WERC
Wood Education and Resource Center

Wood Energy and New Products

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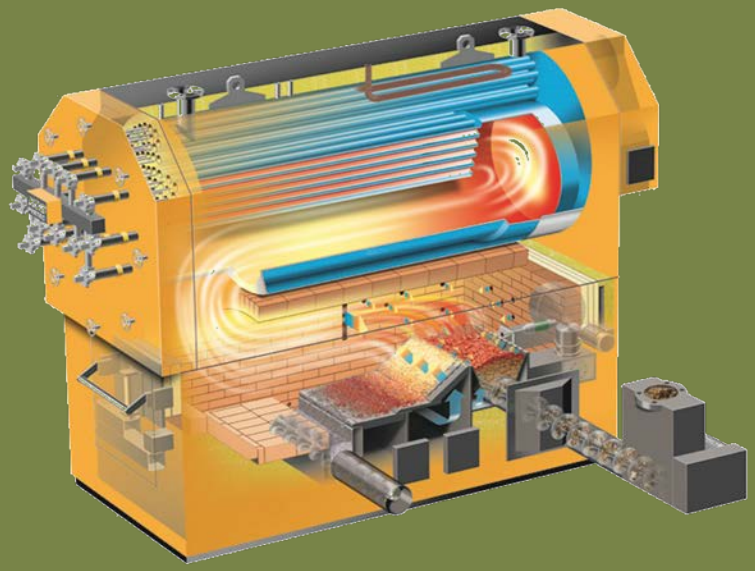
USDA

Today's discussion

- Wood energy overview
- Modern wood system design
- USFS Wood Energy Team
- Project examples
- Program outcomes
- New Wood Products



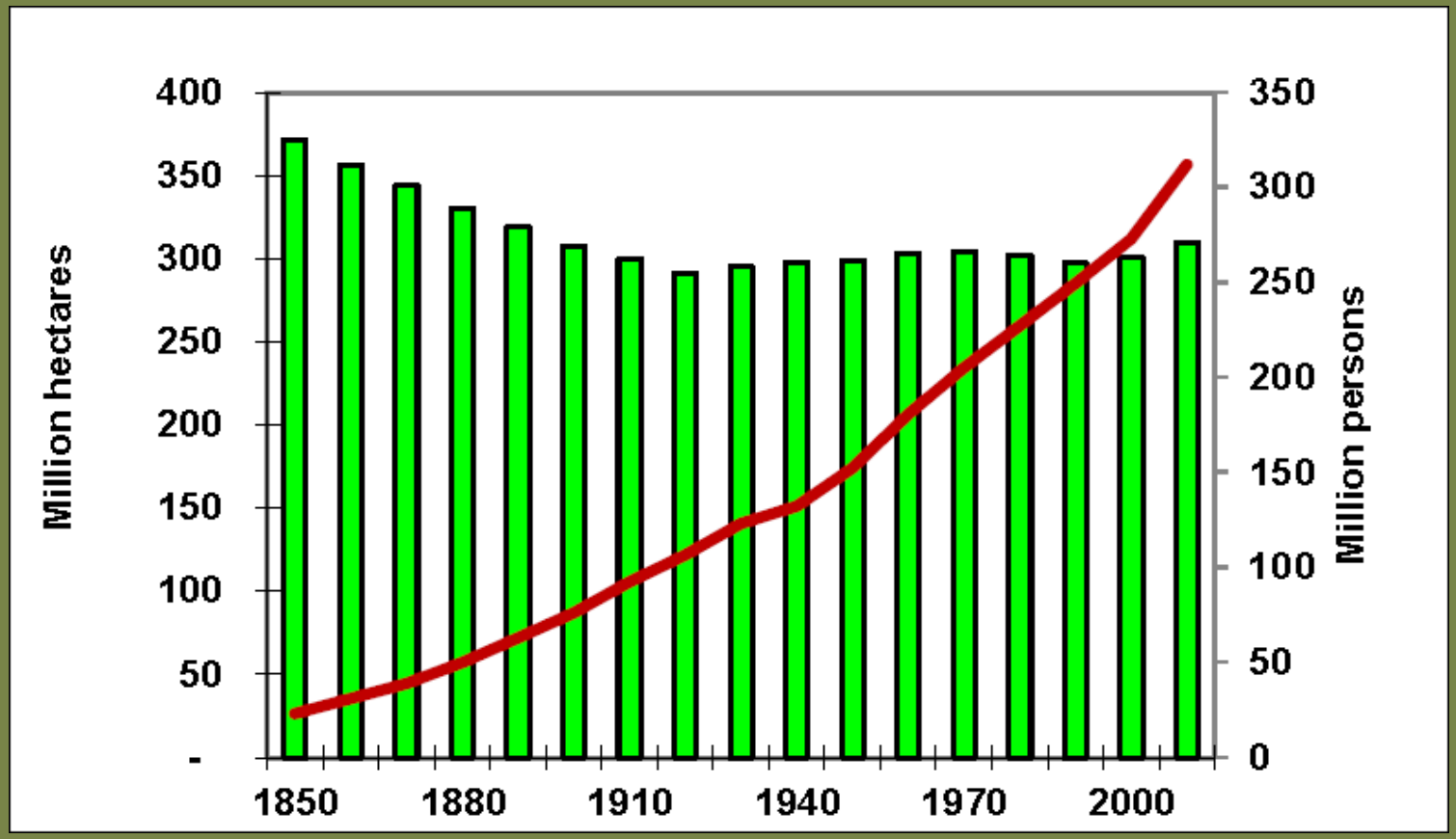
Modern, Clean Biomass Systems
- Staged combustion
- Controlled air and temperature
- High conversion efficiency

The Context for Wood Energy

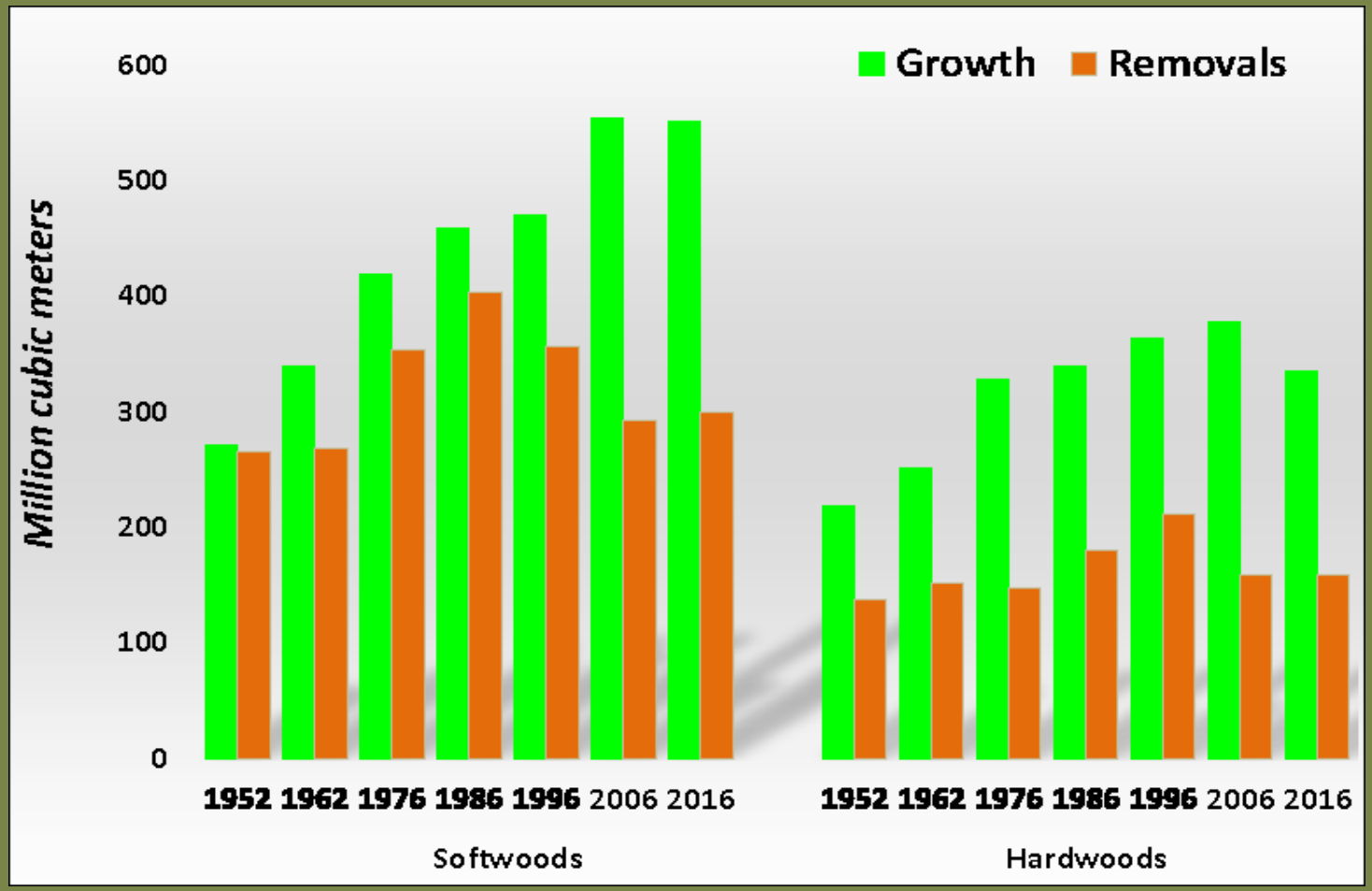
- **Wood energy is part of an integrated wood products industry**
  - Top 10 component of manufacturing sector in 47 states
  - 4% of the total U.S. manufacturing GDP
- **Dependent upon higher value products in most places**
- **Provides a market for low value materials**
  - Wood processing residues
  - Wildfire hazard reduction
  - Response to forest health issues
  - Restoration after storms, fire, insect/disease outbreaks
- **A renewable fuel source**

US Forest Area Stable over 100 yrs.

Population has tripled since 1900



Growth of US forests dramatically exceeds removals



Working Forests

- Provide continuous environmental, social, and economic benefits
- Provide goods & services, jobs, economic support to rural communities & revenue to forest owners
- Provide low carbon renewable energy and building products that combat climate change
- Are renewable / sustainable

Wood energy for thermal / CHP applications?

- **Environmental and Social**
  - Provide renewable energy
  - Replace fossil fuel (foreign)
  - Markets for wood residues (harvesting and processing residuals)
  - Scale allows for sustainable, local use
  - Most efficient use of limited biomass resource (thermal and thermally-led CHP applications (60 – 90% thermal efficiency))
  - Carbon benefits (sale on voluntary market)
- **Economic**
  - Energy dollars stay local=SUSTAINED LOCAL JOBS
  - Energy savings to owner

Wood as a Fuel

- Low energy density
- Contains water
- Type of locally available wood can vary considerably
- Efficiently converted to thermal energy
- Renewable …managed properly
- Carbon neutral .. almost
- Life cycle costs often lower than other fuels
- Emissions must be addressed

Mill Chips

Pellets

Whole-Tree Chips

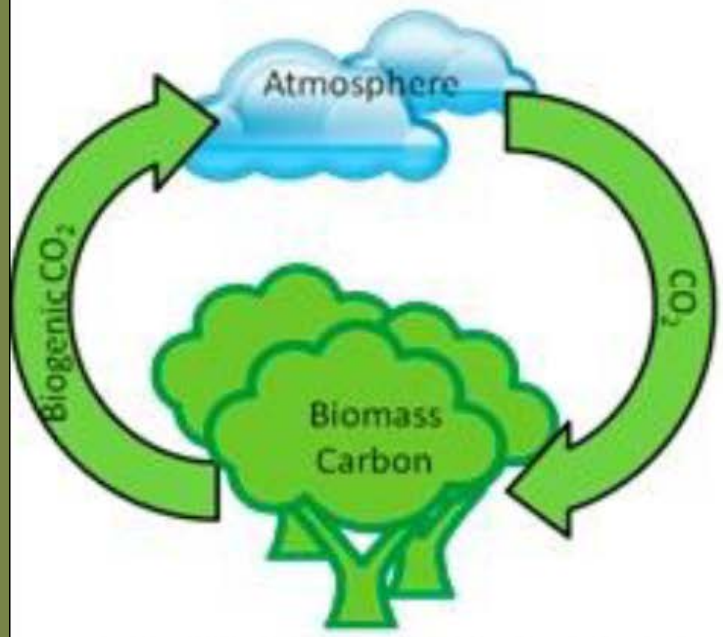
Cordwood

Wood is part of the biogenic carbon cycle

The "neutral" biomass carbon cycle

vs

Carbon transfers from geological reserves



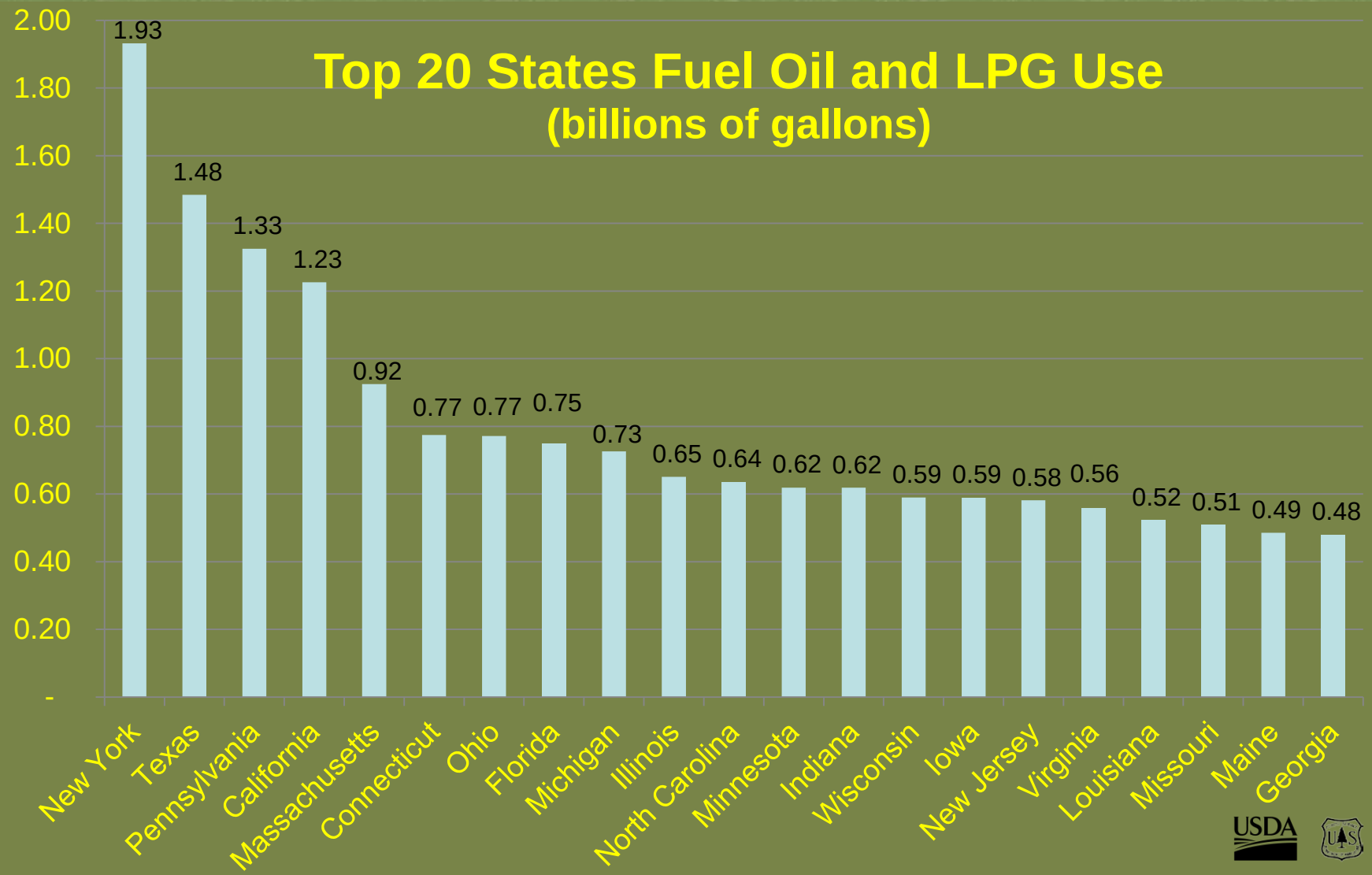
Biogenic carbon is part of a relatively rapid natural cycle that impacts atmospheric CO_2 only if the cycle is out of balance

Fossil fuel combustion transfers geologic carbon into the atmosphere. It is a one-way process

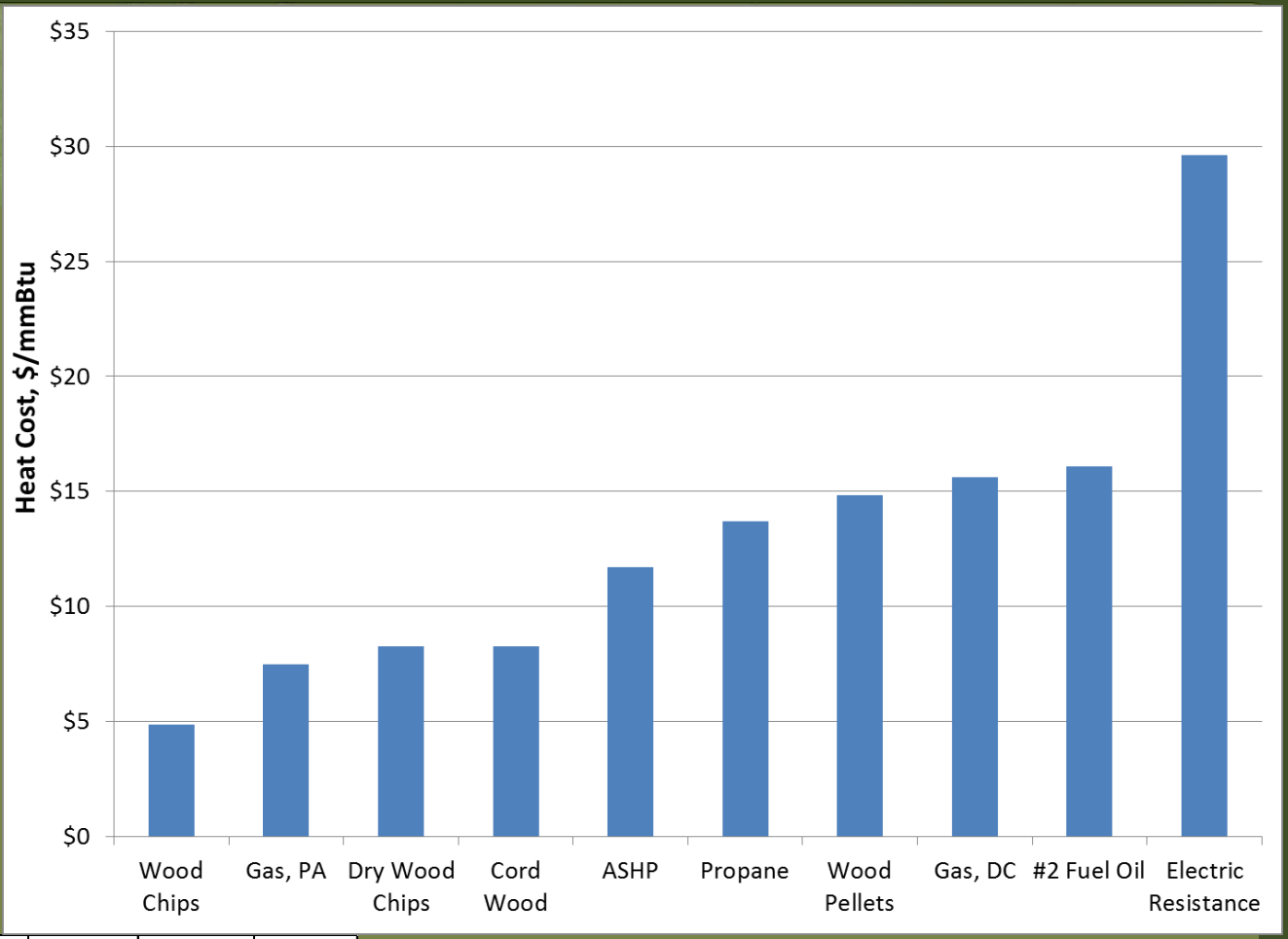
Why Wood for Heating ?

- Thermal energy is about 1/3 of America's energy use
- Sustainably sourced wood is well suited to providing renewable energy for this sector with high efficiencies

Many opportunities in commercial and industrial settings



Woody Biomass Provides Thermal Energy Cost Savings



Fuel, units	Fuel HHV, mmBtu/unit	Seasonal Conversion Efficiency	Fuel Delivered Cost, $/unit	Heat Cost, $/mmBtu
Green Wood Chips (~40% MCwb), tons	10.3	0.70	$35.00	$4.85
Natural Gas (Pennsylvania - large user), mmBtu	1.0	0.80	$6.00	$7.50
Dry Wood Chips (~25% MCwb), tons	12.9	0.75	$80.00	$8.27
Seasoned Cord Wood (~20% MCwb), tons	13.8	0.70	$80.00	$8.28
Electric (air source heat pump), kWh	0.003412	2.50	$0.10	$11.72
Propane, gallons	0.091333	0.80	$1.00	$13.69
Wood Pellets (~7% MCwb), tons	16.0	0.80	$190.00	$14.84
Natural Gas (Washington, DC - large user), mmBtu	1.0	0.80	$12.50	$15.63
#2 Fuel Oil, gallons	0.14	0.80	$1.80	$16.07
Electric (resistance), kWh	0.003412	0.99	$0.10	$29.60

Actual costs and efficiencies vary by location and equipment. These are current values from large users around the Northeast, Midwest, and Southeast.

Key Design Decisions for Modern Wood Energy Systems

- Type of system – chip, pellet, cordwood
  - Fuel availability and price
  - Level of automation
  - Savings opportunity
- Practical loads to connect
- CHP?
- **Sizing the boiler(s) / systems**
- Thermal storage
- Fuel flexibility
- Emission Controls
- MAXIMIZE CASH FLOW

WERC's Woody Biomass Technical Assistance Team

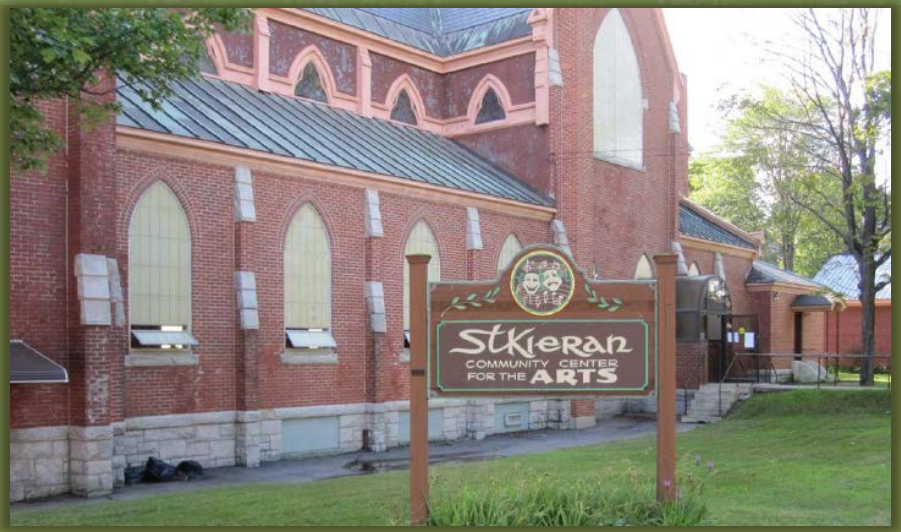
- Provides targeted technical assistance to FS staff, facility owners and managers nationally
- Focus on system efficiency and fuel flexibility
- Modern systems including thermal storage, system monitoring and emissions controls
- Feasibility Studies, Contract Review, Facility Owner Support, Fuel Contract Support
- Technology and Vendor neutral

Harvard Forest Cord Wood District Heating System

- 0.5 mmBtu/hr (3 boilers) cordwood capacity, 2,500 gal thermal storage, propane backup
- $0.8 Million Project Cost (includes $0.3 M shop and boiler room, $0.1 M forestry equipment)
- Connects 5 buildings, 51,600 sf
- Replaced old cord wood boiler, fuel oil boilers, and propane boilers and heaters
- $10,000 annual savings – major avoided costs
- ~50 cords/yr from Campus forestry operations
- Offsetting ~60% of heating demand

St Kieran Art Center Facility Pellet Project

Oil-fired Steam to Pellet-fired Hot Water Conversion

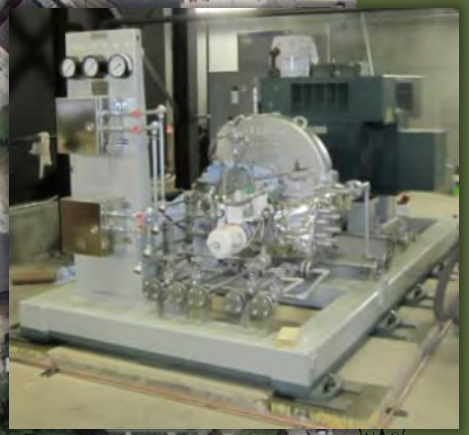


- 8,353 ft^2
- Two 0.2 mmBtu/hr Pellet Boilers
- 300 gal. Thermal Storage
- 12 ton Pellet Storage Room
- $90,000 pellet installation, $65,000 upgrade to HVAC system
- Replace 4,800 gal #2/yr (100%)
- 34 tons Wood Pellets/yr
- $9,930 Annual Savings
- 25.9 mtCO2/yr net carbon offset

Biomass District Heating (Fuel Oil/Steam to Wood Chip/Hot Water conversion) Mt. Saint Alphonsus Seminary

- 165,000 ft^2
- 4.2 mmBtu/hr & 1.8 mm Btu/hr Wood Chip Hot Water Boilers
- Two 2,500 gal Thermal Storage Tanks
- $2.22 Million Project Cost
- Replace 84,500 gal Fuel Oil/year (100%)
- 1,600 tons Wood Chips/year
- $271,300 Annual Energy Savings
- 850 mtCO2/yr net carbon offset

Gunderson Lutheran CHP District Heating



- 1,100,000 sf hospital complex
- 28 mm Btu/hr chip 450 psig steam boiler
- 350 kW steam turbine/gen set
- Replace 157,000 mmBtu ngas/year
- 18,000 tons wood chips per year
- $470,000 annual energy savings ($6.5/mcf)
- 1,600 MWh/yr generated (9%)
- 9,500 mtCO2/yr net carbon offset

Wood Energy Technical Assistance Team Program Outcomes

- 165 project analyses
- 45 conversions
- $5.8 million in annual savings
- $66 million invested
- $2.9 million annually into local economy
  - **LOCAL JOBS**
- 84,000 green tons annually – forest benefits
- Net reduction of 36,000 metric tonnes CO_{2e}

Example Project: 1 million ft²
VA Hospital Campus Chillicothe, OH
Biomass CHP System Heating/Cooling

Emerging Wood Product Opportunities

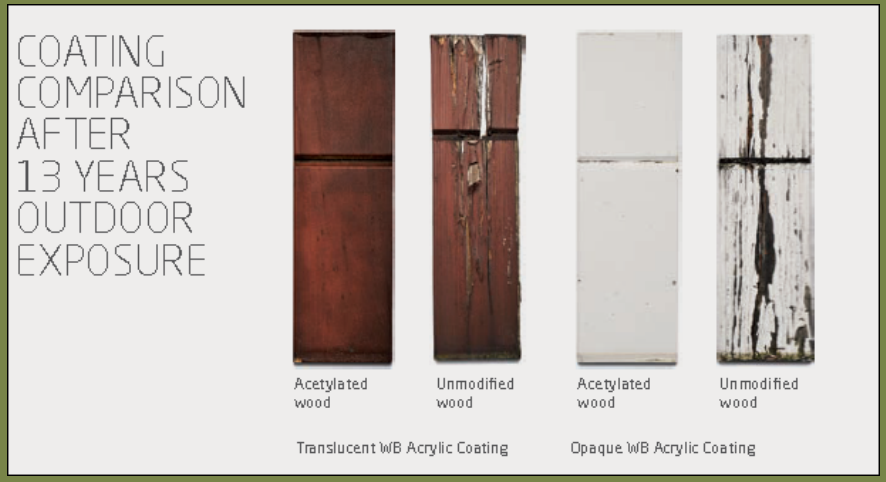
- Biomaterials
- Thermally and chemically modified wood
- Mass timber
- Biochar
- Nanomaterials

Biomaterials

- Wood-plastic composites
- New textiles using cellulose to increase strength
- Cellulose-based insulation - better thermal & acoustical properties
- New adhesives – Ecovative MycoBoard

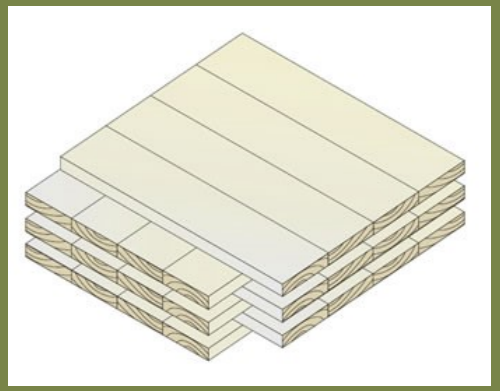
Chemical and Thermal Modification

- **Chemical modification**
  - Acetylation treatment
  - Furfurylation treatment
- **Thermal modification**
  - high heat/low air to improve and increase its dimensional stability.



Mass Timber – CLT, NLT and Glue-Lam

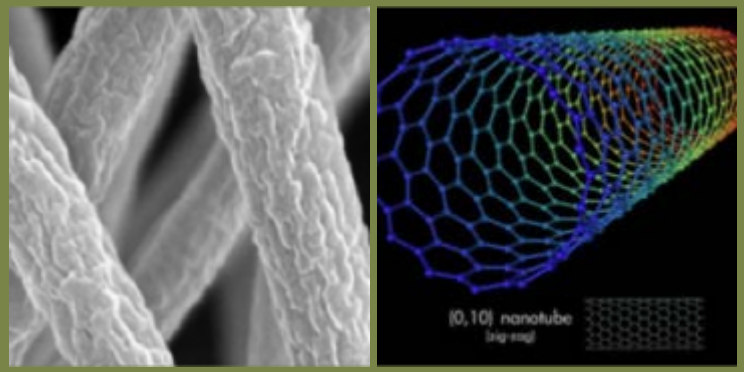
- cost-competitive, carbon efficient, sustainable and reliable
- Can replace concrete, masonry and steel
- fire, seismic, durability, acoustic and vibration tests conducted internationally
- Market demand of lumber for CLT could be 0.8 to 2.5 billion board feet, more than 5% of lumber demand in 2015 in the US.



Nanomaterials and Biochar

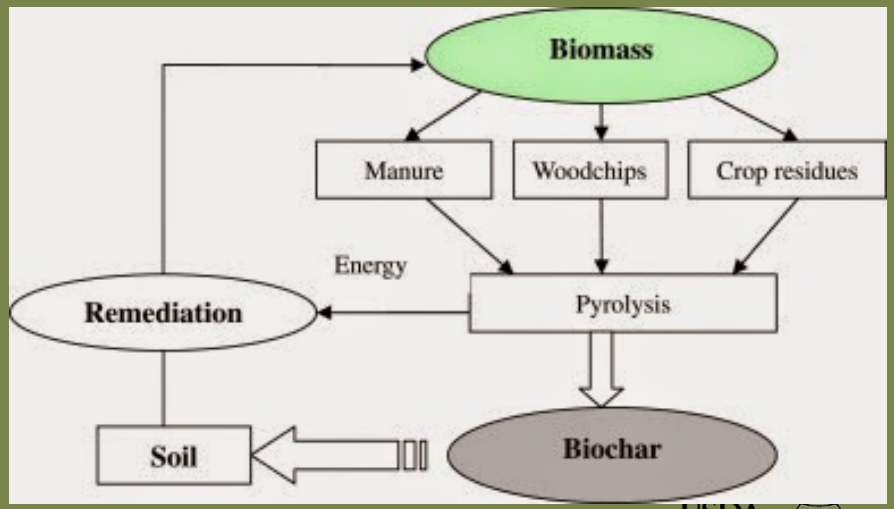
Nanomaterials

- 1-100 nanometers
- (10^{-7} to 10^{-9} meters)
- Nanotubes and nanofibers make waterproof and tear-resistant fabrics



Biochar

- Black carbon produced from biomass sources [i.e., wood chips, plant residues, manure or other ag waste]



Future Carbon Tax?

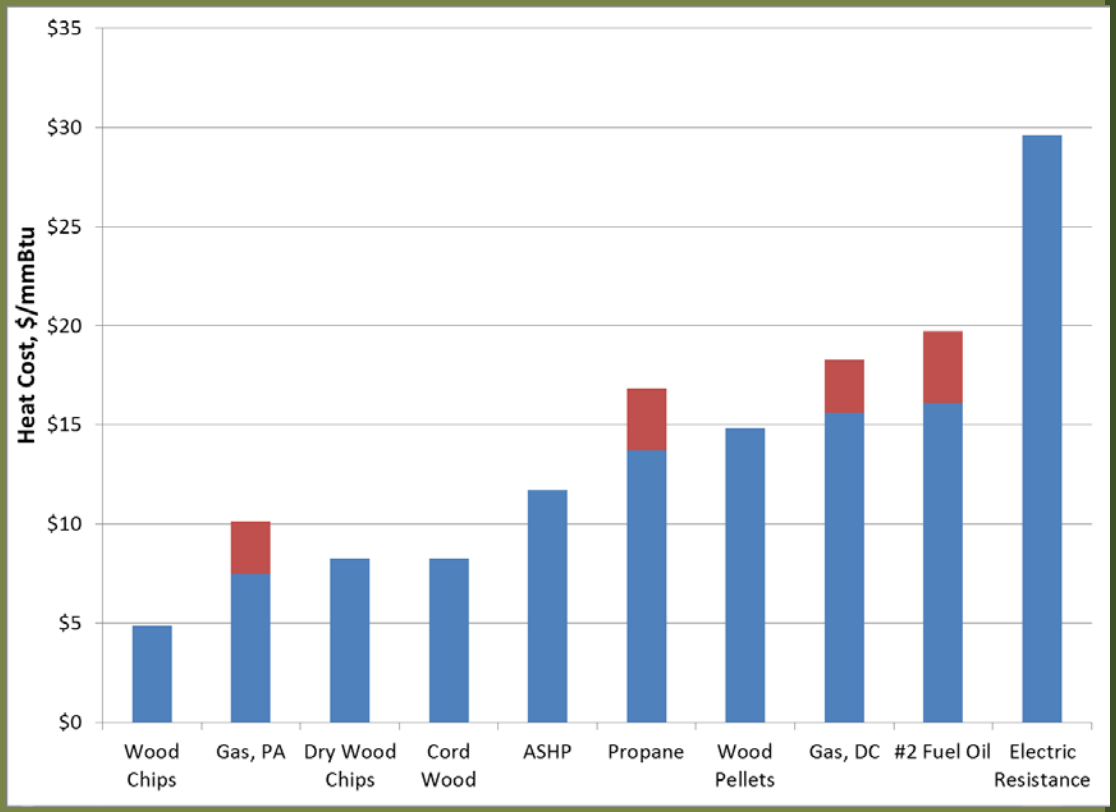
- Former U.S. Secretary of State James Baker wants to replace the Clean Power Plan .
- Suggests a rising carbon tax that starts at $40 per ton

- "The risk is sufficiently strong that we need an insurance policy and this is a damn good insurance policy." – Jim Baker, February 2017

Mr. Baker's $40/ton carbon tax

$40 per ton would add

- **$2.12/mcf to the cost of natural gas**
- **$0.41/gallon to the cost of #2 fuel oil**
- **$0.23/gallon to the cost of propane**



For more information

http://na.fs.fed.us/werc/biomass/technical_assistance.shtm

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