BIOMASS FEASIBILITY

CDI

By
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Cogen Designs, Inc.

Project Descriptions

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- **Project 1**
  - **New Facility**
  - **Essentially Power Only**
  - **Flat Industrial Load Profile**
- **Project 2**
  - **Existing Facility**
  - **Hot Water and Power**
  - **Highly Variable Load Profile**

Biomass Application

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MDF Cabinet Manufacture

1,200,000 parts/month

10% losses (sawdust,chips)

11.1 tons/day waste

350 kW power equivalent

Plant Load: 6 MW
7 Mlb/h Steam

Power Cost Trend

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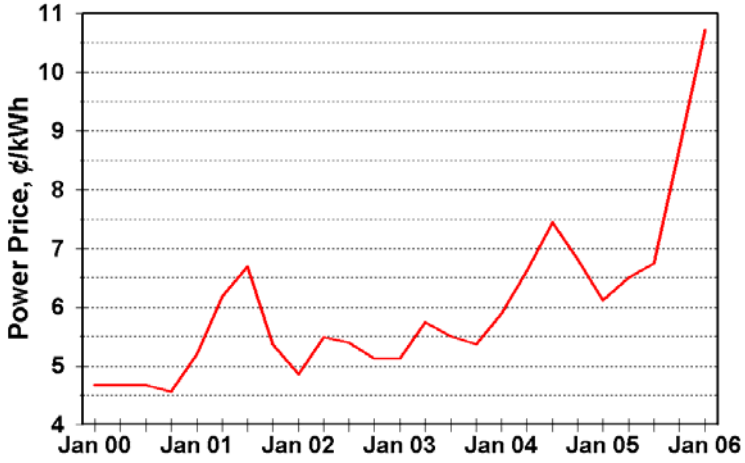

Power Cost vs Load Factor

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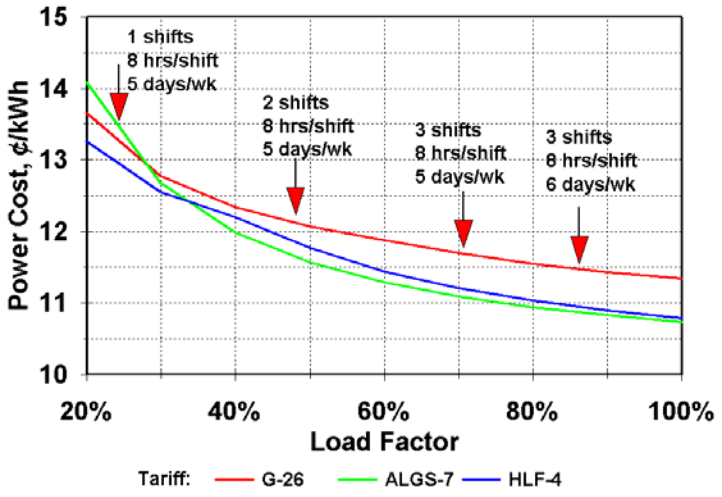

Power Options

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- **Generate only internal loads**
- **Sell 3rd shift surplus power to grid**
- **Oversize plant to export power**
- **Sell all generated power / buy all plant power**

Capacity Additions

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	Additions, MW	Retirements, MW	Purchases, MW	Capacity Payments
2006	0	0	738	0
2007	0	0	854	0
2008	0	0	867	0
2009	0	0	888	0
2010	0	0	910	0
2011	0	0	1,091	0
2012	0	0	1,159	0
2013	0	0	1,264	0

Average Unit Age: 45 years
Newest Unit Built: 1983

Utility Sources

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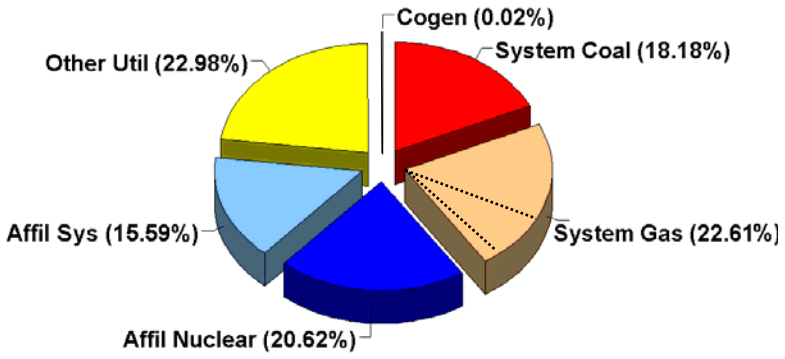

FERC Filings

Utility Power Costs

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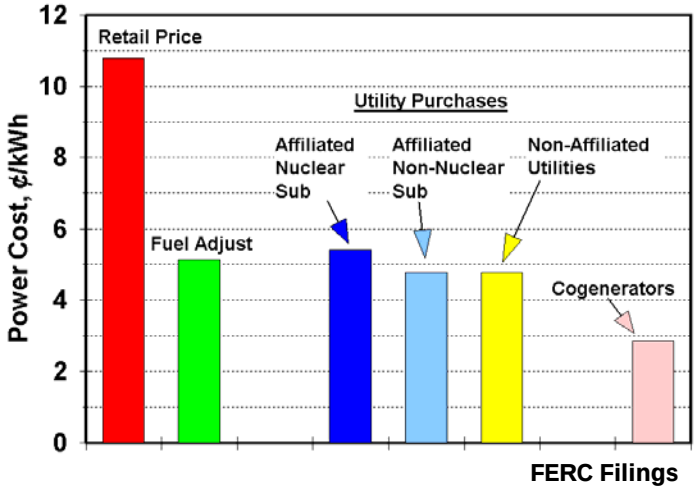

Avoided Costs

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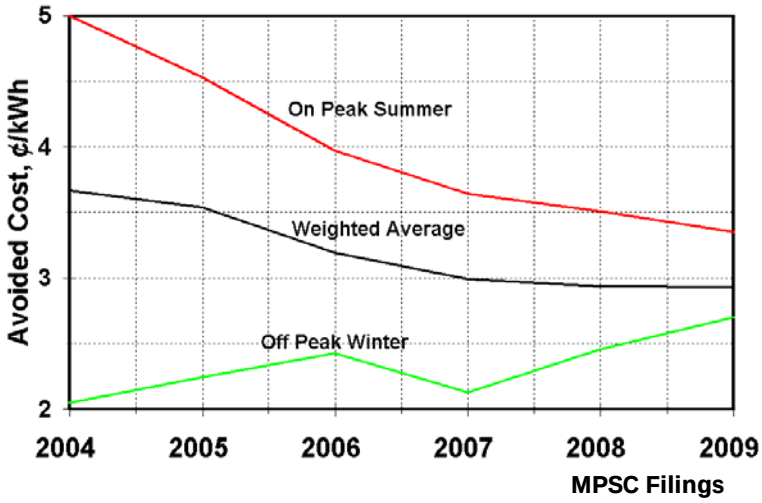

Power Cycle

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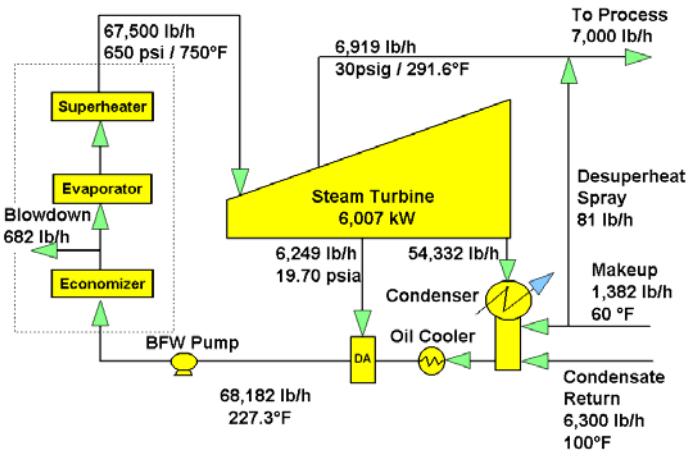

Fuel Options

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	$/ton	$/MMBtu
Wet Wood	$5.60	$1.99
Rice Hulls	15.00	1.13
Tires	42.00	1.41
Bagasse	20.00	2.42
RDF	20.00	1.66

Fuel Sources

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MDF

80% Wood
19% Phenolformaldehyde
1% Paraffin

	MDF	Rice Hulls
C, %	55.3	38.3
H	5.8	4.4
O	38.6	35.5
N	.05	.83
S	.02	.06
Ash	0.23	20.6
HHV	8,902	6,402
% H2O	8.0	9.0

Fluidized Bed Boiler

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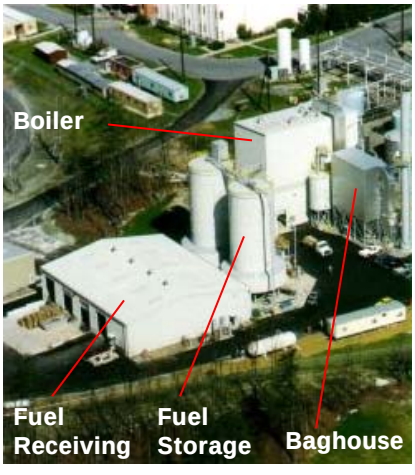

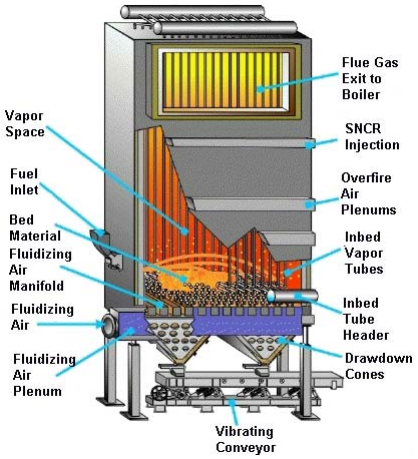

Photo and drawing courtesy Energy Products of Idaho

Project Capital Costs

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Fuel Preparation	$1.2	Million	
Boiler	4.9		
Steam Turbine	2.2		
Auxiliaries	0.1		
Electrical Intertie	0.7		
Total Equipment	$9.1	Million	
Construction	$2.7		
PM & Engineering	0.6		
Freight	0.3		
Contingency	0.6		
Total Installed Cost	$13.4	Million	
Development Costs	0.2		
Int During Construction	0.5		
Debt Placement Fees	0.1		
Total Project Investment	$14.3	Million	$2,380/kW

Operating Assumptions

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Op. Hours	20 hrs/day, 7 days/week (83.3% LF)
Load	6,000 kW / 400 kW
Availability	97%
Power Cost	11.29¢/kWh before
	14.3¢/kWh after
Avoided Cost	3.671¢/kWh

Pricing Assumptions

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Natural Gas	**$14.00 / MMBtu**
Rice Hulls	**$1.13 / MMBtu**
Water	**$0.50 / kgal**
Labor	**8 x $35 / hr**
Maintenance	**0.5¢ / kWh**
Landfill	**$35.00 / ton**

Operating Costs

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	No Cogen	With Cogen
Power	**$4.99 MM**	**$0.19 MM**
Boiler Fuel	**1.01**	**1.05**
O&M	**0.33**	**1.25**
LT&I		**0.12**
Standby		**0.12**
	$6.32 MM	**$2.74 MM**
Operating Savings		**$3.59**
Power Sales		**0.29**
Net Revenues		**$3.88 MM**

Board Plant Operation: 20 hrs / day, 7 days / week

Availability/Load Factor

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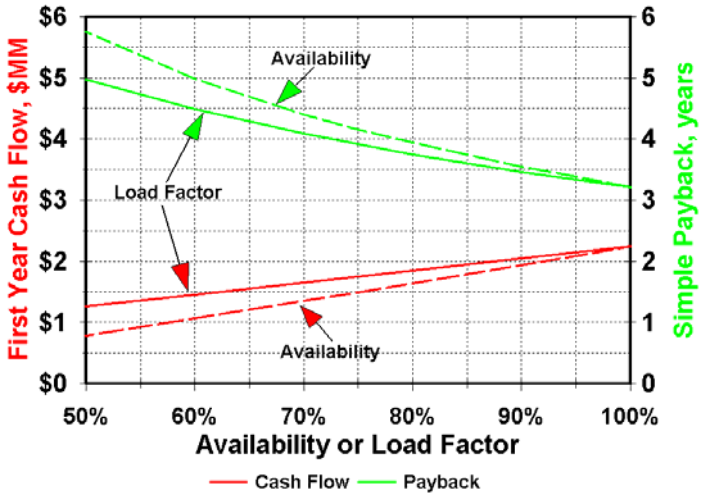

Financial Incentive

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Sell "a preponderance of power" to municipal utility = 250 basis point reduction in debt interest rate.

Investment	Int %	Life	Debt Service
$25 million	7.0%	10 yr	$3.56 million/yr
	4.5%	10 yr	3.16
			$0.40 million/yr

Load kWh	3.69 MMkWh/mo @ 10.94¢		$4.85 million/yr
		Wheeling:	0.24
		Fin. Savings:	-0.40
Gen kWh	4.25 MMkWh/mo @	9.19¢	$4.69 million/yr
	Avoided Cost:	3.67¢	

Value of Steam

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Board Plant Operation: 20 hrs/day, 7 days/week

Load Factor	Op. Sav, $MM/yr	1st Yr CF $MM	Payback, yrs	10 yr ROI, %	10 yr ROE, %
Base Case					
100.0%	$3.808	$1.835	3.75	21.9%	94.1%
No surplus power sales					
83.3%	$3.687	$1.688	3.87	20.6%	87.4%
No steam usage					
100.0%	$2.855	$1.268	4.85	17.0%	69.4%

University Wood Facility

CDI

January Load Profiles

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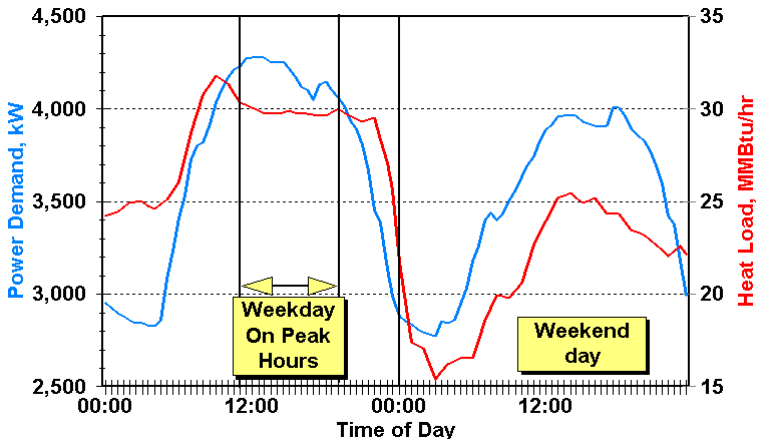

July Load Profiles

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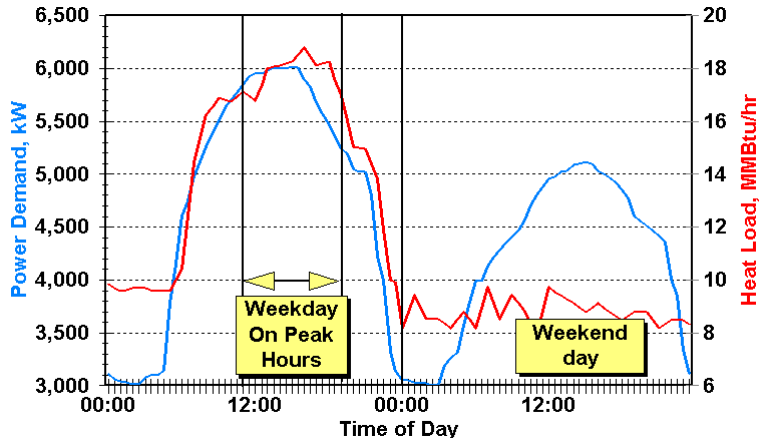

Demand Profiles

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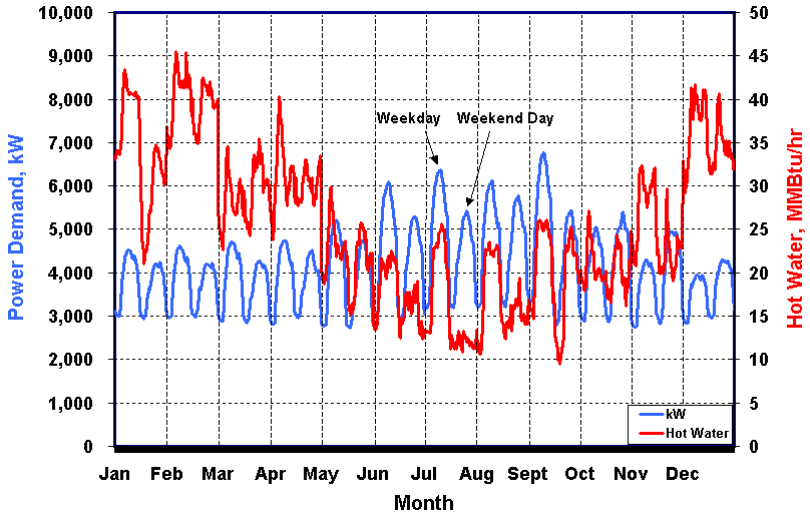

Energy Cost Reduction Strategy

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- **Change from natural gas to a lower cost fuel source for hot water generation.**
- **Use surplus summer heating capacity to reduce summer electrical demand.**
- **Reduce electric power purchases during the more expensive On Peak hours of the day.**

Heat Cycle Options

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- **Hot Water Only**
  - **50 MMBtu/hr Output**
  - **Displaces gas fired HW boiler only**
- **Steam/Hot Water**
  - **50,000 lb/hr Steam at 650psig/750°F**
  - **Provides HW during winter heating season**
  - **Provides electric power during summer**

Boiler Options

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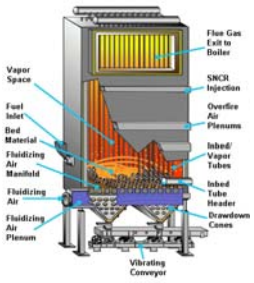
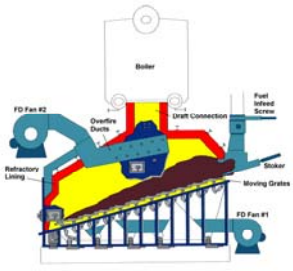


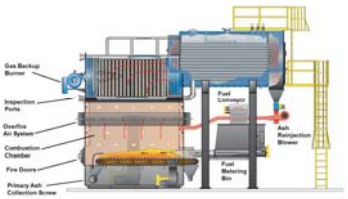
EPI Fluid Bed

(Steam & HW)



English Stoker

(Steam & HW)

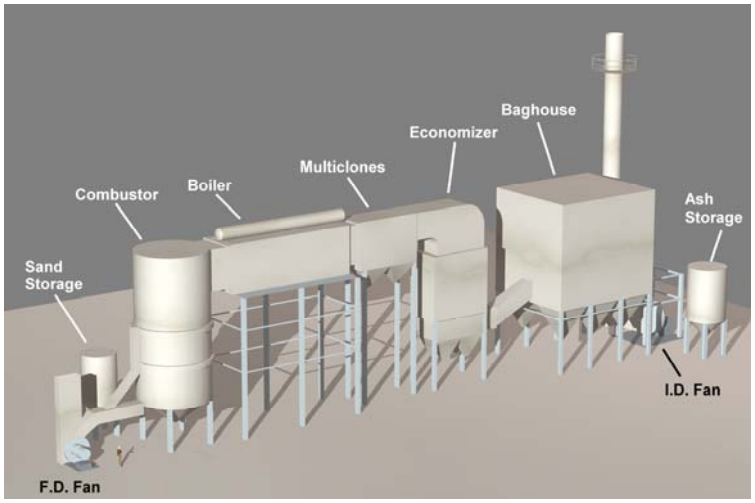


Hurst Stoker

(HW Only)

EPI Boiler System

CDI



Combined Heat/Power Cycle

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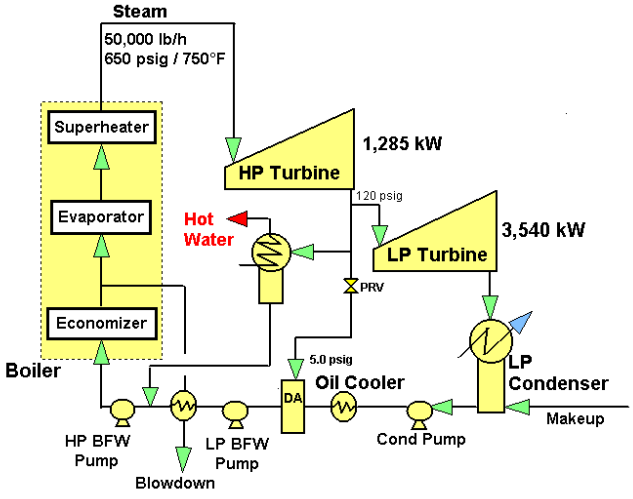

Power/Hot Water Tradeoff

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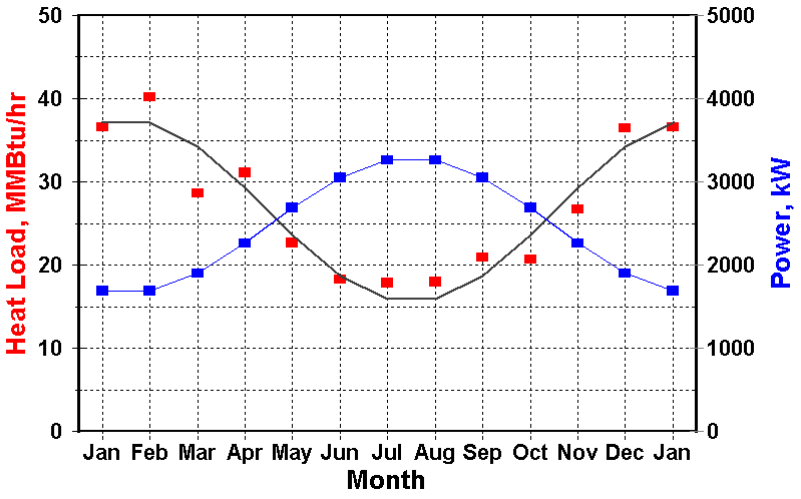

Unit Efficiency

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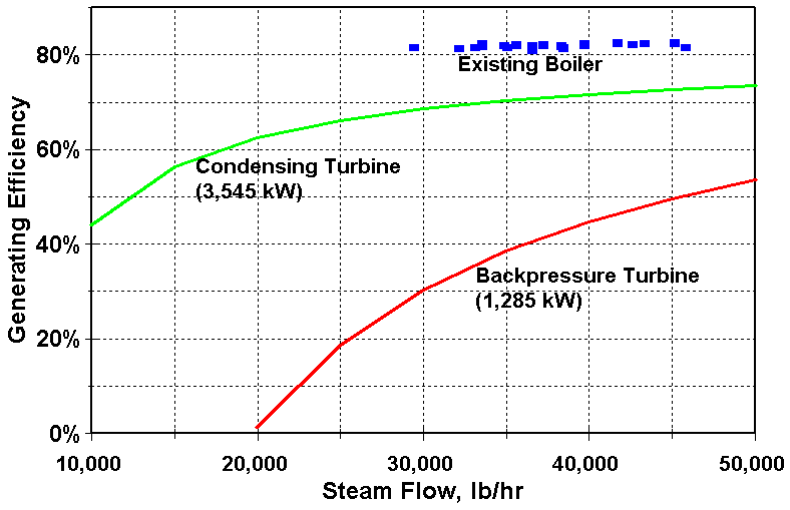

Wood Moisture Content

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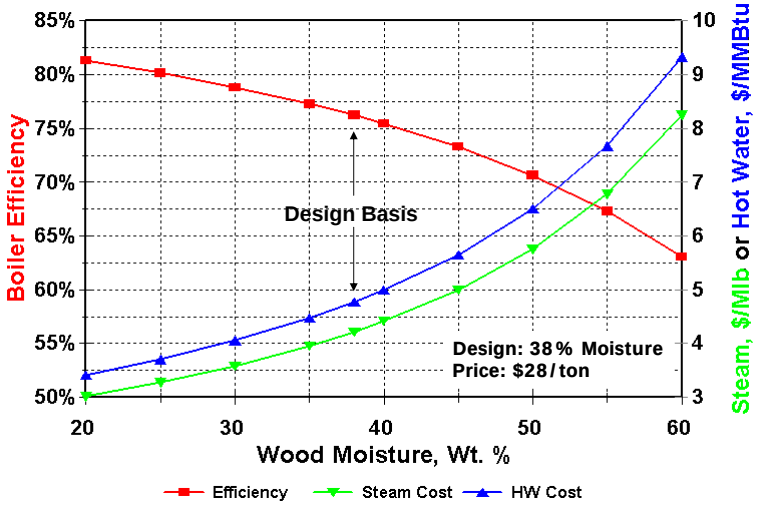

Base Load Option

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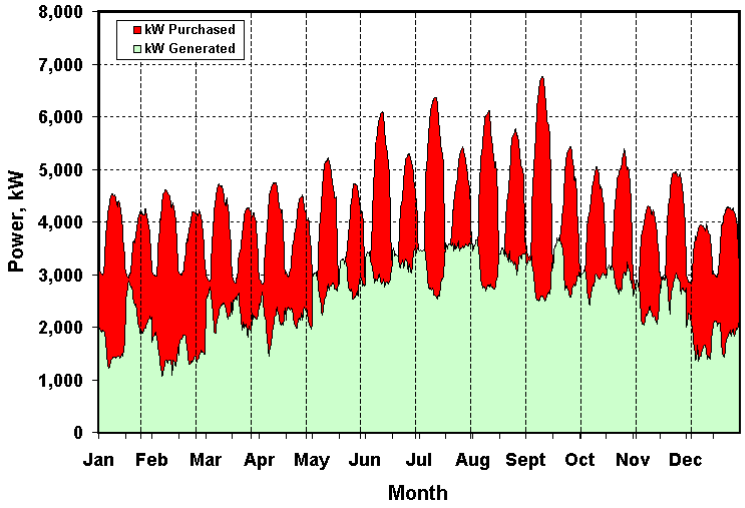

EPI System Layout

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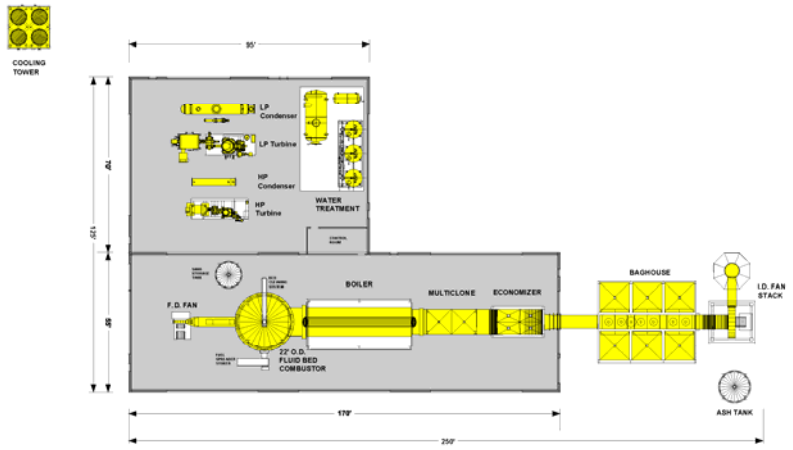

Site #2 Layout

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Capital Costs (Site #3)

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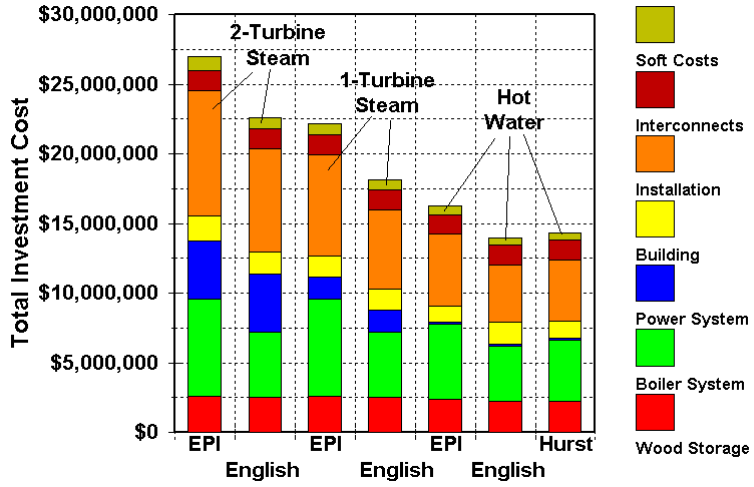
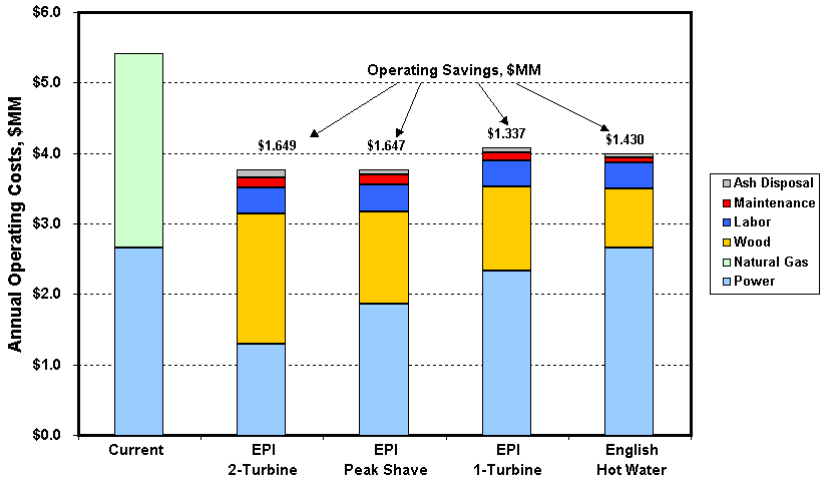


Operating Costs

CDI



Financial Performance Summary

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	Cap Cost $MM	1st Yr Op Sav $MM	1st Yr CF $MM	15 Yr NPV $MM	15 Yr ROI	Simple Payback Yrs
EPI Steam System	$26.95	$1.71	-$0.89	-$4.12	2.5%	15.8
Peak Shaving Option	$26.95	$1.71	-$0.89	-$3.73	2.8%	15.8
Single Turbine Option	$22.16	$1.39	-$0.74	-$2.95	2.9%	15.9
English Steam System	$22.64	$1.73	-$0.45	-$0.33	4.9%	13.1
Peak Shaving Option	$22.64	$1.74	-$0.45	$0.06	5.2%	13.0
Single Turbine Option	$18.12	$1.42	-$0.33	$0.61	5.7%	12.8
EPI Hot Water System	$16.24	$1.48	-$0.09	$2.98	8.0%	11.0
English HW System	$13.97	$1.49	$0.15	$5.01	10.5%	9.4
Hurst HW System	$14.35	$1.49	$0.10	$4.65	10.0%	9.7

Sensitivities

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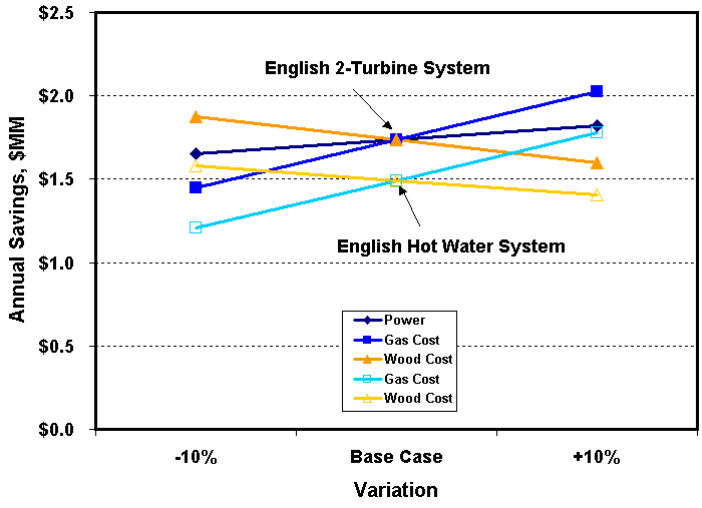

Feasibility Study Essentials

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- **Project complexity and load characteristics determine the techniques needed in the analysis.**
- **A good feasibility study will also address strategic issues, including fuel supply options, operating risks, and economic risk factors.**
- **The study should be a useful tool for the project developer, the plant designer, the project financing team, and the plant operations manager.**

BIOMASS FEASIBILITY

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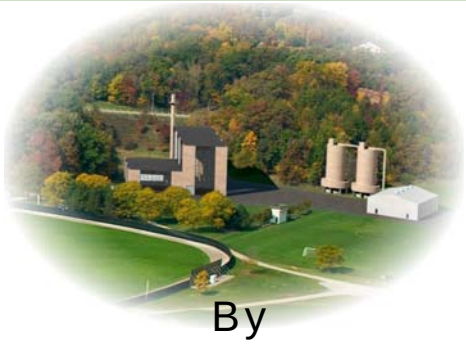

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