



# **Community-Scale Wood Energy: *An Overview***

**Bio-Energy for (Small) Northern Communities**

**Sioux Lookout, Ontario  
November 18th, 2009**


**Adam Sherman, Program Director  
Biomass Energy Resource Center**



**BERC**

Renewable • Reliable • Resourceful

**Biomass Energy  
Resource Center**

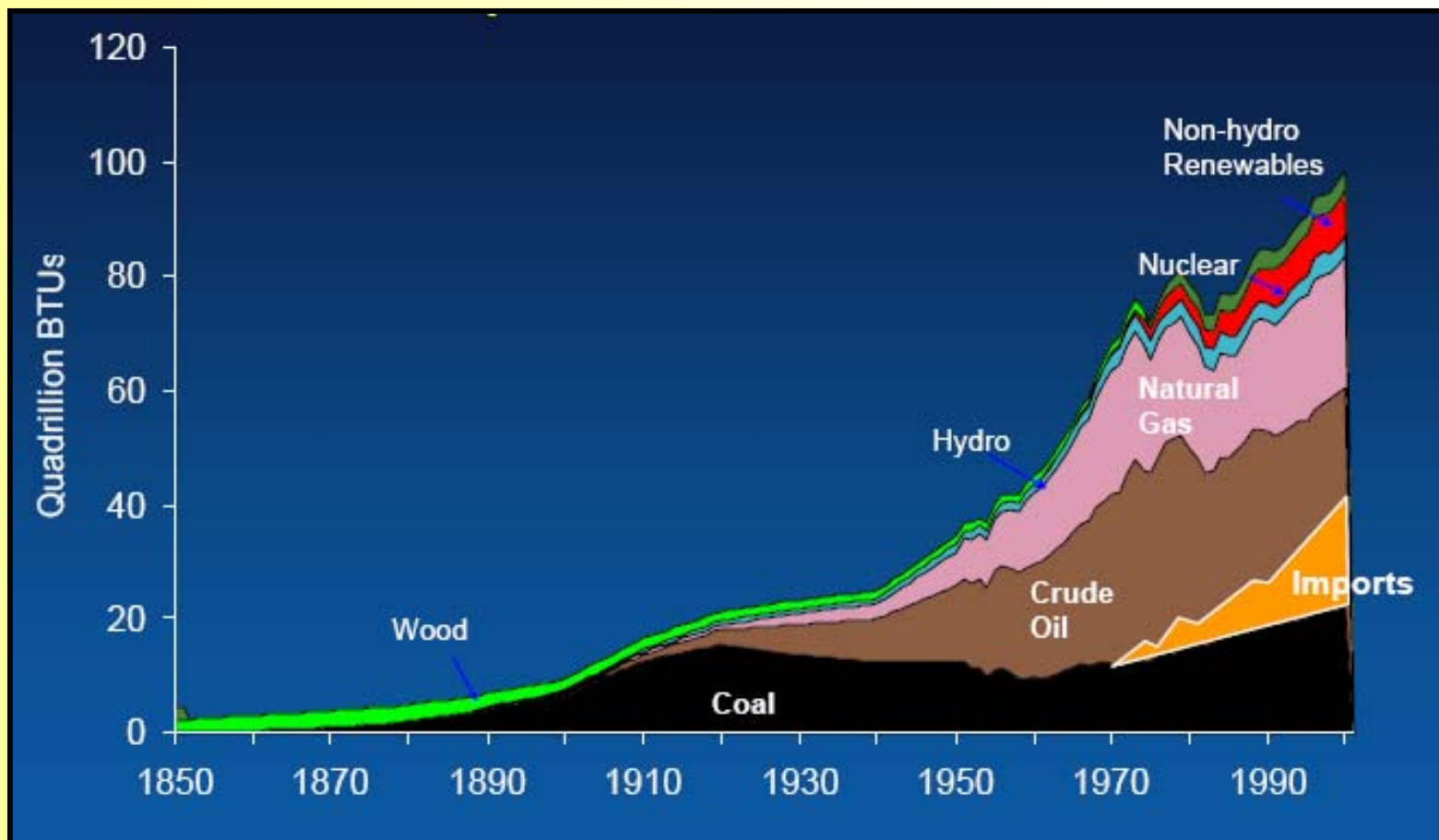


# Biomass Energy Resource Center (BERC)

BERC is a national not-for-profit organization working to promote responsible use of biomass for energy.

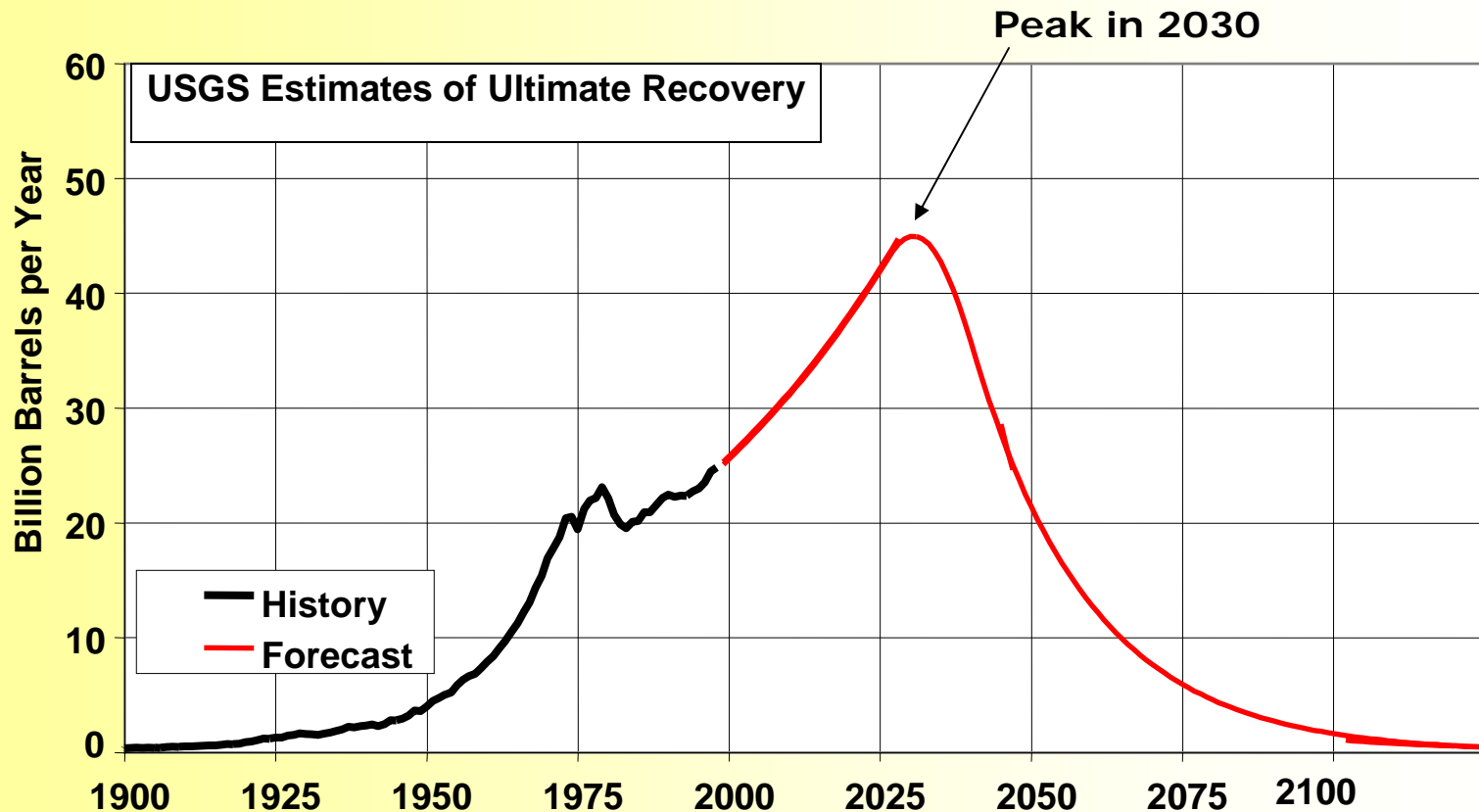
BERC's mission is to achieve a healthier environment, strengthen local economies, and increase energy security across the United States by developing sustainable biomass systems at the community level.

# US Energy Consumption by Source 1850 - 2000



Graph Source: National Renewable Energy Laboratory

# World Oil Production History & Forecast: One Scenario



**Note:** US volumes were added to the USGS foreign volumes to obtain world totals.

**Source:** US DOE, Energy Information Administration

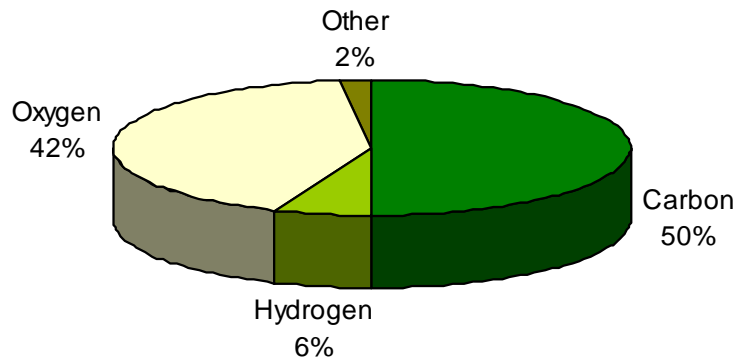
# Renewable Energy Use Matrix

## Energy End-Use Needs

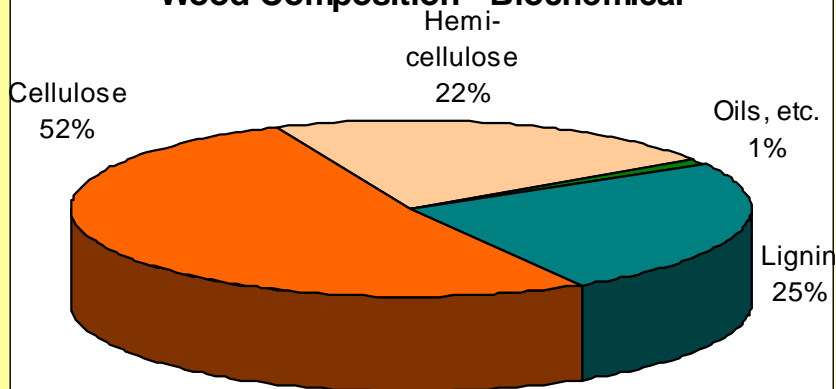
	Heat	Electricity	Fuel Gas	Fuel Liquids
Solar	✓	✓		
Wind		✓		
Geothermal	✓	✓		
Hydro		✓		
Biomass	✓	✓	✓	✓

# Basic Wood Fuel Properties

Wood Composition - Elemental



Wood Composition - Biochemical



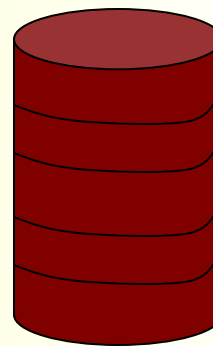
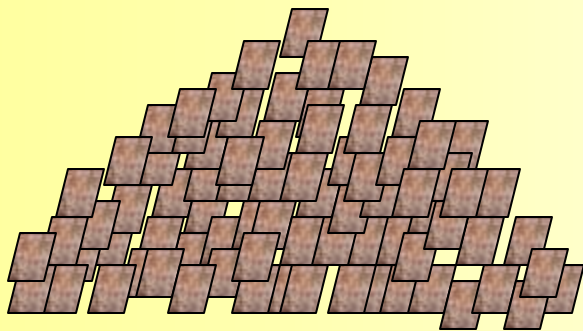
- Wood is 50% Carbon, 42% Oxygen, and 6% Hydrogen
- Wood is 52% cellulose, 22% hemi-cellulose, 25% lignin
- Wood has a HHV range of 8,000 – 12,200 Btu/oven dry pound
- Moisture content range of 5% - 65%
- LHV is dependant on MC

# Wood Energy Content

1 Ton  
Wood (dry)

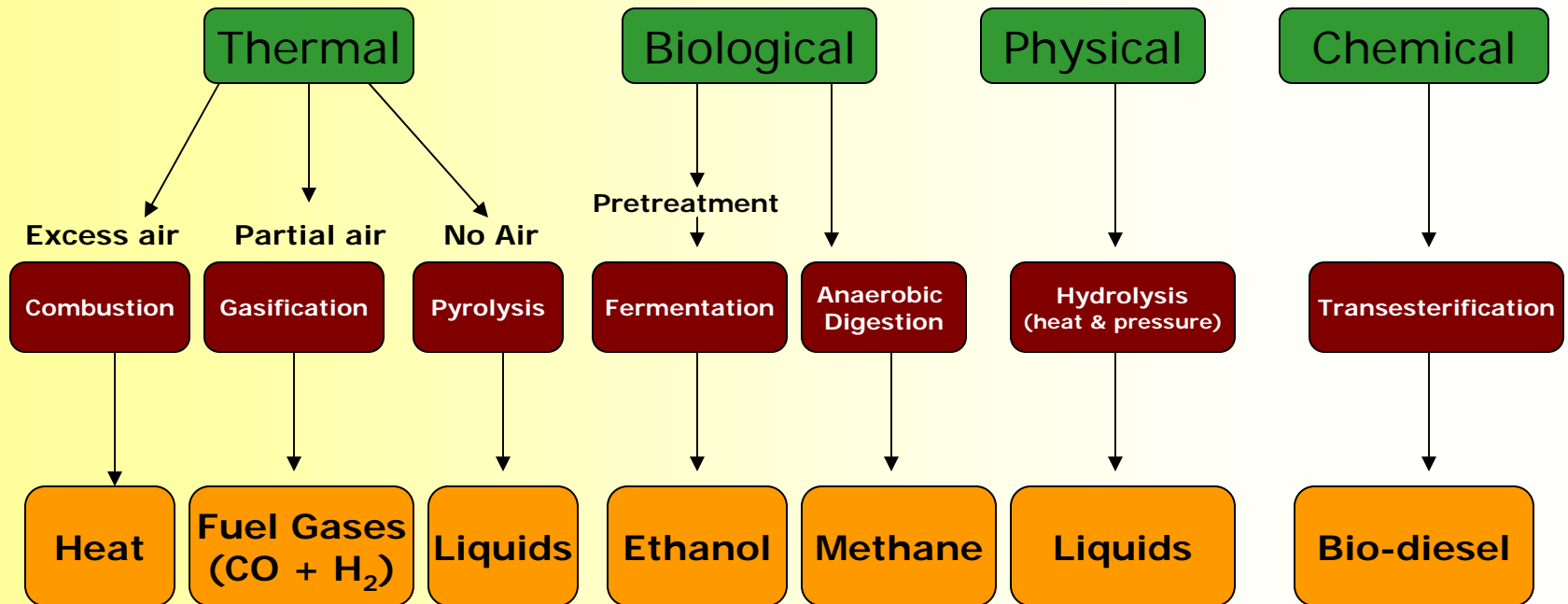
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118 gallons of Oil



*\* Does not account for conversion efficiency*

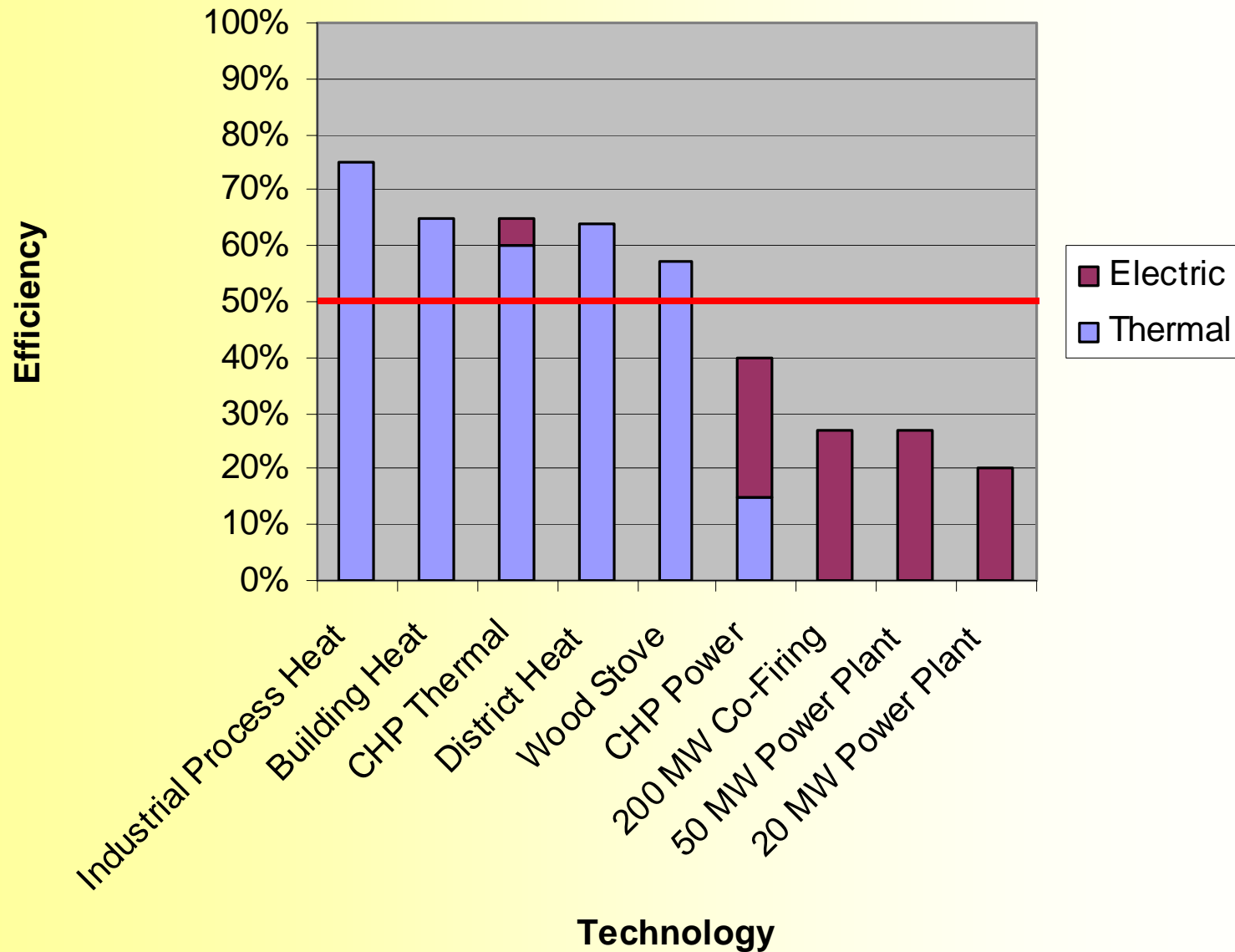
# Biomass Energy Pathways



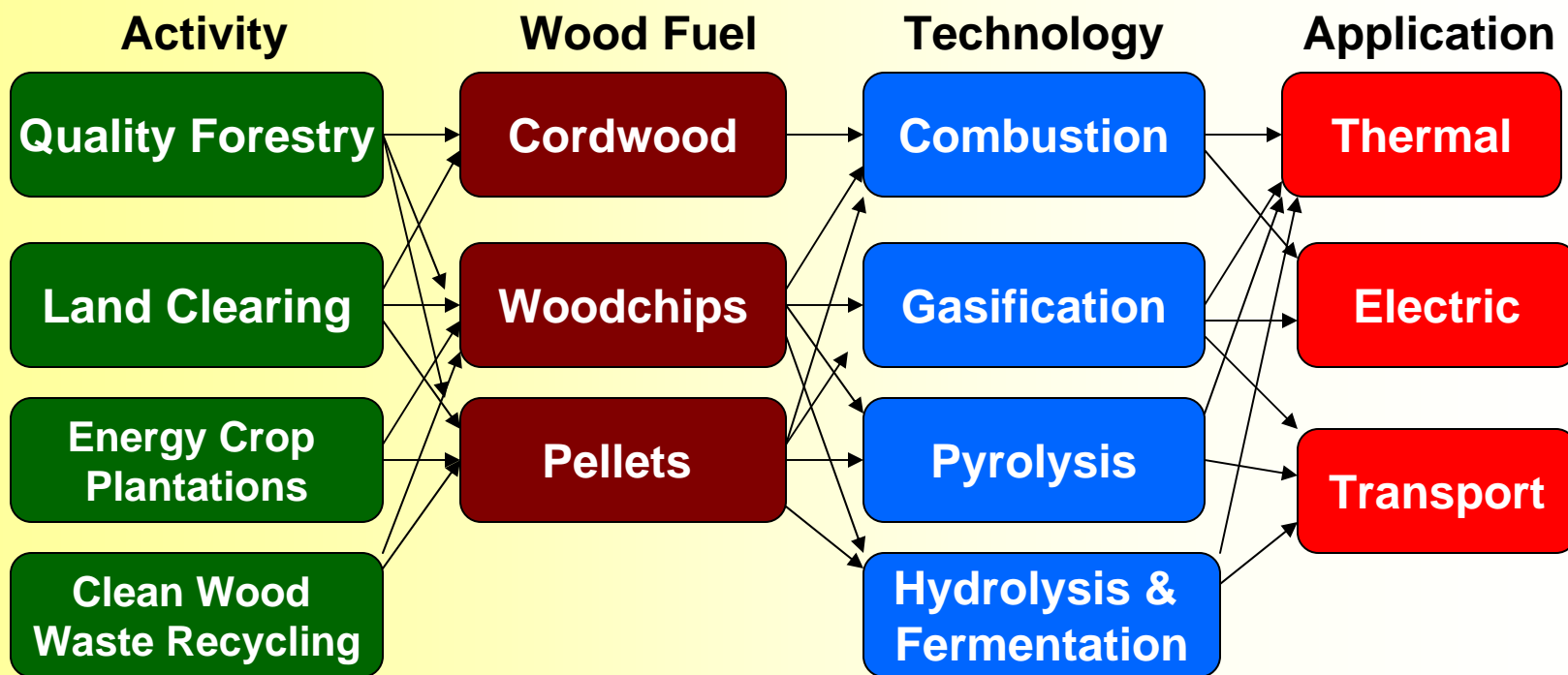


# Conversion Efficiency

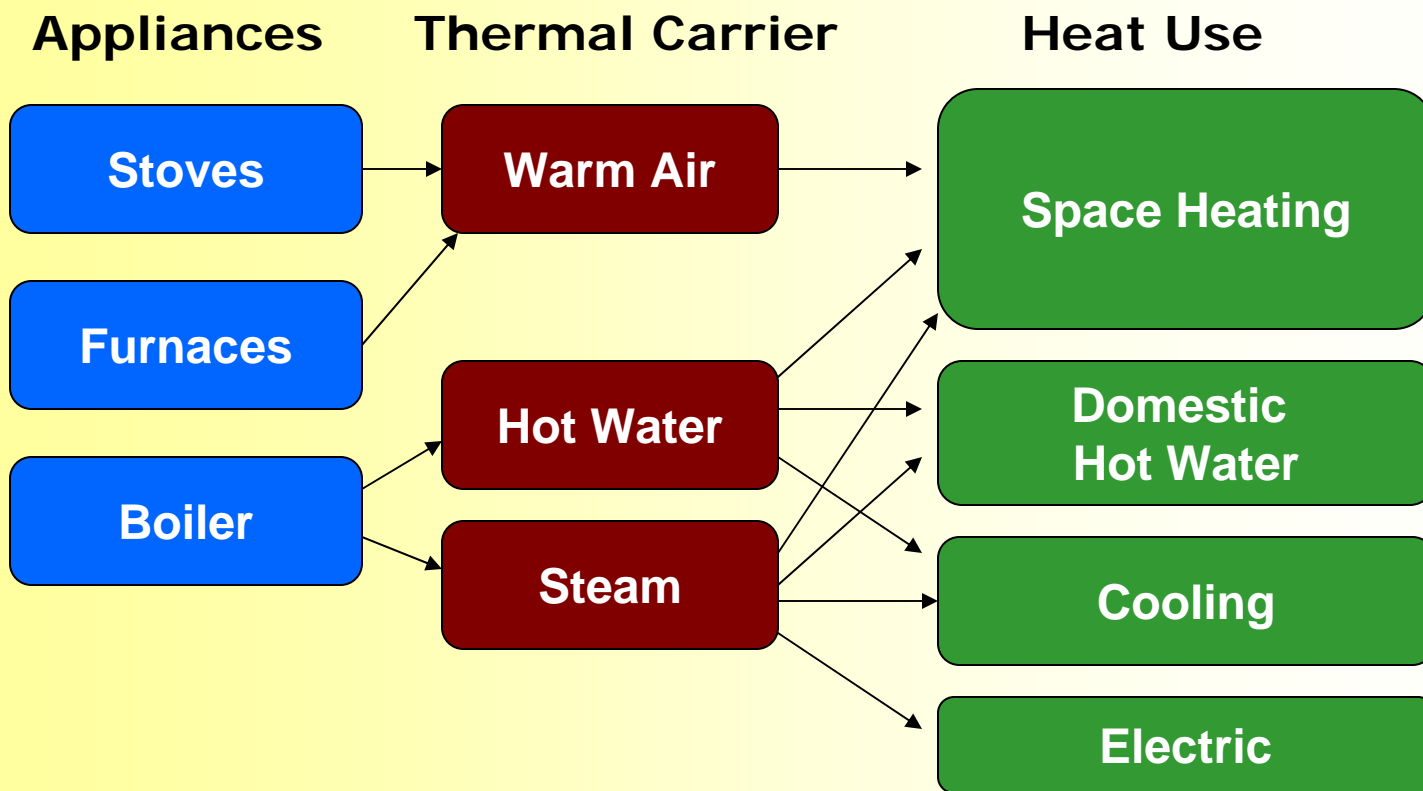
## Wood to Energy (available technology)



# Wood to Energy Pathways



# Appliances, Delivery and Uses



# Traditional Wood Fuels

**Chunkwood**



**Residential Heating**

**Chips**



**Commercial and  
institutional heating**

**Utility-scale power  
production**

**Pellets**



**Residential Heating**

**Small Commercial  
and Institutional  
Heating**

# Woodchip Fuel Options

**Paper Grade Chips**



**Whole-tree Chips**



**Urban Wood Waste**



**Bole Chips**

# Wood Pellet Fuel Options

Premium Grade Pellets



Standard Grade Pellets



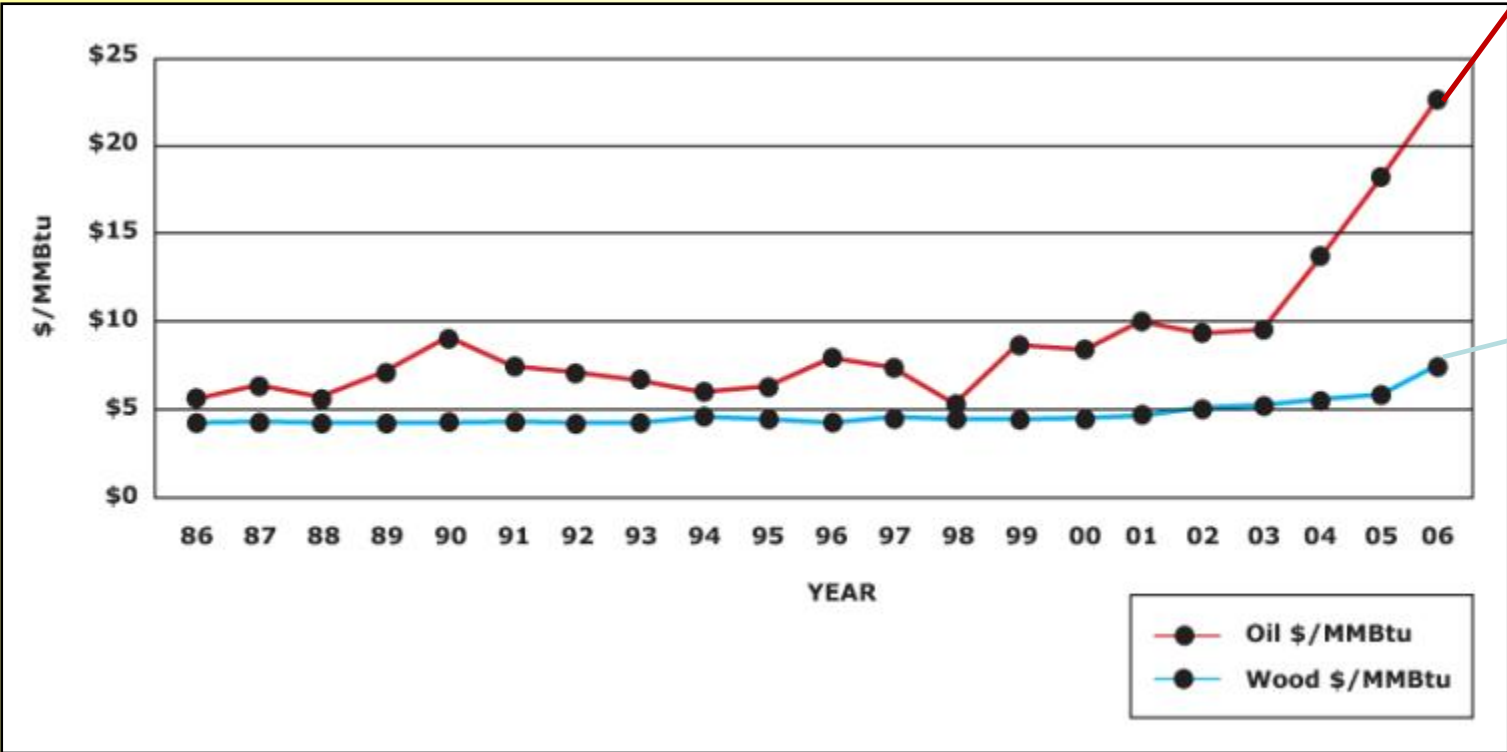
Industrial Grade Pellets/Tables



# Comparative Cost of Heat - Various Fuels

Fuel	Unit	Cost/unit	Average Efficiency	\$/MMBtu Delivered
Heating Oil	gallons	\$3.00	80%	<b>\$28.99</b>
Propane	gallons	\$1.80	85%	<b>\$24.46</b>
Natural Gas	therms	\$1.15	85%	<b>\$14.38</b>
Cordwood	cords	\$225	55%	<b>\$19.48</b>
Woodchips	tons	\$56	65%	<b>\$9.64</b>
Wood Pellets	tons	\$280	75%	<b>\$22.78</b>

# Wood and Oil Energy Price History



# Local Wood Energy:

A new paradigm for the relationship between communities and forests

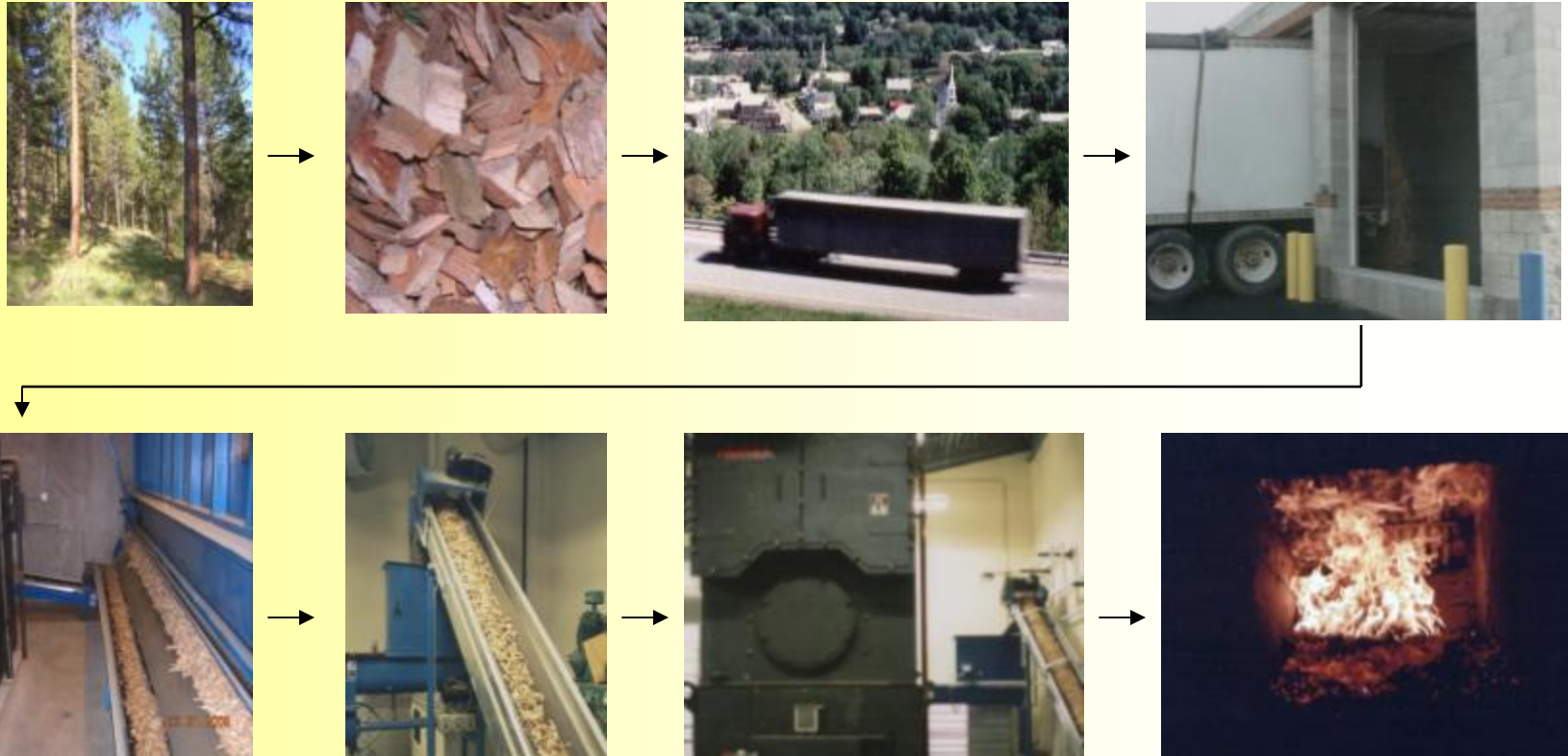


# “Modern” Biomass Heating Systems

- Increased efficiency
- Lower emissions
- Lower time requirements
- Reliable operation
- Automated fuel handling
- Hot water boiler and heat distribution



# Components of Woodchip Heating Systems



- Fuel Sources
- Fuel Transport and Delivery
- Fuel Storage at Facility

- Fuel Handling
- Combustion System

# Indoor Chunkwood Boilers

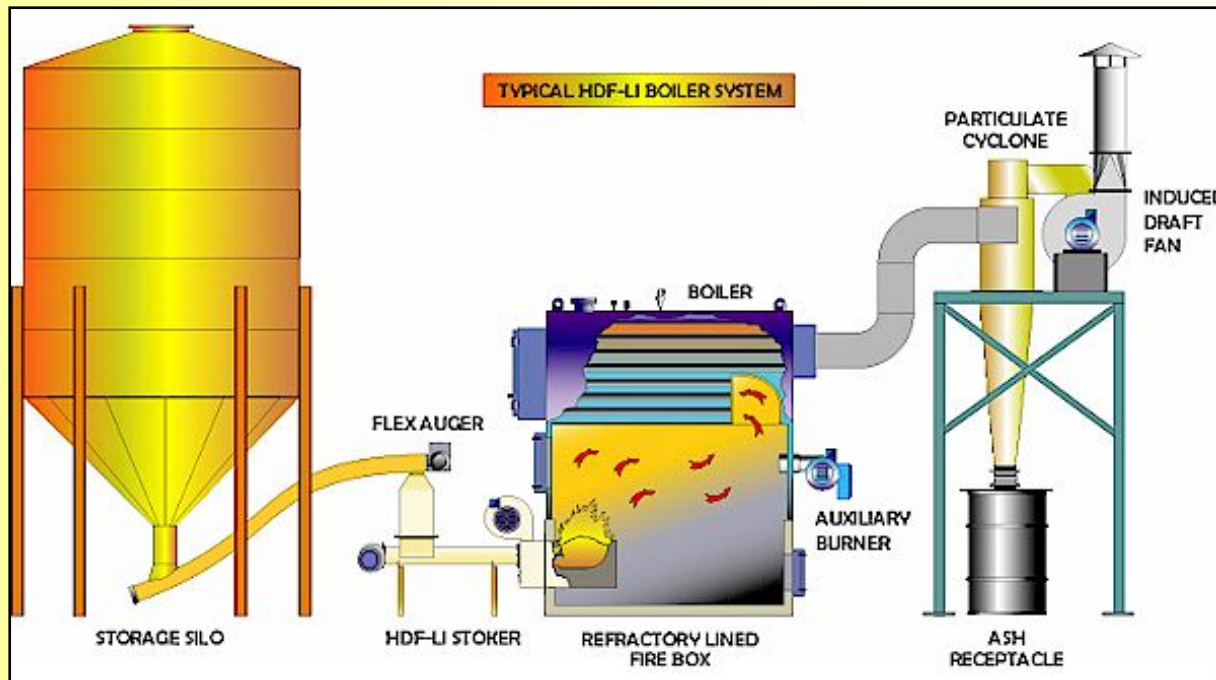


# Indoor Chunkwood Boilers



**Cobb Hill Co-Housing –  
Hartland, Vermont**

# Pellet Boilers





# Pellet Boilers



NRG Systems – Hinesburg, VT

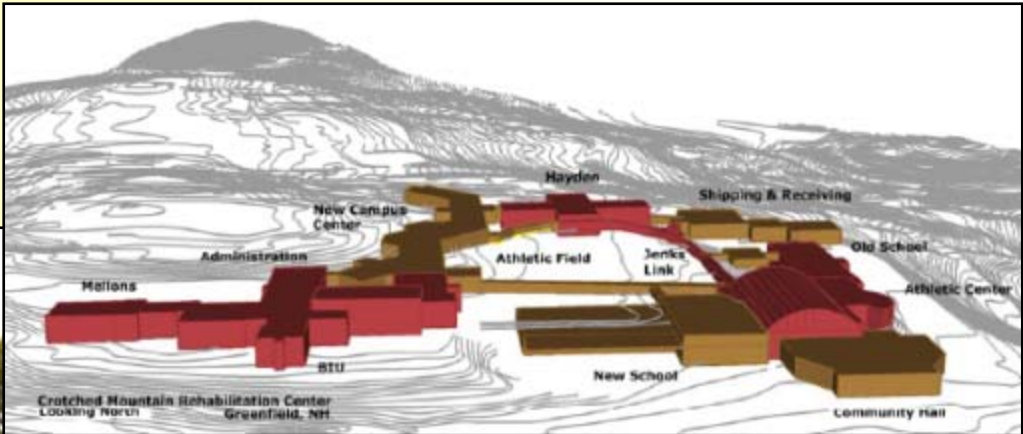




# Woodchip Boilers



# Economic Case Studies



**Crotched Mountain Rehabilitation Center  
Greenfield, New Hampshire**



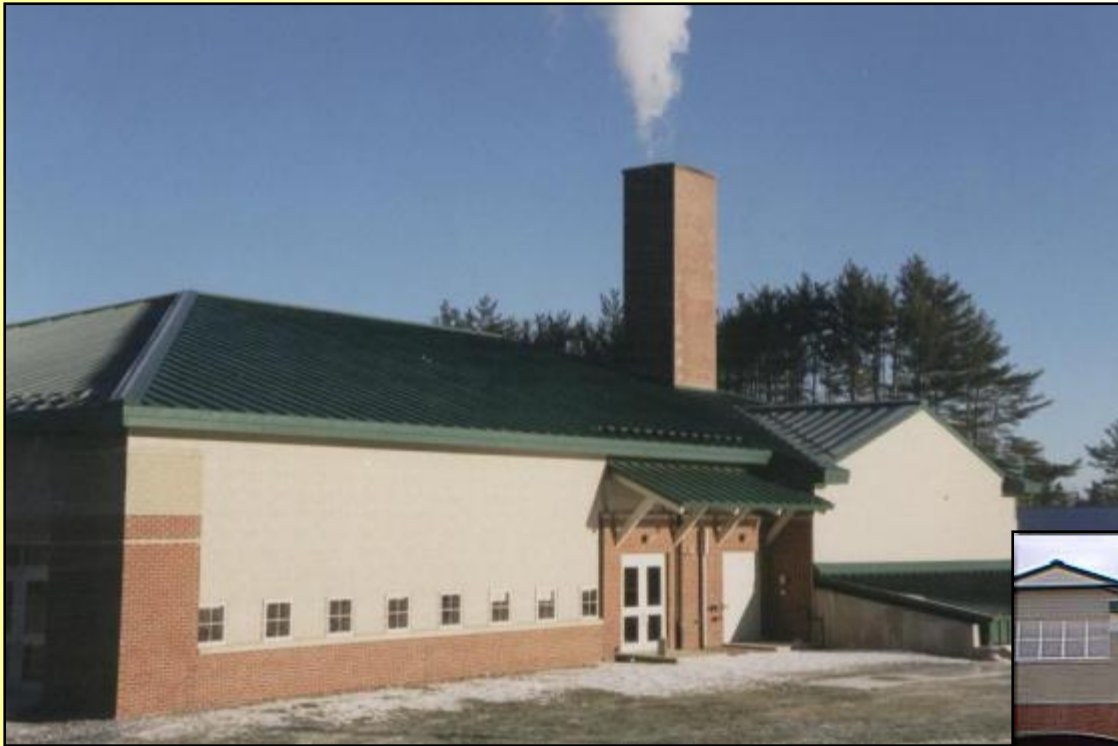
# Economic Case Studies

Installed	2006
System	8 & 4 MMBtu
Heated space	250,000 sf
Prior oil use	115,000 gal
Chip use	92%
Chip use	1,500 gt/yr
Capital cost	\$2 million
Annual fuel savings	\$250,000
Est. Simple Payback	8 years



**Crotched Mountain Rehab Center  
Greenfield, New Hampshire**

# Economic Case Studies



**Leavitt High School**  
Turner, Maine

# Economic Case Studies

Installed	1999
System	4.5 MMBtu
Heated space	166,000 sf
Prior oil use	55,000 gal
Chip use	84%
Chip use	770 gt/yr
Capital cost	\$395,000
Annual fuel savings	\$27,000
Est. Simple Payback	14.6 years



**Leavitt High School  
Turner, Maine**

# Economic Case Studies



**Darby Schools**  
Darby, Montana



## **Fuels For Schools –**

First school in western states

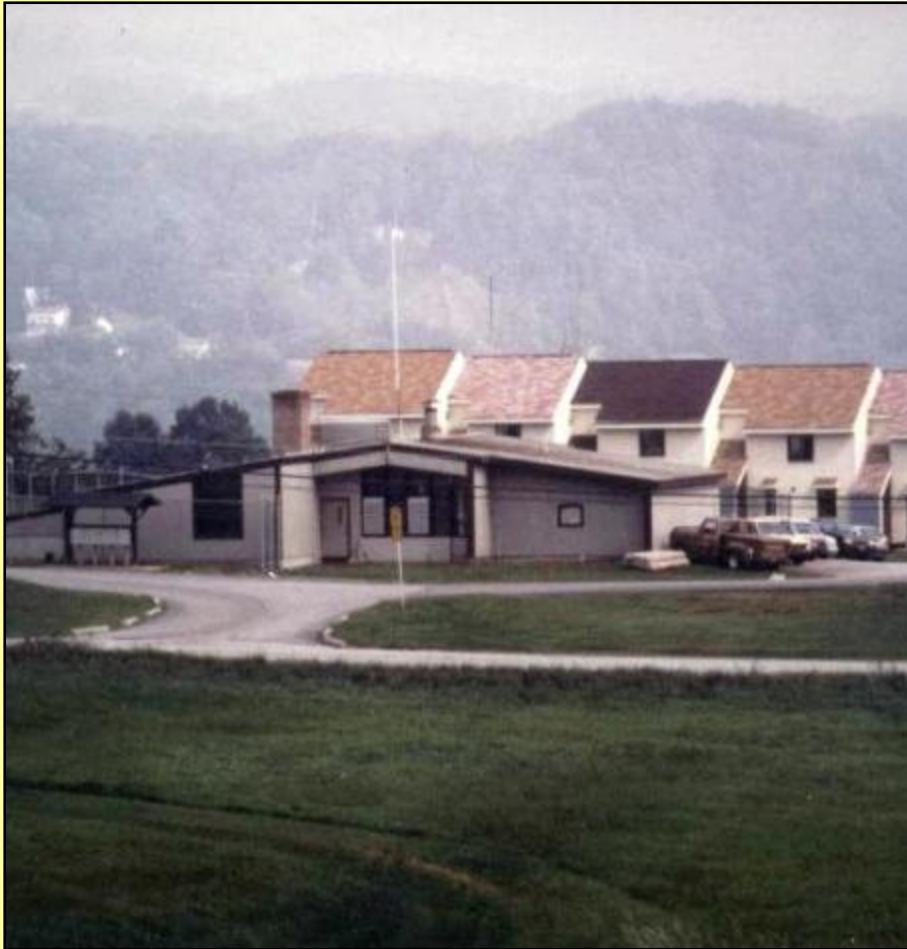
# Economic Case Studies

Installed	2003
System	3MMBtu
Heated space	82,000 sf
Prior oil use	47,600 gal
Chip use	89%
Chip use	755 tons
Capital cost	\$515,000
Annual fuel savings	\$61,000
Est. Simple Payback	8.4 years



**Darby Schools  
Darby, Montana**

# Economic Case Studies



**Green Acres Family Housing**



# Economic Case Studies

Installed	1992
System	2.2MMBtu
Heated space	55,000 sf
Chip use	82%
Chip use	425 tons
Capital cost	\$200,000
Starting oil price	\$0.60/gal
Starting wood price	\$25/ton
Annual fuel savings	\$47,000
Est. Simple Payback	4.25 years

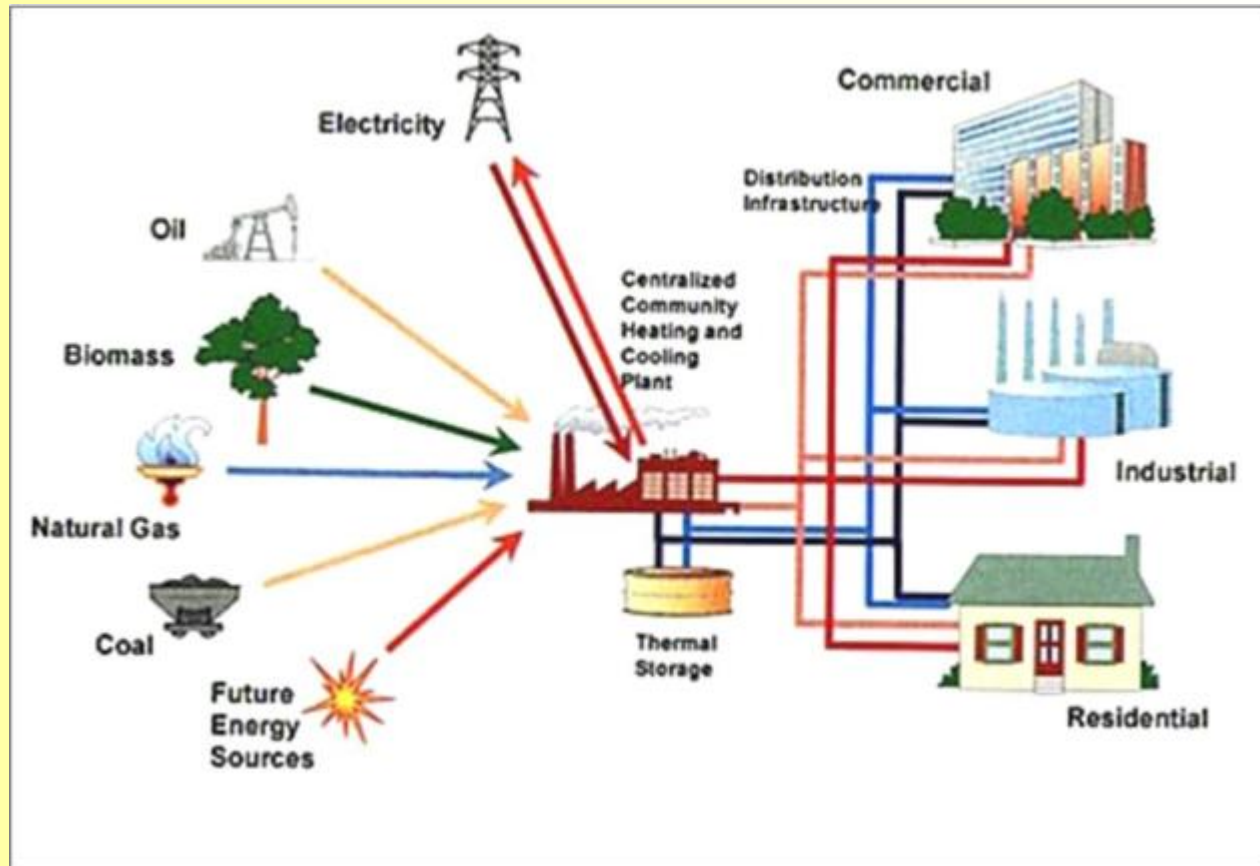


**Green Acres Family Housing**

# District Heating Concept



# Community Energy Diagram



# Thermal Storage for Efficiency and Peak Load Reduction



# Heat Utility Customer



# Contact Information

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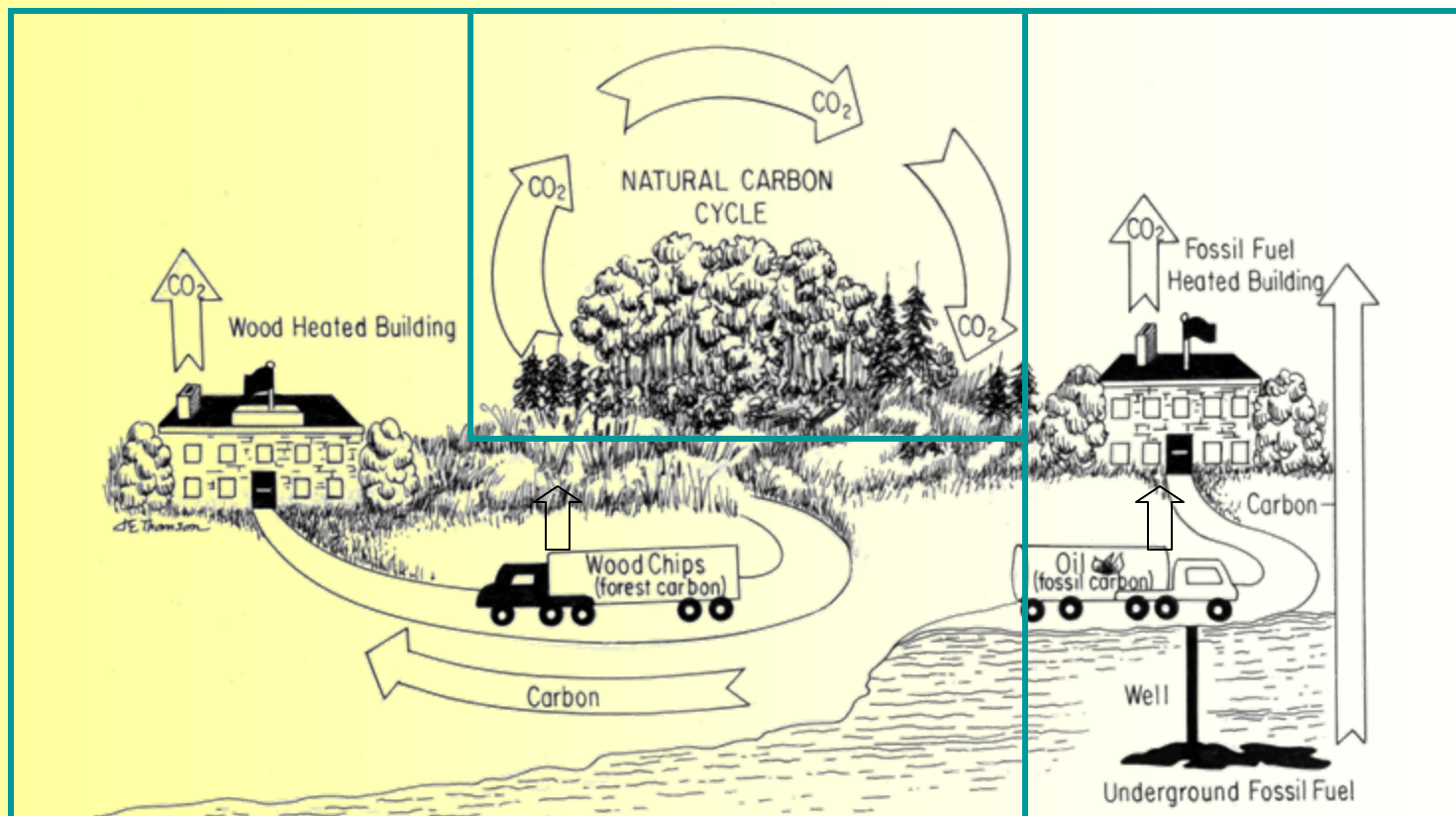


# Air Quality Issues Associated with Switching to Wood Fuel


***Estimated*** Emissions – units of pounds of pollutant per million btu of fuel input (lb/MMBtu)

Pollutant	Natural Gas	No.2 Fuel Oil	Wood
SO <sub>2</sub>	0.001	<b>0.5</b> (10x)	0.025
NO <sub>x</sub>	0.1	0.14	<b>0.22</b> (1.5x)
CO	0.08	0.04	<b>0.2</b> (2.5x)
PM	0.007	0.024	<b>0.25</b> (10x)
VOC	0.005	0.002	<b>0.02</b> (4x)
HAPs	0.002	0.0004	<b>0.04</b> (20x)

# Atmospheric Carbon Impacts of Biomass Energy



THE CARBON CYCLE: Biomass Heated Buildings vs. Fossil Fuel Heated Buildings



# Biomass Energy and Carbon Cycling

## *Is Biomass Energy “Carbon Neutral”?*

Yes, but it really depends on many factors...

- What were the pre-harvest forest conditions?
- What was harvested? How much?
- How was it harvested?
- How much carbon was emitted in harvesting and transporting the wood?
- What was the post harvest condition?
- How is neutrality measured?



# Community-Scale Biomass Energy as a Climate Change Strategy

The two most important questions are:

- What will the harvested wood displace?
- Will the harvesting of the wood used to displace fossil fuels enhance or diminish the forest's capacity to sequester carbon into the future?