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Status Review of California's Low Carbon Fuel Standard

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April 2015 (Revised version)[1]

Highlights

- Lifecycle transportation greenhouse gas (GHG) emissions are subject to regulation under the LCFS. GHG emissions from refineries and combustion of on-road fuels like motor gasoline, diesel, and natural gas are also included in the multi-sector Cap-and-Trade Program.
- By the end of 2014, regulated parties had generated 67 percent more credits than deficits (i.e., 67 percent over compliance needs), a surplus most likely caused by the temporary freeze of the program due to litigation.
- The reported average fuel carbon intensity (AFCI) of all alternative fuels included in the program declined 15 percent from 86.4 gCO_2e/MJ the first year of the program (2011), to 73.5 gCO_2e/MJ in 2014.
- In-state production accounted for an average of 18 percent of the near 1 billion gasoline gallon equivalents (gge) of California ethanol consumption in 2011 – 2013, and roughly 30 percent of the 88 million gge of California biodiesel consumption in 2013.
- An estimated 115,000 plug-in electric vehicles (PEVs) were on the road in California by the end of 2014. We estimate electric vehicle miles traveled (eVMT) for 2014 at 698 million miles, representing electricity consumption of 232 gigawatt-hours (GWh), or about 7 million gge. LCFS data on 2014 transportation electricity is currently 3.95 million gge based on a partial accounting of the year's non-metered residential PEV charging. Full data accounting is expected later this year.
- The LCFS credit price provides an indication of expected compliance cost. It remained around \$20–\$25 per credit from the second half of 2014 through early 2015. This price translates to roughly one-third of one cent per gallon of gasoline used for blending in 2014.
- In early January 2015, the gap between retail gasoline prices in California and the neighboring states of Arizona and Nevada increased, consistent with an assumption of nearly full pass-through of allowance prices of the Cap-and-Trade Program.
- The California Air Resources Board is expected to vote on re-adoption of the LCFS in July 2015 in response to a ruling by California Court of Appeal's Fifth Appellate District. Re-adoption would likely involve a new compliance schedule to 2020, a credit price cap plus provisions for limited deficit rollover under special circumstances, adjustments in carbon intensity ratings including indirect land use change (ILUC), and a streamlining of fuel pathway certification.
- In Oregon, Senate Bill 324 became law, allowing continued implementation of that state's Clean Fuels Program requiring a 10 percent reduction of GHG intensity from state transportation fuels over a 10-year period.

[1] Revised on May 20, 2015 to correct for units in Figure 6.

Introduction

The Low Carbon Fuel Standard (LCFS) is an integral part of the overall strategy to reduce greenhouse gas (GHG) emissions in California. Administered by the California Air Resources Board (ARB), it sets an increasingly stringent carbon intensity standard (measured in gCO_2e/MJ) that limits the total lifecycle GHG emissions intensity from the transportation sector.

In addition to the LCFS, starting on January 1, 2015, GHG emissions from on-road transportation fuels including gasoline, diesel and natural gas became covered under the state's Cap-and-Trade Program, which sets caps for emissions from a broad range of sectors throughout the state economy. More about the Cap-and-Trade Program appears in Section 5.

To meet the LCFS, regulated parties can supply low-carbon fuels to generate credits, purchase LCFS credits generated by other producers of low-carbon fuels, or both. The standard requires a reduction of 1 percent in GHG emissions intensity (or carbon intensity, CI) for gasoline and diesel fuel pools in 2015 from 2010 levels, and of 10 percent in 2020. Credits can be banked for use later, allowing over compliance in early years to aid compliance as the standard grows more stringent. The standard has remained at 1 percent reduction since 2013 due to a court ruling (see Section 6), and is expected to be at 2 percent reduction in 2016 after a formal re-adoption of the rule by the ARB in July 2015.

This issue reviews LCFS compliance metrics from 2011 through 2014: credits and deficits generated and transport fuel energy (Section 1), fuel carbon intensity (Section 2), and credit trading and prices (Section 3). We take a special look at California in-state biofuel production and consumption (Section 4), and revisit fuel price impacts of the LCFS and the Cap-and-Trade Program, and interactive effects of the two (Section 5). We also briefly summarize the proposed changes in the LCFS re-adoption (Section 6).

1. Credits and Deficits

By the end of 2014, regulated parties had generated a total of 10.8 million LCFS credits and 6.5 million deficits (Figure 1) under the program. LCFS credits and deficits are generated based on emissions below or above the annual standard, respectively; credits can be traded or banked for later use. Each credit or deficit represents 1 MT CO_2e. More "net" credits (credits minus deficits) per quarter were accumulated in the second half of 2013 and in 2014 than in previous quarters (green line, Figure 1). Total credits generated so far are 67 percent more than needed to cover deficits generated (i.e., beyond compliance targets to date). Net cumulative credits (the area under the green line, and shown by the red line, right axis) totaled 4.34 million through the end of 2014.

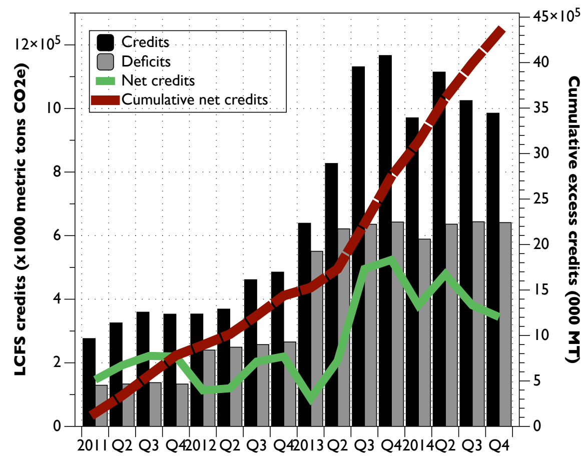

Figure 1. California LCFS carbon credits and deficits generated per quarter. Also shown are net credits per quarter (green line) and cumulative net credits (red line) on the secondary y-axis. Source: ARB (2015b)

The emission reduction between program baseline levels and the standard is 5.82 million tonnes CO_2e from 2011–2014.[1] Due to over compliance, the reported total emission reduction was 10.2 million tonnes below baseline emissions from 2011–2014.

In this review period (2011–2014), biofuels accounted for the majority of the credits generated (87 percent) (Figure 2). Ethanol accounted for 57 percent of credits, while biodiesel and renewable diesel together accounted for 30 percent of the total. Fossil-based natural gas including compressed natural gas (CNG) and liquefied natural gas (LNG) accounted for 8 percent. Biogas and electricity accounted for 3 percent and 2 percent of the total, respectively. The 2014 transportation electricity use reported in the LCFS program does not include the 3rd and 4th quarters' non-metered residential charging data. These credit shortfalls will be fully accounted in future LCFS updates.[2] Thus, reported credit balances and proportions of credits generated for the 3rd and 4th quarters will be readjusted in ARB future updates.

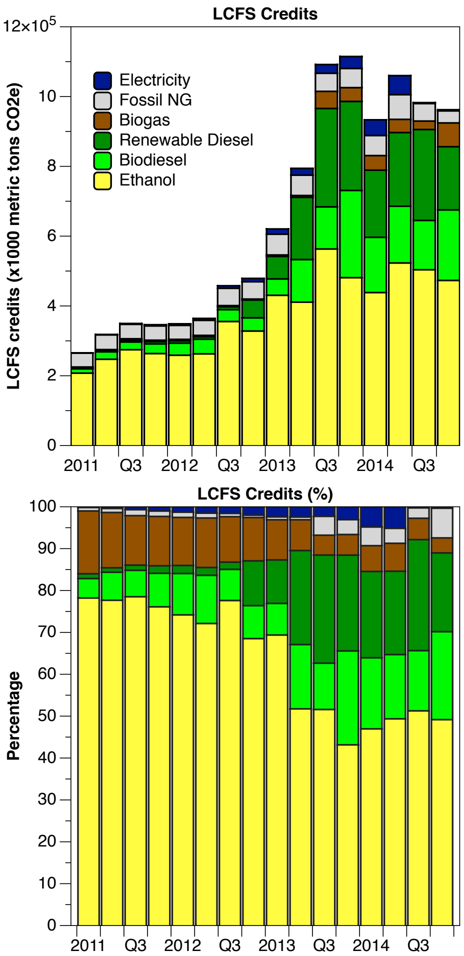

Figure 2. Total net LCFS credits by fuel type per quarter: number of credits (top) and percentage shares (bottom). Electricity credits for 2014 Q3 and Q4 will be re-adjusted in future updates. Source: ARB (2015b).

Among biofuels (here including liquid fuels and biogas), credits generated from ethanol contributed 90 percent in 2011 and 54 percent in 2014. Renewable diesel and biodiesel (the latter almost entirely from byproduct or waste feedstocks such as tallow and used cooking oil) increased from 9 percent in 2011 to 42 percent in 2014 (Figure 3). Less than 0.4 percent of ethanol used in 2014 was from Brazilian sugarcane.

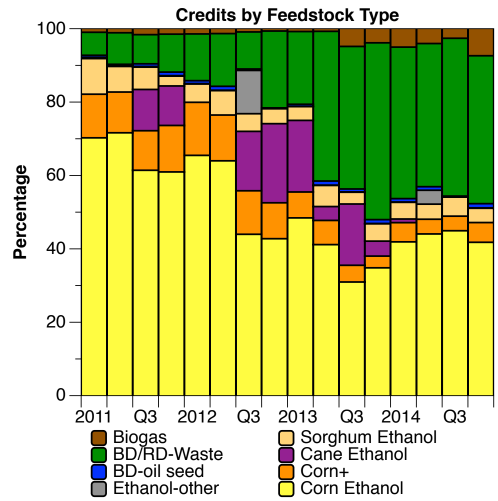

Figure 3. LCFS net credits (%) by biofuel feedstock. "Corn+" pathways include fuels using mixed feedstocks: corn, wheat slurry, and sorghum. "BD oil seed" includes biodiesel from soy and canola. "BD/RD byproducts" includes biodiesel and renewable diesel from used cooking oil, tallow and corn oil. "Other ethanol" includes ethanol from molasses and waste beverage. Source: ARB (2015b)

Alternative fuels contributed 6.2 percent of California's transportation fuels by energy content reported under the LCFS for 2011 and 2012 and 7.2 percent in 2014 (Table 1). Transportation electricity use in the LCFS was reported as 3.95 million gasoline gallon equivalents (gge) in 2014 (Table 1). This translates to 131 GWh or 395 million electric miles traveled (eVMT), assuming the efficiency of electric miles was 100 miles-per-gallon (mpg) on average. Full accounting of non-metered residential charging credits generated in 2014 Q3 and Q4 (and upward adjustment of the year's transportation electricity use under the program) are expected after the utilities submit their annual reports (due April 30).

In collaboration with UC Davis Institute of Transportation Studies Plug-in Hybrid & Electric Vehicle Research Center experts, we estimate eVMT for 2014 was 698 million miles or about 7 million gge, 77 percent higher than the reported volumes. The estimate is based on the number of battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) on the road in California and an estimate of their average annual eVMT. PEVs in California grew from about 60,000 at the beginning of 2014 to 115,000 at the end of the year. The fleet composition was 55 percent BEV, 15 percent PHEV10 (with a 10-mile electric range, i.e., vehicle that can be driven solely by an electric motor for 10 miles without consuming gasoline), 9 percent PHEV20, and 20 percent PHEV40.[3] The average annual eVMT was estimated at 2,910 miles for PHEV10; 4,203 miles for PHEV20; 9,112 miles for PHEV40 and 9,642 miles for BEVs, based on data collected nationally from 21,600 vehicles. The national data came from eight PEV models tracked between 2011 and 2013.[4] The total 2014 eVMT is estimated to be around 698 million miles.[5]

Table 1. Total transportation energy use reported in California's LCFS program (million gge).

	2011	2012	2013	2014
CARBOB (gasoline)	12,948	13,089	12,788	13,064
ULSD (ultra-low sulfur diesel)	3,905	4,026	3,802	3,823
Ethanol	1,015	1,006	1,009	1,011
Biodiesel	13.95	22.45	88.20	85.47
Renewable diesel	1.97	9.56	106.50	115.44
CNG/LNG	82.41	94.84	100.98	91.79
Biogas	1.77	1.79	11.51	23.79
Electricity	0.36	1.27	3.49	3.95*
Total	17,968	18,250	17,910	18,219*
Alt Fuel	1,115	1,136	1,319	1,331*
Alt Fuel (percent of total energy)	6.2%	6.2%	7.4%	7.3%*
Non-biofuel portion of alt fuel	7.6%	8.6%	8.8%	8.2%*

* The 2014 transportation electricity use reported in the LCFS program does not include the 3rd and 4th quarters' non-metered residential charging data. These credit shortfalls will be fully accounted in future LCFS updates. Values are *not* adjusted using energy efficiency ratios (EER), which capture on-road efficiency of the vehicle using the fuel relative to a conventional internal combustion engine, and are used by ARB to calculate program credits. Source: ARB (2015b)

2. Carbon Intensity of Fuels

The reported average fuel carbon intensity (AFCI) of all alternative fuels included in the program declined from 86.4 gCO_2e/MJ in the program's first year (2011), to 73.5 gCO_2e/MJ in 2014, a 15 percent reduction (Figure 4).

As of March 2015, the LCFS program included a list of 286 available transportation fuel pathways (plus the two reference fuels), with each listed fuel's carbon intensity. Of that number, 53 were from ARB and 233 were submitted by regulated parties.[6] For biofuels, 368 physical routes to California originating in 170 individual facilities were registered and approved.[7] Figure 5 shows ranges of CI ratings for available pathways and "pathways in use" for biofuels (from ARB data on registered and approved physical routes and facilities, applicable only to biofuels). It also shows average CIs used for each fuel pathway category (for biofuels, the average of individual pathways in use as just described; for other fuels, based on CI information depicted in Figure 4).

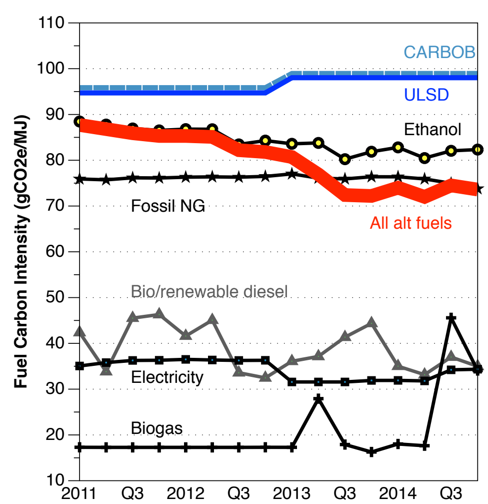

Figure 4. Average fuel carbon intensities (AFCI) of gasoline, diesel and alternative fuels. Source: ARB (2015b)

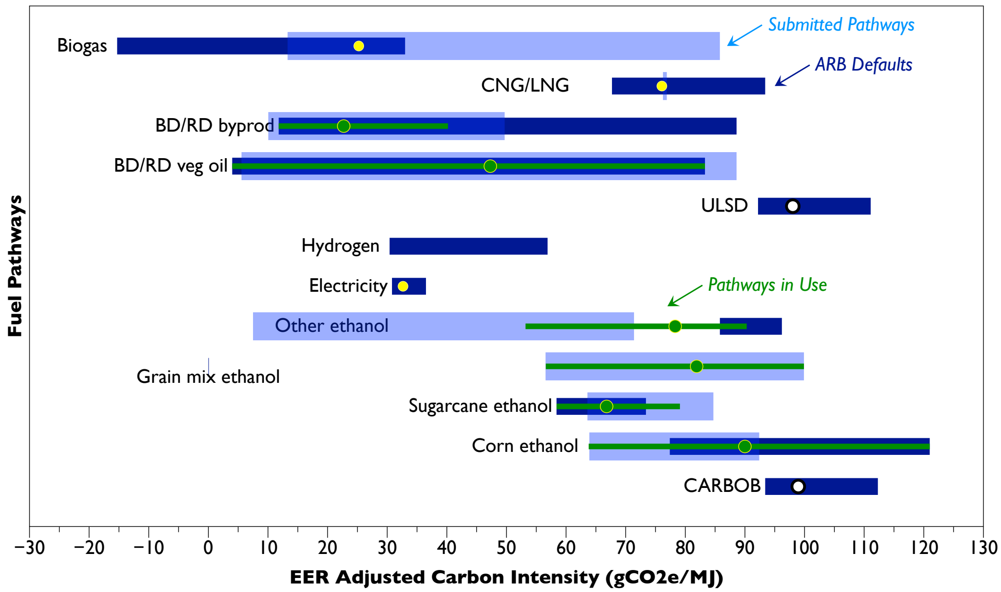

Figure 5. Carbon intensity (CI) ratings of feedstock/fuel combinations in California's LCFS as of March 2015. White circles represent reference fuel values currently used for California Reformulated Gasoline Blendstock for Oxygenate Blending (CARBOB) and Ultra-Low Sulfur Diesel (ULSD) pathways calculated accounting for country of crude oil origin. Dark blue bars represent ARB-derived ratings (pathway defaults). Light blue bars represent pathways submitted by regulated parties (via Methods 2A and 2B). Green bars, relevant just for biofuels, represent pathways with physical routes established in the program. Green circles represent average CI ratings for biofuel pathways in use (not weighted by fuel volume). Yellow circles show average CI ratings for non-biofuel pathways calculated from ARB data (displayed in Figure 4). Submitted values can be higher than defaults for a particular feedstock/fuel combination due to differences in technologies used. CI values are adjusted using the regulatory energy efficiency ratios (EERs) of 3.4 for electricity and 2.5 for hydrogen. "BD/RD byprod" is biodiesel and renewable diesel from animal fat or used cooking oil. "BD/RD veg oil" is biodiesel and renewable diesel from soy, canola, or corn oil. "Grain mix" ethanol pathways include corn/sorghum, corn/sorghum/wheat mixes. "Other ethanol" uses as feedstocks sorghum, molasses, waste beverages, or agricultural residue. Sources: ARB (2012, 2014b, 2015a).

3. Credit Trading and Credit Prices

LCFS credits are used to meet program compliance; they can be generated, bought, or sold by regulated parties as well as banked for compliance in future years. ARB is not involved with LCFS credit sales; however, transfers of credits must be reported to ARB (price reporting is optional). The number of LCFS credits traded increased by just over 90 percent from 2013 to 2014 (Figure 6). The credit market participation rate (number of regulated parties who sold, bought, or both sold and bought credits) through February 2015 was around 60 percent (of 176 regulated parties).

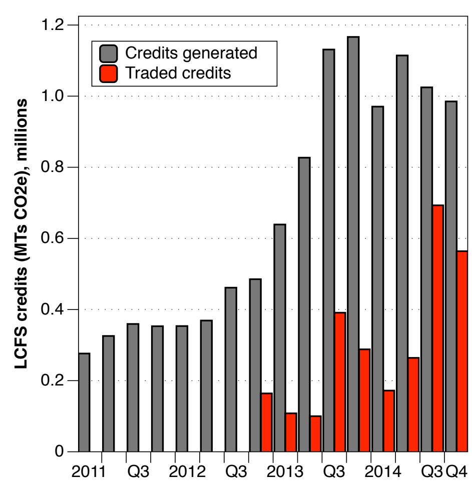

Figure 6. LCFS credits generated and traded per quarter. Source: ARB (2014-2015)

The LCFS credit price fluctuated between $15 and $80/credit in 2013 and 2014 (left axis, Figure 7). The range of credit prices reported to ARB narrowed considerably in August through December 2014, and averaged around $20–$25 per credit in the second half of 2014. This translates to cost for unblended gasoline in 2014 of roughly one-third of one cent per gallon (right axis, Figure 7). The fuel price impacts of the LCFS are discussed in more detail in Section 5.

LCFS credit prices reflect the gap in cost between conventional fuels and low-carbon fuels needed to comply with the policy (more exactly, the cost of the last gallon of low-carbon fuels needed for compliance). Because LCFS credits are bankable, the current credit price should also reflect future expected compliance costs as assessed by the market. The expectation likely also incorporates uncertainties, including proposed changes in the re-adoption package that will affect the standard's stringency and program carbon intensity ratings (hence the credits fuel pathways can generate).

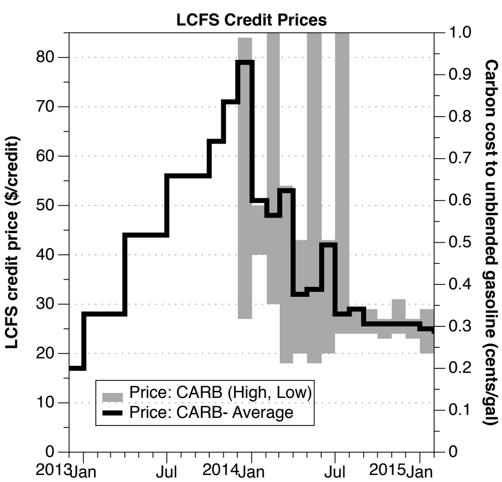

Figure 7. Range and average LCFS credit prices reported to ARB (left axis), translated into cost to unblended gasoline (right axis). Source: ARB (2014-2015; 2015b)

ARB began monthly reports on LCFS credit market data in 2014. Other sources also provide credit trade and price information: Oil Price Information Service (OPIS) reports on daily bid/ask spreads; Progressive Fuels Limited (PFL), an independent broker in physical biofuel wholesale markets, compiles similar information in a daily market report; and Argus (Argus Media Limited) reports information on transactions. In previous Status Reviews, we found gaps between the media reports on credit prices (PFL, Argus and OPIS) and prices reported to ARB. Gaps in average prices narrowed starting in July 2014.

4. California In-state Biofuel Production and Consumption

California ethanol use increased markedly from 2000–2014, to about one billion gge. In-state ethanol production averaged 8 percent of consumption from 2000–2010, and about 18 percent from 2011–2013 (Figure 8) (EIA 2014a, 2014b; CEC 2012 and Government of Nebraska 2014).[8] California consumed about 88 million gge biodiesel in 2013 (ARB 2015b), and produces roughly 30 percent of the state's biodiesel consumption (CEC 2014). Data on in-state biofuel production, particularly biodiesel and renewable diesel, lacks a consistent source. Of registered physical pathways for biofuels ("pathways in use," Section 2), 7.5 percent are California based. We will revisit this topic in a future issue.

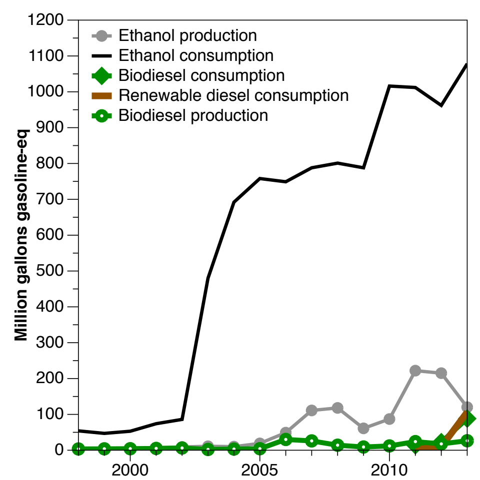

Figure 8. Consumption and production of biofuel in California by fuel type from 1995–2013.[9]

5. Impacts of LCFS and Cap-and-Trade on Fuel Prices and the Interactive Effects

This section discusses the individual effects of the Cap-and-Trade and LCFS programs on California fuels markets and potential interactions of the two.

The Cap-and-Trade Program and LCFS are separate regulations, and there is no trading of compliance credits between the two.[10] The Cap-and-Trade Program's Phase I compliance period (effective January 1, 2013) placed a cap on GHG emissions from large electricity providers and large industrial sources in the state, including refineries. As stated above, starting January 1, 2015, GHG emissions from on-road transportation fuels including gasoline, diesel and natural gas came under the state's Cap-and-Trade Program, which exempts biofuels carbon emissions. In contrast, LCFS covers the lifecycle GHG emissions (both combustion and non-combustion emissions) of all on-road transportation fuels in the program whether the emissions occur inside or outside the state.

LCFS is revenue-neutral through cross-subsidies and its ultimate cost depends on the fuel mix; Cap-and-Trade can raise revenue and adds costs to covered fuels. Since the LCFS adds to the cost of fuels with CI above the standard (such as gasoline and diesel) and reduces the cost of fuels with CI below the standard, the program involves a transfer from high to low CI fuel producers. The overall cost of compliance is determined by any additional cost from alternative fuels needed to assure compliance. The LCFS credit price will be set by the marginal cost of bringing the last unit of low-carbon fuel to meet compliance.

The Cap-and-Trade Program, on the other hand, adds a cost to each tonne of CO_2e combusted from gasoline, diesel and natural gas (Yeh and Witcover, 2014). Under the Cap-and-Trade Program, California refineries are among several industries that receive free allowances; these allowances are unlikely to have price impacts on fuels.[11] In both the first (2013-2014) and the second compliance period (started on January 1, 2015), the refineries received allowance allocations at 100 percent of their expected emissions.[12]

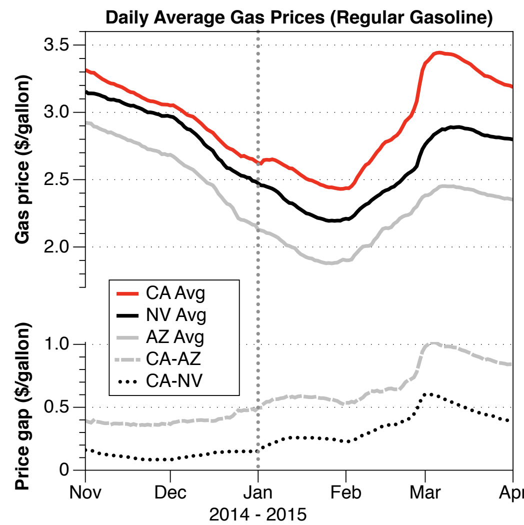

Figure 9. Daily average regular gasoline prices in California, Nevada and Arizona, top panel. The bottom panel shows **daily average price gaps** between California and Arizona, and California and Nevada for several months prior to and after January 1, 2015.

Since January 2015, California gasoline prices have diverged from neighboring states for a variety of reasons, including a refinery accident at the ExxonMobil facility in Torrance on February 18, 2015. It is difficult to deconstruct all the causes of the California gasoline price premium. Since January 1, 2015, when transport fossil fuels were included under the cap, Cap-and-Trade allowance prices have been reported at or near their floor price of around $12.50 per allowance. Under an assumption of full pass-through of that cost onto fuel price, the impact that Cap-and-Trade would have on unblended gasoline is around 10 cents per gallon, or about 9 cents per gallon of E10—10 percent ethanol and 90 percent gasoline—blended fuel. A narrow focus on the period surrounding January 1st indicates that a gap of roughly 10–20 cents per gallon for California gasoline above the typical price gap between California and its neighboring states[13] opened up in the first four weeks of the year (Figure 9). While we did not perform any statistical analysis, the gap is consistent with an assumption of full pass-through of allowance prices.

The impact of LCFS and Cap-and-Trade on fuel prices is likely to be additive. At current levels of LCFS credit price and Cap-and-Trade allowance price, the interactive effect of the two policies is likely to be low. A good approximation of the combined effect of the two policies is simply the two individual impacts added together (Yeh and Witcover, 2014). The interactive effect of the two policies could be much higher around the boundary conditions (i.e., when the credit/allowance prices of one or both programs are high)(Lade and Lin, 2013). If LCFS compliance results in a substantial shift in the market share of biofuels, this will reduce emissions under the cap and start to reduce allowance prices as well as the share of fuels with emissions that require allowances.

In light of the cost containment mechanisms in place for the Cap-and-Trade Program (a $40–$50/ton price reserve) and expected to go into effect next year for the LCFS (a proposed credit clearance market price of $200/credit [14]) the interactive effects of the two programs are likely to be small at current levels of allowance/credit prices. Nevertheless, they should continue to be monitored.

The impact on fuel prices is likely to be 100 percent passed through. The impacts of the LCFS and Cap-and-Trade on *fuel prices* depend on two things: (1) the relative elasticity of fuel supply (i.e., the availability of fuel in response to price changes); and (2) consumer responsiveness to fuel price changes. Given that supplies of gasoline and diesel are fairly elastic (do respond to price changes), the supply elasticity of low-carbon fuels (how much will be available with a high price) is likely to determine the fuel price on the margin. Since consumer demand is relatively inelastic to fuel price changes (consumers are not so responsive to fuel price changes), any added fuel cost due to the programs is likely to be passed through to consumers. Note that prices of some low-carbon fuels including electricity and fossil natural gas are much lower than gasoline and diesel; consumers of these alternative fuels pay lower fuel prices compared to gasoline and diesel fuel consumers, and may also benefit from lowered cost due to LCFS credits earned by the fuels.

6. Court Cases Involving the LCFS and the Recent Proposal for Rulemaking

In July 2013, the California Court of Appeal's Fifth Appellate District ruled that the LCFS could remain in effect while ARB corrects certain procedural aspects of the original standard, and re-adopts the program (Figure 10). Due to this ruling, the Standard's 2013 CI reduction level of 1 percent will remain in effect for 2014 and 2015 until the regulation is re-adopted with the procedural correctives. The Board is expected to decide on the re-adoption in July 2015. Program amendments under consideration during the re-adoption would take effect in 2016 and include:

- Credit clearance provision that effectively sets a $200 cap on credit price and, in any year of system-wide credit shortage, allows deficits to roll over (with interest) for a period of time;[15]
- Credit generation by refineries that reduce GHG emissions through capital investments or use of renewable feedstocks to produce gasoline or diesel, and by crude oil producers that reduce GHG emissions through the use of innovative technologies (and supply crudes to California refineries);
- Modification of compliance curves (the proposal maintains the 10 percent target for 2020);
- Streamlined two-tiered fuel pathway certification system that separates conventional fuel pathways and advanced, innovative fuel pathways;
- Revised indirect land use change (ILUC) values for most crop-based feedstocks (lower) and fuel lifecycle carbon intensity ratings (slightly higher for gasoline and diesel), and updated tools for lifecycle analysis;
- Credit generation from certain off-road transportation fuel uses.

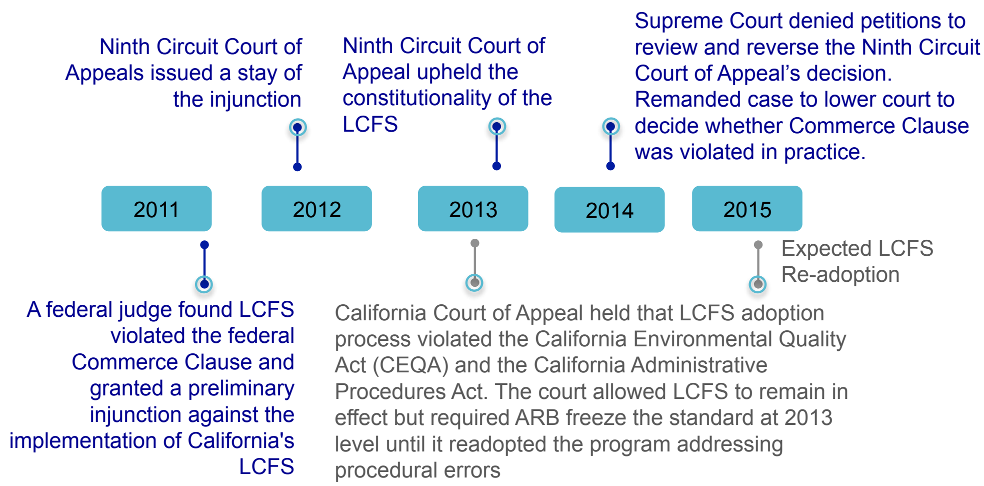

Figure 10. Major court decisions on LCFS cases.

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References

ARB (2012). Low Carbon Fuel Standard Program - LCFS Lookup Tables as of December 2012. http://www.arb.ca.gov/fuels/lcfs/lu_tables_11282012.pdf.

ARB (2014a). Low Carbon Fuel Standard Program - LRT Registered Parties. http://www.arb.ca.gov/fuels/lcfs/regulatedpartiesreporting20141030.pdf

ARB (2014b). Low Carbon Fuel Standard - Method 2 Carbon Intensity Applications. Method 2A/2B Applications and Internal ARB Developed Pathways. Summary of all Pathways Table. http://www.arb.ca.gov/fuels/lcfs/2a2b/112514lcfs_apps_sum.pdf.

ARB (2014c). Staff Report: Initial Statement of Reasons for Proposed Rulemaking. Proposed Re-adoption of the Low Carbon Fuel Standard. http://www.arb.ca.gov/regact/2015/lcfs2015/lcfs15isor.pdf

ARB (2014- 2015). Low Carbon Fuel Standard Credit Trading Activity Reports. Various issues. http://www.arb.ca.gov/fuels/lcfs/lrtmonthlycreditreports.htm

ARB (2015a). Low Carbon Fuel Standard Program - Carbon Intensities from Registered Facilities. http://www.arb.ca.gov/fuels/lcfs/reportingtool/registeredfacilityinfo.htm

ARB (2015b). Low Carbon Fuel Standard Reporting Tool Quarterly Summaries. http://www.arb.ca.gov/fuels/lcfs/lrtqsummaries.htm

California Energy Commission. 2012. Statistics and Data on Ethanol and E85 as Transportation Fuels. http://energyalmanac.ca.gov/transportation/ethanol.html. Accessed March 2015.

California Energy Commission. 2013. *2013 Integrated Energy Policy Report*. Publication Number: CEC-100-2013-001-CMF. http://www.energy.ca.gov/2013publications/CEC-600-2013-003/CEC-600-2013-003-CMF.pdf

California Energy Commission. 2014. *2014 Integrated Energy Policy Update*. Publication Number: CEC-100-2014-001-D. http://www.energy.ca.gov/2014publications/CEC-100-2014-001/CEC-100-2014-001-D.pdf

Energy Information Agency, US Department of Energy (EIA) (2014a). State Energy Data System (SEDS): 1960-2012 (Complete). California State Profile and Energy Estimates. June 2014 release. http://www.eia.gov/state/seds/seds-data-complete.cfm?sid=CA#Production. Accessed March 2015.

EIA (2014b). Table F4: Fuel Ethanol Consumption Estimates, 2013. State Energy Data System (SEDS): 2013 (Updates by Energy Source). Revised December 2014.

http://www.eia.gov/state/seds/sep_fuel/html/pdf/fuel_use_en.pdf. Accessed March 2015.

Government of Nebraska. 2014. Ethanol Facilities Capacity by State and Plant. http://www.neo.ne.gov/statshtml/122.htm. Accessed March 2015.

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Endnotes

[1] The calculations include the original 2010 baseline carbon intensities for gasoline and diesel and updated estimates of 2010 baseline starting in 2013.

[2] Personal communication with ARB staff. According to ARB, the lag is not expected to be a regular occurrence.

[3] Based on the state's rebate program statistics, http://energycenter.org/clean-vehicle-rebate-project/rebate-statistics

[4] http://policyinstitute.ucdavis.edu/files/eVMT-analysis-results_INL-presentation_Oct2_2014.pdf

[5] Sources of uncertainty in the estimate include the representativeness of national samples of eVMT estimates taken between 2011 and 2013 for California's average driving of 2014. California accounts for roughly half of national PEV sales. The eVMT per PEV is likely to be higher in 2014 compared to previous years due to increased charging infrastructure and changing consumer groups from early adopters and low-VMT drivers to some portion of early majority consumer groups.

[6] Of these, 70 have final approval (ARB 2012), and the rest can be used as they await ARB hearings (ARB 2014b). As of October 2014, the LCFS had 176 regulated parties (ARB 2014a).

[7] Another 209 physical pathways had been submitted with approval pending (ARB 2015a).

[8] In-state ethanol production for 2013 is not yet reported by the Department of Energy. Our estimate uses 2012 data from the California Energy Commission (CEC 2012), and data from the Government of Nebraska regarding production in 2014 (Government of Nebraska 2014). The two data sources show nearly identical operating production for California ethanol plants.

[9] Sources: EIA (2014, 2015), Government of Nebraska 2014 for ethanol; CEC (2012) and ARB (2015b) for biodiesel and renewable diesel. In-state production of renewable diesel is not shown as data are not publicly available. The graphed data may suffer from consistency issues: there is no common data source for all the relevant California data (production and consumption for ethanol and biomass-based diesel, up to and including 2013).

[10] The LCFS allows its program credits to be imported by other AB32 (or other) programs, subject to that program's rules; thus far there are no such arrangements.

[11] Allowances are compliance instruments that act as permits to emit a certain amount of carbon within the cap.

[12] Expected refinery emissions are based on the total annual output of all primary products produced including aviation gasoline, motor gasoline, kerosene-type jet fuel, distillate fuel oil, renewable liquid fuels and asphalt. The formula for calculating refinery allocations was adjusted for Phase II (starting January 1, 2015). Emission allowances for an individual facility operator are determined by calculating the product of the output and the emissions benchmark for petroleum, multiplied by the cap adjustment and assistance factors. For more details, see http://www.arb.ca.gov/cc/capandtrade/allowanceallocation/refineryallocation.htm.

[13] The observed price gap between California and Nevada averaged about 12 cents in the two months prior to Jan 1, 2015 and 40 cents between California and Arizona. Arizona and Nevada are chosen for comparison because "California refiners supply most of the transportation fuels for Nevada and nearly half of the supply for Arizona." http://www.energy.ca.gov/2013_energypolicy/documents/2013-06-26_workshop/presentations/10_Supply-Demand%20Balances_Gordon_2013-06-24.pdf

[14] See Section 6 for more on the credit clearance market.

[15] The proposal sets up a 'clearance market' in years of apparent credit shortfall to ensure any credits on sale get traded (at up to the cap of $200/credit), then allows any remaining deficits a rollover term of up to 5 years; debts must be repaid in years where sufficient credits are on the market. The proposed noncompliance penalty is $1,000/credit. For this and other amendments discussed in this section, see ARB (2014c).