Sustainable Biofuels and Bioproducts from our Forests: Meeting the Challenge

Marilyn A. Buford, Bryce J. Stokes, and Daniel G. Neary
US Forest Service R&D

Presented at ESA
Ecological Dimensions of Biofuels Conference
March 10, 2008
U.S. Energy Consumption Overview 2004

Domestic Energy Consumption = 99.7 Quadrillion Btu
Total = 6.2 Quadrillion Btu

- 2% Wind
- 45% Hydroelectric
- 5% Geothermal
- 47% Biomass
- 1% Solar

★ 70% of biomass is wood based

Source: EIA
The Biomass Feedstock Resource Base

• About one-half of the land in the contiguous U.S.
  - Forestland resources -- 504 million acres of timberland, 91 million acres of other forestland
  - Agricultural resources -- 342 million acres cropland, 39 million acres idle cropland, 68 million acres cropland pasture

Forest resources

• Logging residues and other removals
  - Traditional logging activities
  - Cultural operations on timberlands
• Forest thinnings (fuel treatments)
  - Timberland
  - Other forestland
• Industry processing residues
  - Primary wood processing mill wastes
  - Secondary wood processing mill wastes
• Urban wood wastes
• Fuelwood
• Pulping liquors (black liquor)
• Conventional Forestry
• Short Rotation Woody Crops

Land use in the United States

- Copland pasture: 67 million acres
- Idle cropland: 39 million acres
- Active cropland: 342 million acres
- Other forestland: 168 million acres
- Timberland: 504 million acres
- Other land uses: 1,145 million acres
Percent Total US GHG Annual Emissions by Sector (2005)

Note: Negative numbers denote sequestration; forests, trees and wood products sequester 11% US GHG emissions annually
Source: http://www.epa.gov/climatechange/emissions/downloads06/07ES.pdf
Forests: A Strategic Asset

- Energy security
- Environmental quality
- Economic opportunity
Natural Resource Management

Environment
- Climate Change
- Stand Function
- Sustainability

Biomass Management and Use

Energy
- Renewable
- Secure
- Sustainable

Economy
- Costs
- Rural Development
- Global Competition

Infrastructure

Working Lands

Conservation & Utilization

Water

Land

Air
Points to Ponder

- Large volumes of biomass
- Fire risks
- Declining health
- Reduction of services
- Many forms and shapes
- Can produce even more
- Declining infrastructure
  - Industry decline
  - Offshore investments and imports
  - Worker (capacity) shortage
  - Reduced investments
- Markets and barriers
  - Cyclic booms and busts
  - No markets
  - Higher costs
  - Very distributive
The Opportunity & Potential

**Feedstock**
- Forest Residues
- Hazardous Fuel Treatments
- Short Rotation Woody Crops
- Wood Waste
- Conventional Forestry
- Mill Wastes & Residues

**Conversion**
- Manufacturing
- Co-firing
- Combustion
- Gasification
- Hydrolysis
- Digestion
- Pyrolysis
- Extraction
- Separation

**Uses**
- **Fuels:**
  - Ethanol
  - Other Liquid Fuels
  - Hydrogen
- **Electricity and Heat**
- **Biobased Products**
  - Composites
  - Specialty Products
  - New Products
  - Chemicals
  - Traditional Products
Desired Resource Outcome

- Forest systems
  - Healthy
  - Productive
  - Supply goods, services, and values
We will expect forests to produce

- Wood
- Water
- Non-wood products
- Recreational opportunities
- Habitats
- Climate change mitigation
- Energy
So we must

- Manage through changing conditions
  - Environmental
  - Economic
  - Supply & demand
  - Global economy
- Continue to supply goods, services, and values
- Including energy
Challenge

• **NOT merely**
  - Sustaining existing systems
  - Restoring selected systems

• **IS ALSO**
  - Enhance capacity of systems to meet future resource needs
  - Managing systems to provide for increasing levels of a variety of benefits
Woody Biomass

- Derived from any and all parts of trees
  - Bole, limbs, tops, roots, foliage
- Insect-, disease-, or fire- damaged or killed
- Purpose-grown wood for energy
- Conventional forestry
- Pre- and post consumer paper and wood products
- Pulping liquors
Considerations

• Resource availability, sources, production and management, feedstock supply components
• Harvesting and operations technologies, in-forest pre-processing technologies, transportation
• Conversion technologies, feedstock characteristic needs, conversion efficiencies, costs
• Integrated management systems
• Information, data, decision tools
• Development/deployment of biomass energy facilities
Challenges

• Provide quantities of wood needed for energy
  - Increase the supply of renewable and alternative fuels to 35 billion gallons by 2017\(^1\)
  - RFS 36 Bgal biofuels/year by 2022 with 20 Bgal non-corn\(^2\)
  - Replace 15% of current US gasoline consumption with ethanol from wood - ~21 billion gallons of gasoline annually\(^3\)

• Maintain & enhance forest health and productivity
  - Ensure conservation & sustainable delivery of wood products and other benefits
  - Avoid/mitigate potential negative impacts
  - Capitalize on benefits working forests provide in the landscape

• Reduce Costs & increase efficiency
  - Feedstock production & management
  - Harvest, collection & delivery
  - Conversion processes

• Reduce Investor Risk

\(^1\) 2007 State of the Union Address
\(^2\) EISA 2007 (Energy Independence and Security Act of 2007)
\(^3\) FS Chief Gail Kimbell, 9/7/07
Some Critical Information In Hand

- **Resource Assessments**
  - Billion Ton Report
  - Resources Planning Act Assessments
  - Regional Assessments
  - FIA

- **Life Cycle Analyses**
  - CORRIM

- **Soil Productivity**
  - National Long Term Soil Productivity Study
  - Soil carbon syntheses
  - Whole-tree logging and harvest impact studies

- **Water quality**
  - Best Management Practices (42 states)

- **Habitat and biodiversity studies**

- **Forest Certification Programs**

* Items listed as examples – not exhaustive
Integrated Biobased Products And Bioenergy Approach

- Feedstock Production & Management
- Harvest & Delivery
- Biobased Products & Bioenergy
- Utilization & Products
- Disposal

- Research & Development
- Synthesis
- Development of
  - options
  - strategies
  - systems
  - practices

For sustainable goods, services, & values
Critical Research

• Management and utilization systems for forest biomass and residues, forest health and fuels reduction treatments, and production forests

• Science and technology for woody cropping systems at multiple operational scales

• Management and land use systems for specific functions (designed forest systems)
Critical Research (cont)

- More efficient, light-on-the-land harvest, collection, and transportation systems
- Highly productive feedstocks with improved water- and nutrient-use efficiencies
- Efficient technologies for wood conversion to biofuels and bioproducts
- Life cycle analysis of integrated systems

... Sustainability
IEA BIOENERGY

• TASK 31: Biomass Production for Energy from Sustainable Forestry
  - 8 Countries: USA, Canada, United Kingdom, Finland, Sweden, Denmark, Norway, Germany, Netherlands
  - Two State-of-the Science books from Tasks A6 and 31

  TASK 31

  TASK A6
  Dyck et al. 1994. Impacts of Forest Harvesting on Long-Term Site Productivity.

http://www.ieabioenergytask31.org/
IEA BIOENERGY

- TASK 30: Short Rotation Crops for Bioenergy Systems
  - 5 Countries: Brazil, Canada, Australia, New Zealand, Sweden, United Kingdom, USA

http://www.shortrotationcrops.org/
SHORT ROTATION CROPS INTERNATIONAL CONFERENCE: BIOFUELS, BIOENERGY, AND BIOPRODUCTS FROM SUSTAINABLE AGRICULTURAL AND FOREST CROPS

Holiday Inn Select Minneapolis Airport Hotel – Mall of America
Bloomington, Minnesota, USA
August 18-22, 2008

Sponsors
Thank you