Cellulosic Feedstocks: Mitigating Risk and Cost Through a Portfolio Approach

ABLC Feedstocks
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Sam Jackson, VP Business Development

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Genera Energy

- Privately held biomass supply company operating since 2008, based in Vonore, TN
- Bringing an industrial approach and experience to agricultural biomass supply
  - Crop production, harvesting & logistics, biomass pre-processing, management services
  - Most experienced company in the U.S. producing, managing & processing a wide variety of biomass feedstocks
- Custom-tailored biomass supply chain solutions
  - Design, develop and implement project- and customer-specific feedstock supply solutions
  - Focus on reliable supply, consistent quality, highest feedstock value to customer
- Front-end and back-end feedstock portfolio approach
  - Multiple feedstock sources reduce risks and costs with year-round just-in-time supply
  - Early fractionation allows highest value use for each biomass component stream, including biomass-based materials & products
- Extensive partnerships all along the supply chain

Feedstock Supply Chain Risk

Climatic Risk

- Drought/Flooding
- Insects
- Disease
- Crop access at harvest

Quality Risk

- Contaminants
- Inorganic compounds
- Decay through storage
- Inhibitors

Economic Risk

- Yield per unit feedstock input
- Increased processing costs
- Unrealistic expectations on feedstock cost

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Purpose-Grown Crops

Perennial Crops

- Switchgrass
- Energy Cane
- Giant Reed
- Miscanthus
- Napier Grass
- Wide Hybrids

Annual Crops

- Biomass Sorghum
- Sweet Sorghum
- Tobacco

Woody Crops

- Short-rotation Hybrid Poplar
- Short-rotation Hybrid Willow
- Yellow pine

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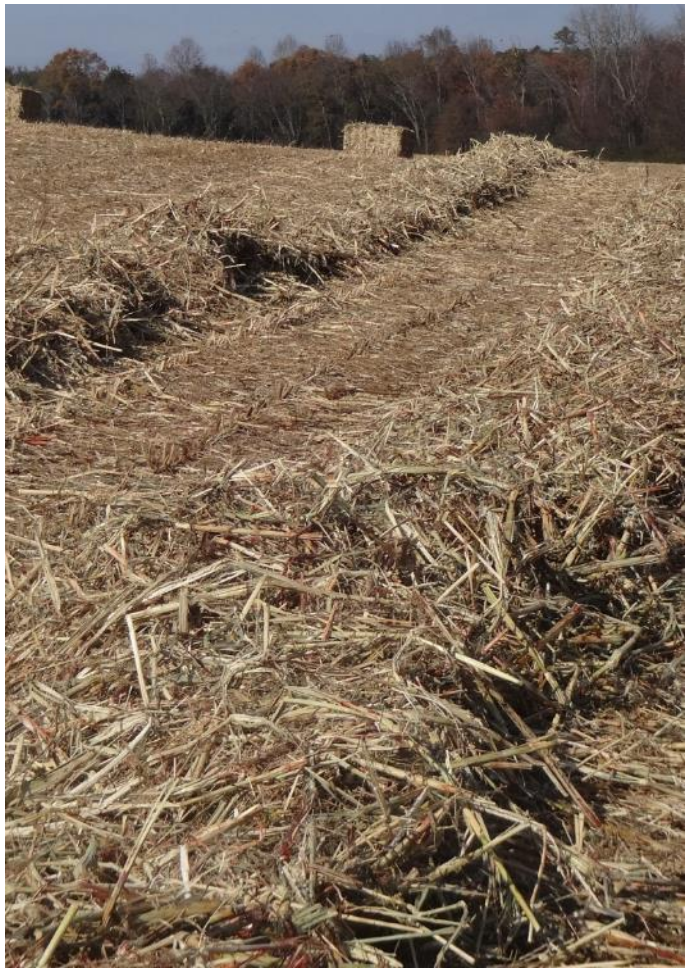
Benefits of Purpose-Grown Crops

- Feedstock Portfolio
  - Utilization of multiple crops
    - Reduces storage requirements and storage loss
    - Makes seasonality an advantage
    - Reduce impacts of climatic variation
    - Allows supply solutions with just-in-time direct delivery year round
  - A mix of annual and perennial crops
    - Improves access to land
    - Offers potential adjust area planted annually to buffer supplies

Benefits of Purpose-Grown Crops

- Cost and Availability
  - Perennials reduce quantity and price risk by contracting for long periods of time (5-10 years) with structured pricing
  - Certain harvest methods, like direct chopping, moves initial sizing to the field
    - Reduces overall material handling and milling costs
    - Allows for bulk (automated) delivery
  - Density of yield can make harvesting and collection more economical

Challenges of Purpose-Grown Crops



- Less opportunistic feedstocks
  - May make more land available though
- Require dedicated land for production
  - Multiple uses of purpose-grown crops
  - Double crop rotations
- Some energy crop management systems not fully developed
  - Advancements are occurring

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Benefits of Purpose-Grown Crops

- Quality Control
  - Reduce levels of contaminants in feedstocks (lower ash)
  - Normally have wider harvest windows than residues
  - Perennials are normally very dry at harvest, increasing storage ability
  - Well trained operators can conduct quality control in the field and during operations

Contaminants in Feedstocks

- Inherent Ash
  - Inorganics
    - Al, Ca, Cl, Fe, K, Mg, Na, S, Si
  - Solubles vs insoluble
- External Ash:
  - Soil – Si
  - Rocks
  - Debris

Thermochemical Case Study

- Feedstock must meet end user specs
  - Low silica
  - Low chlorides
  - Reasonable economics
- Inorganics caused
  - Equipment fouling
  - Negative impacts on catalyst life

- Analysis included:
  - Switchgrass
  - Miscanthus

Thermochemical Case Study

- Chlorine
  - Drivers:
    - Soil type
    - Agronomic management inputs
  - Methods of addressing the issues:
    - Alteration of fertilization regime
    - Washing – shown to reduce chloride in miscanthus and switchgrass by over 94%
    - Evaluating other crops
- Silica
  - Drivers:
    - Soil type
    - Plant component
    - Water-use efficiency of plant
  - Methods of addressing the issues:
    - Sandy soils have less mobile silica
    - Separation of leaves from stems in harvesting or processing
    - Further mechanical separation

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Integrated Feedstock Supply Systems

- Supply chain advances include:
  - Improved and customized crop production practices
  - Most robust harvesting options for multiple crops and technologies
  - Improved logistics and storage techniques
  - Reduced energy consumption in preprocessing

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Summary

- Purpose-grown crops are high quality, diverse feedstocks
- Perennials and annuals provide opportunities for a portfolio approach
- Purpose-grown crops reduce climatic, quality, and cost risk in the supply chain
- High quality, consistent feedstocks provide robust end product economics

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Delivering Sustainable Biomass Solutions

Genera Energy Inc.
167 Tellico Port Road
Vonore, TN 37885

423.884.4110 – Phone
423.884.4129 – Fax

www.generaenergy.com