Proposed Economic Analysis for the Low Carbon Fuel Standard

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The Air Resources Board (ARB or Board) staff is conducting an economic analysis for the draft Low Carbon Fuel Standard (LCFS) regulation. Below is a synopsis of that effort.

Proposed Scoping Plan

In the Proposed Scoping Plan (PSP), staff assumes the costs of producing ethanol and biodiesel are highly competitive with the current and projected high prices of gasoline and diesel. Staff further assumes that alternative fuels could be produced at prices at or below the pretax wholesale cost of petroleum fuels on an energy-equivalent basis. Consumers would not necessarily get this benefit, as the market price commanded by the alternative fuels would simply be the price of petroleum-based products; however, the capital expenditure to produce the alternative fuels would be recovered from this production-cost differential. Therefore, staff estimates that there will be no net difference in the costs of producing fuels to meet the LCFS compared with the cost of producing traditional petroleum gasoline and diesel.

Staff's economic analysis of the LCFS regulation will examine and expand upon estimates made in the PSP. Since future costs for petroleum-based and alternative transportation fuels are uncertain, the staff's economic analysis of the LCFS regulation will present reasonable scenarios.

Baseline Determination

Staff is determining the baseline scenario for the LCFS regulation—the "do nothing" case or "business as usual (BAU)." Even without the LCFS regulation, there are several regulations and programs in place that affect the GHG emissions and costs related to transportation: the federal Renewable Fuel Standard (RFS), the ARB ZEV regulation, the federal Corporate Average Fuel Economy (CAFE) program, and the Pavley regulation. The initial baseline year will be 2010, and staff will extrapolate the BAU case for years 2011 – 2020.

The Energy Independence and Security Act of 2007 (EISA) enhanced the original federal RFS—which was established by the Energy Policy Act of 2005—by requiring the use of 36 billion gallons of renewable fuels annually in 2022, of which only 15 billion gallons can be "conventional biofuel," which is principally ethanol derived from corn starch. The remaining 21 billion gallons are to be from sources other than corn starch and are labeled "advanced biofuels," which require a minimum 40 to 50 percent reduction in carbon intensity. The federal RFS requirements will result in changes in California transportation fuels. ARB staff is considering reflecting this federal requirement as part of the baseline analysis. For example, if staff assumes that California will receive a proportional share of the low-CI biofuels (roughly 11 percent), an estimated two billion gallons of these alternative fuels would be in the California

market by 2020. The LCFS might not change the total amount of biofuels used in California but would likely attract more of the advanced biofuels to the State.

The Board first adopted the Zero Emission Vehicle (ZEV) regulation in 1990 as part of the Low Emission Vehicle Program. Since then, the Board has made modifications to the regulation, the most recent in March 2008. The goal has been to have zero emission technologies on the roads on a mass scale as soon as possible, considering the state of technology, market factors, economic impact, and environmental benefits. ARB staff estimates that the number of advanced technology vehicles using electricity or hydrogen as a fuel — battery electric vehicles (BEVs), plug-in hybrid vehicles (PHEVs), or fuel cell vehicles (FCVs)—will increase to about 560,000 vehicles by 2020. This volume is consistent with the penetration schedule in the 2008 ARB ZEV regulation. Staff is considering reflecting the deployment of this number of ZEV vehicles as part of the baseline analysis.

In August 2005, pursuant to AB 1493 (Pavley, 2002), the Board adopted greenhouse gas emissions standards for new passenger vehicles, beginning with 2009 models (Pavley I). Manufacturers have flexibility in meeting these standards through a combination of reducing tailpipe emissions of carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) and receiving credit for systems demonstrated to mitigate fugitive emissions of hydrofluorocarbons (HFCs) from vehicle air conditioning systems. The emission standards become increasingly more stringent through the 2016 model year. ARB is also committed to further strengthening these standards beginning in 2017 to obtain a 45 percent greenhouse gas reduction from 2020 model year vehicles (Pavley II). Federal approval of this regulation is anticipated, and ARB staff is considering the impacts of the Pavley I regulation as part of the baseline fuel forecast case for the LCFS.

Other considerations for the economic analyses, including for the baseline case, are the price of petroleum (and associated transportation fuels) and the outlook on fuel demand. Crude prices have been volatile in 2008, as high as $140/barrel (bbl) and more recently as low as $50/bbl. For the Proposed Scoping Plan, staff used $89/bbl (in 2007 dollars) as the price estimate in 2020.

Assembly Bill 1007 (Pavley, 2005) directed the California Energy Commission (CEC), in partnership with ARB, to develop a State Alternative Fuels Plan (Plan) to increase the use of alternative fuels without adversely affecting air quality, water quality, or causing negative health effects. Meeting the requirements of AB 1007, the CEC and ARB published the Plan in December 2007. (For reference, the Plan estimated 2010 gasoline prices at $2.72 - $3.47 per gallon and 2020 prices at $2.94 - $4.41 per gallon. Diesel prices were estimated at $2.43 - $3.10 per gallon for 2010 and $2.59 - $3.88 per gallon for 2020.) ARB staff continues to work with the CEC to estimate future crude prices and transportation fuel demand. Furthermore, ARB staff is participating in the development of CEC's 2009 Integrated Energy Policy Report (IEPR). These efforts will provide input to the economic analyses of the LCFS.

The Emission Factors (EMFAC) model is used to calculate emission rates from motor vehicles operating on highways, freeways, and local roads in California. Using this model, ARB staff has generated preliminary results indicating that gasoline demand in

California will decrease slightly between 2010 and 2020, largely due to the Pavley I regulation.

LCFS Costs

ARB staff is also conducting an economic analysis on the draft LCFS regulation. This effort involves estimating the cost of using alternative fuels, including production, transportation, and fueling costs, and costs directly related to the regulation itself, such as metering, recordkeeping, and reporting costs. These costs must then be compared to the traditional fuels they will displace.

A. General Discussion of Costs and Savings

The analysis of costs and savings for the LCFS regulation involves four steps. The first step is to annualize the upfront or capital expenditures using the following formulas:

Annualized Cost of Capital = Capital Expenditures x Capital Recovery Factor

Capital Recovery Factor = $i\ (1 + i)^n/(1 + i)^n - 1$

Where i is the discount rate (for example, 5%) and n is the life of the capital.

The primary rationale for considering a real discount rate of five percent is that it is equivalent to rate of return on an inflation-adjusted 10-year treasury security—about two percent in the past five years—plus the California Environmental Protection Agency (Cal/EPA) recommended three-percent risk premium. The five-percent real discount rate has been used for several recent ARB regulations.

For the LCFS analysis, staff is using 10 years as the life of the equipment. A 20-year life, which is often used for large capital projects, was considered too long for investors to recovery their capital investment in alternative fuels.

The result of this first step is a levelized cost that will be incurred for every year the equipment or device operates until the capital expenditure is fully paid. This way, the costs of the regulation can be matched with the annual savings and the emission reductions the measure provides.

The second step is to determine the on-going costs for producing the alternative fuels. These costs include costs for feedstock, utilities, labor, maintenance, storage, transportation, and dispensing.

The third step is to calculate the value of the savings realized by the LCFS regulation. Essentially, these savings will be the avoided cost of buying the petroleum-based fuels that have been displaced by the alternative fuels. For example, if the implementation of the LCFS results in displacing 20 percent of traditional petroleum-derived products and replacing them with alternative fuels, this equates to approximately three billion gallons per year reduced consumption of traditional gasoline and diesel that the consumers would have otherwise bought.

The last step is to calculate the net cost of the regulation, which is the sum of all costs and savings. As mentioned earlier, any overall net savings of using alternative fuels in the marketplace would not be realized by the consumer, as the market price of the alternative fuels would simply be the price of petroleum-based products. Any net "savings" would be used to recover the capital expenditures necessary to produce the alternative fuels.

AB 32 requires the Board to consider cost-effectiveness of any measure and defines cost-effectiveness as, "the cost per unit of reduced emissions of greenhouse gases adjusted for its global warming potential." (H&S Code 38505 (d)) This definition specifies using a metric of cost per unit of reductions emissions (e.g., dollars per metric ton CO_2E) by which the Board must express cost-effectiveness, but it does specify what should be included in the cost calculation and does not provide criteria to assess if a regulation is or is not cost-effective.

Staff will assess the economic impact of the LCFS on transportation fuel providers, including refiners, oil producers, importers of transportation fuels, biofuel producers, and providers of electricity and hydrogen. As alternative fuels displace traditional fuels in the marketplace, staff expects that refiners would supply nearly similar overall amounts of transportation fuels, except now obtaining their blend stocks from nontraditional sources. Out-of-state producers and importers may see reduced shipments due to the introduction of alternative fuels, although the impacts on fuel distributors in the State would be minimal. The LCFS would provide a significant economic opportunity for producers of alternative fuels, including in-state producers.

Finally, to the extent feasible, staff will include in the economic analysis consideration of significant impacts on any change in motor vehicle fuel efficiency (see below), the existing motor vehicle fuel distribution system, and the competitive position of the affected segment relative to border states.

B. Illustrative Scenarios

The economic analysis will present illustrative examples of compliance paths, or "scenarios." ARB staff has developed seven possible compliance scenarios: four for gasoline and its substitute fuels and three for diesel fuel and its substitute fuels. Each of these scenarios includes a mix of fuels that could be used to meet the LCFS. The purpose of the compliance scenarios is to illustrate how the draft carbon intensity reductions might be achieved, given prevailing and foreseeable future conditions. The compliance scenarios are not intended to predict or forecast the likely combination of fuels and vehicles that will actually be used. (A full discussion of the compliance scenarios can be found in the draft "Supporting Documentation for the Draft Regulation for the California Low Carbon Fuel Standard.") For the economic analysis, ARB staff will estimate the costs for these scenarios as illustrative examples.

The four gasoline-related scenarios differ in the volumes of corn-based ethanol, cellulosic ethanol, sugarcane ethanol, and advanced renewable ethanol. The number of flexible-fuel vehicles (FFVs) assumed to be using E85 and the number of advanced

vehicles (BEVs, PHEVs, and FCVs) using electricity or hydrogen also change significantly in several scenarios. The three possible compliance scenarios for the diesel fuel group include one based on a diversification of the liquid fuel pool using available low-carbon-intensity fuels, a second that includes not only a variety of liquid fuels, but also CNG vehicles penetrating the fleet, and a third that increases the compliance options by expanding the second scenario to include additional advanced-technology vehicles, including PHEVs used to replace conventional diesel vehicles.

Staff is also considering how the economic analysis can be applied more broadly than the seven illustrative scenarios. Staff solicits discussion on this matter.

C. Alternative Fuel Costs

To estimate the costs of the alternative fuels, ARB staff has relied on several studies. One of the analyses referenced is the "Strategic Assessment of Bioenergy Development in the West," conducted for the Western Governors Association by the Antares Group. Antares estimated capital costs, operating & maintenance costs, and transportation costs for several alternative fuels. ARB staff recalculated the capital-cost recovery values presented by Antares, using a real interest rate of five percent and a project life of 10 years, which is consistent with ARB policy. The table below includes a summary of these costs, as well as estimates from other sources, including the CEC, the Department of Energy, the National Research Council, and a document entitled "CO_2 Mitigation and Renewable Oil from Photosynthetic Microbes: A New Appraisal" by Mark E. Huntley and Donald G. Redalje, 2006. ARB staff continues to refine these values and seek other data, and is seeking recommendations on alternative sources of information.

When presenting the results of the economic analysis for the draft proposed LCFS regulation, ARB staff will reference the sources of cost information used to conduct the analysis and the underlying assumptions associated with those cost data. When considering the underlying cost assumptions, ARB staff generally expects the production costs and market prices of many of the alternative fuels to fluctuate with the price of crude, as petroleum prices affect feedstock production costs and transportation costs.

Estimated Alternative Fuels Costs (Dollars per Gallon; CNG, Electricity, and Hydrogen in Gasoline Equivalent [GGE])

Fuel	Feedstock	Capital (Plant) Costs	Production Costs	Co-product Credit	Feedstock	Subtotal (Capital & Production costs)	Storage, Transport, Dispensing	Grand Total	Source
Ethanol	Corn (dry mill)	$0.22	$0.50	-0.34	$1.35	$1.72	$0.12	$1.84	Antares, 2008
Ethanol	Corn (wet mill)	$0.18	$0.59	-0.52	$1.51	$1.76	$0.12	$1.88	Antares, 2008
Ethanol	Lignocellulosics	$0.58	$0.39	-0.36	$0.70	$1.31	$0.12	$1.43	Antares, 2008
Biodiesel	Soybean Oil	$0.06	$0.25	-0.04	$2.64	$2.91	$0.22	$3.13	Antares, 2008
Biodiesel	Yellow Grease	$0.10	$0.59	-0.04	$1.37	$2.03	$0.22	$2.24	Antares, 2008
Biodiesel	Algal Oil	-	-	-	-	$2.62	$0.22	$2.83	Huntley and Redalje, 2006
Fischer-Tropsch Diesel	Poplar	$2.87	$0.95	-1.73	$0.93	$3.02	$0.22	$3.24	Antares, 2008
FAHC Diesel	Virgin oil	$0.15	$0.16	-0.06	$2.67	$2.92	$0.22	$3.14	Antares, 2008
CNG	Natural Gas							$1.78	AB 1007/2005 IEPR Docket Submittal (Fleet)
Electricity	California Marginal Generation	-	-	-	-	$1.41	$1.25	$2.67	Energy and Economics, Inc.
Hydrogen	Lignocellulosics	-	-	-	-	$1.80	$1.70	$3.50	Nat. Research Council, 2008
Hydrogen	Coal Gasification	-	-	-	-	$1.90	$0.70	$2.60	Nat. Research Council, 2008
Hydrogen	Central Natural Gas	-	-	-	-	$1.60	$1.30	$2.90	Nat. Research Council, 2008
Hydrogen	Distributed Natural Gas	-	-	-	-	$3.30	-	$3.30	Nat. Research Council, 2008
Hydrogen	Distributed Electrolysis	-	-	-	-	$7.20	-	$7.20	Nat. Research Council, 2008
Hydrogen	Solar	-	-	-	-	$10.00	-		Department of Energy, 2007
Hydrogen	Central Wind Electrolysis.	-	-	-	-	$3.10	-		Department of Energy, 2007

D. Vehicle and Infrastructure Costs

ARB staff believes that the current and potentially enhanced ZEV regulation will result in a significant number of vehicles capable of utilizing low-carbon fuels such as electricity and hydrogen; therefore, no additional incremental costs for these vehicles would be attributed to the LCFS.

As the table above shows, staff is including in the economic analysis the cost of additional infrastructure related to the alternative fuels: storage, transportation, and distribution costs.

E. Other Regulation Costs

The draft proposed LCFS regulation requires the regulated parties to meter, record, and submit data on the use of all fuels so that the regulation can be appropriately enforced. ARB staff is currently estimating the costs associated with these requirements. Furthermore, staff is estimating the economic impact of the draft proposed regulation on federal, state, and local government agencies and large and small businesses, including competitiveness issues.

F. Socioeconomic Analysis

ARB staff will investigate and identify potential socioeconomic issues of the LCFS. Staff is considering using E-DRAM for this purpose and solicits stakeholder input on the appropriateness of such an application as well as suggestions for alternative approaches.