THE OUTLOOK FOR FOREST BIOENERGY

Cellulosic Supply Chains for Bioenergy

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Why is wood biomass an important component of an energy portfolio?

Advantages of woody biomass:

- Is available
- Is renewable & sustainable
- Minimal heavy metals and sulfur
- Can reduce waste streams
- Does not increase atmospheric levels of CO_2
- Locally produced
- Proven technology

Source:woodforgood.com

Existing Examples

- Important to show that wood can be used outside the forest products industry
- In WV, other than residential use, no good examples outside forest products industry

Warren State Hospital, Warren PA

- 200 patients, 400 faculty and staff
- Steam for heat, hot water
- 71 tons wood residue/day
- Saves $400,000 annually over natural gas

Eastern Correctional Institute, MD

- Houses 450 inmates
- Installed 2.5 MW generating plant to assure uninterrupted power
- 50,000 tons green wood chips per year
- Cut fuel costs by 63%

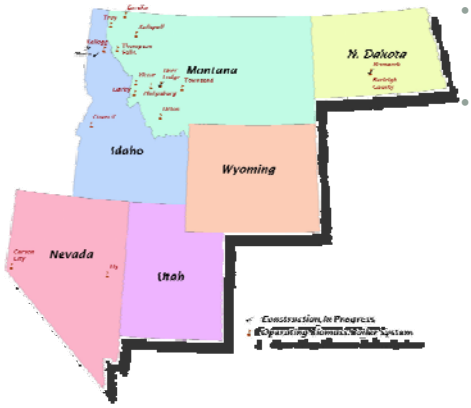
Mt. Wachusett Community College Gardner, MA

- Closed loop, two pipe hydronic heating system
  - ~$4 million invested
- 8MBtu combustion unit
- 03/04 heating season approx. $275,000
- 50kw downdraft gasifier
- Syngas powers a Honda generator

Mountain View School District, PA

- 200,000 square feet
- Uses ~1500 tons wood chips per year
- Savings average ~30k / year

Fuels for Schools Program

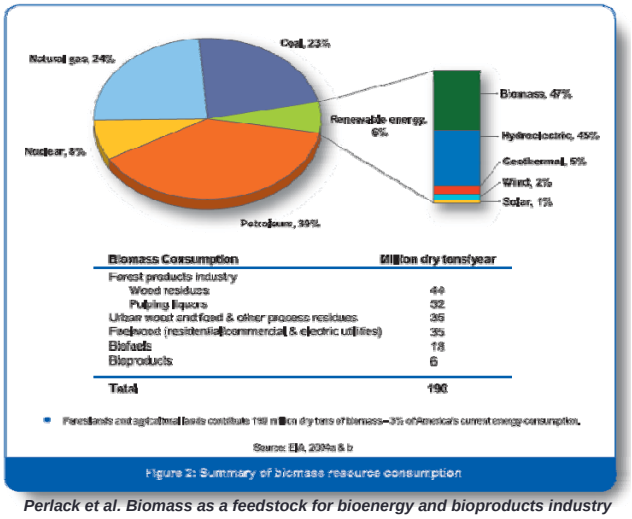


- Active in Western US
- VT - started in 80s
  - Over 30% of public school students attended a wood-heated school
  - Burning ~ 10,000 tons annually – 32 schools

Wood Cost

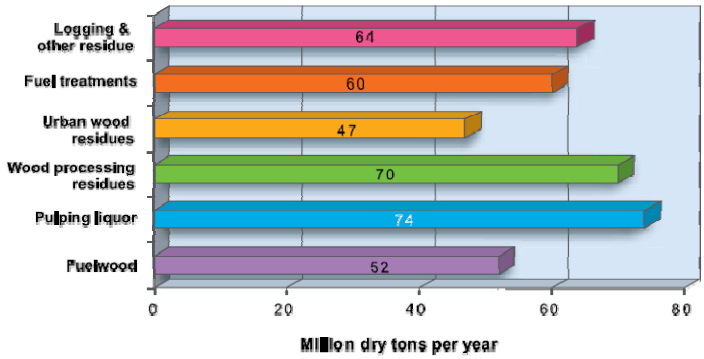
Energy Source	Heating Value	Cost/Unit	Cost/ MMBTU
Green Wood	4900 BTU/lb	$30/ton	$3.06
Coal	12,200 BTU/lb	$71.15/ton	$2.92
Natural Gas	1,028,000 BTU/MCF	$3.85/MCF	$3.75
Fuel Oil	144,000 BTU/Gal	$3.00/Gal	$20.83

Biomass Feedstock Consumption



Perlack et al. Biomass as a feedstock for bioenergy and bioproducts industry

US Forest Derived Biomass Resources



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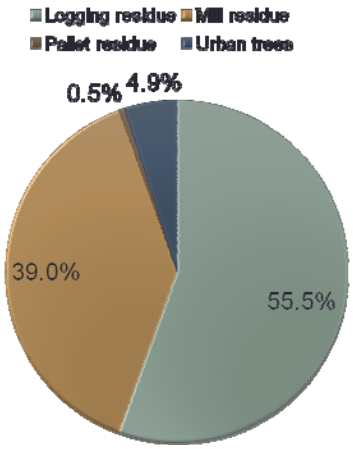
Annual Wood Residue Production WV



Total 2.4 M DT (~5 M GT) of residue/byproducts per year.

- 1.3 M DT of logging residue, 55%.
- 950,000 DT of mill residue (39%).
  - 40,000+ GT weekly
  - 80% from sawmills and 20% from secondary manufacturers
  - 50% chips, 30% sawdust, and 20% bark
- Urban tree & pallet residues

Potential for wood biomass in WV

- ~10,000 tons to produce 1 MW
- 5 M tons of wood residues
- Potential for 500 MW from wood waste
- This would be 10% of WV power consumption from waste wood alone.
- Could substantially increase this capacity through markets for wood produced from forest improvement cuttings and reclamation work

Why is this 10% important?

- WV produces 15,000 MW
- Consumes 5,000 MW
- Portfolio standard requires 500MW from renewable sources by 2015 (10% WV production)
- Under WV portfolio, developers of renewable energy projects get:
  - 1 Credit for project that meets standard (GenPower)
  - 2 Credits for renewable source (wind, biomass and others)
  - 3 Credits for renewable source on mine site

Could be generated with waste wood at this point!

WHAT WILL THE FUTURE BRING?

First Energy Plant – Shadyside OH

- 300 MW Facility
- Switching from coal to woody biomass
- Needed >$300 million in pollution controls
- $200 million for conversion
- Ohio Environmental Council and Consumers Council in opposition – concerned about sustainability of biomass

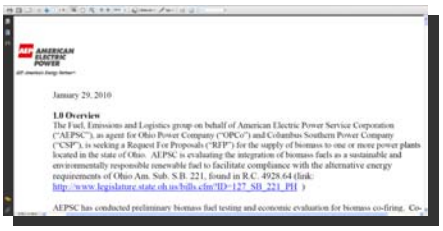
Mingo County Power Plant

- 28 MW – 400,000 Tons/yr
- $150 Million investment
- Surface mine location

Baard Energy - Ohio River Clean Fuels

- Coal/Biomass Gasification plant – Wellsville OH
- Starting at 600,000 green tons/year
- Producing Diesel and Jet Fuel
- Injecting CO_2 for oil field recovery

Also on horizon –cofiring (again)



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1.0 Overview

The Fuel, Emissions and Logistics group on behalf of American Electric Power Service Corporation ("AEPSC"), as agent for Ohio Power Company ("OPCo") and Columbus Southern Power Company ("CSP"), is seeking a Request For Proposals ("RFP") for the supply of biomass to one or more power plants located in the state of Ohio. AEPSC is evaluating the integration of biomass fuels as a sustainable and environmentally responsible renewable fuel to facilitate compliance with the alternative energy requirements of Ohio Am. Sub. S.B. 221, found in R.C. 4928.64 (link: http://www.legislature.state.oh.us/bills.cfm?ID=127_SB_221_PH)

AEPSC has conducted preliminary biomass fuel testing and economic evaluation for biomass co-firing. Co-

- RFP recently in Ohio
- Some interest beginning in WV – especially for blending biomass/wood and shipping via barge out of state

What is cofiring?

Drax Power Plant in the UK - largest cofiring project in world

- Direct co-firing
  - Biomass and coal are burned simultaneously
- Indirect co-firing
  - A biomass gasifier is used to covert biomass to syngas which is then burned with coal

Why co-fire biomass and coal?

- Concerns over potential global environmental impacts of fossil fuels used for power generation
- Is more related to carbon management than renewable portfolios
- Coal-fired power plants have three general opportunities to reduce CO2 emissions:
  - 1. Increase their efficiency
  - 2. CO2 removal and/or sequestration
  - 3. Biomass co-firing

Benefits and Challenges?

Benefits

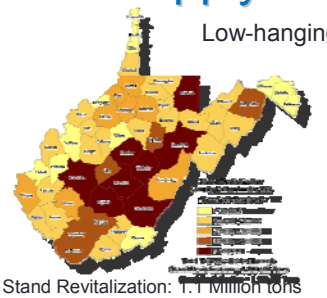
- Extensive knowledge base
- Little or no loss in total efficiency
- Can make up 15% of total energy input with only feed system and burner modifications
- 15% co-firing produces 18.2% decline in GWP emissions (Mann and Spath 2001)
- Create markets for under-utilized forest resources. Also densified fuel opportunities

Challenges

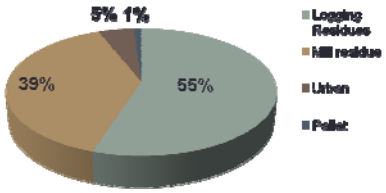
- Biomass fuel preparation, storage and delivery – infrastructure costs can be high
- Permitting process can be difficult
- Biomass fuel cost and availability
- Fly-ash utilization
- May increase corrosion and slag formation in boilers
- May impact SCR systems

Main challenge – biomass supply side

- 14,000 MW from coal/year
- 15% co-fire → 2,100 MW
- 10,000 tons/MW – need 21 MM tons/year
- About 16% available
- Will compete with other sectors
- Today procurement for biomass energy is "cost" restricted

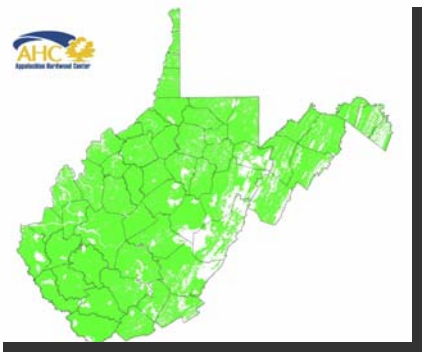


Stand Revitalization: 1.1 Million tons



Increased Utilization: 2.4 Million tons/year

Biomass, Cofiring and Linkage to Terrestrial CO_2 Offsets (another driver)



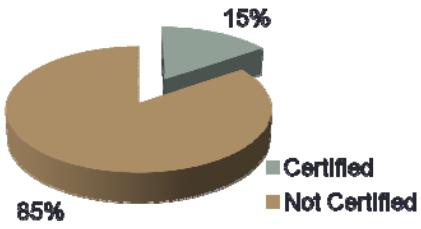
- WV has 12 million acres of forestland
- About 10.5 million acres are private
- This forest sequesters CO_2
- Argument – we should be ready -"IF"

How much are we sequestering?

- ~ 85 million tons of CO_2 released from power plants in WV per year (US Energy Information Administration)
- During growth forests sequester about 4 Tons C/ha/year (range 3.5-10 tons/ha)
- Converting to CO_2 → 1 Ton C ≈ 3.7 units CO_2
- Total intake ~ 20 million Tons CO_2
- Represents ~23% of total electrical emissions
- Ready to "rock and roll", right?

Wrong…

- Typically can't count existing growth under climate programs
- Need to increase the annual carbon storage rate and increase terrestrial carbon accumulation over lifetime of "project"
- Projects include:
  - Forest Management
  - Afforestation
  - Reforestation

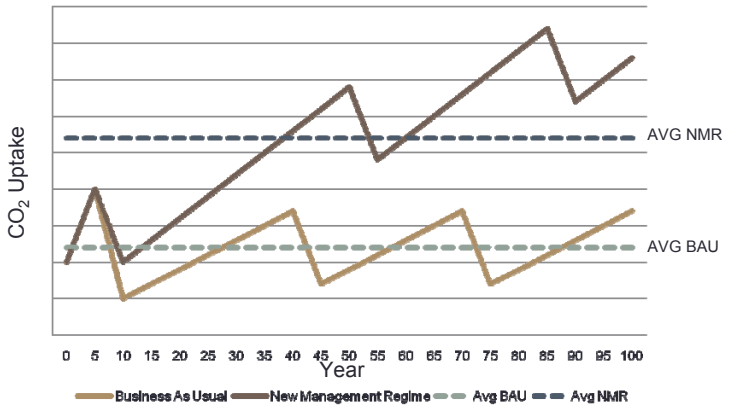


WV landowners with >1000 acres, 4.8 million acres total

What can we do to gain credit?

- Enter active offset project - *First option* – afforestation – establishing forest cover on mineland sites
- Potential to offset 1.5% of annual CO_2 emissions from energy production in WV
- Approximately $660 million needed to offset same amount in recent geologic sequestration project
- Cost of afforestation project on all capable lands (34,000 acres) would be ~$34 million
- 95% reduction in overall project cost for same amount of CO_2 offset

Another Option – Forest Management



Additionality ≠ AVG BAU – 0

Additionality = AVG NMR – AVG BAU

Must understand temporary vs. permanent storage . Define the system boundary

Opportunities

- Encourage WPC to actively seek out potential users of wood fiber for energy – no reason that they should not be entrepreneurial
- Work to facilitate scaled co-firing as a important component of energy strategy.
  - Understand how complete lifecycle of biomass use can impact bottom line – not purely a production cost dynamic
  - Develop projects that have synergies with existing wood products industry
- Develop a better understanding of CO2 sequestration potential of forestland.
  - Become a leader in active systems management
  - Promote continued wood products development
  - Allow us to become a leader in terrestrial sequestration