Introduction to Small-Mid Scale Commercial Biomass Boiler Systems
0.5-3.5 MMBtu/h

Heating the Midwest
April 25-27th, 2012

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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/kW.
Data Source: www.nyserda.org/Energy_Information/energy_prices_supplies.asp
### Boiler Payback Calculation

#### Project Type
- ACT Bioenergy Boiler

- Size: 6,000,000 Btu

#### Total Annual Fossil Fuel Demand
- 4,600 MMBtu

#### Main Fuel Type Replaced
- 1 - 4,600,000 Btu School or Small Hotel

#### Quantity Used or Ordered Per Year
- 500 gallons

#### Cost per Unit
- $1.75

#### Total Cost of Main Fuel Type Replaced
- $87,500

#### Annual Efficiency of Oil/Gas System
- 80%

#### Cost per Useful MMBtu
- $23.88

#### Annual MMBtu Heat From Main Fuel Replaced
- 3,664 MMBtu

#### Annual kWh Electric Immersion Used
- 0 kWh

#### Cost per kWh
- 13 cents

#### Cost per MMBtu
- $19.90

#### Total Cost of Electricity Replaced
- 0

#### Total MMBtu Replaced
- 3,664 MMBtu

#### ACT Bioenergy Boiler Boiler Heating Demand
- 3,664 MMBtu

#### Annual Wood Usage in Tonnes
- 268 Tons

#### Cost of Wood
- $190/t

#### Cost of Wood Per MMBtu
- $12.18

#### ACT Bioenergy Boiler Annual Efficiency
- 85%

#### ACT Bioenergy Boiler Cost per Useful MMBtu Heat in $
- 14.33

#### Year 1 - 15 Year Running Cost

<table>
<thead>
<tr>
<th>Year</th>
<th>Fossil fuel Cost Per MMBtu (5.25% Inflation per year)</th>
<th>Electric Water Heating Cost Per MMBtu (5.25% Inflation)</th>
<th>Wood Fuel Cost Per MMBtu (3.25% Inflation per year)</th>
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#### Year 1 - 15 Year Running Cost Saving

<table>
<thead>
<tr>
<th>Year</th>
<th>Annual Fossil fuel Running Cost</th>
<th>Annual Electricity Water Heating Cost</th>
<th>Total Oil/Gas and Electric Heating Running Costs</th>
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#### Year 1 - 15 Year Running Cost Saving

<table>
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<th>Total Oil/Gas and Electric Heating Running Costs</th>
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#### Year 1 - 15 Year Running Cost Saving

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<th>Cumulative Payback</th>
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#### Total Initial Investment Cost
- $225,000

#### Installed System Cost
- $165,000
- $195,000
- $225,000

#### Money Savings from your ACT Bioenergy Boiler (15yr)
- Wood Boiler 150kW (0.5 MMBtu): $1,157,982
- Wood Boiler 300kW (1.0 MMBtu): $1,243,423
- Wood Boiler 500kW (1.7 MMBtu): $1,382,982

#### CO2 emissions avoided from your ACT Bioenergy Boiler (15yr)
- 4,775 Tons GreenHouse Gases

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### 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**

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[Note: The image contains a table with various data points related to the project economics and a diagram showing the payback calculation process.]
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

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
Biomass Boiler Sizing

Optimal Boiler Configuration Options:
- Wood w/conventional boiler
- Wood w/hot water storage
- Multiple wood boilers

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

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

Natural History Museum of the Adirondacks – The Wild Center

Pellet Boiler

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
Thank You

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