Achieving Zero Emission Success in California

A Case Study on Alternative Fuel Infrastructure for the "Learning from the California Experience Alternative Fuels, Vehicles, and Infrastructure" Workshop

On January 18, 2017, the California Air Resources Board (CARB) released the midterm review for its Zero Emission Vehicle (ZEV) Program and found that electric drive technology is advancing ahead of schedule (see Box 1). The program, which regulates automobile manufacturers that sell vehicles in California, requires manufacturers to attain credits for ZEVs in increasing numbers through 2025. The report cites the success of the state's ambitious program to accelerate the deployment of ZEV technology, with battery costs falling faster than originally anticipated. The state now projects cumulative sales of plug-in hybrid electric vehicles and ZEVs, which include battery electric vehicles and hydrogen fuel cell vehicles, to reach 1.2 million by 2025; this level is slightly lower than what was projected in 2012.

Box 1. About California's ZEV program

The ZEV Program is part of California's Advanced Clean Cars Program, a series of programs developed in coordination with the U.S. Environmental Protection Agency and National Highway Traffic Safety Administration to reduce criteria pollutants and greenhouse gas emissions for model years 2015 through 2025. The ZEV program requires major manufacturers of passenger cars and light trucks to attain a certain number of ZEV credits depending on the number of vehicles produced and delivered for sale in the state. Credits issued per vehicle depend on the technology – plug-in hybrid electric vehicles receive fewer credits than long-range all-electric vehicles or hydrogen fuel cell vehicles. Nine states are currently following the ZEV program.

The report calls for the ZEV program to maintain the key provisions (i.e., regulatory and credit structure), expand complementary policies, and strengthen the program beginning in 2026 to reach the state's 2030 climate goals. In particular, CARB cites the need for more public infrastructure to support ZEVs, especially long range battery electric vehicles and hydrogen fuel cell vehicles.

Below are some key insights from CARB's report:

- Industry is introducing BEVs with longer range and higher charging rates more quickly than expected.
    - Battery costs have declined 20 to 35 percent since 2010.
    - Longer range means vehicles will have an incremental cost higher than the 100-mile vehicles expected in 2012.
    - A 50 percent cost reduction in the fuel cell system is expected once manufacturers reach an annual volume of 100,000 vehicles per year.
- The ratio of vehicles to charging stations in most other ZEV states is lower than in California.
- Three FCEVs are currently for sale in California while 25 retail hydrogen refueling stations are open in California with an additional 20 stations already in development.
- Looking ahead, important incentives will likely disappear before 2025. The federal hydrogen fuel cell tax credit expired on December 31, 2016 and the federal EV tax credit will phase out for leading

automakers (Tesla, General Motors, Nissan, and Ford) in the next few years, state incentives face constant budgetary challenges, and the HOV incentive in California will sunset in 2019.

Californians have purchased fewer than 250,000 EVs from 2011 to October of 2016, and the state aims to deploy over 1 million by 2025. With the introduction of long range electric vehicles and hydrogen fuel cell vehicles, CARB cited deploying new charging and hydrogen fueling infrastructure as a key measure to achieve the program goals (see Table 1). Depending on technological progress, consumer acceptance, and public policy, the fueling infrastructure in 2025 could look considerably different compared to today.

TABLE 1: ZEV FUELING INFRASTRUCTURE

Fueling Type	Equipment and Installation Cost Per Charging Port or Fueling Pump	Vehicles Accommodated Per Charging Station or Fueling Pump Per Hour
Level 2 Charging*	$8,500	< 1
Low-Power DC Fast Charging**	$82,000	1-2
High-Power DC Fast Charging**	$160,000	2-4
Hydrogen Fueling Station***	$1 million	5 or more

** Six stations per site operating at 6 kilowatts. EV Charging Guide: http://atlaspolicy.com/wp-content/uploads/2016/11/2016-07-01_EV_Charging_Guide.pdf*

*** Six stations per site, which are future proof, meaning power at the site can support 350-kilowatt charging stations. Low-power charging stations operate at 50 kilowatts and high-power stations operate at 350 kilowatts. Estimates by Atlas Public Policy and Idaho National Laboratory in coordination with U.S. Department of Energy.*

**** 4-Hose hydrogen refueling station. Estimates by U.S. Department of Energy: https://www.hydrogen.energy.gov/pdfs/progress15/iii_1_elgowainy_2015.pdf*

California state agencies must develop an adaptive policy framework that anticipates and adjusts to changes in market conditions. If advances in battery technology stall, for example, automakers might turn in greater numbers to hydrogen fuel cell technology or longer range plug-in hybrids to meet the ZEV program requirements. In those cases, lower power charging at home and long dwell locations might suit most EV drivers, but the state may require significantly more hydrogen refueling stations. On the other hand, continued advances in battery technology could make long range electric vehicles more common across the light-duty segment. In this case, very high-powered charging (up to 350 kilowatts) could be required for these vehicles to compete with gasoline vehicles.

TABLE 2: THE BALANCE OF VEHICLES AND INFRASTRUCTURE

Region	DC Fast Charging Port per 1,000 People	Level 2 Port per 1,000 People	BEVs per 1,000 People	PHEVs per 1,000 People	BEVs per DC Fast Charing Port	EVs per Level 2 Port
California	0.07	0.30	3.30	3.05	47	21
ZEV States (minus California)	0.03	0.11	0.48	0.80	17	12
Nationwide	0.03	0.11	0.81	0.79	28	14

Hydrogen fuel cell vehicles are in the demonstration deployment phase, so similar data is not available.

The Challenge

The agency considered three scenarios in its analysis that could achieve compliance with the ZEV program: low, mid-range, and high technology (Exhibits 1-3). While each of these scenarios would achieve program compliance, each scenario would differ in its mix of technology. California state agencies will try to design policies and programs that achieve the goals of the ZEV program in a cost-effective manner. Doing so will mean keeping a close eye on the development of zero emission technology, competing conventional technology, overall market conditions and trends in transportation, and consumer preferences.

Discussion Questions

1. Which of the three scenarios CARB analyzed is California most likely going to experience?
2. What are the tradeoffs of investing in hydrogen fueling infrastructure now versus five years from now? What about very high-powered charging? Which is less risky and why?
3. What is the criteria California policymakers should use to encourage private investment and avoid picking winners as it designs and deploys programs to support ZEV infrastructure in the near term?
4. What is the most suitable role for Caltrans and metropolitan planning organizations to play in deploying this infrastructure?

Sources

- CARB Midterm Review: https://www.arb.ca.gov/msprog/acc/acc-mtr.htm
- U.S. EPA Technical Assessment Report: https://www.epa.gov/regulations-emissions-vehicles-and-engines/midterm-evaluation-light-duty-vehicle-greenhouse-gas-ghg#TAR
- Atlas Public Policy analysis of data from the Auto Alliance, U.S. Department of Energy, and the U.S. Census Bureau.

Exhibit 1: Mid-Range ZEV Technology Advancement Case

Continued advancement in ZEV technology leads to balance of new sales of improved capability ZEVs and moderate use of banked ZEV and GHG credits.

- Battery electric vehicles go from 150 miles for model year 2018 to 211 miles for model year 2025
- Plug-in hybrid electric vehicles go from 40 electric miles for model year 2018 to 56 miles for model year 2025
- 5% annual growth in EV adoption; ZEVs and plug-in hybrids make up 8% of annual sales in California in model year 2025
- Hydrogen fuel cell vehicles would have 350 miles of range
- More manufacturers produce hydrogen fuel cell vehicles as infrastructure is built out in California

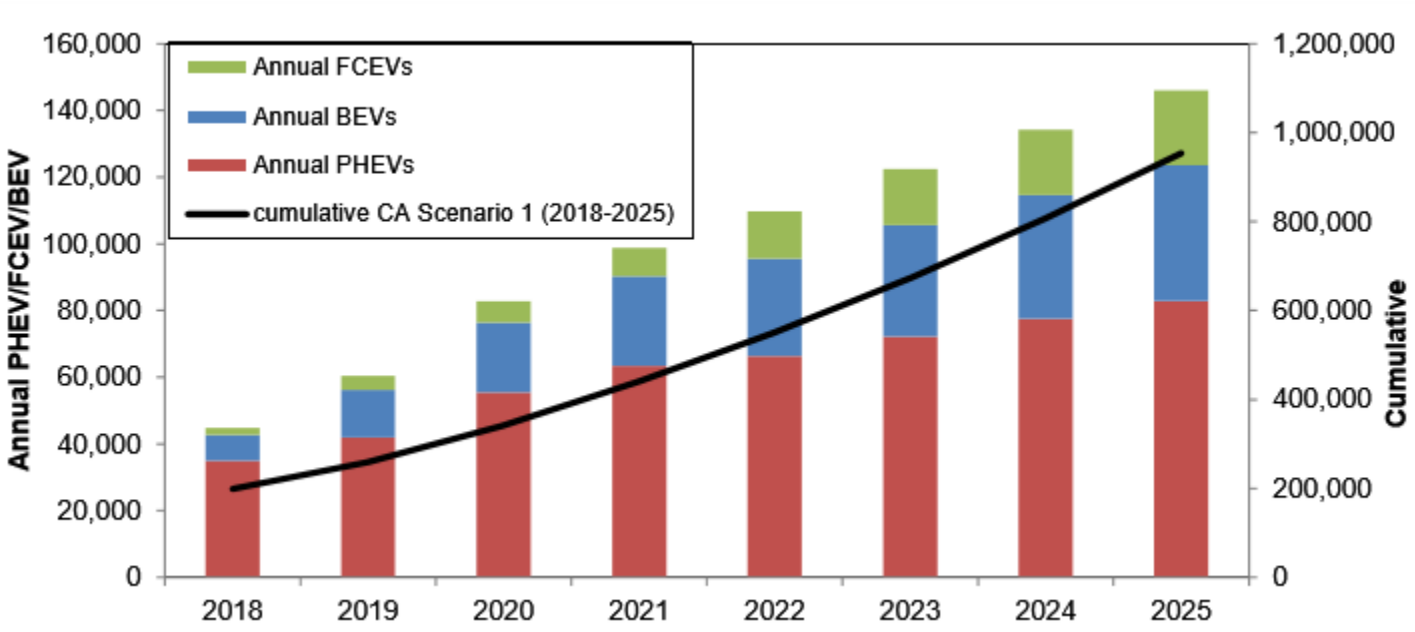

Exhibit 2: Slow ZEV Technology Advancement Case

Delayed advancement in ZEV technology leads to higher dependence on banked ZEV and GHG credits to support sales of only slightly improved ZEVs.

- Battery electric vehicles go from 150 miles for model year 2018 to 178 miles for model year 2025
- Lower all-electric range means more vehicles must be sold for compliance credits, especially in the early years
- Plug-in hybrid electric vehicles go from 40 electric miles for model year 2018 to 56 miles for model year 2025
- 2.5% annual growth in EV adoption; ZEVs and plug-in hybrids make up 8% of annual sales in California in model year 2025
- Hydrogen fuel cell vehicles would have 350 miles of range, but remain at demonstration volume and only about 5% of manufacturers will offer them.

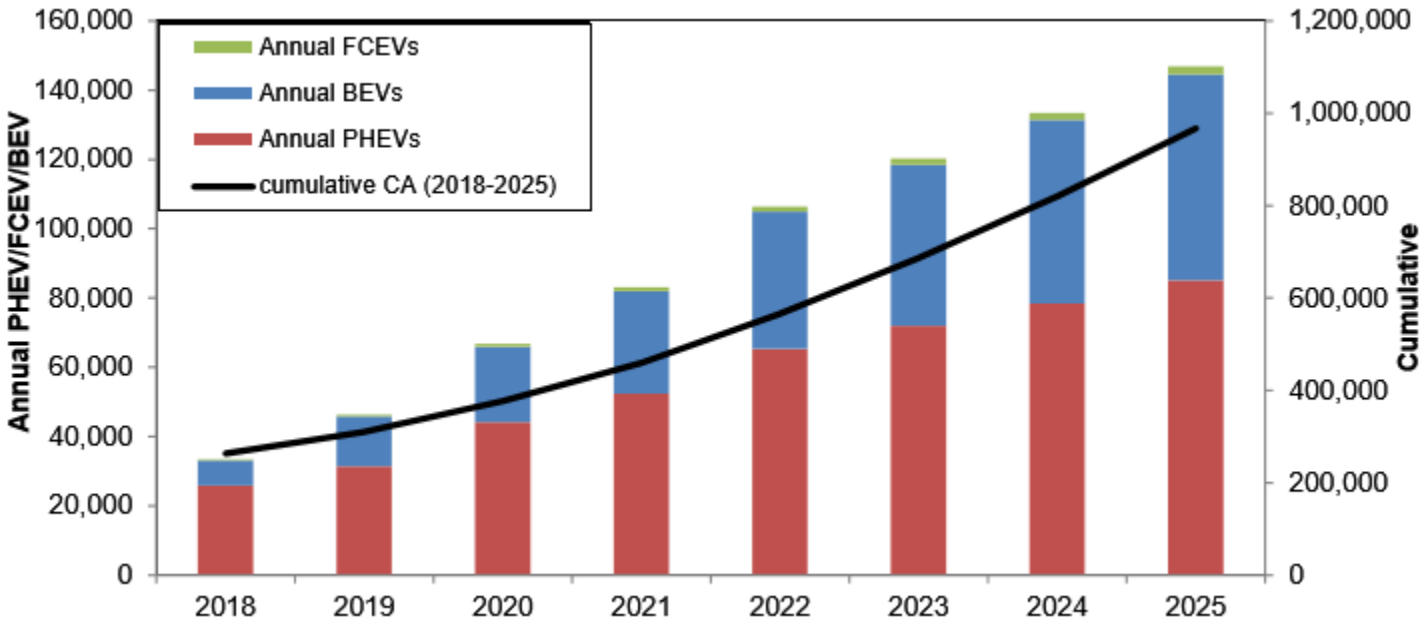

Exhibit 3: High ZEV Technology Advancement Case

Aggressive advancement in ZEV technology leads to larger increase in new sales of highly capable ZEVs as dominant mechanism for compliance.

- Battery electric vehicles go from 200 miles for model year 2018 to 300 miles for model year 2025
- More manufacturers would comply with only battery electric vehicles
- Similar cumulative number of vehicles as in mid-range case due to similar technology assumptions
- Plug-in hybrid electric vehicles go from 40 electric miles for model year 2018 to 56 miles for model year 2025
- 7.5% annual growth in EV adoption; ZEVs and plug-in hybrids make up 8.2% of annual sales in California in model year 2025
- Hydrogen fuel cell vehicles would have 350 miles of range and 50% of manufacturers will offer them in model year 2025.