Uncertainty for California's Low Carbon Fuel Standard:
The Ethanol Tariff, Tax Credits, and Cellulosic Ethanol Industry

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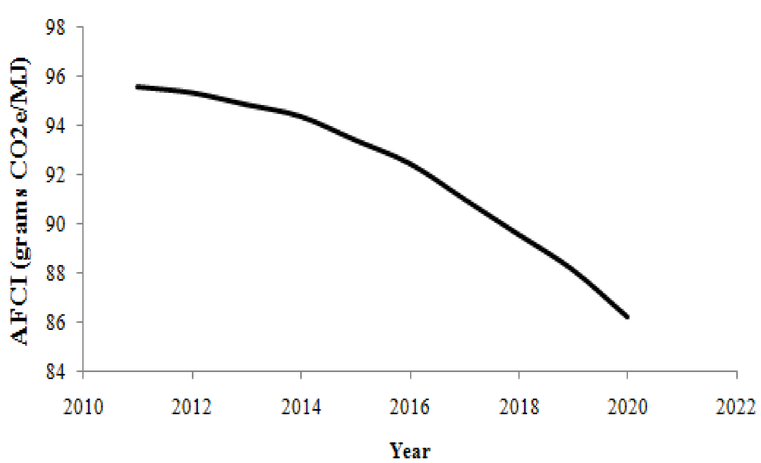
Abstract

A multi-period optimization model is used to analyze how changes in the U.S. ethanol market may affect California's low carbon fuel standard (LCFS). The six market conditions analyzed include: 1) a reference scenario in which the development of the lignocellulosic ethanol industry proceeds according to the Environmental Protection Agency's current industry forecast and the ethanol tariff and federal ethanol tax credits maintain current levels, 2) a five-year delay in the development of the lignocellulosic ethanol industry, 3) accelerated growth of the lignocellulosic ethanol industry, 4) removal of the $0.54/gallon ethanol import tariff, 5) removal of the three federal ethanol tax credits, and 6) removal of both the tariff and tax credits. The most dramatic change in California's compliance pathway occurs with changes in the development of the cellulosic ethanol industry. If the industry is delayed an additional five years, Brazilian ethanol accounts for 25% of all transportation energy in the state by 2020. If the industry development accelerates faster than EPA predictions, lignocellulosic ethanol becomes the main low-carbon fuel by 2013, replacing all Brazilian ethanol. Removal of the ethanol tariff results in very little change from the reference case before 2020. Removal of the tax credits or removal of the tax credits and ethanol tariff result in no Brazilian ethanol before 2019.

Background

California's LCFS reduces the embedded carbon in the state's transportation fuels by regulating each fuel provider's average carbon intensity (measured in grams of CO2e per MJ). Each fuel has an associated carbon intensity (see below table) which, when averaged, must meet the slowly declining regulatory cap each year (see figure below).

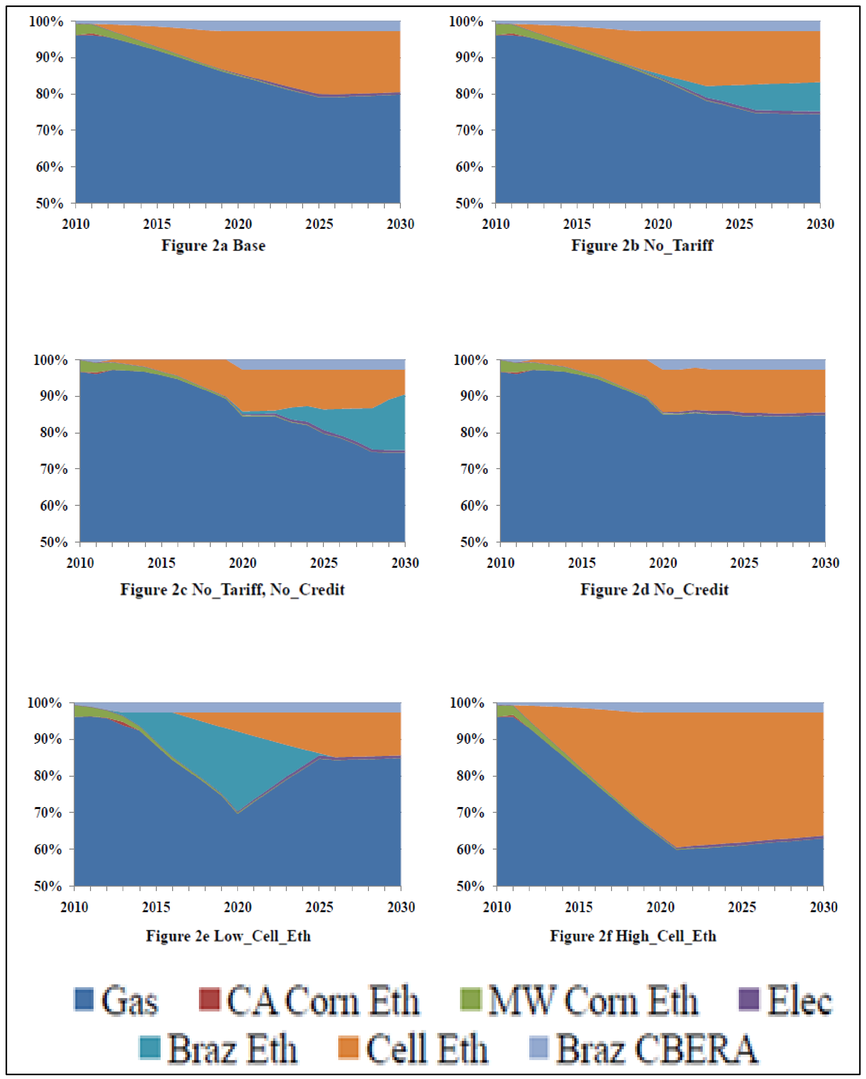
Fuel	Carbon Intensities (gramsCO2e/MJ)
Gasoline	95.86
Ethanol: California; Dry Mill; Wet DGS; 80% NG; 20% Biomass	77.4
Ethanol: Midwest average; 80% Dry Mill; 20% Wet Mill; Dry DGS	99.4
Ethanol: from Sugarcane	73.4
Natural Gas: California produced, transported via pipeline; compressed in California	67.7
Electricity	41.37



Scenarios

Scenario Name	Description
Reference	Lignocellulosic ethanol becomes available in the California fuels market in 2012 and is allowed to increase up to 5 billion gallons per year (BGY) by 2030. The U.S. import tariff and federal ethanol tax credit are maintained at current levels. Electric vehicle adoption occurs at a medium rate as defined by CARB.
No_Tariff	Reference scenario with U.S. import tariff removed.
No_Credit	Reference scenario with U.S. ethanol all federal tax credits removed.
No_Tariff, No_Credit	Reference scenario with U.S. import tariff and all federal tax credits removed.
Low_Cell_Eth	Reference scenario but the development of lignocellulosic ethanol industry is delayed five years to 2017.
High_Cell_Eth	Reference scenario but rapid expansion of lignocellulosic ethanol industry to 9 BGY by 2020.

Results



Scenario Name	Year	Discounted Annual Cost ($ billion)	Cumulative Discounted Cost 2010-2030 ($ billion)	Required FFV (1,000s)
Reference	2010	32.6	713.9	63.8
	2015	37.6		141.4
	2020	35.2		4,214.5
	2030	31.0		6,189.4
No_Tariff	2010	32.6	710.6	63.8
	2015	37.7		141.4
	2020	35.3		4,451.5
	2030	29.8		11,564.7
No_Tariff & No_Credit	2010	32.9	752.0	53.2
	2015	37.9		73.6
	2020	36.7		4,370.7
	2030	33.7		9,539.1
No_Credit	2010	32.7	753.7	63.8
	2015	38.8		322.7
	2020	36.8		10,451.2
	2030	33.8		11,519.9
Low_Cell_Eth	2010	31.2	730.0	63.8
	2015	38.8		204.8
	2020	36.9		8,601.7
	2030	31.8		4,590.3
High_Cell_Eth	2010	35.1	679.1	63.8
	2015	37.9		322.7
	2020	30.2		10,451.2
	2030	28.3		11,519.9

Conclusions

Results suggest the development of the lignocellulosic ethanol industry is a critical component to the success of the LCFS. Even a five-year delay in this emerging industry requires large volumes of Brazilian ethanol to balance the high carbon content of gasoline. The import tariff and ethanol tax credits also affect California's future fuel mix but to a lesser extent and mostly after 2020. Midwest corn ethanol inevitably decreases almost to zero in all six scenarios. Lastly, if corn ethanol producers adopt production practices that demonstrate a lower carbon intensity than the 99.4 g/MJ assumed here, they could be a large part of California's energy future.

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