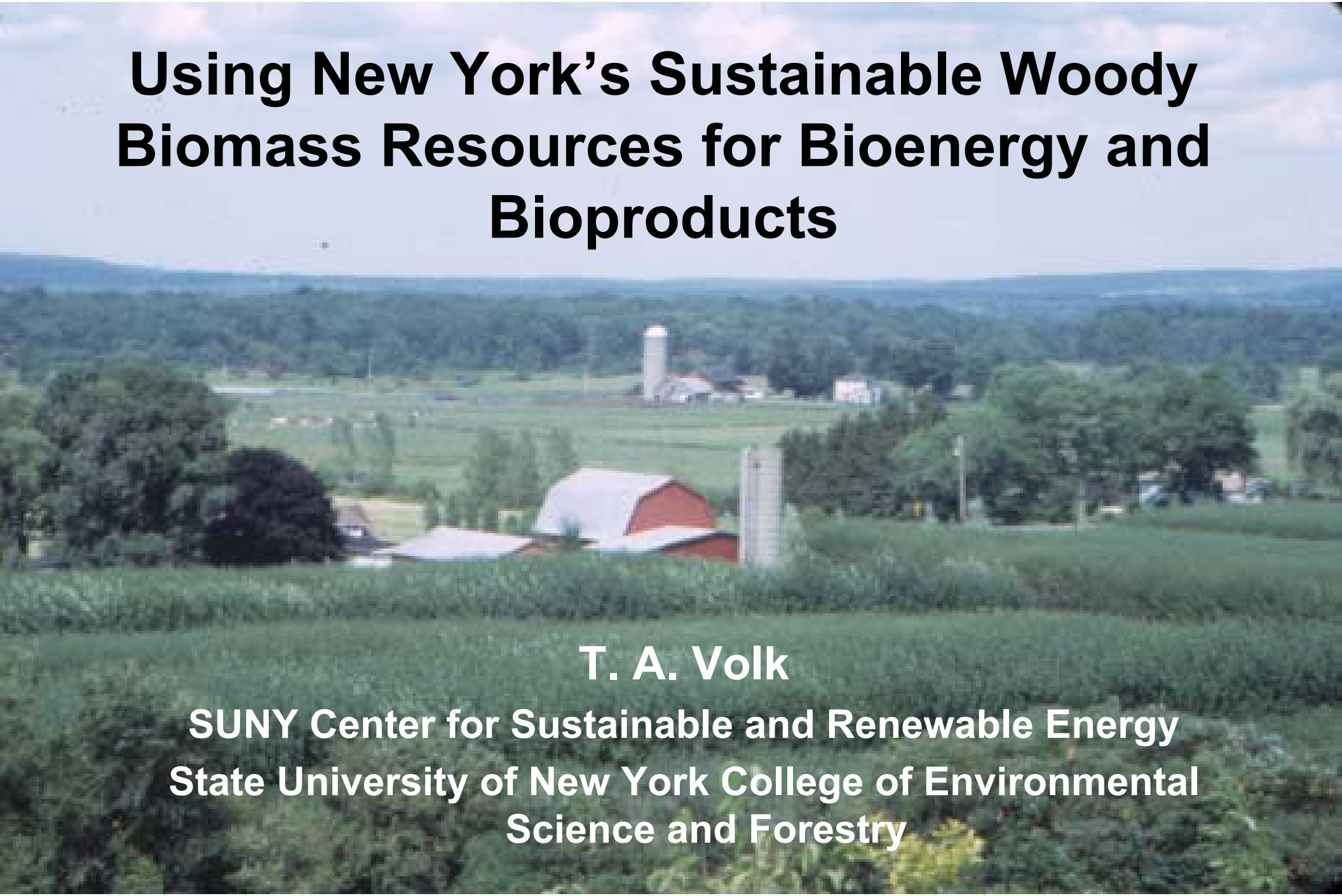
Using New York's Sustainable Woody Biomass Resources for Bioenergy and Bioproducts



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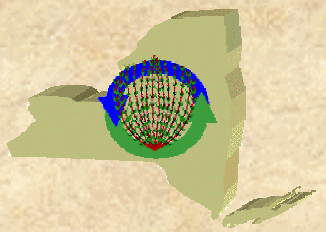
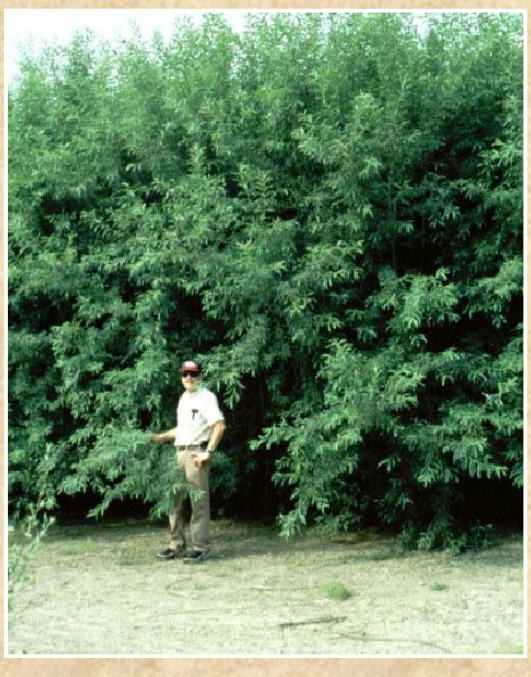


What is Biomass?

- Organic material that is available on a renewable or recurring basis – but will focus on woody biomass
- Executive Order 111 lists ‘sustainably managed biomass’ as one of eight sources of renewable energy
- Biomass is included in RPS in 13 other states
- Less than 1% electricity generation in NY is from biomass
- Potential for a significant increase

Woody Biomass Feedstocks

Low value wood from forests can be harvested sustainably



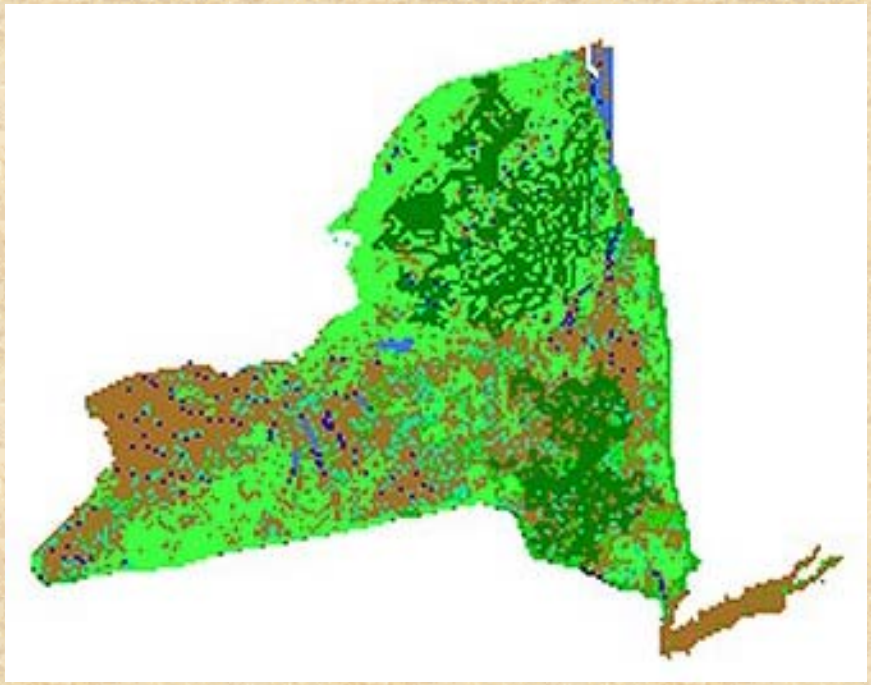
Willow biomass crops can be grown on under utilized open land

Large quantities of wood residues from primary and secondary wood product manufacturers are available

Wood Residues

- 5.5 million tons of residue produced annually from secondary wood manufacturing industries
- About 30% is currently not utilized
- Use for energy rather than being landfilled reduces GHG emissions

NY's Forest Resources

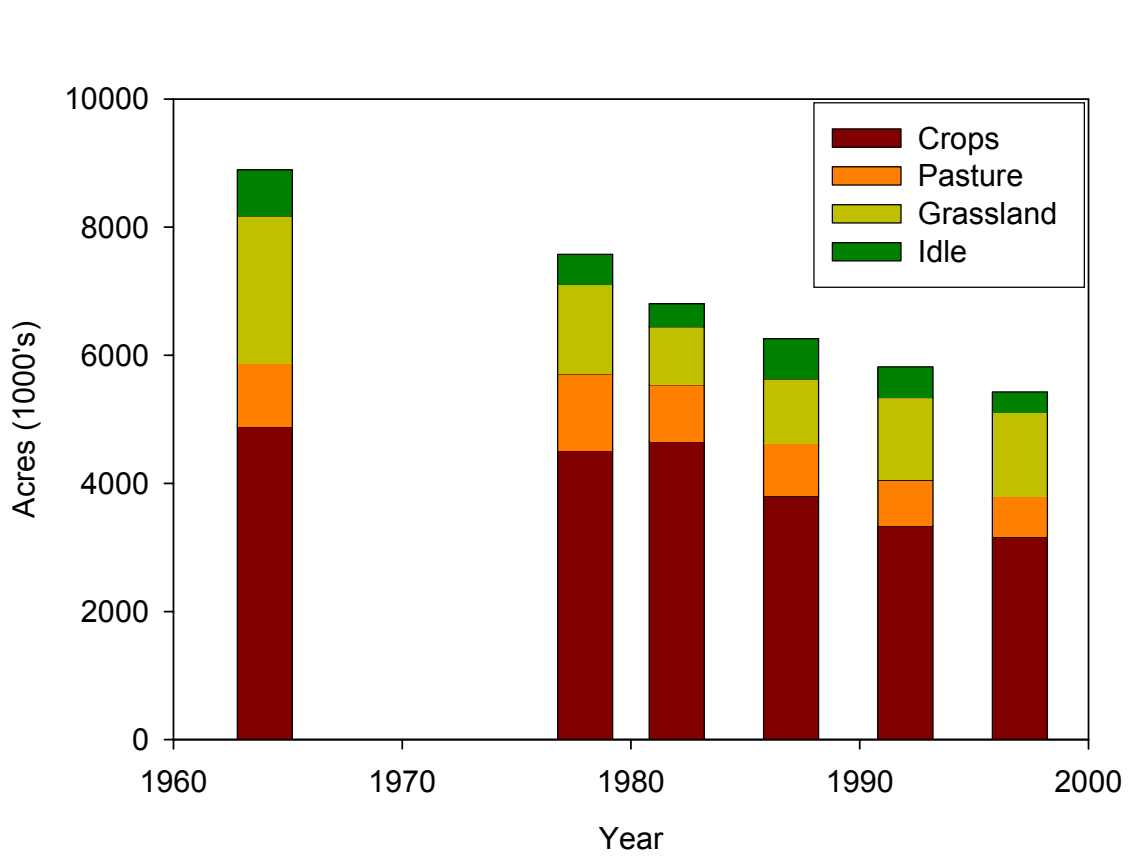


- 18.6 million acres of forest land in NY
- 15.4 million acres of timberland outside of federal and state reserves
- Net annual growth rate of 586 million cubic feet
- 195 million cubic feet harvested annually
- Annual growth is 3X greater than current annual harvest

Low Grade & Forest Residues

- Bioenergy market for low-grade wood will
  - support the sustainable management of NY's forests
  - improve the economic viability of privately owned forest land
  - enhance NY's forest product industry

Woody Biomass Crops



Decline in agricultural land in NY over the the past 40 years.

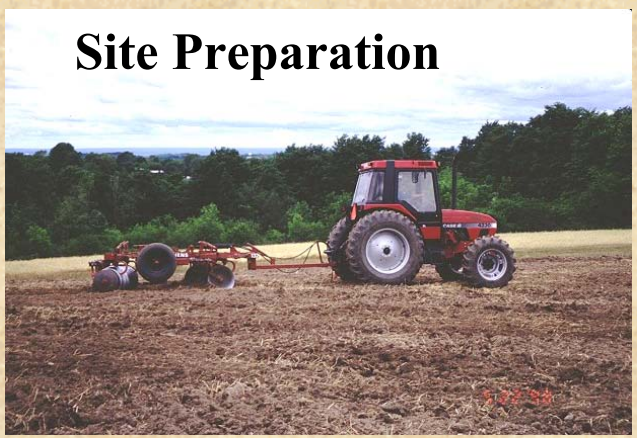
- Land dedicated to agriculture has declined steadily over the past 40 years
- Currently about 5.4 million acres (14% of land area) of agricultural land in NY
- About 1.7 million acres are underutilized

Woody Crop Research History

SUNY-ESF research station in Tully, NY. Site of original willow biomass trials in the US.

- Research on woody biomass crops began at SUNY-ESF in early 1980s
- Studies have ranged from hybrid poplar grown on 10 -12 year rotations to wood grass trials with one year rotations
- Research and development focus shifts to willow biomass crops in the mid 1980s
- Have established 500 acres of willow demonstration areas in NY in the past five years

Willow Biomass Growth Cycle



Planting

First year growth

Coppice

Early spring after coppicing

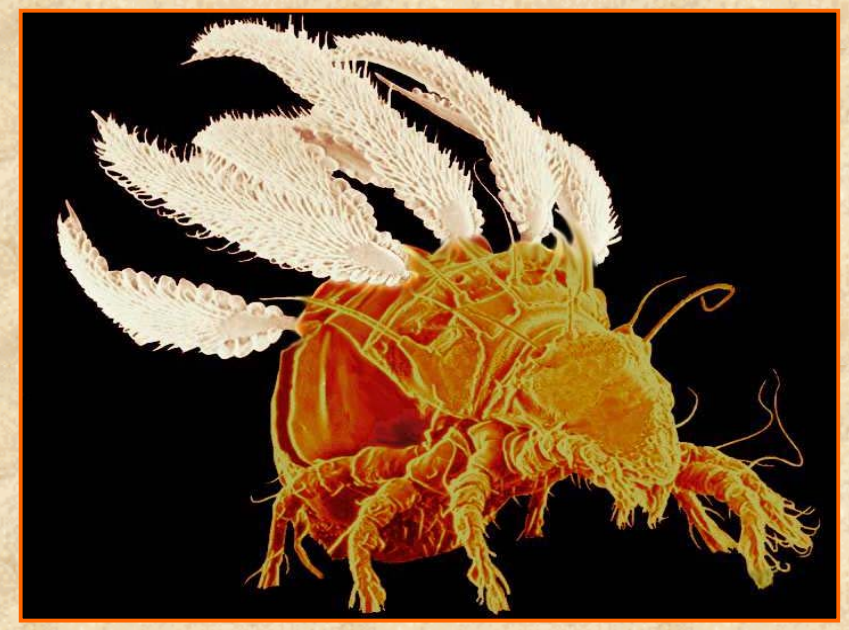
Harvest

Three years old after coppice

One year old after coppice

Biodiversity

Wood Thrush nesting in willow



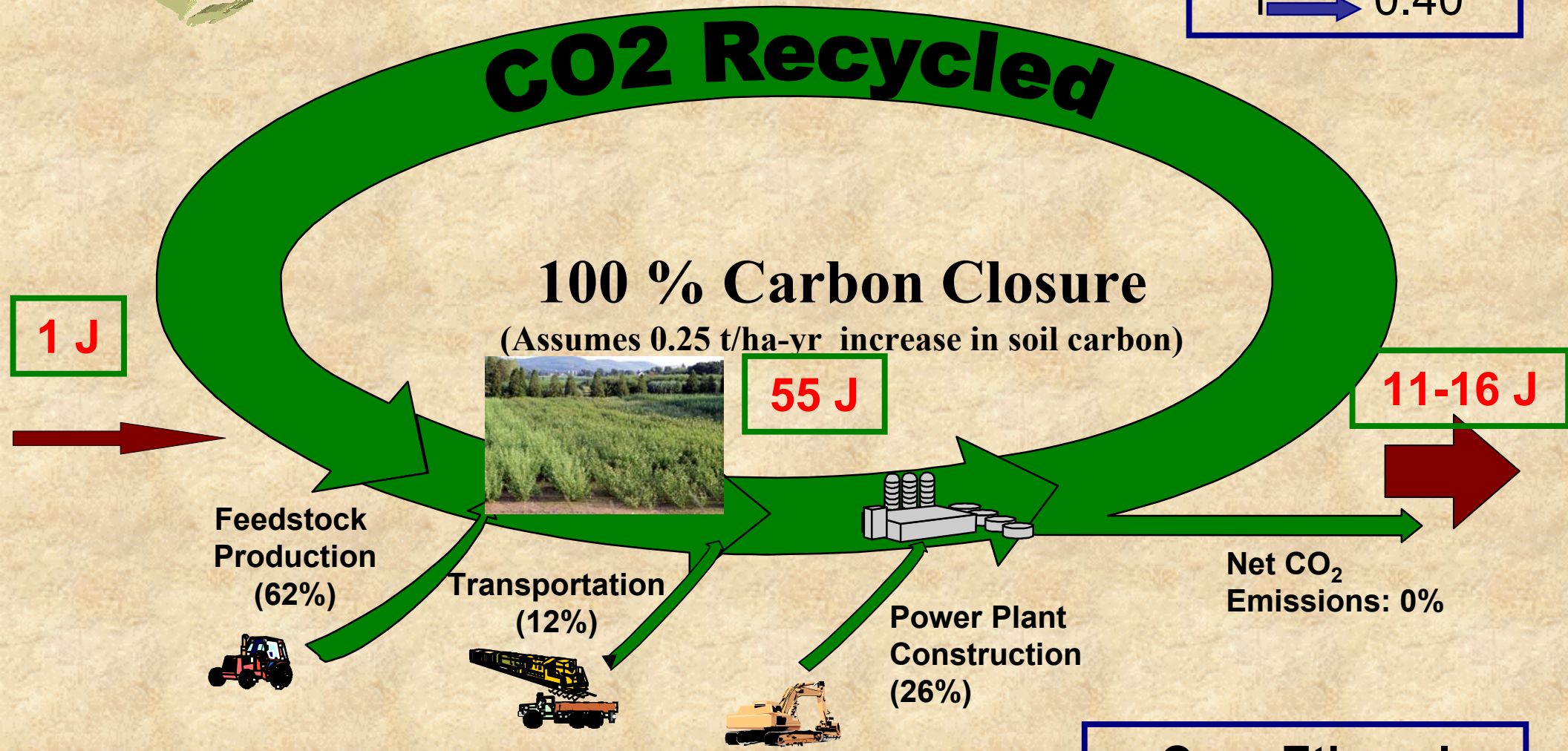
Soil microarthropod - Gozmanyina

- 57 species regularly used SRWC
- 28 species breed in SRWC plots
- Species diversity is similar to natural shrub lands and eastern deciduous forests

- Soil microarthropod diversity and density is similar to undisturbed early successional fields four years after planting SRWC

Global Carbon Cycles

Natural Gas
1 → 0.40

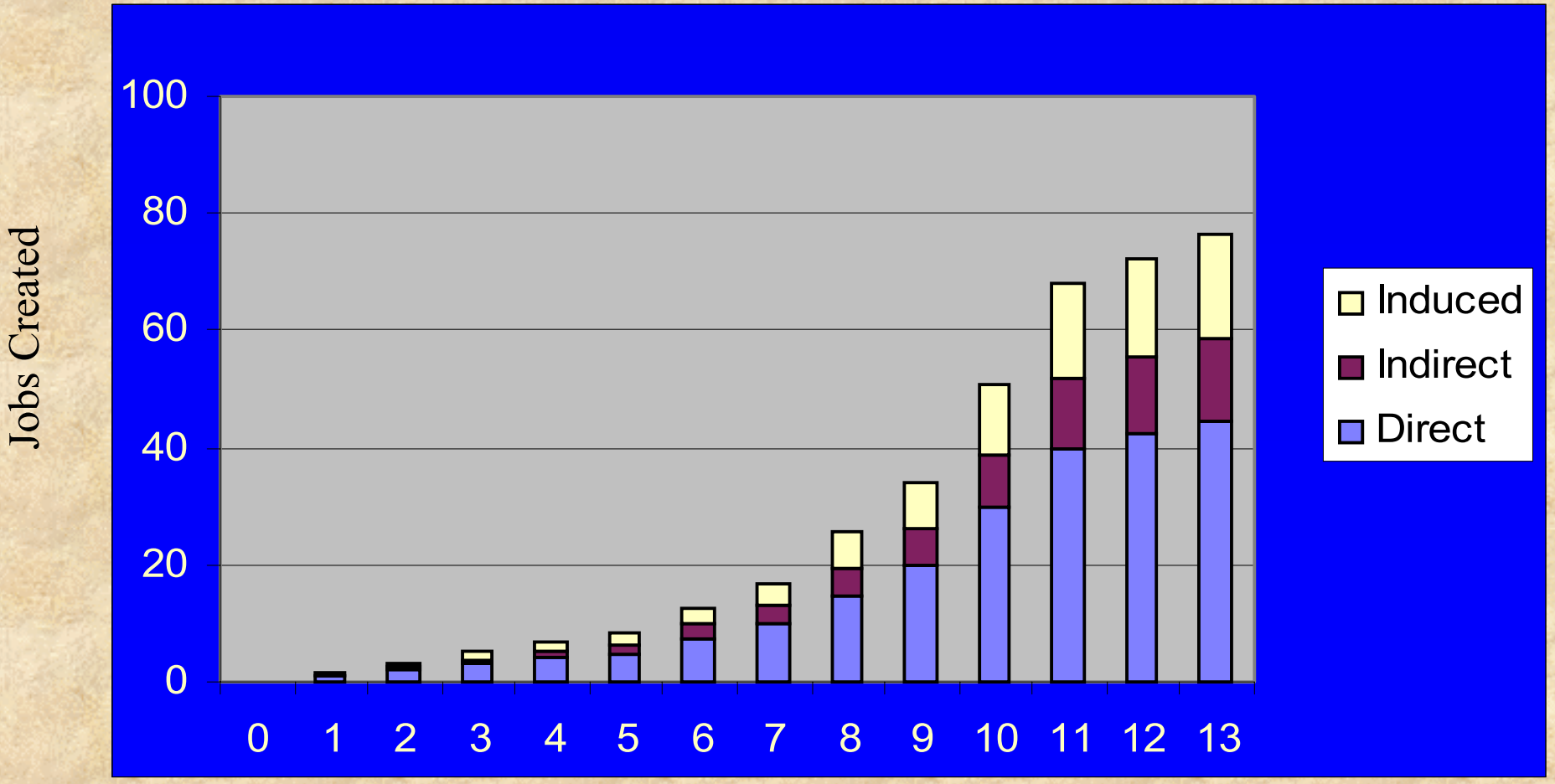


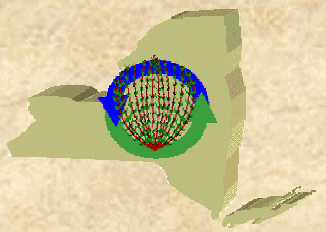
Corn Ethanol
1 → 1.34

(Mann and Spath 1997, Heller et al. 2003)

Rural Development Benefits

(Jobs created per 10,000 acres planted)





Feedstock Costs

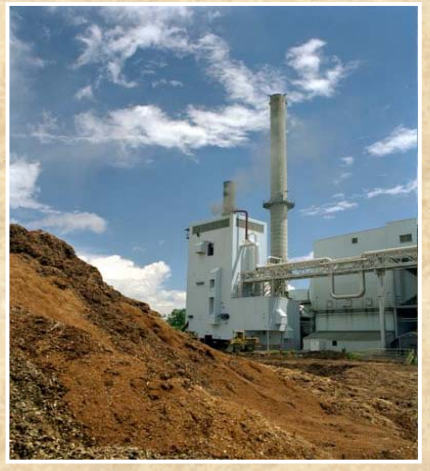
- Valuation of multiple benefits associated with willow biomass required for commercialization
  - Conservation Reserve Program (CRP)
  - Green Price Premium (GPP)
    - ✓ 0.60 – 0.90 ¢ kWh^{-1} required to be competitive
  - Biomass tax credit
    - ✓1.7 – 2.3 ¢ kWh^{-1} required to be competitive
- Future cost reductions will occur as expansion takes place and R&D results (i.e. breeding for increased yield) are deployed

Conversion Technologies

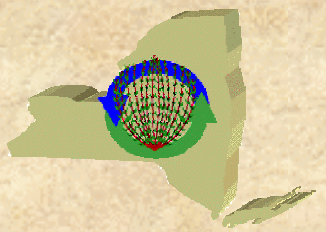
Cofiring

BioRefining

Direct-fired



Gasification



Summary

- NY is endowed with abundant woody biomass resources
  - can be grown and harvested sustainably
  - has the potential to make a significant contribution to energy supplies
  - use of biomass provides a wide range of environmental and rural development benefits