

CALIFORNIA ENERGY COMMISSION

ALTERNATIVE FUELS AND TRANSPORTATION TECHNOLOGIES

2014 INTEGRATED ENERGY POLICY REPORT UPDATE

The California Energy Commission's *2014 Integrated Energy Policy Report Update* focuses on transportation in light of California's energy and climate goals. The following is a summary of information on the Energy Commission's investments to help spur transformation to a clean, low-carbon transportation energy future.

Alternative Fuels and Transportation Technologies

While gasoline consumption has been declining since 2008, it is still by far the dominant fuel:

- » Petroleum comprises about 92 percent of all transportation energy use, excluding fuel consumed for aviation and most marine vessels
- » For 2013, combined use of alternative fuels—those derived from resources other than petroleum, such as hydrogen, natural gas, chemically stored electricity (e.g., batteries), and biofuels—was only slightly more than 7 percent of total transportation fuel use in California

To achieve California's climate change, air quality improvement, and petroleum reduction, the state must transition away from fossil fuels to using predominantly zero-emission and near-zero-emission vehicles.

Hydrogen Fuel Cell Electric Vehicles and Fueling Infrastructure

Hydrogen fuel cell electric vehicles (FCEV) will play a key role in fulfilling the Governor's ZEV Action Plan goals for 1.5 million zero-emission vehicles in 2025:

- » They can travel from 250 to more than 300 miles on a tank of hydrogen and can be refilled in 5 to 10 minutes, which is comparable to fueling gasoline-powered vehicles
- » Fuel cell electric drivetrains can be scaled up and used in larger sedans, vans, SUVs, and light trucks, which will create more zero-emission transportation options than are available with battery-electric vehicles
- » FCEV may also prove attractive to consumers who want zero-emission transportation but do not have access to charging infrastructure

California Needs an Initial Network of 100 Hydrogen Fueling Stations to Support Introduction of Fuel Cell Electric Vehicles

Studies show that California needs an initial network of about 100 strategically placed hydrogen fueling stations

to ensure that hydrogen fuel is convenient and close to the daily driving routes and patterns of the first wave of fuel cell electric vehicle (FCEV) drivers. The Energy Commission has funded 48 hydrogen fueling stations out of the initial 100 to support FCEV roll-out in California.

Creating a completely new fueling system for hydrogen FCEVs requires close collaboration between government and private sector stakeholders, particularly in coordinating the timing of hydrogen station installment and FCEV deployment by automakers, as the advancement of each requires demand for the other.

California Law Requires 33 Percent Renewable Content in Publicly Sold Hydrogen

California law requires all hydrogen sold at publicly funded stations to contain at least one-third renewable hydrogen; therefore, the Energy Commission requires all fuel cell station owners and operators to have at least one-third renewable hydrogen in their hydrogen fuel products. Industry experience and commitments demonstrate that providing a hydrogen fueling stream that is derived from at least 33 percent renewable hydrogen is feasible.

The California Fuel Cell Partnership presented data in their 2014 “Well-to-Wheels Report” suggesting hydrogen FCEVs and battery electric vehicles have fairly comparable well-to-wheel efficiency, measured by the energy needed to drive one mile. Hydrogen FCEVs convert 36-44% of hydrogen energy to power at the wheels, while battery electric vehicles convert 59-62% of grid energy to power at the wheels. In contrast, combustion vehicles convert only 17-21% of gasoline energy to power at the wheels.

Zero-Emission and Near-Zero-Emission Medium- and Heavy-Duty Vehicles

California’s fleets of medium- and heavy-duty vehicles:

- » Total more than 900,000 vehicles
- » Include long haul tractors, refuse hauling trucks,

package delivery vans, medium-duty work trucks and shuttles, and buses.

- » In 2012, comprised about 3.7 percent of the total vehicle population in California, yet consumed more than 20 percent of the total fuel
- » Are responsible for as much as 23 percent of transportation-related greenhouse gas emissions and 30 percent of total smog-forming oxides of nitrogen (NOx) emissions
- » In the San Joaquin Valley and South Coast Air Basins, truck-related NOx emissions are the leading cause of harmful ozone pollution, fine particulate matter emissions, and resulting respiratory diseases.

Role of Truck Emissions in Nonattainment Air Basins in California

The U.S. EPA sets National Ambient Air Quality Standards for pollutants that are considered harmful to public health and the environment and designates areas as either attainment (meeting the standards) or nonattainment (not meeting the standards). U.S. EPA has designated both the San Joaquin Valley and the South Coast air basins as extreme nonattainment under the 8-hour ozone standard. NOx emissions are one of the primary precursor pollutants for the formation of ground-level ozone. In both the San Joaquin Valley and the South Coast air basins, heavy-duty diesel engines are the primary source of NOx emissions. In 2012, NOx emissions from the trucking sector comprised 38 percent of total NOx emissions in the eight-county San Joaquin air basin and 24 percent in the South Coast air basin.

NOx emissions need to be reduced by 70 to 90 percent from the transportation sector by 2023 for the South Coast AQMD to reach attainment with federal public health standards. Dr. Matt Miyasato of the South Coast AQMD described how on-road heavy-duty truck

emissions are the largest contributor to NOx emission levels in his region. To meet the pending federal air quality standards and climate goals, every vehicle sold in the South Coast Air Basin from 2025 to 2030 would need to be a zero-emission vehicle. Dr. Miyasato described the range of public health impacts from this poor air quality, stating that it disproportionately affects children and the elderly in terms of respiratory disease, impacts to brain development and IQ levels, and the premature death of up to 5,000 people each year

The Energy Commission’s Near- and Long-Term Strategy to Facilitate the State’s Goals

The state’s goals for the medium- and heavy-duty vehicle sector are to reduce diesel fuel use, reduce carbon emissions, improve air quality, and improve public health. The Energy Commission’s strategy for helping to achieve these goals is to promote development and commercialization of medium- and heavy-duty truck technologies for goods movement and freight transport with the Alternative and Renewable Fuels and Vehicle Technology Program (ARFVTP) investments.

Currently, the Energy Commission’s near-term strategy is to deploy advanced natural gas trucks and fueling stations, which create immediate near-term benefits by reducing greenhouse gas emissions by one-third over diesel fuel and by displacing toxic diesel PM emissions. The Energy Commission’s long-term strategy is to fund the development of zero-emission electric and fuel cell electric drive truck and bus technologies, and near-zero-emission natural gas engine technologies. However, market uptake of the cleanest trucks remains slow due to cost. Targeted incentives to help bring down the cost of electric trucks are an area of opportunity.

Low Carbon Intensity Biofuels

Biofuels will play a critical role in reducing carbon emissions from the transportation sector and are a key element in the Energy Commission’s portfolio approach to a low-carbon transportation future:

- » Ethanol has already displaced 10 percent of petroleum fuel as a blend in the 14.5-billion-gallon-per-year, gasoline-based, light-duty passenger vehicle sector
- » Biodiesel and renewable diesel could increase threefold to sixfold by 2020 to displace part of the 3.6-billion-gallon-per-year diesel fuel market as a fuel blend in trucks and buses
- » Low-carbon-intensity feedstocks—such as waste residues and some sustainable purpose-grown crop—have begun to displace corn ethanol and soy biodiesel as sources for biofuel production and offer an opportunity to reduce large amounts of greenhouse gas emissions over the next 10 years
- » Low-carbon fuel biofuel options can be used in California’s existing 26 million passenger cars and 1 million trucks and buses
- » There is significant potential job growth from development of California biofuel production plants, particularly in the San Joaquin Valley, where many plants are located or planned

Regulations like the Low Carbon Fuel Standard (LCFS), which requires a 10 percent reduction in the carbon intensity of California transportation fuels by 2020, are the building blocks for achieving these overarching goals. The Renewable Fuel Standard Program (RFS2), administered by the U.S. EPA, sets the minimum volume of renewable transportation fuel that must be sold in the United States with a mandate of 36 billion gallons of renewable fuel to be blended into transportation fuels nationwide by 2022. The Energy Commission invests its Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP) funds into projects that can help support these goals and should look for opportunities to support projects such as co-location of biogas with natural gas and hydrogen

fueling stations. This work will help develop commercial products and markets for a range of biofuels that include ethanols, green gasoline, biodiesel, renewable diesel, and biogas. Biofuels funding for fuel production and infrastructure comprises 29 percent of the current ARFVTP investment portfolio.

Natural Gas and Renewable Natural Gas Fuels and Vehicles Assessment

Since the first round of ARFVTP Investment Plans and funding solicitations in 2009 and 2010, the Energy Commission has viewed natural gas as a near-term bridging fuel that offers a modest 30 percent carbon reduction from petroleum fuels, especially in the truck and bus sectors.

An immediate concern with natural gas is the potential for the modest carbon intensity benefit to be reduced or eliminated due to the leakage of methane—the primary component of natural gas and a very potent but short-lived greenhouse gas. The Energy Commission staff has been, and will continue to be, mindful of methane leakage issues and concerns. To stay well-informed about the changing landscape on methane leakage and the most current research, the Energy Commission will continue to participate in discussions with the Air Resources Board (ARB) and other experts as well as fund studies to help advance the state of knowledge.

In the near term, natural gas engines offer a potential option to reduce carbon and criteria emissions from the long-haul truck sector. At present, there are limited alternative fueling options for long-haul freight: biodiesel has higher NOx emissions than diesel fuel; renewable diesel is not yet available in the volumes needed to satisfy long-haul routes; and battery electric and fuel cell electric drive trucks are in early phase demonstration trials.

Advanced natural gas engines have the potential to operate at extremely low emission levels that could be “electric vehicle equivalent” on a life-cycle emissions basis. The Energy Commission is pooling ARFVTP funds with the South Coast AQMD to fund the development of low NOx natural gas engines that would be 80 percent cleaner than current engine technologies (0.01 grams per brake-horsepower hour). The combination of low NOx natural gas engines and biogas fuel blends creates the potential for a natural gas fuel pathway with the same environmental attributes as electric drive or hydrogen fuel cell trucks.

For more information, please see the 2014 Integrated Energy Policy Report Update, available at www.energy.ca.gov/2014_energy policy/.

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