NREL
NATIONAL RENEWABLE ENERGY LABORATORY

NATIONAL
BIOENERGY CENTER

Providing Solutions with **Experience** and **Scalability**

Bioenergy Feedstocks

30+ YEARS OF EXPERIENCE WITH DIVERSE FEEDSTOCKS

- Screening
- Bulk Handling
- Sampling
- Densification

Feedstock Deconstruction

LAB SCALE → PILOT SCALE

- Screening
- Pretreatment
- Deacetylation
- Mechanical Refining

Bioprocess Development

LAB SCALE → PILOT SCALE

- Screening
- Enzymatic Hydrolysis
- Fermentation

Bioproducts

SUGARS

FUELS

CHEMICALS & PRODUCTS

INTEGRATION ACROSS PROCESS

ANALYTICAL

- Compositional Analysis
- On-Line and At-Line Characterization
- Techno-Economic Analysis

Photos (front, left to right) by Art Wiselogel, NREL 02901; by Dennis Schroeder, NREL 35839; NREL 35857; NREL 34510; (back) by Dennis Schroeder, NREL 35812

WWW.NREL.GOV/BIOENERGY

Collaborate with NREL: Leaders in Advanced Biomass Research

For more than 30 years, the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) has been at the leading edge of research and technology advancements to develop renewable fuels and bioproducts. NREL works to develop cost-competitive alternatives to conventional transportation fuels and value-added bio-based chemicals that can be used to manufacture clothing, plastics, lubricants, and other products.

NREL is developing technologies and processes to produce a range of sustainable, energy-dense advanced biofuels that are compatible with our existing transportation fuel infrastructure. As part of that effort, NREL's National Bioenergy Center has entered into more than 130 collaborations in the past five years with companies ranging in size from start-ups to those that appear on *Fortune* magazine's Fortune 100 list.

Integrated Biorefinery Research Facility (IBRF)

All of NREL's patented biomass technologies are available for licensing, and NREL's world-class biomass user facilities, including the IBRF, are available to industry, university, and government researchers. NREL can provide trained staff to conduct or direct the work, or activities can be performed by staff from the participating organization. The IBRF can handle a wide range of biomass feedstocks and pretreatment processes. Our capabilities accommodate research from bench-scale to pilot-scale (up to one ton per day).

Biomass to Sugars and Products

Fully Integrated Biomass Deconstruction R&D Capabilities

- High-throughput screening
- Variety of bench (mL to L) and pilot (100 to 1,000 L) reactors for pretreatment, saccharification, and fermentation
- Fundamental scientific understanding and optimization/integration of unit operations.

Implementation Examples

- Cooperative development of custom pretreatment technology, enzyme, and strain integration
- Cellulosic ethanol demonstration from bench to pilot.

Biomass Compositional Analysis

NREL provides high-quality analytical characterization of biomass feedstocks, intermediates, and products, a critical step in optimizing biomass conversion processes.

Method Development for Measurement of Key Chemical Constituents

- Raw and pre-processed biomass, sugars, intermediate streams, and products
- Development of fast analytical techniques (e.g., near infrared) and chemometric models to predict chemical composition and feedstock reactivity (total sugar yield) on a wide range of feedstocks and intermediates
- *De facto* standard for biofuels industry worldwide: NREL's Standard Procedures for Biomass Compositional Analysis: www.nrel.gov/bioenergy/biomass-compositional-analysis.html

Implementation Examples

- Complete process characterization around novel feedstocks utilizing established and custom methods
- Evaluation of impacts of natural feedstock variability, ensiling, and other feedstock logistics cost reduction strategies on conversion and total cost of bioproduct and biofuel production.

Partner with NREL

Please contact us if you would like to explore collaboration opportunities with NREL's Bioenergy Program: Bob Baldwin, 303-384-6858, Robert.Baldwin@nrel.gov.

www.nrel.gov/bioenergy

NREL
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National Renewable Energy Laboratory
15013 Denver West Parkway
Golden, CO 80401
303-275-3000 • www.nrel.gov
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