**IN THE UNITED STATES COURT OF APPEALS
FOR THE DISTRICT OF COLUMBIA CIRCUIT**

STATES OF TEXAS, ALABAMA, ALASKA, ARKANSAS, INDIANA, KENTUCKY, LOUISIANA, MISSISSIPPI, MISSOURI, MONTANA, NEBRASKA, OHIO, OKLAHOMA, SOUTH CAROLINA, AND UTAH,

Petitioners,

v.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY AND MICHAEL S. REGAN, ADMINISTRATOR, UNITED STATES ENVIRONMENTAL PROTECTION AGENCY,

Respondents.

No. 22-1031

PETITION FOR REVIEW

In accordance with 42 U.S.C. § 7607(b)(1), Federal Rule of Appellate Procedure 15, and D.C. Circuit Rule 15(a)(1), Petitioners the States of Texas, Alabama, Alaska, Arkansas, Indiana, Kentucky, Louisiana, Mississippi, Missouri, Montana, Nebraska, Ohio, Oklahoma, South Carolina, and Utah hereby petition this Court for review of the final action taken by Respondents United States Environmental Protection Agency and Michael S. Regan, Administrator, United States Environmental Protection Agency, entitled "Revised 2023 and Later Model Year Light-Duty Vehicle

Greenhouse Gas Emissions Standards" (attached hereto), published at 86 Fed. Reg. 74,434 (Dec. 30, 2021).

Respectfully submitted.

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CERTIFICATE OF SERVICE

I hereby certify that I caused a true and correct copy of this Petition for Review to be served on February 28, 2022, by United States first-class mail on the following:

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ATTACHMENT

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 86 and 600

[EPA–HQ–OAR–2021–0208; FRL 8469–01–OAR]

RIN 2060–AV13

Revised 2023 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions Standards

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final rule.

SUMMARY: The Environmental Protection Agency (EPA) is revising the greenhouse gas (GHG) emissions standards under the Clean Air Act section 202(a) for light-duty vehicles for 2023 and later model years to make the standards more stringent. On January 20, 2021, President Biden issued Executive Order 13990 ''Protecting Public Health and the Environment and Restoring Science To Tackle the Climate Crisis'' directing EPA to consider whether to propose suspending, revising, or rescinding the standards previously revised under the ''The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks,'' promulgated in April 2020. EPA is revising the GHG standards to be more stringent than the SAFE rule standards in each model year from 2023 through 2026. EPA is also including temporary targeted flexibilities to address the lead time of the final standards and to incentivize the production of vehicles with zero and near-zero emissions technology. In addition, EPA is making technical amendments to clarify and streamline our regulations.

DATES: This final rule is effective on February 28, 2022. The incorporation by reference of certain publications listed in this regulation is approved by the Director of the Federal Register as of February 28, 2022.

ADDRESSES: EPA has established a docket for this action under Docket ID No. EPA–HQ–OAR–2021–0208. All documents in the docket are listed on the *http://www.regulations.gov* website. Although listed in the index, some information is not publicly available, *e.g.,* CBI or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, is not placed on the internet and will be publicly available only in hard copy form. Publicly available docket materials are available electronically through *http://www.regulations.gov.*

FOR FURTHER INFORMATION CONTACT: Type text here Elizabeth Miller, Office of Transportation and Air Quality, Assessment and Standards Division (ASD), Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; telephone number: (734) 214–4703; email address: *miller.elizabeth@epa.gov.*

SUPPLEMENTARY INFORMATION:

Does this action apply to me?

This action affects companies that manufacture or sell passenger automobiles (passenger cars) and non-passenger automobiles (light trucks) as defined in 49 CFR part 523. Regulated categories and entities include:

Category	NAICS codes [A]	Examples of potentially regulated entities
Industry	336111, 336112	Motor Vehicle Manufacturers.
Industry	811111, 811112, 811198, 423110	Commercial Importers of Vehicles and Vehicle Components.
Industry	335312, 811198	Alternative Fuel Vehicle Converters.

[A] North American Industry Classification System (NAICS).

This list is not intended to be exhaustive, but rather provides a guide regarding entities likely to be regulated by this action. To determine whether particular activities may be regulated by this action, you should carefully examine the regulations. You may direct questions regarding the applicability of this action to the person listed in **FOR FURTHER INFORMATION CONTACT.**

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I. Executive Summary

A. Purpose of This Final Rule and Legal Authority

1. Final Light-Duty GHG Standards for Model Years 2023–2026

In this final action, the Environmental Protection Agency (EPA) is establishing revised, more stringent national greenhouse gas (GHG) emissions standards for passenger cars and light trucks under section 202(a) of the Clean Air Act (CAA), 42 U.S.C. 7521(a). Section 202(a) requires EPA to establish standards for emissions of air pollutants from new motor vehicles which, in the Administrator's judgment, cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare.

This action finalizes the standards that EPA proposed in August 2021.[1]

In response to Executive Order 13990 ''Protecting Public Health and the Environment and Restoring Science To Tackle the Climate Crisis,''[2] EPA conducted an extensive review of the existing regulations, which resulted in EPA proposing revised, more stringent standards. In the proposed rule, EPA sought public comment on a range of alternative standards, including alternatives that were less stringent (Alternative 1) and more stringent (Alternative 2) than the proposed standards as well as standards that were even more stringent (in the range of 5–10 grams CO_2 per mile (g/mile)) for model year (MY) 2026. As discussed in Section I.A.2 of this preamble, based on public comments and EPA's final analyses, EPA is finalizing standards consistent with the standards we proposed for MYs 2023 and 2024, and more stringent than those we proposed for MYs 2025 and 2026. EPA's final standards for MYs 2025 and 2026 are the most stringent standards considered in the proposed rule and establish the most stringent GHG standards ever set for the light-duty vehicle sector. EPA is revising the light-duty vehicle GHG standards for MYs 2023 through 2026, which had been previously revised by the SAFE rule, in part by building on earlier EPA actions and supporting analyses that established or maintained stringent standards. For example, in 2012, EPA issued a final rule establishing light-duty vehicle GHG standards for MYs 2017–2025,[3] which were supported by analyses of compliance costs, lead time and other relevant factors.[4] That rule and its analyses also accounted for the development and availability of advanced GHG emission-reducing vehicle technologies, which demonstrated that the standards were appropriate under section 202(a) of the CAA.

This final rule is also supported by updated analyses that consider the most recent technical and scientific data and continuing developments in the automotive industry, as well as public comments on the proposed rule. As noted in the proposed rule, auto manufacturers continue to implement a broad array of advanced gasoline vehicle GHG emission-reducing technologies at a rapid pace throughout their vehicle fleets. Even more notably, vehicle electrification technologies are advancing at a historic pace as battery costs continue to decline and automakers continue to announce plans for an increasing diversity and production volume of zero- and near-zero emission vehicle models. These trends continue to support EPA's decision to revise the existing GHG standards, particularly in light of factors indicating that more stringent near-term standards are feasible at reasonable cost and would achieve significantly greater GHG emissions reductions and public health and welfare benefits than the existing program.

In developing this final rule, EPA considered comments received during the public comment period, including during the public hearing. EPA held a two-day virtual public hearing on August 25 and 26, 2021 and heard from approximately 175 speakers. During the public comment period that ended on September 27, 2021, EPA received more than 188,000 written comments. This preamble, together with the accompanying Response to Comments (RTC) document, responds to all significant comments we received on the proposed rule.

Comments from automakers that historically have produced primarily internal combustion engine (ICE) vehicles, such as comments by the Alliance for Automotive Innovation (hereafter referred to as ''the Alliance'') as well as comments by several individual automakers, generally supported the proposed standards and did not support the more stringent alternatives on which we requested comment. A common theme from these commenters is that EPA should not overly rely on high penetrations of electric vehicles (EVs) during the period through MY 2026 as a means of compliance for the industry, because of uncertainty about the degree of availability of EV charging infrastructure and market uptake of EVs in this time frame. The United Auto Workers (UAW) commented similarly, generally supporting the proposed standards and flexibilities but not

[1] 86 FR 43726.

[2] 86 FR 7037, January 25, 2021. ''[T]he head of the relevant agency, as appropriate and consistent with applicable law, shall consider publishing for notice and comment a proposed rule suspending, revising, or rescinding the agency action[s set forth below] within the time frame specified.'' ''Establishing Ambitious, Job-Creating Fuel Economy Standards: . . . 'The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks,' 85 FR 24174 (April 30, 2020), by July 2021. In considering whether to propose suspending, revising, or rescinding the latter rule, the agency should consider the views of representatives from labor unions, States, and industry.''

[3] EPA's model year emission standards also apply in subsequent model years, unless revised, *e.g.,* MY 2025 standards issued in the 2012 rule also applied to MY 2026 and beyond.

[4] 77 FR 62624, October 15, 2012.

supporting more stringent standards or reduced flexibilities. In contrast, automakers producing (or planning to produce) only EVs (Tesla, Rivian, and Lucid) supported standards more stringent than the proposed standards, and they generally did not support the proposed flexibilities.

Comments from organizations representing environmental, public health, and consumer groups as well as comments from many states and local governments generally state that in this rulemaking EPA should address public health, climate change, and social equity in a robust manner. These commenters expressed nearly universal support for the more stringent Alternative 2; many also support an additional 10 g/mile more stringent standards in MY 2026, on which we requested comment. In addition, during the public hearing, many of these commenters, as well as speakers who identified themselves as representing frontline communities, urged the strongest possible emissions standards to address environmental impacts on overburdened communities. There was also broad opposition among these commenters to the proposed flexibilities and incentives, based on concerns that the flexibilities were unnecessary and would compromise the stringency of the program. In addition, tens of thousands of individual public commenters echoed these themes, urging EPA to establish the strongest possible GHG emissions standards.

As discussed in Section I.B of this preamble, the final rule revises GHG emissions standards for MYs 2023–2026, incorporating several changes from the proposed standards and flexibilities, based on our consideration of the public comments and updated information and analysis. As discussed in Section I.A.2 of this preamble, it is EPA's assessment that the final standards are reasonable and appropriate, after considering lead time, cost, and other relevant factors under the CAA.

As noted in the proposed rule, EPA set previous light-duty vehicle GHG emission standards in joint rulemakings where NHTSA also established CAFE standards. EPA concluded that it was not necessary for this rulemaking to be jointly issued with the National Highway Traffic Safety Administration (NHTSA). EPA has, however, coordinated with NHTSA, both on a bilateral level as well as through the interagency review process for EPA's proposed rule and this final rule facilitated by the Office of Management and Budget (OMB) under E.O. 12866.

2. Why does EPA believe the final standards are appropriate under the CAA?

EPA is revising GHG emissions standards for passenger cars and light trucks under the authority provided by section 202(a) of the CAA. Section 202(a) requires EPA to establish standards for emissions of pollutants from new motor vehicles which, in the Administrator's judgment, cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare. Standards under section 202(a) 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.'' Thus, in establishing or revising section 202(a) standards designed to reduce air pollution that endangers public health and welfare, EPA also must consider technological feasibility, compliance cost, and lead time. EPA also may consider other factors and in previous light-duty vehicle GHG standards rulemakings has considered the impacts of potential GHG standards on the auto industry, cost impacts for consumers, oil conservation, energy security and other energy impacts, as well as other relevant considerations such as safety.

When considering these factors for the SAFE rule, EPA identified several factors, primarily costs to manufacturers and upfront costs to vehicle purchasers, as disfavoring maintaining or increasing the stringency of the then-existing standards, and other factors, such as reduced emissions that endanger public health and welfare and reduced operating costs for consumers, as favoring increased stringency (or a lesser degree of reduced stringency from the then-existing standards). In balancing these factors in the SAFE rule, EPA placed greater weight on the former factors (reducing the costs for the manufacturers and reducing upfront costs for vehicle buyers), and thereby decided to make EPA's GHG standards significantly less stringent. However, the purpose of adopting standards under CAA section 202 is to address air pollution that may reasonably be anticipated to endanger public health and welfare. Indeed, reducing air pollution has traditionally been the focus of such standards.

EPA has reconsidered how costs, lead time and other factors were weighed in the SAFE rule against the potential for achieving emissions reductions and is reaching a different conclusion as to the appropriate stringency of the standards. In light of the statutory purpose of CAA section 202, the Administrator is placing greater weight on the emission reductions and resulting public health and welfare benefits and, taking into consideration EPA's updated technical analysis, accordingly is establishing significantly more stringent standards for MYs 2023–2026 compared to the standards established by the SAFE rule.

We are revising decisions made in the SAFE final rule in accordance with our updated technical analyses for the proposed and final rule. EPA's approach is consistent with Supreme Court decisions affirming that agencies are free to reconsider and revise their prior decisions where they provide a reasonable explanation for their revised decisions.[5] In this rule, the agency is changing its 2020 position and restoring its previous approach by finding, in light of its updated technical analyses and of the statutory purposes of the CAA and in particular of section 202(a), that it is more appropriate to place greater weight on the magnitude and benefits of reducing emissions that endanger public health and welfare, while continuing to consider compliance costs, lead time and other relevant factors. In addition to the greater emphasis on emissions reductions, the agency's decision to adopt more stringent standards for MYs 2023–2026 is significantly informed by consideration of new information that was not available during the SAFE rule development. Specifically, the agency's decision has been informed by the further technological advancements and successful implementations of electric vehicles since the SAFE rule, by the recent manufacturer announcements signaling an accelerated transition to electrified vehicles, and by additional evidence of sustained and active credit trading as manufacturers take advantage of this additional flexibility for adopting emissions-reducing technologies across the new vehicle fleet.

When considering these factors for the SAFE rule, EPA identified several factors, primarily costs to manufacturers and upfront costs to vehicle purchasers, as disfavoring maintaining or increasing the stringency of the then-existing standards, and other factors, such as reduced emissions that endanger public health and welfare and reduced operating costs for consumers, as favoring increased stringency (or a lesser degree of reduced stringency from the then-existing standards). In balancing these factors in the SAFE rule,

[5] See, *e.g., Encino Motorcars, LLC* v. *Navarro,* 136 S. Ct. 2117, 2125 (2016); *FCC* v. *Fox Television Stations, Inc.,* 556 U.S. 502, 515 (2009).

EPA placed disproportionate weight on the former factors (reducing the costs for the manufacturers and reducing upfront costs for vehicle buyers), and thereby significantly diminished the relative weight given to the latter factors (increased operating costs and increased harmful emissions). The SAFE rule relied on this re-weighting to justify making EPA's GHG standards significantly less stringent in a way that (under the SAFE rule's own analysis) would have resulted in increases in CO2 emissions of 867 MMT (over the vehicles' lifetimes), increases in criteria pollutants, and resulting increases in adverse health effects (as well as net costs to public welfare).[6]

The purpose of adopting standards under CAA section 202, however, is to address air pollution that may reasonably be anticipated to endanger public health and welfare. Indeed, reducing air pollution has traditionally been the focus of such standards. EPA has therefore updated its technical analysis of potential emissions control technologies, costs and lead time and reconsidered how those and other factors were weighed in the SAFE rule against the potential for achieving emissions reductions. In light of the statutory purpose of CAA section 202, the Administrator is restoring the appropriate, central consideration given to the emission reductions from motor vehicles and resulting public health and welfare benefits, while still giving appropriate consideration to compliance costs and other factors (including savings in vehicle operating costs). Accordingly, EPA is establishing significantly more stringent standards for MYs 2023–2026 compared to the standards established by the SAFE rule.

As discussed in Section III.A of this preamble, the standards take into consideration both the updated analyses for the proposed and final rule and past EPA analyses conducted for previous GHG standards. We are revising decisions made in the SAFE final rule in accordance with Supreme Court decisions affirming that agencies are free to reconsider and revise their prior decisions where they provide a reasonable explanation for their revised decisions. In this rulemaking, the agency is changing its 2020 position and restoring its previous approach by finding, in light of the statutory purposes of the CAA and in particular of section 202(a), that it is more appropriate to place considerable weight on the magnitude and benefits of reducing emissions that endanger public health and welfare, while continuing to consider compliance costs, lead time and other relevant factors.

EPA has carefully considered the technological feasibility and cost of the full range of alternatives on which we sought public comment in the proposed rule and the available lead time for manufacturers to comply with them, including the role of flexibilities designed to facilitate compliance. In our technical assessment, discussed in further detail in section VI.A of this preamble, we conclude that there has been ongoing advancement in emissions reducing technologies since the beginning of the EPA's program in 2012, and that there is potential for greater penetration of these technologies across all new vehicles. In addition to improvements in ICE vehicles, recent advancements in electric vehicle technologies have greatly increased the available options for manufacturers to meet more stringent standards. Based on our updated technical analyses and consideration of the public comments, EPA has determined that standards that are more stringent in the later model years (*i.e.,* after MY 2024) than the proposed standards are more appropriate under Section 202(a).

In recognition of lead time considerations, for MYs 2023 and 2024, EPA is finalizing the proposed standards for those model years. For MYs 2025 and 2026, EPA has determined that it is appropriate to finalize standards more stringent than those proposed, and, as described in more detail in section I.B of this preamble, we are finalizing standards that are the most stringent of the alternatives considered in the proposed rule for those model years.

This approach best meets EPA's responsibility under the CAA to protect human health and the environment, as well as its statutory obligation to consider lead time, feasibility, and cost. The final standards will result in significantly greater reductions of GHG emissions over time compared to the proposed standards. EPA projects that the final standards will result in a reduction of 3.1 billion tons of GHG emissions by 2050—50 percent greater emission reductions than our proposed standards. In addition, the final standards will reduce emissions of some criteria pollutants and air toxics, resulting in important public health benefits, as described in Section V of this preamble. The final standards will result in reduced vehicle operating costs for consumers. The fuel consumption reduced by the final standards will save consumers $210 to $420 billion in retail fuel costs through 2050. Although the up-front technology cost for a MY 2026 vehicle meeting the final standards is estimated to be $1,000 on average, drivers will recover that up-front cost over time through savings in fuel costs. For an individual consumer on average, EPA estimates that, over the lifetime of a MY 2026 vehicle, the reduction in fuel costs will exceed the increase in vehicle costs by $1,080 (see Section VII.J of this preamble). Further, the overall benefits of the program will far outweigh the costs, as EPA estimates net benefits of $120 billion to $190 billion through 2050.[7] Section I.B of this preamble describes the final standards in more detail.

In developing this final rulemaking, EPA updated the analyses based, in part, on our assessment of the public comments. We agree with commenters who stated that it is appropriate to update certain key inputs—for example, the vehicle baseline fleet and certain technology costs—to reflect newer data. For example, a key update was to the estimates of battery costs for electrified vehicles, which have decreased significantly in recent years. EPA's approach to updating these costs and other inputs to the analyses is described in Section III.A of this preamble.

The more stringent standards for MY 2025 and 2026 also provide a more appropriate transition to new standards for MY 2027 and beyond. As stated in the proposal, EPA is planning to initiate a rulemaking to establish multi-pollutant emission standards for MY 2027 and later (see the preamble to the proposed rule at section I.A.3). Consistent with the direction of Executive Order 14037, ''Strengthening American Leadership in Clean Cars and Trucks,'' [8] this subsequent rulemaking will extend to at least MY 2030 and will apply to light-duty vehicles as well as medium-duty vehicles (*e.g.,* commercial pickups and vans, also referred to as heavy-duty class 2b and 3 vehicles) and is likely to significantly build upon the standards established in this final rule. EPA looks forward to engaging with all stakeholders, including states and our federal partners, to inform the development of these future standards.

B. Summary of Final Light-Duty Vehicle GHG Program

EPA is finalizing revised GHG standards that begin in MY 2023 and increase in stringency year over year through MY 2026.

After consideration of public comments, EPA is adopting the

[6] See 85 FR 25111, April 30, 2020.

[7] See Section VII.I of this preamble for more detail.

[8] 86 FR 43583, August 10, 2021.

following approach for setting the final standards:

• For MYs 2023 and 2024, EPA is finalizing the proposed standards.

• For MY 2025, EPA is finalizing the Alternative 2 standards (the most stringent standards considered in the proposed rule for this MY).

• For MY 2026, EPA is finalizing the most stringent alternative upon which we sought comment—the Alternative 2 standards with an additional 10 g/mile increased stringency.

EPA is finalizing optional flexibility provisions for manufacturers that are more targeted than proposed, primarily to focus most of the flexibilities on MYs 2023–2024 in consideration of lead time for manufacturers and to help them manage the transition to more stringent standards by providing some additional flexibility. We summarize the final flexibility program elements, including an analysis of key public comments, in Sections II.A.4 and II.B of this preamble.

This final rule accelerates the rate of stringency increases of the MY 2023–2026 SAFE standards from a roughly 1.5 percent year-over-year rate of stringency increase to a nearly 10 percent stringency increase from MY 2022 to MY 2023, followed by a 5 percent stringency increase in MY 2024, as proposed. In MY 2025, the stringency of the final standards increases by 6.6 percent, culminating with a 10 percent stringency increase in MY 2026, as provided in the Alternative 2 standards with an additional 10 g/mile increased stringency in MY 2026, on which we sought comment.

EPA believes the 10 percent increase in stringency in MY 2023 is appropriate given the technological investments industry was on track to make under the 2012 standards and has continued to make beyond what would be required to meet the SAFE rule standards, as well as the compliance flexibilities available within the program. This is illustrated in part by several manufacturers, representing nearly 30 percent of the nationwide auto market, having chosen to participate in the California Framework Agreements. Our decision to finalize the more stringent Alternative 2 standards for MY 2025, and the Alternative 2 standards with a further increase of stringency of 10 g/mile in MY 2026 takes into account the additional lead time available for MYs 2025–2026 compared to MYs 2023–2024. Given this additional lead time, EPA has determined that it is appropriate, particularly in light of the accelerating transition to electrified vehicles that has already begun, to require additional emissions reductions in this time frame. The resulting trajectory of increasing stringency from MYs 2023 to 2026 also takes into account the credit-based emissions averaging, banking and trading flexibilities of the current program, including flexibility provisions that have been retained, and the targeted additional flexibilities that are being extended in this final rule, especially in the early years of the program. EPA has also taken into account manufacturers' ability to generate credits against the existing standards that were relaxed in the SAFE rule for MYs 2021 and 2022, which we are not revising. The final standards for MYs 2023–2026 will achieve significant GHG and other emission reductions and related public health and welfare benefits, while providing consumers with lower operating costs resulting from significant fuel savings. Our analyses described in this final rule support the conclusion that the final standards are appropriate under section 202(a) of the CAA, considering costs, technological feasibility, available lead time, and other factors.

In our design and analyses of the final program, and our overall updated assessment of feasibility, EPA took into account the decade-long light-duty vehicle GHG emission reduction program in which the auto industry has introduced a wide lineup of ever more fuel-efficient, GHG-reducing technologies that are already present in much of the fleet and will enable the industry to achieve the standards established in this rule. As explained in the preamble to the proposed rule, in light of the design cycle timing for manufacturers of light-duty vehicles, EPA reasonably expects that the vehicles that automakers will be selling during the first years of the MY 2023–2026 program were already designed before the less stringent SAFE standards were adopted.

Most automakers have launched ambitious plans to develop and produce increasing numbers of zero- and near-zero-emission vehicles. EPA recognizes that during the near-term timeframe of the standards, the new vehicle fleet likely will continue to consist predominantly of gasoline-fueled vehicles, although the volumes of electrified vehicles will continue to increase, particularly in MYs 2025 and 2026. In this preamble and the Regulatory Impact Analysis (RIA), we provide analyses supporting our assessment that the final standards for MYs 2023 through 2026 are achievable primarily through the application of advanced gasoline vehicle technologies but with a growing percentage of electrified vehicles. We project that during the four-year ramp up of the stringency of the GHG standards, the standards can be met with gradually increasing sales of plug-in electric vehicles in the U.S., from about 7 percent market share in MY 2023 (including both fully electric vehicles (EVs) and plug-in hybrid vehicles (PHEVs)) up to about 17 percent in MY 2026. In MY 2020, EVs and PHEVs represented about 2.2 percent of U.S. new vehicle production.[9] From January through September 2021, EVs and PHEVs represented 3.6 percent of total U.S. light-duty vehicle sales,[10] and are projected to be 4.1 percent of production by the end of MY 2021.[11] This rule is expected to result in an increase in penetration of EV and PHEV vehicles from today's levels, and we believe the projected penetrations are reasonable when considering the results of our analysis as well as these trends in the growth of EV market share, as well as the proliferation of recent automaker announcements on plans to transition toward an electrified fleet (which we discuss in Section III.C of this preamble). Projections of future EV market share also increasingly show rates of EV penetration commensurate with what we project under the final standards.[12 13 14] Numerous automaker announcements of a rapidly increasing focus on EV and PHEV production (see Section III.C of this preamble), which were reiterated in their public comments, show that automakers are already preparing for rapid growth in EV penetration. EPA finds that, given

[9] "The 2021 EPA Automotive Trends Report, Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975," EPA–420R–21023, November 2021.

[10] Argonne National Laboratory, "Light Duty Electric Drive Vehicles Monthly Sales Updates," September 2021, accessed on October 20, 2021 at: *https://www.anl.gov/es/light-duty-electric-drive-vehicles-monthly-sales-updates.*

[11] "The 2021 EPA Automotive Trends Report, Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975," EPA–420R–21023, November 2021.

[12] Bloomberg New Energy Finance (BNEF), BNEF EV Outlook 2021, Figure 5. Accessed on November 1, 2021 at *https://about.bnef.com/electric-vehicle-outlook/* (Figure 5 indicates U.S. BEV+PHEV penetrations of approximately 7% in 2023, 9% in 2024,11% in 2025 and 15% in 2026).

[13] IHS Markit, "US EPA Proposed Greenhouse Gas Emissions Standards for Model Years 2023–2026; What to Expect," August 9, 2021. Accessed on October 28, 2021 at *https://ihsmarkit.com/research-analysis/us-epa-proposed-greenhouse-gas-emissions-standards-MY2023-26.html* (Table indicates 12.2% in 2023, 16% in 2024, 20.1% in 2025 and 24.3% in 2026).

[14] Rhodium Group, "Pathways to Build Back Better: Investing in Transportation Decarbonization," May 13, 2021. Accessed on November 1, 2021 at *https://rhg.com/research/build-back-better-transportation/* (Figure 3 indicates EV penetration of 11% to 19% in 2026 under a current policy scenario).

the rate and breadth of these announcements across the industry, the levels of EV penetration we project to occur are appropriate. As described elsewhere in this preamble, based on our analysis of the final standards, we believe that the targeted incentives and flexibilities that we are finalizing for the early years of the program will further address lead time considerations as well as support the acceleration of automakers' introduction and sales of advanced technologies, including zero and near-zero-emission technologies.

We describe additional details of the final standards below and in later sections of the preamble as well as in the RIA.

1. Final Revised GHG Emissions Standards

As with EPA's previous light-duty GHG programs, as proposed, EPA is finalizing footprint-based standards curves for both passenger cars and light trucks (throughout this action, ''trucks'' or ''light trucks'' refers to light-duty trucks). Each manufacturer has a unique standard for the passenger cars category and another for the truck category [15] for each MY based on the sales-weighted footprint-based CO_2 targets [16] of the vehicles produced in that MY.

EPA is finalizing the proposed standards for MYs 2023 and 2024, the Alternative 2 standards for MY 2025, and the Alternative 2 standards minus 10 g/mile for MY 2026. In the proposed rule, EPA requested comment on standards for MY 2026 that would result in fleet average target levels that are in the range of 5–10 g/mile lower (*i.e.,* more stringent) than the levels proposed in each of the three alternatives, and is finalizing a level 10 g/mile lower than the proposed rule's Alternative 2 for MY 2026.

Figure 1 shows EPA's final standards, expressed as average projected fleetwide GHG emissions targets (cars and trucks combined), through MY 2026. For comparison, the figure also shows the corresponding targets for the proposed standards (Proposal), the Alternative 2 standards reduced by 10 g/mile in MY 2026 (Alternative 2 minus 10), as described further in Section II.C of this preamble, the SAFE standards, and the 2012 FRM standards.[17] The projected fleet targets for the final standards increase in stringency in MY 2023 by almost 10 percent (compared to the SAFE rule standards in MY 2022), followed by stringency increases of 5 percent in MY 2024, 6.6 percent in MY 2025 and 10 percent in MY 2026. As with all EPA vehicle emissions standards, the MY 2026 standards will remain in place for all subsequent MYs, unless and until the standards for future MYs are revised in a subsequent rulemaking. As noted previously, EPA is planning a future rulemaking to establish new emissions standards for MY 2027 and beyond.

Table 1 presents the projected overall industry fleetwide CO_2-equivalent emission compliance target levels, based on EPA's final standards presented in Figure 1. The industry fleet-wide estimates in Table 1 are projections based on EPA's modeling, taking into consideration projected fleet mix and footprints for each manufacturer's fleet in each model year. Table 2 presents projected industry fleet average year-over-year percent reductions (and cumulative reductions from 2022 through 2026) comparing the standards under the SAFE rule and the revised final standards. See Section II.A of this preamble for a full discussion of the final standards and presentations of the footprint standards curves.

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[15] Passenger cars include cars and smaller cross-overs and SUVs, while the truck category includes larger cross-overs and SUVs, minivans, and pickup trucks.

[16] Because compliance is based on the full range of vehicles in a manufacturer's car and truck fleets, with lower-emitting vehicles compensating for higher-emitting vehicles, the emission levels of specific vehicles within the fleet are referred to as targets, rather than standards.

[17] The Proposal and Alternative 2 minus 10 standards are the less and more stringent alternatives EPA analyzed in addition to the final rule. See Sections II.C and III.D of this preamble for more information these alternatives.

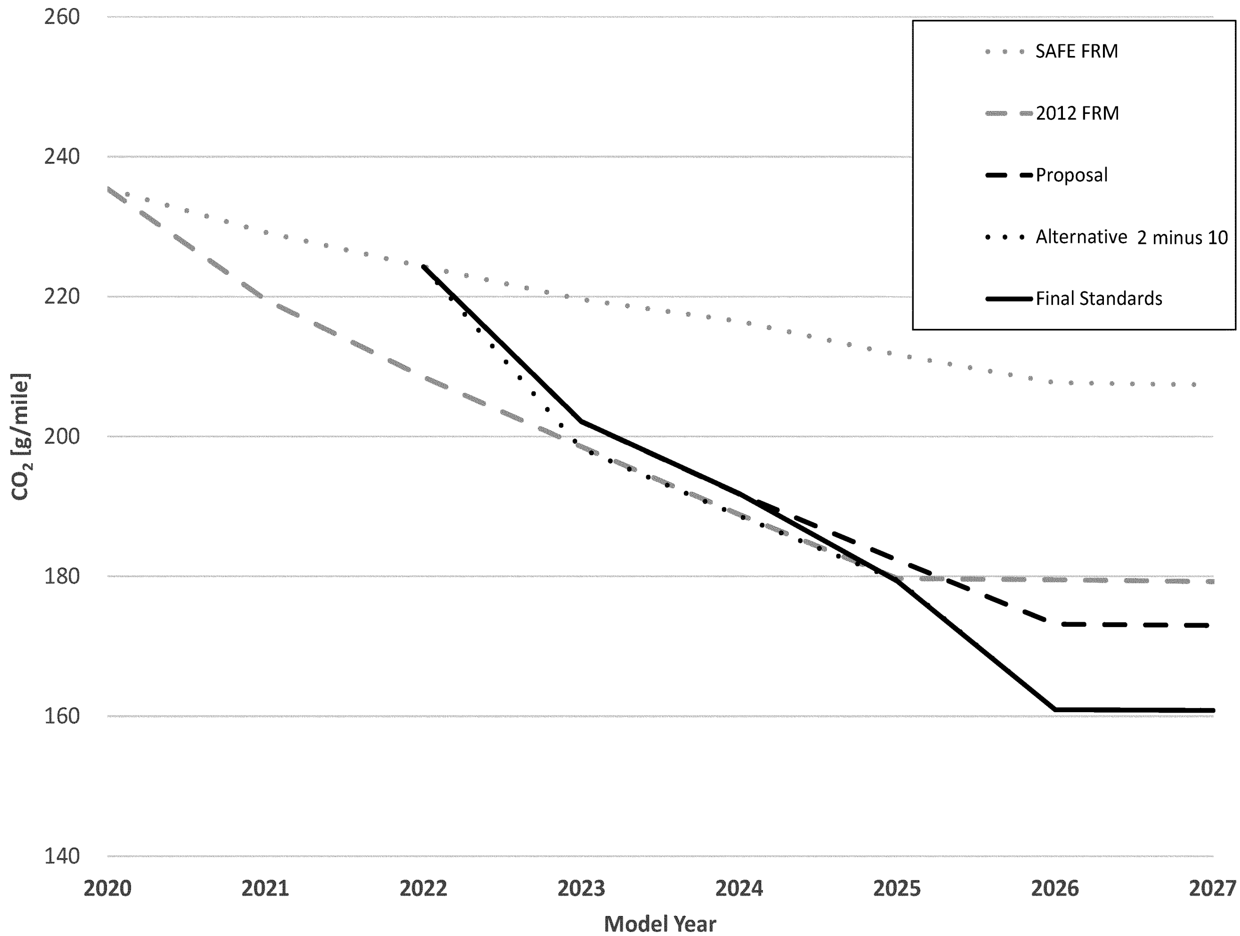

Figure 1 EPA Final Industry Fleet-Wide CO_2 Compliance Targets, Compared to 2012 and SAFE Rules, the Proposal and Alternative 2 minus 10, g/mile, MYs 2020-2026 and later

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TABLE 1—PROJECTED INDUSTRY FLEET-WIDE CO_2 COMPLIANCE TARGETS FOR MYS 2023–2026

[g/mile] *

Model year	Cars CO_2 (g/mile)	Light trucks CO_2 (g/mile)	Fleet CO_2 (g/mile)
2022 (SAFE reference)	181	261	224
2023	166	234	202
2024	158	222	192
2025	149	207	179
2026 and later	132	187	161
Total change 2022–2026	−49	−74	−63

* The combined car/truck CO_2 targets are a function of projected car/light truck shares, which have been updated for this final rule (MY 2020 is 44 percent car and 56 percent light trucks while the projected mix changes to 47 percent cars and 53 percent light trucks by MY 2026).

TABLE 2—PROJECTED INDUSTRY FLEET AVERAGE TARGET YEAR-OVER-YEAR PERCENT REDUCTIONS

	SAFE rule standards *			Proposed standards **			Final standards **		
	Cars (%)	Trucks (%)	Combined (%)	Cars (%)	Trucks (%)	Combined (%)	Cars (%)	Trucks (%)	Combined (%)
2023	1.7	1.7	2.1	8.4	10.4	9.8	8.4	10.4	9.8
2024	0.6	1.5	1.4	4.7	5.0	5.1	4.8	4.9	5.1
2025	2.3	1.7	2.2	4.8	5.0	5.0	5.7	7.0	6.6
2026	1.8	1.6	1.9	4.8	5.0	5.0	11.4	9.5	10.3

TABLE 2—PROJECTED INDUSTRY FLEET AVERAGE TARGET YEAR-OVER-YEAR PERCENT REDUCTIONS—Continued

	SAFE rule standards *			Proposed standards **			Final standards **		
	Cars (%)	Trucks (%)	Combined (%)	Cars (%)	Trucks (%)	Combined (%)	Cars (%)	Trucks (%)	Combined (%)
Cumulative	6.3	6.3	7.4	20.9	23.1	22.8	27.1	28.3	28.3

* Note the percentages shown for the SAFE rule targets have changed slightly from the proposed rule, due to the updates in our base year fleet from MY 2017 to MY 2020 manufacturer fleet data.

** These are modeled results based on projected fleet characteristics and represent percent reductions in projected targets, not the standards (which are the footprint car/truck curves), associated with that projected fleet (see Section III of this preamble for more detail on our modeling results).

2. Final Compliance Flexibilities and Advanced Technology Incentives

EPA received many comments on the proposed flexibility provisions. After considering the comments along with our updated analyses, we are finalizing flexibility provisions that are narrower than proposed in several aspects, primarily to focus the additional flexibilities in MYs 2023–2024 to help manufacturers manage the transition to more stringent standards by providing some additional flexibility in the near-term. We summarize the final flexibility program elements, including a summary and analysis of key comments, in Section II.B of this preamble.

EPA proposed a set of extended or additional temporary compliance flexibilities and incentives that we believed would be appropriate given the stringency and lead time of the proposed standards. We proposed four types of flexibilities/incentives, in addition to those already available under EPA's previously established regulations: (1) A limited extension of carry-forward credits generated in MYs 2016 through 2020 beyond the normal five years otherwise specified in the regulations; (2) an extension of the advanced technology vehicle multiplier credits for MYs 2022 through 2025 with a cumulative credit cap; (3) full-size pickup truck incentives for strong hybrids or similar performance-based credit for MYs 2022 through 2025 (provisions which were removed in the SAFE rule); and (4) an increase of the off-cycle credits menu cap from 10 g/mile to 15 g/mile. EPA also proposed to remove the multiplier incentives for natural gas fueled vehicles for MYs 2023–2026.

The GHG program includes existing provisions initially established in the 2010 rule, which set the MYs 2012–2016 GHG standards, for how credits may be used within the program. These averaging, banking, and trading (ABT) provisions include credit carry-forward, credit carry-back (also called deficit carry-forward), credit transfers (within a manufacturer), and credit trading (across manufacturers). These ABT provisions define how credits may be used and are integral to the program, essentially enabling manufacturers to plan compliance over a multi-year time period. The current program allows credits to be carried forward for 5 years (*i.e.,* a 5-year credit life). EPA proposed a two-year extension of MYs 2016 credit life and a one-year extension of MYs 2017–2020 credit life.

EPA is finalizing a more limited approach to credit life extension, adopting only a one-year extension for MY 2017–2018 credits, as shown in Table 3 below. EPA was persuaded by public comments from non-governmental organizations (NGOs), some states including California, and EV manufacturers that the proposed credit life extension overall was unnecessary and could diminish the stringency of the final standards. While several auto industry commenters suggested even additional credit life extensions, EPA's assessment is that the standards are feasible with the more narrowed credit extensions of one-year for the MYs 2017 and 2018 credits, which make more credits available in the early years of the program, MYs 2023 and 2024, to help manufacturers manage the transition to more stringent standards by providing some additional flexibility. For all other credits generated in MY 2016 and later, credit carry-forward remains unchanged at five years.

TABLE 3—FINAL EXTENSION OF CREDIT CARRY-FORWARD FOR MY 2016–2020 CREDITS

MY credits are banked	MYs credits are valid under extension										
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
2016	....	x	x	x	x	x	....	....	....	....	....
2017	....	x	....	x	x	x	x	+	....	....	....
2018	....	....	x	x	....	x	x	x	+	....	....
2019	....	....	....	x	x	....	x	x	x	....	....
2020	....	....	....	....	x	....	x	x	x	x	....
2021	....	....	....	....	....	....	x	x	x	x	x

x = Previous program. + = Additional years included in Final Rule.

The previous GHG program also includes temporary incentives through MY 2021 that encourage the use of advanced technologies such as electric, hybrid, and fuel cell vehicles, as well as incentives for full-size pickups using strong hybridization or technologies providing similar emissions reductions to hybrid technology. The full-size pickup incentives originally (in the 2012 rule) were available through MY 2025, but the SAFE rule removed these incentives for MYs 2022 through 2025. When EPA established these incentives in the 2012 rule, EPA recognized that they would reduce the effective stringency of the standards, but believed that it was worthwhile to have a limited near-term loss of emissions reduction benefits to increase the potential for far greater emissions reduction and technology diffusion benefits in the longer term.[18] EPA believed that the temporary regulatory incentives would

[18] See Tables III–2 and III–3, 77 FR 62772, October 15, 2012.

help bring low emission technologies to market more quickly than an effective market would in the absence of incentives.[19 20] With these same goals in mind for this program, EPA proposed multiplier incentives from MYs 2022 through MY 2025 with a cap on multiplier credits and to reinstate the full-size pickup incentives also for MYs 2022 through 2025. The proposed incentives were intended as a temporary measure supporting the transition to zero-emission vehicles and to provide additional flexibility in meeting the MY 2023–2026 proposed standards.

However, EPA is finalizing a narrower timeframe for the temporary multiplier and full-size pickup incentives, focusing the incentives only in MYs 2023–2024, to help manufacturers manage the transition to more stringent standards by providing some additional flexibility. After considering comments and further analyzing the potential impact of multipliers on costs and emissions reductions, EPA is adopting temporary multipliers for MYs 2023–2024 at a level lower than proposed while finalizing the proposed credit cap of 10 g/mile cumulatively, as further discussed in Section II.B.1 of this preamble. EPA is not finalizing multiplier incentives for MY 2022 or MY 2025 and is instead sunsetting them at the end of MY 2024. Under this approach, manufacturers utilizing this optional incentive program would need to produce more advanced technology vehicles (EVs, PHEVs or fuel cells) in order to fully utilize multiplier credits before reaching the cap, thus incentivizing greater volumes of these zero and near-zero emission vehicles. Similarly, EPA is finalizing temporary full-size pickup incentives only for MYs 2023–2024 and sunsetting them at the end of MY 2024. These provisions are further discussed in Section II.B.2 of this preamble.

EPA is finalizing our proposed removal of the extended multiplier incentives for natural gas vehicles (NGVs) after MY 2022, which was added by the SAFE rule, because NGVs are not a near-zero emissions technology and EPA believes multipliers are no longer necessary or appropriate for these vehicles. NGV multiplier incentives are discussed in Section II.B.1.iii of this preamble.

For the off-cycle credits program, EPA is finalizing our proposed incentive to increase the menu cap from 10 to 15 g/mile, but for a more limited time frame. EPA is finalizing this cap increase beginning in MY 2023 through MY 2026, instead of beginning the cap increase in MY 2020 as in the proposed rule. Off-cycle credits are intended to reflect real-world emissions reductions for technologies not captured on the CO_2 compliance test cycles. EPA agrees with public comments from many NGOs and states that increasing the off-cycle credit menu cap starting in MY 2020 would unnecessarily provide additional credit opportunities during the years of the weakened SAFE standards in MYs 2021 and 2022. EPA also is finalizing revised definitions for three off-cycle technologies to begin in MY 2023, to ensure real-world emission reductions consistent with the menu credit values. See Section II.B.3 of this preamble for further information.

C. Analytical Support for the Final Revised Standards

EPA updated several key inputs to our analysis for this final rule based on public comments and newer available data, as detailed in Section III.A of this preamble, including updates to the baseline vehicle fleet and battery costs, issues on which we received a substantial number of public comments.

We have updated the baseline vehicle fleet to reflect the MY 2020 fleet rather than the MY 2017 fleet used in the analysis for the proposed rule.[21] As a result, there is slightly more GHG-reducing technology contained in the baseline fleet and the fleet mix has changed to reflect more light trucks in the fleet (56 percent trucks/44 percent cars, compared to the 50/50 car/truck split in the analysis for the proposed rule).

In the proposed rule, we noted that the electrified vehicle battery costs used in the SAFE FRM, which were carried over to the proposed rule analysis, could be lower based on EPA's latest assessment and that updating those costs for the proposed rule would not have had a notable impact on overall cost estimates. This conclusion was based in part on our expectation that electrification would continue to play a relatively modest role in our projections of compliance paths for the proposed standards, as it had in all previous analyses of standards with a similar level of stringency. We also noted in the proposal that we could update battery costs for the final rule and requested comment on whether our choice of modeling inputs such as these should be modified for the final rule analysis. In response to the public comments regarding EPA's battery cost estimates used in the proposed rule, EPA has updated the battery costs for the final rule analysis based on the most recent available data, resulting in lower projected battery costs compared to our proposed rule. EPA agrees with commenters that battery costs used in the proposed rule were higher than recent evidence supports. Consideration of the current costs of batteries for electrified vehicles, as widely reported in the trade and academic literature and further supported by our battery cost modeling tools, led EPA to adjust the battery costs to more accurately account for these trends. Based on an updated assessment, described further in Section III.A of this preamble and Chapter 2 of the RIA, we determined that battery costs should be reduced by about 25 percent. More information on the public comments we received and the revised inputs leading to this change is available in Section III.A of this preamble and Chapter 2 of the RIA.

Other key changes to our analysis since the proposed rule include:

—Updated projections from EIA (AEO 2021), including Gross Domestic Product, number of households, vehicle miles traveled (VMT) growth rates and historic fleet data
—Updated energy security cost per gallon factors
—Updated tailpipe and upstream emission factors
—High compression ratio level 2 (HCR2) technology was removed as a separate compliance option within the model although HCR0 and HCR1 remain as options[22 23]
—Increased utilization of BEVs with a 300 mile range and lower utilization of BEVs with a 200 mile range
—Updated credit banks reflecting more recent information from EPA's manufacturer certification and compliance data
—Updated valuation of off-cycle credits (lower costs) and updated assumptions for off-cycle credit usage across manufacturers
—Updated vehicle sales elasticity (changed from −1 percent to −0.4 percent) based on a recent EPA study[24]

More information on these and other analysis updates is in Section III.A of this preamble.

[19] 77 FR 62812, October 15, 2012.

[20] Manufacturers use of the incentives is provided in ''The 2021 EPA Automotive Trends Report, Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975,'' EPA–420R–21023, November 2021.

[21] EPA's updated MY 2020 baseline fleet is generally consistent with that used by NHTSA in their recent CAFE NPRM (86 FR 49602, September 3, 2021).

[22] For further details on HCR definitions, see Chapter 2.3.2 of the RIA. For HCR implementation in CCEMS, see Chapter 4.1.1.3 of the RIA.

[23] See Section III.A of this preamble.

[24] See Section VII.B of this preamble.

As with our earlier analyses, including SAFE and the August 2021 EPA proposed rule, for this final rule EPA used a model to simulate the decision process of auto manufacturers in choosing among the emission reduction technologies available to incorporate in vehicles across their fleets. The model takes into account both the projected costs of technologies and the relative ability of each of these technologies to reduce GHG emissions. This process identifies potential pathways for manufacturers to comply with a given set of GHG standards. EPA then estimates projected average and total costs for manufacturers to produce these vehicles to meet the standards under evaluation during the model years covered by the analysis.

In addition to projecting the technological capabilities of the industry and estimating compliance costs for each of the four affected model years (MYs 2023–2026), EPA has considered the role of the averaging, banking, and trading system that has been available and extensively used by the industry since the beginning of the light-duty vehicle GHG program in model year 2012. Our analysis of the current and anticipated near-future usage of the GHG credit mechanisms reinforces the trends we identified in our other analyses showing widespread technological advancement in the industry at reasonable per-vehicle costs. Together, these analyses support EPA's conclusion under section 202(a) of the CAA that technologically feasible pathways are available at reasonable costs for automakers to comply with EPA's standards during each of the four model years. We discuss these analyses and their results further in Section III of this preamble.

We also estimate the GHG and non-GHG emission impacts (tailpipe and upstream) of the standards. EPA then builds on the estimated changes in emissions and fuel consumption to calculate projected net economic impacts from these changes. Key economic inputs include: Measures of health impacts from changes in criteria pollutant emissions; a value for the vehicle miles traveled ''rebound effect;'' estimates of energy security impacts of changes in fuel consumption; the social costs of GHGs; and costs associated with crashes, noise, and congestion from additional rebound driving.

Our overall analytical approach generates key results for the following metrics: Incremental costs per vehicle (industry-wide averages and by manufacturer); total vehicle technology costs for the auto industry; GHG emissions reductions and criteria pollutant emissions reductions; penetration of key GHG-reducing technologies across the fleet; consumer fuel savings; oil reductions; and net societal costs and benefits. We discuss these analyses in Sections III, IV, V, and VII of this preamble as well as in the RIA.

D. Summary of Costs, Benefits and GHG Emission Reductions of the Final Program

EPA estimates that the total benefits of this final rule far exceed the total costs—the net present value of benefits is between $120 billion to $190 billion (annualized net benefits between $6.2 billion to $9.5 billion). Table 4 below summarizes EPA's estimates of total discounted costs, fuel savings, and benefits. The results presented here project the monetized environmental and economic impacts associated with the final program during each calendar year through 2050.

The benefits include climate-related economic benefits from reducing emissions of GHGs that contribute to climate change, reductions in energy security externalities caused by U.S. petroleum consumption and imports, the value of certain particulate matter-related health benefits, the value of additional driving attributed to the rebound effect, and the value of reduced refueling time needed to fill a more fuel-efficient vehicle. Between $8 and $19 billion of the total benefits through 2050 are attributable to reduced emissions of non-GHG pollutants, primarily those that contribute to ambient concentrations of smaller particulate matter ($PM_{2.5}$). $PM_{2.5}$ is associated with premature death and serious health effects such as hospital admissions due to respiratory and cardiovascular illnesses, nonfatal heart attacks, aggravated asthma, and decreased lung function. The program will also have other significant social benefits including $130 billion in climate benefits (with the average SC–GHGs at a 3 percent discount rate) and fuel savings of $150 billion to $320 billion exclusive of fuel taxes. For American drivers, who purchase fuel inclusive of fuel taxes, the fuel savings will total $210 billion to $420 billion through 2050 (see Table 44). With these fuel savings, consumers will benefit from reduced operating costs over the vehicle lifetime. Over the lifetime of a MY 2026 vehicle, EPA estimates that the reduction in fuel costs will exceed the increase in vehicle costs by $1,080 for consumers on average.

The analysis also includes estimates of economic impacts stemming from additional vehicle use from increased rebound driving, such as the economic damages caused by crashes, congestion, and noise. See Chapter 3 of the RIA for more information regarding these estimates.

TABLE 4—MONETIZED DISCOUNTED COSTS, BENEFITS, AND NET BENEFITS OF THE FINAL PROGRAM FOR CALENDAR YEARS THROUGH 2050

[billions of 2018 dollars] [a b c d e]

	Present value		Annualized value	
	3% discount rate	7% discount rate	3% discount rate	7% discount rate
Costs	$300	$180	$15	$14
Fuel Savings	320	150	16	12
Benefits	170	150	8.6	8.1
Net Benefits	190	120	9.5	6.2

Notes:

[a] Values rounded to two significant figures; totals may not sum due to rounding. Present and annualized values are based on the stream of annual calendar year costs and benefits included in the analysis (2021–2050) and discounted back to year 2021.

[b] Climate benefits are based on reductions in CO_2, CH_4 and N_2O emissions and are calculated using four different estimates of the social cost of each GHG (SC–GHG model average at 2.5%, 3%, and 5% discount rates; 95th percentile at 3% discount rate), which each increase over time. In this table, we show the benefits associated with the average SC–GHGs at a 3% discount rate but the Agency does not have a single central SC–GHG point estimate. We emphasize the importance and value of considering the benefits calculated using all four SC–GHG estimates and present them later in this preamble. As discussed in Chapter 3.3 of the RIA, a consideration of climate benefits calculated using discount rates below 3 percent, including 2 percent and lower, is also warranted when discounting intergenerational impacts. For further discussion of how EPA accounted for these estimates, please refer to section VI of this preamble and the separate Response to Comments.

[c] The same discount rate used to discount the value of damages from future GHG emissions (SC–GHGs at 5, 3, and 2.5 percent) is used to calculate the present and annualized values of climate benefits for internal consistency, while all other costs and benefits are discounted at either 3% or 7%.

[d] Net benefits reflect the fuel savings plus benefits minus costs.

[e] Non-GHG impacts associated with the standards presented here do not include the full complement of health and environmental effects that, if quantified and monetized, would increase the total monetized benefits. Instead, the non-GHG benefits are based on benefit-per-ton values that reflect only human health impacts associated with reductions in $PM_{2.5}$ exposure.

EPA estimates the average per-vehicle cost to meet the standards to be $1,000 in MY 2026, as shown in Table 5 below. Note that compared to the proposal, the total costs through 2050, shown in Table 4, are somewhat higher, while the per-vehicle costs shown in Table 5 are slightly lower. We discuss this in more detail in Section III.B.2 of this preamble and RIA Chapter 4.1.3.

TABLE 5—CAR, LIGHT TRUCK AND FLEET AVERAGE COST PER VEHICLE RELATIVE TO THE NO ACTION SCENARIO

[2018 dollars]

	2023	2024	2025	2026
Car	$150	$288	$586	$596
Light Truck	485	732	909	1,356
Fleet Average	330	524	759	1,000

The final standards will achieve significant reductions in GHG emissions. As seen in Table 6 below, through 2050 the program will achieve more than 3.1 billion tons of GHG emission reductions, which is 50 percent greater emissions reductions than EPA's proposed standards.

TABLE 6—GHG REDUCTIONS THROUGH 2050

Emission impacts relative to no action			Percent change from no action		
CO_2 (million metric tons)	CH_4 (metric tons)	N_2O (metric tons)	CO_2	CH_4	N_2O
−3,125	−3,272,234	−96,735	−9%	−8%	−8%

E. How has EPA considered environmental justice in this final rule?

Executive Order 12898 (59 FR 7629, February 16, 1994) establishes federal executive policy on environmental justice. It directs federal agencies, to the greatest extent practicable and permitted by law, to make achieving environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations in the United States (U.S.). EPA defines environmental justice as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.[25]

Executive Order 14008 (86 FR 7619, February 1, 2021) also calls on federal agencies to make achieving environmental justice part of their respective missions ''by developing programs, policies, and activities to address the disproportionately high and adverse human health, environmental, climate-related and other cumulative impacts on disadvantaged communities, as well as the accompanying economic challenges of such impacts.'' It declares a policy ''to secure environmental justice and spur economic opportunity for disadvantaged communities that have been historically marginalized and overburdened by pollution and under-investment in housing, transportation, water and wastewater infrastructure and health care.''

Under E.O. 13563, federal agencies may consider equity, human dignity, fairness, and distributional considerations in their regulatory analyses, where appropriate and permitted by law.

EPA's 2016 ''Technical Guidance for Assessing Environmental Justice in Regulatory Analysis'' provides recommendations on conducting the highest quality analysis feasible, recognizing that data limitations, time

[25] Fair treatment means that ''no group of people should bear a disproportionate burden of environmental harms and risks, including those resulting from the negative environmental consequences of industrial, governmental and commercial operations or programs and policies.''. Meaningful involvement occurs when ''(1) potentially affected populations have an appropriate opportunity to participate in decisions about a proposed activity [*e.g.,* rulemaking] that will affect their environment and/or health; (2) the public's contribution can influence [the EPA's rulemaking] decision; (3) the concerns of all participants involved will be considered in the decision-making process; and (4) [the EPA will] seek out and facilitate the involvement of those potentially affected'' A potential EJ concern is defined as ''the actual or potential lack of fair treatment or meaningful involvement of minority populations, low-income populations, tribes, and indigenous peoples in the development, implementation and enforcement of environmental laws, regulations and policies.'' See ''Guidance on Considering Environmental Justice During the Development of an Action.'' Environmental Protection Agency, *https://www.epa.gov/environmentaljustice/guidance-considering-environmental-justice-during-development-action.* See also *https://www.epa.gov/environmentaljustice.*

and resource constraints, and analytic challenges will vary by media and regulatory context.[26]

EPA's mobile source regulatory program has historically reduced significant amounts of both GHG and non-GHG pollutants to the benefit of all U.S. residents, including populations that live near roads and in communities with environmental justice (EJ) concerns. EJ concerns may arise in the context of this rulemaking in two key areas.

First, people of color and low-income populations may be especially vulnerable to the impacts of climate change. As discussed in Section IV.C of this preamble, this rulemaking will mitigate the impacts of climate change by achieving significant GHG emission reductions, which will benefit populations that may be especially vulnerable to various forms of damages associated with climate change.

Second, in addition to significant climate-change benefits, the standards will also impact non-GHG emissions. As discussed in Section VII.L.2 of this preamble, numerous studies have found that environmental hazards such as air pollution are more prevalent in areas where people of color and low-income populations represent a higher fraction of the population compared with the general population. There is substantial evidence, for example, that people who live or attend school near major roadways are more likely to be of a non-White race, Hispanic ethnicity, and/or low socioeconomic status (see Section VII.L.2 of this preamble).

We project that this rule will, over time, result in reductions of non-GHG tailpipe emissions and emissions from upstream refinery sources. We also project that the rule will result in small increases of non-GHG emissions from upstream Electric Generating Unit (EGU) sources. Overall, there are substantial $PM_{2.5}$-related health benefits associated with the non-GHG emissions reductions that this rule will achieve. The benefits from these emissions reductions, as well as the adverse impacts associated with the emissions increases, could potentially impact communities with EJ concerns, though not necessarily immediately and not equally in all locations. The air quality information needed to perform a quantified analysis of the distribution of such impacts was not available for this rulemaking. We therefore recommend caution when interpreting these broad, qualitative observations.

As noted previously, EPA intends to develop a subsequent rule to control emissions of GHGs as well as criteria and air toxic pollutants from light- and medium-duty vehicles for MYs 2027 and beyond. We are considering how to project air quality impacts from the changes in non-GHG emissions for that future rulemaking (see Section V.C of this preamble).

F. Affordability and Equity

In addition to considering environmental justice impacts, we have examined the effects of the standards on affordability of vehicles and transportation services for low-income households in Section VII.L of this preamble and Chapter 8.4 of the RIA. As with the effects of the standards on vehicle sales discussed in Section VII.B of this preamble, the effects of the standards on affordability and equity depend in part on two countervailing effects: The increase in the up-front costs of new vehicles subject to more stringent standards, and the decrease in operating costs from reduced fuel consumption over time. The increase in up-front new vehicle costs has the potential to increase the prices of used vehicles, to make credit more difficult to obtain, and to make the least expensive new vehicles less desirable compared to used vehicles. The reduction in operating costs over time has the potential to mitigate or reverse all these effects. Lower operating costs on their own increase mobility (see RIA Chapter 3.1 for a discussion of rebound driving).

While social equity involves issues beyond income and affordability, including race, ethnicity, gender, gender identification, and residential location, the potential effects of the standards on lower-income households are of great importance for social equity and reflect these contrasting forces. The overall effects on vehicle ownership, including for lower-income households, depend heavily on the role of fuel consumption in vehicle sales decisions, as discussed in Section VII.M of this preamble. At the same time, lower-income households own fewer vehicles per household and are more likely to buy used vehicles than new. In addition, for lower-income households, fuel expenditures are a larger portion of household income, so the fuel savings that will result from this rule may be more impactful to these consumers. Thus, the benefits of this rule may be stronger for lower-income households even (or especially) if they buy used vehicles: As vehicles meeting the standards enter the used vehicle market, they will retain the fuel economy/GHG-reduction benefits, and associated fuel savings, while facing a smaller portion of the upfront vehicle costs; see Section VII.J of this preamble. The reduction in operating costs may also increase access to transportation services, such as ride-hailing and ride-sharing, where the lower per-mile costs may play a larger role than up-front costs in pricing. As a result, lower-income consumers may be affected more from the reduction in operating costs than the increase in up-front costs.

The analysis for this final rule projects that EVs and PHEVs will gradually increase to about 17 percent market share by MY 2026, although the majority of vehicles produced in the time frame of the final standards will continue to be gasoline-fueled vehicles (see Section III.B.3 of this preamble). EPA has heard from some environmental justice groups and Tribes that limited access to electric vehicles and charging infrastructure for electric vehicles can be a barrier for purchasing EVs. A recent report from the National Renewable Energy Laboratory estimates that public and workplace charging is keeping up with projected needs, based on Level 2 and fast charging ports per plug-in EV.[27] Comments received on the proposed rule point out both the higher up-front costs of EVs as challenges for adoption and their lower operating and maintenance costs as incentives for adoption. As noted previously, the higher penetration of EVs in the current analysis as compared to that of the proposed rule is in part an outgrowth of updated estimates of battery costs, which reduce the projected costs of EVs as a compliance path and is consistent with expectations that cost parity with conventional vehicles is in the process of being attained in an increasing number of market segments. A number of auto manufacturers commented on the importance of consumer education, purchase incentives, and charging infrastructure development for promoting adoption of electric vehicles. Some NGOs commented that EV purchase incentives should focus on lower-income households, because they are more responsive to price incentives than higher-income households. EPA will continue to monitor and study affordability issues related to electric

[26] ''Technical Guidance for Assessing Environmental Justice in Regulatory Analysis.'' *Epa.gov*, Environmental Protection Agency, *https://www.epa.gov/sites/production/files/2016-06/documents/ejtg_5_6_16_v5.1.pdf.* (June 2016).

[27] Brown, A., A. Schayowitz, and E. Klotz (2021). ''Electric Vehicle Infrastructure Trends from the Alternative Fueling Station Locator: First Quarter 2021.'' National Renewable Energy Laboratory Technical Report NREL/TP–5400–80684, *https://afdc.energy.gov/files/u/publication/electric_vehicle_charging_infrastructure_trends_first_quarter_2021.pdf,* accessed 11/3/2021.

vehicles as their prevalence in the vehicle fleet increases.

II. EPA Standards for MY 2023–2026 Light-Duty Vehicle GHGs

A. Model Year 2023–2026 GHG Standards for Light-Duty Vehicles, Light-Duty Trucks, and Medium-Duty Passenger Vehicles

As noted, the transportation sector is the largest U.S. source of GHG emissions, making up 29 percent of all emissions.[28] Within the transportation sector, light-duty vehicles are the largest contributor, 58 percent, to transportation GHG emissions in the U.S.[29] EPA has concluded that more stringent standards are appropriate in light of our assessment of the need to reduce GHG emissions, technological feasibility, costs, lead time, and other factors. The MY 2023 through MY 2026 program that EPA is finalizing in this action is based on our assessment of the near-term potential of technologies already available and present in much of the fleet. This program also will serve as an important transition to a longer-term program beyond MY 2026. The following section provides details on EPA's revised standards and related provisions.

EPA is finalizing revised, more stringent standards to control the emissions of GHGs from MY 2023 and later light-duty vehicles.[30] Carbon dioxide (CO_2) is the primary GHG resulting from the combustion of vehicular fuels.[31] The standards regulate CO_2 on a grams per mile (g/mile) basis, which EPA defines by separate footprint curves that apply to vehicles in a manufacturer's car and truck fleets.[32] The final standards apply to passenger cars, light-duty trucks, and medium-duty passenger vehicles (MDPVs).[33] As an overall group, they are referred to in this preamble as light-duty vehicles or simply as vehicles. In this preamble, passenger cars may be referred to as ''cars,'' and light-duty trucks and MDPVs as ''light trucks'' or ''trucks.'' Based on compliance with the final revised standards, the industry-wide average emissions target for new light-duty vehicles is projected to be 161 g/mile of CO_2 in MY 2026.[34] Except for a limited extension of credit carry-forward provisions for certain model years discussed in Section II.A.4 of this preamble, EPA is not changing existing averaging, banking, and trading program elements.

EPA has determined that the revised final standards reflect an appropriate balance of factors considered under section 202(a) of the CAA, as discussed in Section VI of this preamble. In selecting the final standards, EPA carefully considered the concerns raised in public comments submitted by a wide range of stakeholders. EPA appreciates that the auto industry and the UAW generally support the proposed standards, and we also recognize the shorter lead time for the standards beginning in MY 2023. At the same time, we recognize the multitude of stakeholders who voiced the critical need for greater GHG emissions reductions from the light-duty vehicle sector through MY 2026 given the significant need to address air pollution and climate change, as well as the many stakeholders who provided comments and analyses indicating that more stringent standards are achievable in this time frame. EPA has considered all public comments and our updated technical analysis in determining appropriate standards under the CAA. EPA is finalizing standards that maintain the stringency level of the proposed standards in the first two years (MYs 2023 and 2024) in consideration of the shorter lead time, and that are more stringent than the proposed standards in the latter two years (MYs 2025 and 2026). EPA notes that the revised final standards in each model year are significantly more stringent than the SAFE standards.

After considering the public comments received, EPA is finalizing a more limited set of optional manufacturer flexibilities than proposed. Generally, we are narrowing the availability of these flexibilities to MY 2023 and 2024 in consideration of lead time, with the exception of the off-cycle menu credit cap which is available for MY 2023 through 2026 given that these credits achieve real-world emission reductions. The set of four flexibilities includes: (1) A one-year extension of credit life for MYs 2017 and 2018 credits such that they are available for use in MY 2023 and 2024, respectively; (2) an increase in the off-cycle credit menu cap from 10 g/mile to 15 g/mile from MYs 2023 through 2026. EPA also is finalizing revised definitions for three technologies to ensure real-world emission reductions commensurate with the menu credit values; (3) multiplier incentives for EVs, PHEVs, and FCVs, for 2023 and 2024, with a cumulative credit cap of 10 g/mile, and with multiplier levels lower than those proposed to incentivize more production of advanced technologies. EPA is eliminating multiplier incentives for natural gas vehicles adopted in the SAFE rule after MY 2022; (4) full size pick-up truck incentives for MYs 2023 and 2024 for vehicles that meet efficiency performance criteria or include strong hybrid technology at a minimum level of production volumes. The details of EPA's final provisions for these flexibilities are discussed in Section II.A.4 (credit life extension) and Section II.B (off-cycle, advanced technology multipliers, and full-size pickup credits) of this preamble.

The current light-duty vehicle program includes several program elements that will remain in place, without change. EPA is not changing the fundamental structure of the GHG standards, which are based on the footprint attribute with separate footprint curves for cars and trucks. EPA is also not changing the existing CH_4 and N_2O emissions standards or the program structure in terms of vehicle certification, compliance, and enforcement. EPA is continuing to use tailpipe-only values to determine vehicle GHG emissions, without accounting for upstream emissions (*i.e.,* EVs and PHEVs will continue to apply 0 g/mile through MY 2026). EPA is also not changing existing program opportunities to earn compliance credits toward the fleet-wide average CO_2 standards for improvements to air conditioning systems. The current A/C credits program provides credits for improvements to address both hydrofluorocarbon (HFC) refrigerant direct losses (*i.e.,* system ''leakage'') and indirect CO_2 emissions related to the increased load on the engine (also referred to as ''A/C efficiency'' related emissions). We did not propose to change any of these aspects of the existing program, they continue to function as intended and we do not presently believe changes are needed in the context of standards for MY 2023–2026.

[28] *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2019* (EPA–430–R–21–005, published April 2021).

[29] Ibid.

[30] See Sections III and VI of this preamble for discussion of our technical assessment and basis of the final standards.

[31] EPA's existing vehicle GHG program also includes emissions standards for methane (CH4) and nitrous oxide (N2O), and credits for hydrofluorocarbons (HFCs) reductions from air conditioning refrigerants.

[32] Footprint curves are graphical representations of the algebraic formulae defining the emission standards in the regulatory text.

[33] As with previous GHG emissions standards, EPA will continue to use the same vehicle category definitions as in the CAFE program. MDPVs are grouped with light trucks for fleet average compliance determinations.

[34] The reference to CO_2 here refers to CO_2 equivalent reductions, as this level includes some reductions in emissions of greenhouse gases other than CO_2, from refrigerant leakage, as one part of the A/C related reductions.

1. What fleet-wide emissions levels correspond to the CO_2 standards?

EPA is finalizing revised standards for MYs 2023–2026 that are projected to result in an industry-wide average target for the light-duty fleet of 161 g/mile of CO_2 in MY 2026. The final standards are consistent with the proposed standards in MYs 2023 and 2024 and are more stringent than the proposed standards in MYs 2025 and 2026. In MY 2023, the final standards represent a nearly 10 percent increase in stringency from the SAFE rule standards. The final standards continue to increase in stringency by 5 percent in MY 2024, 6.6 percent in MY 2025, and more than 10 percent in 2026. For MYs 2025 and 2026, the final standards are more stringent than the 2012 rule level of stringency, making the MY 2025 and 2026 standards the most stringent vehicle GHG standards that EPA has finalized to date. Based on auto manufacturers' continued technological advancements and progress towards electrification, EPA believes that it is feasible and appropriate to make additional progress in reducing GHG emissions from light-duty vehicles by surpassing the level of stringency of the original MY 2025 and later standards established nine years ago in the 2012 rule, as further described in Sections III and VI of this preamble. EPA is finalizing standards that will take a reasonable approach towards achieving the need for ambitious GHG emission reductions to address climate change. These final standards will play an important role in the transition from the current fleet to even greater GHG emissions reductions in the light-duty fleet, which EPA will pursue in a subsequent rulemaking for MYs 2027 and later.

The industry fleet average and car/light truck year-over-year percent reductions for the final standards compared to the proposed standards and the SAFE rule standards are provided in Table 7 below. For passenger cars, the footprint curves are projected to result in reducing industry fleet average CO_2 emissions targets by 8.4 percent in MY 2023 followed by year over year reductions of 4.8 to 11.4 percent in MY 2024 through MY 2026. For light-duty trucks, the footprint standards curves are projected to result in reducing industry fleet average CO_2 emissions targets by 10.4 percent in MY 2023 followed by year over year reductions of 4.9 to 9.5 percent in MY 2024 through MY 2026. Cumulative reductions in the projected fleet average CO_2 targets over the four model year period are projected to total 27.1 for cars and 28.3 for light-duty trucks.

TABLE 7—PROJECTED INDUSTRY FLEET AVERAGE CO_2 TARGET YEAR-OVER-YEAR PERCENT REDUCTIONS

	SAFE rule standards *			Proposed standards **			Final standards **		
	Cars (%)	Trucks (%)	Combined (%)	Cars (%)	Trucks (%)	Combined (%)	Cars (%)	Trucks (%)	Combined (%)
2023	1.7	1.7	2.1	8.4	10.4	9.8	8.4	10.4	9.8
2024	0.6	1.5	1.4	4.7	5.0	5.1	4.8	4.9	5.1
2025	2.3	1.7	2.2	4.8	5.0	5.0	5.7	7.0	6.6
2026	1.8	1.6	1.9	4.8	5.0	5.0	11.4	9.5	10.3
Cumulative	6.3	6.3	7.4	20.9	23.1	22.8	27.1	28.3	28.3

* Note the percentages shown for the SAFE rule targets have changed slightly from the proposed rule, due to the updates in our base year fleet from MY 2017 to MY 2020 manufacturer fleet data.

** These are modeled results based on projected fleet characteristics and represent percent reductions in projected targets, not the standards (which are the footprint car/truck curves), associated with that projected fleet (see Section III of this preamble for more detail on our modeling results).

For light-trucks, EPA is finalizing, as proposed, a change to the upper right cutpoints of the CO_2-footprint curves (*i.e.,* the footprint sizes in sq. ft. at which the CO_2 standards level off as flat CO_2 target values for larger vehicle footprints. See Figure 4). The SAFE rule altered these cutpoints and EPA is now restoring them to the original upper right cutpoints initially established in the 2012 rule, for MYs 2023–2026, essentially requiring increasingly more stringent CO_2 targets at the higher footprint range up to the revised cutpoint levels. The shapes of the curves and the cutpoints are discussed in Section II.A.2 of this preamble.

The 161 g/mile estimated industry-wide target for MY 2026 noted above is based on EPA's projected fleet mix projections for MY 2026 (approximately 47 percent cars and 53 percent trucks, with only slight variations from MYs 2023–2026). As discussed below, the final fleet average standards for each manufacturer ultimately will depend on each manufacturer's actual rather than projected production in each MY from MY 2023 to MY 2026 under the sales-weighted footprint-based standard curves for the car and truck regulatory classes. In the 2012 rule, EPA estimated that the fleet average target would be 163 g/mile in MY 2025 based on the projected fleet mix for MY 2025 (67 percent car and 33 percent trucks) based on information available at the time of the 2012 rulemaking. Primarily due to the historical and ongoing shift in fleet mix that has included more crossover and small and mid-size SUVs and fewer passenger cars, EPA's projection in the Midterm Evaluation (MTE) January 2017 Final Determination for the original MY 2025 fleet average target level increased to 173 g/mile.[35] EPA has again updated its fleet mix projections for this final rule and projects that the original 2012 rule MY 2025 footprint standards curves would result in an industry-wide fleet average target level of 180 g/mile. The projected fleet average targets under the 2012 rule, using the updated fleet mix projections and the projected fleet average targets for the final rule are provided in Table 8 below. Figure 2 below, based on the values in Table 8, shows the final standards target levels along with estimated targets for the proposed standards, SAFE rule, and the 2012 rule for comparison.[36]

[35] ''Final Determination on the Appropriateness of the Model Year 2022–2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation,'' EPA–420–R–17–001, January 2017.

TABLE 8—FLEET AVERAGE TARGET PROJECTIONS FOR THE FINAL STANDARDS COMPARED TO UPDATED FLEET AVERAGE TARGET PROJECTIONS * FOR THE PROPOSED STANDARDS, SAFE RULE 2012 RULE

[CO_2 g/mile]

MY	Final standards projected targets	Proposed standards projected targets	SAFE rule standards projected targets	2012 rule projected targets
2021	** 229	** 229	229	219
2022	** 224	** 224	224	208
2023	202	202	220	199
2024	192	192	216	189
2025	179	182	212	180
2026	161	173	208	179
Total change 2022–2026	−63	−51	−16	−29

* All projections have been updated to reflect the updated base year fleet, which results in slight changes compared to the values shown in the proposed rule.
** SAFE Rule targets shown for reference.

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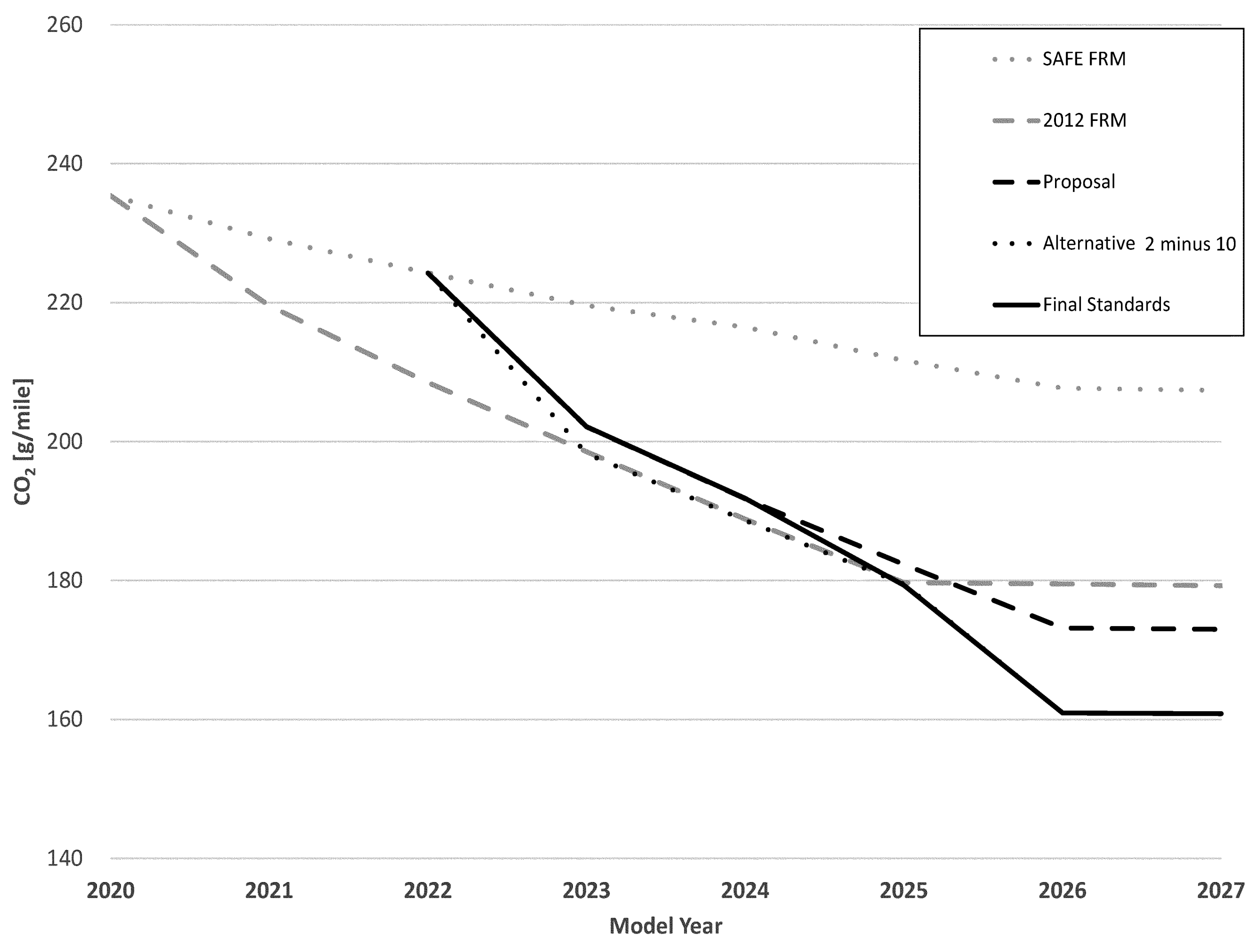

Figure 2 Final CO_2 Standard Target Levels Compared to Other Programs

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EPA's standards are based in part on EPA's projection of average industry wide CO_2-equivalent emission reductions from A/C improvements; specifically the footprint standards curves are made numerically more stringent by an amount equivalent to this projection of industry-wide A/C refrigerant leakage credits.[37] Including this projection of A/C credits for purposes of setting GHG standards levels is consistent with the 2012 rule and the SAFE rule.

Table 9 below shows overall fleet average target levels for both cars and light trucks that are projected over the implementation period of the final standards. A more detailed manufacturer by manufacturer break down of the projected target and achieved levels is provided in Section III.B.1 of this preamble. The actual fleet-wide average g/mile level that would be achieved in any year for cars and trucks will depend on the actual production of vehicles for that year, as well as the use of the various credit and averaging, banking, and trading provisions. For example, in any year, manufacturers would be able to generate credits from cars and use the credits for compliance with the truck standard, or vice versa. In Section V of this preamble, EPA discusses the year-by-year estimate of emissions reductions that are projected to be achieved by the standards.

In general, the level and implementation schedule of the final standards provides for an incremental phase-in to the MY 2026 stringency level and reflects consideration of the appropriate lead time for manufacturers to take actions necessary to meet the final standards.[38] The technical feasibility of the standards is discussed in Section III of this preamble and in the RIA. Note that MY 2026 is the final MY in which the standards become more stringent. The MY 2026 CO_2 standards will remain in place for later MYs, unless and until they are revised by EPA in a future rulemaking. As mentioned in Section I.A.2 of this preamble, EPA is planning a subsequent rulemaking to set more stringent standards for the light-duty vehicle sector in MYs 2027 and beyond.

EPA has estimated the overall fleet-wide CO_2 emission target levels that correspond with the attribute-based footprint standards, based on projections of the composition of each manufacturer's fleet in each year of the program. As noted above, EPA estimates that, on a combined fleet-wide national basis, the 2026 MY standards will result in a target level of 161 g/mile CO_2. The derivation of the 161 g/mile estimate is described in Section III.A of this preamble. EPA aggregated the estimates for individual manufacturers based on projected production volumes into the fleet-wide averages for cars, trucks, and the entire fleet, shown in Table 9.[39] As discussed above, the combined fleet estimates are based on projected fleet mix of cars and trucks that varies over the MY 2023–2026 timeframe. This fleet mix distribution can also be found in Section III.A of this preamble.

TABLE 9—ESTIMATED FLEET-WIDE CO_2 TARGET LEVELS CORRESPONDING TO THE FINAL STANDARDS

Model year	Cars CO_2 (g/mile)	Trucks CO_2 (g/mile)	Fleet CO_2 (g/mile)
2023	166	234	202
2024	158	222	192
2025	149	207	179
2026 and later	132	187	161

As shown in Table 9, fleet-wide CO_2 emission target levels for cars under the final standards are projected to decrease from 166 to 132 g/mile between MY 2023 and MY 2026. Similarly, fleet-wide CO_2 target levels for trucks are projected to decrease from 233 to 187 g/mile during the same period. These target levels reflect both the final standards and the flexibilities and credits available in the program.[40] The estimated fleetwide achieved values can be found in Section III.B.1 of this preamble.

As noted above, EPA is finalizing CO_2 standards that are increasingly more stringent each year from MY 2023 though MY 2026. Applying the CO_2 footprint standard curves applicable in each MY to the vehicles (and their footprint distributions) projected to be sold in each MY produces projections of progressively lower fleet-wide CO_2 emission target levels. EPA believes manufacturers can achieve the final standards and their important CO_2 emissions reductions through the application of available control technology at reasonable cost, as well as the use of optional program flexibilities available in certain model years.

The existing program includes several provisions that we are not changing and so would continue during the implementation timeframe of this final rule. Consistent with CAA section 202(a)(1) that standards be applicable to vehicles "for their useful life," the MY 2023–2026 vehicle standards will apply for the useful life of the vehicle.[41] Also, in this action EPA is not changing the test procedures over which emissions are measured and weighted to determine compliance with the GHG standards. These procedures are the Federal Test Procedure (FTP or "city" test) and the Highway Fuel Economy Test (HFET or "highway" test). While EPA may consider requiring the use of test procedures other than the 2-cycle test procedures in a future rulemaking, EPA did not propose and is not adopting any test procedure changes in this final rule.

EPA has analyzed the feasibility of achieving the car and truck CO_2 footprint based standards through the application of available technologies, based on projections of technology penetration rates that are in turn based on our estimates of the effectiveness and cost of the technology. The results of the analysis are discussed in detail in Section III of this preamble and in the RIA. EPA also presents the overall estimated costs and benefits of the final car and truck CO_2 standards in Section VII.I of this preamble.

[37] The total A/C adjustment is 18.8 g/mile for cars and 24.4 g/mile for trucks.

[38] As discussed in Section III of this preamble, EPA has used the Corporate Average Fuel Economy (CAFE) Compliance and Effects Modeling System (CCEMS) to support the technical assessment. Among the ways EPA has considered lead time is by using the constraints built into the CCEMS model which are designed to represent lead-time constraints, including the use of redesign and refresh cycles. See CCEMS Model Documentation on web page *https://www.nhtsa.gov/corporate-average-fuel-economy/compliance-and-effects-modeling-system* and contained in the docket for this rule.

[39] Due to rounding during calculations, the estimated fleet-wide CO_2 target levels may vary by plus or minus 1 gram.

[40] The target levels do not reflect credit trading across manufacturers under the ABT program.

[41] The GHG emission standards apply for a useful life of 10 years or 120,000 miles for light duty vehicles (LDVs) and light-light-duty trucks (LLDTs) and 11 years or 120,000 miles for heavy-light-duty trucks (HLDTs) and medium-duty passenger vehicles (MDPVs). See 40 CFR 86.1805–17.

2. What are the final CO_2 attribute-based standards?

As with the existing GHG standards, EPA is finalizing separate car and truck standards—that is, vehicles defined as cars have one set of footprint-based curves, and vehicles defined as trucks would have a different set.[42] In general, for a given footprint, the CO_2 g/mile target[43] for trucks is higher than the target for a car with the same footprint. The curves are defined mathematically in EPA's regulations by a family of piecewise linear functions (with respect to vehicle footprint) that gradually and continually ramp down from the MY 2022 curves established in the SAFE rule. EPA's minimum and maximum footprint targets and the corresponding cutpoints are provided below in Table 10 for MYs 2023–2026 along with the slope and intercept defining the linear function for footprints falling between the minimum and maximum footprint values. For footprints falling between the minimum and maximum, the targets are calculated as follows: Slope × Footprint + Intercept = Target. Figure 3 and Figure 4 provide the existing MY 2021–2022 and final MY 2023–2026 footprint curves graphically for both car and light trucks, respectively.

TABLE 10—FINAL FOOTPRINT-BASED CO_2 STANDARD CURVE COEFFICIENTS

	Car				Truck			
	2023	2024	2025	2026	2023	2024	2025	2026
MIN CO_2 (g/mile)	145.6	138.6	130.5	114.3	181.1	172.1	159.3	141.8
MAX CO_2 (g/mile)	199.1	189.5	179.4	160.9	312.1	296.5	277.4	254.4
Slope (g/mile/ft²)	3.56	3.39	3.26	3.11	3.97	3.77	3.58	3.41
Intercept (g/mile)	−0.4	−0.4	−3.2	−13.1	18.4	17.4	12.5	1.9
MIN footprint (ft²)	41	41	41	41	41	41	41	41
MAX footprint (ft²)	56	56	56	56	74	74	74	74

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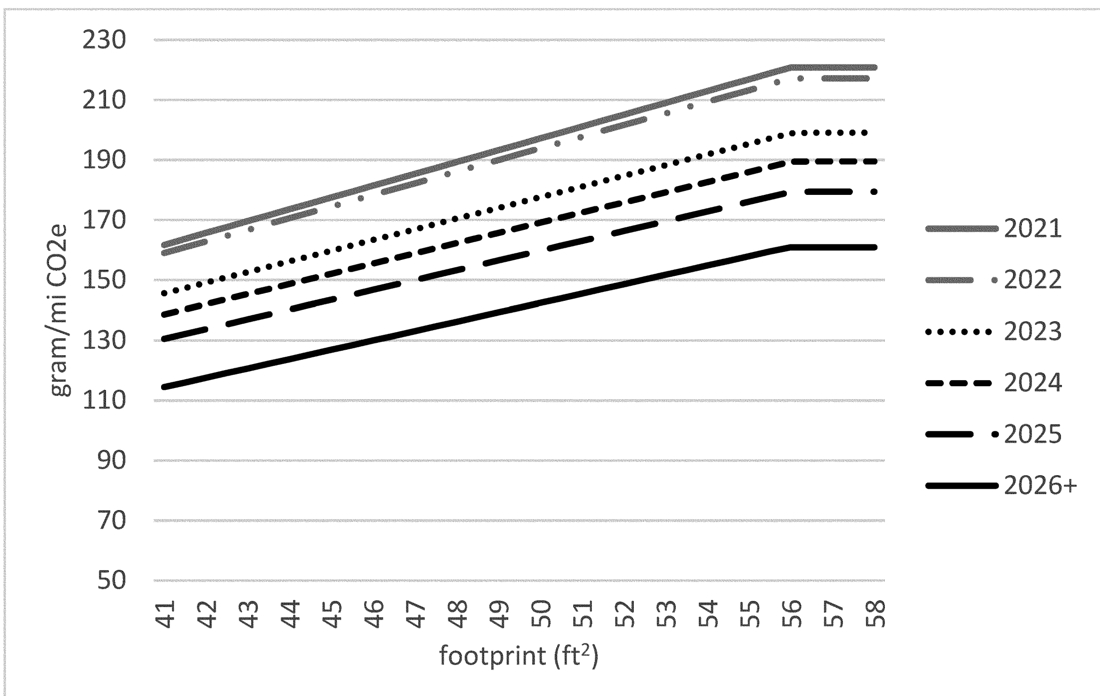

Figure 3 Car Curves

[42] See 49 CFR part 523. Generally, passenger cars include cars and smaller cross-overs and SUVs, while the truck category includes larger cross-overs and SUVs, minivans, and pickup trucks.

[43] Because compliance is based on a sales-weighting of the full range of vehicles in a manufacturer's car and truck fleets, the footprint based CO_2 emission levels of specific vehicles within the fleet are referred to as targets, rather than standards.

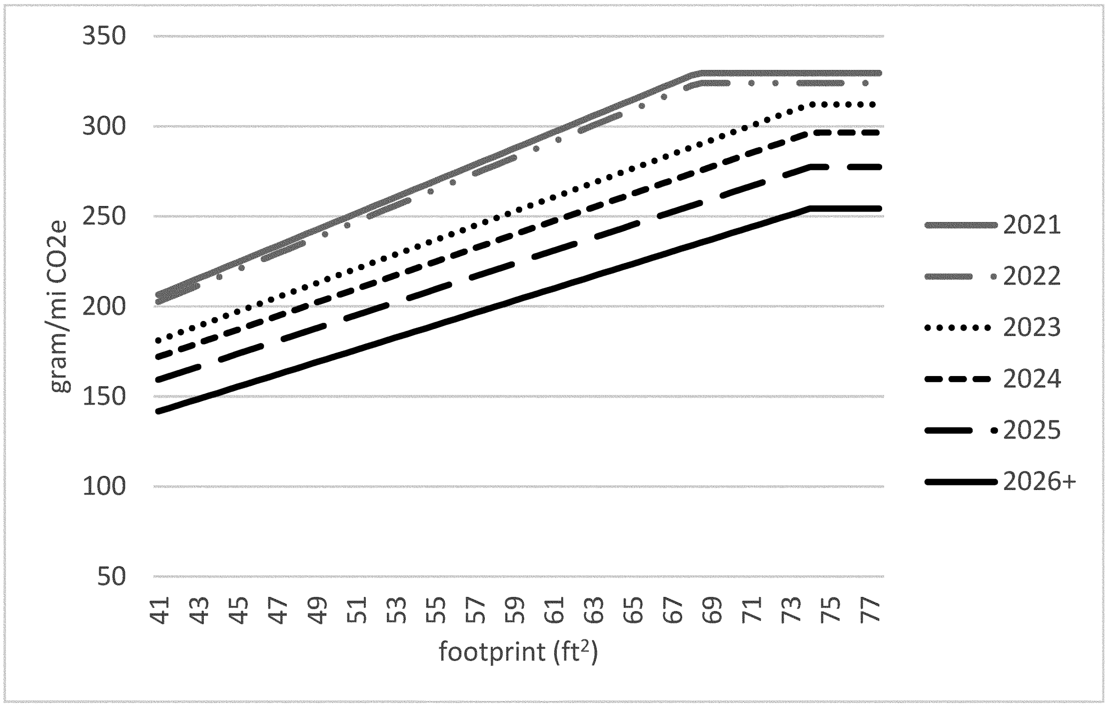

Figure 4 Truck Curves

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The shapes of the MY 2023–2026 car curves are similar to the MY 2022 car curve. By contrast, the MY 2023–2026 truck curves return to the cutpoint of 74.0 sq ft that was originally established in the 2012 rule but was changed in the SAFE rule.[44] The gap between the 2022 curves and the 2023 curves is indicative of the design of the final standards as described earlier, where the gap between the MY 2022 and MY 2023 curves is roughly double the gap between the curves for MYs 2024–2026.

3. EPA's Statutory Authority Under the CAA

i. Standards-Setting Authority Under CAA Section 202(a)

Title II of the CAA provides for comprehensive regulation of mobile sources, authorizing EPA to regulate emissions of air pollutants from all mobile source categories. Pursuant to these sweeping grants of authority, when setting GHG standards for light-duty vehicles, EPA considers such issues as technology effectiveness, technology cost (per vehicle, per manufacturer, and per consumer), the lead time necessary to implement the technology, and—based on these considerations—the feasibility and practicability of potential standards; as well as the impacts of potential standards on emissions reductions of both GHGs and non-GHGs; the impacts of standards on oil conservation and energy security; the impacts of standards on fuel savings by consumers; the impacts of standards on the auto industry; other energy impacts; and other relevant factors such as impacts on safety.

Title II emission standards have stimulated the development of a broad set of advanced automotive technologies, such as on-board computers and fuel injection systems, which have been the building blocks of automotive designs and have yielded not only lower pollutant emissions, but improved vehicle performance, reliability, and durability. In response to EPA's adoption of Title II emission standards for GHGs from light-duty vehicles in 2010 and later, manufacturers have continued to significantly ramp up their development and application of a wide range of new and improved technologies, including more fuel-efficient engine designs, transmissions, aerodynamics, and tires, air conditioning systems that contribute to lower GHG emissions, and various levels of electrified vehicle technologies.

This rule implements a specific provision in Title II, section 202(a) of the CAA. Section 202(a)(1), 42 U.S.C. 7521(a)(1), states that ''the Administrator shall 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 . . . which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare.'' Once EPA makes the appropriate endangerment and cause or contribute findings,[45] CAA section 202(a) authorizes EPA to issue standards applicable to emissions of those pollutants. Indeed, EPA's obligation to do so is mandatory. *See Coalition for Responsible Regulation* v. *EPA,* 684 F.3d 102, 126–27 (D.C. Cir. 2012); *Massachusetts* v. *EPA,* 549 U.S. 497, 533 (2007). Moreover, EPA's mandatory legal duty to promulgate these emission standards derives from ''a statutory obligation wholly independent of DOT's mandate to promote energy efficiency.'' *Massachusetts,* 549 U.S. at 532. Consequently, EPA has no discretion to decline to issue GHG standards under

[44] 77 FR 62781.

[45] EPA did so in 2009 for the group of six well-mixed greenhouse gases—carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride—which taken in combination endanger both the public health and the public welfare of current and future generations. EPA further found that the combined emissions of these greenhouse gases from new motor vehicles and new motor vehicle engines contribute to greenhouse gas air pollution that endangers public health and welfare. 74 FR 66496 (Dec. 15, 2009).

section 202(a), or to defer issuing such standards due to NHTSA's regulatory authority to establish fuel economy standards. Rather, ''[j]ust as EPA lacks authority to refuse to regulate on the grounds of NHTSA's regulatory authority, EPA cannot defer regulation on that basis.'' *Coalition for Responsible Regulation,* 684 F.3d at 127.

Any standards under CAA section 202(a)(1) ''shall be applicable to such vehicles . . . for their useful life.'' Emission standards set by EPA under CAA section 202(a)(1) are technology-based, as the levels chosen must be premised on a finding of technological feasibility. Thus, standards promulgated under CAA section 202(a) are to take effect only ''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.'' CAA section 202(a)(2); see also *NRDC* v. *EPA,* 655 F. 2d 318, 322 (D.C. Cir. 1981). EPA must consider costs to those entities which are directly subject to the standards. *Motor & Equipment Mfrs. Ass'n Inc.* v. *EPA,* 627 F. 2d 1095, 1118 (D.C. Cir. 1979). Thus, ''the [s]ection 202(a)(2) reference to compliance costs encompasses only the cost to the motor-vehicle industry to come into compliance with the new emission standards, and does not mandate consideration of costs to other entities not directly subject to the proposed standards.'' *See Coalition for Responsible Regulation,* 684 F.3d at 128.

EPA is afforded considerable discretion under CAA section 202(a) when assessing issues of technical feasibility and availability of lead time to implement new technology. Such determinations are ''subject to the restraints of reasonableness,'' which ''does not open the door to 'crystal ball' inquiry.'' *NRDC,* 655 F. 2d at 328, quoting *International Harvester Co.* v. *Ruckelshaus,* 478 F. 2d 615, 629 (D.C. Cir. 1973). However, ''EPA is not obliged to provide detailed solutions to every engineering problem posed in the perfection of [a particular device]. In the absence of theoretical objections to the technology, the agency need only identify the major steps necessary for development of the device, and give plausible reasons for its belief that the industry will be able to solve those problems in the time remaining. The EPA is not required to rebut all speculation that unspecified factors may hinder 'real world' emission control.'' *NRDC,* 655 F. 2d at 333–34. In developing such technology-based standards, EPA has the discretion to consider different standards for appropriate groupings of vehicles (''class or classes of new motor vehicles''), or a single standard for a larger grouping of motor vehicles. *NRDC,* 655 F.2d at 338. Finally, with respect to regulation of vehicular GHG emissions, EPA is not ''required to treat NHTSA's . . . regulations as establishing the baseline for the [section 202(a) standards].'' *Coalition for Responsible Regulation,* 684 F.3d at 127 (noting that the section 202(a) standards provide ''benefits above and beyond those resulting from NHTSA's fuel-economy standards.'')

Although standards under CAA section 202(a)(1) are technology-based, they are not based exclusively on technological capability. EPA has the discretion to consider and weigh various factors along with technological feasibility, such as the cost of compliance (section 202(a)(2)), lead time necessary for compliance (section 202(a)(2)), safety (see *NRDC,* 655 F. 2d at 336 n. 31),[46] other impacts on consumers, and energy impacts associated with use of the technology. See *George E. Warren Corp.* v. *EPA,* 159 F.3d 616, 623–624 (D.C. Cir. 1998) (ordinarily permissible for EPA to consider factors not specifically enumerated in the Act).

In addition, EPA has clear authority to set standards under CAA section 202(a) that are technology-forcing when EPA considers that to be appropriate, but EPA is not required to do so (as distinguished from standards under provisions such as section 202(a)(3) and section 213(a)(3)). Section 202(a) of the CAA does not specify the degree of weight to apply to each factor, and EPA accordingly has discretion in choosing an appropriate balance among factors. See *Sierra Club* v. *EPA,* 325 F.3d 374, 378 (D.C. Cir. 2003) (even where a provision is technology-forcing, the provision ''does not resolve how the Administrator should weigh all [the statutory] factors in the process of finding the 'greatest emission reduction achievable' ''); *NPRA* v. *EPA,* 287 F.3d 1130, 1135 (D.C. Cir. 2002) (EPA decisions, under CAA provision authorizing technology-forcing standards, based on complex scientific or technical analysis are accorded particularly great deference); see also *Husqvarna AB* v. *EPA,* 254 F. 3d 195, 200 (D.C. Cir. 2001) (great discretion to balance statutory factors in considering level of technology-based standard, and statutory requirement ''to [give appropriate] consideration to the cost of applying . . . technology'' does not mandate a specific method of cost analysis); *Hercules Inc.* v. *EPA,* 598 F. 2d 91, 106 (D.C. Cir. 1978) (''In reviewing a numerical standard we must ask whether the agency's numbers are within a zone of reasonableness, not whether its numbers are precisely right''); *Permian Basin Area Rate Cases,* 390 U.S. 747, 797 (1968) (same); *Federal Power Commission* v. *Conway Corp.,* 426 U.S. 271, 278 (1976) (same); *Exxon Mobil Gas Marketing Co.* v. *FERC,* 297 F. 3d 1071, 1084 (D.C. Cir. 2002) (same).

ii. Testing Authority

Under section 203 of the CAA, sales of vehicles are prohibited unless the vehicle is covered by a certificate of conformity. EPA issues certificates of conformity pursuant to section 206 of the CAA, based on (necessarily) pre-sale testing conducted either by EPA or by the manufacturer. The Federal Test Procedure (FTP or ''city'' test) and the Highway Fuel Economy Test (HFET or ''highway'' test) are used for this purpose. Compliance with standards is required not only at certification but throughout a vehicle's useful life, so that testing requirements may continue post-certification. Useful life standards may apply an adjustment factor to account for vehicle emission control deterioration or variability in use (section 206(a)).

EPA establishes the test procedures under which compliance with the CAA GHG standards is measured. EPA's testing authority under the CAA is broad and flexible. EPA has also developed tests with additional cycles (the so-called 5-cycle tests) which are used for purposes of fuel economy labeling and are used in EPA's program for extending off-cycle credits under the light-duty vehicle GHG program.

iii. Compliance and Enforcement Authority

EPA oversees testing, collects and processes test data, and performs calculations to determine compliance with CAA standards. CAA standards apply not only at certification but also throughout the vehicle's useful life. The CAA provides for penalties should manufacturers fail to comply with their fleet average standards, and there is no option for manufacturers to pay fines in lieu of compliance with the standards. Under the CAA, penalties for violation of a fleet average standard are typically determined on a vehicle-specific basis

[46] Since its earliest Title II regulations, EPA has considered the safety of pollution control technologies. See 45 FR 14496, 14503 (1980) (''EPA would not require a particulate control technology that was known to involve serious safety problems. If during the development of the trap-oxidizer safety problems are discovered, EPA would reconsider the control requirements implemented by this rulemaking'').

by determining the number of a manufacturer's highest emitting vehicles that cause the fleet average standard violation. Penalties for reporting requirements under Title II of the CAA apply per day of violation, and other violations apply on a per vehicle, or a per part or component basis. See CAA sections 203(a) and 205(a) and 40 CFR 19.4.

Section 207 of the CAA grants EPA broad authority to require manufacturers to remedy vehicles if EPA determines there are a substantial number of noncomplying vehicles. In addition, section 205 of the CAA authorizes EPA to assess penalties of up to $48,762 per vehicle for violations of various prohibited acts specified in the CAA. In determining the appropriate penalty, EPA must consider a variety of factors such as the gravity of the violation, the economic impact of the violation, the violator's history of compliance, and ''such other matters as justice may require.''

4. Averaging, Banking, and Trading Provisions for CO_2 Standards

EPA is finalizing provisions to extend credit life that are more targeted than those proposed. EPA proposed to extend credit carry-forward for MY 2016–2020 credits, including a two-year extension of MY 2016 credits and a one-year extension of MY 2017–2020 credits. After considering the comments received on this topic and further analyzing manufacturers' need for extended credit life, EPA is adopting a narrower approach in the final rule of adopting the one-year credit life extension only for MY 2017 and 2018 credits so they may be used in MYs 2023 and 2024, respectively. This section provides background on the ABT program as well as a summary of the proposed rule, public comments, and final rule provisions.

i. Background on Averaging, Banking, and Trading Program Under Previous Programs

Averaging, banking, and trading (ABT) is an important compliance flexibility that has been built into various highway engine and vehicle programs (and nonroad engine and equipment programs) to support emissions standards that, through the introduction and application of new technologies, result in reductions in air pollution. The light-duty ABT program for GHG standards includes existing provisions initially established in the 2010 rule for how credits may be generated and used within the program.[47] These provisions include credit carry-forward, credit carry-back (also called deficit carry-forward), credit transfers (within a manufacturer), and credit trading (across manufacturers).

Credit carry-forward refers to banking (saving) credits for future use, after satisfying any needs to offset prior MY debits within a vehicle category (car fleet or truck fleet). Credit carry-back refers to using credits to offset any deficit in meeting the fleet average standards that had accrued in a prior MY. A manufacturer may have a deficit at the end of a MY (after averaging across its fleet using credit transfers between cars and trucks)—that is, a manufacturer's fleet average level may fail to meet the manufacturer's required fleet average standard for the MY, for a limited number of model years, as provided in the regulations. The CAA does not specify or limit the duration of such credit provisions, and in the MY 2012–2016 and 2017–2025 light-duty GHG programs, EPA chose to adopt 5-year credit carry-forward (generally, with an exception noted below) and 3-year credit carry-back provisions as a reasonable approach that maintained consistency between EPA's GHG and NHTSA CAFE regulatory provisions.[48] While some stakeholders had suggested that light-duty GHG credits should have an unlimited credit life, EPA did not adopt that suggestion for the light-duty GHG program because it would pose enforcement challenges and could lead to some manufacturers accumulating large banks of credits that could interfere with the program's goal to develop and transition to progressively more advanced emissions control technologies in the future.

Although the existing credit carry-forward and carry-back provisions generally remained in place for MY 2017 and later standards, EPA finalized provisions in the 2012 rule allowing all unused (banked) credits generated in MYs 2010–2015 (but not MY 2009 early credits) to be carried forward through MY 2021. See 40 CFR 86.1865–12(k)(6)(ii); 77 FR 62788 (October 15, 2012). This credit life extension provided additional carry-forward years for credits generated in MYs 2010–2015, thereby providing greater flexibility for manufacturers in using these credits. This provision was intended to facilitate the transition to increasingly stringent standards through MY 2021 by helping manufacturers resolve lead time issues they might face in the early MYs of the program. This extension of credit carry-forward also provided an additional incentive for manufacturers to generate credits earlier, for example in MYs 2014 and 2015, thereby encouraging the earlier use of additional CO_2 reducing technologies. In addition, the existing 5-year carry-forward provisions applied to MY 2016 and later credits, making MY 2016 credits also eligible to be carried forward through MY 2021.

Transferring credits in the GHG program refers to exchanging credits between the two averaging sets—passenger cars and light trucks—within a manufacturer. For example, credits accrued by overcompliance with a manufacturer's car fleet average standard can be used to offset debits accrued due to that manufacturer not meeting the truck fleet average standard in a given model year. In other words, a manufacturer's car and truck fleets together are, in essence, a single averaging set in the GHG program. Finally, accumulated credits may be traded to another manufacturer. Credit trading has occurred on a regular basis in EPA's vehicle program.[49] Manufacturers acquiring credits may offset credit shortfalls and bank credits for use toward future compliance within the carry-forward constraints of the program.

The ABT provisions are an integral part of the vehicle GHG program and the agency expects that manufacturers will continue to utilize these provisions into the future. EPA's annual Automotive Trends Report provides details on the use of these provisions in the GHG program.[50] ABT allows EPA to consider standards more stringent than we would otherwise consider by giving manufacturers an important tool to resolve lead time and feasibility issues. EPA believes the targeted one-year extension of credit carry-forward for MY 2017 and 2018 credits that we are finalizing, discussed below, is appropriate considering the stringency and implementation timeframe of the revised standards.

ii. Extended Credit Carry-Forward

As in the transition to more stringent standards under the 2012 rule, EPA recognizes that auto manufacturers will again be facing a transition to more stringent standards for MYs 2023–2026.

[47] 40 CFR 86.1865–12.

[48] The EPCA/EISA statutory framework for the CAFE program limits credit carry-forward to 5 years and credit carry-back to 3 years.

[49] EPA provides general information on credit trades annually as part of its annual Automotive Trends and GHG Compliance Report. The latest report is available at: *https://www.epa.gov/automotive-trends* and the docket for this rulemaking.

[50] ''The 2021 EPA Automotive Trends Report, Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975,'' EPA–420–R–21–023, November 2021.

We also recognize that the stringency increase from MY 2022 to MY 2023 is a relatively steep step in our program with shorter lead time for MYs 2023 and 2024. Therefore, we believe it is again appropriate in the context of the revised standards to provide a targeted, limited amount of additional flexibility to carry-forward credits into MYs 2023–2024, as manufacturers manage the transition to these more stringent standards.

EPA proposed to temporarily increase the number of years that MY 2016–2020 credits could be carried-forward to provide additional flexibility for manufacturers in the transition to more stringent standards. EPA proposed to increase credit carry-forward for MY 2016 credits by two years such that they would not expire until after MY 2023. For MY 2017–2020 credits, EPA proposed to extend the credit life by one year, so that those banked credits can be used through MYs 2023–2026, depending on the MY in which the credits are banked. For MY 2021 and later credits, EPA did not propose any modification to existing credit carry-forward provisions, which allow credit carry-forward for 5 model years. EPA noted that the proposed extended credit carry-forward would help some manufacturers to have lower overall costs and address any potential lead time issues they may face during these MYs, especially in the first year of the proposed standards (MY 2023). EPA proposed to extend credit life only for credits generated against applicable standards established in the 2012 rule for MYs 2016–2020. EPA viewed these credits as a reflection of manufacturers' having achieved reductions beyond and earlier than those required by the 2012 rule standards.

As noted in the proposed rule and discussed above, there is precedent for extending credit carry-forward temporarily beyond five years to help manufacturers transition to more stringent standards. In the 2012 rule, EPA extended carry-forward for MY 2010–2015 credits to MY 2021 for similar reasons, to provide more flexibility for a limited time during a transition to more stringent standards.[51] ABT is an important compliance flexibility and has been built into various highway engine and vehicle programs to support emissions standards programs that through the introduction of new technologies result in reductions in air pollution. While the existing five-year credit life provisions in the light-duty GHG program are generally sufficient to provide for manufacturer flexibility while balancing the practical challenges of properly tracking credits over an extended period of time for compliance and enforcement purposes, there are occasions—such as when the industry is transitioning to significantly more stringent standards—where more flexibility may be appropriate.

EPA received a mix of comments regarding EPA's proposed provision for limited extended credit carry-forward. The Alliance and several individual manufacturers commented in support of the proposed credit life extensions. The Alliance commented that ''limited expansion of credit carry-forward provisions may provide some additional flexibility for a limited number of manufacturers, and in theory could provide some additional credit market liquidity during the rapidly tightening standards in MYs 2023–2026.'' It also commented that carry-forward credits do not reduce the environmental benefits of the standards as these credits represent tons of emissions avoided in advance of requirements. Honda provided similar comments and commented further that the automobile industry is facing severe global supply chain issues that continue to disrupt vehicle production volumes, launch dates and compliance strategies. Honda stated that slight modifications to the proposed credit carry forward provisions (*e.g.,* Honda suggested a two-year extension for MY 2016–2020 credits) could provide much needed compliance flexibility during an exceedingly challenging compliance planning time. Honda also commented that companies that signed up to the California Framework agreement can reasonably be expected to meet MY 2023 stringencies, but MY 2026 is likely to prove difficult for most, if not all, manufacturers. In addition, Honda commented in support of extending the credit carry forward provisions beyond those specified in the proposed rule. Nissan commented that EPA should extend the life of all model year 2015 and later GHG credits through at least model year 2026 to provide manufacturers with necessary compliance flexibility. Nissan believed that their recommended approach would enable manufacturers to invest appropriate resources at the appropriate time without eroding overall industry GHG benefits.

EV manufacturers did not support the proposed extended credit carry-forward, commenting that it is unnecessary and could lead to loss of emissions reductions. Tesla commented that it estimates the extension of the MY 2016 and 2017 credit bank will result in a reduction in stringency of 4.3 g/mile in MY 2023. Tesla commented that the one-year extension of the credit lifetime for model years beyond MY 2017 will further reduce stringency by another ~5 g/mile. Additionally, Tesla commented that ''the credit lifetime extension will also lessen the immediate value of earned credits in the trading market as underperforming manufacturers now may have greater opportunity on when to deploy credits. Operating under a consistent set of credit lifetime regulations, manufacturers over complying have been able to enter a robust credit marketing, basing credit value and need, in part, on a five-year lifetime. Under the proposal, the immediacy of the market will diminish, meaning less revenue and opportunity for an overperforming manufacturer that seeks to utilize credit revenue sales to invest in increased manufacturing of advanced technology vehicles. Like the other proposed flexibilities, this proposed change in credit lifetime reduces the standard's stringency, diminishes the level of investment going back into advanced manufacturing, and only serves to reward those manufacturers that delay deploying advanced technologies.''

The California Air Resources Board (CARB) also did not support the credit life extensions in the proposed rule, commenting ''when manufacturers planned their products to generate the credits, they were aware of the constraints on their use and available terms. Because these credits were earned before the Final SAFE Rules went into effect, they reflect manufacturer planning to meet the more stringent standards then in effect with improved technology after those credits had expired. Furthermore, extending the credit life is not necessary to facilitate compliance. In the time available, manufacturers can incentivize sales of vehicles with more of the necessary technologies if they are needed to meet the proposed standards, including additional zero-emission technologies.'' The California Attorney General commented that extending credit life for standards weaker than Alternative 2 could further delay the emissions reductions that are urgently needed.

Several environmental and health NGOs opposed the proposed extension as unnecessary and were concerned that it could lead to a loss of emissions reductions. A coalition of NGOs recommended that EPA not extend the lifetime of MY 2016–2020 credits as proposed, particularly not beyond MY 2024. They commented that extending credit life does not spur the development or application of more advanced technologies or vehicle

[51] 77 FR 62788.

electrification and represents a windfall since manufacturers have not taken the extension into account in the product plans. Union of Concerned Scientists (UCS) commented that the proposed extension is not necessary, presenting modeling of the proposed standards and Alternative 2 in the proposed rule and found that the proposed standards could be met without the extended credit life with the same technology penetration rates as estimated by EPA for the proposed rule. American Council for an Energy- Efficient Economy (ACEEE) also commented that the extension was unnecessary because manufacturers could use their MY 2018 and 2019 credits in MYs 2023 and 2024 and those credits would likely still be available because it is unlikely manufacturers would need to use them prior to those years due to the previous credit banks and the less stringent standards adopted in the SAFE rule for MYs 2021–2022.

After analyzing the public comments and further analyzing the need for and impacts of extending credit carry-forward, EPA is finalizing a one-year credit life extension only for MYs 2017–2018 credits, as shown in Table 11. This approach focuses the credit carry-forward extension on MYs 2023–2024 where lead-time is limited and manufacturers' ability to make adjustments to meet the more stringent standards is most constrained. EPA is not including the proposed one-year extension for MYs 2019 and 2020 credits out to MYs 2025 and 2026, respectively, because EPA believes there is sufficient lead time for manufacturers to make adjustments in their product and technology mix to meet the standards without the extension (see EPA's technical assessment of the standards in section III, of this preamble). MYs 2019 and 2020 credits will continue to be allowed to be carried forward through MYs 2024 and 2025, respectively, under the existing five year credit life provisions. EPA is not finalizing the two-year extension of the MY 2016 credits because we agree with the public comments that this additional year of credit life extension is unnecessary and could have the effect of weakening the MY 2022 SAFE standards.

If EPA were to extend MY 2016 credits, given the significant volume of currently banked credits that expire in MY2021 (as do the MY2016 credits), EPA expects that most of the MY 2016 credits would remain banked for use in MY 2023. However, if the MY2016 credits were extended, it is also possible due to the high number of credits held by some manufacturers, that some credits could be used or traded toward compliance with the weakened SAFE standards in MY 2022, for which EPA believes clearly no additional flexibility is warranted. This was not EPA's intent in proposing the extension. After considering the feasibility of the standards without the extension for MY 2016 credits, EPA determined that the MY 2023 standards could be met without the extension. Also, without an extension, MY 2016 credits will expire in MY 2021, a MY where several manufacturers will already have relatively large banks of MY 2010–2015 credits that also expire in MY 2021 (as noted, the 2012 rule provided a ''one-time'' extended credit life for these credits, and thus several manufacturers in the industry have built up extensive banks of credits all due to expire after MY 2021). The result of declining to extend MY 2016 credits, is that there will be an unusually high amount of credits that must be used or expire in MY 2021. In turn, the availability of these expiring credits will likely leave MY 2017–2021 credit balances unused by many manufacturers in MY 2021 and therefore available for use in MYs 2022 and beyond, depending on each manufacturer's MY 2021 and later compliance plans.[52] By extending MY 2017 credits but not MY 2016 credits, manufacturers' need for near-term flexibility are balanced with concerns that excess credit banks could delay the introduction or further penetration of technology. EPA believes that the extension of MY 2017 and 2018 credits by one year provides a reasonable and sufficient level of additional flexibility in meeting the final MYs 2023 and 2024 standards, focusing the additional flexibility on MYs with relatively shorter lead time. Several manufacturers have MY 2017–2018 vintage credits banked for future use, which could be used either internally within the manufacturer or traded to another manufacturer, so this provision provides additional flexibility for MYs 2023–2024 compliance.[53]

TABLE 11—FINAL EXTENSION OF CREDIT CARRY-FORWARD FOR MY 2016–2020 CREDITS

MY credits are banked	MYs credits are valid under extension										
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
2016		x	x	x	x	x					
2017			x	x	x	x	x	+			
2018				x	x	x	x	x	+		
2019					x	x	x	x	x		
2020						x	x	x	x	x	
2021							x	x	x	x	x

x = Existing program. + = Additional years included in Final Rule.

In response to the comments received, EPA believes the approach it is finalizing provides manufacturers with the flexibility asked for given the stated concerns about lead time, while also responding to other concerns raised that the proposed extension is unnecessary and could lead to a delay in application of emissions reducing technology. By adopting a one-year extension only for MYs 2017–2018 credits, EPA more narrowly focuses the extension on MYs 2023–2024 to help manufacturers manage the transition to more stringent standards by providing some additional flexibility. There is greater need for flexibility in these early years because manufacturers will be somewhat limited in making product plan changes in response to the final standards. By not adopting the proposed extension for MY

[52] ''The 2021 EPA Automotive Trends Report, Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975,'' EPA–420–R–21–023, November 2021.

[53] ''The 2021 EPA Automotive Trends Report, Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975,'' EPA–420–R–21–023, November 2021. See Table 5.19. Credits noted as expiring in MYs 2022–2023 represent MY 2017–2018 vintage credits, respectively. These credits will now expire one year later, respectively, in MYs 2023–2024.

2019 and MY 2020 credits, EPA's approach also responds to other commenters' concerns that the proposed extension may slow the adoption of emissions reducing technology. Concerning compliance with MYs 2025–2026 standards, EPA agrees with comments that manufacturers will be able to meet the standards through the application of technology and changes to product mix that includes increasing sales of lower emitting, credit generating vehicles, as shown in our technical analysis for the final rule.

In response to Tesla's comments that the extension may lessen the value of credits in the trading market, EPA believes this could be true if EPA were not adopting more stringent standards at the same time. However, any loss of credit value is likely more than offset by the stringent final standards which could make available credits even more sought after by some manufacturers, and thus potentially increasing credit value. EPA also notes that the GHG program regulations clearly state, ''There are no property rights associated with CO_2 credits generated under this subpart. Credits are a limited authorization to emit the designated amount of emissions. Nothing in this part or any other provision of law should be construed to limit EPA's authority to terminate or limit this authorization through a rulemaking.'' [54] EPA retains the ability to revise credits provisions as it believes prudent through rulemaking.

5. Certification, Compliance, and Enforcement

EPA established comprehensive vehicle certification, compliance, and enforcement provisions for the GHG standards as part of the rulemaking establishing the initial GHG standards for MY 2012–2016 vehicles.[55] Manufacturers have been using these provisions since MY 2012 and EPA neither proposed nor is adopting any changes in the areas of certification, compliance, or enforcement.

6. On-Board Diagnostics Program Updates

EPA regulations state that onboard diagnostics (OBD) systems must generally detect malfunctions in the emission control system, store trouble codes corresponding to detected malfunctions, and alert operators appropriately. EPA adopted (as a requirement for an EPA certificate) the 2013 CARB OBD regulation, with certain additional provisions, clarifications and exceptions, in the Tier 3 Motor Vehicle Emission and Fuel Standards final rulemaking (40 CFR 86.1806–17; 79 FR 23414, April 28, 2014). Since that time, CARB has made several updates to their OBD regulations and continues to consider changes periodically.[56] Manufacturers may find it difficult to meet both the 2013 OBD regulation adopted in EPA regulations and the currently applicable CARB OBD regulation on the same vehicles. This may result in different calibrations being required for vehicles sold in states subject to Federal OBD (2013 CARB OBD) and vehicles sold in states subject to current CARB OBD.

To provide clarity and regulatory certainty to manufacturers, EPA is finalizing as proposed a limited regulatory change to streamline OBD requirements. Under this change, EPA can find that a manufacturer met OBD requirements for purposes of EPA's certification process if the manufacturer can show that the vehicles meet newer CARB OBD regulations than the 2013 CARB regulation which currently establishes the core OBD requirements for EPA certification and that the OBD system meets the intent of EPA's regulation, including provisions that are in addition to or different from the applicable CARB regulation. The intent of this provision is to allow manufacturers to produce vehicles with one OBD system (software, calibration, and hardware) for all 50 states. We received only supportive comments on this change, from the auto industry, as summarized in the Response to Comments (RTC) document for this rulemaking.

7. Stakeholder Engagement

In developing this rule, EPA conducted outreach with a wide range of stakeholders, including auto manufacturers, automotive suppliers, labor groups, state/local governments, environmental and public interest groups, public health professionals, consumer groups, and other organizations. We also coordinated with the California Air Resources Board. Consistent with Executive Order 13990, in developing this rule EPA has considered the views from labor unions, states, and industry, as well as other stakeholders.

EPA has considered all public comments received during the two-day public hearing on August 25 and 26, 2021, and written comments submitted to the docket during the public comment period, which closed September 27, 2021. Responses to comments can be found in this preamble and the Response to Comments document. We look forward to continuing to engage with interested stakeholders as we embark on a future rulemaking to set standards beyond 2026, so diverse views can continue to be considered in our development of a longer-term program.

8. How do EPA's final standards relate to NHTSA's CAFE proposal and to California's GHG program?

i. EPA and NHTSA Rulemaking Coordination

In E.O. 13990, President Biden directed NHTSA and EPA to consider whether to propose suspending, revising, or rescinding the SAFE rule standards for MYs 2021–2026.[57] Both agencies determined that it was appropriate to propose revisions to their respective standards; EPA proposed and is finalizing revisions to its GHG standards and, in a separate rulemaking action, NHTSA proposed to revise its CAFE standards.[58] Since 2010, EPA and NHTSA have adopted fuel economy and GHG standards in joint rulemakings. In the 2010 joint rule, EPA and NHTSA explained the purpose of the joint rulemaking effort was to develop a coordinated and harmonized approach to implementing the two agencies' statutes. The joint rule approach was one appropriate mechanism for the agencies to coordinate closely, given the common technical issues both agencies needed to consider and the importance of avoiding inconsistency between the programs. A few environmental NGOs commented that the CAA does not require EPA to engage in joint rulemaking for its LD GHG program.

In light of additional experience as the GHG and CAFE standards have co-existed since the 2010 rule and the agencies have engaged in several joint rulemakings, EPA has concluded that while it remains committed to ensuring that GHG emissions standards for light duty vehicles are coordinated with fuel economy standards for those vehicles, it is unnecessary for EPA to do so specifically through a joint rulemaking.

In reaching this conclusion, EPA notes that the agencies have different statutory mandates and their respective programs have always reflected those

[54] 30 CFR 86.1865–12(k)(2). EPA adopted this regulatory provision when it established the first GHG standards in the 2010 rule.

[55] See 75 FR 25468–25488 and 77 FR 62884–62887 for a description of these provisions. See also ''The 2020 EPA Automotive Trends Report, Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975,'' EPA–420–R–21–003 January 2021 for additional information regarding EPA compliance determinations.

[56] See *https://ww2.arb.ca.gov/our-work/programs/obd-board-diagnostic-program/obd-workshops.*

[57] 86 FR 7037, January 25, 2021.

[58] 86 FR 49602, September 3, 2021.

differences. As the Supreme Court has noted ''EPA has been charged with protecting the public's 'health' and 'welfare,' a statutory obligation wholly independent of DOT's mandate to promote energy efficiency.'' [59] The agencies have recognized these different mandates, and the fact that they have produced different analytical approaches and standards. For example, since EPA's responsibility is to address air pollution, it sets standards not only for carbon dioxide (measured as grams per mile), but also for methane and nitrous oxide. Even more significantly, EPA regulates leakage of fluorocarbons from air conditioning units by providing a credit against the tailpipe CO_2 standard for leakage reduction and adjusting those standards numerically downwards to reflect the anticipated availability of those credits. NHTSA, given its responsibility for fuel economy (measured as miles per gallon), does not have these elements in the CAFE program but has limits on transfers between car and truck fleets. There have always been other differences between the programs as well, which generally can be traced back to differences in statutory mandates. As the agencies reconsider the SAFE 2 standards, the difference in statutory lead time requirements has similarly led to a difference in the model years for which standards are being revised.

We note that EPA coordinates with NHTSA regardless of whether it is in the formal context of a joint rulemaking, and indeed we have done so during the development of this rulemaking. Although there is no statutory requirement for EPA to consult with NHTSA, EPA has consulted significantly with NHTSA in the development of this rule. For example, staff of the two agencies met to discuss various technical issues including modeling inputs and assumptions, shared technical information, and shared views related to the modeling used for each rule. Under other areas of the CAA, consultation is the usual approach Congress has specified when it recognizes that in addition to EPA, another agency shares expertise and equities in an area. The CAA does not require joint rulemaking, even for its many provisions that require EPA consultation with other agencies on topics such as the impacts of ozone-depleting substances on the atmosphere (CAA section 603(f) requires consultation with Administrators of NASA and NOAA), renewable fuels (CAA section 211(o)(2)(B)(ii) requires coordination with the Secretaries of Energy and Agriculture, and section 211(o)(7) requires consultation with those Secretaries), the importance of visibility on public lands (CAA section 169A(d) requires consultation with Federal Land Manager), regulation of aerospace coatings (CAA section 183(b)(3) requires consultation with Secretaries of Defense and Transportation and NASA Administrator), and federal procurement (CAA section 613 requires consultation with GSA Administrator and Secretary of Defense). For example, for aircraft emissions standards, where CAA section 231(a)(2)(B)(i) requires EPA to set the standards in consultation with the Federal Aviation Administration (FAA), and FAA implements the standards, the two agencies may undertake, and have undertaken, separate rulemakings. Likewise, when EPA revises test procedures for NHTSA's fuel economy standards under EPA's authority in 42 U.S.C. 32904(c), those rules are not done as joint rulemaking (unless they were included as part of a larger joint rulemaking on GHG and fuel economy standards). Thus, EPA concludes that joint rulemaking is unnecessary, particularly to the extent it was originally intended to ensure that the agencies work together and coordinate their rules, which the agencies are indeed doing through separate rulemaking processes.

We note that many commenters, including automakers, suppliers, dealers and the UAW noted benefits of coordination between EPA and NHTSA in establishing their respective programs, and urged EPA to maintain a close alignment with NHTSA, to ensure that automakers can continue to design and build vehicles to meet both sets of standards. As explained above, and at proposal, EPA has coordinated and will continue to coordinate with NHTSA in the development of EPA's and NHTSA's standards even in the absence of joint rulemaking. While the statutory differences between the programs remain, and thus some differences in compliance strategies might result, EPA agrees with commenters that it is an important goal for coordination that automakers be able to produce a fleet of vehicles which achieves compliance with both sets of standards simultaneously, and we believe these standards are consistent with that longstanding practice and goal. For example, EPA believes that the revised MY 2023 GHG standards will not interfere with automakers' ability to comply with MY 2023 CAFE standards even though NHTSA has not proposed revising CAFE standards for that year.

ii. California GHG Program

California has long been a partner in reducing light-duty vehicle emissions, often leading the nation by setting more stringent standards before similar standards are adopted by EPA. This historically has been the case with GHG emissions standards in past federal rulemakings, where California provided technical support to EPA's nationwide programs. Prior to EPA's 2010 rule establishing the first nationwide GHG standards for MYs 2012–2016 vehicles, California had adopted GHG standards for MYs 2009–2016.[60] California subsequently adopted its MYs 2017–2025 GHG standards as part of its Advanced Clean Car (ACC) program. After EPA adopted its standards in the 2012 rule for MYs 2017–2025, California adopted a deemed-to-comply regulation whereby manufacturers could demonstrate compliance with California's standards by complying with EPA's standards.[61] California also assisted and worked with EPA in the development of the 2016 Draft Technical Assessment Report for the Mid-term Evaluation,[62] issued jointly by EPA, CARB and NHTSA, that served as an important technical basis for EPA's original January 2017 Final Determination that the standards adopted in the 2012 rule for MYs 2022–2025 remained appropriate. California also conducted its own Midterm Review that arrived at a similar conclusion.[63]

In August 2018, EPA and NHTSA jointly issued the SAFE rule proposal, which included an EPA proposal to withdraw CARB's Advanced Clean Car (ACC) waiver as it related to California GHG emission standards and ZEV sales requirements (that would preclude California from enforcing its own program) as well as a proposal to

[59] *Massachusetts* v. *EPA*, 549 U.S. at 532.

[60] EPA issued a waiver for CARB's 2009–2016 model year vehicles in 2009 (74 FR 32744). EPA subsequently issued a within-the-scope waiver determination for CARB's subsequent deemed-to-comply regulation (CARB adopted this regulation after EPA finalized its 2012–2016 model year GHG standards in 2010 on June 14, 2011 (76 FR 34693).

[61] The California Air Resources Board (CARB) received a waiver of Clean Air Act preemption on January 9, 2013 (78 FR 2211) for its Advanced Clean Car (ACC) program. CARB's ACC program includes the MYs 2017–2025 greenhouse gas (GHG) standards as well as regulations for zero-emission vehicle (ZEV) sales requirements and California's low emission vehicle (LEV) III requirements.

[62] Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022–2025, EPA–420–D–16–900, July 2016.

[63] *https://ww2.arb.ca.gov/our-work/programs/advanced-clean-cars-program/advanced-clean-cars-midterm-review.*

sharply reduce the stringency of the national standards.[64] In September 2019, EPA and NHTSA then jointly issued a final SAFE ''Part One'' rule, which included a final EPA action withdrawing CARB's ACC waiver as it related to California GHG emission standards and ZEV sales requirements.[65] In response to the SAFE rule proposal, California and five auto manufacturers entered into identical agreements commonly referred to as the California Framework Agreements. The Framework Agreements included national GHG emission reduction targets for MYs 2021–2026 that, in terms of stringency, are about halfway between the original 2012 rule standards and those adopted in the final SAFE rule. The Framework Agreements also included additional flexibilities such as additional incentive multipliers for advanced technologies, off-cycle credits, and full-size pickup strong hybrid incentives.

EPA has considered California standards in past vehicle standards rules as we considered the factors of feasibility, costs of compliance and lead time. The California Framework Agreement provisions, and the fact that five automakers representing nearly 30 percent of national U.S. vehicle sales voluntarily committed to them, at a minimum provide a clear indication of manufacturers' capabilities to produce cleaner vehicles than required by the SAFE rule standards in the implementation timeframe of EPA's revised standards.[66] EPA further discusses how we considered the California Framework Agreements in the context of feasibility and lead time for our standards in Section III.C of this preamble. Some commenters supported continued coordination between EPA and California on our respective light-duty GHG programs. EPA expects to continue our long-standing practice of working closely with CARB and all other interested stakeholders in development of future emissions standards.

In a separate but related action, on April 28, 2021, EPA issued a Notice of Reconsideration for the previous withdrawal of the California's ACC waiver as it relates to the ZEV sales mandate and GHG emission standards (SAFE 1), requesting comments on whether the withdrawal should be rescinded, which would reinstate the waiver.[67] EPA conducted a virtual public hearing on June 2, 2021 and the comment period closed on July 6, 2021. EPA will announce the results of its reconsideration once it is complete.

B. Manufacturer Compliance Flexibilities

EPA is finalizing a targeted set of additional temporary compliance flexibilities intended to provide additional flexibility for manufacturers in meeting the 2023 and 2024 standards. EPA proposed temporary changes to certain flexibility provisions to provide limited additional flexibility for manufacturers in transition to more stringent standards. After considering comments and further analysis, EPA is adopting a narrower set of flexibilities than proposed, focusing them particularly on MYs 2023–2024 to help manufacturers manage the transition to more stringent standards by providing some additional flexibility in the near-term. One of the four flexibilities, extended credit carry-forward, is discussed above in section II.A.4 of this preamble. This section provides a detailed discussion of the remaining three flexibilities, listed below, including a summary of the final flexibility provisions compared to those proposed and public comment highlights.

(1) *Credit carry-forward extension:* As discussed previously in Section II.A.4 of this preamble, EPA is finalizing provisions for credit carry-forward extension that are more targeted than those proposed. EPA proposed to extend credit carry-forward for MY 2016–2020 credits to allow more flexibility for manufacturers in using banked credits in MYs 2023–2026. Specifically, EPA proposed a two-year extension of MY 2016 credits and a one-year extension of MY 2017–2020 credits. After considering comments and further analyzing the need for extended credit life, EPA is adopting a narrower approach for the final rule of only adopting the one-year credit life extension for MY 2017–2018 credits so they may be used in MYs 2023–2024.

(2) *Advanced technology multiplier incentives:* EPA proposed increased and extended advanced technology multiplier incentives for MYs 2021–2025 but is finalizing the multipliers at their MY 2021 levels as established in the 2012 rule (*e.g.,* 1.5 for EVs rather than the proposed 2.0) and including them only for MYs 2023–2024. Also, EPA proposed to remove the multiplier incentives for natural gas vehicles for MYs 2023–2026 established by the SAFE rule and is finalizing this program change as proposed.

(3) *Full-size pickup truck incentives:* EPA proposed to extend the full-size pickup incentives for MYs 2022–2025, reinstating the provisions of the 2012 rule after EPA had eliminated them for these years as part of the SAFE rule. As with multipliers, EPA is finalizing the full-size pickup credits only for MYs 2023–2024.

(4) *Off-cycle credits:* EPA proposed additional opportunities for menu-based off-cycle credits starting in MY 2020, along with updated technology definitions for some of the menu technologies. EPA is finalizing those additional credit opportunities only for MYs 2023–2026 and is not including them as an option for MYs 2020–2022. EPA is adopting new definitions for certain menu technologies as proposed with minor edits after considering comments.

The use of the optional credit and incentive provisions has varied, and EPA continues to expect it to vary, from manufacturer to manufacturer. However, most manufacturers are currently using at least some of the flexibilities.[68] Although a manufacturer's use of the credit and incentive provisions is optional.

1. Multiplier Incentives for Advanced Technology Vehicles

i. Background on Multipliers Under Previous Programs

In the 2012 rule, EPA included incentives for advanced technologies to promote the commercialization of technologies that have the potential to transform the light-duty vehicle sector by achieving zero or near-zero GHG emissions in the longer term, but which faced major near-term market barriers. EPA recognized that providing temporary regulatory incentives for certain advanced technologies would decrease the overall GHG emissions reductions associated with the program in the near term, by reducing the effective stringency of the standards in years in which the incentives were available, to the extent the incentives were used. However, in setting the 2017–2025 standards, EPA believed it was worthwhile to forego modest additional emissions reductions in the near term in order to lay the foundation for much larger GHG emissions reductions in the longer term. EPA also

[64] EPA's waiver for CARB's Advanced Clean Car regulations is at 78 FR 2211 (January 9, 2013). The SAFE NPRM is at 83 FR 42986 (August 24, 2018).

[65] 84 FR 51310 (Sept. 27, 2019).

[66] The five California Framework Agreements may be found in the docket for this rulemaking and at: *https://ww2.arb.ca.gov/news/framework-agreements-clean-cars.*

[67] 80 FR 22421 (April 28, 2021).

[68] See ''The 2020 EPA Automotive Trends Report, Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975,'' EPA–420–R–21–003 January 2021 for additional information regarding manufacturer use of program flexibilities.

believed that the temporary regulatory incentives may help bring some technologies to market more quickly than in the absence of incentives.[69]

EPA established multiplier incentives for MYs 2017–2021 electric vehicles (EVs), plug-in hybrid electric vehicles (PHEVs), fuel cell vehicles (FCVs), and natural gas vehicles (NGVs).[70] The multiplier allows a vehicle to ''count'' as more than one vehicle in the manufacturer's compliance calculation. Table 12 provides the multipliers for the various vehicle technologies included in the 2012 final rule for MY 2017–2021 vehicles.[71] Since the GHG performance for these vehicle types is significantly better than that of conventional vehicles, the multiplier provides a significant benefit to the manufacturer. EPA chose the magnitude of the multiplier levels to be large enough to provide a meaningful incentive, but not be so large as to provide a windfall for vehicles that still would have been produced even at lower multiplier levels. The multipliers for EVs and FCVs were larger because these technologies faced greater market barriers at the time.

TABLE 12—INCENTIVE MULTIPLIERS FOR EV, FCV, PHEVS, AND NGVS ESTABLISHED IN 2012 RULE

Model years	EVs and FCVs	PHEVs and NGVs
2017–2019	2.0	1.6
2020	1.75	1.45
2021	1.5	1.3

In the SAFE rule, EPA adopted a multiplier of 2.0 for MYs 2022–2026 natural gas vehicles (NGVs), noting that no NGVs were being sold by auto manufacturers at that time. EPA did not extend multipliers for other vehicle types in the SAFE rule, as the SAFE standards did not contemplate the extensive use of these technologies in the future so there was no need to continue the incentives.

ii. Proposed and Final Multiplier Extension and Cap

EPA is adopting a narrower set of temporary advanced technology multipliers in the final rule, limiting the multipliers to MYs 2023–2024 and at multiplier values consistent with the MY 2021 multiplier levels shown in Table 12, which are lower than the levels in the proposed rule. EPA is also finalizing the proposed 10 g/mile multiplier credit cap as proposed. This section first discusses the final multiplier levels and model year availability followed by a discussion of the multiplier cap.

a. Multiplier Levels and Model Year Applicability

EPA proposed to extend multipliers for EVs, PHEVs, and FCVs for MYs 2022–2025, but with a cap to limit the magnitude of resulting emissions reduction losses and to provide a means to more definitively project the impact of the multipliers on the overall stringency of the program. EPA noted in the proposed rule that with the revised more stringent standards being proposed, the Agency believed limited additional multiplier incentives would be appropriate for the purposes of encouraging manufacturers to accelerate the introduction of zero and near-zero emissions vehicles and maintaining momentum for that market transition. EPA requested comment on all aspects of the proposed extension of multipliers, including the proposed multiplier levels, model years when multipliers are available, and the size and structure of the multiplier credit cap.

Given that the multipliers previously established in the 2012 rule and modified in the SAFE rule only run through MY 2021, EPA proposed to start the new multipliers in MY 2022 to provide continuity for the incentives over MYs 2021–2025. As proposed the multipliers would function in the same way as they have in the past, allowing manufacturers to count eligible vehicles as more than one vehicle in their fleet average calculations. The levels of the proposed multipliers, shown in Table 13 below, are the same as those contained in the California Framework Agreements for MY 2022–2025. EPA proposed to sunset the multipliers after MY 2025, rather than extending them to MY 2026, because EPA intended them to be a temporary part of the program to incentivize technology in the near-term, consistent with previous multipliers. EPA noted in the proposed rule that sunsetting the multipliers at the end of MY 2025 would help signal that EPA does not intend to include multipliers in its future proposal for standards for MY 2027 and later MYs, where these technologies are likely to be integral to the feasibility of the standards. The goal of a long-term program would be to quickly transition the light-duty fleet to zero-emission technology, in which case ''incentives'' would no longer be appropriate, noting further that as zero-emissions technologies become more mainstream, EPA believes it is appropriate to transition away from multiplier incentives.

TABLE 13—PROPOSED MULTIPLIER INCENTIVES FOR MYS 2022–2025

Model years	EVs and FCVs	PHEVs
2022–2024	2.0	1.6
2025	1.75	1.45
2026+	1.0 (no multiplier credits).	1.0 (no multiplier credits).

EPA also noted in the proposed rule that it believes sunsetting multipliers would simplify programmatically a transition to a more stringent program for MY 2027. The proposed MY 2025 sunset date combined with the cap, discussed below, was intended to begin the process of transitioning away from auto manufacturers' ability to make use of the incentive multipliers. While EPA proposed to end multipliers after MY 2025 for these reasons, EPA requested comments on whether it would be more appropriate to allow multiplier credits to be generated in MY 2026 without an increase in the cap, potentially providing an additional incentive for manufacturers who had not yet produced advanced technology vehicles by MY 2026. EPA noted, however, that extending the multipliers through MY 2026 could also potentially complicate transitioning to MY 2027 standards for some manufacturers.

EPA received a range of comments on its proposed multipliers for MYs 2021–2025, including both support for and opposition to including multipliers in the program. The Alliance and several member auto companies commented in support of including multipliers in the program. The Alliance commented that multipliers have proven effective in incentivizing increased production and sales of EVs and that it is aligned with EPA in recognizing that multipliers have provided, and can continue to provide, a meaningful incentive for manufacturers to help drive additional EVs into the marketplace and to help overcome ongoing market headwinds. The Alliance commented that ''for the duration of this rule, it can be broadly summarized that while improving, there is projected to remain a lingering price disparity between EVs and conventional models. This disparity continues to support the basis of the EV multiplier to deliver ''substantial induced innovation. Separate from the issue of cost, there are several points of friction that EVs have and may continue to struggle to overcome including availability of public charging infrastructure.'' The

[69] See 77 FR 62811 *et seq.*

[70] 77 FR 62810, October 15, 2012.

[71] 77 FR 62813–62816, October 15, 2012.

Alliance commented it believes the inclusion of EV multipliers for MY 2026 and a higher cap would better recognize the current state of EV technology and markets and incentivize additional EV production. The Alliance also commented that extending the multipliers out to MY 2026 would also recognize that some manufacturers are still developing EVs and would be influenced by later incentives. The Alliance suggested that EPA include an EV multiplier in MY 2026, and reconsider the need for such incentives beyond MY 2026 based on technology and market development in a subsequent rulemaking.

Honda commented that policy levers such as advanced technology multipliers can play an important role in driving continued investment in the face of market uncertainty, multipliers have the potential to bring the cost-effectiveness of long-term technologies more in line with those of shorter-term technologies, and can help facilitate a virtuous cycle in which reduced technology costs, passed along to consumers, can further assist market uptake. Jaguar Land Rover commented in support of lowering the multiplier levels to those in place for MY 2021. Toyota commented that the multiplier should be increased for PHEVs, to a level closer to that provided to EVs, as they claim that PHEVs are often driven as EVs. Lucid, an EV-only manufacturer, supported the multipliers.

CARB commented that EPA's proposed multiplier levels are too high because the proposed cap would be reached at around two percent of sales, a level already met by some auto manufacturers. CARB commented that, as such, the proposed cap would not provide much incentive for increased EV sales. CARB commented that EPA should finalize multipliers only for MYs 2023–2025 at a multiplier levels lower than the proposed levels as they believed that this approach would require manufacturers to sell more EVs in order to maximize multiplier incentive credits and reach the cap, thus providing a greater incentive for manufacturers to increase EV sales in this time frame. Similar comments were received from other state government stakeholders including New York, Minnesota, New Mexico, as well as NACAA. South Coast Air Quality Management District (SCAQMD) supported multipliers and suggested extending them out to MY 2026 but at a lower level as part of a phase-out.

Other commenters supporting multipliers include Motor and Equipment Manufacturers Association (MEMA), Manufacturers of Emission Controls Association (MECA), ITB Group, and several individual suppliers. MEMA and MECA commented that their support was conditioned on the incentives sunsetting in 2025 and the program including a stringent cap, discussed below. MEMA commented "while MEMA can support these advanced technology multiplier incentives, these multiplier incentives should not be extended indefinitely, credits should not be set higher than the proposed levels, and the proposed cap should not be increased." The Electric Drive Transportation Association also supported multipliers, commenting that EVs are still an emerging market and industry and that multipliers promote investment in innovation and noting that there is still significant uncertainty in multi-year EV market predictions. The Edison Electric Institute also supported the proposed multipliers as reasonable and well supported.

Rivian and Tesla, both EV-only manufacturers, did not support including multipliers. Rivian commented that "artificially enhancing the compliance value of EVs, the multiplier can enable manufacturers to sell additional conventional vehicles if those units deliver a greater financial return. It is also debatable whether the multiplier is even necessary at this stage to help commercialize EV technology. With a rapidly proliferating lineup of EVs in all body styles and vehicle segments, the auto industry has amply demonstrated its ability to bring compelling and competitive advanced technology vehicles to market." Tesla commented that the renewal of multipliers and increased value are unnecessary and, rather than serve as an incentive, will further delay manufacturers from deploying large amounts of electric vehicles in the U.S. Tesla also commented that the proposed enhanced multiplier unnecessarily rewards late-acting manufacturers with excessive credits and richer credits after over a decade of notice from the EPA that such incentives were temporary and destined to decline in reward.

Environmental and health NGOs also did not support the proposed multipliers, commenting that the incentives were not needed and would result in a loss of emissions reductions. A coalition of NGOs commented that the proposed multipliers would reduce the stringency of proposed rule through MY 2021–MY 2026 by about 6 percent—an amount exceeding one full year of emissions reductions and that the multipliers are no longer serving their original purpose of incentivizing the production of more EVs. NGOs commented that the multiplier credits represent a windfall for manufacturers already planning to sell EVs. They commented further that EPA, at a minimum, should end the lifetimes of any multiplier credit in the final year for which they are granted such that the multiplier credits are not banked to be used in MY 2027 and later. UCS urged EPA to eliminate multipliers as the current program already provides substantial incentives by excluding upstream emissions; UCS submitted a modeling analysis which they believe indicates that multipliers are ineffective in encouraging greater EV sales.

The Southern Environmental Law Center commented that, at a minimum, EPA should revise the proposed rule so the MYs 2022 through 2024 multiplier incentives values start at 1.5 for EVs and FCVs, and 1.3 for PHEVs—the values provided for the last year of advanced technology credits (MY 2021) in the 2012 Rule—and then decrease to a value of 1.0 (no multiplier credits) by MY 2026.

Securing America's Future Energy (SAFE) commented in support of the proposed multipliers. SAFE further commented:

> [I]f EPA remains concerned that the multiplier will result in fewer EV sales because the availability of the multiplier relaxes the stringency of the standard, EPA could modify the operation of the multiplier to mitigate those concerns while still incentivizing the sale of electric vehicles. First, EPA could take into account the possibility that the multiplier might relax the stringency of the standards, and then further tighten the standards to maintain its initial level of stringency. In the alternative, EPA could modify the multiplier so that it would only apply to the incremental percentage of EVs that an automaker sold over the percentage in the previous year. By limiting the availability of the multiplier to the incremental sales of EVs year over year, EPA could reduce the extent to which it decreases the overall stringency of the standard. Yet, by maintaining the multiplier for electric vehicles that represent growth of the EV segment of an automakers' sales, the multiplier would provide an ongoing and robust incentive for automakers to continually increase their EV sales.

The Institute for Policy Integrity commented that EPA should consider whether scaling back some of the multiplier credits, or limiting their application to MY 2023, would increase net social benefits while still preserving more than enough compliance flexibility to satisfy the requirement for lead time.

The Alliance for Vehicle Efficiency (AVE) commented in support of EPA's goal of offering advanced multiplier credits up until 2026 and recommended EPA offer additional performance-based credits to automotive manufacturers (OEMs) for any vehicle that exceeds the standards ahead of EPA's compliance timeline, including ICE vehicles. AVE commented that ''by steering OEMs towards specific technologies that may only affect about 8 percent of the fleet by 2026 with extensive credits, EPA risks losing immediate and more extensive environmental improvements in exchange for estimated environmental gains years from now. EPA instead has an opportunity to accelerate the adoption of advanced vehicle technologies and reduce emissions from the vast majority of vehicles that will be sold between MYs 2023 to 2026 with performance-based credits.''

After careful weighing the diverse and thoughtful comments received regarding multipliers, EPA is finalizing temporary multipliers at lower levels than those proposed and for fewer model years. Table 14 provides the final multipliers.

TABLE 14—FINAL MULTIPLIER INCENTIVES FOR MYS 2023–2024

Model years	EVs and FCVs	PHEVs
2022	None	None.
2023–2024	1.5	1.3.
2025+	None	None.

EPA believes the approach being finalized strikes an appropriate balance between providing additional near-term flexibility (with the goal that multipliers can act as an incentive for manufacturers to ramp up EV sales more quickly in this time period) and the overall emissions reduction goals of the program. To the extent that manufacturers utilize the optional multiplier flexibility to the maximum extent, it provides additional flexibility of up to 10 g/mile (compared to a projected total decrease in the fleet average targets over MYs 2023–2024 of 32 g/mile, as shown in Table 8 of section II.A.1 of this preamble.) for a manufacturer's overall fleet, consistent with the cap level of the proposal. EPA's final approach is also directionally responsive to many of the concerns raised about multipliers and incorporates several of the suggestions made by commenters to narrow the model years and reduce the magnitude of the multipliers. By reducing the multiplier numeric levels by 50 percent compared to the proposed rule (*i.e.*, reducing the EV multiplier from 2.0 to 1.5), manufacturers will need to sell twice as many advanced technology vehicles if they wish to fully utilize the multiplier incentive and reach the cap. In addition, by retaining the proposed cumulative cap of 10 g/mile, but focusing the multiplier incentives on MYs 2023–2024, the result is an effective or average per year cap of 5.0 g/mile as opposed to the 2.5 g/mile nominal per year cap proposed, under which the 10 g/mile cumulative would spread over four rather than 2 years. EPA believes this approach is responsive to comments that the proposed multipliers would not represent an incentive but simply windfall credits manufacturers would generate by selling the same number of EVs as had been planned previously. In response to comments that the proposed multipliers could have the effect of delaying or reducing EV sales, EPA modeled the final program with and without the final multipliers and found that the final multipliers are not expected to reduce EV sales (see RIA Chapter 4.1.4).

In response to comments provided by SAFE, EPA believes the concept SAFE presented regarding incentivizing only incremental sales beyond those sold by manufacturers in the previous model year to focus the incentive more directly on increased sale has some merit, but EPA is not adopting such an approach. EPA proposed that the multipliers would be applied in the same way as those provided previously in the 2012 rule for MYs 2017–2021, with the exception of the credit cap. EPA would want to seek input from all stakeholders on the merits and implementation details of this type of approach prior to adopting such a fundamental change to the program. Also, the approach offered by SAFE would add complexity to the program which EPA does not believe to be necessary for the few model years, MYs 2023–2024, for which EPA is adopting new multipliers.

Some auto manufacturers commented in support of extending multipliers through MYs 2026 and even beyond, while other commenters were concerned that providing multipliers in later model years would reward manufacturers that introduce advanced technology vehicles such as EVs later than other manufacturers. EPA does not intend for multipliers to be an ongoing incentive but only a narrow flexibility to help address lead time concerns in early model years. EPA proposed to end the multipliers in MY 2025 and is finalizing ending them a year earlier in MY 2024, which is consistent with EPA's intention that the incentives be short lived and narrowly targeted. As discussed further in Section III of this preamble, EPA believes that there is enough lead time for manufacturers to prepare to meet the final standards starting in MY 2025 without such incentives. Regarding comments that EPA should not allow the multiplier credits to be used in MYs 2027 and later because the credits could unduly delay the application of technology and delay emissions reductions, EPA understands this concern. When considering the feasibility of standards for MYs 2027 and later, EPA intends to take credit banks and credit availability into consideration.

EPA received many comments on multiplier incentives and responds fully to comments in the RTC for the rule.

b. Multiplier Incentive Credit Cap

To limit the potential effect of the multipliers on reducing the effective stringency of the standards, EPA proposed to cap the credits generated by a manufacturer's use of the multipliers to the Megagram (Mg) equivalent of 2.5 g/mile for their car and light truck fleets per MY for MYs 2022–2025 or 10.0 g/mile on a cumulative basis.[72] Above the cap, the multiplier would effectively have a value of 1.0—in other words, after a manufacturer reaches the cap, the multiplier would no longer be available and would have no further effect on credit calculations. A manufacturer would sum the Mg values calculated for each of its car and light truck fleets at the end of a MY into a single cap value that would serve as the overall multiplier cap for the combined car and light truck fleets for that MY. This approach would limit the effect on stringency of the standards for manufacturers that use the multipliers to no greater than 2.5 g/mile less stringent each year on average over MYs 2022–2025. EPA proposed that manufacturers would be able to choose how to apply the cap within the four-year span of MYs 2022–2025 to best fit their product plans. Under the proposed approach, manufacturers could opt to use values other than 2.5 g/mile in the cap calculation as long as the sum of those values over MYs 2022–2025 did not exceed 10.0 g/mile (*e.g.*, 0.0, 2.5, 2.5, 5.0 g/mile in MYs 2022–2025).

EPA received a range of comments regarding the proposed cap. The

[72] Proposed Multiplier Credit Cap [Mg] = (2.5 g/mile CO_2 × VMT × Actual Annual Production)/1,000,000 calculated annually for each fleet and summed. The proposed approach would allow manufacturers to use values higher than 2.5 g/mile in the calculation as long as the sum of the cumulative values over MYs 2022–2025 did not exceed 10.0 g/mile. The vehicle miles traveled (VMT) used in credit calculations in the GHG program, as specified in the regulations, are 195,264 miles for cars and 225,865 for trucks. See 40 CFR 86.1866–12. See also 40 CFR 86.1866–12(c) for the calculation of multiplier credits to be compared to the cap.

Alliance and some individual auto manufacturers commented that EPA should provide a cap more in line with that included in the California Framework, equivalent to 23 g/mile (about 5.8 g/mile/year) through MY 2025 and 32 g/mile (about 6.4 g/mile/year) through MY 2026, in order to further incentivize EVs. The Alliance commented that the proposed 10 g/mile cap provides little incentive to increase EV production unless it is taken in a single, or limited, years. The Alliance also commented that the increased cap would better recognize the current state of EV technology and markets. Auto Innovators believes additional EV production can be incentivized by a higher credit cap while still balancing with the policy goal of maximizing near-term GHG benefits. Several individual manufacturers including Honda, Hyundai, JLR, Mercedes, Nissan, Stellantis, and Toyota also commented in support of a cap in line with or closer to the California Framework levels.

Ford commented that a larger multiplier should be provided for trucks compared to cars to alleviate proportionally lower benefits provided to OEMs with a higher truck mix. Lucid commented that EV-only manufacturers should not be subject to a cap because they are not off-setting higher emitting ICE vehicles in their own fleets. Lucid commented that the cap was intended to target manufacturers that produce vehicles with internal combustion engines to prevent them from counterbalancing high-emitting vehicles with ZEV sales.

CARB and New York State Department of Environmental Quality (DEQ) supported the proposed cap, but with lower multipliers such that more EVs are needed to reach the cap, thus providing an incentive for greater EV sales. UCS commented it supports EPA's cap and smaller window of time for those multipliers if multipliers are to remain in the final rule. It commented further that ''should EPA continue to move forward with a new phase of EV multipliers, we are strongly supportive of the agency's proposed approach with the cap. The current cap is appropriately low—with a typical fleet compliance of 200–250 g/mile in this timeframe, even using all of the cap in a single year would affect no more than a few percent of a manufacturer's fleet in that year. Because the total impact is relatively low, allowing manufacturers to distribute the total cap utilization according to their own optimal usage does not pose a drastic risk—however, generally such flexibility is maximized by manufacturers at a cost to the goals of the program, and any increase in the total g/mile value of the cap or additional years in which the multipliers are made available significantly enhances such risk.''

MEMA supported including a cap, as noted above, commenting that ''without a cap and sunset, the advanced technology multiplier credits could drive technologies down too narrow of a regulatory path, too quickly. MEMA commented further that the cap should not be increased beyond the level proposed. MECA submitted similar comments.

The Southern Environmental Law Center commented that EPA should cap the amount of credits generated by PHEVs that may be used to satisfy the overall multiplier incentive credit cap—similar to the cap established by California in the ZEV program for transitional zero emissions vehicles.

On the topic of allowing multiplier credits to be generated in MY 2026 and the credit cap, SCAQMD commented that it generally supported sunsetting the multipliers in MY 2025 but if the rule design could recognize narrower eligibility for generating credits in 2026, *e.g.,* extending the incentive only to those manufacturers that have used less than some fraction of the cap, it could promote this beneficial result without further ossifying multipliers. SCAQMD commented ''[m]oreover, if MY 2026 had its own year-specific, lesser cap, such that a manufacturer would not rely too heavily on any new-gained multiplier incentive, that may partly address EPA's stated concern that any MY 2026 credits could 'potentially complicate transitioning to MY 2027 standards for some manufacturers.' ''

After considering comments, EPA is finalizing the proposed credit cap of 10.0 g/mile on a cumulative basis. The nominal credit cap on a per year basis is five g/mile because the cap is spread over two MYs, 2023–2024, rather than the four MYs of 2022–2025 proposed.

Commenters were generally supportive of including a multiplier cap and while comments differed on the appropriate magnitude of the cap, EPA believes its approach for the final cap addresses many of the concerns expressed by commenters. Even though EPA reduced the number of years over which multiplier incentives would be available from four to two years, EPA is retaining the proposed cumulative cap of 10 g/mile. This is equivalent to a nominal per year cap of 5.0 g/mile compared to the 2.5 g/mile per year nominal cap proposed. This preserves the magnitude of the additional flexibility proposed overall but focuses it more narrowly on MYs 2023–2024. Based on current use of multipliers and manufacturers' announced plans for the introduction of more advanced technology vehicles in this time frame, EPA believes this provision will provide additional flexibility in meeting the near-term standards and help them manage the transition to more stringent standards.[73]

EPA considered whether reducing the magnitude of the cap by half would be appropriate, retaining the proposed nominal cap of 2.5 g/mile per year. EPA decided that rather than reduce the magnitude of the cap, it would be more appropriate to retain the 10 g/mile cap so that the available total incentive credits, and the flexibility they represent in the earliest years of the program, is retained. The approach EPA is finalizing is also consistent with the Alliance comments that, as proposed, the multipliers would provide little incentive and did not recognize the current state of technology or the market. We believe, as noted above, that concentrating the multipliers over two years with the same cumulative cap, rather than the proposed four years, provides additional incentive for increasing sales of advanced technology vehicles. EPA recognizes, also, that while the effect on emissions reductions would remain the same as under the proposed rule if manufacturers are able to maximize the use of the multipliers in MYs 2023–24, given that the cap remains at 10 g/mi, we expect it to be less likely for manufacturers to reach that level given the more limited timeline and reduced multiplier levels compared to the proposal. EPA believes the final approach better provides the intended incentive to manufacturers to more quickly ramp up sales of these vehicles, which are key in transitioning the light-duty fleet toward zero-emissions vehicles.

In response to comments that EPA should adopt a more generous multiplier cap, in line with that included in the California Framework, EPA did not take this approach because EPA believed the California Framework cumulative cap to be too generous for the EPA program. Conversely, other commenters believe that no multiplier should be allowed because, even under the proposed cap, multipliers may act to lessen the real world emission reductions from the standards. EPA notes that the California Framework Agreements take effect in MY 2021 compared to EPA's final standards that

[73] ''The 2021 EPA Automotive Trends Report, Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975,'' EPA–420–R–21–023, November 2021. Manufacturers generated overall fleet average multiplier credits equivalent to just under 3 g/mile (See Figure 5.5).

begin in MY 2023 and thus there is a significant difference in the program time frames. Although EPA is adopting a nominal per year cap that is more similar to that of the California Framework, EPA is not increasing the cumulative cap from the proposed 10 g/mile cap. The multipliers in EPA's final program are only available for MYs 2023–2024 compared to the longer duration of multipliers in the California Framework, which provides additional multipliers in MYs 2020–2026. EPA is providing more limited flexibilities in its final program in order to preserve the most emissions reductions feasible while still providing near-term flexibility in consideration of lead time.

iii. Natural Gas Vehicle Multipliers

As noted above, the SAFE rule did not extend multipliers for advanced technology vehicles but did extend and increase multiplier incentives for dual-fuel and dedicated natural gas vehicles (NGVs). The current regulations include a multiplier of 2.0, uncapped, for MYs 2022–2026 NGVs. In the SAFE rule, EPA said it was extending the multipliers for NGVs because ''NGVs could be an important part of the overall light-duty vehicle fleet mix, and such offerings would enhance the diversity of potentially cleaner alternative fueled vehicles available to consumers.'' [74] After further considering the issue, as proposed, EPA is removing the extended multiplier incentives added by the SAFE rule from the GHG program after MY 2022. EPA is ending multipliers for NGVs in this manner because NGVs are not a near-zero emissions technology and EPA no longer believes it is appropriate to incentivize these vehicles to encourage manufacturers to introduce them in the light-duty vehicle market. EPA does not view NGVs as a pathway for significant vehicle GHG emissions reductions in the future. Any NGV multiplier credits generated in MY 2022 would be included under the proposed multiplier cap. There are no NGVs currently offered by manufacturers in the light-duty market and EPA is unaware of any plans to introduce NGVs, so EPA does not expect the removal of multipliers for NGVs to have an impact on manufacturers' ability to meet standards.[75]

EPA requested comment on its proposed treatment of multipliers for NGVs including whether they should be eliminated altogether for MYs 2023–2026 as proposed or retained partially or at a lower level for MYs 2023–2025. Comments on this topic are summarized and discussed in the RTC document for the rule.

2. Full-Size Pickup Truck Incentives

EPA is finalizing temporary full-size pickup incentives for a more limited time frame than proposed, just for MYs 2023–2024 rather than the proposed MYs 2022–2025. This section provides an overview of the incentives, comments received, and the provisions EPA is finalizing in the final rule.

i. Background on Full Size Pickup Incentives in Past Programs

In the 2012 rule, EPA included a per-vehicle credit provision for manufacturers that hybridize a significant number of their full-size pickup trucks or use other technologies that comparably reduce CO_2 emissions. EPA's goal was to incentivize the penetration into the marketplace of low-emissions technologies for these pickups. The incentives were intended to provide an opportunity in the program's early years to begin penetration of advanced technologies into this category of vehicles, which face unique challenges in the costs of applying advanced technologies due to the need to maintain vehicle utility and meet consumer expectations. In turn, the introduction of low-emissions technologies in this market segment creates more opportunities for achieving the more stringent later year standards. Under the existing program, full-size pickup trucks using mild hybrid technology are eligible for a per-truck 10 g/mile CO_2 credit during MYs 2017–2021.[76] Full-size pickup trucks using strong hybrid technology are eligible for a per-truck 20 g/mile CO_2 credit during MYs 2017–2021, if certain minimum production thresholds are met.[77] EPA established definitions in the 2012 rule for full-size pickup and mild and strong hybrid for the program.[78]

Alternatively, manufacturers may generate performance-based credits for full-size pickups. This performance-based credit is 10 g/mile CO_2 or 20 g/mile CO_2 for full-size pickups achieving 15 percent or 20 percent, respectively, better CO_2 performance than their footprint-based targets in a given MY through MY 2021.[79] This second option incentivizes other, non-hybrid, advanced technologies that can reduce pickup truck GHG emissions and fuel consumption at rates comparable to strong and mild hybrid technology. These performance-based credits have no specific technology or design requirements; automakers can use any technology or set of technologies as long as the vehicle's CO_2 performance is at least 15 or 20 percent below the vehicle's footprint-based target. However, a vehicle cannot receive both hybrid and performance-based credits since that would be double-counting.

Access to any of these large pickup credits requires that the technology be used on a minimum percentage of a manufacturer's full-size pickups. These minimum percentages, established in the 2012 final rule, are set to encourage significant penetration of these technologies, leading to long-term market acceptance. Meeting the penetration threshold in one MY does not ensure credits in subsequent years; if the production level in a MY drops below the required threshold, the credit is not earned for that MY. The required penetration levels are shown in Table 15 below.[80]

[74] 85 FR 25211.

[75] The last vehicle to be offered, a CNG Honda Civic, was discontinued after MY 2015. It had approximately 20 percent lower CO_2 than the gasoline Civic. For more recent advanced internal combustion engines, the difference may be less than 20 percent due to lower emissions of the gasoline-fueled vehicles.

[76] As with multiplier credits, full-size pickup credits are in Megagrams (Mg). Full-size pickup credits are derived by multiplying the number of full-size pickups produced with the eligible technology by the incentive credit (either 10 or 20 g/mile) and a vehicle miles traveled (VMT) value for trucks of 225,865, as specified in the regulations. The resulting value is divided by 1,000,000 to convert it from grams to Mg. EPA is not adopting a cap for these credits and they are only available for full-size pickups, rather than the entire fleet, so the calculation is simpler than that for multiplier credits.

[77] 77 FR 62825, October 15, 2012.

[78] 77 FR 62825, October 15, 2012. Mild and strong hybrid definitions as based on energy flow to the high-voltage battery during testing. Both types of vehicles must have start/stop and regenerative braking capability. Mild hybrid is a vehicle where the recovered energy over the Federal Test Procedure is at least 15 percent but less than 65 percent of the total braking energy. Strong hybrid means a hybrid vehicle where the recovered energy over the Federal Test Procedure is at least 65 percent of the total braking energy.

[79] 77 FR 62826, October 15, 2012. For additional discussion of the performance requirements, see Section 5.3.4 of the ''Joint Technical Support Document: Final Rulemaking for 2017–2025 Light-duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards'' for the Final Rule,'' EPA–420–R–12–901, August 2012.

[80] 40 CFR 86.1870–12.

TABLE 15—PENETRATION RATE REQUIREMENTS BY MODEL YEAR FOR FULL-SIZE PICKUP CREDITS

[% of production]

	2017	2018	2019	2020	2021
Strong hybrid	10	10	10	10	10
Mild Hybrid	20	30	55	70	80
20% better performance	10	10	10	10	10
15% better performance	15	20	28	35	40

Under the 2012 rule, the strong hybrid/20 percent better performance incentives initially extended out through MY 2025, the same as the 10 percent production threshold. However, the SAFE rule removed these incentives after MY 2021, given the reduced stringency of the SAFE standards. The mild hybrid/15 percent better performance incentive was not affected by the SAFE rule, as those provisions end after MY 2021.[81]

ii. Proposed and Final Full Size Pickup Truck Incentives

EPA proposed to reinstate the full-size pickup credits as they existed before the SAFE rule, for MYs 2022 through 2025. As discussed in the proposal, while no manufacturer has yet claimed these credits, the rationale for establishing them in the 2012 rule remains valid. In the context of the proposed rule that included more stringent standards for MY 2023–2026, EPA believed these full-size pickup truck credits were appropriate to further incentivize advanced technologies penetrating this particularly challenging segment of the market. As with the original program, EPA proposed to limit this incentive to full-size pickups rather than broadening it to other vehicle types. Introducing advanced technologies with very low CO_2 emissions in the full-size pickup market segment remains a challenge due to the need to preserve the towing and hauling capabilities of the vehicles. The full-size pickup credits incentivize advanced technologies into the full-size pickup truck segment to help address cost, utility, and consumer acceptance challenges.

EPA requested comments on whether or not to reinstate the previously existing full-size pickup strong hybrid/20 percent better performance incentives and on the proposed approach for doing so. EPA also requested comment on the potential impacts of the full-size pickup incentive credit, and whether, and how, EPA should take the projected effects into account in the final rulemaking.

EPA received a range of comments both supporting and opposing the proposed full-size pickup incentives. The Alliance supported the proposed full-size pickup hybrid and over-performance incentive credits and suggested that they should be extended through MY 2026. The Alliance commented that although many full-size pickup trucks are quite efficient for their size, weight, and utility, they remain among the highest emitting non-niche vehicles in the fleet. Incentivizing strong hybridization or other technology solutions that yield GHG emission rates 20 percent or better than their regulatory targets, the Alliance believes, can help encourage manufacturer production and marketing to foster greater long-term consumer market adoption in the transition to EVs.

Ford commented that it believes that the full-size pickup incentives are essential in enabling continued adoption of advanced technology in the full-size pickup segment and supports EPA's proposed reinstatement. Ford commented further that one concern with this credit mechanism is the requirement that 10 percent volume penetration of the relevant technologies must be reached within a given model before any credit is granted. Ford commented ''this 'all-or-nothing' approach poses risks and uncertainty to OEM compliance planning since it is difficult to predict future volumes with precision, particularly for new or advanced technologies such as hybridization. Ford believes that the threshold is also unnecessary since an OEM is already motivated to maximize volumes to the greatest extent possible—within market and material constraints—in order to recoup the sizeable investments needed to implement such technologies. For these reasons, Ford believes it is appropriate to lower or remove the volume threshold requirement. In the alternative, Ford asks that EPA clarify that an OEM may include multiple technologies toward the 10 percent threshold, for example, by combining BEV and HEV volumes to satisfy a given model's 10 percent threshold requirement for the performance-based credit pathway.'' The Alliance also supported this approach.

CARB supported restoring the full-size pickup credits in conjunction with revised standards but disagreed that the credits should be restored for MY 2022, commenting that vehicles produced for MY 2022 will remain subject to the substantially less stringent SAFE standards and no action should be taken to effectively further weaken the 2021 or 2022 standards.

Environmental and health NGOs opposed the pickup incentives. Center for Biological Diversity, Earthjustice, and Sierra Club (hereinafter ''CBD et al.'') jointly commented that the incentives were unnecessary, noting automakers are making new electric trucks, and consumers are buying them. CBD et al. elaborated ''For example, as of early June 2021, Ford had reached 100,000 reservations for its 2022 Ford F–150 electrified full-size truck. Rivian's electric R1T will be released this year, and General Motors is planning an electric version of its popular Chevrolet Silverado for 2023.'' CBD et al. commented that, as these developments are happening on their own, there is no evidence that EPA's incentives would further spur production.

ACEEE commented, ''this is another instance of awarding credits in excess of actual emission reductions, which reduces the stringency of the standards. This specific incentive is also problematic because it could encourage production of full-sized pickup trucks at the expense of smaller vehicles. It also provides a loophole to the 2.5 g/mile EV multiplier credit limit, by creating an alternative pathway for EV pickup trucks to earn unwarranted credits after the fleetwide EV multiplier limit has been reached. ACEEE estimates that this provision alone could reduce stringency by up to 2 g/mile by MY 2025 and reduce emissions savings by up to 1 percent for the entire period of the proposed rule.'' UCS provided similar comments, stating that ''even in the absence of the full-size pick-up strong hybrid/performance credit, manufacturers have moved forward with plans for full-size pick-ups that meet the criteria. The simple reason is that these vehicles are sold by only a

[81] See 85 FR 25229.

small number of manufacturers, and as such represent a critical piece of the portfolio of those manufacturers—a company like Ford cannot afford for its best-selling vehicle to be a deficit-generator under the standards. Since these vehicles are already planned, the agency's reinstatement of the credit cannot be considered an incentive—instead, it is a windfall credit.''

SAFE also opposed the pickup incentives, commenting that hybridization of pick-up trucks is no longer an innovative technology, as it has been replaced by full electric pickup trucks, with towing and hauling capacity similar to conventional pickups, that are entering the market shortly. SAFE further commented that EPA acknowledged that the proposed pickup incentives would allow additional GHG emissions and did not to adequately support its proposed rule. SAFE commented that ''given the current state of pickup truck technology, EPA should focus on incentivizing transformative electric pickup trucks and decline to extend incentives to hybrids.''

Tesla commented that EPA should not renew the full-size pick-ups incentives, commenting that EPA's analysis underestimates the deployment of newly manufactured full EV pick-up trucks. Tesla notes, for example, EPA projects no delivery of the Tesla Cybertruck as is scheduled in MY 2022, ignores any deployment of pickups by Rivian, and appears to underestimate Toyota's deployment despite pronouncement of seven models by MY 2025. Tesla commented that their modeling anticipates that starting in MY 2023 this annual credit would further erode the proposed standard's stringency starting at 0.3 g/mile and grow in usage in MYs 2024 and 2025. Tesla also asserted this incentive is not needed to incentivize deployment of actual EV pickups and should be removed to increase the revised standards' stringency.

Consumer Reports recommended that EPA simplify the credit by eliminating the strong hybrid credit, and only provide the credit to vehicles that meet the 20 percent improvement above the standard threshold, regardless of technology used. Consumer Reports commented that this would avoid potentially giving credits to strong hybrids designed to deliver increased performance, but minimal efficiency improvements. UCS provided similar comments regarding strong hybrid pickups, commenting that strong hybrid pickups are not being designed for efficiency, and given that, it makes sense to eliminate the strong hybrid credit entirely. UCS further commented that if EPA wishes to implement a full-size pick-up credit, it should only be for the 20 percent performance credit to ensure that at least the credit windfall will be limited to efficient vehicles, not just a high-performance trim level.

After considering the wide range of comments, EPA is finalizing a more limited time period for full-size pickup incentives—only for MYs 2023–2024. EPA is not finalizing the proposed incentives for MYs 2022 or 2025. These incentives will sunset at the end of MY 2024. EPA believes this approach balances the need for flexibility in these near-term model years given lead time considerations, with the overall emissions reduction goals of the program. EPA believes that this more targeted approach to full-size pickup truck credits is appropriate to further incentivize advanced technologies in this segment, which continues to be particularly challenging given the need to preserve the towing and hauling capabilities while addressing cost and consumer acceptance challenges. EPA is also retaining the production thresholds to ensure that manufacturers taking advantage of the flexibility must sell a significant number of qualifying vehicles to do so. While this flexibility is more narrowly focused, since not all manufacturers produce full-size pickups, it represents another avenue for credits that may help manufacturers meet the near-term standards, in addition to the other flexibilities included in the program.

Regarding comments from Consumer Reports and UCS that EPA should not include an incentive for strong hybrid technology, EPA understands the concerns raised by the commenters and believes the comments have some merit. However, EPA has decided to constrain the overall program instead in terms of timeframe by only finalizing the incentive for two model years, which directionally responds to the commenters more general concerns about the potential impact of the proposal. The approach EPA is finalizing is more in line with EPA's proposal and request for comments regarding the scope full-size pickup incentives, since EPA did not seek comments or otherwise consider not including the strong hybrid portion of the full-size pickup incentive.

EPA also is finalizing the proposed provision to prevent double counting of the full-size pickup credits and the advanced technology multipliers. In the 2012 rule, EPA included a provision that prevents a manufacturer from using both the full-size pickup performance-based credit pathway and the multiplier credits for the same vehicles. This would prevent, for example, an EV full-size pickup from generating both credits. EPA proposed the same restriction for vehicles qualifying for the full-size pickup hybrid credit pathway. With the extended multiplier credits and the full-size pickup credit, EPA believes allowing both credits would be double-counting and inappropriate. EPA did not receive adverse comments on this provision. Therefore, EPA is modifying the regulations as proposed such that manufacturers may choose between the two credits in instances where full-size pickups qualify for both but may not use both credits for the same vehicles. A manufacturer may choose to use the full-size pickup strong hybrid credit, for example, if the manufacturer either has reached the multiplier credit cap or intends to do so with other qualifying vehicles.

3. Off-Cycle Technology Credits

EPA is finalizing a temporary increase in the off-cycle menu credit cap from 10 to 15 g/mile, but over a more limited time frame than proposed, from MY 2023 through 2026. Coinciding with the increased menu cap, EPA is also adopting revised definitions for certain off-cycle menu technologies as proposed, with minor edits in response to comments, starting in MY 2023. EPA proposed to allow manufacturers the option to take advantage of the higher cap, using the updated definitions, in MYs 2020–2022. After considering comments, EPA is not finalizing the provisions applicable to MYs 2020–2022, due to concerns that they would provide unnecessary additional flexibility for the MY 2020–2022 standards established in the SAFE rule. The off-cycle credits program and the revisions EPA is finalizing are discussed in the section below.

i. Background on Off-Cycle Credits in Prior Programs

Starting with MY 2008, EPA started employing a ''five-cycle'' test methodology to measure fuel economy for purposes of new car window stickers (labels) to give consumers better information on the fuel economy they could more reasonably expect under real-world driving conditions.[82] However, for GHG compliance, EPA continues to use the established ''two-cycle'' (city and highway test cycles, also known as the FTP and HFET) test

[82] *https://www.epa.gov/vehicle-and-fuel-emissions-testing/dynamometer-drive-schedules.* See also 75 FR 25439 for a discussion of 5-cycle testing.

methodology.[83] As learned through development of the ''five-cycle'' methodology and prior rulemakings, there are technologies that provide real-world GHG emissions improvements, but whose improvements are not fully reflected on the ''two-cycle'' test. EPA established the off-cycle credit program to provide an appropriate level of CO_2 credit for technologies that achieve CO_2 reductions, but may not otherwise be chosen as a GHG control strategy, as their GHG benefits are not measured on the specified 2-cycle test. For example: High efficiency lighting is not measured on EPA's 2-cycle tests because lighting is not turned on as part of the test procedure but reduces CO_2 emissions by decreasing the electrical load on the alternator and engine. The key difference between the credits discussed below and the incentives discussed in the previous two sections is that off-cycle credits—as well as A/C credits, discussed in the next section—represent real-world emissions reductions if appropriately sized and therefore their use should not result in deterioration of program benefits, and should not be viewed as cutting into the effective stringency of the program.

Under EPA's existing regulations, there are three pathways by which a manufacturer may accrue off-cycle technology credits.[84] The first pathway is a predetermined list or ''menu'' of credit values for specific off-cycle technologies that was effective starting in MY 2014.[85] This pathway allows manufacturers to use credit values established by EPA for a wide range of off-cycle technologies, with minimal or no data submittal or testing requirements. The menu includes a fleetwide cap on credits of 10 g/mile to address the uncertainty of a one-size-fits-all credit level for all vehicles and the limitations of the data and analysis used as the basis of the menu credits. A second pathway allows manufacturers to use 5-cycle testing to demonstrate and justify off-cycle CO_2 credits.[86] The additional emissions tests allow emission benefits to be demonstrated over some elements of real-world driving not captured by the GHG compliance tests, including high speeds, rapid accelerations, and cold temperatures. Under this pathway, manufacturers submit test data to EPA, and EPA determines whether there is sufficient technical basis to approve the off-cycle credits. The third pathway allows manufacturers to seek EPA approval, through a notice and comment process, to use an alternative methodology other than the menu or 5-cycle methodology for determining the off-cycle technology CO_2 credits.[87] This option is only available if the benefit of the technology cannot be adequately demonstrated using the 5-cycle methodology.

Prior to this rulemaking, EPA received comments from manufacturers on multiple occasions requesting that EPA increase the menu credit cap. Previously, EPA has opted not to increase the cap for several reasons.[88] First, the cap is necessary given the uncertainty in the menu values for any given vehicle. Menu credits are values EPA established to be used across the fleet rather than vehicle-specific values. When EPA established the menu credits in the 2012 rule, EPA included a cap because of the uncertainty inherent in using limited data and modeling as the basis of a single credit value for either cars or trucks. While off-cycle technologies should directionally provide an off-cycle emissions reduction, quantifying the reductions and setting appropriate credit values based on limited data was difficult. Manufacturers wanting to generate credits beyond the cap may do so by bringing in their own test data as the basis for the credits. Credits established under the second and third pathways do not count against the menu cap. Also, until recently most manufacturers still had significant headroom under the cap allowing them to continue to introduce additional menu technologies.[89] Finally, during the implementation of the program, EPA has expended significantly more effort than anticipated on scrutinizing menu credits to determine if a manufacturer's technology approach was eligible under the technology definitions contained in the regulations. This further added to concerns about whether the technology could reasonably be expected to provide the real-world benefits that credits are meant to represent. For these reasons, EPA has been reluctant to consider increasing the cap.

EPA may make changes to the test procedures for the GHG program in the future that could change the need for an off-cycle credits program, but there were no such test procedure changes proposed in this rule. EPA recognizes that off-cycle credits, therefore, will likely remain an important source of emissions reductions under the program, at least through MY 2026. Off-cycle technologies are often more cost effective than other available technologies that reduce vehicle GHG emissions over the 2-cycle tests and manufacturer use of the program continues to grow. Off-cycle credits reduce program costs and provide additional flexibility in terms of technology choices to manufacturers which has resulted in many manufacturers using the program. Multiple manufacturers were at or approaching the 10 g/mile credit cap in MY 2019.[90] Also, in the SAFE rule, EPA added menu credits for high efficiency alternators but did not increase the credit cap for the reasons noted above.[91] While adding the technology to the menu has the potential to reduce the burden associated with the credits for both manufacturers and EPA, it further exacerbates the credit cap issue for some manufacturers.

ii. Proposed and Final Off-Cycle Credit Menu Cap Increase

EPA is finalizing its proposed provision to increase the off-cycle menu cap, but over a more limited time period (MY 2023 through 2026) than proposed. EPA proposed increasing the cap on menu-based credits from the current 10 g/mile to 15 g/mile beginning as early as MY 2020. As a companion to increasing the credit cap, EPA also proposed modifications to some of the off-cycle technology definitions to improve program implementation and to better accomplish the goal of the off-cycle credits program: To ensure emissions reductions occur in the real-world from the use of the off-cycle technologies. EPA proposed that manufacturers could optionally access the 15 g/mile menu cap in MYs 2020–2022 if the manufacturers met all of the revised definitions. EPA is finalizing the increased credit cap of 15 g/mile along with the proposed definition changes

[83] The city and highway test cycles, commonly referred to together as the ''2-cycle tests'' are laboratory compliance tests are effectively required by law for CAFE, and also used for determining compliance with the GHG standards. 49 U.S.C. 32904(c).

[84] See ''The 2020 EPA Automotive Trends Report, Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975,'' EPA–420–R–21–003 January 2021 for information regarding the use of each pathway by manufacturers.

[85] See 40 CFR 86.1869–12(b).

[86] See 40 CFR 86.1869–12(c).

[87] See 40 CFR 86.1869–12(d).

[88] 85 FR 25237.

[89] See ''The 2020 EPA Automotive Trends Report, Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975,'' EPA–420–R–21–003 January 2021 for information on the use of menu credits.

[90] In MY 2019, Ford, FCA, and Jaguar Land Rover reached the 10 g/mile cap and three other manufacturers were within 3 g/mile of the cap. See ''The 2020 EPA Automotive Trends Report, Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975,'' EPA–420–R–21–003 January 2021.

[91] 85 FR 25236.

starting in MY 2023. For reasons discussed below, EPA is not finalizing the proposed MY 2020–2022 opt-in provisions.

EPA believes this is a reasonable approach to provide more opportunity for menu-based credits in the off-cycle program, while still keeping a limit in place. For MY 2020, manufacturers claimed an average of 7.8 g/mile of menu credits with three manufacturers claiming the maximum 10 g/mile of credits.[92] Increasing the cap provides an additional optional flexibility and also an opportunity for manufacturers to earn more menu credits by applying additional menu technologies, recognizing that some manufacturers may need to make changes to some of their current designs if they choose to continue to earn menu credits under the revised definitions.

In the proposal, EPA requested comment on whether the menu credit cap should be increased to 15 g/mile, EPA's proposed approach for implementing the increased credit cap, including the start date of MY 2020, as well as the proposed application of revised technology definitions. EPA specifically requested comment on whether an increased credit cap, if finalized, should begin in MY 2020 as proposed or a later MY such as MY 2021, 2022, or 2023. EPA encouraged commenters supporting off-cycle provisions that differ from EPA's proposed rule to address how such differences could be implemented to improve real-world emissions benefits and how such provisions could be effectively implemented.

EPA received both supportive and adverse comments regarding the proposed off-cycle menu cap increase. The Alliance supported raising the credit cap for the off-cycle technology menu, effective in MY 2020, commenting that the 10 g/mile cap was originally promulgated in the 2012 Rule and has become constraining to technology additions, particularly with the addition of new menu technologies added in the SAFE rule. The Alliance did not support tying the increased menu cap to the revised definitions, commenting that the issues should be considered separately. The Alliance commented that ''the cap should be raised regardless of the decision whether to modify technology definitions or not and, if modified technology definitions are adopted, regardless of when a manufacturer applies the modified definitions.''

The Alliance recommended that EPA not adopt the revised definitions in this rulemaking but wait until the subsequent rule for MYs 2027 and later. The Alliance commented that ''model year 2023 vehicles can be built as soon as January 2022, leaving manufacturers only three to at most nine months to design, validate, and certify vehicles with systems that meet the new definitions. This lead-time is simply insufficient to make the necessary level of changes. In MY 2019, the fleetwide average use of active engine warmup, active transmission warmup, and passive cabin ventilation technologies resulted in a credit of approximately 3.6 g/mile. Modifying definitions without sufficient lead-time would likely result in an immediate loss of most, if not all of this credit, further escalating the challenge of managing the large increase in standard stringency proposed for MY 2023. The new definitions will require innovative solutions and significant changes to vehicle design to meet them.'' The Alliance commented further, ''if EPA adopts new definitions for passive cabin ventilation, active engine warm-up, and/or active transmission warm-up technologies, EPA should also continue to recognize existing designs. EPA justifies its proposed provision to modify technology definitions on the basis that current system designs are not meeting EPA's original expectations. However, current system designs are providing off-cycle emissions benefits. Given the benefits of such systems, EPA should continue to provide credit for systems that meet existing definitions through the menu, in addition to newly defined systems.''

Several individual manufacturers also raised lead time concerns regarding the implementation of revised definitions. Stellantis commented that if EPA wants to implement new technology definitions, EPA should do so starting in MY 2027, allowing manufacturers to plan and implement fleetwide changes. Stellantis argued that previous systems were approved by EPA and that the benefits they provide are threatened by the revised definitions. Toyota requested that the revised definitions be effective starting with the 2025 model year at the earliest to provide adequate lead time for appropriate countermeasures and compliance plan adjustments. Hyundai requested that the revised definitions not be implemented until 2027 MY for similar reasons, adding that ''use of the higher 15 g/mile cap should be permitted without prejudice in order to encourage the inclusion of more fuel saving technologies.'' Ford commented that the ''Notice and Comment process is the appropriate mechanism for making major policy or technology definition clarifications to the off-cycle program. However, such clarifications should not be retroactively applied, or be required in order to qualify for the 15 g/mile cap for previous model years. It should also be noted that Ford has relied on these credits to comply with current and past regulatory structures, such as 'One National Program' and the California Framework Agreement.''

JLR commented that it understands EPA's proposed provision to change the technology definitions but requested that the menu be expanded to include technologies that do not meet the new definition, but do meet the old definition, with appropriate credit values assigned. JLR also commented that there should be an option for manufacturers to remain at the 10 g/mile cap with the original technology definitions up to and including MY 2025. JLR commented that this is required as, for technologies that involve significant changes to the vehicle to meet the new definition such as active transmission warm up, there must be a longer lead time for manufacturers to adapt to this change in the regulation.

MEMA commented that it strongly supports EPA expanding the off-cycle technology credit program by increasing the credit cap on credits received through the off-cycle menu from 10 g/mile to 15 g/mile. Similarly, MECA commented that it supports EPA's continuation and improvement of the off-cycle credit program with the higher credit cap. BorgWarner commented that the credit cap ''should be removed to allow and promote the true potential of these technologies to achieve the new standards. We do not see the value of a cap that excludes technologies that are shown to provide additional real-world fuel economy benefits. Credit programs should be continued and expanded to provide important flexibilities and broader pathways for greater innovation and lower compliance costs.''

Environmental Defense Fund (EDF) commented that the proposed off-cycle program changes would help manufacturers meet the MY 2023–2024 standards and, in modeling performed to support their comments that the standards are feasible, included a portion of the proposed increased off-cycle credits. EDF commented that ''it is also eminently reasonable to assume automakers could (and would) apply relatively inexpensive, widely deployed off-cycle technologies that can be added

[92] ''The 2021 EPA Automotive Trends Report, Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975,'' EPA–420–R–21–023, November 2021.

at the tail end of the product-development process.''

ACEEE supported EPA's proposed provision to revise the definitions, commenting that EPA should continue to scrutinize menu credits to ensure that definitions only allow for technologies that have been researched and tested and not others that may be superficially similar. ACEEE, however, opposed beginning the 15 g/mile credit cap increase in MY 2020, commenting that those vehicles have already been designed and no new menu technologies will be added to the vehicles. Therefore, the change would not lead to any additional emissions reductions but instead, would effectively reduce the stringency of the proposed rule by giving automakers credits for decisions that they have already made and implemented. ACEEE estimated that if automakers were to take advantage of the entire 5 g/mile retroactive cap increase, emission savings from the proposed standards would be reduced by 19 percent.

ACEEE also commented that the credit cap increase is concerning as applied to future model years, as it believes the off-cycle credit system already over awards credits and further weakens the rule stringency. ACEEE commented that research has shown that some technologies are awarded up to 100 percent more credits than appropriate, equaling up to 3 g/mile of credits per technology (Gonder et al. 2016; Kreutzer et al., 2017). Another concern raised by ACEEE is that technologies that qualify for menu credits have not been evaluated for redundancies or overlaps in benefits (Lutsey and Isenstadt 2018). ACEEE commented that a vehicle that has more than one of the technologies addressing the same inefficiencies may not achieve the sum of the benefits of the individual technologies due to synergistic effects.

UCS also did not support raising the menu credit cap, commenting that there is a lack of evidence demonstrating real-world reductions associated with some off-cycle technologies and in some cases, there is evidence that some credit levels are too high, supporting a reduction rather than expansion of the program. UCS also commented in support of implementing the revised definitions and suggest the definitions be implemented immediately to avoid further unwarranted credits for these inferior technologies. UCS also agrees with EPA that any manufacturers seeking credit for technologies that do not meet the revised definitions must do so through the off-cycle credit public comment process pathway.

CBD et al. commented that EPA should end, reduce, or significantly reform the off-cycle credits program. CBD et al. commented that uncertainties arise due to ''the lack of data submission; the lack of testing; and the practice of 'one-size-fits-all installation' by which automakers who install the same technology not just on the specific vehicle type and model they tested, but also on many or all of the other cars and trucks in their fleets, without submitting any test data on the level of emissions reductions, if any, they generate on these different and diverse vehicles. CBD et al. commented that if EPA proceeds with its current proposed rule, off-cycle credits should, at a minimum, be limited and reformed so real-world results are assured and verified, as stated in the Joint Comments. If the agency adopts Alternative 2 plus, off-cycle credits should still not be expanded, and their cap maintained.''

Tesla also commented that EPA should end the off-cycle credits program. Tesla argued that ''extending and expanding these credit rewards old technology and, to the extent new technologies are deployed to generate off-cycle credits, focuses critical R&D budgets on tweaking legacy ICE platforms rather than directing these budgets to electrification and greater emissions reductions. As such, EPA's proposed rule, rather than confronting this built-in bias toward ICE legacy technology, enhances the pre-existing bias by increasing the off-cycle cap to 15 g/mile. Again, such perverse incentives should not be extended, much less increased.''

After carefully considering the comments, EPA is finalizing the 15 g/mile cap and revised definitions, beginning in MYs 2023 through 2026. Given the level of concern expressed regarding optionally allowing the cap to increase retroactively starting in MY 2020 and comments from manufacturers that it would not be particularly useful to the extent they may need to make technology changes in order to meet the new definitions, EPA is not finalizing the optional provisions for MYs 2020–2022. EPA views the definition updates as important refinements to the ongoing off-cycle program to improve its implementation and help ensure that the program produces real-world benefits as intended and continues believes that it is reasonable and appropriate to make these updates in parallel with the cap increase for MYS 2023–2026.

EPA acknowledges that off-cycle credits are meant to represent real-world reductions and theoretically there would not be a loss of emissions reductions associated with allowing manufacturers to use the revised definitions and increased cap in MY 2021–2022 as proposed. However, many commenters were concerned with EPA making any changes in MYs 2021–2022 that could make it easier for manufacturers to meet the revised less stringent standards established in the SAFE rule for those years. EPA understands this concern, and also is concerned that additional off-cycle credits in those years may represent a windfall for manufacturers since there is no lead time for manufacturer to change their product line in MYs 2021–2022 and therefore manufacturers would likely only generate additional credits to the extent they had already deployed qualifying technologies. For these reasons, also, EPA is finalizing the start of both the revised definitions and increased cap prospectively only, rather than retroactively in MYs 2021–2022. The new definitions will go into effect in MY 2023 and EPA believes it's appropriate that the cap be increased only once the revised definitions go into effect to ensure the real-world reductions for these technologies.

EPA disagrees with comments that EPA should continue to allow the use of the unrevised definitions and menu credits for several model years into the future. When EPA established the menu, EPA intended it to be a streamlined process not requiring manufacturers to produce data on which to base credits. There are not data requirements associated with menu credits. Also, EPA notes that claiming menu credits from the off-cycle menu does not require EPA pre-approval. EPA made clear its intended approach in the 2012 rule preamble establishing the menu where EPA stated that ''both technologies and credit values based on the list are established by rule. That is, there is no approval process associated with obtaining the credit.'' [93] As discussed in the proposed rule, the original regulatory definitions for a few technologies have allowed manufacturers to use technological approaches that were not consistent with those envisioned in the 2012 rule that established them. These approaches are unlikely to produce emissions reductions matching the menu credits. For example, when establishing the passive cabin ventilation credit, EPA envisioned air flow consistent with windows and/or sunroof being open for a period of time to allow hot air to escape the cabin through convective air flow. Under the original definitions, manufacturers are generating a sizeable

[93] 77 FR 62833.

credit for simply opening the interior vents when the vehicle is keyed off. EPA recognized that this approach would not produce benefits consistent with the credits but was not able to disallow the credit.

Although EPA may have detailed discussions with manufacturers regarding their claims, in the end, under 40 CFR 86.1869–12(b) EPA's only recourse in situations where the technology may not provide the emissions reductions envisioned is to scrutinize the technologies to determine if the approach does in fact meet the definition. EPA may also request data, engineering analyses, or other information to support a manufacturer's claim that a technology meets the regulatory definition. In cases where EPA finds that it does not meet the definition, it may disallow the claimed credit. However, if EPA finds that the approach does meet the definition, EPA may not disallow the credit even if the technology is not likely to provide a benefit in line with the menu credit level. In those situations, EPA must revise the definitions section of the regulations in order to strengthen the program, a step EPA is now taking in this final rule. To help preserve the integrity of the off-cycle program, EPA believes that updating the program by revising the definitions as needed to correct known deficiencies discovered during implementation is essential to maintaining program integrity and emissions benefits. Also, EPA's requests for information regarding the technologies and follow-up with manufacturers has been flagged by manufacturers as causing delays in the manufacturer ability to claim credits and that further streamlining is needed, so revising the definitions will help with program implementation.

EPA notes that the off-cycle program is optional, and there is no requirement for any manufacturer to produce any menu technology. If a manufacturer does use the off-cycle menu for any given technology, it is important for EPA and the public to have confidence that technology used by manufacturers achieves the emission reductions reflected by the credit value. Thus, we are not persuaded that the issue of lead time is relevant in the context of optional off-cycle credit technologies or outweighs the need to maintain off-cycle program integrity by revising it when necessary to ensure that the program delivers intended emissions reductions. These are optional, additional, potential avenues to manufacturers to achieve the standards, but only to the extent that the technologies indeed provide the expected real-world emission benefits. EPA has had discussions with manufacturers regarding each of the technologies where EPA is now revising the definitions, during which EPA raised questions and concerns regarding certain technological approaches being taken by manufacturers, so these issues have been generally known amongst manufacturers claiming credits. Also, the manufacturers that use technological approaches consistent with the known intent of the regulations, will continue to generate credits without interruption due to the definition changes.

Regarding manufacturer comments that EPA allow some lesser credit for technologies that meet the unrevised definitions but not the updated definitions (definitions are discussed below), EPA does not have sufficient data on which to base an appropriate credit value. Manufacturers may use the other program pathways to demonstrate a credit value for such approaches by presenting data to support an appropriate credit level.

EPA is only finalizing the 15 g/mile menu credit cap through MY 2026. EPA received several critical comments regarding the off-cycle program, its value moving forward, and its implementation which has been challenging both for manufacturers and the agency. EPA intends to thoroughly review all aspects of the off-cycle program for the future rulemaking covering MYs 2027 and later.

EPA received numerous additional comments regarding the structure and implementation of the off-cycle credits program that were not specific to the proposed off-cycle program revisions. See the RTC for a full summary and response to off-cycle credits program comments.

iii. EPA Proposed and Final Modifications to Menu Technology Definitions

Some stakeholders have previously raised concerns about whether the off-cycle credit program produces the real-world emissions reductions as intended, or results in a loss of emissions benefits.[94] EPA believes these are important considerations, as noted above, and believes it is important to address to the extent possible the issues that the agency has experienced in implementing the menu credits, alongside raising the menu cap. EPA believes that raising the menu cap is appropriate so long as the agency can improve the program and reasonably expect the use of menu technologies to provide real-world emissions reductions, consistent with the intent of the program. Providing additional opportunities for menu credits may allow for more emissions reductions sooner and at a lower cost than would otherwise be possible under a program without off-cycle credits. With that in mind, EPA is finalizing modifications to the menu definitions discussed below to coincide with increasing the menu cap in MY 2023.

The existing menu technologies and associated credits are provided below in Table 16 and Table 17 for reference.[95]

TABLE 16—EXISTING OFF-CYCLE TECHNOLOGIES AND CREDITS FOR CARS AND LIGHT TRUCKS

Technology	Credit for cars (g/mile)	Credit for light trucks (g/mile)
High Efficiency Alternator (at 73%; scalable)	1.0	1.0
High Efficiency Exterior Lighting (at 100W)	1.0	1.0
Waste Heat Recovery (at 100W; scalable)	0.7	0.7
Solar Roof Panels (for 75W, battery charging only)	3.3	3.3
Solar Roof Panels (for 75W, active cabin ventilation plus battery charging)	2.5	2.5
Active Aerodynamic Improvements (scalable)	0.6	1.0
Engine Idle Start-Stop with heater circulation system	2.5	4.4
Engine Idle Start-Stop without heater circulation system	1.5	2.9
Active Transmission Warm-Up	1.5	3.2

[94] 85 FR 25237.

[95] See 40 CFR 86.1869–12(b). See also ''Joint Technical Support Document: Final Rulemaking for 2017–2025 Light-duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for the Final Rule,'' EPA–420–R–12–901, August 2012, for further information on the definitions and derivation of the credit values.

TABLE 16—EXISTING OFF-CYCLE TECHNOLOGIES AND CREDITS FOR CARS AND LIGHT TRUCKS—Continued

Technology	Credit for cars (g/mile)	Credit for light trucks (g/mile)
Active Engine Warm-Up	1.5	3.2
Solar/Thermal Control	Up to 3.0	Up to 4.3

TABLE 17—OFF-CYCLE TECHNOLOGIES AND CREDITS FOR SOLAR/THERMAL CONTROL TECHNOLOGIES FOR CARS AND LIGHT TRUCKS

Thermal control technology	Car credit (g/mile)	Truck credit (g/mile)
Glass or Glazing	Up to 2.9	Up to 3.9
Active Seat Ventilation	1.0	1.3
Solar Reflective Paint	0.4	0.5
Passive Cabin Ventilation	1.7	2.3
Active Cabin Ventilation	2.1	2.8

a. Passive Cabin Ventilation

Some manufacturers have claimed the passive cabin ventilation credits based on the addition of software logic to their HVAC system that sets the interior climate control outside air/recirculation vent to the open position when the power to vehicle is turned off at higher ambient temperatures. The manufacturers have claimed that the opening of the vent allows for the flow of ambient temperature air into the cabin. While opening the vent may ensure that the interior of the vehicle is open for flow into the cabin, no other action is taken to improve the flow of heated air out of the vehicle. This technology relies on the pressure in the cabin to reach a sufficient level for the heated air in the interior to flow out through body leaks or the body exhausters to open and vent heated air out of the cabin.

The credits for passive cabin ventilation were determined based on an NREL study that strategically opened a sunroof to allow for the unrestricted flow of heated air to exit the interior of the vehicle while combined with additional floor openings to provide a minimally restricted entry for cooler ambient air to enter the cabin. The modifications that NREL performed on the vehicle reduced the flow restrictions for both heated cabin air to exit the vehicle and cooler ambient air to enter the vehicle, creating a convective airflow path through the vehicle cabin.

Analytical studies performed by manufacturers to evaluate the performance of the open dash vent demonstrate that while the dash vent may allow for additional airflow of ambient temperature air entering the cabin, it does not reduce the existing restrictions on heated cabin air exiting the vehicle, particularly in the target areas of the occupant's upper torso. That hotter air generally must escape through restrictive (by design to prevent water and exhaust fumes from entering the cabin) body leaks and occasional venting of the heated cabin air through the body exhausters. While this may provide some minimal reduction in cabin temperatures, this open dash vent technology is not as effective as the combination of vents used by the NREL researchers to allow additional ambient temperature air to enter the cabin and also to reduce the restriction of heated air exiting the cabin.

As noted in the Joint Technical Support Document: Final Rulemaking for 2017–2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, pg. 584, ''For passive ventilation technologies, such as opening of windows and/or sunroofs and use of floor vents to supply fresh air to the cabin (which enhances convective airflow), (1.7 g/mile for light-duty vehicles and 2.3 g/mile for light-duty trucks) a cabin air temperature reduction of 5.7 °C can be realized.'' The passive cabin ventilation credit values were based on achieving the 5.7 °C cabin temperature reduction.

The Agency is finalizing revisions to the passive cabin ventilation definition with clarifying edits to make it consistent with the technology used to generate the credit value. The Agency continues to allow for innovation as the definition includes demonstrating equivalence to the methods described in the Joint TSD. As proposed, EPA is revising the definition of passive cabin ventilation to include only methods that create and maintain convective airflow through the body's cabin by opening windows or a sunroof, or equivalent means of creating and maintaining convective airflow, when the vehicle is parked outside in direct sunlight. Current systems claiming the passive ventilation credit by opening the dash vent would not meet the updated definition. Manufacturers seeking to claim credits for the open dash vent system will be eligible to petition the Agency for credits for this technology using the alternative EPA approved method outlined in 40 CFR86.1869–12(d). EPA's response to comments and discussion of the clarifying edits are provided in section 8 of the RTC.

b. Active Engine and Transmission Warm-Up

In the NPRM for the 2012 rule (76 FR 74854) EPA proposed capturing waste heat from the exhaust and using that heat to actively warm-up targeted parts of the engine and the transmission fluid. The exhaust waste heat from an internal combustion engine is heat that is not being used as it is exhausted to the atmosphere.

In the 2012 Final Rule (77 FR 62624), the Agency revised the definitions for active engine and transmission warm-up by replacing exhaust waste heat with the waste heat from the vehicle. As noted in the Joint TSD, pages 5–98 and 5–99, the Alliance of Automobile Manufacturers and Volkswagen recommended the definition be broadened to account for other methods of warm-up besides exhaust heat such as a secondary coolant loop.

EPA concluded that other methods, in addition to waste heat from the exhaust, that could provide similar performance—such as coolant loops or direct heating elements—may prove to be a more effective alternative to direct exhaust heat. Therefore, the Agency expanded the definition in the 2012 Final Rule.

In the 2012 Final Rule the Agency also required two unique heat exchanger loops—one for the engine and one for the transmission—for a manufacturer to claim both the Active Engine Warm-up and Active Transmission Warm-up credits. EPA stated in the Joint TSD that manufacturers utilizing a single heat exchanging loop would need to demonstrate that the performance of the single loop would be equivalent to two dedicated loops in order for the manufacturer to claim both credits, and that this test program would need to be performed using the alternative method off-cycle GHG credit application described in 40 CFR 86.1869–12(d).

All Agency analysis regarding active engine and transmission warm-up through the 2012 Final Rule (77 FR 62624) was performed assuming the waste heat utilized for these technologies would be obtained directly from the exhaust prior to being released into the atmosphere and not from any engine-coolant-related loops. At this time, many of the systems in use are engine-coolant-loop-based and are taking heat from the coolant to warm-up the engine oil and transmission fluid.

EPA provided additional clarification on the use of waste heat from the engine coolant in preamble to SAFE rule (85 FR 24174). EPA focused on systems using heat from the exhaust as a primary source of waste heat because that heat would be available quickly and also would be exhausted by the vehicle and otherwise unused (85 FR 25240). Heat from the engine coolant already may be used by design to warm up the internal engine oil and components. That heat is traditionally not considered ''waste heat'' until the engine reaches normal operating temperature and subsequently requires it to be cooled in the radiator or other heat exchanger.

EPA allowed for the possible use of other sources of heat such as engine coolant circuits, as the basis for the credits as long as those methods would ''provide similar performance'' as extracting the heat directly from the exhaust system and would not compromise how the engine systems would heat up normally absent the added heat source. However, the SAFE rule also allowed EPA to require manufacturers to demonstrate that the system is based on ''waste heat'' or heat that is not being preferentially used by the engine or other systems to warm up other areas like engine oil or the interior cabin. Systems using waste heat from the coolant do not qualify for credits if their operation depends on, and is delayed by, engine oil temperature or interior cabin temperature. As the engine and transmission components are warming up, the engine coolant and transmission oil typically do not have any ''waste'' heat available for warming up anything else on the vehicle since they are both absorbing any heat from combustion cylinder walls or from friction between moving parts in order to achieve normal operating temperatures. During engine and transmission warm-up, the only waste heat source in a vehicle with an internal combustion engine is the engine exhaust, as the transmission and coolant have not reached warmed-up operating temperature and therefore do not have any heat to share (85 FR 25240).

As proposed, EPA is finalizing revisions to the menu definitions of active engine and transmission warm-up to no longer allow systems that capture heat from the coolant circulating in the engine block to qualify for the Active Engine and Active Transmission warm-up menu credits. EPA would allow credit for coolant systems that capture heat from a liquid-cooled exhaust manifold if the system is segregated from the coolant loop in the engine block until the engine has reached fully warmed-up operation. The Agency would also allow system design that captures and routes waste heat from the exhaust to the engine or transmission, as this was the basis for these two credits as originally proposed in the proposal for the 2012 rule. The approach EPA is finalizing will help ensure that the level of menu credit is consistent with the technology design envisioned by EPA when it established the credit in the 2012 rule.

Manufacturers seeking to utilize their existing systems that capture coolant heat before the engine is fully warmed-up and transfer this heat to the engine oil and transmission fluid would remain eligible to seek credits through the alternative method application process outlined in 40 CFR 86.1869–12(d). EPA expects that these technologies may provide some benefit, though not the level of credits included in the menu. But, as noted above, since these system designs remove heat that is needed to warm-up the engine the Agency expects that these technologies will be less effective than those that capture and utilize exhaust waste heat.

Ford suggested clarifying edits to the proposed revised definitions for active engine and transmission definitions. In response, EPA has accepted some of their edits where the meaning of the definition is clarified but not altered, and has made some additional clarifying edits as well after reviewing Ford's comments. A full discussion of these comments and the definition revisions finalized by EPA is provided in section 8 of the RTC.

iv. Clarification Regarding Use of Menu Credits

While EPA received extensive comments on implementing the revised definitions, EPA did not receive many comments on the proposed revised definitions themselves. Comments on the revised definitions are summarized and discussed in the RTC.

Finally, as proposed, EPA is finalizing clarifications that manufacturers claiming credits for a menu technology must use the menu pathway rather than claim credits through the public process or 5-cycle testing pathways. EPA views this as addressing a potential loophole around the menu cap. As is currently the case, a new technology that represents an advancement compared to the technology represented by the menu credit—that is, by providing significantly more emissions reductions than the menu credit technology—would be eligible for the other two pathways. Comments received on this provision are summarized and discussed in the RTC.

4. Air Conditioning System Credits

There are two mechanisms by which A/C systems contribute to the emissions of GHGs: through leakage of hydrofluorocarbon refrigerants into the atmosphere (sometimes called ''direct emissions'') and through the consumption of fuel to provide mechanical power to the A/C system (sometimes called ''indirect emissions'').[96] The high global warming potential of the previously most common automotive refrigerant, HFC–134a, means that leakage of a small amount of refrigerant will have a far greater impact on global warming than emissions of a similar amount of CO_2. The impacts of refrigerant leakage can be reduced significantly by systems that incorporate leak-tight components, or, ultimately, by using a refrigerant with a lower global warming potential. The A/C system also contributes to increased tailpipe CO_2 emissions through the additional work required to operate the compressor, fans, and blowers. This additional power demand is ultimately met by using additional fuel, which is converted into CO_2 by the engine during combustion and exhausted through the tailpipe. These emissions can be reduced by increasing the overall efficiency of an A/C system, thus reducing the additional load on the engine from A/C operation, which in turn means a reduction in fuel

[96] 40 CFR 1867–12 and 40 CFR 86.1868–12.

consumption and a commensurate reduction in GHG emissions.

Manufacturers have been able to generate credits for improved A/C systems to help them comply with the CO_2 fleet average standards since the 2012 and later MYs. Because A/C credits represent a low-cost and effective technology pathway, EPA expected manufacturers to generate both A/C refrigerant and efficiency credits, and EPA accounted for those credits in developing the final CO_2 standards for the 2012 and SAFE rules, by adjusting the standards to make them more stringent. EPA believes it is important to encourage manufacturers to continue to implement low GWP refrigerants or low leak systems. Thus, EPA did not propose and is not finalizing any changes for its A/C credit provisions and is taking the same approach in adjusting the level of the standards to reflect the use of the A/C credits.

Comments received regarding A/C credits are summarized in the RTC.

5. Natural Gas Vehicles Technical Correction

EPA is finalizing as proposed a narrow technical amendment to its regulations to correct a clerical error related to natural gas vehicles. In the SAFE rule, EPA established incentive multipliers for MYs 2022–2026 natural gas vehicles.[97] EPA also received comments during the SAFE rulemaking recommending that EPA adopt an additional incentive for natural gas vehicles in the form of a 0.15 multiplicative factor that would be applied to the CO_2 emissions measured from the vehicle when tested on natural gas. Commenters recommended the 0.15 factor as an appropriate way to account for the potential use of renewable natural gas (RNG) in the vehicles.[98]

EPA decided not to adopt the additional 0.15 factor incentive, as discussed in the preamble to the SAFE Rule.[99] EPA provided a detailed rationale for its decision not to implement a 0.15 factor recommended by commenters in the SAFE Rule.[100] EPA is not revisiting or reopening its decision regarding the 0.15 factor. However, the regulatory text adopted in the SAFE rule contains an inadvertent clerical error that conflicts with EPA's decision and rationale in the final SAFE rule preamble and provides an option for manufacturers to use this additional incentive in MYs 2022–2026 by multiplying the measured CO_2 emissions measured during natural gas operation by the 0.15 factor.[101] EPA proposed and is finalizing narrow technical amendments to its regulations to correct this clerical error by removing the option to use the 0.15 factor in MY 2022 (as discussed in Section II.B.1.iii of this preamble EPA is eliminating multipliers for NGVs after MY 2022). This will ensure the regulations are consistent with the decision and rationale in the SAFE final rule. EPA likely would not have granted credits under the erroneous regulatory text if such credits were sought by a manufacturer because the intent of the agency was clear in the preamble text. In addition, natural gas vehicles are not currently offered by any auto manufacturer and EPA is not aware of any plans to do so. Therefore, there are no significant impacts associated with the correction of this clerical error. The comments on this provision as well as EPA's analysis and response are provided in the RTC for the final rule.

C. What alternatives did EPA analyze?

In addition to analyzing the standards we are finalizing, EPA analyzed two alternatives, one less stringent and one more stringent than the final standards. For the less stringent alternative, EPA assessed the proposed standards, *i.e.,* the coefficients of the standards proposed in the NPRM, including the advanced technology multipliers consistent with those proposed. This alternative, referred to as the ''Proposal'' in Table 18 below, is less stringent than the final standards in MYs 2025 and 2026.

For the more stringent alternative, EPA assessed Alternative 2 from our proposed rule with an additional 10 g/mile increased stringency in MY 2026 per our request for public comments on this option. This alternative is more stringent than the final standards, in particular for MYs 2023 and 2024. For this alternative, EPA used the coefficients from Alternative 2 in the proposed rule for MYs 2023 through 2025, with the standards increasing in stringency in MY 2026 by an additional 10 g/mile compared to the Alternative 2. The Alternative 2 minus 10 standards are the same as the final standards in MYs 2025 and 2026 and differ from the final standards in MYs 2023 and 2024.

We provide the fleet average target levels for the two alternatives compared to the final standards in Table 18 below.

TABLE 18—PROJECTED FLEET AVERAGE TARGET LEVELS FOR FINAL STANDARDS AND ALTERNATIVES

[CO_2 g/mile] *

Model year	Final standards projected targets	Proposal projected targets	Alternative 2 minus 10 projected targets
2021 **	229	229	229
2022 **	224	224	224
2023	202	202	198
2024	192	192	189
2025	179	182	180
2026	161	173	161

* Targets shown are modeled results and, therefore, reflect fleet projections impacted by the underlying standards. For that reason, slight differences in targets may occur despite equality of standards in a given year.

** SAFE rule targets shown for reference.

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[97] 85 FR 25211, April 30, 2020.

[98] 85 FR 25210–25211.

[99] 85 FR 25211.

[100] *Ibid.*

[101] See 40 CFR 600.510–12(j)(2)(v) and (j)(2)(vii)(A).

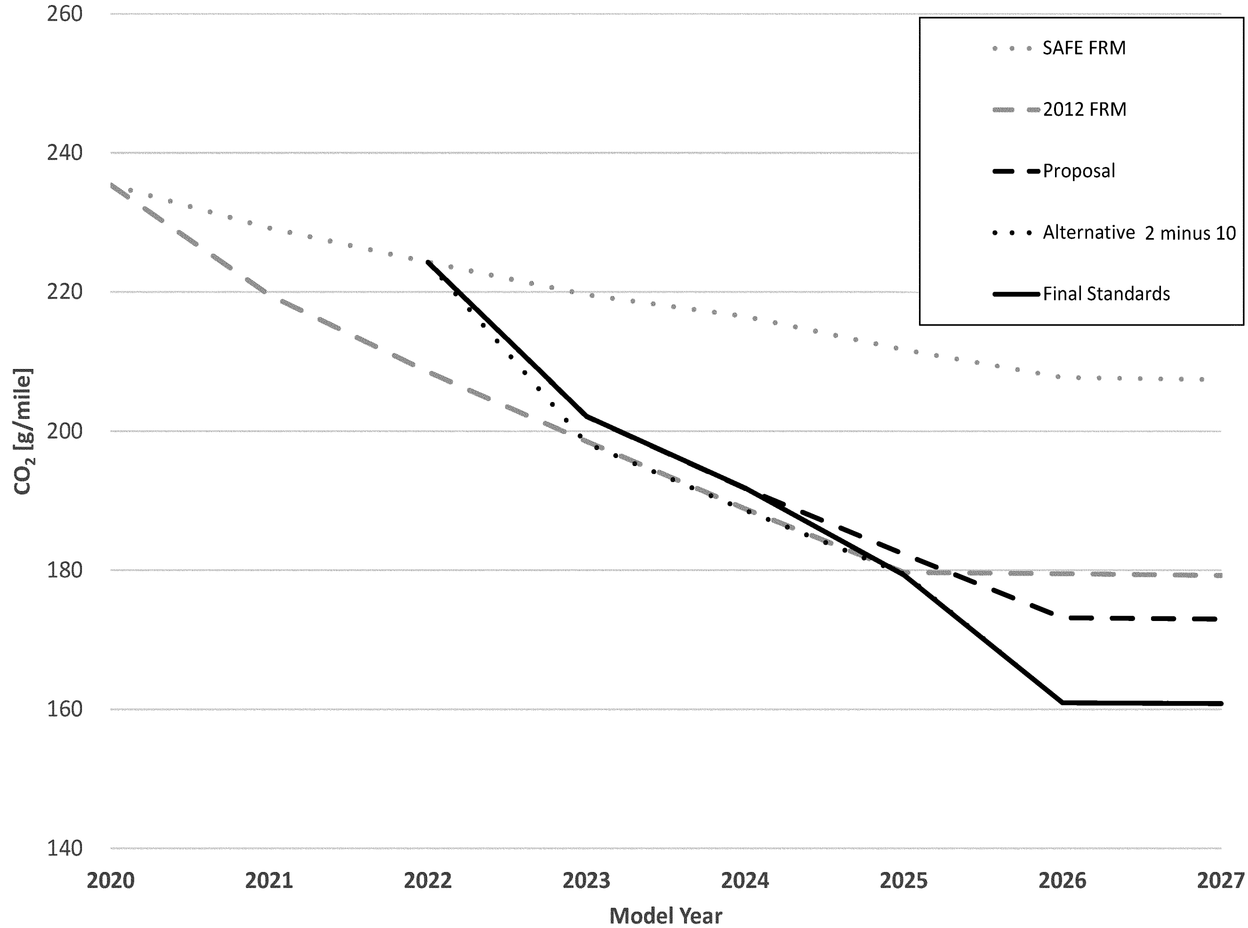

Figure 5 Final Standards Fleet Average Targets Compared to Alternatives

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As shown in Figure 5, the range of alternatives that EPA analyzed is fairly narrow, with the final standard target levels differing from the alternatives in MYs 2023–2025 by 3 to 4 g/mile, and in MY 2026 by 12 g/mile. EPA believes the analysis of these alternatives is reasonable and appropriate considering the shorter lead time for the revised standards, our assessment of feasibility, the existing automaker commitments to meet the California Framework (representing nearly 30 percent of the nationwide auto market), the standards adopted in the 2012 rule, public comments on the proposed rule, and the need to reduce GHG emissions. See Chapters 4, 6, and 10 of the RIA for the analysis of costs and benefits of the alternatives.

III. Technical Assessment of the Final CO_2 Standards

In Section II of this preamble, we describe EPA's final standards and related program elements and present industry-wide estimates of projected GHG emissions targets. Section III of this preamble provides an overview of EPA's technical assessment of the final standards including the analytical approach, projected target levels by manufacturer, projected per vehicle cost for each manufacturer, projections of EV and PHEV technology penetration rates, and a discussion of why the final standards are technologically feasible, drawing from these analyses. Finally, this section discusses the alternative standards EPA analyzed in selecting the final standards. The RIA presents further details of the analysis including a full assessment of feasibility, technology penetration rates and cost projections. In Section VI of this preamble, EPA discusses the basis for our final standards under CAA section 202(a) and in Section VII of this preamble presents aggregate cost and benefit projections as well as other program impacts.

A. What approach did EPA use in analyzing the standards?

The final standards are based on the extensive light-duty GHG technical analytical record developed over the past dozen years, as represented by EPA's supporting analyses for the 2010 and 2012 final rules, the Mid-Term Evaluation (including the Draft TAR, Proposed Determination and Final Determinations), as well as the updated analysis for this final rule, informed by public comments and the best available data. The updated analysis for the proposal and this final rule is not intended to be the sole technical basis of the final standards. EPA's extensive record is consistent and supports EPA's conclusion that year-over-year stringency increases in the time frame of this final rule are feasible at reasonable costs and can result in significant GHG emission reductions and public health and welfare benefits. The updated analysis shows that, consistent with past analyses, when modeling standards of similar stringency to those set forth in the 2012 rule, the results are similar to the results presented previously. Chapter 1 of the RIA further discusses and synthesizes EPA's record supporting stringent GHG standards through the MY 2025–2026 time frame.

To confirm that these past analyses continue to provide valid results for consideration by the Administrator in selecting the most appropriate level of stringency and other aspects of the final standards, we have conducted an updated analysis since the proposed rule issued in August 2021. Prior to the analysis used for the SAFE FRM, EPA has used its OMEGA (Optimization Model for reducing Emissions of Greenhouse gases from Automobiles) model as the basis for setting light-duty GHG emissions standards. EPA's OMEGA model was not used in the technical analysis of the GHG standards established in the SAFE FRM; instead, NHTSA's Corporate Average Fuel Economy (CAFE) Compliance and Effects Modeling System (CCEMS) model was used.

For this final rule, consistent with the proposed rule, EPA has chosen to use the peer reviewed CCEMS model, and to use the same version of that model that was used in support of the SAFE FRM (though, as discussed below, EPA has updated several inputs to the model since the proposed rule based on public comments and newer available data). As explained in the proposed rule, given that the SAFE FRM was published a little over a year ago, direct comparisons between the analysis presented in this rulemaking and the analysis presented in support of the SAFE FRM are more direct if the same modeling tool is used. For example, CCEMS has categorizations of technologies and model output formats that are distinct to the model, so continuing use of CCEMS for this rule has facilitated comparisons to the SAFE FRM. Also, by using the same modeling tool as used in the SAFE rule, we can more clearly illustrate the influence of some of the key updates to the inputs used in the SAFE FRM. EPA considers the SAFE FRM version of the CCEMS model to be an effective modeling tool for purposes of assessing standards through the MY 2026 timeframe, along with changes to some of the key inputs as discussed below (see Table 20).

For use in future vehicle standards analyses, EPA is developing an updated version of its OMEGA model. This updated model, OMEGA2, is being developed to better account for the significant evolution over the past decade in vehicle markets, technologies, and mobility services. In particular, the recent advancements in battery electric vehicles (BEVs), and their introduction into the full range of market segments provides strong evidence that vehicle electrification can play a central role in achieving greater levels of emissions reductions in the future. In developing OMEGA2, EPA is exploring the interaction between consumer and producer decisions when modeling compliance pathways and the associated technology penetration into the vehicle fleet. OMEGA2 also is being designed to have expanded capability to model a wider range of GHG program options than are possible using existing tools, which will be especially important for the assessment of policies that are designed to address future GHG reduction goals. While the OMEGA2 model is not available for use in this rule, peer review of the draft model is underway.

Our updated analysis is based on the same version of the CCEMS model that was used for the proposed rule and for the SAFE FRM. The CCEMS model was extensively documented by NHTSA for the SAFE FRM and the documentation also applies to the updated analysis for this final rule.[102] While the CCEMS model itself remains unchanged from the version used in the final SAFE rule, EPA made the following changes (shown in Table 19) to the inputs for the analysis supporting the proposed rule. Further updates to the inputs based on our assessment of the public comments and newer data are summarized in Table 20.

TABLE 19—CHANGES MADE TO CCEMS MODEL INPUTS FOR THE PROPOSED RULE, RELATIVE TO THE SAFE FRM ANALYSIS

Input file	Changes
Parameters file	Global social cost of carbon $/ton values in place of domestic values (see RIA Chapter 3.3). Inclusion of global social cost of methane (CH4) and nitrous oxide (N_2O) $/ton values (see Section IV of this preamble). Updated $PM_{2.5}$ cost factors (benefit per ton values, see Section VII.E of this preamble). Rebound effect of −0.10 rather than −0.20 (see RIA Chapter 3.1). AEO2021 fuel prices (expressed in 2018 dollars) rather than AEO2019. Updated energy security cost per gallon factors (see Section VII.F of this preamble). Congestion cost factors of 6.34/6.34/5.66 (car/van-SUV/truck) cents/mile rather than 15.4/15/4/13.75 (see RIA Chapter 5). Discounting values to calendar year 2021 rather than calendar year 2019. The following fuel import and refining inputs have been changed based on AEO2021 (see RIA Chapter 3.2): Share of fuel savings leading to lower fuel imports: Gasoline 7%; E85 19%; Diesel 7% rather than 50%; 7.5%; 50% Share of fuel savings leading to reduced domestic fuel refining: Gasoline 93%; E85 25.1%; Diesel 93% rather than 50%; 7.5%; 50% Share of reduced domestic refining from domestic crude: Gasoline 9%; E85 2.4%; Diesel 9% rather than 10%; 1.5%; 10% Share of reduced domestic refining from imported crude: Gasoline 91%; E85 24.6%; Diesel 91% rather than 90%; 13.5%; 90%
Technology file	High compression ratio level 2 (HCR2) technology allowance set to TRUE for all engines beginning in 2018 (see RIA Chapter 2).
Market file	On the Engines sheet, we allow high compression ratio level 1 (HCR1) and HCR2 technology on all 6-cylinder and smaller engines rather than allowing it on no engines (see RIA Chapter 2). Change the off-cycle credit values on the Credits and Adjustments sheet to 15 g/mile for 2020 through 2026 (for the CA Framework) or to 15 g/mile for 2023 through 2026 (for the proposed option) depending on the model run.

[102] See CCEMS Model Documentation on web page *https://www.nhtsa.gov/corporate-average-fuel-economy/compliance-and-effects-modeling-system.*

EPA invited public comment on the input changes noted in Table 19, as well as any other input choices that EPA should consider making for the final rule. EPA encouraged stakeholders to provide technical support for any suggestions on changes to modeling inputs.

We received comments on our analysis. Specifically, the Alliance suggested that we use the updated version of CCEMS used in the recent NHTSA NPRM. The Alliance also suggested that we update our analysis fleet, model HCR2 technology with a more appropriate level of effectiveness relative to the HCR0 and HCR1 technologies, and limit the penetration of BEV200 technology. The Alliance took exception to the share of BEV200 versus BEV300 technology arguing that BEV300 is more in line with where industry is headed due to consumer desire for greater range.

Regarding the first of these comments, that we use an updated version of CCEMS, we have chosen not to do so since it is possible that between the recent CAFE proposal and upcoming CAFE final rule NHTSA may make changes to that version of the model either of their own accord or in response to public comment. Therefore, we believe it is premature to use the NHTSA CAFE NPRM version of the CCEMS model for EPA's final rulemaking. Regarding each of the other Alliance comments on the use of the CCEMS model: As discussed further below, we removed HCR2 technology as a compliance option; we strictly limited BEV200 technology such that it represents a very small portion of the projected BEV technology penetration; and we have updated our analysis fleet to reflect the MY 2020 fleet.

As a result, the analysis supporting this final rule includes several changes to the inputs as shown in Table 20.

TABLE 20—CHANGES MADE TO CCEMS MODEL INPUTS FOR THE FINAL RULE, RELATIVE TO THE PROPOSED ANALYSIS

Input file	Changes *
Parameters file	Updated Gross Domestic Product, Number of Households, VMT growth rates and Historic Fleet data consistent with updated projections from EIA (AEO 2021). Updated energy security cost per gallon factors (see Section VII.F of this preamble). Distinct benefit per ton values for refinery and electricity generating unit benefits instead of treating all upstream emissions as refinery emission (see Section V of this preamble). Updated tailpipe and upstream emission factors from MOVES3 and GREET2020 and consistent with NHTSA's 20201 CAFE NPRM (86 FR 49602, September 3, 2021).
Technology file	High compression ratio level 2 (HCR2, sometimes referred to as Atkinson cycle) technology allowance set to FALSE thereby making this technology unavailable. BEV200 phase-in start year set to the same year as the new market file fleet (see below) which, given the low year-over-year phase-in cap allows for low penetration of BEV200 technology in favor of BEV300 technology. Battery cost was reduced by about 25 percent (see preamble Section III.A of this preamble and RIA 2.3.4); battery cost learning is also held constant (*i.e.,* no further learning) beyond the 2029 model year.
Market file	The market file has been completely updated to reflect the MY 2020 fleet rather than the MY 2017 fleet used in EPA's proposed rule (and the SAFE FRM) using the market file developed by NHTSA in support of their recent CAFE NPRM.[103] Because the market files are slightly different between the version of CCEMS we are using and the version used by NHTSA, the files are not identical. However, the data are the same with the following exceptions: —We conducted all model runs using EPA Multiplier Mode 2 rather than Mode 1 as used in our proposed rule (and the SAFE FRM). —We have used projected off-cycle credits as developed by NHTSA in support of their recent CAFE NRPM rather than modeling all manufacturers as making use of the maximum allowable off-cycle credits (see RIA Chapter 4.1.1.1). —We have updated the credit banks to incorporate more up-to-date information from manufacturer certification and compliance data.
Scenarios file	The off-cycle credit cap has been set to 10 g/mile even in scenarios and years for which 15 g/mile are available. In addition, the off-cycle credit cost is set to $0 and then post-processed back into the costs calculated within CCEMS itself. See RIA Chapter 4.1.1.1 for more detail.
Runtime settings	At runtime (in the CCEMS graphical user interface), the "Price Elasticity Multiplier" is now set to −0.40 rather than the value of −1.0 used in the proposed rule analysis.
*	We are using a MY 2020 baseline fleet rather than a MY 2017 baseline fleet. However, since some date-based data used by the model is hardcoded in the model code, and because we did not want to change the model code for analytical consistency with the proposed rule, we adjusted any date-related input data accordingly. Therefore, the input files we are using have headings and date-related identifiers reflecting a MY 2017-based analysis but the data in the files have been adjusted by 3 years to reflect that anything noted as 2017 is actually 2020. For example, in the Scenarios input file which specifies the standards in a year-by-year format, the standards for MY 2023 through MY 2026 are actually entered in the columns noted as 2020 through 2023 due to this need to "shift years". Importantly, in post-processing of model results, the "year-shift" is corrected back to reflect the actual years.

As noted in Table 20, we have updated the baseline fleet to reflect the MY 2020 fleet rather than the MY 2017 fleet used in the proposed rule. As a result, there is slightly more technology contained in the MY 2020 baseline fleet and the fleet mix has changed to reflect a more truck-heavy fleet (56 percent truck vs. 44 percent cars, while the proposed rule fleet had a 50/50 split). There are also roughly 3.5 million fewer sales in the MY 2020 base fleet than were in the MY 2017 based fleet. As in the proposed rule, the future fleet is based on the CCEMS model's sales, scrappage, and fleet mix responses to the standards being analyzed, whether from the No Action scenario or one of the Action scenarios. The MY 2020 baseline fleet was developed by NHTSA for their recent CAFE NPRM.[104] As in our proposed rule, we split the market file into separate California Framework

[103] 86 FR 49602, September 3, 2021.

[104] 86 FR 49602.

OEM (FW–OEM) and non-Framework OEM (NonFW–OEM) fleets for model runs. Note that the scrappage model received many negative comments in response to the SAFE NPRM, but changes made for the FRM version of the CCEMS model were responsive to the identified issues involving sales and VMT results of the SAFE NPRM version of the CCEMS model.[105] That said, the Institute for Policy Integrity at New York University (NYU IPI) expressed concerns on the EPA proposal about the sales and scrappage modeling and commented that, while EPA has already begun to revise the modeling, we should continue to make adjustments in the future. Michalek and Whitefoot in their comments on the EPA proposal provide some preliminary research suggesting that non-rebound total fleet VMT might increase due to policy-induced scrappage delay. They do not rule out an effect of zero and note that their results are preliminary and not yet peer-reviewed. EPA is maintaining the assumption of constant non-rebound total fleet VMT for this FRM and will continue to review these and other modeling approaches for future analyses.

As mentioned, for some model runs we have split the fleet in two, one fleet consisting of California Framework OEMs and the other consisting of the non-Framework OEMs. This was done because the Framework OEMs would be meeting more stringent emission reduction targets (as set in the scenarios file) and would have access to more advanced technology incentive multipliers as contained in the California Framework Agreements, while the non-Framework OEMs would be meeting less stringent standards and would not have access to any advanced technology multipliers. For such model runs, a post-processing step was necessary to properly sales-weight the two sets of model outputs into a single fleet of results. This post-processing tool is in the docket for this rule.[106]

In the proposed rule, we modeled all manufacturers as making use of the maximum number of off-cycle credits available under any given set of standards being analyzed. For example, under the California Framework and our proposed standards, manufacturers were projected to make use of 15 grams CO_2 per mile of off-cycle credit and to incur a cost for each of those credits at a rate of over $70 per credit (this would be the cost of the technology added to achieve the credits). Since their off-cycle credit allowance was identical in both action and no action scenarios, this resulted in no marginal cost for off-cycle credits for the Framework OEMs. However, for the non-Framework OEMs, modeled as making use of 10 grams per mile of credit under the SAFE FRM standards and 15 grams of credit under the proposed standards, the result was roughly $350 in marginal per vehicle costs (roughly $70 times 5 grams/mile of credits) even though more cost-effective technology, compared to off-cycle credits, may be available to facilitate a manufacturer's efforts toward complying with the standards. Commenters expressed concerns with our proposed rule over this approach as resulting in unreasonably high costs for use of the optional off-cycle credits. In response to the comments, in this final rule we have made two important changes to our modeling. First, we have projected use of off-cycle credits consistent with projections developed by NHTSA for their recent CAFE NPRM except that we have not exceeded 10 g/mile in any case. In this way, we avoid having a case where more off-cycle credits are used in an action scenario relative to a no action scenario. Second, we have set the cost of the off-cycle credits to $0 in the scenarios input file and are post-processing their costs back into the costs per vehicle results. CCEMS does not provide for technology application choices to be made between off-cycle credits and other technologies; instead the off-cycle credits are applied within the model regardless of their cost-effectiveness. Therefore, setting the off-cycle credit cost to $0 in the scenarios input file has no effect on technology application decisions within the model. Further, it allows off-cycle credit costs to be applied in a post-process rather than re-running the model. Last, we have updated the cost of each off-cycle credit to be less than the costs used in our proposed rule. As a result, each off-cycle credit is now roughly $30 less costly on a gram per mile basis than in our NRPM. We outline our methodology for this revised cost in RIA Chapter 4.1.1.1.

Importantly, our primary model runs consist of a ''No Action'' scenario and an ''Action'' scenario. The results, or impact of our final standards (or alternatives being analyzed), are measured relative to the no action scenario. Our No Action scenario consists of the Framework OEMs (roughly 28 percent of fleet sales) meeting the Framework emission reduction targets and the Non-Framework OEMs (roughly 72 percent of fleet sales) meeting the SAFE FRM standards. Our action scenario consists of the whole fleet meeting our final standards (or alternatives) for MYs 2023 and later. Throughout this preamble, our ''No Action scenario'' refers to this Framework-OEM/NonFramework-OEM compliance split.

In our analysis for the proposed rule, as indicated in Table 19, we used a VMT rebound effect of 10 percent. The 10 percent value had been used in EPA supporting analyses for the 2010 and 2012 final rules as well as for the 2017 MTE Final Determination. The SAFE rule used a VMT rebound effect of 20 percent. Our assessment for the proposed rule indicated that a rebound effect of 10 percent was appropriate and supported by the body of research on the rebound effect for light-duty vehicle driving. We requested comment on the use of the 10 percent VMT rebound value, or an alternative value such as 5 or 15 percent, for our analysis of the MY 2023 through 2026 standards.

Several commenters (Center for Biological Diversity et al., CARB/Gillingham, New York University-Institute for Policy Integrity) are supportive of the approach that EPA has utilized to determine the value of the VMT rebound effect for this rule. Several commenters (Center for Biological Diversity et al., CARB/Gillingham, Consumer Federation of America, Consumer Reports, New York University-Institute for Policy Integrity) widely support the use of a 10 percent rebound effect, with a few commenters suggesting that a lower rebound estimate than 10 percent should be used. One commenter (Center for Biological Diversity et al.) suggests that while EPA's proposed rule reported a range of VMT rebound estimates from the Hymel and Small (2015) study of 4 to 18 percent, that only the lower value of the range, 4 percent, should be used in developing an overall estimate of the VMT rebound effect for use in this rule. We agree with this comment and discuss this issue in more detail in both the RIA and the RTC. One commenter (Consumer Reports) requests that EPA consider doing more research prior to future rulemakings on the potential applicability of rebound effects based on studies for conventional vehicles being applied to battery electric vehicles (BEVs). We address this comment in the RTC. After considering the comments received, EPA is continuing to use a 10 percent rebound effect for the analysis of the final rule. Our discussion of the basis for the 10 percent rebound value is in the RIA Chapter 3.1, and our assessment of the public comments is contained in the RTC.

[105] See 85 FR 24647.

[106] See EPA_CCEMS_PostProcessingTool, Release 0.3.1 July 21, 2021.

For the proposed rule, EPA chose to change a select number of the SAFE FRM model inputs, as listed in Table 19, largely because we concluded that other potential updates, regardless of their potential merit, such as the continued use of the MY 2017 base year fleet, would not have a significant impact on the assessment of the proposed standards. In addition, while the technology effectiveness estimates used in the CCEMS model to support the SAFE FRM could have been updated with more recent engine maps, the incremental effectiveness values are of primary importance within the CCEMS model and, while the maps were somewhat dated, the incremental effectiveness values derived from them were in rough agreement with incremental values derived from more up-to-date engine maps (see RIA Chapter 2).

As noted in Table 20, for this final rule we have chosen to conduct model runs with high compression ratio level 2 (HCR2) set to FALSE (*i.e.,* it is not an available technology for the model to choose to apply in simulating compliance with the standards). We have done this due to our concerns over the effectiveness of the technology relative to the HCR0 and HCR1 technologies modeled in the SAFE FRM which were subsequently used in the analysis for our proposed rule. The HCR2 technology in CCEMS would require a level of cylinder deactivation technology (dynamic cylinder deactivation) that has not yet been added to Atkinson Cycle Engines either with or without cooled EGR. HCR1 technologies reflect the effectiveness of Atkinson Cycle engines with either cooled EGR or cylinder deactivation (however, not both technologies in combination) and thus also represent a number of high-volume ICE applications from Mazda, Toyota and Hyundai. The additional step to HCR2 reflected a level of ICE effectiveness that is not yet within the light-duty vehicle fleet, and that we do not anticipate seeing until the later years of this final rule (*e.g.,* MYs 2025–2026).[107]

In the proposed rule, we noted that the electrified vehicle battery costs used in the SAFE FRM, which were carried over to the proposed rule analysis, could have been lower based on EPA's latest assessment and that we had ultimately believed at the time of the proposed rule that updating those costs for the proposed rule would not have a notable impact on overall cost estimates. This conclusion was based in part on our expectation that electrification would continue to play a relatively modest role in our projections of compliance paths for the proposed standards, as it had in all previous analyses of standards having a similar level of stringency. We also noted that we could update battery costs for the final rule and requested comment on whether our choice of modeling inputs such as these should be modified for the final rule analysis.

Commenters on the proposed rule made several observations and recommendations about battery costs, with most saying that the costs in the proposed rule analysis were too high. Tesla commented on [EPA's] ''refusal to revisit admittedly over-estimated battery costs in the agency's analysis,'' further stating that EPA ''failed to complete a review of battery cost for EVs, asserting it was unnecessary given the agency does not rely on significant EV penetration for MY 2023–26.'' Tesla stated that it ''agree[s] battery costs in the SAFE rule were too high,'' further citing various projections for future battery costs: ''UBS reports that leading manufacturers are estimated to reach battery pack costs as low as $67/kWh between 2022 and 2024. Recently, others have also projected costs significantly lower than EPA's past projections. BNEF's recent estimate is that pack prices go below $100/kWh on a volume-weighted average basis by 2024, hit $58/kWh in 2030, and could achieve a volume-weighted average price of $45/kWh in 2035. The National Academies of Sciences found high-volume battery pack production would be at costs of $65–80/kWh by 2030 and DNV–GL has predicted costs declining to $80/kWh in 2025. In short, had the agency rightfully determined that EVs offer the best compliance technology near term and revisited battery pack costs, it would have found dramatically decreasing battery costs that further support that EV deployment will accelerate rapidly near term and represent the best possible emissions reduction technology.''

ACEEE commented: ''Battery cost assumptions in the NRPM are too high and do not consider the manufacturing and technological advancements of the past few years. EPA uses the same cost figures used in the SAFE rule, which are based on 2017 data, effectively inflating the costs of vehicle electrification (EPA 2021b, p. 145).''

Consumer Reports commented that it: ''recommends that EPA update their battery costs to be more in line with the current state of the electric vehicle market. This has the potential to have a significant impact on the cost-benefit analysis of the rule, especially with regards to the ability for EPA to push further, and set a stronger standard than the preferred alternative that is more in line with the administration's climate commitments.''

ICCT commented that: ''EPA used an updated ANL BatPaC model (BatPaC Version 3.1, 9 October 2017) as the basis for BEV, PHEV, HEV and mild HEV battery costs in its 2018 MTE, but these updated costs were not used in the proposed rule.'' ''Unlike for the other technologies in the agencies' analysis, the vast majority of costs related to the RPE markup are already included in the base costs that the agencies used from ANL lookup tables. In other words, those lookup tables do not provide ''direct manufacturing costs,'' they provide total costs, including indirect costs. Thus, EPA erroneously inflated battery costs by applying the retail price equivalent (RPE) markup to base costs that already include indirect costs.'' On this point, ICCT referred to the Joint NGO 2020 Reconsideration Petition, pages 88–90, which was filed in response to the final SAFE rule.

NCAT commented: ''As explained in the Proposed Rule, EPA chose to continue to use certain model inputs from the modeling conducted several years ago for the 2020 Rule, including the continued use of MY 2017 as the base year fleet and use of the electric vehicle battery cost data from the 2020 Rule modeling effort. However, electric vehicle penetration has grown significantly since that time, see Section IV.A of this preamble, and battery costs have continued to decline dramatically [. . .] EPA even acknowledged that the agency may consider updating the battery costs for the final rule, noting that EPA's latest assessment suggests they could have been lower. There was a 13 percent drop in electric vehicle battery cost in just 2020 alone. EPA's approach was very conservative in light of these older model inputs relating to electric vehicles.''

World Resources Institute commented: ''Despite the very dynamic nature of the ZEV market, EPA chose not to update the battery cost assumptions used in its compliance modeling even though EPA considers the assumed battery costs to be too high.'' ''This is a fundamental error. While EPA is correct in observing that ''significant levels of vehicle electrification will not be necessary in order to comply with the proposed standard,'' this in no way obviates the need for EPA to properly evaluate likely ZEV penetration in order to determine

[107] For further information on HCR definitions, see RIA Chapter 2.3.2. For more information on HCR implementation in CCEMS, see RIA Chapter 4.1.1.4.

whether a more stringent standard is appropriate.'' ''EPA should update its projections of ZEV market shares to reflect current trends in battery prices, automaker investment plans and EV market development. EPA should also consider higher penetration scenarios that would occur if Congress enacts additional incentives and infrastructure investments and should update the final rule to reflect any enacted legislation.'' ''EPA's flawed battery price assumptions and resulting underestimate of ZEV market penetration rates have a dramatic impact on the emissions rates that would be required of ICEVs under the proposal as well as the alternatives considered.'' ''In order to have a rational basis for setting emissions standards that allow averaging across ICEVs and ZEVs EPA needs to update its battery cost assumptions and likely additional assumptions related to ZEV adoption rates.'' ''EPA should update its projections of ZEV market shares to reflect current trends in battery prices, automaker investment plans and EV market development.''

The Alliance noted the inherent uncertainty in predicting future battery costs, stating: ''Given high levels of investment in research and development, and production processes, and the considerable uncertainty of what approaches will succeed or fail, it is possible that NHTSA's estimates of battery pack direct manufacturing costs (after learning factor) will be meaningfully low, or high in the MY 2027 timeframe and beyond.'' ''EPA appears to use previous generation assumptions and battery costs from the SAFE Final Rule record, despite updated battery pack assumptions, and direct manufacturing cost assumptions being available for use in the DOT analysis.'' This is a reference to the NHTSA CAFE NPRM, which uses an updated version of the SAFE rule analysis, in which NHTSA uses costs from a more recent release of BatPaC and implements some changes in their input assumptions, which the Alliance states ''better account for high voltage isolation costs, and battery cell specifications.''

The Alliance also encouraged EPA to ''consider costs and specifications that are reasonable for the industry as a whole to inform policy analysis, and not to assume that intellectual property and proprietary production processes that have been the result of billions of dollars of research and development paid by one manufacturer will be readily available to all manufacturers.'' The Alliance went on to state: ''Total industry volumes of battery electric vehicles are not an appropriate volume assumption for BatPaC. Auto Innovators recommends that EPA update their approach to that used in the DOT analysis to estimate battery costs for strong hybrids, plug-in hybrids, and battery electric vehicles, considering vehicle type and synergies with other fuel saving technologies.''

Additional comments from the Alliance that were submitted to NHTSA as comment on the 2021 NHTSA NPRM were also placed in the EPA docket and can be found in Response to Comments Section 12.1. Among other topics, the Alliance commented on the potential for mineral costs to act as a constraint on the downward trajectory of battery costs in the future, citing in part a 2019 MIT report on the subject that suggested that battery costs for chemistries of the type relied on today may not have the potential to reach as low a cost as suggested by forecasts cited by other commenters. In response, EPA agrees that mineral and other material costs are a large component of the cost of the currently prevailing family of lithium-ion chemistries, that these costs might decline more slowly or increase if supply fails to meet demand in a timely manner, and that this is a relevant consideration when forecasting the potential for future reductions in battery costs. EPA also notes that manufacturers are working to reduce the content of some critical minerals in the battery chemistries used today, and that chemistries that have less critical mineral content may have less potential exposure to this effect. We have incorporated the uncertainties surrounding the future effect of mineral costs on battery cost reductions by limiting projected reductions in future battery costs to a level that we can reasonably technically validate at this time, as described below. EPA responds further to these comments in Section 12.1 of the Response to Comments document.

Prompted by the totality of comments received on battery costs, EPA chose to update the battery costs for the FRM analysis. EPA believes that some of the more optimistic scenarios for reductions in battery costs that were cited in the public comments are difficult to validate at this time, given the importance of material costs to the cost of batteries, and the uncertainties surrounding mineral and other material costs as demand for batteries increases in the coming years. With regard to the ICCT comments that BatPaC output costs already include indirect costs that are represented by the RPE markup and hence RPE was double counted, EPA disagrees, and we note that the indirect costs represented in BatPaC output are those that apply to the battery supplier, and do not represent the indirect costs experienced by the OEM who purchases the battery and integrates it into the vehicle. EPA has always considered RPE markup to be applicable to purchased items, with the exception that BatPaC by default includes a warranty cost, which we have traditionally subtracted from BatPaC output because it is already covered in the RPE.

However, EPA agrees with the commenters that battery costs used in the SAFE rulemaking, and hence the proposed rule, were higher than would be supported by information available today. Cited reports that are based on empirical data of what manufacturers are currently paying, and near-term forecasts that can reasonably be corroborated with our battery modeling tools, suggest lower battery costs than were assumed in the proposal. Consideration of the current and expected near-term costs of batteries for electrified vehicles, as widely reported in the trade and academic literature and further supported by our battery cost modeling tools, led to an adjustment of battery costs to more accurately account for these trends. Based on an assessment of the effect of using updated inputs to the BatPaC model in place of those used in the SAFE rulemaking, we determined that battery costs should be reduced by about 25 percent.

We also considered the effect of this reduction on the projected battery costs for future years beyond MY2026, which due to this adjustment were now declining to levels below $80 per kWh (for an example 60 kWh battery) in the mid-2030s, and which our current battery cost modeling tools cannot technically validate at this time.

Due to the widely acknowledged uncertainty of quantitatively projecting declines in battery costs far into the future, and to reflect current uncertainty about future mineral costs as battery demand increases (which is consistent with the points raised by the Alliance), we chose to place a limit on continued battery cost reductions past MY 2029 so as to prevent future costs from declining below $90 per kWh for a 60 kWh battery, a level that we can currently technically validate. More discussion of the rationale for these changes can be found in Chapters 2.3.4 and 4.1.1.2 of the RIA.

We expect that pending updates to the ANL BatPaC model, as well as collection of emerging data on forecasts for future mineral prices and production capacity, will make it possible to more confidently characterize the declines in battery costs that we continue to believe will occur in the 2030s and beyond, and we will incorporate this information in the subsequent rulemaking for MYs 2027 and beyond.

In response to the Alliance comments on appropriate production volumes for developing battery costs, EPA understands how BatPaC considers production volume in developing pack costs and agrees that use of total industry volume to estimate the cost of a specific pack design would be inappropriate and would likely underestimate the true manufacturing cost. However, EPA also recognizes that using a production volume specific to the actual production of a specific pack design would tend to overestimate overhead costs by constructing a plant that is much smaller than the plants currently in operation and being planned today. For example, a 5 Gigawatt-hour (gWh) plant such as the LG Chem plant in Holland, Michigan is large enough to manufacture more than 80,000 60 kWh packs, while other leading plants in operation and under construction are designed for much higher volumes. For example, a 30 to 35 gWh plant such as the Tesla factory in Reno, Nevada, even when manufacturing an assortment of pack and cell designs would be able to amortize its construction, overhead and maintenance costs across 500,000 or more packs per year. Also, manufacturers are increasingly adopting design approaches that reuse cells and parts across multiple pack designs, meaning that the economies of scale that are relevant for those cells and parts are likely to be greater than the volume of a single pack design alone would represent. For these and similar reasons, EPA continues to believe that using a production volume specific to a given pack would create overly conservative estimates of battery manufacturing cost.

With regard to the Alliance comments on the applicability of technology assumptions to all manufacturers, EPA recognizes that different manufacturers may experience different costs resulting from differences in their past research and investments and differences in their approach to sourcing components. Manufacturers have largely approached the sourcing of batteries through joint ventures or contractual relationships with established cell manufacturers rather than true vertical integration. For example, while Tesla has developed intellectual property relating to pack and cell design and production, their production occurs via a joint venture with Panasonic, and also includes sourcing from other suppliers that are not part of this venture. Other manufacturers are increasingly adopting a similar approach in which new manufacturing plants are to be constructed as part of a joint venture, by which the OEM may secure a supply of batteries for its products.[108] [109] [110] [111] [112] As with other technologies, the existence of intellectual property belonging to one manufacturer seldom prevents other manufacturers from developing and benefiting from similarly effective technologies. The battery costs that EPA develops are not taken from the example of any specific manufacturer but are developed based on our assessment of the industry as a whole.

In regard to updating the BEV driving ranges that were considered in the analysis, the Alliance stated that the ''analysis could be improved by using the BatPaC results for BEV400's and BEV500's, instead of scaling up BEV300 costs.'' ''Auto Innovators encourages EPA to include BEV400 and BEV500 in their analysis tool, and to adopt DOT phase-in caps from the CAFE NPRM in place of the phase-in caps used in the EPA proposal, as the EPA proposal likely overestimates the number of consumers who would accept BEV200's, especially given today's charging infrastructure.''

In the updated analysis, we set the BEV200 phase-in start year to the same year as the new market file fleet, which, given the low year-over-year phase-in cap, allows for low penetration of BEV200 technology in favor of BEV300 technology. Thus, the great majority of BEV penetration projected by the model represents BEV300 vehicles. We did not choose to extend the analysis to BEV400 and BEV500 vehicles. While BEV400 and BEV500 vehicles are entering the market and are anticipated to be some part of the future market, the known examples are concentrated in the luxury, high-end market, limiting their likely penetration into the fleet during the time frame of the rule.

B. Projected Compliance Costs and Technology Penetrations

1. GHG Targets and Compliance Levels

The final curve coefficients were presented in Table 10. Here we present the projected fleet targets for each manufacturer. These targets are projected based on each manufacturer's car/truck fleets and their sales weighted footprints. As such, each manufacturer has a set of targets unique to them. The projected targets are shown by manufacturer for MYs 2023 through 2026 in Table 21 for cars, Table 22 for light trucks, and Table 23 for the combined fleets.[113]

TABLE 21—CAR TARGETS

[CO_2 g/mile]

	2023	2024	2025	2026
BMW	169	161	152	135
Daimler	174	166	156	139
FCA	176	168	158	140
Ford	170	162	153	136
General Motors	163	155	147	130
Honda	164	156	147	130
Hyundai Kia-H	165	157	148	131
Hyundai Kia-K	163	155	146	129

[108] Voelcker, J., ''Good News: Ford and GM Are Competing on EV Investments,'' Car and Driver, October 18, 2021. Accessed on December 9, 2021 at *https://www.caranddriver.com/features/a37930458/ford-gm-ev-investments/.*

[109] Stellantis, ''Stellantis and LG Energy Solution to Form Joint Venture for Lithium-Ion Battery Production in North America,'' Press Release, October 18, 2021.

[110] Toyota Motor Corporation, ''Toyota Charges into Electrified Future in the U.S. with 10-year, $3.4 billion Investment,'' Press Release, October 18, 2021.

[111] Ford Motor Company, ''Ford to Lead America's Shift To Electric Vehicles With New Mega Campus in Tennessee and Twin Battery Plants in Kentucky; $11.4B Investment to Create 11,000 Jobs and Power New Lineup of Advanced EVs,'' Press Release, September 27, 2021.

[112] General Motors Corporation, ''GM and LG Energy Solution Investing $2.3 Billion in 2nd Ultium Cells Manufacturing Plant in U.S.,'' Press Release, April 16, 2021.

[113] Note that these targets are projected based on both projected future sales in applicable MYs and our final standards for each MY (*i.e.,* the footprint curve coefficients); the projected targets shown here will change depending on each manufacturer's actual sales in any given MY.

TABLE 21—CAR TARGETS—Continued

[CO_2 g/mile]

	2023	2024	2025	2026
JLR	171	163	154	136
Mazda	163	155	147	130
Mitsubishi	153	145	137	120
Nissan	166	158	149	132
Subaru	159	152	143	126
Tesla	179	171	161	144
Toyota	164	156	147	130
Volvo	176	168	158	141
VWA	164	156	148	131
Total	166	158	149	132

TABLE 22—LIGHT TRUCK TARGETS

[CO_2 g/mile]

	2023	2024	2025	2026
BMW	227	216	201	182
Daimler	227	216	201	182
FCA	241	229	213	193
Ford	249	237	220	200
General Motors	252	240	223	203
Honda	216	205	191	172
Hyundai Kia-H	231	219	204	184
Hyundai Kia-K	218	207	193	174
JLR	223	212	197	177
Mazda	206	196	182	163
Mitsubishi	194	184	171	153
Nissan	221	210	195	176
Subaru	202	192	178	160
Tesla	236	224	209	189
Toyota	227	215	201	181
Volvo	222	211	196	176
VWA	214	203	189	170
Total	234	222	207	187

TABLE 23—COMBINED FLEET TARGETS

[CO_2 g/mile]

	2023	2024	2025	2026
BMW	190	181	170	152
Daimler	200	190	177	159
FCA	231	219	204	185
Ford	228	217	202	183
General Motors	221	210	196	177
Honda	186	176	165	147
Hyundai Kia-H	171	163	153	136
Hyundai Kia-K	182	172	161	144
JLR	220	209	195	175
Mazda	184	175	164	146
Mitsubishi	174	165	155	137
Nissan	181	172	162	144
Subaru	191	182	169	151
Tesla	180	172	162	145
Toyota	191	181	169	151
Volvo	210	200	186	167
VWA	193	183	171	153
Total	202	192	179	161

The modeled achieved CO_2-equivalent (CO_2e) levels for the final standards are shown in Table 24 for cars, Table 25 for light trucks, and Table 26 for the combined fleets. These values were produced by the modeling analysis and represent the projected certification emissions values for possible compliance approaches with the final standards for each manufacturer. These achieved values, shown as averages over the respective car, truck and combined fleets, include the 2-cycle tailpipe emissions based on the modeled application of emissions-reduction technologies minus the modeled application of off-cycle credit technologies and the full A/C efficiency credits. The values also reflect any application of the final advanced technology multipliers, up to the cap. Hybrid pickup truck incentive credits were not modeled (the CCEMS version used does not have this capability) and are therefore not included in the achieved values.

Comparing the target and achieved values, it can be seen that some manufacturers are projected to have achieved values that are over target (higher emissions) on trucks, and under target (lower emissions) on cars, and vice versa for other manufacturers. This is a feature of the unlimited credit transfer (across a manufacturer's car and truck fleets) provision, which results in a compliance determination that is based on the combined car and truck fleet credits rather than a separate determination of each fleet's compliance. The application of technologies is influenced by the relative cost-effectiveness of technologies among each manufacturer's vehicles, which explains why different manufacturers exhibit different compliance approaches in the modeling results. For the combined fleet, the achieved values are typically close to, or slightly under the target values, which would represent the banking of credits that can be carried over into other model years. Note that an achieved value for a manufacturer's combined fleet that is above the target in a given model year does not indicate a likely failure to comply with the standards, since the model includes the GHG program credit banking provisions that allow credits from one year to be carried into another year.

TABLE 24—CAR ACHIEVED LEVELS

[CO_2 g/mile]

	2023	2024	2025	2026
BMW	192	173	138	121
Daimler	171	150	158	155
FCA	160	152	163	149
Ford	158	157	158	146
General Motors	163	158	158	153
Honda	163	153	147	138
Hyundai Kia-H	160	149	134	132
Hyundai Kia-K	166	155	143	142
JLR	224	188	189	189
Mazda	166	146	146	145
Mitsubishi	186	185	127	126
Nissan	170	157	132	132
Subaru	201	189	188	168
Tesla	−10	−10	−10	−10
Toyota	161	138	134	132
Volvo	207	204	198	181
VWA	165	153	156	127
Total	160	148	140	134

TABLE 25—LIGHT TRUCK ACHIEVED LEVELS

[CO_2 g/mile]

	2023	2024	2025	2026
BMW	197	197	203	203
Daimler	229	229	193	84
FCA	215	212	210	189
Ford	250	222	222	192
General Motors	265	238	217	193
Honda	214	167	163	163
Hyundai Kia-H	268	267	266	127
Hyundai Kia-K	209	188	195	194
JLR	214	203	179	146
Mazda	203	202	177	118
Mitsubishi	227	226	130	130
Nissan	205	200	195	181
Subaru	186	175	167	167
Tesla	−9	−9	−9	−9
Toyota	236	208	216	176
Volvo	158	156	162	161
VWA	213	203	171	147
Total	230	211	203	178

TABLE 26—COMBINED FLEET ACHIEVED LEVELS
[CO_2 g/mile]

	2023	2024	2025	2026
BMW	194	182	162	151
Daimler	199	188	175	122
FCA	206	202	203	183
Ford	225	205	205	180
General Motors	230	210	196	179
Honda	184	159	153	148
Hyundai Kia-H	171	160	147	131
Hyundai Kia-K	180	166	160	159
JLR	215	203	179	149
Mazda	184	173	161	132
Mitsubishi	207	206	128	128
Nissan	180	169	150	145
Subaru	190	178	173	168
Tesla	−10	−10	−10	−10
Toyota	192	167	168	150
Volvo	170	169	172	166
VWA	193	182	164	139
Total	197	181	173	157

2. Projected Compliance Costs per Vehicle

EPA has performed an updated assessment of the estimated per vehicle costs for manufacturers to meet the final MYs 2023–2026 standards. The total car, truck and combined fleet costs per vehicle for MY 2023–2026 are shown in Table 27.

TABLE 27—CAR, LIGHT TRUCK AND FLEET AVERAGE COST PER VEHICLE RELATIVE TO THE NO ACTION SCENARIO
[2018 Dollars]

	2023	2024	2025	2026
Car	$150	$288	$586	$596
Light Truck	485	732	909	1,356
Fleet Average	330	524	759	1,000

The car costs per vehicle by manufacturer from this analysis are shown in Table 28, followed by light truck costs by manufacturer in Table 29 and combined fleet costs by manufacturer in Table 30. As shown in these tables, the combined cost for car and truck fleets, averaged over all manufacturers, increases from MY 2023 to MY 2026 as the final standards become more stringent. The costs for trucks tend to be somewhat higher than for cars—many technology costs scale with engine and vehicle size—but it is important to note that the absolute emissions, and therefore emissions reductions, also tend to be higher for trucks. Projected costs for individual manufacturers vary based on the composition of vehicles produced. The estimated costs for California Framework Agreement manufacturers in MY 2026 range from approximately $600-$750 dollars per vehicle—because the final standards are more stringent than the Framework emission reduction targets—and fall within the wider cost range of non-Framework manufacturers. The estimated costs for Framework manufacturers are somewhat lower than the overall industry average costs of approximately $1000 per vehicle in MY 2026.

TABLE 28—CAR COSTS PER VEHICLE RELATIVE TO THE NO ACTION SCENARIO
[2018 Dollars]

	2023	2024	2025	2026
BMW *	$8	$112	$840	$762
Daimler	232	542	480	479
FCA	253	212	158	329
Ford *	19	18	227	202
General Motors	577	546	651	669
Honda *	67	310	362	329
Hyundai Kia-H	92	132	756	790
Hyundai Kia-K	170	273	644	619
JLR	26	619	581	547
Mazda	5	394	471	425
Mitsubishi	0	0	914	898
Nissan	228	327	1,289	1,194
Subaru	18	18	17	209

TABLE 28—CAR COSTS PER VEHICLE RELATIVE TO THE NO ACTION SCENARIO—Continued

[2018 Dollars]

	2023	2024	2025	2026
Tesla	0	0	0	0
Toyota	21	429	576	578
Volvo *	0	−1	119	113
VWA *	0	60	125	549
Total	150	288	586	596

* Framework Manufacturer.

TABLE 29—LIGHT TRUCK COST PER VEHICLE RELATIVE TO THE NO ACTION SCENARIO

[2018 Dollars]

	2023	2024	2025	2026
BMW *	$2	$2	$2	$9
Daimler	35	34	725	3,556
FCA	1,732	1,574	1,465	1,894
Ford *	39	477	428	754
General Motors	385	702	1,377	1,746
Honda *	118	915	950	878
Hyundai Kia-H	45	44	43	4,048
Hyundai Kia-K	1,194	1,327	1,230	1,144
JLR	133	314	1,321	1,770
Mazda	11	11	776	2,500
Mitsubishi	0	0	2,159	2,028
Nissan	699	783	748	1,082
Subaru	2	27	57	57
Tesla	0	0	0	0
Toyota	265	832	763	1,537
Volvo *	958	853	771	702
VWA *	0	125	461	856
Total	485	732	909	1,356

* Framework Manufacturer.

TABLE 30—FLEET AVERAGE COST PER VEHICLE RELATIVE TO THE NO ACTION SCENARIO

[2018 Dollars]

	2023	2024	2025	2026
BMW *	$6	$72	$538	$489
Daimler	136	298	591	1,925
FCA	1,502	1,355	1,254	1,639
Ford *	34	353	373	604
General Motors	452	648	1,123	1,369
Honda *	88	563	606	557
Hyundai Kia-H	87	123	688	1,093
Hyundai Kia-K	518	624	840	797
JLR	128	332	1,283	1,708
Mazda	7	207	612	1,411
Mitsubishi	0	0	1,557	1,482
Nissan	360	453	1,143	1,166
Subaru	6	26	50	101
Tesla	0	0	0	0
Toyota	125	597	655	978
Volvo *	714	634	603	551
VWA *	0	97	318	727
Total	330	524	759	1,000

* Framework Manufacturer.

Overall, EPA estimates the average costs of the final standards at $1,000 per vehicle in MY 2026 relative to meeting the No Action scenario in MY 2026. As discussed in Section VII of this preamble, there are benefits resulting from these costs including savings to consumers in the form of lower fuel costs.

In RIA 4.1.3, we present the costs per vehicle extending out through MY 2050. The data presented there show that projected costs per vehicle rise somewhat beyond MY 2026 prior to falling again due to the projected learning effects on technology costs. This helps to explain the higher present value and annualized costs in this final rule analysis (see Section VII.I of this preamble) compared to the proposed rule despite the MY 2026 cost per vehicle results being slightly lower in this final rule. The similarity of the cost per vehicle projections presented in the tables above and those projected in the proposal despite the more stringent final standards is due in large part to the lower battery costs projected in the final rule. Those lower costs result in higher penetrations of BEV and PHEV technology because, although more costly than non-plug-in technologies, they have such a significant effect on reducing fleet average emissions. In the modeling, the effect of higher penetrations of BEVs and PHEVs in turn results in other vehicles adding less technology toward meeting the fleet average emissions standards, thereby reducing per-vehicle costs on those vehicles as well.

3. Technology Penetration Rates

In this section we discuss the projected new sales technology penetration rates from EPA's updated analysis for the final standards. Additional detail on this topic can be found in the RIA. EPA's assessment, consistent with past EPA assessments, shows that the final standards can largely be met with increased sales of advanced gasoline vehicle technologies, and projects modest (17 percent) penetration rates of electrified vehicle technology.

Table 31, Table 32, and Table 33 show the projected penetration rates of BEVs and PHEVs combined (BEV+PHEV) technology under the final standards, with the remaining share being traditional or advanced ICE technology. Values shown reflect absolute values of fleet penetration and are not increments from the No Action scenario or other standards. It is important to note that this is a projection and represents one out of many possible compliance pathways for the industry. The standards are performance-based and do not mandate any specific technology for any manufacturer or any vehicles. As the standards become more stringent over MYs 2023 to 2026, the projected penetration of plug-in electrified vehicles (BEV and PHEV combined) increases by approximately 10 percentage points over this 4-year period, from about 7 percent in MY 2023 to about 17 percent in MY 2026. This is a greater penetration of BEVs and PHEVs than projected in the proposed rule, and is driven by several factors, including the increased stringency of our final standards, the updated baseline fleet that includes more EVs in the baseline, and the updated battery costs (based on which the model is selecting more BEV+PHEV technology as the optimal least-cost pathway to meet the standards). Conversely, in MY 2026 about 83 percent of new light-duty vehicle sales will continue to utilize ICE technology.

TABLE 31—CAR BEV+PHEV PENETRATION RATES UNDER THE FINAL STANDARDS

	2023 (%)	2024 (%)	2025 (%)	2026 (%)
BMW	4	9	22	29
Daimler	15	18	18	19
FCA	20	22	22	22
Ford	13	13	16	21
General Motors	11	11	11	13
Honda	2	5	8	12
Hyundai Kia-H	10	10	18	18
Hyundai Kia-K	3	3	8	8
JLR	0	3	3	3
Mazda	7	13	13	13
Mitsubishi	3	3	3	3
Nissan	3	3	17	17
Subaru	0	0	0	3
Tesla	100	100	100	100
Toyota	2	6	9	9
Volvo	3	3	4	11
VWA	16	17	17	25
Total	10	12	16	17

TABLE 32—LIGHT TRUCK BEV+PHEV PENETRATION RATES UNDER THE FINAL STANDARDS

	2023 (%)	2024 (%)	2025 (%)	2026 (%)
BMW	10	10	10	10
Daimler	8	8	21	56
FCA	13	13	13	18
Ford	1	7	8	17
General Motors	4	8	14	18
Honda	0	13	17	17
Hyundai Kia-H	0	0	0	23
Hyundai Kia-K	11	11	11	11
JLR	16	16	28	35
Mazda	0	0	0	21
Mitsubishi	0	0	16	16
Nissan	4	5	5	9
Subaru	1	1	1	1
Tesla	100	100	100	100
Toyota	1	12	12	16

TABLE 32—LIGHT TRUCK BEV+PHEV PENETRATION RATES UNDER THE FINAL STANDARDS—Continued

	2023 (%)	2024 (%)	2025 (%)	2026 (%)
Volvo	22	22	23	23
VWA	11	12	12	18
Total	5	9	11	17

TABLE 33—FLEET BEV+PHEV PENETRATION RATES UNDER THE FINAL STANDARDS

	2023 (%)	2024 (%)	2025 (%)	2026 (%)
BMW	6	10	18	22
Daimler	12	14	20	36
FCA	14	15	15	18
Ford	5	9	10	18
General Motors	6	9	13	16
Honda	1	8	12	14
Hyundai Kia-H	9	9	17	19
Hyundai Kia-K	6	6	9	9
JLR	15	15	26	34
Mazda	3	7	7	17
Mitsubishi	2	2	10	10
Nissan	3	4	14	15
Subaru	0	0	0	1
Tesla	100	100	100	100
Toyota	2	9	10	12
Volvo	17	17	18	20
VWA	13	14	14	21
Total	7	10	14	17

C. Are the final standards feasible?

The final standards are based on the extensive light-duty GHG technical analytical record developed over the past dozen years, as represented by EPA's supporting analyses for the 2010 and 2012 final rules, the Mid-Term Evaluation (including the Draft TAR, Proposed Determination and Final Determinations), as well as the updated analyses for this rule and the supporting analyses for the SAFE rule.[114] Our conclusion that the program is feasible is based in part on a projection that the standards primarily will be met using the same advances in light-duty vehicle engine technologies, transmission technologies, electric drive systems, aerodynamics, tires, and vehicle mass reduction that have gradually entered the light-duty vehicle fleet over the past decade and that are already in use in today's vehicles. Further support that the technologies needed to meet the standards do not need to be developed but are already widely available and in use on vehicles can be found in the fact that five vehicle manufacturers, representing nearly 30 percent of U.S. auto sales, agreed in 2019 with the State of California that their nationwide fleets would meet GHG emission reduction targets more stringent than the applicable EPA standards for MYs 2021 and 2022, and similar to the final EPA standards for MYs 2022 and 2023.

Our updated analysis projects that the final standards can be met with a fleet that achieves a gradually increasing market share of EVs and PHEVs, approximately 7 percent in MY 2023 up to about 17 percent in MY 2026 (see Section III.B.3 of this preamble and the following paragraph). While this represents an increasing penetration of zero-emission and near-zero emission vehicles into the fleet during the 2023–2026 model years, we believe that the growth in the projected rate of penetration is consistent with current trends and market forces, as discussed below.

The proliferation of GHG-reducing technologies has been steadily increasing within the light-duty vehicle fleet. As of MY 2020, more than half of light-duty gasoline spark ignition engines use direct injection (GDI) engines and more than a third are turbocharged. Nearly half of all light-duty vehicles have planetary automatic transmissions with 8 or more gear ratios, and one-quarter are using continuously variable transmissions (CVT). The sales of vehicles with 12V start/stop systems has increased from approximately 7 percent to approximately 42 percent between MY 2015 and MY 2020. Significant levels of powertrain electrification of all types (HEV, PHEV, and EV) have increased more than 3-fold from MY 2015 to MY 2020. In MY 2015, hybrid electric vehicles accounted for approximately 2.4 percent of vehicle sales, which increased to approximately 6.5 percent of vehicle sales in MY 2020. Production of plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (EVs) together comprised 0.7 percent of vehicle production in MY 2015 and increased to about 2.2 percent for MY 2020 (projected to be 4.1 percent for MY 2021),[115] and from January through September 2021 they represented 3.6 percent of total U.S. light-duty vehicle sales.[116] The pace of introduction of new EV and PHEV models is rapidly increasing. For

[114] Although the MTE 2018 Revised Final Determination ''withdrew'' the 2017 Final Determination, the D.C. Circuit Court has noted that EPA did ''not erase[ ] the Draft Technical Assessment Report, Technical Support Document, or any of the other prior evidence [EPA] collected.'' California v. EPA, 940 F.3d 1342, 1351 (D.C. Cir. 2019).

[115] The 2021 EPA Automotive Trends Report, Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975,'' EPA–420R–21023, November 2021.

[116] Argonne National Laboratory, ''Light Duty Electric Drive Vehicles Monthly Sales Updates,'' September 2021, accessed on October 20, 2021 at: *https://www.anl.gov/es/light-duty-electric-drive-vehicles-monthly-sales-updates.*

example, the number of EV and PHEV models available for sale in the U.S. has more than doubled from about 24 in MY 2015 to about 60 in MY 2021.[117] Even under the less stringent SAFE standards, manufacturers have indicated that the number of EV and PHEV models will increase to more than 80 by MY 2023, with many more expected to reach production before the end of the decade.[118]

Despite the increased penetration of electrified vehicles that we are projecting for the final standards, the large majority (more than 80 percent) of vehicles projected to be produced by manufacturers in complying with the final standards would draw from the various advanced gasoline vehicle technologies already present in many vehicles within today's new vehicle fleet. This projection is consistent with EPA's previous conclusions that a wide variety of emission reducing technologies are already available at reasonable costs for manufacturers to incorporate into their vehicles within the timeframe of the final standards.

Although the projected penetrations of BEVs and PHEVs are higher than in the proposal, we find they more accurately reflect the current momentum and direction of technological innovation in the automotive industry. By all accounts, a shift to zero-emission vehicle technologies is well underway, and it presents a strong potential for dramatic reductions in GHG and criteria pollutant emissions. Major automakers as well as many global jurisdictions and U.S. states have announced plans to shift the light-duty fleet toward zero-emissions technology.

As noted in the proposed rule, a proliferation of recent announcements from automakers signals a rapidly growing shift in investment away from internal-combustion technologies and toward high levels of electrification. These automaker announcements are supported by continued advances in automotive electrification technologies and are further driven by the need to compete in a global market as other countries implement aggressive zero-emission transportation policies. For example, in January 2021, General Motors announced plans to become carbon neutral by 2040, including an effort to shift its light-duty vehicles entirely to zero-emissions by 2035.[119] In March 2021, Volvo announced plans to make only electric cars by 2030,[120] and Volkswagen announced that it expects half of its U.S. sales will be all-electric by 2030.[121] In April 2021, Honda announced a full electrification plan to take effect by 2040, with 40 percent of North American sales expected to be fully electric or fuel cell vehicles by 2030, 80 percent by 2035 and 100 percent by 2040.[122] In May 2021, Ford announced that they expect 40 percent of their global sales will be all-electric by 2030.[123] In June 2021, Fiat announced a move to all electric vehicles by 2030, and in July 2021 its parent corporation Stellantis announced an intensified focus on electrification across all of its brands.[124] [125] Also in July 2021, Mercedes-Benz announced that all of its new architectures would be electric-only from 2025, with plans to become ready to go all-electric by 2030 where possible.[126] In September 2021, Toyota announced large new investments in battery production and development to support an increasing focus on electrification,[127] and in December 2021, announced plans to increase this investment as well as introduce 30 BEV models by 2030.[128] On August 5, 2021, in conjunction with the announcement of Executive Order 14037, many of these automakers, as well as the United Auto Workers and the Alliance for Automotive Innovation, expressed continued commitment to these announcements and support for the goal of achieving 40 to 50 percent sales of zero emissions vehicles by 2030.[129]

These announcements, and others like them, continue a pattern over the past several years in which many manufacturers have taken steps to aggressively pursue zero-emission technologies, introduce a wide range of zero-emission vehicle models, and reduce their reliance on the internal-combustion engine in various markets around the globe.[130] [131] These goals and investments have been coupled with a continuing increase in the market penetration of new zero-emission vehicles (3.6 percent of new U.S. light-duty vehicle sales so far in calendar year 2021,[132] projected to be 4.1 percent of production in MY 2021, up from 2.2 percent of production in MY 2020),[133] as well as a rapidly increasing diversity of electrified vehicle models.[134] For example, the number of EV and PHEV models available for sale in the U.S. has more than doubled from about 24 in MY 2015 to about 60 in MY 2021, with offerings in a growing range of vehicle segments.[135] Recent model announcements indicate that this number will increase to more than 80 models by MY 2023, with many more expected to reach production before the

[117] *Fueleconomy.gov,* 2015 Fuel Economy Guide and 2021 Fuel Economy Guide.

[118] Environmental Defense Fund and M.J. Bradley & Associates, ''Electric Vehicle Market Status—Update, Manufacturer Commitments to Future Electric Mobility in the U.S. and Worldwide,'' April 2021.

[119] General Motors, ''General Motors, the Largest U.S. Automaker, Plans to be Carbon Neutral by 2040,'' Press Release, January 28, 2021.

[120] Volvo Car Group, ''Volvo Cars to be fully electric by 2030,'' Press Release, March 2, 2021.

[121] Volkswagen Newsroom, ''Strategy update at Volkswagen: The transformation to electromobility was only the beginning,'' March 5, 2021. Accessed June 15, 2021 at *https://www.volkswagen-newsroom.com/en/stories/strategy-update-at-volkswagen-the-transformation-to-electromobility-was-only-the-beginning-6875.*

[122] Honda News Room, ''Summary of Honda Global CEO Inaugural Press Conference,'' April 23, 2021. Accessed June 15, 2021 at *https://global.honda/newsroom/news/2021/c210423eng.html.*

[123] Ford Motor Company, ''Superior Value From EVs, Commercial Business, Connected Services is Strategic Focus of Today's 'Delivering Ford+' Capital Markets Day,'' Press Release, May 26, 2021.

[124] Stellantis, ''World Environment Day 2021—Comparing Visions: Olivier Francois and Stefano Boeri, in Conversation to Rewrite the Future of Cities,'' Press Release, June 4, 2021.

[125] Stellantis, ''Stellantis Intensifies Electrification While Targeting Sustainable Double-Digit Adjusted Operating Income Margins in the Mid-Term,'' Press Release, July 8, 2021.

[126] Mercedes-Benz, ''Mercedes-Benz prepares to go all-electric,'' Press Release, July 22, 2021.

[127] Toyota Motor Corporation, ''Video: Media briefing & Investors briefing on batteries and carbon neutrality'' (transcript), September 7, 2021. Accessed on September 16, 2021 at *https://global.toyota/en/newsroom/corporate/35971839.html#presentation.*

[128] Toyota Motor Corporation, ''Video: Media Briefing on Battery EV Strategies,'' Press Release, December 14, 2021. Accessed on December 14, 2021 at *https://global.toyota/en/newsroom/corporate/36428993.html.*

[129] The White House, ''Statements on the Biden Administration's Steps to Strengthen American Leadership on Clean Cars and Trucks,'' August 5, 2021. Accessed on October 19, 2021 at *https://www.whitehouse.gov/briefing-room/statements-releases/2021/08/05/statements-on-the-biden-administrations-steps-to-strengthen-american-leadership-on-clean-cars-and-trucks/.*

[130] Environmental Defense Fund and M.J. Bradley & Associates, ''Electric Vehicle Market Status—Update, Manufacturer Commitments to Future Electric Mobility in the U.S. and Worldwide,'' April 2021.

[131] International Council on Clean Transportation, ''The end of the road? An overview of combustion-engine car phase-out announcements across Europe,'' May 10, 2020.

[132] Argonne National Laboratory, ''Light Duty Electric Drive Vehicles Monthly Sales Updates,'' September 2021, accessed on October 20, 2021 at: *https://www.anl.gov/es/light-duty-electric-drive-vehicles-monthly-sales-updates.*

[133] ''The 2021 EPA Automotive Trends Report: Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975,'' EPA–420r–21023, November 2021.

[134] Muratori et al., ''The rise of electric vehicles—2020 status and future expectations,'' Progress in Energy v3n2 (2021), March 25, 2021. Accessed July 15, 2021 at *https://iopscience.iop.org/article/10.1088/2516-1083/abe0ad.*

[135] Fueleconomy.gov, 2015 Fuel Economy Guide and 2021 Fuel Economy Guide.

end of the decade.[136] Many of the zero-emission vehicles already on the market today cost less to drive than conventional vehicles,[137 138] offer improved performance and handling,[139] and can be charged at a growing network of public chargers [140] as well as at home.

At the same time, an increasing number of global jurisdictions and U.S. states plan to take actions to shift the light-duty fleet toward zero-emissions technology. In 2020, California announced an intention to require increasing numbers of zero-emission vehicles to meet the goal that, by 2035, all new light-duty vehicles sold in the state be zero-emission vehicles.[141] New York [142 143] has adopted similar targets and requirements to take effect by 2035, with Massachusetts [144] poised to follow. Several other states may adopt similar provisions by 2050 as members of the International Zero-Emission Vehicle Alliance.[145] Globally, at least 12 countries, as well as numerous local jurisdictions, have announced similar goals to shift all new passenger car sales to zero-emission vehicles in the coming years, including Norway (2025); the Netherlands, Denmark, Iceland, Ireland, Sweden, and Slovenia (2030); Canada and the United Kingdom (2035); France and Spain (2040); and Costa Rica (2050).[146 147] Together, these countries represent approximately 13 percent of the global market for passenger cars,[148] in addition to that represented by the aforementioned U.S. states and other global jurisdictions. Already, all-electric and plug-in vehicles together comprise about 18 percent of the new vehicle market in Western Europe,[149] led by Norway which reached 77 percent all-electric and 91 percent plug-in sales in September 2021.[150 151]

In addition to substantially reducing GHG emissions, a subsequent rulemaking for MY 2027 and beyond will address criteria pollutant and air toxics emissions from the new light-duty vehicle fleet—especially important considerations as the fleet transitions toward zero-emission vehicles. EPA expects that this subsequent rulemaking will take critical steps to continue the trajectory of transportation emission reductions needed to protect public health and welfare. Achieving this trajectory with increased fleet penetration of zero-emission vehicles would bring with it other advantages as well, such as potentially large reductions in roadway pollution and noise in overburdened communities, and potentially support for the future development of vehicle-to-grid services that could become a key enabler for increased utilization of renewable energy sources, such as wind and solar, across the grid.[152]

D. How did EPA consider alternatives in selecting the final program?

In Section II.C of this preamble, we described alternatives that we considered in addition to the final standards. See Figure 5 and Table 18 in Section II.C of this preamble. The analyses of the costs, GHG emission reductions, and technology penetrations for each alternative are presented in the RIA Chapters 4 and 5. The alternatives analyzed for the final rule, in addition to the standards we are finalizing, are the ''Proposal'', which are the proposed standards, and ''Alternative 2 minus 10'' which is the Alternative 2 standards reduced by 10 g/mile in MY 2026, on which EPA sought public comment.

In comparing the per-vehicle costs of the final standards and the two alternatives, we first note that, in the updated analysis for this final rule, the estimated costs of both the proposed standards and final standards are lower than the estimated cost of the proposed standards as originally presented in the proposed rule, largely due to the updated battery costs used in our final rule analysis. For example, in the proposed rule the proposed standards were projected to cost about $1,044 per vehicle in MY 2026 whereas in the final rule analysis the costs for the proposed standards are estimated at $644 per vehicle, about $400 lower than in the proposed rule. Further, the cost of our final standards ($1,000 per vehicle) remains less than the costs for the proposed standards presented in the proposed rule, as well as being slightly less than the costs for Alternative 2 minus 10 standards ($1,070 per vehicle). In addition, while the final standards and Alternative 2 minus 10 standards have similar per-vehicle costs in MY 2026, it is important to consider the per-vehicle costs in MY 2023 and 2024—when available lead time is shorter. In these model years, the final standards are slightly more costly than the proposed standards (by about $55 per vehicle in 2023 and $140 per vehicle in 2024) and less costly than the Alternative 2 minus 10 standards (by more than $200 per vehicle in MYs 2023 and 2024). EPA believes that given lead time considerations for the early years of the program (MY 2023 and 2024), the lower per-vehicle cost to manufacturers of the final standards compared to the Alternative 2 minus 10 standards are an

[136] Environmental Defense Fund and M.J. Bradley & Associates, ''Electric Vehicle Market Status—Update, Manufacturer Commitments to Future Electric Mobility in the U.S. and Worldwide,'' April 2021.

[137] Department of Energy Vehicle Technologies Office, Transportation Analysis Fact of the Week #1186, ''The National Average Cost of Fuel for an Electric Vehicle is about 60% Less than for a Gasoline Vehicle,'' May 17, 2021.

[138] Department of Energy Vehicle Technologies Office, Transportation Analysis Fact of the Week #1190, ''Battery-Electric Vehicles Have Lower Scheduled Maintenance Costs than Other Light-Duty Vehicles,'' June 14, 2021.

[139] Consumer Reports, ''Electric Cars 101: The Answers to All Your EV Questions,'' November 5, 2020. Accessed June 8, 2021 at *https://www.consumerreports.org/hybrids-evs/electric-cars-101-the-answers-to-all-your-ev-questions/*.

[140] Department of Energy Alternative Fuels Data Center, Electric Vehicle Charging Station Locations. Accessed on May 19, 2021 at *https://afdc.energy.gov/fuels/electricity_locations.html#/find/nearest?fuel=ELEC*.

[141] State of California Office of the Governor, ''Governor Newsom Announces California Will Phase Out Gasoline-Powered Cars & Drastically Reduce Demand for Fossil Fuel in California's Fight Against Climate Change,'' Press Release, September 23, 2020.

[142] New York State Senate, Senate Bill S2758, 2021–2022 Legislative Session. January 25, 2021.

[143] Governor of New York Press Office, ''In Advance of Climate Week 2021, Governor Hochul Announces New Actions to Make New York's Transportation Sector Greener, Reduce Climate-Altering Emissions,'' September 8, 2021. Accessed on September 16, 2021 at *https://www.governor.ny.gov/news/advance-climate-week-2021-governor-hochul-announces-new-actions-make-new-yorks-transportation*.

[144] Commonwealth of Massachusetts, ''Request for Comment on Clean Energy and Climate Plan for 2030,'' December 30, 2020.

[145] ZEV Alliance, ''International ZEV Alliance Announcement,'' Dec. 3, 2015. Accessed on July 16, 2021 at *http://www.zevalliance.org/international-zev-alliance-announcement/*.

[146] International Council on Clean Transportation, ''Update on the global transition to electric vehicles through 2019,'' July 2020.

[147] Reuters, ''Canada to ban sale of new fuel-powered cars and light trucks from 2035,'' June 29, 2021. Accessed July 1, 2021 from *https://www.reuters.com/world/americas/canada-ban-sale-new-fuel-powered-cars-light-trucks-2035-2021-06-29/*.

[148] International Council on Clean Transportation, ''Growing momentum: Global overview of government targets for phasing out new internal combustion engine vehicles,'' posted 11 November 2020, accessed April 28, 2021 at *https://theicct.org/blog/staff/global-ice-phaseout-nov2020*.

[149] Ewing, J., ''China's Popular Electric Vehicles Have Put Europe's Automakers on Notice,'' New York Times, accessed on November 1, 2021 at *https://www.nytimes.com/2021/10/31/business/electric-cars-china-europe.html*.

[150] Klesty, V., ''With help from Tesla, nearly 80% of Norway's new car sales are electric,'' Reuters, accessed on November 1, 2021 at *https://www.reuters.com/business/autos-transportation/tesla-pushes-norways-ev-sales-new-record-2021-10-01/*.

[151] Norwegian Information Council for Road Traffic (OFV), ''New car boom and electric car record in September,'' October 1, 2021, accessed on November 1, 2021 at *https://ofv.no/aktuelt/2021/nybil-boom-og-elbilrekord-i-september*.

[152] Department of Energy Electricity Advisory Committee, ''Enhancing Grid Resilience with Integrated Storage from Electric Vehicles: Recommendations for the U.S. Department of Energy,'' June 25, 2018.

important consideration. See Section VI of this preamble and RIA Chapter 6.

In comparing the cumulative CO_2 emissions reductions of the final standards and the two alternatives, the final standards and the Alternative 2 minus 10 standards achieve essentially identical cumulative CO2 reductions through 2050, about 1.1 billion tons (about 50 percent) more than the proposed standards. See RIA Chapter 5.1.1.2.

Finally, when comparing the combined BEV+PHEV technology penetrations across the alternatives, the final standards and the Alternative 2 minus 10 standards provide the same level of BEV+PHEV market penetration (17 percent) in MY 2026 and thus the same strong launching point for a more ambitious program for 2027 and later, which EPA will establish in a subsequent rulemaking. The proposed standards would achieve less penetration of BEV+PHEV (13 percent) in MY 2026. See RIA Table 4–26, and Table 4–31. EPA believes that the higher projected penetration of BEVs and PHEVs that would be achieved through the final standards or the Alternative 2 minus 10 standards represents a reasonable level of technology commensurate with industry projections for this time period and is feasible in this time frame as further discussed in Section III.B.3 and III.C of this preamble.

EPA's updated analysis shows that the final standards and the Alternative 2 minus 10 standards achieve nearly the same cumulative CO_2 reductions and the same level of electric vehicle penetration in 2026—and thus provide the same strong launch point for the next phase of standards for MY 2027 and later. The important difference between the final standards and the Alternative 2 minus 10 standards is in the per-vehicle costs during the earlier years (MYs 2023 and 2024), where we believe the lower costs of the final standards are important considering the shorter lead time for manufacturers. EPA discusses further in Section VI of this preamble the reasons we believe the final standards represent the appropriate standards under the CAA.

IV. How does this final rule reduce GHG emissions and their associated effects?

A. Impact on GHG Emissions

EPA used the CCEMS to estimate GHG emissions inventories including tailpipe emissions from light-duty cars and trucks and the upstream emissions associated with the fuels used to power those vehicles (both at the refinery and the electricity generating unit). The upstream emission factors used in this final rule modeling have been updated since EPA's proposed rule. The updated upstream emission factors are identical to those used in the recent NHTSA CAFE proposal and were generated using the DOE/Argonne GREET model.[153 154]

The resultant annual GHG inventory estimates are shown in Table 34 for the calendar years 2023 through 2050. The table shows that the final program would result in significant net GHG reductions compared to the No Action scenario. The cumulative CO_2, CH4 and N_2O emissions reductions from the final program total 3,100 MMT, 3.3 MMT and 0.097 MMT, respectively, through 2050.

TABLE 34—ESTIMATED GHG IMPACTS OF THE FINAL STANDARDS RELATIVE TO THE NO ACTION SCENARIO

Year	Emission impacts relative to no action			Percent change from no action		
	CO_2 (million metric tons)	CH_4 (metric tons)	N_2O (metric tons)	CO_2 (%)	CH_4 (%)	N_2O (%)
2023	−5	−5,160	−145	0	0	0
2024	−10	−10,121	−293	−1	−1	−1
2025	−17	−17,385	−514	−1	−1	−1
2026	−27	−27,382	−818	−2	−2	−2
2027	−39	−39,716	−1,174	−3	−2	−2
2028	−51	−52,913	−1,558	−4	−3	−3
2029	−63	−65,083	−1,915	−5	−4	−4
2030	−74	−76,908	−2,263	−6	−5	−5
2031	−85	−88,128	−2,592	−7	−6	−6
2032	−95	−99,017	−2,912	−7	−6	−7
2033	−105	−109,272	−3,214	−8	−7	−8
2034	−114	−118,720	−3,498	−9	−8	−8
2035	−122	−127,397	−3,756	−10	−8	−9
2036	−129	−135,037	−3,989	−11	−9	−10
2037	−136	−141,600	−4,193	−11	−10	−11
2038	−141	−147,293	−4,371	−12	−10	−11
2039	−146	−152,481	−4,529	−12	−10	−12
2040	−150	−156,884	−4,663	−13	−11	−12
2041	−154	−160,588	−4,774	−13	−11	−13
2042	−156	−163,579	−4,863	−13	−11	−13
2043	−159	−166,077	−4,937	−14	−12	−13
2044	−161	−168,294	−4,998	−14	−12	−14
2045	−162	−170,147	−5,049	−14	−12	−14
2046	−163	−171,666	−5,090	−14	−12	−14
2047	−164	−172,863	−5,122	−15	−12	−14
2048	−165	−173,945	−5,150	−15	−13	−14
2049	−166	−176,188	−5,169	−15	−13	−14
2050	−166	−178,391	−5,187	−15	−13	−15

[153] U.S. Department of Transportation National Highway Traffic Safety Administration, 2021. Technical Support Document: Proposed Rulemaking for Model Years 2024–2026 Light-Duty Vehicle Corporate Average Fuel Economy Standards, Section 5.2.

[154] U.S. Department of Energy, Argonne National Laboratory, Greenhouse gases, Regulated Emissions, and Energy use in Transportation (GREET) Model, Last Update: 9 Oct. 2020, *https://greet.es.anl.gov/.*

TABLE 34—ESTIMATED GHG IMPACTS OF THE FINAL STANDARDS RELATIVE TO THE NO ACTION SCENARIO—Continued

Year	Emission impacts relative to no action			Percent change from no action		
	CO_2 (million metric tons)	CH_4 (metric tons)	N_2O (metric tons)	CO_2 (%)	CH_4 (%)	N_2O (%)
Sum	−3,125	−3,272,234	−96,735	−9	−8	−8

B. Climate Change Impacts From GHG Emissions

Elevated concentrations of GHGs have been warming the planet, leading to changes in the Earth's climate including changes in the frequency and intensity of heat waves, precipitation, and extreme weather events, rising seas, and retreating snow and ice. The changes taking place in the atmosphere as a result of the well-documented buildup of GHGs due to human activities are changing the climate at a pace and in a way that threatens human health, society, and the natural environment. While EPA is not making any new scientific or factual findings with regard to the well-documented impact of GHG emissions on public health and welfare in support of this rule, EPA is providing some scientific background on climate change to offer additional context for this rulemaking and to increase the public's understanding of the environmental impacts of GHGs.

Extensive additional information on climate change is available in the scientific assessments and the EPA documents that are briefly described in this section, as well as in the technical and scientific information supporting them. One of those documents is EPA's 2009 Endangerment and Cause or Contribute Findings for Greenhouse Gases Under section 202(a) of the CAA (74 FR 66496, December 15, 2009). In the 2009 Endangerment Finding, the Administrator found under section 202(a) of the CAA that elevated atmospheric concentrations of six key well-mixed GHGs—CO_2, methane (CH_4), nitrous oxide (N_2O), HFCs, perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6)—''may reasonably be anticipated to endanger the public health and welfare of current and future generations'' (74 FR 66523). The 2009 Endangerment Finding, together with the extensive scientific and technical evidence in the supporting record, documented that climate change caused by human emissions of GHGs (including HFCs) threatens the public health of the U.S. population. It explained that by raising average temperatures, climate change increases the likelihood of heat waves, which are associated with increased deaths and illnesses (74 FR 66497). While climate change also increases the likelihood of reductions in cold-related mortality, evidence indicates that the increases in heat mortality will be larger than the decreases in cold mortality in the U.S. (74 FR 66525). The 2009 Endangerment Finding further explained that compared with a future without climate change, climate change is expected to increase tropospheric ozone pollution over broad areas of the U.S., including in the largest metropolitan areas with the worst tropospheric ozone problems, and thereby increase the risk of adverse effects on public health (74 FR 66525). Climate change is also expected to cause more intense hurricanes and more frequent and intense storms of other types and heavy precipitation, with impacts on other areas of public health, such as the potential for increased deaths, injuries, infectious and waterborne diseases, and stress-related disorders (74 FR 66525). Children, the elderly, and the poor are among the most vulnerable to these climate-related health effects (74 FR 66498).

The 2009 Endangerment Finding also documented, together with the extensive scientific and technical evidence in the supporting record, that climate change touches nearly every aspect of public welfare [155] in the U.S. with resulting economic costs, including: Changes in water supply and quality due to changes in drought and extreme rainfall events; increased risk of storm surge and flooding in coastal areas and land loss due to inundation; increases in peak electricity demand and risks to electricity infrastructure; and the potential for significant agricultural disruptions and crop failures (though offset to some extent by carbon fertilization). These impacts are also global and may exacerbate problems outside the U.S. that raise humanitarian, trade, and national security issues for the U.S. (74 FR 66530).

In 2016, the Administrator issued a similar finding for GHG emissions from aircraft under section 231(a)(2)(A) of the CAA.[156] In the 2016 Endangerment Finding, the Administrator found that the body of scientific evidence amassed in the record for the 2009 Endangerment Finding compellingly supported a similar endangerment finding under CAA section 231(a)(2)(A), and also found that the science assessments released between the 2009 and the 2016 Findings ''strengthen and further support the judgment that GHGs in the atmosphere may reasonably be anticipated to endanger the public health and welfare of current and future generations'' (81 FR 54424).

Since the 2016 Endangerment Finding, the climate has continued to change, with new observational records being set for several climate indicators such as global average surface temperatures, GHG concentrations, and sea level rise. Additionally, major scientific assessments continue to be released that further advance our understanding of the climate system and the impacts that GHGs have on public health and welfare both for current and future generations. These updated observations and projections document the rapid rate of current and future climate change both globally and in the U.S.[157 158 159 160]

155 The CAA states in section 302(h) that ''[a]ll language referring to effects on welfare includes, but is not limited to, effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other air pollutants.'' 42 U.S.C. 7602(h).

156 ''Finding that Greenhouse Gas Emissions From Aircraft Cause or Contribute to Air Pollution That May Reasonably Be Anticipated To Endanger Public Health and Welfare.'' 81 FR 54422, August 15, 2016. (''2016 Endangerment Finding'').

157 USGCRP, 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018. *https://nca2018.globalchange.gov*.

158 Roy, J., P. Tschakert, H. Waisman, S. Abdul Halim, P. Antwi-Agyei, P. Dasgupta, B. Hayward, M. Kanninen, D. Liverman, C. Okereke, P.F. Pinho, K. Riahi, and A.G. Suarez Rodriguez, 2018: Sustainable Development, Poverty Eradication and Reducing Inequalities. In: Global Warming of 1.5 °C. An IPCC Special Report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to

Continued

C. Global Climate Impacts and Benefits Associated With the Final Rule's Estimated GHG Emissions Reductions

Transportation is the largest source of GHG emissions in the U.S., making up 29 percent of all emissions. Within the transportation sector, light-duty vehicles are the largest contributor, 58 percent, to transportation GHG emissions in the U.S., and 17 percent of all emissions.[161] Reducing GHG emissions, including the four GHGs affected by this program, will contribute toward the goal of holding the increase in the global average temperature to well below 2 °C above pre-industrial levels, and subsequently reducing the probability of severe climate change related impacts including heat waves, drought, sea level rise, extreme climate and weather events, coastal flooding, and wildfires. While EPA did not conduct modeling to specifically quantify changes in climate impacts resulting from this rule in terms of avoided temperature change or sea-level rise, we did quantify the climate benefits by monetizing the emission reductions through the application of the social cost of greenhouse gases (SC–GHGs), as described in Section VII.D of this preamble.

V. How would the final rule impact non-GHG emissions and their associated effects?

A. Impact on Non-GHG Emissions

The model runs that EPA conducted estimated the inventories of non-GHG air pollutants resulting from tailpipe emissions from light-duty cars and trucks, and the upstream emissions associated with the fuels used to power those vehicles (both at the refinery and the electricity generating unit). The tailpipe emissions of $PM_{2.5}$, NO_X, VOCs, CO and SO_2 are estimated using emission factors from EPA's MOVES model. The tailpipe emission factors used have been updated since EPA's proposed rule to be identical to those used in NHTSA's recent CAFE NPRM.[162] The upstream emissions are calculated using emission factors applied to the gallons of liquid fuels projected to be consumed and the kilowatt hours of electricity projected to be consumed. The upstream emission factors used in this final rule modeling have also been updated since EPA's proposed rule. The updated upstream emission factors are identical to those used in the recent NHTSA CAFE proposal and were generated using the DOE/Argonne GREET model.[163] [164] Table 35 presents the annual refinery and electricity generating unit upstream emission impacts for years 2023 through 2050. See RIA Chapter 5.1 for more information on emission impacts. We estimate that the final standards will lead to reductions in non-GHG pollutants from the refinery sector and increases in non-GHG pollutants from the EGU sector. The projected net upstream NO_X and $PM_{2.5}$ reductions are smaller in the final rule compared to the proposal, and the projected net increase in upstream SO_2 emissions is larger in the final rule compared to the proposal.

On the whole, the final standards reduce non-GHG emissions and Section VII.A of this preamble details the substantial $PM_{2.5}$-related health benefits associated with the non-GHG emissions reductions that this rule will achieve. Table 36 presents the annual tailpipe and total upstream inventory impacts for years 2023 through 2050 and Table 37 presents the net annual inventory impacts for those same years. Specifically, we project net reductions in emissions of non-GHG pollutants from upstream sources, except for SO_2. For tailpipe emissions we project initial increases from most non-GHG pollutants, except SO_2, followed by decreases in all non-GHG pollutants over time. The initial increases in non-GHG tailpipe emissions in the years after the rule's implementation are due to projections about the gasoline-fueled LD vehicle population in the final rule scenario, including decreased scrappage of older vehicles, see Section III of this preamble. Increases in total upstream SO_2 are due to increased EGU emissions associated with fleet penetration of electric vehicles.

TABLE 35—ESTIMATED REFINERY AND ELECTRICITY GENERATING UNIT NON-GHG EMISSION IMPACTS OF THE FINAL STANDARDS RELATIVE TO THE NO ACTION SCENARIO

Year	$PM_{2.5}$ (U.S. tons)		NO_X (U.S. tons)		SO_2 (U.S. tons)		VOC (U.S. tons)		CO (U.S. tons)	
	EGU	Refinery	EGU	Refinery	EGU	Refinery	EGU	Refinery	EGU	Refinery
2023	111	−110	1,320	−1,226	1,154	−558	197	−1,941	699	−688
2024	244	−222	2,898	−2,471	2,512	−1,118	437	−3,899	1,551	−1,392
2025	417	−380	4,957	−4,231	4,260	−1,911	756	−6,713	2,681	−2,391
2026	640	−595	7,601	−6,607	6,473	−2,984	1,174	−10,560	4,158	−3,745
2027	857	−842	10,172	−9,329	8,577	−4,214	1,592	−15,010	5,632	−5,302
2028	1,067	−1,099	12,667	−12,161	10,565	−5,494	2,011	−19,700	7,105	−6,930
2029	1,291	−1,344	15,275	−14,850	12,836	−6,731	2,425	−24,132	8,571	−8,475
2030	1,506	−1,581	17,773	−17,440	15,045	−7,930	2,821	−28,421	9,976	−9,968
2031	1,704	−1,802	20,057	−19,858	17,106	−9,057	3,183	−32,456	11,262	−11,368
2032	1,898	−2,018	22,283	−22,197	19,147	−10,154	3,536	−36,385	12,517	−12,729
2033	2,078	−2,219	24,324	−24,373	21,060	−11,181	3,859	−40,068	13,669	−14,000
2034	2,243	−2,408	26,254	−26,430	22,645	−12,139	4,187	−43,508	14,818	−15,196
2035	2,389	−2,579	27,964	−28,286	24,029	−13,006	4,483	−46,623	15,853	−16,278
2036	2,521	−2,732	29,497	−29,940	25,249	−13,781	4,753	−49,415	16,797	−17,247
2037	2,636	−2,864	30,849	−31,373	26,304	−14,456	4,997	−51,846	17,646	−18,089
2038	2,735	−2,979	31,996	−32,607	27,175	−15,040	5,210	−53,952	18,384	−18,819

the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press. *https://www.ipcc.ch/sr15/chapter/chapter-5*.

[159] National Academies of Sciences, Engineering, and Medicine. 2019. Climate Change and Ecosystems. Washington, DC: The National Academies Press. *https://doi.org/10.17226/25504*.

[160] NOAA National Centers for Environmental Information, State of the Climate: Global Climate Report for Annual 2020, published online January 2021, retrieved on February 10, 2021, from *https://www.ncdc.noaa.gov/sotc/global/202013*.

[161] *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2019* (EPA–430–R–21–005, published April 2021).

[162] 86 FR 49602, September 3, 2021.

[163] U.S. Department of Transportation National Highway Traffic Safety Administration, 2021. Technical Support Document: Proposed Rulemaking for Model Years 2024–2026 Light-Duty Vehicle Corporate Average Fuel Economy Standards, Section 5.2.

[164] U.S. Department of Energy, Argonne National Laboratory, Greenhouse gases, Regulated Emissions, and Energy use in Transportation (GREET) Model, Last Update: 9 Oct. 2020, *https://greet.es.anl.gov/*.

TABLE 35—ESTIMATED REFINERY AND ELECTRICITY GENERATING UNIT NON-GHG EMISSION IMPACTS OF THE FINAL STANDARDS RELATIVE TO THE NO ACTION SCENARIO—Continued

Year	$PM_{2.5}$ (U.S. tons)		NO_X (U.S. tons)		SO_2 (U.S. tons)		VOC (U.S. tons)		CO (U.S. tons)	
	EGU	Refinery	EGU	Refinery	EGU	Refinery	EGU	Refinery	EGU	Refinery
2039	2,806	−3,077	32,826	−33,659	27,772	−15,529	5,368	−55,763	18,930	−19,443
2040	2,862	−3,159	33,480	−34,535	28,215	−15,938	5,498	−57,286	19,380	−19,966
2041	2,900	−3,226	33,932	−35,240	28,481	−16,267	5,596	−58,526	19,716	−20,391
2042	2,924	−3,277	34,212	−35,780	28,598	−16,520	5,667	−59,496	19,955	−20,721
2043	2,939	−3,318	34,384	−36,211	28,621	−16,722	5,721	−60,285	20,134	−20,989
2044	2,933	−3,349	34,312	−36,539	28,528	−16,869	5,719	−60,881	20,122	−21,179
2045	2,921	−3,372	34,165	−36,788	28,371	−16,979	5,704	−61,342	20,067	−21,323
2046	2,905	−3,389	33,977	−36,973	28,180	−17,058	5,682	−61,694	19,988	−21,430
2047	2,883	−3,399	33,714	−37,083	27,927	−17,103	5,648	−61,923	19,866	−21,495
2048	2,860	−3,407	33,436	−37,170	27,660	−17,137	5,612	−62,111	19,734	−21,545
2049	2,851	−3,431	33,350	−37,475	27,512	−17,308	5,606	−62,238	19,706	−21,633
2050	2,841	−3,454	33,249	−37,769	27,351	−17,473	5,597	−62,347	19,669	−21,713

TABLE 36—ESTIMATED UPSTREAM AND TAILPIPE NON-GHG EMISSION IMPACTS OF THE FINAL STANDARDS RELATIVE TO THE NO ACTION SCENARIO

Year	Upstream (U.S. tons)					Tailpipe emissions (U.S. tons)				
	$PM_{2.5}$	NO_X	SO_2	VOC	CO	$PM_{2.5}$	NO_X	SO_2	VOC	CO
2023	1	94	596	−1,744	12	7	717	−37	1,003	6,505
2024	22	427	1,394	−3,462	159	9	1,173	−77	1,693	10,048
2025	37	726	2,349	−5,957	290	8	1,645	−133	2,424	13,248
2026	45	994	3,490	−9,386	413	4	2,090	−208	3,149	15,356
2027	15	843	4,363	−13,418	331	−4	2,399	−295	3,702	15,150
2028	−32	505	5,072	−17,689	174	−21	2,383	−386	3,820	9,475
2029	−53	425	6,105	−21,707	96	−46	2,108	−471	3,566	−474
2030	−75	333	7,115	−25,601	8	−77	1,588	−554	2,962	−14,786
2031	−99	199	8,049	−29,273	−106	−106	1,167	−633	2,469	−27,521
2032	−120	85	8,994	−32,849	−212	−137	699	−709	1,896	−41,484
2033	−141	−49	9,878	−36,209	−331	−168	228	−780	1,287	−55,715
2034	−165	−177	10,506	−39,321	−377	−199	−241	−846	666	−70,103
2035	−190	−322	11,023	−42,140	−425	−287	−1,250	−906	−2,905	−92,848
2036	−211	−443	11,468	−44,661	−449	−321	−1,693	−959	−3,647	−106,860
2037	−228	−524	11,848	−46,849	−444	−353	−2,079	−1,006	−4,323	−119,740
2038	−244	−610	12,135	−48,742	−435	−383	−2,419	−1,046	−4,946	−131,691
2039	−271	−833	12,243	−50,395	−512	−409	−2,698	−1,081	−5,495	−142,121
2040	−297	−1,055	12,277	−51,788	−586	−434	−2,943	−1,110	−5,993	−151,549
2041	−325	−1,308	12,214	−52,930	−674	−455	−3,138	−1,134	−6,422	−159,628
2042	−353	−1,568	12,078	−53,829	−766	−473	−3,290	−1,153	−6,784	−166,420
2043	−379	−1,827	11,899	−54,564	−855	−490	−3,416	−1,168	−7,117	−172,314
2044	−415	−2,227	11,659	−55,162	−1,057	−503	−3,508	−1,178	−7,402	−177,017
2045	−451	−2,624	11,392	−55,638	−1,256	−514	−3,575	−1,185	−7,660	−180,783
2046	−483	−2,995	11,122	−56,012	−1,442	−523	−3,633	−1,191	−7,914	−184,085
2047	−516	−3,368	10,823	−56,274	−1,629	−531	−3,675	−1,194	−8,135	−186,783
2048	−548	−3,734	10,523	−56,499	−1,811	−538	−3,708	−1,196	−8,332	−189,005
2049	−580	−4,124	10,204	−56,633	−1,926	−543	−3,729	−1,197	−8,488	−190,712
2050	−613	−4,519	9,878	−56,749	−2,044	−547	−3,745	−1,198	−8,619	−192,095

TABLE 37—ESTIMATED NON-GHG NET EMISSION IMPACTS OF THE FINAL STANDARDS RELATIVE TO THE NO ACTION SCENARIO

Year	Emission impacts relative to no action (U.S. tons)					Percent change from no action				
	$PM_{2.5}$	NO_X	SO_2	VOC	CO	$PM_{2.5}$	NO_X	SO_2	VOC	CO
2023	9	811	559	−741	6,517	0	0	0	0	0
2024	31	1,601	1,318	−1,769	10,207	0	0	1	0	0
2025	45	2,371	2,217	−3,533	13,538	0	0	2	0	0
2026	49	3,084	3,282	−6,237	15,769	0	0	2	0	0
2027	11	3,242	4,068	−9,716	15,480	0	0	3	−1	0
2028	−53	2,889	4,686	−13,869	9,649	0	0	4	−1	0
2029	−99	2,534	5,633	−18,141	−378	0	0	4	−2	0
2030	−152	1,921	6,560	−22,639	−14,778	0	0	5	−2	0
2031	−205	1,366	7,416	−26,804	−27,627	−1	0	6	−3	0
2032	−256	785	8,285	−30,953	−41,695	−1	0	7	−4	−1
2033	−309	179	9,098	−34,922	−56,045	−1	0	7	−5	−1
2034	−364	−417	9,660	−38,656	−70,480	−1	0	8	−6	−1
2035	−477	−1,572	10,117	−45,045	−93,272	−2	0	8	−7	−2
2036	−532	−2,136	10,508	−48,309	−107,310	−2	−1	8	−8	−3
2037	−581	−2,603	10,842	−51,172	−120,183	−2	−1	9	−9	−3
2038	−627	−3,030	11,088	−53,688	−132,126	−2	−1	9	−10	−4
2039	−680	−3,531	11,162	−55,890	−142,633	−2	−1	9	−11	−5
2040	−731	−3,998	11,167	−57,781	−152,135	−3	−1	9	−11	−5
2041	−780	−4,445	11,080	−59,352	−160,302	−3	−1	9	−12	−6
2042	−826	−4,859	10,925	−60,612	−167,186	−3	−2	9	−13	−7

TABLE 37—ESTIMATED NON-GHG NET EMISSION IMPACTS OF THE FINAL STANDARDS RELATIVE TO THE NO ACTION SCENARIO—Continued

Year	Emission impacts relative to no action (U.S. tons)					Percent change from no action				
	$PM_{2.5}$	NO_X	SO_2	VOC	CO	$PM_{2.5}$	NO_X	SO_2	VOC	CO
2043	−869	−5,242	10,731	−61,681	−173,168	−3	−2	9	−13	−7
2044	−918	−5,735	10,481	−62,564	−178,073	−3	−2	9	−14	−8
2045	−964	−6,199	10,207	−63,298	−182,039	−4	−2	9	−14	−8
2046	−1,007	−6,629	9,931	−63,926	−185,527	−4	−2	8	−15	−9
2047	−1,047	−7,044	9,630	−64,409	−188,412	−4	−3	8	−15	−9
2048	−1,085	−7,441	9,326	−64,831	−190,816	−4	−3	8	−16	−10
2049	−1,123	−7,854	9,007	−65,121	−192,639	−4	−3	8	−16	−10
2050	−1,161	−8,264	8,680	−65,368	−194,139	−5	−3	7	−16	−11

B. Health and Environmental Effects Associated With Exposure to Non-GHG Pollutants Impacted by the Final Standards

Along with reducing GHG emissions, these standards will also have an impact on non-GHG (criteria and air toxic pollutant) emissions from vehicles and non-GHG emissions that occur during the extraction, transport, distribution and refining of fuel and from power plants. The non-GHG emissions that will be impacted by the standards contribute, directly or via secondary formation, to concentrations of pollutants in the air which affect human and environmental health. These pollutants include particulate matter, ozone, nitrogen oxides, sulfur oxides, carbon monoxide and air toxics. Chapter 7 of the RIA includes more detailed information about the health and environmental effects associated with exposure to these non-GHG pollutants. This includes pollutant-specific health effect information, discussion of exposure to the mixture of traffic-related pollutants in the near road environment, and effects of particulate matter and gases on visibility, effects of ozone on ecosystems, and the effect of deposition of pollutants from the atmosphere to the surface.

C. Air Quality Impacts of Non-GHG Pollutants

Photochemical air quality modeling is necessary to accurately project levels of most criteria and air toxic pollutants, including ozone and PM. Air quality models use mathematical and numerical techniques to simulate the physical and chemical processes that affect air pollutants as they disperse and react in the atmosphere. Based on inputs of meteorological data and source information, these models are designed to characterize primary pollutants that are emitted directly into the atmosphere and secondary pollutants that are formed through complex chemical reactions within the atmosphere. Photochemical air quality models have become widely recognized and routinely utilized tools in regulatory analysis for assessing the impacts of control strategies.

Section V.A of this preamble presents projections of the changes in non-GHG emissions due to the standards. Section VII.E of this preamble describes the monetized non-GHG health impacts of this final rule which are estimated using a reduced-form benefit-per-ton approach. The atmospheric chemistry related to ambient concentrations of $PM_{2.5}$, ozone and air toxics is very complex, and making predictions based solely on emissions changes is extremely difficult. However, based on the magnitude of the emissions changes predicted to result from the standards, we expect that there will be very small changes in ambient air quality in most places. The changes in tailpipe and upstream non-GHG emissions that were inputs to the air quality modeling analysis for the 2012 rule were larger than the changes in non-GHG emissions projected for this final rule. The air quality modeling for the 2012 rule projected very small impacts across most of the country, with the direction of the small impact (increase or decrease) dependent on location.[165] The next phase of LD standards will be considered in a separate, future multi-pollutant rulemaking for model years 2027 and beyond. We are considering how best to project air quality impacts from changes in non-GHG emissions in that future rulemaking analysis.

VI. Basis for the Final GHG Standards Under CAA Section 202(a)

In this section, EPA discusses the basis for our final standards under our authority in CAA section 202(a), how we are balancing the factors considered in our assessment that the final standards are appropriate, how this balancing of factors differs from that used in the SAFE rule, and how further technical analysis and consideration of the comments we received has informed our decision on the final standards. This section draws from information presented elsewhere in this preamble, including EPA's statutory authority in Section II.A.3 of this preamble, our technical analysis in Section III of this preamble, GHG emissions impacts in Section IV of this preamble, non-GHG emissions impacts in Section V, and the total costs and benefits of the rule in Section VII of this preamble.

EPA is finalizing standards for MYs 2023 and 2024 as proposed and more stringent standards than proposed for MYs 2025 and 2026. Supported by analytical updates that respond to public comments on battery costs and other model inputs, our analysis shows that ICE vehicles are projected to remain the large majority of new vehicles in this timeframe, and that together with moderate levels of electrification, the continued adoption of advanced gasoline vehicle GHG-reducing technologies already existing in the market will be sufficient to meet the final standards. Our technical analysis includes projections of increased BEV+PHEV penetration that are reasonable and commensurate with other industry projections for this same time period. Taking into consideration the full technical record, public comments on the proposal, and the available compliance flexibilities, we believe the final standards represent an appropriate level of stringency, considering relevant factors as discussed below.

EPA has considered the technological feasibility and cost of the final standards, available lead time for manufacturers, and other relevant factors under section 202(a) of the CAA. Based on our analysis, discussed in greater detail in other sections of this preamble and Chapter 2 of the RIA, we believe that the final standards are reasonable and appropriate. Greater reductions in GHG emissions from light duty vehicles over these model years are

[165] U.S. EPA, 2012. Regulatory Impact Analysis: Final Rulemaking for 2017–2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average fuel Economy Standards. EPA–420–R–12–016.

both feasible and warranted as a step to reduce the impacts of climate change on public health and welfare. In addition, the rule will achieve reductions in emissions of some criteria pollutants and air toxics that will achieve benefits for public health and welfare. Our analysis for this rule supports the conclusion that standards for MYs 2023–2026 are technologically feasible and the costs of compliance for manufacturers are reasonable. In addition, we project that there will be net savings to consumers over the lifetime of vehicles meeting the standards, which we think is a more significant consideration than the anticipated increase in the initial cost for new vehicles. We also note the benefits of the program are projected to significantly exceed the costs.

In selecting the final standards, we considered a range of more- and less-stringent alternatives. Compared to the most stringent alternative that EPA considered (see Section III.D of this preamble), the final standards achieve nearly the same cumulative GHG, criteria pollutant, and air toxics emissions reductions, and a similar level of BEV+PHEV penetration in MY 2026. However, the final standards have lower costs during MYs 2023 and 2024, which EPA considered when determining the appropriate balance between emissions reductions and cost, in the limited lead time available in these earlier years. Compared to the less stringent proposed standards, the final standards achieve greater emissions reductions at similar costs to those we had estimated for the proposed standards in the proposed rule, given the updates to our cost estimates based on public comments and updated data.

A. Consideration of Technological Feasibility and Lead Time

The technological readiness of the auto industry to meet the final standards for MYs 2023–2026 is best understood in the context of the decade-long light-duty vehicle GHG emission reduction program in which the auto industry has developed and introduced on an ongoing basis ever more effective GHG-reducing technologies. The result is that now manufacturers have access to a wide range of GHG-reducing technologies, many of which were in the early stages of development at the beginning of EPA's program in 2012, and which still have potential to reach greater penetration across all new vehicles. (See Sections III.B and III.C of this preamble and Chapter 2 of the RIA for a discussion of technological progression, status of technology penetration, and our assessment of continuing technology penetration across the fleet.)

In addition to the technologies that were anticipated by EPA in the 2012 rule to make significant contributions toward compliance with standards for this timeframe, the recent technological advancements and successful implementations of electrification have been particularly significant and have greatly increased the available options for manufacturers to meet more stringent standards. Because BEVs and PHEVs have GHG emissions well below their vehicle footprint targets, even a relatively small number of these vehicles can have a large influence on a manufacturer's compliance credits in a given year.

As part of EPA's evaluation of the technological feasibility of the final standards, we have modeled manufacturers' decisions in choosing among available emission reduction technologies to incorporate in their vehicles, taking into account both the projected costs and effectiveness of the technologies. This analytic approach is consistent with EPA's past analyses. See Section III.C of this preamble and Chapter 2 of the RIA. The analysis demonstrates that a wide variety of emission reducing technologies are already available for manufacturers to incorporate into their vehicles within the time frame of the final standards.

Our updated analysis projects that about 17 percent of vehicles meeting the MY 2026 final standards will be BEVs or PHEVs (See Section III.B.3 of this preamble). In making this projection, we are considering both the influence of the standards in that year and the availability and cost of the various available technologies. Among the updates for this final rule analysis, our updated battery costs are one significant factor. For the final rule assessment, EPA is projecting lower battery costs over this timeframe compared to our projections in the proposed rule. We believe that together with other analysis updates (described further in Section III of this preamble and Chapter 2 of the RIA), the cost for manufacturers to implement BEV and PHEV technologies is more accurately represented.

In addition to considering the contribution of BEV and PHEV technologies in the overall feasibility of the standards, EPA also considered the continued advancements and further fleet penetration of internal combustion engine (ICE) powertrain emissions-reducing technology. As was the case for each of the prior EPA assessments for this timeframe, the large majority of vehicles are projected to remain ICE (non-BEV+PHEVs) under the final standards (*e.g.,* ICE levels are projected to be 83 percent in MY 2026). As shown in more detail in Chapter 4 of the RIA, together with moderate levels of electrification, the final standards can be met by continued adoption of advanced ICE technologies already existing in the market. We believe the penetrations of existing emissions-reducing ICE technologies projected by our analysis support our conclusion that the final standards are appropriate.

EPA believes the technological achievements already developed and applied to vehicles within the current new vehicle fleet will enable the industry to achieve the final standards even without the development of new technologies beyond those already widely available. Rather, in response to the increased stringency of the final standards, automakers would be expected to adopt such technologies at an increasing pace across more of their vehicle fleets. As we discuss further below, our assessment shows that a large portion of the current fleet (MY 2021 vehicles), across a wide range of vehicle segments, already meets the MY 2023 footprint-based GHG targets being finalized here. Compliance with the final standards will necessitate greater implementation and pace of technology penetration through MY 2026 using existing GHG reduction technologies, including further deployment of BEV and PHEV technologies.

Another factor in considering the feasibility of the final standards is the fact that five automakers voluntarily entered into the California Framework Agreements with the California Air Resources Board, first announced in July 2019, to meet more stringent GHG emission reduction targets nationwide than the relaxed standards in the SAFE rule.[166] These voluntary actions by automakers that collectively represent nearly 30 percent of the U.S. vehicle market speak directly to the feasibility of meeting standards at least as stringent as the emission reduction targets under the California Framework Agreements. As discussed in Section II.A.8 of this preamble, the California Framework Agreements were a consideration in our assessment of the revised EPA standards.

In the SAFE rulemaking EPA concluded that the projected level of advanced technologies was ''too high from a consumer-choice perspective'' and ultimately could lead to automakers

[166] *https://ww2.arb.ca.gov/resources/documents/framework-agreements-clean-cars* (last updated on May 22, 2021).

changing the vehicle types they offer.[167] EPA currently does not believe these conclusions are accurate, even with the higher technology penetration rates for BEVs and PHEVs that we project in this rulemaking compared to rates that we projected in the SAFE rulemaking. Rather, EPA's judgment is that the history of significant developments in automotive offerings over the last ten years supports the conclusion that automakers are capable of deploying a wide range of advanced technologies across the entire vehicle fleet, and that consumers remain interested and willing to purchase vehicles with advanced technologies. Reinforcing this updated judgment are the recent automaker announcements (reviewed in Section III.C of this preamble) signaling an accelerating transition to electrified vehicles across a wide range of vehicle segments, including not only passenger cars and SUVs but also including examples of light-duty pickup trucks and minivans. EPA sees no reason why the standards revised by this final rule would fundamentally alter such trends in technology deployment.

We believe that the continuation of trends already underway, as exemplified in part by the aforementioned public announcements about manufacturers' plans to transition to electrified vehicles, as well as continuing advancements in EV technology, support the feasibility of this level of BEV+PHEV penetration during the time period of the rule. EPA also believes that current levels and trends, which include significant ongoing and near-term growth, of public and private charging infrastructure are consistent with the projected levels of BEV+PHEV penetration.[168] Moreover, EPA is committed to encouraging the rapid development and deployment of zero-emission vehicles, and we are finalizing compliance flexibilities and incentives to support this transition (see Section II.B.1 of this preamble).

As noted above, we are projecting that BEVs and PHEVs can play a significant role in complying with the final standards. While not all manufacturers will introduce these technologies into their lineups at the same rate, a robust market exists for credit trading between manufacturers, as discussed further below, which has enabled more manufacturers to access the credits generated by the implementation of BEVs and PHEVs by other manufacturers.

In our modeling of manufacturer decisions and technology applications, the current and previous assessments of potential standards for this timeframe have relied primarily on projections that do not account for credit trading between manufacturers. When credits are available for less than the marginal cost of compliance, EPA anticipates that an automaker might choose to adopt a compliance strategy relying on credits.[169] As noted in the proposal, EPA recognizes that it previously considered that some manufacturers may be unwilling to design a compliance strategy based on purchase of credits from another manufacturer. However, based in part on our review of the evidence of active credit trading cataloged in the annual EPA Automotive Trends Report [170] [171] and consideration of public comments, we conclude there is increased acceptance of credit trading among manufacturers and that it is appropriate to recognize that manufacturers consider credit trading as a compliance strategy. For both of these reasons, we believe it is appropriate to consider the effect of credit trading between firms in our assessment of the feasibility of the final standards.

The potential contribution of traded credits towards a manufacturer's compliance strategy is magnified as more BEVs and PHEVs are introduced into the fleet. Because the standards are largely set assuming the overall fleet will be largely ICE vehicles, a manufacturer who produces more than a moderate number of BEVs and PHEVs may end up with GHG credits that could expire if not used internally or sold to another manufacturer. EPA believes that credit trading will continue to be an important compliance flexibility that manufacturers will take advantage of, especially when differences and timing of product strategies are likely to persist across manufacturers.

As an additional way to evaluate the potential effect of credit trading on the auto industry's compliance costs, EPA conducted a sensitivity analysis to evaluate the potential contribution of credit trading between manufacturers towards compliance in MYs 2023 and 2024 (as well as the later MYs), and the more realistic treatment of banked credits which are otherwise modeled as unused in our primary analysis which assumes no trading. Under this scenario, credits that are generated by one manufacturer can be used by another manufacturer if it results in an overall reduction in compliance costs.[172] The results of this sensitivity analysis, presented in RIA 4.1.5.1 under the 'perfect trading' case, show that by accounting for credit trading between manufacturers the projected vehicle costs are reduced dramatically from $330 without trading to $147 with trading in MY 2023, and from $534 to $360 in MY 2024. Considering lead-time for these earlier model years, these results illustrate how credit trading allows manufacturers to meet the standards in a more cost-effective manner from an overall industry perspective, which can involve some manufacturers applying additional technology and selling credits while other manufacturers might rely on purchasing credits in lieu of adding technology. We would consider any analysis which assumes all manufactures participate in a frictionless and transparent market to be a bounding representation of how credits might actually be traded between manufacturers. It is likely that the actual market behavior will lie somewhere between our no-trading (central case) and a frictionless market with all manufacturers. We believe our modeling of the 'perfect trading' sensitivity case, with two groups of manufacturers participating in independent markets, will be closer to actual credit trading behavior than the no-trading case. Note that the results of our central case

[167] 85 FR 25116.

[168] Brown, A., A. Schayowitz, and E. Klotz (2021). ''Electric Vehicle Infrastructure Trends from the Alternative Fueling Station Locator: First Quarter 2021.'' National Renewable Energy Laboratory Technical Report NREL/TP–5400–80684, *https://afdc.energy.gov/files/u/publication/electric_vehicle_charging_infrastructure_trends_first_quarter_2021.pdf,* accessed 11/3/2021.

[169] ''FCA historically pursued compliance with fuel economy and greenhouse gas regulations in the markets where it operated through the most cost effective combination of developing, manufacturing and selling vehicles with better fuel economy and lower GHG emissions, purchasing compliance credits, and, as allowed by the U.S. federal Corporate Average Fuel Economy (''CAFE'') program, paying regulatory penalties. The cost of each of these components of FCA's strategy has increased and is expected to continue to increase in the future. The compliance strategy for the combined company is currently being assessed by Stellantis management.'' Stellantis N.V. (2020). ''Annual Report and Form 20–F for the year ended December 31, 2020.''

[170] More than 10 vehicle firms collectively have participated in 70 credit trading transactions since the inception of EPA's program through MY 2019, including many of the largest automotive firms. (See EPA Report 420–R–21–003 page 110 and Figure 5.15, January 2021).

[171] Credit trading between firms has occurred throughout the nearly ten year history of the EPA light-duty vehicle GHG program, including during MY 2012, the first year (See EPA Report 420–R–14–011, April 2014).

[172] Note that the fleet was divided between non-Framework and Framework manufacturers, and trading was assumed to occur for manufacturers within those groups, but not between. This is a relatively more restrictive assumption than true ''perfect'' trading, that will tend to increase the likelihood of credits going unused or applied inefficiently, and thus potentially higher costs than in a true perfect trading scenario.

analysis, even without accounting for trading between manufacturers, projects feasible compliance pathways for MYs 2023 and 2024.

EPA also received comments which cited independent analyses of how the industry's existing bank of credits can contribute towards meeting the proposed standards for MYs 2023 and 2024. UCS provided in their comments modeling results generated using a version of the CCEMS model which had been modified to include manufacturer credit trading. UCS also included the modeling restriction that non-Framework manufacturers would continue with technology adoption in MY2023 as projected under the less stringent SAFE standards. UCS concluded that with the use of existing banked credits and maintaining product plans projected under a no-action case, there is ''sufficient credit availability for manufacturers to comply with the proposed MY2023 and 2024 standards, even without resorting to additional technology deployment or credit carryback from improvements made post-MY2024.'' Similarly, EDF cited recent modeling results generated using the OMEGA model, concluding that ''the analysis demonstrates that automakers will be able to comply with the proposed MY 2023 standard largely through the application of existing credits.'' The commenter's analysis supported this conclusion even under the most conservative assumption where non-Framework manufacturers did not have access to credits held through MY2020 by Framework manufacturers, had limited use of off-cycle credits, and only reduced tailpipe GHG emissions along the trajectory of the SAFE rule's MY2021–2023 requirements. In other words, these commenters concluded that automakers could comply with the model year 2023 and 2024 standards without adjusting their existing product plans at all, simply by acquiring a portion of the large bank of available credits (and this analysis did not even consider the flexibilities available to manufacturers of carrying back credits earned in future years). EPA agrees with the commenters' central conclusion that the standards can be met in MYs 2023 and 2024 only with the technology deployment that would have been expected under the SAFE rule standards, the voluntary actions taken by some manufacturers beyond the SAFE standards (*e.g.,* the California Framework agreements), and the effective utilization of existing credits. This further reinforces that the lead time for the MYs 2023 and 2024 standards is sufficient.

In any given model year, some vehicles will be ''credit generators,'' over-performing compared to the footprint-based CO_2 target in that model year, while other vehicles will be ''debit generators'' and under-performing against their footprint-based targets. Together, an automaker's mix of credit-generator and debit-generator vehicles contribute to its sales-weighted fleet average CO_2 performance, compared to its standard, for that year. If a manufacturer's sales-weighted fleet CO_2 performance is better than its fleet average standard at the end of the model year, those credits can be banked for the automaker's future use in certain years (under the credit carry-forward provisions) or sold to other manufacturers (under the credit trading provisions). Likewise, if a manufacturer's sales-weighted fleet CO_2 performance falls short of its fleet average standard at the end of a model year, the automaker can use banked credits or purchased credits to meet the standard. These provisions of the GHG credit program were designed to recognize that automakers typically have a multi-year redesign cycle and not every vehicle will be redesigned every year to add GHG-reducing technology. Moreover, when GHG-reducing technology is added, it will generally not achieve emissions reductions corresponding exactly to a single year-over-year change in stringency of the standards. Furthermore, in recognition of the possibility that a manufacturer might comply with a standard for a given model year with credits earned in a future model year (under the allowance for ''credit carryback''), a manufacturer may also choose to carry a deficit forward up to three years before showing compliance with that model year.

EPA examined manufacturer certification data to assess the extent to which MY 2021 vehicles already being produced and sold today would be credit generators compared to the model year 2023 targets (accounting for projected off-cycle and air conditioning credits). As detailed in Chapter 2.4 of the RIA, automakers are selling approximately 216 vehicle models (60 percent of which are advanced gasoline technology vehicles) that would be credit generators compared to the proposed model year 2023 targets, and they appear in nearly all light-duty vehicle market segments. This information supports our conclusion about the feasibility of vehicles with existing technologies meeting the MY 2023 standards. We also considered the ability of MY 2021 vehicles to generate credits based on the MY 2021 and MY 2022 standards relaxed in the SAFE rule. Of the 1370 distinct MY 2021 vehicle models, EPA's analysis (RIA, Chapter 2.4) indicates that 336 of these models (25 percent of today's new vehicle fleet offerings) are credit generators for the MY 2022 SAFE standards: It can be assumed that those models are also generating credits for the MY 2021 standards.

This represents an opportunity for manufacturers to build their credit banks for both MY 2021 and MY 2022 and carry those credits forward to help meet the MY 2023–2026 standards. These data demonstrate that the technology to meet these standards is available today, as well as opportunities for manufacturers to sell more of the credit-generator vehicles as another available strategy to generate credits that will help them comply with the model year 2023 and later standards. Our analysis clearly shows this could be done within vehicle segments to maintain consumer choice (we would not expect that overall car/truck fleet mix would shift), as credit-generating vehicles exist across vehicle segments, representing 95 percent of vehicle sales. Under the fleet-average based standards, manufacturers have multiple feasible paths to compliance, including varying sales volumes of credit generating vehicles, adopting GHG-reducing technologies, and implementing other credit strategies and incentive provisions including those finalized in this rule. Pricing strategy is a well-documented approach [173] to shifting a manufacturer's sales mix to achieve compliance. As UCS mentioned in their comments, General Motors published

[173] *E.g.,* When fuel economy standards were not footprint-based, less efficient vehicles were priced higher than more efficient vehicles to encourage sales of the latter. Austin, D., and T. Dinan (2004). ''Clearing the air: The costs and consequences of higher CAFE standards and increased gasoline taxes.'' Journal of Environmental Economics and Management 50: 562–582. Greene, D., P. Patterson, M. Singh, and J. Li (2005). ''Feebates, rebates, and gas-guzzler taxes: A study of incentives for increased fuel economy.'' Energy Policy 33: 757–775 found that automakers were more likely to add technology than use pricing mechanisms to achieve standards. Whitefoot, K., M. Fowlie, and S. Skerlos (2017). ''Compliance by Design: Influence of Acceleration Trade-offs on CO_2 Emissions and Costs of Fuel Economy and Greenhouse Gas Regulations.'' Environmental Science and Technology 51: 10307–10315 found evidence consistent with automakers using trade-offs with acceleration as yet another path to comply with fuel economy standards. However, EPA's Trends Report (420–R–21–003 Figure 3.11 and Figure 3.15) shows that manufacturers have proven capable of increasing both fuel economy and acceleration performance simultaneously.

literature[174] on its own pricing strategy model it uses to make decisions on how best to motivate consumers into purchasing alternate vehicles that help achieve fleetwide CAFE compliance.

The availability of current models across a range of vehicle segments meeting the final standards is notable. EPA recognizes that auto design and development is a multi-year process, which imposes some constraints on the ability of manufacturers to immediately redesign vehicles with new technologies. However, EPA also understands that this multi-year process means that the industry's product plans developed in response to EPA's 2012 GHG standards rulemaking for MYs 2017–2025 have largely continued, notwithstanding the SAFE rule that was published on April 30, 2020 and that did not relax standards until MY 2021. In their past comments on EPA's light-duty GHG programs, some automakers broadly stated that they generally require about five years to design, develop, and produce a new vehicle model.[175] Under that schedule, it would follow that in most cases the vehicles that automakers will be selling during the first years of this MY 2023–26 program were already designed under the original, more stringent GHG standards finalized in 2012 for those model years. At the time of the proposal of these final standards, the relaxed GHG standards under the SAFE rule had been in place for little more than one year. During this time, the ability of the industry to commit to a change of plans to take advantage of the SAFE rule's relaxed standards, especially for MYs 2023 and later, was highly uncertain in light of pending litigation,[176] and concern was regularly expressed across the auto industry over the uncertain future of the SAFE standards.

In its comments, the Alliance emphasized ''the importance and significance of design cycles on real world response to changes proposed in today's policy. DOT and EPA jointly proposed the SAFE Vehicles Rule on August 24, 2018, signaling some probability of changes in federal regulations on GHG and CAFE. It is reasonable to expect that some manufacturers updated production plans for new vehicles accordingly, and consistent with the corporate strategies, for some of the affected model years in the SAFE proposal (MYs 2021–2024, for instance).'' If it were indeed the case that auto manufacturers updated product plans based on the SAFE proposed rule as a signal of policy changes, then it also seems reasonable that automakers might have similarly initiated production planning to prepare for potentially more stringent standards in response to the President's January 21, 2021 Executive Order 13990 directing EPA to review the SAFE rule standards, or if not then when EPA's proposed rule issued later in 2021. In any case, EPA's modeling reflects the significance of design cycles, and is not dependent on manufacturers having retained their pre-SAFE product strategies without change. While EPA anticipates that different manufacturers will adopt different compliance strategies for the standards established by this rule, EPA believes, based on the availability of technologies, the results of its modeling, and the flexibilities of the program, that these standards can be achieved by manufacturers at a reasonable cost.

In fact, due in part to this uncertainty, five automakers voluntarily agreed to more stringent national emission reduction targets under the California Framework Agreements. Therefore, the automakers' own past comments regarding product plan development and the regulatory and litigation history of the GHG standards since 2012 support EPA's expectation that automakers remain largely on track in terms of technological readiness within their product plans to meet the approximate trajectory of increasingly stringent standards initially promulgated in 2012. Although we do not believe that automakers have significantly changed their product plans in response to the SAFE final rule issued in 2020, any that did would have done so relatively recently and there is reason to expect that, for any automakers that changed their plans after the SAFE rule, the automakers' earlier plans could be reinstated or adapted with little change. We also note that some automakers may have adopted product plans to over comply with the more stringent, pre-SAFE standards, with the intention of selling credits to other automakers. For these automakers, the final standards of this rule reduce or eliminate the sudden disruption to product plans caused by the SAFE rule.

Despite the relaxed SAFE standards in the U.S., manufacturers have continued to advance technology deployment in response to steadily more stringent standards in other global markets. In comments referenced by CARB, Roush provided further justification that adequate lead time and available technology already exist, in part, due to global regulatory pressures. Roush indicates that, globally, manufacturers have been developing and implementing technology to meet international standards more stringent than in the U.S., and regularly incorporate these technologies into U.S. products.

EPA considers this an additional aspect of its analysis that mitigates concerns about lead time for manufacturers to meet the final standards beginning with the 2023 model year. We see no reason to expect that the major GHG-reducing technologies that automakers have already developed and introduced, or have already been planning for near-term implementation, will not be available for model year 2023–2026 vehicles. Thus, in contrast to the situation that existed prior to EPA's adoption of the initial light-duty GHG standards in the 2012 rule, automakers now have had the benefit of at least 8 to 9 years of planning and development for increasing levels of GHG-reducing technologies in preparation for meeting the final standards.

EPA sought and received comment on generating credits against the MY 2021 and MY 2022 SAFE standards in the context of lead time for the standards in this rulemaking. The California Attorney General commented that for MY 2023, automakers can comply with standards at least as stringent as EPA's proposed preferred alternative without the use of the credit banks they will likely hold coming into that year. Those banks, including the windfall credits available under the SAFE standards, support EPA's consideration of its Alternative 2 standards for MY 2023 and underscore that EPA should not finalize standards less stringent than its preferred alternative for that model year. The California Attorney General commented further that if EPA were to adopt MY 2023 standards weaker than its preferred alternative (*i.e.,* the Alternative 1 standards), they would support some form of discounting of the credits generated during MYs 2021–2022. In their comments, CARB argued that EPA should protect against what it views as windfall credits from manufacturers over-complying with the SAFE standards in MYs 2021 and 2022. CARB believes that auto manufacturers

[174] Biller, S., and Swann, J. (2006). ''Pricing for Environmental Compliance in the Auto Industry.'' Interfaces 36(2): 118–125. *https://pubsonline.informs.org/doi/abs/10.1287/inte.1050.0174.*

[175] For example, in its comments on the 2012 rule, Ford stated that manufacturers typically begin to firm up their product plans roughly five years in advance of actual production. (Docket OAR–2009–0472–7082.1, p. 10.)

[176] *See Competitive Enterprise Institute* v. *NHTSA*, D.C. Cir. No. 20–1145 (and consolidated cases brought by several states, localities, environmental and public organizations, and others), filed on May 1, 2020 and later dates.

were on a path to compliance with the original 2012 standards, those plans should not have been changed by the 2020 SAFE rule, and thus credits generated off the relaxed SAFE standards should be considered windfall and not be made available to offset future compliance.

EPA has considered the comments but is not finalizing any changes to the existing credit generating or credit carry-forward provisions for the MY 2021 and 2022 standards. While we appreciate the view of commenters that manufacturers could have feasibly met more stringent standards in MYs 2021 and 2022, we believe the credit system is an integral part of the design of the GHG standards, which allow for multi-year compliance strategies. We think it would be inappropriate to deny any credits for manufacturers who outperformed their applicable footprint standards in those years, and choosing a more stringent compliance baseline now for credit generation would be difficult in light of the significant increase in stringency for MY 2023. In addition to CARB's comments, EPA also considered the recent performance of the auto industry in meeting the GHG standards; in MY 2020 the industry-wide average performance was 6 g/mile above the industry-wide average standard and compliance was achieved by many manufacturers through applying banked credits.[177] Rather than denying or discounting credits, we have considered the relative stringency of the MY 2021 and MY 2022 standards as part of our consideration of the appropriate MY 2023–2026 standards. In light of the implementation timeframe of the final standards beginning in model year 2023, we are continuing to allow manufacturers to generate credits against the SAFE standards in model years 2021 and 2022. We are not changing the existing 5-year credit carry-forward provision for credits generated in model years 2021 and 2022, so those credits can be carried forward under the existing regulations to facilitate the transition from the SAFE standards to the final standards. We believe our approach in this rulemaking on revising credit provisions appropriately balances the benefits of credits, especially for compliance in earlier model years, with the benefits of achieving greater emissions reductions. EPA will consider future program provisions for credits in the context of future standards and timing.

In summary, manufacturers have access to a wide range of GHG-reducing technologies and have made significant technological advances in recent years, which together provide ample evidence of the technological feasibility of the final standards particularly in light of the wide range of credit and flexibility strategies, as well as fleet mix strategies, that manufacturers can marshal to comply with the standards.

In considering feasibility of the final standards EPA also considered the impact of available compliance flexibilities on automakers' compliance options, including the additional four compliance flexibility options we are finalizing primarily to address lead time considerations in MYs 2023 and 2024 (See Section II of this preamble). EPA is adopting a one-year credit life extension for credits earned in MYs 2017 and 2018 so they can be used in MYs 2023 and 2024, respectively. EPA is finalizing the extension of advanced technology vehicle multiplier incentives for MYs 2023 and 2024, which offer the potential for an additional cumulative 10 g/mi of emission credits. EPA is finalizing a 20 g/mi incentive for full-size pickup trucks equipped with strong hybrid technology or achieving 20 percent better GHG performance compared to their footprint targets for MYs 2023 and 2024. And finally, and EPA is providing 5 g/mi of additional credit generation opportunity for off-cycle credits from the menu.

As we discuss above, the advanced technologies that automakers are continuing to incorporate in vehicle models today directly contribute to each company's compliance plan (*i.e.,* these vehicle models have lower GHG emissions). In addition, automakers widely utilize the program's established ABT provisions which provide a variety of flexible paths to plan compliance (See more detail in Section II.A.4 of this preamble). EPA's annual Automotive Trends Report illustrates how different automakers have chosen to make use of the GHG program's various credit features.[178] It is clear that manufacturers are widely utilizing the various credit programs available, and we have every expectation that manufacturers will continue to take advantage of the compliance flexibilities and crediting programs to their fullest extent, thereby providing them with additional powerful tools in finding the lowest cost compliance solutions in light of the final standards.

B. Consideration of Vehicle Costs of Compliance

In addition to technological feasibility and lead time, EPA considered the cost for the auto industry to comply with the final standards. See Section III.B of this preamble and Chapter 2 of the RIA for our analysis of compliance costs. As shown in Section III.B.2 of this preamble and Chapter 4.1.3 of the RIA, our updated estimate of the average per-vehicle cost increase for a MY 2026 vehicle is $1,000 compared to the No Action scenario. Average per-vehicle costs are projected to rise from $330 in MY 2023 to $1,000 in MY 2026. EPA has also evaluated costs by manufacturer (see Section III.B.2 of this preamble) and finds the range of costs to be similarly reasonable. EPA has also projected the cost impacts for MYs beyond 2026 due to the revised final standards, and those per-vehicle cost increases are in the range of $1,000 to $1,200, which EPA also believes is a reasonable cost increase. EPA also considered the cost impacts across a number of sensitivity cases using a range of input assumptions (see RIA Chapter 4.1.5). We conclude that per-vehicle costs are also reasonable for these cases, including those with higher cost impacts. For example, in the higher battery cost sensitivity case, per-vehicle costs are $1,396 in MY 2026, and in the MYs beyond, up to as $1,590 in MY 2028.

As part of these cost estimates, we continue to project significant increases in the use of advanced gasoline technologies (including mild and strong hybrids), comprising 83 percent of the fleet (see Section III.B.3 of this preamble). EPA has considered the feasibility of the standards under several different assumptions about future fuel prices, technology application or credit trading (see RIA Chapters 4 and 10), which shows very small variations in average per-vehicle cost or technology penetration mix. Our conclusion that there are multiple ways the MY 2023–2026 standards can be met given the wide range of technologies at reasonable cost, and predominantly with advanced gasoline engine and vehicle technologies, holds true across all these alternative assumptions and scenarios.

EPA concludes that the costs of the standards are reasonable.

C. Consideration of Impacts on Consumers

Another important consideration for EPA is the impact of the standards on consumers. EPA concludes that the standards will be beneficial for consumers because the lower operating

[177] Trends Report, Figure ES–8.

[178] ''The 2020 EPA Automotive Trends Report, Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975,'' EPA–420–R–21–003 January 2021.

costs from significant fuel savings will offset the vehicle costs. Total fuel savings for consumers through 2050 are estimated at $210 billion to $420 billion (7 percent and 3 percent discount rates, see Section VII.I of this preamble, Table 44, ''Retail Fuel Savings''). For an individual consumer on average, we project that over the lifetime of a MY 2026 vehicle, the reduction in fuel costs will exceed the increase in vehicle costs by $1,083. Thus, the standards will result in significant savings for consumers, as further described in Section VII.J of this preamble.

The Administrator also carefully considered the affordability impacts of these standards, especially considering E.O. 14008 and EPA's increasing focus on environmental justice and equity. EPA examined the impacts of the standards on the affordability of new and used cars and trucks in Section VII.M of this preamble and Chapter 8.4 of the RIA. Because lower-income households spend a larger share of their household income on gasoline than do higher-income households, the effects of reduced operating costs may be especially important for these households.

EPA recognizes that in the SAFE rulemaking we placed greater weight on the upfront costs of vehicles, and little weight on total cost of ownership. In part, that rulemaking explained that approach on the ground that ''[n]ew vehicle purchasers are not likely to place as much weight on fuel savings that will be realized by subsequent owners.'' [179] However EPA now believes that in assessing the benefits of these standards it is more appropriate to consider the fuel savings of the vehicle, over its lifetime, including those fuel savings that may accrue to later owners, consistent with the approach EPA took in both the 2010 and 2012 light-duty vehicle GHG standard final rules. Disregarding those savings for consumers, which often accrue to lower income households, who more often purchase used cars, would provide a less accurate picture of total benefits to society.

Likewise, EPA has reconsidered the weight placed in the SAFE rulemaking on promoting fleet turnover as a standalone factor and is now considering the influence of turnover in the context of the full range effects of the proposed standards. As discussed in Section VII.B of this preamble and RIA Chapter 8.1, EPA estimates a reduction in new vehicle sales associated with these standards of one percent or less, though we also describe why sales impacts may be even less negative, or potentially positive. For comparison, the SAFE standards were estimated to increase sales by up to 1.7 percent.[180] Thus, while recognizing that standards can influence purchasing decisions, EPA finds that the emissions reductions from these final standards far outweigh any temporary effect from delayed purchases.

D. Consideration of Emissions of GHGs and Other Air Pollutants

An essential factor that EPA considered in determining the appropriate level of the standards is the reductions in emissions that would result from the program. This primarily includes reductions in vehicle GHG emissions, given the increased urgency of the climate crisis. We also considered the effects of the standards on criteria pollutant and air toxics emissions and associated public health and welfare impacts.

The GHG emissions reductions from our standards are projected to be 3,100 MMT of CO_2, 3.3 MMT of CH4 and 97,000 metric tons of N_2O, as the fleet turns over year-by-year to new vehicles that meet the standards, in an analysis through 2050.[181] See Section IV.A of this preamble, Table 34. EPA recognizes there are a number of limitations and uncertainties with respect to quantifying the benefits of GHG reductions. EPA estimates the monetized benefit of these GHG reductions through 2050 at $31 billion to $390 billion across a range of discount rates and values for the social cost of greenhouse gases (SC–GHG) carbon (see Section VII.I of this preamble, Table 47). Under Section 202 of the CAA, EPA is required to establish standards to reduce air pollution that endangers public health and welfare, taking into consideration the cost of compliance and lead time. EPA is not required to conduct formal cost benefit analysis to determine the appropriate standard under Section 202. EPA weighed the relevant statutory factors to determine the appropriate standard and the analysis of monetized GHG benefits was not material to the choice of that standard. E.O. 12866 requires EPA to perform a cost-benefit analysis, including monetizing costs and benefits where practicable, and the EPA has conducted such an analysis. The monetized GHG benefits are included in the cost-benefit analysis. That cost-benefit analysis provides additional support for the EPA's final standards.

These GHG reductions projected to result from the standards are important to continued progress in addressing climate change. In fact, EPA believes that we will need to achieve far deeper GHG reductions from the light-duty sector in future years beyond the compliance timeframe for the standards, which is why we are initiating a rulemaking in the near future to consider establishing more stringent standards after MY 2026.

The criteria pollutant emissions reductions expected to result from the standards are also a factor considered by the Administrator. The standards would result in emissions reductions of some criteria pollutants and air toxics and associated benefits for public health and welfare. Public health benefits through 2050 from reducing these pollutants are estimated to total $8.1 billion to $19 billion (7 percent and 3 percent discount rates, see Section VII.I of this preamble, Table 46).[182] EPA concludes that this rule is important in reducing the public health and welfare impacts of air pollution, including GHG, criteria, and air toxics emissions.

E. Consideration of Energy, Safety and Other Factors

EPA also evaluated the impacts of the final standards on energy, in terms of fuel consumption and energy security. This final rule is projected to reduce U.S. gasoline consumption by more than 440 million barrels through 2050, a roughly 15 percent reduction in U.S. gasoline consumption (see Section VII.C of this preamble). EPA considered the impacts of this projected reduction in fuel consumption on energy security, specifically the avoided costs of macroeconomic disruption (See Section VII.F of this preamble). We estimate the energy security benefits of the final rule at $7 billion to $14 billion (7 percent and 3 percent discount rate, see Section VII.I of this preamble, Table 45). EPA considers this final rule to be beneficial from an energy security perspective.

Section 202(a)(4)(A) of the CAA specifically prohibits the use of an emission control device, system or element of design that will cause or contribute to an unreasonable risk to public health, welfare, or safety. We have concluded that no device, system,

[179] 85 FR 25114.

[180] U.S. Department of Transportation and U.S. Environmental Protection Agency (2020). Final Regulatory Impact Analysis: The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Year 2021–2026 Passenger Cars and Light Trucks. Table VI–189, p. 875. *https://www.nhtsa.gov/sites/nhtsa.gov/files/documents/final_safe_fria_web_version_200330.pdf,* accessed 11/9/21.

[181] These emission reductions have increased compared to the proposed rule due to the increased stringency of the final standards.

[182] Similar to the GHG emission reductions, public health and welfare benefits have increased compared to the proposed rule due to the increased stringency of the final standards.

or element of design adopted for the purposes of complying with these standards will impact vehicle operation or function in such a way as to increase risk. However, we have also more broadly considered effects beyond vehicle operation and function. For example, we considered the estimated societal costs of fatal and non-fatal injuries due to projected changes in overall VMT and changes in the relative usage of vehicles due to rebound, and scrappage effects on fleet mix. EPA has a long history of considering the safety implications of its emission standards,[183] up to and including the more recent light-duty GHG regulations: The 2010 rule which established the MY 2012–2016 light-duty vehicle GHG standards, the 2012 rule which first established MY 2017–2025 light-duty vehicle GHG standards, the MTE 2016 Proposed Determination and the 2020 SAFE rule. The relationship between GHG emissions standards and safety is multi-faceted, and can be influenced not only by control technologies, but also by consumer decisions about vehicle ownership and use. EPA has estimated safety implications of this rule by accounting for changes in new vehicle purchase, changes in vehicle scrappage, fleet turnover, and VMT, and changes in vehicle weight as an emissions control strategy. EPA finds that under this rule, the estimated risk of fatal and non-fatal injuries per distance traveled will remain virtually unchanged (see Section VII.H of this preamble).

This rule also projects that as the costs of driving declines due to the improvement in fuel economy, consumers overall will choose to drive more miles (this is the ''VMT rebound'' effect). As a result of this personal decision by consumers to drive more due to the reduced cost of driving, EPA also projects this will result in an increase in accidents, injuries, and fatalities. EPA recognizes that in the SAFE rulemaking EPA placed emphasis on the estimated total number of fatal and non-fatal injuries. However, EPA currently believes it is more appropriate to consider the risk of injuries per mile traveled. The risk of injuries per mile traveled is a measure of how safe driving as an activity is (and whether this rule is projected to impact that safety). Assessing whether the risk of injury per mile traveled has changed is a better means of attributing any projected changes in fatal and nonfatal injuries between the effects of this rule and other contributing factors such as voluntary decisions to drive more. In addition, by focusing on whether the technologies applied by manufacturers to meet the standards established by this rule will make use of a car more dangerous (rather than whether people will use their cars more), we believe that considering risk of injury per vehicle mile traveled is more consistent with the statutory direction in section 202(a)(4)(A) prohibiting ''an emission control device, system or element of design that will cause or contribute to an unreasonable risk.'' Two commenters (CARB, Center for Biological Diversity) expressed support for the use of this metric. Even in the SAFE rule EPA recognized that ''EPA's intention is not to restrict mobility, or to discourage driving, based on the level of the standards.'' [184] For these reasons, EPA finds that the most important safety considerations are EPA's conclusions that the rule will not increase risk, as calculated on an injury per mile traveled basis.

F. Balancing of Factors Under CAA 202(a)

Under CAA section 202(a) EPA has statutory authority providing considerable discretion in setting or revising vehicle emission standards with adequate lead time for the development and application of technology to meet the standards. EPA's final standards properly implement this statutory provision, as discussed above. As discussed throughout this preamble, and consistent with the proposed rule, the emission reduction technologies needed to meet the standards are already available at reasonable cost, and a significant fraction of new vehicles today already meets these standards. Moreover, the flexibilities already available under EPA's existing regulations, including fleet average standards and the ABT program—in effect enabling manufacturers to spread the compliance requirement for any particular model year across multiple model years—and the additional flexibilities finalized in this rule further support EPA's conclusion that the standards provide sufficient time for the development and application of technology, giving appropriate consideration to cost.

The Administrator in this rule is balancing the factors differently than in the SAFE rule in reaching the conclusion about what standards to finalize. In the SAFE rulemaking, EPA promulgated relaxed GHG standards that were projected to result in increases in GHG and criteria pollutant emissions and adverse public health impacts (*e.g.,* increases in premature mortality and illnesses due to increased air pollution). The SAFE rulemaking was the most significant weakening of mobile source emissions standards in EPA's history. It is particularly notable that the rationale for the revision was not that the standards prior to the SAFE rulemaking had turned out to be technologically infeasible or that they would impose unexpectedly high costs on society. As we have noted, the estimated per-vehicle costs in the SAFE rulemaking for more stringent standards were not significantly different from the costs estimated in the 2012 rule or for this rulemaking. Rather, in considering the factors for the SAFE rulemaking, EPA placed greatest weight on reducing the per-vehicle cost of compliance on the regulated industry and the upfront (but not total) cost to consumers and placed little weight on reductions in GHGs and other pollutants, contrary to EPA's traditional approach to adopting standards under CAA section 202(a).

Although EPA continues to believe that the Administrator has significant discretion to weigh various factors under CAA section 202(a), the Administrator notes, consistent with the proposal, that the purpose of adopting standards under that provision is to address air pollution that may reasonably be anticipated to endanger public health and welfare and that reducing air pollution has traditionally been the focus of such standards. In this action, the Administrator is setting more stringent standards based on a weighing of factors under consideration different from that in the SAFE rulemaking, which the Administrator believes is more consistent with the purpose of the CAA.[185] The Administrator finds it is appropriate to place greater weight on the importance of reducing GHG emissions and the primary purpose of CAA section 202, to reduce the threat posed to human health and the environment by air pollution, and to adopt standards that, when implemented, would result in

[183] See, *e.g.,* 45 FR 14496, 14503 (1980) (''EPA would not require a particulate control technology that was known to involve serious safety problems.'').

[184] 85 FR 25119. See also 85 FR 24826 (''For the proposal, the agencies assumed that, in deciding to drive more, drivers internalize the full cost to themselves and others, including the cost of accidents, associated with their additional driving.'').

[185] See, *e.g.,* CAA sections 101(a)(2) (finding that ''the increasing use of motor vehicles[ ] has resulted in mounting dangers to the public health and welfare''); 101(b)(1) (declaring one purpose of the CAA is ''to protect and enhance the quality of the Nation's air resources, so as to promote the public health and welfare''); 101(c) (''a primary goal of this chapter is to encourage or otherwise promote reasonable Federal . . . actions . . . for pollution prevention'').

significant reductions of light duty vehicle emissions both in the near term and over the longer term, while giving appropriate consideration to costs of compliance and lead time.

In addition to the greater consideration of emissions reductions, several technological developments since the SAFE rule was promulgated have informed the Administrator's decision on what level of standards are appropriate. These developments include technological advancements (including reductions in battery costs) and successful introductions of electric vehicles, recent manufacturer announcements signaling an accelerated transition to electrified vehicles, and further evidence of credit trading which has now been demonstrated as an important compliance strategy. The Administrator's consideration of these technological developments support his conclusion that greater emissions reductions can be achieved in the near term at reasonable costs and within the lead time provided by each model year of the revised standards.

EPA estimates net benefits of this rule at $120 billion to $190 billion (7 percent and 3 percent discount rates, with 3 percent SC–GHG) (see Section VII.I of this preamble, Table 48).[186] Our projection that the estimated benefits exceed the estimated costs of the program reinforces our view that the final standards represent an appropriate weighing of the statutory factors and other relevant considerations. EPA is presenting a range of net benefits which reflect our best estimates for SC–GHG and health benefits. EPA acknowledges that the best available estimates do not eliminate uncertainties. We consider potential variation in costs in part through sensitivity analyses, as we recognize that the cost estimates also contain uncertainties. For example, as noted above, we did a sensitivity analysis considering costs of the program if battery costs are higher than we project.[187] EPA notes that even with these uncertainties in quantified estimates of costs and benefits taken into account, the Administrator finds that the final standards are appropriate when considering the full range of potential costs and other impacts assessed in this rulemaking.

In summary, the Administrator has selected standards which achieve appropriate emissions reductions in light of the need to reduce emissions and taking into account the potential for, and cost of, the application of emissions reducing technologies for the model years at issue and other relevant factors. In the Administrator's judgment, the final standards are appropriate under EPA's CAA section 202(a) authority.

[186] Net benefits of this final rule are higher than those estimated for the proposed rule, as well as those estimated for the SAFE rule.

[187] See section VI.B of this preamble and RIA Chapter 4.1.5 for further discussion of the sensitivity analyses.

VII. What are the estimated cost, economic, and other impacts of the rule?

This section discusses EPA's assessment of a variety of impacts related to the standards, including impacts on vehicle sales, fuel consumption, energy security, additional driving, and safety. It presents an overview of EPA's estimates of GHG reduction benefits and non-GHG health impacts and a summary of aggregate costs through 2050, drawing from the per-vehicle cost estimates presented in Section III of this preamble, and estimated program benefits. Finally, it discusses EPA's assessment of the potential impacts on consumers and employment. The RIA presents further details of the analyses presented in this section.

A. Conceptual Framework for Evaluating Consumer Impacts

A significant question in analyzing consumer impacts from vehicle GHG standards has been why there have appeared to be existing technologies that, if adopted, would reduce fuel consumption enough to pay for themselves in short periods, but which were not widely adopted. If the benefits to vehicle buyers outweigh the costs to those buyers of the new technologies, conventional economic principles suggest that automakers would provide them, and people would buy them. Yet engineering analyses have identified a number of technologies whose costs are quickly covered by their fuel savings, such as downsized-turbocharged engines, gasoline direct injection, and improved aerodynamics, that were not widely adopted before the issuance of standards, but which were adopted rapidly afterwards.[188] Why did markets fail, on their own, to adopt these technologies? This question, termed the ''energy paradox'' or ''energy efficiency gap,'' [189] has been discussed in detail in previous rulemakings.[190] As discussed in what follows, and in more detail in RIA Chapter 8.1.1, EPA has evaluated whether the efficiency gap exists, as well as potential explanations for why the gap might exist.

[188] U.S. Environmental Protection Agency (2021). 2020 EPA Automotive Trends Report: Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975, Chapter 4. EPA–420–R–21–003, *https://www.epa.gov/automotive-trends/download-automotive-trends-report#Full%20Report,* accessed 4/15/2021.

[189] Jaffe, A.B., and Stavins, R.N. (1994). ''The Energy Paradox and the Diffusion of Conservation Technology.'' Resource and Energy Economics 16(2): 91–122.

Whether the efficiency gap exists depends on the assessment of fuel savings relative to technology costs and ''hidden costs,'' *i.e.,* any adverse effects on other vehicle attributes. In the Midterm Evaluation,[191] EPA evaluated both the costs and the effectiveness for reducing fuel consumption (and GHG emissions) of technologies used to meet the emissions standards to date; the agency found that the estimates used in the original rulemakings were generally correct.

EPA also examined the relationship between the presence of fuel-saving technologies and negative evaluations of vehicle operating characteristics, such as performance and noise, in auto reviews and found that the presence of the technologies was more often correlated with positive evaluations than negative ones.[192] Preliminary work with data from recent purchasers of new vehicles found similar results.[193] While these studies cannot prove that the technologies pose no problems to other vehicle attributes, they suggest that it is possible to implement the technologies without imposing hidden costs.

A few public comments addressed perspectives on the issue of potential tradeoffs among vehicle attributes. The National Automobile Dealers Association (NADA) raises concerns that vehicle buyers must give up vehicle attributes, especially performance, to get improved fuel economy. NYU IPI, on the other hand, finds no evidence of tradeoffs and notes that some fuel-saving technologies improve other vehicle attributes, including

[190] 75 FR 25510–25513; 77 FR 62913–62917; U.S. Environmental Protection Agency (2016), Proposed Determination on the Appropriateness of the Model Year 2022–2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation, EPA–420–R–16–020, Appendix B.1.2; 85 FR 24603–24613.

[191] *https://www.epa.gov/regulations-emissions-vehicles-and-engines/midterm-evaluation-light-duty-vehicle-greenhouse-gas.*

[192] Helfand, G., et al. (2016). ''Searching for Hidden Costs: A Technology-Based Approach to the Energy Efficiency Gap in Light-Duty Vehicles.'' Energy Policy 98: 590–606; Huang, H., et al. (2018). ''Re-Searching for Hidden Costs: Evidence from the Adoption of Fuel-Saving Technologies in Light-Duty Vehicles.'' Transportation Research Part D 65: 194–212.

[193] Huang, H., G. Helfand, and K. Bolon (2018a). ''Consumer Satisfaction with New Vehicles Subject to Greenhouse Gas and Fuel Economy Standards.'' Presentation at the Society for Benefit-Cost Analysis annual conference, March. *https://benefitcostanalysis.org/docs/G.4_Huang_Slides.pdf,* accessed 4/7/2021.

performance. In response to these comments, EPA notes that we have evaluated the relationship between performance and fuel economy, in light of research arguing that fuel consumption must come at the expense of other vehicle attributes.[194] Research in progress from Watten et al. (2021) [195] distinguishes between technologies that improve, or do not adversely affect, both performance and fuel economy and technologies that reduce engine displacement, which does trade off improved fuel economy for performance. Thus, EPA does not agree with NADA that vehicle buyers must give up performance to get better fuel economy; it is possible to get more of both. Following Moskalik et al. (2018),[196] Watten et al. observe that the ''marginal rate of attribute substitution'' between power and fuel economy has changed substantially over time. In particular, it has become relatively more costly to improve efficiency by reducing power, and relatively less costly to add technologies that improve efficiency. These technology improvements do not reduce power and in some cases may enhance it. This research supports the concept that automakers take consumer preferences into account in identifying where to add technology.

EPA does not reject the observation that the energy efficiency gap has existed for light-duty vehicles—that is, it appears that markets on their own have not led to incorporation by manufacturers, and purchase by new vehicle buyers, of a number of technologies whose fuel savings quickly outweigh the costs in the absence of standards. As discussed in RIA Chapter 8.1.1.2, EPA has previously identified a number of hypotheses to explain this apparent market failure.[197] Some relate to consumer behavior, such as putting little emphasis on future fuel savings compared to up-front costs (a form of ''myopic loss aversion''), not having a full understanding of potential cost savings, or not prioritizing fuel consumption in the complex process of selecting a vehicle. Explanations of these kinds tend to draw on the conceptual and empirical literature in behavioral economics, which emphasizes the importance of limited attention, the relevance of salience, ''present bias'' or myopia, and loss aversion. (Some of these are described as contributing to ''behavioral market failures.'') Other potential explanations relate to automaker behaviors that grow out of the large fixed costs of investments involved with switching to new technologies, as well as the complex and uncertain processes involved in technological innovation and adoption.

We note that it is challenging to identify which of these hypotheses for the efficiency gap explain its apparent existence. On the consumer side, EPA has explored the evidence on how consumers evaluate fuel economy in their vehicle purchase decisions.[198] As noted, there does not appear to be consensus in that literature on that behavior; the variation in estimates is very large. Even less research has been conducted on producer-side behavior. The reason there continues to be limited adoption of cost-effective fuel-saving technologies before the implementation of more stringent standards remains an open question. Yet, more stringent standards have been adopted without apparent disruption to the vehicle market after they become effective.[199] NYU IPI commented that EPA should include additional potential market failures in its assessment, as well as additional evidence related to the market failures already mentioned. The American Enterprise Institute, in contrast, asserts based on economic theory, but without evidence, that failures in the market for fuel savings do not exist. EPA agrees with NYU IPI that evidence on technology costs, fuel savings, and the absence of hidden costs suggest that there are market failures in the provision of fuel-saving technologies, though we cannot demonstrate at this time which specific failures operate in this market. Adding additional possible market failures to the list of hypotheses is useful for suggesting future research activities, but does not change the finding that market failures appear to exist in the provision of fuel economy.

B. Vehicle Sales Impacts

As discussed in Section III.A of this preamble, EPA utilized the CCEMS model for this analysis. For this final rule as with the proposed rule, we have continued to estimate vehicle sales impacts through this model.[200] First, the model projects future new vehicle sales in the reference case based on projections of macroeconomic variables. Second, it applies a demand elasticity (that is, the percent change in quantity associated with a one percent increase in price) to the change in net price, where net price is the difference in technology costs less an estimate of the change in fuel costs over 2.5 years. This approach assumes that both automakers and vehicle buyers take into consideration the fuel savings that buyers might expect to accrue over the first 2.5 years of vehicle ownership.

As discussed in Section VII.A of this preamble, and in more detail in RIA Chapter 8.1.2, there does not yet appear to be consensus around the role of fuel consumption in vehicle purchase decisions, and the assumption that 2.5 years of fuel consumption is the right number for both automakers and vehicle buyers deserves further evaluation. As noted there, Greene et al. (2018) provides a reference value of $1,150 for the value of reducing fuel costs by $0.01/mile over the lifetime of an average vehicle; for comparison, 2.5 years of fuel savings is only about 30 percent of that value, or about $334.[201]

[194] Knittel, C.R. (2011). ''Automobiles on Steroids: Product Attribute Trade-Offs and Technological Progress in the Automobile Sector.'' American Economic Review 101(7): pp. 3368–3399; Klier, T. and Linn, J. (2016). ''The Effect of Vehicle Fuel Economy Standards on Technology Adoption.'' Journal of Public Economics 133: 41–63; McKenzie, D. and Heywood, J.B. (2015). ''Quantifying efficiency technology improvements in U.S. cars from 1975–2009.'' Applied Energy 157: 918–928.

[195] Watten, A., S. Anderson, and G. Helfand (2021). ''Attribute Production and Technical Change: Rethinking the Performance and Fuel Economy Trade-off for Light-duty Vehicles.'' Working paper.

[196] Moskalik, A., K. Bolon, K. Newman, and J. Cherry (2018). ''Representing GHG Reduction Technologies in the Future Fleet with Full Vehicle Simulation.'' SAE Technical Paper 2018–01–1273. doi:10.4271/2018–01–1273.

[197] 75 FR 25510–25513; 77 FR 62913–62917; U.S. Environmental Protection Agency (2016), Proposed Determination on the Appropriateness of the Model Year 2022–2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation, EPA–420–R–16–020, Appendix B.1.2; 85 FR 24603–24613.

[198] U.S. Environmental Protection Agency (2010). ''How Consumers Value Fuel Economy: A Literature Review.'' EPA–420–R–10–008, *https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=499454&Lab=OTAQ* (accessed 4/15/2021); U.S. Environmental Protection Agency (2018). ''Consumer Willingness to Pay for Vehicle Attributes: What is the Current State of Knowledge?'' EPA–420–R–18–016, *https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=536423&Lab=OTAQ* (accessed 4/15/2021); Greene, D., A. Hossain, J. Hofmann, G. Helfand, and R. Beach (2018). ''Consumer Willingness to Pay for Vehicle Attributes: What Do We Know?'' Transportation Research Part A 118: 258–279.

[199] ''The 2020 EPA Automotive Trends Report, Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975,'' EPA–420–R–21–003 January 2021. See Table 2–1 for total vehicle production by model year.

[200] U.S. Department of Transportation and U.S. Environmental Protection Agency (2020). Final Regulatory Impact Analysis: The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Year 2021–2026 Passenger Cars and Light Trucks.'' *https://www.nhtsa.gov/sites/nhtsa.gov/files/documents/final_safe_fria_web_version_200701.pdf*, accessed 11/1/2021, p. 871.

[201] See Greene et al. (2018), Footnote 198. Greene et al. (2018) cite a ballpark value of reducing driving costs by $0.01/mile as $1150, but does not provide enough detail to replicate their analysis perfectly. The 30% estimate is calculated by assuming, following assumptions in Greene et al. (2018), that a vehicle is driven 15,000 miles per

Continued

This $334 is within the large standard deviation in Greene et al. (2018) for the willingness to pay to reduce fuel costs, but it is far lower than both the mean of $1,880 (160 percent of that value) and the median of $990 (85 percent of that value) per one cent per mile in the paper. On the other hand, the 2021 NAS report, citing the 2015 NAS report, observed that automakers ''perceive that typical consumers would pay upfront for only one to four years of fuel savings'' (pp. 9–10),[202] a range of values within that identified in Greene et al. (2018) for consumer response, but well below the median or mean. Thus, it appears possible that automakers operate under a different perception of consumer willingness to pay for additional fuel economy than how consumers actually behave. Both NYU IPI and Consumer Reports comment that new vehicle buyers care more about fuel consumption than the use of 2.5 years suggests. Consumer Reports comments that EPA should model automaker adoption of fuel-saving technologies based on historical actions. While EPA considers these concerns as deserving additional consideration for future actions, the CCEMS model used for this rulemaking uses 2.5 years for both automaker perception and consumer perception of the value of additional fuel economy in its sales modeling. The decision to use the CCEMS model is further discussed in Section III.A of this preamble.

In addition, setting the elasticity of demand at −1 in the SAFE FRIA was based on literature more than 25 years old. In the proposed rule, EPA mentioned that it was sponsoring a review of more recent estimates of the elasticity of demand for new vehicles and requested comment on using an elasticity value of −1. As discussed further in RIA Chapter 8.1.2, EPA recently completed the report reviewing this literature.[203] The report also describes a method based in economic principles to examine the effects of changes in new vehicle prices, taking into account changes in the used vehicle market and scrappage of used vehicles. Several commenters (CARB, NYU IPI, and a coalition of environmental NGOs) provide assessments of the literature. These commenters all observe that the value of −1 is based on older studies that focus on short-term changes in the new vehicle market and suggest using an elasticity no larger (in absolute value) than −0.4. EPA agrees that more recent evidence incorporating longer-term effects, such as interactions with the used vehicle market, suggests that −0.4 may be an upper limit (in absolute value) for this elasticity, and values as low as −0.15 are plausible. A smaller elasticity does not change the direction of sales effects, but it does reduce the magnitude of the effects.

The CCEMS model also makes use of a dynamic fleet share model (SAFE FRIA p. 877) that estimates, separately, the shares of passenger cars and light trucks based on vehicle characteristics, and then adjusts them so that the market shares sum to one. The model also includes the effects of the standards on vehicle scrappage based on a statistical analysis (FRIA starting p. 926). The model looks for associations between vehicle age, change in new vehicle prices, fuel prices, cost per mile of driving, and macroeconomic measures and the scrappage rate, with different equations for cars, SUVs/vans, and pickups. EPA's report to review new vehicle demand elasticities also includes a review of the literature on the relationship between new and used vehicle markets and scrappage.

For this final rule, EPA is maintaining the previous assumptions for its modeling, with the exception of updating the new-vehicle demand elasticity to −0.4 based on more recent evidence. As EPA's recently issued literature review and public commenters have noted, −0.4 appears to be the largest estimate (in absolute value) for a long-run new vehicle demand elasticity in recent studies. Further, EPA's report examining the relationship between new and used vehicle markets shows that, for plausible values reflecting that interaction, the new vehicle demand elasticity varies from −0.15 to −0.4. The proposed rule presented results with −0.4, and for the final rule we are using this value in our central case, with sensitivities of −0.15 (a lower value from the report) and −1 (for continuity with the proposed rule). See Section III.A of this preamble and the Response to Comments document for further discussion of our updated approach.

With the modeling assumptions that both automakers and vehicle buyers consider 2.5 years of future fuel consumption in the purchase decision and that the demand elasticity is −0.4, vehicle sales are projected to decrease by roughly one-half to one percent compared to sales under the SAFE standards, as discussed in more detail in RIA Chapter 8.1.3. In contrast, when modeled using a demand elasticity of −0.15, sales decrease by no more than 0.3 percent; and, using a demand elasticity of −1, sales decrease by about 2 percent. These results show how the value of the elasticity affects sales impacts. If, however, automakers underestimate consumers' valuation of fuel economy, then sales may increase relative to the baseline under the standards. NADA commented that EPA underestimated adverse sales impacts but does not provide analytical support for that statement. For reasons noted above, including the limited consideration of fuel consumption in consumer vehicle purchase decisions, EPA disagrees that adverse sales impacts are underestimated.

How easily new vehicle buyers will be willing to substitute EVs for internal combustion engine (ICE) vehicles is a matter of some uncertainty. With up-front costs dropping, the total cost of ownership for EVs is also dropping and becoming more competitive with ICE vehicles. Some commenters, including the California Attorney General Office, Consumer Reports, the National Coalition for Advanced Technology, Southern Environmental Law Center, Tesla, and some EV owners, expect EVs to be attractive to many new vehicle buyers as their costs drop, ranges improve, and more charging infrastructure is developed. Other commenters, including many automakers, Alliance for Automotive Innovation, Center for Climate and Energy Solutions, Environmental Protection Network, and Motor & Equipment Manufacturers Association, raise the role of complementary policies outside of this rule, such as purchase subsidies and more development of charging infrastructure, to facilitate consumer acceptance of EVs. As discussed in Section III.B.3 of this preamble, our analysis suggests that EV penetration under these standards is projected to increase from about 7 percent in MY 2023 to about 17 percent in MY 2026. Consistent with the objectives of E.O. 14037, EPA believes that the transition to zero emission vehicles is an important pathway in addressing the climate crisis; in addition, as discussed in Section VII.K

year for 13.5 years, 10% discount rate. Those figures produce a ''present value of miles'' of 108,600; thus, a $0.01/mile change in the cost of driving would be worth $1086. In contrast, saving $0.01/mile for 2.5 years using these assumptions is worth about $318, or 29% of the value over 13.5 years. Multiplying Greene et al.'s 29 percent to $1150 = $334.

[202] National Research Council (2015). Cost, Effectiveness, and Deployment of Fuel Economy Technologies for Light-Duty Vehicles. Washington, DC: The National Academies Press. *https://doi.org/10.17226/21744,* p. 9–10.

[203] U.S. Environmental Protection Agency (2021). ''The Effects of New-Vehicle Price Changes on New- and Used-Vehicle Markets and Scrappage.'' EPA–420–R–21–019, *https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=352754&Lab=OTAQ* (accessed 10/06/2021).

of this preamble, increasing domestic production of EVs will be important for future leadership and competitiveness of the U.S. auto industry as other markets also make this transition.

C. Changes in Fuel Consumption

The final standards will reduce not only GHG emissions but also fuel consumption. Reducing fuel consumption is a significant means of reducing GHG emissions from the transportation fleet. EPA received comments on fuel consumption and savings in the sales and net benefits analysis as summarized in Sections 13, 17, and 17.1 of the RTC document for this rulemaking. Table 38 shows the estimated fuel consumption changes under the final standards relative to the No Action scenario and include rebound effects, credit usage and advanced technology multiplier use.

The largest changes in fuel consumption come from gasoline, which follows from our projection that improvements to gasoline vehicles will be the primary way that manufacturers meet the final standards. Through 2050, our rule will reduce gasoline consumption by more than 360,000 million gallons—reaching a 15 percent reduction in annual U.S. gasoline consumption in 2050. Roughly 17 percent of the fleet is projected to be either EV or PHEV by MY 2026 to meet the final standards for which we project smaller percentage changes in the U.S. electricity consumption to fuel these vehicles.

TABLE 38—CHANGE IN FUEL CONSUMPTION FROM THE LIGHT-DUTY FLEET

	Gasoline equivalents (million gallons)	Percent of 2020 U.S. consumption	Electricity (gigawatt hours)	Percent of 2020 U.S. consumption
2023	582	0	3,631	0
2026	3,245	−3	23,196	1
2030	8,680	−7	59,241	2
2035	14,203	−11	95,798	3
2040	17,424	−14	118,225	3
2050	18,860	−15	128,625	3
Sum	−361,438		2,457,336	

Notes: The CCEMS reports all liquid fuels as gasoline equivalents; according to the Energy Information Administration (EIA), U.S. gasoline consumption in 2020 was 123.73 billion gallons, roughly 16 percent less (due to the coronavirus pandemic) than the highest consumption on record (2018). According to the Department of Energy, there are 33.7 kWh of electricity per gallon gasoline equivalent, the metric reported by CCEMS for electricity consumption and used here to convert to kWh. According to EIA, the U.S. consumed 3,800,000 gigawatt hours of electricity in 2020.

With changes in fuel consumption come associated changes in the amount of time spent refueling vehicles. Consistent with the assumptions used in the proposed rule (and presented in Table 39 and Table 40), the costs of time spent refueling are calculated as the total amount of time the driver of a typical vehicle would spend refueling multiplied by the value of their time. If less time is spent refueling vehicles under the final standards, then a refueling time savings would be incurred.

TABLE 39—CCEMS INPUTS USED TO ESTIMATE LIQUID REFUELING TIME COSTS

	Cars	Vans/SUVs	Pickups
Fixed Component of Average Refueling Time in Minutes (by Fuel Type)			
Gasoline	3.5	3.5	3.5
Ethanol-85	3.5	3.5	3.5
Diesel	3.5	3.5	3.5
Electricity	3.5	3.5	3.5
Hydrogen	0	0	0
Compressed Natural Gas	0	0	0
Average Tank Volume Refueled	65%	65%	65%
Value of Travel Time per Vehicle (2018 $/hour)	20.46	20.79	20.79

TABLE 40—CCEMS INPUTS USED TO ESTIMATE ELECTRIC REFUELING TIME COSTS

	Cars	Vans/SUVs	Pickups
Electric Vehicle Recharge Thresholds (BEV200)			
Miles until mid-trip charging event	2,000	1,500	1,600
Share of miles charged mid-trip	6.00%	9.00%	8.00%
Charge rate (miles/hour)	67	67	67
Electric Vehicle Recharge Thresholds (BEV300)			
Miles until mid-trip charging event	5,200	3,500	3,800
Share of miles charged mid-trip	3.00%	4.00%	4.00%

TABLE 40—CCEMS INPUTS USED TO ESTIMATE ELECTRIC REFUELING TIME COSTS—Continued

	Cars	Vans/SUVs	Pickups
Charge rate (miles/hour)	100	100	100

Note that the values presented in this table were also used in the August 2021 EPA proposed rule, but this table was inadvertently not presented then.

D. Greenhouse Gas Emission Reduction Benefits

EPA estimated the climate benefits for the final standards using measures of the social cost of three GHGs: Carbon, methane, and nitrous oxide. While the program also accounts for reduction in HFCs through the AC credits program, EPA has not quantified the associated emission reductions. The social cost of each gas (*i.e.,* the social cost of carbon (SC–CO_2), methane (SC–CH_4), and nitrous oxide (SC–N_2O)) is the monetary value of the net harm to society associated with a marginal increase in emissions in a given year, or the benefit of avoiding that increase. Collectively, these values are referenced as the ''social cost of greenhouse gases'' (SC–GHG). In principle, SC–GHG includes the value of all climate change impacts, including (but not limited to) changes in net agricultural productivity, human health effects, property damage from increased flood risk and natural disasters, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem services. The SC–GHG therefore, reflects the societal value of reducing emissions of the gas in question by one metric ton.

We estimate the global social benefits of CO_2, CH_4, and N_2O emission reductions expected from the final rule using the SC–GHG estimates presented in the February 2021 Technical Support Document (TSD): Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under E.O. 13990 (IWG 2021). These SC–GHG estimates are interim values developed under E.O. 13990 for use in benefit-cost analyses until an improved estimate of the impacts of climate change can be developed based on the best available climate science and economics. We have evaluated the SC–GHG estimates in the TSD and have determined that these estimates are appropriate for use in estimating the global social benefits of CO2, CH4, and N2O emission reductions expected from this final rule. After considering the TSD, and the issues and studies discussed therein, EPA finds that these estimates, while likely an underestimate, are the best currently available SC–GHG estimates. As discussed in Chapter 3.3 of the RIA, these interim SC–GHG estimates have a number of limitations, including that the models used to produce them do not include all of the important physical, ecological, and economic impacts of climate change recognized in the climate-change literature and that several modeling input assumptions are outdated. As discussed in the February 2021 TSD, the Interagency Working Group on the Social Cost of Greenhouse Gases (IWG) finds that, taken together, the limitations suggest that these SC–GHG estimates likely underestimate the damages from GHG emissions. We received comments on the use and application of the interim SC–GHG estimates as summarized in the RTC document for this rulemaking. The IWG is currently working on a comprehensive update of the SC–GHG estimates (to be released by January 2022 under E.O. 13990) taking into consideration recommendations from the National Academies of Sciences, Engineering and Medicine, recent scientific literature, public comments received on the February 2021 TSD and other input from experts and diverse stakeholder groups. See Section VII.I of this preamble for a summary of the monetized GHG benefits and Chapter 3.3 of the RIA for more on the application of SC–GHG estimates.

E. Non-Greenhouse Gas Health Impacts

It is important to quantify the non-GHG health and environmental impacts associated with the final program because a failure to adequately consider ancillary impacts could lead to an incorrect assessment of a program's costs and benefits. Moreover, the health and other impacts of exposure to criteria air pollutants and airborne toxics tend to occur in the near term, while most effects from reduced climate change are likely to occur over a time frame of several decades or longer. Ideally, human health benefits would be estimated based on changes in ambient $PM_{2.5}$ and ozone as determined by full-scale air quality modeling. However, the projected non-GHG emissions impacts associated with the final program are expected to contribute to very small changes in ambient air quality (see Preamble Section V.C of this preamble for more detail). EPA intends to develop a future rule to control emissions of GHGs, criteria pollutants, and air toxic pollutants from light-duty vehicles for model years beyond 2026. We are considering how to project air quality impacts, and associated health benefits, from the changes in non-GHG emissions for that future rulemaking.

In lieu of air quality modeling, we use a reduced-form benefit-per-ton (BPT) approach to inform our assessment of $PM_{2.5}$-related health impacts, which is conceptually consistent with EPA's use of BPT estimates in several previous RIAs.[204] [205] In this approach, the $PM_{2.5}$-related BPT values are the total monetized human health benefits (the sum of the economic value of the reduced risk of premature death and illness) that are expected from reducing one ton of directly-emitted $PM_{2.5}$ or $PM_{2.5}$ precursor such as NO_X or SO_2. We note, however, that the complex, non-linear photochemical processes that govern ozone formation prevent us from developing reduced-form ozone BPT values for mobile sources. This is an important limitation to recognize when using the BPT approach.

EPA received comment about the use of BPT values to estimate the PM-related health benefits of the program. EPA agrees with commenters that the use of BPT values to estimate the PM-related health benefits of the program ''is a well-established approach'' that nonetheless omits a number of other health and environmental benefits, such as ozone-related benefits. Commenters expressed concern that because the BPT approach leaves these benefits unquantified, the analysis undercounts air quality benefits. EPA believes that using the reduced-form BPT approach to benefits estimation was reasonable for the analysis conducted for this

[204] U.S. Environmental Protection Agency (U.S. EPA). 2015. Regulatory Impact Analysis for the Final Revisions to the National Ambient Air Quality Standards for Ground-Level Ozone. EPA452/R–15–007. Office of Air Quality Planning and Standards, Health and Environmental Impacts Division, Research Triangle Park, NC. December. Available at: *http://www.epa.gov/ttnecas1/regdata/RIAs/finalria.pdf.*

[205] U.S. Environmental Protection Agency (U.S. EPA). (2012). Regulatory Impact Analysis: Final Rulemaking for 2017–2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, Assessment and Standards Division, Office of Transportation and Air Quality, EPA–420–R–12–016, August 2012. Available on the internet at: *http://www3.epa.gov/otaq/climate/documents/420r12016.pdf.*

rulemaking though less robust than an analysis based on photochemical air quality modeling. EPA continues to refine our reduced form methods. We note that criteria pollutant-related health benefits are typically driven by reductions in PM-related mortality risk, which are reflected in the BPT-based analysis of benefits associated with the final rule. We would expect that monetizing the full suite of health and environmental benefits associated with the final rule would increase total benefits, and benefits would increase in proportion to the criteria pollutant emissions reductions achieved, for both the final program and the alternatives that were considered. However, as explained earlier in this section, we are limited to the use of $PM_{2.5}$-related BPT values for this analysis. We do not expect that the omission of unquantified benefits would meaningfully change how the impacts of the final program compare to the alternatives, though the rule would be even more beneficial on net (compared to costs) if all benefits were quantified and monetized.

For tailpipe emissions, we apply national $PM_{2.5}$-related BPT values that were recently derived for the ''Onroad Light Duty Vehicle'' sector.[206] The onroad light-duty vehicle BPT values were derived using detailed mobile sector source-apportionment air quality modeling, and apply EPA's existing method for using reduced-form tools to estimate $PM_{2.5}$-related benefits.[207] [208]

To monetize the $PM_{2.5}$-related impacts of upstream emissions, we apply BPT values that were developed for the refinery and electric generating unit (EGU) sectors.[209] While upstream emissions also include petroleum extraction, storage and transport sources, as well as sources upstream from the refinery, the modeling tool used to support this analysis only provides estimates of upstream emissions impacts aggregated across refinery and EGU sources. We believe that for purposes of this rule the separate accounting of refinery and EGU impacts adequately monetizes upstream PM-related health impacts.

EPA received comment about the use of refinery-related BPT values as a surrogate for the monetization of all upstream emissions impacts. EPA agrees with the commenters that sector-specific BPT values are preferable to monetize sector-specific emissions. For the final rule, upstream emissions have been apportioned to the refinery and EGU sectors and we apply corresponding BPT values to monetize those emissions impacts. More information on non-GHG emissions impacts of the final rule can be found in Preamble Section V.

EPA bases its benefits analyses on peer-reviewed studies of air quality and health effects and peer-reviewed studies of the monetary values of public health and welfare improvements. Recently, EPA updated its approach to estimating the benefits of changes in $PM_{2.5}$ and ozone.[210] [211] These updates were based on information drawn from the recent 2019 $PM_{2.5}$ and 2020 Ozone Integrated Science Assessments (ISAs), which were reviewed by the Clean Air Science Advisory Committee (CASAC) and the public.[212] [213] As part of the update, EPA identified $PM_{2.5}$-related long-term premature mortality risk estimates from two studies deemed most appropriate to inform a benefits analysis: A retrospective analysis of Medicare beneficiaries (Medicare) and the American Cancer Society Cancer Prevention II study (ACS CPS–II).[214] [215] [216]

EPA has not had an opportunity to update its mobile source BPT estimates to reflect these updates in time for this analysis. Instead, we use $PM_{2.5}$ BPT estimates that are based on the review of the 2009 PM ISA[217] and 2012 PM ISA Provisional Assessment[218] and include a mortality risk estimate derived from the Krewski et al. (2009)[219] analysis of the ACS CPS–II cohort and nonfatal illnesses consistent with benefits analyses performed for the analysis of the final Tier 3 Vehicle Rule,[220] the final 2012 PM NAAQS Revision,[221] and the final 2017–2025 Light-duty Vehicle GHG Rule.[222] We expect this lag in updating our BPT estimates to have only a small impact on total PM benefits, since the underlying mortality risk estimate based on the Krewski study is identical to the updated $PM_{2.5}$ mortality risk estimate derived from an expanded analysis of

[206] Wolfe, P.; Davidson, K.; Fulcher, C.; Fann, N.; Zawacki, M.; Baker, K.R. 2019. Monetized Health Benefits Attributable to Mobile Source Emission Reductions across the United States in 2025. Sci. Total Environ. 650, 2490–2498. *https://doi.org/10.1016/J.SCITOTENV.2018.09.273.* Also see *https://www.epa.gov/benmap/mobile-sector-source-apportionment-air-quality-and-benefits-ton.*

[207] Zawacki, M.; Baker, K.R.; Phillips, S.; Davidson, K.; Wolfe, P. 2018. Mobile Source Contributions to Ambient Ozone and Particulate Matter in 2025. Atmos. Environ. 188, 129–141.

[208] Fann, N.; Fulcher, C.M.; Baker, K. 2013. The Recent and Future Health Burden of Air Pollution Apportioned across U.S. Sectors. Environ. Sci. Technol. 47 (8), 3580–3589. *https://doi.org/10.1021/es304831q.*

[209] U.S. Environmental Protection Agency (U.S. EPA). 2018. Technical Support Document: Estimating the Benefit per Ton of Reducing $PM_{2.5}$ Precursors from 17 Sectors. 2018. Office of Air Quality Planning and Standards. Research Triangle Park, NC.

[210] U.S. Environmental Protection Agency (U.S. EPA). 2021. Regulatory Impact Analysis for the Final Revised Cross-State Air Pollution Rule (CSAPR) Update for the 2008 Ozone NAAQS. EPA–452/R–21–002.

[211] U.S. Environmental Protection Agency (U.S. EPA). 2021. Estimating $PM_{2.5}$- and Ozone-Attributable Health Benefits. Technical Support Document (TSD) for the Final Revised Cross-State Air Pollution Rule Update for the 2008 Ozone Season NAAQS. EPA–HQ–OAR–2020–0272.

[212] U.S. Environmental Protection Agency (U.S. EPA). 2019. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, 2019). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–19/188, 2019.

[213] U.S. Environmental Protection Agency (U.S. EPA). 2020. Integrated Science Assessment (ISA) for Ozone and Related Photochemical Oxidants (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–20/012, 2020.

[214] Di, Q, Wang, Y, Zanobetti, A, Wang, Y, Koutrakis, P, Choirat, C, Dominici, F and Schwartz, JD (2017). Air pollution and mortality in the Medicare population. New Engl J Med 376(26): 2513–2522.

[215] Turner, MC, Jerrett, M, Pope, A, III, Krewski, D, Gapstur, SM, Diver, WR, Beckerman, BS, Marshall, JD, Su, J, Crouse, DL and Burnett, RT (2016). Long-term ozone exposure and mortality in a large prospective study. Am J Respir Crit Care Med 193(10): 1134–1142.

[216] The Harvard Six Cities Study (Lepeule et al., 2012), which had been identified for use in estimating mortality impacts in previous PM benefits analyses, was not identified as most appropriate for the benefits update due to geographic limitations.

[217] U.S. Environmental Protection Agency (U.S. EPA). 2009. Integrated Science Assessment for Particulate Matter (Final Report). EPA–600–R–08–139F. National Center for Environmental Assessment—RTP Division, Research Triangle Park, NC. December. Available at: *https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=216546.*

[218] U.S. Environmental Protection Agency (U.S. EPA). 2012. Provisional Assessment of Recent Studies on Health Effect of Particulate Matter Exposure. EPA/600/R–12/056F. National Center for Environmental Assessment—RTP Division, Research Triangle Park, NC. December. Available at: *https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=247132.*

[219] Krewski D., M. Jerrett, R.T. Burnett, R. Ma, E. Hughes, Y. Shi, et al. 2009. Extended Follow-Up and Spatial Analysis of the American Cancer Society Study Linking Particulate Air Pollution and Mortality. HEI Research Report, 140, Health Effects Institute, Boston, MA.

[220] U.S. Environmental Protection Agency. (2014). Control of Air Pollution from Motor Vehicles: Tier 3 Motor Vehicle Emission and Fuel Standards Final Rule: Regulatory Impact Analysis, Assessment and Standards Division, Office of Transportation and Air Quality, EPA–420–R–14–005, March 2014. Available on the internet: *http://www3.epa.gov/otaq/documents/tier3/420r14005.pdf.*

[221] U.S. Environmental Protection Agency. (2012). *Regulatory Impact Analysis for the Final Revisions to the National Ambient Air Quality Standards for Particulate Matter,* Health and Environmental Impacts Division, Office of Air Quality Planning and Standards, EPA–452–R–12–005, December 2012. Available on the internet: *http://www3.epa.gov/ttnecas1/regdata/RIAs/finalria.pdf.*

[222] U.S. Environmental Protection Agency (U.S. EPA). (2012). Regulatory Impact Analysis: Final Rulemaking for 2017–2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, Assessment and Standards Division, Office of Transportation and Air Quality, EPA–420–R–12–016, August 2012. Available on the internet at: *http://www3.epa.gov/otaq/climate/documents/420r12016.pdf.*

the same ACS CPS–II cohort.[223] The Agency is currently working to update its mobile source BPT estimates to reflect these recent updates for use in future rulemaking analyses. More information on the BPT approach to valuing PM-related benefits can be found in RIA Chapter 7.2.

EPA received comments asserting that quantifying and monetizing the health benefits of reduced emissions of particulate matter is not consistent with the available scientific evidence and that EPA did not consider the advice made by some members of CASAC that reviewed the 2019 PM ISA. We disagree that our estimates are not consistent with the available scientific evidence and the advice of the Clean Air Science Advisory Committee. In determining which health outcomes to quantify and monetize, EPA relies on the weight-of-evidence evaluation of relationships between $PM_{2.5}$ exposure and health effects conducted within the ISAs, which are the scientific basis of the NAAQS review process. ISAs represent thorough evaluations and syntheses of the most policy-relevant science. EPA uses a structured and transparent process for evaluating scientific information and determining the causal nature of relationships between air pollution exposures and health effects. The ISA development process is detailed in the *Preamble of the Integrated Science Assessments*,[224] which describes approaches for literature searches, criteria for selecting and evaluating relevant studies, and a framework for evaluating the weight of evidence and forming causality determinations. EPA quantifies and monetizes health effects that the ISA determines are ''causal'' or ''likely to be causal.'' The focus on categories identified as having a ''causal'' or ''likely to be causal'' relationship with the pollutant of interest allows for the estimation of pollutant-attributable human health benefits in which the Agency is most confident.

As part of the process of developing an ISA, the Clean Air Scientific Advisory Committee (CASAC) is statutorily required to review the science underlying decisions about the NAAQS. CASAC provides independent review of draft ISA documents for scientific quality and sound implementation of the causal framework that informs the ISA before it is finalized. The 2020 PM NAAQS review was completed without the benefit of a PM-specific panel supporting the CASAC, as had been done in prior reviews. However, CASAC did have access to a pool of consultants who were available to respond in writing to questions from CASAC members. With limited access to relevant expertise, CASAC did not reach consensus on the determination that there is a causal relationship for $PM_{2.5}$ exposure (*i.e.,* both short- and long-term) and mortality presented within the draft PM ISA. After the disbandment of the 20-member CASAC PM panel, CASAC noted that ''Additional expertise is needed for [CASAC] to provide a thorough review of the [PM NAAQS] documents'' and recommended the Administrator reappoint ''the previous CASAC PM panel or panel with similar expertise.''[225] In his final decision to retain the PM standards, after considering CASAC's advice, the EPA Administrator, ''placing the greatest weight on evidence of effects for which the ISA determined there is a causal or likely causal relationship with long- and short-term $PM_{2.5}$ exposures,''[226] concluded that the current PM NAAQS are necessary to protect public health. Thus, the Administrator fully considered CASAC's recommendations with respect to assessing the health risks of PM in the review of the PM NAAQS and EPA is being consistent with the conclusions of the PM NAAQS review in this action.

Commenters also asserted that health benefits from reductions in human exposure to ambient concentrations of $PM_{2.5}$ only occur above the level of the primary health-based NAAQS, and that accounting for the health benefits of $PM_{2.5}$ at all represents double counting given other regulatory measures promulgated under the Clean Air Act to reduce ambient concentrations of $PM_{2.5}$. The EPA disagrees with this assertion. First, it is important to recognize that the NAAQS ''shall be ambient air quality standards . . . which in the judgment of the Administrator'' are ''requisite'' to protect public health with an ''adequate margin of safety'' (CAA Section 109). ''Requisite'' means sufficient but not more than necessary while an ''adequate margin of safety'' is intended to address uncertainties associated with inconclusive evidence and to provide a reasonable degree of protection against hazards that research has not yet identified. The CAA does not require eliminating all risk, and therefore, the NAAQS does not represent a zero-risk standard. Additionally, EPA is reconsidering the 2020 decision to retain the PM standards because available scientific evidence and technical information suggests that the current standards may not be adequate to protect public health and welfare, as required by the Clean Air Act.

As detailed in the 2019 PM ISA and previous assessments in support of the PM NAAQS, EPA's review of the science has consistently found no evidence of a threshold below which exposure to $PM_{2.5}$ yields no health response. Specifically, the 2019 p.m. ISA found that ''extensive analyses across health effects continues to support a linear, no-threshold concentration-response (C–R) relationship.'' This conclusion in the 2019 PM ISA is supported by the more recent evaluation of the health effects evidence detailed in the recently released Draft Supplement to the PM ISA which found ''continued evidence of a linear, no-threshold concentration-response (C–R) relationship.''

Regarding double-counting, the emissions attributed to this final rulemaking are incremental to all other currently promulgated air pollution regulations and can therefore be monetized without double-counting previously achieved benefits from mobile source emissions reductions.

The PM-related BPT estimates used in this analysis are provided in Table 41. We multiply these BPT values by projected national changes in NO_X, SO_2 and directly-emitted $PM_{2.5}$, in tons, to estimate the total $PM_{2.5}$-related monetized human health benefits associated with the final program. As the table indicates, these values differ among pollutants and depend on their original source, because emissions from different sources can result in different degrees of population exposure and resulting health impacts. The BPT values for emissions of non-GHG pollutants from both onroad light-duty vehicle use and upstream sources such as fuel refineries will increase over time. These projected increases reflect rising income levels, which increase affected individuals' willingness to pay for

[223] Turner, MC, Jerrett, M, Pope, A, III, Krewski, D, Gapstur, SM, Diver, WR, Beckerman, BS, Marshall, JD, Su, J, Crouse, DL and Burnett, RT (2016). Long-term ozone exposure and mortality in a large prospective study. Am J Respir Crit Care Med 193(10): 1134–1142.

[224] See *https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=310244.*

[225] In the time since the previously chartered CASAC, EPA has recognized the significant accumulation of new scientific studies since the cutoff date of the 2019 PM ISA (January 2018) and published a draft supplement to the 2019 PM ISA. The Supplement found that recent studies further support, and in some instances extend, the evidence that formed the basis of the causality determinations presented within the 2019 PM ISA that characterizes relationships between PM exposure and health, including mortality.

[226] 85 FR 82715. The effects for which the 2019 ISA determined there is a causal or likely causal relationship with long- and short-term $PM_{2.5}$ exposures include respiratory effects, cardiovascular effects, and mortality.

reduced exposure to health threats from air pollution. The BPT values also reflect future population growth and increased life expectancy, which expands the size of the population exposed to air pollution in both urban and rural areas, especially among older age groups with the highest mortality risk.[227]

TABLE 41—$PM_{2.5}$-RELATED BENEFIT-PER-TON VALUES

[2018$] [a]

Year	Onroad light duty vehicles [b]			Upstream sources—refineries [c]			Upstream sources—EGUs [c]		
	Direct $PM_{2.5}$	SO_2	NO_X	Direct $PM_{2.5}$	SO_2	NO_X	Direct $PM_{2.5}$	SO_2	NO_X
Estimated Using a 3 Percent Discount Rate									
2020	$600,000	$150,000	$6,400	$380,000	$81,000	$8,100	$160,000	$44,000	$6,600
2025	660,000	170,000	6,900	420,000	90,000	8,800	180,000	49,000	7,100
2030	740,000	190,000	7,600	450,000	98,000	9,600	190,000	52,000	7,600
2035	830,000	210,000	8,400						
2040	920,000	230,000	9,000						
2045	1,000,000	250,000	9,600						
Estimated Using a 7 Percent Discount Rate									
2020	540,000	140,000	5,800	350,000	74,000	7,300	150,000	40,000	5,900
2025	600,000	150,000	6,200	380,000	80,000	7,900	160,000	43,000	6,400
2030	660,000	170,000	6,800	410,000	88,000	8,600	170,000	48,000	6,900
2035	750,000	190,000	7,500						
2040	830,000	210,000	8,200						
2045	900,000	230,000	8,600						

Notes:

[a] The benefit-per-ton estimates presented in this table are based on estimates derived from the American Cancer Society cohort study (Krewski et al., 2009). They also assume either a 3 percent or 7 percent discount rate in the valuation of premature mortality to account for a twenty-year segmented premature mortality cessation lag.

[b] Benefit-per-ton values for onroad light duty vehicles were estimated for the years 2020, 2025, 2030, 2035, 2040, and 2045. We hold values constant for intervening years (*e.g.,* the 2020 values are assumed to apply to years 2021–2024; 2025 values for years 2026–2029; and 2045 values for years 2046 and beyond).

[c] Benefit-per-ton values for upstream sources were estimated only for the years 2020, 2025 and 2030. We hold values constant for intervening years and 2030 values are applied to years 2031 and beyond.

The monetized $PM_{2.5}$ health impacts of the final standards are presented in Table 46. Using $PM_{2.5}$-related BPT values to monetize the non-GHG impacts of the final standards omits ozone-related impacts, unquantified PM-related health impacts, as well as other impacts associated with reductions in exposure to air toxics, ecosystem benefits, and visibility improvement. Section V of this preamble provides a qualitative description of both the health and environmental effects of the non-GHG pollutants impacted by the final program.

F. Energy Security Impacts

This final rule will require reductions in the GHG emissions from light-duty vehicles and, thereby, reduce fuel consumption. In turn, this final rule will help to reduce U.S. petroleum imports. A reduction of U.S. petroleum imports reduces both financial and strategic risks caused by potential sudden disruptions in the supply of imported petroleum to the U.S., thus increasing U.S. energy security. In other words, reduced U.S. oil imports act as a ''shock absorber'' when there is a supply disruption in world oil markets.

Given that the U.S. is projected to be a net exporter of crude oil and product over the time frame of the analysis of this final rule (2023–2050), one could surmise that the U.S. no longer has a significant energy security problem. However, U.S. refineries still rely on significant imports of heavy crude oil from potentially unstable regions of the world. Also, oil exporters with a large share of global production have the ability to raise or lower the price of oil by exerting market power through the Organization of Petroleum Exporting Countries (OPEC) to alter oil supply relative to demand. These factors contribute to the vulnerability of the U.S. economy to episodic oil supply shocks and price spikes, even when the U.S. is projected to be an overall net exporter of crude oil and product.

In order to understand the energy security implications of reducing U.S. oil imports, EPA has worked with Oak Ridge National Laboratory (ORNL), which has developed approaches for evaluating the social costs and energy security implications of oil use. When conducting this analysis, ORNL considers the full cost of importing petroleum into the U.S. The full economic cost (*i.e.,* oil security premiums, as labeled below) is defined to include two components in addition to the purchase price of petroleum itself. These are: (1) The higher costs/benefits for oil imports resulting from the effect of changes in U.S. demand on the world oil price (*i.e.,* the ''demand'' or ''monopsony'' costs/benefits); and (2) the risk of reductions in U.S. economic output and disruption to the U.S. economy caused by sudden disruptions in the supply of imported oil to the U.S. (*i.e.,* the avoided macroeconomic disruption/adjustment costs). One commenter (American Enterprise Institute) suggests that there are no energy security benefits associated with this rule, since there is only one price in the international petroleum market, confronted equally by economies importing all or none of their oil. We disagree and believe that there are energy security benefits to the U.S. from decreased exposure to volatile world oil prices. We respond to this comment in more detail in the RTC.

For this final rule, EPA is using oil security premiums estimated using ORNL's methodology, which incorporates oil price projections and energy market and economic trends from the EIA's Annual Energy Outlook (AEO). Specifically, we are using oil security premiums based on AEO 2021, updating the oil security premiums from the AEO 2018 used in the proposed rule. In addition, for this final rule, EPA and ORNL have worked together to revise the oil security premiums based

[227] For more information about income growth adjustment factors and EPA's population projections, please refer to the following: *https://www.epa.gov/sites/production/files/2015-04/documents/benmap-ce_user_manual_march_2015.pdf.*

upon recent energy security literature (see Chapter 3.2.5 of the RIA accompanying this rule for how the macroeconomic oil security premiums have been updated based upon a review of recent energy security literature on this topic). These revisions have lowered the estimated oil security premiums since the proposal of this rule. However, this modest decrease in oil security premiums is offset by an increase in fuel savings since the proposal, resulting in an overall increase in energy security benefits for this final rule compared to the proposal.

In our analysis, we only consider the avoided macroeconomic disruption/adjustment costs in the oil security premiums (*i.e.,* labeled macroeconomic oil security premiums below), since the monopsony impacts are considered transfer payments. Two commenters (Center for Biological Diversity et al., CARB) suggest that EPA is underestimating the energy security benefits of the final rule by not accounting for the monopsony oil security impacts. EPA continues to believe that the monopsony impacts of this rule are transfer payments. Therefore, EPA disagrees that the energy security benefits of this final rule are underestimated for this reason. See more discussion of the monopsony oil security premiums in the RIA and RTC.

Three commenters (Center for Biological Diversity et al., CARB, SAFE) suggest that EPA understates the energy security benefits of the final rule by not considering military cost impacts. One commenter (American Enterprise Institute) suggests that reductions in military costs from the rule would be imperceptible. While EPA believes that military costs are important considerations, we continue to believe that there are methodological limitations in our ability to quantify these impacts (*e.g.,* how a reduction of U.S. oil imports would incrementally reduce oil supply protection forces). As a result, we do not quantify military cost impacts for this final rule. (See Chapter 3.2.3 of the RIA for a review of the literature on the military costs impacts of U.S. oil import reductions). In addition, some commenters (Attorney General of Missouri, et al., SAFE, Alliance for Automotive Innovation, an energy company, private citizens) express concern that these standards would reduce U.S. security by increasing the U.S.'s reliance on foreign countries (*i.e.,* China) for electric vehicle components such as electric batteries. We respond to both sets of comments, military cost impacts and U.S. security implications of this final rule, in more detail in the RTC.

To calculate the energy security benefits of this final rule, EPA is using the ORNL oil security premium methodology with: (1) Estimated oil savings calculated by EPA and (2) an oil import reduction factor of 91 percent, which represents how much U.S. oil imports are reduced resulting from changes in U.S. oil consumption. One commenter (Center for Biological Diversity et al.) requests more explanation of how EPA estimates the oil import reduction factor. The Alliance for Automotive Innovation believes that U.S. refiners and oil producers may see a greater reduction in fuel demand than EPA is estimating as a result of this final rule. We continue to believe that EPA's use of the most recent AEO 2021 provides a reasonable estimate of the oil import reduction factor being used in this rule and also the impacts of this rule on U.S. oil producers and refineries. We respond to both of these comments in more detail in the RTC. Each of the assumptions used to calculate the energy security benefits of this final rule, oil savings and the oil import reduction factor, are discussed in more detail in Chapter 3.2 of the RIA. EPA presents the macroeconomic oil security premiums used for the final standards for selected years from 2023–2050 in Table 42.

TABLE 42—MACROECONOMIC OIL SECURITY PREMIUMS FOR SELECTED YEARS FROM 2023–2050

[2018$/Barrel] *

Year (range)	Macroeconomic oil security premiums (range)
2023	$3.15 ($0.92–$5.71).
2026	$3.23 ($0.74–$6.00).
2030	$3.41 ($0.62–$6.41).
2035	$3.76 ($0.70–$7.05).
2040	$4.21 ($1.04–$7.77).
2050	$4.94 ($1.46–$8.91).

* Top values in each cell are the midpoints, the values in parentheses are the 90 percent confidence intervals.

G. Impacts of Additional Driving

As discussed in Chapter 3.1 of the RIA, the assumed rebound effect might occur when an increase in vehicle fuel efficiency encourages people to drive more as a result of the lower cost per mile of driving. Along with the safety considerations associated with increased vehicle miles traveled (described in Section VII.H of this preamble), additional driving can lead to other costs and benefits that can be monetized. For a discussion of these impacts—Drive Value, Congestion, Noise—all of which are calculated in the same way as done in the proposed rule, see RIA Chapter 3.4. EPA did not receive any comments on these elements of our proposal.

H. Safety Considerations in Establishing GHG Standards

Consistent with previous light-duty GHG analyses, EPA has assessed the potential of the final MY 2023–2026 standards to affect vehicle safety. EPA applied the same historical relationships between mass, size, and fatality risk that were established and documented in the SAFE rulemaking. These relationships are based on the statistical analysis of historical crash data, which included an analysis performed by using the most recently available crash studies based on data for model years 2007 to 2011. EPA used the findings of this analysis to estimate safety impacts of the modeled mass reductions over the lifetimes of new vehicles in response to MY 2023–2026 standards. As in the initial promulgation of the GHG standards and the MTE Proposed Determination, EPA's assessment in this rulemaking is that manufacturers can achieve the MY 2023–2026 standards while using modest levels of mass reduction as one technology option among many. On the whole, EPA considers safety impacts in the context of all projected health impacts from the rule including public health benefits from the projected reductions in air pollution. Based on the findings of our safety analysis, we concluded there are no changes to the vehicles themselves, nor the combined effects of fleet composition and vehicle design, that will have a statistically significant impact on safety. All fatalities that are statistically significant are due to changes in use (VMT) rather than changes to the vehicles themselves.

The projected change in risk of fatal and non-fatal injuries is influenced by changes in fleet mix (car/truck share), vehicle scrappage rates, distribution of VMT among vehicles in the fleet and vehicle mass. Because the empirical analysis described previously did not produce any mass-safety coefficients with a statistically significant difference from zero, we analyzed safety results over the range of coefficient values. We project that the effect of the final standards on annual fatalities per billion miles driven ranges from a decrease of 0.25 percent to an increase of 0.36 percent, with a central estimate of a 0.06 percent increase.[228]

[228] These fatality risk values are the average of changes in annual risk through 2050. The range of values is based on the 5% to 95% confidence interval of mass-safety coefficients presented in the SAFE FRM.

In addition to changes in risk, EPA also considered the projected impact of the standards on the absolute number of fatal and non-fatal injuries. The majority of the fatalities projected would result from the projected increased driving—*i.e.,* people choosing to drive more due to the lower operating costs of more efficient vehicles. Our cost-benefit analysis accounts for both the value of this additional driving and its associated risk, which we assume are considerations in the decision to drive. The risk valuation associated with this increase in driving partially offsets the associated increase in societal costs due to increased fatalities and non-fatal injuries.

This analysis projects that there will be an increase in VMT under the standards of 304 billion miles compared to the No Action scenario through 2050 (an increase of about 0.3 percent). EPA estimates that vehicle safety, in terms of risk measured as the total fatalities per the total distance traveled over this period, will remain almost unchanged at 5.012 fatalities per billion miles under the final rule, compared to 5.010 fatalities per billion miles for the no-action scenario. EPA has also estimated, over the same 30 year period, that total fatalities will increase by 1,780, with 1,348 deaths attributed to increased driving and 432 deaths attributed to the increase in fatality risk. In other words, approximately 75 percent of the change in fatalities under these standards is due to projected increases in VMT and mobility (*i.e.,* people driving more). Our analysis also considered the increase in non-fatal injuries. Consistent with the SAFE FRM, EPA assumed that non-fatal injuries scale with fatal injuries.

EPA also estimated the societal costs of these safety impacts using assumptions consistent with the SAFE FRM (see Table 43.) Specifically, we are continuing to use the cost associated with each fatality of $10.4 million (2018 dollars). We have also continued to use a scalar of approximately 1.6 applied to fatality costs to estimate non-fatal injury costs. In addition, we have accounted for the driver's inherent valuation of risk when making the decision to drive more due to rebound. This risk valuation partially offsets the fatal and non-fatal injury costs described previously, and, consistent with the SAFE FRM, is calculated as 90 percent of the fatal and non-fatal injury costs due to rebound to reflect the fact that consumers do not fully evaluate the risks associated with this additional driving.

I. Summary of Costs and Benefits

This section presents a summary of costs, benefits, and net benefits of the program. Table 43 shows the estimated annual monetized costs of the program for the indicated calendar years. The table also shows the present-values (PV) of those costs and the annualized costs for the calendar years 2021–2050 using both 3 percent and 7 percent discount rates.[229] The table includes an estimate of foregone consumer sales surplus, which measures the loss in benefits attributed to consumers who would have purchased a new vehicle in the absence of the final standards.

TABLE 43—COSTS ASSOCIATED WITH THE FINAL PROGRAM

[Billions of 2018 dollars]

Calendar year	Foregone consumer sales surplus [a]	Technology costs	Congestion	Noise	Fatality costs	Non-fatal crash costs	Total costs
2023	$0.029	$5.6	$0.03	$0.00045	$0.13	$0.23	$6.1
2026	0.11	16	0.12	0.002	0.42	0.7	17
2030	0.093	17	0.4	0.0067	0.44	0.73	19
2035	0.078	17	0.68	0.011	0.27	0.44	19
2040	0.063	16	0.84	0.014	0.15	0.25	17
2050	0.052	15	0.9	0.015	0.16	0.25	16
PV, 3%	1.3	280	9.6	0.16	4.9	8.1	300
PV, 7%	0.84	160	4.8	0.08	3.2	5.3	180
Annualized, 3%	0.069	14	0.49	0.0082	0.25	0.42	15
Annualized, 7%	0.068	13	0.39	0.0065	0.26	0.43	14

[a] "Foregone Consumer Sales Surplus" refers to the difference between a vehicle's price and the buyer's willingness to pay for the new vehicle; the impact reflects the reduction in new vehicle sales described in Section VII.B of this preamble. See Section 8 of *CAFE_Model_Documentation_FR_2020.pdf* in the docket for more information.

Table 44 shows the undiscounted annual monetized fuel savings of the program. The table also shows the present- and annualized-values of those fuel savings for the same calendar years using both 3 percent and 7 percent discount rates. The net benefits calculations use the aggregate value of fuel savings (calculated using pre-tax fuel prices) since savings in fuel taxes do not represent a reduction in the value of economic resources utilized in producing and consuming fuel. Note that the fuel savings shown in Table 44 result from reductions in fleet-wide fuel use (including rebound effects, credit usage and advanced technology multiplier use). Thus, fuel savings grow over time as an increasing fraction of the fleet is projected to meet the standards.

TABLE 44—FUEL SAVINGS ASSOCIATED WITH THE FINAL PROGRAM

[Billions of 2018 dollars]

Calendar year	Retail fuel savings	Fuel tax savings	Pre-tax fuel savings
2023	$0.94	$0.31	$0.62
2026	5.1	1.7	3.3
2030	16	4.5	12

[229] For the estimation of the stream of costs and benefits, we assume that after implementation of the MY 2023–2026 standards, the 2026 standards apply to each year thereafter.

TABLE 44—FUEL SAVINGS ASSOCIATED WITH THE FINAL PROGRAM—Continued

[Billions of 2018 dollars]

Calendar year	Retail fuel savings	Fuel tax savings	Pre-tax fuel savings
2035	28	7.1	21
2040	37	8.5	29
2050	42	8.6	33
PV, 3%	420	100	320
PV, 7%	210	51	150
Annualized, 3%	21	5.1	16
Annualized, 7%	17	4.1	12

Note: Electricity expenditure increases are included.

Table 45 presents estimated annual monetized benefits from non-emission sources for the indicated calendar years. The table also shows the present- and annualized-value of those benefits for the calendar years 2021–2050 using both 3 percent and 7 percent discount rates.

TABLE 45—BENEFITS FROM NON-EMISSION SOURCES

[Billions of 2018 dollars]

Calendar year	Drive value	Refueling time savings	Energy security benefits	Total non-emission benefits
2023	$0.035	−$0.0052	$0.031	$0.061
2026	0.14	−0.12	0.18	0.2
2030	0.55	−0.27	0.51	0.79
2035	1	−0.47	0.92	1.5
2040	1.3	−0.67	1.3	1.9
2050	1.5	−0.83	1.6	2.3
PV, 3%	15	−7.4	14	21
PV, 7%	7.2	−3.6	7	11
Annualized, 3%	0.75	−0.38	0.73	1.1
Annualized, 7%	0.58	−0.29	0.56	0.85

* See Section VII.G, Section VII.C and Section VII.F of this preamble for more on drive value, refueling time and energy security, respectively.

Table 46 presents estimated annual monetized benefits from non-GHG emission sources for the indicated calendar years. The table also shows the present- and annualized-values of those benefits for the calendar years 2021–2050 using both 3 percent and 7 percent discount rates.

TABLE 46—$PM_{2.5}$-RELATED EMISSION REDUCTION BENEFITS

[Billions of 2018 dollars] [a b]

Calendar year	Tailpipe benefits		Upstream benefits		Total $PM_{2.5}$-related benefits	
	3% DR	7% DR	3% DR	7% DR	3% DR	7% DR
2023	−$0.0034	−$0.0031	$0.02	$0.018	$0.016	$0.015
2026	0.018	0.016	0.097	0.088	0.11	0.1
2030	0.15	0.13	0.45	0.41	0.6	0.54
2035	0.44	0.4	0.79	0.72	1.2	1.1
2040	0.68	0.62	1	0.95	1.7	1.6
2050	0.89	0.8	1.4	1.3	2.3	2.1
PV	6.7	2.8	12	5.3	19	8.1
Annualized	0.34	0.22	0.61	0.43	0.96	0.65

Notes:

[a] Note that the non-GHG impacts associated with the standards presented here do not include the full complement of health and environmental effects that, if quantified and monetized, would increase the total monetized benefits. Instead, the non-GHG benefits are based on benefit-per-ton values that reflect only human health impacts associated with reductions in $PM_{2.5}$ exposure.

[b] Calendar year non-GHG benefits presented in this table assume either a 3 percent or 7 percent discount rate in the valuation of PM-related premature mortality to account for a twenty-year segmented cessation lag. Note that annual benefits estimated using a 3 percent discount rate were used to calculate the present and annualized values using a 3 percent discount rate and the annual benefits estimated using a 7 percent discount rate were used to calculate the present and annualized values using a 7 percent discount rate.

Table 47 shows the benefits of reduced GHG emissions, and consequently the annual quantified benefits (*i.e.,* total GHG benefits), for each of the four interim social cost of GHG (SC–GHG) values estimated by the interagency working group. As discussed in the RIA Chapter 3.3, there are some limitations to the SC–GHG analysis, including the incomplete way in which the integrated assessment models capture catastrophic and noncatastrophic impacts, their incomplete treatment of adaptation and technological change, uncertainty in the extrapolation of damages to high temperatures, and assumptions regarding risk aversion.

TABLE 47—CLIMATE BENEFITS FROM REDUCTIONS IN GHG EMISSIONS

[Billions of 2018 dollars]

Calendar year	Discount rate and statistic			
	5% average	3% average	2.5% average	3% 95th percentile
2023	$0.081	$0.27	$0.4	$0.8
2026	0.48	1.6	2.3	4.7
2030	1.5	4.6	6.7	14
2035	2.8	8.4	12	25
2040	3.9	11	16	34
2050	5.5	14	20	44
PV	31	130	200	390
Annualized	2	6.6	9.5	20

Notes: The present value of reduced GHG emissions is calculated differently than other benefits. The same discount rate used to discount the value of damages from future emissions (SC–GHGs at 5, 3, 2.5 percent) is used to calculate the present value of SC–GHGs for internal consistency. Annual benefits shown are undiscounted values.

Table 48 presents estimated annual net benefits for the indicated calendar years. The table also shows the present and annualized value of those net benefits for the calendar years 2021–2050 using both 3 percent and 7 percent discount rates. The table includes the benefits of reduced GHG emissions (and consequently the annual net benefits) for each of the four SC–GHG values considered by EPA. We estimate that the total benefits of the program far exceed the costs and would result in a net present value of benefits that ranges between $27–$450 billion, depending on which SC–GHG and discount rate is assumed.

TABLE 48—NET BENEFITS (EMISSION BENEFITS + NON-EMISSION BENEFITS + FUEL SAVINGS − COSTS) ASSOCIATED WITH THE FINAL PROGRAM

[Billions of 2018 dollars] [a b]

Calendar year	Net benefits, with climate benefits based on 5% discount rate	Net benefits, with climate benefits based on 3% discount rate	Net benefits, with climate benefits based on 2.5% discount rate	Net benefits, with climate benefits based on 3% discount rate, 95th percentile SC–GHG
2023	−$5.3	−$5.1	−$5	−$4.6
2026	−13	−12	−11	−9.1
2030	−4.6	−1.4	0.63	7.9
2035	7.8	13	17	30
2040	19	26	31	49
2050	27	36	41	66
PV, 3%	88	190	260	450
PV, 7%	27	120	190	390
Annualized, 3%	4.9	9.5	12	23
Annualized, 7%	1.7	6.2	9.2	20

Notes:

[a] The present value of reduced GHG emissions is calculated differently than other benefits. The same discount rate used to discount the value of damages from future emissions (SC–GHG at 5, 3, 2.5 percent) is used to calculate present value of SC–GHGs for internal consistency, while all other costs and benefits are discounted at either 3% or 7%. Annual costs and benefits shown are undiscounted values.

[b] Note that the non-GHG impacts associated with the standards presented here do not include the full complement of health and environmental effects that, if quantified and monetized, would increase the total monetized benefits. Instead, the non-GHG benefits are based on benefit-per-ton values that reflect only human health impacts associated with reductions in $PM_{2.5}$ exposure.

J. Impacts on Consumers of Vehicle Costs and Fuel Savings

Although the primary purpose of this regulatory action is to reduce GHG emissions, the impact of EPA's standards on consumers is an important consideration for EPA. This section discusses the impact of the standards on consumer net costs for purchasing and fueling vehicles. For further discussion of impacts on vehicle sales, see Section VII.B of this preamble and for impacts on affordability, see Section VII.M of this preamble.

EPA estimates that the average cost of a new MY 2026 vehicle will increase by $1,000 due to the final standards, while we estimate that the average per-mile fuel cost in the first year will decrease by 0.73 cents.[230] Over time, reductions

[230] See U.S. Environmental Protection Agency, ''Fuel Savings Offset to Vehicle Costs_20211031.xlsx,'' in the docket for this and the other calculations in this section. Fuel prices are based on AEO2021 and change over time; for the Reference Case, the average retail fuel price for years 2026–2036 ranged from $2.53 to $2.98/gallon (2020$) for gasoline and $0.118 to $0.119/kWh of electricity (2020$). U.S. Energy Information Administration (EIA), U.S. Department of Energy

Continued

in fuel consumption will offset the increase in upfront costs. For instance, EPA estimates that, over the lifetime of a MY 2026 vehicle,[231] the reduction in fuel costs will exceed the increase in vehicle costs by $1,083, using a 3 percent discount rate.[232]

Another way to look at the effects on vehicle buyers is to examine how the costs are distributed among new and used vehicle owners. Because depreciation occurs over the lifetime of the vehicle, the net purchase cost to an owner will depend on the vehicle age when it was bought, and, if sold, the length of time that the vehicle was owned. A study from Argonne National Laboratory provides estimates for the depreciation of light-duty vehicles by age, as summarized in Table 49.[233] If the additional cost of fuel-saving technology depreciates at the same rates, then a person who buys a new vehicle and sells it after 5 years would incur 60 percent of the upfront costs (100 percent of the original value, less 40 percent paid back). Analogously, the person who buys the vehicle at age 5 would incur 20 percent of those costs (40 percent, less 20 percent paid back), and the purchaser of the 10-year-old vehicle would face a net 10 percent of the cost of the technology after it is sold five years later at vehicle age 15. A person purchasing a new vehicle, driving the average fleetwide VMT for the given age and facing the fuel prices used in this analysis, would face an estimated net cost of $60, shown in Table 50, which reflects fuel savings that offset 91 percent of the depreciation cost. The buyer of that 5-year-old used vehicle would see an estimated reduction in net cost—that is, a net saving—of $357, while the buyer of that same 10-year-old used vehicle would see an estimated reduction of net cost of $430. In general, the purchasers of older vehicles will see a greater portion of their depreciation costs offset by fuel savings.

TABLE 49—DEPRECIATION ESTIMATES FOR LIGHT DUTY VEHICLES

Vehicle age	1	2	3	4	5	10	15
Fraction of original value retained	0.70	0.61	0.53	0.475	0.40	0.20	0.10

Estimated by Argonne National Laboratory using Edmunds data for MYs 2013–2019 vehicles (see figure ES–2).[233]

TABLE 50—IMPACT OF STANDARDS ON DEPRECIATION AND FUEL COSTS FOR MY 2026 VEHICLE OVER 5 YEARS OF OWNERSHIP

	Vehicle depreciation plus fuel costs	Portion of depreciation costs offset by fuel savings (%)
Vehicle Purchased New	$60	91
Vehicle Purchased at Age 5	($357)	257
Vehicle Purchased at Age 10	($430)	478

Calculated using analysis VMT assumptions for standards, using a 3% discount rate from year of purchase.

Because the use of vehicles varies widely across vehicle owners, another way to estimate the effects of the standards is to examine the ‘‘break even’’ number of miles—that is, the number of miles driven that would result in fuel savings matching the increase in up-front costs. For example, if operating costs of a MY 2026 vehicle decrease by 0.73 cents per mile due to reduced fuel consumption, the upfront costs (when purchased new) would be recovered after 137,000 miles of driving, excluding discounting.[234] As this measure makes clear, the financial effect on a new vehicle owner depends on the amount that the vehicle is driven. Mobility service providers, such as taxis or ride-sharing services, are likely to accumulate miles more quickly than most people who use their vehicles for personal use. As discussed in Section VII.M of this preamble, the lower per-mile cost for these vehicles may reduce the importance of up-front costs in the charge for mobility as a service, and thus further enable use of that service.

Table 51 shows, for purchasers of different-age MY 2026 vehicles, how the degree to which fuel savings offset depreciation costs will depend on vehicle use levels.[235] Cost recovery is again higher for older vehicles, and faster for vehicles that accumulate VMT more quickly. For example, a consumer who purchases a 5-year old used MY 2026 vehicle would recover their vehicle costs through fuel savings after only 23,000 miles of driving.

(DOE), Annual Energy Outlook, 2021. For the analysis involving 5-year ownership periods, we use the fuel costs associated with the initial year of purchase for each owner, *i.e.,* 2026, 2031, 2036. The analysis includes the program flexibilities of credit banking, fleet averaging, advanced technology multipliers, and air conditioning and off-cycle credits.

[231] The CCEMS models vehicles over a 30 year lifetime; however, it includes scrappage rates such that fewer and fewer vehicles of any vintage remain on the road year after year, and those vehicles that remain are driven fewer and fewer miles year after year.

[232] EPA Guidelines for Preparing Economic Analysis, Chapter 6.4, suggests that a 3 percent discount rate is appropriate for calculations involving consumption, instead of the opportunity cost of capital. Here, the discount rate is applied, beginning in 2026 when the vehicle is purchased new, to the stream of fuel costs over the vehicle lifetime. U.S. Environmental Protection Agency (2010). ‘‘Guidelines for Preparing Economic Analysis,’’ Chapter 6. *https://www.epa.gov/sites/production/files/2017-09/documents/ee-0568-06.pdf,* accessed 6/14/2021.

[233] Argonne National Laboratory (2021). ‘‘Comprehensive Total Cost of Ownership Quantification for Vehicles with Different Size Classes and Powertrains.’’ ANL/ESD–21/4, Figure ES–2. *https://publications.anl.gov/anlpubs/2021/05/167399.pdf,* accessed 6/8/2021.

[234] This estimate is calculated as the increase in cost, $1,000, divided by the reduced per-mile cost, $0.0073, to get miles until cost is recovered.

[235] The up-front costs for each purchaser are based on the cost to the owner based on the depreciated price for the vehicle's age, with recovery of some further depreciated cost after 5 years of ownership. Cost recovery per mile is $0.0073, and is multiplied by the number of miles in the second column. The remaining columns are cost recovery divided by the relevant cost. Discounting is not used to abstract from the VMT occurring during a specified timeframe.

TABLE 51—PROPORTION OF DEPRECIATION COSTS OFFSET BY FUEL SAVINGS, FOR NEW AND USED VEHICLE PURCHASERS, FOR A MY 2026 VEHICLE

		When vehicle purchased new	When vehicle purchased at 5 years old	When vehicle purchased at 10 years old
Portion of vehicle depreciation cost offset by fuel savings (own vehicle for 5 years).	At 10,000 miles	12%	43%	93%
	At 50,000 miles	61%	214%	467%
	At 100,000 miles	122%	428%	933%
Miles where fuel savings fully offset the vehicle owner's depreciation cost.	Owned vehicle for 5 years	82,000	23,000	11,000
	Owned vehicle for full remaining lifetime	137,000	47,000	21,000

Thus, the financial effects on a vehicle buyer depend on how much that person drives, as well as whether the vehicle is bought new or used. Importantly, all people receive the benefits of reduced GHG emissions, the primary focus of this rule.

K. Employment Impacts

Several commenters, including the Alliance, Blue-Green Alliance, International Union, United Automobile, Aerospace & Agricultural Implement Workers of America (UAW), SAFE (Securing America's Future Energy), and a coalition of 25 Great Lakes and Midwest environmental organizations, indicated that domestic employment effects, especially in the auto industry, are an important impact of the standards. The Blue-Green Alliance, Ceres, Environmental Entrepreneurs, EDF, Environmental Law and Policy Center, EOS at Federated Hermes, New Mexico Environment Department, New York State Department of Environmental Conservation, and the coalition of organizations argue that strong standards contribute to job-supporting domestic manufacturing. CBD et al. considers EPA's employment estimates to be too low, by not considering impacts in the broader economy. National Coalition for Advanced Transportation, SAFE and Alliance discuss the role of domestic supply chains for electric vehicles in promoting domestic employment. The UAW notes their involvement in building these ''vehicles of the future.'' Volkswagen describes its partnership with Chattanooga State Community College to train workers in next-generation auto manufacturing skills. EPA acknowledges these comments and recognizes employment impacts as an important impact to be assessed, and thus we present an assessment of impacts of these standards on employment.

If the U.S. economy is at full employment, even a large-scale environmental regulation is unlikely to have a noticeable impact on aggregate net employment.[236] Instead, labor would primarily be reallocated from one productive use to another, and net national employment effects from environmental regulation would be small and transitory (*e.g.,* as workers move from one job to another).[237] Affected sectors may nevertheless experience transitory effects as workers change jobs. Some workers may retrain or relocate in anticipation of new requirements or require time to search for new jobs, while shortages in some sectors or regions could bid up wages to attract workers. These adjustment costs can lead to local labor disruptions. Even if the net change in the national workforce is small, localized reductions in employment may adversely impact individuals and communities just as localized increases may have positive impacts.

If the economy is operating at less than full employment, economic theory does not clearly indicate the direction or magnitude of the net impact of environmental regulation on employment; it could cause either a short-run net increase or short-run net decrease.[238] At the level of individual companies, employers affected by environmental regulation may increase their demand for some types of labor, decrease demand for other types of labor, or for still other types, not change it at all. The uncertain direction of labor impacts is due to the different channels by which regulations affect labor demand.

Morgenstern et al. (2002)[239] decompose the labor consequences in a regulated industry facing increased abatement costs into three separate components. First, there is a demand effect caused by higher production costs raising market prices. Higher prices reduce consumption (and production), reducing demand for labor within the regulated industry. Second, there is a cost effect where, as production costs increase, plants use more of all inputs, including labor, to produce the same level of output. Third, there is a factor-shift effect where post-regulation production technologies may have different labor intensities. Other researchers use different frameworks along a similar vein.[240]

RIA Chapter 8.2 discusses the calculation of employment impacts in the model used for this analysis. The estimates include effects on three sectors: Automotive dealers, final assembly labor and parts production, and fuel economy technology labor. The first two of these are examples of Morgenstern *et al.'s* (2002) demand-effect employment, while the third reflects cost-effect employment. For automotive dealers, the model estimates the hours involved in each new vehicle sale. To estimate the labor involved in final assembly, the model used average labor hours per vehicle at a sample of U.S. assembly plants, adjusted by the ratio of vehicle assembly manufacturing employment to employment for total

[236] Full employment is a conceptual target for the economy where everyone who wants to work and is available to do so at prevailing wages is actively employed. The unemployment rate at full employment is not zero.

[237] Arrow et al. (1996). ''Benefit-Cost Analysis in Environmental, Health, and Safety Regulation: A Statement of Principles.'' American Enterprise Institute, The Annapolis Center, and Resources for the Future. See discussion on bottom of p. 6. In practice, distributional impacts on individual workers can be important, as discussed later in this section.

[238] Schmalensee, Richard, and Stavins, Robert N. ''A Guide to Economic and Policy Analysis of EPA's Transport Rule.'' White paper commissioned by Excelon Corporation, March 2011.

[239] Morgenstern, R.D.; Pizer, W.A.; and Shih, J.-S. (2002). ''Jobs Versus the Environment: An Industry-Level Perspective.'' Journal of Environmental Economics and Management 43: 412–436. 2002.

[240] Berman, E. and Bui, L. T. M. (2001). ''Environmental Regulation and Labor Demand: Evidence from the South Coast Air Basin.'' Journal of Public Economics 79(2): 265–295; Deschênes, O. (2018). ''Balancing the Benefits of Environmental Regulations for Everyone and the Costs to Workers and Firms.'' IZA World of Labor 22v2. *https://wol.iza.org/uploads/articles/458/pdfs/environmental-regulations-and-labor-markets.pdf,* accessed 4/19/2021.

vehicle and equipment manufacturing for new vehicles. Finally, for fuel economy technology labor, DOT calculated the average revenue per job-year for automakers.

The new-vehicle demand elasticity, among other factors, affects employment impacts because it affects the estimated changes in new vehicle sales due to the standards. In the proposed rule, EPA's central analysis used a new-vehicle demand elasticity of −1, with a sensitivity analysis using −0.4 as the demand elasticity. As discussed in Section VII.B of this preamble, in this FRM, EPA's central case uses a new-vehicle demand elasticity of −0.4, with sensitivities of −0.15 and −1, due to evidence that the value of −1 used in the proposed rule, from older studies, is no longer supported by recent studies. EPA's assessment of employment impacts, in RIA Chapter 8.2.3, using the sales assumptions of both automakers and consumers using 2.5 years of fuel consumption in vehicle decisions and a demand elasticity of −0.4, shows an increase in employment of between about 1 and 2.4 percent due to the labor involved in producing the technologies needed to meet the standards. If, instead, we use the sensitivity analysis with a demand elasticity of −0.15, employment is higher for both the no-action alternative and the standards, but the percent change is almost the same. In contrast, in our sensitivity analysis using the −1 demand elasticity, which EPA now believes is outdated, employment increases by between 0 and 0.7 percent. If automakers underestimate consumers' valuation of fuel economy, as noted in Section VII.B of this preamble, then demand-effect employment is likely to be higher, and employment impacts are likely to be more positive.

Note that these are employment impacts in the directly regulated sector, plus the impacts for automotive dealers. These do not include economy-wide labor impacts. As discussed earlier, economy-wide impacts on employment are generally driven by broad macroeconomic effects. It also does not reflect employment effects due to reduced spending on fuel consumption. Those changes may lead to some reductions in employment in gas stations, and some increases in other sectors to which people reallocate those expenditures.

Electrification of the vehicle fleet is likely to affect both the number and the nature of employment in the auto and parts sectors and related sectors, such as providers of charging infrastructure. The kinds of jobs in auto manufacturing are expected to change: For instance, there will be no need for engine and exhaust system assembly for EVs, while many assembly tasks will involve electrical rather than mechanical fitting. Batteries represent a significant portion of the manufacturing content of an electrified vehicle, and some automakers are likely to purchase the cells, if not pre-assembled modules or packs, from suppliers. The effect on total employment for auto manufacturing is uncertain: Some suggest that fewer workers will be needed because BEVs have fewer moving parts,[241] while others estimate that the labor-hours involved in BEVs are almost identical to that for ICE vehicles.[242] Effects in the supply chain, as Securing America's Energy Future (SAFE) and Alliance noted, depend on where goods in the supply chain are developed. Blue-Green Alliance, BICEP, Ceres, Environmental Entrepreneurs, Elders Climate Action, SAFE, and the UAW all argue that developing EVs in the U.S. is critical for domestic employment and for the global competitiveness of the U.S. in the future auto industry. EPA agrees that these concerns are important and will continue to assess changes in employment associated with electrification of the auto industry.

L. Environmental Justice

Executive Order 12898 (59 FR 7629, February 16, 1994) establishes federal executive policy on environmental justice. It directs federal agencies, to the greatest extent practicable and permitted by law, to make achieving environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations in the U.S. EPA defines environmental justice as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.[243]

Executive Order 14008 (86 FR 7619, February 1, 2021) also calls on federal agencies to make achieving environmental justice part of their respective missions ''by developing programs, policies, and activities to address the disproportionately high and adverse human health, environmental, climate-related and other cumulative impacts on disadvantaged communities, as well as the accompanying economic challenges of such impacts.'' It also declares a policy ''to secure environmental justice and spur economic opportunity for disadvantaged communities that have been historically marginalized and overburdened by pollution and under-investment in housing, transportation, water and wastewater infrastructure and health care.''

Under Executive Order 13563 (76 FR 3821, January 21, 2011), federal agencies may consider equity, human dignity, fairness, and distributional considerations in their regulatory analyses, where appropriate and permitted by law.

EPA's 2016 ''Technical Guidance for Assessing Environmental Justice in Regulatory Analysis'' provides recommendations on conducting the highest quality analysis feasible, recognizing that data limitations, time and resource constraints, and analytic challenges will vary by media and regulatory context.[244]

When assessing the potential for disproportionately high and adverse health or environmental impacts of regulatory actions on populations of color, low-income populations, tribes, and/or indigenous peoples, EPA strives

[241] Krisher, T., and Seewer, J. (2021). ''Autoworkers face uncertain future in an era of electric cars.'' *https://abcnews.go.com/US/wireStory/autoworkers-face-dimmer-future-era-electric-cars-75828610,* accessed 10/20/2021.

[242] Kupper, D., K. Kuhlmann, K. Tominaga, A. Arora, and J. Schlageter (2020). ''Shifting Gears in Auto Manufacturing.'' *https://www.bcg.com/publications/2020/transformative-impact-of-electric-vehicles-on-auto-manufacturing,* accessed 10/20/2021.

[243] Fair treatment means that ''no group of people should bear a disproportionate burden of environmental harms and risks, including those resulting from the negative environmental consequences of industrial, governmental and commercial operations or programs and policies.'' Meaningful involvement occurs when ''(1) potentially affected populations have an appropriate opportunity to participate in decisions about a proposed activity [*e.g.,* rulemaking] that will affect their environment and/or health; (2) the public's contribution can influence [EPA's rulemaking] decision; (3) the concerns of all participants involved will be considered in the decision-making process; and (4) [EPA will] seek out and facilitate the involvement of those potentially affected'' A potential EJ concern is defined as ''the actual or potential lack of fair treatment or meaningful involvement of minority populations, low-income populations, tribes, and indigenous peoples in the development, implementation and enforcement of environmental laws, regulations and policies.'' See ''Guidance on Considering Environmental Justice During the Development of an Action.'' Environmental Protection Agency, *www.epa.gov/environmentaljustice/guidanceconsidering-environmental-justice-duringdevelopment-action.* See also *https://www.epa.gov/environmentaljustice.*

[244] ''Technical Guidance for Assessing Environmental Justice in Regulatory Analysis.'' *Epa.gov,* Environmental Protection Agency, *https://www.epa.gov/sites/production/files/2016-06/documents/ejtg_5_6_16_v5.1.pdf.*

to answer three broad questions: (1) Is there evidence of potential EJ concerns in the baseline (the state of the world absent the regulatory action)? Assessing the baseline will allow EPA to determine whether pre-existing disparities are associated with the pollutant(s) under consideration (*e.g.,* if the effects of the pollutant(s) are more concentrated in some population groups). (2) Is there evidence of potential EJ concerns for the regulatory option(s) under consideration? Specifically, how are the pollutant(s) and its effects distributed for the regulatory options under consideration? (3) Do the regulatory option(s) under consideration exacerbate or mitigate EJ concerns relative to the baseline? It is not always possible to quantitatively assess these questions.

EPA's 2016 Technical Guidance does not prescribe or recommend a specific approach or methodology for conducting an environmental justice analysis, though a key consideration is consistency with the assumptions underlying other parts of the regulatory analysis when evaluating the baseline and regulatory options. Where applicable and practicable, the Agency endeavors to conduct such an analysis. Going forward, EPA is committed to conducting environmental justice analysis for rulemakings based on a framework similar to what is outlined in EPA's Technical Guidance, in addition to investigating ways to further weave environmental justice into the fabric of the rulemaking process. EPA greatly values input from EJ stakeholders and communities and looks forward to engagement as we consider the impacts of light-duty vehicle emissions.

1. GHG Impacts

In 2009, under the *Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act* (''Endangerment Finding''), the Administrator considered how climate change threatens the health and welfare of the U.S. population. As part of that consideration, she also considered risks to minority and low-income individuals and communities, finding that certain parts of the U.S. population may be especially vulnerable based on their characteristics or circumstances. These groups include economically and socially disadvantaged communities; individuals at vulnerable lifestages, such as the elderly, the very young, and pregnant or nursing women; those already in poor health or with comorbidities; the disabled; those experiencing homelessness, mental illness, or substance abuse; and/or Indigenous or minority populations dependent on one or limited resources for subsistence due to factors including but not limited to geography, access, and mobility.

Scientific assessment reports produced over the past decade by the U.S. Global Change Research Program (USGCRP),[245] [246] the Intergovernmental Panel on Climate Change (IPCC),[247] [248] [249] [250] and the National Academies of Science, Engineering, and Medicine [251] [252] add more evidence that the impacts of climate change raise potential environmental justice concerns. These reports conclude that poorer or predominantly non-White communities can be especially vulnerable to climate change impacts because they tend to have limited adaptive capacities and are more dependent on climate-sensitive resources such as local water and food supplies, or have less access to social and information resources. Some communities of color, specifically populations defined jointly by ethnic/racial characteristics and geographic location, may be uniquely vulnerable to climate change health impacts in the U.S. In particular, the 2016 scientific assessment on the *Impacts of Climate Change on Human Health* [253] found with high confidence that vulnerabilities are place- and time-specific, lifestages and ages are linked to immediate and future health impacts, and social determinants of health are linked to greater extent and severity of climate change-related health impacts.

i. Effects on Specific Populations of Concern

Individuals living in socially and economically disadvantaged communities, such as those living at or below the poverty line or who are experiencing homelessness or social isolation, are at greater risk of health effects from climate change. This is also true with respect to people at vulnerable lifestages, specifically women who are pre- and perinatal, or are nursing; *in utero* fetuses; children at all stages of development; and the elderly. Per the Fourth National Climate Assessment, ''Climate change affects human health by altering exposures to heat waves, floods, droughts, and other extreme events; vector-, food- and waterborne infectious diseases; changes in the quality and safety of air, food, and water; and stresses to mental health and well-being.'' [254] Many health conditions

[245] USGCRP, 2018: *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018.

[246] USGCRP, 2016: The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. Crimmins, A., J. Balbus, J.L. Gamble, C.B. Beard, J.E. Bell, D. Dodgen, R.J. Eisen, N. Fann, M.D. Hawkins, S.C. Herring, L. Jantarasami, D.M. Mills, S. Saha, M.C. Sarofim, J. Trtanj, and L. Ziska, Eds. U.S. Global Change Research Program, Washington, DC, 312 pp. *http://dx.doi.org/10.7930/J0R49NQX.*

[247] Oppenheimer, M., M. Campos, R.Warren, J. Birkmann, G. Luber, B. O'Neill, and K. Takahashi, 2014: Emergent risks and key vulnerabilities. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1039–1099.

[248] Porter, J.R., L. Xie, A.J. Challinor, K. Cochrane, S.M. Howden, M.M. Iqbal, D.B. Lobell, and M.I. Travasso, 2014: Food security and food production systems. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 485–533.

[249] Smith, K.R., A.Woodward, D. Campbell-Lendrum, D.D. Chadee, Y. Honda, Q. Liu, J.M. Olwoch, B. Revich, and R. Sauerborn, 2014: Human health: Impacts, adaptation, and co-benefits. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 709–754.

[250] IPCC, 2018: Global Warming of 1.5 °C. An IPCC Special Report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.

[251] National Research Council. 2011. America's Climate Choices. Washington, DC: The National Academies Press. *https://doi.org/10.17226/12781.*

[252] National Academies of Sciences, Engineering, and Medicine. 2017. Communities in Action: Pathways to Health Equity. Washington, DC: The National Academies Press. *https://doi.org/10.17226/24624.*

[253] USGCRP, 2016: The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment.

[254] Ebi, K.L., J.M. Balbus, G. Luber, A. Bole, A. Crimmins, G. Glass, S. Saha, M.M. Shimamoto, J. Trtanj, and J.L. White-Newsome, 2018: Human

Continued

such as cardiopulmonary or respiratory illness and other health impacts are associated with and exacerbated by an increase in GHGs and climate change outcomes, which is problematic as these diseases occur at higher rates within vulnerable communities. Importantly, negative public health outcomes include those that are physical in nature, as well as mental, emotional, social, and economic.

To this end, the scientific assessment literature, including the aforementioned reports, demonstrates that there are myriad ways in which these populations may be affected at the individual and community levels. Individuals face differential exposure to criteria pollutants, in part due to the proximities of highways, trains, factories, and other major sources of pollutant-emitting sources to less-affluent residential areas. Outdoor workers, such as construction or utility crews and agricultural laborers, who frequently are comprised of already at-risk groups, are exposed to poor air quality and extreme temperatures without relief. Furthermore, individuals within EJ populations of concern face greater housing, clean water, and food insecurity and bear disproportionate economic impacts and health burdens associated with climate change effects. They have less or limited access to healthcare and affordable, adequate health or homeowner insurance. Finally, resiliency and adaptation are more difficult for economically disadvantaged communities: They have less liquidity, individually and collectively, to move or to make the types of infrastructure or policy changes to limit or reduce the hazards they face. They frequently are less able to self-advocate for resources that would otherwise aid in building resilience and hazard reduction and mitigation.

The assessment literature cited in EPA's 2009 and 2016 Endangerment Findings, as well as *Impacts of Climate Change on Human Health,* also concluded that certain populations and life stages, including children, are most vulnerable to climate-related health effects. The assessment literature produced from 2016 to the present strengthens these conclusions by providing more detailed findings regarding related vulnerabilities and the projected impacts youth may experience. These assessments—including the Fourth National Climate Assessment (2018) and *The Impacts of Climate Change on Human Health in the United States* (2016)—describe how children's unique physiological and developmental factors contribute to making them particularly vulnerable to climate change. Impacts to children are expected from heat waves, air pollution, infectious and waterborne illnesses, and mental health effects resulting from extreme weather events. In addition, children are among those especially susceptible to allergens, as well as health effects associated with heat waves, storms, and floods. Additional health concerns may arise in low-income households, especially those with children, if climate change reduces food availability and increases prices, leading to food insecurity within households.

The Impacts of Climate Change on Human Health [253] also found that some communities of color, low-income groups, people with limited English proficiency, and certain immigrant groups (especially those who are undocumented) live with many of the factors that contribute to their vulnerability to the health impacts of climate change. While difficult to isolate from related socioeconomic factors, race appears to be an important factor in vulnerability to climate-related stress, with elevated risks for mortality from high temperatures reported for Black or African American individuals compared to White individuals after controlling for factors such as air conditioning use. Moreover, people of color are disproportionately exposed to air pollution based on where they live, and disproportionately vulnerable due to higher baseline prevalence of underlying diseases such as asthma, so climate exacerbations of air pollution are expected to have disproportionate effects on these communities.

Native American Tribal communities possess unique vulnerabilities to climate change, particularly those impacted by degradation of natural and cultural resources within established reservation boundaries and threats to traditional subsistence lifestyles. Tribal communities whose health, economic well-being, and cultural traditions depend upon the natural environment will likely be affected by the degradation of ecosystem goods and services associated with climate change. The IPCC indicates that losses of customs and historical knowledge may cause communities to be less resilient or adaptable.[255] The Fourth National Climate Assessment (2018) noted that while Indigenous peoples are diverse and will be impacted by the climate changes universal to all Americans, there are several ways in which climate change uniquely threatens Indigenous peoples' livelihoods and economies.[256] In addition, there can institutional barriers to their management of water, land, and other natural resources that could impede adaptive measures.

For example, Indigenous agriculture in the Southwest is already being adversely affected by changing patterns of flooding, drought, dust storms, and rising temperatures leading to increased soil erosion, irrigation water demand, and decreased crop quality and herd sizes. The Confederated Tribes of the Umatilla Indian Reservation in the Northwest have identified climate risks to salmon, elk, deer, roots, and huckleberry habitat. Housing and sanitary water supply infrastructure are vulnerable to disruption from extreme precipitation events.

NCA4 noted that Indigenous peoples often have disproportionately higher rates of asthma, cardiovascular disease, Alzheimer's, diabetes, and obesity, which can all contribute to increased vulnerability to climate-driven extreme heat and air pollution events. These factors also may be exacerbated by stressful situations, such as extreme weather events, wildfires, and other circumstances.

NCA4 and IPCC AR5 [257] also highlighted several impacts specific to Alaskan Indigenous Peoples. Coastal erosion and permafrost thaw will lead to more coastal erosion, exacerbated risks of winter travel, and damage to buildings, roads, and other infrastructure—these impacts on archaeological sites, structures, and objects that will lead to a loss of cultural heritage for Alaska's Indigenous people. In terms of food security, the NCA discussed reductions in suitable ice conditions for hunting, warmer temperatures impairing the use of traditional ice cellars for food storage, and declining shellfish populations due to warming and acidification. While the NCA also noted that climate change provided more opportunity to hunt from

Health. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 539–571. doi: 10.7930/NCA4.2018.CH14.

[255] Porter et al., 2014: Food security and food production systems.

[256] Jantarasami, L.C., R. Novak, R. Delgado, E. Marino, S. McNeeley, C. Narducci, J. Raymond-Yakoubian, L. Singletary, and K. Powys Whyte, 2018: Tribes and Indigenous Peoples. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 572–603. doi: 10.7930/NCA4.2018.CH15.

[257] Porter et al., 2014: Food security and food production systems.

boats later in the fall season or earlier in the spring, the assessment found that the net impact was an overall decrease in food security.

In addition, the U.S. Pacific Islands and the indigenous communities that live there are also uniquely vulnerable to the effects of climate change due to their remote location and geographic isolation. They rely on the land, ocean, and natural resources for their livelihoods, but face challenges in obtaining energy and food supplies that need to be shipped in at high costs. As a result, they face higher energy costs than the rest of the nation and depend on imported fossil fuels for electricity generation and diesel. These challenges exacerbate the climate impacts that the Pacific Islands are experiencing. NCA4 notes that Indigenous peoples of the Pacific are threatened by rising sea levels, diminishing freshwater availability, and negative effects to ecosystem services that threaten these individuals' health and well-being.

2. Non-GHG Impacts

In addition to significant climate change benefits, the final rule will also affect non-GHG emissions. In general, we expect small non-GHG emissions reductions from upstream sources related to refining petroleum fuels. We also expect small increases in emissions from upstream electricity generating units (EGUs). An increase in emissions from coal- and NG-fired electricity generation to meet increased EV electricity demand could result in adverse EJ impacts. For on-road light duty vehicles, the final rule will reduce total non-GHG tailpipe emissions, though we expect small increases in some non-GHG emissions in the years immediately following implementation of the standards, followed by growing decreases in emissions in later years. This is due to our projections about the gasoline-fueled LD vehicle population in the final rule scenario, including decreased scrappage of older vehicles. See Table 35, Table 36, and Table 37 for more detail on the estimated non-GHG emissions impacts of the rule.[258] As discussed in Section III.C of this preamble, future EPA regulatory actions that would result in increased zero-emission vehicles and cleaner energy generation may have greater non-GHG impacts for transportation and electricity generation, and those impacts will be analyzed in more detail in those future actions.

There is evidence that communities with EJ concerns are disproportionately impacted by the non-GHG emissions associated with this rule.[259] Numerous studies have found that environmental hazards such as air pollution are more prevalent in areas where populations of color and low-income populations represent a higher fraction of the population compared with the general population.[260 261 262] Consistent with this evidence, a recent study found that most anthropogenic sources of $PM_{2.5}$, including industrial sources, and light- and heavy-duty vehicle sources, disproportionately affect people of color.[263]

Analyses of communities in close proximity to upstream sources, such as EGUs, have found that a higher percentage of communities of color and low-income communities live near these sources when compared to national averages.[264] Vulnerable populations near upstream refineries may experience potential disparities in pollution-related health risk from that source.[265] We expect that small increases in non-GHG emissions from EGUs and small reductions in petroleum-sector emissions would lead to small changes in exposure to these non-GHG pollutants for people living in the communities near these facilities.

There is also substantial evidence that people who live or attend school near major roadways are more likely to be of a non-White race, Hispanic ethnicity, and/or low socioeconomic status.[266 267] We would expect that communities near roads will benefit from reductions of non-GHG pollutants as fuel efficiency improves and the use of zero-emission vehicles (such as full battery electric vehicles) increases, though projections about the gasoline-fueled LD vehicle population in the final rule scenario, including decreased scrappage of older vehicles, may offset some of these emission reductions, especially in the years immediately after finalization of the standards.

Although proximity to an emissions source is a useful indicator of potential exposure, it is important to note that the impacts of emissions from both upstream and tailpipe sources are not limited to communities in close proximity to these sources. The effects of potential increases and decreases in emissions from the sources affected by this final rule might also be felt many miles away, including in communities with EJ concerns. The spatial extent of these impacts from upstream and tailpipe sources depend on a range of interacting and complex factors including the amount of pollutant emitted, atmospheric chemistry and meteorology.

In summary, we expect this rule will, over time, result in reductions of non-GHG tailpipe emissions and emissions from upstream refinery sources. We also project that the rule will result in small increases of non-GHG emissions from upstream EGU sources. Overall, there are substantial $PM_{2.5}$-related health benefits associated with the non-GHG emissions reductions that this rule will achieve. The benefits from these emissions reductions, as well as the adverse impacts associated with the emissions increases, could potentially impact communities with EJ concerns, though not necessarily immediately and not equally in all locations. For this rulemaking, the air quality information needed to perform a quantified analysis of the distribution of such impacts was not available. We therefore recommend caution when interpreting these broad, qualitative observations. We note in Section I.A.2 of this preamble that EPA intends to develop a future rule to control emissions of GHGs as well as criteria and air toxic pollutants from light-duty vehicles for model years beyond 2026. We are considering how to project air quality impacts from the changes in non-GHG emissions for that future rulemaking (see Section V.C of this preamble).

[258]

[259] Mohai, P.; Pellow, D.; Roberts Timmons, J. (2009) Environmental justice. Annual Reviews 34: 405–430. *https://doi.org/10.1146/annurev-environ-082508-094348.*

[260] Rowangould, G.M. (2013) A census of the near-roadway population: Public health and environmental justice considerations. Trans Res D 25: 59–67. *http://dx.doi.org/10.1016/j.trd.2013.08.003.*

[261] Marshall, J.D., Swor, K.R.; Nguyen, N.P (2014) Prioritizing environmental justice and equality: Diesel emissions in Southern California. Environ Sci Technol 48: 4063–4068. *https://doi.org/10.1021/es405167f.*

[262] Marshall, J.D. (2000) Environmental inequality: Air pollution exposures in California's South Coast Air Basin. Atmos Environ 21: 5499–5503. *https://doi.org/10.1016/j.atmosenv.2008.02.005.*

[263] C.W. Tessum, D.A. Paolella, S.E. Chambliss, J.S. Apte, J.D. Hill, J.D. Marshall, $PM_{2.5}$ polluters disproportionately and systemically affect people of color in the United States. Sci. Adv. 7, eabf4491 (2021).

[264] See 80 FR 64662, 64915–64916 (October 23, 2015).

[265] U.S. EPA (2014). Risk and Technology Review—Analysis of Socio-Economic Factors for Populations Living Near Petroleum Refineries. Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. January.

[266] Tian, N.; Xue, J.; Barzyk. T.M. (2013) Evaluating socioeconomic and racial differences in traffic-related metrics in the United States using a GIS approach. J Exposure Sci Environ Epidemiol 23: 215–222.

[267] Boehmer, T.K.; Foster, S.L.; Henry, J.R.; Woghiren-Akinnifesi, E.L.; Yip, F.Y. (2013) Residential proximity to major highways—United States, 2010. Morbidity and Mortality Weekly Report 62(3): 46–50.

M. Affordability and Equity Impacts

The impacts of the standards on social equity depend in part on their effects on the affordability of vehicles and transportation services, especially for lower-income households. Access to transportation improves the ability of people, including those with low income, to pursue jobs, education, health care, and necessities of daily life such as food and housing. This section discusses how these standards might affect affordability of vehicles. We acknowledge that vehicles, especially household ownership of vehicles, are only a portion of the larger issues concerning access to transportation and mobility services, which also take into consideration public transportation and land use design. Though these issues are inextricably linked, the following discussion focuses on effects related to private vehicle ownership and use. We also acknowledge that the emissions of vehicles, both local pollutants and GHGs, can have disproportionate impacts on lower-income and minority communities; see Preamble Sections I.E and VII.L for further discussion of these topics. Finally, we note that social equity involves issues beyond income and affordability, including race, ethnicity, gender, gender identification, and residential location; EPA will continue to examine such impacts.

Affordability is not a well-defined concept in academic literature. As discussed in Cassidy et al. (2016),[268] researchers have generally applied the term to necessities such as food, housing, or energy, and have identified some themes related to:

> Instead of focusing on the traditional economic concept of willingness to pay, any consideration of affordability must also consider the ability to pay for a socially defined minimum level of a good, especially of a necessity.
>
> Although the ability to pay is often based on the proportion of income devoted to expenditures on a particular good, this ratio approach is widely criticized for not considering expenditures on other possibly necessary goods, quality differences in the good, and heterogeneity of consumer preferences for the good.
>
> Assessing affordability should take into account both the short-term costs and long-term costs associated with consumption of a particular good.

As noted in Cassidy et al., (2016), there is very little literature applying the concept of affordability to transportation, much less to vehicle ownership. It is not clear how to identify a socially acceptable minimum level of transportation service. However, it seems reasonable that some minimum level of transportation services is necessary to enable households' access to employment, education, and basic services such as buying food. It also seems reasonable to assume that transportation requirements vary substantially across populations and geographic locations, and it is not clear when consumption of transportation moves from being a necessity to optional. Normatively defining the minimum adequate level of transportation consumption is difficult given the heterogeneity of consumer preferences and living situations. As a result, it is challenging to define how much residual income should remain with each household after transportation expenditures. It is therefore not surprising that academic and policy literature have largely avoided attempting to define transportation affordability.

As with the proposed rule, we are following the approach in the 2016 EPA Proposed Determination for the Midterm Evaluation [269] of considering four questions that relate to the effects of the final standards on new vehicle affordability: How the standards affect lower-income households; how the standards affect the used vehicle market; how the standards affect access to credit; and how the standards affect the low-priced vehicle segment. See RIA Chapter 8.3 for further detail.

Americans for Prosperity, Attorneys General of Missouri and Ohio, Competitive Enterprise Institute, some individual commenters, NADA, Taxpayers Protection Alliance, and Valero Energy Corporation express concern that increases in new vehicle prices will hurt low- and middle-income households by making new vehicles more expensive. EPA notes that the effects of the standards on lower-income households depend on the responses not just to up-front costs but also to the reduction in fuel and operating costs associated with the standards. These responses will affect not only the sales of new vehicles, as discussed in Section VII.B of this preamble, but also the prices of used vehicles as well as the costs associated with ride-hailing and ride-sharing services. Consumer Reports, Dream Corps Green for All, and Center for Biological Diversity et al. say that, although up-front costs are higher, the total cost of ownership is lower. In addition, they say that lower-income households may disproportionately benefit, as they observe that low-income households typically buy used vehicles, whose up-front cost increases are more modest compared to the fuel savings; because fuel costs are a larger proportion of household income for lower-income people, these savings are especially important. Hutchens et al. (2021) [270] find that lower-income households spend more on used vehicles than new ones. A recent study notes that lower-income households spend more on gasoline as a proportion of their income than higher-income households,[271] suggesting the importance of operating costs for these households. If the per-mile costs of services such as ride hailing and ride sharing decrease to reflect lower operating costs, those who do not own vehicles may benefit. The National Coalition for Advanced Technology comments that Uber and Lyft have a target in 2030 of going all-electric; if those lower operating and maintenance costs are passed along to users, these services may become more affordable.

Most people who buy vehicles purchase used vehicles, instead of new.[272] If sales of new vehicles decrease, then prices of used vehicles, which are disproportionately purchased by lower-income households, would be expected to increase; the reverse would happen if new vehicle sales increase. These effects in the used vehicle market also affect how long people hold onto their used vehicles. This effect, sometimes termed the ''Gruenspecht effect'' after Gruenspecht (1982),[273] would lead to both slower adoption of vehicles subject to the new standards, and more use of older vehicles not subject to the new standards, with

[268] Cassidy, A., G. Burmeister, and G. Helfand. ''Impacts of the Model Year 2017–2025 Light-Duty Vehicle Greenhouse Gas Emission Standards on Vehicle Affordability.'' Working paper.

[269] U.S. Environmental Protection Agency (2016). Proposed Determination on the Appropriateness of the Model Year 2022–2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation, Chapter 4.3.3. EPA–420–R–16–020. *https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100Q3DO.pdf*, accessed 4/26/2021.

[270] Hutchens, A., A. Cassidy, G. Burmeister, and G. Helfand. ''Impacts of Light-Duty Vehicle Greenhouse Gas Emission Standards on Vehicle Affordability.'' Working paper.

[271] Vaidyanathan, S., P. Huether, and B. Jennings (2021). ''Understanding Transportation Energy Burdens.'' Washington, DC: American Council for an Energy-Efficient Economy White Paper. *https://www.aceee.org/white-paper/2021/05/understanding-transportation-energy-burdens*, accessed 5/24/2021.

[272] U.S. Department of Transportation, Bureau of Transportation Statistics. ''New and Used Passenger Car and Light Truck Sales and Leases.'' National Transportation Statistics Table 1–17. *https://www.bts.gov/content/new-and-used-passenger-car-sales-and-leases-thousands-vehicles*, accessed 11/3/2021.

[273] Gruenspecht, H. (1982). ''Differentiated Regulation: The Case of Auto Emissions Standards.'' American Economic Review 72: 328–331.

associated higher emissions, if new vehicle sales decrease. The Gruenspecht effect, therefore, may have the additional consequence of increased concentrations of older vehicles in some communities in the short term, and may delay benefits associated with advanced vehicle technologies for those communities. As discussed in Section VII.B of this preamble, new vehicle sales are projected to show a roughly one-half to one percent decrease from sales under the SAFE rule; that value depends on the uncertain assumption that vehicle buyers consider just a small share of future fuel consumption in the purchase decision. Changes in the new vehicle market are expected not only to have immediate effects on the prices of used vehicles, but also to affect the market over time, as the supply of used vehicles in the future depends on how many new vehicles are sold.[274] As discussed in Section VII.J of this preamble, because the prices of used vehicles depreciate more rapidly than fuel savings, buyers of used vehicles will recover any increase in up-front costs more rapidly than buyers of new vehicles.

Access to credit is a potential barrier to purchase of vehicles whose up-front costs have increased; access may also be affected by race, ethnicity, gender, gender identity, residential location, religion, or other factors. If lenders are not willing to provide financing for buyers who face higher prices, perhaps because the potential buyers are hitting a maximum on the debt-to-income ratio (DTI) that lenders are willing to accept, then those buyers may not be able to purchase new vehicles. NADA in its comments provided results of two surveys of financial institutions, which were asked whether they would increase credit for a more expensive vehicle with lower cost of ownership. With about half of those surveyed responding, over 80 percent of respondents replied that they would not; the remainder said they would. These survey results do not contradict EPA's observation, discussed in the proposed rule, that some lenders are willing to give discounts on loans to purchase more fuel-efficient vehicles.[275] Subsidies exist from the federal government, and some state governments, for plug-in electric vehicles.[276] In addition, the DTI does not appear to be a fixed obstacle for access to finance; from 2007 to 2019, 40 percent of lower-income households and 8 percent of higher-income households who both had a DTI of over 36 percent and purchased at least one new vehicle financed their vehicle purchases.[277]

Low-priced vehicles may be considered an entry point for people into buying new vehicles instead of used ones; automakers may seek to entice people to buy new vehicles through a low price point. It is possible that higher costs associated with standards could affect the ability of automakers to maintain vehicles in this value segment. At the same time, this segment historically tended to include more fuel-efficient vehicles that assisted automakers in achieving CAFE standards.[278] The footprint-based standards, by encouraging improvements in GHG emissions and fuel economy across the vehicle fleet, reduce the need for low-priced vehicles to be a primary means of compliance with the standards. This change in incentives for the marketing of this segment may contribute to the increases in the prices of vehicles previously in this category. Low-priced vehicles still exist; the Chevrolet Spark, for example, is listed as starting at $13,400.[279] At the same time, this segment is gaining more content, such as improved entertainment systems and electric windows; they may be developing an identity as a desirable market segment without regard to their previous purpose in enabling the sales of less efficient vehicles and compliance with CAFE standards.[280] Whether this segment continues to exist, and in what form, may depend on the marketing plans of manufacturers: whether benefits are greater from offering basic new vehicles to first-time new-vehicle buyers, or from making small vehicles more attractive by adding more desirable features to them.

The updated analysis for the final rule projects that, although the vast majority of vehicles produced in the time frame of the standards will be gasoline-fueled vehicles, EVs and PHEVs increase with each MY up to about 17 percent total market share by MY 2026, compared to about 7 percent MY 2023; see Table 33. New EVs and PHEVs have lower operating costs than gasoline vehicles, but currently have higher up-front costs and require access to a means of charging. EPA has heard from some environmental justice groups and Tribes that limited access to electric vehicles and charging infrastructure can be a barrier for purchasing EVs. Comments received on the proposed rule cited both the higher up-front costs of EVs as challenges for adoption, and their lower operating and maintenance costs as incentives for adoption. A number of auto manufacturers commented on the importance of consumer education, purchase incentives, and charging infrastructure development for promoting adoption of electric vehicles. Some NGOs commented that EVs have lower total cost of ownership than ICE vehicles, and that EV purchase incentives should focus on lower-income households, because they are more responsive to price incentives than higher-income households. Access to charging infrastructure may be especially challenging for those who do not have easy access to home charging, such as people living in multi-unit dwellings, unless public charging infrastructure or charging at workplaces becomes more widespread. On the other hand, a recent report from the National Renewable Energy Laboratory estimated that public and workplace charging is keeping up with projected needs, based on Level 2 and fast charging ports per plug-in vehicle.[281] EPA acknowledges the comments received. As the up-front costs of EVs drops, as discussed in Section III.A of this preamble, EPA expects consumer acceptance of EVs to increase; as more EVs enter the new vehicle market, those EVs will gradually move into the used vehicle fleet and become more accessible to lower-income households. In addition, as adoption of EVs increases, EPA expects greater development of charging

[274] U.S. Environmental Protection Agency (2021). ''The Effects of New-Vehicle Price Changes on New- and Used-Vehicle Markets and Scrappage.'' EPA–420–R–21–019, *https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=352754&Lab=OTAQ* (accessed 10/06/2021).

[275] Helfand, Gloria (2021). ''Memorandum: Lending Institutions that Provide Discounts for more Fuel Efficient Vehicles.'' U.S. EPA Office of Transportation and Air Quality, Memorandum to the Docket.

[276] U.S. Department of Energy and U.S. Environmental Protection Agency. ''Federal Tax Credits for New All-Electric and Plug-in Hybrid Vehicles.'' *https://www.fueleconomy.gov/feg/taxevb.shtml,* accessed 4/28/2021.

[277] Hutchens, A., et al. (2021). ''Impacts of Light-Duty Vehicle Greenhouse Gas Emission Standards on Vehicle Affordability.'' Working paper.

[278] Austin, D., and T. Dinan (2005). ''Clearing the Air: The Costs and Consequences of Higher CAFE Standards and Increased Gasoline.'' Journal of Environmental Economics and Management 50(3): 562–82; Kleit, A. (2004). ''Impacts of Long-Range Increases in the Fuel Economy (CAFE) Standard.'' Economic Inquiry 42(2): 279–294.

[279] Motortrend (2021). ''These Are the 10 Cheapest Cars You Can Buy in 2021.'' *https://www.motortrend.com/features-collections/top-10-cheapest-new-cars/,* accessed 4/28/2021; Chevrolet Spark, *https://www.chevrolet.com/cars/spark,* accessed 5/27/2021.

[280] See Note 268.

[281] Brown, A., A. Schayowitz, and E. Klotz (2021). ''Electric Vehicle Infrastructure Trends from the Alternative Fueling Station Locator: First Quarter 2021.'' National Renewable Energy Laboratory Technical Report NREL/TP–5400–80684, *https://afdc.energy.gov/files/u/publication/electric_vehicle_charging_infrastructure_trends_first_quarter_2021.pdf,* accessed 11/3/2021.

infrastructure. EPA will continue to monitor and further study affordability issues related to electric vehicles as their prevalence in the vehicle fleet increases. We respond to these comments in more detail in the RTC.

In sum, as with the effects of the standards on vehicle sales discussed in Section VII.B of this preamble, the effects of the standards on affordability depend on two countervailing effects: the increase in the up-front costs of the vehicles, and the decrease in operating costs. As discussed here, different commenters emphasize one or the other aspect of this tradeoff. The increase in up-front costs has the potential to increase the prices of used vehicles, to make credit more difficult to obtain, and to make the least expensive new vehicles less desirable compared to used vehicles. The reduction in operating costs has the potential to mitigate or reverse all these effects. Lower operating costs on their own increase mobility (see RIA Chapter 3.1 for a discussion of rebound driving). It is possible that lower-income households may benefit more from the reduction in operating costs than the increase in up-front costs, because they own fewer vehicles per household, spend more on fuel than on vehicles on an annual basis, and those fuel expenditures represent a higher fraction of their household income.

See RIA Chapter 8.4 for more detailed discussion of these issues.

VIII. Statutory and Executive Order Reviews

A. Executive Order 12866: ''Regulatory Planning and Review and Executive Order 13563: Improving Regulation and Regulatory Review''

This action is an economically significant regulatory action that was submitted to OMB for review. Any changes made in response to OMB recommendations have been documented in the docket. EPA prepared an analysis of the potential costs and benefits associated with this action.

This analysis is in the Regulatory Impact Analysis, which can be found in the docket for this rule and is briefly summarized in Section VII of this preamble.

B. Paperwork Reduction Act

This action does not impose any new information collection burden under the PRA. OMB has previously approved the information collection activities contained in the existing regulations and has assigned OMB control number 2127–0019. This final rule changes the level of the existing emission standards and revises several existing credit provisions, but imposes no new information collection requirements.

C. Regulatory Flexibility Act

I certify that this action will not have a significant economic impact on a substantial number of small entities under the RFA. This action will not impose any requirements on small entities. EPA's existing regulations exempt from the GHG standards any manufacturer, domestic or foreign, meeting Small Business Administration's size definitions of small business in 13 CFR 121.201. EPA is not finalizing any changes to the provisions for small businesses under this rule, and thus they would remain exempt. For additional discussion see Chapter 9 of the RIA.

D. Unfunded Mandates Reform Act

This final rule contains no federal mandates under UMRA, 2 U.S.C. 1531–1538, for State, local, or tribal governments. The final rule imposes no enforceable duty on any State, local or tribal government. This final rule contains a federal mandate under UMRA that may result in expenditures of $100 million or more for the private sector in any one year. Accordingly, the costs and benefits associated with the final rule are discussed in Section VII of this preamble and in the RIA, which are in the docket for this rule.

This action is not subject to the requirements of section 203 of UMRA because it contains no regulatory requirements that might significantly or uniquely affect small governments.

E. Executive Order 13132: ''Federalism''

This action does not have federalism implications. It will not have substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government.

F. Executive Order 13175: ''Consultation and Coordination With Indian Tribal Governments''

This action does not have tribal implications as specified in Executive Order 13175. Thus, Executive Order 13175 does not apply to this action. However, EPA has engaged with our tribal stakeholders in the development of this rulemaking by offering a tribal workshop and offering government-to-government consultation upon request.

G. Executive Order 13045: ''Protection of Children From Environmental Health Risks and Safety Risks''

With respect to GHG emissions, EPA has determined that this rule will not have disproportionate impacts on children (62 FR 19885, April 23, 1997). This rule will reduce emissions of potent GHGs, which as noted earlier in Section IV of this preamble, will reduce the effects of climate change, including the public health and welfare effects on children.

GHGs contribute to climate change and the GHG emissions reductions resulting from implementation of this final rule would further improve children's health. The assessment literature cited in EPA's 2009 and 2016 Endangerment Findings concluded that certain populations and life stages, including children, the elderly, and the poor, are most vulnerable to climate-related health effects. The assessment literature since 2016 strengthens these conclusions by providing more detailed findings regarding these groups' vulnerabilities and the projected impacts they may experience. These assessments describe how children's unique physiological and developmental factors contribute to making them particularly vulnerable to climate change. Impacts to children are expected from heat waves, air pollution, infectious and waterborne illnesses, and mental health effects resulting from extreme weather events. In addition, children are among those especially susceptible to most allergic diseases, as well as health effects associated with heat waves, storms, and floods. Additional health concerns may arise in low-income households, especially those with children, if climate change reduces food availability and increases prices, leading to food insecurity within households. More detailed information on the impacts of climate change to human health and welfare is provided in Section IV.B of this preamble.

We expect this rule would, on net, result in both small reductions and small increases in non-GHG emissions that could impact children, though not necessarily immediately and not equally in all locations. However, with respect to non-GHG emissions, EPA has concluded that it is not practicable to determine whether there would be disproportionate impacts on children. As mentioned in Section I.A.2 of this preamble, EPA intends to initiate another rulemaking to further reduce emissions of GHGs from light-duty vehicles for model years beyond 2026. We are considering how to project air quality and health impacts from the changes in non-GHG emissions for that future rulemaking (see Section V.C of this preamble).

H. Executive Order 13211: "Energy Effects"

This action is not a "significant energy action" because it is not likely to have a significant adverse effect on the supply, distribution, or use of energy. EPA has outlined the energy effects in Table 5–7 of the Regulatory Impact Analysis (RIA), which is available in the docket for this action and is briefly summarized here.

This action reduces CO_2 for passenger cars and light trucks under revised GHG standards, which will result in significant reductions of the consumption of petroleum, will achieve energy security benefits, and have no adverse energy effects. Because the GHG emission standards result in significant fuel savings, this rule encourages more efficient use of fuels. Table 5–10 in the RIA shows over 360 billion gallons of retail gasoline reduced through 2050 or nearly seven billion barrels of oil reduced through 2050.

I. National Technology Transfer and Advancement Act and 1 CFR Part 51

This rulemaking involves technical standards. The Agency conducted a search to identify potentially applicable voluntary consensus standards. For CO_2 emissions, we identified no such standards and none were identified in comments; EPA is therefore collecting data over the same tests that are used for the current CO_2 standards and for the CAFE program. This will minimize the amount of testing done by manufacturers, since manufacturers are already required to run these tests. For A/C credits, EPA is using the test specified in 40 CFR 1066.845. EPA knows of no voluntary consensus standard for the A/C test and none were identified in comments.

In accordance with the requirements of 1 CFR 51.5, we are incorporating by reference the use of a test method from SAE International, specifically SAE J1711, "Recommended Practice for Measuring the Exhaust Emissions and Fuel Economy of Hybrid-Electric Vehicles, Including Plug-in Hybrid Vehicles", Revised June 2010. The Recommended Practice establishes uniform chassis dynamometer test procedures for hybrid electric vehicles to allow for measuring and calculating exhaust emissions and fuel economy when vehicles drive over specified duty cycles. We adopted regulatory requirements in an earlier rulemaking, but did not complete all the steps necessary to formally incorporate this test method by reference into the EPA regulation. The referenced test method may be obtained through the SAE International website (*www.sae.org*) or by calling SAE at (877) 606–7323 (U.S. and Canada) or (724) 776–4970 (outside the U.S. and Canada).

J. Executive Order 12898: "Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations"

For this final action, EPA is only able to qualitatively evaluate the extent to which this action may result in disproportionately high and adverse human health or environmental effects on minority populations, low income populations, and/or indigenous peoples, as specified in Executive Order 12898 (59 FR 7629, February 16, 1994). With respect to GHG emissions, EPA has determined that this rule will benefit all U.S. populations, including communities of color, low-income populations and/or indigenous peoples. While this final rule will substantially reduce GHG emissions, future impacts of climate change are still expected in the baseline and will likely be unevenly distributed in ways that uniquely impact these communities. EPA has not quantitatively assessed these effects.

For non-GHG pollutants, EPA has concluded that it is not practicable given the timing of this final action to determine the extent to which effects on communities of color, low-income populations and/or indigenous peoples are differentially distributed. We expect this final rule will result in both small reductions and small increases of non-GHG emissions that could impact communities with EJ concerns in the near term, though not necessarily immediately and not equally in all locations. It was not practicable to develop the air quality information needed to perform a quantified analysis of the distribution of such non-GHG impacts. EPA intends to initiate a future rule to further reduce emissions of GHGs and criteria and toxic pollutants from light-duty vehicles for model years beyond 2026. We are considering how to project air quality impacts from the changes in non-GHG emissions for that future rulemaking (see Section V.C of this preamble). Section VII.L of this preamble describes how we considered environmental justice in this action.

K. Congressional Review Act (CRA)

This action is subject to the CRA, and the EPA will submit a rule report to each House of the Congress and to the Comptroller General of the United States. This action is a "major rule" as defined by 5 U.S.C. 804(2).

L. Judicial Review

This final action is "nationally applicable" within the meaning of CAA section 307(b)(1) because it is expressly listed in the section (*i.e.,* "any standard under section [202] of this title"). Under section 307(b)(1) of the CAA, petitions for judicial review of this action must be filed in the United States Court of Appeals for the District of Columbia Circuit within 60 days from the date this final action is published in the **Federal Register**. Filing a petition for reconsideration by the Administrator of this final action does not affect the finality of the action for the purposes of judicial review, nor does it extend the time within which a petition for judicial review must be filed and shall not postpone the effectiveness of such rule or action.

IX. Statutory Provisions and Legal Authority

Statutory authority for this final rule is found in section 202(a) (which authorizes standards for emissions of pollutants from new motor vehicles which emissions cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare), 202(d), 203–209, 216, and 301 of the Clean Air Act, 42 U.S.C. 7521(a), 7521(d), 7522–7525, 7541–7543, 7550, and 7601.

List of Subjects

40 CFR Part 86

Environmental protection, Administrative practice and procedure, Confidential business information, Incorporation by reference, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements.

40 CFR Part 600

Environmental protection, Administrative practice and procedure, Electric power, Fuel economy, Labeling, Reporting and recordkeeping requirements.

Michael S. Regan,

Administrator.

For the reasons set out in the preamble, we are amending title 40, chapter I of the Code of Federal Regulations as set forth below.

PART 86—CONTROL OF EMISSIONS FROM NEW AND IN-USE HIGHWAY VEHICLES AND ENGINES

■ 1. The authority citation for part 86 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

■ 2. Amend § 86.1 by redesignating paragraphs (g)(3) through (27) as (g)(4) through (28) and adding a new paragraph (g)(3) to read as follows:

§ 86.1 Incorporation by reference.

* * * * *

(g) * * *

(3) SAE J1711, Recommended Practice for Measuring the Exhaust Emissions and Fuel Economy of Hybrid-Electric Vehicles, Including Plug-in Hybrid Vehicles, Revised June 2010, IBR approved for § 86.1866–12(b).

* * * * *

■ 3. Amend § 86.1806–17 by revising paragraph (a) introductory text to read as follows:

§ 86.1806–17 Onboard diagnostics.

* * * * *

(a) Vehicles must comply with the 2013 OBD requirements adopted for California as described in this paragraph (a). California's 2013 OBD–II requirements are part of Title 13, § 1968.2 of the California Code of Regulations, approved on July 31, 2013 (incorporated by reference in § 86.1). We may approve your request to certify an OBD system meeting a later version of California's OBD requirements if you demonstrate that it complies with the intent of this section. The following clarifications and exceptions apply for vehicles certified under this subpart:

* * * * *

■ 4. Amend § 86.1818–12 by revising paragraph (c)(2)(i), (c)(3)(i), and (e)(3)(ii)(A) to read as follows:

§ 86.1818–12 Greenhouse gas emission standards for light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles.

* * * * *

(c) * * *

(2) * * *

(i) *Calculation of CO_2 target values for passenger automobiles.* A CO_2 target value shall be determined for each passenger automobile as follows:

(A) For passenger automobiles with a footprint of less than or equal to 41 square feet, the gram/mile CO_2 target value shall be selected for the appropriate model year from the following table:

TABLE 1 TO § 86.1818–12(C)(2)(I)(A)

Model year	CO_2 target value (grams/mile)
2012	244.0
2013	237.0
2014	228.0
2015	217.0
2016	206.0
2017	195.0
2018	185.0
2019	175.0
2020	166.0
2021	161.8
2022	159.0
2023	145.6
2024	138.6
2025	130.5
2026 and later	114.3

(B) For passenger automobiles with a footprint of greater than 56 square feet, the gram/mile CO_2 target value shall be selected for the appropriate model year from the following table:

TABLE 2 TO § 86.1818–12(C)(2)(I)(B)

Model year	CO_2 target value (grams/mile)
2012	315.0
2013	307.0
2014	299.0
2015	288.0
2016	277.0
2017	263.0
2018	250.0
2019	238.0
2020	226.0
2021	220.9
2022	217.3
2023	199.1
2024	189.5
2025	179.4
2026 and later	160.9

(C) For passenger automobiles with a footprint that is greater than 41 square feet and less than or equal to 56 square feet, the gram/mile CO_2 target value shall be calculated using the following equation and rounded to the nearest 0.1 gram/mile:

Target $CO_2 = [a \times f] + b$

Where:

f is the vehicle footprint, as defined in § 86.1803; and *a and b* are selected from the following table for the appropriate model year:

TABLE 3 TO § 86.1818–12(c)(2)(i)(C)

Model year	A	B
2012	4.72	50.5
2013	4.72	43.3
2014	4.72	34.8
2015	4.72	23.4
2016	4.72	12.7
2017	4.53	8.9
2018	4.35	6.5
2019	4.17	4.2
2020	4.01	1.9
2021	3.94	0.2
2022	3.88	−0.1
2023	3.56	−0.4
2024	3.39	−0.4
2025	3.26	−3.2
2026 and later	3.11	−13.1

* * * * *

(3) * * *

(i) *Calculation of CO_2 target values for light trucks.* A CO_2 target value shall be determined for each light truck as follows:

(A) For light trucks with a footprint of less than or equal to 41 square feet, the gram/mile CO_2 target value shall be selected for the appropriate model year from the following table:

TABLE 4 TO § 86.1818–12(c)(3)(i)(A)

Model year	CO_2 target value (grams/mile)
2012	294.0
2013	284.0
2014	275.0
2015	261.0
2016	247.0
2017	238.0
2018	227.0
2019	220.0
2020	212.0
2021	206.5
2022	203.0
2023	181.1
2024	172.1
2025	159.3
2026 and later	141.8

(B) For light trucks with a footprint that is greater than 41 square feet and less than or equal to the maximum footprint value specified in the table below for each model year, the gram/mile CO_2 target value shall be calculated using the following equation and rounded to the nearest 0.1 gram/mile, except as specified in paragraph (c)(3)(i)(D) of this section:

Target $CO_2 = (a \times f) + b$

Where:

f is the footprint, as defined in § 86.1803; and *a and b* are selected from the following table for the appropriate model year:

TABLE 5 TO § 86.1818–12(c)(3)(i)(B)

Model year	Maximum footprint	A	B
2012	66.0	4.04	128.6
2013	66.0	4.04	118.7
2014	66.0	4.04	109.4
2015	66.0	4.04	95.1
2016	66.0	4.04	81.1
2017	50.7	4.87	38.3
2018	60.2	4.76	31.6
2019	66.4	4.68	27.7
2020	68.3	4.57	24.6
2021	68.3	4.51	21.5
2022	68.3	4.44	20.6
2023	74.0	3.97	18.4
2024	74.0	3.77	17.4
2025	74.0	3.58	12.5
2026 and later	74.0	3.41	1.9

(C) For light trucks with a footprint that is greater than the minimum footprint value specified in the table below and less than or equal to the maximum footprint value specified in the table below for each model year, the gram/mile CO_2 target value shall be calculated using the following equation and rounded to the nearest 0.1 gram/mile, except as specified in paragraph (c)(3)(i)(D) of this section:

Target $CO_2 = (a \times f) + b$

Where:

f is the footprint, as defined in § 86.1803; and *a and b* are selected from the following table for the appropriate model year:

TABLE 6 TO § 86.1818–12(c)(3)(i)(C)

Model year	Minimum footprint	Maximum footprint	A	b
2017	50.7	66.0	4.04	80.5
2018	60.2	66.0	4.04	75.0

(D) For light trucks with a footprint greater than the minimum value specified in the table below for each model year, the gram/mile CO_2 target value shall be selected for the appropriate model year from the following table:

TABLE 7 TO § 86.1818–12(c)(3)(i)(D)

Model year	Minimum footprint	CO_2 target value (grams/mile)
2012	66.0	395.0
2013	66.0	385.0
2014	66.0	376.0
2015	66.0	362.0
2016	66.0	348.0
2017	66.0	347.0
2018	66.0	342.0
2019	66.4	339.0
2020	68.3	337.0
2021	68.3	329.4
2022	68.3	324.1
2023	74.0	312.1
2024	74.0	296.5
2025	74.0	277.4
2026 and later	74.0	254.4

* * * * *

(e) * * *

(3) * * *

(ii) * * *

(A) The alternative compliance schedule is as described in this paragraph (e)(3)(ii)(A). In lieu of the standards in paragraph (c) of this section that would otherwise be applicable to the model year shown in the first column of table 8 to § 86.1818–12(e)(3)(ii)(A), a qualifying manufacturer may comply with the standards in paragraph (c) of this section determined for the model year shown in the second column of the table. In the 2021 and later model years the manufacturer must meet the standards designated for each model year in paragraph (c) of this section.

Table 8 to § 86.1818–12(e)(3)(ii)(A) follows:

TABLE 8 TO § 86.1818–12(e)(3)(ii)(A)

Model year	Applicable standards
2017	2016
2018	2016
2019	2018
2020	2019

* * * * *

■ 5. Amend § 86.1865–12 by revising paragraphs (k)(2), (3), and (6) to read as follows:

§ 86.1865–12 How to comply with the fleet average CO_2 standards.

* * * * *

(k) * * *

(2) There are no property rights associated with CO_2 credits generated under this subpart. Credits are a limited authorization to emit the designated amount of emissions. Nothing in this part or any other provision of law shall be construed to limit EPA's authority to terminate or limit this authorization through a rulemaking.

(3) Each manufacturer must comply with the reporting and recordkeeping requirements of paragraph (l) of this section for CO_2 credits, including early credits. The averaging, banking and trading program is enforceable as provided in paragraphs (k)(7)(ii), (k)(9)(iii), and (l)(1)(vi) of this section through the certificate of conformity that allows the manufacturer to introduce any regulated vehicles into U.S. commerce.

* * * * *

(6) Unused CO_2 credits generally retain their full value through five model years after the model year in which they were generated; credits remaining at the end of the fifth model year after the model year in which they were generated may not be used to demonstrate compliance for later model years. However, in the case of model year 2017 and 2018 passenger cars and light trucks, unused CO_2 credits retain their full value through six model years after the year in which they were generated.

* * * * *

■ 6. Amend § 86.1866–12 by revising the section heading and paragraph (b) and adding paragraph (c)(3) to read as follows:

§ 86.1866–12 CO_2 credits for advanced technology vehicles.

* * * * *

(b) For electric vehicles, plug-in hybrid electric vehicles, fuel cell vehicles, dedicated natural gas vehicles, and dual-fuel natural gas vehicles as those terms are defined in § 86.1803–01, that are certified and produced for U.S. sale in the specified model years and that meet the additional specifications in this section, the manufacturer may use the production multipliers in this paragraph (b) when determining additional credits for advanced technology vehicles. Full size pickup trucks eligible for and using a production multiplier are not eligible for the strong hybrid-based credits described in § 86.1870–12(a)(2) or the performance-based credits described in § 86.1870–12(b).

(1) The following production multipliers apply for model year 2017 through 2025 vehicles:

TABLE 1 TO PARAGRAPH (b)(1)

Model year	Electric vehicles and fuel cell vehicles	Plug-in hybrid electric vehicles	Dedicated and dual-fuel natural gas vehicles
2017	2.0	1.6	1.6
2018	2.0	1.6	1.6
2019	2.0	1.6	1.6
2020	1.75	1.45	1.45
2021	1.5	1.3	1.3
2022	....	....	2.0
2023–2024	1.5	1.3	....

(2) The minimum all-electric driving range that a plug-in hybrid electric vehicle must have in order to qualify for use of a production multiplier is 10.2 miles on its nominal storage capacity of electricity when operated on the highway fuel economy test cycle. Alternatively, a plug-in hybrid electric vehicle may qualify for use of a production multiplier by having an equivalent all-electric driving range greater than or equal to 10.2 miles during its actual charge-depleting range as measured on the highway fuel economy test cycle and tested according to the requirements of SAE J1711 (incorporated by reference in § 86.1). The equivalent all-electric range of a PHEV is determined from the following formula:

$$EAER = R_{CDA} \times (CO_{2CS} - CO_{2CD}/CO_{2CS})$$

Where:

EAER = the equivalent all-electric range attributed to charge-depleting operation of a plug-in hybrid electric vehicle on the highway fuel economy test cycle.

R_{CDA} = The actual charge-depleting range determined according to SAE J1711 (incorporated by reference in § 86.1).

CO_{2CS} = The charge-sustaining CO_2 emissions in grams per mile on the highway fuel economy test determined according to SAE J1711 (incorporated by reference in § 86.1).

CO_{2CD} = The charge-depleting CO_2 emissions in grams per mile on the highway fuel economy test determined according to SAE J1711 (incorporated by reference in § 86.1).

(3) The actual production of qualifying vehicles may be multiplied by the applicable value according to the model year, and the result, rounded to the nearest whole number, may be used to represent the production of qualifying vehicles when calculating average carbon-related exhaust emissions under § 600.512 of this chapter.

(c) * * *

(3) Multiplier-based credits for model years 2022 through 2025 may not exceed credit caps, as follows:

(i) Calculate a nominal annual credit cap in Mg using the following equation, rounded to the nearest whole number:

$$CAP_{annual} = 2.5\frac{\text{g}}{\text{mile}} \cdot [195{,}264 \text{ miles} \cdot P_{auto} + 225{,}865 \cdot P_{truck}] \cdot 10^{-6}\frac{\text{tonne}}{\text{g}}$$

Where:

P_{auto} = total number of certified passenger automobiles the manufacturer produced in a given model year for sale in any state or territory of the United States.

P_{truck} = total number of certified light trucks (including MDPV) the manufacturer produced in a given model year for sale in any state or territory of the United States.

(ii) Calculate an annual g/mile equivalent value for the multiplier-based credits using the following equation, rounded to the nearest 0.1 g/mile:

$$annual\ g\ per\ mile\ equivalent\ value = 2.5 \cdot \frac{annual\ credits}{CAP_{annual}}$$

Where:

annual credits = a manufacturer's total multiplier-based credits in a given model year from all passenger automobiles and light trucks as calculated under this paragraph (c).

(iii) Calculate a cumulative g/mile equivalent value for the multiplier-based credits in 2022 through 2025 by adding the annual g/mile equivalent values calculated under paragraph (c)(3)(ii) of this section.

(iv) The cumulative g/mile equivalent value may not exceed 10.0 in any year.

(v) The annual credit report must include for every model year from 2022 through 2025, as applicable, the calculated values for the nominal annual credit cap in Mg and the cumulative g/mile equivalent value.

■ 7. Revise the section heading for § 86.1867–12 to read as follows:

§ 86.1867–12 CO_2 credits for reducing leakage of air conditioning refrigerant.

* * * * *

■ 8. Amend § 86.1869–12 by revising paragraphs (b)(2) and (b)(4)(v), (vi), and (x) and (d)(2)(ii)(A) to read as follows:

§ 86.1869–12 CO_2 credits for off-cycle CO_2 reducing technologies.

* * * * *

(b) * * *

(2) The maximum allowable decrease in the manufacturer's combined passenger automobile and light truck fleet average CO_2 emissions attributable to use of the default credit values in paragraph (b)(1) of this section is 15 g/mi for model years 2023 through 2026 and 10 g/mi in all other model years. If the total of the CO_2 g/mi credit values from paragraph (b)(1) of this section does not exceed 10 or 15 g/mi (as applicable) for any passenger automobile or light truck in a manufacturer's fleet, then the total off-cycle credits may be calculated according to paragraph (f) of this section. If the total of the CO_2 g/mi credit values from paragraph (b)(1) of this section exceeds 10 or 15 g/mi (as applicable) for any passenger automobile or light truck in a manufacturer's fleet, then the gram per mile decrease for the combined passenger automobile and light truck fleet must be determined according to paragraph (b)(2)(ii) of this section to determine whether the applicable limitation has been exceeded.

(i) Determine the gram per mile decrease for the combined passenger automobile and light truck fleet using the following formula:

$$\text{Decrease} = \frac{Credits \times 1{,}000{,}000}{[(\text{Prod}_C \times 195{,}264) + (\text{Prod}_T \times 225{,}865)]}$$

Where:

Credits = The total of passenger automobile and light truck credits, in Megagrams, determined according to paragraph (f) of this section and limited to those credits accrued by using the default gram per mile values in paragraph (b)(1) of this section.

Prod_C = The number of passenger automobiles produced by the manufacturer and delivered for sale in the U.S.

Prod_T = The number of light trucks produced by the manufacturer and delivered for sale in the U.S.

(ii) If the value determined in paragraph (b)(2)(i) of this section is greater than 10 or 15 grams per mile (as applicable), the total credits, in Megagrams, that may be accrued by a manufacturer using the default gram per mile values in paragraph (b)(1) of this section shall be determined using the following formula:

$$\text{Credit (Megagrams)} = \frac{[10 \times ((\text{Prod}_C \times 195{,}264) + (\text{Prod}_T \times 225{,}865))]}{1{,}000{,}000}$$

Where:

Prod_C = The number of passenger automobiles produced by the manufacturer and delivered for sale in the U.S.

Prod_T = The number of light trucks produced by the manufacturer and delivered for sale in the U.S.

(iii) If the value determined in paragraph (b)(2)(i) of this section is not greater than 10 or 15 grams per mile (as applicable), then the credits that may be accrued by a manufacturer using the default gram per mile values in paragraph (b)(1) of this section do not exceed the allowable limit, and total credits may be determined for each category of vehicles according to paragraph (f) of this section.

(iv) If the value determined in paragraph (b)(2)(i) of this section is greater than 10 or 15 grams per mile (as applicable), then the combined passenger automobile and light truck credits, in Megagrams, that may be accrued using the calculations in paragraph (f) of this section must not exceed the value determined in paragraph (b)(2)(ii) of this section. This limitation should generally be done by reducing the amount of credits attributable to the vehicle category that caused the limit to be exceeded such that the total value does not exceed the value determined in paragraph (b)(2)(ii) of this section.

* * * * *

(4) * * *

(v) *Active transmission warm-up* means one of the following:

(A) Through model year 2022, *active transmission warm-up* means a system that uses waste heat from the vehicle to quickly warm the transmission fluid to an operating temperature range using a heat exchanger, increasing the overall transmission efficiency by reducing parasitic losses associated with the transmission fluid, such as losses related to friction and fluid viscosity.

(B) Starting in model year 2023, *active transmission warm-up* means a system that uses waste heat from the vehicle's exhaust to warm the transmission fluid to an operating temperature range using a dedicated heat exchanger. *Active transmission warm-up* may also include coolant systems that capture heat from a liquid-cooled exhaust manifold if the coolant loop to the transmission heat exchanger is not shared with other heat-extracting systems and it starts heat transfer to the transmission fluid immediately after engine starting, consistent with designs that exchange heat directly from exhaust gases to the transmission fluid.

(vi) *Active engine warm-up* means one of the following:

(A) Through model year 2022, *active engine warm-up* means a system that uses waste heat from the vehicle to warm up targeted parts of the engine so it reduces engine friction losses and enables closed-loop fuel control to start sooner.

(B) Starting in model year 2023, *active engine warm-up* means a system that uses waste heat from the vehicle's exhaust to warm up targeted parts of the engine so it reduces engine friction losses and enables closed-loop fuel control to start sooner. *Active engine warm-up* may also include coolant systems that capture heat from a liquid-cooled exhaust manifold.

* * * * *

(x) *Passive cabin ventilation* means one of the following:

(A) Through model year 2022, *passive cabin ventilation* means ducts, devices, or methods that utilize convective airflow to move heated air from the cabin interior to the exterior of the vehicle.

(B) Starting in model year 2023, *passive cabin ventilation* means methods that create and maintain convective airflow through the body's cabin by keeping windows or sunroof open to prevent excessive interior temperatures when the vehicle is parked outside in direct sunlight.

* * * * *

(d) * * *

(2) * * *

(ii) * * *

(A) A citation to the appropriate previously approved methodology, including the appropriate **Federal Register** Notice and any subsequent EPA documentation of the Administrator's decision;

* * * * *

■ 9. Amend § 86.1870–12 by revising the section heading and paragraphs (a)(2) and (b)(2) to read as follows:

§ 86.1870–12 CO_2 credits for qualifying full-size pickup trucks.

* * * * *

(a) * * *

(2) Full-size pickup trucks that are strong hybrid electric vehicles and that are produced in 2017 through 2021 model years are eligible for a credit of 20 grams/mile. This same credit is available again for those vehicles produced in 2023 and 2024 model years. To receive this credit in a model year, the manufacturer must produce a quantity of strong hybrid electric full-size pickup trucks such that the proportion of production of such vehicles, when compared to the manufacturer's total production of full-size pickup trucks, is not less than 10 percent in that model year. Full-size pickup trucks earning credits under this paragraph (a)(2) may not earn credits based on the production multipliers described in § 86.1866–12(b).

* * * * *

(b) * * *

(2) Full-size pickup trucks that are produced in 2017 through 2021 model years and that achieve carbon-related exhaust emissions less than or equal to the applicable target value determined in § 86.1818–12(c)(3) multiplied by 0.80 (rounded to the nearest gram/mile) in a model year are eligible for a credit of 20 grams/mile. This same credit is available again for qualifying vehicles produced in 2023 and 2024 model years. A pickup truck that qualifies for this credit in a model year may claim this credit for a maximum of four subsequent model years (a total of five consecutive model years) if the carbon-related exhaust emissions of that pickup truck do not increase relative to the emissions in the model year in which the pickup truck first qualified for the credit. This credit may not be claimed in model year 2022 or in any model year after 2024. To qualify for this credit in a model year, the manufacturer must produce a quantity of full-size pickup trucks that meet the emission requirements of this paragraph (b)(2) such that the proportion of production of such vehicles, when compared to the manufacturer's total production of full-size pickup trucks, is not less than 10 percent in that model year. A pickup truck that qualifies for this credit in a model year and is subject to a major redesign in a subsequent model year such that it qualifies for the credit in the model year of the redesign may be allowed to qualify for an additional five years with EPA approval (not to go beyond the 2024 model year). Use good engineering judgment to determine whether a pickup truck has been subject to a major redesign.

* * * * *

PART 600—FUEL ECONOMY AND GREENHOUSE GAS EXHAUST EMISSIONS OF MOTOR VEHICLES

■ 10. The authority citation for part 600 continues to read as follows:

Authority: 49 U.S.C. 32901–23919q, Pub. L. 109–58.

■ 11. Amend § 600.510–12 by revising paragraphs (j)(2)(v) introductory text and (j)(2)(vii)(A) introductory text to read as follows:

§ 600.510–12 Calculation of average fuel economy and average carbon-related exhaust emissions.

* * * * *

(j) * * *

(2) * * *

(v) For natural gas dual fuel model types, for model years 2012 through 2015, the arithmetic average of the following two terms; the result rounded to the nearest gram per mile:

* * * * *

(vii)(A) This paragraph (j)(2)(vii) applies to model year 2016 and later natural gas dual fuel model types. Model year 2021 and later natural gas dual fuel model types may use a utility factor of 0.5 or the utility factor prescribed in this paragraph (j)(2)(vii).

* * * * *

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