Employment, Income, Revenue and Land Use Impacts of Biofuel Mandates in Pacific Northwest Regions

Incorporating Land Classes into Regional CGE

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Objectives

- Separate out irrigated land and dry land as primary factors in agricultural production.
- Analyze impact on the regional economy of demand induced by the mandated blend ratio of ethanol.
- Analyze effects of improved ethanol yield resulting from outcomes of DOE's Genomic Science Program (GSP).



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Basic CGE Structure



Region and Crop Selection



Study Areas



Data

- Implan SAM 2008
- GIS spatial USDA's 2009 Cropland Data Layer
- NASS imagery 2008
- Biomass feedstock potential estimates for MSW and Forest Residue (OSU)
- Land cost estimates (PNNL)
- CropSyst simulation of switchgrass yields (WSU)
- Comprehensive feedstock inventory based on a 5-mile grid (PNNL)
- Feedstock transportation cost estimates (WSU)

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Assumed Average Annual Yield

CropSyst simulation of switchgrass yields, Dr. Claudio Stöckle, WSU:



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L36: Lowland cultivar originating at about 36° N Latitude U40: Upland cultivar originating at about 40° N Latitude

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Switchgrass Yield Probability

CropSyst simulation of switchgrass yields, Dr. Claudio Stöckle, WSU



Feedstock Inventory Map



Biomass Availability by Feedstock, Mid-Columbia

Transportation cost vs. biomass availability,

Dr. Eric Jessup, Dr. Hayk Khachatyran and Dr. Jeremy Sage, WSU



Transportation Cost (\$/ton)

Total Biomass Availability

Transportation cost vs. biomass availability,

Dr. Eric Jessup, Dr. Hayk Khachatyran and Dr. Jeremy Sage, WSU



Structural Assumptions

- Capital:
 - Mobile (free to move between activities), supply is variable
 - Supply, demand, and the return on capital are endogenous
- Labor:
 - Mobile (free to move between activities), supply is variable
 - Supply, demand, and the return on capital are endogenous

Land:

- Categorized into irrigated land and dry land.
- Transferable between sectors.
- The overall supply is fixed.
- Demand and the land returns are endogenous.

Elasticity of substitution between production factors

- Higher in industrial and service sectors (Cap and Lab)
- Lower in agricultural sectors (Land, Cap and Lab)
- The demand elasticity for production factors
 - High for labor and capital
 - Low for land



Bio Refining Technology Potential



Baseline and Counterfactual Scenarios

Baseline, Mid-Columbia*: <u>Tax credit, Mandate low at 2% blend rate</u>

* Neither the production of switchgrass or cellulosic ethanol currently exist in WA.

OR	FedGov	Volumetric Ethanol Excise Tax Credit (VEETC)	\$0.45/gallon		
	FedGov	Cellulosic Biofuel Producer Tax Credit	\$0.46/gallon		

Counterfactual Scenarios: <u>Tax credit + meeting mandate + ethanol yield growth</u>

- 1. Tax credit + Mandate demand level at 6.15% blending ratio (MD)
- 2. Tax credit + MD and 5% yield growth in biorefining technology
- 3. Tax credit + MD, 10%
- 4. Tax credit + MD, 20%
- 5. Tax credit + MD, 50%



Value of Output, \$Million





Reduction of GHG, Million Ton Equivalent





M & 50%

Value of Output, % change







■M&5% ■M&10% ■M&20%

■MD

Composite Commodity Price Change, %





Aggregate HH Income, \$ Million						
HHD9	150K+	755				
HHD8	100-150K	887				
HHD7	75-100K	1107				
HHD6	50-75K	1437				
HHD5	35-50K	853				
HHD4	25-35K	489				
HHD3	15-25K	424				
HHD2	10-15K	164				
HHD1	< 10K	183				



Total EV, \$ Million



Irrigated Land Demand, Quantity



Factor Return, % Change



- As feedstock conversion rate improves, GDP does not change. Reallocation between sectors.
- Blending mandate increases bio refining and switchgrass growth
- Gasoline production and agricultural sectors that extensively use irrigated land experience contraction.
- Growth in feedstock conversion rate reverses this effect. The primary impact is illustrated by changes in irrigated land demand.
- Emission reduction is observed for all analyzed scenarios.

Project Team

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Appendix



Adding Land and Biofuels to Regional CGE



Switchgrass Yield Probability

CropSyst simulation of switchgrass yields, Dr. Claudio Stöckle, WSU









Current policy

FedGov	Volumetric Ethanol Excise Tax Credit (VEETC)	\$0.45/gallon	Tax Credit
FedGov	Cellulosic Biofuel Producer Tax Credit	\$0.46/gallon	Tax Credit
WA	Property/Leasehold Tax Exemption for		
	Manufacturers of Biodiesel/Alcohol Fuel	Varies	Tax Exemption
OR	Biomass Production/Collection Tax Credit		
	(for Grass and Woody Biomass)	\$10/ton	Tax Credit

	-								
	2008	State	Implied	2008	Share of	Implied	Percent of	Federal	Federal
	Gasoline	Mandate	Ethanol	Proportion	EISA 2007	Ethanol	Total	Portion	Manda
	Consumption	(%)	Demand	of US	Goal*	Demand**	Gasoline	(MGY)	te(%)
	(MGY)		(MGY)	Gasoline	(MGY)	(MGY)	Demand		
WA	2,684	2%	53.68	1.94%	165.1	165.1	6.15%	111.41	4.15%
OR	1,529	10%	152.88	1.11%	100.3	152.9	10.00%	-	-
ID	655	10%	65.53	0.47%	43.0	65.5	10.00%	-	-
NW	4,868	6%	272	3.52%	299.43	383.5	8%	111.41	2.29%

* The US Environmental Protection Agency has cut the 2010 US cellulosic ethanol volume mandate from 100 million gallons to 6.5 million. Quota to be rest by EPA every year.

** Assuming the US total production quota of 8.5 billion cellulosic ethanol for this analysis.

Ag Sectors Aggregation

Other Livestock	-
Poultry and egg production	6.78
Animal production except cattle and	
poultry and e	4.65
Forestry	-
Forestry- forest products- and timber	45.37
Commercial logging	-
Commercial Fishing	-
Commercial hunting and trapping	4.63
Oil and Gas Extraction	-
Extraction of oil and natural gas	0.77
Drilling oil and gas wells	-
Other Mining	-
Mining coal	-
Mining iron ore	-
Mining copper nickel lead and zinc	-
Mining gold silver and other metal ore	
mining	-
Mining quarrying stone	7.32
Mining and quarrying sand gravel	10.11
Mining and quarrying other nonmetallic	-
Support activities for other mining	-
Power Utilities	-
Electric power generation- transmission	52.76
not unique commodity (fed govt electr)	79.76
not unique commode (S&LG electr)	103.78
Gas Utilities	-
Natural gas distribution	17.49
2Water Utilities	•
Water sewage and other systems	2.59

Grain Farming	
Grain farming	111.38
Vegetable Farming	-
Vegetable and melon farming	413.76
Horticulture Farming	-
Tree nut farming	444.40
Fruit farming	-
Greenhouse and nursery	
production	12.52
Economic Crop Farming	-
Oilseed farming	0.27
Tobacco farming	-
Cotton farming	-
Sugarcane and sugar beet farming	2.45
Other Crop Farming	-
All other crop farming	345.27
Cattle	-
Cattle ranching and farming	68.52
Dairy	-
Dairy Cattle and Milk Production	66.73



Feedstock and Refining Assumptions

* Neither the production of switchgrass or cellulosic ethanol currently exist in WA.

Switchgrass Production*	Mid-Columbia	Palouse	Cellulosic Ethanol*	
Irrigated land rent (\$/acre)	335	281	Conversion rate (gallons/ton)	76.5
Yield (ton/Acre)	14	12	Plant capacity (MGY)	53.5
Cost (\$/acre)	884	807	Cost of SWG ethanol (\$/gallon)	2.68
Cost (\$/ton)	64	68	Imposed starting quantity* (MG)	9.5

