

A Concept for a Robust Biomass Supply Chain

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The Challenge:

Provide biorefineries with a *robust, viable, supply chain* for biomass feedstocks

Biomass Logistics Challenges

	Corn grain refinery	Corn Stover Biorefinery
Ethanol Capacity: gallons/year	100 million	100 million
Bulk density (kg/m³)	700	120
Capacity: tons/day	2850	3360
Collection radius (mile)	21.8	39.5
Farms to contract with	N/A	2600
Storage footprint	37 acres	630 acres



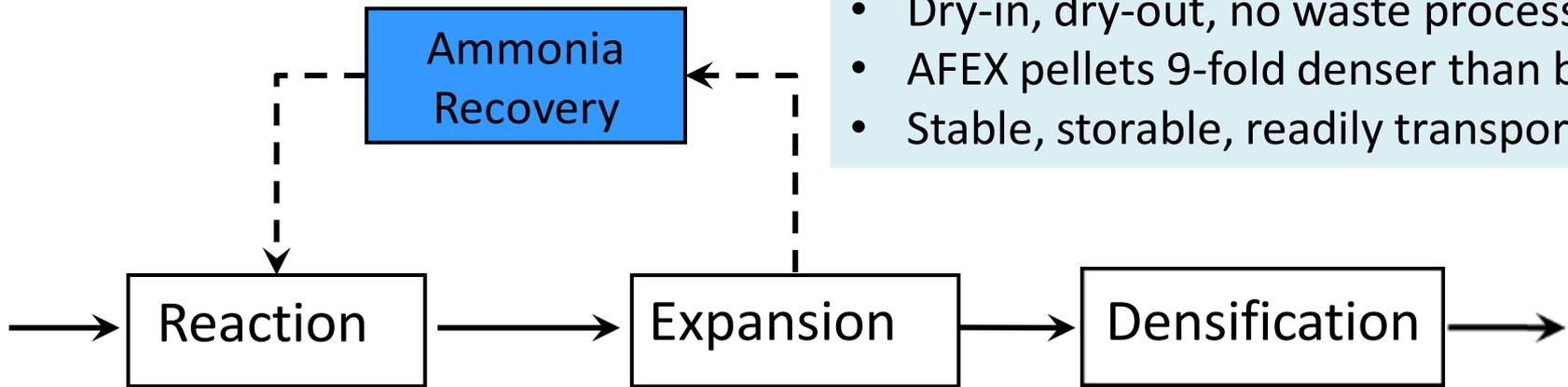
Approach:

Use a *novel technology* to create a storable, readily transportable *biomass commodity* in a *decentralized* manner to support biorefineries

*The novel technology:
AFEX™ Biomass Pretreatment*

AFEX™ Biomass Pretreatment

- Applicable to variety of ag residues
- Dry-in, dry-out, no waste process
- AFEX pellets 9-fold denser than biomass
- Stable, storable, readily transportable



Raw Biomass



Treated Biomass



AFEX Pellets

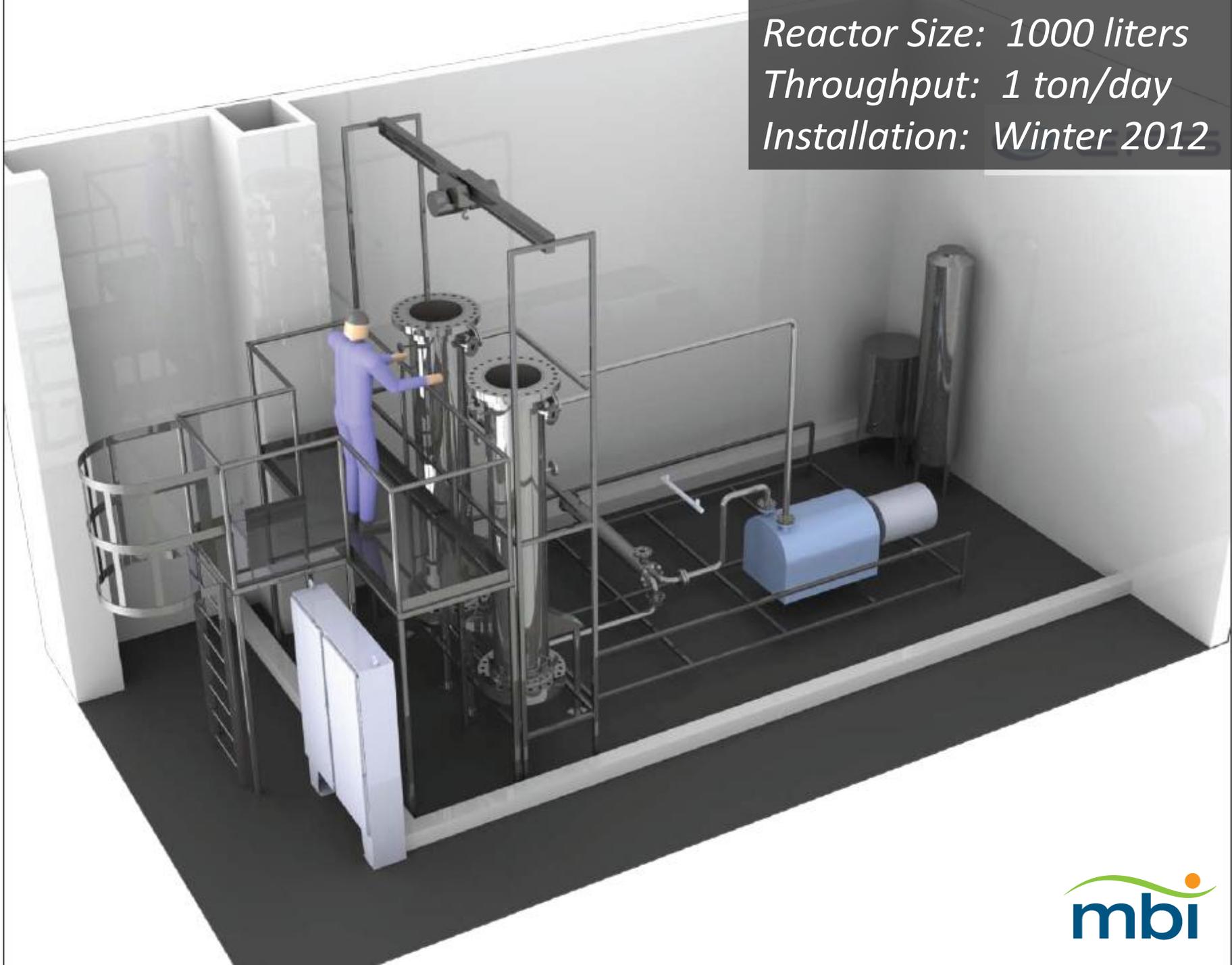


MBI develops low-cost AFEX™ reactor

Performance in 10-L prototype meets ideal-batch reactor benchmarks

MBI-led team (MSU, INL) wins \$5.3 mil DOE/EERE grant for 100-fold scale up in 2011

*Reactor Size: 1000 liters
Throughput: 1 ton/day
Installation: Winter 2012*



*The biomass commodity:
AFEX™ Pellets*

AFEX™ Pellets: A Versatile Biomass Commodity



- Biorefinery sugar feedstock
- Releases 75+% of sugars for fuels and chemicals



- Ruminant animal feed for beef and dairy cattle
- Potential to displace corn grain

Decentralized Processing:

From *landscape* to *local depot* to *biorefinery*



Depot Considerations

- Availability of 50 – 200 tons per day of agricultural residue biomass
- Cluster of 7 to 10 depots could serve cattle feed and biorefinery demand
- Depot envisioned to be associated with existing infrastructure
- Capital investment estimated at \$10 MM to \$15 MM per depot
- Foster economic, ecological and social sustainability



AFEX™ Depot processing costs = \$50 to \$75 per ton biomass

Assumptions:

- Throughput 100 ton per day
- Brownfield/existing infrastructure
- Capital investment estimated at \$10 - \$15 million

Category	Cost Breakdown (\$ per ton biomass)
Labor	7 - 20
Maintenance	4 - 5
Utilities	7 - 8
Ammonia	10 - 14
<i>Subtotal</i>	<i>28 - 47</i>
Depreciation	12 - 17
Cost of Capital/Interest	10 - 11
<i>Total</i>	<i>50 - 75</i>

AFEX PELLETS: VALUE PROPOSITIONS



- \$30 - \$60*/ton
- Sugar yield 0.5



- Biorefinery sugar feedstock at \$260 to \$410 per ton
- Benchmark: corn sugars at \$300+/ton

* Based on NREL estimate



\$ 50 - \$75/ton



- Animal feed for beef and dairy cattle at \$100 to \$155/ton
- Benchmark: corn at \$200+/ton



\$ 50 - \$70/ton

\$0 - \$10/ton

Summary

- We have developed a concept based on AFEX technology and local depots to create a versatile commodity
- The AFEX pellets are storable, readily transportable, and can serve as a multipurpose feedstock
- Value propositions are compelling for animal feed and biorefinery applications

Next Steps

- Install and shakedown 1TPD AFEX reactor (late 2012)
- Produce 40+ tons of pellets (mid 2013)
- Conduct animal feed trials (in plans for 2013)
- Conduct pilot scale fermentation trials (2013)
- Derisk technology and value proposition (2013/2014)
- Partner to build and demonstrate pioneer depot (2014/2015)
- Facilitate broad deployment (2015 onward)

MBI: A Resource for the Bio-based Economy



- Mission: to accelerate commercialization of biobased technologies
- What we do: road-mapping, derisking, scale up and commercial transition
- Cross-disciplinary expertise in biosciences, chemistry, engineering, business; 37 professional staff
- Integrated labs with high-bay pilot plant, 3800-Liter fermentors, biomass pretreatment capabilities
- Not-for-profit, established in 1981, affiliated with Michigan State University

Supplementary Slides

Value Proposition: AFEX pellets as biorefinery feedstock

Category	Cost (\$ per ton biomass)
Harvested Biomass	50 - 70
Depot Processing	50 - 75
<i>Subtotal</i>	<i>100 - 145</i>
Transport to biorefinery	5 - 10
Enzyme hydrolysis at biorefinery (NREL Estimate)	25 - 50
<i>Total</i>	<i>\$130 - 205</i>

- At yields of 1000 pounds per ton, biomass sugar costs are estimated at \$260 - \$410/ton sugar (13 – 20 cents/lb)
- *Corn sugar cost is \$320/ton (16 cents/lb) at \$6 per bushel*

Value Proposition: AFEX pellets as animal feed

Category	Cost (\$ per ton pellets)
Harvested Biomass	50 - 70
Depot Processing	50 - 75
Subtotal	100 - 145
Transport to Market	0 - 10
<i>Total</i>	<i>100 - 155</i>

- Estimated costs of AFEX pellets is \$100 - \$155 per ton
- *At \$6 per bushel , corn grain costs \$214/ton*