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## **Introduction to Small-Mid Scale Commercial Biomass Boiler Systems**

0.5-3.5 MMBtu/h

**Heating the Midwest  
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## **Presentation Outline**

- Customer Expectations
- Key Customer Questions
- System Sizing
- System Configurations
- Project Examples



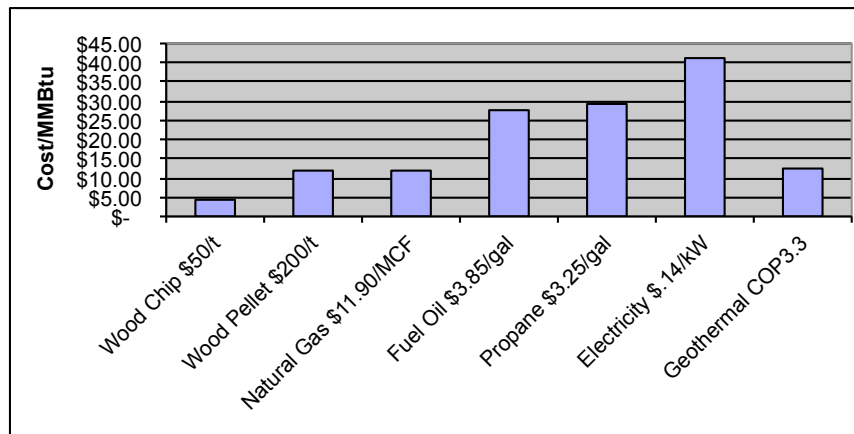


## Key Issues for Customers

- Lack of awareness of advanced wood boiler technology
- Systems payback
- Service and maintenance
- Fuel supply is uncertain (price/standards)
- Emission issues
- System sizing/configuration



## Fuel Price Comparison



Notes: Pellets = 15.6 MMBtu/ton, chips @30% moisture = 10.9 MMBtu/ton, geothermal heat pump using electricity at \$.14/kWh.

Data Source: [www.nyserda.org/Energy\\_Information/energy\\_prices\\_supplies.asp](http://www.nyserda.org/Energy_Information/energy_prices_supplies.asp)



# Boiler Payback Calculation



**Project Type**  
**ACT Bioenergy Boiler size** 6  
**ACT Bioenergy Boiler** 1700000 Btu  
**Total annual fossil fuel demand** 4 MMBtu  
**Main Fuel Type Replaced** 1-4  
**Quantity Used or Ordered Per Year** 5  
**Cost per Unit** 17.15 \$  
**Total Cost of Main Fuel Type Replaced** 67,800 \$  
**Annual Efficiency of Oil/Gas System %** 80 %  
**Cost per Useful MMBtu Heat in \$** 23.88 \$/MMBtu  
**Annual MMBtu Heat From Main Fuel Replaced** 3,664 MMBtu  
**Annual kWh Electric Immersion Used** 0 kWh  
**Cost per kWh Unit of Electricity** 13 \$/kWh  
**Conversion kWh to MMBtu (x2412)** 0 MMBtu  
**Total Cost of Electricity Replaced** 0 \$  
**Total MMBtu Replaced** 3,664 MMBtu

**Free Solar MMBtu** 0 MMBtu  
**ACT Bioenergy Boiler Heating Demand** 3,664 MMBtu  
**Wood Fuel Type 5-6** 0  
**Annual Wood Demand in Tons** 308 Tons of pellets  
**Cost of Wood Per Tonne** \$ 190.00  
**Cost of Wood Per MMBtu** 12.18 \$/MMBtu  
**ACT Bioenergy Boiler Annual Efficiency** 85 %  
**ACT Bioenergy Boiler cost per useful MMBtu Heat in \$** 14.33 \$/MMBtu

**Project type?** BTUs 3412  
 4 500,000 Btu School or Small Hotel 511800  
 5 1 MMBtu 1000 Student School 1023600  
 6 1.7 MMBtu 100 Bed Hotel & Resort 1706000

**Fuel Type?** \$ Units \$/MMBtu  
 1 Natural Gas 4600 12.00 \$/MMBtu \$ 12.00  
 2 Kerosene Oil = 136,600 Btu/gallon 33824 3.06 \$/gallon \$ 22.50  
 3 Fuel Oil = 138,200 Btu/gallon 33285 2.76 \$/gallon \$ 19.80  
 4 Propane = 92,000 Btu/gallon 50000 1.76 \$/gallon \$ 19.02  
 5 Wood pellets = 16,100,000 Btu/ton 228 190.00 \$/ton \$ 11.80  
 6 Chips 35% MC = 10,600,000 Btu/ton 346 50.00 \$/ton \$ 4.72

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Fossil fuel Cost Per MMBtu (5.25% Inflation per year)	23.88	25.13	26.43	27.84	29.30	30.84	32.46	34.17	35.96	37.85	39.84	41.93	44.13	46.44	48.88
Electric Water Heating Cost Per MMBtu (5.25% Inflation)	38.10	40.10	42.21	44.42	46.73	49.21	51.78	54.51	57.37	60.39	63.58	66.95	70.49	74.19	77.99
Wood Fuel Cost Per MMBtu (5.25% Inflation per year)	14.33	14.79	15.29	15.77	16.29	16.81	17.36	17.92	18.51	19.11	19.73	20.37	21.03	21.72	22.42
Annual fossil fuel Running Cost \$	109,853	116,820	121,890	128,079	134,803	141,880	149,329	157,168	165,420	174,104	183,243	192,865	202,990	213,647	224,864
Annual Electricity Water Heating Cost \$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Oil/Gas and Electric Heating Running Costs \$	109,853	116,820	121,890	128,079	134,803	141,880	149,329	157,168	165,420	174,104	183,243	192,865	202,990	213,647	224,864
ACT Bioenergy Boiler O&M	2000	2066	2134	2203	2277	2353	2430	2510	2593	2679	2767	2858	2953	3050	3151
Annual ACT Bioenergy Boiler Running Cost \$	54,800	57,273	59,103	60,950	61,943	63,097	64,321	65,615	66,981	68,419	69,930	71,515	73,176	74,915	76,734
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Cumulative Payback \$	55,352	114,699	178,294	246,372	319,232	397,154	480,445	569,429	664,447	765,660	874,040	989,418	1,112,593	1,243,423	1,382,082
Total Initial Investment Cost \$	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000	225,000

**Installed System Cost**  
 Wood Boiler 150kW (0.5 MMBtu) Price Estimate \$ 165,000  
 Wood Boiler 300kW (1.0 MMBtu) \$ 195,000  
 Wood Boiler 600kW (1.7 MMBtu) \$ 225,000

**Money Savings from your ACT Bioenergy Boiler (15yr)**  
 \$ 1,157,982

**CO2 emissions avoided from your ACT Bioenergy Boiler (15yr)**  
 Tons Greenhouse Gases 4,775

Notes:  
 1. Price estimate includes fuel storage silo and installation costs.  
 2. Building heating load estimates based on Retroscreen Software data(www.retroscreen.net)



# Typical Project Economics



- Boiler size 1.7 MMBtu/h
- Building heat load 5100 MMBtu/yr.
- Heating Oil @\$3.50/gal replaced with wood pellets @\$190/ton
- Installed Cost \$250,000
- Simple ROI = 3.5 yrs. (without incentives)
- 15 yr savings = \$1,444,000
- 410 t/yr of GHG reduction

High efficiency wood combustion particulate is 5x less toxic than diesel emissions (home heating oil)



Source: 15th European Biomass Conference and Exhibition, 7–11 May 2007, Berlin  
N. Klippel and T. Nussbaumer. **HEALTH RELEVANCE OF PARTICLES FROM WOOD COMBUSTION IN COMPARISON TO DIESEL SOOT** [www.verenum.ch](http://www.verenum.ch)



## Key Features of Advanced Boiler Systems

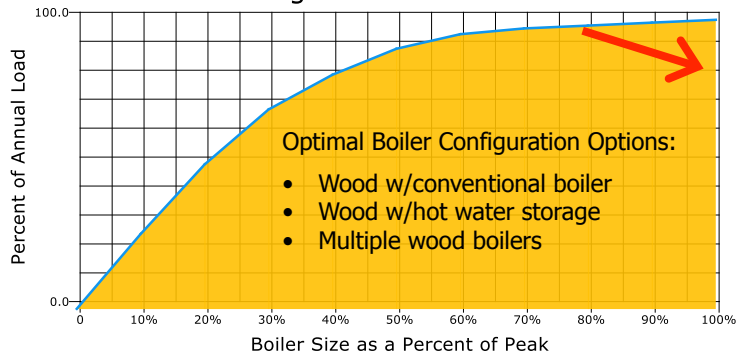
- Automated Controls
  - Fuel metering
  - Automatic ignition
  - Automatic ash removal
  - Combustion modulation and optimization with oxygen sensor
    - Residence Time - excess air at 50%
    - Combustion Temperatures 1200-1600F.
    - Turbulence – tangential air/turbulators
- Thermal buffering – Hot water storage tank 100gal/ 100,000 Btu/h output
- Can be integrated with Building Management System

**ACTbioenergy™**  
clear, green heating solutions



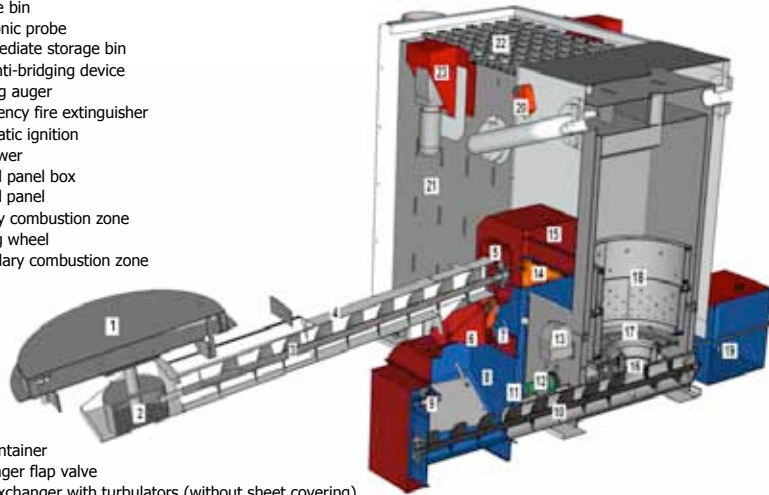
# Biomass Boiler Sizing

Boiler Sizing vs. Percent Load Met

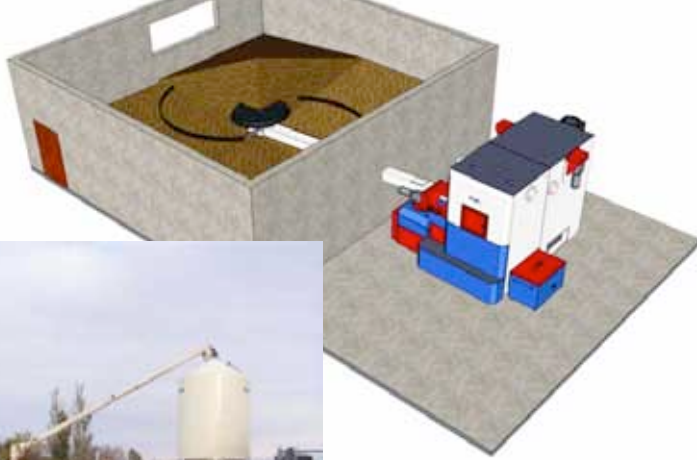


## ACT Boiler Configuration

1. Fuel bin stirrer
2. Gear motor
3. Fuel auger
4. Fuel auger channel
5. Auger drive motor
6. Separating flap valve for the channel and intermediate storage bin
7. Ultrasonic probe
8. Intermediate storage bin
9. Fuel anti-bridging device
10. Feeding auger
11. Emergency fire extinguisher
12. Automatic ignition
13. Air blower
14. Control panel box
15. Control panel
16. Primary combustion zone
17. Grating wheel
18. Secondary combustion zone
19. Ash container
20. Exchanger flap valve
21. Heat exchanger with turbulators (without sheet covering)
22. Turbulators
23. Turbulator drive



## Typical Wood Boiler Configuration



**ACTbioenergy™**  
clean, green heating solutions



## Containerized Wood Chip Boiler

0.5 MMBtu Boiler installed in a 20' shipping container



Cayuga Nature Center  
Ithaca, NY



Combustion chamber



Auger/Stirrer in  
the chip fuel bin



Wood chip fuel bin





## 1.7 MMBtu Pellet Boiler Integrated with Solar Panels



Pellet Boiler



Natural History Museum of the Adirondacks – The Wild Center

- 1) PELLET STORAGE CONTAINER
- 2) AIR FLOW OF WOOD PELLETS
- 3) SOLAR THERMAL PANELS
- 4) PELLET DISTRIBUTION DISPLAY
- 5) WOOD PELLET DELIVERY AUGER
- 6) HEATING AND/OR COOLING LOOP
- 7) SOLAR THERMAL STORAGE TANK
- 8) HEATING/COOLING ZONE BOILERS
- 9) WOOD PELLET BOILER SYSTEM
- 10) HEATING/COOLING EQUIPMENT
- 11) CHIMNEY



Pellet storage



## Pellet Boiler Federal Bldg. Ketchikan, AK





## Hospital Wood Chip Boiler



## Containerized Pellet Boiler







## Greenhouse Pellet Boiler



## Keys to a Successful Project

- Early engagement of stakeholders (maintenance staff, board members)
- Create realistic customer expectation
- Get support of experienced with wood boiler system professionals

**ACTbioenergy™**  
clean, green heating solutions



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## Thank You

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