

Biofuel Supply in the Western United States

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Abstract

The Western U.S. is well positioned to contribute to the nation's bioenergy future. This research examines the West's energy supply potential, the barriers to achieving the full potential, and the policy measures and incentives to enable the transformation to use the supply. The goal of this research is to help the Western governors identify their options for promoting biofuels in their states: feedstock and biofuel development and production.

The analysis investigates the biofuel conversion technologies that are currently available as well as technologies that are currently under development. The latter technologies are those that are far enough along the development path to potentially be available on a commercial basis in the relatively near term.

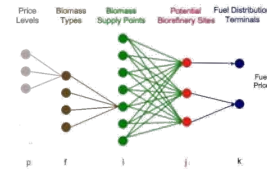
Geographic Information System modeling was used in conjunction with an infrastructure system cost optimization model to develop biofuel supply curves using biomass feedstocks throughout the Western U.S. Feedstocks considered include agricultural crop residues, beef tallow and yellow grease, forest biomass resources, herbaceous energy crops, orchard and vineyard trimmings, municipal solid waste biomass, and grain and oilseeds. The model estimates gallons of gasoline equivalent of biofuels per year that could be produced at varying prices using technologies and feedstocks that are anticipated available by 2015.

Spatial Supply Optimization Model

The resource assessment and conversion cost models are combined with a geographic transportation cost model in an integrated supply chain optimization model. This model analyzes the supply chain in order to maximize the profitability of producing biofuels at given market prices. In doing so, it chooses:

- Location of the biorefineries
- Conversion technology and size of each biorefinery
- Allocation of resources to biorefineries

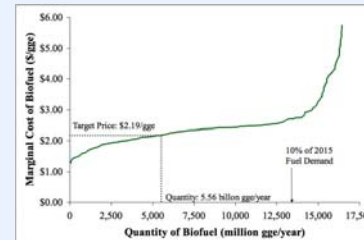
Model Diagram



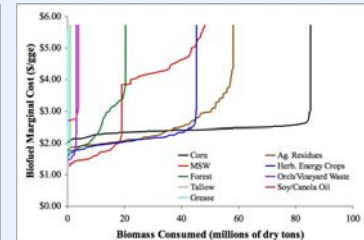
The choice set and costs are defined through a Geographic Information System (GIS) model. The potential sites for biorefineries were chosen using logical criteria including access to transportation infrastructure, access to labor, and distance between potential sites. The transportation cost were calculated over existing road, rail and marine transportation networks.

Supply Curves for Biofuels in the WGA Region

Biofuel Supply



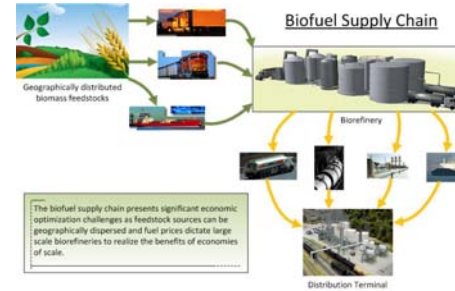
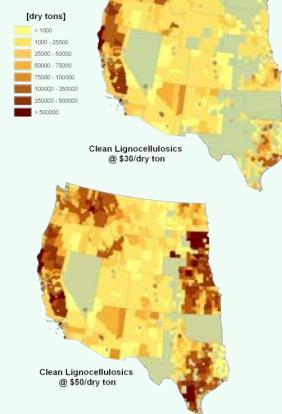
Biomass Resources Consumed



Marginal cost of biofuel includes cost of production and delivery to the nearest distribution terminal. Taxes, local distribution and marketing costs are excluded.

Biomass Resource Assessment

Feedstock Class	Specific Feedstock	Method of Evaluation
Agricultural Resources		
Residues	Corn stover, small grain straws	Residues not needed for erosion prevention are available
Grains	Corn	FAPRI projections
Herbaceous Energy Crops	Switchgrass	Native grass yields on marginal lands
Oilseed Crops	Soy, canola	FAPRI projections
Forest Resources		
Forest Thinnings	Public and Private lands includes juniper and pinyon pine	Biomass is secondary output of forest management practices
Residues and Byproducts		
Animal Fats & Waste Greases	Beef Tallow, Pork Lard, Yellow Grease	Based on meatpacking industry Assigned by population
Municipal Solid Waste (MSW)	Wood residues, paper, yard waste, etc	Assigned by population from aggregate state statistics
Woody Residues	Orchard and vineyard waste	Yields and acreage



The biofuel supply chain presents significant economic optimization challenges as feedstock sources can be geographically dispersed and fuel prices dictate large scale biorefineries to realize the benefits of economies of scale.

Conclusions

The results illustrate the potential to produce substantial quantities of biofuels from western U.S. biomass resources, but they are also subject to substantial uncertainties. In interpreting the supply estimates, unresolved questions remain regarding economic performance of the different conversion technologies and the overall sustainability of many of the biomass resources considered.

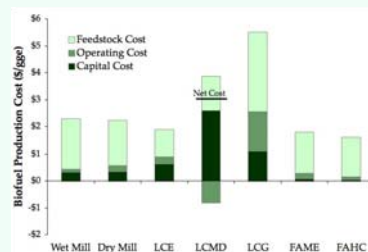
The region-wide supply is most sensitive to the following factors.

- The development of low-cost cellulosic ethanol technology or a technology with similar performance to LCE as modeled,
- The availability and yield of herbaceous energy crops from marginal farmland,
- The price and availability of corn for fuel production,
- Acceptability of MSW resources as a biofuel feedstock,
- Access to forest resources.

Conversion Technologies

Current Representative Technologies	
Grain to Ethanol - Dry Mill	Dry Mill
Grain to Ethanol - Wet Mill	Wet Mill
Fatty Acid to Methyl Ester	FAME
Technologies Projected to be Available in 2015	
Lignocellulosics to Ethanol - Fermentation/Hydrolysis	LCE
Lignocellulosics to Middle Distillates - Fischer Tropsch	LCMD
Lignocellulosics to Gasoline - Upgrading/Pyrolysis	LCG
Fatty Acids to Hydrocarbon - Hydrotreatment	FAHC

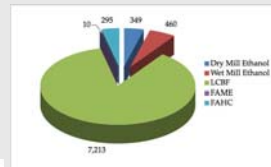
Conversion Cost by Technology



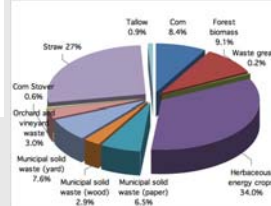
Target Price Biofuel Production System



Breakdown of Output Fuel at \$2.19/gge

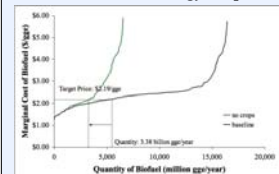


Resource Consumption at \$2.19/gge

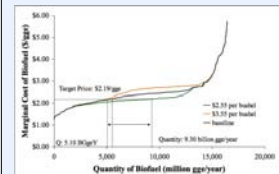


Sensitivity Analysis

No Dedicated Energy Crops



Corn Price



Stalled Technology

