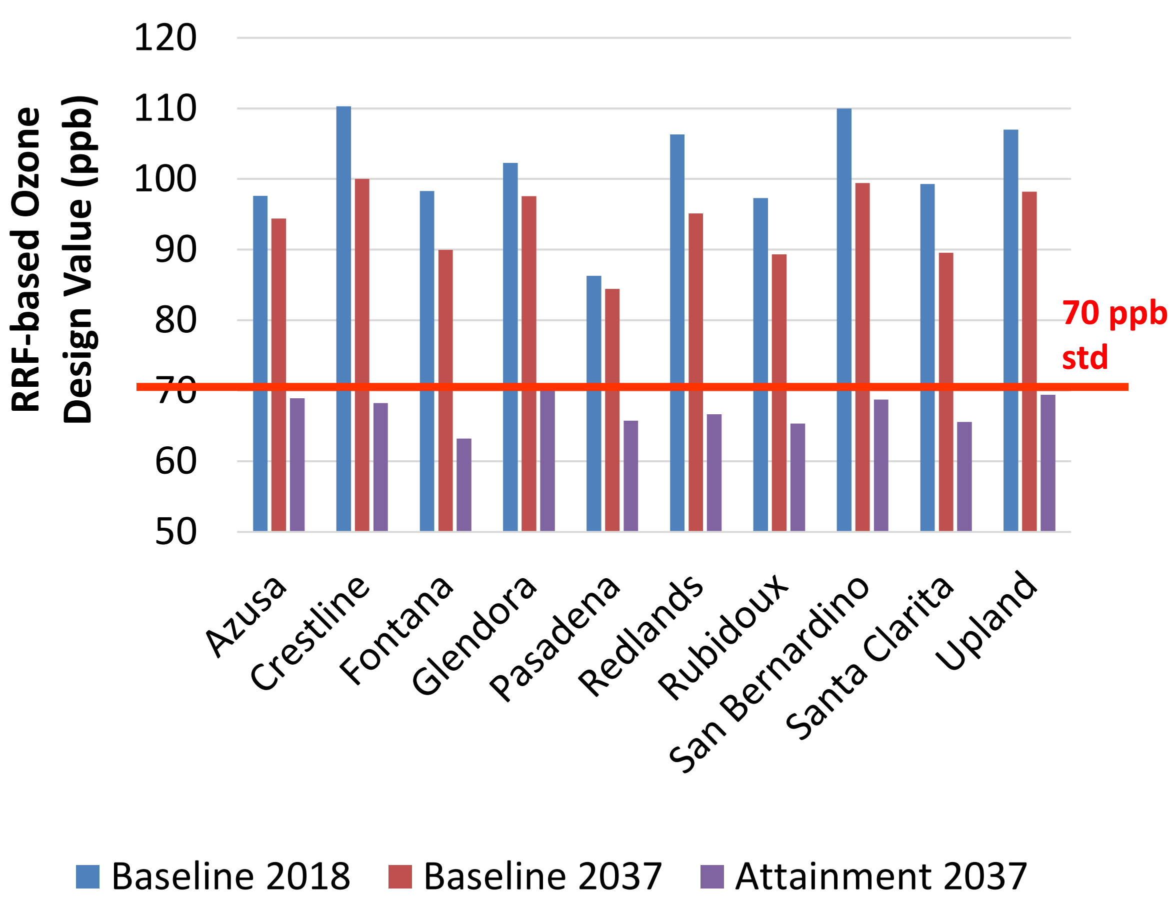

**RRF-adjusted 2037 DV (Attainment)**



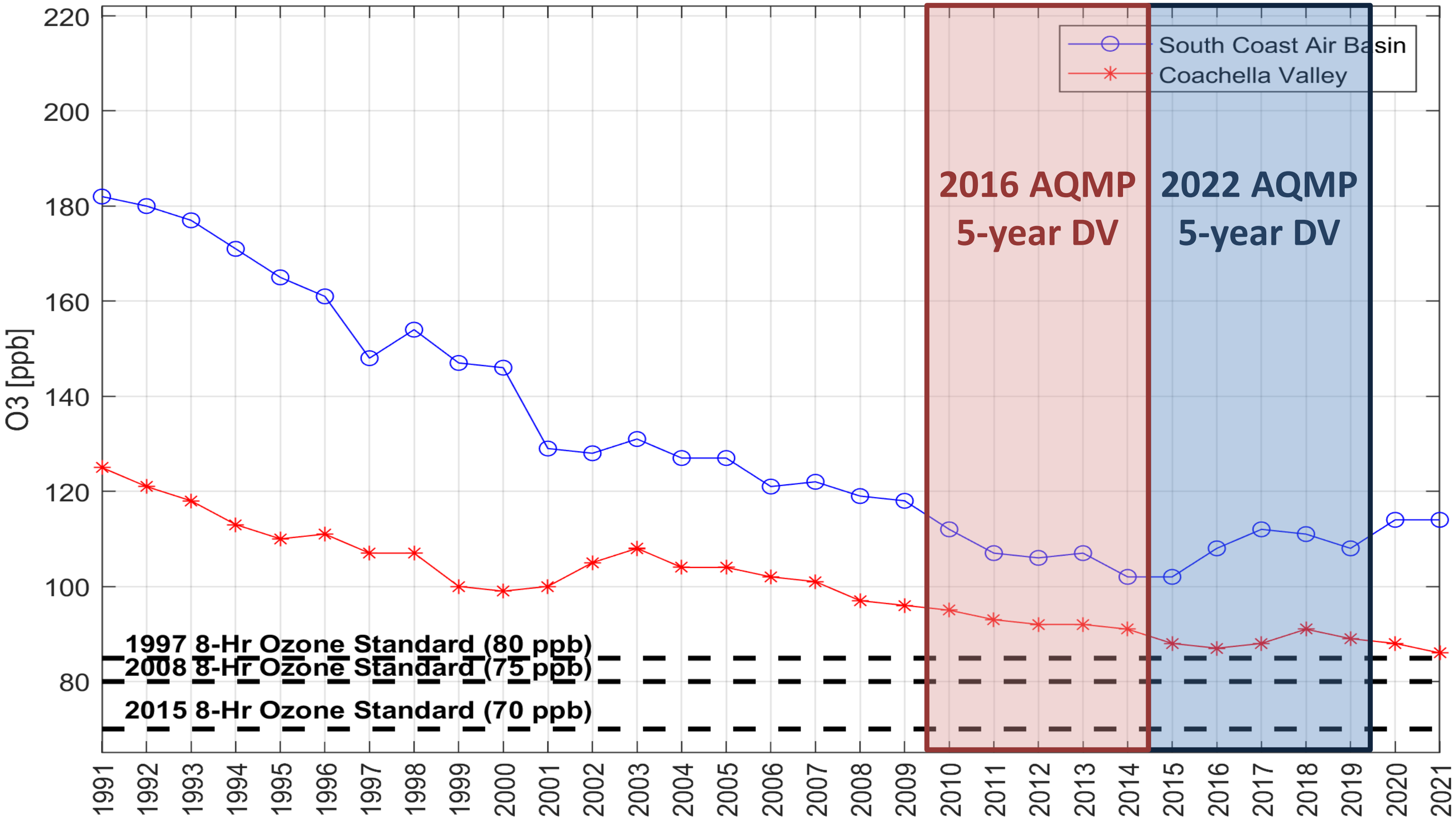

- Controls for mobile sources (except aircraft) are applied to entire modeling domain
- All emission controls over stationary sources and aircrafts are only applied SCAB and the Coachella Valley

# Preliminary Attainment Demonstration at Selected Stations



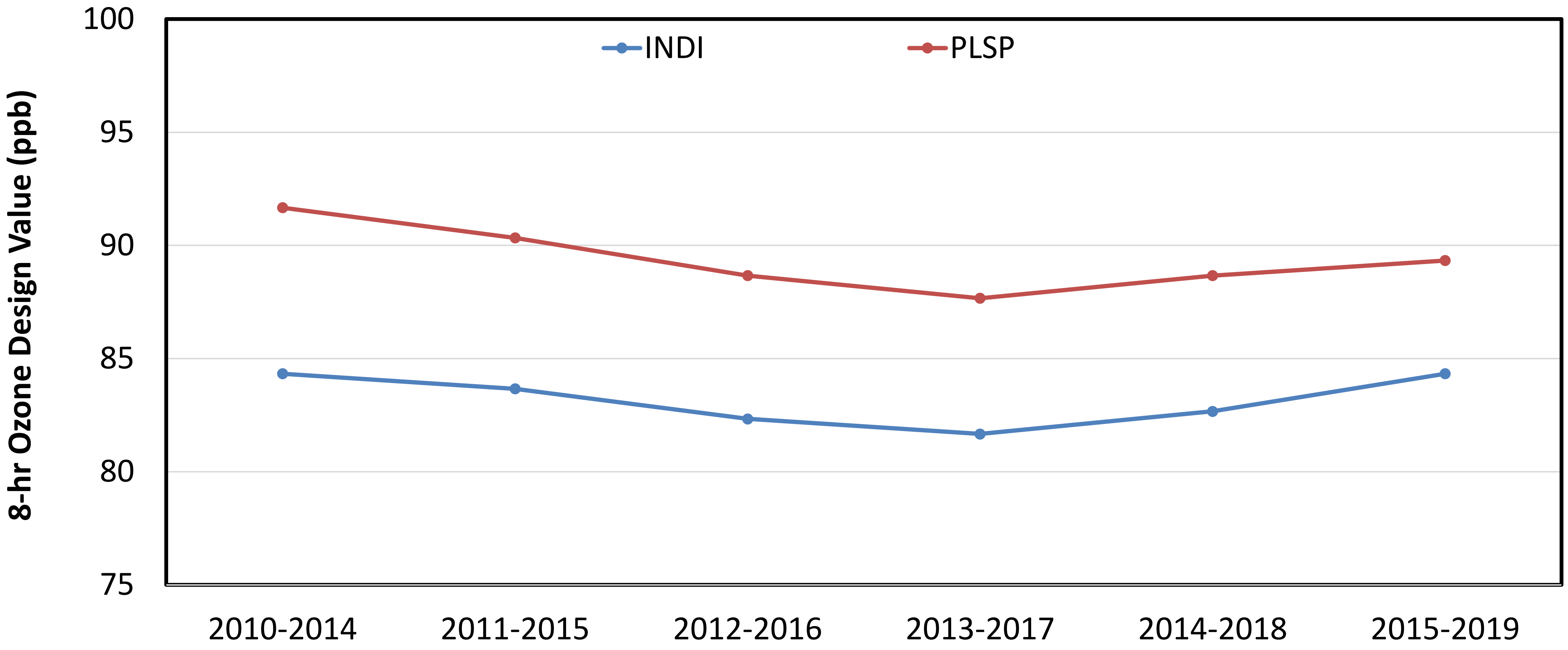
# Ozone Trends in Coachella Valley



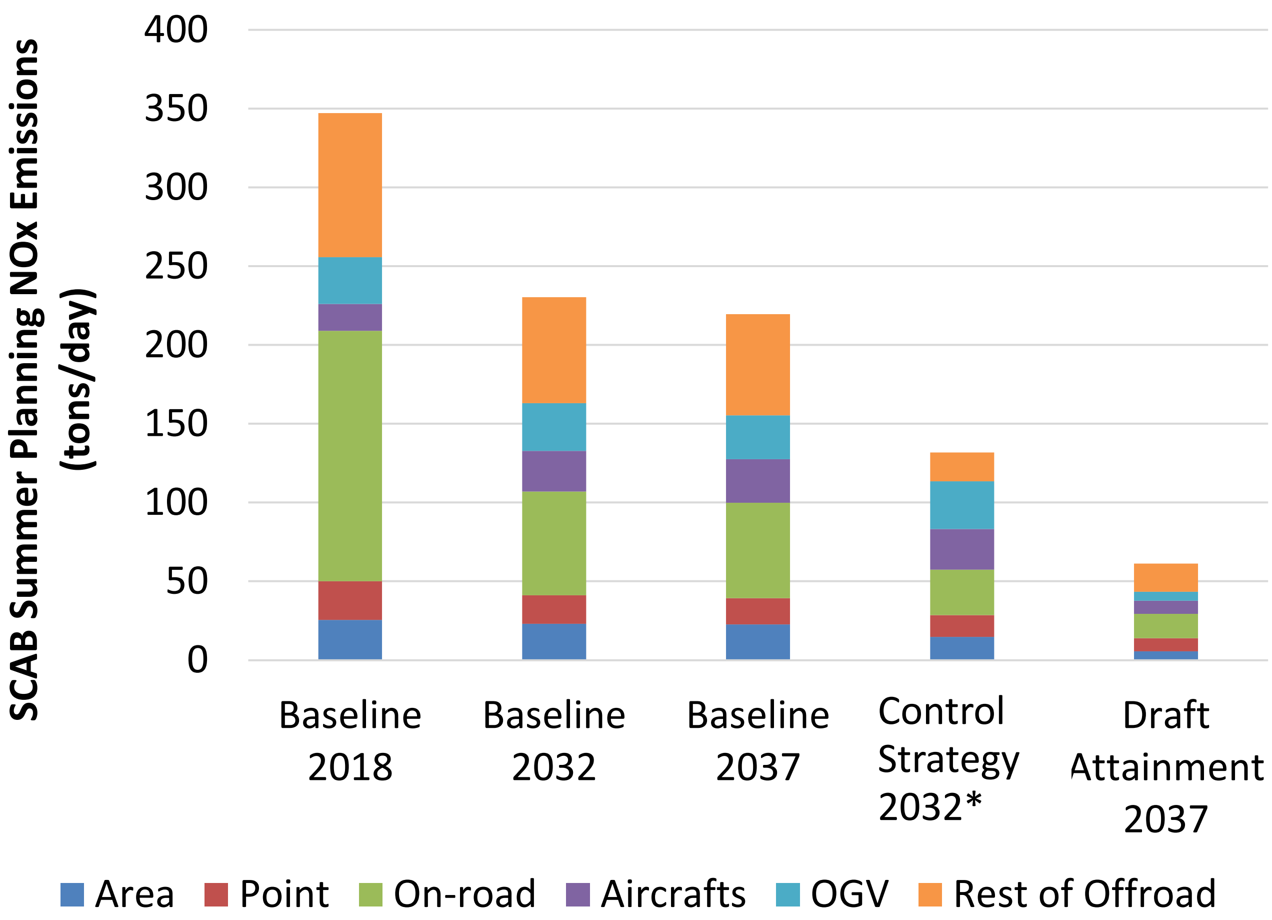

*Unlike the SoCAB, ozone in Coachella Valley has continued to improve except for a spike in 2017-2018*

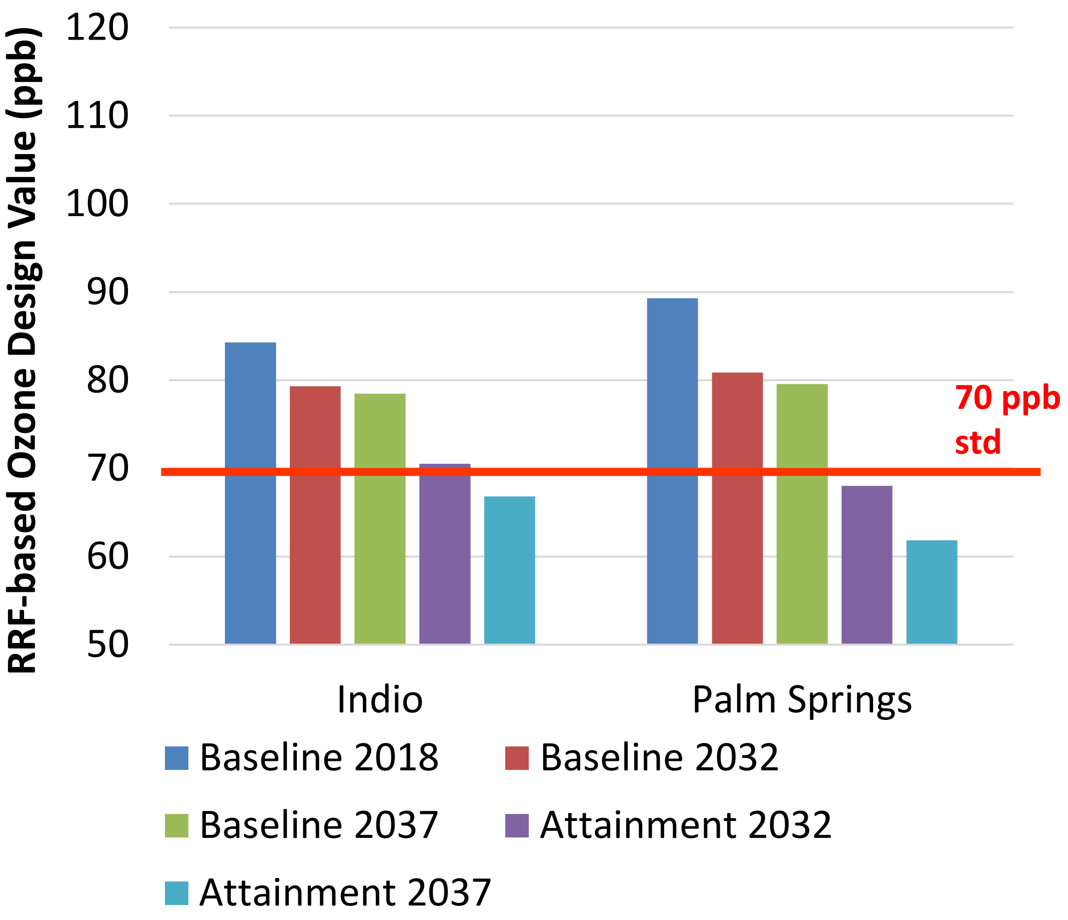
**Preliminary data for 2021*

# 5-year weighted 8-hour Ozone Design Value Trends – CV



# Preliminary Attainment Scenario for Coachella Valley




* South Coast strategy – approximately 2/3 of the commitment for 2037
CARB strategy – year specific control factors based on the draft 2022 SIP Strategy
No reductions in aircraft emissions

# Summary

- Carrying capacity plots based on draft inventory and air quality modeling are completed:
  - Carrying capacity estimated to be approximately 60 tons of NOx
  - Ozone responds to emission reductions differently, depending on the source of emissions
  - The preliminary attainment scenario relies on control profiles specified for individual source category
  - Preliminary attainment scenario suggests carrying capacity is approximately 60 tons per day of NOx emissions
  - Glendora is expected to be the design site in 2037
- Attainment for CV needs undefined control measures to attain ozone standard by 2032 using all the measures included in the South Coast Air Basin's scenario

# Sensitivity Analysis for the VOC emissions and its Impact on Attainment Scenario

Item #3

Scientific, Technical & Modeling Peer Review (STMPR)
Advisory Group Meeting

March 16, 2022

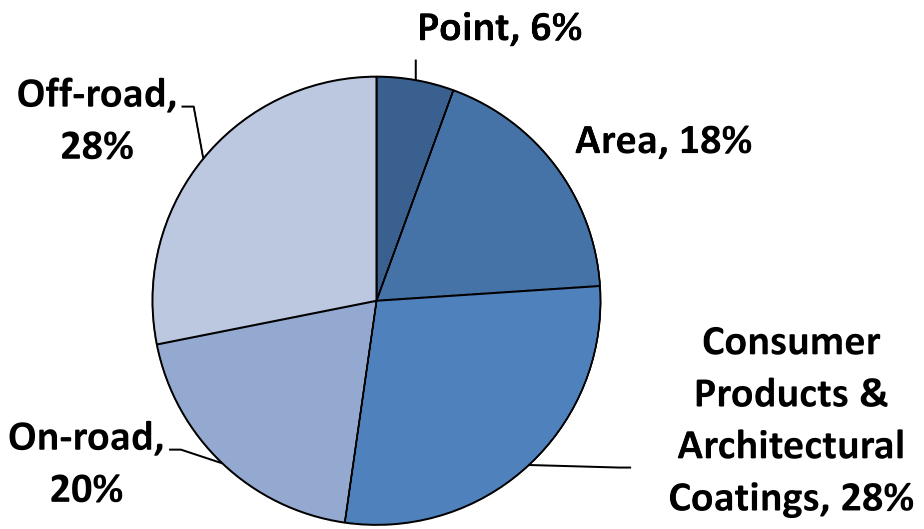
# Outline

- Updates in VOC and Consumer Product emissions reflected in the 2022 AQMP
- Preliminary analyses looking into the effect of uncertainties in consumer product emissions
- Ozone responses to VOC emissions in base and future years

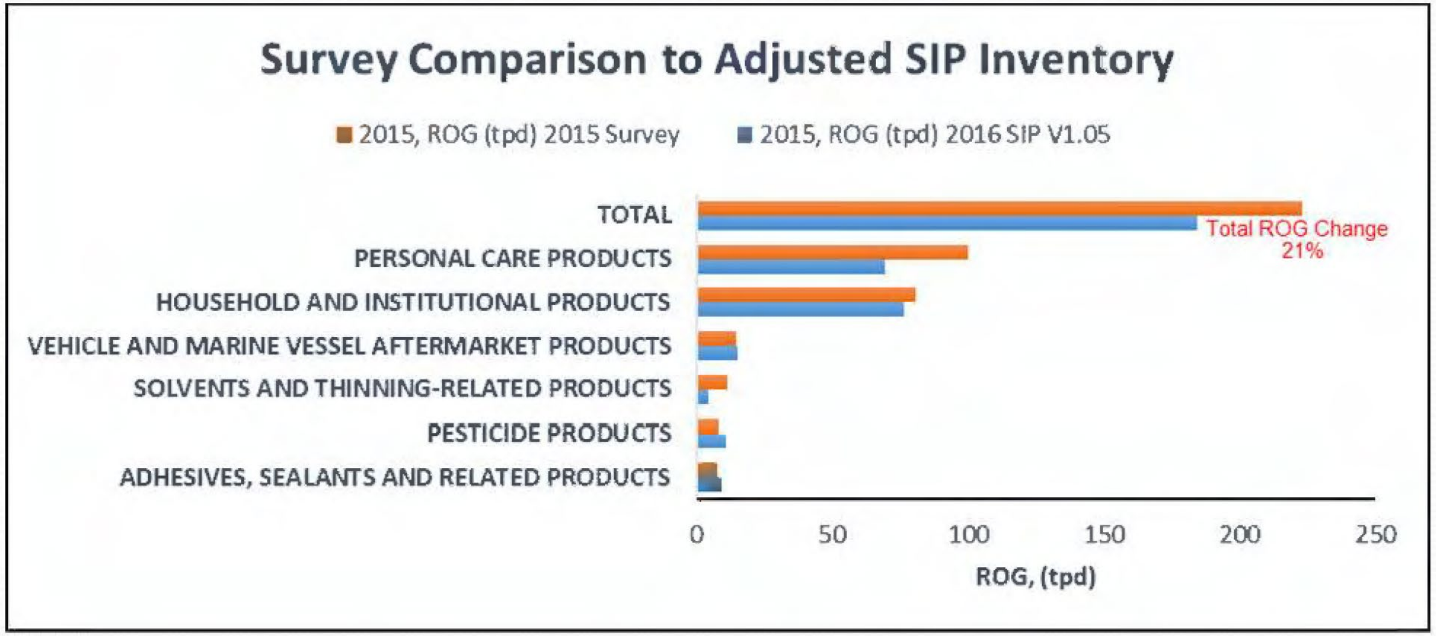
# Updated Emissions Inventory for Consumer Products

- Consumer products account for 28% of the total anthropogenic emissions in the Basin
- CARB's survey on consumer products quantified uncertainty in the 2016 SIP inventory
- Some studies postulate that VOC emissions from consumer products could be ~2X higher than SIP inventory

**Draft 2022 AQMP VOC Emissions (2018)**




**VOC Emissions: 417 tons/day**




CARB Public Workshop for Consumer Products rule making (Apr12, 2019)

# CARB's 2015 Survey for Consumer Products

**2015 CARB Consumer and Commercial Product Survey - December 12, 2019**

| Category Code | Category Name | Product Data | | | | | Emissions Data *(Fate and Transport Adjusted)* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Reporting Companies | Reported Products | Sales (tpd) | Sales Weighted Average VOC Content (undiluted) | Speciation (VOC, LVP-VOC, Exempt, Water, Other) | VOC (tpd) | ROG (tpd) | TOG (tpd) | PWMIR ($gO_3/g$) | Ozone Forming Potential (tpd) |
| 70199 | Other vehicle and marine vessel detailing products | 32 | 171 | 1.43 | 4.23% | | 0.06 | 0.13 | 0.14 | 0.12 | 0.17 |
| | **Detailing Products** | 122 | 2635 | 53.30 | 4.24% | | 2.26 | 4.01 | 7.01 | 0.09 | 4.71 |
| 70203 | Automotive Windshield Washer Fluid (Type "A" Areas) | 7 | 35 | 3.73 | 21.73% | | 0.81 | 0.81 | 0.81 | 0.15 | 0.54 |
| 70204 | Automotive Windshield Washer Fluid (Non Type "A" Areas) | 12 | 42 | 65.32 | 0.07% | | 0.05 | 0.05 | 0.05 | 0.00 | 0.05 |
| 70205 | Belt Dressing | 22 | 28 | 0.16 | 47.52% | | 0.08 | 0.08 | 0.15 | 0.82 | 0.13 |
| 70206 | Body Repair Products (other than coatings) | 17 | 438 | 6.17 | 18.82% | | 1.16 | 1.17 | 1.17 | 0.33 | 2.06 |
| 70207 | Brake Anti-Squeal Compound* | 13 | 68 | 0.04 | 60.18% | | 0.02 | 0.02 | 0.03 | 0.73 | 0.03 |
| 70208 | Brake Cleaner | 41 | 120 | 10.14 | 8.73% | | 0.89 | 0.89 | 9.29 | 0.40 | 4.06 |
| 70209 | Carburetor or Fuel-Injection Air Intake Cleaner | 41 | 99 | 2.31 | 9.98% | | 0.23 | 0.25 | 1.99 | 0.58 | 1.35 |
| 70210 | Engine Degreaser (aerosol) | 20 | 32 | 1.15 | 12.57% | | 0.15 | 0.70 | 0.70 | 0.92 | 1.06 |
| 70211 | Engine Degreaser (nonaerosol)* | 15 | 53 | 0.32 | 11.28% | | 0.04 | 0.04 | 0.04 | 0.54 | 0.17 |
| 70212 | Engine Starting Fluid | 17 | 31 | 0.49 | 93.78% | | 0.05 | 0.05 | 0.05 | 0.17 | 0.08 |
| 70213 | Home-Use Metal Parts Immersion Wash* | 4 | 5 | 0.02 | 1.98% | | 0.00 | 0.00 | 0.00 | 0.10 | 0.00 |
| 70214 | Mold and Mildew Retardant* | 4 | 4 | 0.00 | 1.16% | | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 |
| 70216 | Tire Sealants and Inflator | 16 | 103 | 2.95 | 10.21% | | 0.30 | 0.38 | 0.83 | 0.37 | 1.09 |
| 70217 | Windshield De-Icer* | 19 | 30 | 0.17 | 54.08% | | 0.09 | 0.10 | 0.10 | 0.65 | 0.11 |
| 70218 | Windshield Washer Fluid Additive | 20 | 53 | 4.22 | 26.99% | | 1.14 | 1.14 | 1.14 | 0.19 | 0.81 |
| 70219 | Windshield Water Repellent | 9 | 17 | 0.25 | 72.68% | | 0.18 | 0.18 | 0.22 | 1.03 | 0.26 |
| 70299 | Other vehicle and marine vessel maintenance and repair products | 53 | 401 | 2.14 | 8.99% | | 0.19 | 0.20 | 0.21 | 0.14 | 0.30 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Aerosol Coating Products** | **Reporting for 2015 Not Requested** | | | | | |
| **All Categories** | | 134.86 | 202.03 | 252.27 | 0.05 | 391.32 |

# 2016 AQMP vs 2022 AQMP

- TOG and VOC emissions from consumer products have been revised in the new AQMP inventory

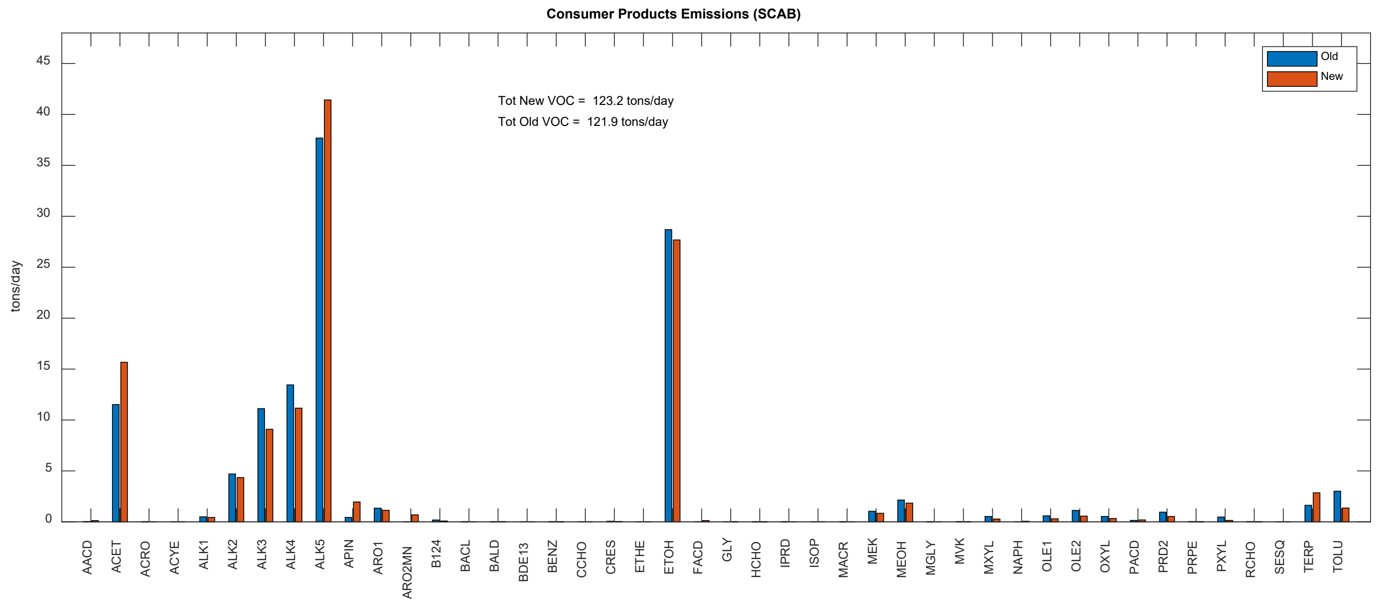
- Annual average emissions from consumer products (tons per day):

| | AQMP2016 | | AQMP2022 | |
|---|---|---|---|---|
| **Year** | **TOG** | **ROG** | **TOG** | **ROG** |
| 2018 | 105.3 | 87.6 | 135.8 | 107.4 |
| 2023 | 108.3 | 90.1 | 141.2 | 111.8 |
| 2031 | 113.1 | 94.1 | 154.9 | 123.0 |
| 2037 | - | - | 165.6 | 131.9 |

# Preliminary Analysis of VOC Emissions Uncertainties

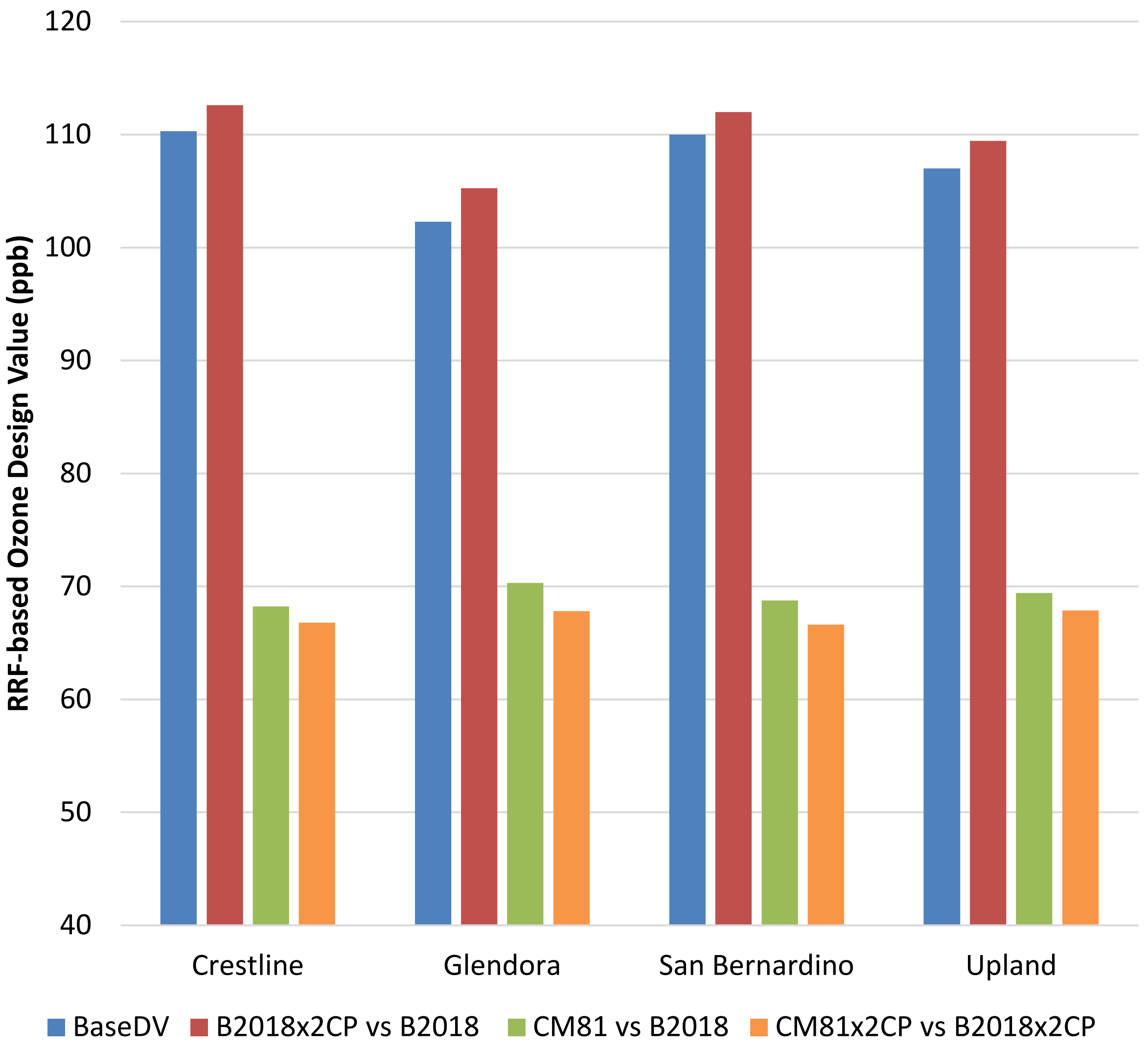
- Analyzed the potential contribution to increased intermediate-volatility VOC (IVOC) from diesel evaporative emissions (AQMP2016)
  - Simplified analysis suggested potential increase in O3 DV by up to 1.5 ppb

- Analyzed the effect of sensitivity to chemical speciation profiles
  - Updated VOC speciation profiles shift VOC speciation towards slightly more reactive species
  - Update profiles could increase O3 DV by 0.3 ppb

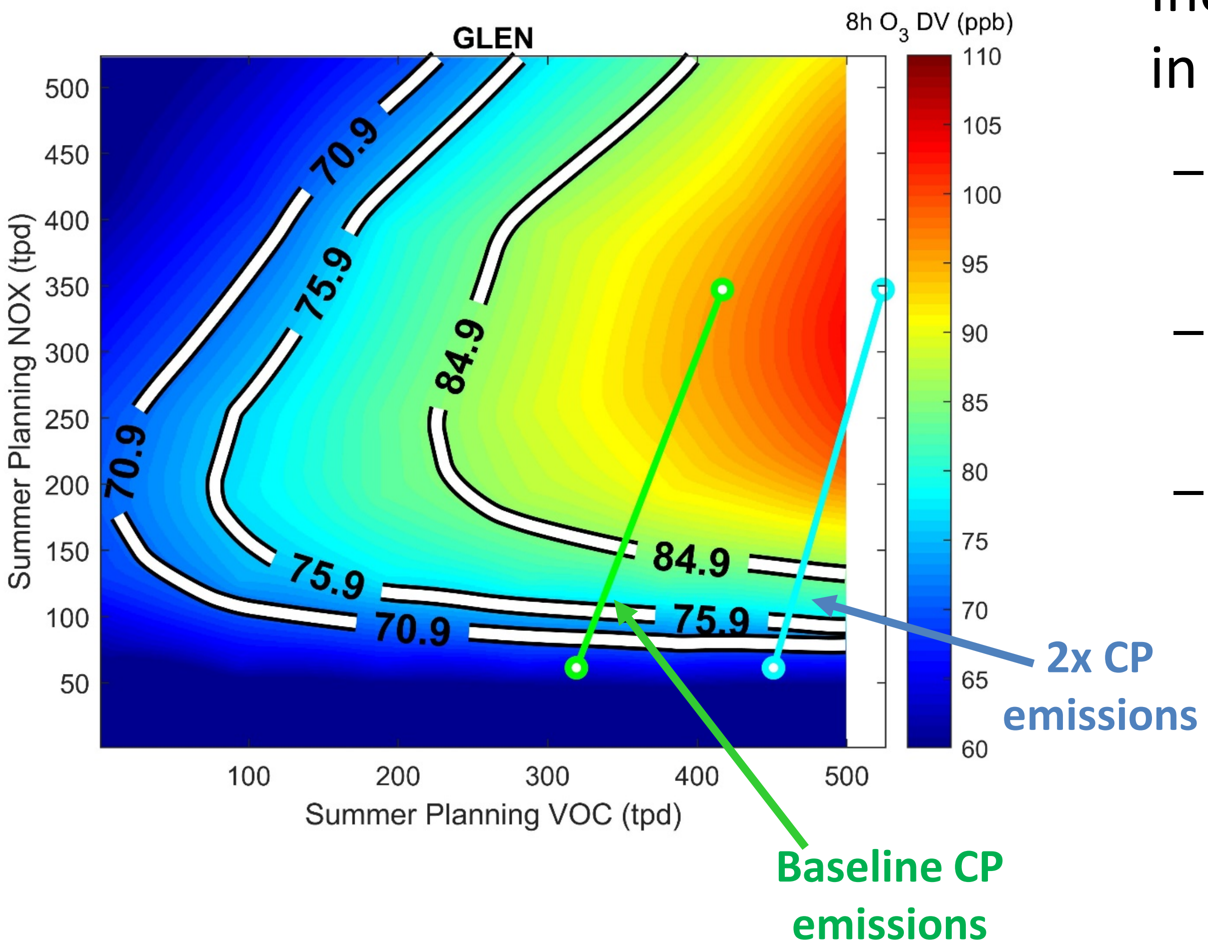


# Preliminary Analysis of VOC emissions uncertainties

- Analyzed the implication of increasing consumer products (CP) VOC emissions
  - Doubling emissions of CP increases baseline 2018 O3 DV by up to 3 ppb (~3% increase in ozone DV)
  - Increasing CP in baseline and future scenarios makes NOx reductions more effective
    - Attainment scenario DV decreases by 2.5 ppb



# Ozone sensitivity to VOC emissions




- Increasing emissions of consumer products in base year and future years decreases RRF:
  - Base year ozone ($O_{3,b}$) increases with increasing VOC: $(O_{3,b})_{2x\ CP} > (O_{3,b})_{base\ CP}$
  - Future year ozone ($O_{3,f}$) is not sensitive to VOC emissions: $(O_{3,f})_{2x\ CP} \approx (O_{3,f})_{base\ CP}$
  - $RRF_{2xCP} = (O_{3,f}/O_{3,b})_{2x\ CP}$ is lower than $RRF_{base\ CP} = (O_{3,f}/O_{3,b})_{base\ CP}$

# Ozone Impacts from Consumer Products

- Recent studies suggest VOC emissions from consumer products are currently underestimated in a regulatory inventory
  - Research suggests that adding these emissions results in increased O3 formation in SCAB
- Staff will explore a future modeling framework that incorporates:
  - Increased consumer product emissions
  - Improved speciation profiles
  - A revised chemical mechanism with improved treatment of consumer product species
- New modeling framework could be used to assess impacts to the attainment scenario in collaboration with EPA scientists

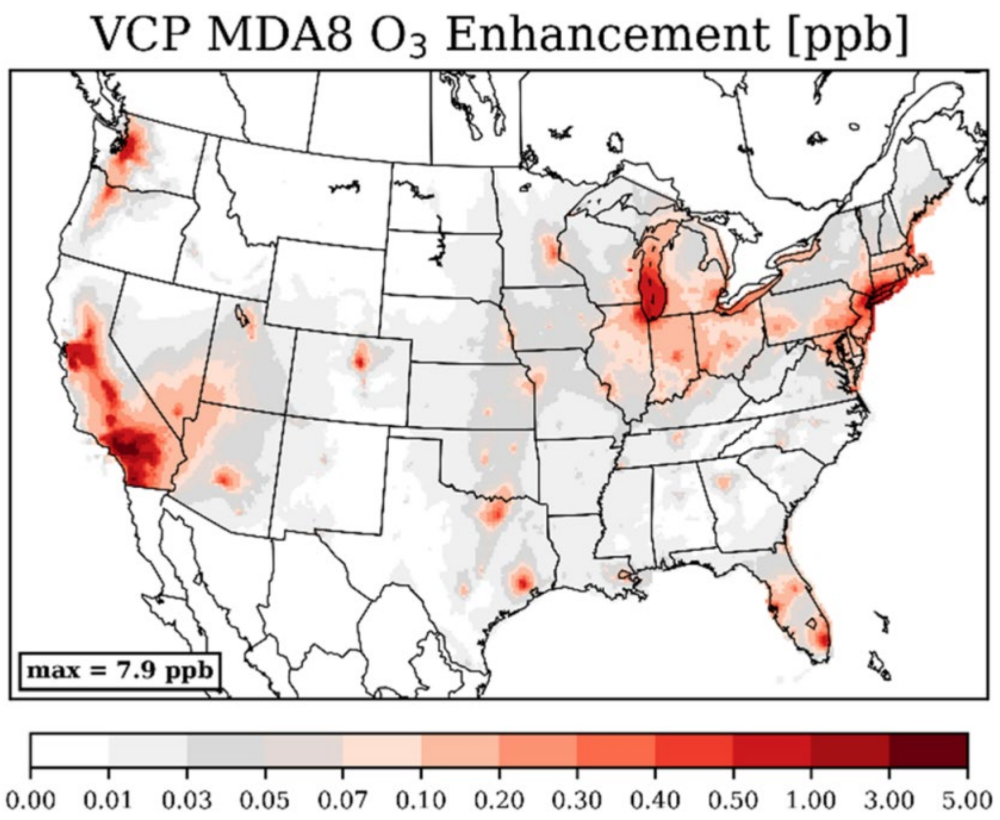



Figure reproduced from Seltzer et al., ES&T 2021. https://doi.org/10.1021/acs.est.1c04298

# Summary

- Ozone sensitivity to VOC emissions from consumer products was evaluated using the AQMP modeling system
- While there may be likely uncertainties in VOC emissions from consumer products and/or fugitive emissions, NOx control strategy is the only viable attainment path for the ozone NAAQS
- Further analysis will be conducted using emerging data from fenceline monitoring (South Coast AQMD Rule 1180), field measurements data and collaboration with experts in U.S. EPA, academic institutes and other agencies

# EMFAC Heavy-Duty Vehicle Emission Rates

Mobile Source Analysis Branch
Air Quality Planning and Science Division
California Air Resources Board

March 16, 2022

# Today's Presentation

- Overview of EMFAC Heavy-Duty NOx Emission Rates
  - Heavy-Duty Diesel
  - Heavy-Duty Natural Gas
- Port Congestion Assessment

# EMFAC Heavy-Duty Emission Rates

# Modeling Heavy-Duty (HD) Emission Rates in EMFAC

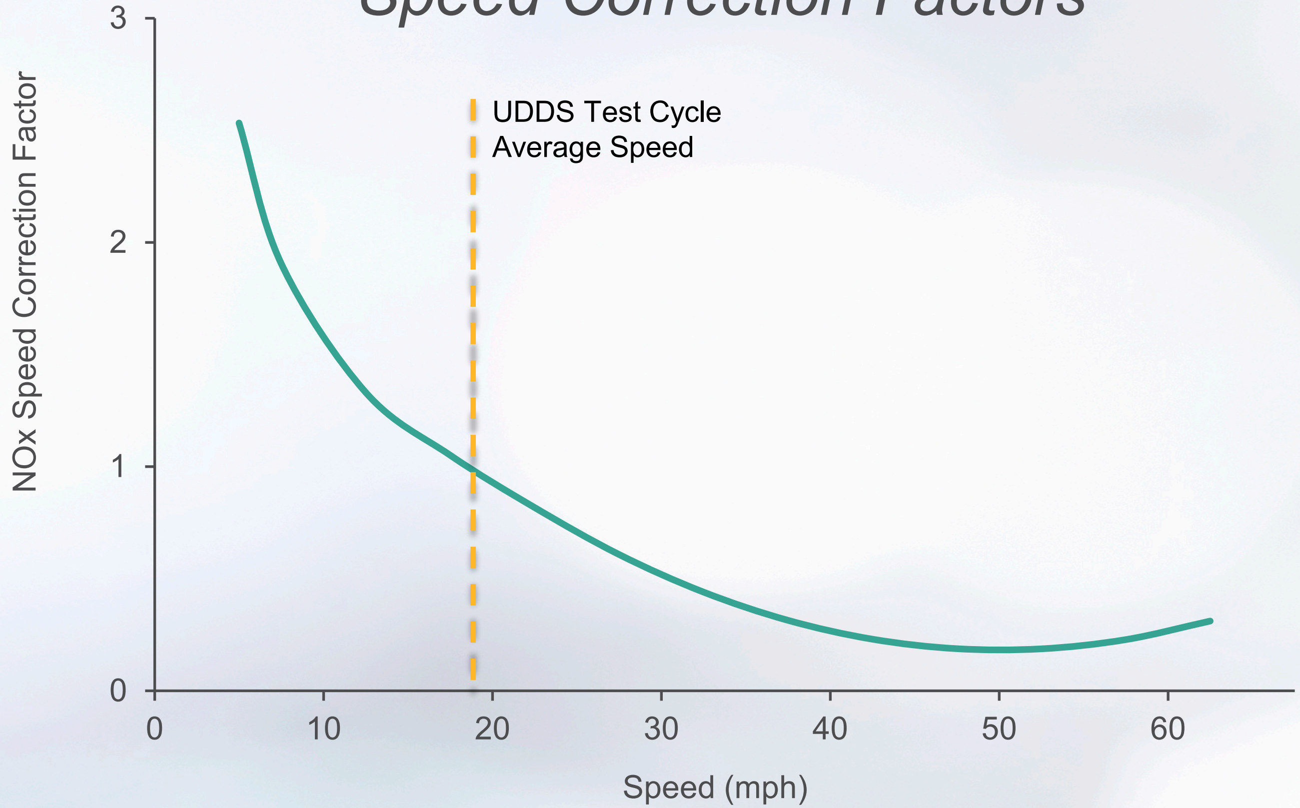
$$Emission\ Rate\ (\frac{g}{mile}) = (ZMR + DR \times Odometer) \times SCF$$

- Zero-mile emission rate (**ZMR**) – Fleet average UDDS emission rates while trucks are new
- In-Use Emission Deterioration (**DR**) – Increase of emissions over time within the in-use fleet caused by tampering, malfunction and mal-maintenance (TM&M) of engine components, and emission control systems
- Speed Correction Factors (**SCF**) – A method to correct emission rates at different driving speeds

# Emission Rate Modelling

*Deterioration Rate*


*Speed Correction Factors*




Increasing percentage of high-emitting (up to 12X ZMR) vehicles w/ emissions after-treatment malfunction as the fleet ages → larger fleet-average emission rate

Speed correction factors account for variation of emissions for SCR-equipped vehicles under different operating conditions (e.g. low load)

CARB

# HD Emission Rates Updates Overview

## EMFAC 2017

**Heavy Heavy-Duty Diesel**
- Revised running exhaust emission rates of 2013+ MY using dyno data from CARB and other sources
- Revised start and idle emission rates of 2010+ MY using PEMS data from CARB and other sources

**Medium Heavy-Duty Diesel**
- Estimated MHD diesel truck emission rates by scaling HHD truck emission rates

**CNG**
- Revised emission rates of 0.2g CNG transit buses using limited dyno data from several sources

## EMFAC 2021

**Heavy Heavy-Duty Diesel**
- Revised running exhaust emission rates of 2013+ MY using additional dyno data from CARB
- Start emission rates of 2013+ MY diesel HD trucks based on PEMS data of CARB TBSP

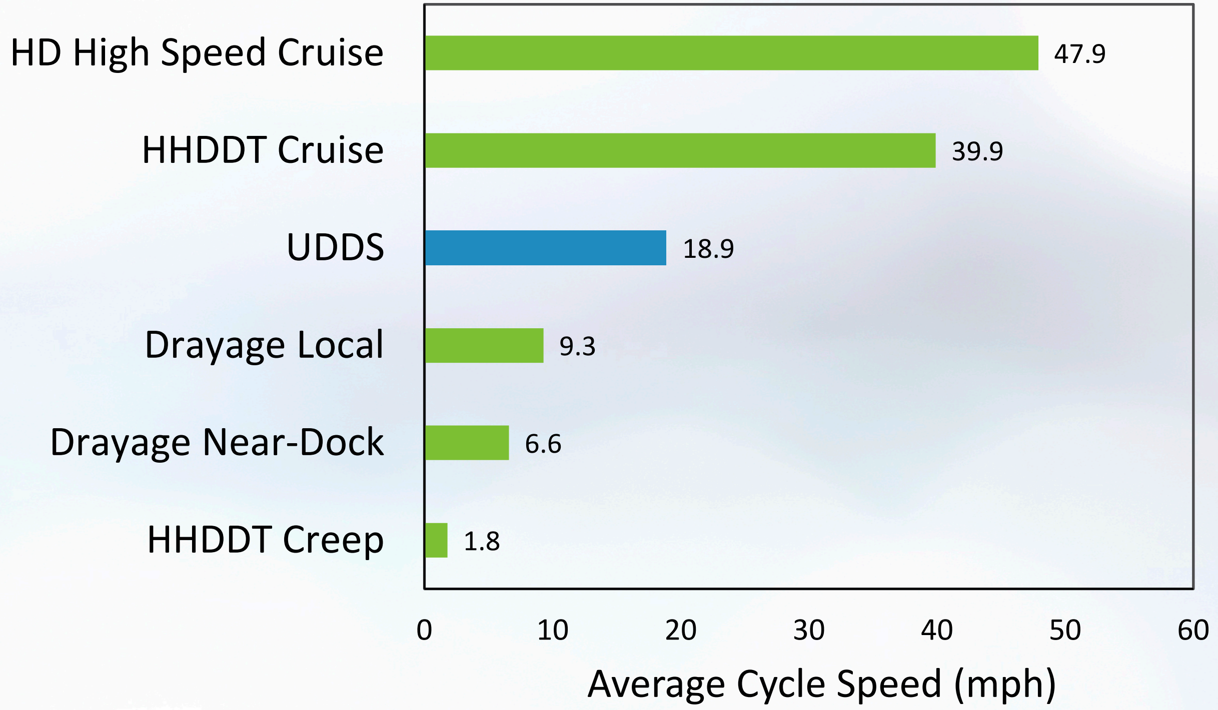
**Medium Heavy-Duty Diesel**
- Running exhaust emission rates of 2013+ MY MHD based on dyno test data from CARB TBSP

**CNG**
- Running exhaust emission rates of natural gas HD vehicles based on PEMS data from a multi-agency **200-vehicle testing project**

CARB

# CARB Truck & Bus Surveillance Program (TBSP)

- In EMFAC2021, **38** MY2013+ trucks tested on dyno over 6 test cycles
- Testing data were used to update EMFAC2021 HHD diesel truck emission rates



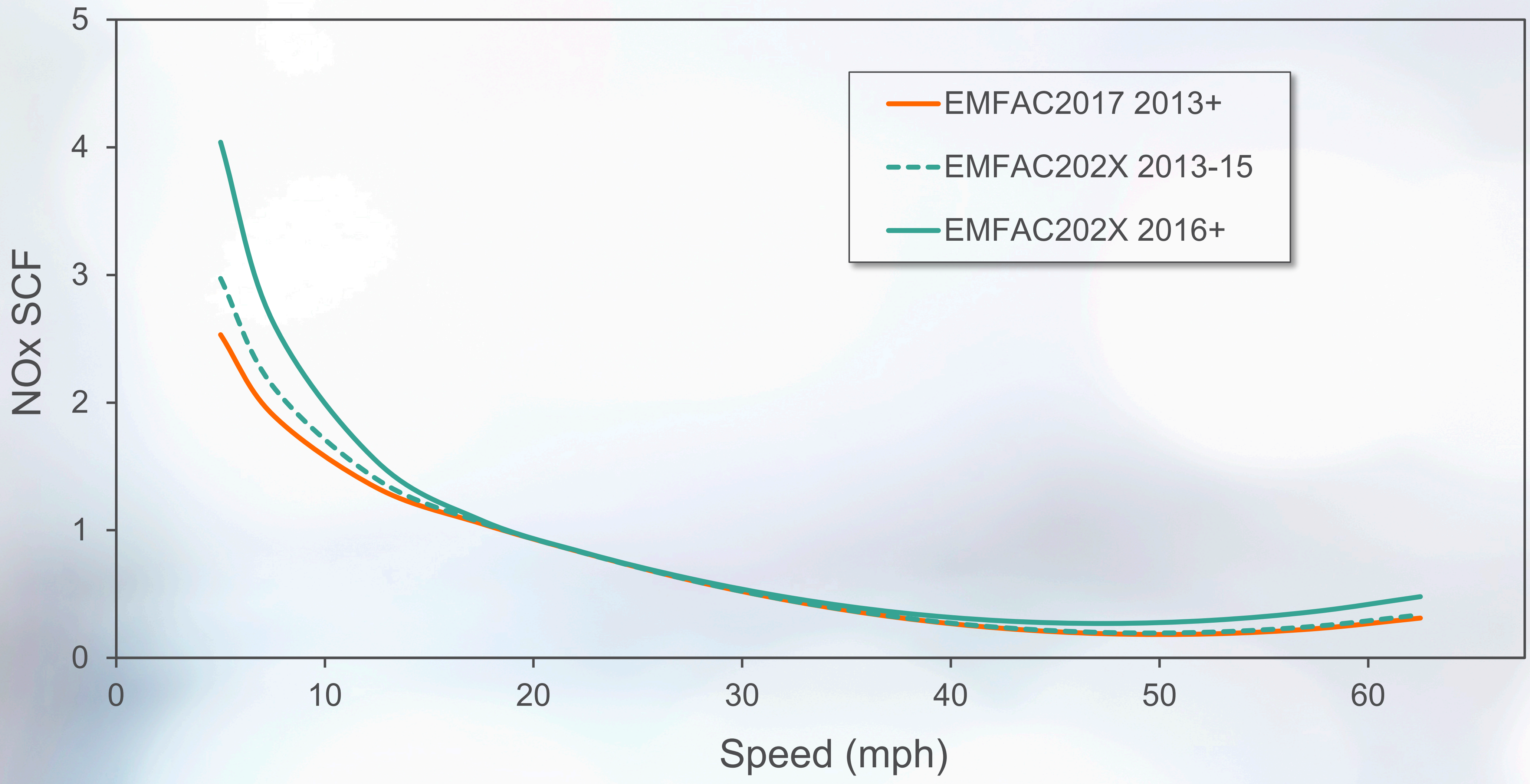
# HHD Diesel Speed Correction Factors Derivation

- For a given MY group, a pollutant's emission rates of all test cycles were first plotted versus the cycles' speeds.
- Curves were then fitted to find the equations best representing the data.
- a two-segment empirical curve was found best-fit and used in order to reasonably fit all the data points:

$$SCF = A \cdot speed^{B}$$

$$SCF = C \cdot speed^{2} + D \cdot speed + E$$

# HHD Diesel Speed Correction Factors for NOx




CARB

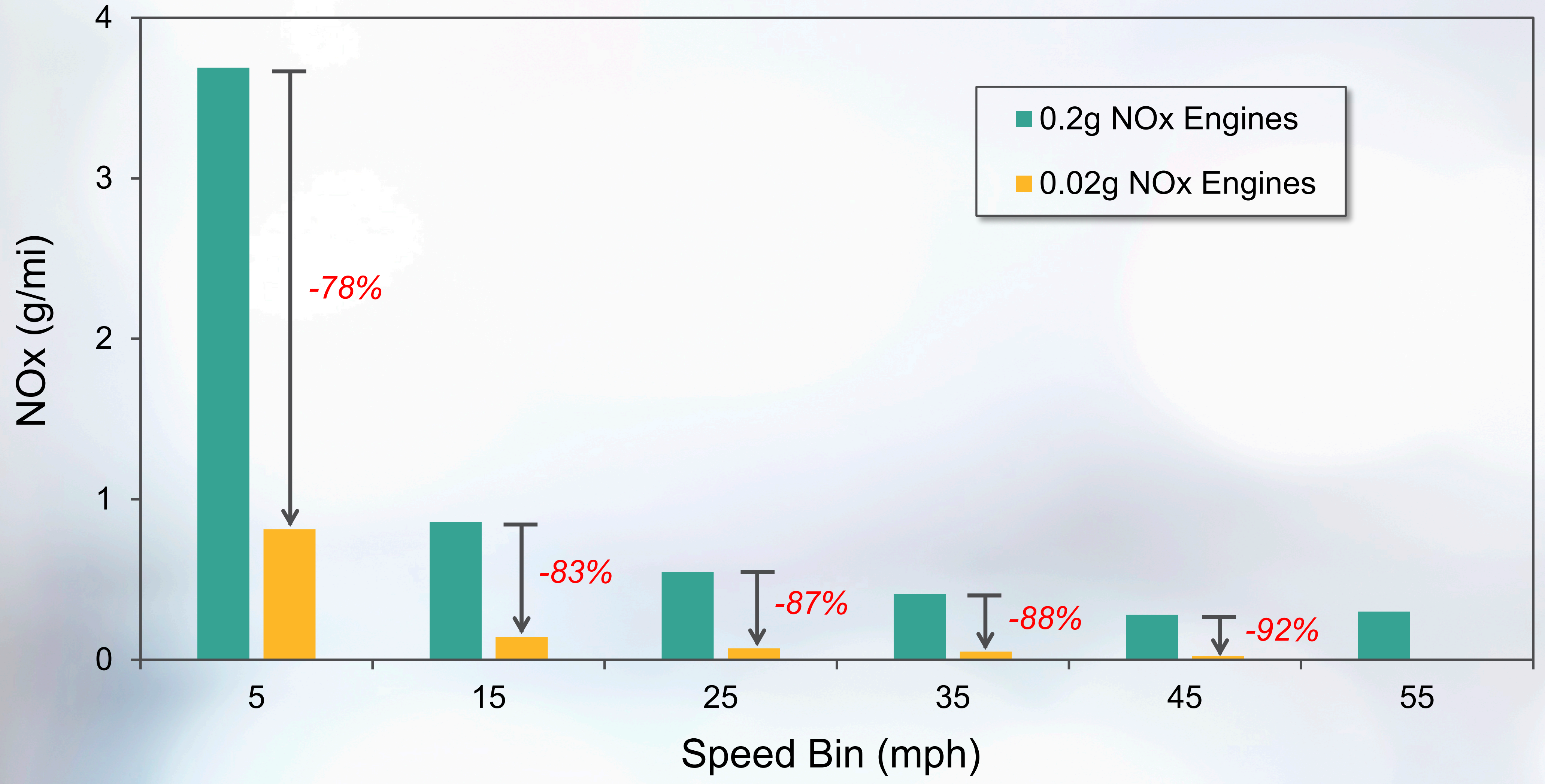
# Emission Factors for Natural Gas Vehicles

- Test data from the multi-agency 200-vehicle testing project
  - PEMS testing of ~100 vehicles
- PEMS data from 47 NG HD vehicles were used in EMFAC2021

| Technology | Transit Bus | School Bus | Refuse Truck | Goods Movement Truck | Delivery Trucks |
|---|---|---|---|---|---|
| TWC (0.2 g/bhp-hr) | 5 | 5 | 11 | 8 | 3 |
| TWC (0.02 g/bhp-hr) | 5 | -- | 1 | 9 | -- |

*Preliminary Results*

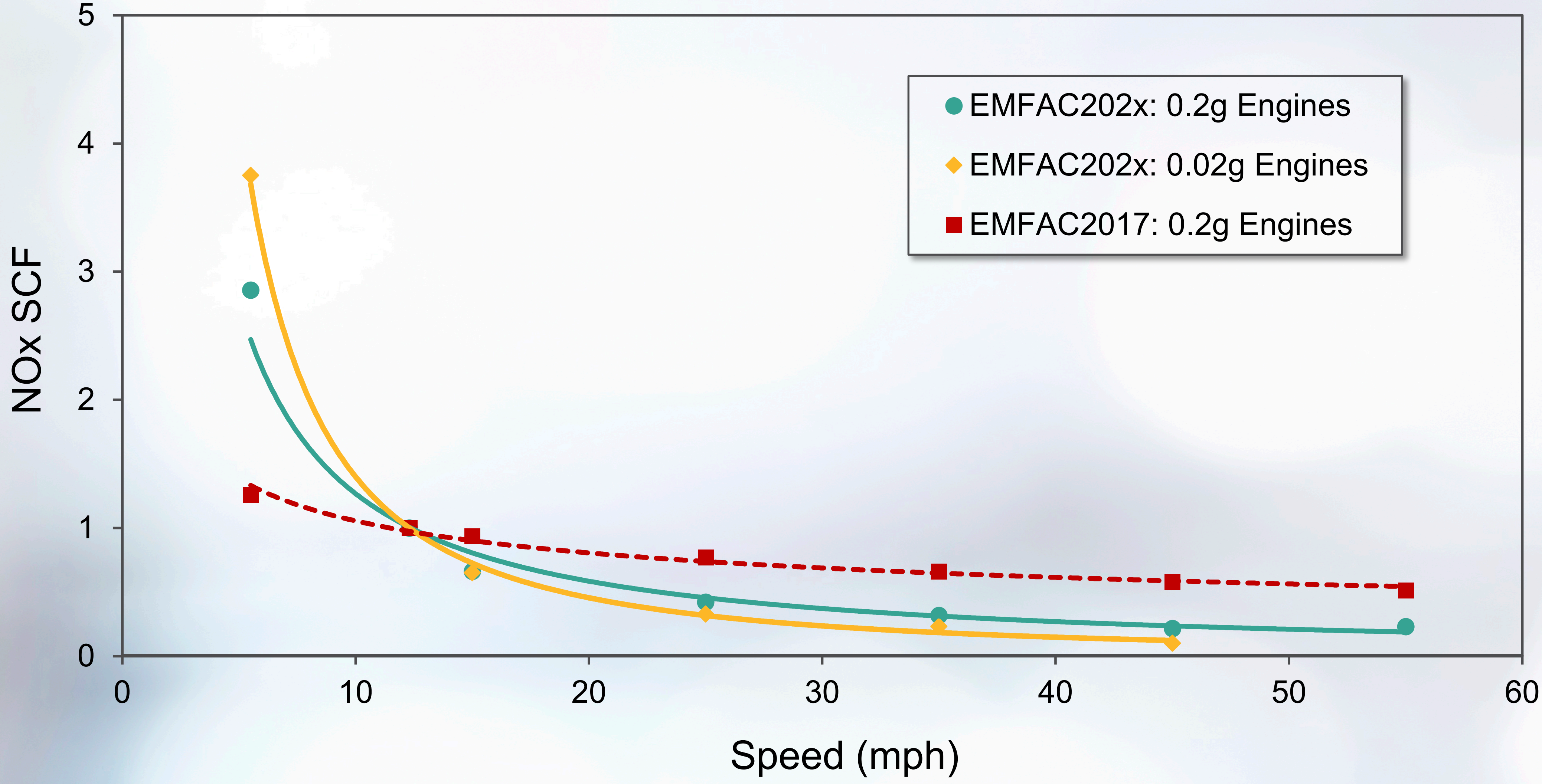
# CNG Bus NOx Rates by Speed Bin




CARB

*Preliminary Results*

# CNG Bus NOx Speed Correction Curves




CARB

# Actions to Control Low Load Emissions

**California Heavy-Duty Omnibus** (adopted)

- Suite of requirements that reduce NOx emissions from new CA-certified heavy-duty vehicles starting in 2024
- Includes low load cycle (LLC) certification standards to control NOx emissions under low load conditions

**Federal Clean Trucks Plan** (under development)

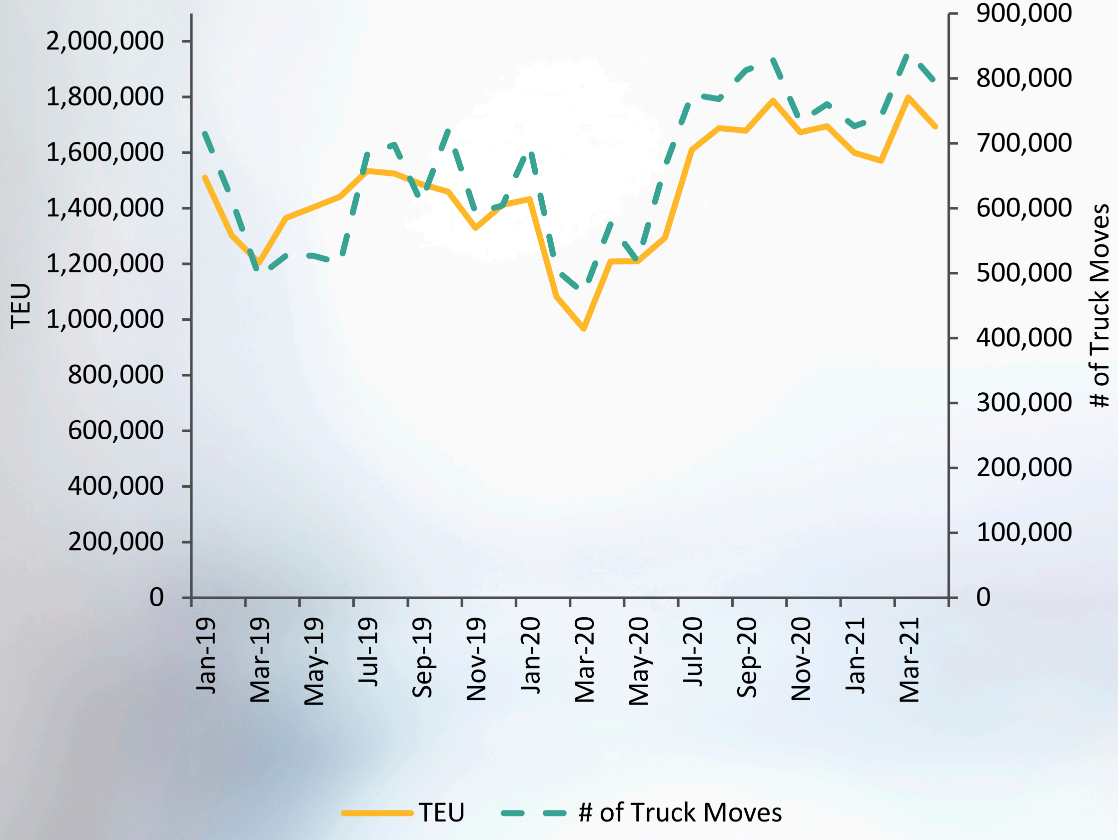
- Reduces NOx emissions from Federal-certified heavy-duty vehicles starting in 2027
- NPRM released in March 2022 includes proposed LLC standards

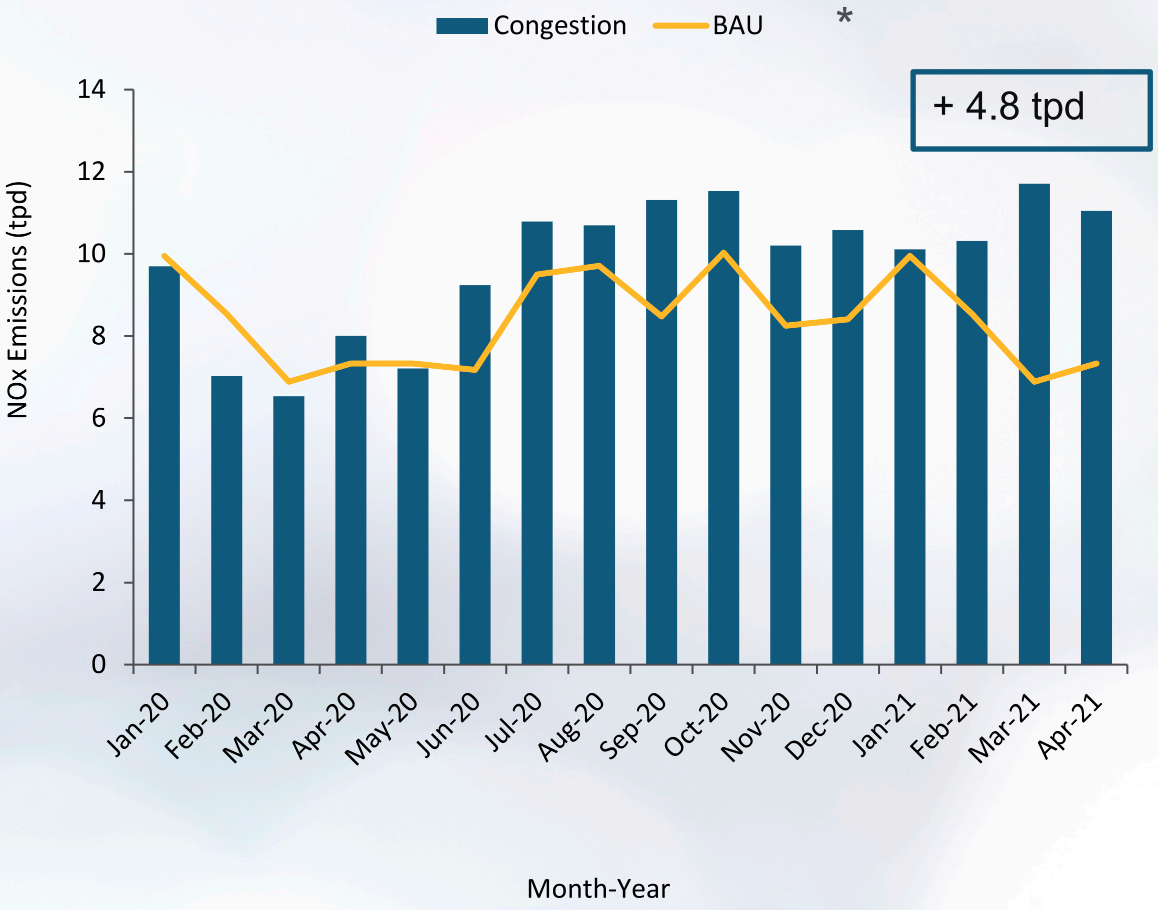
**Advanced Clean Fleets** (under development)

- Phase-in zero-emission trucks and buses starting in 2023
- Includes state and local government fleets, high priority private fleets, and drayage trucks serving ports and railyards

# Technical Analysis of Port Truck Emissions Based on EMFAC2021

# Emissions Impact of Recent Congestion at Port of Los Angeles and Long Beach




* BAU based on EMFAC2021

CARB

# Summary and future directions

- The 200-vehicle in-use emissions project data have been used in EMFAC2021 and will continue to inform inventory building in next EMFAC version
- Analyze more PEMS data from multiple sources (including TBSP, HDIUT, HDIUC) as they become available, and keep improving our understanding of HD emission rates and SCFs
- Continue to track the impact of increased port congestion on truck activity and emissions

# Zero Emission Infrastructure and Other Cost Considerations

South Coast Air Quality Management District

2022 Air Quality Management Plan

Socioeconomic Impact Assessment

*Science, Technical, and Modeling Peer Review Advisory Group Meeting*

March 16, 2022

South Coast AQMD

# Widespread Deployment of Zero Emission Technology Needed for All Sectors

2022 AQMP

Residential

Commercial

Industrial / Large Combustion Sources

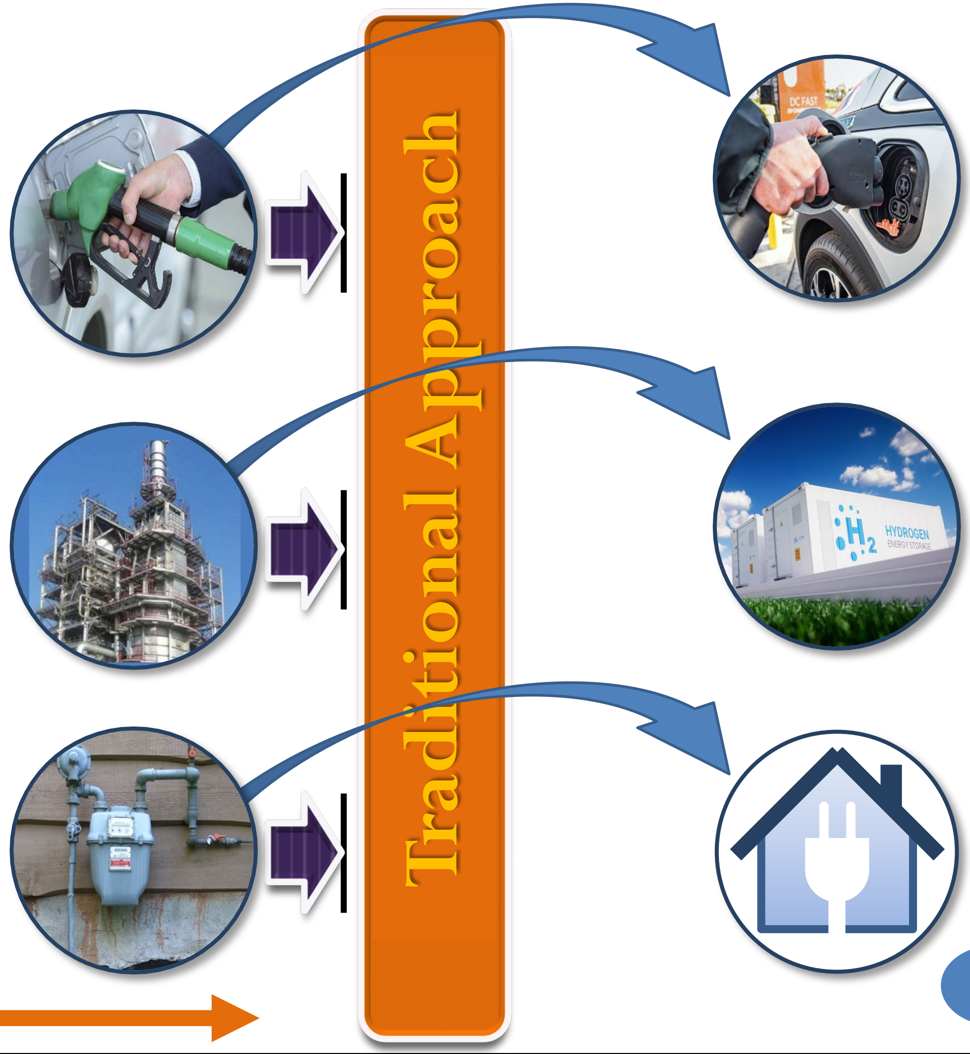
Mobile - On-Road

Mobile - Off-Road

# Traditional Air Quality Planning Won’t Work

**Traditional approach relies on additional *__tailpipe/exhaust stack controls__*, *__new engines technology__*, or *__fuel improvements__* tailored to individual use cases**

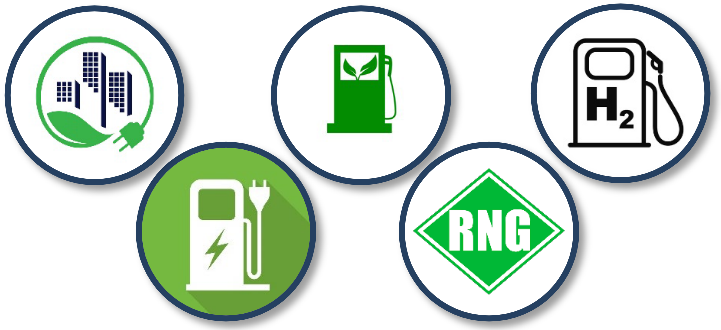
***These traditional approaches on already highly controlled sources cannot achieve additional ~73% reduction in South Coast and must be bypassed wherever possible***



# Key Considerations on a Zero Emissions Approach

- **What does the pathway look like through time?**

- **Which fuels for which applications?**

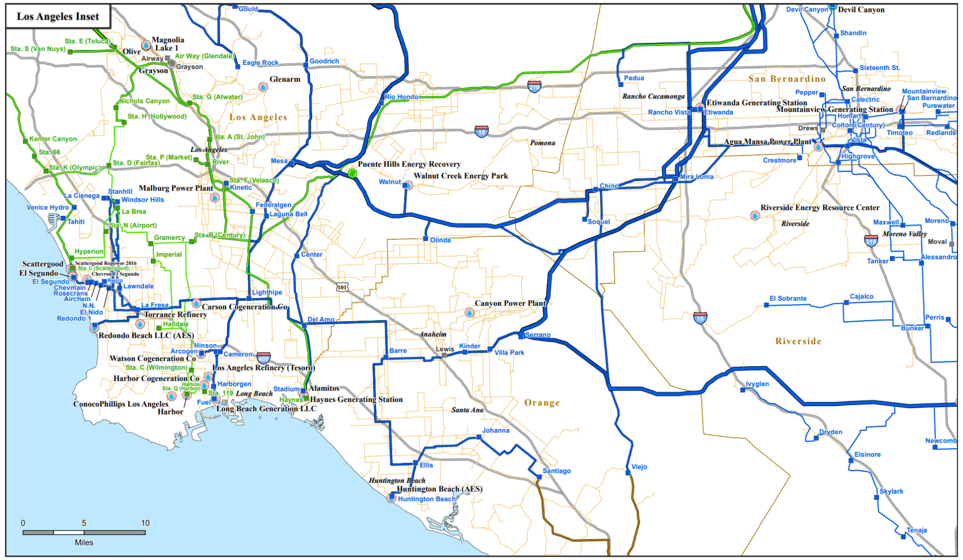



- **How can this be made most affordable?**
  - **Ensures adoption at scale, and available equitably**

# Infrastructure Costs of Implementing 2022 AQMP

- 2022 AQMP: requires larger scale deployment of zero-emission (ZE) technologies relative to prior AQMPs
- More infrastructure planning and building needed to support ZE deployment
  - E.g., electricity generation and grid development, hydrogen production and transportation, etc.
- ZE infrastructure driven by many concurrent federal, state, and local policies and actions
  - How to quantify overall costs?
  - Whether/how to attribute the costs to clean air measures for regional attainment in the South Coast Air Basin?

2021 CEC Electric Transmission Lines



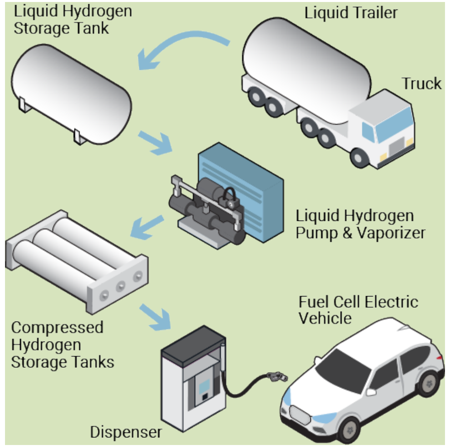



*Image source: California Fuel Cell Partnership*

# Infrastructure Costs in Past AQMPs

- 2016 AQMP
  - Qualitative discussion of expanded electric grid, build up of hydrogen supply logistics, etc. (Chapter 10 of AQMP)
  - Quantified infrastructure costs to the extent possible for hydrogen and electric fueling/charging stations (Appendix 2-A of Final Socioeconomic Report)
- Prior to 2016 AQMP, infrastructure costs qualitatively considered, but not quantified

# Infrastructure Costs Quantified in Recent Air Quality Related Public Documents Prepared by the State

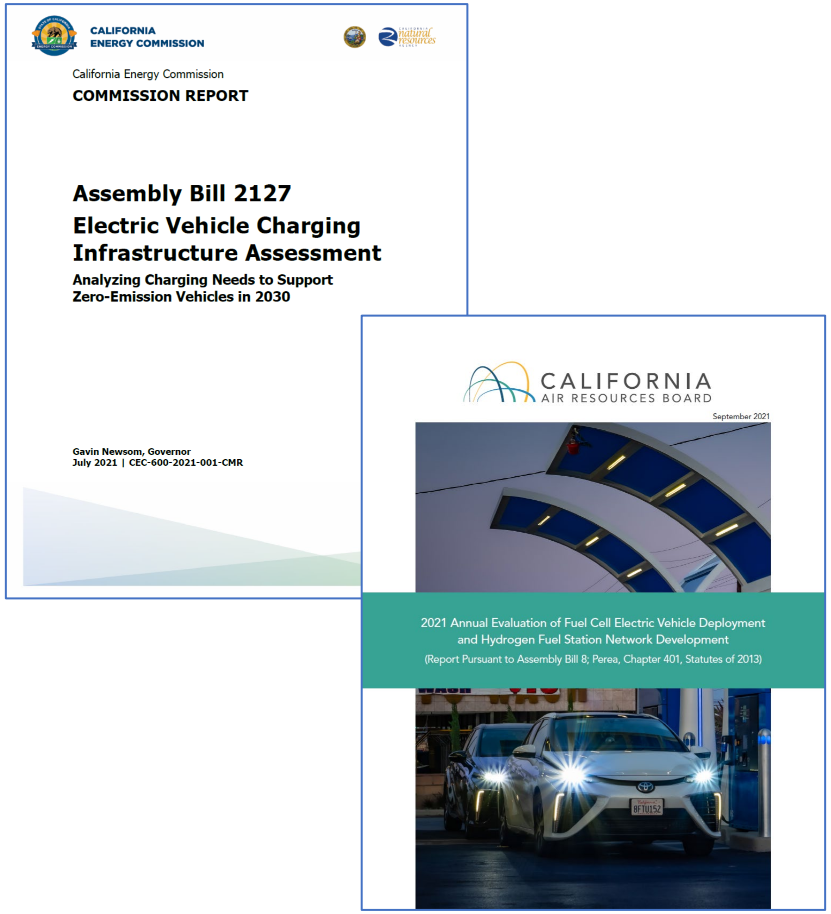
| Infrastructure Cost Component | CAL eVIP | At Berth | ICT | ACT | CMS | TRU | ACF | ACC2 | Draft 2022 SIP |
|---|---|---|---|---|---|---|---|---|---|
| On-site charging equipment, installation, and transformer upgrades | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Retail charging/fueling stations | | | ✓ | | | | ✓* | ✓* | ✓ |
| Electric grid/hydrogen supply development | | | | | | | | | |

* Reflected in retail charging/fueling prices paid by fleet owner/operator or consumers.

*CALeVIP = California Electric Vehicle Infrastructure Project; At Berth = CARB Ocean Going Vessels At Berth Regulation; ICT = CARB Innovative Clean Transit; ACT = CARB Advanced Clean Trucks; CMS = CARB Clean Miles Standard; TRU = CARB Transportation Refrigeration Unit Regulation; ACF = CARB Advanced Clean Fleets; ACC2 = CARB Advanced Clean Cars II; 2022 SIP = CARB Draft 2022 State SIP Strategy*

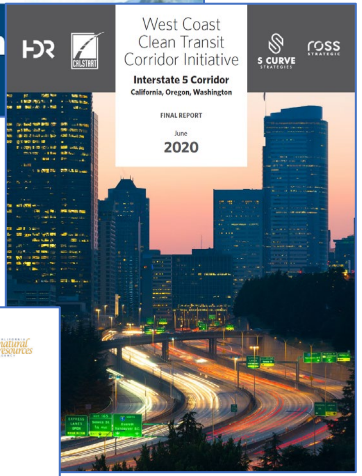
# ZE Infrastructure Forecasts

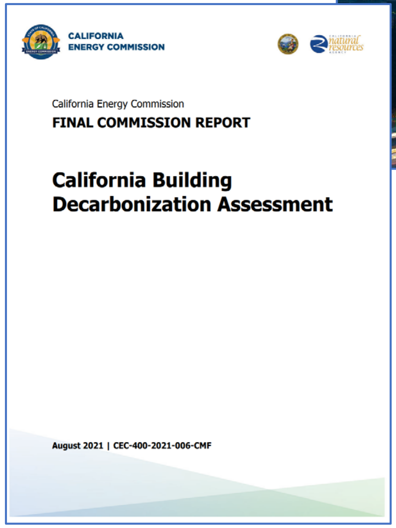
- Existing ZE fueling infrastructure estimates:
  - CEC's AB 2127 Electric Vehicle Charging Infrastructure Assessment
  - CEC's 2021 Integrated Energy Policy Report
  - CARB's Annual Evaluation of FCEV Deployment and Hydrogen Fuel Station Network Development



# Electric Grid Infrastructure Cost Considerations

- Staff is researching the availability of any all-inclusive infrastructure cost assessments for clean air regulations
  - CEC funding programs (e.g., Clean Transportation Program, CALeVIP)
    - Program cost data, if/when publicly available, could be used for 2022 AQMP
  - West Coast Clean Transit Corridor Initiative 2020 Final Report
  - Electricity transmission and distribution grid expansion costs:
    - CEC's 2021 California Building Decarbonization Assessment
    - E3's California Avoided Cost Calculator


Energy+Environmental Economics

# Cost Quantification Integral to Socioeconomic Impact Assessment of AQMP and Its Implementation

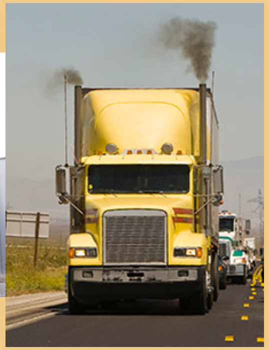
**Steps to Clean Air**

- Air Quality Management Plan
- Rule/Program Development
- Rule/Program Adoption
- Rule/Program Implementation
- Air Quality Improvement

## Benefit-Cost Analysis (BCA)

**Benefits of Clean Air**

V.S.



**Compliance Costs**

## Economic Feasibility/Affordability Considerations

South Coast AQMD rulemaking relies on cost-effectiveness as a simplified metric for BCA and economic feasibility

# Cost-Effectiveness Thresholds in AQMPs

- Past AQMPs established general cost-effectiveness thresholds for implementation of South Coast AQMD control measures
  - Not applicable to CARB's SIP measures included in AQMP, i.e., most mobile and area source measures
- Would trigger more rigorous analyses and additional public process if a proposed rule/amendment exceeds the applicable threshold

| **Cost Effectiveness Thresholds by AQMP year (in thousands)** | | | | | |
|---|---|---|---|---|---|
| Pollutant | 1997 | 2003 | 2007 | 2012 | 2016 |
| Nitrogen Oxides (NOx) | n/a | n/a | n/a | $22.5 | $50* |
| Volatile Organic Compounds (VOCs) | $13.5 | $13.5 | $16.5 | $16.5 | $30 |

*Consistent with 2010 SOx RECLAIM amendment threshold used to exclude individual equipment from the Best Available Retrofit Control Technology (BARCT) analysis using the discounted cash flow (DCF) method. The comparable threshold is $80,000/ton when calculated with the levelized cash flow (LCF) method assuming a 4% real interest rate and 25 years equipment life

# STMPR Thought Questions

1. What additional literature, resources, or tools could aid South Coast AQMD staff in identifying the best practice to quantify infrastructure costs of control measures either mandating or incentivizing zero-emission technology adoption?

2. Are you aware of other studies disaggregating larger regional costs to the South Coast AQMD region for 2022 AQMP?
   - Geographical region
   - Specific industry sectors

3. What parameters should staff be considering when evaluating cost-benefit analysis and economic feasibility of control measures?

# Next Steps for Socioeconomic Analysis

- Preliminary cost analysis underway for draft control measures in AQMP
  - More detailed cost analysis conducted during later rulemaking
- Draft Socioeconomic Report will be released for public comment after Draft AQMP release
  - 60 day review period for Draft Socioeconomic Report
- Draft Final Socioeconomic Report released at least 30 days before Board hearing on AQMP

# Staff Contacts

| Socioeconomic Impact Assessment | | | General AQMP Questions and Inquiries |
|---|---|---|---|
| Ryan Finseth, Ph.D.<br>Air Quality Specialist<br>rfinseth@aqmd.gov<br>909.396.3575 | Paul Stroik, Ph.D.<br>Air Quality Specialist<br>pstroik@aqmd.gov<br>909.396.2851 | Brian Vlasich<br>Air Quality Specialist<br>bvlasich@aqmd.gov<br>909.396.2176 | Sang-Mi Lee, Ph.D.<br>Planning & Rules Manager<br>slee@aqmd.gov<br>909.396.3169 |
| Shah Dabirian, Ph.D.<br>Program Supervisor<br>sdabirian@aqmd.gov<br>909.396.3076 | Elaine Shen, Ph.D.<br>Planning & Rules Manager<br>eshen@aqmd.gov<br>909.396.2715 | | Ian MacMillan<br>Assistant Deputy Executive Officer<br>Planning & Rule Development<br>imacmillan@aqmd.gov<br>909.396.3244 |
| For more information, visit: www.aqmd.gov/home/air-quality/clean-air-plans/air-quality-mgt-plan/socioeconomic-analysis | | | |

# Endnotes - Sources

- CEC California Electric Vehicle Infrastructure Project (CALeVIP): https://www.energy.ca.gov/programs-and-topics/programs/clean-transportation-program/california-electric-vehicle
- CARB Ocean Going Vessels At Berth Regulation *Standardized Regulatory Impact Assessment*: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2019/ogvatberth2019/appc-1.pdf
- CARB Innovative Clean Transit (ICT) Standardized Regulatory Impact Assessment: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2018/ict2018/appb-1.pdf
- CARB Advanced Clean Trucks (ACT) *Total Cost of Ownership*: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2019/act2019/apph.pdf
- CARB Clean Miles Standard (CMS) *Standardized Regulatory Impact Assessment*: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2021/cleanmilesstandard/appc-1.pdf
- CARB Transportation Refrigeration Unit (TRU) *Preliminary Cost Document*: https://ww2.arb.ca.gov/sites/default/files/2020-08/Preliminary%20TRU%20Cost%20Doc%2008202020.pdf
- CARB Advanced Clean Fleets (ACF) *Total Cost of Ownership*: https://ww2.arb.ca.gov/sites/default/files/2021-08/210909costdoc_ADA.pdf
- CARB Advanced Clean Cars II (ACC2) *Standardized Regulatory Impact Assessment*: https://www.dof.ca.gov/forecasting/economics/major_regulations/major_regulations_table/documents/ACCII-SRIA.pdf
- CARB *Draft 2022 State SIP Strategy*: https://ww2.arb.ca.gov/sites/default/files/2022-01/Draft_2022_State_SIP_Strategy.pdf
- West Coast Clean Transit Initiative Final Report: https://www.westcoastcleantransit.com/
- CEC Building Decarbonization Assessment: https://www.energy.ca.gov/publications/2021/california-building-decarbonization-assessment
- Energy and Environmental Economics' (E3) California Avoided Cost Calculator: https://www.ethree.com/public_proceedings/energy-efficiency-calculator/

# How to Raise Your Hand to Speak

**ZOOM**: Click on the "Raise Hand" button at the bottom of your screen.


**TELECONFERENCE**: Dial *9 to "raise your hand"

Your name will be called when it is your turn to speak and the meeting host will unmute your line.