November, 2014

Evaluating California's Zero-Emission Vehicle (ZEV) Credits and Trading Mechanism and its Potential Suitability for Implementation in Chinese Cities

Innovation Center for Energy and Transportation

iCET

能源与交通创新中心

Acknowledgement
We are gracious for the generous support of the Blue Moon Fund, as well as for the valuable comments provided by experts and colleagues. Special thanks to Tom Cackette for his instrumental guidance and inputs.

Report Title
Evaluating California's Zero-Emission Vehicle (ZEV) Credits and Trading Mechanism and its Potential Suitability for Implementation in Chinese Cities

Report Date
November 2014

Authors
Maya Ben Dror, Feng An, Daniel Ding, Ayaka Habu

The Innovation Center for Energy and Transportation
Phone: +86.10.65857324 | Fax: +86.10.65857394
Email: info@icet.org.cn | Website: www.icet.org.cn

Content

List of Figures

List of Tables

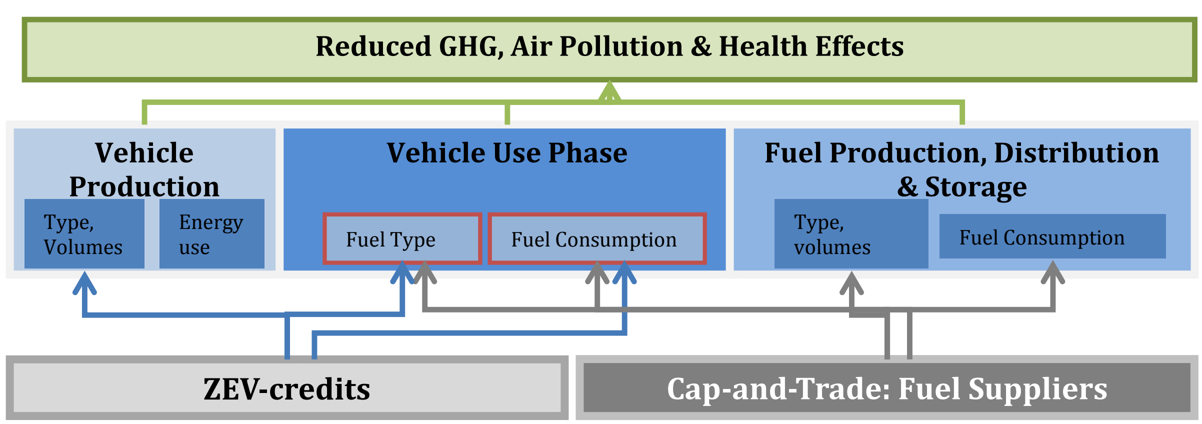
Executive summary

The State of California, representing one of the most polluted regions in the US with over 26 million cars on its roads accounting for about25% of its GHG emissions, is continuously developing and implementing some of the world's most innovative programs for air quality improvement. The underlying targets of this advanced and rich regulatory framework include: the sales of 1/7 cars (15.4% of projected sales estimated at 1.4M) of none or nearly-none polluting vehicles and significant increase in vehicles' fuel economy by 2025; 34% and 75% reduction in new vehicles GHG emissions and smog-forming emissions, respectively; Environmentally superior cars will be available across the range of vehicle models (compacts, SUVs, pickups, minivans etc.) for minimizing consumer compromise while shifting to greener vehicles; Consumer savings on fuel costs will average $6,000 over the life of the car (from a BAU level) and greater than the average $1,900 increase in vehicle price (for ultra-clean, high-efficiency technology).

California's stringent and complementary programs include zero as well as low-emission vehicles' development and market commercialization, and low-carbon fuels development and commercialization. The central goal and advantage of California's ZEV approach lays in its integrated methodology for addressing both criteria of pollution (and GHG emissions) while allowing ZEV credits trading in a pre-defined market place. Through credits trading, early stage zero and near-zero emission vehicle companies are funded and all automakers are provided with an added incentive to develop ever-cleaner vehicles and related technologies. California's cap-and-trade is also a market-based approach based on emission caps.

While California's early ZEV-credits program was designed to accelerate and diversify zero-emissions vehicle solutions development and commercialization since 1990, the recent cap-and-trade program includes fuel supply with the aim of advancing the commercial development of clean and alternative fuels and to incentivize adequate infrastructure (started 2013 and extended to include fuels from 2015). Cap-and-trade fuel governance may influence fuel availability and prices, therefore potentially impacting low-carbon and zero-emissions vehicle use-phase costs. In turn, this may influence car purchase choices. As the two programs thus feed into the transport sector both directly and indirectly, their impacts can be accelerated or offset if management and implementation are not coherent, as demonstrated in this work (section 2.2).

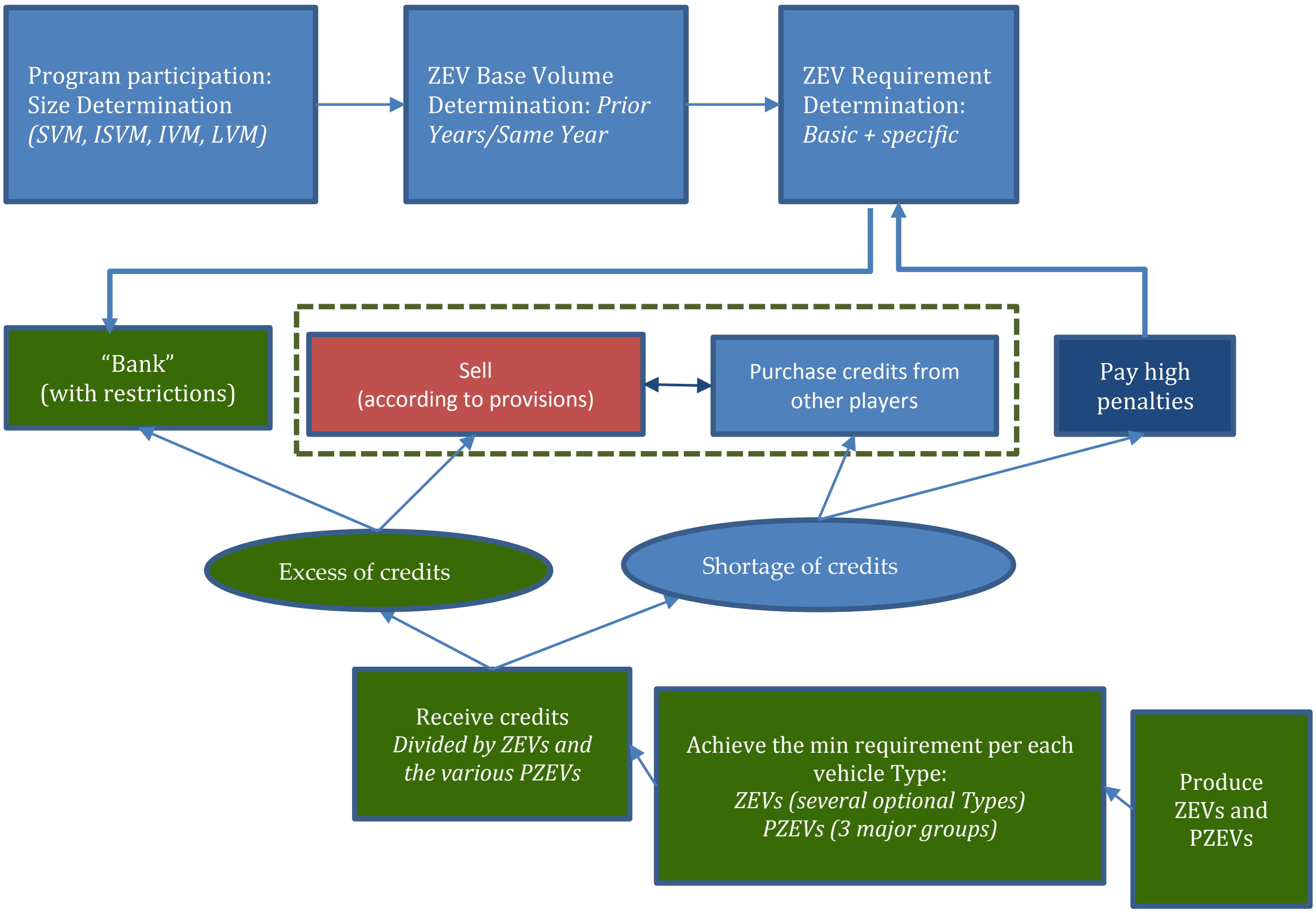
An illustration of the linkage between the ZEV-credits and Cap-and-Trade



The ZEV credits program has proven to deliver ground-breaking results: no manufacturer selling vehicles in California breached the regulation in its 17 years of implementation; nearly 2 million Californians are driving partial zero and advanced technology partial zero emission vehicles (PZEV and AT PZEV), with near-zero tailpipe emissions and some 80% cleaner exhausts than the average 2002 model year car. Gas-electric hybrid vehicles are also a success, accounting for over 400,000 vehicles on California's roads. Various vehicles and vehicle technologies were developed in conjunction by manufacturers with the support of the ZEV-regulation (e.g. "MOA" Vehicles, FreedomCar), which also arguably triggered the development of several other successful vehicle models (e.g. Toyota Prius, Honda Insight).Innovative energy vehicle manufacturers new to the industry were able to survive their initial years arguably by the demand and external profit enabled by the regulation .This phenomenon has been extensively studied in this work (section 3) through the story of Tesla Motors, which achieved revenues of about $245M over 5.5 years thus enabling it to reach market maturity in an overwhelmingly resources-consuming new energy vehicle industry that had previously diminished PEV players elsewhere.

These outcomes, however, may be the result of California's unique characteristics (such as its role as an innovation hub, its comprehensive regulatory framework, the amount of early-adopters is houses etc.). In order to assess the program's suitability for the case of China, local market conditions and the robustness of its institutional framework should be examined. Furthermore, experts point out that a multi-stakeholders collaboration, led by dedicated pilot city planners, is needed to enable in-depth understanding of both the forces that may lead to the success of a China-tailored program as well as to assist in designing such a program (section 3.3). One clear shortfall of the ZEV-credits program's scope lays in its neglect of low-emissions infrastructure, fuels and components players: while auto manufacturers can enjoy the fruit of the program during their seed period, other complementary players that have a significant influence on market demand and uptake are excluded from this scheme. Another issue with the current California-grown ZEV credit scheme is the inability of a participating seed-company to expand geographically and internalize its market potential at every technological step. As evidenced in the case of Tesla, selling its first model the Roadster abroad has resulted in a slowdown of revenue.

An illustration of the ZEV credits program

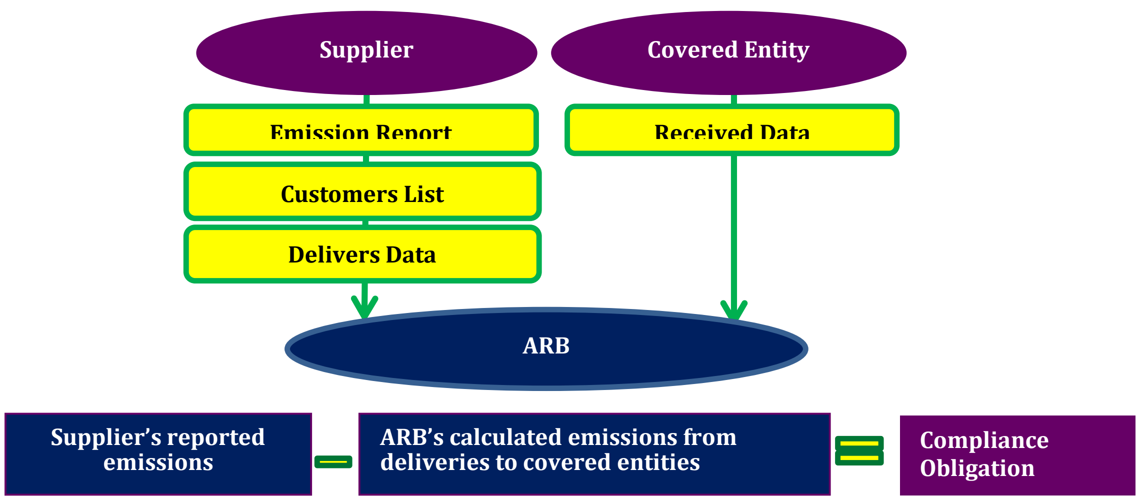


As the worlds' larger GHG emitter, and home to 16 of world's 20 most air-polluted cities, China is aggressively promoting its New Energy Vehicle (NEV) demonstration project aimed at showcasing and assessing a variety of climate mitigation measurements. In particular, its "10 cities 1000 vehicles" program from 2008 for accelerating the development of new PEV technologies was quickly followed by the gradual formation of 25 pilot cities meant to exemplify commercially scalable PEV projects under governmental support. These schemes have not only prepared the participating cities for NEV incorporation in city planning, but have also set the direction for further energy savings and the development of new energy vehicles' institutional framework. This work suggests that the city or cities given the task of assessing and designing a ZEV credit type program and related trading mechanisms (e.g. cap-and-trade) should be selected carefully to ensure market readiness, institutional feasibility, government proactive collaboration, and potential linkages to broader areas and sectors.

China has recently committed itself to ambitious air pollution and energy targets, and has already started incentivizing the commercial development of New Energy Vehicles (NEVs) and related infrastructure. In 2012, China announced a challenging target of the sale of 5 million NEVs by 2020[1]. However, in 2013, NEV sales reached only 20 thousand vehicles[2], and in the first 8 months of 2014 sales only reached 22.8k. Recognizing some of the barriers for NEV demand, China exempted NEVs from import and purchase tax as of September 2014[3], incentivizing purchases of well-recognized global brands by potential early-adopters. This step is projected to not only assist in triggering demand for NEVs and potentially serving local brands down the road, but also in motivating infrastructure development as demonstrated new agreements between importers and strong local players aimed at advancing the development and deployment of EV infrastructure. The Tesla and China Unicom partnership announced early August 2014[4] is an example of one of these agreements. Tackling yet another commercialization barrier, the MIIT abolished the protectionist local NEV approval lists[5] paving the way for the national market growth of local brands, which until recently couldn't secure purchase benefits to potential clients in areas beyond their production geographies.

However, local experiences show that more aggressive, comprehensive, and innovative approaches are in need for decoupling socio-economic development from private mobility usage and creating a commercial clean vehicle supply with adequate supportive networks of operation. Not only should the high-profile automakers, electricity utilities, and fuel providers be included in the design and implementation of new-energy-vehicle programs, but new players providing hardware and software solutions for the rapidly evolving connected car market should be included as well.

An illustration of the cap-and-trade process



In recognition of the importance that market-based mechanisms play in the transition to a low-emission economy, the national government has recently stated its wish to create market-based mechanism for accelerating vehicle standards' compliance and advancing

[1] http://www.gov.cn/zwgk/2012-07/09/content_2179032.htm
[2] http://chinaafc.miit.gov.cn/n2257/n2260/c95046/content.html
[3] http://www.gov.cn/guowuyuan/2014-07/09/content_2714830.htm
[4] http://www.reuters.com/article/2014/08/29/us-tesla-motors-china-unicom-hk-idUSKBN0GT0I320140829
[5] http://www.miit.gov.cn/n11293472/n11505629/n11506277/n11984220/n11984250/index.html

home-grown high-end technologies integration[6]. Chinese mega cities such as Shenzhen, Shanghai, and Beijing have launched carbon emissions trading systems over the past couple of years. These systems, currently in their pilot stages, are projected to further test the grounds for innovative market approaches and multidisciplinary participation aimed at increasing carbon efficiency and improving air quality (e.g. cap-and-trade). The city of Shenzhen, for example, is currently developing a consumer-based mechanism for tracking energy efficiency and carbon reduction, as well as mobile sources emissions capping and trading which could be thereafter linked to its pilot China Shenzhen Emissions Rights Exchange (CERX). A potential gap between national and local efforts is the centralization of standards, disabling local governments from creating a market-based program for accelerating truly innovative and advanced technology commercialization.

This study only infers potential barriers outlined by California experts rather than key players from China. Through key stakeholders' engagement, key barriers for implementing a ZEV credits type program in a pilot city (or cities) in China and measures recommended to overcome them may be identified. A recommended next step is a stakeholder workshop and roundtable discussion for suggesting areas to be further explored and issues of importance when considering ZEV-type design for China.

[6] For example, Article 21 in MIIT's announcement from July 21 2014: http://zbs.miit.gov.cn/n11293472/n11295142/n11299183/16074587.html

1. Background

Accounting for over 25% of GHG emissions and about 50% of city center air pollution, China's petroleum-based transportation system is growing at an unprecedented rate and driving the global production and sales of automobiles. The rapid increase in China's vehicle fuel consumption is in stark contrast to the global goal of reducing petroleum consumption by 50%-80% by mid-century. Meanwhile, air quality in China's major cities continues to deteriorate at alarming rates, posing major health risks and triggering social unrest.

China has recently committed itself to ambitious air pollution and energy targets, and has already started incentivizing the commercial development of New Energy Vehicles (NEVs) and related infrastructure, aiming at 5 million NEVs deployment by 2020[7] and an incorporation of trading mechanism in vehicle mandates[8]. It is clear that more aggressive, comprehensive, and innovative approaches are needed. For example, instead of solely incentivizing consumption through end-user subsidies, it is necessary that we also address the inventive structure that drives manufacturing in order to create diverse and attractive commuting alternatives. Through such an inclusive approach, socio-economic development could be decoupled from private mobility usage. Furthermore, multi-stakeholder engagement that is guided by the government but managed through market mechanisms is deeply needed to slow and eventually reverse the trend of worsening air pollution.

In recognition of the importance that market-based mechanisms play in the transition to a low-emission economy, Chinese mega cities such as Shenzhen, Shanghai, and Beijing have launched carbon emissions trading systems over the last couple of years. These systems, currently in their pilot stages, are projected to further test the grounds for innovative market approaches and multidisciplinary participation aimed at increasing carbon efficiency and improving air quality. The city of Shenzhen, for example, is currently developing a consumer-based mechanism for tracking energy efficiency and carbon reduction, as well as mobile sources emissions capping and trading, which could be thereafter linked to its pilot China Shenzhen Emissions Rights Exchange (CERX).

This project is aimed at evaluating recent innovative schemes for incentivizing sustainable vehicle and fuel production and financing clean transportation technology development through the industry players themselves. The first, the California Zero Emissions Vehicles (ZEV) credit scheme, is unique program that evolved over a twenty year period and was able to drive local low-emissions vehicle innovations through a mandate combined with market-based implementation mechanism. The second is a recent Cap-and-Trade scheme aimed at incentivizing energy and fuel supply through market forces. The two programs, although not officially linked, are both serving similar air-quality improvement and fuel and GHG emissions reduction targets under the state's scoping plan for better air quality and later on - reduced GHG emissions. After outlining these programs' development and evaluating their success, this report will highlight the potential and impediments for similar programs design for implementation in Chinese cities.

[7] http://www.gov.cn/zwgk/2012-07/09/content_2179032.htm

[8] http://zbs.miit.gov.cn/n11293472/n11295142/n11299183/16074587.html

2. Introduction to California's Major Market-Oriented Low-Carbon Development Programs: ZEV and cap-and-trade

This section is aimed at outlining two of California's transport related programs covering cleaner vehicles and fuel commercialization using market-based mechanism: the ZEV-credits program, designed to promote the development and commercialization of new energy vehicles; and the cap-and-trade scheme, designed to (among other sectors) promote the production and distribution of cleaner fuels (including electricity).

First, this section will lay out major drivers for the design and implementation of the California Air Resource Board regulations, then provide an introduction into the concept of clean transport in the context of California's regulatory framework followed by a high-level overview of targets, tools and challenges faced by China in benefitting from California's experiences.

2.1 California's role: CARB's major goals and tools

The State of California, representing one of the most polluted regions in the US with over 26 million cars on its roads accounting for nearly 25% of its GHG emissions, is continuously developing and implementing some of the world's most innovative programs for improving the state's air quality[9]. These stringent and complementary programs include zero and low-emission vehicle development and market commercialization, as well as low-carbon fuel development and commercialization. California's leading regulatory role started in 1967 with the Air Quality Act, giving the state a waiver to set its own emissions standards from mobile sources.

With the target of advancing sales of 1/7 cars (15.4% of projected sales estimated at 1.4M) of non or nearly-nonpolluting vehicles[10]and achieving a significant increase in vehicle fuel economy by 2025[11], California is aiming to achieve the following goals**:**

- New vehicles will emit 34% fewer GHGs and 75% fewer smog-forming emissions, therefore addressing both global and local challenges.
- Environmentally superior cars will be available across the range of models (compacts, SUVs, pickups, minivans etc.), thus avoiding consumer compromise while shifting to greener vehicles.
- Consumer savings on fuel costs will average $6,000 over the life of the car. The savings are projected to be greater than the average $1,900 increase in vehicle price for ultra-clean, high-efficiency technology (however this contention excludes electric fuel cell vehicles of higher costs at this stage and probably also through 2025). Market conditions which independently promote the adoption of cleaner private transportation would hence be put in place allowing for mass adoption beyond the limited early-adoption.

[9] Source: CARB ZEV tutorial.
[10]PHEV, EV and Hydrogen Fuel-cell vehicles.
[11] Large volume manufacturers selling at least 20k vehicles in California, would have to introduce Zero Emissions Vehicles that would account for at least 15.4% of their fleets.

Since the 1990s, CARB continues to refine its definition of vehicles by their relative volume of emissions, making sure technological progress is constantly being incentivized towards an end-goal of zero-emissions vehicles. The current general definitions are as follows:

Table 1: California Vehicle Groups Introduction

Vehicle group acronym	Definition
LEV(Low Emission Vehicle)	The least stringent emission standard for all new cars sold in California beyond 2004.
ULEV(Ultra Low Emission Vehicle)	50% cleaner than the average new 2003 model vehicle.
SULEV(Super Ultra Low Emission Vehicle)	These vehicles emit substantially lower levels of hydrocarbons, carbon monoxide, oxides of nitrogen and particulate matter than conventional vehicles. They are 90% cleaner than the average new 2003 model vehicle.
PZEV (Partial Zero Emission Vehicle)	Meets SULEV tailpipe standards, has a 15-year / 150,000 mile warranty, and zero evaporative emissions. These vehicles are 80% cleaner than the average 2002 model car.
AT PZEV (Advanced Technology PZEV)	These are advanced technology vehicles that meet PZEV standards and include ZEV enabling technology. They are 80% cleaner than the average 2002 model car.
ZEV (Zero Emission Vehicle)	Zero tailpipe emissions, and 98% cleaner than the average new 2003 model vehicle.
TZEV (Transitional Zero Emissions Vehicles)	Transitional zero emission vehicles (TZEVs) are vehicles with **ultra-low tailpipe emissions and** are propelled by a **zero emission fuel** such as electricity or hydrogen. *e,g. PHEV, HICE*. The name was changed during the 2012 ZEV amendments from Enhanced AT PZEVs to TZEVs for simplicity.

In January 2012, California has adopted a new Advanced Clean Cars program for further refining the path for its above stated goals, which is composed of four separate yet related and somewhat inter-dependent mandate-based programs: GHG standards for cars and light trucks; Clean Fuels Outlet; Reducing Smog-Forming Emissions; and Zero Emissions Vehicle (ZEV) Regulation. The latter two are uniquely Californian, and the ZEV regulation has been successfully adopted by 8otherUS states[12], collectively representing about 25% of the US vehicle market[13].

Table 2: An outline of ZEV requirements' adjustments per vehicle model in brief*

Model year	1998	2001	2003	2009	2012	2015	2018
fleet portion requirement	2%	5%	10%	11%	12%	14%	16%

* This table is a simplification of a dynamic and complex requirements measurement method and is meant for providing an illustration only (in-depth introduction of the latest two versions of the regulation, before and after model year 2018, are available in Appendix I).

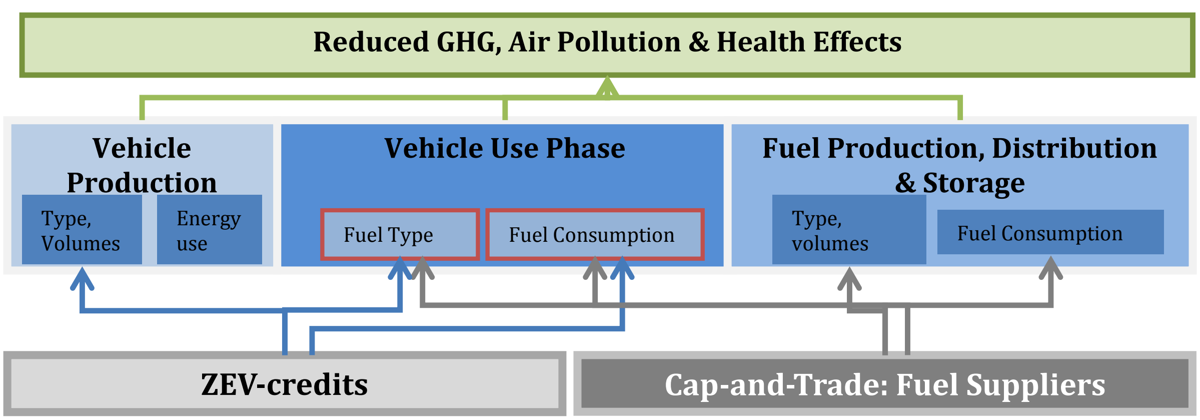
[12] Connecticut, Maine, Maryland, Massachusetts, New-Jersey, New-York, Oregon, Rohde Islands and Vermont. Arizona and New-Mexico have initially joined the California ZEV program but later pulled back from that decision.
[13]http://www.mass.gov/eea/agencies/massdep/news/releases/governors-initiative-to-put-3-3-m-zevs-on-road-by-2025.html

Moreover, the ZEV strategy has been appropriately taking market factors and economic impacts under consideration since 1990. Its results have been evidenced in recent years by the number of clean vehicles conceived and the financial stabilization of innovative clean technology companies. The ZEV program will therefore be at the focus of this work, and the case of Tesla Motors will be examined to exemplify the program's advantages and robustness. California's new Cap-and-Trade program, which will soon include entities from fuel supply chains, is contributing to a broader inclusion of transportation ecosystem emissions under the regulatory framework. Although with little experience to date, this cap-and-trade approach offers a useful angle into transportation emissions and pollutants governance.

2.2 CARB's ZEV-credits and cap-and-trade programs: a coherent framework?

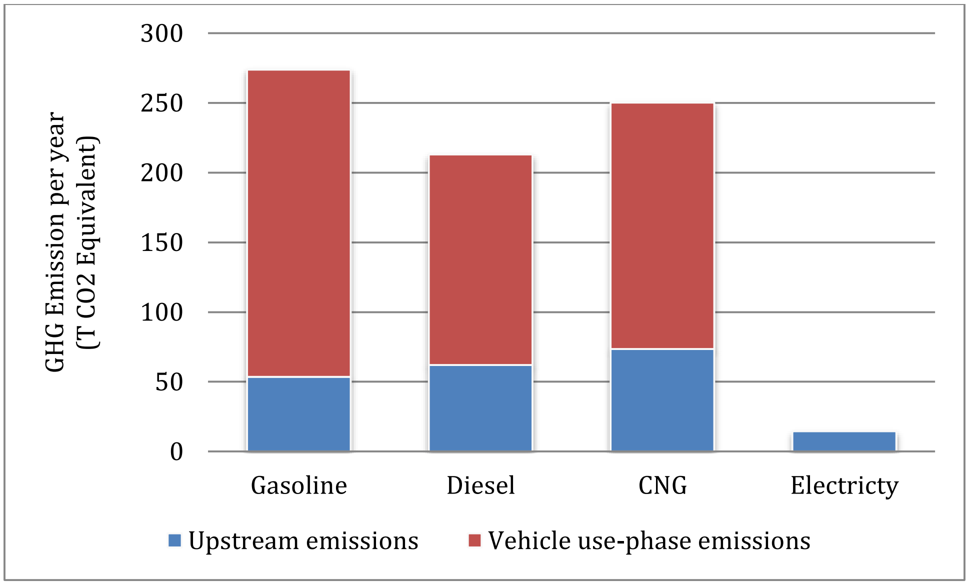
While California's early ZEV-credits program is designed to accelerate vehicle solutions development through sales-based mandate and incentivize the commercialization of zero emissions vehicles through both the mandate and a complementary credits market, the recent cap-and-trade program includes fuel supply with the aim of advancing the commercial development of cleaner and alternative fuels and incentivizing adequate infrastructure. Cap-and-trade fuel governance may influence fuel prices, thus impacting low-carbon and zero-emissions vehicle use-phase costs potentially influencing car purchase choices.

Figure 1: An illustration of the linkage between the ZEV-credits and Cap-and-Trade



As the two programs feed into the transport sector both directly and indirectly, their impacts can be accelerated or offset if management and implementation are not coherent. The below figure is meant to highlight the major GHG impacts of these two separate yet linked schemes through the case of selected vehicle models: gasoline, diesel, CNG and electricity, for the case of China.

Figure 2: Vehicle types emissions sources, by use-phase



Assumptions: Based on Beijing Transport Annual Report (2013) vehicle's average annual travel distance is 12,391 km; Based on *i*CET's China Passenger Vehicle Fuel Consumption Development Annual Report (2013) China's average fuel consumption is 7.33L/100km; Vehicle use-phase emissions averages are based on ACEEE`s Green Book Methodology (2011); Upstream emissions are based on the Proposed Updates to ACEEE`s Greener cars Rating System for Model Year 2014.

As demonstrated in the above figure, both the ZEV-credits and cap-and-trade programs are instrumental for advancing a coherent low-emissions transport development platform– the first through elimination of use-phase emissions and the later through the creation of complimentary infrastructure for cleaner vehicles and an appropriate reduction of upstream emissions. The first includes a GHG standards-based mandate and complementary credits trading mechanism, while the latter is a more straightforward trading platform.

2.3 Chinese Cities: Goals, Tools, and Implementation Gaps

The central government has been promoting low-carbon and zero emissions transport development since 2009. Key programs for guiding and incentivizing such development include public transportation and private vehicle. Although these schemes have successfully developed the concept of low and zero emission vehicles and created various pilot projects, in-house solutions development and market commercialization has been limited. Several barriers hamper medium and long-term market commitment, however all face a similar underlying challenge: lack of independent business-case.

Major city-level projects aimed at assessing low and zero-emissions vehicle solutions, development paths, and governances, include new energy vehicle (NEV) development and emissions trading schemes. Although such programs are typically independent and governed by different local-government entities, the limited market engagement to date has led to recent studies for evaluating the issues of implementation and examining the opportunities in linking between these various methods.

Table 3: NEV and Trading programs in Selected Pilot Cities

	NEV Pilot[14]	Emission trading pilot
Beijing	Since 2009, focused on taxi and buses programs	Since 2008,established Beijing Environment Exchange[15]
Tianjin	Since 2010,focused on buses program	Since 2008,established Tianjin Climate Exchange[16]
Shanghai	Since 2009,focused on buses program	Since2011,established Shanghai Environment Energy Exchange[17]
Shenzhen	Since 2009, focused on taxis and buses programs	Since 2010,established Shenzhen Emission Exchange[18]
Guangzhou	Since 2010,focused on buses program	Since 2012,established Guangzhou Emission Exchange [19]
Xiamen	Since 2010,focused on buses program	Since 2011,established pollution and carbon allowance trade center[20]
Hefei	Since 2009,focused on a private car[21]	

Players from different sectors comprising a coherent zero-emissions vehicle ecosystem, including electricity providers, infrastructure operators and new power-train developers, all seem to be waiting for the "winning" new energy vehicle technology to reach economies of scale and create enough demand that will justify solutions development and integration. Once the risky and capital-intense investment shows a positive return on investment (ROI) in the foreseeable future, players would be able to commit themselves to the national task of shifting to clean mobility.

Table 4: Challenges facing major ZEV ecosystem players

	ZEV ecosystem angel	Solutions/ innovation	Commercialization Impediments
State Grid[22]	Electricity suppliers	Advanced bus battery switch solutions; preliminary e-Taxi battery switch solutions; charging solutions development	Lacks the business-case for commercial solutions development and operation
China Southern		e-Taxi charging network development	

[14]http://www.gov.cn/zwgk/2009-02/05/content_1222338.htmhttp://www.gxdrc.gov.cn/zt/gglm_zt_jnjp/jnjp_wjgg/201006/t20100613_193693.htm
[15]http://www.cbeex.com.cn/
[16]http://www.chinatcx.com.cn/tcxweb/
[17]http://www.cneeex.com/
[18]http://www.cerx.cn/Portal/home.seam
[19]http://www.cnemission.com
[20]http://www.xemas.com.cn/
[21]http://www.ahkjt.gov.cn/technologi/dynamic/mtjj/webinfo/2014/07/1402451705152988.htm
[22]http://www.sgcc.com.cn/

Grid[23]			
Wangxiang[24]	Battery manufacturers	Acquisition of solutions (e.g. A123, Fischer[25]) for vehicle powertrain components.	Regulatory limitations and reputation issues preventing from entering the global market
CALB[26]		EV Batteries	High costs for low energy density solutions and limited demand to compensate for such costs
PRIDE[27] **BYD[28]**		Batteries and complete electric powertrains	
GUOXUAN[29]		Battery monitor	
Potevio[30]	Electric car software providers	Providing operational services	
SHANGHAI EDRIVE[31]	Electric power-train		Reliance on imported high-end products

The design of a regulatory framework that encounters for the challenges these various industry-players are facing is instrumental for enabling market-oriented innovation, development, deployment and operation of all aspects of new energy mobility. Without such coherent and bottom-up considerations, new energy vehicle governance would continue to make slow achievements with limited applicability in the market-place and little potential for groundbreaking commercialization.

2.4 Conclusions

The ZEV and cap-and-trade programs, although not linked, are together creating more inclusive governance aimed at cleaner transportation development: while one is encouraging innovative vehicle technologies commercialization, the other is advancing more sustainable fuels production and market introduction; while one is looking at driving cycle emissions, the other is going beyond use-phase perspective and utilizes a well-to-wheel approach.

This section introduced California's underlying goals and two main approaches for achieving its goals: the ZEV-credits program and the new cap-and-trade program. Section 3 and 4 will provide richer background on each as well as experts' views, and in section 5 main conclusions will be presented.

---

[23]http://www.csg.cn/
[24]http://www.wanxiang.com.cn/product/index.asp
[25] According to a new regulation, Wangxiang is not considered vehicle manufacturer unless it purchased or registered as a domestic auto company.
[26]http://en.calb.cn/
[27]http://www.pride-power.com/
[28]http://bydit.com/doce/index.html
[29]http://www.hfgxgk.com/
[30]http://www.potevio.com/
[31]http://www.chinaedrive.com/english/index2.asp

3. The ZEV-Credits Program

The Zero Emission Vehicle (ZEV) regulation was first adopted in 1990 as part of the Low Emission Vehicle Program set by the California Air Resources Board (CARB). Its original goal was to reduce smog-forming emissions. More recently, it has also become a leading strategy to help achieve an 80% reduction in GHG emissions from 1990 levels by 2050. At the core of this regulation is the utilization of industry players' resources. The program is designed to rapidly increase ZEV production to early commercial volumes, establishing a sustainable and growing market for these advanced technology vehicles (mainly plug-in and hydrogen fuel cell cars).

The ZEV regulation is a credit scheme based on manufacturers' mandatory requirements for a portion of vehicles sold in a state during each model year to be zero emission vehicles. It provides that a manufacturer earns credits, referred to as ZEV credits, for each zero emissions vehicle it manufacturers. A manufacturer with a surplus of credits may sell its excess credits to other manufacturers who can then apply those credits in order to comply with the regulatory requirements, including making up for deficits and banking credits for future use as long as the regulatory provisions permit.

This section will review the ZEV-credits history and regulation (section 3.1), assess its success through meta-analysis and the case of Tesla-Motors (section 3.2), and suggest in-depth understating of its design mechanism and effectiveness through qualitative analysis (section 3.3).

3.1 ZEV-Credits program introduction

3.1.1 ZEV-credits program history

Zero-emissions vehicles regained momentum following the 1970's oil crisis, yet failed to break the domination of oil and auto companies in the vehicle market. However, the California Air Resource Board (CARB), faced with severe air quality issues, developed its initial ZEV requirement within its broader first Low Emissions Vehicle (LEV I) regulation. In 1990, the Board adopted the Low Emission Vehicle (LEV) fleet average standard to dramatically reduce the environmental impact of light-duty vehicles through more stringent emission limits on conventional cars and the gradual introduction of zero emission vehicles (ZEV) into the California fleet. A requirement that at least 10% of the fleet be ZEVs was adopted based on commercializing ZEVs and creating the opportunity for even greater emission reductions in the future.

The first inclusion of ZEV-credits, in the first Low Emission Vehicle (LEV) regulation, which was enforced from 1994 through 2003, was as a footnote: "While meeting the fleet average standards, each manufacturer's sales fleet shall be composed of at least 2% ZEVs in the model years 1998 through 2000, 5% ZEVs in 2001 and2002, and 10% ZEVs in 2003 and subsequent." Since its original adoption, the ZEV regulation has been adjusted six times - in 1996, 1998, 2001, 2003, 2008, and 2012, to reflect the pace of ZEV development and the emergence of new ZEV and ZEV-like technologies.

The rationale behind this new requirement, was that (i) the projected improvements in conventional vehicle technology was not and will not be sufficient to meet air quality standards, and that(ii) ZEVs can avoid internal combustion engine vehicle emissions performance deterioration with age. These underlying assumptions are in line with experts' comprehensive technology studies. Such research also led to the state's 1994 announced "road map" for attaining clean air standards, the State Implementation Plan (SIP).

In 1996, the ZEV regulation was revised, retaining the 10% requirement by 2003 but eliminating early requirements. CARB further established agreements with large auto makers to place a technology demonstration fleet ("MOA" Vehicles), which was considered successful in operation, yet exposed electric vehicle marketability challenges such as sufficient battery availability.

In 1998, the LEV II was introduced, aimed at replacing LEV I from 2004 through 2010, requiring lower emission standards for all vehicle categories and announcing new Super Ultra Low Emissions Vehicle (SULEV) emission standards and near (and zero) evaporative requirements. The ZEV was moved to its own section (section 1962), detailing partial ZEV (PZEV) credits for qualifying technologies, and stating PZEVs substitution up to 6% for large volume manufacturers (LVM). PZEVs were defined as SULEVs with stringent exhaust emissions[32] and evaporation[33] requirements, which have a 15-year or 150,000-mile warranty, and have specific on-board specifications.

In 2001, the ZEV regulations underwent amendments, yet maintained a technology forcing mandate: it phased in ZEV and PZEV requirements; allowed further offset with Advanced Technology PZEVs (AT PZEVs), recognizing them as technologies that would lead to ZEVs; segregated low speed Neighborhood Electric Vehicles (NEVs) and assigned them fractional ZEV credit; and gradually increased future ZEV requirements.

Interestingly, CARB was facing litigation, including federal and state law-suit[34] complaints that challenged the legality CARB's 2001 amendments on the ground that the amended regulations violate the Supremacy Clause of the United States Constitution. The litigation concluded that the credits are linked to efficiency, and the preliminary injunction issued on June 2002 prohibited CARB from enforcing the regulation in both 2003 and2004 model years. CARB modified the regulation in 2003, and a settlement agreement for all cases was signed in August of the same year.

In 2003, following the litigation, CARB made further amendments that entered force in 2005: the calculation method for AT PZEVs was changed; flexibility was inserted by offering two paths (banking credits via the base path and new placement of ZEVs through the alternative path); group demonstrations were enabled through phases (Phase I: 2005-08, Phase II: 2009-11, Phase III: 2012-14, Phase IV: 2015-17); and the requirement was divided from a general 10% to more detailed a maximum of 6% for PZEVs, with the remaining 4%

---

[32] SULEV exhaust emissions requirements included: dual wall exhaust manifolds, close coupled catalyst plus downstream catalyst with integral adsorbers, linear O2sensor, retarded timing at cold start, electric air injection, and greater catalyst loading.

[33] Evaporation requirements included: Additional trap on canister vent, carbon vent on engine inlet, improved seals at joints/junctions, consolidation of parts to minimize junctions, better materials.

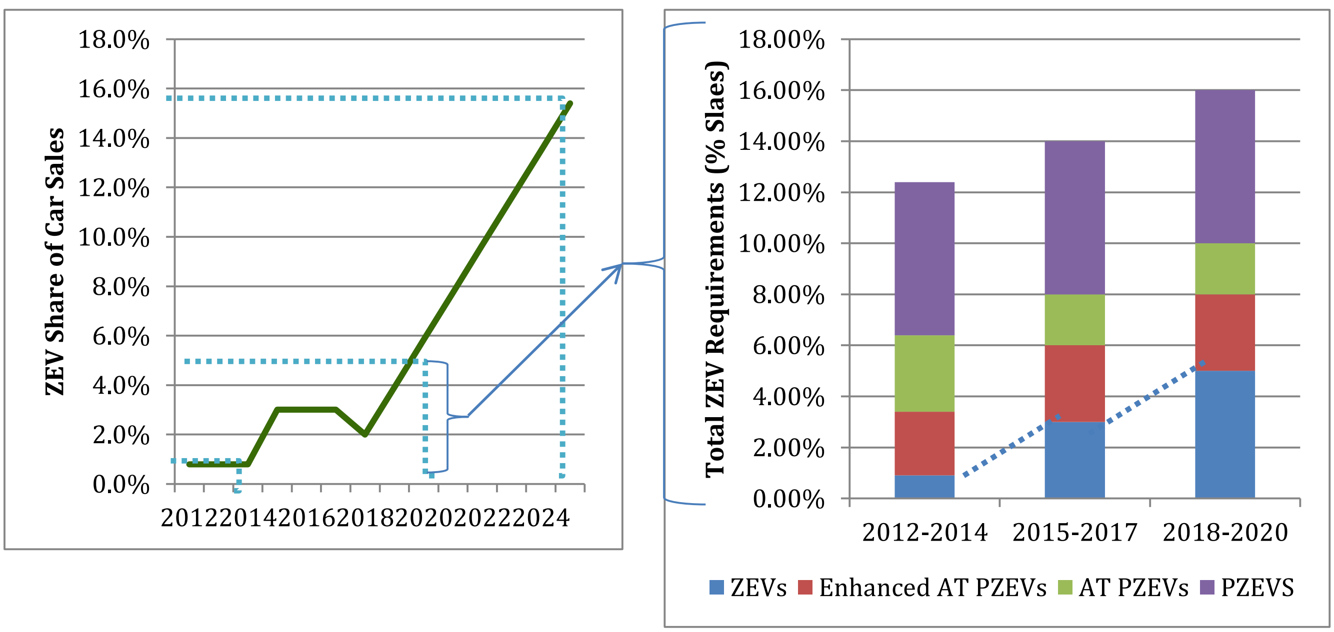
[34] Including: CENTRAL VALLEY CHRYSLER-PLYMOUTH, INC., DAIMLERCHRYSLER CORP., FRONTIER DODGE, INC., GENERAL MOTORS CORP., HALLOWELL CHEVROLET COMPANY, INC., KELLER MOTORS, INC., KITAHARA PONTIAC-GMC-BUICK, INC., SURROZ MOTORS, INC., AND TOM FIELDS MOTORS, INC.

equally divided between AT PZEVs and ZEVs.

In 2006 and 2008, expert panels were held, highlighting the potential of electric vehicle commercialization with a short-medium term focus on plug-in hybrids. The panels increased transparency and have sparked revisions in the ZEV definitions for better fitting the regulation with industrial capacities and development. Additional conforming changes were adopted in October 2013, and further revisions for meeting requests for flexibility by Intermediate Volume Manufacturers (IVMs) are underway[35].

The most bold revisions were made in 2012, expressing the increase in stringency by recognizing that hybrid have reach market maturity and thus should no longer be stimulated through the ZEV credits program. In conjunction with the GHG2 standard, adopted in January that year, the ZEV requirements were raised to 15.4% of sales by 2025 and the concept of Transitional ZEVs replaced the previously known Enhanced Advanced PZEV, highlighting the value of zero-emissions tail-pipe and electricity/hydrogen fuel. The below figures illustrated the gradual increase in minimum ZEV floor which is the heart of the ZEV credits program mandate.

Figure 3: California ZEV program – minimum ZEV floor throughout the years

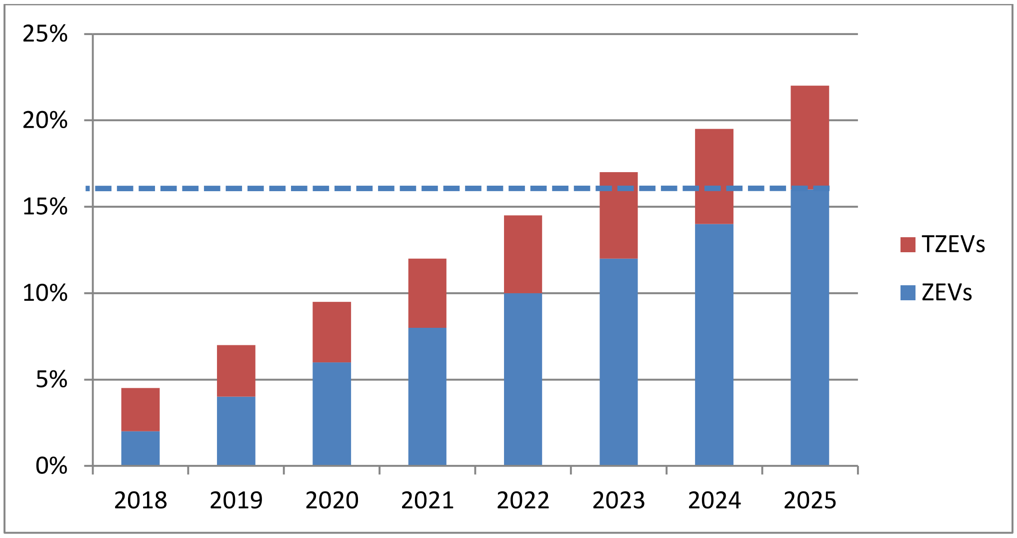


Note: Enhanced AT PZEVs were replaced with TZEVs from 2012.

Source: Enerknol Research Policy Brief, July 2014; Adapted from NRDC, 2010.

35 http://www.arb.ca.gov/msprog/zevprog/2014zevreg/zev_workshop_pres_july2014.pdf

Figure 4: ZEV Requirements Simplified Broken From 2018 Down by Vehicle Types



Note: Vehicles with ultra-low tailpipe emissions and are propelled by a zero emission fuel such as electricity or hydrogen. (since 2012 amendments) e,g. PHEV, HICE; Zero tailpipe emissions (98% cleaner than the average new 2003 model vehicle) e.g. BEV, BEVx, FCV.

Source: Adapted from CARB Oct 2014 new calculation tool.

Throughout the regulation evolvement, market initiatives were developed and inspired key vehicle designs and collaborations today. The late 1990s-developed Honda Insight, which met these requirements, is believed to have inspired the design and features of the recently bestselling Toyota Prius[36]. The FreedomCar developed through collaboration between Ford, GM, and Daimler Chrysler was arguably an important milestone towards the establishment of the current California Fuel Cell Partnership[37].

3.1.2 A short introduction to the ZEV regulation

The ZEV program implementation is built upon six key steps, as detailed in **Table 5** and illustrated in **Figure 5.** This section will describe the essence of each step in order to enable general understanding of how the California-based scheme works. In Appendix I, a more detailed description of the program is offered through the simplification of the regulation, including examples and major revisions to the regulation made to date.

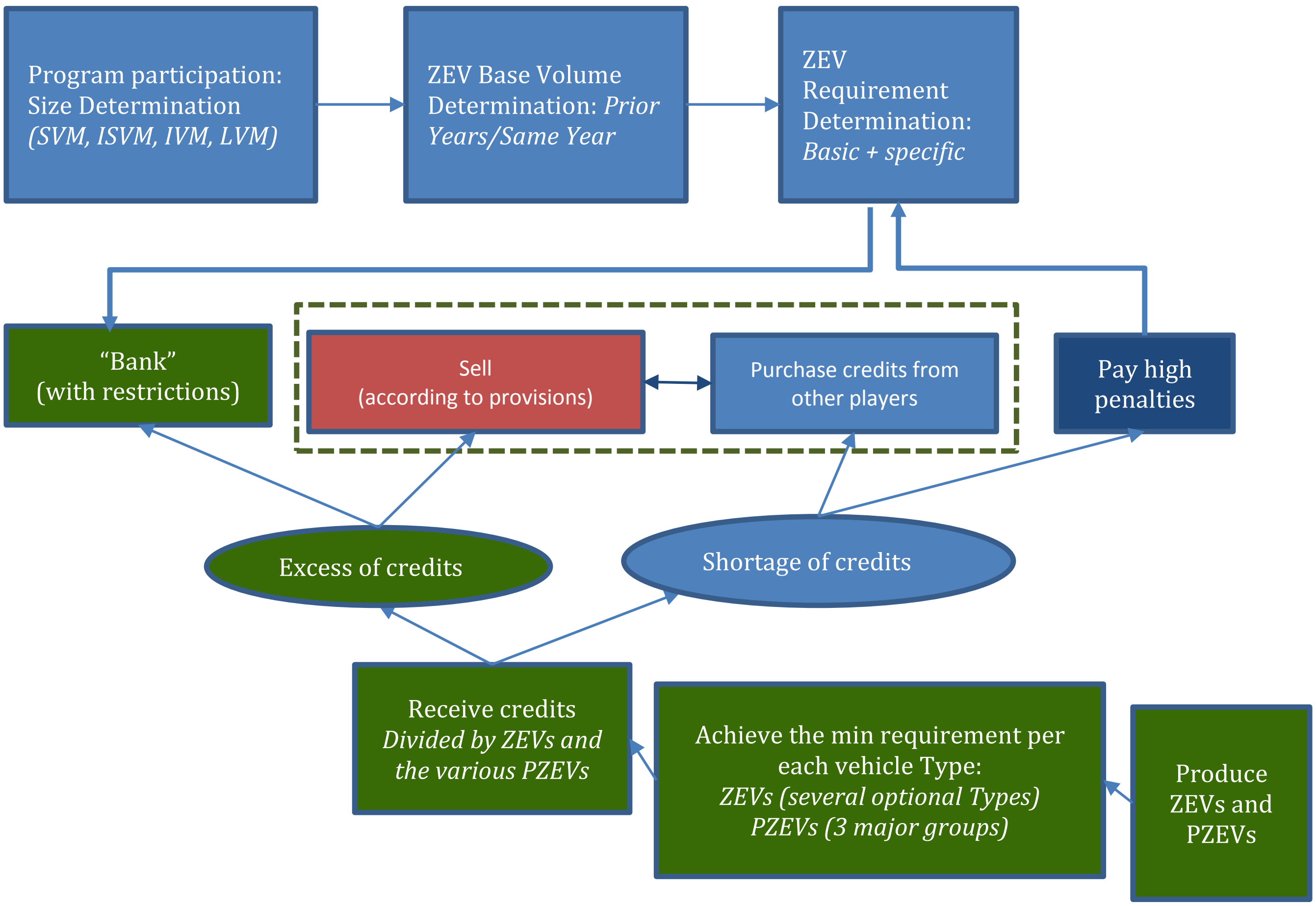
Table 5: Detailed steps of the California ZEV-credits regulation

Step	Description
Step 1	*Size Determination*
Step 2	*ZEV Base Volume Determination*
Step 3	*Requirement Determination*

[36]CARB (June 2009), California's Zero Emissions Vehicle Program, Slide 20.
[37]Ibid, Slide 23.

Step 4	*Credit Calculation*
Step5	*Rules on Credit Use*
Step6	*Compliance and non-compliance*

Figure 5: ZEV Credits Program Illustration



Step 1: Size Determination

The ZEV credits regulation does not require all vehicle manufacturers (VM) to comply, and compliance requirements vary between different volume manufacturers. Typically, large volume manufacturers face stricter ZEV production and credits obligations (elaborated under Step 3). The threshold for compliance is determined by company size: Large Volume Manufacturers (LVM), Intermediate Volume Manufacturers (IVM), Independent Small Volume Manufacturers (ISVM) and Small Volume Manufacturers (SVM). Company size is evaluated on the basis of average vehicle sales in the previous three consecutive years. Sales of passenger vehicles, light duty trucks (LDTs) and Medium duty vehicle (MDVs) are all included in sales calculations. The threshold is detailed in **Table 6**.

Table 6: Company subjection to the ZEV regulation

Company type*	Company sales**	Compliance requirement
Small vehicle manufacturer (SVM)	= or <4,500	Not subject***
Independent Small vehicle manufacturer (ISVM)	< 10,000	Not subject
Intermediate vehicle manufacturer (IVM)	= or > 4501 and = or <60,000	Subject to regulation, but can meet all with PZEVs
Large vehicle manufacturer (LVM)	> 60,000	Subject to regulation,

* Company size is determined by company sales in the previous three consecutive years.
** Passenger vehicles, light duty trucks (LDTs) and Medium duty vehicle (MDVs) are all included in sales calculation. For most manufacturers, "delivered for sale" means the number of vehicles delivered to dealerships in the state of California.
*** From models year 2003

Step 2: ZEV Base Volume Determination

While the above section takes a manufacturer's size (sales-based approach) to determine its compliance requirement, the volume of vehicles delivered for sale in California also determines each manufacturer's ZEV base requirement. This assessment is taking into account the average Passenger Cars (PCs) and light duty trucks (LDTs)[38] delivered over a period specified in one of two optional calculation methods (Method A and Method B). Manufacturers are free to choose between these two ZEV-base volume determination methods and may switch between these methods on an annual basis prior to the beginning of a model year and in accordance with their production pipeline and strategy.

Method A: Prior Years	Method B: Same Year
An average of the previous 4th, 5th, and 6th model year from the model year in which the manufacturer is complying	A projection of sales for the model year in which the manufacturer is complying

Method A – *Example:*

2013	Compliance year	MY assessment inclusion*
2012	1st	N/A
2011	2nd	N/A
2010	3rd	N/A
2009	4th	For the 2013 MY, manufacturers would use their 2007-2009 sales average
2008	5th	
2007	6th	

* For LDV2, multiply the fixed annual percentage specified in Figure 6 to the LDV2s average 2003-2005 production.

Method B – *Example:*

2013
Use 2013 sales*

* For LDV2s, multiply the fixed annual percentage specified in Figure 5 to the LDV2s production.

[38] Including light duty truck produced as of 2003, namely LDT1, and prior to 1993, namely LDT2.

PCs and LDT1s are calculated simply according to sales while as of 2009 LDT2s deliveries are phased in by multiplying the relevant period delivery numbers with a fixed multiplier for each ZEV credit requirement year as illustrated in **Table7**.

Table 7: LDT2* calculation into the ZEV base volume determination

2009	2010	2011	2012+
51%	68%	85%	100%

* LDT2 is defined as LDT Model Year < 1993 while LDT1 is defined as LDT Model Year >= 1993.

Step 3: ZEV Requirement

All vehicle manufacturers that are required to comply with the ZEV regulation (as described in Step 1) are required to have a ZEV-defined portion of their annually determined ZEB-based volume (described in Step 2) as detailed in **Table 8**. The required portion is comprised of a single or combination of ZEV-credit types, while they must meet a minimum of ZEVs ("gold" category, namely truly zero tailpipe emissions vehicles e.g. EVs and FCVs) before moving on to other ZEV categories, as defined in **Table 9**. Most manufacturers choose to combine credit types (keeping the required minimum for each) as it is a cost-effective way for complying with the ZEV regulation. Different volume manufacturers face different provisions, generally pushing large volume manufacturers to better perform.

Table 8: Minimum general ZEV requirements per vehicle year model

Model Year (MY)	1998-2000	2001-2002	2003-2008	2009-2011	2012-2014	2015-2017	2018-2020
General ZEV fleet portion requirement	2%	5%	10%	11%	12%	14%	16%

Table 9: ZEV credits categories and minimum annual requirement per ZEVs

ZEV vehicle type	ZEV credits category	Annual min requirement of ZEV base volume***	
		2012-2014: Base Path	**2012-2014**: New Path
Zero Emissions Vehicles(ZEVs)*	**Gold, up to seven credits**	**0.79%**	**0.93%-3%**
Transitional Zero Emissions Vehicles (TZEVs)**	Silver +	2.21%	2.07%
Advanced Technology Vehicles with Partial Zero-	Silver	3%	2%

Emissions Rating (AT PZEVs)			
Partial Zero-Emissions Rating Vehicles (PZEVS)	Bronze	6%	6%

* A manufacturer must fulfill its ZEV (gold) requirement, but may fulfill the rest of its requirement with lower levels (for each a minimum must be met before shifting toward a lower level). ZEVs include electric vehicles (EVs) and Fuel Cell Vehicles (FCVs).
** Previously known as Enhanced Advanced Technology Vehicles with Partial Zero-Emissions Rating (Enhanced AT PZEVs), including vehicles with electric powertrain and an electric fueling option (Plug-in hybrids).
*** The obligation sees increase in ZEVs over time from 2% in 2018 to as much as 16% by 2025.

In order to obtain a ZEV category credit, there are specified minimum sales figures for each ZEV category type, detailed in **Table 10**. Typically, ZEVs earn 1 credit for delivery into California and earn additional credits when placed in service.

Table 10: ZEVs type vehicles and ZEVs credits earned per vehicle type

	Definition: ***UDDS ZEV Range (miles)***	***Fast refueling (FR) capabilities***	**Credit per vehicle 2009-2011**	**Credit per vehicle 2012-2017**	**Credit per vehicle 2018+***
Type V	≥ 300 miles range	285 miles in ≤ 15 min	7	2012-2014: 7 2015-2017: 9	3
Type IV	≥ 200 miles range	190 miles in ≤ 15 min	5	5	3
Type III	≥ 100 miles range	95 miles in ≤ 10 min	4	4	3
	≥ 200 miles range	N/A			
Type IIx	≥ 100 miles range		N/A	3	3
Type II		N/A	3		
Type I.5x**	≥ 75, <100 miles range		N/A	2.5	2.5
Type I.5		N/A	2.5		
Type I	≥ 50, <75 miles range	N/A	2	2	2
Type 0	< 50	N/A	1	1	1
NEV (Neighborhood Electric Vehicles)	No minimum	N/A	0.3	0.3	0.3

* Estimations.
** A Type I.5x is a range extended battery electric vehicles powered predominantly by a zero emission energy storage device, able to drive the vehicle for more than 75 all-electric miles, and also equipped with a backup auxiliary power unit (typically a small gasoline powered engine), which does not operate until the battery is fully depleted. Type I.5x vehicles can only meet up to 50% of a manufacturer's pure ZEV requirement.

***Example base ZEV obligation calculation*:**

MY 2012: ZEV-base volume determined: 100,000 cars		
Total 12% credits obligation	(Table8)	= 12,000 cars
Must generate 0.79% credits from ZEVs	(Table9)	= 790 ZEVs (EV, FCV)
May generate 2.21% credits from TZEVs	(Table9)	= 2,210 TZEVs (e.g. PHEV)
May generate 3% credits from AT PZEVs	(Table9)	= 2,000 Enhanced AT PZEVs (e.g. HEV)
May generate 6% credits from PZEVs	(Table9)	=6,000 Enhanced AT PZEVs (e.g. Ultra low emissions ICE)

Step 4: Credits Calculation

There are three types of allowances dedicated for PZEV type vehicles (namely PZEVs, AT PZEV and Enhanced AT PZEV or TZEVs) built upon an initial (i) Baseline PZEV Allowance, as follows: (ii) Zero Emission Fuel Cycle Allowance, (iii) Zero Emission Vehicle Miles Traveled (VMT) Allowance, and (iv) Advanced Componentry Allowance. In order to qualify for any type of allowance, the vehicle manufacturer must demonstrate compliance with the respective type allowance requirements, and may be eligible for a minimum allowance.

The total ZEV calculation is determined upon vehicle segmentation (outlined in **Table9**), specific tier in the case of ZEVs (**Table10**), and specific allowance in the case of PZEVs (described above), as summarized in **Table11**.

Table 11: Basic credits calculation method

Vehicle segmentation	Basic credits allowance	+ Additional credits allowance*	X Multiplier**
Pure Electric Vehicles (ZEVs)	Ranges 0.3-7 (See **Figure 9**)***	N/A	1.25 (excluding NEVs and Type 0)
Enhanced Advanced Technology Vehicles with Partial Zero-Emissions Rating (Enhanced AT PZEVs)	0.2	**+** Zero Emission VMT (1.39 or 1.5) **+**Adv. Comp. (Ranges 0.15-0.95) **+** Low Fuel Cycle (0.3)	1.25 (PHEVs)
Advanced Technology Vehicles with Partial Zero-Emissions Rating (AT PZEVs)	0.2	**+** Adv. Comp. (Ranges 0.15-0.95) **+** Low Fuel Cycle (0.3)	N/A

Partial Zero-Emissions Rating Vehicles (PZEVS)	0.2	N/A	N/A
Formula:	***(X +***	***Y)***	**** Z = Credits***

* See section 2.2.4 for additional credits allowances determination
**A multiplier applies only for model year vehicles before 2011, thus not discussed here (see Appendix I for more details). Excluded from this table are: (i) multiplier for ZEVs and > 10 mile zero emission VMT allowance PZEVs
*** ZEVs receive 1 credit upon delivery in CA and additional when placed in service.

***Example A*:**	
MY 2011Type D Hybrid (AT PZEV) would receive:	
0.2 (PZEV basic allowance) **+ 0.4 (for Advanced Componentry Allowance)**	**= 0.6 credits**
***Example B*:**	
MY 2011CNG Vehicle (AT PZEV) would receive:	
0.2 (PZEV basic allowance) **+ 0.2 (for Advanced Componentry Allowance)** **+ 0.3 (Low Fuel Cycle)**	**= 0.7 credits**
Example C:	
2009 sold Type F 10mi EAER PHEV (Enhanced AT PZEV or TZEVs):	
0.2 (PZEV basic allowance) **+ 0.72 (for Advanced Componentry Allowance)** **+ 0.7 (Zero Emission VMT)** **X 1.25 (multiplier)**	***= 2.03 credits***
Example D:	
2012 sold Type F 10mi EAER PHEV (Enhanced AT PZEV or TZEVs)	
0.2 (PZEV basic allowance) **+ 0.67 (for Advanced Componentry Allowance)** **+ 0.7 (Zero Emission VMT)**	***= 1.57 credits***

Step 5: Rules on Credit Use

In general, all credits produced in excess of a manufacturer's requirements may be "banked" for future use. Credits earned from all types of vehicles may be traded or sold to any other party, and traded credits can be used the same way as credits earned from vehicles placed. Special provisions allow for manufacturers to meet up to a certain amount of their requirements, based on the type of vehicle produced and the regulatory period.

Table 12: PZEV credits cap restriction in fulfillment of ZEV credits requirement

PZEV Type	Period	Restriction	% out of the company's credit-base requirement
PZEVs	2009-2011	55%	6% (out of 11%)
	2012-2014	50%	6% (out of 12%)

AT PZEVs	2009-2011	72.5%	8.5% (out of 11%)
	2009-2011 Alternative Path	100%	11% (out of 11%)
Enhanced AT PZEVs	2009-2011	75%	9% (out of 12%)
	2012-2014	93.4%	11.21% (out of 12%)

Rules also exist for the case of "neighborhood electric vehicle" or "NEV"[39], gradually decreasing their use is fulfillment of ZEVs but allowing for their use in fulfillment in PZEVs - which reflects CARB's endorsement of this small zero-emissions vehicle segment. Special provisions also enable demonstration vehicle and transportation systems credits for meeting the ZEV-credits requirements. Advanced demonstration vehicles (not delivered for sale or registered with the regulator) may also earn credits, if they are (i) placed for two years, (ii) spend 50% of the time in California, (iii) up to 25 vehicles per model, and (iv) of 2009-2014 model year vehicles. Further special provisions enable to earn credits from vehicles placed in projects with innovative transportation systems, such as Shared Use and Intelligent Technologies and transportation tools of Linkage to Transit.

Step 6: Compliance and non-compliance

For manufacturers subject to the regulation, all compliance reports (including path selection) are due May 1 of the calendar year following the compliance model year (for example, for the 2014 MY, reports are due May 1, 2015) yet manufacturers may update reports until September. However, manufacturers not subject to the regulation may submit credits at any time, and credit trades or sales may be reported at any time[40].

The public disclosure of the 2009 MY was of each manufacturer's annual production and ZEV credits earned per vehicle. As of the 2010 MY, each manufacturer's annual ZEV credit balances, including credits from transportation systems, advanced demonstrations, and trades and sales from other parties, are also available to public through CARB website. The value of credits, however, is a discrete property of the trading partners. Financial reporting may expose revenues from credits sales; however, it may not detail the credits volumes and trading partners, and thus a full picture of the value of credits may not be available to the public.

If a manufacturer demonstrates non-compliance, it has an additional two years to make up a ZEV deficit. Penalties apply as of the 3rd year, and are specified in the Health and Safety Code (HSC 43211).There is a $5,000 penalty per vehicle or credit not produced, under the defined default 1 ZEV credit equivalent value of Type 0 ZEV. For instance, if a vehicle manufacturer is 500 credits short in fulfilling its regulatory requirement, and does not make up the deficit within the following two-year grace period, it will pay a penalty of 500*$5,000=$2.5 million.

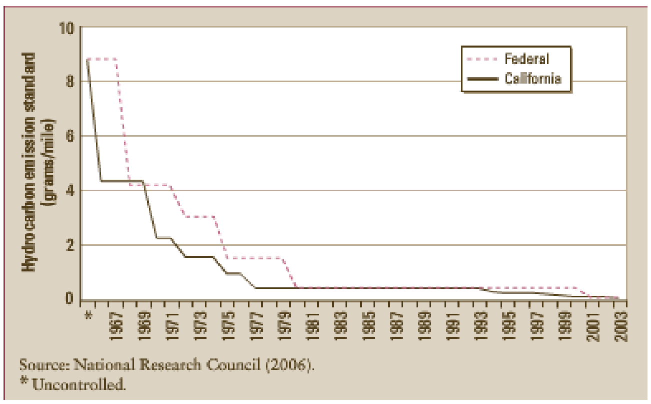
[39]NEV is a motor vehicle that meets the definition of Low-Speed Vehicle either in section 385.5 of the Vehicle Code or in 49 CFR 571.500 (as it existed on July 1, 2000), and is certified to zero-emission vehicle standards
[40]http://www.arb.ca.gov/msprog/macs/macs.htm

3.2 ZEV-credits quantitative assessment

3.2.1 Meta-analysis: ZEV mandate evaluation

This section reviews papers and data instrumental for assessing the success of the ZEV-credits regulation. As California has been leading standards regulating emissions from mobile sources since the late 1960s, and has been driving federal GHG emissions standards since the 1990s – the task of isolating the influences of the ZEV mandate from the enhanced LEV (I and II) regulatory outcomes is a challenging one**. Figure 6** illustrates the pioneering approach of California through its hydrocarbon reductions.

Figure 6: California and Federal Hydrocarbon Emissions Standard Development



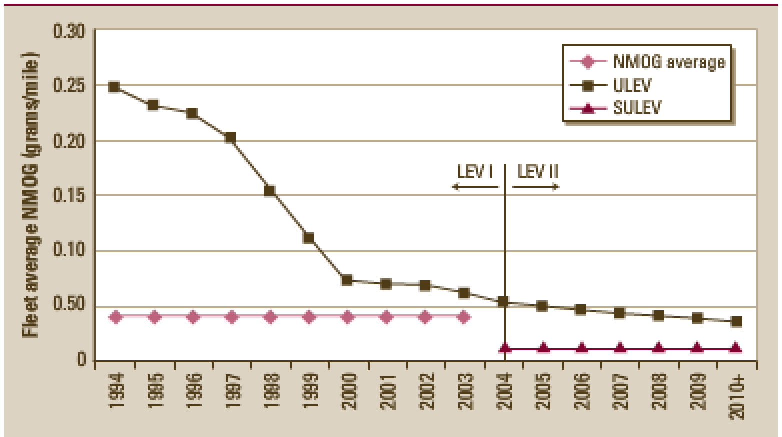
Source: Public Policy Institute of California. (2007), p. 3.

CARB's LEV regulations, crafted in 1990, have kicked-off a set of performance standards that are not single but rather divided to vehicle type categories and with varying levels of stringency. Manufacturers can choose a compliance pathway, and are ultimately assessed against a sales-weight emissions fleet average emissions rate. The level of standard is set to be "technology forcing" – "in a sense that the standards are set to be met through unspecified technology that is not yet available for widespread commercial use"[41]. The LEV standards are aimed at capping and reducing the primary compositors of smog (and major ozone precursors) – oxides of nitrogen (NMOG) and carbon monoxide. A sales-weight average of emissions for vehicle sales in California needs to maintain below a defined (and gradually reduced) threshold – NMGO average. In the case of the ZEV mandate, two risky measures have been used: specified technologies and flexibility.

By comparing the NMOG average requirement with the non-ZEV LEV I and II type average emissions, the Ultra LEV (ULEV) and Super-Ultra LEV (SULEV), it is evident that short term emission levels could have been achieved without ZEV – most stringent ULEVs and SULEVs under LEV could have delivered the required results, as shown in **Figure 7**. This emphasizes the goal of the ZEV mandate – bring long term environmental benefits and deliver complete mitigation of tailpipe emissions.

[41]Public Policy Institute of California. (2007). Learning from California's zero-Emission Vehicle Program. *California Economic Policy*, Vol 3 (4), p. 4.

Figure 7: Fleet Average NMOG Compared with Most Stringent LEV Emissions Categories



Source: Public Policy Institute of California. (2007), p. 5.

CARB have committed itself to biennial evaluations of state of technology, based on which it revised the time frame of the ZEV mandate and the vehicle technologies it included. For example, a Battery Technology Advisory Panel (BTAP) was convened for assessing the state of battery technology development, and has concluded in 1995 that battery achievement are projected to lag behind the mandate by three years. Hence, the ZEV requirement was pushed ahead and vehicle that would deliver similar immediate environmental improvements (PZEVs) were phased in. A snapshot of the mandate vehicle types and their commercialization timeline is offered in **Figure 8**.

Figure 8: ZEV mandate phase in and commercial uptake

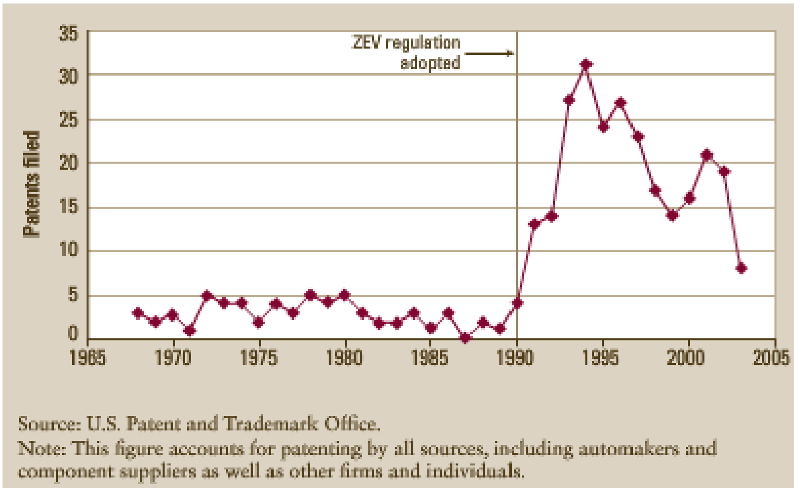
Vehicle Category	Date Introduced in ZEV	Vehicle Sales 2001–2005	Example Models
Zero-emission vehicle	1990	4,400[a]	Toyota RAV4 electric vehicle
Partial-zero-emission vehicle (PZEV): Vehicle that meets the most stringent tailpipe standards, meets the zero-evaporative-emission standard, and has a 150,000-mile emission warranty	1998	430,000	Some models of Ford Focus, Toyota Camry
Advanced technology partial-zero-emission vehicle (AT-PZEV): Vehicle that meets the PZEV requirements and incorporates such advanced technology as energy storage or electric motors	2001	70,000	Toyota Prius, Honda Civic Hybrid, Honda Civic GX (CNG)
Fuel cell vehicle (FCV)	2003	None to date, although some demonstration vehicles are in use	

Source: Vehicle sales figures were obtained through personal communication with K. Eley, Air Pollution Specialist, ZEV Implementation Section, California Air Resources Board, 2006.
[a] These are BEVs that were either sold or placed into use between 1996 and 2003.

Source: Public Policy Institute of California. (2007), p. 7.

Since the only near-term available ZEV technology was the battery electric vehicle, the approval of the ZEV mandate in 1990 saw a sheer amount of battery electric vehicle patents being filed in the following years, as demonstrated in **Figure 9**. The regulatory power placed in the hands of government have therefore proven to spur innovation arguably by providing confidence in future vehicle technology direction and minimizing risks associated with vehicle innovation. Further support of this contention can be found in the origins of patents applications, the majority of which are not by US companies but rather Japanese companies.

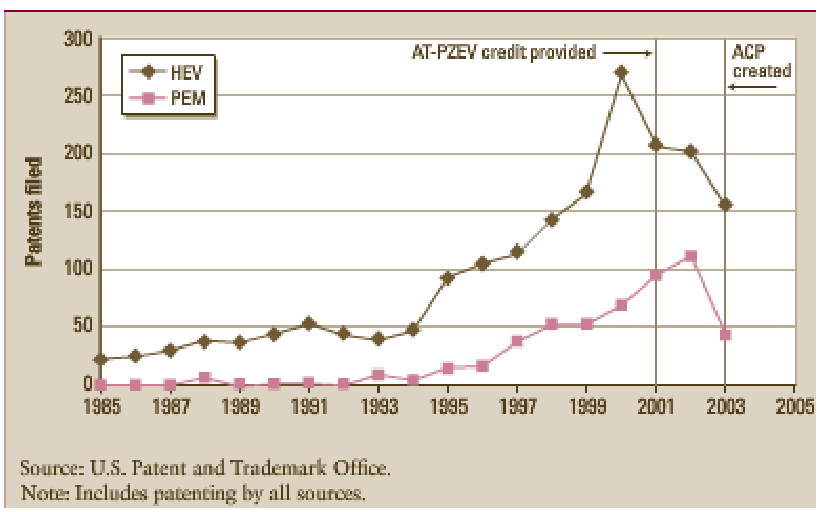
Figure 9: Battery Electric Vehicle Patents filed



Source: Public Policy Institute of California. (2007), p. 10.

However, the growth in patents filling for hybrid and fuel cell vehicle technologies seem to have appeared before CARB enabled these vehicle technologies in meeting its requirements, indicating that in this case CARB followed market developments in crafting the ZEV mandate amendments in the late 1990s. That said, experts assert that the acceleration of battery improvements, which was motivated by the ZEV mandate, have benefited the hybrid car and thus largely contributed to its mass production and commercialization.

Figure 10: Hybrid (HEV) and Fuel Cell (PEM) Vehicle Patents filed

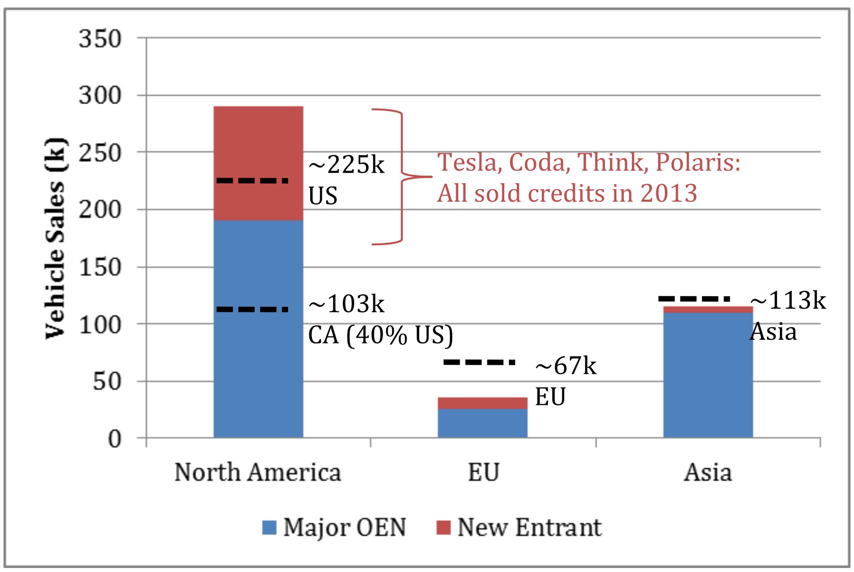


Source: Public Policy Institute of California. (2007), p. 11.

Another clear outcome of the ZEV mandate are ZEV system concepts, solutions development and deployment: home-refueling is claimed to be ZEV-mandate born concept; various electric charging outlets innovations have been developed to service plug-in hybrids and electric cars sold for gaining ZEV credits; software developments and "connected-car" innovations have spurred since the mandate managed to showcase commercialization of the next generation of vehicles.

Shifting from past-looking observations to future prediction, the Natural Resources Defense Council (NRDC) produced a paper in 2010 in support of the ZEV mandate, estimating the US and California ZEV market growth[42]. By building on historic vehicle manufacturing and innovation tracks as well as government support and incentives for manufacturers and consumer (of which the ZEV plays important role), NRDC estimated that North America would see the sharpest increase in EV manufacturing from both major OEMs and new entrants to this vehicle segments (e.g. Tesla Motors), as shown in **Figure 11**. 2013 figures show that four out of seven companies that have sold credits are small manufacturers which are not required to comply with the regulation (Tesla, Think, Polaris, Coda), affirming NRDC's projections. The study also estimated that the US EV market will grow to 320,000-540,000, and in California, as much as 40,000-140,000 EVs could be sold in MY 2015 – up to 44% of US sales, as illustrated in **Figure 12**. 2013 figures show that California's EV production accounted for about 40% of the total US EV production.

Figure 11: Production Locations for MY 2015 Electric Vehicles Sold in the US

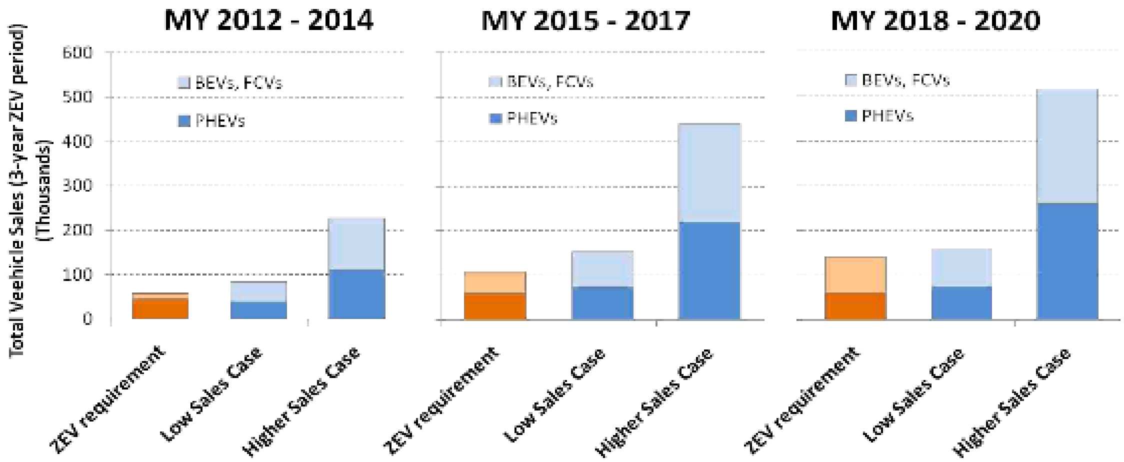


Note: BLUE are actual PEVs sales from December 2010 through August 2014 [Adapted from CARB data]; BLACK are actual PEVs sales by 2013 [ZSW 2014 Report]

Source: Adapted from NRDC, 2010; CARB 2013[43]; Central Valley Business Times[44].

[42]NRDC. (2010). The Zero Emission Vehicle Program: An Analysis of Industry Ability to Meet the Standards.
[43] http://www.arb.ca.gov/msprog/zevprog/zevcredits/2013zevcredits.htm
[44] http://www.centralvalleybusinesstimes.com/stories/001/?ID=26678

Figure 12: Projections of ZEV sales in California by major types in comparison to the ZEV requirement



Source: Adapted from NRDC, 2010.

On the individual company front, building on projected vehicle models announced and pace of production, the report projects that most of the OEMs will produce more than the requirement of ZEVs over the coming five years. As shown in **Figures 13-15 and Table 13**, vehicle manufacturers earn and bank credits for future use, indicating their response to what is perceived as a long-lasting program with large scaling and expansion potential (enabling utilization of the banked credits rather than their depreciation). A 2013 snapshot shows as much as 22,137.8 credits in total are banked as of September 2013, of which 5,305.746 were generated from pure ZEVs (EVs, excluding NEVs) and their ownership is dominated by Nissan and Honda (Tesla's major buyers).

Figure 13: Total credits balance by company, Sep 2013

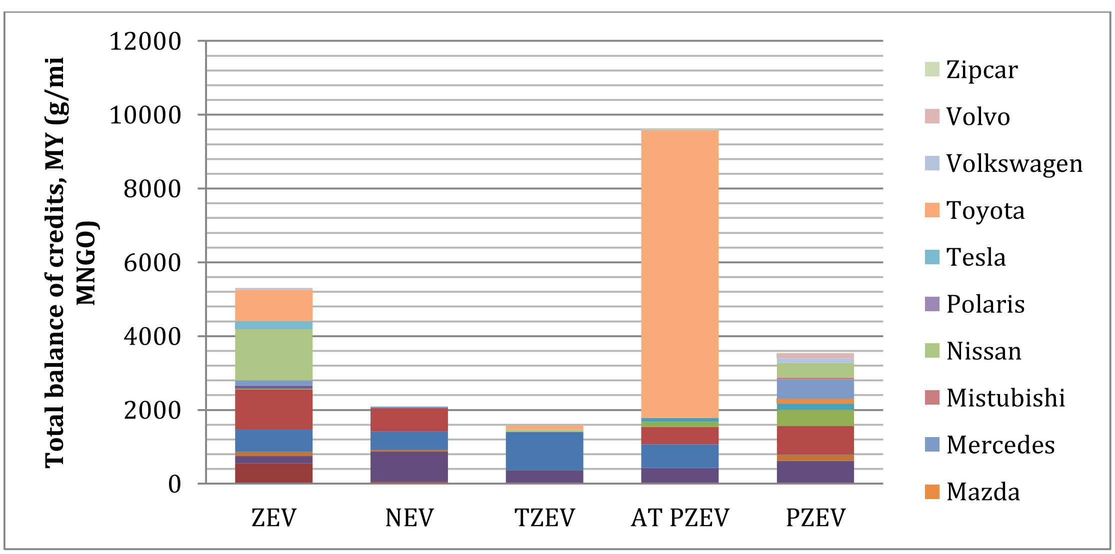
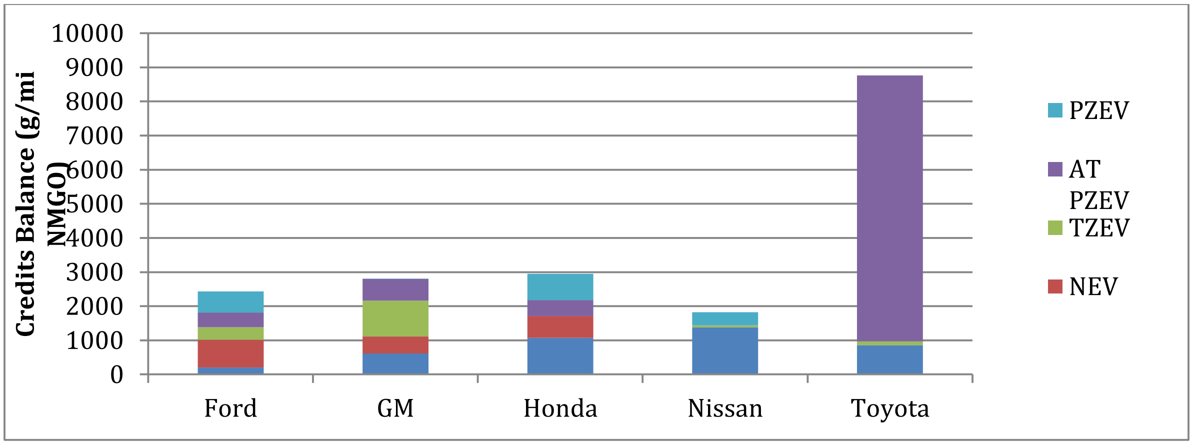
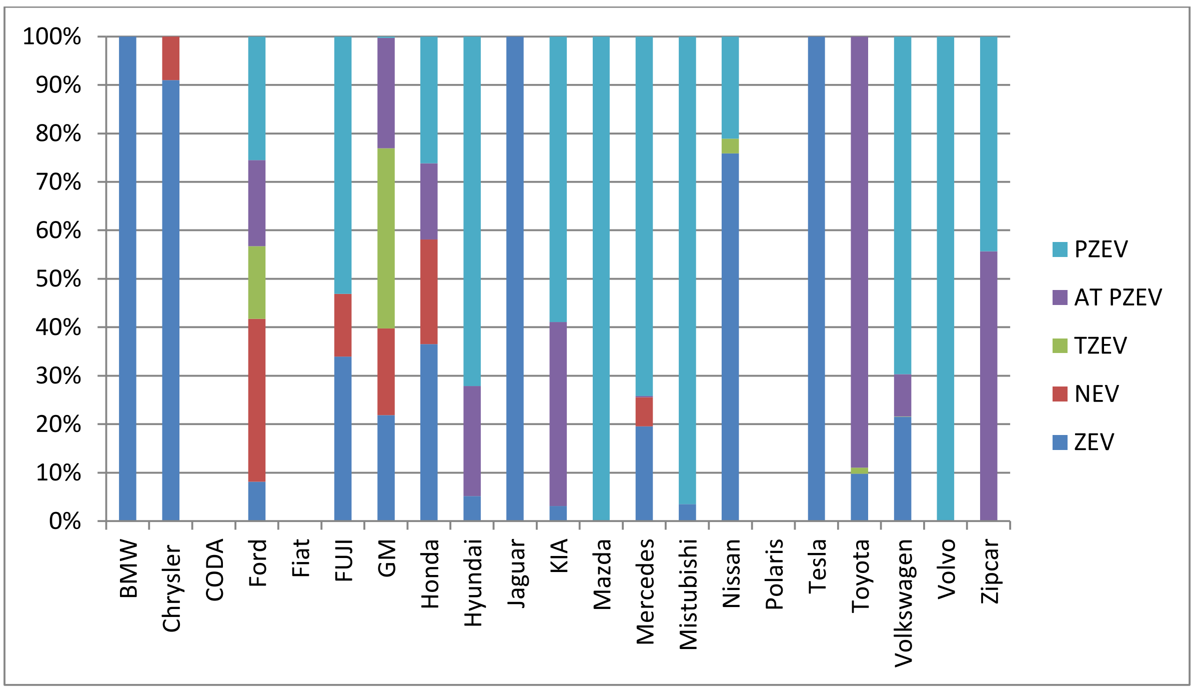


Figure 14: Credits balance of the top 5 "bankers" by credits type, Sep 2013



Note: The top 5 outlined in this figure are the only companies with total credits balance acceding 1000 credits.

Figure 15: Total credits balance by company as percentage of the total credits type, Sep 2013



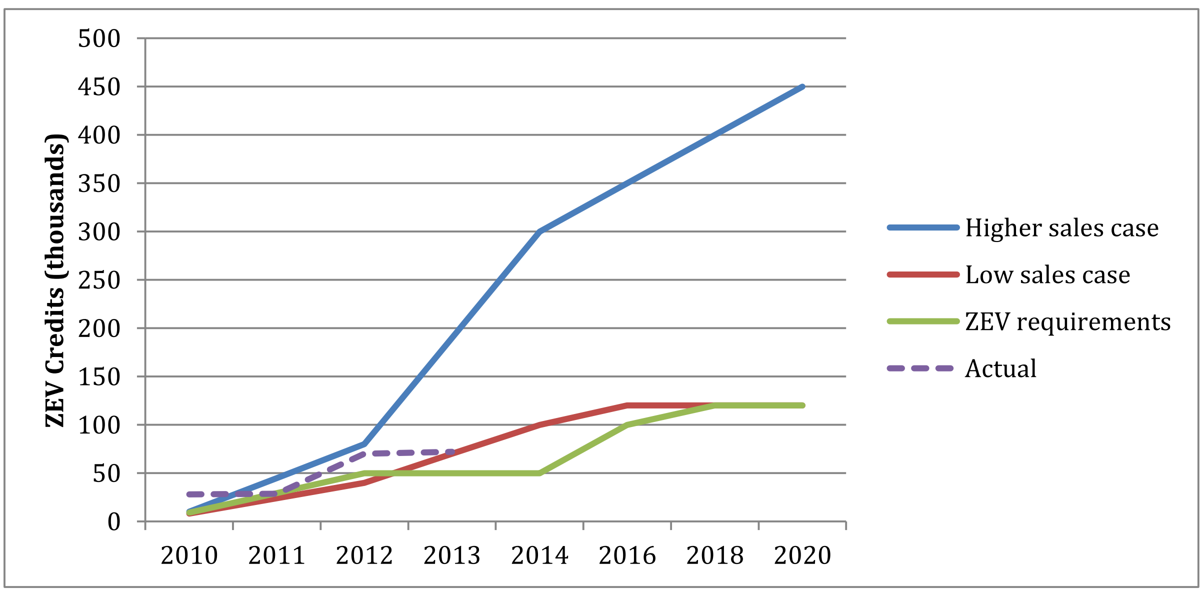
Note: Companies listed here with no credits balance are companies that have generated credits yet did not bank them (CODA and Polaris are companies with no requirements that have generated and sold all of their credits).

In particular, Nissan, Toyota and GM are projected to go beyond the credits requirement in the coming 6 years even for their low-sales case, and Ford and Honda may or may not fulfill the requirements, while other major OEMS are projected to have continues demand for credits in order to fulfill the ZEV mandate requirements. 2013 major buyers of ZEV credits are Honda and Mercedes, with 542.5 and 663.6 ZEV purchases respectively. The first three auto manufacturers have also been of the first to introduce EV technology and register EV patents throughout the 1990s.

In terms of credit transfer, it should be noted that some players, like Azure Dynamics and Suzuki, have occasionally generated profit from the ZEV program, while others, including Tesla, Coda, Think, and Polaris, have experienced more sustained ZEV credit profits, whether as a small portion or the bulk of the total as illustrated in **Figures 16-20**. Interestingly, as of 2012 the volume of transactions has increased significantly from less than 55 (about 22 in 2010 and 52 in 2011) to around 1000 (about 1375 in 2012 and 894 in 2013) in units of grams per mile Non-Methane Organic Gases (g/mi NMOG).

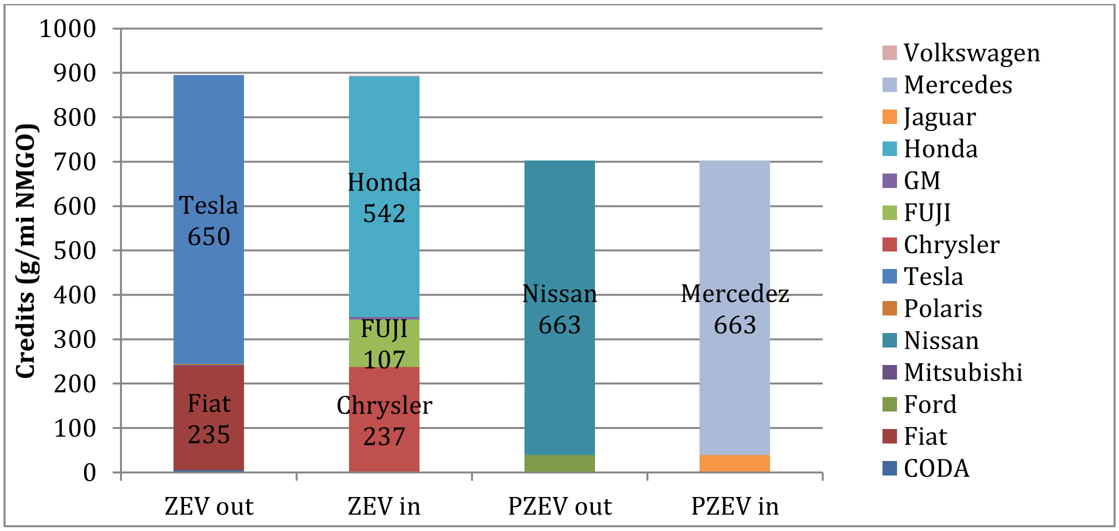
Since each company is following its own strategy based on the development costs and commercialization predictions of its own models, it is difficult to discern their individual approach to fulfilling the ZEV credit mandate. One significant observation from the 2013 credit transaction data is that only premium conventional car manufacturers purchased PZEVs. The fourteen companies stated in **Figure 17** have all been involved in credit transactions in 2013, however only eight companies have played a significant role: Tesla and Fiat among ZEV credits sellers and Honda, Chrysler and FUJI among major ZEV buyers; Nissan and Ford were the only PZEV sellers while Mercedes and Jaguar were among the PZEV buyers.

Figure 16: Annual ZEV credit generation predictions vs. requirements in California



Source: Adapted from NRDC, 2010; actual figures based on CARB's ZEV credits annual archive.

Figure 17: ZEV credit transfers out/in by company between October 1, 2013 and September 30, 2014



Note: The 14 companies identified in the figures have all been involved in credit transactions in 2013, however only eight companies played a significant role: Tesla and Fiat among ZEV credits sellers and Honda, Chrysler and FUJI among major ZEV buyers. Nissan and Ford were the only PZEV sellers, while Mercedes and Jaguar were among PZEV buyers.

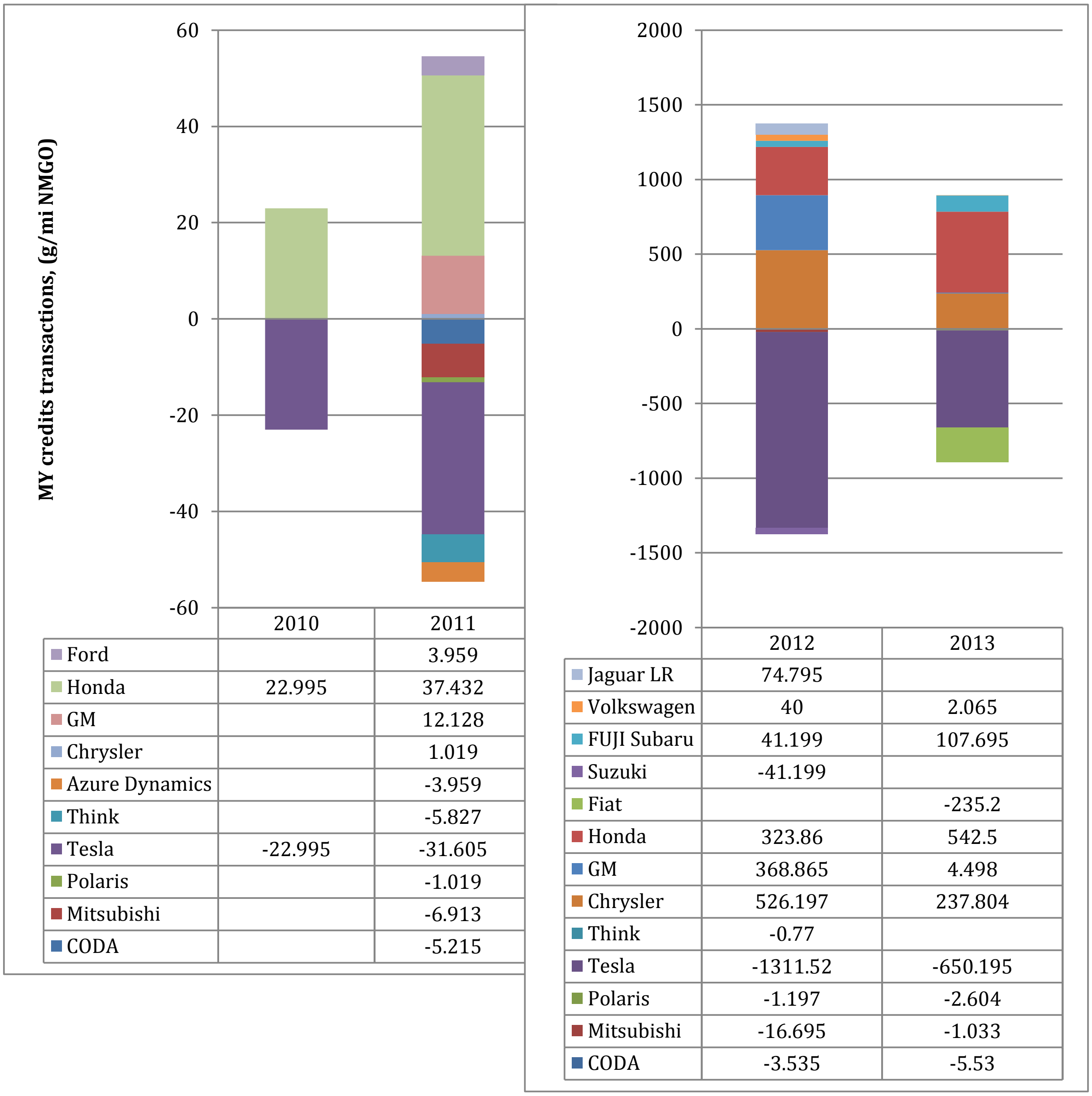
Table 13: ZEVs and PZEVs transactions for MY 2013 period and Sep 2013 credits balance

	2013 binding requirement (LVM, IVM, or 0)	2013 Production Volume	ZEV transactions and balance, 2013			PZEV transactions and balance, 2013			Total balance
			ZEV out	ZEV in	ZEV balance	PZEV out	PZEV in	PZEV balance	
CODA	0	N/A	5.53	0	0	0	0	0	0
Fiat	0	N/A	235.2	0	0	0	0	0	0
Ford	LVM	215,277	0	0	1014.6	38.7	0	1414.5	2429.2
Mitsubishi	0	N/A	1.033	0	1.855	0	0	51.3	53.2
Nissan	LVM	143,535	0	0	1382.8	663.6	0	439.4	1822.3
Polaris	0	N/A	2.604	0	0	0	0	0	0
Tesla	0	N/A	650.1	0	221.55	0	0	0	221.5
Chrysler	LVM	125,542	0	237.8	580.2	0	0	0	580.2
FUJI Subaru	IVM	36,167	0	107.6	148.8	0	0	168.4	317.3
GM	LVM	175,583	0	4.4	1114.8	0	0	1690.6	2805.5
Honda	LVM	234,349	0	542.5	1713.9	0	0	1234	2947.9
Jaguar LR	IVM	11,477	0	0	74.7	0	38.738	0	74.8
Mercedes	IVM	68,717	0	0	183.1	0	663.6	532.7	715.9
Volkswagen	IVM	96,405	0	2	41.96	0	0	152.6	194.5
BMW	IVM	87,255	0	0	24.3	0	0	0	24.3
Hyundai	IVM	120,599	0	0	31.3	0	0	579.1	610.4

KIA	IVM	72,664	0	0	8.54	0	0	266.1	274.7
Toyota	LVM	368,909	0	0	855.5	0	0	7910.4	8765.9
Mazda	IVM	30,719	0	0	0	0	0	133.1	133.2
Volvo	0	N/A	0	0	0	0	0	127.9	127.9
Zipcar	0	N/A	0	0	0	0	0	38.5	38.5
Total		1,787,198	894.5	894.5	7398.5	702.3	702.3	14739.2	22137.8

Note: Consider previous MY transactions where balance appears yet no transactions in or out appear for MY2013; Calculations of credits per vehicle produced depends on the vehicle model characteristics and its CARB approved credits adequacy.

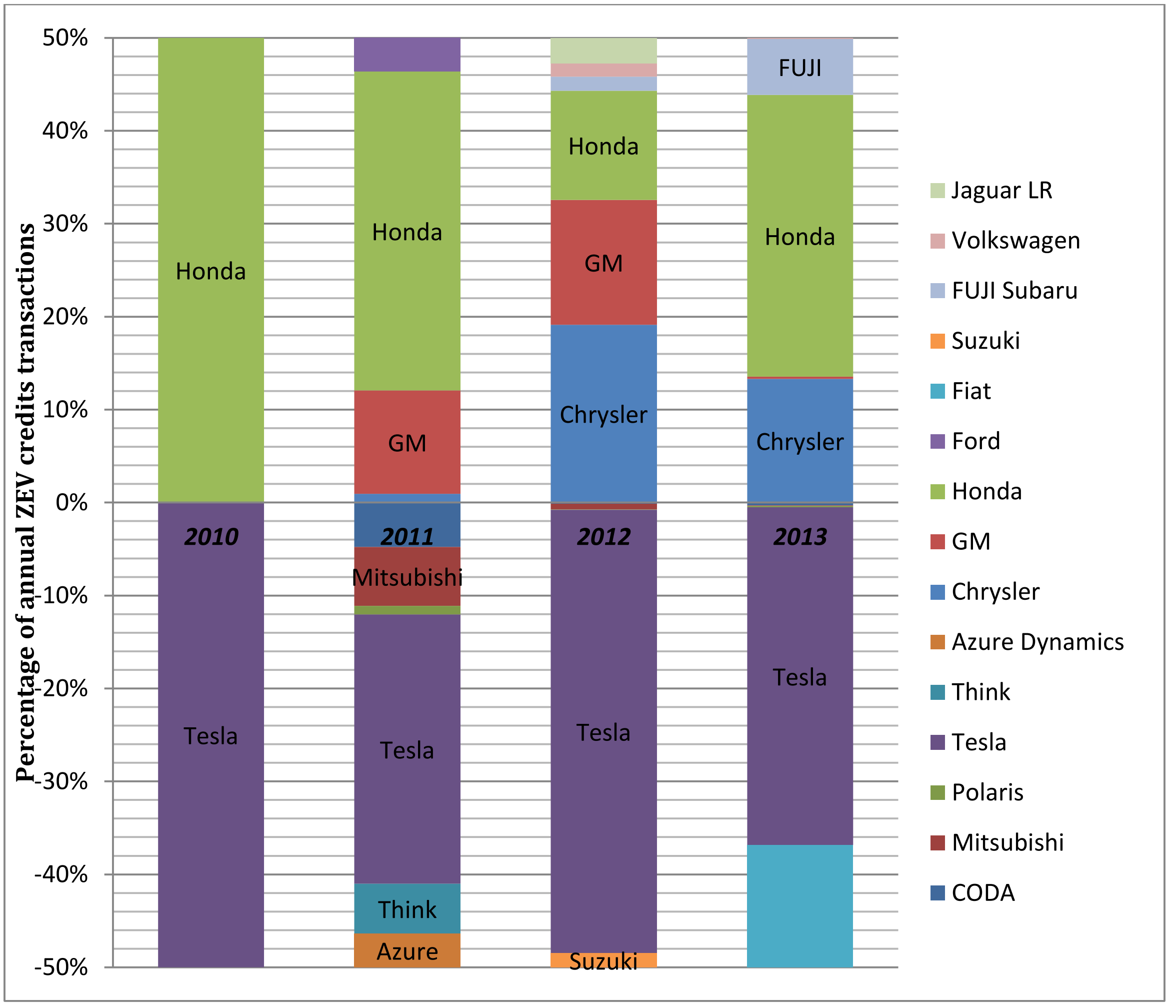
Figure 18: Annual trends of ZEV credit (excluding all PZEVs) transfer



	2010	2011
Ford		3.959
Honda	22.995	37.432
GM		12.128
Chrysler		1.019
Azure Dynamics		-3.959
Think		-5.827
Tesla	-22.995	-31.605
Polaris		-1.019
Mitsubishi		-6.913
CODA		-5.215

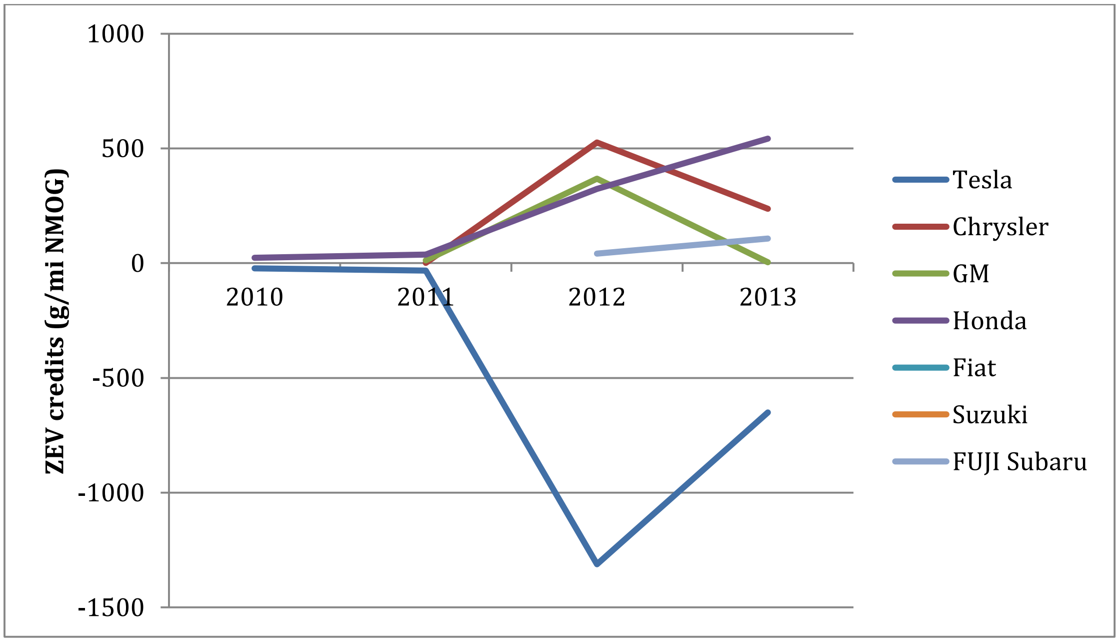
	2012	2013
Jaguar LR	74.795	
Volkswagen	40	2.065
FUJI Subaru	41.199	107.695
Suzuki	-41.199	
Fiat		-235.2
Honda	323.86	542.5
GM	368.865	4.498
Chrysler	526.197	237.804
Think	-0.77	
Tesla	-1311.52	-650.195
Polaris	-1.197	-2.604
Mitsubishi	-16.695	-1.033
CODA	-3.535	-5.53

Figure 19: Annual trends of ZEV credit transfer (excluding all PZEVs) by company percentage



Note: Companies with credits below the scale are major credit sellers, and those above the scale are major buyers of credits over the years; Out of 15 companies involved in ZEV credit transactions, ten have made significant relative contributions over the years – four major buyers (Honda with cumulative 927, Chrysler with 765, GM with 385, and Fuji with 149) and six sellers (Tesla with cumulative 2016, Fiat with 235, Suzuki with 41, Mitsubishi with 24, Coda with 14).

Figure 20: Annual contribution of major ZEV credit-transferring companies (excluding all PZEVs credits)



Note: Companies with credits below the scale are major credits sellers, and those above the scale are major buyers of credits over the years; Only the seven major companies active in the credit trading market are outlined here (over the years, 21 companies have been directly involved in transactions of credits).

3.2.2 Tesla Motors Inc. case study

Tesla Motors Inc. (hereafter "Tesla"), a California-based innovative electric vehicles and electric power-train components designer and manufacturer established in 2003, is one of very few global PEV companies that are on the course of reaching market maturity and financial sufficiency. As a public company since 2008 and registered on the Nasdaq stock exchange (*TSLA*), Tesla offers transparency in its financial and operational information. The case of Tesla is therefore a unique Californian PEV story that could be learnt from, offering traceable financial records and elaborative strategic planning through which the ZEV scheme's market influence could be assessed.

Since the financial data publically released by Tesla typically doesn't make a distinction between the federal (national) GHG credit scheme and the California-grown ZEV credit scheme, this analysis assumes a majority of ZEV credits and treats the publically declared general credit figures as representative of the ZEV credits scheme credits. As of 2013 annual financial report filed in February 2014, Tesla started reporting the total revenues from ZEV credits specifically, however doesn't specify from what geographies. Furthermore, as credit inventories are reported by CARB not by the fiscal calendar year but rather between the period of October 1 and September 30 of each year, a monthly average is used for tracing Tesla's periodic earnings from ZEV credits.

3.2.2.1 Company introduction

Tesla Motors Inc. was incorporated in 2003 in California by several entrepreneurs. Elon Musk, an inventor and investor who joined Tesla's Board of Directors as its Chairman in 2004, was very involved in the companies' production and operations, and became the companies' CEO in early 2008. The company, in its quest to accelerate the shift to electric vehicles, designs, develops, manufactures and sells high-performance fully electric vehicles and advanced electric vehicle powertrain components.

Tesla Motors is unique as it is the only stand-alone global electric vehicle manufacturer, the company that introduced the first commercially certified EV in the US, and manufacturer of the world's highest range EV (of 425 km) on the new EPA 5-cycle test. Tesla Motors is considered an EV market leader. In 2007, General Motors' Vice Chairman Robert Lutz claimed that the Tesla Roadster inspired him to push GM to develop the Chevrolet Volt, a plug-in hybrid sedan[45]. In 2009 Germany's Daimler AG, maker of Mercedes-Benz, acquired an equity stake of less than 10% of Tesla (for a reported US$50 million) and in 2010, Tesla signed a strategic partnership with Toyota, which purchased US$50 million in Tesla common stock. These automaker engagements exemplify the company's robust positioning in the vehicle market.

Tesla Motors was registered on the Nasdaq stock exchange (*TSLA*) as soon as 2010, on the same year it started selling its first vehicle, raising as much as $265 million. This IPO was the second American auto manufacturer IPO on the Nasdaq exchange since Ford's 1956 IPO. Its public filings are providing insight over the company's strategic planning, its

[45]http://www.newsweek.com/bob-lutz-man-who-revived-electric-car-94987

predictions and periodical outcomes. The company has raised another $415 million in seven funding rounds between 2004 and 2010.

Tesla Motors expanded to markets outside of the US in 2010, commenced sales in Europe and Asia in 2012, and started selling its vehicle in China in early 2014. The company has over 5,800 employees and operates in 116 locations including North America, Europe and Asia.

3.2.2.2 Market penetration: challenges and strategy

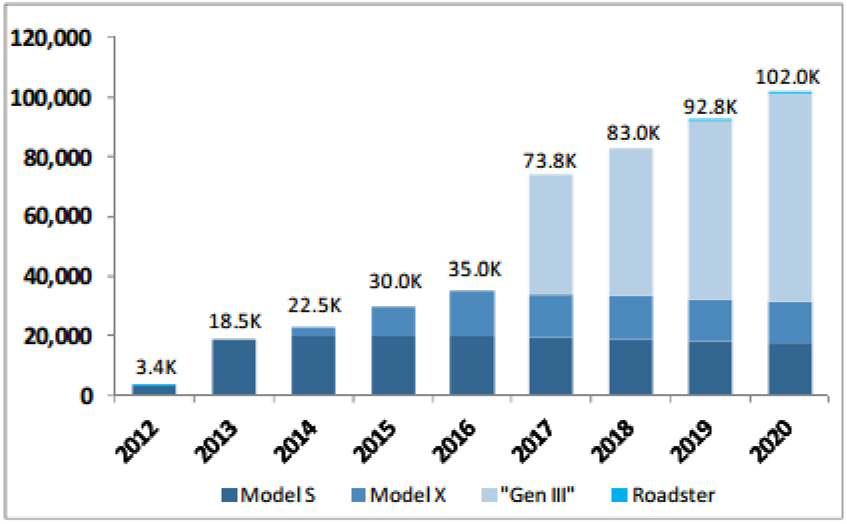
Being an entirely new auto manufacturer in a well-established capital-intensive and very competitive industry, Tesla had to create a strategy that enables it to carefully reach economies of scale. Such a strategy required cost-effective development with minimum expenses and as little waste. This means secured demand and slow development that will improve alongside consumer experience feedback and upstream production improves (e.g. battery).

Tesla Motors penetrated the vehicle market and became considered as a leader in the pure electric vehicle (PEV) market utilizing the following unique business strategy: Tesla targeted premium car consumers in its first phase, then enabled vehicle leasing options to a wider variety of consumers, and finally announced it would introduce models for the mass market. This enabled limited high-quality production that gears up as company credibility and market positioning strengthens.

In order to internalize its strategy, Tesla started off by introducing a single premium sports-car model, the Roadster, available at the market price of $128,500 (before tax reliefs). This relatively high selling price has narrowed the spectrum of potential buyers' to mainly vehicle collectors and early adopters from high socio-economic status, reaching a moderate total production volume of 2,500 after nearly 4 years. The second vehicle, Model S, had picked with sales of about 25,000 within just 18 months since its market introduction in mid-2012. Model S sales volume comprised about 70% of all plug-in sales[46], and was made available for the approximate price of$82,000 (and over $55,000 after tax relief). Model X, a crossover model adapted from the platform of its predecessor Model S, is expected to become available in 2015, addressing consumers of other taste and preferences. A Gen III electric car is planned to be developed and sold at lower cost, estimated at around $30,000[47], and higher volumes in the coming years.

[46] Based on estimations provided the Electric Drive Transportation Association (EDTA): http://electricdrive.org/index.php?ht=d/sp/i/20952/pid/20952
[47]http://onpoint.wbur.org/2009/09/25/teslas-elon-musk-on-a-sub-30000-electric-car

Figure 21: JPM TSLA Vehicle Production Volume Forecast (2012E-2020E)



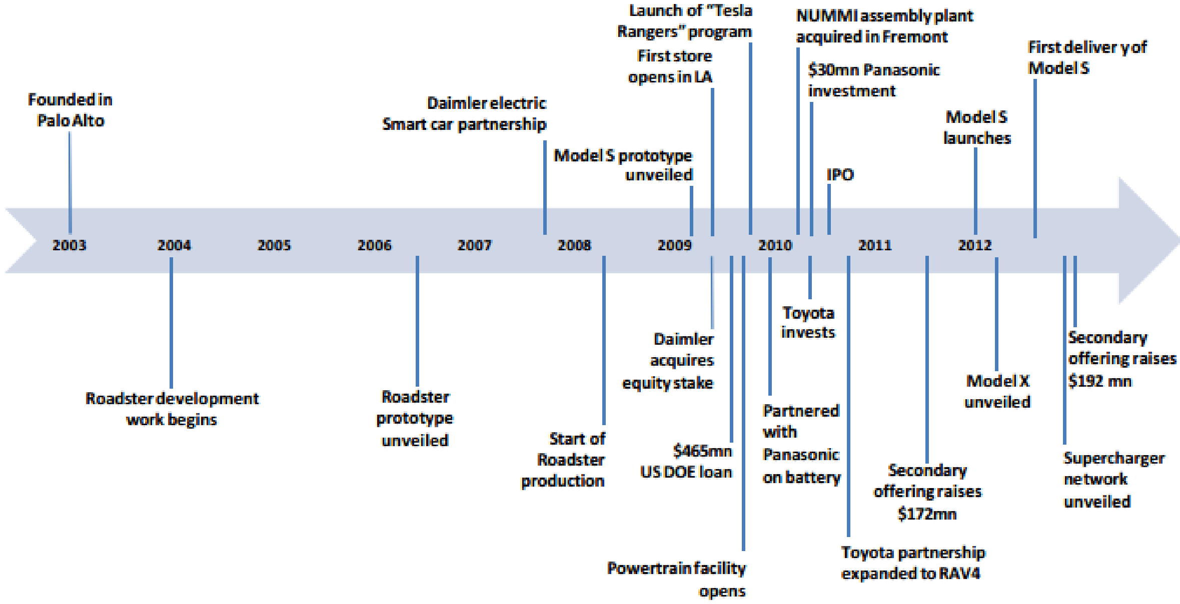
Source: J.P.Morgan, 18 December 2012, Tesla Motors, North America Equity Research, p.8

The development cost and associated risks were reduced by focusing on a single model at first, which was improved twice in each of the following years. Marketing expenses were minimal and so were costumer service efforts. On the risks front, by providing electric powertrain services and components to the well-established conservative auto manufacturers (e.g. Daimler AG, Toyota) Tesla was able to secure stable income channels, gain market credibility based on which consumers and investors' trust was built (as well as other stakeholders' trust, such as suppliers and analysts) and impact the electrification of the auto market.

Influencing the vehicle market and leading auto electrification is recognized as key factors in paving a path towards market stability should a standardize system develop around electric vehicle and powertrain components, creating economies of scale that will in turn further accelerate market demand. In 2009, GM's former Vice Chairman Robert Lutz was quoted in the *The New Yorker*: "All the geniuses here at General Motors kept saying lithium-ion technology is 10 years away, and Toyota agreed with us – and boom, along comes Tesla. So I said, 'How come some tiny little California startup, run by guys who know nothing about the car business, can do this, and we can't?' That was the crowbar that helped break up the log jam."[48]

[48]http://www.newyorker.com/reporting/2009/08/24/090824fa_fact_friend

Figure 22: Tesla major developments timeline (2003-2012)



Source: J.P.Morgan, 18 December 2012, Tesla Motors, North America Equity Research, p.7

After the introduction of the vehicle, Tesla started developing its supporting infrastructure solutions (e.g. battery private/public charging and battery switch) and software solutions (e.g. range predictions and in-car updates). The company has also developed a unique and independent sales method that required further resources and multiple risks, catering for its ambition to lead the new vehicle market, avoid direct competition in other sedan vehicles' (e.g. Audi, BMW, Lexus and Mercedes) sales channels, and maintain close connection to its consumers. These efforts resulted in negative gross revenue margins over the second half of 2012.

In order to allow for its expensive design, development, procurement, and sales, Tesla relied on receiving pre-announced ZEV credits, sales of its electric powertrain components, the financial market (since 2008), as well as pre-orders and down payments. In its 2012 financial filing report, it stated that its revenues and gross margins would be impacted by the following factors: Models S sales at the projected price, commodity-related costs, planned cost reductions, and selling regulatory credits to other vehicle manufacturers. The report emphasizes that any inability to sell credits may result in financial losses in the short term.

3.2.2.3 ZEV contribution to Tesla's market stabilization

As a manufacturer solely of zero-emission vehicles (Pure Electric Vehicles), Tesla was able to earn ZEV credits for each of its sold vehicles (sold in the US) and was qualified for selling these credits to other manufacturers. It has therefore entered into agreements with auto manufacturers as early as 2008 when its first vehicles were sold and its first credits were earned, and enjoys a guaranteed income from selling ZEV credits at a pre-determined price.

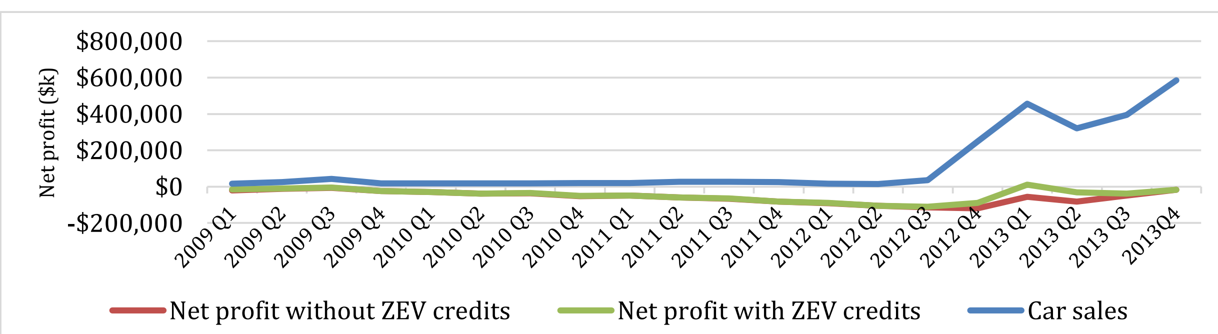
Tesla's revenue divide by vehicle and options sales, powertrain components and related sales, and ZEV (including federal GHG sales) revenues for the last 6 years of annual financial reporting are shown in **Table 14**.

Table 14: Tesla's 2008-2013 annual ZEV credits n the context of revenues and cost

	2008	2009	2010	2011	2012	2013
Total Revenue ($k)	$14,742	$111,943	$116,744	$204,242	$413,256	$2,013,496
Total cost of revenue ($k)	$15,883	$102,408	$86,013	$142,647	$383,189	$1,557,234
Gross profit ($k)	-$1,141	$9,535	$30,731	$61,595	$30,067	$456,262
Credits revenues ($k)	$3,500	$8,200	$2,800	$2,700	$40,500	$194,400
Detailed Breakdown						
Auto sales revenues ($k)	$11,242	$103,355	$72,659	$99,008	$313,844	$1,758,284
Powertrain sales revenues ($k)	$0	$388	$21,619	$46,860	$31,355	$45,102
ZEV Credits revenues ($k)	$3,500	$8,200	$2,800	$2,700	$32,400	$129,800
Other credits revenues ($K)	$0	$0	$0	$0	$8,100	$64,600
Development services revenues ($k)	$0	$0	$19,666	$55,674	$27,557	$15,710
Automotive sales costs ($k)	$15,883	$102,408	$79,982	$115,482	$371,658	$1,543,878
Development services costs ($k)	$0	$0	$6,031	$27,165	$11,531	$13,356
Net profit ($k)	**-$82,782**	**-$55,740**	**-$154,328**	**-$254,411**	**-$396,213**	**-$74,014**

In its 2012 financial disclosure, Tesla recognized that the sharp increase of some 350% in gross revenues from car and credit sales was derived by ZEV credits. **Figure 23** exemplifies the strong connection between Tesla's credits allowances internalized in the first half of 2013 and its shift from net loss to net profitability.

Figure 23: ZEV Credits Drove Tesla's Net Profitability

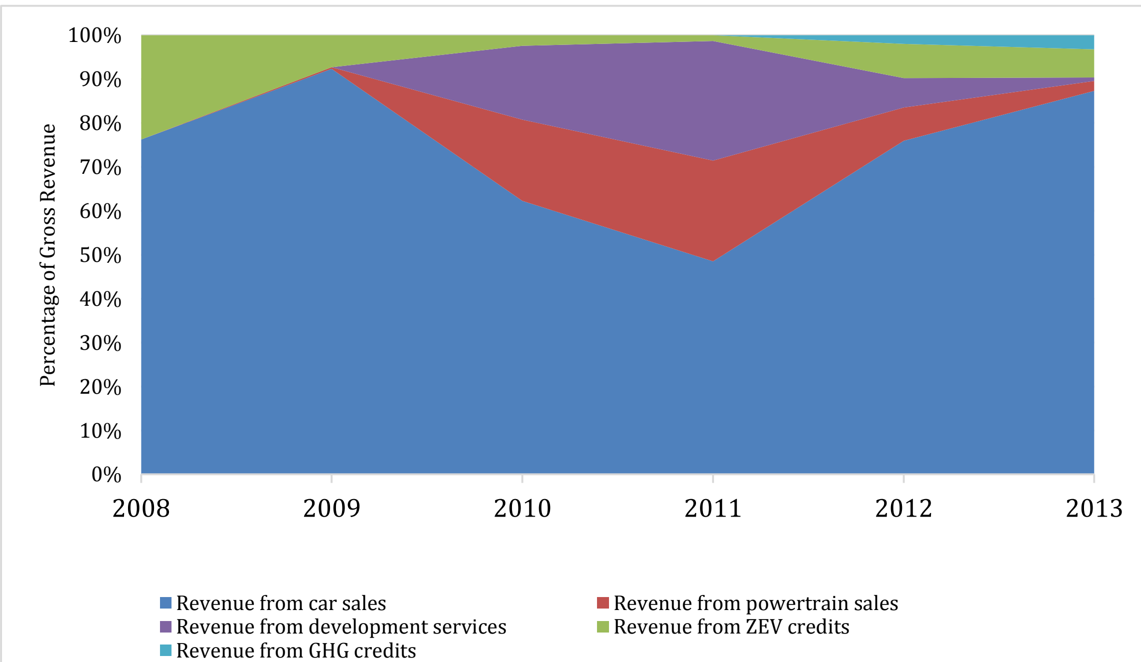


3.2.2.4 ZEV credits' role in Tesla's product development

Since credits are agreed upon in the beginning of the physical year, they play a crucial role in Tesla's development – the company can rely on this income stream when rolling out its research, marketing and other development activities, without which it may be "stuck" with limited and "outdated" products which in turn, as Tesla recognizes, would diminish its competitive edge and market penetration efforts (Tesla Motors, Inc., 2013)[49].

Figure 24 illustrates the portion of ZEV credits out of the total annual revenue sources of Tesla over the past five years. Vehicles ordered in 2007 have only been delivered as of February 2008 therefore no credits were internalized in 2007. As the sale of credits was negotiated and agreed upon throughout 2007, in 2008 already $3.5 million ware transferred to the company from its ZEV-credits trading partners. The total value of credits represented close to 25% of the company's total revenue and 307% of the company gross profit for that year.

Figure 24: ZEV Credits Drove Tesla's Net Profitability



The revenue from credits in 2008 has enabled the company to engage in powertrain deliveries to mature and leading auto manufacturers, commencing in 2010 with shipments of batteries and chargers as part of Daimler's Smart for Two and A-class program. A more detailed analysis shows that this first batch of credit value internalized by Tesla could have covered the cost of about 350 battery packs of 60 kWh (assuming the battery cost is of about $200 per kWh or $10,000 a pack upon large volume supply).

[49] Tesla Motors Inc. 2012 Annual Financial Disclosure, p.27.

The following year, Tesla received $8.2 million for the sale of its ZEV credits. This time, the total value of credits represented only 86% of the company's 2009 gross profit. This could imply that the company has internalized the value of anticipated credits throughout the year via product enhancement towards the shift to commercial production of the Tesla's second awaiting product, Model S. Alternatively, the total value of the company's 2009 earned credits could have covered 136% of the following year's (2010) development services costs, amounting to over $6 million. Therefore, the credits could have enabled Tesla to meet the obligations of service agreement with leading automakers.

In 2011, the production of the Roadster had ceased, making its way to commercial production of Model S, which is rated better thanks to its advanced features and higher score on the ZEV credits application. Tesla's new 85 kWh version of the Tesla Model S (hereafter refers to as S85) was reclassified from a Type III zero-emissions vehicle to a Type V on October 12th 2012 due to its battery swap capacity[50]. The reclassification increased the number of ZEV credits Tesla got per each S85 vehicle from 4 to 7, as detailed in **Table 15**.

Table 15: Tesla's vehicles eligibility for ZEV credits

Vehicle	Features	Type	Credits	Dated	Comments
Roadster		Type III	4	2008	If Range: > or = to 100 miles (160km) than – Refueling: Must be capable of replacing 95 miles (UDDS ZEV range) in ≤ 10 minutes per section 1962.1(d)(5)(B) If Range: > or = 200 miles (320km) than – Refueling: N/A
Model S 60 kWh battery pack	208miles (EPA 5-cycle) /230miles (est.), optional supercharging	Type III	4	June 15, 2012	
Model S 85 kWh version	265miles (EPA 5-cycle) /300miles (est.), supercharging included, battery switch included	Type V	7	October 12, 2012	Range: > or = to 300 miles (480km); Refueling: Must be capable of replacing 285 miles (UDDS ZEV range) in ≤ 15 minutes per section 1962.1(d)(5)(B)
Model S 85 kWh version Performance	265miles (EPA 5-cycle) /230miles (est.), supercharging included				
Model X 60 kWh battery pack		Type V	4-7	Est.	
Model X 85 kWh version		Type V	4-7	Est.	

Tesla's technology improvements in its second vehicle model allowed it to gain more credits for such car sold in the ZEV geographies while expanding its other non-switchable battery Model S models elsewhere without harming the total amount of credits in gained per quarter. In other words, new innovation was rewarded allowing for the company to expand

[50]http://www.arb.ca.gov/msprog/onroad/cert/pcldtmdv/2012/tesla_pc_a3740006r2_0_z_e.pdf

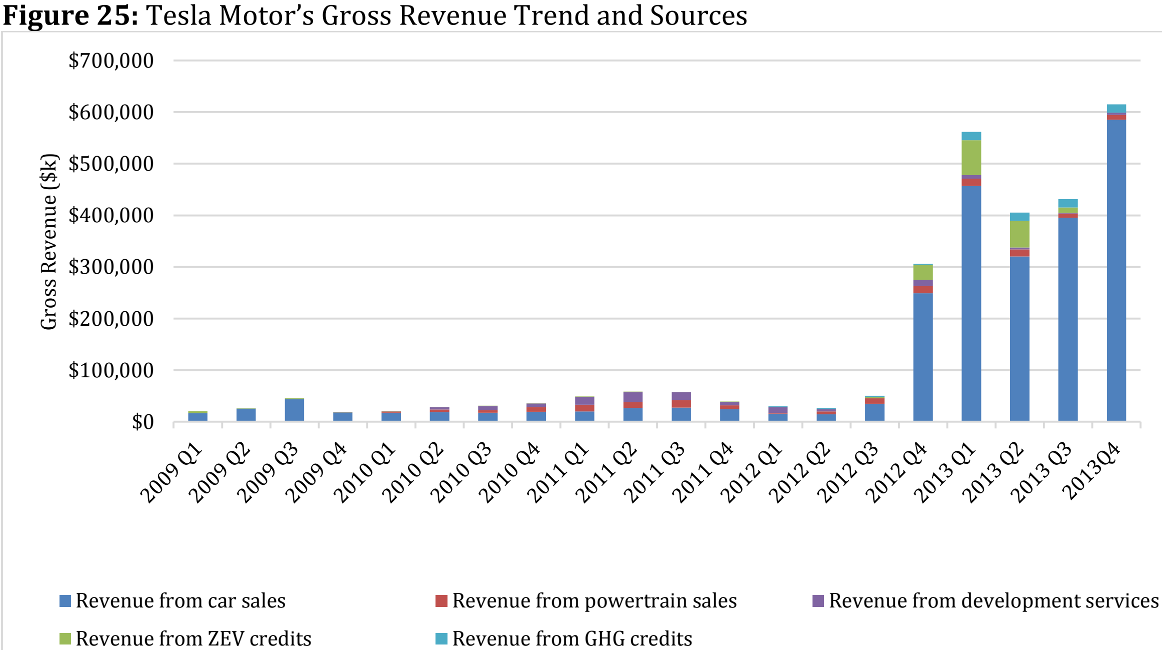
its market outreach without compromising on its potential gains within the ZEV-credits scheme geography.

Therefore, although limited remaining stock of the legendary Roadster was dedicated to markets outside of the US with no entitlement for ZEV credits, 2012 marked an annual growth increase in revenues all across the company's resource components – vehicle and options sales, components and related sales, as well as credits. These revenue sources increased as Tesla started delivering its Model S sedan in the US, as planned[51]. Not only Tesla has reached a more diverse and mature production line, it has also been able to stay financially viable thanks to its Model S sales in the geographical boundaries of the ZEV-credits scheme.

3.2.2.5 ZEV credits' role in Tesla's market expansion

Not surprisingly, Tesla seems to have been influenced year after year by the target markets of its annual car sales via loss of credits. For instance, Tesla states that its 2010 market loss is linked to its entrance to "higher average selling prices outside of the US"[52]. There is a clear advantage, created by the ZEV scheme, in selling vehicles within the scheme's geographical boundaries. However, for a premium product, geographical restriction creates a limited annual consumer growth potential. This contentment may explain the sharp increase in sales from the fourth quarter of 2012 as the Model S became available, and a further sales increase with less ZEV credits income already in the third quarter of 2013, as demonstrated in **Figure 25**.

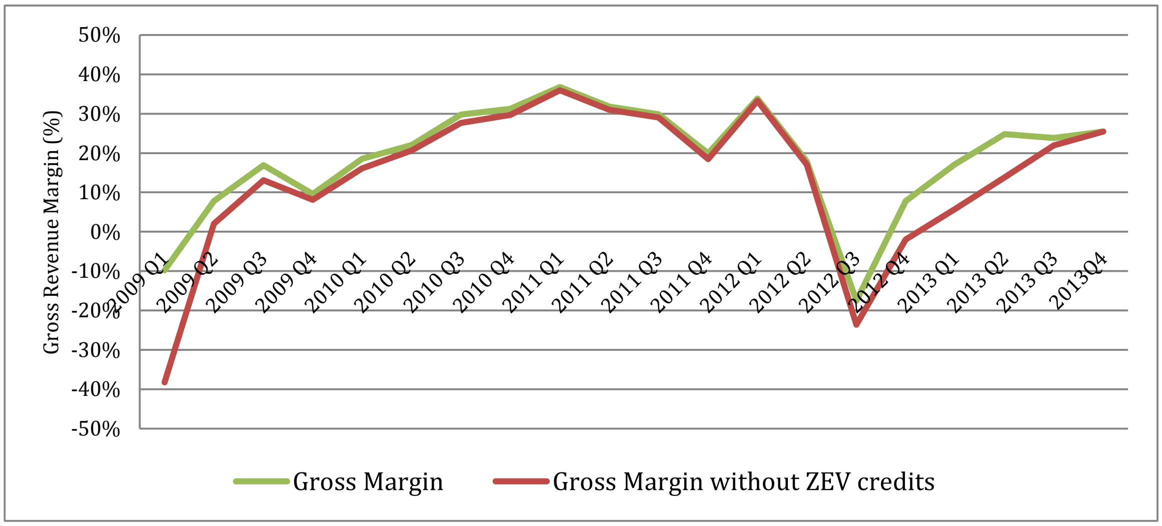
Figure 25: Tesla Motor's Gross Revenue Trend and Sources



51 Tesla Motors Inc. 2012 Annual Financial Disclosure, p.7.
52 Tesla Motors Inc. 2010 Annual Financial Disclosure, p.91.

Tesla's income from the ZEV credits in 2008 and 2009 allowed it to expand abroad while increasing its gross margin. In 2010 the company started selling abroad, and in late 2011, it had shut down its Roadster production and targeted the global market for its remaining stock sales. However, between 2010 and 2011, as Tesla expanded outside of the US (mainly EU and Asia), it received less credits per vehicle sold and experienced unchanged and decreased margin, as illustrated in **Figure 26**.

Figure 26: The ZEV Credits Impact on Tesla's Gross Margin

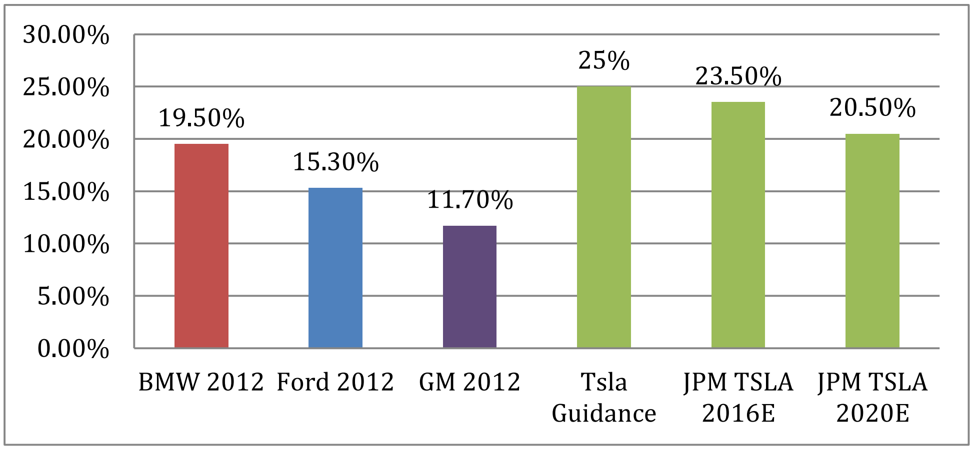


Tesla's $40.5 million revenues from credits in 2012, the largest to that date, could have covered 27% and 14% of the company's general expenses beyond its automotive and development services for 2012 and 2014, respectively. This secondary cost stream, excluded from its direct gross margin, is assumed to include its marketing and business development efforts outside the US. Therefore, Tesla's 2012 credit revenues could have contributed much to the company's ability to expand globally and reach sales in highly cost-driven markets such as Asia. Even the company's relatively low revenues from credits in 2011, amounting $2.8 million, could have covered for over five years of rent cost of the company's office and showroom in Beijing (assuming Tesla's 737 sqm located in the capital's CBD is rented at a modest cost of 12RMB/sqm/day).

3.2.2.6 ZEV credits' role in Tesla's financial market robustness

As illustrated in **Figure 26**, the ZEV credits impact on Tesla's gross margin is significant, enabling the company to reach a whopping margin of 25% in the last quarter of 2013, overtaking Ford's 15.5% and General Motors' 12% gross profit margin. The ZEV credits accounted for up to 125% of the company's gross revenue over the past five years specifically in relation to the automotive market, and projected to continue as illustrated in **Figure 27.** As gross margin is often used by analysts from the financial market, the ZEV-credits arguably made an important contribution to the company's stock valuation and subsequently influenced its liquidity (as discussed in previous product development and market expansion sections).

Figure 27: TSLA Gross Margins vs. Automaker Peers

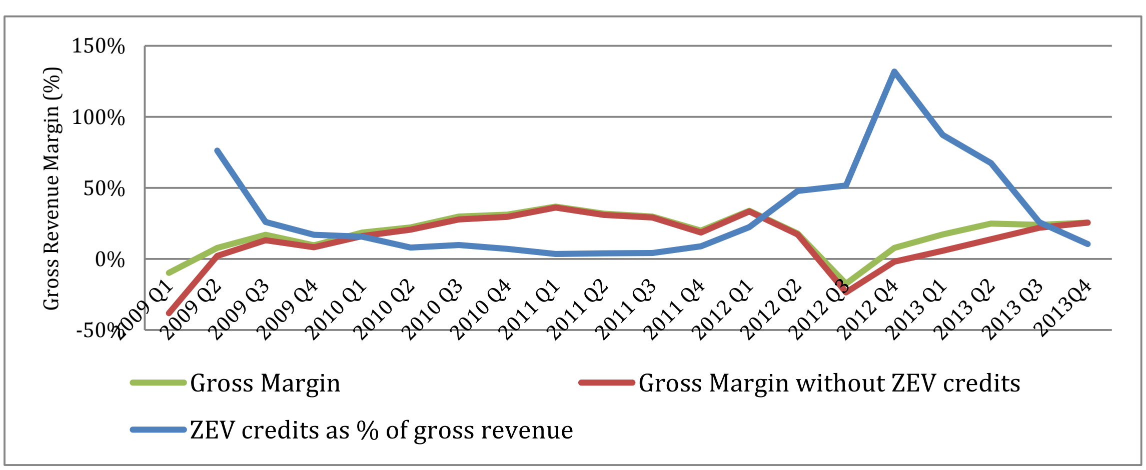


Source: J.P.Morgan, 18 December 2012, Tesla Motors, North America Equity Research, p.22

As further illustrated in **Figure 29**, the company registered on the Nasdaq under the symbol TSLA, has a market capitalization of nearly $25 billion, slightly less than half of General Motors Co's (GM.N) $57.7 billion market cap[53] (and nearly 100 times its initial IPO funding round). Tesla's weekly stock sales were relatively high in early 2010 despite the decline in vehicle sales, and have picked up again in 2013 as its first year half ZEV credits sky-rocketed $119 million, accounting for 77% and 386% of its gross and net profit, respectively. JP Morgan stated in its Tesla 2013 fourth quarter evaluation brief that "4Q execution was strong, lending credence to management outlook for higher 2014 gross margin exit run-rate. TSLA met its long-standing 25% 4Q13 gross margin guidance (widely not believed prior to 3Q earnings), reporting 25.2% excluding ZEV credits"[54]. Furthermore, Tesla was the top performer on the Nasdaq100 index in 2013[55].

In congestion to the company's statement of zero ZEV credits anticipation for the last annual quarter, and despite the fact it had projected solid sales of its Model S vehicles throughout the year end, the company stock fell in October 2013. In November, news over a fire in a Tesla vehicle had also influenced the company's stock. Later on, as the annual filing was published, the stock went up again, this time on the premise that the company had reached market maturity and gained significant revenues despite the decrease in ZEV credits towards the year end.

Figure 28: The ZEV Credits Impact on Tesla's Gross Margin



Source: http://www.nasdaq.com/symbol/tsla/interactive-chart

Not surprisingly, there is a heated debate among auto industry experts and investors over whether Tesla's sky-high valuation is justified, and how dependent the company is on government credits (ZEV, GHG, CAFE). However, as credits have shrunk toward the end of 2014 and gross margin grew; many analysts recommended the company's stock[56].

3.2.2.7ZEV credits' role in Tesla's business development

In the first quarter of 2013, Tesla reached profitability for the first time while credits accounted for 604% of its profit (and 87% of its gross margin) as exemplified in **Table 16**. In Tesla's 2013 first half-year disclosure, it recognized $119.4M in ZEV credits sales that have largely contributed to the company's gross margin growth. These credits have become available as Tesla's new model S sales in the eligible areas have ramped up to over 5k per quarter. Tesla projected it will meet the pre-planned production capacity of over 20k vehicles in 2013[57] and have delivered over 25,000 Model S vehicles by the end of 2013 in North America and Europe[58].

[56]http://www.forbes.com/sites/markrogowsky/2014/02/20/bear-clawed-how-tesla-keeps-crushing-the-naysayers/
[57]Tesla Motors Inc. 2013 3rd Quarter Financial Disclosure, p.23.
[58] Tesla Motors Inc. 2014 Annual Financial Disclosure, p.4.

Table 16: 2013 quarterly ZEV credits as part of revenues and profits

Indicator	2013 Q1	2013 Q2	2013 Q3	2013 Q4	Accumulated
Car sales ($k)	$456,733	$320,620	$395,454	$585,477	**$1,758,284**
Powertrain sales ($k)	$14,420	$13,265	$8,192	$9,225	**$45,102**
Development services ($k)	$6,589	$3,604	$1,150	$4,367	**$15,710**
ZEV Credits ($k)	$67,900	$51,500	$10,400	$0	**$129,800**
Other Credits ($k)	$16,150	$16,150	$16,150	$16,150	**$64,600**
Total Revenue ($k)	$561,792	$405,139	$431,346	$615,219	**$2,013,496**
Automotive sales ($k)	$461,818	$303,599	$324,883	$453,578	**$1,543,878**
Development services ($k)	$3,654	$1,057	$3,595	$5,050	**$13,356**
Total cost of Revenue	$465,472	$304,656	$328,478	$458,628	**$1,557,234**
Gross profit	$96,320	$100,483	$102,868	$156,591	**$456,262**
Gross margin (%)	17%	25%	24%	25%	**23%**
Revenue growth (%)	83%	28%	6%	43%	**40%**
Profit growth (%)	113%	371%	26%	58%	**113%**
Credits/Total Revenue (%)	12%	13%	2%	0%	**7%**
Credits/Revenue from car sales (%)	15%	16%	3%	0%	**7%**
Credits/Gross profit (%)	87%	67%	26%	10%	**48%**
Net profit	$11,248	-$30,502	-$38,496	-$16,264	**-$74,014**
Credits/Net profit (%)	604%	169%	27%	0%	**-100%**

Tesla has also repeatedly stated in its 2013 quarterly reports that should its current and future models (e.g. Tesla model S and model X) fail to be eligible for saleable credits due to regulatory adjustments, or due to its expenditure in sales outside the regulatory scheme boundaries, its revenues and margins will be negatively impacted and "may negatively impact our ability to reach or maintain profitability in the short term"[59]. In its annual report, Tesla stated that "over 90% of ZEV credit sales were recognized during the first half of 2013". The company also stated to "expect the contribution of ZEV credit revenue to remain low in the future relative to our automotive sales as we continue to grow our sales outside the United States"[60]. However the company has also stressed that it has reached a stage in which its business model no longer relies on these credits, a contentment that is well demonstrated in the above **Table 16**.

Tesla's future revenues from ZEV credits sales will depend not only on the number of credits it sells but also on their market value fluctuations, which is determined through negotiations between the company and its credits' buyers and therefore dependent upon tensions in the credit market supply and demand. As new geographies enter the ZEV-credits

[59] Tesla Motors Inc. 2012 Annual Financial Disclosure, p.31.
[60] Tesla Motors Inc. 2013 Annual Financial Disclosure, p.68.

program, Tesla's revenues from car sales outside California and within the US will grow as so may its bargaining power. As the regulation evolves and introduces more stringent requirements for eligibility, Tesla's pool of credits, which led the chart in recent years, may shrink in the absence of adequate innovation.

3.2.2.8ZEV credits' value in the case of Tesla

The value of credits is not publically disclosed and determined according to market forces and negotiated between the buyer and sells of credits. This section attempts to hint at possible past and future values of Tesla's ZEV credits, however the below figures suggested below are not officially approved and may not reflect the real market value of credits.

In 2010, Tesla disclosed selling credits to Honda for 491 vehicles sold in 2009 and 2010 for $11M. This implies that Tesla internalized an average of about $22k for each vehicle sold during that year in ZEV credits, which represents about 35% of vehicle price to consumer after federal tax relief. In Tesla's first quarterly report of 2011 the company disclosed that 521 of its vehicles sold were granted credits that were purchased by Honda. It also stated that its ZEV-credits revenues were $600,000. If no other credits were issued and sold during that period, a raw estimate of about $1,500-3,500 was provided per vehicle credit.

As of its second quarter filling of 2011, Tesla began reporting its revenues from credits on a quarterly basis rather than on an annual basis, however mentioned it had entered a third contract with another company for selling its 2012 Model S ZEV-credits excesses. As of 2012, the company also started reporting revenues from GHG credits without any specifications. In 2013, the company resumed more detailed ZEV credits financial filing, however the value of credits is not fixed nor stated directly by any party of the agreement of government authorities.

At the last quarter of 2013, Tesla has kept an inventory of 276 ZEV-credits that can be internalized by the end of CARB inventory year ending October 1st 2014, along with vehicle sales from October 1st 2013 to that date. Assuming Tesla's Model S sales in the ZEV-credits geography areas will remain the same (about 4k per quarter) and the estimated market value per credit will remain around $3.5k ($5k is the penalty ballpark), market analysts suggest Tesla may be able to enjoy revenues of over $90 million from ZEV credits per quarter[61].

3.3 ZEV-credits qualitative evaluation

3.3.1 Key stakeholders interviews

This section presents the results of a qualitative analysis conducted through interviews with CARB representatives (**Table 17**). The qualitative study results are grouped around several major themes designed to provide in-depth understanding of the ZEV-credits design, revisions, management, and implementation issues.

[61]http://wattsupwiththat.com/2014/03/12/analysis-tesla-may-have-made-over-100-million-off-the-carb-enabled-battery-swap-scheme/

Table 17: CARB ZEV-Credits Key Experts Interviewed

Interviewee	Position	Date	Method
CARB Representative	Executive Officer	July-August 2014	Email correspondence
Tom Cackette	Retired, CARB's ZEV designer and expert since 1990	August 2014	Phone interview
Michael Walsh	Retired, CARB expert	June 2014	Meeting Interview

As ARB conducts an extensive public process in any rulemaking activity, all stakeholders have the ability to comment on staff proposals before and during the ARB rule adoption. The qualitative analysis also makes use of public hearings and stakeholder meetings materials to understand the processes, concerns and considerations that have taken place through the ZEV design. Other experts considered for the qualitative analysis are detailed in **Table 18.**

Table 18: CARB ZEV-Credits Key Experts

Role	Experts
Development of the LEV regulation	Paul Hughes, Steve Albu, and Bob Cross
Drafting and Structure of the LEV regulation	Sarah Carter
On-going updates, modifications, and restructuring of the ZEV regulation	Tom Cackette, Chuck Shulock, and Analisa Bevan

3.3.1.1 Underlying ZEV-credits design considerations

The ZEV credits scheme was initially aimed at combating air pollution. As such, it was placing emphasize on the promotion of alternative vehicles that could make contribution to air quality improvement. However, as energy saving technologies quickly emerged as a quicker and more impactful immediate solution, the ZEV scheme received a renewed and more pivotal role in California's vehicle regulatory landscape after Climate Change became an important part of the state's agenda.

"Alternative fuels were keyfor achieving such advancements at the time, however later on energy saving technologies' capacity to improve vehicles efficiency and curb pollution was becoming a mainstream solution with much broader industry enthusiasm… Climate Change pulled the ZEV program back into the game"[Tom Cackette]

The design of the ZEV-credits scheme was a complex one, and had evolved not only as states' targets evolved but also as industry solutions advanced. The initial prediction of

10% pure ZEV market introduction in order to achieve the fleet average standard was very preliminary and involved many assumptions and industry inputs.

"Experts were studying industrial capacity through extensive visits to various industry players, aiming at informing implementable policy-making" [Michael Walsh]

"We were looking three to five years ahead, and even then we had to make careful assumptions… Working with industry to advance demonstration programs was important for understanding industrial capacities, technological barriers and assess consumer uptake"[Tom Cackette]

Adoption rates and clarity over the actual impacts achieved through the integration of various technologies were providing clarity as for which pathways the regulatory framework should adopt for advancing its targets or how the existing framework should be adjusted to maximize performance. Annual requirements and their scaling were determined through public consultation.

"All changes to the ZEV regulation are made through a public process. Staff work with stakeholders (regulated manufacturers, non-regulated manufacturers, environmental groups, Section 177 states, other state agencies) to develop the annual ZEV requirements, which the Board votes on and are formalized in the California Code of Regulations. In 2008, the Board set requirements for 2009 through 2017 model years. You can find the 2008 staff report which explains the process for that Board Hearing online[62]."[CARB ZEV-credits Executive Officer]

Requirements per manufacturer type (LVM, IVM, ISVM, SVM) are designed to spread innovation and technology integration costs across the sector. Targets, provisions, grace periods, and other instruments are meant to serve this purpose.

"In general, the ZEV regulation is applicable to the largest manufacturers in California. It is assumed that those manufacturers with larger sales volume have access to larger research and development (R&D) budgets, can spread costs amongst a greater number of vehicles, and build partnerships with suppliers to help develop advanced technology vehicles. Therefore large volume manufacturers are required to comply with the full ZEV regulation including producing pure ZEVs. Intermediate volume manufacturers are also required to comply, but are currently allowed to meet their entire requirement with PZEVs (clean gasoline vehicles) through 2017 model year. Starting in 2018 intermediate volume manufacturers will be required to start producing plug-in hybrids (TZEVs), but will still be exempt from having to produce pure ZEVs." [CARB ZEV-credits Executive Officer]

Since one of the underlying goals of the ZEV-credits scheme is for new vehicles in California to emit 34% fewer global warming gases and 75% fewer smog-forming emissions by 2025, the underlying life-cycle analysis which guides the rating of different vehicles is that pure ZEVs and plug-in hybrids are the preferable vehicle type while all other PZEV Types are measured against it. In order to achieve pure ZEV commercialization, PZEVs are an optional compliance tool in the shorter term.

"The ultimate solution is pure ZEVs, meaning battery electric vehicles and hydrogen fuel cell vehicles. Pure ZEVs are essential for meeting near term criteria pollutant emission targets

[62]http://www.arb.ca.gov/regact/2008/zev2008/zevisor.pdf.

as well as long term greenhouse gas targets. In the near term, hybrids (AT PZEVs) and plug-in hybrids (Transitional ZEVs or TZEVs, formerly known as Enhanced AT PZEVs) might be more cost effective and potentially better market accepted vehicles. But in terms of environmental benefit, even on a lifetime emission basis, pure ZEVs are more effective solutions in the near and long term…. ZEV credits for plug-in hybrids and pure ZEVs are based on the vehicle's zero-emission range, assuming that all plug-in hybrids receiving ZEV credit are certified to California's super-ultra low emission vehicle standard (SULEV). PZEVs receive a flat credit of 0.2 credits, which is not necessarily scaled to emission performance, but rather as a function of relative value to plug-in hybrids and pure ZEVs." [CARB ZEV-credits Executive Officer]

"Industry players seemed reluctant to advance pure ZEVs, for various reasons related to economic costs and benefits… PZEVs were therefore a tool for engaging them in the ZEV credits regulation".[Tom Cackette]

Small manufacturers have quickly and willingly engaged in the regulation, while large volume manufacturers had to be pulled in and to this date remain less devoted. Non-LVMs may earn and bank their ZEV credits until they are subject to LVM requirements, while large volume manufacturers face less flexible provisions and requirements.

"Since the beginning of the ZEV regulation, small manufacturers have been interested in producing ZEVs and earning ZEV credits. We believe that allowing earning, trading, and selling of credits between all sizes of manufacturers provides compliance flexibility that allows regulated manufacturers to pursue the most advantageous way to focus on their unique path to compliance. Having increasing requirements year over year helps to ensure that manufacturers do not depend solely on compliance through purchasing credits from another manufacturer. We have also seen partnerships form between smaller ZEV focused manufacturers and large volume manufacturers that have ended up benefiting both companies. " [CARB ZEV-credits Executive Officer]

"Tesla is a great case study showcasing the huge income a small manufacturer can gain through the program, which is instrumental for its ability to perform and survive in this very competitive market place." [Tom Cackette]

3.3.1.2 Major ZEV-credits management and implementation issues

One core issue in securing effective regulatory management is providing long-term and predictable design, as well as transparent management which openly interacts with all stakeholders involved.

"We were criticized for the relatively frequent adjustment in regulation. This has probably contributed to large volume manufacturers' lack of faith in the durability of the regulation, which in turn explains why large manufacturers do not go and buy all the credits they may need for future compliance already now even though supply and demand are relatively balanced and prices are reasonable".[Tom Cackette]

Once the Section 177 state was created, the program became more feasible from an industry perspective and the adoption rate grew higher.

"Hard to say how effective the ZEV regulation was before requirements started in the Section 177 states. The early ZEV regulation had its own successes, such as introducing partial zero emission vehicles (PZEVs), which are clean gasoline vehicles that meet stringent criteria pollutant standards and have emission systems warranted for 15 years or 150,000 miles. Conventional hybrids (such as the Toyota Prius) were also a success of the ZEV regulation before the Section 177 state requirements came online. To comply with the pure ZEV requirements, the Board entered into memorandums of understanding (MOUs) with the auto manufacturers to ensure demonstration quantities of pure ZEVs were delivered to the state. After the 2003 amendments, which restarted the ZEV regulation starting with the 2005 model year, the Section 177 states started implementing their own programs, which is when we saw larger volumes of pure ZEVs in California. Obviously, the larger the ZEV demand or requirement grows nationally, or internationally, the greater the shift in economies of scale for commercialization." [CARB ZEV-credits Executive Officer]

However even without a geographical expansion, the tightening of California's standards and enforcement mechanism was instrumental for preventing leakage risks.

"There is currently no significant pattern of the issue of "leakage", that meaning new car buyers being forced to purchase their vehicles outside of the state of California due to the cost of compliance with the ZEV regulation or any of California's other regulations. Over time, there has been some periods where this was an issue, but this was solved by requiring all new vehicles (those with less than 7,500 miles or 2 years) registered in California to be certified to California standards. Additionally, over time, the United States Environmental Protection Agency (US EPA) has adopted similar standards for all new cars as California, so there is less incentive (financial or otherwise) to purchase cars outside of California. "[CARB ZEV-credits Executive Officer]

Recently, CARB staff has been working closely with IVMs for revisions concerning their regulatory status. This type of engagement is important for not only advising implementable and impactful program but also building trust in the program.

IVMs provided publically available comments at the 2012 Board Hearing voicing concerns over their 2018 and subsequent model year requirements and treatment, as well as at the 2013 Board Hearing.[63]

"CARB staff has worked closely with the affected intermediate volume manufacturers as well as other interested stakeholders, holding one public workshop in July 2014, to come up with a solution that guarantees forward progress is made on ZEV technologies in a way that makes sense." [CARB ZEV-credits Executive Officer]

Typically, ZEVs earn 1 credit for delivery into California and earn additional credits when placed in service. No credits are given for vehicle that has not been put in service prior to December of the 5th calendar year after its model year. This management mechanism is designed to ensure implementable enforcement:

"This was added in 2012 to ensure that manufacturers would do their best to submit up-to-date and accurate data year after year, rather than complicate the rule. Generally, it is

[63] http://www.arb.ca.gov/board/meetings.htm#future

simpler to disallow the earning of credits rather than enforce a complicated decrease in the amount of credits earned." [CARB ZEV-credits Executive Officer]

The ZEV regulation is linked to other regulations. However, no linkage between the cap-and-trade and the ZEV program was made possible to date on a practical level.

"Plug-in hybrids must be certified to the SULEV 30 emission standard, which can be found in the low emission vehicle regulation. And one provision in the ZEV regulation allows manufacturers to use over-compliance with the federal GHG program to comply with a portion of the ZEV regulation in model years 2018 through 2021." [CARB ZEV-credits Executive Officer]

3.3.1.3 Initial ZEV-credits related thoughts for the case of China

Some lessons from California may not be suited for the case of China. In particular, experts' initial thoughts suggest that infrastructure may pose a much larger barrier to commercialization in China than in California. In designing a commercial pure ZEV cars program in China, a study of the end-consumer (usage, preferences, public infrastructure and access to infrastructure) should be considered as well as an assessment of the potential for participation among infrastructure players (which was not developed in California).

"In California, the average daily travel distance is 45km, and the typical consumer would have a charging point at their private home parking, and another car for longer distance travels. In China, the case may be very different…. At some point over 6 years ago we offered to auto manufacturers to subsidies infrastructure development as part of the ZEV-credits program, however they highly opposed the idea. This is not surprising, since auto manufacturers from the very beginning had an interest not to show commercialization capacity of pure ZEV but rather PZEVs." [Tom Cackette]

China's regulators should learn the ZEV mandate and its development, however are suggested to use the latest program design as a key reference point rather than using older versions of the ZEV program.

"…many of the program features and requirements for 2012-17 have been modified of deleted for 2018 -2025. This was done for a number of reasons e.g. they we not used, they were no longer needed, they were too complicated, etc. So if China were to consider a CA-like ZEV program, it should model it on the 2018 and beyond program as it is the most current, and then review if any of the credit modifiers should be include to encourage specific actions e.g. integration with transit, etc."[Tom Cackette]

In order to go beyond pilot programs and ensure a real market is created, two instrumental tolls can be included: (i) demonstration programs, like what was done in the ZEV-credits program, and (ii) a consumer preferences evaluation and tailored vehicle segments and design.

"Demonstration phases were instrumental in assessing technologies, building industry collaboration and evaluating how marketable vehicle models are…. It seems that in the case of

China pilot programs typically include limited vehicle models which may not necessarily match the average consumer or early adopter preferences."[Tom Cackette]

Understanding what the market is capable of is key for designing an implementable and impactful program. Even California, despite its intense efforts to understand technological capacities and roadmaps, has gone through several design stages attempting to match its requirements with the industry's ability and willingness to implement them. For the case of China, much can be learned from developments in imported vehicles and JVs, and assumptions related to the uptake of independent domestic manufacturers can be made to ensure that there are players that will produce and sell credits and others that would purchase them.

"The feasibility of a regulation is key to its success. Even in California, in which much effort were made for understanding technological roadmaps of all types of manufacturers, the program's design was challenging. This may be very important for the case of China."[Michael Walsh]

"Companies know they can make the product, but not sure how much they can sell, and this is how they decide whether they will produce or buy credits. The regulation needs to be tight enough to ensure production is more cost effective than credits purchase, but at the same time having market for credits is necessary for maintaining a trading market".[Tom Cackette]

Unlike the case of California, in which some companies are not purchasing credits, new players from complementary industries may complement the supply and demand of credits in China.

3.3.2 Meta-analysis: Roles and responsibilities

A meta-analysis of limited qualitative studies conducted and resources available to date have enabled the study of perspectives on appropriate roles and responsibilities key stakeholders may undertake for contributing to the success for the ZEV-credits (and a ZEV-like) program. Useful takeaways are highlighted in this section.

3.3.2.1 The role of government

On the national level, the federal government has given the state of California the permission to set up regulations that go beyond the federal regulation in stringency and boldness (since the Air Quality Act of 1967, which is maintain in the current clean Air Act). Cutting-edge governing methods as well as regulatory design could therefore have been tested in the case of one state before scaling to other states. Another more commonly used method which was instrumental for promoting state implementation was federal funds. In the late 1980's, California found itself at risk of losing federal funds for the construction of transportation infrastructure if the state did not show progress towards air quality attainment[64].

Throughout this work, the status of the ZEV regulation as a mandate has been repeatedly stated to be of key importance to its success. The balance between stringency and feasibility of a standard is crucial, particularly when binding – a standard that is not stringent enough may leave potential environmental benefits on the table, while an unfeasible standard may entail huge compliance economic loses. However, "most previous studies of environmental innovation in the automotive sector link higher levels of innovation activity directly to regulatory efforts"[65]. The ZEV credits rule is "arguably one of the most daring and controversial air quality policies ever adopted"[66]. Without securing the status of a regulatory binding requirement, this the ZEV credits program would lose its effectiveness. The trading mechanism was a supplementary implementation incentive, and has proven to drive industry innovation.

This ability to spearhead US vehicle and fuel regulations has been well tested and with remarkable results – eight states have followed California's ZEV program path and have empowered it by doing so. Furthermore, states have been collaborating with the Californian government on complementary initiatives, most predominantly "The Multi-State ZEV Action Plan" signed in October 2013 by Connecticut, California, Maryland, Massachusetts, New-York, Oregon, Rhode Island and Vermont – constituting 23.6% of US vehicle 2012 vehicle sales. This relatively new initiative set a deployment target of 3.3 million ZEVs (approximately 15% of projected new car sales in 2025[67]) and adequate fuelling infrastructure by 2025. The power of several states in promoting new industry development seems to be crucial for the case of ZEVs for two main reasons: infrastructure should be continuous and enable as unlimited driving distances as possible; and equipment (fueling/charging and powertrain) should be as united as possible, standardized[68]. State collaboration caters for both of these major impediments for ZEVs commercialization from industry market of scale perspective and consumers concerns. The recent May 2014 Multi-State Action Plan for action focuses on these elements, as well as identifying research and partnership opportunities.

State-directed collaborative efforts to bring players together have developed alongside the ZEV mandate for supporting its goals. In 1990, the US Advanced Battery Consortium (USABC) was formed for developing electric batteries and advice standards through joint research work between government agencies and industry players. In 1993, the Partnership for the New Generation Vehicles (PNGV) was initiated, and in 2000, the California Fuel Cell Partnership was created. Although the majority of government initiated partnership did not result indirect commercial solutions, they have facilitated more open and direct

---

[64] Collantes, G., & Sperling, D. (2008). The origin of California's zero emission vehicle mandate. *Transportation Research Part A 42*, p. 1304.

[65] Public Policy Institute of California. (2007). Learning from California's zero-Emission Vehicle Program. *California Economic Policy*, Vol 3(4), p. 4.

[66] Collantes, G., & Sperling, D. (2008). The origin of California's zero emission vehicle mandate. *Transportation Research Part A 42*, p. 1302.

[67] Carson, E., & Davis, E. (July 2014). *Multi-State ZEV Action Plan: driving the Zero-Emission Vehicle Market Forward.* ENERKNOL, p. 2.

[68] To date, for example, Nissan Leaf drivers can only use CHAdeMO standard stations, BMW i3 and Chevrolet Spark EV can only use SAE Combo stations, while Tesla drivers can only use the Supercharger network – these players account for about 80% of the US EV market.

communication and enabled testing and evaluating vehicle technologies in a cost-effective manner.

Another contribution of government players to the development of ZEVs is through local government's independent support of demonstration projects. For instance, the L.A. Initiative received government support (the Los Angeles Department of Water and Power) as well as private support (which in many cases is encouraged by the government support) for the deployment of 10,000 BEVs by 1995. Although limited auto manufacturers responded to the challenge and the project delivered only prototypes, it has enabled the attainment of knowledge and proof of concept. Demonstration projects by themselves cannot deliver commercialization, yet are instrumental for bringing stakeholders together, directing industry efforts to a similar direction. Multi-state programs such as the US 2011 Transportation and Climate Initiative (TCI), formed of 11 northeast and mid-Atlantic states, was funded by about $1M Department of Commerce (DOE) grant to provide a blueprint for EV infrastructure deployment and standards. Federal HEV and BEV tax credits and nearly $100 million DOE grants in 9 states have proven critical for EV infrastructure deployment[69].

In the case of the California Air Resources Board (CARB[70]), an agency of the California government, its independent structure has been crucial for the ability to pass the regulation and support its implementation throughout the years. CARB is headed by a board of full-time chair and 10 part-time members, half of which are elected from air quality districts, three are expert members (public health, automotive engineering, science and agriculture or low), and two are unspecified citizens. The board oversees some 1000 staff with technical expertise, and in the case of the ZEV mandate, it required staff to prepare biennial reviews to assess the technology advancement and capacity to meet the standard requirements in due course[71]. All decisions are made in public through monthly board meetings, and any stakeholder contact must be disclosed before each vote, ensuring professionalism and transparency and suppressing political attempts to influence decisions. The Achilles heel of CARB's structure is in the governor's ability to appoint and dismiss board members at any time, and the legislature ability to influence the agency's annual budget. However, no abuse of these breaches has been noted to date.

Another useful governmental tool for promoting clean vehicles and fuels are high-level guiding frameworks. In the case of the ZEV program, which is only one program of the larger Low Emissions Vehicle (LEV) regulations, it has been stated that the roots for its forming were made in the Assembly Bill 234 (AB 234) as early as 1987 and the Sher Act of 1988. AB 234 was aimed at accelerating the adoption of alternative fuels as way of achieving emissions reduction, however since it received strong opposition from oil companies, it has resulted in advisory board recommendations for alternative fuels feasible adoption. Although the conclusion of a need for "fuel-pool" promotion (which was referred to as "Fool-pool" by the opposition), the bill has planted the seed of alternative fuels regulation, and introduced

---

[69] Carson, E., & Davis, E. (July 2014). *Multi-State ZEV Action Plan: driving the Zero-Emission Vehicle Market Forward.* ENERKNOL, p. 6.

[70] CARB was formed in the late 1960s by combining the California Motor Vehicle Pollution board and the Bureau of Air Sanitation.

[71]Public Policy Institute of California. (2007). Learning from California's zero-Emission Vehicle Program. *California Economic Policy*, Vol 3(4), p. 6.

the "revolutionary concept of averaging"[72] which was used in various vehicle regulations to follow (e.g. ZEV standard).

As the AB 234 showcases, policy designers need to develop roadmaps and collaborate with the industry while maintaining an independent and credible position for informing feasible and impactful regulations. Here comes in to play third party players and academia experts as well, as further discussed in the below sections. Without government long-term and broad perspective, feasibility studies may fail to be representative of long-term solutions to problems of public concern. In the case of the ZEV-Credits program, CARB have argued that the increase in population, vehicle ownership and vehicle use, all call for the promotion of ZEVs rather than advanced ICE technologies for delivering long-term air quality improvements, despite industry inputs. Furthermore, in recognition of industry leg-dragging approach and the need to spur consumerism, sales of vehicle rather than vehicle production was chosen as the mandate.

3.3.2.2 The role of industry

The development of the California ZEV-Credits program has proven industry reluctance to commercialize cutting edge vehicle technologies. At the time the ZEV-Credits program was introduced, the rule fully applied to companies with annual sales of over 35,000 vehicles in LA, targeting Chrysler, Ford, General Motors, Honda, Mazda, Nissan and Toyota. In a workshop organized by CARB to introduce the regulatory concept, most automakers expressed opposition. Chrysler for example, stated forcing mandate cannot bring forth adequate innovations in the required timeframe. However, policymakers, accustomed to industry reluctance to bring progress, have aimed at one large industry supporter for pushing their regulation forward. Also, the ZEV long-term phase in plan have made it less acute for industry players to intervene with - they were busy with more immediate and broader elements of the LEV regulation.

General Motor's introduction of the Impact (known also by its earlier name – Santana) and its scaling plans in 1990, provided back-wind to the ZEV-Credits program. In the Los Angeles Auto Show of January 1990 Roger Smith, the Chairman and CEO of General Motors, unveiled the company's two-seater electric car prototype and stated "we want an electric car that's producible, that can handle itself on the highway and that can meet the federal standards out there and that is a marketable product. We believe we've accomplished two-thirds of that"[73]. Smith further provided economic estimations and predicted the vehicle could be commercially viable in just several years (although his calculations neglected vehicle cost and depreciation). These statements, and CARB's staff test-drive of the Impact car later that year, have arguably encouraged CARB to design and promote the ZEV-Credits program, showcasing industry informs policy-making.

Although the enhanced version of GM's electric car, the EV1, was put into production in 1996, it never sold as well as the expectations built around it, mainly by policymakers. The initial EV1 price was $33,995, however after tax incentives in California kicked-in, the price

[72]Collantes, G., & Sperling, D. (2008). The origin of California's zero emission vehicle mandate. *Transportation Research Part A 42*, p.1305.
[73] Lee, P. (January 4 1990). GM Unveils an Advanced Electric Passanger Car. *Los Angeles Times*.

declined to $25,595, which translated to a $399 3-year monthly lease. Still, after leasing no more than 300 in 1997 and putting some $350 million into developing the car, GM maintained its production only until 2003. The company stated "it was never intended to be a profit unit. We had a negotiated loss on the vehicle because we felt the learning and some of the image that we would create by producing a vehicle of that type was worth the investment that we were going to make"[74].

Qualitative analysis done in this study indicates industry information sharing is crucial for the ensuring feasible policy design. Although GM has unintentionally supported the ZEV-Credits program formation by providing positive commercialization outlook, CARB have proactively collected industry inputs for advising its work (although it was criticized for not studying the case for ZEVs comprehensively enough). Industry cooperation with policy-makers on studying technological readiness and projections is instrumental for bringing impactful results. Interesting is the case of Tesla, which showcased that large players are not always as well-positioned to deliver disruptive innovation as small and independent new players. Although regulations depend on large players willingness to cooperate, small players fighting for their existence may be well suited for informing advanced regulations.

Industry players who are not the core objective of a regulation can and should influence its making. More obvious is the case of complementary industries, such as the oil industry's involvement in the creation of ZEV mandate. The oil industry, which was closely monitoring the development of electric-vehicles in the late 1980's, has not devoted much attention to the ZEV program but focused on influencing the clean fuels elements of the LEV regulation as they were expecting huge costs should alternative fuels commercialize. ARCO submitted a letter arguing that "the same air quality effect, (fuel-vehicle life cycle costs) are lower for formulated gasoline than for any of the other commonly discussed clean fuels: CNG, Methanol (as M85), or electricity". This contention, although represent policymaking weighting of costs which phased out in the 1990's as discussed in the below section, was important for demonstrating timeframes for the integration of regulation.

The discovery of this study's qualitative analysis, that the automotive sector opposed the idea of infrastructure incorporation in the ZEV mandate, is once again singling that there is a need for a broader stakeholder involvement in regulatory design. The authors of this work assume that should potential services providers, operators, solutions developers and alike be given an adequate stage to showcase their market insights and requirements, consumers and auto manufacturers would enjoy smoother acceptance of ZEVs. For example, Better Place was a company built to develop, deploy and operate electric vehicles systems (from powertrains to battery switch and vehicle head-unit software) – however without policy incorporation of its independent and unique cost-intensive knowledge and capacities gained through the company's initial start-up years, policy-makers lacked important perspectives on electric vehicle marketability.

A notable recent industry move in the US, made in conjunction to promotion of the Multi-State ZEV Action Plan, is Tesla's announcement of opening its innovations for other companies to use (without initiating patents lawsuits). This open sources announcement led Nissan and BMW to begin collaborative talks on charging networks and standards, increase

[74] Pinkse, J., Bohnsack, R., & Kolk, A. (2014). The Role of Public and Private Protection in Disruptive Innovation: The Automotive Industry and the Emergence of Low-Emission Vehicles. *Product Development and Management*, 31(1) p. 54.

EV popularity and unleash demand (and with it – economics of scale). Such bold announcements, should internalize, would make an unprecedented contribution to ZEV commercialization. Interestingly, the Partnership for the New Generation Vehicles (PNGV, later replaced by FreedomCAR), was a unique industry initiative which started in 1993 by GM, Ford and Chrysler ("The Big Three") in which an exemption to antitrust regulation was made and allowed collaboration by US carmakers. It also brought carmakers, government agencies and research institutions together "and allowed the use of national research free of charge"[75]. This early initiative, although resulted only in the development of the Toyota Prius, may be seen as the seed to collaborative initiative.

3.3.2.3 The role of third sector and other players

The socio-political context that have steered the ZEV credits program development and approval includes third party sector players. In the late 1980's, the Natural Resources Defense Council (NRDC) won an appeal in court which changes the US Environmental Protection Agency (EPA) methodology for determining safety levels of toxic pollutants: instead of using considerations of cost to industry, EPA should use health considerations. This fundamental change in regulatory design is considered revolutionary and set the stage for more aggressive governing frameworks forcing environmental improvements despite the heavy costs to industry. Another case, brought to court by the Coalition for Clean Air and the Sierra Club, EPA was instructed to address the failure of the South Coast Air Quality Management District to attain air quality standards by providing a clean action plan.

In the first CARB board meeting setting the ZEV mandate, NGOs have generally maintained low-key. Although major environmental organizations saw an overall reduction in vehicle use as an end goal, and were generally skeptic about technological improvements and their impact, they saw the benefits of a mandate to promote zero tailpipe emissions vehicles. The Environmental Defense fund and the NRDC, although supportive of the mandate, were among the first to highlight the neglect of life-cycle emissions the ZEVs entail (e.g. electricity generation).Later on as industry rages against the mandate, "mainstream members of the community assert themselves and launch a fight on behalf of electric vehicles and the ZEV mandate"[76].

Beyond organized third party sector players, namely NGOs and think tanks, other non-industry and non-government institutions can play a role in the development of a coherent and credible regulatory framework. Academic institutions inspire and test innovative solutions, map stakeholders' engagements and have the capacity to bring together different players for addressing a mutual goal. For example, Opower consumer data revealed some issues that need to be better addressed by all stakeholder promoting the shift to electric drive: households using EVs in the US are 3 times more electric intensive during peak hours and use 58% more electricity than a typical household, while households with solar

[75]Pinkse, J., Bohnsack, R., & Kolk, A. (2014). The Role of Public and Private Protection in Disruptive Innovation: The Automotive Industry and the Emergence of Low-Emission Vehicles. *Product Development and Management*, 31(1) p. 49.

[76]Collantes, G., & Sperling, D. (2008). The origin of California's zero emission vehicle mandate. *Transportation Research Part A 42,* p. 1310.

installations consume similar levels of grid as a typical household[77]. This type of information and mass data gathering can inform more comprehensive and forward looking governance and well as industry strategies, including energy storage and efficiency solutions, alternative electricity and off-peak charging incentives etc.

Public opinion shapers, which can also be referred to as a type of industry players, are also of pivotal importance to increase ZEV demand and alternate the vehicle market. For example, in the recent Multi-State ZEV Plan, car dealerships are addressed as part of a larger effort to inform consumers of the merits of ZEVs. Further initiatives to inform sustainable consumption and adjust consumers to the notion of new type of private mobility are typically left to the hands of the third sector. *i*CET, for example, has been reflecting on the GHG footprint of private vehicle choices in China through its China Green Car system since 2006. Such efforts, however, are toothless without the support of strong government and opinion shapers.

3.4 Conclusion

While China's need for sustainable city planning increases along with its rapid urbanization rates, Chinese decision-makers are examining various options for reducing transportation emissions and direct market development. Global programs are also being evaluated and are playing important roles in the form of case studies and success stories. As this report points out, the ZEV credits program is a well-demonstrated regulatory framework capable of accelerating innovations primarily through market sources.

The ZEV credits program has proven to deliver ground-breaking results, however these results may be the result of California's unique characteristics (such as its role as an innovation hub, its comprehensive regulatory framework, the amount of early-adopters, etc.). In order to assess the program's suitability for the case of China, local market conditions and the robustness of its institutional framework should be examined. Furthermore, a multi-stakeholders collaboration led by dedicated pilot city planners is needed to enable in-depth understanding of the forces that may enable the fruits of a China-tailored program, as well as to assist in designing such a program.

As the worlds' largest GHG emitter, and home to 16 of world's 20 most air-polluted cities[78], China is aggressively promoting New Energy Vehicles (NEVs) demonstration projects aimed at showcasing and assessing a variety of climate mitigation measurements. In particular, its 2008 "10 cities 1000 vehicles" project of new battery-electric vehicle technology integration was quickly followed by the gradual formation of 25 pilot cities meant to exemplify commercially scalable PEV projects under governmental support. These schemes have not only prepared the participating cities for NEVs incorporation in city planning, but have also set the direction for further energy saving and new energy vehicles' institutional framework development. The appropriate city or cities for taking on the task of assessing and designing a ZEV credit type program should be selected carefully to ensure

[77]Carson, E., & Davis, E. (July 2014). *Multi-State ZEV Action Plan: driving the Zero-Emission Vehicle Market Forward.* ENERKNOL, p. 8.
[78]According to WB report (as soon as 2006).

market readiness, institutional feasibility, government proactive collaboration, and potential linkages to broader areas and sectors.

While critics doubt the ZEV regulation has contributed to California's emission reduction goals, CARB claims that in reality it has spurred a significant commercial integration of near-zero emissions vehicles[79]. For instance, nearly 2 million Californians are driving partial zero and advanced technology partial zero emission vehicles (PZEV and AT PZEV) with near-zero tailpipe emissions and some 80% cleaner exhausts than the average 2002 model year car. In addition, gas-electric hybrid vehicles are a success, with over 400,000 hybrids on California's roads. Lastly, and as can be inferred from the number of zero emission vehicles on the roads, all vehicle manufacturers in California have been and currently remain in compliance with the program. Notwithstanding, the program should be scrutinized through in-depth interviews with planners and participants for drawing effective and implementable lessons.

The central goal and advantage of California's ZEV approach lays in its integrated methodology for addressing both criteria pollution and GHG emissions while allowing ZEV credits trading in a pre-defined market place. Through credit trading, early stage zero and near-zero emission vehicle companies are funded and all automakers are provided with an added incentive to develop ever-cleaner vehicles and related technologies. For example, Tesla Motors has earned a revenue of about $245M over 5.5 years from the sale of ZEV credits, enabling it to reach market maturity in an overwhelmingly resources-consuming new energy vehicle industry that has typically diminished PEV players elsewhere (e.g. Coda).

One clear shortfall of this program's scope lays in its neglect of low-emissions infrastructure and components players. While auto manufacturers can enjoy the fruit of the program during their seed period, other complementary players (e.g. service and infrastructure providers) that have a significant influence on market demand and uptake are excluded from this scheme. As evidenced in recent years' financial instability of electric powertrain components producers, such as the bankruptcy of A123 Inc. battery manufacturer[80] and the integrated charge-switch network provider Better Place Inc.[81], lack of support in the complete zero-emissions car ecosystem may result in delays in the mass-market integration of zero-emissions vehicles.

Another issue with the current California-grown ZEV credit scheme is the inability of a participating seed-company to expand geographically and internalize its market potential at every technological step. In Tesla's case, for example, selling its first model the Roadster abroad has resulted in a slowdown of revenue. The utilization of potential profits for every technologically-intensive product is essential for breakthrough technology market shapers, as they are typically facing scarce demand and limited resources.

In the case of China, the above described adverse effect of a geographically confined ZEV credits program is even more complex. While large geographies within China are important potential revenue streams for local manufacturers, local protectionism and a

---

[79] http://www.arb.ca.gov/msprog/zevprog/zevregs/zevregs.htm

[80] A123 applied bankruptcy in October 2012 and was eventually purchased by China's Wangxiang.

[81] Better Place was actively engaged in complete charging and switch infrastructure and battery management systems for supporting mass-demand for electric vehicles and filed for bankruptcy in May 2013. Its CA office have attempted to receive local government support.

favorable institutional framework may hamper the expansion of a local ZEV credit scheme. Furthermore, the goal of enhancing local manufacturing by decision-makers may prevent credit schemes expansion to imported vehicles, therefore interfering with consumer preferences. The industry's motivation to bring to market advanced solutions which suit consumers' preferences is crucial for commercialization, and regulators' program design and flexibility are key for promoting such a supportive environment. Notwithstanding, the expansion of a ZEV credit scheme is crucial for real and robust financial backing of seed companies that cannot attract financial market cash flow injections, which is the case for most home-grown seed companies in China.

This study only infers potential barriers outlined by California experts rather than key players from China. Through key stakeholders engagement key barriers for implementing a ZEV credits type program in a pilot city (or cities) in China may be identified, and measures recommended to overcoming these barriers. A recommended next step is a stakeholder workshop and roundtable discussion for suggesting areas to be further explored and issues of importance when considering ZEV-type regulation design for the case of China.

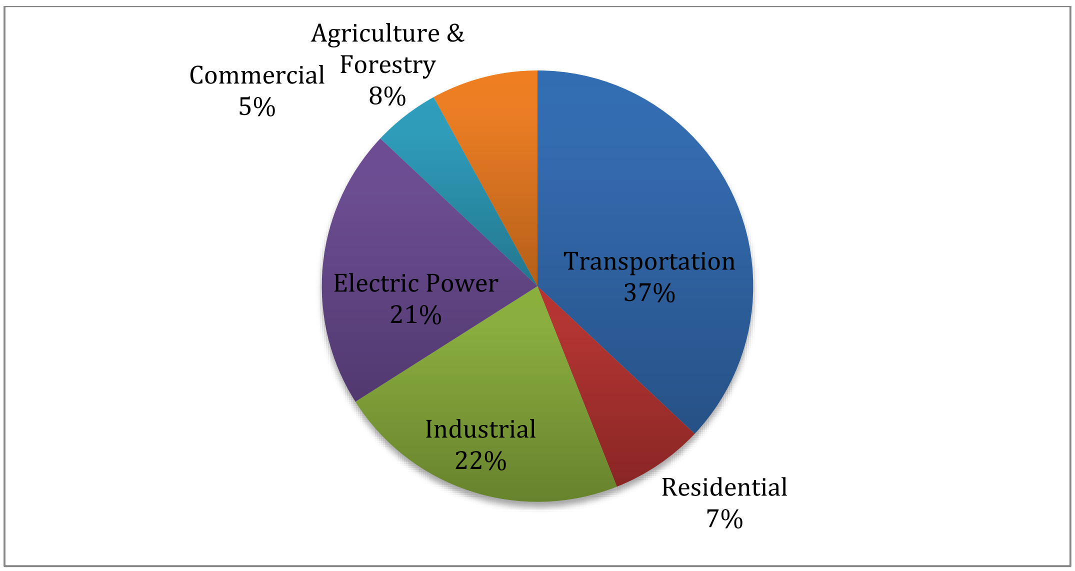
4. The California Cap-and-Trade program

4. 1 Introduction

California's 2006 Assembly Bill 32 is promoting the reduction of GHG emissions to 1990 levels by 2020, from 507 to 427 $MMTCO_2e$ (some 16% reduction). One of its new methods is the market based cap-and-trade program, which is believed to be both environmentally effective and economically efficient. California's new cap-and-trade program was initiated in 2013 as a narrow budget scope requiring the electricity and related industry sectors to comply. These two sectors are accountable for over 40% of California's GHG emissions. As of 2015, cap-and-trade will enter its broad budget scope to include all fuel suppliers and related industries.

The program added the Business As Usual (BAU) estimate of emissions for the distributed fuel use sector to the "broad-scope sources" in 2015. The transportation sector itself is responsible for nearly 40% of the state's GHG emissions, thus by combining upstream emissions (fuel and electricity production and distribution) with downstream emissions (vehicles usage) as much as 80% of California's GHG emissions could be mitigated.

Figure 30: 2012 California Total GHG emissions distribution map



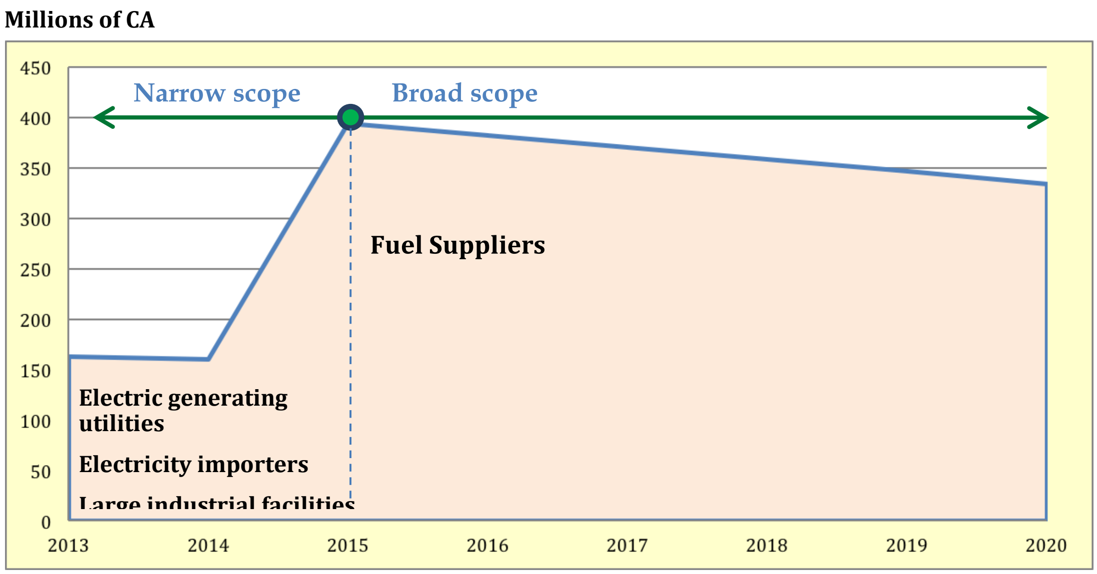
Source: *California Air Resources Board, California Greenhouse Gas Inventory - by Sector and Activity. Analysis: Collaborative Economics*
http://www.next10.org/sites/next10.huang.radicaldesigns.org/files/2014%20Green%20Innovation%20Index.pdf

In the cap-and-trade system the government sets a "cap", or an overall emission limit for the covered entities. The covered entities receive tradable emission allowances (a "right to emit") either through free allocation, auction, or both. Entities are required to purchase allowances if exceeding their emissions cap allowance or sell their surplus allowance to firms with excess emissions if their own emissions are below the cap.

4.1.2 Fuel Suppliers

California's cap-and-trade emissions allowances will increase over the next couple of years as fuel suppliers are added into the program, from 160 million tons in 2014, to approximately 390 million tons in 2015. The budget level in 2015 is comprised of the narrow-scope cap (which has been declining since its introduction in 2013) and the additional incremental increase equal to the distributed fuel use sources' emissions in 2015. The transportation sector accounts for the majority of the fuel distribution emissions budget.

Figure 31: An illustration of California's cap-and-trade scope



4.1.3 Covered Entities

Fuel suppliers covered under the cap-and-trade program include natural gas, RBOB, liquefied petroleum gas, blended fuels, and liquefied natural gas suppliers, distributors, producers, and importers. The downstream approach, which controls specific disposal facilities, dominates the regulatory framework. However, as of 2015, it will be integrated with an upstream approach, which also controls fuel suppliers. The upstream approach is projected to be more efficient as there are fewer upstream suppliers than downstream users.

Suppliers of natural gas receive free allowances and are eligible to acquire the same amount of allowances commensurate with their compliance obligations each year. However, the revenue from trading allowances will be dedicated to compensate their end users. The others such as RBOB, Distillated fuel oil, liquefied petroleum gas, and blended fuels - mainly transportation fuel suppliers - do not receive such free allowances and thus will become the largest buyer in the California carbon market. Experts predict that these fuel suppliers may pass their compliance costs on to end-users.

4.1.4 Inclusion Thresholds

Oil and gas production facilities with annual emissions of over 25,000 TCO_2e (the threshold) are subject to compliance with the CAP-AND-TRADE obligations since 2013. This threshold applies equally to fuel suppliers. From 2015, if entity emissions exceed the threshold between 2011 and 2014 without purchasing adequate allowances, they will be penalized.

4.1.5 Allowance Allocation

The allowance is allocated to the covered entities based on the dataset that represents historical emissions of each firm in order to anticipate the way in which these emissions will change in the future. Allowances are distributed either through free allocation or auction, or both.

In the case of fuel suppliers, natural gas entities receive free allowances and are eligible to acquire the same amount of allowances commensurate with their compliance obligations each year. The revenue from trading allowances will be dedicated to compensate their end-users and not as extra income to the facility.

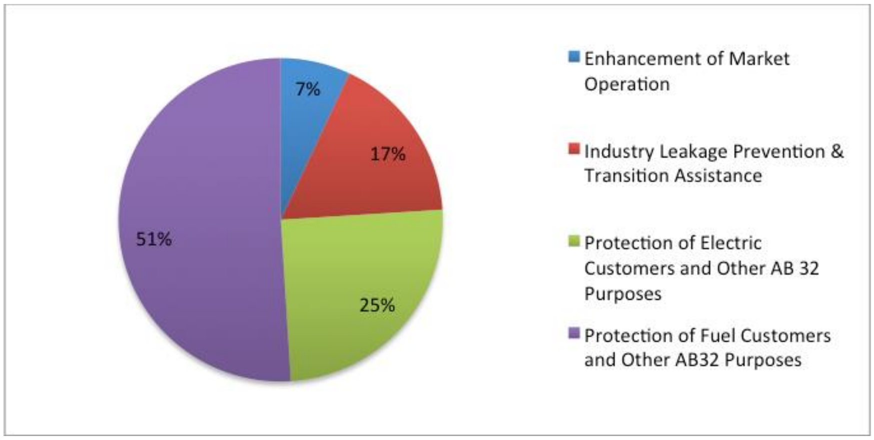
Other fuel entities do not receive free allocation and are therefore major buyers of carbon emissions allowances. In order to avoid a rise in fuel prices and compensate for new energy vehicle infrastructure and facilities development, CARB distributes allowances based ongas entities' annual reporting. A percentage is being allocated to the vendors' Compliance Account and the rest to their Limited Use Holding Accounts.

Table 19: Natural gas suppliers' projected proportions of Limited Use Holding Accounts

Phase	Initial Phase			Second Phase		
Year	2015	2016	2017	2018	2019	2020
Percentage (%)	25	30	35	40	45	50

CARB distributes allowance values to four categories, including the enhancement of market operation, the protection of utility customers, the protection of industry and leakage prevention, and the protection of fuel providers. The allowance value is projected to increase over the years since distributed fuel use will be covered under the cap-and-trade and the level of transition assistance to industrial source will be reduced.

Figure 32: Proposed Distribution of Cumulative Allowance Value (2012-2020)

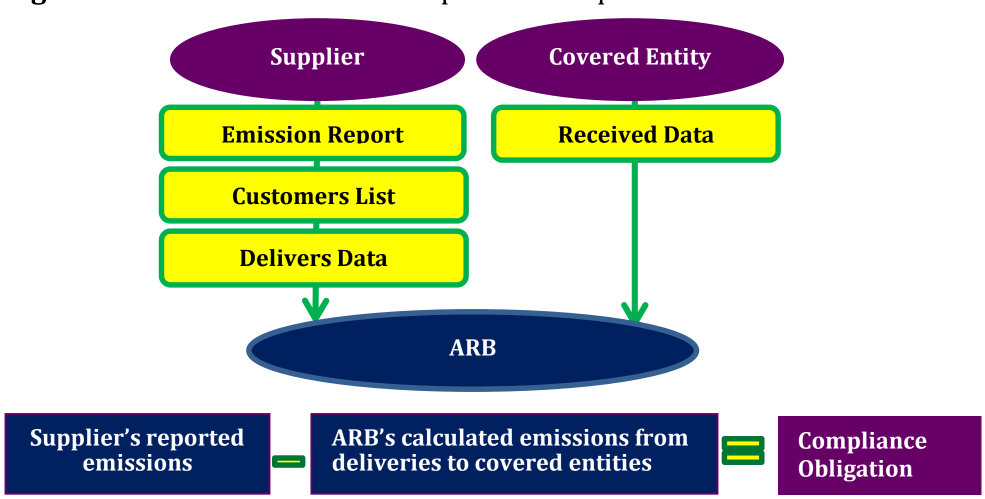


In order to further protect fuel customers, revenues from auctions would be transferred to the Air Pollution Control Fund to advance emissions mitigation and support energy-saving innovation development (part of AB 32 goals). The proceeds raised at the auction are designed to minimize the increase of fuel prices while still providing adequate incentives to reduce fossil fuel use.

4.1.6 Compliance Path

Different fuel suppliers are required to submit annual third-party approved reports stating their actual emissions and credits usage. To avoid double counting of the covered sources, the trading system stipulates that direct emissions and oxidation process are not to be taken into account in the compliance obligation calculation. However, because natural gas suppliers do not follow the new requirement, the problem of double counting between covered industrial facilities and fuel suppliers must be avoided by providing a list of customers and their amount of natural gas transported. In this way, CARB obtains the output data from fuel suppliers and input data from the covered entities.

Figure 33: An illustration of the cap-and-trade process



In order for covered entities to reduce emissions at a lower cost, the trading system allows certain complementary compliance tools, such as carbon offset credits, for mitigating any foreseeable compliance obligation burdens.

Two credit transfer methods are available in the primary cap-and-trade market: auction and allowance price containment reserve: "The allowance price containment reserve was established to provide a safety valve to the allowance price and help to mitigate undue volatility in allowance prices. It is accompanied by an associated floor price that will be enforced in the allowance auctions"[82]. When auctions are held quarterly, it can effectively help track short-term price fluctuation and the supply and demand trends in markets. Since 2013, CARB has successfully held seven auctions. California held five auctions by the end of 2013 (its first year) through which compliance and non-compliance entities have purchased more than 117 million allowances. CARB has estimated it will auction approximately 118 million allowances in 2014[83]. Covered entities are allowed to buy quotas from the Allowance Price Containment Reserve at a fixed rate to prevent an excessive increase in carbon market price.

Figure 34: 2013 Auctions of vintage allowances

Current auction of 2013 vintage allowances

	Nov 2012	Feb 2013	May 2013	Aug 2013	Nov 2013
Floor price	$10.00	$10.71	$10.71	$10.71	$10.71
Settlement price	$10.09	$13.62	$14.00	$12.22	$11.48
Current allowances offered	23,126,110	12,924,822	14,522,048	13,865,422	16,614,526
Current allowances purchased	23,126,110	12,924,822	14,522,048	13,865,422	16,614,526
% of current allowances purchased	100.0%	100.0%	100.0%	100.0%	100.0%
# of bids: # sold (ratio)	1.06	2.47	1.78	1.62	1.82

Source: EDF report, *Carbon Market California: A Comprehensive Analysis of the Golden State's Cap-and-Trade Program, Year One*

Offset credits provide additional low cost abatement options to the covered entities, and can reduce the overall cost of the program for them. However, this complementary policy is limited to equate to 4% of the emissions from capped sources, since, if unrestrained, it is likely to downgrade the purpose of cap-and-trade. There are certain requirements regarding its feasibility, covering scopes, location, and authenticity. Examples are the U.S Forest Projects Protocol, ODS Project Protocol and Mine Methane Capture.

[82]http://www.arb.ca.gov/cc/capandtrade/emissionsmarketassessment/pricecontainment.pdf

[83] http://www.arb.ca.gov/cc/capandtrade/auction/2014_annual_reserve_price_notice.pdf

4.1.7 Penalties

In order to guarantee regulatory effectiveness, covered entities are subject to four times the usual quota as a penalty, of which 1/3 must be actual emissions offsetting and the rest can be compensated through the purchase of offset credits.

According to section 95857 an untimely surrender obligation is calculated as four times the entity's excess emissions[84], meaning if an entity is missing 10 allowances when the surrender obligation is due, it owes 40 allowances within 5 days of the next quarterly auction (ARB does not consider this 4x multiplier part of its enforcement activity). There are separate provisions that allow for enforcement penalties per day per metric ton of late compliance obligation surrender.

4.2 Cap-and-Trade qualitative evaluation: Key stakeholders interviews

This section presents the results of a qualitative analysis conducted through interviews with CARB representatives (**Table 20**). The qualitative study results are grouped around several major themes designed to provide insights into vehicle fuel related issues addressed in California's cap-and-trade program, its cost implications, and its potential linkage to the ZEV program.

Table 20: CARB Cap-and -Trade Key Experts Interviewed

Interviewee	Position	Date	Method
CARB Representative	Executive Officer	July-August 2014	Email correspondence

As ARB conducts an extensive public process in any rulemaking activity, all stakeholders have the ability to comment on staff proposals before and during the ARB rule adoption. The qualitative analysis also makes use of public hearings and stakeholder meeting materials.

4.2.1Cap-and-trade influence over ZEV purchase choices and use-phase costs

Passenger vehicle manufacturers are not among the entities covered in the cap and trade program since none of them emit 25,000 metric tons of carbon dioxide equivalent a year. *"Therefore, there are no auto manufactures that meet the threshold to be covered in the Cap-and-Trade Program"*[CARB, executive officer].

In 2015, fuel suppliers are projected to be obligated to purchase allowances (natural gas suppliers still have a lower purchase requirement) with the full ability to transfer the implicated costs to their consumers. However, no end-user price control mechanisms are available.

[84]http://www.arb.ca.gov/cc/capandtrade/ct_oal_april2014.pdf)

"The Cap-and-Trade Program does not mandate any price increase in transportation fuels. Instead under the Program, fuel suppliers will be required to hold compliance instruments equal to the amount of GHG emissions associated with the fuel that is delivered and used within California"[CARB, executive officer].

Nevertheless, a consumer rebate plan has been put in place to return revenue which the Independently Owned Utilities (IOUs) receive from auctioning their allowances[85]. *"This has been called the "climate dividend", and is a credit issued biannually on rate payer utility bills. The California Public Utilities Commission is the agency which regulates how utilities spend and collect revenue and has put the climate dividend in place"*[CARB, executive officer].

As for the secondary markets: *"Prices in the secondary market are determined by supply and demand forces. That said, the price of allowances at State sponsored quarterly allowances auctions may influence the secondary market price. While ARB does not comment on price trends, the auction reserve price in 2014 is $11.34 and increases annually, at a rate of 5 percent plus inflation"* [CARB, executive officer].

4.2.3The value of a separate cap-and-trade scheme for governing fuel

LCFS (relative emissions concentrations approach) and Cap-and-Trade (total emissions approach) do have some common grounds as they feed into a single transportation platform (a car and its fuel). CARB experts were asked why the two emissions reduction regulatory programs are separate, and whether they see any value in somehow combining the two schemes. In response they have stressed that the two schemes share a similar framework and are designed to serve the same goal; thus they are complementary by nature.

> *"Combating global climate change requires a comprehensive policy response that encompasses all viable regulatory options. In California, AB 32 gave ARB broad authority to develop a strategy and a suite of regulatory measures to address climate change to limit greenhouse gas (GHG) emissions to 1990 levels by 2020 and to continue and maintain the reductions beyond 2020. Additional provisions in AB 32 require ARB to consider other societal benefits in achieving the 2020 GHG target, including reductions in other air pollutants, diversification of energy sources, and other benefits to the economy, environment, and public health.86*
>
> *In the transportation sector, ARB has outlined a complementary, multi-pronged approach to meet the goals of AB 32. Through the Advanced Clean Car programs, the LCFS, and the Cap-and-Trade Program, ARB encourages the development, deployment, and demand for clean fuels and vehicles.*
>
> *The Cap-and-Trade Program sets a limit on the overall emissions from 85% of California's GHG emissions sources. As this limit, or cap, declines over time, GHG emissions decline. The Cap-and-Trade Program seeks to find the least-cost reduction opportunities throughout the economy while encouraging all sectors to take action to become more efficient. In the transportation sector, fuel providers have a compliance obligation for the GHG emissions that result from the production and use of fuels and therefore have an*

[85]http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M034/K966/34966395.PDF
[86]California Government Code section 38562(b)(6).

incentive to increase the GHG emissions efficiency in the production of fuels and to develop fuels with lower GHG emissions. Cap-and-Trade also encourages end-users of transportation fuels to reduce demand for fuels with high GHG emissions and encourages the use of lower carbon alternatives and fuel efficient cars. Any reductions in production of fuels to comply with LCFS are also counted towards compliance in Cap-and-Trade, making these complimentary programs.

The LCFS regulation is a rule designed to induce innovation in transportation fuels used in California. The LCFS requires a 10% reduction in the carbon intensity of the statewide mix of transportation fuels by 2020 and creates a market to encourage the development and deployment of clean fuels technology. The regulation's market-based structure provides economic incentives to encourage the steady introduction of low-carbon fuels, such as natural gas, biofuels, electricity, and hydrogen (for use in fuel cells),as well as gasoline and diesel produced with lower carbon intensity. As the LCFS reduces the carbon intensity of fuels, it changes the composition of the state's transportation fuel mix. Over time, low carbon alternative fuels comprise an increasing portion of the state's fuel portfolio reducing GHG emissions and California's dependence on traditional petroleum-based fuels.

CARB experts have also outlined the main challenge for providing direct linkage between these two programs:

Without the LCFS, Cap-and-Trade by itself may not encourage the development of lower carbon fuels, and without Cap-and-Trade, LCFS by itself would not achieve all of the emission reductions needed to meet the AB 32 mandate. The LCFS reduces the overall carbon intensity of vehicle use while Cap-and-Trade provides incentives to reduce GHG-intensive vehicle use. The LCFS provides market flexibility to allow a wide variety of fuels in the transportation sector while establishing clear investment signals that encourage the long-term development and use of waste-based biofuels, electricity-based transportation, and other very low carbon-intensity transportation fuels. While Cap-and-Trade can incentivize the use of biomass-derived fuels (as they have no compliance obligation), it does not account for the carbon intensity of fuels. Thus, when not complemented by the LCFS, Cap-and-Trade could over-incentivize fuels with low combustion but high lifecycle emissions, resulting in net GHG emission increases."

4.3 Conclusion

Cap and Trade, a program aimed at reducing GHG emissions to 1990 levels by 2020 and ultimately achieving an 80% reduction from 1990 level by 2050, is about to enter its second stage and adding fuel distributors to capped entities starting in 2015 (further to electric utilities and supply-chain entities). The Cap and Trade program sets a limit "cap" on the total annual pollution and distributes a limited amount of allowance correspondent to a fixed amount of pollutant emissions to the complying entities. The allowances then can be traded through supply and demand thus creating a carbon market. The program covers as much as 80% of the total California GHG emissions.

The compliance path upholds the accuracy and integrity of information provided by requiring the submission of annual third-party approved reports stating emissions and credit usage. Another key instrument for increasing the program's effectiveness are complementary compliance tools, including carbon offset credits.

CARB experts provided further insights into the program's impact on potential vehicle purchase choice and use-phase cost, and the value of a separate C&T scheme for governing fuel. As fuel suppliers are obligated to purchase allowances as of 2015, there will be no end-user price control mechanism. However, a consumer rebate plan may direct utilities spending.

The potential added value of the cap-and-trade to the development of commercial clean transportation should be further evaluated as the California program evolves. Meanwhile, a similar program that is complimentary to other regulatory tools (standards, ZEV-credits) should be considered in the broader context of emissions reduction and air quality improvement. Specifically, the likelihood that such a program will increase clean transportation fuels and appropriate infrastructure availability should be studied. As China is planning on leading global new-energy-vehicle development, a Chinese-city case study evaluation, using both quantitative and qualitative analyses, is suggested.

5. Conclusions

The ZEV and cap-and-trade programs, although not linked, are together creating more inclusive governance aimed at cleaner transportation development: while one is encouraging the commercialization of innovative vehicle technologies, the other is advancing sustainable fuel production and market introduction; furthermore, while one is looking at driving cycle emissions, the other is going beyond use-phase perspective and utilizes a well-to-wheel approach.

While China's need for sustainable city planning is increasing along with its rapid urbanization rates and economic growth, Chinese decision-makers are examining various options for reducing transportation emissions, improving urban air quality, and directing market development. Global programs are also being evaluated and considered for the case of China on either national or local levels, and are playing an important role as case studies and assessable success stories. As this report points out, California's programs pose a good example for creative governance. The ZEV-credits program in particular is a well-demonstrated regulatory framework capable of accelerating technological development through market sources.

Nonetheless, although the ZEV credits program has proven to deliver ground-breaking outcomes, its benefits may be the result of California's unique characteristics, such as its role as an innovation hub, its comprehensive regulatory framework, the amount of early-adopters, etc. In order to assess the program's suitability for the case of China, local market conditions and the robustness of its institutional framework should be examined. Furthermore, a multi-stakeholders collaboration led by dedicated pilot city planners is needed to develop an in-depth understanding of the forces that could enable the success of a China-tailored program as well as to assist in designing such a program.

As China is aggressively promoting New Energy Vehicle (NEV) demonstration projects and aims to exemplify commercially scalable PEV projects under governmental support, market-based mechanisms have potential as suitable solutions to air quality issues, clean vehicle commercialization and diversity issues, and consumer adoption issues. Chinese NEV pilot cities, and in particular those with a pilot emissions exchange, can perform as testing grounds for California's market-based governance of clean low-carbon transportation development.

When considering a China-tailored program design, an in-depth and open stakeholder discussion of the barriers to implementation is key: not only should the existing program be evaluated for the case of China, but also China's market readiness and characteristics must be assessed. Californian experts highlighted the characteristics of Chinese production and consumption, its local protectionism, and possible leakages, pointing out economic business sense as a crucial factor for a market-based regulation. While auto manufacturers can enjoy the fruit of the program during their seed period and leading auto manufacturers can lead advancements with relatively low investments, other complementary players that have a significant influence on market demand and uptake (e.g. infrastructure and battery manufacturers) are excluded from the Californian scheme, arguably causing a delay in consumer adoption. A lack of support in the complete zero-emissions car ecosystem may hamper the mass-market integration of zero-emissions vehicles.

The potential added value of the cap-and-trade mechanism to the development of commercial clean transportation should be further evaluated as the California program evolves. Meanwhile, a similar program that is complimentary to other regulatory tools (standards, ZEV-credits) should be considered in the broader context of emissions reduction and air quality improvement. Specifically, the likelihood that such a program will increase clean transportation fuels and appropriate infrastructure availability should be studied. As China is striving to lead future mobility and urban planning, the scope of cap-and-trade can be extended to include more diverse transportation segments (e.g. public transport, freight) and even commuters.

This study only infers potential barriers outlined by California experts rather than key players from China. Through key stakeholders' engagement, key barriers for implementing a ZEV credits type program in a pilot city (or cities) in China may be identified, and measures recommended to overcome these barriers. A recommended next step is a stakeholder workshop and roundtable discussion for suggesting areas for further exploration and issues of importance when considering ZEV-type program design for the case of China.

Appendix I

This section is offering a more detailed description of the ZEV credits program that that offered in chapter 3. The following description of the program is comprised of a simplification of the current regulation (pre- October 2014), examples and major revisions to the regulation which have been made to date.

Table 21: Detailed steps of the California ZEV-credits regulation

Step	Description
Step 1	Size Determination
Step 2	ZEV Base Volume Determination
Step 3	Requirement Determination
Step 4	Allowances
Step 5	Applicable Multiplier Determination*
Step 6	Total Credit Calculation
Step 7	Rules on Credit Use
Step 8	Special Provisions
Step 9	Travel Provision
Step 10	Demonstration of Compliance
Step 11	Penalties

* This step is phase out as of MY 2011, however may be useful for policy-makers in a design of a ZEV-like scheme thus overviewed in this section.

Step 1: Size Determination

The ZEV credits regulation does not require all vehicle manufacturers (VM) to comply, and compliance requirements vary between different volume manufacturers. Typically, large volume manufacturers face stricter ZEV production and credits obligations (elaborated under Step 3). The threshold for compliance is determined by company size: Large Volume Manufacturers (LVM), Intermediate Volume Manufacturers (IVM), Independent Small Volume Manufacturers (ISVM) and Small Volume Manufacturers (SVM). Company size is evaluated on the basis of average vehicle sales in the previous three consecutive years. Sales of passenger vehicles, light duty trucks (LDTs) and Medium duty vehicle (MDVs) are all included in sales calculations. The threshold is detailed in **Table 22**.

An ISVM is defined as a manufacturer with a California annual sales total of less than 10,000 new passenger cars, light-duty trucks and medium-duty vehicles following an aggregation of sales pursuant to section 1900(b)(8). Annual sales shall be determined as the average number of sales of the three previous consecutive model years for which a manufacturer seeks certification; however, for a manufacturer certifying for the first time in California, annual sales shall be based on the projected California sales for the model year. A manufacturer's California sales shall consist of all vehicles or engines produced by the manufacturer and delivered for sale in California. Vehicles or engines produced by the manufacturer and marketed in California by another manufacturer under the other manufacturer's nameplate shall be treated as California sales of the marketing manufacturer.

The annual sales from different firms shall be aggregated in the following situations: (1) vehicles produced by two or more firms, one of which is 10% or greater part owned by another, except in circumstances for which the Executive Officer determines that 10% or greater ownership by one of the firms does not result in responsibility for overall direction of both firms; (2) vehicles produced by any two or more firms if a third party has equity ownership of 10% or more in each of the firms; (3) vehicles produced by two or more firms having (a) common corporate officer(s) who is (are) responsible for the overall direction of the companies; or (4) vehicles imported or distributed by all firms where the vehicles are manufactured by the same entity and the importer or distributor is an authorized agent of that entity.

Table 22: Company subjection to the ZEV regulation

Company type*	Company sales**	Compliance requirement
Small vehicle manufacturer (SVM)	= or <4,500	Not subject***
Independent Small vehicle manufacturer (ISVM)	< 10,000	Not subject
Intermediate vehicle manufacturer (IVM)	= or > 4501 and = or <60,000	Subject to regulation, but can meet all with PZEVs
Large vehicle manufacturer (LVM)	> 60,000	Subject to regulation,

* Company size is determined by company sales in the previous three consecutive years.
** Passenger vehicles, light duty trucks (LDTs) and Medium duty vehicle (MDVs) are all included in sales calculation. For most manufacturers, "delivered for sale" means the number of vehicles delivered to dealerships in the state of California.
*** From models year 2003

In the case of a sales volumes shift that changes vehicle manufacturer's categorization downwards, the adequate new compliance requirement applies in the following model year (MY). In the case of a sales shift (or majority ownership agreement) that changes vehicle manufacturer categorization upwards, there is a grace period to the adequate shift in compliance requirement[87]. **Table 23** describes these shifts in categorization and compliance requirements.

Table 23: Company subjection to the ZEV regulation

Size shift direction	Previous company type	New company type	Compliance requirement
Increase	SVM	→ IVM	5 years lead time
	IVM	→ LVM	5 years lead time
Decrease	IVM	→SVM	Following MY
	LVM	→IVM	Following MY
Majority ownership agreement*	IVM+IVM	→LVM	3 years lead time

* In one manufacturer has 50% or greater ownership in another manufacturer, their sales are aggregated for determining size.

[87] Or beginning 2018, whichever comes first.

***Example size determination with an increase in size*:**

IVM Assessing manufacturing categorization in Model Year 2009

Step I: Calculating averages

MY	2004	2005	2006	2007	2008
Sale	45,000	53,000	59,000	63,000	64,000

2004-2006: 52,333 → IVM
2005-2007: 58,333 → IVM
2006-2008: 62,000 → LVM

Step II: preparing for transition

2009	2010	2011	2012	2013	**2014**
Avg. over 60,000	→	→	→	→	Subject to LVM requirement

Following the regulations amendments in October 2013, several IVM[88] requested for flexibility in requirements towards their potential shift from IVMs to LVMs. CARB is considering adding up to four years of lead time (extend lead time to five 3-year averages in excess of the 20,000 vehicle sales and global revenue threshold), and defining a temporary second LVM defining test (3 year average global revenue exceeds $40B, a test that would sunset in 2020).

New IVM-LVM lead time currently being considered by CARB

2015	2016	2017	2018	2019	2020	2021	2022	2023
1st 3 year average sales >20k sales								
	2nd 3 year average sales of >20k							
		3rd 3 year average sales >20k						
			4th 3 year average sales >20k					
				5th 3 year average sales >20k				
							LVM	

Step 2: ZEV Base Volume Determination

While the above section takes a manufacturer's size (sales-based approach) to determine its compliance requirement, the volume of vehicles delivered for sale in California also determines each manufacturer's ZEV base requirement. This assessment is taking into account the average Passenger Cars (PCs) and LDTs (including light duty truck produced as of 2003, namely LDT1, and prior to 1993, namely LDT2) delivered over a period specified in one of two optional calculation methods (See Method A and Method B). Manufacturers are free to choose between these two ZEV-base volume determination methods and may switch between these methods on an annual basis.

<u>Method A</u>: Prior Years
An average of the previous 4th, 5th, and 6th model year from the model year in which the manufacturer is complying.

[88]Jaguar Land Rover, Mazda, Mitsubishi, Subaru, and Volvo.

***Example Method A ZEV-base Volume Determination*:**

2013	Compliance year	MY assessment inclusion*
2012	1st	N/A
2011	2nd	N/A
2010	3rd	N/A
2009	4th	For the 2013 MY, manufacturers would use their 2007-2009 sales average
2008	5th	
2007	6th	

* For LDV2, multiply the fixed annual percentage specified in the above appropriate example to the LDV2s average 2003-2005 production.

<u>Method B</u>: Same Year
A projection of sales for the model year in which the manufacturer is complying

Example Method B ZEV-base Volume Determination:

2013
Use 2013 sales*

* For LDV2s, multiply the fixed annual percentage specified the above appropriate example to the LDV2s production.

PCs and LDT1s are calculated simply according to sales while as of 2009 LDT2s deliveries are phased in by multiplying the relevant period delivery numbers with a fixed multiplier for each ZEV credit requirement year as illustrated in **Table 24**.

Table 24: LDT2* calculation into the ZEV base volume determination

2009	2010	2011	2012+
51%	68%	85%	100%

* LDT2 is defined as LDT Model Year < 1993 while LDT1 is defined as LDT Model Year >= 1993.

In applying the ZEV requirement, a PC, LDT1, or LDT2 that is produced by one manufacturer (e.g., Manufacturer A), but is marketed in California by another manufacturer (e.g., Manufacturer B) under the other manufacturer's (Manufacturer B) nameplate, shall be treated as having been produced by the marketing manufacturer (Manufacturer B).

Step 3: ZEV Requirement

All vehicle manufacturers that are required to comply with the ZEV regulation (as described in section 3.4.1) are required to have a ZEV-defined portion of their annually determined ZEB-based volume (described in section 3.4.2) as detailed in **Table 25**. The required portion is comprised of a single or combination of ZEV-credit types, while they must meet a minimum of ZEVs ("gold" category) before moving on to other ZEV categories, as defined in **Table 26**. Most manufacturers choose to combine credit types (keeping the required minimum for each) as it is a cost-effective way for complying with the ZEV regulation. The ZEV requirement was initially based on the annual NMGO (None-Methane Organic Gas) production report for the appropriate model year[89], however it has recently been revised to a simplified credits figures illustration.

---

[89] http://www.arb.ca.gov/msprog/levprog/cleando/clean_nmogtps_final.pdf

Table 25: Minimum ZEV requirements per vehicle year model

Model Year (MY)	1998-2000	2001-2002	2003-2008	2009-2011	2012-2014	2015-2017	2018+**
ZEV fleet portion requirement	2%	5%	10%	11%	12%	14%	16%

* To be officially confirmed at a later date.

Table 26: ZEV credits categories and minimum annual requirement per ZEVs

ZEV vehicle type	ZEV credits category	Annual min requirement of ZEV base volume	
		2012-2014: Base Path	**2012-2014**: New Path
Pure Electric Vehicles (ZEVs)	**Gold, up to seven credits**	**0.79%**	**0.93%-3%**
Enhanced Advanced Technology Vehicles with Partial Zero-Emissions Rating (Enhanced AT PZEVs)	Silver +	2.21%	2.07%
Advanced Technology Vehicles with Partial Zero-Emissions Rating (AT PZEVs)	Silver	3%	2%
Partial Zero-Emissions Rating Vehicles (PZEVS)	Bronze	6%	6%

* A manufacturer must fulfill its ZEV (gold) requirement, but may fulfill the rest of its requirement with lower levels (for each a minimum must be met before shifting toward a lower level).

In order to obtain a ZEV category credit, there are specified minimum sales figures for each ZEV category type, detailed in **Table 27**. Typically, ZEVs earn 1 credit for delivery into California and earn additional credits when placed in service. No credits are given for vehicle that has not been put in service prior to December of the 5th calendar year after its model year (credits are considered of a specified calendar year if they are placed in the same year or prior to June 30th of the following year). If a ZEV is utilizing more than one ZEV fuel type (e.g. plug-in fuel cell vehicles) the basic fast refueling requirement (Type III,IV and V) can be waived by the executive officer approving the credits allowance.

Table 27: ZEVs type vehicles and ZEVs credits earned per vehicle type

	Definition: ***UDDS ZEV Range (miles)***	***Fast refueling (FR) capabilities***	**Credit per vehicle 2009-2011**	**Credit per vehicle 2012-2017**	**Credit per vehicle 2018+***
Type V	≥ 300 miles range	285 miles in ≤ 15 min	7	2012-2014: 7 2015-2017: 9	3
Type IV	≥ 200 miles range	190 miles in ≤ 15 min	5	5	3
Type III	≥ 100 miles range	95 miles in ≤ 10 min	4	4	3
	≥ 200 miles range	N/A			
Type IIx	≥ 100 miles range		N/A	3	3
Type II		N/A	3		
Type I.5x**	≥ 75, <100 miles range		N/A	2.5	2.5
Type I.5		N/A	2.5		
Type I	≥ 50, <75 miles range	N/A	2	2	2
Type 0	< 50	N/A	1	1	1
NEV	No minimum	N/A	0.3	0.3	0.3

* Estimations.
** A Type I.5x is a range extended battery electric vehicles powered predominantly by a zero emission energy storage device, able to drive the vehicle for more than 75 all-electric miles, and also equipped with a backup auxiliary power unit (typically a small gasoline powered engine), which does not operate until the battery is fully depleted. Type I.5x vehicles can only meet up to 50% of a manufacturer's pure ZEV requirement.

***Example base ZEV obligation calculation*:**

MY 2012: ZEV-base volume determined: 100,000 cars		
Total 12% credits obligation	(Figure 7)	= 12,000 cars
Must generate 0.79% credits from ZEVs	(Figure 8)	= 790 ZEVs
May generate 2.21% credits from Enhanced AT PZEVs	(Figure 8)	= 2,210 Enhanced AT PZEVs
May generate 3% credits from AT PZEVs	(Figure 8)	= 2,000 Enhanced AT PZEVs
May generate 6% credits from PZEVs	(Figure 8)	=6,000 Enhanced AT PZEVs

ZEV requirement for LVMs

Large Volume Manufacturers (LVMs) have two paths for meeting a stricter ZEV requirement. The selected path must be notified to the Executive Officer for CARB in writing prior to the start of a new model year[90].

In the 2009 through 2011 model years, Large Volume Manufacturers (LVMs) are

[90] Model year in the US still runs from October to September.

faced with the following two paths: primary path and alternative path. According to the primary path, LVMs must meet at least 22.5% of their ZEV requirement with ZEVs or ZEV credits generated by ZEVs, and at least 22.5% with ZEVs, AT PZEVs, or credits generated by such vehicles. The remainder of the ZEV credits requirement must be met using PZEVs or credits generated by such vehicles. The alternative path makes several provisions:

(i) Sets minimum floor for production of Type III ZEVs. The alternative path first requires the manufacturer to ensure its ZEV credits are equal to 0.82% of its total deliveries during 2003 through 2005 and is made by deliveries of ZEVs (other than NEVs and Type 0 ZEVs) using thecredits substitution ratio specified in **Table 28**. Furthermore, under specific limitations, manufacturers may use credits generated by 1997-2003 model year ZEVs for a year during calendar years 2009-2011[91]. ZEV credits earned between 2005 and 2008 can also be used in the 2009 through 2011 period given they are included in the minimum ZEV requirement and valued based on their model production year, whereas as of 2012 these credits can only be considered as TZEV, AT PZEV, or PZEV credits. A similar 4 year period of ZEV flexibility is applied for credits earned starting 2009, whereas as of the 4th year they may only be considered as TZEV, AT PZEV, or PZEV credits. A manufacturer that fails to meet the alternative path's requirement by the end of 2011 will be subject to the primary path from 2009 through 2011.

Table 28: LVMs 2009-2011 model year period: Alternative Path for meeting ZEV requirements

ZEV Type	Credits Substitution Ratio Compared to a Type III ZEV
Type I	2
Type I.5	1.6
Type II	1.33
Type IV	0.8
Type V	0.57

(ii) Compliance with percentage ZEV requirements.

A manufacturer electing the alternative compliance path must meet at least 45% of its ZEV credits requirement with ZEVs, AT PZEVs, TZEVs, or credits generated from such vehicles (but not PZEVs).

In the 2012 through 2017 model years, Large Volume Manufacturers (LVMs) face two separate periods with different requirements: 2012 through 2014 and 2015 through 2017both require a minimum of 0.79% and 3% of ZEVs (excluding NEVs and Type 0 ZEVs) respectively. In addition to periodic minimum requirements, during 2012-2014 model years an upper limit of 50% is placed on PZEVs, 75% on AT PZEVs, and 93.4% on TZEVs, Type 0 ZEVs, and NEVs. During 2015-2017, an upper limit of 42.8% will be placed on PZEVs, 57.1% on AT PZEVs and 78.5% on TZEVs, Type 0 ZEVs and NEVs. Should a manufacturer comply with the minimum ZEV requirement and maximum other credit types, the below **Table 29** will illustrate the appropriate annual percentage obligation.

[91] Provided that 33 years of such a multiplier will equal 4 ZEV credits.

Table 29: LVMs annual percentage obligation for the 2012 through 2017 model years

MY	Total ZEV Percent Requirement	Minimum ZEV Floor	TZEVs, Type Os, or NEVs	AT PZEVs	PZEVs
2012-2014	12%	0.79%	2.21%	3.0%	6.0%
2015-2017	14%	3.0%	3.0%	2.0%	6.0%

ZEV requirement for IVMs

From the 2009 through 2011 model years, Intermediate Volume Manufacturers (IVMs) are allowed to meet their requirement with up to 100% PZEVs or credits generated by such vehicles. For the 2005 through 2017 model years, the overall credits percentage requirements is 12% (instead of the basic 14%).

ZEV requirement for SVMs and Independent LVMs

Small Volume Manufacturers (SMVs) or independent low volume manufacturers are not required to meet the percentage of ZEV requirements; however, they can earn and market credits for ZEVs, TZEVs, AT PZEVs or PZEVs they produce and deliver for sale in California.

Step 4: ZEV Allowances

There are three types of allowances dedicated for PZEV type vehicles (namely PZEVs, AT PZEV and Enhanced AT PZEV or TZEVs) built upon an initial(i) Baseline PZEV Allowance, as follows: (ii) Zero Emission Fuel Cycle Allowance, (iii) Zero Emission Vehicle Miles Traveled (VMT) Allowance, and (iv) Advanced Componentry Allowance. In order to qualify for any type of allowance, the vehicle manufacturer must demonstrate compliance with the respective type allowance requirements, and may be eligible for a minimum allowance.

(i) For ***Baseline PZEV Allowance*** eligibility, which stands at ***0.2 allowance*** per vehicle, a manufacturer is required to:
a) meet SULEV emission standards;
b) have zero evaporative emissions from the 2009 through 2013 model years and comply with evaporative emissions standards for the 2014 through 2017 model years (subdivision 1976(b)(1)(G) or 1976(b)(1)(E));
c) meet the n-board diagnostic (OBD) requirement for 150,000 miles (section 1968.1 or 1968.2, as applicable);
d) have an extended warranty of15 years or 150,000 miles, whichever occurs first (2037(b)(2) and 2038(b)(2)).

(ii) In order to qualify for additional ***Zero Emission Fuel Cycle Allowance***, a manufacturer must demonstrate to the Executive Officer, using peer-reviewed studies or other relevant information, that NMOG emissions associated with the fuel(s) used by the vehicle (on a grams/mile basis) are lower than or equal to 0.01 grams/mile. Fuel-cycle emissions must be calculated based on near-term production methods and infrastructure assumptions, and the uncertainty in the results must be quantified. A vehicle that makes exclusive use of fuel(s) with very low fuel-cycle emissions shall receive a PZEV ***allowance of 0.3***.

(iii) There are two options for determining the ***Zero-Emission VMT Allowance*** of a manufacturer added to the basic PZEV allowance:
a) First option -PZEV that has zero-emission vehicle miles traveled ("VMT") capability, namely PHEV, will generate an additional Zero Emission Vehicle Miles Traveled (VMT) Allowance limited at ***1.39 allowance***, calculated as follows:

Table 30: Zero-Emission VMT Allowance Determination Option A

Range	Zero-emission VMT Allowance
EAERu< 10 miles	0.0
EAERu ≥ 10 to 40 miles	EAERu x (1-UFRcda)/11.028
EAERu> 40 miles	3.627 x (1-UFn) *Where, n= 40x(Rcda/EAERu)*

Note: EAERu stands for urban equivalent all-electric range, the Rcda stands for urban charge depletion range actual, and UF is defined as Utility Factor[92].

b) Second option - As an alternative to determining the zero-emission VMT allowance a manufacturer may submit for Executive Officer approval an alternative procedure for determining the zero-emission VMT potential of the vehicle as a percent of total VMT, along with an engineering evaluation that adequately substantiates the zero-emission VMT determination. For example, an alternative procedure may provide that a vehicle with zero-emissions of one regulated pollutant (e.g., NOx) and not another (e.g., NMOG) will qualify for a zero-emission VMT ***allowance of 1.5***.

(iv) ***Advanced Componentry Allowance*** can be obtained by two types of PZEVs: High Pressure Gaseous Fuel or Hydrogen Storage (detailed in the below (a) sub-section) and Use of a Qualifying HEV Electric Drive System (detailed in the below (b) sub-section).
a) A vehicle equipped with a high pressure gaseous fuel storage system capable of refueling at 3600 pounds per square inch or more and operating exclusively on this gaseous fuel shall qualify for an advanced componentry PZEV ***allowance of 0.2***. A vehicle capable of operating exclusively on hydrogen stored in a high pressure system capable of refueling at 5000 pounds per square inch or more, stored in nongaseous form or at cryogenic temperatures, shall instead qualify for an advanced componentry PZEV ***allowance of 0.3***.

Table 31: Advanced Componentry Allowance Determination for PZEVs in Use of High Pressure Gaseous Fuel or Hydrogen Storage

Fuel Type	Psi	*AC allowance*
Gaseous fuel	3600 psi	***0.2***
Hydrogen fuel	5000 psi	***0.3***

[92]The urban equivalent all-electric range (EAERu) and urban charge depletion range actual (Rcda) are determined in accordance with section G.11.4 and G.11.9, respectively, of the "California Exhaust Emission Standards and Test Procedures for 2009 through 2017 Model Zero-Emission Vehicles, and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium Duty Vehicle Classes" adopted November 2008 and last amended December 2012. The utility factor (UF) is determined according to SAE International's Surface Vehicle Information Report J2841 SEP2010 (Revised September 2010).

b) HEVs qualifying for additional advanced componentry PZEV allowance or allowances that may be used in the AT PZEV category are classified in one of four types of HEVs based on the criteria in the following table:

Table 32: Advanced Componentry Allowance Determination for PZEVs in Use of a Qualifying HEV Electric Drive System

Characteristics		Type C*	Type D	Type E	Type F	Type G
Electric Drive System Peak Power Output		≥10 kw	≥10 kw	≥50 kw	Zero-Emission VMT allowance; ≥ 10 mile all-electric UDDS range	Zero-Emission VMT allowance; ≥ 10 mile all-electric US06 range
Traction Drive System Voltage		<60 Volts	≥60 Volts	≥60 Volts	≥60 Volts	≥60 Volts
Traction Drive Boost		Yes	Yes	Yes	Yes	Yes
Regenerative Braking		Yes	Yes	Yes	Yes	Yes
Idle Start/Stop		Yes	Yes	Yes	Yes	Yes
Additional advanced allowance	***2009-2011 MY***	***0.2***	***0.4***	***0.5***	***0.72***	***0.95***
	2012-2014 MY	***0.15***	***0.35***	***0.45***	***0.67***	***0.9***
	2015-2017 MY	***N/A***	***0.25***	***0.35***	***0.57***	***0.8***

* Type C hybrid electric vehicles were removed in 2012, due to the fact that no manufacturer ever pursued this type of hybrid vehicle or architecture and manufacturers agreed that it was no longer relevant to the current state of technology.

Step 5: Applicable Multiplier Determination

The ZEV credits program adds a phase-in multiplier applicable to zero-emission VMT allowance, as generally illustrated in **Table 33**. The current 1.25 multiplier available for ZEVs (excluding NEVs and Type 0) exists if the vehicle is sold to motorists or leased for at least three years with a re-lease option for another two years or purchase are available. This multiplier is however phased out for model years after 2011.

Table 33: Applicable multiplier determination

Vehicle Type	Requirements	Multiplier
PHEV	- 2009-2011 MY - Vehicles sold or leased for 3 years (with 2 years re-lease or purchase option)	1.25
ZEV (excluding NEVs and Type 0)	- 2009-2011 MY - Vehicles sold or leased for 3 years (with 2 years re-lease or purchase option)	1.25
ZEVs and > 10 mile zero emission VMT allowance PZEVs	- 1997-2003 MY - Vehicles still registered in California and placed after April 24 2013	0.2 of the credit they would receive if placed in the compliance model year

Step 6: Total Credit Calculation

The total ZEV calculation is determined upon vehicle segmentation (outlined in **Table 26**), specific tier in the case of ZEVs (**Table 27**), and specific allowance in the case of PZEVs (generally described in **section 3.1.2 of this report**), as summarized in **Table 34**.

Table 34: Basic credits calculation method

Vehicle segmentation	Basic credits allowance	+ Additional credits allowance*	X Multiplier**
Pure Electric Vehicles (ZEVs)	Ranges 0.3-7 (See **Figure 8**)***	N/A	1.25 (excluding NEVs and Type 0)
Enhanced Advanced Technology Vehicles with Partial Zero-Emissions Rating (Enhanced AT PZEVs or TZEVs)	0.2	**+** Zero Emission VMT (1.39 or 1.5) **+**Adv. Comp. (Ranges 0.15-0.95) **+** Low Fuel Cycle (0.3)	1.25 (PHEVs)
Advanced Technology Vehicles with Partial Zero-Emissions Rating (AT PZEVs)	0.2	**+** Adv. Comp. (Ranges 0.15-0.95) **+** Low Fuel Cycle (0.3)	N/A
Partial Zero-Emissions Rating Vehicles (PZEVS)	0.2	N/A	N/A
Formula:	***(X +***	***Y)***	**** Z = Credits***

* See additional credits allowances determination example below
** Excluded from this table are: (i) multiplier for ZEVs and **>** 10 mile zero emission VMT allowance PZEVs
*** ZEVs receive 1 credit upon delivery in CA and additional when placed in service.

Example A:	
MY 2011Type D Hybrid (AT PZEV) would receive:	
0.2 (PZEV basic allowance) **+ 0.4 (for Advanced Componentry Allowance)**	**= 0.6 credits**
Example B:	
MY 2011CNG Vehicle (AT PZEV) would receive:	
0.2 (PZEV basic allowance) **+ 0.2 (for Advanced Componentry Allowance)** **+ 0.3 (Low Fuel Cycle)**	**= 0.7 credits**
Example C:	
2009 sold Type F 10mi EAER PHEV (Enhanced AT PZEV or TZEVs):	
0.2 (PZEV basic allowance) **+ 0.72 (for Advanced Componentry Allowance)** **+ 0.7 (Zero Emission VMT)** **X 1.25 (multiplier)**	***= 2.03 credits***
Example D:	
2012 sold Type F 10mi EAER PHEV (Enhanced AT PZEV or TZEVs):	
0.2 (PZEV basic allowance) **+ 0.67 (for Advanced Componentry Allowance)** **+ 0.7 (Zero Emission VMT)**	***= 1.57 credits***

Step 7: Rules on Credit Use

In general, all credits produced in excess of a manufacturer's requirements may be "banked" for future use. Credits earned from all types of vehicles may be traded or sold to any other party, and traded credits can be used the same way as credits earned from vehicles placed.

Special provisions allow for manufacturers to meet up to a certain amount of their requirements, based on the type of vehicle produced and the regulatory period. As illustrated in **Table 35**, AT PZEVs are not restricted between 2009 and 2011 for manufacturers that elect the alternative path, possibly in an attempt to promote advanced solutions that have good market entry potential.

Table 35: PZEV credits cap restriction in fulfillment of ZEV credits requirement

PZEV Type	Period	Restriction	% out of the company's credit-base requirement
PZEVs	2009-2011	55%	6% (out of 11%)
	2012-2014	50%	6% (out of 12%)
AT PZEVs	2009-2011	72.5%	8.5% (out of 11%)
	2009-2011 Alternative Path	100%	11% (out of 11%)
Enhanced AT PZEVs or TZEVs	2009-2011	75%	9% (out of 12%)
	2012-2014	93.4%	11.21% (out of 12%)

Carry forward provisions exist for allowing the utilization of credits from ZEV vehicles from model year 2005 through 2008, with specific more stringent restrictions on LVMs. LVMs can apply such credits for meeting their 2009 through 2011 obligations, including the ZEV minimum requirement. However, beginning 2012 these 2005-08 ZEV credits may only be applied to the Enhanced AT PZEV, AT PZEV, and PZEV categories. Non-LVMs may earn and bank their ZEV credits until they are subject to LVM requirements. This rule on credits use is aimed at triggering a ZEV-development focus (or credits purchase for sponsorship of small companies ZEV introduction) by LVMs. Trades/sales also trigger LVM carry forward provision, further incentivizing LVM to purchase ZEV credits by allowing flexibility in using them for complying with the regulation.

Rules also exist for the case of "neighborhood electric vehicle" or "NEV"[93], gradually decreasing their use is fulfillment of ZEVs but allowing for their use in fulfillment in PZEVs - which reflects CARB's endorsement of this small zero-emissions vehicle segment.

Table 36: Special provisions for utilizing NEV credits in meeting ZEV requirements

Model Years	Obligation	Allowed %
2009-2011	ZEVs	Up to 50%
2009	AT PZEVs, but not PZEVs	Up to 75%
2010-2011		Up to 50%
2009-2011	PZEVs	100%
2012-2014	ZEVs	0%
2012-2014	AT PZEVs, but not PZEVs	50%
2012-2014	PZEVs	100%

Step 8: Special Provisions

Special provisions enable demonstration vehicle and transportation systems credits for meeting the ZEV-credits requirements:

Advanced demonstration vehicles (not delivered for sale or registered with the regulator) may also earn credits, if they are (i) placed for two years, (ii) spend 50% of the time in California, (iii) up to 25 vehicles per model, and (iv) of 2009-2014 model year vehicles.

Further special provisions enable to earn credits from vehicles placed in projects with innovative transportation systems, such as Shared Use and Intelligent Technologies and transportation tools of Linkage to Transit, as summarized in **Table 37**. Manufacturers must have executive officer approval in order to earn these credits. Credits can be earned for ZEVs for either Shared Use and Intelligent Technologies or Linkage to Transit, or both, but Non-ZEVs can only be used for Shared Use or both and not just for linkage to transit.

[93]NEV is a motor vehicle that meets the definition of Low-Speed Vehicle either in section 385.5 of the Vehicle Code or in 49 CFR 571.500 (as it existed on July 1, 2000), and is certified to zero-emission vehicle standards

Table 37: Transportation systems credits

2009-2011	Shared-Use / Intelligence	Link to Transit	Limit
PZEV	2	1	<1/50th of AT PZEV Requirement
AT PZEV	4	2	<1/20th of AT PZEV Requirement
Enhanced AT PZEV or TZEVs	4	2	<1/10th of Enhanced AT PZEV Requirement
ZEV	6	3	<1/10th of ZEV Requirement
2012+			
Enhanced AT PZEV	1	1	
ZEV	2	1	

Step 9: Travel Provision

"Section 177 State" isa state that is administering the California ZEV requirements pursuant to section 177 of the federal Clean Air Act (42 U.S.C. Sec. 7507). The section enables travel provisions of credits earned by vehicles for demonstration or placed in use if they are ZEVs (excluding Type 0s and NEVs), where Type I, I.5, and II ZEVs can be earned and transferred between 2009 and 2014, while Type III, IV, or V ZEVs can be earned and transferred between 2009 and 2017, and Type I.5x or Type IIx can be earned and transferred between 2012 and 2017 as described in **Table 38**. Manufacturers must deliver ZEVs to 177 states prior to 2018 to earn the flexibility to pool compliance in ZEV states and to earn a reduced TZEV requirement, with 0.75% two years prior to 2018 (2016), and 1.5% one year prior to 2018 (2017).

Table 38: Model Years that can be transferred per ZEV type under the travel provisions

Vehicle Type	Model Year
Type I, I.5 or II ZEV	2009-2017
Type III, IV or V ZEV	
Type I.5x or Type IIx	2012-2017

For model year 2009 the full amount of credits earned can be transferred. However, between 2010 and 2017, ZEVs are placed in California "travel" at a proportional value to Section 177 States: the ratio of the manufacturers' Section 177 state sales are multiplied by the manufacturers' California sales. For example, if a manufacturer earns 40 credits in California for its ZEV sales, these credits will be converted to 20 if transferred to New York, where the manufacturer's sales are only 50% of its California sales. For models produced in 2010 and 2011 by manufacturers on the Alternative Path, the credits transfer fully to meet the requirement of the destination, however credits beyond the requirement are transferred proportionally. For example, if a manufacturer earns 1200 credits in California from selling 300 Type III cars, it can transfer 200 credits to meet its full New-York requirement (equal to 50 Type III vehicles)and transfer another 500 credits (equal to 1000 California credits or 250 Type III cars if its New-York sales are 50% of its California sales). On the administration front, any LVM or IVM manufacturer intending to transfer credits between section 177 states should inform them of their Alternative Path selection (as well as CARB executive office) prior to September 1st 2014.

Example: Credits traveled between California and Section 177 State

Manufacturer specs	ZEVs sold in CA	Credits in CA	NY sales/ CA sales	ZEV sales requirement in NY	Credits in NY
Alternative Path; Type III ZEV	300	1200	50%	50	200 (=50 cars) + 500 (50%*(1200-200)) = 700
Basic Path; Type III	40	160	50%	N/A	80 (=50%*160)

The regulation obligates LVM and IVM to an additional 2016 and 2017 model year ZEV requirement for compliance with the optional section 177 state path: a manufacturer must generate additional model year 2012 through 2017 credits in each section 177 state (excluding NEV and Type 0, and with a cap of 50% on Type I.5x and Type IIx) by selling ZEVs of a total volume equal to the following percentage of their sales volume in the applicable state by no later than June 30, 2018 (defined in Step II):

Table 39: Additional 2016 and 2017 Model Year ZEV requirements for LVMs and IVMs

Model Years	Additional Section 177 State ZEV requirements
2016	0.75%
2017	1.5%

LVMs and IVMs complying with the above additional 2016 and 2017 ZEV requirements of their optional section 177 state compliance path are allowed to meet reduced TZEV requirements as detailed in **Table 40** below.

Table 40: Reduced TZEVs for LVMs and IVMs meeting the Additional Section 177 State 2016 and 2017 requirement

Model Year	2015	2016	2017
Existing TZEV %*	3%	3%	3%
Section 177 state Adjustment for Optional Compliance Path for TZEVs	75%	80%	85%
New Section 177 State Optional Compliance Path TZEV %	2.25% (=3%*75%)	2.4% (=3%*80%)	2.55% (=3%*85%)

* As stated in **Table 12**

Table 41: Total, floor ZEV and Ceiling TZEV requirements for LVMs and IVMs electing the optional path for section 177 state compliance

Years	Total ZEV % requirement	Minimum ZEV floor	Maximum TZEV ceiling	AT PZEV (no change)	PZEV (no change)
2015	13.25%	3%	2.25%	2%	6%
2016	14.15%	3.75%	2.4%	2%	6%
2017	15.05%	4.5%	2.55%	2%	6%

Following the regulations amendments in October 2013, several IVMs[94] requested revisions in the section 177 State compliance considerations: (i) exclusion from the prior 2018 ZEV requirement; (ii) revision of their ZEV placement requirement to only two years before the start of their LVM status (0.75% ZEVs two years prior and 1.5% ZEVs one year prior);(iii) allowance for another two years for fulfilling their ZEV requirements (after becoming LVM, one year more from the current provision); and (iv) no reduction in TZEVs[95].

Credits within the West Region Pool and East Region Pool[96] may be traded if on the same model year and compliance year. However, trading of transfer credits between the West Region Pool and East Region Pool incurs a premium of 30%. For example, a manufacturer that need to compensate for 100 credits shortfall in the West Region Pool can transfer 100 credits earned at another West Region Pool state, but would have to transfer 130 credits if earned at the East Region Pool. The California ZEV bank is excluded from all within and between pool trading.

Step 10: Demonstration of Compliance

For manufacturers subject to the regulation, all compliance reports (including path selection) are due May 1 of the calendar year following the compliance model year (for example, for the 2014 MY, reports are due May 1, 2015) yet manufacturers may update reports until September. However, manufacturers not subject to the regulation may submit credits at any time, and credit trades or sales may be reported at any time[97].

The public disclosure of the 2009 MY was of each manufacturer's annual production and ZEV credits earned per vehicle. As of the 2010 MY, each manufacturer's annual ZEV credit balances, including credits from transportation systems, advanced demonstrations, and trades and sales from other parties, are also available to public through CARB website. The value of credits, however, is a discrete property of the trading partners. Financial reporting may expose revenues from credits sales; however, it may not detail the credits volumes and trading partners, and thus a full picture of the value of credits may not be available to the public.

The certification requirements and test procedures for determining compliance with the ZEV-credits regulation are set forth in "California Exhaust Emission Standards and Test Procedures for 2009 through 2017 Model Zero-Emission Vehicles and Hybrid Electric

[94] Major stakeholders: Jaguar Land Rover, Mazda, Mitsubishi, Subaru, and Volvo.
[95]In 2018 PZEV credits are converted to T-ZEV credits using a conversion factor. IVM PZEV credits are discounted by 75% and LVM PZEV credits are discounted by 93.25%.
96 "East Region pool" means the combination Section 177 states east of the Mississippi River; "West Region Pool" means the combination of Section 177 states west of the Mississippi River.
[97]http://www.arb.ca.gov/msprog/macs/macs.htm

Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes," adopted December 17, 2008, and last amended December 6, 2012. The test procedures for determining compliance with the regulation are set forth in ETA-NTP002 (revision 3) "Implementation of SAE Standard J1666 May 93: Electric Vehicle Acceleration, Grade ability, and Deceleration Test Procedure" (December 1, 2004), and ETA-NTP004 (revision 23) "Electric Vehicle Constant Speed Range Tests" (February 1, 2008).

Step 11: Penalties

If a manufacturer demonstrates non-compliance, it has an additional two years to make up a ZEV deficit. Penalties apply as of the 3rd year, and are specified in the Health and Safety Code (HSC 43211).

There is a $5,000 penalty per vehicle or credit not produced, under the defined default 1 ZEV credit equivalent value of Type 0 ZEV. For instance, if a vehicle manufacturer is 500 credits short in fulfilling its regulatory requirement, and does not make up the deficit within the following two-year grace period, it will pay a penalty of 500*$5,000=$2.5 million.

A manufacturer that elects the optional section 177 state compliance path and does not meet its requirements (described in **Step 9**) by June 30th 2018 in all or part of section 177 states within an applicable pool shall be treated as subject to the total ZEV percentage requirements in **Step 2** (requirement volume determination) for the 2015 through 2017 model years in each section 177 state. The pooling provisions (detailed in **Step 9**) shall not apply. Any transfers of ZEV credits between section 177 states will be null and void, and ZEV credits will return to the section 177 state in which the credits were earned.

Appendix II

Tesla Moors' Annually Reported Financial Status							
	2007	2008	2009	2010	2011	2012	2013
Gross revenue revenue margin (%)	88%	-8%	9%	26%	30%	7%	23%
Gross margin without ZEV credits (%)	88%	-41%	1%	25%	29%	-3%	14%
Simple Breakdown							
Total Revenue ($M)	$73	$14,742	$111,943	$116,744	$204,242	$413,256	$2,013,496
Total cost of revenue ($M)	$9	$15,883	$102,408	$86,013	$142,647	$383,189	$1,557,234
Gross profit ($M)	$64	-$1,141	$9,535	$30,731	$61,595	$30,067	$456,262
Credits revenues ($M)	$0	$3,500	$8,200	$2,800	$2,700	$40,500	$194,400
Detailed Breakdown							
Auto sales revenues ($M)	$73	$11,242	$103,355	$72,659	$99,008	$313,844	$1,758,284
Powertrain sales revenues ($M)	$0	$0	$388	$21,619	$46,860	$31,355	$45,102
ZEV Credits revenues ($M)	$0	$3,500	$8,200	$2,800	$2,700	$32,400	$129,800
Other credits revenues ($M)	$0	$0	$0	$0	$0	$8,100	$64,600
Development services revenues ($M)	$0	$0	$0	$19,666	$55,674	$27,557	$15,710
Automotive sales costs ($M)	$9	$15,883	$102,408	$79,982	$115,482	$371,658	$1,543,878
Development services costs ($M)	$0	$0	$0	$6,031	$27,165	$11,531	$13,356
Other data							
Net profit ($M)	-$78,157	-$82,782	-$55,740	-$154,328	-$254,411	-$396,213	-$74,014
Net profit without ZEV credits ($M)							
ZEV credits % / Gross profit	0%	-307%	86%	9%	4%	135%	43%
ZEV credits % / Net profit	0%	-4%	-15%	-2%	-1%	-8%	-175%
Net porfit margin	6%	-33%	177%	65%	56%	-81%	

Tesla Motors Quarterly Reported Financial Status

	2009 Q1	2009 Q2	2009 Q3	2009 Q4	2010 Q1	2010 Q2	2010 Q3	2010 Q4	2011 Q1	2011 Q2	2011 Q3	2011 Q4	2012 Q1	2012 Q2	2012 Q3	2012 Q4	2013 Q1	2013 Q2	2013 Q3	2013 Q4
Gross revenue revenue margin (%)	-10%	8%	17%	10%	19%	22%	30%	31%	37%	32%	30%	20%	34%	18%	-17%	8%	17%	25%	24%	25%
Gross margin without ZEV credits (%)	-38%	2%	13%	8%	16%	21%	28%	30%	36%	31%	29%	18%	33%	17%	-24%	-2%	6%	14%	22%	25%
Simple Breakdown																				
Total Revenue ($M)	$21	$27	$46	$19	$21	$28	$31	$36	$49	$58	$58	$39	$30	$27	$50	$306	$562	$405	$431	$615
Total cost of revenue ($M)	$23	$25	$38	$17	$17	$22	$22	$25	$31	$40	$40	$32	$20	$22	$59	$282	$465	$305	$328	$459
Gross profit ($M)	-$2	$2	$8	$2	$4	$6	$9	$11	$18	$19	$17	$8	$10	$5	-$9	$24	$96	$100	$103	$157
Credits revenues ($M)	$4	$2	$2	$0	$1	$1	$1	$1	$1	$1	$1	$1	$2	$2	$5	$31	$84	$68	$27	$16
Detailed Breakdown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto sales revenues ($M)	$17	$25	$44	$18	$17	$19	$17	$19	$20	$27	$28	$25	$16	$14	$35	$249	$457	$321	$395	$585
Powertrain sales revenues ($M)	$0	$0	$0	$0	$2	$5	$5	$9	$13	$11	$15	$7	$1	$6	$10	$14	$14	$13	$8	$9
ZEV Credits revenues ($M)	$4	$2	$2	$0	$1	$1	$1	$1	$1	$1	$1	$1	$0	$0	$3	$29	$68	$52	$10	$0
Other credits revenues ($M)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2	$2	$2	$2	$16	$16	$16	$16
Development services revenues ($M)	$0	$0	$0	$0	$0	$4	$8	$7	$15	$19	$14	$7	$11	$5	$0	$12	$7	$4	$1	$4
Automotive sales costs ($M)	$23	$25	$38	$17	$17	$20	$19	$23	$27	$31	$33	$25	$14	$20	$59	$279	$462	$304	$325	$454
Development services costs ($M)	$0	$0	$0	$0	$0	$2	$2	$2	$4	$9	$8	$6	$6	$2	$0	$4	$4	$1	$4	$5
Other data	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Net profit ($M)	-$16	-$11	-$5	-$24	-$30	-$39	-$35	-$51	-$49	-$59	-$65	-$81	-$90	-$106	-$111	-$90	$11	-$31	-$38	-$16
Net profit without ZEV credits ($M)	-$20	-$12	-$7	-$25	-$30	-$39	-$36	-$52	-$50	-$60	-$66	-$82	-$90	-$106	-$113	-$119	-$57	-$82	-$49	-$16
ZEV credits % / Gross profit		76%	26%	17%	16%	8%	10%	7%	3%	4%	4%	9%	22%	48%	52%	132%	87%	67%	26%	10%
ZEV credits % / Net profit		15%	43%	1%	2%	1%	3%	2%	1%	1%	1%	1%	0%	0%	2%	33%	604%	169%	27%	0%
Net profit margin		-32%	-58%	425%	22%	30%	-9%	47%	-5%	20%	10%	25%	10%	18%	5%	-19%	-113%	-371%	26%	-58%