

Dr. Stokes received his BS and MS from Mississippi State University in Engineering and PhD from Auburn University in Forestry. He worked as a Forest Engineer for Weyerhaeuser Company prior to joining the USDA Forest Service in Auburn, Alabama as a Research Engineer. He later served as Project Leader for the Engineering Unit at Auburn and now serves as National Program Leader for Forest Operations Research as part of the Resource Use Sciences Staff in the R&D Washington Office. His 20 years of research focused on harvesting machine and system design and management; biomass recovery and utilization; reducing forest operations environmental impacts; and specialty systems for pine thinning and wet area harvesting.

Dr. Stokes currently has oversight for forest operations research and co-oversight in biomass/bioenergy research programs and the Agenda 2020 Sustainable Forestry industrial research partnership. He currently serves in a support role for the USDA Energy Council and is Past Chair of the USDA Biobased Products and Bioenergy Coordination Council and the Federal Working Group on Woody Biomass Utilization. He is active in the Council on Forest Engineering, Forest Products Society, and the American Society of Agricultural and Biological Engineers. He has over 140 scientific and technical publications. Please welcome Bryce Stokes.....

# Forest Biomass Supply Chain

**A Strategic Planning Session for the Forest Bioproducts Industry**

**Bangor, ME, October 18-19, 2007**

**Bryce Stokes, Ph.D.**

**National Program Leader**

**U.S. Forest Service R&D**

**Washington, DC**



# Preamble

## Woody Biomass Sources

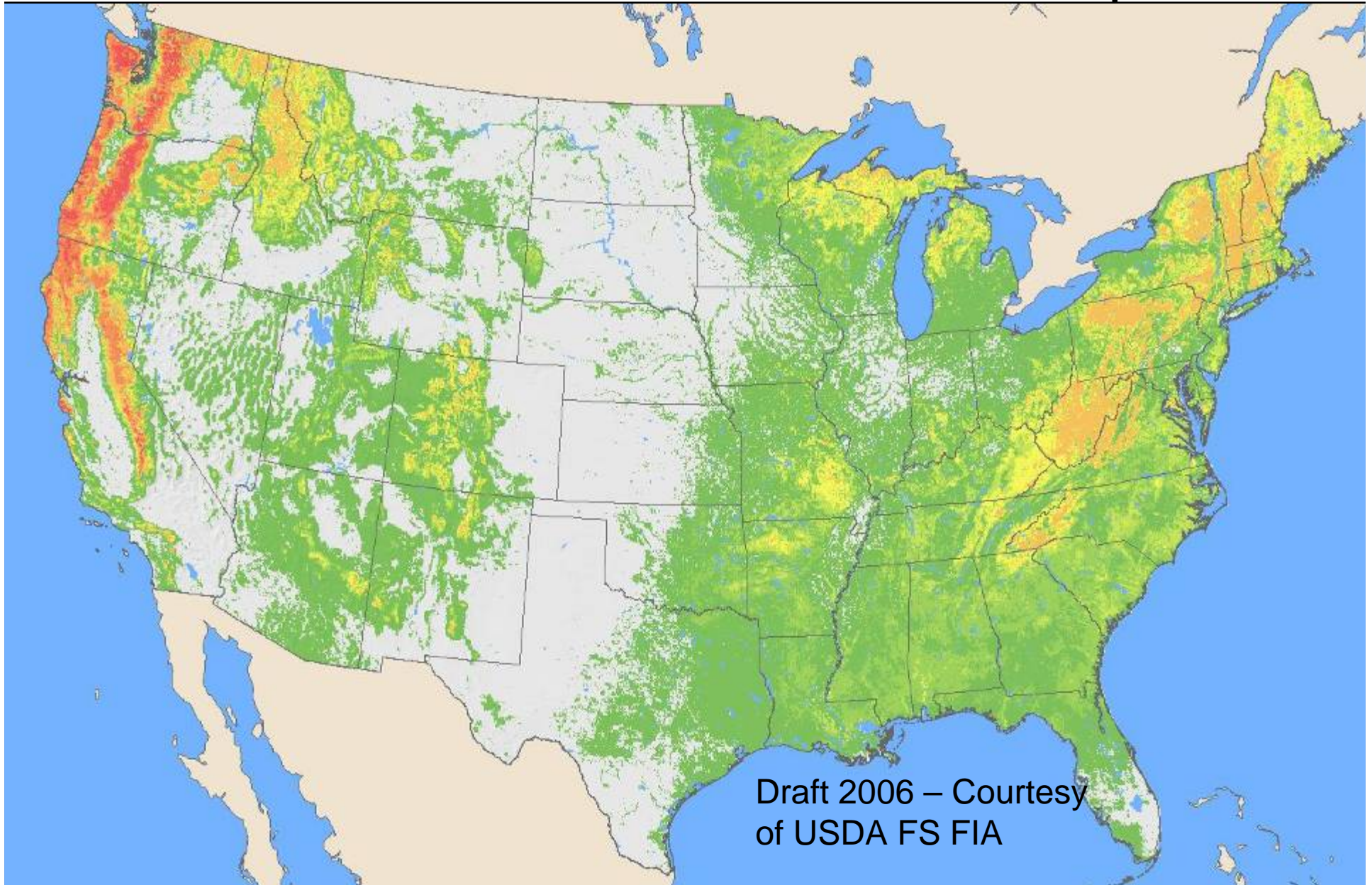
- **Small-diameter trees**
- **Forest Residues**
- **Clearings and conversions of timberland**
- **Wastes**
  - Processing
  - Construction/demolition
  - Yard trimmings
- **Production**
  - Conventional harvests
  - Short-rotation woody crops
  - Land use change
- **All Lands**
  - Public
  - Private
  - Industry

## Woody Biomass Uses

- **Biopower (any scale)**
  - Electricity
  - Heat and cooling
  - Conversion
    - Combustion
    - Syngas
    - Liquid fuels
- **Biofuels**
  - Ethanol
  - Biodiesel
  - Jet fuels
  - Methanol/biobutanol, etc
- **Bioproducts (offset fossil energy)**
  - Construction/facility
  - Preferred products



# USDA Forest Inventory & Analysis Nationwide Forest Biomass Map

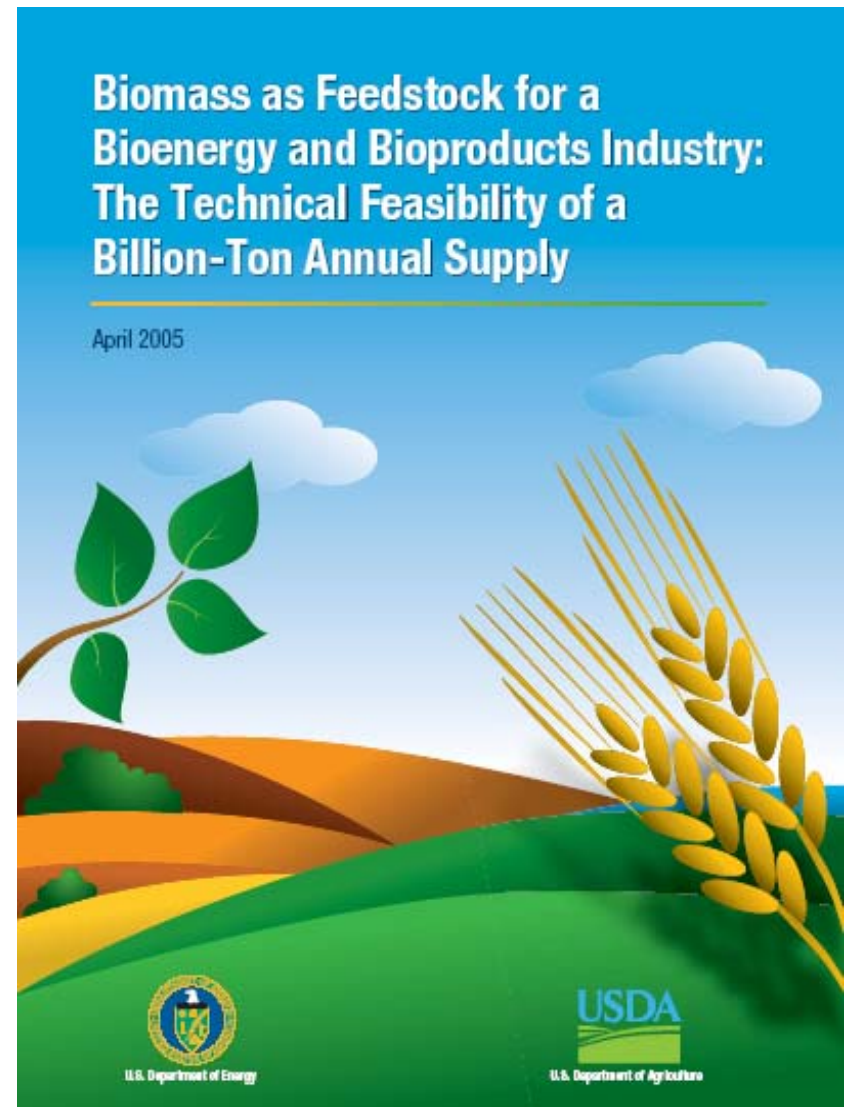




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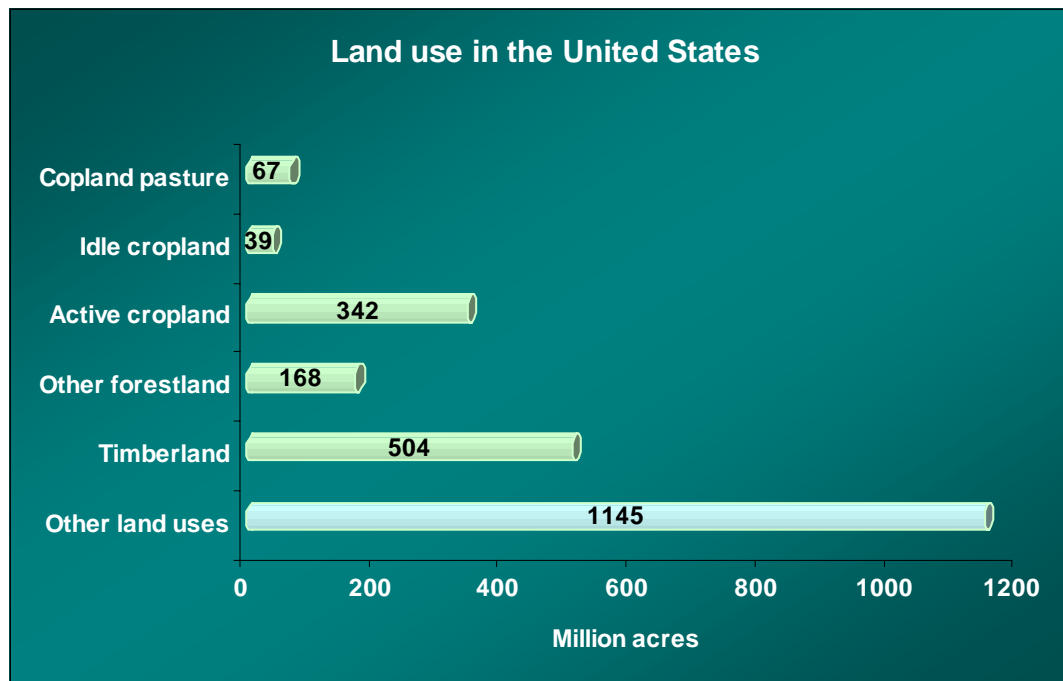
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[http://www1.eere.energy.gov/biomass/pdfs/final\\_billionton\\_vision\\_report2.pdf](http://www1.eere.energy.gov/biomass/pdfs/final_billionton_vision_report2.pdf)

# 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

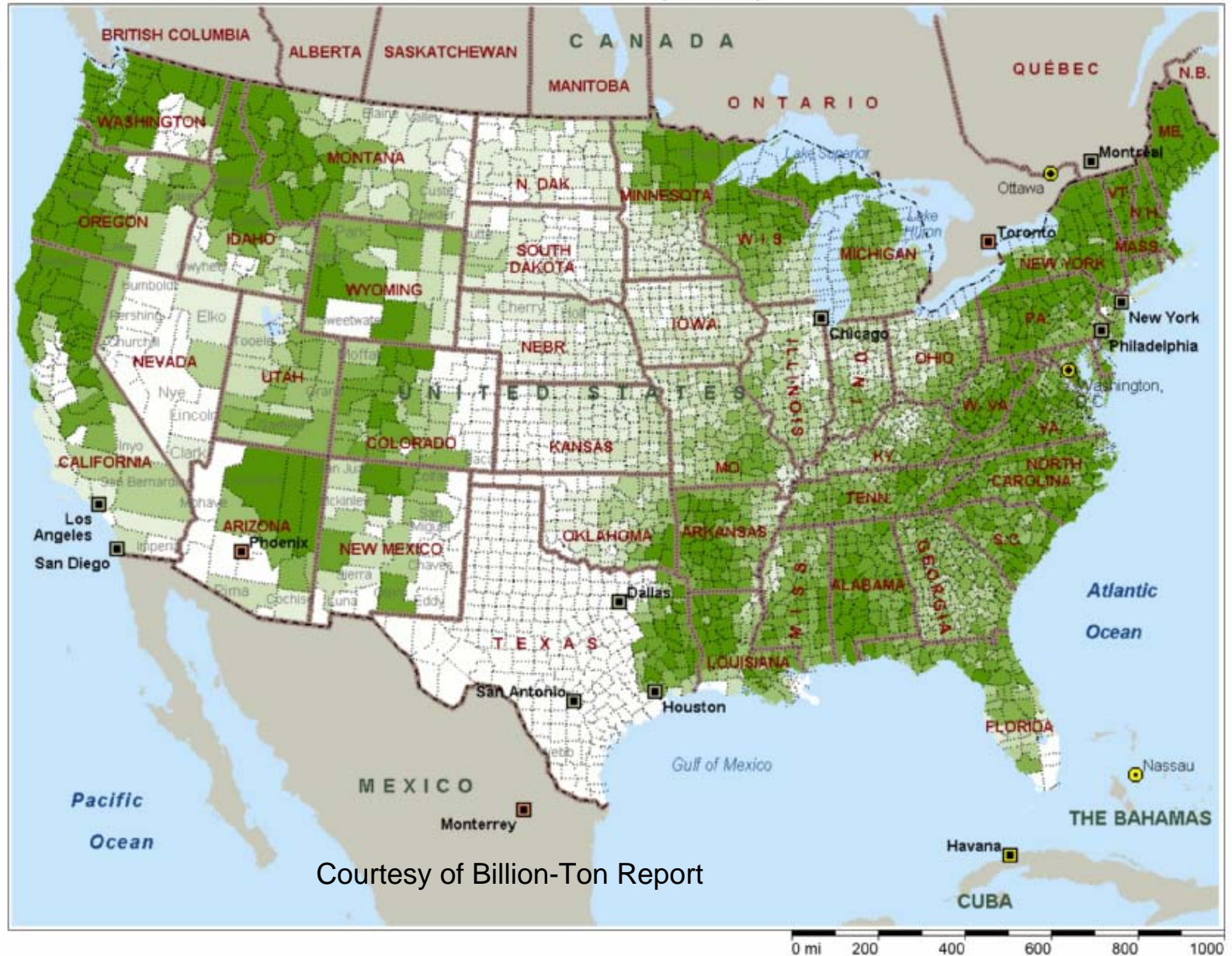


## Forest resources

- **Logging residues** and other removals
  - Traditional logging activities
  - Cultural operations and clearing of 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)



## Total Fuel Treatment Residues by County

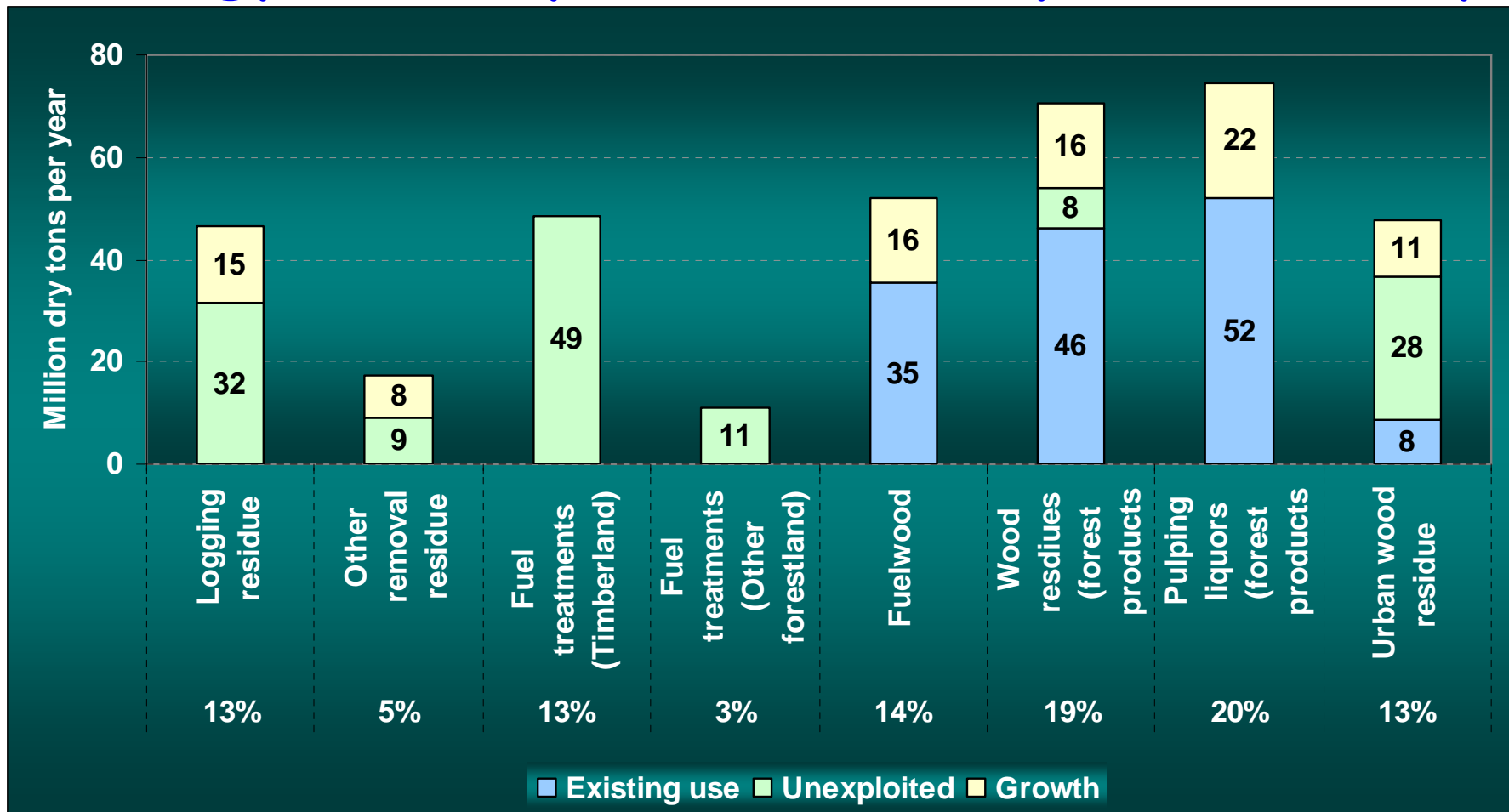


Courtesy of Billion-Ton Report

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# Forest Resource Analysis

The sustainable forest resource potential for energy is nearly 370 million dry tons annually





# Wood Wastes<sup>1</sup> in Northeast

NE ~ MN & over; WV & up – million dry tons

	Logging Residue	Other Removal	Thinning Timberland	Thinning Other	Mill Residue Not Used	Urban	Total
<b>NE</b>	<b>11.5</b>	<b>0.8</b>	<b>14.5</b>	<b>0.5</b>	<b>0.6</b>	<b>6.2</b>	<b>34.1</b>
<b>Percent of US</b>	<b>36.3</b>	<b>8.8</b>	<b>4.3</b>	<b>4.5</b>	<b>35.3</b>	<b>22.1</b>	<b>9.2</b>
<b>Maine</b>	<b>2.2</b>	<b>---</b>	<b>1.9</b>	<b>---</b>	<b>---</b>	<b>0.1</b>	

<sup>1</sup>Does not include used mill residue, black liquor, or firewood

# Wood in Agricultural Analysis

## Short Rotation Woody Crops in High Yield/Land Change Scenario

- Not in forestry assessment - in agriculture *Wood Fiber*
- 5.1 millions acres
- 8 dry tons per acre per year
- 25 percent of annual harvest is allocated to energy biomass
- Total is 9.2 million dry tons annually

## Total Wood in Agricultural Analysis

**~11 and about 150 million dry tons per year**



## Additional CRP Trees

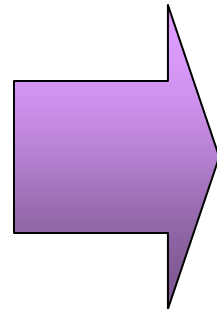
- 2.2 million dry tons per year

## Potential as a Perennial Crop

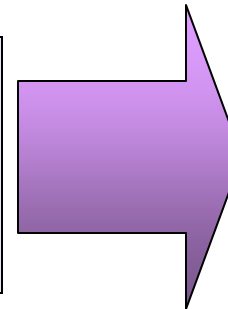
- Part or all of 146 million dry tons per year under moderate yield/land change scenario
- Part of 368 million dry tons per year under high yield/land change



## Forest Biomass Feedstock



## Conversion Processes



## Uses

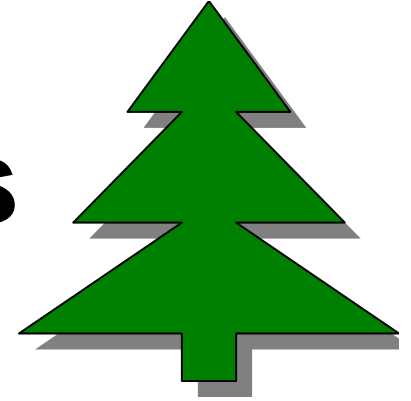
- Forest Residues
- Hazardous Fuel Treatments
- Short Rotation Woody Crops
- Wood Wastes
- Conventional forestry

- Manufacturing
- Co-firing
- Combustion
- Gasification
- Enzymatic Fermentation
- Gas/liquid Fermentation
- Acid Hydrolysis/Fermentation

- BioFuels:
  - Diesel & Ethanol
- Electricity and Heat
- Biobased Products
  - Composites
  - Specialty Products
  - Chemicals
- Traditional Products



# Forest Opportunities



## Finding uses for woody biomass will

- Help restore our forests (forest infrastructure)
  - Offset forest management costs
  - Reduce risk from wildfires
  - Decrease risk from insects and disease and recover value
  - Active management
- Provide jobs and economic opportunities
- Help reduce our dependence on foreign oil
- Provide environmental values





# Natural Resource Management

**Environment**

- Climate Change
- Stand Function

**Energy**

- Renewable
- Secure

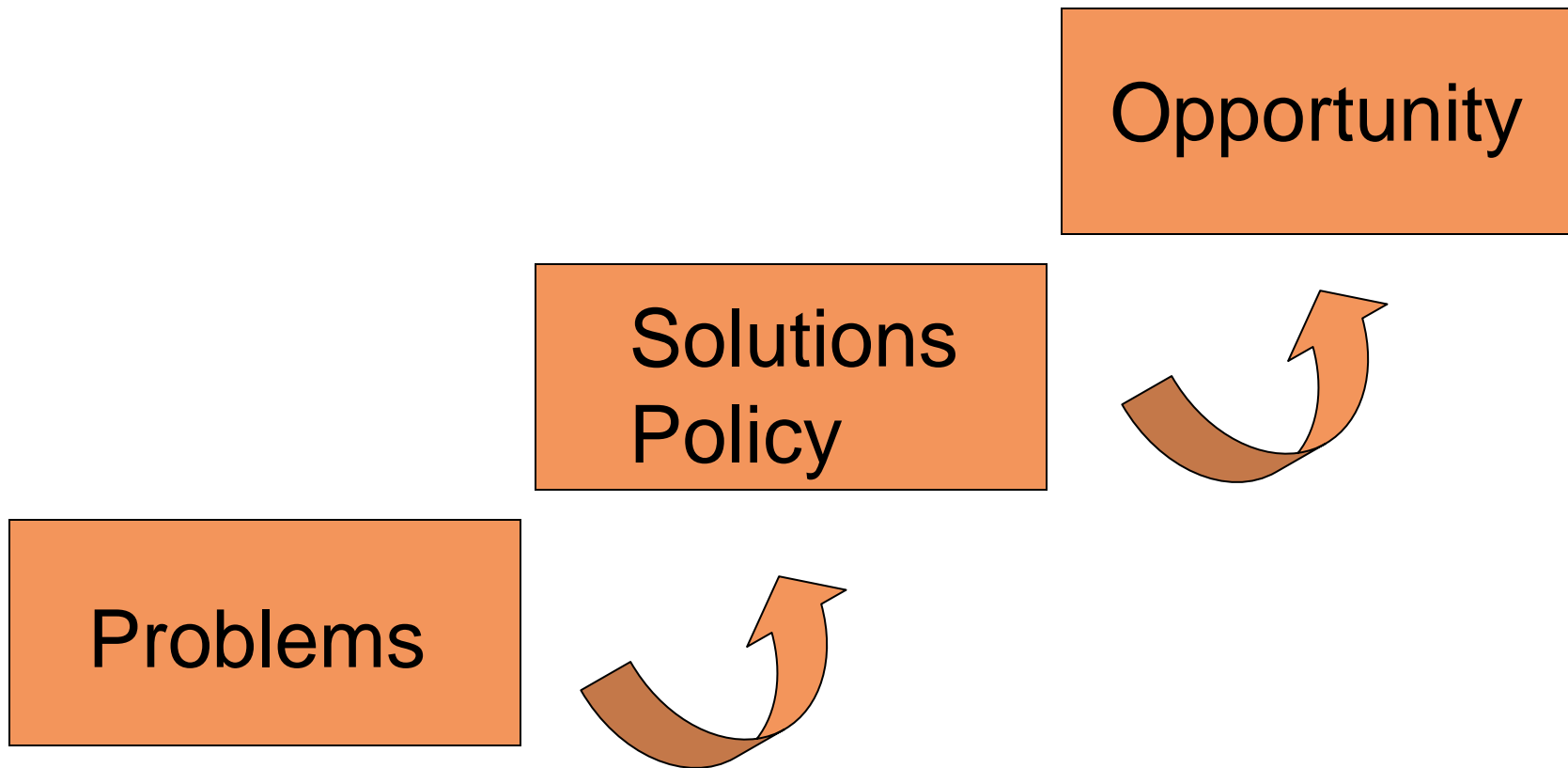
**Biomass  
Management  
and Use**

**Economy**

- Costs
- Rural Development
- Global Competition



# Why Wood for Energy?



# Drivers for Woody Biomass Use

## General Attributes

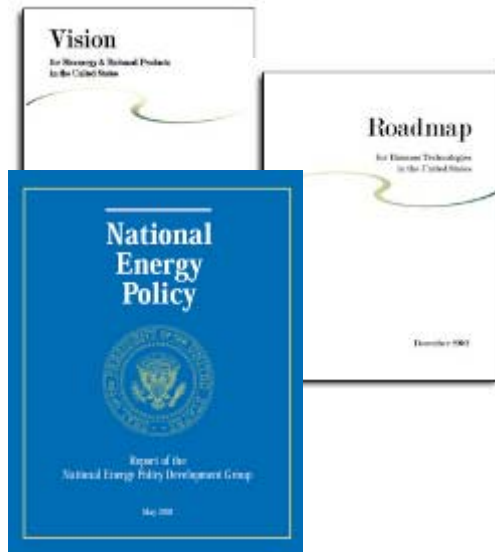
- **Most abundant renewable material on Earth**
- **Only renewable for transportation liquid fuels**
- **“Fairly” distributed with infrastructure in place**
- **Has multiple owners, open markets**
- **Has many established “best practices” and “certification”**
- **Has good energy ratio**
- **Good opportunity for enhanced productivity (residual & value)**
- **Integrated products and values with market flexibility**
- **Mixes with other feedstock in production and conversion**
- **Provides environmental and ecological benefits and values**

## Other Drivers Public Land

- **Public lands with 190 million acres at risk from extreme fire**
- **Forest health decline and restoration**
- **Provides offset costs or extra opportunities**



# Biomass Policy



- The Biomass R&D Act of 2000 directs DOE and USDA to enhance and coordinate biomass R&D efforts.
- The Energy Policy Act of 2005 provides direction on program content as well as loan guarantee authorization for commercial scale demonstrations.
- The President's National Energy Policy includes multiple recommendations that support bioenergy.
- The President's Advance Energy Initiative.
- The President's "20 in 10" Initiative.
- The Energy Title (Title IX) of the 2002 Farm Bill provides support for increased use of biomass energy and products and for R&D.
- National Fire Plan & Ten-Year Comprehensive Strategy, Healthy Forest Initiative, and Healthy Forest Restoration Act provide for biomass management for fire and health.
- DOE/DOI/USDA MOU on Woody Biomass Utilization
- New Farm Bill and Energy Bills



# Barriers to Wood for Energy

**No Markets; No Contracts; No Certainty; No Investment Capital; No Hope; No Help  
Fear for Wood; Fear for Fool**

- **Regulatory, & Statutory**
  - Unfavorable policy
  - Uncertainty
- **Costs**
  - High cost of tech.
  - Unproven tech. risks
  - Market risks
  - External benefits (ex. GHG credit) not realized
  - Lack of specialized knowledge
- **Other**
  - Public/special interest groups perspectives
  - Misplaced incentives
  - Insufficient information
  - Infrastructure limitations
  - Industry structure
  - Policy uncertainty
  - Intellectual property

# Gloom and Doom

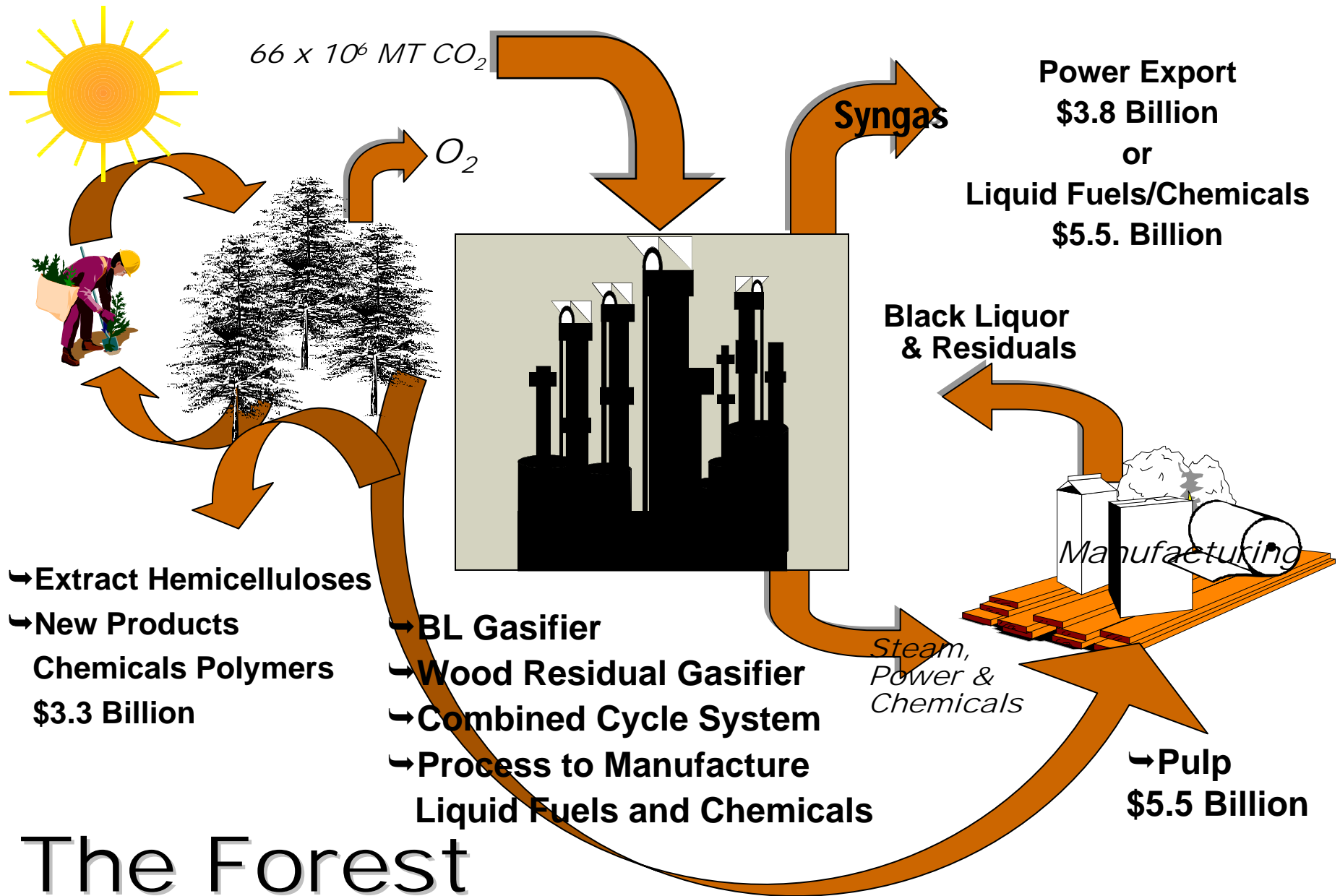
or



# WBU Feedstock Potential (Millions of BDTs Annually)

- Electricity:
  - 8,500 Bone Dry Tons = One Megawatt/Hour for an entire Year of Electricity (1 MWY)
  - 368 Million BDT = 43,294 MW Years
  - One Megawatt = 1000 Households
  - 43,294 MWY = 43.3 Million Households
- Ethanol\*:
  - One BDT = 80 gallons (Range 65-100 gallons)
  - 368 million BDT = 29.4 Billion Gallons of Ethanol per Year
  - Current production is about 3.5 billion gallons per year (mostly corn)
- \* Potential only, further research and technology development needed





# The Forest Biorefinery

## Net Revenue Assumptions:

Acetic Acid - \$1.73/gallon	Purchased Electricity - \$43.16/MWH
Ethanol - \$1.15/gallon	Exported Electricity - \$40.44/MWH
Pulp - \$100/ton net profit	Renewable Fisher Tropsch Fuel - \$57/bbl