

Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles – Phase 3

Overview Briefing of the Proposal Presentation for National Association of Clean Air Agencies (NACAA) Mobile Source and Fuels Committee & for the Northeast States for Coordinated Air Use Management (NESCAUM)

US EPA, OFFICE OF TRANSPORTATION AND AIR QUALITY

APRIL 25, 2023



Agenda

- Background: Authority, Need and Phases 1 and 2 GHG Rules
- What's Changed Since Phase 2
- Proposal Scope, Highlights and Stringency of Standards
- Technical Analysis and Projected Mix of Technologies for Meeting Standards
- Emissions Impacts, Benefits, and Costs
- Model Year 2027 Advanced Technology Credit Multipliers
- Other Program Elements
- Public Participation

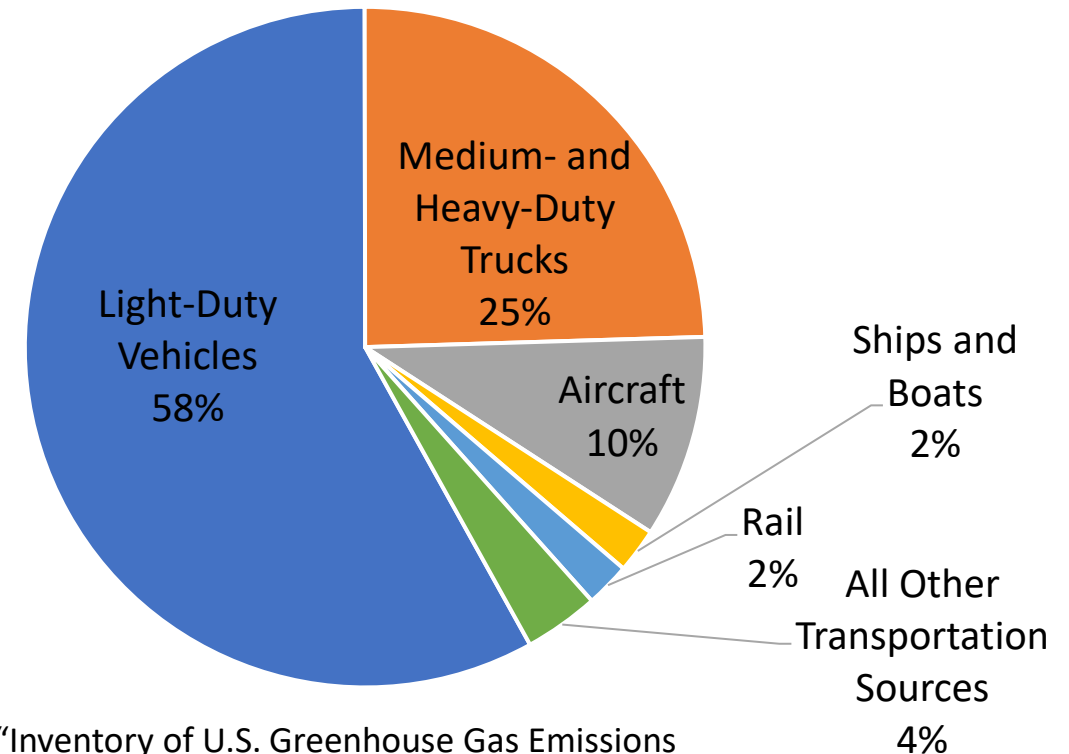
Background: Key Statutory Provisions and Importance of Reducing HD Air Pollution



Clean Air Act Statutory Authority

- Section 202(a)(1) of the Clean Air Act (CAA) requires the EPA to “by regulation prescribe (and from time to time revise) . . . standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines. . . , which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare.”
- Standards take effect "after such period as the Administrator finds necessary to permit the development and application of the requisite technology, giving appropriate consideration to the cost of compliance within such period."
- **EPA also must consider issues of technological feasibility, compliance cost, and lead time. EPA may consider other factors.**

HD is the 2nd largest source of GHG emissions in the transportation sector, and a significant source of local & regional air pollution



“Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020,” EPA 430-R-22-003

Background: HD GHG Phases 1 and 2 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 2021, fully phase in by 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



What Has Changed Since Phase 2?

- EPA has considered new data and recent policy changes and we are now projecting that zero-emission vehicle (ZEV) technologies will be readily available and technologically feasible much sooner than we had projected when we established the Phase 2 rule
- **HD ZEV market**
 - Over 200 models in use today for some applications, many more applications to come
 - Costs of ZEV technologies are projected to fall
 - Manufacturers have set goals for ZEV sales reaching 50-60% by 2030
- **Inflation Reduction Act and Bipartisan Infrastructure Law** provide many monetary incentives to support the supply chain, production, and purchase of HD ZEVs and associated infrastructure
- Actions by states to accelerate adoption of HD ZEVs
 - **Multi-State Medium- and Heavy-Duty Zero Emission Vehicle MOU** signed by 17 states, D.C., and Quebec to achieve 100% MHD ZEV sales by 2050 and 30% by 2030 in their jurisdictions
 - California's **Advanced Clean Trucks** program adopted by 8 states and requiring 40-75% MHD ZEV sales by 2035
- These developments support the feasibility of ZEV technologies and render adoption of ZEV technologies to reduce GHG emissions more cost-competitive than ever before

Scope of HD Phase 3 and EO 14037

Light- and Medium- Duty Proposal

Light-Duty



Medium-Duty



This Proposal

Vocational Vehicles



Short-haul Tractors



Long-haul Tractors



Executive Order 14037, “Strengthening American Leadership in Clean Cars and Trucks,” August 2021, provides EPA direction for this rulemaking

Medium- and Heavy-Duty Engines and Vehicles Greenhouse Gas and Fuel Efficiency Standards as Soon as 2030 and Later.

*(3b) The Administrator of the EPA shall, as appropriate and consistent with applicable law, and in consideration of the role that zero-emission heavy-duty vehicles might have in reducing emissions from certain market segments, **consider updating the existing greenhouse gas emissions standards for heavy-duty engines and vehicles beginning with model year 2027 and extending through and including at least model year 2029.***

*(4a) The Administrator of the EPA shall, as appropriate and consistent with applicable law, consider beginning work on a rulemaking under the Clean Air Act to establish **new greenhouse gas emissions standards for heavy-duty engines and vehicles to begin as soon as model year 2030.***



HD GHG Phase 3 Highlights

- EPA is not proposing a ZEV mandate. We are proposing stronger performance-based CO₂ emission standards that begin in MY 2027 and phase in **through MY 2032**. We also request comment on standards more and less stringent than the proposal.
- The proposed standards **align with and support the commitments and investments** from trucking fleets, vehicle manufacturers, and U.S. states as they plan to increase the use of zero-emission vehicle (ZEV) technologies in heavy-duty fleets
- The proposal considers new information such as the **Bipartisan Infrastructure Law and the Inflation Reduction Act**, which provide unprecedented investments to support the development of and market for ZEV technologies and their infrastructure



Phase 3 Builds off of Phase 2's Program Structure

- **Phase 3 standards maintain the flexible structure** created in EPA's Phase 2 GHG program, which is designed to reflect the diverse nature of the heavy-duty industry
- The proposed standards are **performance based and do not mandate the use of a specific technology**
- Standards are first differentiated between tractors and vocational vehicles
 - Vocational vehicles are divided into 23 different **subcategories for setting standards** – 8 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 each model year of the program
- Optional CO₂ Emissions Averaging, Banking and Trading (ABT) program
 - Allows emissions credits to be generated and used to meet the standards
 - 5-year credit life, 3-year deficit carry forward
- Note: We are not proposing to change the separate CO₂, N₂O and CH₄ standards for HD engines set under the Phase 3 program



Stringency of Standards for the Proposal

- The proposed Phase 3 program would update the existing MY 2027 GHG emission standards and set new GHG emission standards starting in MYs 2028 through 2032 and later for HD vehicles. The proposed standards:
 - are numeric CO₂ emission values in grams/ton-mile by regulatory subcategory and can be found in Section II of the preamble
 - would increase in stringency every model year from 2027 through 2032 for vocational vehicles and short-haul tractors
 - would start in 2030 and increase in stringency in model years 2031 and 2032 for long haul tractors
- The proposed standards are strong, reflecting our projection that heavy-duty ZEV technology will grow from approximately 0.2% in model year 2021 to 25% of long-haul tractors, 35% of short-haul tractors and 50% of vocational vehicles in model year 2032
- EPA requests comment on an alternative set of CO₂ standards that would more gradually increase in stringency than the proposed standards for the same model years
- The preamble also includes a broad range of requests for comment on setting CO₂ standards based on:
 - values less stringent than the lower stringency alternative for certain market segments
 - values in between the proposed standards and the alternative standards
 - values in between the proposed standards and those that would reflect ZEV adoption levels (i.e., percent of ZEVs in production volumes) used in California's ACT
 - values that would reflect the level of ZEV adoption in California's ACT program
 - and values beyond those that would reflect ZEV adoption levels in ACT such as the 50- to 60-percent ZEV adoption range represented by the publicly stated goals of several major manufacturers for 2030
- EPA also requests comment on setting new standards with increasing stringency in MYs 2033 through 2035

Analysis of Technologies that *Could* be Used to Meet Phase 3



- In the timeframe of this rule, we believe that technologies that reduce CO₂ emissions from vehicles with internal combustion engines, such as those we expect to see under Phase 2, will continue to play important roles in reducing GHG emissions.
- Recent potential for the **application of ZEV technologies** presents an opportunity for **significant reductions in heavy-duty GHG emissions** over the long term. So for Phase 3, EPA also evaluated ZEV technologies, including **battery electric vehicles and fuel cell electric vehicles**, and the needed **infrastructure** to support these technologies
- For this evaluation, EPA developed a tool to evaluate design features that would be needed for a HD vehicle to perform its functions using ZEV technology, considering:
 - HD vehicles perform **lots of different kinds of work**, e.g., carrying passengers, moving freight, pushing snow, fixing utilities, etc.
 - The **amount of energy** each type of HD vehicle needs **to perform this work** (including driving, heating/cooling, work typically performed by power take-off units)
- We also estimate the incremental upfront cost of the technologies, the operating costs, depot charging equipment and installation costs, and **how long it would take to recover the increased upfront cost (the “payback” period)**

Aggregated Projected Mix of Technologies by Model Year

- For each model year of the program, we projected a technology mix that could be used to meet the proposed standards and those we ask for comment on by aggregating projected ZEV adoption rates from 100+ individual vehicle types
- Underlying these aggregated ZEV adoption rates, we expect some specific vehicle applications to achieve much higher adoption rates, e.g., 80% for step vans by 2032

ZEV Adoption Rates in the Technology Packages that Support the Proposed Standards

Proposal	2027	2028	2029	2030	2031	2032
Vocational (light/medium/heavy types shown on next page)	20%	25%	30%	35%	40%	50%
Short-Haul Tractors	10%	12%	15%	20%	30%	35%
Long-Haul Tractors	0%	0%	0%	10%	20%	25%
Alternative	2027	2028	2029	2030	2031	2032
Vocational	14%	20%	25%	30%	35%	40%
Short-Haul Tractors	5%	8%	10%	15%	20%	25%
Long-Haul Tractors	0%	0%	0%	10%	15%	20%
Seek Comment – CARB ACT Rule	2027	2028	2029	2030	2031	2032
Vocational	20%	30%	40%	50%	55%	60%
Tractors	15%	20%	25%	30%	35%	40%



Vocational Vehicle Projected ZEV Adoption By Model Year

- We expect ZEV adoption to vary by vocational vehicle type and our projections at a finer scale are shown in the table below
- We propose maintaining the same structure in Phase 2 where manufacturers of certain vocational vehicle types can meet optional custom chassis standards that are exclusive to these types - as shown in the table, we expect to see ZEV adoption for buses, refuse haulers, and concrete mixers

ZEV Adoption Rates that Support the Proposed Vocational Vehicle Standards

Regulatory Subcategory	MY 2027	MY 2028	MY 2029	MY 2030	MY 2031	MY 2032
Light-Heavy Duty Vocational	22%	28%	34%	39%	45%	57%
Medium-Heavy Duty Vocational	19%	21%	24%	27%	30%	35%
Heavy-Heavy Duty Vocational	16%	18%	19%	30%	33%	40%
Optional Custom Chassis: School Bus	30%	33%	35%	38%	40%	45%
Optional Custom Chassis: Other Bus	0%	6%	11%	17%	23%	34%
Optional Custom Chassis: Coach Bus	0%	0%	0%	10%	20%	25%
Optional Custom Chassis: Refuse Hauler	15%	19%	22%	26%	29%	36%
Optional Custom Chassis: Concrete Mixer	18%	21%	24%	27%	29%	35%

- We are not proposing to change the Phase 2 optional custom chassis standards for emergency vehicles, recreational vehicles and mixed use vehicles, as we project minimal ZEV adoption for these vehicles types

Projected Emission Impacts of the Proposed GHG Standards

- GHG Emission Impacts
 - **Net (downstream and upstream) cumulative CO₂ reductions of 1.8 billion metric tons through 2055**
 - Downstream CO₂ reductions of **2.2 billion metric tons** through 2055
 - Upstream CO₂ increases from power plants of **0.4 billion metric tons** through 2055
 - **Equivalent to a whole year's emissions from the entire transportation sector**

- Non-GHG emission impacts that would result from increased use of ZEV technology projected under the Phase 3 program
 - In 2055 (U.S. Short Tons)

Pollutant	Downstream Vehicle Emissions	Electricity Generation Units	Refinery	Net Impact
Nitrogen Oxides (NO _x)	-71,000	790	-1,800	-72,000
Primary PM _{2.5}	-970	750	-440	-650
Volatile Organic Compounds (VOC)	-21,000	750	-1,200	-21,000
Sulfur Dioxide (SO ₂)	-520	910	-640	-250



Expected Environmental Justice Impacts

- People of color, low-income populations and/or indigenous peoples may be especially vulnerable to the impacts of climate change and this proposal would reduce GHG emissions and thus contribute to efforts to reduce the probability of severe impacts related to climate change.
- The proposed standards would also reduce air pollution near roads
 - Near-roadway communities are often low income or communities of color, and children who attend school near major roads are disproportionately represented by children of color and children from low-income households
 - These populations would benefit most directly from the projected emission reductions
 - Reducing these emissions would also provide cleaner air for communities across the country, prevent health issues like asthma, and ultimately save money, lives, and trips to the hospital



Monetized Benefits to Society

- The Phase 3 Program would reduce adverse impacts associated with climate change and exposure to non-GHG pollutants and thus would yield significant benefits, both monetized and unmonetized
- EPA estimates that monetized **net benefits to society would be approximately \$320 billion** through the year 2055, **more than 5 times the cost** in vehicle technology and associated electric vehicle supply equipment (EVSE) combined
- The cost of vehicle technology (not including the vehicle or battery tax credits) and EVSE would be approximately \$9 billion and \$47 billion respectively
- The HD industry would save approximately \$250 billion in operating costs (e.g., savings that come from less liquid fuel used, lower maintenance and repair costs for ZEV technologies as compared to ICE technologies, etc.)
- **Significant social benefits include:**
 - \$87 billion in climate benefits
 - Between \$15 billion and \$29 billion in reduced emissions of non-GHG pollutants, primarily those that contribute to ambient concentrations of PM_{2.5}
 - \$12 billion in energy security benefits from 4.3B barrels of reduced oil imports

Values presented here are present value for 2027 through 2055 at 3% discount rate in 2021 dollars

Estimated Cost to **Manufacturers** for Model Year 2032 Vehicles

- The **per-vehicle estimated cost to manufacturers** for a **2032 ZEV relative to a comparable internal combustion engine vehicle** are shown by regulatory group in the table below
- These estimates account for the battery tax credit under the Inflation Reduction Act (IRS 45X), but not the vehicle tax credit (IRS 45W) as this credit is available to purchasers (next slide)

Regulatory Group	Fleet-Average Per-Vehicle Manufacturer Cost
LHD Vocational	-\$4,300
MHD Vocational	\$330
HHD Vocational	\$2,300
Short-Haul (Day Cab) Tractors	\$8,000
Long-Haul (Sleeper Cab) Tractors	\$11,000

For comparison, the projected fleet average per-vehicle costs projected of the HD GHG Phase 2 CO₂ standards were:

- between \$1,500 and \$5,700 per vehicle for a MY 2027 vocational vehicles
- between \$10,000 and \$14,000 per vehicle for MY 2027 tractors



Estimated Cost and Payback for **Purchasers of MY 2032 Vehicles**

- The **per-vehicle estimated upfront cost to purchasers** for a **2032 ZEV relative to a comparable internal combustion engine vehicle** are shown in the table below, including vehicle and Electric Vehicle Supply Equipment (EVSE) costs
- This is supported by incentives such as tax credits under the Inflation Reduction Act, including the vehicle tax credit (IRS 45W) and the battery tax credit (IRS 45X)
- We project the upfront cost increases would be recouped by owners over the vehicle lifetime through operational savings, with pay back periods ranging from 1 to 7 years

Regulatory Group	Upfront vehicle cost difference (including tax credits)	Upfront EVSE costs	Annual Operational Savings (fuel, M&R)	Payback period (year)
LHD Vocational	-\$9,600	\$11,000	\$4,000	1
MHD Vocational	-\$2,900	\$14,000	\$5,400	3
HHD Vocational	-\$8,500	\$17,000	\$7,400	2
Short-Haul (Day Cab) Tractors	\$580	\$17,000	\$6,800	3
Long-Haul (Sleeper Cab) Tractors	\$15,000	\$0	\$2,300	7



Phase 2 Model Year 2027 EV Credit Multipliers

- Under the existing Phase 2 Averaging, Banking and Trading program, incentive credit multipliers are available for battery electric, plug-in hybrid, and fuel cell vehicles for 2021–2027
- We are concerned about these credits' impact on GHG emissions with the rise in EVs
- **EPA proposes to eliminate battery electric and plug-in hybrid credit multipliers beginning in 2027 (one year early).**
- **EPA proposes to leave the fuel cell credit multiplier as-is** (expires in 2027). HD vehicle market for this technology continues to be in the early stage of development.



Other Elements in the NPRM

- **Exempting small businesses vehicle manufacturers**
 - We are proposing to exempt small businesses from Phase 3 GHG standards
 - Minimal impact on emissions, few small vehicle companies, and still required to meet existing MY 2027 standards
- **EPA locomotive state preemption regulations**
 - We are proposing to revise regulations addressing preemption of state regulation of new locomotives and new engines used in locomotives to more closely align with language in the CAA
- **Heavy-Duty technical amendments**
 - We are proposing limited amendments to correct, clarify, or create consistency in the test procedures and other compliance provisions relating to highway heavy-duty engines and vehicles
- **Removing vacated Phase 2 trailer standards**



Public Participation

- **Public input is very important to EPA**
- HD Phase 3 public hearings on May 2 and 3
- Public comment period will be open for 50 days following NPRM publication in Federal Register (we expected this to be through mid-June, dependent on timing of publication)
- See our website for more information:
<https://www.epa.gov/regulations-emissions-vehicles-and-engines/proposed-rule-greenhouse-gas-emissions-standards-heavy>
- **Goal is to issue final rule in December 2023**