

# *Partnering with Argonne North Dakota CleanTech 2011*

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<http://pe.es.anl.gov> [www.anl.gov/biofuels](http://www.anl.gov/biofuels)

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# Argonne National Laboratory

## *America's first national laboratory*

- Chartered in 1946 from Enrico Fermi's work on the Manhattan Project.
- Operating budget of \$600+ million
- Operated by UChicago-Argonne LLC
- Science Council includes
  - Northwestern U and U of Illinois
- 25 miles S.W. of the Chicago Loop

The Advanced Photon Source is the North America's most brilliant X-ray.



## Sponsors:

DOE Office of Biomass, DOE Industrial Technologies Program, DOE Fossil Energy, Fossil Energy, BES, Geothermal, APRA-E

USDA

Illinois Corn Marketing Board

RPSEA

Private



The white deer are native to Northern Africa and Europe and were a gift to Gustav Freund, the estate owner in the 1930's.



# Team

***Life cycle analysis*** - Michael Wang, May Wu, Jennifer Dunn, Ignasi Palou-Rivera, Ed Frank

***Trees*** - M. Cristina Negri, Gayathri Gopalakrishnan, Paul Benda

***Catalysis – Drop-in Biofuels*** Jeff Miller, Ted Krause, Jeff Elam, Joe Libera, Anil Mane, Angel Yanguas-Gil

***Integrated Biofuel/Engine Design*** – Doug Longman, Mike Davis, Steve Klippenstein, Som Sibendu, Lisa LaRocco, Phil Laible

***Bioprocessing*** - YuPo Lin, Mike Henry, Sabeen Ahmad, Saurav Datta, Ed St. Martin, Cindy Millard, Dimple Kundiyana

***Water*** - Patricia Gillenwater, Meltem Urgun Demirtas

# Academic Partners

- Univ of Illinois at Urbana Champaign
  - CABER
  - IGB
- Northwestern University
  - Sustainability Institutes
  - ANSER
- Univ of Illinois at Chicago
  - UIC Energy Center
- Purdue University
- Iowa State University
  - Bioeconomy Center
- U Chicago
  - IGSB
- South Dakota School of Mines and Technology
  - CBERD
  - CBRD
- Illinois Institute of Technology
- SUNY-ESF
- IUPUI
  - Lugar Renewable Energy Center



# Other Partners

- NABC
- ORNL
- PNNL
- INL
- NREL
- Army Corp of Engineers
- USEPA reg 5
- Conservation Technology Information Center
- NRCS
- Mendel
- Ceres
- Monsanto
- Archer Daniel Midland
- NREL
- Nalco
- BP

# Examples of Projects in Bioenergy

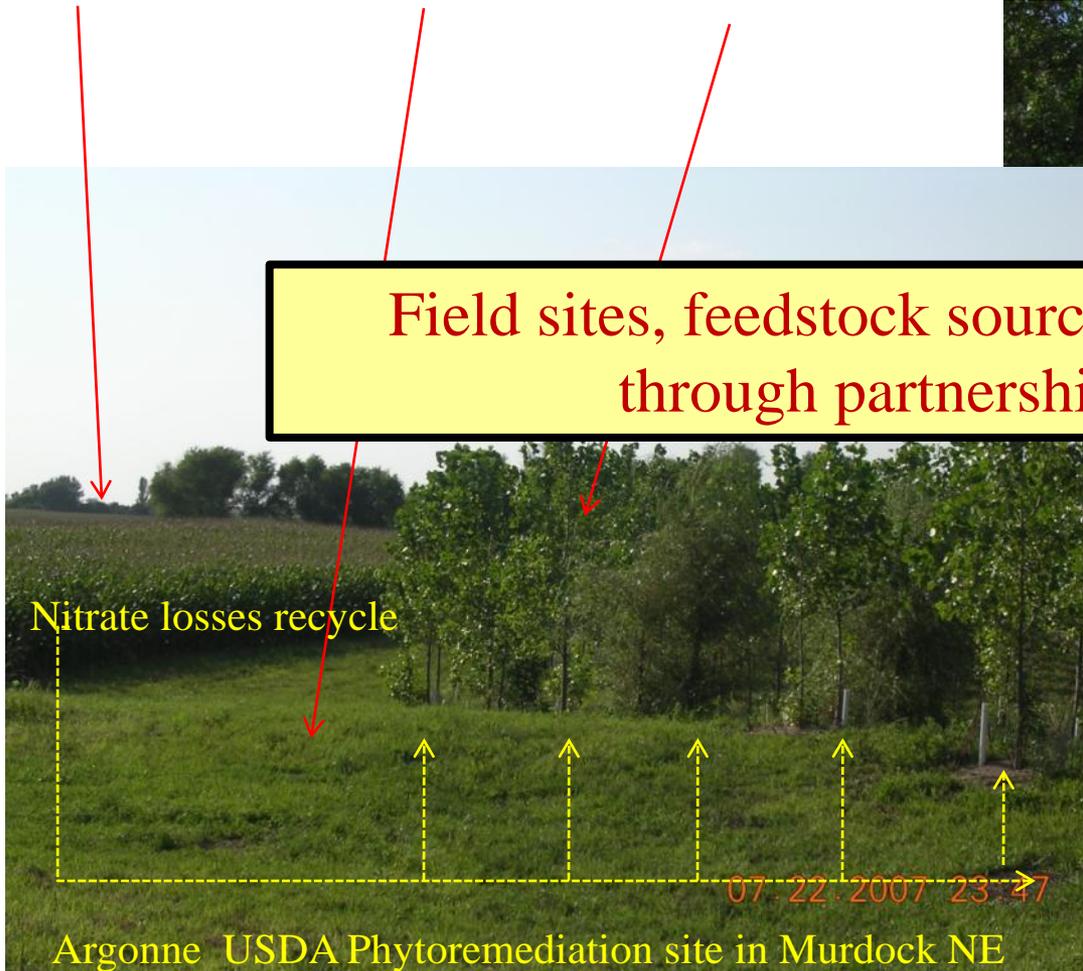
... and how we build projects and relationships

# Enhanced productivity and better use of resources. - Murdock, Nebraska

corn

switchgrass

poplar



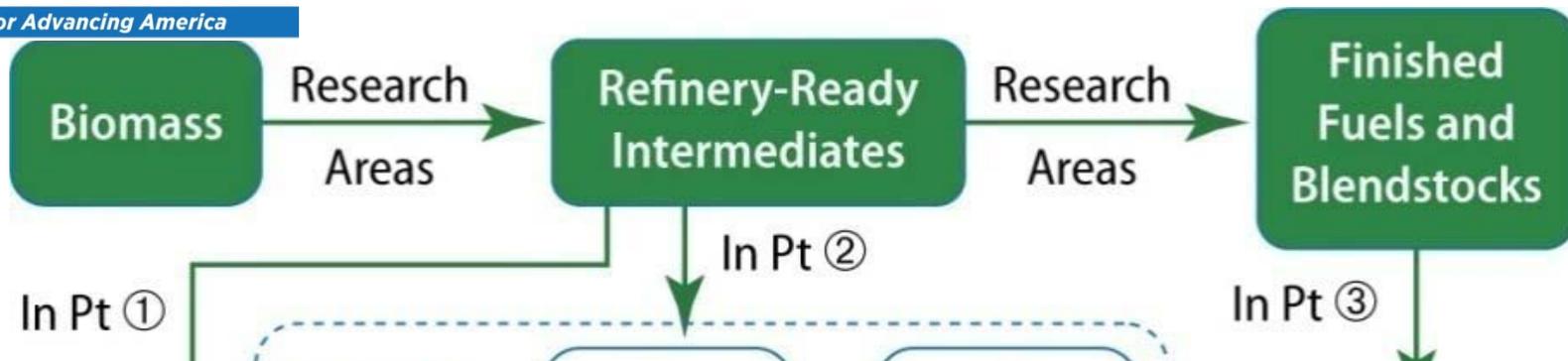
Field sites, feedstock sources, analysis through partnerships

- More than a riparian buffer:
  - An engineered, integrated biorefinery feedstock production model.



# NABC - Drop-in Fuels

Biofuels for Advancing America



- Multi-institutional partnership led by NREL/PNNL
- Several academic partners
- Targeted goals – with a down select process

Crude  
Oil

Atmospheric  
Vacuum

VGO  
Atm. Res.  
Vac. Res.

HT/HC  
Coker

Jet Fuel

Existing Refinery Infrastructure

## Six Process Strategies

- 1) Fermentation of Sugars
- 2) Catalytic Conversion of Sugars
- 3) Catalytic Fast Pyrolysis
- 4) Hydropyrolysis
- 5) Hydrothermal Liquefaction
- 6) Syngas to Distillates

\$35 M ARRA funding  
NREL, PNNL, etc

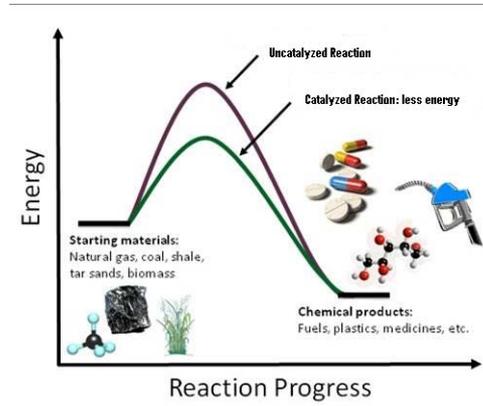
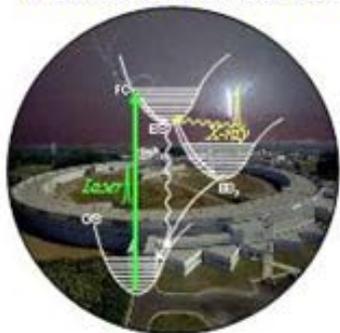


# Argonne: Four Interlinked Catalyst Capabilities

Argonne has critical expertise but not a complete system

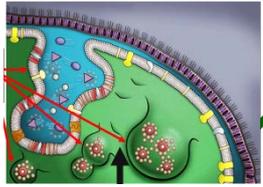
- Catalyst Synthesis.
- In situ Characterization
- Computational Modeling
- Catalytic and Chemical Reaction Science

Advanced Photon Source



# Integrated Biofuel / Engine Design

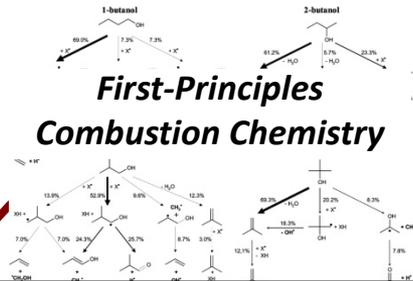
Approach: a system-level, iterative feedback loop – new feedstocks, processing, combustion science, modeling, world testing, optimization, and life-cycle analysis.



Feedstock Optimization



Bio-based Feedstock Selection



Modeling and Fundamental Testing

Bio-Processes

- Internally developed project
- We developed critical systems expertise
- Just starting to look for partners as funding opportunities arise

Solar/Bio Feedstocks

Catalyst Design and Synthesis

Chemical Processes

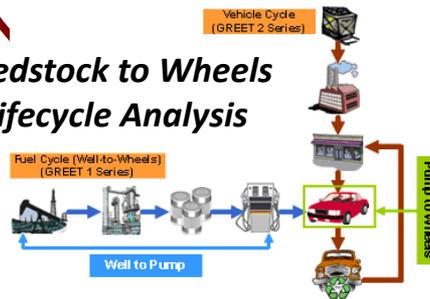
Production

Feedstock to Wheels Lifecycle Analysis

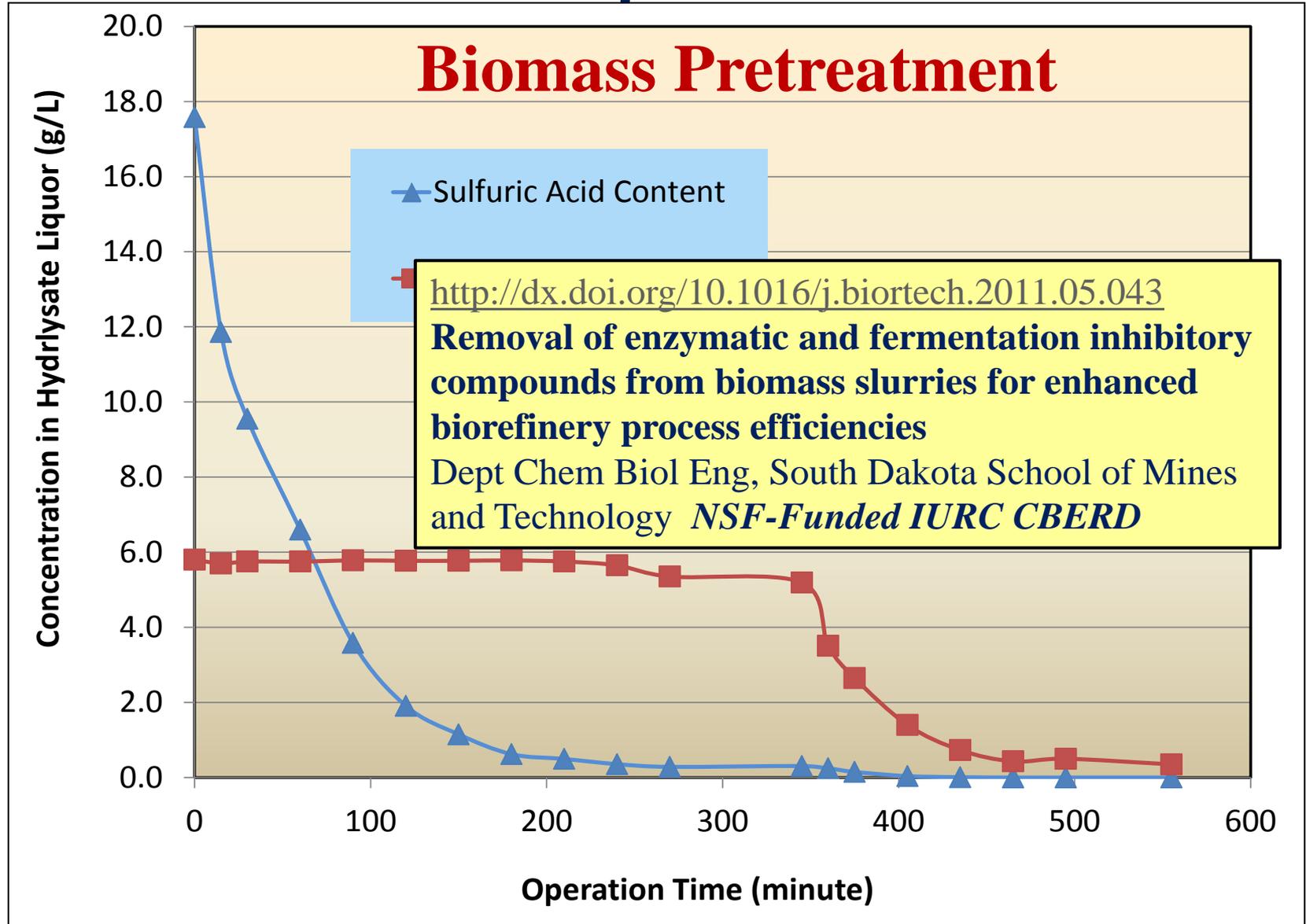
in situ Engine Studies

Vehicle Integration

in situ Testing and Characterization

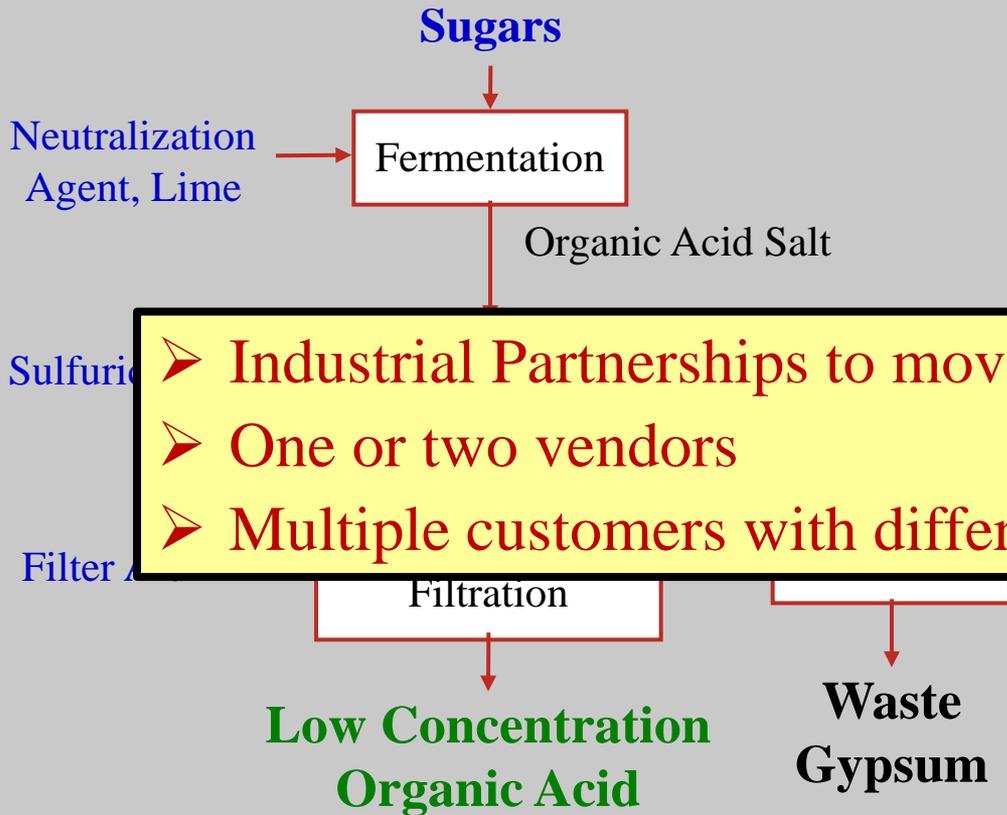


# Acid Removal and Separations with RW-EDI

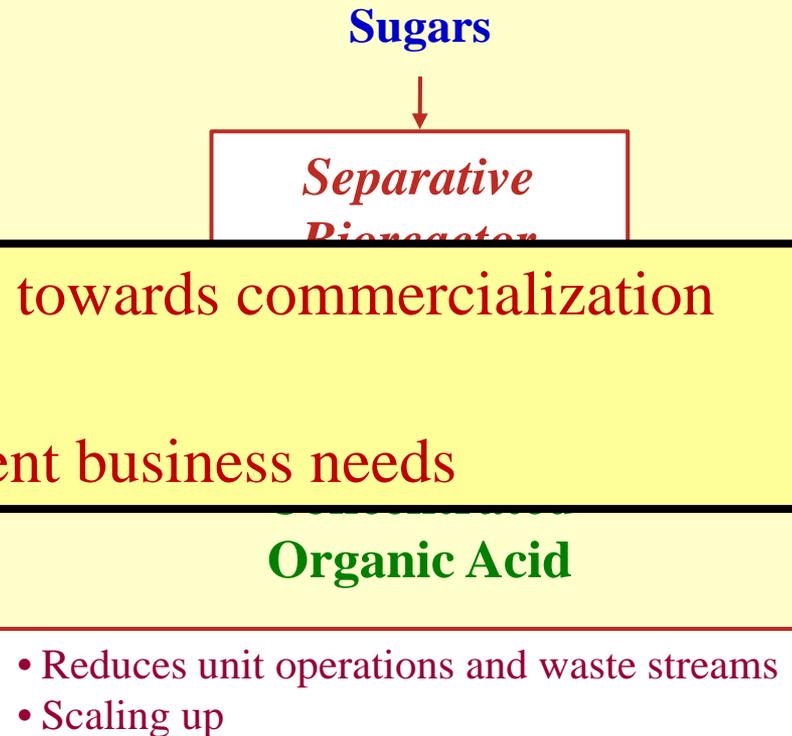


# A new way to produce biobased chemicals

## Conventional Process



## Separative Bioreactor



- Industrial Partnerships to move towards commercialization
- One or two vendors
- Multiple customers with different business needs

- Integrates bioprocessing and separations
- *Costs competitive with petrochemicals!*

# Working with Argonne

- Facility Users
- Joint Proposals
  - DOE, other (not NSF), EPSCOR
  - Project Level, Center Level
- Grad Research - Thesis Parts
- Undergrad Research
  - SULI, FAST
- Postdoctoral
- Pre-doctoral
- On-site housing
- Joint Appointments
- Faculty - Summer/Sabbatical
  - Visiting Scientist
  - “STA” Special Term Associate

- Resources
  - Funding
  - feedstocks, specialized equipment, ideas)
- Alignment
  - Complementary goals
  - Distinct expertise
  - e.g. R&D supply chain
- Relationships