Bioenergy Prospects in Mexico: Biorefineries at the West Region

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Overview

About 90% of Mexican energy consumption comes from fossil fuels, including both the electricity and transportation sectors (SENER, 2014). This helps make the country the 14th largest Greenhouse Gas (GHG) emitter in the world, contributing with about 1.5% of the global GHG emissions. The country's environmental goals, in accordance with the Intended Nationally Determined Contribution, require that 35% domestic energy should come from renewable sources by 2024 and a 22% GHG reduction by 2030 respect to a business-as-usual scenario. Meeting those goal is likely to require a domestic bioenergy industry, which will be highly interconnected to the agroindustry sector.

Besides the unsuccessful attempts to introduce bioethanol into the market, there are few or none attempts to do it with other biofuel products like biojet fuel, biogas and biodiesel (Urías Urías, R., Meza Ramos, E. Mendoza Guerrero, 2014). Anecdotal evidence suggests potential producers are unwilling to bear the fixed costs of setting up production systems because they doubt policies will endure, mainly when facing unfavorable market conditions like current low oil prices. The Mexican agricultural sector, however, has a high biomass and byproducts potential that could be converted to bioenergy. Some of them may have an impact on the land use, like sugarcane, which has reported surplus in several recent years, but no industrial-scale fermentation or distillation facilities to turn it into biofuels. But most of the bioenergy sources have a small impact on land use and will not compete with any food crop. These include, for instance, castor-oil plant, residues from corn, sorghum and agave, byproducts from sugar, tequila and mezcal production, landfill sites, manure from the livestock among others.

The tequila industry is especially strong in the West México region, which comprises 304 municipalities allocated in four states. Out of those municipalities, 170 counts with Designation of Origin Tequila (DOT); thus, according to the Tequila's Regulatory Council (CRT, in Spanish), a great amount of agave production (close to 1 million tons in 2016) are dedicated mainly for tequila production in this region, which is either consumed domestically or exported to about 100 countries around the world (CRT, 2017). Several authors have pointed out the potential of agave residues (such as leaves and roots) and tequila byproducts (such as vinasses and bagasse) as biomass to produce biofuels (see for example Pérez-Pimienta, López-Ortega, & Sanchez, 2017).

It is thus paramount that whatever policies the country implements to promote bioenergy be seen as sustainable. This paper is aimed to develop a framework to analize policy impacts on land use, environment, and agricultural markets about a decade ahead so that the probability a consolidated biofuel industry can be assessed. Especially, the possibility of developing biorefineries in México's West Region based on the agave and tequila production can be evaluated.

Methods

Technically, this work develops an endogenous-price mathematical programming model[1] emphasizing the Mexican agricultural and energy sectors, which are embedded in a multi-region, multi-product, spatial partial equilibrium model of the world economy. There is a module for the United States (Mexico's main trade partner) and another for Rest of the World. Mexico is disaggregated in two different ways: The Western region is disaggregated in 304 municipalities, for which we know how much agave land there is and how many tequila producers there are, while the rest of the country is disaggregated into agricultural districts. Production functions are specified for main crops and pasture including sugarcane, and agave. For the agave specifically, all biofuels (biogas, ethanol, biodiesel and biojet) can be produced from dedicated crops, landfill sites, and from agro-industrial residues (such as agave residues, as mentioned at the previous section). Electricity, gas, oil, diesel, and gasoline production are also modeled in detail.

[1] Similar models have been developed for other regions (e.g. Nuñez, Önal, and Khanna 2013; Chen et al. 2010; Adams et al. 2005; Fabiosa et al. 2010 etc.), but none has considered the internal sectors within Mexico linked to the international sector.

As usual, the model assumes all markets are competitive (an assumption which may be relaxed in various ways in future work) so that the economy maximizes the sum of producer and consumer surplus subject to resource limitations, material balance, technical constraints, foreign offer surfaces and policy restrictions. Consumers' surplus is derived from consumption of agricultural commodities and energy (electricity and transportation). The model is calibrated to 2008 market conditions. GHG emissions are calculated based on CO_2 emissions factors for each crop, fuel or other products specified.

Results

This work considers three policy alternatives as well as a base case in which, as now, most of the energy sources are derived from fossil sources. The first alternative consists of subsidies to bioenergy producers, the second of blending mandates and the third of both combined. Under all three cases two alternatives are considered, 1) no biofuel imports are allowed – such as the Mexican legislation requires – and 2) biofuel free trade.

Projecting market conditions to 2025, model preliminary results show losses for fuel and agricultural consumers, offset by biofuel producer gains. Results show that maximum production would be about 2 billion litters when a 15% blending mandate is in place and producers receive a subsidy equivalent to half of the gasoline price. Under the same policy scenario, sugarcane producers will be able to provide more ethanol than that from agave. The biofuel production from both groups is expected since they are getting the subsidy and making a significant increase in their economic surplus. Specifically, the agave/tequila industry would be accountable for almost 1 billion of the biofuel production, which will be produced exclusively at the West Region. The reduction of GHG emissions results in a small social welfare gain for Mexico.

Conclusions

From this research can be concluded preliminary that biofuel potential in Mexico is low and some compensating redistribution may be needed if policies to develop a domestic market are to be seen as politically sustainable. On the other hand, developing some few biorefineries in the west region may be feasible due to the biomass potential.

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