Bioenergy:
Opportunities & Challenges for Local, Renewable Grass Energy in the Midwest

For the Vermont Grass Energy Symposium

Shelburne Farms November 12, 2008

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Today's presentation

- Midwest - policy context
- Building a market for grass-based bioheat

Growing Wisconsin Energy: A Native Grass Pellet BioHeat Roadmap for Wisconsin
http://www.agrecol.com/
Heating with Biomass: A Feasibility Study of Wisconsin Schools
http://www.biomasscenter.org/

Midwest – Storied History

- Major economic power
- Launching pad for new industries, global agricultural revolution
- Strong blue collar middle class
- Today faces profound challenges: global economy, demographic and climate change
- Lags far behind in policies to reduce GHG emissions

The Midwest (6 states) contributes 25% of the U.S. and 5% of the world's GHG emissions

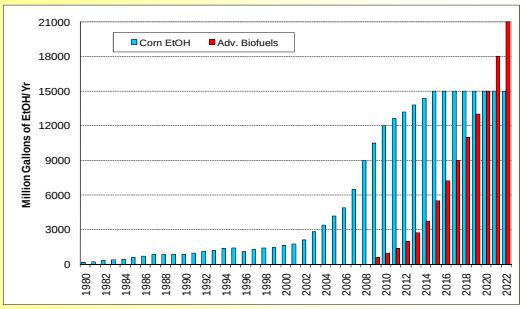
Midwest Governor's Association:
Energy Security & Climate Stewardship Platform & Midwest MGA Accord

- Establish greenhouse gas reduction targets and timeframes;
- Set of goals & initiatives to meet them by 2030
- Develop a market-based and multi-sector cap-and-trade mechanism;
- Establish a system to enable tracking, management, and crediting reduction of greenhouse gas emissions;
- Develop other low carbon policies, incentives and funding mechanisms.

Energy & Farm Bills

- Expands RFS (9 billion gallons/yr by 2008; 36 billion gallons/yr 2022)
- Establishes new "advanced" (non corn-starch based) biofuel category (21 billion gallon/yr)
- GHG performance requirements

Energy Independence and Security Act Advanced Biofuel Targets

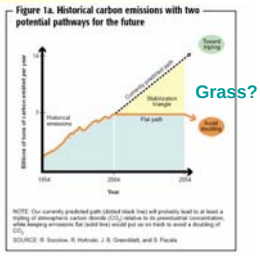


Farm, Conservation and Energy Act

- Biomass Crop Assistance Program (BCAP)
- Rural Energy for America (REAP) Program
- Repowering Assistance
- Biomass R&D

Market Direction for Biomass?

- Transportation fuels
- Power
- Buildings

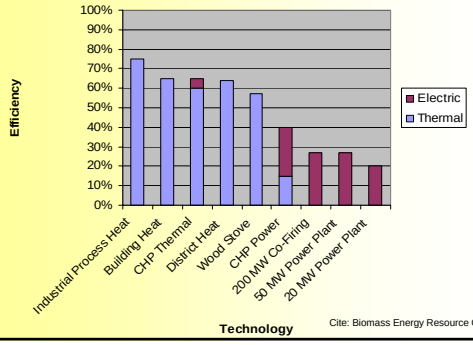


Expand the use of community scale, locally grown, renewable fuels for heating; build intermediary heat market now.

Many Biomass Heating Projects in Midwest

- Over 200 industrial and commercial businesses, WI
- District Energy, St Paul, MN
- Dept of Corrections, 4 state prison's, IN
- University of Iowa, Hospital and Clinics, Iowa City, IA
- Show-Me Cooperative, Centerville, MO

Most Efficient and Economical Use for Biomass is for Heating and CHP



Cite: Biomass Energy Resource Center, 2008

Heating Value of Fuels

Fuel Type	Unit	Cost per Unit	MMBtu per Unit	Cost per MMBtu	Average Seasonal Efficiency	Delivered MMBTU	Cost per MMBtu After
Wood Chips	ton	$50	9.9	$5.05	65%	6.4	**$7.77**
Natural Gas	therm	$1.10	0.100	$11.00	90%	0.090	**$12.22**
Wood Pellets	ton	$150	15.7	$9.57	75%	11.8	**$12.76**
Switchgrass Pellets	ton	$140	14.560	$9.62	75%	10.920	**$12.82**
Corn	bushel	$4.50	0.331	$13.59	80%	0.265	**$16.98**
LP Gas	gallon	$2.20	0.092	$23.91	90%	0.083	**$26.57**
Electricity	kwh	$0.10	0.003	$29.31	99%	0.003	**$29.60**
Fuel Oil (No.2)	gallon	$3.30	0.138	$23.91	80%	0.110	**$29.89**

Fuel Chart data provided by Biomass Energy Resource Center (BERC). Note prices change daily.

Scope of study: Using Native Grasses for Heating: Building a Bioheat Roadmap

- Is pelleted switchgrass a feasible fuel for commercial heating in Wisconsin and upper midwest?
- What are the expectations: yield, fertilization, cost of production? economic impacts?
- What is the right business model?
- Recommendations for moving ahead?

In 2004, Agrecol converted their heating system from LP, and now heats their entire production facilities with native grass pellets

Growing Wisconsin Energy: A Native Grass Pellet BioHeat Roadmap for Wisconsin
http://www.agrecol.com/

Agrecol®
Agricultural Ecological Solutions

Bioenergy – A New Chance for Native Grasses?

- Renewable, farmer-grown fuel
- Replace fossil fuels
- Reduces GHG
- Economic opportunity for rural Midwest.
- Replace row crops with grass on marginal lands?
- Beneficial to water, soil, wildlife

Switchgrass: "model energy crop"

US.DOE screened 130 crops
Switchgrass and hybrid poplar selected as "model energy crops"

- Ease of propagation
- Native; broad distribution
- Perennial growth
- High yield potential
- Compatibility with conventional farming
- Conservation (water quality and wildlife)
- ***Carbon sequestration***

Densification Options

1/4" diameter Pellets

2"- 4-3/4" diameter Briquettes

Densities are comparable

Case Studies:Commercial Scale

- Agrecol Seed Company
- America's Best Greenhouse
- State of Wisconsin Oakhill Correction Facility
- Pecatonica Elementary School

What did we learn? Biomass saves a lot of money

- Agrecol – 52%
- America's Best Greenhouse – 62%
- Oakhill Correctional – 15%
- Pecatonica Elementary – 39%

Avg.Fuel Savings 42%

Ed & Carol Knapton, America's Best Greenhouse Cottage Grove,WI

Switchgrass Production Costs

Inputs (fertilizer, crop insurance)	$84.52
Energy expenses	$8.76
Repair & maintenance	$4.02
Interest Expenses	$6.06
Land rent	$100.00
Labor	$13.84
Interest & insurance	$16.05
Depreciation	$17.07
Total Costs/Acre	**$250.32**

Avg. yield @

5 tons/Acre

= $50.06/ton

Cite: Ken Barnett; UW Ag Enterprise Budget: Center for Dairy Profitability

Estimated costs of pelleted Switchgrass

- $50/ton baled (assume $100/rent & 5 tons/acre yield)
- Avg FOB farm $70-90/ton (assume $100-200/acre profit)
- Trucking costs: $4.68/ton (30 miles @ $3.75/loaded mile)
- Avg FOB pellet mill - $74.68-$94.68/ton
- Costs to pellet – $40-$60/ton
- $114 - $154/ton pelleted

Growing switchgrass pellets on marginal land

$80/ton x 5 ton/acre = $400/acre gross profit

- $150/acre (land rent + cost)

= $250/acre net profit

Potential economic impact of advancing grass energy

100,000 acre biomass project =

500,000 tons biomass @$140/ton

$70 million new, local dollars

$70-150 million not exported out of state for fossil fuel

Proposed business model

- Grow switchgrass on marginal acres
- Marginal acres growing corn now; not sustainably profitable
- Net income ($250/acre) sufficient for landowners to choose switchgrass on marginal acres if long term contract
- Pelleting: Ease of handling, transporting, storing

Start Now!

Expand biomass heating now – begin building a feedstock supply chain for future biopower and/or biofuel?

Taking cars off the road: Using grasses to mitigate emissions

Land use type	Acres	Total Co2 sequestered Soil C (MT/acre/yr)	Equivalent Automobiles[1]
CRP	1.0	1.32	2.4

Carbon benefit from 100,000 marginal acres planted to grass (10 years) = Removing 240,000 cars

Cite: Kucharik UW, Robertson, MSU

[1] CO_2 emissions per automobile = 5.48 MT CO_2 yr^{-1}; EPA publication 420-F-05--004

Corn to Grass - Better for water quality

"If an acre of corn grown on highly erodible land were converted to grass, soil losses would be reduced by at least 94%. Reduction in phosphorus runoff would be similar."

Cite: Panuska et al., 2007. UW Publication #A-3830.

Mowing Indian Grass for Biofuel

Indian Grass windrows

Little Bluestem production field (after seed harvest) ready to be mowed.

Field-chopped Raw Biomass

Hammer mill reduces size of chopped biomass

Bliss 100 hp Hammer mill

Biomass after milling

Cyclone separating leaf from stem material

Fractionation process decreases ash%

Pellet Mill

Pellets are extruded through 1/4” diameter die

Exterior of the Extrusion Die

Mill operator checks the temperature of the pellets.

Pellets entering counter-flow Cooling Chamber

Pellets in the hopper bin after cooling

Pellets in mini bulk storage bags

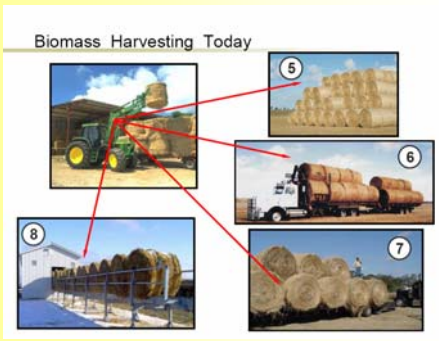
Agrecol's pellet boiler

2.5 MBTU burn chamber

Pelleting Process

1. Receive chopped biomass
2. Fractionate stem from leaf <3% ash content
3. Moisture pretreatment on working floor of plant
4. Move to ingredient live bottom hopper bin
5. Create recipe mix using computer automation
6. Elevate to tower surge hopper
7. Hammer mill to required particle size
8. Cool pellets in counter flow cooler (dust to briquette line)
9. Screen fines (fines to briquette line)
10. Bag
11. Ship to market

Cite: Dr. Kevin Shinners, UW-Madison



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Conclusions

- Policy driving bioenergy
- Future role of biomass is unclear
- Most efficient use is heating and CHP
- Biomass heating, a proven, viable, low cost & low risk technology
- 4 case studies; biomass reduced fuel costs 42%
- Switchgrass on marginal acres can provide a sustainable profit to farmer
- Each 100,000 acres: would generate 500,000 tons of biomass, heat 100,000 homes or 500 schools or businesses & $70 million in farmer grown energy

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