The Zero Emission Vehicle Program

An Analysis of Industry's Ability to Meet the Standards

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Disclaimer: The Planning Edge and Baum and Associates are pleased to collaborate with NRDC on the technical analysis presented in this paper. The policy recommendations contained herein do not represent the views of the Planning Edge or Baum and Associates, whose expertise is limited to the technical and forecasting areas.

1. Summary

Since the 1990s, California's Zero Emission Vehicle (ZEV) program has served as a critical technology-forcing component of the state's vehicle emissions program. Today, the ZEV program has also been adopted by ten other states, making it one of the single-largest policy drivers for the production of electric-drive vehicles nationally such as pure battery electrics (BEVs), fuel cell vehicles (FCVs), and plug-in hybrid electric vehicles (PHEVs).

Currently, California's Air Resources Board (ARB) is moving to strengthen the program for model years 2015 and beyond, focusing the program more on electric-drive vehicles and greenhouse gas (GHG) emissions reduction.[1] The goals of the ZEV program include helping assure the transformation needed for very low or zero-emitting vehicles consistent with the State goal of an 80% reduction in GHG emissions by 2050. Improvements in conventional internal combustion engine vehicles are critical, but will be unlikely to enable this 2050 goal to be reached. A strengthened ZEV program that leads to commercialization of electric-drive vehicles in the near term will be needed to achieve this goal because of the time needed for the current fleet to turnover, or be replaced, and the emission reductions trajectory.

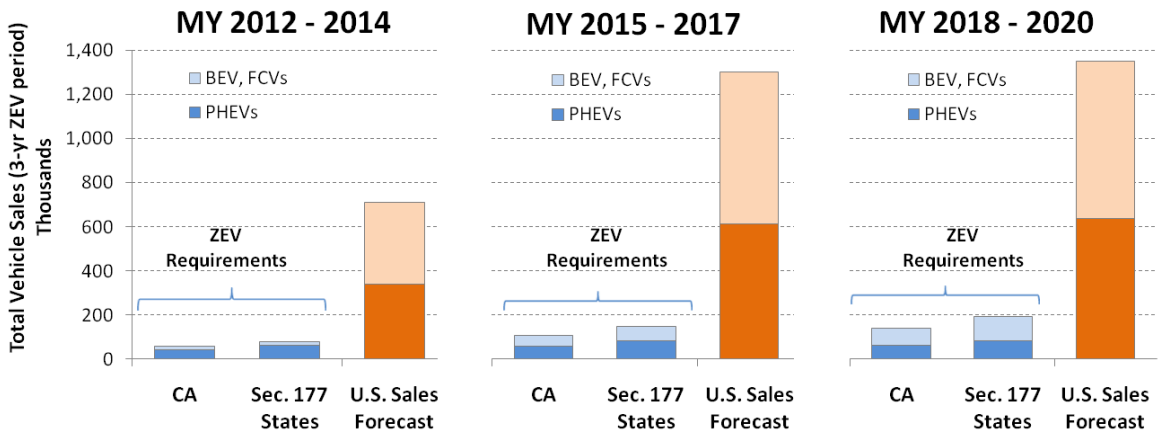
An assessment was conducted to evaluate automaker's ability to comply with the ZEV requirements in California and in other states that have adopted the standards (herein, section 177 states). Forecasts generated by The Planning Edge were conducted on automakers' planned production and sales of electric-drive vehicles over the next five model years. Over forty vehicle models from twelve major original equipment manufacturers (OEMs) and ten new entrants are considered in the forecasts.

The results of the forecasts show that the U.S. market for electric-drive vehicles will grow from approximately 85,000 vehicles in model year (MY) 2012 to between 320,000 to 540,000 by MY 2015, with cumulative U.S. sales reaching 1 to 1.3 million for electric-drive vehicles by 2015. The range reflects low and high oil price cases. Slightly over one-quarter of these vehicles are estimated to be produced by new entrants.

For California, it is estimated that 40,000 to 140,000 vehicles could be sold in MY 2015 in the low and high cases, respectively, with cumulative sales ranging from 115,000 to 370,000 by 2015. The analysis also considers the industry's ability to comply given California's requirements together with other states that have adopted California's ZEV program, as authorized under Clean Air Act Section 177. As shown below, the forecasted U.S. sales over each ZEV period will likely greatly exceed the ZEV requirements for both CA and Section 177 states. Overall, the forecasts show that the auto industry will likely over-comply with the ZEV requirements through the MY 2020 time period even for a low-growth case scenario that holds MY 2015 sales nearly flat out to MY 2020.

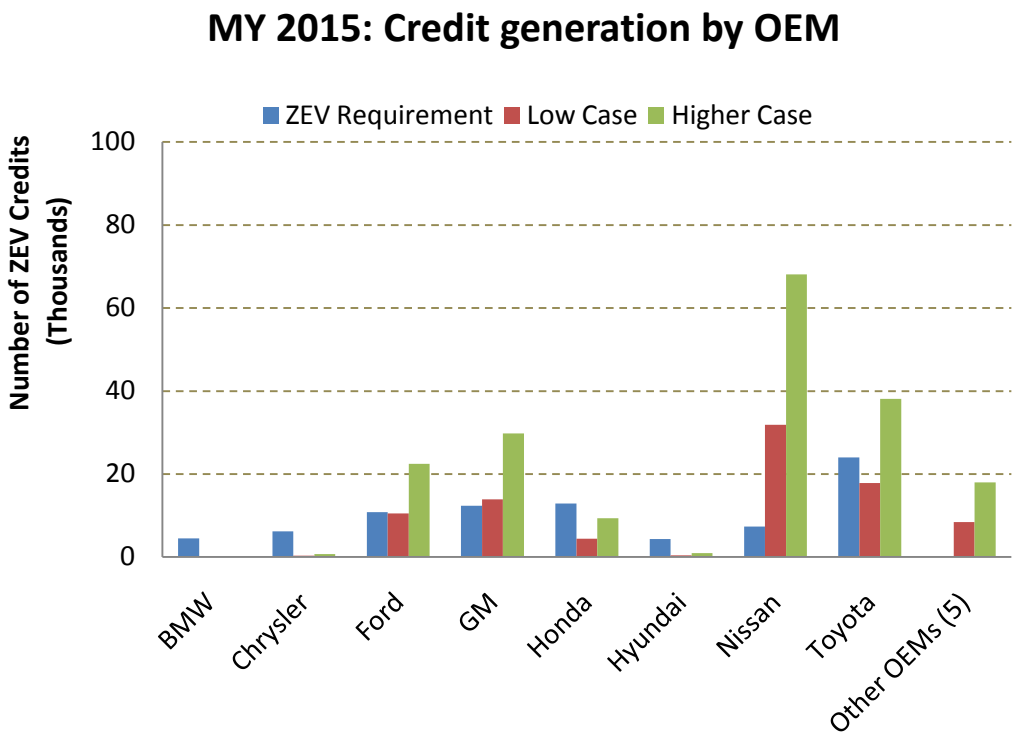
[1] The ARB is also moving to simplify the program by removing some categories commercialized "partial" zero emission vehicles and considering their emission benefits as part of the next revision of the state's low emission vehicle (LEV) standards for criteria emission. Air Resources Board, State of California, Resolution 09-66, December 9, 2009.

Summary Figure 1: Comparison of ZEV requirements for California and Other States Adopting the ZEV program (Section 177 states) versus the Planning Edge's forecasts of U.S. ZEV Sales. Total sales for the three-year ZEV periods are shown. BEV (battery electric vehicles, FCV (fuel cell vehicles), PHEVs (plug-in hybrid electric vehicles).



An analysis using the forecasts was also conducted for major OEMs, intermediate volume manufacturers, and new entrant firms. Overall, Nissan, GM, Ford, and Toyota are forecasted to be well positioned among the major OEMs to over-comply with the program using their own product launches. BMW, Chrysler, Honda, and Hyundai would likely under-generate credits absent greater introduction of ZEVs or near-ZEVs than forecasted here. However, a modest introduction of ZEV vehicles over the ten year time period would allow these companies to comply with their own product lines. It is important to note that this analysis does not account for the considerable numbers of ZEV credits that automakers have currently banked – with some banks said to be substantial. This would tend to make the number of ZEVs required even lower than shown.

Summary Figure 2: ZEV credits required by each major OEM (left bar) compared to the ZEV credits forecasted to be generated by the OEMs in the low sales case (middle bar) and higher sales case (right bar). Results for MY 2015 are shown.



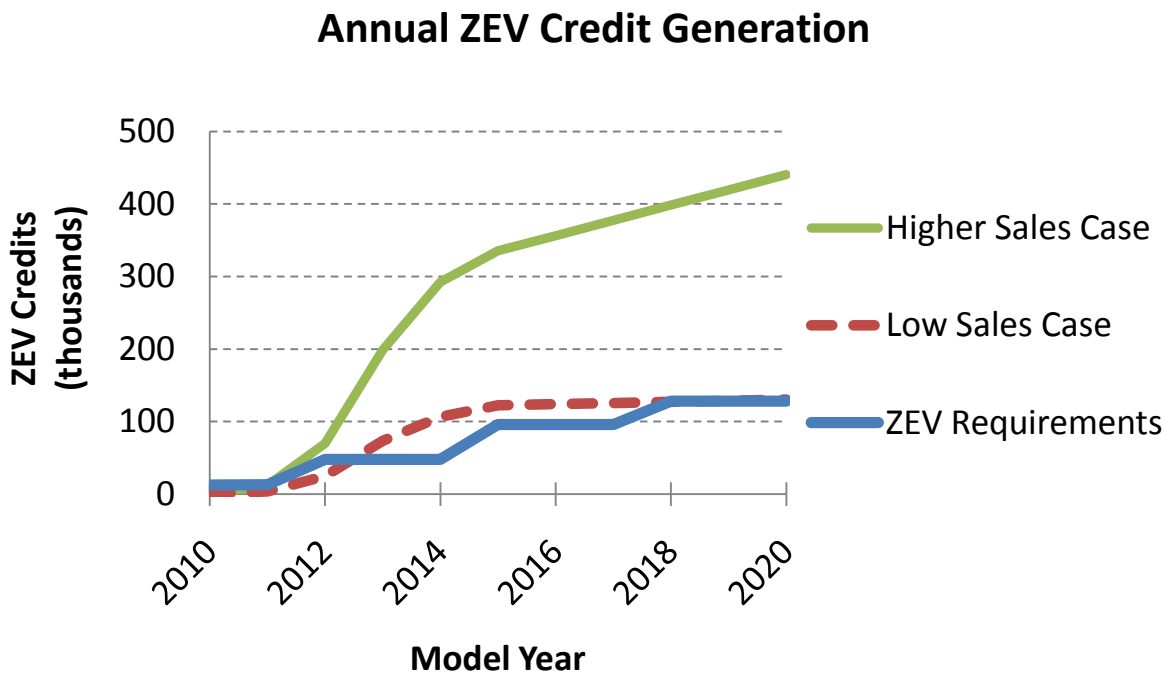
In addition, a large number of excess ZEV credits will be generated by both intermediate volume producers, new entrant firms, and several of the major OEMs. The ZEV program provides all companies with the flexibility to comply by purchasing ZEV credits from early movers, helping reward those making investments earlier while providing more time for those investing later. In summary Figure 3, it is shown that industry is likely to over comply with the current ZEV requirements. The credit generation values are based on vehicle sale forecasts by The Planning Edge (MY2010 to MY2015) and what-if scenarios beyond MY2015.

The current ZEV program, left unchanged, will serve as a "floor" for the production and sale of ZEV vehicles by the auto industry over the 2010 to 2020 time period. In part, this shift is due to major changes in the automotive industry, supported in part by government investments, to produce and offer electric-drive vehicles such as plug-in electric vehicles. Nearly all major OEMs as well as numerous new entrant firms and Tier 1 suppliers are investing heavily in electric drive vehicles and components over the next several years. This is a significant change from even five years ago, when nearly no major OEM was publicly announcing plans to commercialize ZEV or near-ZEV vehicles and new entrants were not as prominent. There will be continued uncertainty, however, in the battery costs going forward and the consumer market for these vehicles. Beyond 2015, there will be a continued role for policy to help drive

down technology costs and to address other hurdles faced by ZEVs and near-term ZEVs, such as the need for ZEV charging or refueling infrastructure. However, the ZEV program by itself provides a critical floor to ensure that current investments continue and that certainty is provided to the marketplace for the nascent electric-drive industry.

Based on NRDC's analysis, the ZEV program can be justifiably strengthened above current requirements over the MY2015 to MY2020 time period. Doing so will allow the ZEV program to better reflect real changes in the industries' expected product offerings and help ensure automakers are investing to commercialize technology necessary to reach post 2020 GHG emission reduction goals. Particularly in the post MY 2015 time period, increased ZEV requirements would help ensure that major OEMs offer ZEV or near-ZEV technologies in their product lines.

Summary Figure 3: Estimated industry ZEV credit generation versus current industry ZEV requirements (California).



2. Forecasts

The forecast of sales volumes for the U.S. market, conducted by The Planning Edge, includes estimates for plug-in hybrid electric vehicles (PHEVs), pure battery electric vehicles (BEVs), and fuel cell vehicles (FCVs). Note that The Planning Edge's forecast period was for the 2010 through 2015 model years (MY) only. This forecast was then used by NRDC as a basis to consider "what if" cases for sales to the California market, with a low case based on California's historic market share and a higher case based on a higher market share for California, analogous to historic sales of conventional hybrids.

2.1 Assumptions

The data and figures are based on a bottom-up assessment of over forty vehicle models planned for introduction over the next five years. The list includes twelve large and intermediate volume manufacturers and ten new entrant firms. The estimates by The Planning Edge account for information from company reports, media reports, consulting reports, capital investments, expert judgment, and forecasting tools. The approach is described below in more detail by walking through the methodologies for established OEMs and for new entrants.

In general, these estimates are more conservative – in some cases far more -- than media or company reports. This approach reflects several hurdles including:

- concerns about market demand (perhaps due to lower fuel prices than anticipated);
- concerns that government policies and incentives do not reach the level to maintain demand beyond early adopters; and
- lack of technological progress that would not allow for reduced costs beyond current levels for large automakers.

The Planning Edge forecasts use different approaches for established automakers and the significant number of startups. Established OEMs have a number of key advantages that allow us to have more confidence in their ability to reach higher levels of output at a quicker pace including:

1) an existing product development process which is critical in an area where technology is so critical;
2) access to an existing supply base and the ability to broaden that base as required;
3) capital availability as well as the ability to sustain financial losses early on;
4) production capacity either in place or which can be added; and
5) an existing system to market and sell its products.

The Planning Edge forecast results for these manufacturers take into account their stated goals and put them into context with other programs from these companies, including those in the new technology area or in more traditional products. We also evaluate the positioning of this product within their broader product mix, the goals of the product for the company (e.g., the Volt is central to GM's positioning of the entire company), and the company's financial position. Different companies are focusing on different approaches within the alternative vehicle area and an evaluation is made of each product and how it "fits" with the company's goals. In the early years, demand is less important than the available supply since volumes will generally be limited due to cost and production constraints. In later

years, customer demand will be critical and the alternative scenarios account for variations in that demand based on a number of factors including product cost and the price of gasoline. Thus, beyond 2015 there will still be a continued role for policy to help drive down costs and to address other hurdles faced by ZEVs and near-term ZEVs, such as the need for ZEV charging or refueling infrastructure.

The approach for startup manufacturers takes into account their special circumstances with a focus on the following factors:

1) access to capital varies among these firms with some well-funded from established sources, while others are more reliant on a limited number of sources (e.g., more than one company has foundered due to its failure to obtain government loan and grant funding);

2) ability to develop product is a factor with some "starting from scratch" while others are using full or partial existing designs and modifying them for their specific purpose;

3) ability to produce the product and attract appropriate suppliers to their projects; and

4) marketing approach to attract customers beyond the early adopters who are already interested in new technology products.

The Planning Edge is particularly conservative, and in some cases skeptical, of the volumes cited by many of the new startup companies (particularly as compared to existing OEMs) because these numbers are often used to attract both private capital and governmental support. The track record of key individuals is important (some of which have big names from the financial or governmental sectors), but must be supplemented by operating personnel in the product development, manufacturing, and marketing arenas. With these firms in particular, the ramp-up from initial production to greater scale is subject to a number of hurdles.

For the more speculative, new entrant firms, the hurdles include marketing hurdles, even if the segment takes off, since the larger firms will exploit that opportunity thereby taking a greater share of the overall demand. There are many uncertainties because this market is a nascent one, but the analysis attempts to balance these factors in order to arrive at a forecast that encompasses multiple scenarios.

While costs to both the manufacturers and the consumers are a major issue (and in any event will have a significant impact on the level of supply and demand of alternative vehicles), it would be too simplistic to assume that these costs will preclude the industry from succeeding. The significant amount of public and private investment as well as national Corporate Average Fuel Economy (CAFE),greenhouse gas requirements, and California's ZEV requirements are providing useful incentives to the developing industry. The Advanced Technology Credits for ZEVs and near ZEVs written into the U.S. Environmental Protection Agency and Department of Transportation's National Program, also called Advanced Technology Credits, will provide additional incentive to this growing market.[2] While it might seem that

[2] As part of the joint final rule for light duty vehicle GHG emission and CAFE standards (http://www.epa.gov/otaq/climate/regulations.htm), EPA provides an incentive for the first 200,000 vehicles produced by each automaker over the MY2012 to MY2016 time period that are EVs, PHEVs, or FCVs. The incentive

the ZEV market is unusual in terms of its development, the consumer market and the automotive market in particular is full of examples where new products were costly to both companies and consumers at early stages of development. Costs are of course critical to the timing and scale of the development of the market, but it should not be assumed that the current cost level will result in an aborted effort in this product area.

The forecast for ZEV vehicles benefits from being part of a forecasting model of the entire North American automotive market. This model incorporates a variety of economic and industry factors and uses mathematical relationships among these factors, but also includes the judgment of the model's authors to inform the assumptions. This is particularly critical for this developing market where a long history of experience is not available. While detailed econometric models have their place, better results for the ZEV market will be obtained with detailed analysis by forecasters understanding the unique circumstances of the companies involved in the production of the vehicles and knowledge of the consumers that will purchase these products. Of course, emerging markets such as this one are difficult to forecast. The inclusion of multiple scenarios is intended to address this issue.

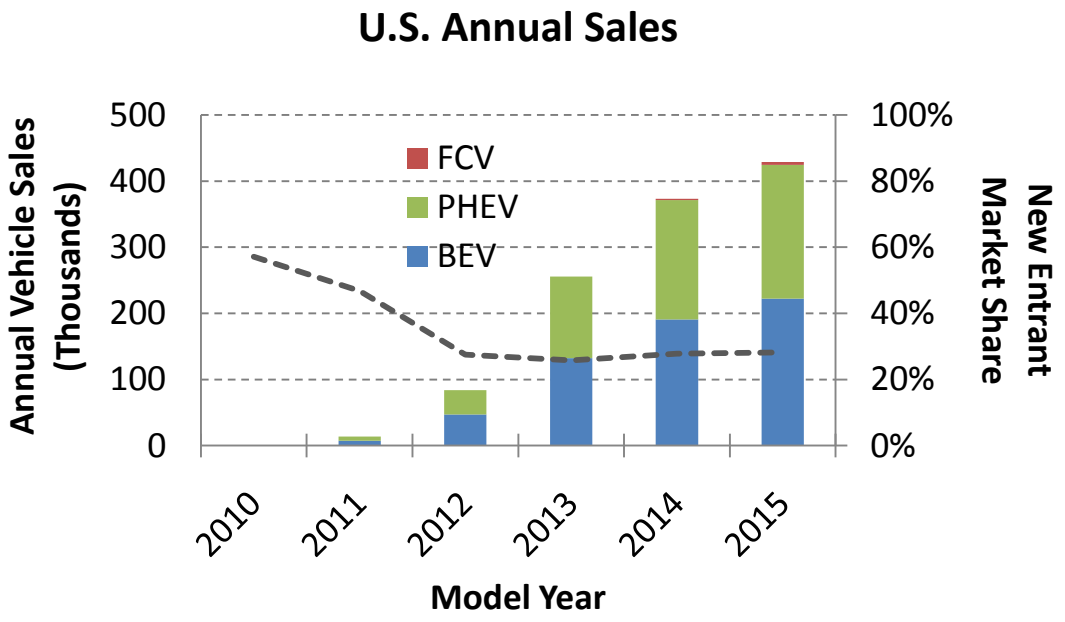
2.2 Results

Figure 1 displays a summary of the forecasts broken down by technology type and model year. Note that FCVs are largely expected to be test fleets before 2015, and that numbers will increase modestly after 2015 if these tests are successful, technology and cost milestones are met, and market conditions and/or incentives are favorable.[3] The percent of total annual sales that is forecasted to be comprised of offerings by new entrant firms is also shown on the right-axis. New entrants firms are defined as automakers that have not sold vehicles previously in the U.S. in intermediate or large volumes. New entrants include start-ups such as Tesla or Coda as well as Fisker, BYD, Meyers Motors, and Reva.

is in the form of a "zero" CO_2e/mile value for these ZEV and near-ZEV vehicles. Manufacturers that act early to produce 25,000 advanced technology vehicles in MY2012 will have their production cap increased to 300,000 vehicles.

[3] Note that several major OEMs are investing in hydrogen fuel cell programs and are considering vehicle launches, particularly in areas where infrastructure concerns are addressed by policy, such as with California's Clean Fuels Outlet regulations for example.

Figure 1: Forecast of annual ZEV and near ZEV sales for the U.S. market (mid-range estimate). FCV (fuel cell vehicles), PHEV (plug-in hybrid electric vehicles), BEV (battery electric vehicles).



By MY 2015, U.S. sales of BEV, PHEVs, and FCVs (herein collectively called "electric-drive vehicles") reach 430,000 in the mid-range case. Slightly over half of the forecasted sales are comprised of BEVs with the other half comprised of PHEVs. New sales continue to rise but still represent 2.8% of the 15.3 million expected U.S. sales for MY2015. Note that under the forecasts, U.S. vehicle sales are assumed to recover steadily from the economic downturn, rising steadily from 10.4 million in 2009 but still short of the 16.1 million reached in 2007.

Low, mid, and high-range sales forecasts are also shown in Figure 2, reflecting several gasoline price assumptions from the Annual Energy Outlook (AEO) 2010 produced by the U.S. Department of Energy. The mid fuel price case reflects gasoline prices of about $3/gallon in 2015. The low fuel price case reflects a $2.25/gallon assumption, and the high price case reflects about a $4/gallon range. (All dollar amounts are in 2010 real dollars.) There is little change to the forecasts due to oil prices as these vehicles are being launched. The main impact appears in the later years, with higher end models seeing little impact and more mainstream models being more sensitive to fuel price. The divergence between scenarios is modest until 2013 or 2014 while vehicles are in their launch phase (particularly from the mainstream OEMs where higher volumes are possible) but increases thereafter. In the early years of production, the scenarios have little impact on volume because output is based on supply constraints rather than consumer demand. As the products become more established and the capacity to increase production occurs, consumer demand will influence volume thereby resulting in differences between the scenarios which are generally distinguished by consumer costs (including fuel price). Throughout this analysis, the midrange gasoline price scenario is used.

The cumulative sales for MY 2010 to MY 2015 are shown in Figure 3. By MY 2015, cumulative sales reach 0.95 to 1.32 million vehicles. In Figure 4, the breakdown of estimates for large manufacturers is provided for MY 2015.

Figure 2: Forecasts of annual sales (PHEV, BEV, and FCVs) assuming high, mid, and low gasoline price scenarios.

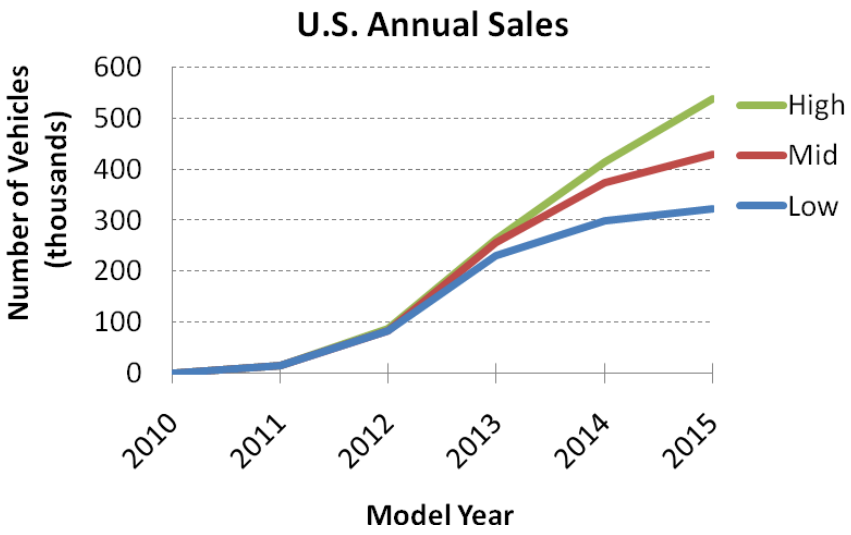


Figure 3: Cumulative sales volume over time.

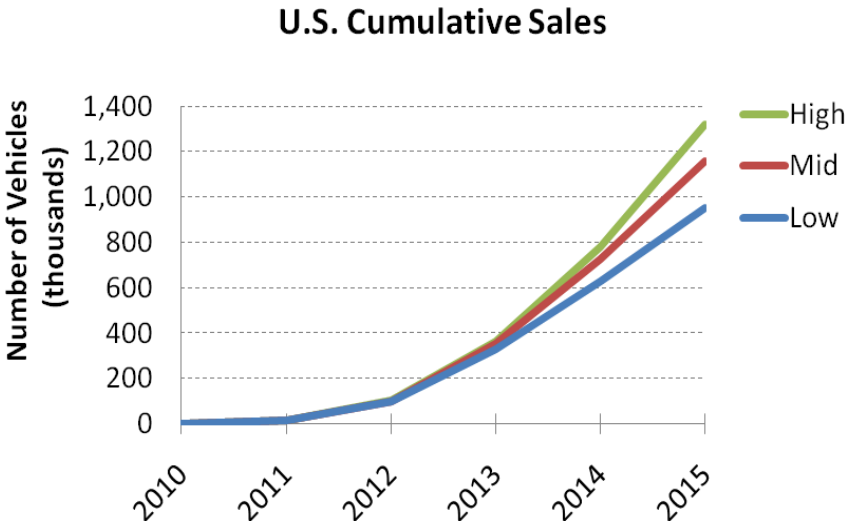
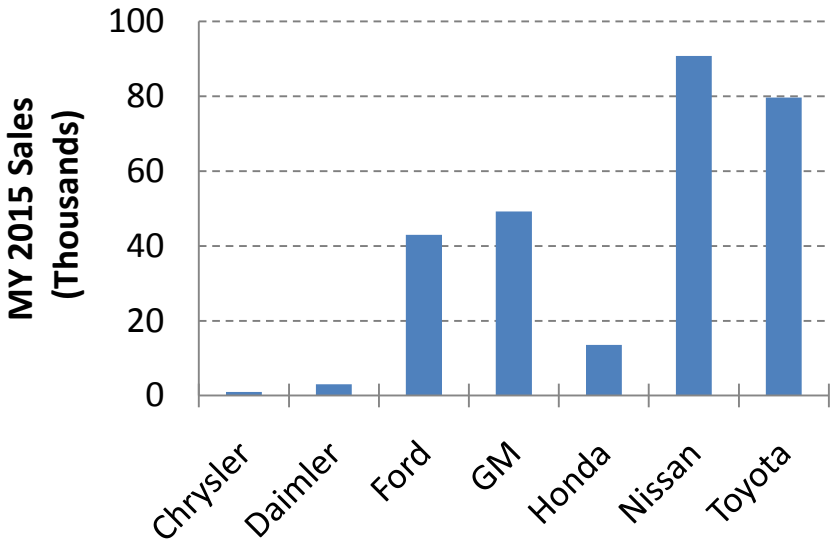


Figure 4: Model Year 2015 Forecasts broken down by Large Manufacturer.



2.3 Comparison with Other Forecasts

The results of several other forecasts are provided here for comparison. Pike Research (2009) forecasts sales of PHEVs in 2015 of just over 200,000 vehicles, consistent with the estimates for PHEVs here.[4] No estimate was provided for battery electric vehicles. By contrast, J.D. Power and Associates estimates that together, EV and PHEVs will not exceed 200,000 vehicles until 2015 and is therefore more conservative than the bottom-up estimates developed here. Boston Consulting Group (2010) is more pessimistic on the costs of batteries declining over time, and is therefore more pessimistic on PHEV and EV sales.[5] The estimates provided here are more conservative compared to estimates by PRTM Consulting and estimates by the California Fuel Cell Partnership.[6] Note that many of the forecasts, while having differences over the initial volumes in the early years, generally identify a large increase in sales over the 2015 to 2020 time period.

Many other forecasts do not fully account for additional, yet significant, market drivers for fuel efficient and cleaner vehicles in the U.S. These include standards established by the California's Zero Emission Vehicle (ZEV) program, California's Pavley tailpipe emission standards, and most recently, the National Program setting national standards for vehicle greenhouse gas emissions and fuel economy. Other market drivers include initial current consumer and manufacturer incentives as well as higher fuel prices, forecasted to remain high over time.

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[4] Pike Research, *Hybrid Electricity Vehicles for Fleet Markets*, Boulder, CO. November 2009
[5] Boston Consulting Group, *Batteries for Electric Cars: Challenges, Opportunities, and the Outlook to 2020*,
[6] PRTM, *Electrification Roadmap*, Electrification Coalition, December 19, 2009 and California Fuel Cell Partnership, *Hydrogen Fuel Cell Vehicles and Station Deployment Plan: A Strategy for Meeting the Challenge Ahead*, February 2009.

The history of penetration of standard hybrid vehicles provides some guidance for the extent to which ZEV vehicles are likely to be adopted absent fuel efficiency or GHG emission standards and at relatively low fuel prices. However, the market drivers for hybrids during the late 1990s and past decade were significantly different than today. In general, the adoption of these vehicles has been relatively modest, with rates of 2 to 3 percent of total national vehicle sales. However, the commitment of most manufacturers to hybrid products has also been modest until more recently. The first five years of hybrid introduction into the U.S. (starting in 1999) was characterized by two OEMs introducing a total of three hybrid model (Toyota Prius, Honda Insight and Civic). More recently, other manufacturers recognized the marketing advantages obtained by Toyota as the leader in hybrids via the Prius, thereby influencing other manufacturers to invest in alternative vehicle products.

Compared to the early years of hybrid introduction, The Planning Edge forecasts that the first five years of ZEV and near ZEV introductions could see thirteen (13) intermediate and major volume OEMs offering over thirty (30) models and ten (10) new entrants offering over ten (10) models. While not all of these model offerings are expected to go forward, significantly more ZEV models will likely be introduced compared to the experience with conventional hybrids. In addition, both the market and regulatory environment have significantly changed since the late 1990s. As noted above, stronger regulations in the U.S. – and globally – in the areas of fuel efficiency and GHG emissions are resulting in increased commitment by automakers to producing electric-drive products. Fuel prices are also forecasted to remain high versus the previous decade and rise over time as global oil demand increases. Going forward, increased ZEV demand will occur from consumers as product choice increases along with more competitive pricing for these vehicles (including government incentives).

Normalizing the hybrid sale volumes by model offering is illustrative. In 2007, when U.S. hybrid sales peaked, approximately 350,000 hybrids were sold in the U.S. and six hybrid models offered. On average, roughly 58,300 units were sold per model offering in 2007, led mainly by the Toyota Prius. By 2009, the economic downturn had dramatically reduced U.S. auto and hybrid sales. By then, twenty-one hybrid models were offered with most of the new hybrids being in the first year or two of introduction (four Lexus hybrid, eight GM hybrids, two additional Ford hybrids, and one Toyota hybrid). With the economic downturn and most of the hybrids being in their initial year of sales, just over 290,000 hybrid units were sold. On average, 13,800 units per were sold per model offering in 2009. For comparison, the forecasts by The Planning Edge show on average result in 9,500 ZEV or near-ZEV vehicles sold per model offering. This is significantly less than the hybrid experience in both the peak year (2007) and low year (2009).

2.4 Planned Production Locations

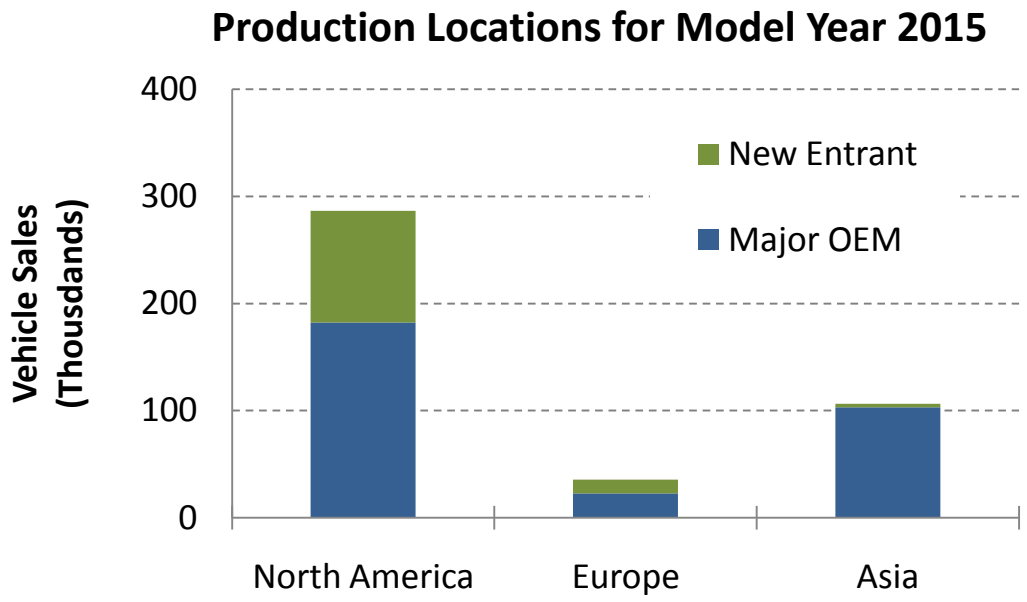
By model year 2015, approximately two-thirds of electric drive vehicles sold in the U.S. market would likely be produced in North America.[7] These include both domestic automakers as well as transplants with facilities in the U.S. The Nissan LEAF will initially be produced and imported from Japan. For MY2013, it is assumed that half of Nissan LEAF production will be produced in the US, and by MY2014 and MY2015, all production will likely be domestic. The Fisker Karma is assumed to be produced entirely

[7] At least one automaker has considered producing a fuel cell vehicle in Ontario, Canada. All other electric drive vehicles in the forecast have planned production facilities in the U.S.

in Finland through 2015. Half of the Ford Transit Connect vehicles are assumed to be built in Kentucky in MY13 and by MY2015 entirely produced in Kentucky. While some "new entrant" firms in China are expected to produce significant numbers of electric drive vehicles over the next several years for the Asian market, the numbers that are forecasted to reach the U.S. market are very small, reflecting both the attempt to be conservative and the large hurdles to entering the U.S. automotive market in terms of safety, quality, emissions performance, competition, and marketing. Figure 5 shows the production locations for electric-drive vehicles sold in model year 2015.

For purposes of comparison, roughly three-fourths of 2007 vehicle sales in the U.S. were categorized as North American built (with 84% of light trucks being produced domestically versus 69% of passenger cars).[8] Given that nearly all electric drive vehicles in this forecast would be passenger cars, the share of electric drive vehicles that would be domestically produced are generally consistent with historical industry trends for passenger cars. Continued incentives and support for domestic manufacturing of electric-drive vehicles and components may result in an even higher share of North American built vehicles over time.

Figure 5: Production locations for the electric-drive vehicles sold in the U.S. (MY 2015)



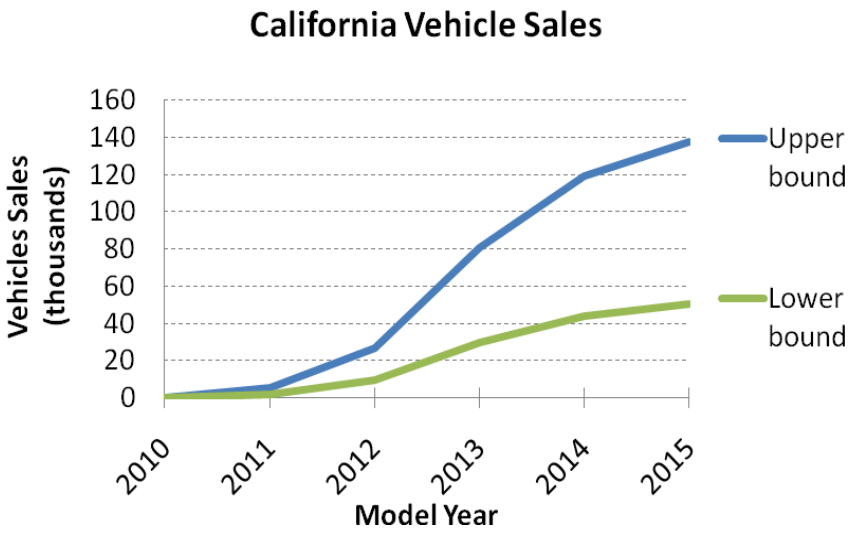
2.5 California Share of Electric-Drive Vehicles

Using the above forecasts for the U.S., a "what-if" lower and upper bound estimate for the California market is presented. The *lower bound* "what-if" scenario assumes the lower end of California's historic share of approximately 10 to 13% of the total U.S. vehicle market. Here, we assume California only

[8] Stacy Davis, Susan Diegel, and Robert Boundy (2009), *Transportation Energy Data Book: Edition 28*, Oak Ridge National Laboratory, ORNL-6984.

accounts for 10% of the U.S. electric-drive vehicle sales. Note that this can be considered highly conservative. For comparison, California's share of conventional hybrid sales has been nearly double that of the U.S. market and represents approximately 25% of the U.S. conventional hybrid vehicle market.[9] In addition, most automakers planning to produce electric drive vehicles are currently expected to launch or preferentially target the California market as well. For the *upper bound "*what-if" scenario, it is assumed that California has a higher market share: 25% of vehicles produced by high volume manufacturers and 50% of vehicles produced by low volume manufacturers (or new entrants). This may reflect a scenario where new entrant firms focus primarily on the California market whereas more established OEMs are capable of marketing in other regions of the U.S. as well. Manufacturers are likely to target California, at least over the first five years, partly because of the State's reputation for more environmentally conscious consumers, its early-adopter status for new technologies, and the state's Zero Emission Vehicle requirements. For automakers, targeting early sales to California would also allow them to take advantage of California consumer tax credits. The California forecasts are shown in Figure 6.

Figure 6: Forecasts of vehicle sales in California: Electric drive vehicles.



3. The Zero Emission Vehicle Program (ZEV)

Originally conceived in 1990, the California ZEV program has morphed over time from just an electric vehicle requirement to a standard that incorporates a broad spectrum of clean, advanced technology vehicles. These technologies have included hybrid vehicles as well as "partial" ZEVs that meet high standards for emission controls on vehicles. Now that hybrid and partial ZEV technologies have been

[9] For example, 5.3% of 2009 California sales were hybrid vehicles compared to 2.8% for the entire U.S. The 25% CA share of the market will drop over time as hybrid sales increase nationwide.

successfully introduced and commercialized in the marketplace, the ZEV requirement is currently being retooled to focus more exclusively on electric-drive vehicles and reducing GHG emissions.[10]

3.1 ZEV Program Requirements

Figure 7 displays the current overall ZEV requirements, which show that an increasing percentage of vehicles sales in California needing to be near-zero or zero-emitting technologies over time, such as BEVs, FCVs, PHEVs, or hydrogen internal combustion engine (H_2-ICE). The ZEV requirements for MY 2015 and beyond are currently being revised to combine the standards with California's "Low Emission Vehicle" or LEV III program incorporating both tailpipe criteria emissions and greenhouse gas emission standards.[11]

The planned revisions to the ZEV program would fold the requirements and credits for conventional "very clean" hybrids (Advanced Technology PZEVs) and "very clean" conventional vehicles (PZEVs) into future LEV III GHG emissions and LEV III criteria emission requirements. Thus, throughout this document the analysis covers only the requirements for pure ZEVs (i.e. BEV, FCVs) and near-ZEVs (i.e. PHEVs, H_2 ICE).

The current ZEV program rewards automakers with greater credits for producing vehicles that incorporate better performance, such as greater battery or fuel cell ranges and fast-refueling capabilities. The basic current credit structure is shown below in Table 1. Note that for some of the vehicle types, the current ZEV requirements are slightly lower in the out years. However, because most of the vehicles forecasted were types that would not have their ZEV credit changed, for simplicity the ZEV credit variation over time was not accounted for in this analysis. All the electric-drive vehicles forecasted here would be eligible to generate multiple credits under the ZEV program. For example, the Nissan LEAF would likely be categorized as a Type II ZEV and generate three (3) ZEV credits for each vehicle sold, while the GM Chevy Volt two and four tenths (2.4) credits, and the Honda Clarity FCV five (5) credits. The ZEV credit system was designed to reward automakers for different vehicle performance levels, provide automakers flexibility to produce different vehicle mixes, and allow the ability to comply by purchasing credits from others producing ZEV vehicles. Because of the ability to generate multiple credits for each ZEV or near-ZEV vehicle, the actual sale requirements are much lower than those shown in Figure 7. As an example, the MY 2015 to 2017 requirement for a minimum ZEV sales level of 3% could be met by selling 1% BEVs achieving 100 miles (i.e. getting 3 ZEV credits each).

[10] California Air Resources Board (2009), *Informational Update on Zero Emission Vehicle Regulations Revision*, December 10, 2009. Board Hearing. http://www.arb.ca.gov/msprog/zevprog/2009zevreview/2009zevreview.htm
[11] For further information, see http://www.arb.ca.gov/msprog/levprog/leviii/leviii.htm

Figure 7: Current ZEV Requirements, broken down by example vehicle technologies.[12]

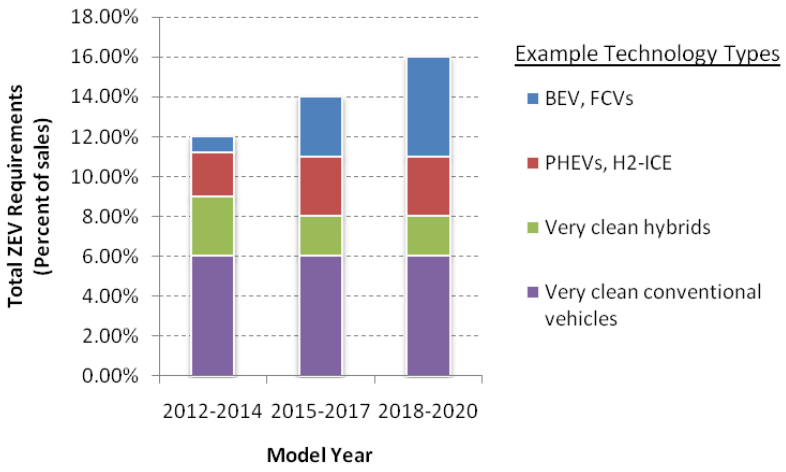


Table 1: ZEV credit generation for different technologies and performance characteristics.

Tier	Expected Tech	Credit/veh
Type V	FCV ≥300mi, fast fuel	7
Type IV	FCV ≥200mi, fast fuel	5
Type III	FCV 100-199mi, BEV ≥200mi	4
Type II	BEV ≥100mi	3
Type I.5	BEV 75-99mi	2.5
Type I	BEV 50-74mi	2
Type 0	BEV < 50	1
Enh AT-PZEV	PHEV, 40 mile AER	2.4
Enh AT-PZEV	PHEVs 20 mile AER, H2ICE	1.5

[12] Very clean conventional vehicles refer to the "Partial ZEV or PZEV" category and include vehicles like the 2009 Honda Accord and Ford Fusion that meet SULEV emission standards, have zero evaporative emissions, and offer a 15-year (or 150,000 mile) warranty on emission control systems. Very clean hybrids refer to the "Advanced Technology PZEV " category and include vehicles like the 2009 Honda Civic Hybrid and Toyota Prius that contain advanced technologies such as a hybrid drive train and meet PZEV requirements. PHEVs and Hydrogen Internal Combustion Engines (H2-ICE) would fall into the "Enhanced Advanced Technology PZEV" technology and refers to vehicles that use ZEV fuels such as hydrogen or electricity. The BEVs and FCVs are considered pure ZEVs.

3.2 Can the ZEV program requirements be met? An analysis of the industry's ability to comply

Using the above forecasts as a basis, an analysis was conducted of the ability for the industry as a whole, as well as each manufacturer, to meet the ZEV standards. For purposes of evaluating the ability for industry compliance beyond 2015 (the end of the forecast period) the California lower and upper bound cases were extrapolated from 2015 to 2020 (Figure 8). To remain highly conservative, the *low case* extrapolation assumes that, for each vehicle model, sales do not grow after 2015 and remain flat to 2020. This might reflect a scenario where sales plateau and electric-drive vehicles remain a niche market; or it may reflect a scenario where the forecasts here are overly optimistic by several years. As discussed above, this is highly conservative as all other forecasts show faster growth over the 2015 to 2020 time period. For the *higher case*, the sales trend is extrapolated to MY2020 at a quarter (25%) of the sales growth rate forecasted for the MY2010-2015 period. This might reflect a scenario where technology adoption of electric-drive vehicles gradually moves from early adopters to more mainstream consumers. However this higher case is still conservative and does not reflect an aggressive vehicle penetration case.

Figure 8: Low and higher case "what-if scenarios" for the California market. Beyond MY 2015, it was assumed in the low case that sales remains flat while for the higher case, the rate of growth slows.

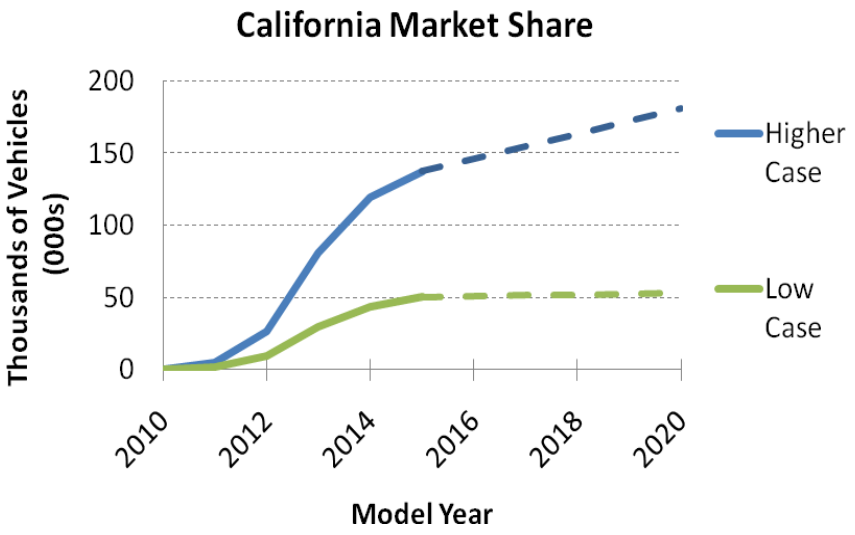
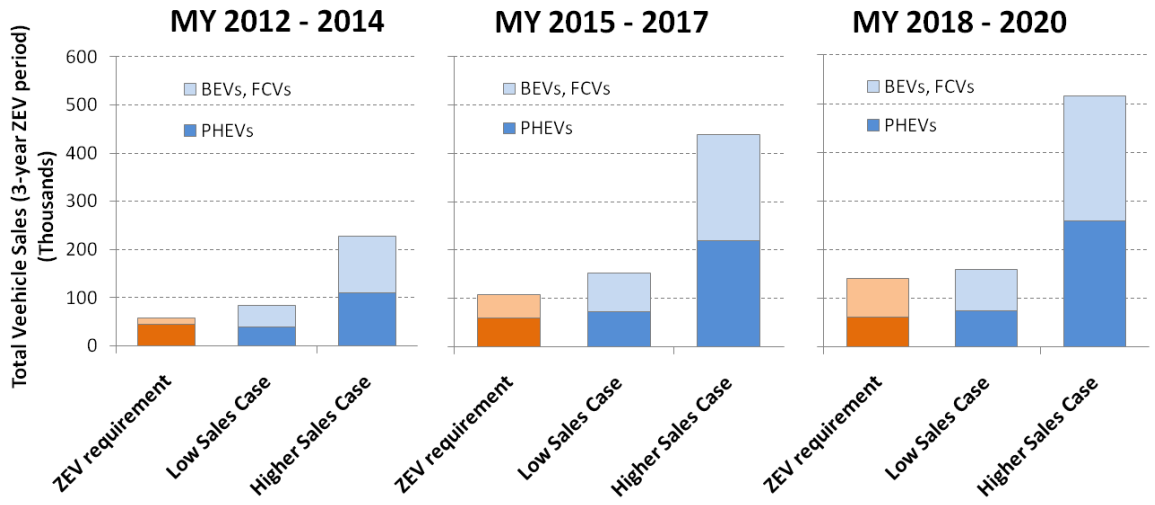


Figure 9 below shows one possible ZEV compliance scenario (based on the ZEV requirements) and compares this against the California forecasts. The ZEV requirements calculated here are based on light-duty vehicle sales of approximately 1.6 million vehicles per year, extended over the 2010 to 2020 time period. As discussed earlier, overall national sales (including California sales) have decreased dramatically over the past two years and are not expected to fully recover until after 2015. Because of

actual differences in sales, the actual ZEV requirements will likely be lower than shown here initially and potentially slightly higher in the out years.

Figure 9: Comparison of the current ZEV program requirements with the low sales and higher sales case for California.[13] Total cumulative vehicle sales over the three year time periods are shown (e.g. total sales for MY2015 through MY2017).



3.3 Forecasted ZEV Credit Generation by the Industry

The number of ZEV credits generated by the entire industry, including major OEMs and new entrants, is estimated and shown below in Figure 10. The ranges were calculated by using Table 1 and the bottom-up forecasting data. The total ZEV credits required, based on the current regulations were estimated out to MY 2020. Again, the estimates for the credit requirements are based on California's annual sales of 1.6 million passenger cars and light trucks. The numbers shown are likely overestimated by about 15%, largely because intermediate and small vehicle manufacturers – defined respectively as producing less than 60,000 and 4,500 per year – are not currently required to generate credits from ZEV or near-ZEV vehicles. However, future ZEV modifications may require intermediate producers to also generate credits. It is also important to note that this analysis does not account for the considerable numbers of ZEV credits that automakers have currently banked – with some banks said to be substantial. This would tend to make the number of ZEVs required even lower than shown, also tending to make the ZEV volumes needed shown here an overestimate.

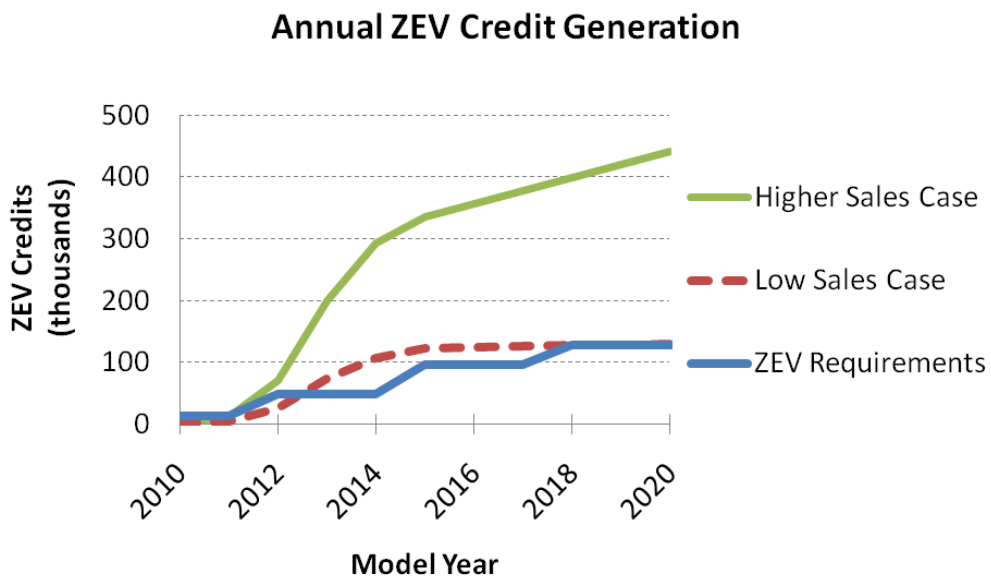
Overall, even considering these factors, it can be seen that industry will likely exceed the ZEV requirements in both the low and higher cases for electric-drive vehicle sales.

The existence of the ZEV credit program allows automakers, in theory, the flexibility to buy and sell credits due to under-compliance or over-compliance. This feature allows automakers and new entrants who invest early and take additional risks to be rewarded. The feature also provides automakers that

[13] The ZEV requirements shown assume compliance is met using ZEV Type II vehicles and AT-Enhanced PZEV-40s.

chose not to produce as many ZEVs, or that pursue longer-term technologies such as FCVs versus BEVs, to have a pathway to comply with the program while potentially rewarding early movers.

Figure 10: Industry ZEV credit generation for California versus the current ZEV requirements.



3.4 Forecasted ZEV Credit Generation by Manufacturer

An analysis was also conducted to evaluate each manufacturer's ability to comply with the ZEV program using their forecasted production plans and sales. Each large and intermediate manufacturer's sales share was based on their historic 2008 and 2009 calendar year sales, as obtained from *California Auto Outlook* by Baum and Associates. Intermediate volume manufacturers, while not required to generate ZEV or near-ZEV credits, will also likely introduce models and have credits available for sale. Figure 11 below presents the number of credits required by large OEMs (those selling above 60,000 vehicles per year) and intermediate volume manufacturers (4,500 to 60,000 vehicles per year). Each OEM's likely credit generation is shown based on the low sales case and higher sales case. Snapshots for MY 2015 and 2020 are shown.

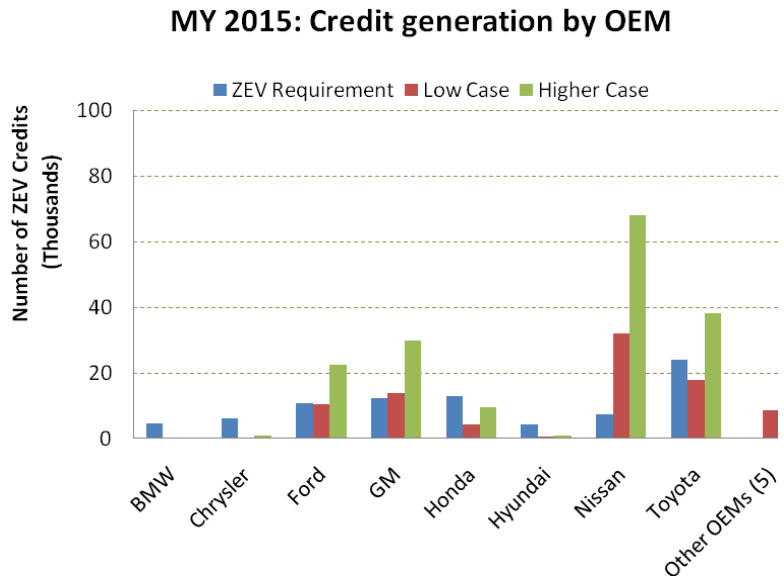
The analysis shows that Nissan, GM, Ford, and Toyota would be expected to generate enough credits to meet or exceed the ZEV requirements based on their own sales. Nissan and GM in particular are expected to significantly exceed their requirements allowing them to make these credits available for sale to other automakers. BMW, Chrysler, Honda, and Hyundai would likely under-generate absent greater introduction of ZEVs or near-ZEVs into California. Note that for BMW, it was conservatively assumed that the electric Mini, the electric version of the BMW 1-series, and the longer term Project i (or BMW "City") models would be offered commercially in Europe but not in the U.S. or California. Introduction of any of these three models would likely lead to BMW meeting or exceeding the ZEV

requirements. Honda would nearly meet its ZEV requirements with the forecasted introduction of an electric vehicle planned for Japan into the California market and through pre-commercialization of the FCX Clarity. The annual sale volumes needed by Honda for MY2018+ would be on the order of roughly 3,500 city-type electric vehicles (50-75 mile range) and roughly 1,600 fuel cell vehicles for the California market out of the 190,000 vehicles sold by Honda. Because of the uncertainty of Chrysler's electric-drive vehicle plans, virtually no vehicle sales were forecasted over the MY 2010 – 2015. The cancellation of the Chrysler ENVI program as well as the uncertainty regarding introduction of the Fiat Doblo resulted in no to little credits being assigned, respectively. However, introduction of an electric-drive vehicle post MY 2015 is possible, but the model-by-model forecasts do not extend beyond MY 2015. Hyundai also may have one potential product offering involving a plug-in electric vehicle but, similar to the Chrysler case, the uncertainty leads to little credits being assigned to Hyundai. Introduction of electric-drive vehicles post MY 2015 remain distinct possibilities but was beyond the range of the forecast.

As shown in Figure 11 and 12, intermediate volume manufacturers as well as new entrants are forecasted to generate substantial numbers of ZEV credits. The ZEV program allows for automakers that choose not to produce ZEVs or near-ZEVS to purchase credits from other producers. Collectively, as shown in Figure 10, the industry would over-generate ZEV credits.

Ten new entrant firms were also evaluated for their ability to generate ZEV credits that could be purchased by larger OEMs (Figure 12). At least one new entrant, Tesla Motors, has already sold credits to a major OEM. It is important to note that not all new entrant firms are expected to produce vehicles and sell in the U.S. market over the 2010 to 2020 time period given the challenges and barriers to introducing vehicles. Thus, the forecast suggests only a handful of companies being successful and reaching intermediate sale volumes and generating significant credits. The large variation in ZEV credits generated by new entrants reflect the possible upper and lower bound cases where new entrants target mainly the CA market (50% of their U.S. sales) and where new entrants do not specifically target the CA market (10% of their U.S. sales).

Figure 11: Credits required and generated by manufacturer for (top) MY 2015 and (bottom) MY 2020.



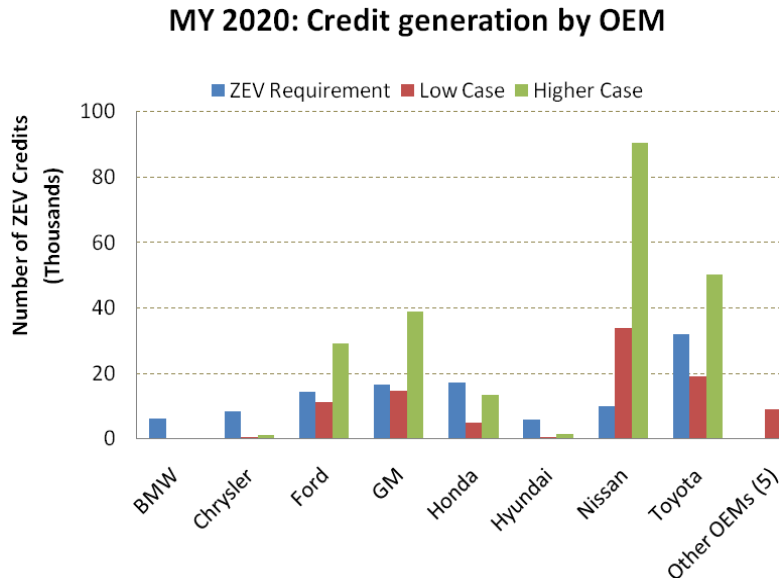
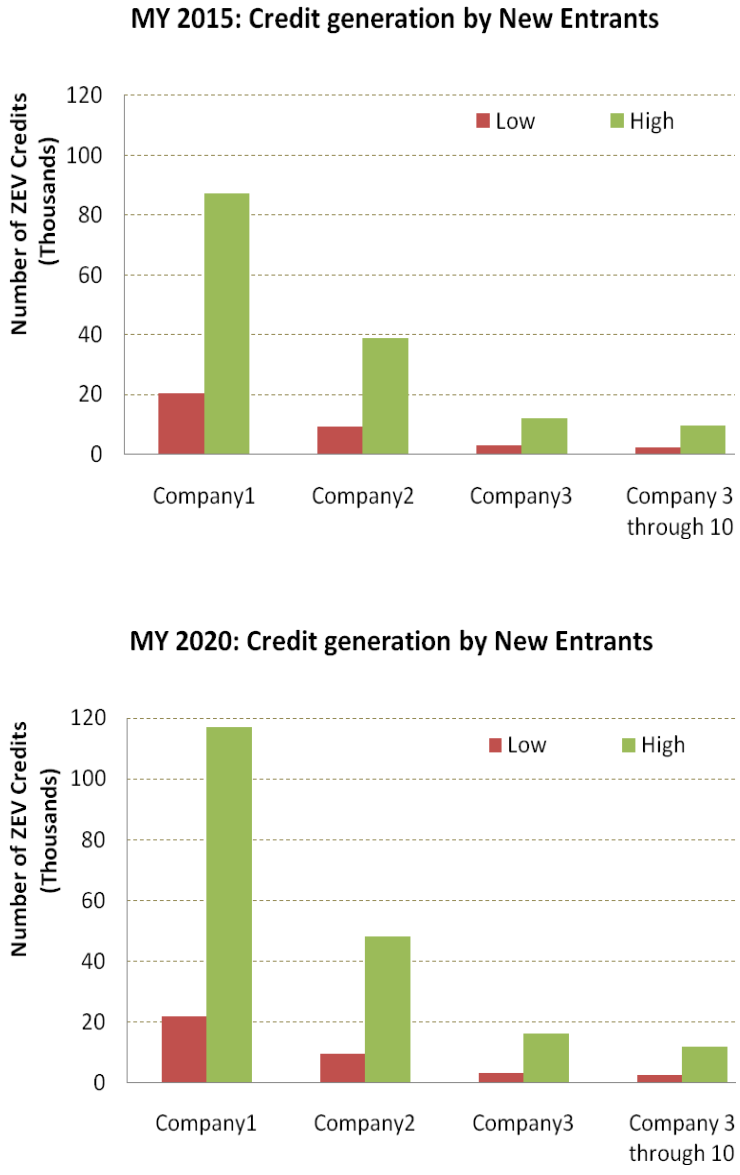


Figure 12: Credit generation by new entrants for (top) MY 2015 and (bottom) MY 2020. Note that new entrant firms would likely not be required to generate pure and near-ZEV credits given their small production volumes and would have these available for sale.



3.5 ZEV and Section 177 States

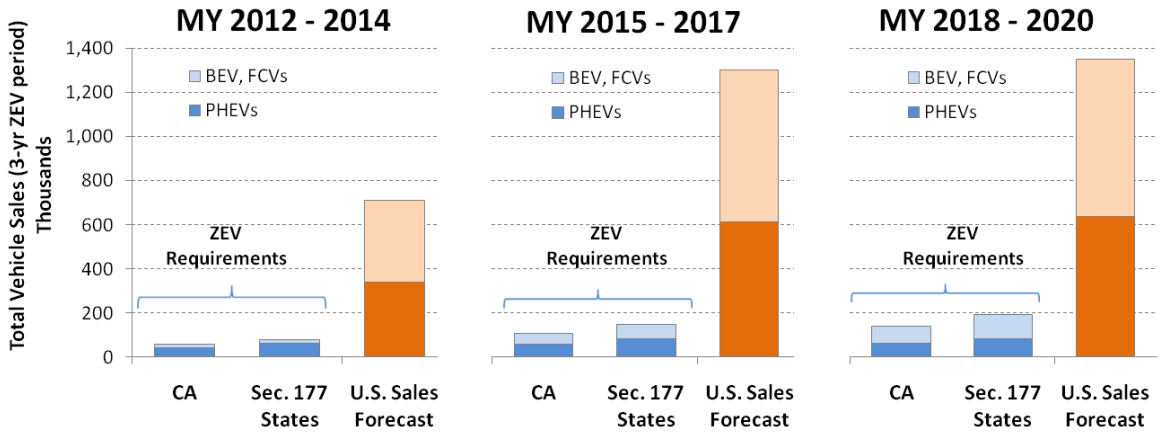
California's ZEV program has been adopted by ten states as authorized under Clean Air Act Section 177. These include eight Northeast and Mid-Atlantic states (Connecticut, Maine, Massachusetts, New Jersey, New York, Rhode Island, Vermont, Maryland), as well as New Mexico and Oregon.

To obtain a rough approximation of vehicle sales for these additional ten states, new vehicle registrations from R.L. Polk & Company were averaged for calendar years 2006, 2007, and 2008 for each

of the above states.[14] New vehicle registrations generally exceed the actual model year sales, so an adjustment factor was estimated based on sales data obtained for seven of the eleven states. The average vehicle sales were estimated to be 2.2 million vehicles per year for Section 177 ZEV states. This results in an estimate slightly below the peak in sales for 2006, but still above the drop in sales in 2008 due to the economic collapse.

The ten Sec. 177 ZEV states currently represent about 17% of the U.S. vehicle market. A comparison of the number of ZEV vehicles that would be required for California and the ten Sec. 177 states is shown in Figure 13. The figure also displays the forecasted U.S. sales of electric-drive vehicles using the low growth case (which conservatively holds sales flat from 2015 to 2020). The higher growth case for U.S. sales of electric-drive vehicles is not shown. The total BEVs, FCVs, and PHEVs required are shown over each three-year ZEV period (i.e. MY 2012-2014, 2015-2017, and 2018-2020).

Figure 13: Comparison of ZEV Requirements versus U.S. Sale Forecasts. Cumulative sales for the three-year ZEV periods are shown.



As can be seen in Figure 13, the forecasted U.S. sales greatly exceed the ZEV requirements for both CA and ten Sec. 177 states. The ZEV requirements shown above represent about 21 to 25% of the total U.S. ZEV sales forecast for electric drive vehicles over MY 2018 – 2020. For comparison, California and ten Sec. 177 states represent roughly 30% of U.S. sales for all vehicles. Thus, the industry as a whole would likely be able to comply without assuming a greater share of electric-drive vehicles going to California and Sec. ZEV 177 states. If sales of electric-drive vehicle sales follow the higher-growth case, then industry as a whole would be even better positioned to meet ZEV requirements in CA and Sec. 177 states.

[14] NADA Data, AutoExecMag.org, 2009, citing R.L. Polk and Company.

4. Conclusion

Forecasts generated by The Planning Edge for over forty vehicle models were used to assess the ability of the industry to comply with ZEV requirements both in California and in Section 177 states. Total U.S. sales of ZEV or near-ZEV vehicles are forecasted to be between 320,000 to 540,000 in MY 2015 depending on fuel prices. Cumulative new entrant firms are estimated to represent slightly over one quarter of new sales.

For California, it is estimated that 40,000 to 140,000 vehicles could be sold in MY 2015 in the low and higher cases, respectively. These estimates exceed the estimated 32,000 ZEVS and near-ZEVs required by the program for MY 2015. Overall, the forecasts show that the auto industry will over-comply the ZEV requirements through the MY2020 time period even for a low what-if scenario, where there is a zero increase in sales rate after MY 2015, which is likely to be highly conservative.

Nissan, GM, Ford, and Toyota are the best positioned among the major OEMs to comply or over-comply with ZEVs using their own product launches. BMW, Chrysler, Honda, and Hyundai would likely under-generate credits absent greater introduction of ZEVs or near-ZEVs than forecasted. However, a modest introduction of ZEV vehicles over the ten year time period would allow these companies to comply with using their own product lines. For example, Honda could comply through producing roughly 3,500 city-type electric vehicles (50-75 mile range) and roughly 1,600 fuel cell vehicles for the California market for MY 2018+.

In addition, a large number of excess ZEV credits will be generated by both intermediate volume producers, new entrant firms, and several of the major OEMs. The ZEV program provides companies not meeting the ZEV requirements with the flexibility to purchase ZEV credits.

Based on this analysis, the ZEV program can be justifiably strengthened by simply reflecting the forecasted vehicle offerings by the industry. Particularly in the post MY 2015 time period, increased credit requirements would help ensure that all major OEMs offer ZEV or near-ZEV technologies in their own product lines and that all OEMs are on track to achieve longer-term GHG emission reduction goals post 2020.

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