
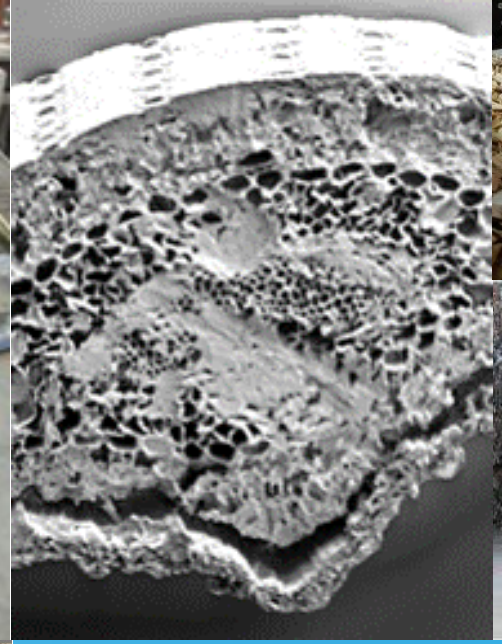


Biomass Feedstock National User Facility Upgrade

March 24

System Development and Integration

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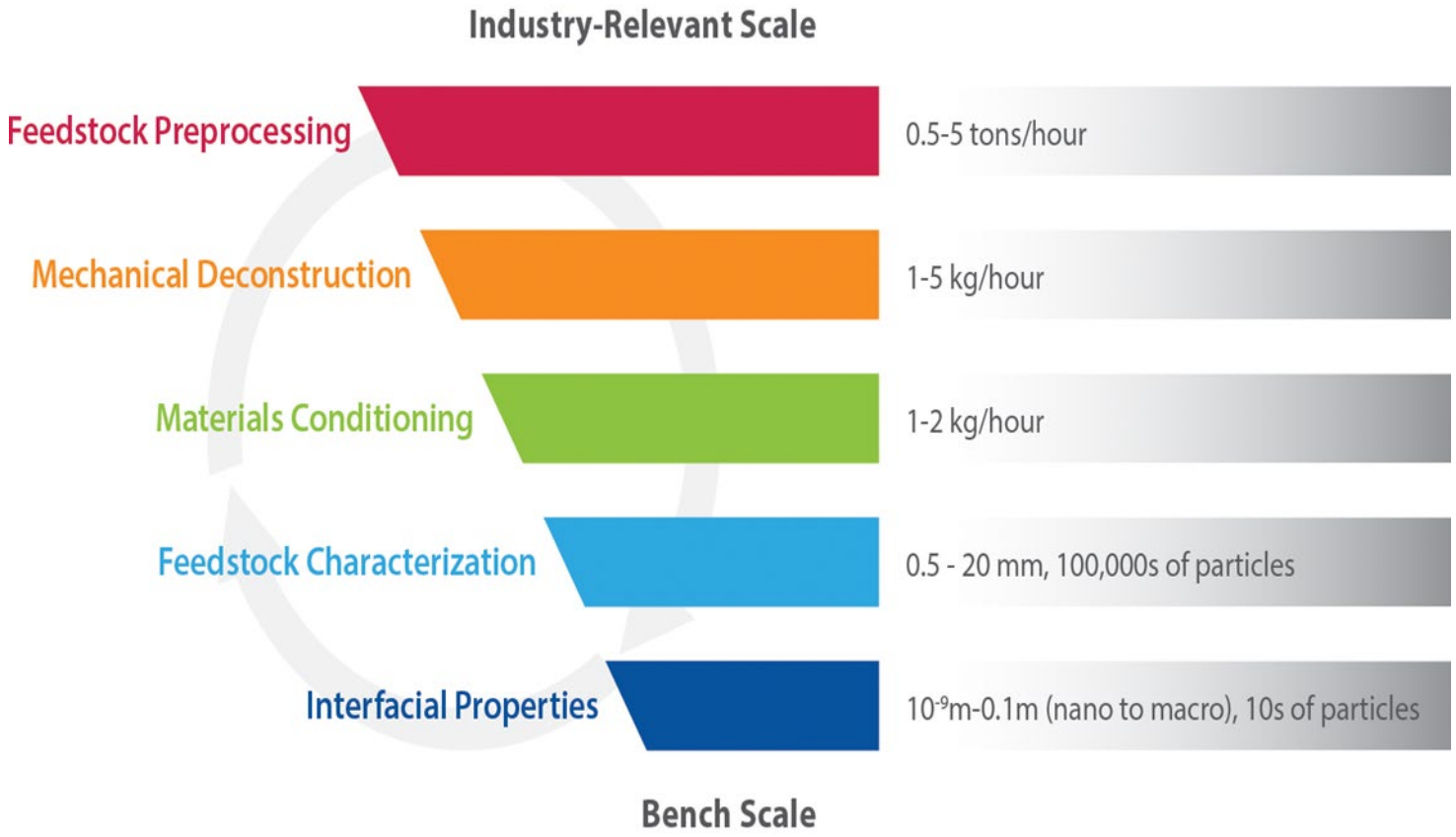
Project Overview

- *This project has been funded at $5M a year for Fiscal Years 19, 20, and 21 to upgrade the Biomass Feedstock National User Facility (BFNUF)*
- *The goal is to build a facility for enabling research and development across technology readiness levels (TRLs) and reduce the risk of process scale-up.*
- ***BFNUF's** Heilmeier Catechism (What's Current, What's New, Why, Risks):*
  - *The 2010 BFNUF was designed to process corn stover into a uniform format and is limited in waste processing breadth.*
  - *The 2020 BFNUF should be a facility that can address R&D challenges in transforming waste into feedstocks for the next decade.*
  - *New waste streams are constantly emerging as value added opportunities i.e. critical materials in electronic waste.*
  - *There is some probability that we will not be able to anticipate all possible waste streams and miss critical equipment needs.*

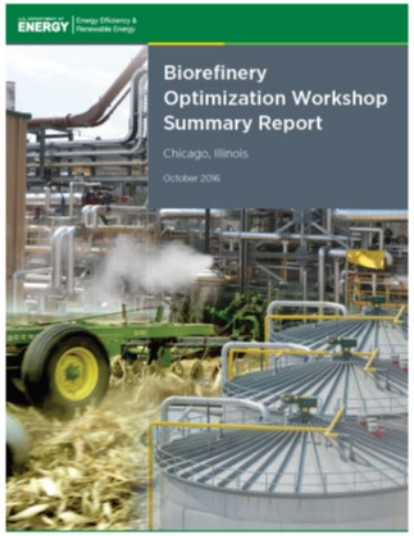
1 – Management – Project Structure

The BFNUF upgrade is divided into five different capability groupings, each managed by a “center” lead, which cover a range of scales and research needs. Each lead is responsible for coordinating center needs and passing information to the project lead for stakeholder outreach.



1 – Management – Project Risk Mitigation

The **greatest project risk is that future research needs will not be met by the upgrade purchases**. This is being mitigated by leveraging past BETO workshops, communicating with other national laboratories, and holding our own stakeholder workshop and interviews.



Two major findings from workshops

1) Flowability challenges lead to crippling downtime and a lack of performance data
2) Waste variability exacerbates poorly defined quality specifications for new feedstocks

Three keys features to support research partnerships

1) Wide ranging analytical capability for both materials and process characterization
2) Smaller scale flexible operations that support a variety of emerging technologies
3) Facilities that support process scale-up

2 – Approach – Technical Methods

The approach for this project follows three major steps:

1. **Gather information from past stakeholders** and relevant BETO workshops to inform the design of the 2020 BFNUF upgrade.
2. Design the BFNUF upgrade and **receive buy-in from external stakeholders** in industry, academia, and other national laboratories.
3. Proceed through the **Critical Decision Process** to build the 2020 BFNUF

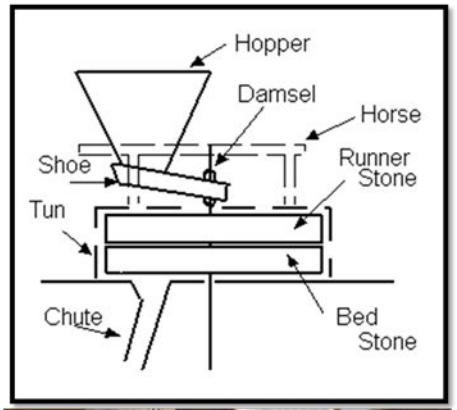
Critical Decision (CD) Step	CD-0	CD-1	CD-2	CD-3	CD-4
CD Description	Conceptual design and scope	Approve concept design package	Finalize additional system needs (power, water, etc.)	Begin site preparation and equipment purchase	Complete systems and initiate operation

2 – Approach – Challenges and Success Metrics

The **two main challenges** for the BFNUF Upgrade Project are.

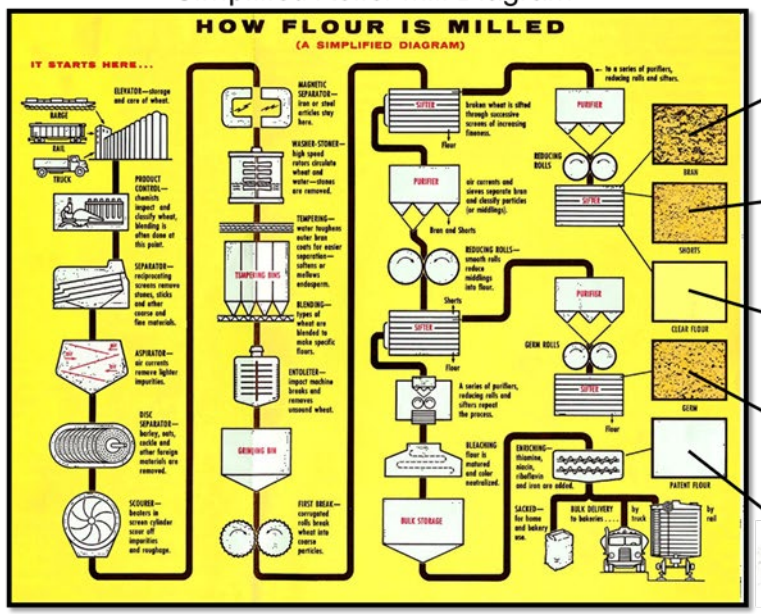
1. Anticipating the diversity of waste materials to be turned into feedstocks.
2. Anticipating the advent of new conversion processes and feedstock specifications.

Grist Mill Diagram



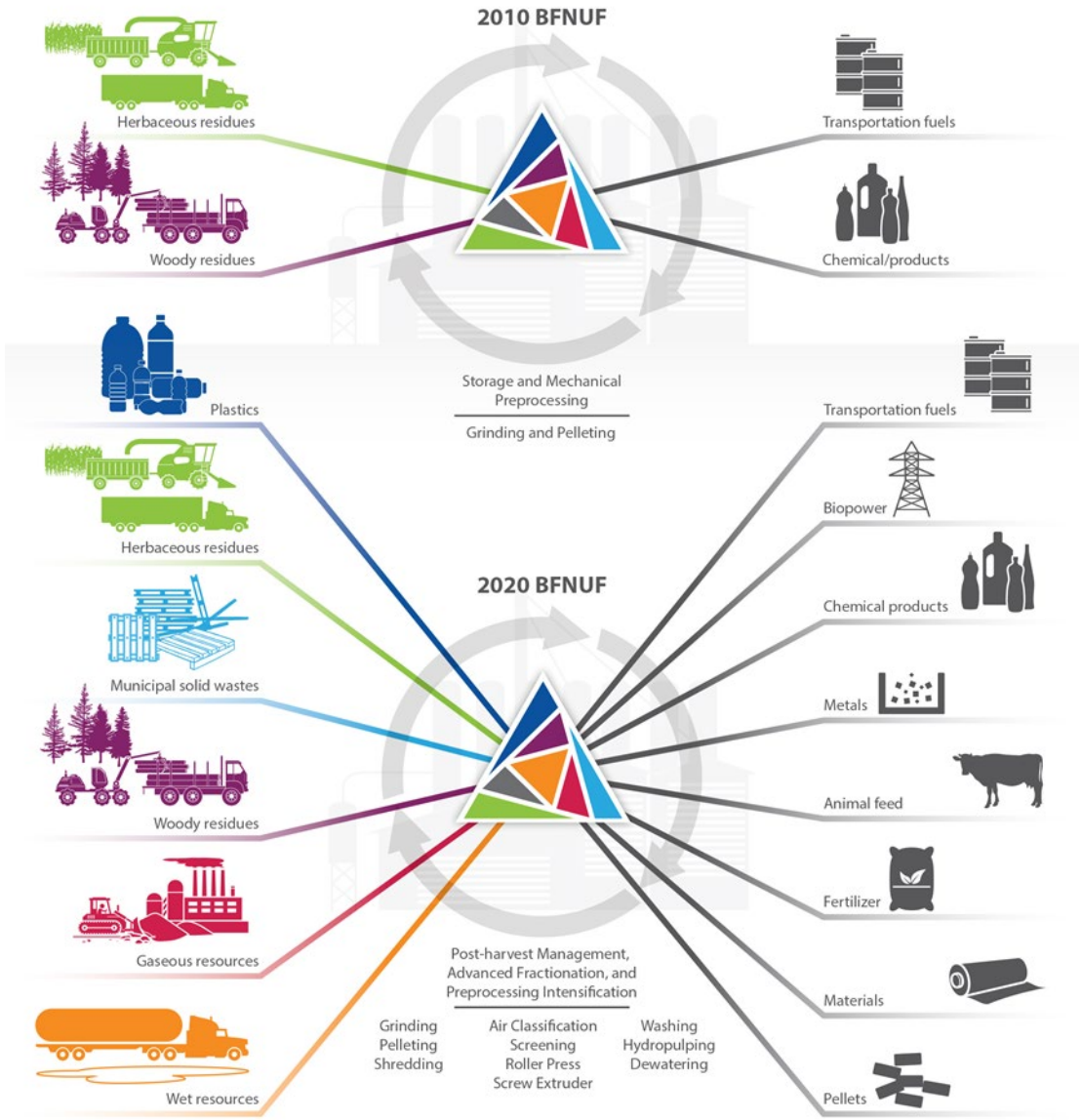
Whole Wheat Stone Milled Flour

Simplified Roller Mill Diagram



A successful user facility will accelerate innovation and reduce the timeline for bringing new feedstocks and processes to market from decades to years.

3 – Impact – Advancing the State of Technology



Uniform Format Feedstock Supply System

Stone Milling Approach

Simple supply systems that grinds, dries and densifies

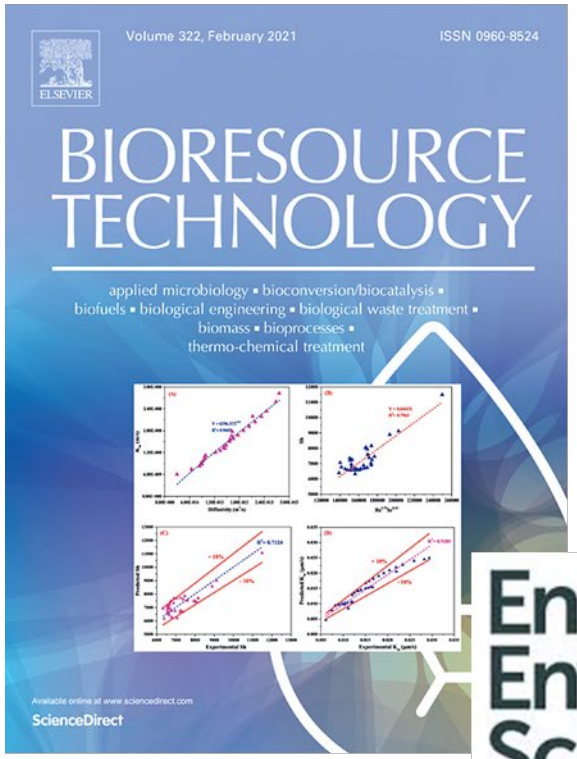
Quality-by-Design Feedstock Supply System

Fractional Roller Milling Approach

Expands preprocessing operations:

- Enables access to new feedstocks
- Selective pairing of feedstock and conversion processes based on feedstock quality
- Midstream for fractionation and value-add.

3 – Impact – Dissemination of Results



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2020

BiofuelsDigest
The world's most widely read biofuels daily

Energy & Environmental Science

Results will be disseminated through trade magazines, publications in the peer reviewed literature, and Department of Energy events. **This upgrade will be utilized in research for a variety of DOE consortiums** and be disseminated through their networks.

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FEEDSTOCK-CONVERSION INTERFACE CONSORTIUM
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4 – Progress and Outcomes – Milestones and Goals Met

Talk with at least 10 stakeholders about the BFNUF Framework document and gather feedback on the BFNUF Upgrade. Additionally, bring 80% of the equipment purchased with the first $5M into an operational state.

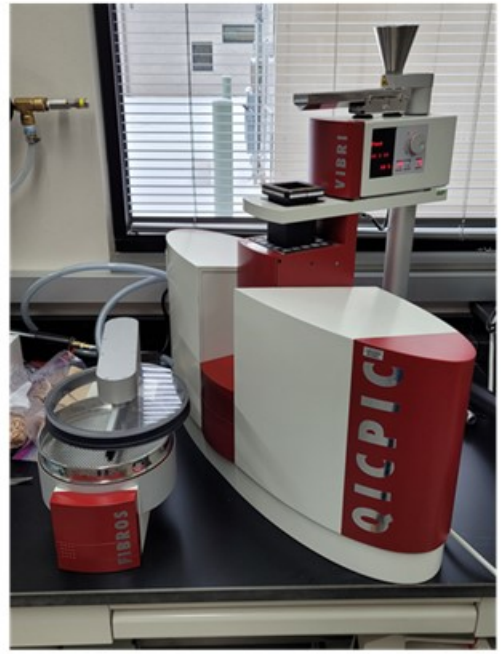
Workshop Metric	Relevant #
People at the Workshop	171
People in GroupMap	121
# of Comments	239
# of Individual Interviews	11 (and counting)

Since the first $5M we have **broadened our base of input** and exceeded the initial number of participants. We have also **installed about 84% of the equipment from the first phase** of upgrades.

4 – Progress and Outcomes – Technical Accomplishments

We have spent the first $5M of the $15M upgrade investment and significantly improved our Feedstock Preprocessing and Characterization capabilities.

3D particle size control will improve the handling characteristics of woody feedstocks and allow the BFNUF to **meet the specifications of external Verification partners**.



New particle characterization techniques allow the BFNUF to **investigate wet and dry materials** down to the micron range and **better define specifications around "fines"**.

4 – Progress and Outcomes – Technical Accomplishments

The new BFNUF can uniformly deconstruct and precisely fractionate both MSW and Biomass

Raw MSW

2010 BFNUF

2020 BFNUF

Hammer mill

FC Shear Mill

New milling and fractionation makes narrow size distributions and enables **separation of paper and plastic**

Forest Residue

White Wood

Bark

Needles

Forest residues can now be **separated into almost pure anatomical fractions** that will **reduce fines generation** and energy consumption in downstream milling operations

4 – Progress and Outcomes – Technical Accomplishments

Uniform size reduction and tissue level fractionation will be followed by measuring the feedstock quality attributes and performing feed handling studies in equipment like a novel plug screw feeder.

Impact Milling

High aspect ratio

Shear Milling

Uniform aspect ratio

High speed impact mills result in fibrous material from herbaceous feedstocks but **shear milling produces a more uniform aspect ratio**.

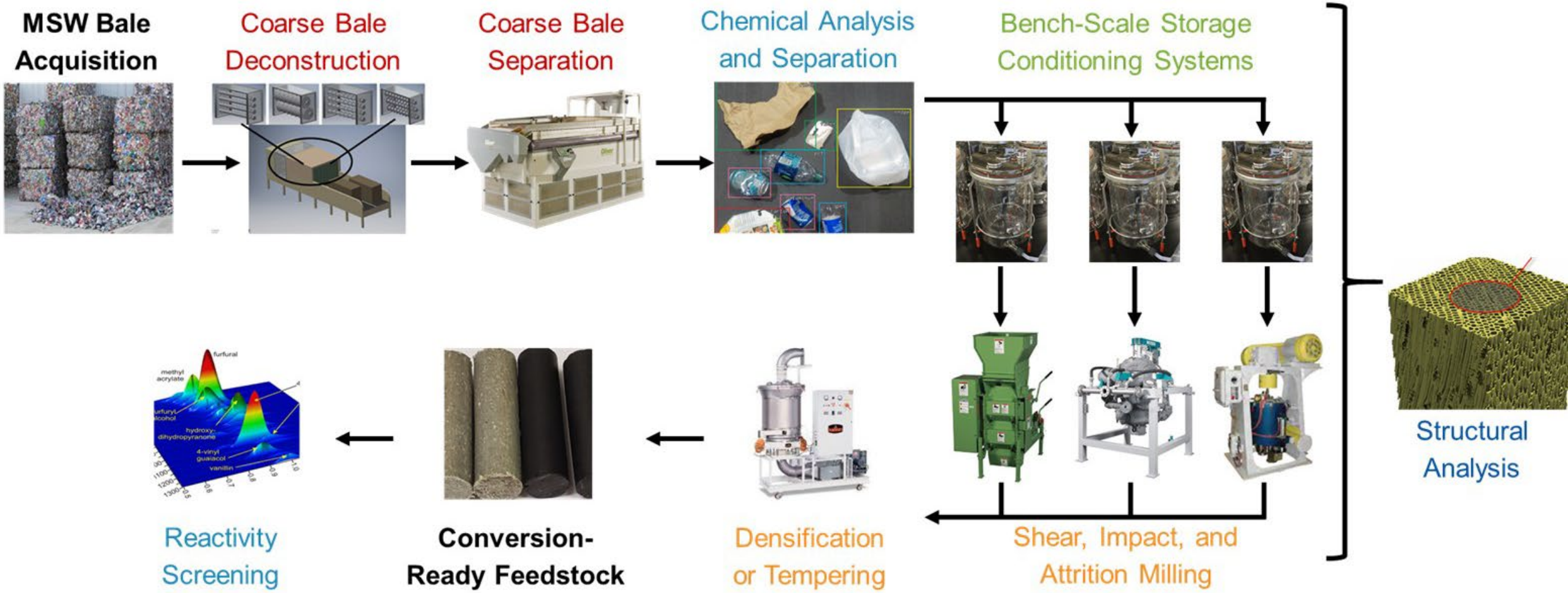
Whole Cob

Cob Chaff
$\rho \sim 45\ kg/m^3$

Cob Pith
$\rho \sim 225\ kg/m^3$

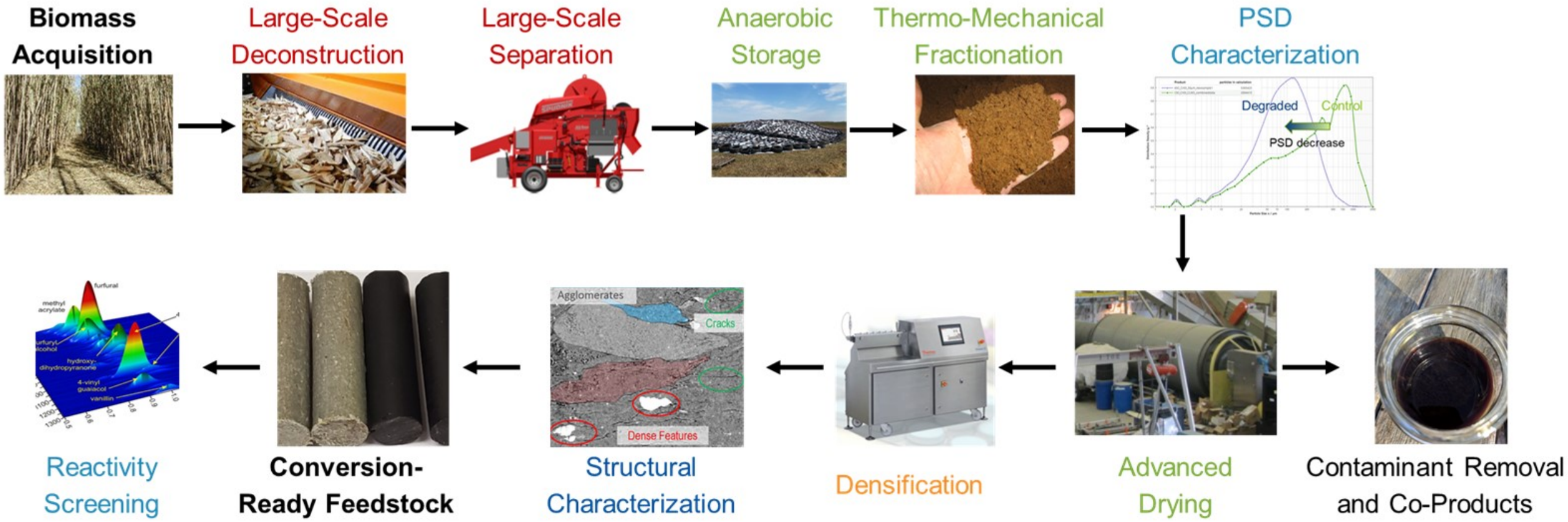
The new BFNUF can go **beyond anatomical fractionation** to separate tissue level components.

4 – Progress and Outcomes – Technical Accomplishments



Plans for the final $10M have **developed innovate materials preprocessing operations** such as this theoretical process for recycling a multi-layer package containing biodegradable plastic.

4 – Progress and Outcomes – Technical Accomplishments



Transformation of low cost herbaceous biomass to conversion ready **thermochemical through unique conditioning, size reduction, and drying processes** could benefit emerging technologies.

Summary

1. The *management* of the BFNUF **upgrade is based on knowledge generated in past BETO workshops** as well as interactions with various partner institutions and their needs.

2. The *approach* for the upgrade follows the **Critical Decision process is being followed** as the BFNUF looks to the future of waste streams that could become available for transformation into conversion ready feedstocks.

3. The *impact* of expanding the BFNUFs capabilities will transition from a “stone milling” to a “fractional milling” **innovation scheme that will broadly benefit the biofuels industry**.

4. The *progress* so far is roughly a third of the way complete and has **significantly expanded the preprocessing and characterization operations** to control particle size in three dimensions and fractionate wastes into feedstocks with less variability.

Quad Chart Overview WBS# 1.2.3.10

Timeline

- 10/01/2018
- 09/30/2021

	FY20	Active Project
DOE Funding	$5M	$15M

Project Partners*

- None (Or Everyone… Depending on your Perspective)

Barriers addressed

Im-A. Inadequate Supply Chain Infrastructure: This project will reduce variability for a wider array of low cost wastes while processing materials to meet conversion specifications.

It-C. Technical Risk of Scaling: Equipment purchased in the second round of funding will include scalable feed handling characterization tools as well as a variety of comminution mechanisms critical for linking material properties to handling performance.

Project Goal

The goal of this project is to upgrade the Biomass Feedstock National User Facility so that it can process a wider array of waste materials, including wet and dry municipal solid waste, into conversion ready feedstocks. These feedstocks should have improved flow performance, reduced variability, and the ability to scale with the size of the desired conversion process, regardless whether or not the conversion technology is old or emerging.

End of Project Milestone

Pass CD-4 for the remaining portion of the $10M and purchase at least 70% of the equipment to be brought in for the BFNUF upgrade amounting to at least $7M in equipment investment.

Funding Mechanism

Annual Operating Procedure.

Additional Slides

Responses to Previous Reviewers' Comments

- This project has not peer reviewed previously. There have also been no Go/No-Go reviews.

Publications, Patents, Presentations, Awards, and Commercialization

- This project has not had any specific publications, patents, or awards. The only significant presentation resulting from this work has been a workshop on the upgrade that was attended by ~170 people from all over the country (and a few international participants).
- As the facility is not complete yet there have been no technologies commercialized or transferred. However, this facility is designed to move technologies from TRL2 through TRL5 and transfer them to industry after pilot scale verification.