Clean Cars Nevada

An Analysis of Its Feasibility and Impact on Consumers and the Environment

Prepared by
Shulock Consulting

With modeling
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About Shulock Consulting

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About Meszler Engineering Services

Dan Meszler, the sole proprietor of Meszler Engineering Services, is an independent contractor with more than 38 years of experience and expertise in a wide range of energy and air quality issues, with an emphasis on transportation sources. Before starting Meszler Engineering Services, he worked for Energy and Environmental Analysis (since acquired by ICF International) and the Maryland Department of the Environment.

The conclusions and opinions expressed in this report are those of the author, Charles Shulock, and do not necessarily represent the views or positions of Dan Meszler or the Natural Resources Defense Council. Any and all errors are the responsibility of the author alone.

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Executive Summary

Nevada has established ambitious goals to reduce greenhouse gas (GHG) emissions by 28 percent by 2025 (relative to the 2005 baseline) and 45 percent by 2030, and to achieve zero or near-zero emissions by 2050. To date the state is not on track to achieve these goals, and the task has been made even more difficult by the Trump administration's rollback of federal passenger vehicle GHG emission standards.

In November 2019 Governor Steve Sisolak issued Executive Order 2019-22, which directed his administration to identify and evaluate policies and regulatory strategies to achieve reductions in GHG emissions, and to develop a state climate strategy. One of the key measures identified in the Nevada Climate Strategy is Clean Cars Nevada, which will put in place low emission vehicle (LEV) tailpipe standards and zero emission vehicle (ZEV) sales targets. This report describes the impact of Clean Cars Nevada as compared with current law.

The LEV component of Clean Cars Nevada will restore, beginning in model year (MY) 2025, what had been the status quo prior to the federal rollback. It will result in automakers meeting state standards that are more stringent than the federal Safer Affordable Fuel Efficient (SAFE) vehicle standards adopted in March 2020 by the Trump administration. It will also establish a ZEV regulation that requires manufacturers to deliver for sale an increasing number of ZEVs in the state. It is important to note that these regulations are applied at the auto manufacturer level—independent auto dealerships have no regulatory obligation, and individual consumers remain free to choose the vehicle that best meets their needs.

The results presented here demonstrate that both the LEV and ZEV components of Clean Cars Nevada will provide significant benefits to the state. This report evaluates three scenarios, which differ in how manufacturers respond to the ZEV requirement and how strongly state policy supports ZEV adoption. The first is based on manufacturers producing only the minimum required number of ZEVs, which we calculate to be about 8 percent in 2025 with slight growth in subsequent years. The second and third scenarios examine the potential benefits if ZEV sales exceed the 2025 regulatory requirement. The "ZEV Goals" scenario reaches about 21 percent annual ZEV sales in 2035, and the "Meets Climate Goals" scenario reaches about 90 percent ZEV sales in that year. We review the number of ZEVs that will be sold under each scenario and the resulting benefits, and we note the need to carefully consider how providing manufacturers with an initial ZEV credit balance affects the number of vehicles needed to comply.

Clean Cars Nevada Reduces Pollution

We project significant reductions in GHG emissions under all scenarios, driven primarily by the LEV component of the rule. We find even greater reductions if ZEV sales increase beyond the minimum required level. For GHGs, under "exact ZEV compliance" (Scenario 1), the estimated reductions are approximately 0.6 million metric tons (MMT) per year in 2030, 1.3 MMT per year in 2040, and 1.6 MMT per year in 2050.* Scenario 2 achieves similar reductions because it allows manufacturers to continue to "average" internal combustion engine and ZEV GHG emissions across the fleet. Scenario 3, with greatly increased ZEV sales and the elimination of averaging, results in much larger reductions of 1.7 MMT in 2030, 7.8 MMT in 2040, and 10.8 MMT in 2050.

There are also significant reductions in other regulated emissions, including ozone-forming pollutants (nitrogen oxides and volatile organic compounds), fine particulate matter, sulfur oxides, and toxic air contaminants including benzene and formaldehyde. Collectively these pollutants are linked to many adverse health effects, including decreases in lung function, inflammation of airways, aggravated asthma, increased risk of cancer, and damage to the immune system, as well as neurological, reproductive, developmental, and other health problems.

Clean Cars Nevada Saves Consumers Money

Purchasers of new passenger cars and trucks will save money because lower expenditures on fuel will greatly outweigh the incrementally higher up-front cost of a vehicle. We estimate that given exact ZEV compliance, cash purchasers on average will save about $1,200 over the life of a MY 2025 vehicle, and almost $1,300 for a MY 2030 vehicle. Note that those are fleetwide averages—truck purchasers will save more because their fuel savings are greater. For those who finance their vehicles, we estimate that with a typical six-year loan the monthly out-of-pocket expenditure (car loan payment plus cost of fuel) for a compliant car will be immediately reduced.

The fuel cost savings will be particularly helpful for low-income purchasers, because fuel costs typically make up a larger proportion of their income. Moreover, low-income purchasers often buy used vehicles, for which much of the up-front cost for improved technology is absorbed by the first owner but the fuel savings persist for the life of the vehicle.

*Scenario 1 GHG reduction totals for all years have been revised to correct an error in the original version of this report.

These individual savings, multiplied by the more than 150,000 passenger vehicles sold in Nevada each year, will result in statewide savings of about $30 million annually by calendar year 2030 and $124 million annually by 2040, given exact compliance. Under the "Meets Climate Goals" aggressive ZEV adoption scenario, savings could reach $800 million per year by 2040.

Additional Benefits

Consumer choice will be expanded as auto manufacturers make available in Nevada the full range of electric vehicles available in other ZEV states. The regulation will not degrade driver safety. With managed charging of ZEVs, electric utility companies can increase electricity sales without increasing fixed costs. This allows utilities to spread their fixed costs across a larger base, which in turn reduces the cost per kilowatt hour for their ratepayers.

Automobile Dealer and State Agency Implementation

Automobile dealers in other states have argued that the Clean Cars regulations will limit their ability to trade cars between states or buy vehicles out of state. However, there has been no evidence of any systemic problems associated with LEV or ZEV adoption in other states, and a thorough investigation during the Colorado LEV rulemaking concluded that any purported problems relating to these issues are not supported by data. To date, 14 states have implemented one or both of the LEV and ZEV regulations with minimal impact on state agency staff and resource needs.

Feasibility for Auto Manufacturers

For internal combustion vehicles, Clean Cars Nevada will restore the federal rules as adopted in 2012, which were approved following an extremely thorough cost and feasibility analysis. For ZEVs, there are a number of factors that together suggest that manufacturers will be able to meet the ZEV requirement. First of all, as required under federal law, if Clean Cars Nevada is adopted in 2021 it will not take effect until 2024, when MY 2025 vehicles are released. Once the regulation is adopted, a marketplace will be established in which manufacturers may buy, sell, and trade "ZEV credits" among themselves to flexibly meet their compliance obligation. ZEVs are in the process of becoming mainstream as costs decline and performance increases. As manufacturers continue to invest in future electrification, propelled by growing consumer demand and policies such as Clean Cars Nevada, there will be an ever-increasing number of ZEVs on the market, including pickups, sport utility vehicles, and crossovers favored by some drivers in Nevada.

Last, stakeholder discussions are getting underway in California to define the next phase of Advanced Clean Car standards beyond MY 2025. However, as any new standards adopted by California would be considered a new set of rules, they would be subject to affirmative action by the Nevada Division of Environmental Protection beyond what is proposed in the Clean Cars Nevada rulemaking. Therefore those discussions have no bearing on the decision facing Nevada in this rulemaking.

I. Introduction

This report presents the likely impacts resulting from the adoption of Clean Cars Nevada. It describes the regulatory requirements and their projected effect on the internal combustion engine vehicle fleet and sales of zero emission vehicles. It then outlines the expected reductions in greenhouse gas (GHG), criteria pollutant, and toxic air contaminant emissions and the net savings and other benefits to Nevada consumers who purchase or finance new passenger vehicles. It addresses the impact of the program on automobile dealers, utility companies, and the Nevada Division of Environmental Protection (NDEP) and the ability of auto manufacturers to meet the requirements. It concludes by discussing California's consideration of new regulatory requirements.

II. Current Situation

A. State Goals

First, however, we examine how Clean Cars Nevada fits into the broader context of Nevada's climate and energy goals. An early assessment of the implications of climate change for Nevada was provided in a 2008 report by the Nevada Climate Change Advisory Committee.[1] The report concluded that anticipated climate change would have an undesirable impact on public health in the Silver State and developed a series of recommendations.

In March 2019, Governor Steve Sisolak announced that Nevada would join the United States Climate Alliance, a coalition of states committed to reaching the goals of the Paris Agreement.[2] Later in 2019, SB 254 set aggressive economy-wide GHG emission reduction targets, calling for a 28 percent reduction by 2025 (relative to the 2005 baseline), a 45 percent reduction by 2030, and zero or near-zero emissions by 2050.[3] SB 254 also stated legislative intent that Nevada greenhouse gas emissions decrease on a trajectory consistent with the Paris Agreement. Finally, SB 254 directed the Nevada Department of Conservation and Natural Resources to issue annual reports that provide an inventory of greenhouse gas emissions and a statement of policies to achieve the necessary reductions.

B. Progress Toward Goals

Nevada is currently not on track to meet it climate goals. The 2020 *Nevada Statewide Greenhouse Gas Emissions Inventory* found that under current policies Nevada is on track to reduce economy-wide GHG emissions by 24 percent below 2005 levels in 2025 (4 percentage points short of the SB 254 goal) and 27 percent below 2005 levels in 2030 (18 percentage points short of the SB 254 goal).[4] The expected statewide reduction would have been even smaller without significant progress in the electricity sector, which is projected to reduce its share of statewide GHG emissions from 47 percent in 2005 to 25 percent in 2030.[5] The transportation sector's share in 2030, in contrast, is projected to be 36 percent (up from 30 percent in 2005); indeed, since 2015 transportation has been the largest source of GHG emissions in Nevada.[6] Importantly, these inventory projections do not include the impact of the Trump administration's rollback of passenger vehicle GHG standards, so under current law the shortfalls will be even greater than noted above.[7]

C. Recent Commitments

In November 2019 Governor Sisolak issued Executive Order 2019-22, which directed his administration to identify and evaluate policies and regulatory strategies to achieve reductions in GHG emissions, and to develop a state climate strategy with specific policy and budget recommendations.[8] This was followed by the launch of the State of Nevada Climate Initiative in the summer of 2020 and the release of the Nevada Climate Strategy on December 1, 2020. The Nevada Climate Strategy "builds a foundation for future climate action . . . and serves as a roadmap for policymakers at all levels of government in Nevada for achieving the state's collective climate goals."[9]

One of the key measures identified in the Nevada Climate Strategy is Clean Cars Nevada, which Governor Sisolak announced in June 2020.[10] Clean Cars Nevada will put in place low emission vehicle (LEV) tailpipe standards and zero emission vehicle (ZEV) sales targets. The remainder of this report describes how the rules will work and their projected impacts on Nevadans.

Executive Order 13990 issued by President Biden directs the administration to review the recently rolled back federal GHG standards, and during the campaign candidate Biden indicated his intent to "move quickly to reestablish strong standards for clean cars and trucks and the charging infrastructure needed to fuel them."[11] The details of any such proposal are unknown at this time, however, and it is premature to attempt to quantify its impact. Nor does this report address litigation issues related to federal actions; rather it describes the impact of Clean Cars Nevada as compared with current law.

III. Clean Cars Nevada

Section 177 of the federal Clean Air Act authorizes states to adopt stricter-than-federal emission standards for passenger vehicles, so long as they are identical to those of California and do not result in a "third vehicle" (a vehicle that must meet standards that differ from both the federal and the California requirements).

In 2012 the California Air Resources Board (CARB) updated its regulations to control emissions from passenger vehicles, with the revised regulations collectively referred to as Advanced Clean Cars.[12] The goal of these regulations is to guide the development of environmentally advanced cars that continue to deliver the performance, utility, and safety that car owners have come to expect.

The regulations combine the control of GHG emissions and the control of criteria pollutants (those contributing to the formation of smog and particulate matter [PM]) into a single, coordinated package of regulations: the Low-Emission Vehicle (LEV III) tailpipe standards for criteria pollutants, LEV III tailpipe standards for GHG emissions, and a ZEV requirement.[13] The suite of regulations is designed to work as an integrated whole, with the LEV III tailpipe standards providing significant near-term emission reductions and the ZEV requirement enabling a longer-term transition to electric drive—and even larger emission reductions in the future. These elements are described in more detail in the Appendix to this report.

To date 11 states have adopted these stricter-than-federal regulations in their entirety (LEV III GHG and criteria pollutant, and ZEV), and an additional 3 states and the District of Columbia have adopted the LEV III GHG and criteria pollutant portions. Minnesota has undertaken a Clean Cars rulemaking which includes both LEV and ZEV, and Washington State is currently considering adopting the program in its entirety. Clean Cars Nevada will likewise adopt all components, keeping the comprehensive regulatory structure intact and maximizing benefits to the state.

The results presented here are based on a comparison of Clean Cars Nevada versus the final Safer Affordable Fuel-Efficient (SAFE) vehicles rule. The SAFE rule, adopted in March 2020, rolled back the stringency of the 2012 Unified National Program, which harmonized tailpipe emission standards adopted by the California Air Resources Board and by the U.S Environmental Protection Agency with fuel economy standards adopted by the National Highway Traffic Safety Administration (NHTSA). The Unified National Program increased the stringency of the standards by about 5 percent per year through model year 2025; the SAFE rule instead requires a 1.5 percent improvement each year for model years 2021 through 2026.

A. What Clean Cars Nevada Requires, and What It Doesn't

The LEV III criteria pollutant and GHG standards require auto manufacturers to meet annually decreasing "fleet average" levels of emissions for their passenger vehicles, while the ZEV rule requires auto manufacturers to deliver a specified number of "ZEV credits" each year.

The GHG standards are performance-based rather than prescriptive—manufacturers can use any desired mix of technologies, applied as they wish across their various models, so long as the average emissions from all vehicles sold in a given model year achieve the standard. The GHG standards account for the size ("footprint") of the vehicle, so that a manufacturer selling mostly light-duty trucks will have a different, less stringent fleet average standard than one selling mainly passenger cars.

The criteria pollutant standards, aside from PM, define a set of pollution “bins” to which vehicles can certify, with the fleet as a whole required to meet the fleet average. For example, to be certified as meeting “Bin 30,” a vehicle can emit no more than 30 micrograms per mile of non-methane organic gases plus nitrogen oxides and must also meet specified limits for carbon monoxide and other pollutants. For PM, whose impact is felt immediately in the vicinity of the tailpipe, there are specific per-vehicle emission standards.[14]

The ZEV regulation seeks to expand the availability of electric-drive vehicles and begin the transformation of the light-duty vehicle fleet to zero emissions. The regulation, first adopted in 1990, has been a catalyst for manufacturer investment and innovation. It has worked as intended, with multiple manufacturers bringing new ZEV models to the market, new entrants competing for market share, continual improvements in electric vehicle performance, and significant cost reductions.

The ZEV regulation does not require manufacturers to reach specific sales levels, but rather requires that they annually deliver a specified number of ZEV credits. The credit obligation is calculated as a percentage of the average annual passenger vehicle sales by an automaker over a defined three-year period.[15] ZEV credits are earned by automakers delivering battery electric vehicles (BEVs), fuel cell vehicles (FCEVs), or plug-in hybrid electric vehicles (PHEVs) for sale. The number of ZEV credits earned is based primarily on the all-electric range of the vehicle sold.[16] Because ZEVs typically earn more than one credit each, the nominal credit requirement is higher than the resulting percentage of ZEV sales needed to comply. For Nevada, we estimate that the ZEV credit requirement of 22 percent in MY 2025 will require about 8 percent of total passenger vehicle sales to be ZEVs.

As is the case with the LEV regulation, manufacturers have flexibility to determine how to configure their fleet to earn the required number of ZEV credits. Auto manufacturers can also purchase credits from and sell credits to other manufacturers, such that an automaker delivering more ZEVs than needed (e.g., Nissan) can sell credits to those with a slower rate of product introduction.

It is critical to understand that Clean Cars Nevada will impose requirements only on auto manufacturers, not on auto dealers or vehicle purchasers. The regulation does not require individual dealers to meet any specific sales goals for particular vehicle types. Rather, it is the manufacturer that will determine the product offerings among its affiliated dealerships, such that on a statewide basis the requirements are met. Similarly, the regulation does not require consumers to purchase any particular type of vehicle. Drivers are free to buy whatever vehicle type and powertrain best meet their needs.

Clean Cars Nevada only regulates passenger vehicles, such as cars, crossover vehicles, sport utility vehicles, and pickup trucks. It will not apply to other types of vehicles such as larger trucks or farming equipment.

B. Anticipated Changes to the Vehicle Fleet

To allow manufacturers ample time to plan, under federal law the earliest the Clean Cars Nevada standards can apply to passenger vehicles will be MY 2025. For conventional, internal combustion engine (ICE) vehicles, Clean Cars Nevada will restore, as of MY 2025, the harmonized federal standards that had been governing the passenger vehicle fleet prior to the federal rollback. The improved technology employed will mean that vehicles meeting the Clean Cars Nevada standards will be cleaner, more efficient, and less costly to consumers over the life of the vehicle.

A variety of cost-effective approaches are available to meet the original MY 2025 standards. In 2017 the International Council on Clean Transportation (ICCT) published a detailed assessment of efficiency technology available for U.S. 2025 to 2030 light-duty vehicles.[17] That report provided "cost progressions" that ranked technologies in order of their cost effectiveness for representative passenger cars and light-duty trucks. The modeled technologies are well proven, already in use today on some cars, and readily available to be applied across the vehicle fleet. Examples include dual cam phasing, mass reduction, improved aerodynamics, further reductions in engine friction and tire rolling resistance, cylinder deactivation, and gasoline direct injection. Vehicles meeting the standards will be cheaper to operate, but from the driver's standpoint their other attributes, such as safety and performance, will be the same.

In addition to restoring the standards that were operative for internal combustion vehicles prior to the federal rollback, Clean Cars Nevada will put in place a ZEV regulation that requires manufacturers to deliver for sale an increasing number of such vehicles in the state.[18] Electric vehicle adoption has been steadily increasing in Nevada, but the ZEV requirement will have an important incremental effect. Auto manufacturers may bring in models currently available in other ZEV states but not in Nevada, increase consumer advertising and dealership incentives, provide additional dealership education and outreach, and in general do what is needed to move ZEVs into the mainstream.

Depending on the types of vehicles that manufacturers choose to produce, there can be a wide variation in the number of vehicles they must deliver in order to meet their credit requirements. The precise mix of vehicle technologies employed—e.g., BEVs and PHEVs—is therefore uncertain, as is the exact impact of Clean Cars Nevada on ZEV sales. As shown below, however, the impact can be estimated using reasonable assumptions.

IV. Analysis of Emission, Cost, and Other Impacts

Clean Cars Nevada will provide many benefits to Nevada drivers and to the public at large. Numerous recent studies have demonstrated that the 2012 national program is cost effective and enhances driver safety.[19] Recent work evaluating Clean Cars adoption in Minnesota has shown that both the LEV and ZEV components will provide significant benefits to the state.[20] Adoption of the Clean Cars program in Colorado, including the ZEV component, was found to "have a broad range of substantial benefits for Coloradans, reducing harmful air pollution and saving consumers money."[21]

While the above is noted for context, this report does not attempt to add to the broader discussion of the merits of the original harmonized national program as opposed to the Trump administration rollback. Nor does it elaborate on the need for Nevada to take aggressive action to reduce transportation emissions. Those issues are thoroughly analyzed elsewhere. Instead, this report focuses on assessing the impacts of Clean Cars Nevada adoption.

The quantitative results presented in this analysis are derived from two spreadsheet tools developed for the Natural Resources Defense Council. Details on these tools are provided in the Appendix. The projected number of ZEVs is calculated using a spreadsheet developed by Shulock Consulting, building on the 2017 California ZEV Regulatory Calculator released by CARB.[22] The modified spreadsheet used here is applicable to other states, allows additional flexibility in the scenarios considered, and provides a wider range of outputs. The spreadsheet has been used to assess the impacts of Clean Cars adoption for regulatory proceedings in Colorado and Minnesota and has been verified to replicate the results of the CARB calculator when using identical assumptions.

The cost and emissions impact components of this analysis employ a new spreadsheet tool developed for the Natural Resources Defense Council by Meszler Engineering Services. This tool allows the user to scale the results of a comprehensive national model developed by the U.S. Environmental Protection Agency (EPA) in a simplified fashion to apply to state-level rule adoption. This capability has previously not been available for use at the state level. It is first being employed in the Minnesota rulemaking and greatly enhances our ability to quantify the impacts of changes to the standards.

A. Scenarios

The Meszler Engineering spreadsheet tool projects cost and emission impacts for the new car fleet as a whole—the ICE component and the ZEV component—taking into account how these two constituents of the fleet interact. The underlying engineering-based cost and emission calculations for each vehicle type are the same in all cases. What vary are the assumptions made about other factors, including:

- ZEV sales, range, and cost
- The price of gasoline and electricity
- The grid mix (percentage contributions of the sources of electricity used to charge ZEVs)
- How ZEV reductions are factored into the fleetwide average for LEV compliance

A set of assumptions defines a scenario. We examine three scenarios, which differ in how manufacturers respond to the ZEV requirement and how strongly state policy supports ZEV adoption. The first is based on exact ZEV regulatory compliance. The second and third assume greater ZEV penetration, modeled after the “ZEV Goals” and “Meets Climate Goals” scenarios developed by Nevada advocates. They examine the potential benefits if ZEV sales in 2026 and beyond exceed the 2025 regulatory requirement, through either self-sustaining growth in ZEV penetration or a future strengthening of the regulation. Details are provided in the Appendix. The scenarios are:

Scenario 1: Exact Regulatory Compliance, Shulock Consulting Assumptions. This scenario is premised on manufacturers producing no more than the minimum number of ZEVs needed to comply. Under this scenario, ZEV sales are about 8 percent of total sales in 2025, stay at that level through 2029, and then increase slightly each year through 2035 because beginning in 2030, assumed “business as usual” sales exceed the regulatory requirement. (The LEV/ZEV Tool allows variation in ZEV sales only through 2035, so the 2035 ZEV sales percentage is applied to subsequent model years through 2050).

Scenario 1 provides our most direct analysis of the forthcoming NDEP proposal, given our current understanding of the details and excluding the impact of proposals to grant manufacturers an initial bank of credits to ease early compliance.

Scenario 2: Greater ZEV Deployment—ZEV Goals Case. This scenario illustrates the emission reductions possible with increased sales of ZEVs. The ZEV Goals case is premised on ZEVs accounting for about 20 percent of the vehicle fleet by 2045. This translates to annual ZEV sales increasing on a trajectory to reach 21 percent by 2035, then remaining constant at that level through 2050.

Scenario 3: Greater ZEV Deployment—Meets Climate Goals Case. This scenario illustrates the emission reductions possible with greatly increased ZEV sales and decarbonization of the grid. The Meets Climate Goals case results in annual ZEV sales of about 90 percent in 2035. As used elsewhere, the Meets Climate Goals case goes on to achieve 100 percent ZEV sales by 2045. As modeled here, however, due to the structure of the LEV/ZEV Tool the 90 percent sales fraction for 2035 is carried forward through 2050. Thus this projection somewhat underestimates the full impact of the case.

Also, in Scenario 3 manufacturers are constrained from using ZEV GHG reductions to offset the need for GHG reductions from ICEs. (The LEV III regulation allows tailpipe emissions to be averaged across the entire fleet. Our modeling assumes for all scenarios that manufacturers do not use averaging for criteria pollutants, but Scenarios 1 and 2 employ averaging for GHGs.[23] The impact of emission averaging is discussed in more detail in the Appendix.)

B. ZEV Sales

The first step in projecting the impact of Clean Cars Nevada is to define the overall makeup of the fleet, including the number of ZEVs to be sold. The number of ZEV sales is then used as an input to the cost and emission impact calculations for the entire fleet. The estimates provided here do not include any provision for an initial credit bank. The impact of initial credit bank alternatives is detailed in subsection E.6, below.

Figure 1 shows for each of the three scenarios the projected percentage of total sales that will be ZEVs, and Figure 2 shows the projected annual number of ZEVs sold. Details of the calculations and the assumed level of business-as-usual ZEV sales are provided in the Appendix. All emission and cost results reported below are based on the impact of incremental ZEV sales above business-as-usual levels.

Figure 1: ZEV Annual Sales, Percentage of Total Sales

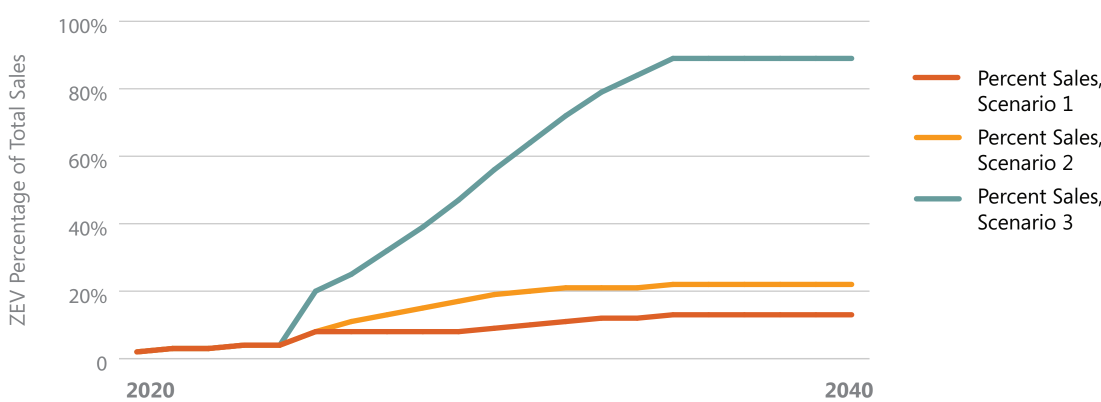
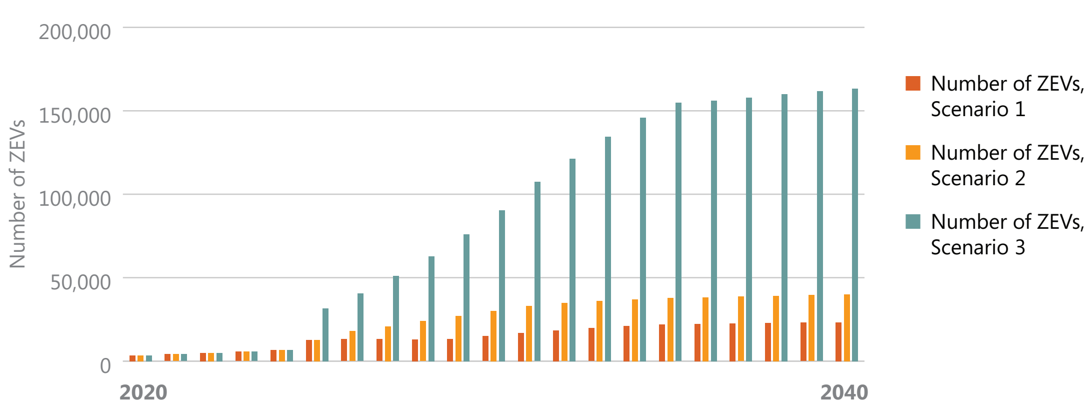


Figure 2: ZEV Annual Sales, Number of Vehicles



C. Emission Benefits

Clean Cars Nevada will provide significant reductions in GHG and health-threatening pollutant emissions. Air pollution has been demonstrated to result in a variety of adverse health outcomes. The National Institute of Environmental Health Sciences identifies respiratory diseases (including asthma and changes in lung function), cardiovascular diseases, adverse pregnancy outcomes (such as preterm birth), and even death as believed to be associated with air pollution exposure.[24]

There are three components to the emission impact of the program, which taken together result in a net decrease. They are:

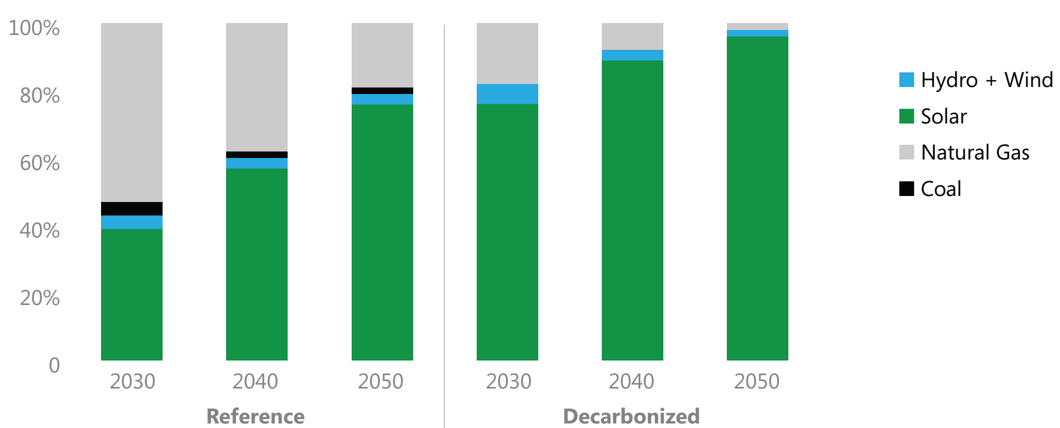
- Reduced tailpipe emissions from internal combustion vehicles, due to the more stringent standards and the replacement of internal combustion vehicles by ZEVs.
- Reduced upstream (fuel production and distribution) emissions from internal combustion vehicles, due to reduced demand for fuel.
- Increased upstream emissions from power generation, due to additional electricity generation to power ZEVs.

The level of ZEV-related upstream emissions will vary depending on the resources used to generate the needed electricity. Unlike internal combustion vehicles, whose emission controls deteriorate over time, ZEVs sold today will produce lower levels of emissions in the future as the grid becomes cleaner. Ultimately, a 100 percent renewable grid would result in zero upstream emissions. The prospect of emissions being reduced to zero over time is a central justification for policies that encourage ZEV adoption.

Figure 3 shows the composition of the grid mix for our three scenarios, using inputs provided by M. J. Bradley & Associates (MJB&A). Scenario 1 uses the Reference grid mix, and Scenarios 2 and 3 use the Meets Climate Goals mix.

The Reference mix (Scenario 1) relies heavily on natural gas in the initial years, with some coal. The Meets Carbon Goals mix (Scenarios 2 and 3) eliminates coal and relies primarily on solar generation. The specific generation source fractions are shown in the Appendix.

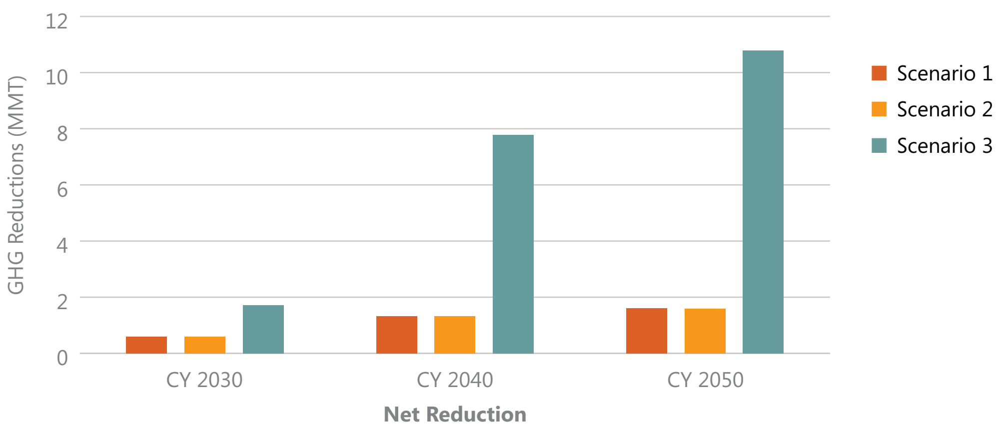
Figure 3: Assumed Grid Mix



1. Greenhouse Gas Emissions

Figure 4 shows projected net fleetwide GHG emission reductions from Clean Cars Nevada for our three scenarios for calendar years 2030, 2040, and 2050. The GHG reductions are the sum of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) reductions, weighted by their global warming potential.[25] Details for each component of the net impact are provided in the Appendix.

Figure 4: Annual Projected Greenhouse Gas Reductions, Million Metric Tons

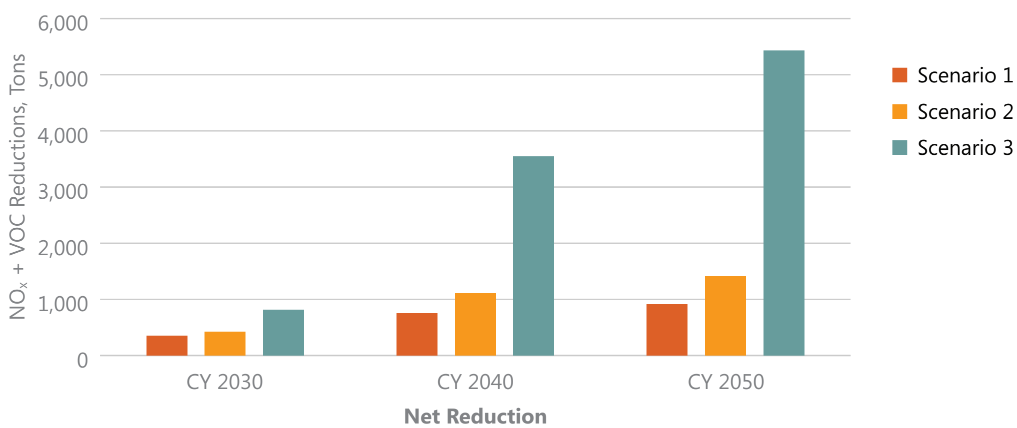


The reductions shown above for Scenarios 1 and 2 accurately reflect the fleetwide GHG reductions achieved under the current regulatory structure. But because GHG averaging is employed, there are "hidden" ZEV GHG reductions in those scenarios that are not apparent because they are offset by ICE GHG increases, largely masking the impact of the additional ZEVs. The impact of averaging is discussed in more detail in the Appendix.

2. Ozone-Forming Pollutants

Clean Cars Nevada likewise results in significant reductions in ozone-forming pollutants. The EPA has concluded that "breathing ground-level ozone can result in a number of health effects that are observed in broad segments of the population," including respiratory symptoms, decreases in lung function, and inflammation of airways.[26] Figure 5 shows the combined emission reductions of the two most significant ozone-forming pollutants, nitrogen oxides (NO_x) and volatile organic compounds (VOCs). As noted above, emission averaging is not employed in our modeling for criteria pollutants. All ZEV-based reductions are fully incorporated in the fleetwide totals, and the impact of the additional ZEVs in Scenarios 2 and 3 is readily seen.

Figure 5: NO_x plus VOC Reductions, Tons



3. Other Pollutants

Clean Cars Nevada will also provide reductions in other criteria pollutant emissions and in emissions of toxic air pollutants. Table 1 shows the net statewide reductions for calendar years 2030, 2040, and 2050 for the criteria pollutants carbon monoxide (CO), sulfur oxides (SOx), and fine particulate matter ($PM_{2.5}$), and for the toxic air pollutants benzene and formaldehyde. Scientific studies have linked particle pollution exposure to a variety of health effects, including premature death in people with heart or lung disease, nonfatal heart attacks, irregular heartbeat, aggravated asthma, decreased lung function, and increased respiratory symptoms.[27] People exposed to toxic air pollutants may have an increased risk of cancer or other serious health effects, including damage to the immune system as well as neurological, reproductive, developmental, respiratory, and other health problems.[28]

Table 1: Other Pollutant Reductions, Tons

		CY 2030	CY 2040	CY 2050
Scenario 1	CO	-2	404	682
	SO_X	-43	-103	-128
	$PM_{2.5}$	-26	-89	-124
	Benzene	-2	-3	-4
	Formaldehyde	0	-1	-1
Scenario 2	CO	-561	-2,634	-3,751
	SO_X	-49	-116	-144
	$PM_{2.5}$	-27	-89	-123
	Benzene	-3	-9	-12
	Formaldehyde	-1	-2	-3
Scenario 3	CO	-3,835	-25,627	-42,606
	SO_X	-60	-187	-247
	$PM_{2.5}$	-20	-74	-106
	Benzene	-9	-49	-79
	Formaldehyde	-3	-14	-23

While upstream emissions from electricity generation typically occur in more remote areas, the tailpipe criteria pollutant emissions from internal combustion vehicles are concentrated in urban areas and near highways, which can often pass through low-income communities. Thus, in addition to achieving statewide reductions, the program will reduce criteria pollutant health impacts in localized urban areas.

D. Cost Savings

Clean Cars Nevada will not only result in emission reductions but also lead to cost savings for individual vehicle purchasers and for the state as a whole. This has been previously demonstrated for the 2012 national rule as well as for Colorado and Minnesota; here we provide a Nevada-specific cost projection.[29] The assumed energy prices for all scenarios are taken from Energy Information Agency Pacific region, scaled to Nevada, and are shown in Table 2. For ZEVs, we account only for the cost impact of incremental ZEVs above and beyond business-as-usual sales. The calculation methodology and additional assumptions are detailed in the Appendix.

Table 2: Assumed Gasoline and Electricity Prices

		Calendar Year					
		2025	**2030**	**2035**	**2040**	**2045**	**2050**
Price of Gasoline ($/gallon)	Retail	$3.00	$3.54	$3.72	$3.85	$4.00	$4.15
	Pretax	$2.48	$3.02	$3.20	$3.33	$3.47	$3.63
	Tax	$0.52	$0.52	$0.52	$0.52	$0.52	$0.52
Price of Elecctricity ($/kWh)	Regular	$0.11	$0.12	$0.13	$0.13	$0.13	$0.13

1. Individual Consumer Savings

Manufacturers will comply with the Clean Cars Nevada standards by selling more ZEVs and employing more-efficient powertrains in the gasoline-powered fleet. These changes affect three aspects of consumer cost, which together result in a net savings over the life of the vehicle:

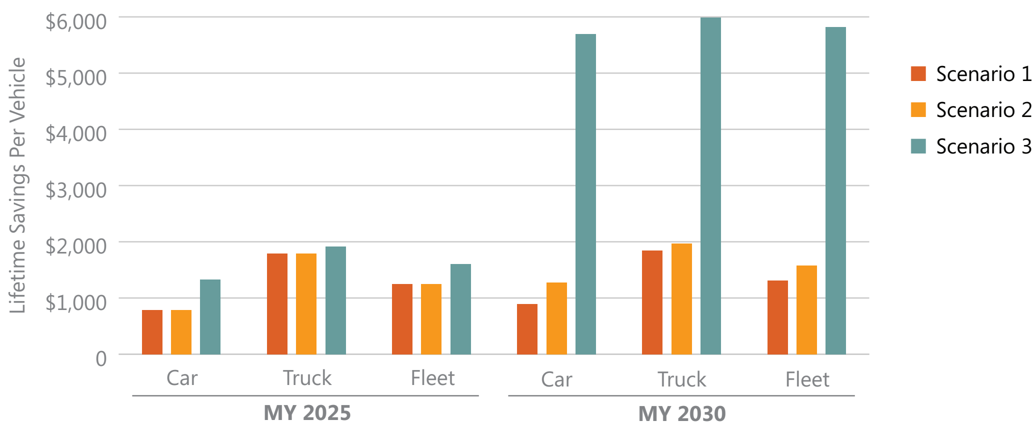
- Up-front cost of the vehicle, including tax.
- Lifetime insurance and maintenance cost.
- Lifetime fuel savings.

Not included in this cost analysis, but important to consider and note, are the anticipated reductions in health care costs from fewer hospital and clinic visits due to lower harmful emissions of particulate matter and other criteria pollutants under Clean Cars Nevada.

a. New Vehicle Cash Purchase

Figure 6 shows results for the most straightforward case: the cash purchase of a new "fleet average" passenger vehicle in model years 2025 and 2030. Lifetime maintenance, insurance, and fuel costs are discounted at 3 percent per year. The individual cost elements and the payback period for each vehicle type are detailed in the Appendix.

Figure 6: Net Lifetime Savings Per Vehicle—Cash Purchase

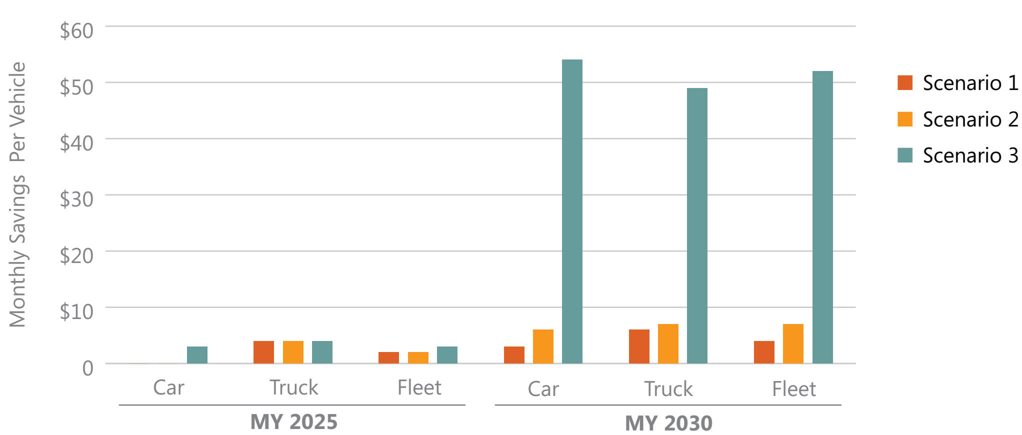


All vehicles show a lifetime net savings, with payback periods ranging from five to six years in 2025 and one to four years in 2030 as technology costs decrease. Trucks have much higher lifetime savings than cars. This occurs because a given percentage improvement in efficiency provides a greater fuel savings when applied to the larger fuel consumption of trucks. Rural purchasers, who tend to drive longer distances, will similarly receive a larger net benefit than urban buyers.

b. New Vehicle Financed Purchase

About 85 percent of new passenger vehicle purchases are financed (purchased using a loan).[30] Financing a vehicle that meets the Clean Cars Nevada standards results in savings from day one in nearly all cases, following the same pattern as a cash purchase—a minor increase in the monthly loan payment is more than offset by the reduction in monthly fuel expenditures. Figure 7 shows the average reduction in monthly out-of-pocket costs for a consumer financing a vehicle with a standard six-year auto loan, with all costs discounted at 3 percent per year. Other than the 2025 car (which shows a $0.43 monthly net increase), all vehicles are less expensive to the customer from the outset, increasingly so in future model years as technology costs decline. Again, truck owners receive a larger net benefit, as do rural residents who drive long distances.

Figure 7: Net Monthly Savings Per Vehicle—Financed



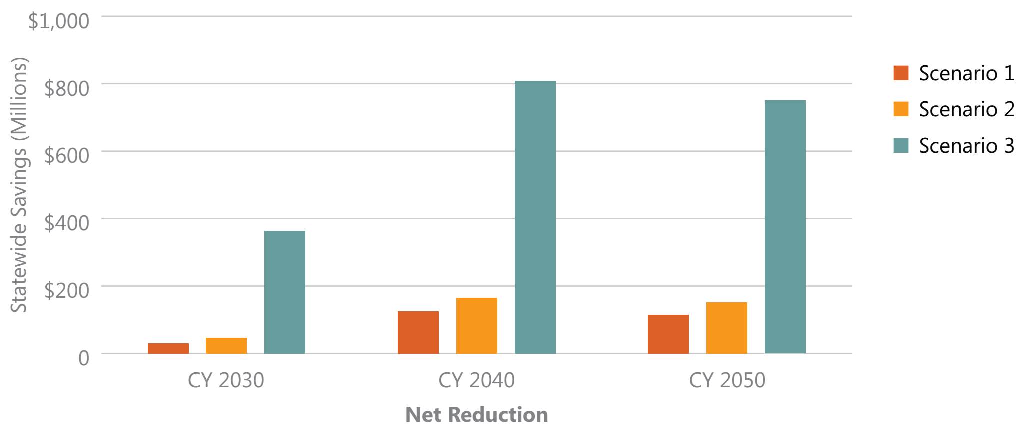
c. Impact on Low-Income Purchasers

Low-income purchasers will also benefit from cost savings under Clean Cars Nevada. Operating cost savings provide a greater benefit to low-income consumers because they tend to spend a larger proportion of their income on fuel than do higher-income consumers.[31] Moreover, lower-income consumers disproportionately buy used vehicles, for which most of the incremental costs for improved technology will have been absorbed by the first owners. But the fuel savings from that improved technology persist for the life of the vehicle. As new clean cars become used clean cars, those operational cost savings will be passed on to subsequent owners and continue to yield benefits to Nevadans.

2. Statewide Savings

The savings to purchasers of individual vehicles, when multiplied across the more than 150,000 vehicles sold in Nevada each year, result in significant statewide savings. The societal savings increase over time as larger numbers of the more efficient vehicles are added to the fleet. Figure 8 shows results for the on-road vehicle fleet in calendar years 2030, 2040, and 2050, again using a discount rate of 3 percent. In all cases the incremental cost of the vehicles sold is more than offset by the lifetime fuel savings, resulting in net societal savings for Nevada. In these scenarios savings range from roughly $125 million to almost $800 million annually in calendar year 2040. Savings in 2050 are lower in today's dollars due to discounting.

Figure 8: Statewide Savings by Calendar Year (Dollars, in Millions)



E. Other Issues

The adoption of Clean Cars Nevada will result in a number of other impacts, detailed below.

1. Consumer Choice

The regulation does not affect the availability of internal combustion engine vehicles. Consumers will remain free to purchase whatever vehicle meets their needs. For consumers interested in electric vehicles, however, implementation of a ZEV program will increase the number of models available.

ZEV model availability is limited in Nevada. A survey of dealership inventories in June 2019 showed that of the 43 plug-in electric vehicle model offerings on the market somewhere in the United States, consumers had access to only 15 (including 3 from Tesla) within a 25-mile radius of the Las Vegas metropolitan area. In the Reno metropolitan area, only 6 models were available (including 3 from Tesla).[32] Table 3 lists the models that were available and not available in the Las Vegas region, according to the 2019 survey.

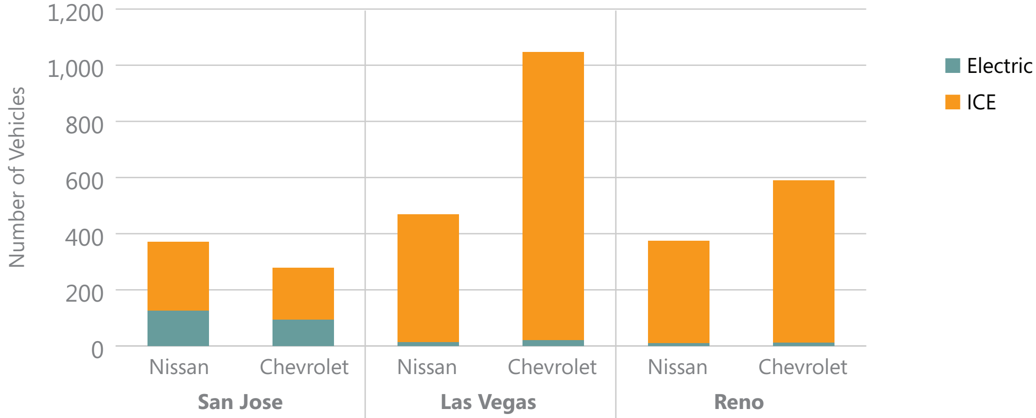
Table 3: EV Models in Dealership Inventories Within 25 Miles of Las Vegas

Vehicle	Available in Las Vegas?	
	Yes	No
Audi A3 e-tron		✓
BMW 330E		✓
BMW 530E		✓
BMW 740E		✓
BMW 745E		✓
BMW I3		✓
BMW I8		✓
BMW X5		✓
Cadillac CT6 Plugin		✓
Chevy Bolt EV	✓	
Chevy Volt	✓	
Chrysler Pacifica Hybrid	✓	
FIAT 500e		✓
Ford Focus Electric		✓
Ford Fusion Energi	✓	
Ford CMax Hybrid		✓
Honda Clarity PHEV		✓
Honda Clarity Electric		✓
Hyundai Ioniq EV		✓
Hyundai Ioniq PHEV		✓
Hyundai Sonata PHEV		✓
Hyundai Kona EV		✓

Vehicle	Available in Las Vegas?	
	Yes	No
Jaguar I-Pace	✓	
Karma Revero	✓	
KIA Nero PHEV	✓	
KIA Optima PHEV		✓
KIA Soul EV		✓
Mercedes-Benz GLC 350e PHEV	✓	
Mercedes-Benz GLE 550e PHEV		✓
Mini E Countryman		✓
Mitsubishi Outlander	✓	
Nissan Leaf	✓	
Smart ForTwo Electric		✓
Subaru Crosstrek Hybrid		✓
Tesla Model S	✓	
Tesla Model X	✓	
Tesla Model 3	✓	
Toyota Prius Prime	✓	
Volkswagen e-Golf		✓
Volvo S60 PHEV		✓
Volvo S90 PHEV		✓
Volvo XC60 PHEV	✓	
Volvo XC90 PHEV		✓

Dealership inventories for manufacturers other than Tesla also show that ZEVs make up only a small portion of stock on the lot, so that even for the few models of ZEVs that are available there is limited actual consumer access to models. We searched on the websites of two large Nissan and Chevrolet dealerships each in San Jose, Las Vegas and Reno/Carson City to determine how many LEAFs and Bolts were on the lots.[33] Not surprisingly, we found that the San Jose dealerships had a much higher number and percentage of electrified vehicles listed, as shown in Figure 9. In total, in San Jose about 34 percent of the vehicles on the surveyed lot were BEVs, while in both Las Vegas and Reno/Carson City the BEV share was just above 2 percent.

Figure 9: Number of BEVs vs. ICEs on Surveyed Dealer Lots—San Jose, Las Vegas, Reno



2. Safety

Supporters of the federal rollback have incorrectly claimed that the 2012 standards would reduce sales of new cars, and that therefore motorists would drive older, less safe vehicles. A thorough analysis of these issues was conducted by Consumer Reports and Synapse Energy Economics, which identified and corrected a number of errors in the SAFE rule's sales and safety impacts evaluation.[34] Their study found that the rollback of fuel economy standards would actually reduce rather than increase sales, such that "vehicle sales are projected to decline by an average of around 1 percent for MY 2026 to 2035, or more than 2 million vehicles." With regard to the overall impact of the rollback on safety, the study concluded:

> Lower auto sales [due to the fuel economy rollback] will reduce automakers' bottom lines, but they may also reduce highway safety because reductions in new vehicle sales slow the deployment of newer, safer vehicles into the fleet. [The analysis] shows that weakening fuel-economy standards does not improve highway safety and may in fact slightly diminish it. It should be noted, however, that the effects on safety from changes in fuel-economy standards are quite small and likely not statistically different from zero. When compared with the 37,133 motor-vehicle-related fatalities in 2017, the annual increase in fatalities is less than 0.1 percent in all years modeled. This effect is likely to be difficult to discern from other, more significant factors affecting highway safety, including the deployment across the fleet of advanced safety technologies, such as automatic emergency braking.

Clean Cars Nevada likewise will not have a negative impact on vehicle safety.

3. Utility Companies

Concerns are sometimes raised regarding a purported negative impact of vehicle electrification on electric utilities and their customers. Studies of the issue, however, have found that increased ZEV deployment can actually benefit all utility customers. EVs, when participating in managed charging programs, are generally charged during off-peak hours when there is spare capacity on the electric grid, which puts downward pressure on electricity rates to the benefit of all ratepayers. Although there has not yet been a Nevada-specific quantification, a 2018 study of Arizona completed by M.J. Bradley & Associates found that under a high ZEV adoption scenario, ratepayers will save an average of $180 annually by 2050.[35] A 2019 analysis of the benefits of electric vehicles in Nevada then found that "electricity customers in Nevada can expect similar long-term savings, regardless of whether they own an EV."[36]

A real-world benefit has been observed in utility service territories that already have hundreds of thousands of EV customers. A 2019 Synapse Energy Economics report analyzed the costs versus savings from 2012–2018 EV adoption for the two utilities with the highest deployment of EVs in the United States—Southern California Edison and Pacific Gas & Electric. The report concluded that during those six years, the revenue associated with sales of electricity for EV charging exceeded by more than $584 million the utilities' costs to support EV charging and deploy charging infrastructure.[37] In summary, increasing adoption of EVs reduces bills for all electric ratepayers by increasing the pool of net utility revenue available to pay down system costs.

4. Automobile Dealers

In the Advanced Clean Cars rulemaking in Colorado, automobile dealers argued that imposing stricter regulations would create hardships for dealers due to Colorado's shared borders with states that follow the federal requirements. The dealers raised concerns that the regulations would limit their ability to trade cars between states or buy cars out of state. Although dealers to date have not supplied any evidence of systemic problems associated with LEV or ZEV adoption in other states, a thorough investigation of such issues was provided in the Rebuttal Statement filed by the Environmental Coalition during the Colorado rulemaking.[38]

That review noted that cross-border trade and registration can still occur, as they do for other states that have adopted LEV III and/or ZEV, and that out-of-state leakage issues (residents purchasing vehicles from adjacent states) are overstated. It further noted that Colorado's adoption of GHG and criteria tailpipe emission standards will not restrict Coloradans from being able to purchase vehicles across state lines, nor will it prevent Colorado dealers from shipping vehicles to and from other states. The Coalition concluded overall that "any purported problems relating to these arguments are overstated and not supported."

Looking more broadly at potential impacts on dealership sales, a 2018 study conducted by Shulock Consulting compared revenue for dealers in ZEV states and non-ZEV states.[39] It found that:

- From 2012 through 2017, growth in the total dollar value of vehicle sales in ZEV states was more rapid than in non-ZEV states.
- ZEV states also had more rapid growth in personal income, but at a smaller rate than the rate of vehicle dollar sales growth. Thus, income growth alone does not explain the higher rate of dollar sales growth.
- If adoption of the ZEV program does have a negative impact on dealers, which was not observable in the 2018 study due to other factors that were not examined, any such impact must be small given that no negative impact was discernable in the data.
- Comparing ZEV states versus neighboring non-ZEV states, the growth in the dollar value of sales in Arizona and Nevada (non-ZEV) was slightly greater than in California (ZEV), while growth in New York (ZEV) was substantially greater than in Pennsylvania (non-ZEV). There was no consistent pattern across ZEV and non-ZEV states.

5. State Implementation

Clean Cars Nevada can be implemented without imposing an undue burden on state staff. Mechanisms for monitoring and reporting compliance are well defined in the 10 states that administer the LEV III and ZEV programs, and a spreadsheet tool is available for tracking auto manufacturer credit totals and ZEV compliance. These states have implemented the rules with limited staffing. Expertise on LEV III and ZEV adoption is provided to member states by the Northeast States for Coordinated Air Use Management (NESCAUM), a nonprofit association that provides scientific, technical, analytical, and policy support to the air quality programs of the eight Northeast states.[40] NESCAUM staff provided technical assistance for our analysis of ZEV availability and are a resource for state implementation.

6. Initial Credit Awards

NDEP is proposing to award an initial ZEV credit bank to ease manufacturers' transition into compliance. The rationale for such an approach, which has been adopted by some but not all states in the past, is that adopting the ZEV regulation "midstream" forces manufacturers to make unduly large year-over-year increases in ZEV sales to catch up to current requirements. As noted below, however, the required sales levels appear to be quite feasible given current circumstances and trends.

We have reviewed various methods to provide such an award that have been adopted or proposed in other states. Our assessment of the incentives that they offer to manufacturers indicates, in brief, that:

- Proportional credits (credits awarded based on manufacturers' ZEV credit balances in California, prorated according to Nevada sales) incentivize additional sales in California.
- Early credits (credits granted for ZEVs sold before the effective date of the regulation) incentivize additional ZEV sales in Nevada.
- A one-time award (equal to each manufacturer's credit requirement for the year when the regulation takes effect) provides no incentive for increased ZEV sales.

The January 5 Working Draft regulatory language proposed by NDEP provides unrestricted proportional credits based on the 2024 California credit bank, and also allows manufacturers to earn early credits for placements in MY 2023 and 2024. We have reviewed the potential impact of that proposal, using two different estimates of proportional credits—one based on the existing 2019 California bank and one that assumes that the current growth rate in the California bank continues through 2024.

We have also evaluated, for comparison purposes:

- Two years' early credit alone, without proportional credits.
- Proportional credits alone, without early credits.
- A one-time award equal to the MY 2025 obligation (as is being considered in Minnesota).

The impact of initial credit awards on the number of ZEVs sold in a given year cannot be projected with certainty because much depends on the types of vehicles sold and when manufacturers use the additional credits. But it is instructive to compare the size of the 2025 initial credit award with the number of credits needed for compliance each year, and the resulting change in when additional ZEV sales would first be needed. Figure 10 shows when additional placements would first occur under each option, assuming that manufacturers maximized the use of credits.[41]

Figure 10: Potential Impact of Initial Credit Award Options on Start Year

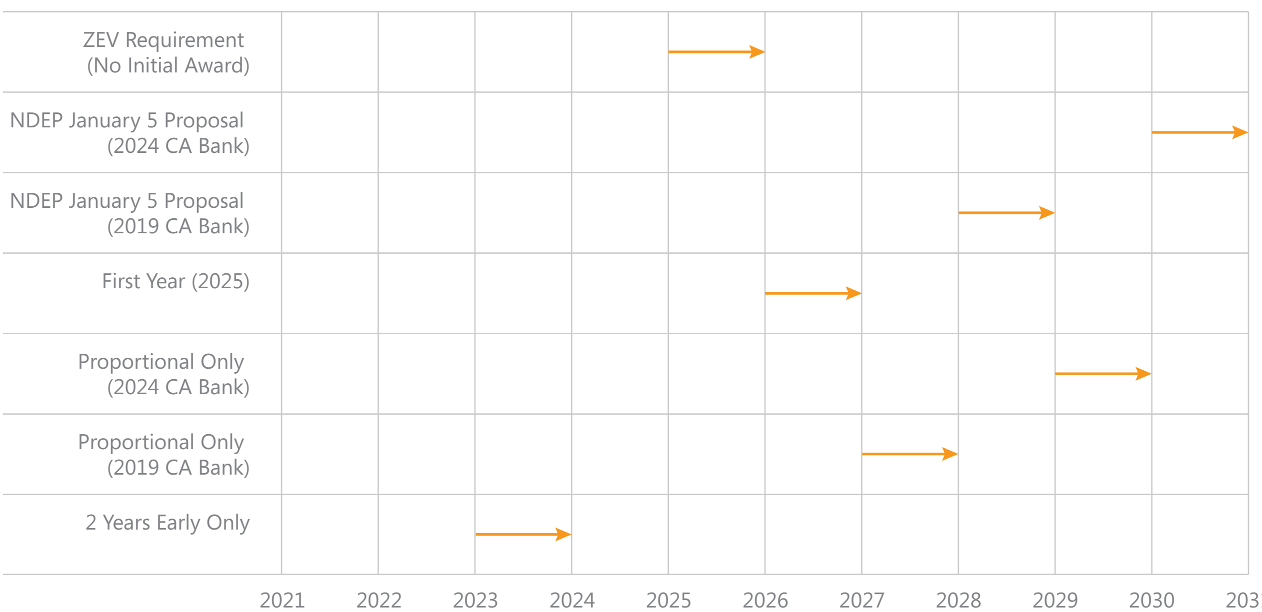


Table 4 shows the projected number of credits awarded under the various initial credit options, and their impact on the number of credits needed from new ZEV sales. Years in which no new sales would be needed are highlighted in grey; years with a remaining credit obligation are highlighted in orange.

Table 4: Potential Impact of Initial Credit Awards on Credits Needed for Compliance

		2023	2024	2025	2026	2027	2028	2029	2030
	ZEV Requirement			33,697	34,032	34,543	34,953	35,213	35,375
NDEP Proposal, 2024 CA Bank	Credits Awarded	12,629	15,650	168,527					
	Credits Needed from New Sales			0	0	0	0	0	12,686
NDEP Proposal, 2019 CA Bank	Credits Awarded	12,629	15,650	101,740					
	Credits Needed from New Sales			0	0	0	8,462	35,213	35,375
First Year Requirement	Credits Awarded			33,697					
	Credits Needed from New Sales			0	34,032	34,543	34,953	35,213	35,375
Proportional, 2024 CA Bank	Credits Awarded			168,527					
	Credits Needed from New Sales			0	0	0	0	5,427	35,375
Proportional, 2019 CA Bank	Credits Awarded			101,740					
	Credits Needed from New Sales			0	0	1,378	34,953	35,213	35,375
2 Years Early	Credits Awarded	12,629	15,650						
	Credits Needed from New Sales			5,419	34,032	34,543	34,953	35,213	35,375

As Table 4 shows, the different options vary greatly in their projected impact. Two years of early credit, taken alone, reduces the number of additional credits needed in 2025 but has no impact thereafter. At the other extreme, if the California bank continues to grow through 2024 at its current rate the NDEP proposal would provide initial credits sufficient to entirely satisfy the ZEV obligation through 2029.

There are many ways to provide an initial credit bank, but strong restrictions are needed to limit its potential impact on sales in the early years.

V. Feasibility

For internal combustion vehicles, Clean Cars Nevada will restore the federal rules that had been in place prior to the federal rollback, which were approved in 2012 following an extremely thorough cost and feasibility analysis. A detailed discussion of internal combustion vehicle technical feasibility and cost effectiveness is provided in the Environmental Coalition Prehearing Statement for the Colorado LEV rulemaking.[42] For zero emission vehicles, many factors suggest that manufacturers will be able to meet the ZEV requirement in Nevada, with increasing ease as technology improves.

A. Manufacturer Lead Time

Section 177 of the Clean Air Act gives states the option to adopt emission standards that are equivalent to the standards adopted in California. The Clean Air Act requires that state standards be adopted at least two years before commencement of the applicable model year. [43] A "model year" begins on January 2 of the previous calendar year. So, for example, the 2020 model year began on January 2, 2019. Therefore, if Nevada adopts the Clean Cars standards before January 2, 2022 (that is, before the start of the 2023 model year), the standards will first apply to model year 2025 vehicles. Manufacturers can use that time to adjust their product and sales planning and take other necessary steps to meet the requirements.

B. Credit Banking and Trading

Manufacturers can bank credits that are earned but not needed to comply in a particular model year. This can help smooth out the credit requirement as manufacturers retire and introduce models. Credits can also be purchased, sold, and traded across manufacturers. In California, for example, during the 2016 through 2019 model years, Tesla, General Motors, Fiat Chrysler, Honda, Toyota, Mazda and Subaru all engaged in credit transfers.[44] This gives manufacturers facing a credit deficit an opportunity to comply without upsetting their product strategy, and it financially rewards manufacturers that are market leaders.

C. ZEVs Becoming Mainstream

The ongoing trend toward electrification is being driven by major forces operating at a global level. Regulations in China and the European Union, along with carmakers' need to keep pace with their competitors, are driving substantial manufacturer investment. This in turn brings about cost reduction, technology improvement, and increased model availability. Given these developments, ZEV sales are increasing. The International Energy Agency reports that sales of electric cars topped 2.1 million globally in 2019, surpassing 2018—already a record year—and registered a 40 percent year over year increase.[45] Through September 2020, ZEVs accounted for 7.9 percent of total sales in California, more than the 7.6 percent ZEV sales (not accounting for initial credits) projected to be needed in Nevada in 2025.[46]

Although the COVID-19 outbreak is having an adverse impact on global auto manufacturing, the long-term commitment to electrification remains firm. Most notably, in January 2021 General Motors broke new ground by announcing that it aspires to eliminate tailpipe emissions from its new light-duty vehicles by 2035. The Environmental Defense Fund, which collaborated with General Motors on this strategy, stated "GM is making it crystal clear that taking action to eliminate pollution from all new light-duty vehicles by 2035 is an essential element of any automaker's business plan".[47]

A July 2020 article in the *Wall Street Journal* reviewed the current status of manufacturer investment.[48] Among its findings:

- Pressure is building on General Motors, Volkswagen, and other major automakers to deliver on their electric vehicle plans, as investor enthusiasm for the technology has grown in recent months.
- Despite some coronavirus-related setbacks, car companies in the coming months are expected to unleash a wave of new plug-in models in an effort to catch up with Tesla and meet governments' tightening restrictions on how much vehicles can pollute.
- While there have been some delays and cancellations tied to the health crisis, executives say that longer-term trends make continued investment in this technology a necessity and that the influx will help reduce their more than century-long reliance on selling gasoline-powered vehicles.

1. Decreasing Cost

Battery cost is the primary driver of the incremental cost of electric vehicles. The rest of an electric vehicle drivetrain is simpler than that of an ICE vehicle (no engine or transmission, for example). Therefore, the ongoing reductions in battery cost, which outpace past projections, have a significant effect on electric vehicles' cost-competitiveness versus an ICE vehicle. The ICCT reviewed a number of recent studies and from that work derived an estimate that battery pack cost will decline from $176 per kWh today to $104 per kWh in 2025 and $72 per kWh in 2030.[49] These cost reductions, along with other technology improvements, led ICCT to conclude that initial cost parity for electric vehicles versus ICE vehicles will arrive within 5 to 10 years, depending on the vehicle segment, and that cost-competitiveness for consumers on a total cost of ownership basis (including operating cost savings) will occur even sooner.

2. Increasing Performance

The dramatic declines in battery cost and ongoing improvements in electric drive efficiency will allow manufacturers to offer increased range. A recent compilation by *Motor Trend* magazine identified six model year 2020 cars with real-world range greater than 300 miles, six more that exceed 225 miles, and an additional seven with a range greater than 200 miles.[50] This will encourage more consumers to consider and purchase electric drive vehicles.

3. Greater Number of Models

Manufacturers continue to announce new ZEV models that will soon be introduced. A tally of ZEVs expected to be launched to market indicates that by 2023 there will be more than 100 EVs in the U.S. market, of which more than 60 will be crossover vehicles, SUVs, and pickup trucks.[51] A complete list is provided in the Appendix.

Manufacturers have announced investments and product plans that will result in a proliferation of new models by the time Clean Cars Nevada takes effect in the 2025 model year. The *Wall Street Journal* article noted above, and a similar outlook published by the Atlantic Council's *EnergySource*, highlighted specific plans for several manufacturers:[52]

- GM is developing 20 new electric models by 2023 as part of a $20 billion investment in electric and autonomous technologies. That includes reviving Hummer as an all-electric SUV in early 2022 and building a $2.3 billion battery plant with South Korea's LG Chem in northeast Ohio.
- Ford plans to sell a Mustang-inspired, all-electric SUV, and Jeep will offer a plug-in hybrid version of its top-selling Wrangler. Both models are due out [in 2021].

- Nissan, which is slashing $2.8 billion in costs as part of a global restructuring, revealed a new electric SUV. The company's stock rose 7.2 percent following the news.
- Including hybrids, half of the roughly 350 new models expected to be brought to market in the next few years will be electrified in some way, says John Murphy, senior automotive analyst at the Bank of America.
- Last year Volvo committed to making every new vehicle model launched from 2019 onwards available with either a hybrid or full-electric powertrain. The Swedish automaker wants all-electric vehicles to make up 50 percent of its global sales by 2025.
- In late May, Volkswagen announced it will funnel $2.37 billion into joint ventures with Chinese EV manufacturers. In a separate development, VW and Ford announced an expansion of their strategic partnership to include work on a new electric mass-market passenger car in Europe.

4. Enhanced Charging Infrastructure

More than 80 percent of EV charging takes place at home because that is the most convenient and affordable way to power electric driving. To cover other charging needs, work is underway to expand Nevada's network of electric vehicle charging stations. Volkswagen Settlement funds are being earmarked to support the Nevada Electric Highway, and other plans call for placing charging stations every 50 miles along Interstate 15.[53,54]

5. ZEV-Focused Automakers

The ZEV regulation allows automakers to acquire ZEV credits from other automakers. Tesla is already generating a large number of credits from its sales, which will greatly increase as Model 3 and Model Y production ramps up. Rivian is reported to have a significant number of preorders for its R1T truck in Nevada and throughout the United States, with deliveries beginning in 2021. These credits will be available for sale to other manufacturers to cover any shortfall. Although future sales levels from such manufacturers are uncertain, these credits could dramatically affect how the ZEV regulation impacts other manufacturers. The availability of credits from ZEV-focused automakers will give traditional manufacturers the option to reduce the number of ZEVs they must deliver while still meeting the ZEV credit requirements.

D. Suitability for Nevada Conditions

Those unfamiliar with electric vehicle trends often raise concern that truck purchasers will not be able to buy trucks under Clean Cars Nevada. This is inaccurate. First, Clean Cars Nevada applies to manufacturers, not to consumers. Second, while the regulation results in improvements to internal combustion vehicles' fuel economy and increases the availability of electric vehicles, it does not require replacing an internal combustion vehicle with a ZEV. Just as trucks, crossovers, and SUVs were sold prior to the SAFE rule under the previous national tailpipe and GHG emissions standards, they will be sold under Clean Cars Nevada. Moreover, it should be remembered that only light-duty cars and trucks are governed by Clean Cars Nevada. Other vehicles such as tractors, construction equipment, and long-haul commercial and industrial vehicles are not regulated under this rule.

For those that do want an electric truck, they are on the way. Recent announcements foreshadow an influx of models that will be available well in advance of MY 2025, the first model year affected by Clean Cars Nevada. In addition to the widely publicized Tesla Cybertruck, pending EV models include the Ford F-150, GMC Hummer, Rivian R1T, Bollinger Motors B2, and Lordstown Motors Endurance.[55]

Finally, opponents of electrification argue that vehicle performance and utility suffer in cold weather. It is true that batteries are affected by temperature, and heating an electric vehicle requires additional energy. (Internal combustion engines produce waste heat that can be used to warm the vehicle's interior—part of the reason why they are inefficient.) But the impact of cold weather is mitigated by the increasingly large batteries now provided in long-range vehicles. Moreover, electric vehicles avoid many of the cold-weather challenges posed by internal combustion vehicles, such as drivers' outdoor exposure while fueling vehicles and wasted fuel and excess emissions from vehicles idling prior to use on cold mornings.

VI. Future Clean Cars Standards

The adoption of Clean Cars Nevada is not taking place in a vacuum. California regulators are starting to consider the next stage of regulatory development to govern model years 2026 and beyond. Opponents of Nevada adoption may argue that it is premature to consider implementing the current California regulation when it may be modified in the future. A related argument holds that the state must grant large numbers of ZEV credits now to provide a cushion for 2026, in the event that California increases the future stringency of the program. Both of these arguments are based on conjecture. Any issues related to modifications by California can be meaningfully addressed only after California has acted. Moreover, any future modifications to the California regulation will not automatically take effect in Nevada; rather, the state will have an opportunity to consider the modifications and adopt the course of action deemed appropriate at that time.

VII. Appendix

A. Elements of Clean Cars Nevada

Clean Cars Nevada comprises three interrelated components:

LEV III Criteria: Reducing Smog-Forming Pollution

Cars today are significantly cleaner than they were just a decade ago, but there are nearly two and one-half million vehicles on Nevada roads now, and that number will continue to increase. Drivers also cover more miles now than in previous years. In order to continue to improve air quality, the LEV III criteria pollutant standards reduce smog-forming emissions. In MY 2025, cars will emit 75 percent less of this pollution than the average car sold in MY 2012.

LEV III GHG: Reducing Greenhouse Gas Emissions

The GHG regulations are projected to reduce GHG emissions from new vehicles by approximately 40 percent in 2025 (relative to model year 2012 vehicles). Technologies to achieve the new standards include engine and emission control advancements, wider application of advanced hybrid technology, and greater use of stronger and lighter materials.

Zero Emission Vehicle Regulation: Promoting the Cleanest Cars

The ZEV regulation is designed to achieve long-term emission reduction goals by requiring auto manufacturers to deliver for sale specific numbers of the very cleanest cars available. These vehicle technologies include full battery-electric, hydrogen fuel cell, and plug-in hybrid-electric vehicles. The ZEV program at its inception employed a "technology forcing" approach to vehicle regulation. Throughout the history of the mobile source control program, regulators have imposed requirements that manufacturers initially viewed as infeasible but that spurred research and development and ultimately resulted in well-engineered, cost-effective advancements, from adoption of the catalytic converter to development of low-NO_x engine technologies. This phenomenon continues today, as illustrated by the rapid improvement in ZEV technology.

B. Assumptions

Total Sales

The projected emission reductions from Clean Cars Nevada are a direct function of the assumed trajectory of total vehicle sales. All vehicles sold are subject to the LEV III GHG and criteria pollutant standards, and the ZEV credit requirement for a manufacturer in a given model year is a percentage of that manufacturer's average total sales over a specified prior three-year period. Therefore, emission reductions and the required number of ZEVs each will increase or decrease in proportion to total sales.

Our sales data are taken from M.J. Bradley & Associates, as shown in Table 4.

Table 5: Assumed Nevada Total Vehicle Sales

	2020	2021	2022	2023	2024	2025	2026	2027
Car Sales	81,068	80,586	80,031	81,847	83,733	85,398	86,493	87,686
Truck Sales	71,718	72,134	71,909	73,004	73,550	73,512	73,941	73,147
Total Sales	152,786	152,719	151,941	154,850	157,283	158,910	160,434	160,832

	2028	2029	2030	2031	2032	2033	2034	2035
Car Sales	88,527	89,473	91,029	94,782	96,488	98,415	100,614	102,479
Truck Sales	72,599	71,635	71,497	72,938	72,513	72,667	72,682	72,248
Total Sales	161,126	161,107	162,526	167,720	169,001	171,082	173,296	174,727

Business-as-Usual ZEV Sales

Some ZEVs are being sold in Nevada today, and more will be sold even in the absence of a ZEV regulation. The projected number of such business-as-usual sales has an important impact on several aspects of ZEV compliance:

- The number of early credits earned for ZEV sales in 2023 and 2024.
- The baseline number of sales in model years 2025 and beyond, which determines the shortfall that must be met by additional vehicles.

Our estimate of business-as-usual sales also comes from M.J. Bradley & Associates, as shown in Table 6.

Table 6: Assumed Nevada Business-as-Usual ZEV Sales

	2020	2021	2022	2023	2024	2025	2026	2027
Total	3,323	4,137	4,882	5,628	6,631	7,809	8,984	10,351
Percent	2.2%	2.7%	3.2%	3.6%	4.2%	4.9%	5.6%	6.4%

	2028	2029	2030	2031	2032	2033	2034	2035
Total	11,755	13,364	14,975	16,896	18,350	19,735	21,017	22,070
Percent	7.3%	8.3%	9.2%	10.1%	10.9%	11.5%	12.1%	12.6%

ZEV Range

The ZEV cost information supplied by ICCT is presented for a discrete set of ZEV ranges: 150, 200, and 250 miles for BEVs and 40, 50, and 60 miles of all-electric range for PHEVs. To maintain internal consistency between our ZEV compliance and ZEV cost calculations, we assume vehicles with a constant range equal to one of the ICCT-defined examples. For BEVs we use 150- and 250-mile vehicles, with the share of 250-mile vehicles increasing over time. For PHEVs we use 50-mile vehicles.

Grid Mix for Electricity Used to Charge EVs

Table 7 shows the assumed Reference and Decarbonized grid mixes, based on estimates provided by NRDC. The Reference grid used for Scenario 1 assumes some continued reliance on coal and natural gas, transitioning to more reliance on solar. The Decarbonized grid used for Scenarios 2 and 3 relies in large part on solar and other renewables.

Table 7: Grid Mix

	Reference			Decarbonized		
	2030	2040	2050	2030	2040	2050
Coal	3.7%	2.4%	1.9%	0.0%	0.0%	0.0%
Natural Gas	53.4%	38.1%	19.3%	18.0%	7.9%	2.3%
Solar	38.9%	56.9%	76.1%	76.2%	89.0%	96.0%
Hydro + Wind	4.0%	2.6%	2.8%	5.9%	3.2%	1.8%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

C. Derivation of Projected ZEV Sales in Nevada

The ZEV regulation requires automakers to generate an increasing number of ZEV credits, calculated as a percentage of their total annual sales in the relevant state. The ZEV requirement in 2025 is 22 percent. Large-volume manufacturers (LVMs) must meet a specified fraction of the requirement with credits from ZEVs, while intermediate-volume manufacturers (IVMs) can meet their entire ZEV requirement with credits from PHEVs.[56]

Vehicles can earn between 0.7 and 4.0 credits each, depending on the characteristics of the vehicle (PHEV, BEV, or FCEV; all-electric range). To calculate the number of vehicles required, it therefore is necessary to project the characteristics of the future ZEV fleet.

This section of the Appendix provides an overview of the construction and operation of the ZEV compliance spreadsheet and the assumptions used. The spreadsheet is a modified version of the 2017 CARB ZEV Regulatory Calculator spreadsheet. The user must assign values to a number of variables. The spreadsheet then performs a series of calculations using those values to arrive at the expected number of ZEVs, by year, for 2018 through 2030. To provide inputs to the cost and emission calculations (performed by the Low Emission Vehicle/Zero Emission Vehicle Impact Tool described in the next section), the 2030 values are increased as needed through 2035, then continued at that level through 2050.

Variables

The primary variables employed are shown in Table 8. The spreadsheet includes other variables, not listed here, that control more detailed aspects of the calculation but are generally not modified from case to case.

Table 8: Variables to Be Specified to Calculate the ZEV Credit Requirement

Variable	Values	Comments
Percentage requirements	Per current regulation or specified by user	User can vary total requirement as well as individual components
BEV and PHEV business-as-usual sales	Zero or per user projection	User can specify any initial sales level and rate of increase
FCEV business-as-usual sales	Zero or derived from CARB fuel cell and infrastructure deployment report[57]	User can specify any fraction of the projection or can flatline sales at 2015 level
BEV range	Specified by user	Two BEV types can be defined. Range can stay constant or increase in any desired pattern
PHEV range	Specified by user	Two PHEV types can be defined. Range can stay constant or increase in any desired pattern
PHEV US06 capability	Yes or no	US06 capability means that the vehicle can meet the US06 test cycle, which includes higher acceleration and higher speeds
Early credits	Include or do not include	User can specify the number of years for which early credits can be earned
Proportional credits	Include or do not include	Proportional credits are calculated based on Nevada sales as a fraction of California sales. User can specify what fraction of the obligation can be met using proportional credits.
One-time award	Include or do not include	Set to equal first compliance obligation
LVM vehicle mix	Specified by user	User can specify LVM mix of vehicle types, by year
IVM vehicle mix	Specified by user	User can specify IVM mix of vehicle types, by year

Calculation Methodology

The starting point for the calculation is projected total manufacturer sales, separated into LVM and IVM. For purposes of these calculations, manufacturers are treated as a group rather than as individual entities, reflecting the fact that credits can be traded. For the next steps in the calculation, the spreadsheet does the following:

1. Derives annual sales for ZEV compliance purposes by applying the regulatory rules (e.g., average of specified prior years).

2. Multiplies annual sales for compliance purposes by the percentage requirements to determine the ZEV credit requirement, by year.

3. Determines the per-vehicle credit generated by each vehicle type based on the user-specified values for vehicle range.

4. Multiplies business-as-usual ZEV and PHEV sales (i.e., vehicles that manufacturers would produce regardless of their compliance requirement) by the credit earned per vehicle (step 3) to determine the number of credits generated.

5. Subtracts the credits earned via baseline sales (step 4) from the annual compliance requirement (step 2) to determine the interim remaining requirement.

6. If the case being run allows use of banked/proportional/one-time credits, determines if credits are available to fulfill the interim remaining requirement, then subtracts the banked credits used from the interim remaining requirement (step 5) to determine the final remaining requirement.

7. Using the assumed per-vehicle credit (step 3), determines the number of additional vehicles needed to satisfy the final remaining requirement (step 6).

8. Adds the number of baseline vehicles (step 4) and additional vehicles needed (step 7) to determine the total number of vehicles produced, by year.

The outputs of the model are reasonable scenarios but should not be viewed as firm predictions.

D. Design and Methodologies Employed in the LEV/ZEV Impact Tool

The Low Emission Vehicle/Zero Emission Vehicle Impact Tool (hereafter the LEV/ZEV Tool) is designed to help estimate the emission, fuel consumption, and economic impacts associated with the adoption of California LEV and ZEV program requirements, either in conjunction with or independent of the 2025 GHG standards adopted by the U.S. EPA and, in equivalent form, by CARB.[58] The EPA maintains a set of modeling tools, generally referred to as the OMEGA model, that allow the estimation of impacts from such programs.[59] The EPA tools actually consist of a series of "preprocessors" (spreadsheets, Python scripts, Matlab executables), the OMEGA model itself, and spreadsheet-based post-processors denoted as the Inventory, Cost and Benefits Tool (ICBT). Adapting these tools to accurately model the impacts of local (i.e., state-level rather than national-level) LEV and ZEV program implementation is generally resource intensive and quite complex. The LEV/ZEV Tool is designed to produce impact estimates consistent with those of the OMEGA process but with substantially fewer and less complex resource demands.

The LEV/ZEV Tool accomplishes this by using the outputs of the EPA modeling undertaken for the 2025 GHG standards as a benchmark database, from which the impacts associated with similar emissions-influencing programs can be derived. Detailed emission, fuel consumption, and economic estimates derived through the EPA modeling serve as standardized inputs to the LEV/ZEV Tool. Generally the LEV/ZEV Tool accomplishes such derivation by developing emission, fuel consumption, and economic scaling factors for various parameters of influence (e.g., vehicle sales populations, vehicle miles of travel, incremental vehicle prices, fuel prices) and applying these factors as appropriate to tailor impacts estimated through the EPA benchmark modeling to accurately reflect local conditions. This process mimics what the EPA model would estimate if it were run explicitly for the same set of local conditions. In effect, the model estimates emission, fuel consumption, and economic impacts from the top down (starting with impact estimates derived for a set of national inputs and adjusting them, as appropriate, to a local level) rather than from the bottom up (building emission, fuel consumption, and economic impacts from a first-principles analysis of local conditions, emission factors, and travel estimates). Implemented properly, the two approaches will yield equivalent results.

The LEV/ZEV Tool implements a detailed set of algorithms to produce five comprehensive estimates: (1) consumer cost impacts, (2) societal cost impacts, (3) vehicle tailpipe emission impacts, (4) upstream emission impacts for vehicles with internal combustion engines (ICEs), and (5) upstream emission impacts for ZEVs. These impacts are derived from the benchmark EPA modeling estimates that serve as standardized inputs to the LEV/ZEV Tool but fully reflect the impacts associated with a set of local modeling parameters as specified by the LEV/ZEV Tool user.

Local Input Parameters: To estimate localized LEV/ZEV program impacts, the LEV/ZEV Tool requires the following inputs to be defined:

- Annual national sales estimates for cars and light trucks (separately) from model year 2024 through model year 2050. Generally these data are set at the values utilized in the EPA benchmark modeling, but the LEV/ZEV Tool allows alteration if forecasts evolve or the user has another reason to do so.
- Annual local total sales estimates for cars and light trucks (separately) from model year 2024 through model year 2050. These data serve as the basis for developing vehicle population–based scalers.
- Annual local ZEV sales estimates for cars and light trucks (separately) from model year 2024 through model year 2035. These data serve as the basis for developing ZEV impact scalers. Inputs are allowed for five specific ZEV configurations: BEV150, BEV200, BEV250, PHEV20, and PHEV50.[60] ZEV sales shares in model years after 2035 are held constant at model year 2035 values.
- The per-vehicle incremental ZEV cost relative to a 2015 ICE vehicle. These costs are specified for model years 2024 through 2035 and are specified for the same five ZEV configurations for which sales estimates are provided. Costs can be set at user-specified values or at the values used for the benchmark EPA modeling. Costs are specified as incremental to a 2015 ICE vehicle because 2015 is the "zero cost" baseline year reflected in the benchmark EPA modeling data. Costs for model years after 2035 are held constant at model year 2035 values (i.e., no additional cost reduction due to learning is implemented for ZEVs after 2035).
- Fuel prices for gasoline and electricity in five-year intervals between 2020 and 2050. These prices can be set at user-specified values or at the values used for the benchmark EPA modeling. Fuel prices for intervening years are interpolated.
- The tax rate to be applied to ZEV purchases.
- A series of economic inputs defining such parameters as the discount rate to be applied to future cash flows, the period (term) associated with vehicle finance purchases, the interest rate associated with vehicle finance purchases, and the dollar year in which economic outputs are expressed.
- The baseline program assumed to be in effect locally, either (1) the EPA/CARB 2025 GHG standards, (2) the EPA 2020 GHG standards as proposed in the initial SAFE rule, or (3) the 2021–2026 GHG standards adopted in the final EPA SAFE rule. The final SAFE standards are hereafter referred to as the rollback standards. In either case, a ZEV program is assumed not to be in effect under baseline conditions.
- The alternative program for which LEV/ZEV impacts are to be evaluated, again either the EPA/CARB 2025 GHG standards, the initial SAFE proposal, or the final SAFE rule. The user must also specify whether ZEV costs should be spread over all national vehicles or all local vehicles.
- A series of inputs defining the distribution of upstream sources of electricity used to power ZEVs. These inputs are defined in five-year intervals from 2020 to 2050 and specify the percentage of power generated from coal, natural gas, nuclear, residual oil, biomass, hydroelectric, geothermal, wind, solar, and other feedstocks. The distribution for intervening years is determined through

interpolation. Generally these data should reflect not the current source distribution for the electric grid but rather the distribution for the additional power demand associated with ZEV use. The data can be set at user-specified values or at the values used for the benchmark EPA modeling.

- Inputs specifying whether the impacts of California Tier 4 emission standards should be estimated and whether vehicle manufacturers should be assumed to offset any ZEV-driven criteria pollutant reductions. Tier 4 emission standards reflect a potential future reduction in emission standards applicable to the California Low Emissions Vehicle program, under which California ZEV program requirements are codified.
- A series of inputs defining the stringency of California Tier 4 emission standards. These can be set at user-specified values or at default values included with the LEV/ZEV Tool.
- A set of inputs defining the format and units associated with LEV/ZEV Tool outputs.
- A set of parameters to allow the exclusion of all or part of the emission impact estimates. These parameters can, for example, be used to exclude upstream emission impacts that occur outside the local area.

Outputs: The LEV/ZEV Tool produces a series of outputs defining program impacts as follows:

- Per-vehicle incremental costs due to program adoption.
- Payback period and lifetime cash flow impacts associated with program adoption.
- Societal cost impacts for vehicle model years from 2024 through 2035 and calendar years 2024 through 2050. Calendar year-specific data for model years 2036 and later are reported, but since these model years are not fully retired by the 2065 sunset date of the LEV/ZEV Tool, lifetime impacts for model years after 2035 are not reported. Similarly, data for model years 2024 through 2050 in calendar years 2051 through 2065 are reported, but since model years after 2050 are not modeled, total impacts for calendar years after 2050 are not reported.
- Upstream electricity emission impacts for vehicle model years from 2024 through 2035 and calendar years 2024 through 2050. The same limitations regarding model years after 2035 and calendar years after 2050 (as described above for societal cost impacts) apply to reported totals. Impacts are estimated for volatile organic compounds (VOCs), carbon monoxide (CO), oxides of nitrogen (NO_x), particular matter smaller than 2.5 microns ($PM_{2.5}$), oxides of sulfur (SOx), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), 1,3-butadiene, acetaldehyde, acrolein, benzene, and formaldehyde.
- Upstream ICE emission impacts for vehicle model years from 2024 through 2035 and calendar years 2024 through 2050. The same limitations regarding model years after 2035 and calendar years after 2050 (as described above for societal cost impacts) apply to reported totals. Impacts are estimated for the same emissions species as listed above for upstream electricity emissions, plus naphthalene.
- Vehicle tailpipe emission impacts for vehicle model years from 2024 through 2035 and calendar years 2024 through 2050. The same limitations regarding model years after 2035 and calendar years after 2050 (as described above for societal cost impacts) apply to reported totals. Impacts are estimated for the same emissions species as listed above for upstream electricity emissions.

Cost Impact Estimation: The cost impacts of LEV/ZEV adoption include several influences: (1) the incremental purchase price of ZEVs, (2) the incremental purchase price of ICEs if more stringent GHG standards apply, (3) incremental taxes associated with the change in vehicle purchase price, (4) incremental insurance costs associated with the change in vehicle purchase price, (5) incremental finance costs associated with the change in vehicle purchase price, (6) incremental maintenance costs associated with the change in vehicle technology, and (7) incremental fuel costs associated with the change in vehicle technology.

Given sensitivity to rapid developments in electric power train and battery technology, the incremental purchase price of ZEVs (per vehicle) is a LEV/ZEV Tool input, but users may specify the price assumptions employed in the EPA benchmark modeling at their discretion. Incremental ICE price impacts (per vehicle) are taken from EPA benchmark modeling. Per-vehicle taxes are scaled from EPA benchmark modeling impacts using purchase price and tax rate ratios. Per-vehicle insurance impacts are scaled from EPA benchmark modeling impacts using purchase price ratios. Per-vehicle finance cost impacts are calculated from purchase price impacts and user-input finance rate and length of loan. Per-vehicle maintenance cost impacts are scaled from EPA benchmark modeling using ratios developed for the local vehicle technology mix relative to the EPA benchmark modeling technology mix. Per-vehicle fuel cost impacts are scaled from those of the EPA benchmark modeling using ratios developed to reflect changes in GHG standards, changes in the ICE and ZEV population shares, and changes in local gasoline and electricity prices relative to those assumed in the EPA benchmark modeling. Cost impacts are aggregated from per-vehicle to local totals using local sales data. Impacts are estimated annually and by age, and future cash flows are discounted in accordance with user-specified inputs. Cost impacts are estimated from two vantage points: that of an individual consumer, and that of society at large.

Upstream Electricity Impact Estimation: Upstream electric grid emission impacts are a function of ZEV mileage and ZEV energy consumption per mile. The LEV/ZEV Tool calculates grid emissions by scaling EPA benchmark modeling estimates in accordance with (local-to-EPA benchmark) ratios of ZEV populations, aggregate energy consumption rates for the pool of ZEVs, and the distribution of feedstocks used to produce electricity. The per-vehicle mileage of ZEVs is assumed to be the same as that assumed in the EPA benchmark modeling. ZEV efficiency is assumed to be constant over the forecast period, so the LEV/ZEV Tool does not adjust ZEV mileage in response to the elasticity of vehicle miles of travel (VMT) with efficiency (i.e., VMT rebound is assumed to be zero for ZEVs).[61] This assumption is consistent with the benchmark EPA modeling. Note, however, that per-vehicle mileage does increase over time (independent of ZEV efficiency) in accordance with the time-based assumptions of the benchmark EPA modeling, so that upstream emissions will increase proportionally, even if the subject ZEV population is held constant.

Upstream ICE Impact Estimation: Upstream ICE emission impact estimation is more complex than upstream electricity impact estimation, as upstream ICE impacts are driven by four influences: (1) applicable GHG standards, (2) ICE VMT displaced by ZEVs, (3) ZEV effects on ICE fuel consumption, and (4) VMT rebound. Changes in fuel demand due to changes in vehicle fuel efficiency alter upstream emissions proportionally. ZEV sales displace travel that would otherwise be undertaken by ICE vehicles, thereby reducing upstream ICE emissions (and increasing upstream electricity-generation emissions). ZEVs generally have a lower GHG profile than ICEs, so increasing ZEV sales provides a fleet average GHG benefit that is assumed to be “consumed” through higher ICE GHG emissions (and associated upstream emissions) elsewhere in the fleet than would otherwise be the case. Finally, the LEV/ZEV Tool assumes the same level of VMT rebound for changes in ICE fuel efficiency as is assumed in the EPA benchmark modeling. The net effect of all four influences is reflected in the upstream emission impacts estimated by the LEV/ZEV Tool. As with all emission impact estimates, the LEV/ZEV Tool calculates upstream ICE impacts by scaling EPA benchmark modeling estimates. Scaling ratios are developed for changes in ICE fuel efficiency (due to GHG standards and ZEV displacement), changes in the ICE population (due to ZEV displacement), and changes in ICE VMT profiles (due to VMT rebound and ZEV displacement).

Vehicle Tailpipe Emission Impact Estimation: ZEV tailpipe emissions are zero by design.[62] While ICE tailpipe emissions are subject to the same four influences as discussed for upstream ICE impacts (changes in standards, ICE VMT displacement, ZEV effects on fuel consumption, and VMT rebound), there are nuances that do not come into play for upstream emission impacts that must be addressed. GHG standards are based on fleet average emissions, but compliance with criteria emission standards is per-vehicle based. Thus, while vehicle manufacturers are able to compensate for the reduced GHG emissions of ZEVs by adjusting fleet mixes or altering vehicle fuel consumption profiles (referred to elsewhere as emission averaging), they generally cannot do the same with regard to criteria emissions. As a result, the LEV/ZEV Tool assumes that fleetwide criteria emissions change in accordance with ZEV displacement (while GHG emissions do not).[63] Additionally, the LEV/ZEV Tool allows the user to estimate the impacts of California Tier 4 emission standards on vehicle tailpipe emissions. Impacts can be estimated for VOCs, CO, NO_x, $PM_{2.5}$, benzene, 1,3-butadiene, formaldehyde, acetaldehyde, acrolein, CH_4, N_2O, and SOx. As with all emission impact estimates, the LEV/ZEV Tool calculates tailpipe emission impacts by scaling EPA benchmark modeling estimates. Scaling ratios are developed for changes in ICE fuel efficiency (due to GHG standards and ZEV displacement), changes in the ICE population (due to ZEV displacement), changes in ICE VMT profiles (due to VMT rebound and ZEV displacement), and changes in criteria pollutant emission standards (due to California Tier 4 standard adoption).

E. Impact of Emission Averaging

Under the LEV III regulation tailpipe emissions are averaged across a manufacturer's entire fleet, with the resulting fleet average used to determine compliance with the standard. This approach is intended to provide flexibility and reduce compliance cost.

1. Criteria Pollutants

For criteria pollutants other than PM, the standards require manufacturers to certify each vehicle to one of a limited number of "emission bins," and manufacturers are unlikely to adjust the certification levels in response to ZEV sales. For that and other reasons, our technical experts have concluded that manufacturers will not employ averaging for criteria pollutants, and it is not reflected in our modeling.

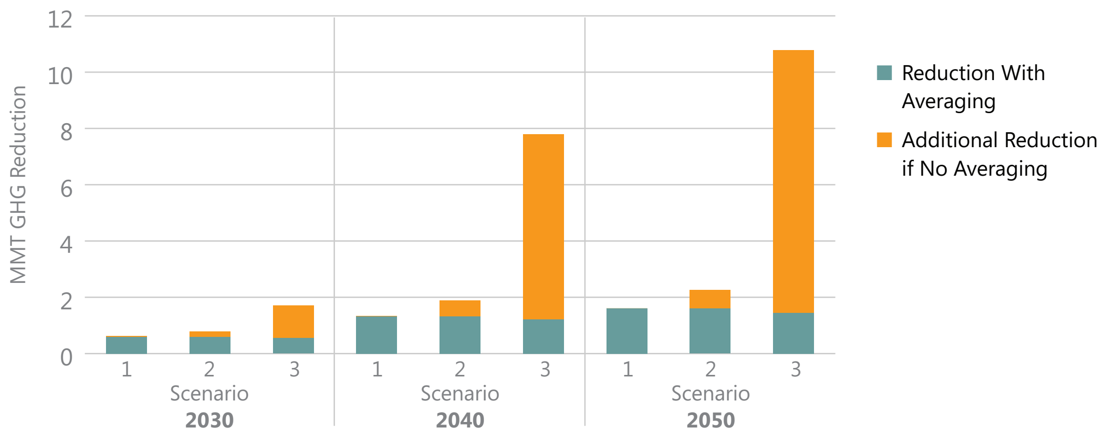
2. GHGs

For GHGs, the regulations allow any level of emissions per vehicle as long as the fleet average standard is achieved (there are no GHG "bins"). Therefore it is easier for manufacturers to incorporate the GHG tailpipe impact of ZEV sales into their compliance planning, and in practice emission averaging has been taken into account when manufacturers determine the emission controls needed for the ICE portion of the fleet. At today's relatively low levels of ZEV sales, including ZEVs in the fleet average has little impact because the fleet average is dominated by the much larger number of ICEs. But as ZEV sales increase, averaging will become more of a factor.

The GHG emission results presented in the main text assume that averaging is employed for Scenarios 1 and 2, but not for Scenario 3. Figure 11 shows the additional reductions achieved for all scenarios if averaging is not available for MY 2026 and beyond. This provides a more accurate view of the real-world emission reductions achieved by ZEVs. Moreover, it is likely that the Advanced Clean Cars II regulation currently being developed by the California Air Resources Board will eliminate averaging beginning in

MY 2026 or 2027. Such a change would affect almost all of the model years included in this analysis, so it is appropriate to show the potential impact. As Figure 11 indicates, the much larger number of ZEVs in Scenario 3 results in a much greater impact from averaging.

Figure 11: Emission Impact of GHG Averaging



F. Current and Announced ZEV Models

Table 9: Current and Announced ZEV Models

Count	Make and Model	Type	Market arrival
1	Audi e-tron	BEV SUV	On market
2	Audi e-tron Sportback	BEV SUV	2020
3	Audi Q4 e-tron	BEV crossover	2021
4	Audi Q5e	PHEV SUV	On market
5	Audi e-tron GT	BEV luxury sport	2021
6	Audi A8L	PHEV sedan	On market
7	BMW i3	BEV hatchback	On market
8	BMW i4	BEV hatchback	2021
9	BMW iNext (i5)	BEV SUV	2021
10	BMW i8	PHEV luxury sport	On market
11	BMW 530e	PHEV sedan	On market
12	BMW 745e	PHEV sedan	On market
13	BMW iX3	BEV crossover	2021
14	BMW X3 xDrive 30e	PHEV crossover	2020
15	Bollinger B1	BEV SUV	2021
16	Bollinger B2	BEV pickup	2021
17	Buick EV	BEV crossover	2022
18	Cadillac EV SUV	BEV SUV	2023
19	Cadillac Lyriq	BEV SUV	2022
20	Cadillac Celestiq	BEV sedan	2023

Count	Make and Model	Type	Market arrival
21	Chevrolet Bolt	BEV hatchback	On market
22	Chevrolet Bolt EUV	BEV crossover	2021
23	Chevrolet crossover	BEV crossover	2023
24	GMC Hummer EV	BEV truck	2021
25	Chevrolet pickup	BEV pickup	2023
26	Chrysler Pacifica Hybrid	PHEV minivan	2021
27	Ford Escape PHEV	PHEV SUV	2020
28	Ford/Lincoln EV crossover	BEV crossover	2022
29	Ford Fusion PHEV	PHEV sedan	On market
30	Ford F-150	BEV pickup	2021
31	Ford Mustang Mach-E	BEV crossover	2020
32	Ford Transit Electric	BEV van	2022
33	Genesis EV	BEV sedan	2021
34	Honda Clarity FCEV	FCEV sedan	On market
35	Honda Clarity PHEV	PHEV sedan	On market
36	Hyundai Ioniq PHEV	PHEV sedan	On market
37	Hyundai Ioniq EV	BEV sedan	On market
38	Hyundai Kona EV	BEV hatchback	On market
39	Hyundai Sonata	PHEV sedan	On market
40	Infiniti Q50	BEV sedan	2022
41	Infiniti EV crossover	BEV crossover	2022
42	Jaguar I-Pace	BEV SUV	On market
43	Jaguar XJ EV	BEV luxury sedan	2021
44	Jeep Grand Cherokee	PHEV SUV	2021
45	Jeep Compass	PHEV crossover	2021
46	Jeep Renegade	PHEV crossover	2021
47	Jeep Wrangler	PHEV crossover	2021
48	Lincoln Corsair	PHEV SUV	2020
49	Lincoln Aviator Grand Touring	PHEV SUV	2020
50	Lincoln compact SUV	BEV SUV	2021
51	Lincoln SUV U787 (Rivian)	BEV SUV	2022
52	Lincoln midsize SUV	BEV SUV	2022
53	Kia Niro PHEV	PHEV hatchback	On market
54	Kia Niro EV	BEV hatchback	On market
55	Kia Optima PHEV	PHEV sedan	On market
56	Kia Soul EV	BEV hatchback	2021
57	Mazda MX 30	BEV crossover	2021
58	Mercedes-Benz GLA	PHEV crossover	2021
59	Mercedes-Benz GLB	PHEV SUV	2021
60	Mercedes-Benz GLC 350e	PHEV SUV	On market
61	Mercedes-Benz EQA	BEV crossover	2021
62	Mercedes-Benz EQB	BEV crossover	2022

Count	Make and Model	Type	Market arrival
63	Mercedes-Benz EQC	BEV SUV	2021
64	Mercedes-Benz EQE	BEV sedan	2022
65	Mini Cooper SE	BEV hatchback	2020
66	Mitsubishi Outlander PHEV	PHEV SUV	On market
67	Nissan Arya	PHEV SUV	2022
68	NISSAN LEAF	BEV hatchback	On market
69	Nissan Maxima EV	BEV sedan	2022
70	Polestar 2	BEV sedan	2020
71	Polestar 3	BEV crossover	2022
72	Porsche Cayenne S e-hybrid	PHEV SUV	On market
73	Porsche Panamera S e-hybrid	PHEV sedan	2021
74	Porsche Taycan	BEV sports car	On market
75	Porsche Taycan Sport Turismo	BEV hatchback	2021
76	Porsche Macan	BEV SUV	2021
77	Range Rover Sport PHEV	BEV SUV	On market
78	Range Rover PHEV HSE	PHEV SUV	On market
79	Rivian R1T	BEV pickup	2021
80	Rivian R1S	BEV SUV	2021
81	Rivian van	BEV van	2021
82	Subaru Crosstrek	PHEV wagon	On market
83	Tesla Model 3	BEV sedan	On market
84	Tesla Model Y	BEV crossover	On market
85	Tesla Model S	BEV sedan	On market
86	Tesla Roadster	BEV sports car	2022
87	Tesla Model X	BEV SUV	On market
88	Tesla Cybertruck	BEV pickup	2022
89	Toyota Prius Prime	PHEV sedan	On market
90	Toyota RAV4 PHEV	PHEV crossover	2020
91	Volkswagen e-Golf	BEV hatchback	On market
92	Volkswagen ID4	BEV crossover	2020
93	Volkswagen Space Vizzion	BEV crossover	2022
94	Volkswagen ID Buzz	BEV van	2022
95	Volvo S60 T8	PHEV sedan	On market
96	Volvo S90 T8	PHEV sedan	On market
97	Volvo V60 T8	PHEV wagon	2020
98	Volvo XC 40 Recharge	BEV SUV	2020
99	Volvo XC 60 T8	PHEV SUV	On market
100	Volvo XC90 T8	PHEV SUV	On market
101	Volvo XC90 Recharge	BEV SUV	2022

G. Detailed Results

This section provides additional supporting detail for certain figures presented in the report. The tables are organized and labeled according to the relevant figure in the report text.

Table 10: Data for Figure 1: ZEV Annual Sales, Percentage of Total Sales, and Figure 2: ZEV Annual Sales, Number of Vehicles

		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of ZEVs	Business-as-Usual	3,323	4,137	4,882	5,628	6,631	7,809	8,984	10,351	11,755	13,364	14,975
	Scenario 1	3,323	4,137	4,882	5,628	6,631	12,663	13,124	13,140	13,103	13,364	14,975
	Scenario 2	3,323	4,137	4,882	5,628	6,631	12,663	17,914	20,704	23,967	27,181	30,148
	Scenario 3	3,323	4,137	4,882	5,628	6,631	31,693	40,495	50,978	62,887	76,045	90,469
ZEV Percent Sales	Business-as-Usual	2.2%	2.7%	3.2%	3.6%	4.2%	4.9%	5.6%	6.4%	7.3%	8.3%	9.2%
	Scenario 1	2.2%	2.7%	3.2%	3.6%	4.2%	8.0%	8.2%	8.2%	8.1%	8.3%	9.2%
	Scenario 2	2.2%	2.7%	3.2%	3.6%	4.2%	8.0%	11.2%	12.9%	14.9%	16.9%	18.5%
	Scenario 3	2.2%	2.7%	3.2%	3.6%	4.2%	19.9%	25.2%	31.7%	39.0%	47.2%	55.7%

		2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Number of ZEVs	Business-as-Usual	16,896	18,350	19,735	21,017	22,070	22,258	22,525	22,816	23,050	23,300
	Scenario 1	16,896	18,350	19,735	21,017	22,070	22,258	22,525	22,816	23,050	23,300
	Scenario 2	33,158	34,761	36,022	36,979	37,916	38,239	38,697	39,199	39,599	40,029
	Scenario 3	107,372	121,349	134,442	145,889	154,768	156,087	157,958	160,004	161,639	163,393
ZEV Percent Sales	Business-as-Usual	10.1%	10.9%	11.5%	12.1%	12.6%	12.6%	12.6%	12.6%	12.6%	12.6%
	Scenario 1	10.1%	10.9%	11.5%	12.1%	12.6%	12.6%	12.6%	12.6%	12.6%	12.6%
	Scenario 2	19.8%	20.6%	21.1%	21.3%	21.7%	21.7%	21.7%	21.7%	21.7%	21.7%
	Scenario 3	64.0%	71.8%	78.6%	84.2%	88.6%	88.6%	88.6%	88.6%	88.6%	88.6%

Table 11: Data for Figure 4: Annual Projected Greenhouse Gas Reductions, Million Metric Tons

		Scenario 1	Scenario 2	Scenario 3
Tailpipe	CY 2030	0.48	0.48	1.32
	CY 2040	1.05	1.05	5.27
	CY 2050	1.26	1.26	7.02
EV Upstream	CY 2030	-0.02	-0.03	-0.15
	CY 2040	-0.01	-0.06	-0.54
	CY 2050	0.00	-0.08	-0.77
ICE Upstream	CY 2030	0.13	0.14	0.54
	CY 2040	0.28	0.34	3.05
	CY 2050	0.35	0.42	0.91
Net Reduction	CY 2030	0.59	0.59	1.71
	CY 2040	1.32	1.32	7.79
	CY 2050	1.61	1.60	10.78

Table 12: Data for Figure 5: NO_x plus VOC Reductions, Tons

		CY 2030	CY 2040	CY 2050
Scenario 1	Tailpipe	2	36	61
	ICE Upstream	-364	-794	-973
	EV Upstream	11	4	0
	Net Total	-351	-754	-912

		CY 2030	CY 2040	CY 2050
Scenario 2	Tailpipe	-45	-207	-299
	ICE Upstream	-398	-939	-1167
	EV Upstream	19	43	55
	Net Total	-425	-1103	-1411

		CY 2030	CY 2040	CY 2050
Scenario 3	Tailpipe	-317	-2018	-3405
	ICE Upstream	-599	-1901	-2558
	EV Upstream	106	375	535
	Net Total	-811	-3544	-5427

Table 13: Data for Figure 6: Net Lifetime Savings Per Vehicle—Cash Purchase

Incremental Per-Vehicle Costs—Purchase		Car		Truck		Fleet	
		MY 2025	MY 2030	MY 2025	MY 2030	MY 2025	MY 2030
Scenario 1	Vehicle (Purchase + Tax)	$699	$449	$942	$791	$811	$600
	Lifetime Insurance, Maintenance	$170	$149	$222	$202	$194	$172
	Lifetime Fuel	-$1,654	-$1,494	-$2,954	-$2,838	-$2,255	-$2,085
	Lifetime Net Savings	-$785	-$895	-$1,790	-$1,845	-$1,250	-$1,313
	Payback Period (Years)	6	4	5	4		

Incremental Per-Vehicle Costs—Purchase		Car		Truck		Fleet	
		MY 2025	MY 2030	MY 2025	MY 2030	MY 2025	MY 2030
Scenario 2	Vehicle (Purchase + Tax)	$699	$316	$942	$775	$811	$518
	Lifetime Insurance, Maintenance	$170	$25	$222	$172	$194	$89
	Lifetime Fuel	-$1,654	-$1,615	-$2,954	-$2,919	-$2,255	-$2,189
	Lifetime Net Savings	-$785	-$1,274	-$1,790	-$1,972	-$1,250	-$1,581
	Payback Period (Years)	6	3	5	4		

Incremental Per-Vehicle Costs—Purchase		Car		Truck		Fleet	
		MY 2025	MY 2030	MY 2025	MY 2030	MY 2025	MY 2030
Scenario 3	Vehicle (Purchase + Tax)	$703	-$2,110	$1,024	-$1,217	$852	-$1,717
	Lifetime Insurance, Maintenance	-$139	-$1,152	$138	-$731	-$11	-$967
	Lifetime Fuel	-$1,897	-$2,430	-$3,077	-$4,044	-$2,443	-$3,140
	Lifetime Net Savings	-$1,333	-$5,692	-$1,915	-$5,992	-$1,603	-$5,824
	Payback Period (Years)	5	1	5	1		

Table 14: Data for Figure 7: Net Monthly Savings Per Vehicle—Financed

Net Change in Monthly Cost over Life of Loan		MY 2025			MY 2030		
		Car	Truck	Fleet	Car	Truck	Fleet
Scenario 1	Loan Payment, Insurance, Maintenance	$11	$15	$13	$8	$13	$10
	Fuel	-$11	-$19	-$15	-$10	-$19	-$14
	Net Cost	$0	-$4	-$2	-$3	-$6	-$4

Net Change in Monthly Cost over Life of Loan		MY 2025			MY 2030		
		Car	Truck	Fleet	Car	Truck	Fleet
Scenario 2	Loan Payment, Insurance, Maintenance	$11	$15	$13	$5	$12	$8
	Fuel	-$11	-$19	-$15	-$11	-$20	-$15
	Net Cost	$0	-$4	-$2	-$6	-$7	-$7

Net Change in Monthly Cost over Life of Loan		MY 2025			MY 2030		
		Car	Truck	Fleet	Car	Truck	Fleet
Scenario 3	Loan Payment, Insurance, Maintenance	$10	$16	$13	-$37	-$22	-$30
	Fuel	-$13	-$20	-$16	-$17	-$27	-$21
	Net Cost	-$2	-$4	-$3	-$54	-$49	-$52

Table 15: Data for Figure 8: Statewide Savings by Calendar Year (Dollars, in Millions)

		CY 2030	CY 2040	CY 2050
Scenario 1	Purchase, Tax, Insurance, Maintenance	$82	$68	$54
	Fuel	-$112	-$193	-$169
	Net Total	-$31	-$125	-$115

		CY 2030	CY 2040	CY 2050
Scenario 2	Purchase, Tax, Insurance, Maintenance	$70	$38	$27
	Fuel	-$116	-$203	-$179
	Net Total	-$46	-$165	-$152

		CY 2030	CY 2040	CY 2050
Scenario 3	Purchase, Tax, Insurance, Maintenance	-$220	-$438	-$384
	Fuel	-$143	-$370	-$366
	Net Total	-$364	-$808	-$750

Table 16: Data for Figure 9: Number of BEVs vs. ICEs on Surveyed Dealer Lots—San Jose, Las Vegas, Reno

	San Jose		Las Vegas		Reno	
	Nissan	**Chevrolet**	**Nissan**	**Chevrolet**	**Nissan**	**Chevrolet**
Electric	125	93	13	21	10	12
ICE	246	185	456	1026	365	577

Table 17: Data for Figure 11: Emission Impact of GHG Averaging

	2030			2040			2050		
	Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 1**	**Scenario 2**	**Scenario 3**
Reduction With Averaging	0.59	0.59	0.55	1.32	1.32	1.22	1.61	1.60	1.45
Additional Reduction if No Averaging	0.03	0.19	1.16	0.01	0.56	6.57	0.00	0.67	9.33

Endnotes

1 State of Nevada, *Governor Jim Gibbons' Nevada Climate Change Advisory Committee Final Report*, May 31, 2008, https://www.cakex.org/documents/nevada-climate-change-advisory-committee-final-report.

2 State of Nevada Climate Initiative, "Nevada's Climate Strategy," https://climateaction.nv.gov/policies/introduction/ (accessed December 10).

3 An Act Related to Greenhouse Gas Emissions, S.B. 254, Nevada State Legislature 80th Session (2019), https://www.leg.state.nv.us/App/NELIS/REL/80th2019/Bill/6431/Text.

4 Nevada Division of Environmental Protection, *Nevada Statewide Greenhouse Gas Emissions Inventory and Projections, 1990–2040,* 2020, 15. https://ndep.nv.gov/uploads/air-pollutants-docs/ghg_report_2020.pdf.

5 Ibid., 20.

6 Ibid., 15, 23.

7 Ibid., 27.

8 State of Nevada Executive Department, "Executive Order Directing Executive Branch to Advance Nevada's Climate Goals," Executive Order 2019-22, November 2019, https://gov.nv.gov/News/Executive_Orders/2019/Executive_Order_2019-22_Directing_Executive_Branch_to_Advance_Nevada_s_Climate_Goals/.

9 State of Nevada Climate Initiative, "Nevada's Climate Strategy."

10 State of Nevada Executive Department, "Gov Sisolak Announces 'Clean Cars Nevada,' Initiative to Provide Nevadans With More Choices for Less-Polluting Cars and Trucks," press release, June 22, 2020, https://gov.nv.gov/News/Press/2020/Gov__Sisolak_announces_%E2%80%9CClean_Cars_Nevada,%E2%80%9D_initiative_to_provide_Nevadans_with_more_choices_for_less-polluting_cars_and_trucks/.

11 Executive Order 13990 of January 20, 2021, *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis*, https://www.federalregister.gov/documents/2021/01/25/2021-01765/protecting-public-health-and-the-environment-and-restoring-science-to-tackle-the-climate-crisis , "Biden–Sanders Unity Task Force Recommendations: Combating the Climate Crisis and Pursuing Environmental Justice," July 2020, 48, https://joebiden.com/wp-content/uploads/2020/07/UNITY-TASK-FORCE-RECOMMENDATIONS.pdf.

12 The program descriptions provided here and in the Appendix are adapted from the California Air Resources Board (hereinafter CARB), "Advanced Clean Cars Program," https://ww2.arb.ca.gov/our-work/programs/advanced-clean-cars-program/about (accessed March 10, 2020).

13 The EPA has identified six pollutants as "criteria" air pollutants, so named because the agency regulates them by developing human health–based and/or environment-based criteria (science-based guidelines) for setting permissible levels. These six pollutants are carbon monoxide, lead, nitrogen oxides, ground-level ozone, particle pollution (often referred to as particulate matter), and sulfur oxides. Centers for Disease Control and Prevention, "Air Quality: Air Pollutants," last reviewed September 4, 2019, https://www.cdc.gov/air/pollutants.htm.

14 The federal rollback is focused on GHG and fuel economy standards. The existing criteria pollutant standards are retained. But increased fuel use due to relaxing the GHG and fuel economy standards will result in increased upstream emissions of all pollutants.

15 The sales total used to determine the credit requirement is the average of total sales over a three-year period beginning four years before the applicable model year. So, for example, the sales total used for the model year 2024 credit requirement is the average of total sales in the 2020, 2021, and 2022 model years.

16 BEVs must have a minimum electric range of 50 miles to earn credit. For BEVs, ZEV credit = 0.01 x UDDS (city cycle) range, plus 0.5, up to a maximum value of 4.0. PHEVs (referred to as TZEVs in the regulation) must have a minimum electric range of 10 miles. For PHEVs, ZEV credit = 0.01 x all electric range + 0.3, up to a maximum value of 1.1. TZEVs can earn an additional 0.2 credit if they are able to meet the US06 test cycle, which includes higher acceleration and higher speeds. See California Code of Regulations, "Zero-Emission Vehicle Standards for 2018 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," 13 CCR § 1962.2, https://govt.westlaw.com/calregs/Document/I505CA51BB0AD454499B57FC8B03D7856?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default).

17 Nic Lutsey et al., *Efficiency Technology and Cost Assessment for U.S. 2025–2030 Light-Duty Vehicles*, International Council on Clean Transportation, March 2017, https://theicct.org/sites/default/files/publications/US-LDV-tech-potential_ICCT_white-paper_22032017.pdf.

18 The ZEV requirement increases through MY 2025, then remains constant at that level. If California modifies the requirement for future model years, additional affirmative action would need to be undertaken by the NDE.

19 Chris Harto, Shannon Baker-Branstetter, and Jamie Hall, *The Un-SAFE Rule: How a Fuel-Economy Rollback Costs Americans Billions in Fuel Savings and Does Not Improve Safety*, Consumer Reports, August 2019, 3, https://advocacy.consumerreports.org/wp-content/uploads/2019/08/The-Un-SAFE-Rule-How-a-Fuel-Economy-Rollback-Costs-Americans-Billions-in-Fuel-Savings-and-Does-Not-Improve-Safety-2.pdf.

20 Charles Shulock, *Clean Cars Minnesota: An Analysis of Its Feasibility and Impact on Consumers and the Environment*, Shulock Consulting, August 2020, https://minnesotansforcleancars.com/wp-content/uploads/2020/08/Minnesota-EV-Report_08.pdf.

21 Richard Rykowski, *Colorado Zero Emission Vehicle Program Will Deliver Extensive Economic, Health and Environmental Benefits*, prepared for the Environmental Defense Fund, July 2019, 4, http://blogs.edf.org/climate411/files/2019/08/FINAL-EDF-Colorado-ZEV-report-2019.pdf.

22 CARB, "ZEV Regulatory Calculator," https://ww2.arb.ca.gov/resources/documents/zev-regulatory-calculator (accessed March 10, 2020).

23 The criteria pollutant standards require manufacturers to certify vehicles to one of a limited number of "emission bins" and thus are far less flexible than the GHG standards, which allow any level of GHG emissions per vehicle as long as the fleet average standard is achieved. For that and other reasons, technical experts for the Colorado rulemaking concluded that manufacturers will not take advantage of averaging for criteria pollutants. A detailed explanation is provided in Environmental Coalition, *Prehearing Statement in the Matter Regarding Clean Car Rulemaking Efforts—Proposed Revisions to Regulation Number 20, Zero Emission Vehicle Program*, July 19, 2019, 16-17, https://drive.google.com/drive/folders/1ViSIw_dxV1csgJ7ZCOCCHpFT0wlkJso0 and related materials.

24 National Institute of Environmental Health Sciences, "Air Pollution," https://www.niehs.nih.gov/health/topics/agents/air-pollution/index.cfm (accessed March 31, 2020).

25 Global warming potential values for methane and nitrous oxide are taken from Greenhouse Gas Protocol, "Global Warming Potential Values," https://www.ghgprotocol.org/sites/default/files/ghgp/Global-Warming-Potential-Values%20%28Feb%2016%202016%29_1.pdf (accessed March 20, 2020).

26 U.S. Environmental Protection Agency (hereinafter EPA), "Health Effects of Ozone in the General Population," https://www.epa.gov/ozone-pollution-and-your-patients-health/health-effects-ozone-general-population (accessed March 31, 2020).

27 EPA, "Health and Environmental Effects of Particulate Matter (PM)," https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm (accessed March 31, 2020).

28 EPA, "Health and Environmental Effects of Hazardous Air Pollutants," https://www.epa.gov/haps/health-and-environmental-effects-hazardous-air-pollutants (accessed March 31, 2020).

29 For analysis of the national program, see Harto, Baker-Branstetter, and Hall, *The Un-SAFE Rule*. For Colorado, see Rykowski, *Colorado Zero Emission Vehicle Program*. For Minnesota, see Shulock, *Clean Cars Minnesota*.

30 Melinda Zabritski, Experian, *Automotive Industry Insights Finance Market Report Q3 2020*, https://www.experian.com/content/dam/marketing/na/automotive/quarterly-webinars/credit-trends/q3-2020-safm.pdf.

31 David L. Greene and Jilleah G. Welch, *The Impact of Increased Fuel Economy for Light-Duty Vehicles on the Distribution of Income in the United States*, Baker Center for Public Policy, September 2016, http://bakercenter.utk.edu/wp-content/uploads/2016/09/Equity-Impacts-of-Fuel-Economy-Report_final.pdf.

32 Survey of dealership inventories from Cars.com on June 10, 2019.

33 Dealerships searched were Premier Nissan, Stevens Creek Nissan, Capitol Chevrolet, and Stevens Creek Chevrolet in the San Jose metro area; AutoNation Nissan, Planet Nissan, Ed Bozarth Chevrolet, and Fairway Chevrolet in the Las Vegas metro area; and United Nissan, Nissan Carson City, Champion Chevrolet, and Michael Hohl Motor Co. in the Reno metro area. Websites accessed on December 16, 2020.

34 Harto, Baker-Branstetter, and Hall, *The Un-SAFE Rule*.

35 M.J. Bradley & Associates, *Plug-In Electric Vehicle Cost-Benefit Analysis: Arizona,* December 2018, http://www.swenergy.org/pubs/azev-study.

36 Southwest Energy Efficiency Project, *Economic and Emissions Benefits of Electric Vehicles in Nevada*, January 2019, https://swenergy.org/pubs/economic-and-emissions-benefits-of-electric-vehicles-in-nevada.

37 Jason Frost, Melissa Whited, and Avi Allison, *Electric Vehicles Are Driving Electric Rates Down*, Synapse Energy Economics, updated June 2019, 3, https://www.synapse-energy.com/sites/default/files/EV-Impacts-June-2019-18-122.pdf.

38 Environmental Coalition, *Rebuttal Prehearing Statement in the Matter Regarding Proposed Addition of Regulation Number 20*, 2018, 26–30.

39 Charles M. Shulock, *Comparison of Automobile Sales in States That Have Adopted a Zero Emission Vehicle Regulation Versus States That Have Not Adopted*, Shulock Consulting, May 7, 2018, 2, Shulock Consulting Reports, Comparison of Auto Sales.

40 Northeast States for Coordinated Air Use Management, "Mobile Sources," https://www.nescaum.org/focus-areas/mobile-sources (accessed March 20, 2020).

41 This calculation assumes that manufacturers maximize the use of available credits each year. They likely would not completely follow that strategy but this comparison best puts in context the magnitude of the initial credit awards relative to the compliance obligation.

42 Environmental Coalition, *Prehearing Statement,* 7-10.

43 42. U.S.C. § 7505, "New Motor Vehicle Emission Standards in Nonattainment Areas," 2010, https://www.law.cornell.edu/uscode/text/42/7507.

44 For 2016 transfers, see CARB, "2016 Zero Emission Vehicle Credits," https://ww2.arb.ca.gov/sites/default/files/2019-03/2016-zev-credits.pdf (accessed March 15, 2020). For 2017 transfers, see CARB, "2017 Zero Emission Vehicle Credits," https://ww2.arb.ca.gov/sites/default/files/2020-01/2017_zev_credits_ac.pdf (accessed March 15, 2020). For 2018 transfers, see CARB, "2018 Zero Emission Vehicle Credits," https://ww2.arb.ca.gov/sites/default/files/2020-01/2018%20ZEV%20Credits_ac.pdf (accessed March 15, 2020). For 2019 transfers see CARB, "2019 Zero Emission Vehicle Credits", https://ww2.arb.ca.gov/sites/default/files/2020-10/2019_zev_credit_annual_disclosure.pdf. (Accessed January 20, 2021).

45 International Energy Agency, Global EV Outlook 2020, https://www.iea.org/reports/global-ev-outlook-2020 (Accessed January 31, 2021).

46 California New Car Dealers Association, California Auto Outlook, Volume 16, Number 4, November 2020, https://www.cncda.org/wp-content/uploads/Cal-Covering-4Q-19.pdf.

47 https://media.gm.com/media/us/en/gm/home.detail.html/content/Pages/news/us/en/2021/jan/0128-carbon.html (Accessed January 29, 2021).

48 Ben Foldy, "Auto Makers Charge Ahead With Electric-Vehicle Plans," *Wall Street Journal*, July 19, 2020, https://www.wsj.com/articles/automakers-charge-ahead-with-electric-vehicle-plans-11595156400.

49 Nic Lutsey and Michael Nicholas, "Update on Electric Vehicle Costs in the United States Through 2030," International Council on Clean Transportation, April 2, 2019, https://theicct.org/sites/default/files/publications/EV_cost_2020_2030_20190401.pdf.

50 Kelly Lin, "Longest-Range Electric Cars of 2020: 19 EVs That Can Go the Distance," *Motor Trend*, December 23, 2019, https://www.motortrend.com/news/longest-range-electric-cars-2020-19-evs-can-go-distance/.

51 Personal communication from Jukka Kukkonen, founder, Shift2Electric, March 31, 2020.

52 Julia Pyper, "Automaker Electric Vehicle Plans 'Progressing at a Rapid Pace' Despite Pandemic, Economic Downturn," Atlantic Council EnergySource blog, June 24, 2020, https://www.atlanticcouncil.org/blogs/energysource/automaker-electric-vehicle-plans-progressing-at-a-rapid-pace-despite-pandemic-economic-downturn/.

53 Nevada Governor's Office of Energy, "Nevada Electric Highway," 2019, https://energy.nv.gov/Programs/Nevada_Electric_Highway/.

54 John Sadler, "Nevada to Add EV Charging Network Across Frequented Highway, *Las Vegas Sun*, January 29, 2020, https://lasvegassun.com/news/2020/jan/29/nevada-nears-completion-of-electric-vehicle-chargi/.

55 Peter Valdes-Dapena, "The Electric Pickup Wars Are About to Begin," CNN Business, last updated February 14, 2020, https://www.cnn.com/2020/02/14/cars/electric-pickup-truck-wars/index.html.

56 As of 2020, large-volume manufacturers are BMW, Fiat Chrysler, Ford, General Motors, Honda, Hyundai, Kia, Mercedes, Nissan, Toyota, and Volkswagen. Intermediate-volume manufacturers are Jaguar Land Rover, Mazda, Subaru, and Volvo. CARB, "2018 Zero Emission Vehicle Credits."

57 CARB, *Annual Evaluation of Fuel Cell Electric Vehicle Deployment & Hydrogen Fuel Station Network Development*, July 2019, https://ww2.arb.ca.gov/sites/default/files/2019-07/AB8_report_2019_Final.pdf.

58 EPA, "Final Determination on the Appropriateness of the Model Year 2022–2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards Under the Midterm Evaluation," January 2017, https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100QQ91.pdf.

59 *OMEGA* stands for Optimization Model for Reducing Emissions of Greenhouse Gases From Automobiles. See EPA, "Optimization Model for Reducing Emissions of Greenhouse Gases From Automobiles (OMEGA)," last revised November 30, 2010, https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=OTAQ&dirEntryID=215026.

60 BEVxxx indicates a battery electric vehicle (a vehicle without an internal combustion engine) with a driving range of xxx miles. PHEVxx indicates a plug-in hybrid electric vehicle (an electric vehicle with a supplemental, range-extending internal combustion engine, whose battery can be recharged from off-board power sources) with an all-electric driving range of xx miles.

61 This is a conservative assumption from an emission impact standpoint because upstream emission decreases due to improved ZEV efficiency will be greater than any offsetting emission increases due to any increase in travel resulting from that improved efficiency.

62 From a greenhouse gas compliance standpoint, ZEV tailpipe emissions are not treated as zero. This is to account for upstream emissions that would otherwise not be recognized. Since ZEV-related upstream emissions are accounted for explicitly in both the LEV/ZEV Tool and the benchmark EPA modeling, tailpipe emissions are properly modeled as zero.

63 The LEV/ZEV Tool provides users with an input switch to "turn off" the criteria emissions assumption if they so desire. If this switch is turned off, the LEV/ZEV Tool will estimate ICE tailpipe criteria emission impacts as if they were unchanged on a fleet-average basis.