APPENDIX C

STATUS OF ALTERNATIVE FUEL INFRASTRUCTURE

FOR NON- ZERO EMISSION VEHICLE ALTERNATIVE FUEL VEHICLES

Appendix C

Status of Alternative Fuel Infrastructure for Non-Zero Emission Vehicle (ZEV) Alternative Fuel Vehicles

Currently, the number of facilities offering alternative fuel in California represents just over 5 percent of the total number of retail gasoline outlets in California. Approximately 580 outlets offer compressed natural gas (CNG), E85, or liquefied petroleum gas (LPG), and most of these outlets are not associated with a retail gasoline outlet. Our records indicate that no stations offer methanol.

Sales and leases of non-ZEV alternative fuel vehicles (i.e., vehicles that can operate on CNG, LPG and E85) in California has increased substantially since the late 1990s. In 1997, only 282 alternative fuel vehicles were sold or leased in California; however by 2010, that figure increased to over 63,000. The cumulative number of alternative fuel vehicles sold or leased from 1997 to 2010 is over 475,000.

The following provides a summary of the status of alternative fuel infrastructure and vehicles for each of these non-ZEV fuels and vehicles.

A. CNG Vehicles and Fueling Infrastructure

Auto manufacturers started making dedicated CNG vehicles and bi-fuel vehicles, which operate on either gasoline or CNG, in the late 1990's. Starting in mid-2000, certified after-market CNG conversions started replacing the CNG vehicles being produced by auto manufacturers. In 1999, the Air Resources Board (ARB) estimated that nearly 95 percent of the CNG vehicles in the State were fleet-operated and the majority of CNG fueling facilities were private or government owned with limited to no public access.[1] Following is a discussion of the current status of natural gas fueling infrastructure and CNG vehicle development.

1. CNG Vehicles

From 1997 through model year 2009, approximately 23,500 light and medium duty Alternative Fueled Vehicle operating on CNG were sold or leased in California. That number of CNG vehicles is projected to increase to over 30,000 by the end of the 2014 model year. The majority of CNG vehicles operating in California are light and medium duty vehicles that are owned and operated as part of fleets and are fueled at private

[1] ARB, 1999. California Air Resources Board. "Staff Report: Initial Statement of Reasons for Proposed Amendments to the Clean Fuels Regulations Regarding Clean Fuel Outlets." June 4, 1999.

refueling facilities. A significant portion of the CNG fleet includes after-market conversions.

2. CNG Infrastructure

According to the U.S. Department of Energy (U.S. DOE) Alternative Fuels and Advanced Vehicle Data Center, there are 224 CNG fueling facilities in California. Of these stations, 126 are accessible to the public and 98 are exclusively private. Information submitted by the California Natural Gas Vehicle Coalition at the January 25, 2012 board hearing[2] provides a more accurate account of CNG stations in California – 140 public and 424 private stations totaling 564. Most CNG fueling facilities, including facilities classified as "public," do not offer unrestricted access to the general public. Most require the motorist to prearrange the acquisition of a key card for entry into the facility and/or purchase of CNG. It is noteworthy that the profitability of a CNG station is largely based upon the volume of CNG sold. However, stations that have the lowest CNG sales are public stations not associated with a fleet operator, especially since these public stations are rarely co-located with retail gasoline or convenience stores. This explains why exclusively public stations, with unrestricted access, are on the decline; less than 10 CNG stations are integrated with retail gasoline stations, and currently there are no CNG stations that operate as joint ventures with major petroleum companies.[3]

For proprietary reasons, it is difficult to obtain exact funding information for public CNG fueling stations. However, many governmental programs like Congestion Mitigation and Air Quality, Federal tax credits, California's Mobile Source Air Pollution Reduction Review Committee (Assembly Bill (AB) 2766), AB 118, and local air district grants fund CNG infrastructure. Additionally, CNG refueling equipment can cost between $750,000 to several million dollars, so many of the existing public CNG refueling stations would not have been built without the assistance of various governmental incentive programs due to low potential for gaining return on their investment. This low potential can be attributed to the following: 1) the price for natural gas is set by the California Public Utilities Commission; 2) usage by fleets is low due to the availability of private fueling; and 3) most non-fleet customer's CNG vehicles are light-duty and require small amounts of fuel compared to the medium and heavy duty vehicles typically operated by fleets. Previously, California Energy Commission (CEC) invested $5.7 million for up to 20 CNG stations from funding allocated through their 2008-09 and 2009-10 AB 118 Investment Plan. The current 2011-2012 AB 118 Investment Plan allocates $8 million

[2] California Natural Gas Vehicle Coalition comment letter submitted at the ACC board hearing. January 25, 2012. http://www.arb.ca.gov/lispub/comm/bccommlog.php?listname=cfo2012
[3] CEC, 2006. California Energy Commission. "California Alternative Fuels Market Assessment." Oct. 2006. Pg. 2-21,

for CNG fueling infrastructure, and $12 million in vehicle incentives for medium and heavy duty natural gas vehicles.[4] At an investment level of approximately $500,000 per station, it is anticipated that private sector investment will compliment State funds.

Most CNG facilities utilize high pressure systems and are classified as "fast fill" facilities. As the name implies, these "fast fill" facilities can refuel a vehicle in minutes and providing the facility with a higher annual throughput. Home refueling devices are also available and are most practical for owners of light-duty CNG vehicles and are incentivized by rebates in some areas.[5] These home refueling devices require up to 10 hours to dispense and fully pressurize a tank of natural gas from a standard utility gas line – ideal for overnight refueling and similar to the amount of time required to charge a battery electric vehicles (BEV) with a 110 volt outlet.

3. Station coverage for CNG vehicles

With an estimated 25,000 light and medium duty CNG vehicles in operation in California today and approximately 564 public and private stations offering CNG, each public station could serve 179 light and medium duty vehicles on average. If the number of CNG vehicles increases to 30,000 by 2013 as projected above and approximately 32 new public CNG stations are added with the help of CEC funding, the average number of vehicles per station decreases to 174. As mentioned earlier, public access stations have lower CNG sales compared to private stations, and station profitability is primarily based on the volume of CNG sold. One could reason that increasing CNG vehicle sales to private customers in addition to fleet customers would result in increased utilization and profitability of public CNG stations. It is interesting to note that, verbal comments submitted by Clean Energy[6] and the California Natural Gas Vehicle Coalition on the draft 2011-2012 AB 118 Investment Plan urged CEC to reallocate the money slated for CNG infrastructure toward incentives for purchasing CNG vehicles.[7]

In addition to the funding and rebates offered for CNG fueling, California and the federal government offer incentives for buying or leasing CNG vehicles, such as high occupancy vehicle (HOV) lane access, federal tax credits, and vehicle rebates (limited to available funding). A few cities are also offering rebates for certain CNG vehicles

[4] CEC, 2011c. California Energy Commission. "2011-2012 Investment Plan for the Alternative Fuels and Vehicle Technology Program." Publication No. CEC-600-2011-006-CMF. Sept. 7, 2011.
[5] SCAQMD, 2005. South Coast Air Quality Management District. Website. "Incentives Offered to Refuel Natural Gas Vehicles At Home." May 6, 2005. http://www.aqmd.gov/news1/2005/phillhomerefuelingunitpr.html.
[6] Clean Energy builds and operates natural gas fueling stations, and owns a significant number of the public natural gas fueling stations in California. http://www.cleanenergyfuels.com/main.html.
[7] CEC, 2011c.

while funds last.[8] These incentives are an important factor in customers decisions to purchase CNG vehicles.

While natural gas continues to play an important role in emission reductions in public and private fleets, especially in the heavy duty sector, natural gas vehicles are not a necessary part of State and federal long-term strategies for reducing emissions from the light duty vehicle sector. In the near term, however, the State will continue to incentivize CNG through station funding, HOV access and vehicle rebates, while they last.

B. E85 Vehicles and Fueling Infrastructure

Flex-fuel vehicles (FFV) that can operate on gasoline-blends of up to 85 percent ethanol were introduced in small quantities in 1997. Auto manufacturers started increasing production in 2000 – the trend has continued upward ever since. FFV buyers include both fleet and private customers. Development of E85 fueling infrastructure has lagged behind vehicle deployments, primarily because E85 is not required for FFV operation. In fact, most early FFV buyers did not know that their vehicles could run on E85. In late 2000, federal and State regulations pertaining to biofuels prompted the funding and development of E85 fueling infrastructure in an effort to encourage FFV drivers to choose E85 over gasoline. Following is a discussion of the current status of E85 fueling and FFVs in California as well as activities and rules that may affect future trends.

1. E85 Vehicles

In the late 1990s, manufacturers began selling FFV capable of running on either E85 or traditional gasoline. FFVs have been extremely popular from an auto manufacturer's perspective because of the relatively low incremental production cost and the fleet average fuel economy compliance benefits discussed below. As a result, E85 FFVs comprise approximately 96 percent of the alternative fuel vehicle fleet in California. In 1998, only 200 FFVs were sold or leased in California. By 2009, over 684,000 FFV were sold or leased in California, and by 2013, the cumulative number of FFVs is projected to exceed one million vehicles. Figure C-2 show the actual and projected growth of FFVs.

[8] ARB's DriveClean website provides a complete list of incentives offered to CNG vehicle owners. http://www.dirveclean.ca.gov.

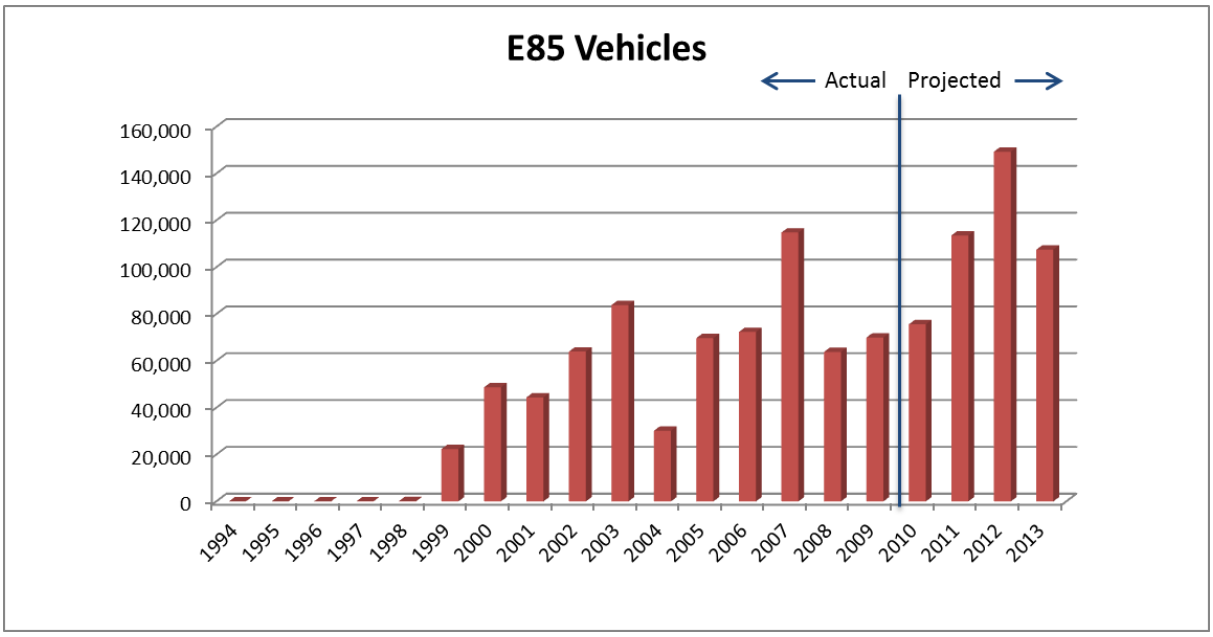

Figure C-2: Light and Medium Duty E85 FFV Sales and Leases

This increase in production and availability of E85 FFVs, as well as projections for even greater numbers in the future, can be attributed to the federal Corporate Average Fuel Economy (CAFE) credits offered to auto manufacturers that produce FFVs. Auto manufacturers can use special calculations to boost their FFV fuel economy levels for compliance purposes under CAFE; these boosts help to offset the reductions in their fleet average fuel economy caused by producing vehicles with low fuel economy. The maximum fleet average offset of 1.2 miles per gallon (mpg) will be available to auto manufacturers through model year 2014. The offset will be reduced by 0.2 mpg per year until it is phased out completely after model year 2019. Starting model year 2016, auto manufacturers wishing to use the calculations to boost their FFV fuel economy must provide data demonstrating that alternative fuels are being used.[9] Given that it is the FFV driver who decides which fuel to purchase, it will be interesting to see how the above changes to the treatment of FFVs in calculating CAFE credits will affect auto manufacturers' plans and projections for model years beyond 2014.

2. E 85 Infrastructure

The growth of E85 fueling stations over the past decade has been a success. In the late 1990s, no E85 refueling stations existed; today there are 118 E85 fueling facilities

[9] USEPA, 2010. United States Environmental Protection Agency, National Highway Transportation and Safety Administration, California Air Resources Board. "Interim Joint Technical Assessment Report: Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2017-2025." Docket ID Number: EPA-HQ-OAR-2010-0799. September 2010. http://www.epa.gov/otaq/climate/regulations/ldv-ghg-tar.pdf. Page 5-2.

in California. Of these facilities, 63 are public or retail facilities and 55 are private fleet facilities. Table C-2 shows the details the number of E85 stations.

Table C-2: E85 Fueling Stations

	Northern CA	Southern CA	Total
Public/Retail	41	22	63
Private/Fleet	35	20	55
Total	76	42	118

Tanks and pumps at existing gasoline fueling stations can be modified to sell E85. Although there are questions about the cost of modifications vs. new installations, most E85 retail outlets are co-located with traditional gasoline outlets. This provides convenience to the consumer but can work against the ethanol distributor, and possibly the retailer, if drivers can choose between E85 and gasoline. A gallon of E85 has approximately 23 percent to percent less energy than a gallon of gasoline and consequently, these vehicles cannot travel as far on E85 compared to the same volume of gasoline. Studies have shown that drivers of FFVs are aware of this energy reduction and will purchase E85 when it is priced proportionally lower than gasoline. [10] Over the past decade, gasoline prices have seen considerable fluctuation; this has resulted in swings in E85 sales. This lack of consistent demand for E85 has led some retailers to report that it is difficult to justify the investment in equipment to sell E85.

Construction of many of the current E85 stations has been co-funded by government grants. In 2010 Propel Fuels, Incorporated was awarded $6.9 million in Federal stimulus funds from the U.S.DOE. Under AB 118, the CEC allocated $5 million in fiscal year 2011-2012 for the construction of up to 50 E85 stations and $8 million for advanced ethanol and gasoline substitute production plants. Through prior AB 118 funding, CEC has invested $1 million for E85 fueling stations, $6 million to incentivize California's ethanol production, and $5.4 million toward the development of advanced ethanol and gasoline substitutes. [11] Propel Fuels matched these State and federal grants with $16.2 million in private equity funding for the construction of up to 75 E85 facilities. Federal tax credits of up to $50,000 were available to parties installing E85 stations through 2009 and 2010, and up to $30,000 for stations installed in 2011.[12] However, as previously stated, it is difficult to justify the investment in E85 infrastructure due to the lack of consistent demand for E85. Therefore, the government's involvement in funding these stations has been essential.

[10] ORNL, 2006. Oak Ridge National Laboratory. Anderson, Soren. "The Demand for E85 Ethanol," University of Michigan, 2006. https://biokdfapp.ornl.gov/node/228. Accessed Nov. 10, 2011.
[11] CEC, 2011c.
[12] US DOE, 2010b. U.S. Department of Energy Alternative Fuel Infrastructure Tax Credit. http://www.afdc.energy.gov/afdc/laws/law/US/351

3. Fuels Regulations Affecting Ethanol

In 2007, the federal government passed the Energy Independence and Security Act, which include changes to the Renewable Fuels Standard (RFS).[13] By 2022, United States transportation fuels used each year must include a minimum of 36 billion gallons of biofuels. Starting in 2016, the increases over the prior year must be comprised of advanced biofuels, defined as cellulosic ethanol and other biofuels derived from feedstock other than corn starch. In 2009, California adopted the Low Carbon Fuel Standard (LCFS) to reduce greenhouse gas emissions associated with the lifecycle of transportation fuels used in California. LCFS is designed to ensure that producers and importers of transportation fuel collectively reduce the overall carbon intensity of California's fuel pool by 10 percent by 2020. LCFS is not limited to liquid biofuels and includes CNG, electricity and hydrogen.

For both regulations, compliance rests primarily in the hands of producers and importers of transportation fuels. For RFS, compliance may include increasing the amount of liquid biofuels used in conventional gasoline and diesel vehicles and/or offering biofuel blends, such as E85, that require infrastructure and vehicle adaptations. For compliance with LCFS, regulated parties may choose the above options as well, but may also include CNG, electricity and/or hydrogen in their compliance portfolio.

The State and federal government are promoting increased utilization of ethanol in transportation fuels through RFS and LCFS–both of which give regulated parties some flexibility in how they increase the use of biofuels, including ethanol, in transportation. Mandating E85 outlets in addition to these requirements could be conflicting, counter-productive, and does not address the customer choice issue. Also, like CNG, E85 FFVs are not a necessary part of State and federal long-term strategies for reducing emissions from the light duty subsector.

C. Liquefied Petroleum Gas (LPG) Vehicles and Fueling Infrastructure

LPG is gaseous hydrocarbon consisting primarily of propane and butane. Sometimes LPG is simply referred to as "propane". LPG has a lower energy content than gasoline and its use as a motor vehicle fuel is very limited. According to American Petroleum Institute approximately three percent of the LPG sold in the United States is for transportation. The majority of LPG use is for industrial, commercial, and recreational applications.

[13] Federal Register, National Archives and Records Administration. March 26, 2010. Pages 14669-15320 http://edocket.access.gpo.gov/2010/pdf/2010-3851.pdf

Due to the limited use of LPG as a transportation fuel, the majority of LPG fueling facilities are not designed for exclusive motor vehicle refueling. Most "stations" are collated with other commercial ventures like commercial equipment rental or industrial gas suppliers. Currently there are 238 LPG facilities in California, 233 public facilities and 5 private facilities. It should be noted that most public facilities do not offer unrestricted access, most require a key card or the customer to call ahead for access and service.

Except for safety and storage, LPG is essentially an unregulated fuel in California. ARB does not have standards for LPG as a transportation fuel. Therefore, no data is collected by the state on LPG sales or usage. LPG prices are set by the market.

CEC estimates that the cost to retrofit an existing station to dispense LPG is between $37,000 and $152,000. Existing federal incentives cover 30 percent of this cost, up to $30,000. Given the relatively low cost of LPG infrastructure and existing incentive programs, only a minimal amount of support is needed to continue the growth of LPG stations. Under AB 118 the CEC is allocating $500,000 in fiscal year 2011-2012 for LPG fueling infrastructure.[14] This funding is intended to cover the cost of 10 fueling stations along the I-5 corridor in Northern California. No AB 118 funding was provided for LPG infrastructure in fiscal years 2008-2009 and 2009-2010.[15]

While LPG to has an important role in reducing emissions primarily in the heavy duty vehicle sector, it is not part of State and federal long-term strategies for reducing emissions from light duty vehicles.

D. Methanol

Methanol FFV (vehicles that run on up to 85 percent methanol/gasoline blends [M85]) started to receive attention in the late 1970s and by the 1990s over 20,000 methanol FFVs had been introduced into the market, with over 100 M85 fueling stations in California. When compared to gasoline, one gallon of M85 contains slightly more than half the energy as a gallon of gasoline; however, methanol is typically less expensive on an energy equivalent basis. In the 1980s and 1990s when gasoline was cheap, methanol fuel costs to the consumer were generally equivalent to premium gasoline. As a result, consumers opted to fill their FFVs with gasoline most of the time, making it difficult to build volume sales to encourage the operation of M85 retail pumps.[16]

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[14] CEC, 2011c.
[15] CEC, 2009. California Energy Commission. "Investment Plan for the Alternative and Renewable Fuel and Vehicle Technology Program." Publication No. CEC-600-2009-008-CMF. April 22, 2009.
[16] Methanol, 2011. Methanol Institute. Website. "Methanol, The Clear Alternative for Transportation." April 2011. http://www.methanol.org/Energy/Resources/Alternative-Fuel/Methanol-Flexible-Fuel-Vehicles.aspx.

Methanol's decline was also affected by technology advancements that enabled low-emission vehicle standards to be met through improved emissions controls and cleaner burning gasoline formulations, and without alternative fuels. Currently, ARB has no records of public or fleet methanol refueling stations in California. The CEC has allocated no funds for methanol infrastructure under AB 118.