

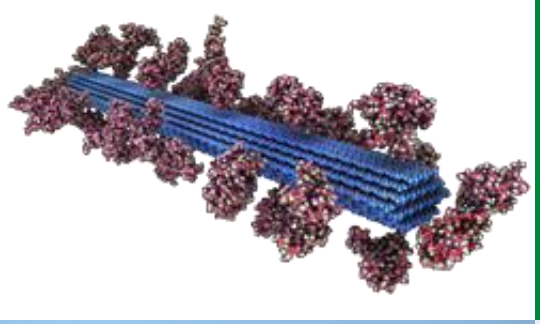
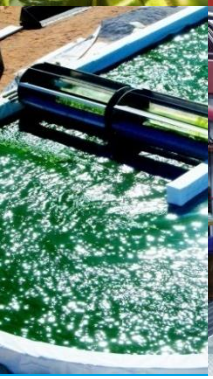



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2015 PROJECT PEER REVIEW

U.S. DEPARTMENT OF ENERGY
BIOENERGY TECHNOLOGIES OFFICE

Feedstocks Supply & Logistics R&D

Alison Goss Eng

Feedstocks Supply and Logistics Program Manager (Acting)

Feedstock Supply and Logistics Program Introduction

- Goals & Objectives
- Challenges & Barriers
- Strategic Approach
- Funding History
- Partnerships
- Accomplishments

Introductions – Feedstock Supply and Logistics Team

Alison Goss Eng,
Feedstock Program Manager(Acting)

Sam Tagore,
Technology Manager

Daniel Adams,
BCS

Steve Thomas,
Technology Manager

Mark Elless,
Technology Manager

Erin Searcy,
M&O Contractor
Idaho National Lab

Laurence Eaton,
M&O Contractor
Oak Ridge National Lab

Art Wiselogel,
Project Monitor,
CNJV

Bryce Stokes
Senior Advisor,
CNJV

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Feedstock Supply and Logistics Focus Areas

- **The strategic goal of Feedstock Supply and Logistics (FSL) is to develop technologies to provide a sustainable, secure, reliable, and affordable biomass feedstock supply for the U.S. bioenergy industry, in partnership with USDA and other key stakeholders. This goal corresponds to the following cost targets:**
  - Validate efficient, **low-cost**, and **sustainable** feedstock supply and logistics systems that can deliver feedstock to the conversion reactor throat at required conversion process infeed specifications, at or below $80/dry ton by **2017**.
  - By **2022**, develop and validate feedstock supply and logistics systems that can economically and sustainably supply 285 million dry tons per year at a delivered cost of $80/dry ton to support a biorefining industry (i.e., multiple biorefineries) utilizing a diversity of biomass resources.

FSL Focus Areas

Components of Achieving Program Goals

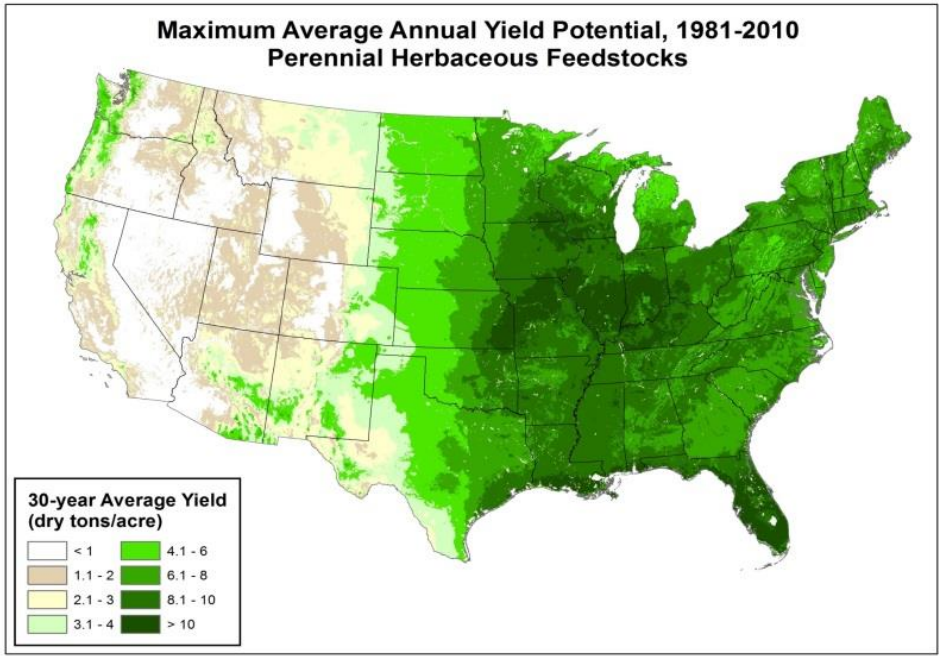
Providing Adequate Biomass Supply

Focus:

Develop productivity baselines for bioenergy crops through field trials

Understand the factors affecting yield potential and biomass quality

Inform biofuels commercialization strategies with feedstock supply and price projections



Approach:

Regional Feedstock Partnership

U.S Billion Ton Update

Biomass Analytical Library

U.S. BILLION TON UPDATE

SunGrant INITIATIVE

Idaho National Laboratory

OAK RIDGE National Laboratory

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FSL Focus Areas

Components of Achieving Program Goals

Reducing Feedstock Cost

Focus:

Actively managing biomass variability using biomass harvesting equipment.

Meet the capacity, efficiency, and delivered price requirements of large cellulosic biorefineries through developing advanced preprocessing technologies.

Approach:

High Tonnage Competitive Awards

INL Logistics Work

National Biomass Feedstock User Facility and Process Demonstration Unit

FDC Enterprises Grasslands Services

Idaho National Laboratory

Genera energy

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FSL Focus Areas

Components of Achieving Program Goals

Promoting Sustainability

Focus:

Research how and where to grow biomass feedstocks to maximize yield and sustainability.

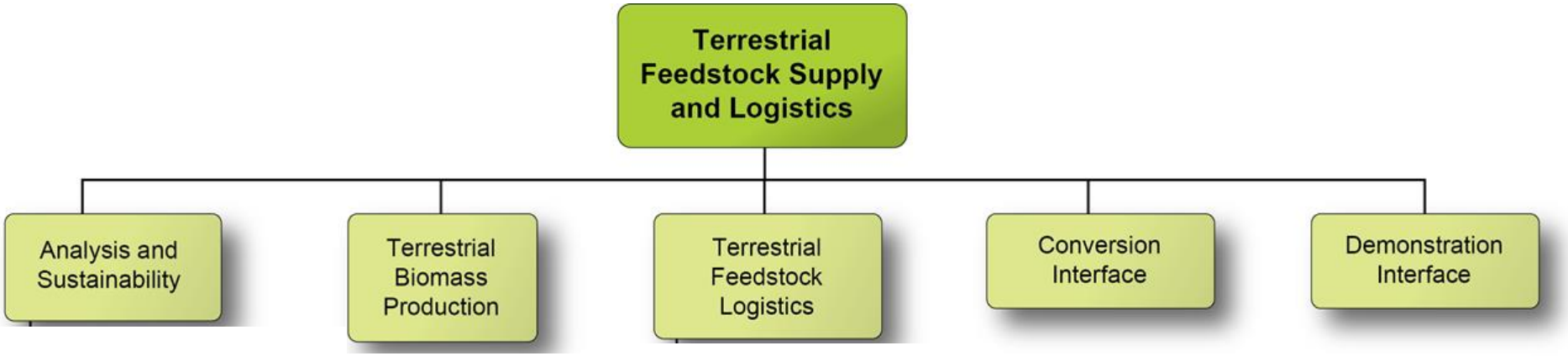
Sustainability metrics of interest include soil carbon, GHG emissions, water quality, biodiversity

Approach:

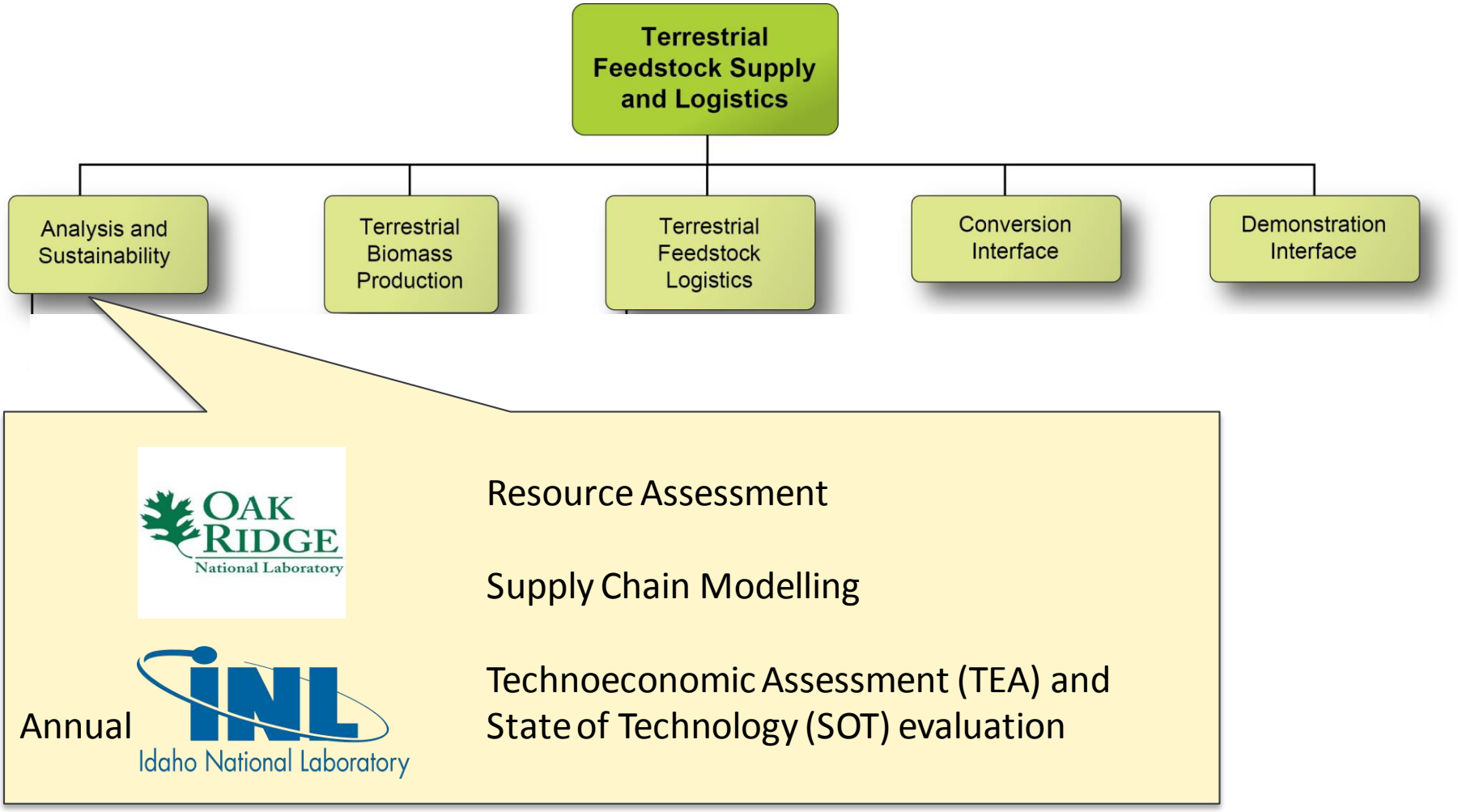
Landscape Design FOA

U.S Billion Ton Update

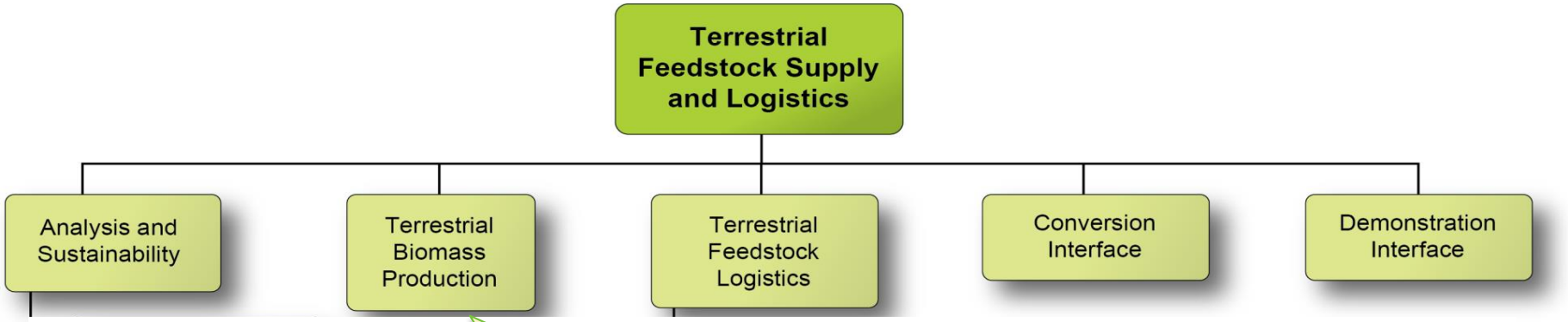
Approach: Work Breakdown Structure



Approach: Work Breakdown Structure



Approach: Work Breakdown Structure



SunGrant INITIATIVE

Grow renewable energy and biobased industries that revitalize rural communities by harnessing science and technological capacities of Land-Grant University research, education, and Extension programs

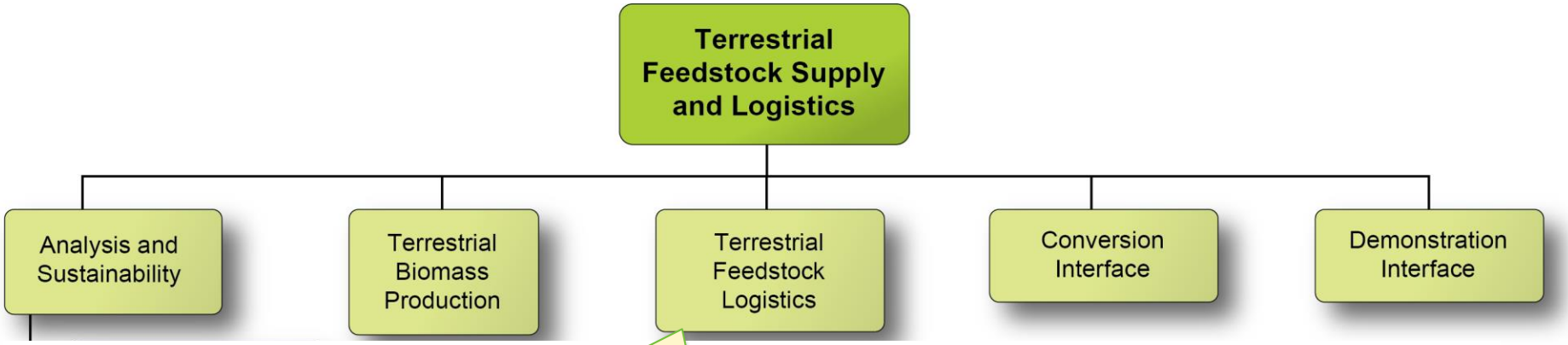
From Growth to Harvest

Yield Mapping

Partners with USDA

OAK RIDGE National Laboratory

Approach: Work Breakdown Structure



Harvest to Conversion

Bringing down Cost Associated with:
Storage
Preprocessing
Handling
Transportation

Genera energy

INL Idaho National Laboratory

AUBURN UNIVERSITY

ESF

AGCO Your Agriculture Company

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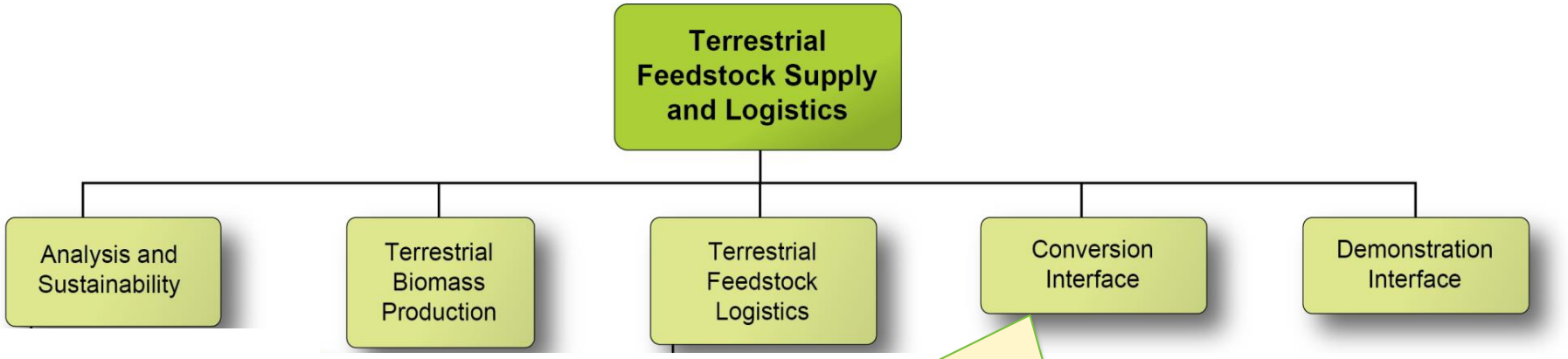
Approach: Work Breakdown Structure



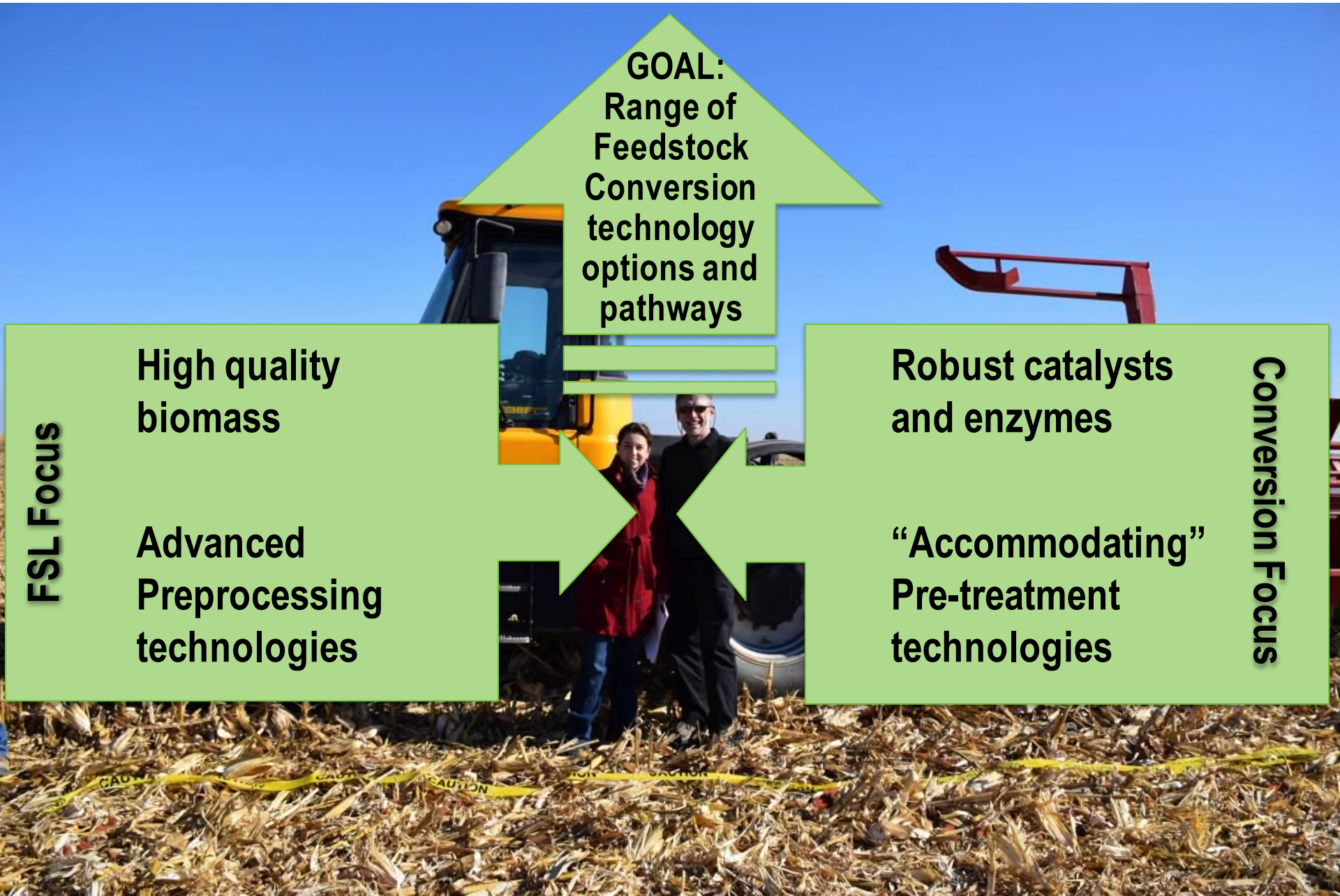
Idaho National Laboratory

Feedstock Quality

In-feed Specifications

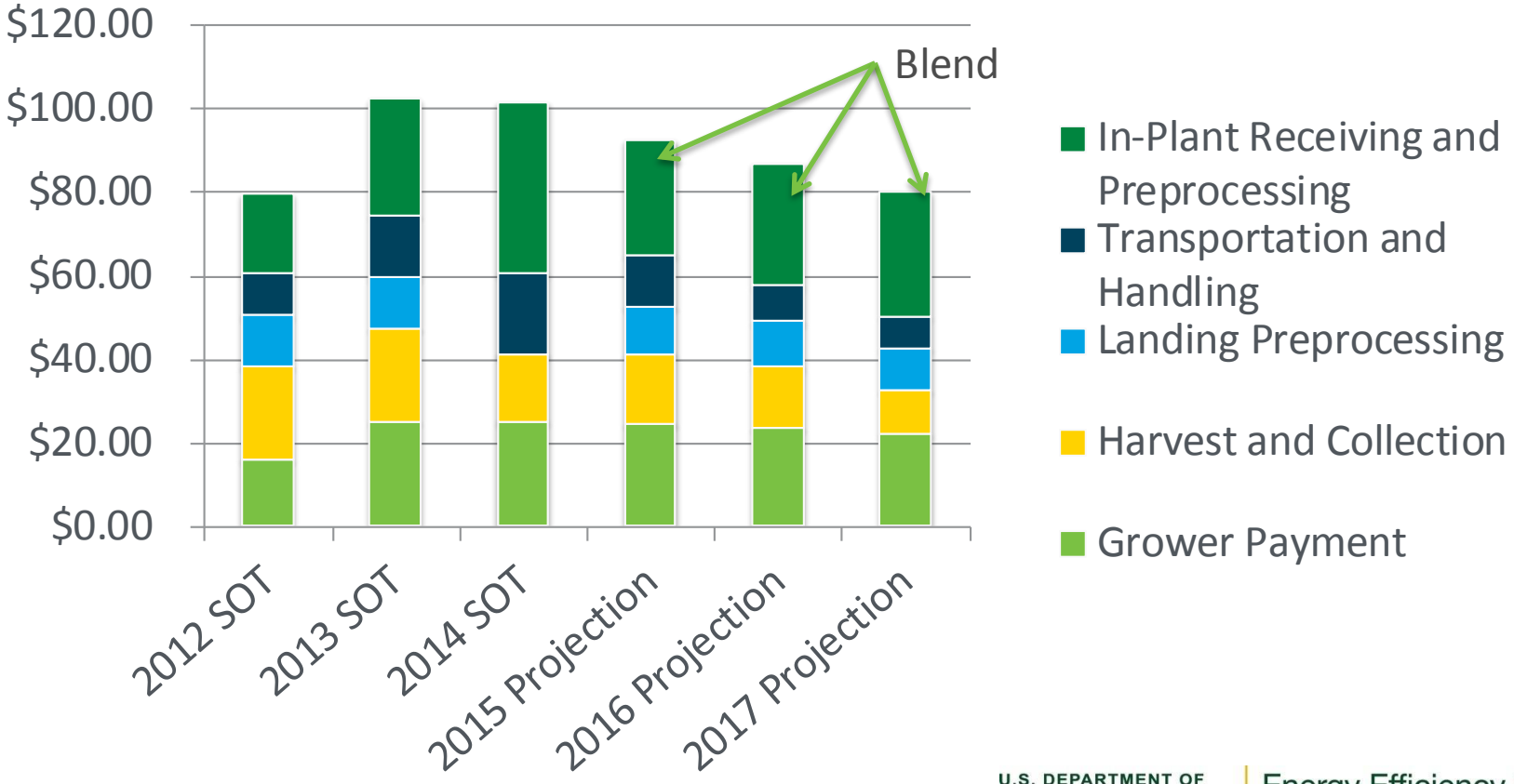
Current SBIR/STTR Topic Area

Conversion Interface



Blending Woody Feedstocks

- FY15 SOT: $101.45/ton (2011$)
  - ($25.00 grower payment + $76.45 logistics per dry ton)
- Sustainability Metrics- GHGs: 237.82 kg CO_2 eq/ton
  - other metrics depend on supply system



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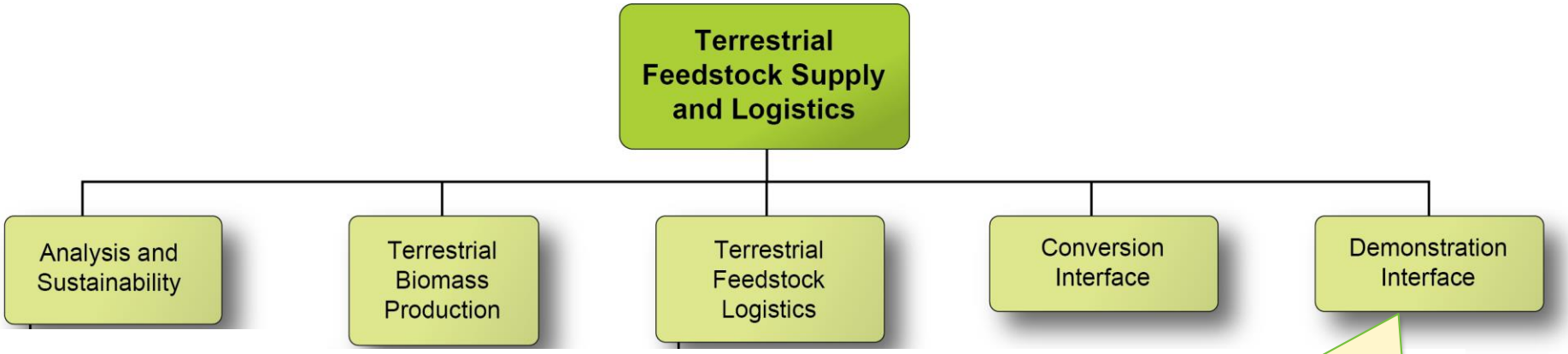


ABENGOA BIOENERGY
Science. Solutions. Service.

ZeaChem

Cost, Quality, Quantity of Feedstocks

Advanced vs Conventional Supply Systems

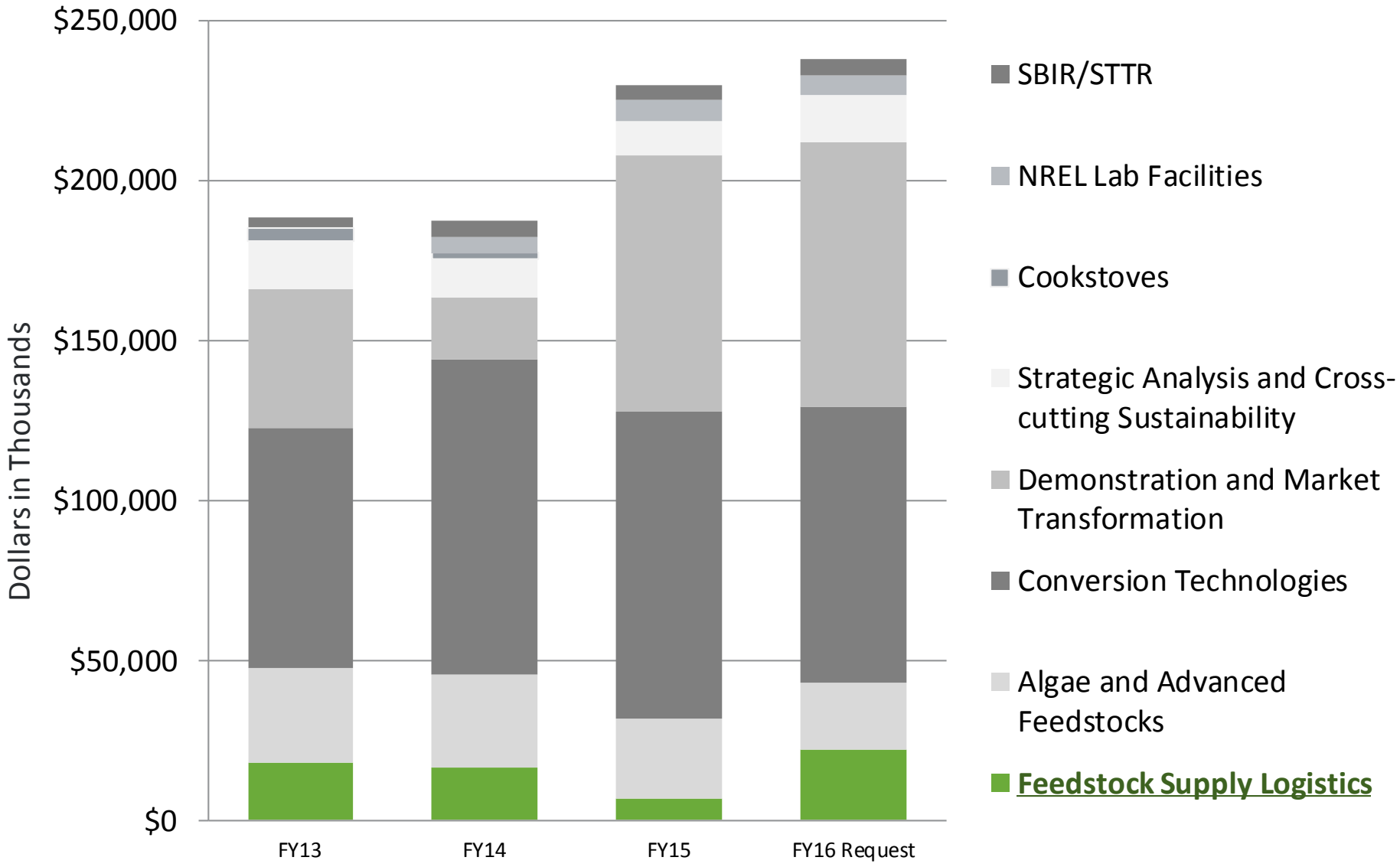
Logistics Projects Required to Partner with IBR

POET | DSM

Advanced Biofuels

Demonstration Interface

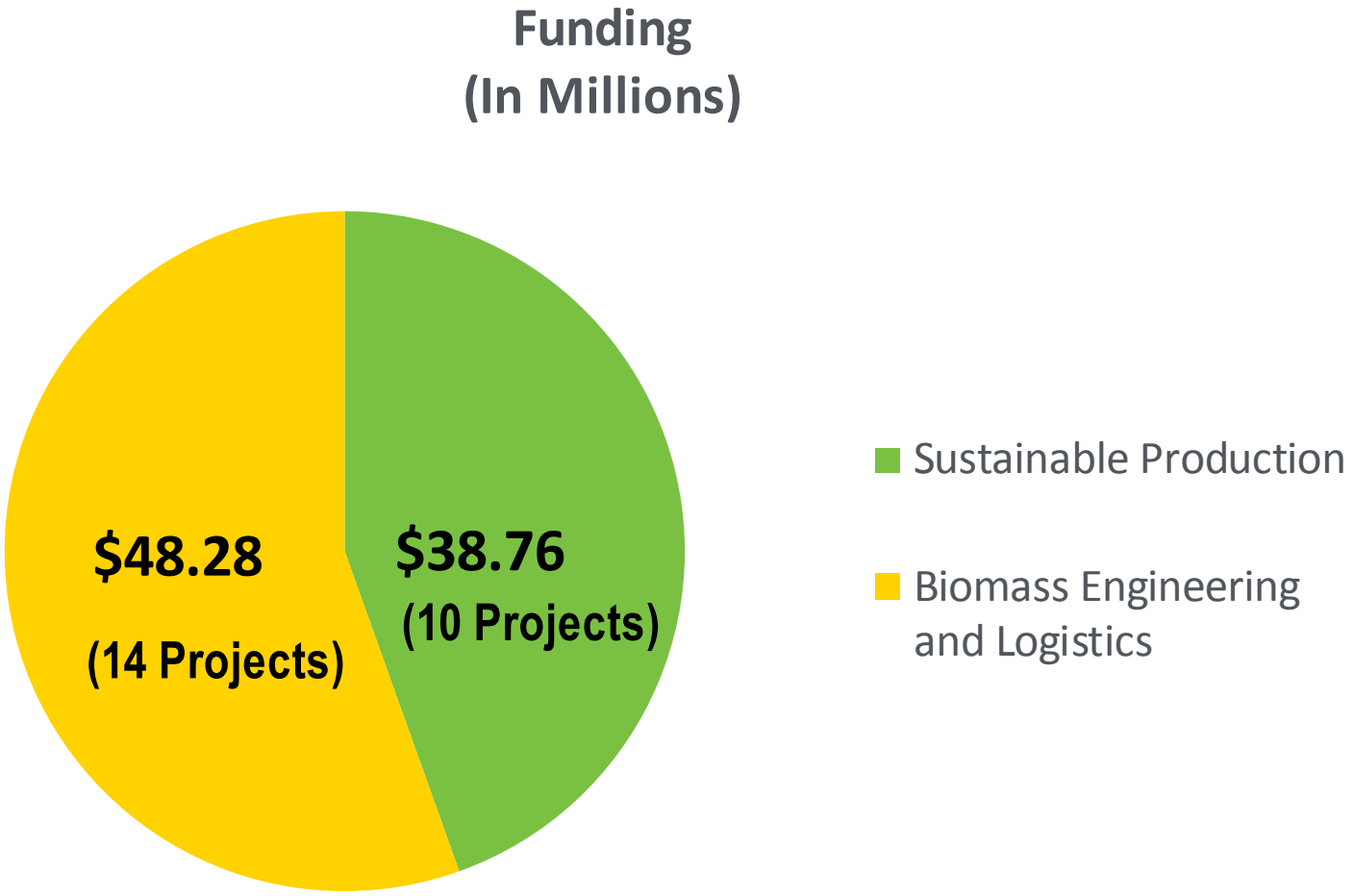
BETO Funding History



*$45 million was transferred in FY14 to DPA

Peer Reviewed Project Funding by Activity

Feedstock Program FY13-15 Funding for the 24 Projects to be Reviewed this Week



Feedstock Program FOA History

2009 2012 2013 2014 2015 2016 2018

Advanced Biomass Feedstock Logistics Systems I ($21 Million)

The Projects were selected to stimulate the design and demonstration of a comprehensive system to handle the harvesting, collection, prepro storage of sufficient volumes of su feedstocks.

Advanced Biomass Feedstock Logistics Systems II (Up to $13 Million)

Projects focused on development and demonstrating strategies, equipment, and rapid analytical methods to manage feedstock quality within economic constrains through the feedstock supply chain.

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Landscape Design (Up to $14 million)

Integrated production and logistics R&D at a meaningful scale

AGCO Your Agriculture Company

FDC Enterprises Grasslands Services

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Advanced Biomass Feedstock Logistics Systems II

The U.S. Department of Energy funded three projects focused on development and demonstrating strategies, equipment, and rapid analytical methods to manage feedstock quality within economic constraints throughout the feedstock supply chain.

Awardees

- **FDC Enterprises** will design and demonstrate an advanced biomass supply chain for high impact, high quality feedstocks from the field to the throat of the biorefinery. Target feedstocks will be corn stover and switchgrass.

- **The State University of New York—College of Environmental Science and Forestry** will lower the delivered cost of short rotation woody crops; rapidly, accurately, and reliably assess feedstock quality; and improve harvest and preprocessing operations to produce feedstocks that meet key biorefinery partner specifications.
- **The University of Tennessee** will develop and demonstrate a state-of-the-art biomass processing depot to reduce sources of variation along the supply chain of multiple, high-impact biomass sources (pine and switchgrass) and deliver a consistent feedstock optimized for performance.

Funding Opportunity Announcement

Landscape Design for Sustainable Bioenergy Systems — Announced on October 20, 2014

- DOE announced up to $14 million to support landscape design approaches that maintain or enhance the environmental and socio-economic sustainability of cellulosic bioenergy through the improvement of feedstock production, logistics systems, and technology development.

Jointly supported by
Analysis & Sustainability and
Feedstock Supply & Logistics

Collaborations With Other Federal Agencies

The Feedstock Supply and Logistics program partners with other agencies, such as USDA, DOT, ARPA-E, Forest Service, Office of Science, on efforts related to feedstocks production, management, and supply

- USDA/DOE Biomass Feedstocks Coordination Group
- Interagency Feedstock Logistics and Biofuels Distribution Working Group
- Interagency Feedstock Production Working Group
- Woody Biomass Utilization Group (WBUG)

Coordinating with Key Stakeholders

The Feedstock Supply and Logistics portfolio is committed to receiving input from all stakeholders.

Incorporating Bioenergy into Sustainable Landscape Designs

Two workshops exploring the science and practice of bioenergy landscape design

Workshop 1- March 2014, New Bern, NC

- Focus on woody/forestry systems
- Organized by ORNL and NCASI

Workshop 2- June 2014, Argonne, IL

- Focus on Midwest/agricultural systems
- Organized by ANL

Jointly supported by
Analysis & Sustainability and
Feedstock Supply & Logistics

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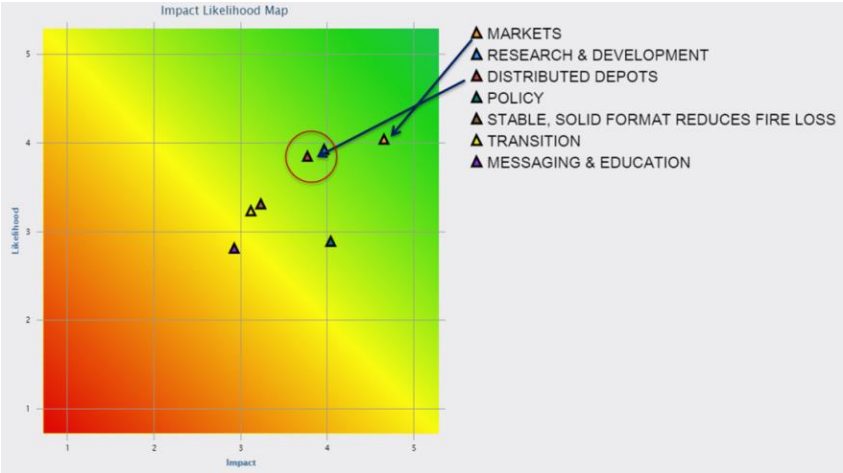
Advanced Supply System Design Workshop

Workshop Highlights

- 27 experts (5 Academia, 22 Industry)
  - Industry representation included biorefinery managers, equipment manufacturers, consultants
  - Note: Participants provided their own travel expenses
- 1.5 days, 3 sessions (Scaling, Quality, Risk)
- Computer-moderated brainstorming management (ThinkTank), with over 35 MB of data collected
- Two resonant themes:
  - The distributed depot design is the future
  - The transition from current to future is vital

Word Cloud – Session 1



Heat Map of Solutions

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FSL Program R&D Partners

Upcoming Activities

- Advanced Supply System Design Workshop Report
- June 23 & 24, Bioenergy 2015 Breakout Session on Resource Assessment
- Landscape Design Funding Opportunity Selection Announcement
- 2016 Billion Ton Update
- Regional Feedstock Partnership Synthesis Report

Introductions – Peer Reviewers

- Bruce Dale (Lead), Michigan State University
- Harry Baumes, USDA, Office of Energy Policy and New Uses (OEPNU)
- Daniel Cassidy, USDA-NIFA
- Beth Dodson, University of Montana
- Harrison Pettit, Pacific Ag
- Bob Rummer, University of Kansas

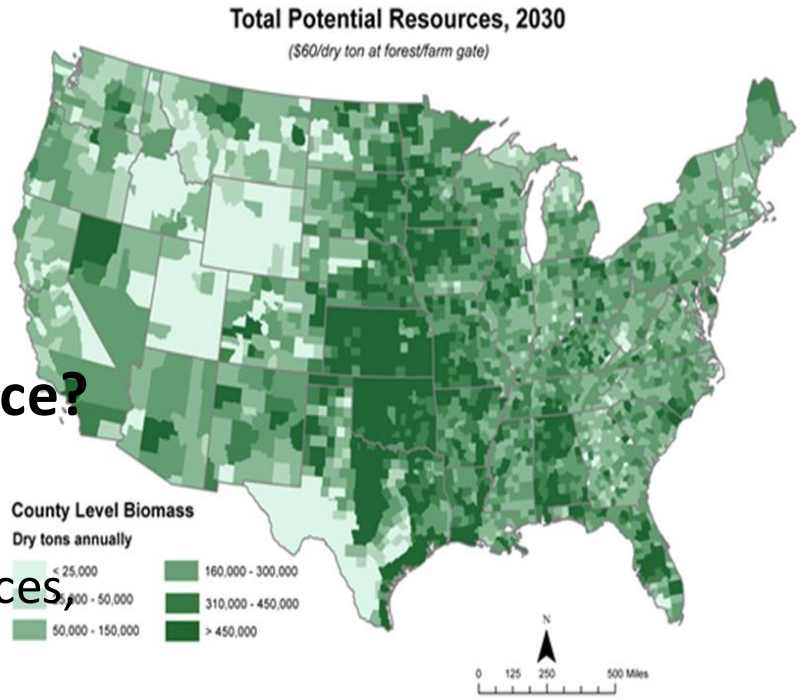
THANK YOU!


Vermeer

Extra Slides

Quantity: Will the US have enough biomass to meet targets?

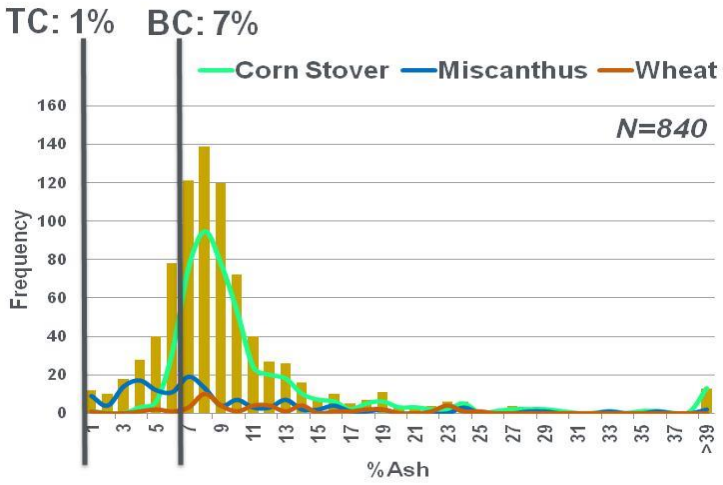
- **YES** - but depends on your assumptions; requires development
- **What kind of biomass?**
  - Ag residues
  - Woody residues
  - Energy crops (woody and herbaceous)
  - MSW (new addition)
- **Where is the biomass, and at what price?**
  - A lot of it is in high-yielding regions
    - A lot of it is not
  - Transition from residues to a mix of resources, including energy crops
  - Work with production partners
- **Production and availability drivers?**
  - Increase number and size of biorefineries
  - Maintain RFS2 at current volume targets

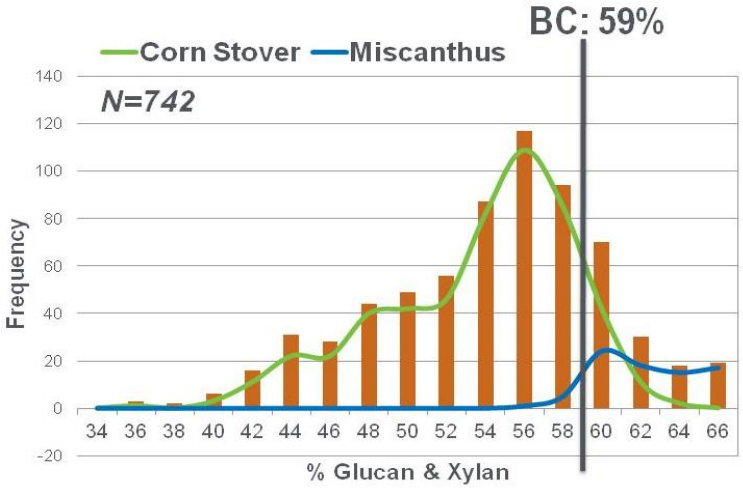


Raw biomass is NOT a biorefinery feedstock!

Quality: How Do We Manage Biomass Variability?

- **Biomass is highly variable, even within feedstock types**
- **What do biorefineries want in a feedstock?**
  - *Consistency*
  - Low ash
  - Dry (generally)
  - Consistent particle size range
  - High carbon and/or sugar content
  - Dense – bulk and energy
  - Flowable
  - Aerobically stable
- **Management of biomass variability**
  - PDU – real-time testing; impact of variability on conversion performance
  - Biomass Library – characterization to assess magnitude of variability within samples and species across wide geography
  - Managing regional variability during production (best agronomic practices)





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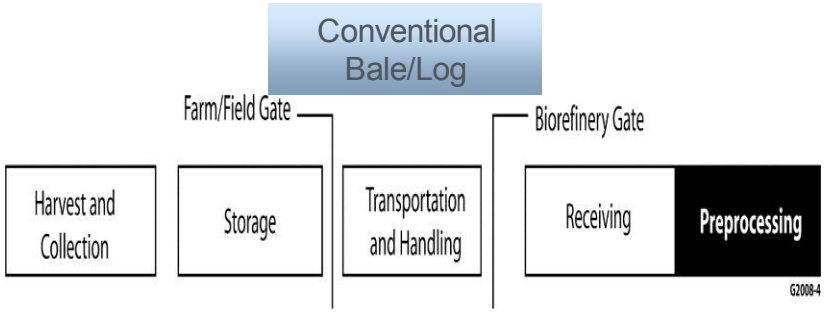
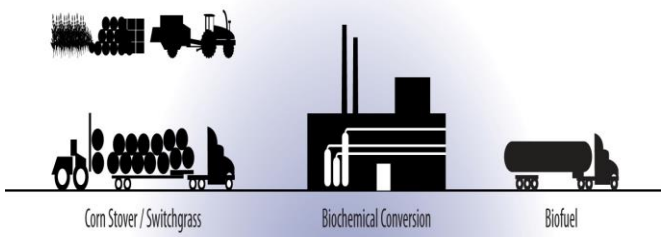
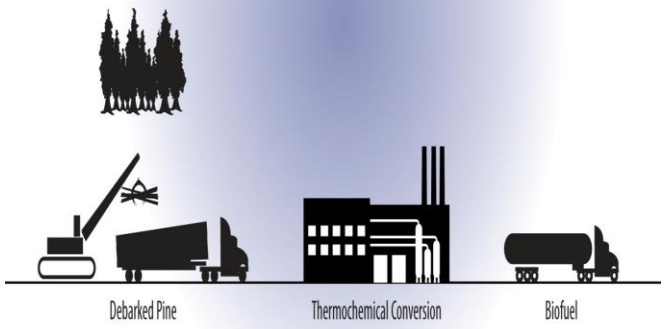
Cost: Can We Economically & Sustainably Supply Feedstock?

- **Conventional feedstock supply systems exist, and are very effective in doing what they were designed to do: *agricultural and forestry systems*.**
- **Conventional systems situate the biorefinery near the area of production**
- **These systems can meet cost targets for *high-yielding regions*, such as corn stover in Iowa ($35/dt), or woodchips in the SE US.**
- **However-**
  - Resources that are less dense on the landscape are effectively inaccessible to the industry due to cost constraints intrinsic to conventional systems, but are needed to supply the quantity of biomass required to meet long-term biofuels production goals (RFS2)
  - Increased risk to biorefinery
    - Refineries that rely solely on local resources are vulnerable to supply chain upsets (e.g., drought, flooding, pests), and
    - Must also absorb cost of dealing with challenges presented by variable quality feedstocks (limited ability to mitigate)
    - Size of biorefinery is limited by available feedstock supply (impact on per unit output cost)

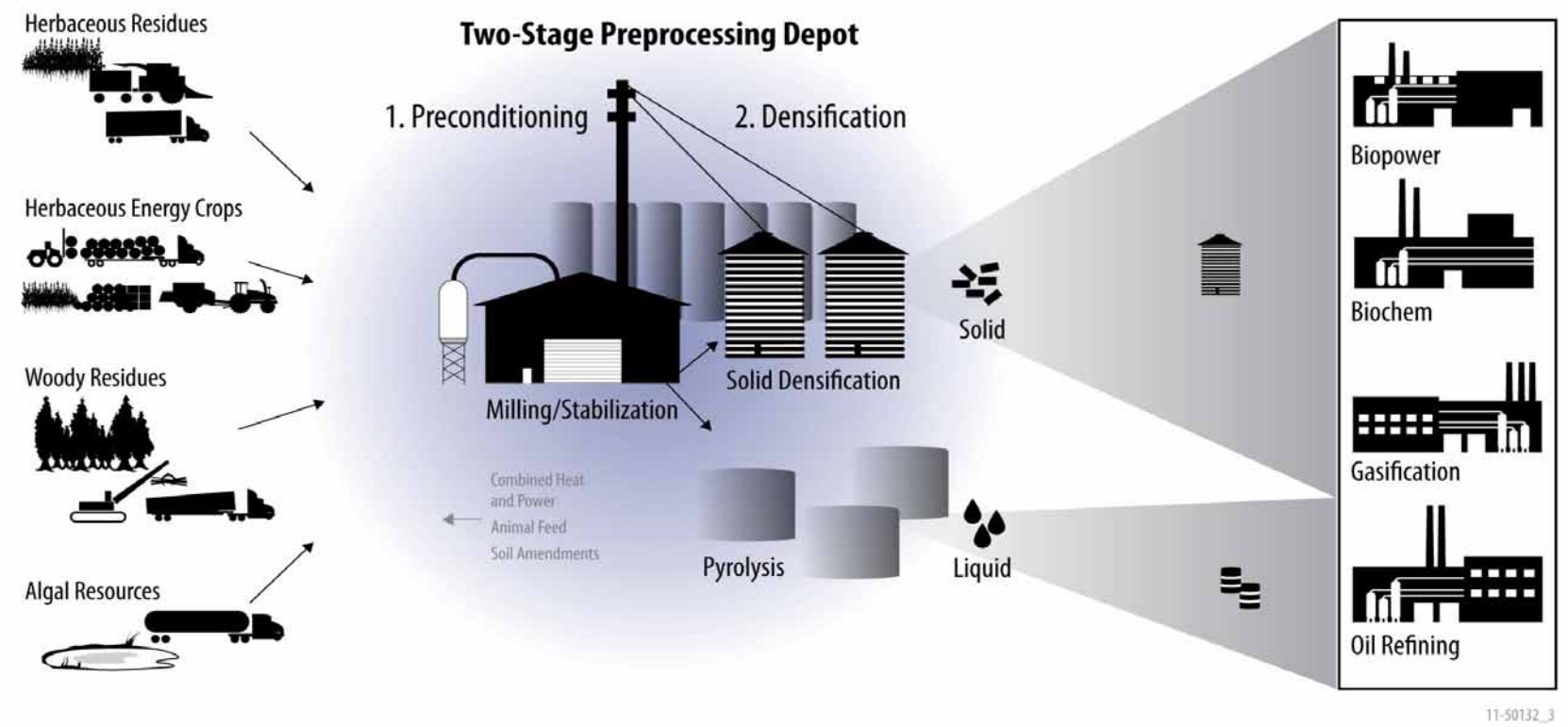






Cost: Can We Economically & Sustainably Supply Feedstock?

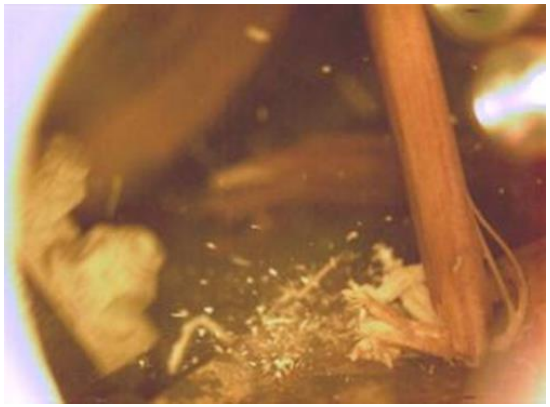
Advanced logistics systems bring additional resources into the mix and deliver an on-spec feedstock to biorefineries, thereby reducing risk for the biorefinery.



- Additional testing of advanced concepts at the PDU, as well as cost and production models (TEA, IBSAL, etc.) are needed to fully understand advanced systems that leverage existing transportation and handling infrastructure.

Key Challenges to Achieving Cost, Quantity, & Quality Goals

- **Inherent Challenges Associated with Biomass**
  - Availability and cost of biomass
  - Biomass is distributed at variable density on the landscape
  - Variability/Quality
    - Moisture/Stability
    - Density
    - Flowability
  - Preserving soil health, water quality and biodiversity (sustainability)
- **Infrastructure and Equipment Limitations**
  - Capacity and efficiency
    - Size reduction
    - Pre-processing, including drying
    - Handling and Transport
  - Scale-up

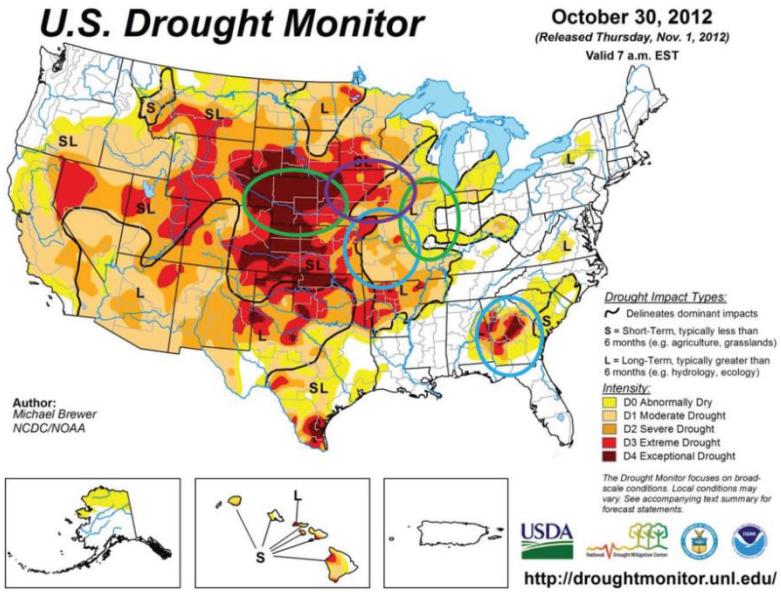


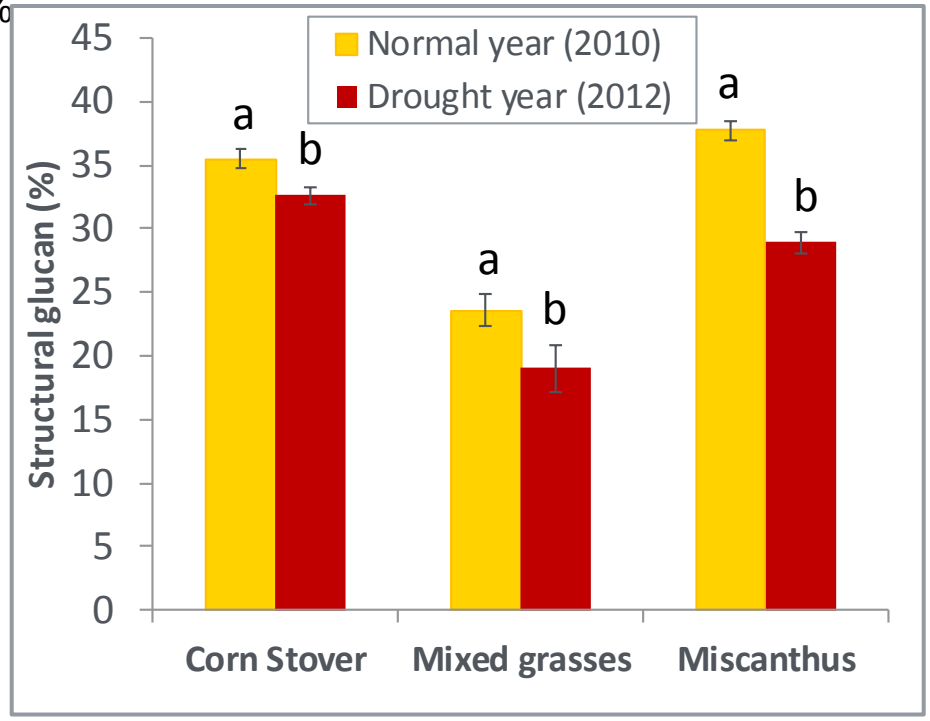
FSL's Approach to Addressing Challenges

- Continue to assess feedstock resources, where they are, what they are, and how much is available by location at a variety of price points.
- Identify barriers that impact (i.e., restrict or enhance) a sustainable and affordable supply of quality feedstock, and address those barriers through research.
- Continue to develop and demonstrate advanced systems where it makes sense to do so.
- Leverage existing infrastructure and technologies.
- Feedstock specifications and conversion performance drive logistics and preprocessing.
  - Advanced preprocessing accesses low-grade and diffuse resources (i.e., use any and all available resources to achieve cost and quality targets).
- Actively manage feedstock variability and supply uncertainty.
- Transform raw biomass into high-density, stable, commodity feedstocks.

INL - Regional Feedstock Partnership

- Over 2000 RFP samples (CRP grasses, *Miscanthus*, energycane, switchgrass, corn stover) characterized via NIR-prediction thru INL/NREL collaboration
- Subset investigated for impact of drought, where research indicated that:
  - Dry biomass yields were lower for mixed grasses and *Miscanthus*
  - Feedstock composition was significantly different i.e., structural glucan%
  - Theoretical ethanol yield decreased by 10 – 15%





"Drought effects on composition and yield for corn stover, mixed grasses, and Miscanthus as bioenergy feedstocks," Biofuels, 2014, 5(3), 275-291.