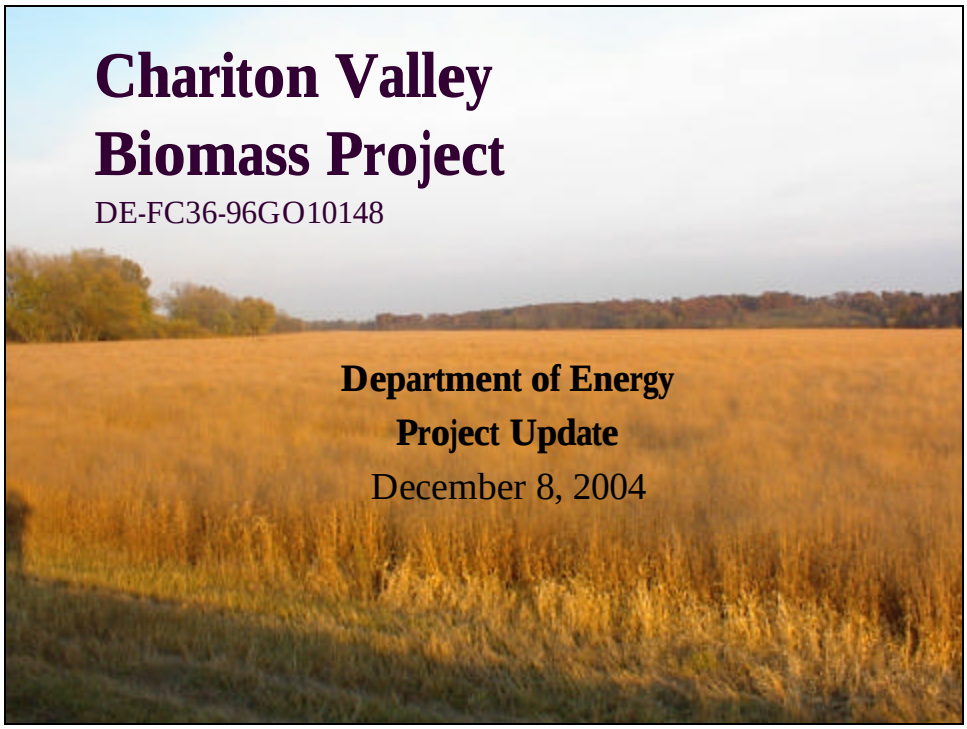


Chariton Valley Biomass Project

DE-FC36-96GO10148

Department of Energy

Project Update

December 8, 2004

Overview of Meeting

- Introductions
- Process Equipment Development
- Interim Test Burn Results
- Business Development Progress
- PrairieLands Update
- Alliant Perspective
- Feedstock Technology
- Agronomic Research
- Budget Issues

Process Equipment Development: 2000 Cofire Objectives

- Demonstrate cofire
- Adapt successful Danish technology to OGS
  - Slow speed debaling, high speed hammermill
- Emission tests for permitting long term burn

Process Equipment Development: 2000 Cofire

Air Knife for Rocks

Ground Straw

Attrition Hammermill and Pneumatic Conveyor

Process Equipment Development: Results

2000 Cofire – 4 months, 12-18 tph

- Attrition grinding (no screen) demonstrated
- Pneumatic SWG handling clean and efficient, limited by available power
- Straw cofiring had Zero impact on OGS operations
- OGS plant gained confidence in cofiring
- Need uniform and safe debaling with industrial equipment (knife wear 1000 tons/set)
- Need automated twine removal
- Need confirmation of emissions impacts
- Need confirmation of flyash impacts

Process Equipment Development:

2001-2002 Plan Long Term Test, Commercial Design

OBJECTIVES

- Plan three month test corrosion for deposits
- Preliminary layout and cost estimates

RESULTS

- Located, bid and selected equipment for commercial plant: crane, debaler, moisture detection, primary and secondary milling options
- Tested debalers, and hammermills for secondary milling
- Need (interim) test for long term test burn permit
- Need additional flyash for acceptance tests

Process Equipment Development:
Interim Test Objectives 2003

- Emissions compliance for permitting
- Flyash utilization
- 800 tons at 10-15 tph 2 wks

Uniform Process Line

Bale Infeed Conveyor

Automatic twine removal 30 sec/bale

Process Equipment Development:
Interim Test 2003 – 800 tons at 10-15 tph 2 wks

Hammers 30,000 t/set
Screens 20,000 t/set

Attrition hammers 30,000 t/set

400 Hp De-baler 24 TPH 2in

Process Equipment Development:
Interim Test Results 2003

- Emissions permit for Long Term Burn expected from IDNR
- Flyash meets ASTM C618 requirements for Class C flyash
- Demonstrated clean, safe, reliable operation of SWG processing for 8-10 hour periods
- 800 tons, 10-15 tph 2 wks
- Need more power on pneumatic conveyor: tests limited to 8.9 TPH
- Need automated bale moisture
- Need automated bale weight
- Need to reduce particle size
- Need verify optimum power consumption

Enclosed infeed conveyor

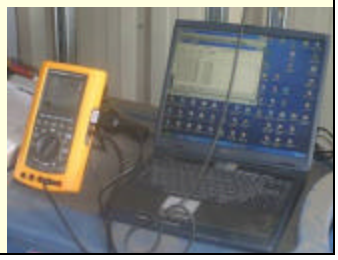
Process Equipment Development:
2004 Equipment Tests

Objectives

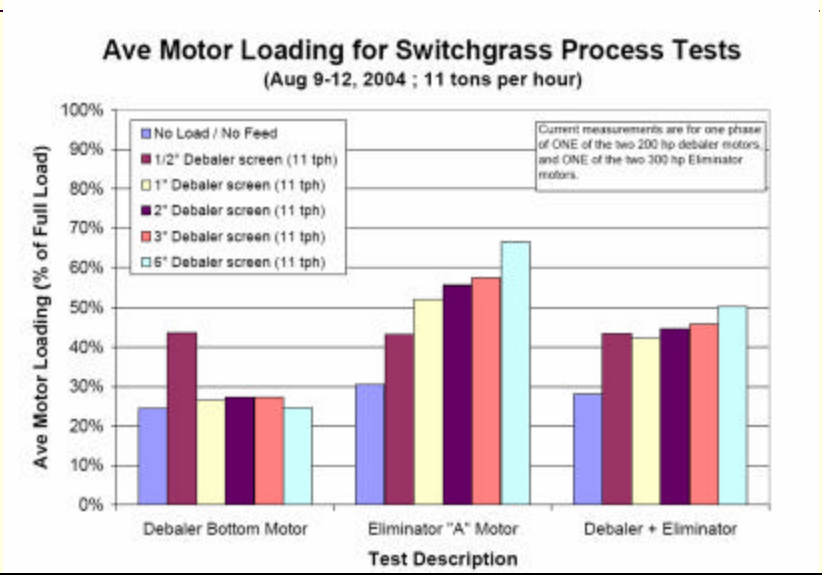
- Reduce Particle size
- Optimize Power consumption
- Analyze system components for reliable operation in Long Term Burn

Modifications

- Debaler: 6, 3, 2, 1, 0.5 in screens
- Eliminator
  - Widen infeed
  - Replace internal weirs
  - High wear hammers



Process Equipment Development:
2004 Equipment Test Results



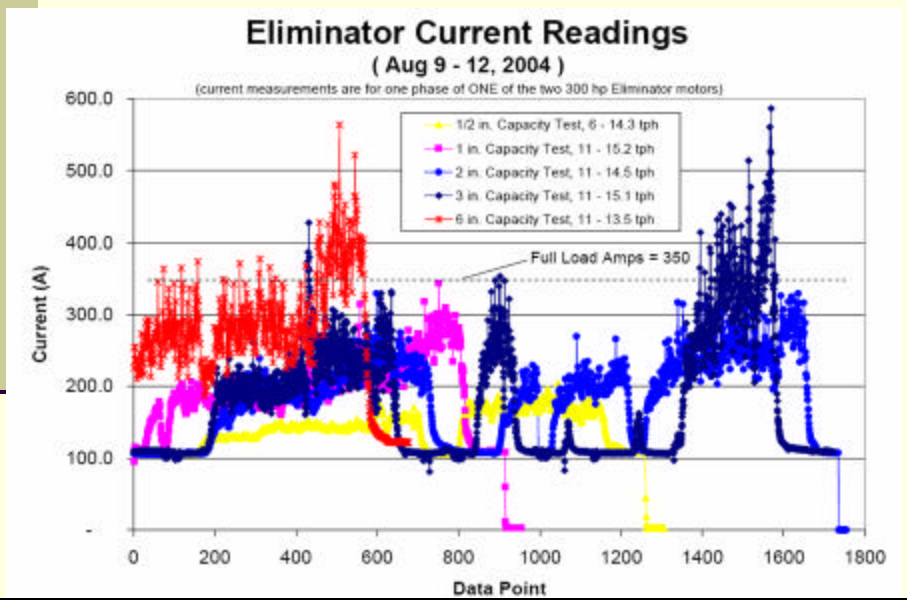
Process Equipment Development:
2004 Equipment Test Results

Improved particle size at optimum power achieved with 2in screen and modified eliminator

Compare Interim Test

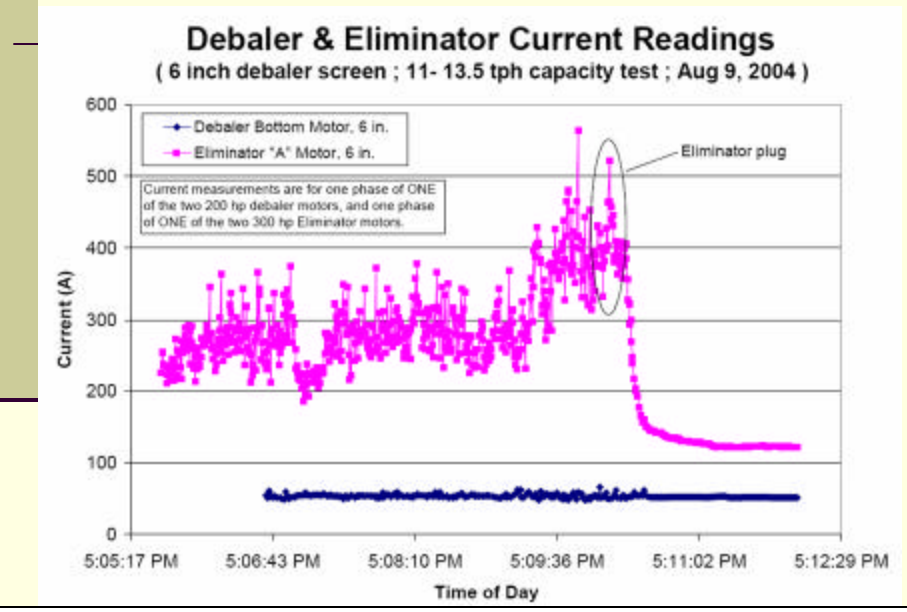
Process Equipment Development:

2 in Screen Uniform Load on Eliminator



Process Equipment Development:

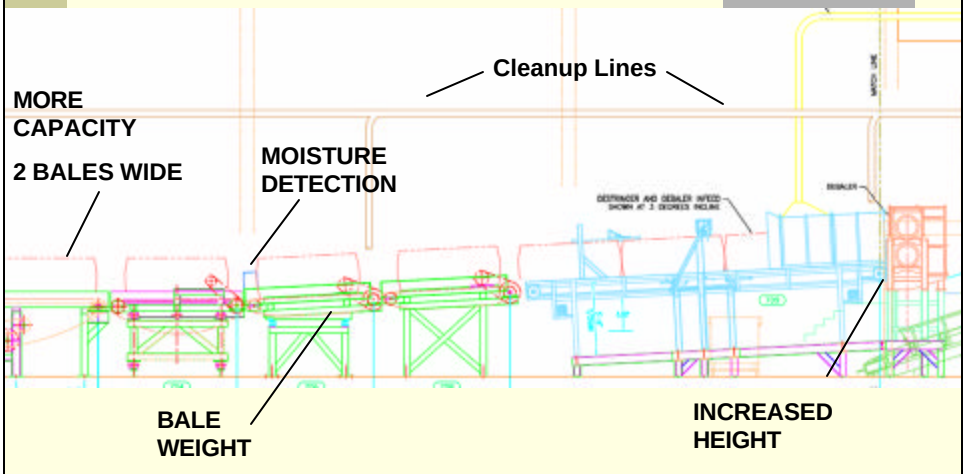
Current detects plug in Eliminator



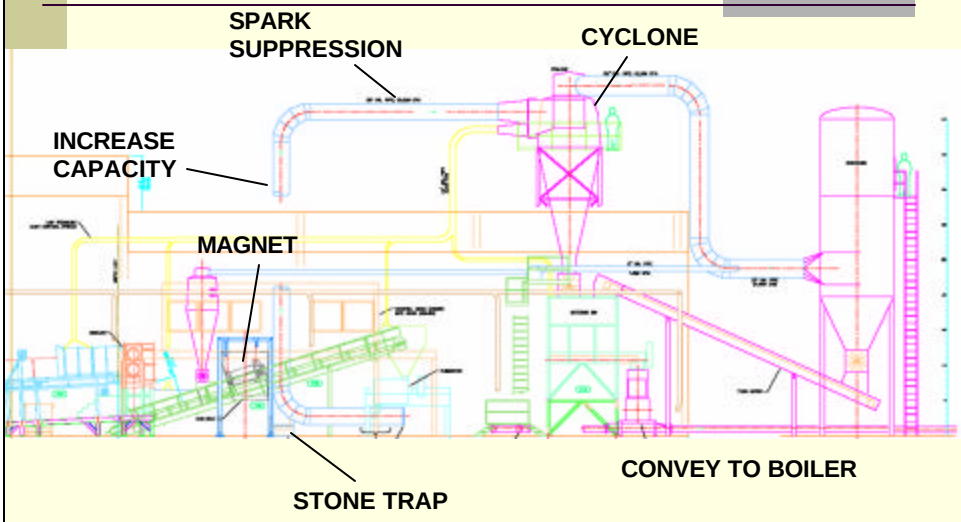
Process Equipment Development: Test Facility **Design for Long Term Burn**

- Extend bale conveyor
- Widen bale conveyor
- Add bale shuttle
- Add bale weight and MC stage
- Increase debaler height
- Add controls to twine remover
- Add cleanup line and cyclone
- Discharge directly from eliminator to meter bin in cyclone
- Add metal separator and spark detector in cyclone leg.
- Increase capacity of pneumatic line
- Add spark detection and suppression
- Add fire protection in building
- Etc.

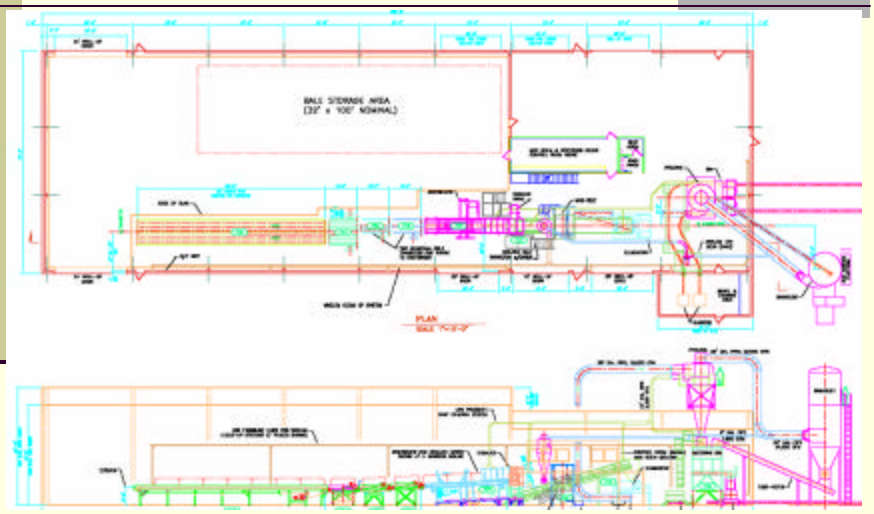
Long Term Burn Debaler Infeed



Long Term Burn: Secondary Milling



Long Term Test Facility



Location of Long Term Test Burn Facility

Interim Test Burn Objectives

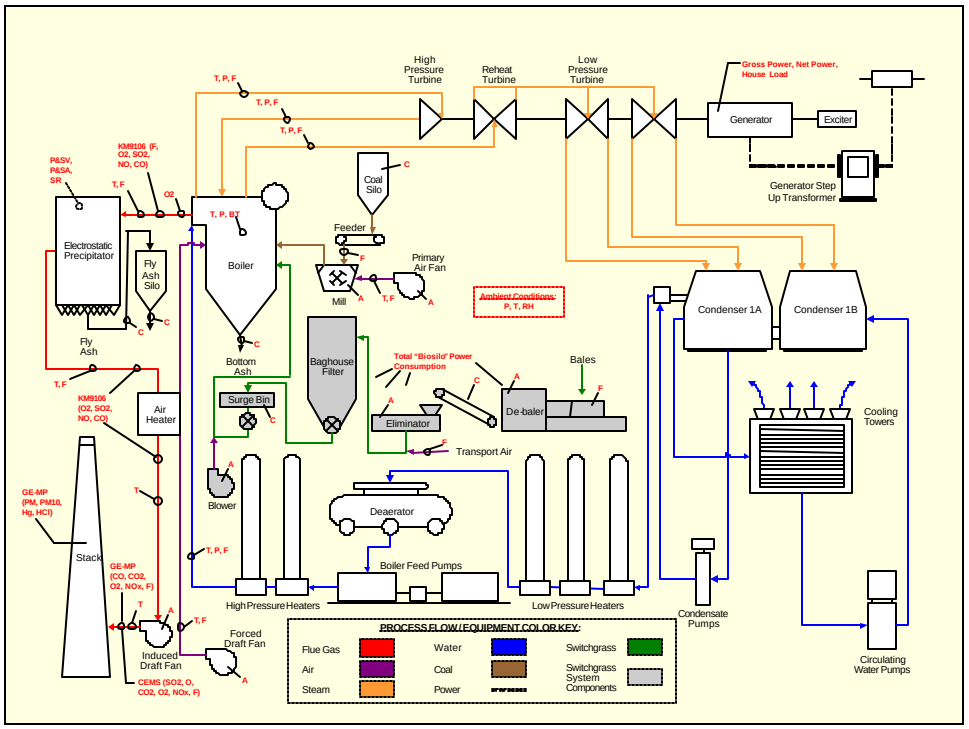
- Test & Optimize Biomass Processing Equipment
- Obtain Clearer, More Definitive Understanding of Air Emissions
  - SO_2, NO_x, Opacity, CO, PM, PM_{10}, (Hg, Cl)
- Determine SWG Effect on Fly Ash Marketability
- Obtain OGS & Biosilo Performance Data
  - Power consumption, bale weights & moisture, boiler efficiency, ash resistivity, particle size distribution, bulk densities, etc.
- Collect & Characterize Coal, SWG, and Ash Samples

Interim Test Burn Statistics

- Co-fired 1,673 bales of SWG (781 tons)
  - Average weight of 931 lbs.
  - Average moisture 12.9%
- Generated Approx 1,100 MWh (from SWG)
- Gathered nearly 300 samples for lab analysis
  - Coal, SWG Samples (baled, debaled, ground), Ash Samples (Bottom ash, Fly ash, Economizer), Bottom Ash Liquids
- Collected 2,760 lbs. of Fly Ash for Analysis & Testing
  - 160 lbs. from auto sampler (5 gallon buckets)
  - 2,600 lbs. from bulk samples (55 gallon drums)

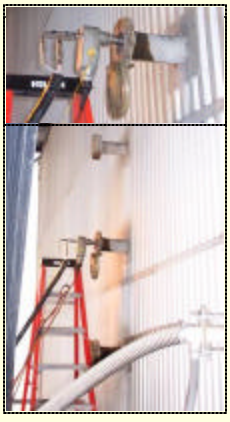
Interim Test Burn Statistics

- Daily SWG Feed Rates
  - Average = 8.9 tph (1.9% of heat input)
  - Range: 5.6 to 10.6 tph (1.1% to 2.2% of heat input)
  - Maximum *Instantaneous* Feed Rate: 11.6 tph
- Gathered & analyzed 6000 minutes of CEMS data for comparison during December Test Period
  - 53 hours of cofire data; 47 hours of coal-only data
- Gathered & analyzed 30-days of pretest CEMS Data
- Collected data from OGS Data System 24 hr/day, minute-by-minute (automated collection)
  - About 80 parameters (T, P, Flows, Amps, Power, etc.)



Emissions Monitoring (GE)

Emissions Probe In Outlet Duct



GE's Mobile Emissions Lab

GE's Emissions Vans at Stack

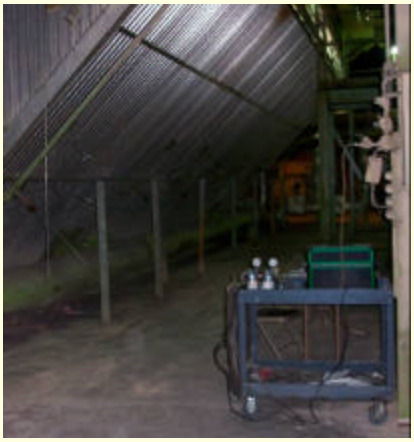
CO, NO_x, O_2, PM, PM_{10}, Hg, Cl

Emissions Equipment at OGS

CEMS Probes In Outlet Duct

SO_2, NO_x, Opacity

Portable Emissions Monitor



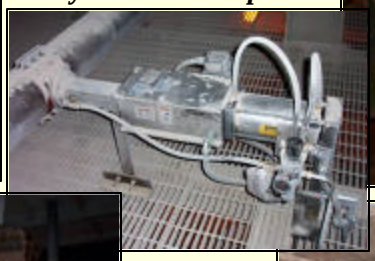
CO, SO_2, NO_x, O_2

Other Sampling

Bottom Ash Liquids

Economizer Ash

Fly Ash Auto Sampler



Bottom Ash

Bulk Fly Ash

Bale Counting & Flow to Boiler

Other Measurements at Biosilo

Ash & Coal Samples




Debaled and Ground Switchgrass

Debaled Switchgrass

Ground Switchgrass

Interim Test Burn Emissions Results

- From Continuous Emissions Monitoring System:
  - Average SO_2 emissions decreased by over 4%
  - Average NO_x emissions did not change
  - Average Opacity increased by 0.4 *percentage points*
    - Not a problem under normal conditions
- From Stack Emissions Testing:
  - Particulates decreased by 4% (PM), and 14% (PM10)
  - CO emissions did not change
  - Mercury emissions decreased by 7%
  - Chlorine emissions increased by 11%
- IDNR/EPA supportive of permitting for full-scale, permanent installation for commercial operations

Interim Test Burn Ash Results

- Extensive testing & analysis program is in process
  - Chemical & physical properties, freeze/thaw, slump, X-ray diffraction, compression strength (vs. time), blend/mixing requirements & strategy
- Ash samples met mandatory chemical and physical requirements specified for Class C fly ash in ASTM C 618
- Next steps:
  - Complete testing, analysis, report (March 2005)
  - Arrange test application/site for fly ash from Long Term Burn

Interim Test Burn Ash Results

"All test results from both Phase 1 and Phase 2 of this project have indicated that the co-combustion fly ash is essentially the same as the baseline fly ash from OGS. Hence, I do not believe that it should be treated any differently than the fly ash that is currently produced at OGS. However, only the DOT can comment on their acceptance of the co-combustion fly ash. The technical information provided by this study strongly supports the concept that fly ash is a resource that should be recycled, even if it is produced from the co-combustion of coal and switchgrass and thus does not meet the current ASTM C 618 definition of fly ash. Since the DOT has never hesitated to construct their own specifications in prior situations like this, I anticipate that they will behave in a similar matter on the co-combustion issue. They need good fly ash to meet their construction needs - OGS produces good fly ash."

Dr. Scott Schlorholtz, Iowa State University

Interim Test Burn Results

- No statistically significant reductions in boiler efficiency
- Good switchgrass burn-out
  - Small quantities in fly, bottom, & economizer ash
- Steady-state operation at 12.5 ton/hr was difficult
  - Equipment modified and tested in August
    - Problem solved and demonstrated; incorporated in final system design
    - Finer switchgrass grind produced at same time

Business Development Progress

- Incorporation of Prairie Lands LLC
- Biomass Supply Agreement
- Production Tax Credit
- Outreach Efforts
- Pathways to Phase III

Business Development Progress

Incorporation of Prairie Lands LLC

- Accomplished in September 2004
- Steve Gardner – President
- Legal entity empowered to negotiate with IPL, grower / suppliers, premium power, and bio-product customers
- Next steps include:
  - Revise business plan
  - Negotiate grower / supplier contracts
  - Obtain premium power customers

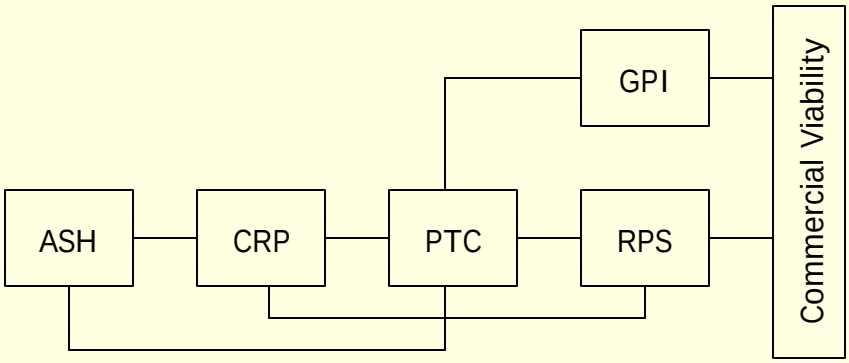
Business Development Progress

Biomass Supply Agreement

- Signed by IPL and Prairie Lands in September 2004
- Product of weekly telecons over two months, multiple departments, culminating with intensive principal to principal, facilitated in-person negotiation at Alliant HQs
- Protects IPL customers and shareholders concerning regulatory and cost exposure
- Contract good for 5 years or 300,000 tons
- Pricing formula passes value to Prairie Lands
- Flexibility to negotiate premium power and environmental value added
- Several risk factors accounted for (PTC, test results, sufficient funding)

Business Development Progress

Pathways to Commercial Success



Business Development Progress

Production Tax Credit

- Obtained via H.R. 4520 signed by the President in October 2004
- Credit goes to IPL but value flows to farmer via higher offering price for switchgrass
- Equivalent to $35 per ton of switchgrass
- Credit available for 10 years without reduction due to Federal funding
- Must have system built and cofire some switchgrass before January 1, 2006 expiration

Business Development Progress

Outreach efforts

- Premium power sales – already identified major federal customers in Iowa and Minnesota. Plans on accessing large industrial customers via Alliant's Second Nature program.
- Farmer outreach to add to supplier base and to impose field management plans
- Development of website to facilitate both supplier signups and premium power sales
- Prairie Lands business model to explore other value added opportunities such as plastics
- Share information on vast and unique knowledge of feedstock characteristics from field to stack

Business Development Progress

Pathways to Phase III

- Sell / market the premium power generated by SWG (value up to $25 per ton)
- Improve yields by implementing management plans
- Lower operating costs at process building (current estimated cost at $16 per ton)
- Use CRP land and gain ability to harvest annually (lower current costs up to $13 per ton)
- Expand Iowa RPS (value = $19 to $48 per ton)

Alliant Involvement

- Devote operations and management staff and lead project engineer
- Access to largest single generating unit in Iowa for modifications and testing
  - Alliant is the largest cost-share partner
- Pursue interests that promote renewable energy and development of a biomass market
- Execution of Fuel Supply Agreement with PL
- Outreach efforts

Alliant Perspective

- Opportunity for good PR in Southern Iowa
- Among most attractive CO_2 mitigation strategies evaluated
- Test results to date are very promising
  - Emissions – permitting, SO_2 & Hg reductions
  - Ash
  - Operations
- Long-term test expected to yield promising results
- Support moving forward to commercial operation
  - Pending results from Long Term Burn
- *Second Nature* (National Top 10 Green Power Program)
  - Need/desire to add biomass project in Southern Iowa
- Foster economic development in Southern Iowa

Feedstock Technology

Kelderman Manufacturing

- Advances in harvest techniques and methods have been much to the credit of Gary Kelderman, through his participation as a harvester.
- Gary continues to develop new techniques and equipment to be utilized in increasing the efficiency and cost effectiveness during harvesting and staging of switchgrass bales.

Feedstock Technology

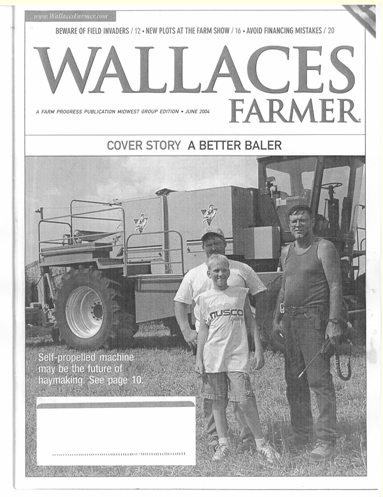
Self-propelled Baler

Feedstock Technology

Baler benefits

- Simplifies process
- Minimize costs through direct cutting, sickle bar attachment
- Addition of accumulator – drops 3 bales
- Adaptable – could be used for baling small grain straw, dried corn stalks, stubble from grass seed production, and other types of biomass

Feedstock Technology



Prototype equipment featured as cover articles, interest by John Deere

Feedstock Technology

Staging and loading biomass for delivery to off-site storage

Feedstock Technology

Strategies for efficiency and cost reduction

- Staging methods –
  - Develop equipment that will haul trailer, pick up bales and place on trailer without unhooking trailer
  - Eliminate load time for semi-driver
- Harvest methods –
  - Develop bale singulator that will leave stacks of 3 or 6 bales for more efficient loading

Feedstock Technology

Investigated alternative storage options to maintain feedstock quality
Fully enclosed buildings ensure low moisture, high BTU value

Feedstock Technology

Delivery of feedstock into off-site storage

Feedstock Technology

Telescopic forklift with hydraulic push off bars for handling biomass

Diversion System Design

- Developed for collection of processed switchgrass into 1000 pound bags
- Biomass is ground but not cofired
- Allows potential for biomass processing to occur during power plant outages
- Value-added products

Agronomic Research

- The first phase of the project was the critical homework stage where detailed investigation and planning were the emphasis.
- Much of that research revolved around agronomic practices and investigating production, genetic, and economic analysis of switchgrass production.
- The current phase of the project focuses on the development of convincing data that sufficient work has been completed to carry the project into the final phase of validation and commercialization.

Agronomic Research

Cropping Systems Research

Harvest Impacts on Wildlife

Agronomic Research

Soil Stability and Erosion

Carbon Sequestration

Agronomic Research

Switchgrass Production Studies

Dual Purpose Management

Agronomic Research

- Outcomes
  - Rapid, low-cost method for predicting biomass productivity
    - Contracting purposes
    - Inventory control
  - Development of site-specific management practices
  - Other results to date summarized in Agronomic Research Review, July 2004
  - ISU Extension Publications

Agronomic Research -- Reports

Switchgrass Management Guide


Management Guide for the Production of Switchgrass for Biomass Fuel in Southern Iowa

IOWA STATE UNIVERSITY
University Extension

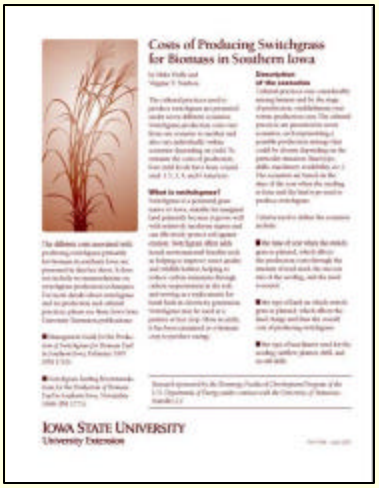
Switchgrass Seeding Guide


Switchgrass Seeding Recommendations for the Production of Biomass Fuel in Southern Iowa

IOWA STATE UNIVERSITY
University Extension

Agronomic Research -- Reports

Switchgrass Production Costs


Costs of Producing Switchgrass for Biomass in Southern Iowa

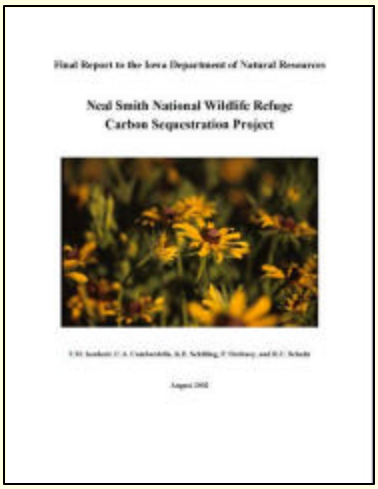
IOWA STATE UNIVERSITY
University Extension

Switchgrass Soils & Varietal Study


Switchgrass Production in Iowa: Economic Analysis, Soil Suitability, and Varietal Performance

Agronomic Research -- Reports

Carbon Sequestration Studies



- Other Research Results:
  - Cropping systems
  - Avian studies
  - Warm-season grasses
  - Properties of a wide variety of prairie grasses

Project Goals Remaining

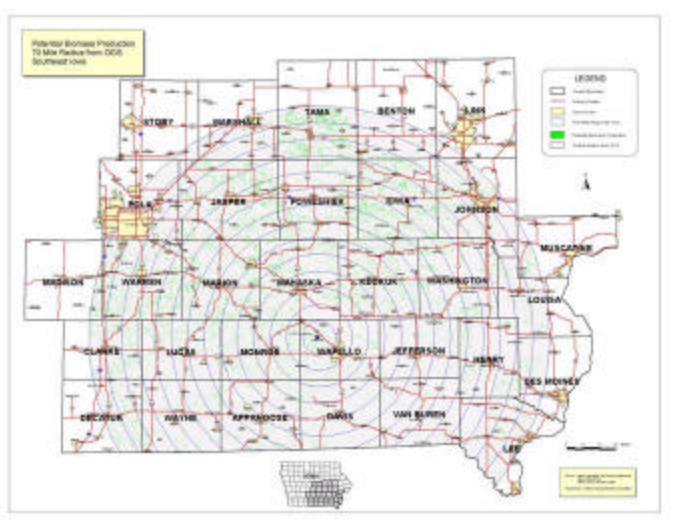
- Continuing research
  - Increase yield
  - Genetic breeding
  - Management
- Long Term Burn
  - Boiler performance
  - Long term impacts on boiler
  - Demonstration of process equipment, system
  - Demonstration of integration into real industrial conditions and commercial operation, on a smaller scale
- Supply & market development

Project Goals Remaining: Long Term Test Burn

- Tentatively scheduled for winter 2005/2006
- 2000 hour cofire test, 24-7
- 25,000 tons of switchgrass

- **Objectives:**
  - Obtain data to prove that cofiring will not adversely affect boiler condition or performance
  - Convince industry that technology has been developed that could easily be scaled up to commercial operation

Project Goals Remaining: Supply Development



Budget Issues

- Funding requirements for completion
  - FY05 – $4.5 million
    - Relocate & reconfigure scaled back test facility
    - Initial cost of conducting Long Term Burn
  - FY06 - $1.6 million
    - Balance of cost for conducting Test Burn
    - Final reporting
    - Close out
  - As discussed in Feb. 04 “White Paper” / Meeting
- Costs per year of delay: $1.1 million
  - Also causes cost-share deficit
  - PTC, Supply Agreement Expiration

Home-grown Renewable Energy