Sustainable Biofuels and Bioproducts from our Forests: Meeting the Challenge

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US Forest Service R&D

Expanding Biofuel Production: Sustainability and the Transition to Advanced Biofuels Workshop
June, 2009
U.S. Energy Consumption Overview
2007

Domestic Energy Consumption = 101.9 Quadrillion Btu

Total_{RE} = 7.1 Quadrillion Btu

- 4.7% Wind
- 36% Hydroelectric
- 4.6% Geothermal
- 51% Biomass
- 0.6% Solar

~ 65% of biomass is wood based

Source: http://www.eia.doe.gov/emeu/aer/contents.html
## Regional Forest Statistics

<table>
<thead>
<tr>
<th>State</th>
<th>Net Growing Stock Volume</th>
<th>Net Growth</th>
<th>Removals</th>
<th>Mortality</th>
<th>Thousand cubic feet</th>
<th>Thousand acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illinois</td>
<td>6,875,000</td>
<td>327,042</td>
<td>77,655</td>
<td>86,618</td>
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<td>Indiana</td>
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<td>101,337</td>
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<td>Michigan</td>
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<td>237,615</td>
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<tr>
<td>Missouri</td>
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<td>134,842</td>
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<td>Ohio</td>
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<tr>
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<td>603,978</td>
<td>453,883</td>
<td>192,803</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Ownership group</th>
<th>All Ownerships</th>
<th>National Forest</th>
<th>Other Public</th>
<th>Private Corp</th>
<th>Private non-corp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illinois</td>
<td>4,363</td>
<td>281</td>
<td>358</td>
<td>215</td>
<td>3,509</td>
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<tr>
<td>Indiana</td>
<td>4,533</td>
<td>178</td>
<td>473</td>
<td>294</td>
<td>3,588</td>
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<td>Iowa</td>
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<td>312</td>
<td>41</td>
<td>2,471</td>
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<tr>
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<td>2,497</td>
<td>4,503</td>
<td>2,631</td>
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<td>Minnesota</td>
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<td>3,638</td>
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</tbody>
</table>
Percent Total US GHG Annual Emissions by Sector (2007)

Note: Negative numbers denote sequestration; forests, trees and wood products sequester 14% US GHG emissions annually.
Source: http://www.epa.gov/climatechange/emissions/usinventoryreport.html
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 distributed
- Ownership
  - Forest land - 56% Private
  - Timberland - 70% Private
Forests: A Strategic Asset

- Energy security
- Environmental quality
- Economic opportunity
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
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
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
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
Foundations

- Science-based
- Objectively and feasibly measurable
- Clearly and quantifiably related to bioenergy/bioproduct production
Challenges

• Provide quantities of wood needed for energy
  - double renewable energy production\(^1\)
  - 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

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\(^1\) [http://change.gov/newsroom/entry/american_recovery_and_reinvestment/](http://change.gov/newsroom/entry/american_recovery_and_reinvestment/), 1/3/09
\(^2\) 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

- Research & Development
- Synthesis
- Development of
  - options
  - strategies
  - systems
  - practices
For sustainable goods, services, & values
Critical Research

- Sustainable and economical forest biomass management and production systems
- Competitive biofuels and biopower conversion technologies and bioproducts
- Information and tools for decision-making and policy analysis

... Sustainability
Thank you
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 thinning (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
So we must

• Manage through changing conditions
  - Environmental
  - Economic
  - Supply & demand
  - Global economy

• Continue to supply goods, services, and values

• Including energy