

# Zero Emission Vehicle Populations Under CARB's Advanced Clean Cars Program

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## Executive Summary

The California Air Resources Board (CARB) adopted the Advanced Clean Cars (ACC) regulation in 2012 and forecast that there will be about 1.6 million ZEVs on California roads by 2025.<sup>1</sup> Shortly after the adoption of the ACC program by CARB, Governor Brown issued Executive Order B-16-2012 which, among other things, established a goal of having 1.5 million zero emission vehicles (ZEVs) on the road in California by 2025. Recently, the Natural Resources Defense Council (NRDC) published a study based on a number of assumptions more optimistic than those used by CARB in 2012 that indicates that only about 1 million ZEVs will be on the road in California in 2025.

In light of the optimistic assumptions used in the NRDC study, the Alliance of Automobile Manufacturers (Alliance) commissioned an analysis of the sensitivity of the NRDC ZEV population forecast to changes in those assumptions.

The key differences in the assumptions used in the sensitivity analysis are as follows:

1. Use of actual vehicle sales data instead of CARB's estimates for model years through 2015 in determining the ZEV requirement;
2. Assignment of high-performance credits for plug-in hybrids to only a subset of models, rather than all models;
3. Manufacturers' developing and maintaining a balance of banked credits to ensure future compliance rather than being expected to accurately determine exactly how many credits they will require in each model year;
4. Less optimistic, rather than highly optimistic, assumptions regarding future increases in electric vehicle range; and
5. Some Intermediate Volume Manufacturers (IVMs) using the provisions of the ACC regulation to comply only through Transitional Zero Emission Vehicle (TZEV) credits, rather than through a mix of battery electric vehicles (BEVs) and TZEVs.

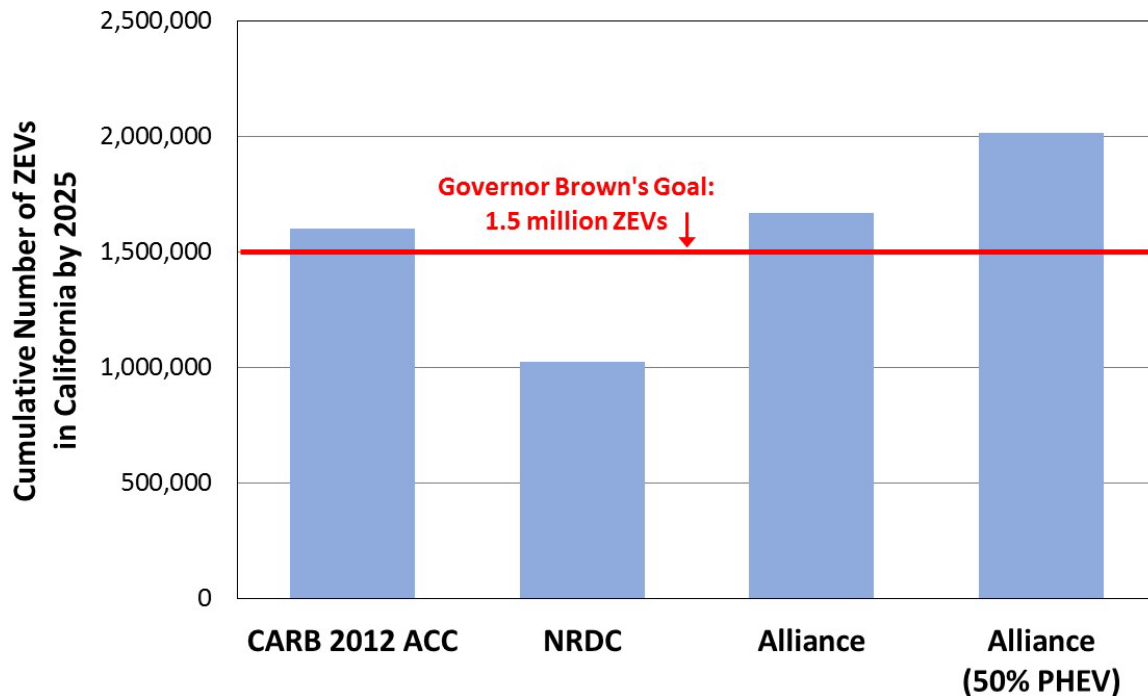
<sup>1</sup> This value combines CARB's forecast for model years 2018-2025 due to adoption of the ACC regulation with the agency's forecast of model-year 2011-2017 ZEVs in operation in 2025 due to the pre-existing ZEV regulation.

These changes in assumptions significantly impact the number of ZEVs forecast to be required by the ZEV regulations in California by 2025. Accounting for all of the above changes in assumptions, the forecast 2025 ZEV population remains at more than 1.6 million vehicles.

Furthermore, if the ACC regulation were modified, as has been suggested by the Alliance, to increase the amount of TZEV credits allowed to be used to meet manufacturers' compliance obligations to 50%, more than 2 million ZEVs would be forecast to be required by the ZEV regulations in California in 2025.

Figure 1 presents the 2025 ZEV population forecasts developed by CARB and NRDC as well as the results from the two "Alliance" scenarios developed in this study. Finally, it must be stressed that all of the ZEV forecasts shown in Figure 1 reflect only the number of ZEVs required to comply with the ACC regulation and do not in any way address issues associated with consumer acceptance of ZEVs.

**Figure 1**  
**Number of ZEVs Forecast in California by 2025 with Each Model**



### Background

The ACC program establishes minimum ZEV credit requirements specifying that automakers must produce and deliver for sale ZEVs that generate a minimum number of ZEV credits. The minimum number of ZEV credits is determined as a percent of an automaker's California vehicle sales, with the percent increasing from 4.5 percent in 2018 to 22 percent in 2025. For example, in 2025, the regulations require an automaker

with sales of 100,000 vehicles to produce and deliver for sale ZEVs that will generate 22,000 ZEV credits.

ZEVs include BEVs, fuel cell electric vehicles (FCEVs), and plug-in hybrid electric vehicles (PHEVs, also called TZEVs). Each PHEV generates between 0.4 and 1.3 ZEV credits depending on its range and capability, while each BEV or FCEV generates between 1 and 4 ZEV credits depending on its range.

The minimum pure ZEV credit requirements can be met using only BEVs and/or FCEVs. Automakers can also use TZEVs to meet a portion of the ZEV credit requirements, but regulations limit the use of TZEV credits to a fraction of the overall requirements.

As noted above, at the time CARB adopted the ACC program in 2012, the agency forecast that compliance with the regulations would result in over 1.6 million ZEVs being on the road in California by 2025. About 500,000 of these ZEVs were expected to be BEVs and FCEVs based on CARB's assumptions.

Shortly after the adoption of the ACC program by CARB, Governor Brown issued Executive Order B-16-2012 which, among other things, established a goal of having 1.5 million ZEVs on the road in California by 2025. More recently, the NRDC published a study by Shulock Consulting that suggests the number of ZEVs operating in California by 2025 will total slightly more than 1 million vehicles.<sup>2</sup>

In light of California's 2025 ZEV goal and the NRDC study, the Alliance of Automobile Manufacturers (Alliance) sponsored an effort to reproduce the results of the NRDC study and assess the forecast population of ZEVs in California by 2025 under several scenarios based on updated assumptions regarding ZEV vehicle characteristics and the choices made by manufacturers in complying with the requirements of the ACC program. As is documented below, the results of this analysis indicate that, depending on the various assumptions, the 2025 ZEV forecast ranges from the 1 million vehicles suggested by NRDC on the low end to well above 1.5 million under the current regulatory scenario and to as many as 2 million vehicles with only slight modifications to the regulations.

### Recreation of the NRDC Study Model

In July 2016, NRDC released a report entitled "Manufacturer Sales Under the Zero Emission Vehicle Regulation: 2012 Expectations and Governor's Commitments Versus Today's Likely Outcomes,"<sup>3</sup> which was performed for NRDC. This study presents estimates of the number of ZEVs expected in California through 2025. The modeling work described in the report indicates just slightly more than 1 million ZEVs in California by 2025, and the report describes potential changes to the ACC program that the authors believe will lead to a smaller ZEV population.

<sup>2</sup> Chuck Shulock, "Manufacturer Sales under the Zero Emission Vehicle Regulation: 2012 Expectations and Governors' Commitments Versus Today's Likely Outcomes," Shulock Consulting, prepared for Natural Resources Defense Council, 2016, available at [www.nrdc.org/sites/default/files/media-uploads/nrdc\\_commissioned\\_zev\\_report\\_july\\_2016\\_0.pdf](http://www.nrdc.org/sites/default/files/media-uploads/nrdc_commissioned_zev_report_july_2016_0.pdf)

<sup>3</sup> [www.nrdc.org/sites/default/files/media-uploads/nrdc\\_commissioned\\_zev\\_report\\_july\\_2016\\_0.pdf](http://www.nrdc.org/sites/default/files/media-uploads/nrdc_commissioned_zev_report_july_2016_0.pdf)

Unfortunately, the model used in the NRDC study has not been made publicly available, which meant that the model used in that study had to be recreated to evaluate the updated scenarios developed by the Alliance. Given this, the effort to recreate the NRDC model began with the incorporation of several assumptions clearly stated in the NRDC report, as outlined below.

1. Annual vehicle sales, shown in Table 1 of the NRDC report, as derived from CARB's EMFAC2014 model.
2. ZEV ranges, shown in Table 2 of the NRDC report.
3. Annual sales of BEVs, which are kept at or above levels observed in 2015, and annual sales of FCEVs, which are taken from the 2015 AB 8 report.<sup>4</sup> These data are shown in Table 12 of the NRDC report.
4. Annual sales of Tesla vehicles as shown in Table 12 of the NRDC report.

The next step was to account for the ZEV provisions of the ACC program.<sup>5</sup> Table 1 shows the ZEV credit requirements for Large Volume Manufacturers (LVMs) as a function of model year from 2015 through 2025.

**Table 1**  
**Annual ZEV Credit Requirements for LVMs**  
**(Percentage of Vehicle Sales)**

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
ZEV Credits (Minimum)	3.0%	3.0%	3.0%	2.0%	4.0%	6.0%	8.0%	10.0%	12.0%	14.0%	16.0%
TZEV Credits (Maximum)	3.0%	3.0%	3.0%	2.5%	3.0%	3.5%	4.0%	4.5%	5.0%	5.5%	6.0%

As noted by NRDC, vehicle manufacturers can comply with the ACC ZEV credit requirements in a number of ways, but the regulations require that a certain percentage of credits—those shown in the top row of Table 1—be only from vehicles that are pure ZEVs, either BEVs or FCEVs. Credits derived from the sale of TZEVs cannot be used to meet this requirement. The remaining number of credits, derived from the percentages shown in the second row of Table 1, may be earned through either the sale of TZEVs or through the sale of pure ZEVs. In addition to the requirements for LVMs, the ACC program imposes requirements on IVMs calling for the same number of credits but allowing compliance entirely through the sale of TZEVs. Given this, the actual number

<sup>4</sup> [www.arb.ca.gov/msprog/zevprog/ab8/ab8\\_report\\_2015.pdf](http://www.arb.ca.gov/msprog/zevprog/ab8/ab8_report_2015.pdf)

<sup>5</sup> [www.arb.ca.gov/msprog/zevprog/2011zevreg/attachb1.pdf](http://www.arb.ca.gov/msprog/zevprog/2011zevreg/attachb1.pdf);  
[www.arb.ca.gov/msprog/zevprog/2011zevreg/attachb3.pdf](http://www.arb.ca.gov/msprog/zevprog/2011zevreg/attachb3.pdf)

of ZEVs required for compliance depends on the compliance choices made by vehicle manufacturers.

The assumptions used in the NRDC study with respect to IVM compliance are not clear from the information presented in the report. Table 12 of the NRDC report indicates that the IVMs would produce only TZEVS for compliance, but the number of credits earned from the sales shown in Table 12 would fall far short of the credit requirement. To address this, in proportioning the sales of vehicles in California between LVMs and IVMs (and small-volume manufacturers, from whom no credits are required), data released by CARB for 2015 were used. These data indicated that LVMs would account for 71% of vehicle sales in California, while IVMs would account for 27% until 2018.<sup>6</sup> Of the IVMs listed on CARB's website, the four largest—BMW, Kia, Mercedes, and Volkswagen—offer BEVs and thus are modeled as meeting a portion of their credit requirement with pure ZEVs, in a manner similar to LVMs. These manufacturers represented 65% of the IVMs listed on CARB's website, by sales volume in 2015, and so 88% ( $71\% + 27\% \times 65\%$ ) of the annual compliance requirements were modeled as being met with a mix of pure ZEVs and TZEVS. The remaining 9% of the fleet was modeled as meeting ZEV requirements with just TZEVS. CARB has stated that as of the 2018 model year, only Subaru, Mazda, Jaguar Land Rover, and Mitsubishi will be IVMs. These manufacturers represented 6% of sales in California in 2015, so LVMs were modeled post-2017 as representing 92% of vehicle sales while IVMs were modeled as representing 6% of vehicle sales.

The number of credits earned by BEVs and FCEVs for model years 2015-2017 is a function of the range of the vehicles and is determined by the table within CCR13 1962.1 (d)(5)(C). These are estimated at 3 credits/vehicle for BEVs and 9 credits/vehicle for FCEVs. The number of credits earned by vehicles of these types for model years 2018-2025 is also a function of range as calculated using formulas in the ACC regulations, which for BEVs averages 2.2 credits/vehicle in 2018, increasing to 2.8 credits/vehicle in 2025, and 4 credits/vehicle for FCEVs for all years.

The number of credits earned per TZEVS, between 2015 and 2017, is a function of the all-electric range of that vehicle and the utility factor that would be associated with that range. For model years 2018-2025, the number of credits is again a function of range and is capped at 1.10. In addition, each TZEVS that can travel more than 10 miles all-electric on the US06 test cycle can receive another 0.20 credits. In replicating the NRDC model, the credits estimated per vehicle shown in Table 12 of the NRDC report were used.

BEVs produced by Tesla, which are sold with ranges varying anywhere from 200 to 300 miles based upon the size of the battery, were all modeled as having received 4 credits/vehicle despite the fact that Tesla has demonstrated the ability to swap batteries in its BEVs, making it possible for those vehicles to receive credits for fast recharging. This is based on CARB staff's having commented that very few, if any, applications have been made for such credits.

<sup>6</sup> [www.arb.ca.gov/msprog/zevprog/zevcredits/2015zevcredits.htm](http://www.arb.ca.gov/msprog/zevprog/zevcredits/2015zevcredits.htm)

Using the above assumptions, the recreated model was structured to estimate ZEV sales as outlined below.

1. Use the vehicles from estimates in EMFAC2014 in combination with the ZEV credit requirements shown in Table 1 to estimate the number of credits required for compliance in each model year for both pure ZEVs and TZEVs.
2. Calculate the credits associated with sales of at least the number of pure ZEVs and TZEVs sold in 2015 for each model year between 2016 and 2025, as NRDC indicated to have done within its memo. These numbers correspond to 24,780 for BEVs, as indicated by the NRDC report, and 27,645, which is the number of TZEVs reported by the Alliance of Automobile Manufacturers as having been sold in California in 2015.<sup>7</sup>
3. Determine, for both pure ZEVs and TZEVs, whether the number of credits that result from Step 2 is sufficient for compliance, when combined with the credit balance advanced from the previous year, to meet the credit requirements for the current year.<sup>8</sup>
4. If the number of credits estimated in Step 3 is sufficient for compliance, ZEV sales are kept at 2015 levels.
5. If the number of pure ZEV credits estimated in Step 2 is insufficient for compliance and pure ZEV credits are estimated to be available from Tesla, assume those pure ZEV credits are purchased from Tesla and that pure ZEV sales are kept at 2015 levels. Note that, as was assumed by NRDC, Tesla credits are not considered for compliance with TZEV requirements.
6. If the number of credits from Step 2 and pure ZEV credits from Tesla is insufficient for compliance, assume that the number of additional pure ZEVs and TZEVs required for compliance is produced.

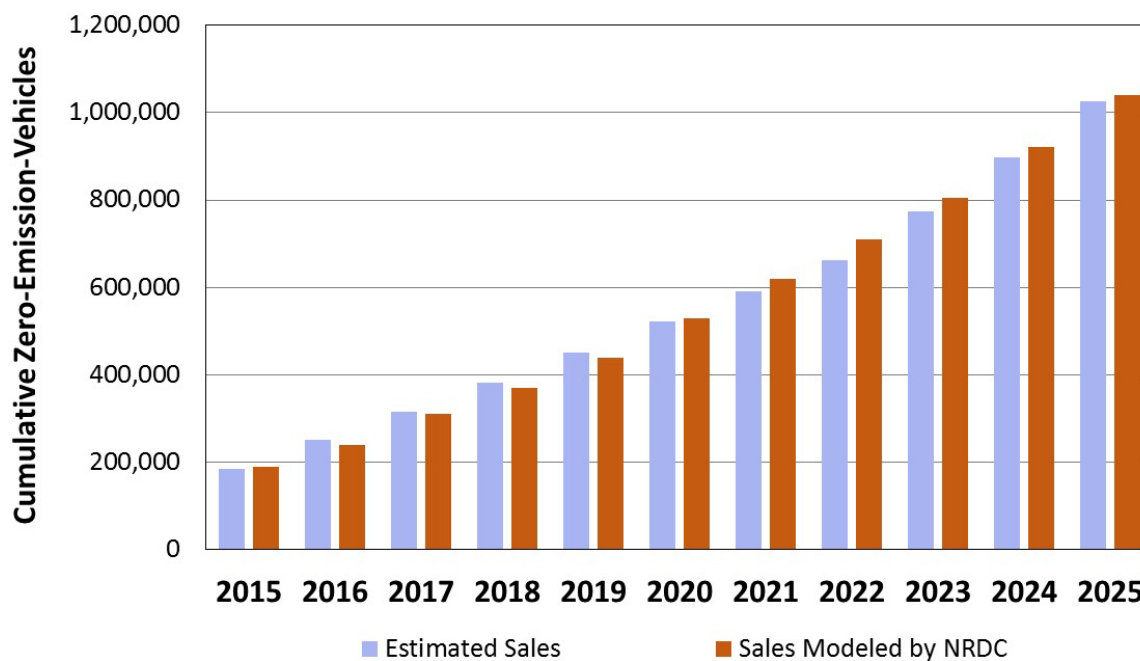
The ZEV populations calculated with the recreated model are compared to those from the NRDC report in Figure 2. As shown, there is very good agreement between the recreated and NRDC models given that the NRDC model and information regarding some of its key assumptions are not currently publicly available.<sup>9</sup>

<sup>7</sup> [www.zevfacts.com/sales-dashboard.html](http://www.zevfacts.com/sales-dashboard.html)

<sup>8</sup> Note that the PZEV and AT PZEV credits listed within the appendix from the NRDC memo were converted to TZEV credits in 2018 per the ACC regulations.

<sup>9</sup> The actual sales forecasted by NRDC are presented only within figures, and thus NRDC data provided here for comparison are estimated only from those figures.

**Figure 2**  
**Comparison of ZEV Populations from the NRDC and Recreated Models**



### Updated Scenarios

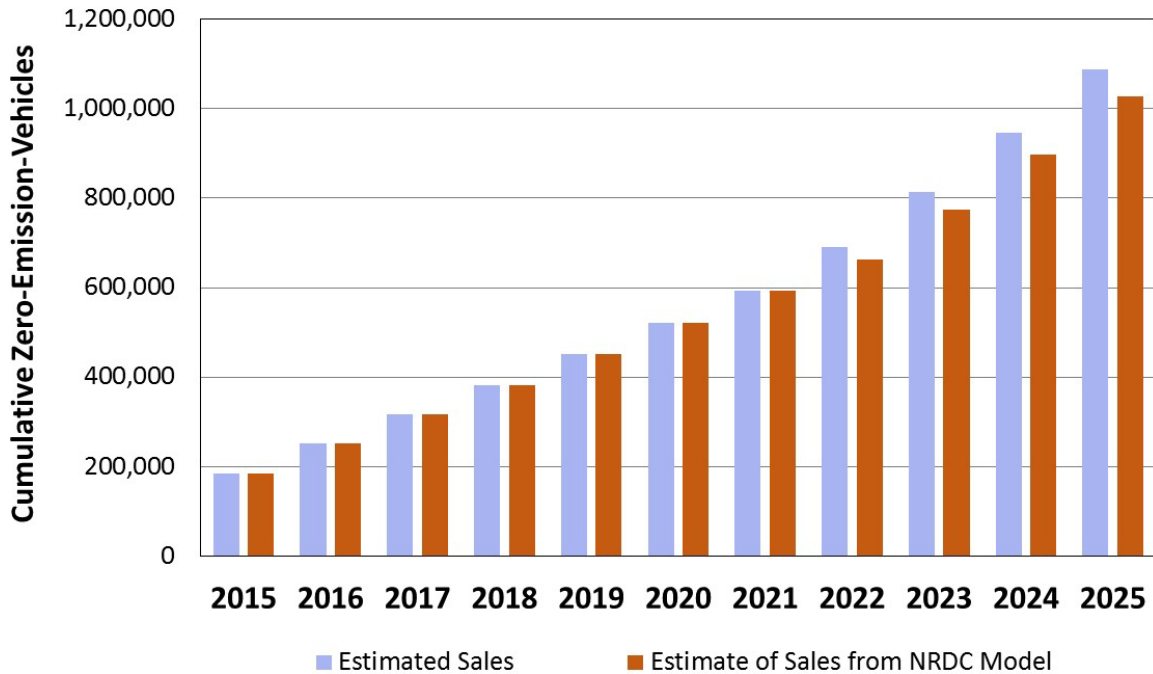
As discussed above, there are a number of key assumptions that are required to estimate future ZEV populations. Given this, the impacts of changes in these key assumptions were assessed. More specifically, the sensitivity analysis investigated the impacts of the following:

- IVMs complying with only TZEVs, rather than a mix of pure ZEVs and TZEVs;
- Using actual sales data rather than EMFAC2014 sales forecasts;
- Changes in the assumptions regarding the fraction of TZEVs likely to receive US06 credits;
- Use of more realistic ranges for BEVs; and
- Manufacturers' plans for maintaining ZEV credit balances to ensure future compliance.

IVMs Compliance with TZEVs – For this scenario, it was assumed that a portion of the IVMs would comply with the ACC requirements using only TZEVs, as the regulations allow.<sup>10</sup> The results are shown in Figure 3 and are compared to the results that were obtained from the recreated NRDC model.

<sup>10</sup> 35% of IVMs, by sales volume, did not manufacture a pure ZEV in 2015. Thus 35% of the IVMs, or ~10% of all manufacturers, were modeled as complying with only TZEVs pre-2018. From 2018 forward, IVMs were modeled as representing 6% of the annual sales volume, compliance being solely from TZEVs.

**Figure 3**  
**Comparison of ZEV Populations from Recreated NRDC Model and**  
**Those Forecast if IVMs Comply with TZEVs**



As Figure 3 shows, the ZEV population forecast when IVMs comply with TZEVs is just below 1.1 million, about 60,000 more than those from the recreated NRDC model. This increase follows from the fact that TZEVs, on average, receive fewer credits per vehicle, thus requiring that more vehicles be sold to achieve the same number of credits. Since a greater portion of the IVMs' sales are from TZEVs, those IVMs are not consuming pure ZEV credits. Consequently, in addition to increasing the number of TZEVs, complying with TZEVs in place of pure ZEVs would result in an additional 124,000 credits remaining in the pure ZEV credit bank in 2025.

Using Actual Vehicle Sales Data – This scenario involved replacing estimated vehicle sales data from EMFAC2014 with actual sales data from years between 2011 and 2015 and assuming that the annual sales in future years would be equal to that in 2015 even though the California Auto Outlook projects 2016 sales will exceed 2015 levels. The annual sales data used were obtained from California Auto Outlook, issued quarterly by the California New Car Dealers Association. Table 2 compares the sales forecast by EMFAC2014 with the actual sales data for model years 2011 and 2015.

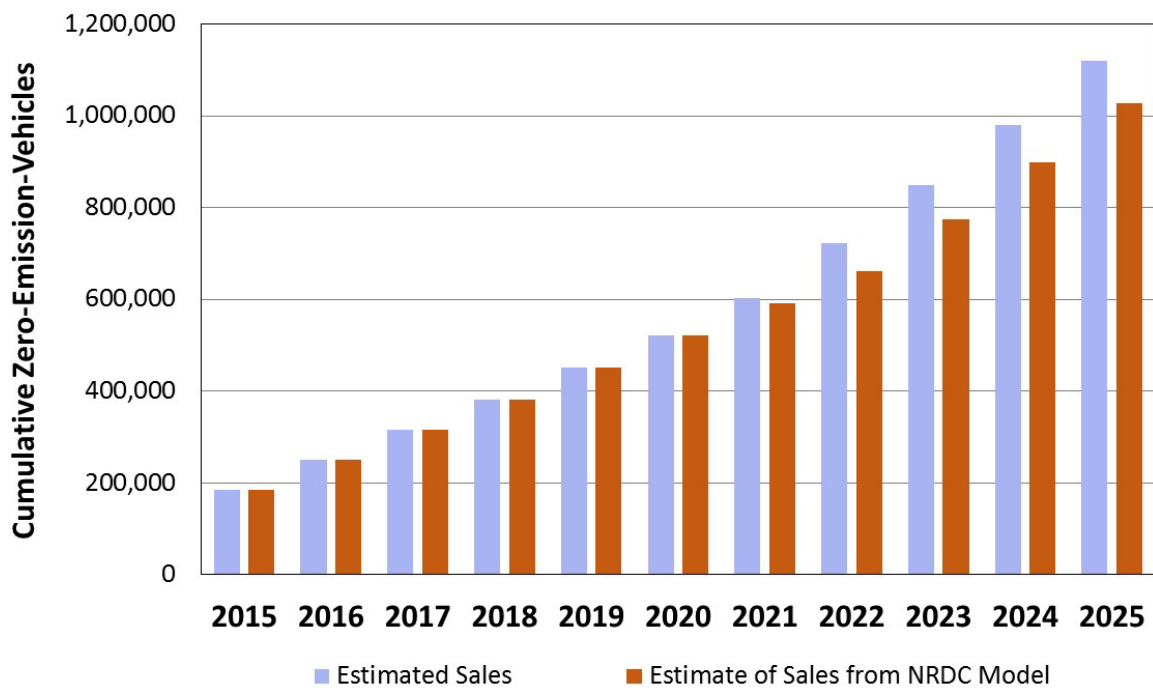
As shown, actual sales data would represent 15% more vehicles between 2011 and 2025 than forecast within EMFAC2014, which means that 15% more ZEV credits would be required. The impact on ZEV sales of this additional demand for credits is shown in Figure 4 and is again compared to those forecast from the recreated NRDC model.

**Table 2**  
**Annual Vehicle Sales Data – Comparison of EMFAC2014 Estimates**  
**and Actual Sales Data Through 2015**

	2011	2012	2013	2014	2015	2016	2017	2018
Annual Sales (EMFAC 2014)	991,601	1,193,525	1,367,202	1,468,064	1,580,488	1,675,075	1,720,057	1,756,116
Annual Sales (CNCDA)	1,222,965	1,529,212	1,711,563	1,848,254	2,052,750	2,052,750	2,052,750	2,052,750

	2019	2020	2021	2022	2023	2024	2025	Total
Annual Sales (EMFAC 2014)	1,786,723	1,806,321	1,819,994	1,842,257	1,864,509	1,886,125	1,908,353	24,666,410
Annual Sales (CNCDA)	2,052,750	2,052,750	2,052,750	2,052,750	2,052,750	2,052,750	2,052,750	28,892,244

**Figure 4**  
**Impact of Using Annual Sales Data Instead of EMFAC2014 Estimates**  
**on Forecast ZEV Populations**

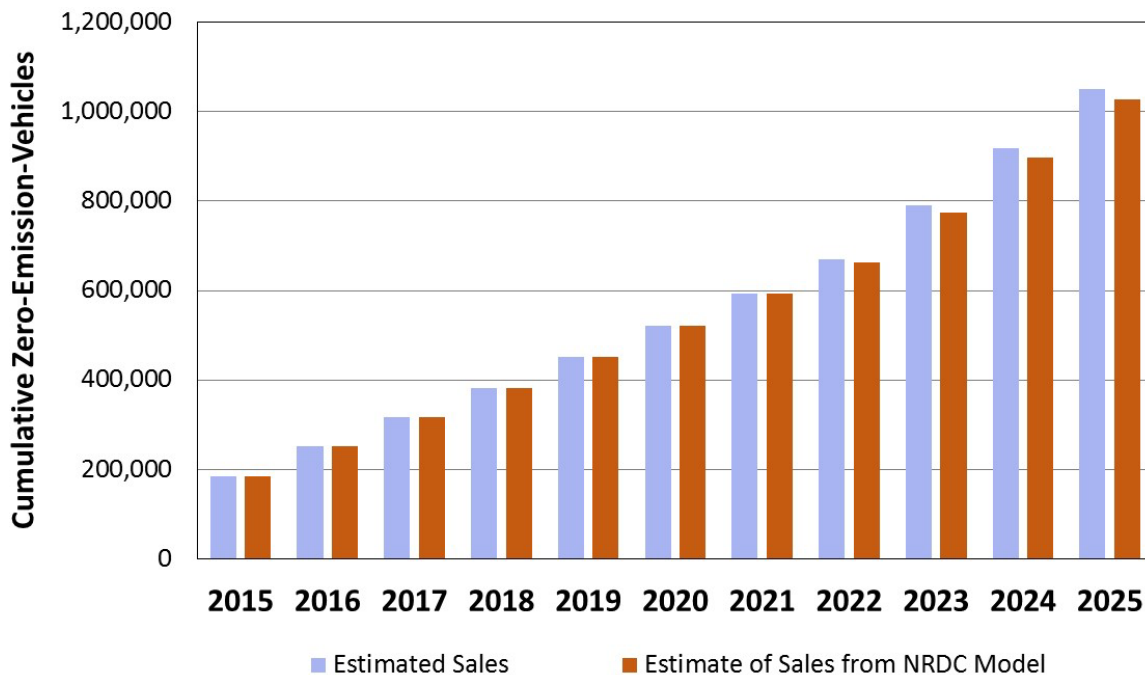


The use of actual sales data results in an increase of about 120,000 TZEVs by 2025. Compliance based upon actual sales data would also result in the depletion of an additional 200,000 credits—the equivalent of about 80,000 BEVs—from the pure ZEV credit bank.

Adjusting the Percentage of TZEVs Assumed to Receive the US06 ZEV Credit – The NRDC report assumed that all TZEVs receive the 0.2 ZEV credits for zero-emission operation for at least 10 miles over the US06 cycle. However, only one of 17 TZEVs currently receive this credit. In this scenario, the assumption that every TZEV would receive the additional 0.2 credits was modified such that only 36% of TZEVs were assumed to receive this credit in 2015 and that the share would then increase linearly to 70% by 2025. This assumption is based on the fact that only the Chevrolet Volt currently qualifies for this credit and that the Chevy Volt accounted for approximately 36% of TZEV sales in the United States in 2015.<sup>11</sup> It is expected that improvements in battery technology over time will lead to more eligible TZEVs. However, meeting this requirement is far more difficult for larger vehicles; the 70% cap in 2025 recognizes the availability of PHEVs in larger vehicles. The results are shown in Figure 5.

As shown in Figure 5, updating the US06 credit results in an increase of about 25,000 TZEVs. Because the credit bank for TZEVs is already anticipated as being depleted, and as the reduced compliance with US06 credits does not affect pure ZEVs, the credit balance for each category remains unchanged.

**Figure 5**  
**Impact of Revised Assumptions Regarding TZEV US06 Credits**



<sup>11</sup> <http://insideevs.com/monthly-plug-in-sales-scorecard/>

The Impact of Lower Range for BEVs – The NRDC study assumed that the BEV range would increase from 128 miles in 2018 to 240 miles in 2025. This is a very aggressive forecast which exceeds the forecast from a recent Technical Assessment Report,<sup>12</sup> co-authored by CARB, which suggests that BEV range will increase by approximately 5% per year.<sup>13</sup> Given this, this scenario assumed a 5% increase in range, rather than the increase assumed within the NRDC forecast.

Table 3 presents the resulting comparison of the BEV range assumed in the scenario with the NRDC forecast.

**Table 3**  
**Comparison of Assumed BEV Range with NRDC Forecast**

	2018	2019	2020	2021	2022	2023	2024	2025
Average Label Range, BEV - NRDC	127	154	179	199	214	224	232	239
Average Label Range, BEV	115	121	127	133	140	147	154	162

Because the annual sales of pure ZEVs is kept at the level observed in 2015 as a floor for the sale of pure ZEVs until 2025, the actual number of pure ZEVs sold is not expected to be impacted by this adjustment. The number of pure ZEVs and the number of TZEVS forecast as being sold prior to 2025 are not affected by the actual range of the BEVs modeled. What is instead impacted is the balance of credits that would be remaining in 2025, which in turn would affect the number of ZEVs likely to be sold beyond 2025 or the number of additional ZEVs that would be anticipated by 2025 when this adjustment is combined with other adjustments in a later scenario. We anticipate just over 169,000 pure ZEV credits as being depleted as a result of accounting for a more realistic battery range.

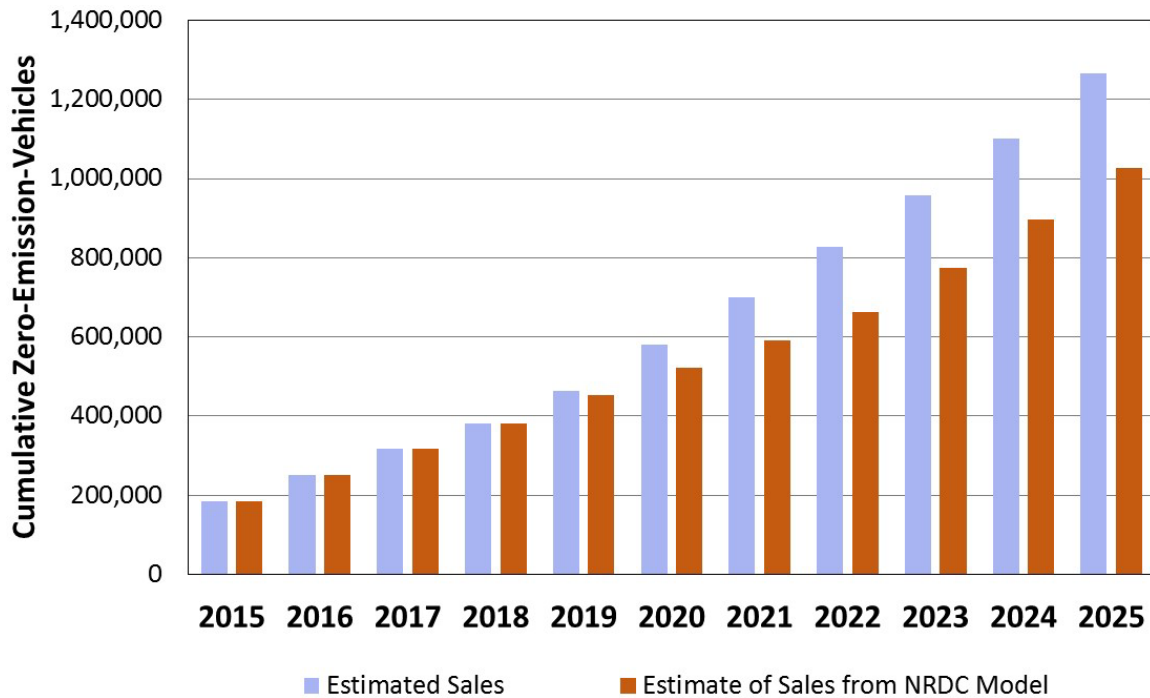
Maintaining a Minimum Balance of Credits – The last scenario examined the impact of vehicle manufacturers planning for compliance with the ZEV mandate by maintaining a credit balance equal to the number of credits anticipated as being required over the next two model years. Reasons why manufacturers would maintain a credit balance could include insurance against unforeseen impacts on their ability to sell ZEVs in future years, such as market shifts, fuel price changes, or increasing requirements. A credit balance scenario was modeled by first using banked credits in excess of the amount required for compliance and then Tesla credits. The results are depicted in Figure 6. As shown, the increase in the number of ZEVs that would be forecast when the minimum balance is properly accounted for is more than 240,000 vehicles—about 45,000 pure ZEVs and just under 200,000 TZEVS. These additional ZEVs would be needed to meet credit

<sup>12</sup> EPA, NHTSA, and CARB, “Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025,” EPA-420-D-16-900, 2016, available at

<https://nepis.epa.gov/Exe/ZyPDF.cgi/P100OXEO.PDF?Dockey=P100OXEO.PDF>

<sup>13</sup> National Academy of Sciences, “Overcoming Barriers to Deployment of Plug-In Electric Vehicles,” Committee on Overcoming Barriers to Electric-Vehicle Deployment; Board of Energy and Environmental Systems; Division on Engineering and Physical Sciences; Transportation Research Board; National Research Council, 2015, available at [www.nap.edu/download/21725#](http://www.nap.edu/download/21725#)

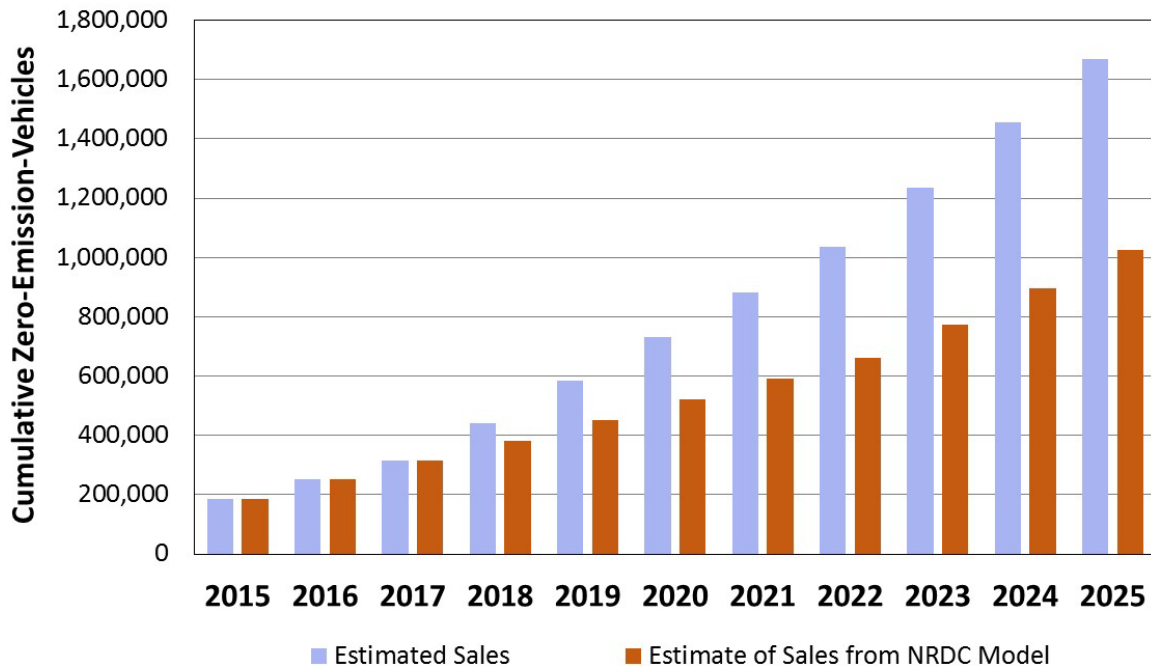
**Figure 6**  
**Impact of Manufacturers Maintaining Credit Balances**  
**on Forecast ZEV Populations**



requirements and maintain the more proper balances—an additional 180,000 credits for pure ZEVS and 225,000 credits for TZEVS. The results released by NRDC did not indicate that any number of credits were banked as insurance.

Cumulative Impacts – In addition to evaluating the impact of individual changes to key assumptions, this study assessed the cumulative impact of these assumptions when taken together. Note that the cumulative impact on the number of ZEVs is larger than the sum of the impact from each alternative because each alternative results not just in an increase in the number of ZEVs but also in a decrease in the credits remaining banked in 2025. These credits need to be replaced if a minimum balance is to be maintained, as in the cumulative scenario. Accounting for the cumulative impact of different assumptions at once also increases the credit requirements; for example, the amount of banked ZEV credits necessary is larger if actual sales data replace the lower sales forecast by EMFAC and larger still if the assumed range of BEVs is lower as the number of credits generated by each BEV is itself lower. As shown in Figure 7, the results indicate that the number of ZEVs likely in California by 2025 would in fact be much higher than forecast by NRDC, would exceed the Governor’s target of 1.5 million vehicles, and would even exceed the sales forecast in the compliance scenario chosen by CARB when the ACC program was presented.

**Figure 7**  
**Forecast ZEV Populations Accounting for All Sensitivity Cases**

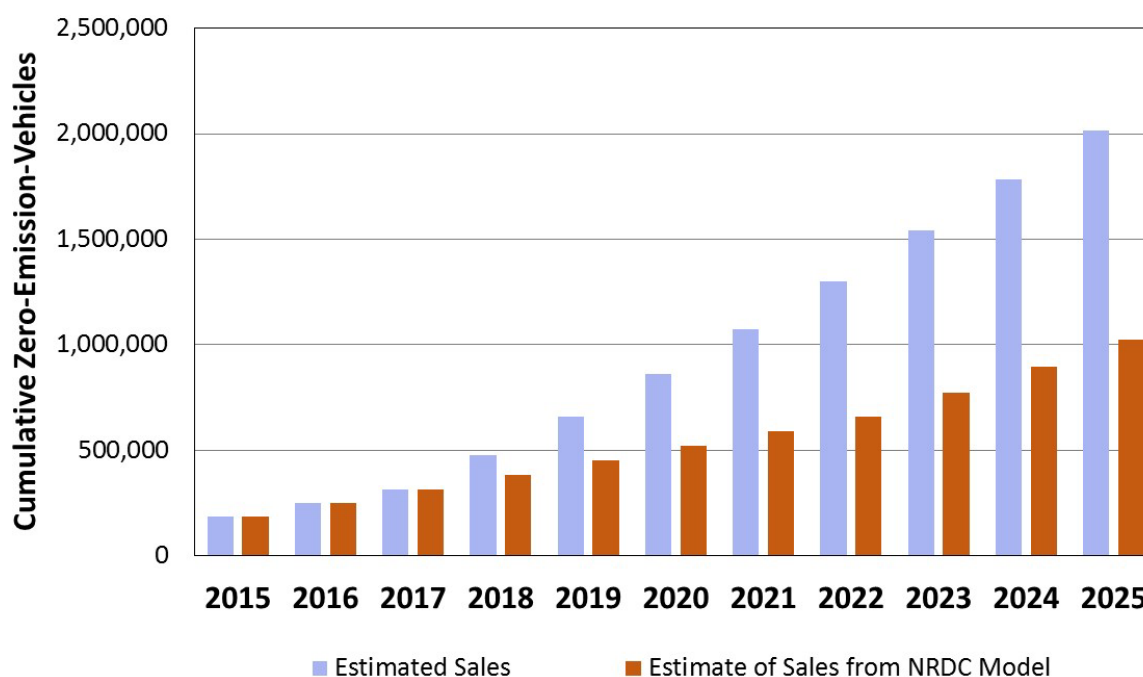


### Increased TZEV Presence

The results shown in Figure 7 represent the impacts of the changed assumptions on forecast ZEV populations under the current ACC regulation. One change to that regulation that has been put forth by the Alliance is to allow manufacturers to comply with the ZEV requirements using a greater number of TZEVs. This request is based on studies that have consistently found that pure ZEVs may be less feasible in single-car households without the availability of sufficient public infrastructure due to the need for occasional long-range trips<sup>14</sup> and the reduced utility factor of vehicles with reduced range, which suggests that TZEVs could provide these households with the ability to drive some miles under electric power while eliminating the obstacles associated with pure ZEVs. To assess the potential impact of such a change on forecast ZEV populations, it was assumed that 50% of ZEV requirements could be met with TZEVs instead of current requirements. This impact was assessed cumulatively with the other changed assumptions shown in Figure 7. As depicted by the results shown in Figure 8, and as expected, the number of ZEV sales forecast under this scenario is even larger than what would be forecast with all of the adjustments described earlier. In fact, the number of ZEVs anticipated as being sold in this scenario exceeds even two million, far above the sales requested by Governor Brown and others in California by 2025.

<sup>14</sup> Tamor, M.A. et al., "Electric Vehicles in Multi-Vehicle Households," Transportation Research C:E Emerging Technologies, Ford Motor Company, 2015, available at [www.researchgate.net/publication/274573106\\_Electric\\_vehicles\\_in\\_multi-vehicle\\_households](http://www.researchgate.net/publication/274573106_Electric_vehicles_in_multi-vehicle_households)

**Figure 8**  
**Forecast ZEV Populations Accounting for All Sensitivity Cases**  
**Cumulative Impacts Plus Allowing 50% of Credits to be Generated by TZEVs**

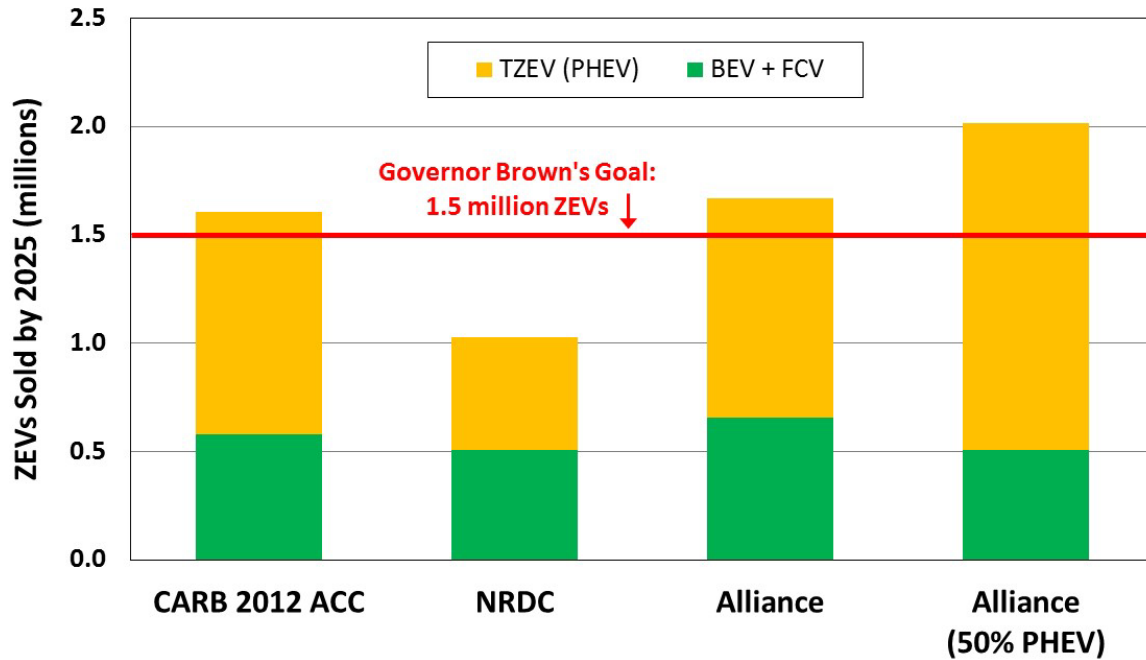


### Summary

Figures 9 and 10 summarize the results presented above. Figure 9 shows the number of ZEVS that would be anticipated with the adjustments presented here, as well as the population forecast by CARB and NRDC, and Figure 10 shows the number of banked credits<sup>15</sup> anticipated as remaining in 2025 for the scenarios presented here and the NRDC model. Remember that any decrease in the number of credits resulting from a scenario, even if not affecting the number of vehicles sold due to the floor held for sales volumes, would still affect the number of ZEVS sold when a minimum number of credits need be maintained. Note also that the credits needed to maintain a minimum balance will increase when actual sales data are accounted for, and that the number of ZEVS needed to generate those credits increases when the more realistic battery range or US06 compliance is taken into account. The “NRDC” results in both figures are those from the recreated model.

<sup>15</sup> Including credits held by Tesla.

**Figure 9**  
**Summary of Study Results – ZEV Sales**



**Figure 10**  
**Summary of Study Results – ZEV Credit Balances**

