Presentation to National Academies of Sciences Committee on Assessment of Technologies for Improving Fuel Economy of Light-Duty Vehicles

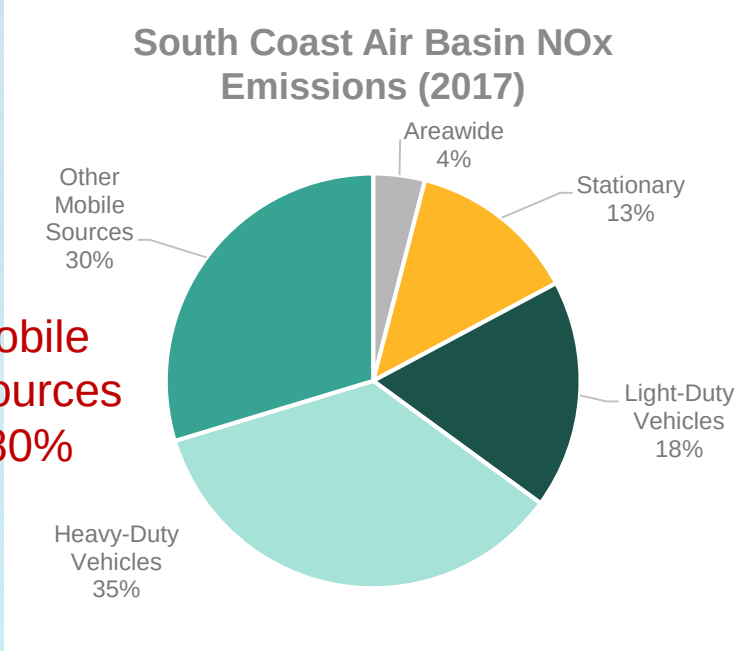
January 24, 2019

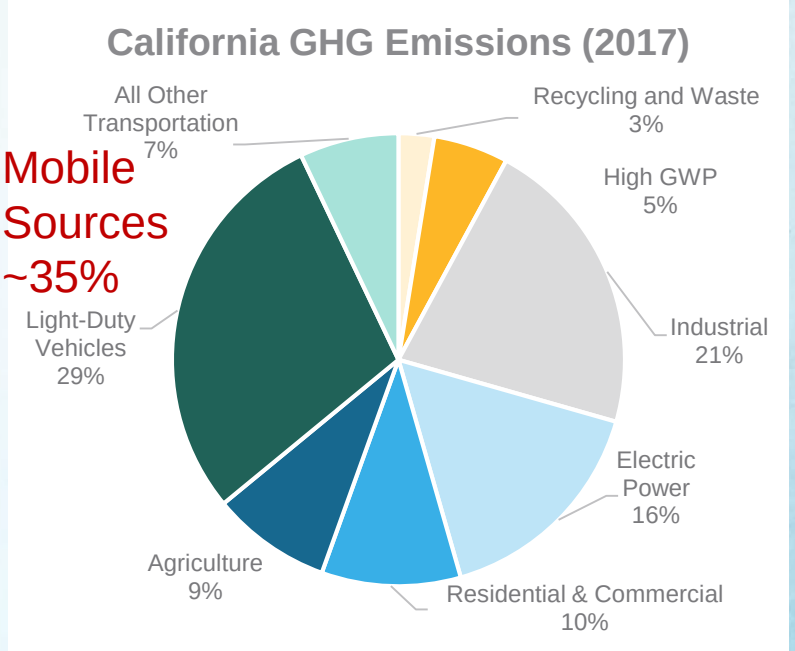
Davis, CA

Outline

1. Need for further emission reductions
2. Brief background of Advanced Clean Cars (ACC) and Midterm Review
   - Federal SAFE Proposal and California's Stds
3. Technology Assessment for ACC II
4. Emission reduction requirements of ride hailing (re SB1014) in collaboration with CPUC

After 50 years of standards, mobile source emissions still significant share of inventory





Mobile sources represent ~50% of GHG inventory when including emissions from fuel production

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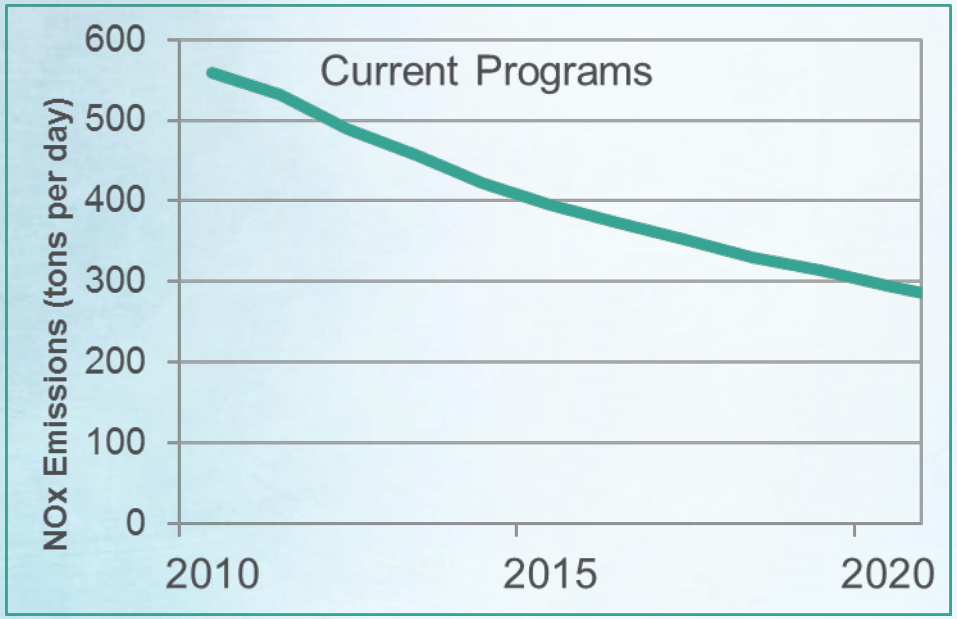
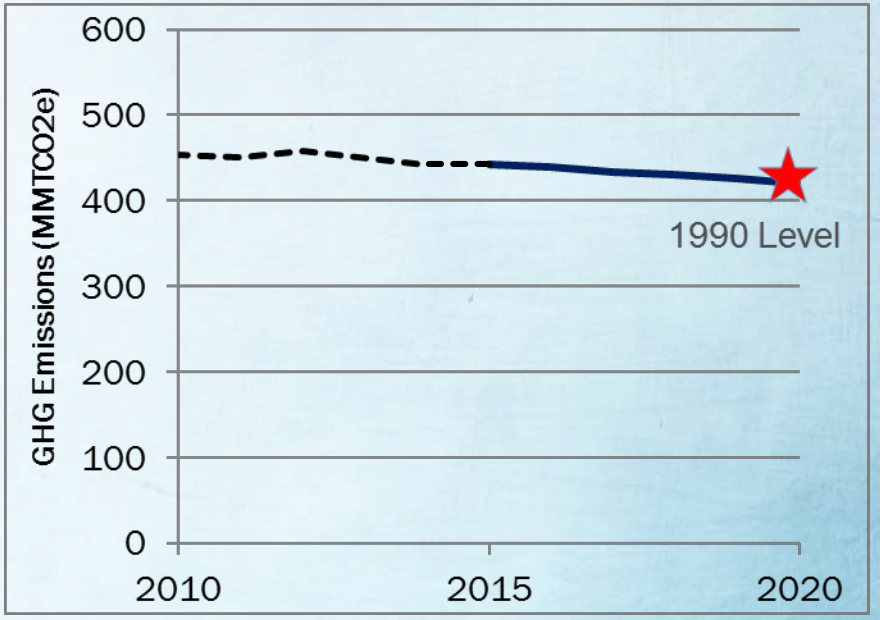
Current programs have achieved significant reductions…

NOx, South Coast, All Sources



GHGs, Statewide, All Sources



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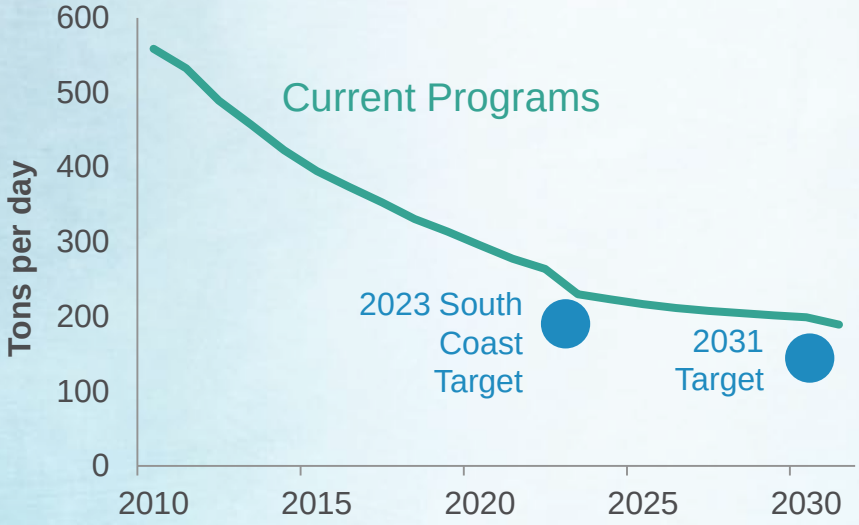
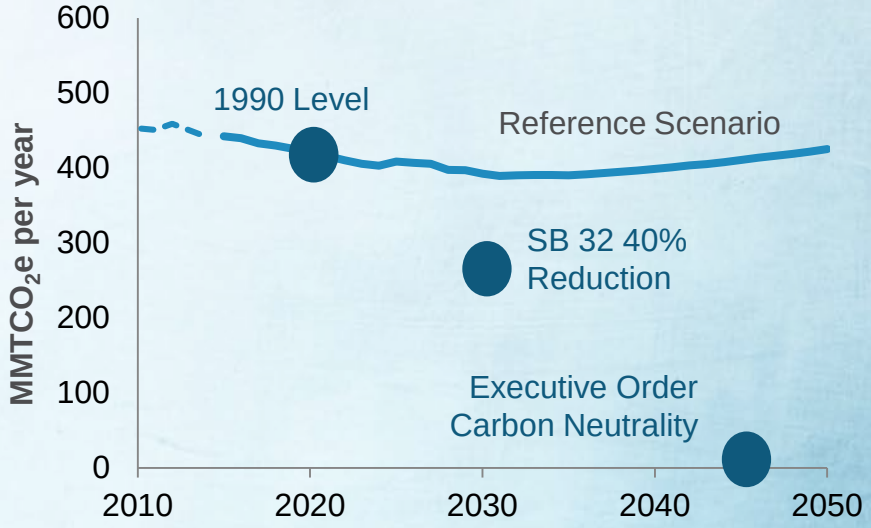
…But we still need more

NO_X Emissions, South Coast Air Basin (All Sources)



Source: CARB, 2016 Mobile Source Strategy

Greenhouse Gas Emissions, Statewide (All Sources)



Source: CARB, 2017 Climate Change Scoping Plan; 2018 Exec. Order B-55-18

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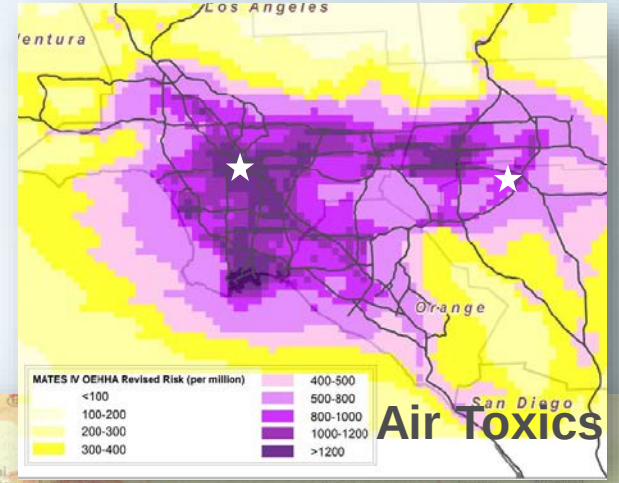
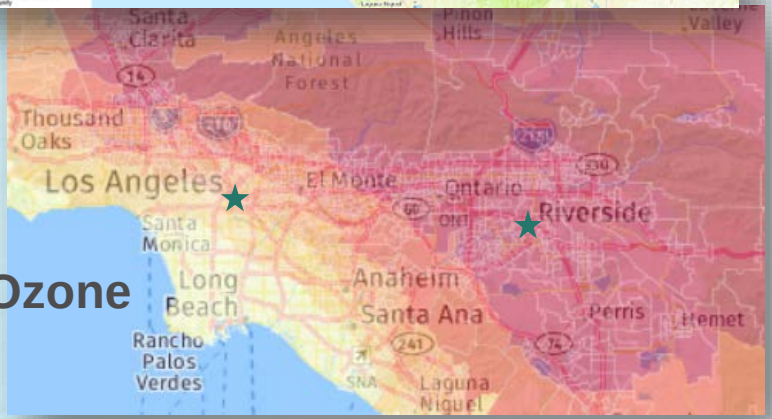
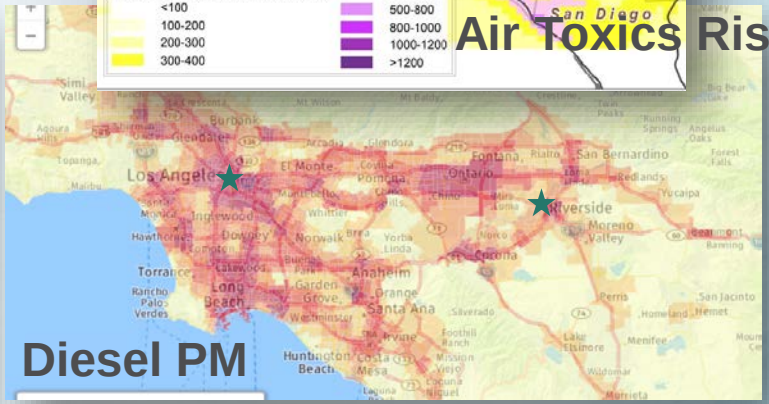
…And environmental justice communities need more



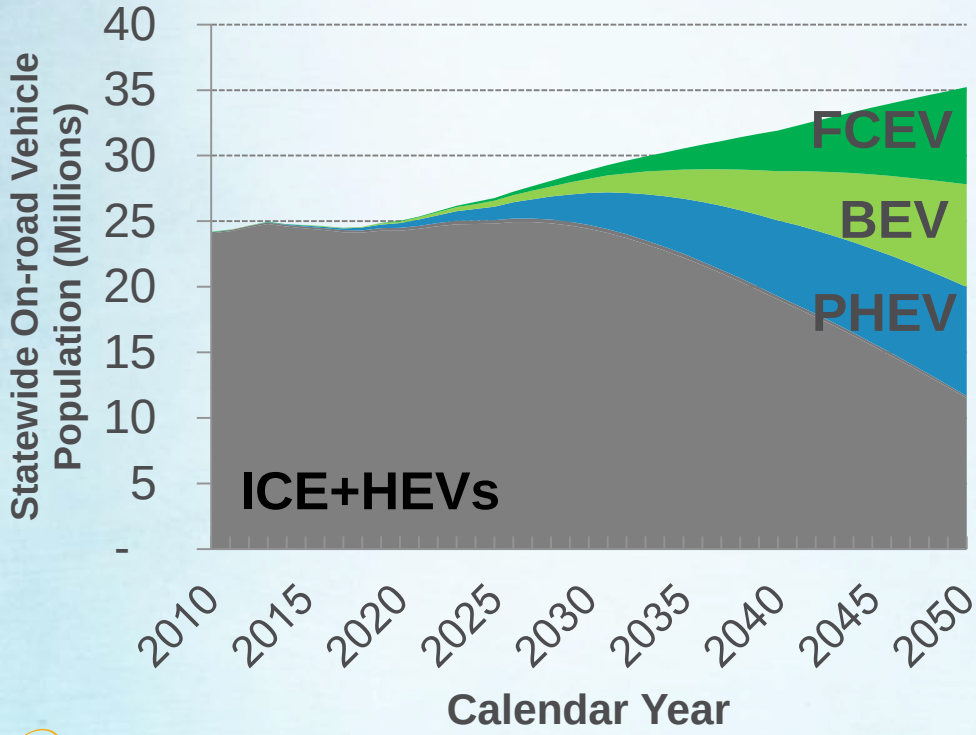




https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/lowincomemapfull.htm
http://www.aqmd.gov/docs/default-source/air-quality/air-toxic-studies/mates-iv/mates-iv-final-draft-report-4-1-5.pdf?sfvrsn=7
http://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2012-air-quality-management-plan/final-2012-aqmp-(february-2013)/chapter-9-final-2012.pdf
http://graphics.latimes.com/responsivemap-pollution-burdens/ visualized by percentile of census tract

How do we do more?

All scenarios show electrification is ultimate solution but combustion engines still dominant for decades



- Compared to MY2025, MY2035 fleet emissions:
  - ~50% lower GHG
  - ~40% lower NOx
- Significant increases in renewable fuel and electricity
- Slower growth of vehicle miles traveled (VMT)

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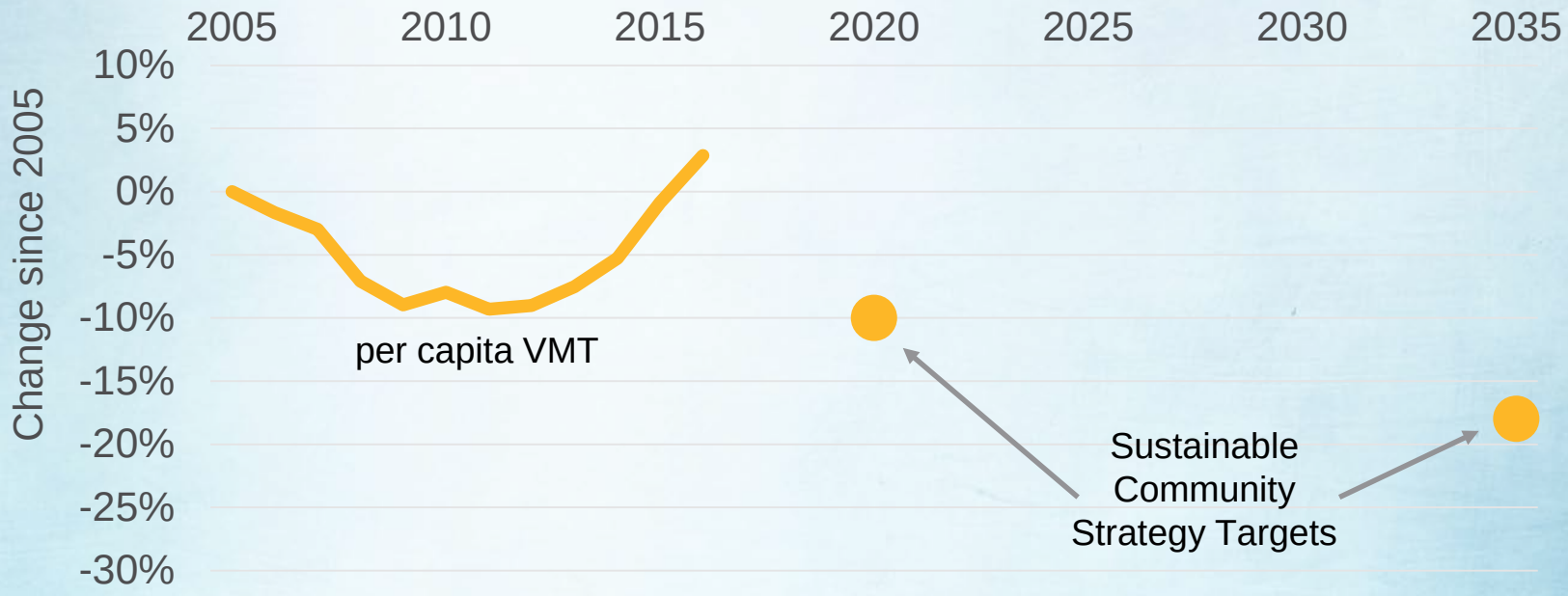
https://www.arb.ca.gov/planning/sip/2016sip/2016mobsrc.htm

CA Clean Fuel New Actions

- Electricity Renewable Portfolio Stds (in statute)
  - 60% by 2030
  - 100% by 2045
- Low Carbon Fuel Standard expanded to 2030
  - 20% Carbon intensity reduction requirement
  - New credit provisions for H2 and DCFC infra
- Substantial investments in ZEV infrastructure
  - State, Electric utilities, VW settlement, Private

VMT trends moving in the wrong direction for meeting State goals



Source: 2018 Progress Report for California's Sustainable Communities and Climate Protection Act

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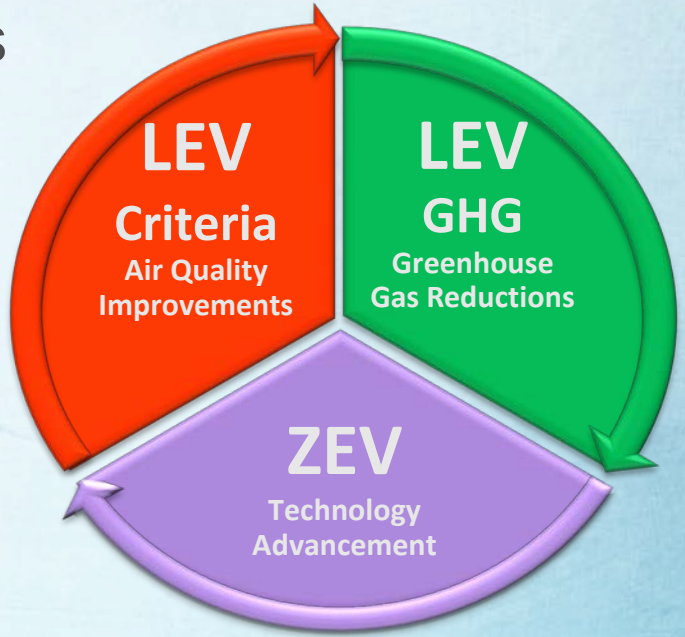
California's Advanced Clean Cars (ACC) Program

Approved as an integrated regulatory package in 2012

- LEV III Criteria and GHG standards
  - ✓ 75% reduction in fleet average NMOG + NOx emissions
  - ✓ 90% reduction in PM emission standard
  - ✓ 34% reduction in GHG emissions
- ZEV Regulation
  - ✓ More ZEVs and PHEVs



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We aren't alone: Section 177 States

- Clean Air Act (Section 177) allows other states to adopt CA rules in lieu of federal rules
- CA + S177 States represent ~35% of US new vehicle market

	CO	CT	DE	DC	MD	ME	MA	NJ	NY	OR	PA	RI	VT	WA
LEV	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ZEV	✓	✓			✓	✓	✓	✓	✓	✓		✓	✓	

✓ = currently in process of adopting regulations

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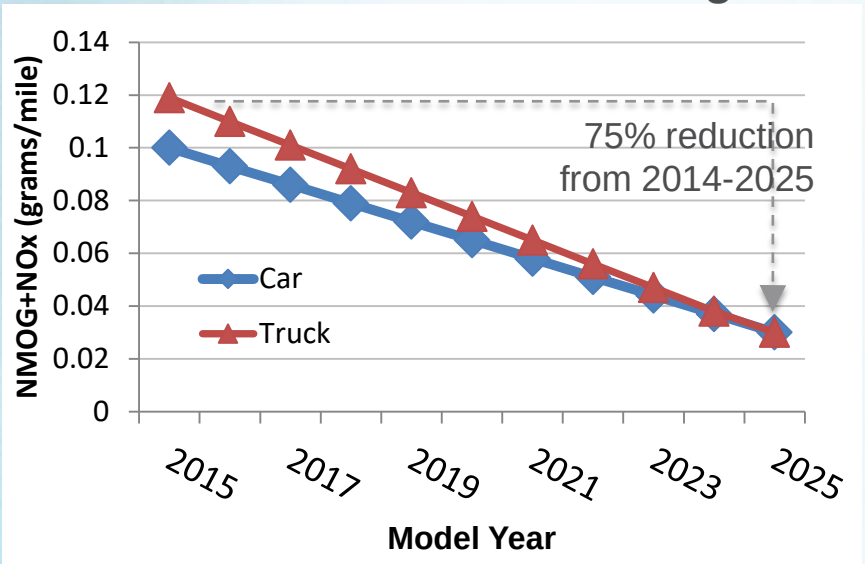
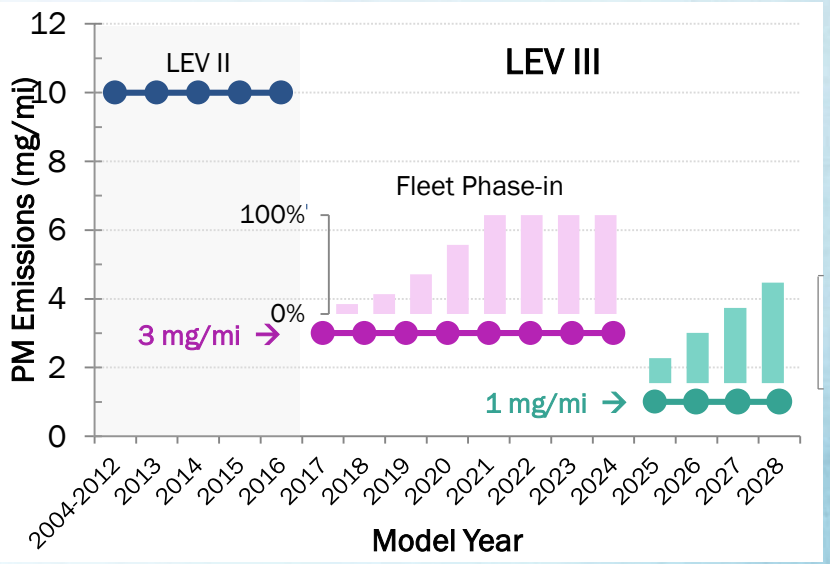
LEV III Criteria
Exhaust Emission Standards

NMOG + NOx Fleet Average



Particulate Matter Standard



NMOG = Non-Methane Organic Gas, NOx = oxides of Nitrogen
Carbon monoxide emission standards not shown.

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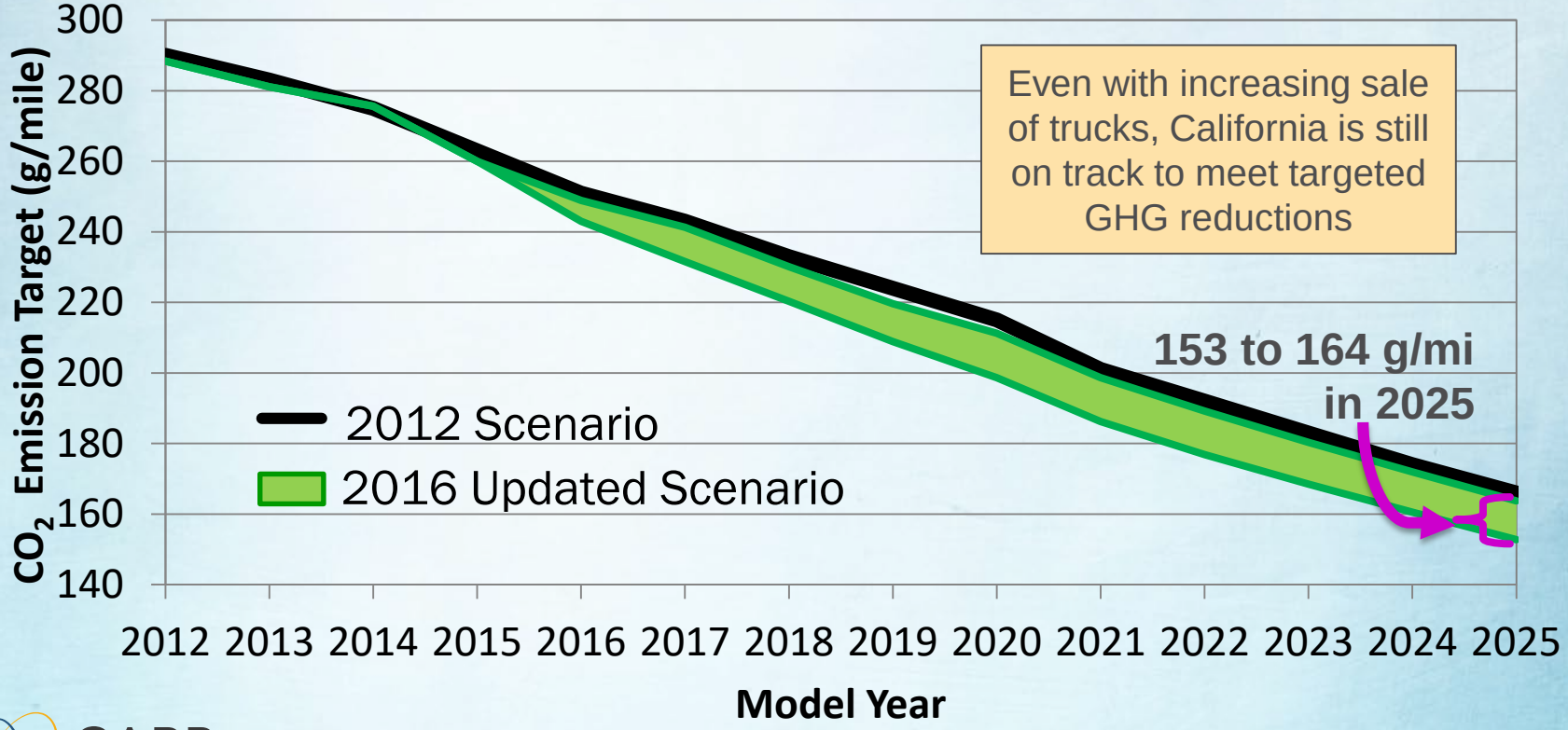
LEV GHG
Fleet Average Emission Standards



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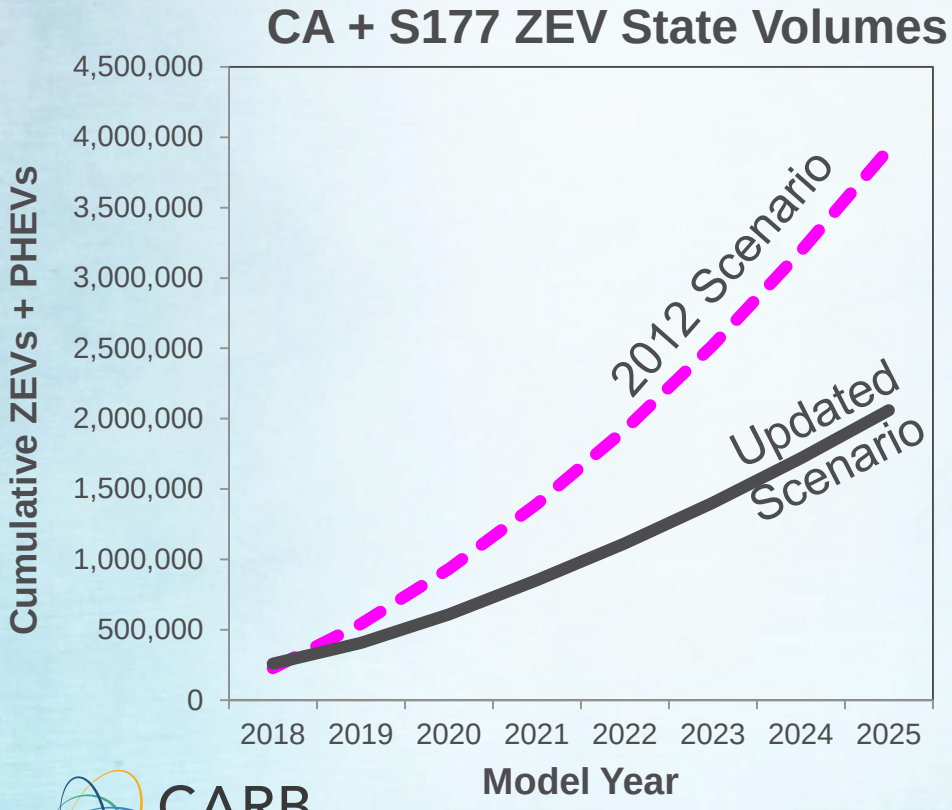
ZEV Regulation Fundamentals

1. Annual Credit Percentage Requirements
   - E.g., 22% credits required in 2025, not 22% of sales
   - Applied to an OEM's annual CA vehicle production
2. OEMs earn credits for each ZEV produced for sale
   - Longer range vehicles given more credit than shorter range
3. Several flexibilities also exist:
   - Some portion of ZEVs can be PHEVs
   - Banking/trading of credits
   - Pooling of the requirement across multiple S177 states

Updated ZEV Sales Compliance Scenarios



Updates reflect:

- ✓ Increased electric range on BEVs and PHEVs
- ✓ Use of regulatory flexibilities
- ✓ Use of banked ZEV credits
- ✓ Misc. other updates (e.g., total new vehicle sales)

Note: Actual market performance may exceed these levels.

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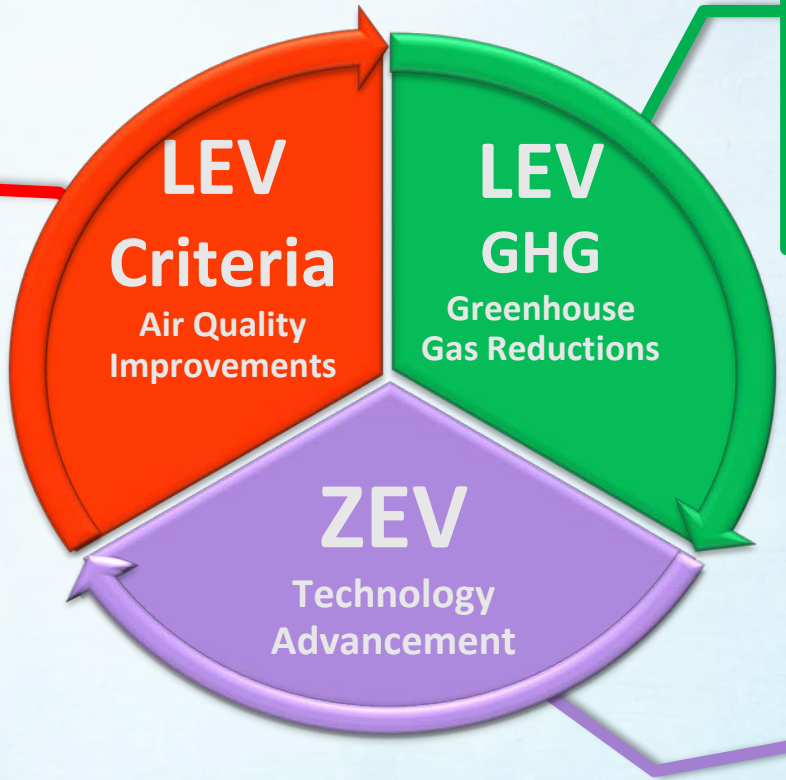
Advanced Clean Cars Midterm Review
Key Questions to Answer

1) Is 1 mg/mi PM measurable?
2) Is 1 mg/mi PM feasible for MY2025?



Are the GHG standards appropriate for MY 2022-2025?

Are MY 2018-2025 requirements:
1) on track for CA and S177?
2) appropriate for PHEVs?

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2017 ACC Midterm Review Recommendations Summary

- **GHG:** Adopted MY 2022-2025 GHG standards remain appropriate
- **PM:** Standard is measurable and feasible but further action needed to ensure robust control
- **ZEV:** Continue with existing technology-forcing ZEV requirements to develop the market; and

  Maintain current treatment and crediting of PHEVs
- Direct staff to begin rule development for MY 2026+

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Advanced Clean Cars and the Federal Process

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New Federal Proposal Severely Weakens Current GHG Standards and Challenges California's Authority

Joint U.S. EPA and NHTSA NPRM published August 24, 2018

- Proposes to flat-line GHG and fuel economy standards at MY2020 levels through MY2026
- U.S. EPA proposes to rescind waiver for current CA GHG regulation and zero-emission vehicle (ZEV) regulation
  - NHTSA claims CA GHG and ZEV regulations are preempted by federal fuel economy statute

2018 Update to CA GHG Regulation

- CA GHG regulation allows OEMs to use federal compliance to satisfy CA's requirements
  - Last year, clarified this "deemed to comply" option is valid only with existing U.S. EPA GHG standards
- If Federal standards change, OEMs will also need to separately meet CA standards
  - Only for those model years that the Federal standards change (potentially model year 2021+)
  - In CA and in all 14 S177 states that have adopted CA GHG

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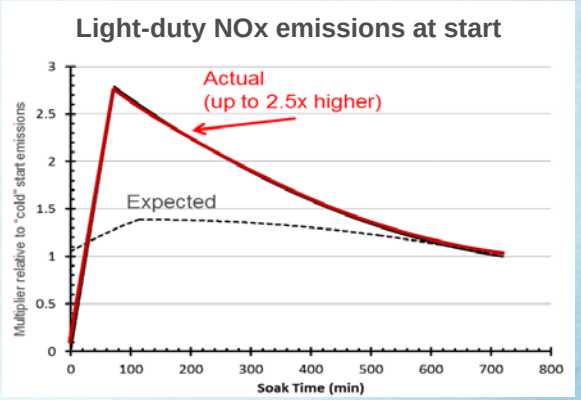
Guiding principles for ACC II, the next generation of standards:

- High assurance of real-world emission reductions in the light-duty sector
- Increased certainty of future ZEV sales volumes and maximizing zero emission miles traveled
- Clear policy signal to ensure continued investments in innovation and advanced low carbon and ZEV technologies needed for meeting long term goals
- Program structure that promotes similar or lower system-wide emissions from new mobility options
- Implementation feasibility and consideration of global technology trends

LEV-Criteria Next Steps

- Emphasis on real-world emission reductions so that test cycle results reflect in-use performance
  - Already identified increased HC+NOx start emissions under non-tested conditions
  - Investigating PM emissions under higher speed driving and colder ambient temperatures
  - Other issues include evaporative emissions, non-stoichiometric ‘off-cycle’ standards, fleet averaging rules



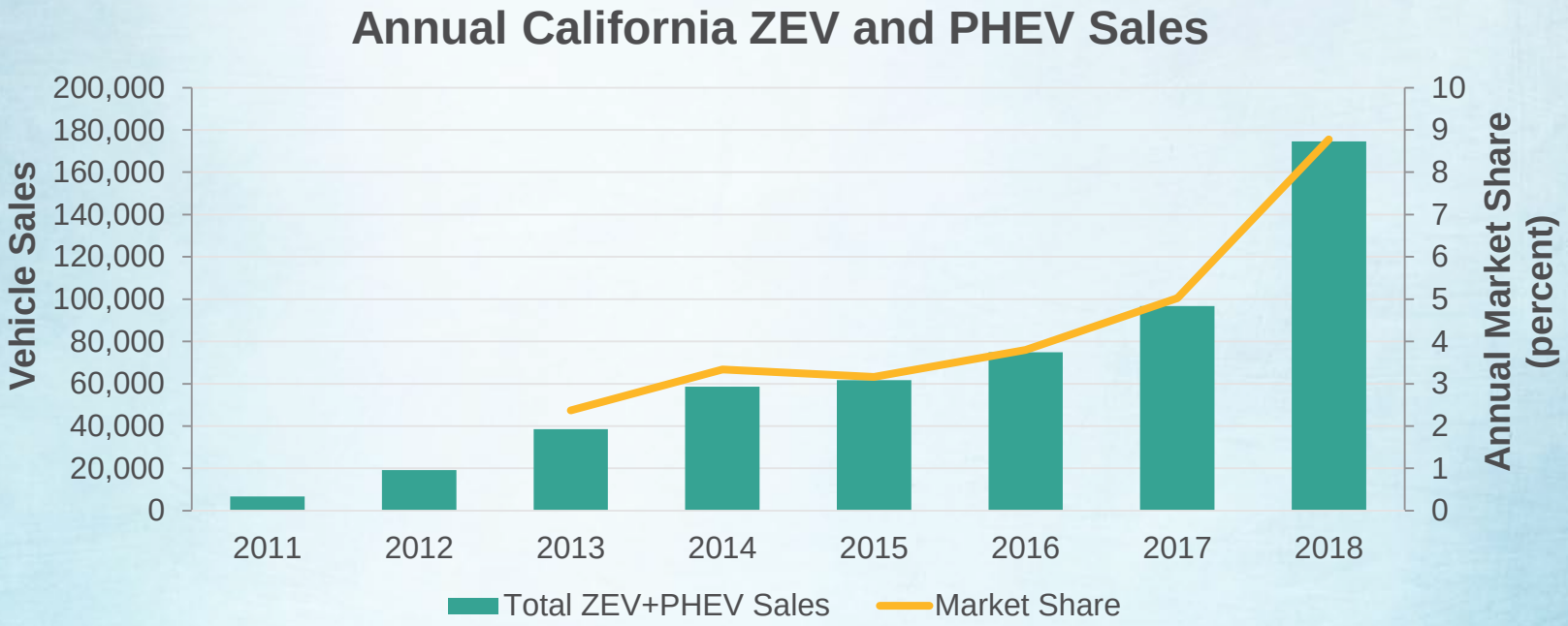
LEV-GHG Next Steps

- Beginning evaluation for post 2025MY GHG stds
  - Update conventional vehicle technology review
  - Update electrified vehicle technology review
  - Assess feasibility for various stringencies
  - Evaluate various combinations of GHG and ZEV requirements
  - Consider implications of higher mileage vehicles

ZEV Next Steps

- Beginning analysis for post 2025MY ZEV Reg
  - Update electrified vehicle technology assumptions
  - Continue studies of consumer acceptance
  - Re-examine role of PHEVs
  - Consider electrification requirements on AVs
  - Assess other market factors: Sufficiency of fueling infrastructure; Total Cost of Operation; etc

ZEV Sales are Gaining Momentum & Market Share



Sources: Auto Alliance Sales Dashboard for 2011 through August 2018, Veloz Sales Dashboard for September 2018 through December 2018

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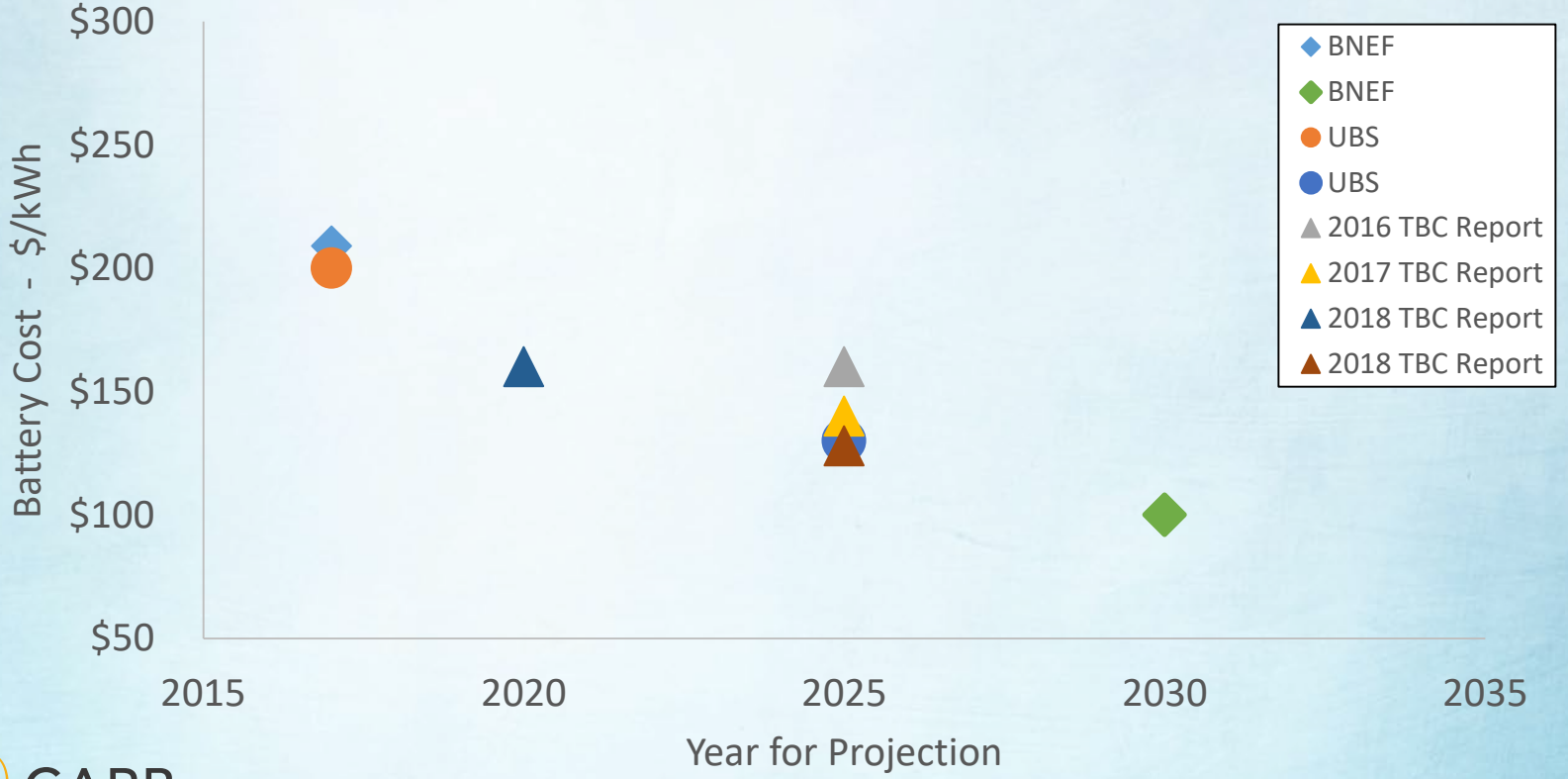
Examples of Battery Technology Costs



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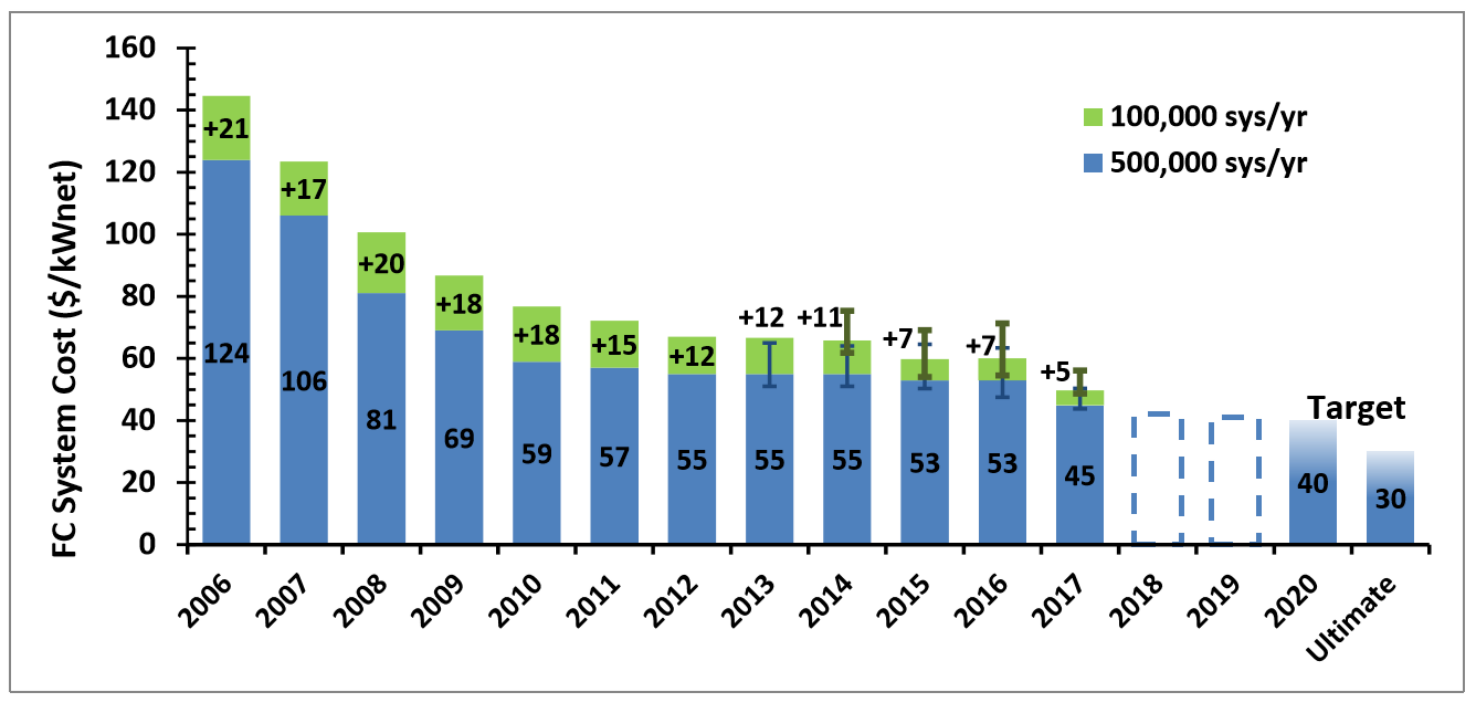
Fuel Cell System Costs (U.S. DOE)



Source: DOE Hydrogen and Fuel Cells Program Record #17007

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SB 1014 – California Clean Miles Standard

The transportation sector, with fuel production, accounts for almost 50 percent of GHG emissions in California with light-duty making up ~30 percent of the state's emissions.

SB 1014 requires CARB and CPUC to adopt and implement a program to reduce GHG emissions from transportation network companies (TNC).

New regulation will encourage zero-emission vehicles and VMT reduction strategies, and account for automated vehicles in TNC fleets.

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SB 1014 Requirements

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Ride Hailing and AVs Require Changing Fleet Impact Evaluation

- Total VMT implications
  - New “dead-head” miles (aka Period 1 in SB 1014)
  - Mode shift *away* from transit
  - Ridership levels
- LDV fleet potential Implications
  - Shift VMT to more sedans
  - Reduced average age of fleet (high annual mileage vehicles retire earlier)
  - Fewer cold starts; possibly more idling

Clean Mile Standard Guiding Principles

Regulation Design

- Decrease GHG emissions and increase zero-emission miles
- Encourage pooling, active transport, and transit usage
- Forward-looking with automated vehicles
- Aligned with other State policies

Development Process

- A synergistic process
- Data-driven
- Encourage ZEV infrastructure
- Maximize benefits to low- and moderate-income drivers

Statute direction:

- gCO2/passenger-mi
- % electric mile target

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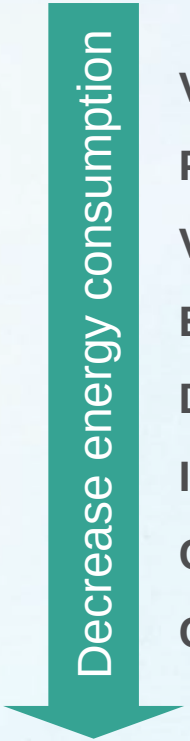
Unknowns about the Automated Vehicle Future

- Ease of travel
- Travel cost reduction
- Higher highway speeds
- Increased features
- New user groups
- Mode switch



- Vehicle/powertrain resizing
- Platooning
- Vehicle right-sizing
- Eco-driving
- De-emphasized performance
- Improved crash avoidance
- Changed mobility services
- Congestion mitigation

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Source: Wadud et al. (2016)

CA Automated Vehicle Principles for Healthy and Sustainable Communities*

State's Efforts to Nudge AVs Toward Sustainable Transportation Goals

1. Shared use
2. Pooled
3. Low-emissions
4. Right-sized
4. Part of an efficient multimodal system
5. Efficient land use
6. Complete and livable streets
7. Transportation equity

SB 1014 and ACC II can address some of these

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Now posted at Governor's Office Automated Vehicles website:

Regulatory Timelines

- Clean Miles Standard (ride hailing fleets)
  - Board proposal fall 2020
  - Statute driven timing
- Advanced Clean Cars II (automakers)
  - Board proposal in 2020
  - Consistent lead time with prior vehicle rulemakings for a 2026MY program start

Thank you!