

Crumbles® Technology

Reactor-ready Feedstocks

2017 AE50 Award for Innovation In Biomass Feedstock Processing

BioEconomy 2017

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U.S. DEPARTMENT OF ENERGY

Since 1998…

USDA United States Department of Agriculture National Institute of Food and Agriculture

forestconcepts™

Industry Agnostic…

The new bio-economy needs cost-effective, quality optimized feedstocks…

Bio-Intermediates	Solid Bio-Fuels	Bio-Materials	Liquid & Gaseous Fuels
Reactor-ready Feedstocks	Wood chips	Industrial fiber	Cellulosic ethanol
Precision Feedstocks®	Processed wood chips	Absorbents	Butanol
Biomass-derived sugars	Residential pellets	Carriers (coated/infused)	Aviation Fuel (Jet A)
Aromatics	Industrial pellets	Erosion control materials	Methanol
Hydrolysate	Torrefied fuels	Filter media	Naptha
AFEX fiber feedstock	Biochar	Animal bedding	Renewable Diesel
Biocrude (pyoil)	Semi-activated carbon	Pet litter	Renewable Marine Fuel
Biocrude (HTL)	Activated carbon		Renewable Natural Gas
Syngas (gasification)			Green Gas (RNG)
Pyrolytic acid			Bio-based heating oil (No.2)
Acetic Acid			
Furfural			
Lignin			

More than 40 prospective customers waiting…

The Problem

The current standard of drying wood chips and hammermilling consumes an average of 70% of the total energy used in a pellet plant.

The Opportunity:

Reduce the upfront energy cost by 50% = $ millions in savings

Forest Concepts' Crumbles® Technology can…

and is about to go commercial!

Market Potential

Future Market Insights predicts:

Bio-plastic market $43.8B by 2020 at a CAGR of 28.8%

Build-out of the bio-economy industry between now and 2025 will require more than **$180 billion** of capital.

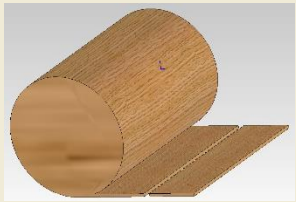
Our feedstock processing innovations apply to at least **$10 billion** of equipment.

What are Crumbles®?

- Flows like grain
- Crumble at Field Moisture
- Don’t dry unless needed

- Dry After milling = more than 50% savings
- 1/3 the energy of hammer milling

Crumbles® Particles



- Precision particles
- Physical properties are optimized for specific conversion processes
  - Length
  - Thickness
  - Moisture
  - Uniformity of size
  - Flowability
- Two pathways
  - From veneer
  - From chips
- Cascading processing of chip - particle size converges on cutter thickness
  - Minimal production of fines

The Economics

	Process	Particle Size	Moisture	Specific Energy	Total Energy	Total Energy	Electricity Use
		(Xgm, mm)	(%wb)	(MJ/odMg)	(MJ/odMg)	(Kwh/ odUS Ton)	($/ odUS Ton)
Poplar Chips							
Crumbler®, cascading	As recorded	1.0	55%	240	550	139	$7.80
Hammermill, 2.18mm	Mill and Blower	1.6	45%	690	2350	592	$33.32
Corn Stalks							
Crumbler®, cascading	As recorded	1.5	82%	180	680	171	$9.64
Hammermill, 12.5mm	Mill and Blower	1.5	46%	730	4530	1096	$61.68

Results of testing at the Washington State University Wood Science and Bioproducts lab

- For poplar chips, savings of $25.52 per U.S. dry ton (-77%) translates to multi-million dollars per year in electricity savings for biorefiners.

- Processing green corn stalks through the two comminution systems yielded an energy savings of more than -84%.

Business Model

We will compete for market share and revenues as:

- a direct equipment seller
- a toll processor of feedstocks
- a licensor of technology

21% Market Share-5 Years

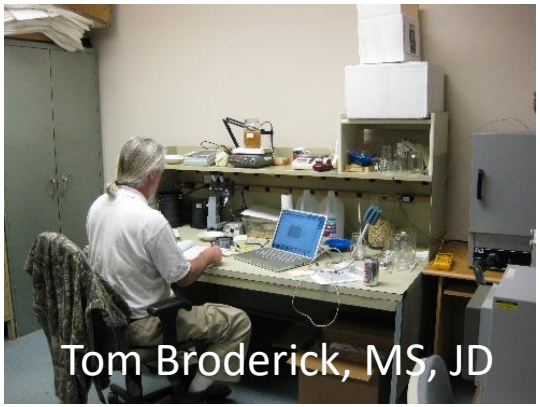
Revenues by Product Type	Estimated Market Size at Saturation			First Five Years - Penetration		
	Qty	Price / Unit	$ Market Size	market share	Units	Revenues
CrumblesMuncher - 1 TPH	200	$125,000	**$25,000,000**	25%	50	**$6,250,000**
CrumblesMuncher - 10 TPH	1,500	$700,000	**$1,050,000,000**	20%	300	**$210,000,000**
Screen System - 1 TPH	200	$20,000	**$6,000,000**	30%	60	**$1,200,000**
Screen System - 5 TPH	200	$45,000	**$9,000,000**	20%	40	**$1,800,000**
Screen System - 10 TPH	1,500	$75,000	**$112,500,000**	20%	300	**$22,500,000**
			-		-	-
			-		-	-
			-		-	-
Total Products Revenues	**3,600**		**$1,202,500,000**	**21%**	**750**	**$241,750,000**

Success Factors

- 2017 3rd party evaluations critical
  - Refine commercial prototype Crumbler®
  - Real-time proof of benefits to costs and savings
- Prepare for demand for commercial scale machines
  - Build inventory (contract manufacturing)
  - Build parts inventory & support
  - Add marketing & business development
  - Contract field service
  - Funding required

- Complete development of dryer control systems

An Experienced Team



Combining structural plant biology with engineering…

Ask = $10 Million

Commercialization

- Build machines, heads & parts inventory (contract manufacturing)
- Add support system for installation, training & service
- Add staff in business development and engineering

Expand our development efforts and commercialize our novel drying systems for small particle feedstocks.

IP development and maintenance

Why Invest?

"Every bio-company needs quality feedstocks"

- Commercial scale (10 tph) Crumbler® evaluations set
- 14 U.S. Patents issued on the processes and the feedstock particles (more pending)
- $180 billion market with $10 billion potential
- Experienced team: Dr. James Dooley, Tom Broderick, and an excellent staff of engineers.
- The opportunity for an ROI within 3-5 years

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www.forestconcepts.com

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