Developing a Uniform-Format Feedstock Supply System

Transition to a Bio Economy
The Role of Extension in Energy

June 30 - July 1, 2009

Christopher T. Wright, Ph.D.
Idaho National Laboratory

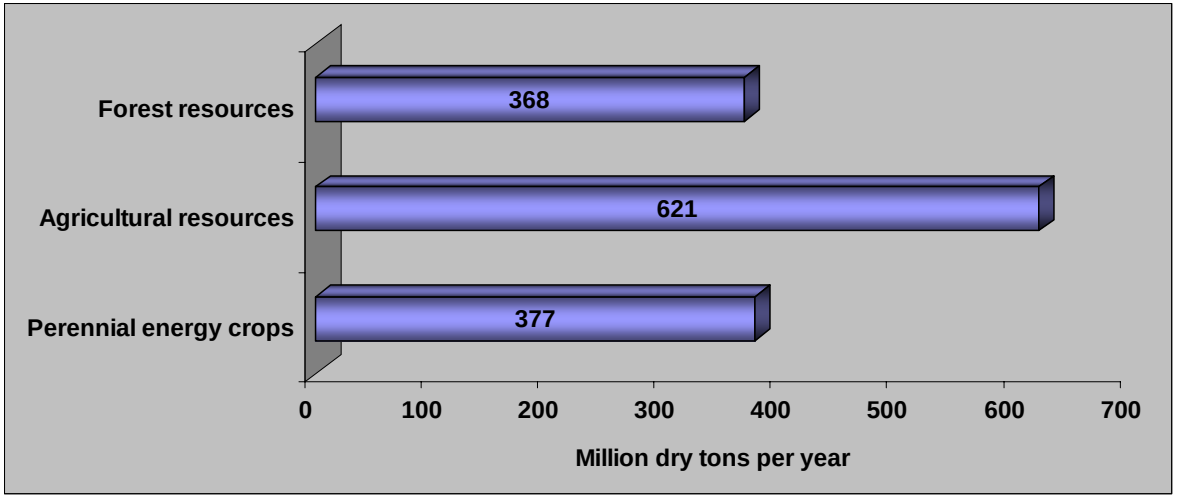
Goals and Objectives

1. Provide a base supply system design to:
   - deliver feedstock to pioneer biorefining facilities (section 932 and 10%)
   - provide feedstock attribute and equipment data to evaluate the efficacy of the design.
2. Establish “uniform format feedstock supply system,” concepts to:
   - create simplified, infrastructure compatible supply systems and conversion facility designs
   - achieve the 20 in 10 Plan (Bush, 2007), 30 x 30 Scenario (Foust et al., 2007), and the RFS (EISA, 2007) fuel displacement goals.
3. Develop a uniform feedstock supply system that can achieve feedstock cost and quantity targets established in the biochemical (Aden et al., 2002) and thermochemical (Aden et al., 2007) conversion platform design documents.

Biomass Feedstock Resource Base

biomass program

- 1.3 billion ton annuals biomass supply from US land resources
- Estimates are reasonable given trends and time for biorefinery deployment

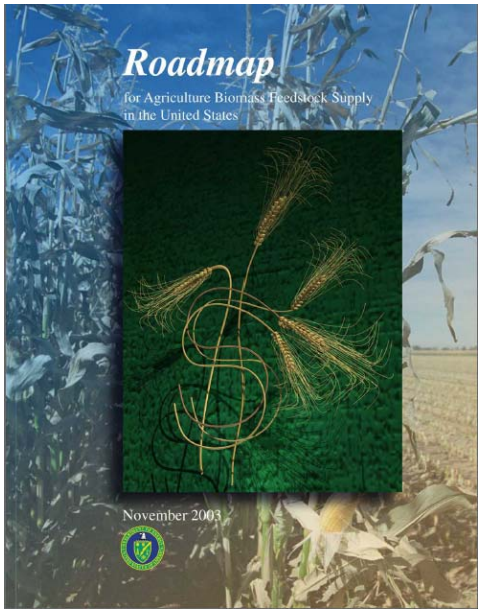


- **Forest resources**
  - **Logging residues**
  - **Forest thinnings (fuel treatments)**
  - Fuelwood
  - Primary wood processing mill residues
  - Secondary wood processing mill residues
  - Pulping liquors
  - Urban wood residues
- **Agricultural resources**
  - **Crop residues**
  - **Grains to biofuels**
  - **Perennial grasses**
  - **Perennial woody crops**
  - Animal manures
  - Food/feed processing residues
  - MSW and landfill gases

Feedstock Supply System Base

biomass program

Feedstock Supply System R&D Scope



Performance Metrics:
- Efficiency ($/hr)
- Equipment Capacity (ton/hr)
- Biomass Quality ($/ton)

Biomass Production:
- Ag. Resources
- Forest Resources

Feedstock Production Interface

Harvest & Collection → Storage → Preprocessing → Transportation → Handling & Queuing

Biomass Conversion:
- Biochemical
- Thermochemical

Feedstock Conversion Interface

- Equipment Capacity
- Compositional Impacts
- Pretreatment Impacts

- Shrinkage
- Compositional Impacts
- Pretreatment Impacts
- Soluble Sugar Capture

- Equipment Capacity
- Equipment Efficiency
- Material Bulk Density
- Compositional Impacts
- Pretreatment Impacts

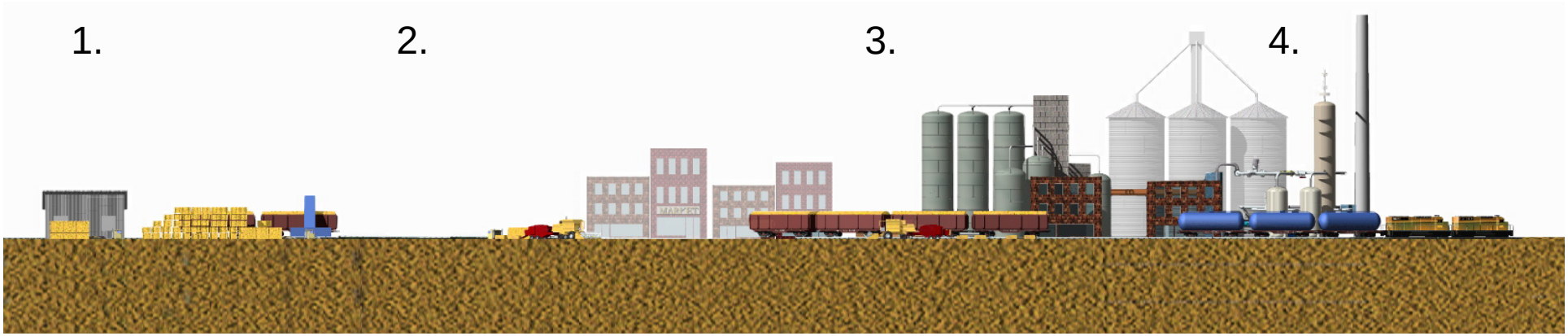
- Truck Capacity
- Loading compaction
- Loading efficiencies

- Handling efficiencies
- Handling compaction
- Material Bulk Properties

Feedstock Logistics Challenges

biomass program

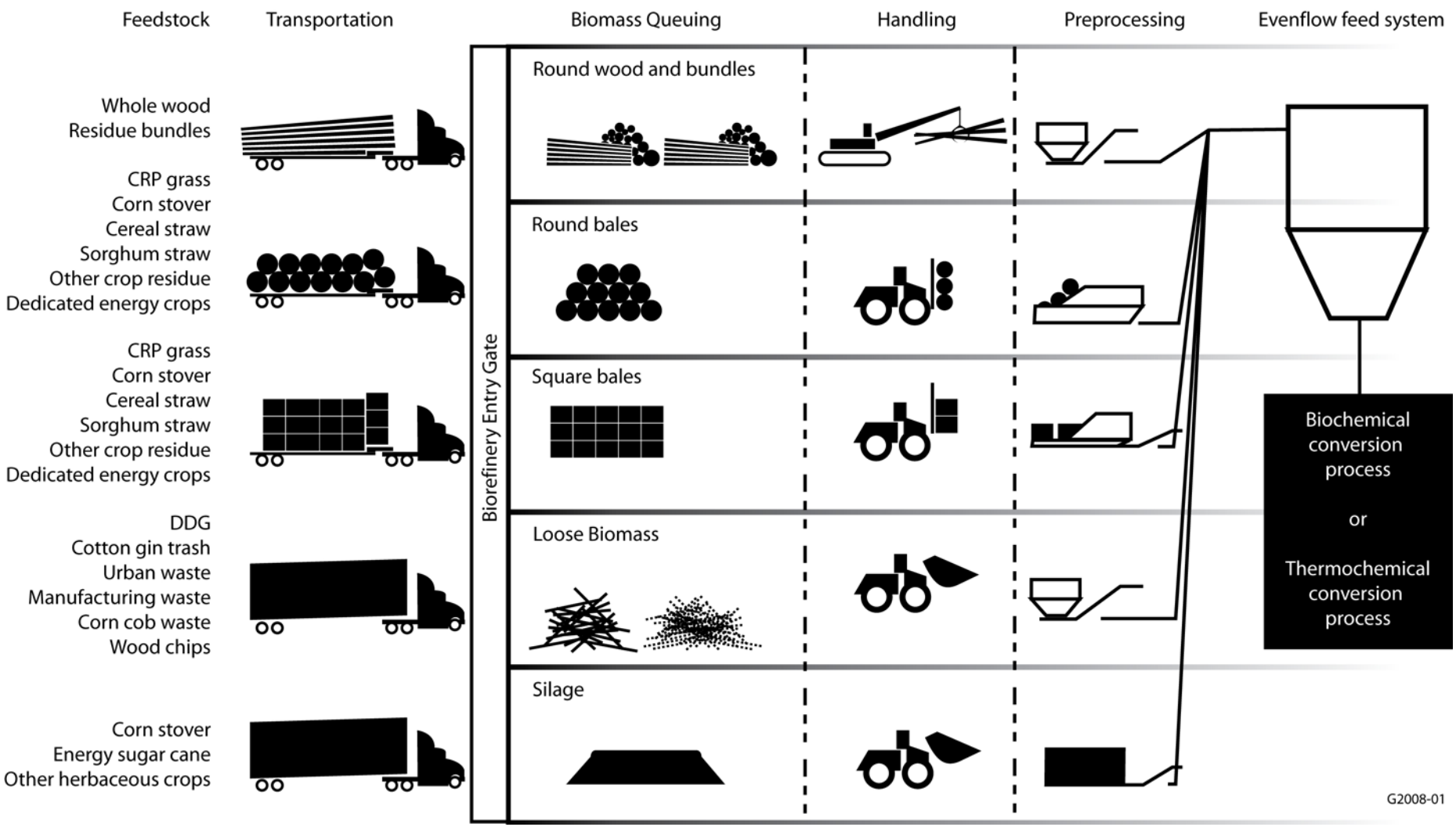
1. Connect Feedstock Supply Systems to Feedstock Resources
   - Dry Herbaceous – Agriculture Residues/Crops < about 20% moisture
   - Wet Herbaceous - Agriculture Residues/Crops > about 50% moisture
   - Woody – Forest resources and woody energy crops
2. Improve Feedstock Supply Logistics
3. Develop a Uniform Format Commodity Supply System
4. Connect Feedstock Supply System to Uniform Format Biorefinery Conversion Facilities



U.S. Department of Energy
Energy Efficiency and Renewable Energy

Conventional-Bale Feedstock Supply System Design

biomass program



Producer Owned Supply System Design

2006 Case Study Design:

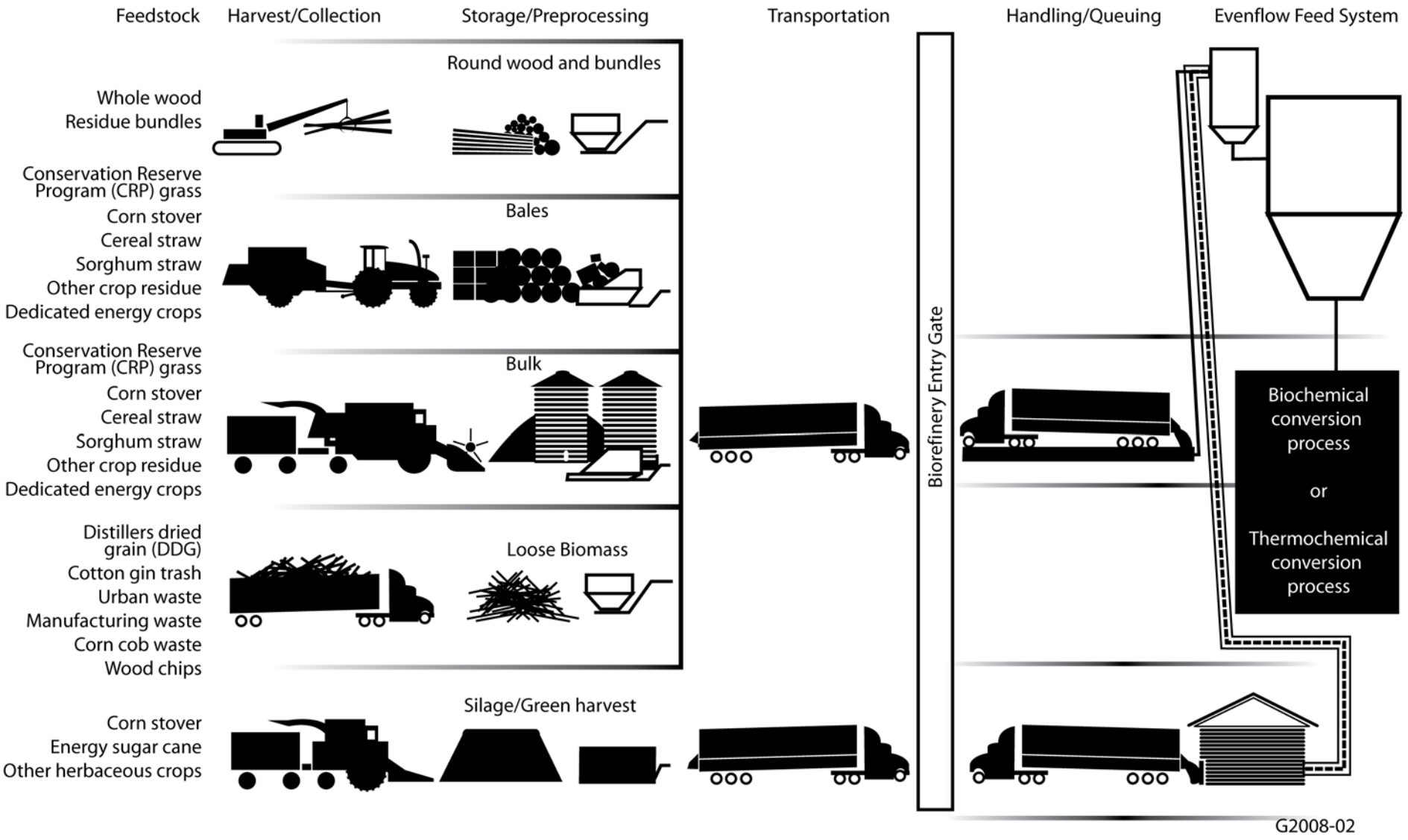
- Pioneer Supply System Design
- Excel Spreadsheet Design Database
- Engineering Design Review and Permitting Analysis
- Business Plan / Structure Analysis

Documents Located at:
http://www.inl.gov/bioenergy/projects/index.shtml

U.S. Department of Energy
Energy Efficiency and Renewable Energy

Pioneer-Uniform Feedstock Supply System Design

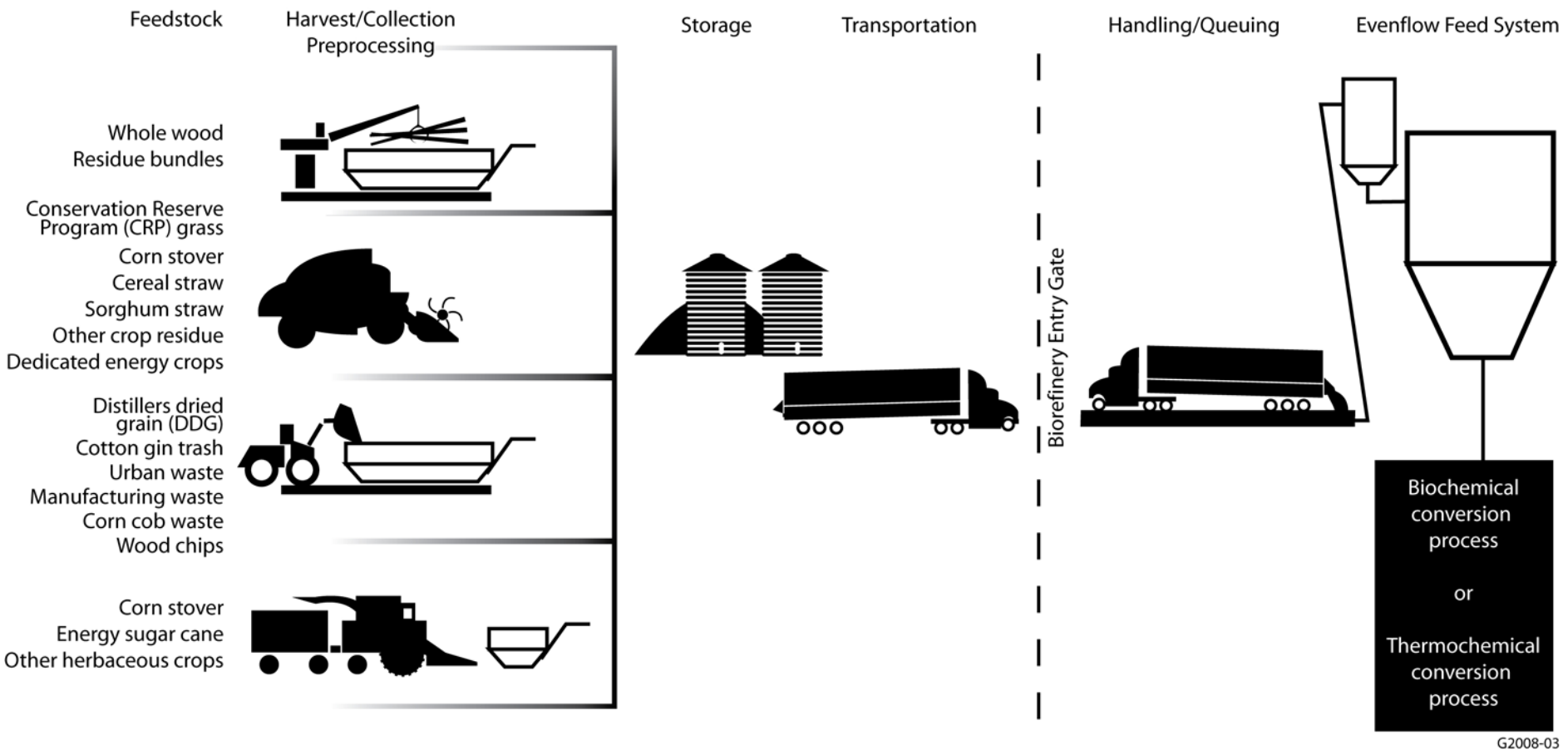
biomass program



U.S. Department of Energy
Energy Efficiency and Renewable Energy

Advanced-Uniform Feedstock Supply System Design

biomass program

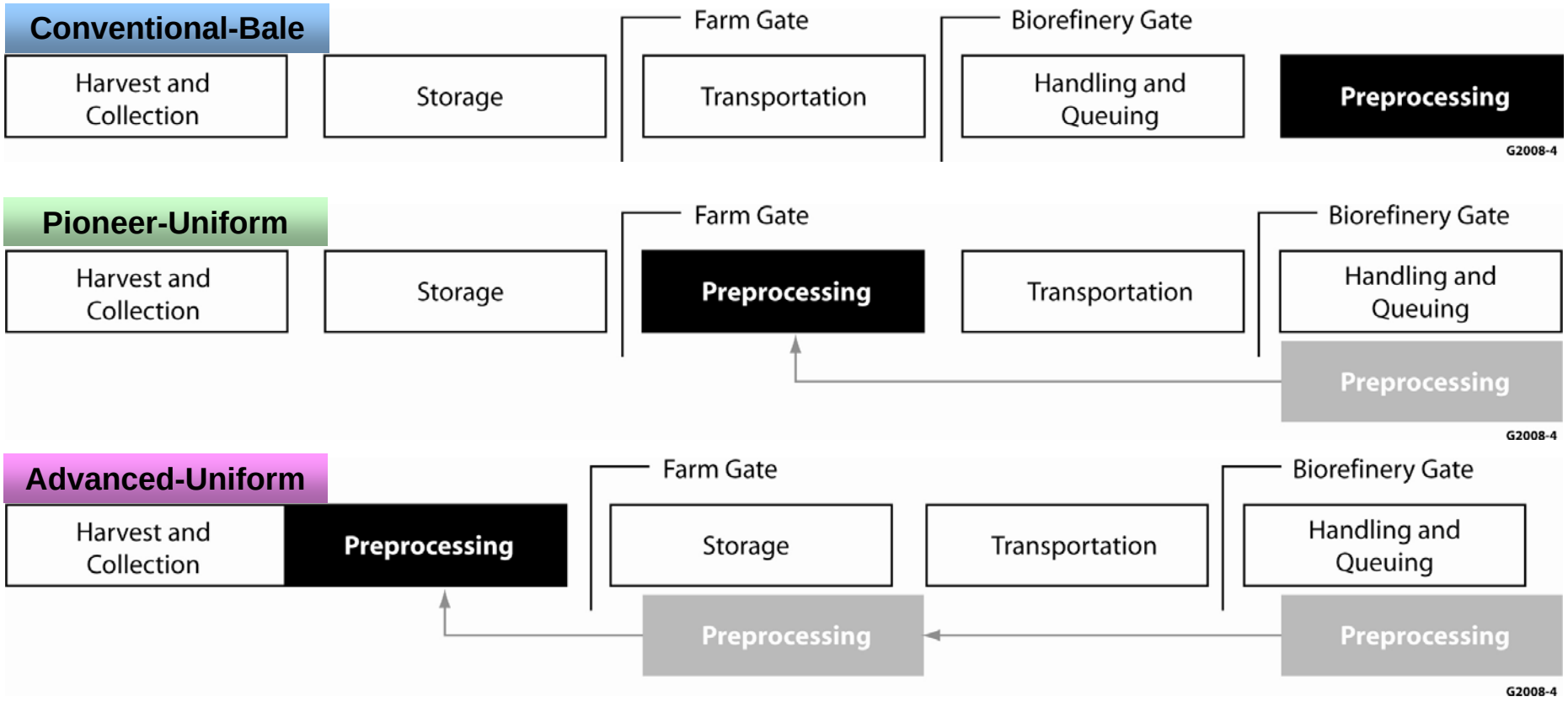


U.S. Department of Energy
Energy Efficiency and Renewable Energy

R&D Path to the Uniform Feedstock Supply System Design

biomass program

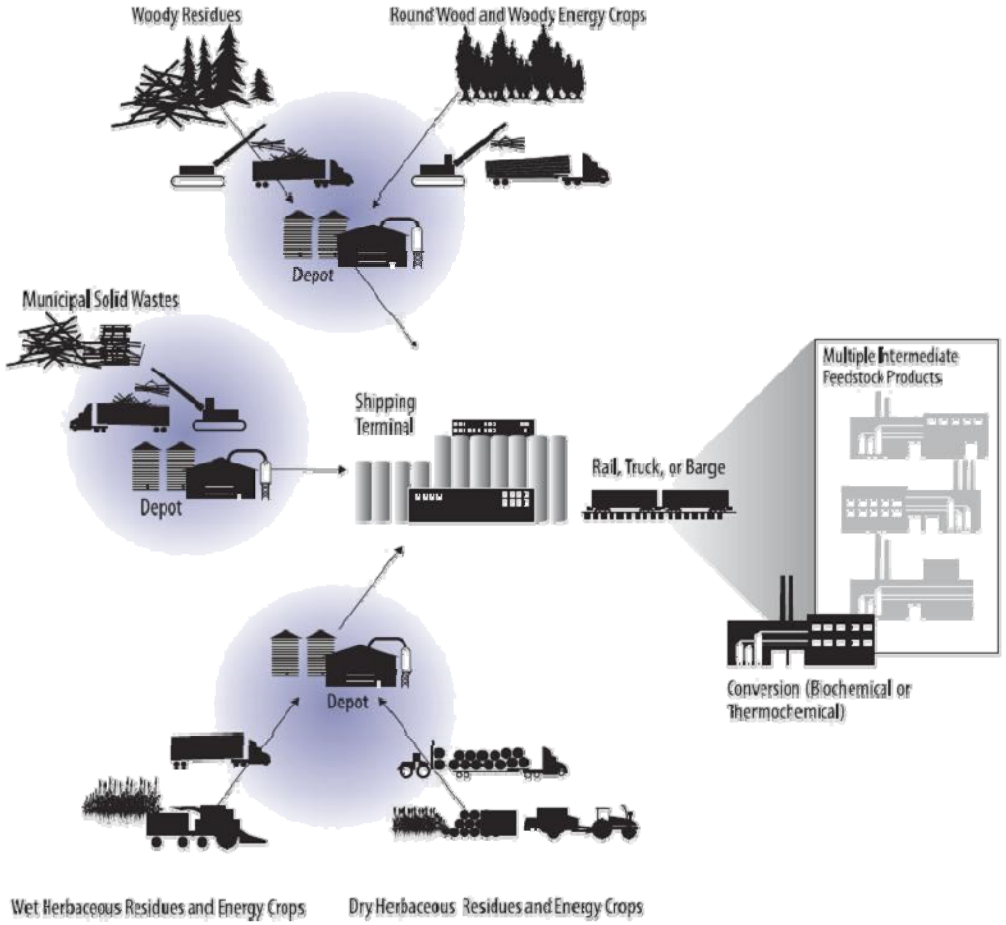
- Harvesting/Collection and Preprocessing are Key Unit Processes
- Harvesting addresses feedstock diversity
- Moving preprocessing forward in the supply system creates down-stream uniformity and increases system efficiencies



U.S. Department of Energy
Energy Efficiency and Renewable Energy

Design Report for Uniform-Format Feedstock Vision

biomass program

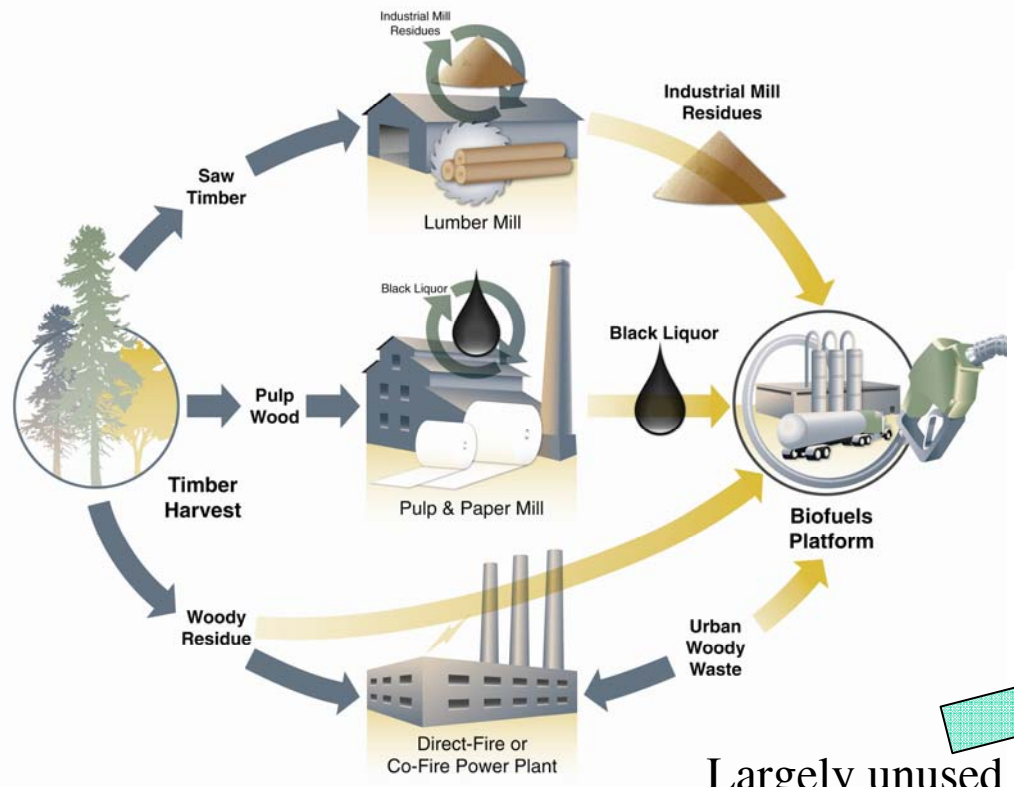


Documents Located at:
http://www.inl.gov/bioenergy/uniform-feedstock

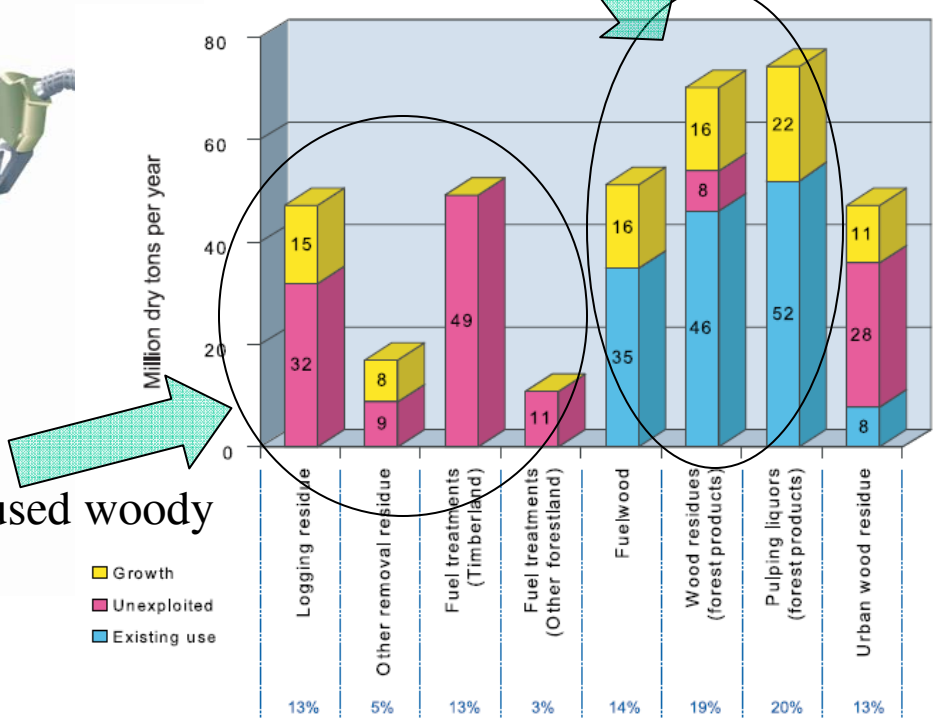
Woody Design Report (Path Forward)

biomass program

Current Uses of Harvested Timber and Possible Links to Biofuel Production



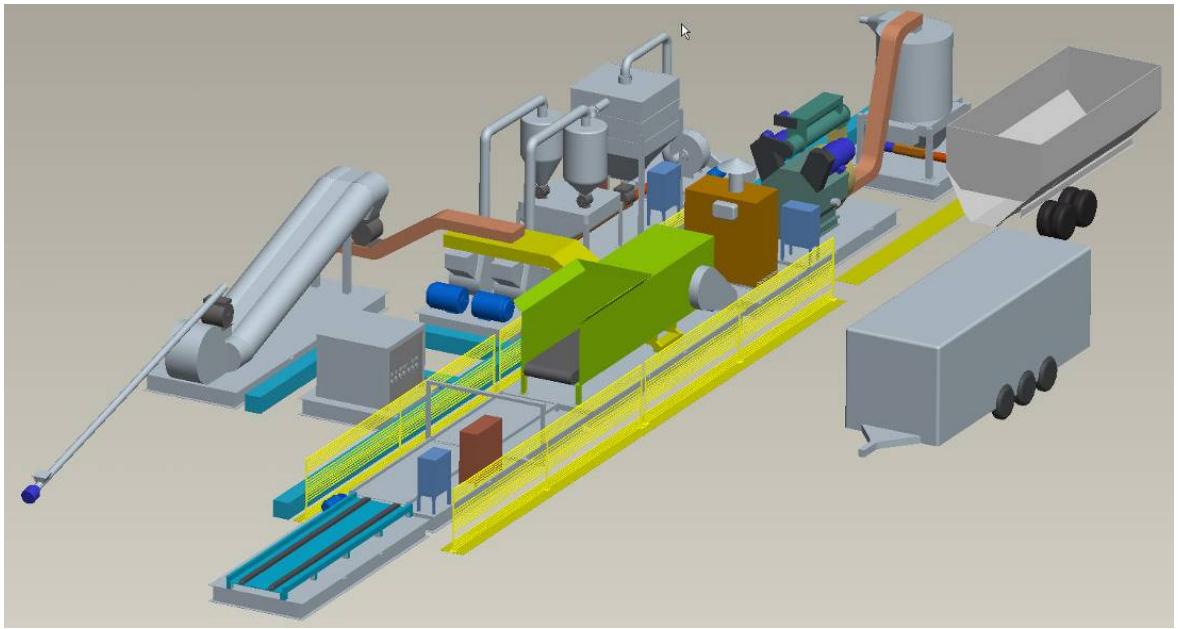
Currently extensively utilized



Largely unused woody feedstocks

R&D Process Demonstration Unit (PDU)

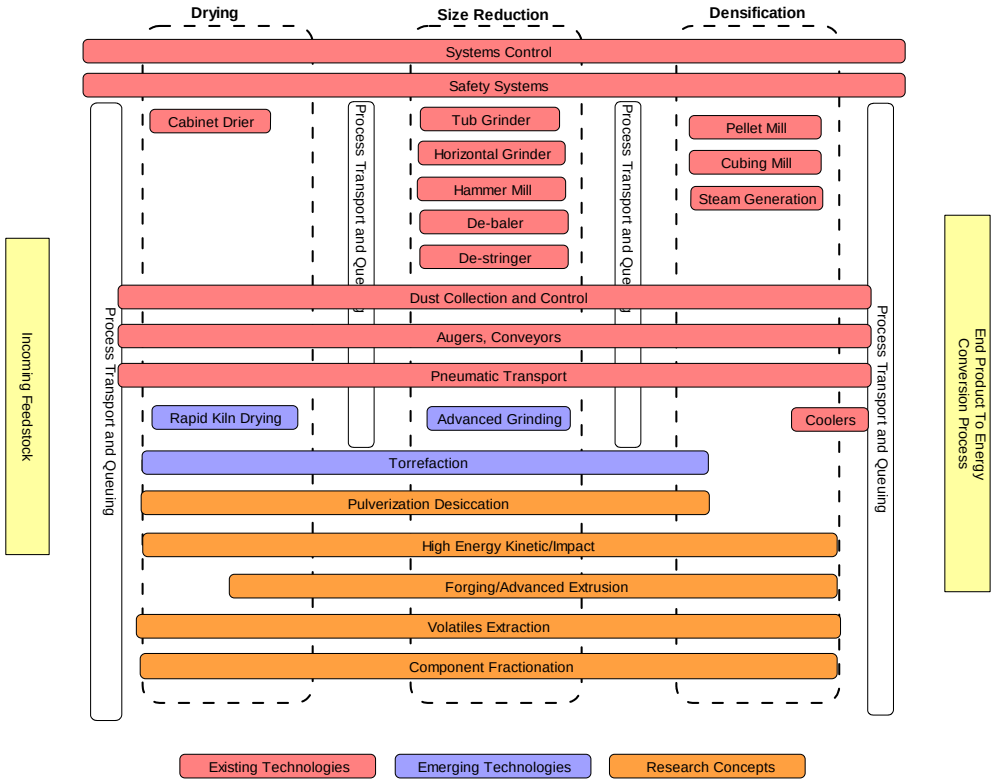
- Procurement of base equipment underway to produce engineered model feedstocks for testing in current pilot systems
  - Produce multiple fractions with identifiable quality
  - Test multiple process configurations
  - Can directly attach to or produce needed feedstocks for IBR partners
  - Can be used in current DOE solicitations, state projects, or other industrial projects



PDU Advanced Concept Equipment

biomass program

- Identified concept equipment to test advanced uniform supply system designs and fabricate commodity-scale feedstock material
  - Drying
    - Torrefaction System
    - Multi-stage Pulva Dryer
    - Mechanical Dewatering System
  - Size Reduction
    - Modified Hammer Mill Concepts
    - Collision/Kenetic Mill Concepts
  - Densification
    - Forging & Advanced Extrusion
  - Component Fractionation
    - Air Vectoring Separation
    - Cyclone Separation
    - Gravimetric Sieve Separation
  - Volatile Extraction & Energy Recycling



Summary

National biofuel goals cannot be met with

- multiple unique and site-specific supply system designs
- complex designs requiring multiple sets of unique equipment

Achieving biofuel goals can only be accomplished through

- development of a highly efficient commodity-like feedstock supply system with
  - harvesting and preprocessing equipment that can be adapted to the diversity of feedstocks
  - uniform commodity-scale receiving systems of “standardized” and highly replicable biorefinery designs

U.S. Department of Energy
Energy Efficiency and Renewable Energy

Biorefining Depends on Feedstock