Institutional & Commercial Woodchip Heating

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NAEMI Biomass & Business Training Workshop

May 16, 2006
Spokane, Washington

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Biomass Energy Resource Center

BERC works to provide public benefits by promoting and assisting in the development of projects that use biomass fuels in a sustainable manner for supplying thermal and electrical energy in a broad range of community, institutional, commercial, industrial and utility settings.

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Presentation Overview

- **Why institutional & commercial woodchip heating?**
- **Brief overview of woodchip combustion systems**
- **Various examples of woodchip heated facilities**
- **Life-cycle cost analysis**
- **Air emissions**
- **Observations and lessons learned**
- **Q&A**

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Why use wood to heat institutional & commercial facilities?

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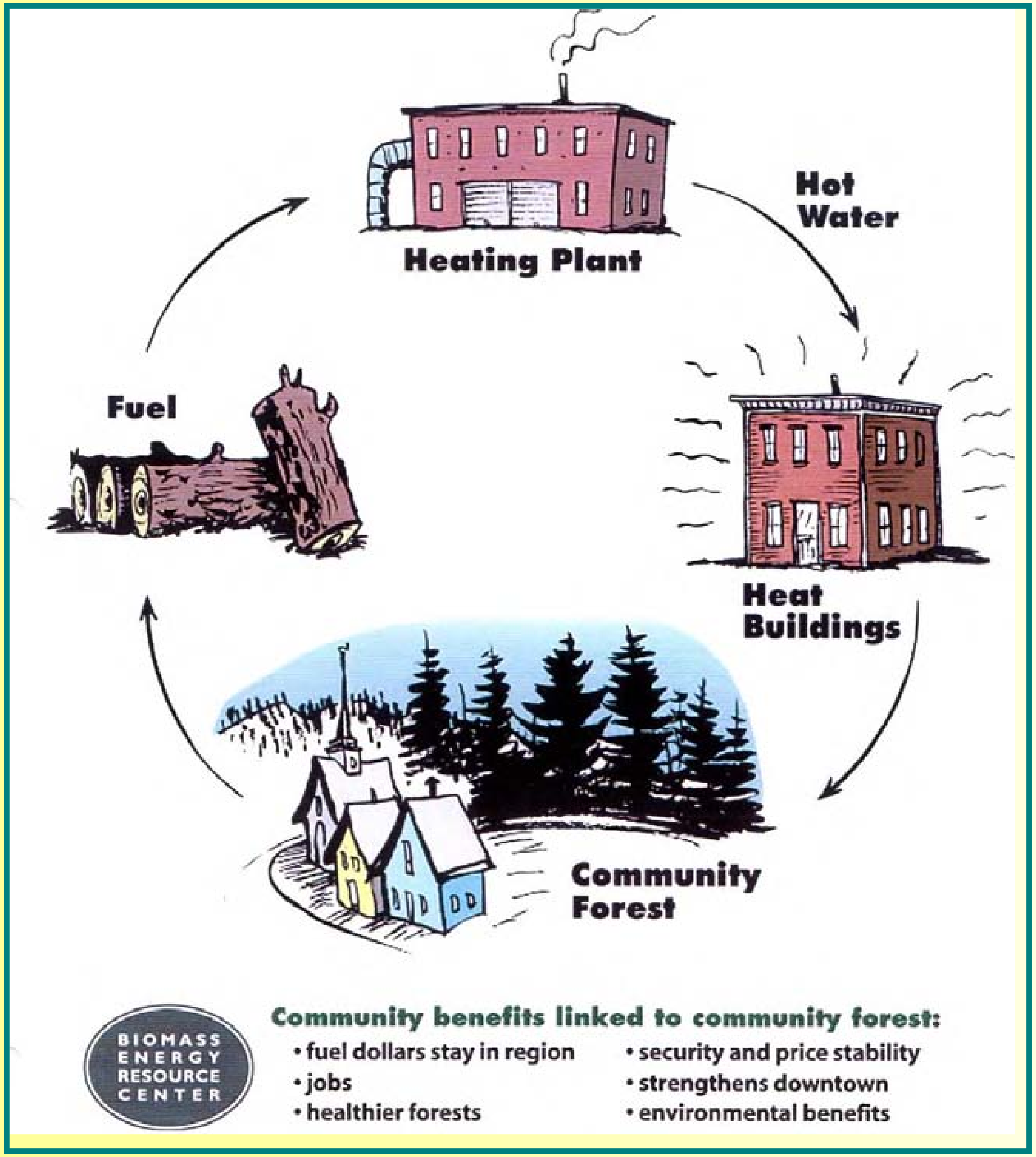
Benefits of Using Forest Biomass



- Sustainable renewable fuel source
- Local and regional economic development
- Positive action on climate change
- Low cost fuel
- Restoring forest health

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Fuel Energy Value Comparison

Fuel	Unit	Cost/unit	Average Efficiency	$/MMBtu Delivered
#2 Oil	gallons	$2.20	75%	$21.26
Propane	gallons	$1.80	80%	$21.74
Natural gas	therms	$1.00	80%	$13.13
Wood chips	**tons**	**$45.00**	**65%**	**$6.87**
Wood pellets	tons	$175.00	80%	$14.10

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Wood Energy Applications

- Space heat, cooling, domestic hot water, and power generation
- Wide range of building sizes (23,000 – 750,000 square feet)
- Wide range of building types
- Multiple buildings using central heating plant
- In regions with over 8,000 HDD and under 4,500 HDD

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Wood Chip Heating Applications

- Schools
- Office Complexes
- College and University Campuses
- Maintenance Facilities
- Hospitals
- Correctional Facilities
- Farms and Greenhouses
- Other Commercial Facilities

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Wood Chip Heating in Vermont

- 26 public schools currently heating with woodchips
- 2 major state office complexes heating with chips
- 8 other state facilities heating with chips (including correctional facilities, court houses, etc.)
- 1 hospital using wood for CHP
- 1 college campus system – under development
- Numerous commercial systems

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Institutional Wood Energy - Schools

Vermont's School Experience

- 26 Schools over 20 years
- 12% of student population
- Schools range in size between 23,000 ft^2 and 270,000 ft^2, average is 110,000 ft^2
- 16,000 tons of wood chips per year total
- Average annual fuel cost is $0. 24/ ft^2

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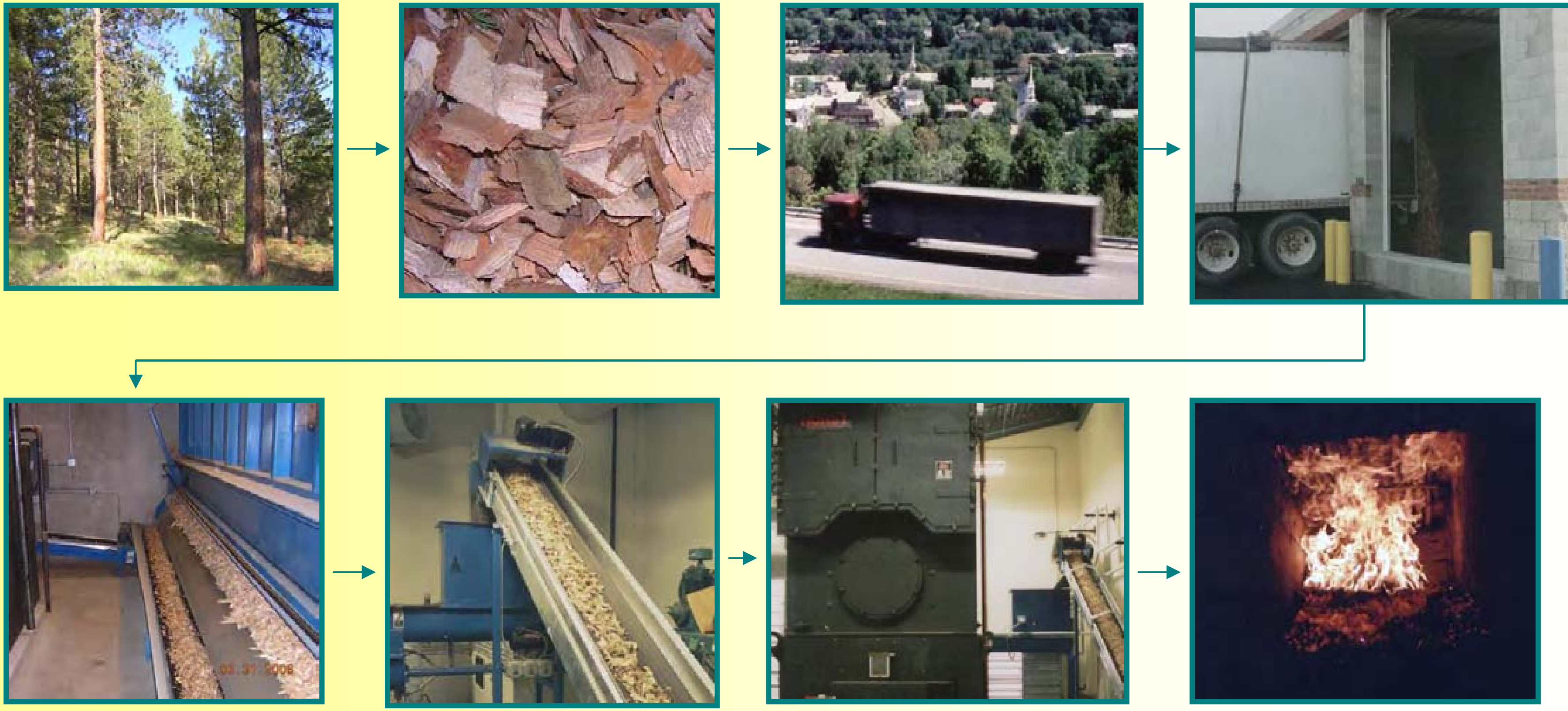
How Woodchip Systems Work



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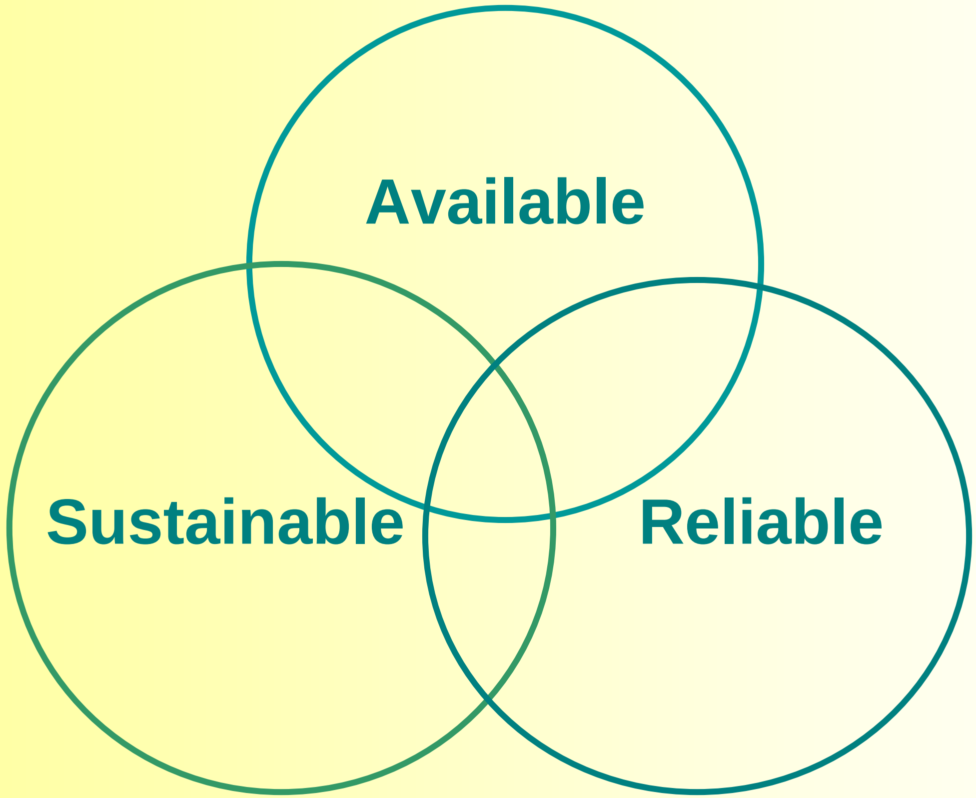
Fuel supply needs to be…



Wood Fuel Types

- Cord wood
- **Wood chips**
- Wood pellets
- Other (sawdust, bark, etc.)

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Where does the fuel come from?

- Directly from forest harvesting
- Sawmills or other generators of by-product

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Fuel Sources

Sawmill Residues

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Fuel Sources

Low-grade & small diameter wood & harvesting residues

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What makes quality wood chips?

- Uniform shape and size
- Moisture content
- Absence of dirt and bark
- Tree species

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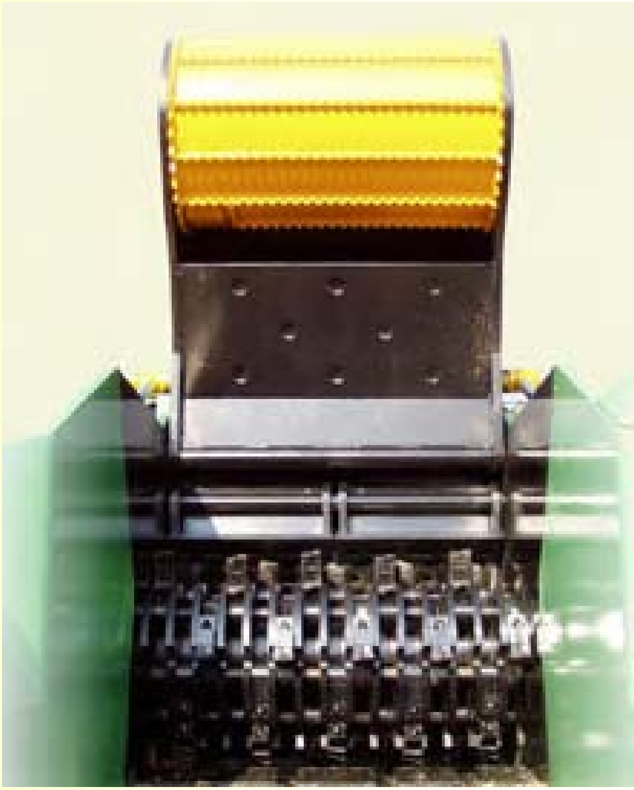
Chipping vs. Grinding



Even slicing or random hacking

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Wood Fuel Properties

- Dry basis 16.8 MMBtu/ ton
- Average moisture content 35-45%
- Wet basis 10.1 MMBtu/ ton

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Wood Fuel Properties

- **Ash content**
- **Silica**
- **Alkali**

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Fuel Transport and Delivery

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Fuel Transport and Delivery

“Walking floor” trailer

Dump truck

Fuel Storage

Emory Hebard State Office Building
Newport, Vermont

Mt. Mansfield Union HS
Jericho, Vermont

Automated Fuel Handling

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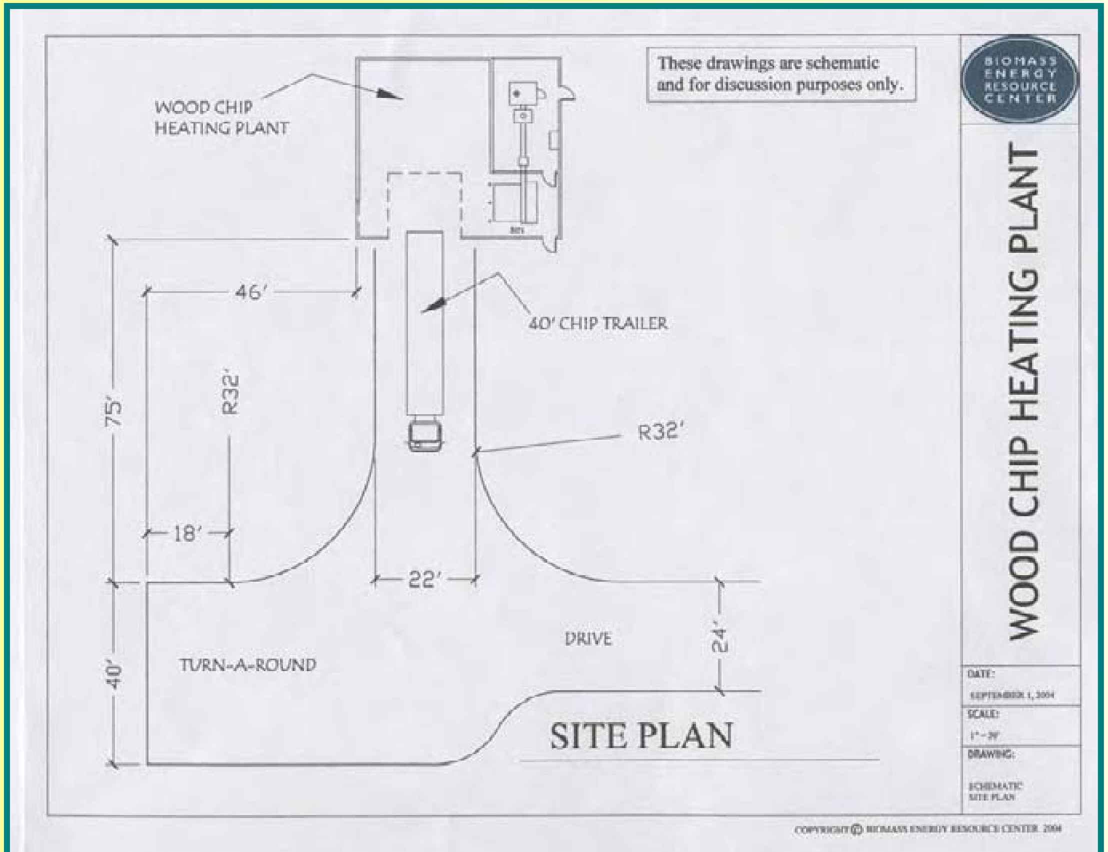
Semi-Automated Fuel Handling



(Conceptual Drawings)

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Boiler Configuration

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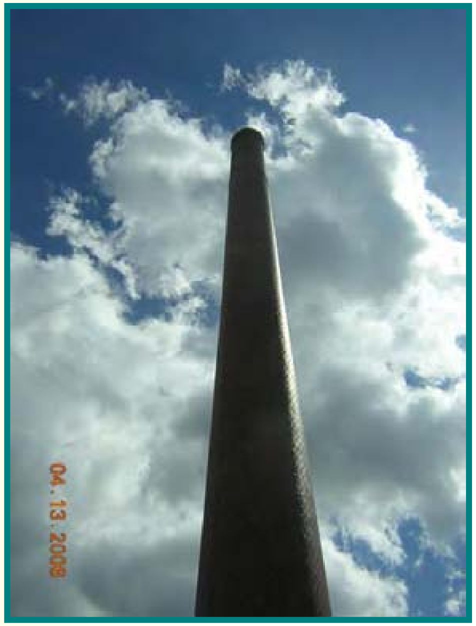
Air Emissions Controls



Cyclone Separator, Waterbury, VT

Schools

U-32 High School, Montpelier, VT

Schools

Spaulding High School, Barre, VT

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Schools

Calais Elementary School, VT

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Schools

Darby School District
Montana

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Office Complexes

State Office Complex, Waterbury, VT

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Office Complexes

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State Capital Complex, Montpelier, VT

College & University Campuses

Mt. Wachusett Community College, Gardner, MA

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College & University Campuses

Middlebury College, Middlebury, VT

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College & University Campuses

Maryville College, Tennessee

University of Idaho, Moscow

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Maintenance Facilities

Town Garage, Lyme, NH

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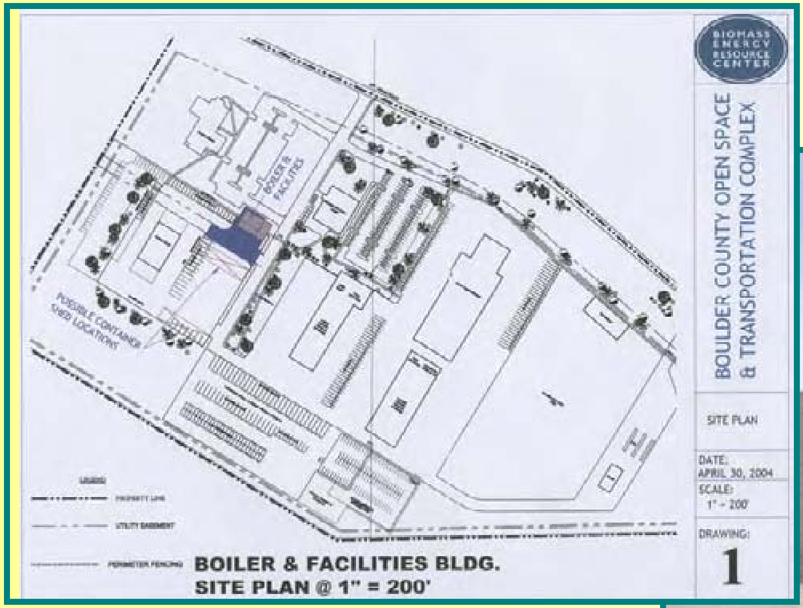
Maintenance Facilities



Boulder County Open Space & Transportation Department Complex

Hospitals

South Shore Regional Hospital, Bridgewater, Nova Scotia

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Businesses

Wood products business

Farm – slab floor heating

Commercial greenhouse

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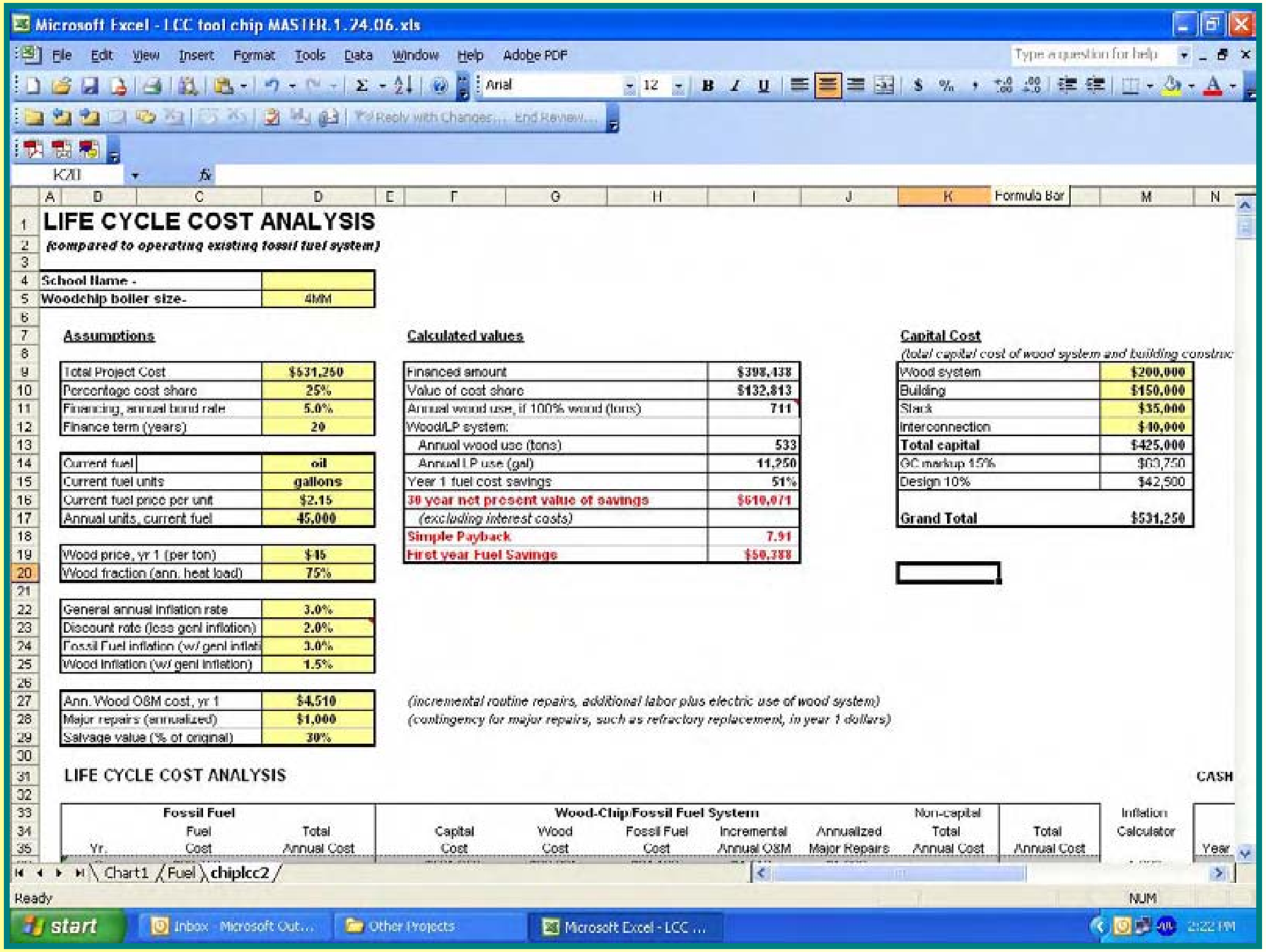
Life Cycle Cost Analysis



Microsoft Excel - LCC tool chip MASTER.1.24.06.xls

LIFE CYCLE COST ANALYSIS

(compared to operating existing fossil fuel system)

School Name -	
Woodchip boiler size-	4MM

Assumptions

Total Project Cost	$531,250
Percentage cost share	25%
Financing, annual bond rate	5.0%
Finance term (years)	20
Current fuel	oil
Current fuel units	gallons
Current fuel price per unit	$2.15
Annual units, current fuel	45,000
Wood price, yr 1 (per ton)	$45
Wood fraction (ann. heat load)	75%
General annual inflation rate	3.0%
Discount rate (less genl inflation)	2.0%
Fossil Fuel inflation (w/ genl inflati	3.0%
Wood inflation (w/ genl inflation)	1.5%
Ann. Wood O&M cost, yr 1	$4,510
Major repairs (annualized)	$1,000
Salvage value (% of original)	30%

Calculated values

Financed amount	$398,438
Value of cost share	$132,813
Annual wood use, if 100% wood (tons)	711
Wood/LP system:	
Annual wood use (tons)	533
Annual LP use (gal)	11,250
Year 1 fuel cost savings	51%
30 year net present value of savings	$610,071
(excluding interest costs)	
Simple Payback	7.91
First year Fuel Savings	$50,388

Capital Cost

(total capital cost of wood system and building construc

Wood system	$200,000
Building	$150,000
Stack	$35,000
Interconnection	$40,000
Total capital	$425,000
GC markup 15%	$63,750
Design 10%	$42,500
Grand Total	$531,250

(incremental routine repairs, additional labor plus electric use of wood system)

(contingency for major repairs, such as refractory replacement, in year 1 dollars)

LIFE CYCLE COST ANALYSIS | CASH

Fossil Fuel			Wood-Chip/Fossil Fuel System								
Yr.	Fuel Cost	Total Annual Cost	Capital Cost	Wood Cost	Fossil Fuel Cost	Incremental Annual O&M	Annualized Major Repairs	Non-capital Total Annual Cost	Total Annual Cost	Inflation Calculator	Year

Chart1 / Fuel / chiplcc2

LCC Analysis Tool developed by BERC

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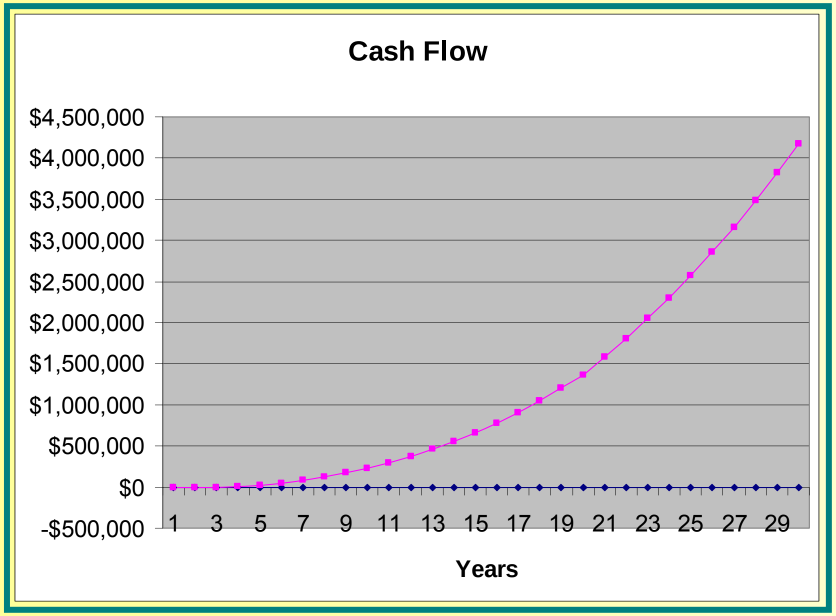
Life Cycle Cost Analysis - (Example 1)

Key Assumptions

- 200,000 square feet
- 120,000 therms natural gas @ $1.10/therm
- Wood cost = $35/ton
- $850,000 financed over 20 years @ 5.5%
- Offsetting 85% natural gas
- 20% cost share

First Year Fuel Savings	$72,096
Positive Cash Flow	Year 3
Simple Payback	9.4 years
30 Year Net Present Value of Savings	$1,434,476

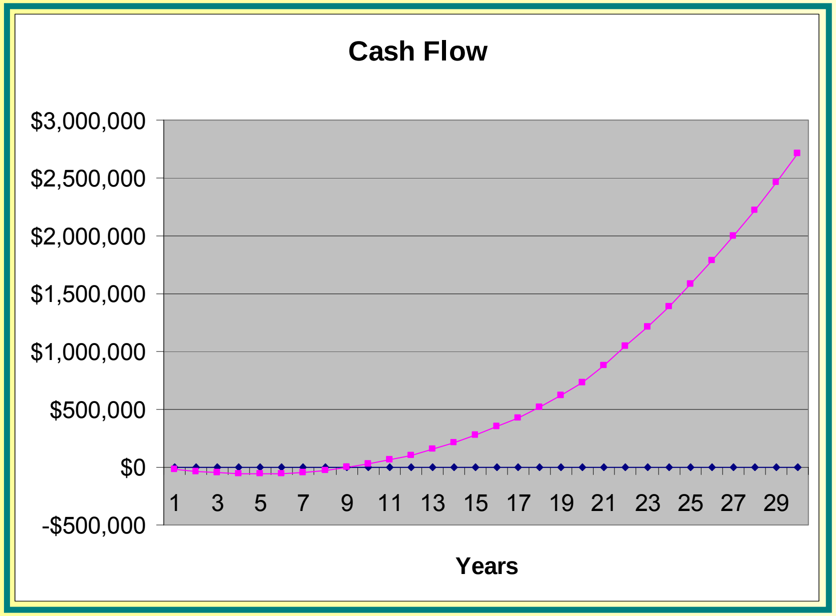


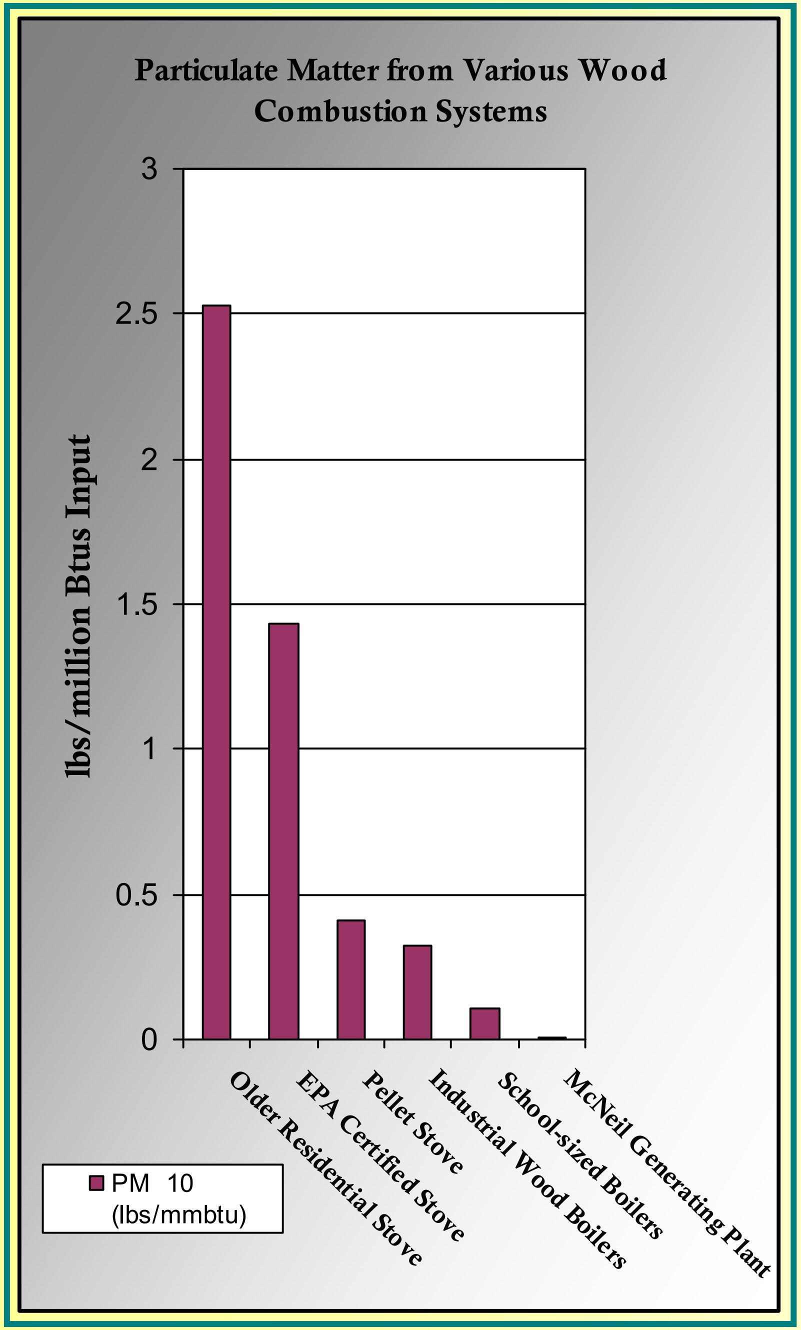
Life Cycle Cost Analysis - (Example 2)

Key Assumptions

- 100,000 square feet
- 40,000 gallons oil @ $2.10/gallon
- Wood cost = $40/ton
- $650,000 financed over 20 years @ 5.5%
- Offsetting 85% heating oil
- No cost share

First Year Fuel Savings	$31,420
Positive Cash Flow	Year 10
Simple Payback	11.7 years
30 Year Net Present Value of Savings	$131,450





Air Emissions

- **Particulates (PM 10)**
- **SO_x**
- **NO_x**
- **VOC's**

Air Emissions – BACT for PM(10)

Control Technology	Description	Comments
Bag House (fabric filters)	Very effective control using fabric to filter particles down to 1 micrometer and under	Effectively used on much larger boilers but run high risk of fire hazard due to unburned wood dust. High capital and operating costs
Electrostatic Precipitator (ESP)	Very effective control using electric fields to capture particles	High capital and operating costs.
Core Separator	Mechanical collection of particles via re circulating air through cyclone	No longer commercially available
Multi-Cyclone	Uses multiple cyclones and velocity to mechanically separate particles from gas	Potentially cost-effective for wood boilers 5 MMBtu/hr or larger
Cyclone	Least effective control device with little difference over no control use	Not recommended for institutional heating systems.

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Observations & Lessons Learned

Fuel Supply

- Fuel supply market (in VT) is transitioning from waste to commodity fuel
- Because heating systems can burn lower quality wood doesn’t mean they necessarily should
- Smaller systems should be clustered
- Need larger fuel supply industry anchors like pulpmills or biomass power plants

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Observations & Lessons Learned

System Design

- Systems need to be well designed
- Need architects and engineers who have experience with wood systems
- Need more vendors interested in this market
- Involve maintenance staff – build something they will want to run 24/7
- ASME boiler ratings

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Observations & Lessons Learned

General Project Development

- Target “low hanging fruit” facilities first
- Projects need community support and public education
- Need to include air quality regulators early in the process

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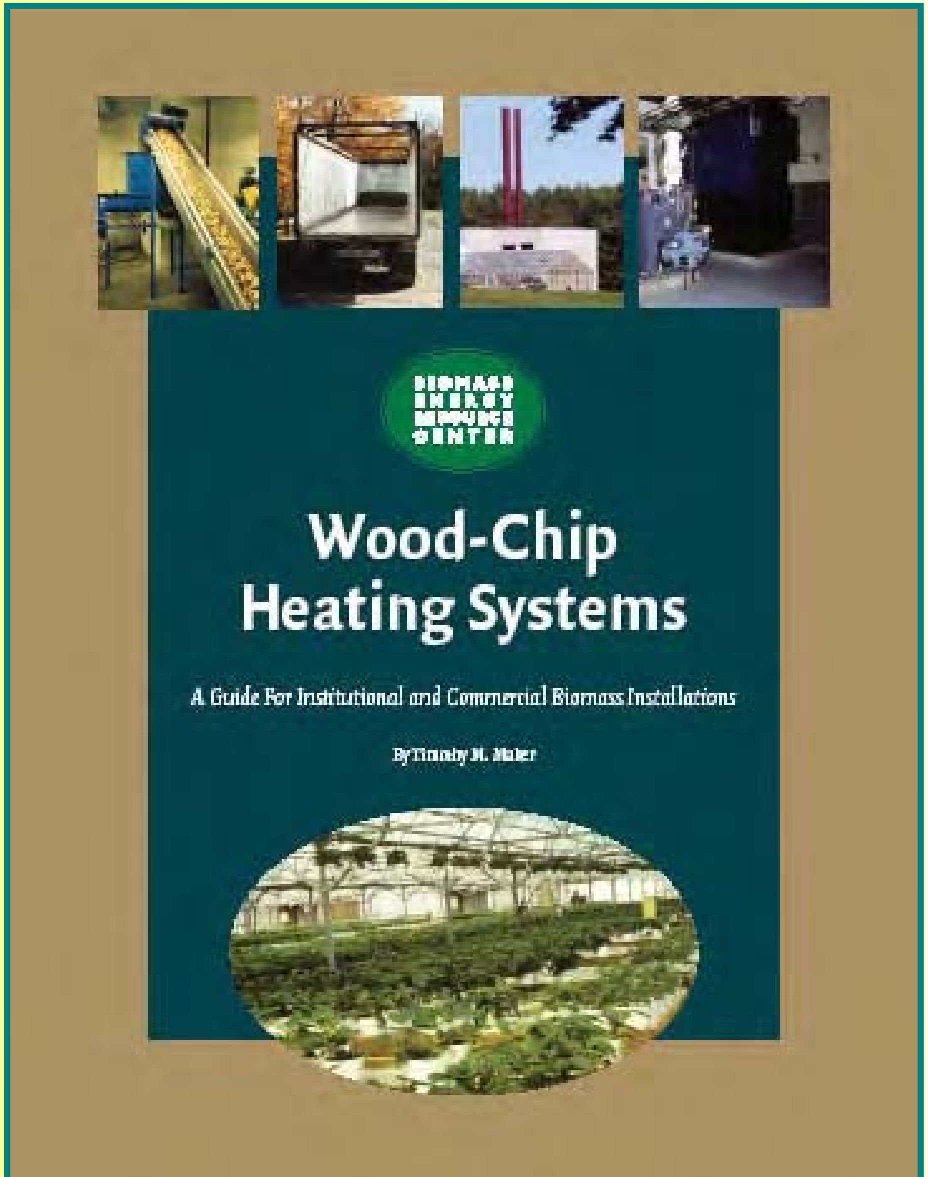

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