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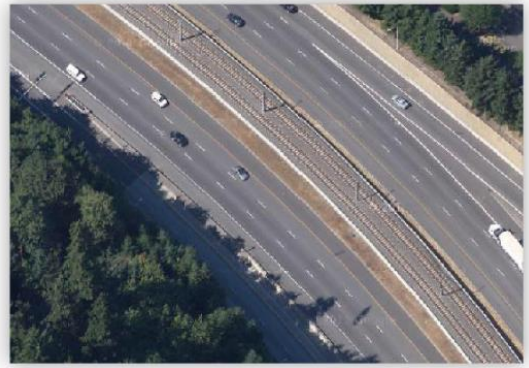
# Benefits from Low-$NO_x$ Omnibus and Advanced Clean Trucks (ACT) Adoption in 13 States and D.C. from 2020 to 2050



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# Outline

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  - Advanced Clean Trucks (ACT)
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- Multi-state medium- and heavy-duty low and zero emission vehicle (ZEV)
- Motivation of this Project
- Methods
  - MOVES3
  - Analysis of MOVES3 outputs
  - Greenhouse gases, regulated emissions, and energy use in technologies model
- Emission Reductions

# California Regulations – Advanced Clean Trucks (ACT)

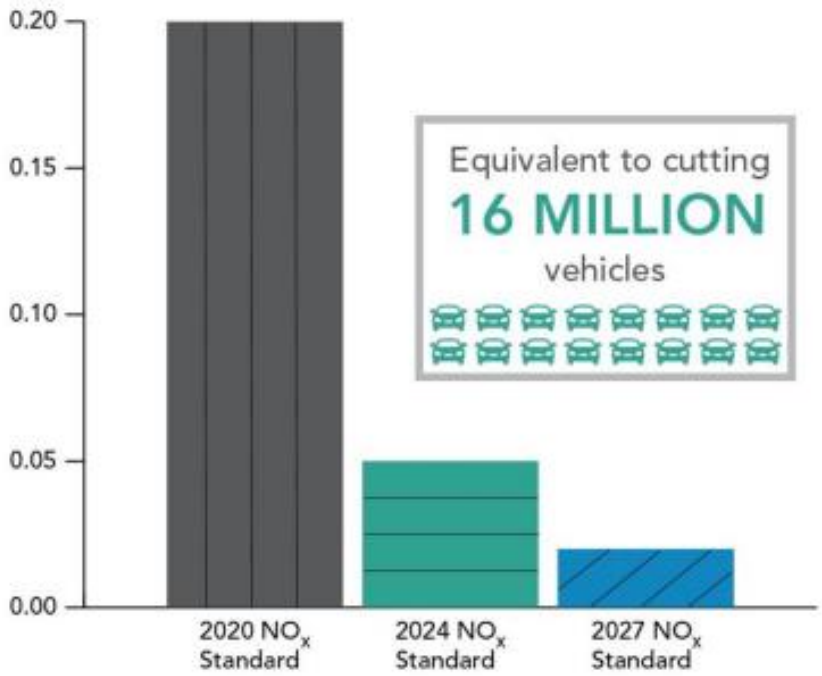
- Regulates sales of zero-emission medium- and heavy-duty vehicles (Class 2b to Class 8) (buses not included)
- Zero-emission truck sales by 2035
  - ZEV 55% 2b – 3 truck sales
  - ZEV 75% 4 – 8 truck sales
  - ZEV 40% truck tractor sales.
- Company and fleet reporting


Credit: https://www.environmentalhealth.org/index.php/en/media-center/blog-for-environmental-justice/127-toxic-free-neighborhoods/1363-breaking-carb-votes-to-adopt-advanced-clean-truck-act-rule

https://ww2.arb.ca.gov/resources/fact-sheets/advanced-clean-trucks-fact-sheet

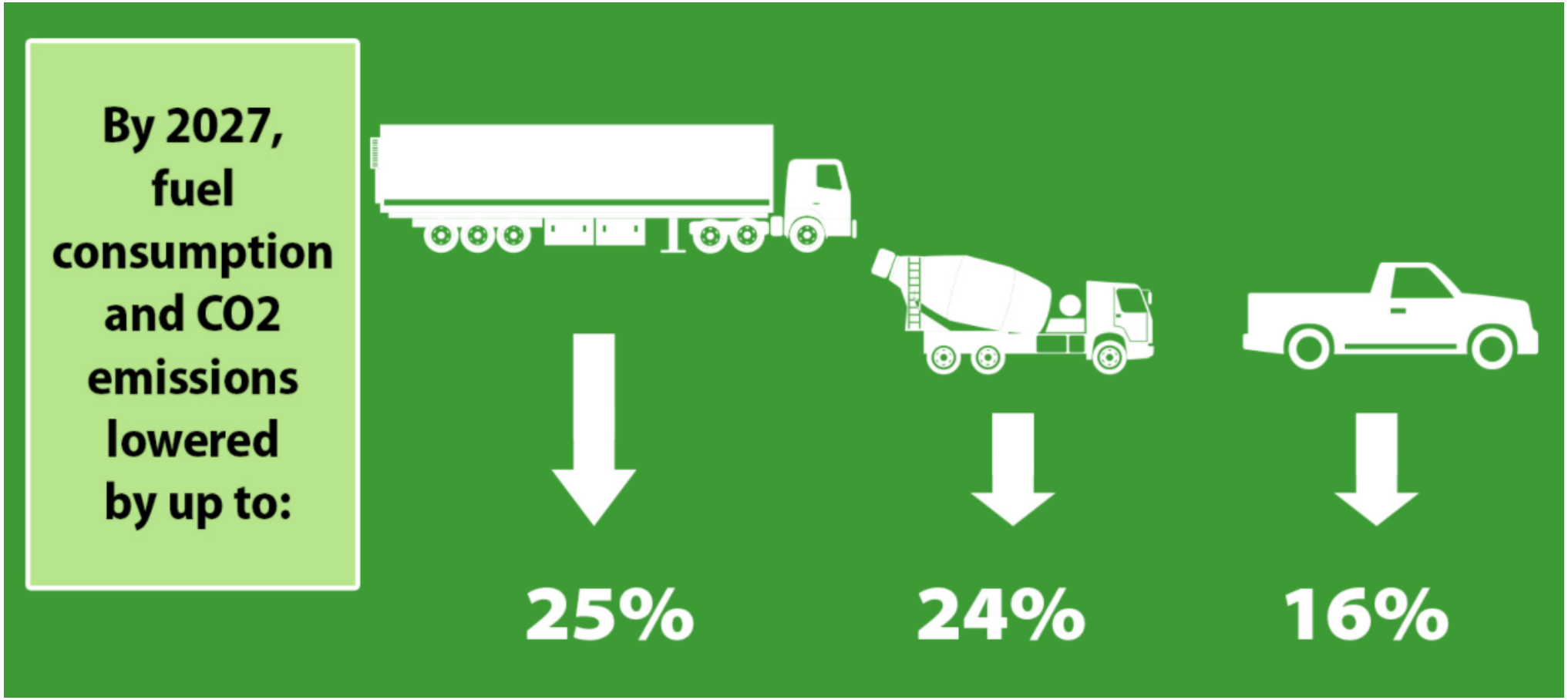
# California Regulations – Low-$NO_x$ Heavy-Duty Omnibus Regulation

- Medium-and heavy-duty vehicles from Class 3 to Class 8 (buses not included)
- The $NO_x$ standards
  - 75% below current standards in 2024
  - 90% below current standards in 2027




Credit: https://ww2.arb.ca.gov/sites/default/files/classic//msprog/hdlownox/files/HD_NOx_Omnibus_Fact_Sheet.pdf

# Regulations – GHG Phase 2




Credit: https://www.epa.gov/sites/default/files/2016-10/med-hv-trucks-infograph-2016_0.jpg

# Multi-State Medium- and Heavy-Duty Zero Emission Vehicle

- CA, **CT, CO**, HI, **ME, MD, MA, NJ, NY, NC, OR, PA, RI, VT, WA** signed memorandum of understanding
- Established goals for
  - 30% medium and heavy-duty zero-emission (M/HD ZEV) sales by 2030
  - 100% ZEV sales by 2050

Credit: https://www.lord.com/blog/electronics/electrifying-medium-and-heavy-duty-trucks-part-one

bdlaw.com/content/uploads/2020/07/Multistate-Truck-ZEV-Governors-MOU-20200714.pdf

# Motivation of this Project

To help policymakers understand the potential emissions benefits of zero-emission vehicle and Low-$NO_x$ regulations

# Alternative EV Scenarios for the ACT Program

- "**ACT EVs**" models the ACT program exactly as California did, with assumptions regarding out-of-state sales, out-of-state migration over time, and fractions of the fleet that would be EV regardless of the ACT program (to meet emissions requirements of the existing GHG Phase 2 program)
- "**All EVs**" models the ACT program without California assumptions regarding out-of-state migration and GHG Phase 2 EV sales (accounts for all EVs in the fleet)

# Methods – Scenarios

| Scenarios | Description |
|---|---|
| **Scenario 1** | Business as Usual |
| **Scenario 2** | Dual Harmonization (ACT and Low-$NO_x$ Omnibus Rule w/urban buses) starting from model year (MY) 2025 |
| **Scenario 2a** | Full Harmonization (Scenario 2 above plus benefit of GHG Phase 2 trailer requirements) |
| **Scenario 3** | Advanced Clean Trucks Rule starting from MY2025 |
| **Scenario 4** | Low-$NO_x$ Omnibus Rule w/urban buses starting from MY2025 |
| **Scenario 5** | GHG Phase 2 trailer requirements starting from MY2025 |

# Methods – Data Analysis Configuration

## MOVES

- MOVES default data
- Metropolitan planning organizations data
- EQUATES 2017 data

## Post Process

- CARB ACT EV table
- $NO_x$ reduction, Low $NO_x$ regulation
- GHG phase 2

## Well-to-Wheel

- GREET emission factors by region

# Methods – MOVES3 Input Data

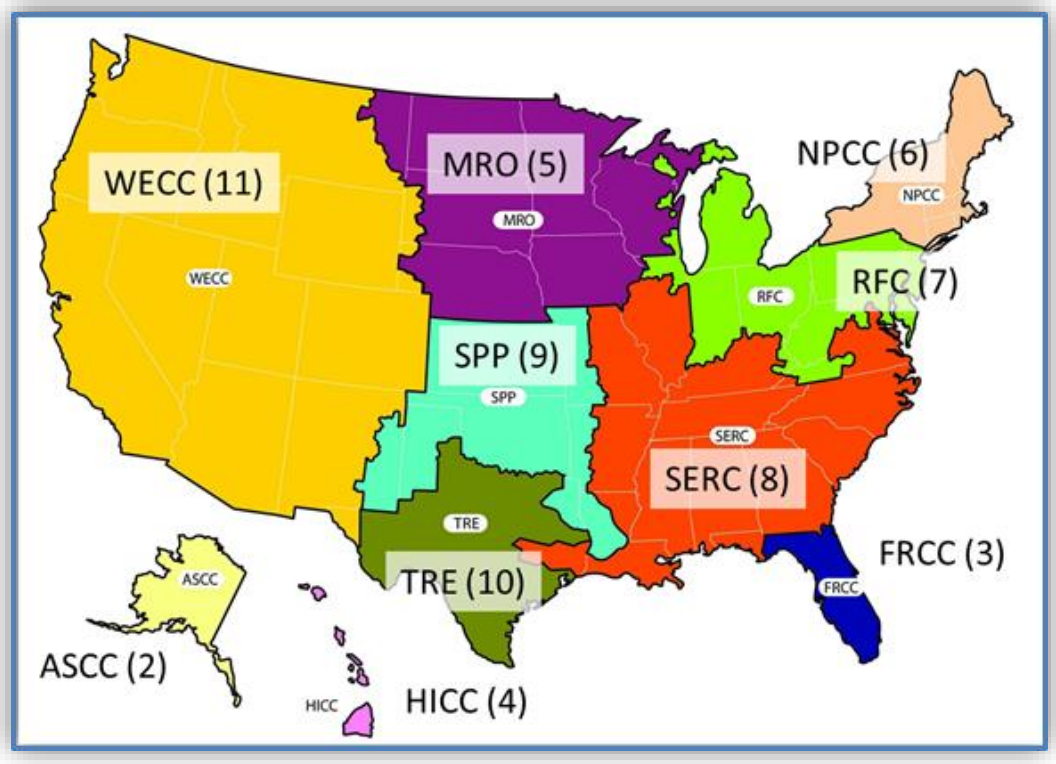
## County-Level Run | EQUATES 2017 Representative Counties in Each State

| MOVES3 Input | Typical Data Source | State-Specific Variations |
|---|---|---|
| **VMT, VPOP** | EQUATES 2017, grown to future years (2020, 2025, 2030, 2035, 2040, 2045, and 2050) using MOVES3 default growth rates | Growth rates based on MPO data for select counties (New Jersey) or the entire state (Massachusetts) |
| **Fuel supply, fuel usage fractions, inspection/maintenance program parameters, VMT month, day, hour fractions** | MOVES3 defaults (MOVESdb20210209) | MOVES3 defaults (MOVESdb20210209) |
| **Road type VMT distribution, vehicle age distribution** | EQUATES 2017 data for corresponding county | MPO data where provided (New Jersey) |
| **Vehicle technology distribution, speed distribution** | EQUATES 2017 data for corresponding county | EQUATES 2017 data for corresponding county |
| **Meteorology, retrofit program data** | MOVES3 defaults (MOVESdb20210209) | MPO data where provided (New Jersey) |

# Methods – Post Processes

| Topic | Description | EPA Regulatory Classes Affected | Pollutants Affected |
|---|---|---|---|
| **GHG Phase 2 Trailer provisions** | Adjustment to remove the benefit of the trailer component of the HDV Phase 2 GHG rule. | 46, 47 | $CO_2$ (emissions increase) |
| **Advanced Clean Trucks program** | Adjustment to reflect phased introduction of electric HDVs into the fleet. Also includes use of GREET emissions factors to calculate resulting increase in grid emissions. | 41, 42, 46, 47 | All (emissions decrease) |
| **CA Low-$NO_x$ Omnibus program** | Adjustment to reflect ARB's proposed Low-$NO_x$ Omnibus rule. | 42, 46, 47, 48 | $NO_x$ (emissions decrease) |

# Methods – GREET Emissions Factors for Vehicles Using Electricity (Grams/Million BTU) for Transportation End-Users: Well-To-Wheel




| | NPCC Mix (CT, MA, ME, NY, RI, VT) | RFC Mix (DC, MD, NJ, PA) | SERC Mix (NC) | WECC Mix (CO, OR, WA) |
|---|---|---|---|---|
| $NO_x$ | 19.370 | 45.157 | 50.017 | 39.549 |
| $PM_{2.5}$ | 2.180 | 5.985 | 5.147 | 3.988 |
| $CH_4$ | 3.787 | 9.491 | 8.497 | 6.273 |
| $N_2O$ | 0.177 | 1.510 | 1.325 | 0.936 |
| $CO_2$ | 51,233 | 106,161 | 94,078 | 68,252 |

These 2020 values used for all calendar years for most states, but some states provided grid renewable energy projections for future years.

# Results – $NO_x$ Emissions Reductions

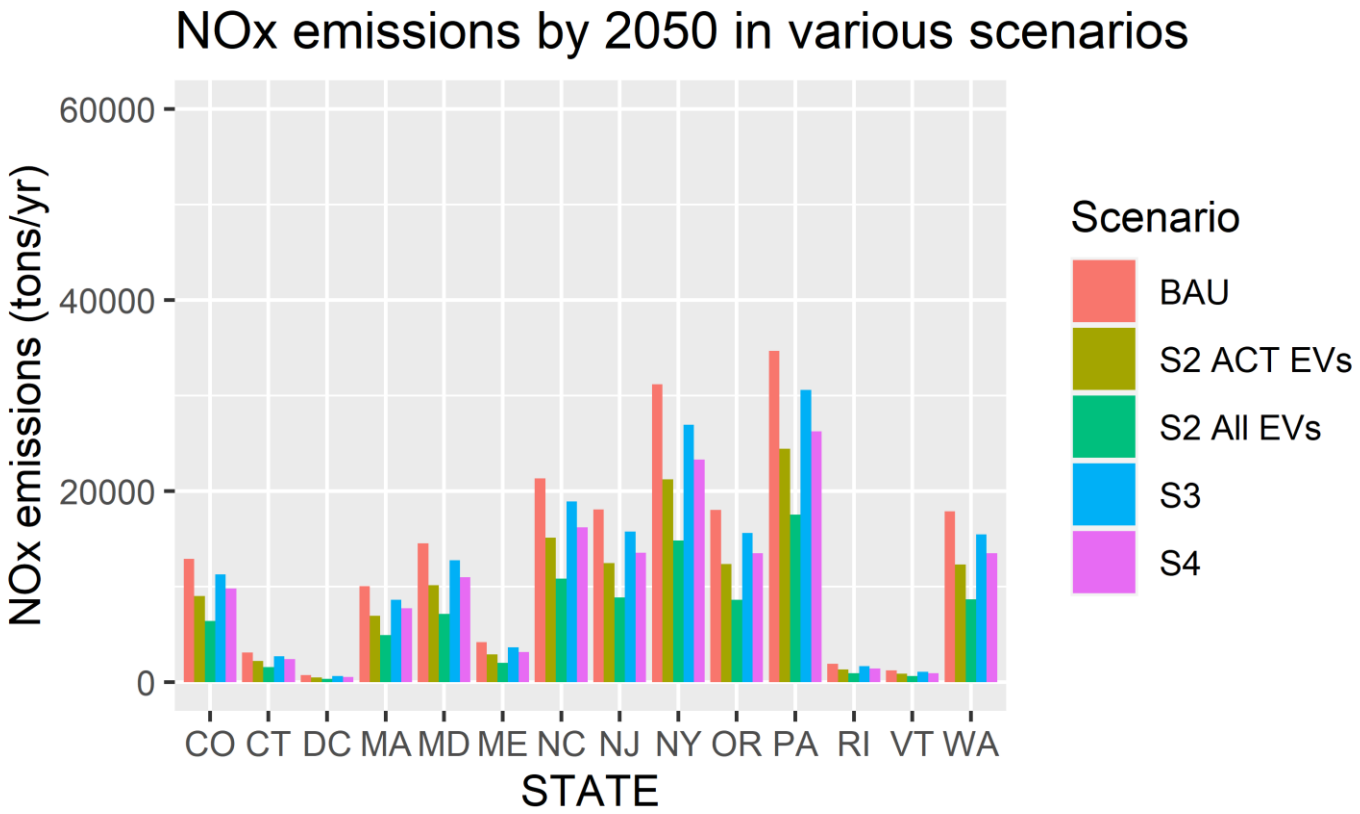
**2050 $NO_x$ reduction compared to BAU**

Scenario 2: ACT EVs: 30%

Scenario 2: All EVs: 50%

Scenario 3: 12-14%

Scenario 4: 22-26%



# Results – $PM_{2.5}$ Emissions Reductions

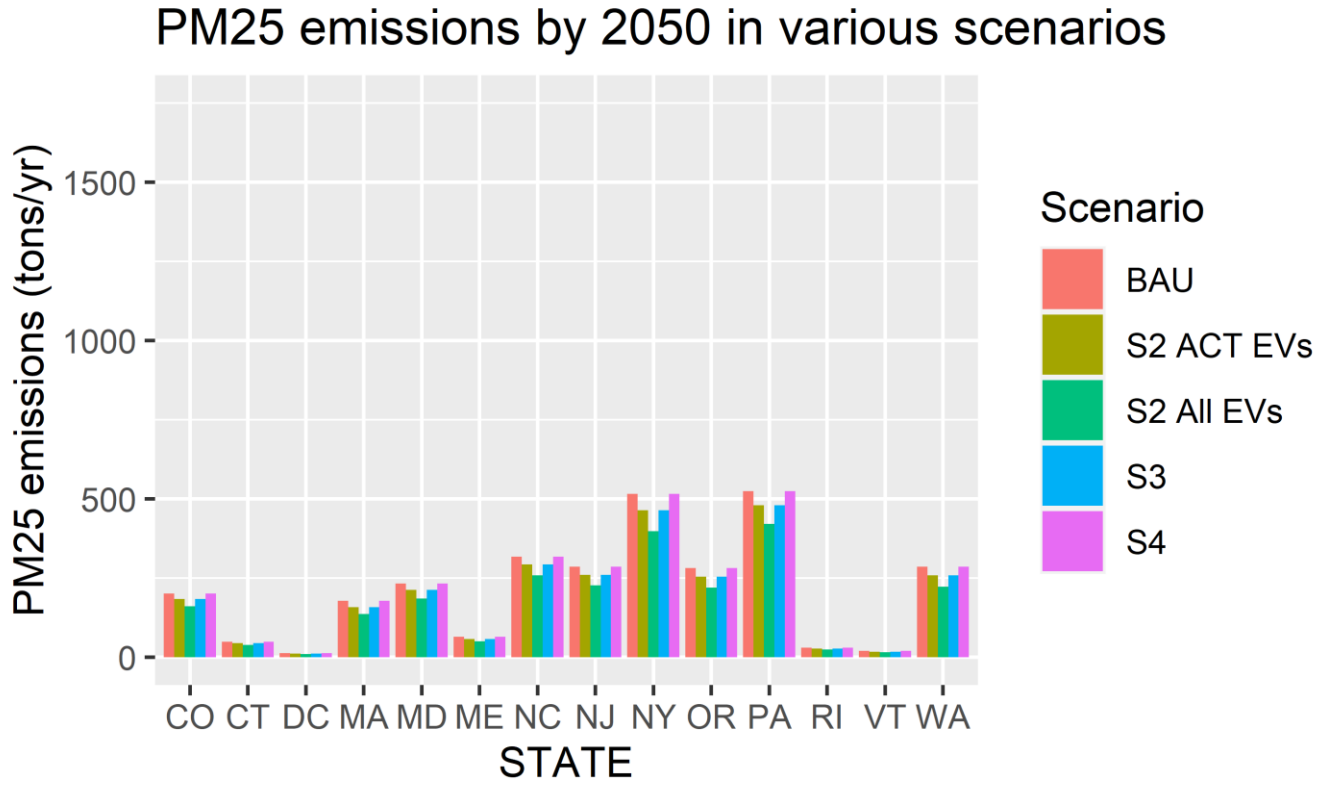
**2050 $PM_{2.5}$ reduction compared to BAU**

Scenario 2: ACT EVs: 8-11 %

Scenario 2: All EVs: 20-23%

Scenario 3: 8-11%

Scenario 4: 0 %



# Results – $CO_2e$ Emissions Reductions Well-To-Wheel

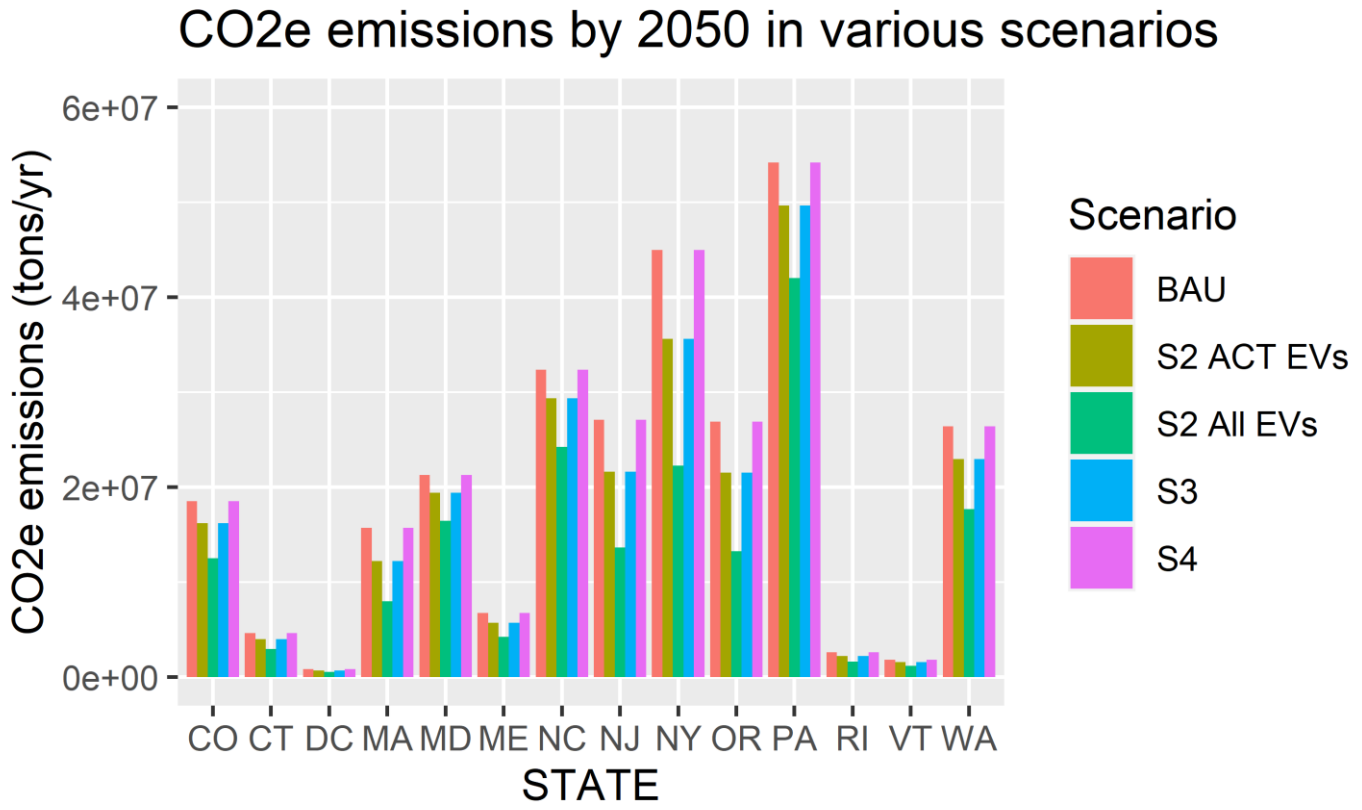
**2050 $CO_2e$ reduction compared to BAU**

Scenario 2: ACT EVs: 2-24 %

Scenario 2: All EVs: 6-55%

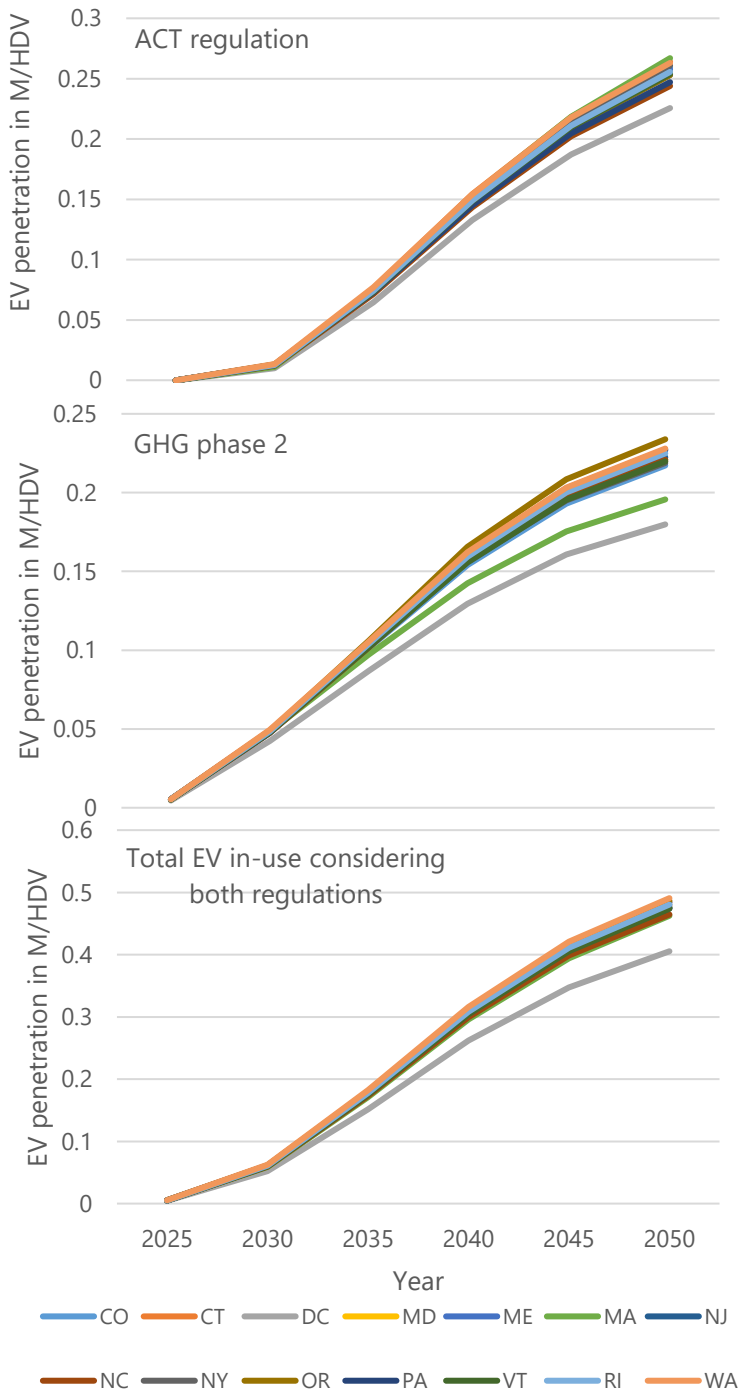
Scenario 3: 2-24%

Scenario 4: 0 %



# Results – Electric Medium- and Heavy-Duty Vehicle Penetration

- 2030
  - ACT EV penetration (“ACT EVs”): ~1%
  - GHG phase 2: ~5%
  - Both (“All EVs”): ~6%
- 2050
  - ACT EV penetration (“ACT EVs”): ~25%
  - GHG phase 2: ~17-23%
  - Both (“All EVs”): ~40-50 %



# Conclusions - Emissions

- Low-$NO_x$ Omni (Scenario 4) and GHG phase 2 EVs (Scenario 2 All EVs – Scenario 2 ACT EVs) have similar $NO_x$ reduction, which is approximately 2 times higher than the ACT impact on $NO_x$ reduction (Scenario 3)
- GHG Phase 2 regulation results in more $PM_{2.5}$ and $CO_2e$ emission reductions than the ACT regulation
- Overall, in 2050, $NO_x$ emission reductions compared to BAU are 50%, $PM_{2.5}$ emission reductions are 20%, and $CO_2e$ emission reductions are 6-55%

# Conclusions – EV Penetration

- ACT starts in 2025, and therefore there is less EV penetration in the initial period of this scenario; by 2040, M/HDV ZEV penetration is similar for both the ACT and GHG Phase 2 regulation scenarios
- If both the ACT and GHG phase 2 scenarios are implemented in the future, the resulting EV penetration is 6% by 2030 and 48% in 2050

# Acknowledgments


- Ben Sharpe at ICCT
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- CARB technical assistance

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# Benefits of adopting California medium- and heavy-duty vehicle regulations in New York State

Working paper

Published: 2021.05.27 • By Ray Minjares, Jeff Houk (Sonoma Technology, Inc.), and Joey Huang (Sonoma Technology, Inc.)

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This paper evaluates the benefits to New York State of adopting three California regulations: the Advanced Clean Trucks rule, the Heavy-Duty Omnibus rule, and the California Phase II greenhouse gas rule.

Without any new policy, fleet-wide emissions of nitrogen oxides and fine particulate matter will decline 40% and 60%, respectively, from 2020 to 2035. But, from 2035 to 2050, NOx and PM emissions will grow 28% and 13%, respectively, as a result of a growing vehicle population and the absence of further emission reductions from the phase-in of model year 2010 emission control technologies.



Credit: https://theicct.org/publications/nys-hdv-regulation-benefits-may2021

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