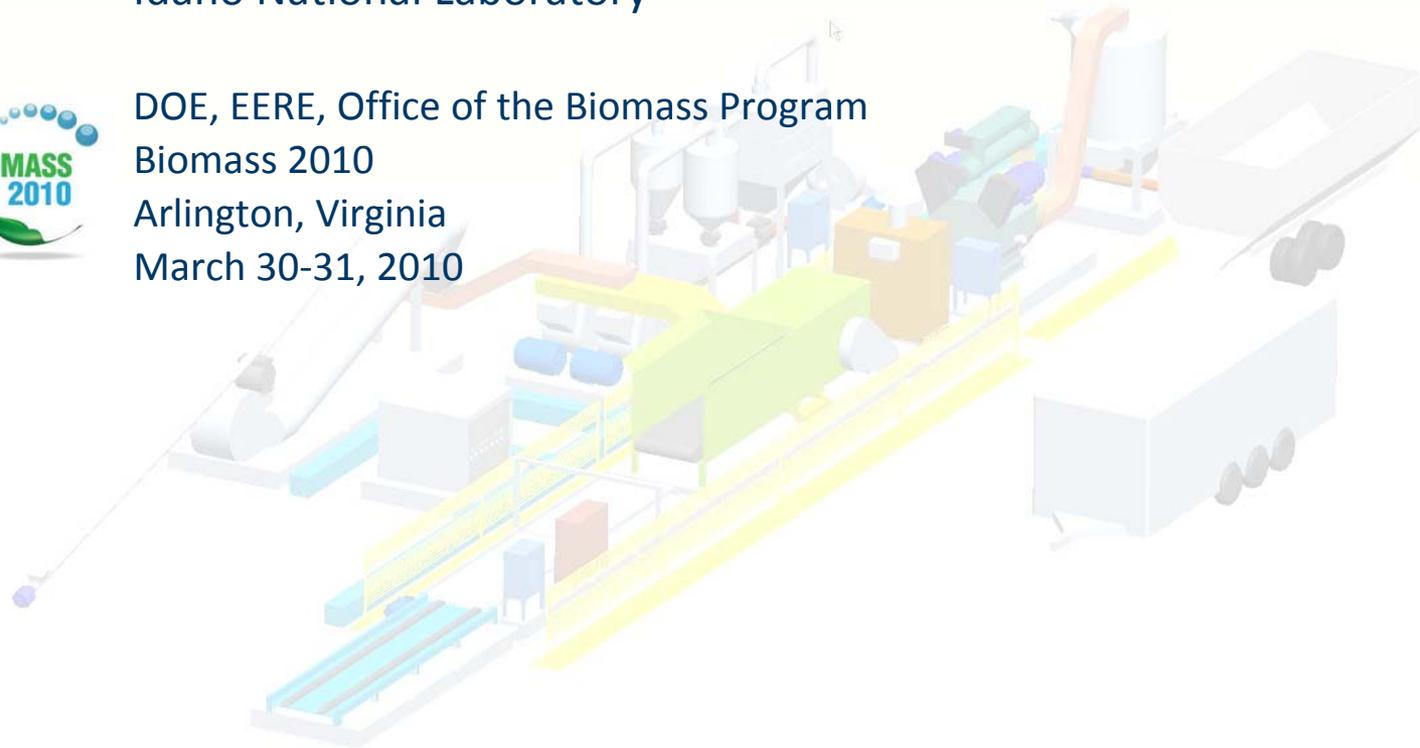


Uniform Format Design and Deployable Process Demonstration Unit

Christopher T. Wright, Ph.D
Idaho National Laboratory

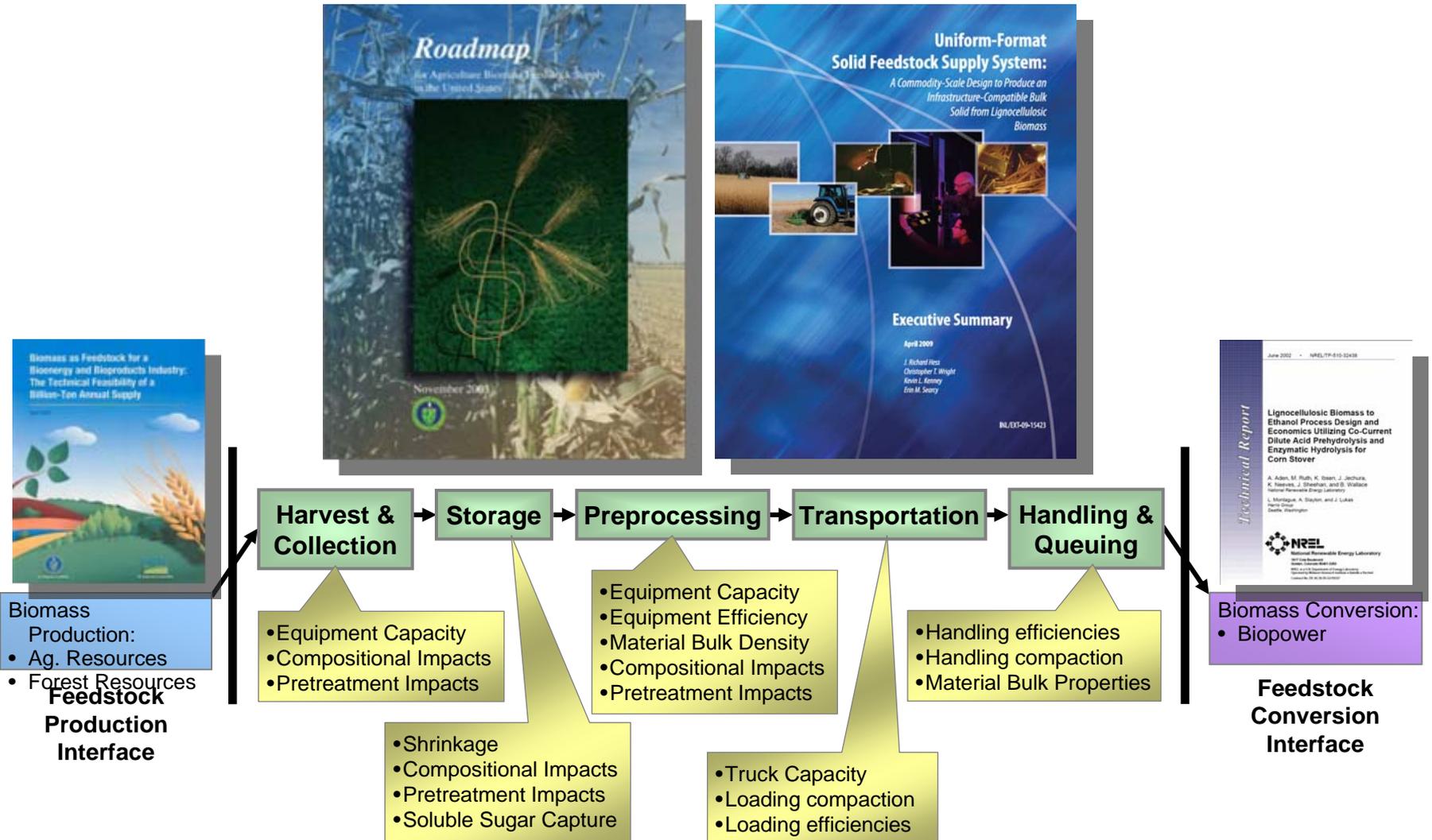
DOE, EERE, Office of the Biomass Program
Biomass 2010
Arlington, Virginia
March 30-31, 2010



www.inl.gov

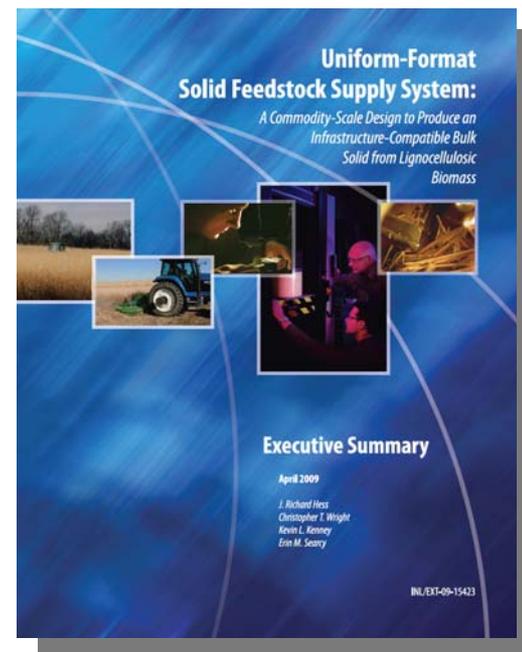
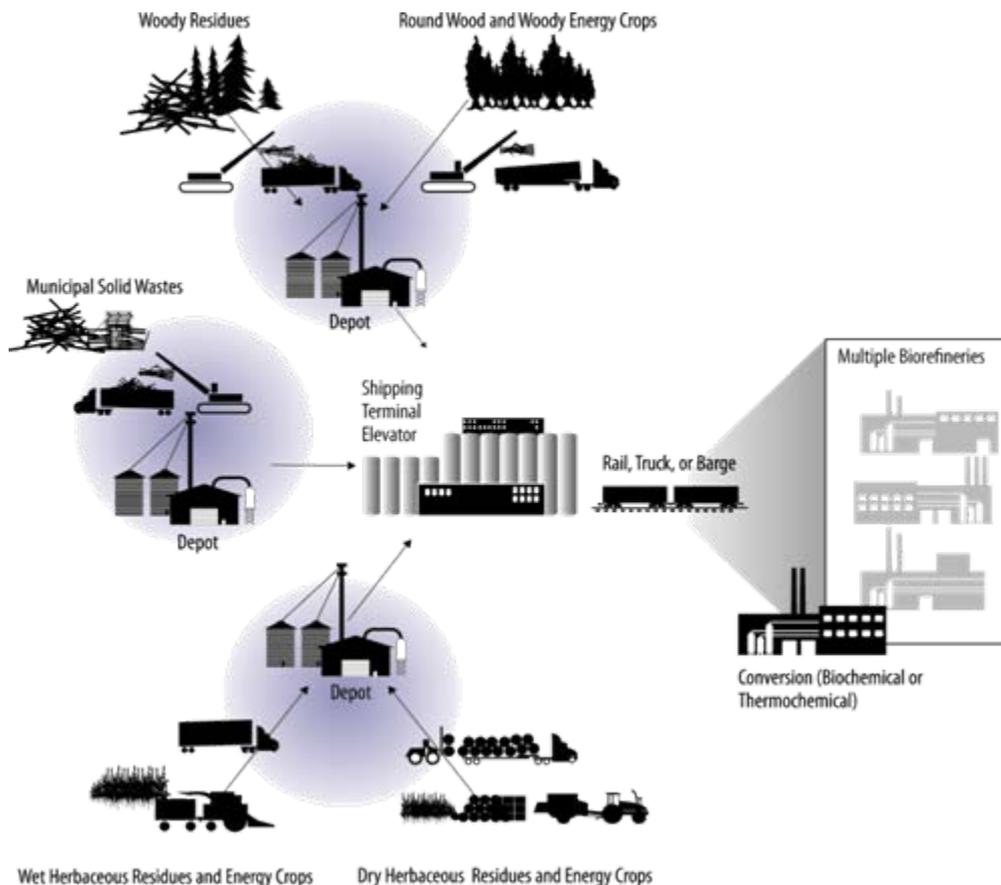


Basis of Feedstock Supply System R&D



Uniform-Format Solid Feedstock Supply System

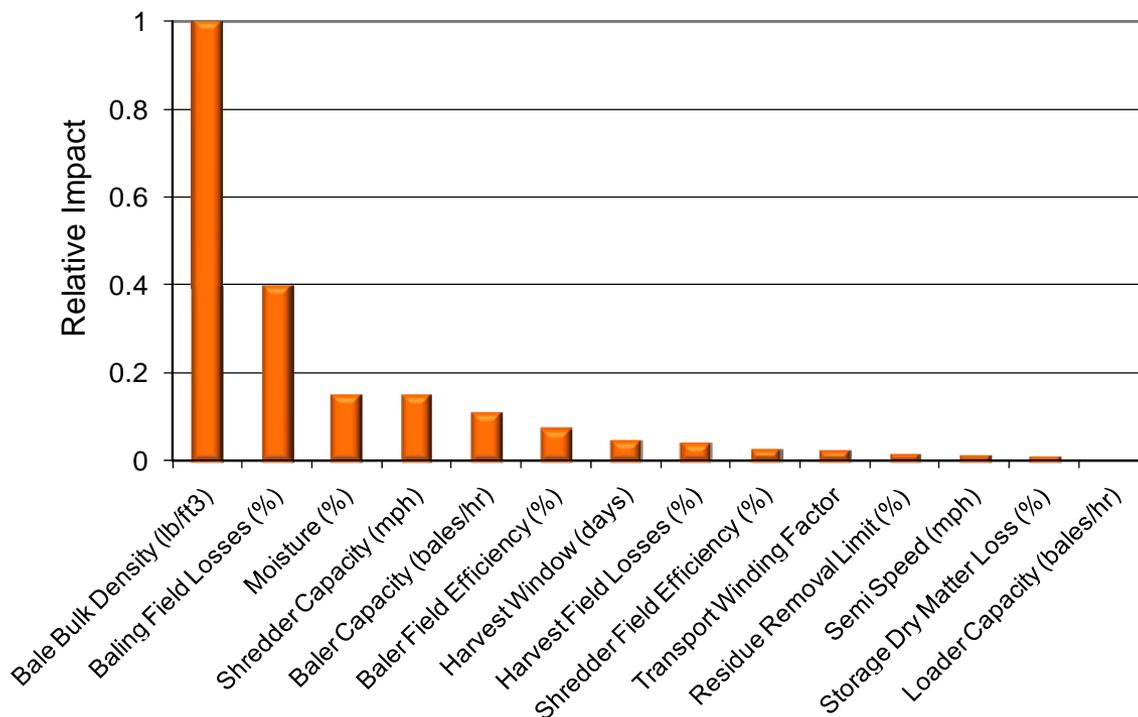
A Commodity-Scale Design for Bulk Solid Lignocellulosic Biomass



Commodity Attributes:

- National Market
- Governing Body
- Standardized Material/Quality

Ranking Factors Influencing Cost



DM Bulk Density

Targets

(point where bulk density is not a limiting factor) :

Collection & Transportation

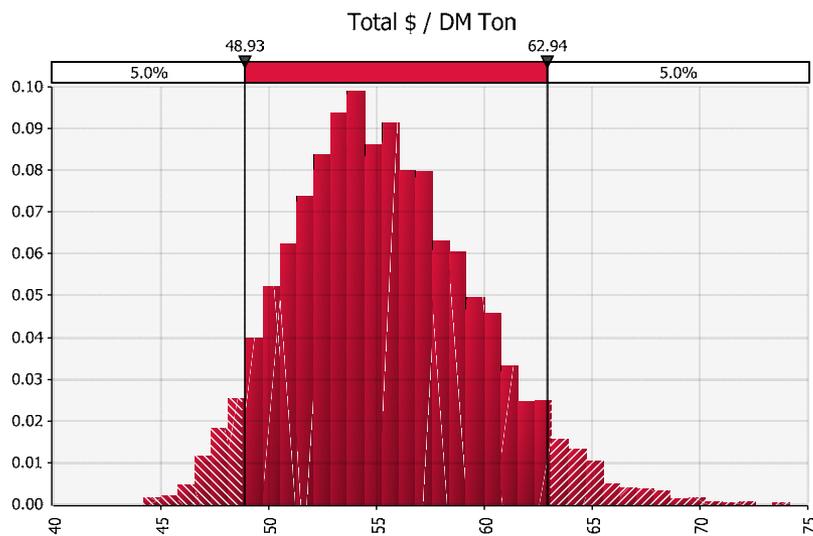
- 16 lbs/ft³

Handling & Storage

- >30 lbs/ft³

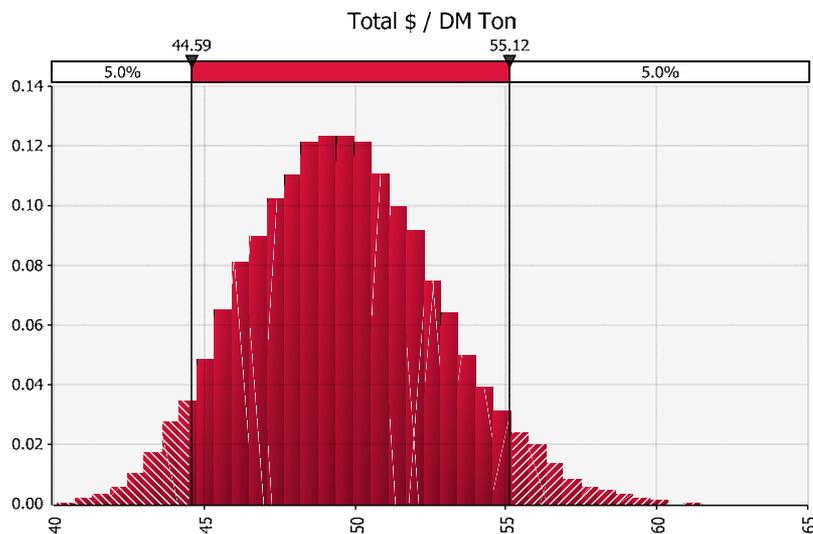
	Baled Yield (DM ton/acre)	DM Bulk Density (lb/ft ³)	Bales (4×4×8-ft) /Acre	Bales (3×4×8-ft) /Acre
Corn Stover	1.6	8–9	2.8–3.1	3.7–4.2
Cereal Straws	1.1	7–9	1.9–2.5	2.6–3.1
Switchgrass	4.0	11–12	7.0–7.8	9.3–10.4
Miscanthus	5.1	9–11	8.9–10.0	11.8–13.3

Conventional Bale Supply System Costs (\$2008)



Corn Stover – Lg. Sq. Bale

← Mean = \$55.40 / DM ton



Switchgrass – Lg. Sq. Bale

← Mean = \$49.61 / DM ton

Critical Biomass Attributes and Barriers

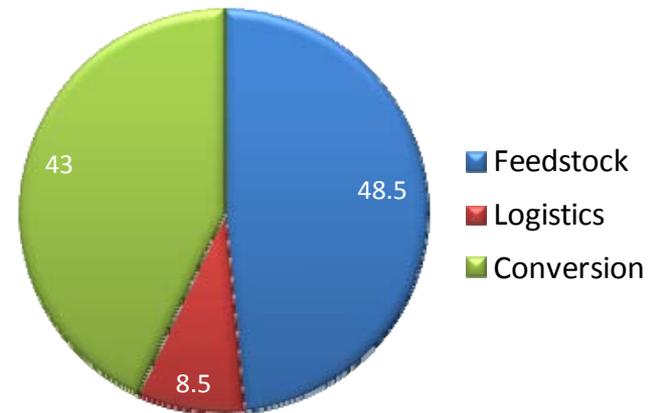
- Handling Attributes

- Bulk density
- Flowability
- Particle size, shape, & distribution
- Compressibility

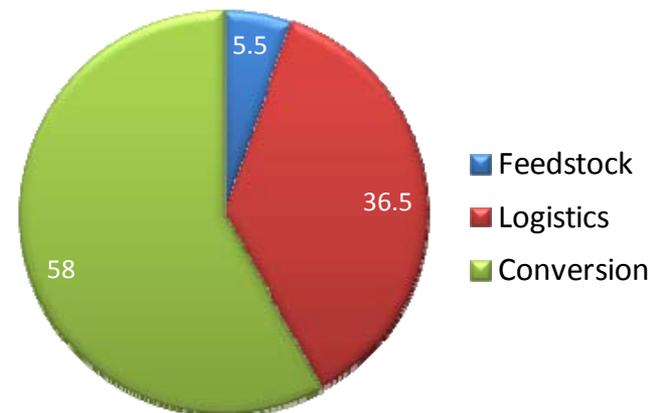
- Conversion Attributes

- BTU content
- Energy density
- Moisture content
- Ash content & chemistry
- Carbohydrate content
- Chlorine & alkali content

Corn Ethanol



Cellulose Ethanol



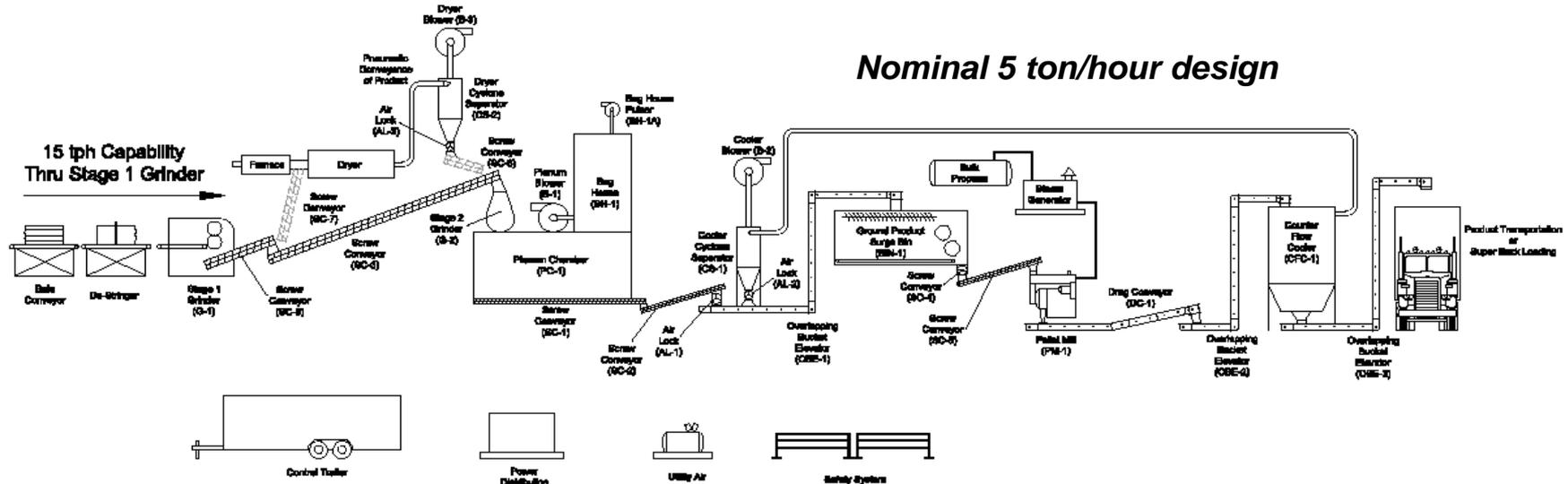
How Do We Build a Commodity Biomass Supply?

- Assemble a pilot-scale Preprocessing Depot to demonstrate and validate advanced-uniform feedstock supply system technologies
 - A deployable Process Development Unit (PDU)
- PDU approximates one replicable biomass depot described in the Uniform-Format Design Report.
- Major PDU components to be on-line early summer



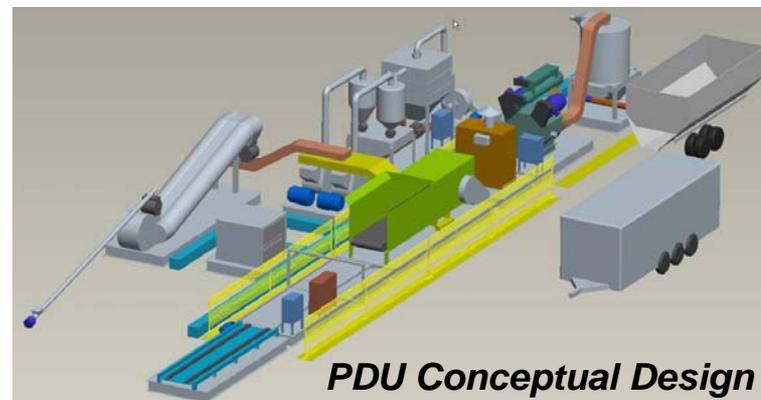
The Process Demonstration Unit Design

- PDU is a modular and reconfigurable biomass feedstock preprocessing system
- Design allows technologies to be tested in a fixed system for comparison and process improvement
- The baseline configuration will utilize existing technologies, allow equipment to be swapped, or operated independently



PDU Modular Concept

- Module 1 (Decomposition) – Stage I grinding (shredding)
- Module 2 (Grinding) – Stage II grinding (hammer mill)
- Module 3 (Drying) – Dryer for moisture reduction
- Module 4 (Densification) – Pelleting or other densification
- Module 5 (Control) – Power, instrumentation, and safety
- Modules are portable allowing deployment in any location with adequate space and available utilities



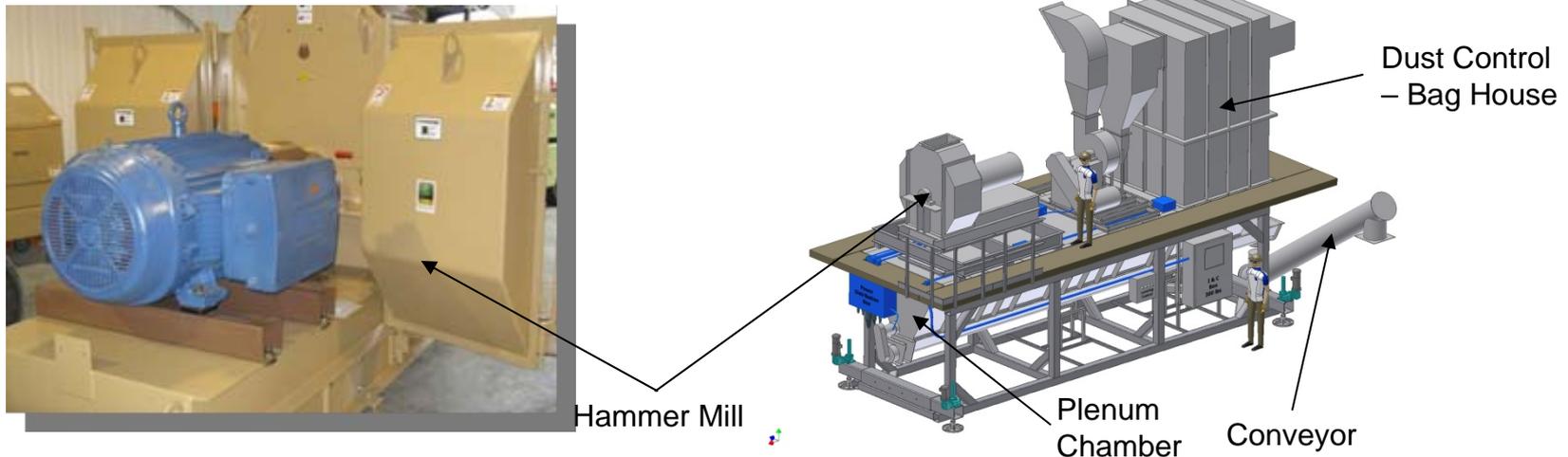
Module 1 – Decomposition

- Input conveyor, weigh belt, and de-stringer for baled material
- Size reduction for bale/bulk material, target < 2 inches
- Output conveyor to move material to dryer or stage II grinder (hammer mill)



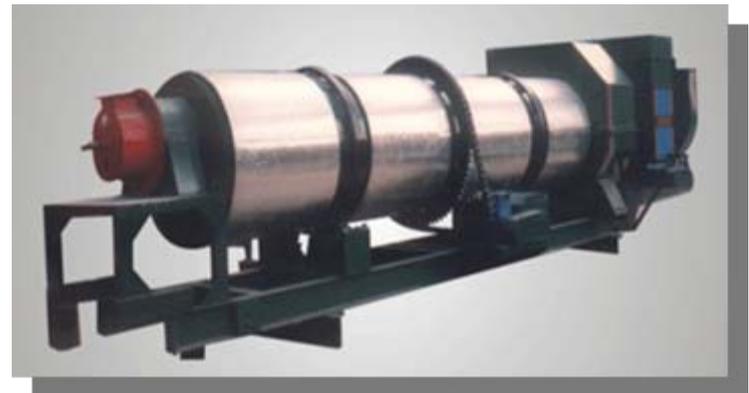
Module 2 – Grinding

- Size reduction to final densification particle size <math>< \frac{1}{4}</math> inch.
 - Hammer mill mounted on a plenum chamber for dust collection/control
- Dust and fines collected at each module and returned to system or filtered
 - Equipment can be moved to other modules
 - Components: blower, bag house, air locks and plenum chamber



Module 3 – Drying

- Three pass rotating drum, variable heat furnace, variable blower, cyclone separator, and pneumatic conveyance
- Drying is not required for all materials thus feed stream can be diverted
- Oversized pneumatic transfer system for various operation modes
- The drum allows the dryer to operate as a single pass flash dryer or cycled for optimum end moisture



Module 4 – *Densification*

- Densification and conditioning converts ground material into $> 40 \text{ lb/ft}^3$ product
- Base system includes pellet mill; can substitute cubers or briquetters
- Metering bin controls feeding of ground material into other modules
- Cooler improves quality and durability of product

Metering Bin



Steam Conditioning



Pellet Mill



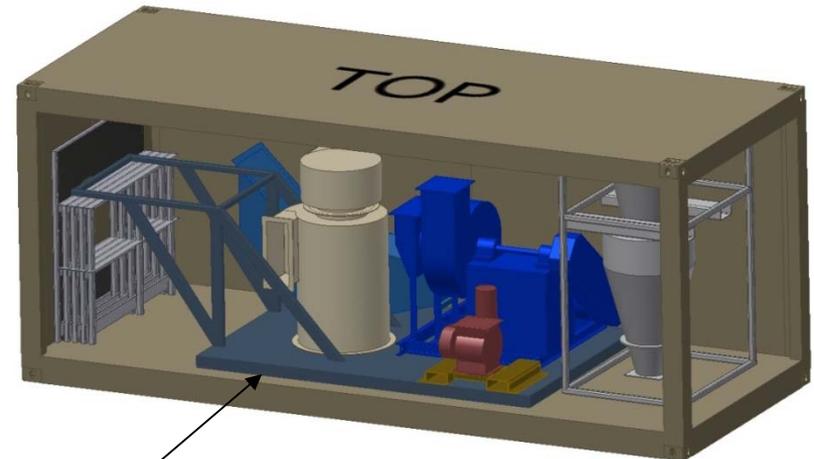
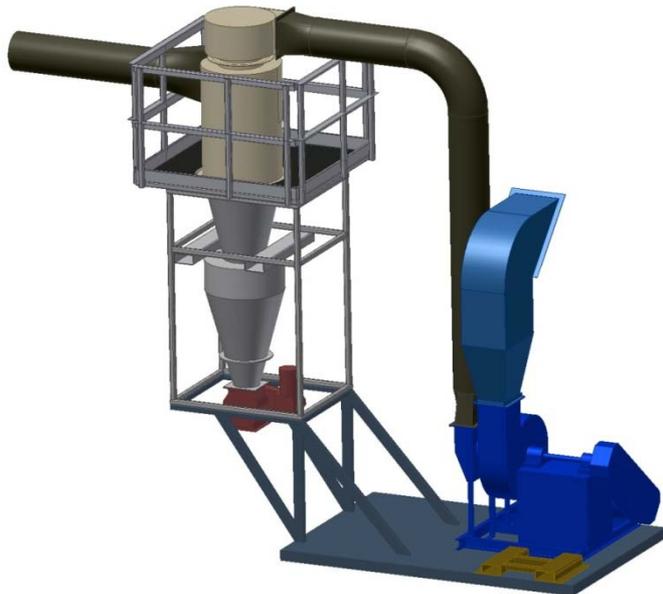
Cooler



Pneumatic Conveyance Setup and Packaged



Clam shell cargo container

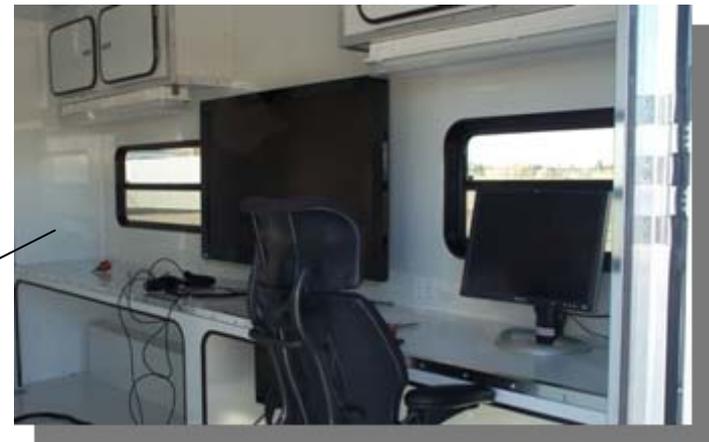


Cyclone components disassembled and stored in a cargo container

Motor Control Center and Control Trailer



MCCs



Operator work station



Control cabinets in front section



Conceptual Equipment Examples

- **Roller Forging Mill:**
 - low energy process, larger particle input
- **Thermal Treating:**
 - slow heating in a low/no oxygen atmosphere for more friable and low moisture material
- **High Energy Kinetic/Impact Processing:**
 - high velocity impact milling to reduce particle size and removing moisture
- **Extrusion Drying:**
 - friction and compression energy to dry
- **Fractionation and Volatiles Extraction:**
 - material fractionation and lignin separation in solvent and high-shear extrusion

Bench-scale
Thermal Treating Unit



Bioenergy Depends on Feedstock

