Comments of the American Council for an Energy-Efficient Economy (ACEEE) on the "Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles – Phase 3" Proposed Rule
(88 FR 25926)

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June 2023

The American Council for an Energy-Efficient Economy (ACEEE) welcomes the opportunity to comment on the Environmental Protection Agency's (EPA) proposed "Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles – Phase 3." ACEEE is an independent non-profit organization dedicated to advancing energy efficiency policies, programs, technologies, investments, and behaviors. ACEEE aims to build a vibrant and equitable economy, one that uses energy more productively, reduces costs, protects the environment, and promotes public health and safety. If EPA has any questions, please do not hesitate to contact Shruti Vaidyanathan, Director of Transportation, at svaidyanathan@aceee.org.

EPA must set heavy-duty standards that maximize GHG emissions reductions from transportation

Transportation is the largest source of greenhouse gas (GHG) emissions in the United States, accounting for 27% of total economy-wide emissions.[1] Medium- (MDV) and heavy-duty (HDV) vehicles, despite being just 5% of the on-road fleet, are responsible for 26% of sector-wide emissions.[2] To stave off the worst impacts of climate change, the United States will need to make rapid progress toward eliminating pollution from heavier vehicles.

EPA must issue Phase 3 standards that will put heavy-duty vehicles on a sustainable path and help to meet nationwide climate goals. Upon taking office in 2021, President Biden set an ambitious new target to reduce US GHG pollution by 50-52% by 2030 from 2005 levels.[3] The Phase 3 HDV standards must ensure that our transportation sector will contribute adequately to meeting these goals and that future progress on vehicles will help to limit the warming of the planet to no more than 1.5 degrees Celsius.[4] Recent analysis finds, however, that for the heavy-duty sector to support attainment of U.S. commitments under the Paris

[1] https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions
[2] https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions
[3] https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-president-biden-sets-2030-greenhouse-gas-pollution-reduction-target-aimed-at-creating-good-paying-union-jobs-and-securing-u-s-leadership-on-clean-energy-technologies/
[4] https://theicct.org/wp-content/uploads/2022/05/globalhvsZEV-hdzev-pace-transition-may22.pdf

Agreement for 2030 and 2050, emissions reductions will need to occur substantially faster than they would under the proposed Phase 3 standards, in combination with other policies now in place.[5]

Heavy-duty vehicles also represent a substantial share of the transportation sector's criteria air pollution such as nitrogen oxides (NO_x), sulfur oxides (SO_x), and particulate matter (PM).[6] These emissions lead to localized air pollution and the associated health impacts, such as increased rates of asthma, increased risk of heart attacks or strokes, and lung cancer, conditions that are particularly bad in low-income communities and communities of color, which have borne and continue to bear a disproportionate burden of transportation pollution.

If designed and implemented correctly, the next phase of EPA's GHG standards for heavy-duty vehicles can help the United States meet its climate goals and improve the health outcomes of historically disadvantaged communities, while also reducing fueling costs for truck and fleet owners in the short run and total ownership costs in the long run; costs that reduce competitiveness and are passed on to consumers. Rigorous updated standards that drive efficiency and emissions improvements in both internal combustion engine vehicles (ICEVs) and zero emission vehicles (ZEVs) are crucial to achieving the above goals, and EPA cannot miss the opportunity to deliver such standards for model years 2027 to 2032.

EPA must set stringency based on ambitious EV market penetration rates

EPA's proposed Phase 3 standards would constitute a major step toward the electrification of heavy-duty vehicles. Yet the market for heavy-duty electric vehicles is changing radically and rapidly , and ACEEE believes that higher adoption rates are achievable and should be included in the final standards.

Manufacturers now offer market-ready electric options in a wide variety of vehicle categories including semis and delivery vans.[7] Large corporations such as Amazon, Fedex, and Walmart have all set targets for fleet electrification and have placed substantial orders with EV manufacturers for the coming years.[8]

Additionally, recent landmark legislation has energized the market for heavy-duty EVs through major investments in EV deployment and charging infrastructure. The Inflation Reduction Act (IRA) and the Infrastructure Investment and Jobs Act (IIJA) combined have set

[5] https://theicct.org/publication/hdv-phase3-ghg-standards-benefits-apr23/
[6] https://www.ucsusa.org/resources/heavy-duty-vehicles-and-nox
[7] https://www.aceee.org/blog-post/2023/02/ev-sales-soar-electrifying-big-rigs-remains-challenge
[8] https://www.aceee.org/blog-post/2023/02/ev-sales-soar-electrifying-big-rigs-remains-challenge

aside up to $100 billion of funding for which EVs are eligible.[9] A recent report by the International Council for Clean Transportation found that the tax credits in IRA alone could encourage rapid EV uptake in the heavy-duty sector, reaching 44%-52% sales share by 2032.[10]

Nevertheless, additional research has found that the recent landscape of electrification policies -the Phase 2 GHG standards, state adoption of California's Advanced Clean Truck rule, and IRA incentives - and manufacturer commitments will not go far enough to align with our nation-wide climate goals.[11] It is crucial that EPA take the opportunity of the Phase 3 standards to push for the highest feasible level of EV adoption and contribute adequately to the achievement of national climate goals.

The collaboration of other stakeholders will be essential to large-scale EV deployment. In particular, utilities must step up to the plate and commit to EV charging and grid improvement investments for EV adoption in both the light- and heavy-duty sectors. Vehicle electrification presents a major business opportunity for these companies, and as a result, utilities have a big role to play in driving transportation decarbonization. EPA cannot wait for other stakeholders to lead the way, however, and must set a pace for EV adoption that meets the needs and capabilities of the nation.

Phase 3 targets should account for actions taken to date by manufacturers and federal and state governments to drive vehicle electrification. In light of the rapid push to zero emissions vehicles globally, standards based on aggressive electrification are essential for the economic wellbeing of the country and the success of HDV manufacturers (OEMs) in the U.S. All major global vehicle markets have adopted or are working on requirements to electrify heavy-duty vehicles. Setting a pace that keeps U.S. manufacturers at the forefront of this transition will boost their position, help them maintain or grow share as buying patterns shift, and prevent laggards from gaining near-term advantages by postponing investment in ZEV technology.

To be effective, the standards should be ambitious enough to drive the industry beyond what the market alone will deliver. The proposed standards reflect EPA's projected ZEV adoption rates based on ZEVs' ability to meet buyers' payback requirements and perform the same work as an ICEV in each vehicle application. A well-functioning market should deliver these levels of ZEV adoption, but market barriers such as fleets' lack of familiarity with the technology may prevent this. In that case, the role of standards is precisely to address those barriers and close the gap between market-driven and economically feasible levels of adoption. Indeed, this view underlies the approach that NHTSA and EPA have taken

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[9] https://www.atlasevhub.com/data_story/3-billion-in-federal-funding-for-evs-to-date/
[10] https://theicct.org/wp-content/uploads/2023/01/ira-impact-evs-us-jan23.pdf
[11] https://theicct.org/wp-content/uploads/2023/04/hdv-phase3-ghg-standards-benefits-apr23.pdf

to vehicle standards for years and is appropriate for these heavy-duty standards as well. However, EPA's analysis of ZEV adoption rates does not adequately account for other factors driving ZEV adoption, including state actions, discussed next.

EPA should adjust its ZEV adoption projections to fully reflect state actions

EPA's analysis of MY 2032 EV sales shares for the Phase 3 standards should fully reflect states' adoption of the ACT to date, as well as further actions through the Advanced Clean Fleet (ACF) program. Both regulations will have significant impact on the market for heavy-duty vehicles nationally.

In March of 2023, EPA granted California's request for a waiver to set vehicle emissions standards related to heavy-duty vehicles.[12] The waiver gives California the authority to move forward with its Advanced Clean Truck (ACT) rule, which requires that manufacturers sell increasing numbers of MDV and HDV zero-emission vehicles.

The approval of the waiver means that California and other states that have committed to adopting ACT can implement their regulations. As of April 2023, seven states, representing 23% of total relevant vehicles sales (including California,)[13] had adopted ACT: Massachusetts, Vermont, New York, New Jersey, Washington, Oregon, and Colorado. On top of that, Maryland and Connecticut have passed ACT legislation and will soon embark on the rulemaking process. Six other states and the District of Columbia were signatories to a memorandum of understanding signed in 2020, committing to ACT adoption.[14] These 17 states represented 34% of the total medium- and heavy-duty vehicle market in 2021.[15]

While EPA's proposal reflects heavy-duty ZEV sales shares in a subset of these states in the reference case, it does not reflect the full extent of state ACT adoption. Moreover, the ZEV adoption rates EPA projects in the control case do not account for ACT-driven sales shares at all. This does not comport with EPA's stated goal of maximizing emissions reductions to the greatest feasible extent (FR 26005). EPA appropriately includes ACT state ZEV sales in the reference case, and these vehicles will still be sold under the control scenarios. The adoption rates EPA found to be feasible in its HD TRUCS analysis are below the rates required under ACT, so the ACT levels would prevail in ACT states, while the adoption rates found in the HD TRUCS analysis would remain feasible in the rest of the nation. The final rule should reflect this.

ACT requires that ZEV penetration rates for vocational vehicles will reach 60% and that 40% of tractors be ZEVs by MY 2032. EPA's proposed scenario assumes that ZEV penetration of

[12] https://www.epa.gov/newsreleases/epa-grants-waivers-californias-highway-heavy-duty-vehicle-and-engine-emission
[13] https://www.fhwa.dot.gov/policyinformation/statistics/2021/mv1.cfm
[14] https://www.nescaum.org/documents/mhdv-zev-mou-20220329.pdf
[15] https://www.fhwa.dot.gov/policyinformation/statistics/2021/mv1.cfm

vocational vehicles reaches 50% in 2032 (FR25933, Table ES-4) while short-haul tractors and long-haul tractors reach EV penetration levels of 35% and 25% respectively in 2032 and beyond. Given that the states that have already adopted ACT rules or legislation make up 23% of the heavy-duty vehicle market, EPA should, at a minimum, increase its assumed MY 2032 ZEV adoption levels by 23% of the difference between the proposed rule and ACT levels for each of those vehicle types. Table 1 highlights what this would mean for the targets for vocational vehicles and tractors in MY 2032.

Table 1. Comparison of MY 2032 ZEV Shares under EPA Proposal and with ACT Regulation Shares

Vehicle category	EPA Proposal	w/ ACT State Vehicles
Vocational trucks	50%	52%
Short-haul tractors	35%	36%
Long-haul tractors	25%	28.5%

For the final MY 2027-2032 final rule, EPA should apply ACT-projected ZEV market shares to any state that adopts ACT between now and the completion of the final rule.

Assumptions in EPA's analysis of ZEV adoption rates are too limiting

Fully incorporating the results of state actions as recommended above would not be sufficient to bring EPA's projections of ZEV adoption to highest feasible levels. Certain key elements of EPA's ZEV analysis tool, HD TRUCS, are overly conservative, leading to low projections of ZEV adoption. These include battery and payback period requirements.

EPA's battery requirements may unnecessarily limit BEV adoption in some applications, as a result of high cost or payload constraints. Examples of onerous requirements include sizing the battery for a given vehicle type to meet the daily needs for vehicle-miles-traveled (VMT) of 90% of all vehicles of that type (FR 25977). For long-haul tractors in particular, it is reasonable to expect that OEMs would offer a range of battery sizes so that fleets would not need to overspecify their trucks. However, HD TRUCS requires, for example, that a BEV Class 8 sleeper cab tractor with average daily operational VMT of 200 miles (vehicle type 78) have a battery that serves for 400 miles of daily operation. Consequently its battery is sized at more than 1450 kWh through MY 2032 and reduces the truck's payload capacity by more than EPA's threshold value of 30% until MY 2031. Such requirements result not only in long payback periods but the exclusion of BEVs for all sleeper cab trucks, with ZEVs first appearing in 2030 as fuel cell electric vehicles (FCEVs).

Another factor that may lead to prolonged, excessive battery requirements is EPA's low expectations regarding BEV efficiency improvement. Battery efficiency remains constant in MY 2027-2032, and inverter and motor efficiencies are assumed to improve by only a half percentage point over this period (Table II-6 FR 25977). Charging efficiency improves by a single percentage point (HD TRUCS). This issue is discussed further in the section below on upstream emissions.

Payback requirements may also unnecessarily constrain ZEV adoption. Time to payback determines projected ZEV penetration through the HD TRUCS adoption rate schedule set out in in Table 2-73 (p.232) of the Draft Regulatory Impact Analysis (DRIA) .[16] The schedule imposes onerous payback requirements in part because it does not differentiate by vehicle type. Typical first vehicle ownership period varies across type, affecting the payback period sought by the prospective buyer. An adoption rate under 45% in MY 2032 for a 1-2 year payback, as HD TRUCS dictates, is surprisingly low, even for the long-haul tractors purchased by large fleets that may sell their trucks after a few years. Indeed, fleets commonly cited 18 months as an acceptable payback period for efficiency technology in the Phase 1 and Phase 2 heavy-duty rulemaking processes. For a vocational fleet likely to own its vehicles for many years, one would expect that a payback period of several years would be acceptable and that MY 2032 adoption rates would reflect that. Furthermore, the Phase 3 program should be expected to play a role in tuning the vehicle market to properly value fuel cost savings for used as well as new vehicles. Hence, assigning high adoption rates to vehicles that pay back well within the life of the vehicle would be reasonable and would lead to adoption rates substantially higher than the proposed standards reflect.

EPA should consider matching or exceeding ACF's level of ambition for ZEV adoption in the final rule

To further push ZEV adoption to the highest feasible levels, EPA should consider including the market effects of California's new Advanced Clean Fleets (ACF) targets in the final MY 2027-2032 standards. Having determined that ACT will not move the EV market fast enough to meet Governor Newsom's goal that 100% of MDV and HDV vehicles be zero-emissions by 2045 where feasible, California recently adopted the ACF rule.[17] ACF goes beyond ACT to set out an ambitious trajectory for ZEV penetration, requiring that all medium- and heavy-duty vehicles that are sold by manufacturers in California be electric starting in 2036. To the extent that other states adopt the more ambitious targets laid out in the ACF rule, EPA's final standards should take into account these higher ZEV market shares for those states.

To demonstrate that ACF is realistically achievable, California uses findings from their one-time fleet reporting requirement for ACT to highlight that most fleets of MDVs and HDVs

[16] https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10178RN.pdf
[17] https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-Climate.pdf

can be serviced by ZEV models on the market today.[18] The Initial Statement of Reasons (ISOR) issued by the Air Resources Board for the ACF regulation finds that the majority of trucks operating in California drive, on average, less than 100 miles a day and most of the ZEVs available today have batteries and energy storage systems big enough to satisfy those driving requirements.[19] Additionally, California's TCO assessment of six different vehicle types shows that, even before accounting for cost reductions that will likely come from the ZEV sales requirements in the states that have adopted ACT, BEVs and FCEVs will be cost-competitive with ICEVs as soon as 2025 thanks to the declining cost of batteries and fuel cell components.[20] ACEEE supports EPA's consideration of ACF levels of ZEV penetration nation-wide to set appropriate targets in the final rule.

Phase 3 stringency should reflect remaining potential for efficiency improvements to ICEVs

EPA bases the proposed increases in stringency of HDV standards for MY 2027-2032 entirely on projected ZEV sales shares. The remaining sales are assumed to be ICEVs achieving the current MY 2027 standards (FR 25996). The resulting standards would fail to take advantage of the considerable remaining potential for improvement in ICEV efficiency and, furthermore, would not be consistent with EPA's stated goal of maximizing emissions reductions to the greatest feasible extent (FR 26005). This is a major failing, especially given that under the compliance pathway presented in the proposal ICEVs would be the great majority of vehicles sold in MY 2027-2032. These ICEVs should continue to improve from one model year to the next over the time frame of the Phase 3 standards.

It is essential that EPA include ICEV improvements in setting the level of the final targets to maximize the emissions reduction benefits of the standards and chart a course for minimizing cumulative heavy-duty GHG emissions out to 2050. According to a recent ICCT paper, the heavy-duty sector will fall short of meeting its share of the transportation GHG reductions needed to reach the U.S. nationally determined contribution under the Paris Agreement in 2030 and beyond unless ICE vehicle fuel efficiency continues to improve under Phase 3 and ambitious ZEV adoption targets are achieved.[21]

Continued improvement in ICEV efficiency cannot be treated simply as an option that provides compliance flexibility to manufacturers

In the past, EPA has frequently and appropriately demonstrated the achievability of proposed vehicle standards by presenting a single compliance pathway, knowing that manufacturers will use different technology pathways based on considerations specific to

[18] https://ww2.arb.ca.gov/sites/default/files/2022-02/Large_Entity_Reporting_Aggregated_Data_ADA.pdf
[19] https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/acf22/isor2.pdf
[20] https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/acf22/appg.pdf
[21] https://theicct.org/wp-content/uploads/2023/04/hdv-phase3-ghg-standards-benefits-apr23.pdf.

them. In that spirit, EPA might argue that there is no need to include remaining conventional efficiency technologies in the compliance pathway presented for the Phase 3 standards, and that justifying the proposed stringency increase through increasing ZEV adoption alone is a simple and satisfactory approach. In this view, any available ICEV efficiency improvements constitute flexibility for manufacturers to meet the standards with a different technology mix. However, we object strongly to this notion, which underpins a proposal that leaves substantial, cost-effective GHG reduction opportunities on the table.

In the proposal, EPA has demonstrated the feasibility of the projected ZEV adoption rates based on vehicle cost and availability, infrastructure development and federal tax incentives. Those adoption rates are far below 100%, however. To the extent that there are cost-effective technologies available to improve the efficiency of the ICEVs that comprise the remainder of sales, EPA's approach is best described not as flexibility for manufacturers but rather as a missed opportunity to reach higher levels of cost-effective emissions reduction. This is inconsistent with EPA's stated goal "to maximize emissions reductions given our assessment of technological feasibility and accounting for cost of compliance, lead time, and impacts on purchasers and willingness to purchase" (FR 26005). Manufacturer flexibility would be retained under a standard based on broadly feasible improvements in both ICEVs and ZEV adoption; manufacturers that were in a position to achieve still higher levels of ZEV adoption would be able to comply with lower levels of ICEV efficiency improvement.

Sleeper cab tractors constitute a particularly important demonstration of the importance of continuing ICEV emissions rate reductions. These trucks, which make up 12.8% of MDV and HDV sales (per HD TRUCS) and a larger share of MDV and HDV emissions, are projected to reach only 25% ZEV adoption (all FCEV) by 2032. Using the HD TRUCS assumption of constant sales of sleeper cabs across model years and the adoption rates in proposal Table II-24 (FR 25992), 92% of sleeper sales (as well as 78% of sales of other tractors) will be ICEVs in MY 2027-2032. It would be unacceptable for these trucks to emit at the level of the current MY 2027 standard. The industry can and must do better to ensure HDVs contribute adequately to transportation GHG emissions reductions.

Failing to assume such conventional technology improvements in setting the standards also opens up the possibility of a manufacturer using these technologies to slacken its pace on ZEV production. For ICE sleeper cab tractors, for example, a recent ICCT report identifies readily available, cost-effective technology to achieve 23%-24% emissions reduction below the levels of the current MY 2027 standard.[22] Adopting these technologies would allow manufacturers to comply with sleeper cab standards throughout Phase 3 without any of the ZEV sales the proposed standard assumes (25% FCEVs in MY 2032). While this alternative pathway may demonstrate the flexibility and non-prescriptive nature of the standards, it

[22] https://theicct.org/wp-content/uploads/2023/04/hdv-phase3-ghg-standards-benefits-apr23.pdf

would represent a total and unnecessary failure to drive ZEV adoption at a rate that is both feasible and necessary to achieve national commitments.

There are multiple ICE vehicle technologies that could support more stringent standards than those proposed, and the final standards should be strengthened accordingly

The rapid electrification of heavy-duty vehicles will present many challenges to truck manufacturers and dealers. Public policies such as those in IIJA and IRA have a key role in ensuring that the industry has the resources to make this transition successfully. Given the millions of heavy-duty ICEVs that will be produced and sold in the coming years, however, allowing these vehicles to stagnate technologically should not be an option. There are cost-effective technologies already available that have yet to achieve high penetration, but face no market obstacles to doing so, as discussed further below. These technologies do not require substantial additional investment on the part of manufacturers.

Furthermore, for market segments in which ICEVs will remain a substantial share of sales through the next few product cycles, continued investment in emerging efficiency technologies is warranted. This is especially the case of for tractors, which EPA projects will reach only 25%-35% ZEV sales shares by MY 2032. But EPA also assumes that no segment will achieve over 80% ZEVs (FR 25992), seeming to hedge its bets on a full phase-out of ICEVs. This perspective on the part of the agency makes it all the more important that the rule ensures continued progress on ICEV efficiency.[23]

Moreover, vehicle efficiency improvements such as aerodynamic drag reduction, reductions in tire rolling resistance, and mass reduction can contribute to the efficiency, and hence cost-effectiveness and/or range, of BEVs and FCEVs. As EPA notes: "By reducing the energy required to move a truck down the road, aerodynamic improvements can extend the range of BEV/FCEV/hybrid for a given battery size"(DRIA p.27). Hence continued investment in these areas will also be worthwhile. The need to promote the advancement of such technologies only increases in view of EPA's proposal to continue excluding upstream vehicle emissions from certification values (FR 25994). This policy, which we urge EPA below to discontinue, eliminates an important manufacturer incentive to make their ZEVs as efficient as possible. Failure to incentivize development of these broadly applicable "no-regrets" technologies by allowing ICEV efficiency to stagnate as well would compound the error.

[23] EPA's exclusion of 20% of vehicles is based on the argument that the highest-VMT vehicles would have battery requirements exceeding those of the great majority of vehicles and hence should be excluded from the calculation of EV specs in HD TRUCS, and that other vehicles might face special charging challenges making electrification especially difficult (FR 25992). While not unreasonable so far as is goes, this approach should not be taken to preclude electrification of high-VMT vehicles or vehicles with special charging needs in perpetuity.

EPA provides only a cursory discussion of specific ICEV technologies that could reduce conventional vehicle emissions in Phase 3 but requests comments on such technologies (FR 25993). Sources of relevant information include DOE's SuperTruck Program, ICCT reports, and NACFE's Annual Fleet Fuel Study. These sources identify multiple technologies available in the market today that remain underutilized, as well as emerging technologies that can provide substantial additional benefits.

The above-mentioned 2023 ICCT white paper on the emissions benefits of the Phase 3 standards identifies technology packages for each heavy-duty class and regulatory type that would substantially and cost-effectively (with 2-year payback) improve efficiency beyond current MY 2027 requirements.[24] They found additional savings potential ranging from 22% to 31%, depending upon vehicle type.

Many technologies in the ICCT packages were also part of EPA's Phase 2 compliance packages but have not been fully adopted in the market, including improvements to tires, aerodynamics and accessories, as well as waste heat recovery. Other technologies, including engines achieving 55% brake thermal efficiency, mild hybridization, and additional aerodynamic improvements were tested extensively in DOE's SuperTruck 2 program for long-haul tractors, a segment expected to remain less than fully electrified well into the future. EPA should consider all of these ICE technology improvements in setting the stringency of the Phase 3 standards.

The cumulative GHG benefit of maintaining the emissions reduction trajectory of ICEVs is substantial

The potential to reduce ICEV carbon dioxide (CO_2) emissions below the level of current MY 2027 standards, together with the expectation that ICEV sales will continue to MY 2039 (based on the US National Blueprint for Transportation Decarbonization,[25]) imply that EPA could substantially increase emissions reductions out to 2050 by steadily increasing ICEV efficiency through the Phase 3 standards.

For long-haul tractors, for example, the potential for 23% cost-effective efficiency improvements, as estimated by ICCT, could translate to an annual reduction in long-haul ICEV emissions of more than 5% per year in MY 2028-2032. Using Argonne National Laboratory's VISION model, we estimated that this would reduce cumulative emissions out to 2050 from MY 2027 and beyond sleeper cab tractors by 154 million metric tons (MMT) of CO_2. This would add 11% to the emissions reductions achieved throughan electrification-only strategy in which BEV share reached 100% in 2040 per the National Blueprint. If sleeper

[24] https://theicct.org/wp-content/uploads/2023/04/hdv-phase3-ghg-standards-benefits-apr23.pdf.
[25] https://www.energy.gov/sites/default/files/2023-01/the-us-national-blueprint-for-transportation-decarbonization.pdf

cab BEV market share were instead to max out at 80% in 2040 or alternatively to reach 100% only in 2050, the ICEV efficiency improvements would add 18% or 24%, respectively, to cumulative emissions reductions from electrification alone. (See Figure 1.) Otherwise viewed, these results show that raising ICEV efficiency by 5% per year in MY 2028-2032 would nearly (97%) make up for the shortfall in cumulative emissions reduction resulting from a maximum BEV sales share for sleepers of 80%, instead of 100%, in 2040.

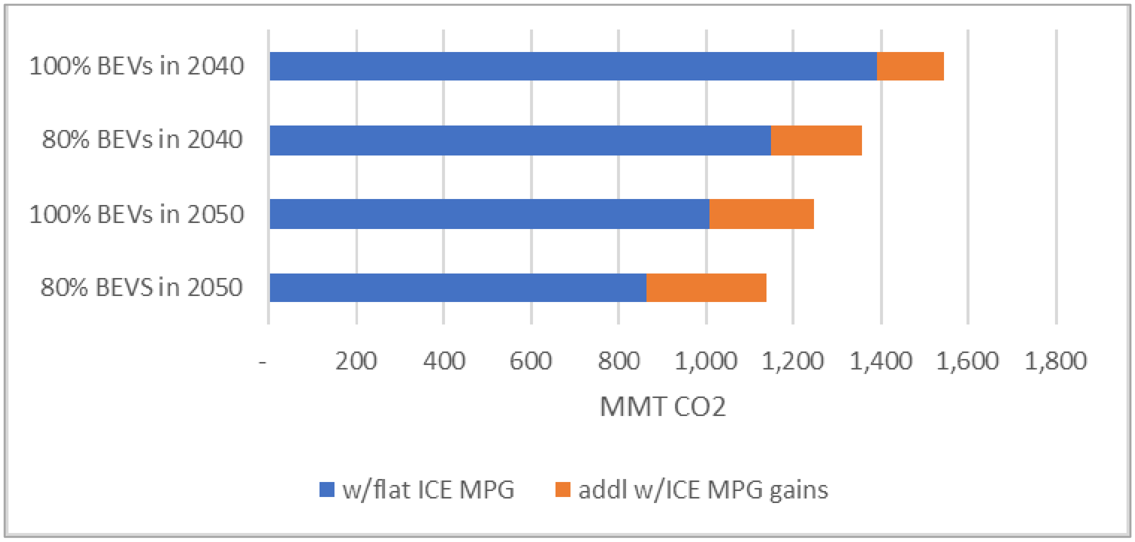

Figure 1. Cumulative emissions reductions from electrification of long-haul tractors, 2027-2050

Failure to include upstream emissions accounting will undermine the standards

The proposed rule would prolong the policy of assigning zero emissions to ZEVs through Phase 3. In the Phase 2 heavy-duty rule, EPA justified its decision to extend its zero-upstream treatment of electric vehicles:

> As we look to the future, we project limited adoption of all-electric vehicles into the market. Therefore, we believe that this provision [zero upstream] is still appropriate. Unlike the 2017–2025 light-duty rule, which included a cap whereby upstream emissions would be counted after a certain volume of sales (see 77 FR 62816–62822), we believe there is no need to establish a cap for heavy-duty vehicles because of the small likelihood of significant production of EV technologies in the Phase 2 timeframe.[26]

[26] https://www.govinfo.gov/content/pkg/FR-2016-10-25/pdf/2016-21203.pdf

As this rationale suggests, however, ignoring upstream emissions in vehicle compliance values could have serious adverse consequences at a time when the objective is to move ZEVs into the mainstream throughout the heavy-duty vehicle market. The timeframe of Phase 3 is just such a time.

Upstream emissions resulting from the fueling of ZEVs will remain significant throughout the Phase 3 time frame, and excluding them from vehicles' compliance certification values will prevent the standards from helping to reduce those emissions. In particular, the standards will not promote vehicle efficiency, one of the most important means of reducing emissions for ICEVs and ZEVs alike.

Another adverse effect of zero-upstream accounting is that it distorts the relative emissions of ICEVs and BEVs. ANL's GREET 2022 model projects that a MY 2030 BEV tractor emits 52% as much CO_2 on a well-to-wheels basis as a comparable diesel tractor would. The nominal reduction from BEV adoption under the rule, by contrast, would be 100%. As a result, if a manufacturer were to exceed EPA's projected ZEV adoption—which is a distinct possibility under the proposed standards—emissions reductions under the program could fall well below the anticipated reductions.

Treating hydrogen-fueled vehicles as ZEVs adds to the risk of zero-upstream accounting

EPA expanded the definition of ZEVs to include hydrogen FCEVs (H_2-FCEVs) in the heavy-duty 2027 final rule and now proposes to expand it further to include hydrogen ICEVs (H_2-ICEVs) (FR 25994, footnote 517). Considering hydrogen-fueled vehicles to be ZEVs compounds the problems created by ignoring upstream emissions for BEVs, however. Both H_2-FCEVs and H_2-ICEVs currently have pump-to-wheels efficiencies closer to diesel vehicles than to battery electric vehicles, as illustrated by the numbers for long-haul combination trucks in Table 2.

Table 2: Energy usage and GHG emissions rates of MY 2030 long-haul combination trucks.

	Diesel	BEV	H_2-FCEV truck, default gaseous H_2 (SMR)	H_2-FCEV, gaseous H_2 (electrolysis, US energy mix)	H_2 -ICEV-liquid H_2
WTP energy consumption (MJ per mile)	2.5	5.6	4.9	19.5	8.5
Operational energy consumption (MJ per mile)	13.8	7.0	10.9	10.9	11.5

	Diesel	BEV	H_2-FCEV truck, default gaseous H_2 (SMR)	H_2-FCEV, gaseous H_2 (electrolysis, US energy mix)	H_2 - ICEV-liquid H_2
Well-to-wheels CO_2 emissions (grams per mile)	1,195	610	880	1,472	1,259

Source: GREET 2022 app, March 2023 update

We note that, in contrast to the energy efficiency ratios implied by Table 2 showing that the H_2-FCEV truck uses 57% more energy per mile than the BEV, EPA adopts an assumption that a H_2-FCEV uses only 25% more energy than a BEV (DRIA p.313). ACEEE looked at the sources referenced in the DRIA, which include the GREET and MOVES models, and was unable to find the basis for this claim. In fact, the MOVES document cited by the DRIA states the following:

> In addition, heavy-duty fuel cell vehicles (FCEVs) have a lower efficiency ratio than their BEV counterparts. However, an identical EER is implicitly applied to both BEVs and FCEVSs in MOVES, since BEV and FCEV vehicles have been aggregated within the electricity fuel type by the time the EERs are applied. To account for this, the energy consumption rates for FCEVs in EmissionRate are **scaled up by a ratio of 1.6**, based on values in GREET 2021[64] as explained in Appendix D…[27] (emphasis added).

Appendix D states (p.51):

> The 1.6 multiplier for the FCEV emission rates was derived from the relative miles per gallon diesel equivalent estimated in GREET 2021. While the GREET model anticipates that the relative miles per gallon will vary with vehicle class, as show in Table D-5, we currently expect most FCEVs will be used in long-haul applications. Thus, we selected the values for Combination Long-Haul Vans to represent all heavy-duty FCEVs. Consistent with GREET and with the MOVES adjustment report, the listed value for EVs was also decreased by 15 percent to account for battery and charging losses that are not relevant for FCEVs. This results in a ratio of 1.61 which we rounded to 1.6.

Hence the cited MOVES document does not appear to support the DRIA claim that an FCEV uses only 25% more energy to operate than a BEV, but instead supports the values shown in Table 2 above.

[27] https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=546473&Lab=OTAQ, p.24

H_2-ICEVs are likely to provide smaller efficiency gains over diesel vehicles than H_2-FCEVs provide and could even result in GHG emissions increases relative to diesel well into the time frame of the Phase 3 rule, as indicated by Table 2.[28] Yet EPA states in the proposal that, "a new technology under development that would reduce GHG emissions from heavy-duty vehicles with ICEs is hydrogen-fueled internal combustion engines (H_2–ICE)" (FR 25960). EPA's enthusiasm is premature.

EPA notes that most hydrogen is produced today via steam methane reforming (SMR) but cites provisions in IIJA and IRA promoting green hydrogen production in support of its "simplifying assumption", for purposes of the rule impacts analysis, that any hydrogen used to fuel heavy-duty FCEVs will be produced through grid electrolysis (FR 26042, footnote 664). Based on this assumption, EPA calculates declining carbon intensity of hydrogen fuel as a result of anticipated grid decarbonization. However, it is not clear that the hydrogen for use as a transportation fuel will generally be produced through grid electrolysis in the coming years or will have carbon emissions similar to hydrogen from grid electrolysis.

EPA points to incentives for clean hydrogen production in IIJA and IRA, as well as "new transportation and other demand drivers and potential future regulation" (DRIA p.321) to support this assumption. However, potential dramatic increases in the coming years in the volume of both clean hydrogen and hydrogen produced through electrolysis are insufficient to ensure that hydrogen production through SMR will decline or that hydrogen used to fuel heavy-duty vehicles will become cleaner in tandem with grid decarbonization. This is especially true given the many uses to which a growing hydrogen supply could be put.

It should be noted that EPA's analysis of the upstream impacts of BEVs, as well as those of hydrogen-fueled vehicles, relies on assumptions regarding the decarbonization of the electricity (FR 26044). However, those assumptions, unlike the hydrogen assumptions, are based on a quantitative analysis of IIJA and IRA incentives, resulting in a much more convincing case for low-carbon electricity generation.

EPA should not incentivize hydrogen-fueled vehicles without strong evidence that hydrogen fuel for transportation will be clean in the foreseeable future. For H_2-ICEVs in particular, for which intrinsic efficiency advantages are modest, actual GHG benefits may be negative, and potential future benefits are based largely on changes to the fuel rather than to the vehicle, the zero-upstream incentive is inappropriate. It would offer manufacturers the same compliance benefit for an H_2-ICEV as for a BEV or FCEV but require only relatively small changes to the engine, as described At FR 25960. The fact that H_2-ICEVs produce NO_x makes

[28] GREET does not currently include HD H_2-ICEs. We obtained the (rough) values shown in Table 2 for such a vehicle by scaling the diesel combination truck values by E10/liquid H_2 LD (SI) ICE vehicle ratios from GREET 2022.

confering ZEV benefits on them all the more inappropriate. Low-carbon hydrogen-fueled vehicles are best incentivized through performance-based standards.

Including upstream emissions in vehicle certification emissions values based on national average GHG emissions associated with fuel production and distribution would achieve this outcome, both for electricity and for hydrogen. Refining this approach to better reflect the real-world benefits of ZEVs, for example by averaging upstream emissions over the life of the vehicle based on projected carbon reductions in electricity and hydrogen production and/or by weighting emissions geographically by vehicle sales distribution, would be appropriate ways to preserve the program's incentive for ZEV production while maintaining the performance basis of the standards.

The longer EPA delays accounting for upstream emissions in ZEV compliance values, the more difficult it will be to introduce this feature when ZEV shares are high. The federal government has provided large subsidies for heavy-duty ZEV purchase and charging infrastructure, which is the best way to incentivize their adoption beyond the credits these vehicles could obtain through performance-based standards. EPA properly notes that advanced technology multipliers should be phased out as heavy-duty EV adoption ramps up rapidly and as monetary incentives are offered (FR 25931); similarly, zero-upstream accounting should cease in this phase of the standards.

Distorting performance-based standards with unearned emissions reduction credits has undermined vehicle standards for decades and this practice should be avoided in future rules. Furthermore, the incentive upstream accounting provides to steadily increase the efficiency of BEV and hydrogen-fueled vehicles would improve the sustainability and affordability of these vehicles in the future. Absent upstream accounting, the EPA rule loses all oversight of the emissions caused by these vehicles, and the market is left to maximize their efficiency and maintain a downward emission trajectory.

If EPA is not prepared to fully implement upstream accounting by MY 2027, it could phase in this treatment over the time frame of Phase 3. At the bare minimum, EPA should affirm in the final rule that, after MY 2032, the presumption is that upstream emissions will be accounted for in vehicle certification values. This will enable EPA to ensure that emissions reductions do in fact continue to progress as ZEVs achieve dominance in the market.

Phase 3 standards should promote BEV and FCEV efficiency

The energy efficiency of ZEVs is an important determinant of their economics and environmental impacts. While BEVs, and to a lesser extent FCEVs, already have a sizable energy efficiency advantage over ICEVs, continuing efficiency gains will be key to overcoming the remaining barriers to these vehicles' achieving dominance in the market and minimizing their environmental and societal impacts, including mineral resource requirements and demands on the electric grid. Given the cost savings and range increases that greater efficiency can provide, the heavy-duty vehicle market will drive efficiency gains over time, but the standards should be used to accelerate these gains at this critical juncture. However, the standards cannot promote BEV and FCEV efficiency if they consider these vehicles to have zero GHG emissions and, therefore, cannot distinguish among them.

Gains in ZEV efficiency could increase feasible adoption rates, which should be reflected in EPA's analysis. Increasing efficiency would be captured in HD TRUCS' adoption rate projections through at least two mechanisms. First, HD TRUCS rules out BEVs if battery size/weight exceeds 30% of vehicle payload. Increased efficiency could allow some vehicles to avoid that constraint by reducing the size and weight of the battery. Second, even for vehicles unaffected by the constraint, greater efficiency would reduce battery and fuel cell system costs and thus payback period, increasing ZEV adoption rates.

There is significant potential for BEV and FCEV efficiency improvement

Table II-6 (FR 25977) shows EPA's assumed BEV component (battery, inverter, e-motor) efficiency improvements from MY 2027 to 2032. Their combined efficiency improves only 1% over the life of the standards, from 87% to 88%. This de minimus improvement does not represent the full potential for efficiency gains, however. The NAS Phase 3 light-duty vehicle report assumed that EV efficiency would improve by 1% per year through a combination of vehicle and powertrain improvements discussed in the report.[29] The report found, for example, that "[wide bandgap devices] could result in boosting inverter and converter efficiencies to 99% (from 96%)."[30] Similar improvements should be available for heavy-duty BEVs.

FCEVs would benefit from any inverter or battery efficiency gains for BEVs. For the fuel cell stack, EPA assumes that efficiency increases from 64.5% to 66% in MY 2027-2032, stopping short of DOE's 2030 efficiency target of 68% and long-term target of 72% (FR 25979-25980). A more efficient fuel cell stack may require less cooling and a smaller radiator, compounding efficiency gains.[31]

Both BEV and FCEV efficiencies could also be substantially increased from the improvements to tires, aerodynamics, and auxiliary systems referenced earlier as efficiency opportunities for ICEVs. The final rule should promote these efficiency gains both through standards reflecting ICEV improvements beyond MY 2027 targets and through realistic upstream emissions accounting.

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[29] https://nap.nationalacademies.org/catalog/26092/assessment-of-technologies-for-improving-light-duty-vehicle-fuel-economy-2025-2035

[30] https://nap.nationalacademies.org/catalog/26092/assessment-of-technologies-for-improving-light-duty-vehicle-fuel-economy-2025-2035

[31] https://nap.nationalacademies.org/catalog/26092/assessment-of-technologies-for-improving-light-duty-vehicle-fuel-economy-2025-2035

EPA should ensure that credits from Phase 2 do not undermine the Phase 3 standards

Manufacturers' credits carried over from the Phase 2 program could substantially affect the efficacy of Phase 3. The proposal states: "In considering feasibility of the proposed standards, EPA also considers the impact of available compliance flexibilities on manufacturers' compliance options" (FR 26002). Yet EPA has not offered any projection of the credit balances to be carried over from Phase 2 to Phase 3, much less indicated how these credits might affect the levels of electrification achieved or the potential for backsliding on ICEV emissions under the proposed standards.

This concern is heightened by the proposal to leave in place the advanced technology multipliers for BEVs through 2026 (FR 26013). As discussed in ACEEE's comments on the 2022 heavy-duty NPRM, these very high multipliers together with sales mandates at the state level and market forces will generate sufficient credits to allow stagnation of average truck emissions levels in the early years of Phase 3, exactly when momentum must build toward rapid decarbonization of the commercial fleet.[32]

As an example of the ability of carryover credits to undermine the standards, consider the effects of maintaining the advanced technology multipliers in MY 2024-2026. Based on EPA's estimates of ZEV penetration in MY 2024-2026 in the DRIA (Tables 4-6), carryover of advanced technology multiplier credits would more than nullify EPA's proposed increase in stringency in the MY 2027 standards, which therefore would no longer serve to prompt the industry to start meaningful production of BEVs by MY 2027.[33]

EPA also raises the possibility of allowing advanced technology credits to be used across averaging sets (FR 26013), even though the ZEV adoption targets in the proposal are tailored to the opportunities and constraints for electrification for each specific vehicle type. As EPA and NHTSA observed in the preamble to the final Phase 2 rule, "combined with the very large multipliers being adopted, there could be too large a risk of market distortions if we allowed the use of these credits across averaging sets" (Phase 2 FR 73498). That risk remains.

For the final rule, EPA should present its analysis of likely credit balances in Phase 3 and adjust the stringency of the standards accordingly to ensure they deliver the intended CO_2 reductions and technology advancement under the program. Advanced technology credits should remain applicable within averaging sets only.

[32] https://www.aceee.org/sites/default/files/pdfs/aceee_hd_phase_2_ghg_comments.pdf
[33] https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10178RN.pdf

Recommendations

The proposed standards provide a reasonable framework to drive heavy-duty emissions reduction, but the final rule needs significant improvement to ensure that the heavy-duty sector is contributing adequately to meeting economy-wide GHG emissions targets. As mentioned above, the current proposal underestimates the pace of EV penetration due to state action while also failing to incorporate internal combustion technologies already on the market and those that are prime for future deployment to maintain ICEV efficiency progress. This, combined with incentives for hydrogen ICEVs and a continued failure to consider the upstream impacts of electric and fuel cell vehicles, undermines the proposal that EPA has put forward.

ACEEE makes the following recommendations for the final rule:

1. The final targets should reflect higher EV penetration rates in all vehicle categories:
    - To fully account for state actions by, at a minimum, increasing proposed Phase 3 EV adoption levels to ACT or ACF levels for the share of the market accounted for by states that have adopted these policies.
    - By adjusting overly conservative assumptions in HD TRUCS, and
    - By considering a more ambitious approach, matching or exceeding ACF targets nationally.
2. EPA should incentivize continued improvement in the efficiency of internal combustion engine vehicles in the Phase 3 standards by including cost-effective ICEV technologies in the basis for the stringency of the Phase 3 standards. This includes :
    - Currently available cost-effective efficiency technologies that have yet to reach maximum market penetration
    - Technologies that will be available in the time frame of the Phase 3 regulation
    - Advanced vehicle technologies applicable to ICEVs, BEVs and FCEVs alike

    ICEV emissions reductions of at least 5% per year should be assumed in setting stringency.
3. EPA should include upstream emissions in vehicle certification values starting in MY 2027.
    - If EPA is unable to do this, it should phase in upstream accounting over the time frame of Phase 3 or affirm in the final rule that inclusion of upstream emissions will be considered for model years after 2032.
    - Hydrogen fueled vehicles should be considered ZEVs only if clean hydrogen fuel can be ensured; hydrogen ICEVs should not be considered ZEVs.
4. EPA should use the standards to drive efficiency gains for ZEVs as well as ICEVs.
5. To ensure emissions reductions in the early years of the Phase 3 standards, EPA should reassess the role that credits will play in meeting targets and adjust targets accordingly. Advanced technology credits should not be applicable across averaging sets.

Getting the Phase 3 standards right will be critical to setting the United States on a path to meeting national climate and ZEV deployment goals, in addition to reducing health-harming pollution, particularly in disadvantaged communities. The above recommendations will help create more ambitious targets for MY 2027-2032 to ensure the most rapid feasible ZEV penetration. EPA must take the lead on reducing vehicles' GHG emissions and enact powerful standards for the heavy-duty vehicle sector that will spur manufacturer commitment and innovation, enable collaboration between stakeholders on charging deployment, and achieve the needed emissions reductions. The Inflation Reduction Act and the Infrastructure Investment and Jobs Act have created a real and serious opportunity to accelerate transportation electrification in the United States, and the EPA's Phase 3 standards must provide the critical framework to translate those investments into measurable and significant EV adoption outcomes. ACEEE thanks EPA for the opportunity to contribute comments and improve the final rule.