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Low-Carbon Fuel Standards: Do They Really Work?

By Frank A. Wolak

Transportation accounts for more than 40 percent of California's greenhouse gas (GHG) emissions and poses unique technological and economic challenges for the design of cost-effective GHG-emissions-control policies. Gasoline and other oil-based fuels are efficient ways to store on-board energy to power automobiles, trucks, and airplanes. Moreover, an extensive nationwide distribution infrastructure for making oil-based fuels available to the transportation sector has existed for almost 100 years. Finally, oil-based fuels currently maintain a cost advantage over domestically produced alternative low-emissions fuels. As a result, oil-based products provide more than 95 percent of California's transportation fuel needs.

A number of technologically feasible low-carbon transportation fuels exist. Electricity, hydrogen, and biofuel are the current leading candidates. But there is substantial uncertainty about the future market shares of these fuels and about what other new low-carbon transportation technologies will emerge. Even more uncertainty exists about current policies that will lead to a low-carbon transportation sector at least cost to the U.S. economy. A low-carbon fuel standard (LCFS) is gaining popularity as a policy to reduce GHG emissions from the transportation sector, but not because it is a cost-effective way to achieve GHG emissions reductions.

In mid-January 2007, Governor Arnold Schwarzenegger issued an executive order establishing an LCFS for transportation fuels sold in California. The initial goal of this LCFS is to reduce the GHG emissions intensity of California's pas-

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senger vehicle fuels by at least 10 percent by 2020. Senator John McCain and Senator Barak Obama both called for similar national policies soon thereafter. The European Union and provinces of Ontario and British Columbia in Canada have also adopted LCFS policies to reduce the carbon intensity of their transportation fuels by 10 percent by 2020.

The widespread adoption of an LCFS suggests that policymakers perceive it as a low-cost approach to transitioning to a low-carbon transportation sector. Recent economic research shows that there are substantially lower-cost alternatives for achieving a given reduction in GHG emissions in the transportation sector, so cost-effectiveness is not the reason for the political popularity of an LCFS. There are more administratively straightforward and lower-cost approaches to achieving a given quantity of GHG reductions from the transportation sector than an LCFS.

What Is a Low-Carbon Fuel Standard and Why Is It So Popular?

The California LCFS places an upper bound on the "full fuel cycle" GHG emissions intensity of transportation fuels sold by California suppliers. The "full fuel cycle" measure of the GHG emissions includes all emissions from upstream production and extraction of the energy resource, refining of the resource, transport of the fuel to market, and consumption of the fuel.

Under the California LCFS, fuel suppliers – refiners, importers, and blenders of passenger vehicle fuels – will be required to ensure that the mix they sell in California has a declining full fuel cycle GHG emissions content in CO_2-equivalent grams per British thermal unit (BTU) of heat energy. All greenhouse gases are included in this measure converted to CO_2-equivalents based on their impact on global climate change.

Each California fuel supplier will need to demonstrate that the annual average GHG content of the fuels it sold during the past year is below the standard or face stiff penalties. Fuel suppliers that reduce the average carbon content of the fuels they sell below the standard in the present year or in past years will receive credits. Suppliers can also use credits previously banked or purchased from other California suppliers to meet the standard.

Proponents of the LCFS argue that it will achieve a pre-specified GHG content for California's transportation fuels at least cost to California consumers. However, this statement does not imply that an LCFS will reduce total GHG emissions from the transportation sector at least cost. In fact, an LCFS could lead to increased GHG emissions. Moreover, even if reducing the carbon intensity of transportation fuels reduces GHG emissions, there are substantially lower-cost policies for achieving the same total GHG emissions reduction from the transportation sector.

Given these properties of the LCFS, what explains its popularity with politicians? The LCFS subsidizes the production of transportation fuels with GHG contents below the standard and taxes the production of transportation fuels with GHG contents above the standard. Each transportation fuel supplier must collect this tax by charging a higher price for the high-carbon fuel than it would in the absence of the standard and pay this subsidy by charging a lower price for the low-carbon fuel than it would in the absence of the standard in order to meet the overall GHG emissions intensity standard.

Ethanol, which is produced domestically and in Canada primarily using corn as the input biomass, is the main fuel thought to have a GHG emissions content below the standard. This means that the LCFS subsidizes the production of corn-based ethanol. Because gasoline is the major transportation fuel with a GHG content above the standard, an LCFS imposes a tax

on its sale in California without explicitly raising the state's gasoline tax. The higher price has the environmental benefit of reducing consumption of this high-GHG emissions content transportation fuel.

The cost-effectiveness of the LCFS as a GHG-emissions-reduction policy is reduced by the fact that it subsidizes the production of corn-based ethanol and other fuels with GHG emissions contents below the standard. This subsidy has an environmental cost because the consumption of biofuels also produces GHG emissions, just not at the same rate per BTU of energy consumed as gasoline. Nevertheless, corn-based ethanol has the political benefit that it is produced domestically.

This tax and subsidy equivalence of the LCFS explains why it can lead to an increase in total GHG emissions and why it is an extremely costly way to achieve a given reduction in total GHG emissions. There are two ways to achieve compliance with the LCFS: reducing the production of high-GHG-emissions fuels or increasing the production of low-GHG-emissions fuels. Depending on the relative prices of the two fuels, suppliers may find it optimal to increase the production of both fuels to meet the standard in a way that increases total GHG emissions.

Although recent research demonstrates that a national LCFS is unlikely to lead to increased GHG emissions, the average cost per ton of CO_2 reduced is substantially higher than the average cost of a policy designed to reduce *total* GHG emissions from the transportation sector.[1] Specifically, this research estimates that the average cost per ton of CO_2 reduced under a 10 percent national LCFS is three to four times higher than the least-cost policy for achieving the same national total CO_2 emissions reduction. This research also finds that the lowest estimated average cost per ton of CO_2 reduced under a 10 percent national LCFS is higher than most estimates of the environmental damage per ton of CO_2 emitted, which implies that a 10 percent LCFS imposes more costs on producers and consumers than the environmental damage it prevents.

Déjà Vu All Over Again

The LCFS resembles another controversial intensity-based standard in the transportation sector – the Corporate Average Fuel Economy (CAFE) standard. The CAFE standard imposes an upper bound on the sales-weighted average fuel economy in miles per gallon (mpg) of a manufacturer's fleet of passenger cars or light trucks sold in the U.S. The CAFE standard is an inefficient mechanism relative to a gasoline tax, for reducing gasoline consumption for the same reasons that the LCFS is a costly way to reduce total GHG emissions.

A number of CAFE standard compliance issues have analogues for an LCFS, and these are likely to undermine significantly the effectiveness of an LCFS at producing lower GHG emissions. The first compliance issue under the CAFE standard is the process for determining the fuel economy of each vehicle sold by an automobile manufacturer. The U.S. Environmental Protection Agency (EPA) uses either test data provided by the manufacturer or obtains a vehicle and tests it in an EPA facility to collect vehicle-level fuel economy data.

The analogous issue for the LCFS is the process for determining the GHG emissions intensity of a fuel. The full fuel cycle GHG emissions content of a fuel cannot be determined

[1] Holland, Stephen P., Knittel, Christopher R., and Hughes, Jonathan E., (2007) "Greenhouse Gas Reductions under Low Carbon Fuel Standards?" Center for the Study of Energy Markets, University of California Energy Institute, Working Paper WP-167 (available at *http://www.ucei.berkeley.edu/*).

by burning it in a test facility. This would only provide an estimate of the GHG emissions for the fuel at the consumption stage. Estimates of the emissions produced in upstream production and extraction of the energy resource, refining of the resource, and transport of the fuel to final consumers must all be compiled to compute the full fuel cycle GHG emissions. Scientifically defensible differences in modeling assumptions can yield sizeable differences in the GHG emissions estimates for each stage of the full fuel cycle. For example, there is considerable scientific debate whether the full fuel cycle GHG emissions for corn-based ethanol are lower than those for gasoline. However, because corn-based ethanol is the major domestically produced alternative transportation fuel, it is difficult to see how a regulatory process subject to federal or state government oversight would produce a full fuel cycle GHG emissions content greater than or equal to that of gasoline for the purposes of the LCFS, regardless of the best available scientific evidence on this issue.

The process of computing the rates used to convert other greenhouse gases produced in the full fuel cycle into CO_2 equivalents is also plagued by scientific uncertainty. For each fuel, plausible differences in modeling assumptions will yield significantly different rates for converting each GHG into a CO_2-equivalent magnitude. All of these sources of uncertainty imply that determining the GHG emissions rates for each fuel is likely to be an extremely contentious process subject to much more bureaucratic discretion than the one used to determine the fuel economy of vehicles under a CAFE standard.

The experience of the CAFE standard with dual-fuel vehicles is a prime example of how bureaucratic discretion can effectively relax a standard. The fuel economy of a dual-fuel vehicle that can burn gasoline or an alternative fuel is computed as the average of the fuel economy using gasoline and an administratively determined fuel economy in gasoline-equivalent miles per gallon for the alternative fuel. This administrative mechanism combined with the assumption that the dual-fuel vehicle will use the alternative fuel 50 percent of the time implies a roughly 65 percent increase in the fuel economy credited to dual-fuel vehicles. For example, in 2006 a 19-mpg Ford F-150 pickup truck that could also burn E85 (a blend of 85 percent ethanol and 15 percent gasoline) received a 31-mpg rating for the purposes of Ford's CAFE standard compliance.

The assumption of equally likely gasoline and E85 consumption directly contradicts government survey data that reveals a very small frequency of alternative fuel use and the fact that a very small fraction of the more than 200,000 gas stations in the United States sell E85. For example, in California there are currently four stations open to the public selling E85.

The experience with the dual-fuel credit under the CAFE standard suggests that there will be ample opportunities in the full fuel cycle GHG emissions determination process to set the GHG content of alternative fuels to ensure compliance with the LCFS without ever achieving tangible GHG emissions reductions.

Cost-Effective GHG Emissions Reduction for the Transportation Sector

There are many lower cost ways to achieve equivalent GHG emissions reductions with fewer opportunities for administrative discretion to undermine their effectiveness. Rather than suggest a specific policy, I will describe the major features that I believe any policy should have.

To a first approximation, one ton of CO_2-equivalent

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GHG emissions causes the same environmental damage regardless of its source. This logic implies that the price a fuel supplier pays for producing one ton of CO_2-equivalent GHG emissions should be the same for all of the fuels it sells. If the GHG emissions content of a BTU of energy from one transportation fuel is lower than it is for gasoline, the dollar per BTU cost of GHG emissions for this fuel should be lower, but all fuels should face the same price per ton of GHG emissions.

A single price for GHG emissions can be implemented by setting an overall cap on the full fuel cycle GHG emissions from all transportation fuels sold in California. The price of GHG emissions would be determined by the highest cost control technology used comply with the overall cap. Alternatively, California fuel suppliers could be required to pay a fixed dollar per ton for the full fuel cycle GHG emissions in all of the transportation fuels they sell. In this case, the level of this price would determine the total amount of transportation sector GHG emissions in California.

Having all fuels pay the same price for their GHG emissions does not eliminate the problem of setting the full fuel cycle GHG emissions for each fuel. Because there is not yet a single scientifically valid way to determine the full fuel cycle GHG emissions content of transportation fuels, the process used to make this determination should take advantage of the best available and most current scientific evidence and be subject to extensive stakeholder review. This will increase the cost of determining the GHG emissions content of transportation fuels, but it will also significantly reduce the likelihood that that any GHG emissions control policy is rendered ineffective by an administrative loophole implemented to favor a politically powerful constituency.

A final desirable feature of a transportation sector GHG emissions control policy is a mechanism to address the concern that the relative burden of including the price of full fuel cycle GHG emissions in the price of all transportation fuels will fall most heavily on poorer households. There are various ways to address this concern that differ in terms of their complexity and accuracy. One way is to give all households a state or federal income credit for some or all of the GHG emissions they paid for during the year based on the total amount of miles driven.

Fad Diets and Low-Carbon Fuel Standards

Everyone has heard of fad diets claiming to make weight loss easier. Consider a diet that promises weight loss by allowing the participant to eat as much food as they would like as long as the average calories per pound of food eaten is less than some standard. Unless the average calories per pound of food eaten standard is set extremely low, this diet is unlikely to work. The only proven way to lose weight is to eat fewer calories or increase physical activity so that the amount of calories burned exceeds the amount eaten. Reducing the average calorie content of foods eaten will not work unless this inequality is satisfied. Replacing "calories" by "GHG emissions" and "pounds of food" by "BTUs of energy" produces the LCFS. Policymakers wanting to reduce transportation-sector GHG emissions should take note. The vast majority of climate scientists agree that the only way to reduce atmospheric CO_2 concentration is to consume less CO_2-producing fuels or increase carbon sequestration activity so that the net amount of CO_2 released to the atmosphere is reduced. Before more jurisdictions adopt an LCFS, there should be some demonstration of its efficacy in increasing the amount of effort devoted to these two proven mechanisms for achieving GHG emissions reductions.

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