

4 Economic Analysis

4.1 Reid Plant Case

4.1.1 Capital and O&M Cost Estimates

Primenergy developed capital cost for the gasification plant and supporting equipment required for the gasifier. Nexant developed detailed concept for the fuel receiving, storage and transport to the gasifier. Cost for this system was estimated by contacting vendors and requesting written quotes. Installation cost was established based on bulk material estimates and vendor input. Table 4-1 provide summary of the capital cost for three different material handling system configurations.

Table 4-1 Capital Cost Estimates for the Fuel Storage and Conveying

Material Handling System	8 t/h System			
	Conveying System	Mechanical	Pneumatic	Alternate Mechanical
Truck Unloading	\$ 65,220	\$ 75,000	\$ 200,969	
Long Term Storage	\$ 433,170	\$ 450,000	\$ 882,716	
Day Storage	\$ 94,437	\$ 90,000	\$ 228,911	
Additional Equipment/Parts	\$ 94,587	\$ 60,000	\$ 99,000	
Conveying	\$ 375,000	\$ 250,000	\$ 434,710	
Trench construction/ Cover	\$ 130,000	\$ -	\$ -	
On Site Construction	\$ 481,000	\$ 250,000	\$ 258,456	
Total	\$ 1,673,414	\$ 1,175,000	\$ 2,104,762	

The following table 4-2 is the total capital cost for the entire system, including boiler modification and on site construction management for WKE case.

Table 4-2 Total Capital Cost for WKE's Case

Item	Cost \$	
	Mechanical	Pneumatic
Conveying Systems		
Primenergy Equipment and Site Installation	\$ 6,951,847	\$ 6,951,847
Material Handling Equipment	\$ 1,673,414	\$ 1,175,000
Boiler Penetrations/ Other Eng.	\$ 250,000	\$ 250,000
Contingency (5% of above)	\$ 443,763	\$ 418,842
WKE Construction Management (12 week Construction Phase)	\$ 144,000	\$ 144,000
Total Capital Cost	\$ 9,463,024	\$ 8,939,689

Table 4-3 provides an estimate for the fuel and O&M cost for the gasifier system.

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Table 4-3 Operation, Maintenance and Fuel Cost Estimate - WKE Case

Item		Units	Cost	Basis
Gasifier Fuel & Ash				
Poultry Litter	7.45 (8.20)	t/h (tons/hr)	\$10.90 (\$12.00)	\$/t (\$/ton)
Heating Value (LHV)	9,768 (4,200)	kJ/kg (Btu/lb)	\$1.12 (\$1.43)	\$/GJ (\$/MMBtu)
Natural Gas	20.9 (46)	kg/h (lbs/hr)		
Heating Value (LHV)	50,007 (21,502)	kJ/kg (Btu/lb)	\$5.68 (\$6.00)	\$/GJ (\$/MMBtu)
Nominal Ash in Litter	20-26	%		
Ash Produced (@26% ash)	1.96 (2.16)	t/h (tons/hr)	\$1.82 (\$2.00)	\$/t (\$/ton)
Credit for sale of Ash (year 3+)			(\$5.45) (\$6.00)	\$/t (\$/ton)
Boiler Availability Factor	70%	%/year	(assumed)	
Gasifier Capacity Factor	90%	%/year		
Total Poultry Litter Usage	41,091 (45,254)	tpy (tons/yr)	\$543,050	/year Litter Cost
Total NG Usage	115,255 (253,865)	kg/y (lbs/y)	\$32,752	/year NG Cost
Total Ash Produced & cost	10,814 (11,910)	tpy (tons/yr)	\$23,819	/year (year 1,2)
Ash Credits (year 3+)			(\$71,457)	/year (year 3+)
Net Gasifier Output Eq. kWe	5,238.9	kWe		
Total Power Produced	28,912,496	kWh/y		
Fuel Cost (year 1,2)	\$ 0.021		\$599,621	/year (year 1,2)
Fuel Cost (year 3+)	\$ 0.017		\$504,344	/year (year 3+)
Operation				
Operation Manpower	2.50	man-year	\$15.00	/hr
OH Multiplier	1.50		\$22.50	/hr
Operation Payroll Cost	\$ 0.004	\$/kWh	\$117,000	/year
Utility				
Water	3.41 (54.02)	l/s (gpm)	\$0.53 (\$2.00)	\$/kl (\$/1000 gal)
Air (Accounted as Aux Load)				
Electricity (-do-)				
Utility Cost	\$ 0.001	\$/kWh	\$35,774	/year
Annual Maintenance	\$ 0.005	\$/kWh	\$144,562	/year
Total O&M Cost	\$ 0.010	\$/kWh	\$297,337	/year
Operating Cost of Power				
Fuel & O&M Cost (year 1,2)	\$ 0.031	\$/kWh	\$896,957	/year
Fuel & O&M Cost (year 3+)	\$ 0.028	\$/kWh	\$801,681	/year

The delivered litter cost was developed by contacting local farmers and also requesting written quotes from local haulers who traditionally haul litter for the farmers. The maintenance cost was based on EPRI guideline for typical power plant with 5 mills per kWh produced. To minimize operating cost of the gasifier, the controls are to be integrated with the existing control room. Thus the plant

operating personnel can operate the gasifier from the control room with no additional personnel. The total burden on the plant operation, including material handling for the poultry litter and ash removal was estimated at 2 1/2 men equivalent.

Two separate estimates were developed. It is assumed that during the first two years of operation, no market for the gasifier ash is available. Thus \$2/ton of disposal cost was assigned to the electricity production cost. Since, the ash is a valuable P&K source, it can be sold to local farmers as a supplemental fertilizer. Nominal revenue of \$6/ton was assigned for year 3 analyses.

As shown in the above table, the fuel and O&M cost for the first two years of operation is calculated at 3.1c/kWh and for subsequent years it is 2.8c/kWh. This cost can be considerably reduced, if the litter can be procured at lower or negative price and higher price can be commended for the ash. A sensitivity analyses based on these and other financial factors is provided in the Appendix.

4.1.2 Financial Pro Forma

The levelized cost of the electricity is calculated using financial parameters in table 4-4:

Table 4-4 Input Financial Parameters

Financial Factors		
Inflation rate (annual)	3	%
Fuel escalation rate (annual)	0	%
Start of construction	2003	
Years of construction	1	
Debt	80	%
Return on Debt	7.5	%
Return on Equity	12	%
Base year (for economic reporting)	2002	
Book life	20	years
Capacity factor (0.70x0.90=0.63)	63	%

Table 4-5 Levelized Cost of Electricity for WKE Case

Economic Summary	
(Costs are in thousands of mid-2002 dollars)	
Item	\$ Cost
Total plant cost (TPC)	4,732
Cost of land	0
Organizational and startup expenses	126
Working capital	169
AFUDC	-4
Fuel cost, \$/GJ (\$/MM Btu)	1.12 (1.43)
Allocation of TPC over design/const. years	
Year	
1	1.00
2	0.00
Annual fixed O&M costs	259
Annual variable O&M costs @100% CF	10
Power output (kWe) @ design capacity	5,239
Heat rate, kJ/kWh (Btu/kWh)	13.883 (13,148)
Constant dollars levelized Cost of Electricity (COE), mills/kWh	
Capital	17.8
O&M	9.2
Fuel	14.0
COE \$/kWh	0.041
(mills/kWh)	(41.0)

4.1.3 Sensitivity Analysis for Reid Plant Case

The price of electricity produced from the biomass gasifier is dependent upon capital cost, fuel cost and fixed O&M cost for the gasification operation. The table 4-6 on next page provides sensitivity analysis for changes in some of these parameters.

Table 4-6 COE Sensitivity Analyses for Reid Case

Case	Litter Cost	Ash Credits	Capital Cost	WKE Cost	Interest	Period	Fuel	O&M	Capital	Total
	\$/ton	\$/Ton			%	Years	c/kWh	c/kWh	c/kWh	c/kWh
Base Case	12	(6)	\$9,500,000	\$ 4,750,000	7.5%	10	1.74	1.03	2.39	5.17
2	8	(6)	\$9,500,000	\$ 4,750,000	7.5%	10	1.12	1.03	2.39	4.54
3	10	(8)	\$9,500,000	\$ 4,750,000	7.0%	15	1.35	1.03	1.80	4.18
4	12	(10)	\$9,500,000	\$ 4,750,000	7.0%	15	1.58	1.03	1.80	4.41
5	6	(12)	\$8,900,000	\$ 4,450,000	7.0%	15	0.56	1.03	1.69	3.28
6	8	(12)	\$8,900,000	\$ 4,450,000	7.5%	10	0.87	1.03	2.24	4.14
7	10	(14)	\$8,900,000	\$ 4,450,000	7.0%	10	1.10	1.03	2.19	4.32
8	12	(16)	\$8,900,000	\$ 4,450,000	7.0%	10	1.33	1.03	2.19	4.55

One of the variables for the cost of electricity is cost of litter. The other variable is disposal cost of ash. As previously mentioned, the ash from the gasifier can be a useful source as a P&K based fertilizer. If the ash was sold as a fertilizer, it will contribute toward reducing the cost of electricity production. The figure 4-1 provides impact of litter cost and benefit of ash credits.

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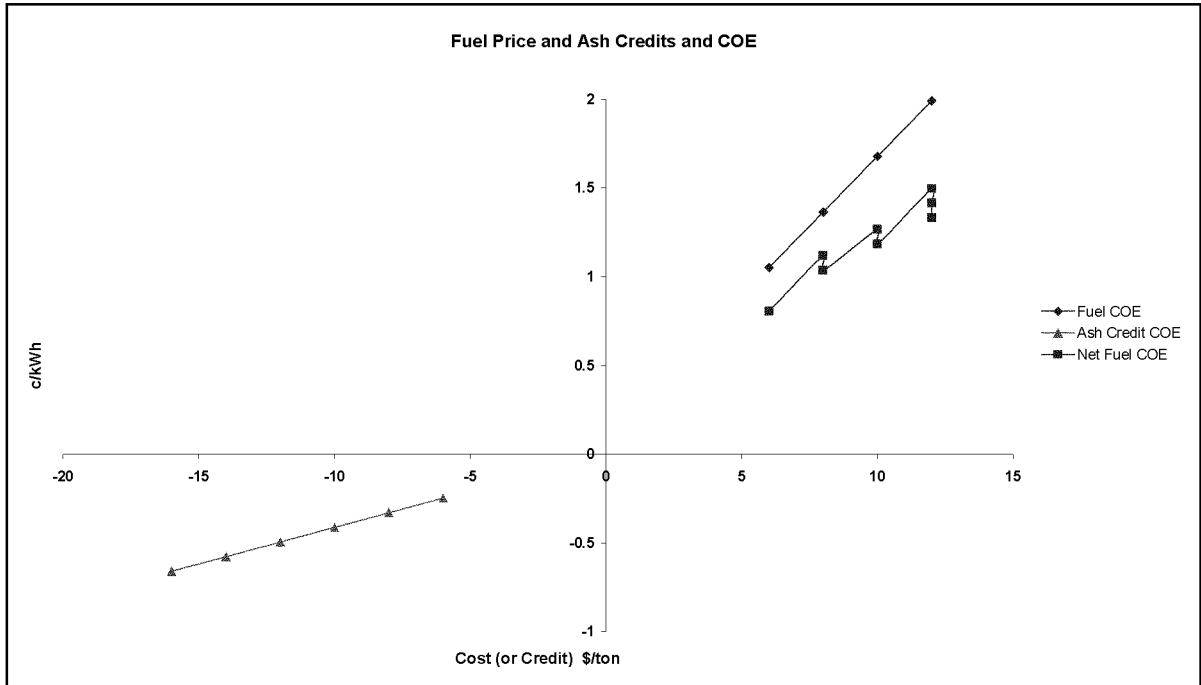


Figure 4-1 COE Sensitivity to Fuel Price and Ash Credit

4.2 Monticello Unit 1 Case

4.2.1 Capital and O&M Cost Estimate

As in the case of Reid plant, Primenergy developed capital cost for the gasification plant and supporting equipment required for the gasifier. Nexant developed detailed concept for the fuel receiving, storage and transport to the gasifier. Cost of these systems was estimated by contacting vendors and requesting written quotes. Installation cost was established based on bulk material estimates and vendor input.

Table 4-7 Capital Cost Estimates for Fuel Storage and Conveying

Material Handling Cost Estimate	Mechanical System
Major Equipment	\$ 672,800
Bulk Material	\$ 269,200
Direct Sub Contract	\$ 438,300
Direct Labor	\$ 287,200
Sales Tax @8% Freight @3%	\$ 103,600
Total Direct Costs	\$ 1,771,100
Field Indirect @100% Labor	\$ 287,200
Total Field Cost	\$ 2,058,300
Home Office Cost @ 12%	\$ 247,000
Escalation (none assumed)	\$ -
Total Mat. Handling Cost w/o Escalation	\$ 2,305,300
Contingency @10%	\$ 230,530
Total Estimate	\$ 2,535,830

The following is the total capital cost for the entire system, including boiler modification and on site construction management for the TXU Monticello case. The Monticello case was analyzed as a commercial unit.

Table 4-8 Total Capital Cost for the Monticello Plant

Item	\$ Cost Estimate
Primenergy Equipment	\$ 11,000,000
Material Handling Equipment	\$ 2,535,830
Boiler Penetrations/ Other Eng.	\$ 400,000
Contingency @ 5% of above	\$ 696,792
TXU Construction Management (16 week Construction Phase)	\$ 250,000
Total Capital Cost	\$ 14,882,622

Table 4-9 provides an estimate for the fuel and O&M cost for the gasifier system.

As in the WKE case, the delivered litter cost was developed by contacting local farmers and also requesting written quotes from local haulers who traditionally haul litter for the farmers. The maintenance cost was based on EPRI guideline for typical power plant with 5 mills per kWh produced. To minimize operating cost of the gasifier, the controls are to be integrated with the existing control room. Thus the plant operating personnel can operate the gasifier from the control room with no additional personnel. The total burden on the plant operation, including material handling for the poultry litter and ash removal was estimated at 21/2 men equivalent.

Two separate estimates were developed. It is assumed that during the first two years of operation, no market for the gasifier ash is available. Thus \$2/ton of disposal cost was assigned to the electricity production cost. Since, the ash is a valuable P&K source, it can be sold to local farmers as an supplemental fertilizer. Nominal revenue of \$6/ton was assigned for year 3 analyses.

As shown in the table 4-9 below, the fuel and O&M cost for the first two years of operation is calculated at 3.1c/kWh and for subsequent years it is 2.8c/kWh. This cost can be considerably reduced, if the litter can be procured at lower or negative price and higher price can be commended for the ash. A sensitivity analyses based on these and other financial factors is provided in the Appendix B TXU Case.

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Table 4-9 Operation, Maintenance and Fuel Cost Estimate - Monticello Case

Item		Units	Cost	Basis
Gasifier Fuel and Ash				
Poultry Litter	14.53 (16.00)	t/h (tons/hr)	\$7.26 (\$8.00)	\$/t (\$/ton)
Heating Value (LHV)	9,768 (4,200)	kJ/kg (Btu/lb)	\$0.74 (\$0.95)	\$/GJ (\$/MMBtu)
Natural Gas	0 (0)	kg/h (lbs/hr)		
Heating Value (LHV)	50,007 (21,502)	kJ/kg (Btu/lb)	\$5.68 (\$6.00)	\$/GJ (\$/MMBtu)
Nominal Ash in Litter	18~23	%		
Ash Produced (@23% Level)	3.34 (3.68)	t/h (tons/hr)	\$1.82 (\$2.00)	\$/t (\$/ton)
Credit for sale of ash (year 3+)			(\$5.45) ((\$6.00))	\$/t (\$/ton)
Boiler Availability Factor	80%	%/year	(assumed)	
Gasifier Capacity Factor	90%	%/year		
Total Poultry Litter Usage	91,631 (100,915)	tpy (tons/yr)	\$807,322	/year
Total NG Usage	0 (0)	kg/y (lbs/y)	\$0	/year
Total Ash Produced	21,075 (23,210)	tpy (tons/yr)	\$46,421	/year (year 1,2)
Ash Credits (year 3+)			(\$139,263)	/year (year 3+)
Total Gasifier Output Eq. kWe	12,782.7	kWe		
Total Power Produced	80,622,887	kWh/y		
Fuel Cost (year 1,2)	\$ 0.011		\$853,743	/year (year 1,2)
Fuel Cost (year 3+)	\$ 0.008		\$668,059	/year (year 3+)
Operation				
Operation Manpower	3.00	man-year	\$20.00	/hr
OH Multiplier	1.50		\$30.00	/hr
Operation Payroll Cost	\$ 0.002	\$/kWh	\$187,200	/year
Utility				
Water	3.41 (54.02)	l/s (gpm)	\$0.53 (\$2.00)	\$/kl (\$/1000 gal)
Air (Accounted as Aux Load)				
Electricity (-do-)				
Utility Cost	\$ 0.001	\$/kWh	\$40,885	/year
Annual Maintenance	\$ 0.005	\$/kWh	\$403,114	/year
Total O&M Cost	\$ 0.008	\$/kWh	\$631,199	/year
Operating Cost of Power				
Fuel & O&M Cost (year 1,2)	\$ 0.018	\$/kWh	\$1,484,942	/year
Fuel & O&M Cost (year 3+)	\$ 0.016	\$/kWh	\$1,299,258	/year

4.2.2 Financial Pro Forma

Table 4-10 Levelized Cost of Electricity for Monticello Case

Economic Summary	
(Costs are in thousands of mid-2002 dollars)	
Item	\$ Cost
Total plant cost (TPC)	14,883
Cost of land	0
Organizational and startup expenses	355
Working capital	263
AFUDC	384
Fuel cost, \$/MM Btu	0.95
Allocation of TPC over design/const. years	
Year	
1	0.12
2	0.88
3	0.00
Annual fixed O&M costs	587
Annual variable O&M costs @100% CF	14
Power output (kWe) @ design capacity	12,783
Heat rate, kJ/kWh (Btu/kWh)	11,101 (10,514)
Constant dollars levelized Cost of Electricity (COE), mills/kWh	
Capital	19.8
O&M	7.4
Fuel	7.2
COE \$/kWh (mills/kWh)	0.0345 (34.5)

4.2.3 Sensitivity Analysis for Monticello Case

As mentioned in the Reid plant case, the price of electricity produced from the biomass gasifier is dependent upon capital cost, fuel cost and fixed O&M cost for the gasification operation. Table 4-11 below provides sensitivity analysis for changes in some of these parameters for the Monticello case.

Table 4-11 COE Sensitivity Analyses for Monticello Case

Case	Litter Cost \$/ton	Ash Credits \$/Ton	Capital Cost (TXU Cost)	Interest %	Period Years	Fuel c/kWh	O&M c/kWh	Capital c/kWh	Total c/kWh
Base Case	8	0	\$14,882,622	7.5%	10	1.00	0.78	2.69	4.47
2	8	(6)	\$ 4,882,622	7.5%	10	0.83	0.78	2.69	4.30
3	8	0	\$14,882,622	7.5%	10	1.00	0.78	1.34	3.13
4	6	(6)	\$14,882,622	7.5%	10	0.58	0.78	2.69	4.05
5	6	(6)	\$14,882,622	7.5%	10	0.58	0.78	1.34	2.71
6	4	0	\$14,882,622	7.5%	10	0.50	0.78	2.69	3.97
7	4	0	\$14,882,622	7.5%	10	0.50	0.78	1.34	2.63
8	0	(6)	\$14,882,622	7.5%	10	-0.17	0.78	2.69	3.30

The effect of changes in the litter price and credit for the ash sales will be same for the Monticello plant as in the Reid case.