**WOOD FUELED BOILER FINANCIAL FEASIBILITY USER'S MANUAL**

WISCONSIN
DEPT. OF NATURAL RESOURCES

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*(Continued)*

Assuming an approximately 150 horsepower wood fueled boiler would be installed (capable of meeting average load of existing kilns while at approximate 50% of capacity and offering room for kiln expansion to at least 300 MBF), and assuming the wood fueled system would represent an incremental investment of about $200,000, the estimated payback on the wood fueled system would be less than three years. Even assuming the full cost of investment (versus incremental cost) is used as the basis of investment in the analysis, the payback period would be less than five years – and in both cases, if kiln capacity were expanded, the payback periods would be reduced.

Within the follow-on preliminary assessment section of the model, the data used in most cases represent and initial "best-guess" with an effort to be somewhat conservative as a starting point, taking care to not consciously favor the installation of the wood fueled boiler. The net result of this 20-year analysis was still very favorable, reflecting a significant positive net present value, even assuming a 20% overall cost of capital (discounting interest rate) in the analysis. This is, of course, is only a starting point, and the inputs would be refined in working with engineering professionals and others if the project is taken to the next steps of design and planning.

# ACKNOWLEDGEMENTS

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# APPENDIX: DISCUSSION OF SAMPLE WOOD FUELED BOILER FEASIBILITY ANALYSIS CASE

The following sample case represents an actual case study analysis conducted in the Lake States region of the United States. To maintain confidentiality, the company name and specific location is not included, and the company-sensitive circumstances have been slightly altered in the form of either data inputs or some assumptions related to costs, sizes and loads. These slight modifications are sufficient to disguise company identity and provide confidentiality. However, in aggregate they are not sufficient to significantly alter the case study results for any of these illustrations. The case analysis provides the sample entries that are used in the standard model form of the "Wood Fueled Boiler Financial Feasibility" spreadsheet program.

The case was an analysis conducted for a secondary forest products manufacturer. The company has lumber dry kiln capacity of approximately 200 MBF (multiple kilns, all used to dry hardwood lumber). This capacity is currently served by an approximately 200 horsepower natural gas boiler which can also be fueled by kerosene. The existing boiler is of an age and in a condition where it is not desirable as a primary boiler, but it is suitable as a back-up boiler. Additional capacity for potential near-future kiln expansion is desired. Fuel costs for existing fuels are typical for an industrial customer of that size in the area. Wood fuel for the wood fueled boiler would primarily be purchased from local companies in a well-developed local market with adequate supply in a green/dry mixture.

An estimated 60 million (net) Btu are required per day (year-round) on average. The cost per net million Btu is estimated to be approximately $8.50 at current natural gas prices with the existing boiler system at average efficiency. Assuming a delivered price of $27.50 per green ton of wood fuel at an average of approximately 35% moisture content (green basis), the fuel cost for the wood fired boiler is estimated to be less than approximately $3.50 per net million Btu, or about 40% of the fuel cost using natural gas.

Assuming the existing natural gas fired boiler is due to be replaced regardless, and the existing boiler will be kept as a back-up, by installing a wood fueled boiler (versus natural gas fueled boiler), the incremental additional investment in the wood boiler (in excess of the cost of a gas boiler of the same size) would be equal to approximately 50% of the cost of the wood fueled system. The difference in investment alternatives is the basis for investment costs to compare the operational savings which are in excess of approximately $100,000 per annum at current loads based on fuel costs only, or about $85,000 per year when some additional operational costs are also considered (NOTE: Kiln expansion would increase annual fuel cost savings).

# INTRODUCTION

"Wood Fueled Boiler Financial Feasibility" is a spreadsheet program designed for easy use on a personal computer. This program provides a starting point for interested parties to perform financial feasibility analysis of a steam boiler system for space heating or process heat. By allowing users to input the conditions applicable to their current or proposed fuel systems, "Wood Fueled Boiler Financial Feasibility" provides an opportunity to compare wood or bark fuel as alternates to the existing fuel.

This program has been designed for use by most decision-makers seeking basic insight such as annual savings and potential payback of wood fuel. More detailed financial feasibility estimates can also be done on a 20-year period of analysis for those who have greater technical expertise and are more knowledgeable in conducting such analyses.

It is suggested that first-time users read this manual and carefully examine all explanatory text in the spreadsheet related to entries, calculations, and interpretations prior to initial use of the spreadsheet.

## Important Things to Keep in Mind

This program is for preliminary financial analysis. More robust models exist for very detailed analysis of biomass projects that extend beyond the scope of this program. This program is not intended to replace technical systems analyses, planning efforts, or pro-forma financial statements prepared by engineering, accounting, or other planning professionals.

# INITIAL ASSESSMENT

## Overview
The spreadsheet is comprised of step-by-step sections that allow analysis to flow logically – often building on previous sections. Upon opening the program at the top of the spreadsheet, the user will see a brief section of text followed by the calculation sections. Important notes defining variable parameters and assumptions are provided directly in the program. First-time users should read the explanatory text provided in the program.

## Getting Started
For those experienced with spreadsheets, using the initial assessment section of the program should be fairly easy with only limited and readily accessible user-specific information. Users follow the step-by-step format outlined in the spreadsheet. The user will need to input estimates of the fuel costs and average boiler load. The program will estimate potential variable cost savings associated with wood fuel. With limited information, most users can do a "quick and dirty" analysis, however, the quality of the results is directly related to the estimates that are used. Consequently, refined estimates will ultimately be desired.

Like any spreadsheet, "Wood Fueled Boiler Financial Feasibility" consists of rows (horizontal cells across the page) and columns (vertical cells up and down the page). Users must enter data where the code "e>" (or "e>>") is shown in column A. The user enters the data in column C (or multiple columns). In the initial assessment section in instances where the user wishes to ignore a particular fuel – current or alternative – they can simply leave column C blank.

Sample numbers are already entered in all entry cells mentioned above. These numbers are provided for illustrative purposes. In many cases, these values represent a reasonable estimate for the value in question (e.g., the estimates of gross Btu per unit of various fuel types and the typical associated boiler efficiency). Fuel costs used in the program examples were reasonable point estimates in the Lake States region of the United States when the program was developed, However, it is likely the user's fuel costs could be significantly different. It is up to the user to examine all data values relative to their circumstances. In particular, all values for fuel costs should be examined and changed by the user if necessary.

## Fuel Cost Estimations for Current or Alternate Fuels

The first step in determining the economic feasibility of replacing your operation's current boiler system fuel(s) and replacing it with wood or bark fuel, is to input data regarding your current fuel. The first section of the program allows the user to do this for 11 possible fuel sources. User inputs are required for fuel costs, Btu's per unit, and net boiler efficiency; however, reasonable estimates are provided. Using these inputs, the program calculates an estimate of the cost per net million Btu for the various fuels. Remember that entries are required for only the existing fuel (or alternate to wood fuel) that you are using or consider using in your analysis. For illustrative

purposes only, inputs for all 11 alternate fuels have been entered in the spreadsheet.

For example, scroll down to the section beginning with row 75 "To Calculate for Natural Gas." In this subsection, use *FIGURE 1* (below) for reference.

Note that for each row with "**e>**" in column A, a value was required to be entered by the user. In this case it was reasonably assumed that $.68288 was currently an accurate cost estimate for a therm of natural gas, and that boiler efficiency was 80% (by definition a therm is 100,000 Btu; for other fuels, adjusting entry may be required). Using the three inputs, a calculation is made by the spreadsheet and appears in bolded text. In this case, it was found that the calculated cost per net million Btu of natural gas was $8.536. For any current or alternative fuel choices, entries are made in the same way.

## Fuel Cost Estimations Summary

The program displays the calculated cost per net million Btu for all of the 11 non wood fuels. This appears in bold text at the bottom of each fuel analyzed, and again with all fuels displayed together (beginning at cell B112) at the end of this first subsection for quick comparison. NOTE: These calculated fuel values are only meaningful if the three entries have been considered and appropriately modified to represent the users' circumstance.

## Alternate Fuel
A commercially available resource capable of providing energy but different from that currently in use for a given operation.

## British Thermal Unit (BTU)
The quantity of heat which is required to increase the temperature of one pound of water one degree Fahrenheit.

## Heat of Combustion
The quantity of heat that is released when a measurable amount of a combustible substance is burned to form incombustible substances. Examining the differences in heats of combustion for different fuel sources is a way to explore which is more economic.

## Incremental Investment
The difference in the costs of two systems. For example, the difference between wood boiler systems costs and an alternate fuel boilers costs (e.g., the excess investment cost associated with the wood fueled system).

## Moisture Content (MC) - Green Basis
The percentage of the total weight (of wood plus water in the wood) that is water. This varies widely depending on the species and if the wood has dried somewhat after harvest. In general, a reasonable estimate for many hardwoods is about 44% to 45% MC on a green basis. Some dense hardwoods are lower. Alternatively, many softwoods and low density hardwoods such as aspen can exceed 50% MC.

## Moisture Content (MC) - Ovendry Basis
The total moisture (water in wood) as a percentage of the weight of ovendry wood. Frequently, the ovendry basis MC percent will exceed 100% (this simply means the water in green wood weighs more than the dry wood). The ovendry basis MC varies widely with species, and also within species (e.g., if the wood has dried after harvest, etc.). About 80% ovendry MC is a reasonable estimate for many hardwoods. Many softwoods and hardwoods such as aspen can exceed 100%.

## Net Present Value (NPV)
The benefits less the costs of a given item over time. (A current value assigned to net benefits and derived using a discount rate.)

*FIGURE 1*



| | A | B | C |
|---|---|---|---|
| 75 | | to calculate for natural gas | |
| 76 | e> | What is the cost per therm (or "CCF") for this fuel? | $0.68288 |
| 77 | e> | What is the assumed MILLION gross Btu per therm? | 0.1000 |
| 78 | e> | What is the assumed net boiler efficiency in %? | 80.0% |
| 79 | | Calculated cost per net MILLION Btu of natural gas is: | **$8.536** |

User determines values to input

e> Signifies needed input

Bold text shows calculated output

FIGURE 7

| | FINANCIAL SUMMARY ANALYSIS | YEAR #1 | YEAR #2 | YEAR #3 | YEAR #4 | YEAR #5 | YEAR #6 |
|---|---|---|---|---|---|---|---|
| | MILLION Btu (net) THAT ARE REQUIRED PER YEAR IS: | 16,425 | 21,900 | 21,900 | 21,900 | 21,900 | 21,900 |
| | FUEL COST FOR THE YEAR IF CURRENT OR ALTERNATE FUEL WAS USED | $139,613 | $186,150 | $193,596 | $201,340 | $209,393 | $217,769 |
| | TOTAL FUEL COST WITH THE WOOD FIRED SYSTEM (AND BACKUP) | $73,548 | $81,547 | $84,809 | $88,201 | $91,729 | $95,399 |
| | ANNUAL INCREASE IN VARIABLE LABOR COST WITH WOOD SYSTEM | $10,666 | $14,207 | $14,775 | $15,366 | $15,981 | $16,620 |
| | ANNUAL INCREASE IN OTHER VARIABLE COST WITH WOOD SYSTEM | $4,538 | $6,050 | $6,232 | $6,418 | $6,611 | $6,809 |
| | OPERATIONAL COST SAVINGS ASSOCIATED WITH THE WOOD SYSTEM ($/YEAR) | $90,872 | $84,346 | $87,780 | $91,364 | $95,072 | $98,941 |
| | OPERATIONAL COST SAVINGS FOR THE WOOD SYSTEM (% ALTERNATE FUEL FOR YEAR) | 36% | 45% | 45% | 45% | 45% | 45% |
| e>> | other associated net revenue (or operational cost savings) subject to normal tax | $0 | $0 | $0 | $0 | $0 | $0 |
| | TOTAL FUEL COST SAVINGS WITH THE WOOD FIRED SYSTEM (AND OTHER REVENUE) | $95,065 | $104,603 | $108,797 | $113,139 | $117,664 | $122,371 |
| | TOTAL INCREASE IN NON-FUEL VARIABLE COST/YEAR WITH WOOD SYSTEM | $15,193 | $20,257 | $21,007 | $21,785 | $22,592 | $23,429 |
| | TOTAL INCREASE IN FIXED COST/YEAR WITH WOOD SYSTEM | $400 | $400 | $412 | $424 | $437 | $450 |
| | INTEREST ON LOAN | $15,527 | $14,443 | $13,275 | $12,016 | $10,659 | $9,198 |
| | INCREASE IN NET PROFIT BEFORE DEPREC. & TAX (SAVINGS WITH WOOD SYSTEM) | $34,946 | $69,503 | $74,094 | $78,914 | $83,976 | $89,293 |
| | TOTAL DEPRECIATION INCREASE ASSOCIATED WITH WOOD SYSTEM | $30,580 | $52,180 | $36,900 | $26,132 | $19,012 | $18,416 |
| | CHANGE IN TAXABLE INCOME ASSOCIATED WITH WOOD SYSTEM | $4,366 | $17,323 | $37,194 | $52,782 | $64,964 | $70,877 |
| | TAX | $1,834 | $7,276 | $15,621 | $22,168 | $27,285 | $29,768 |
| | CHANGE IN (operational) AFTER TAX PROFIT (LOSS) DUE TO WOOD SYSTEM | $2,532 | $10,048 | $21,572 | $30,613 | $37,679 | $41,109 |
| | CHANGE IN (operational) AFTER TAX NET CASH FLOW WITH WOOD SYSTEM | $33,112 | $62,229 | $58,472 | $56,745 | $56,691 | $59,525 |
| e>> | other net revenue or equivalent positive cash flows NOT subject to capital gains tax | $0 | $0 | $0 | $0 | $0 | $0 |
| e>> | other net revenue subject to capital gains tax | $0 | $0 | $0 | $0 | $0 | $0 |
| | CAPITAL GAINS TAX | $0 | $0 | $0 | $0 | $0 | $0 |
| | CHANGE IN AFTER TAX NET CASH FLOW WITH WOOD SYSTEM | $33,112 | $62,229 | $58,472 | $56,745 | $56,691 | $59,525 |
| | MINIMUM LOAN PRINCIPAL REPAYMENT | $13,962 | $15,046 | $16,214 | $17,473 | $18,829 | $20,291 |
| e>> | Additional loan principal repayment | $0 | $0 | $0 | $0 | $0 | $0 |
| | CHANGE IN NET ADDITION TO RETAINED EARNINGS WITH WOOD SYSTEM | $19,150 | $47,182 | $42,259 | $39,273 | $37,862 | $39,234 |

Actual spreadsheet shows Years 1 through 20

FIGURE 8

| | SUMMARY OF LOAN INFORMATION | YEAR #1 | YEAR #2 | YEAR #3 | YEAR #4 | YEAR #5 | YEAR #6 |
|---|---|---|---|---|---|---|---|
| | BEGINNING PRINCIPAL DUE | $200,000 | $186,038 | $170,992 | $154,779 | $137,306 | $118,477 |
| | MINIMUM PRINCIPAL REPAYMENT | $13,962 | $15,046 | $16,214 | $17,473 | $18,829 | $20,291 |
| | ADDITIONAL PRINCIPAL REPAYMENT | $0 | $0 | $0 | $0 | $0 | $0 |
| | ENDING PRINCIPAL DUE | $186,038 | $170,992 | $154,779 | $137,306 | $118,477 | $98,186 |
| | INTEREST PAYMENTS | $15,527 | $14,443 | $13,275 | $12,016 | $10,659 | $9,198 |

| | CALCULATION OF NET PRESENT VALUE OF AFTER TAX NET CASH FLOW ASSOCIATED WITH WOOD OR BARK FUELED SYSTEM | |
|---|---|---|
| | TOTAL (INCREMENTAL) INITIAL INVESTMENT INCLUDING WORKING CAPITAL | $215,000 |
| | APPROX. NET PRESENT VALUE OF TOTAL INVESTMENTS ALL YEARS | $215,000 |
| e>> | Cost Of Capital to use as "i" in NPV Calculation | 20.00% |
| | PRESENT VALUE OF AT NET CASH FLOW (ATNCF NPV) | $283,411 |
| | SUM OF DEPRECIATION (TOTAL FOR YEARS 1-20) | $210,000 |
| | PRESENT VALUE OF RESIDUAL ASSET SUBJECT TO CAPITAL GAINS TAX (Year 20) | $430 |
| | PRESENT VALUE OF INITIAL WORKING CAPITAL | $104 |
| | APPROXIMATE FINAL NPV OF AFTER TAX NET CASH FLOW | $68,958 |

# ANNUAL FUEL COSTS ESTIMATION

The next section of the spreadsheet is titled "Preliminary Economic Analysis - Initial Assessment - Estimation of Fuel Costs Per Year, and Comparison of Current (or Alternate) Fuel with Wood or Bark Fueled Boiler System" (see row 128).

This section will first develop an estimate of the average cost (annual basis) for current (or alternate) and the wood fuel systems. This will then provide a basis to compare the current (or alternate) fueled system to one that uses wood or bark for fuel.

In this section, users provide the following information for each system:

- The cost per net million Btu of fuel
- The net daily Btu (in million Btu) required for operation
- The number of days that the boiler is used during a one-year cycle

The cost per net million Btu of fuel has already been estimated. The net daily Btu (in million Btu) required for operation may be known or it can be estimated if other data is known. This would include the number of days that the boiler is used during a one-year cycle, the boiler efficiency, and the annual fuel bill.

For illustration, consider the section beginning after the explanatory text in row 128 where the entries and calculations appear; see *FIGURE 2* (below). (NOTE: Brown lines and text are not in the spreadsheet. They are presented here to highlight the various aspects of data entry and interpretation).

NOTE: The example shows the calculations made using both ways (if all input data are known or with an estimate based on fuel cost per year). In most cases, one or the other would be entered by the user.

# COMPARISON OF SYSTEMS

Information developed thus far allows the program a basis to compare the current (or alternate) fuel with the wood or bark fueled system. Entries are required for both systems as follows.

## Alternate (Non Wood or Bark) Fueled System

In this section, simply input the requested data (using the same prompt code as before, "e>"). These are the values that were obtained previously and provided in bold text.

FIGURE 2

| | A | B | C |
|---|---|---|---|
| 139 | | to calculate for current (or alternate) system if above data are known: | |
| 140 | e> | What is the cost per net MILLION Btu of current fuel? | $8.500 |
| 141 | e> | How many MILLION Btu (net) are required per Day? | 60.000 |
| 142 | | **Calculated Average Fuel Cost per day of boiler operation** | **$510.00** |
| 143 | e> | Assumed # days boiler is used per year (for analysis) is? | 365 |
| 144 | | **Calculated Average Fuel Cost per Year - current system** | **$186,150** |
| 145 | | | |
| 146 | | to calculate for current system if: | |
| 147 | | the MILLION Btu (net) required per Day is NOT known....... | |
| 148 | | BUT the Average Fuel Cost per Year with the current system IS known | |
| 149 | e> | What is the average Fuel Cost per Year - current system | $186,150 |
| 150 | e> | Assumed # days boiler is used per year (for analysis) is? | 365 |
| 151 | | **Calculated Average Fuel Cost per day of boiler operation** | **$510.00** |
| 152 | e> | What is the cost per net MILLION Btu of current fuel? | $8.500 |
| 153 | | **Calculated number of MILLION Btu (net) required per Day?** | **60.000** |

User determines values to input

e> Signifies needed input

Bold text shows calculated outputs

FIGURE 3

| | A | B | C |
|---|---|---|---|
| 160 | e> | What is the cost per net MILLION Btu of current fuel? | $8.500 |
| 161 | e> | How many MILLION Btu (net) are required per Day? | 60 |
| 162 | | **Calculated Average Fuel Cost per day of boiler operation** | **$510.00** |
| 163 | e> | Assumed # days boiler is used per year (for analysis) is? | 365 |
| 164 | | **Calculated MILLION Btu (net) that are required per YEAR** | **21,900** |
| 165 | | **Calculated Average Fuel Cost per Year - current system** | **$186,150** |
| 166 | | | |
| 167 | | **FOR THE WOOD/BARK FUELED SYSTEM** | |
| 168 | | **to calculate for wood or bark fueled boiler system** | |
| 169 | e> | What is the delivered cost per green ton for this fuel? | $27.50 |
| 170 | e> | What is the green basis moisture content for this fuel as delivered? | 35.0% |
| 171 | | **Calculated ovendry basis moisture content for this fuel is:** | **53.8%** |
| 172 | e> | What is the assumed heat of combustion (HHV) in Btu per dry pound of wood or bark? | 8,250 |
| 173 | | **Calculated fuel value in Btu/lb at moisture content for this fuel is:** | **4,950** |
| 174 | | **Calculated as the assumed MILLION gross Btu per green ton of fuel:** | **9,900** |
| 175 | e> | What is the assumed net boiler efficiency in %? | 80.0% |
| 176 | | **Calculated cost per net MILLION Btu of wood or bark boiler system is:** | **$3.472** |
| 177 | e> | What is the estimated additional annual (non-fuel) operating cost for the wood system? | $20,000 |
| 178 | e> | What is the fraction of annual Btu needs to be supplied by the wood system %? | 95.0% |
| 179 | | **Calculated MILLION Btu (net) to be supplied from the wood system per YEAR is:** | **20,805** |
| 180 | | **Calculated MILLION Btu (net) from the wood system per operational day is:** | **57.00** |
| 181 | | **Calculated fuel cost per YEAR for the wood or bark boiler system is:** | **$72,240** |
| 182 | | **Calculated annual Btu needs to be supplied by a backup system %?** | **5.0%** |
| 183 | | **Calculated MILLION Btu (net) supplied from the backup system per YEAR** | **1,095** |
| 184 | e> | What is the cost per net MILLION Btu of fuel for the backup boiler system? | $8.500 |
| 185 | | **Calculated fuel cost per YEAR for the backup boiler system is:** | **$9,308** |
| 186 | | **Calculated average TOTAL fuel cost per YEAR for the wood system is:** | **$81,547** |

e> Indicates fields where users are to input requested data. Some of these inputs were calculated in the previous section and simply need to be carried down by the user.

## Wood or Bark Fueled System

Information will be entered in the section beginning in row 157. Continuing with the example provided in the spreadsheet, you will see *FIGURE 3* (above) beginning with the information for the current (or alternate) fuel and followed with entries for the wood fueled system.

Required entries for the wood fueled system include delivered fuel cost, moisture content, heating values, and information regarding the back-up boiler system. The final row in the subsection gives the total fuel cost per year for the proposed wood system.

## Summary: Average Annual Fuel Cost Savings with Wood/Bark Fueled Boiler System

The previous section estimated the average annual fuel costs of the current (or alternate) and the wood fueled system. The other primary thing to consider as a variable cost is the potential increase in variable cost with a wood system (e.g., labor for fuel loading). Rows 204 and 206 show the annual savings associated with the wood system in both ways (fuel cost only and total variable respectively); see *FIGURE 4* (below).

FIGURE 4

| | B | C | D | E |
|---|---|---|---|---|
| 202 | PRELIMINARY ECONOMIC ANALYSIS - INITIAL ASSESSMENT - ESTIMATION OF AVERAGE ANNUAL FUEL COST SAVINGS | | | |
| 203 | WITH WOOD OR BARK FUELED BOILER SYSTEM | | | |
| 204 | Calculated potential annual savings considering fuel cost differences ONLY | $104,603 | | |
| 205 | | | | |
| 206 | Calculated potential NET annual savings considering BOTH fuel and operational costs: | $84,603 | | |

FIGURE 6

| | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| 444 | | | | | e>> (IMPORTANT - see note above) | | |
| 445 | | | | | CALCULATED | ENTRY | |
| 446 | e>> | MILLION Btu (net) that are required per YEAR is: | | | 21,900 | 21,900 | |
| 447 | e>> | Cost per net MILLION Btu of current (or alternate) fuel is: | | | $8.50 | $8.50 | |
| 448 | e>> | Cost per net MILLION Btu of wood or bark boiler system is: | | | $3.47 | $3.47 | |
| 449 | e>> | Cost per net MILLION Btu of fuel for the backup boiler system? | | | $8.50 | $8.50 | |
| 450 | e>> | Fraction of annual Btu needs to be supplied by the wood system is: | | | 95% | 95.00% | |
| 451 | e>> | Increase in Total Payroll With the Wood Fueled System Per MILLION Btu Net | | | $0.649 | $0.65 | |
| 452 | e>> | Increase in Total Other Variable Costs With the Wood Fueled System Per MILLION Btu Net | | | $0.276 | $0.28 | |
| 453 | e>> | Increase in Total Fixed Costs With the Wood Fueled System in Total $/Year | | | $400 | $400 | |

## Capital Investments and Simplified Estimation of Depreciation

Where an analysis is conducted as an incremental analysis, the incremental investment associated with the wood or bark fueled system should be used.

Note that the model estimates depreciation for investments in the different property classes using the MACRS GDS system with 200% DB and half-year convention. To do this, the total INITIAL investment in the different property classes is simply entered in column C as appropriate.

If any other depreciation method is desired, the appropriate values for non-depreciable property and working capital should still be entered, and any other appropriate depreciation values may be directly entered in either of the two rows labeled "Other Depreciation in Year."

In the capital investment summary, note that all standard Year #1 investments, including Year #1 working capital, are entered automatically. Total investments in all other years (if any) must be manually entered.

# SUMMARY

In the section titled "Financial Summary Analysis" data provided and key variable items calculated from the data are used. Also, the user enters data for four additional criterion. Calculations for

criteria listed in bold text appear as yearly estimates extended out to 20 years. Loan summary information is also calculated at this point and is displayed for easy user reference.

The last section of the spreadsheet (illustrated in *Figure 7* and *Figure 8* found on page 10), is "Calculation of Net Present Value of After Tax Net Cash Flow Associated with Wood or Bark Fueled System." In this section, the only user input is the "Cost of Capital to Use as 'i'" (discount interest rate) which will be used in the NPV calculation. The result of the initial assessment section of the spreadsheet provided a simplistic decision criteria of payback periods. The result of the follow-on section provides a much more sophisticated decision criteria, and includes parameters of the time value of money in establishing a cost of capital, and the increased sophistication of depreciation, taxation, change of variables over time, etc. In interpreting the decision criteria results of the net present value, a positive number would justify the project. Within payback analysis, a savings with the wood system could appear attractive but ignore the cost of capital or time value of money. Within NPV analysis, the result hinges heavily on the discount rate. Consequently, a large assumed cost of capital requires commensurate increase in savings as an offsetting factor. Within NPV analysis, a negative number could be achieved in circumstances that exhibit savings with the wood fueled system that is insufficient to recover the investment plus interest.

Continuing from here, other costs of wood fueled boiler operations are examined. The program is building on previous calculations and using them to generate related outputs. For some variables, the spreadsheet has the user provide estimates for each year in the 20-year period of analysis. This permits change over time in variables such as fuel costs, other variable costs, fixed costs, and load. The first year (or period) of the analysis is likely to be a "partial year" as the boiler system would not likely be in place on day one of the year. Consequently, the program treats year two as the first full year.

## Summary of Inputs Into Analysis for Period #2 (First Full Year)

The items in column E under the label "Entry" are reflecting a relative address of items which are in column C under the label "Calculated." If you change nothing, these "calculated" values will become the "entry" values for the first full year (period or year #2) of the following financial analysis. If adjustments to first full year values (year #2) are desired, they can be made directly within the "Entry" area of column E. This structure with an attached link that may be easily broken

and re-attached, facilitates easy heuristic ("What if?") analyses. After an initial run, the analyst may wish to change some parameters of the economic analysis without changing the prior calculations. This breakable link allows that to be done easily but retains the calculated original value for comparison and quickly identifies that such heuristic experimentation is being conducted. Thus, any or all of the key assumption variables calculated for use in the analysis may be directly modified to a desired value (for illustration, see *FIGURE 6* found on page 9).

## Period Inputs into Economic Model

The data under "Entry" in column E will automatically be reflected as the values for the first full year (Year #2) in the subsequent entries.

An entry is required in all other cells of each row in each column, for items in Year #1 and Year #3 thru Year #20 with entry as a percent of the item value entered for Year #2. The percentage change entry format convention is used because it is generally easier. These data will be transformed to values in the "Key Production Data" section.

*FIGURE 5*



e>> Insert requested data        The program runs calculations and displays results here

## Simplified Interpretation of the Initial Results

In the event the calculated potential NET annual savings might be negative (i.e., wood system has a higher annual cost), or if the savings calculated for wood is a very small number, then it probably does not make sense to spend considerable resources in further analysis at this time. However, if your circumstances change significantly, you may wish to investigate this again at a later date. On the other hand, in the event the calculated net annual savings (considering fuel and operational costs) is significant, then the user will probably wish to proceed with some simple payback estimates.

# SIMPLIFIED PAYBACK ESTIMATION FOR A WOOD OR BARK FUELED BOILER SYSTEM

## Overview

In continuing on to the remaining sections of the spreadsheet program, the user should be comfortable with the assumptions and data inputs required of the previous sections. Also, they should feel additional calculations are warranted to examine the financial feasibility of a wood or bark fueled boiler system in their operations. The following sections expand earlier analysis, however, the user is reminded that calculations still only provide preliminary estimates. If, after running these calculations, it is found that a wood fueled boiler system may appear to be economically attractive, it is then suggested that the user further explore their options with experienced professionals instead of solely relying on this program. In this section, the same data entry format is used. Where indicated, users provide the requested information in column C and view generated output as bold text. As before, important notes are included directly in the spreadsheet.

The first step in creating a simplified payback estimation for a wood or bark fueled boiler system is to estimate the requirements of such a system. Examining the horsepower requirements of a wood system boiler begins this section. Users are prompted to enter the assumed wood system boiler horsepower. The value entered should be greater than the calculated average requirement. In sizing the wood boiler, the size should be greater than the average daily load to accommodate higher than average demand (e.g., winter season versus summer season load). However, the boiler size cannot be made so large that the minimum load is a very small percentage of the total capacity. Wood fueled boilers do not operate well at very low loads. This underscores the need to involve trained professionals in the analysis.

A table in this section beginning at row 218 provides boiler information. For a given boiler size this table provides approximate installed cost estimates for wood fueled boilers designed to burn either green wood/bark fuel, or dry wood/bark fuel. The table provides rough estimates that will not precisely match most wood/bark fueled boiler system costs. Also, it is important to remember these average costs will change over time. Consequently, these are only generalized estimations of what might be expected as a cost for an installed wood/bark fuel boiler system including the low pressure steam boiler, the fuel stoker and combustion device, flue gas cleaning system, steam piping with water side auxiliaries, assembly, installation, start-up, and operator training. As a rule of thumb, for each 50 horsepower of the boiler system, an area of approximately 2,000 cubic feet is required for wood fuel receiving, metering, and storage for a three-day fuel supply.

Where a wood or bark fueled system is being considered as an alternate to another system which would need to be installed anyway (e.g., the existing boiler needs to be replaced and the choice is between a wood fueled system or other non wood fueled system), this is an incremental investment. In this example, the difference in the annual operational cost (savings) associated with the wood or bark fuel would be considered against the difference in the total investment associated with the two systems (i.e., the incremental investment in the wood system). However, if the existing system is in good condition, has considerable remaining life, and does not currently require major (costly) repairs to extend the system life, then the investment in the wood system is essentially the full cost of the wood system (less any salvage value, plus any savings associated with avoided repairs immediately needed on the existing system). This is a very simplified explanation of determining values to be considered in investment, many professions including business and engineering have extensive training in this area. The professional assisting with follow-on analysis should be well versed in this. Also, when considering investment alternatives such as different types of boilers, it is desirable that the economic lives of the two alternatives be the same. Otherwise it will be necessary for the analyst to make appropriate adjustments.

This part of the spreadsheet does a simple "payback" analysis. Payback analysis is often used in preliminary analyses for many reasons. Chief among these – it is simple. Payback estimates the number of years (periods) that would be required to recoup the investment. There are some technical problems associated with payback analysis (including that it does not consider the time value of money). Consequently, payback analysis should not be used as sole decision criteria. Following the example provided, the next two entry prompts ask users to enter the "Estimated Incremental Investment for the

Wood or Bark Boiler System" and "The Maximum "Payback" Period (in Years) Required to Recover Incremental Investment." Desired calculated output, as always, appears as bold text and numbers.

The first of these results is the payback period (in years) for the estimated incremental investment (cell C 271). What this means in this example is that the incremental investment of $200,000 would be recovered (without considering time value of money) in about 2.4 years.

The second of these results is a value for the estimated maximum incremental investment that could be justified for the wood or bark boiler system (value in cell C 275). What this means is that for the maximum acceptable payback period as specified by the decision-maker (in this example seven years) a maximum incremental investment of about $590,000 could be justified. (If only a shorter payback period could be accepted, then the maximum acceptable investment would be smaller.)

The following two interpretations can be applied to the generated output:

1. If, according to the decision criteria being used, the payback period required to recover the incremental investment is excessively long, then the operational cost savings associated with a wood or bark fueled boiler does not likely justify the investment at this time. Likewise, if according to the maximum payback period you would be willing to accept, the maximum incremental investment is unrealistically low, then the operational cost savings associated with a wood or bark fueled boiler does not likely justify the investment at this time. Assuming as a result of analysis the wood fueled system is rejected, if circumstances change (e.g., the existing system fails, must be replaced, costs of operation increase significantly, or major facility renovations are being considered), then perhaps the analysis of a wood or bark fueled system should be reconsidered at that time.

2. If, according to the decision criteria being used, the payback period required to recover the incremental investment is short enough, then the operational cost savings associated with a wood or bark fueled boiler could likely justify the required incremental investment at this time. Similarly, if according to the maximum payback period you would be willing to accept, a realistic value for incremental investment is acceptable, then the operational cost savings associated with a wood or bark fueled boiler could justify the required incremental investment at this time. If this is the case, further analysis is justified.

## Follow-on Preliminary Assessment

In this section, the spreadsheet program builds further on previous sections. Here the program will provide a fairly detailed estimate of operations for a 20-year analysis period to include the net present value of the expected change in after tax net cash flow associated with the wood fueled boiler. This (the NPV of the ATNCF) is the final calculation at the end of the spreadsheet. Unlike the payback method, this does include an interest cost of capital which considers the time value of money. This section also includes much more detailed analysis to consider the effects of loans, depreciation, taxes and the changes in an array of key variables over time. Users with a familiarity of this type of analysis will find this section straightforward. Those without much experience will want to pay close attention to the prompts in the spreadsheet.

For a user continuing on, it is recommended to scan the spreadsheet for an appreciation of the information required for the follow-on. On rows where the code "e>" "e>>" is shown in column A, an entry is to be made in one or more columns. In some areas, entries may be required in 20 columns for a single row. This reflects a 20-year analysis. As before, entry numbers in the rows are included only for illustrative purposes.

They should not be considered as suitable estimates for your analysis. (The exception is where data calculated in your initial assessment above is shown and clearly labeled as such.)

The user should realize that this section of the spreadsheet is much more technical than the initial assessment section, and it requires some very specific entry assumptions. As a result, many users comfortable with the initial assessment section of the spreadsheet may desire expert assistance to continue with the follow-on section, or to seek expert assistance in checking assumptions and overall analysis.

To continue, follow the "e>>" prompts and enter all the requested data accurately for your company.

The first subsection utilizes employee-related data inputs as they pertain to existing or alternate fueled boiler systems. (For illustrative purposes, the spreadsheet displays what is seen in *FIGURE 5* found at the bottom of page 8.)

The second subsection applies to wood or bark fueled systems and, once completed, allows for comparisons between systems. This section proceeds in the same manner as the previous one by utilizing user inputs to generate necessary output.

Upon entering the requested data, the user is presented with a summary section providing detailed information about each boiler system. For convenience, results are shown in both monetary (U.S. dollars) and the percentage each criterion represents to the total payroll.

With these subsections completed, the program provides the estimated annual wood or bark fueled boiler related labor costs for the first full year of operation. These results appear in bold text beginning in cell C 374.