



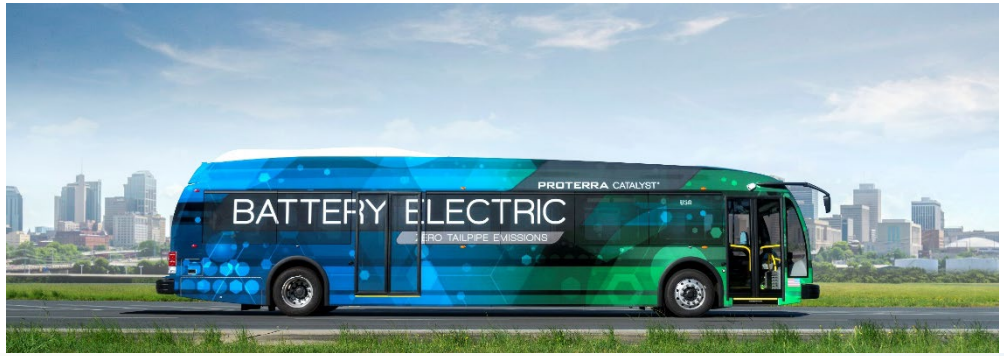

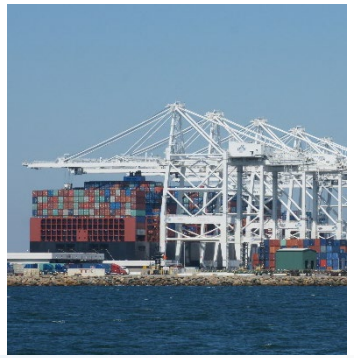


2020 Mobile Source Strategy

Public Webinar
October 7, 2020

CALIFORNIA
AIR RESOURCES BOARD

Today's Webinar

- Overview & Background
- Implementing the 2016 MSS
- 2020 MSS Scenarios
- Costs to Achieve California's Goals
- Pathways Forward
- META Tool Demonstration

We will be taking questions through GoToWebinar
at intervals during and after the presentation

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Timeline
for 2020 MSS Development

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2020 Mobile Source Strategy

A conceptual scenario approach to identifying the technology mixes needed to meet California's goals

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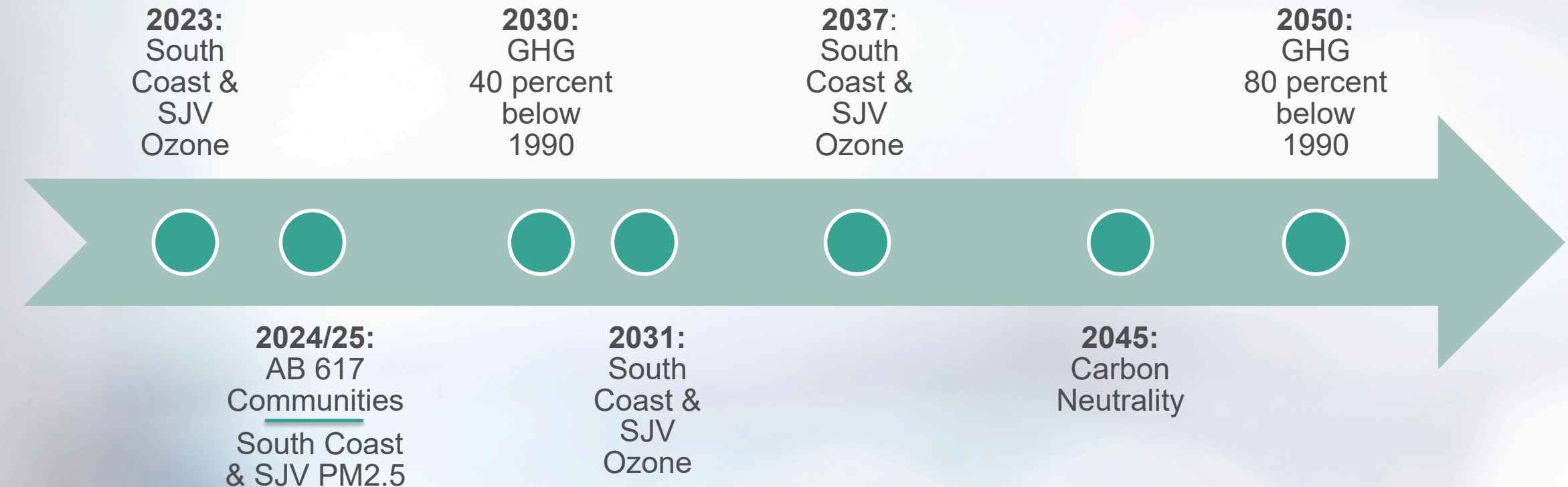
2020 Mobile Source Strategy

- Scenario-focused document that outlines trajectories needed in all mobile sectors to meet air quality and climate goals
- Scenarios go beyond current and planned regulations in many cases
- 2020 Mobile Source Strategy has concepts, while 2016 Mobile Source Strategy had defined measures
- Defined measures will be developed for the next State SIP Strategy, Scoping Plan, and/or CERPs

Background

California's Goals



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Senate Bill 44

- Requires CARB to update the Mobile Source Strategy to include a comprehensive strategy for the deployment of medium- and heavy-duty vehicles in the State
  - In consultation with CEC, GoBiz, Caltrans
  - Public Process
- CARB shall recommend goals for reducing emissions from medium- and heavy-duty vehicles consistent with 2030 and 2050 climate goals

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Executive Order N-79-20

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*

*where feasible

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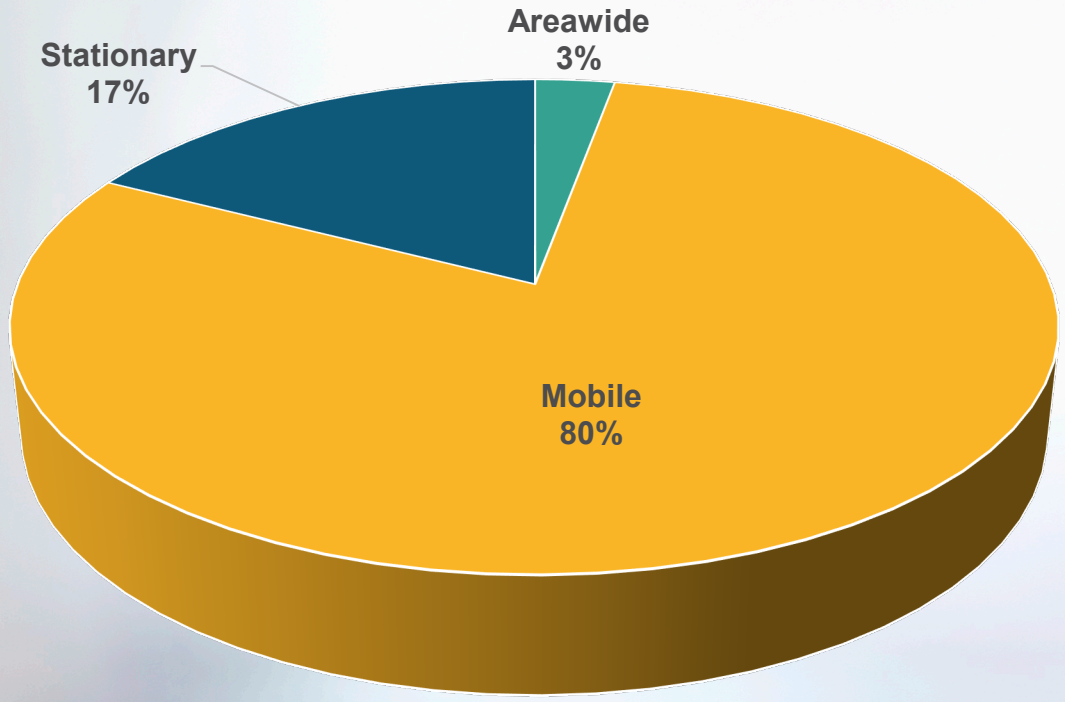
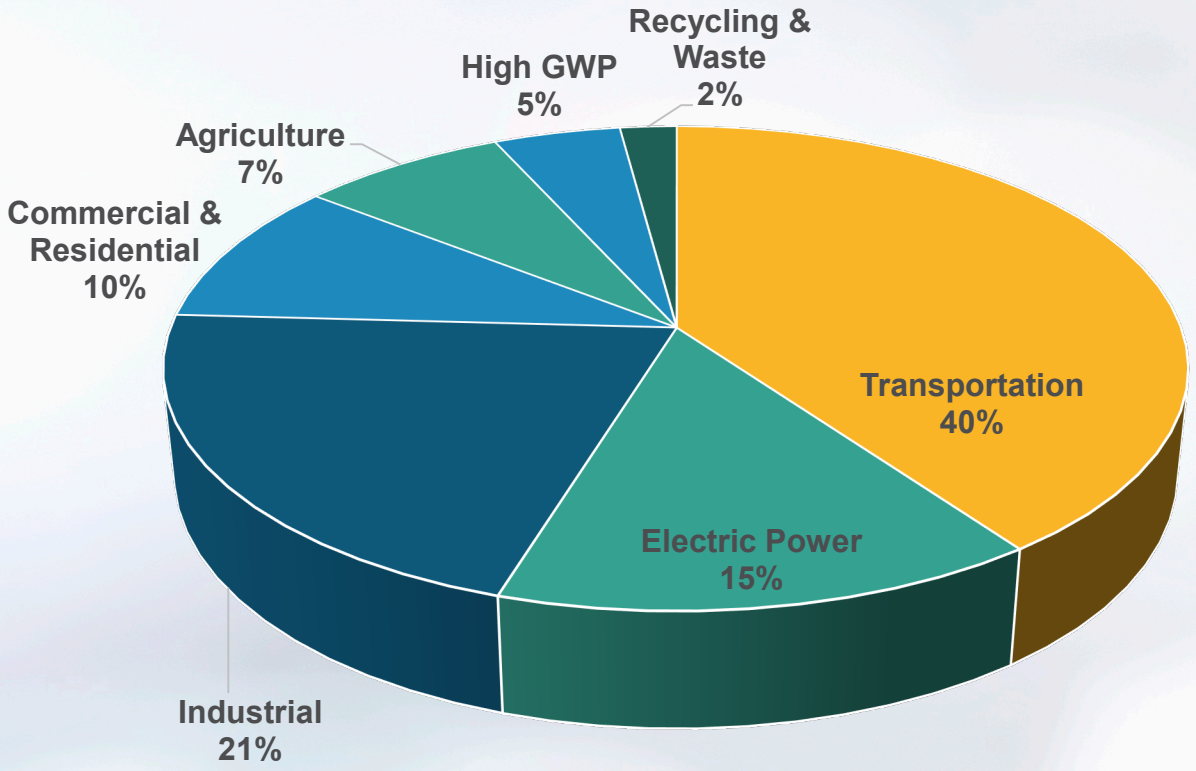
Integrated Planning

Mobile Source Contribution



2017 Statewide NOx Emissions
Total = 1294 tons per day



2017 Statewide GHG Emissions
Total = 424 MMTCO2e

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Health Cost of Pollution

Annually, $PM_{2.5}$ exposure results in:

- 5,400 premature deaths due to cardiopulmonary causes*
- 2,800 hospitalizations for cardiovascular and respiratory diseases*
- 6,700 emergency room visits for asthma*

Oakland Railyard Cancer Risk

CARB, 2008

Diesel PM also increases cancer risk

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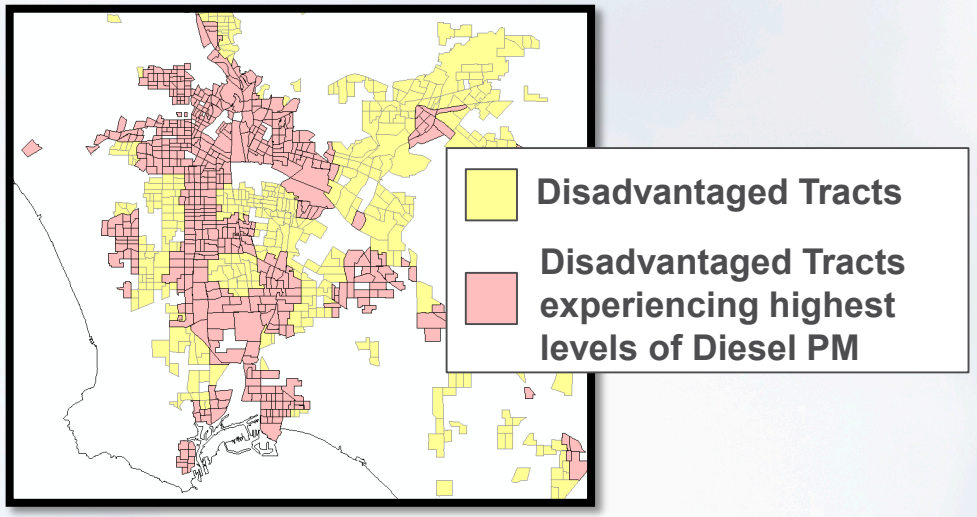
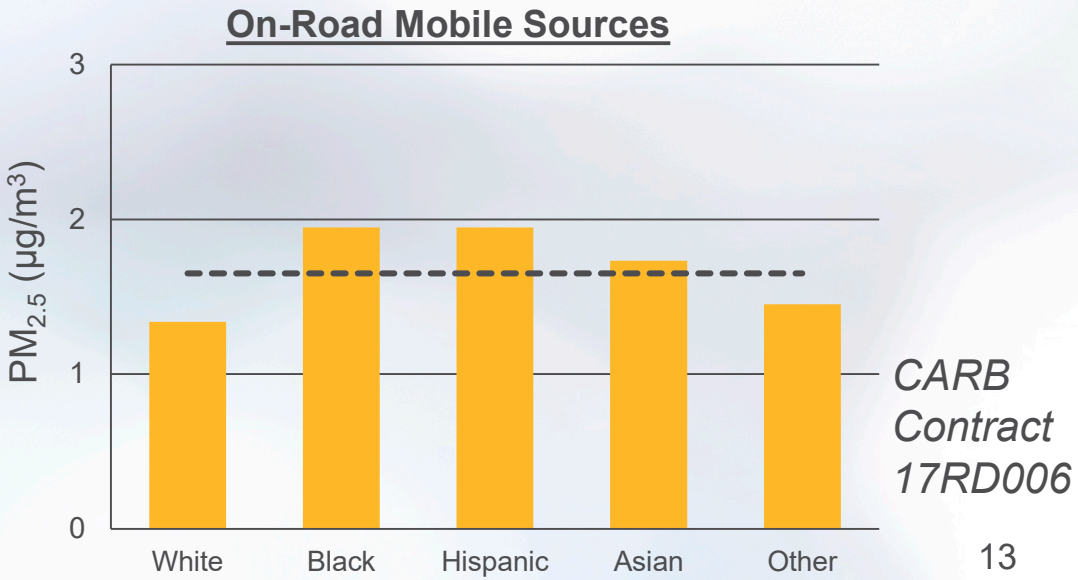
*Based on California 2014-2016 air quality data

Health Cost of Pollution

Disadvantaged communities and people of color are highly affected by mobile pollution



- 46% of disadvantaged census tracts in 75th percentile for Diesel PM
- Black and Hispanic communities exposed to $PM_{2.5}$ at concentrations 18% above average (on-road sources)



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Implementing the 2016 Mobile Source Strategy

2016 Mobile Source Strategy

- Released May 16, 2016
- Elements incorporated into:
  - 2016 State SIP Strategy
  - 2017 Climate Change Scoping Plan
  - CA Sustainable Freight Action Plan
  - Short-Lived Climate Pollutant Reduction Strategy

Regulatory Items Adopted

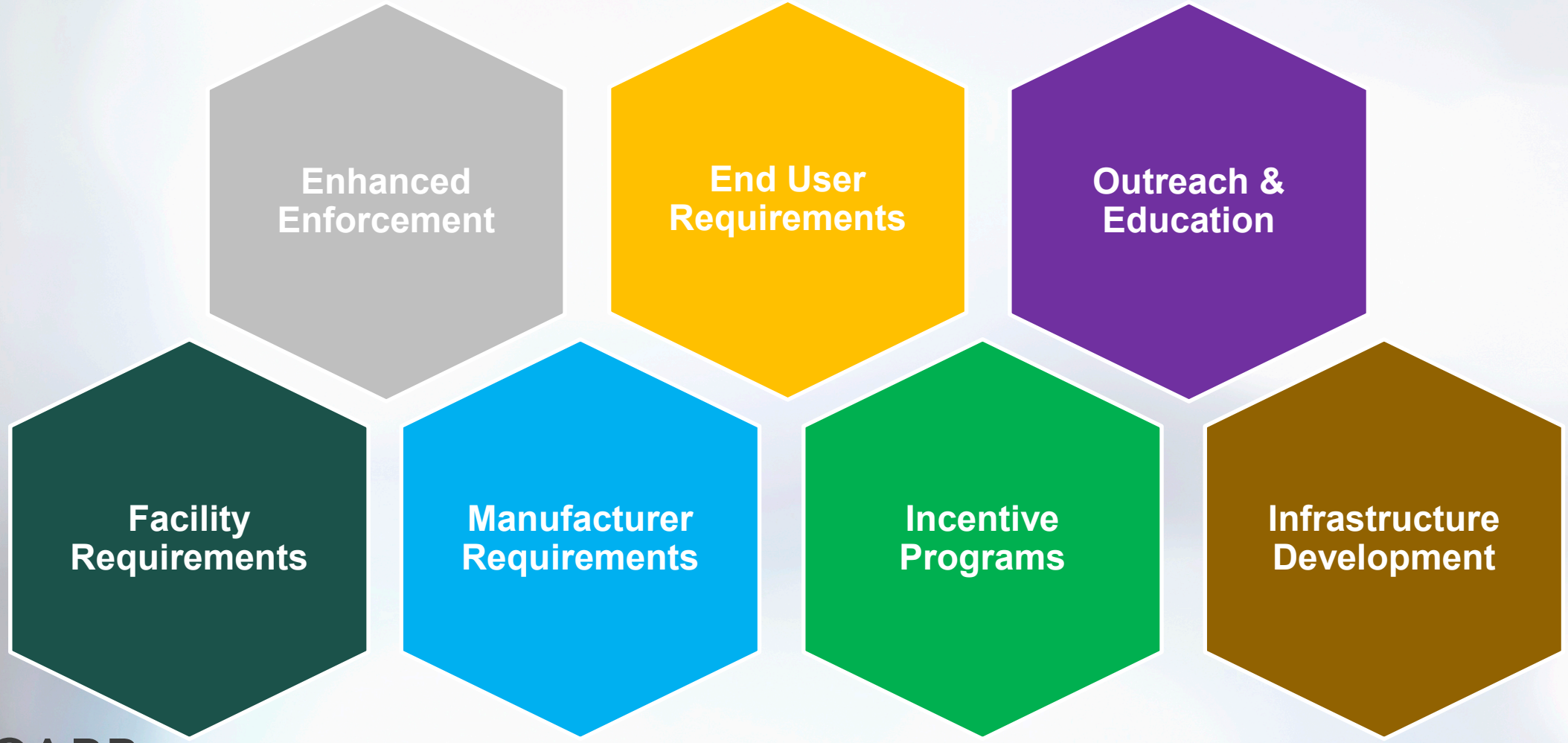
Regulation	Adopted
Innovative Technology Certification Flexibility	October 2016
Medium- and Heavy-Duty GHG Phase 2	February 2018
Lower Opacity Limits for HD Vehicles	May 2018
Amended Warranty Requirements for HD Vehicles	June 2018
Innovative Clean Transit	December 2018
Zero-Emission Airport Shuttle Buses	June 2019
Advanced Clean Trucks Regulation	June 2020
Heavy-Duty Omnibus Regulation	August 2020
Control Measure for Ocean-Going Vessels At Berth	August 2020

Regulations In Development

Regulation	Progress	Anticipated Consideration
Transport Refrigeration Units	Workshops since 2016	Early 2021
Small Off-Road Engines	Workshops since 2016 Evap Reg amended 11/2016	2021
Heavy-Duty Inspection & Maintenance	Workshops since 2019	2021
Low-Emission Diesel Requirement	Workshops since 2019	2021
Advanced Clean Cars II	In Development	2021
Zero-Emission Forklift Regulation	In Development	2022

2020 Mobile Source Strategy Scenarios

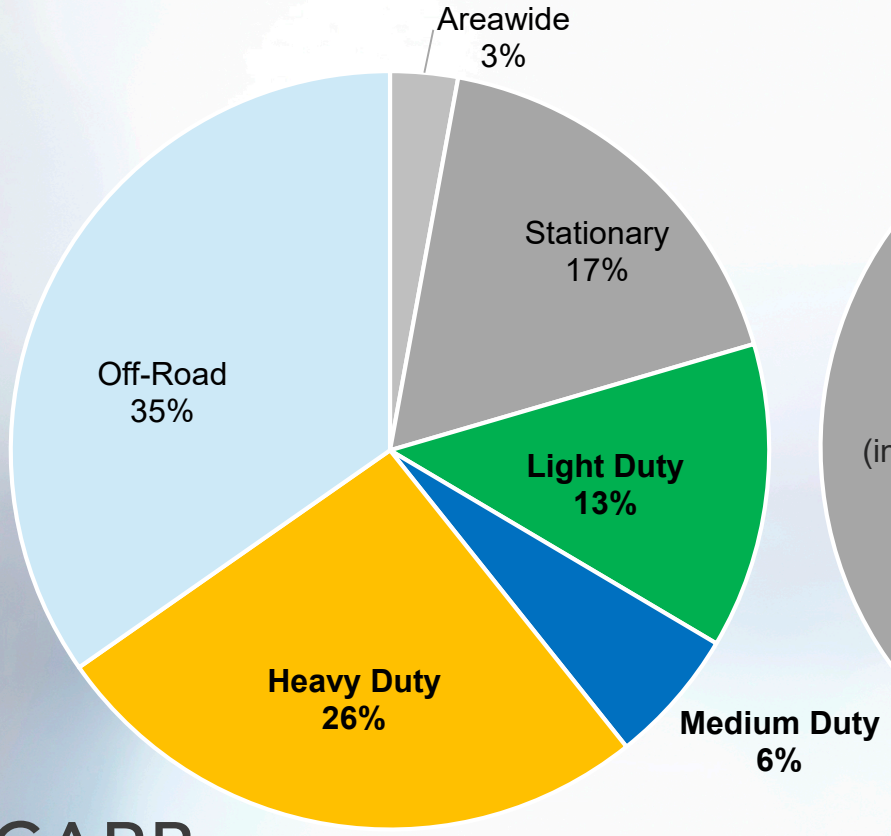
Achieving Air Quality and Climate Goals Requires Multiple Tools



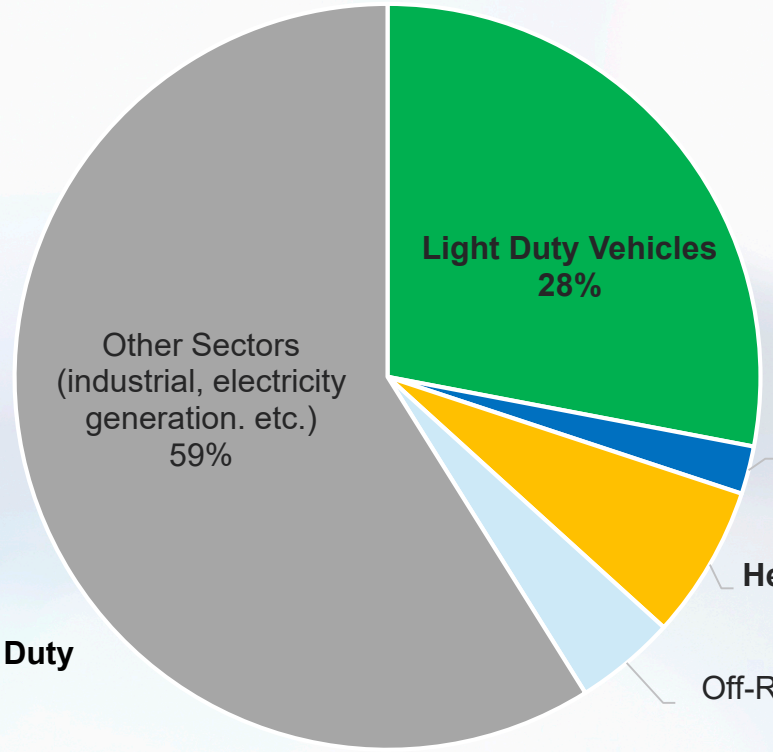
On-Road Vehicles

On-road mobile sources contributed to 45% of statewide NOx emissions and 37% of statewide GHG emissions in 2017

Statewide NOx Emissions



Statewide GHG Emissions



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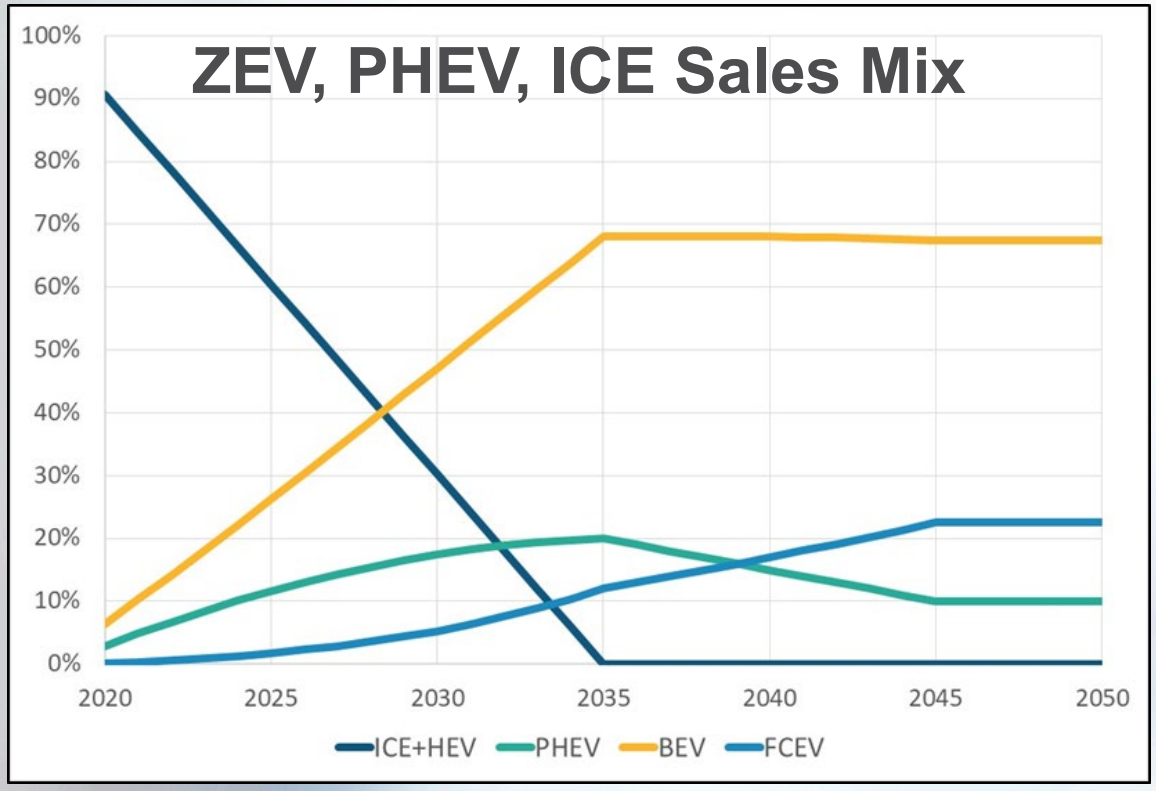
On-Road Light-Duty Vehicles

Scenario Framework

- Exploratory scenarios pushing assumptions that are “aggressive but possible”
  - Technology and cost feasibility not yet assessed
- Using commercialized vehicle and fuel technologies, but not yet scaled in market

Input Assumptions – Vehicles & VMT

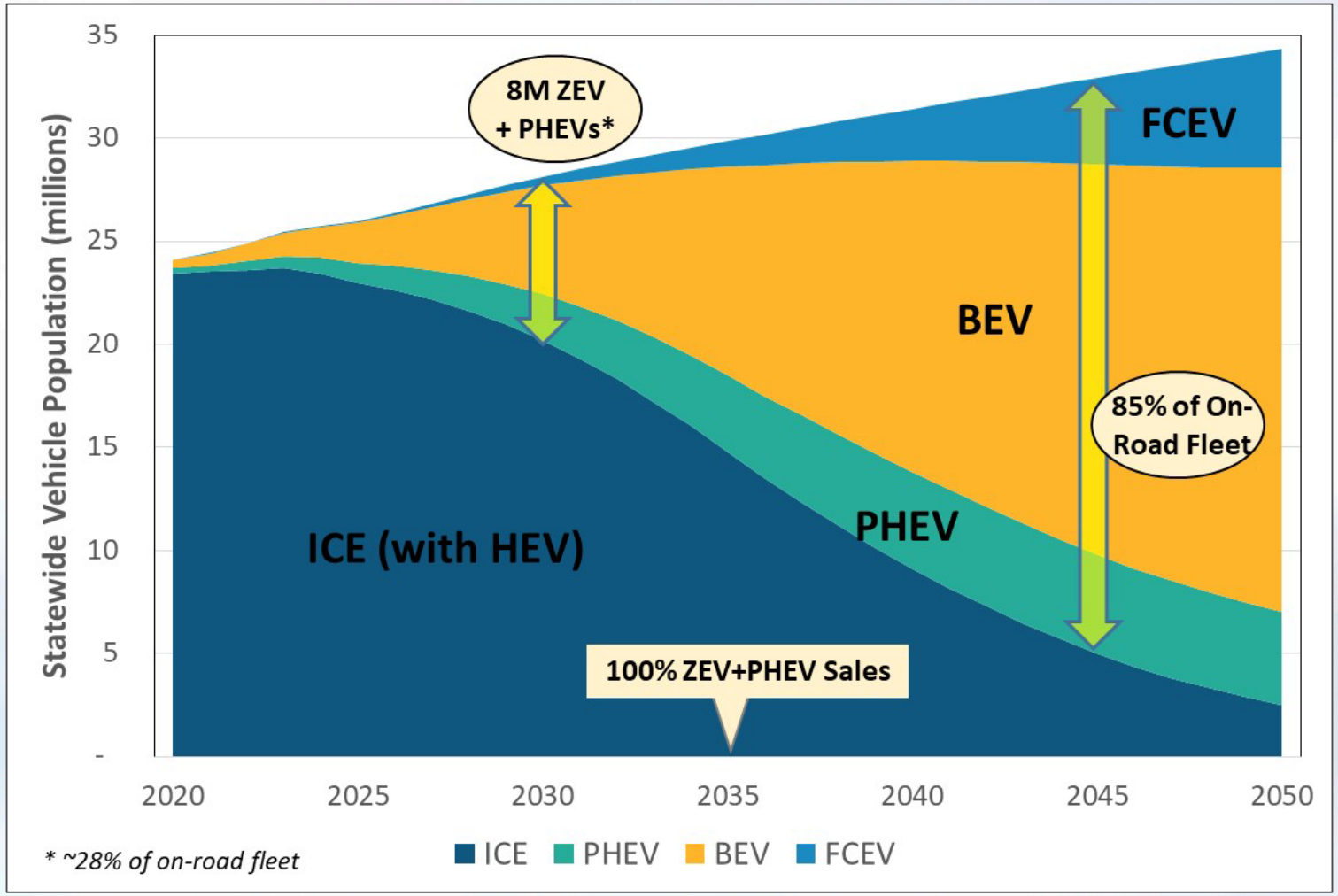


- New conventional vehicles, including non-plug-in hybrids
  - 2%/yr GHG reduction 2026-2035
  - NOx tailpipe kept at 2025 levels as ZEV sales scale up (no back-sliding
- Aggressive reductions of vehicle miles traveled beyond SB 375 Sustainable Communities Strategy (SCS) commitments
  - SCSs: 19% below 2005 levels
  - Scenario: 25% below 2005 levels

Input Assumptions – Fuels

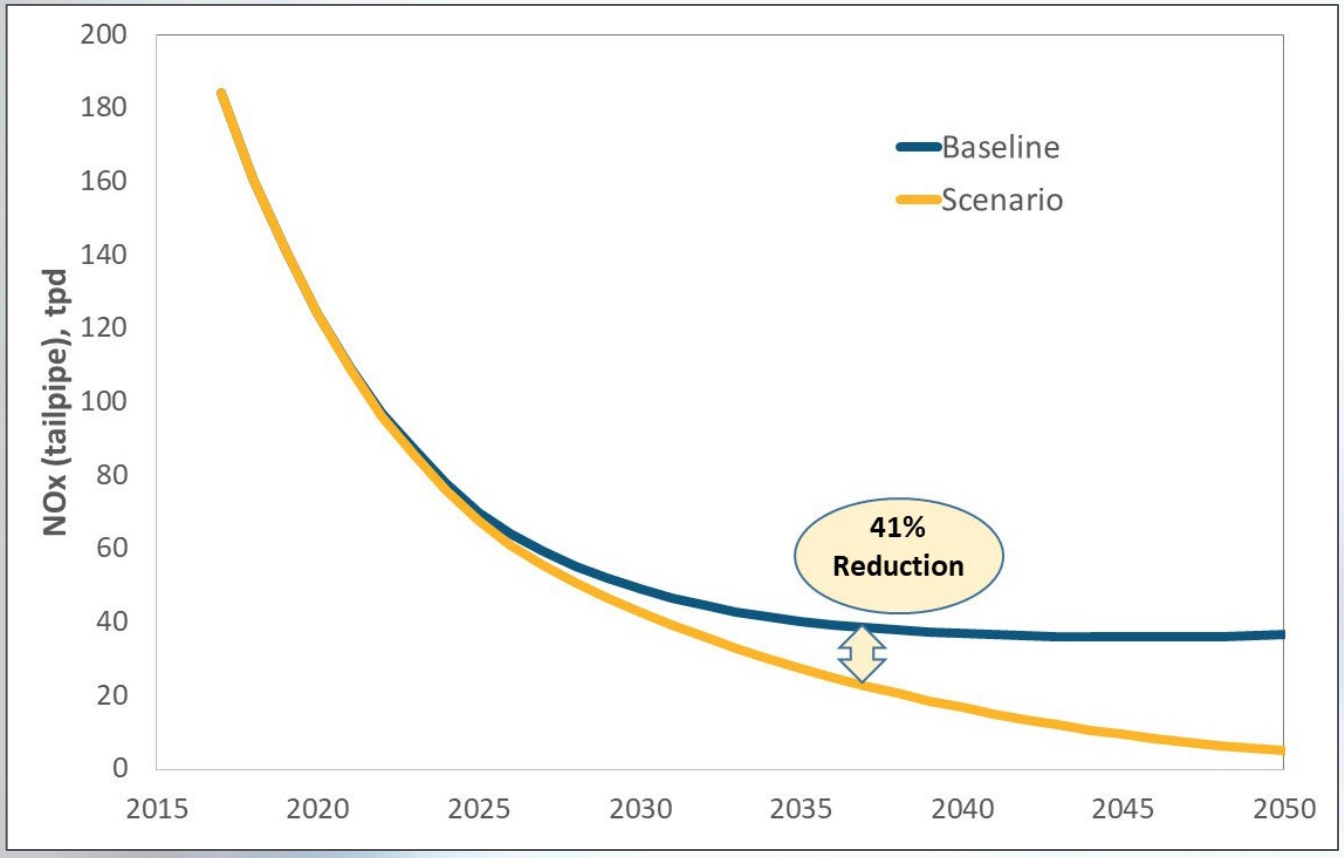
- Electric grid assumed to have ~10% fossil natural gas in 2045
- Hydrogen assumed to be fully renewable by 2045 given low fuel volumes
- Drop-in renewable gasoline not included
- Lower carbon ethanol used up to 10% blend wall

LDV Scenario for Deep Emission Reductions

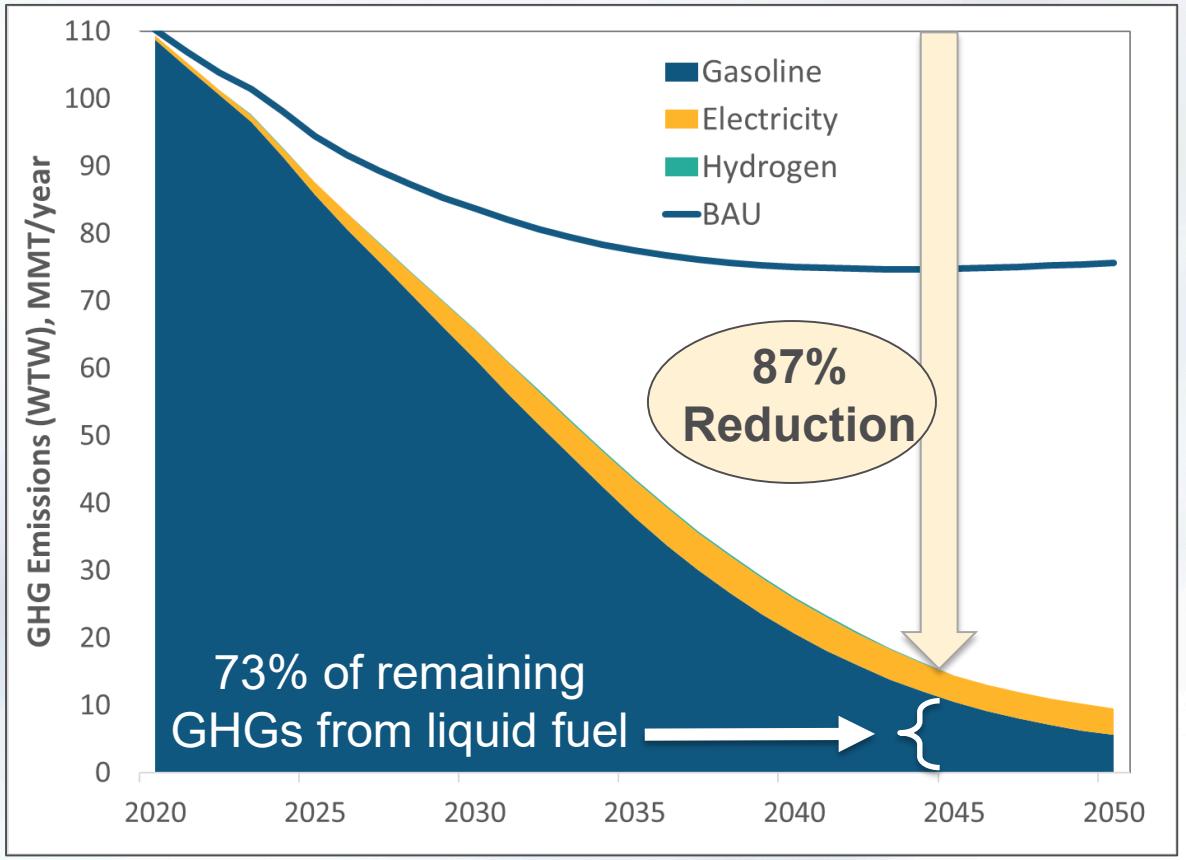


Emission Impacts - Statewide

NOx, Vehicle tailpipe, tons/day (tpd)



GHG, Well-to-Wheel, MMT CO2/yr

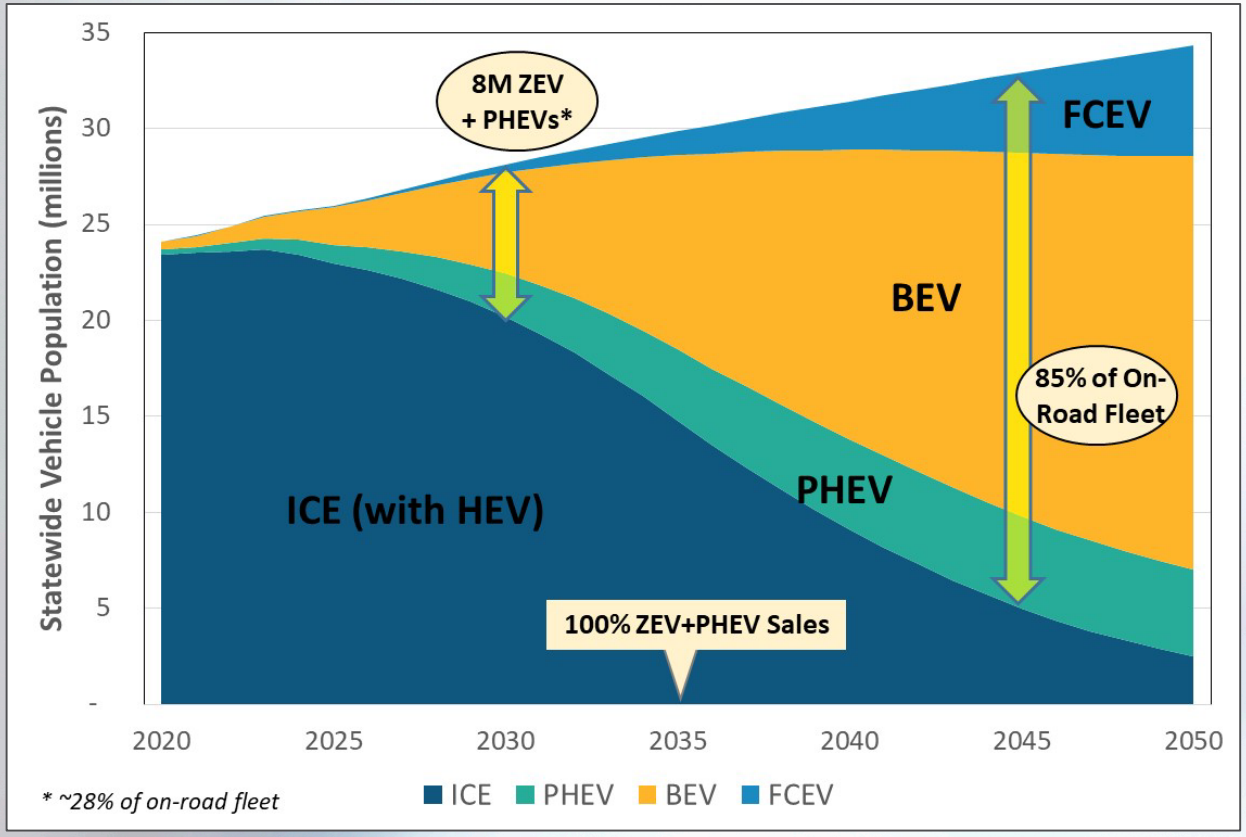


Success Depends on Multiple Strategies

- Clean Vehicles
  - ZEV sales are foundational, but accelerated turn-over may be necessary
- VMT Reduction
  - Land use change; Investment in alternative modes
- Clean Fuels
  - Renewables; Biomass where possible; Vehicle-grid integration services

Reducing VMT in California

ZEVs Are Not Enough



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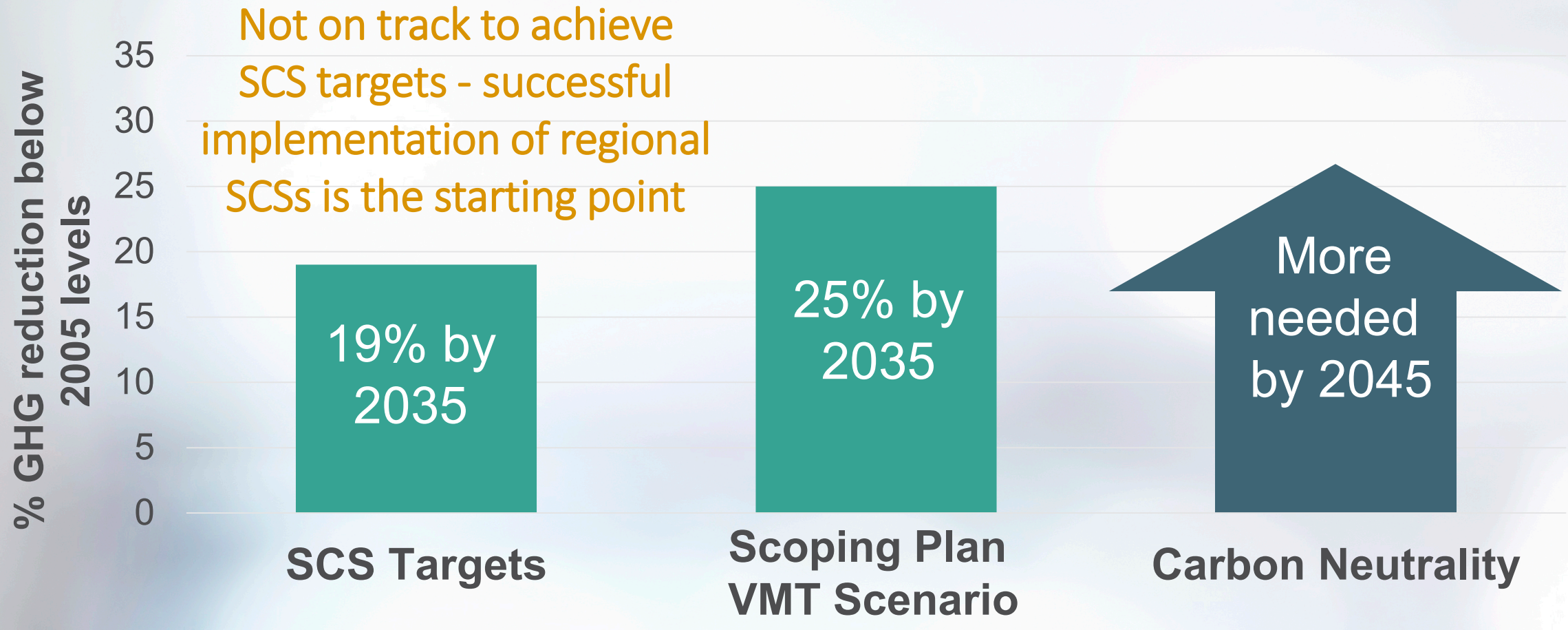
VMT Reductions and Climate Goals



Strategies to Reduce VMT

- Secure and sustain emissions reductions from SB 375
- Develop a VMT/GHG mitigation bank to assist with SB 743 implementation
- Align with the goals of CaI ITP and integrate incentives and rebates
- Explore Non-regressive Transportation Pricing and Demand Management

Secure and Sustain Emissions Reductions from SB 375

- Update the SB 375 targets and metric to better align with current planning assumptions
- Clarify what it means for a project to be “consistent with” an RTP/SCS
- Emphasize the importance of conservation, restoration, and management of natural and working lands in SCSs.
- Pilot regional and local partnerships to implement VMT reduction measures

Develop a VMT/GHG Mitigation Bank to Assist with SB 743 Implementation

- Explore options for off-site VMT/GHG project-level mitigation measures.
- Build on successes from existing programs that address community mobility needs while reducing VMT
  - Clean Mobility Vouchers Pilot
  - Sustainable Transportation Equity Projects (STEP)
- Promote land-based carbon storage and VMT reduction
  - Land conservation easements through Sustainable Agriculture Land Conservation (SALC) program

Align with the Goals of Cal ITP and Integrate Incentives and Rebates

- Cal ITP would facilitate easy and accessible travel planning and payments across California
  - first demonstration project with Monterey-Salinas Transit (MST) to implement contactless payments
- Incentives can promote public private partnerships
  - draft Clean Miles Standard proposal includes voluntary compliance path for integrated TNC/transit fares.

Explore Non-regressive Transportation Pricing and Demand Management

- Regions already including them in transportation plans
  - SACOG's 2020 RTP includes regional facility-based congestion pricing through managed express lanes and a regional mileage-based user fee
  - SCAG's 2020 RTP includes facility-based congestion pricing through cordon zones and managed express lanes, a regional mileage-based user fee, and a TNC user fee

Changes and Additional Work by All Levels of Government are Necessary

- Recent successes provide opportunity for improved collaboration and aligned decision-making
  - Executive Order N-19-19
  - SB 743 implementation
  - CARB/CTC/HCD Joint Meetings

Questions?

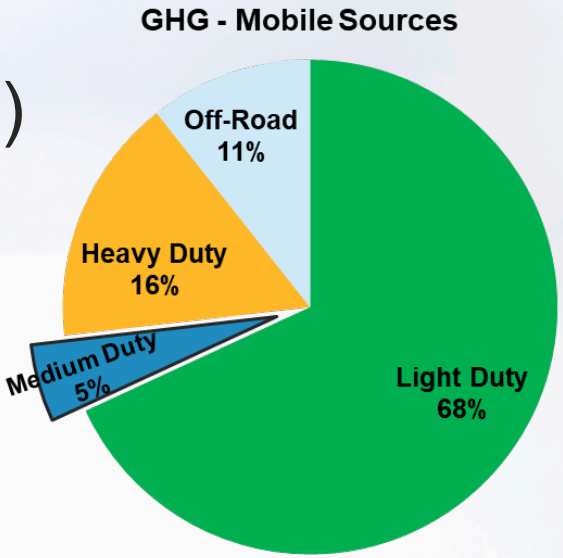
Please type them into the Questions window,
or use the Raise Hand feature in GoToWebinar

https://ww2.arb.ca.gov/resources/documents/2020-mobile-source-strategy

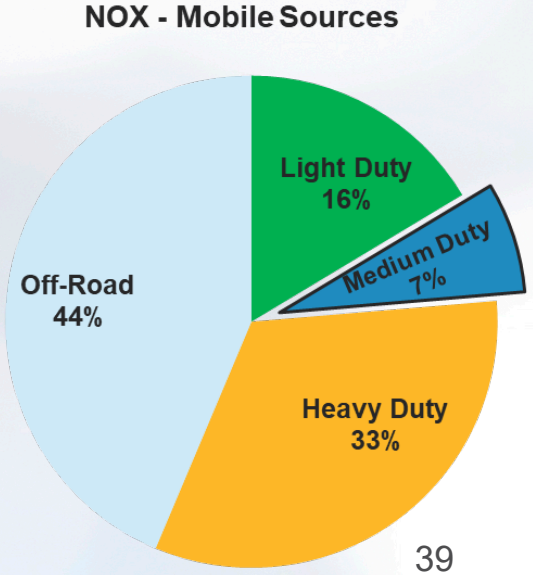
On-Road Medium and Heavy-Duty Vehicles

On-Road Medium-Duty Vehicles

- Medium-duty vehicles (8,501 – 14,000 lbs. GVWR) are responsible for 7% of statewide mobile source NOx and 5% of statewide mobile source GHG emissions

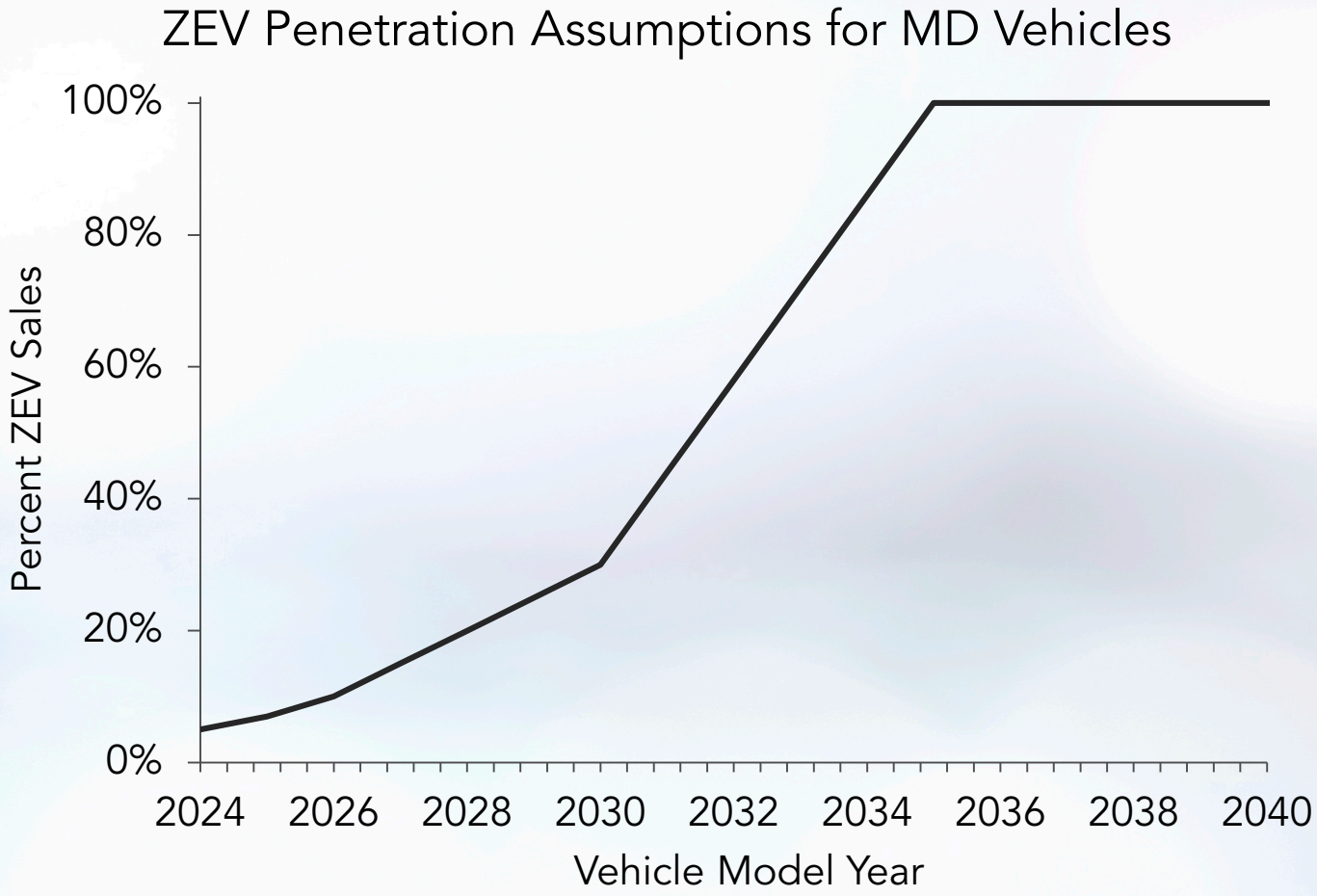


- **Strategies** for on-road medium-duty vehicles (MDVs) include:
  - ✓ Zero-emission technology transformation starting in 2024
  - ✓ Enhanced LEV regulations through ACC II
  - ✓ Continued energy efficiency improvements (e.g., Phase 3)



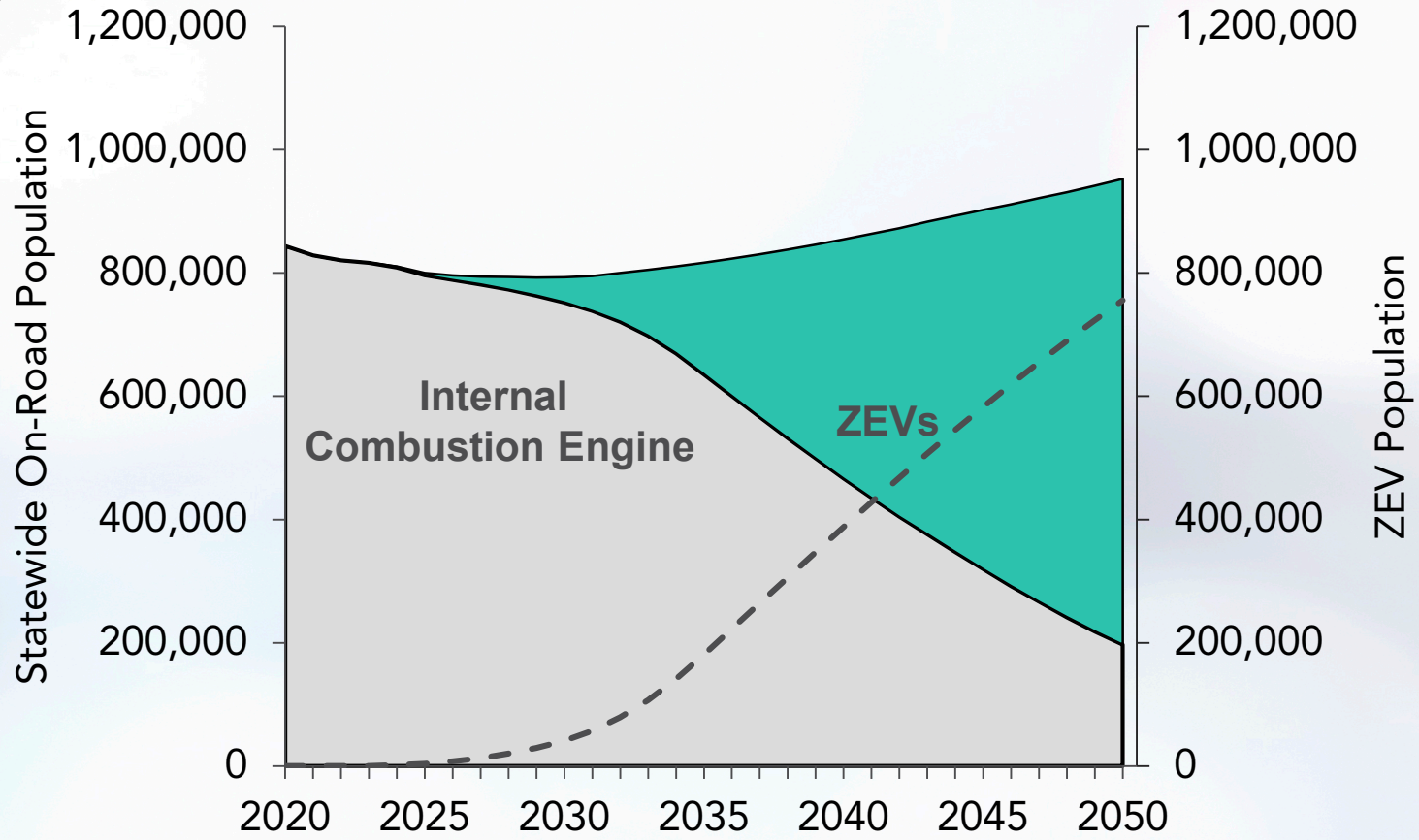
Medium-Duty ZEV Phase-In Assumptions

- ZEV phase-in matches Advanced Clean Trucks (ACT) requirements until model year 2030, after which ZEV sales assumptions ramp up to **100 percent sales in 2035**



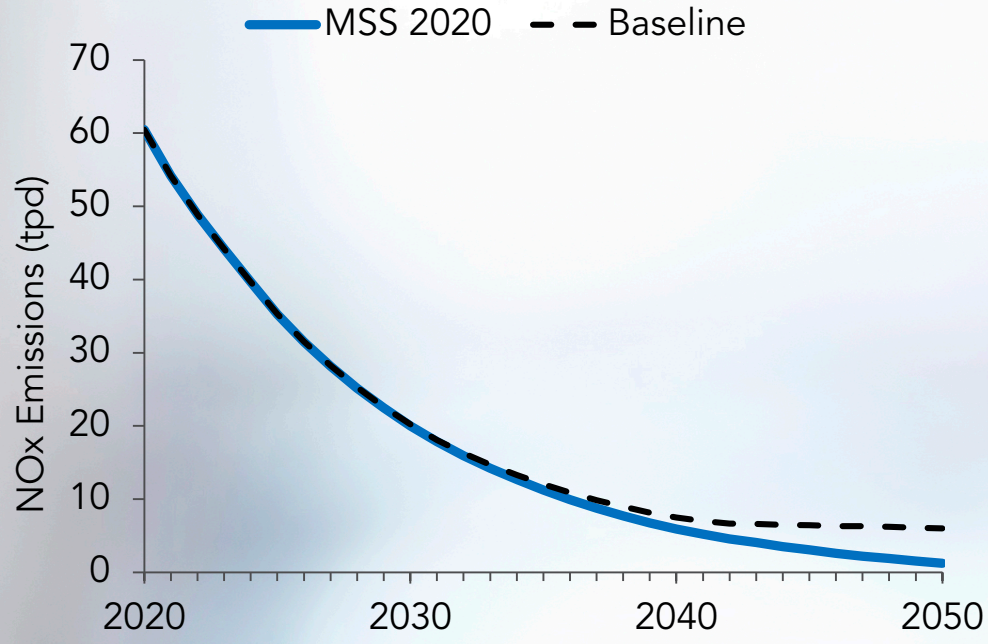
Medium-Duty Vehicles - Scenario

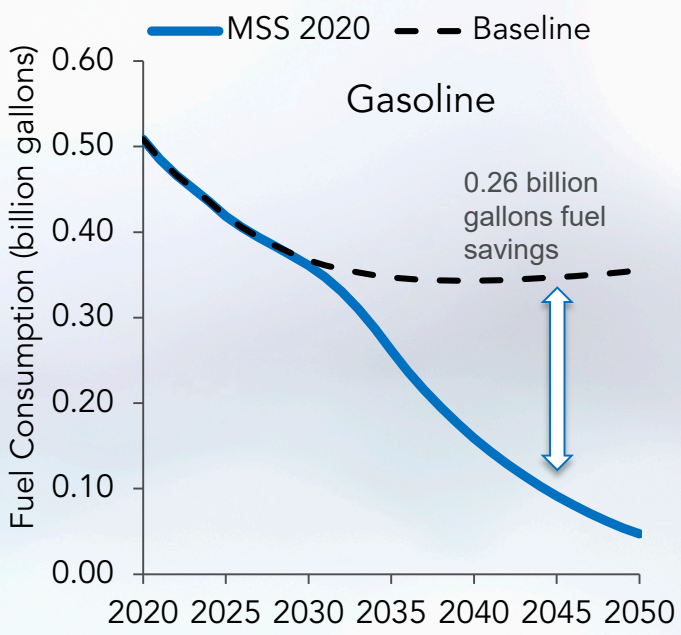
- 100% of sales are zero emissions vehicles (ZEVs) in 2035
- Results in about 40,000 and 600,000 medium-duty ZEVs by 2030 and 2045, respectively

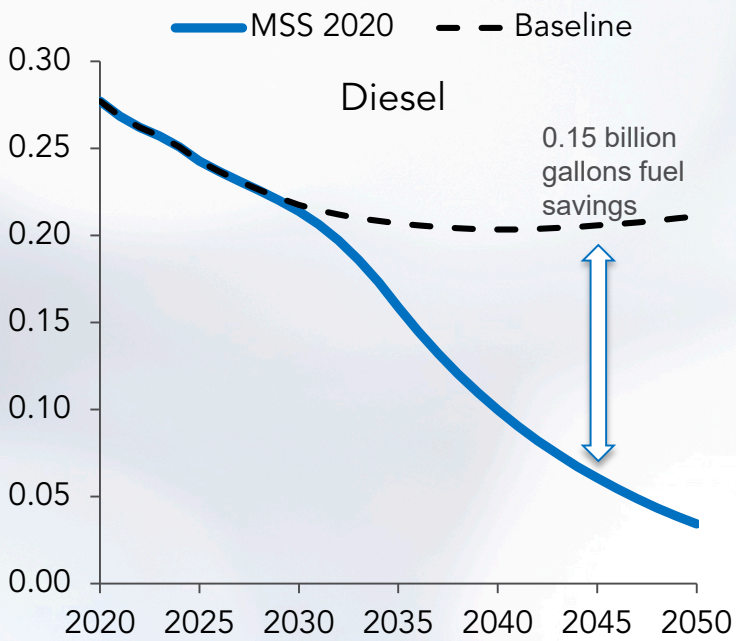


Medium-Duty Vehicles - Reductions

- The scenario will result in NOx emissions that are 1 and 11 percent lower from the current baseline in 2031 and 2037, respectively
- 0.26 and 0.15 billions gallons per year in gasoline and diesel fuel savings, respectively, by 2045







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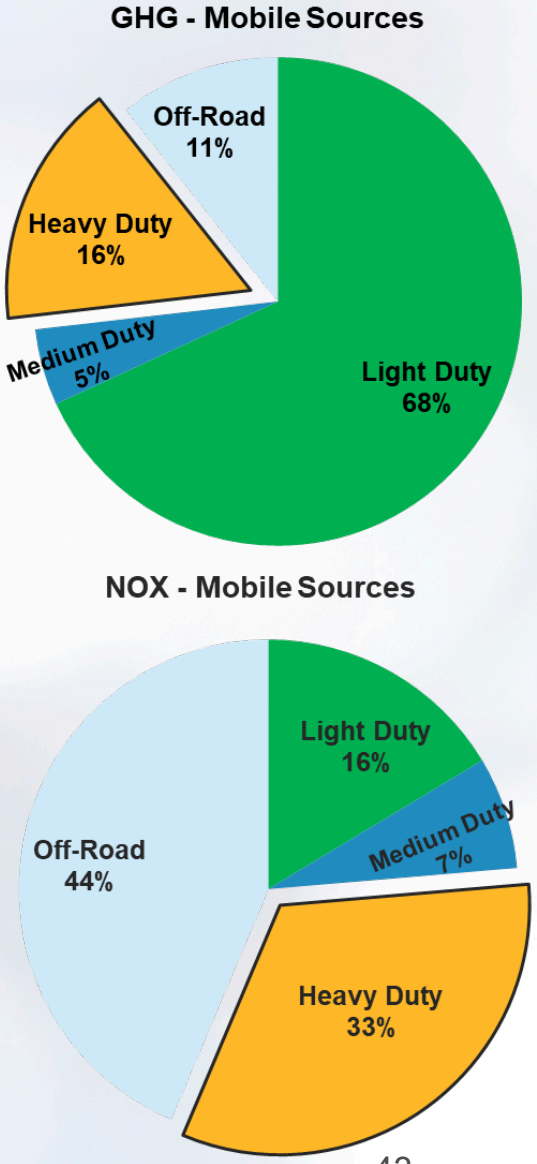
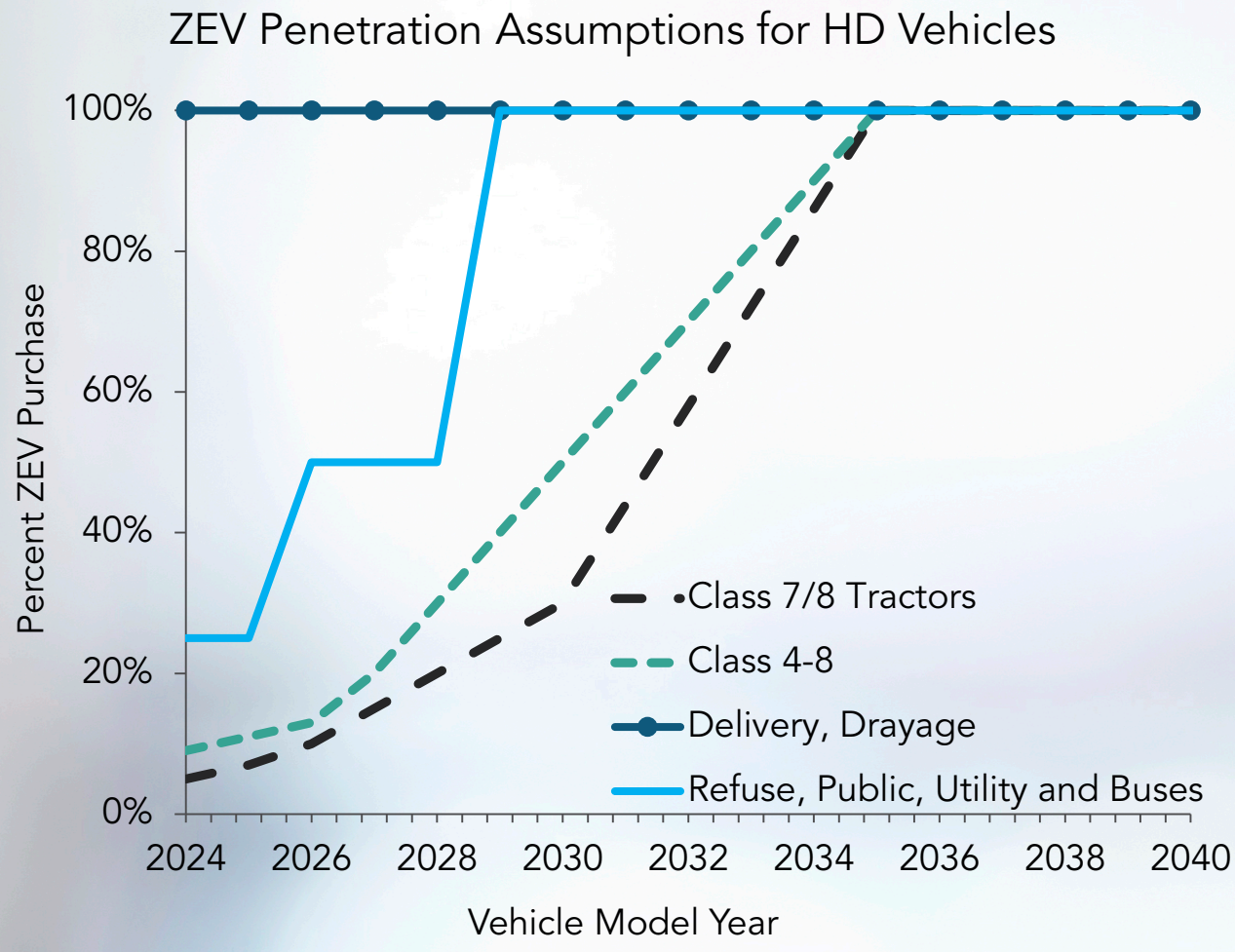
On-Road Heavy-Duty Vehicles

- Heavy-duty vehicles (above 14,000 lbs. GVWR) are responsible for 33% of statewide mobile source NOx and 16% of statewide mobile source GHG emissions

- **Strategies** for on-road heavy-duty vehicles (HDVs) include:
  - ✓ Zero-emission technology starting in 2024
  - ✓ Cleaner combustion technology (i.e., Omnibus) starting in 2024
  - ✓ Use of renewable fuels where electrification is not available
  - ✓ Continued energy efficiency improvements



Heavy-Duty ZEV Phase-In Assumptions



- 100% ZEV CA fleet purchases by 2035
- **Delivery and drayage fleets:** 100 percent ZEV sales starting with model year 2024
- **Vehicle categories with low annual mileage or return-to-base operation:** Similar phase-in schedule as the innovative clean transit regulation
- **Other vocational and tractor vehicle categories:** ZEV phase-in matches ACT requirements until model year 2030, after which ZEV sales assumptions ramp up to 100 percent sales in 2035

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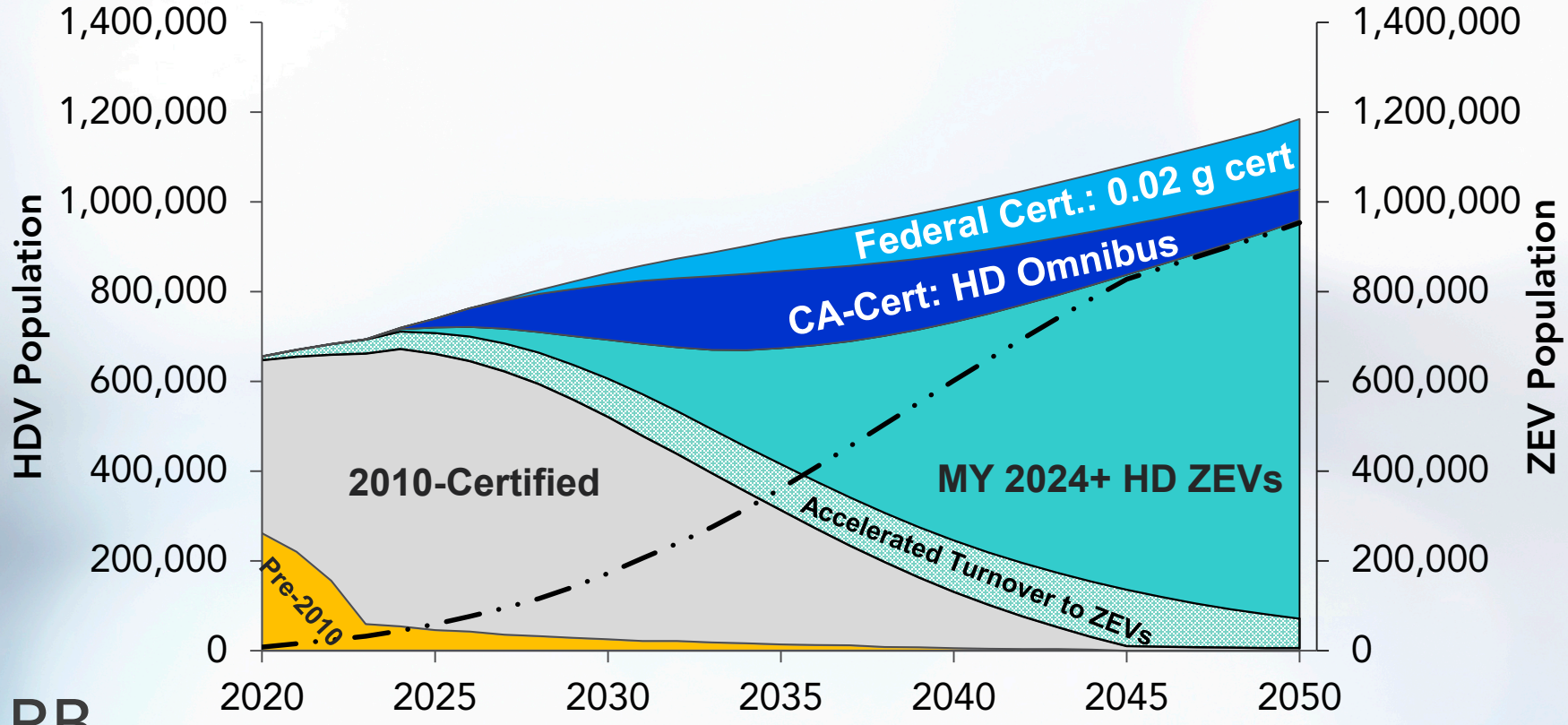
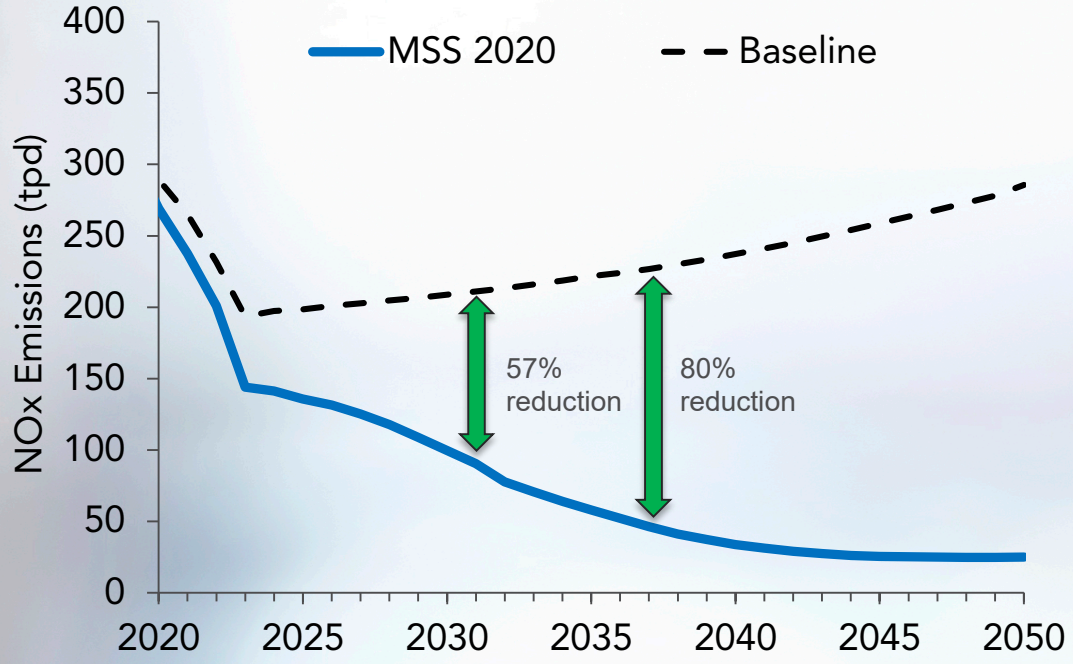
Heavy-Duty Vehicles - Scenario

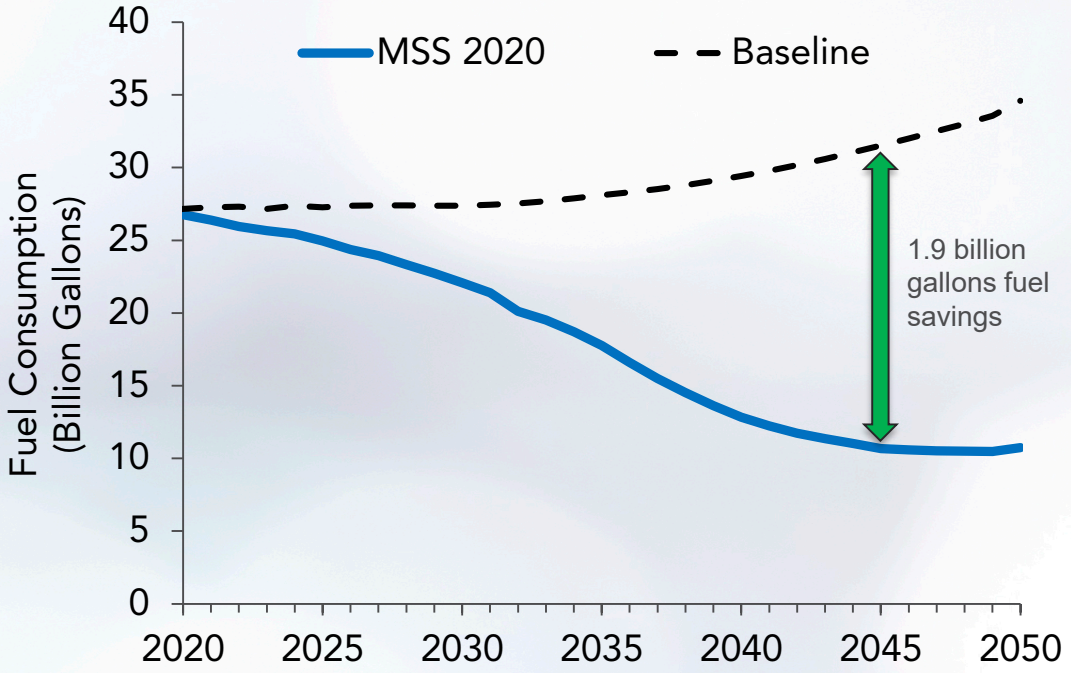
- 100% of CA fleet purchases are ZEV in 2035
- Accelerated turnover of 94,000 vehicles to ZEVs by 2031
- Results in about 170,000 and 830,000 zero-emission HDVs by 2030 and 2045, respectively



Heavy-Duty Vehicles - Reductions

- The scenario will result in NOx emissions that are 57 and 80 percent reduction from the current baseline in 2031 and 2037, respectively
- 1.9 billions gallons per year in diesel fuel savings by 2045

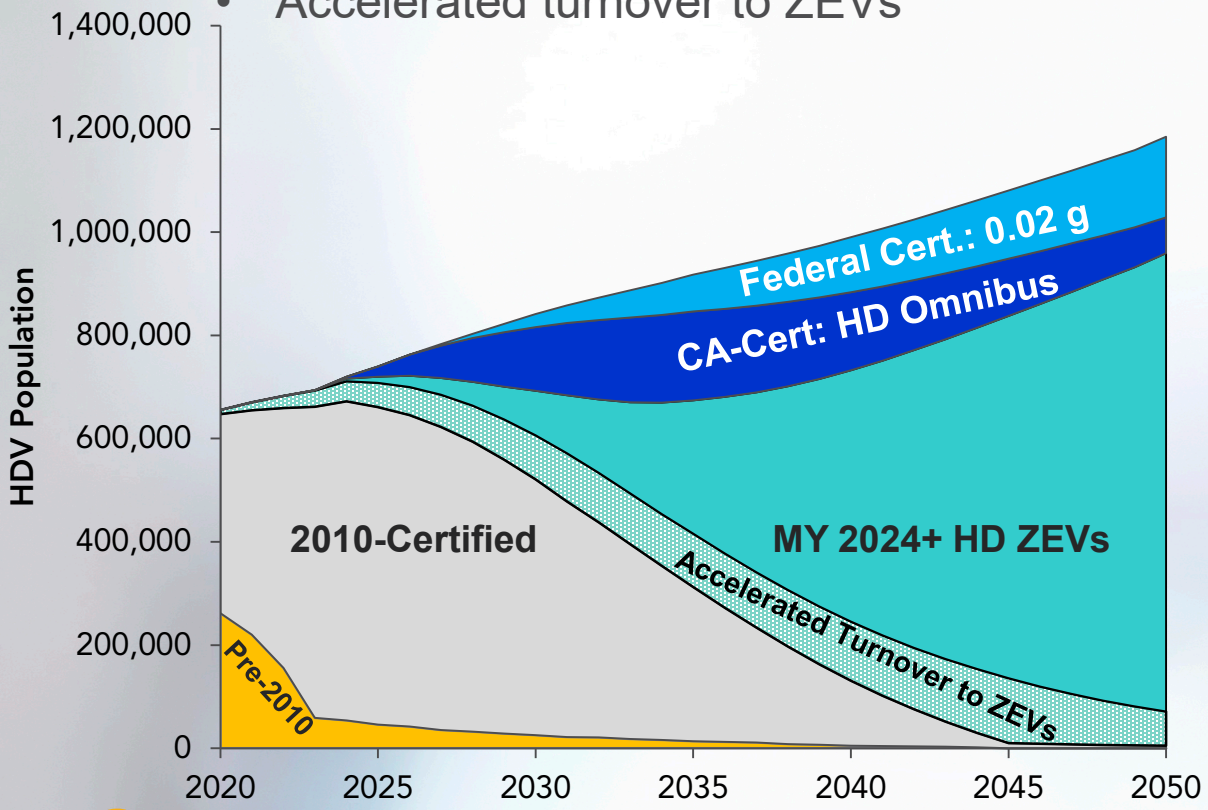




Alternative Heavy-Duty Scenario

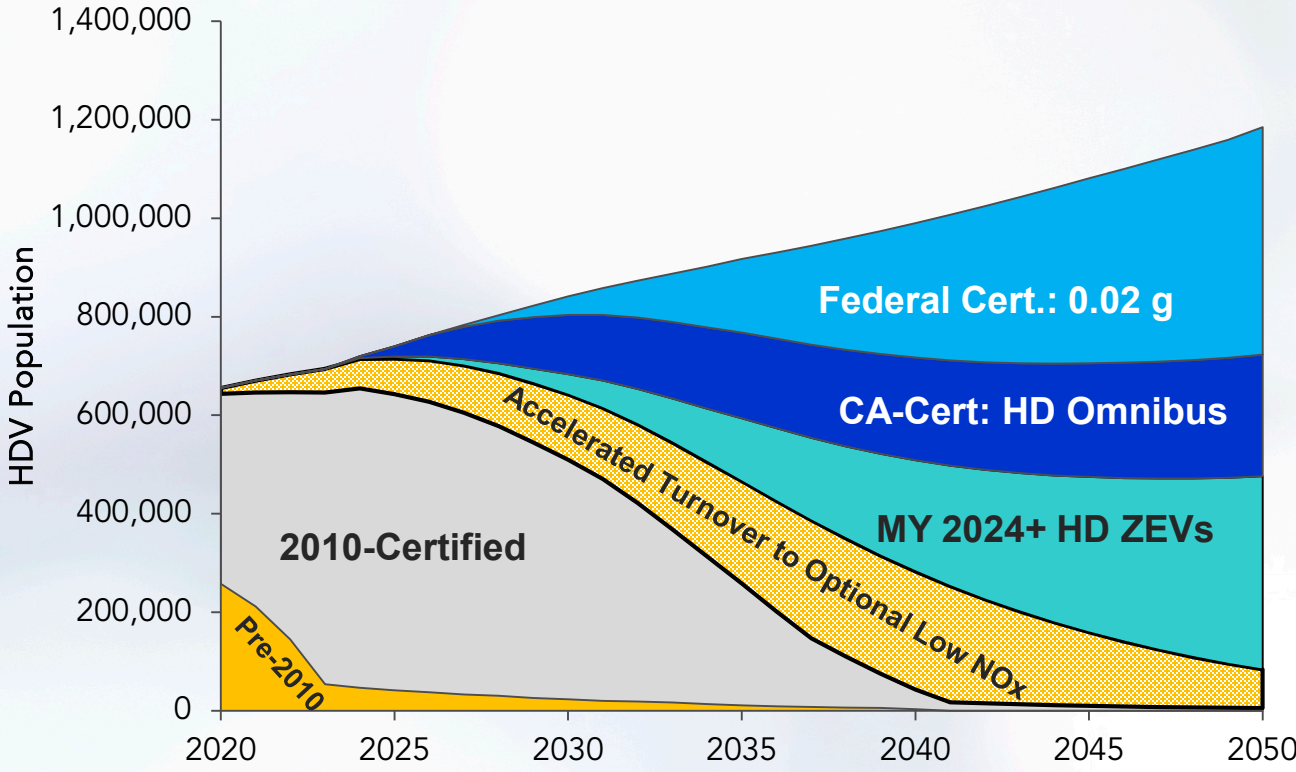
2020 Mobile Source Strategy

- Ambitious ZEV phase-in schedule
- 100% ZEV sales by 2035 to meet Climate goals
- Accelerated turnover to ZEVs



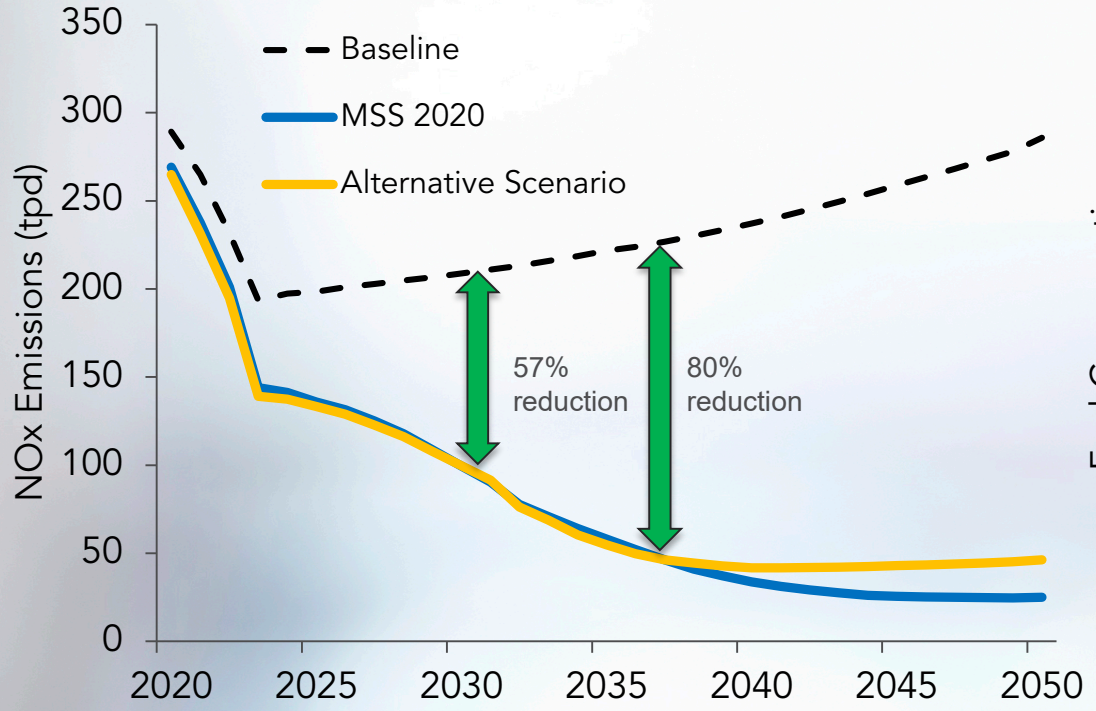
Alternative Scenario

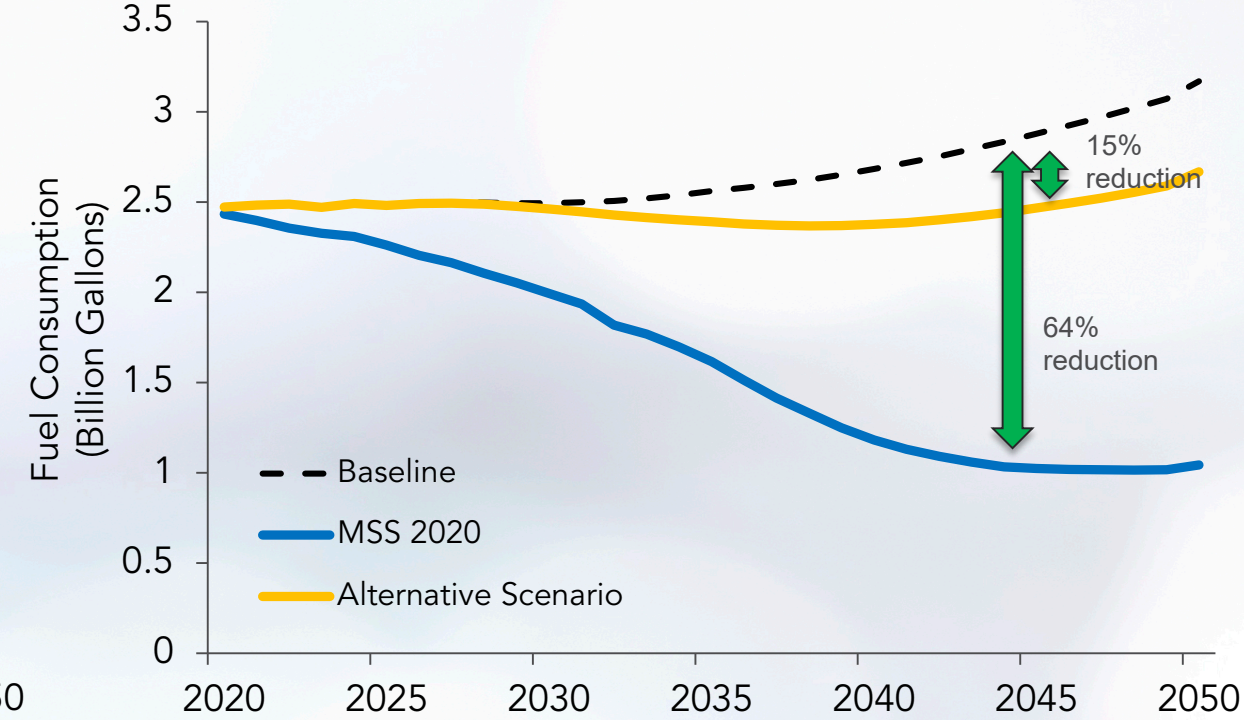
- Follows current ACT ZEV phase-in schedule
- Accelerated turnover to Optional Low NOx engines



Alternative Heavy-Duty Scenario

- Similar NOx reductions for the Alternative Scenario
- Much less fuel savings – significant fuel efficiency improvement will be needed to close the gap



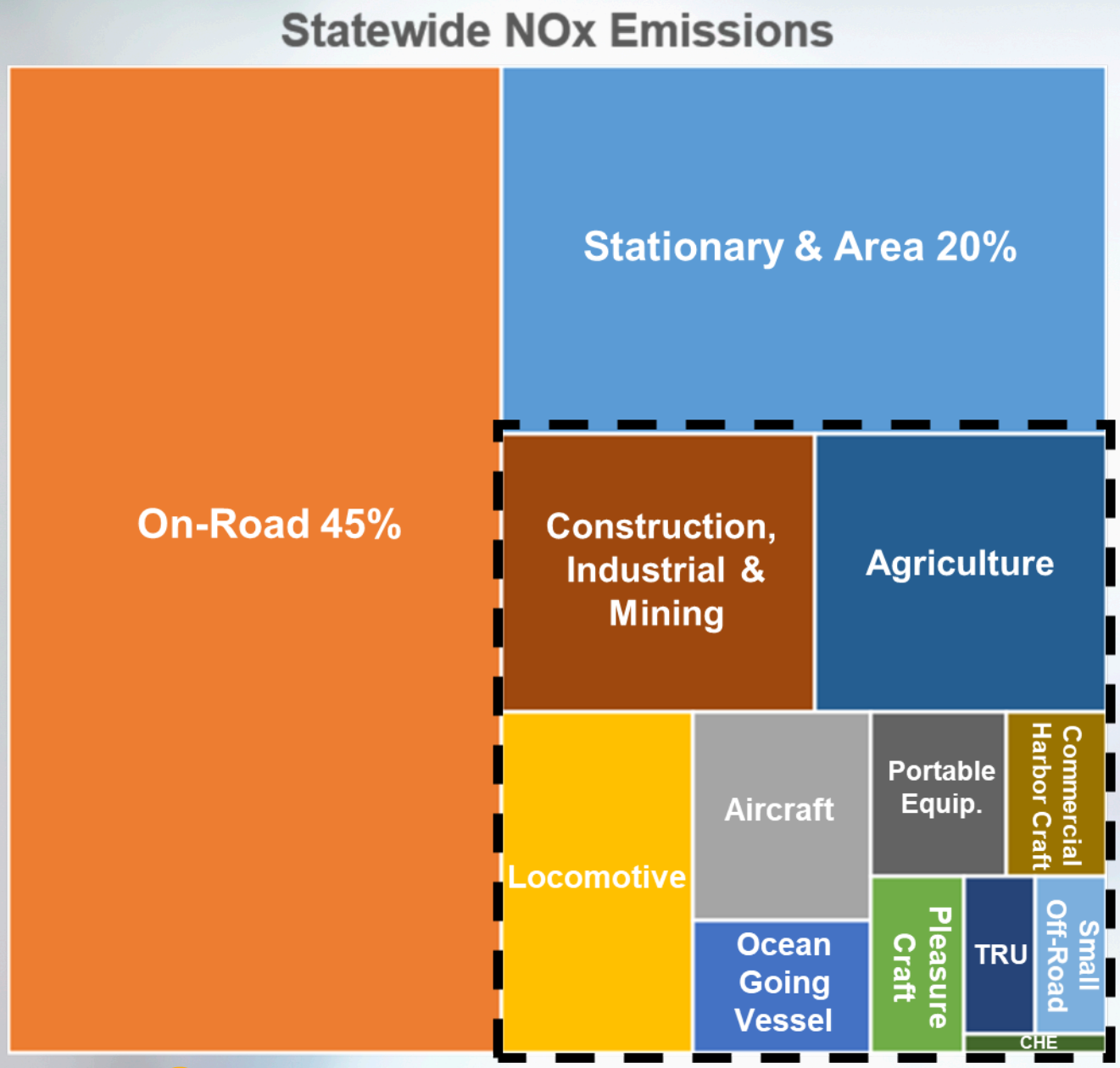


Interagency Coordination on Infrastructure

- Staff have been working with CEC and CPUC throughout development of the 2020 MSS
- Results from the 2020 MSS are being incorporated into the CEC's technical analysis for AB 2127 report

Off-Road Vehicles and Equipment

Off-Road Sector



- Off-road mobile sources contributes to 35% of Statewide NOx and 4% of GHG emissions in 2017
- Off-road NOx contribution will grow to 37% (largest) by 2022

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Strategies for Off-Road Sector

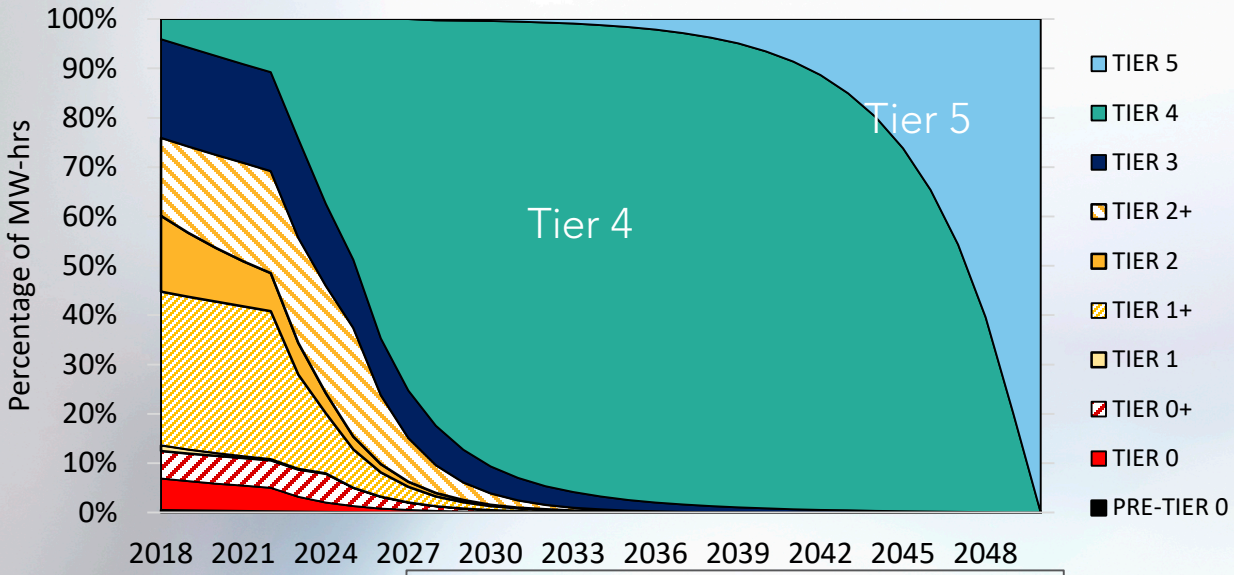
Guiding Principles

- ✓ Zero-emission technology wherever feasible
- ✓ Introduce cleaner combustion technology such as Tier 5 and on-board diagnostic (OBD) standard
- ✓ Accelerate turnover of older equipment to cleanest available technology, and retrofit with after-treatment technology
- ✓ Adopt hybridization and renewable fuels where electrification is not feasible to reduce GHG emissions

Locomotives

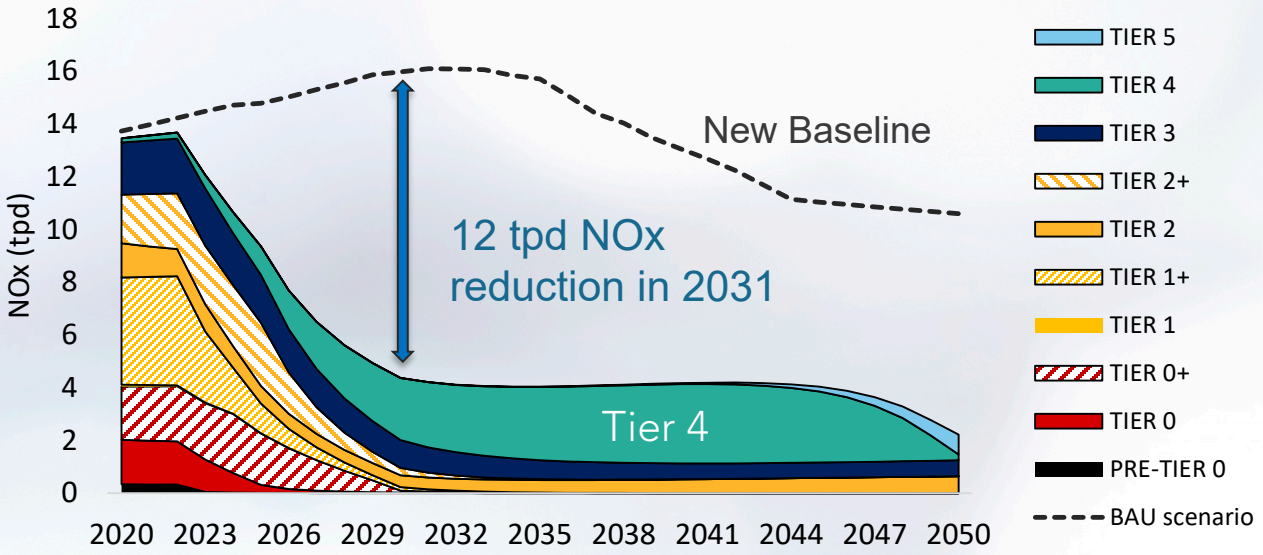
- Significant source of statewide NOx and diesel PM emissions
- **MSS Scenario:**
  - Adopt Tier 5 locomotive standard in 2028
  - Significantly accelerate the turnover of all line-hauls operating in California to Tier 4/5
  - Replace Tier 0/0+ switchers in railyards with Tier 4/5 by 2030

SC Locomotive Energy Use: MSS Scenario



*Tier 4 only accounts for **4%** of loco activity in 2018*

SC NOx Emissions from Locomotives: MSS Scenario



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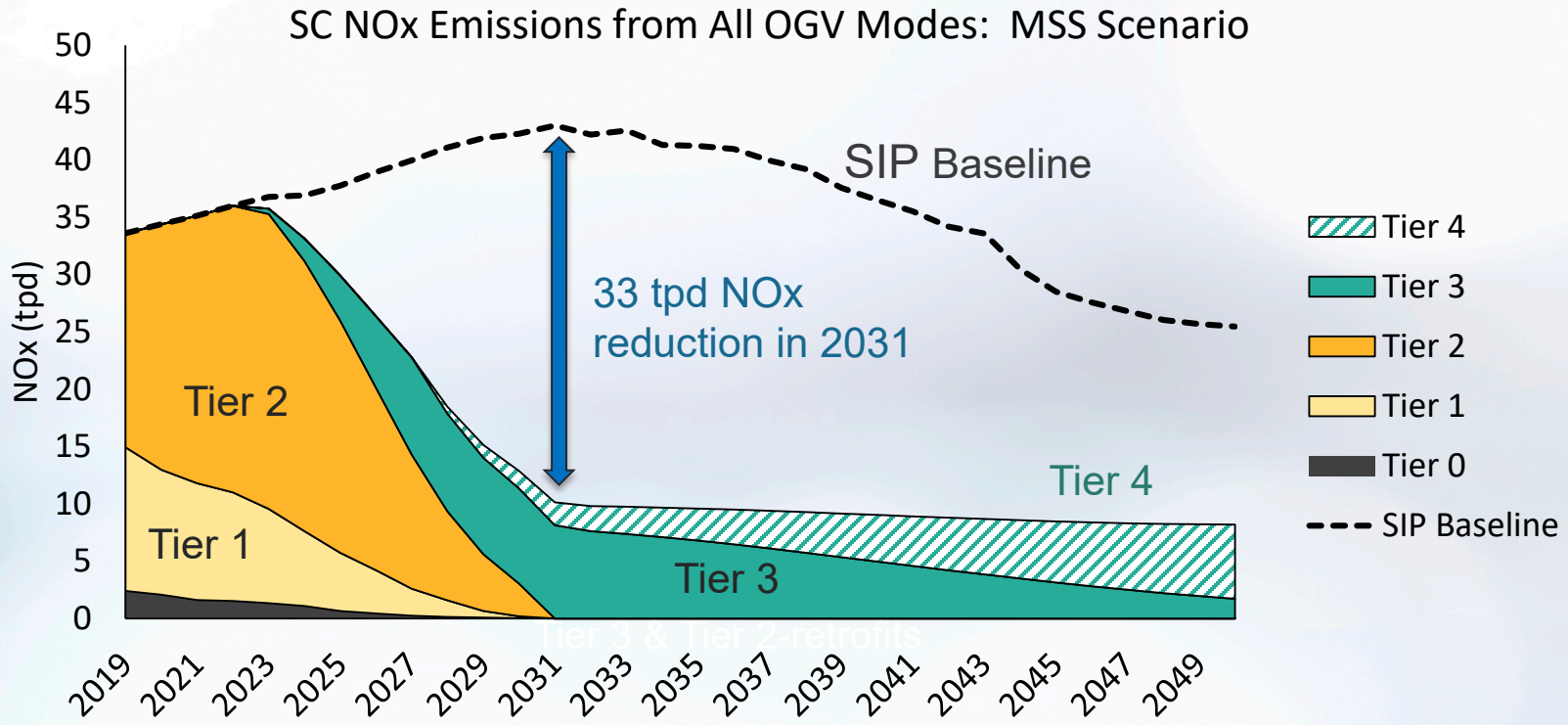
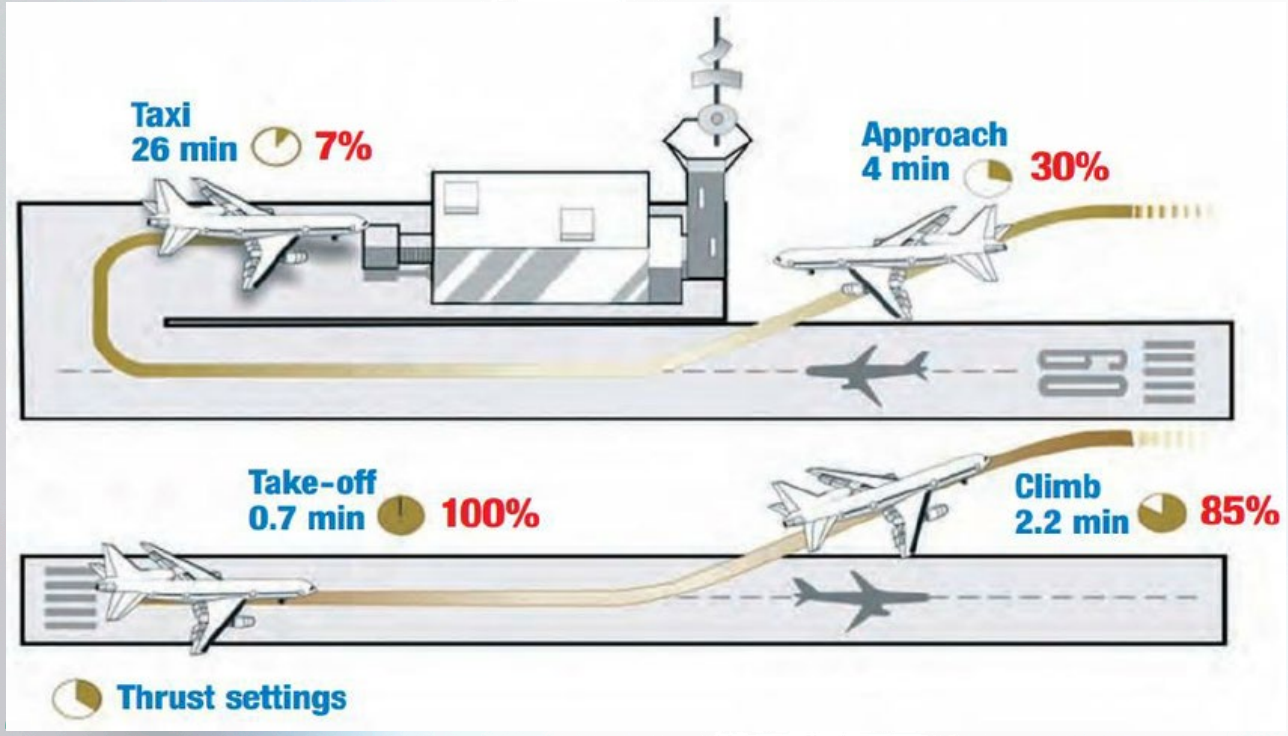
Ocean-Going Vessels (OGVs)

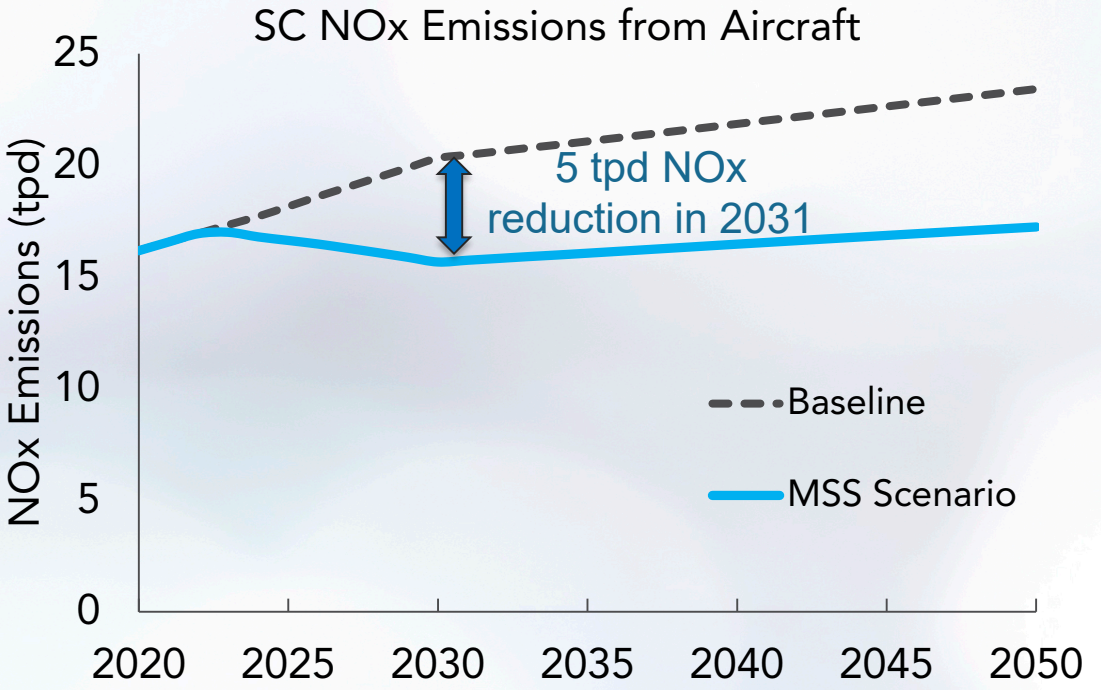
- **Adopted Rule:** Expansion of at-berth rule to cover more vessel types and locations
- **MSS Scenario**: Address transit, anchorage and maneuvering emissions
  - Replace Tier 0/1/2 visits with Tier 3 or cleaner by 2031
  - Introduce Tier 4 marine standards in 2028
  - Working with SC AQMD on a scenario to retrofit Tier 2 vessels, similar NOx reductions as Tier 3



Aircraft

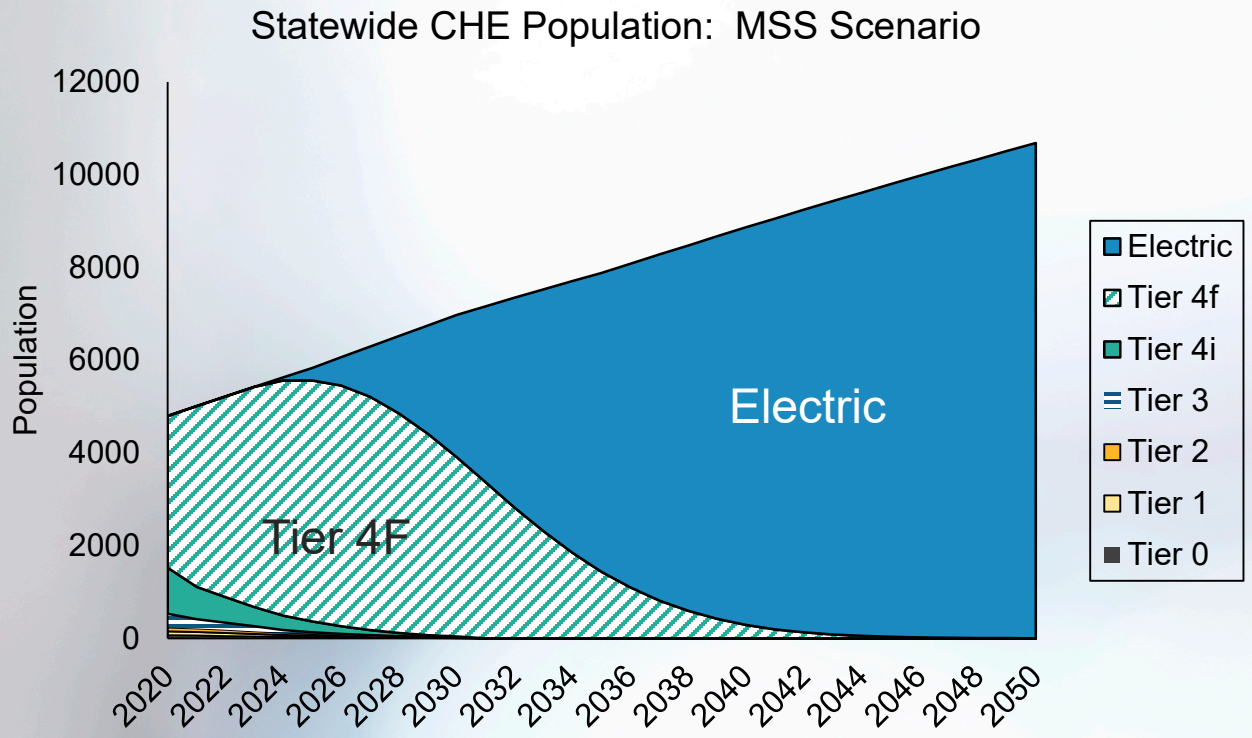
- Significant NOx emitter in South Coast: 4.5% NOx in 2018, 9% in 2031
- U.S. EPA standards are technology-following and not stringent enough
- **MSS Scenario:**
  - Operational efficiency improvement: de-rated take-offs, reduce power/time during taxiing
  - Reduce auxiliary power unit (APU) usage: transition to zero emission APUs

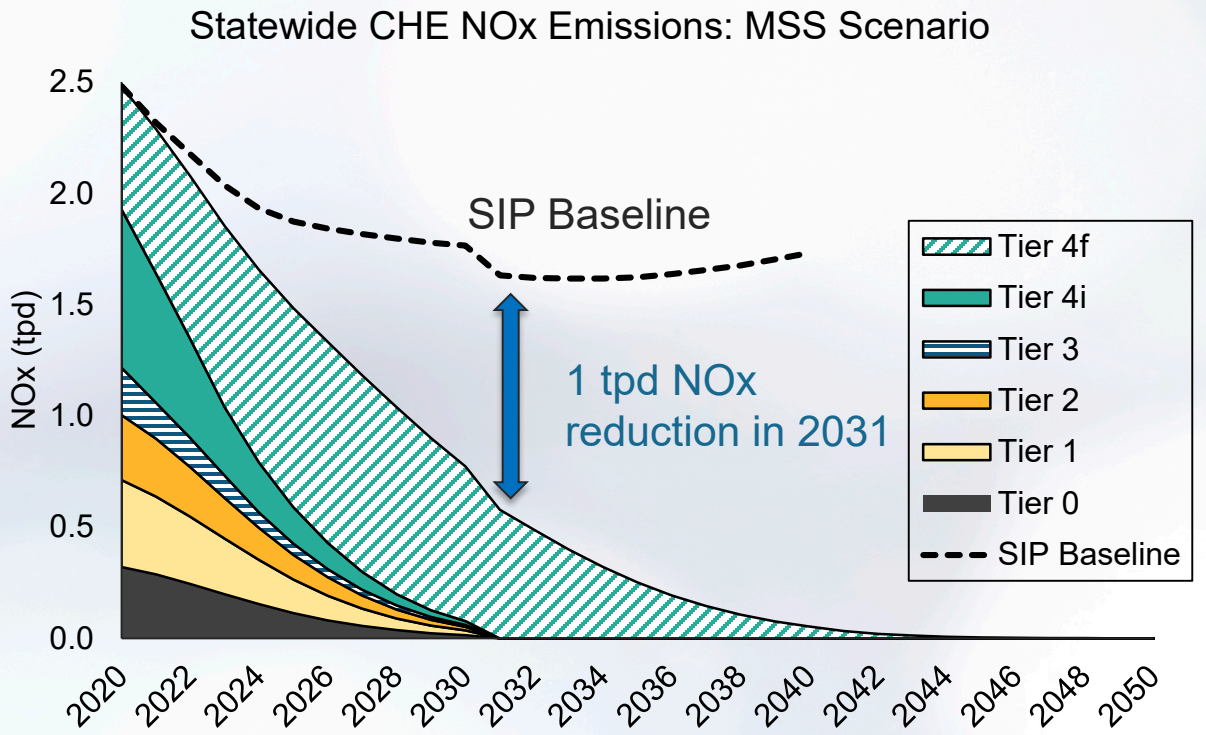




Cargo Handling Equipment (CHE)

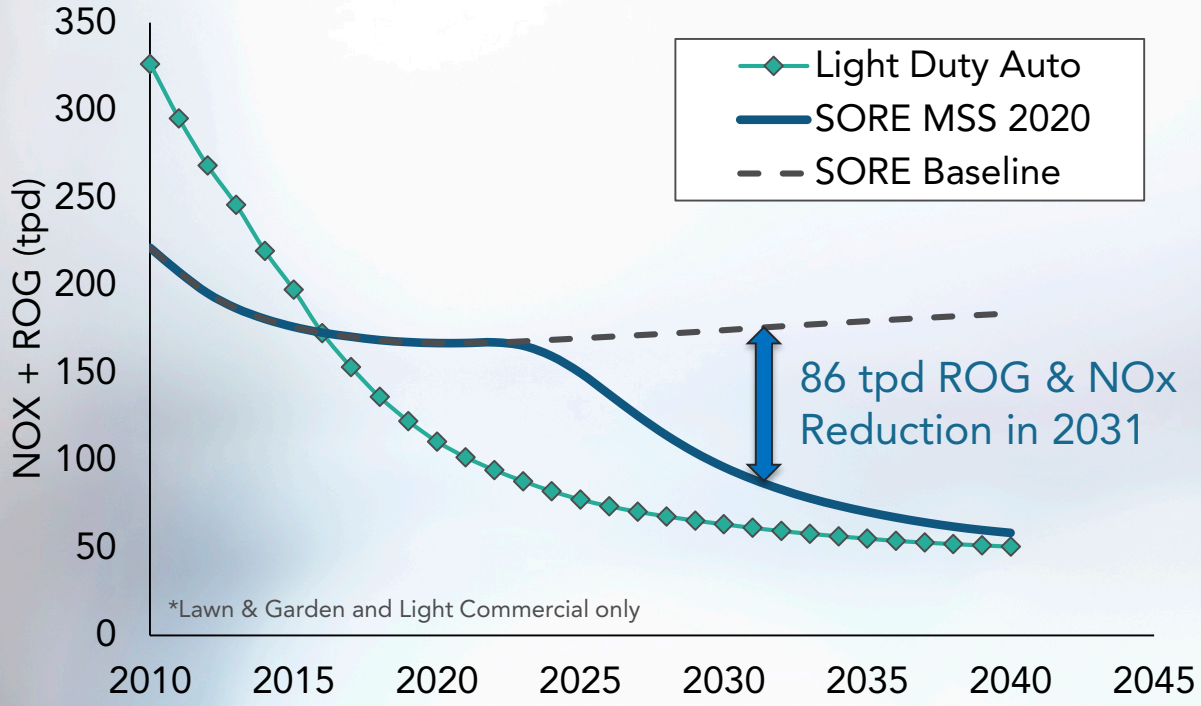
- Important due to proximity of communities and at-risk population centers, primarily significant in South Coast and Bay Area
- **MSS Scenario:** begin transition to full electric operation in 2026





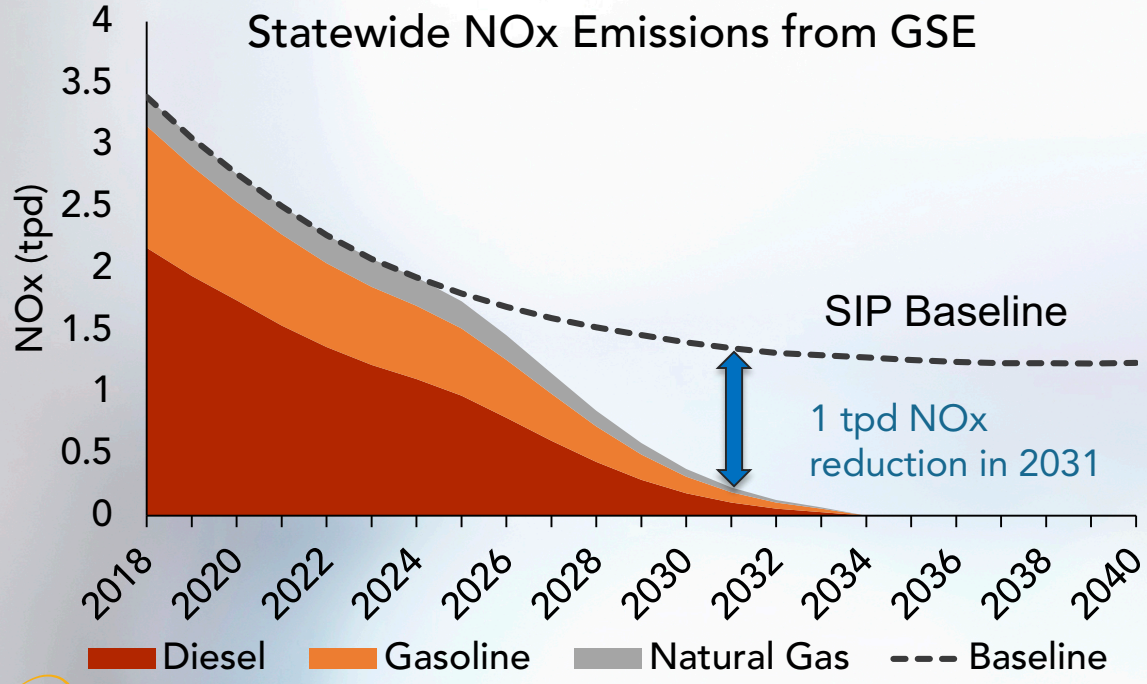
Small Off-Road Engines (SORE)

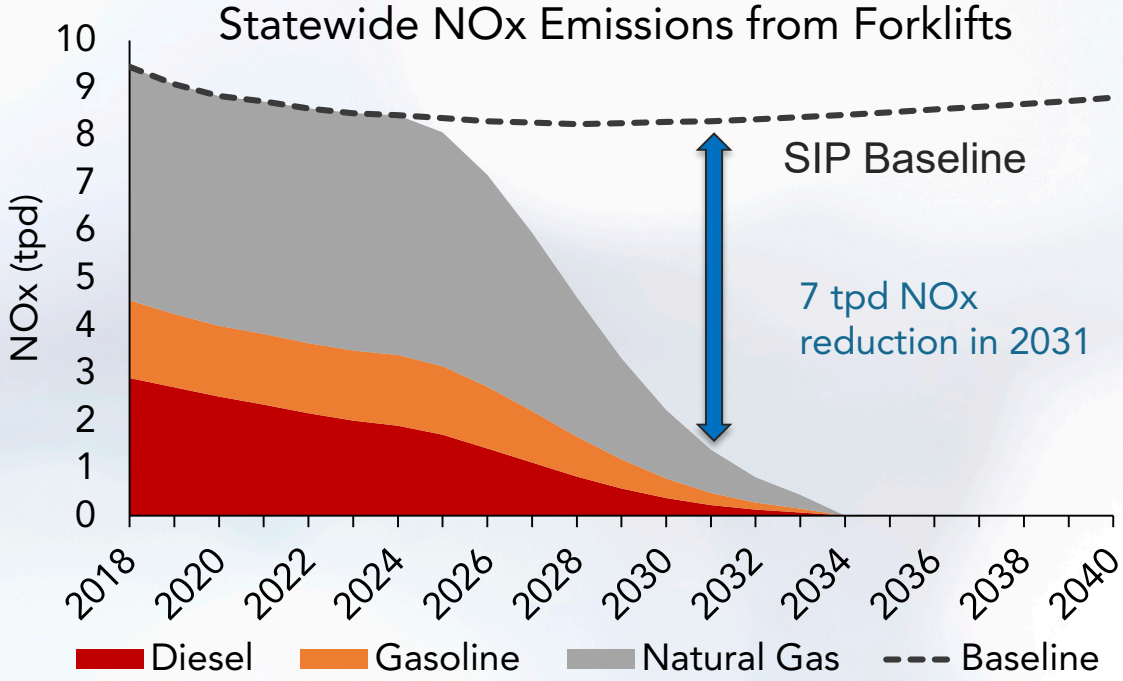
- Significant source of statewide ROG emissions
- Types: Lawn & Garden equipment, light commercial equipment
- **MSS Scenario:** all new sales will be zero-emission starting in 2025 (except for federal preempted equipment)



Airport Ground Support Equipment (GSE) & Forklifts

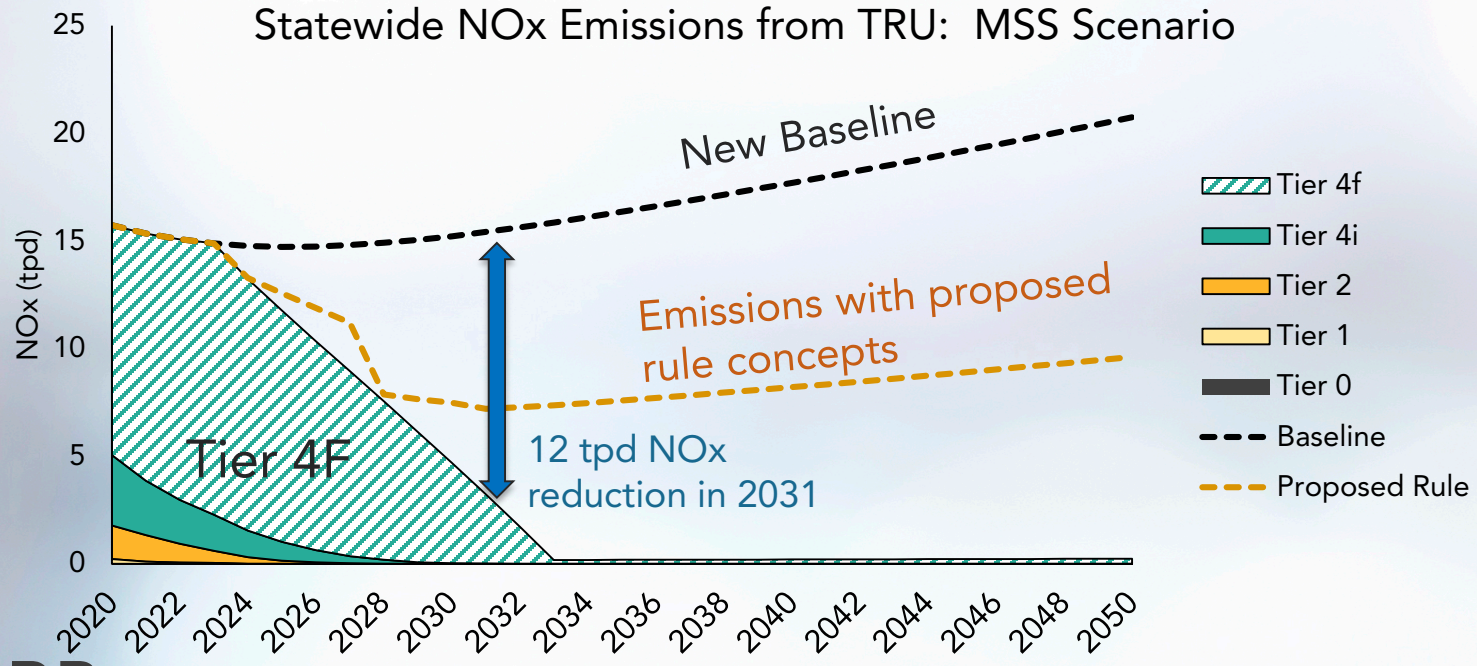
- **MSS Scenario:** full electrification by 2034 for GSE and Forklifts
  - **GSE:** currently 34% electric, electrification penetration has been steady and would likely not increase without incentives or regulatory measures
  - **Forklifts:** electrification suitable for moderate/low lift capacity forklifts, lifting capacity threshold is under development





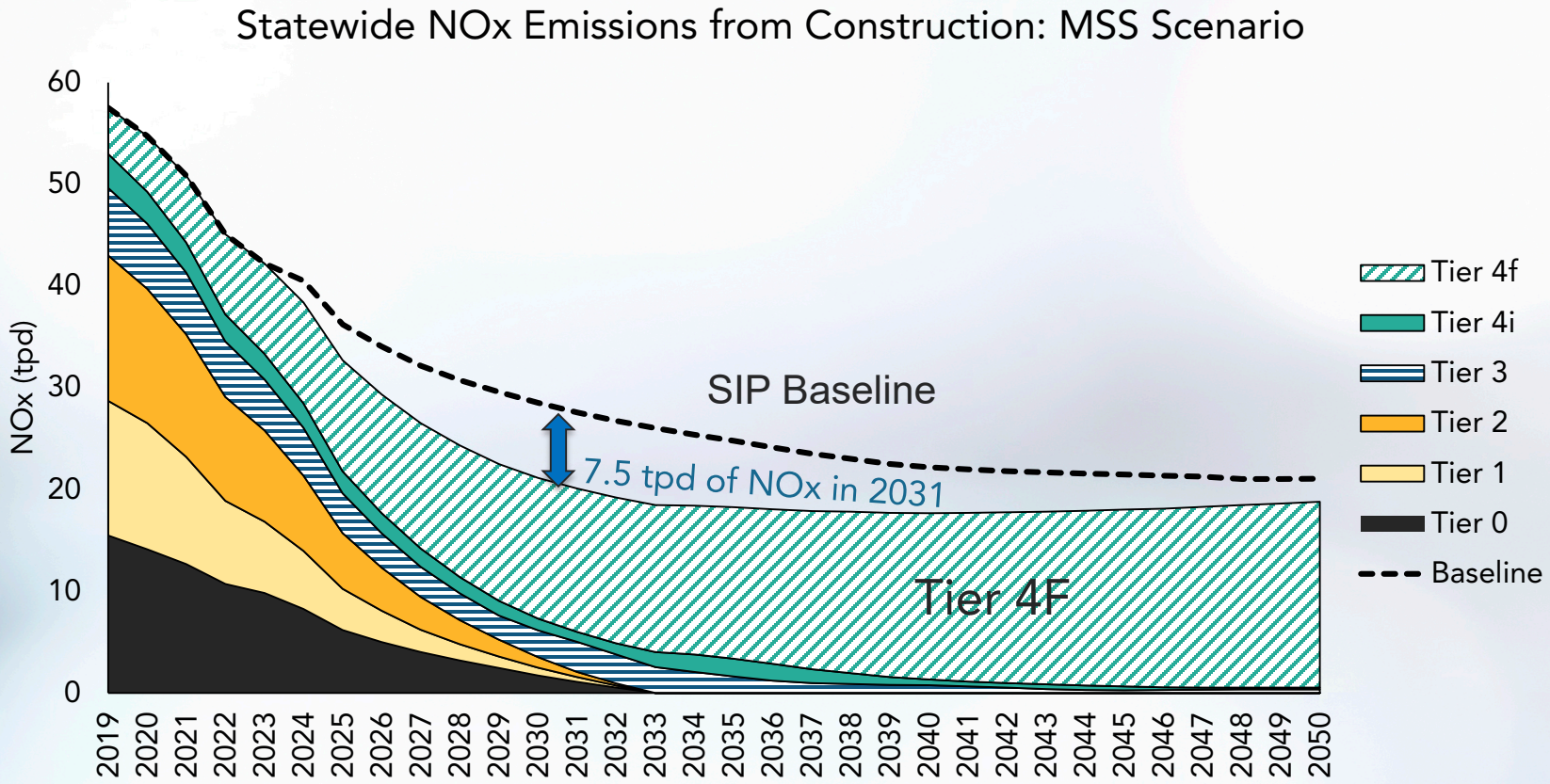
Transport Refrigeration Units (TRUs)

- **Rule Concepts:**
  - Zero-emission requirements for truck TRUs
  - Zero-emission operation requirements while *stationary* for trailer TRUs
  - Less than 25 hp TRUs and TRU gensets meet standard for 25 to 50 hp
- **MSS Scenario:** Transition to zero emission TRUs from 10% in 2024 to 100% in 2033



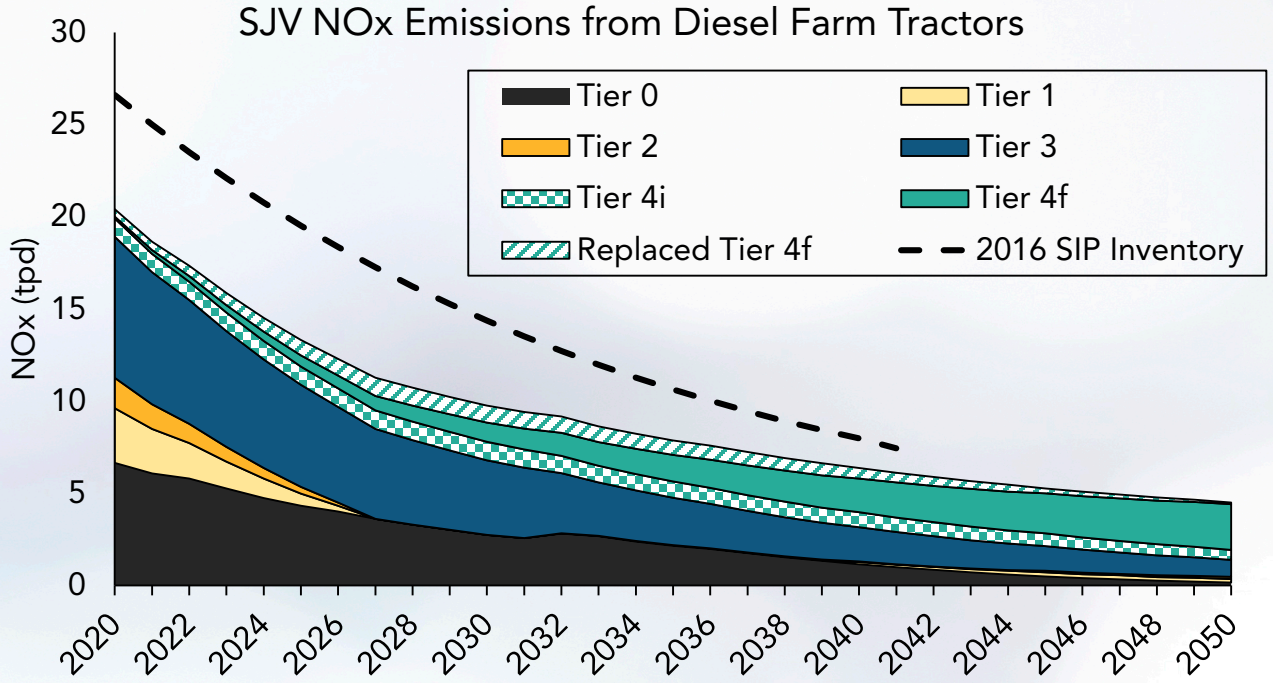
Construction, Industrial, Mining (In-Use Off-Road)

- **Current regulation** allows continued use of Tier 0 to Tier 2 indefinitely if meeting Fleet Average requirements
- **MSS Scenario**: Implement full turnover of Tier 0/1/2 equipment by 2033



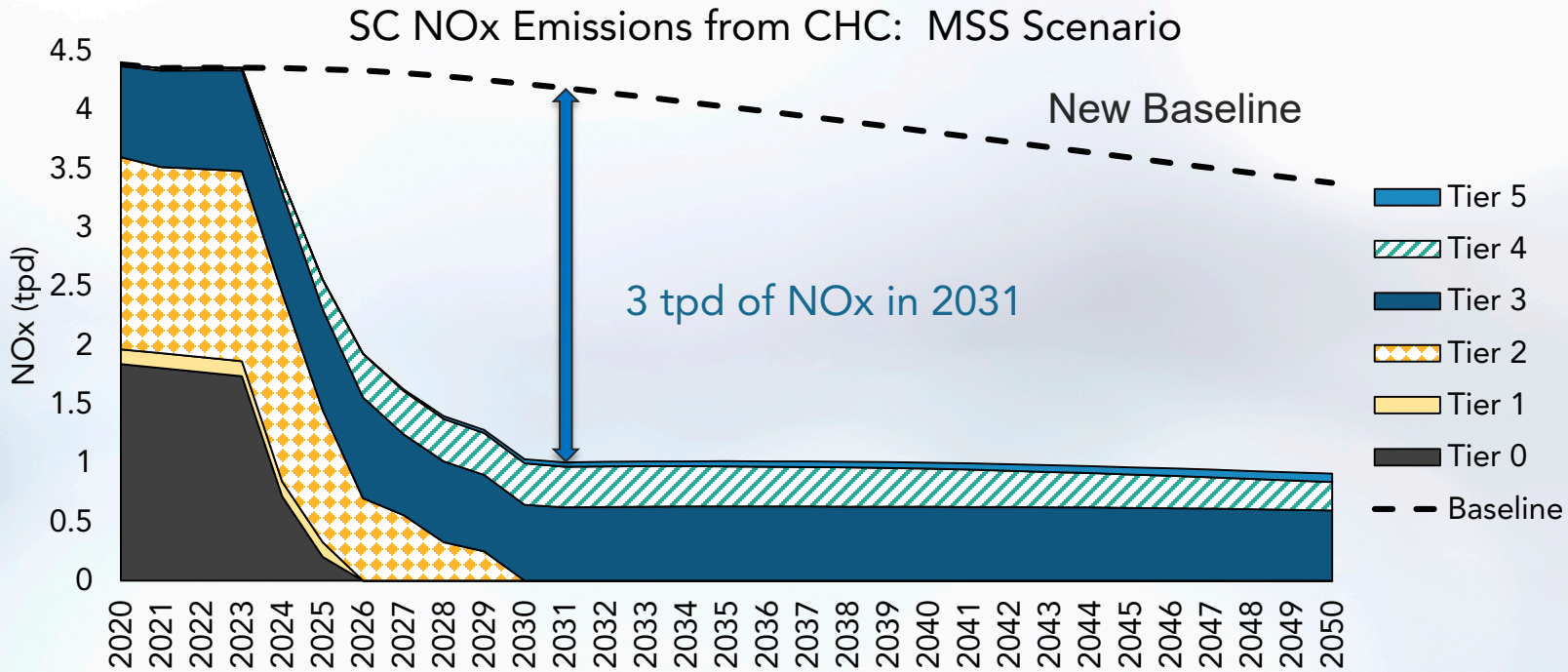
Agriculture

- Important contributor in San Joaquin Valley (SJV): 18% of NOx in 2019
- Incentive funding since 2009 (e.g. FARMER) has significantly accelerated the turnover of older equipment → ***6.5 tpd*** *NOx reduction in SJV in 2024*
- **MSS Scenario:** continue incentive programs through 2031
  - Additional **$565M** → ***additional 4.5 tpd*** *NOx reduction;* replacing Tier 0/1/2 equipment over 100 annual hours with Tier 4F
  - Another $1B can further reduce NOx by another 6.5 tpd



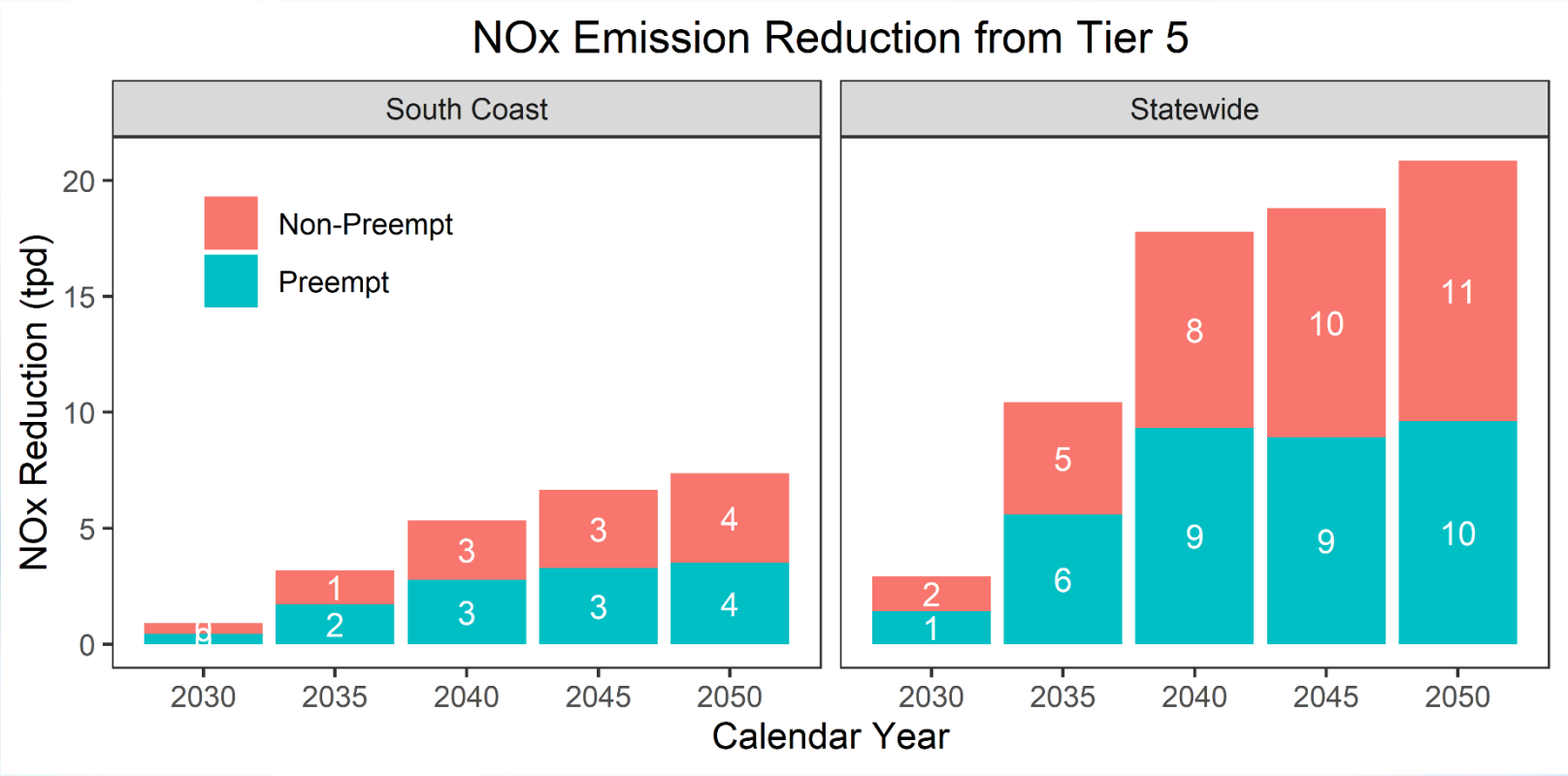
Commercial Harbor Craft (CHC)

- **Rule Concepts:**
  - Turn over all vessels except for commercial fishing to cleanest engines and retrofit with DPF
  - Plug-in hybrid for new excursion boats, diesel-electric for new tugs, zero-emission for short-run ferries (9%) beginning in 2023
- **MSS Scenario**:
  - Introduce Tier 4 standard in 2024, and Tier 5 in 2027 for all vessels
  - Plug-in hybrid for all excursion, diesel-electric for tugs, zero-emission for 20% ferries by 2030



Cleaner Off-Road Engine Standards

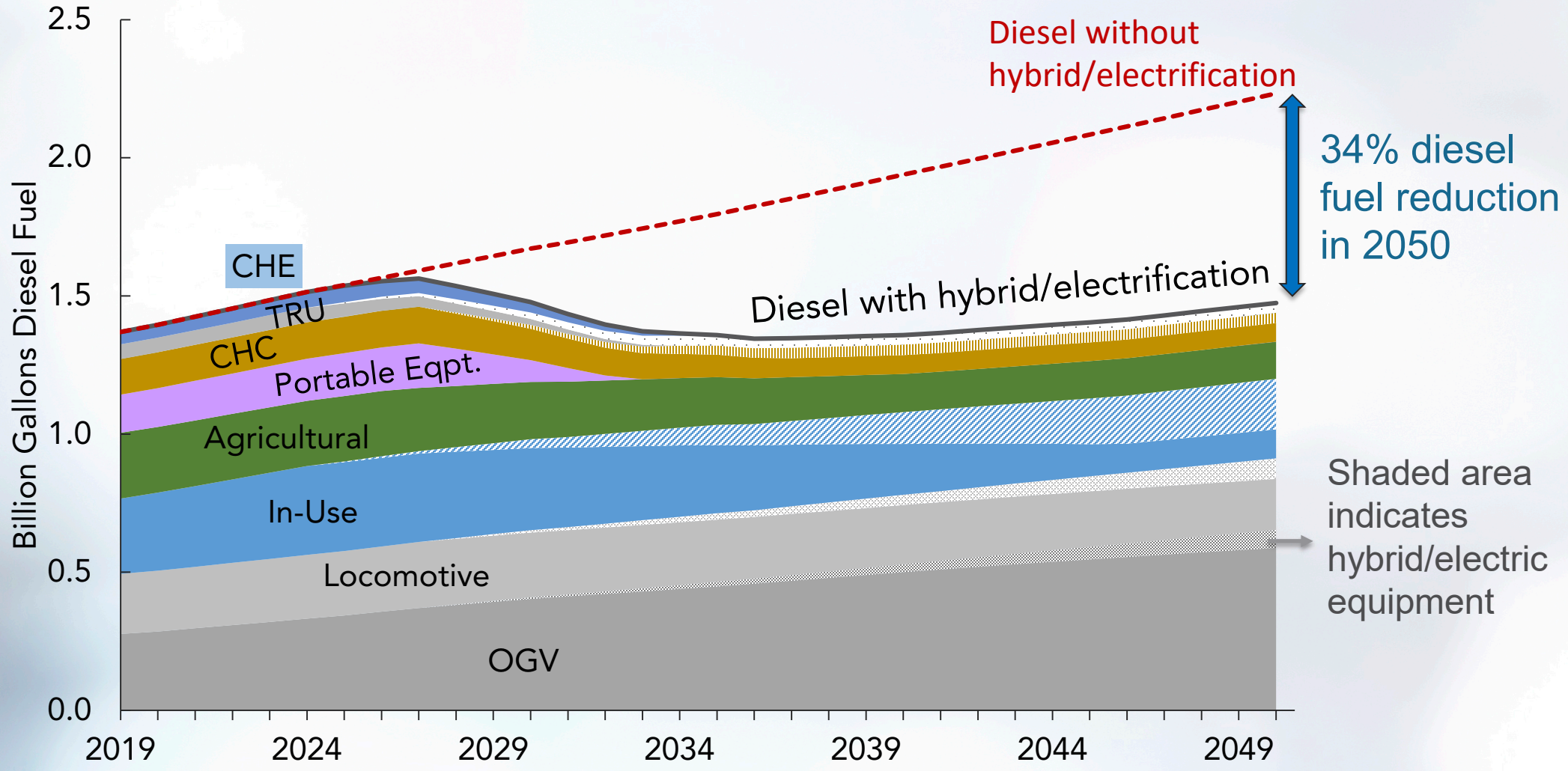
- **Off-Road Tier 5**: 50%-90% NOx and PM reduction from Tier 4F; adoption from 2028 - 2030
- **Additional standards:**
  - Off-Road on-board diagnostic (OBD) standards
  - Off-Road GHG standards



Off-Road Efficiency Improvement

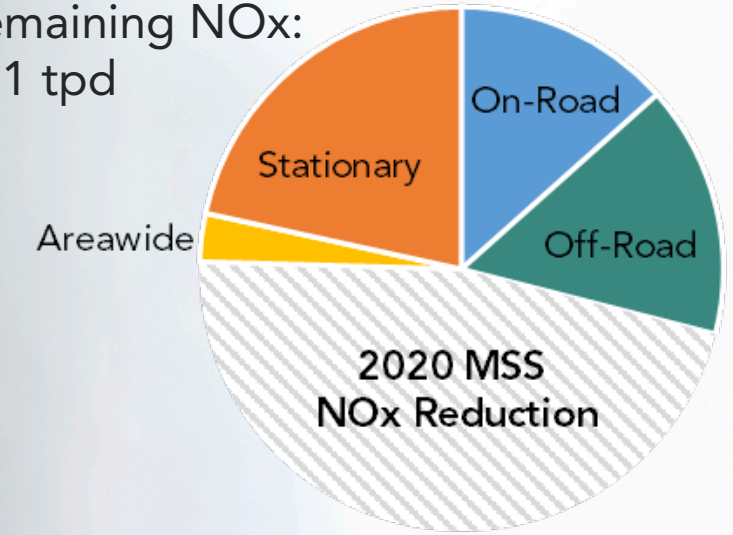
- Wide-scale hybridization could significantly reduce off-road GHG emissions
  - By 2045, diesel use from off-road will reach 2.1 B gallons, ~ 490,000 HD trucks
  - Global hybrid powertrains production around 3% in 2017
  - Hybridization increases fuel efficiency by around 25% on average
- **MSS Scenario:**
  - Hybridization/electrification penetration for off-road diesel engines starting in 2018
  - Overall GHG reduction goal: 12% by 2030, 30% by 2040

Off-Road Diesel Fuel Use: Hybridization Scenario



2020 MSS AT-A-GLANCE

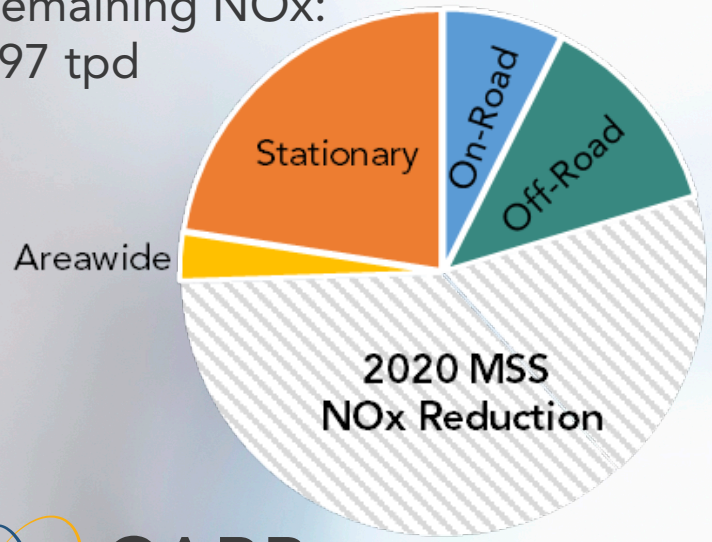
Remaining NOx:
591 tpd



2031

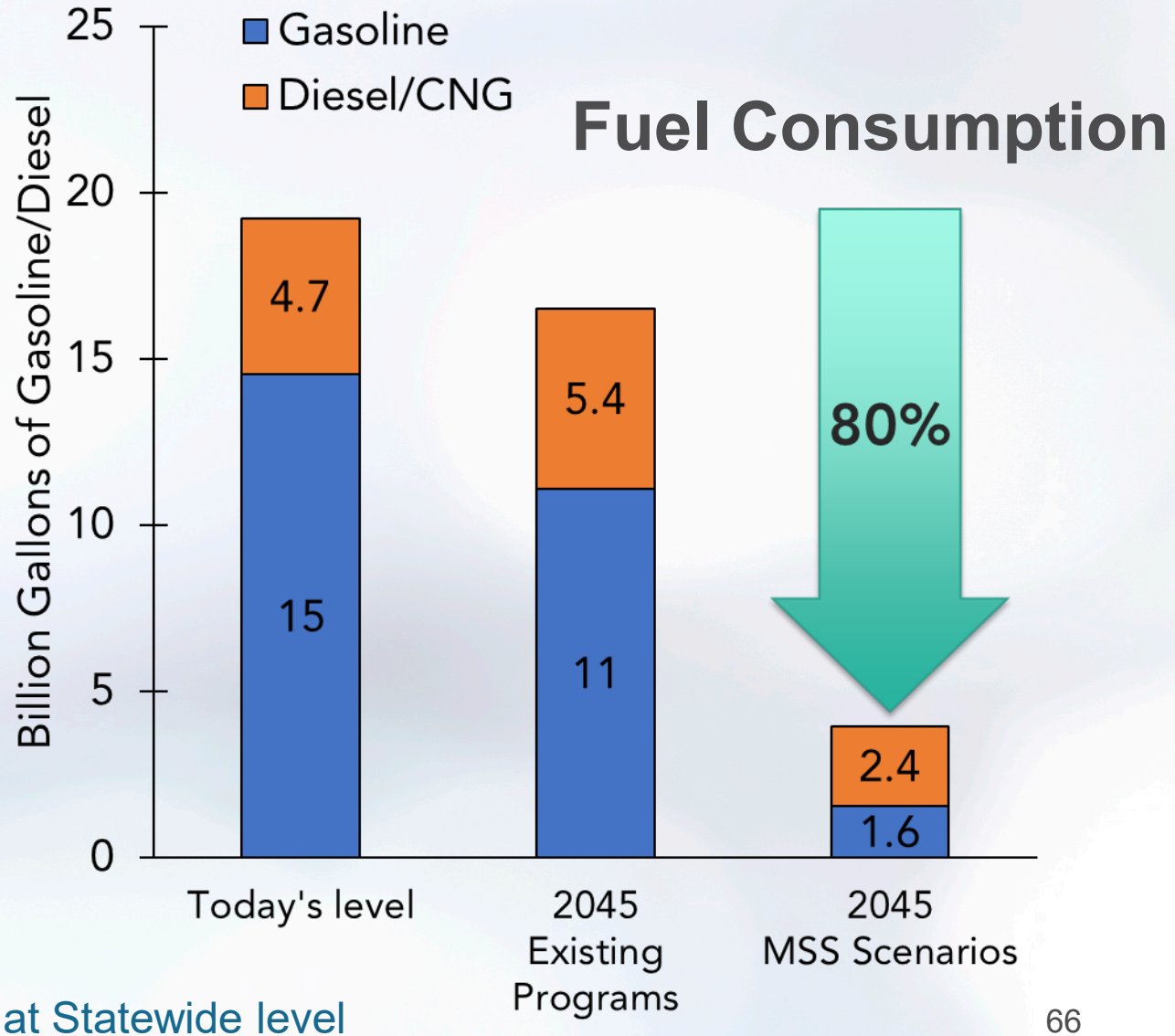
46%

Remaining NOx:
497 tpd



2037

54%



All numbers are at Statewide level

Questions?

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https://ww2.arb.ca.gov/resources/documents/2020-mobile-source-strategy

Costs to Achieve California's Goals

Transitioning to Cleaner Technology

- A transition of the mobile fleet, both on- and off-road, to zero-emission vehicles wherever possible, with cleaner combustion everywhere else, is essential
- Estimates here include current capital costs for vehicles and pieces of equipment based on CARB regulatory and incentive program documentation
- Potential fuel cost savings and charging/fueling infrastructure costs are the subject of other reports and are not considered here

Funding Needed

Category	Technology Type	Funding per Vehicle or Piece of Equipment (in 2020)	Incremental Statewide 2025 Population*	Total Funding
On-Road LDV	ZE	$2,000 - $7,000	1,011,199	$2 Billion - $7 Billion
On-Road MDV	ZE	$80,000	0	$0
On-Road HDV	ZE	$150,000 - $300,000	46,905	$7 Billion - $14 Billion
Construction Equipment	Tier 4	$60,000 - $325,000	783	$47 Million - $254.5 Million
Transport Refrigeration Units	ZE Truck	$50,000	7,503	$375 Million
	ZE Trailer	$60,000	41,648	$2.5 Billion
Commercial Harbor Craft	Tier 4	$1,000,000	2,749	$2.7 Billion
	Plug-in Hybrid	$1,000,000	N/A – Pilot / Demonstration Projects	
	Diesel-Electric	$3,000,000	N/A – Pilot / Demonstration Projects	
	ZE	$2,500,000 - $3,000,000	N/A – Pilot / Demonstration Projects	
Cargo Handling Equipment	ZE	$175,000 - $500,000	315	$55 Million - $158 Million
Agricultural Equipment	Tier 4	$70,000 - $90,000	6,257	$440 Million - $565 Million
	ZE	$25,000 - $45,000	N/A – Pilot / Demonstration Projects	
Ground Support Equipment	ZE	$100,000	996	$100 Million
Forklifts	ZE	$15,000 - $200,000	6,631	$100 Million - $1.3 Billion
			Total	$15.4 Billion - $29.2 Billion
			Total (Annualized over 5 years)	$3.1 Billion - $5.8 Billion

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Expected Cost to Transition

Category	Technology Type	Capital Cost of Vehicle or Equipment (in 2020)	Statewide Population Based on MSS Scenario	
			2037	2045
On-Road LDV	ZE	$30,000 - $60,000	13,944,426	23,101,069
On-Road MDV	ZE	$200,000	90,422	241,157
On-Road HDV	ZE	$350,000 - $1,000,000	288,460	512,472
Construction Equipment	Tier 4	$25,000 - $2,900,000	5,526	3,165
	Tier 5	TBD	N/A	N/A
Small Off-Road Engines	ZE Lawn & Garden	$560	17,907,557	20,983,762
Transport Refrigeration Units	ZE (Truck)	$50,000	9,077	10,306
	ZE (Trailer)	$100,000 - $150,000	248,429	282,066
Commercial Harbor Craft	Tier 4	$700,000	87	0
	Tier 5	TBD	7,678	7,736
	ZE	$5,500,000	67	79
Cargo Handling Equipment	ZE	$500,000 - $1,500,000	7,737	9,786
Agricultural Equipment	Tier 4f	$143,700	36,126*	40,304*
	Tier 5	TBD	N/A	N/A
	ZE	$85,000	N/A	N/A
Ground Support Equipment	ZE	$250,000	11,456	12,009
Forklifts	ZE	$60,000 - $500,000	73,325	75,818

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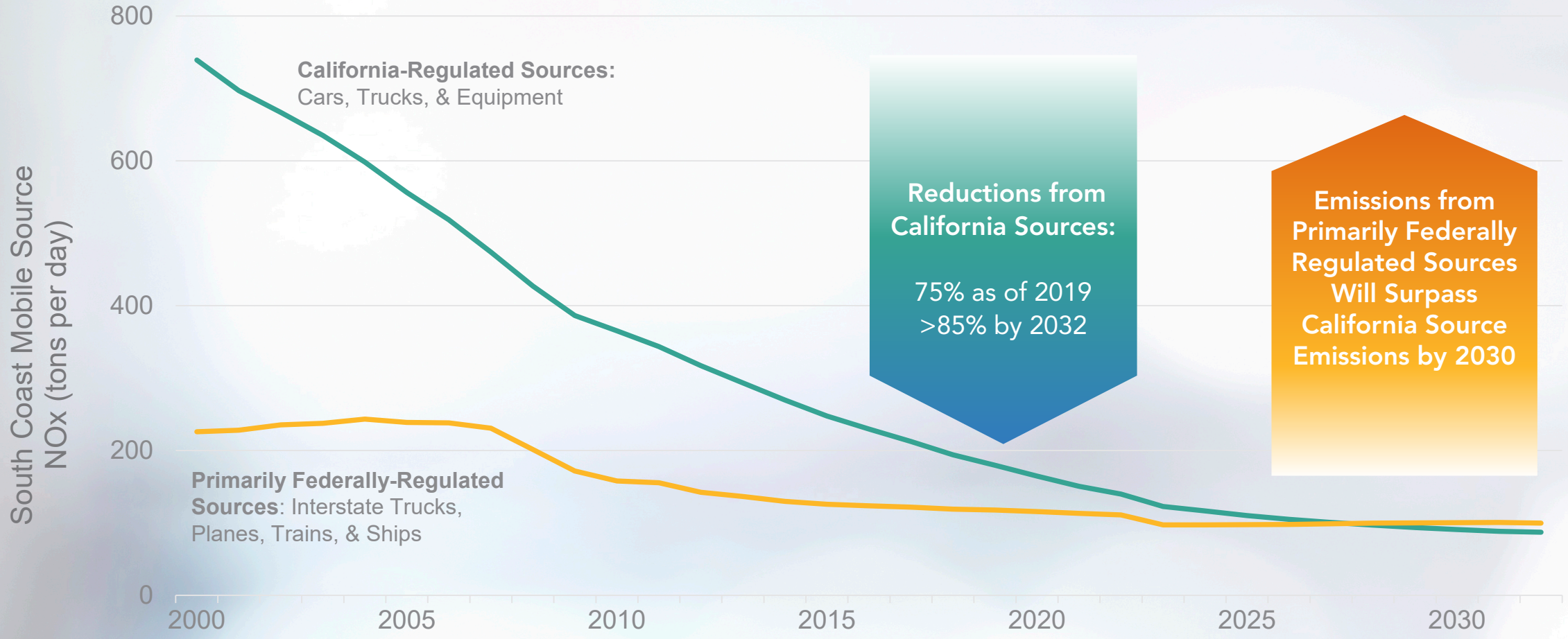
Pathways Forward

Targeting Benefits in Disadvantaged Communities

- Actions targeting reductions from freight and goods movement will highly benefit near-source communities
- AB 617 Community Air Protection Program
- AB 1550 requirements for expenditure of California Climate Investment funds
  - Many Low Carbon Transportation projects designed to advance equity

Federal Action is Increasingly Critical



Source: CARB, CEPAM 2016 SIP - Standard Emission Tool (v1.05), https://www.arb.ca.gov/app/emsinv/fcemssumcat/fcemssumcat2016.php

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Increased Funding is Needed

- Natural rates of turnover to cleaner and zero-emission technologies will not occur at the pace needed, and regulatory efforts alone cannot achieve the volume of turnover required
- South Coast and San Joaquin Valley's ozone and PM2.5 attainment requires increases in incentive funding
- AB 617 funding is important to provide critical near-term reductions in impacted communities

CARB Continues to Push Forward

- CARB continues to look for new control strategies in all mobile sectors
- New regulatory concepts have been identified
- Work will continue to develop concepts with ongoing public and stakeholder feedback

Next Steps

Consider Public Feedback on Workshop Discussion Draft	Ongoing
Release 2020 Mobile Source Strategy for Board Consideration	November 2020
Board Consideration	December 2020

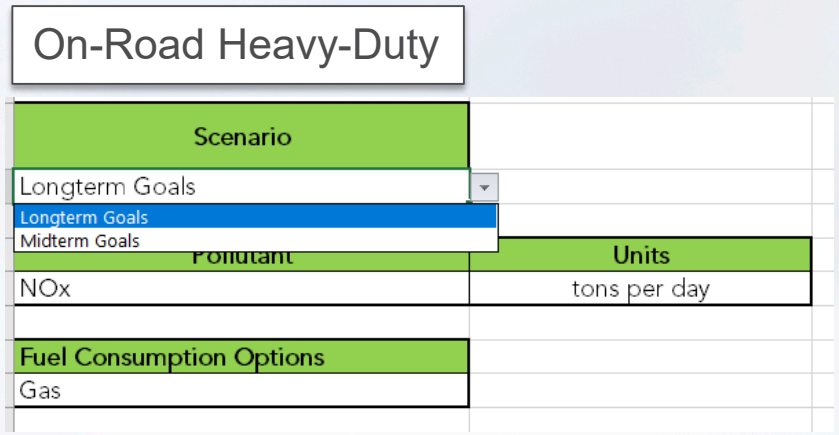
Contact us!

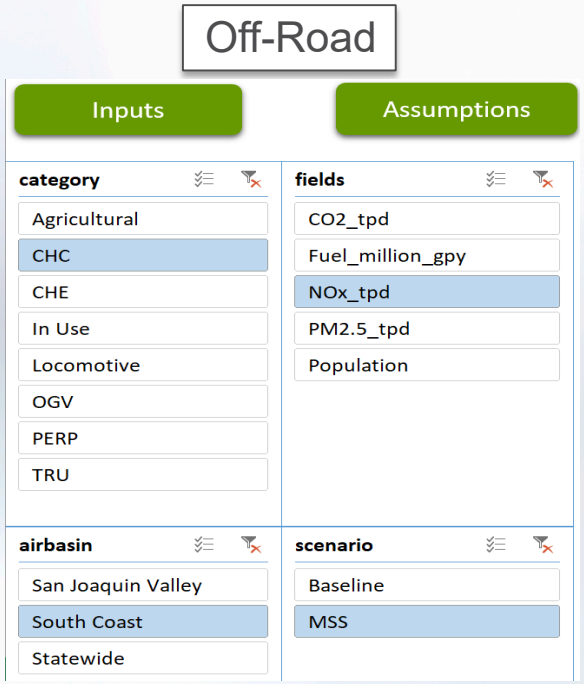
- Comments on the Workshop Discussion Draft 2020 MSS: MSS@arb.ca.gov
- General information: Ariel Fideldy, Ariel.Fideldy@arb.ca.gov
- Scenario modeling
  - On-Road LDV: Kathy Jaw, Kathy.Jaw@arb.ca.gov
  - On-Road MD/HD: Sara Forestieri, Sara.Forestieri@arb.ca.gov
  - Off-Road: Liang Liu, Liang.Liu@arb.ca.gov

https://ww2.arb.ca.gov/resources/documents/2020-mobile-source-strategy

Mobile Emissions Toolkit for Analysis (META)

- A process to share technical details of the MSS scenarios
- Provides a visualization of scenario results and more information on the major assumptions for on-road medium/heavy-duty and off-road
- Improves transparency for MSS scenarios and has been a valuable tool for external stakeholder engagement
- Demo





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