Manufacturer Sales Under the Zero Emission Vehicle Regulation

2012 Expectations and Governors' Commitments Versus Today's Likely Outcomes

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About Shulock Consulting

Chuck Shulock is an environmental and climate policy consultant. 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.

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I. Introduction

A. Purpose

The Zero Emission Vehicle (ZEV) regulation is a visionary measure that seeks a transformation of the light duty vehicle fleet. Originally adopted in California in 1990, and now in force in nine other Clean Car ZEV states as well, the regulation has been a catalyst for manufacturer investment and innovation. The regulation has worked as intended, with multiple manufacturers bringing new models to the market, new entrants competing for market share, and sustained improvements in vehicle performance. The resulting ramp-up in battery production has helped bring about rapid cost reductions.

The ZEV regulation has evolved over the years as new information has emerged, with the stringency of the requirement being adjusted to better reflect the pace of technology development and customer response to newly developed vehicle platforms. In that spirit, this report was commissioned by the Natural Resources Defense Council (NRDC) to examine the likely number of vehicles that auto manufacturers (also referred to here as Original Equipment Manufacturers, or OEMs) will need to deliver through 2025 in order to comply with the current ZEV regulation, and identify possible modifications to ensure that the program remains on track to meet its long term goals.

In 2013, the Governors of eight of the ZEV states (including California, Connecticut, Maryland, Massachusetts, New York, Oregon, Rhode Island, and Vermont) signed a Memorandum of Understanding to place 3.3 million zero-emission vehicles on the road by 2025, equivalent to about 15% of passenger car and light duty truck sales by 2025 being plug-in hybrid, full battery electric, or fuel cell vehicles. The same jurisdictions, as part of the COP-21 Climate Agreement discussions in Paris, agreed to work with other jurisdictions toward having all new passenger vehicle sales being ZEVs by 2050 or sooner in order to meet climate stabilization targets.[1]

This year, as part of California's midterm review of its Advanced Clean Cars program, the Air Resources Board (ARB) is intending to conduct a comprehensive evaluation of the ZEV regulation to evaluate whether the program is on track out to 2025. The evaluation will address banked ZEV credits, market trends in California and other ZEV states, and if warranted, will propose regulatory modifications in 2017.[2] Within that broader context, this report presents the impact of recent developments on business-as-usual sales expected under the regulation. This study updates and more thoroughly accounts for factors that can affect the volume and types of vehicles required - such as manufacturers' existing ZEV

[1] "International ZEV Alliance Announcement," December 3, 2015, http://zevalliance.org/
[2] October 23, 2014, ARB Staff presentation to Board, "2014 Update to the Board: Advanced Clean Cars Program Midterm Review," Diamond Bar, CA.

credit bank, rapid improvements in electric range, new entrants such as Tesla, and the effects of other ZEV credit flexibilities.

The results strongly indicate that the number of vehicles required through 2025 will be smaller than originally projected in 2012 when ARB adopted the last major revisions to the ZEV program. While some of these vehicles will be higher performing in terms of electric range than the vehicles originally assumed in 2012, the net result is that the total number of vehicles is likely to fall short of the 2025 goals established by the Governors of California and the other ZEV states. The analysis indicates that – absent a strengthening of the program or a tightening of the ZEV credit structure – the ZEV program will deliver approximately 2.1 million electric-drive vehicles across the ten ZEV states compared to the 3.3 million goal. In 2025, this would translate to a market share of 6% of passenger vehicle sales in 2025 in California versus the 15.4% originally estimated, and 5.6% of passenger vehicle sales in 2025 in the so-called "Section 177" ZEV states.

Over the past decade, the technology-forcing nature of the ZEV program has resulted in many auto manufacturers developing ever-more-capable vehicles and new types of vehicles that increasingly can meet the needs of mainstream customers. However, going forward automakers such as Tesla, even if only partly successful with its Model 3 launch, could generate enough ZEV credits to cover the entire auto industry's ZEV portion of the requirements. The results indicate that the ZEV program may likely become "non-binding" as a regulation, and give rise to questions as to whether the program in its current form still provides the appropriate degree of technology-forcing pressure and will enable California to be on course to meet longer-term criteria pollutant and GHG reduction climate goals, as outlined in ARB's 2016 Mobile Source Reduction Strategy. [3]

With the 2030 and 2050 trajectory in mind, the report then identifies some possible regulatory options that make it far more likely that the program will result in vehicle deliveries hitting a minimum of 3.3 million across the ZEV states and reaching 15% sales by 2025, and thereby provide a more plausible bridge to the much higher deployments needed by 2030 and beyond.

B. Methodology

The ZEV regulation - despite the portrayals often found in the press - does not require the industry to reach specific vehicle sales share targets of ZEVs, but rather requires a certain number of "ZEV credits" to be delivered annually. The regulation awards ZEV credits to manufacturers based primarily on various performance characteristics of the vehicles produced to comply. This means that vehicles with longer electric (or zero tailpipe emission) range earn more credit, and in turn fewer such vehicles are needed to meet a manufacturer's credit obligation. Thus the type of vehicles that a manufacturer chooses to produce has a large impact on the number of vehicles needed to comply. Currently the possible number of ZEV credits that can be earned by model year (MY) 2018 through 2025

[3] http://www.arb.ca.gov/planning/sip/2016sip/2016mobsrc.htm

vehicles goes from as little as 0.6 credits per vehicle, for a plug-in hybrid that gets 10 miles real-world electric range and does not qualify for an additional "US06" credit (explained below), to as high as 4 credits for a fuel cell vehicle placed in California, with credits from the latter also able to be used to help meet the compliance obligations in all other ZEV program states, more than doubling their effective value.

To support this analysis the consultant developed a new spreadsheet model that calculates the number of vehicles that will need to be delivered given various assumptions. The model has the capability to show the impact of changes in manufacturer total sales and ZEV program sales, Tesla sales, vehicle range, the rate of technical improvement, use of banked credits, the criteria used to calculate ZEV credit, and many other factors. More detail regarding the model and the assumptions used is provided in Appendix A: Spreadsheet Model and Assumptions.

Given the many variables at work there is great uncertainty regarding the ultimate number of vehicles to be delivered in future years. This uncertainty has raised questions on how the ZEV crediting structure could achieve – with far more certainty - the desired policy outcomes in terms of ZEV volumes and market share.

This report was prepared for the Natural Resources Defense Council by Shulock Consulting, with policy direction and input from Simon Mui, who leads NRDC's vehicle and fuels work in California. Shulock Consulting developed a spreadsheet model to evaluate the expected number of vehicles to be delivered by the ZEV program. For the scenarios looking at potential modifications to the ZEV program, NRDC defined the goals to be achieved by the program and chose the specific modifications to the crediting structure to be included in the policy packages. The inputs to the model used for the NRDC base case and other scenarios, such as vehicle range, were developed by NRDC with advice from the consultant and external reports. The consultant then ran the model using the specified inputs and adjusted the credit calculation methodology as needed to achieve the defined goals.

The outputs of the model are snapshots of plausible scenarios, but should not be viewed as firm predictions. Rather the model provides a consistent framework for exploring the impact of different assumptions, under the existing regulation as well as possible alternatives.

II. ZEV Policy Goals

The goal of the California mobile source control programs is to help achieve health-based air quality standards and reduce emissions of greenhouse gases. The ZEV program is an integral part of that effort, both by directly reducing vehicle emissions and by commercializing zero emission technologies and thus enabling future reductions in fleet average emission standards. To play its critical part in the overall mobile source control program, the ZEV program must work towards a number of more specific goals, both quantitative and qualitative.

A. Quantitative Goals

1. Governors' Stated Goals for California and MOU States

In 2012 Governor Brown of California signed Executive Order B-16-2012 which outlined a series of aggressive measures to support ZEV deployment and directed ARB and other state agencies to establish benchmarks to help achieve over 1.5 million zero emission vehicles on California roads by 2025, with an expanding market share. This was followed in 2013 by a multi-state Memorandum of Understanding signed by Governor Brown and seven other Governors, under which their states agreed to a collective target of having at least 3.3 million zero emission vehicles on the road by 2025.

2. Other California Statutory Goals

The 1.5 million vehicle goal in Governor Brown's Executive Order goal has been reinforced by subsequent statutory measures. Chapter 530, Statutes of 2013 (SB 1275, De Leon) established the Charge Ahead California Initiative with a goal to place in service at least one million zero-emission and near-zero-emission vehicles in California by January 1, 2023. Chapter 418, Statutes of 2013 (SB 454, Corbett) references a goal of 1.5 million electric drive vehicles in California by 2025.

3. Trajectory for Long Term Success

Governor Brown's Executive Order B-16-12 also established a California target to reduce greenhouse gas emissions from the transportation sector in 2050 by 80 percent as compared to 1990 levels. This was followed in 2015 by his Executive Order B-30-15, which established an interim statewide greenhouse gas reduction target of 40 percent below 1990 levels by 2030. Once again subsequent legislation has reinforced those targets. Chapter 547, Statutes of 2015 (SB 350, De Leon) references the Executive Order goals, making a finding that reducing emissions of greenhouse gases to 40 percent below 1990 levels by 2030 and to 80 percent below 1990 levels by 2050 will require widespread transportation electrification. Chapter 547 also directs that agencies designing and implementing regulations to reduce greenhouse gas emissions shall take the above finding into account.

Various studies have attempted to define the levels of ZEV penetration needed to meet these long term goals in California. A detailed analysis of that work is beyond the scope of this effort, but some relevant findings are highlighted here to provide context. In June 2016 ARB staff released a 2030 Target Scoping Plan Concept Paper outlining potential policy concepts to achieve the 2030 target. All four of the concepts presented included 1.5 million zero emission and plug-in hybrid light duty electric vehicles by 2025. The Air Resources Board's May 2016 Mobile Source Strategy Report examined the impact of several ZEV penetration scenarios. The Cleaner Technology and Fuels Scenario, under which the mobile source sector contributed its equal share of the emission reductions needed to reach the 2030 and 2050 greenhouse gas reduction targets, resulted in 1.7 million cumulative ZEVs and PHEVs in 2025 and 4.3 million in 2030. The annual sales fraction was

18 percent in 2025 (slightly higher than the 2012 ARB projections for the existing regulation) with a rapid acceleration to a 2030 sales fraction of 40 percent. A similar 2015 study commissioned by several state agencies and performed by Energy and Environmental Economics (E3) projected under its "straight line" scenario a population of 2.5 million cumulative ZEVs and PHEVs in 2025 and 6.75 million in 2030, with sales fractions of 35 percent in 2025 and 56 percent in 2030.

There is considerable uncertainty associated with all such projections. In addition, the vehicle totals referenced in the above studies are not directly comparable to the NRDC base case vehicle totals. For this study, NRDC assumed improvements in electric-drive range for both BEVs and TZEVs. This means that on a per-vehicle basis more VMT may be electrified and greater GHG emission reductions achieved as compared to ARB's original 2012 assumptions. Nonetheless it appears that the 1.5 million Executive Order cumulative target for 2025, and the associated ARB baseline projection of a 15 percent sales fraction in 2025, are if anything at the low end of the range needed to maintain progress towards 2030 and 2050.

B. Qualitative Goals

In addition to the numeric goals noted above the ZEV program has other goals that are more difficult to quantify but also important.

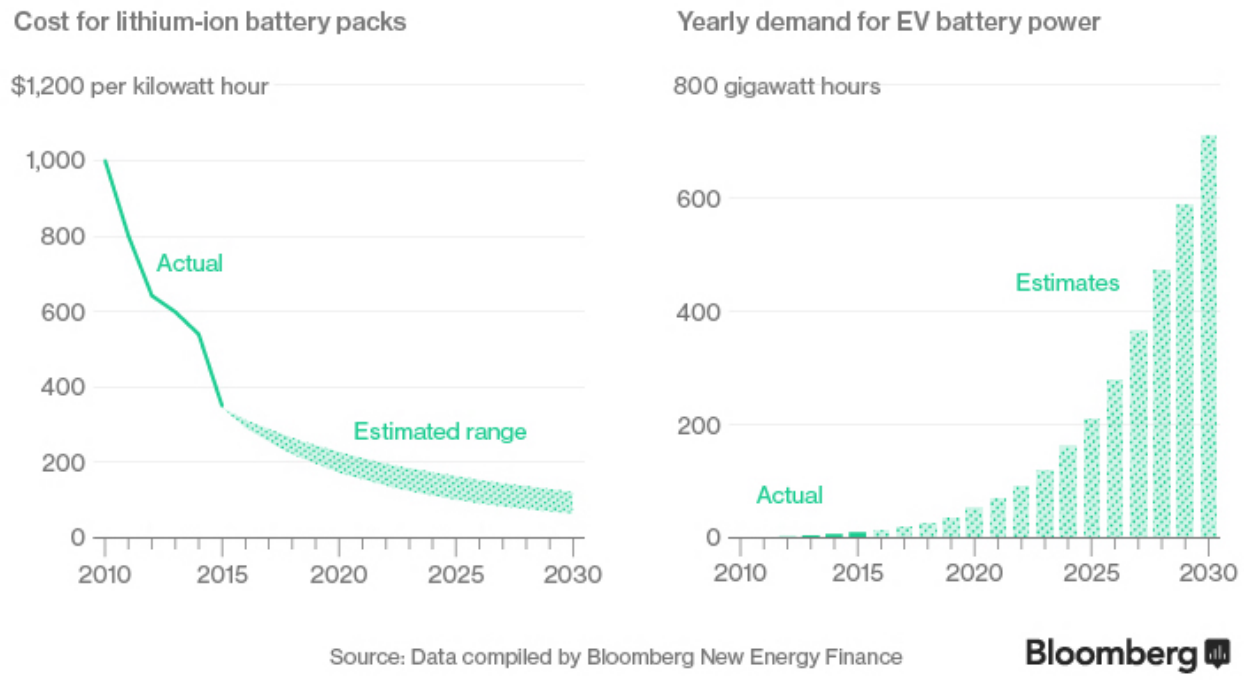
1. Technology Forcing

The ZEV program is a textbook example of the ARB's technology-forcing approach to vehicle regulation. Throughout the history of the mobile source control program the ARB has imposed requirements that manufacturers initially viewed as infeasible, but that spurred manufacturer research and development and ultimately resulted in well-engineered cost-effective solutions, from adoption of the catalytic converter to development of low-NOx engine technologies. The challenge for regulators has been to find the appropriate degree of technology-forcing pressure that induces progress but does not call for unattainable results. Finding this balance has been particularly difficult for the ZEV program, which requires fundamentally different powertrains rather than incremental improvements to existing technology. When ZEV technology did not advance as quickly as projected in the early years, the ARB responded by repeatedly relaxing the requirement for pure ZEVs while providing ZEV credit for extremely clean gasoline vehicles and for ZEV-enabling technology such as hybrids and plug-in hybrids. In recent years, however, cost reductions and performance improvements are proceeding at a rapid pace such that in 2012, for the first time, the ZEV program was made more stringent during a rulemaking rather than relaxed.

As will be shown below, these recent technology improvements, along with a large supply of banked credits from early placements, have made it possible for manufacturers to comply with the ZEV regulation with a much smaller number of higher-performing vehicles than originally anticipated. For the auto industry, this is good news as it points to significant over-compliance with the ZEV program going forward, and means that the

program has thus far worked as intended to spur early introductions and technical progress, including significant cost reductions in batteries as shown in Figure 1. The question for now, however, is whether the program still maintains its original degree of technology-forcing pressure. Although significant challenges still must be overcome before ZEV technology reaches mainstream status, the fact remains that the pace of future technical progress needed to comply with the regulation appears to be declining over time. As will also be shown below, this is particularly true when taking into account the impact of potential Tesla sales on the supply of ZEV credits.

Figure 1: Early deployment of BEVs and PHEVs has resulted in rapid cost reductions in battery packs.



2. Product Diversity

The ZEV program seeks to commercialize ZEV technology such that it can successfully compete in the mainstream market without subsidies or mandates. Commercial success at the 40 or 50 percent market shares noted above will require that ZEV options exist in many market segments, above and beyond the small car market served by most existing offerings. There also is a need, at least for the near term, to provide options for customers who do not want to deal with vehicle range concerns. Thus the ZEV regulation ideally would encourage manufacturers to use a variety of platforms, including longer-range BEVs, fuel cell vehicles, and higher performing plug-in hybrids, and explore ways to reach the broadest customer base while maintaining progress towards an electric drive future. As explored in Package 2 below, greater encouragement for high performance "Transitional Zero Emission Vehicles" (or "TZEVs", which refers to plug-in hybrids) could be a step in that direction.

3. Export and Scale-Up of Clean Vehicle Technologies

Together with other Clean Car States, California has long positioned itself to be the incubator for cleaner vehicle technologies, with many of the programs successfully exported to other jurisdictions. Acceleration of ZEV deployment beyond California will help achieve the scale-up and cost-reductions needed for long-term success. California and other ZEV states have already represented over one fifth of the global ZEV market to date.[4]

III. Base Case--Current Trends Continued: California

This section of the report discusses the "business as usual" baseline number of cars. The starting point is the Likely Compliance Scenario developed by Air Resources Board staff during the 2012 amendments to the ZEV regulation. The report then determines how updates to the assumptions used by ARB in 2012 affect the expected number of vehicles. (Please note that the ARB plans to release updated compliance calculations that will similarly revise their assumptions. For the moment we are using the published technical backup to the 2012 amendments.)

A. Key Assumptions

Any calculation of the number of vehicles needed to comply with the ZEV regulation is necessarily based on a number of assumptions. The assumptions with the greatest impact are:

- Total manufacturer sales: The number of ZEV credits needed by manufacturers is a percentage of their total sales. Therefore higher sales mean more ZEVs, and vice versa.
- Use of banked credits: Manufacturers can meet their entire obligation using banked credits earned from previous sales or purchased from other manufacturers. Greater reliance on banked credits reduces the number of new vehicles needed.
- Tesla sales: Tesla sales of course increase the number of ZEVs being produced. But Tesla sales also generate ZEV credits that can be used by other manufacturers to meet their own ZEV obligation, which reduces the number of vehicles needed by OEMs.
- Vehicle performance: A longer range vehicle earns more credit, and TZEVs earn additional credit if they travel 10 miles or more on the US06 driving test cycle, which approximates the higher speeds and more aggressive accelerations seen on freeways. The more credits earned per vehicle the fewer such vehicles are needed to earn a given amount of ZEV credit.

Table 1 shows the assumptions used for manufacturer sales, use of banked credits, and Tesla sales in the ARB 2012 Likely Compliance Scenario versus the assumptions used in the updated NRDC base case. The EMFAC 2010 California sales projections used by ARB predate the recent rebound in manufacturer sales, so the more recent EMFAC 2014

[4] http://www.theicct.org/transition-global-zero-emission-vehicle-fleet-collaborative-agenda-governments

numbers are higher. For example, EMFAC 2010 projects 2020 sales of about 1.7 million, staying at about that rate through 2025, while EMFAC 2014 projects 2020 sales of about 1.8 million rising to 1.9 million in 2025. This change results in a higher number of vehicles required. On the other hand ARB did not consider the use of banked credits, nor did it include any Tesla sales, both of which reduce the number of vehicles required from other manufacturers. This simplified approach was adequate for looking at the impact of alternative regulatory strategies but it overstates the number of vehicles actually to be delivered in the real world.

Table 1: Major Assumptions Used in Modeling the "Likely Compliance Scenario" or Base Case

	OEM Total Sales	Banked Credits	Tesla Sales
ARB 2012	EMFAC 2010	Not Included	Not Included
NRDC 2016	EMFAC 2014	Included	Included

Table 2 shows the vehicle range assumptions used by ARB in 2012 versus the updated assumptions used in the NRDC Base Case. The TZEV "transitional zero emission vehicles" are essentially extended range plug-in hybrids like the GM Chevy Volt or blended mode plug-in hybrids like the Toyota Prius Plug-in that have some all-electric range while using the gasoline hybrid engine for non-electric portions of a trip. The ARB 2012 range estimates for 2020 and beyond fall short of levels already achieved today, so updated assumptions are in order. For example, the current GM Bolt EV to be offered for MY2017 is expected to deliver 200 miles or more of real-world range. Similar, the MY2017 Volt delivers 53 miles of electric range as a TZEV. (Note that for ease of comprehension Table 2 shows the label (real world) range. The calculation of ZEV credits is based on city cycle (UDDS) range, which is higher by a factor of roughly 1.45).

Table 2:

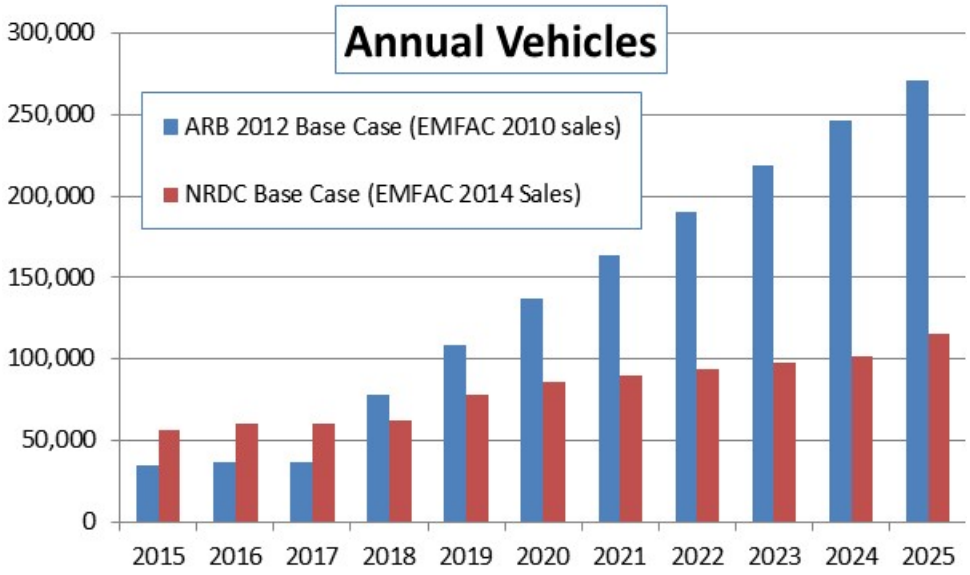
Electric Range (Label)	2018	2019	2020	2021	2022	2023	2024	2025
ARB BEV	69	69	69	69	69	69	69	69
ARB FCV	241	241	241	241	241	241	241	241
ARB TZEV	14	14	14	14	14	14	14	14
NRDC BEV	128	155	179	200	215	225	233	240
NRDC FCV	320	320	320	320	320	320	320	320
NRDC TZEV	28	34	40	44	48	50	52	53

The NRDC base case also assumes that at a minimum manufacturers maintain BEV sales at their 2015 levels and produce FCVs at the level projected in the 2015 AB 8 report.[5] Additional detail regarding the updated NRDC assumptions and their rationale are provided in Appendix A.

B. 2012 ARB Likely Compliance Scenario vs. NRDC 2016 Base Case Scenario

Using EMFAC 2014 vehicle sales projections rather than EMFAC 2010 increases the cumulative number of vehicles needed through 2025 by about 10 percent. However the other NRDC modified assumptions (increased range, use of banked credits, Tesla sales) collectively have about a 50 percent impact in the opposite direction, with the net result being about a 40 percent decrease in expected deliveries by OEMs. Figure 2 shows the annual and cumulative (from program inception through 2025) number of vehicles that result from the ARB 2012 Likely Compliance Scenario versus the NRDC Base Case.

Figure 2



[5] The AB 8 report projects cumulative FCV sales of 10,500 by 2018 and 34,300 by 2021. For this report we convert those cumulative figures to annual sales and continue the 2021 level through 2025.

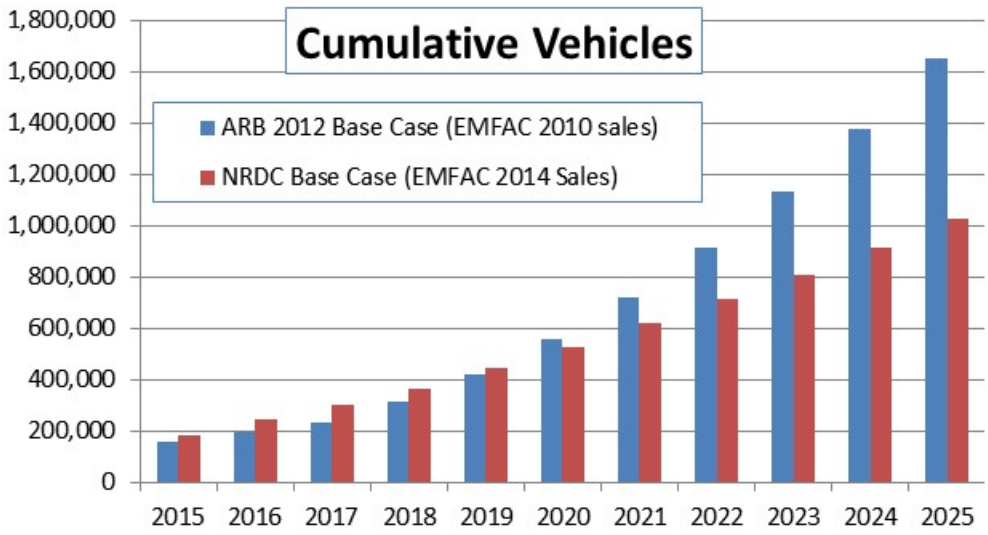


Table 3 shows totals for cumulative EVs and TZEVs through 2025, as well as annual sales and percent sales in 2025. As the figure and table illustrate, under the NRDC base case both cumulative sales through 2025 as well as annual sales in 2025 are lower than ARB's 2012 Likely Compliance Scenario, and also fall short of the Governor's Executive Order goals. Details of the NRDC calculations are provided in Appendix A.

Table 3

	Cumulative Vehicles through 2025			2025	
	EV	TZEV	Total	Sales	Percent
ARB Base Case	617,227	1,030,195	1,647,421	270,655	15.4%
NRDC Base Case	505,707	520,856	1,026,563	115,161	6.0%

C. The Impact of Tesla and Potential Other EV Producers

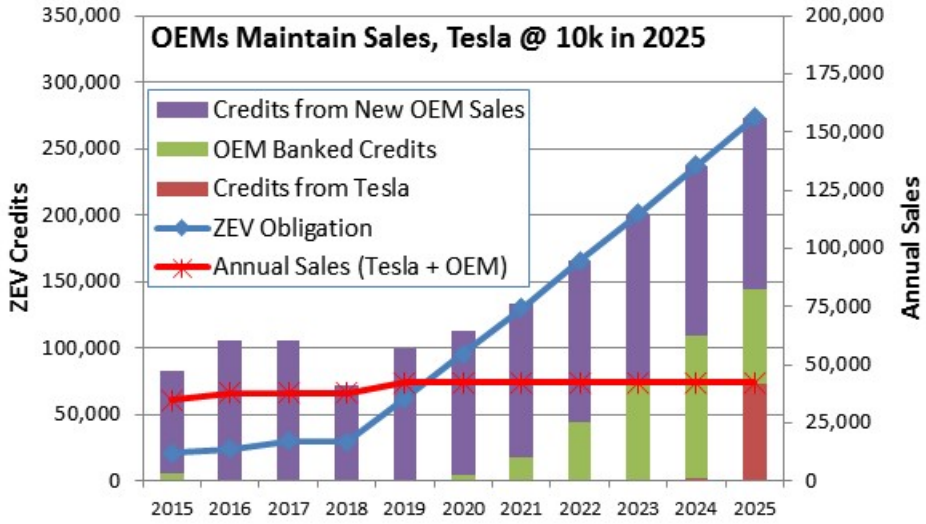
Tesla sales have the potential to substantially affect vehicle totals, both directly through their own sales and indirectly through the sale of credits to other manufacturers who can use them to offset their own ZEV obligation. The overall impact will depend on the number of Tesla sales, and also on manufacturers' compliance strategies, i.e. do manufacturers aggressively market new ZEVs, even in excess of their ZEV obligation, do they maintain existing sales levels, or do they maximize the use of Tesla credits in order to minimize their own obligation?

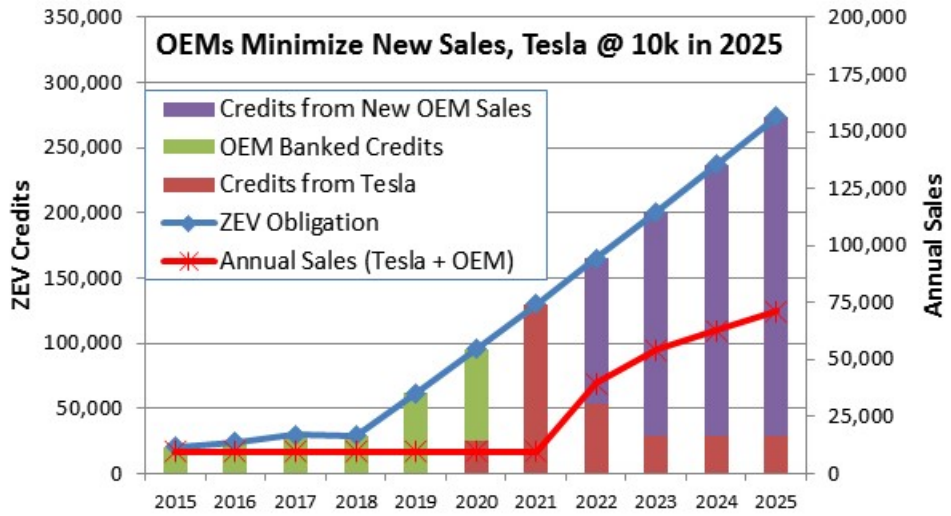
Given these unknowns it is not possible to accurately predict Tesla's impact or the potential impact of other EV producers that could enter California's market (e.g. BYD, Apple, Faraday Future). We have developed four scenarios to illustrate a range of potential outcomes in California. These scenarios only look at sales of pure ZEVs, under the assumption that manufacturers would only use Tesla credits to meet the pure ZEV portion of their obligation. As a low-end bounding case, Figure 3 shows the first two such cases, both of which assume that Tesla sales stay static at 2015 levels through 2025 (approximately 10,000 per annum in California). (As a reference point, currently Tesla has received almost

400,000 deposits globally for its planned $35,000 Model 3 vehicle targeted for introduction at the end of 2017. With California historically having received nearly 27% of Tesla's production, this would represent nearly 110,000 pre-orders, not accounting for future orders or purchases.) The top figure assumes, per the NRDC base case, that OEMs maintain BEV sales at their 2015 level (about 25,000 per annum) through 2025 and produce FCVs at the level projected in the 2015 AB 8 report (increasing to about 8,000 per annum by 2021), even if that exceeds what is needed for ZEV compliance. The results show that most of the necessary ZEV credits come from keeping new OEM sales flat at 2015 levels. Some banked OEM credits are needed starting in 2020, and Tesla credits are only needed in 2025.

The bottom figure assumes that OEMs choose to minimize their ZEV sales, only producing new vehicles when their own banked credits or Tesla credits are fully utilized. In this case no new OEM sales of ZEVs are needed until 2022, with new OEM sales providing the majority of needed credits from that point forward. In both cases Tesla has only a minor impact on overall credit generation and use.

Figure 3



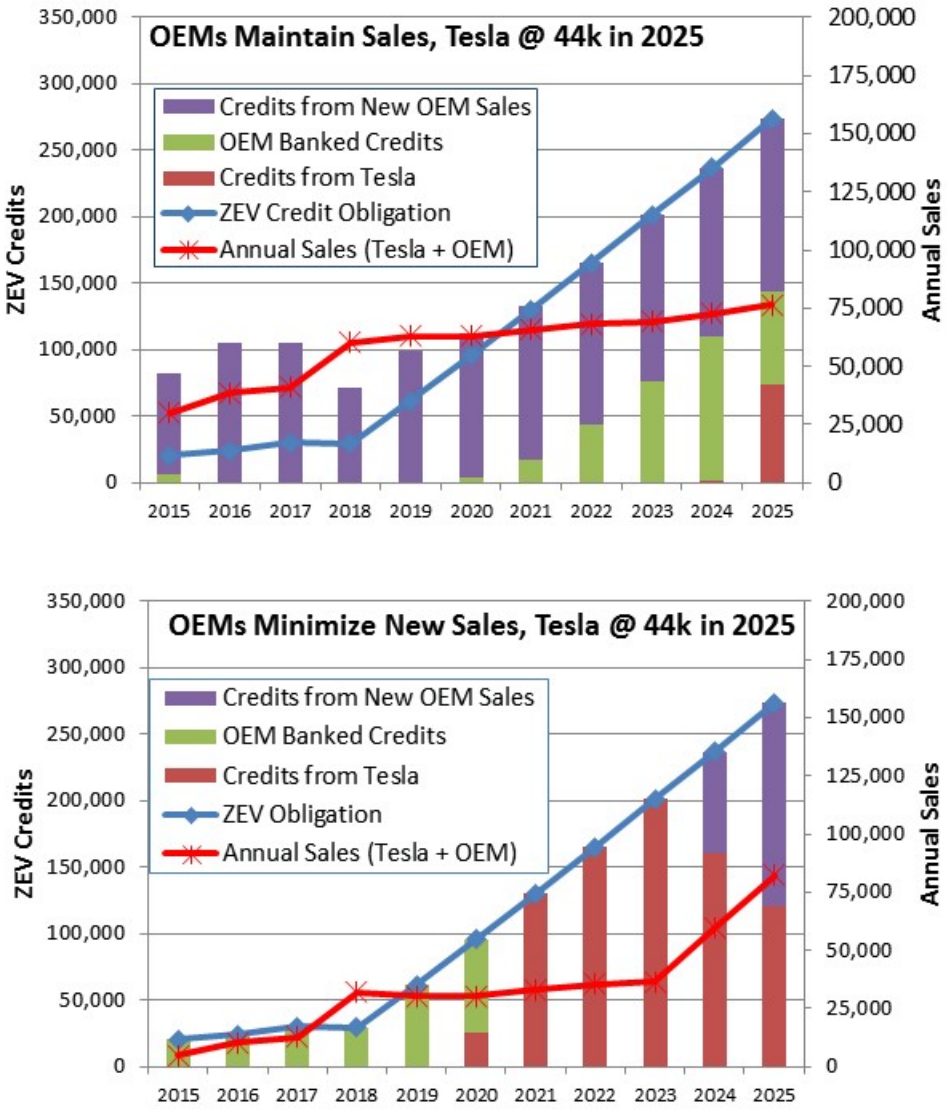


The second set of cases, shown in Figure 4, both assume that Tesla sales increase steadily over time, reaching about 44,000 in 2025 for California. (This represents only 50 percent of a recent Tesla sales projection made by Alan Baum and Associates and provided to NRDC, prior to the Tesla Model 3 pre-order news). Once again the top figure assumes that OEMs maintain the NRDC base case sales level. Here very few Tesla credits are needed, so there would be a large bank of Tesla credits available for future use (about 570,000 credits in 2025, which would meet about 2 years of the OEM obligation at that point). From a vehicle standpoint the Tesla sales are additive and this results in higher annual sales.

The bottom figure again assumes that OEM new sales are minimized. At this higher Tesla sales level there are enough Tesla credits available to meet the entire OEM obligation until 2024, and very few credits come from new OEM sales. Here the Tesla vehicles offset OEM vehicles, so fewer vehicles are produced overall than in the "maintain sales" case. These results indicate that at plausible Tesla sales levels the large number of Tesla credits generated would in effect render the regulation "non-binding", i.e. manufacturers would not be required to produce new vehicles but rather could comply entirely with banked and Tesla credits.

The results indicate that even under a zero growth or conservative growth scenario for Tesla, the OEMS as a whole would not be required to produce ZEVs directly until 2022 or 2024.

Figure 4



IV. Base Case--Current Trends Continued: ZEV States

Section 177 of the Clean Air Act authorizes other states to adopt California's motor vehicle emission standards in lieu of federal standards. Nine states, primarily in the Northeast, have adopted the complete California program including the ZEV requirements. The same factors that have a downward impact on the number of ZEVs to be delivered under the ZEV program in California (increasing range, manufacturer banked credits) also apply in other states. In addition, the "travel" provision of the ZEV regulation, discussed below, further reduces the expected number of vehicles. This section discusses the impact of these factors on the number of vehicles to be expected in the Section 177 ZEV states.

ZEV banked credit information from each of the ZEV states was requested for this analysis. Due to limitations and inconsistencies in the available sales and banked credit data outside of California, we are not able to develop a detailed state-by-state calculation that directly models the impact of these updated assumptions for the Section 177 ZEV states in a consistent fashion. We instead use the same methodology that ARB has used in the past to calculate vehicle placements in the ZEV states, under which a "scaling factor" is used to go from California to ZEV state results. Specifically we assume that in the Section 177 ZEV states manufacturers' sales, baseline ZEV placements and banked credit balances are all 1.4 times the corresponding California totals. The 1.4X scaling factor for manufacturer sales has been used by ARB in the past to model Section 177 ZEV state impacts and still accurately reflects current sales. To verify its applicability for banked credit balances we compared data from all ZEV states, and were able to obtain information (albeit somewhat dated for some states) from all states other than Vermont and Rhode Island. Table 4 shows that the ZEV state credit balance for pure ZEV credits is about 1.2 times the California balance while NEV and TZEV ratios are 1.9. We note that some of these ratios may be lower since some of the Section 177 ZEV data was dated and OEMs may take additional time to "travel" credits. In theory, there is little economic rationale for OEMs not to eventually "travel" all vehicles placed in California to other ZEV states, and for all vehicles placed in other ZEV states to be traveled back to California. Thus, the 1.4X scaling factor seems reasonable and even conservative.

Table 4. Manufacturer Credit Balances

	ZEV	NEV + TZEV	AT PZEV + PZEV
California	241,343	145,496	361,162
ZEV States	292,773	276,349	441,742
Ratio	1.21	1.90	1.22

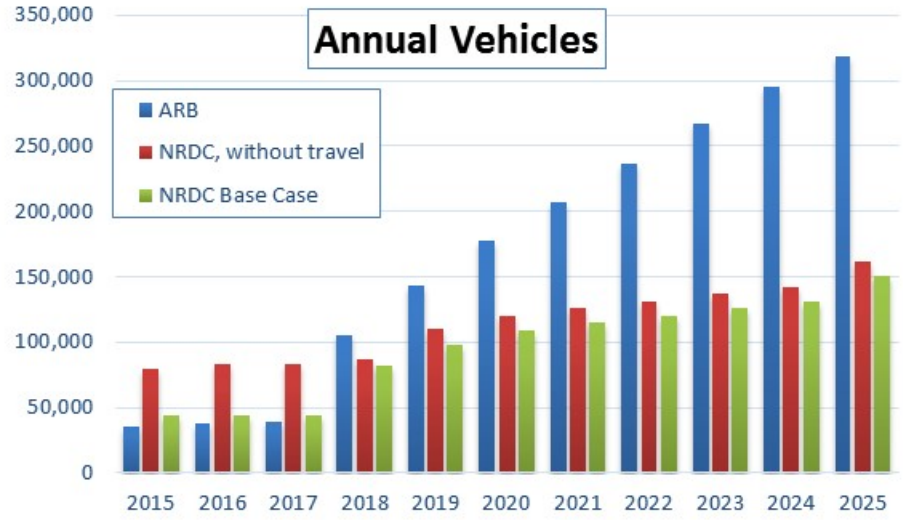
Figure 5 shows the annual and cumulative number of vehicles for three cases.[6] The first case uses a modified version of the ARB's most recent published calculation for ZEV placements in the Section 177 ZEV states. The ARB calculation uses as a starting point the 2012 California likely compliance scenario then applies a scaling factor[7] as noted above. It then reduces the ZEV state total of estimated ZEV placements to account for the impact of the travel provision of the ZEV regulation. Under that provision a ZEV placed in California may be counted towards compliance in all Section 177 states, at a "proportional value" based on the ratio of a manufacturer's California sales to their sales in each state. This provision applies to BEVs placed through 2017 and to FCVs placed in all model years.

The second case takes the California NRDC base case and multiplies it by 1.4. This is an intermediate calculation, shown here for comparison purposes to illustrate the impact of the travel provision. The third case, which serves as the NRDC base case for the Section

[6] For the ZEV state calculations "cumulative" refers to sales from 2015 through 2025.
[7] The ARB calculation used a scaling factor of 2.0. We instead use a factor of 1.4, which has been commonly used in the past by ARB and more closely corresponds to the actual ratio of ZEV state to California sales.

177 states, adds in the impact of the travel provision, which lowers the number of vehicles particularly prior to 2018 when BEV travel still remains.[8]

Figure 5



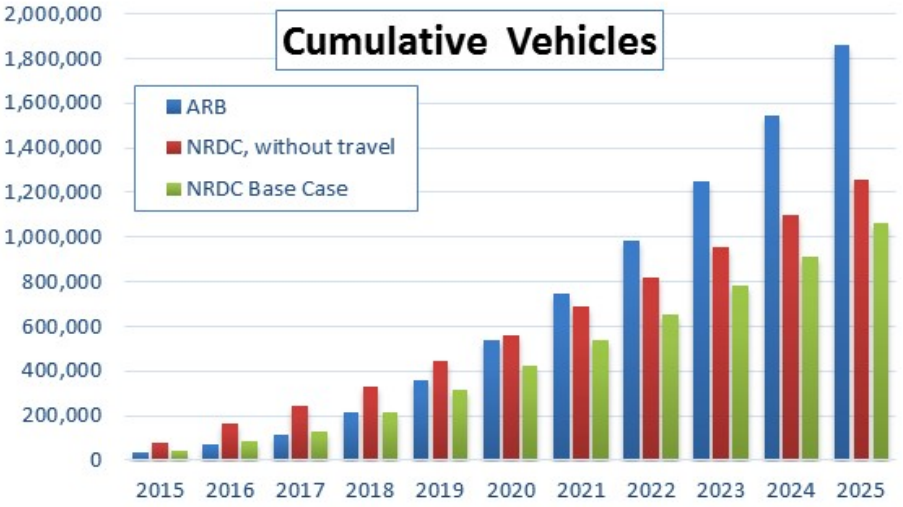


Table 5 shows totals for cumulative EVs and TZEVs from 2015 through 2025, as well as annual sales and percent sales in 2025 for the Section 177 ZEV states. As the figure and table illustrate, under the NRDC base case both cumulative sales through 2025 as well as annual sales in 2025 are lower than the ARB scenario.

[8] Due to the data limitations noted above we are unable to model the travel provision on a state-by-state basis, so to approximate its impact we multiplied California placements subject to travel by 1.4, then subtracted that total from the aggregate Section 177 ZEV state placements.

Looking at cumulative sales for California plus the Section 177 ZEV states, the California NRDC base case (1 million) plus the NRDC ZEV state Base Case (1.1 million) is about 2.1 million, as compared to the 3.3 million vehicles called for under the multi-state Memorandum of Understanding on State Zero Emission Vehicle Programs, or about 37% lower than the goal.

Table 5

	Cumulative Vehicles through 2025			2025	
	EV	TZEV	Total	Sales	Percent
ARB	513,417	1,349,675	1,863,092	317,893	12.9%
NRDC, without travel	623,533	636,600	1,260,134	161,225	6.0%
NRDC Base Case	426,916	636,600	1,063,516	150,119	5.6%

These calculations provide a clear indication that the same phenomenon observed for California applies to the Section 177 ZEV states--the number of vehicles to be delivered will likely be significantly lower than originally anticipated during the 2012 rulemaking.

V. Potential ZEV Policy Approaches

This report next looks at potential regulatory changes that would make the ZEV regulation more likely to reach the goals outlined in Section II above, focusing most directly on the California quantitative goals of 1.5 million cumulative sales and 15 percent annual sales by 2025 but also looking at the impact in the ZEV states. It first details the available regulatory "levers"--aspects of the regulation that can be adjusted to affect the number of vehicles required. It then presents two policy packages--combinations of several changes working in concert--that would bring the number of vehicles more closely in line with the policy goals.

A. Regulatory Levers

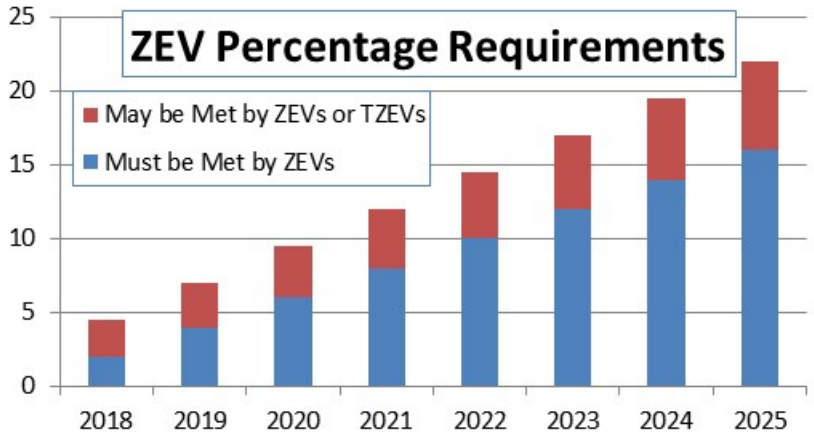
The ZEV regulation requires manufacturers to submit in each model year a number of ZEV credits equal to a specified percentage of its sales. Put most simply, the number of vehicles needed to demonstrate compliance in a given year is determined by three basic variables, each of which can be modified to change the required number of vehicles. These variables are discussed in turn below, based on their operation for model years 2018 and beyond.

1. Percentage Requirements

The regulation establishes an overall percentage requirement that manufacturers must meet, and also defines the portion of the requirement that can be met by various types of vehicles. Over the history of the regulation a number of different types of vehicles have been eligible to earn ZEV credit, with the level of advanced technology needed to qualify increasing over time. In its current form, the regulation allows credit to be earned by ZEVs and TZEVs, with the percentage requirements shown in Figure 6. Over time, an increasing

fraction of compliance must be met through pure ZEVs such as battery electric vehicles and fuel cell vehicles that have zero tailpipe emissions under all operating modes.

Figure 6



An increase in the total overall percentage requirement will result in proportionally more vehicles. A change in the allowable TZEV fraction of the requirement has a more complex effect. In 2012, ARB assumed that manufacturers maximize the use of the TZEV option (which has been the standard assumption for all non-ZEV options for the life of the program). Based on this assumption, if the fraction of allowable TZEVs increases the results would be to (1) reduce the number of ZEVs (because the minimum ZEV fraction is smaller), (2) increase the number of TZEVs (because the maximum TZEV fraction is larger), and (3) increase the total number of vehicles (because TZEVs on average will earn fewer credits per vehicle than ZEVs, which means that more vehicles are needed to earn a given number of credits).

2. Credit Earned Per Vehicle

The current regulation uses a formula to determine the amount of credit earned by a given ZEV or TZEV, which for ZEVs includes a fixed base credit and a variable credit based on the vehicle's all electric range. For TZEVs, the regulation includes a fixed base credit and a variable range-based credit plus an additional fixed credit awarded if the vehicle is capable of 10 or more miles of all electric range on the US06 test cycle. Changing the formula such that it awards fewer credits per vehicle going forward would result in more vehicles needed to generate a given number of credits.

Another important lever for the ZEV program is the allowance for “travel” of credits between states. Travel allows automakers to comply with credit requirements in other ZEV states if vehicles are sold in California, and vice versa. As aforementioned, travel of BEVs under the current requirements will end in MY2017 while travel of FCVs continues indefinitely. Effectively, travel works as a strong credit “multiplier” for automakers to the detriment of vehicles being required in Section 177 states.

3. Use of Banked Credits

Credits earned by manufacturers but not used for compliance in a given year can be banked indefinitely for future use. The current regulation allows unlimited use of banked credits to achieve compliance. Based on the most recent information available, the supply of banked ZEV credits across the industry is sufficient to meet the manufacturers' entire California ZEV obligation from 2016 through most of 2020, and the supply of banked TZEV credits is sufficient for 2016 through most of 2019. If desired there are several ways to limit the impact of banked credits on future vehicle production and deliveries. One possible approach is to reduce the value of previously earned credits. For example at the end of the 2017 model year the current regulation will discount the value of banked Advanced Technology Partial Zero Emission Vehicle ("AT PZEV") credits, such as are being earned currently by conventional Toyota Prius vehicles, by 75 percent and will discount the value of banked "Partial Zero Emission Vehicle" ("PZEV") credits, such as are being earned by the conventional Honda Civic, by 93.25 percent. Applying a discount factor to banked ZEV credits will increase the number of vehicles required over time. Another possible approach is to require a "minimum effort" of vehicle production, such that some portion of a manufacturer's credit obligation must be met with credits from vehicles produced in that same model year. This option primarily affects the timing of vehicle production rather than the amount--it would increase the number of vehicles required in early years, but the banked credits that could not be used in early years would be available to reduce vehicle production in later years.

B. Policy Packages

All of the above elements can be changed in isolation or in combination, and to varying degrees, which means that there are a variety of ways to approach the policy targets. NRDC reviewed a wide range of possible regulatory changes. Two combinations, or packages, are presented here as examples for further exploration. Due to considerations of lead time for manufacturers to adjust to regulatory changes, it is assumed the modifications take effect starting in the 2021 model year. It should be noted that this delayed introduction limits the impact of the modifications on the cumulative number of vehicles, because cumulative production through 2021 is unaffected.

1. Minimum Floor, Stricter Crediting, Minimum TZEV Performance

The first package restricts the use of banked credits and modifies the formula for awarding per-vehicle credit. It includes the following elements:

- Minimum Protective Floor: At least 25 percent of credits used to comply must come from vehicles produced in that model year. This helps ensure that auto manufacturers are less likely to discontinue vehicle offerings to the public after they have met their credit obligations. This strategy has been referred to in the trade press as a "compliance

car" strategy whereby an automaker only offers a fixed volume of vehicles to the public to meet its compliance obligation with little intent to sell in volume.[9]

- Stricter Crediting: Per-vehicle credits are reduced as needed to approach the 2025 targets, better ensuring that the credit structure is updated to reflect volume and sale goals of the jurisdictions.
- Minimum TZEV Performance: TZEVs need US06 all electric range capability and a 20 mile real world range (29 UDDS) in order to qualify for credit. This change would update the standard to account for technology improvement and help ensure that the flexibility provisions allowing for TZEVs to qualify as ZEVs are more likely to result in vehicles capable of all-electric mode at freeway speeds and more aggressive acceleration. This package assumes that TZEVs have on average the range shown in the NRDC base case as shown in Figure 4 above.

Table 6 shows the per-vehicle credit that results from the adjustments applied in the package, and Table 7 shows the resulting number of vehicles for California, the Section 177 ZEV states, and both combined.

Table 6

		2018	2019	2020	2021	2022	2023	2024	2025
BEV	Range (UDDS)	184	224	259	289	311	325	336	347
	Credit, Current Regulation	2.34	2.74	3.09	3.39	3.61	3.75	3.86	3.97
	Credit, Alternative	2.35	2.74	3.10	1.85	1.97	2.05	2.11	2.17
	Percent Reduction	0%	0%	0%	45%	45%	45%	45%	45%
TZEV	Range (UDDS)	41	50	58	65	70	73	75	78
	Credit, Current Regulation	0.91	1.00	1.08	1.15	1.20	1.23	1.25	1.28
	Credit, Alternative	0.91	1.00	1.08	0.43	0.46	0.47	0.49	0.50
	Percent Reduction	0%	0%	0%	62%	62%	61%	61%	61%

Table 7

California	Cumulative Vehicles through 2025			2025	
	EV	TZEV	Total	Sales	Percent
ARB	617,227	1,030,195	1,647,421	270,655	15.4%
NRDC Base Case	505,707	520,856	1,026,563	115,161	6.0%
Alternative	615,226	992,393	1,607,620	295,685	15.5%
Section 177 ZEV States					
ARB	513,417	1,349,675	1,863,092	317,893	12.9%
NRDC Base Case	426,916	636,600	1,063,516	150,119	5.6%
Alternative	530,543	1,296,753	1,827,296	389,362	14.6%
Total					
ARB	1,130,644	2,379,870	3,510,513	588,548	14.0%
NRDC Base Case	932,623	1,157,456	2,090,079	265,279	5.8%
Alternative	1,145,770	2,289,147	3,434,916	685,046	15.0%

[9] http://www.greencarreports.com/news/1068832_electric-cars-some-are-real-most-are-only-compliance-cars--we-name-names

2. Minimum Floor, Stricter Crediting, Minimum TZEV Performance, Allow High Performance TZEVs to Satisfy Larger Portion of ZEV Requirement

The second package likewise restricts the use of banked credits and modifies the formula for awarding per-vehicle credit, and also creates a new category of vehicles known as High Performance TZEVs. It includes the following elements:

- Minimum Protective Floor: At least 25 percent of credits used to comply must come from vehicles produced in that model year (same as package 1).
- Stricter Crediting: Per-vehicle credits are reduced to approximate what would be earned if crediting based on vehicle range were based more closely to what is achieved in the real world range rather than UDDS (i.e. city only) driving cycle (discussed further below).
- High Performance TZEV Flexibility: Allow High Performance TZEVs (75 mile UDDS range; about 52 miles label/real world, with US06 all electric range capability) to meet 50% of the ZEV requirement (discussed further below).
- Minimum TZEV Performance: TZEVs need US06 all electric range capability and a minimum of 20 mile real world range (29 UDDS) in order to qualify for credit (same as package 1). This package assumes that range for the remaining TZEVs (other than high performance TZEVs) is on average 34 real world (49 UDDS).

In package 1 the per-vehicle credit is adjusted as needed to meet the numeric goals. In package 2 a different approach is used--rather than basing credit on the range achieved on the UDDS (city) laboratory test cycle, which is much higher than actually seen in real world driving, credits adjusted and awarded based on an approximation of the vehicle's real world range. This results in a smaller credit value. A minor additional reduction is introduced in order to meet the targets.

This package also creates a new class of vehicle known as a High Performance TZEV, with the characteristics noted above, and allows such vehicles to earn a greater proportion of ZEV credits. This is intended to provide a greater incentive for manufacturers to produce TZEVs with significant all-electric range.

Under this approach, again assuming maximum manufacturer use the TZEV options, (1) the number of pure ZEVs expected is reduced by 12%, because the pure ZEV requirement makes up a smaller portion of the overall obligation, (2) High Performance TZEVs are produced, (3) the number of regular TZEVs increases (because in this scenario regular TZEVs are assumed to have a lower range), and (4) the total number of ZEV program vehicles is increased (because the number of High Performance TZEVs and the additional regular TZEVs more than offset the reduction in pure ZEVs).

By way of comparison, under the existing regulation the LEAF (100 mile UDDS range) earns 1.5 ZEV credits and the new Volt (53 mile UDDS range) earns 1.03 TZEV credits. Under the package 2 credit structure the LEAF would earn 1.05 ZEV credits and the Volt would earn

0.94 ZEV credits as a High Performance TZEV, or 0.83 TZEV credits if treated as a regular TZEV.

Table 8 shows the per-vehicle credit that results from the adjustments applied in the package, and Table 9 shows the resulting number of vehicles.

Table 8

		2018	2019	2020	2021	2022	2023	2024	2025
BEV	Range (UDDS)	184	224	259	289	311	325	336	347
	Credit, Current Regulation	2.34	2.74	3.09	3.39	3.61	3.75	3.86	3.97
	Credit, Alternative	2.35	2.74	3.10	1.81	1.86	1.88	1.91	1.93
	Percent Reduction	0%	0%	0%	47%	49%	50%	51%	51%
FCV	Range (UDDS)	464	464	464	464	464	464	464	464
	Credit, Current Regulation	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Credit, Alternative	4.00	4.00	4.00	2.17	2.17	2.17	2.17	2.17
	Percent Reduction	0%	0%	0%	46%	46%	46%	46%	46%
Super TZEV	Range (UDDS)				75	75	75	75	75
	TZEV Credit, Current Regulation				1.25	1.25	1.25	1.25	1.25
	ZEV Credit, Alternative				0.76	0.76	0.76	0.76	0.76
	Percent Reduction				39%	39%	39%	39%	39%
TZEV	Range (UDDS)	41	50	58	49	49	49	49	49
	Credit, Current Regulation	0.91	1.00	1.08	0.99	0.99	0.99	0.99	0.99
	Credit, Alternative	0.91	1.00	1.08	0.53	0.53	0.53	0.53	0.53
	Percent Reduction	0%	0%	0%	47%	47%	47%	47%	47%

Table 9

California	Cumulative Vehicles through 2025				2025	
	EV	Super TZEV	TZEV	Total	Sales	Percent
ARB Base Case	617,227	0	1,030,195	1,647,421	270,655	15.4%
NRDC Base Case	505,707	0	520,856	1,026,563	115,161	6.0%
Alternative	506,443	230,890	930,986	1,668,319	280,807	14.7%
Section 177 ZEV States						
ARB Base Case	513,417	0	1,349,675	1,863,092	317,893	12.9%
NRDC Base Case	426,916	0	636,600	1,063,516	150,119	5.6%
Alternative	520,487	286,236	1,210,783	2,017,507	393,130	14.7%
Total						
ARB Base Case	1,130,644	0	2,379,870	3,510,513	588,548	14.0%
NRDC Base Case	932,623	0	1,157,456	2,090,079	265,279	5.8%
Alternative	1,026,930	517,127	2,141,769	3,685,826	673,937	14.7%

VI. Conclusion

As this report has attempted to make clear, there are many variables that affect the number of vehicles that will be produced to comply with the ZEV regulation, and any such predictions are uncertain. Moreover, the raw number of vehicles produced is not the only measure of success--the desired environmental outcomes are also driven by the types and diversity of ZEV and TZEV vehicles produced, their performance characteristics, and ultimately their marketability and attractiveness of vehicles offered to customers. This report has focused on the expected number of vehicles given a reasonable set of updated assumptions, and how that compares to previous estimates, Governors' commitments, and

the sales trajectory needed to meet longer term criteria pollutant and climate goals. Within that more narrow context, the report demonstrates several points:

- The trend towards longer range vehicles, both ZEVs and TZEVs, the banked credits that have been accrued by automakers, and new entrants such as Tesla means that major OEM manufacturers are likely to deliver smaller numbers of vehicles than originally projected in 2012 by the ARB.
- Absent updates that modify the ZEV credit structure, the resulting number of vehicles and market share are likely to fall short of the 2025 goals established by the Governor of California and the Governors of eight Northeast states that have joined in a Memorandum of Understanding on State Zero Emission Vehicle Programs.
- Modifications to the regulation are possible that increase the number of vehicles, ensure product diversity of long-range ZEVs and high-performance TZEVs, and improve the likelihood of meeting the Governors' goals.

This report demonstrates a need to consider changes to the ZEV regulation. To simplify the calculations the spreadsheet developed to support this analysis uses a single "average" vehicle of each category (ZEV, FCEV, TZEV, High Performance TZEV). In reality there will be a mix of vehicles produced, and therefore the details of alternative credit calculation methodologies and their results across a variety of possible vehicle types will be important. More work is needed to fully assess the specific alternatives outlined here, but the need to consider modifications is clear.

Appendix A: Spreadsheet Model and Assumptions

This Appendix provides an overview of the construction and operation of the ZEV compliance spreadsheet and the assumptions used for the NRDC base case. The spreadsheet requires the user to assign values to a number of variables. It then performs a series of calculations using those values to arrive at the expected number of ZEV program vehicles, by year, for 2015 through 2025.

Variables

The primary variables that define each scenario are shown in Table 10. The spreadsheet includes other variables, not listed here, that control more detailed aspects of the calculation but which generally are not modified from case to case.

Table 10

Variable	Values	Comments
Percentage Requirements	Per current regulation or specified by user.	User can vary total requirement as well as individual components.
OEM BEV and TZEV sales	Zero or per Alan Baum and Associates projection.	User can specify any fraction of the Alan Baum and Associates projection, or can "flatline" sales at 2015 level.
OEM FCV sales	Zero or per AB 8 projection.	User can specify any fraction of the AB 8 projection, or can "flatline" sales at 2015 level.
Tesla sales	Zero or per Alan Baum and Associates projection.	User can specify any fraction of the Alan Baum and Associates projection, or can "flatline" sales at 2015 level.
BEV range	Specified by user.	Range can stay constant at 2017 level or increase over time.
FCV range	Specified by user.	Range can stay constant at 2017 level or increase over time.
TZEV range	Specified by user.	Range can stay constant at 2017 level or increase over time.
TZEV US06 capability	Yes or no.	
BEV and FCV credit per vehicle	Per current regulation or specified by user.	User can specify base credit and credit per mile of range. Spreadsheet can also award credit based on eVMT; not used here.

TZEV credit per vehicle	Per current regulation or specified by user.	User can specify base credit, US06 credit, and credit per mile of range. Spreadsheet can also award credit based on eVMT; not used here.
LVM and IVM use of OEM banked credits	Use or do not use	User can specify fraction of obligation that can be met by OEM banked credits, separately for 2015-2020 and for 2021 and beyond.
LVM and IVM use of Tesla banked credits	Use or do not use	User can specify fraction of obligation that can be met by Tesla banked credits, separately for 2015-2020 and for 2021 and beyond.
High Performance TZEV Option	Use or do not use	Specifying use of High Performance TZEV invokes a number of other adjustments.

Calculation Methodology

The starting point for the calculation is projected total manufacturer sales, broken into four groups as shown in Table 11. The assignment of manufacturers to groups varies depending on whether the Base or High Performance TZEV option is being used.

Table 11

Group	Base Case	High Performance TZEV Option
1.	LVM BEV producers	50% of LVM production
2.	LVM FCV producers	50% of LVM production
3.	IVMs	IVMs
4.	Tesla	Tesla

For the next steps in the calculation, the spreadsheet does the following for each group:

1. Derives annual sales for ZEV compliance purposes by applying the specified rules (e.g. average of specified prior years, or current year).
2. Multiplies annual sales for compliance purposes by the percentage requirements (either the current regulation or an alternative) to determine the ZEV credit obligation by year. The spreadsheet does not assign a compliance obligation to Tesla.
3. Determines the per-vehicle credit generated by each vehicle type based on the user-specified values for vehicle range and criteria for awarding credit.
4. Multiplies baseline ZEV and TZEV sales (i.e. vehicles that manufacturers will produce regardless of their compliance obligation) by the credit earned per vehicle (step 3) to determine the number of credits generated by baseline sales.
5. Subtracts the credits earned from baseline sales (step 4) from the annual compliance obligation (step 2) to determine the interim remaining obligation.
6. If the case being run allows use of banked credits, determines if OEM or Tesla credits are available to fulfill the interim remaining obligation, then subtracts the banked

credits used from the interim remaining obligation (step 5) to determine the final remaining obligation.

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

NRDC Base Case Assumptions

The NRDC base case assumptions for total sales as well as OEM and Tesla ZEV program baseline sales (sales level maintained independent of the ZEV obligation) are shown in Table 12. As noted above total sales are taken from EMFAC 2014. BEV and TZEV baseline sales are taken from Alan Baum and Associates data, with a base case assumption that manufacturers maintain sales at the 2015 level. FCV sales are taken from the most recent AB 8 projection through 2021, then carried forward at the 2021 level through 2025.

Table 12

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Total Annual Sales	1,580,488	1,675,075	1,720,057	1,756,116	1,786,723	1,806,321	1,819,994	1,842,257	1,864,509	1,886,125	1,908,353
Baseline ZEV Program Sales											
Group 1: LVM PEV											
ZEV	24,780	24,780	24,780	24,780	24,780	24,780	24,780	24,780	24,780	24,780	24,780
TZEV	17,050	17,050	17,050	17,050	17,050	17,050	17,050	17,050	17,050	17,050	17,050
Total	41,830	41,830	41,830	41,830	41,830	41,830	41,830	41,830	41,830	41,830	41,830
Group 2: LVM FCV											
ZEV	250	3,440	3,440	3,440	7,933	7,933	7,933	7,933	7,933	7,933	7,933
TZEV	4,450	4,450	4,450	4,450	4,450	4,450	4,450	4,450	4,450	4,450	4,450
Total	4,700	7,890	7,890	7,890	12,383	12,383	12,383	12,383	12,383	12,383	12,383
Group 3: IVM											
ZEV	0	0	0	0	0	0	0	0	0	0	0
TZEV	320	320	320	320	320	320	320	320	320	320	320
Total	320	320	320	320	320	320	320	320	320	320	320
LVM and IVM Fleet Total											
ZEV	25,030	28,220	28,220	28,220	32,713	32,713	32,713	32,713	32,713	32,713	32,713
TZEV	21,820	21,820	21,820	21,820	21,820	21,820	21,820	21,820	21,820	21,820	21,820
Total	46,850	50,040	50,040	50,040	54,533	54,533	54,533	54,533	54,533	54,533	54,533
Tesla	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,700
Fleet Total With Tesla	56,550	59,740	59,740	59,740	64,233	64,233	64,233	64,233	64,233	64,233	64,233

NRDC base case assumptions for vehicle range were shown in Table 2, Section III above. The starting point for developing the NRDC base case range estimates is an Alan Baum and Associates projection of 2018 fleet average range for BEVs (excluding Tesla), FCVs and TZEVs. We then apply to BEVs and TZEVs a growth factor that is taken from a Navigant projection of annual improvements in battery energy density, with a two year time lag to allow for incorporation of pack level improvements into vehicles. FCV range is left unchanged over time.

Existing manufacturer banked credit totals for California are taken from the 2015 ARB release, as shown in Table 13. A total of 26,537 ZEV credits were transferred from the IVM category to the LVM FCV category based on an assumption that IVMs would market any ZEV credits to LVMs rather than use them to offset an IVM TZEV requirement.

Table 13

	Credit Balance as of 9/30/2015 (NMOG)						Credit Balance as of 9/30/2015 (ZEV Credits)				
Manufacturer	ZEV	NEV	TZEV	AT PZEV	PZEV		ZEV	NEV	TZEV	AT PZEV	PZEV
Group 1: LVM PEV											
BMW	141.522	0	0	0	0		4,043	0	0	0	0
Chrysler Group	422.244	0.001	0	615.637	0		12,064	0	0	17,590	0
Ford	986.181	706.323	912.652	367.435	605.614		28,177	20,181	26,076	10,498	17,303
General Motors	731.594	440.212	1958.215	373.776	0		20,903	12,577	55,949	10,679	0
KIA	8.543	0	0	133.229	204.575		244	0	0	3,807	5,845
Mercedes Benz	527.918	43.143	0	3.384	512.456		15,083	1,233	0	97	14,642
Nissan	1608.039	0	0	0	148.106		45,944	0	0	0	4,232
Volkswagen	43.465	0	0	24.447	120.112		1,242	0	0	698	3,432
Total	4469.506	1189.679	2870.867	1517.908	1590.863		127,700	33,991	82,025	43,369	45,453
Group 2: LVM FCV											
Honda	1051.997	569.758	0	391.286	1222.734		30,057	16,279	0	11,180	34,935
Hyundai	31.36	0	0	168.9	380.197		896	0	0	4,826	10,863
Toyota	1790.77	0	420.863	6936.775	0		51,165	0	12,025	198,194	0
Transfer from IVM							26,537				
Total	2874.127	569.758	420.863	7496.961	1602.931		108,655	16,279	12,025	214,199	45,798
Group 3: IVM											
FUJI/Subaru	854	41.199	0	19.385	236.313		0	1,177	0	554	6,752
Jaguar Land Rover	74.795	0	0	0	0		0	0	0	0	0
Mazda	0	0	0	0	45.393		0	0	0	0	1,297
Total	928.795	41.199	0	19.385	412.636		0	1,177	0	554	11,790

Banked credit totals for the Section 177 ZEV states are taken from the most recent releases from each state, not reproduced here.