# Scenarios Modeling Macroeconomic Impacts of a California-Style Low-Carbon Fuel Standard in Oregon

**Extended Abstract #26**

**Scott T. Williamson and Michael F. Lawrence**
Jack Faucett Associates, Inc., 4550 Montgomery Avenue, Suite 300N, Bethesda, MD 20814

## INTRODUCTION

Low-carbon fuel standard (LCFS) policies have been described as economically efficient by proponents and economically disastrous by skeptics. Supporters point out the flexibility of the policy, which simply sets a target for the carbon intensity of the overall fuel mix and allows the affected parties to identify the most practical and cost-effective route to compliance, as a form of allowing the market to select the most efficient approach to the task of reducing emissions. Opponents fear that supplies of clean fuels will struggle to meet this mandated demand, forcing fuel prices dramatically higher. Under this scenario, the policy would constrain the transportation sector and apply the brakes to economic activity in general. The research also lacks consensus: existing studies on the effectiveness and economic impacts of LCFS policies vary in their projections, relying on divergent assumptions and using different analytical methods and tools.

This paper presents the results of macroeconomic analyses of multiple scenarios seeking to model possible responses to a low-carbon fuel standard (LCFS) policy in the state of Oregon, completed at the request of the Oregon Department of Environmental Quality.[1] While not all LCFS policies are equal, they are generally characterized by a focus on the intensity of emissions from fuel consumed, rather than on the exact type of fuel consumed. Unlike mandates to displace gasoline with ethanol or electricity, or to displace diesel with biodiesel, an LCFS strategy simply establishes an overall emissions standard for the fuel supply. California is the only state to have an active LCFS policy and target (a ten-percent cleaner fuel mix over ten years), and this policy was designed to duplicate that target for Oregon.

This approach seeks to create flexibility, allowing regulated parties to identify the most cost-effective path to compliance. There are many different fuels available to the transportation sector, including natural gas, electricity, and a wide variety of biofuels feed stocks, each with its own cost and its own greenhouse gas emissions intensity. This variety produces many different options for achievement of a lower-carbon fuel mix.

The estimation of economic impacts of a public policy often focuses on three types of impacts. Direct economic impacts refer to the changes in behavior and costs that result from actions to comply with the policy. For example, the development of distilling resources to produce fuel ethanol would be a direct impact. Indirect economic impacts are defined as the behavior and costs that result in the economy to facilitate the direct impacts. An example of indirect impacts is the economic impact resulting from the likely changes in spending on labor and fertilizer which are needed to produce new fuel types. Finally, induced economic impacts are the behavior and expenditures by households given the changes in income earned as a result of both direct and indirect activities. Induced impacts may occur across the entire economy.

The proposed Oregon LCFS is distinct in its economic impact from typical environmental regulation, because it seeks to encourage a shift from the consumption of imported fuels to the consumption of fuels produced not only in the US but within the state. This shift would produce a stimulus as capital investment and producer surplus enter the state's economy. This stimulus results from a reduction in petroleum imports and an increase in domestic investment to provide feedstock, production facilities and delivery infrastructure for the replacement fuels (such as ethanol, biodiesel, natural gas or electricity). In this study, all alternative fuel supply investment within Oregon is deemed to come from outside the state as there is now no significant transportation fuel production industry in Oregon. This influx of investment in production facilities and infrastructure in Oregon creates employment, income and gross state product at levels greater than would exist without this stimulation.

## LITERATURE DISCUSSION

In the past decade, several entities have analyzed the potential impacts of an LCFS or other similar policies. A range of statistical, mathematical, and econometric methods are used to quantify economic impacts resulting from expected changes to the economy.

Many studies addressing low-carbon fuel standards correctly identify the significant capital and durable-goods costs associated with developing a significant new supply of biofuels and the vehicle fleet needed to consume that supply.[2,3,5] Others take as an assumption that producing sufficient supply to achieve an LCFS may be impractical, hurting the economy through high prices and low supply.[2] The research here, by contrast, reports very positive economic impacts. This may appear to be in direct disagreement with other studies, but in fact it is not.

First, this study of an LCFS in Oregon is a study of a statewide rule, rather than a national rule, for a state representing only about 1% of the national on-road travel volume. As such, supply concerns and price impacts raised in other studies are less salient. A similar study in the State of Washington, which contains about 2% of national on-road travel volume, approached supply concerns similarly.[4]

Second, this study considers the use of electricity and natural gas, which offer significant cost savings and efficiency improvements per mile traveled when compared to conventional fuels and biofuels.[5] It also relies on advanced low-carbon biofuels rather than conventional biofuels. Many other studies limit themselves to conventional biofuels which offer little carbon-intensity reduction, thus requiring huge amounts of supply to hit the LCFS target. By focusing on cellulosic fuels, electricity and natural gas, this study produces scenarios very different from those likely to occur when assuming reliance on corn ethanol.

Third, this study models the effect of significant new investment coming from outside the state in order to develop a new in-state industry. This new influx of capital, rather than the change in fuels, is the main driver of economic gains – though changes in fuel type do create positive gains. As such, this policy serves as the rare combination of an environmental regulation and an economic-development initiative. In a national study, it would be less reasonable to assume inflows of outside capital.

# MACROECONOMIC ANALYSIS PROCESS

## Scenario Development

The Oregon Department of Environmental Quality (DEQ), working with the low carbon fuel advisory committee and TIAX LLC, developed a set of compliance scenarios that are believed to bracket the range of potential fuel supply options. Additional scenarios were developed to test the importance of fuel prices, the importance of in-state production, and the consideration of indirect land-use change. All of the selected scenarios achieve the LCFS goal. Scenario analyses were conducted for changes to light- and heavy-duty fleets, both separately and in a single fuel pool. The scenarios analyzed were as follows:[1]

Scenario A – Cellulosic ethanol and biodiesel, with Indirect Land Use Change
Scenario B – A mix of cellulosic and corn ethanol and conventional biodiesel, with Indirect Land Use Change
Scenario C – A mix of cellulosic and corn ethanol and conventional biodiesel, without Indirect Land Use Change
Scenario D – Electricity and cellulosic ethanol for light vehicles and CNG and cellulosic biodiesel for heavy vehicles, with Indirect Land Use Change
Scenario E – One pool of multiple fuel sources, allowing heavy vehicles to achieve most compliance
Scenario F – Same as Scenario C, but assuming higher oil prices
Scenario G – Same as Scenario C, but assuming lower oil prices
Scenario H – Cellulosic ethanol and biodiesel, all from out-of-state sources, with Indirect Land Use Change

## Development of Microeconomic Impacts as Inputs to Macroeconomic (Economy-Wide) Impact Analysis

The VISION Model, developed by Argonne National Laboratories, is a spreadsheet-based tool that seeks to measure energy and greenhouse gas emissions from the entire US on-road vehicle fleet. It relies on perpetual inventories of 22 classes of light-duty vehicles and six classes of heavy-duty vehicles. The tool allows extensive customization of the assumptions underlying the types of fuel used, the types of vehicles entering the market, the carbon intensities of each type of fuel, and the extent to which various fuels are blended together.[6]

The standard tool was extensively modified to reflect Oregon, rather than the entire US, before any analyses were completed. The vehicle fleet was adjusted in both size and composition to reflect state rather than national data. Fuel price data and projections were adjusted to reflect projections for the Pacific region, rather than national average projections.

For each scenario, analysts developed a detailed picture of the exact sources from which various fuel supplies would be obtained. The model was expanded to reflect this detailed picture of the scenario's fuel supply, and the carbon intensities used were adjusted to reflect the scenario's unique mix as well.

Key assumptions in the VISION analyses (beyond those related to developing the LCFS scenarios) are as follows:[1]

- Fleet composition
- Fuel efficiency.
- Fuel and Vehicle prices
- Carbon intensity
- Vehicle duration and scrappage

To provide custom inputs, analysts (with input from the Low Carbon Fuel Standards Advisory Committee) developed estimates for a number of direct expenditures expected as part of each scenario. These inputs included the following for each scenario (where appropriate):[1]

- retail fuel-spending changes (using US Department of Energy, Argonne National Laboratories and DEQ price forecasts)
- new vehicle purchase cost changes (electrics assumed over 60% more expensive; plug-in hybrids 40% more expensive)
- importation, permitting and installation of charging stations for electric and plug-in hybrid vehicles ($1000-$2000 per station)
- capital, labor and infrastructure costs for expanding natural-gas consumption
- capital, labor, permitting, feedstock and operating costs for new ethanol and/or biodiesel plants in the state of Oregon
- transportation and storage costs, as well as capital and labor for fueling stations, for additional ethanol, regardless of presence or absence of new refining capacity.

## Macroeconomic Impact Modeling and Results

The macroeconomic analysis was accomplished with the use of the REMI PI+ model. First, the business as usual (BAU) case was run for Oregon using the REMI default case. Then, a model run was conducted for each scenario (A through H as described above) and the results were compared to the baseline BAU. The analysis focused on the change in employment, personal income and gross state product, but comparisons are available for each economic sector characterized in the 70 sector REMI as well as all categories of final demand.[*]

In every scenario, the overall Gross State Product changes are positive, indicating that the scenarios drive growth in economic activity in the state.

[*] Final demand is the total demand for final goods and services in the economy.

Results for six of the eight scenarios (those which rely principally on in-state biofuels produced by newly-developed in-state crops and infrastructure) produce a very similar projection. These scenarios all produce minor changes to GSP for the first five years of policy implementation (2013 to 2017), followed by rapid rises in the GSP impact in 2018 and continuing through 2021. This sudden increase in impact corresponds to the beginning of construction of plants for the refining of biofuels. This construction, timed to account for design, permitting and site selection, represents a significant infusion of money into the state's economy.

Scenario D, which is distinct in that it envisions an approach more focused on electricity and natural gas than on biofuels, produces a larger and different GSP impact pattern. Unlike other scenarios, significant GSP impacts begin immediately, due to the expected early investment in electrical charging stations. Some in-state biofuels refining remains part of the scenario, and so the GSP impact of Scenario D spikes upward just as in the other scenarios. Further, significant savings to consumers are recognized as fuel costs per mile drop, due to low per-mile prices of natural gas and electricity. This produces economic gains throughout the economy as retail spending and savings both grow.

At the other extreme is Scenario H, which envisions reliance on biofuels provided entirely from out-of-state agriculture and out-of-state refining. Scenario H produces the lowest impact on GSP. With little investment change in the state, and little change in overall fuel spending, this scenario produces very small changes from the business-as-usual projection.

The scenarios reflect a correlation between the intensity of investment, which tracks with the timing of refinery construction, and increases in employment. Plants, once built, directly employ relatively small numbers of people (below 100 per plant). During the construction phase, by contrast, the spending involved works through the economy to create employment for thousands of people. Scenarios D and H stand out in their employment projections in much the way they do in the GSP projections. In Scenario D, the investment in natural-gas fueling capacity and EV charger station installation drives higher levels of employment. This scenario results in approximately 2,000 additional jobs every year throughout the ten-year period caused by electrical infrastructure investment. Scenario H, which assumes no construction in the state, produces no significant impact on employment.

## CONCLUSION

This study models a statewide LCFS assuming (in most scenarios) significant new investment coming from outside the state in order to develop a new in-state industry. This new influx of capital, rather than the change in fuels, is the main driver of economic gains – though changes in fuel type do consistently create positive gains. As such, this policy serves as the rare combination of an environmental regulation and an economic-development initiative. In a scenario producing little influx of capital, the positive benefits would be much smaller, but this study indicates those impacts would not be negative. The potential for long-term economic benefits from a mature industry providing a range of domestic alternative fuels to displace imported petroleum is not fully explored by this analysis, which ends just as the construction of infrastructure is to be completed.

## KEYWORDS

Oregon, Low Carbon Fuel Standard, LCFS, Economic Impact, Alternative Fuels, Ethanol, Biodiesel, Biofuels, Natural Gas, Electricity, Capital Investment

## Acknowledgments

The authors wish to thank the staff of the Oregon Department of Environmental Quality, and Cory-Ann Wind and Sue Langston in particular, for their excellent support and feedback throughout this research effort. Macroeconomic modeling was completed by Alec Miller of REMI Northwest and initial scenario development work was supported extensively by Jennifer Pont and Jeff Rosenfeld, among others, of TIAX LLC.

## REFERENCES

1. Oregon Department of Environmental Quality Low Carbon Fuel Advisory Committee, reports and documentation of process available at http://www.deq.state.or.us/aq/committees/advcomLowCarbonFuel.htm

2. Economic and Energy Impacts Resulting from a National Low-Carbon Fuel Standard, *Charles River Associates*

3. National Low Carbon Fuel Standard Analysis, *University of California, Davis*

4. Washington State Low Carbon Fuel Standard Analysis, *Washington Department of Environmental Quality*

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

6. US Department of Energy, Energy Information Administration, *Annual Energy Outlook 2010*

7. The VISION model and supporting guidance is available at http://www.transportation.anl.gov/modeling_simulation/VISION/