

Memo

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Date: October 8, 2010

Re: Other Macroeconomic Analyses of LCFS – Task 1 Report

Introduction

This report summarizes recent macroeconomic impact analyses focusing on scenarios involving the implementation of a low-carbon fuel standard. In these studies, the analyses sought, or are seeking, to estimate a) carbon reduction potential, b) fuel usage patterns, and c) economic impacts of a low-carbon fuel standard strategy. The studies covered were completed by the Center for Climate Strategies and the Governmental Studies faculty at Johns Hopkins University, Professor Adam Rose at the University of Southern California, the Washington State Department of Ecology, the California Air Resources Board, NESCAUM¹, the California Climate Action Team, and Charles River Associates.

Most of these studies use econometric models, which are either custom-built programs or extensive spreadsheets that seek to quantify the economic impacts that result from certain expected changes to parts of the economy. Those changes may be driven by policy, as in the case of a low-carbon fuel standard, or by external market forces, as in the case of a rise in the market price of oil. The models are “econometric” in that they use statistical and mathematical methods to attempt to produce numeric measurements (usually in dollar amounts) of the impacts these changes would have.

Not all of these studies have similar scenarios, assumptions or methods to those utilized for the Oregon analysis. In addition, not all have been completed to the point where results have been published. The table below briefly summarizes the year of publication and the perceived similarity of each study to the work being completed for Oregon.

¹ NESCAUM stands for Northeast States for Coordinated Air Use Management.

Studies Reviewed

<u>Study</u>	<u>Date of Publication</u>	<u>Similarity to Oregon Study and Usefulness for Comparison</u>
Impacts of Comprehensive Climate and Energy Policy Options on the U.S. Economy <i>Center for Climate Strategies and Johns Hopkins University</i>	2010	Limited. Considers macro effects of biofuels only as part of a 23-policy bundle a) on a national scale and b) without detailed infrastructure assumptions
The Economic Impact of the Florida Energy and Climate Change Action Plan on the State's Economy <i>Adam Rose and Dan Wei, University of Southern California</i>	2008	Somewhat. A state-level study with macroeconomic analysis, finding \$15 billion in direct savings from advanced biofuels savings. No macro analysis published for this strategy, however, beyond a projection of 11,000 net positive new jobs created from this strategy.
Washington State Low Carbon Fuel Standard Analysis <i>Washington State Department of Environmental Quality</i>	Expected 2010	Superior, but not yet complete. This study undertakes very similar methodologies and uses very similar sets of inputs and an equivalent LCFS scenario. Pathways and assumptions differ only slightly. Study not yet completed, however.
Northeast States Low Carbon Fuel Standard Analysis <i>NESCAUM</i>	Ongoing	Significant, but not yet complete. This study undertakes very similar methodologies and uses very similar sets of inputs. Pathways may differ; they have not yet been established. This study is in its beginning stages.
Updated Macroeconomic Analysis of Climate Strategies Presented in the March 2006 Climate Action Team Report <i>California Climate Action Team – Economics Subgroup</i>	2006	Limited. As with Florida's study, this study completes a macroeconomic analysis of a bundle of 40 climate strategies, but no individual results for major LCFS components. Also uses different methods and model types from Oregon's approach.
Economic and Energy Impacts Resulting from a National Low-Carbon Fuel Standard <i>Charles River Associates</i>	2010	Very Limited. The study analyzes the impacts of a severe rationing regime imposed on gasoline and diesel, rather than the displacement of those fuels by lower-carbon-content alternatives. It specifically assumes that any new low-carbon fuel

		capacity is impossible within the next 15 years, and thus models no such expansion. The likelihood of its other assumptions are open to question on political, technological and economic grounds.
California Air Resources Board, Economic Impact Estimate of Low-Carbon Fuel Standard http://www.arb.ca.gov/fuels/lcfs/030409lcfs_isor_voll.pdf	2009	Somewhat. CARB's analysis considered a similar LCFS standard and also considered several alternate pathways to achieving that standard over a 10-year period. However, their economic analysis was limited to direct microeconomic impacts, rather than a wider macroeconomic impact showing the effect on the economy as a whole.
National Low Carbon Fuel Standard Analysis <i>University of California, Davis</i>	Ongoing	Somewhat, but not yet complete. UC Davis researchers seek to complete a macroeconomic analysis of a national LCFS scenario. The scenario design is not yet complete and the analytical methods have not yet been publicly described.

The ambition of this report is to provide a basis for the comparison of Oregon's eventual results to those reported by other research and studies assessing the macroeconomic impacts attributable to the implementation of a low-carbon fuel standard. Given that purpose, a caveat regarding the research covered in this memo is appropriate at the outset. As the table above suggests, no existing completed study provides a valuable basis for direct comparison with the eventual results of the ongoing analysis currently underway in Oregon. The Washington LCFS macroeconomic analysis uses a very similar set of methods, assumptions and data, but that study has not yet been completed. The work by NESCAUM is also expected to use a similar methodology and a comparable set of economic models, but that study is also in its early phases. The national study by the Center for Climate Strategies includes macroeconomic analyses of certain biofuels and electric-vehicles strategies, but contains no analysis of an LCFS designed with any similarity to the standard contemplated by DEQ. It also fails to address related infrastructure spending in anything like the detail considered as part of Oregon's analysis. Finally, the analysis by Charles River Associates, while purporting to address low-carbon fuel standards, is substantively an analysis of a severe federal petroleum-rationing scenario, and in fact specifically assumes no change from business as usual in the production, consumption or state of infrastructure regarding alternate fuels. It should be considered least germane of all to Oregon's LCFS analysis.

For the purpose of providing current policy context, neither of the two versions of a federal climate-change bill proposed this year contained a low-carbon fuel standard requirement. Each addressed the carbon content of transportation fuels in a much more limited fashion. Waxman-Markey, the house bill and the bill generally

considered the more aggressive of the two, contained funding for smart-growth infrastructure spending, as well as higher fuel-efficiency standards and support for more plug-in hybrid-electric vehicle usage. It also contained funding for advanced biofuels. However, it did not contain a carbon-content standard for fuels. Kerry-Lieberman was also without an LCFS, and contained less specific support for biofuels than Waxman-Markey. However, both bills sought to expand natural-gas spending.²³

Center for Climate Strategies Studies

The Center for Climate Strategies (CCS), in partnership with faculty at the University of Southern California, has completed multiple macroeconomic analyses of strategies that were close to low-carbon fuel standards. These analyses were done as part of larger studies of the impacts and efficacy of state-level climate action plans. These analyses were completed by CCS with consulting support. Professor Adam Rose and post-doctoral researcher Dan Wei at USC completed macroeconomic modeling work using the REMI-PI+ model in a consulting role to CCS. The president of CCS holds a post as a teaching fellow at Johns Hopkins University, which served as the publisher of CCS's 2010 report, "Impacts of Comprehensive Climate and Energy Policy Options on the US Economy."

1. Impacts of Comprehensive Climate and Energy Policy Options on the U.S. Economy

Center for Climate Strategies and Johns Hopkins University

This study compiles and updates the findings of 16 comprehensive state climate action plans and extrapolates the results to the nation. This approach analyzed and extrapolated the environmental and economic impacts of 23 separate strategies (six in the transportation/land use sector). The study then takes those results and using a widely accepted econometric model projects the national impact of these policies on employment, incomes, gross domestic product (GDP) and consumer energy prices. Finally, using the bottom-up data developed by the states and aggregated here, the study models the national impact of major features of the Kerry-Lieberman (K-L) bill considered in Congress in 2009 and 2010.

No one of the six transportation-related strategies was identified as a LCFS strategy by name. Two strategies did address parts of an LCFS as assessed in other studies: a renewable-fuels (biofuels) strategy and an incentives and taxation strategy ("feebates") to encourage shifting vehicle fleets to fuel-efficient and alternative-fuel vehicles.

² Legislative Summary, Energy and Commerce Committee.

http://energycommerce.house.gov/Press_111/20090724/hr2454_housesummary.pdf

³ Science Magazine, "Kerry/Lieberman 'American Power Act' Released," 05/12/10. Retrieved 10/1/2010 from <http://news.sciencemag.org/scienceinsider/2010/05/kerrylieberman-american-power-ac.html>

This study used the Regional Economic Models, Inc. (REMI) Policy Insight Plus (PI+) modeling software to be discussed below (REMI, 2009) to evaluate the macroeconomic impacts to the U.S. of implementing the 23 GHG mitigation super options across the states. The REMI model is the most widely used economic modeling software package in the U.S. and has been heavily peer reviewed. The model is used extensively to measure proposed legislative and other program and policy economic impacts across the private and public sectors by government agencies in nearly every state of the US.

The use of the REMI PI+ model involves the generation of a baseline forecast of the economy through 2020. Then simulations are run of the changes brought about through the implementation of the various GHG mitigation options. Again, this includes the direct effects in the sectors in which the options are implemented, and then the combination of multiplier (purely quantitative interactions) general equilibrium (price-quantity interactions) and macroeconomic (aggregate interactions) impacts. The differences between the baseline and the “counter-factual” simulation represent the total regional economic impacts of these policy options.

In order to perform macroeconomic impact analysis of climate action plans using REMI, information is needed on basic microeconomic considerations, such as the direct costs and direct savings of each GHG mitigation option, as well as on aspects that relate to macro linkages. The results reported in the state action plans include GHG reduction potentials, net cost/savings in Net Present Value (NPV), and cost-effectiveness (per ton cost/saving of GHG removed). The macro study needs more detailed and disaggregated information on both the costs and savings aspects. For example, program costs need to be disaggregated into capital cost, operation and maintenance (O&M) cost, and fuel cost; energy savings need to be specified in different types of energy and for specific economic sectors. In addition, all these data are needed for individual years in the study period (2010-2020).

This level of detailed information may not always be reported in the state action plans for each option. Therefore, it was necessary to obtain the calculation workbooks used to quantify the policy options, and to extract the data needed by the REMI analysis from the workbooks. Because of the time limitation of this study, the study focused its data collection for macroeconomic linkage variables on seven states (Colorado, Florida, Iowa, Michigan, North Carolina, Pennsylvania, and Washington) that were believed to be representative of national diversity, and used the weighted average costs and savings of each individual super option to get the scaled-up estimates at the national level.

Findings show potential national improvements from implementation of a top set of 23 major sector-based policies and measures drawn from state plans. If implemented U.S.-wide at all levels of government, the measures yield:

- 2.5 million net new jobs in 2020 and a \$159.6 billion (in 2007\$) expansion in GDP in 2020;

- Over \$5 billion net direct economic savings in 2020, at an average net savings of \$1.57 per ton of GHG emissions avoided or removed; and
- Consumer energy price reductions of 0.56% for gasoline and oil; 0.60% for fuel oil and coal; 2.01% for electricity; and 0.87% for natural gas by 2020.

Assuming full and appropriately scaled implementation of all 23 actions in all U.S. states, the resulting greenhouse gas (GHG) reductions would surpass national GHG targets proposed by President Obama and congressional legislation, and would reduce U.S. emissions to 27% below 1990 levels in 2020, equal to 4.46 billion metric tons of carbon dioxide equivalent (BMtCO_{2e}). Estimates were developed for two additional scenarios – one envisioning the additional application of a cap-and-trade regime and the other envisioning a less broad adoption of the 23 policies in question.

2. The Economic Impact of the Florida Energy and Climate Change Action Plan on the State's Economy

Adam Rose and Dan Wei, University of Southern California

This analysis analyzed the microeconomic and macroeconomic impacts of 28 climate change mitigation strategies selected by the Florida Action Team on Energy and Climate Change, which was itself appointed by the office of Governor Charlie Crist. Individual strategies were analyzed for greenhouse gas emissions reduction potential, as well as for microeconomic impacts such as direct costs and savings. The macroeconomic analysis assessed the strategies in concert. Analyses were conducted for the time period 2007 to 2025.

The macroeconomic analysis utilized the REMI model, customized to the state of Florida. The methodology involved running REMI analyses for each strategy individually. Once done, REMI was run modeling a scenario in which all strategies were applied simultaneously. As a result, any overlaps or synergies could be detected if the aggregate analysis produced numbers that differed from the sum of all the individual analyses. All quantified strategies in concert were estimated to produce a 0.66% increase in gross state product by the year 2025.

In the transportation sector, the most relevant greenhouse gas mitigation strategy is one focused on developing and expanding low-GHG fuels. The individual microeconomic analysis found this strategy to be a possible money-saver, representing a possible savings of approximately \$15 billion (in 2000 dollars) statewide by the year 2025. This represents a net savings of \$142 per metric ton of GHG emissions avoided over the same time period. From the macroeconomic analysis, the low-GHG fuels strategy was projected to produce a positive impact in gross state product of nearly a billion dollars by 2025, and nearly four billion dollars over the period of analysis. The model also projected that this strategy would produce over 11,000 jobs per year above the baseline by the year 2025.

The results from the application of a renewable-fuels standard in Florida were also positive – the 20% renewable electricity supply by 2020 was projected to produce 4.5 billion dollars in additional gross state product by 2025, and over 16 billion dollars over the period of analysis.

Similar Reports

Similar reports were completed by the same authors for the states of Michigan, Pennsylvania and Wisconsin. As was the case in the Florida report, the authors (Rose and Wei, sometimes with co-authors) took estimates produced from stakeholder-based processes run by the Center for Climate strategies. Those microeconomic outputs from analyses of individual strategies were converted to inputs for REMI models, and aggregate macroeconomic impacts were estimated using the REMI tool.

Despite this similarity of process, the reports produced different estimates of economic impacts from different strategies. This is due to several factors:

1. Different states' stakeholder processes established different strategies regarding low-carbon fuels or biofuels; some set targets while others proposed incentives.
2. Periods of analysis differed in terms of duration, start date and end date.
3. Different analyses established different assumptions about fuel prices, economic activity, transportation behaviors and other important factors.

In Michigan, their analysis found that a strategy encouraging low-carbon fuels would create direct costs of about \$820 million statewide, working out to about \$16 per ton of emissions avoided. No single-policy macroeconomic impact was completed. In Pennsylvania and in Wisconsin, no relevant strategy was analyzed.

3. Washington State Low Carbon Fuel Standard Analysis

Washington State Department of Environmental Quality

Washington's Department of Ecology recently commissioned a study measuring the economic impacts of a low-carbon fuel standard applied statewide.

The methodology utilized in Washington is substantially the same as will be utilized in Oregon. Washington identified six distinct scenarios, each envisioning a combination of a heavy-duty biofuels pathway and a light-duty biofuels pathway. The initial step involved developing a version of Argonne National Labs' Vision model for the state of Washington. Using this tool, TIAX LLC consultants developed an array of estimates from each of the six scenarios. These estimates included resulting fuel volumes of all fuels, energy usage, direct expenditures on

vehicles and fuels, and full fuel-cycle greenhouse gas emissions impacts. Jack Faucett Associates then developed inputs to macroeconomic models from those Vision analyses, as well as inputs for the costs related to the production, transportation, storage and fueling infrastructure needed for a changed transportation fuel mix. Finally, the Washington State, Office of Financial Management (OFM) is utilizing the REMI PI+ macroeconomic analysis model to develop a full range of macroeconomic impacts from each scenario.

Six low-carbon fuel standard scenarios were analyzed, representing six different approaches to achieving the target goal by the year 2023. They were as follows:

1. Scenario A: Expansion of cellulosic ethanol and biodiesel supply from in-state feedstocks.
2. Scenario B: Expansion of cellulosic ethanol and biodiesel supply, but from out-of-state feedstocks.
3. Scenario C: Expansion of ethanol and biodiesel from a blend of feedstocks (not all cellulosic). This approach involved incentivizing E85 vehicles in the light-duty fleet and expanding canola biodiesel production from in-state feedstocks.
4. Scenario D: Expansion of electric vehicle use and cellulosic ethanol from in-state feedstocks, as well as expanding canola biodiesel production from in-state feedstocks.
5. Scenario E: Expansion of electric vehicle use and cellulosic ethanol from out-of-state feedstocks, as well as expanding canola biodiesel production from in-state feedstocks.
6. Scenario F: A one-pool approach to a single overall target for light-duty and heavy-duty fuels. This involved maximizing in-state canola biodiesel production, consuming twice the targeted goal for ethanol set in the RFS2 standard passed as part of the EISA 2007 legislation, and applying sugarcane and corn ethanol as needed to reach the 10% reduction target.

The graphic below seeks to summarize the components of Washington’s six pathway scenarios for easy comparison:

Summary of Washington LCFS Scenarios

	Source of New Biofuels – In State or Out?	Type of New Biofuels	Any Electric or Plug-in Hybrid Strategy?	Any Alternate Low-Carbon Fuels?
Scenario A	<i>In-State</i>	<i>All Cellulosic</i>	<i>None</i>	<i>None</i>
Scenario B	<i>Out-of-State</i>	<i>All Cellulosic</i>	<i>None</i>	<i>None</i>
Scenario C	<i>Some of Each</i>	<i>Part Cellulosic</i>	<i>None</i>	<i>Canola Biodiesel, Conventional Ethanol</i>
Scenario D	<i>In-State</i>	<i>Part Cellulosic</i>	<i>EV/PHEV Infrastructure and tax credit</i>	<i>Canola Biodiesel</i>
Scenario E	<i>Out-of-State</i>	<i>Part Cellulosic</i>	<i>EV/PHEV Infrastructure and</i>	<i>Canola Biodiesel</i>

			<i>tax credit</i>	
Scenario F	<i>Some of Each</i>	<i>Part Cellulosic</i>	<i>None</i>	<i>Canola Biodiesel, sugarcane and corn ethanol</i>

The Washington state analysis is still ongoing, so results have not yet been finalized or reported.

4. NESCAUM Low-Carbon Fuel Standard Macroeconomic Analysis (ongoing)

NESCAUM (Northeast States for Coordinated Air Use Management) is in the process of completing a macroeconomic analysis for its region. Its methodology is almost exactly that being used in Washington and in Oregon. They are beginning with emissions factor development specific to the region using the GREET model. Those emissions factors are then applied to a customized VISION model built to represent the region. Fuel, vehicle, energy and direct-cost outputs are developed through analyses in Vision. Those outputs are then converted to inputs suitable for REMI analysis, and REMI analysis will be completed as the final step.

5. Updated Macroeconomic Analysis of Climate Strategies Presented in the March 2006 Climate Action Team Report

California Climate Action Team – Economics Subgroup

This report is included for completeness, but is less germane in that it does not develop a macroeconomic impact for a low-carbon fuel standard. Instead, it estimates macroeconomic impacts for a combined bundle of forty strategies proposed to California’s Climate Action Team. The forty strategies ranged across sectors and were not limited to the transportation sector, but did include higher biodiesel and ethanol blend requirements.

The strategies were not assessed for macroeconomic impacts on an individual basis. The bundle of strategies was assessed as a whole. The process involved the use of two distinct macroeconomic models, the Environmental Dynamic Revenue Analysis Model (E-DRAM) from CARB and the Berkeley Energy and Resources model (BEAR), provided by UC Berkeley. Both are Computable General Equilibrium models. Each model was run independently, and the results were compared. The E-DRAM model showed slight improvements over baseline projections for gross state output, personal income and employment (less than 1% for all three indicators), and the BEAR model showed very slight reductions in gross state output and personal income (-0.1 and -0.6% respectively), but slightly positive changes in employment (0.2%).

6. Economic and Energy Impacts Resulting from a National Low-Carbon Fuel Standard

Charles River Associates

This study was completed in June 2010, and considered a scenario in which the United States would adopt a low-carbon fuel standard akin to California's over the period 2015 to 2025.

California's low-carbon fuel standard mandates a gradual reduction in the carbon intensity of gasoline and diesel (and any substitutes for gas and diesel) over a 10-year period from 2011 to 2020. Fuels must be 0.5% less carbon-intense in 2011 than they are in 2010, and progressively less carbon intense until they achieve a 10% reduction from 2010 measurements in the year 2020.

This report uses as its scenario the same 10-year gradual reduction in carbon intensity of transportation fuels, with three important differences:

1. The period of analysis is 2015 to 2025, rather than 2010 to 2020
2. The low-carbon requirement appears to be applied to all transportation fuels, rather than just gasoline and diesel
3. The scenario is nation-wide, rather than simply applied to California.

The import of these differences is primarily that the supply of alternative fuels becomes an issue. While a single state (even a large state) consumes only a few percent of the national demand for transportation fuels, and can source feedstocks for alternative fuels from around the country, a nation-wide low-carbon mandate faces the prospect of an insufficient supply of alternate fuels to achieve the carbon-intensity reduction required.

The report takes as a given that the US does not, and will not, have sufficient biofuels to add to the fuel supply in order to reach 10% reductions in fuel carbon-intensity by 2025. They also assume that the 15-year horizon is too short for any new fuel infrastructure to be constructed, or for any new technologies to be made operational. The authors assume that the federal government, in order to meet the standard despite this shortfall, will simply ration gasoline and diesel in order to achieve the necessary mix of fuels.

The authors assume this rationing will drive significant gas price rises – 30 to 80% within 5 years and 90 to 170% by 2025. Because gas is rationed, light and heavy duty VMT, including freight movement, is also assumed to be constrained, by between 9 and 14% below the baseline. Overall macroeconomic impacts are predicted to be dire: GDP would fall by 2 to 3%, employment would fall by between 2.3 and 4.5 million jobs.

The methodology of CRA's economic analysis is not laid out in great detail. They utilize a pair of proprietary modeling and analysis tools, a Multi-Region National model and a National Electricity and Environment Model (referred to as MRN-NEEM when used in concert). Baseline energy-use and fuel price assumptions are taken from the Energy Information Administration.

The assumptions underlying this analysis merit some question. The assumption that the federal government would impose restrictive measures to comply with an LCFS mandate is at variance with recent real-world experience. The federal government already has a policy similar to a national LCFS in the form of the renewable-fuels mandate (RFS2) included as part of the EISA legislation in 2007. Like an LCFS, RFS2 sets an aggressive target: it requires that progressively more biofuels be mixed with standard fuels, reaching 36 billion gallons by 2022. Also like an LCFS, this target is considered to be unattainable. The Department of Energy's EIA fuel-use projections currently expect the US fuel supply will achieve only about half the RFS2 standard. Despite this mandate and the perceived shortfall in supply, no federal action as of now has occurred that would force compliance with RFS2. It is unlikely that an LCFS would receive different treatment, let alone so extreme a treatment as restraints on the supply of conventional fuels.

In addition, biodiesel and ethanol are primarily consumed as components of gasoline blends, rather than as substitutes for gasoline. Because those blends are capped at low fixed ratios, restraining gasoline and diesel consumption would restrain biofuels consumption as well, and would be a self-defeating approach to achieving a low-carbon fuel standard.

The assumption that no new infrastructure or technology progress could be made within 15 years is also open to question. In the analysis of economic impacts from a LCFS in Washington State, this team found that advanced ethanol refining facilities require only a two-year period for construction (though site selection and permitting could add more years to the timeframe). Pipeline construction, even if delayed by debates over site selection and rights of way, requires less than 15 years for completion.

While the assumptions behind the results of this analysis are debatable, the same often holds true for other reports. Just as this report assumes no possibility of new infrastructure or technologies between now and 2025, other reports often assume that new fuels or vehicle technologies will be freely available, and that costs will be low. The assumptions underlying each analysis often define the character of the results projected.

7. California Air Resources Board, Economic Impact Estimate of Low-Carbon Fuel Standard

http://www.arb.ca.gov/fuels/lcfs/030409lcfs_isor_vol1.pdf

As part of the proposal for a low-carbon fuel standard for the state of California, the state's Air Resources Board estimated the economic impacts associated with the implementation of such a standard. The LCFS in California seeks to achieve a 10% reduction in the carbon intensity of fuels consumed by the transportation sector over a ten-year period, much like the LCFS under review in both Washington and Oregon.

As with Washington and Oregon, this analysis considered several pathways through which the state could achieve the LCFS target. They involved different levels of reliance on different alternatives to gasoline and diesel. The table below summarizes the pathways:

Summary of CARB LCFS Scenarios

	Source of New Biofuels – In State or Out?	Type of New Biofuels	Any Electric or Plug-in Hybrid Strategy?	Any Alternate Low-Carbon Fuels?
Gasoline Scenario 1	<i>Not Stated</i>	<i>Corn Ethanol Gradually Replaced by Cellulosic</i>		
Gasoline Scenario 2	<i>Not Stated</i>	<i>Corn Ethanol Quickly Replaced by Cellulosic</i>		
Gasoline Scenario 3	<i>Not Stated</i>	<i>Corn Ethanol Quickly Replaced by Cellulosic</i>	<i>PHEVs, BEVs, FCVs at 2X business as usual; displaces some ethanol</i>	
Gasoline Scenario 4	<i>Not Stated</i>	<i>Corn Ethanol Quickly Replaced by Cellulosic</i>	<i>PHEVs, BEVs, FCVs at 4X business as usual; displaces much ethanol</i>	
Diesel Scenario 1	<i>Not Stated</i>	<i>Conventional Biodiesel</i>		
Diesel Scenario 2	<i>Not Stated</i>	<i>Conventional and Advanced Biodiesel</i>		<i>Increased Compressed Natural Gas</i>
Diesel Scenario 3	<i>Not Stated</i>	<i>Conventional and Advanced Biodiesel</i>	<i>PHEV vehicles to displace diesel</i>	<i>Increased Compressed Natural Gas</i>

The CARB assessment found that an LCFS would produce a net savings in total fuel expenditure of \$11 billion over the duration of the 10-year period. The analysis found this to be equivalent to less than \$0.08 per gallon of fuel consumed, or below three percent of the current fuel cost. State and local sales tax revenues were expected to fall as a result. By 2020, those revenues are projected to fall between

\$78 million and \$421 million below the business-as-usual scenario. Projections for job impacts are neutral to slightly positive.

In this analysis, CARB made an important assumption, deciding that much of the infrastructure needed for a rapid growth in low-carbon fuels could be expected to be built up as part of the federal biofuels mandate known as RFS2. As a result, they assumed no expenses for infrastructure for ethanol (a major component of the LCFS) in their economic analysis.

The CARB staff did not utilize any macroeconomic model as part of this analysis. They instead created a fairly detailed estimate of direct fuel costs and savings, as well as direct compliance costs (in the form of capital costs for new infrastructure). The wider impacts to various sectors of the economy were not estimated. As a result, this analysis should be considered a microeconomic analysis. The analysis also did not consider all alternate pathways in full detail, and did not produce different impacts from different investments in advanced vehicles or advanced fuels.

McKinsey and Company Low-Carbon Economic Analysis Tool

McKinsey and Company have developed their own proprietary analytical approach to macroeconomic scenario analysis, consisting of five distinct proprietary data sets and analytical tools. The overall result, however, is a distinct set of inputs to apply to the REMI model. REMI is then utilized to produce macroeconomic impact estimates. McKinsey's fills the same role as the first phase of the process used for both Oregon and Washington, in which extensive work is done to develop customized projections of the microeconomic impacts of various low-carbon fuel pathways. As is done with the results of McKinsey's proprietary approach, those projections are then expressed as inputs to the REMI model, which estimates larger macroeconomic impacts. McKinsey has not made its methodology public, and as such their approach is unavailable for a more detailed analysis.

University of California, Davis: National Low Carbon Fuel Standard Analysis Lead Researchers: Daniel Sperling, Professor (ITS - Davis), Sonia Yeh, Research scientist (ITS - Davis), James Rhodes, Researcher (UC San Diego)

This project is a collaborative effort between several academic institutions and national research organizations to assess a national LCFS. We have requested additional information on the macroeconomic analysis planned and status from the study team. The study web site describes the project as follows.

This study has two objectives: 1) design an effective and implementable national LCFS; and 2) compare an LCFS with other policy instruments that have the potential to significantly reduce transportation GHG emissions from fuel use.

The study will propose a design of a robust national LCFS policy that balances environmental, political, and economic goals and is readily implementable and enforceable (in terms of data availability, simplicity, etc). The study will consider regional differences in resource availability, compliance costs, economic opportunities and policy impacts, and the sustainability safeguards needed to ensure an effective environmental performance of fuel policies. We will recommend a design of policy instruments for implementing a national LCFS based on the lessons learned from our study. We will examine the potential for innovation of low carbon fuels that will be encouraged by an LCFS policy and in particular the type of feedstocks and technologies that will be used and their implications for regional land use, infrastructure needs, food and fuel prices, and other environmental impacts in the U.S.

This project is ongoing and some of the research is evolving and may change before the final reports are prepared. At the present time, it does not appear that a separate macro-economic analysis will be conducted within this study.⁴

Resources

1. Sperling, Daniel, and Sonia Yeh. 2010. Toward a global low carbon fuel standard. *Transport Policy* 17, 47-49.
2. Yeh, Sonia and Daniel Sperling. 2009. Role of Low Carbon Fuel Standard in Reducing (US) Transportation Emissions. 2009 Asilomar Transportation Conference Proceedings.
3. Yeh, Sonia and Daniel Sperling. 2009. Reducing the Demand of High Carbon Fuels Through Low Carbon Fuel Standards: Challenges and Opportunities. *Energy Policy*. Invited for the special issue on Modeling Energy Demand in Transport. Submitted

⁴ See the department website dedicated to this analysis at http://steps.ucdavis.edu/research/Thread_6/lcfs/national-lcfs for further information.