Biomass Boiler Project Development

Eastern Idaho Biomass Energy Workshop
Lost Trail Ski Resort
June 2014

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Your Background

A. Facility Operators
B. Wood Heating System Vendors
C. Building Contractors
D. Community Administrators
E. Community Members
F. Building Users

CTA's Biomass Experience

26 Designed/Completed Projects:

UAF-Yukon Flats, Tetlin Community, Yukon-Koyukuk Elder Assisted Living Facility - Galena, Alaska Gateway School District – Tok, City of Craig-Craig School District, Mentasta District Heatloop*, Holy Cross Community Center*, Grayling Community Center.

Council, Darby, Deer Lodge, Enterprise, Eureka, Kalispell, Kellogg, Philipsburg, St. Maries, Thompson Falls, Townsend, Troy, Victor, White Pine School Districts, Harney District Hospital, University of Idaho, University of Montana-Western, Bismarck Public Works.

111,701 Potential & 26 Actual Projects

~350 Boilers for 150 +/- Pre-Feasibility Assessments
7,239 Montana Boilers
38,599 Colorado Boilers
65,535 Michigan Boilers
____
111,723 Potential Projects

Why woody biomass as an energy source?

A. Typically better cost stability than conventional fuels.
B. Local fuel production creates jobs and keeps money in the community.
C. Can promote improved forest health and reduced wildfire danger.
D. Renewable energy source.
E. Net carbon emissions to the atmosphere are near zero.
F. Biomass is a cheaper/greener energy source, not necessarily a more efficient one.

Exploring woody biomass projects

A. Key Project Considerations
B. Lessons Learned
C. Project Guidance

Project Considerations

A. Strong Project Advocate
B. Current Fuel/Energy Use
C. Fuel Resource
D. Site Considerations
E. System Integration
F. Air Quality
G. Costs
H. Economic Viability
I. Funding
J. Project Delivery

A. Strong Project Advocate

1. Projects can be complicated – need a consistent, steady hand.
2. Need buy-in from all levels of organization – maintenance to management.
3. Ideally the advocate would be around for the long haul – from initial investigation through construction and into the first couple of years of operation.

Pre-Feasibility Assessments What are they?

1. Address items B through H.
2. Typically 10 – 20 pages.
3. Pre-Feasibility vs. Full Feasibility.

Pre-Feasibility Assessments
What is done?

1. Usually a mechanical engineer performs the work.
2. Site Visit to review the building and heating systems.
3. Collect energy data.
4. Collect building drawings.
5. Review local forest product industry.
6. Develop a report.
7. Includes costs and economic analysis.

Current Fuel/Energy Use

1. How much energy is the current system using?
2. What fuels are currently being used?
3. What are the costs both total $ and $/unit energy.
4. Do you know your Energy Use Index (EUI)? kBtu/SF

Potential for Energy Cost Savings

Unit Fuel Costs Equalized to $/MMBtu							
Fuel Type	Units	Gross Btu/unit	System Effeciency	Net System Btu/unit	Fuel $/unit	Gross $/MMBtu	Delivered $/MMBtu
Fuel Oil	gal	134500	0.8	107600	$3.00	$22.30	$27.88
					$3.50	$26.02	$32.53
					$4.00	$29.74	$37.17
					$4.50	$33.46	$41.82
Propane	gal	90500	0.8	72400	$2.50	$27.62	$34.53
					$3.00	$33.15	$41.44
					$3.50	$38.67	$48.34
					$4.00	$44.20	$55.25
Electricity	kwh	3413	1	3413	$0.08	$23.44	$23.44
					$0.09	$26.37	$26.37
					$0.10	$29.30	$29.30
Cord Wood	cords	16173800	0.65	10512970	$200.00	$12.37	$19.02
					$250.00	$15.46	$23.78
					$300.00	$18.55	$28.54
Pellets	tons	16400000	0.7	11480000	$250.00	$15.24	$21.78
					$300.00	$18.29	$26.13
					$350.00	$21.34	$30.49
Ground Wood	tons	10800000	0.65	7020000	$35.00	$3.24	$4.99
					$50.00	$4.63	$7.12
					$75.00	$6.94	$10.68
					$100.00	$9.26	$14.25

Quick math for savings potential…

10,000 gal fuel oil at $4.00/gal
= $40,000 per year and 1345 dekatherms (dkt)

Chips available at $50/ton
= $7.12/dkt = $9600 per year

Potential for ~$30,000 per year savings
Assuming a 10 year payback – could support a $300,000 project

WARNING:
These are very rough assumptions to get a quick ball park! If project is not viable here, it is unlikely to be a strong project.

Fuel Resource

1. Type and availability of fuel.
2. Fuel cost.
3. Are there multiple sources?
4. Is the infrastructure in place to process and deliver the fuel?
5. Fuel quality and consistency is extremely important!

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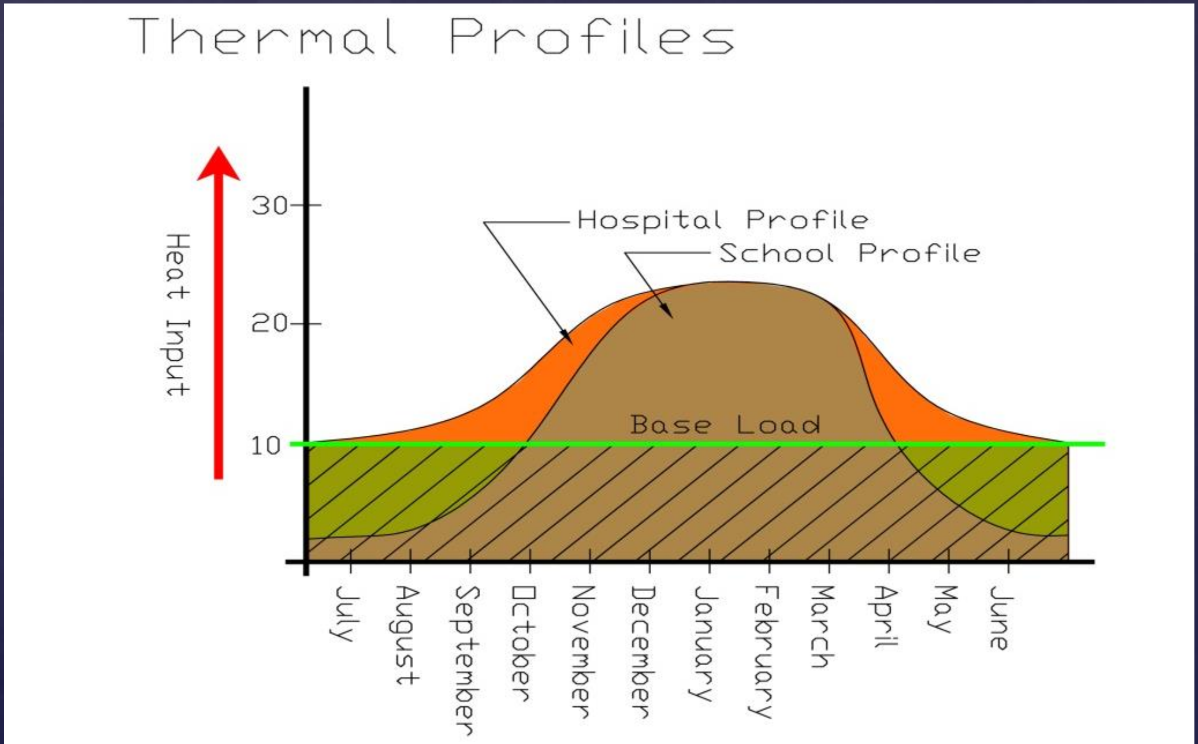
Biomass Boiler Size

1. What is total connected load?
   Heating system, domestic hot water, process loads
2. Biomass Boiler Size: Target 90% of boiler run hours, not peak load. Consistent base load is important.
3. Do not oversize boiler!



System Integration

1. What is (are) existing HVAC system(s)? (Steam, hot water, forced air?)
2. Single boiler room or campus system?

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Biomass Boiler Technologies

1. Cord Wood
2. Pellets
3. Chipped or Ground Fuel

Cord Wood

Typically up to 200,000 Btu/hr

Advantages

1. Lowest cost
2. Smaller
3. Simple to operate
4. Local resource

Disadvantages

1. Hand fed - large labor commitment
2. Atmospheric (non ASME)
3. Need thermal storage tank
4. Difficult to maintain typical heating water temps (180 deg F)

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Pellet

Typically up to 5,000,000 Btu/hr

Advantages

1. Smaller than chip system
2. Automated
3. Easy/flexible fuel handling
4. Good emissions

Disadvantages

1. Higher cost than cord wood
2. Highest wood unit fuel cost ($/dkt)
3. Need to be near a pellet mill

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Chips/Ground Fuel

Typically over 1,000,000 Btu/hr

Advantages

1. Lowest unit fuel cost ($/dkt)
2. Automated
3. Local fuel resource

Disadvantages

1. Highest capital cost
2. Largest fuel storage required
3. Less consistent fuel quality can cause operational issues

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Factors in Boiler Selection

1. What is existing heating system?
2. What size is needed? Btu/hr and physical size.
3. What wood fuel is available?
4. What is project budget?

Site Considerations

1. Will biomass boiler fit in existing building or is new construction needed?
2. Can delivery vehicles access and maneuver the site?
3. Stack concerns – height, HVAC intakes, building occupants.

Air Quality

1. Involve an air quality engineer early
2. Determine the standards in play
3. Find unusual weather conditions (calms, inversions)
4. Get direction on air pollution control devices/ stack height
5. PM standards most difficult for biomass boilers to meet
6. Stack concerns – height, intakes, building occupants.

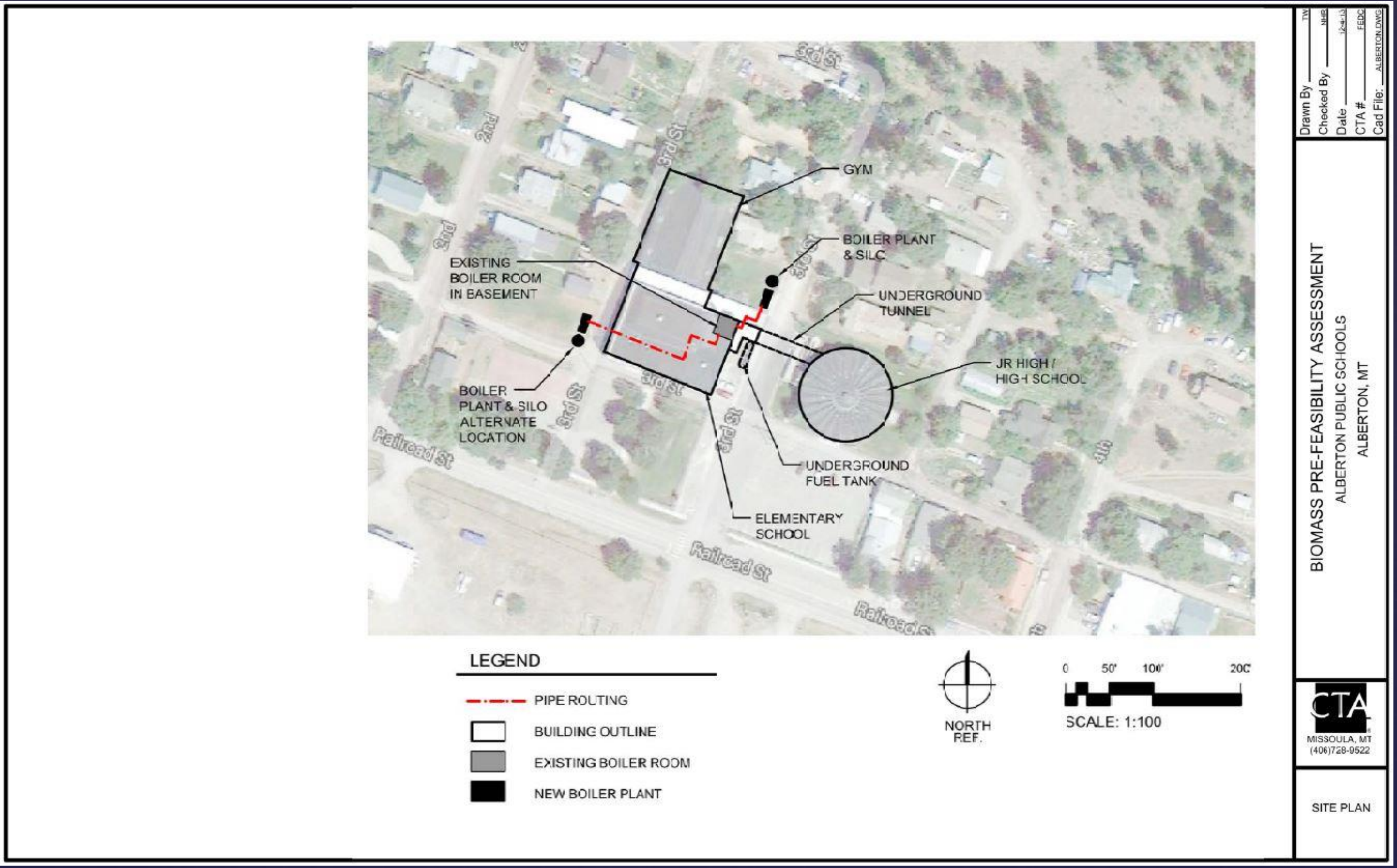
Other Considerations

1. Building Authority Having Jurisdiction.
2. Asbestos survey recommended.
3. Combined Heat Power desired?

Develop system options

1. Put it all together.
2. Three wood fuel type boilers to consider.
3. What is existing heating system?
4. What size of boiler is needed? Btu/hr and physical size.
5. What wood fuel is available?
6. What is project budget?
7. Additional construction needed?
8. District system?

Site Plan


GYM
BOILER PLANT & SILO
EXISTING BOILER ROOM IN BASEMENT
UNDERGROUND TUNNEL
JR HIGH / HIGH SCHOOL
BOILER PLANT & SILO ALTERNATE LOCATION
UNDERGROUND FUEL TANK
ELEMENTARY SCHOOL
3rd St
2nd
Railroad St
4th
LEGEND
PIPE ROUTING
BUILDING OUTLINE
EXISTING BOILER ROOM
NEW BOILER PLANT
NORTH REF.
0 50' 100' 200'
SCALE: 1:100
Drawn By
Checked By
Date
CTA #
Cad File:
BIOMASS PRE-FEASIBILITY ASSESSMENT
ALBERTON PUBLIC SCHOOLS
ALBERTON, MT
CTA
MISSOULA, MT
(406)728-9522
SITE PLAN

Costs

1. Boiler System - Installed
2. Boiler Building
3. Mechanical and Electrical Integration
4. Design Fees (Arch/Eng/Air Quality)
5. Contingency/Bid Escalation
6. Permit Fees
7. Project Delivery Method

There are more costs than just the boiler!

Example Simple Estimate

Option A.1 Wood Chip	
Chip Storage/ Boiler Building:	$270,000
Wood Heating & Wood Handling System:	$325,000
Stack/Air Pollution Control Device:	$180,000
Mechanical/Electrical within Boiler Building:	$150,000
Underground Piping	$25,000
KHS Integration	$56,000
Subtotal:	$1,006,000
30% Remote Factor	$301,800
Subtotal:	$1,307,800
Design Fees, Building Permit, Miscellaneous Expenses 15'	$196,170
Subtotal:	$1,503,970
15% Contingency:	$225,596
Total Project Costs	**$ 1,729,566**

Option B.1 Pellet	
Chip Storage/ Boiler Building:	$270,000
Wood Heating & Wood Handling System:	$265,000
Stack/Air Pollution Control Device:	$50,000
Mechanical/Electrical within Boiler Building:	$150,000
Underground Piping	$25,000
KHS Integration	$56,000
Subtotal:	$816,000
30% Remote Factor	$244,800
Subtotal:	$1,060,800
Design Fees, Building Permit, Miscellaneous Expenses 15'	$159,120
Subtotal:	$1,219,920
15% Contingency:	$182,988
Total Project Costs	**$ 1,402,908**

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Economics

1. Recommend Cash Flow Analysis.
2. Account for different inflation rates.
3. Account for additional boiler plant energy use.
4. Assume 85% of current energy use supplanted by wood, and 15% for current fuel.
5. Account for addition maintenance.
6. What capital money or grants are likely to be used?
7. Look at economic sensitivities – i.e. fuel costs, inflation rates, etc.

Cash Flow Analysis Part 1

Ketchikan High School				**Option B.1**		
Ketchikan, AK				**Wood Pellet Boiler**		
Date: July 24, 2012						
Analyst: CTA Architects Engineers – Nick Salmon & Nathan Ratz						
EXISTING CONDITIONS	**KHS**				**Total**	
Existing Fuel Type:	Fuel Oil	Fuel Oil	Fuel Oil	Fuel Oil		
Fuel Units:	gal	gal	gal	gal		
Current Fuel Unit Cost:	$3.70	$3.70	$3.70	$3.70		
Estimated Average Annual Fuel Usage:	127,900				127,900	
Annual Heating Costs:	$473,230	$0	$0	$0	$473,230	
ENERGY CONVERSION (to 1,000,000 Btu; or 1 dkt)						
Fuel Heating Value (Btu/unit of fuel):	138500	138500	138500	138500		
Current Annual Fuel Volume (Btu):	17,714,150,000	0	0	0		
Assumed efficiency of existing heating system (%):	80%	80%	80%	80%		
Net Annual Energy Produced (Btu):	14,171,320,000	0	0	0	14,171,320,000	
WOOD FUEL COST				**Wood Pellets**		
$/ton:				$300.00		
Assumed efficiency of wood heating system (%):				70%		
PROJECTED WOOD FUEL USAGE						
Estimated Btu content of wood fuel (Btu/lb) - **Assumed 7% MC**				8200		
Tons of wood fuel to supplant net equivalent of 100% annual heating load.				1,234		
Tons of wood fuel to supplant net equivalent of 85% annual heating load.				1,049		
25 ton chip van loads to supplant net equivalent of 85% annual heating load.				42		

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Cash Flow Analysis Part 2

Project Capital Cost	-$1,400,000

Project Financing Information	
Percent Financed	**0.0%**
Amount Financed	$0
Amount of Grants	$1,400,000
Interest Rate	5.00%
Term	10
Annual Finance Cost (years)	$0

Additional Power Use		
Est. Pwr Use	25000	kWh
Elec Rate	$0.100	/kWh

Additional Maintenance					
Type	Hr/Wk	Wk/Yr	Total Hr	Wage/Hr	Total
Biomass System	4.0	40	160	$20.00	$3,200
Other	0.0	40	0	$20.00	$0
1st 2 Year Learning	2.0	40	80	$20.00	$1,600

		Net Benefit	B/C Ratio
Simple Payback: Total Project Cost/Year One Operating Cost Savings:	17.5 years		
Net Present Value (30 year analysis):	$6,373,815	$4,973,815	4.55
Net Present Value (20 year analysis):	$3,213,382	$1,813,382	2.30
Year Accumulated Cash Flow > 0	#N/A		
Year Accumulated Cash Flow > Project Capital Cost	11		

Inflation Factors	
O&M Inflation Rate	2.0%
Fossil Fuel Inflation Rate	5.0%
Wood Fuel Inflation Rate	3.0%
Electricity Inflation Rate	3.0%
Discount Rate for Net Present Value Calculation	3.0%

Cash Flow Analysis Part 3

Cash flow Descriptions	Unit Costs	Heating Source Proportion	Annual Heating Source	Heating Units	Year 1	Year 2	Year 3	Year 4	Year 5
Existing Heating System Operating Costs									
Displaced heating costs	$3.70		127900	gal	$473,230	$496,892	$521,736	$547,823	$575,214
Displaced heating costs	$3.70		0	gal	$0	$0	$0	$0	$0
Displaced heating costs	$3.70		0	gal	$0	$0	$0	$0	$0
Displaced heating costs	$3.70		0	gal	$0	$0	$0	$0	$0
Biomass System Operating Costs									
Wood Fuel ($/ton, delivered to boiler site)	$300.00	85%	1049	tons	$314,781	$324,224	$333,951	$343,970	$354,289
Small load existing fuel	$3.70	15%	19185	gal	$70,985	$74,534	$78,260	$82,173	$86,282
Small load existing fuel	$3.70	15%	0	gal	$0	$0	$0	$0	$0
Small load existing fuel	$3.70	15%	0	gal	$0	$0	$0	$0	$0
Small load existing fuel	$3.70	15%	0	gal	$0	$0	$0	$0	$0
Additional Operation and Maintenance Costs					$3,200	$3,264	$3,329	$3,396	$3,464
Additional Operation and Maintenance Costs First 2 years					$1,600	$1,632			
Additional Electrical Cost	$0.100				$2,500	$2,575	$2,652	$2,732	$2,814
Annual Operating Cost Savings					***$80,164***	***$90,662***	***$103,543***	***$115,552***	***$128,366***
Financed Project Costs - Principal and Interest					***0***	***0***	***0***	***0***	***0***
Displaced System Replacement Costs (year one only)					***0***				
Net Annual Cash Flow					***80,164***	***90,662***	***103,543***	***115,552***	***128,366***
Accumulated Cash Flow					***80,164***	***170,827***	***274,370***	***389,922***	***518,287***

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Economics the Bottom Line

1. Simple payback not best metric to look at.
2. CTA likes to use Accumulated Cash Flow.
3. If positive accumulated cash flow is reached in 20 years or less, project has viability. If ACF is reached 10 years or less, then project is strong.
4. Reality is in the lower 48 – grant money is necessary to make projects viable.

Funding Sources - Local

1. Building Reserves
2. Bond Levy
3. Local Lending Institutions
4. Utility Company Rebates
5. Performance Contracting

Funding Sources - National

1. Qualified Energy Conservation Bonds (QECB). Low interest bonds for 20% reduction in energy use. Administered by US Dept. of Treasury.
2. USDA Rural Economic Development Loan and Grant Program (REDLG). 0% loans. Money flows through electric or telephone cooperatives, so generally only available in rural areas.
3. USDA Rural Energy for America Program (REAP). Money for grants and low interest loans for energy improvements or renewable energy systems.
4. USDA Forest Service Woody Biomass Utilization Grants
5. Carbon Credits.

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Design and Construction

1. Design – Bid – Build
2. Design – Build
3. Construction Manager
4. Energy Service Company/Performance Contractor
5. Bid Wood Boiler package early if possible – send fuel
6. Be aware of general contractor/biomass boiler contractor interface

Project Closeout

1. Commission all equipment.
2. Have biomass boiler vendor provide training at start up, and then again in 3 months, at end of heating season, and at start up of next heating season.
3. Don’t plan on full savings in first year – learning curve issues.

Operation & Maintenance

- Daily
  - Inspection
  - Log temperatures
  - Rake grates
- Weekly
  - Ash removal
  - Service air pollution control device
- Semi Annually
  - Clean Tubes
  - Inspect grates
- Amount of maintenance is directly proportional to the quality of the fuel!

Lessons Learned and Keys to Success:

A. Facility Manager committed to project.
B. Wood Fuel: Quality, Price & Delivery.
C. Total Project Cost: Wood system, integration & design.
D. Construction Contingency.
E. General Contractor/Wood Vendor interface.
F. Integration with existing systems.
G. Project Schedule.
H. Emission standards & stack height.

Project Guidance

- Focus on energy conservation first.
- Find new projects before they are designed-boiler size & integration.
- Address limits on co-generation– steam flows, staffing, sustainable fuel supply.
- Overcome challenges of transferring technology from industry to public sector.

Precautions

- Select wood fired heating system vendor first.
- Educate team on the importance of fuel quality.
- Prepare for start up problems (keep existing energy budget for two years).

Some Good Biomass Resources

Fuels for Schools and Beyond
www.fuelsforschools.info

Biomass Energy Resource Center (BERC)
www.biomasscenter.org

National Renewable Energy Laboratory (NREL)
www.nrel.gov/biomass

UND Energy & Environmental Research Center (EERC)
www.undeerc.org/renewables

Michigan Statewide Assessment
www.michiganwoodenergy.org

Questions?

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