Bioenergy Supply Chains

The Biorefinery Perspective

April 23, 2013

Agenda

Introduction To Renmatix

Biorefinery Facility Biomass Needs

Feedstock Supply Agreement Terms
Renmatix Has A Novel Approach To Cellulosic Sugar Production Compared To Existing Routes

Enzymatic hydrolysis  Acid hydrolysis  Gasification

Renmatix advantage

Capex ✓ Speed of process (minutes vs. days) ✓ Materials of construction and not having acid recovery ✓ Less complex system; no expensive catalysts

Opex ✓ Lack of expensive consumables (enzymes) ✓ Less consumables and resulting waste streams ✓ Higher yield of carbon in biomass to useful products

Technology Overview:
The Plantrose™ Process – Renmatix’s Fast & Flexible Platform

Feedstock  Very Fast Reaction  Products

Biomass
- Woody Biomass
- Agricultural Residues
- Energy Grasses
- Waste Sources

Hemicellulose Hydrolysis reactor  Hemicellulose solid/liquid separation

Supercritical Hydrolysis (SCH) reactor  SCH solid/liquid separation

Xylose liquor  Sugars  Glucose liquor  Lignin

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Many Types Of Biomass Are Used By Biorefineries For The Production Of Biobased Energy, Fuels & Chemicals

- Wood chips
- MSW
- Switchgrass
- Biomass pellets
- Empty palm fruit bunches
- Corn Stover
- Wheat Straw
- Sugarcane Bagasse
- Miscanthus

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Key Characteristics Are Common Across The Value Chain For A Variety Of Upstream Feedstocks

Value Chain For Woody Biomass

- Biomass
  - 10-20% of cost attributed to stumpage
- Harvesting
  - ~50% of cost attributed to logging
- Freight
  - 15-20% of cost attributed to shipping
- Processing
  - 15-20% of cost attributed to chipping

- Value chains for different biomass differ in cost splits and required processes, but will fundamentally follow these stages before it is usable by biorefineries
  - E.g. Stover and grassy biomass would need baling before transportation, and would not require chipping

Upstream Requirements Fit Into Two Categories: Biomass Facility Requirements & Feedstock Requirements

Facility Requirements

- Land, power, water, rail access roads, and other infrastructure
- Appropriate zoning, permits, EPA approval, etc.
- Proximity to the biorefinery
- Large volume of biomass available within a reasonable procurement radius

Feedstock Requirements

- Good composition: cellulose, hemicellulose, lignin, others
- Able to meet specs: size, density, shape, etc.
- Good price: USDA estimates $40-60/ton as typical price of feedstock
- Year-round guaranteed supply, ability to inventory, etc.
Biorefineries Use Different Types Of Biomass Based On The Process Requirements And Supply Chain Feasibility

Feedstock Characteristics – Determined By Testing
- **Composition** plays a vital role in processes. Biomass is tested for key components (cellulose, hemicellulose, lignin) as well as certain organic acids and extractives
- **Seasonality** plays an important role in the composition of the biomass
- **Ash and other contaminants** in the biomass have degenerative effects on equipment and end products

<table>
<thead>
<tr>
<th>Company</th>
<th>Current feedstock</th>
<th>Future feedstock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renmatix</td>
<td>Hardwood chips</td>
<td>MSW, Corn stover etc.</td>
</tr>
<tr>
<td>DuPont</td>
<td>Corn stover</td>
<td>Switchgrass</td>
</tr>
<tr>
<td>POET-DSM</td>
<td>Corn stover</td>
<td></td>
</tr>
<tr>
<td>Beta Renewables</td>
<td>Arundo Donax</td>
<td>Wheat Straw</td>
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<tr>
<td>KIOR</td>
<td>Pine chips</td>
<td>Forest residue</td>
</tr>
</tbody>
</table>

Biomass Being Used As Feedstock By Biorefineries

Biomass Composition

- **Hardwood**
- **Switchgrass**
- **Corn Stover**
- **Miscanthus**

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**Introduction To Renmatix**

**Biorefinery Facility Biomass Needs**

**Expected Feedstock Supply Agreement Terms**

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Typical Topics Covered In Feedstock Supply Agreement (Slide 1 of 3)

**Sustainability Of Feedstock / Supplier Certification**
- For woody biomass, suppliers need to be certified to ensure that the feedstock comes from forests managed in accordance with strict environmental and social standards.
- Safety certifications might be necessary to follow regulations in certain cases.

**Supply Quantity And Inventory Management**
- The quantity of biomass delivered to the plant should comply with the contract.
- Supply of biomass should ensure that plant has feedstock for 24x7x360 operations.
- Delivery should ensure there is sufficient inventory buffer for bad weather conditions/other emergencies.

Typical Topics Covered In A Feedstock Supply Agreement (Slide 2 of 3)

**Product Specifications**
- Composition of the biomass - Cellulose, Hemicellulose, Lignin and others.
- Ash content – intrinsic and extrinsic.
- Bark/other impurities present in the biomass.
- Size of the biomass entering the plant.
- Mix of species permissible.

**Biomass Procurement, Handling, And Size Reduction**
- The partner should provide an uninterrupted supply of biomass.
- Biomass brought to facility must be weighed, validated for quality and stored.
- Size reduction of biomass includes grinding/chipping/separating etc.
Typical Topics Covered In A Feedstock Supply Agreement (Slide 3 of 3)

### Pricing methodology

Biomass pricing includes the following:

- Biomass cost
- Biomass procurement costs
- Biomass processing cost
- Overhead fee for running the scale house, accounting services, human resources, safety training, purchasing support and Chip quality consultation services
- Inventory carrying cost

### Length of contract and Payment terms

- Terms negotiated in the agreement with a supplier include the length of the contract which dictates how often the terms can be modified in terms of pricing and delivery terms.
- The payment schedule is also an important factor.
  
  e.g. Prior to the start of each Contract Year, Seller determines projected total cost of ready-to-use biomass (including overhead charge) and divides that amount by 52. The result shall be the weekly invoiced amount.

Questions?