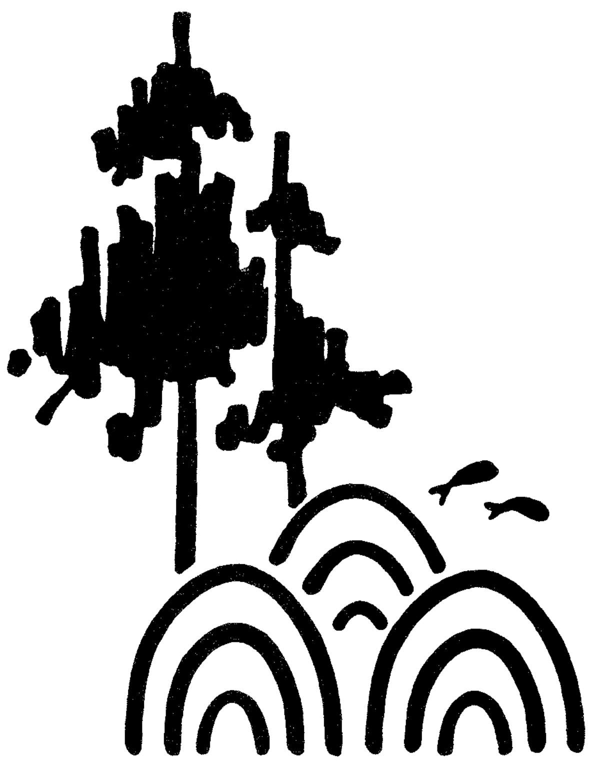
An Analysis of Several Alternatives to Oil as an Industrial Fuel



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School of Forestry and Wildlife Resources
Virginia Polytechnic Institute and State University
Blacksburg, Virginia

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An Analysis of Several Alternatives to Oil As an Industrial Fuel

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FOREWORD

This paper presents an analysis of some significant factors that should be evaluated when considering alternatives to oil burning boilers. Managers contemplating using or increasing the use of wood for energy should find the analysis particularly pertinent. A fundamental assumption of the analysis is that additional boiler capacity is to be added to an existing power generating facility. The method of analysis provides a yearly cash flow stream that tells how much better off the installation would be with an alternative to oil. A logical extension of this is the ranking of alternatives from most to least attractive.

Caution should be exercised in interpreting the ranking of investment alternatives. During the course of this research, a number of comparisons were made using the criteria of Internal Rate of Return (IRR) and Present Net Value (PNV) of the alternatives. At times these two methods of investment analysis gave conflicting answers as to the optimal course of action. Further investigation into this apparent discrepancy revealed that PNV is generally considered the most reliable method of ranking alternatives by financial consultants. The results have led us to the belief that PNV alone should be considered as the selection criteria for this analysis. An additional feature of PNV is that it gives the manager a feel for the dollar return on his investment, which IRR does not. For example, a very high IRR could be realized on a low investment without the value of the total cash flow savings being truly significant. The results of this study are presented based on PNV, but IRR values have been included for comparison. In addition, graphical displays of the results are presented in terms of IRR for easier interpretation.

Credit is due the New England Regional Commission for developing the computer program, WOOD II, which was used in our analysis. Modifications were made before the program was used for this study.

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INTRODUCTION

Planning for Alternatives

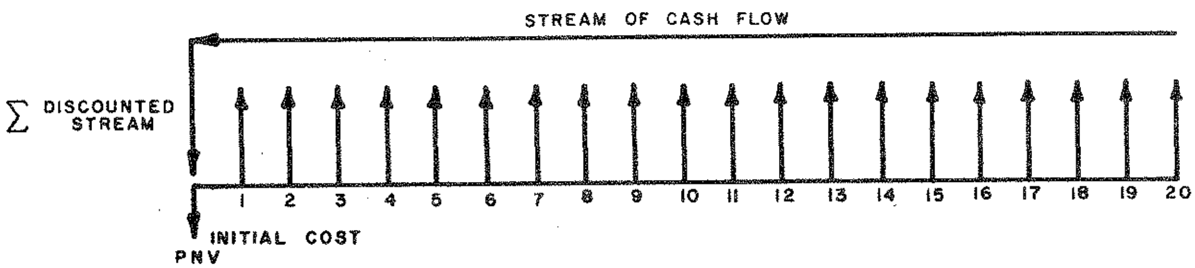
Publications in the early 1970's concerning the industrial use of wood as an alternative fuel for oil focused on the high fuel cost differential. Although this difference is great, other factors must be considered by managers when making decisions concerning boiler installations. Among these are:

1. Total capital cost for the installation and any ancillary equipment needed for fuel storage and handling;
2. Availability of alternative fuels on both an immediate and a long term basis;
3. Cost of these fuels on a cost per Btu basis;
4. Annual operating and maintenance (O&M) costs;
5. Expected inflation rate of the various fuel alternatives; and
6. General compatibility of the proposed system expansion with existing facilities.

These questions are addressed in this paper which compares oil to natural gas, coal and wood as fuel alternatives.

Cash Flow Analysis

In considering a major installation of a boiler several variables need to be considered simultaneously. For example, fuel cost, capital cost, installation costs and O&M costs are all critical to the decision. Thus, a simple comparison among alternatives with a simple model is impossible when total investment minimization is the objective. The approach used here examines cash flows over the life of both investments, essentially developing projected operating budgets, to develop a total present net worth (PNW). Two other measures commonly used, the internal rate of return (IRR) and payback period were also calculated. The process is depicted in Figure 1.



$$PNV = \sum \frac{\text{AFTER TAX CASH FLOW YEAR } 'n'}{(1+P)^n} - \text{INITIAL CAPITAL COST}$$

Where: PNV = Present Net Value

P = Interest Rate Expressed as Decimal

n = Years Since Initial Investment

Figure 1: Cash Flow Diagram

The PNV of the cash flows was used to evaluate several alternatives to oil. Natural gas, coal, and wood-fired boilers were compared for their relative costs and their total suitability for adaptation to industrial units on a large scale. The analysis produced three values for ranking the alternatives:

1. Present net value of the alternative as compared to oil;

2. Internal rate of return (IRR) of the investment; and

3. Payback period.

Additionally, the sensitivity to factors such as inflation rate, capital cost, and fuel cost was analyzed.

BASIC ASSUMPTIONS

Boiler Data

In order to compare the desirability of various alternative fuel systems, basic specifications for the boilers were determined. A 200,000 lb. per hour boiler was selected for the sample analysis. This is considered a medium sized unit in pulp and paper industry and is the size commonly selected in expansions (Reisinger 1981). The annual operating time scheduled for the boiler was 8,760 hours with 95% availability during that time. In this analysis, at typical operating pressures a pound of steam contained 1,100 Btu's.

Fuel Data

The moisture content of woody fuels causes a greater variation in energy yields per pound or per cubic foot than found in other fuel types. Oven dry wood, regardless of species, will yield approximately 8,600 Btu's per pound. The moisture content of wood fuels delivered to a mill may range from less than 20% (green weight basis) for planing mill and furniture mill residuals to over 60% for whole tree chips. One pound of wood at 50% moisture content yields about 2,800 Btu's of available energy. One half of the delivered weight is water, which not only does not yield energy, but consumes energy during the evaporation process. Additional energy is consumed in vaporizing the wood into a burnable gas. All fuels suffer from conversion efficiency in the boiler. However, wood boilers are between 15 and 20% less efficient than coal, oil or gas. Table 1 lists the fuel assumptions used to develop the cash flows used in assessing the feasibility of alternatives.

TABLE 1

Basic Fuel Data

Fuel Type	
Wood	
Moisture content (wet basis)	50%
Btu's per ton	17,000,000
Cost per ton	$12
Burning efficiency	65%
Coal	
Moisture content (entrapped water)	3%
Btu's per ton	27,000,000
Cost per ton	$35
Burning efficiency	85%
Gas	
Moisture content	0%
Btu's per mcf	1,000
Cost per mcf	$3.45
Burning efficiency	78%
Oil	
Moisture content	0%
Btu's per gallon	170,000
Cost per gallon	$1.20
Burning efficiency	80%

Financial Data

In order to compare the feasibility of investments on a cash flow basis certain financial assumptions were necessary. The assumptions used in the research program are given in Table 2, and are described below.

Operating and Maintenance Cost

Average estimates for O&M costs for various boilers are given in Table 2. Power engineers and consultants customarily estimate these costs on an annual basis at a standard percentage of the total capital cost. During the early years of the investment, O&M costs can be expected to be lower. Eventually, retrofits, improvements and repairs increase the yearly average cost. Whenever conveyors and other solid material handling systems are needed (coal and wood), rather than fluid control (oil and gas), the maintenance costs are higher.

Taxes

Federal and state tax rates were chosen to be representative of a large southern firm and are listed in Table 2. Wood has an additional 10% federal tax credit associated with it which the other systems do not. State tax credits are not universal; hence, additional state tax credits were not considered.

Depreciation

The double declining balance depreciation option was chosen based on the assumption that the company would want to recover the investment as quickly as possible to offset loan costs.

Inflation Rate

Inflation rates for various fuels were derived from the average inflation rates over the past five years. For example, O&M costs tend to rise with the general inflation rate, while oil prices have in the immediate past led the general inflation rate. Prices for coal have remained remarkably stable for a number of years. The purchase price for wood residuals is rising as more users enter the industrial wood-burning market. This has slowly increased the price of wood fuels. This rate,

TABLE 2

Basic Financial Data

Operating and Maintenance (Rate) and Cost		
Wood	(15%)	$3,750,000
Coal	(15%)	$3,000,000
Gas	(5%)	$500,000
Oil	(5%)	$500,000
Federal Taxes		
Tax rate (all systems)		46%
Investment credit (all systems)		10%
Energy incentive credit (wood only)		10%
State Taxes		
Tax rate (all systems)		5%
Tax credit		0%
Depreciation		
Method		double declining balance
Period		20 years
Annual Inflation Rate		
O&M costs		12%
Wood fuel		15%
Coal		15%
Gas		15%
Oil		20%
Operating Life (all systems)		20 years
Discount Rate		30%
Capital Costs		
Loan period		10 years
Loan interest rate		17.5%
Equity capital, at 20% of total capital cost		
Wood		$5,000,000
Coal		$4,000,000
Gas		$2,000,000
Oil		$2,000,000
Total Capital Cost		
Wood		$25,000,000
Coal		$20,000,000
Gas		$10,000,000
Oil		$10,000,000

however, will probably accelerate in the future. Gas prices have remained stable because of government regulation. When gas is deregulated in 1983, the price structure will probably change rapidly, fluctuate for a period of time and then settle at a fairly high rate.

Operating Life

A twenty year life can normally be expected for large industrial boilers. Cases can be found where 50 year old boilers are still operating, and others where newly installed boilers need major repairs after only a few years of operation. Power consultants usually estimate an operating life of 20 years.

Discount Rate

The discount rate is that rate set by management for estimating the value of future cash flows in current dollars. It is usually based on the earning potential the company foresees if the funds are invested in another, equally attractive, project. A discount rate of 30% is used in this analysis.

Capital Cost

A ten year loan period was established, in an attempt to clear the cost of the boiler with manageable payments, while still satisfying lenders. A prime interest rate of 17.5% was used in the initial calculations. Equity capital was assumed to be a flat 20% of the total capital cost of the installation for all systems. On larger systems the down payment percentage may be somewhat lower, or in the case of the lower total cost boilers (gas and oil), somewhat higher.

Total Capital Cost

The total investment required for the four systems compared are listed in Table 2. These figures are for the basic boiler, fuel storage and handling equipment required for boiler operation. These figures do not include the cost of woodyard renovation that may be necessary if oil or gas systems are converted to coal or wood. Additionally, these costs are midrange values for a boiler that will provide 200,000 lbs. of steam per hour. Sophisticated control systems, or "cadillac" systems cost more. Lower cost, fundamental systems may require an additional operator or two. Current figures were obtained from consultants in the power field and appear to be reasonable given the above restrictions. Announcements of $50 million installations are not unheard of but usually include items in addition to the cost of the boilers and ancillary equipment included in this analysis.

Compatibility With Existing System

The match of the new system with existing facilities is an important consideration in an expansion. If handling conveyors and loaders for moving wood or coal are in place, little may have to be added in the way of new equipment. If, however, the expansion boiler is of a different fuel type than previously in use, a complete renovation may be necessary. The cost of additional grading, truck dumpers, and relocation of existing lines may all be a part of such an expansion. Consequently, the capital cost of the expansion may exceed the cost of the boiler and fuel system. These additional costs should be added to the total boiler cost. If such changes are required because of age, they should not be charged against the new installation.

INVESTMENT ANALYSIS

Basic Investment Alternatives

Table 3 presents information on the ranking of fuel alternatives based on the initial fuel and financial assumptions in the previous discussion. If the internal rate of return is the only method of comparison considered, a natural gas boiler is clearly the best alternative because of its low initial cost and artificially low fuel cost.

The deregulation of gas prices in 1983 will reduce or eliminate the fuel cost advantage. The high IRR of 86% for gas was generated for two reasons. First, the cost of a gas boiler is only about 1/10 that of coal or wood installed. Second, the delivered price of gas on a cost per Btu basis is extremely low.

A greater problem, however, exists in the policy of the government and utilities which limits the expansion or installation of any new large-scale industrial gas boilers. This limitation virtually eliminates gas as a reasonable consideration in this analysis. Therefore, the remaining analysis will consider only coal and wood as viable substitutes to oil.

Coal vs. Wood

Coal shows substantial economic advantages over wood in the analysis using both PNV and IRR. Higher burning efficiency, lower fuel cost per Btu delivered, lower capital cost of installation and lower O&M costs all contribute to the attractiveness of coal.

Air quality is an important consideration for coal systems. The class I pristine air regulations, required by the Clean Air Act of 1975, have affected industrial growth in many areas where the forest products industry is still growing. The capital cost of coal burning systems is increased by the expense of cleaning the flue gas. Additionally, the high level of sulphur emissions of much of the coal mined in the East is considered a source of acid rain.

The greatest potential air quality problem from burning wood results from nitrous oxides that are released when combustion efficiencies

TABLE 3

Comparison of Investment Alternatives

when oil consumption = 15.25MM gal./yr
and oil cost = $18.3MM /yr.

	Gas	*Coal*	*Wood*
Annual Consumption	2.35 MMMMcf	82.2M tons	331.4M tons
Fuel Cost ($)	8.1MM	2.88MM	3.97MM
PNV ($)	45.7MM	51.28MM	44.98MM
IRR	86%	62%	55%
Years to payback	1.0	1.5	2.3

are relatively low. Well engineered and maintained boilers can achieve acceptable levels of pollution. However, high volumes of particulate matter can result when high excess air is used to maintain combustion efficiencies. These particles can be removed by electrostatic precipitators or collected in bag houses. Both solutions, however, increase the cost of a wood burning installation above that of coal.

In summary, if coal is available at a reasonable cost and air regulations permit, a coal-powered boiler is the only logical choice. Where air regulations are tight, or permits are unobtainable, and coal prices higher than those used here, wood is an attractive alternative and should be considered.

SENSITIVITY ANALYSIS

Overview

After determining the ranking of fuel alternatives for the example systems, a series of analyses were performed to determine the sensitivity of the internal rate of return to incremental changes in capital and cost variables.

The variables which had the greatest effect on the sample problem are listed below in order of descending influence:

1. Fuel Oil Cost
2. Oil Inflation Rate
3. Alternative Fuel Inflation Rate
4. Alternative Fuel Cost
5. Alternative Fuel Capital Cost

This ordering is applicable only for the input variables used in this example and should be considered with caution. With a different boiler or different set of input variables the ordering may change. It should be noted that the ordering of these factors is at least partially dependent on the magnitude of differences in the cost values themselves.

When making a decision about alternative investments these factors should be considered in the order listed since they effect the investment returns in the order listed. For example, a manager's expectations about what the cost of oil will be in 1988 is a clear factor in the decision process. When faced with less obvious choices such as the expected differences in inflation of coal and wood inflation rates, decisions are harder to make. Although the model does not consider decision making under risk or uncertainty it does allow the user the option of exploring a wide variety of 'what if' questions inexpensively. An indication of the relative impact of a unit change in the various decision variables is presented in Table 4.

O&M costs had little effect on the investment alternatives. The IRR for the wood option was raised if the O&M cost decreased. Oil and wood/coal O&M were generally considered to vary at the same rate. For example, if oil O&M inflated by 15%, it would be reasonable to assume that wood/coal O&M would also inflate at 15% because of the nature of the expenses. Figure 2 shows the effect of changing O&M costs on IRR.

Table 4 shows the effect of changes in the investment factors on IRR. However, a manager must often make decisions based on multivariate changes, that is, when more than one factor is changing at the same time. Some of these changes are presented later in this section.

Multiple Variation of Investment Factors

Various factor combinations were selected for multiple analysis based on the single factor analysis in the above section. The results of multiple factor variation are depicted in several graphs in this section.

Varying Fuel Costs

Figure 3 demonstrates the effect of selected combinations of oil, wood and coal prices on the IRR. The IRR is most sensitive to increases in oil cost (the distance between the curves in each family), somewhat sensitive to changes in wood costs (the slope of the lines in the wood family) and relatively insensitive to changes in coal costs (the slope of the curves in the coal family.)

This graph indicates that the desirability of wood over oil is more strongly controlled by the price or expected price of wood than it is by the price or expected price of oil. This fact is important for managers of forest products firms that have a relatively cheap source of wood fuel. It implies that he cannot lose if he burns wood.

Varying Inflation Rates

The effect of varying inflation rates for both oil and wood/coal is shown in Figure 4. As the oil inflation rate increases the IRR decreases slightly for both replacement fuels. The oil inflation rates had a smaller impact on coal investment than wood as indicated by the steeper slope of the wood inflation rates. The higher IRR for coal was not as strongly affected, as is indicated by Figure 4. This means that the

TABLE 4

Ranking of Factors In Investment Decision

A 1% change in:____produces a __% change in IRR

Fuel Oil Price	+.8292
Oil Inflation Rate	+.2578
Coal Inflation Rate	-.0156
Wood Inflation Rate	-.0219
Wood Moisture Content	-.0345
Coal Fuel Rate	-.1129
Wood Fuel Cost	-.1599
Coal Capital Cost	-.3225
Wood Capital Cost	-.3288

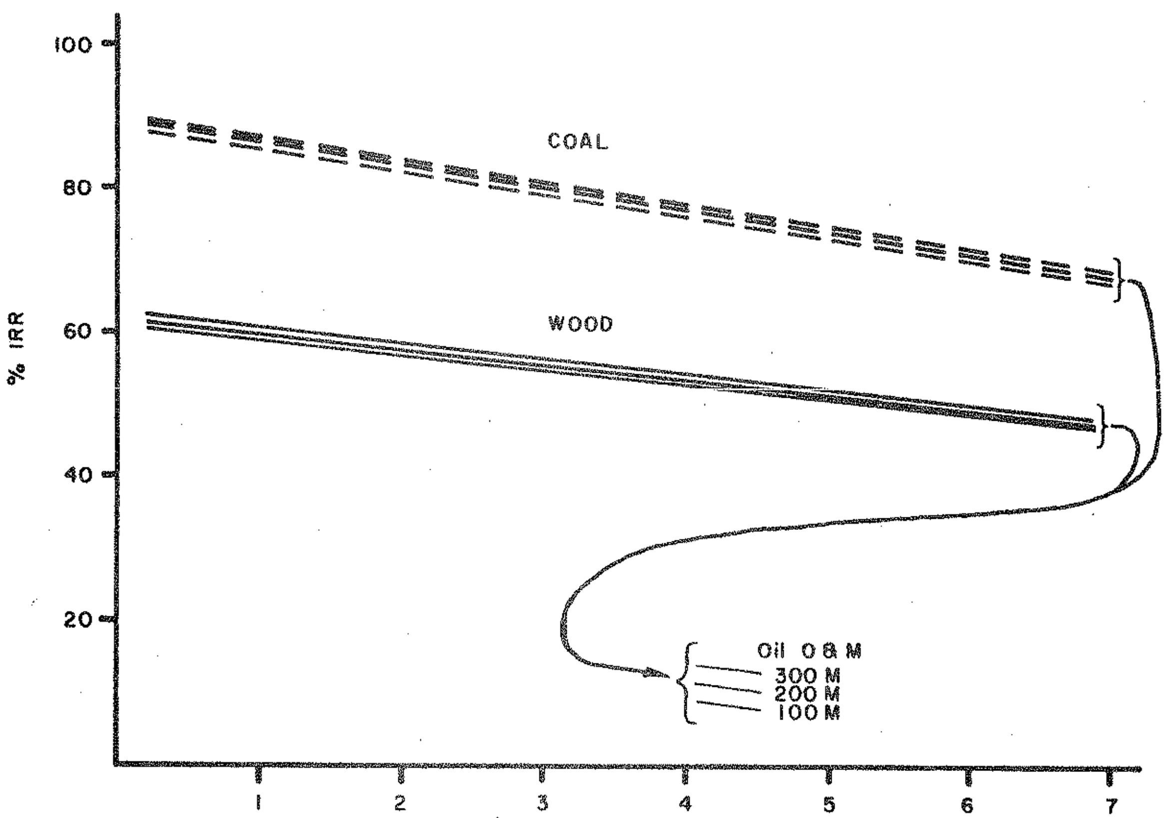


Figure 2: Effect of Changing O & M Costs on IRR

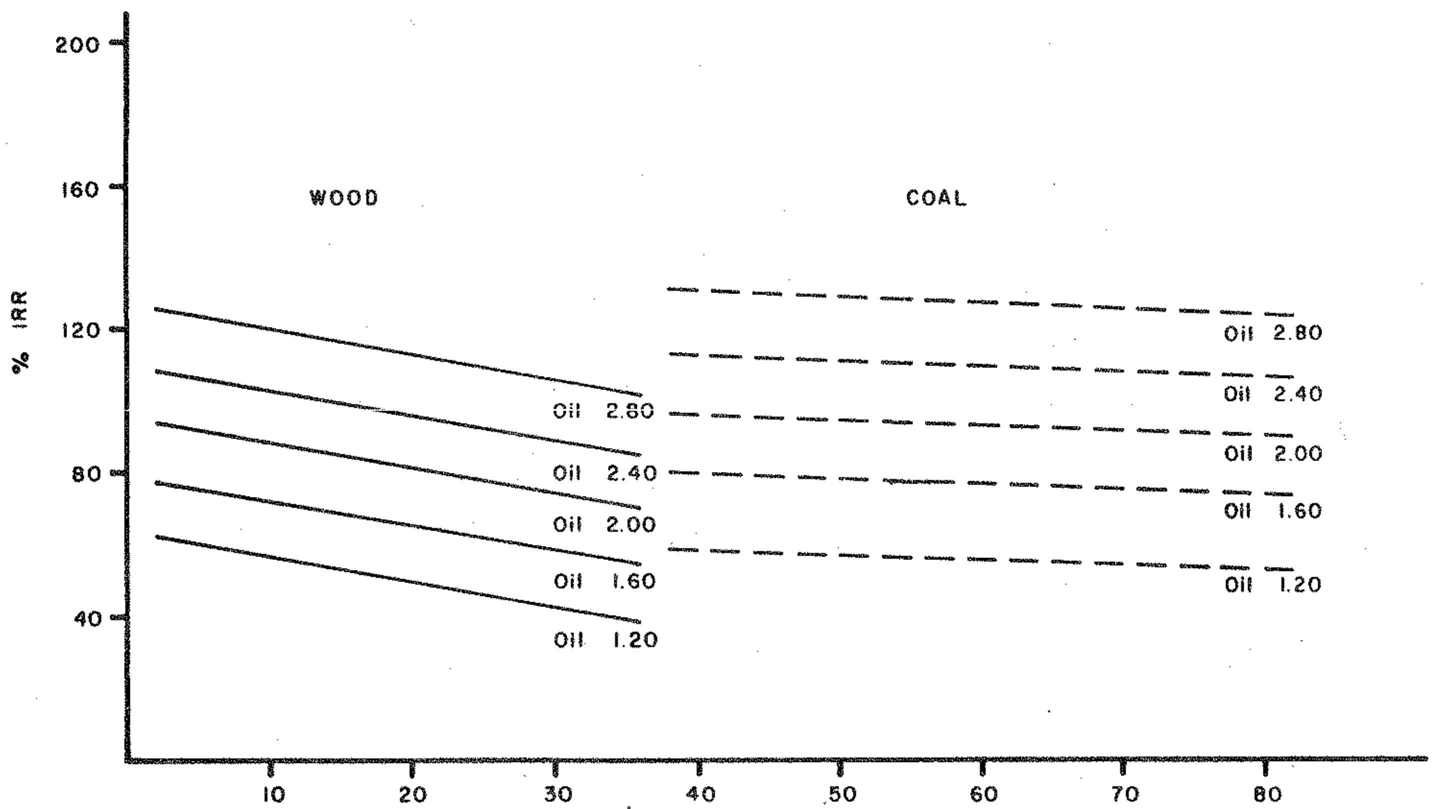


Figure 3: Fuel Cost (per Ton) for Wood and Coal at Various Oil Costs

coal investment is less affected by inflation than is wood. In addition, IRR drops only slightly for both coal and wood when the fuel rate does increase.

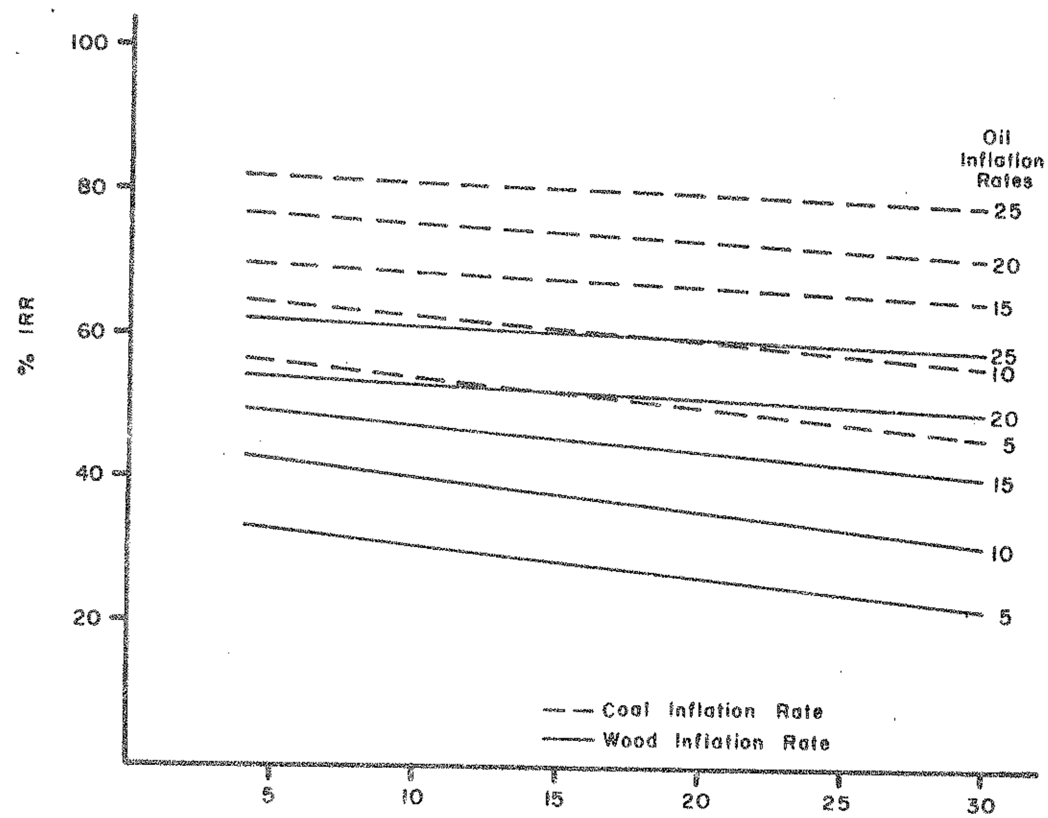
Figure 4: Effect of Oil Inflation Rate on IRR

Varying Capital Expenditure Levels

When coal and wood fuel cost was analyzed at various capital investment levels, several interesting factors became apparent as indicated in Figure 5. First, at low capital rates IRR is more sensitive to changes in fuel cost. This is indicated by the steep slope of the \$10MM investment curve for wood and the \$5MM curve for coal. As capital cost increases, IRR falls and the effect (slope) of oil price is decreased. As noted above, the IRR for the coal system is less sensitive to changes in price at all levels of capital investment when compared to the wood system.

Varying O&M Rates

When the O&M inflation rate was changed for the oil and the wood/coal systems virtually no difference occurred in the IRR. As noted above, the O&M cost is essentially a constant that is only a small part of the total capital investment and therefore has a minimal effect on IRR if changed. The effect of varying the O&M inflation rate is demonstrated in Figure 6.



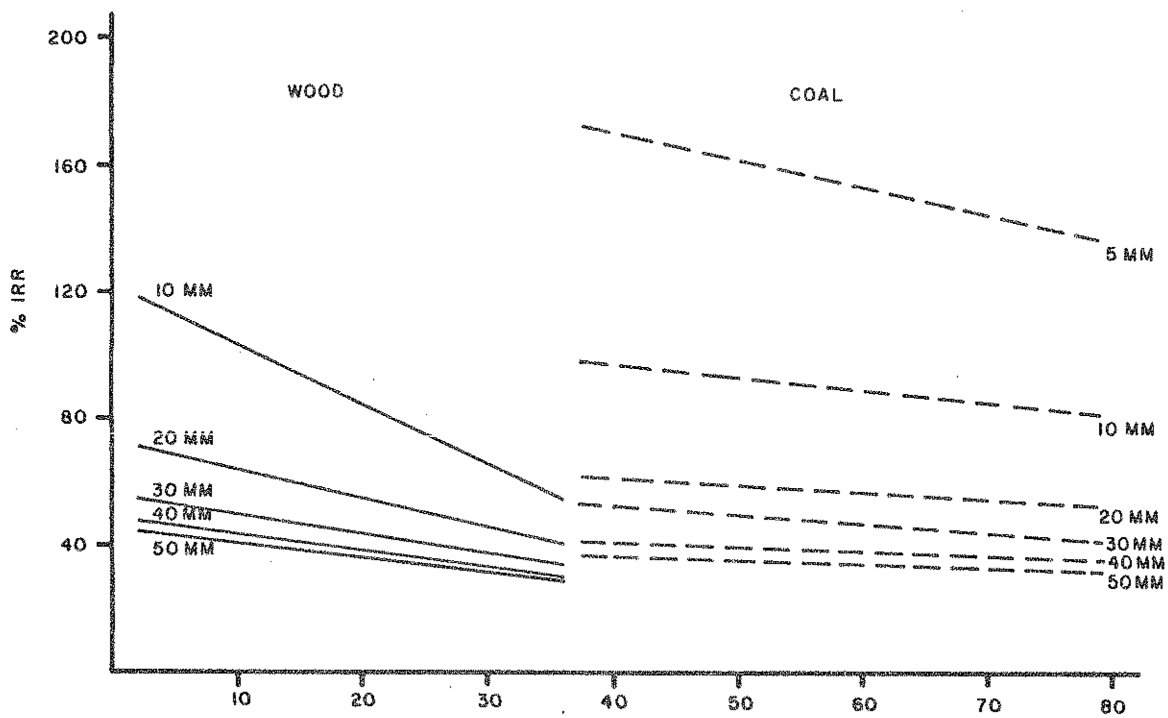


Figure 5: Fuel Cost per Ton at Various Capital Levels

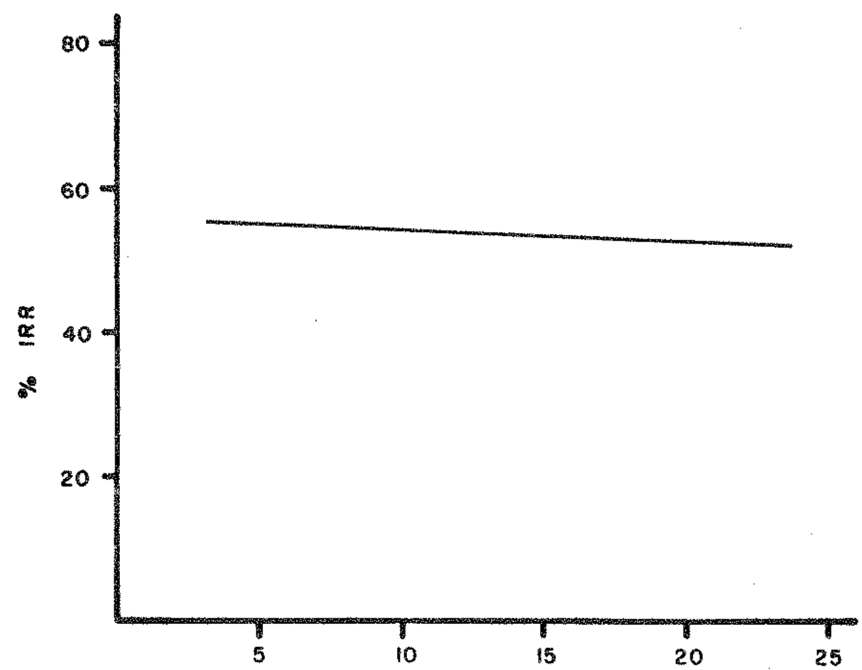


Figure 6: Effect of O & M Inflation Rate on IRR

SUMMARY

Given the assumptions stated, several conclusions can be made based on this analysis. They are:

1. Ranking of alternative investments compared to oil fired boilers based on PNV are:

   a) Coal $51.28 Million

   b) Natural Gas $45.70 Million

   c) Wood $44.98 Million

2. Since natural gas is regulated by the government and will continue to have severe restrictions on its use, the only practical alternatives for consideration in a large scale expansion are coal and wood-fired boilers.

3. Factors that are most important in determining which alternative to adopt, either coal or wood, are ranked from the most important to least important, when considered individually:

   a) Expected fuel oil price

   b) Oil inflation rate

   c) Coal inflation rate

   d) Wood inflation rate

   e) Coal fuel cost

   f) Wood fuel cost

   g) Coal capital cost

   h) Wood capital cost

4. When several factors were considered simultaneously, the most significant combinations were:

a) Fuel cost of oil in concert with coal/wood cost resulted in a strong effect on IRR primarily when oil price was increased. (Figures 7 and 8)

b) Fuel cost compared with various levels of capital investment resulted in a strong effect on IRR primarily when capital cost was decreased. (Figures 9 and 10)

c) Fuel inflation rate for both coal/wood and oil resulted in a weak effect, and

d) O&M costs for both oil and coal/wood resulted in a weak effect.

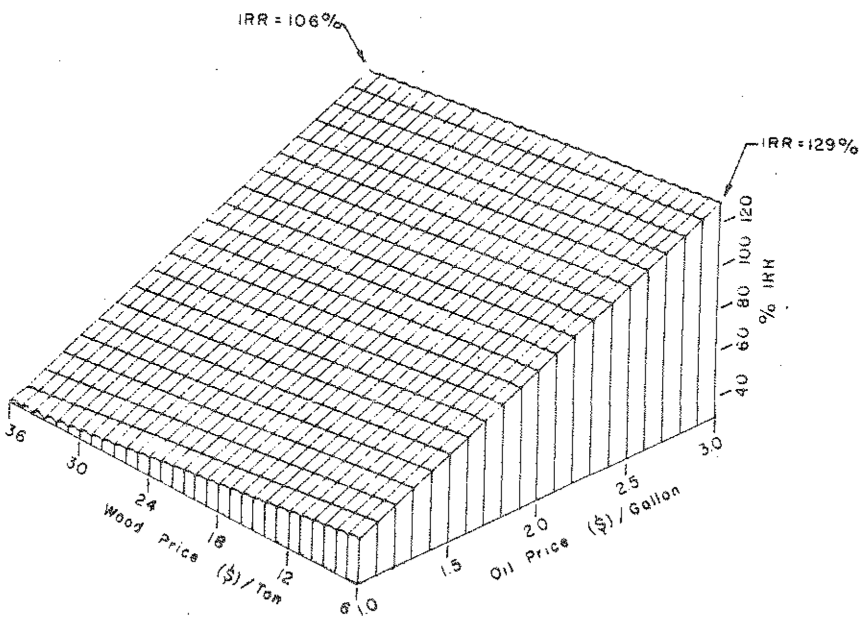


Figure 7: Wood Price vs. Oil Price vs. IRR

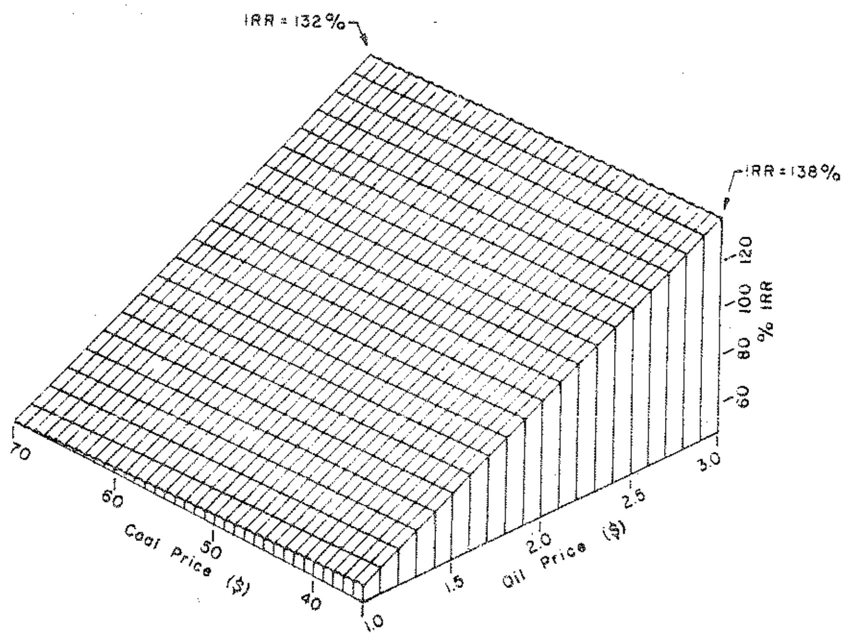


Figure 8: Coal Price vs. Oil Price vs IRR

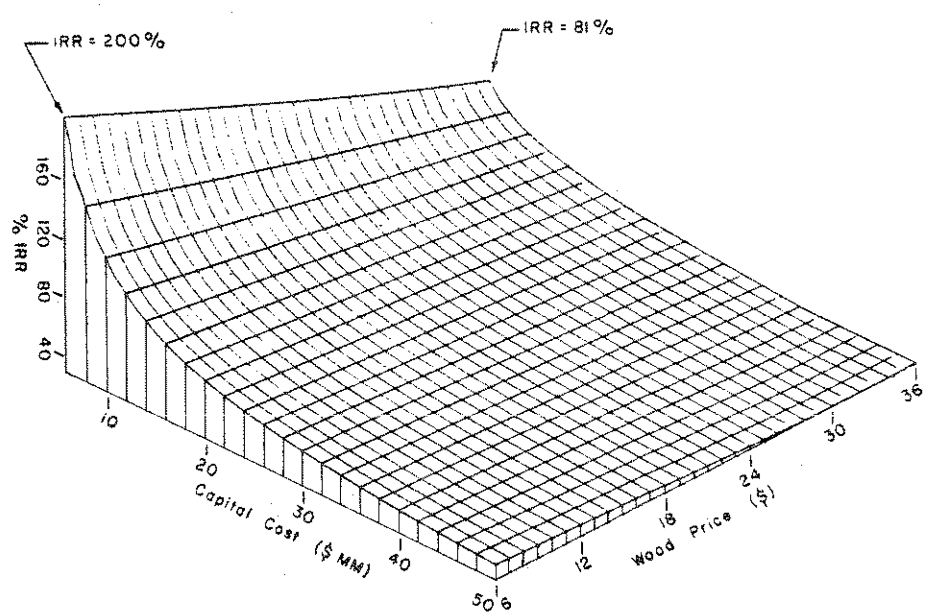


Figure 9: Capital Cost vs. Coal Cost vs. IRR

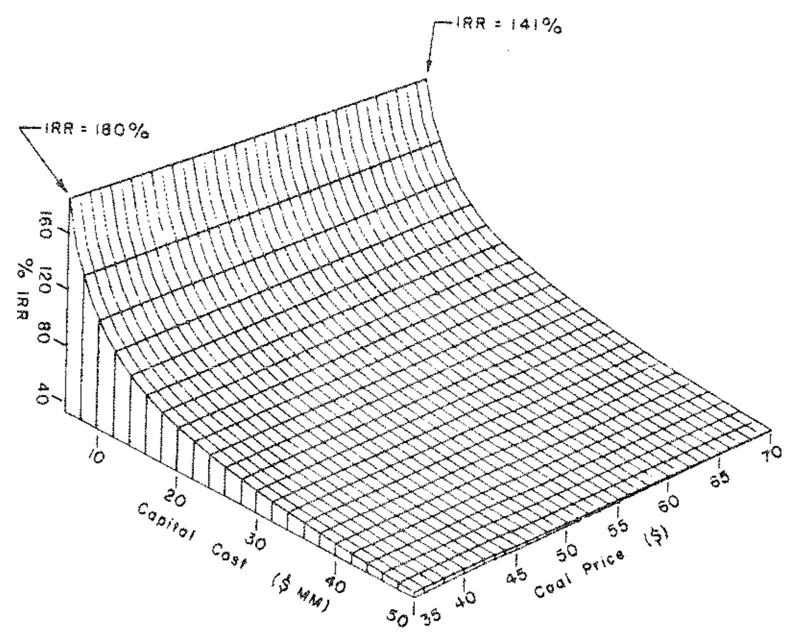


Figure 10: Capital Cost vs. Wood Cost vs. IRR

Appendix A

CALCULATIONS USED IN THE PROGRAM

Several types of mathematical calculations were performed in this analysis. These fall into four groups of calculations. They are:

1. Oil system consumption
2. Wood system consumption
3. Net annual cash flows
4. IRR and PNV calculation

Oil System Consumption.

$$\text{Energy Required} = \frac{\text{Btu} \times \text{Eff}}{100}$$

Where: Btu = Btu/Gallon Oil
Eff = Boiler Efficiency

$$\text{Demand} = \frac{\text{Hours} \times \text{Util}}{100 \times \text{Size} \times \text{Steamheat}}$$

Where: Hours = Hours per year used
Util = Utilization factor (%)
Size = Pounds of steam per hour
Steamheat = Btu per lb. of steam

$$\text{Quantity Oil} = \frac{\text{Demand}}{\text{Utilization}}$$

Wood System Consumption.

$$\text{Energy} = \text{BTU} \times 1{,}000{,}000 \times (1 - \text{moisture}) \times \text{EFF}$$

Where: BTU = Heating value of Wood

Moisture = M. C. of wood, wet basis
EFF = Burning efficiency of wood boiler

Demand = Hours x Util x Size x Steamheat

Where: Hours = Hours per year
Util = Utilization in decimal form
Size = lbs. per hour steam rqd.
Steamheat = Btu per lb. of steam

$$\text{Quantity Wood} = \frac{\text{Demand}}{\text{Energy}}$$

Net Annual Cash Flow. The economic basis of the model is dependent on the cash flow stream beginning in year 0. The calculations in year 0, however, are done in a different manner than the remaining life of the investment because of the different costs. Thus, there are two separate sets of calculations below:

Year 0

Federal tax credit = Cap cost x Credit

Where: Cap cost = Installed capital cost
Credit = Fed invest tax credit + energy credit

State tax credit = Cap cost x Credit

Where: Cap cost = Installed capital cost
Credit = State tax invest credit + energy credit

Financed amount = Cap cost - Down - Credits

Where: Cap cost = Installed capital cost
Down = Down payment; equity
Credits = St. + Fed. Tax Credits

$$\text{Loan Payment} = \text{Rate} \times \text{Loan} \times \frac{(1 + \text{rate})}{(1 + \text{rate}) - 1}$$

Where: Rate = loan rate in decimal form
Loan = Total borrowed capital

Year 1 Through N

Fuel Cost Savings = OCost x (1+OInf) **(n-1)
- WCost x (1-WInf) **(n-1)

Where: OCost = Yearly oil cost
OInf = Inflation rate for oil
WCost = Yearly wood cost
WInf = Inflation rate for wood

Depreciation = (Install Cost - Claimed Deprec.) / Depreciation Life
Doub. Declin. Bal.

Where: Install Cost = Total capital cost
Claimed Deprec. = Previous deprec.
Depreciation Life = Boiler life

Net O&M Increase = (Ann Oil O&M - Ann Wood O&M)
x (1+infl)**(n-1)

Where: Ann Oil O&M = Oil O&M cost
Ann Wood O&M = Wood O&M cost
Infl = O&M Inflation rate

Interest Payments = Fin. Amt. x Rate x (1+Rate)**(n-1) -
Pmt.(1+Rate)**((n-1)-1)

Where: Fin. Amt.= Amount financed
Rate = Loan interest rate (decimal form)
Pmt. = Actual loan payment
n = year

Taxable Profit = Fuel Sav. - O&M Incr.
- Deprec. - Loan Int. Pmt.

Where: Fuel Sav. = Oil - Wood Cost
O&M Incr. = Wood O&M - Oil O&M
Deprec. = Annual depreciation allowance
Loan Int Pmt = Annual interest payment

After Tax Profit = (1-State Tax Rate) x Profit
x (1-Fed Tax Rate)

Where: State Tax Rate = State corp. rate
Profit = Yr. Cash Flow - Expens.
Fed. Tax Rate = Fed corp rate

Net Cash Flow = After Tax Profit - Depreciation
-Loan Principal Payment

IRR and PNV.

The net present value of the investment is the stream of the cash flows discounted to present, minus the equity cost.

$$PNV = \frac{\text{Net Cash Flow (year n)}}{\text{(1-Rate)n power - Equity}}$$

The IRR of the investment is the lowest discount rate for which the present value of the cash flows is just less than or equal to 0. i.e., the discount rate required to reduce the cash flow stream zero.

Appendix B

SAMPLE PROGRAM

The following data is an example of the program output from the WOOD II program used in this analysis. It contains a listing of the input data, the calculated answers for the consumption, and the economic analysis.

PULPMILL, WOOD

BASE CASE DATA:

LBS STEAM PER HOUR (OIL)	:	200000.00
LBS STEAM PER HOUR(WOOD)	:	200000.00
ANNUAL OPTG HRS (OIL)	:	8760.00
ANNUAL OPTG HRS (WOOD)	:	8760.00
AVERAGE UTIL (%) (OIL)	:	95.00
AVERAGE UTIL (%) (WOOD)	:	95.00
BOILER EFFIC (%) (OIL)	:	80.00
BOILER EFFIC (%) (WOOD)	:	65.00
BTUS/LB STEAM (OIL)	:	1100.00
BTUS/LB STEAM (WOOD)	:	1100.00
TYPE OF OIL (NO.)	:	6.00
PRICE/GAL OIL ($)	:	1.20
PRICE/TON WOOD ($)	:	12.00
DRY WOOD ENERGY (MMBTU)	:	17.00
WET BASIS M.C. (%)	:	50.00
ANNUAL O&M COSTS (OIL)	:	500000.00
ANNUAL O&M COSTS (WOOD)	:	3750000.00
O&M INFLATION RATE (%)	:	12.00
OIL INFLATION RATE (%)	:	20.00
WOOD INFLATION RATE (%)	:	15.00
FEDERAL TAX RATE (%)	:	46.00
FEDERAL TAX CREDIT (%)	:	20.00
STATE TAX RATE (%)	:	5.00
STATE TAX CREDIT (%)	:	0.0
DEPREC PERIOD (YRS)	:	20.00
DEPREC METHOD	:	DOUBLE-DECLINING BALANCE
LOAN PERIOD (YRS)	:	10.00
LOAN INTEREST RATE (%)	:	17.50
EQUITY CAPITAL ($)	:	5000000.00
CAPITAL COST ($)	:	25000000.0
OPERATING LIFE (YRS)	:	20.00
DISCOUNT RATE (%)	:	30.00

ESTIMATED ANNUAL CONSUMPTION & COSTS

ANNUAL OIL CONSUMPTION: 15256990. GALLONS
ANNUAL COST AT $1.200 PER GALLON: $18308384.0

ANNUAL WOOD CONSUMPTION: 331374. TONS
ANNUAL COST AT $12.00 PER TON: $ 3976482.00

ECONOMIC VALUES OF WOOD FUEL ALTERNATIVE

DISCOUNT RATE: 30.00%
NET PRESENT VALUE: $ 44977104.
INTERNAL RATE OF RETURN: 54.3%
UNDISCOUNTED YEARS TO PAYBACK: 2.3

FINANCIAL ANALYSIS OF WOOD FUEL ALTERNATIVE

'EAR	FUEL SAVGS	ADDL O&M	DEPREC	LOAN PRINC	LOAN INT	STATE TAX	FED TAX	CASH FLOW
0	0.	0.	0.	0.	0.	0.	-5000000.	-5000000.
1	14331902.	3249999.	2500000.	653599.	2625000.	297845.	2603166.	4902292.
2	17397088.	3639998.	2250000.	767980.	2510619.	449823.	3931456.	6097210.
3	21105136.	4076797.	2025000.	902373.	2376226.	631355.	5518041.	7600334.
4	25589104.	4566012.	1822499.	1060288.	2218311.	849113.	7421245.	9474110.
5	31009296.	5113933.	1640249.	1245837.	2032762.	1111116.	9711157.	11794471.
6	37558896.	5727604.	1476224.	1463858.	1814741.	1427015.	12472107.	14653539.
7	45470560.	6414915.	1328602.	1720032.	1558567.	1808422.	15805606.	18162960.
8	55024560.	7184704.	1195742.	2021036.	1257563.	2269326.	19833904.	22457984.
9	65556288.	8046857.	1076168.	2374714.	903885.	2826565.	24704192.	27702016.
10	80478144.	9012490.	968551.	2790288.	488311.	3500436.	30593824.	34092752.
11	97273136.	10093987.	871696.	0.	0.	4315371.	37715336.	45147424.
12	117532096.	11305264.	784528.	0.	0.	5272112.	46078272.	54876432.
13	141963408.	12661894.	706075.	0.	0.	6429770.	56195176.	66575536.
14	171419840.	14181319.	635469.	0.	0.	7830151.	68435504.	80972332.
15	206926960.	15883073.	571923.	0.	0.	9523596.	83236208.	98284048.
16	249718864.	17789024.	514731.	0.	0.	********	101128352.	119230704.
17	301260000.	19923696.	463259.	0.	0.	********	122750192.	144561344.
18	363396352.	22314528.	416934.	0.	0.	********	148870384.	175177904.
19	438214912.	24992256.	375242.	0.	0.	********	180414048.	212165728.
20	528318464.	27991312.	337718.	0.	0.	********	218495056.	256331968.

Appendix C

FUEL COST AND CAPITAL COST ITERATION

The following examples show the effect on IRR and PNV when fuel cost and capital cost are iterated in a stepwise manner.

PULPMILL, WOOD

PRICE/TON WOOD ($)

	OIL CONS (GAL/YR)	OIL COST ($/YR 1)	WOOD CONS (TON/YR)	WOOD COST ($/YR 1)	NT PR VAL ($)	IRR (%)	PAYBACK (YR)
6.00	15256990.	18308384.	331374.	1988241.	51191312.	58.9	1.9
7.00	15256990.	18308384.	331374.	2319614.	50155584.	58.1	2.0
8.00	15256990.	18308384.	331374.	2650988.	49119856.	57.3	2.0
9.00	15256990.	18308384.	331374.	2982362.	48084192.	56.6	2.1
10.00	15256990.	18308384.	331374.	3313735.	47048464.	55.8	2.1
11.00	15256990.	18308384.	331374.	3645109.	46012752.	55.1	2.2
12.00	15256990.	18308384.	331374.	3976482.	44977104.	54.3	2.3
13.00	15256990.	18308384.	331374.	4307856.	43941360.	53.6	2.3
14.00	15256990.	18308384.	331374.	4639229.	42905680.	52.8	2.4
15.00	15256990.	18308384.	331374.	4970603.	41869952.	52.1	2.5
16.00	15256990.	18308384.	331374.	5301977.	40834272.	51.4	2.6
17.00	15256990.	18308384.	331374.	5633350.	39798576.	50.6	2.7
18.00	15256990.	18308384.	331374.	5964724.	38762896.	49.9	2.7
19.00	15256990.	18308384.	331374.	6296097.	37727168.	49.2	2.9
20.00	15256990.	18308384.	331374.	6627471.	36691488.	48.5	3.0
21.00	15256990.	18308384.	331374.	6958844.	35655760.	47.7	3.1
22.00	15256990.	18308384.	331374.	7290218.	34620064.	47.0	3.2
23.00	15256990.	18308384.	331374.	7621591.	33584368.	46.3	3.4
24.00	15256990.	18308384.	331374.	7952965.	32548688.	45.6	3.5
25.00	15256990.	18308384.	331374.	8284339.	31512976.	44.9	3.7
26.00	15256990.	18308384.	331374.	8615712.	30477264.	44.2	3.9
27.00	15256990.	18308384.	331374.	8947086.	29441600.	43.5	4.1
28.00	15256990.	18308384.	331374.	9278459.	28405872.	42.8	4.3
29.00	15256990.	18308384.	331374.	9609833.	27370176.	42.1	4.6
30.00	15256990.	18308384.	331374.	9941206.	26331568.	41.4	4.9
31.00	15256990.	18308384.	331374.	10272580.	25171744.	40.6	5.2
32.00	15256990.	18308384.	331374.	10603954.	24011888.	39.8	5.6
33.00	15256990.	18308384.	331374.	10935327.	22852064.	39.1	6.1
34.00	15256990.	18308384.	331374.	11266701.	21692224.	38.3	6.6
35.00	15256990.	18308384.	331374.	11598074.	20532384.	37.5	7.2
36.00	15256990.	18308384.	331374.	11929448.	19329504.	36.8	8.0

PULPMILL, WOOD

CAPITAL COST ($)	OIL CONS (GAL/YR)	OIL COST ($/YR 1)	WOOD CONS (TON/YR)	WOOD COST ($/YR 1)	NT PR VAL ($)	IRR (%)	PAYBACK (YR)
5000000.00	15256990.	18308384.	331374.	3976482.	50363232.	171.0	0.45
10000000.0	15256990.	18308384.	331374.	3976482.	48607680.	99.0	0.90
15000000.0	15256990.	18308384.	331374.	3976482.	47397472.	74.5	1.35
20000000.0	15256990.	18308384.	331374.	3976482.	46187264.	62.0	1.80
25000000.0	15256990.	18308384.	331374.	3976482.	44977104.	54.3	2.26
30000000.0	15256990.	18308384.	331374.	3976482.	43766896.	49.0	2.71
35000000.0	15256990.	18308384.	331374.	3976482.	42556736.	45.1	3.16
40000000.0	15256990.	18308384.	331374.	3976482.	41346496.	42.1	3.61
45000000.0	15256990.	18308384.	331374.	3976482.	40136304.	39.6	4.06
50000000.0	15256990.	18308384.	331374.	3976482.	38909952.	37.6	4.51