Evaluation of Potential Water Quality Improvement from Herbaceous Energy-Crop Production and Use as a Co-firing Fuel to Meet Renewable Portfolio Standard (RPS) Requirements

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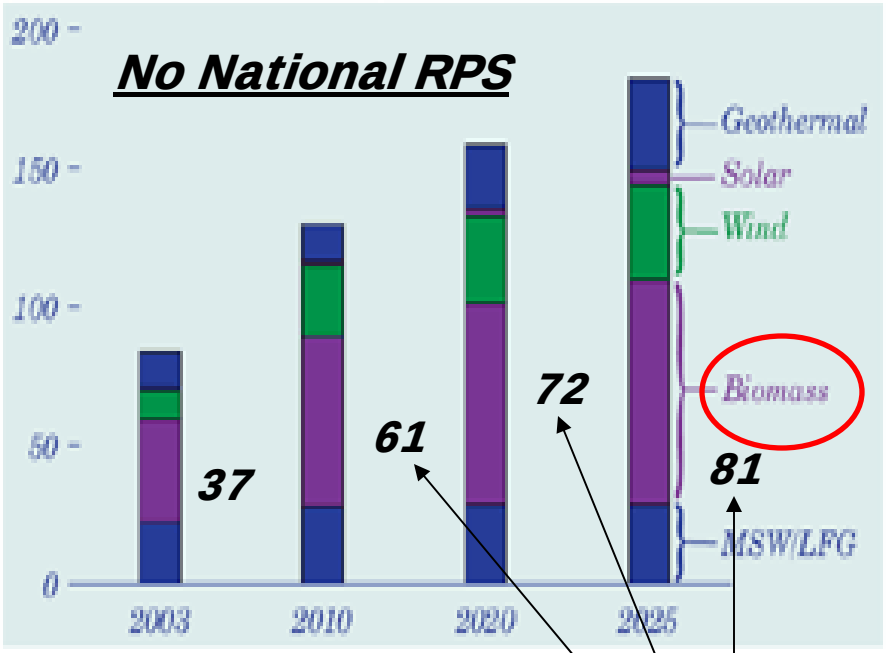
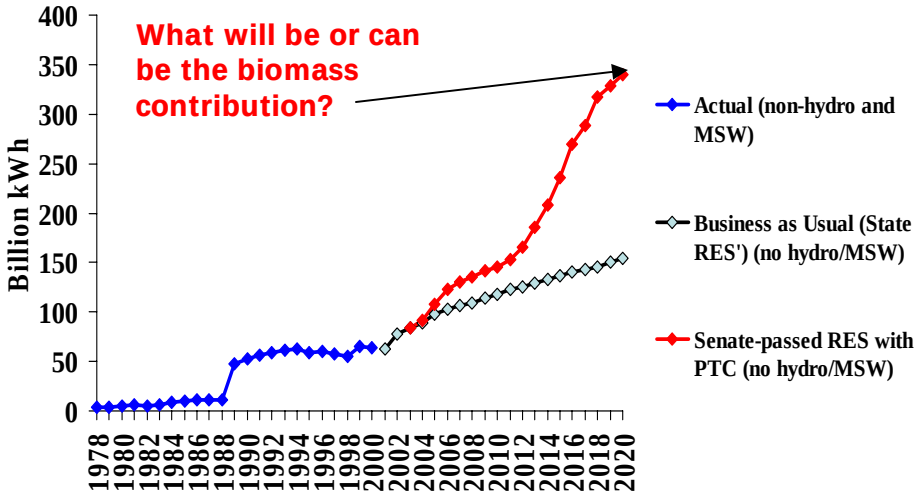
General Background

Figure 75. Nonhydroelectric renewable electricity generation by energy source, 2003-2025 (billion kilowatthours)



What are the resources that will comprise the 61-81 billion kW-h of renewable biomass electricity?

National 10 % RPS Scenario



Renewable Fuels Standard Projections

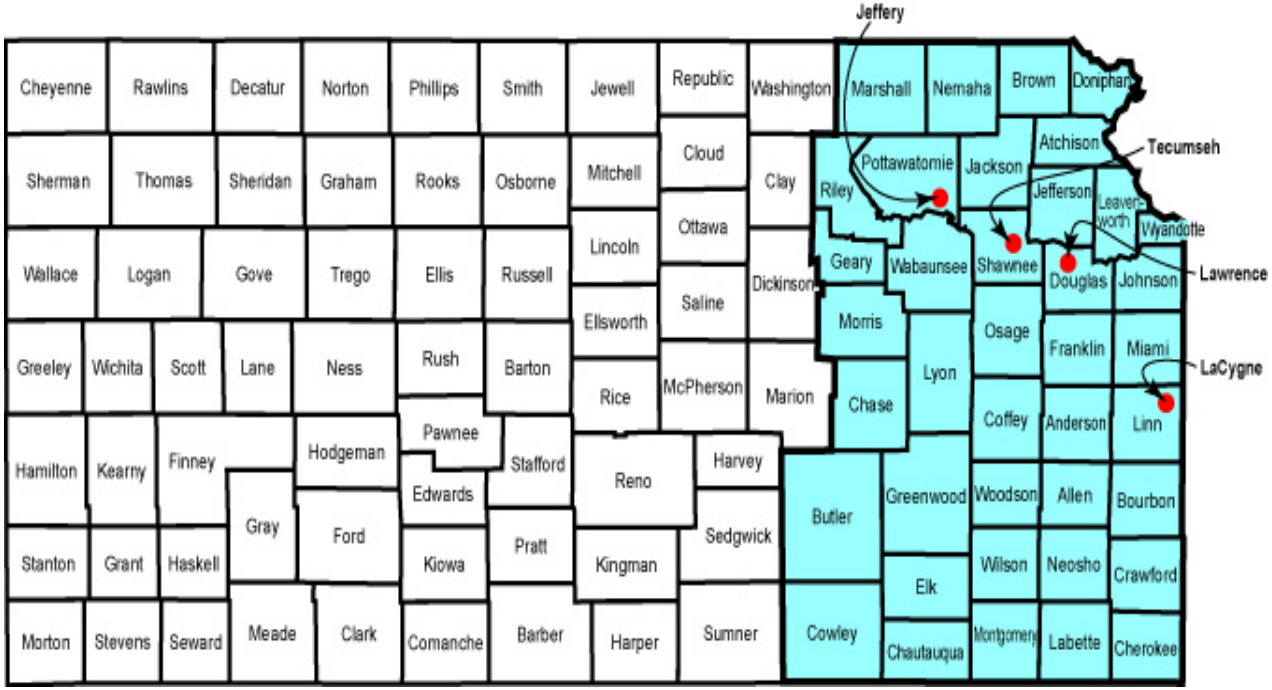
2012 7.5 billion gallons

- Beginning in 2013, a minimum of 250 million gallons a year of cellulosic derived ethanol be included in the RFS.
- **Credit trading** program for refiners that allows for the most efficient and cost-effective use of renewables.
- ***Every gallon of cellulose-derived ethanol is equal to 2.5 gallons of renewable fuel.***

Project Background

Estimate potential improvements in regional-scale water quality in Kansas resulting from the utilization of herbaceous energy crops (switchgrass) as a utility co-firing fuel for meeting renewable resource requirements in a RPS.

Qualified Electric Generating Facilities for Biomass (Herbaceous Energy Crop) Co-firing in Kansas



Nameplate Capacities

Jeffrey - 2,160 MW

LaCygne - 1,578 MW

Lawrence - 566 MW

Tecumseh - 232 MW

Renewable Portfolio Standard (RPS)

A RPS is a proposed policy requiring electricity suppliers or generators to obtain or generate a certain percentage (1% to 20%) of their electricity from qualified renewable resources (biomass, wind, and solar).

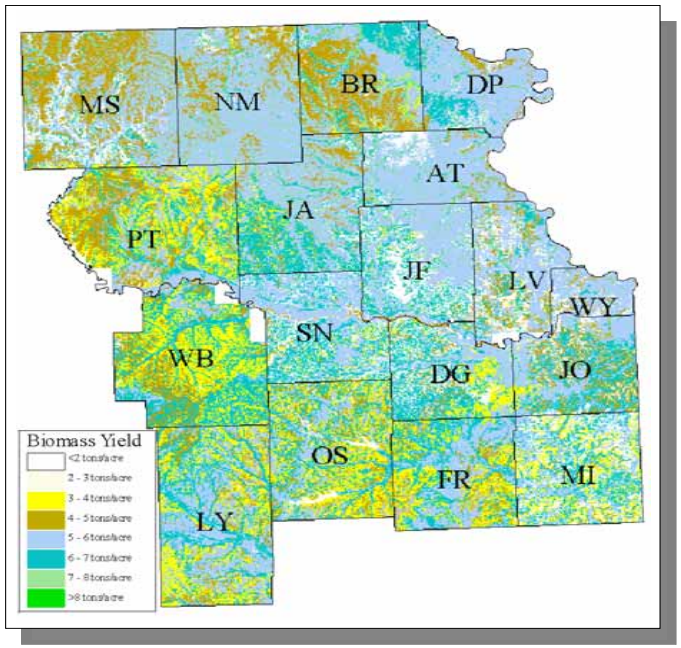
Co-firing herbaceous energy crops with coal, a proven technology, is one way to meet RPS requirements and can also provide many energetic, environmental, and economic benefits.

Kansas RPS Scenarios - 10% by 2020, 10% by 2025, and 20% by 2020

Biomass contribution to each RPS Scenario (% of total RPS scenario electricity generation)

	RPS #1	RPS #2	RPS #3	RPS #4
2010	1.50%	1.50%	0.75%	0.65%
2015	5.00%	5.00%	2.50%	0.90%
2020	10.0%	7.50%	5.00%	2.00%
2025	10.0%	10.0%	5.00%	2.00%

Switchgrass Yields – NE Kansas



Example modeled cumulative, 24-year soil erosion (total tons) comparison between switchgrass and four conventional commodity crops on two major soil types in Pottawatomie county, Kansas.

Soil Type	Switchgrass	Corn	Soybeans	Wheat	Grain Sorghum
Pawnee	0.34	30.28	33.42	11.21	33.54
Clime	0.77	68.87	76.98	27.86	76.93

Switchgrass Yields, Brown County, Kansas

Soil Type	Area (acres)	Erosion Index (EI)	Max Yield (tons/ acre)	Min Yield (tons/ acre)	Average Yield (tons/ acre)
BURCHARD	2,786	16.55	11.36	1.30	5.60
STEINAUER	2,786	22.80	12.44	0.25	5.22
MARTIN	12,377	14.18	12.82	1.48	6.29
PAWNEE	188,210	11.34	10.99	1.25	5.57
WAMEGO	7,121	16.35	8.05	0.14	3.37
SHELBY	7,034	12.30	11.43	1.27	5.44
OSKA	558	35.32	8.98	0.17	4.07
SOGN	2,505	**27.41**	4.52	0.01	1.76
JUDSON	4,618	8.58	13.78	0.78	6.30
OLMITZ	4,596	8.36	12.20	0.25	5.58
KIPSON	14,640	**27.41**	6.84	0.01	2.72
VINLAND	3,726	**45.12**	6.16	0.01	2.59
KENNEBEC	132,433	2.82	14.87	1.52	7.03

Environmental Quality Improvement Magnitude via Herbaceous Energy Crop Utilization

Magnitude of reduction in soil erosion, and hence, the water quality benefit, potentially achievable from herbaceous energy-crop production as co-firing fuels is a function of:

- structure of the RPS (percentage of renewables required),
- herbaceous energy crop yield,
- quantity of herbaceous energy crop required by each particular RPS scenario and geographic location of production (climate characteristics),
- soil types and physical characteristics of the soils (soil erodibility),
- operating characteristics of the electric generating facility (required heat-rate input), and
- cost of competing agricultural commodity crop crop/land use and energy source.

Estimated cumulative environmental parameter improvement versus conventional commodity crop production for two co-firing scenarios at Jeffrey and Tecumseh electric generating facilities

10% by 2020 / 5% by 2020

Jeffrey

	Savings in soil erosion (tons)	Savings in N w/ sediment (kgs)	CO_2 sequestered (tons)
2010	42,972 / 22,393	709,912 / 493,949	20,492 / 10,607
2015	138,364 / 89,320	2,213,510 / 1,490,738	68,465 / 38,081
2020	268,043 / 138,364	4,555,267 / 2,213,510	138,462 / 68,465

Tecumseh

	Savings in soil erosion (tons)	Savings in N w/ sediment (kgs)	CO2 sequestered (tons)
2010	7,237 / 1,867	142,513 / 31,912	1,903 / 827
2015	15,284 / 9,967	271,676 / 186,202	5,985 / 3,254
2020	25,173 / 16,333	402,282 / 295,792	13,015 / 6,688

Conclusions

- Switchgrass for co-firing purposes coupled with a RPS "driver" would have a significant energetic, and air, soil, and water quality impact

- Average edge-of-field cost of ~ $1.70 per million Btu

Bottom Line:

Environmental externalities of renewables must be "monetized" to realize full societal benefit.