

BioEnergy

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&

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Presented at:
ICLCS, LCS-RNET
IGES

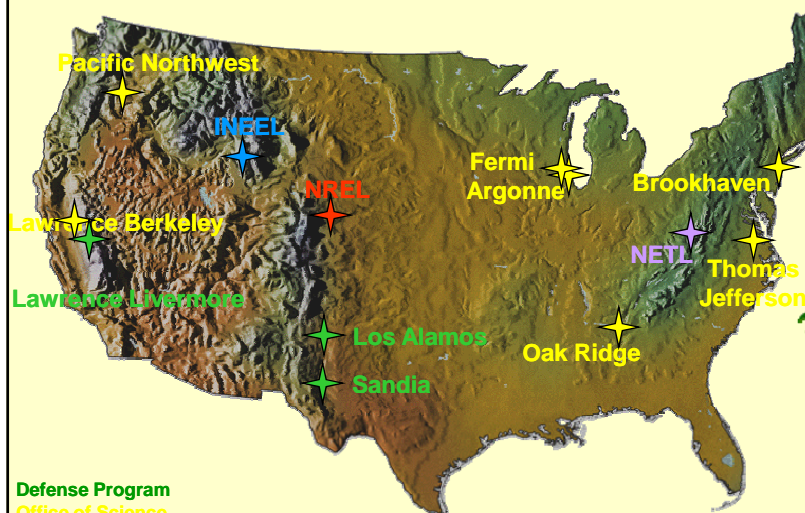
Hayama, Japan
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Industry/University Cooperative Research Centers

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US DOE National Laboratories

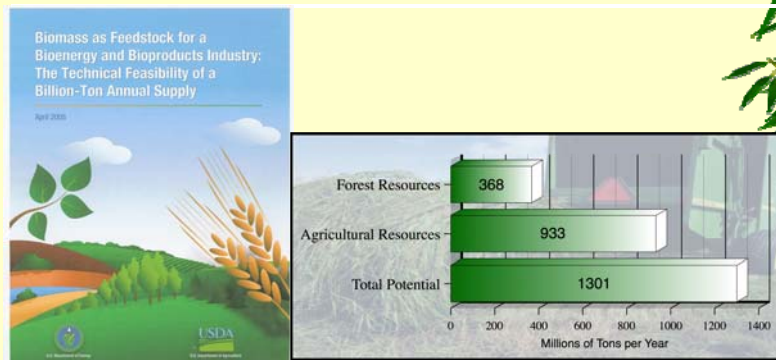


Defense Program
Office of Science
Energy Efficiency and Renewable Energy
Office of Nuclear Energy
Fossil Energy

Our Location



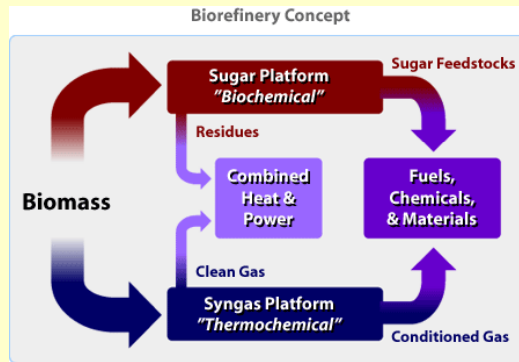
Biomass Feedstock



“Billion ton” study (USDA/DOE)

- **Agriculture:** Corn stover, wheat straw, soybean residue, manure, switchgrass, other energy crops.
- **Forest:** Forest thinnings, fuelwoods, logging residues, wood processing and paper mill residues, urban wood wastes.

Biomass to BioEnergy Options



Source: NREL

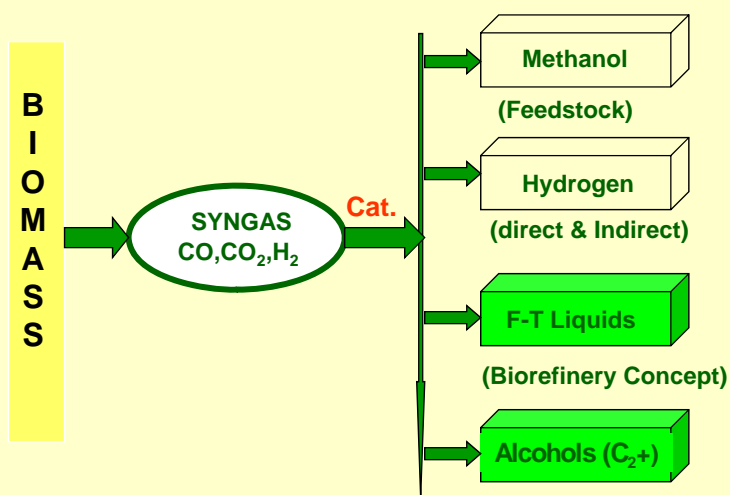
Driver: "Billion ton biomass is available in the U.S. (USDA/DOE Study).

Approach: Depolymerize biomass to 1C feedstock and then recombine ("Thermochemical" Pathway).

Product Focus: Transportation and Utility fuels

Biomass to Fuels

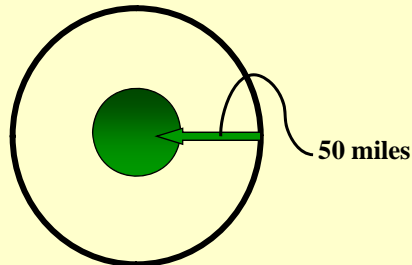
Thermochemical Route: Syngas Platform



Challenge: Total Carbon Utility with Product specificity.

Economical Biomass Processing- Targets

USDA Model



- **Biomass collection: 2000 T/d over 50-mile radius.**
- **Biofuel Yield (per dry ton):**
 - Mixed Alcohols: 77 gallons/ton
 - F-T liquids: 3000 barrels /d
- **Simple process:**
 - No gas recycle
 - Managed gas clean up
 - Maximum per pass C conversion (DOE 2012 goal: 50%)

SBU/BNL- Biomass Utilization Initiative


National Science Foundation- Engineering Directorate
II/UCRC (Industry/University Cooperative Research Center) Program
National Center for BioEnergy R&D (C-BERD)

Founding Members

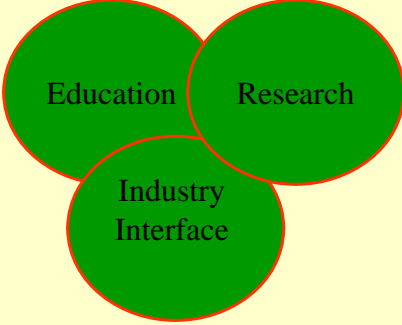
Kansas State University (K-State)
North Carolina State University (NCSU)
South Dakota School of Mines and Technology (SDSMT)
South Dakota State University (SDSU)
Stony Brook University (SBU)
University of Hawaii (UH)

Stony Brook Site- Industry Members

NYSERDA
National Grid
E-Renewables
Brookhaven National Laboratory
AERTC
Under discussion: 5

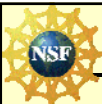



C-BERD Mission



Mission:

- To train students at all levels.
- Develop energy technologies based on renewables by working with industry.



National Center for BioEnergy R&D (C-BERD)

Features


- National Biofuels Center
- University consortium
- Industry driven- Initially 50-70 industries are expected to join.
- Industrial Advisory Board (IAB)

Focus Areas

- Focus Area 1: Feedstock agronomy and supply
- Focus Area 2: Feedstock breeding and genomics
- Focus Area 3: Bioprocessing microbes and enzymes
- Focus Area 4: Biomass processing
- Focus Area 5: New platform technologies
- Focus Area 6: Modeling and Process lifecycle analysis

Theme

- Efficient Biofuels production and storage
- Fuel utilization coupled with carbon sequestration





C-BERD: Sample Projects

- Biogas upgrading using membranes templated with supercritical (Sc) CO₂
- Advanced concept in C sequestration: CO₂ recycling by catalytic conversion into bioalcohols.
- Ultra-deep (< 5 ppm) sulfur removal from biomass-derived fuels: The next-generation nano catalyst based technology.
- High conversion once-through catalysis: Biomass-derived syngas to renewable diesel.
- Advanced concept in C sequestration: CO₂ recycling by catalytic conversion into bioalcohols.
- Biofuel combustion: combustion characteristics and emissions.
- PEM fuel cells (Bipolar plate technology): efficiency management with bioalcohols as fuel feed.
- H₂ production by thermophilic bacteria.
- Interaction of biofuels with skin tissue: Potential toxicity of oxygenated fuels.

Enabling Approach

Goal: Develop Atom-economical Processes

Interdisciplinary

Materials Science/Chemistry/chemical Engineering Interface

Approach

Combine Process Engineering and Process Chemistry

Process Chemistry

Liquid Phase Low Temperature (LPLT) concept

- Single-site or Nano catalysis

Process Engineering

Heat management

- Microchannel Reactors

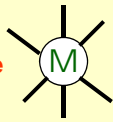
Process Chemistry

Liquid Phase Low Temperature (LPLT) concept
- Single-site or Nano catalysis

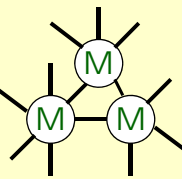
Controlled-site Catalyst**

Liquid Phase Operation ↔ Low Temperature

Use Single site



or Clusters

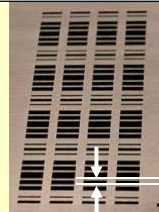


Process Engineering

Heat management
- Microchannel Reactors

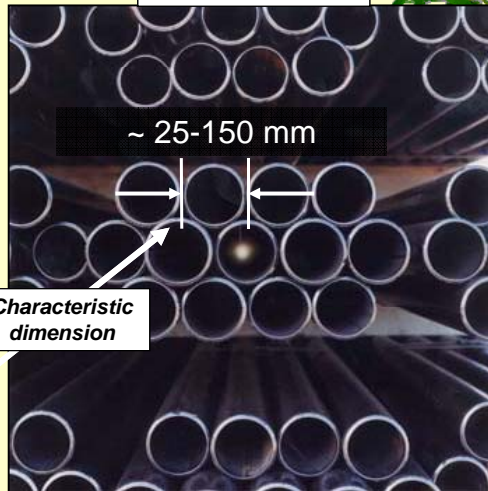
Microchannel
vs
Conventional
Process Technology

Microchannel



~ 0.1-
1.0 mm

Conventional

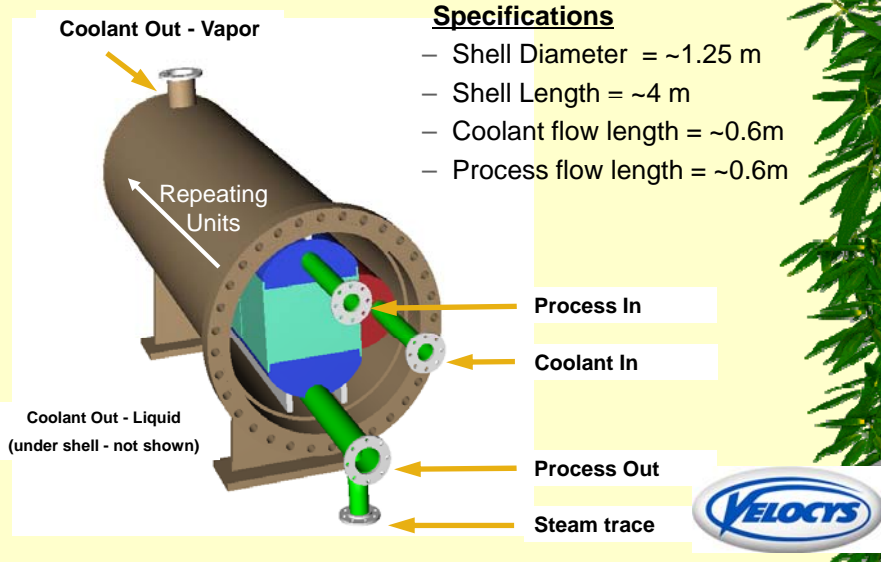


~ 25-150 mm

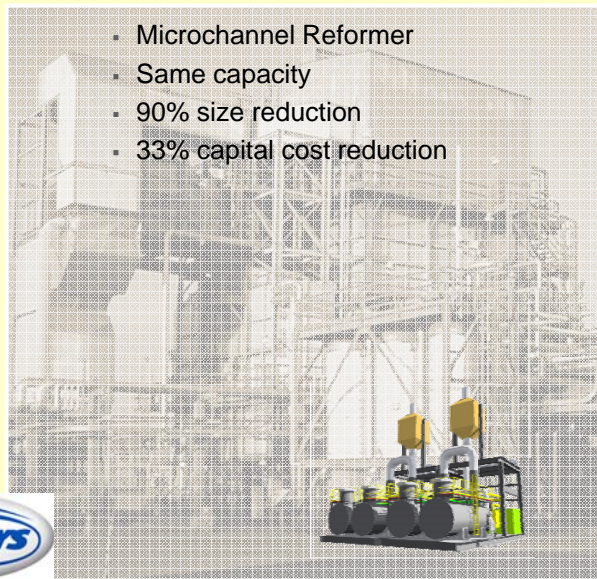
Characteristic
dimension



Microchannel F-T Technology



Velocys Steam Reformer



Unique Facilities



Research Facility

- New York State funded \$45 million at SBU.
 - Build the Advanced Energy Research & Technology Center (AERTC)
- NSF C-BERD will be housed in this building.

Characterization Facilities

- Center for Functional Nanomaterials (CFN)
 - A U.S. Department of Energy (US DOE) \$85 million facility at BNL.

Biofuels: A Path to Sustainable Development

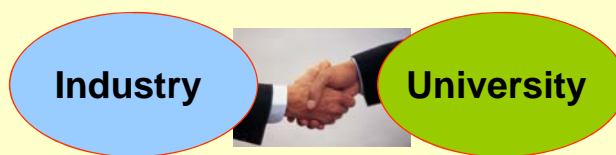
- * Resource consideration
 - >1 billion ton biomass is available
- * Distributive fuel production
 - "Small is beautiful"
- * Process and related chemistry need to be integrated for Product flexibility
 - Closely related process chemistry
- * "Oxygenates (Alcohols) Economy" - A transition to "Hydrogen Economy"

Acknowledgments

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- National Science Foundation (NSF)
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- BNL: LDRD funds.
- U.S. Department of Energy.
- AERTC Seed Grant.
- **Industry**

- **Finding sustainable sources of ENERGY is a global problem**



International participation is welcomed!