# *Biomass Feedstock National User Facility (BFNUF)*

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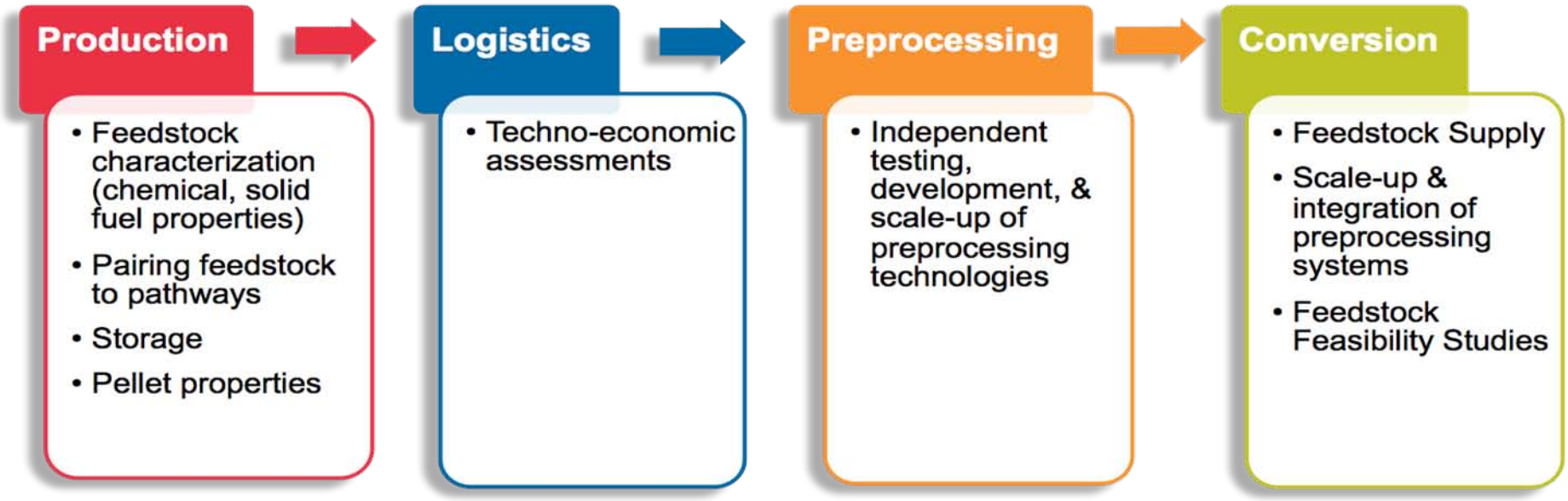
# Capabilities that Span the Biofuels Supply Chain




**Feedstock Supply/Logistics Demonstration**

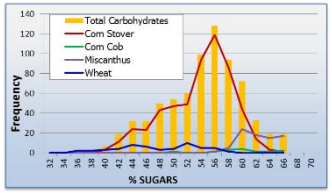
# Core Competencies

**Biological/Bioprocess Science & Engineering**
Identifying how biomass attributes translate to supply chain performance (logistics, preprocessing, feed handling and conversion performance)

**Applied Materials Science & Engineering, Chemical Engineering**
Developing consistent, conversion-ready feedstocks from variable and diverse biomass resources

**Mechanical Design & Engineering, Large-Scale User Facilities/Advanced Instrumentation**
Improving operability and reliability of feed handling

**Biomass Characterization**




**Feedstock Engineering (Preprocessing)**

**Integration & Scale-up**

**Biomass Utilization**

- Informs feedstock selection, development, and valuation
- Informs equipment and process design, selection, and operability
- Accelerates scale-up and start-up
- Reduces risk and costs

# Process Demonstration Unit (PDU)

Full-scale, integrated biomass processing system
- Hammer mill grinding
- Rotary drying and torrefaction
- Pelleting and cubing
- Multiple packaging options
- Chemical preprocessing

In operation since October 2013
- Toll processing & characterization
- Process Development
- Preprocessing R&D

More than 1,000 tons of feedstock processed
- Ag residues (corn stover, sugarcane bagasse)
- Energy Crops (switchgrass, miscanthus)
- Woody biomass (clean and whole tree chips, logging residue)
- Municipal Solid Waste
- Cellulosic ethanol co-product

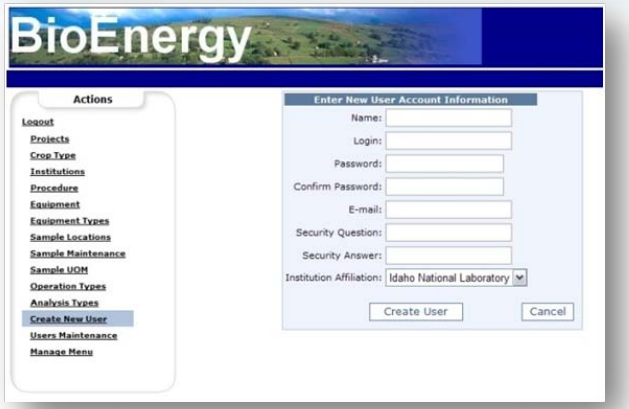
# Supply Chain Development

- Feasibility studies and techno-economic assessments
- Storage performance characterization (unique in-lab capability)
- Characterization of biomass resources
- Feedstock product characterization
- Supply chain design

*Our understanding of cost, quality, and risk tradeoffs helps customers establish a successful supply chain*

# Feedstock Specifications

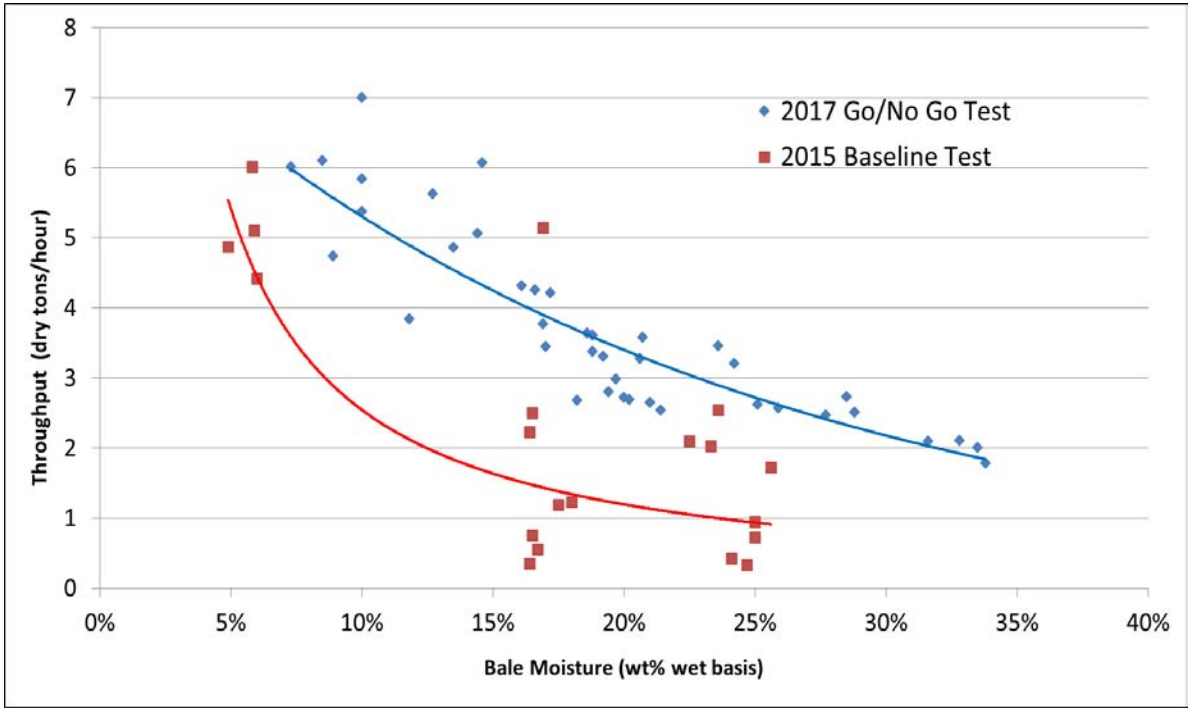
- Bioenergy Feedstock Library - Integrated knowledge management that facilitates physical storage and tracking of research feedstocks
- Assimilates biomass sample data into a single data system
  - Operational data from the PDU and field trials
  - Physiochemical characterization data
  - Lab- and full-scale conversion data
- Enables better understanding of supply chain processes and feedstock performar




# Major Accomplishments in FY17

- Intelligent, Adaptive Control System development to mitigate preprocessing of variable biomass
  - Achieved 50% increase in reliability over baseline in a 20 ton test run
  - Topic of EERE Success Story
  - Patent application filed in September 2017
  - Methodology is applicable to conversion processes
- Fractional milling and high-moisture pelleting meeting the BETO target cost of $84/dry ton of conversion ready feedstock

# *Adaptive Control System Improves the Reliability and Throughput of Feedstock Preprocessing*

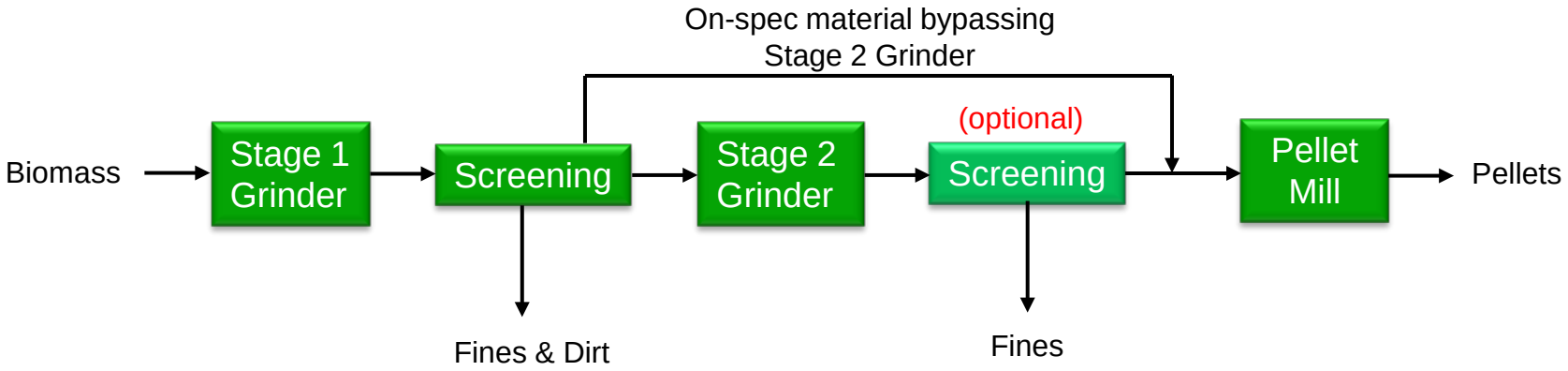



- The operating reliability of 2-stage grinding was raised from 63% to 96%
- The throughput was doubled for high-moisture corn stover bales

# Demonstration of $84/dry ton Feedstock Preprocessing

- Key technical areas of cost reduction:
  - Fractional milling: 40-50% of 1st-stage ground biomass bypasses 2nd-stage milling, which results in energy saving and lower 2nd-stage milling equipment cost
  - High-moisture pelleting saves energy consumption

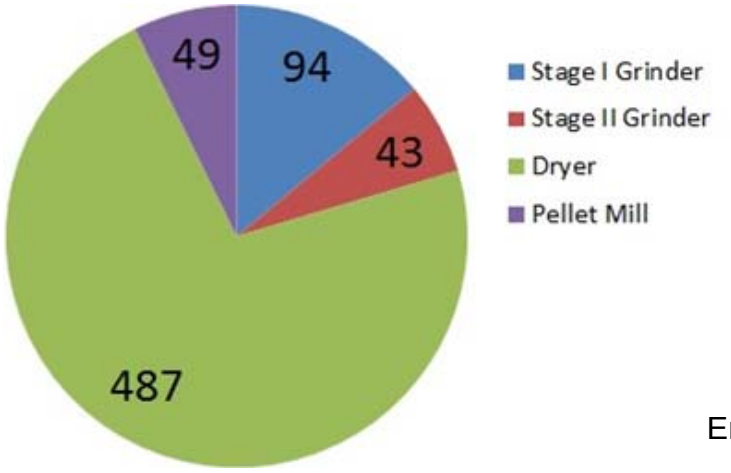
- Trade off between higher grinder throughput by using larger screen size vs. lower pelleting throughput



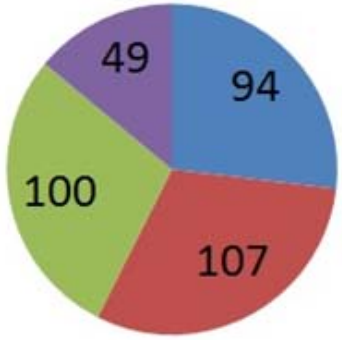

**Schematic Diagram of Fractional Milling**

# High-Moisture Densification

- Reduces cost of moisture management and improves solids handling
- Approach: Pellet biomass at 3x normal moisture content (10%), using preheating, frictional heat, and energy-efficient pellet drying
- Results: Lignin glass transition temp is lowered at high moisture resulting in reduced energy inputs and up to 40% cost reduction




Conventional Pelleting




Energy consumption in kWhr/ton

High Moisture Pelleting

# *Impact*

- Industry often carried out feedstock pre-process integration during engineering design and construction and not during process development.
- The lack of knowledge of biomass properties, flow behavior, and equipment capability led to ineffective equipment selection and integration, which often results in low operating reliability, throughput and varying feedstock quality.
- The Biomass Feedstock National User Facility provides a wide range of unit operations found in biorefineries that enable researchers and industry to measure the **mechanical properties of feedstock** and **equipment performance characteristics** which help identifying the root causes of material handling problems.
- Researchers then use this data to develop **feedstock physical models** and **improve process and equipment design** to meet specific needs and achieve robust feedstock preprocessing technologies .

***Thank you***