

**Projection of ZEV Sales in Colorado  
With and Without Adoption of a ZEV Regulation**

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## **About Shulock Consulting**

Chuck Shulock is an environmental and climate policy consultant, focusing primarily on electric transportation. His clients have included the Natural Resources Defense Council, the California Electric Transportation Coalition, the Energy Foundation, the World Bank, and the International Council on Clean Transportation.

Before becoming a consultant Mr. Shulock was Assistant Executive Officer and Director of Climate Programs at the California Air Resources Board, where he led the Board's initial implementation of the California Global Warming Solutions Act (AB 32). He also served as project leader for the adoption of regulations pursuant to AB 1493, California legislation that directed the Board to reduce greenhouse gas emissions from passenger vehicles, and led the staff teams that prepared the 2001 and 2003 amendments to the Zero Emission Vehicle regulation.

## Projection of ZEV Sales in Colorado With and Without Adoption of a ZEV Regulation

To help inform the ongoing work of the Colorado Department of Public Health and the Environment (CDPHE) as the Department prepares to propose a rule adopting a Zero Emission Vehicle (ZEV) program in Colorado, the Natural Resources Defense Council has commissioned an analysis of the number of ZEVs that would be placed in Colorado under various scenarios. Because some ZEV sales will occur in Colorado even in the absence of a ZEV regulation, the cost and emission impacts of ZEV regulatory adoption are those stemming from the additional ZEV sales that are required under the regulation, above and beyond those that would otherwise occur. Thus in order to develop such estimates it first is necessary to project the number of ZEVs that will be sold in Colorado with and without the Colorado adoption of a ZEV regulation. This memo provides such estimates and explains how they are derived.

Such projections are subject to considerable uncertainty. The ZEV regulation allows for wide variation in the number of vehicles that manufacturers must sell in order to comply. The regulation does not require the industry to reach specific ZEV sales targets, but rather requires a certain number of “ZEV credits” to be delivered annually. ZEV credits are awarded based on the performance of the vehicles produced. Vehicles with longer electric range earn more credit, and in turn fewer such vehicles are needed to meet a manufacturer's credit obligation. Pure electric vehicles (without a tailpipe, referred to in this paper as battery electric vehicles, or BEVs<sup>1</sup>) earn more credit than plug-in hybrid electric vehicles (PHEVs). Thus the type of vehicles that a manufacturer chooses to produce has a large impact on the number of vehicles needed.

As outlined more fully below, the business as usual projections in this analysis are based on reputable third party sources, and the regulatory compliance projections use the ZEV compliance calculator developed by the California Air Resources Board, modified by this consultant to match Colorado circumstances. We are confident that these projections provide a reasonable description of likely outcomes. Our assumptions regarding future vehicle characteristics and other parameters are based on our most recent information, and are subject to revision if new information becomes available in the course of the rulemaking.

### “Business as Usual” ZEV Sales in Colorado (No ZEV Regulation)

ZEV technology is advancing rapidly, battery cost is declining, manufacturers are continually announcing new electrified models, and public awareness of ZEV offerings is growing. It is clear that a long-term transition to electrified transportation is underway. Much less clear, however, is the pace at which that transition will occur, particularly in states without a ZEV regulation.

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<sup>1</sup> Hydrogen fuel cell vehicles (FCVs) also earn ZEV credit. Due to infrastructure constraints we do not anticipate FCV placements in Colorado in the timeframe of these projections. The projections do, however, take into account credits earned by FCV placements in other states that will be available to offset Colorado obligations.

This paper provides a conservative estimate of business as usual ZEV sales in Colorado, with modest growth through 2030. This allows for a more focused look at the impact of the ZEV regulation. A conservative view of business as usual progress also is in keeping with the guiding intent of the ZEV regulation, which is to provide a “technology-forcing” push to ensure that manufacturers continue to invest in ZEV research and development whatever the near-term circumstances. If far more rapid growth occurs than the ZEV regulation has achieved its purpose, and its incremental costs and benefits are no longer relevant because the regulation is no longer driving additional sales.

To project business as usual ZEV sales we take projected national ZEV sales through 2025 and then scale that national projection to fit Colorado’s 2018 actual sales and its projected future share of the national ZEV market. The projection of future national ZEV sales comes from work by Baum and Associates, who use proprietary sources, industry data, expert judgement, and proprietary analytical tools to develop various forecasts of future automotive sales. We obtained from Baum and Associates a forecast of model year and calendar year ZEV sales by manufacturer, brand, model, segment, and powertrain<sup>2</sup>. For public reporting we aggregated the detailed data into calendar year totals for BEVs, PHEVs, and the BEV percentage of total ZEV sales, as shown in Table 1. The Baum national projection does not include calendar year 2024 so we interpolated values for that year.

**Table 1: Projected National ZEV Sales by Type**

	Baum National CY						Interpolated	
	2018	2019	2020	2021	2022	2023	2024	2025
Total	364,337	343,415	451,560	622,070	746,120	784,730	917,365	1,050,000
BEV	235,444	218,605	302,320	460,770	571,820	603,800	701,900	800,000
PHEV	128,893	124,810	149,240	161,300	174,300	180,930	215,465	250,000
BEV %	64.6%	63.7%	67.0%	74.1%	76.6%	76.9%	76.5%	76.2%

Next, taking Colorado’s 2018 actual BEV and PHEV sales as the starting point, for 2019 and beyond we scaled the Baum national projections to match Colorado’s projected share of national EV sales, as estimated by Navigant Research<sup>3</sup>. We constrained the results of that calculation to ensure that each year’s total was no smaller than the previous year. The results are shown in Table 2 below. Once again the 2024 values are interpolated.

<sup>2</sup> Alan Baum and Associates, Hybrid Electric Vehicle Forecast Values Mar 19

<sup>3</sup> Navigant Research, Market Data: EV Geographic Forecasts, Published 3Q 2017

**Table 2: Projected Colorado Business as Usual ZEV Sales by Type**

	Baum National Scaled to Colorado per Navigant				Interpolated			
	2018	2019	2020	2021	2022	2023	2024	2025
Total	7,147	7,147	7,147	7,147	7,495	8,204	10,084	11,809
BEV	4,988	4,988	4,988	4,988	5,336	6,045	7,565	8,862
PHEV	2,159	2,159	2,159	2,159	2,159	2,159	2,519	2,947
BEV %	69.8%	69.8%	69.8%	69.8%	71.2%	73.7%	75.0%	75.0%

### Additional ZEV Sales in Colorado Needed to Comply with the ZEV Regulation

The California Air Resources Board has developed a “Compliance Calculator<sup>4</sup>” to estimate the number of vehicles needed to comply with the ZEV regulation under a given set of assumptions, in California and in the Section 177 ZEV states<sup>5</sup>. To develop compliance estimates for Colorado we first modified the ARB calculator to apply to Colorado, as follows:

- The ZEV credit requirement is a specified percentage of total sales. The modified calculator uses an estimate of total Colorado sales provided by the Colorado Department of Public Health and the Environment (CDPHE). The CDPHE estimate used in this analysis assumes constant annual total Colorado sales of 278,128, of which 239,591 are sales by Large Volume Manufacturers and 38,357 are sales by Intermediate Volume Manufacturers. We note that the CDPHE sales estimate may be revised as its analysis continues.
- The ARB calculator assumes manufacturer compliance beginning in 2018. In the Colorado calculator the starting date for compliance is delayed until 2023, consistent with the Colorado regulatory timeframe.
- The modified calculator takes into account Colorado’s proportional share of fuel cell vehicle credits earned for vehicles placed in other states<sup>6</sup>. These credits are available to offset a manufacturer’s Colorado ZEV obligation.

In the course of modifying the calculator we made other changes, not specifically related to Colorado, that increase its functionality. We added the capability to separately consider business as usual sales versus additional sales, extended the projections out to the 2030 model year, provided additional displays of scenario outputs, and made other minor changes.

As noted above, the number of vehicles needed to comply with the ZEV regulation will vary based on the types of vehicles that manufacturers sell. For simplicity purposes the ARB calculator uses “average” vehicles, that reflect the performance of the fleet as a whole, rather than multiple individual models. Our baseline vehicles are a BEV with a 150 mile range, a BEV

<sup>4</sup> <https://ww2.arb.ca.gov/resources/documents/zev-regulatory-calculator>.

<sup>5</sup> States that have adopted the California ZEV regulation pursuant to Section 177 of the Clean Air Act: Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Rhode Island, and Vermont.

<sup>6</sup> The regulation allows manufacturers that place FCEVs in any ZEV state to apply that credit to all ZEV states, in an amount proportional to the manufacturers’ total sales in each state.

with a 250 mile range, and a PHEV with a 50 mile all-electric range and US06 capability<sup>7</sup>. These values were chosen to maintain consistency with cost estimates provided by other sources.

One factor that strongly affects the projected number of vehicles is the proportion of ZEV sales that are BEVs as opposed to PHEVs. Because BEVs earn more credit than PHEVs, a “BEV-heavy” fleet will have fewer total vehicles than a “PHEV-heavy” fleet, even though both fully comply with the regulation. We developed two scenarios that illustrate a range of outcomes. Both scenarios use the same business as usual sales shown above, but differ in the mix of additional vehicles that are sold to comply.

Scenario 1 roughly parallels the projected Baum sales mix, and incorporates a “BEV-heavy” approach with a BEV share of about 80 percent. Scenario 2 is a more “PHEV-heavy” approach, with a roughly 50/50 BEV/PHEV sales split. The results are shown in Table 3 and Table 4 below. As expected, Scenario 2 has fewer BEVs, more PHEVs, and more vehicles overall.

**Table 3: Projected Colorado ZEV Sales, Scenario 1**

CO Additional Vehicles due to Regulation								
	2023	2024	2025	2026	2027	2028	2029	2030
BEV A (BEV 150)	3,184	3,418	3,762	3,750	3,750	3,750	3,750	3,750
BEV B (BEV 250)	3,273	3,514	3,867	3,875	3,875	3,875	3,875	3,875
Annual Additional BEVs--Total	6,457	6,932	7,629	7,625	7,625	7,625	7,625	7,625
PHEV A (PHEV 50)	0	0	0	0	0	0	0	0
PHEV B (PHEV 50)	468	543	599	599	599	599	599	599
Annual Additional PHEVs--Total	468	543	599	599	599	599	599	599
Annual Additional Total ZEVs	6,926	7,475	8,228	8,224	8,224	8,224	8,224	8,224
CO BAU Vehicles								
	2023	2024	2025	2026	2027	2028	2029	2030
BEV A (BEV 150)	3,023	3,782	4,431	4,431	4,431	4,431	4,431	4,431
BEV B (BEV 250)	3,023	3,782	4,431	4,431	4,431	4,431	4,431	4,431
Annual BAU BEVs--Total	6,045	7,565	8,862	8,862	8,862	8,862	8,862	8,862
PHEV A (PHEV 50)	0	0	0	0	0	0	0	0
PHEV B (PHEV 50)	2,460	2,779	3,233	3,233	3,233	3,233	3,233	3,233
Annual BAU PHEVs--Total	2,460	2,779	3,233	3,233	3,233	3,233	3,233	3,233
Annual BAU ZEV Total	8,505	10,344	12,095	12,095	12,095	12,095	12,095	12,095
CO Total Vehicles (Additional plus BAU)								
	2023	2024	2025	2026	2027	2028	2029	2030
BEV A (BEV 150)	6,207	7,201	8,193	8,181	8,181	8,181	8,181	8,181
BEV B (BEV 250)	6,296	7,296	8,298	8,306	8,306	8,306	8,306	8,306
Total BEVs	12,503	14,497	16,491	16,487	16,487	16,487	16,487	16,487
PHEV A (PHEV 50)	0	0	0	0	0	0	0	0
PHEV B (PHEV 50)	2,929	3,322	3,832	3,832	3,832	3,832	3,832	3,832
Total PHEVs	2,929	3,322	3,832	3,832	3,832	3,832	3,832	3,832
Total ZEVs	15,431	17,819	20,323	20,319	20,319	20,319	20,319	20,319
Percent of Total Sales	5.55%	6.41%	7.31%	7.31%	7.31%	7.31%	7.31%	7.31%

<sup>7</sup> The ZEV regulation awards additional ZEV credit to PHEVs that can operate for 10 miles or more on electricity alone while meeting the more aggressive high speed/high acceleration US06 test cycle.

**Table 4: Projected Colorado ZEV Sales, Scenario 2**

<b>CO Additional Vehicles due to Regulation</b>								
	<b>2023</b>	<b>2024</b>	<b>2025</b>	<b>2026</b>	<b>2027</b>	<b>2028</b>	<b>2029</b>	<b>2030</b>
BEV A (BEV 150)	1,655	1,758	1,958	2,400	2,400	2,400	2,400	2,400
BEV B (BEV 250)	1,640	1,743	1,941	2,378	2,378	2,378	2,378	2,378
Annual Additional BEVs	3,295	3,501	3,899	4,778	4,778	4,778	4,778	4,778
PHEV A (PHEV 20)	0	0	0	0	0	0	0	0
PHEV B (PHEV 50)	8,536	9,224	9,861	9,861	9,861	9,861	9,861	9,861
Annual Additional PHEVs	8,536	9,224	9,861	9,861	9,861	9,861	9,861	9,861
Annual Additional Total ZEVs	11,831	12,725	13,760	14,639	14,639	14,639	14,639	14,639
<b>CO BAU Vehicles</b>								
	<b>2023</b>	<b>2024</b>	<b>2025</b>	<b>2026</b>	<b>2027</b>	<b>2028</b>	<b>2029</b>	<b>2030</b>
BEV A (BEV 150)	3,023	3,782	4,431	4,431	4,431	4,431	4,431	4,431
BEV B (BEV 250)	3,023	3,782	4,431	4,431	4,431	4,431	4,431	4,431
Annual BAU BEVs	6,045	7,565	8,862	8,862	8,862	8,862	8,862	8,862
PHEV A (PHEV 20)	0	0	0	0	0	0	0	0
PHEV B (PHEV 50)	2,460	2,779	3,233	3,233	3,233	3,233	3,233	3,233
Annual BAU PHEVs	2,460	2,779	3,233	3,233	3,233	3,233	3,233	3,233
Annual BAU ZEV Total	8,505	10,344	12,095	12,095	12,095	12,095	12,095	12,095
<b>CO Total Vehicles (Additional plus BAU)</b>								
	<b>2023</b>	<b>2024</b>	<b>2025</b>	<b>2026</b>	<b>2027</b>	<b>2028</b>	<b>2029</b>	<b>2030</b>
BEV A (BEV 150)	4,678	5,541	6,389	6,830	6,830	6,830	6,830	6,830
BEV B (BEV 250)	4,663	5,525	6,372	6,809	6,809	6,809	6,809	6,809
Total BEVs	9,340	11,066	12,761	13,639	13,639	13,639	13,639	13,639
PHEV A (PHEV 20)	0	0	0	0	0	0	0	0
PHEV B (PHEV 50)	10,996	12,003	13,094	13,094	13,094	13,094	13,094	13,094
Total PHEVs	10,996	12,003	13,094	13,094	13,094	13,094	13,094	13,094
Total ZEVs	20,337	23,069	25,855	26,734	26,734	26,734	26,734	26,734
Percent of Total Sales	7.31%	8.29%	9.30%	9.61%	9.61%	9.61%	9.61%	9.61%