Preliminary Feasibility Assessment for High Efficiency, Low Emission Wood Heating
In Huslia, Alaska

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Daniel Parrent, Wood Utilization Specialist, Juneau Economic Development Council on behalf of Orville H.
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Table of Contents

Abstract

Section 1. Executive Summary
    1.1 Goals and Objectives
    1.2 Evaluation Criteria, Project Scale, Operating Standards, General Observations
    1.3 Assessment Summary and Recommended Actions
        1.3.1 “Downtown” cluster
        1.3.2 Jimmy Huntington School
        1.3.3 Water plant, washeteria and health clinic

Section 2. Evaluation Criteria, Implementation, Wood Heating Systems
    2.1 Evaluation Criteria
    2.2 Successful Implementation
    2.3 Classes of Wood Heating Systems

Section 3. The Nature of Wood Fuels
    3.1 Wood Fuel Forms and Current Utilization
    3.2 Heating Value of Wood

Section 4. Wood Fueled Heating Systems
    4.1 Low Efficiency High Emission Cordwood Boilers
    4.2 High Efficiency Low Emission Cordwood Boilers
    4.3 Bulk Fuel Boiler Systems

Section 5. Selecting the Appropriate System
    5.1 Comparative Costs of Fuels
    5.2(a) Cost per MMBtu Sensitivity – Cordwood
    5.2(b) Cost per MMBtu Sensitivity – Bulk Fuels
    5.3 Determining Demand
    5.4 Summary of Current Conditions

Section 6. Economic Feasibility of Cordwood Systems
    6.1 Initial Investment Cost Estimates
    6.2 Operating Parameters of HELE Cordwood Boilers
    6.3 Hypothetical OM&R Cost Estimates
    6.4 Calculation of Financial Metrics
    6.5 Simple Payback Period for HELE Cordwood Boilers
    6.6 Present Value, Net Present Value and Internal Rate of Return Values for HELE Cordwood Boilers

Section 7. Economic Feasibility of Bulk Fuel Systems

Section 8. Conclusions

References and Resources
Appendices

Appendix A  AWEDTG Evaluation Criteria
Appendix B  Recoverable Heating Value Determination
Appendix C  List of Abbreviations and Acronyms
Appendix D  Wood Fuel Properties
Appendix E  Financial Metrics
Appendix F  Operational Parameters of HELE Cordwood Boilers
Appendix G  Calculation of Present Value, Net Present Value and Internal Rate of Return
Appendix H  Garn Boiler Specifications

List of Tables and Figures

Table 4-1  HELE Cordwood Boiler Suppliers
Table 4-2  Emissions from Wood Heating Appliances
Table 5-1  Comparative Cost of Fuel Oil vs. Wood Fuel
Figure 5-1  Effect of White Spruce Cordwood (MC30) Cost on Cost of Delivered Heat
Table 5-2  Reported Annual Fuel Oil Consumption, Huslia Facilities
Table 5-3  Estimate of Heat Required in Coldest 24 Hr Period
Table 5-4  Estimate of Total Wood Consumption, Comparative Costs and Potential Savings
Table 6-1  Initial Investment Cost Scenarios for Hypothetical Cordwood Systems
Table 6-2  Labor/Cost Estimates for HELE Cordwood Systems
Table 6-3  Summary of Total Annual Non-fuel OM&R Cost Estimates
Table 6-4  Simple Payback Period Analysis for HELE Cordwood Boilers
Table 6-5  PV, NPV and IRR Values for HELE Cordwood Boilers
Key words: HELE, LEHE, bulk fuel, cordwood

ABSTRACT

The potential for heating various public buildings in Huslia with high efficiency, low emission (HELE) wood boilers is evaluated for the Huslia Tribal Council and City of Huslia.

Early in 2008, organizations and local/tribal governments were invited to submit a Statement of Interest (SOI) in wood energy heating projects to the Alaska Wood Energy Development Task Group (AWEDTG). Task Group members reviewed all the SOIs and selected projects for further review based on the selection criteria presented in Appendix A. AWEDTG representatives met with the representatives of the Huslia Tribal Council and City of Huslia in Huslia in July 2008. Preliminary assessments were made and challenges identified. Potential wood energy systems were considered for each facility using AWEDTG, USDA and AEA objectives for energy efficiency and emissions. Preliminary recommendations are made for each facility.

SECTION 1. EXECUTIVE SUMMARY

1.1 Goals and Objectives

- Identify various public buildings as potential candidates for heating with wood
- Evaluate the suitability of the facility(s) and site(s) for siting a wood-fired boiler
- Assess the type(s) and availability of wood fuels
- Size and estimate the capital costs of suitable wood-fired system(s)
- Estimate the annual operation and maintenance costs of a wood-fired system
- Estimate the potential economic benefits from installing a wood-fired heating system

1.2 Evaluation Criteria, Project Scale, Operating Parameters, General Observations

- This project meets the AWEDTG objectives for petroleum fuel displacement, use of hazardous forest fuels or forest treatment residues, sustainability of the wood supply, project implementation, operation and maintenance, and community support
- Wood-fired systems are not feasible for very small applications. These may be satisfied with domestic wood appliances, such as wood stoves or pellet stoves/furnaces
- Individual facilities consuming less than 3,000 gallons per year represent minimal savings with wood-fired systems unless such systems can be enclosed in an existing structure, and wood and labor are very low cost or free
- Marginal economic metrics (such as those associated with small installations) can be improved with low-cost buildings and piping systems
- Medium and large energy consumers have the best potential for feasibly implementing a wood energy system and deserve detailed engineering analysis
- Efficiency and emissions standards for Outdoor Wood Boilers (OWB) changed in 2006, which could increase costs for small systems
1.3 Assessment Summary and Recommended Actions

Overview. Three separate building “clusters” were identified:

1. The “Downtown” cluster, consisting of 4 or 5 individual structures
2. The Jimmy Huntington School (Yukon-Koyukuk School District)
3. The water plant, washeteria and health clinic

1.3.1. “Downtown” Cluster

• Overview. The “downtown” cluster consists of the Huslia city office building, Huslia Tribal Council office building, the Environmental Office, the Nutrition Center, and possibly, the Head Start facility

1.3.1.1. The Huslia city office building, is a small, frame structure, heated by a Weil-McLain Gold P-WTGO-4 boiler rated at 131,000 Btu per hour (net), in good condition. Reported annual fuel consumption amounts to approximately 1,500 gallons per year.

1.3.1.2. The Huslia Tribal Council office building, is a small, 3-sided log structure, heated by a Weil-McLain Gold P-WTGO-4 boiler rated at 131,000 Btu per hour (net), in good condition. Reported annual fuel consumption amounts to approximately 1,500 gallons per year.

1.3.1.3. The Environment Office, is a small, 3-sided log structure, heated by a Monitor space heater (size and condition unknown). Reported annual fuel consumption amounts to approximately 2,250 gallons per year.

1.3.1.4. The Nutrition Center, is a larger, 3-sided log structure, heated by a Weil-McLain Gold P-WGO-3 boiler rated at 100,000 Btu per hour (net), in fair condition (due for replacement). Heat is distributed by 7/8” copper fin tube pipe (2” x 2 ¼” x 60 fins per foot) in fairly good condition. Reported annual fuel consumption amounts to approximately 3,500 gallons per year.

1.3.1.5. The Head Start building, is a small, frame structure located between the Tribal Council office building and the City office building. The building was inaccessible at the time of our field visit, and the heating system specifications were unknown. Estimated annual fuel consumption amounts to approximately 1,000 gallons per year.

Total fuel consumption = 9,750

• Potential Savings. At the current price of nearly $6.00 per gallon, the current cost of heating the “downtown cluster” amounts to $58,500 per year. The HELE cordwood fuel equivalent of 9,750 gallons of #1 fuel oil is approximately 114 cords, and at $350 per cord represents a potential annual fuel cost savings of $18,600 (debt service and non-fuel OM&R costs notwithstanding).

• Required boiler capacity. The estimated required boiler capacity (RBC) to heat the entire “downtown cluster” is approximately 321,229 Btu/hr during the coldest 24-hour period.

• Recommended action regarding a cordwood system. Given the initial assumptions and cost estimates for the alternatives presented in this report, this project appears to be marginally viable. Further consideration is probably warranted. (See Section 6)
• **Recommended action regarding a bulk fuel wood system.** Given the relatively small heating demand, lack of known fuel supplies, and the probable costs of such a project, a “bulk fuel” system is not cost-effective for the “downtown cluster”.

### 1.3.2. Jimmy Huntington School

• **Overview.** The Jimmy Huntington School is operated by the Yukon-Koyukuk School District, with main offices located in Fairbanks. The school consists of several separate buildings, including the main school building, administration building and elementary school classrooms, the Taylor Building (carpenter’s shop), 6 teacher housing units, and at least 3 “outbuildings” (unheated).

The main school building is heated by two Burnham V905A oil-fired boilers rated at 562 MBH (net, each) in reasonably good condition. Heat is distributed in the classrooms via box-style radiators and with air handlers in the gymnasium. Domestic hot water is provided by a BoilerMate unit.

The administration building is heated by two Burnham V903A oil-fired boilers rated at 302 MBH (net, each), and the Taylor Building is heated by a single Burnham PV84WC-G5 boiler rated at 110 to 138 MBH (net). Each teacher housing unit has its own small boiler.

• **Fuel Consumption.** The Jimmy Huntington School reportedly consumes about 17,000 gallons of #1 fuel oil per year, although consumption data by building was not provided.

• **Potential Savings.** At the current price of about $6.00 per gallon, the cost of oil for the Jimmy Huntington School amounts to $102,000 per year. The HELE cordwood fuel equivalent of 17,000 gallons of #1 fuel oil is approximately 199 cords, and at $350 per cord represents a potential annual fuel cost savings of $32,350 (debt service and non-fuel OM&R costs notwithstanding).

• **Required boiler capacity.** The estimated required boiler capacity (RBC) to heat the Jimmy Huntington School (based on annual fuel consumption of 17,000 gpy) is approximately 559,629 Btu/hr during the coldest 24-hour period.

• **Recommended action regarding a cordwood system.** Given the initial assumptions and cost estimates for the alternatives presented in this report, this project appears to be marginally viable. Further consideration is probably warranted. (See Section 6)

• **Recommended action regarding a bulk fuel wood system.** Given the heating demand, lack of known fuel supplies, and the probable costs of such a project, a “bulk fuel” system is not cost-effective for the Jimmy Huntington School.

### 1.3.3. Water plant, washeteria and health clinic

• **Overview.** The water plant, washeteria and health clinic are new facilities located near the old landing strip. The water plant and washeteria are co-located in one building, and the clinic is next door in its own building.

The water plant/washeteria was still under construction at the time of our field visit, but they should be ready for use within a couple months. Space heat and process heat is provided by two new Burnham PV89WT-GBWF28 oil-fired boilers rated at 260 MBH (net, each).
The new health clinic (open for business) is heated by a single Weil-McLain Gold P-WGO-5 oil-fired boiler rated at 152 MBH (net). Heat is distributed via hot water baseboard heaters and domestic hot water is provided by a BoilerMate unit.

- **Fuel Consumption.** Water plant: Approximately 100 households are connected to the municipal water system and current usage can amount to 20,000 gallons per day, which the existing water plant struggles to meet. Well-water comes into the plant at approximately 35 degrees F, and is heated 12 to 14 degrees before distribution. Water quality is currently fair to poor, which limits consumption. Water quality from the new well at the new water plant is reported to be very high, and consumption is expected to increase, perhaps by as much as 100%. The current water plant uses approximately 12,000 gallons of fuel oil per year. Since the new plant is not yet online, fuel consumption is unknown. A figure of 20,000 gallons is being used for purposes of this report (assuming greater water consumption and improved efficiencies).

Fuel consumption at the health clinic is reportedly 4,500 gallons per year

- **Potential Savings.** It appears that the water plant and clinic could be served by a common wood-fired heating plant consisting of a number of large boilers. At the projected price of about $6.00 per gallon, it is projected to cost approximately $147,000 per year for fuel oil for the water plant and clinic. The HELE cordwood fuel equivalent of 24,500 gallons of #1 fuel oil is approximately 287 cords, and at $350 per cord represents a potential annual fuel cost savings of $46,550 (debt service and non-fuel OM&R costs notwithstanding).

- **Required boiler capacity.** The estimated required boiler capacity (RBC) to heat the water plant, washeteria and health clinic during the coldest 24-hour period is undeterminable, since most of the fuel will be used to heat water.

- **Recommended action regarding a cordwood system.** Given the initial assumptions and cost estimates for the alternatives presented in this report, this project appears to be cost-effective and operationally viable. Further consideration is warranted. (See Section 6)

- **Recommended action regarding a bulk fuel wood system.** Given the heating demand, lack of known fuel supplies, and the probable costs of such a project, a “bulk fuel” system is not cost-effective for the water plant/washeteria and clinic.

**SECTION 2. EVALUATION CRITERIA, IMPLEMENTATION, WOOD HEATING SYSTEMS**

The approach being taken by the Alaska Wood Energy Development Task Group (AWEDTG) regarding biomass energy heating projects follows the recommendations of the Biomass Energy Resource Center (BERC), which advises that, “[T]he most cost-effective approach to studying the feasibility for a biomass energy project is to approach the study in stages.” Further, BERC advises “not spending too much time, effort, or money on a full feasibility study before discovering whether the potential project makes basic economic sense” and suggests, “[U]ndertaking a pre-feasibility study . . . a basic assessment, not yet at the engineering level, to determine the project's apparent cost-effectiveness”. [Biomass Energy Resource Center, Montpelier, VT. www.biomasscenter.org]

**2.1 Evaluation Criteria**

The AWEDTG selected projects for evaluation based on the criteria listed in Appendix A. The Huslia projects meet the AWEDTG criteria for potential petroleum fuel displacement, use of forest
residues for public benefit, use of local residues (though limited), sustainability of the wood supply, project implementation, operation and maintenance, and community support.

In the case of cordwood boiler applications, the wood supply from forest fuels and/or local processing residues appears adequate and matches the application. Currently, “bulk fuel” (chips, bark, sawdust, etc.) supplies are non-existent.

2.2 Successful Implementation

In general, four aspects of project implementation have been important to wood energy projects in the past: 1) a project “champion”, 2) clear identification of a sponsoring agency/entity, 3) dedication of and commitment by facility personnel, and 4) a reliable and consistent supply of fuel.

In situations where several organizations may be responsible for different community services, it must be clear which organization(s) would sponsor or implement a wood-burning project. (NOTE: This is not necessarily the case with the Huslia projects but the issue should be considered.)

Boiler stoking and/or maintenance is required for approximately 5-15 minutes per boiler several times a day (depending on the heating demand) for manual wood-fueled systems, and dedicating personnel for the operation is critical to realizing savings from wood fuel use. For this report, it is assumed that new personnel would be hired or existing personnel would be assigned as necessary, and that “boiler duties” would be included in the responsibilities and/or job description of facilities personnel.

2.3 Classes of Wood Energy Systems

There are, essentially, two classes of wood energy systems: manual cordwood systems and automated “bulk fuel” systems. Cordwood systems are generally appropriate for applications where the maximum heating demand ranges from 100,000 to 1,000,000 Btu per hour, although smaller and larger applications are possible. “Bulk fuel” systems are systems that burn wood chips, sawdust, bark/hog fuel, shavings, pellets, etc. They are generally applicable for situations where the heating demand exceeds 1 million Btu per hour, although local conditions, especially fuel availability, can exert strong influences on the feasibility of a bulk fuel system.

Usually, an automated bulk fuel boiler is tied-in directly with the existing oil-fired system. With a cordwood system, hot water or glycol from the existing oil-fired boiler system would be circulated through a heat exchanger at the wood boiler ahead of the existing oil boiler. A bulk fuel system is usually designed to replace 100% of the fuel oil used in the oil-fired boiler, and although it is possible for a cordwood system to be similarly designed, they are usually intended as a supplement, albeit a large supplement, to an oil-fired system. In either case, the existing oil-fired system would remain in place and be available for peak demand or backup in the event of a failure or other downtime (scheduled or unscheduled) in the wood system.

One of the objectives of the AWEDTG is to support projects that would use energy-efficient and clean burning wood heating systems, i.e., high efficiency, low emission (HELE) systems.

SECTION 3. THE NATURE OF WOOD FUELS

3.1 Wood Fuel Forms and Current Utilization

Wood fuels in western interior Alaska are most likely to be in the form of cordwood, derived from standing trees. For communities located along major rivers, such as Huslia, driftwood can be a significant source of wood.
The forest industry infrastructure in the Huslia area is limited to very small, subsistence-scale sawmills. Local forest resources are owned by the Koyukuk National Wildlife Refuge, Huslia Village Council, and K’ooyit’ots’ina Limited. There is some (small, limited) tree mortality as a result of bark beetle activity, but the threat of wildfires is significant.

For this report, it is assumed that wood supplies, in the form of cordwood, driftwood, and/or occasional mill residues, are sufficient to meet the heating needs of the facilities under consideration. Supply issues must be resolved at the local level prior to installing a wood fired heating system of any substantial size.

### 3.2 Heating Value of Wood

Wood is a unique fuel whose heating value is quite variable, depending on species of wood, moisture content, and other factors. There are also several ‘heating values’, namely high heating value (HHV), gross heating value (GHV), recoverable heating value (RHV), and deliverable heating value (DHV), that may be assigned to wood at various stages in the calculations.

For this report, white spruce cordwood at 30 percent moisture content (MC30, calculated on the “wet” or “green” weight basis) is used as the benchmark.

The HHV of white spruce at 0% moisture content (MC0) is 8,890 Btu/lb1 and the GHV at 30% moisture content (MC30) is 6,223 Btu/lb

The RHV for white spruce cordwood (MC30), given the variables in Appendix B, is calculated at 12.22 million Btu per cord, and the DHV, which is a function of boiler efficiency (assumed to be 75%), is 9.165 million Btu per cord. The delivered heating value of 1 cord of white spruce cordwood (MC30) equals the delivered heating value of 85.5 gallons of #1 fuel oil when the wood is burned at 75% conversion efficiency and the oil is burned at 80% efficiency.

A more thorough discussion of the heating value of wood can be found in Appendix B and Appendix D.

### SECTION 4. WOOD-FUELED HEATING SYSTEMS

#### 4.1 Low Efficiency High Emission (LEHE) Cordwood Boilers

Most manual outdoor wood boilers (OWBs) that burn cordwood are relatively low-cost and can save fuel oil but have been criticized for low efficiency and smoky operation. These could be called low efficiency, high emission (LEHE) systems and there are dozens of manufacturers. In 2006, the State of New York instituted a moratorium on new LEHE OWB installations due to concerns over emissions and air quality5. Other states have also considered or implemented new regulations6,7,8,9. Since there are no standards for OWBs (“boilers” and “furnaces” were exempt from the 1988 EPA regulations10), OWB ratings are inconsistent and can be misleading. Prior to 2006, standard procedures for evaluating wood boilers did not exist, but test data from New York, Michigan and elsewhere showed a wide range of apparent [in]efficiencies and emissions among OWBs.

In 2006, a committee was formed under the American Society for Testing and Materials (ASTM) to develop a standard test protocol for OWBs11. The standards included uniform procedures for determining performance and emissions. Subsequently, the ASTM committee sponsored tests of three common outdoor wood boilers using the new procedures. The results showed efficiencies as low as 25% and emissions more than nine times the standard for other industrial boilers. Obviously, these results were deemed unsatisfactory and new OWB standards were called for.
In a news release dated January 29, 2007, the U.S. Environmental Protection Agency announced a new voluntary partnership agreement with 10 major OWB manufacturers to make cleaner-burning appliances. The new phase-one standard calls for emissions not to exceed 0.60 pounds of particulate emissions per million Btu of heat input. The phase-two standard, which will follow 2 years after phase-one, will limit emissions to 0.30 pounds per million Btus of heat delivered, thereby creating an efficiency standard as well.

To address local and state concerns over regulating OWB installations, the Northeast States for Coordinated Air Use Management (NeSCAUM), and EPA have developed model regulations that recommend OWB installation specifications, clean fuel standards and owner/operator training. (http://www.epa.gov/woodheaters/ and http://www.nescaum.org/topics/outdoor-hydronic-heaters)

Implementation of the new standard will improve air quality and boiler efficiency but will also increase costs as manufacturers modify their designs, fabrication and marketing to adjust to the new standards. Some low-end models will no longer be available.

4.2 High Efficiency Low Emission (HELE) Cordwood Boilers

In contrast to low efficiency, high emission cordwood boilers there are a few units that can be considered high efficiency, low emission (HELE). These systems are designed to burn cordwood fuel cleanly and efficiently.

Table 4-1 lists three HELE boiler suppliers, all of which have units operating in Alaska. Greenwood and TarmUSA, Inc. have a number of residential units operating in Alaska, and a Garn boiler manufactured by Dectra Corporation is used in Dot Lake, AK to heat several homes and the washeteria, replacing 7,000 gallons per year (gpy) of fuel oil. Two Garn boilers were recently installed in Tanana, AK to provide heat to the washeteria and water plant, and two others were installed near Kasilof. Several more are being planned.

<table>
<thead>
<tr>
<th>Btu/hr ratings</th>
<th>Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>100,000 to 198,000</td>
<td>Tarm USA</td>
</tr>
<tr>
<td></td>
<td><a href="http://www.tarmusa.com">www.tarmusa.com</a></td>
</tr>
<tr>
<td>100,000 to 300,000</td>
<td>Greenwood</td>
</tr>
<tr>
<td></td>
<td><a href="http://www.GreenwoodFurnace.com">www.GreenwoodFurnace.com</a></td>
</tr>
<tr>
<td>350,000 to 950,000</td>
<td>Dectra Corp.</td>
</tr>
<tr>
<td></td>
<td><a href="http://www.dectra.net/garn">www.dectra.net/garn</a></td>
</tr>
</tbody>
</table>

Note: Listing of any manufacturer, distributor or service provider does not constitute an endorsement.

Table 4-2 shows the results for a Garn WHS 1350 boiler that was tested at 157,000 to 173,000 Btu/hr by the State of Michigan using the new ASTM testing procedures, compared with EPA standards for wood stoves and boilers. It is important to remember that wood fired boilers are not entirely smokeless; even very efficient wood boilers may smoke for a few minutes on startup.
### Table 4-2. Emissions from Wood Heating Appliances

<table>
<thead>
<tr>
<th>Appliance</th>
<th>Emissions (grams/1,000 Btu delivered)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPA Certified Non Catalytic Stove</td>
<td>0.500</td>
</tr>
<tr>
<td>EPA Certified Catalytic Stove</td>
<td>0.250</td>
</tr>
<tr>
<td>EPA Industrial Boiler (many states)</td>
<td>0.225</td>
</tr>
<tr>
<td>GARN WHS 1350 Boiler*</td>
<td>0.179</td>
</tr>
</tbody>
</table>

Note: *With dry oak cordwood; average efficiency of 75.4% based upon the high heating value (HHV) of wood

### 4.3 Bulk Fuel Boiler Systems

The term “bulk fuel” as used in this report refers, generically, to sawdust, wood chips, shavings, bark, pellets, etc. Since the availability of bulk fuel is non-existent in Huslia, the cost of bulk fuel systems is so high (i.e., $1 million and up), and the relatively small heating demand for the projects under consideration, the discussion of bulk fuel boiler systems has been omitted from this report.

### SECTION 5. SELECTING THE APPROPRIATE SYSTEM

Selecting the appropriate heating system is, primarily, a function of heating demand. It is generally not feasible to install automated bulk fuel systems in/at small facilities, and it is likely to be impractical to install cordwood boilers at very large facilities. Other than demand, system choice can be limited by fuel (form) availability, labor, financial resources, and limitations of the site.

The selection of a wood-fueled heating system has an impact on fuel economy. Potential savings in fuel costs must be weighed against initial investment costs and ongoing operating, maintenance and repair (OM&R) costs. Wood system costs include the initial capital costs of purchasing and installing the equipment, non-capital costs (engineering, permitting, etc.), the cost of the fuel storage building and boiler building (if required), the financial burden associated with loan interest, the fuel cost, and the other costs associated with operating and maintaining the heating system, especially labor.

### 5.1 Comparative Costs of Fuels

Table 5-1 compares the cost of #1 fuel oil to white spruce cordwood (MC30). In order to make reasonable comparisons, costs are calculated on a “per million Btu (MMBtu)” basis.

### Table 5-1. Comparative Cost of Fuel Oil vs. Wood Fuel

<table>
<thead>
<tr>
<th>FUEL</th>
<th>RHVa (Btu)</th>
<th>Conversion Efficiencya</th>
<th>DHVa (Btu)</th>
<th>Price per unit ($)</th>
<th>Cost per MMBtu (delivered, $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel oil, #1, 1 gallon</td>
<td>134,000</td>
<td>80%</td>
<td>107,200 per gallon</td>
<td>5.50/gal</td>
<td>51.306</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6.00</td>
<td>55.970</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6.50</td>
<td>60.634</td>
</tr>
<tr>
<td>White spruce, 1 cord, MC30</td>
<td>12.22 million</td>
<td>75%</td>
<td>9.165 million</td>
<td>300/cord</td>
<td>32.733</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>350</td>
<td>38.189</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>400</td>
<td>43.644</td>
</tr>
</tbody>
</table>

Notes:
* from Appendix D
5.2(a) Cost per MMBtu Sensitivity – Cordwood

Figure 5-1 illustrates the relationship between the price of white spruce cordwood (MC30) and the cost of delivered heat, (the slanted line). For each $10 per cord increase in the price of cordwood, the cost per million Btu increases by about $1.09. The chart assumes that the cordwood boiler delivers 75% of the RHV energy in the cordwood to useful heat and that oil is converted to heat at 80% efficiency. The dashed lines represent #1 fuel oil at $5.50, $6.00 and $6.50 per gallon ($51.306, $55.97 and $60.624 per million Btu respectively).

At high efficiency, heat from white spruce cordwood (MC30) at $512.96 per cord is equal to the cost of oil at $6.00 per gallon, before considering the cost of the equipment and operation, maintenance and repair (OM&R) costs. At 75% efficiency and $350 per cord, a high-efficiency cordwood boiler will deliver heat at about 32% less than the cost of #1 fuel oil at $6.00 per gallon ($38.189 versus $55.97 per MMBtu). Figure 5-1 indicates that, at a given efficiency, savings increase significantly with decreases in the delivered price of cordwood and/or with increases in the price of fuel oil.

![Figure 5-1. Effect of White Spruce Cordwood Price on Cost of Delivered Heat](image)

5.2(b) Cost per MMBtu Sensitivity – Bulk Fuels

Not included in this report
5.3 Determining Demand

Table 5-2 shows the amount of fuel oil consumed by the various building clusters in Huslia.

<table>
<thead>
<tr>
<th>Facility</th>
<th>Reported Annual Fuel Consumption</th>
<th>Gallons</th>
<th>Cost ($) @ $6.00/gallon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Downtown cluster</td>
<td></td>
<td>9,750</td>
<td>58,500</td>
</tr>
<tr>
<td>Jimmy Huntington School</td>
<td></td>
<td>17,000</td>
<td>102,000</td>
</tr>
<tr>
<td>Water plant, washeteria and health clinic</td>
<td></td>
<td>24,500</td>
<td>147,000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>51,250</strong></td>
<td><strong>307,500</strong></td>
</tr>
</tbody>
</table>

Wood boilers, especially cordwood boilers, are often sized to displace only a portion of the heating load since the oil system will remain in place, in standby mode, for “shoulder seasons” and peak demand. Fuel oil consumption for the Huslia building clusters was compared with heating demand based on heating degree days (HDD) to determine the required boiler capacity (RBC) for heating only on the coldest 24-hour day (Table 5-3). While there are many factors to consider when sizing heating systems it is clear that, in most cases, a wood system of less-than-maximum size could still replace a substantial quantity of fuel oil.

Typically, installed oil-fired heating capacity at most sites is two to four times the demand for the coldest day. This appears to be true for the Jimmy Huntington School, even without including the installed heating capacity in the teacher housing units, which would push the multiple even higher. That multiple cannot be determined for the Downtown cluster, given that the heating capacity of the appliances in the Environmental Office and Head Start building are unknown. But for those buildings whose boiler heating capacities are known (City office building, Tribal Council office building and Nutrition Center), it appears that the multiple is less than 2. The multiplier is also less than 2 at the Health Clinic, based on reported consumption of 4,500 gpy. And lastly, for the water plant and washeteria, required boiler capacity for heating cannot be determined because, 1) most of the fuel will be used to heat water for domestic consumption, and 2) there are no fuel consumption records, as the plant is not yet operational.

Manual HELE cordwood boilers, equipped with special tanks for extra thermal storage, can supply heat at higher than their rated capacity for short periods. For example, while rated at 425,000 Btu/hr (heat input) each, a pair of Garn WHS 2000 boilers can store more than 2½ million Btu, which would be enough to heat the Downtown cluster during the coldest 24-hour period for nearly 8 hours (2,544,000 ÷ 321,229).
### Table 5-3. Estimate of Heat Required in Coldest 24 Hr Period

<table>
<thead>
<tr>
<th>Facility</th>
<th>Facility Fuel Oil Used gal/year&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Heating Degree Days&lt;sup&gt;d&lt;/sup&gt;</th>
<th>Btu/DD&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Design Temp&lt;sup&gt;f&lt;/sup&gt; F</th>
<th>RBC&lt;sup&gt;e&lt;/sup&gt; Btu/hr</th>
<th>Installed (net) Btu/hr&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Downtown cluster</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City Office bldg.</td>
<td>1,500</td>
<td>10,762</td>
<td>49,947</td>
<td>131,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tribal Council bldg.</td>
<td>1,500</td>
<td>10,762</td>
<td>49,947</td>
<td>131,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nutrition Center</td>
<td>3,500</td>
<td>25,110</td>
<td>115,712</td>
<td>100,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Ofc.</td>
<td>2,250</td>
<td>16,142</td>
<td>74,609</td>
<td>unknown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head Start</td>
<td>1,000</td>
<td>7,174</td>
<td>33,505</td>
<td>unknown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>9,750</td>
<td>69,950</td>
<td>321,229</td>
<td>362,000+unknown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>School</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admin &amp; grade school</td>
<td></td>
<td>14,942</td>
<td></td>
<td>-45 (Bettles)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main school bldg</td>
<td>17,000</td>
<td>121,965</td>
<td>559,629</td>
<td>604,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taylor Bldg (shop)</td>
<td></td>
<td></td>
<td></td>
<td>1,124,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher housing</td>
<td></td>
<td></td>
<td></td>
<td>138,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>20,000</td>
<td>24,500</td>
<td>unknown</td>
<td>1,866,000+unknown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water plant/washeteria</td>
<td></td>
<td></td>
<td></td>
<td>unknown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health Clinic</td>
<td>4,500</td>
<td>32,285</td>
<td>148,595</td>
<td>520,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>24,500</td>
<td></td>
<td>unknown</td>
<td>152,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 5-3 Notes:**

<sup>a</sup> From SOI and site visit; net Btu/hr  
<sup>b</sup> NOAA, July 1, 2005 through June 30, 2006:  
<sup>c</sup> Btu/DD= Btu/year x oil furnace conversion efficiency (0.85) /Degree Days  
<sup>e</sup> RBC = Required Boiler Capacity for the coldest Day, Btu/hr= [Btu/DD x (65 F-Design Temp)+DD]/24 hrs
5.4 Summary of Current Conditions

Table 5-4 summarizes the findings thus far: annual fuel oil usage, range of annual fuel oil costs, estimated annual wood fuel requirement, range of estimated annual wood fuel costs, and potential gross annual savings for the Huslia building clusters. [Note: potential gross annual fuel cost savings do not consider capital costs and non-fuel operation, maintenance and repair (OM&R) costs.]

Table 5-4. Estimate of Total Wood Consumption, Comparative Costs and Potential Savings

<table>
<thead>
<tr>
<th>Facility</th>
<th>Fuel Oil Used(^a) (gal/year)</th>
<th>Annual Fuel Oil Cost (@ $ ___ /gal)</th>
<th>Approximate Wood Requirement(^b) (White spruce, MC30, CE 75%)</th>
<th>Annual Wood Cost (@ $ ___ /unit)</th>
<th>Potential Gross Annual Fuel Cost Savings ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5.50</td>
<td>6.00</td>
<td>6.50</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>Downtown cluster</td>
<td>9,750</td>
<td>53,625</td>
<td>58,500</td>
<td>63,375</td>
<td>114</td>
</tr>
<tr>
<td>Jimmy Huntington School and teacher housing</td>
<td>17,000</td>
<td>93,500</td>
<td>102,000</td>
<td>110,500</td>
<td>199</td>
</tr>
<tr>
<td>Water plant/washeteria and Health Clinic</td>
<td>24,500</td>
<td>134,750</td>
<td>147,000</td>
<td>159,250</td>
<td>287</td>
</tr>
<tr>
<td>Total</td>
<td><strong>51,250</strong></td>
<td><strong>281,875</strong></td>
<td><strong>307,500</strong></td>
<td><strong>333,125</strong></td>
<td><strong>600</strong></td>
</tr>
</tbody>
</table>

NOTES:
\(^a\) From Table 5-3; used the numerical average where a range was indicated
\(^b\) From Table D-3, Fuel Oil Equivalents
SECTION 6. ECONOMIC FEASIBILITY OF CORDWOOD SYSTEMS

6.1 Initial Investment Cost Estimates

DISCLAIMER: Short of having an actual Design & Engineering Report prepared by a team of architects and/or engineers, actual costs for any particular system at any particular site cannot be positively determined. Such a report is beyond the scope of this preliminary assessment. However, several hypothetical systems are offered as a means of comparison. Actual costs, assumptions and “guess-timates” are identified as such, where appropriate. Recalculations of financial metrics, given different/updated cost estimates, are readily accomplished.

Wood heating systems include the cost of the fuel storage building (if necessary), boiler building (if necessary), boiler equipment (and shipping), plumbing and electrical connections (including plumbing, heat exchangers and electrical service to integrate with existing distribution systems), installation, and an allowance for contingencies.

Before a true economic analysis can be performed, all of the costs (investment and OM&R) must be identified, and this is where the services of qualified experts are necessary.

Table 6-1 (next page) presents hypothetical scenarios of initial investment costs for four cordwood boiler heating installations in medium and large heating demand situations.

Building(s) and plumbing/connections are the most significant costs besides the boiler(s). Building costs deserve more site-specific investigation and often need to be minimized to the extent possible. Piping from the wood-fired boiler is another area of potential cost saving. Long plumbing runs and additional heat exchangers substantially increase project costs. The high cost of hard copper and/or iron pipe normally used in Alaska now precludes its use in nearly all applications. If plastic or PEX® piping is used significant cost savings may be possible.

Allowances for indirect non-capital costs such as engineering and contingency are most important for large systems that involve extensive permitting and budget approval by public agencies. This can increase the cost of a project by 25% to 50%. For the examples in Table 6-1, a 25% contingency allowance was used.

NOTES:

a. With the exception of the list prices for Garn boilers, all of the figures in Table 6-1 are gross estimates.

b. The cost estimates presented in Table 6-1 do not include the cost(s) of any upgrades or improvements to the existing heating/heat distribution system currently in place.
Table 6-1. Initial Investment Cost Scenarios for Hypothetical Cordwood Systems

<table>
<thead>
<tr>
<th></th>
<th>Huslia Building Clusters</th>
<th>Jimmy Huntington School</th>
<th>Water Plant/Washeteria and Health Clinic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Downtown Cluster</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel oil consumption</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(gallons per year)</td>
<td>9,750</td>
<td>17,000</td>
<td>24,500</td>
</tr>
<tr>
<td>Required boiler capacity (RBC),</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Btu/hr</td>
<td>321,229</td>
<td>559,629</td>
<td>Undetermined</td>
</tr>
<tr>
<td>Cordwood boiler</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model</td>
<td>(2) Garn WHS 2000</td>
<td>(1) Garn WHS 3200</td>
<td>(2) Garn WHS 3200</td>
</tr>
<tr>
<td>Rating - Btu/hr</td>
<td>850,000 combined</td>
<td>950,000 combined</td>
<td>1,900,000 combined</td>
</tr>
<tr>
<td>Btu stored</td>
<td>2,544,000 combined</td>
<td>2,064,000 combined</td>
<td>4,128,000 combined</td>
</tr>
</tbody>
</table>

Building and Equipment (B&E) Costs (for discussion purposes only), $

<table>
<thead>
<tr>
<th>Fuel storage buildinga (fabric bldg, gravel pad, $20 per sf)</th>
<th>45,600 (114 cords, 2,280 s.f)</th>
<th>79,600 (199 cords, 3,980 s.f)</th>
<th>114,800 (287 cords, 5,740 s.f)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiler building @ $150 per sf (minimum footprint, w/concrete pad)b</td>
<td>38,400 (16’ x 16’)</td>
<td>60,000 (20’ x 20’)</td>
<td>60,000 (20’ x 20’)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Boilers</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base pricec</td>
<td>29,800</td>
<td>32,900</td>
</tr>
<tr>
<td></td>
<td>Shippingd</td>
<td>5,000</td>
<td>5,000</td>
</tr>
<tr>
<td></td>
<td>Bush deliverye</td>
<td>5,000</td>
<td>5,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plumbing/connections e</th>
<th>20,000</th>
<th>40,000</th>
<th>40,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation e</td>
<td>15,000</td>
<td>25,000</td>
<td>25,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subtotal - B&amp;E Costs</th>
<th>158,800</th>
<th>161,900</th>
<th>285,400</th>
<th>320,600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contingency (25%)e</td>
<td>39,700</td>
<td>40,475</td>
<td>71,350</td>
<td>80,150</td>
</tr>
</tbody>
</table>

| Grand Total          | 198,500 | 202,375 | 356,750 | 400,750 |

Notes:

a. A cord occupies 128 cubic feet. If the wood is stacked 6½ feet high, the area required to store the wood is 20 square feet per cord.

b. Does not allow for any fuel storage within the boiler building.


d. To Anchorage or Fairbanks;

e. guess-timate”; for illustrative purposes only

6.2 Operating Parameters of HELE Cordwood Boilers

A detailed discussion of the operating parameters of HELE cordwood boilers can be found in Appendix F.

6.3 Hypothetical OM&R Cost Estimates

The primary operating cost of a cordwood boiler, other than the cost of fuel, is labor. Labor is required to move fuel from its storage area to the boiler building, fire the boiler, clean the boiler.
and dispose of ash. For purposes of this analysis, it is assumed that the boiler will operate every day for 210 days (30 weeks) per year between mid-September and mid-April.

Table 6-2 presents labor/cost estimates for various HELE cordwood systems. A detailed analysis of labor requirement estimates can be found in Appendix F.

<table>
<thead>
<tr>
<th>System (Garn Model)</th>
<th>Downtown cluster (114 cds/yr)</th>
<th>Jimmy Huntington School (199 cds/yr)</th>
<th>Water Plant/Washeteria and Health Clinic (287 cds/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(2) WHS 2000</td>
<td>(1) WHS 3200</td>
<td>(2) WHS 3200 (combined capacity)</td>
</tr>
<tr>
<td>Total Daily labor (hrs/yr)*</td>
<td>155.76</td>
<td>114.00</td>
<td>222.36</td>
</tr>
<tr>
<td></td>
<td>(hrs/day X 210 days/yr)</td>
<td></td>
<td>320.69</td>
</tr>
<tr>
<td>Total Periodic labor (hrs/yr)*</td>
<td>114.00</td>
<td>114.00</td>
<td>199</td>
</tr>
<tr>
<td></td>
<td>(hrs/wk X 30 wks/yr)</td>
<td></td>
<td>287</td>
</tr>
<tr>
<td>Total Annual labor (hrs/yr)*</td>
<td>40</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>(hrs/yr)</td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>Total labor (hrs/yr)</td>
<td>309.76</td>
<td>248.00</td>
<td>461.36</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>647.69</td>
</tr>
<tr>
<td>Total annual labor cost ($/yr)</td>
<td>6,195.20</td>
<td>4,960.00</td>
<td>9,227.20</td>
</tr>
<tr>
<td></td>
<td>(total hrs x $20)</td>
<td></td>
<td>12,953.80</td>
</tr>
</tbody>
</table>

Notes:
* From Table 6-2
* From Appendix F

There is also an electrical cost component to the boiler operation. An electric fan creates the induced draft that contributes to boiler efficiency. The cost of operating circulation pumps and/or blowers would be about the same as it would be with the oil-fired boiler or furnaces in the existing heating system.

Lastly there is the cost of maintenance and repair items, such as fire brick, door gaskets, water treatment chemicals, etc. For the following examples, a value of $1,000 per boiler is used.

<table>
<thead>
<tr>
<th>System (Garn Model)</th>
<th>Downtown cluster (114 cds/yr)</th>
<th>Jimmy Huntington School (199 cds/yr)</th>
<th>Water Plant/Washeteria and Health Clinic (287 cds/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor a</td>
<td>6,195.20</td>
<td>4,960.00</td>
<td>9,227.20</td>
</tr>
<tr>
<td>Electricity b</td>
<td>2,536.62</td>
<td>812.87</td>
<td>1,419.06</td>
</tr>
<tr>
<td>Maintenance/Repairs</td>
<td>2,000.00</td>
<td>1,000.00</td>
<td>2,000.00</td>
</tr>
<tr>
<td>Total non-fuel OM&amp;R ($)</td>
<td>10,731.82</td>
<td>6,772.87</td>
<td>12,646.80</td>
</tr>
<tr>
<td></td>
<td>(2) WHS 2000</td>
<td>(1) WHS 3200</td>
<td>(2) WHS 3200 (combined capacity)</td>
</tr>
</tbody>
</table>

Notes:
a From Table 6-2
b Electrical cost based on a formula of horsepower x kWh rate x operating time. Assumed kWh rate = $0.80
6.4 Calculation of Financial Metrics

Biomass heating projects are viable when, over the long run, the annual fuel cost savings generated by converting to biomass are greater than the cost of the new biomass boiler system plus the additional operation, maintenance and repair (OM&R) costs associated with a biomass boiler (compared to those of a fossil fuel boiler or furnace).

Converting from an existing boiler to a wood biomass boiler (or retrofitting/integrating a biomass boiler with an existing boiler system) requires a greater initial investment and higher annual OM&R costs than for an equivalent oil or gas system alone. However, in a viable project, the savings in fuel costs (wood vs. fossil fuel) will pay for the initial investment and cover the additional OM&R costs in a relatively short period of time. After the initial investment is paid off, the project continues to save money (avoided fuel cost) for the life of the boiler. Since inflation rates for fossil fuels are typically higher than inflation rates for wood fuel, increasing inflation rates result in greater fuel savings and thus greater project viability.17

The potential financial viability of a given project depends not only on the relative costs and cost savings, but also on the financial objectives and expectations of the facility owner. For this reason, the impact of selected factors on potential project viability is presented using the following metrics:

Simple Payback Period
Present Value (PV)
Net Present Value (NPV)
Internal Rate of Return (IRR)

Total initial investment costs include all of the capital and non-capital costs required to design, purchase, construct and install a biomass boiler system in an existing facility with an existing furnace or boiler system.

A more detailed discussion of Simple Payback Period, Present Value, Net Present Value and Internal Rate of Return can be found in Appendix E.

6.5 Simple Payback Period for HELE Cordwood Boilers

Table 6-4 presents a Simple Payback Period analysis for hypothetical HELE cordwood boiler installations.

<table>
<thead>
<tr>
<th></th>
<th>(2) WHS 2000</th>
<th>(1) WHS 3200</th>
<th>(2) WHS 3200 (combined capacity)</th>
<th>(2) WHS 3200 (combined capacity)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fuel oil cost</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>($ per year @ $6.00 per gal.)</td>
<td>58,500</td>
<td>102,000</td>
<td>147,000</td>
<td></td>
</tr>
<tr>
<td><strong>Cordwood cost</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>($ per year @ $350 per cord)</td>
<td>39,900</td>
<td>69,650</td>
<td>100,450</td>
<td></td>
</tr>
<tr>
<td><strong>Annual fuel cost savings ($)</strong></td>
<td>18,600</td>
<td>32,350</td>
<td>46,550</td>
<td></td>
</tr>
<tr>
<td><strong>Total Investment Costs ($)</strong></td>
<td>198,500</td>
<td>202,375</td>
<td>356,750</td>
<td></td>
</tr>
<tr>
<td><strong>Simple Payback</strong></td>
<td>10.67</td>
<td>10.88</td>
<td>11.03</td>
<td>8.61</td>
</tr>
</tbody>
</table>

Notes:

a From Table 6-3
b From Table 6-1
c Total investment costs divided by annual fuel cost savings
Table 6-5 presents PV, NPV and IRR values for hypothetical small and large HELE cordwood boilers.

<table>
<thead>
<tr>
<th>Table 6-5. PV, NPV and IRR Values for HELE Cordwood Boilers</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2) WHS 2000</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td><strong>Discount Rate</strong></td>
</tr>
<tr>
<td><strong>Time, “t”, (years)</strong></td>
</tr>
<tr>
<td><strong>Initial Investment ($)</strong></td>
</tr>
<tr>
<td><strong>Annual Cash Flow ($)</strong></td>
</tr>
<tr>
<td><strong>Present Value</strong> (of expected cash flows, $ at “t” years)</td>
</tr>
<tr>
<td><strong>Net Present Value</strong> ($ at “t” years)</td>
</tr>
<tr>
<td><strong>Internal Rate of Return</strong> (% at “t” years)</td>
</tr>
<tr>
<td><strong>See Note #____ below</strong></td>
</tr>
</tbody>
</table>

Notes:

- **b** From Table 6-1
- **c** Equals annual cost of fuel oil minus annual cost of wood minus annual non-fuel OM&R costs (i.e. Net Annual Savings)

Note #1. With a real discount rate of 3.00% and after a span of 20 years, the projected cash flows are worth $117,056 today (PV), which is less than the initial investment of $198,500. The resulting NPV of the project is -$81,444, which means that the project, given the stated assumptions and cost estimates, will not achieve the stated return [i.e., 3%] at the end of 20 years.

Given the assumptions and cost estimates for this example, this alternative does not appear to be cost-effective. However, the initial investment cost estimates and/or OM&R cost estimates could be too high, and/or annual fuel cost savings too low. Furthermore, annual cash flows will increase if oil prices continue to increase above the general rate of inflation and/or disproportionately to the cost of wood fuel.

Note #2. With a real discount rate of 3.00% and after a span of 20 years, the projected cash flows are worth $175,956 today (PV), which is less than the initial investment of $202,375. The resulting NPV of the project is -$26,419, which means that the project, given the stated assumptions and cost estimates, will not achieve the stated return [i.e., 3%] at the end of 20 years.

Given the assumptions and cost estimates for this example, this alternative appears to be marginally cost-effective; the internal rate of return is positive. However, the initial investment cost estimates and/or OM&R cost estimates could be too high, and/or annual fuel cost savings too low. Furthermore, annual cash flows will increase if oil prices continue to increase above the general rate of inflation and/or disproportionately to the cost of wood fuel.

Note #3. With a real discount rate of 3.00% and after a span of 20 years, the projected cash flows are worth $293,131 today (PV), which is less than the initial investment of $356,700. The resulting NPV of the project is -$63,569, which means that the project, given the stated assumptions and cost estimates, will not achieve the stated return [i.e., 3%] at the end of 20 years.

Given the assumptions and cost estimates for this example, this alternative appears to be somewhat marginally cost-effective; the internal rate of return is positive, though barely. However, the initial investment cost
estimates and/or OM&R cost estimates could be too high, and/or annual fuel cost savings too low. Furthermore, annual cash flows will increase if oil prices continue to increase above the general rate of inflation and/or disproportionately to the cost of wood fuel.

Note #4. With a real discount rate of 3.00% and after a span of 20 years, the projected cash flows are worth $439,629 today (PV), which is greater than the initial investment of $400,750. The resulting NPV of the project is $38,879, and the project achieves an internal rate of return of 4.02% at the end of 20 years. Based on the assumed inputs, these numbers are reasonably positive and would indicate that this project is cost-effective.

SECTION 7. ECONOMIC FEASIBILITY OF BULK FUEL SYSTEMS

The discussion of bulk fuel systems is not included in this report.

SECTION 8. CONCLUSIONS

This report discusses potential wood-fired heating projects in Huslia in western interior Alaska, and attempts to demonstrate, by use of realistic, though hypothetical, examples, the feasibility of installing high efficiency, low emission cordwood boilers in various medium and large applications.

Wood is a viable heating fuel in a wide range of institutional applications, however, below a certain minimum and above a certain maximum, it may be impractical to heat with wood, or it may require a different form of wood fuel and heating system.

Huslia Clusters

Three building “clusters” were identified as potential heating projects in Huslia. The “Downtown” cluster consists of the Huslia city office building, Huslia Tribal Council office building, the Environmental Office, the Nutrition Center, and possibly, the Head Start facility. Cluster 2 consists of the Jimmy Huntington School complex, and cluster 3 consists of the water treatment plant, washeteria and health clinic. Each of these clusters is analyzed in this report.

The individual fuel oil consumption for each of these buildings is reasonably well known (with the exception of the new water plant), and taken all together, these buildings consume an estimated 51,250 gallons of fuel oil per year. Each of the clusters could be served by its own boiler system consisting of one or two cordwood boilers of various sizes. The heat distribution systems within all the buildings appear to be in reasonably good condition, so costs of modifying them should be minimal.

In the hypothetical examples presented in Section 6, the gross annual fuel cost savings ranged from $18,600 for the smallest cluster to $46,550 for the largest cluster.

Downtown cluster. Two boiler configurations were considered for the Downtown cluster. With a pair of medium boilers (Garn WHS 2000) being fired approximately 6 times per day, the simple payback period would be 10.67 years (given a cordwood boiler installation costing an estimated $198,500). The present value, net present value and internal rate of return after 20 years, assuming a real discount rate of 3%, would be $117,056, -$81,444 and -2.12% respectively.

With a single large boiler (Garn WHS 3200) being fired approximately 4 times per day, the simple payback period would be 10.88 years (given a cordwood boiler installation costing an estimated $202,375). However, due to lower estimated OM&R costs, the other financial metrics were more
positive. The present value, net present value and internal rate of return after 20 years, assuming a real discount rate of 3%, would be $175,956, -$26,419 and 1.53% respectively.

Jimmy Huntington School. With a pair of large boilers (Garn WHS 3200) being fired an average of 3.3 times per day, the simple payback period would be 11.03 years (given a cordwood boiler installation costing an estimated $356,750). The present value, net present value and internal rate of return after 20 years, assuming a discount rate of 3%, are $293,131, -$63,569 and 0.97% respectively.

Water plant, washeteria and health clinic. With a pair of large boilers (Garn WHS 3200) being fired an average of 4.8 times per day, the simple payback period would be 8.61 years (given a cordwood boiler installation costing an estimated $400,750). The present value, net present value and internal rate of return after 20 years, assuming a discount rate of 3%, are $439,629, $38,879 and 4.02% respectively.

Closer scrutiny of these projects by qualified professionals would be justified.

Observations regarding relative fuel costs

The difference in the cost of heat derived from wood versus the cost of heat derived fuel oil can be significant. It is this difference in the cost of heat that must “pay” for the substantially higher investment and OM&R costs associated with wood-fuel systems. However, the situation in Huslia is somewhat problematic, given the projected cost of wood fuel ($350 per cord) versus the expected cost of fuel oil ($6.00 per gallon). Or, put in another way, $38 per MMBtu (for wood) versus $56 per MMBtu (for oil).

In most places, the cost of wood (on a Btu basis) is roughly half that of oil. That would mean about $257 per cord given oil at $6 per gallon. But even at $300 per cord, the financial picture of the proposed projects would improve significantly. The least cost-effective alternative (i.e., (2) WHS 2000 boilers at the Downtown cluster), would become strongly cost-effective with an estimated simple payback of 8.17 years, given wood at $300 per cord. The present value, net present value and internal rate of return after 20 years, assuming a discount rate of 3%, would be $201,858, $3,358 and 3.18% respectively.

I am not suggesting that $350 per cord is not a fair price, given current harvesting practices and production methods. However, it may be possible to reduce that price if wood can be processed faster and/or more efficiently. With a demand of 600 cords per year (if all three clusters were converted to wood), a firewood producer could probably justify the purchase of a commercial firewood processor and keep costs in check.