

Utilization of Biomass in Institutional & Residential Applications



"Working local biomass energy into our lives responsibly"



Energy Production in the U.S.



Source: 2005 US Energy Production, USDOE

Renewable energy = 8.6%

Biomass = 1.3%

Why Biomass for Energy???

Current Fossil Fuels

- Fossil fuels are used for meeting over 80% of the USA's energy demand
- Large quantities of oil and gas are imported into the USA
- Non-renewable
- High input for extracting/recovering fuels
- Large amounts of emissions (CO, CO2, SOx, NOx, etc.)
- Cost

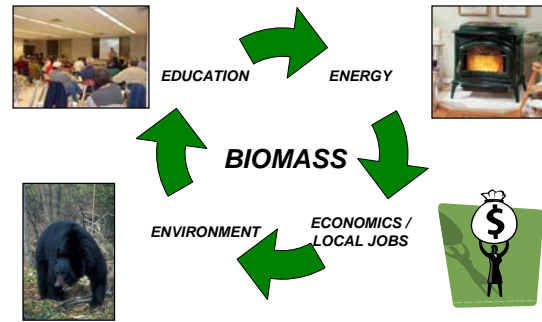
Biomass as a Fuel

- Renewable
- Locally available
 - Local production = local infrastructure = local revenue
- Fewer emissions than fossil fuels
- Additional environmental benefits
- Averages 1/3 the cost of fuel oil

Oil Price History

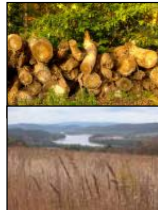


Why Biomass for Energy???



Biomass Feedstock Sources

- Forest**
 - Firewood
 - Low grade wood and logging residues from timber sales
 - Timber stand improvements
 - Rehabilitation of understocked sites
 - Short rotation woody crops: poplar, willow, etc.
 - Restoring abandoned mine lands
- Grasses**
 - Native warm-season grasses
 - Cool season grasses
- Crops**
 - Corn, grains, soybeans
- Waste**
 - Urban and suburban wood/lawn residues
 - Industrial: packaging, pallets, dunnage
 - Food/animal byproducts




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Why Biomass for Energy???

	Gross btu	Unit	Efficiency	Net btu	COST per unit	\$ per million BTU
Green wood- wood chips (40% MC)	10,200,000	Btu/ton	0.71	7,237,000	\$ 38.00	\$ 4.78
Coal	30,600,000	Btu/ton	0.85	26,010,000	\$ 180.00	\$ 6.92
Seasoned firewood	20,000,000	Btu/ton	0.77	15,400,000	\$ 150.00	\$ 9.74
Switchgrass (pellets)	15,000,000	Btu/ton	0.80	12,000,000	\$ 180.00	\$ 14.82
Shelled corn @15% MC (50lb/bush)	14,000,000	Btu/ton	0.80	11,200,000	\$ 178.00	\$ 15.80
Natural Gas	1,025,000	Btu/mcf	0.80	820,000	\$ 13.70	\$ 16.71
Electricity	3,412	btu/kwh	0.98	3,344	\$ 0.118	\$ 35.29
Fuel oil #2	138,800	Btu/gal	0.83	115,204	\$ 4.30	\$ 37.33
Propane	91,300	Btu/gal	0.79	72,127	\$ 3.11	\$ 43.12

Based on work done originally by USDA-FS. Expanded with values and prices from variety of sources (such as <http://www.heart.com/coalventrindex.php?fuelis>)
http://www.eia.doe.gov/cneaf/solar_renewables/page/trends/table10.html




Pennsylvania's Fuels for Schools & Beyond (Institutional)

FUELS FOR SCHOOLS
PENNSYLVANIA
AND BEYOND

Mission Statement
Working local biomass energy into our lives responsibly.

www.pafuelsforschools.psu.edu




Pennsylvania's Fuels for Schools & Beyond

The Pennsylvania Fuels for Schools & Beyond Working Group Supports and fosters a statewide biomass energy use initiative promoting local renewable natural resources to provide reliable energy for Pennsylvania schools and businesses.

Working Group Subcommittees

- **Education/Outreach**
 - Development of program media including brochures, factsheets, and booklets on: resource, sustainability, economics, case studies, etc.
- **Technical**
 - Provide technical guidance to end-users on pre-feasibility assessments, feedstock options, and availability
- **Financial**
 - Identification of financing options- grants, loans, and dedicated funding



Pennsylvania's Fuels for Schools & Beyond


Resource Demands

Average Estimates: green tons per year (chips)

- 1) *Small scale: Pennsylvania Fuels for Schools & Beyond*
 - 1,000-2,000 tons/year per installation
- 2) *Mid-sized: combined heat and power (CHP)*
 - 2-8 MW range- 8 MW is 120,000 tons/year
- 3) *Very large: cellulosic ethanol*
 - 500,000 to 750,000 tons/year (equivalent to large pulp mill)

Moisture Content- it is a big deal

0%= 4.6 tons/hour
20%= 6 tons/hour
50%= 10.4 tons/hour



Pennsylvania's Fuels for Schools & Beyond



Concerns

Resources (Forest, grasses, etc)

- Productivity
- Regeneration
- Community composition
 - Control of invasive or native competing vegetation
 - Distribution across the landscape
 - Consideration of cultural and ecological sensitive areas

Size of Facilities


- Small scale appears to keep resource demands reasonable and local
- Large scale has enormous appetites and transportation costs
 - Sustainability
 - Feedstock footprint

Pennsylvania's Fuels for Schools & Beyond

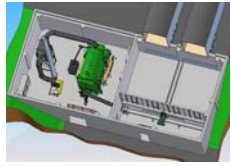
Project Partners...over 54 organizations, agencies, and individuals

<ul style="list-style-type: none"> ■ Pocono Northeast RC&D Council ■ PA Dept. Conservation and Natural Resources (DCNR) ■ PA Dept. of Environmental Protection (DEP) ■ USDA-Natural Resources Conservation Service (NRCS) ■ PA Dept of Agriculture (PDA) ■ Penn State University ■ Advanced Recycling Equipment ■ Bradford County Conservation District ■ Regional Economic Development Districts Initiative (REDDI) ■ Pennsylvania Higher Educational Facilities Authority/ PA's State Public School Building Authority ■ Pennsylvania School Boards Association. ■ PA Association of School Administrators ■ USDA Forest Service ■ USDA-Rural Development ■ PA Forest Products Association ■ Warluft Forestry Services 	<ul style="list-style-type: none"> ■ Penn TAP ■ Endless Mountains RC&D Council ■ Southern Alleghenies RC&D Council ■ Capital Area RC&D Council ■ Penn Soil RC&D Council ■ Penn's Corner RC&D Council ■ Southern Alleghenies Conservancy ■ PA Hardwoods Council ■ PA Dept. of General Services (DGS) ■ PA Sustainable Forestry Initiative (SFI) ■ Bradford Forest Landowners ■ Elk County Regional Health Facility ■ Cycle-Ward, Inc. ■ AFS Energy ■ Mountain View School District ■ Warrior Run School District ■ Clarion Limestone School District ■ Mount Union School District ■ Energy Resources Group ■ Resource Professionals Group
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Biomass Combustion Applications

- **Heating/Cooling**
 - Hot Air
 - Hot Water
 - Hot Oil
 - Steam
- **Co-firing**
- **Combined Heat & Power (CHP)**



We are Not talking about this!



We are talking about this!



- Wood fired heat system at PA hospital



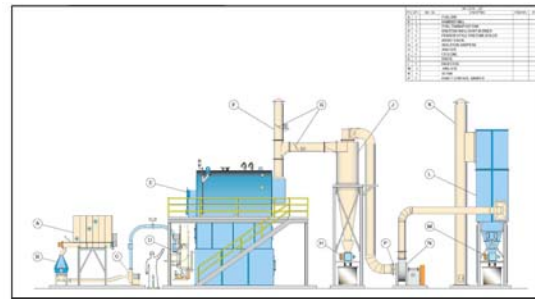
- Wood fired heat system at PA wholesale greenhouse

Components of a Biomass Heating System

- Fuel storage
- Fuel handling system
- Combustion unit
- Combustion unit components/controls
- Heat exchange
- Air pollution controls
- Exhaust / emissions / permitting
- Ash handling system



Example Institutional Biomass Heating System



Current Examples of Cost Savings

- Mountain View School District - **\$131,000/yr.**
 - Current savings per year versus fuel oil
- Dillon Floral Corporation (Greenhouse) - **\$191,000/yr.**
 - Savings per year versus #6 fuel oil
- Elk Regional Health Facility (Hospital) - **\$300,000/yr.**
 - Anticipated savings versus natural gas
- Benton Area School District - **\$72,800/yr.**
 - Anticipated savings versus fuel oil



Mountain View School District (Susquehanna County)

- Installed Wood Chip Boiler in 1991 as part of capital improvement project
- Heating with wood chips from local supplier(s)
 - Wood chips are bid out every year (~\$25-35 per ton)
 - Chips are required to meet certain specifications (moisture, size, non-foreign material, etc.)
- In 2005-2006 Mt. View saved **\$69,000** and in 2006-2007 saved **\$60,000** heating with wood chips versus fuel oil
- In 2007-2008 Mt. View saved **\$131,000**



Dillon Floral Corporation (Columbia County)

- Installed Wood Chip Boiler in 2007 to replace #6 Heating Oil burning system
- Annual heating requirement is of 145,152 gallons of #6 heating oil
- In 2006 #6 heating oil was \$1.26/gallon= \$182,891
- In 2007 #6 heating oil is \$1.80/gallon= **\$252,000**
- Annual heating requirement using wood chips would be 2,444 tons of wood chips annually at \$30/ton= **\$73,320**
- Using these figures there would be **\$178,680** savings per year in 2007
- Actual savings in 2007-2008 were **\$191,000**
- Wood chips are being supplied locally from: sawmills, furniture manufacturer, right-of-way clearings, and other suppliers.



Elk County Regional Health Facility (Elk County)

- Installed Wood Chip Boiler in 2007
- Heating with wood chips from local supplier(s)
- System is not only providing heat but also domestic water and hospital equipment
- IN 2007-2008 for 6 months savings were **\$94,000**
- In 2008-2009 Facility is expected to save **\$300,000**



Benton School District (Columbia County)

■ Heating Requirements & Costs

- Five years average indicates approximately 46,400 gallons of oil required to heat the elementary, high school/middle school buildings
- In 2005-06 **\$107,648** was spent to heat the buildings
- In 2004-05, bid cost was \$1.54 per gallon, in 2007 the cost was \$2.32 per gallon.
- In 2008 the price quoted was \$4.00 per gallon



Benton School District (Columbia County)

■ Anticipated \$\$ Savings with Biomass

- **Wood Chips:** 995 tons/year @ **\$35/ton** \$34,825 annual cost: savings of **\$113,655** annually
- **Grass Pellets:** 430 tons/year @ **\$180/ton** \$77,400 annual cost: savings of **\$71,080** annually
- **Corn:** 461 tons/year @ **\$178/ton** \$82,058 annual cost: savings of **\$66,422** annually
- **Wood Pellets:** 403 tons/year @ **\$225/ton** \$90,675 annual cost: savings of **\$57,805** annually

* Costs and figures using average BTU's values for feedstock, 80% efficient heating system, cost of fuel oil was at **\$4.00 per gallon in 2008**, and biomass providing 80% of heating requirement of school.

How Can We Help?

- Prefeasibility technical assistance
- Arrange tours of operating systems
- System manufacturer references
- Energy service provider references
- Air permitting references
- Funding resources reference
- Case studies
- Education and outreach reference materials

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Residential Biomass Heating Opportunities



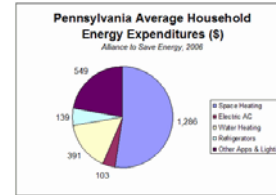
Energy Usage by Homeowners



- 1) Space Heating
- 2) Hot Water Heating
- 3) Appliances

These pie charts show average end use as a percent for residents in the Northeast states. This data is from the USDOE publication titled "Household Energy Consumption and Expenditures 1993" published in October 1995 by the Energy Information Administration. Each household will have unique energy use characteristics based on climate, number of occupants, occupant behavior, and building characteristics.

Energy Usage by Homeowners



- 1) Space Heating
- 2) Air Conditioning
- 3) Water Heating

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Residential Biomass Heating Opportunities

- High efficiency appliances
- Low emissions
- Multi-fuel capabilities
- Boiler, forced air, ambient heat

<http://www.epa.gov/woodstoves/basic.html>

<http://www.epa.gov/woodheaters/models.htm>

Mobile Pelletizer

Project Objectives

- Demonstration of mobile pelletizing equipment
- Provide farmers with opportunity to increase profitability on the farm
- Increased use of biomass (grass pellets) in small industrial and home heating type applications
- Heat/Energy created using a renewable resource
- Reduce air pollution by burning biomass as opposed to fossil fuels
- Improve water quality and reduce water pollution raising grasses as opposed to row crops
- Market/job/business creation
- Reduce fuel costs to both consumer and producer



Pocono Northeast
Resource Conservation & Development Council

Why Biomass Works!

- Saves Money \$\$\$!!!
- Locally Produced Feedstocks
- Boost to Local Economy
- Utilization of Biomass (Renewable Resources)
- Utilization of Waste Product (Wood Waste)
- Reduces Dependence on Fossil Fuels
- Carbon Neutral
- Environmental (Water Quality, Wildlife Habitat, etc.)
- Other

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