Low Carbon Fuel Standard & Zero Emissions Fuel Infrastructure

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April 2020

1. Introduction

A few weeks ago I posted a paper on Geologic Greenhouse Gas Sequestration Projects. This paper is described and linked below.

“Geologic Greenhouse Gas Sequestration Projects” deals with site selection, the business justification for CCS and describes several large projects.


The second chapter of that covered the economic justification for carbon capture and storage (CCS) a.k.a. carbon capture and sequestration in California. One of the programs that allow firms implementing CCS to monetize this practice is California’s Low Carbon Fuel Standard (LCFS), and one method of gaining returns from CCS using LCFS is a recent method that deploys zero emission vehicle infrastructure. In researching this subject I found several good sources of information, including an excellent and recent (this year) presentation from the California Air Resources Board (CARB). I thought that the LCFS and specifically the Zero Emissions Fuel Infrastructure were important enough for climate change and (the latter) future changes in energy use to where in deserved its own paper.

This post will review California’s Low Carbon Fuel Standard (LCFS), the Zero Emissions Fuel Infrastructure (part of LCFS) and California’s Advanced Clean Cars Program.

2. LCFS Declining Carbon Intensity

The primary source (presentation) I mentioned in the Introduction is referenced here.¹

The Low Carbon Fuel Standard (LCFS) is designed to encourage the production of low-carbon fuels, and therefore reduce greenhouse gas (GHG) emissions and decrease petroleum dependence in the transportation sector. These standards are expressed in terms of the “carbon intensity” (CI) of gasoline fuel, diesel fuel other fuels and their respective substitutes (typically bio-fuels). The program is based on the principle that each fuel has "life cycle" greenhouse gas emissions. The life cycle assessment examines the GHG emissions associated with the production, transportation, and use of a given fuel. Using CCS to reduce the amount of GHG emitted during the lifecycle of a transportation fuel reduces the CI of that fuel.

Credits and deficits are measured in metric tons of CO₂ equivalent (CO₂e) GHG emissions. Providers of transportation fuels must show that the fuels they supply in California meet the LCFS carbon intensity standards, or benchmarks, for each year. A deficit generator meets its compliance obligation by ensuring that the amount of credits it earns or otherwise acquires from another party is equal to, or greater than, the deficits it

has incurred. The CI standards decline over time. The figure below shows the declining carbon intensity.

The table below shows the specific CI for gasoline and diesel fuel where the CI is measured in grams of CO₂ equivalent GHG emitted per mega-joule of energy:

### Carbon Intensity Benchmarks for Gasoline and Diesel Fuel and their Substitutes

<table>
<thead>
<tr>
<th>Year</th>
<th>Gasoline Average CI (gCO₂e/MJ)</th>
<th>Diesel Average CI (gCO₂e/MJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>93.23</td>
<td>94.17</td>
</tr>
<tr>
<td>2020</td>
<td>91.98</td>
<td>92.92</td>
</tr>
<tr>
<td>2021</td>
<td>90.74</td>
<td>91.66</td>
</tr>
<tr>
<td>2022</td>
<td>89.50</td>
<td>90.41</td>
</tr>
<tr>
<td>2023</td>
<td>88.25</td>
<td>89.15</td>
</tr>
<tr>
<td>2024</td>
<td>87.01</td>
<td>87.89</td>
</tr>
<tr>
<td>2025</td>
<td>85.77</td>
<td>86.64</td>
</tr>
<tr>
<td>2026</td>
<td>84.52</td>
<td>85.38</td>
</tr>
<tr>
<td>2027</td>
<td>83.28</td>
<td>84.13</td>
</tr>
<tr>
<td>2028</td>
<td>82.04</td>
<td>82.87</td>
</tr>
<tr>
<td>2029</td>
<td>80.80</td>
<td>81.62</td>
</tr>
<tr>
<td>2030 onwards</td>
<td>79.55</td>
<td>80.36</td>
</tr>
</tbody>
</table>
The figure below shows the components of for gasoline lifecycle:

The figure below shows the fuel lifecycle for biodiesel based on used cooking oil:
3. Zero Emissions Fuel Infrastructure

The site reference here\(^2\) is used for this section. This is a really complex program, and I tried to put together enough information so that the reader can gain an idea of how this works.

The LCFS incentivizes use of electricity and hydrogen as low carbon transportation fuels by providing several opportunities to generate LCFS credits. These credits can be traded in the California LCFS credit market.

Two charts from the above referenced site showing the available programs are below.

Entities can claim zero-CI or low-CI electricity used as a transportation fuel using indirectly supplied electricity, claimed using book-and-claim accounting.

For reporting transactions in Q1 2019 and onwards, the LCFS recognizes the use of book-and-claim accounting of environmental attributes for electricity that is either used

as a transportation fuel or used in electrolysis to produce hydrogen for transportation purposes (including hydrogen that is used in the production of a transportation fuel).

For the purposes of the LCFS Regulation, “environmental attribute” means greenhouse gas emission reduction recognition in any form, including verified emission reductions, voluntary emission reductions, offsets, allowances, credits, avoided compliance costs, emission rights and authorizations under any law or regulation, or any emission reduction registry, trading system, or reporting or reduction program for greenhouse gas emissions that is established, certified, maintained, or recognized by any international, governmental, or nongovernmental agency.

4. **California Advanced Clean Cars Program**

The following text is from the reference here³ and other web pages linked from that reference page.

California, like all other states, has the inherent obligation to protect the health of its citizens. Federal law limiting vehicle pollution has recognized and respected that right for over 50 years, by allowing California to set its own new vehicle emissions standards to address our extraordinary and compelling air pollution problems, and allowing other states to choose those standards as well. California has led the nation in cleaning up cars precisely because our circumstances required more stringent standards to protect public health and clear the air. Now 13 other states and the District of Columbia freely choose to follow our rules.

California’s demonstrated progress in leading the nation’s control of vehicle emissions has established a precedent that has benefitted the entire nation when our more stringent rules supplanted national rules over time.

California needed those waivers to support strong standards in the past – and we continue to need them. We have made great progress, but with more cars on the road and stricter federal standards, 7 of the 10 cities with the worst air in the nation are now in California.

The standards we now have, which have been issued a waiver including the requirement for more zero-emission vehicles, are absolutely required to continue to protect public health, and to meet the federal and state air standards in the future.

All the existing standards, including California’s Advanced Clean Cars rule, plus additional standards, are needed to meet the 2031 ozone standard in the Los Angeles basin, to avoid condemning the 12 million people living there to breathe unhealthy air.

We can clear the air, if we keep our existing standards, which are designed to ensure an increasing number of zero-emissions vehicles on the roads through 2026 and beyond. Preventing California’s ability to do that jeopardizes the health and well-being of millions of Californians, with increased levels of ozone and smog, exacerbated by rising temperatures because of climate change.

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³ California Air Resources Board, Advanced Clean Cars Program, [https://ww2.arb.ca.gov/our-work/programs/advanced-clean-cars-program](https://ww2.arb.ca.gov/our-work/programs/advanced-clean-cars-program)
4.1. Emission Technologies Driven by California’s Actions

California’s vehicle rules have directly resulted in the development of major technological advances to clean vehicle emissions. As a result, in terms of smog-forming pollution the average new car sold in California – and nationwide – is more than 99 percent cleaner than a car from the 1970s.


1973: Catalytic converter – In response to state regulations, automakers developed an exhaust-system technology to cut emissions of smog-forming gases; converters were first required on 1975 model-year cars. Also led to removal of lead from gasoline.

1986: Check engine light – Starting with the 1988 model year, required all vehicles to have computers capable of detecting whether emissions-control equipment is working properly (Onboard Diagnostics) and turn on the Check Engine Light if not.

1990: Low-Emission Vehicle standards – Established standards for allowable levels of smog-forming emissions from passenger vehicles and some SUVs and pickups, for the 1994-2003 model years.

1999: Low-Emission Vehicle II standards – Extended emissions restrictions to include all light trucks and SUVs for the 2004-2010 model years and tightened emissions standards for passenger cars.

2012: Advanced clean cars – Coordinated greenhouse gas and smog-reducing standards and requirements for passenger cars, light-duty trucks and some medium-duty vehicles to align California and national standards for model years 2017-2025, and enacted provisions to enable the increased commercialization of zero-emission vehicles (ZEVs). This program reduced smog-forming pollution 75 percent (compared to 2014) and greenhouse gas emissions by 40% (compared to 2016). (13 other states have adopted at least some parts of California’s program.) Included is a California-only requirement for sales of zero-emission vehicles through 2025. Nine other states adopted the ZEV component.

4.2. Advanced Clean Cars

Advanced Clean Cars, developed in coordination with the United States (U.S.) Environmental Protection Agency (EPA) and National Highway Traffic Safety Administration (NHTSA), combined the control of smog-causing (criteria) pollutants and greenhouse gas (GHG) emissions into a single coordinated package of regulations: the Low-Emission Vehicle III Regulation for criteria (LEV III Criteria) and GHG (LEV III GHG) emissions, and a technology-forcing mandate for zero-emission vehicles (ZEV).

The goal of the program was to guide the development of environmentally advanced cars that would continue to deliver the performance, utility and safety car owners have come to expect. Advanced Clean Cars includes the following elements:

LEV III Criteria: Reducing Smog-Forming Pollution: Cars today are significantly cleaner than they were just a decade ago, but there are millions of vehicles on California roads now, and those numbers will continue to increase. We are also driving more now than in previous years. In order to address this situation and continue to improve air quality, CARB adopted new emission standards to reduce smog-forming emissions (also
known as ‘criteria pollutants’) beginning with 2015 model year vehicles. Thanks to this regulation, in 2025, cars will emit 75 percent less smog-forming pollution than the average car sold in 2012.

**LEV III GHG: Reducing Greenhouse Gas Emissions:** California’s GHG regulations are projected to reduce greenhouse gas emissions from new vehicles by approximately 40 percent (from 2012 model year vehicles) in 2025. Studies indicate that they are technologically feasible and will save consumers money over the life of the vehicle because lower fuel use accompanies reductions of greenhouse gases. Technologies to achieve the new standards include engine and emission control advancements, wider application of advanced hybrid technology, and greater use of stronger and lighter materials.

**Zero Emission Vehicle Regulation: Promoting the Cleanest Cars:** The ZEV regulation is designed to achieve the state’s long-term emission reduction goals by requiring auto manufacturers to offer for sale specific numbers of the very cleanest cars available. These vehicle technologies include full battery-electric, hydrogen fuel cell, and plug-in hybrid-electric vehicles. Updated estimates using publicly available information show about 8 percent of California new vehicle sales in 2025 will be ZEVs and plug-in hybrids.