

# ALTERNATIVE REGULATORY SCENARIOS FOR HEAVY-DUTY DIESEL TRUCKS

## NO<sub>x</sub> EMISSION EFFECTS

February 10, 2022



FEB 2022

### EXECUTIVE SUMMARY

| Task                                                                                                                                                                                                                                                                                          |                                                                           | Results                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                     | Conclusions     |                                                                           |       |                    |      |                                            |                     |  |       |       |       |            |       |       |         |       |        |                                            |  |  |       |      |      |            |      |      |         |      |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
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| <p>Conduct emissions modeling to estimate heavy-duty diesel truck emissions for new federal emissions standard scenarios, accounting for potential market responses to the low emission standards</p> <ul style="list-style-type: none"> <li>Scenarios Evaluated:</li> </ul>                  |                                                                           | <p><b>NO<sub>x</sub> Emission Reductions from Current Standards Baseline (tpd)</b></p> <table border="1"> <thead> <tr> <th rowspan="2">Area</th> <th colspan="2">NO<sub>x</sub> Emission Reductions from Current Standards Baseline (tpd)</th> </tr> <tr> <th>2030</th> <th>2035</th> </tr> </thead> <tbody> <tr> <td colspan="3" style="text-align:center"><b>0.020 g/bhp-hr Federal FTP Standard</b></td> </tr> <tr> <td>SoCAB</td> <td>-2.2%</td> <td>-6.5%</td> </tr> <tr> <td>California</td> <td>-2.8%</td> <td>-7.7%</td> </tr> <tr> <td>US-Wide</td> <td>-9.7%</td> <td>-11.6%</td> </tr> <tr> <td colspan="3" style="text-align:center"><b>0.050 g/bhp-hr Federal FTP Standard</b></td> </tr> <tr> <td>SoCAB</td> <td>0.7%</td> <td>1.8%</td> </tr> <tr> <td>California</td> <td>0.9%</td> <td>2.4%</td> </tr> <tr> <td>US-Wide</td> <td>7.5%</td> <td>23.0%</td> </tr> </tbody> </table> <p>Emission Increases </p> <p>Emission Decreases </p> |                                     | Area            | NO <sub>x</sub> Emission Reductions from Current Standards Baseline (tpd) |       | 2030               | 2035 | <b>0.020 g/bhp-hr Federal FTP Standard</b> |                     |  | SoCAB | -2.2% | -6.5% | California | -2.8% | -7.7% | US-Wide | -9.7% | -11.6% | <b>0.050 g/bhp-hr Federal FTP Standard</b> |  |  | SoCAB | 0.7% | 1.8% | California | 0.9% | 2.4% | US-Wide | 7.5% | 23.0% | <ul style="list-style-type: none"> <li>0.020 g/bhp-hr Federal FTP Std                             <ul style="list-style-type: none"> <li><u>NO<sub>x</sub> emissions increase</u> from 2.2%-11.6% relative to the current Federal standard.</li> <li>Pre-buy/no buy-related effects is the dominant factor resulting in NO<sub>x</sub> emission increases.</li> </ul> </li> <li>0.050 g/bhp-hr Federal FTP Std                             <ul style="list-style-type: none"> <li><u>NO<sub>x</sub> emissions decrease</u> from 0.7%-23.0% relative to the current Federal standard.</li> <li>The 0.050 g/bhp-hr federal FTP emission standard is the dominant factor resulting in NO<sub>x</sub> emission reductions.</li> </ul> </li> </ul> |  |
| Area                                                                                                                                                                                                                                                                                          | NO <sub>x</sub> Emission Reductions from Current Standards Baseline (tpd) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                     |                 |                                                                           |       |                    |      |                                            |                     |  |       |       |       |            |       |       |         |       |        |                                            |  |  |       |      |      |            |      |      |         |      |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
|                                                                                                                                                                                                                                                                                               | 2030                                                                      | 2035                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                     |                 |                                                                           |       |                    |      |                                            |                     |  |       |       |       |            |       |       |         |       |        |                                            |  |  |       |      |      |            |      |      |         |      |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
| <b>0.020 g/bhp-hr Federal FTP Standard</b>                                                                                                                                                                                                                                                    |                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                     |                 |                                                                           |       |                    |      |                                            |                     |  |       |       |       |            |       |       |         |       |        |                                            |  |  |       |      |      |            |      |      |         |      |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
| SoCAB                                                                                                                                                                                                                                                                                         | -2.2%                                                                     | -6.5%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                     |                 |                                                                           |       |                    |      |                                            |                     |  |       |       |       |            |       |       |         |       |        |                                            |  |  |       |      |      |            |      |      |         |      |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
| California                                                                                                                                                                                                                                                                                    | -2.8%                                                                     | -7.7%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                     |                 |                                                                           |       |                    |      |                                            |                     |  |       |       |       |            |       |       |         |       |        |                                            |  |  |       |      |      |            |      |      |         |      |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
| US-Wide                                                                                                                                                                                                                                                                                       | -9.7%                                                                     | -11.6%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                     |                 |                                                                           |       |                    |      |                                            |                     |  |       |       |       |            |       |       |         |       |        |                                            |  |  |       |      |      |            |      |      |         |      |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
| <b>0.050 g/bhp-hr Federal FTP Standard</b>                                                                                                                                                                                                                                                    |                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                     |                 |                                                                           |       |                    |      |                                            |                     |  |       |       |       |            |       |       |         |       |        |                                            |  |  |       |      |      |            |      |      |         |      |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
| SoCAB                                                                                                                                                                                                                                                                                         | 0.7%                                                                      | 1.8%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                     |                 |                                                                           |       |                    |      |                                            |                     |  |       |       |       |            |       |       |         |       |        |                                            |  |  |       |      |      |            |      |      |         |      |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
| California                                                                                                                                                                                                                                                                                    | 0.9%                                                                      | 2.4%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                     |                 |                                                                           |       |                    |      |                                            |                     |  |       |       |       |            |       |       |         |       |        |                                            |  |  |       |      |      |            |      |      |         |      |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
| US-Wide                                                                                                                                                                                                                                                                                       | 7.5%                                                                      | 23.0%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                     |                 |                                                                           |       |                    |      |                                            |                     |  |       |       |       |            |       |       |         |       |        |                                            |  |  |       |      |      |            |      |      |         |      |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
| <table border="1"> <thead> <tr> <th></th> <th>New Federal FTP Standard (g/bhp-hr)</th> <th>Market Response</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>0.020</td> <td>pre-buy/<br/>no buy</td> </tr> <tr> <td>2</td> <td>0.050</td> <td>pre-buy/<br/>low buy</td> </tr> </tbody> </table> |                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | New Federal FTP Standard (g/bhp-hr) | Market Response | 1                                                                         | 0.020 | pre-buy/<br>no buy | 2    | 0.050                                      | pre-buy/<br>low buy |  |       |       |       |            |       |       |         |       |        |                                            |  |  |       |      |      |            |      |      |         |      |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
|                                                                                                                                                                                                                                                                                               | New Federal FTP Standard (g/bhp-hr)                                       | Market Response                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                     |                 |                                                                           |       |                    |      |                                            |                     |  |       |       |       |            |       |       |         |       |        |                                            |  |  |       |      |      |            |      |      |         |      |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
| 1                                                                                                                                                                                                                                                                                             | 0.020                                                                     | pre-buy/<br>no buy                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                     |                 |                                                                           |       |                    |      |                                            |                     |  |       |       |       |            |       |       |         |       |        |                                            |  |  |       |      |      |            |      |      |         |      |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
| 2                                                                                                                                                                                                                                                                                             | 0.050                                                                     | pre-buy/<br>low buy                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                     |                 |                                                                           |       |                    |      |                                            |                     |  |       |       |       |            |       |       |         |       |        |                                            |  |  |       |      |      |            |      |      |         |      |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |



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# OUTLINE

- Purpose & Basis
- Scenarios
- NOx reduction methods
- Market response assumptions
- Emissions development methodology
- Results

## SUMMARY OF PURPOSE & BASIS

- **Purpose:** Compare NOx emissions under differing regulatory regimes for model year (MY) 2027+ medium-heavy-duty (MHD) and heavy-heavy-duty (HHD) trucks
- **California Certified Trucks Basis** (CARB HD Omnibus)
  - Inventory: CARB EMFAC2021 emission inventory (in-state vehicles); CARB Advanced Clean Truck (ACT) assumptions unchanged from EMFAC2021
- **Federal Certified Trucks Basis** (new, lower federal FTP standard)
  - **US, except California Inventory:** MOVES3 emission inventory with adjustments to account for emission standard effects on the NOx emission inventory for MHD and HHD trucks
  - **California Inventory:** CARB EMFAC2021 emission inventory with adjustments to account for emission standard effects on the NOx emission inventory for MHD and HHD trucks (out-of-state vehicles only)
  - Does not incorporate any changes for CARB Advanced Clean Truck (ACT) opt-in states
- **Market Response Assumptions**
  - **Pre-buy/no buy:** Increased sales prior to and no sales after implementation of 0.020 g/bhp-hr FTP standard.
    - Prior to New Standard: Implemented Scenario 3 from Ricardo PLC Pre-buy/Low buy Analysis
    - Subsequent to New Standard: Implemented no-buy for diesel trucks, x3 sales for natural gas trucks
  - **Pre-buy/low buy:** Increased sales prior to and decreased sales after implementation of 0.050 g/bhp-hr FTP standard.
    - Prior to New Standard: Implemented Scenario 3 from Ricardo PLC Pre-buy/Low buy Analysis with market response reduced by 50%
    - Subsequent to New Standard: Implemented mirror of Scenario 3 from Ricardo PLC Pre-buy/Low buy Analysis with market response reduced by 50%

## SCOPE & KEY ASSUMPTIONS

- **Pollutant:** NO<sub>x</sub>
- **Calendar Years (CYs):** 2030, 2035
- **Geographies:** California-wide, South Coast Air Basin (SoCAB)
- **Applicable Vehicles:** Diesel and Natural Gas MHD and HHD Trucks
- **Applicable Model Years (MYs):**
  - Alternative Emission Standards: Engine model years 2027+ (corresponding to vehicle model years 2028+)
- **Current Standards Scenario** emissions are based on EMFAC2021 and MOVES3 with market response effects as applicable
- **New Federal Standard Scenario** emissions will be estimated based on 1) adjustment of EMFAC2021 (out-of-state MHD and HHD trucks only) emission rates by mode and scenario and 2) applicable market response effects

## EMISSION SCENARIOS SUMMARY: EMISSION STANDARDS

| Scenario | FTP Emission Standard<br>(g/bhp-hr)<br>[market response] |                                                   |
|----------|----------------------------------------------------------|---------------------------------------------------|
|          | California                                               | Federal                                           |
| Base     |                                                          | Existing Federal Standard<br>[no market response] |
| 1        | Model Years 2024-2026:<br>0.050 [pre-buy/low buy]        | Model Years 2027+:<br>0.020 [pre-buy/no buy]      |
| 2        | Model Years 2027+:<br>0.020 [pre-buy/no buy]             | Model Years 2027+:<br>0.050 [pre-buy/low buy]     |

## EMISSION SCALARS BASIS BY FTP STANDARD

| Mode                              | Units    | Current Federal Program | CARB Omnibus 2027-2030 <sup>1,3</sup> | CARB Omnibus 2031+ <sup>1,3</sup> | Federal 0.020 g/bhp-hr FTP | Federal 0.050 g/bhp-hr FTP |
|-----------------------------------|----------|-------------------------|---------------------------------------|-----------------------------------|----------------------------|----------------------------|
| Running Exhaust: FTP              | g/bhp-hr | 0.200                   | 0.020                                 | 0.020                             | 0.020                      | 0.050                      |
| MAW Conformity Factor             |          | -                       | 2.0                                   | 1.5                               | 1.5                        | 1.5                        |
| Running Exhaust: ZMR <sup>2</sup> | g/mi     | 0.600                   | 0.157                                 | 0.118                             | 0.118                      | 0.295                      |
| Extended Idle Exhaust             | g/hr     | 30                      | 5                                     | 5                                 | 5                          | 10                         |

<sup>1</sup> Emission changes applied to only to engine model years 2027+ corresponding to EMFAC vehicle model years 2028+

<sup>2</sup> Running Exhaust: ZMR = Running Exhaust: FTP x MAW Correction Factor x 3.93 bhp-hr/mi

<sup>3</sup> CARB Advanced Clean Truck (ACT) assumptions unchanged from EMFAC2021

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## EMFAC SCENARIOS EMISSION STANDARDS: SCALARS SUMMARY

| EMFAC Input                        | Federal 0.020 g/bhp-hr FTP (relative to 0.20 g/bhp-hr FTP) | Federal 0.050 g/bhp-hr FTP (relative to 0.20 g/bhp-hr FTP) |
|------------------------------------|------------------------------------------------------------|------------------------------------------------------------|
| Running Exhaust: ZMR <sup>1</sup>  | 0.20                                                       | 0.49                                                       |
| Start Exhaust <sup>1,2</sup>       | 0.20                                                       | 0.49                                                       |
| Extended Idle Exhaust <sup>1</sup> | 0.17                                                       | 0.33                                                       |

<sup>1</sup> Emission changes applied to only to engine model years 2027+ corresponding to vehicle model years 2028+

<sup>2</sup> Start exhaust changes are assumed equivalent to running exhaust changes

- For California, 1) first purchased in-state vehicles conform to CARB HD Omnibus emission standards and 2) first purchased out-of-state (OOS) conform to federal standards

## MARKET RESPONSE ASSUMPTIONS (PRE-BUY/NO BUY AND PRE-BUY/LOW BUY)

Fleet Population: percent change by engine model year

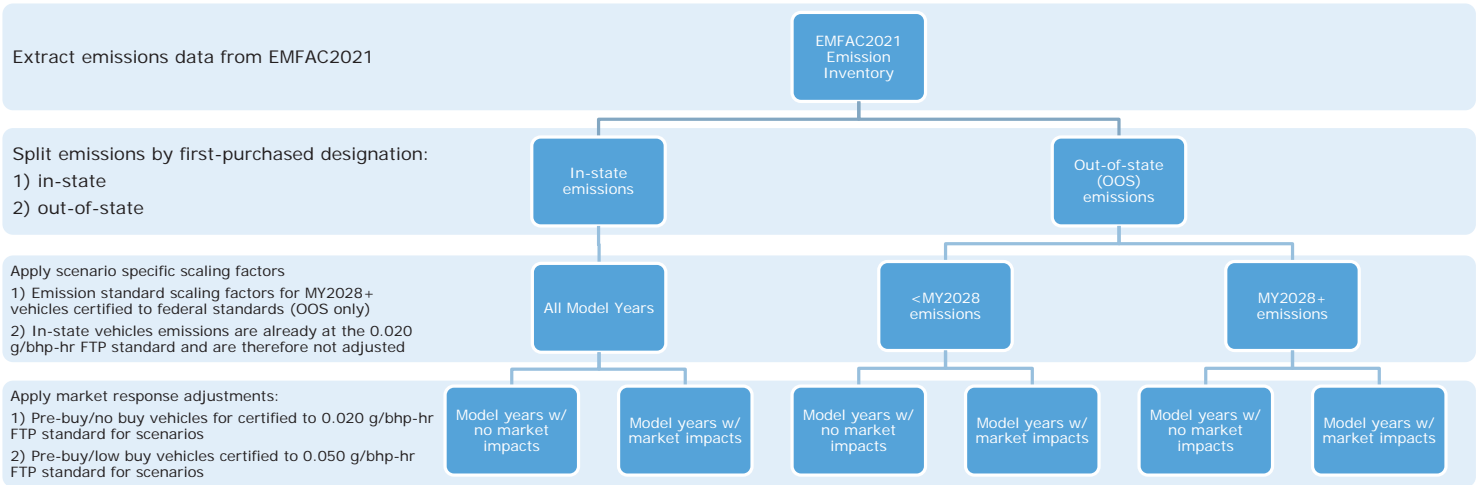
| Engine Model Year<br>Relative to New<br>Standard<br>Implementation | Pre-buy/ <u>low buy</u><br>0.050 g/bhp-hr standard |         |        |        | Pre-buy/ <u>no buy</u><br>0.020 g/bhp-hr standard |         |        |                     |
|--------------------------------------------------------------------|----------------------------------------------------|---------|--------|--------|---------------------------------------------------|---------|--------|---------------------|
|                                                                    | Dsl HHD                                            | Dsl MHD | NG HHD | NG MHD | Dsl HHD                                           | Dsl MHD | NG HHD | NG MHD <sup>a</sup> |
| 3+ Years Prior to<br>Implementation                                | 0%                                                 | 0%      | 0%     | 0%     | 0%                                                | 0%      | 0%     | 0%                  |
| 2 Years Prior to<br>Implementation                                 | +1.20%                                             | +2.09%  | 0%     | 0%     | +2.40%                                            | +4.17%  | 0%     | 0%                  |
| 1 Year Prior to<br>Implementation                                  | +17.73%                                            | +16.36% | 0%     | 0%     | +35.45%                                           | +32.71% | 0%     | 0%                  |
| Year 1 of Applicability                                            | -17.73%                                            | -16.36% | 0%     | 0%     | -100%                                             | -100%   | +200%  | +200%               |
| Year 2 of Applicability                                            | -1.20%                                             | -2.09%  | 0%     | 0%     | -100%                                             | -100%   | +200%  | +200%               |
| 3+ Years of<br>Applicability                                       | 0%                                                 | 0%      | 0%     | 0%     | -100%                                             | -100%   | +200%  | +200%               |

<sup>a</sup> MOVES3 does not include any natural gas fueled-MHD trucks, therefore, the increase to natural gas fleet population applies only to HHD trucks outside of California

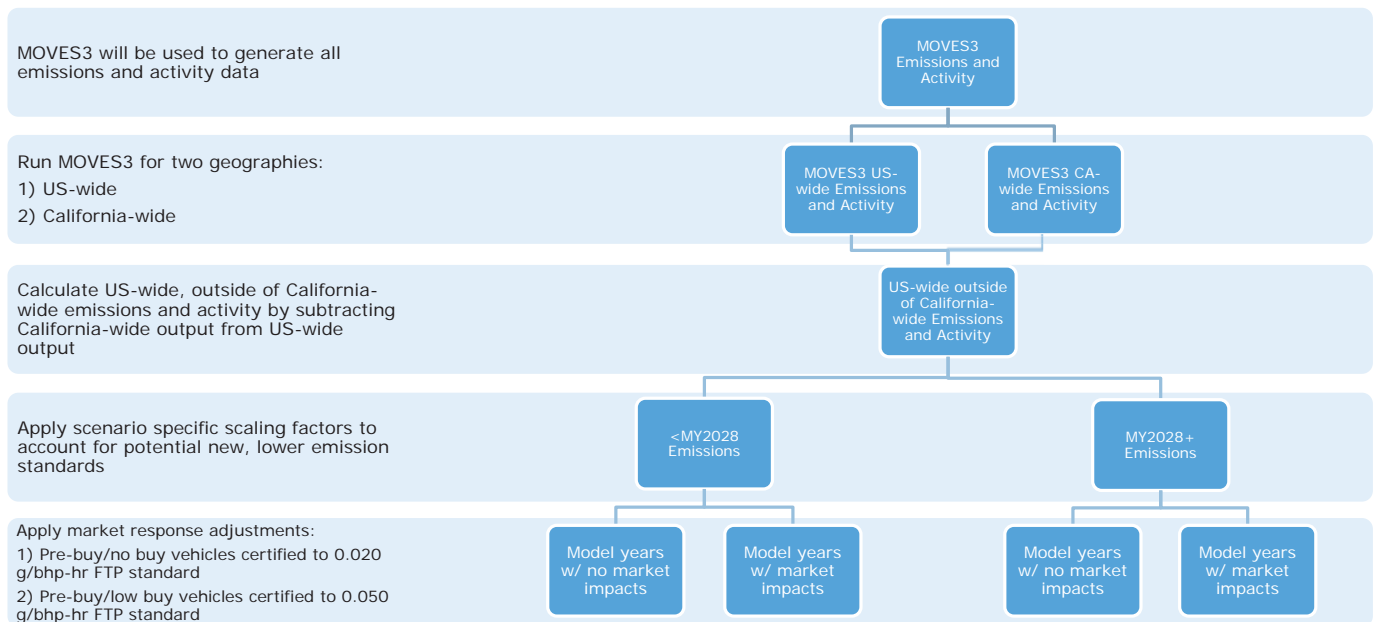
## SUMMARY OF EMISSION INVENTORY BASIS

- **California** emissions based on CARB EMFAC2021
- **US, outside California** emissions based on EPA MOVES3. MOVES3 was run for US-wide and California-wide geographies. US, outside of California emissions and activity were generated by subtracting MOVES3 output from California from MOVES3 US-wide output. To generate US- and California-wide emissions, MOVES3 was run at the national scale (i.e., MOVES3 national defaults, rather than county-level inputs, were used for parameters such as age distribution, speed regimes, etc.).

# CALIFORNIA EMISSIONS DEVELOPMENT METHODOLOGY



# US-WIDE OUTSIDE OF CALIFORNIA EMISSIONS DEVELOPMENT METHODOLOGY



## ESTIMATED NOx REDUCTIONS BY GEOGRAPHY (tpd)

| Scenario                     | California Certified Vehicles        |                                 | Federal Certified Vehicles           |                 | Emissions Reduction from Current Standards (tpd) <sup>c</sup> |        |
|------------------------------|--------------------------------------|---------------------------------|--------------------------------------|-----------------|---------------------------------------------------------------|--------|
|                              | FTP Standard (g/bhp-hr) <sup>a</sup> | Market Effects                  | FTP Standard (g/bhp-hr) <sup>b</sup> | Market Effects  | 2030                                                          | 2035   |
| <b>US-wide</b>               |                                      |                                 |                                      |                 |                                                               |        |
| Current Standards            | Not applicable                       |                                 | 0.200                                | None            | -                                                             | -      |
| 1                            |                                      |                                 | 0.020                                | pre-buy/no buy  | -205.7                                                        | -236.0 |
| 2                            |                                      |                                 | 0.050                                | pre-buy/low buy | 159.3                                                         | 469.1  |
| <b>California-wide</b>       |                                      |                                 |                                      |                 |                                                               |        |
| Current Standards            | 0.050, 0.020                         | pre-buy/low buy, pre-buy/no buy | 0.200                                | None            | -                                                             | -      |
| 1                            |                                      |                                 | 0.020                                | pre-buy/no buy  | -4.1                                                          | -11.2  |
| 2                            |                                      |                                 | 0.050                                | pre-buy/low buy | 1.3                                                           | 3.4    |
| <b>South Coast Air Basin</b> |                                      |                                 |                                      |                 |                                                               |        |
| Current Standards            | 0.050, 0.020                         | pre-buy/low buy, pre-buy/no buy | 0.200                                | None            | -                                                             | -      |
| 1                            |                                      |                                 | 0.020                                | pre-buy/no buy  | -0.9                                                          | -2.6   |
| 2                            |                                      |                                 | 0.050                                | pre-buy/low buy | 0.3                                                           | 0.7    |

<sup>a</sup> 0.050 g/bhp-hr standard applies to 2024-2026 and the 0.020 g/bhp-hr standard applies to 2027+ engine model years

<sup>b</sup> Federal FTP standards apply to 2027+ engine model years

<sup>c</sup> HD Trucks include MHD and HHD trucks

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## ESTIMATED NOx % REDUCTIONS BY GEOGRAPHY

| Scenario                     | California Certified Vehicles        |                                 | Federal Certified Vehicles           |                 | % Reduction from Current Standards (%) <sup>c</sup> |       |
|------------------------------|--------------------------------------|---------------------------------|--------------------------------------|-----------------|-----------------------------------------------------|-------|
|                              | FTP Standard (g/bhp-hr) <sup>a</sup> | Market Effects                  | FTP Standard (g/bhp-hr) <sup>b</sup> | Market Effects  | 2030                                                | 2035  |
| <b>US-wide</b>               |                                      |                                 |                                      |                 |                                                     |       |
| Current Standards            | Not applicable                       |                                 | 0.200                                | None            | -                                                   | -     |
| 1                            |                                      |                                 | 0.020                                | pre-buy/no buy  | -9.7                                                | -11.6 |
| 2                            |                                      |                                 | 0.050                                | pre-buy/low buy | 7.5                                                 | 23.0  |
| <b>California-wide</b>       |                                      |                                 |                                      |                 |                                                     |       |
| Current Standards            | 0.050, 0.020                         | pre-buy/low buy, pre-buy/no buy | 0.200                                | None            | -                                                   | -     |
| 1                            |                                      |                                 | 0.020                                | pre-buy/no buy  | -2.8%                                               | -7.7% |
| 2                            |                                      |                                 | 0.050                                | pre-buy/low buy | 0.9%                                                | 2.4%  |
| <b>South Coast Air Basin</b> |                                      |                                 |                                      |                 |                                                     |       |
| Current Standards            | 0.050, 0.020                         | pre-buy/low buy, pre-buy/no buy | 0.200                                | None            | -                                                   | -     |
| 1                            |                                      |                                 | 0.020                                | pre-buy/no buy  | -2.2%                                               | -6.5% |
| 2                            |                                      |                                 | 0.050                                | pre-buy/low buy | 0.7%                                                | 1.8%  |

<sup>a</sup> 0.050 g/bhp-hr standard applies to 2024-2026 and the 0.020 g/bhp-hr standard applies to 2027+ engine model years

<sup>b</sup> Federal FTP standards apply to 2027+ engine model years

<sup>c</sup> HD Trucks include MHD and HHD trucks

Emission Increases

Emission Decreases

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## DISCUSSION

- Comparison of 0.020 g/bhp-hr FTP standard scenario to base case:
  - NOx emissions increases from 2.2%-11.6%.
  - **Main Reason for Emission Changes:** Pre-buy/no buy-related effects cause NOx emission increases. Diesel truck activity from 2027+ engine model years is shifted to older model years. The shift to older model year trucks results in higher emissions because older diesel trucks have higher accumulated mileage and therefore higher emission rates compared to newer trucks.
  - **Other Reasons for Emission Changes:** To a small extent, increased activity for low emissions, natural gas vehicles offsets emission increases due to the pre-buy/no buy market response.
  - **Factors that have No Effect on Emissions:** Under pre-buy/no buy market response assumptions, no vehicle certified to federal standards will meet the 0.020 g/bhp-hr FTP standard.
- Comparison of 0.050 g/bhp-hr FTP standard scenario to base case:
  - NOx emissions decreases from 0.7%-23.0%.
  - **Main Reason for Emission Changes:** Vehicles with engines certified to the 0.050 g/bhp-hr FTP standard (i.e., 2027+ engine model years) result in lower emissions compared to the base case 0.20 g/bhp-hr FTP standard.
  - **Other Reasons for Emission Changes:** Pre-buy/low buy market responses assumptions offset emission decreases due to the 0.050 g/bhp-hr Federal emission standard, to a small extent.

END



## MOVES3 ASSUMPTIONS AND LIMITATIONS

- **Geography:** US-wide outside of California emission and activity estimates are based on National-scale MOVES3 runs. National-scale California-wide MOVES3 output was subtracted from National-scale US-wide MOVES3 output to estimate outside of California emissions and activity.
- **MOVES3 Limitations/Assumptions**
  - Glider Emissions are assumed to be unaffected by a new FTP standard. Gliders are HHDs with unknown older engine model years
  - MHD Natural Gas vehicles are not included in MOVES3
  - MOVES3 only includes idle emissions for Combination Unit Long-Haul Trucks
  - Crankcase running exhaust and auxiliary power exhaust are assumed to be unaffected by a new FTP standard
  - Consistent with MOVES3 assumptions, chassis model year is assumed equivalent to engine model year
  - MOVES3 model year fleet assumes a maximum vehicle age of thirty (30) years