

# Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards

## Overview Briefing of the Proposal for UNECE GRPE

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JUNE 1<sup>ST</sup>, 2022

# Context for EPA Heavy-Duty Proposal

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- The **heavy-duty industry is diverse**, spanning delivery trucks, tractor-trailers, school buses, and other types of vocational vehicles
- Heavy-duty vehicles **contribute significantly to local, regional, and global air pollution**
- The Clean Air Act gives EPA authority to set standards for heavy-duty engine and vehicle emissions to **protect public health and welfare**
  - In considering stringency, EPA's feasibility assessment must consider **technologies** needed to reduce the air pollutant emissions, **lead time** needed to bring technologies to the market, and **cost** for the industry to comply
  - Standards for hydrocarbons (HC), carbon monoxide (CO), oxides of nitrogen (NOx) and particulate matter (PM) must "**reflect the greatest degree of emission reduction achievable ...**", for the applicable model year, and provide **a minimum of 4 years lead-time**, and 3 years of stability between new standards
- EPA's last heavy-duty rulemaking for these pollutants was over 20 years ago, with standards that phased in through 2010.

# Categories of Highway Vehicles

## Heavy-Duty Engines & Vehicles

Light-Duty Vehicles



Medium-Duty Vehicles

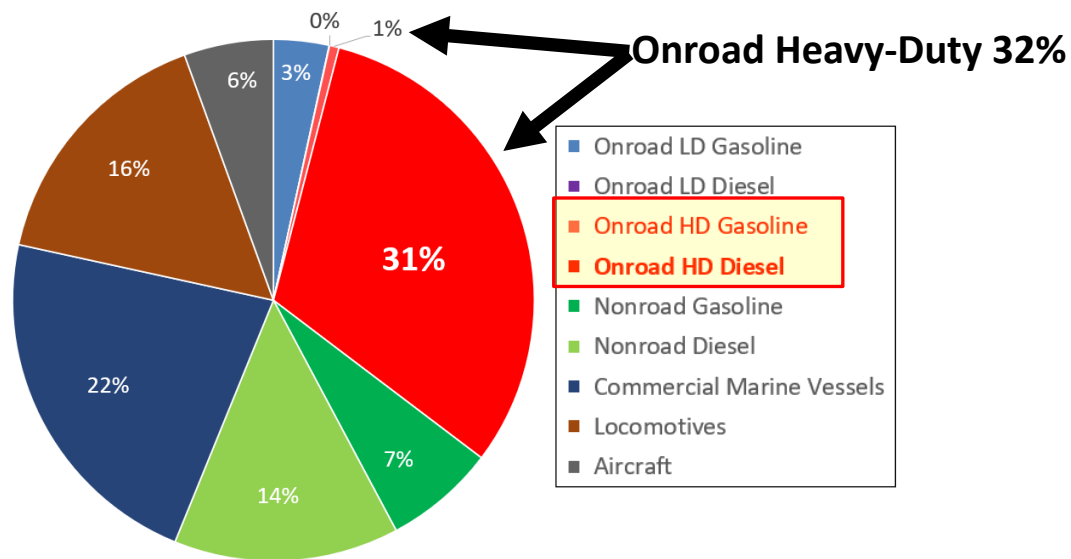


This proposed action's primary focus is on **heavy-duty vehicles and the engines/powertrains** which drive them

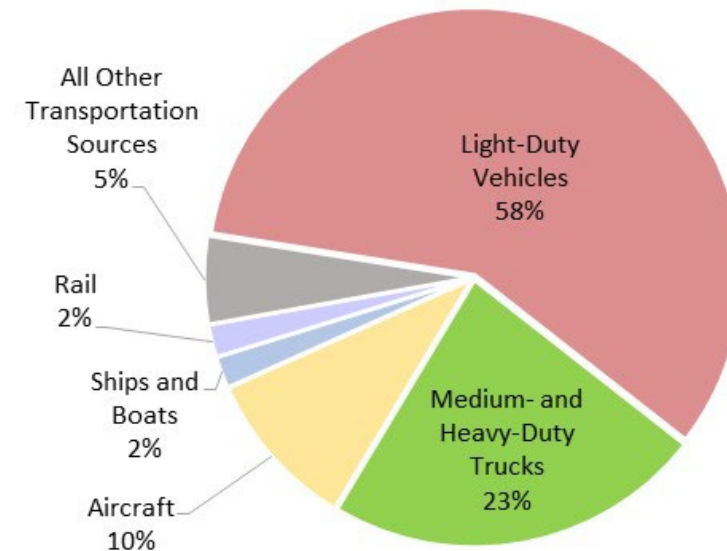
# Highway Heavy-Duty Vehicle Emission Inventories

- Heavy-duty vehicles contribute significantly to local, regional, and global air pollution
  - Largest source of mobile source NOx
  - Second largest source of GHG emissions in the transportation sector

Mobile Source NOx (2045)



Mobile Source GHGs (2019)



MOVES3 for onroad and nonroad and 2016 Emissions Modeling Platform for all other mobile sectors

“Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019,” EPA 430-R-21-005

# EPA's Clean Truck Plan: A Road Map to a Zero Emission Future

Federal Register	<b>Presidential Documents</b>
Vol. 86, No. 151	
Tuesday, August 10, 2021	
Title 3—	Executive Order 14037 of August 5, 2021
The President	Strengthening American Leadership in Clean Cars and Trucks

EPA is developing multiple heavy-duty rules under our Clean Truck Plan, consistent with EO 14037:

- 1) This proposal to set more stringent NOx standards for **heavy-duty engines & vehicles** beginning in model year (MY) 2027 and tightening the “Phase 2” greenhouse gas (GHG) emissions for MY 2027 and beyond.
- 2) An upcoming proposal to set more stringent emissions standards for **medium-duty vehicles** for MY 2027 and later. These revised standards will be proposed in combination with new standards for **light-duty vehicles** for MY 2027 and beyond.
- 3) An upcoming proposal to set “Phase 3” GHG standards for **heavy-duty vehicles** beginning as soon as MY 2030 that are significantly stronger than the MY 2027 GHG standards.

# Overview of Proposal

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- EPA presents two regulatory options for new NOx standards:
  - Both would change key provisions of the heavy-duty emission control program
    - Proposed Option 1: starts in MY 2027 with final step in MY 2031 that provides up to 90% reduction in NOx standard over the city (FTP) and highway (SET) driving cycles\*
    - Proposed Option 2: starts in MY 2027 with no phase-in; provides 75% reduction in NOx standard over the FTP and SET driving cycles
  - Request comment on both regulatory options and the range in between them, as well as an Alternative presented
- Targeted updates to existing Heavy-Duty GHG Phase 2 Program
  - Proposal would revise MYs 2027 and later GHG emission standards for specific vehicle subcategories to reflect known electric vehicle products

\*level of reduction varies by useful life period and engine regulatory class

# Proposed Criteria Pollutant Program

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# Key Program Elements to Reduce Emissions

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- The proposal includes changes to 4 key program elements
  - **Test Procedures**
  - **Regulatory Useful Life**
  - **Numeric Emission Standards**
  - **Emissions Warranty**



# Applying Four Program Elements:

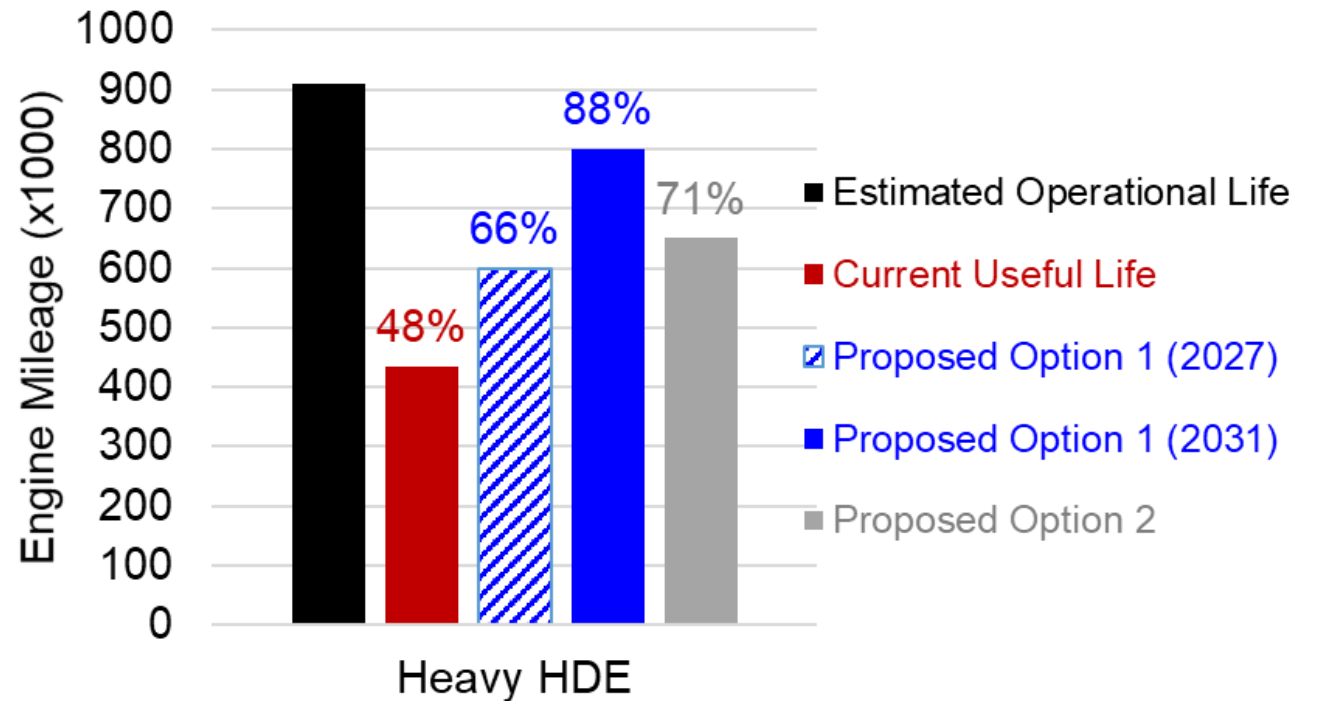
## Update Test Procedures

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- Significant data collected by EPA, OEMs, and many other stakeholders makes it clear that EPA's existing test procedures do not adequately address all vehicle operations
- EPA is proposing to change existing test procedures, and add new test procedures to cover all vehicle operations
  - New laboratory duty cycle (a “low-load” cycle) and standards to cover stop-and-go and idle operation
  - Updated test procedure and standards for vehicles on-the-road (“off-cycle”)
  - Lower emissions standards for the existing laboratory duty cycles that cover FTP and SET operation

# Applying Four Program Elements: Update Regulatory Useful Life

- We estimate the “operational life” of engines based on average mileage at time of rebuild or replacement.
- Our rebuild and replacement data suggest engines remain in the field at **least twice their current regulatory useful life** across all heavy-duty classes.
- Longer useful life can ensure engines are designed to meet emission standards through more of their operational life
  - Values also must be technically grounded in the capabilities of the emissions control technology



*Values shown are % of operational life*

# Applying Four Program Elements: Update Emissions Standards

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- Evolution of today's selective catalytic reduction (SCR) technology and use of existing cylinder deactivation hardware can reduce NOx emissions by 90% or more for diesel engines over a wide range of engine operation:
  - Close-coupled SCR (or dual SCR) allows the catalyst to warm up quickly
  - Cylinder deactivation under low-load conditions keeps the SCR catalyst warm
- Strategies to optimize three-way catalyst performance can reduce HC and CO emissions from gasoline engines
- Multi-year engine demonstration program at SwRI
  - Accelerated aging of two aftertreatment systems to the equivalent of 800,000 miles
  - Laboratory testing of advanced technologies on regulatory cycles and on-the-road (or in-use) cycles
    - Regulatory cycles: FTP (urban driving), SET (highway driving), and the LLC (low load cycle)
    - Five on-the-road cycles that cover a range of operation from ports and city operation, to highway operation through the mountains
- These technologies are well understood, already in production, and are not expected to negatively impact reliability of the model year 2027 products

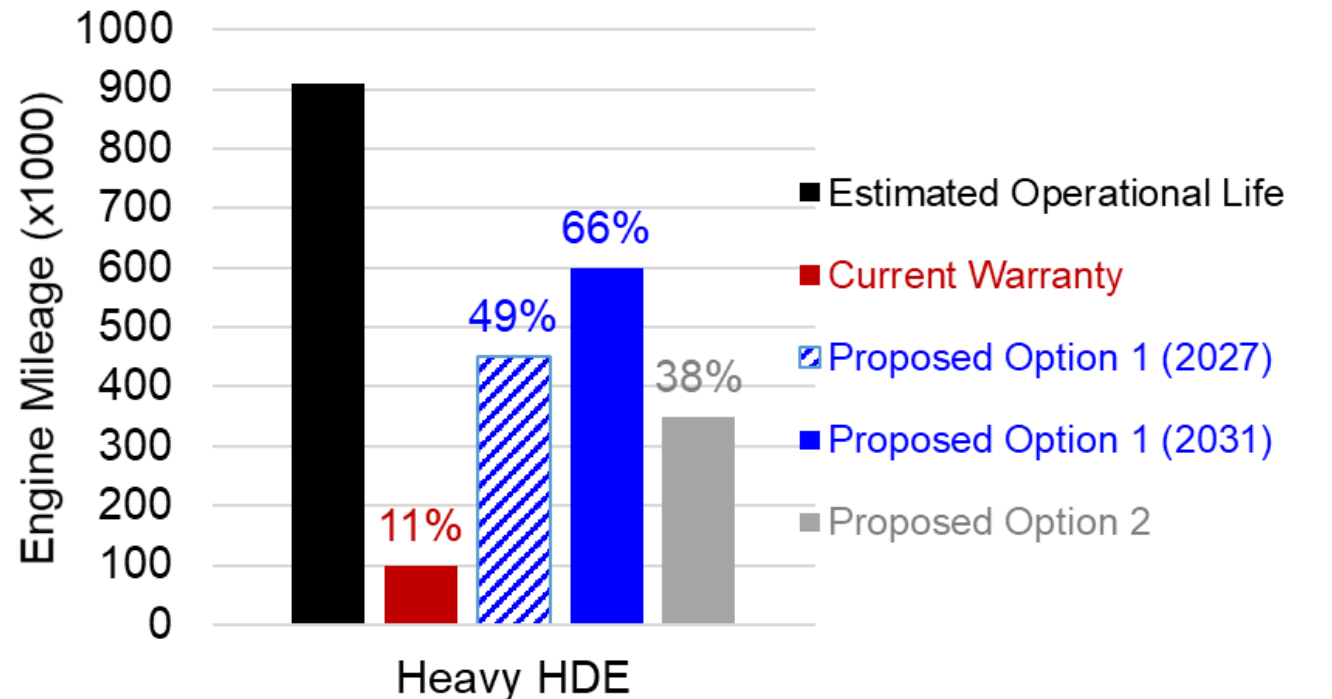
# Applying Four Program Elements: Update Emissions Standards

	Reduction from current FTP and SET driving standard (%)	Key differences between Options*
<b>Proposed Option 1 (MY 2031)</b>	90% for Light, Medium and Spark Ignition HDE	<ul style="list-style-type: none"> <li>Provides phase-in to lower levels of standards, whereas proposed Option 2 begins fully in 2027.</li> <li>Includes lower numeric standards for all duty cycles than proposed Option 2</li> </ul>
	90% for Heavy HDE at IUL	
<b>Proposed Option 2</b>	75% for all HDE	<ul style="list-style-type: none"> <li>Standards could be met with less improvement to the durability of the technology than required for the proposed Option 1.</li> </ul>

\*Useful life and warranty periods vary between Options

# Applying Four Program Elements: Update EPA Emissions Warranty

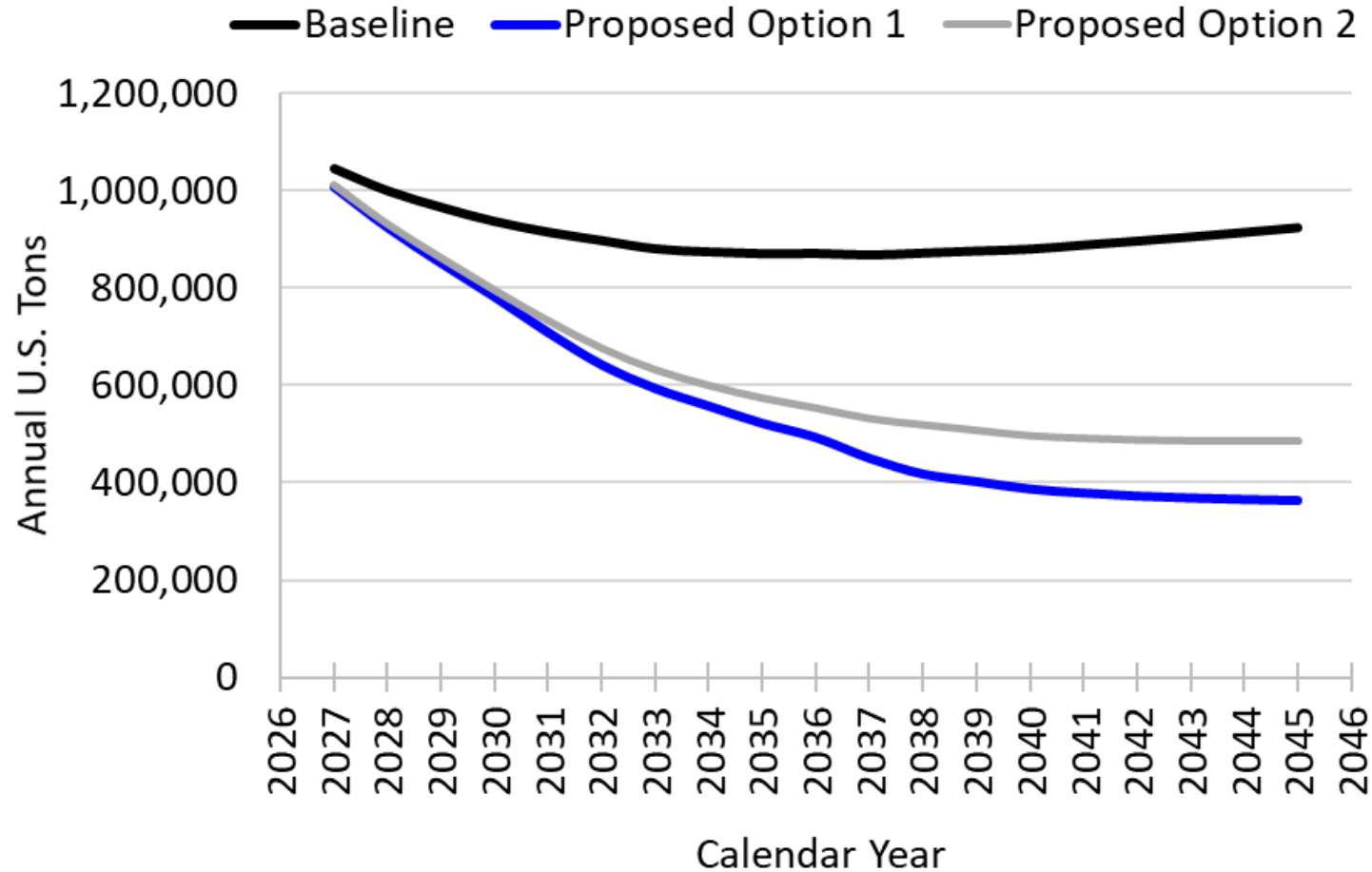
- Warranty ensures end-users don't bear all the risk of emission technologies that fail prematurely
- Current warranty periods for most heavy-duty engine classes cover a small fraction of real-world operation
- We propose to lengthen warranty, in part, because owners are **more likely to make repairs and less likely to tamper** if emission controls are covered by warranty



*Values shown are % of operational life*

Note: We estimate the “operational life” of engines based on average mileage at time of rebuild or replacement.

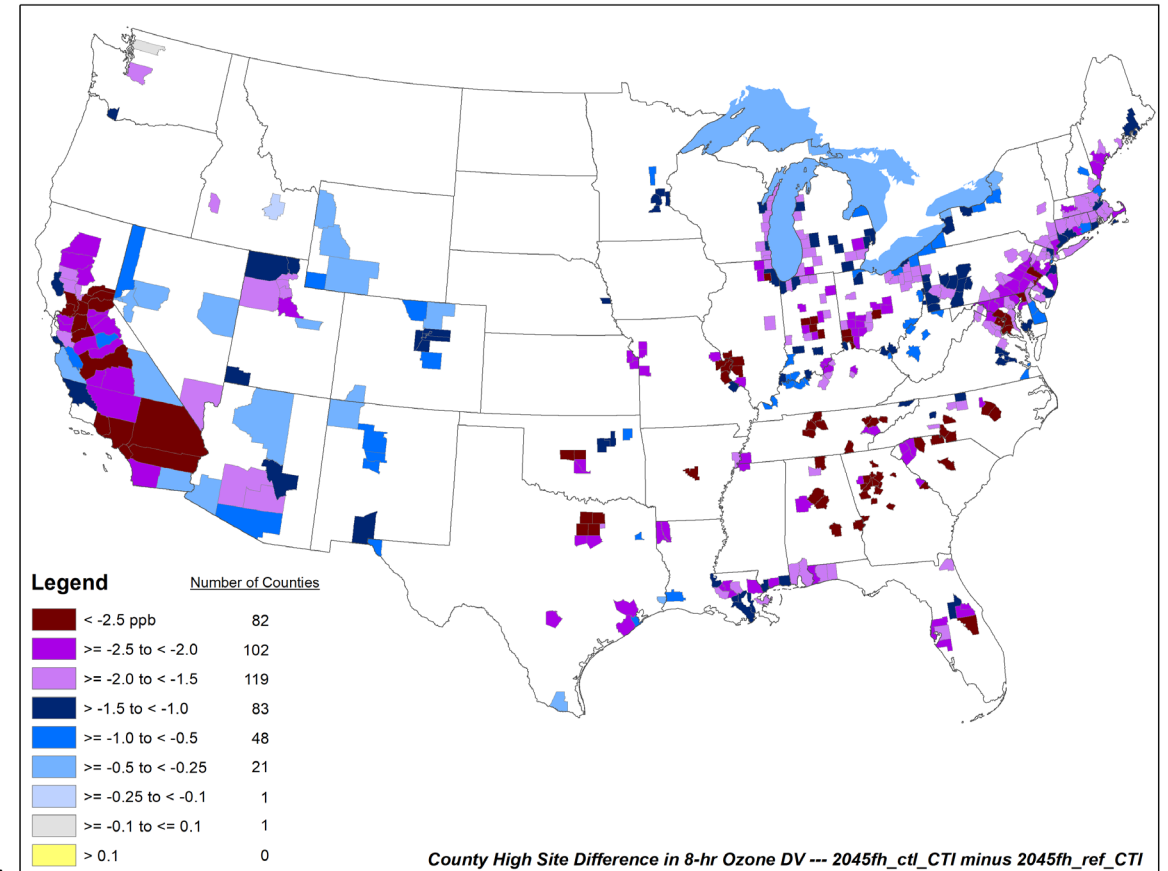
# Heavy-Duty Highway NO<sub>x</sub> Emissions Inventory: Baseline versus Proposed Options 1 and 2



	NO <sub>x</sub> Reduction (%)	
	CY 2036	CY 2045
<b>Proposed Option 1</b>	43%	61%
<b>Proposed Option 2</b>	37%	47%

# Projected Air Quality Improvements of Option 1

- The proposed Option 1 would reduce concentrations of ozone and PM<sub>2.5</sub> across the country
- Ozone decreases are especially significant
  - Average pop-wtd decrease in ozone design value for all counties in 2045: 2.2 ppb
- Modeling projects some continued nonattainment in 2045 without the proposal, including in areas outside CA
  - 15 counties in CA, NY, CT, UT, WI, TX
- The proposed Option 1 would reduce concentrations in counties projected to be over the standard
  - Average pop-wtd decrease in ozone design value for all counties where reference case is projected above the level of the NAAQS (70 ppb) in 2045: 3.0 ppb



Projected Change in 8-hour Ozone Design Values in 2045 for the proposed Option 1

# Technical Work Included in the Proposal

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- New assessment of NOx emission aftertreatment system (EAS) aged out to the equivalent of 800,000 miles (See Preamble Section III, Draft RIA Chapter 3, EPA Technical Memo “Test Results from EPA Diesel Demonstration”)
- New cost estimation for EAS and CDA from peer-reviewed teardown study conducted by FEV (See Draft RIA Chapter 3)
- New methodology for projecting emission warranty costs (See Draft RIA Chapter 7)
- New, peer reviewed, analysis on the potential impacts of EPA regulations on heavy-duty vehicle sales (pre- and low-buy) (See Draft RIA Chapter 10)



# Targeted Revisions to Heavy Duty GHG Phase 2

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# Background: HD GHG Program Highlights

- Standards set by heavy-duty regulatory categories, e.g., tractors, vocational vehicles, large pickups/vans
- Phase 1 vehicle standards implemented 2014 through 2018; Phase 2 program started in MY 2021, fully phase in by MY 2027

**Combination  
Tractors**



**Vocational Vehicles**



**Large Pickups & Vans**



When designing program in 2016, EPA envisioned these technologies *could* be used to meet Phase 2:

- Engine, transmission, and driveline improvements
- Extended and workday idle reduction technologies
- Aerodynamic devices
- Lower rolling resistance tires
- Automatic tire inflation systems
- Weight reduction
- Engine stop start
- Powertrain hybridization
- Combustion optimization
- Improved air handling
- Reduced friction within the engine
- Improved emissions after-treatment technologies
- Engine waste heat recovery

# Background: How Does the GHG Phase 2 Program Work?

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## ***Performance-based standards to capture the diversity in heavy-duty vehicles and operations***

- Standards are first differentiated between tractors and vocational vehicles as shown in detail on the next slide
  - Vocational vehicles are divided into 23 different **subcategories for setting standards** – 8 of these are for specialized vehicles
  - For tractors, standards are divided into 10 different **subcategories** for standards
  - In total, there are 33 unique HD vehicle subcategories for standards for Model Year 2027 (in addition to the MY 2021 and MY 2024 standards)
- Vehicles are produced that have emissions at, above, or below the standard, and a company's compliance is based on a *sales-weighted average*
- Averaging, Banking and Trading (ABT) program allows emissions credits to be generated and used in meeting the standards

# Proposed Revisions to GHG Standards in the HD 2027 NPRM

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- We used EPA certification data, California Advanced Clean Truck (ACT) mandate values, industry product announcements, and other data sources to project the expected percentage of EVs in the national market for MY 2027 for vocational vehicles (which includes school buses, urban buses, and delivery trucks) and tractors (which includes day cabs)
- EV manufacturers today are certifying into nearly all of the vocational vehicle subcategories, with school and urban buses in many of these, and into day cab tractor subcategories
- The data shows that these EV products are being certified in 17 of the 33 Vocational and Tractor regulatory categories defined in the Phase 2 program structure
- We estimate a market penetration of 1.5% ZEVs in these categories in MY 2027
  - Request information and data available that would support higher HD ZEV penetration rates in this timeframe (e.g., 5 or 10% or more)
- We propose to increase the stringency of the MY 2027 standards for these 17 vehicle categories to reflect the market penetration of ZEVs in these vehicle categories
  - Request comment on the potential for progressively more stringent CO<sub>2</sub> standards across model years 2027, 2028 and 2029

# Additional request for comments on HD GHG Phase 2 program revisions

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Phase 2 includes large CO<sub>2</sub> credit multipliers for MY 2027 and earlier vehicles with advanced technology, designed to incentivize the market.

EPA requests comment on three different approaches to limit the potential impact on GHG emissions due to the EV credit multipliers. With all three approaches, EVs would continue to be deemed to have zero grams CO<sub>2</sub> per ton-mile emissions for vehicles produced over the cap.

1. All EVs certified in California in MY 2024 through MY 2027 would not receive the advanced technology credit multiplier that currently exists.
2. Cap use of the multiplier to reflect a 1% level of EV production.
3. Transition the credit multipliers by lowering them each model year.

# Public participation

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- Several opportunities to provide comments:
  - Public comment period March 28<sup>th</sup> – May 16<sup>th</sup>
  - Public hearings for this proposal on April 12<sup>th</sup> and 13<sup>th</sup>
- More information on the proposal and how to provide input is available on the EPA rule webpage: <https://www.epa.gov/regulations-emissions-vehicles-and-engines/proposed-rule-and-related-materials-control-air-1>
- Goal is to issue final rule in December 2022
  - To provide Clean Air Act 4-year lead-time to enable new NOx standards to begin in Model Year 2027