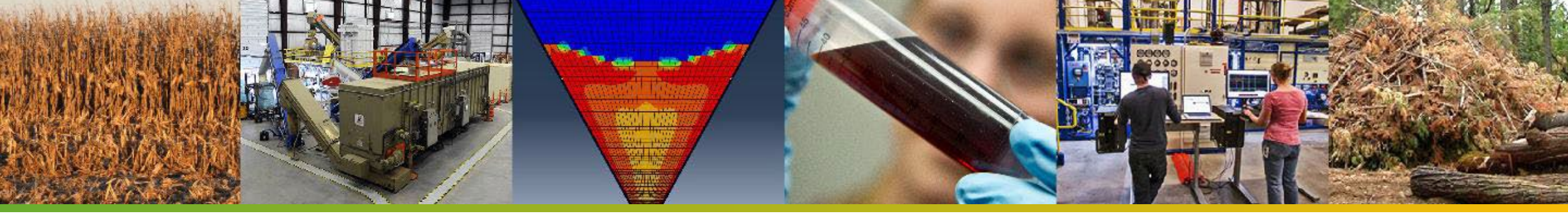


# 2023 Feedstock-Conversion Interface Consortium CRADA Call

## Informational Webinar

**Beau Hoffman, Technology Manager, EERE-BETO**

**Ed Wolfrum, FCIC Principal Investigator**

**March 14, 2023**

fcic
FEEDSTOCK-CONVERSION INTERFACE CONSORTIUM
U.S. DEPARTMENT OF ENERGY

# Webinar Housekeeping

- Attendees will be in listen-only mode
- Audio connection options:
  - Computer audio
  - Dial in through your phone (best connection)
- Automated closed captions available

- Use the Q&A panel to ask questions
- Technical difficulties? Contact us through the chat section, lower right of your screen
- Today's webinar will be recorded and posted to the 2023 FCIC CRADA call website: https://www.energy.gov/eere/bioenergy/fcic-cooperative-research-and-development-agreement-call

# Today's Speakers

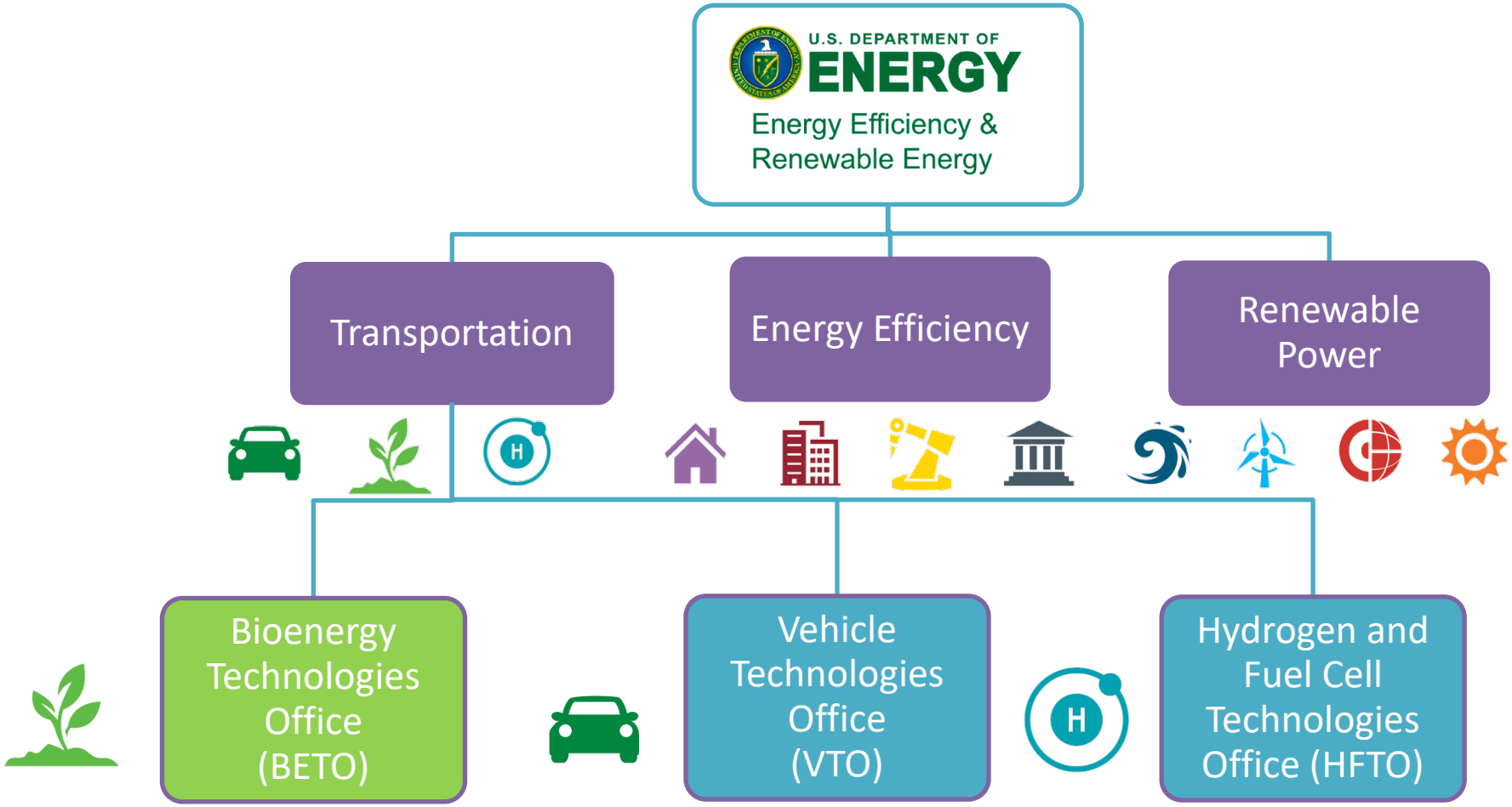
## Beau Hoffman

Technology Manager, BETO

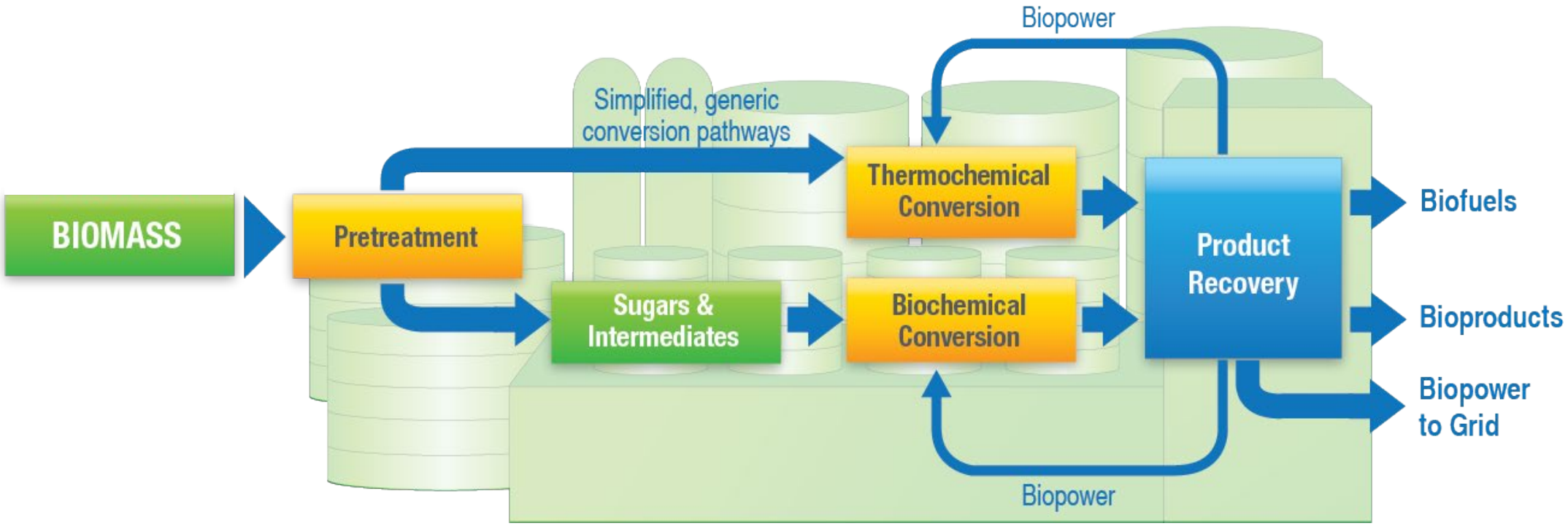
## Ed Wolfrum

Principal Investigator, FCIC

# DOE Office of Energy Efficiency and Renewable Energy



# Feedstocks to Fuels, Bioenergy, and Bioproducts




| Key Challenges | | | |
|---|---|---|---|
| Feedstock | Pretreatment | Conversion | Product |
| • Reliable supply<br>• Consistent quality<br>• Affordable delivery | • Biomass feeding, sizing and moisture<br>• Solids handling<br>• Material of construction | • Products yields<br>• Material of construction<br>• Catalysts<br>• Fermentation organisms | • Separations<br>• Catalytic upgrading<br>• Recycle loops |

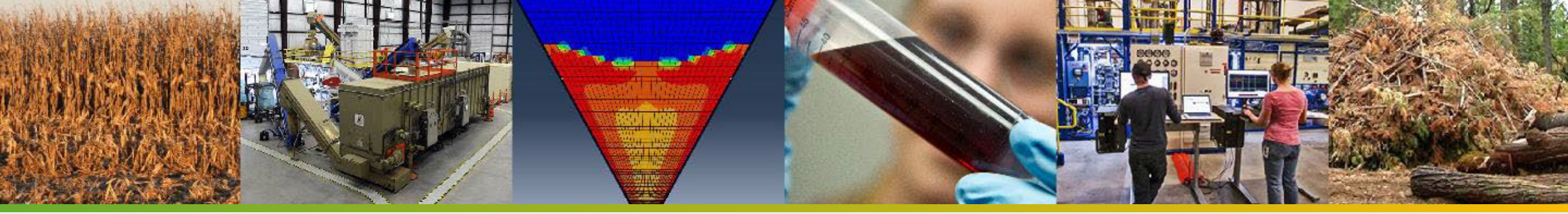
# Renewable Carbon Resources Program Goals

**Strategic Goal:** *Develop science-based strategies and technologies to **cost-effectively** transform renewable carbon sources into **high-quality**, **sustainable**, **conversion-ready**, and **energy-dense** feedstocks for biofuels, bioproducts, and biopower.*

**Approaches:**

- Defining requirements and specifications for high-quality, conversion-ready intermediates
- Developing fundamental understanding of the interactions between feedstock properties and conversion performance
- Identifying the key feedstock quality and performance factors affecting biorefineries
- Improving the efficiency of feedstock logistics operations

*Cost-effective, high-quality, sustainable, and energy-dense feedstocks*



# *FCIC Overview*

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# 1-slide guide to the FCIC

The Feedstock-Conversion Interface Consortium is led by DOE as a collaborative effort among researchers from 9 national labs

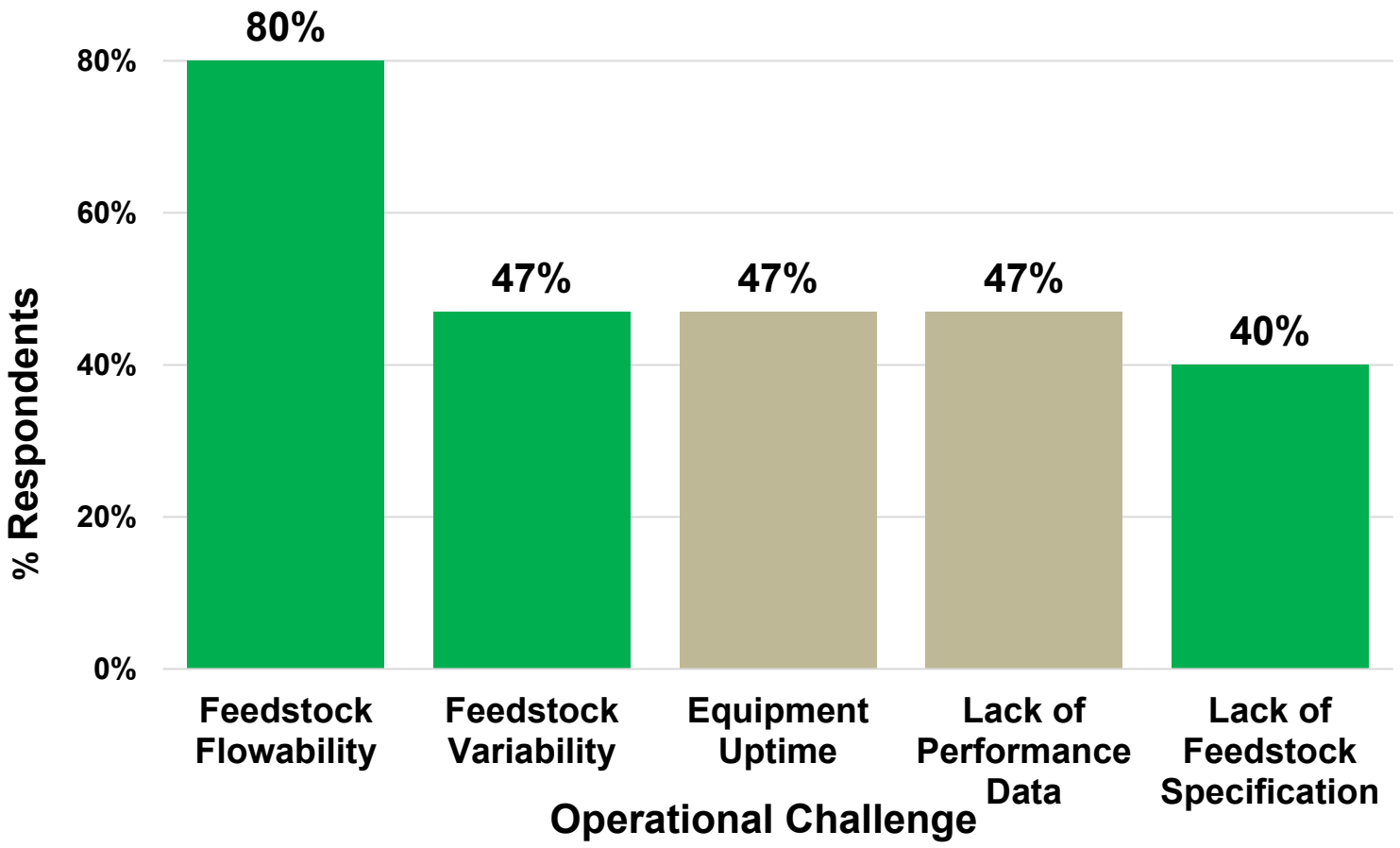
**Key Ideas**

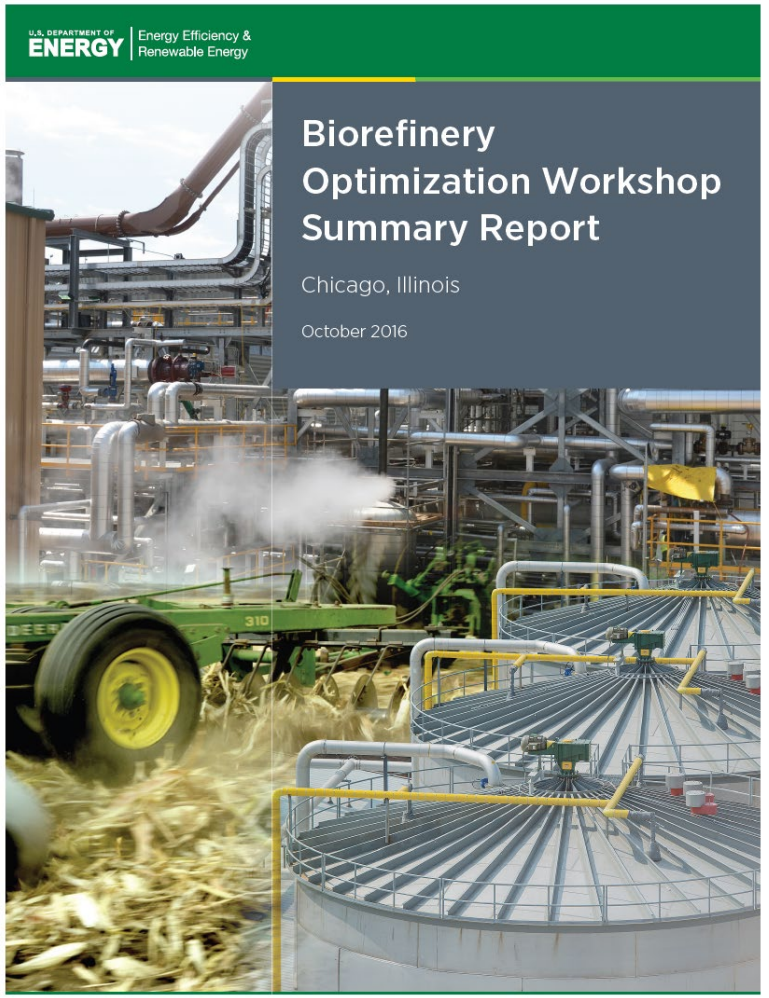
- Biomass feedstock properties are **variable** and **different** from other commodities
- **Empirical** approaches to address these issues have been **unsuccessful**

We are developing **first-principles** based knowledge and tools to **understand** and **mitigate** the effects of biomass feedstock and process **variability** on biorefineries

# 2016 Biorefinery Optimization Workshop

- Challenges, recommendations, and lessons learned from over 100 participants (industry, NL, academic)

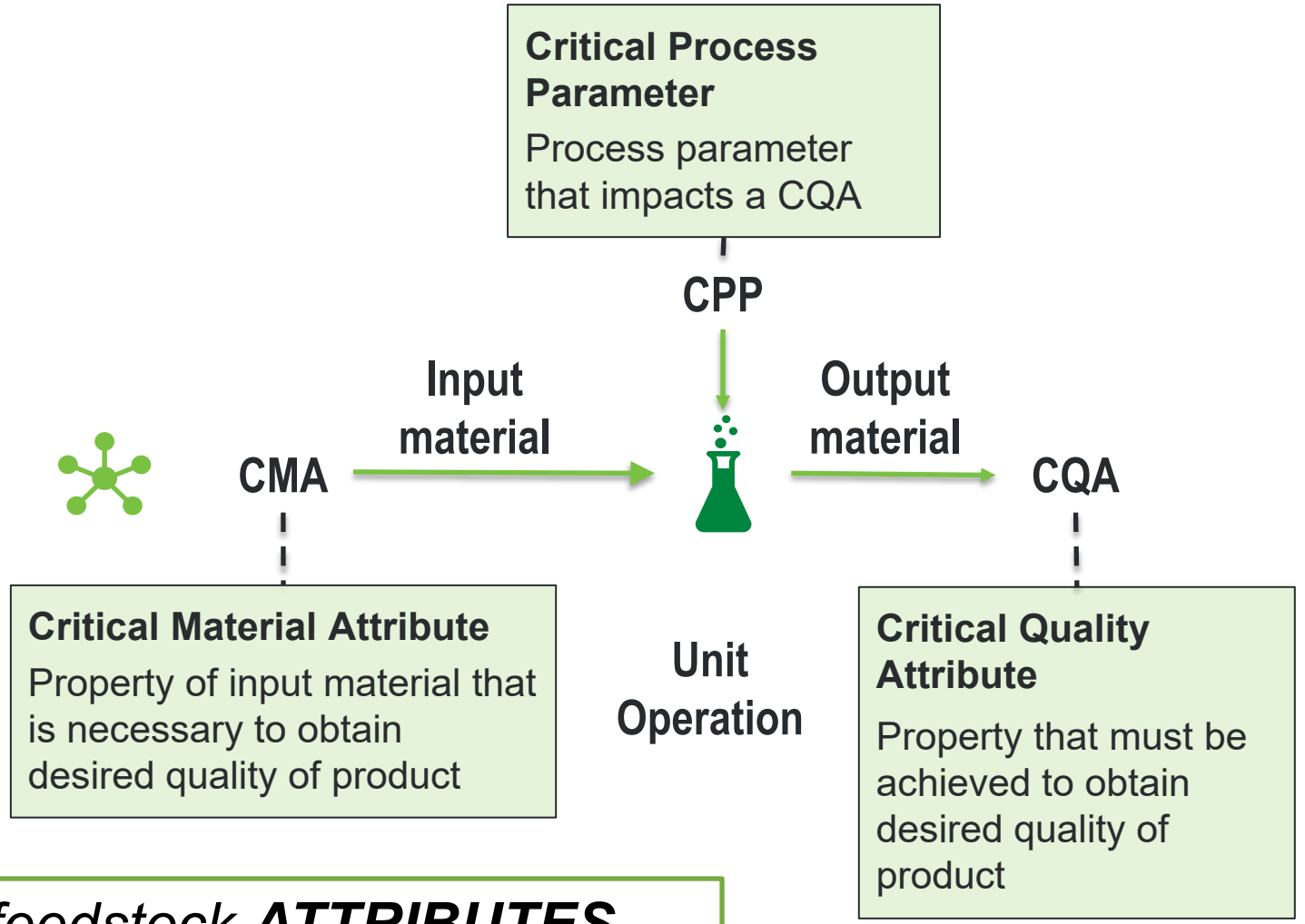



https://energy.gov/eere/bioenergy/downloads/biorefinery-optimization-workshop-summary-report

# Quality by Design (QbD)

- Key operating concept and organizing principle
- Widely used in pharmaceutical manufacturing – FDA-endorsed
- Chemical processes are collections of specific unit operations
- Unit operations are discrete but connected




*Moving from feedstock **NAMES** to feedstock **ATTRIBUTES***

# FCIC Task Organization

**Feedstock** → **Preprocessing** → **Conversion**

**Task 2: Feedstock Variability**

**Task 5: Preprocessing**

**Task 6: High-Temperature Conversion**

**Task 1: Materials of Construction**

**Task 7: Low-Temperature Conversion**

**Task 3: Materials Handling**

**Enabling Tasks**

**Task X: Project Management**

**Task 4: Data Integration**

**Task 8: TEA/LCA**
**Task 9: FMEA**

**Task X: Project Management:** Provide scientific leadership and organizational project management

**Task 1: Materials of Construction:** Specify materials that do not wear, or break at unacceptable rates

**Task 2: Feedstock Variability:** Quantify & understand the sources of biomass resource and feedstock variability

**Task 3: Materials Handling:** Develop tools that enable continuous, steady, trouble free feed into reactors

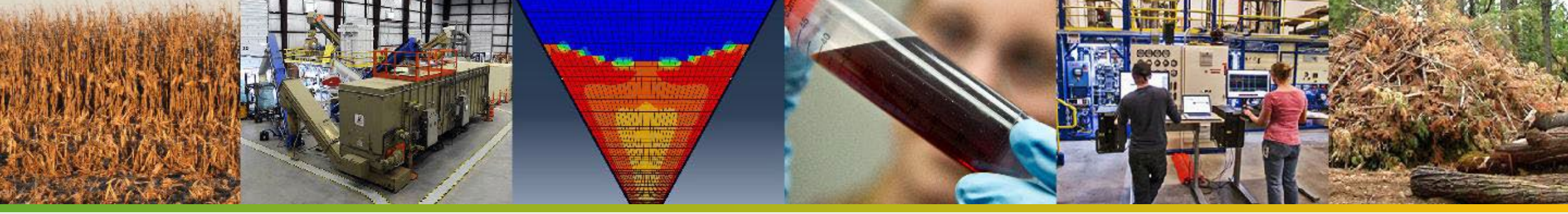
**Task 4: Data Integration:** Ensure the data generated in the FCIC are curated and stored – FAIR guidelines

**Task 5: Preprocessing:** Enable well-defined and homogeneous feedstock from variable biomass resources

**Task 6 & 7: Conversion (High- & Low-Temp Pathways):** Produce intermediates for further processing

**Task 8:Crosscutting Analyses TEA/LCA:** Valuation of intermediate streams & quantify variability impact

**Task 9:Failure Mode & Effects Analysis (FMEA):** Standardized approach for assessing attribute criticality



# 2023 FCIC CRADA Call

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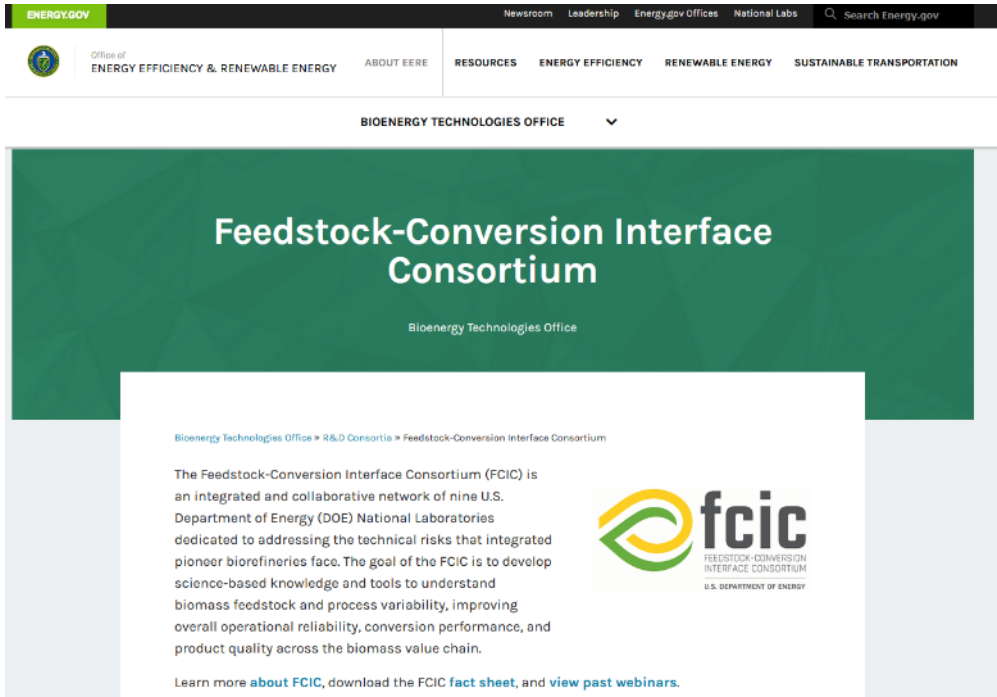
# Intent

- The full CRADA Call is available at https://www.energy.gov/eere/bioenergy/fcic-cooperative-research-and-development-agreement-call
- The intent of this CRADA call is to **apply FCIC capabilities to real world problems** that the bioenergy and bioproduct industries are facing.
- To maximize the likelihood of near-term impact for industrial partners, the FCIC wants to **leverage existing capabilities** within the consortium as opposed to projects that require novel model or tool development.
- A full list of capabilities and tools can be found at: https://www.energy.gov/fcic



# Example Capabilities

## Characterizing Feedstock Variability

https://pubs.acs.org/doi/abs/10.1021/acssuschemeng.9b06263

RETURN TO ISSUE | **PERSPECTIVE** | NEXT ›

**Characterizing Variability in Lignocellulosic Biomass: A Review**

Jipeng Yan, Oluwafemi Oyedeji, Juan H. Leal, Bryon S. Donohoe, Troy A. Semelsberger, Chenlin Li, Amber N. Hoover, Erin Webb, Elizabeth A. Bose, Yining Zeng, C. Luke Williams, Kastli D. Schaller, Ning Sun, Allison E. Ray*, and Deepti Tanjore*

**Cite this:** *ACS Sustainable Chem. Eng.* 2020, 8, 22, 8059−8085
Publication Date: May 4, 2020
https://doi.org/10.1021/acssuschemeng.9b06263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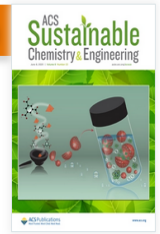


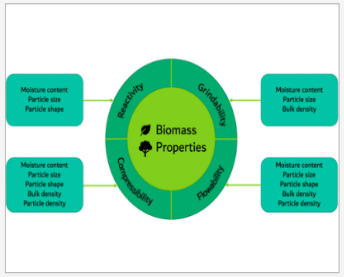
ACS Sustainable Chemistry & Engineering

PDF (13 MB) NREL JOURNALS

**SUBJECTS:** Biomass, Biomaterials, Cellulose, Granular materials, Materials

### Abstract

Feedstock variability is a significant barrier to the scale-up and commercialization of lignocellulosic biofuel technologies. Variability in feedstock characteristics and behavior creates numerous challenges to the biorefining industry by affecting continuous operation and biofuels yields. Currently, feedstock variability is understood and explained largely on the basis of chemical composition. Physical and mechanical properties and behavior of lignocellulosic feedstock in various unit operations, studied through advanced analytical methods, can further explain variability. Such studies will enable us in developing processes and designing equipment to improve operation and conversion performance. In this perspective, we review several advanced analytical methods that measure density, moisture content, thermal properties, flowability, grindability, rheology properties, and micromorphological characteristics. We also discuss the correlations and interactions among these properties that reflect the complexity of lignocellulosic biomass as a feedstock and the associated quality metrics and logistics of supplying consistent quality feedstock to a biorefinery. We also examine methods that have not traditionally been used to characterize lignocellulosic feedstocks but have the potential to bridge the gap in our explanation of feedstock variability.




## Examining Feedstock Storage Options

https://www.energy.gov/eere/bioenergy/articles/fcic-techno-economic-case-study


### FEEDSTOCK-CONVERSION INTERFACE CONSORTIUM

**Techno-Economic Analysis Case Study:** Corn Stover Storage Options Considering Variable Degradation Within Bale Stacks

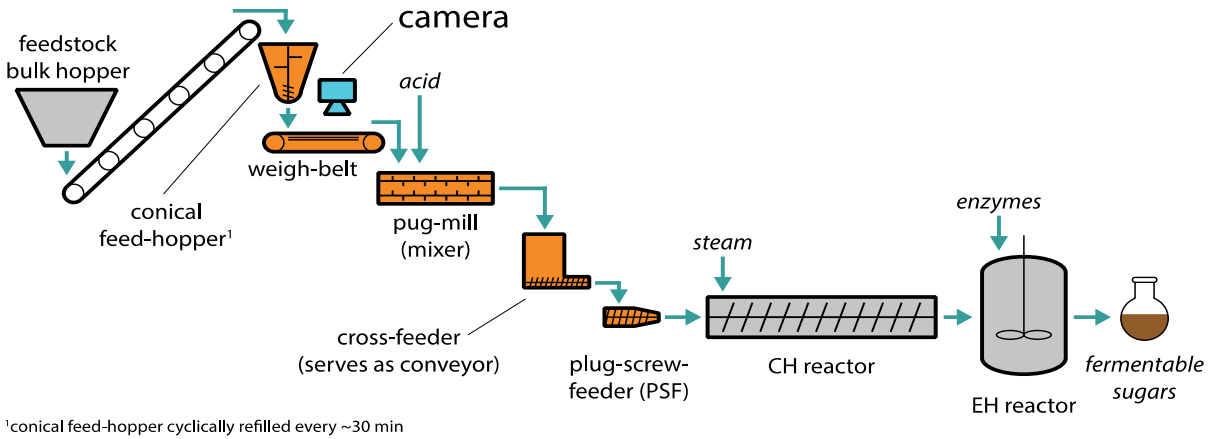
### CHANGING THE PARADIGM OF CONVENTIONAL APPROACHES

| Conventional Approach | New Information | Improved Approach |
|---|---|---|
| Prior studies using average estimates of losses and compositional changes during storage miss the operational impacts of biomass variability. | This new corn stover techno-economic analysis model better represents moisture migration through biomass bale stacks that create zones of varying degradation, which behave differently in preprocessing and conversion operations. | Using this approach, researchers can more accurately estimate costs of storage losses and protected storage, as well as predict the impact of bale-to-bale variability on biorefinery operations. |

# Example Capabilities (2)

## Identifying Feedstocks that May Cause System Upsets in Real Time

https://link.springer.com/article/10.1007/s13399-020-00904-w




[1]conical feed-hopper cyclically refilled every ~30 min


## Developing Tools to Predict Blade Wear in Mills

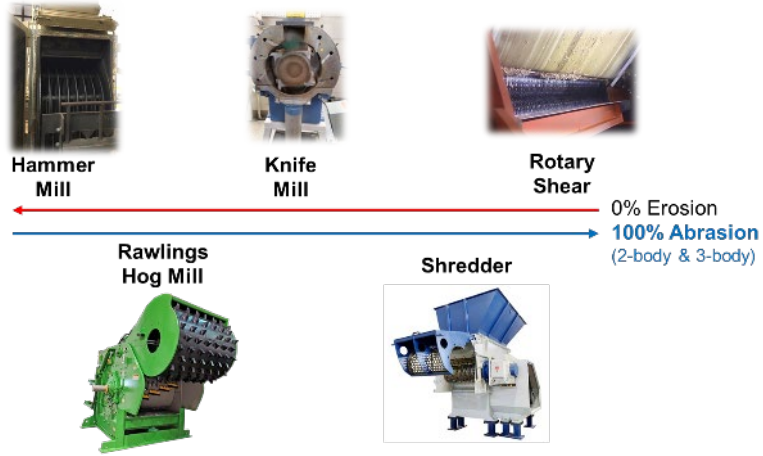
https://www.energy.gov/eere/bioenergy/fcic-materials-construction-research#outcomes

Argonne NATIONAL LABORATORY — RESEARCH

APPLIED MATERIALS

### ABRADE Model

ABRADE is an Excel-based model that calculates the recession of the leading edge of a knife blade due to abrasion by hard inorganic particles entrained in biomass feedstock.

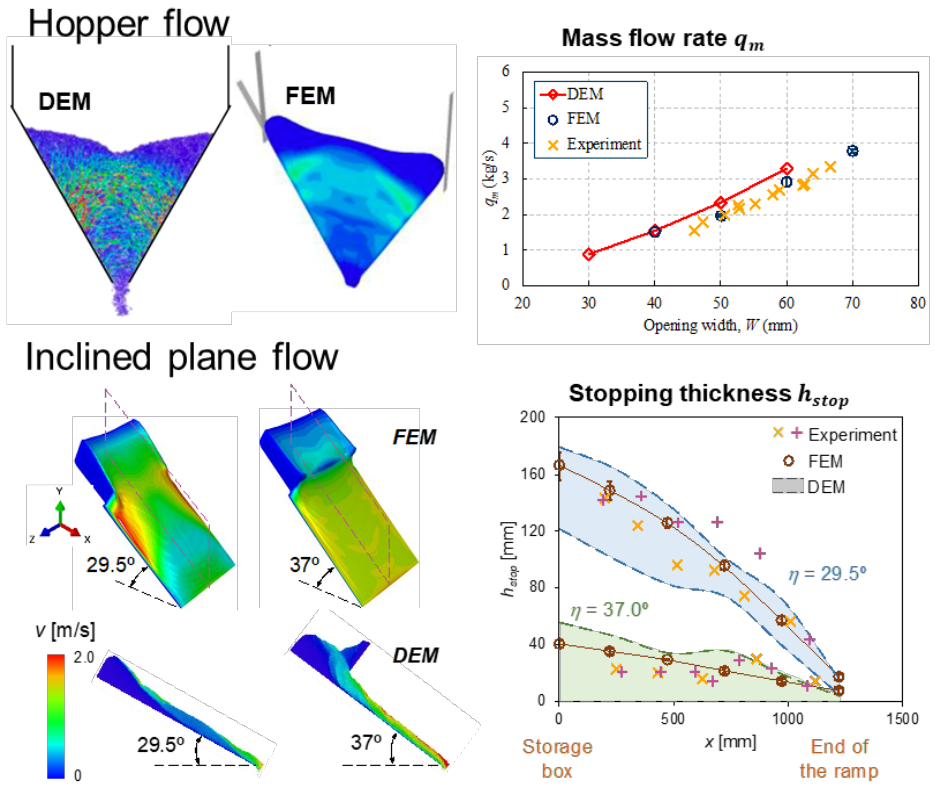


# Example Capabilities (3)

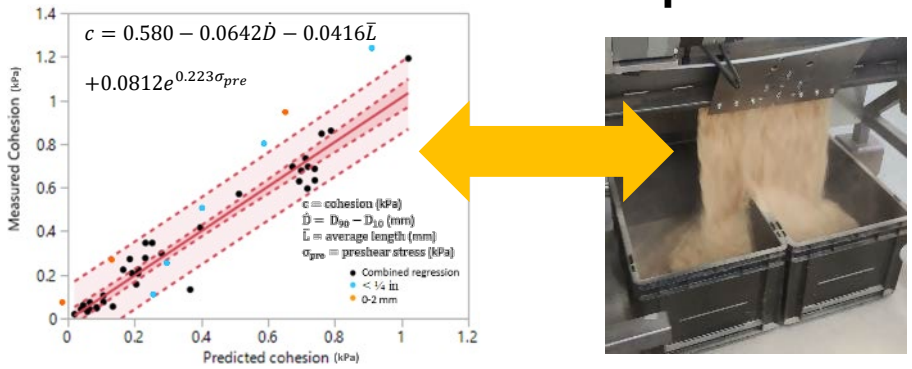
## Developing Tools to Predict the Flow of Biomass

https://www.energy.gov/eere/bioenergy/fcic-materials-handling-research#outcomes

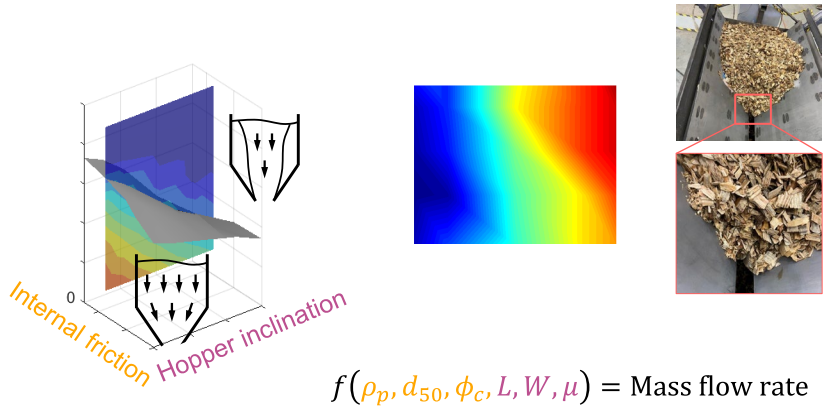
### DEM & FEM models for milled pine flow




### Relate Material Attributes to Shear and Bulk Flow Properties




### Wedge Hopper Design Chart




$f(\rho_p, d_{50}, \phi_c, L, W, \mu) =$ Mass flow rate

https://github.com/idaholab/GranularFlowModels

# Eligible Feedstocks

- **Lignocellulosic biomass - agricultural or forestry** residues and dedicated energy crops
- **Oilseed crops -** U.S.-produced, oil-producing crops including, but not limited to, soybeans, cottonseed, sunflower seed, canola, rapeseed, peanuts, camelina, carinata, pennycress, and oil-producing annual cover crops
- **Municipal solid waste (MSW) -** the non-recycled portion of MSW that is sorted and discharged from material recovery facilities (MRF) and **ordinarily is sent to a landfill but not considered or used for recycling**. Specifically, the focus is the **organic portions of MSW that can be converted to biofuels/bioproducts**, including non-recycled paper, plastic, rubber and leather, textiles, wood, food waste, and yard trimming constituents of the MSW stream, and the relevant contaminants that could affect conversion of the feedstock to a fuel or product.
- **Organic waste -** food waste from industrial, commercial, and residential sources; primary, secondary, tertiary, and post-anaerobic digestion sludge (i.e., biosolids) from municipal wastewater treatment systems; animal manure; and fats, oils, and greases
- **Food waste -** food from industrial, commercial, and residential sources that is no longer suitable for human consumption, and which would have otherwise entered an anaerobic digester, landfill, or other post-consumer disposition

# Eligible Unit Operations

## Eligible Unit Operations

- Any unit operation(s) that occur after the initial collection of the feedstock
  - For projects involving **lignocellulosic biomass and oilseed crops**, all unit operations after harvesting, up to and including eligible conversion unit operations
  - For projects involving **MSW**, any unit operations after the MRF, up to and including eligible conversion unit operations
  - For projects involving **organic wastes**, all unit operations after the initial collection of the material, up to and including eligible conversion unit operations

## Eligible Conversion Processes

- Both **low-temperature processes** (e.g., pretreatment, enzymatic hydrolysis, microbial conversion, and anaerobic digestion) and **high-temperature processes** (e.g., pyrolysis, gasification, and hydrothermal liquefaction)

## Eligible Conversion Products

- **Finished biofuels, bioproducts, and intermediates** that can be converted to finished biofuels or bioproducts through additional unit operations

# More Details

**Proposer Eligibility**

- All U.S. companies and universities, foreign companies and universities, subject to DOE headquarters approval of the project
- Individual U.S. citizens and lawful permanent residents
- Domestic for-profit entities, educational institutions, and nonprofits
- Foreign entities (but **must receive approval from DOE if selected**)

**Project Costs**

- All federal funds will be spent by one of the national laboratories in the FCIC.
- No funds will “pass-through” to partner organizations
- Partner organizations are required to contribute > 20% cost-share

**Award Size**

- Proposals should be written to $400,000 - $2,000,000 of federal funds

# CRADA Call Timeline

| Date | Event |
|---|---|
| Mar 14th | Informational Webinar |
| **April 14th** | Notice of Intent **Deadline** |
| **April 21st** | Applicant Presentation **Deadline** |
| **May 5th** | Proposal Submission **Deadline** |
| May/June | Project Proposal Review |
| June 30th | Announcement of Selections |
| October | Anticipated project kickoffs |

# Send a Notice of Intent

- A notice of intent is required by **April 14th**
  - Email FCIC@nrel.gov with the following information: Name, Organization, Email, and proposed National Lab Partner (if appliable).
  - You will receive a confirmation of receipt email within 1 working day.

- Prior to submitting a notice to propose a project, please read the terms of the Cooperative Research and Development Agreements (CRADA) at https://www.energy.gov/sites/default/files/2023-03/FCIC%20FY23%20CRADA-call-%20CRADA%20template.docx. This has been reviewed and approved by most participating DOE labs. This template will be used for all FCIC projects and is non-negotiable.

# Meet with FCIC Researchers

- All applicants will be required to give a short presentation on the proposed project, using the FCIC CRADA Call presentation template at https://www.energy.gov/sites/default/files/2023-03/FCIC%20CRADA%20Call%20Pitch%20Slides%20Template.pptx
- The presentation should be no longer than 20 minutes and the applicant should be available for up to an additional 20 minutes to answer questions. Applicants will receive an email to schedule presentations.
- Based on this preliminary presentation, applicants will be encouraged or discouraged to provide a full proposal submission. This feedback will be provided via email within 5 working days after the applicant presentation.
- If a proposal is encouraged, applicants will be partnered with a laboratory and FCIC researcher to assist with developing the proposal.

# Develop & Submit a Proposal

- Use the FCIC CRADA Call proposal template at https://www.energy.gov/sites/default/files/2023-03/FCIC%20FY23%20CRADA-call-%20Proposal%20template.docx to develop your proposal.
- Read the proposal template carefully to ensure you are following all instructions.
- Proposals should be no more than **10 pages in length**.
- Applicants are required to commit resources to the partnership in the form of **20%+ cost share.**
- The minimum DOE funding for a proposed project is $400,000 and the maximum is $2,000,000. These amounts do not reflect cost share or project totals.

**Submit your completed proposal to FCIC@nrel.gov no later than 11:59 p.m. MST May 5th, 2023.**

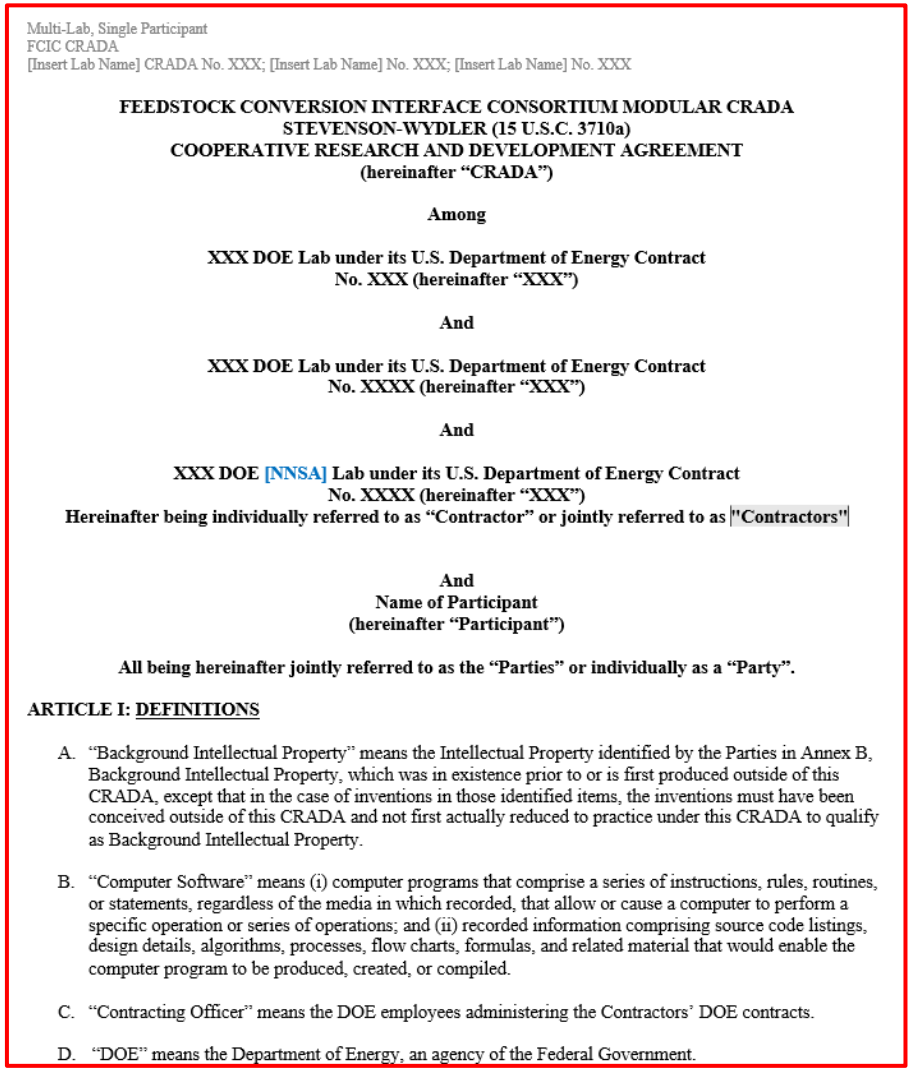
# Proposal Review Factors

3rd Party Reviewers are being chosen to independently evaluate these proposals. All reviewers will sign a conflict of interest/non-disclosure agreement

| Criteria | Weight |
|---|---|
| **Technical approach:** research plan, technical challenges addressed, FCIC capabilities leveraged, milestones, proposed budget, schedule | 30% |
| **Potential impact:** targeting BETO goals, addressing technical barriers, and market impact on the biofuels and bioproducts industry, and public dissemination strategy | 50% |
| **Appropriateness** of government and FCIC funding, key personnel, and resources | 10% |
| **Diversity, equity, and inclusion (DEI) plan**: appropriate DEI impacts considered for project size and scope | 10% |

# Contractual Information – the CRADA

- Successful applicants must sign a Cooperative Research and Development Agreement (CRADA) with the partnering national laboratory **prior to project start**.
- Terms of the CRADA are non-negotiable
- Applicants are strongly encouraged to review the example CRADA Document at https://www.energy.gov/sites/default/files/2023-03/FCIC FY23 CRADA-call-CRADA template.docx.



Multi-Lab, Single Participant
FCIC CRADA
[Insert Lab Name] CRADA No. XXX; [Insert Lab Name] No. XXX; [Insert Lab Name] No. XXX

**FEEDSTOCK CONVERSION INTERFACE CONSORTIUM MODULAR CRADA**
**STEVENSON-WYDLER (15 U.S.C. 3710a)**
**COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENT**
**(hereinafter "CRADA")**

**Among**

**XXX DOE Lab under its U.S. Department of Energy Contract**
**No. XXX (hereinafter "XXX")**

**And**

**XXX DOE Lab under its U.S. Department of Energy Contract**
**No. XXXX (hereinafter "XXX")**

**And**

**XXX DOE [NNSA] Lab under its U.S. Department of Energy Contract**
**No. XXXX (hereinafter "XXX")**
**Hereinafter being individually referred to as "Contractor" or jointly referred to as "Contractors"**

**And**
**Name of Participant**
**(hereinafter "Participant")**

**All being hereinafter jointly referred to as the "Parties" or individually as a "Party".**

**ARTICLE I: DEFINITIONS**

A. "Background Intellectual Property" means the Intellectual Property identified by the Parties in Annex B, Background Intellectual Property, which was in existence prior to or is first produced outside of this CRADA, except that in the case of inventions in those identified items, the inventions must have been conceived outside of this CRADA and not first actually reduced to practice under this CRADA to qualify as Background Intellectual Property.

B. "Computer Software" means (i) computer programs that comprise a series of instructions, rules, routines, or statements, regardless of the media in which recorded, that allow or cause a computer to perform a specific operation or series of operations; and (ii) recorded information comprising source code listings, design details, algorithms, processes, flow charts, formulas, and related material that would enable the computer program to be produced, created, or compiled.

C. "Contracting Officer" means the DOE employees administering the Contractors' DOE contracts.

D. "DOE" means the Department of Energy, an agency of the Federal Government.

# FAQs

**Will these slides be posted?**

- These slides and a recording of the webinar will be posted on the website

**Will funding be available to companies/universities?**

- All federal funds under this program will be spent by researchers at FCIC member national laboratories

**Can I submit multiple proposals?**

- Yes, provided the requests are unique and distinct

# FAQs

**What is cost share?**

- Cost share principles are available in 2 CFR 200.306 https://www.ecfr.gov/current/title-2/subtitle-A/chapter-II/part-200/subpart-D/section-200.306. In-kind cost share (such as technical consulting/expertise, or use of equipment) is allowed as is cash cost share

**How is 20% cost share calculated?**

- 20% cost share is calculated based on the total project cost (not just the federal share). For example:
  - A project is requesting $400K of Federal support, a minimum cost share of $100K would be required. $100K is 20% of $500K.

**What if I have other questions?**

- Please visit the website to view our current list of FAQs. If your question has not been answered, please submit them to FCIC@nrel.gov

# Questions?

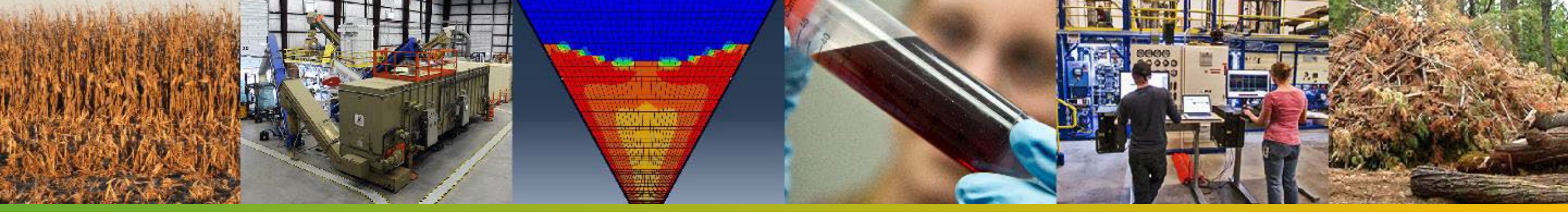
**Beau Hoffman**
Technology Manager, BETO
beau.hoffman@ee.doe.gov

**Ed Wolfrum**
Principal Investigator, FCIC
ed.wolfrum@nrel.gov

**More about this CRADA Call**

https://www.energy.gov/eere/bioenergy/fcic-cooperative-research-and-development-agreement-call

**CRADA Call Contact: FCIC@nrel.gov**



*Thank you*

**http://energy.gov/fcic**

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