Hog Fuel Waste Management (Under NDA)
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Client: Weyerhaeuser
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Background
Weyerhaeuser is a multinational company specializing in lumber, paper, and forest products. The company has a large presence in North America, where it operates a plant in Grayling, MI. This plant produces biomass waste, which is currently landfilled. However, this is not a sustainable practice, and alternative strategies are needed.

Objectives & Constraints
The objective of this project is to determine the most cost-effective on-site biomass conversion technology for utilizing Weyerhaeuser’s waste stream to replace the company’s current off-site heating system. The project aims to assess the feasibility of different technologies and determine the best option for Weyerhaeuser to meet its sustainability goals.

Design Alternatives

Stoker Boilers
• Direct-fired, fixed-bed combustion system
• Used in most biomass power plants
• Low capital and O&M costs
• Lower operation efficiency, responsiveness, and poor pollution controls

Fixed Bed Gasifier
• Gasification uses an oxygen-deprived environment and produce syngas, which can be combusted to generate steam
• Cleaner alternative to stoker systems without the extra costs associated with operating a fluidized bed

Fluidized Bed Boiler
• Direct combustion system
• Utilizes inert bed material (e.g., silica sand) mixed with solid fuel, which is fluidized using pressurized air
• Accepts "wettest and dirtiest fuels"
• Produce minimal pollution and highly flexible, but can be more costly than stoker systems of the same scale

Fluidized Bed Fast Pyrolysis
• Similar process to fixed bed gasification, but utilizes a fluidized bed
• Clean, produces saleable products
• Expensive due to high heating rates and short vapor residence times

Selected Design
The fluidized bed boiler (FBB) for direct combustion of hog fuel was chosen for economic analysis. An FBB operates by mixing the fuel with an incombustible particle (like silica sand) and injecting pressurized air from below. The sand-fuel mixture is suspended by the air flow, creating a fluid-like state where combustion occurs. (Grammelis et al., 2011)

Key characteristics of an FBB include:
• Can handle high moisture, dirty fuels (Simpkins, 2006)
• Accepts varying moisture contents, ash contents, and heating values (Sarkar, 2015)
• Provides excellent built in NOx and SO2 pollution control
• Requires well-maintained high pressure air fans (Basu & Fraser, 2015)
• Accrues higher operation and maintenance costs than traditional stoker boilers

Selected Model
The selected model for Weyerhaeuser’s hog fuel boiler economic analysis is the modular Towerpak® FBB from Babcock & Wilcox (B&W). This boiler has been used for decades in the forest products industries for burning of hog fuel (personal communication).

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Economic Analysis
The cost estimates for the 70MBtu/hr Towerpak boiler are Class 3 with an accuracy of -20%/+30% (Christensen et al., 2005).

Table 1: Economic evaluation of Combustion vs Landfilling

<table>
<thead>
<tr>
<th>Computation</th>
<th>Landfilling</th>
<th>Combustion</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPV ($)</td>
<td>1,130,200</td>
<td>1,520,700</td>
</tr>
<tr>
<td>B/C</td>
<td>1.30</td>
<td>1.66</td>
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<tr>
<td>IRR (%)</td>
<td>&gt; MARR</td>
<td>&gt; MARR</td>
</tr>
<tr>
<td>B/C ratio for boiler</td>
<td>&gt; 1</td>
<td>&gt; 1</td>
</tr>
<tr>
<td>Payback period (yrs)</td>
<td>8</td>
<td>n.a</td>
</tr>
<tr>
<td>Annual Savings ($)</td>
<td>1,773,634</td>
<td>0</td>
</tr>
</tbody>
</table>

Although Proposal 2 does not utilize all the hog fuel, it increases operational ease and was chosen for analysis.

References
