



A Low Carbon Fuel Standard: State and Federal Legislation and Regulations

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Summary

On January 18, 2007, California Governor Arnold Schwarzenegger issued an executive order directing the California Environmental Protection Agency to establish a Low Carbon Fuel Standard (LCFS). The California LCFS would require a 10% reduction in the carbon intensity of fuels in the State of California by 2020. It would require fuel suppliers to reduce the expected lifecycle greenhouse gas emissions from motor fuels, based on fuels' energy content. In this way, the greenhouse gas intensity of transportation fuels would decrease, regardless of the growth in transportation or fuel demand. While California has not formally proposed regulations, the state Air Resources Board has released drafts of possible regulations.

Several bills were introduced in the 110th Congress to establish a similar national LCFS. These bills varied based on their target dates and required reductions; some were stand-alone bills, while others were proposed as part of more comprehensive greenhouse gas legislation. None were adopted; one was discussed on the Senate floor.

The establishment of a low carbon fuel standard could significantly affect fuel supplies and fuel prices. However, the details of any program are key to determining those effects. The stringency, scope, time frame, and flexibility of the program would determine its ultimate effects on both fuel markets and greenhouse gas emissions. The development of California's rules could inform policymakers looking to establish a federal LCFS. However, the scope of a federal program—requiring compliance nationwide—would likely affect the fuel system in ways not comparable to California's experience. If more low-carbon fuel is needed in California, supply can be shifted from other parts of the country not under an LCFS. If more low-carbon fuel is needed nationwide, higher production and/or imports would be necessary. If the requirements of a low carbon fuel standard get ahead of the necessary supply, conventional fuel supply would need to be curtailed, or the program would need to be delayed. It is likely that the proposals with later time frames would be less disruptive to the fuel supply.

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Introduction

On January 18, 2007, California Governor Arnold Schwarzenegger issued an executive order directing the California Environmental Protection Agency to establish a Low Carbon Fuel Standard (LCFS).¹ The Executive Order requires the State of California to reduce the carbon intensity of fuels in the state by 10% by 2020. In October 2008, the California Air Resources Board (ARB) released draft implementing regulations, and updated that draft in December 2008. This was one of many actions taken by California in response to California Assembly Bill AB32, which also requires ARB to adopt rules and regulations to achieve the maximum feasible and cost-effective reductions in greenhouse gas (GHG) emissions.

If finalized, the California LCFS would require fuel suppliers to reduce the expected lifecycle greenhouse gas emissions from motor fuels, based on fuels' energy content. In this way, the greenhouse gas intensity of transportation fuels would decrease, regardless of the growth in transportation or fuel demand.

Several bills were introduced in the 110th Congress to establish a similar national LCFS. These bills varied based on their target dates and required reductions; some were stand-alone bills, while others were proposed as part of more comprehensive greenhouse gas legislation. None were adopted; one was discussed on the Senate floor.

Motor fuels face significant regulatory requirements at the state and federal levels for fuel quality, content of toxic materials, expected criteria pollutant emissions, and other properties. The establishment of a Low Carbon Fuel Standard—at either the state or federal level—would add another major regulatory requirement. Further, a federal requirement would likely be far more challenging for fuel providers since, under a state standard, low-carbon fuels would likely be shipped to the regulated states from unregulated states, while a federal standard could not be met by this sort of product shifting.

This report analyzes the draft California standards, and discusses how those standards might work, given that the draft regulations leave many details to be decided later. Next, the report analyzes federal LCFS legislation proposed in the 110th Congress. Finally, the report analyzes what effects an LCFS might have on state and national fuel supplies.

What is a Low Carbon Fuel Standard?

Transportation is a key source of greenhouse gas emissions both nationally and worldwide. In 2006, transportation represented roughly 33% of total U.S. carbon dioxide (CO₂) emissions, and

¹ Governor Arnold Schwarzenegger, *Executive Order S-01-07*, Office of the Governor of California, Sacramento, CA, January 18, 2007.

roughly 26% of total GHG emissions.² Of those emissions, combustion of gasoline and diesel fuel in passenger vehicles, trucks, and non-road engines account for nearly 90% of total transportation emissions—the remainder is mostly the use of jet fuel in aviation. Transportation GHG emissions are essentially a function of total vehicle miles traveled (VMT), the fuel economy of the vehicle, the carbon content of the fuel, and the rate of release of non-fuel-related emissions (e.g., air conditioner refrigerant):

$$GHG\ Emissions(gCO_2e) = VMT(miles) \times \left[\frac{Fuel\ Carbon\ Content(gCO_2e / gallon)}{Fuel\ Economy(miles / gallon)} + NonFuel\ Emissions(gCO_2e / mile) \right]$$

To reduce transportation GHG emissions generally requires at least one of four approaches:

1. decrease total vehicle miles traveled;
2. increase the efficiency of fuel consumption;
3. decrease the carbon content of transportation fuel; and/or
4. decrease the rate of release of non-fuel-related emissions.³

A low carbon fuel standard would aim to reduce the carbon content variable in the above equation.⁴

There are two basic ways to reduce the carbon intensity of fuels. The first method would be to switch to direct fuel substitutes or blending components with lower carbon content. For example, biofuels with lower lifecycle greenhouse gas emissions could be blended directly into gasoline and diesel fuel. The second method would be to switch from petroleum-based fuels to other alternatives, such as natural gas, hydrogen, or electricity.

Lifecycle Emissions of Transportation Fuels

Regardless of the approach taken to reduce the carbon intensity of a fuel, the full lifecycle emissions of the replacement fuel must be considered. Otherwise, vehicle GHG emissions could simply be shifted to another location, and could lead to a net increase in emissions. For example, an electric vehicle has zero greenhouse gas emissions, but there can be significant emissions

² U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006*, Washington, DC, April 15, 2008, pp. ES-5-ES-6, http://www.epa.gov/climatechange/emissions/downloads/08_ES.pdf.

³ In most cases, the fuel-related emissions form the majority of transportation emissions.

⁴ California's Low Carbon Fuel Standard is part of a larger effort to reduce greenhouse emissions from the transportation sector (and the economy as a whole), including: 1) vehicle GHG emissions standards that would either increase the fuel economy of new vehicles or decrease the carbon intensity of their use (both fuel-related and non-fuel-related emissions); and 2) incentives to reduce VMT (e.g., transit subsidies).

upstream at the electric power plant, especially if coal is the primary fuel. Therefore, all direct and indirect emissions from every step in the production process and use of a fuel should be considered, to the extent possible. These steps vary widely among fuels, and even among different feedstocks for the same fuel.

For petroleum fuels, potential emissions can come from: petroleum extraction; transport of crude oil to the refinery; refining; distribution of refined fuel; final combustion. For electricity produced from coal, potential emissions include coal mining and transport, and burning the coal at the power plant. While the lifecycle emissions from wind electricity may be negligible, they could include the production and installation of wind turbines. Perhaps the most involved and varied fuel lifecycles are those for biofuels. Potential emissions may come from: fertilizer production and use; use of farm equipment to plant and harvest feedstocks; feedstock transport; refining and/or conversion; fuel distribution; and combustion. However, some or all of these emissions may be offset by the growth cycle of the feedstock plant, which required carbon dioxide. A key question is the effect of indirect emissions, which may result from changes in current practices. For example, if higher biofuel use leads to increased corn production, that may displace soybean production. If virgin land is then used to grow soybeans, the potential release of carbon from that virgin land may be significant.

Valuing the emissions of each step in a fuel's lifecycle is key to the development of a low carbon fuel standard. However, in many cases there is little or no consensus on the amount of emissions from each step, especially where biofuels are concerned. Key questions remain over how to value emissions from land use change, especially indirect land use change, or whether indirect changes should be considered at all.⁵

California's Proposed Low Carbon Fuel Standard

On September 27, 2006, California Governor Arnold Schwarzenegger signed Assembly Bill AB32, which, among other provisions, requires the California Air Resources Board (ARB) of the California Environmental Protection Agency (Cal-EPA) to “adopt rules and regulations in an open public process to achieve the maximum technologically feasible and cost-effective greenhouse gas emission reductions from sources or categories of sources.”⁶ As part of that requirement, on January 18, 2007, Governor Schwarzenegger issued an executive order directing Cal-EPA to establish a low carbon fuel standard, reducing the carbon intensity of transportation fuels by at least 10% by 2020. In response to that Executive Order, ARB established four LCFS

⁵ In a similar vein, the Energy Independence and Security Act of 2007 (EISA, P.L. 110-140) expanded the renewable fuel standard (RFS) established in the Energy Policy Act of 2005 (P.L. 109-58). The RFS requires the use of renewable fuel in gasoline and other fuels nationwide. EISA further requires the use of “advanced biofuels” with 50% or lower greenhouse gas emissions relative to petroleum fuels, as determined by the Environmental Protection Agency (EPA) Administrator. This advanced biofuel requirement begins in calendar year 2009. However, EPA has not published a draft or proposed rule detailing which fuels will qualify, or the methodology for how lifecycle emissions will be calculated.

⁶ State of California, *California Health and Safety Code*, Division 25.5, Part 4, Section 38560.

working groups,⁷ held public workshops and meetings, and compiled detailed background information.⁸ On October 10, 2008, ARB released draft regulations for the program; on December 1, 2008, ARB released an updated draft.⁹ ARB plans to have the rule adopted and implemented by 2010.

The draft rule would require fuel providers to achieve a set average GHG emissions level—which would decrease each year—on an energy-equivalent basis (see **Table 1**). The draft essentially sets up two average requirements, one for gasoline and one for diesel fuel. All fuels that substitute for gasoline would be calculated in the gasoline average; all diesel substitutes would be calculated in the diesel average. For example, natural gas or electricity used for passenger cars would be counted in the gasoline average. Any over-compliance with the annual standard would generate credits for the fuel provider—credits that could be used by that provider to meet other requirements (e.g., transferred from the gasoline average to the diesel average), banked for future use,¹⁰ or traded to other fuel providers.

Table 1. Draft LCFS Compliance Schedule for Gasoline and Gasoline Substitutes

| Year | Carbon Intensity (gCO ₂ /MJ) | %Reduction |
|----------------------|---|------------|
| 2010 | 96.7 | 0.0 |
| 2011 | 96.5 | -0.3 |
| 2012 | 96.2 | -0.5 |
| 2013 | 96.0 | -0.8 |
| 2014 | 95.5 | -1.3 |
| 2015 | 94.5 | -2.3 |
| 2016 | 93.1 | -3.8 |
| 2017 | 91.4 | -5.5 |
| 2018 | 89.6 | -7.3 |
| 2019 | 87.9 | -9.1 |
| 2020 | 86.5 | -10.5 |
| and subsequent years | | |

Source: California Air Resources Board, *The California Low Carbon Fuel Standard Regulation: Draft-For Discussion Only*, Sacramento, CA, December 2008, http://www.arb.ca.gov/fuels/lcfs/l208lcfsreg_draft.pdf.

⁷ Lifecycle Analysis; Compliance and Enforcement; Policy and Regulatory; and Environmental and Economic.

⁸ California Air Resources Board, *Low Carbon Fuel Standard Program*, Sacramento, CA, November 24, 2008, <http://www.arb.ca.gov/fuels/lcfs/lcfs.htm>.

⁹ California Air Resources Board, *The California Low Carbon Fuel Standard Regulation: Draft-For Discussion Only*, Sacramento, CA, December 2008, http://www.arb.ca.gov/fuels/lcfs/l208lcfsreg_draft.pdf.

¹⁰ ARB is considering whether to limit to 20% the amount of banked credits that could be used in any one year to meet a covered entity's obligation. *Ibid.* p. 33.

Calculation of Average Fuel Carbon Intensity

To allow for comparison on an energy-equivalent basis, fuel volumes would be converted into gasoline (or diesel) gallon equivalents (gge). To determine a fuel provider's average in a given year, ARB would calculate a weighted average of lifecycle GHG emissions of the various fuels provided. As this is a draft regulation, the specifics may change, but the average seems likely to be calculated in this manner:

$$\text{Average Fuel Carbon Intensity} = \frac{\sum \text{Energy Supplied}_i \times \text{Fuel Carbon Intensity}_i}{\text{Total Energy Supplied}}$$

The greater the reduction in emissions intensity (relative to gasoline), the fewer gallons needed to achieve the necessary overall reductions.

Under the draft rule, fuel providers could calculate a fuel's carbon intensity using values provided by ARB in a lookup table in the final rule. ARB provides a sample lookup table for corn-based ethanol (with no numeric values). In that sample table, fuel providers could determine their specific fuel's carbon intensity based on the location and method of production of the ethanol (e.g., Midwest corn ethanol produced in a dry mill plant powered by natural gas).¹¹ Presumably, similar lookup tables will be constructed for electric fuel incorporating location and fuel type (e.g., coal, natural gas, or hydroelectric).¹² Alternatively to using the lookup tables, a fuel provider could submit data to ARB certifying a carbon intensity lower than that shown in the table.

The draft rule is under development, and key determinations still necessary include:

- The energy content and average carbon intensity for each fuel;
- "Energy economy ratios" for various fuel/vehicle combinations relative to gasoline and/or diesel fuel; and
- Baseline carbon intensity levels (from which the 10% reduction by 2020 would be calculated).

¹¹ Ibid. p. 53.

¹² A potential issue with electric fuel is that most electricity producers generate their electricity from a variety of sources and supply that power to the grid. It is impossible to "count electrons" to see which end user consumed power from one fuel source vs. another. Therefore, there may be the potential for electric fuel producers to count all of the electric vehicle fuel they produce as coming from their lowest carbon sources, in order to generate the most credits possible. For this reason, ARB might require electric fuel providers to certify their fuel carbon content based on their average fuel mix.

Potential Effects on the California Fuel Market

In the short term, California's LCFS is likely to promote the use of biofuels that can be readily blended into gasoline and diesel fuel. However, the determination of the baseline and the average carbon intensity values will directly affect the role of biofuels. For example, the 2010 baseline for the rule will likely incorporate the fact that by 2010 most of California's gasoline is expected to be E10 (90% gasoline and 10% ethanol) using corn-based ethanol from the Midwest (or sugar-based ethanol from Brazil). If so, then the carbon reductions from that fuel have already been accounted for.

Without significant changes to the fuel supply, fuel providers face a "blend wall," which limits gasoline ethanol content to 10%. This blend wall is the result of three key factors:

1. Environmental Protection Agency's (EPA) implementation of the Clean Air Act, which limits the allowable amount of ethanol in gasoline to 10% by volume;¹³
2. Motor vehicle warranties, which currently may be voided if owners fuel their vehicles on blends of higher than 10% ethanol;¹⁴ and
3. Manufacturers who supply tanks and pumps to retailers, who currently limit ethanol content to 15%.¹⁵

Therefore, without changes to eliminate the blend wall, in the short term conventional corn ethanol would need to be replaced by ethanol with lower lifecycle emissions, although even this would not be enough to meet a 10% reduction, unless ARB were to certify a 100% carbon-free ethanol fuel. It is expected that ethanol produced from cellulosic feedstocks (e.g., perennial grasses, trees, or municipal waste) will have significantly lower GHG emissions than gasoline (or corn ethanol), but the total lifecycle GHG reductions are uncertain, and there are currently no commercial-scale cellulosic ethanol plants.

On the diesel side, there is more potential to blend biodiesel or renewable diesel (diesel substitutes produced from vegetable oils and animal fats). However, the current supply of these fuels is limited. To displace 10% of the carbon in California's diesel fuel alone (roughly 3 billion gallons in 2006)¹⁶ would require all of the estimated U.S. biodiesel production for FY2007 (450 million gallons),¹⁷ assuming a 68% reduction in lifecycle greenhouse gas emissions.¹⁸

¹³ To increase gasoline ethanol content above this level, fuel producers would need to petition EPA to allow higher blends, and prove to EPA that the higher blends will not lead to higher pollutant emissions or compromise the durability of vehicle emissions control systems.

¹⁴ Automakers would need to be confident that the higher blend would not compromise the performance and reliability of their new vehicles, which would likely require extensive testing. Further, to allow the higher blends in existing vehicles, automakers would likely need even more test data.

¹⁵ Similarly to automakers, pump and tank manufacturers might need extensive data to update their warranties.

¹⁶ U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2006*, Washington, DC, October 2007, Table MF-21, <http://www.fhwa.dot.gov/policy/ohim/hs06/htm/mf21.htm>.

¹⁷ National Biodiesel Board, *Estimated US Biodiesel Production by Fiscal Year*, Jefferson City, MO, 2008, (continued...)

In the longer term, the LCFS is likely to promote the use of various alternative fuels, especially natural gas and electricity. Initial estimates from EPA indicate that natural gas could lead to GHG reductions of 20% or more, while electric fuel could lead to a nearly 50% reduction using the national average fuel mix—relying solely on renewable electricity would lead to even greater reductions. The LCFS could also promote the development of fuel cell vehicles and hydrogen fuel. However, like electricity, the primary energy supply for hydrogen will directly affect its GHG profile, and current hydrogen supply is dependent on fossil fuels.

The LCFS is likely to promote various options in the short and long term, as opposed to a single solution. A study of California’s LCFS by the University of California, Davis, Institute for Transportation Studies (ITS) concluded that “on the basis of a study of a wide range of vehicle fuel options, we find a 10 percent reduction in the carbon intensity of transportation fuels by 2020 to be an ambitious but attainable target.”¹⁹

Potential Barriers to Implementation

Several potential barriers to implementation of California’s LCFS have been expressed by ITS and others. These include limited supply of low-carbon fuels (and in many cases, the need to commercialize those fuels), infrastructure constraints in delivering those fuels to California, and a limited number of vehicles to utilize the fuels (especially for longer-term solutions like hydrogen or electricity). This report will address a few of those potential barriers.

Ethanol Limitations

A relatively straightforward way to reduce the carbon content of gasoline is to blend ethanol into all gasoline. That way, consumers can use their existing vehicles, and the fuel is one they are familiar with. However, as noted above on page 6, the E10 blend wall may limit the ability of fuel providers to blend additional ethanol into gasoline. There seem to be only two remedies to this situation:

1. Eliminate the blend wall by successfully petitioning EPA to increase the limit on gasoline ethanol content beyond 10% (e.g., E15, E20, or higher), and at the same time, gain approval of higher level blends under automakers’ warranties and fuel pump certifications; or

(...continued)

http://www.biodiesel.org/pdf_files/fuelfactsheets/Production_graph_slide.pdf

¹⁸ Environmental Protection Agency, *Greenhouse Gas Impacts of Expanded Renewable and Alternative Fuels Use*, EPA420-F-07-035, Washington, DC, April 2007, <http://www.epa.gov/OMS/renewablefuels/420f07035.htm>.

¹⁹ Alexander E. Farrell, Daniel Sperling, et al., *A Low-Carbon Fuel Standard for California, Part 1: Technical Analysis*, University of California, Davis, Institute of Transportation Studies, UCD—ITS—RR—07—07, August 1, 2007, p. 8, http://pubs.its.ucdavis.edu/publication_detail.php?id=1082.

2. Replace corn-based ethanol in E10 by using ethanol from other sources that have lower carbon intensity (which may include ethanol from Brazilian sugar or cellulose).

In addition to blending higher levels of ethanol into gasoline, fuel providers could promote the use of E85 in flexible fuel vehicles (FFV).²⁰ However, FFVs represent a small fraction of motor vehicles, and it is unclear how many of those vehicles are registered in California. Further, currently most FFVs are fueled on gasoline as opposed to E85. ITS and others conclude that for E85 to play a significant role in the LCFS, both the penetration of FFVs into the California market, and the share of those vehicles operated on E85 would need to increase substantially.²¹ Likewise, the infrastructure for E85 refueling would need to expand—currently, there are only 13 E85 stations in California, and roughly 40 in neighboring states.²²

Other barriers include the need for increased rail and/or port capacity to bring ethanol into the state, increased tank capacity at fuel terminals to store more ethanol, and upgraded storage and delivery systems.

Electricity Limitations

The key barrier to using electricity to meet California's LCFS is the limited number of vehicles available to use the fuel. While there were several models of highway-capable electric vehicles in the 1990s, they were mostly available only for lease, and most of those have been recalled by their manufacturers. Currently, only one company, Tesla Motors, produces a plug-in electric vehicle that is permitted on the highway, and only about 100 Teslas have been delivered nationwide.²³ The majority of electric vehicles currently in service are neighborhood electric vehicles (NEVs), electric vehicles certified to operate on streets with posted speed limits of 35 miles per hour or lower.²⁴

To play a significant role in California's LCFS, the number of electric vehicles, as well as the infrastructure to charge them, would need to grow dramatically. The ITS study found that electric vehicles could form part of a multi-fuel, multi-vehicle strategy, but that electric vehicles alone would not likely lead to the necessary 10% reduction by 2020.²⁵ Likewise, ITS finds that hydrogen fuel and fuel cell vehicles are unlikely to play a key role before 2020.

²⁰ An FFV is a vehicle capable of running on conventional gasoline, an alternative fuel, or any mixture of the two. Although a general term for any such vehicle, in most cases the term is used to refer to E85/gasoline FFVs.

²¹ Presumably, E85 prices would need to be lower than gasoline (on an equivalent energy basis) for consumers to prefer E85. Therefore, E85 subsidies (or high gasoline prices) might be necessary to promote the expansion of E85.

²² U.S. Department of Energy, Alternative Fuels and Advanced Vehicles Data Center, *Alternative Fueling Station Total Counts by State and Fuel Type*, Washington, DC, December 4, 2008, http://www.afdc.energy.gov/afdc/fuels/stations_counts.html.

²³ Laura Dudnick, "Tesla Motors Hands Keys to 100th Roadster Owner," *Palo Alto Daily News*, December 10, 2008.

²⁴ Sometimes referred to as "golf carts," these vehicles are street legal on roads with posted speed limits up to 35 mph.

²⁵ Alexander E. Farrell, Daniel Sperling, et al., op. cit. p. 11.

Proposed Federal LCFS Legislation

In the 110th Congress, seven bills were introduced to establish a low carbon fuel standard similar to California's (see **Table 2**). These seven bills were H.R. 2215 (Inslee), H.R. 2809 (Inslee), H.R. 6186 (Markey), H.R. 7284 (Lewis), S. 1324 (Obama), S. 2191 (Lieberman), and S. 3036 (Boxer). Of these bills, S. 2191 was reported out of committee, and S. 3036 was discussed on the Senate floor. A substitute to S. 3036, S.Amdt. 4825, would also have established an LCFS. In most cases, these bills would have established the overall requirements of the program, but left the details to EPA. Key differences between these proposals include the stringency of the emissions reduction (i.e., percent reduction required), the timeframe for that reduction, and the fuels covered by the program. The more stringent proposals would require deeper cuts earlier, and include more fuels in the mandate.

Table 2. Low Carbon Fuel Standard Bills Introduced in the 110th Congress

| Bill No. | Sponsor | Covered Fuels | Target Year for 10% Reduction | Maximum Required Reduction (%) | Target Year for Maximum Reduction |
|--------------|-----------|---|-------------------------------|--------------------------------|-----------------------------------|
| H.R. 2215 | Inslee | Motor vehicle and non-road vehicle fuels ^a | 2034 | 21% | 2050 |
| H.R. 2809 | Inslee | Motor vehicle and non-road vehicle fuels ^a | 2034 | 21% | 2050 |
| H.R. 6186 | Markey | Motor vehicle, non-road vehicle, and aircraft fuels | 2028 | 10% ^b | 2028 |
| H.R. 7284 | Lewis | Motor gasoline | 2020 | 10% ^b | 2020 |
| S. 1324 | Obama | Motor gasoline | 2020 | 10% ^b | 2020 |
| S. 2191 | Lieberman | Motor vehicle, non-road vehicle, and aircraft fuels | 2020 | 10% ^b | 2020 |
| S. 3036 | Boxer | Motor vehicle, non-road vehicle, and aircraft fuels | 2020 | 10% ^b | 2020 |
| S.Amdt. 4825 | Boxer | Motor vehicle, non-road vehicle, and aircraft fuels | 2028 | 10% ^b | 2028 |

Source: CRS analysis of proposed legislation

Notes: In some cases, these are provisions in larger bills. In others, they are stand-alone bills.

- a. Separate standard for aircraft fuel at discretion of EPA Administrator.
- b. The EPA Administrator has discretion to increase the percentage in subsequent years.

Fuel Supply Under a Federal Low Carbon Fuel Standard

A key difference between a national LCFS and that proposed by California is the scope of the program, and its effects on fuel supply. When implemented, the California program will only apply in California. Presumably, increased demand for low-carbon fuels in California would be met through both increased U.S. production and imports of low-carbon fuel, and by shifting low-carbon fuels from areas of the country not covered by the program. In a national program, the second option, fuel shifting, would not be possible. Therefore, if domestic production were inadequate to meet the mandate, national production and/or imports would need to increase to meet the increased demand. Otherwise, total national consumption of conventional (non-low-carbon) fuels would need to decrease in order to meet the averaging requirement. In its analysis of S. 2191, CRA International found that under a 10% national standard in 2020, covering all transportation fuels, there would not be enough low-carbon fuel to offset total fuel demand.²⁶ Therefore, in CRA's model, total transportation fuel consumption dropped dramatically, and motor fuel prices increased roughly 140% above baseline projections. In later years, they found that this price effect was diminished as more cellulosic biofuel and electricity were introduced into the fuel system.²⁷ The magnitude of the price increase is perhaps less relevant than the potential effect of establishing a mandate before the fuel is expected to be available to meet that mandate. It is likely that the proposals with later time frames would be less disruptive to the fuel supply.

Interaction With Other Federal Programs or Proposals

The establishment of a federal LCFS would likely have ramifications for other federal environmental programs. Most notably, the interaction between a federal LCFS and the existing renewable fuel standard (RFS), would be key, as would the interaction between the LCFS and any future federal greenhouse gas control program (e.g., cap-and-trade, carbon tax).

Renewable Fuel Standard

The Energy Policy Act of 2005 (EPAAct, P.L. 109-58) established a renewable fuel standard (RFS), requiring the blending of biofuels (such as ethanol) in the nation's fuel supply. The Energy Independence and Security Act of 2007 (EISA, P.L. 110-140) significantly expanded this mandate. Currently, the RFS requires the blending of 9.0 billion gallons of renewable fuel in transportation fuels in 2008, increasing to 36 billion gallons in 2022. Of this mandate, an increasing share must be met with "advanced biofuels"—biofuels produced from feedstocks other than corn starch and with 50% lower lifecycle GHG emissions relative to gasoline. Within the

²⁶ CRA International, *Economic Analysis of the Lieberman-Warner Climate Security Act of 2007 Using CRA's MRN-NEEM Model*, April 8, 2008.

²⁷ For more information and analysis of S. 2191, see CRS Report RL34489, *Climate Change: Costs and Benefits of S. 2191/S. 3036*, by Larry Parker and Brent D. Yacobucci.

advanced biofuel mandate, there are specific carve-outs for cellulosic biofuel and bio-based diesel substitutes.

EPA has not published a draft or proposed rule detailing which fuels will qualify, or the methodology for how lifecycle emissions will be calculated, but the development of that methodology will likely affect any future rules for a federal LCFS. Further, depending on how the requirements for the RFS and the LCFS overlap, fuel suppliers could potentially face a complex mix of low-carbon regulations. This may be more likely if definitions or methodologies for lifecycle analysis differ between the two programs.

In general, LCFS legislation introduced in the 110th Congress does not explicitly link compliance with the LCFS and compliance with the RFS. However, several proposals would insert the LCFS requirements into Section 211(o) of the Clean Air Act,²⁸ the same subsection that established the RFS (H.R. 6186, S. 2191, S. 3036, and S.Amdt. 4825). In that case, the two programs would share definitions, even if they do not necessarily share methodology for calculating emissions. Two bills would add new sections to Title II of the Clean Air Act (H.R. 7284 and S. 1324). Placing the program in Title II would link it with other fuels programs, including the RFS, but the link would not be as direct as placing the two programs in the same section of the code. Finally, two bills would establish a new Title VII of the Clean Air Act (H.R. 2215 and H.R. 2807). Establishing the program in a new title of the Clean Air Act would further decrease the linkage between the LCFS and the RFS.

Greenhouse Gas Controls

Several bills were introduced in the 110th Congress that would have established economy-wide market-based limits on greenhouse gas emissions. Most of these were cap-and-trade proposals. While most of the cap-and-trade proposals would not have established an LCFS, two bills and one amendment would have done so (S. 2191, S. 3036, and S.Amdt. 4825).

A key question regarding the interaction between an LCFS and an economy-wide cap-and-trade system is: how are the two programs linked? The programs could be directly linked, so that credits earned in one program can be used for the other, or there can be no link between the two, and a covered entity must comply with both programs separately. In the proposals in the 110th Congress, there was no link between the two programs, forcing fuel suppliers to comply with the LCFS regardless of whether there were more cost-effective carbon reductions in other parts of the economy. This could effectively result in double regulation for the fuels sector, and is one of the factors that led CRA International to conclude that the LCFS in S. 2191 would result in dramatically higher fuel prices. Future proposals could allow some flexibility by allowing fuel providers to use a limited number of cap-and-trade credits for compliance with the LCFS, and vice-versa.

²⁸ 42 U.S.C. § 7545(o).

Conclusion

The establishment of a low carbon fuel standard could significantly affect fuel supplies and fuel prices. However, the details of any program are key to determining those effects. The stringency, scope, time frame, and flexibility of the program would determine its ultimate effects on both fuel markets and greenhouse gas emissions. California has not officially proposed regulations for its program, but instead has released drafts of possible regulations. The development of those rules could inform policymakers looking to establish a federal LCFS. However, the scope of a federal program—requiring compliance nationwide—would likely affect the fuel system in ways not comparable to California’s experience. If more low-carbon fuel is needed in California, supply can be shifted from other parts of the country not under an LCFS. If more low-carbon fuel is needed nationwide, higher production and/or imports would be necessary. If the requirements of a low carbon fuel standard get ahead of the necessary supply, conventional fuel supply would need to be curtailed, or the program would need to be delayed. It is likely that the proposals with later time frames would be less disruptive to the fuel supply.

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