

Oroville, September 14 2010

Biomass thermal (heat) applications

Gareth J Mayhead
University of California Berkeley
In partnership with:
USDA Forest Service Region 5

<http://ucanr.org/WoodyBiomass>



University of California
Agriculture and Natural Resources

Woody Biomass Utilization



Overview

- Wood fuel types
- Domestic stoves
- Institutional systems
 - Scale
 - Typical system
 - Examples
 - Conclusions

<http://ucanr.org/WoodyBiomass>



University of California
Agriculture and Natural Resources
Woody Biomass Utilization



Wood fuel types

Logs/cordwood



Chips



Pellets/densified fuels



<http://ucanr.org/WoodyBiomass>



University of California
Agriculture and Natural Resources
Woody Biomass Utilization



Biomass fuel types

- **Chips**
 - Cheaper
 - Simple
 - **More variable**
 - **Can be problematic to feed/handle**
 - Best for buildings above 50,000 ft²
- **Pellets (densified wood fuel)**
 - Higher energy density
 - Consistent product
 - Clean/convenient
 - Global commodity
 - **Equipment intensive**
 - **Energy input (70-80kWh/t)**
 - **Expensive end-product**
 - Best for buildings 10,000-50,000 ft²

<http://ucanr.org/WoodyBiomass>



University of California
Agriculture and Natural Resources
Woody Biomass Utilization



Firewood – a valuable product



University of California
Agriculture and Natural Resources
Woody Biomass Utilization



Domestic stoves



<http://ucanr.org/WoodyBiomass>



University of California
Agriculture and Natural Resources
Woody Biomass Utilization

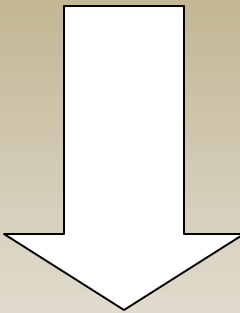


Scale for institutional heat

10,000 ft²-1 million+ ft²

0.35 million BTU/hr-10 million+ BTU/hr

Heat only



Campfire



Powerplant

<http://ucanr.org/WoodyBiomass>



University of California
Agriculture and Natural Resources
Woody Biomass Utilization



Potential biomass heat users

- Schools
- Hospitals
- Recreation and Aquatic Centers
- Correctional Facilities
- College Campuses
- Shopping Complexes
- Large Warehouses or Garages
- Large Greenhouse Operations
- Industrial Process Heat

<http://ucanr.org/WoodyBiomass>



University of California
Agriculture and Natural Resources
Woody Biomass Utilization

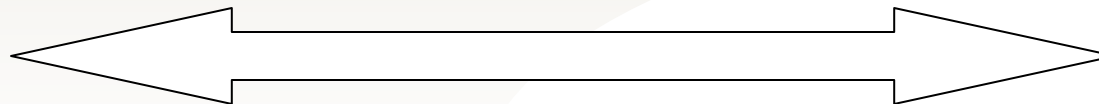


Scale

Facility:	Tilamook Forest Center, OR	Enterprise Public Schools, OR	Chadron State College, NE
Area:	12,500 ft ²	105,000 ft ²	1.1 million ft ²
Fuel:	Wood pellets	Wood chips	Wood chips
Boiler:	0.42 million BTU/hr	2.5 million BTU/hr	9 million BTU/hr

small

large



<http://ucanr.org/WoodyBiomass>



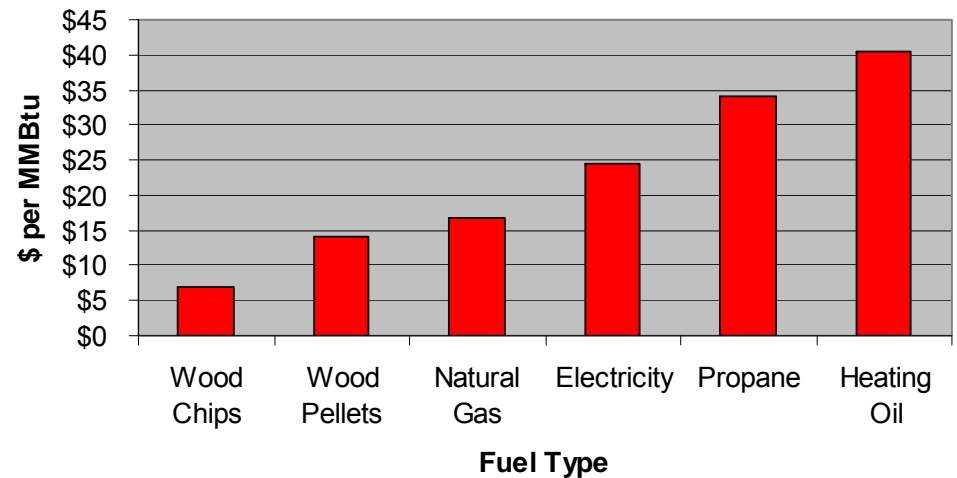
University of California
Agriculture and Natural Resources
Woody Biomass Utilization



Small scale heat (institutional)

- Can be cheaper than alternatives – it is easy to calculate simple payback
- Carbon neutral
- Local market
- Opportunities for buildings (10,000 sq ft to 1m+ sq ft)

Heating Fuel Cost Comparison (Av National Prices)



Source: US DOE Energy Information Administration, Sept 08

<http://ucanr.org/WoodyBiomass>



University of California
Agriculture and Natural Resources
Woody Biomass Utilization



Technology and Performance Benefits

- Off the Shelf Technologies
- Long History of Performance
 - Vermont State: 25 Schools heat with Biomass
 - Chadron Community College, Nebraska – 25+ years of operation



<http://ucanr.org/WoodyBiomass>



University of California
Agriculture and Natural Resources
Woody Biomass Utilization



Typical Parts of a Biomass Heat System:

1. Storage Bin – container to keep fuel supply dry and clean.
2. Equipment to handle fuel – to transport the fuel from the bin to the boiler.
3. Firebox and boiler – to burn fuel and generate hot water or steam.
4. Controls – to ensure efficient and clean combustion.
5. Chimney and clean-up equipment – to disperse combustion gases and manage emissions.
6. Building – to house equipment.

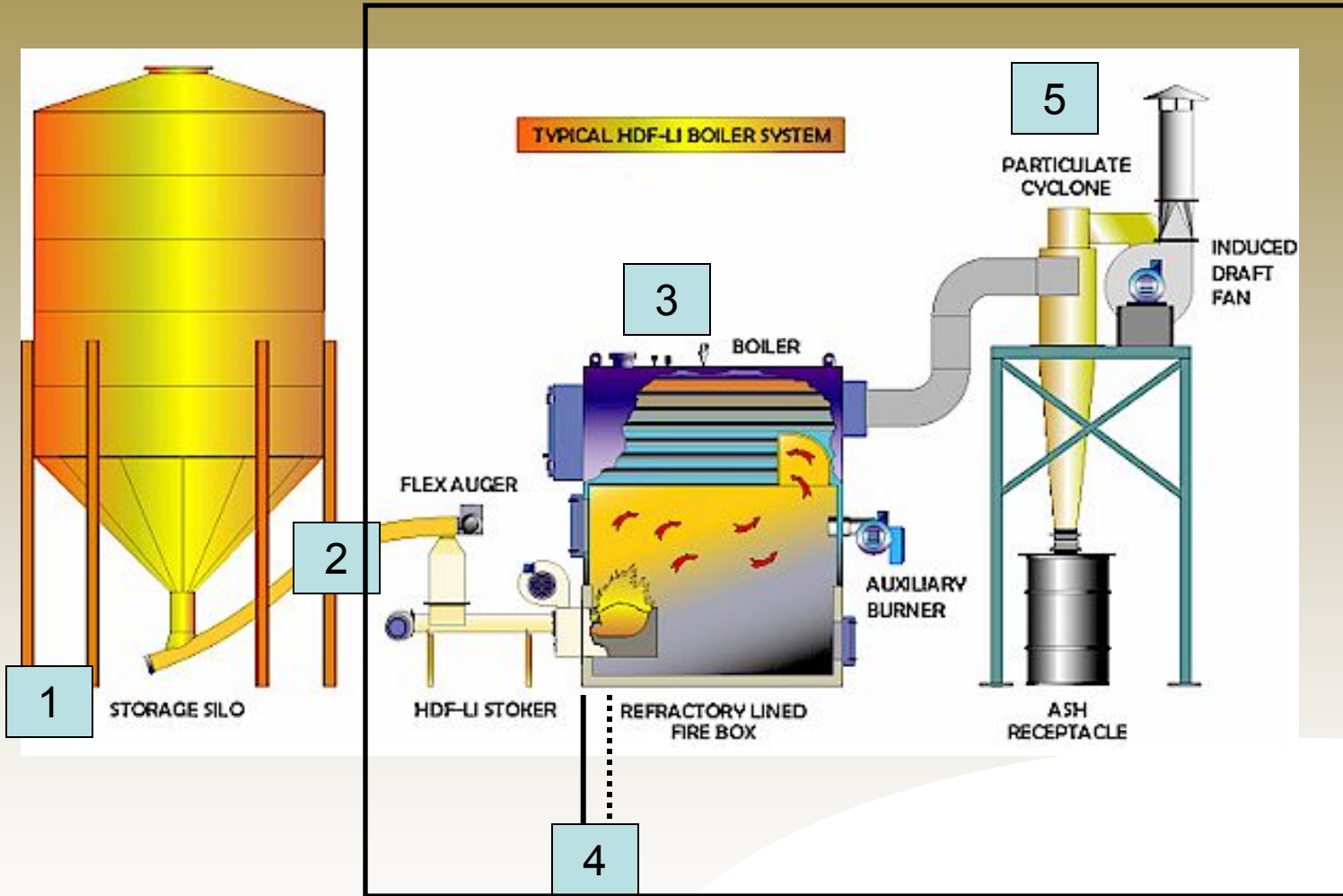
<http://ucanr.org/WoodyBiomass>



University of California
Agriculture and Natural Resources
Woody Biomass Utilization



Typical pellet boiler system



Source: SolarGen <http://www.solageninc.com/>

<http://ucanr.org/WoodyBiomass>



University of California
Agriculture and Natural Resources
Woody Biomass Utilization



What do they look like?



<http://ucanr.org/WoodyBiomass>



Woody Biomass Utilization



Typical school unit



17,000 BTU/hr hot water
(80% efficiency)

Supplemented by:

- Solar hot water
- Gas boiler (peak load and back-up)



<http://ucanr.org/WoodyBiomass>



University of California
Agriculture and Natural Resources
Woody Biomass Utilization



Basic feasibility questions

- Fuel Supply Availability and Predictability
- Commitment: Maintenance, First Cost
- Site Layout: Space, Existing Structures
- Air Quality: Non-attainment Area?
- Project Cost Supported By The Savings

<http://ucanr.org/WoodyBiomass>



University of California
Agriculture and Natural Resources
Woody Biomass Utilization



Payback and finance

- Simple Payback
 - Project Cost, Fuel Cost Savings
- More complex payback tool:
 - <http://www.fwe.wisc.edu/extension/BoilerProgram.xls>
- Consider an energy savings performance contract (ESPC)
 - Guarantees your energy cost savings to allow access to finance
 - List of federal ESPC vendors on our website

<http://ucanr.org/WoodyBiomass>



University of California
Agriculture and Natural Resources
Woody Biomass Utilization



Air Quality Considerations

Air Emissions	Open Field Burning	Biomass Fueled Boiler	Natural Gas Boiler
	lb/Million Btu		
CO	6.89	2.267	0.058
CO ₂ fossil		0	114.6
CO ₂ non fossil		350.0	0
NO _x	0.36	0.250	0.301
SO _x	0.03	0.013	0.073
VOC	0.74	0	0.009
Methane		0	0.003
Particulates	0.66	0.028	0.009

<http://ucanr.org/WoodyBiomass>



University of California
Agriculture and Natural Resources
Woody Biomass Utilization



Example: school project using chips

- Alturas Elementary/Modoc Middle School
- 4 MMBTU boiler
- 280-360 GT/yr
- \$34.50/GT delivered cost for fuel
- Savings in fuel oil: \$60,000/yr
- Cost: \$1.24m
 - Biomass System : **\$332,185**
 - Fuel Reclaiming System : **\$86,541**
 - Pumps, Heat Ex., Piping : **\$70,732**
 - Installation Costs : **\$71,000**
 - Buildings, Roads, Engineering : **\$588,600**
- 15 year payback period

<http://ucanr.org/WoodyBiomass>



University of California
Agriculture and Natural Resources
Woody Biomass Utilization



Example: hospital project using pellets

- New build hospital, Burns, OR
- Heating plus evaporative cooling
- 54,000 sq ft
- ~\$300,000 investment
- Savings: \$58,590/year
- 5 year payback



<http://ucanr.org/WoodyBiomass>



University of California
Agriculture and Natural Resources
Woody Biomass Utilization



Siting Considerations – biomass heat

- Heating needs
 - More is better
 - Consistent demand is better
- Air basin - cleaner air sheds are more amenable
- Timing: new construction or a replacement?
- Current type of fuel
- Biomass fuel availability:
 - Harvest
 - Processing
 - Transport infrastructure
- Fuel storage - fixed or mobile storage takes room and costs money
- Facility staff interest and capacity
- Public support
- Initial investment and payback period

<http://ucanr.org/WoodyBiomass>



University of California
Agriculture and Natural Resources
Woody Biomass Utilization



Main Points

- Wood based heating can make a lot of sense
- Local fuel sourcing – jobs, fuels reduction
- Community/small scale
- Running payback calculations and initial feasibility is simple

<http://ucanr.org/WoodyBiomass>



University of California
Agriculture and Natural Resources
Woody Biomass Utilization



