



December 6, 2023

Submitted by email: a-and-r-docket@epa.gov

Attention: Docket ID No. EPA-HQ-OAR-2022-0829

Re.: Supplemental Comments on Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles, 88 Fed. Reg. 29184 (May 5, 2023)

Environmental Defense Fund (EDF) respectfully submits supplemental comments on EPA’s Proposed Rule, *Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles*, 88 Fed. Reg. 29184 (May 5, 2023) (“Proposal” or “Proposed Standards”). Since the close of the comment period, EDF evaluated additional alternative technology pathways for manufacturers to meet the Proposed Standards. Our analysis reinforces and expands on findings submitted in our earlier comments and concludes that there are numerous additional pathways that are technologically feasible and cost beneficial even in counterfactual scenarios of very low and no baseline deployment of battery electric vehicles (BEVs). The analysis underscores the technology neutrality of the standards and further demonstrates that there is no single technology necessary to meet the standards (though certainly not a requirement for standards established under section 202 of the Clean Air Act).

EPA has long established performance-based light-duty vehicle greenhouse gas standards that allow manufacturers to comply with a range of emissions-improving technologies. The Proposed Standards are no exception – they are performance-based and can be met using a range of internal combustion engine vehicle (ICEV) improvements and/or electrification technologies.

In our comments submitted on July 5, 2023, EDF evaluated 3 pathways – in addition to those that EPA modeled – to demonstrate that EPA’s proposed standards can be met with a range of technologies, including battery BEVs, plug-in hybrid electric vehicles (PHEVs) and ICEV improvements.¹ EDF contracted with Roush to project the relative cost of PHEVs and BEVs in the 2024-2035 timeframe.² EDF then used Roush’s cost projections for PHEVs in conjunction

¹ Comments of the Environmental Defense Fund, EPA-HQ-OAR-2022-0829-0786, <https://www.regulations.gov/comment/EPA-HQ-OAR-2022-0829-0786>.

² Vishnu Nair, Himanshu Saxena, Sajit Pillai, Alternative Powertrain Pathways for Light-Duty and Class 3 Vehicles for MYs 2024, 2027, and 2035 to Meet Future CO₂ Emission Targets, Roush for EDF (June 2023).

with EPA’s costs for BEVs and ICEVs to conduct an analysis of compliance costs under possible scenarios in which PHEV and ICEV sales represent a greater proportional share of manufacturers’ sales than EPA modeled while still meeting the emissions targets set in EPA’s Proposal. The original alternative pathways EDF modeled included:

- Pathway 1 (ICEV Pathway): assumed the greatest possible GHG control from ICEVs using EPA’s OMEGA 2 model; assumed no PHEV technologies
- Pathway 2: set PHEV and BEV sales to roughly equivalent levels leaving ICEV emissions at the level projected in EPA’s compliance simulation of its Proposed Standards
- Pathway 3: held ICEV sales at the level found in Pathway 2; increased PHEV sales further than Pathway 2 by maximizing ICEV emission controls as in Pathway 1

Each of these pathways provided a viable example of compliance pathways automakers could choose to take—one relatively more reliant on ICEVs, one more so on PHEV controls and the third on both—all of which demonstrating the flexibility afforded manufacturers to cost-effectively reduce emissions using a mix of technologies with lesser reliance on BEV sales than was shown in EPA’s cost-minimizing modeling.

Since our original analysis and comment submission, some stakeholders have asserted or implied that the Proposed Standards could not be met without significant BEV sales.³ EDF has performed a follow-up detailed analysis, set forth below, assessing additional pathways to compliance through fuller reliance on PHEVs, hybrids, and ICE efficiency improvements with zero to moderate levels of battery electric vehicles (BEVs). Our analysis concludes that EPA’s proposed standards can be met with varying levels of technology and that no particular technology is required – in whole or in part – to meet the fleet-average standards. This is true even in exceedingly unrealistic low- and no-BEV baseline scenarios. Our analysis also finds that even a zero-BEV pathway would result in significant net benefits, and as BEV sales increase so do the net benefits.

Analysis: Feasibility of low- to zero-BEV pathways

This analysis investigates manufacturers’ ability to comply with EPA’s standards with fewer BEVs compared to EPA projections or even no BEVs at all, substituting further ICEV emissions control and PHEVs compared to our previous pathways analysis. Starting with four different levels of BEV sales, we evaluate the PHEV sales required to comply with the standards under two levels of ICEV emissions control—a MY2022 average level of control as estimated by the National Highway Traffic Safety Administration (NHTSA) in its recent proposed rule,⁴ and an

³ See, e.g., Comments of the Alliance for Automotive Innovation at i-ii, EPA-HQ-OAR-2022-0829-0701, <https://www.regulations.gov/comment/EPA-HQ-OAR-2022-0829-0701>; Comments of the Kentucky Office of the Attorney General et al. at 4, EPA-HQ-OAR-2022-0829-0649, <https://www.regulations.gov/comment/EPA-HQ-OAR-2022-0829-0649>; Comments of Valero Energy Corporation at 65, EPA-HQ-OAR-2022-0829-0451, <https://www.regulations.gov/comment/EPA-HQ-OAR-2022-0829-0707>.

⁴ *Corporate Average Fuel Economy Standards for Passenger Cars and Light Trucks for Model Years 2027–2032 and Fuel Efficiency Standards for Heavy-Duty Pickup Trucks and Vans for Model Years 2030–2035*, 88 Fed. Reg. 56128 (August 17, 2023).

advanced level of emissions control for a vehicle powered entirely by gasoline. This analysis included calculations for two model years, MY2027 and MY2032. The different levels of BEVs included are 0% BEVs, 7% BEVs - roughly the share of BEV sales in the US today, 17% BEVs – EPA’s projection in the final rulemaking for its MY 2023-2026 standards, and finally the level of BEV sales projected under the current EPA Proposal No Action Case, 27% in 2027 and 40% in 2032. In all the scenarios presented below, no additional BEVs are deployed beyond the above-stated baseline sales levels.

MY2022 ICEV Technology Scenario:

The MY2022 ICEV control scenario reflects the ICEV performance of the current fleet. In its modeling for the Proposal, EPA projected that minimal ICEV improvement would occur and compliance with vehicle emission standards would be mostly achieved using BEVs. As a result, MY2022 ICEVs are consistent with all the ICEVs used in EPA’s modeling for MY2027 through MY2032. For reasons described below, we decided to use the level of MY2022 vehicle emissions as estimated by NHTSA and obtained from the CAFE Compliance and Effects Model (CCEM) used in NHTSA’s recent proposed rule.⁵ Over half of these vehicles had advanced engines (turbocharged, with cylinder deactivation, or high compression ratio). Nearly half had transmissions with more than 8 speeds or continuously variable. Just under 7% and 2% were strong hybrids or PHEVs.

Advanced ICEV Technology Scenario:

We also evaluated an advanced level of emission reductions available from ICEV technologies, which includes nearly complete conversion to strong hybrid technology and is also taken from a CCEM run. EDF conducted a run of CCEM in which BEV and PHEV technologies were strictly limited resulting in all ICEV emission control technology available in the model being applied, converting 94% of ICEV sales to strong hybrids. The use of the CCEM to estimate the benefit of ICEV technology necessitated the use of 2022 MY emissions from the CCEM to maintain technical consistency. These strong hybrids include advanced engines, high or continuously variable transmissions and additional weight reduction in glider mass. Fleetwide, the application of all ICEV technologies present in CCEM has a significant impact on emission reductions, reducing carbon dioxide (CO₂) emissions for passenger cars by 30% and light trucks by 28% compared to MY 2022 ICEV control levels. Together, the two ICEV control scenarios are intended to bookend the realistic and feasible emissions from ICEVs in the near term.

Methodology and Assumptions

In this analysis we assume PHEVs to have an onroad range of 50 miles. Per EPA’s Proposal, PHEV50s have a utility factor of 0.68.⁶ PHEVs also must have a minimum range over the two-cycle test of 70 miles (equivalent to an onroad range of 50 miles) to qualify as ZEVs under California’s Advanced Clean Cars II program. Therefore, we assumed that a manufacturer intending to comply with EPA’s proposed standards using PHEVs would aim for an onroad

⁵ We did not use EPA’s OMEGA 2 model to estimate the emission impact of advanced ICEV emission control technology because the OMEGA 2 model does not include P2 strong hybrid technology.

⁶ Fed. Reg. 88 at 29441 (May 5, 2023), Tables 1 and 2.

range of roughly 50 miles.⁷ PHEV50s are assumed to have the same CO₂ emissions as an ICEV with advanced emissions control technology when they are operating on gasoline.

We separate new vehicle sales into their two regulatory classes - cars and light trucks - and apply ICEV technology and conversion to PHEV and BEV technology proportionately to both vehicle classes.⁸ In this portion of our analysis, we focus on compliance with EPA's standards in MYs 2027 and 2032, the first and last model years covered under the Proposed Rule.

Manufacturer sales projections for MY 2027 and 2032 are available from both EPA's and NHTSA's modeling supporting their respective proposed rules. We use EPA's sales projections for each manufacturer's total sales of cars and light trucks to maintain consistency with the focus on compliance with EPA's emission standards.

Manufacturer-specific compliance with EPA's proposed CO₂ standards is accomplished with a spreadsheet model. Neither OMEGA 2 nor the CAFE model are designed to allow the user to specify the mix of technology to be applied as an input to the model. This model is very accurate in projecting compliance in MY 2032 with a BEV-heavy strategy.⁹

Results

The first two tables below show the level of PHEV sales in 2027 that would be required to meet EPA's proposed standards given various levels of assumed BEV baseline penetration and the two ICEV technology scenarios described above (2022 ICEV technology and advanced ICEV control). Table 1 assumes ICEVs with 2022-levels of emission control technology, while Table 2 assumes advanced application of technology to ICEVs, including strong hybridization.

Our analysis shows that there are many feasible pathways to compliance and no particular technology is required to meet the standards. Column one in both tables shows that meeting the proposed standards in 2027 with baseline BEV sales at 0% would require the incremental sale of 36% to 61% PHEVs on a fleetwide basis, depending on the level of ICEV control technology applied. At a 7% BEVs baseline sales rate, only a quarter to a half of all sales would need to be PHEVs to meet the proposed 2027 vehicle standards. And assuming BEV sales of 17%, manufacturers could meet the proposed 2027 vehicle standards with PHEV sales of 11-39%. Finally, our analysis shows that if BEV sales reach 27% in 2027, then manufacturers would only need to sell 3% PHEVs if they choose to adopt advanced control technology on all ICEVs and a quarter PHEVs if they do not. We recognize that 0% and 7% baseline ZEV sales are either counterfactual (0%) or overly pessimistic (7%) given the current rate of ZEV sales and their upwards trend. In our earlier comments to EPA, EDF included an analysis that indicates EPA's projection of high BEV adoption over the next decade is justified and likely an underestimate

⁷ Even those PHEVs sold outside of California and the states that have adopted California's ACC2 program.

⁸ While EPA allows unrestricted trading of CO₂ credits from one category to the other, their emissions need to be tracked separately due to differences in assumed lifetime mileages.

⁹ The model indicates that BEV sales in 2032, assuming 2022 ICEV technology, would need to be 66%. EPA, using OMEGA 2, projected BEV sales of 67% to meet the proposed standards with 1% strong hybrid sales (i.e., ICEV emissions essentially consistent with the 2022 ICEV fleet).

greatly lessening the likelihood that any of the low-BEV scenarios would occur.¹⁰ We have nonetheless included them to demonstrate that the same conclusions that no additional BEV sales are required to meet the standards hold under the full range of possible assumptions regarding baseline ZEV deployment, including for lower assumed baseline levels that are not reasonably likely to occur.

	MY 2022 ICEV Technology			
	0% BEVs	7% BEVs	17% BEVs	27% BEVs
Fleet	61%	52%	39%	26%
BMW	67%	58%	45%	32%
Mercedes-Benz	67%	58%	45%	32%
Stellantis	68%	59%	47%	34%
Ford	63%	54%	41%	28%
GM	64%	55%	42%	29%
Honda	57%	48%	34%	21%
Hyundai	52%	43%	30%	17%
Kia	57%	48%	36%	23%
JLR	69%	60%	47%	34%
Mazda	56%	47%	35%	22%
Mitsubishi	56%	48%	35%	23%
Nissan	56%	47%	34%	22%
Subaru	57%	49%	36%	23%
Toyota	56%	47%	34%	21%
Volvo	62%	53%	40%	27%
VWA	65%	56%	43%	30%

¹⁰ See supra fn 1.

Table 2: PHEV Sales Enabling Compliance with EPA’s 2027 Emission Standards at Four Baseline Levels of BEV Sales and Advanced ICEV technology

	Advanced ICEV Technology			
	0% BEVs	7% BEVs	17% BEVs	27% BEVs
Fleet	36%	26%	11%	3%
BMW	49%	38%	24%	9%
Mercedes-Benz	53%	42%	28%	13%
Stellantis	46%	35%	21%	6%
Ford	42%	32%	17%	2%
GM	46%	35%	21%	6%
Honda	33%	23%	8%	0%
Hyundai	23%	13%	0%	0%
Kia	27%	17%	2%	0%
JLR	52%	41%	27%	12%
Mazda	24%	14%	0%	0%
Mitsubishi	16%	5%	0%	0%
Nissan	26%	16%	1%	0%
Subaru	24%	14%	0%	0%
Toyota	26%	16%	1%	0%
Volvo	38%	28%	13%	0%
VWA	42%	32%	17%	2%

Tables 3 and 4 below show the level of PHEV sales that would be required to meet EPA’s proposed standards in 2032 at varying levels of baseline BEV sales and ICEV technology adoption. The tables show that on average, manufacturers could meet the proposed 2032 standards by selling zero BEVs if they instead sell somewhere between 86% and 91% PHEVs, depending on the degree of ICEV control technology. Alternatively, if just 7% of sales are BEVs in 2032 (roughly today’s current rate of BEV sales), PHEV sales could drop to 76% if advanced ICEV technology is used (Table 4) or 82% if 2022 ICEV technology is assumed (Table 3). And assuming BEV sales of 40%, in line with EPA’s “No Action” projections for 2030-2032,¹¹ fleet average PHEV sales could be as low as 28% to 40% in 2032. As above, we underscore that the zero and seven percent BEV baselines are unrealistic; we include them to demonstrate the robustness of our conclusions.

¹¹ The BEV sales under the No Action Case are 40% in 2030 and 2031 and 39% in 2032. 88 Fed. Reg. 29184 (May 5, 2023) Table 81.

Table 3: PHEV Sales Enabling Compliance with EPA’s 2032 Emission Standards at Four Baseline Levels of BEV Sales and 2022 ICEV Technology

	MY 2022 ICEV Technology			
	0% BEVs	7% BEVs	17% BEVs	40% BEVs
Fleet	91%	82%	69%	40%
BMW	96%	86%	73%	43%
Mercedes-Benz	97%	87%	74%	44%
Stellantis	95%	86%	73%	44%
Ford	94%	85%	72%	42%
GM	95%	86%	73%	43%
Honda	90%	81%	68%	38%
Hyundai	87%	78%	65%	36%
Kia	89%	80%	67%	38%
JLR	98%	89%	76%	46%
Mazda	88%	79%	67%	38%
Mitsubishi	87%	78%	65%	37%
Nissan	89%	80%	67%	38%
Subaru	88%	79%	67%	38%
Toyota	89%	80%	67%	37%
Volvo	92%	83%	70%	41%
VWA	93%	85%	72%	42%

	Advanced ICEV Technology			
	0% BEVs	7% BEVs	17% BEVs	40% BEVs
Fleet	86%	76%	61%	28%
BMW	93%	83%	68%	34%
Mercedes-Benz	95%	85%	70%	36%
Stellantis	91%	81%	66%	32%
Ford	91%	809%	66%	32%
GM	92%	82%	67%	34%
Honda	85%	74%	60%	26%
Hyundai	80%	69%	55%	21%
Kia	81%	71%	56%	22%
JLR	96%	86%	71%	38%
Mazda	80%	709%	55%	21%
Mitsubishi	74%	64%	49%	15%
Nissan	81%	71%	56%	22%
Subaru	79%	68%	54%	20%
Toyota	81%	71%	56%	22%
Volvo	88%	77%	63%	29%
VWA	89%	79%	64%	30%

Analysis: Costs and benefits of low- to zero-BEV pathways

In addition to evaluating the feasibility of meeting EPA’s Proposed Standards through different technology pathways, we estimated the net benefits of compliance for the lowest (0% BEV sales) and highest (40% BEV sales in 2032) BEV scenarios presented above. As shown in Table 7 below, all of the alternative scenarios evaluated are projected to produce significant net benefits compared to a No Action scenario, with net benefits ranging from \$767 billion to \$1.4 trillion.

Methodology

To estimate net benefits, we assessed the differences in the cost of compliance technology, adjusting the No Action scenario to be consistent with the compliance strategy to which it was being compared. Vehicle technology is the largest cost associated with the Proposal. The largest savings or benefits, in order of magnitude, are from reduced fuel costs, health and climate change impacts, and reduced maintenance and repair costs.

Alternative Scenarios for No Action Case and Proposal

To estimate net benefits, EDF evaluated the costs and benefits of EPA’s Proposal in three alternative compliance scenarios with corresponding No Action cases. The scenarios are summarized in Table 5 below. We considered the two Proposal scenarios with the lowest and highest levels of ZEVs described above and shown in Table 4. In the Zero-BEV sales scenario we assess the net benefits of compliance with the Proposal using higher sales of PHEVs and ICEVs with advanced emissions control technology (Scenario 2). In the 40% BEV sales scenario we assess the net benefits where BEV sales are 40%, and the remaining sales are a combination of PHEVs and ICEVs with advanced technology (Scenarios 3 and 4).

	Scenario	No Action Case				Proposal			
		BEV	PHEV	MY2022 ICEV	Adv. ICEV Tech	BEV	PHEV	MY2022 ICEV	Adv.ICEV Tech
1	EPA Proposal	40%	0%	60%	0%	67%	0%	33%	0%
2	Zero BEV	0%	33%	67%	0%	0%	86%	0%	14%
3	No Incremental BEVs	40%	0%	60%	0%	40%	28%	0%	32%
4	Proportional BEVs	16%	11%	73%	0%	40%	28%	0%	32%

For Scenarios 2, 3 and 4 we assumed different starting points (No Action Case) from that assumed by EPA (line 1 of Table 5). We assume that a manufacturer would use a similar strategy to comply with the current standards under the No Action case as with the Proposed Standards. For example, as shown in row 1 of Table 5, EPA projected that manufacturer’s will use BEVs to comply with both the current standards and the Proposed standards, in their evaluation of the Proposal’s costs and benefits. Consistent with this approach, in our Zero-BEV scenario as shown in row 2 of Table 5, in which we assume manufacturers use only PHEVs and ICEVs to comply with the Proposal, EDF also assumes that these manufacturers will use only PHEVs and ICEVs to comply with the current standards.¹²

For the 40% BEV scenarios (rows 3 and 4 in Table 5), we used two separate No Action cases for comparison, These two cases allow for an evaluation of the net benefits of compliance with the Proposed Standards following manufacturers’ compliance with the current standards using two possible fleet mixes. In the “No Incremental BEVs” scenario at row 3 of Table 5, we assume the same No Action case that EPA used for the Proposal, with the Proposal leading to increased sales of PHEVs and improved ICEVs. In the “Proportional BEVs” scenario at row 4, we assume

¹² For the purposes of evaluating the net benefits of the zero-BEV compliance pathway, we use a zero-BEV reference case as well, though extremely unlikely given current BEV sales, and though the 40% BEV scenario uses a different reference case.

that manufacturers would sell a mix of BEVs and PHEVs under the No Action case in a similar ratio to that projected for the Proposal.

Calculation of Costs and Benefits

To calculate the costs and benefits of these alternative pathways EDF started with EPA's Proposal and No Action Case costs and benefits to account for the differences. The primary driver of the differences in benefits from these alternative compliance pathways is the change in vehicle costs due to the different fleet technology mix.

Emission Benefits

Both tailpipe CO₂ emissions and fuel costs are the same whether PHEVs and cleaner ICEVs or BEVs are used to comply with the GHG standards.¹³¹⁴ We assumed that criteria pollutant emissions under the Zero-BEV scenario are also the same as under EPA's Proposal. This is a conservative assumption as a higher use of PHEVs will result in lower overall criteria pollutant emissions.¹⁵

Maintenance Costs

We also assume that maintenance costs would be the same under all the alternative scenarios evaluated in this analysis as EPA's Proposal. While smaller than climate and health-related benefits and fuel savings, maintenance cost savings are a significant factor in the estimation of the net benefits of the Proposal. EPA estimates that PHEVs will have lower maintenance costs than ICEVs (and higher costs than BEVs), but not to the degree indicated by the utility factor. At the same time, EPA projected roughly the same maintenance cost savings for strong hybrids as PHEVs, and very few strong hybrids were projected to be sold in EPA's modeling of the No Action and proposed standards cases. Thus, our assumption may overestimate maintenance cost savings assuming ICEVs remain at 2022 emission levels, but both over- and underestimate maintenance cost savings assuming advanced technology ICEVs. However, any overestimation of maintenance savings in the former case would be much smaller than the value of reduced NMOG+NO_x emissions resulting from a fleet consisting mostly of PHEVs.

¹³ While all the scenarios modeled use the same amount of gasoline, scenarios with a higher level of strong hybrids or PHEVs use slightly less electricity than a scenario of all BEVs and conventional ICEVs like the ones EPA projected. This means the assumption that the alternative compliance scenarios modeled here have the same level of emission reductions is conservative since they will have lower EGU emissions.

¹⁴ This analysis used a discount rate of 3%. OMB recently released a revised version of Circular A-4 which lowers the recommended discount rate to be used by agencies in the cost benefit analyses. If this analysis used the new values, the benefits would likely be higher.

Circular No. A-4, Office of Management and Budget, November 9, 2023. <https://www.whitehouse.gov/wp-content/uploads/2023/11/CircularA-4.pdf>.

¹⁵ EPA's current non-methane organic gases plus nitrogen oxides (NMOG+NO_x) emission standards do not adjust PHEV emissions through use of the utility factor. One result of this is PHEVs must have the same emission control technology as ICEVs. This is consistent with Roush's approach to estimating the cost of a PHEV, which includes the same aftertreatment system costs for PHEVs as ICEVs. Thus, any PHEV travel using electricity will reduce NMOG+NO_x emissions relative to those resulting from a BEV strategy to GHG compliance.

Vehicle Costs

The average cost of MY2022 ICEVs and BEVs were taken directly from EPA's analysis supporting the Proposal. We then developed incremental costs of 1) a PHEV50 over a BEV300 and 2) of an ICEV with all of the available technology applied over the cost of a MY 2022 ICEV.

EPA does not include PHEV costs in its modeling for the Proposal. To determine reasonable PHEV50 cost estimates to use in conjunction with EPA's BEV cost estimates, we adjusted Roush's PHEV50 costs to match the ratio of PHEV50 to BEV300 costs projected by Roush.¹⁶ Roush projected that PHEV50s would cost \$4,800 to \$8,100 more than BEV300s across 5 vehicle classes in MYs 2027 and 2032 with fleet average costs of \$5,700 and \$7,400, respectively, in MYs 2027 and 2032.¹⁷ Adjusting Roush's incremental PHEV costs (relative to BEVs) to match EPA's methodology reduces the incremental PHEV costs by 30%, to \$4,000 in 2027 and \$5,200 in 2032.¹⁸

We obtained the incremental cost of a vehicle with advanced ICEV emission control technology from the CAFE model.¹⁹ The incremental ICEV cost of a MY 2032 vehicle with all available ICEV technology applied was \$1,267 above average MY 2022 costs.

We then combined these costs for the four vehicle technologies into a single fleetwide cost for the No Action and Proposal scenarios for each of the alternative pathways being evaluated here.

The average incremental vehicle costs (on a fleetwide basis) of the four scenarios are shown in Table 6. These fleetwide estimates were developed from the incremental costs for each of the four vehicle types described above: 1) 2022 ICEVs, 2) advanced ICEV technology, 3) PHEV50s, and 4) BEV300s.

¹⁶ Vishnu Nair, Himanshu Saxena, Sajit Pillai, Alternative Powertrain Pathways for Light-Duty and Class 3 Vehicles for MYs 2024, 2027, and 2035 to Meet Future CO2 Emission Targets, Roush for EDF (June 2023).

¹⁷ This is using vehicle segment sales from EPA's OMEGA 2 modeling for the Proposal.

¹⁸ We adjusted Roush's incremental costs for PHEV50s to harmonize with EPA's BEV cost estimates. EPA's and Roush's accounting for engine, transmission and aftertreatment removal with full electrification are similar, so no adjustment was necessary. However, EPA's battery capacities for BEV300s¹⁸ are 23% larger than Roush's estimates.¹⁸ We increased Roush's projected battery capacities for both PHEV50s and BEV300s by 23% to match EPA's methodology. And while EPA and Roush battery direct manufacturing costs for BEVs are comparable, EPA applies a 1.5 RPE factor to BEVs, while Roush applies a factor of 1.2 in 2027 and beyond to the entire electric powertrain. Similarly, we adjusted Roush's battery RPEs for both PHEV50s and BEVs to reflect EPA's RPE factor of 1.5. There was no need to do this for non-battery powertrain costs, as these are essentially the same for both BEVs and PHEVs. Both adjustments reduce the incremental cost of PHEV50s over BEVs. Combining these two factors, the PHEV50 battery savings are 54% higher using EPA's battery capacities and battery RPEs than originally projected by Roush.

¹⁹ This used the same run used to estimate the emission benefits of the advanced application of ICEV technology described above. Specifically, we modelled a scenario beyond NHTSA's proposal without allowing any ZEV technologies to be used to ensure that all available ICEV technology was applied.

	Scenario	Incremental Vehicle Costs
1	EPA Proposal	\$1,200
2	Zero BEV	\$3,200
3	No Incremental BEVs	\$2,900
4	Proportional BEVs	\$2,600

As shown in Table 6, a greater reliance on PHEV sales increases the fleetwide cost of complying with the Proposal. The average fleetwide cost is highest under the Zero BEV scenario, as the increase in PHEV sales is 55 percentage points. It is lowest under the Proportional BEV scenario as the increase in PHEV sales is only 16 percentage points.

No Action Case Costs and Benefits

While EPA projected a significant degree of over-compliance in its modeling of the No Action scenario,²⁰ the Zero-BEV and Proportional BEV No Action cases are assumed to strictly comply with the MY2026 vehicle standards. To account for this, EDF developed a second set of costs and benefits for the case where manufacturers strictly complied with the current MY 2026 standards, the binding regulations under EPA’s No Action scenario for the Proposed Standards.²¹

Net Benefit Results

Table 7 shows the estimated net benefits of EPA’s proposed standards for MY 2027 and beyond under different compliance pathways. As described above, we assume that manufacturers that intend to comply with the proposed standards using PHEVs would already be deploying PHEVs to comply with the current standards.

²⁰ This is due to the expected favorable economics of BEVs leading to more BEV sales than required for manufacturers to comply with the current regulations.

²¹ We did this by reducing the number of BEVs sold in EPA’s No Action scenario to the level where manufacturers just complied with the standards. Sales of ICEVs were increased accordingly. As EPA’s OMEGA 2 model provides outputs for BEVs and ICEVs separately, all outputs were adjusted to reflect the increase or decrease in vehicle sales. This resulting set of OMEGA 2 outputs was then input to EPA’s OMEGA 2 Effects Model to develop an alternative set of costs and benefits for the Proposal where manufacturers just complied with the current standards. The net benefits from this analysis could then serve as the basis for estimating the net benefits of the Zero BEV and Proportional BEV scenarios shown in Table 6. The net benefits of the Proposal relative to the “just complying” No Action scenario from calendar year (CY) 2027-2055 are about \$150 billion higher than EPA’s estimates, as the costs and benefits of some of the BEVs sold under EPA’s No Action scenario now contribute to the incremental costs and benefits of the Proposal.

Table 7: Net Benefits of EPA’s Proposed Emission Standards from CY 2027-2055, Discounted at 3%/year to 2027, Per EPA Methodology (\$ Billion)		
	Scenario	Net Benefits
1	EPA Proposal	\$1,400-\$1,600
2	Zero BEV	\$770-\$900
3	No Incremental BEVs	\$970-\$1,100
4	Proportional BEVs	\$1,300-\$1,400

As shown in Table 7, all of the alternative scenarios evaluated here are projected to produce significant levels of net benefits relative to their No Action scenarios. The net benefits of the Proportional BEV scenario are the highest of the three alternative scenarios. They approach those of EPA’s Proposal due to the fact that sales of both BEVs and PHEVs increase between the No Action and Proposal scenarios. The net benefits are the lowest for the No BEV scenario due to its reliance on PHEV sales, though they are still very substantial. The net benefits of the No Incremental BEV sales fall in between those of the other two alternative scenarios.

Conclusion

Our follow-up detailed analysis assessing additional pathways to compliance through fuller reliance on PHEVs, hybrids, and ICE efficiency improvements and less reliance on BEVs concludes that EPA’s proposed standards can be met with varying levels of technology and no particular technology is required – in whole or in part – to meet the fleet-average standards.

Our analysis also finds that even a zero-BEV pathway would result in significant net benefits of more than \$770 billion and as BEV sales increase so do the net benefits. This analysis reinforces the performance-based nature of EPA’s Proposed Standards and the technology flexibility manufacturers have toward compliance.

We welcome any questions about our analysis.

Sincerely,

Environmental Defense Fund