M E M O R A N D U M

TO: Rep. Kathy Castor, Chair
U.S. House Select Committee on the Climate Crisis

FROM: Whit Koch, Jake Miller, and Sierra Waechter

CC: Prof. Greg Dotson, University of Oregon, School of Law

DATE: November 15, 2019

RE: National Zero Emission Vehicle Program

In recognition of the need to decrease greenhouse gas emissions and air pollutants, many countries are looking to electric vehicles as a potential path forward. This paper identifies and analyzes a variety of potential ways to accomplish this reduction through the implementation of a national Zero Emission Vehicle (ZEV) program. The main objective of a ZEV program is to increase the number of electric vehicles on the road in order to help scale up production of such vehicles and drive down emissions from the transportation sector.

This analysis will include an overview of the market for ZEVs in existence today, the benefits and impediments to developing a ZEV market, and the status of the battery market. Additionally, this paper will look at the existing ZEV programs around the world, including California, China, and the European Union. Finally, this analysis will discuss some pathways to a national ZEV program in the United States, including congressional and administrative action.

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I. Introduction

To begin, it is vital to understand exactly what is meant by the term "Zero Emission Vehicle." According to the California Air Resources Board (CARB), a Zero Emissions Vehicle is "any new vehicle which produces zero exhaust emissions of any criteria air pollutant under any and all operational modes and conditions."[1] Despite this seemingly obvious definition, there are many different examples of ZEVs and, depending on the structure of a program, vehicles that do emit criteria air pollutants can still be counted towards satisfying the ZEV credit. These vehicles are referred to as Transitional Zero Emission Vehicles (TZEVs) and are subject to a variety of different emissions standards.[2] Additionally, each ZEV program uses its own terminology. For example, the ZEV program implemented in China refers to ZEVs as New Energy Vehicles (NEV),[3] and the European Union refers to ZEVs as Zero Low Emission Vehicles (ZLEV).[4] For the purposes of this paper, we will utilize the term ZEV for all sections that are not directly addressing the Chinese and European Union programs.

As stated earlier, there are multiple subcategories of ZEVs. The first example is a Battery Electric Vehicle (BEV) which is a typical battery powered vehicle that likely comes to mind when thinking about an electric car. These vehicles' batteries are the source of power for the vehicle's electric motor and are charged from an external power supply.[5] Additionally, BEVs can charge through the use of regenerative braking.[6] Examples of BEVs include the Tesla Model S

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[1] Office of Energy Efficiency & Renewable Energy, *Zero Emission Vehicle (ZEV) Production Requirements*, U.S. DEP'T OF ENERGY, https://afdc.energy.gov/laws/4249 (last visited Nov. 2, 2019).
[2] *Id.*
[3] CHINA'S NEW ENERGY VEHICLE MANDATE POLICY (FINAL RULE), INT'L COUNCIL ON CLEAN TRANSP. 1, 1 (Jan. 2018).
[4] *See* European Commission on Energy, Climate Change, Environment, *Post-2020 CO2 emission performance standards for cars and vans: Policy*, EUROPEAN UNION, https://ec.europa.eu/clima/policies/transport/vehicles/regulation_en#tab-0-0. (last visited Nov. 2, 2019).
[5] Office of Energy Efficiency & Renewable Energy, *How Do All-Electric Cars Work?*, U.S. DEP'T OF ENERGY, https://afdc.energy.gov/vehicles/how-do-all-electric-cars-work (last visited Nov. 2, 2019).
[6] *Id.*

and the Ford Focus Electric.[7] There is also a subcategory of BEVs called Extended Range Battery Electric Vehicles (BEVx) which is occasionally referenced when discussing BEVs. These vehicles can be powered by both a battery or an internal combustion engine. To fall into this category, the vehicle's range under electrical power has to exceed the range with the internal combustion engine.[8] One noteworthy example of a BEVx is the BMW i3 REx which has a range of 97 miles all electric and a total range of over 180 miles.[9]

The next category of ZEVs is Plug-In Hybrid Electric Vehicles (PHEV). Like a BEVx, a PHEV uses both an electric engine powered by a battery and an internal combustion engine (ICE) which is powered by a fuel source like gasoline.[10] However with a PHEV, the range of the vehicle under battery power is typically much less than the range with the internal combustion engine.[11] Another aspect of PHEVs is their ability to charge the battery through the use of regenerative braking.[12] Examples of PHEVs include the Toyota Prius Prime and the Honda Clarity PHEV.[13] Plug-In Hybrid Electric Vehicles are one example of a TZEV mentioned earlier based on their ability to emit criteria air pollutants.[14]

Another category of ZEVs is Fuel Cell Electric Vehicles (FCEV). These vehicles have an electric motor like BEVs, but unlike BEVs their electric motors are powered by a fuel cell fueled

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[7] *Types of Electric Vehicles*, EVGO, https://www.evgo.com/why-evs/types-of-electric-vehicles/ (last visited Nov. 2, 2019).
[8] *California's Advanced Clean Cars Midterm Review: Appendix I*, CAL. ENVTL. PROTECTION AGENCY AIR RES. BD., I-i, I-3 (Jan. 18, 2017), https://ww3.arb.ca.gov/msprog/acc/mtr/appendix_i.pdf.
[9] Jay Cole, *2017 BMW i3 Rex (94 Ah) Arrives In US, Rated At 97 Miles AER, 180 Total Miles*, InsideEVs, (Sept. 10, 2016, 12:15 AM), https://insideevs.com/news/331204/2017-bmw-i3-rex-94-ah-arrives-in-us-rated-at-97-miles-aer-180-total-miles/.
[10] Office of Energy Efficiency & Renewable Energy, *How Do Plug-In Hybrid Cars Work?*, U.S. DEP'T OF ENERGY, https://afdc.energy.gov/vehicles/how-do-plug-in-hybrid-electric-cars-work (last visited Nov. 2, 2019).
[11] *California's Advanced Clean Cars Midterm Review: Appendix I*, *supra* note 8, at I-3.
[12] *Types of Electric Vehicles*, *supra* note 7.
[13] *Id.*
[14] *What is ZEV?* Union of Concerned Scientists, (Aug. 7, 2012). https://www.ucsusa.org/resources/what-zev

by hydrogen.[15] One example of a currently available FCEV is the Toyota Mirai.[16] Although there are a few FCEVs on the road, these vehicles are located almost exclusively in California, where the state has invested in fueling stations for them.[17]

Now that the foundation for this discussion has been laid, the analysis of ZEV markets and policy recommendations can begin. This paper will first describe the transportation sector of the United States. Additionally, this paper will look at the existing ZEV programs around the world, including California, China, and the European Union. Finally, this paper will examine four policy pathways that will enhance the growth of the ZEV market in the United States.

II. State of the Transportation Market in the United States

This section will first describe the existing ZEV market in the United States. Next, this section will examine how quickly a market transition to ZEVs can occur by analyzing the decreasing price of batteries. Then this section will examine the amount of emissions coming from the United States' economy, especially the transportation sector. Finally, this section will analyze the benefits of switching to ZEVs and the impediments preventing the development of EVs.

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[15] Office of Energy Efficiency & Renewable Energy, *How Do Fuel Cell Electric Cars Work?*, U.S. DEP'T OF ENERGY, https://afdc.energy.gov/vehicles/how-do-fuel-cell-electric-cars-work (last visited Nov. 2, 2019).
[16] Antuan Goodwin, *2021 Toyota Mirai Fuel Cell Vehicle Revealed and it Looks Amazing*, Road Show (Oct. 10, 2019, 1:00 PM), https://www.cnet.com/roadshow/news/2021-toyota-mirai-hydrogen-fuel-cell-revealed/.
[17] Office of Energy Efficiency & Renewable Energy, *Hydrogen Fueling Station Locations*, U.S. DEP'T OF ENERGY, https://afdc.energy.gov/fuels/hydrogen_locations.html#/find/nearest?fuel=HY (last visited Nov. 2, 2019).

1. Growth of EVs in the United States Auto Market

As of June 30, 2019, there were about 1,270,000 ZEV cars on U.S. roadways.[18] The growth in sales of ZEVs increased dramatically over the last ten years.[19] In 2011, 18,000 ZEVs were sold in the United States.[20] In comparison, in 2018 the number of ZEVs sold jumped to about 361,000 cars.[21] The 2018 sale's figures represent about a 1,900 percent increase in sales.[22]

This explosive growth continues as 85,000 EVs were sold in the United States during the second quarter of 2019.[23] This figure represented a 23% increase in sales for the second quarter of 2019 when compared to the second quarter of 2018.[24] As of September of 2019, there were a total of forty-five electric vehicle (EV) models offered for sale in the United States.[25] This is a substantial growth from 2012 when only nine models were offered.[26]

Many auto manufacturers are developing ZEVs on a massive scale as part of each company's climate strategy. Volkswagen has committed to making eighty new electric car models by 2025.[27] Further, Volkswagen aims at producing 4 million ZEVs per year by 2030.[28] On a somewhat smaller scale Nissan-Renault plans on developing 8 EV models and 12 electrified vehicles.[29] Nissan-Renault also plans on selling between two and three million EVs by

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[18] *Electric Vehicle Trends & Key Issues*, EDISON ELEC. INST., 1,1 (Sept. 2019), https://www.eei.org/issuesandpolicy/electrictransportation/Documents/Quarterly%20Update_EV%20Trends%20and%20Key%20Issues_Sept2019_WEB.pdf.
[19] David Gohlke & Yan Zhou, *Assessment of Light-Duty Plug-In Electric Vehicles in the United States: 2010-2018*, ARGONNE NATIONAL LIBRARY (Mar. 2019).
[20] *Id.*
[21] *Id.*
[22] *See Id.*
[23] *Electric Vehicle Trends & Key Issues*, *supra* note 18, at 1.
[24] *Id.*
[25] *See* Steven Loveday, *Monthly Plug-In EV Sales Scorecard: Historical Scorechart*, INSIDEEVS (Dec. 3, 2018, 9:25 PM) https://insideevs.com/news/344007/monthly-plug-in-ev-sales-scorecard-historical-charts/.
[26] *Id.*
[27] *Volkswagen Group to Expand Production of Electric Vehicles World Wide on a Massive Scale,* VOLKSWAGEN (Mar. 13, 2018) https://www.volkswagenag.com/en/news/2018/03/VolkswagenGroup_expand_production.htm.
[28] Drew Kodjak, *What to Make of Volkkswagen's Electric Vehicle "Offensive"?* INT'L COUNCIL ON CLEAN TRANSP., (Aug. 1, 2019), https://theicct.org/blog/staff/vw-ev-offensive-20190801.
[29] *All Electric Vehicles on a Massive Scale*, Groupe Renault https://group.renault.com/en/innovation-2/electric-vehicle (last visited Nov. 2, 2019).

2025.[30] General Motors (GM) has announced that Cadillac will lead the company's electrification push with a new EV crossover.[31] GM has set a goal of selling 1 million EVs.[32] These announcements are being followed by major capital investment from these manufacturers.

2. Batteries and Cost Parity

This section will discuss the decreasing cost of batteries and what that means for the development of EVs. The cost of lithium-ion batteries is one of the main determinants on the rate of adoption.[33] EV manufacturers and policy makers believe that as batteries become cheaper the cost of producing EVs will become roughly equal to similar vehicles powered by internal combustion vehicles.[34] Manufacturers refer to this point as cost parity.[35] The decreasing price of lithium-ion batteries will ensure that this point is reached.

The BloombergNEF publishes an annual Battery Price Survey which has become an important benchmark in the industry.[36] The benchmark shows that from 2010 until 2018 the cost of lithium-ion batteries dropped eighty-five percent.[37] In 2010, a lithium-ion battery cost $1,160 per Kilowatt Hour (Kwh). In 2018 the total cost dropped to $176/Kwh.[38] As the battery costs have decreased the number of ZEVs on the road has increased.[39] Battery prices are anticipated to continue to decrease by ten percent per year until 2025.[40]

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[30] Kodjak, *supra* note 28.
[31] *GM Technology Paves the Way for an All-Electric Future*, GENERAL MOTORS, https://www.gm.com/our-stories/technology/gm-technology-paves-the-way-for-an-all-electric-future.html (last visited Nov. 2, 2019).
[32] Kodjak, *supra* note 28.
[33] Logan Goldie-Scot, *A Behind the Scenes Take on Lithium-Ion Battery Prices*, BLOOMBERGNEF, (Mar. 5, 2019), https://about.bnef.com/blog/behind-scenes-take-lithium-ion-battery-prices/.
[34] THOMAS TURRETINE ET. AL., STEERING THE ELECTRIC VEHICLE TRANSITION TO SUSTAINABILITY, 4 (July, 1, 2018).
[35] *Id.*
[36] Goldie-Scot, *supra* note 33.
[37] *Id.*
[38] *Id.*
[39] NEXT 10, THE ROAD AHEAD FOR ZERO-EMISSION VEHICLES IN CALIFORNIA: MARKET TRENDS AND POLICY ANALYSIS 32 (Jan. 2018), http://next10.org/sites/default/files/ca-zev-brief.pdf.
[40] *Id.*

Additionally, new advancements in battery technology is anticipated. For example, a Chinese electric vehicle manufacturer Enovate, has announced it will bring an EV on the market in 2021 with a solid-state battery.[41] These solid-state batteries differ from lithium ion batteries as they do not require liquid lithium.[42] The benefits of solid-state batteries are greatly reduced charging times, high energy density, and increased safety.[43] Toyota plans on unveiling a solid-state battery in time for the 2020 summer Olympics in Tokyo.[44] The range for EVs with solid-state batteries could be between 500 and 1,000 miles on a single charge.[45] Tesla's battery guru Jeff Dahn has unveiled a lithium-ion battery which may be capable of driving one million miles.[46] This constant evolution in technology ensures that EV performance will continue to improve and the cost of the vehicles should continue to decrease.

3. Emissions From and Total Number of Vehicles in the Transportation Sector

The transportation sector of the United States' economy produces more greenhouse gas (GHG) emissions than any other sector of the economy.[47] In 2017, the United States released 6,457 million metric tons of CO_2 equivalent into the atmosphere.[48] The Transportation sector accounted for twenty-nine percent of the United States' GHG emissions.[49] This sector includes the movement of people and goods by cars, trucks, trains, ships, airplanes, and other vehicles.[50]

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[41] Bill Roberson, *If Electric Car Maker Enovate Can Produce and EV with a Solid State Battery, Everything Changes*, FORBES, (Apr. 24, 2019, 12:08 PM), https://www.forbes.com/sites/billroberson/2019/04/24/chinese-ev-maker-enovate-claims-upcoming-2021-model-will-have-a-solid-state-battery/#3c47aaa6654c.
[42] *Id.*
[43] *Id.*
[44] John O'Dell, *Solid-State Batteries Could Power Electric Vehicle Breakthrough*, (Aug. 13, 2019), https://www.trucks.com/2019/08/13/solid-state-batteries-power-electric-vehicle-breakthrough/.
[45] *Id.*
[46] Steven Loveday, *Tesla's Jeff Dahn Unviels Million Mile Battery Cell,* INSIDEEVS, Sept. 09, 2019. https://insideevs.com/news/369722/tesla-jeff-dahn-new-battery-cell-1-million-miles/.
[47] U.S. ENVT'L PROT. AGENCY, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990-2017*,* ES-4 (Apr. 11, 2019).
[48] *Id.*
[49] *Sources of Greenhouse Gas Emissions*, U.S. ENVTL PROT. AGENCY, https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions#transportation (last visited Nov. 2, 2019).
[50] *Id.*

The predominance of vehicle emissions may be explained by the sheer number of light-duty vehicles on the road. According to the Department of Transportation, light-duty vehicles are passenger cars and light trucks including sports utility vehicles, pickup trucks and minivans.[51] In 2017, there were 250,553,248 light-duty vehicles on the road in the United States.[52] As of 2017, these vehicles contributed 59% of all GHG emissions for the transportation sector.[53] In the same year, these light-duty vehicles drove approximately 3 trillion miles, and consumed approximately 129 billion gallons of gasoline and diesel.[54] Given this information on the transportation sector, switching to ZEVs would drastically reduce emissions in this sector.

4. Benefits and Impediments of Switching to ZEVs

ZEVs provide many benefits for the owner of the car as well as the environment. ZEVs are more energy efficient than their combustion counterparts.[55] Further, using electricity as a fuel source is generally cheaper than gasoline per unit distance.[56] Since ZEVs have a simplified drivetrain with fewer moving parts maintenance costs are generally lower across the board.[57] For daily commuting, ZEVs offer a greater time savings for owners because they can be charged at home. Finally, use of ZEVs offer significant decrease in GHG emissions and local air

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[51] U.S. DEP'T OF TRANSP., TABLE 1-11: NUMBER OF U.S. AIRCRAFT, VEHICLES, VESSELS, AND OTHER CONVEYANCES, https://www.bts.gov/content/number-us-aircraft-vehicles-vessels-and-other-conveyances. (last visited Oct. 28, 2018) *See* descriptions.
[52] *Id.* (totaling light duty vehicles short wheel base and light duty vehicle long wheel base).
[53] *Fast Facts on Transportation Greenhouse Gas Emissions,* U.S. ENVTL PROT. AGENCY, https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions. (last visited Nov. 2, 2019).
[54] *See* U.S. DEP'T OF TRANSP., TABLE 4-11: LIGHT DUTY VEHICLE, SHORT WHEEL BASE AND MOTORCYCLE FUEL CONSUMPTION AND TRAVEL, https://www.bts.gov/content/light-duty-vehicle-short-wheel-base-and-motorcycle-fuel-consumption-and-travel, (last visited Oct. 2, 2019); U.S. DEP'T OF TRANSP., TABLE 4-12: LIGHT DUTY VEHICLE, LONG WHEEL BASE FUEL CONSUMPTION AND TRAVEL, https://www.bts.gov/content/other-2-axle-4-tire-vehicle-fuel-consumption-and-travel (last visited Oct. 6, 2019).
[55] Office of Energy Efficiency & Renewable Energy, *Saving on Fuel & Vehicle Costs*, U.S. DEP'T OF ENERGY, https://www.energy.gov/eere/electricvehicles/saving-fuel-and-vehicle-costs. (last visited Nov. 2, 2019).
[56] PETER SLOWIK ET. AL., FUNDING THE TRANSITION TO ALL ZERO-EMISSION VEHICLES, INT'L COUNCIL ON CLEAN TRANSP., 1, 3 (Oct. 2019).
[57] *Id.*

pollution.[58] By transitioning to ZEVs, consumers will enjoy savings on fuel, maintenance, and time, as well as reduced emissions.[59] Further, benefits include a diminished need for fossil fuel exploration, extraction, refining and transportation.[60]

The International Council on Clean Transportation identifies the following impediments for mainstream adoption of ZEVs: affordability, availability, awareness, and convenience.[61] As stated above, the growing market for ZEVs and the lowering cost of batteries will allow ZEVs to overcome the affordability impediment. [62] The increasing number of ZEVs being manufactured and the development of a widespread charging infrastructure are key enablers for toppling the availability barrier.[63] Government efforts to improve consumer awareness are needed until ZEVs become a major component of auto manufacturers' marketing campaigns.[64] Finally, the development of faster charging technology and greater availability of charging infrastructure will help to alleviate the convenience impediment.[65]

Another important aspect of this analysis is the relationship between these impediments and benefits in the future.[66] As can be seen in the graph below,[67] while the initial costs are fairly significant, the overall benefits will quickly overcome those costs.[68]

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[58] Bonnie Holmes-Gen & Will Barret, Clean Air Future: Health & Climate Benefits of Zero Emission Vehicles, AMERICAN LUNG ASSOCIATION 5 (Oct. 2016), https://www.lung.org/local-content/california/documents/2016zeroemissions.pdf.
[59] FUNDING THE TRANSITION TO ALL ZERO-EMISSION VEHICLES, *supra* note 56, at 3.
[60] *Id.*
[61] Michael Nicholas, Quantifying the electric Vehicle Charging Infrastructure Gap Across U.S. Markets, Int'l Council on Clean Transp. 1, 1 (Jan. 2019).
[62] *See* Section 2.2 Battery & Cost Parity
[63] SLOWIK, *supra* note 56, at 26.
[64] *Id.* at 5.
[65] *Id.* at 4.
[66] *Id.* at 22.
[67] *Id.*
[68] *Id.*

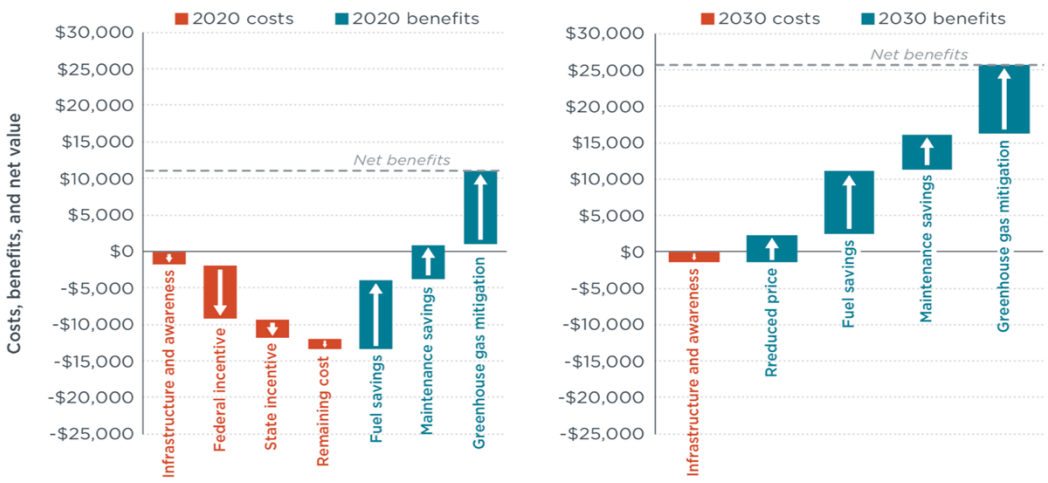

Figure 8. Per-vehicle lifetime costs and benefits in California for new 250-mile electric vehicles in 2020 and 2030.

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In summary, the initial costs are large, but the benefits far outweigh those costs in the immediate future.

III. Existing ZEV Programs

This section will analyze three ZEV programs in turn: the California program which sets a percentage credit requirement for all manufacturers that sell vehicles in the state, the Chinese program which utilizes a dual-credit system, and the European Union program which sets a general goal for its members but encourages the individual countries to adopt their own program as well. Additionally, this section will compare and contrast these three programs and how they operate.

1. California, USA

This section will examine the development of California's electric vehicle program. This section will begin by describing the origin of electric vehicle policy development in California, now referred to as the Zero Emission Vehicle (ZEV) program. This section will analyze the ZEV program by discussing the classification of automobile manufacturers, the calculation of credits,

[69] *Id.*

the trading and banking of credits, and penalties for noncompliance with the program. Finally, this section will discuss national and state incentives for EVs outside of the ZEV program.

a. Origin of the Program

In the United States, California has taken the lead when it comes to establishing a ZEV program. Under Clean Air Act (CAA) § 209, California has been allowed to retain authority to set their own automobile emissions standards.[70] Additionally, § 177 allows other states to opt into California's tailpipe standards for vehicles sold within their borders.[71] Under this authority, the state of California began their ZEV program in 1990.[72] Since California created the ZEV program, nine other states have chosen to adopt the program: Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Rhode Island, and Vermont.[73] Additionally, Colorado has recently adopted California's ZEV program, but it will not take effect until 2023.[74]

In 2012 California adopted a new set of standards for vehicles for 2012-2025 known as the Advanced Clean Cars (ACC) program.[75] Also, as part of the ACC, the new ZEV percentage credit requirement schedule was set.[76] California's ZEV program is overseen by the California Air Resources Board (CARB).[77] It is under this program that the ZEV mandate operates today.[78]

However, recently the Department of Transportation (DOT) and Environmental Protection Agency (EPA) have withdrawn California's permission to run the program arguing

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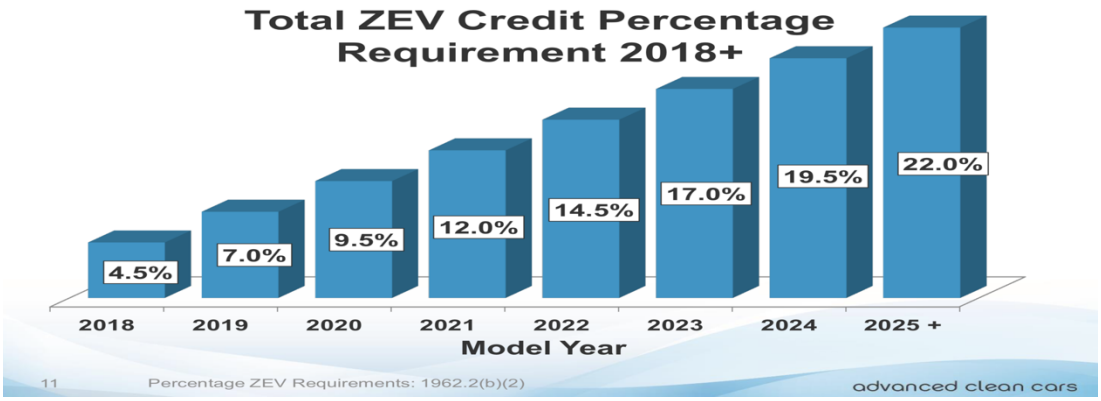
[70] *US: Section 177 States*, TRANSPORT POLICY, https://www.transportpolicy.net/standard/us-section-177-states/. (last visited Nov. 2, 2019)
[71] *Id.*
[72] International Council on Clean Transportation, Briefing: Overview of Global Zero-Emission Mandate Programs 3 (Apr. 2019) [hereinafter ICCT Briefing].
[73] *Id.* at 2.
[74] *US: Section 177 States*, *supra* note 70.
[75] ICCT Briefing, *supra* note 72 at 3.
[76] *Id.*
[77] *Id.* at 2.
[78] *Id.* at 3.

that the state program is preempted by a 1975 law.[79] In response, California and twenty-two other states have sued the Administration, arguing that the rule exceeds the National Highway and Traffic Safety Administration's authority, fails to comply with the National Environmental Policy Act, and conflicts with the congressional intent of the Clean Air Act.[80]

b. ZEV Mandate

The California ZEV program is driven by a general ZEV mandate, which requires that automakers satisfy a ZEV percentage credit requirement for each model year of production.[81] The ZEV mandate is designed to help meet California's long-term emissions reduction goals by requiring the production of clean, zero emission vehicles.[82] Under the current rules, the ZEV percentage credit requirement increases every year, rising to twenty-two percent by 2025 for all levels of manufacturers.[83] The full schedule by year is illustrated in the graph below.[84]



[85]

[79] Anna M. Phillips, *Trump Plans to Revoke a Key California Power: State Officials Vow to FIght It*, L.A. TIMES (Sept. 17, 2019, 2:24 PM), https://www.latimes.com/environment/story/2019-09-17/trump-revokes-california-environmental-authority-auto-deal.
[80] Colin Dwyer, *23 States Sue Trump Administration in Escalating Battle Over Emissions Standards*, NPR (Sept. 20, 2019, 8:23 PM), https://www.npr.org/2019/09/20/762763138/23-states-sue-trump-administration-in-escalating-battle-over-emissions-standards.
[81] ICCT Briefing, *supra* note 72, at 3.
[82] *Zero Emissions Vehicle Program: About*, CAL. AIR RES. BOARD, https://ww2.arb.ca.gov/our-work/programs/zero-emission-vehicle-program/about. (last visited Nov. 2, 2019).
[83] ICCT Briefing, *supra* note 72, at 3.
[84] Webinar Recording: ZEV Regulation Tutorial for 2018+, held by Cal. Air Res. Board (May 31, 2016) [hereinafter CARB Webinar].
[85] *Id.*

The ZEV mandate aspires to produce 1.5 million ZEVs by 2025 and 5 million in 2030.[86]

c. Classifications

The ZEV mandate in California breaks auto manufacturers into three categories based on volume status: Small-Volume Manufacturers (SVM), Intermediate-Volume Manufacturers (IVM), and Large-Volume Manufacturers (LVM).[87] Each manufacturer falls into a category based on the volume of vehicles they produce.[88] Volume status is determined by averaging the manufacturer's sales of passenger vehicles and light-duty trucks in California in the three previous consecutive model years.[89]

SVMs are those that have a volume status of less than 4,500 vehicles per year.[90] These SVMs are not subject to the ZEV percentage credit requirement.[91] IVMs are those manufacturers with a volume status between 4,501-20,000 vehicles per year.[92] In California, companies like Jaguar, Mazda, and Volvo are examples of IVMs. LVMs are those manufacturers that have a volume status of greater than 20,000 vehicles per year.[93] In California, companies like Nissan, Toyota, BMW, & Volkswagen are examples of LVMs.[94]

d. Credits

As discussed above, the California ZEV program requires a certain percentage credit requirement to be met. The number of credits a manufacturer needs is based on a calculation

[86] *New Analysis Of California Zev Market Finds State Will Meet Or Exceed 1.5 Million By 2025 Goal,* NEXT10 (Jan. 24, 2018), https://www.next10.org/press-releases/zev.
[87] *Id.*
[88] ICCT Briefing, *supra* note 72, at 4.
[89] *Id.*
[90] CARB Webinar, *supra* note 84.
[91] *Id.*
[92] ICCT Briefing, *supra* note 72, at 4.
[93] *Id.*
[94] CAL. AIR RES. BOARD, FACT SHEET: THE ZERO EMISSION VEHICLE (ZEV) REGULATION (Dec. 10, 2018), https://ww2.arb.ca.gov/sites/default/files/2019-06/zev_regulation_factsheet_082418_0.pdf.

similar to the volume status, but slightly different.[95] The number of credits needed is based on a percentage (determined from the graph above on page 14) of the manufacturer's production volume.[96] Production volume is calculated by averaging the manufacturer's sales in their second, third, and fourth previous model year.[97] For example, a manufacturer's 2018 production volume would be based on the average of its 2014-2016 model year sales.[98]

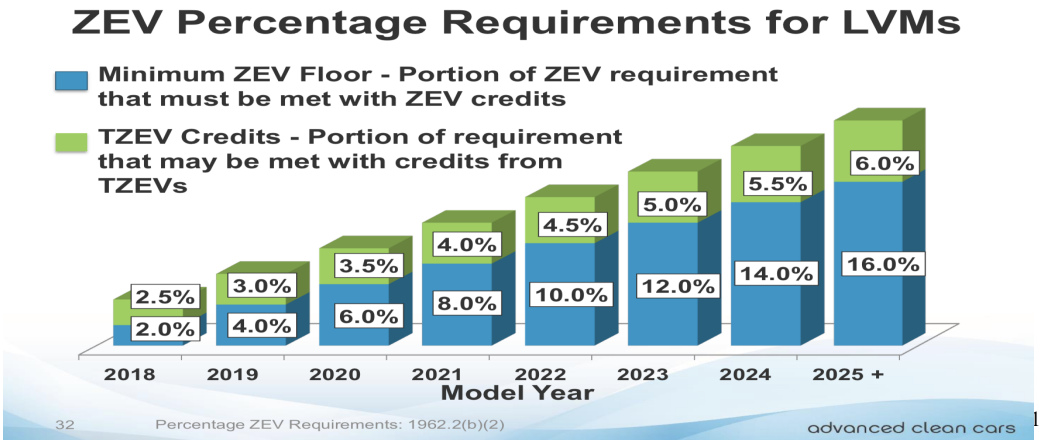
Additionally, there are different rules for satisfying the ZEV requirement based on the different classifications.[99] LVMs and IVMs can meet their ZEV credit requirement in different ways.[100] One important note is that despite the difference in how IVMs and LVMs may achieve their ZEV percentage credit requirement, the same percentage applies to both classifications, e.g. 4.5% in 2018.[101]

IVMs are subject to the ZEV percentage credit requirement, but, unlike LVMs, they are allowed to satisfy their entire ZEV percentage credit requirement through the production of TZEVs, mostly consisting of plug-in hybrid electric vehicles.[102]

LVMs are also subject to the ZEV percentage credit requirement.[103] These manufacturers must satisfy a certain percentage of their ZEV requirement through the use of only 'pure ZEVs', which consist of BEVs and FCEVs.[104] This percentage requirement which must be achieved through only pure ZEVs is called the "minimum floor volume."[105] This minimum floor volume

[95] CARB Webinar, *supra* note 84.
[96] *Id.*
[97] *Id.*
[98] *Id.*
[99] *Id.*
[100] *Id.*
[101] ICCT Briefing, *supra* note 72, at 4.
[102] *See id.*
[103] *Id.*
[104] *Id.* at 3.
[105] *Id.*

is determined for each year by CARB.[106] Demonstrated graphically below, the blue section is the minimum floor volume, while the sum of the green and blue sections is the percentage requirement for that year.[107]



[108]

The remaining portion of the ZEV percentage requirement may be satisfied using any combination of ZEVs & TZEVs.[109] However, this remaining percentage is not a TZEV requirement. In other words, a manufacturer could satisfy their entire requirement using only pure ZEV credits or through the use of TZEVs.[110] For example, in the graph seen above, the ZEV percentage credit requirement for IVMs and LVMs in 2018 is 4.5 percent, while the minimum floor volume for LVMs is only 2 percent in 2018.[111]

Another important aspect of the ZEV requirement is how the credits for each vehicle are calculated. Under the California ZEV program, one vehicle produced could be worth more or less than one credit.[112] Under the California program TZEVs and pure ZEVs are treated

[106] *See id.* at 2.
[107] CARB Webinar, *supra* note 84.
[108] *Id.*
[109] *Id.*
[110] *Id.*
[111] *Id.*
[112] *Id.*

differently when it comes to the calculation of credits earned by each vehicle.[113]

Credits for pure ZEVs is based on the vehicle's All Electric Range (AER).[114] The maximum number of credits for a pure ZEV is four credits per vehicle.[115] To earn any credits pure ZEVs must have an AER of greater than 50 miles, and to earn all four credits a vehicle must have an AER of greater than 350 miles.[116] Pure ZEVs with an AER between 50-350 miles earn credits based on a formula determined by CARB.[117]

Credits for TZEVs is based on the vehicle's Equivalent All-Electric Range (EAER).[118] The maximum credit available for production of a TZEV is only 1.3 credits per vehicle.[119] A TZEV must have a EAER of at least ten miles to earn any credits, while an EAER of greater than eighty miles earns 1.3 credits.[120] Any TZEV with an EAER between ten and eighty will earn credit based on a formula determined by CARB.[121]

To summarize this section, consider the following example. Suppose a manufacturer has the following California sales:

Model Year	California Sales
2014	50,000
2015	100,000
2016	150,000
2017	200,000
2018	?

[113] *Zero Emission Vehicle (ZEV) Regulation*, INT'L COUNCIL ON CLEAN TRANSP., https://theicct.org/sites/default/files/5c_ARB_ZEV.pdf.
[114] ICCT Briefing, *supra* note 72, at 5.
[115] *Id.* at 3.
[116] *Id.* at 5.
[117] *Id.*
[118] *Id.* at 4.
[119] *Id.* at 3-4.
[120] *Id.* at 5.
[121] *Id.*

Volume Status = Average CA sales of previous three consecutive model years

$$= \frac{100{,}000 + 150{,}000 + 200{,}000}{3} = 150{,}000$$

So, the volume status of this manufacturer in 2018 is 150,000, which is above 20,000 making this manufacturer a Large-Volume Manufacturer.

Production Volume = Average sales in the 2nd, 3rd, and 4th previous model years

$$= \frac{50{,}000 + 100{,}000 + 150{,}000}{3} = 100{,}000$$

The total ZEV requirement for 2018 is 4.5%, and the minimum floor volume for 2018 is 2%. Meaning this manufacturer has to produce at least 2,000 ZEV credits to meet this requirement. Additionally, the manufacturer can produce the remaining 2.5% from TZEVs which would require 2500 TZEV credits.

Next, assume the manufacturer produces only ZEVs that earn 4 credits, and TZEVs earning 1 credit. In this case, this manufacturer would need to produce at least 500 ZEVs to meet the minimum floor volume requirement and could produce up to 2500 TZEVs to fulfill the remainder of the requirement.

e. Banking, Trading, and Penalties

In the event that a manufacturer produces more credits than required, those credits are allowed to be banked for future use or traded to other manufacturers.[122] Credits earned from all types of vehicles can be banked, traded, or sold.[123] Additionally, credits acquired by trade or purchase can be used in the same way earned credits are used.[124] Alternatively, if a manufacturer does not produce enough credits to satisfy their requirements they may face penalties. The

[122] CARB Webinar, *supra* note 84.
[123] *Id.*
[124] *Id.*

penalties each manufacturer faces depends on their classification.[125] An IVM that fails to meet their credit requirement is allowed to request up to three consecutive model years to make up the deficit in credits.[126] However, an LVM that fails to meet their credit requirement is only given one model year to make up their deficit.[127] The general penalty is $5,000 for each vehicle not produced.[128] Based on the formula used by CARB, at the lowest a ZEV can earn one credit.[129] In other words, the penalty for failure to produce a ZEV credit is $5,000 per credit owed.[130]

One final feature of the California program is the ability to transfer GHG credits over to meet ZEV requirements.[131] A manufacturer who over complies with their corporate average GHG program by at least two g CO_2/mile can earn these credits.[132] The specific number of credits earned is calculated by a formula determined by CARB.[133] These GHG-ZEV over compliance credits may only be used up to a certain cap for each model year. The percentage of ZEV requirement allowed to be met with these over compliance credits decreases by year, going as low as thirty percent by 2021.[134] These over compliance credits are subjected to a few important limitations. First, these credits may only be used in the model year they were earned, meaning they cannot be banked or used towards previous ZEV debts.[135] Second, these credits cannot be traded to another manufacturer.[136] Third, credits earned with over compliance with

[125] *Id.*
[126] *Id.*
[127] *Id.*
[128] *Id.*
[129] *Id.*
[130] *Id.*
[131] *Id.*
[132] *Id.*
[133] *Id.*
[134] *Id.*
[135] *Id.*
[136] *Id.*

GHG programs may be used for ZEV credit requirements, but the opposite is not allowed.[137] In other words, ZEV credits cannot be used to offset GHG program requirements.[138]

f. National and State Incentives

In addition to the California and § 177 states ZEV program, there are additional methods to incentivize EVs on the national level. One example is the Federal Tax Credit which provides up to $7,500 for sales of EVs.[139] The size of the tax credit is determined by the size of the vehicle's battery capacity.[140] In addition to the national program, several states have implemented their own incentives. For example, in Oregon the state has instituted a rebate for up to $2,500 for purchase or lease of a plug-in electric vehicle.[141]

2. China

This section will examine the development of China's electric vehicle policy. This section will begin by describing the origin of electric vehicle policy development in China, culminating in the New Energy Vehicle (NEV) policy. This section will analyze the NEV policy by discussing the classification of manufacturers, the calculation of credits, the trading and banking of credits, and penalties for noncompliance with the policy. Finally, this section will discuss China's new incentive for EVs.

a. Origin of the Chinese ZEV program

China has prioritized the development of NEV technology to deal with the increase in carbon emissions as China transitions into being the largest auto market in the world.[142] Vehicle

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[137] *Id.*
[138] *Id.*
[139] TURRETINE, *supra* note 34, at 10.
[140] Office of Energy Efficiency & Renewable Energy, *EVs: Tax Credits and Other Incentives*, U.S. DEP'T OF ENERGY, https://www.energy.gov/eere/electricvehicles/electric-vehicles-tax-credits-and-other-incentives. (last visited Nov. 2, 2019).
[141] *Id.*
[142] Ye Wu, et al., *Energy Consumption and CO2 Emission Impacts of Vehicle Electrification in Three Developed Regions of China*, 48 ENERGY POL'Y 537, 537 (2012).

ownership in China is still very low with only 58 per 1,000 people owning a car as of 2010.[143] In 2014, among 161 monitored cities, only 9 met the minimum ambient air quality standard.[144] China views NEVs as an important asset in the reduction of air pollution.[145]

In 2008, the Chinese government announced the Ten Cities, Thousand Vehicles campaign, which promoted the development of NEVs through subsidies.[146] This program was the first time the Chinese government offered subsidies for the production and purchase of NEVs.[147] The initiative grew from the original 10 cities to encompasses more than 88 cities.[148] Every city that joined the program was designated as a new energy vehicle pilot city.[149] By receiving this designation, cities qualified for large subsidies and other preferential policies to develop their local EV markets.[150] These subsidies were dependent on the recipient cities ensuring the existence of an adequate charging infrastructure to support the increasing shift toward an EV fleet.[151]

Historically, the city governments took these central subsidies and passed them on to manufacturers and users.[152] The size of the central subsidies directly impacted local subsidies as many pilot cities provided a matching local subsidy proportionate to the central subsidy.[153] Pilot cities developed direct and indirect consumer incentives to stimulate private purchase and use of

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[143] *Id.* This number stands in stark contrast as 800 per 1,000 own a car in the United States. *Id.*
[144] Bree Feng, *Only 9 Chinese Cities Past Clean Air Test*, N.Y. TIMES (Aug. 7, 2014, 8:01 AM), https://sinosphere.blogs.nytimes.com/2014/08/07/only-9-chinese-cities-pass-clean-air-test/?mtrref=www.google.com&gwh=3060C545BE1A4453FA6DC9EC484590BB&gwt=pay&assetType=REGIWALL.
[145] Wu, *supra* note 142, at 538.
[146] *Id.*
[147] *Id.*
[148] HUI HE, ET AL., ASSESSMENT OF ELECTRIC CAR PROMOTION POLICES IN CHINESE CITIES, INT'L COUNCIL ON CLEAN TRANSP, i, i (Oct. 2018).
[149] *Id.*
[150] *Id.*
[151] *Id.* at 14.
[152] *Id.*
[153] *Id.*

electric cars. Direct incentives reduce the cost to EV owners, during vehicle purchase, ownership, and use by offering a direct monetary value.[154] Cities also offered indirect subsidies by either building public charging stations or offering public financing for the construction of those stations.[155]

On September 27, 2017, China's Ministry of Industry and Technology (MIIT) finalized the New Energy Vehicle mandate policy.[156] The NEV mandate, is a modified version of California's Zero Emission Vehicle (ZEV) mandate.[157] The policy was developed in the context of the decision to phase out the existing subsidy program.[158]

b. NEV Mandate

The NEV mandate adds a NEV credit program to the existing corporate average fuel consumption (CAFC) regulations for passenger vehicles overseen by MIIT.[159] Since the NEV policy was added to the existing CAFC credit policy, the NEV mandate is known as the "Dual Credit Policy" in China.[160] The policy only applies to passenger cars and went into effect on April 1, 2018. The goal of the mandate is to improve traditional fuel vehicle's efficiency and encourage the utilization of NEVs.[161] When the mandate was proposed, the MIIT believed that this program "would save 35.5 million tons of fuel (equivalent to 114 million tons of CO_2 emissions) and generate a market of more than 5 million new-energy cars cumulatively from

[154] *Id.* at 18.
[155] *Id.* at 21.
[156] CHINA'S NEW ENERGY VEHICLE MANDATE POLICY (FINAL RULE), *supra* note 3, at 1.
[157] CHINA ANNOUNCED 2019 SUBSIDIES FOR NEW ENERGY VEHICLES, INT'L COUNCIL ON CLEAN TRANSP, 1, 1 (June. 2019).
[158] PROPOSED TEMPORARY MANAGEMENT REGULATION FOR CORPORATE AVERAGE FUEL CONSUMPTION AND NEW-ENERGY VEHICLE CREDITS FOR NEW PASSENGER CARS IN CHINA, INT'L COUNCIL ON CLEAN TRANSP, 1, 1 (Oct. 2016).
[159] *Id.*
[160] CHINA'S NEW ENERGY VEHICLE MANDATE POLICY (FINAL RULE), *supra* note 3, at 2.
[161] *Id.* at 1.

2016 to 2020."[162] The ICCT believes this policy will result in the production of 2.2 million to 8.7 million new energy passenger cars.[163]

c. Classifications

The NEV mandate breaks auto manufacturers into two groups, small-scale auto companies and large-scale auto companies.[164] A small-scale company imports or produces less than 30,000 traditional passenger fuel cars.[165] A large-scale auto company produces and/or imports 30,000 or more passenger cars a year.[166] Examples of large-scale auto companies in China include automotive companies familiar to car buyers in the United States, such as Volkswagen, Honda and Ford.[167] This classification also includes Chinese companies like Dongfeng Motor Corporation, Changan, and SAIC Motor Corporation Limited.[168] All auto companies who either produce or import cars into China need to comply with the CAFC regulatory scheme.[169]

d. Credits

As mentioned previously, the NEV mandate requires all automakers to meet the CAFC requirements and large-scale manufacturers also must meet the NEV requirements.

Every auto company in China must meet a specific annual CAFC target, depending on the company's fleet for each calendar year.[170] A company's CAFC target and actual CAFC are

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[162] PROPOSED TEMPORARY MANAGEMENT REGULATION FOR CORPORATE AVERAGE FUEL CONSUMPTION AND NEW-ENERGY VEHICLE CREDITS FOR NEW PASSENGER CARS IN CHINA, *supra* note 158, at 1.
[163] CHINA'S NEW ENERGY VEHICLE MANDATE POLICY (FINAL RULE), *supra* note 3, at 10.
[164] *Id.* at 2.
[165] *Id*
[166] *Id.*
[167] *2017 Production Statistics*, INT'L ORG. OF MOTOR VEHICLE MANUFACTURERS, http://www.oica.net/category/production-statistics/2017-statistics/ (last visited Nov. 6, 2019).
[168] *Id.*
[169] PROPOSED TEMPORARY MANAGEMENT REGULATION FOR CORPORATE AVERAGE FUEL CONSUMPTION AND NEW-ENERGY VEHICLE CREDITS FOR NEW PASSENGER CARS IN CHINA, *supra* note 158, at 3.
[170] *Id.* at 2.

calculated by sales-weighting each model's specific fuel consumption standard as prescribed in a national standard and the car's certified fuel consumption.[171] If after completing the calculations a company's actual CAFC is less than its annual CAFC target for a given year, the company will generate CAFC credits.[172] If the inverse occurs, and a company's CAFC credits are less than its CAFC target than that company is in CAFC deficit.[173]

NEV credits are easier to calculate. Large-scale auto companies create NEV credits by producing or importing NEV vehicles.[174] The NEV score is calculated by adding up the number of NEVs associated with the company and the pre-NEV score.[175] The pre-vehicle score varies by the technology and the electric driving range of the vehicle.[176] BEVs with a range between 80 kilometers and 150 kilometers receive a pre-vehicle NEV score of two.[177] BEVs with a range between 150 kilometers and 250 kilometers has pre-vehicle NEV score of three.[178] BEVs and Fuel Cell Vehicles (FCV) with a range between 250 kilometers and 350 kilometers receive a pre-vehicle NEV score of four.[179] BEVs and FCVs with a range over 350 kilometers receive a pre-vehicle NEV score of five.[180] PHEVs with a range over 50 kilometers receive a pre-vehicle NEV score of two.[181] The NEV target score for each auto company is found by taking a percentage of the company's total annual conventional-fuel passenger car production or import for the year.[182] The Chinese government has set the following percentage requirements, eight percent in 2018,

[171] *Id.* at 4.
[172] *Id*.
[173] *Id.*
[174] *Id.* at 5.
[175] *Id.*
[176] *Id.*
[177] *Id.*
[178] *Id.*
[179] *Id.*
[180] *Id.*
[181] *Id.*
[182] *Id.*

ten percent in 2019, and twelve percent in 2020.[183] A company will have NEV credits if its actual NEV score is greater than its target NEV score.[184] If a company's actual NEV score is less than its target NEV score than the company is in a NEV deficit and it will be forced to purchase credits on the open market.[185]

e. Banking, Trading, and Penalties

As shown above it is possible for companies to have either deficits or surpluses of CAFC and NEV credits. If a company has a surplus of CAFC credits than the company can bank those credits and carry them forward for the next three years.[186] The banked credits are subject to a weighting factor which reduces the number of credits every year they are carried forward.[187]

If an auto company has a CAFC deficit than the company can take the following four actions to offset the deficit. One, the company can use its own banked CAFC credits.[188] Two, the company can transfer CAFC credits from an affiliated company to aid in offsetting the deficit.[189] Three, the company could use its own NEV credits to account for the CAFC deficit.[190] Four, the company could purchase NEV credits from other companies to resolve the deficit.[191]

NEV credits cannot be banked or carried forward, instead they be freely traded between auto companies.[192] Thus, if a company is in NEV deficit than that company will be required to purchase NEV credits.[193] Purchased NEV credits must be used in the current year and are barred

[183] *Id.* at 6.
[184] *Id.*
[185] *Id.*
[186] *Id.*
[187] *Id.*
[188] *Id.* at 7.
[189] *Id.*
[190] *Id.*
[191] *Id.*
[192] *Id.* at 6.
[193] *Id.* at 7.

from being resold.[194] Failure to meet either CAFC or NEV target will result in significant penalties.[195] Such as the MIIT denying the release of new models that cannot meet the CAFC standards and suspension of specific high-fuel consumption models until the company has achieved CAFC compliance.[196]

f. Description of China's Incentive Program

In 2019, the Chinese government released a Notice of Further Adjusting Fiscal Subsidies for Promoting New Energy Vehicles.[197] To qualify for a subsidy under the new policy a BEV must meet a minimum electric mileage of 250 kilometers.[198] The subsidy for BEVs is determined by the car's electric drive range, battery capacity, battery energy density, energy consumption, and ownership type.[199] The base subsidy is the smaller value between the subsidy level derived from electric drive range, and that derived from battery capacity.[200] This value is then taken and then calculated "via three multipliers – a battery energy density multiplier, an energy consumption multiplier, and an ownership type multiplier."[201] Also, if a PHEV can travel for more than eighty kilometers on a charge than it qualifies for the subsidy.[202] To determine the amount of the subsidy one looks at the weight of the battery.[203] PHEVs which have a range of under forty kilometers on a charge can also qualify for the subsidy if that PHEV can show that the electric engine results in a forty-five percent fuel savings.[204]

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[194] *Id.* at 6.
[195] *Id.* at 8.
[196] *Id.*
[197] CHINA ANNOUNCED 2019 SUBSIDIES FOR NEW ENERGY VEHICLES, *supra* note 157, at 1.
[198] *Id.* at 5.
[199] *Id.*
[200] *Id.*
[201] *Id. at 3.*
[202] *Id. at 4.*
[203] *Id.*
[204] *Id.* at 5.

Aside from creating a new subsidy structure the notice ended the practice of local governments providing upfront purchases subsidies.[205] Instead, pilot cities are urged to incentivize the installation and operation of new charging infrastructure.[206] The new central subsidy tightens the qualification requirements across all vehicle types and technologies except for plug-in hybrid commercial passenger vehicles.[207] The limitation on the availability of subsidies seems to stem from China's belief that the NEV Policy will ensure the continued growth of EVs.[208]

3. European Union

This section will examine the development of the European Union's (EU) *voluntary* electric vehicle policy. This section will begin by reviewing the EU GHG emissions regulations and the implications on member states. Then, this section will look specifically at how the Zero Low Emission Vehicle (ZLEV) program has been implemented within the mandatory GHG emission regulations. Additionally, this section will discuss how the ZLEV program is being incentivized in various EU member states.

a. The EU and its Members Generally

In April 2019, the EU introduced *mandatory* carbon performance standards for new passenger cars and new light commercial vehicles to take effect in January 2020.[209] One way member states can meet the mandatory fleet emission targets is by implementing a ZLEV credit program.[210] Manufacturers will be able to apply credits earned by overproducing ZLEVs to meet

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[205] *Id.* at 11.
[206] *Id.*
[207] *Id.*
[208] Christian Shepherd, *China New Energy Vehicle Sales Drop 34%,* FINANCIAL TIMES (Oct. 14, 2019) https://www.ft.com/content/adeb6c18-ee53-11e9-bfa4-b25f11f42901.
[209] European Commission on Energy, Climate Change, Environment, *Post-2020 CO2 emission performance standards for cars and vans: Policy*, EUROPEAN UNION, https://ec.europa.eu/clima/policies/transport/vehicles/regulation_en#tab-0-0. (last visited Nov. 2, 2019).
[210] *Id.*

its fleet carbon performance standards.[211] The EU has implemented actions to meet its goal of avoiding an increase in average global temperature by two degree Celsius.[212] These actions include eliminating carbon passenger vehicles on European roadways by 2050.[213]

Several EU members have initiated further programs in addition to the EU mandate. The United Kingdom has already implemented their own targets for lowering transportation GHG emissions and manufacturing ZLEV vehicles.[214] The UK has stated its goal to eliminate the sale of combustion vehicles by 2040 and for every car on the road to be a ZLEV by 2050.[215] Similarly, with the EU structure, the UK has chosen to implement a voluntary policy for the manufacturing of ZLEVs.[216] The government emphasized that the transition to zero emissions will be industry and consumer led.[217] Germany on the other hand has developed a stronger zero emission vehicle policy. In 2016, Germany became the first major country to set a deadline for banning the sale of combustion vehicles by 2030.[218]

b. EU Zero Low Emissions Program

By 2025, manufacturers will have to meet a fleet-wide-average reduction in emissions of GHGs by fifteen percent.[219] By 2030, these reductions must be reduced by 37.5 percent.[220] These new performance standards were created in order for the EU to meet its obligations set under the Paris Agreement.[221] The EU parliament has agreed that the most effective and efficient way to

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[211] *Id.*
[212] *Id.*
[213] *Id.*
[214] DEPARTMENT FOR TRANSPORT, THE ROAD TO ZERO: NEXT STEPS TOWARDS CLEANER ROAD TRANSPORT AND DELIVERING OUR INDUSTRIAL STRATEGY, Report, 2018, at 7 (UK).
[215] *Id.* at 2.
[216] *See id.* at 15.
[217] *Id.* at 2.
[218] Fred Lambert, *All New Cars Mandated to be Electric in Germany by 2030*, ELECTREK, (June 14, 2016), https://electrek.co/2016/06/14/all-new-cars-mandated-electric-germany-2030/.
[219] Regulation 2019/631, 2019 O.J. (L 111) 13 (EU).
[220] *Id.*
[221] *Id.*

reduce carbon in the atmosphere is accelerating the transportation sector's adoption of zero emission technologies.[222] Their goal is to achieve this partially through a voluntary ZLEV market share program.[223] The EU defines passenger vehicles that emit between 0 g/km to 50 g/km as a ZLEV.

c. ZLEV Credit Program

Under the new carbon performance standards, all passenger vehicles are limited to emitting 95 g/km by 2021 with further reductions over the next decade.[224] Manufacturers are eligible for offset credits through the production of ZLEV vehicles. Production of 0 g/km emission passenger vehicles include Battery Operated Electric Vehicles (BEVs) and Fuel Cell Electric Vehicles (FCEVs) which are eligible for full credit.[225] Additionally, vehicles that emit between 0 g/km and 50 g/km, such as plug in hybrid vehicles, are eligible for partial credit.[226] Vehicles that emit greater than 50 g/km are not eligible for credit reductions.[227] Generally, as manufacturers must meet a fifteen percent production of ZLEVs benchmark after 2025 and the thirty-five percent benchmark after 2035. Any manufacturers that surpass those benchmarks are eligible for the ZLEV credits to reduce its fleet wide GHG emission standards, up to an additional five percent.[228]

d. Incentives

Several member states have implemented consumer subsides to incentivize the purchase of ZLEVs. There are twelve European countries that offer incentives to promote the production

[222] *Id.*
[223] *Id.*
[224] *Id.*
[225] *Id.*
[226] *Id.*
[227] ICCT Briefing, *supra* note 72, at 8.
[228] Regulation 2019/631, 2019 O.J. (L 111) 13 (EU).

and purchase of ZLEVs.[229] For example, Germany has recently proposed an increase in the number of grants available to buyers and an increase in the value of grants.[230] The UK has "plug-in" grants, like the German grants, to allow people to purchase ZLEVs.[231] Norway is not an official member of the EU but is a member of the European Economic Area.[232] Norway provides a laundry list of incentives for purchasing EVs, including no purchase or import taxes, no charges for toll roads or use of ferries, free municipal parking, and no annual road tax.[233] While the EU members continue to meet their GHG emission targets, it is likely that more incentives will be introduced by other member states.

4. Comparison of the Three Programs

While all three programs share the commonality of attempting to incentivize an increase in the number of zero emission vehicles produced, it is important to notice the difference in perspective. One major difference between the programs is that both China and § 177 states are mandatory, while the EU's program is voluntary. [234]

All three programs have a credit requirement, but these programs accomplish slightly different goals. Section 177 states have a percentage requirement based on manufacturer's production volume.[235] China uses a dual credit requirement.[236] The EU uses its credit

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[229] *Interactive map: Electric vehicle purchase incentives per country in Europe (2019 update)*, EUROPEAN AUTOMOTIVE MANUFACTURERS ASS'N, https://www.acea.be/statistics/article/interactive-map-electric-vehicle-incentives-per-country-in-europe-2018. (last visited Nov. 2, 2019).
[230] Thomas Escritt & Edward Taylor, *Germany to Hike Electric Car Subsidies as VW Launches Car*, REUTERS (Nov. 4, 2019, 4:44 AM), https://www.reuters.com/article/us-germany-autos/germany-to-hike-electric-car-subsidies-as-vw-launches-car-idUSKBN1XE1AK.
[231] *Low-Emission Vehicles Eligible for Plug-In Grants*, UK GOV'T, https://www.gov.uk/plug-in-car-van-grants. (last visited Nov. 2, 2019).
[232] *The EEA Agreement*, Mission of Norway to the EU, https://www.norway.no/en/missions/eu/areas-of-cooperation/the-eea-agreement/. (last visited Nov. 2, 2019).
[233] Mark Lewis, *With Government Incentives, Norway Sees Electric Car Sales Boom*, Associated Press (Dec. 19, 2018), https://www.csmonitor.com/Environment/2018/1219/With-government-incentives-Norway-sees-electric-car-sales-boom.
[234] ICCT Briefing, *supra* note 72, at 11.
[235] *Id.* at 3.
[236] *Id.* at 6.

requirement to gradually increase the number of ZEVs that a manufacturer is making.[237] The credit requirements differ on how credits can be used once they are generated. The EU allows manufacturers to apply credits they generate to their emissions requirements.[238] In contrast, § 177 states and China allow the trading and banking of excess credits.[239] One, significant difference between the two programs is how each program views ZEV credits. Section 177 states allow for excess GHG compliance to offset some of the manufacturers' ZEV credit requirements.[240] China allows ZEV credits to count towards a manufacture's GHG compliance.[241] This slight difference illuminates each programs policy goal. Section 177 states are prioritizing the reduction of GHG emissions from cars.[242] In contrast, China's program incentives the creation of ZEVs over making a more efficient enteral combustion engine vehicle.[243]

Each program allots ZEVs credits in a different way. Section 177 states and China are similar in that they both measure credits based on the range a vehicle can achieve.[244] However, China also factors in the efficiency of an individual vehicle when determining credits.[245] The EU focuses on emissions that a particular vehicle emits.[246]

All of these programs classify manufactures differently. Section 177 states classify auto manufacturers into three categories: Small-Volume, Intermediate-Volume and Large-Volume Manufactures.[247] These categories are based on the number of cars sold by the manufacturer in

[237] *Id.* at 9.
[238] *Id.*
[239] *Id.* at 4, 6.
[240] *Id.* at 4.
[241] *Id.* at 7.
[242] *See id.* at 4
[243] *See id.* at 7
[244] *Id.* at 4, 6.
[245] *Id.* at 6.
[246] *Id.* at 8.
[247] *Id.* at 3.

California.[248] China classifies auto companies as either a small-scale or large-scale manufacture.[249] China makes this determination based on the number of cars the auto company manufactures or imports to China.[250] Given the voluntary nature of the EU's ZLEV program the EU has no need to classify auto manufacturers.[251]

Only § 177 states and China have penalties for a company's failure to comply with a ZEV requirement. Section 177 states use fines based on number of credits the manufacturer owes based off the percentage requirement.[252] China employs a similar model, but emphasizes to auto companies that continued noncompliance could result in a ban from manufacturing ICEs.[253]

While none of these programs are completely alike, they all represent the successes and pitfalls of transitioning the market to ZEVs.

IV. Policy Recommendations

This section will propose four different policy pathways which will incentive the further development of ZEVs in the United States. The first policy pathway will discuss why California's ZEV program should be allowed to continue to grow independent of federal action. The second pathway will propose a nationwide ZEV credit program to be established legislatively. Included in this proposal will be analysis of §177 of the Clean Air Act, a discussion of the legislative options, and key features of a ZEV scheme. The third pathway will briefly examine how agency rulemaking could be used to create a national ZEV program. Finally, the fourth pathway will discuss an incentive program, including Senator Schumer's New Clean Cars

[248] *Id.*
[249] *Id.* at 6.
[250] *Id.*
[251] *See id.* at 6-7.
[252] *Id.* at 5.
[253] *Id.* at 7.

for America Climate Proposal. This discussion will explain why such an incentive program could function as a standalone policy or as a significant aid to pathways one through three.

1. Policy Pathway One: Continuing the California ZEV Program

The California program has been successful in advancing the market for ZEVs which demonstrates its validity as a policy pathway.[254] Over the last ten years, the growth in sales of ZEVs increased about 1,900 percent.[255] As of 2019, there about 1,270,000 ZEVs on the road in the United States.[256] Vehicle manufacturers have demonstrated their willingness to invest in ZEVs.[257] Since the implementation of the program, manufacturers have significantly expanded the number of ZEV models offered.[258] As the California program drives production and economies of scale are reached, ZEVs will continue to expand into other markets beyond the borders of California.

There is significant auto manufacturer support for California's regulatory advanced clean cars program. Four major automakers have publicly supported California's program by entering an agreement with CARB recognizing California's authority to regulate.[259] Important provisions

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[254] This authority granting California the ability to regulate emissions independently of the Federal Standards is being challenged by the Trump Administration, and will likely be argued in the courts to determine if this is a valid provision.
[255] *See* David Gohlke & Yan Zhou, *Assessment of Light-Duty Plug-In Electric Vehicles in the United States: 2010-2018*, 2 ARGONNE NATIONAL LIBRARY (Mar. 2019).
[256] *Electric Vehicle Trends & Key Issues*, *supra* note 18, at 1.
[257] *See generally Volkswagen Zero-Emission Vehicle (ZEV) Investment Commitment*, CAL. AIR RES. BOARD, https://ww2.arb.ca.gov/our-work/programs/volkswagen-zero-emission-vehicle-zev-investment-commitment. (last visited Nov. 2, 2019); Danielle Szatkowski, *VW's Electrify America to Invest $300 million in Cycle 2 of ZEV Plan*, AUTOMOTIVE NEWS, (Feb. 8, 2019, 12:17 PM), https://www.autonews.com/technology/vws-electrify-america-invest-300-million-cycle-2-zev-plan.
[258] *See National ZEV Investment Plan: Cycle 2*, U.S. ENVTL PROT. AGENCY 1,19 (Feb. 2019), https://www.epa.gov/sites/production/files/2019-02/documents/cycle2-nationalzevinvestmentplan.pdf; Steven Loveday, *Monthly Plug-In EV Sales Scorecard: Historical Scorechart*, InsideEVs (Dec. 3, 2018, 9:25 PM) https://insideevs.com/news/344007/monthly-plug-in-ev-sales-scorecard-historical-charts/; *See also* Section 2.1.
[259] *California and Major Automakers Reach Groundbreaking Framework Agreement on Clean Emission Standards*, CAL. AIR RES. BOARD, https://ww2.arb.ca.gov/news/california-and-major-automakers-reach-groundbreaking-framework-agreement-clean-emission. (last visited Nov. 2, 2019); *Terms for Light-Duty Greenhouse Gas Emissions Standards*, CAL. AIR RES. BOARD, https://ww2.arb.ca.gov/sites/default/files/2019-07/Auto%20Terms%20Signed.pdf.

of the agreement include continued participation in California's GHG emissions and ZEV programs.[260]

This first policy pathway offers several benefits. First, the program is already in existence, has a functioning regulating body, and has operated successfully for a long period of time.[261] Second, the program is politically popular among representatives of California and the § 177 States.[262] Third, the California program has already been implemented in ten states including California, with an eleventh state joining in 2023.[263] Finally, this policy pathway ensures the growth of the ZEV market, is supported by industry, and remains politically popular.

2. Policy Pathway Two: Congressional Action Creating a National ZEV Program

The second policy pathway is for Congress to enact a law establishing a national ZEV program. A national program would mandate that every state participate in the program. This Congressional action should be modeled off of California's existing ZEV program.

There are multiple examples of the Federal government learning from and adopting innovative emissions regulations created by the state of California.[264] This iterative process was intended by the drafters of the Clean Air Act by including §177.[265] Quoting Representative Moss speaking from the floor, "California … offers a unique laboratory, with all the resources

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[260] *See id.*
[261] CARB Webinar, *supra* note 84.
[262] Bradley Berman, *EVs Popularity To Rise Outside California, Thanks To Arcane ZEV Rule*, INSIDEEVS (Feb. 15, 2019, 11:23 AM), https://insideevs.com/news/342825/evs-popularity-to-rise-outside-california-thanks-to-arcane-zev-rule/
[263] *States that have Adopted California's Vehicle Standards under Section 177 of the Federal Clean Air Act*, CAL. AIR RES. BOARD (Feb. 21, 2019), https://ww2.arb.ca.gov/sites/default/files/2019-03/177-states.pdf.
[264] *See* Ann E. Carlson, *Iterative Federalism and Climate Change*, 103 N.W. U. L. REV., 1097, 1111 (2009). Through allowing the existence of the Federal floor and the California program, there are benefits from what scholars have called iterative federalism. Iterative federalism occurs when the federal government allows a state or group of states as "super-regulators" with special regulatory authority. *Id.* at 1107. Iterative federalism promotes regulatory innovation and achieves environmental success more effectively than either devolving regulation to the states or centralized regulation at the nation level. *Id.*
[265] 113 Cong. Rec. 3975 (Cong. Moss). *See also* 113 Cong. Rec. 32478 (Sen. Murphy).

necessary, to develop effective control devices which can become a part of the resources of this Nation and contribute significantly to the lessening of the growing problems of air pollution throughout the Nation."[266] Further, quoting Senator Murphy, "[By] granting California a waiver of Federal preemption of the field in control of motor vehicle emissions … our State will act as a testing agent for various types of controls and the country as a whole will be the beneficiary of this research."[267] As the Congressmen from California stated, California's innovations should be used for the benefit of the Nation. In this instance, California demonstrated the effectiveness of a ZEV credit program. The Federal government should respond to this successful innovation by implementing a program on a national scale.[268]

This policy pathway can be implemented by the legislature as an amendment to existing legislation or as a new freestanding law.[269] Senator Merkley and Senator Whitehouse proposed legislation that would amend the Clean Air Act to establish a national ZEV program in November 2018.[270] The bill was referred to the Committee on Environment and Public Works but has seen no legislative action to date.[271]

The bill proposes a credit trading program similar to the California model. It would implement a zero emission vehicle credit requirement on manufacturers who sold 100 or more

[266] 113 Cong. Rec. 3975 (Cong. Moss).
[267] 113 Cong. Rec. 32478 (Sen. Murphy).
[268] Any national legislation should expressly state that the national program will not preempt California's existing program under §177. This should be done so California can continue to innovate in the field of ZEVs.
[269] This policy pathway risks garnering significant political opposition. A national ZEV program may be opposed by representatives from current § 177 states as well as representatives who oppose a national program. Further opposition could come from the oil industry as ZEVS will reduce the need for gasoline to power vehicles. Gavin Bede, *The Oil Industry v. The Electric Car*, POLITICO (Sept. 16, 2019, 5:04 AM), https://www.politico.com/story/2019/09/16/oil- industry-electric-car-1729429. Additionally, auto-dealership owners may fight the proposed legislation as ZEVs cut into their profits from servicing vehicles. *Id.* This political opposition could prevent the passage of a national ZEV law. Other stakeholders such as utility companies and auto manufacturers would likely be involved in the drafting and passing of the act.
[270] Zero-Emission Vehicles Act, S. 3664, 115th Cong. §2 (1997).
[271] *Id.*

cars per year.[272] Under the bill's credit trading program credits would be tradeable and bankable.[273] The bill will implement a credit trading scheme with a minimum required annual percentage of new ZEV sales in each model year beginning with fifty percent in 2030.[274] This percentage requirement would increase annually culminating in one hundred percent by 2040. [275] Failure to meet the credit requirement will result in civil penalties being assessed against the manufacturer.[276] Importantly, the legislative proposal includes a provision to ensure that the authority of California and other states to "set standards for motor vehicle emissions and zero-emission vehicle requirements under section 177 and section 209" would not be preempted by the bill.[277]

Based on the discussion of existing ZEV programs outlined above, a successful program to grow the ZEV market could have the following elements:

- Establish a national ZEV mandate, which requires auto manufacturers to satisfy a percentage credit requirement for each model year of production.
- Divide auto manufacturers into two classifications: Large-Volume Manufacturers & Small-Volume Manufacturers based on the number of vehicles manufactured and imported for sale in the United States. A Small-Volume Manufacturer should be classified as producing or importing less than one hundred vehicles. A Large-Volume Manufacturer includes all manufacturers importing or producing one hundred or more vehicles.

[272] *Id.*
[273] *Id.*
[274] *Id.*
[275] *Id.*
[276] *Id.*
[277] *Id.*

- All classifications should be subject to the same annual percentage requirement based on sales. However Large-Volume Manufacturers will need to satisfy a portion of their percentage requirement solely through the production of ZEVs (BEVs & FCEVs). Alternatively, Small-Volume Manufacturers could satisfy their entire requirement through production of TZEVs (PHEVs).
- The credit requirement should be a percentage of sales which increases incrementally each year.
- The production of a ZEV should result in more credits than the production of a TZEV. Vehicles will be allotted credits based on Battery Efficiency and Range.
- Allowing for overcompliance to further incentivize supply of ZEVs by permitting Trading and Banking of ZEV credits.
- Companies should be allowed to trade any excess ZEV credits generated during the year to other manufacturers.
- Banking of excess credits should be allowed for all manufacturers in compliance with their ZEV credit requirements for the year.
- Failing to meet the ZEV mandate should result in penalties such as fines and may lead to the company being banned from trading and banking credits in future years. Continued failure to meet credit requirements could ultimately result in a ban on selling ICE vehicles in the United States.

3. Policy Pathway Three: A National ZEV Program through Agency Rulemaking

A third possible policy pathway for adopting a national ZEV program would be for an agency to create a program through Administrative Procedure Act § 553 Notice and Comment

Rulemaking.[278] In October 2018, General Motors (GM) submitted a comment on a proposed rule issued by the National Highway Traffic Safety Administration and the Environmental Protection Agency (EPA). In their comment, GM proposed the adoption of a national ZEV program based off California's ZEV Credit Program.[279] GM stated its interpretation of the Clean Air Act as providing EPA sufficient authority to promulgate a rule creating a national ZEV program.[280]

This comment by GM signifies the viability of creating a program of this kind through rulemaking. Although there may be some drawbacks, the ability to regulate in this area appears to be within EPA's authority and accordingly is an option that should be considered.

One major benefit of using rulemaking to bring about a national ZEV program is that the political barriers involved with Congressional action are not implicated here. Another benefit of utilizing rulemaking is that § 209 of the Clean Air Act has allowed EPA to waive the issue of preemption for California.[281]

4. Policy Pathway Four: Creating a ZEV Incentive Program

The fourth policy pathway is the implementation of an incentives program to aid the purchase of ZEVs. This policy pathway could be a stand-alone policy, or it could be used to augment the first three pathways.[282] One example of an incentive program is Senator Schumer's New Clean Cars for America Climate Proposal. The proposal calls for $454 billion over ten

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[278] 5 U.S.C. § 553 (2018).
[279] General Motors, Comment Letter on The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks (NPRM) 1 (Oct. 26, 2018), https://www.regulations.gov/document?D=NHTSA-2018-0067-11858.
[280] *Id.* at 6-8. EPA is authorized to regulate vehicle emissions, including GHG, under Clean Air Act § 209(a)(1). *See also Massachusetts v. EPA,* 549 U.S. 497, (2007).
[281] *Id.* at 8. One significant drawback of this alternative is the length of the rulemaking process. *Regulatory Accountability Act of 2011: Hearing on H.R. 3010 Before the H. Comm. on the Judiciary,* 112th Cong. 93 (2011) (quoting Sidney A. Shapiro). The rulemaking process to create a national ZEV program could last several years just to complete the notice and comment period. *Id.*
[282] There is evidence suggesting that removing EV subsidies prematurely can crash the existing EV market. TURRETINE, STEERING THE ELECTRIC VEHICLE TRANSITION TO SUSTAINABILITY, *supra* note 34 at 11.

years to aid the transition to ZEVs.[283] This incentive policy aims to make clean vehicles affordable, make charging infrastructure accessible, and reasserting U.S. leadership in clean car manufacturing.[284] This direct incentive will speed up the transition to ZEVs, the program will encourage trading in older gas powered vehicles for cash vouchers to help purchase ZEVs.[285]

As seen in the United States, China, and Europe, incentives help shift consumer perception and make a new technology like ZEVs more appealing. Incentives ability to shift consumer's choices ensures that this policy could single handedly spur growth in the ZEV market. Additionally, this same power to shift consumer choice makes this type of incentive program an appealing addition to any of the other policy pathways. For example, China continues to offer subsidies on high performing EVs to further bolster its NEV policy. Senator Schumer's proposal or another incentive program is a flexible policy option and could standalone or augment other policies while spurring the growth of EVs nationally.

V. Conclusion

The electric vehicle market is expanding quickly, and as it does it also drives down GHG emissions from the transportation sector. As a result, creating a ZEV program is a major tool for policymakers. This paper has provided an overview of the existing ZEV programs at work today, and the different ways in which those programs have found success. Although the United States does not currently have a national ZEV program, there are some possible policy pathways to

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[283] David Shepardson, *Senate Democrat Schumer Proposes Plan to Swap Gas Cars for Electric Vehicles*, REUTERS (Oct. 24, 2019, 6:07 PM), https://www.reuters.com/article/us-autos-emissions-congress/senate-democrat-schumer-proposes-plan-to-swap-gas-cars-for-electric-vehicles-idUSKBN1X403N.

[284] *Leader Schumer Unveils New Clean Cars For America Climate Proposal, A Transformative Plan To Reduce Number Of Carbon-emitting Cars On The Road, Create Jobs, And Accelerate Transition Net-zero Carbon Emissions*, Senate Democrats (Oct. 25, 2019), https://www.democrats.senate.gov/newsroom/press-releases/leader-schumer-unveils-new-clean-cars-for-america-climate-proposal-a-transformative-plan-to-reduce-number-of-carbon-emitting-cars-on-the-road-create-jobs-and-accelerate-transition-net-zero-carbon-emissions-.

[285] *Id.*

creating such a program. However, should the United States not adopt a national program, the California program is already an existing and successful tool for progressing the ZEV market in the United States.

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