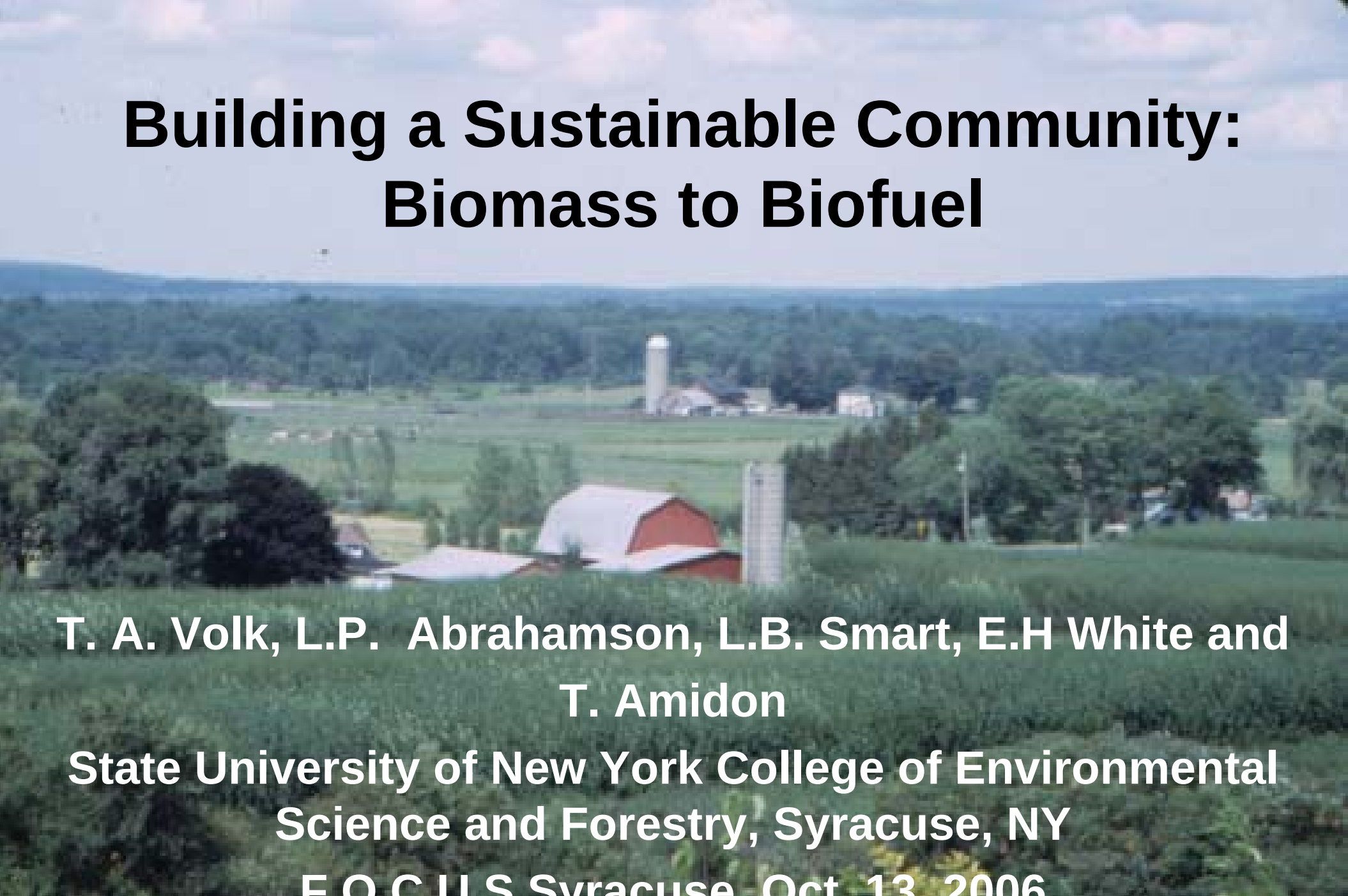
Building a Sustainable Community: Biomass to Biofuel



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F.O.C.U.S Syracuse, Oct. 13, 2006

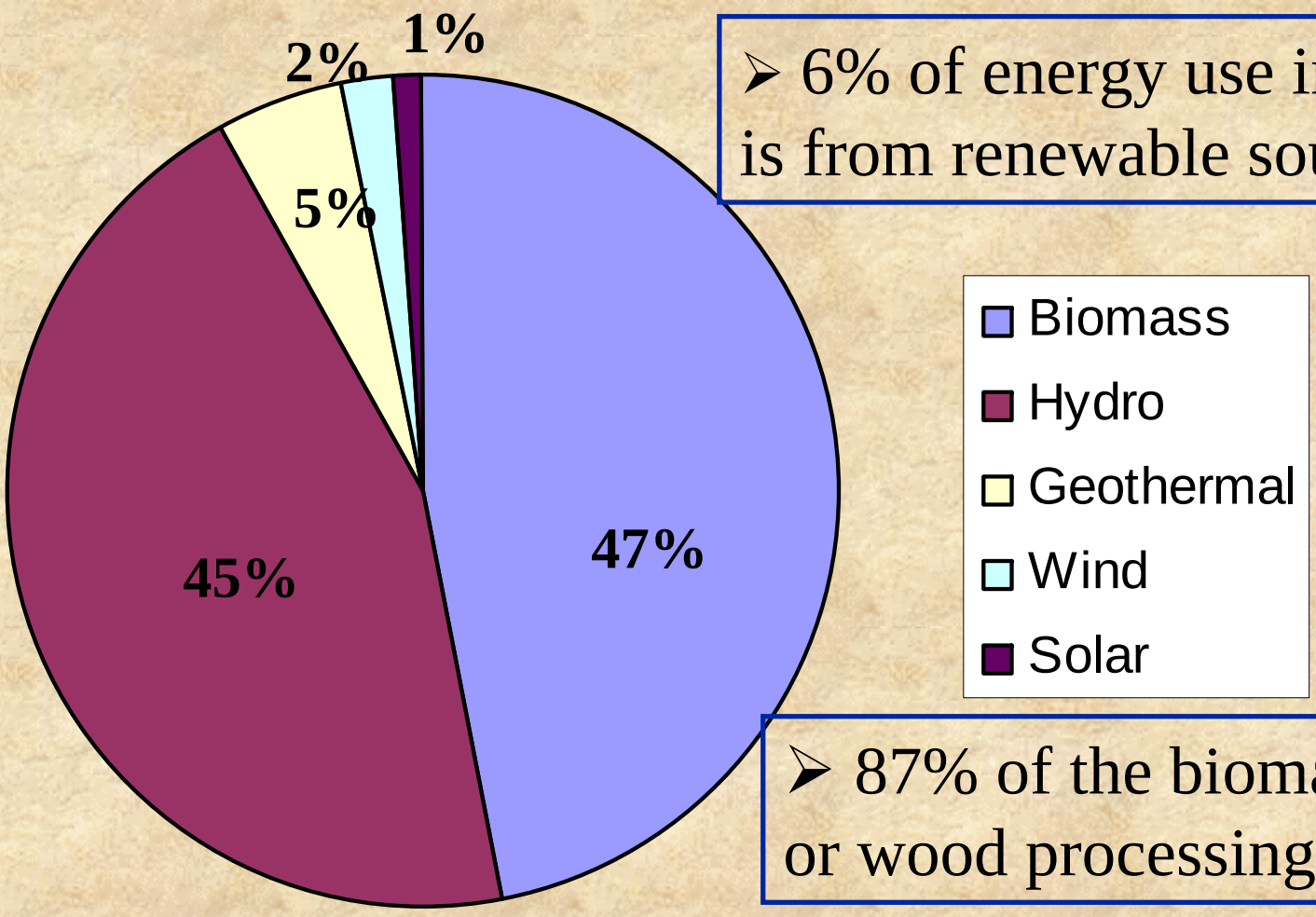
Overview

- Renewable energy and biomass
- NY’s woody biomass feedstocks
- Willow biomass crops
- Wood based biorefinery

Energy Use in the US

- We use 25% of the world's energy, but make up only 5% of the world's population
- We use about 98 quads of energy
- And the sources are…….
  - Petroleum – 38% (Supply expected to peak in 10-30 years)
  - Natural gas – 24%
  - Coal – 24%
  - Nuclear – 8%
  - Renewables - 6%

Renewables in the US



- 6% of energy use in the U.S. is from renewable sources

- 87% of the biomass is wood or wood processing residues

What is Biomass?

- Recent organic material derived from plants or animals that is available on a renewable or recurring basis
- A diverse renewable resource with lots of potential
  - different feedstocks
  - multiple conversion pathways
  - variety of end products and energy forms
- Can be used at a variety of different scales.

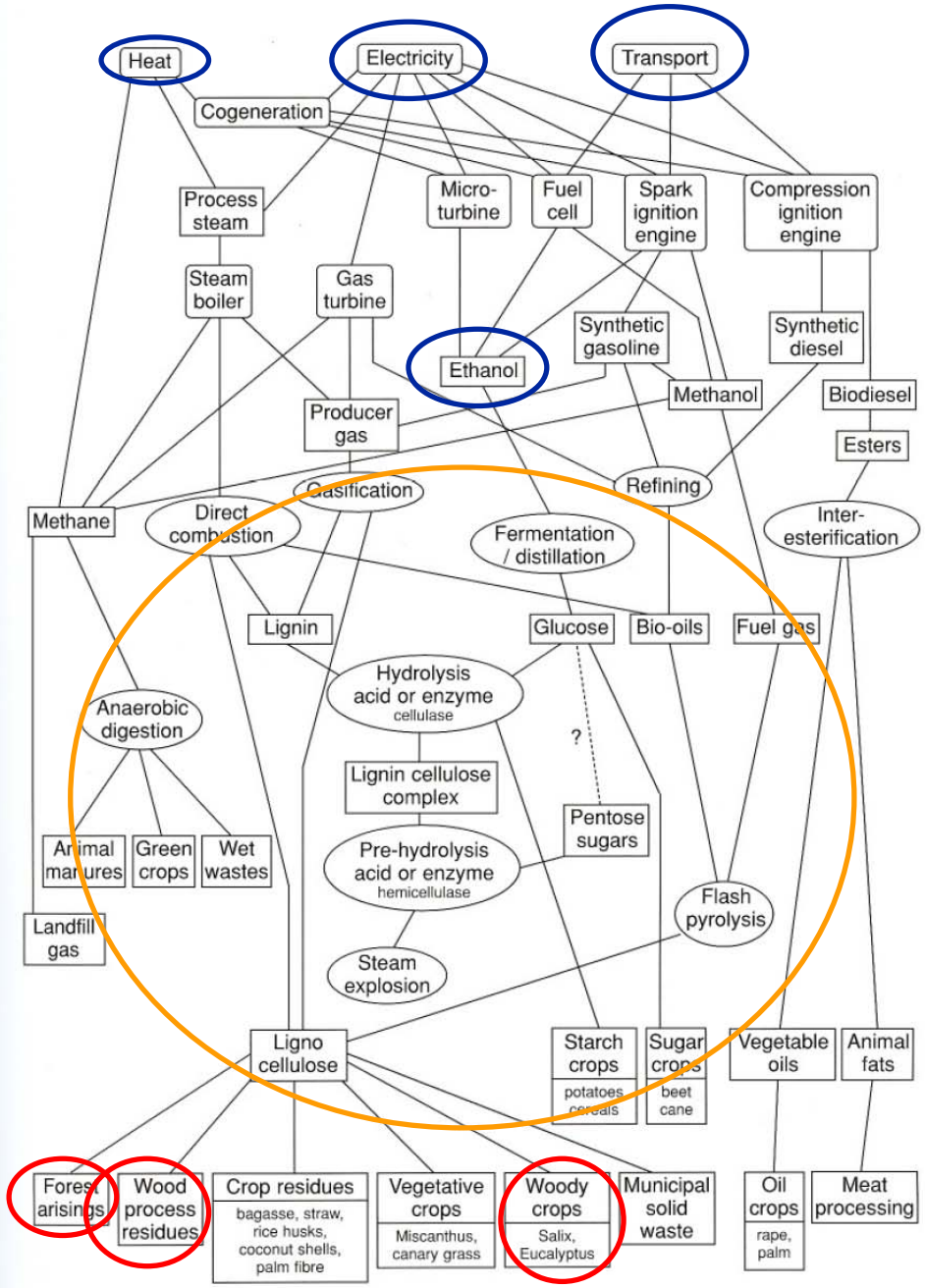
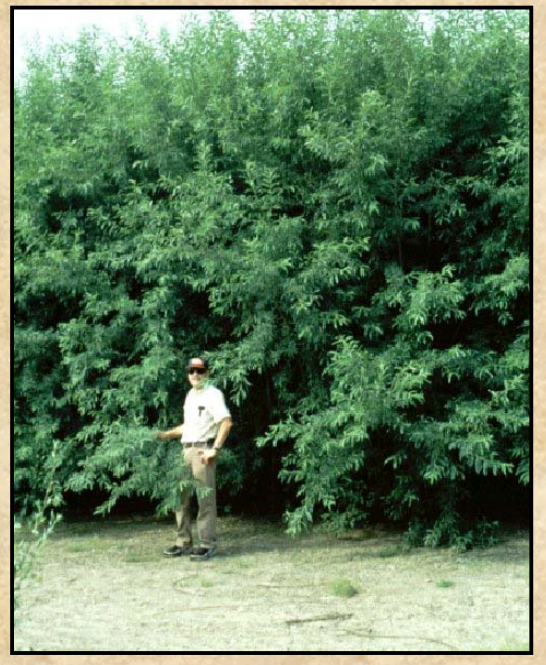


Figure 1.1 Some routes for converting a number of different biomass materials into useful energy products

Woody Biomass Feedstocks

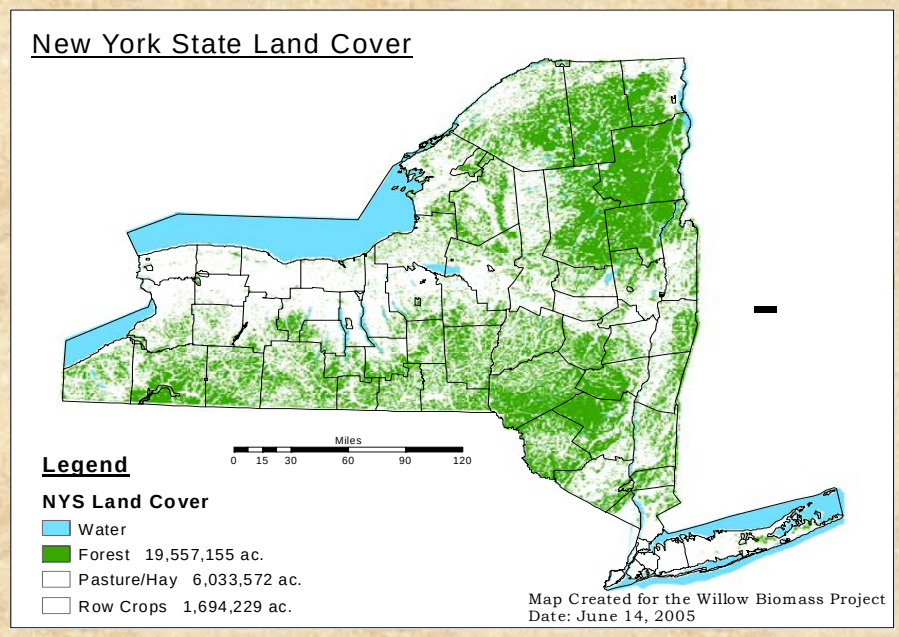
Wood residues from primary and secondary wood product manufacturers are available

Low value wood from forests can be harvested sustainably



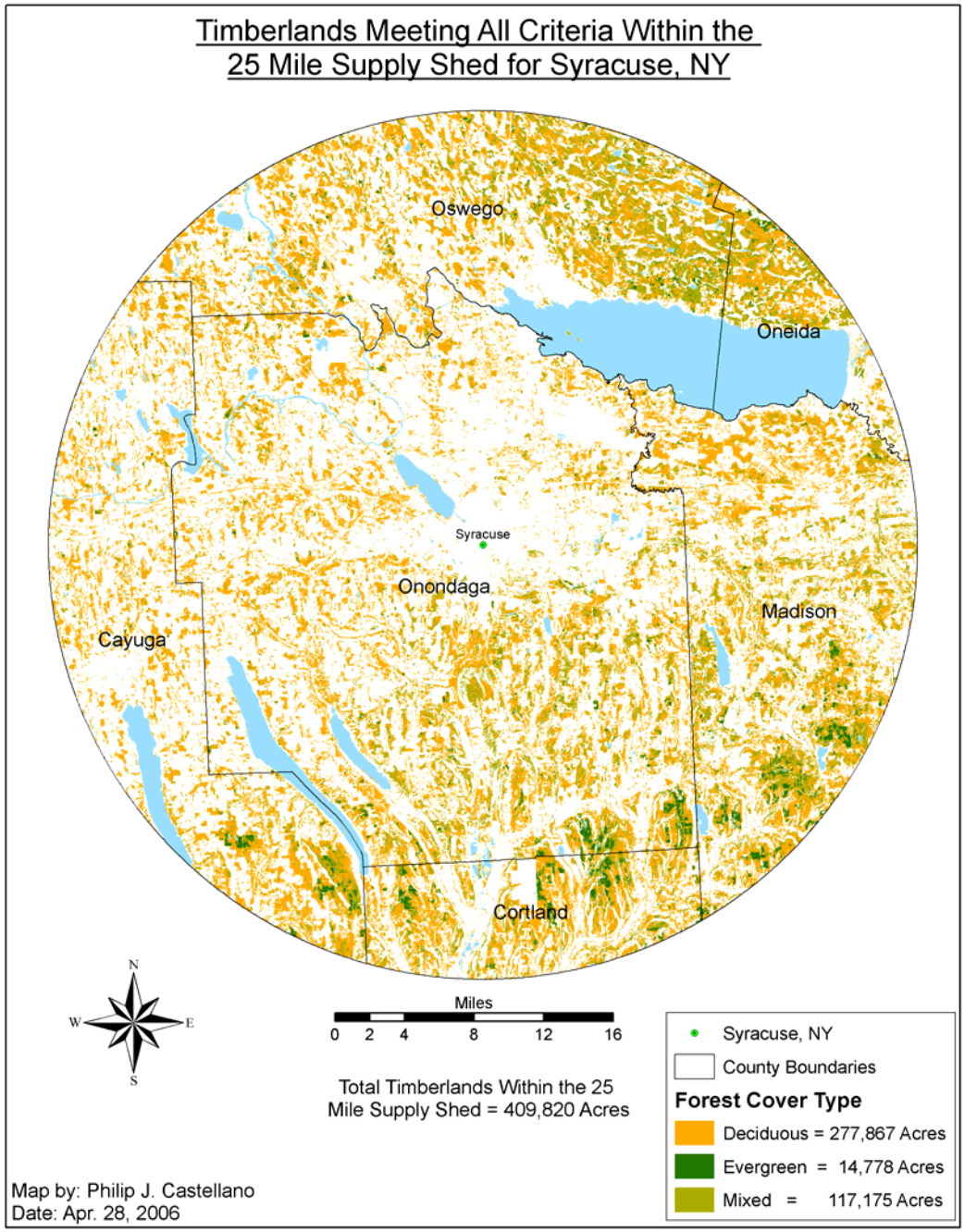
Willow biomass crops can be grown on under utilized open land

NY's Forest Resources



Forest land in NY

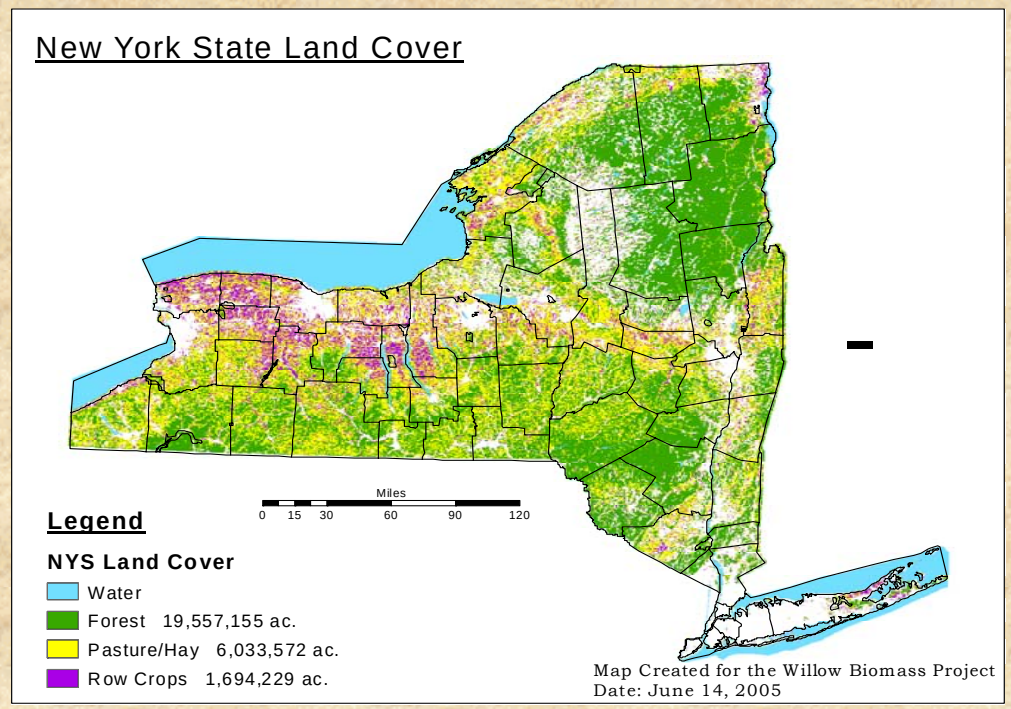
- 18.5 million acres of forest land
- 15.4 million acres of timber land
- Annual growth 3X greater than harvest
- Only 2 pulp mills in NY, down from 15 in the mid 1980s
  - Limited markets for low value trees
  - Results in poor forest management, especially high grading
- Bioenergy/bioproducts markets will
  - support sustainable management
  - improve the economic viability of rural communities



Timber land within 25 miles of Syracuse

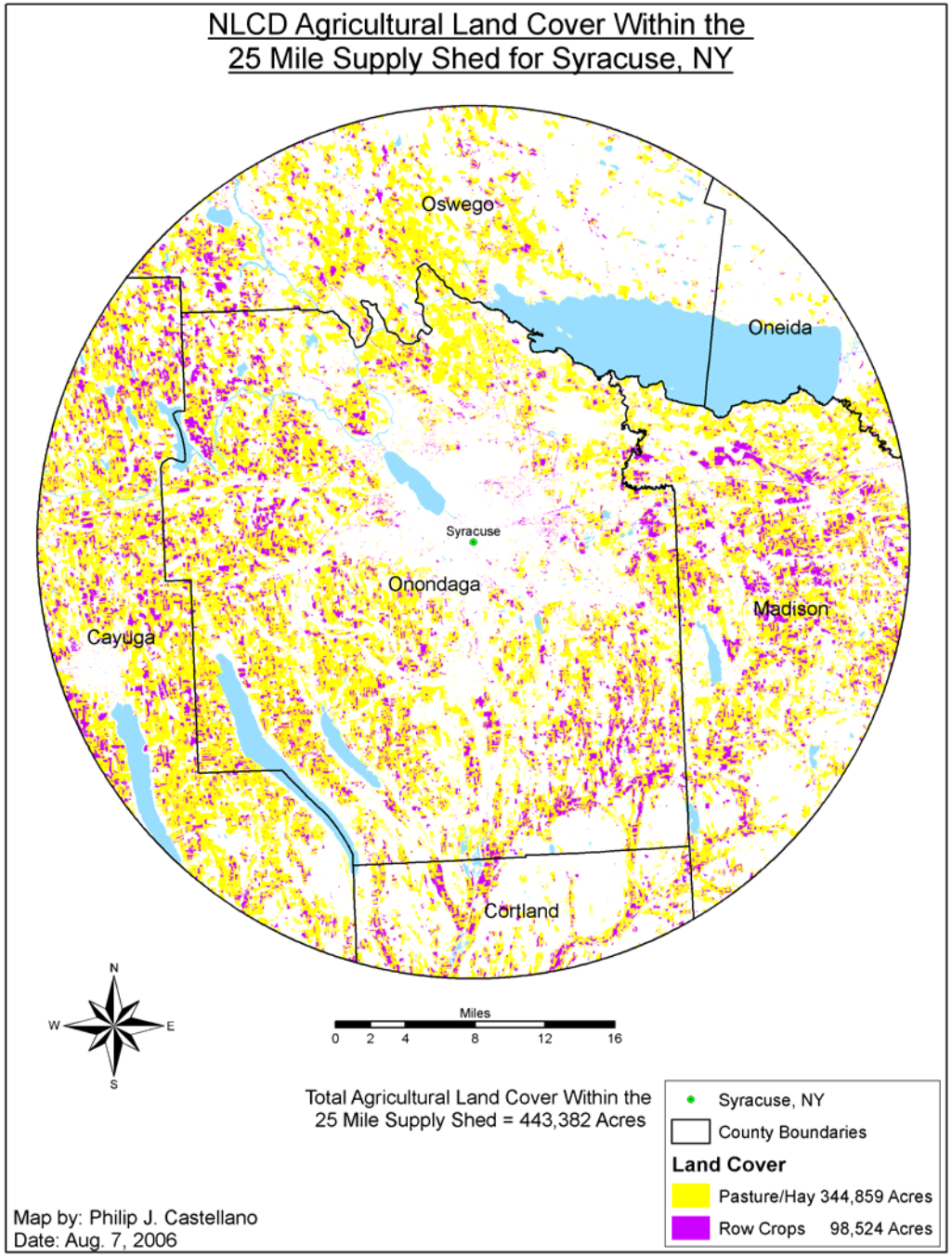
- Over 400,000 acres of timberland
- Potential to sustainably produce over 230,000 dry tons of woody biomass per year
- Enough woody biomass for 30-60 Mw_e

Willow Biomass Crops on Marginal Agricultural Land



Willow biomass crops three months after being harvested.

- Over 7.5 million acres classified as agricultural land in NY
- About 1.5 - 2.0 million acres are under utilized
- Willow biomass crops could be an alternative crop for farmers and landowners
- Produces environmental and rural development benefits in addition to bioenergy and/or bioproducts



Agricultural land within 25 miles of Syracuse

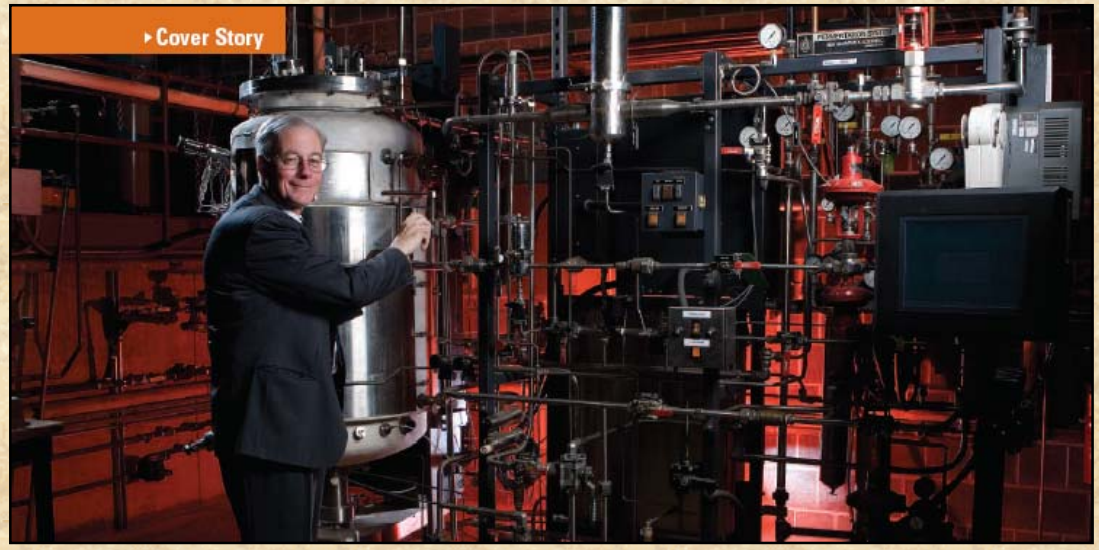
- Over 160,000 acres of timberland
- Sustainably produce over 80,000 dry tons of woody biomass per year using just 10% of this land
- Enough woody biomass for 10-20 Mw_e

Connection to the Past

Willow rods being prepared for basket production in the early 1900s.

- Willow cultivation began in area in mid 1800s
- In the late 1890s the Syracuse region was the largest producer of willow baskets in the country
- Production declines dramatically in early 1900s
- Research on shrub willow for biomass resumes at SUNY-ESF in 1986

Developing Pathways to a Sustainable Future



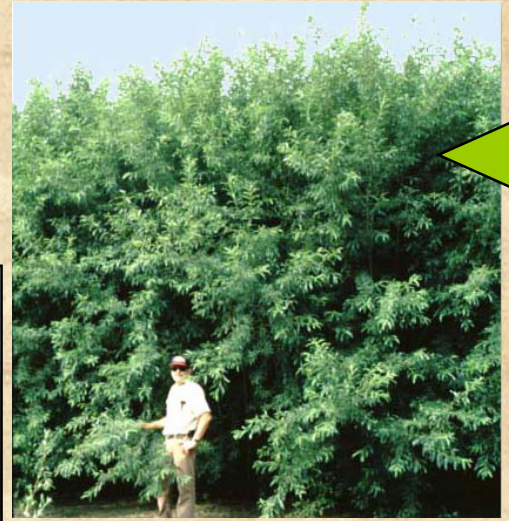
Fermentation equipment at SUNY-ESF being used to optimize the production of ethanol from sugars extracted from woody biomass

- Linking research and regional development
  - 20 years of research on willow biomass crops at SUNY-ESF
  - Extraction of sugars and other chemicals from woody biomass
  - Conversion of sugars to ethanol
- Sustainable woody biomass production from forests and dedicated woody crops

Willow Biomass Production Cycle

Planting

Harvest



Three years old after coppice

One year old after coppice

First year growth

Coppice

Early spring after coppicing

Establishing Willow Biomass Crops

Large scale planting willow with a Step planter at a rate of about 2.0 ac hr^{-1}

- Commercial nursery has planted over 100,000 willows for planting stock production
- Millions of cuttings will be produced in a few years
- Commercial expansion will include new willow varieties bred at SUNY-ESF
- The first commercial planting was established in Lewis county in 2006
- Thousands more commercial acres being planned for central NY

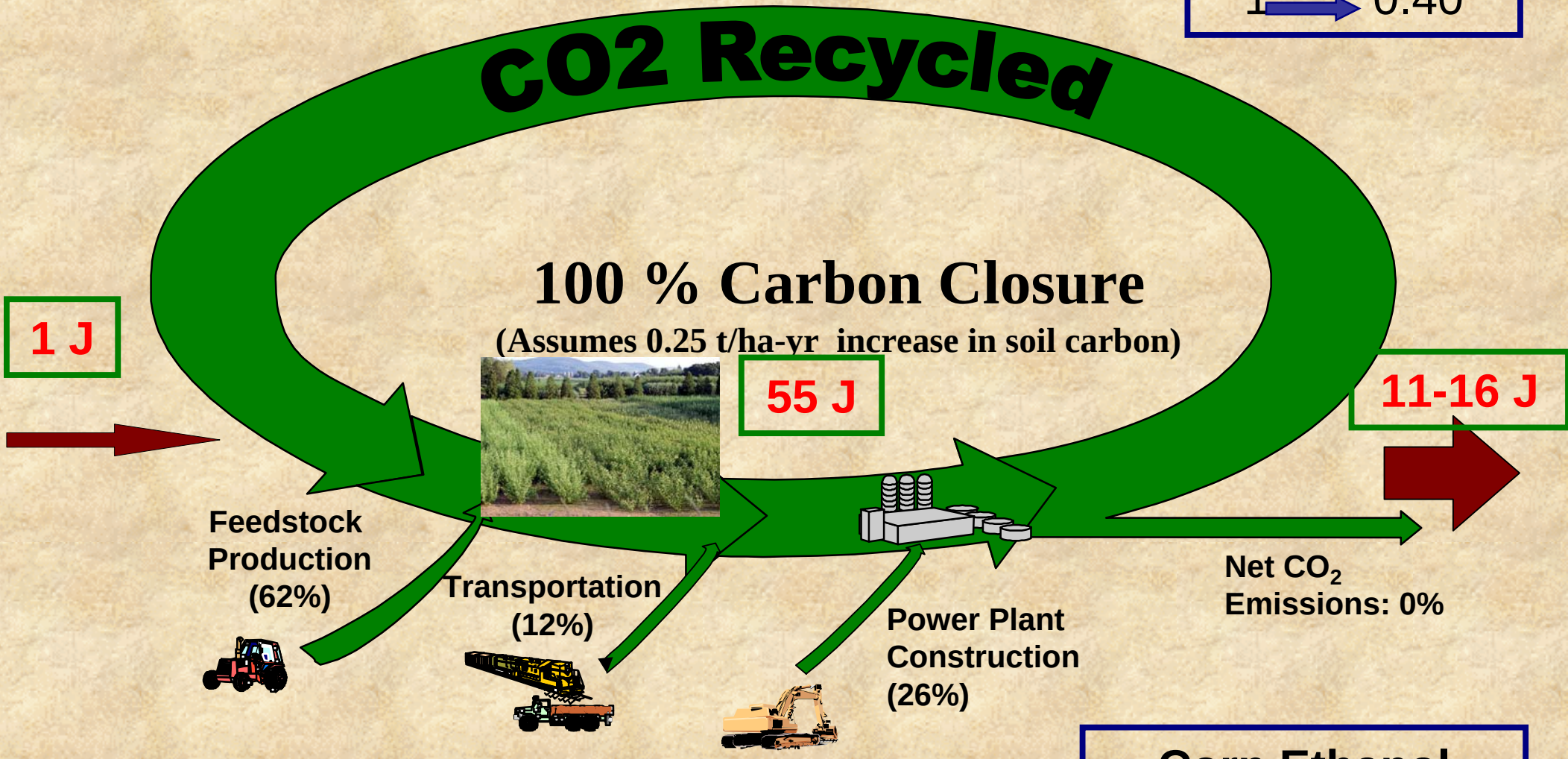
Willow Harvesting Systems

New Holland forage harvester with specially designed head harvesting three year old willow biomass crops

Global Carbon Cycles

Natural Gas

1 → 0.40



(Mann and Spath 1997, Keolian and Volk 2005)

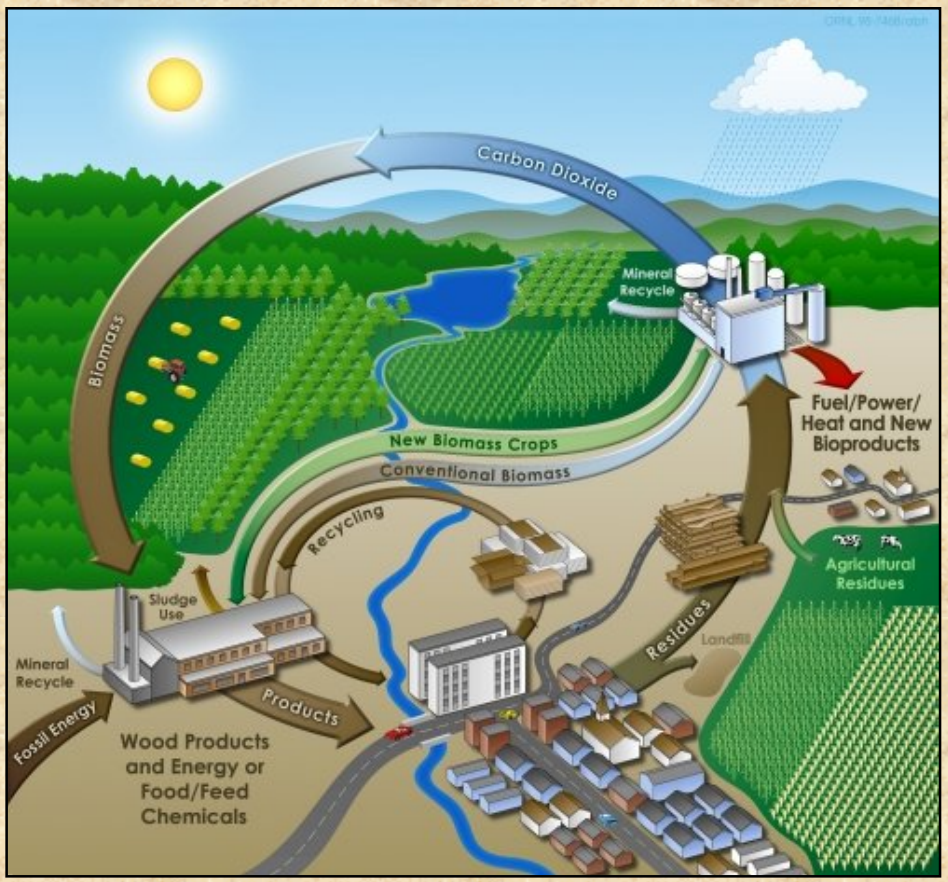
Corn Ethanol

1 → 1.67

Bird Diversity in Willow

Cornell
Lab of Ornithology

Economic Development Benefits



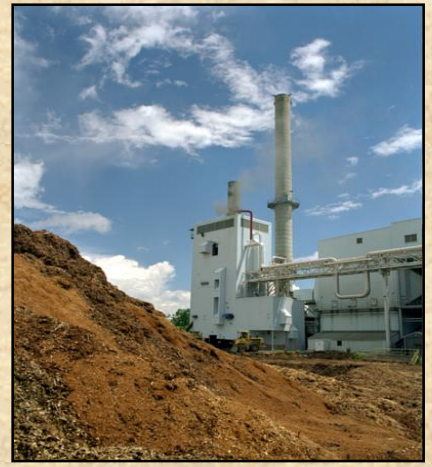
- Biomass is produced and then converted to higher value products locally
- Currently we spend about $2,000 each for energy in NYS
- Dollars spent regionally support the regional economy
- About 75 direct and indirect jobs are created for every 10,000 acres of willow crops

Conversion Technologies

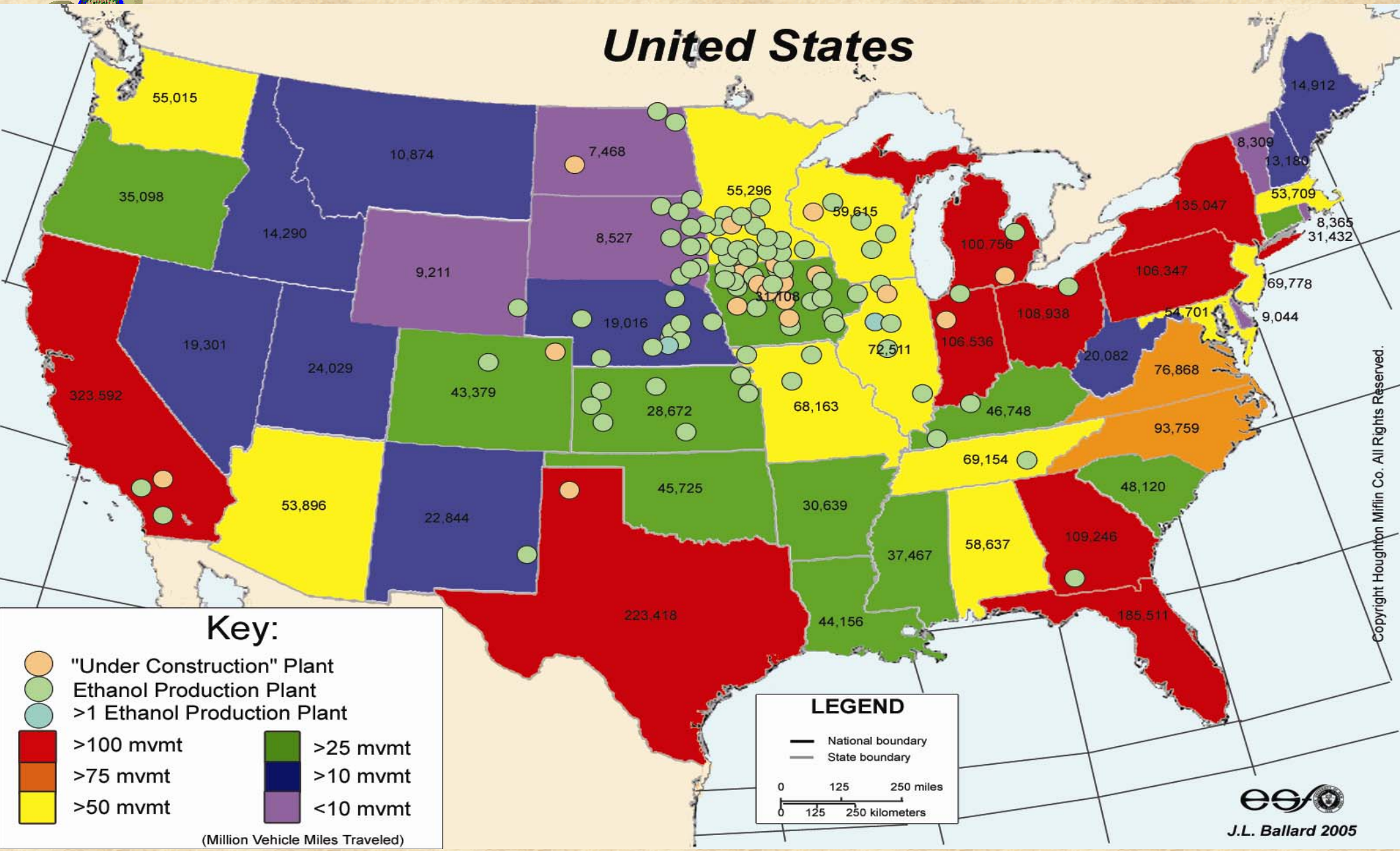
Direct-fired CHP/Biorefinery

Biorefinery

Co-firing



Gasification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19,016
19,301
24,029
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53,896
22,844
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44,156
37,467
100,756
106,536
108,938
46,748
69,154
58,637
109,246
185,511
48,120
93,759
76,868
20,082
54,701
106,347
135,047
8,309
13,180
14,912
53,709
8,365
31,432
69,778
9,044
Key:
"Under Construction" Plant
Ethanol Production Plant
>1 Ethanol Production Plant
>100 mvmt
>75 mvmt
>50 mvmt
>25 mvmt
>10 mvmt
<10 mvmt
(Million Vehicle Miles Traveled)
LEGEND
National boundary
State boundary
0 125 250 miles
0 125 250 kilometers
J.L. Ballard 2005
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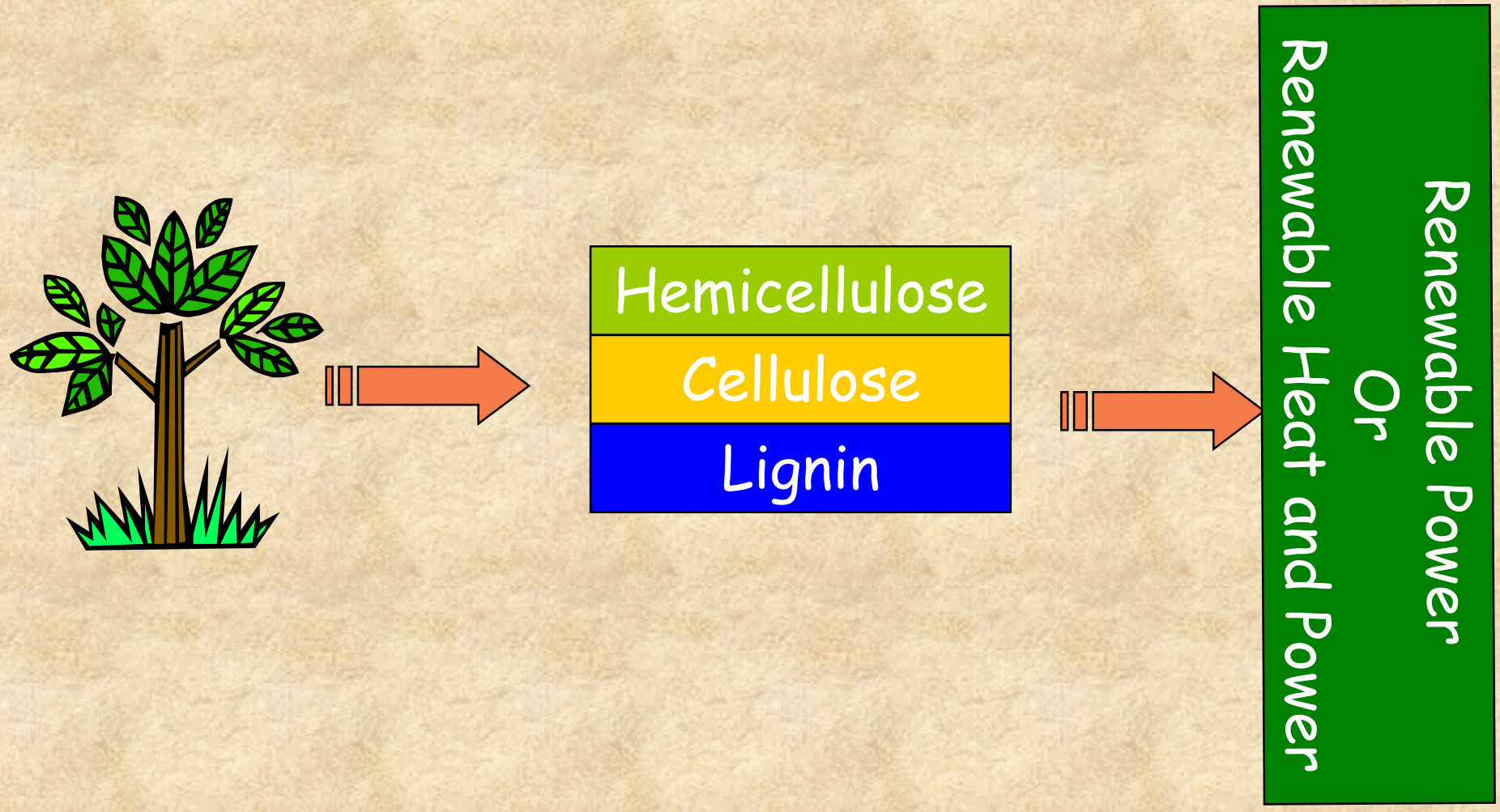
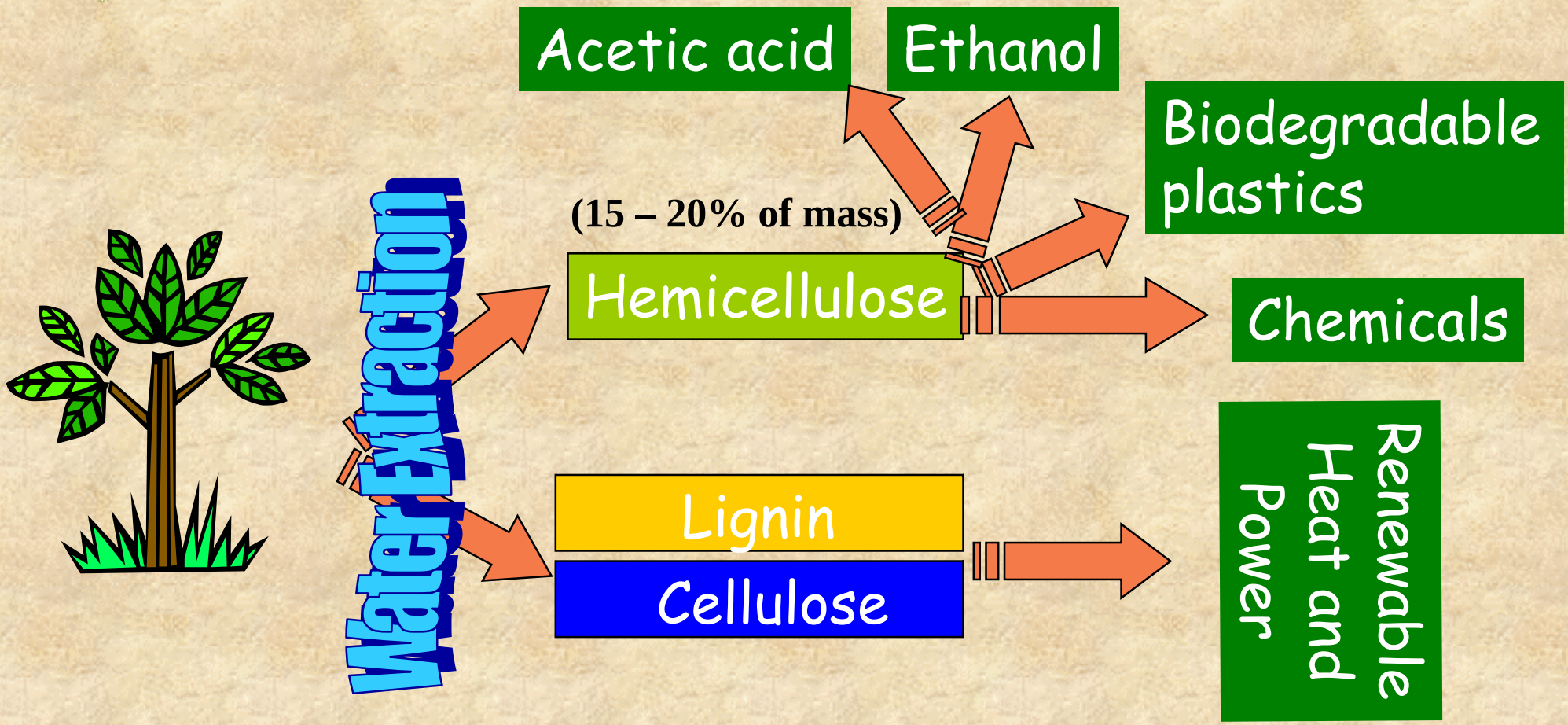
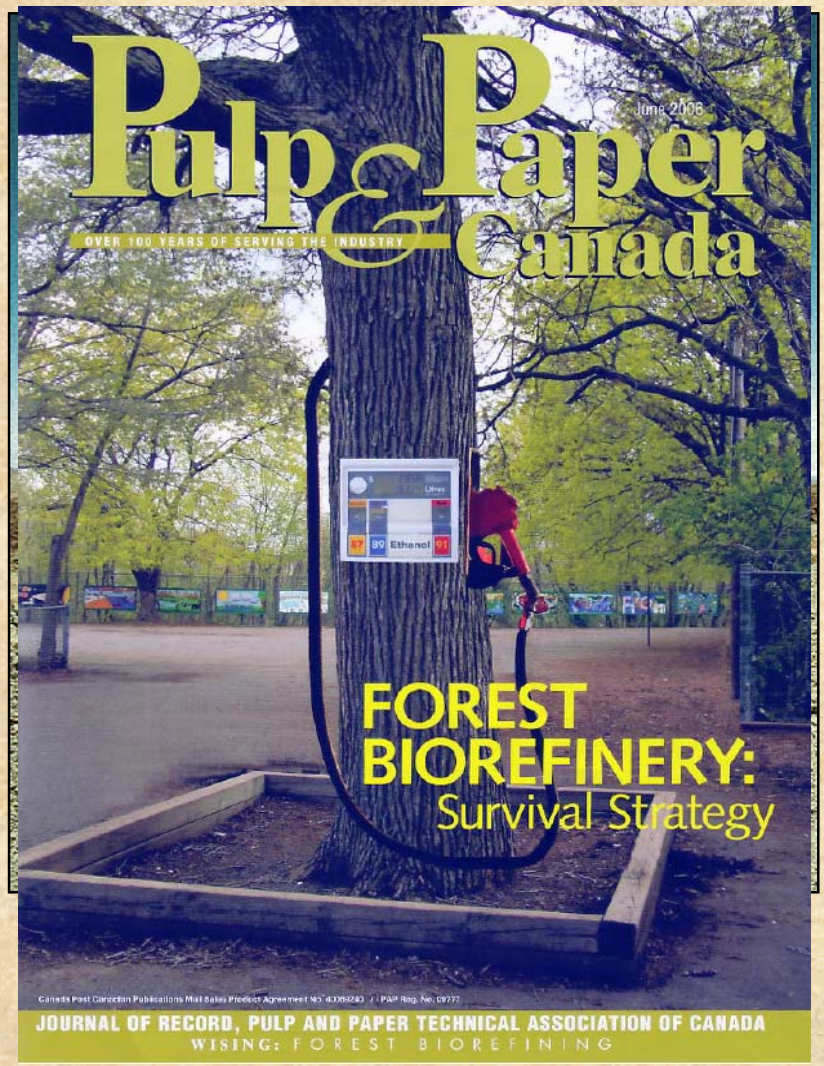
Current Wood to Energy Facilities



Wood to Energy Biorefinery



Now is the Time for Action



- "The stone age did not end for lack of stone, and the oil age will end long before the world runs out of oil."
  - Sheikh Zaki Yamani, former oil minister for Saudi Arabia

Current Willow Biomass Production System

- Decades of worldwide knowledge and experience
- Inherent characteristics of willow

Tailor biomass production system for specific objectives and site conditions

- use an adaptive management model

Phytoremediation

Living Willow Snowfences

Willow Riparian Buffers