California's Advanced Clean Cars Midterm Review

Appendix A: Analysis of Zero Emission Vehicle Regulation Compliance Scenarios:

Estimated minimum 1.2 million ZEVs and PHEVs by 2025

January 18, 2017

California Environmental Protection Agency
Air Resources Board

I. Introduction

California's zero emission vehicle (ZEV) regulation is a credit-based percentage requirement intended to balance new vehicle sales with the type of vehicle technology being produced. The regulation itself does not specify a total vehicle sales volume target. In the original Advanced Clean Cars (ACC) rulemaking, a potential compliance path was identified that manufacturers could pursue in the 2018 through 2025 model years for meeting ZEV regulation requirements. This compliance path estimated 1.4 million ZEVs (meaning battery electric vehicles, or BEV, and fuel cell electric vehicles, or FCEV) and plug-in hybrid electric vehicles (PHEV) on the road by 2025, making up approximately 15% of new vehicle sales in 2025 model year. Since the 2012 adoption of the ACC requirements, vehicle technology has advanced faster and developed more broadly than originally anticipated, and the assumptions used in the original rulemaking scenario no longer reflect vehicles expected in the 2018 through 2025 timeframe.

The ZEV midterm review (MTR) includes the detailed examination of all of the manufacturers subject to this regulation to assess the status of technology through their product plans. This proprietary information was used to develop revised compliance scenarios and a "ZEV Calculator" which are intended to explain the potential effect various flexibilities and developing technology has on the overall number of vehicles expected from the regulation. These scenarios are "minimum compliance scenarios", which emphasizes the main function of the ZEV regulation: to set a floor to ensure pure ZEV technology is being produced to help the technology reach commercialization. The question that these scenarios answer is how much could be expected (at a minimum) from the ZEV regulation in any given model year.

Minimum compliance scenarios are typically used by ARB to determine the cost for manufacturers to meet regulatory requirements and are combined with projected emission benefits to determine the cost-effectiveness of the requirements. These scenarios are not a market forecast of what actual total sales may be or will likely be in any given model year, but rather are regulatory compliance projections using the best available information at the time of this review. The purpose of this appendix is to explain the inputs and process to develop these draft scenarios, as well as the ZEV Calculator tool, an Excel spreadsheet that can be used to compare various compliance scenarios simultaneously.

II. Summary

Staff developed three scenarios using the latest version of the ZEV calculator:[1] a mid-range ZEV-technology case, a slow ZEV-technology advancement case, and a high ZEV-technology development case. Each of these cases uses a different set of assumptions briefly described in Table 1 that are consistent within each case, and pertain to overarching themes of technology

[1] The ZEV calculator, an Excel tool, was first developed for the 2012 ZEV/ACC rulemaking to calculate minimum compliance with the 2018 through 2025 model year requirements. This appendix describes updated inputs used in an expanded ZEV calculator tool. The updated ZEV calculator is posted: https://arb.ca.gov/msprog/zevprog/zevcalculator/zevcalculator.htm

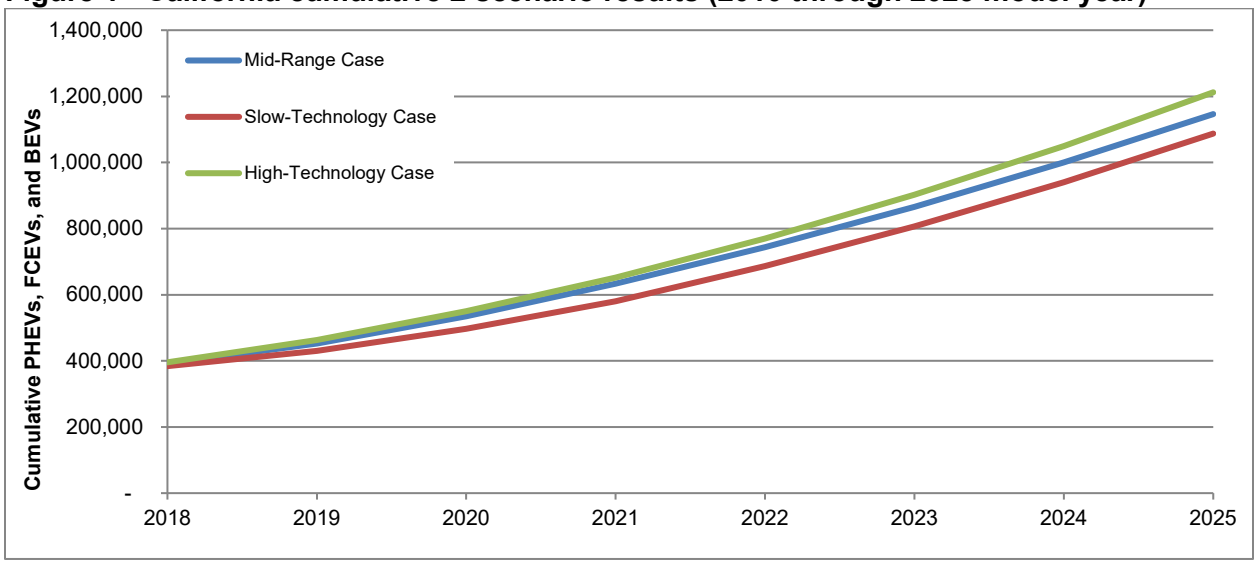
readiness and pace of future development. In addition to considering future vehicle technology advancements and expected usage of regulatory flexibilities when developing these scenarios, the current ZEV credit banks were factored in, including near term expected credit generation and longer term expected credit usage. Details of the assumptions used for each scenario are provided in section IV.

Table 1 - Summary of Scenario Themes

Scenario	Theme
Mid-Range ZEV Technology Advancement Case	Continued advancement in ZEV technology leads to balance of new sales of improved capability ZEVs and moderate use of banked ZEV and GHG credits
Slow ZEV Technology Advancement Case	Delayed advancement in ZEV technology leads to higher dependence on banked ZEV and GHG credits to support sales of only slightly improved ZEVs
High ZEV Technology Advancement Case	Aggressive advancement in ZEV technology leads to larger increase in new sales of highly capable ZEVs as dominant mechanism for compliance

Figure 1 below is a summary of the three cases and the minimum cumulative number of ZEVs and PHEVs[2] expected from each scenario.

Figure 1 - California cumulative 2 scenario results (2010 through 2025 model year)



*For each scenario, it is assumed 347,000 ZEVs and PHEVs have been placed in California through 2017 model year. See Section III.B.2 and Section V.C (Table 8).

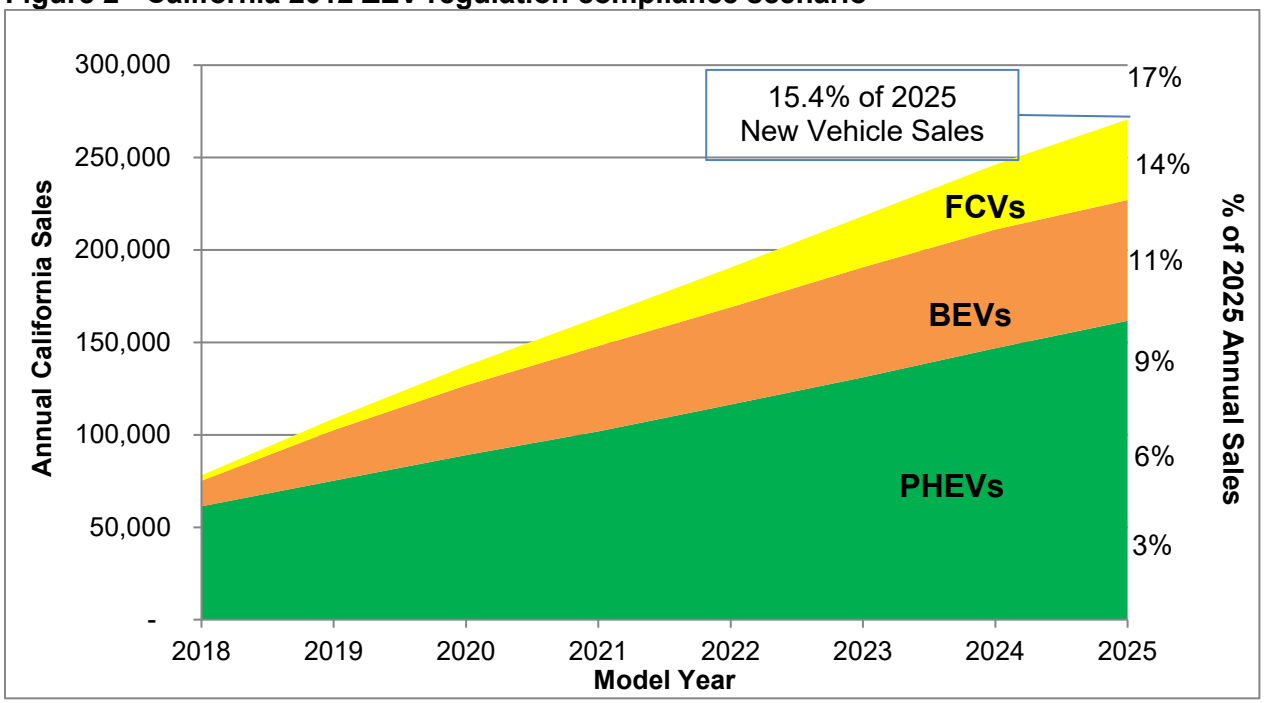
[2] Throughout this report, PHEVs are assumed to be transitional zero-emission vehicles (TZEV) that meet the requirements in CCR 1962.2 (c), meaning all PHEV numbers shown throughout the report meet SULEV 30 exhaust emission certification, zero evaporative emissions, and have an extended warranty on the battery and emission system. Not all PHEVs currently sold are TZEVs and only TZEVs can be counted towards a manufacturer's ZEV requirements. Accordingly, staff has excluded non-TZEVs from the PHEV calculations and analysis throughout this appendix.

The mid-range case yields a minimum 800,000 ZEVs and PHEVs cumulatively between 2018 and 2025 model year to meet the regulation. When added to the 182,000 ZEVs and PHEVs sold between 2011 and 2015 model year (based on data from the California Department of Motor Vehicles), and the additional 165,000 projected for 2016 and 2017 model years,[3] approximately 1.2 million cumulative ZEVs, and PHEVs, can be expected by 2025 model year.

II.A 2012 "Expected Compliance Scenario"

In the initial statement of reasons (ISOR) for the 2012 Advanced Clean Car (ACC) rulemaking,[4] a scenario was developed to help explain the effect of the proposal on the projected vehicle deliveries as a result of the amendments to the ZEV regulation in California. At that time, the main scenario in the staff report estimated 1.4 million cumulative ZEVs and PHEVs for the 2018 to 2025 model years. Figure 2 was presented in the original staff report.

Figure 2 - California 2012 ZEV regulation compliance scenario



When this scenario was developed for the 2012 rulemaking, the following assumptions were used:

- manufacturers would maximize the portion of the requirement that could be met with PHEVs
- manufacturers would minimize the number of pure ZEVs (BEVs, FCEVs) in any given year
- BEVs would be capable of 100 miles on the urban dynamometer drive schedule (UDDS) in the 2018 through 2025 model year timeframe

[3] See Section III.B.2 for details on the projection of 165,000 ZEVs and PHEVs for 2016 and 2017 model years.
[4] ARB 2011a. California Air Resources Board. Initial Statement of Reasons: 2012 Proposed Amendments To The California Zero-Emission Vehicle Program Regulations. http://www.arb.ca.gov/regact/2012/zev2012/zevisor.pdf

- PHEVs would be comprised of a mix of blended (non-US06 test cycle capable) and non-blended (US06 test cycle capable) PHEVs with an electric range between 22 and 40 miles on the test cycle
- a growing number of manufacturers would be producing FCEVs with a 350 mile UDDS range through 2025

This original scenario did not take into account several regulatory flexibilities that were subsequently considered and adopted by the Board in the 2012 ACC rulemaking. Historical earned ZEV credits were also not considered in the scenario because most manufacturers, at the time of developing the ACC amendments, had modest levels of credits in their banks and limited numbers of announced products that they would be offering in the next few years.

Technology assumptions were also based on the best available information at that time. Neither manufacturers nor technology development projections supported the feasibility of 200 (or more) mile range BEVs in the near term, and only two PHEVs were on the market,[5,6] with few others announced. Technology developed rapidly, and five years later, much more capable BEVs and PHEVs are available, and even more are scheduled for release within the next five model years.

III. Developing new minimum compliance scenarios

III.A Updating the ZEV Calculator

As part of the 2012 ACC rulemaking, staff developed a "ZEV Calculator",[7] which showed an industry wide minimum compliance scenario through 2025 for the ZEV regulation. Other analysis, which showed the impact of other regulatory flexibilities that were being considered for adoption, were also released, but until this point, one tool had not been released which combined all the flexibilities adopted into one calculator. In addition to regulatory flexibilities, the calculator has been updated so that a user can readily change assumptions regarding the use of flexibilities, banked credits, compliance strategy, and technology assumptions for the types of vehicles being produced. The output of the calculator remains the same: a ***minimum number*** of vehicles needed under each scenario to achieve annual compliance with the regulation on a fleet-wide basis. Staff used this enhanced ZEV Calculator when developing these new scenarios and, for convenience, the calculator has been pre-populated with the three scenarios presented in this document.

In developing the new minimum compliance scenarios presented in this report, a new analysis was conducted for compliance within the Section 177 ZEV states. In many cases, the analysis includes the same key assumptions for both California and Section 177 ZEV states. For example, manufacturers are assumed to produce and deliver for sale the same technology

[5] Stenquist 2010. Paul Stenquist. Blog entry. New York Times. October 11, 2010. http://wheels.blogs.nytimes.com/2010/10/11/g-m-officially-introduces-2011-chevrolet-volt-amid-controversy/
[6] Voelcker 2012. John Voelcker. Article. Green Car Reports. April 3, 2012. http://www.greencarreports.com/news/1074785_plug-in-car-sales-soar-in-march-led-by-chevrolet-volt
[7] ARB 2011b. California Air Resources Board. ZEV Calculator (Excel Worksheet) December 2011. http://www.arb.ca.gov/msprog/clean_cars/clean_cars_ab1085/clean_cars_ab1085.htm

PEVs (with the same range) in California and each of the Section 177 ZEV states. As will be discussed in detail below, the analysis takes into account the differences in the California and Section 177 ZEV state credit banks.

III.B Process

In developing the scenarios and ZEV Calculator, various assumptions in the ZEV Calculator used for the 2012 ACC rulemaking have been updated. The following section reviews the assumptions and inputs that were modified and how regulatory flexibilities were modeled to better represent the annual minimum (the "floor") requirement through 2025 model year.

III.B.1 Annual Sales and Original Equipment Manufacturer (OEM) Market Shares

The annual sales assumptions affect every other output in the scenarios, since a manufacturer's annual ZEV requirement is based on its total new vehicle sales. The scenario for the 2012 ACC rulemaking utilized ARB's EMFAC 2010 projections of future California sales volumes to generate annual sales volume for each manufacturer. To calculate Section 177 ZEV state volumes, California volumes were multiplied by a factor of 2.0, a factor which was based on known sales data at the time. For the updated scenarios, new information exists both for total industry sales and for Section 177 ZEV state volumes. For total volumes, the updated scenarios are based on the U.S. Energy Information Administration's Annual Energy Outlook (AEO) 2015 national sales projections.[8] In accordance with the regulation, the revised analyses assume all manufacturers would use the previous year's average method[9] through 2025 model year to calculate their applicable sales volumes (and thus, their ZEV credit obligation).

According to IHS Automotive, in calendar year 2015, 12% of U.S. new vehicle sales were in California, and 16% were in the Section 177 ZEV states that have a ZEV requirement.[10] Total annual sales projections for California and the Section 177 ZEV states were then calculated using these market shares and the AEO projections for nationwide volumes. In addition to data from IHS, calculated OEM specific market shares are based on publically available data posted with ZEV credit bank disclosure for California and the Section 177 ZEV states. Three of the nine states (Oregon, New York, and New Jersey) have easily accessible ZEV credit bank data. An average of these three market shares yields new representative OEM specific market shares for the Section 177 ZEV states.[11] Because large volume and intermediate volume manufacturers (LVM and IVM, respectively) can comply with credit percentage requirements in different ways, the ZEV calculator allows for separate assumptions for the LVM market and the IVM market. Below is a list of manufacturers' size classifications expected by 2018 model year.

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[8] AEO 2015. U.S. Energy Information Administration. Annual Energy Outlook Light-Duty New Vehicle Sales Projections. Website. Accessed March 20, 2016. http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2015&subject=15-AEO2015&table=48-AEO2015&region=1-0&cases=ref2015-d021915a

[9] CCR 1962.2 (b)(1)(B), Calculating the Number of Vehicles to Which the Percentage ZEV Requirement is Applied.

[10] IHS 2015. IHS Automotive. Polk new vehicle registrations for CYE2015

[11] Staff confirmed the average of NY, NJ, and OR market shares closely align with actual OEM market shares in all nine states with confidential Polk vehicle registration data.

Table 2 - Manufacturers Definitions*

LVM	IVM
BMW	Jaguar Land Rover
Fiat Chrysler	Mazda
Ford	Subaru
GM	Tesla (2020)
Honda	Volvo
Hyundai	
Kia	
Mercedes	
Mitsubishi**	
Nissan	
Toyota	
VW	

* Based on best available data. Subject to change based on total vehicle volume
** Pending completion of Nissan's acquisition of Mitsubishi

For the calculator, current market shares for each individual manufacturer (based on publicly available information) have been provided solely for informational purposes. These numbers have not been used directly in any of the assumptions other than determining the portion of total California and Section 177 ZEV state sales attributable to LVM and IVMs (to calculate their correspondingly different credit requirements). The individual manufacturer market shares provided in the calculator, however, represent that manufacturer's market share of the LVM (or IVM, as applicable) market rather than its market share of total vehicles sales. For example, the total share of General Motors sales in CA is 9% on average for 2013 through 2015 model year. However, General Motors market share of the LVM market is 12%. The three new scenarios utilize confidential business information provided by individual vehicle manufacturers along with additional information to arrive at industry-wide generalizations of the technologies and paths expected to be used for minimum compliance. Accordingly, the scenario assumptions are not aligned with any individual manufacturer's market share nor do they reflect manufacturer-specific future product plans or assumptions.

III.B.2 ZEV Credit Bank: Generating Credits

One aspect excluded from the model in past scenarios was the effect of banked ZEV credits on the overall number of vehicles that could be expected in any given year. During the development of the ACC rulemaking, historical credits were at relatively low levels and were expected to have an insignificant impact on compliance. Manufacturers have been over complying with ZEV regulations since the early years of the program. Typically, manufacturers have amassed credits banks under three conditions.

1) In early years, the Board awarded technology development with a larger number of credits per vehicle. For example, in the late 1990s and early 2000s, manufacturers could earn 40 credits per FCEV produced, and 10 credits per BEV produced when vehicles were basically non-existent and the Board wanted to jumpstart a very early technology market. Generally, these older

credits have already been used toward compliance or have been capped and, therefore, have limited use.

2) Manufacturers will purchase and trade credits to either diversify their credit bank, comply with current year requirements in the case on unforeseen technology failure, or prepare to meet future model year requirements

3) Manufacturers are successful in producing vehicles, and sell more than the requirements call for in a given model year in response to growing consumer demand in an expanding market. Manufacturers choose to hold these credits rather than sell on the open market

Since the 2012 ACC rulemaking, the ZEV market has grown significantly and manufacturers have started earning and banking credits while the requirements remain low. Compliance with 2015 model year ZEV regulation requirements is now complete for California and the Section 177 ZEV states, which is the basis for staff's assumption on the total number of credits available in the credit bank.[12] Some manufacturers carry a two to three model year credit compliance buffer, even after 2015 model year compliance.

In order to create a more accurate picture of credit balances into the 2018 model year, projections are included for 2016 and 2017 model year actual market sales to determine compliance and credit generation. To calculate the projected sales volumes for ZEVs and PHEVs in model years 2016 and 2017, historical sales numbers were used for ZEVs and PHEVs in California and Section 177 ZEV states for model years 2011 through 2015.[13] A linear extrapolation of the historical sales data was then used to calculate projected sales of ZEVs and PHEVs in California and the Section 177 ZEV states. This data was also used to create a sales-weighted average per vehicle credit value of 3.29 for ZEVs[14] and 1.98 for PHEVs in model year 2015. The average per vehicle credit values were used to convert the projected new vehicle sales numbers into the total projected number of credits generated for model year 2016 and 2017 ZEVs and PHEVs.

Each manufacturer's total production volume for model years 2016 and 2017 was projected (to determine the ZEV credit obligation for each year). Since the 2008 ZEV regulatory amendments, Section 177 ZEV states have been required to publically disclose manufacturers' annual ZEV compliance data, including banked credits and total production volumes.[15] However, as there is a lag in time for actual sales to complete (i.e., prior model year vehicles can be sold up to six months into the next calendar year), final accounting of actual sales and credits generated is not known until September of the following year (e.g., 2015 model year sales are not fully accounted for and documented until September of 2016). Accordingly, only

[12] ARB 2016b. California Air Resources Board. 2015 Zero-Emission Vehicle Credits. Website. http://www.arb.ca.gov/msprog/zevprog/zevcredits/2015zevcredits.htm
[13] See Appendix B, Section III.A.2.c. for total ZEV and PHEV sales volumes in California and Section 177 ZEV states.
[14] For purposes of calculating average ZEV credit, a sales weighted average of BEVs, range extended battery electric vehicles (or BEVx) and FCEVs was computed
[15] California Exhaust Emission Standards and Test Procedures for 2018 and Subsequent ZEVs, section D.3.

ZEV and PHEV sales through 2015 model year are fully accounted for at this time and 2016 and 2017 sales must use projected sales numbers.

California posts ZEV compliance data including total bank balances, annual production volumes, and credit transfers, and has done so for model years 2009 through 2015.[16] California's ZEV compliance data was used to determine total production volumes for each regulated manufacturer in California for model years 2010 through 2015. Using Section 177 ZEV state model year 2014 compliance data, it was possible to determine each manufacturer's annual light-duty production volume in each state. These production volumes were used to calculate the proportional value of each manufacturer's light-duty sales (as compared to California sales). The proportional value was then applied to the manufacturer's production volumes from the California ZEV compliance reports to estimate the yearly production volume for each regulated manufacturer in each of the Section 177 ZEV states for model years 2010 through 2015.

Through model year 2017, a manufacturer has the option to calculate the applicable production volume to which its ZEV credit percentages are applied by using either the current model year volume or a 3-year running average calculation (the average of the 4th, 5th, and 6th prior model year volumes).[17] For simplification, staff assumed each manufacturer's total sales volumes will grow over time, and as a result, the 3-year average calculation method would be more favorable to manufacturers as it will yield a lower applicable production volume and a lower annual ZEV credit requirement. The 3-year average method was used to calculate the total ZEV credit requirement for each manufacturer, in each state, for model year 2016 and 2017 compliance. The calculation of the total ZEV credit requirements also took into account various compliance flexibilities and regulatory requirements, such as the Section 177 ZEV state "Optional Compliance Path"[18] and the carry forward provisions of previously earned ZEV credits.[19]

One important provision to consider was the "travel provision" which has an effect on both California and Section 177 ZEV state ZEV credit banks. This provision allows manufacturers, through 2017 model year, to earn credits for BEVs and FCEVs placed in California or in a Section 177 ZEV state at a proportional value as if they were also placed in all the other states.[20] This provision does not apply to PHEVs but does extend indefinitely beyond 2017 for FCEVs given the state of deployment of hydrogen refueling infrastructure. The applicable production volumes, calculated as explained above, were also used to calculate the proportional value for CA and the Section 177 ZEV states, in order to determine the number of credits that manufacturers could generate as a result of traveling credits. While not all previously earned ZEV credits eligible for travel have indeed been traveled as of this time, staff assumed for these

[16] Section 177 ZEV states also make their ZEV credit banks publically available, though some require compliance with public records act guidelines.
[17] CCR 1962.1 (b)(1)(B)2. "Calculating the Number of Vehicles to Which the Percentage ZEV Requirement is Applied"
[18] CCR 1962.1(d)(5)(E)3. "Optional Section 177 ZEV state Compliance Path"
[19] CCR 1962.1(g)(6)(B) and (C) "Carry forward for 2009 – 2011 model year ZEV credits"
[20] CCR 1962.1(d)(5)(E) 2. "Counting Specified ZEVs Placed in a Section 177 ZEV state and in California: Provisions for 2010 through 2017 Model Years"

scenarios that all manufacturers would choose to travel all credits earned in model year 2016 and 2017. The total ZEV credit requirement was subtracted from the total number of credits earned after all manufacturers traveled their eligible credits to calculate the projected 2016 and 2017 model year ZEV and PHEV credit banks. This value was then added to the manufacturer's reported 2015 credit banks[21] to determine the projected total number of banked credits after model year 2017 compliance.

As a result, all three scenarios essentially began with the assumptions that the industry, as a whole, would carry the following bank of ZEV credits into 2018 model year:

Table 3 - Post-2017 Model Year ZEV Credit Bank Values

California		
	Industry Credits	IVM
ZEV Credits	662,900	66,000
PHEV Credits	208,000	0
Section 177 ZEV states		
ZEV Credits	776,600	15,500
PHEV Credits	45,000	0

Due to changes in the volume status definitions for manufacturers starting in model year 2018, many of the current IVMs will transition to LVM status. The projected number of credits that will be held by those manufacturers that will be IVMs in model year 2018 and beyond was estimated based on the projected industry credit total. First, 2015 ZEV compliance reports were used to determine the current percentage of total banked ZEV credits that are held by manufacturers expected to be IVMs in 2018 and beyond. This same percentage was then applied to the total projected industry credits to calculate the amount of banked credits that will be held by IVMs starting in 2018 model year.

III.B.3 Credit Usage

Manufacturers have emphasized that it is unrealistic to carry a "zero balance" in their ZEV credit bank going into a future model year. Manufacturers traditionally factor in compliance margins to ensure compliance given uncertainties in knowing ahead of time how well a particular vehicle model will sell. Therefore, a key assumption for each of the scenarios relates to how many credits OEMs would leave in their banks relative to what would be needed for 2026 and subsequent model year compliance. Given the adopted ZEV requirement is constant from 2025 model year on, the assumptions ranged between a compliance buffer representing as little as half a year's compliance and as much as two years of compliance. This range is consistent with feedback from manufacturers who typically expressed targets of one to two years depending on their tolerance for risk. This is also consistent with historic compliance margins by vehicle manufacturers with emission regulations such as the GHG and criteria pollutant fleet average

[21] One manufacturer did not submit a complete report for model year 2015 compliance. Historical registration data was used to estimate the number of vehicles sold and approximately 22,000 credits were added to the California model year 2015 BEV bank balance.

standards where industry is usually complying at a level equivalent to at least the next model year's requirements if not beyond.

For the new scenarios, any ZEV credits in excess of the targeted level for 2026 are spread out and used evenly across the 2018 through 2025 model years to reduce the manufacturer's obligation for those years. For example, for the mid-range case, it was assumed that manufacturers (both IVMs and LVMs) would target a one year credit buffer (to be able to satisfy 100% of their 2026 model year requirements). Accordingly, all credits in excess of that needed volume were used evenly across all eight compliance years (2018-2025) to reduce the annual obligation. This resulted in LVMs selling vehicles to meet 80% of their obligation each year and using approximately 400,000 ZEV and TZEV credits to satisfy approximately 20% of the annual credit requirement in the 2018 through 2025 model years.

However, because one purpose of the scenarios is to determine the total number of vehicles that would be used to meet the 2018 to 2025 requirements, any credits used to meet a portion of the requirements must also be converted to the number of vehicles used to create those credits to get an accurate total vehicle count. In each scenario, the number of historical credits cumulatively used is translated back into the number of vehicles that would have had to be produced to originally generate those credits. This is done by dividing the number of historical credits used by the average credits per vehicle generated in the pre-2018 timeframe. These "vehicles" are then added into the cumulative number for each scenario to give a more accurate depiction of the true number of vehicles—produced during those years or prior to those years—used to meet the 2018-2025 requirements. For instance, if 50,000 extra ZEVs are produced prior to 2018 and the credits from those cars are then used to satisfy some of the credit obligation in 2018-2025, those 50,000 ZEVs are counted towards the cumulative number of vehicles required to meet the 2018-2025 requirements. These vehicle calculations were done for California only; the travel provision, as discussed previously, has helped generate credit banks in the Section 177 ZEV states prior to 2018 model year.

III.B.4 Credit Trading and Credit Purchases

Based on reported ZEV credit transaction activity, many manufacturers have participated in credit transfers, trades, and purchases. According to the 2015 model year ZEV credit bank, one manufacturer (Tesla) accounted for 85% of the credits (sold) to other manufacturers.[22] As mentioned above, 2015 model year sales were used to forecast sales for 2016 and 2017 model year for purposes of creating a post-2017 bank, and all manufacturers producing ZEVs and PHEVs were considered in these forecasts. The output of each scenario is a minimum number of vehicles that could result from the entire industry, in minimum compliance with the regulation, in a given year. The scenarios equally represent a case where each manufacturer completely satisfies its own obligation or a case where "perfect" credit trading occurs, meaning individual manufacturers would generate, trade, buy, and sell credits as necessary for industry as a whole to exactly meet the annual requirements.

[22] ARB 2016b.

III.B.5 OEM Technology Assumptions and Compliance

With recent product announcements about longer range BEVs in ever increasing numbers, many have speculated about the effect this could have on compliance with the ZEV mandate. [23] Since 2012, OEMs have made significant progress in improving electric vehicle range, capability, and efficiency. Some manufacturers have focused on a specific ZEV technology while others have produced offerings in multiple technologies. This is a flexibility currently allowed by the regulation, but not necessarily modeled in past scenarios. All of these factors have been updated with the best available information in order to reflect these improvements in the new scenarios.

As previously mentioned, in Section II.B ARB's expected compliance scenario developed for the 2012 ACC rulemaking assumed that all BEVs produced in compliance (through 2025 model year) would have a 100 mile test cycle range, all PHEVs would have 22-40 miles of test cycle range, and all FCEVs would have at least 350 miles of range (maxing out the number of credits that could be earned within the program).[24] It was also assumed that all LVMs would make the maximum number of PHEVs allowed in any given year, and the minimum number of pure ZEVs. Additionally, it was assumed that all IVMs would produce only PHEVs to comply.

Using the most recent information for these updated scenarios, significantly more aggressive improvements in BEV and PHEV technology advancement are assumed. For example, the average BEV label (not test cycle) range for 2018 is projected to be approximately 150 miles in both the "Slower ZEV Tech" and "Mid-Range" cases. This assumption was determined from the sales-weighted label ranges of all non-premium BEV models in the California market for 2015 model year and factoring in expected short term improvements and announced product offerings. Several manufacturers have announced significantly increased driving ranges for their current BEV models beginning with the 2017 model year. Estimations of those increased ranges, based on such announcements, were then applied to vehicles that were available in 2015 model year, since those were known to be available for 2016 and 2017 model years. Additionally, for these new scenarios, the revised analysis considered an annual growth rate in electric range for both BEVs and PHEVs, rather than a constant or a discrete step change in average electric range. The assumptions for annual growth rate in range and for the average range in 2018 model year change for each of the three scenarios. FCEVs are still assumed to maximize credits (4 credits each, at 350 or more miles test cycle range) between 2018 and 2025 model year. The analysis does, however, include a modification of the projected market shares in the auto industry that would involve BEVs and/or FCEVs. All cases assumed some level of FCEV production, and the mid-range and high technology cases include the same number of FCEVs as in the latest projections reported in the ARB Assembly Bill 8 report.[25]

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[23] Shulock 2016. Manufacturers Sales under the Zero-Emission Vehicle Regulation. July 2016. Shulock Consulting. https://www.nrdc.org/sites/default/files/media-uploads/nrdc_commissioned_zev_report_july_2016_0.pdf

[24] Credits are awarded according to a vehicle's UDDS range. Some stakeholders have commented that label range is easier to understand. The updated compliance calculator does use a "label" range as an input; however, the label range is converted into a UDDS test cycle range by dividing the label range by 0.7.

[25] ARB 2016c. California Air Resources Board. 2016 Annual Evaluation of Fuel Cell Electric Vehicle Deployment and Hydrogen Fuel Station Network Development. July 2016 Available: http://www.arb.ca.gov/msprog/zevprog/ab8/ab8_report_2016.pdf

In general, OEMs have also coalesced (for the moment) on two distinct variants of PHEVs. To reflect this current trend, the ZEV Calculator allows for two separate PHEVs to be factored in (noted as PHEV A and PHEV B in the updated ZEV calculator) and the assumptions used for each PHEV vary across the three scenarios. In the regulation, a PHEV able to complete 10 miles in all electric mode (without an engine start) on the US06 test cycle earns an additional 0.2 credits based on the expectation that such a vehicle will be operated more like a ZEV and thus, credited using the same exact formula as ZEVs.[26] As of today, only two PHEVs have been able to satisfy this requirement. Currently, the Chevrolet Volt[27] and the Toyota Prius Prime are the only certified PHEVs able to earn this additional credit. Most other PHEVs on the market are blended, meaning the engine will come on independently as needed to meet higher driving demands before the battery is fully depleted, and they are unable to follow the US06 trace without starting and using the engine to supplement the electric powertrain. For these scenarios, the market shares of the industry were modified for each of the two types of PHEVs, as well as the assumed average range on each of these vehicles types.

Most manufacturers (LVM and IVM) have plans to produce a pure ZEV, with the majority focusing on longer than 100 mile range BEVs. This is evident from OEM press announcements, and confirmed directly by industry. Many have also announced plans to produce PHEVs at various ranges, with various all-electric power capabilities.[28] Taking this into consideration suggests a slightly larger portion of the ZEV credit obligation would be met with production of pure ZEVs, rather than assuming all LVMs would fulfill as much of their requirement as possible with credits from PHEVs. Additionally, IVMs are on track to comply with a mix of BEVs and PHEVs, even though the regulation allows IVMs to comply fully with PHEVs. As pure ZEVs generally earn more credits per car than PHEVs, this change in assumptions directionally resulted in higher ZEV penetration, lower PHEV penetration, and lower overall ZEV and PHEV combined volumes in the new scenarios.

IV. Scenarios

IV.A Mid-Range ZEV Technology Advancement Case (Scenario 1)

In this new, central compliance scenario, there is continued advancement in ZEV technology, consistent with trends observed in the last few years, which would result in manufacturers selling an increasing number of ZEVs and PHEVs each year and utilizing flexibilities allowed within the regulation to reduce their ZEV obligation.

IV.A.1 Technology Assumptions:

This scenario includes a steady 5% annual growth in electric range for BEVs and both variants of blended and US06 capable PHEVs, starting from an all-electric range (AER), (label not test cycle) of 150, 20, and 40 miles, respectively. The range assumptions below show an industry wide average for BEVs and PHEVs in 2018 and 2025 model year.

[26] CCR 1962.2(c)(3)(A)1. “Allowance for US06 Capability”
[27] Including the similar version with a shared architecture marketed as the Cadillac ELR
[28] See Appendix C for future product offerings.

Table 4 - Mid-Range Scenario AER Label Average by Technology Type

PEV type	model year 2018	model year 2025
BEV	150 miles	211 miles
Non-US06 PHEV	20 miles	28 miles
US06 PHEV	40 miles	56 miles

Manufacturer technology diversity also plays into the number of vehicles that result in each of these scenarios. In the mid-range case, the manufacturers continue making the same types of vehicles and technologies (with higher ranges and more capability) they have been producing through 2016 model year. For example, manufacturers pursuing FCEVs in 2016 would continue to pursue producing FCEVs in 2018 and beyond. Those manufacturers working on US06 capable PHEVs would continue working on that technology in 2018 and beyond. However, competitive pressures, increased infrastructure availability, reduced battery prices, and positive market reception result in increases in vehicle capability and electric range over time. More manufacturers produce FCEVs as hydrogen infrastructure is built-out throughout California. The same trend is assumed for those manufacturers pursuing BEV and PHEV technology. More manufacturers (50% by 2025) offer longer range and US06 capable PHEVs. BEVs continue to be increasing in range through the 2025 timeframe. IVMs offer both BEVs and PHEVs, though no selection is made about which individual manufacturers would pursue one technology over the other or offer both. For IVMs, compliance was assumed to be met with a 50-50 split of non-US06 capable PHEVs and BEVs throughout the eight years of compliance with the standards.

IV.A.2 Regulation Assumptions:

By the end of December 2016, manufacturers are required to notify ARB of their intent to pursue the GHG-ZEV over compliance option, which allows manufacturers that over comply by at least 2 grams per mile with the federal GHG standard[29] to use those credits, towards ZEV compliance through the 2021 model year. For this mid-range case, only a small portion of the LVM market (10%), consistent with product announcements in the time period, utilize this path. Another flexibility not previously considered in early scenarios is the cap on the usage of historical partial zero-emission vehicle (PZEV), advanced technology PZEV (AT PZEV), and neighborhood electric vehicle (NEV) credits.[30] Analysis on the potential resulting bank of historical AT PZEV, PZEV, and NEV credits found that there were enough credits to fulfill approximately 75% of the allowed cap for these types of credits between 2018 and 2025. This assumption was held for all eight compliance years for the mid-range case.

As explained in Section II of this appendix, ZEV bank balances were examined. In this case, manufacturers maintain one model years' worth of credit reserve in their banks (i.e., enough to

[29] 40 CFR Part 86.1818-12

[30] CCR 1962.2 (g)(6)(A) "Use of Discounted PZEV and AT PZEV Credits and NEV Credits"

fully comply with 2026 model year requirements[31]). Since the ZEV regulation requirements remain constant post 2025, manufacturers would have the same credit requirement in 2026 model year. Given the projected credit banks going into 2018, in any given compliance year, a LVM would meet (on average) 20% of its credit requirement with banked credits. Using the same one model year reserve assumption for IVMs, one of those smaller manufacturers would be able to meet almost 25% percent of its annual credit requirement with banked ZEV credits.[32]

IV.A.3 Results

Figure 3 - Mid-Range Scenario Results (California)

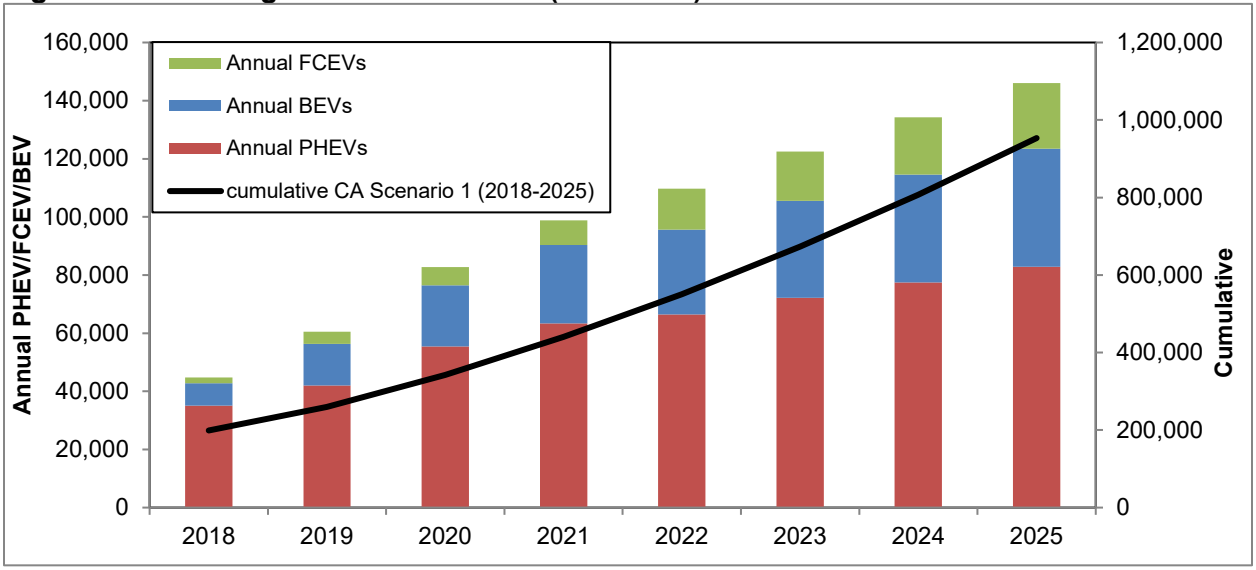
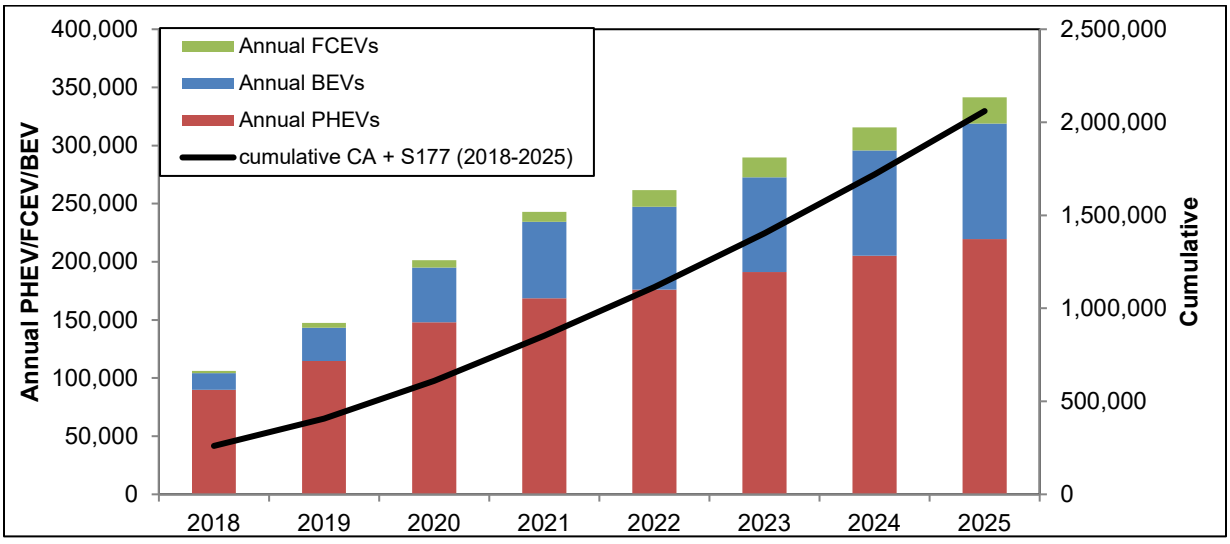


Figure 4 - Mid-Range Scenario Results (California and Section 177 ZEV State Combined)



[31] 2026 model year requirements are assumed to be the same credit percentage requirements as 2025 model year
[32] See Section IV of this appendix for a detailed description of how banked credits have been accounted for in each scenario

The mid-range case results in approximately 8% of 2025 model year annual sales in California being ZEVs and PHEVs. By 2025, the mid-range case results in close to 900,000[33] ZEVs and PHEVs in California from minimum compliance with the regulation (solely for 2018 through 2025 model year requirements), with one million more cumulatively in the Section 177 ZEV states. Looking at combined Section 177 ZEV state and California sales, the mid-range scenario results in 7.5% of annual sales being ZEVs and PHEVs by 2025.

IV.B Slow ZEV Technology Case (Scenario 2)

For the second case, the scenario considers potential delays in technology advancement (i.e., battery costs remaining high, low demand, slow infrastructure development) leading to manufacturers spending more banked credits in order to comply with the regulation. The purpose of this scenario is to explore sensitivities showing high historical credit use over the 2018 through 2025 timeframe.[34]

IV.B.1 Technology Assumptions:

This scenario includes a less aggressive 2.5% annual growth in range for BEVs and blended and non-blended PHEVs. In this case, BEVs and PHEVs have the same 2018 model year label range averages as for the mid-range case.

Table 5 - Slow-Technology Scenario AER Label Average by Technology Type

PEV type	model year 2018	model year 2025
BEV	150 miles	178 miles
Non-US06 PHEV	20 miles	24 miles
US06 PHEV	40 miles	48 miles

However, fewer manufacturers opt into putting as much technology on their vehicles, resulting in a greater number of manufacturers making non-US06 capable PHEVs, and all manufacturers by making both ZEV and PHEVs. Also, in this case, FCEVs remain at low (demonstration volume) levels. Due to lower AER and slower growth rate, this has the effect of fewer credits per vehicle, resulting in higher vehicle numbers needed to meet the requirements, especially in the earlier years of the regulation.

IV.B.2 Regulation Assumptions:

As stated above, manufacturers are more reliant upon regulatory flexibilities in meeting annual requirements. It is assumed that manufacturers representing 20% of the LVM market would need to take the GHG-ZEV over compliance provision, leaning more heavily on more of their GHG fleet compliance in order to meet ZEV compliance. In terms of PZEV, AT PZEV, and NEV

[33] This number includes both vehicles newly produced and vehicles previously produced to generate credits that are then used to meet the regulatory obligation specifically in model years 2018 through 2025. See section V.C for analysis showing how these compliance scenarios can be used to calculate total cumulative vehicle numbers on the road in California by 2025.
[34] Shulock 2016.

credits, 100% of the cap for both IVMs and LVMs for this set of historical credits would be met through 2025.

Finally, manufacturers use more of their ZEV credits, and only carry a credit bank at the end of 2025 representing one-quarter of their 2026 model year obligation.

IV.B.3 Results

Figure 5 - Slow-Technology Scenario Results (California)

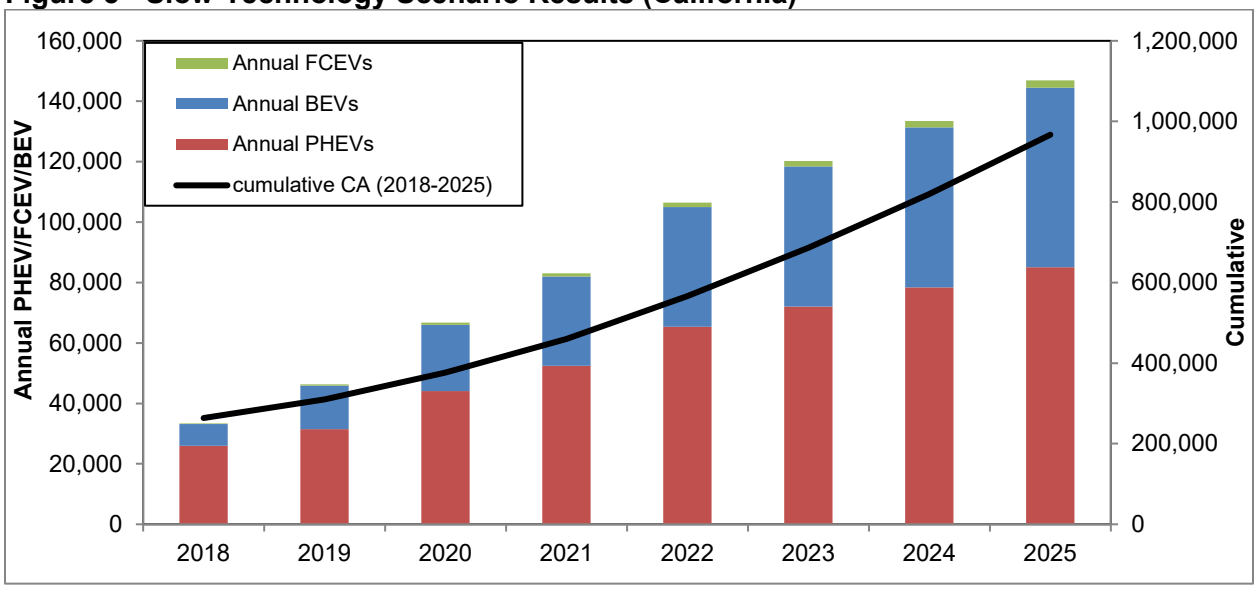
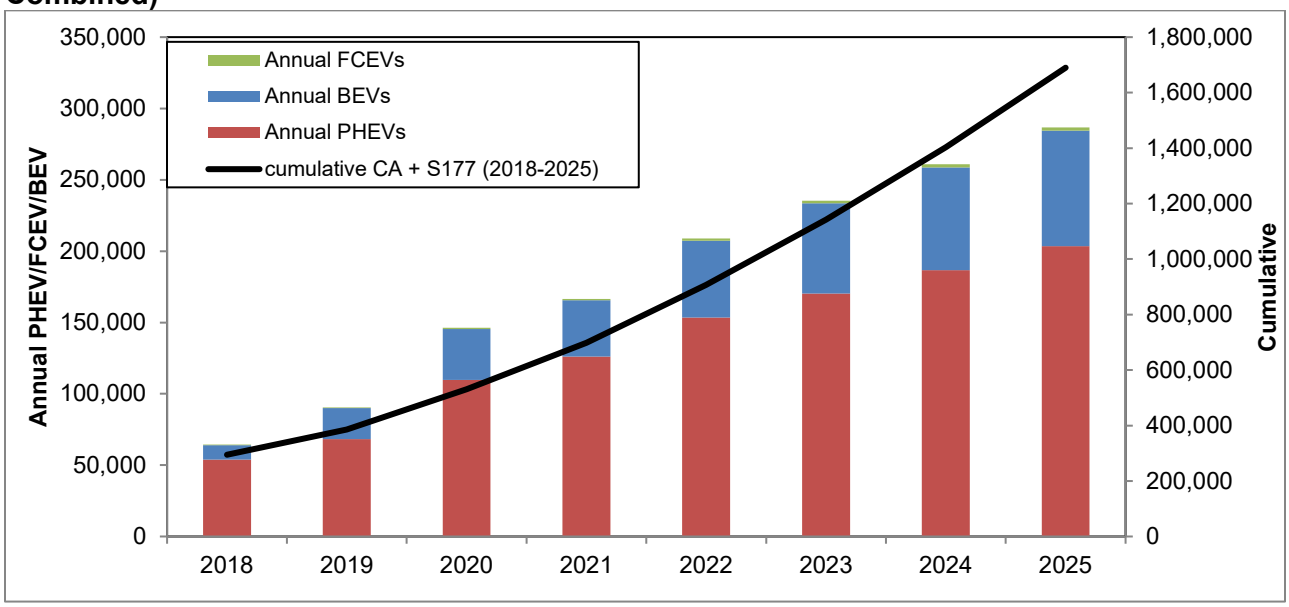


Figure 6 - Slow-Technology Scenario Results (California and Section 177 ZEV State Combined)



The slow-technology case results in the fewest number of vehicles over the 2018 through 2025 time period that are the least technologically developed and consequently of lower consumer

appeal, however due to higher historical credit use, it is assumed those vehicles would have to have been placed prior to 2018 model year (or in excess of the requirements) and are counted in the cumulative numbers show above, and discussed in further detail in Section V.A. While the lower range assumptions would lead to a need for more cars to meet the requirement, the scenario assumes these less capable PHEVs and BEVs, and lower production of FCEVs, result in a slower growth of ZEV sales. Additionally, this case results in a lower number of vehicles in the Section 177 ZEV states, because there are larger credit banks that are being spent. The slow technology case results in slightly more than 8% of 2025 model year annual sales in California being ZEVs and PHEVs. In the Section 177 ZEV states, PEVs resulting from the regulation would be 5% of annual sales in 2025.

IV.C High ZEV Technology Case (Scenario 3)

For a third scenario, the analysis explores the effect of aggressive advancement (even greater than currently announced) in all ZEV technology categories. In turn, this leads to longer range BEVs and PHEVs, and manufacturers not needing to utilize many of the flexibilities allowed by the regulation.

IV.C.1 Technology Assumptions:

An aggressive 7.5% annual growth in range for BEVs and US06 and non-US06 capable PHEVs is included in this scenario. In this case, the average 2018 model year BEV and PHEV label ranges are longer than previous scenarios. The table shows the averages assumed for the high technology case.

Table 6 - High Technology Scenario AER Label Average by Technology Type

PEV type	model year 2018	model year 2025
BEV	200 miles	300 miles
Non-US06 PHEV	25 miles	40 miles
US06 PHEV	45 miles	75 miles

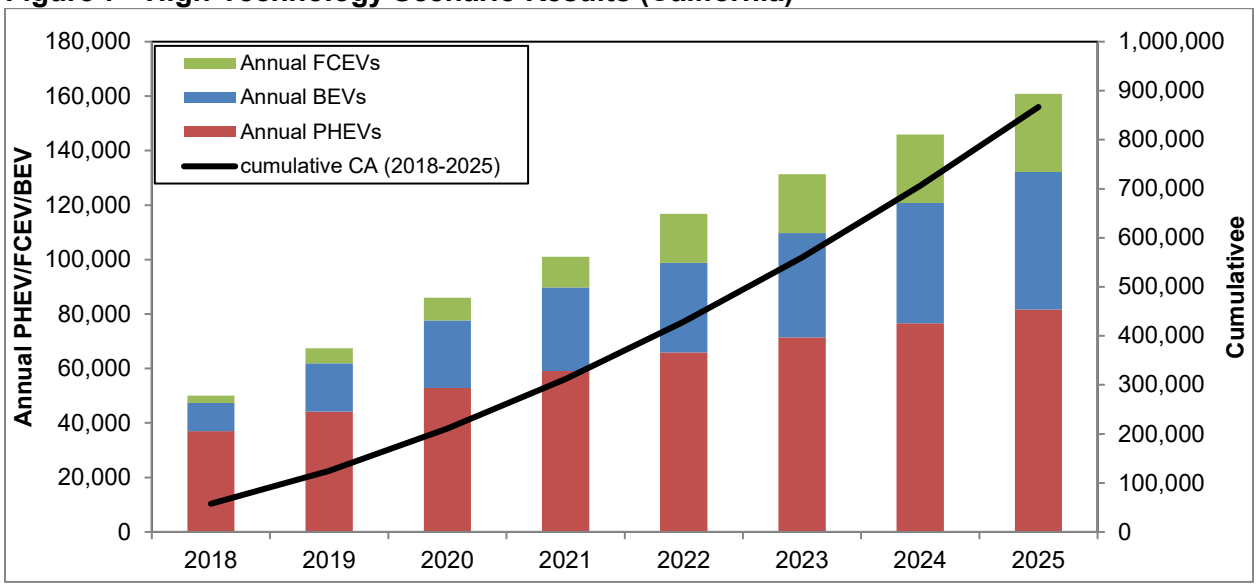
A greater number of manufacturers are also assumed to be producing higher range US06 and non-US06 capable PHEVs, as well as FCEVs. Also, more manufacturers would comply fully with their annual ZEV requirement with BEVs only (vs. a mix of PHEVs and BEVs).

IV.C.2 Regulation Assumptions:

Like in the mid-range case, only a small portion of the LVM market (10%) takes the GHG-ZEV over compliance provision, and the same amount of the allowable cap (75%) would utilize historical PZEV, AT PZEV, and NEV credits. In this case, the manufacturers maintain enough credits in their bank at the end of 2025 to fully meet two additional model years' requirements.

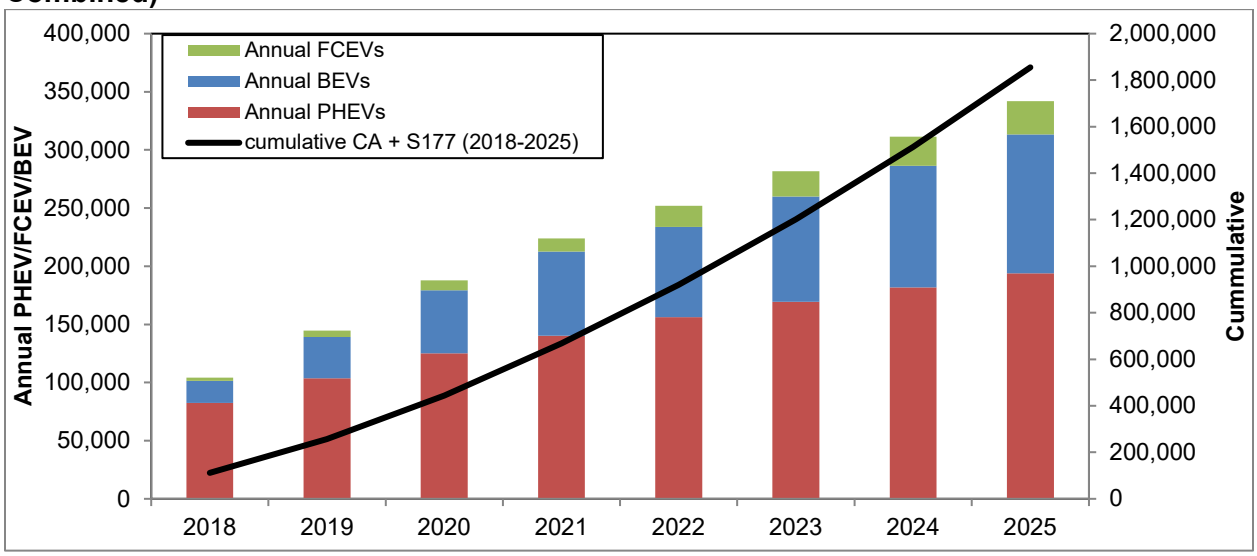
IV.C.3 Results

Figure 7 - High-Technology Scenario Results (California)



The high technology case results in a similar cumulative number of vehicles that result from the regulation as in the mid-range case. This is because technology assumptions have the greatest effect on the number of vehicles expected from each scenario, and similar technology assumptions are made in each case. The high technology case also results in fewer PHEVs, because more manufacturers are pursuing higher technology/longer range BEVs and FCEVs. By 2025, PHEVs and ZEVs represent 8.2% of annual California LDV sales, and cumulatively more than 850,000 vehicles between 2018 and 2025 model year. In the Section 177 ZEV states, due to FCEVs taking advantage of the travel provision and more credits being available, annual sales reach 5% by 2025, more than 600,000 cumulatively in all nine states.

Figure 8 - High-Technology Scenario Results (California and Section 177 ZEV State Combined)



Below is a summary of all assumptions (including assumptions made in the scenario developed for the 2012 ACC rulemaking) across all minimum compliance scenarios.

Table 7 - Summary of Compliance Scenario Assumptions

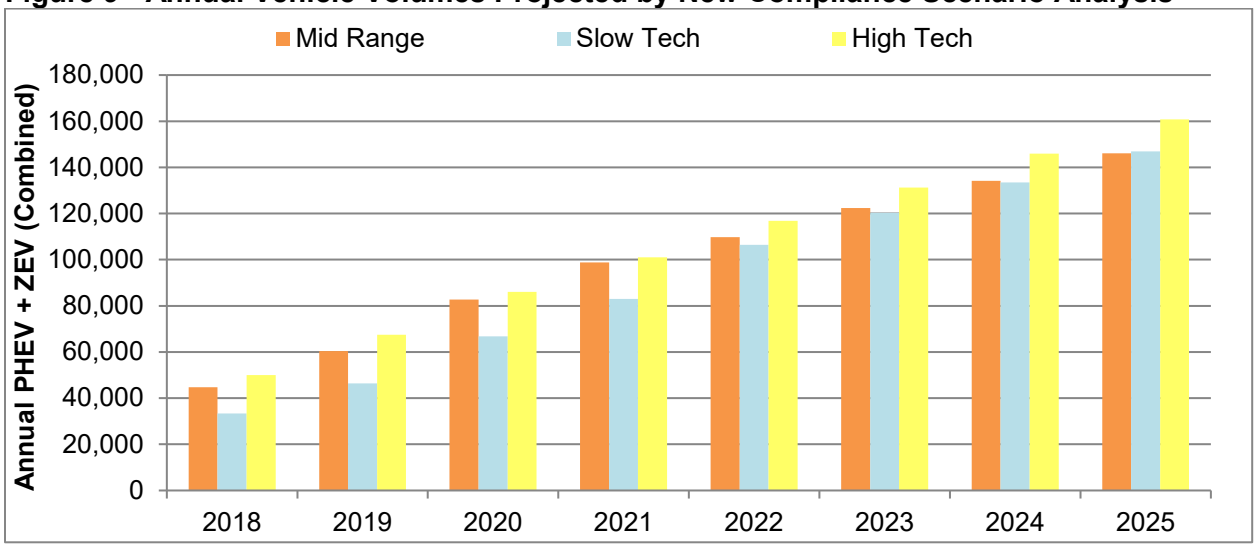
Inputs	***2012 ACC Rulemaking***	**Slower ZEV Tech**	**Mid-range**	**High ZEV Tech**
Annual growth in electric range	*0%*	2.5%	5.0%	7.5%
'18-'25 model year BEV label range (mi)	*70*	150→180	150→210	200→300
'18-'25 model year non-US06 PHEV label range (mi)	*15 mile US06* ***or*** *28 mile non-US06*	20→25	20→30	25→40
'18-'25 model year US06 PHEV label range (mi)		40→50	40→55	45→75
GHG over-compliance	*n/a*	20% of LVMs	10% of LVMs	10% of LVMs
Credit Reserve (in '26 model year)	*n/a*	25%	100%	200%
BEV only LVMs	*n/a*	0%	10%	10%
FCEV LVMs	*17→40%*	5%	35→45%	40→50%
US06 PHEV OEMs	*n/a*	35%	35→50%	50%

V. Summary of Results

New scenarios were developed reflecting updated or new information to analyze the impact of the regulatory requirements on the number and type of ZEVs reasonably expected for compliance in 2025. Three distinct scenarios were considered in order to explore model sensitivities. Each of the new scenarios result in fewer cumulative vehicles than the original compliance scenario used for the 2012 ACC rulemaking. This is due mostly to more capable

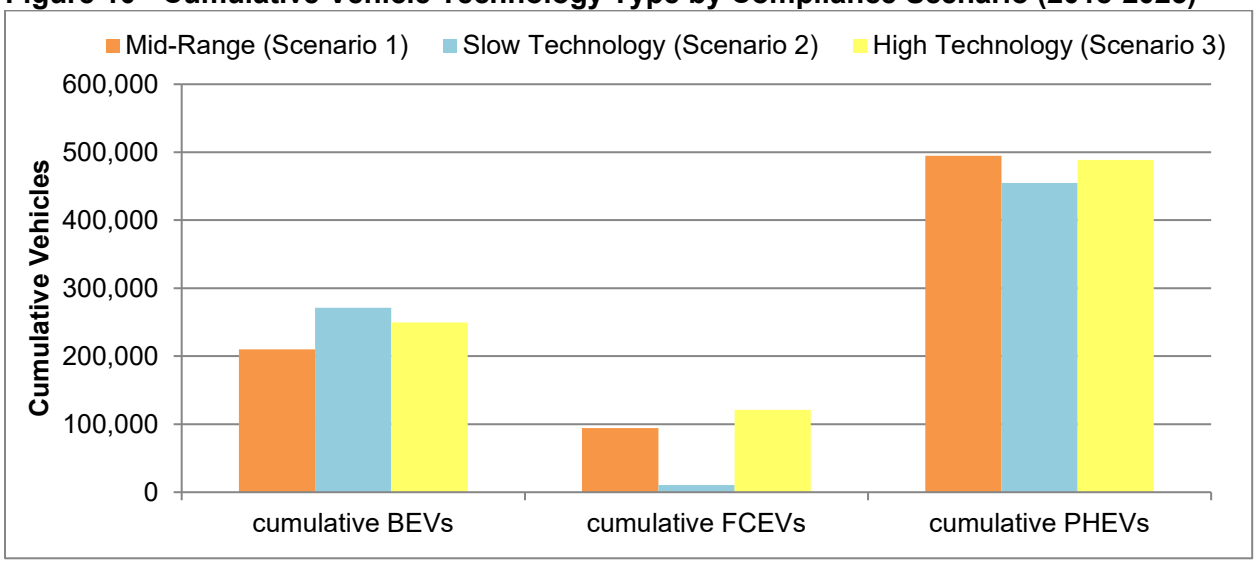
ZEVs projected for the market, which translated to longer range BEVs and PHEVs earning more credits (in some cases twice as much) than in the original compliance scenarios. However, the differences in the three new projected annual vehicle volumes are minimal, as shown below in Figure 9.

Figure 9 - Annual Vehicle Volumes Projected by New Compliance Scenario Analysis



The similarity between the projected annual number of vehicles expected based on each of the three new compliance scenarios suggests the regulatory flexibilities have a marginal effect relative to the effect of higher technology assumptions, which are vital in helping build the market. Manufacturers are responding to market demand by making more capable (and likely higher cost) BEVs and PHEVs. Below Figure 10 summarizes the results from each scenario by technology type.

Figure 10 - Cumulative Vehicle Technology Type by Compliance Scenario (2018-2025)



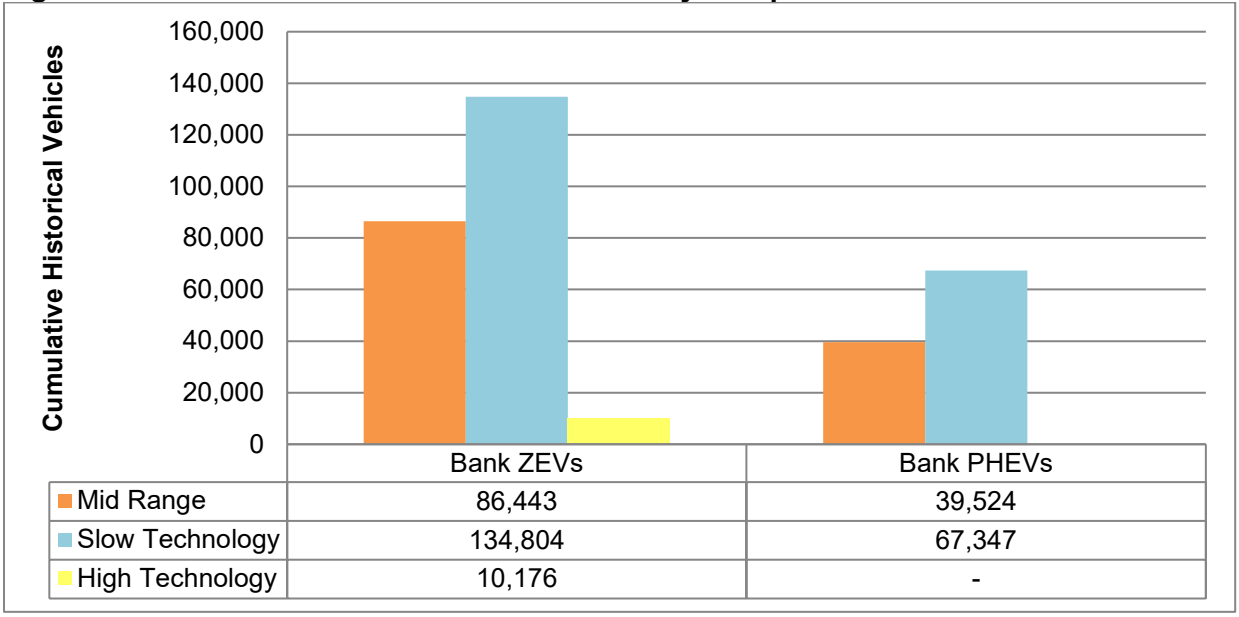
V.A "Bank Vehicles": Accounting for Historical Credits

As noted above, these new scenarios represent the total number of vehicles that, for compliance, result from the updated analysis for the 2018 through 2025 model years presented in this report.

In the public process, an idea emerged that ZEV credits represent "paper cars" because presumably superfluous credits exist in the ZEV Bank (and are continuing to be awarded) that never came from actual vehicles. However, this idea is incorrect since every ZEV credit in the bank is the result of an actual vehicle being placed in California or the Section 177 ZEV states. In each of the new scenarios for analysis, the number of historical credits cumulatively used by the auto industry is translated back into the number of vehicles that would have had to be produced to originally generate those credits. This is done by dividing the number of historical credits used by the average credits per vehicle generated in the pre-2018 timeframe. These "vehicles" are then added into the cumulative number for each scenario to give an improved depiction of the number of vehicles—produced during those years or prior to those years—used to meet the 2018-2025 requirements. For example, if 50,000 extra ZEVs are produced prior to 2018 and the credits from those cars are then used to satisfy a credit obligation in 2018-2025, those 50,000 ZEVs are counted towards the cumulative number of vehicles required to meet the 2018-2025 requirements.

Below is the summary of the number of vehicles that would have had to have been produced in the pre-2018 timeframe, above and beyond the requirements, in order to generate sufficient additional credits used in each of the new three scenarios.

Figure 11 - Historical Banked ZEVs and PHEVs by Compliance Scenario



	Bank ZEVs	Bank PHEVs
Mid Range	86,443	39,524
Slow Technology	134,804	67,347
High Technology	10,176	-

V.B Longer range vehicles means more battery capacity

As stated previously, the purpose of the ZEV regulation is to help achieve commercialization and increasing the production volume of key technology components is an integral part of

achieving that goal. Most often, the total number of vehicles sold is considered a key metric for progress towards the regulation goal. However, as presented at the 2016 ACC Symposium, work by ARPA-E affirms that high volume battery manufacturing will be instrumental in getting costs and prices down, suggesting that other metrics may also be appropriate.[35] Accordingly, this analysis considers the impacts to total battery volumes relative to the original 2012 assumptions. This was accomplished by assuming a battery pack capacity for each technology and range used in the three new scenarios, and multiplying that battery capacity by the volume of vehicles expected for those technologies and ranges. Battery capacity assumptions were developed in the same way for both BEVs and PHEVs, using the reported test cycle range from certification for available 2015 model year BEVs and PHEVs, and dividing that into the battery capacity of each of those models to identify each vehicle's watt-hour per mile (Wh/mi) efficiency.[36] A separate Wh/mi efficiency for BEVs and PHEVs was then calculated from the average of the 2015 model year BEVs and PHEVs, respectively. Each technology's average efficiency was assumed to be the same for all model years or ranges across all compliance scenarios. That average efficiency was then used to calculate the required battery pack size to meet the required range identified for each technology by model year. Those required ranges were then used to calculate the total battery capacity by model year and the cumulative capacity across 2018 through 2025 model years of each scenario.

Figure 12 - Cumulative Battery Capacity (kWh) for Mid-Range and 2012 Compliance Scenarios (California)

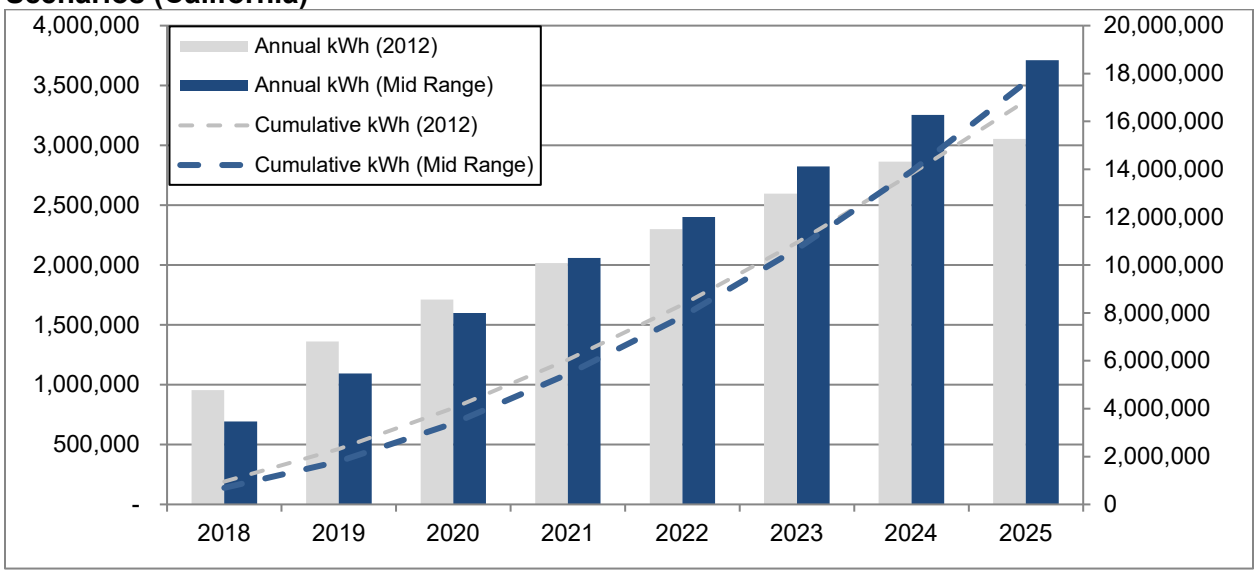


Figure 12 shows that the updated compliance scenarios result in similar cumulative kWh of batteries produced by 2025, with annual accumulation of those kWh increasing above the original compliance scenario levels in the latter years. This is due to technology advancements,

[35] Babinec, 2016. Sue Babinec, "Energy Storage Technology for Transportation" in Advanced Clean Cars Symposium: The Road Ahead, Diamond Bar, September 27, 2016. https://www.arb.ca.gov/msprog/consumer_info/advanced_clean_cars/advancements_in_liion_technology_andor_manufacturing_sue_babinec.pdf

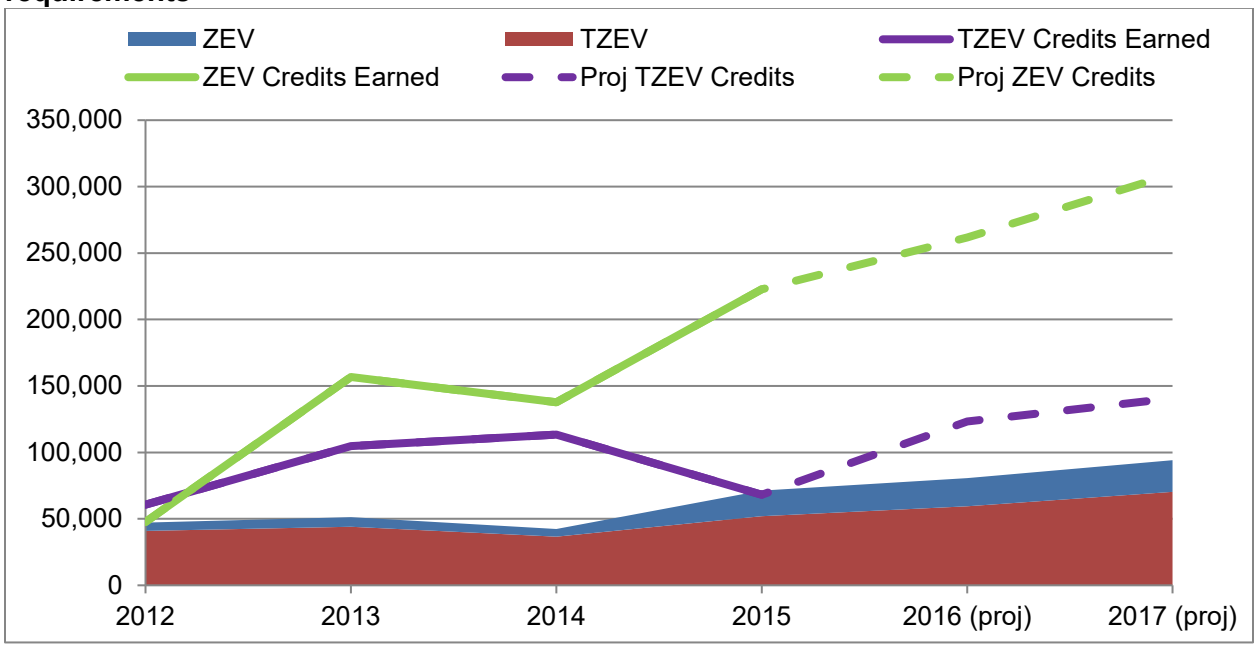
[36] Tesla vehicles' Wh/mi efficiencies were not calculated, because UDDS range numbers were not updated during the 2015 model year when Tesla added the 70kWh and 90kWh battery pack options.

and more BEVs and PHEVs with greater battery capacity. These results help confirm that, despite a lower cumulative number of vehicles expected by 2025, significant progress is still being made within the current regulation towards achieving the broader goals of the ZEV regulation for advancing commercially viable technologies.

V.C How to use these compliance scenario results

The ZEV regulation intends to advance pure ZEV technology towards mainstream commercialization and ultimately transform the light duty vehicle market. One way it does this is by setting a regulatory minimum, or floor, to ensure an increasing number of vehicles are produced each year. As is shown below in Figure 13, manufacturers have over-complied with the regulatory requirements since the 2012 model year. And while this trend may continue, it is important to note that the updated compliance scenarios do not include any projection of vehicles above the regulatory minimum for 2018 through 2025 model years. Projections for 2016 and 2017 model year are based on partial year to date sales and DMV data and do, however, exceed the regulatory minimum, consistent with sales numbers for the past few years.

Figure 13 - Actual (and projected) annual compliance with 2012 through 2017 ZEV requirements



Through 2015 model year, 182,000 ZEVs and PHEVs have been registered in California according to Department of Motor Vehicles (DMV) data. According to projections derived from historical sales data[37] and partial year to date sales information, approximately 165,000 additional ZEVs and PHEVs are expected for 2016 and 2017 model years. As explained above, the new scenarios take into account the number of vehicles produced above and beyond the requirements (in the 2016 and 2017 model years only) in order to more accurately project the credit banks available to manufacturers for the 2018 through 2025 years. And because the scenarios explicitly account for the number of vehicles used to generate credits that are

[37] See Appendix B for more information on historical sales data.

subsequently used by manufacturers to meet part of their 2018 through 2025 requirements, these historical credits must be removed when summing 2018 through 2025 model year scenario results with the pre-2018 ZEV sales to avoid double-counting. Below is a summary table of these calculations for California for each scenario.

Table 8 - Summary of Expected ZEVs and PHEVs by Compliance Scenario (California)

	2011-2015 Model Years	**2016 & 2017 Model Year Projected**	**Cum Min Scenario (2018-2025)**	**Historical Credit Cars** incl in Cum. Min Scenario	**Min. 2025 Cum. Number**
Mid-Range (Scenario 1)	182,000	165,000	953,000	(154,000)	~1.2 million
Slow Tech (Scenario 2)	182,000	165,000	967,000	(230,000)	~1.1 million
High Tech (Scenario 3)	182,000	165,000	867,000	(7,500)	~1.2 million

The outcome is similar for the Section 177 ZEV states, as seen below.

Table 9 Summary of Expected Vehicles by Compliance Scenario (Section 177 ZEV States)

	2011-2015 Model Years	**2016 & 2017 Model Year Projected**	**Cum Min Scenario (2018-2025)**	**Historical Credit Cars**	**Min. 2025 Cum. Number**
Mid Range (Scenario 1)	48,000	34,000	1.1 million	(0)	~1.2 million
Low Tech (Scenario 2)	48,000	34,000	720,000	(0)	~800,000
High Tech (Scenario 3)	48,000	34,000	987,000	(0)	~1.1 million

The total number of ZEV vehicles deployed in 2018 through 2025 would be the sum of these compliance numbers and any vehicles produced in over-compliance with the regulation requirements for the same years.

VI. Conclusion

The ZEV market has developed rapidly since the adoption of the ACC regulations in 2012. ZEV technology, especially for BEVs, has developed faster than anticipated and at declining costs resulting in longer range vehicles earlier than projected. Consumer feedback in support of longer range vehicles, competition, and the sales of current shorter range BEVs suggest that shorter range BEVs will have an increasingly more limited market than originally projected. Based on this new data and knowledge, updates were made to the technical assumptions and inputs to develop new compliance scenario projections, as well as to develop an enhanced ZEV

Calculator. The updated ZEV Calculator has been improved with newer data and added functionality which gives a more complete picture of compliance with the ZEV regulation through 2025. The updated minimum compliance scenarios reflect these changes, as well as regulatory flexibilities added in 2012 or later, and project approximately 1.2 million ZEVs and PHEVs on the road in California by 2025. Though these updated scenarios show a lower overall number of vehicles expected as compared to the scenarios developed for the 2012 ACC rulemaking, the vehicles will be more capable ZEVs and PHEVs that are critical to expand the market beyond early ZEV and PHEV consumers while continuing to drive increased battery volumes necessary to reduce ZEV costs.

Staff will continue to track technology progress to further refine the technology assumptions to better reflect trends in vehicle ranges, as well as electric powertrain developments. For future rulemakings, staff expects to utilize and continue to improve upon the ZEV calculator to develop further updated compliance scenarios.

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