Agricultural Fiber Opportunities

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Genera Inc. • 167 Tellico Port Road • Vonore, TN • www.generaenergy.com
1 | Suitability

2 | Availability

3 | Practicality

4 | Reliability

5 | Cost
Integrated Feedstock Solution

Over nearly a decade, Genera has developed the country’s leading purpose-grown biomass supply chain, fully integrated from identification, recruitment and management of land through crop establishment, annual management, harvesting, logistics and transportation, inventory management, material handling, and mechanical sizing and processing.

- Genera has completed dozens of projects focused on biomass feedstock development and supply for fuel, chemicals, electricity and other product applications; seven of these projects involved over 100,000 tons of annual biomass feedstock supply.
- Specific customers Genera has served include three of the ten largest oil and gas companies in the world, five Fortune 500 companies, two of the world’s largest livestock producers, an international biopower corporation, and several small to medium sized privately held companies.
- Developed partnerships and collaborations with leading ag producer groups, equipment manufacturers, seed and input suppliers, processing equipment vendors.
- Extensive variety trials and demonstration plots across the U.S., with multiple partners.

Agrished® Management
- Planning
- Land
- Production
- Harvest
- Logistics
- Storage
- Inventory
- Handling
- Milling
- Transport

Supply ASSURE® System
- Data-Rich Feedstock Supply & Cost Model
- Landowner Relations & Contracts
- Proven Establishment Success
- Optimized Harvesting Systems
- Max Axle Weight Efficiencies
- Moisture Management
- Optimized Location & Scheduling
- Risk Management & QA/QC
- Project-Specific System Design
- Maintain Quality & Minimize Cost

BIN-SPEC® Processing
Genera has spent more than a decade building dedicated agricultural biomass supply chains

• Perennial Herbaceous Crops
  – Switchgrass
  – Energy Cane
  – Arundo Donax
  – Energy Cane

• Annual Fiber Crops
  – Biomass Sorghum
  – Hemp
  – Kenaf
  – Tobacco

• Crop Residues
  – Sugarcane Bagasse
  – Wheat Straw
  – Corn Stover
  – Other Straw Residues

• Woody Biomass
  – Short Rotation Hybrid Poplar & Willow
  – Forest Residues
  – Secondary Processing Residues
• Composition (lignin)
• Homogeneity (heterogeneity)
• Location
• Seasonality
• Sustainability
• Scale
497 million DT available

- in 20 years
- at $60/dt
- 1-3% yield growth
- moderate housing growth
- moderate energy growth

**Herbaceous Crops**
- Switchgrass
- Miscanthus
- Biomass Sorghum

**Herbaceous Crops** (continued)
- Wheat Straw
- Other Straws (Barley, Oat, Rye)
- Sugarcane Bagasse

**Short Rotation Woody Crops**
- Poplar
- Willow
- Eucalyptus

**Agricultural Residues**
- Poplar
- Willow
- Eucalyptus

**Forestry**
- Hardwood
- Softwood
- Mixed Wood

Potential Production by Biomass Type

Annual & Perennial Crops
340.2 million

Wheat & Other Straws
21.4 million

Sugarcane Bagasse
3.8 million

Short Rotation Woody Crops
71.0 million

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# Feedstock Considerations

<table>
<thead>
<tr>
<th><strong>Switchgrass</strong></th>
<th><strong>Biomass Sorghum</strong></th>
<th><strong>Wheat Straw</strong></th>
<th><strong>Long-Fiber Annual Crops</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>High yield (6-8 tons/ac) perennial grass</td>
<td>High yield (7-12 tons/ac) annual crop</td>
<td>Secondary post harvest residue</td>
<td>Limited scale production today</td>
</tr>
<tr>
<td>Drought tolerant native species</td>
<td>Drought resistant, highly adapted</td>
<td>Also winter cover crop</td>
<td>One annual harvest</td>
</tr>
<tr>
<td>One annual harvest, Nov – Feb</td>
<td>One annual harvest, Aug – Oct</td>
<td>Yields 1.5 - 2.5 tons/acre</td>
<td>Yields are highly variable</td>
</tr>
<tr>
<td>Grows well on low productivity soils</td>
<td>Good fiber quality, in 15’-20’ stalks</td>
<td>One annual harvest, May – June</td>
<td>One annual harvest, Aug – Oct</td>
</tr>
<tr>
<td>Minimal management requirements</td>
<td>Low chemical use vs. other row crops</td>
<td>Works well in crop rotations</td>
<td>Potential fractionation valorization</td>
</tr>
</tbody>
</table>

## Supply Chain
- Acreage / yields
- Bulk density
- Seasonality
- Equipment
- Land use competition
- Familiarity
- Risk

## Pulpability
- Process yield
- Lignin content
- Fiber length & properties
- Material handling
- Silica, elementals
- Color, bleachability

## Sustainability
- Land use
- CO2 footprint
- Water intensity
- Chemical usage
- Energy intensity
Complex Supply Chains

Robust ERP System integrating procurement, BOMs, inventory tracking, fixed assets, maintenance schedules, contracts, AR/AP, Payroll

- Scoping Modeling Trials/Demo Validation Assumptions
- Targeting Incentives Timing ID Key Stakeholders Outreach Marketing Community Relations
- Tax Legal Targeting Recruiting Incentives/Programs/Easements Contracts Land Owner Relations Tracking Evaluations & Assessments Renewals Renegotiation Communication
- Format Specifications & Tolerances Spatial Data Collection Labor Safety Procedures Nutrient Mgmt Input Procurement Scouting Pest & Disease Mgmt
- Storage Site Prep In-field Logistics Site Security Inventory Entry
- Inventory Entry Lot Tracking SOPs Safety Training Security Insurance & Risk Mgmt Continuous Monitoring Shrinkage Quality Control Stack/Pile Maintenance
- Equipment Labor SOPs & Training Dispatch Preventive Maint. Transport Regs Tracking Safety
- Packaging Lab Tests Particle Size Dist. Bulk Density Staging Sampling Cert of Analysis
- Variety Trials Crop Mix Soil Mapping Variety Selection Seed/Plant Procurement
- Customer Requirements Planning Vendor Qualification Timing & Scheduling Equipment - Staging Labor Training Geospatial Safety Data Collection
- Logistics & Inventory Management Equipment - Staging Labor Training Geospatial Safety Data Collection
- Sizing & Material Handling Staging/Loading Quality Control Material Prep. Delivery
- Varieties Trials Variety Trials Crop Mix Soil Mapping Variety Selection Seed/Plant Procurement
- Customer Relations Planning Weather Forecasting Timing
- Quality Control Scheduling Weather Forecasting Turnaround Time GPS Monitoring Weighing
- Sorting/Cleaning/Separations Tracking Labor Equipment System Entry & Flow

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Portfolio Approach

- Overall, a more robust supply chain
- Allows within-year adjustment of production and supply
- Buffers against climatic and disease/pest impacts
- Allows management of storage losses and degradation
- Distributes risk
- Competitive tension promotes market pricing
- Tailored pulp performance / characteristics with blending
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1. Lower feedstock costs through supply chain integration & innovation

2. Reduce price volatility with long-term contracts & tailored biomass portfolio

3. Lower risk profile across the agricultural supply chain

4. Generate more consistent quality, improving process yields & lowering operating costs
Cost Reduction Opportunities

- Preprocessing
- Inventory Control
- Harvest/Transport
- Crop Production
- Crop Establishment
- Mngmt and Risk

Feedstock Cost ($/dt)

- Piecemeal Supply Chain
- Integrated Supply Chain
- Optimized Supply Chain

Improvement Through Integration

Improvement Through Innovation
Operational Cost Advantages & Opportunities

- Predictable costs
- Long-term supply contracts
- Fungible feedstocks = redundancy
- Year-round just-in-time supply

- Clean, consistent feedstock stream
- Cost effective buffer stock solutions
- Fractionation into constituent components
- Tailoring feedstocks to process or application
the

RIGHT FEEDSTOCK

for the

RIGHT PROCESS

in the

RIGHT PLACE

at the

RIGHT TIME

in the

RIGHT FORMAT

at the

RIGHT COST
Lessons Learned

- There are no fairy tale feedstocks
- Feedstocks are expensive
- There’s no such thing as a waste feedstock
- Predictability and reliability are critical
- Designing around feedstocks is actually much more effective—and cheaper—than redesigning to accommodate feedstocks

Even good feedstocks can behave badly ... and they will if left to chance

DO NOT START HERE

- Invasiveness potential
- High cost of establishment
- Specialized equipment

- Minimal experience at scale
- Limited risk management tools
- Dependence on incentives
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