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May 31, 2022

California Air Resources Board
1001 I Street
Sacramento, CA 95814

Dear Chair Randolph and Members of the Board,

On behalf of our over 500,000 supporters, the Union of Concerned Scientists (UCS) urges the Air Resources Board (ARB) to adopt strong Advanced Clean Cars II (ACCII) standards. The ACCII standards are one the most important air and climate pollution regulations to come before this board and the rules are the culmination of decades of ARB action on clean cars and zero emission vehicles (ZEVs). UCS thanks the members of the board and ARB staff for their work on ACCII and for consideration of concerns UCS and other have raised during the development of the regulations.

Adoption of ACCII standards is important not only for ensuring cleaner air and lower climate-changing emissions in California, but also for other states that rely on California to set emissions standards equal to or more stringent than federal standards. California needs to continue to show leadership on protecting health and minimizing climate change damage.

ARB needs to adopt as strong as possible ZEV rule now

Action on climate and air quality is needed as quickly as possible. According to the American Lung Association, 98 percent of Californians live in a county impacted by poor air quality and six California cities were in the top ten in the United States for days with unhealthy ozone levels.[1] Transportation, including light-duty vehicles, is a significant source of air pollution in the state and reducing or eliminating tailpipe air pollution is needed to reduce harmful exposures. Light-duty vehicles not only contribute to unhealthy air quality, but they are also the single largest source of climate-changing emissions. ARB estimates that passenger vehicles are responsible for over 28 percent of total human-caused climate-changing emissions, more than the residential, commercial, and agricultural sectors combined.[2] In order to address these concerns, ARB should act as quickly as possible. By adopting ACCII now, ARB can set standards for vehicles starting with model year 2026 and also allow other states to potentially adopt in time to also impact model year 2026 vehicles.

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[1] American Lung Association. 2022. State of the Air. Online at https://www.lung.org/research/sota

[2] California Air Resources Board. 2021. "California Greenhouse Gas Emissions for 2000 to 2019: Trends of Emissions and Other Indicators" Online at https://ww2.arb.ca.gov/sites/default/files/classic/cc/inventory/2000_2019_ghg_inventory_trends_20220516.pdf

ARB's own analysis shows the need for deep reductions in passenger car emissions. The Mobile Source Strategy is ARB's strategy "identifying the technology trajectories and programmatic concepts to meet our criteria pollutant, greenhouse gas, and toxic air contaminant reduction goals from mobile sources."[3] In the Mobile Source Strategy, ARB's primary scenario shows 46 percent ZEV sales in 2026 and 70 percent ZEV sales in 2030 as needed to meet emissions targets. This is but one sales scenario possible, but it shows the magnitude of new ZEV sales needed to protect health and address climate change. As the ACCII ZEV regulations start below the scenario in the Mobile Source Strategy at 35 percent in 2026 (assuming no use of ACCI or Early Action ACCII credits), ARB will need to increase the ZEV requirement in later years of the regulation to achieve the emissions reductions called for in the Mobile Source Strategy.

UCS recommends increasing the ZEV credit requirement to require at least 75 percent ZEV credits by model year 2030 (Figure 1). Increasing the ZEV sales requirement would result in an increase of more than 350,000 ZEVs on the road by 2030, based on UCS modeling.[4] An improved ZEV requirement would also result in nearly 700,000 fewer gasoline vehicles on the road in 2035 (Figures 2 & 3). This modest increase in the sales requirement is estimated to have similar cumulative global warming emissions reductions as the 2020 Mobile Source Strategy for the 2026 to 2035 period and greater reductions for the 2026 to 2045 time period. Therefore, an increase in ZEV requirements is needed to achieve the targets laid out in the Mobile Source Strategy.

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[3] California Air Resources Board. 2021. "2020 Mobile Source Strategy" Online at https://ww2.arb.ca.gov/resources/documents/2020-mobile-source-strategy

[4] Vehicle deployment modeled using EMFAC2021 sales rates and implied survival rates for light duty vehicles.

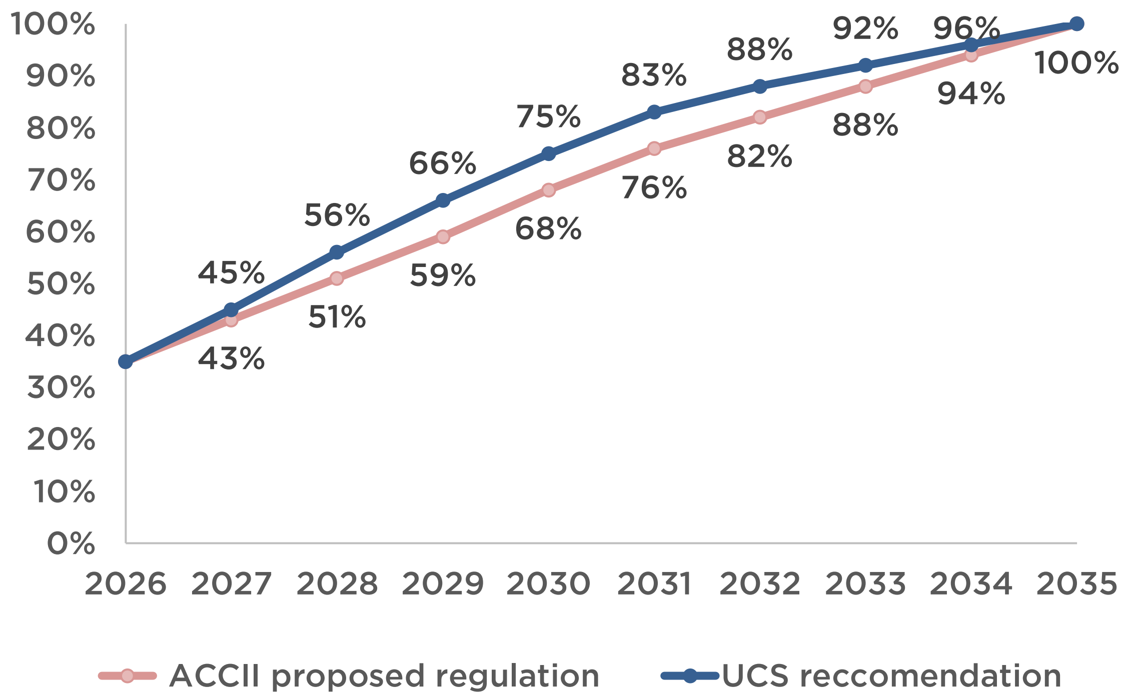

Figure 1: A modest increase in the ZEV credit requirement would lead to emissions savings comparable to the 2020 Mobile Source Strategy targets for light duty vehicles.

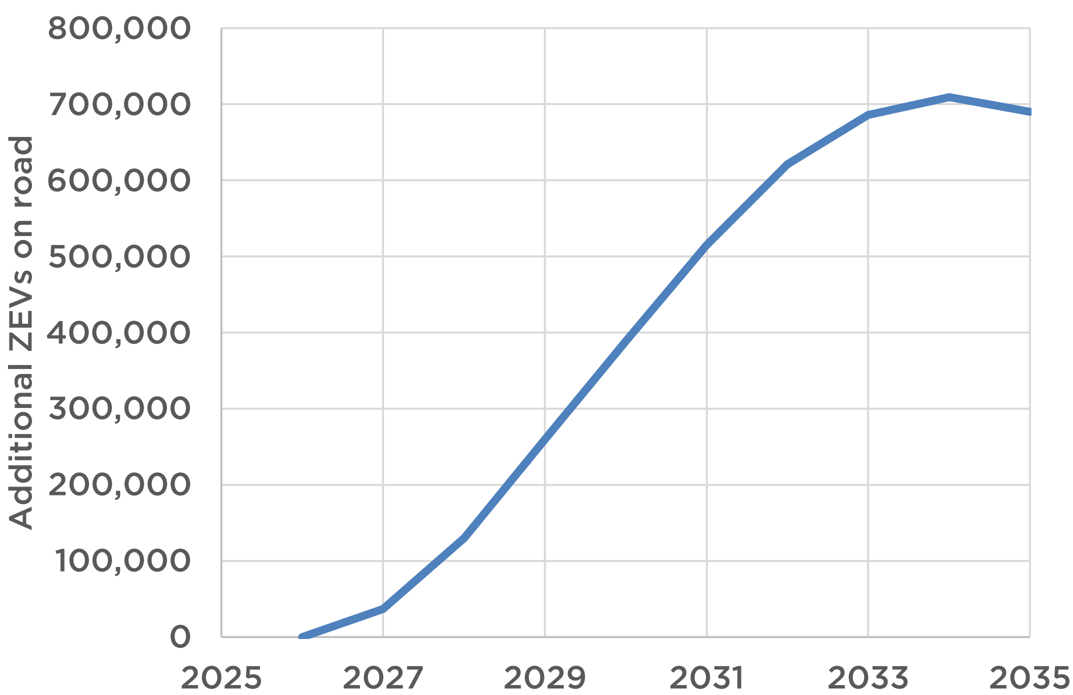

Figure 2: Increasing the ZEV credit requirement to 75% by 2030 would result in over 500,000 more ZEVs (and fewer gasoline vehicles) by 2031

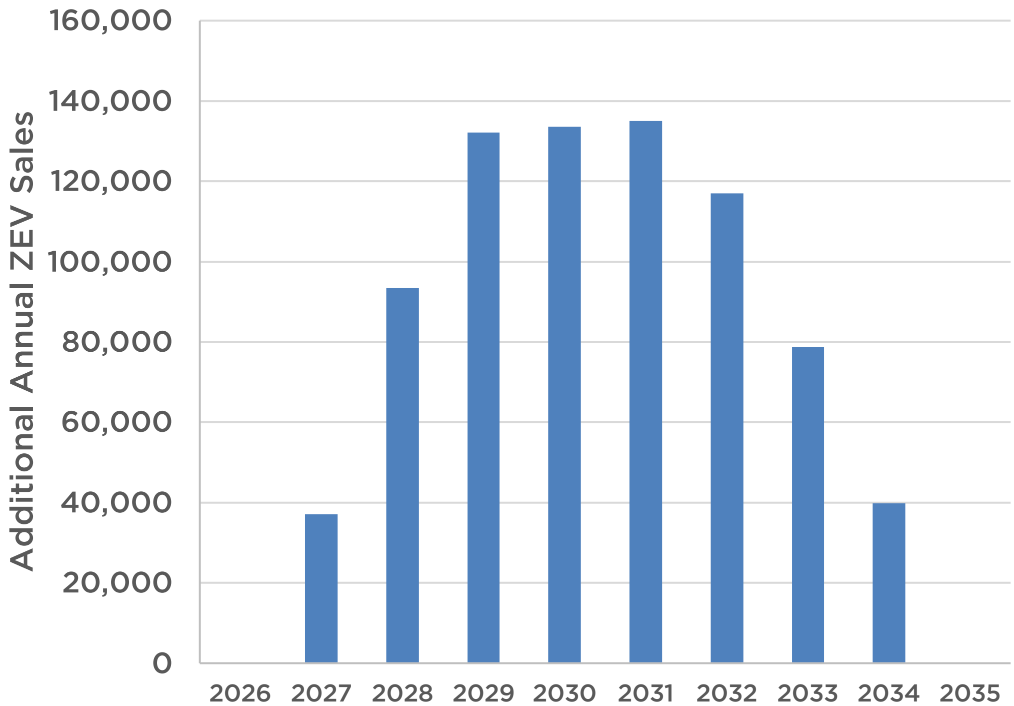

Figure 3: Increasing the ZEV credit requirement to 75% by 2030 would result in over 100,000 additional ZEVs required each year between 2029 and 2032

In addition to being more protective of health and having higher emissions reductions, a higher target will allow more ZEV choices for buyers. Automakers will need to address the entire vehicle market including a range of vehicle sizes. A higher ZEV credit requirement will also ensure that automakers have certainty in vehicle emissions rules and encourage more research and development.

Based on the growing number of plug-in ZEV options, including multiple battery electric pickup truck and SUV models, it is likely ZEV standards can be achieved with plug-in vehicle technologies alone. Hydrogen fuel cell electric vehicles may also play a role in light duty ZEV market, but for the sake of public health and welfare, standards should not be weakened or slowed because some automakers have chosen to comply with current standards using fuel cell electric vehicles. In addition, the three automakers that currently or have recently sold or leased hydrogen fuel cell vehicles in California (Toyota, Hyundai, and Honda) also have plug-in EV production plans, showing their ability to pursue models using different ZEV technologies at the same time. We support the proposed ACCII ZEV regulations that value hydrogen fuel cell electric and battery electric vehicles equally.

ARB analysis supports ability to require 75% ZEV sales by MY2030

In the Initial Statement of Reasons (ISOR) for the ACCII regulations, ARB staff created scenarios based on approximately 350 vehicle model redesign schedules to predict how industry could shift existing vehicle models to ZEVs. The results of this model show that the proposed ZEV sales requirement is well below the most aggressive deployment scenario ("as soon as possible") and is below even a "slow phase-in" scenario (Figure 4). The ARB model redesign analysis shows that manufacturers could meet increased stringency targets while remaining on a conventional redesign schedule and not having to prematurely terminate or redesign an existing model.

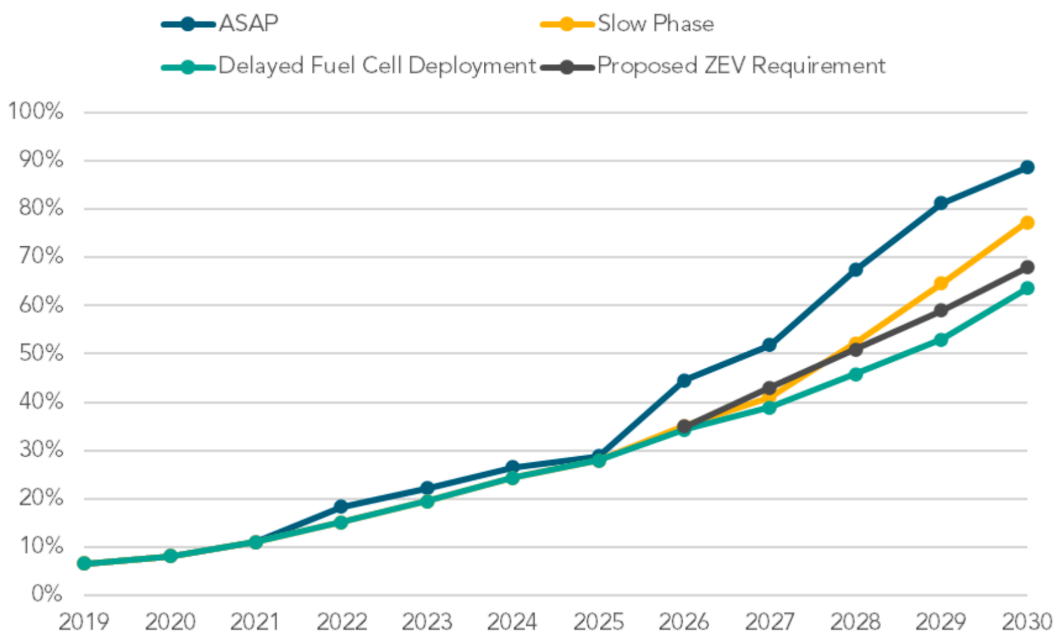

Figure 4: ARB's model turnover analysis shows that the proposed ZEV requirement is significantly slower than a "as soon as possible" scenario and is even slower than a "slow phase-in" scenario. (Source: ARB ACCII Initial Statement of Reasons)

ZEV technologies are being are already being deployed here and abroad

The ability for automakers to comply with more stringent ZEV credit requirement is also shown by current increases in ZEV sales both in California and globally. In the first quarter of 2022, ZEV sales in California made up over 17% of all new passenger car sales, increasing from 7% only 4 years ago.[5] In other markets with more aggressive emissions regulations, manufacturers have shown the ability to achieve even higher ZEV sales. For example, 2021 plug-in and fuel cell vehicle sales in Germany were over 25% of all new passenger cars.[6] In the United Kingdom, sales hit 18.5%. These markets are not perfect parallels to the California market, but there are clear indications that automakers are offering more models and higher volumes of ZEVs in these markets. For example, in Germany, the Hyundai Ioniq 5 had sales in the hundreds of units in July 2021, while this model was only available in California starting in December 2021 with 22 new registrations. There are also differences in the models made available outside the of California. In the United Kingdom, Lexus offers a battery electric vehicle; in Germany Ford sells a plug-in hybrid version of its popular Explorer SUV, and Volkswagen offers additional ZEV models like the ID.3 ZEV. ACCII and ZEV requirements will help ensure that automakers once again prioritize the California market for clean vehicles.

In addition to the automakers' demonstrated ability to deliver ZEVs to other markets, many manufacturers have also made significant public commitments to new ZEV models and electric vehicle sales targets. For example, General Motors has announced that it intends to sell only ZEVs by 2035[7], while both Fiat and Volvo have said that they are going to sell only electric vehicles by 2030.[8] These and other automakers that have made commitments to increase ZEV availability (see ISOR Appendix G) show that increased ZEV requirements would be consistent with the outlook of industry leaders on electrification.

Plug-in hybrid range requirements are important to limit emissions

UCS supports the stronger plug-in hybrid (PHEV) ZEVs specified in the ACCII regulations. To minimize emissions, it is important to ensure that PHEVs have all-electric operation available when the battery has sufficient charge, even when the vehicle is in a high-power demand situation. The requirement for 40 mile range on the US06 drive cycle will help ensure that PHEVs have an electric powertrain with enough capability to handle common driving situations like highway driving. It is also important that PHEVs have adequate electric range to allow most daily driving without gasoline combustion. The proposed ACCII regulation requires the equivalent of 50-mile real-world all-electric range to earn a ZEV

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[5] California New Car Dealers Association. 2022. "California Auto Outlook" Online at https://www.cncda.org/wp-content/uploads/Cal-Covering-1Q-22-002.pdf

[6] German Federal Motor Transport Authority (Kraftfahrt-Bundesamt) Online at https://www.kba.de/DE/Statistik/Fahrzeuge/Neuzulassungen/neuzulassungen_node.html

[7] NY Times. 2021. "G.M. Will Sell Only Zero-Emission Vehicles by 2035." https://www.nytimes.com/2021/01/28/business/gm-zero-emission-vehicles.html

[8] https://www.media.volvocars.com/us/en-us/media/pressreleases/277409/volvo-cars-to-be-fully-electric-by-2030; https://www.media.stellantis.com/em-en/fiat/press/world-environment-day-2021-comparing-visions-olivier-franois-and-stefano-boeri-in-conversation-to-rewrite-the-future-of-cities

credit, which would be sufficient range to allow a majority of PHEV driving to be combustion-free.

However, even with these performance requirements, using PHEVs can result in global-warming and smog-forming pollution. There is no assurance that PHEVs will be plugged-in and even if charged frequently, some driving will inevitability use the combustion engine. Therefore, it is important that the ACCII regulations include a cap on the fraction of ZEV credit compliance that can come from PHEVs.

ARB should increase certainty of equity provision use

Low-income communities and communities of color in California are inequitably exposed to higher levels of air pollution from on-road transportation.[9] ARB has proposed several mechanisms to address environmental justice by increasing access and use of ZEVs in priority communities to reduce this disproportionate burden.[10] UCS supports the inclusion of environmental justice measures, but they will have no impact if they are unused by manufacturers. In order to achieve greater certainty in the use of environmental justice credit programs, ARB should predicate use of credit flexibilities on participation in these equity programs. In the current ACCII proposal, use of pre-2026 ACCI credits are allowed in the to fulfil up to 15 percent of the annual credit requirement. Some or all of this allowance should be tied to an automaker's participation in environmental justice programs. In addition to linking credit flexibilities to participation, increasing the stringency of the ZEV credit requirement will provide a greater incentive for manufacturers to generate additional credits from the environmental justice programs.

UCS supports measures to provide battery information and set warranty standards for ZEVs

ARB is proposing battery warranty and state-of-health metrics as a requirement for ZEV credit eligibility. UCS supports these measures as they will increase the utility of ZEVs, especially those purchased on the secondary market. Providing this information and warranty will allow ZEVs to displace gasoline cars in this important market segment.

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[9] D. Reichmuth. 2019. Inequitable Exposure to Air Pollution from Vehicles in California. Online at https://www.ucsusa.org/resources/inequitable-exposure-air-pollution-vehicles-california-2019

[10] ARB defines priority communities to include neighborhoods that disproportionately suffer from historic environmental, health, and other social burdens, including disadvantaged communities and low-income communities.

UCS supports battery labeling and on-battery state-of-health metrics to assist reuse and recycling

We support the proposed battery labeling requirement to assist reuse and recycling and enable a circular economy for battery materials. However, one shortcoming of the proposed ACCII regulation is that the standardized battery state of health metric proposed does not require the ability to access information once the battery is removed from the vehicle.

Access to the data when the battery is removed will allow for more locations to make educated decisions about the next step for the battery at end of life (such as recycling or reuse) and also reduce the cost of testing for the repurposer. In some cases, repurposers will receive only the battery, so a state-of-health metric or battery history that is only readable in an intact vehicle will be less useful.

CalEPA's Lithium-ion Car Battery Recycling Advisory Group (established by AB2832) considered this issue and supported a required "Universal Diagnostic System" which addresses this issue.[11] It requires access to state of health information both while the battery is in the car and after it is removed. UCS recommends ARB amend the ACCII regulations to require a state-of-health metric that can be read both through the vehicle and directly from the battery if the battery pack is removed from the vehicle.

UCS supports proposed changes to LEV criteria emissions standards

UCS supports the proposed changes to the LEV criteria emissions standards. As new vehicles sales transition to higher fractions of ZEVs, it will be important to prevent backsliding from combustion engine-powered vehicles by applying fleet emission standards exclusively to internal combustion engine vehicles. This change, combined with lower maximum emissions limits and changes to cold-start regulations will provide emissions benefits from the shrinking but still significant conventional vehicle fleet.

Vehicle cost of ZEVs is overestimated

UCS appreciates staff's effort to estimate ZEV costs and we note that ARB staff has made changes to the ZEV cost estimates since the publication of the Standardized Regulatory Impact Assessment to reflect newer data. However, we believe that several assumptions made by ARB have led to an overestimation of ZEV costs.

First, the range requirement for battery electric vehicles (BEVs) should be reexamined considering a range of likely household use case scenarios. The range requirement is a primary determinant of battery capacity and battery capacity has a large impact on the modeled vehicle cost. ARB has chosen to require 300 mile and 400 mile range for BEVs, however it is likely that lower range vehicles will be part of the vehicle mix, especially in households with multiple BEVs. Additionally, increases in fast-charging infrastructure and

[11] CalEPA. 2022. Lithium-ion Car Battery Recycling Advisory Group Final Report. Online at https://calepa.ca.gov/wp-content/uploads/sites/6/2022/05/2022_AB-2832_Lithium-Ion-Car-Battery-Recycling-Advisory-Goup-Final-Report.pdf

the battery warranty provisions of ACCII could make BEVs with range lower than 300 miles useful.

Second, the towing requirements established by ARB for a subset of BEV SUVs and pickup trucks lead to greatly inflated cost estimates. The towing requirements as formulated require battery capacities much larger than the battery capacity used in BEV pickups currently on the market.

ARB should reexamine the assumptions that require large increases of battery capacity on towing package BEVs. ARB's cost model for pickup trucks requires between 102 and 131 kWh of *additional* battery capacity. In the case of the 'base' BEV pickup model, this additional battery is larger than the battery in non-towing models (i.e., more than double the battery capacity), meaning that the "300 mile" BEV pickup model is modeled as having over 600 miles of range when not towing, a result which artificially inflates BEV costs and places them much higher than other powertrain options.

Finally, we agree with the decision to include a delete cost for mechanical all-wheel drive (AWD) systems when considering the cost of electric drive AWD system. However, UCS believes that the estimate of $500 is too low. Based on research commissioned by UCS and the Center for Applied Environmental Law and Policy (see attached report), we believe that mechanical AWD systems have a cost of $1,409, based on the same Manufacturers' Suggested Retail Price (MSRP) and Retail Price Equivalent (RPE) approach used by ARB. Using ARB staff's estimate of $325 for shared AWD and electric drive AWD components, the delete cost for mechanical AWD should be increased to $1,084.

Conclusion

UCS thanks the board and ARB staff for their work to protect the health and wellbeing of Californians.

We urge the board to adopt the ACCII regulations with stronger ZEV sales standards and measures to increase certainty that environmental justice provisions will be used. Timely adoption of ACCII is critical to avoid the worst impacts of climate change and ensure cleaner air for all in the state.

Sincerely,

David Reichmuth, Ph.D.
Senior Engineer
Clean Transportation Program
Union of Concerned Scientists

Appendix A: Report on estimated mechanical all-wheel drive costs

ZEV AWD Costs Analysis Report

Date:	5/20/2022	Roush Project:	128762	Report Revision:	1.0
Authors (Roush):		Sawyer Stone (Development Engineer—Roush)			
Program Manager:	Sajit Pillai	Advanced Engineering V.P.:	Matt Van Benschoten		
Program Sponsors:		Union of Concerned Scientists (UCS) Center for Applied Environmental Law and Policy (CAELP)			

Abstract

California Air Resources Board has published delete costs associated with powertrain components when replacing an internal combustion engine (ICE) vehicle with a battery electric vehicle (BEV). Using publicly available sources, Roush attempts to construct the costs of the deleted powertrain components for a 2026 vehicle. The selection is based on a market sample of currently available vehicles and their powertrains. A representative powertrain for the car segment and the light truck/SUV segment was chosen. To accurately reflect the expected development of technology in engines and powertrains to meet 2026 standards, costs for hybridization, engine development, and AWD are included as a fleet-weighted additional cost in the values. The results show differences in the delete cost which are documented in this report.

Revision Summary

Date	Revision Number	Change Description
5/20/2022	1.0	Initial AWD Report based on ZEV Memo

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1.0 Introduction

The objective of this study is to assess the delete costs of the AWD portion of an ICE powertrain presented by CARB in their 2021 ZEV workbook by using alternate available cost data for expected AWD technology penetration in the 2026 timeframe. Sources examined include the EPA Final Rule Making runs of the NHTSA CAFE model, EPA Regulatory Impact Analyses, ICCT, and vehicle manufacturer information [1] [2] [3]. From these sources, costs and technology penetration rates were used to calculate an alternative ICE AWD delete cost for a 2026 vehicle that would meet the 2026 GHG standards.

2.0 Costs Buildup

To create a baseline assessment of the vehicles and associated powertrain technologies in each class, a representative sample of multiple vehicles from a wide range of manufacturers was taken and categorized based on class, engine, transmission, and driveline (Section 3.1). Where possible, vehicles with the option of 2WD or AWD with no other option differences were selected to ascertain a direct MSRP difference for AWD. Values sourced from the NHTSA models and vehicle MSRP data were converted to costs via a retail price equivalent (RPE) of 1.5.

In addition to the electrification costs necessary to comply with 2026 standards, the other significant powertrain cost presented by the ARB in the ZEV workbook is AWD. Since AWD is not a technology that the NHTSA model used, secondary axle disconnect (or SAX) is used as a proxy, as gaining fuel efficiency in AWD vehicles moving forward may likely include disconnecting one of the drive axles when not needed. SAX cost was taken from the NHTSA model, while AWD was costed based on the MSRP difference between vehicles with the option to add AWD without any other option changes, which results in an additional cost of $1,409. This cost was also market weighted based on the penetration rates shown in Figure 1.

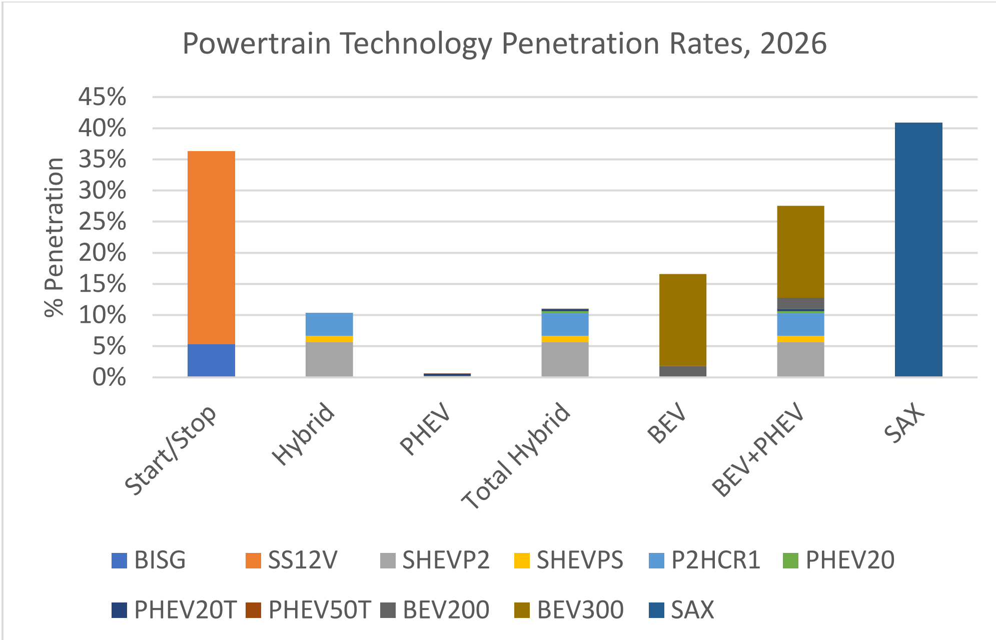

Figure 1: Powertrain technology penetration rates in 2026.

The resulting fleet weighted tech costs are shown in Table 1.

Table 1: Fleet-weighted technology costs.

Start/Stop	$133.14
P2 Hybrid	$434.64
AWD	$694.77
Total	$1,262.55

3.0 Background Data

3.1 Market Sample

MY	Brand	Make	Trim	Class	Disp	Cyl.	MSRP	Trans	Drive	Engine Code	Engine Class		Turbo	Other Tech	Cams
2022	Chevy	Equinox	LS	SUV	1.5	4	$26,995	6sp	fwd	111511	4C1B	TURBO1	Yes	DI, VVT	DOHC
2022	Chevy	Equinox	LS	SUV	1.5	4	$28,595	6sp	awd	111511	4c1b	TURBO1	Yes	DI, VVT	DOHC
2021	Chevy	Malibu	L	Sedan	1.5	4	$23,265	CVT	fwd	111511	4c1b	TURBO1	Yes	DI, VVT	DOHC
2022	Honda	Civic	EX	Compact	1.5	4	$25,350	CVT	fwd	211512	4c1b	TURBO1	VGT	VVT, DI, PI	DOHC
2022	Honda	Civic	Touring	Compact	1.5	4	$28,950	CVT	fwd	211512	4c1b	TURBO1	VGT	VVT, DI, PI	DOHC
2022	Acura	ILX	Base	Sedan	2.4	4	$27,300	8sp DCT	fwd	212401	4C1B	DOHC; VVT; VVL; SGDI	No	DI, VVT	DOHC
2022	Toyota	RAV4	LE	SUV	2.5	4	$26,525	8sp	fwd	232501	4c1b	DOHC; VVT; SGDI	No	DI, VVT, HCR, PI	DOHC
2022	Toyota	RAV4	LE AWD	SUV	2.5	4	$27,925	8sp	AWD	232501	4c1b	DOHC; VVT; SGDI	NO	DI, VVT, HCR, PI	DOHC
2021	Ford	Escape	S	SUV	1.5	3	$25,555	8sp	fwd	131511	4c1b_L	TURBOD	Yes	VVT, DI	DOHC
2021	Ford	Escape	SE	SUV	1.5	3	$27,035	8sp	fwd	131511	4c1b_L	TURBOD	Yes	VVT, DI	DOHC
2021	Ford	Escape	SEL	SUV	1.5	3	$29,505	8sp	fwd	131511	4c1b_l	TURBOD	Yes	VVT, DI	DOHC
2021	Ford	Escape	SEL	SUV	2	4	$32,050	8sp	awd	131511	4c1b_l	TURBOD	Twin Scroll	VVT, DI	DOHC
2021	Ford	Escape	SE Hybrid	SUV	2.5	4	$28,030	eCVT	fwd	132502	4c1b_L	HCR0	no	DI, VVT	DOHC
2022	Honda	Civic	LX	Compact	2	4	$22,350	CVT	fwd	212001	4c1b_L	DOHC; VVT; VVL	No	VVT, VVL, DI	DOHC
2022	Honda	Civic	Sport	Compact	2	4	$23,750	CVT	fwd	212001	4c1b_L	DOHC; VVT; VVL	No	VVT, VVL, DI	DOHC
2022	Toyota	Corolla	L	Compact	1.8	4	$20,075	Cvt	fwd	231802	4c1b_L	DOHC; VVT; SGDI	No	VVT, VVL	DOHC
2022	Toyota	Corolla	XLE	Compact	1.8	4	$24,475	Cvt	fwd	231802	4c1b_L	DOHC; VVT; SGDI	No	VVT, VVL	DOHC
2022	Toyota	Corolla	SE	Compact	2	4	$22,525	Cvt	fwd	232001	4c1b_L	DOHC; HCR1	No	VVT, DI, PI	DOHC
2022	Toyota	Corolla	XSE	Compact	2	4	$25,975	CVT	fwd	232001	4c1b_L	DOHC; HCR1	No	VVT, DI, PI	DOHC
2022	Toyota	RAV4	Hybrid LE	SUV	2.5	4	$29,075	eCVT	AWD	232502	4c1b_l	DOHC; HCR0	No	DI, VVT, HCR, PI	DOHC
2022	Cadillac	XT4	Luxury	SUV	2	4	$36,990	9sp	fwd	112011	6c2b	TURBOD	Yes	VVT, VVL, DI	DOHC
2022	Cadillac	XT4	Luxury AWD	SUV	2	4	$39,490	9sp	awd	112011	6c2b	TURBOD	Yes	VVT, VVL, DI	DOHC
2022	Cadillac	XT5	Luxury	SUV	2	4	$45,190	9sp	fwd	112011	6c2b	TURBOD	Yes	VVT, VVL, DI	DOHC
2022	Cadillac	XT5	Luxury	SUV	2	4	$47,190	9sp	awd	112011	6c2b	TURBOD	Yes	VVT, VVL, DI	DOHC
2021	Chevy	Malibu	Premier	Sedan	2	4	$34,495	9 sp	fwd	112012	6c2b	TURBO1	Yes	DI, VVT	DOHC

2022	Cadillac	XT5	Sport	SUV	3.6	6	$57,090	9sp	awd	113601	6c2b	DOHC; VVT; SGDI; DEAC	No	VVT, DI, DEAC	DOHC
2021	Dodge	Charger	SXT	Sedan	3.6	6	$31,125	8 sp	rwd	123601	6c2b	DOHC; VVT	No	VVT	DOHC
2021	Dodge	Charger	GT Fastback	Sedan	3.6	6	$33,125	8sp	rwd	123601	6c2b	DOHC; VVT	No	VVT	DOHC
2021	Ford	Escape	Titanium	SUV	2	4	$36,055	8sp	fwd	132011	6c2b	TURBO1	Twin Scroll	VVT, DI	DOHC
2022	Lincoln	Corsair	Standard	SUV	2	4	$36,105	8sp	fwd	132012	6c2b	TURBO1	Twin Scroll	VVT, DI	DOHC
2022	Lincoln	Corsair	Reserve	SUV	2	4	$40,825	8sp	fwd	132012	6c2b	TURBO1	Twin Scroll	VVT, DI	DOHC
2021	Lincoln	Navigator	Standard	SUV	3.5	6	$78,705	10sp	rwd	132013	6c2b	TURBO1	Yes	DI, VVT	DOHC
2022	Lincoln	Corsair	Standard	SUV	2.3	4	$42,955	8sp	awd	132311	6c2b	TURBO1	Twin Scroll	VVT, DI	DOHC
2022	Lincoln	Corsair	Reserve	SUV	2.3	4	$45,125	8sp	awd	132311	6c2b	TURBO1	Twin Scroll	VVT, DI	DOHC
2022	Ford	Explorer	Base	SUV	2.3	4	$33,245	10sp	rwd	132313	6c2b	TURBO1	Yes	DI, VVT	DOHC
2022	Ford	Explorer	Limited	SUV	2.3	4	$45,495	10sp	rwd	132313	6c2b	TURBO1	Yes	Di, VVT	DOHC
2022	Lexus	IS	300 Base	Compact	2	4	$39,850	8sp	rwd	232011	6c2b	TURBO1	Twin Scroll	VVT, DI, PI	DOHC
2022	Lexus	IS	300 AWD	Compact	3.5	6	$41,850	6sp	awd	233501	6c2b	DOHC; VVT; SGDI	No	VVT, DI, PI	DOHC
2022	BMW	230i	Coupe	Compact	2	4	$36,350	8sp	rwd	412011	6C2B	TURBO1	Twin Scroll	DI, VVL, VVT	DOHC
2022	BMW	330i	Sedan	Sedan	2	4	$41,450	8sp	rwd	412011	6c2b	TURBO1	Twin Scroll	DI, VVL, VVT	DOHC
2022	BMW	330i Xdrive	Sedan	Sedan	2	4	$43,450	8sp	awd	412011	6c2b	TURBO1	Twin Scroll	DI, VVL, VVT	DOHC
2022	BMW	430i	Coupe	Sedan	2	4	$45,800	8sp	rwd	412011	6c2b	TURBO1	Twin Scroll	VVT, VVL, DI	DOHC
2022	BMW	430i Xdrive	Coupe	Sedan	2	4	$47,800	8sp	awd	412011	6c2b	TURBO1	Twin Scroll	VVT, VVL, DI	DOHC
2022	Honda	Pilot	Sport	SUV	3.5	6	$37,580	9sp	fwd	213501	6c2b_sohc	SOHC; VVT; VVL; SGDI; DEAC	No	VVT, VVL, DI, DEAC	SOHC
2022	Honda	Pilot	Sport	SUV	3.5	6	$39,580	9sp	awd	213501	6c2b_sohc	SOHC; VVT; VVL; SGDI; DEAC	no	VVT, VVL, DI, DEAC	SOHC
2022	Acura	MDX	Base	SUV	3.5	6	$48,000	10 sp	fwd	213501	6C2BSOHC	SOHC; VVT; VVL; SGDI; DEAC	No	VVT, VVL, DI, DEAC	SOHC
2022	Acura	MDX	Base	SUV	3.5	6	$50,200	10 sp	awd	213501	6C2BSOHC	SOHC; VVT; VVL; SGDI; DEAC	no	VVT, VVL, DI, DEAC	SOHC
2022	Lincoln	Aviator	Standard	SUV	3	6	$51,465	10sp	rwd	133011	8c2b	TURBO1	Yes	DI, VVT	DOHC
2022	Lincoln	Aviator	Reserve	SUV	3	6	$57,355	10sp	rwd	133011	8c2b	TURBO1	YEs	DI, VVT	DOHC
2022	Ford	Explorer	Platinum	SUV	3	6	$52,115	10sp	rwd	133011	8c2b	TURBO1	Yes	DI, VVT	DOHC

2021	Ford	Expedition	XL STX	SUV	3.5	6	$50,595	10 sp	rwd	133513	8c2b	TURBO1	Yes	DI, VVT	DOHC
2021	Ford	Expedition	XLT	SUV	3.5	6	$53,410	10 sp	rwd	133513	8c2b	TURBO1	Yes	DI, VVT	DOHC
2021	Ford	Expedition	Limited	SUV	3.5	6	$62,175	10 sp	rwd	133513	8c2b	TURBO1	Yes	DI, VVT	DOHC
2021	Ford	Expedition	Platinum	SUV	3.5	6	$74,150	10 sp	rwd	133513	8c2b	TURBO1	Yes	DI, VVT	DOHC
2022	Chevrolet	Tahoe	LS	SUV	5.3	8	$51,895	10sp	rwd	115301	8c2b_ohv	DOHC; VVT; SGDI; DEAC	No	DI, VVT, DEAC	OHV
2022	Cadillac	Escalade	Luxury	SUV	6.2	8	$77,990	10sp	rwd	116202	8c2b_ohv	SOHC; VVT; SGDI; DEAC	No	DI, VVT, DEAC	OHV
2022	Cadillac	Escalade	Luxury	SUV	6.2	8	$80,990	10sp	awd	116202	8c2b_ohv	SOHC; VVT; SGDI; DEAC	No	DI, VVT, DEAC	OHV
2022	Cadillac	Escalade	Sport Platinum	SUV	6.2	8	$103,290	10sp	rwd	116202	8c2b_ohv	SOHC; VVT; SGDI; DEAC	No	DI, VVT, DEAC	OHV
2022	Chevrolet	Tahoe	High Country	SUV	6.2	8	$72,195	10sp	rwd	116202	8c2b_ohv	SOHC; VVT; SGDI; DEAC	No	DI, VVT, DEAC	OHV
2021	Dodge	Charger	R/T	Sedan	5.7	8	$38,125	8sp	rwd	125701	8c2b_ohv	SOHC; VVT; DEAC	No	VVT	OHV
2021	Dodge	Charger	Scat Pack	Sedan	6.4	8	$42,800	8sp	rwd	126402	8c2b_ohv	SOHC; VVT; DEAC	No	DEAC, VVT	OHV
2022	Chevy	Trailblazer	LS	SUV	1.2	3	$22,795	cvt	fwd				Yes	DI, VVT	DOHC
2022	Chevy	Trailblazer	LT	SUV	1.2	3	$24,995	cvt	fwd				Yes	DI, VVT	DOHC
2022	Chevy	Trailblazer	LT	SUV	1.3	3	$26,945	9sp	awd				Yes	DI, VVT	DOHC
2022	Chevy	Trailblazer	LT	SUV	1.3	3	$25,340	cvt	fwd				Yes	DI, VVT	DOHC

4.0 Bibliography

[1] Environmental Protection Agency, "Revised 2023 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions Standards," 2021.

[2] Environmental Protection Agency, "Control of Air Pollution from Motor Vehicles: Tier 3 Motor Vehicle emission and Fuel Standards Final Rule: Regulatory Impact Analysis," 2014.

[3] National Highway Traffic Safety Administration, "CAFE Compliance and Effects Modeling System: The Volpe Model," 2022. [Online]. Available: https://www.govinfo.gov/content/pkg/FR-2021-12-30/pdf/2021-27854.pdf.