Overview of Biomass Heating

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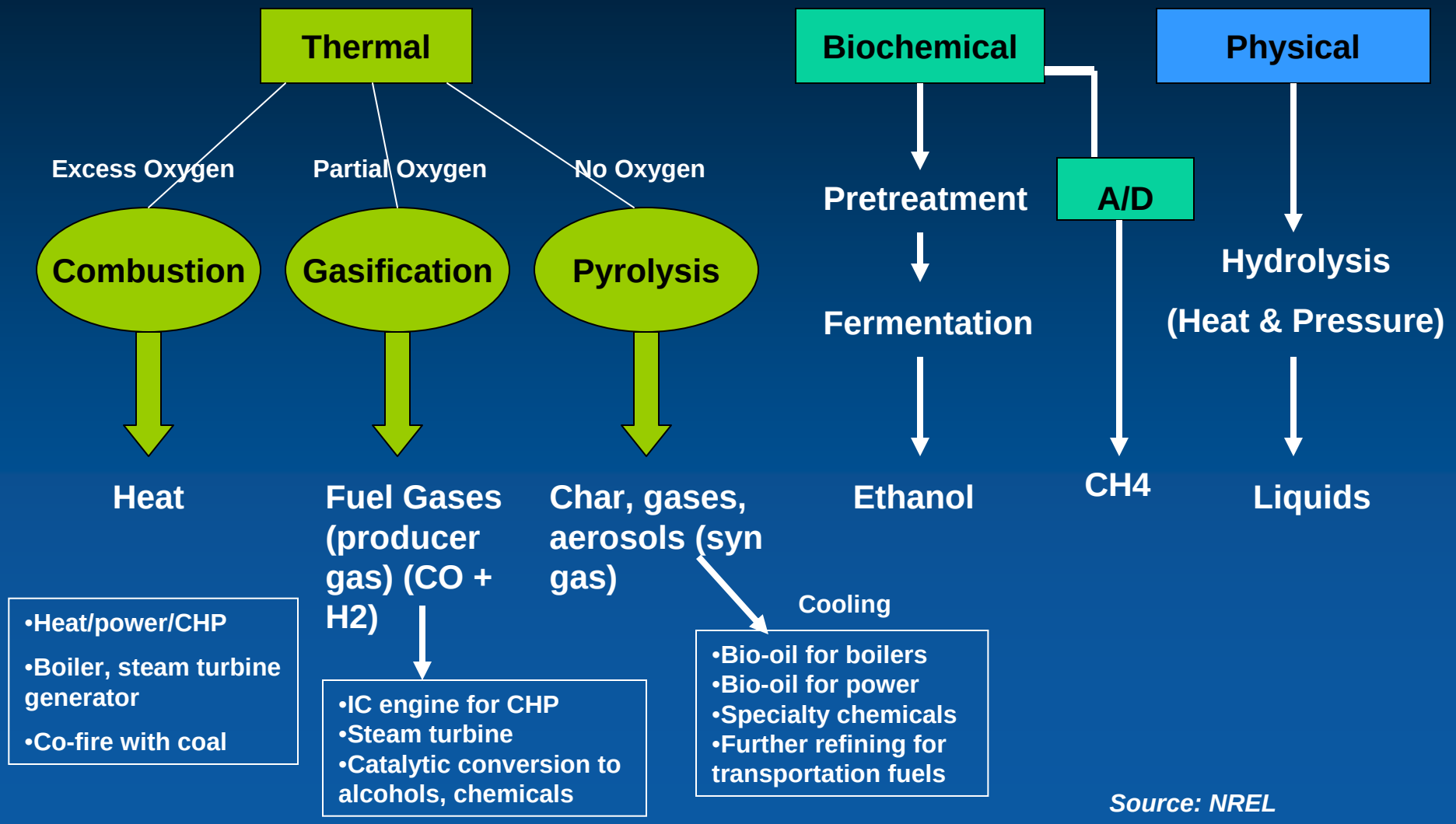
Presentation Outline

- Technologies
- Economics
- Supply
  - Urban wood waste
  - Forest residues
- NREL biomass system

Biomass Resources

- The term "biomass" means any plant derived organic matter available on a renewable basis
- States have various definitions of eligible biomass resources for state RPS targets, e.g.:
  - Colorado has the term “slash and brush” for forest biomass
  - Urban wood waste must be clean and free of contaminants

Biomass Energy Pathways

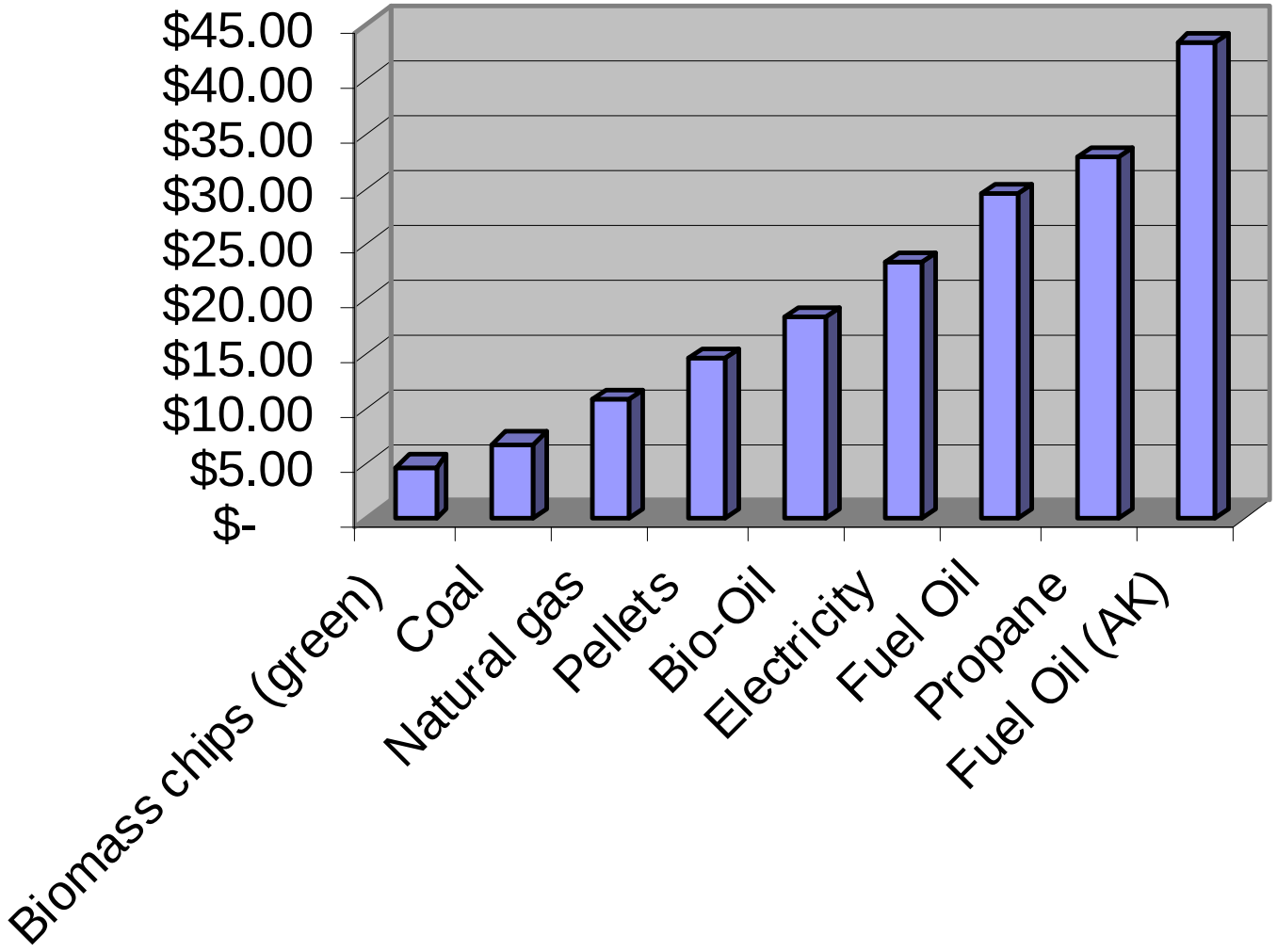


Source: NREL

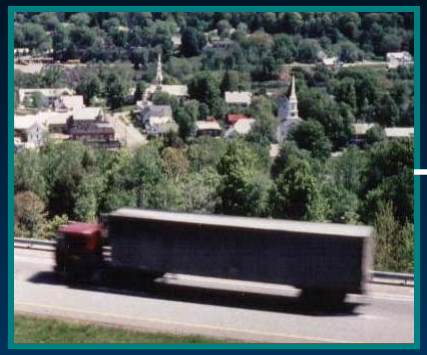
Biomass Heating Plant Overview

1. Fuel Handling
   - Storage, sizing, movement
2. Conversion technology
   - Combustion, gasification, pyrolysis,
3. Control system and programs
4. Emissions control
5. Ash removal
6. Water treatment
7. Back-up system
8. Product delivery (pipes, heat exchanger)

Sample Fuel Cost Comparisons ($/MMBtu Delivered)



Commercial-Scale Wood Heating



Green wood chips (50% moisture) @ $50/ton
~8.6 MBTU/ton in a
high efficiency wood boiler @ 85% efficiency

~ $7.00/MBTU delivered to building

Biomass Heating Technologies

- Commercial, proven technologies
  - Hot water or low pressure steam
  - Chiptec, Messersmith, Advanced Recycling are leading vendors for non-residential systems
  - Positive operator experience
  - Automated to hand fed
  - Clean burning
  - Wood chips, cord wood or pellets
  - Moisture up to 50-60%
- Low to moderate payback periods depending on wood cost and alternate fuel cost

Existing Systems

Darby, MT

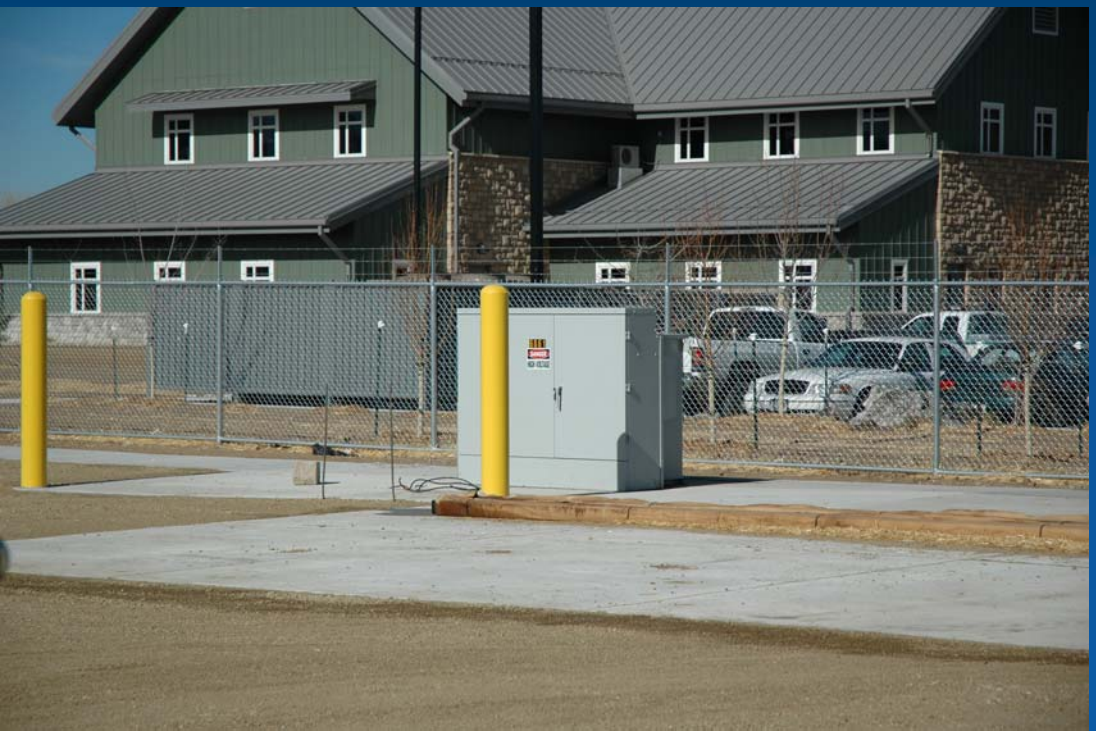
Wood Products

Industry

Court House
Middlebury, VT

Biomass stored below grade

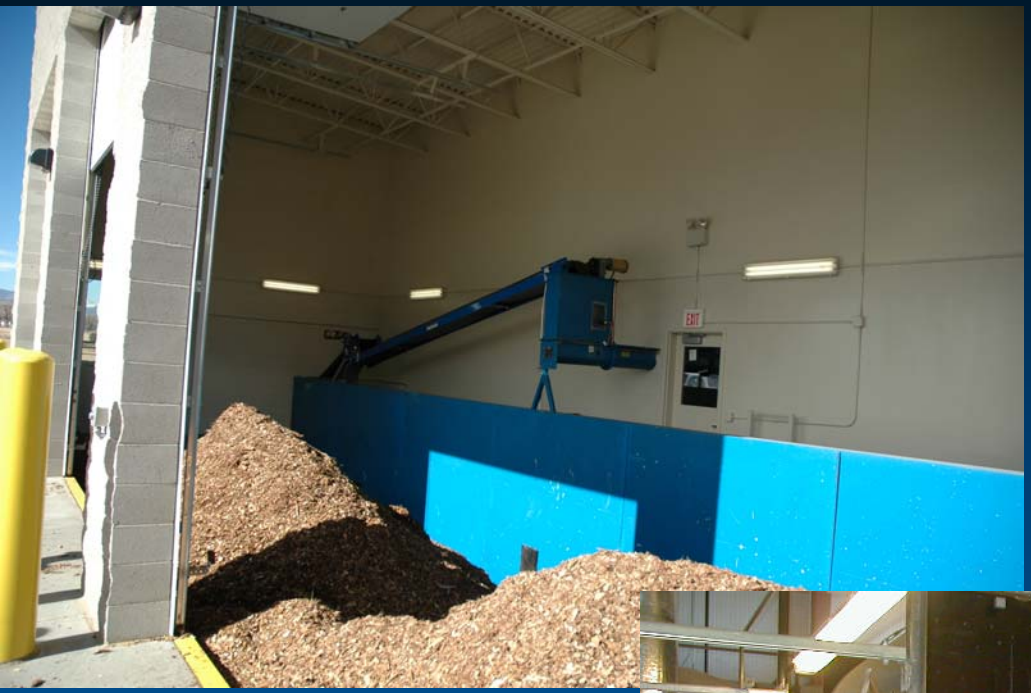
Boulder County, Longmont Campus



Four Main System Types

- Large, automated wood chip
  - Typically buildings over 100,000 square feet
    - Smaller buildings if they have year round need for hot water (prison, hospital
  - Must have large heating bills to justify the investment
- Semi-automated surge bin
  - 10,000 – 100,000 square feet
  - Bucket loader
- Pellet-fired
  - 5,000 square feet and up
  - Systems less expensive, less storage
- Cord wood
  - 5,000 – 50,000 square feet
  - Manual loading of fire wood 1-3 times per day

Automated Chip Systems



- High capital costs,
- Storage needs,
- Fuel must be consistent, no sticks
- Minimal labor

Vermont Army National Guard

MESSERSMITH
MANUFACTURING

Spaulding High School, Barre Vermont (Messersmith)

- 4 acres under glass
- Biomass system saves $400/day in propane costs
- Without biomass, would need to close down due to high propane costs

Cedar Mills Organic Greenhouse, Jackson, CA

Surge-bin system

Smaller,

Simpler,

Cheaper

Source: USFS Fuels for Schools Program

Pellet Systems

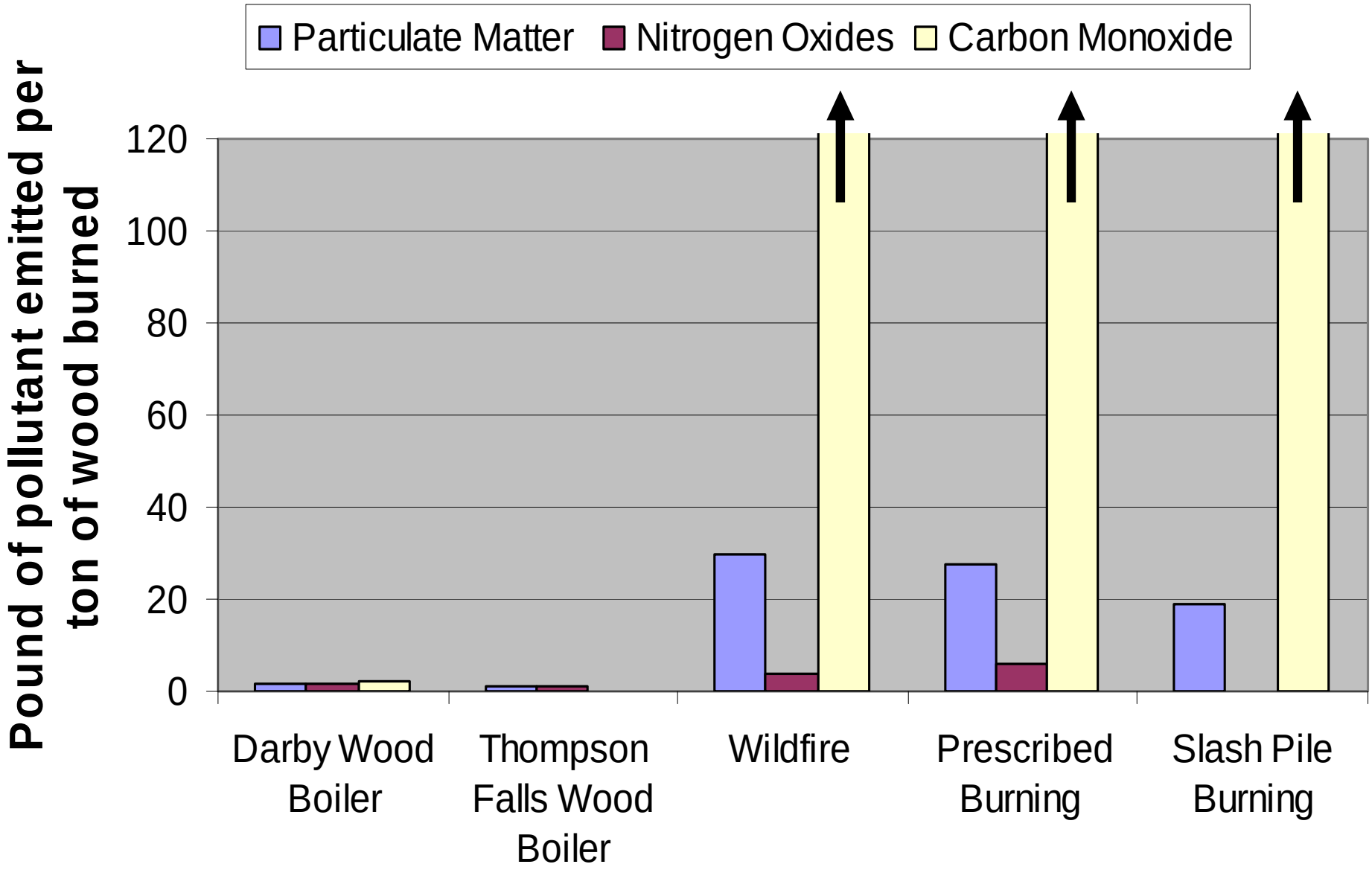
- Fuel is more expensive
- Storage smaller, cheaper
- Boiler smaller, cheaper

Source: USFS Fuels for Schools Program

Garn – Cordwood

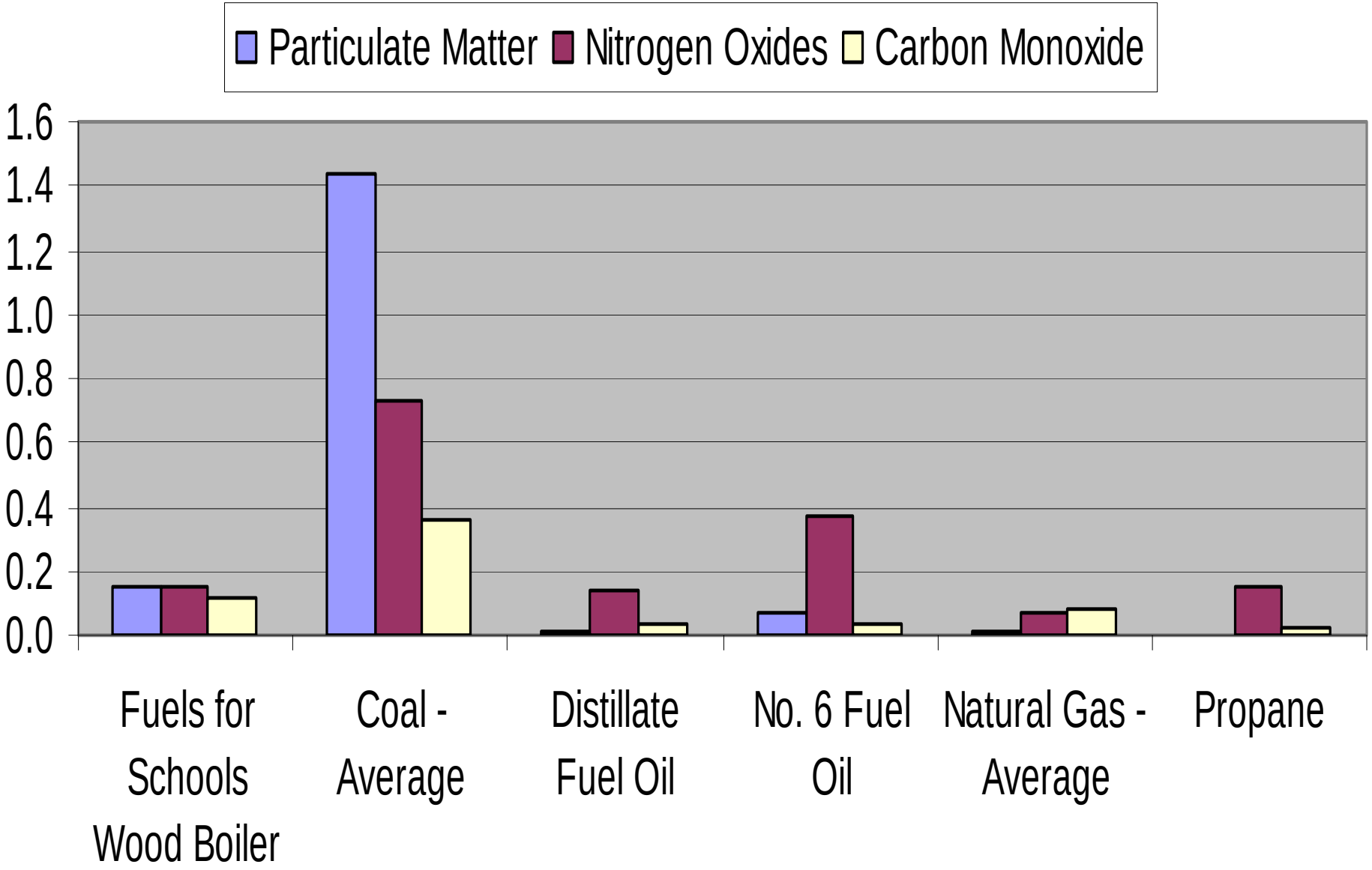
Source: USFS Fuels for Schools Program

Pollutant Emission Rates for Wood Boilers and Fire Activities

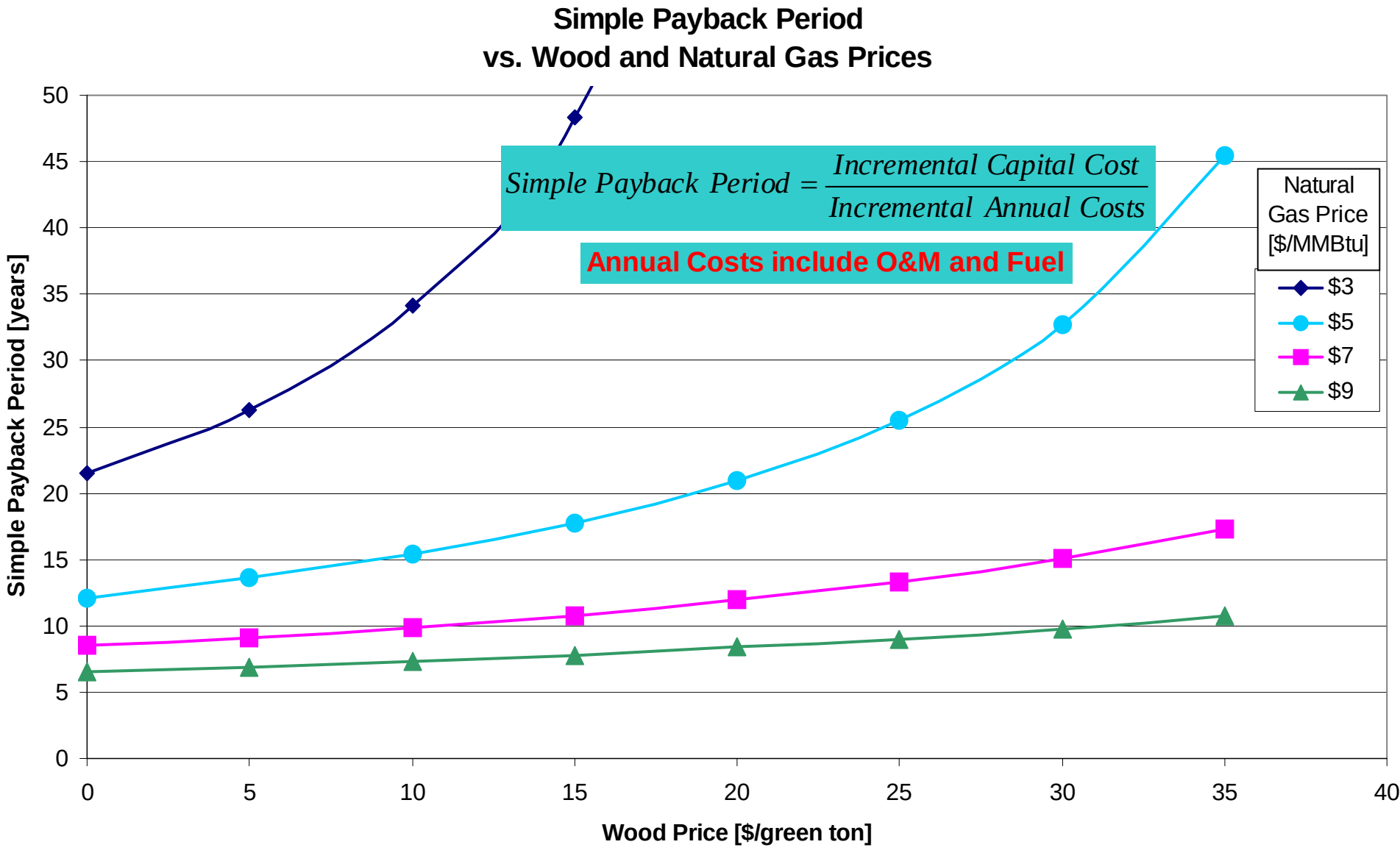


Source: USFS Fuels for Schools (note: no pollution control on boiler systems)

Pollutant Emission Rates by Fuel Type (lb/MMBtu)



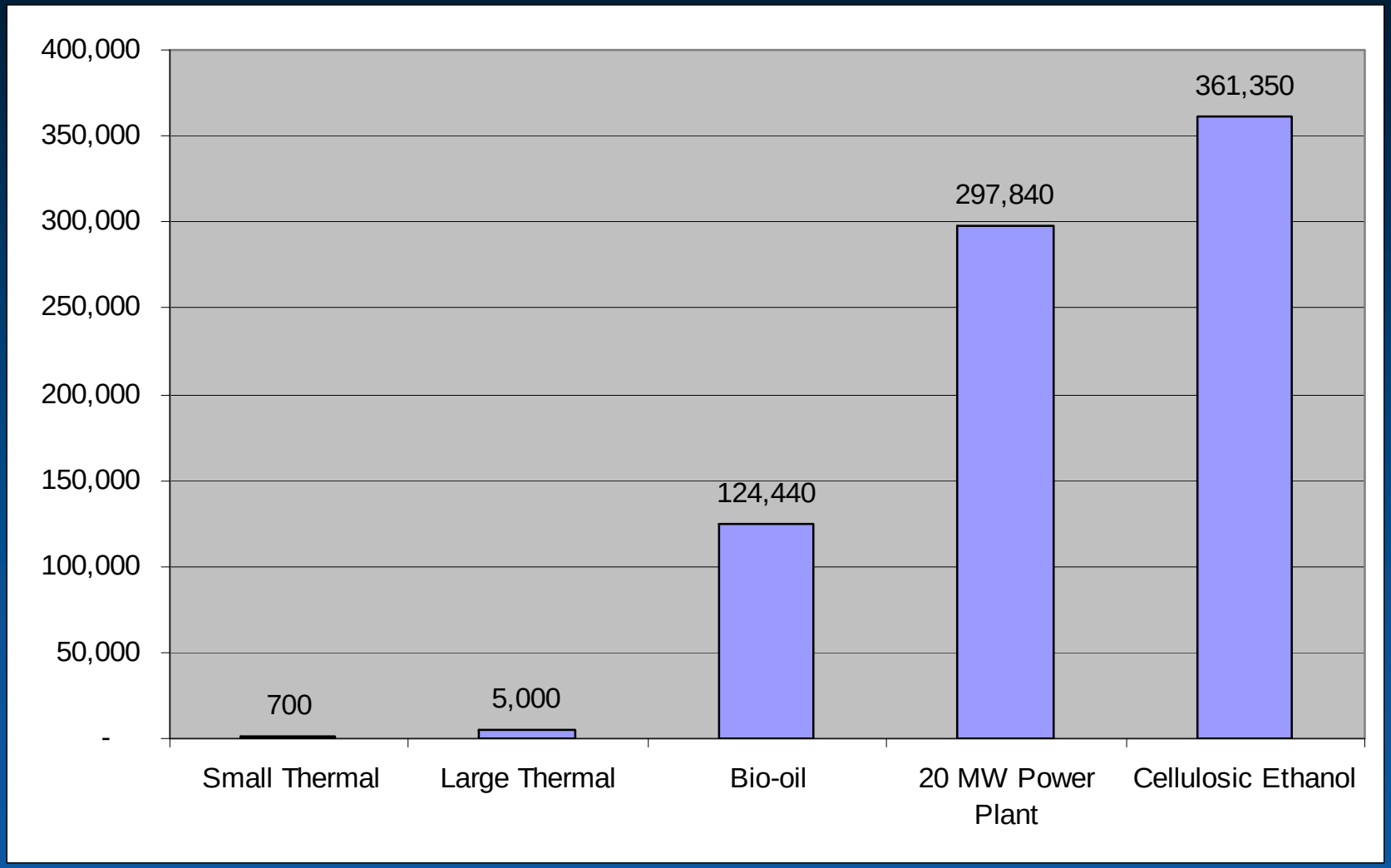
Source: USFS Fuels for Schools

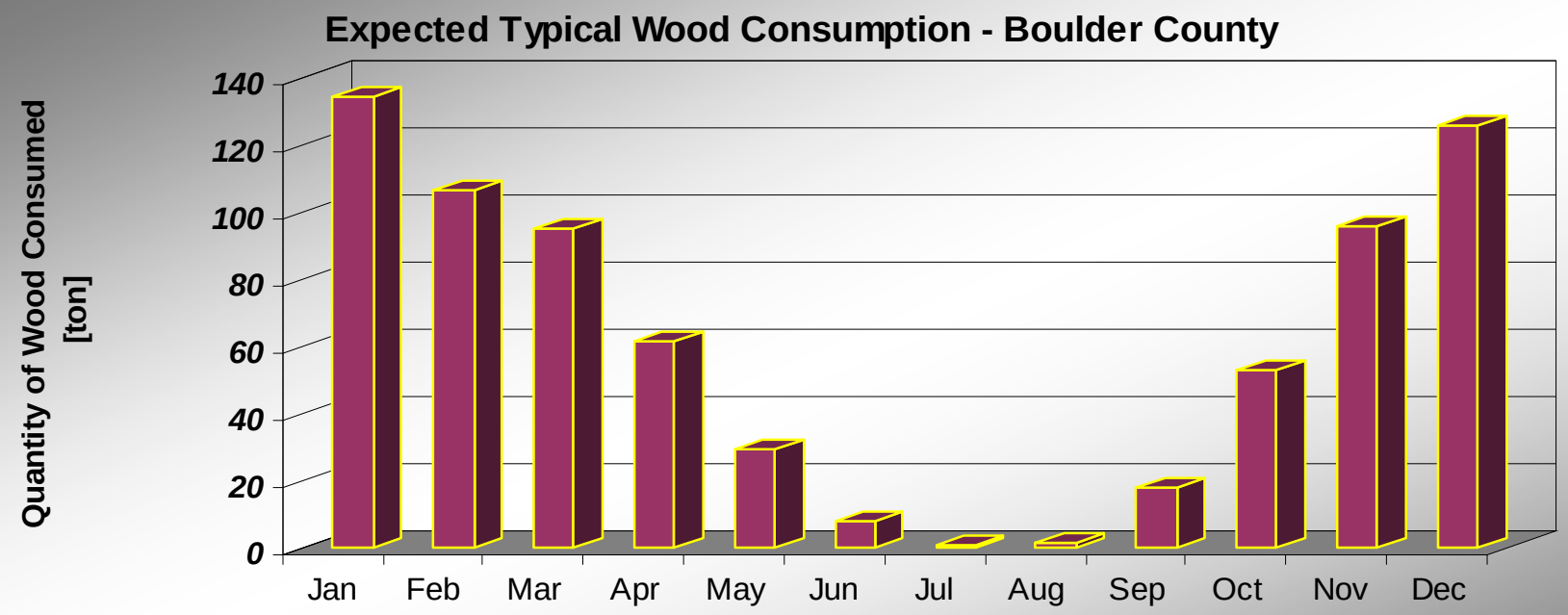

Simple Payback Period
vs. Wood and Natural Gas Prices
Simple Payback Period = Incremental Capital Cost / Incremental Annual Costs
Annual Costs include O&M and Fuel
Natural Gas Price [$/MMBtu]
$3
$5
$7
$9
Simple Payback Period [years]
Wood Price [$/green ton]
0
5
10
15
20
25
30
35
40
45
50

Biomass Supply Issues

- How much do I need?
- Where will it come from?
- How reliable is the source?
- Who will bring it to me?
- What will it cost?
- Quality, moisture, contaminants?
- Sizing, storing?
- Pave your storage site

Typical annual biomass fuel requirements (green tons/year)





	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wood	134	107	95	61	30	8	1	2	18	53	96	125

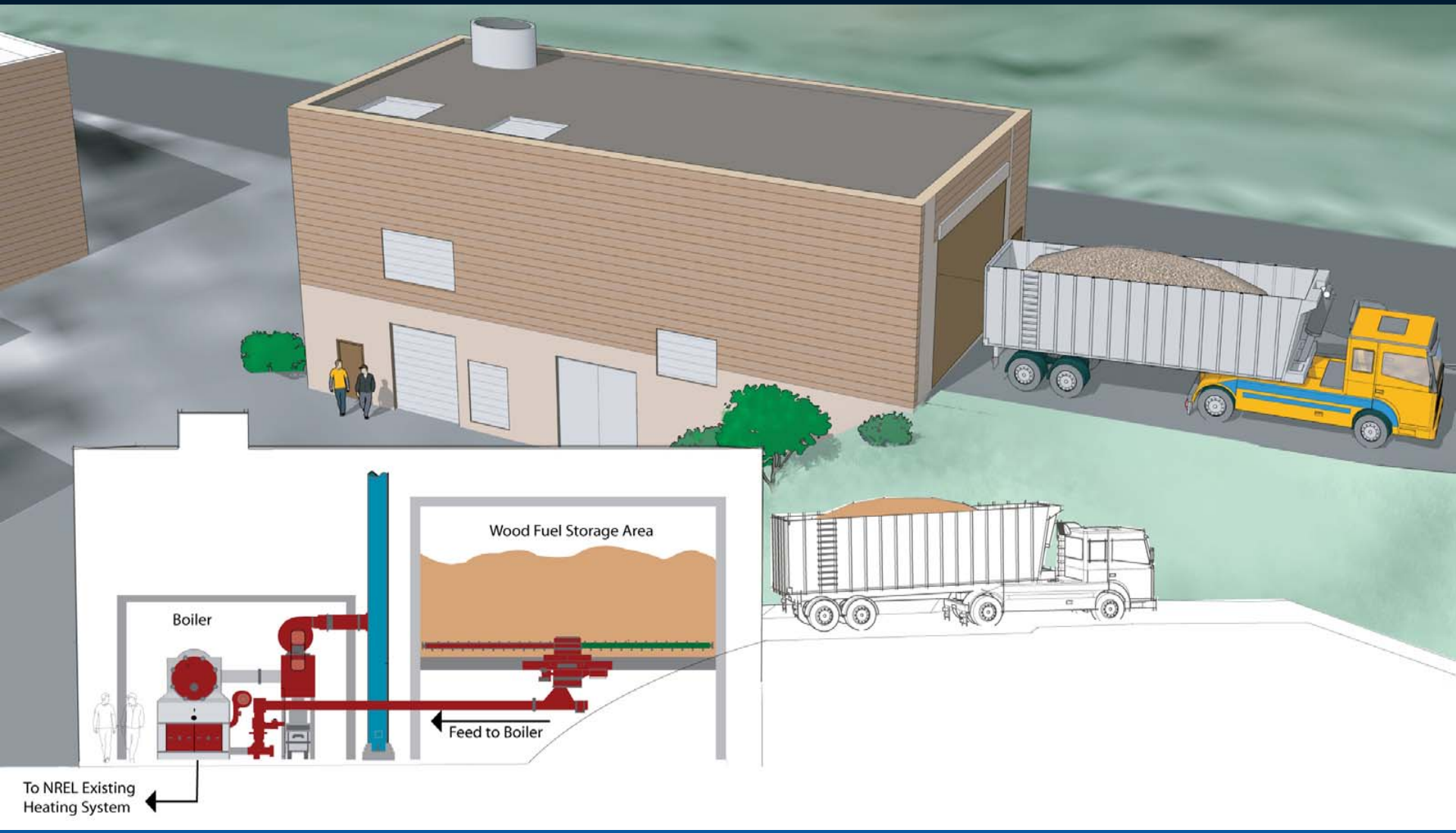
Front Range - Total Biomass Availability (1000 BDT/year)

(Source: Jefferson County Biomass Feasibility Study, 2005)

	Urban	Forest Biomass				
County	Wood Waste	(USFS)	Other public	Private	Sub-Total	Total
Adams	12.3	-	-	-	-	12.3
Arapahoe	12.5	-	-	-	-	12.5
Boulder	8.2	7.4	2.7	-	10.0	18.2
Clear Creek	0.3	1.4	-	-	1.5	1.7
Denver	15.0	-	-	-	-	15.0
Douglas	8.3	4.3	-	0.4	4.6	13.0
El Paso	17.9	-	-	13.0	13.0	30.9
Gilpin	0.2	2.8	-	-	2.8	3.0
Grand	-	5.2	-	-	5.2	5.2
Jefferson	14.2	6.3	-	1.1	7.4	21.6
Larimer	1.4	11.2	-	-	11.2	12.6
Park	0.7	10.2	0.1	-	10.4	11.1
Teller	0.9	7.8	0.1	0.2	8.1	8.9
Total	**91.9**	**56.6**	**2.9**	**14.7**	**74.2**	**166.0**

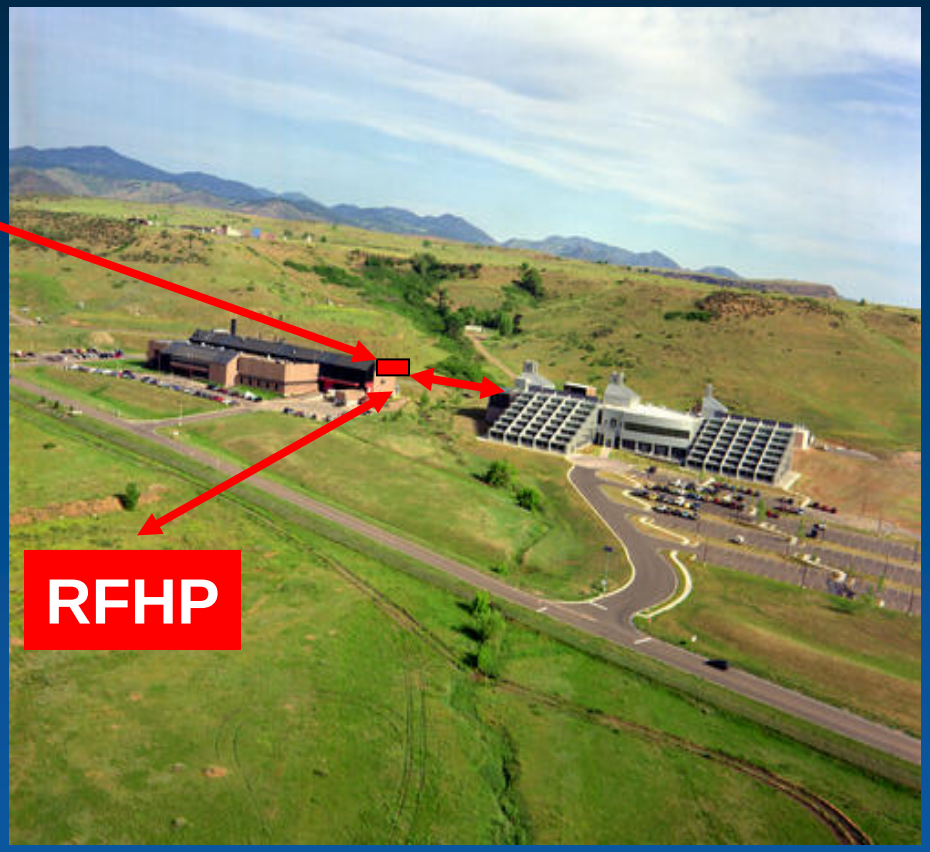
- Costs will be $20 to $60 per ton (green) depending upon quality, moisture content, haul distance

NREL's Renewable Fuel Heating Plant



RFHP Will Heat Major Lab Buildings

- 62% of campus heat
- Fuel from Front Range forest thinnings (USFS, private landowners) and urban wood
- Biomass cost is $29/ton ($2.42/MMBtu vs. $10.00/MMBtu gas)
- 2,200 tonnes CO_2 reduction/year
- 8 year simple payback



Overview

- Completely automated system
  - Includes combustion system, hot water system, fuel storage and handling system, ash removal
  - Existing NG boilers provide 100% backup
- Performance guarantee through ESPC
  - Continuous metering of RFHP output
  - Payments based on guaranteed cost savings

NREL RFHP - System and Economics

- 9 MMBtu/hr wood-fired boiler
- ESCO investment: $3,307,200
- Annual savings: $ 406,072
- Simple pay-back: 8.3 years
- Delivery order term: 25 years

Colorado Projects

- Boulder County (operational)
- Gilpin County (operational)
- NREL (construction)
- CSU (design)
- Fort Lupton greenhouse (on hold)
- Summit county (on hold)
- Jefferson county jail (on-hold)
- About 10-12 schools and other public buildings are in evaluation phase
- Jefferson county pellet mill (planned)
- Grand/Jackson county pellet mills

Bioenergy Success Factors

- Supply
  - Cost, quantity, quality, sizing, storage
  - Delivery contract structure (who bears risk?)
  - Delivery infrastructure?
- Cost of competing fuel
- Biomass conversion technology
  - Reliable, efficient, fuel flexible
- Facility issues
  - Champion
  - Familiarity with technology
  - Technical details

Resources

- Wood Chip Heating Systems
  - http://www.biomasscenter.org/pdfs/Wood-Chip-Heating-Guide.pdf
- Boulder County Feasibility Study
  - http://www.co.boulder.co.us/openspace/resources/forestry/for_pdfs/BCPOS_Final_Biomas_Report_web.pdf
- US Forest Service Fuels for Schools
  - http://www.fuelsforschools.info