



6th Goddard Forum

"Wood to Energy" The Governor's Task Force for Low-Use Hardwoods

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Why look to our Forests for Energy?

- From 1980 to 2000, Wood averaged 3.4% of US total energy
- Wood (forest biomass) can provide 10% of US energy needs!!!

US Department of Energy, 2005

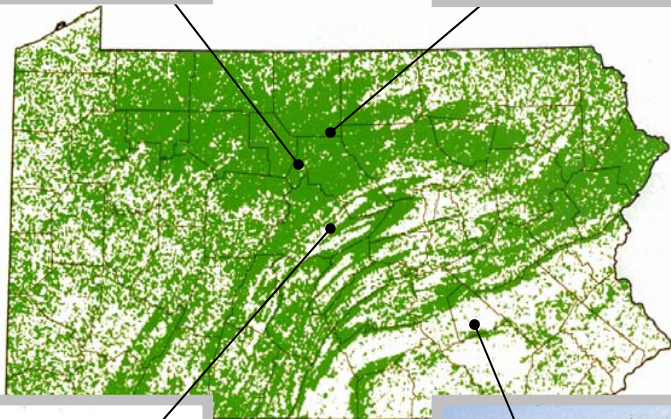
"Trees are the Answer"

- Solar energy to potential energy through photosynthesis
- Forests=ultimate system for carbon sequestration
- No added energy needed vs. AG
- Low emissions from combustion
- Carbon (CO₂)neutral OR BETTER!

Penn's Woods

Forested Area

- 1630 95% 27 +/- million acres
- 1907 30% 8.6 +/- million acres
- 1955 52% 15 +/- million acres
- 1978 59% 16.8 million acres
- 1989 58% 16.7 million acres
- 2005 58% 16.6 million acres



Wood to Burn, Not from Our Forests!

- Parcelization/Fragmentation
- Logger/system availability
- Location/Inconvenience
- Viable Forest Products Industry
- Local ordinances
- Old fashioned
- Environmental Impact

Forestry in Pennsylvania

Sustainable Forest Management

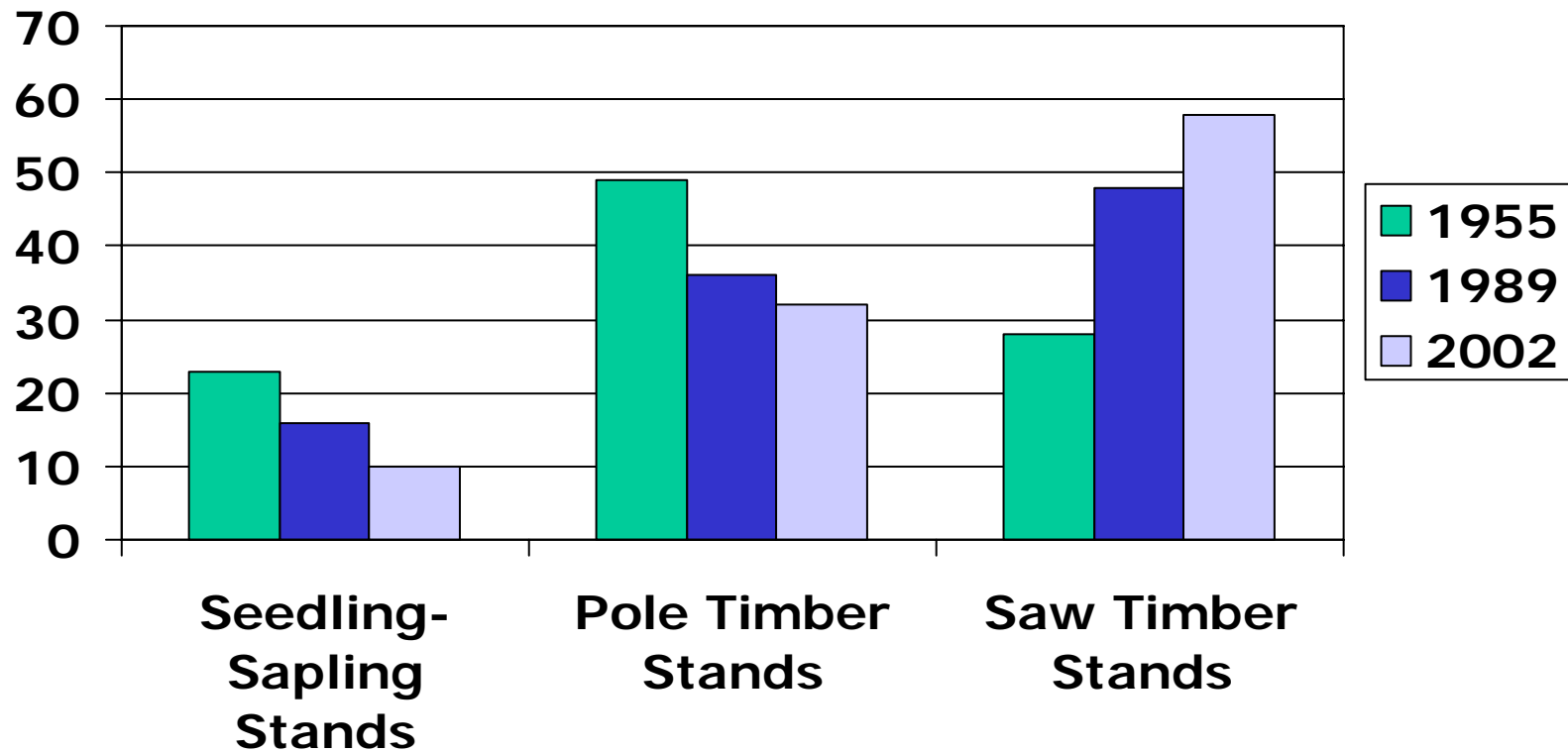
- PA State Forests FSC/SFI Certified
- SFI logger training programs w/BMP's
- SAF Certified Forester Program and Standards of Forestry Established
- 28% of PA Forestland Public
- Long history of good forest management: Pinchot thru Goddard

Forest Inventory Analysis: Forest Woody Biomass

US Forest Service FIA of PA

- Completed in 2005
- Updated annually; 1" and above DBH
- 5000 plots (60% in forestlands)
- Provides basis for computing low-use wood volume
- Stand Classifications: Sawtimber; Poletimber; S&S (Seedlings & Saplings)

Maturing Pennsylvania Forests



Defining Low Use & Availability

- Sawtimber (58%) 9" DBH softwood,
11" DBH hardwood
- Poletimber (32%) 5" DBH
- S&S (10%): Not Included
- Low grade & rough & rotten
- All species
- 30 Tons per acre minimum
- Less than 40% slope

Low-Use Wood Statewide

“Preliminary -Not for publication”

- 719.5 Million tons-59% of total volume of forest woody biomass
- 72% is Privately Owned, 515.4 Million Tons
- 28% is Public, 204.1 Million Tons

Practical Availability of Low-Use Wood State-wide

“Preliminary-Not for publication”

- 71% of Low-Use Wood Forest Biomass is in Stands with less than 40% slope and a minimum of 30/tons acre (green) of Low-Use Wood.
- 509.4 Million Tons (67 Tons/acre)

Available Forest/Woody Biomass Statewide: Working Number

“Preliminary-Not for publication”

Constrain 509.4 million tons with two factors:

- Reduce 50% for high-conservation, recreation, wilderness, wild areas, non-harvesting landowners & current use (pulp & paper, heat)
- 254.7 Million Tons
- Add 10% for limbs and tops,.
- 280.2 Million Tons

Forest Woody Biomass

Assuming 3% harvesting of total low-use woody forest biomass annually, yield is 8.4 million tons (green weight) forest biomass per year. This excludes mill waste, landscape/arboreal cuttings, and land/road clearing wood.

Availability-Bottom Line

In Pennsylvania, there is sufficient, reasonably available forest-woody biomass to vigorously pursue energy production from this largely unused natural renewable & sustainable resource: Low-Use Woody Forest Biomass.

5-10 million tons annually available

Wood to Energy Processes

- Combustion
- Pyrolysis
- Gasification
- Fermentation
- Pelletization

Wood BTU Values

Wood: BTU's/lb

- Oven Dry (OD) 7100 BTU's
- 25% MC 5400 BTU's
- 50% MC 4300 BTU's
- Coal 11,000 BTU's
- Crude Oil 19,500 BTU's

US Forest Products Laboratory

Wood Make-Up

Cellulose	40%-50%
Hemi-Cellulose	20%-35%
Lignin	15%-35%
Extractives	2%-5%
(gums, oils, resins, etc.)	
Ash	1/2%-5%
(% based on OD Weight)	

Pyrolysis/Liquefaction

(Destructive/Thermal Distillation)

Reduction of wood into liquids (tar, bio-oil, and pyrolytic (pyroligneous) acid, char, and combustible & convertible gases.

- Heat
- No/Low Oxygen presence

Gasification

- Partial thermal combustion process: combustible &/or convertible gases, ash
- Direct (on site) linkage to gas burner or IC engine; combustion for heat
- Higher efficiency than direct combustion

Bio-Chemical Production

Production of Bio-Ethanol & Methanol

- Hydrolysis of cellulose and hemicellulose (w/acid) to produce sugar platform (saccharification).
- Fermentation: wood alcohols
- SSF: Simultaneous Saccharification and Fermentation (US DOE, EERE)
- Distillation

Wood Pelletization

- Growing consumer & industrial product-primarily heat
- Requires AD or Kiln-Dried furnish: secondary wood processors
- Not likely candidate for electricity generation in PA

*Electrical Generation, Co-Gen,
Direct Power*

Combustion
Gasification

Heating

Seasonal heat, industrial heat and
steam

Combustion

Gasification

Wood Pellets

Transportation Fuels

BIO-ETHANOL

- Fuel additive: diesel/gasoline
- Independent bio-fuels

Low-Use Woody Forest Biomass For Energy in Pennsylvania

- Plenty of it!
- Proven thermal technologies now available.
- Improving bio-chemical technology in advanced development.
- Wood for energy is (again) practical!!

Websites

US Department of Energy, Energy
Efficiency and Renewable Energy

www.eere.energy.gov

Biomass Program

Biomass Energy Research Center

www.biomasscenter.org