

# **THE FUTURE OF DROP-IN FUELS**

## **I. OBJECTIVE**

Advances in fuels that are derived from renewable feedstock are essential for California to meet its climate change and air quality goals. Although there are several types of renewable fuels, one that requires the least modifications to the existing infrastructure and vehicle fleet are drop-in fuels—that is, fuels that, once produced, are nearly identical to fossil-derived gasoline and diesel. This project should address the technology, feasibility, costs, and environmental impacts associated with producing these fuels on a commercial scale. The study would provide essential data that will be used to influence and shape the Low Carbon Fuel Standard (LCFS) policy. Additionally, the data could further support other climate change initiatives (within California and world-wide), the Federal Renewable Fuels Standard, and long-term air quality projects.

## **II. BACKGROUND**

ARB adopted the LCFS regulation in January 2010<sup>1</sup>. The first year was a reporting only year; full implementation began in 2011. The LCFS will reduce greenhouse gas (GHG) emissions from the transportation sector in California by about 16 million metric tons (MMT) in 2020. These reductions account for almost 10 percent of the total GHG emission reductions needed to achieve the State's mandate of reducing GHG emissions to 1990 levels by 2020. In addition, the LCFS is designed to reduce California's dependence on petroleum, create a lasting market for clean transportation technology, and stimulate the production and use of alternative, low-carbon fuels in California.

The LCFS is designed to provide a durable framework that uses market mechanisms to spur the steady introduction of lower-carbon fuels. The framework establishes performance standards that fuel producers and importers must meet each year beginning in 2011. One standard is established for gasoline and the alternative fuels that can replace it; a second similar standard is set for diesel fuel and its replacements. Each standard is set to achieve an average 10 percent reduction in the carbon intensity of the statewide transportation fuels mix by 2020.

The standards are “back-loaded”; that is, there are more reductions required in the last five years than the first five years. This schedule allows for the development of advanced fuels that are lower in carbon than today's fuels and the penetration of plug-in hybrid electric vehicles, battery electric vehicles, fuel cell vehicles, and flexible fuel vehicles.

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<sup>1</sup> Codified at title 17, California Code of Regulations, sections 95480—95490. Additional changes went into effect in April 2010. Last amended February 12, 2012. Additional amendments, approved by the Board at its December 2011 hearing, are pending approval by the Office of Administrative Law.

The lynchpin of the LCFS is the development of lower-carbon fuels and the adoption of more efficient, advanced-technology vehicles. The original design of the LCFS provides time for the development of these technologies, but in order to achieve commercial production, the technologies need to be encouraged now. If a low carbon intensity drop-in fuel were developed, it would aid in compliance without adding costs associated with fleet turnover and additional infrastructure. But, in order to be commercially viable, the fuel needs to be available in sufficient quantities and available at competitive prices to its conventional counterparts.

Several industry studies<sup>2,3,4</sup> have contended that the fuels necessary to comply with the LCFS standards in the 2015 timeframe will not be available when they are needed. Not only are these studies pessimistic with respect to availability, but they also focus on the alleged large cost impact it will have on the consumer if these fuels are either unavailable or very expensive to produce.

In addition to the immediate need for LCFS compliance, there are several longer-term goals that will benefit from the data generated from this study. Reducing emissions in the transportation sector is key to attaining the State's air quality and climate goals. A recent ARB staff report<sup>5</sup> examined several technology-transformation scenarios needed to meet California's 2050 goals for the reduction of both GHG and criteria pollutant emissions. The scenarios in this report relied on the assumption that all liquid fuels are derived from renewable feedstocks by 2050, preferably in the form of drop-in fuels. While drop-in fuels are essential to meeting California's climate change and air pollution goals, the technology and infrastructure needed to develop commercially available renewable fuels still requires significant research.

Additional studies have also indicated that biofuels will be needed to achieve long-term energy and climate goals in the transportation sector, especially for aviation, shipping, and heavy-duty and off-road vehicles that cannot be easily electrified.<sup>6</sup>

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<sup>2</sup> Andrew Chang & Company, LLC, "The Fiscal and Economic Impact of the California Global Warming Solutions Act of 2006," Commissioned by California Manufacturers & Technology Association, June 2012. <http://www.cmta.net/pdfs/CMTA%20-%20Local%20Case%20Study%20Final.pdf>.

<sup>3</sup> Stonebridge Associates, Inc., "The Impact of the Low Carbon Fuel Standard and Cap and Trade Programs on California Retail Diesel Prices," Commissioned by California Trucking Association, April 2012. <http://caltrux.org/sites/default/files/CTALCFS.pdf>

<sup>4</sup> Boston Consulting Group, "Understanding the impact of AB 32," Commissioned by Western States Petroleum Association, June 2012. [http://www.cafuelfacts.com/wp-content/uploads/2012/07/BCG\\_report.pdf](http://www.cafuelfacts.com/wp-content/uploads/2012/07/BCG_report.pdf).

<sup>5</sup> Vision for Clean Air: A Framework for Air Quality and Climate Planning. June 27, 2012. [http://www.arb.ca.gov/planning/vision/docs/vision\\_for\\_clean\\_air\\_public\\_review\\_draft.pdf](http://www.arb.ca.gov/planning/vision/docs/vision_for_clean_air_public_review_draft.pdf)

<sup>6</sup> California Council on Science and Technology (2011) *California's Energy Future – The View to 2050*, available at (<http://www.ccst.us/publications/2011/CEF%20index.php>); California's Climate Challenge; or Yang et al (2009) Meeting an 80% Reduction in Greenhouse Gas Emissions from Transportation by 2050: A Case Study in California, USA, *Transportation Research Part D: Transport and the Environment*, Vol. 14, Issue 3, 147-156.

### **III. SCOPE OF WORK**

Drop-in fuels are in a research and development phase with pilot- and demonstration-scale plants under construction. Potential technology pathways include, but aren't limited to: (1) upgrading alcohols to hydrocarbons, (2) catalytic conversion of sugars to hydrocarbons, (3) fermentation of sugars to hydrocarbons, (4) hydrotreating algal oils, (5) upgrading of syngas (CO and H<sub>2</sub>) from gasification, and (6) pyrolysis or liquefaction of biomass to bio-oil with hydro-processing.

The primary goals for this project are defined below.

- Review the literature to gather existing information related to renewable drop-in fuels. Establish if data are available for life cycle analysis of various technology pathways and their related costs and environmental impacts.
- Analyze the technology, feasibility, costs, and environmental impacts at both demonstration and commercial scale. Estimate where facilities could potentially be located in order to maximize production while minimizing environmental impacts.
- Identify additional areas of research to facilitate the growing need for data related to technological advancement, costs, and environmental impacts.
- Identify barriers to the success of these technologies, and where applicable, strategies to overcome these barriers.
- Develop a strategy to monitor and track progress of these technologies as well as supplies and costs.

These results will provide data that will influence LCFS policy. If this research leads to the development of lower-carbon fuels, it will be to the benefit of regulated parties under the LCFS and to the California consumers. In the longer term, the data will inform many other initiatives of ARB that might support the need for drop-in fuels. In addition to benefits provided to the California's LCFS program, this research can also provide support to other jurisdictions worldwide that are developing their own LCFS-like programs.

### **IV. DELIVERABLES**

- Quarterly progress reports
- Final report
- Additional deliverables to be determined in consultation with ARB staff.

### **V. TIMELINE**

It is anticipated that projects will be completed in 36 months from the start date. Note that this allows 30 months for completion of all work through delivery of a draft final report; the last 6 months are for ARB and RSC review of the draft final report and delivery of a revised final report and data files to the ARB.