Biomass Conversion Feasibility Study

Supply Analysis

Presentation to
2nd Annual Biomass Workshop

Presentation by
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Feedstocks

Biomass	
Flax shives	
Oat hulls	
Sunflower hulls	
Wheat straw	
Hemp hurds	

Feedstocks

Biomass	Potential Suppliers
Flax shives	Schweitzer-Mauduit
Oat hulls	Can-Oat Emerson Milling
Sunflower hulls	Keystone Grain Nestibo Agra Prairie Sun Seeds
Wheat straw	Manitoba Straw Coop Individual producers
Hemp hurds	Emerson Hemp Distribution Company

Feedstocks

Biomass	Current Quantity
Flax shives	60,000 – 70,000 t/yr
Oat hulls	48,500 t/yr
Sunflower hulls	11,000 – 13,500 t/yr
Wheat straw	Depends upon area
Hemp hurds	negligible

Feedstocks

Biomass	Approximate Costs
Flax shives	$25 - $30 per tonne
Oat hulls	$30 - $40 per tonne
Sunflower hulls	$30 - $45 per tonne
Wheat straw	$5 - $25 per tonne
Hemp hurds	$0.20 per pound ($440 per tonne)

Transportation

- Given the volumes of this material most, if not all transportation needs will need to be met by trucks.
- Most rail movement today occurs in 100 car unit trains that can carry at least 60,000 tonnes per train.
- While there may be an option to look at rail transportation for the Pine Falls, Brandon/ACC and Parkland regions, preliminary analysis indicates that trucking is the lowest cost option.
- According to one estimate the cost of rail freight from Portage to Brandon was $13.33 per tonne as compared to $9.52 per tonne by truck.

Storage options

Feedstock	Storage
Flax shives	- Outside - Inside for screened product (e.g. Powerlog)
Oat hulls (ground)	- Flat bottom grain bins - can be stored outside
Sunflower hulls	- Hopper bottom bins - for unloading, walking floor trucks would need solid floor
Wheat straw	- Options depend upon use - refer to Straw Procurement Business Case Study
Hemp hurds	- Potential for high value products could involve enclosed storage

Feedstocks

Biomass	Composition
Flax shives	• Relatively low ash content • Relatively high energy value
Flax shive pellets	• Relatively low ash content • Relatively high energy value
Oat hulls	• Moderately low potassium, chlorine and nitrogen • Relatively high energy value
Sunflower hulls	• Quite high potassium levels • Moderate energy value
Wheat straw	• Quite high in ash, N, K and Cl • Moderate energy value
Hemp hurds	• Moderate energy value

- Study continuing to assemble information
- Lack of information particularly blended feedstocks
- Feedstocks must be individually analyzed for composition as feedstocks will vary significantly

Densification Processes and Quality Needs

Densification Process	Feedstock Material	Process Quality Needs
Cubes	Cereal straws, Flax shives, Milling residues, Wood residues, Cardboard, Oat hulls, Sunflower hulls	• Typically cube is ¾ in. by ¾ in. In various lengths. • Material ground prior to processing • Can accept wide variation of feedstocks • Moisture content target 17% however in range 15 – 20% • Quality of biomass depends on combustion system and the ability of the system to take material with higher ash content and high alkali metal content.

Densification Processes and Quality Needs

Densification Process	Feedstock Material	Process Quality Needs
Pellets	Cereal Straws, Milling Residues, Wood Residues, Oat Hulls, Sunflower Hulls	• Feedstock material first ground • If necessary feedstock then dried to about 10% (w.b.) • May be able to by pass drying stage with straw • High ash content of straw can lead to problems in combustion unit • High silica level in straw – greater abrasion in pellet plants (replacing parts) • Relatively low potassium and chlorine levels of oat hulls may ease combustion.

Densification Processes and Quality Needs

Densification Process	Feedstock Material	Process Quality Needs
Briquettes	Cereal Straws, Flax Shives, Milling Residues, Wood Residues, Recycled Cardboard, Oat Hulls, Sunflower Hulls	• Can accept wide variation of feedstocks • Companies vary in type of briquette produced and in feedstock particle size and m.c. • Briquetting Systems – m.c. Max 15%, particle size ¾ in by ¾ in by 1/8 in. • Quality of biomass depends on combustion system and the ability of the system to take material with higher ash content and high alkali metal content.

Densification Processes and Quality Needs

Densification Process	Feedstock Material	Process Quality Needs
Loose	Cereal Straws Oat Hulls Sunflower Hulls Flax Shives	• If feedstock produced in close proximity to end user may be option. • Vidir – BEST System uses loose straw. • Material ground prior to combustion • Feedstocks in loose form may not be homogeneous and free flowing and there may be feed in problems. • Study provides examples of oat hulls and sunflower hulls that have been utilized in loose form. • Quality of biomass depends on combustion system and the ability of the system to take material with higher ash content and high alkali metal content.

Determine best central base location with satellite facilities strategically located adjacent to feedstock

- *The selection of satellite facilities is dependent on the business case scenario*
- *For the most part, it appears that storage should occur near the processing plant of primary processing operators and having the material delivered on a JIT basis to the densification operation.*

Location for administration and sales office

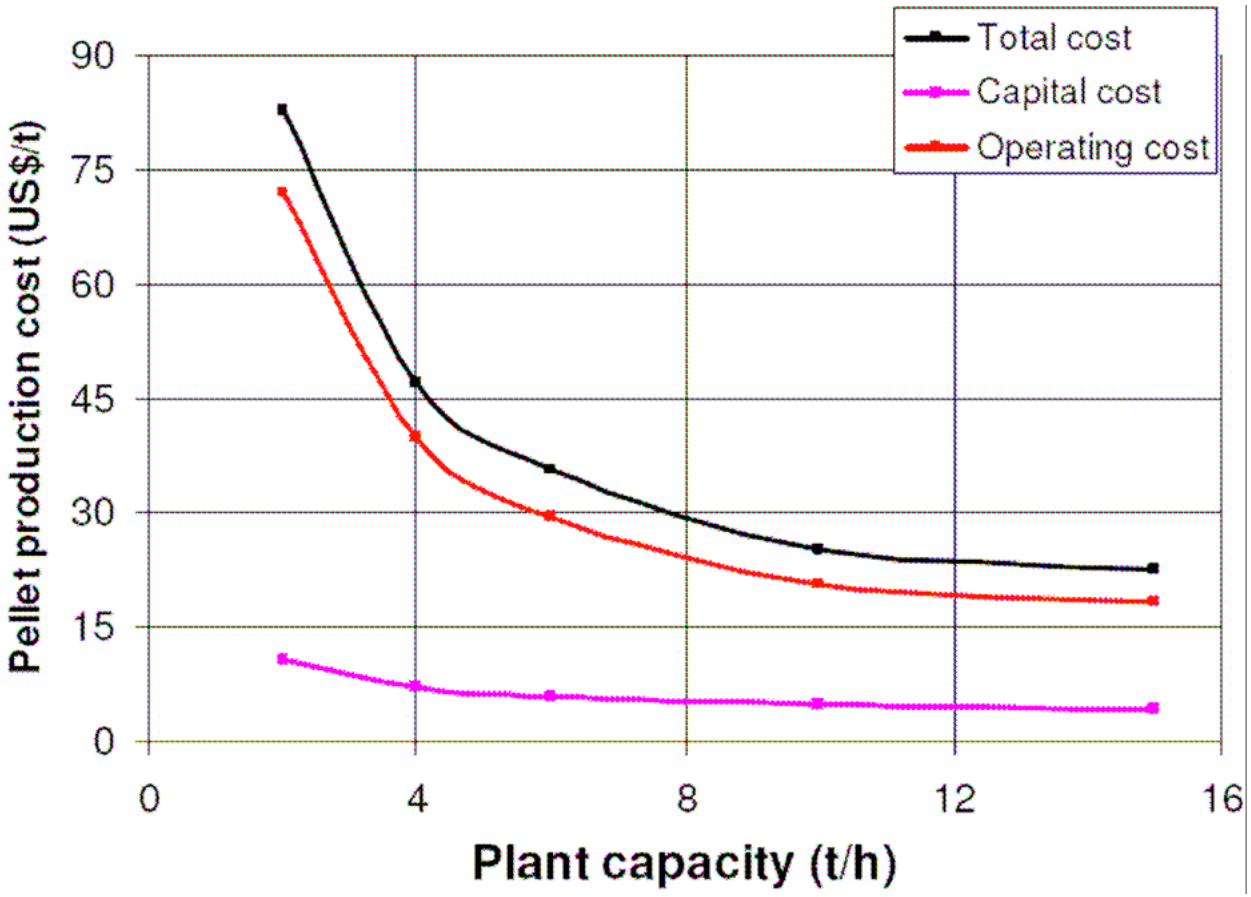
- Balance of numbers of suppliers versus numbers of buyers
- Need for plant tours or visits
- Communication systems can accommodate different configurations

Cost of a densification facility (including operating costs)

- Capital costs
  - Information to be provided in final report
- Operating costs
  - Pelleting of ground oat hulls - $15 per tonne
  - Cubing - $35 to $45 per tonne depending on quality and type of material
- There is limited information of the cost of converting ag bio-mass into pellets
  - Issue to consider are binding agents, power costs, and wear on the machinery
  - More applied research needs to be done on alternative feedstock materials
- The cost of densification is a moving target
  - Pellets appear to be the most expensive with cubes, pucks, briquettes, and logs being less expensive
  - The issue is what can end user employ in their process?

Cost of Densification

The following chart provides an illustrative example of the relationship between the capacity of the plant and the processing cost per tonne for finished product. Based on this information, a pilot plant operating at under 30,000 tonnes a year will be twice as expensive to operate as one operating at 100,000 tonnes per year.



Freight or transportation options for distributing final products

- *There are two aspects of the transportation challenge.*
  - *The first is the bulk transport of finished product to a storage depot and the second is transportation to end-users.*
- *The bulk transportation will need to occur in covered vehicles that are resistant to moisture absorption.*
  - *While there are a select number of customers who could be served by rail (e.g. Manitoba Hydro), most will need to be supplied by hopper bottom trucks.*
- *It should be noted that just like pulse crops and feed pellets, more gentle and less handling is desirable.*
  - *Replicating the handling and transportation practices in these sectors is advised.*
    - *For example, employing conveyor belt handling systems and methods to minimize drop distance during loading should be considered.*

Freight or transportation options for distributing final products (con'd)

- Rail versus Truck
  - For rail the availability of cars may be an issue (may have to lease or purchase cars)
  - For rail the per day cost of a car sitting on a CP or CN line is an additional expense
  - Estimates indicate that the cost of rail freight within Manitoba is higher than the cost by truck (for example, Portage to Brandon – by rail $13.33/t and by truck $9.52)

Determine requirements to solidify long term supply agreements with biomass feedstock suppliers.

- Issues to be addressed:
  - Location and quantities of supplies which must be stockpiled
  - Provisions for years of low supply
  - Plant shutdown
  - Length of contract (2 to 5 years, option to renew)
  - Price
  - Other contract details: price point, transportation, handling

Determine requirements to solidify long term supply agreements with end users of biomass solid fuels.

- End User Analysis Consultants have identified samples of agreements
- The RFEI from Ontario Power Generation includes some factors of interest (see the table on the next slide)
- An individual biofuel supplier may be willing to commit only part of its supply to one end user

Determine requirements to solidify long term supply agreements with end users of biomass solid fuels (con'd)

Solid Biofuel Specifications – OPG RFEI

Element	Unit	Typical (as received)
Heat content (min) – of the delivered fuel	Kcal/kg Btu/lb MJ/kg	4350 7850 18.2
Moisture	% (max)	10.0
Ash	% (max)	1.5
Sulphur	% (max)	0.01
Chlorine	% (max)	0.03
Nitrogen	% (max)	0.2
Density	Kg/m3	675
Particle size		
Binding agent		

Biomass densification patents or intellectual properties that could have major impact.

- Patents
  - Cubing - Prairie BioEnergy
  - Flax Power Ltd. – applied for patents for the processing equipment for the “firelog”
- Confidentiality
  - Pelleting equipment is “usually” purchased as patented but the details of the actual pelleting process used may be confidential

Feedstocks

Biomass	Ash	Energy (MJ/kg)
Flax shives	2.7	16.9 – 17.8
Oat hulls	5.2 – 7.0	16.2 – 19.5
Sunflower hulls	3.1 – 7.0	17.4 19.7
Wheat straw	3.0 – 8.0	18.2 – 18.7
Hemp hurds	4.8	17.0

Biomass Feedstock Data from PHYLLIS Database

Biomass	Ash (dry) %	Energy (HHV) kj/kg	Energy (LHV) kj/kg
Wheat Straw Pellets	7.7	17629	16298
Sunflower Pellets	6.8	17263	15799
Oat hulls	4.9	18083 (HHV milne)	
Sunflower shell	4	18000	16734
Flax shives	1.8	20190	18859

Energy contents can be expressed as Lower Heating Value (LHV) or Higher Heating Value (HHV). The Lower Heating Value (LHV) is closest to the actual energy yield in most cases. Higher Heating Value (HHV, including condensation of combustion products) is greater by between 5% (in the case of coal) and 10% (for natural gas), depending mainly on the hydrogen content of the fuel. For most biomass feedstocks this difference appears to be 6-7%. (Information from Bioenergy Feedstock Development Program at ORNL)