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BRIEFING

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Consumer benefits of increased efficiency in 2025-2030 light-duty vehicles in the U.S.

This briefing outlines the consumer benefits of increases in the efficiency of light-duty vehicles to meet the 2025 U.S. standards, as well as a hypothetical extension of the standards through 2030. It summarizes the impacts of emerging efficiency technology, including its effects on consumer fuel savings, benefit-to-cost ratio, and payback period.

INTRODUCTION

In addition to their substantial energy and environmental benefits to society, fuel economy regulations result in direct consumer benefits. In 2016 and 2017, the regulatory agencies in the United States conducted several studies as part of their midterm reviews of 2025 vehicle efficiency and emissions regulations. These include the Draft Technology Assessment Report by the United States Environmental Protection Agency (U.S. EPA), the California Air Resources Board (CARB), and the National Highway Traffic Safety Administration (NHTSA), and subsequent analyses by U.S. EPA and CARB.[1] A critical question that springs from these regulatory analyses is how attractive the efficiency technologies are from a consumer perspective.

1 U.S. Environmental Protection Agency, “Proposed determination on the appropriateness of the model year 2022–2025 light-duty vehicle greenhouse gas emissions standards under the midterm evaluation” (2016). https://www.federalregister.gov/documents/2016/12/06/2016-29255/proposed-determination-on-the-appropriateness-of-the-model-year-2022-2025-light-duty-vehicle. U.S. Environmental Protection Agency, “Final determination on the appropriateness of the model year 2022–2025 light-duty vehicle greenhouse gas emissions standards under the midterm evaluation” (2017). https://www.epa.gov/sites/production/files/2017-01/documents/420r17001.pdf. California Air Resources Board, “Advanced Clean Cars: Midterm Review” (2017). https://www.arb.ca.gov/msprog/acc/acc-mtr.htm.

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This briefing assesses the fuel-saving impact on consumers of continued adoption of efficiency technologies in light-duty vehicles to meet the 2025 standards. It applies the technology cost results from the March 2017 ICCT report *Efficiency technology and cost assessment for U.S. 2025–2030 light-duty vehicles*[2] to a consumer-impact analysis. Like that technology assessment, this paper first examines the impacts of the technologies for the adopted 2025 standards, then examines the impact of continued efficiency improvements through 2030, based on our technical analysis.

We estimate the direct fuel-saving benefits to buyers of model year 2025 and 2030 vehicles under four sets of targets. The first compares vehicles under the adopted 2025 targets against a baseline of 2021 targets, as reflected in the most recent assessment by U.S. EPA. Next, three sets of targets are evaluated for model year 2030 vehicles. These evaluate vehicles under 4%, 5%, and 6% compounded annual reductions in CO_2 targets for cars and light trucks for 2026–2030, compared against vehicles that meet the adopted 2025 targets. The following sections evaluate each of these sets of targets according to three measures of consumer benefits: payback period, lifetime fuel savings, and consumer benefit-to-cost ratio. Results are analyzed for technology costs developed by U.S. EPA and ICCT. Consumer benefits are evaluated under low, reference, and high fuel prices, as detailed in the next section. In addition, we summarize what the specific results mean for representative cars and light trucks. The non-consumer benefits of adopted 2025 standards—namely greenhouse gas emission mitigation, energy security, and health benefits, among others—are not analyzed in this consumer-focused briefing.

ASSESSING 2025 CONSUMER EFFICIENCY BENEFITS

We evaluate the consumer benefits of light-duty vehicle efficiency technology using three distinct measures. The first—payback period—refers to the number of years it takes for cumulative fuel savings to recover the initial investment in vehicle technology. For this, we look at the payback period for the average cash purchase, as well as for the average new vehicle that is acquired via standard financing terms. The second measure—lifetime fuel savings—reflects the cumulative fuel savings over the lifetime of the vehicle, including those that take place after the investment in vehicle technology has been fully recovered. The third measure—the benefit-to-cost ratio—reflects lifetime fuel savings divided by the investment in vehicle technology, including any changes in maintenance costs, insurance costs, and vehicle taxes over the vehicle lifetime. For the economic valuation of future cash flows, the consumer benefits are estimated for a 3% discount rate. Of the three measures considered, the latter two (lifetime fuel savings and benefit-to-cost ratio) are more complete measures of consumer benefits than the payback period, since these count fuel savings that continue to accrue after the investment is paid back. These two measures are quantified for all sensitivity scenarios (including low and high fuel prices), whereas payback periods are calculated only for reference fuel prices.

Our method applies the same underlying assumptions and method as in U.S. EPA's assessments, except that we update vehicle efficiency technology data to reflect the

2 Nic Lutsey, Dan Meszler, Aaron Isenstadt, John German, Josh Miller, "Efficiency technology and cost assessment for U.S. 2025–2030 light-duty vehicles" (ICCT: Washington DC, 2017). http://www.theicct.org/US-2030-technology-cost-assessment.

ICCT's latest technology assessment.[3] Our analysis assesses average consumer net present value impacts following the U.S. EPA analytical approach from its January 2017 final determination of model year 2022–2025 standards. These payback methods apply detailed outputs from the U.S. EPA Optimization Model for Reducing Emissions of Greenhouse Gases from Automobiles (OMEGA)[4] for incremental vehicle technology costs and technology uptake to meet CO_2 targets. They also include projections for the new vehicle fleet, including annual vehicle mileage, retail fuel prices, and electricity prices for electric vehicles.

U.S. EPA assumptions are derived from several different sources. Fuel prices are from U.S. Energy Information Administration's (U.S. EIA) Annual Energy Outlook (AEO), the 2016 version. We primarily analyze the Annual Energy Outlook's reference fuel case for future years and include sensitivity analysis of fuel savings for the low and high cases for fuel price. To give a sense of the costs over time, the motor gasoline per-gallon fuel prices for calendar years 2025 through 2035 are from $1.97 to $2.24 for the low case, $2.97 to $3.47 for the reference, and $4.94 to $5.45 for the high case. The vehicle survival rates assume vehicle median lifetimes of 15–16 years. The annual mileage reduces with vehicle age, and the average lifetime accrual for model year 2025 vehicles is assumed to be approximately 209,000 miles for passenger cars and 224,000 miles for light trucks, as in U.S. EPA's analysis.

Figure 1 shows the cost of vehicle technology, vehicle taxes, insurance, maintenance, and fuel for the sales-weighted average model year 2025 vehicle by year of ownership. These results are shown assuming a 3% discount rate, AEO Reference fuel prices, and cash purchase. The figure includes results for model year 2025 vehicles from U.S. EPA's Proposed Determination analysis, along with our updated technology assumptions. The cost line items for vehicle taxes and insurance include the additional sales tax on the new vehicle purchase and the change in insurance premiums resulting from the more valuable vehicle, including depreciation. Maintenance costs reflect estimates of the cost to keep the vehicle properly maintained in accordance with manufacturer recommendations. Examples of the associated costs are periodic replacement of tires, oil, air filters, engine coolant, and spark plugs. This assessment includes several small changes in maintenance costs that are associated with new technologies entering the fleet, including replacement of low-rolling-resistance tires, elimination of engine maintenance in electric vehicles, and increased battery coolant and checks for electric vehicles, as done by U.S. EPA.

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3 Ibid.

4 U.S. Environmental Protection Agency (U.S. EPA), "Optimization Model for reducing Emissions of Greenhouse Gases from Automobiles (OMEGA), Version v1.4.56" (2016). https://www.epa.gov/regulations-emissions-vehicles-and-engines/optimization-model-reducing-emissions-greenhouse-gases.

Scenario	Year of Ownership	Vehicle Technology	Vehicle Taxes	Insurance	Maintenance	Fuel Savings	Cumulative Operational Savings
U.S. EPA 2025	1	-863	-47	-16	-6	238	-693
	2	0	0	-15	-6	232	-483
	3	0	0	-14	-5	223	-279
	4	0	0	-13	-5	213	-85
	5	0	0	-12	-5	202	**5th** 100
	6	0	0	-11	-5	189	274
	7	0	0	-10	-4	178	437
	8	0	0	-9	-4	166	589
ICCT 2025	1	-543	-30	-10	-7	238	-351
	2	0	0	-10	-7	232	-136
	3	0	0	-9	-7	223	**3rd** 72
	4	0	0	-8	-6	213	270
	5	0	0	-8	-6	202	459
	6	0	0	-7	-6	189	635
	7	0	0	-6	-5	178	801
	8	0	0	-6	-5	166	956

Figure 1. Technology costs, benefits, and payback period for the average model year 2025 vehicle purchased with cash.

These costs and impacts are evaluated as compared to a reference fleet that complies with the model year 2021 standards. This 2021 to 2025 timeframe for the cost assessment is shown, as this is the timeframe under review for the federal midterm evaluation. The cumulative operational savings are the sum of fuel savings minus the incremental costs, assuming a 3% discount rate and including each year and those above it; the consumer payback occurs when these cumulative operating costs shift from negative (reflecting a net outflow of cash) to positive (reflecting net savings). Whereas U.S. EPA estimates a consumer payback in the 5th year, our analysis indicates that payback will occur a full two years earlier, in the 3rd year of ownership, for a new 2025 vehicle purchase. The figure shows the first 8 years of vehicle use, but fuel savings continue to accrue in subsequent years. The median vehicle lifetime for passenger cars and light trucks is about 15-16 years.[5]

Table 1 shows the lifetime incremental costs, fuel savings, and net benefits for the average model year 2025 vehicle, including the sensitivity of these results to fuel price assumptions. Again, the comparable U.S. EPA and ICCT results are both shown. The results are rounded to two significant digits, though the benefit-to-cost ratio is calculated using unrounded results. As in U.S. EPA's methods, technology costs are discounted to the mid-year point of the first year of ownership. Accordingly, ICCT's cost estimate of $540 here corresponds to the $551 estimate in our recent paper.[6] Based on reference fuel prices, the central result is that the 2025 standards have consumer benefits that are about three times the costs. In the ICCT case, we see benefits are 3.6 times the costs; in the U.S. EPA case, the benefits are 2.4 times the costs. The analysis for varying future fuel prices reveals that the result, whereby benefits significantly exceed cost, is robust. The U.S. EPA analysis for model year 2025

5 Stacy C. Davis, Susan E. Williams, Robert G. Boundy, Transportation Energy Data Book Oak Ridge National Laboratory. http://cta.ornl.gov/data/index.shtm/

6 Nic Lutsey, Dan Meszler, Aaron Isenstadt, John German, Josh Miller, "Efficiency technology and cost assessment for U.S. 2025–2030 light-duty vehicles" (ICCT: Washington DC, 2017). http://www.theicct.org/US-2030-technology-cost-assessment.

vehicles indicates lifetime fuel savings exceed the costs by a factor of 1.6, with low fuel prices, to 3.6, with high prices. Because of advancements in technology effectiveness and reductions in technology costs, our analysis indicates higher benefit-to-cost ratios of 2.4, with low fuel prices, to 5.4, with high prices.

Table 1. Summary of costs and benefits for the average model year 2025 vehicle, including impacts of low and high fuel prices.

	Fuel price assumption	Technology cost	Other costs	Lifetime fuel saving	Net lifetime benefit	Benefit-to-cost ratio
U.S. EPA	Low	870	300	1,900	720	1.6
	Reference	**860**	**290**	**2,800**	**1,600**	**2.4**
	High	870	290	4,200	3,100	3.6
ICCT	Low	540	240	1,900	1,100	2.4
	Reference	**540**	**240**	**2,800**	**2,000**	**3.6**
	High	540	240	4,200	3,400	5.4

Notes: Other costs include differences in taxes, maintenance, and insurance from new technologies

While analyzing a cash vehicle purchase as above is the most conservative assumption for calculating consumer payback period, acquiring a vehicle via financing, and increasingly leasing, is more customary. Most new vehicles are acquired using financing, with an average loan term of 66 to 72 months (5.5 to 6 years).[7] Following U.S. EPA's methods for evaluating consumer payback assuming a loan term of 48, 60, or 72 months, Figure 2 shows the sensitivity of payback results to whether a vehicle is purchased with cash or with a 72-month loan at an interest rate of 4.25%. These results are shown assuming a 3% discount rate and AEO reference fuel prices. The first two columns show the change in total vehicle purchase costs (including vehicle payments, taxes and insurance) for each type of purchase by year of ownership, and the last two columns show the respective change in cumulative operating costs (adding in maintenance costs and fuel savings). Whereas a cash purchase results in a 3-year payback, under typical financing terms, new efficient 2025 vehicles will have "off the lot" savings because the fuel savings greatly outweigh the increased loan payments.

7 Melinda Zabritski, "State of the Automotive Finance Market: A look at loans and leases in Q1 2016," Experian, https://www.experian.com/assets/automotive/quarterly-webinars/2016-q1-safm.pdf

Scenario	Year of Ownership	Vehicle Cost with Cash Purchase	Vehicle Cost with 72-Month Loan Purchase	Maintenance	Fuel Savings	Cumulative Net Operational Savings with Cash Purchase	Cumulative Net Operational Savings with 72-Month Loan Purchase
U.S. EPA 2025	1	-926	-187	-6	238	-693	**1st** 46
	2	-15	-180	-6	232	-483	91
	3	-14	-173	-5	223	-279	136
	4	-13	-166	-5	213	-85	178
	5	-12	-158	-5	202	**5th** 100	217
	6	-11	-150	-5	189	274	252
	7	-10	-10	-4	178	437	415
	8	-9	-9	-4	166	589	567
ICCT 2025	1	-583	-118	-7	238	-351	**1st** 114
	2	-10	-113	-7	232	-136	225
	3	-9	-109	-7	223	**3rd** 72	333
	4	-8	-104	-6	213	270	435
	5	-8	-100	-6	202	459	532
	6	-7	-95	-6	189	635	621
	7	-6	-6	-5	178	801	787
	8	-6	-6	-5	166	956	942

Figure 2. Vehicle cost with cash and loan purchase, maintenance costs, fuel savings, cumulative net operational savings, and payback period for 2025 vehicles, based on U.S. EPA and ICCT results.

ASSESSING 2030 CONSUMER EFFICIENCY BENEFITS

We apply the same modeling approach to estimate the consumer benefits of potential model year 2030 standards under various assumptions for the rate of efficiency improvement. To estimate the costs of fueling electric vehicles, we apply U.S. EPA's assumptions for rates of electricity consumption, charging and transmission losses, and retail electricity prices (12–13 cents per kWh). We assess extending the CO_2 emission standards at 4%, 5%, and 6% annual rates of improvement from 2025 to 2030. This progression of the fleet to higher efficiency takes the fleet from an average new vehicle fleet consumer fuel economy of 35 miles per gallon (mpg) in 2025, up to 42 mpg (4%/year), 44 mpg (5%/year), or 46 mpg (6%/year). Figure 3 shows the lifetime fuel savings, vehicle technology costs, and other impacts for the average model year 2030 vehicle compared to a baseline of adopted 2025 standards. These results are shown assuming a 3% discount rate, AEO reference fuel prices, and cash purchase. Our analysis indicates that the additional lifetime fuel savings associated with a more fuel-efficient 2030 vehicle fleet outweigh the costs by more than two to one. The figure shows how both costs and benefits increase with a fleet that achieves more stringent 2030 standards. In the case of the 4%/year standards the benefits are 2.9 times the costs, compared to 2.5 for 5%/year standards, and 2.2 for 6%/year.

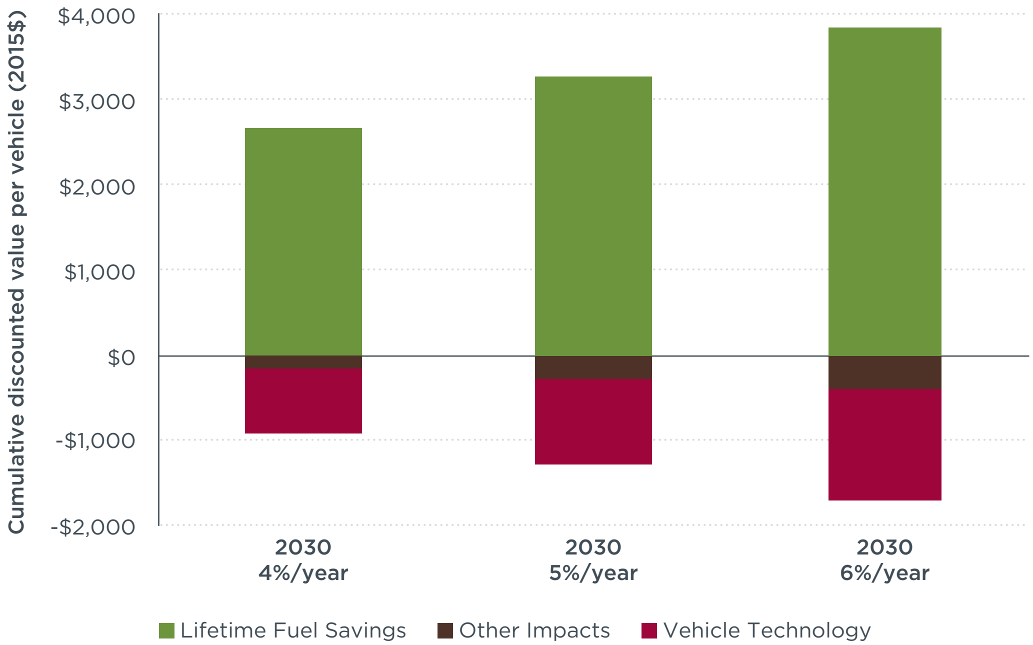

Figure 3. Lifetime fuel savings, vehicle technology costs, and other cost impacts for vehicles achieving three different efficiency levels by 2030.

Table 2 summarizes the analysis of lifetime incremental costs, fuel savings, and net benefits for the average model year 2030 vehicle, including the sensitivity of these results to fuel price assumptions. The results are shown rounded to two significant digits, though the benefit-to-cost ratio is calculated using unrounded results. As in U.S. EPA's methods, technology costs are discounted to the mid-year point of the first year of ownership: accordingly, ICCT's cost estimate of $750 here (4%/year scenario) corresponds to the $772 estimate in our recent paper.[8] As also shown above, compared to a baseline of adopted 2025 standards, our analysis indicates that the potential 2030 efficiency levels analyzed here have consumer benefits that are between two and three times the costs under reference fuel prices. The associated payback periods are 4 years (4%/year) to 5 years (5–6%/year) for a cash purchase under reference fuel prices. As above for the 2025 standards, we find that the average 2030 high-efficiency vehicle acquisition, under typical 72-month loan financing terms, also results in off-the-lot savings within the first year. Of course, the consumer fuel-saving benefits are greater for the higher fuel price case, and lower for the low fuel price case. Even the most stringent scenario evaluated (i.e., 6%/year) would result in lifetime consumer fuel savings that outweigh the costs by a factor of 1.4 with sustained low fuel prices and up to 3.4 if fuel prices increase over time.

8 Nic Lutsey, Dan Meszler, Aaron Isenstadt, John German, Josh Miller, "Efficiency technology and cost assessment for U.S. 2025–2030 light-duty vehicles" (ICCT: Washington DC, 2017). http://www.theicct.org/US-2030-technology-cost-assessment.

Table 2. Summary of costs and benefits for the average model year 2030 vehicle, including impacts of low and high fuel prices.

Scenario	Fuel price assumption	Technology cost	Other costs	Lifetime fuel saving	Net lifetime benefit	Benefit-to-cost ratio
ICCT 2030 4%/year	Low	750	170	1,700	790	1.9
	Reference	**750**	**170**	**2,600**	**1,700**	**2.9**
	High	750	170	4,100	3,200	4.4
ICCT 2030 5%/year	Low	1,000	280	2,100	810	1.6
	Reference	**1,000**	**280**	**3,300**	**2,000**	**2.5**
	High	1,000	280	5,000	3,700	3.9
ICCT 2030 6%/year	Low	1,300	410	2,500	760	1.4
	Reference	**1,300**	**410**	**3,800**	**2,100**	**2.2**
	High	1,300	410	5,900	4,200	3.4

Notes: Other costs include differences in taxes, maintenance, and insurance from new technologies

PASSENGER CAR EFFICIENCY BENEFITS

The above results show the fleet-wide impacts on new vehicles with the deployment of more advanced efficiency technology. The light-duty vehicle fleet includes a wide array of cars, large sedans, crossovers, sport utility vehicles, minivans, and pickup trucks. The vehicle efficiency standards have two primary categories, passenger cars and light trucks, and the standards for those categories are size-indexed. This structure ensures that all vehicle types see more high-efficiency vehicle options over time, rather than allowing the standards to promote smaller cars or trucks. These size-indexed standards are designed to flexibly allow the fleet to naturally shift with gasoline prices and broader economic trends.[9]

To provide a clearer sense of how 2025 and 2030 results above would impact car and light truck consumers, we quantitatively describe the impact on the two categories.

Consumer fuel economy for passenger cars in future years is illustrated in Figure 4, showing the progression from the 2016 fleet, to a fleet that meets the adopted 2025 standards, to a new 2030 fleet that reduces CO_2 at 5%/year after 2025, as assessed above. Following U.S. EPA's approach, we assume consumer label fuel economy to be 23% lower than the regulatory test-cycle fuel economy. The starting point of 29 miles per gallon is for the average fuel economy of passenger cars, including crossover vehicles that are categorized as passenger cars, in 2016. The new passenger car fleet would improve to 41 mpg in 2025, and then to 52 mpg in 2030. Examples of passenger cars models at approximately 28–30 mpg consumer fuel economy in 2016 are Buick Encore, Chevrolet Malibu, Chrysler 200, Ford Focus, Honda Accord, Honda CR-V, Hyundai Sonata, Mazda CX-5, Mitsubishi Outlander, Nissan Rogue, Toyota Camry, Volkswagen Passat, and Volvo S60. Some of these are crossover vehicles, which, due to their vehicle dimensions or being two-wheel-drive, are categorized as passenger cars (some also have four-wheel-drive versions that are classified as light trucks).

9 Nic Lutsey, "A primer on U.S. fuel economy standards," The International Council on Clean Transportation, April 10, 2015, http://www.theicct.org/blogs/staff/primer-us-fuel-economy-standards.

Figure 4 illustrates the incremental cost increases from efficiency technologies and the associated fuel savings as cars increase in fuel economy to meet higher 2025 and 2030 efficiency levels. From 2021 to 2025, the latest step in the adopted 2025 standards, the average passenger car cost would be $490, and the fuel savings would be $2,300—more than 4 times greater than the cost. In the scenario examined for 2030 in which fuel economy reaches 52 mpg, there would be $750 in additional technology, $2,600 in fuel savings, and a 4-year payback period.

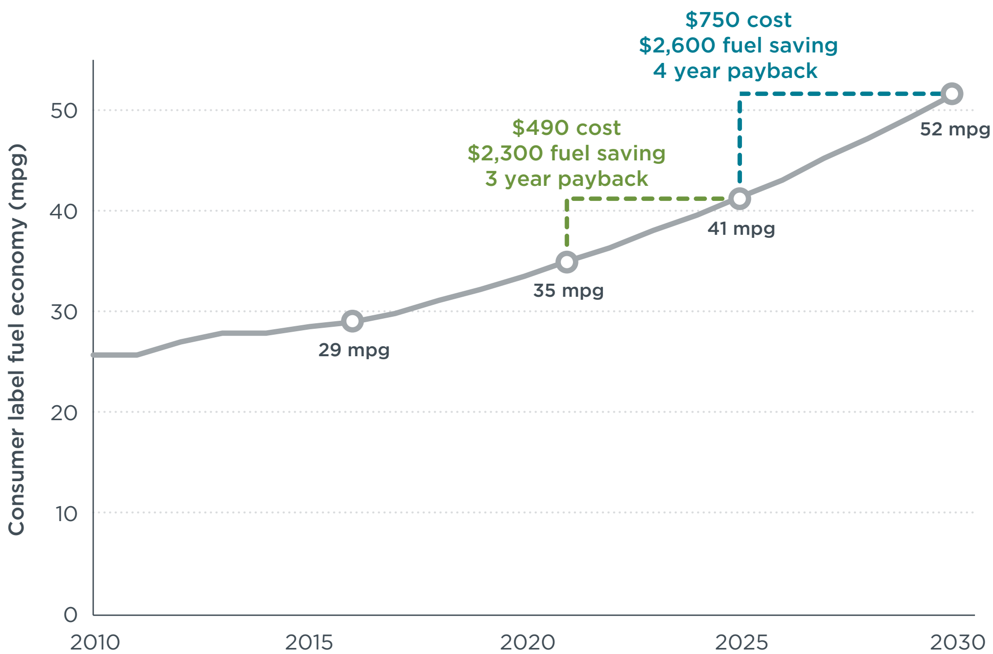

Figure 4. Associated cost, fuel savings, and payback period for increased passenger car efficiency in 2025 and 2030, using reference case fuel prices.

LIGHT TRUCK EFFICIENCY BENEFITS

Consumer fuel economy for light trucks through model year 2030 is illustrated in Figure 5, showing the progression from the 2016 fleet, to a fleet that meets the adopted 2025 standards, to a new 2030 fleet that reduces CO_2 at 5%/year after 2025. As above for cars, we assume light truck consumer fuel economy is 23% lower than the regulatory test-cycle fuel economy. The 2016 starting point of 21 mpg is for the average fuel economy of light trucks, including some crossover vehicles, most sport utility vehicles, minivans, and pickup trucks. The new light truck fleet would increase to 30 mpg in 2025, and then to 38 mpg in 2030. Examples of light truck models that have offerings of approximately 20-22 mpg consumer fuel economy in 2016 are Acura RDX, BMW X5, Chevrolet Colorado, Chrysler Town and Country, Jeep Grand Cherokee, Ford Edge, Ford Explorer, Ford F150, Honda Odyssey, Subaru Outback, Toyota Highlander, and Volvo XC60.

Figure 5 illustrates the incremental cost increases from efficiency technologies and the associated fuel savings as light trucks increase in fuel economy to meet higher 2025 and 2030 targets. From 2021 to 2025, the latest step in the adopted 2025 standards, the average light truck cost would be $610, and the fuel savings would be $3,900—

more than six times greater than the cost. In the scenario examined for 2030 in which fuel economy reaches 38 mpg, there would be $1,300 in additional technology, $4,000 in fuel savings, and a 5-year payback period.

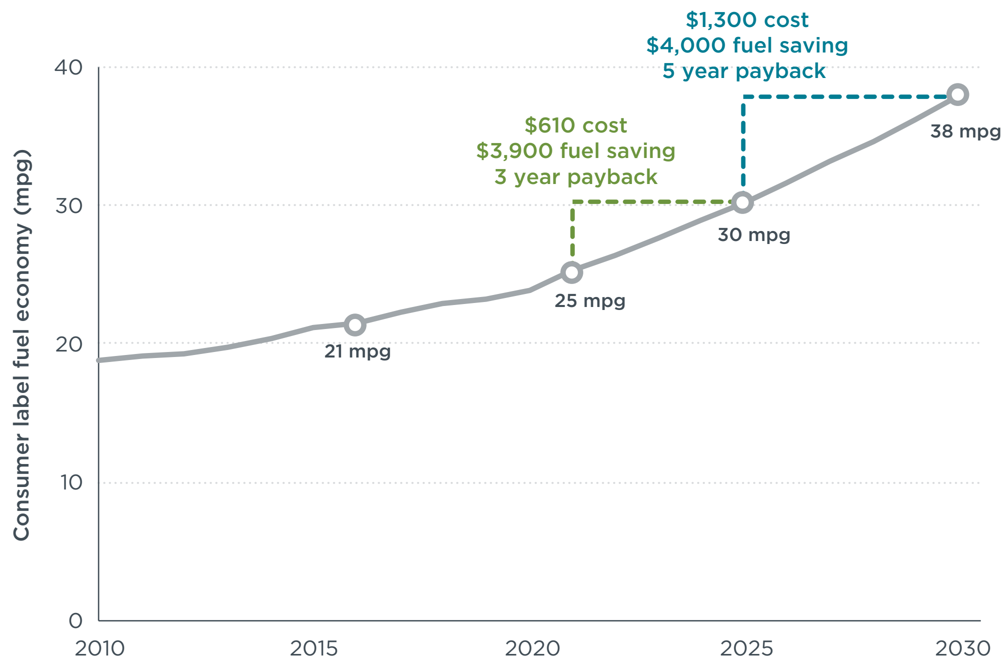

Figure 5. Associated cost, fuel savings, and payback period for increased light truck efficiency in 2025 and 2030, using reference case fuel prices.

CONCLUSION

This paper estimates the costs and benefits for buyers of model year 2025 and 2030 vehicles, considering the impacts of adopted 2025 standards and the potential extension of fuel efficiency benefits at a rate of 4% to 6% per year to 2030. It evaluates the impacts of these standards on the costs of vehicle technology, insurance, taxes, and maintenance, as well as fuel savings under low, reference, and high fuel prices. Three implications for current, and potential future, fuel efficiency regulations in the United States stand out.

The adopted 2025 standards provide tremendous value for American consumers. Under the adopted standards, buyers of model year 2025 vehicles will fully recoup their investment in the 3rd year of ownership for a cash purchase. Those who finance their vehicles will see a net positive cash flow starting immediately. Moreover, the standards will net consumers thousands of dollars over the lifetime of the vehicle. Under reference fuel prices in future years, the consumer benefits would be more than 3 times the costs of the standards. These findings are robust to changes in market conditions: fuel savings are 2.4 times the costs if fuel prices stay low for the next several decades.

Fuel efficiency and CO_2 standards are an exemplary public policy with benefits that consistently and greatly exceed costs. Consumers directly benefit from the 2025 standards with thousands of dollars in fuel savings per vehicle. These consumer savings alone justify the efficiency standards. If the public benefits of the standards for energy security, climate change mitigation, and air quality were also included, the efficiency standards would make for an even bigger public policy win. Continuing these vehicle efficiency improvements to 2030 will continue to provide consumer benefits that exceed the costs—by a factor of 2 to 3 times under reference fuel prices, and a range of 1.4 to 4.4 times under low and high fuel prices, respectively. For a typical car loan, each of these 2030 standards would result in off-the-lot savings.

High consumer benefits are available across vehicle types, from cars to light trucks. The size-indexed standards ensure that all vehicle types see more high-efficiency vehicle options over time and allow the fleet to naturally shift with gasoline prices and broader economic trends. The average new car fuel economy label would increase from 35 mpg in 2021 to 41 mpg in 2025 under the adopted standards, and to 52 mpg in 2030 assuming improvements of 5%/year—each of these steps would save consumers $2,300–$2,600 in fuel costs over the lifetime of the vehicle. For trucks, the average fuel economy would increase from 25 mpg in 2021, to 30 mpg in 2025, to 38 mpg in 2030—similarly, each step would save consumers $3,900–$4,000 in fuel costs per vehicle.