Biomass Cofiring at a Pulverized Coal District Heating Plant
The Education and of a Biomass Novice
Designed in the late 1920s
Built in 1932
Duluth’s District Energy System

- 170 Customers
- $7 million in annual revenue
- 25 on-site employees
- 50,000 tons coal / year
- 11 miles of steam pipe
- Serves 50 square blocks
A Brief History

- Plant designed in 1929; Construction completed in 1932
- Operated as a private utility from 1932 – 1970s
- City purchased the system in 1970s to prevent it’s closure
- Operated as Duluth Steam Cooperative Association until 2012.
- Ever-Green Energy hired to manage and operate the City –owned system in 2012.
2010 Test Burn

- Principle Investigator: Tim Hagen, University Of Minnesota – Duluth’s Natural Resources Research Institute (NRRI)

- Objectives:
  - Measure CO, CO$_2$, SO$_2$, NO$_x$, O$_2$ and Hg while cofiring 25% (by Btu) dried, pulverized sawdust with 75% coal
  - Observe the nature and extent of “sparklers” in the boiler.

- Procedure: Sawdust pneumatically injected into pulverized coal & air burner tube at a rate of approximately 1,500 lbs/hr.

- Test probes monitored boiler exhaust gas composition.

- 3-hour test
Pulverized PRB Coal

(80% minus 200 mesh)
Test Burn Sawdust
(10% moisture content)
Cofire Test Method

Fine, dry sawdust was blown into coal pulverizer exhauster tube ....
Cofire Test Method

...and into firebox through the two coal burners.
Results / Conclusions

25% sawdust  -  75% sub-bituminous coal cofiring

- Significant (43%) decrease in SO$_2$ emissions
- Significant (23%) decrease in Hg emissions
- Minor reductions in NOx
- Sparklers estimated to be $\frac{1}{8}$” to $\frac{1}{4}$” observed hitting back wall of firebox and dropping to the bottom of the boiler. No evidence of sparklers escaping from the boiler.

1. NRRI Project Number: 1026 10417 20109 1000004091; Report Number: NRRI/TR-2010/17
Duluth Steam

Ever-Green Energy presents Master Plan for Duluth Steam

On December 5, Ever-Green Energy presented the final Duluth City Council Findings and recommendations from meetings with Mayor Ned Lamont staff, customers, community leaders.

View the Master Plan. This version is optimized for the screen.

The City of Duluth is a unique community, serving as a hub for industry and natural resources of the North Shore. The City of Duluth is responsible for operating and maintaining the Duluth Steam System in Canal Park and downtown Duluth and has a strong financial system. Ever-Green team is responsible for system operations, procurement, customer service, billing and accounting, and outreach. The system is owned by the City of Duluth and funded by Duluth. Rates are reviewed by the City annually and with a commitment to providing Duluth Steam reliability, rate stability, and opportunities to increase system efficiency and environmental stewardship.

Ever-Green Energy

http://www.ever-greenenergy.com/operations/duluth-steam/
The Plan....... 

“Without any changes to the existing coal boiler fuel preparation system, sawdust is the only possible form of wood biomass that could be cofired with coal.”
Biomass Cofiring Project

Goal: Replace 25% of annual coal consumption with locally sourced woody biomass (85,000 tons green wood per year)

1. Air Emissions Permit Amendment Approved

2. System Design
   ▪ Maximize the repurposing of existing infrastructure

3. Fuel Supplier Market Research
   ▪ It’s out there
   ▪ Trade-off between capital and fuel costs
# Biomass* Market Survey
(as delivered)

<table>
<thead>
<tr>
<th>Product</th>
<th>Price ($ / mmBtu)</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pellets</td>
<td>$9.00</td>
<td>2</td>
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<tr>
<td>Dry Wood Powder</td>
<td>?</td>
<td>None</td>
</tr>
<tr>
<td>Wet Sawdust</td>
<td>$5.00</td>
<td>1</td>
</tr>
<tr>
<td>Green Chips</td>
<td>$4.45</td>
<td>Several</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>$5.00</td>
<td></td>
</tr>
<tr>
<td>Coal</td>
<td>$2.65</td>
<td></td>
</tr>
</tbody>
</table>
The Challenges

- Bowl-type coal mills
- Biomass tends to collect on inside of bowl
The Challenges – continued

• Small furnace; short dwell time
The Challenges – continued again

- Fabric Filter Baghouse
.... and again
and again....
....and finally, there’s this!
The Opportunity
Plan #1 - Buy & burn fine, dry sawdust

**PRO:**
- Very low initial capital cost
- Proven during test burn

**CON:**
- No ready supply of fuel
- Dust control challenge
- No fuel flexibility
Plan #2 - Crush pellets back into sawdust & then burn

PRO:
• Pellets available
• Relatively low capital cost

CON:
• High cost of fuel
  • Paying for processing we’d have to pay to “undo”
• Limited fuel flexibility
Plan #3 - Buy green sawdust or chips, grind, dry, grind again and then burn

**PRO:**
- Greatest fuel flexibility
- Lowest fuel cost

**CON:**
- Higher capital cost
- Higher maintenance costs
- Lots of stuff...small space
- Higher risk of incomplete combustion
Plan #4 - Hot gas generator approach

PRO:
• Greatest fuel flexibility
• Lowest fuel cost
• The wood stays outside the boiler room.

CON:
• High capital cost
• Potential additional air permitting
Hot Gas Generator might fit...
...inside plant too
...and into the boiler.
What’s next?

1. RFP for Design – Summer 2015 award
   a. Recommend & make case for best approach
   b. Quote for Detailed Design and Commissioning.