NATIONAL ENERGY TECHNOLOGY LABORATORY

Current and Future Technologies for Power Generation with Post-Combustion Carbon Capture

Final Report

March 16, 2012

DOE/NETL-2012/1557

U.S. DEPARTMENT OF ENERGY

Disclaimer

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Exhibits

Acronyms and Abbreviations

AACE	American Association of Cost Engineering
ASU	Air separation unit
BFD	Block flow diagram
BFW	Boiler feed water
BLS	U.S. Bureau of Labor Statistics
Btu	British thermal unit
Btu/kWh	British thermal unit per kilowatt hour
Btu/lb	British thermal unit per pound
CCFp	Capital charge factor for a levelization period of P years
CCS	Carbon capture and storage
CF	Capacity factor
CO_2	Carbon dioxide
COE	Cost of electricity
DCS	Distributed control system
DOE	Department of Energy
ft	Foot, feet
FGD	Flue gas desulfurization
Gal	Gallon
gpm	Gallons per minute
GJ	Gigajoule
H_2O	Water
hr	Hour
HHV	Higher heating value
HP	High pressure
HRSG	Heat recovery steam generator
HVAC	Heating, ventilating, and air conditioning
IEA	International Energy Agency
ISO	International Organization for Standardization
IOU	Investor-owned utility
kg	Kilogram
kg/hr	Kilogram per hour
kJ	Kilojoule
kV	Kilovolts
kW	Kilowatt
kWh	Kilowatt-hour
kW_{th}	Kilowatt-thermal
lb	Pound
lb/hr	Pound per hour
LCOE	Levelized cost of electricity
LF	Levelization factor
LHV	Lower heating value
LP	Low pressure
m	Meter
MMBtu	Million British thermal units (also shown as 10^6 Btu)
MMBtu/hr	Million British thermal units per hour (also shown as 10^6 Btu/hr)
MW	Megawatt
MWe	Megawatt electric
MWh	Megawatt-hour
NETL	National Energy Technology Laboratory
N_2	Nitrogen
NO_x	Nitrogen oxide
O&M	Operations and maintenance
O_2	Oxygen
PC	Pulverized coal
ppm	Parts per million
psi	Pounds per square inch
psia	Pounds per square inch absolute
psig	Pounds per square inch gage
SC	Supercritical
SCR	Selective catalytic reduction
TASC	Total as spent cost
TOC	Total overnight cost
TPC	Total plant cost
ton	2,000 pounds
tonne	1,000 kg
TS&M	Transport, storage, and monitoring
USC	Ultra-supercritical
V	Volts
vol%	Percent by volume

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Executive Summary

Objective

The National Energy Technology Laboratory (NETL) is funding research aimed at improving the performance and reducing the cost of conventional pulverized coal (PC) power plants adapted to use post-combustion carbon capture technologies. The objective of this study is to support DOE's Carbon Capture and Advanced Combustion R&D Programs by completing an "R&D Pathway" study for PC power plants that employ post-combustion carbon capture. The pathway begins with a 1st generation supercritical plant with a representation of a post-combustion capture technology that would be offered today. The post-combustion capture technologies considered in this study include representations of three currently offered post-combustion capture technologies that reflect near-term enhancements in capture technology. Two advanced capture technologies in the research and development phase were selected to evaluate the potential for meeting the DOE goal of achieving a cost of electricity for a PC plant with carbon capture and CO_2 compression that has $\leq$ 35% increase over the PC plant without capture. Advances in the steam conditions for power generation and the CO_2 compression are included in the pathway. These technologies also provide opportunities to increase plant efficiency and reduce the cost of electricity. The technology pathways thus include advances in the capture technology, the power generation steam conditions, and the CO_2 compression. The results represent the future benefits from a successful post-combustion carbon capture technology development program. The results also provide a basis to guide technology development and to measure and prioritize the contribution of research and development.

Power Plant Study Basis and Approach

The study assumes a mid-Western, Greenfield site using Illinois No. 6 coal. The nominal plant capacity for all cases is 550 MW with all plants using an evaporative cooling tower. The plants are designed for 90 percent CO_2 capture and the plant capacity factor for all cases is 85 percent. The cost for transport, storage, and monitoring is not included in this analysis. Each plant is simulated using ASPEN. All major chemical processes and equipment are simulated. Mass and energy balances, performance, and costs are presented for each case.

Plants Simulated

Exhibit ES-1 lists the pathway progression of the technology steps assessed in the report. It identifies the capture technology, the steam conditions, and the CO_2 compression technology assumed for each case. Three steam conditions are considered: supercritical (SC) with 3500 psig/1100 °F/ 1100 °F steam, ultra-supercritical (USC) with 5000 psig/1200 °F/1200 °F steam, and advanced ultra-supercritical (AUSC) with 5000 psig/1350 °F/1400 °F steam. The compression technology considers conventional state-of-the-art compression and an advanced shockwave compression concept.

Exhibit ES-1 Case Study Summary

Case	Capture Technology	Steam Conditions	CO_2 Compression Technology
1A	None	SC	None
1B	None	AUSC	None
2	Fluor Econamine	SC	Conventional
3	Enhanced Fluor Econamine	SC	Conventional
4	MHI KS-1 Solvent	SC	Conventional
5A	MTR Membrane	SC	Conventional
5B	MTR Membrane	USC	Conventional
5C	MTR Membrane	AUSC	Conventional
5D	MTR Membrane	AUSC	Shockwave
6A	TDA Adsorbent	SC	Conventional
6B	TDA Adsorbent	USC	Conventional
6C	TDA Adsorbent	AUSC	Conventional
6D	TDA Adsorbent	AUSC	Shockwave

Case 1A represents the conventional baseline PC plant using a supercritical steam plant without carbon capture. Case 1B is based on the Case 1A plant with an advanced ultra-supercritical steam (AUSC) cycle. Case 2 is a current, state-of-the-art PC plant using supercritical steam plant and applying conventional post-combustion CO_2 absorption technology. A representation of the Fluor Econamine technology is used for this case. Case 3 is a supercritical PC plant that assumes enhanced solvent performance for the Fluor Econamine technology represented in Case 2. Cases 1A, 2, and 3 are reproductions of Cases 11, 12, and 12A, reported in the previous NETL study "Cost and Performance Baseline for Fossil Energy Plants, Volume 1, Bituminous Coal and Natural Gas to Electricity" [4], and is referred throughout this report as the "Bituminous Baseline report." Case 4 utilizes a representation of the MHI KS-1 solvent technology. This capture technology is currently being demonstrated at the Southern Company Plant Berry.

Four pathway cases are presented for each of the advanced post-combustion capture technologies. An advanced CO_2 membrane technology and an advanced CO_2 adsorbent process were selected for this study. The advanced membrane technology is based on the membrane technology being developed by MTR, Inc. The advanced adsorbent process is based on a concept being developed by TDA Research, Inc. These capture technologies are currently in the small-scale development phase. The design bases for the two advanced technologies utilize

design and operating parameter that represent a 'stretch' from the current respective technology development projects. Thus the design bases do not represent the current state of the technologies but assume successful technology development to achieve program goals.

The design basis for the two advanced carbon capture technologies used in Cases 5 and 6 were submitted to the two technology developers for their review and comment. The parameter values selected are based on feedback from the technology developers.

Pathway Metrics

In order to meet the challenges of reducing greenhouse gas emissions, DOE/NETL has established carbon capture and storage (CCS) goals for the "Existing Plants, Emissions & Capture" program. By 2020, advanced technologies will be developed and best practices will be implemented to achieve the following goals:

- A CO_2 capture of 90 percent
- A storage permanence of 99+ percent
- A cost of electricity (COE) of less than 35-percent above that of a reference plant without carbon capture and sequestration. This will be for post- and oxy-combustion carbon capture

In addition to estimating the PC power plant performance and cost along the proposed post-combustion CO_2 removal development pathway, the advanced post-combustion technologies studied were evaluated to determine if they could meet this DOE 35-percent goal. The reference plant is the supercritical plant without capture – Case 1A. The first year COE for this plant is $58.9/MWh. With a goal of achieving a 35% increase, the COE for the capture case would be $79.5/MWh.

Two finance structures were considered in projecting the COE for the pathway cases. A low risk finance structure for investor-owned utilities was used for the state-of-the-art plant without carbon capture (Case 1A). A high-risk finance structure was used for all other cases listed in Exhibit ES-1. This reflects the inclusion of the advanced technologies (e.g. AUSC in Case 1B and capture technologies that have not reached a maturity consistent with conventional financing). Two additional low-risk cases are included for the advanced capture technologies (Cases 5E and 6E) to show the effect of these advanced plants achieving an n^{th}-of-a-kind plant and market maturity.

Five metrics are used to summarize the technology pathways:

- Net plant efficiency
- First year COE
- Total overnight plant capital cost
- Cost of CO_2 avoided (based on the difference in CO_2 emissions from the plants with capture and the reference supercritical steam plant without capture)
- Cost of CO_2 removed (represents the cost of the CO_2 removed and available for use in enhanced oil recovery)

Pathway Performance and Cost Profiles

Two technology pathways are presented: a pathway with the MTR membrane technology and a pathway with the TDA adsorbent process. Each pathway includes the reference supercritical PC plant without capture (Case 1A), the same plant that replaces the steam cycle with advanced ultra-supercritical (AUSC) steam (Case 1B), and the three capture technologies reflecting current technology projections. The following exhibits present the pathway results for both MTR and TDA. In addition to these data, the sensitivity of selected process design and plant operation on the cost of electricity was analyzed and results presented in the report. Parameters selected include MTR membrane cost and pressure drop across the membrane, TDA adsorbent cost, plant steam conditions, and plant capacity factor.

Advanced Membrane[1] Pathway

Exhibit ES-2 Membrane Pathway Performance and Cost Data

	PC, SC w/o Capture (Low Risk)	PC, AUSC w/o Capture (High Risk)	Fluor Solvent, SC (High Risk)	Adv. Fluor Solvent, SC (High Risk)	MHI KS-1 Solvent, SC (High Risk)	MTR, SC (High Risk)	MTR, USC (High Risk)	MTR, AUSC (High Risk)	MTR, AUSC, Adv. Compression (High Risk)	MTR, AUSC, Adv. Compression (Low Risk)
Case	1A	1B	2	3	4	5A	5B	5C	5D	5E
Plant Efficiency, %	39.3	42.5	28.4	29.8	30.4	32.7	34.2	36.1	36.5	36.5
Auxiliary Power, MW	30.4	27.8	112.8	104.2	101.7	141.0	135.6	129.9	131.9	131.9
Auxiliary Steam for Capture, 1000 lb/hr	NA	NA	2,036	1,415	1,262	NA	NA	NA	NA	NA
Capture Process Auxiliary Power, MW	NA	NA	20.6	16.4	16.3	NA	NA	NA	NA	NA
CO_2 Compression Power	NA	NA	44.9	42.8	42.1	49.5	47.8	45.9	53.1	53.1
CO_2 Emissions, lb/net MWh	1,768	1,634	245	233	229	240	231	218	181	181
Raw water withdrawal, gpm	5,321	4,618	10,071	9,446	8,505	7,281	6,930	6,451	5,938	5,938
Raw water consumption, gpn	4,227	3,674	7,733	7,273	6,508	5,543	5,275	4,908	4,497	4,497
TOC, $/kW	2,024	1,902	3,570	3,364	3,427	3,095	2,993	2,920	2,898	2,898
FY COE, $/MWh	**58.9**	**55.0**	**100.9**	**95.5**	**96.6**	**88.2**	**85.1**	**82.4**	**81.7**	**78.7**
Capital, $/MWh	31.7	29.8	59.6	56.1	57.2	51.6	50.0	48.7	48.4	45.4
Fixed, $/MWh	8.0	7.5	13.0	12.3	12.5	11.5	11.2	10.9	10.8	10.8
Variable, $/MWh	5.0	4.6	8.7	8.3	8.6	7.9	7.7	7.3	7.2	7.2
Fuel, $/MWh	14.2	13.1	19.6	18.7	18.4	17.1	16.3	15.5	15.3	15.3

[1] Since the advanced membrane technology is based on the MTR technology concept, 'MTR' is used as a designation for the membrane capture technology

Exhibit ES-3 PC Plant Efficiency – Membrane Pathway

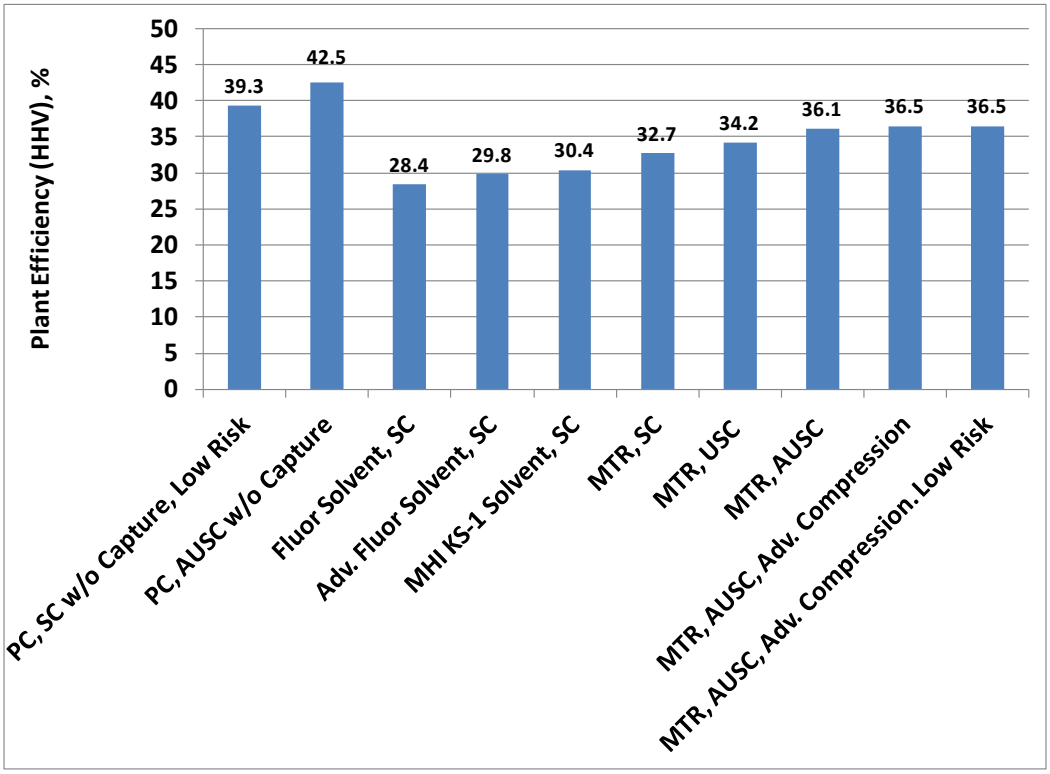


Exhibit ES-4 PC Plant First Year Cost of Electricity – Membrane Pathway

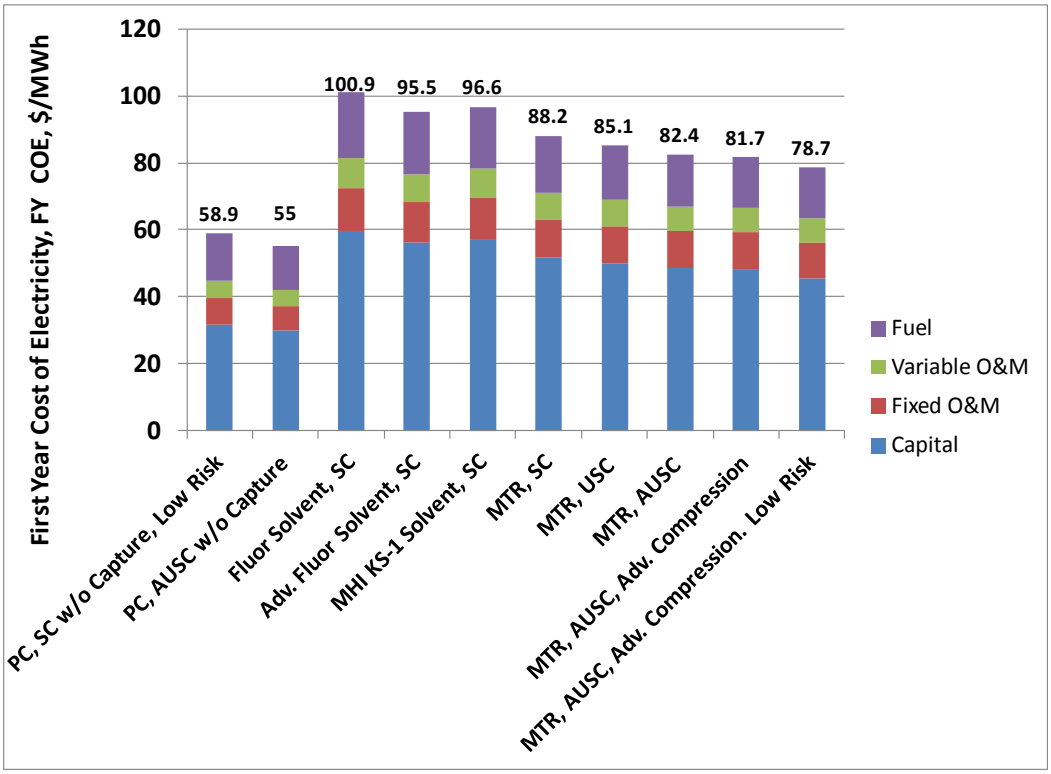


Exhibit ES-5 PC Plant Total Overnight Plant Cost – Membrane Pathway

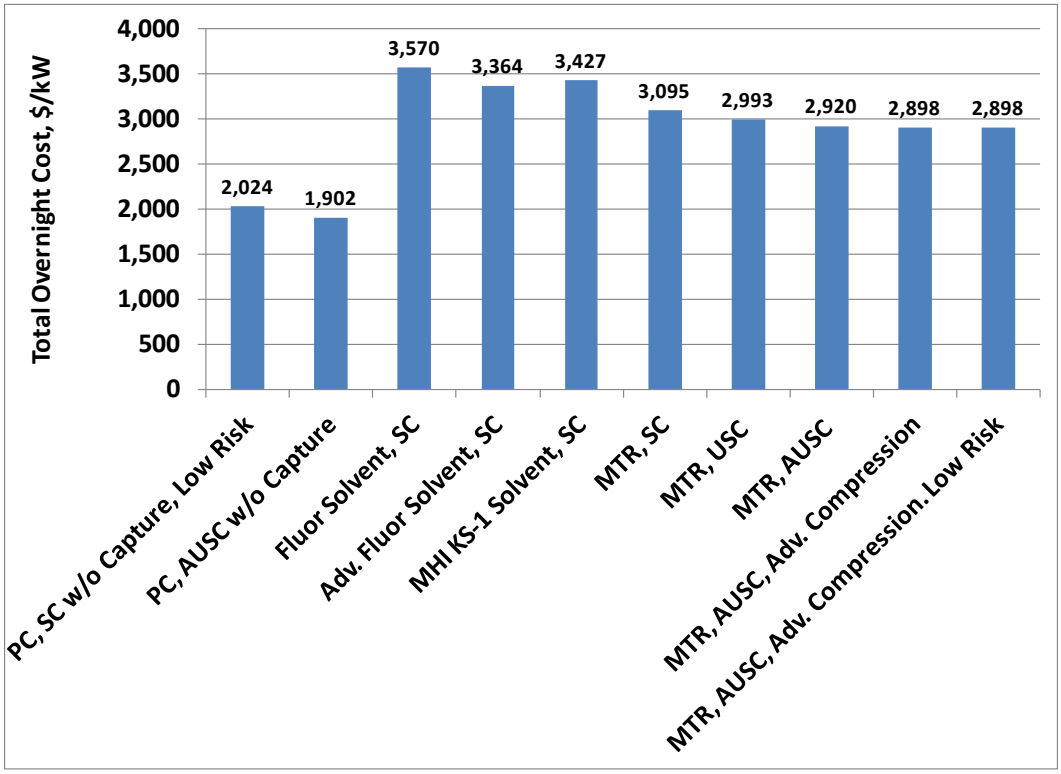


Exhibit ES-6 PC Plant Cost of Avoided CO_2 – Membrane Pathway

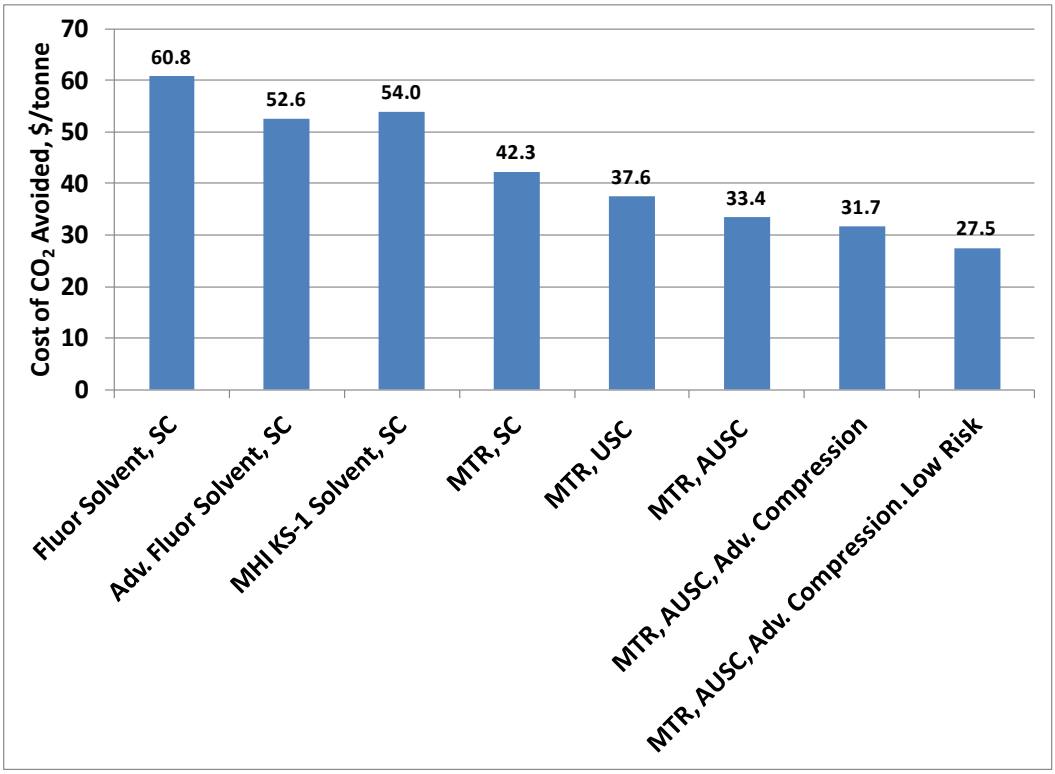
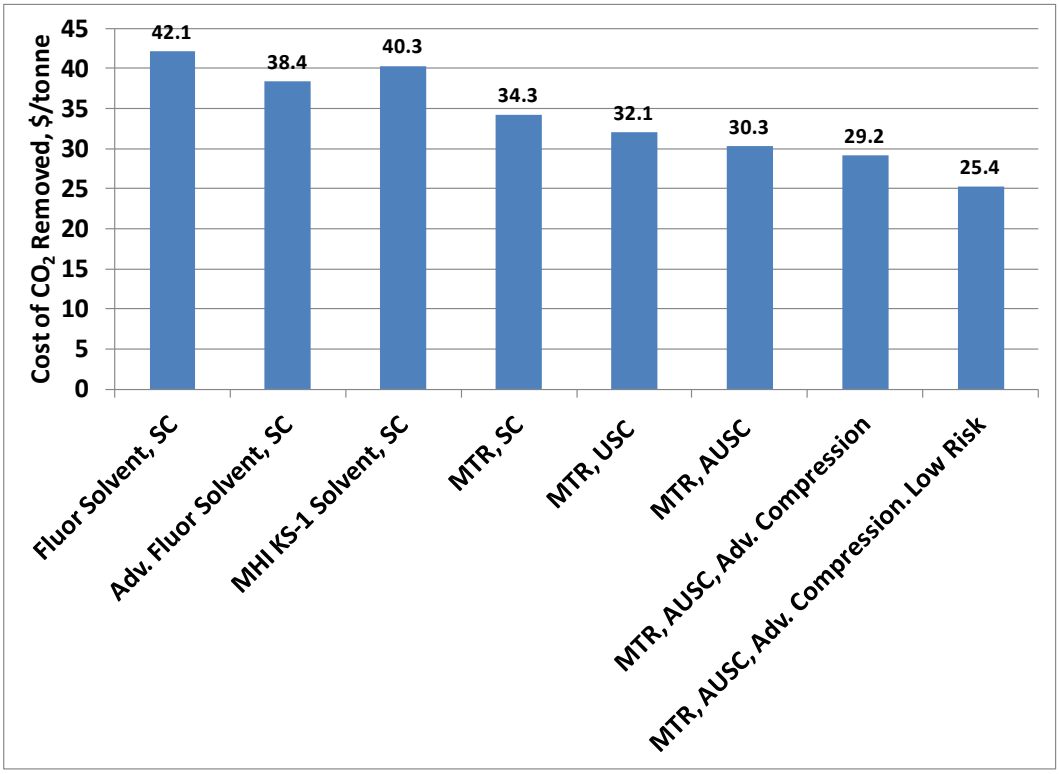


Exhibit ES-7 PC Plant Cost of CO_2 Removed – Membrane Pathway



Advanced Adsorbent[2] Pathway

Exhibit ES-8 Adsorbent Pathway Performance and Cost Data

	PC, SC w/o Capture (Low Risk)	PC, AUSC w/o Capture (High Risk)	Fluor Solvent, SC (High Risk)	Adv. Fluor Solvent, SC (High Risk)	MHI KS-1 Solvent, SC (High Risk)	TDA, SC (High Risk)	TDA USC (High Risk)	TDA, AUSC (High Risk)	TDA, AUSC, Adv. Compression (High Risk)	TDA, AUSC, Adv. Compression (Low Risk)
Case	1A	1B	2	3	4	6A	6B	6C	6D	6E
Plant Efficiency, %	39.3	42.5	28.4	29.8	30.4	31.5	32.9	34.4	34.7	34.7
Auxiliary Power, MW	30.4	27.8	112.8	104.2	101.7	106.6	101.0	97.4	105.6	105.6
Auxiliary Steam for Capture, 1000 lb/hr	NA	NA	2,036	1,415	1,262	1,437	1,365	1,319	1,304	1,304
Capture Process Auxiliary Power, MW	NA	NA	20.6	16.4	16.3	12.0	11.4	11.0	10.9	10.9
CO_2 Compression Power	NA	NA	44.9	42.8	42.1	50	47.5	45.9	54.6	54.6
CO_2 Emissions, lb/net MWh	1,768	1,634	245	233	229	225	215	206	203	203
Raw water withdrawal, gpm	5,321	4,618	10,071	9,446	8,505	7,696	7,131	6,726	6,582	6,582
Raw water consumption, gpn	4,227	3,674	7,733	7,273	6,508	6,059	5,617	5,299	5,186	5,186
TOC, $/kW	2,024	1,902	3,570	3,364	3,427	3,157	3,047	2,995	2,963	2,963
FY COE, $/MWh	**58.9**	**55.0**	**100.9**	**95.5**	**96.6**	**91.3**	**88.0**	**85.9**	**83.7**	**80.6**
Capital, $/MWh	31.7	29.8	59.6	56.1	57.2	52.7	50.9	50	49.4	46.4
Fixed, $/MWh	8.0	7.5	13.0	12.3	12.5	11.7	11.3	11.1	11.0	11.0
Variable, $/MWh	5.0	4.6	8.7	8.3	8.6	9.2	8.9	8.6	7.2	7.2
Fuel, $/MWh	14.2	13.1	19.6	18.7	18.4	17.7	16.9	16.3	16.1	16.1

[2] Since the advanced adsorbent technology is based on the TDA Research technology concept, 'TDA' is used as a designation for the adsorbent capture technology

Exhibit ES-9 PC Plant Efficiency – Adsorbent Pathway

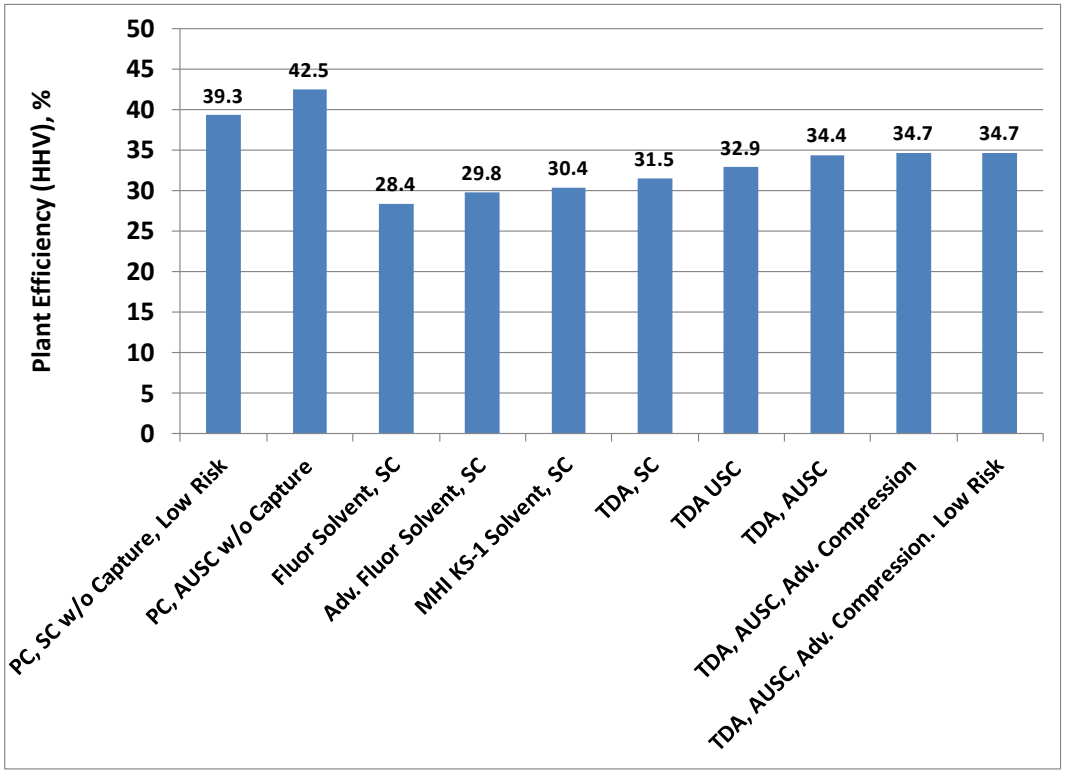


Exhibit ES-10 PC Plant First Year Cost of Electricity – Adsorbent Pathway

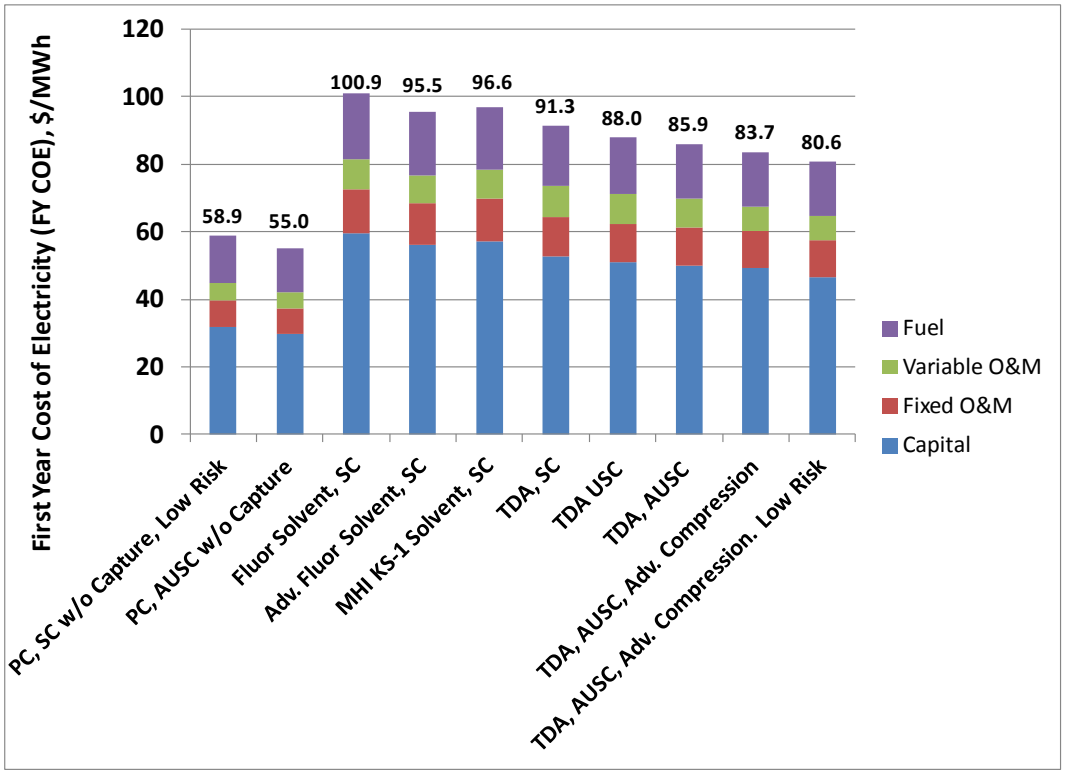


Exhibit ES-11 PC Plant Total Overnight Plant Cost – Adsorbent Pathway

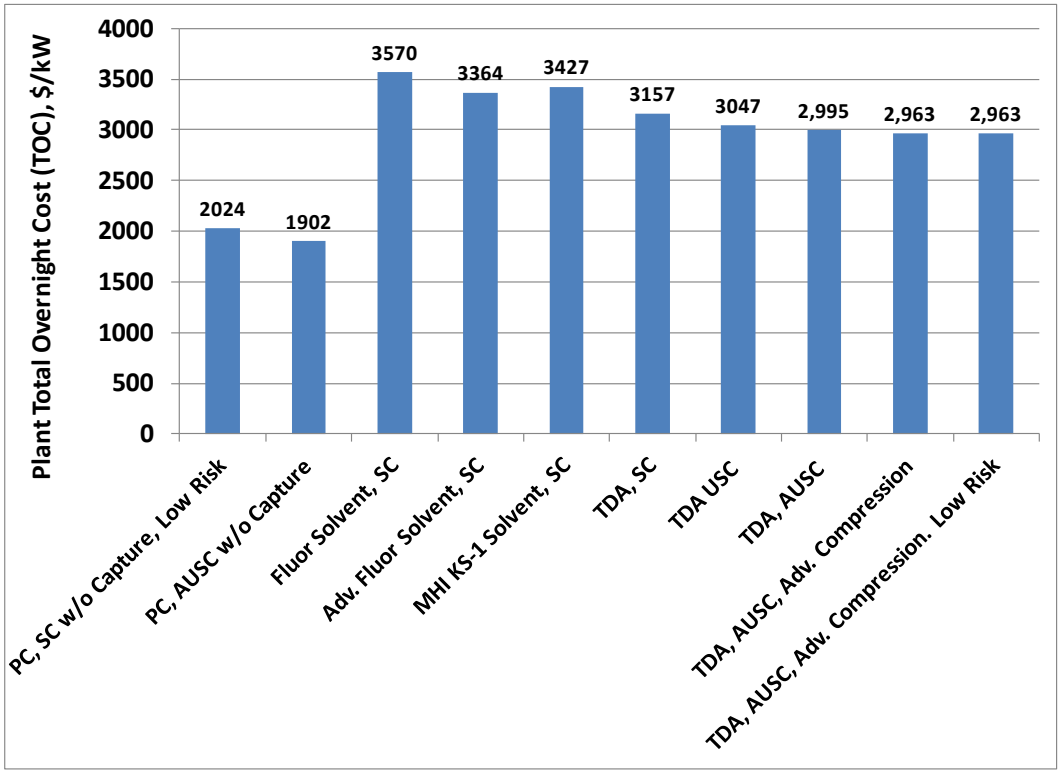


Exhibit ES-12 PC Plant Cost of Avoided CO_2 – Adsorbent Pathway

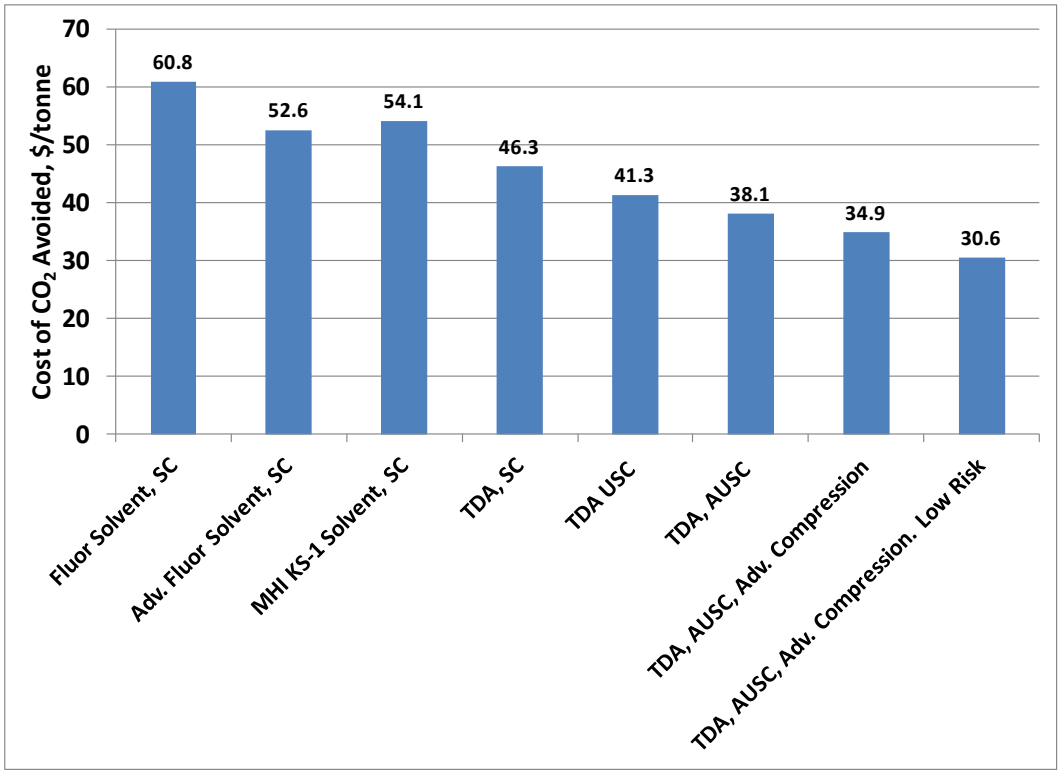
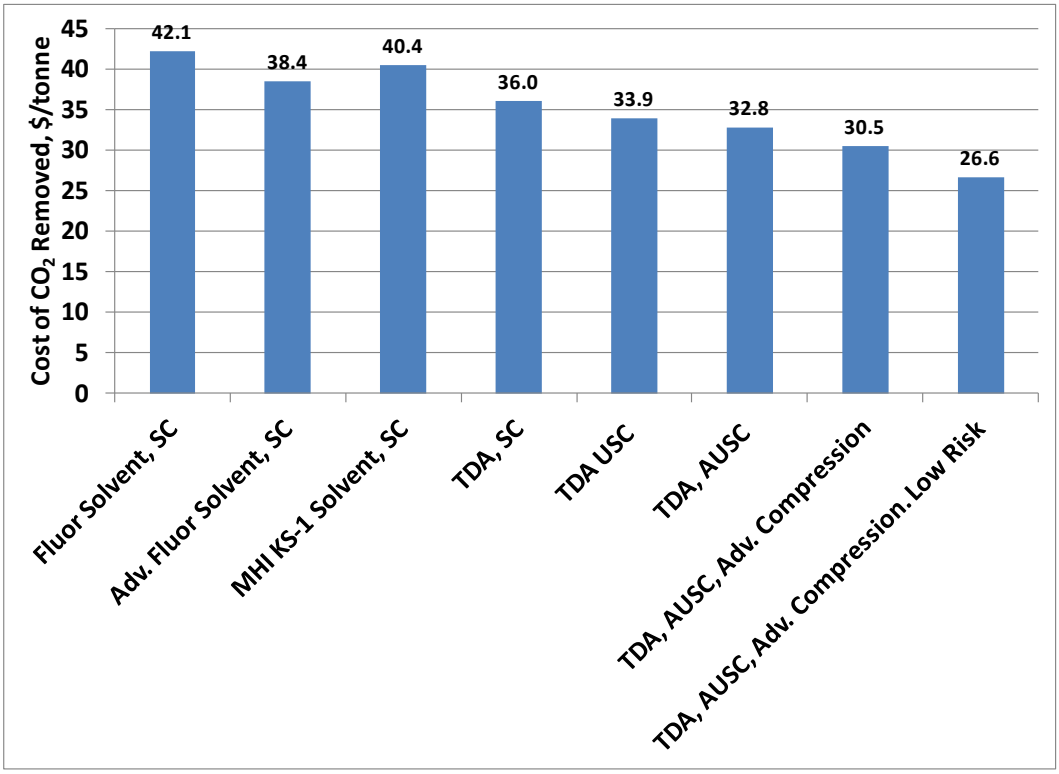


Exhibit ES-13 PC Plant Cost of CO_2 Removed – Adsorbent Pathway



Conclusion

This study concludes that a PC power plant utilizing an advanced CO_2 membrane technology (Case 5E), or an advanced CO_2 adsorbent technology (Case 6E), has the potential to meet the DOE 35-percent goal. The respective capture technology performance and cost for these cases assumes process design and operating parameters beyond current demonstrated performance. These cases also include advances in the steam conditions and CO_2 compression. Thus, meeting the goal will require advances in CO_2 capture technology, operating boiler and steam turbine steam conditions, and CO_2 compression technology. The results from the integrated system analyses provide information that will inform and guide technology development.

1 Introduction

A progression of PC power plant post-combustion CO_2 removal technologies has been assessed for performance and cost to identify the benefits of technology development. The Exhibit Exhibit 1-1 pathway case matrix summarizes the key features of the cases considered in this pathway study. Brief descriptions of the cases follow.

Exhibit 1-1 Pathway Case Matrix

Case	Carbon Removal Technology	Boiler Technology psig/°F/°F	CO_2 Compression Technology	Plant Capacity Factor (%)	Financial Risk Assumption
1A	None	Supercritical 3500/1100/1100	None	85	Low-risk
1B	None	AUSC 5000/1350/1400	None	85	High-risk
2	Fluor Econamine	Supercritical 3500/1100/1100	Conventional	85	High-risk
3	Fluor Econamine with enhanced performance	Supercritical 3500/1100/1100	Conventional	85	High-risk
4	MHI KS-1 solvent	Supercritical 3500/1100/1100	Conventional	85	High-risk
5A	Advanced CO_2 membrane (MTR)	Supercritical 3500/1100/1100	Conventional	85	High-risk
5B	(MTR) Advanced CO_2 membrane	Ultra-supercritical 5000/1200/1200	Conventional	85	High-risk
5C	(MTR) Advanced CO_2 membrane	AUSC 5000/1350/1400	Conventional	85	High-risk
5D	(MTR) Advanced CO_2 membrane	AUSC 5000/1350/1400	Enhanced Shockwave Compression	85	High-risk
5E	Advanced CO_2 membrane	AUSC 5000/1350/1400	Enhanced Shockwave Compression	85	Low-risk
6A	Advanced CO_2 adsorber (TDA)	Supercritical 3500/1100/1100	Conventional	85	High-risk
6B	Advanced CO_2 adsorber (TDA)	Ultra-supercritical 5000/1200/1200	Conventional	85	High-risk
6C	Advanced CO_2 adsorber (TDA)	AUSC 5000/1350/1400	Conventional	85	High-risk
6D	Advanced CO_2 adsorber (TDA)	AUSC 5000/1350/1400	Enhanced Shockwave Compression	85	High-risk
6E	Advanced CO_2 adsorber (TDA)	AUSC 5000/1350/1400	Enhanced Shockwave Compression	85	Low-risk

Case 1A – This case represents a conventional supercritical (SC) PC plant having a wet FGD unit and operating without carbon capture. The steam conditions selected are supercritical, 24.1MPa/593°C/593°C (3,500 psig/1,100°F/1,100°F). The financial analysis is based on low risk cost premises. It is used as the baseline plant for comparison with the other case plants.

Case 1B – This case represents the baseline plant (Case 1) with advanced ultra-supercritical (AUSC) steam conditions. The financial analysis is based on high risk cost premises since the steam conditions require advances in the boiler materials and the steam turbine.

Case 2 – This case represents the baseline plant (Case 1) with carbon capture incorporated. The carbon capture technology used is a representation of a conventional Fluor Econamine technology. Conventional, staged, intercooled CO_2 compression is applied, with glycol-based dehydration.

Case 3 – This case is identical to Case 2 except that the Fluor Econamine technology is enhanced with improved solvent properties that result in reduced extraction steam consumption. Again, conventional, staged, intercooled CO_2 compression is applied, with glycol-based dehydration.

Case 4 – This case is identical to Case 2 except that the Fluor Econamine technology is replaced with a representation of the MHI KS-1 solvent technology, leading to even greater reduction in extraction steam consumption. Again, conventional, staged, intercooled CO_2 compression is applied, with glycol-based dehydration.

Case 5A – This case applies an advanced, developing post-combustion CO_2 removal technology based on CO_2 membrane technology, as represented by the MTR CO_2 membrane process. The membrane process completely eliminates the use of steam turbine extraction steam to operate the CO_2 removal system, but requires the use of a large vacuum pump system for CO_2 membrane operation. MTR membrane performance factors are assumed to achieve levels above their current sub-scale testing levels, but representative of the development program goals. The MTR membrane process is also more closely integrated with the plant boiler than the other cases, requiring extensive flue gas recycle to the boiler. This case uses a SC steam system and conventional CO_2 compression technology.

Case 5B – This case is analogous to case 5A, but uses ultra-supercritical (USC) steam conditions in place of the case 5A SC steam conditions.

Case 5C – This case is analogous to case 5B, but uses advanced ultra-supercritical (AUSC) steam conditions in place of the case 5A SC steam conditions.

Case 5D – This case is analogous to case 5C, but applies a representation of an advanced shockwave CO_2 compression technology in place of conventional CO_2 compression.

Case 5E – This case is the same as case 5D, but assumes the technology advances have matured allowing the financial analysis to be based on low risk cost premises.

Case 6A – This case applies an advanced, developing post-combustion CO_2 removal technology based on a CO_2 adsorbent technology as represented by the TDA Research CO_2 adsorbent process. An advanced CO_2 adsorbent process is applied in this case, as represented by the TDA CO_2 adsorbent process. The steam turbine extraction rate for the CO_2 removal process is comparable to Case 5, but the extraction steam condition in Case 6A is very low-grade at 16 psia and 110°C. This case uses a SC steam system and conventional CO_2 compression technology.

Case 6B – This case is analogous to case 6A, but uses USC steam conditions in place of the case 5A SC steam conditions.

Case 6C – This case is analogous to case 6B, but uses AUSC steam conditions in place of the case 5A SC steam conditions.

Case 6D -- This case is analogous to case 6C, but applies a representation of an advanced shockwave CO_2 compression technology in place of conventional CO_2 compression.

Case 6E – This case is the same as case 6D, but assumes the technology advances have matured allowing the financial analysis to be based on low risk cost premises.

The pathway design and cost bases applied in this report reproduce those used in the Bituminous Baseline report so that the performance and cost results will provide a direct comparison with the conventional fossil fuel power generation technologies assessed in the Bituminous Baseline report [2].

2 Pathway Study Basis

The basis for design of the plant cases assessed is outlined in this section. The various plant technologies are described and their development status reviewed.

2.1 Site Characteristics

All plants in this study are assumed to be located at a generic Midwestern U.S. plant site, with ambient conditions and site characteristics as presented in Exhibit 2-1 and Exhibit 2-2. The ambient conditions are the same as International Organization for Standardization (ISO) conditions [1].

Exhibit 2-1 Site Ambient Conditions

Average Elevation, ft	0
Barometric Pressure, psia	14.696
Design Ambient Temperature, Dry Bulb, °F	59
Design Ambient Temperature, Wet Bulb, °F	51.5
Design Ambient Relative Humidity, %	60

Exhibit 2-2 Site Characteristics

Location	A greenfield site in the Midwestern United States[a]
Topography	Level
Size, acres	300
Transportation	Rail and truck (barge may be considered)
Ash Disposal	Off Site
Water	Municipal (50%) / Groundwater (50%)
Access	Access by rail and highway (Waterway access may be considered)
CO_2	Compressed to 15.3 MPa (2,215 psia), transported 50 miles, and sequestered in a saline formation at a depth of 4,055 feet
[a]Champaign County, Illinois, is assumed for assessment of construction costs.	

The following design parameters are considered site-specific, and are not quantified for this study. Allowances for normal conditions and construction are included in the cost estimates:

- Flood plain considerations
- Existing soil/site conditions
- Water discharges and reuse
- Rainfall/snowfall criteria

- Seismic design
- Buildings/enclosures
- Fire protection
- Local code height requirements
- Noise regulations (impact on site and surrounding area)

2.2 Coal Characteristics

The design coal characteristics are presented in Exhibit 2-3 as taken from the Bituminous Baseline report [2]. All cases in this study were modeled using Illinois No. 6 bituminous coal. The delivered cost for Illinois No. 6 coal used in the calculations is $42.09/tonne ($38.18/ton) or $1.55 per gigajoule (GJ) ($1.64/MMBtu).

Exhibit 2-3 Design Coal Analysis – Illinois No. 6

Rank (per ASTM D388)	**Bituminous**	
Seam	**Illinois No. 6 (Herrin)**	
Source	**Old Ben Mine**	
Proximate Analysis (weight %)[a]		
	As Received	**Dry**
Moisture	11.12	0.00
Ash	9.70	10.91
Volatile Matter	34.99	39.37
Fixed Carbon	44.19	49.72
Total	100.0	100.0
Reported Heating Values		
HHV, Btu/lb	11,666	13,126
LHV, Btu/lb	11,252	12,712
Ultimate Analysis (weight %)		
	As Received	**Dry**
Moisture	11.12	0.00
Carbon	63.75	71.72
Hydrogen	4.50	5.06
Nitrogen	1.25	1.41
Chlorine	0.29	0.33
Sulfur	2.51	2.82
Ash	9.70	10.91
Oxygen[b]	6.88	7.75
Total	100.00	100.00
Ash Mineral Analysis (weight %)		
Silica	45.0	
Aluminum Oxide	18.0	
Titanium Dioxide	1.0	
Iron Oxide	20.0	
Calcium Oxide	7.0	
Magnesium Oxide	1.0	
Sodium Oxide	0.6	
Potassium Oxide	1.9	
Phosphorus Pentoxide	0.2	
Sulfur Trioxide	3.5	
Barium Oxide	0.00	
Strontium Oxide	0.00	
Manganese Dioxide	0.00	
Unknown	1.8	
Trace Components (ppm dry)		
Mercury	---	0.15

Notes: [a] The proximate analysis assumes sulfur as volatile matter
[b] By difference

The mercury content in the Illinois No. 6 coal is reported as an arithmetic mean value of 0.09 ppm (dry basis), with a standard deviation of 0.06. Hence, there is a 50 percent probability that the mercury content in the Illinois No. 6 coal would not exceed 0.09 ppm (dry basis), and 99.9 percent probability that the mercury content in the Illinois No. 6 coal would not exceed 0.28 ppm (dry basis). For the cases in this study, coal mercury content was assumed to be equal to the arithmetic mean mercury concentration plus one standard deviation, or 0.15 ppmd.

2.3 Environmental Targets

BACT was applied to each of the PC cases and the resulting emissions compared to NSPS limits and recent permit averages. Since the BACT results met or exceeded the NSPS requirements and the average of recent permits, they were used as the environmental targets as shown in Exhibit 2-4.

It was assumed that LNBs and staged overfire air (OFA) would limit NOx emissions to 0.5 lb/MMBtu and that selective catalytic reduction (SCR) technology would be 86 percent efficient, resulting in emissions of 0.07 lb/MMBtu for all cases.

The wet limestone scrubber was assumed to be 98 percent efficient which results in SO_2 emissions of 0.085 lb/MMBtu. Current technology allows flue gas desulfurization (FGD) removal efficiencies in excess of 99 percent, but based on NSPS requirements and recent permit averages, such high removal efficiency is not necessary.

The fabric filter used for particulate control was assumed to be 99.8 percent efficient. The result is particulate emissions of 0.013 lb/MMBtu in all cases, which more than meets NSPS and recent permit average requirements.

Exhibit 2-4 Environmental Targets for PC Plants

Pollutant	Environmental Target	NSPS Limit	Average of Recent Permits	Control Technology
NOx	0.07 lb/MMBtu	1.0 lb/MWh (0.111 lb/MMBtu)	0.08 lb/MMBtu	Low NOx burners, overfire air and SCR
SO_2	0.085 lb/MMBtu	1.4 lb/MWh (0.156 lb/MMBtu)	0.16 lb/MMBtu	Wet limestone scrubber
Particulate Matter (Filterable)	0.013 lb/MMBtu	0.015 lb/MMBtu	0.017 lb/MMBtu	Fabric filter
Mercury	1.14 lb/TBtu	20×10^{-6} lb/MWh (2.2 lb/TBtu)	2.49 lb/TBtu	Co-benefit capture

Mercury control for PC cases was assumed to occur through 90 percent co-benefit capture in the fabric filter and the wet FGD scrubber. Since co-benefit capture alone exceeds the requirements of NSPS and recent permit averages, no activated carbon injection is included in this study.

CO_2 specifications on purity and pressure are consistent with the Bituminous Baseline report for PC cases [2]. All plant cases are designed to satisfy the CO_2 purity specification. The current environmental targets do not reflect potential future changes in the regulations.

2.4 Balance of Plant

Assumed balance of plant requirements are defined in the following exhibit:

Exhibit 2-5 Balance of Plant Assumptions

Fuel and Other storage	
Coal	30 days
Slag	30 days
Plant Distribution Voltage	
Motors below 1 hp	110/220 volt
Motors 250 hp and below	480 volt
Motors above 250 hp	4,160 volt
Motors above 5,000 hp	13,800 volt
Steam and Gas Turbine generators	24,000 volt
Grid Interconnection voltage	345 kV
Water and Waste Water	
Makeup Water	Process water is available at a flow rate of 1,500 gpm. The quality of the process water is available in Exhibit 2-6.
Feed Water	Process water treatment is included and will produce boiler feed quality water for the PC plant.
Process Wastewater	Process wastewater and storm water that contacts equipment surfaces will be collected and treated for. Selected blowdown will be discharged through a discharge permit.
Cooling system	Evaporative Cooling Tower. Cooling tower makeup water composition is available in Exhibit 2-6.
Sanitary Waste Disposal	Design will include a packaged domestic sewage treatment plant with effluent discharged to the industrial wastewater treatment system. Sludge will be hauled off site.
Solids Disposal	
Solid Waste	Ash is assumed to be a solid waste that is classified as non-hazardous. An offsite waste disposal site is assumed to have the capacity to accept waste generated throughout the life of the facility. Solid waste sent to disposal is at an assumed nominal fee per ton, even if the waste is hauled back to the mine. Solid waste generated that can be recycled or reused is assumed to have a zero cost to the technology

Process water and cooling water come from two different treatment facilities. Their composition and physical properties are shown in Exhibit 2-6.

Exhibit 2-6 Water Characteristics

Property	Process Water	Cooling Water
Total Dissolved Solids (TDS)	200 µS/cm	1250 µS/cm
Total Suspended Solids (TSS)	Not Available	Not Available
Hardness	100 mg/l as $CaCO_3$	75 mg/l as $CaCO_3$
Alkalinity	100 ppm	350 ppm
Sulfate	4 ppm	50 ppm
Chloride	10 ppm	200 ppm
Silica	30 mg/l	30 mg/l
Aluminum	Not Available	Not Available
Iron	0.25 mg/l	0.25 mg/l
Calcium	70 mg/l	25 mg/l
Magnesium	25 mg/l	45 mg/l
Phosphate	0.4 mg/l	6.0 mg/l (ortho)
Ammonia	<1 mg/l	19 mg/l
Chlorine	<0.1 mg/l	<0.1 mg/l
pH	8.0	8.0

2.5 Plant Capacity

The plant net generation capacity of each study case power plant is fixed at 550 MW. This is consistent with prior performance and cost studies for PC plants [2].

2.6 Capacity Factor

This study assumes that each new plant would be dispatched any time it is available and would be capable of generating maximum capacity when online. Therefore, capacity factor and availability are equal. The availability of PC power generation was determined using the Generating Availability Data System (GADS) from the North American Electric Reliability Council (NERC) [3].

The average EAF for coal-fired plants in the 400-599 MW size range was 84.9 percent in 2004 and averaged 83.9 percent from 2000-2004. Given that many of the plants in this size range are older, the EAF was rounded up to 85 percent and that value was used as the PC plant capacity factor for the current technology plants.

The addition of CO_2 capture to each technology was assumed not to impact the capacity factor. This assumption was made to enable a comparison based on the impact of capital and variable operating costs only. Any reduction in assumed capacity factor would further increase the COE for the CO_2 capture cases.

2.7 Water Use

A water balance was performed for each case on the major water consumers in the process. The total water demand for each subsystem was determined and internal recycle water available from various sources like boiler feedwater blowdown and condensate from flue gas (in CO_2 capture

cases) was applied to offset the water demand. The difference between demand and recycle is raw water withdrawal. Raw water withdrawal is the water removed from the ground or diverted from a surface-water source for use in the plant. Raw water consumption is also accounted for as the portion of the raw water withdrawn that is evaporated, transpired, incorporated into products or otherwise not returned to the water source it was withdrawn from.

Raw water makeup was assumed to be provided 50 percent by a publicly owned treatment works (POTW) and 50 percent from groundwater. Raw water withdrawal is defined as the water metered from a raw water source and used in the plant processes for any and all purposes, such as cooling tower makeup, boiler feedwater makeup, ash handling makeup, quench system makeup, and FGD system makeup. The difference between withdrawal and process water returned to the source is consumption. Consumption represents the net impact of the process on the water source.

The largest consumer of raw water in all cases is cooling tower makeup. It was assumed that all cases utilized a mechanical draft, evaporative cooling tower, and all process blowdown streams were assumed to be treated and recycled to the cooling tower. The design ambient wet bulb temperature of 11°C (51.5°F) was used to achieve a cooling water temperature of 16°C (60°F) using an approach of 5°C (8.5°F). The cooling water range was assumed to be 11°C (20°F). The cooling tower makeup rate was determined using the following [4]:

- Evaporative losses of 0.8 percent of the circulating water flow rate per 10°F of range
- Drift losses of 0.001 percent of the circulating water flow rate
- Blowdown losses were calculated as follows:
    - Blowdown Losses = Evaporative Losses / (Cycles of Concentration - 1)

      Where cycles of concentration is a measure of water quality and a mid-range value of 4 was chosen for this study.

The water balances presented in subsequent sections include the water demand of the major water consumers within the process, the amount provided by internal recycle, the amount of raw water withdrawal by difference, the amount of process water returned to the source and the raw water consumption, again by difference.

2.8 Cost Estimating Methodology

Capital cost and production cost estimates utilize data and procedures from the Bituminous Baseline report. The costs are based on adjusted vendor-furnished, actual cost data, or projections for next generation technology.

2.8.1 Capital, Operation, and Maintenance Costs

The total overnight cost (TOC) for each plant was calculated by adding owner's costs to the total plant cost (TPC). The cost estimation methodology is explained in more detail in Section 2.7 of the Bituminous Baseline report. The TOC level includes equipment (which includes initial chemical and catalyst loadings), materials, labor, indirect construction costs, engineering, contingencies, and owner's costs. All capital and O&M costs are presented as "overnight costs" expressed in June 2007 dollars.

The case estimates provided include technologies currently at different commercial maturity levels. Since this is a pathway study, the estimates for both the non-CO_2-capture PC case, representing well-developed, commercial technology or "n^{th} plant," is treated as a low-risk case with contingencies representative of mature technologies, and the estimates for the advanced CO_2-capture cases, representing developing technology, are treated all as high-risk cases with contingencies representative of mature technologies.

Both the project contingency and process contingency costs represent costs that are expected to be spent in the development and execution of the project that are not yet fully reflected in the design. It is industry practice to include project contingency in the TOC to cover project uncertainty and the cost of any additional equipment that would result during detailed design. Likewise, the estimates include process contingency to cover the cost of any additional equipment that would be required as a result of continued technology development.

Project Contingency

Project contingencies were added to each of the capital accounts to cover project uncertainty and the cost of any additional equipment that could result from detailed design. The project contingencies represent costs that are expected to occur. Each bare erected cost account was evaluated against the level of estimate detail, field experience, and the basis for the equipment pricing to define project contingency. The project contingencies for all technology components in the plants have been held consistent with the NETL bituminous baseline study. This includes the CO_2 removal equipment component contingencies, regardless of their level of uncertainty.

Process Contingency

Process contingency is intended to compensate for uncertainties arising as a result of the state of technology development. The American Association of Cost Engineering (AACE) International provides standards for process contingency relative to technology status; from commercial technology at 0 to 5 percent, to new technology with little or no test data at 40 percent. The process contingency applied in this pathway study is zero for all plant components except for the advanced technology sub-systems. The CO_2 capture equipment uses a process contingency of 20 percent of the bare erected equipment cost. The process contingency for the advanced ultra-supercritical steam (AUSC) conditions use 10 percent for the boiler and 15 percent for the steam turbine, reflective of the advanced material needs for those components. These percentages are a percent of the bare erected equipment cost and the engineering.

Owner's Costs

The owner's costs included in the cost estimates are shown in Exhibit 2-7.

Exhibit 2-7 Owner's Costs

Owner's Cost	Comprised of
Preproduction Costs	• 6 months O&M, and administrative & support labor • 1 month maintenance materials @ 100% CF • 1 month non-fuel consumables @ 100% CF • 1 month of waste disposal costs @ 100% CF • 25% of one month's fuel cost @ 100% CF • 2% of TPC
Inventory Capital	• 60 day supply of fuel and consumables @100% CF • 0.5% of TPC (spare parts)
Land	• $3,000/acre (300 acres for greenfield PC)
Financing Costs	• 2.7% of TPC
Other Owner's Costs	• 15% of TPC
Initial Cost for Catalyst and Chemicals	• All initial fills not included in BEC
Prepaid Royalties	• Not included in owner's costs (included with BEC)
AFUDC and Escalation	• Varies based on levelization period and financing scenario • 33-yr IOU high risk: TASC = TOC * 1.078 • 33-yr IOU low risk: TASC = TOC * 1.075 • 35-yr IOU high risk: TASC = TOC * 1.140 • 35-yr IOU low risk: TASC = TOC * 1.134

The category labeled "Other Owner's Costs" includes the following:

- Preliminary feasibility studies, including a Front-End Engineering Design (FEED) study
- Economic development (costs for incentivizing local collaboration and support)
- Construction and/or improvement of roads and/or railroad spurs outside of site boundary.
- Legal fees
- Permitting costs
- Owner's engineering (staff paid by owner to give third-party advice and to help the owner oversee/evaluate the work of the EPC contractor and other contractors)
- Owner's contingency: sometimes called "management reserve", these are funds to cover costs relating to delayed startup, fluctuations in equipment costs, unplanned labor incentives in excess of a 5/10s

Cost items excluded from "Other Owner's Costs" include:

- EPC Risk Premiums: Costs estimates are based on an EPCM approach utilizing multiple subcontracts, in which the owner assumes project risks for performance, schedule and cost. This approach provides the owner with greater control of the project, while minimizing, if not eliminating most of the risk premiums typically included in a lump-sum, "turnkey" EPC contract, under which the EPC contractor assumes some or all of the

project risks. The EPCM approach used as the basis for the estimates here is anticipated to be the most cost effective approach for the owner.

- Transmission interconnection: the cost of interconnecting with power transmission infrastructure beyond the plant busbar.
- Taxes on capital costs: all capital costs are assumed to be exempt from state and local taxes.
- Unusual site improvements: normal costs associated with improvements to the plant site are included in the BEC, assuming that the site is level and requires no environmental remediation. Unusual costs associated with the following design parameters are excluded: flood plain considerations, existing soil/site conditions, water discharges and reuse, rainfall/snowfall criteria, seismic design, buildings/enclosures, fire protection, local code height requirements, noise regulations.

Production Costs and Expenses

O&M costs will be determined on a first-year basis and subsequently levelized over the 30-year plant book life to form a part of the economic analysis. Quantities for major consumables such as fuel will be taken from the heat and mass balance developed for this application. Other consumables will be evaluated on the basis of the quantity required using reference data. Operating costs will be determined on the basis of the number of operators. Maintenance costs will be evaluated on the basis of requirements for each major plant section.

The O&M costs and expenses associated with the plant include:

- Operating labor
- Maintenance – material and labor
- Administrative and support labor
- Consumables
- Fuel cost
- Taxes and insurance

These costs and expenses will be estimated on a reference basis (June 2007). The first-year costs assume normal operation and do not include the initial startup costs. The operating labor, maintenance material and labor, and other labor-related costs will be combined and then divided into two components: fixed O&M, which is independent of liquids production, and variable O&M, which is proportional to liquids production. The first-year variable O&M cost estimate allocation will be based on the plant capacity factor.

The other operating costs, consumables and fuel, will be determined on a daily 100 percent operating capacity basis and adjusted to an annual plant operation basis.

2.8.2 Cost of Electricity

Finance structures were chosen based on the assumed type of developer/owner (investor-owned utility (IOU) or independent power producer) and the assumed risk profile of the plant being assessed (low-risk or high-risk). For this study the owner/developer was assumed to be an IOU. In this pathway study, the state-of-the-art PC plant with supercritical steam and no carbon

capture is assumed low-risk. All cases with CO_2 capture assume high-risk financial structure. Low-risk cases are projected as the end-points for the two pathways. This reflects the potential assuming successful technology development with mature, commercial plants. The finance structures applied are outlined in the Bituminous Baseline report [2].

Exhibit 2-8 describes the low-risk IOU and high-risk IOU finance structures that were assumed for this study

Exhibit 2-8 Financial Structure for Investor Owned Utility High and Low Risk Projects

Type of Security	% of Total	Current (Nominal) Dollar Cost	Weighted Current (Nominal) Cost	After Tax Weighted Cost of Capital
Low Risk				
Debt	50	4.5%	2.25%	
Equity	50	12%	6%	
Total			8.25%	7.39%
High Risk				
Debt	45	5.5%	2.475%	
Equity	55	12%	6.6%	
Total			9.075%	8.13%

The NETL Power Systems Financial Model (PSFM) is a nominal-dollar (current dollar) discounted cash flow (DCF) analysis tool. As explained below, the PSFM was used to calculate cost of electricity in two ways: a first-year COE (COE) and a levelized COE (LCOE).

- The COE is the revenue received by the generator per net megawatt-hour during the power plant's first year of operation, assuming that the COE escalates thereafter at a nominal annual rate equal to the general inflation rate, i.e., that it remains constant in real terms over the operational period of the power plant. To calculate the COE, the PSFM was used to determine a "base-year" (2007) COE that, when escalated at an assumed nominal annual general inflation rate of 3 percent, provided the stipulated internal rate of return on equity over the entire economic analysis period (capital expenditure period plus thirty years of operation). Since this analysis assumes that COE increases over the economic analysis period at the nominal annual general inflation rate, it remains constant in real terms and the first-year COE is equivalent to the base-year COE when expressed in base-year (2007) dollars.
- The levelized COE is the revenue received by the generator per net megawatt-hour during the power plant's first year of operation, assuming that the COE escalates thereafter at a nominal annual rate of 0 percent, i.e., that it remains constant in nominal terms over the operational period of the power plant. This study reports LCOE on a current-dollar basis over thirty years. "Current dollar" refers to the fact that levelization is

done on a nominal, rather than a real, basis. "Thirty-years" refers to the length of the operational period assumed for the economic analysis. To calculate the LCOE, the PSFM was used to calculate a base-year COE that, when escalated at a nominal annual rate of 0 percent, provided the stipulated return on equity over the entire economic analysis period.

All capital costs included in this analysis, including project development and construction costs, are assumed to be incurred during the capital expenditure period. Coal-fueled plants are assumed to have a capital expenditure period of five years. Since the plant begins expending capital in the base year (2007), this means that the analysis assumes that they begin operating 2012 in this study.

In addition to the capital expenditure period, the economic analysis considers thirty years of operation for coal plants. Since 2007 is the first year of the capital expenditure period, it is also the base year for the economic analysis. Accordingly, it is convenient to report the results of the economic analysis in base-year (June 2007) dollars, except for TASC, which is expressed in mixed-year, current dollars over the capital expenditure period. Consistent with our nominal-dollar discounted cash flow methodology, the COEs are expressed in current dollars. However, they can also be expressed in constant, base year dollars (June 2007) by adjusting them with the assumed nominal annual general inflation rate (3 percent).

For scenarios that adhere to the global economic assumptions and utilize the finance structure, the following simplified equation can be used to estimate COE as a function of TOC. These CCFs are valid only for the global economic assumptions, the stated finance structure, and the stated capital expenditure period.

All factors in the COE equation are expressed in base-year dollars. The base year is the first year of capital expenditure, which for this study is assumed to be 2007. All factors (COE, O&M and fuel) are assumed to escalate at a nominal annual general inflation rate of 3.0 percent. Accordingly, all first-year costs (COE and O&M) are equivalent to base-year costs when expressed in base-year (2007) dollars.

$$COE = [\ (CCF)\ (TOC) + OC_{FIX} + (CF)\ (OC_{VAR})\ ]\ /\ [\ (CF)\ (MWH)\ ]$$

where:

COE = revenue received by the generator ($/MWh, equivalent to mills/kWh) during the power plant's first year of operation (*but expressed in base-year dollars*), assuming that the COE escalates thereafter at a nominal annual rate equal to the general inflation rate, i.e., that it remains constant in real terms over the operational period of the power plant.

CCF = capital charge factor that matches the applicable finance structure and capital expenditure period (0.1691 for low-risk cases and 0.1773 for high-risk cases in the pathway study)

TOC = total overnight capital, expressed in *base-year dollars*

OCFIX = the sum of all fixed annual operating costs, *expressed in base-year dollars*

OCVAR = the sum of all variable annual operating costs, including fuel at 100 percent capacity factor, *expressed in base-year dollars*

CF = plant capacity factor, assumed to be constant over the operational period

MWH = annual net megawatt-hours of power generated at 100 percent capacity

The primary cost metric in this study is the COE, which is the base-year cost presented in base-year dollars. The LCOE is approximately 1.47 times the COE in this pathway study.

2.8.3 Cost of CO_2 Avoided

CO_2 is not currently regulated. However, the possibility exists that carbon limits will be imposed in the future, and this study is focused on technology to reduce CO_2 emissions.

The equation used to calculate the cost of CO_2 avoided in $/tonne is as follows:

$$\text{Avoided Cost} = \frac{(\text{FY COE}_{\text{with removal}} - \text{FY COE}_{\text{w/o removal}})}{(\text{Emissions}_{\text{w/o removal}} - \text{Emissions}_{\text{with removal}})}$$

where FY COE = first year cost of electricity ($/$MWh_{net}$), and Emissions = CO_2 emissions for case (tonnes/MWh_{net})

2.8.4 Cost of CO_2 Removed

The cost of CO_2 removed is calculated based on the following equation:

$$\text{Cost of } CO_2 \text{ Removed} = \frac{(\text{FY COE}_{\text{with removal}} - \text{FY COE}_{\text{w/o removal}})}{CO_2 \text{ Removed}}$$

Where the FY COE = first year cost of electricity ($/MWh) and the CO_2 removed = CO_2 stream leaving the plant (tonnes/MWh_{net}). The FY COE for this study does not include a cost for transport, storage and monitoring.

2.8.5 Costs of CO_2 Transport, Storage, and Monitoring

For those cases that feature CO_2 capture, the capital and operating costs for CO_2 transport, storage, and monitoring (TS&M) were not included in the plant COE.

3 Description of Common Process Areas

3.1 Coal Receiving and Storage Area

The function of the Coal Receiving and Storage system is to unload, convey, prepare, and store the coal delivered to the plant. The scope of the system is from the trestle bottom dumper and coal receiving hoppers up to and including the slide gate valves at the outlet of the coal storage silos.

The coal is delivered to the site by 100-car unit trains comprised of 91 tonne (100 ton) rail cars. The unloading is done by a trestle bottom dumper, which unloads the coal into two receiving hoppers. Coal from each hopper is fed directly into a vibratory feeder. The 8 cm x 0 (3" x 0) coal from the feeder is discharged onto a belt conveyor. Two conveyors with an intermediate transfer tower are assumed to convey the coal to the coal stacker, which transfer the coal to either the long-term storage pile or to the reclaim area. The conveyor passes under a magnetic plate separator to remove tramp iron and then to the reclaim pile.

The reclaimer loads the coal into two vibratory feeders located in the reclaim hopper under the pile. The feeders transfer the coal onto a belt conveyor that transfers the coal to the coal surge bin located in the crusher tower. The coal is reduced in size to 3 cm x 0 (1¼" x 0) by the crusher. A conveyor then transfers the coal to a transfer tower. In the transfer tower the coal is routed to the tripper, which loads the coal into one of three silos. Two sampling systems are supplied: the as-received sampling system and the as-fired sampling system. Data from the analyses are used to support the reliable and efficient operation of the plant.

3.2 Steam Boiler

The steam generator for the supercritical plants is a once-through, spiral-wound, Benson-boiler, wall-fired, balanced draft type unit with a water-cooled dry bottom furnace. It includes superheater, reheater, economizer, and air heater.

The steam generator for the ultra-supercritical and advanced ultra-supercritical power plants are assumed to be identical to those of the supercritical power plants with the exception that the ultra-supercritical plants use advanced materials capable of withstanding the higher temperatures and pressures. The combustion system is equipped with LNBs and OFA.

The steam generator operates as follows:

Feedwater and Steam

For the supercritical steam system feedwater enters the bottom header of the economizer and passes upward through the economizer tube bank, through stringer tubes which support the primary superheater, and discharges to the economizer outlet headers. From the outlet headers, water flows to the furnace hopper inlet headers via external downcomers. Water then flows upward through the furnace hopper and furnace wall tubes. From the furnace, water flows to the steam water separator. During low load operation (operation below the Benson point), the water from the separator is returned to the economizer inlet with the boiler recirculating pump. Operation at loads above the Benson point is once through.

Steam flows from the separator through the furnace roof to the convection pass enclosure walls, primary superheater, through the first stage of water attemperation, to the furnace platens. From

the platens, the steam flows through the second stage of attemperation and then to the intermediate superheater. The steam then flows to the final superheater and on to the outlet pipe terminal. Two stages of spray attemperation are used to provide tight temperature control in all high temperature sections during rapid load changes.

Steam returning from the turbine passes through the primary reheater surface, then through crossover piping containing inter-stage attemperation. The crossover piping feeds the steam to the final reheater banks and then out to the turbine. Inter-stage attemperation is used to provide outlet temperature control during load changes.

Air and Combustion Products

Combustion air from the FD fans is heated in Ljungstrom type air preheaters, recovering heat energy from the exhaust gases exiting the boiler. This air is distributed to the burner windbox as secondary air. Air for conveying pulverized coal to the burners is supplied by the PA fans. This air is heated in the Ljungstrom type air preheaters to permit drying of the pulverized coal, and a portion of the air from the PA fans bypasses the air preheaters to be used for regulating the outlet coal/air temperature leaving the mills.

The pulverized coal and air mixture flows to the coal nozzles at various elevations of the furnace. The hot combustion products rise to the top of the boiler and pass through the superheater and reheater sections. The gases then pass through the economizer and air preheater. The gases exit the steam generator at this point and flow to the SCR reactor, fabric filter, ID fan, FGD system, and stack.

Fuel Feed

The crushed Illinois No. 6 bituminous coal is fed through feeders to each of the mills (pulverizers), where its size is reduced to approximately 72 percent passing 200 mesh and less than 0.5 percent remaining on 50 mesh. The pulverized coal exits each mill via the coal piping and is distributed to the coal nozzles in the furnace walls using air supplied by the PA fans.

Ash Removal

The furnace bottom comprises several hoppers, with a clinker grinder under each hopper. The hoppers are of welded steel construction, lined with refractory. The hopper design incorporates a water-filled seal trough around the upper periphery for cooling and sealing. Water and ash discharged from the hopper pass through the clinker grinder to an ash sluice system for conveyance to hydrobins, where the ash is dewatered before it is transferred to trucks for offsite disposal. The steam generator incorporates fly ash hoppers under the economizer outlet and air heater outlet.

Burners

A boiler of this capacity employs approximately 24 to 36 coal nozzles arranged at multiple elevations. Each burner is designed as a low-NOx configuration, with staging of the coal combustion to minimize NOx formation. In addition, overfire air nozzles are provided to further stage combustion and thereby minimize NOx formation.

Oil-fired pilot torches are provided for each coal burner for ignition, warm-up and flame stabilization at startup and low loads.

Air Preheaters

Each steam generator is furnished with two vertical-shaft Ljungstrom regenerative type air preheaters. These units are driven by electric motors through gear reducers.

Soot Blowers

The soot-blowing system utilizes an array of 50 to 150 retractable nozzles and lances that clean the furnace walls and convection surfaces with jets of high-pressure steam. The blowers are sequenced to provide an effective cleaning cycle depending on the coal quality and design of the furnace and convection surfaces. Electric motors drive the soot blowers through their cycles.

3.3 Gas Cleaning

3.3.1 NOx Control

The SCR system is designed for 86 percent reduction and 2 ppm ammonia slip based on an assumed 0.5 lb/MMBtu NOx inlet loading from the low-NOx burners. This will achieve NOx emissions of 0.07 lb/MMBtu.

3.3.2 Particulate Control

Two separate single-stage, inline, multi-compartment baghouse units are provided. Pulse jet cleaning is provided.

3.3.3 FGD

FGD system is a wet limestone forced oxidation positive pressure absorber non-reheat unit, with wet-stack, and waste solids for disposal or gypsum production. It is sized for sulfur removal efficiency of approximately 98 percent to achieve SOx emissions of 0.085 lb/MMBtu.

To prevent the accumulation of heat stable salts when conducting amine-based CO_2 removal, the incoming flue gas must have an SO_2 concentration of 10 ppmv or less. The gas exiting the FGD system passes through an SO_2 polishing step to achieve this objective. The polishing step consists of a non-plugging, low-differential-pressure, spray-baffle-type scrubber using a 20 wt-percent solution of sodium hydroxide (NaOH). A removal efficiency of about 75 percent is necessary to reduce SO_2 emissions from the FGD outlet to 10 ppmv as required by the CO_2 removal processes. The polishing scrubber proposed for this application has been demonstrated in numerous industrial applications throughout the world and can achieve removal efficiencies of over 95 percent if necessary.

The polishing scrubber also serves as the flue gas cooling system. Cooling water from the PC plant is used to reduce the temperature and hence moisture content of the saturated flue gas exiting the FGD system. Flue gas is cooled beyond the CO_2 absorption process requirements to 32°C (90°F) to account for the subsequent flue gas temperature increase of about 17°C (30°F) in the flue gas blower. Downstream from the Polishing Scrubber flue gas pressure is boosted in the Flue Gas Blowers by approximately 0.014 MPa (2 psi) to overcome pressure drop in the CO_2 removal process.

3.3.4 Mercury Control

As discussed in the Bituminous Baseline report, with the assumed oxidation of mercury in passing through the baghouse filters and SCR, and its removal across the wet FGD, no additional equipment is needed to meet mercury emission limits.

3.4 Power Island

The steam turbine for supercritical steam is a tandem compound, three-casing, four-flow exhaust, single reheat, condensing, non-automatic extractions, GE G-series model TC4F, or equal. The condenser vacuum is 2" HgA. Design redundancy incorporated is 2 x 100 percent condensate pumps and 2 x 100 percent circulating water pumps.

The steam turbine for the ultra-supercritical and advanced ultra-supercritical power plants are assumed to be identical to those of the supercritical power plants with the exception that they use advanced materials capable of withstanding the higher temperatures and pressures.

3.5 Balance of Plant

The balance of plant components consist of systems for the following functions: condensate, feedwater, main and reheat steam, extraction steam, ash handling, ducting and stack, waste treatment and miscellaneous systems.

4 Pathway Study Technologies

Conventional and advanced technologies are applied in this assessment for carbon capture, steam rankine-cycle power generation, and CO_2 compression. These technologies are described and their development status and design assumptions are presented.

4.1 Carbon Capture Technologies

Three commercial, or near-term post-combustion CO_2 absorber technologies are addressed, 1) the Fluor commercial Econamine FG Plus^{SM} system, 2) an enhanced Fluor absorber system using an improved solvent, and 3) the commercial MHI absorption system using their KS-1 solvent. In addition, two advanced, developing, post-combustion CO_2 removal technologies are assessed, 1) the TDA advanced CO_2 adsorption system, and 2) the MTR advanced CO_2 membrane system.

4.1.1 Fluor Econamine FG Plus™ Design Basis[3]

Fluor provides a commercial flue gas, amine-based, CO_2 absorber technology, the Econamine FG Plus^{SM} process. In this process, the FGD outlet stream passes to the Fluor Econamine FG Plus^{SM} unit, which absorbs CO_2 from the flue gas. The CO_2 absorber system includes a polishing scrubber to reduce the flue gas SO_2 content to an acceptable level (10 ppmv) to minimize the formation of heat stable salts (HSS) in the Econamine solvent. The vendor information from Fluor applied for this evaluation has incorporated an appropriate pressure drop and auxiliary power for the polishing scrubber within the overall process quote. A solvent reclaimer removes impurities from the solvent using caustic and steam heating. CO_2 is then compressed and is sequestered. The treated flue gas is vented to atmosphere through the stack.

The CO_2 absorption/stripping/solvent reclaim process is based on the Fluor Econamine FG Plus^{SM} technology. The Econamine FG Plus^{SM} process uses a formulation of MEA and a proprietary corrosion inhibitor to recover CO_2 from the flue gas. This process is designed to recover high-purity CO_2 from low-pressure streams that contain oxygen, such as flue gas from coal-fired power plants, GT exhaust gas, and other waste gases.

SO_2 Polishing and FG Cooling and Supply

To minimize the accumulation of HSS, the incoming flue gas must have an SO_2 concentration of 10 ppmv or less. The gas exiting the FGD system passes through an SO_2 polishing step to achieve this objective. The polishing step consists of a non-plugging, low-differential-pressure, spray-baffle-type scrubber using a 20 wt% solution of sodium hydroxide (NaOH). A removal efficiency of about 75 percent is necessary to reduce SO_2 emissions from the FGD outlet to 10 ppmv as required by the Econamine process. The polishing scrubber proposed for this application has been demonstrated in numerous industrial applications throughout the world and can achieve removal efficiencies of over 95 percent.

The polishing scrubber also serves as the flue gas cooling system. Cooling water from the PC plant is used to reduce the flue gas temperature to below the adiabatic saturation temperature resulting in a reduction of the flue gas moisture content. Flue gas is cooled beyond the CO_2 absorption process requirements to 32°C (90°F) to account for the subsequent temperature

[3] This representation of the Fluor technology uses the performance and cost basis from the NETL Bituminous Baseline Report

increase of about 17°C (30°F) in the flue gas blower. Downstream from the Polishing Scrubber flue gas pressure is boosted in the flue gas blowers by approximately 0.014 MPa (2 psi) to overcome pressure drop in the CO_2 absorber tower.

CO_2 Absorption Section

The cooled flue gas enters the bottom of the CO_2 absorber and flows up through the tower countercurrent to a stream of lean MEA-based solvent. Approximately 90 percent of the CO_2 in the feed gas is absorbed into the lean solvent, and the rest leaves the top of the absorber section and flows into the water wash section of the tower. The lean solvent enters the top of the absorber section, absorbs the CO_2 from the flue gas and leaves the bottom of the absorber with the absorbed CO_2. The process also includes solvent intercooling. The semi-rich solvent is extracted from the column, cooled using cooling water, and returned to the absorber section just below the extraction point. The CO_2 carrying capacity of the solvent is increased at lower temperature, which reduces the solvent circulation rate.

Water Wash Section

The purpose of the water wash section is to minimize solvent losses due to mechanical entrainment and evaporation. The flue gas from the top of the CO_2 absorption section is contacted with a re-circulating stream of water for the removal of most of the lean solvent. The scrubbed gases, along with unrecovered solvent, exit the top of the wash section for discharge to the atmosphere via the vent stack. The water stream from the bottom of the wash section is collected on a chimney tray. A portion of the water collected on the chimney tray spills over to the absorber section as water makeup for the amine, with the remainder pumped via the wash water pump, cooled by the water wash cooler, and recirculated to the top of the CO_2 absorber. The wash water level is maintained by wash water makeup.

Rich/Lean Amine Heat Exchange System

The rich solvent from the bottom of the CO_2 absorber is preheated by the lean solvent from the solvent stripper in the lean/rich cross exchanger. The heated rich solvent is routed to the solvent stripper for removal of the absorbed CO_2. The stripped solvent from the bottom of the solvent stripper is pumped via the lean solvent pump to the lean solvent cooler. A slipstream of the lean solvent is then sent through the amine filter package to prevent buildup of contaminants in the solution. The filtered lean solvent is mixed with the remaining lean solvent from the lean solvent cooler and sent to the CO_2 absorber, completing the circulating solvent circuit.

Solvent Stripper

The purpose of the solvent stripper is to separate the CO_2 from the rich solvent feed exiting the bottom of the CO_2 Absorber. The rich solvent is collected on a chimney tray below the bottom packed section of the stripper and routed to the reboiler where the rich solvent is heated by steam, stripping the CO_2 from the solution. Steam is provided from the crossover pipe between the IP and LP sections of the steam turbine and is 0.5 MPa (74 psia) and 152°C (306°F). The hot, wet vapor from the top of the stripper containing CO_2, steam, and solvent vapor, is partially condensed in the reflux condenser by cross exchanging the hot wet vapor with cooling water. The partially condensed stream then flows to the reflux drum where the vapor and liquid are separated. The uncondensed CO_2-rich gas is then delivered to the CO_2 product compressor. The condensed liquid from the reflux drum is pumped via the reflux pump where a portion of condensed overhead liquid is combined with the lean solvent entering the CO_2 absorber. The rest

of the pumped liquid is routed back to the solvent stripper as reflux, which aids in limiting the amount of solvent vapors entering the stripper overhead system.

Solvent Reclaimer

The low temperature reclaimer technology is a recent development for the Fluor technology. A small slipstream of the lean solvent is fed to the solvent reclaimer for the removal of high-boiling nonvolatile impurities including HSS, volatile acids and iron products from the circulating solvent solution. Reclaiming occurs in two steps, the first is an ion-exchange process. There is a small amount of degradation products that cannot be removed via ion-exchange, and a second atmospheric pressure reclaiming process is used to remove the degradation products. The solvent reclaimer system reduces corrosion, foaming and fouling in the solvent system. The reclaimed solvent is returned to the solvent stripper and the spent solvent is pumped via the solvent reclaimer drain pump to the solvent reclaimer drain tank for disposal. The quantity of spent solvent is greatly reduced from the previously used thermal reclaimer systems.

Steam Condensate

Steam condensate from the solvent stripper reclaimer accumulates in the solvent reclaimer condensate drum and is level controlled to the solvent reboiler condensate drum. Steam condensate from the solvent stripper reboilers is also collected in the solvent reboiler condensate drum and returned to the steam cycle between BFW heaters via the solvent reboiler condensate pumps.

A proprietary corrosion inhibitor is intermittently injected into the CO_2 absorber rich solvent bottoms outlet line. This additive is to help control the rate of corrosion throughout the CO_2 recovery plant system.

4.1.2 Fluor CO_2 Absorber Advanced Design Basis

A Fluor publication [10] indicates that Fluor has improved the Econamine system. According to Fluor, the improved system is able to achieve a reboiler steam requirement of 1,270 Btu per lb of CO_2 as compared to the 1,530 Btu per lb of CO_2 for their commercial technology. Fluor also indicates concurrent reductions in auxiliary electrical power requirements and capital costs.

The Fluor publication indicates the improvements in performance and cost are enabled by an improved solvent formulation with an MEA concentration greater than 30 percent and improved corrosion inhibitors. Fluor states that the improved solvent results in increased reaction rates enabling less absorber packing and lower capital cost. Also, the higher solvent carrying capacity results in lower solvent circulation rates, lower steam requirements, and lower capital cost of solvent circulation equipment.

Cost and performance data on the improved system were unavailable directly from Fluor. Therefore, a sensitivity analysis was performed using published data from Fluor and best engineering judgment to estimate the impact of an improved MEA CO_2 capture system on the plant performance and cost.

4.1.3 MHI CO_2 Absorber Design Basis

This design basis is based on a prior proposal received from MHI that provided process flow diagrams, utility consumptions, and chemical consumption. These utility loads were incorporated into an Aspen model for the plant. MHI also provided an estimated capital cost. In addition,

missing performance data for the KS-1 solvent was estimated from EPRI Report 1012239, "Review of CO_2-Capture Development Activities for Coal-Fired Power Generation Plants".

MHI has constructed four commercial units. All use KS-1 solvent and low-pressure drop structured packing developed by MHI and are currently in operation. Three of these plants are in the fertilizer industry and one is in energy production firing natural gas or oil. The size of the CO_2 capture plant in the energy sector is 450 tonnes/day, which is roughly one third of the capacity needed in this study. A block flow diagram of the CO_2 recovery process is presented in Exhibit 4-1.

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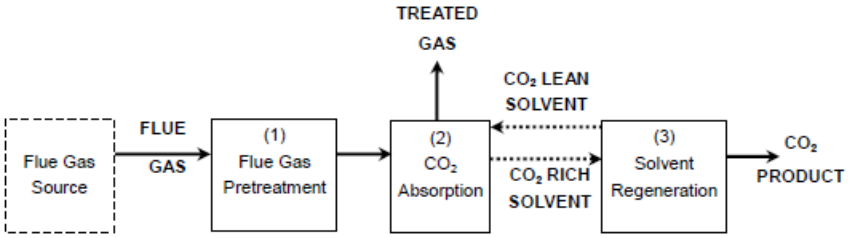
Exhibit 4-1 Block Flow Diagram of the CO_2 Recovery Plant



For this technology, it was assumed that installation of a polishing scrubber downstream of the wet FGD is needed. This polisher reduces SO_2 in the flue gas from about 44 ppmv to about 10 ppmv. The intent of including an SO_2 polisher is to minimize solvent degradation of KS-1 solvent. The vendor information from MHI applied for this evaluation has incorporated an appropriate pressure drop and auxiliary power for the polishing scrubber within the overall process quote, and this has been utilized in all of the cases using the MHI technology.

The CO_2 absorber is a rectangular packed column with two main sections, the absorption section in the lower portion and the treated flue gas washing section in the upper portion. The flue gas is passed through the absorber counter currently to the solvent. The CO_2 rich solvent is then sent to the regenerator.

After the flue gas has passed through the lower portion of the absorber, it is washed with water to minimize solvent losses. The water wash section consists of packing material and demisters. The treated gas is then exhausted from the absorber.

The regenerator is a cylindrical packed column where the CO_2 is removed from the rich solvent by use of low-pressure steam. The regenerated, lean solvent is then recycled back to the CO_2 absorber.

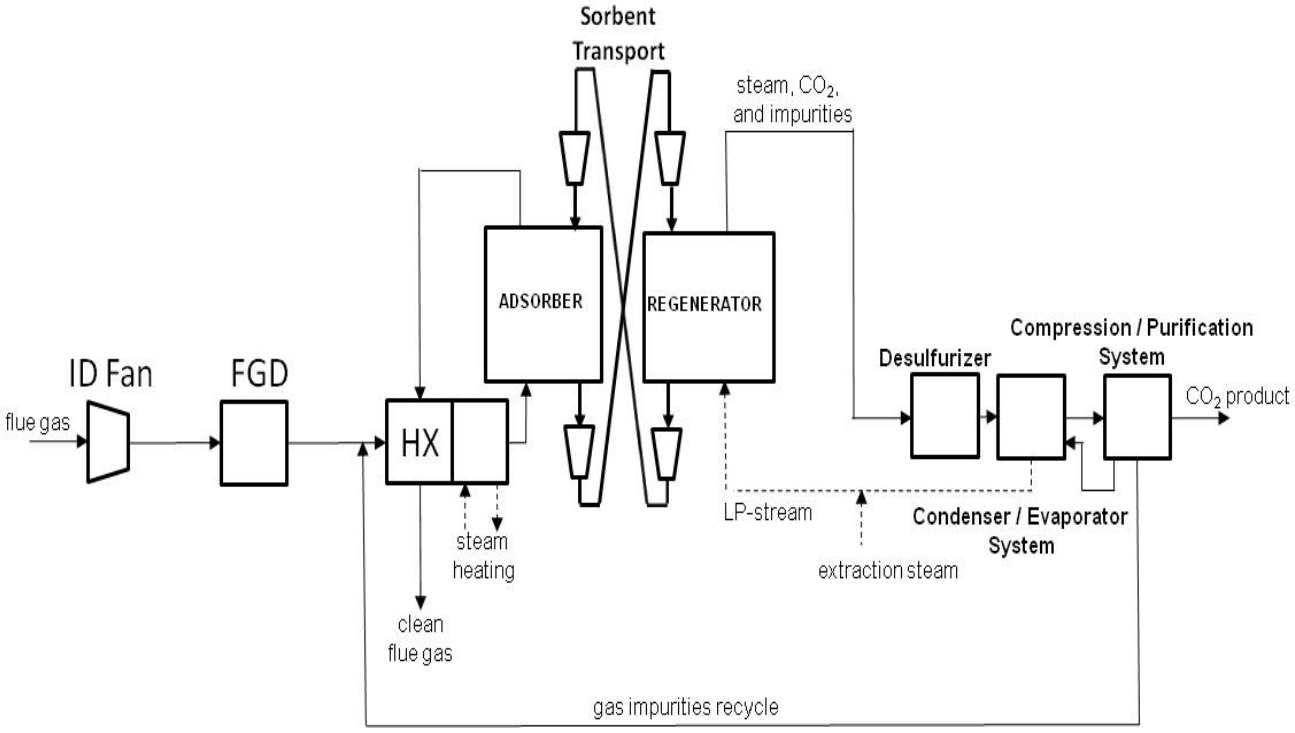
MHI's CO_2 removal process using KS-1 solvent uses low-pressure steam (298 °F, 50 psig) at 1,153 Btu of steam per lb of CO_2 product. This is in comparison to the Fluor Econamine process, which uses 1,526 Btu of steam per lb of CO_2 product. This is a 24 percent reduction in regeneration energy requirement.

4.1.4 TDA Advanced CO_2 Adsorber Design Basis

Advanced CO_2 adsorber processes are being developed, as represented by the TDA CO_2 adsorbent process. The steam turbine extraction rate for this CO_2 removal process is comparable to that of the CO_2 absorber technologies, but the extraction steam condition for the TDA technology is very low-grade at 16 psia and 110°C.

TDA is developing an inorganic, pelletized adsorbent to capture CO_2 from flue gas, and this adsorbent technology is applied to this pathway assessment [5]. An independent NETL representation of an advanced CO_2 adsorber process concept, utilizing the TDA advanced CO_2 adsorbent technology, is illustrated in Exhibit 4-2.

Exhibit 4-2 TDA CO_2 Sorbent Process



The adsorber vessel is placed in the plant to follow the FGD unit, and the flue gas is first heated up to the adsorber operating temperature by a gas-to-gas heat exchanger, followed by additional extraction steam preheating. The TDA adsorbent contacts the flue gas at a relatively low temperature of 110 to 130°C, where CO_2 and any residual SO_2 in the flue gas are effectively adsorbed on the pellet surfaces. The adsorbent is regenerated by contacting it with low-pressure steam, at about 16 psia and 110 to 130°C, under isothermal conditions. The process consumes some 2.5 to 3.5 moles of steam per mole of CO_2 captured, comparable to the steam consumption rates for flue gas CO_2 adsorbers. Even so, the low temperature condition of the absorber and regenerator, and the very low heats of adsorption and desorption make this a promising process. Water is condensed from the regenerator offgas and the CO_2 is compressed for sequestration.

BFW heating is performed as part of the CO_2 shockwave compressor interstage cooling, in cases where the shockwave technology is used, to utilize some of the available compression heat energy. The very low-grade steam used for adsorbent regeneration is partially generated by flue gas cooling prior to the FGD unit, cooling the flue gas to about 150°C. The remaining low-pressure-steam required is provided by very low-pressure turbine extraction steam.

The raw CO_2 product will contain some level of contaminants that depend on the configuration of the adsorber-regenerator system utilized, these contaminants being primarily N_2 and O_2. This stream may need some level of purification to satisfy the CO_2 product specification, and this purification in included in the process simulation.

Several types of adsorber-regenerator configurations have been considered. These include fixed beds, moving beds and a rotating wheel configuration (analogous to a Ljungstrom air preheater). The moving bed adsorber-regenerator configuration requires a large adsorbent circulation system. Fixed bed adsorber and regenerator configurations require no adsorbent circulation, but require multiple, parallel vessels with periodic gas stream switching and purge cycles. Both the moving bed and fixed bed configurations generally have relatively high pressure drop. In the rotating bed configuration, segmented sections of absorbent would be exposed to either flue gas or to regeneration steam. This configuration has low pressure drop potential, but has some complex features requiring substantial development effort at a large scale. Because the TDA adsorbent has a relatively low CO_2 capacity, fixed bed operating would require very rapid vessel switching and would probably be impractical. This evaluation utilizes a moving bed configuration with conventional, mechanical adsorbent circulation between the adsorber and regenerator vessels.

This technology is in a small-scale development phase. Integrated plant or pilot scale testing is planned, but has not been implemented. Thus, there are significant uncertainties associated with the basic technology components, as well as with how these components will ultimately be integrated into the plant. The design basis for the basic technology components is taken from available data generated on small-scale test facilities, as well as from engineering projections for the technology potential. Exhibit 4-3 lists the major design assumptions applied assuming successful development of the technology to high levels of performance, and compares these assumptions to the current program development goals.

Exhibit 4-3 TDA CO_2 Adsorbent System Key Design Basis Assumptions

Parameter	Design Basis for Assessment	Near-Term Performance Objective
Moles of H_2O desorbed for each mole of CO_2 adsorbed	2.0	2.0
Mole % CO_2 in regenerator off-gas	50	50
Adsorber inlet temperature (°C).	140	140
Sorbent CO_2 loading, wt%	3.0	2.5
Adsorber gas contact time, s	2	2
Adsorber solids contact time, s	100	100
Regenerator. adsorbent contact time, s	200	200
Regenerator. gas contact time, s	4	4

For the TDA CO_2 adsorbent technology, installation of a polishing scrubber downstream of the wet FGD has been assumed. This polisher will reduce SO_2 in the flue gas from 35 ppmv to 1-2 ppmv. In the absence of a polishing scrubber, it is believed that much of the residual SO_2 will pass into the CO_2 product stream. SO_2 content in this stream could pose a safety hazard for CO_2 pipeline operations. TDA is investigating the disposition of SO_2 in their testing programs. An appropriate pressure drop has been applied for this polishing scrubber, but the auxiliary power required for the polishing scrubber has been assumed to be negligible and a specific estimate has not been included.

The design-basis information applied for the TDA CO_2 adsorbent process is listed below, with values shown as extracted from published information and discussions with TDA. Design assumptions that are significant development challenges are highlighted in bold. The design basis selected reflects the projection of advanced TDA technology capabilities that are within the goals of the development program, and areas of significant assumed enhancements are noted:

- Adsorber inlet temperature: 140°C
- Flue gas preheat technique: Recuperative heating against adsorber off-gas, followed by saturated steam heating, with an assumed heat exchanger system pressure drop of 0.2 psi
- Adsorber performance:
  - Adsorbs 90 percent of the flue gas CO_2
  - Desorbs two moles of H_2O for each mole of CO_2 adsorbed

    - **Sorbent CO_2 loading achieves 3.0 weight percent**
    - Adsorber vessel pressure drop of 0.4 psi
    - Sorbent heat of adsorption 2.8 kcal/mole CO_2 (0.25 Btu/lb CO_2)
    - Sorbent heat of desorption 14 kcal/mole H_2O (3.09 Btu/lb H_2O)
    - Makeup adsorbent needed -- annual adsorbent inventory replacement assumed
    - Adsorbent entrains 1.0 weight percent of inlet O_2, N_2 and water vapor to the regenerator
- Adsorbent characteristics:
    - Alkalized alumina
    - 3/8-inch diameter spheres
    - 0.7 g/cc bulk density
    - 1.0 g/cc pellet density
    - Adsorbent cost 5.0 $/lb
- Vessel size:
    - Minimum gas contact time 1.0 s
    - Minimum solids contact time 50 s
    - Select gas velocity and bed depth that will meet vessel pressure drop limit
- Adsorbent transport using enclosed, insulated bucket conveyor-elevators
- Regenerator performance:
    - Regeneration steam condition: 16 psia steam at 110°C for desorption by concentration swing
    - Assumed regenerator vessel pressure drop 0.4 psi
    - Regenerator gas contact time 4 seconds
    - Minimum adsorbent contact time 200 s
    - Complete desorption of CO_2 and SO_2
    - Two moles of H_2O adsorbed for each mole of CO_2 desorbed
    - Complete release of 1.0 weight percent of inlet O_2, N_2 and water vapor entrained from adsorber
    - **50 mole percent CO_2 in off-gas**

For the assumed operating conditions, four parallel CO_2 adsorber vessels are used, each having a diameter of about 55 ft with a height of about 44 ft. To be able to maintain an acceptably low adsorber pressure drop, the circulating adsorbent stream must be split into multiple streams and each of these distributed uniformly to the top of the adsorber moving bed. This requires seven parallel hopper drains from the base of each adsorber vessel, each feeding an adsorbent transport line that elevates the adsorbent to locations above the vessel. Each of these adsorbent streams is then distributed to the moving bed top surface using a screw conveyor that spreads the adsorbent uniformly. In addition, inlet flue gas must be uniformly distributed to the bottom of each adsorber bed using orifice pipe distributors.

Similarly, four parallel regenerator vessels are used, each having a diameter of about 35 ft with a height of about 28 ft. An identical scheme for transporting and distributing adsorbent and regeneration steam to the regenerator vessels is used.

The adsorbent total circulation rate is about 25,000,000 lb/hr, and seven parallel, conventional, enclosed drag-type conveyor and elevator trains are used with each vessel to transport the adsorbent.

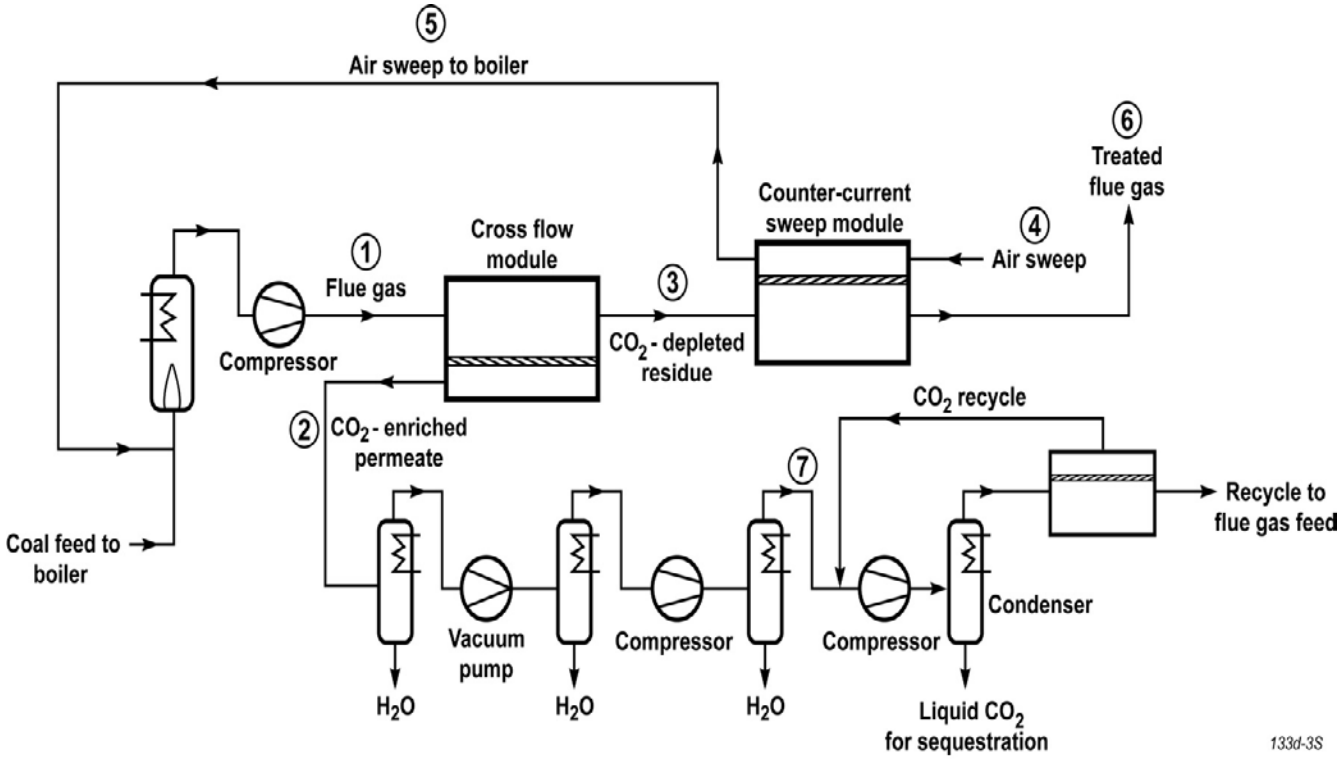
4.1.5 MTR Advanced CO_2 Membrane Design basis

Advanced, developing CO_2 removal technology based on CO_2 membrane technology is represented by the MTR CO_2 membrane process [6, 7]. The membrane process completely eliminates the use of steam turbine extraction steam to operate the CO_2 removal system, but requires the use of a large vacuum pump system for CO_2 process operation. The MTR membrane performance factors are assumed to achieve levels above their current sub-scale testing levels, but representative of current program goals. The MTR membrane process is also closely integrated with the plant boiler, requiring extensive flue gas recycle to the boiler. Any impact on the boiler performance due to this is neglected.

MTR is developing a compact, spiral-wound, polymeric membrane to separate CO_2 from flue gas. Current activities include operation of a test unit installed at the Cholla power plant for Arizona Public Service Co. with a skid to process a 0.25 MMSCFD slipstream and capture 1 ton CO_2/day. A recent funding award (July 2010) includes 6-month testing at the Cholla plant with a larger skid designed to capture 20 tons CO_2/day (1 MW slipstream).

A simplified flow diagram of the MTR membrane process is shown in Exhibit 4-4. The MTR process concept for removing CO_2 from flue gas consists of two membrane modules. The first module is a cross-flow module which removes about 50 percent of the CO_2 from its inlet flue gas stream to produce a concentrated CO_2 stream for sequestration that represents 90 percent of the total coal carbon feed rate. The second membrane module is a counter-flow configuration which utilizes boiler combustion air as membrane sweep gas to recover CO_2 that has not permeated the first, cross-flow membrane. The permeated gas from the second, counter-flow membrane is recycled to the boiler, and its off-gas is rejected to the plant stack.

Exhibit 4-4 MTR CO_2 Membrane System



Salient points of the design include:

- Since the MTR process is not an add-on for CO_2 removal, but is integrated with the boiler air feed, the process has several potential impacts on the plant performance.
- Recycling more CO_2 and removing a smaller percentage from the cross-flow module minimizes the total membrane area and the additional gases in the membrane permeate, thereby reducing the CO_2 compression load.
- The membrane is nearly transparent to water vapor, but has relatively small N_2 and O_2 permeance.
- The CO_2 recycled with the boiler feed air is sufficient to reduce the stack CO_2 to 10 percent of the coal-produced CO_2.
- Increased CO_2 content in the boiler is one issue of concern for retrofit applications. A significant amount of CO_2 may be recycled to the boiler. This largely replaces N_2 in air; however, some O_2 is lost as well, so that boiler may have a depleted O_2 feed rate. Oxygen content in the combustion air is lowered from 21 mole percent to 17-18 mole percent.
- Because of the requirement to maintain a high differential pressure across the counter-flow membrane by creating a partial vacuum, the largest contributor to the power plant auxiliary load is the vacuum pump and combined CO_2 compressor.
- The MTR CO_2 membrane process eliminates the need for the consumption of low-pressure steam for solvent regeneration.

This technology is in a field development phase. Integrated plant or pilot scale testing has not been implemented for the MTR technology. Thus, there are uncertainties associated with the basic technology components, as well as with how these components will ultimately be integrated into the plant. The design basis for the basic technology components has been extracted from data from available small-scale testing and projections for the technology potential.

For this technology, installation of a polishing scrubber downstream of the wet FGD has been assumed. This polisher will reduce SO_2 in the flue gas from 35 ppmv to 10 ppmv. In the absence of a polishing scrubber, much of the residual SO_2 will pass into the CO_2 product stream. SO_2 content in this stream could pose a safety hazard for CO_2 pipeline operations. SO_2 can also be captured in the MTR counterflow membrane and recycled with combustion air. This SO_2 could also pose a safety hazard in the plant. MTR is investigating the disposition of SO_2 in their testing programs. An appropriate pressure drop has been applied for this polishing scrubber, but the auxiliary power required for the polishing scrubber has been assumed to be negligible and a specific estimate has not been included.

The vacuum pump flows in the process exceed the boundaries of commercially available rotating vacuum pumps. This type of service is normally handled with ejectors that consume large amounts of steam for moving large volumes of non-condensable vapor. For the membrane technology to be realized in the future, vacuum pump vendors will need to develop much larger-scale equipment capable of this pressure and flow duty.

Exhibit 4-5 lists the design basis applied for the MTR CO_2 membrane technology assuming successful development and the achievement of high performance level beyond the current status. The current project goals and current test data achieved are also listed.

Exhibit 4-5 MTR CO_2 Membrane System Key Design Basis Assumptions

Parameter	Design Basis for Assessment	Near-Term Performance Objective
CO_2 Permeance, gpu	3500	3500
H_2O Permeance, gpu	5000	5000
Selectivity, CO_2/N_2	35	50
Membrane installed cost, $/m^2	80	150
Pressure drop on flue gas and sweep sides, psi	1.0	1.0
Membrane replacement time, yrs	5	4
Membrane surface area estimated, m^2	1,500,000	1,500,000

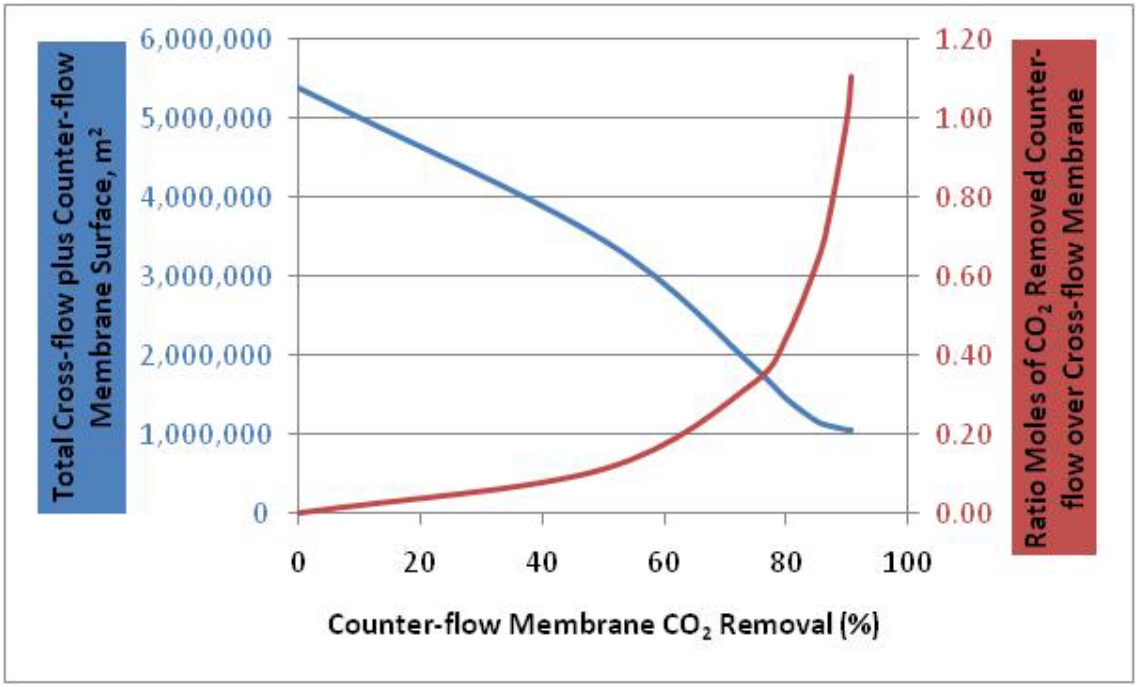
The design-basis information is listed below. This represents an advanced vision of the MTR CO_2 removal process, with assumed values shown as extrapolated from published information:

- Cross-flow Membrane
  - Flue gas inlet is at the FGD outlet temperature of 58°C
  - **Pressure drop of 1.0 psi on flue gas and sweep sides is assumed**
  - CO_2 removal is about 50 percent of the total CO_2 removed
  - CO_2 and SO_2 permeances are assumed to be 3,500 gpu. Note that the gas permeance unit, gpu, is equal to 7.5×10^{-16} m/s/Pa.
  - N_2, Ar, O_2 have nearly all identical permeance, at an assumed value of 100 gpu based on current membrane test experience
  - H_2O permeance is assumed to be 5,000 gpu based on current membrane test experience
  - The assumed permeances result in selectivities for CO_2/N_2 of 35, CO_2/H_2O of 0.7
  - Vacuum pump assumed to achieve 0.2 bar pressure
  - Membrane replacement time 5 years with little degradation in permeance
  - Membrane installed cost is 80 $\$/m^2$
  - Membrane replacement cost is 15 $\$/m^2$
- Counter-Current Flow Membrane
  - 100 percent of boiler air passes through as sweep gas
  - Inlet air is preheated to 50°C
  - **Pressure drop of 1.0 psi on flue gas and sweep sides**
  - The total CO_2 removal for the plant achieves 90 percent
  - Same permeance values as for the cross-flow membrane
  - Same cost-basis as for the cross-flow membrane
  - Total membrane surface area required (cross-flow plus counter-flow) is 1,500,000 m^2

The total MTR membrane surface area needed with the selected distribution of cross-flow and counterflow membranes in the process is estimated to be 1,500,000 m^2 using simplified, numerical models for the spiral-wound membrane vessels. The model indicates, as is illustrated in Exhibit 4-6, the sensitivity of the total membrane surface area needed to the distribution of the plant CO_2 removal between the cross-flow and counter-flow membranes. Without using the counter-flow membrane this process would require a very large cross-flow membrane with very high capital investment.

Each membrane should remove CO_2 at nearly equal rates to achieve a low total membrane surface area, and consequently the counter-flow, air sweep membrane needing to achieve about 90 percent removal of CO_2 from its inlet stream. The large recycle of CO_2 to the boiler that results increases the CO_2 content of the flue gas to the cross-flow membrane greatly, achieving about 21 mole percent CO_2.

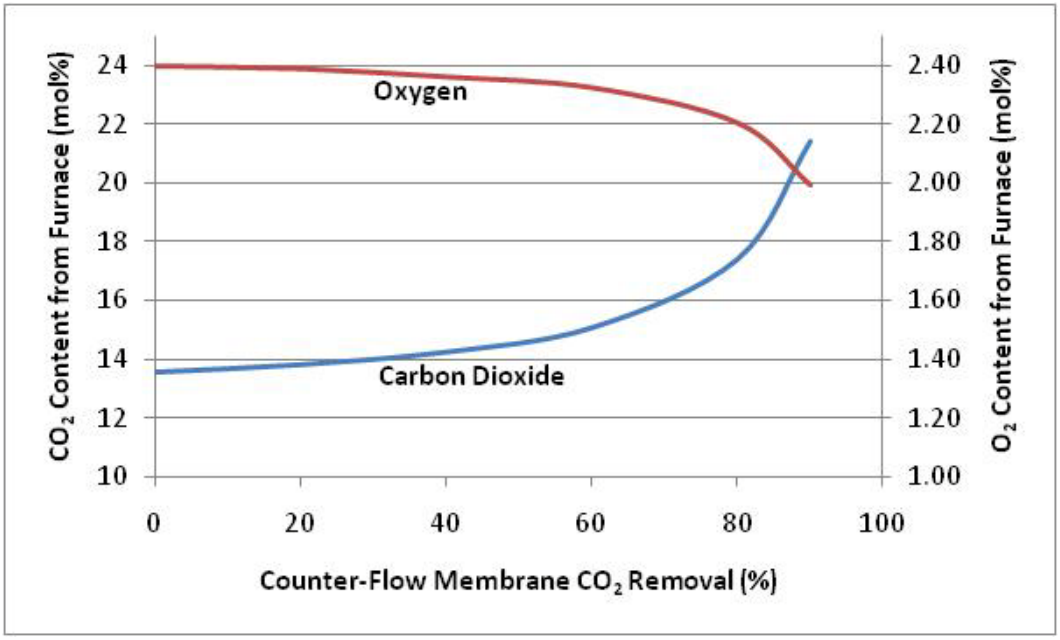
Exhibit 4-6 Total Membrane Surface Area Modeling Results



The raw CO_2 stream from the cross-flow membrane in has an estimated composition of about 48 mole percent CO_2, 48 mole percent water vapor, and 4 mole percent N_2, O_2, and Ar. Low-temperature processing of the stream following dehydration removes and vents the N_2, O_2, and Ar contaminants in the stream.

The large recycle of CO_2 to the boiler, and the reduction of the furnace oxygen content may have some significant impacts on the furnace and boiler performance which need to be dealt with during larger-scale process development. Exhibit 4-7 illustrates how the furnace outlet flue gas CO_2 and O_2 contents are influenced by the counter-flow membrane CO_2 removal and its associated CO_2 recycle.

Exhibit 4-7 Influence of CO_2 Recycle on Furnace Outlet Flue Gas CO_2 and O_2 Content



A quote from a commercial vendor for lower-temperature CO_2 purification schemes that are integrated with the CO_2 compression system was applied. The quote indicates that overall impact of the CO_2 purification process on the auxiliary power needed for purification and CO_2 compression, as well as on MP-steam consumption needed for CO_2 purification, is negligible.

The cost for the SO_2 polishing scrubber used has not been separately estimated and is assumed to be a negligible cost item. Based on the commercial cost quote, it is assumed that the CO_2 purification process has a negligible impact on the overall cost of the plant.

4.2 Steam Cycle

Steam conditions for the study cases were selected to reflect current supercritical steam plants and expectations for ultra-supercritical, and advanced ultra-super critical steam plants. While the current DOE program for the ultra-supercritical cycle materials development targets 732°C/760°C (1,350ºF/1,400ºF) at 34.5 MPa (5,000 psi) cycle conditions to be available by 2015, and a similar Thermie program in the European Union (EU) has targeted 700°C/720°C (1,292ºF/1,328ºF) at about 29.0 MPa (4,200 psi), steam temperature selection for boilers depends upon fuel corrosiveness. Most of the contacted OEMs were of the opinion that the steam conditions in this range would be limited to low sulfur coal applications (such as PRB). Their primary concern is that elevated temperature operation while firing high sulfur coal (such as Illinois No. 6) would result in an exponential increase of the material wastage rates of the highest temperature portions of the superheater and RH due to coal ash corrosion, requiring pressure parts replacement outages approximately every 10 or 15 years. This cost would offset the value of fuel savings and emissions reduction due to the higher efficiency.

The availability/reliability of the more exotic materials required supporting the elevated temperature environment for high sulfur/chlorine applications, while extensively demonstrated in the laboratory has not been commercially demonstrated. In addition, the three most recently built supercritical units in North America have steam cycles similar to this study's design basis, namely Genesee Phase 3 in Canada, which started operations in 2004 (25.0 MPa/570°C/568°C [3,625 psia/1,058°F/1,054°F]), Council Bluffs 4 in the United States, which started operation in 2007 (25.4 MPa/566°C/593°C [3,690 psia/1,050°F/1,100°F]), and Oak Creek 1 and 2, which are currently under construction (24.1 MPa/566°C [3,500 psig/1,050°F]).

4.2.1 Supercritical (SC)

The steam conditions selected are 24.1MPa/593°C/593°C (3,500 psig/1,100°F/1,100°F). The steam generator for the supercritical plants is a once-through, spiral-wound, Benson-boiler, wall-fired, balanced draft type unit with a water-cooled dry bottom furnace. It includes superheater, reheater, economizer, and air heater. The combustion system for the supercritical steam conditions is equipped with LNBs and OFA.

4.2.2 Ultra-Supercritical (USC)

Steam conditions are 34.5 MPa/732°C/760°C (5,000 psig/1,200°F/1,200°F). This case does not include double reheat. The USC steam system provides significantly improved power plant efficiency.

The steam generator for the ultra-supercritical power plants are assumed to be identical to those of the supercritical power plants with the exception that the ultra-supercritical plants use advanced materials capable of withstanding the higher temperatures and pressures.

The combustion system for the ultra-supercritical steam conditions is equipped with LNBs and OFA. The power plant simulation was modified to generate higher pressure steam and to incorporate ultra-supercritical steam turbine performance. NETL advanced materials program cost projections for USC materials have been factored into the cost estimates for all of the USC steam cases by increasing process contingencies for the SC steam boiler and steam turbine equipment costs (increased from 0 percent to 10 percent for the boiler and from 0 percent to 15 percent for the steam turbine).

4.2.3 Advanced Ultra-Supercritical (AUSC)

Steam conditions are 34.5 MPa/732°C/760°C (5,000 psig/1,350°F/1,400°F). This case does not include double reheat. The AUSC steam system provides further improved power plant efficiency.

The steam generator for the advanced ultra-supercritical power plants are assumed to be identical to those of the supercritical power plants with the exception that the advanced ultra-supercritical plants use advanced materials capable of withstanding the higher temperatures and pressures.

The combustion system for the advanced ultra-supercritical steam conditions is equipped with LNBs and OFA. The power plant simulation was modified to generate higher pressure steam and to incorporate advanced ultra-supercritical steam turbine performance. NETL advanced materials program cost projections for AUSC materials have been factored into the cost estimates for all of the AUSC steam cases by increasing process contingencies for the SC steam boiler and steam

turbine equipment costs (increased from 0 percent to 10 percent for the boiler and from 0 percent to 15 percent for the steam turbine).

4.3 CO_2 Compression

4.3.1 Conventional Compression

In the compression section, the CO_2 is compressed to 15.3 MPa (2,215 psia) by a conventional six-stage centrifugal compressor. The discharge pressures of the stages were balanced to give reasonable power distribution and discharge temperatures across the various stages. Power consumption for this large compressor was estimated assuming a polytropic efficiency of 86 percent and a mechanical efficiency of 98 percent for all stages. During compression to 15.3 MPa (2,215 psia) in the multiple-stage, intercooled compressor, the CO_2 stream is dehydrated to a dewpoint of -40ºC (-40°F) with triethylene glycol. The virtually moisture-free SC CO_2 stream is delivered to the plant battery limit as sequestration ready.

4.3.2 Advanced Shockwave Compression

Advanced shockwave compression representative of the Ramgen technology [8, 9] is applied in selected cases. A cross sectional image of the Ramgen compressor is presented in Exhibit 4-8.

Exhibit 4-8 Ramgen Single-Stage, Direct-Drive HP Configuration

Conventional compression must limit the inlet flow at the blade tip to avoid generating shock waves. This results in pressure ratio limits of approximately 2:1 per stage. Due to the low pressure ratio, the heat generated during intercooling is of low quality, and therefore, of little use.

Ramgen, however, designs its compressors in such a way that it creates and utilizes shock waves, resulting in very high pressure ratios with reduced impact on efficiency. This increased pressure ratio allows for the desired pressure to be achieved in 2 stages, compared to 6 to 8 stages required by conventional compression.

The shock compressor uses fewer stages and simpler design, while maintaining the same output, and has smaller size. It is expected that shock compression will be able to reduce the capital cost of compression. The developer claims that, by using shock wave technology, the size of a CO_2 compressor can be reduced to ~1/5 of that of a conventional compressor, and the cost per

compression ratio is about 1/2 to 1/3 of that of a similar conventional compression system. The technology has been demonstrated only at the laboratory scale.

The polytropic efficiency for the shockwave compressor is assumed to be 86 percent, similar to that of a conventional compressor, and the technology developer expects efficiencies to ultimately exceed those of conventional compressors. BFW heating is performed as part of Ramgen compressor interstage cooling to utilize some of the available compression heat energy.

5 Base Plants (Cases 1A and 1B) without CO_2 Capture

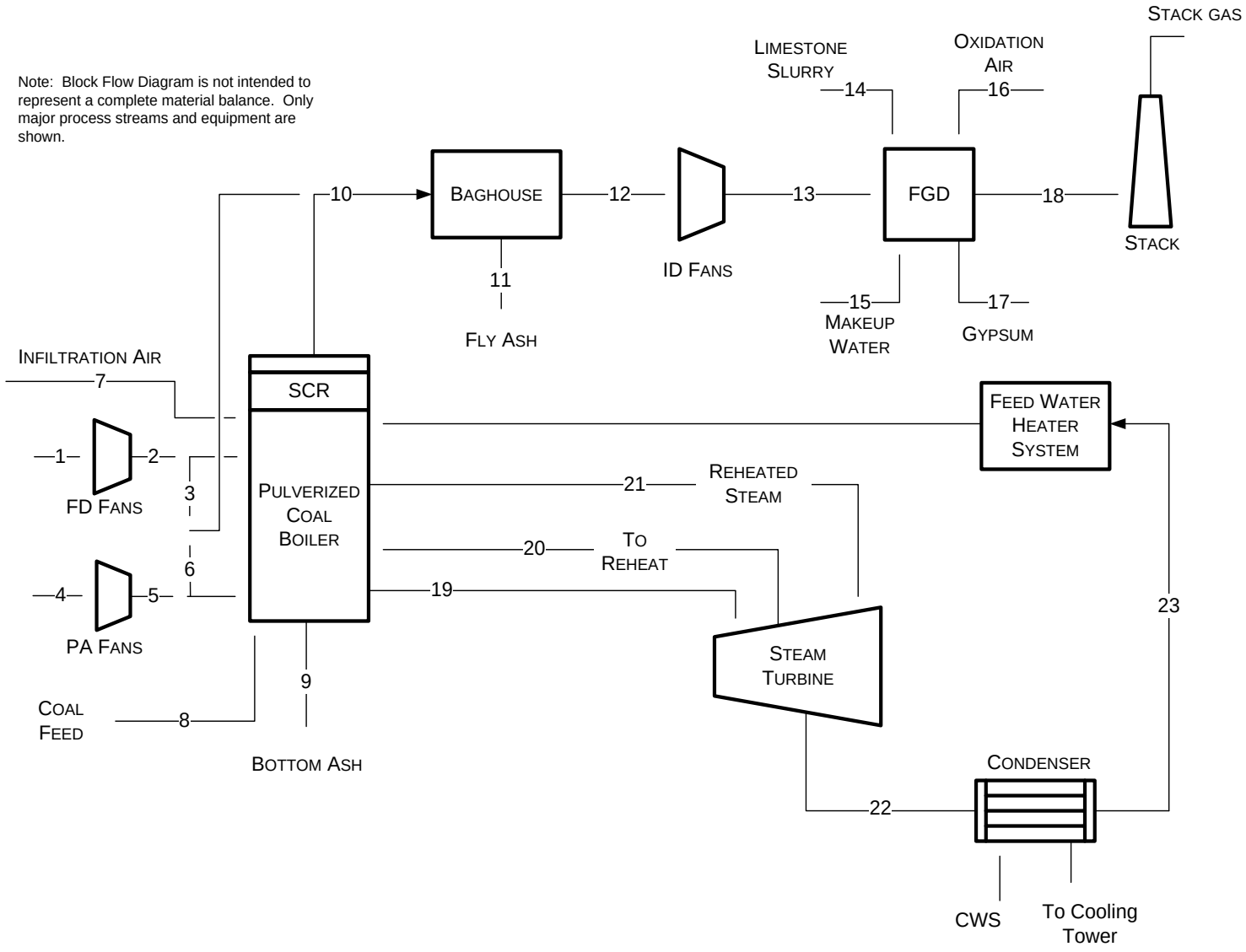
This section consists of two cases:

Case 1A is a SC (3,500 psig/1,100°F/1,100°F) PC plant with a wet FGD unit and no CO_2 Capture. The costing for this case was performed on a low risk financial basis. This case is used as the baseline plant for comparison with the other cases.

Case 1B is based on Case 1A but is operated at AUSC steam conditions (5,000 psig/1,350°F/1,400°F). As such, the costing for this case was performed on a high risk financial basis.

Exhibit 5-1 provides the block flow diagram for Cases 1A and 1B.

Exhibit 5-1 Cases 1A and 1B block flow diagram



5.1 Case 1A

Exhibit 5-2 Case 1A Stream table

	1	2	3	4	5	6	7	8	9	10	11	12
V-L Mole Fraction												
Ar	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092	0.0000	0.0000	0.0087	0.0000	0.0087
CO_2	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0000	0.0000	0.1450	0.0000	0.1450
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	0.0099	0.0099	0.0099	0.0099	0.0099	0.0099	0.0099	0.0000	0.0000	0.0870	0.0000	0.0870
N_2	0.7732	0.7732	0.7732	0.7732	0.7732	0.7732	0.7732	0.0000	0.0000	0.7324	0.0000	0.7324
O_2	0.2074	0.2074	0.2074	0.2074	0.2074	0.2074	0.2074	0.0000	0.0000	0.0247	0.0000	0.0247
SO_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0021	0.0000	0.0021
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000	0.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	48,414	48,414	1,434	14,872	14,872	2,047	1,119	0	0	68,126	0	68,126
V-L Flowrate (kg/hr)	1,397,067	1,397,067	41,378	429,164	429,164	59,064	32,284	0	0	2,026,262	0	2,026,262
Solids Flowrate (kg/hr)	0	0	0	0	0	0	0	185,759	3,603	14,410	14,410	0
Temperature (°C)	15	19	19	15	25	25	15	15	15	169	15	169
Pressure (MPa, abs)	0.10	0.11	0.11	0.10	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10
Enthalpy (kJ/kg)[A]	30.23	34.36	34.36	30.23	40.78	40.78	30.23	---	---	327.37	---	308.94
Density (kg/m^3)	1.2	1.2	1.2	1.2	1.3	1.3	1.2	---	---	0.8	---	0.8
V-L Molecular Weight	28.857	28.857	28.857	28.857	28.857	28.857	28.857	---	---	29.743	---	29.743
V-L Flowrate (lb_{mol}/hr)	106,734	106,734	3,161	32,787	32,787	4,512	2,466	0	0	150,191	0	150,191
V-L Flowrate (lb/hr)	3,080,006	3,080,006	91,224	946,145	946,145	130,215	71,175	0	0	4,467,142	0	4,467,142
Solids Flowrate (lb/hr)	0	0	0	0	0	0	0	409,528	7,942	31,769	31,769	0
Temperature (°F)	59	66	66	59	78	78	59	59	59	337	59	337
Pressure (psia)	14.7	15.3	15.3	14.7	16.1	16.1	14.7	14.7	14.7	14.4	14.7	14.2
Enthalpy (Btu/lb)[A]	13.0	14.8	14.8	13.0	17.5	17.5	13.0	---	---	140.7	---	132.8
Density (lb/ft^3)	0.076	0.078	0.078	0.076	0.081	0.081	0.076	---	---	0.050	---	0.049
	A - Reference conditions are 32.02 F & 0.089 PSIA											

Exhibit 5-2 Case 1A Stream table (Continued)

	13	14	15	16	17	18	19	20	21	22	23
V-L Mole Fraction											
Ar	0.0087	0.0000	0.0000	0.0128	0.0000	0.0082	0.0000	0.0000	0.0000	0.0000	0.0000
CO_2	0.1450	0.0000	0.0000	0.0005	0.0004	0.1353	0.0000	0.0000	0.0000	0.0000	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	0.0870	1.0000	1.0000	0.0062	0.9995	0.1517	1.0000	1.0000	1.0000	1.0000	1.0000
N_2	0.7324	0.0000	0.0000	0.7506	0.0000	0.6808	0.0000	0.0000	0.0000	0.0000	0.0000
O_2	0.0247	0.0000	0.0000	0.2300	0.0000	0.0240	0.0000	0.0000	0.0000	0.0000	0.0000
SO_2	0.0021	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	68,126	2,369	9,597	726	176	74,091	92,389	76,591	76,591	69,891	69,891
V-L Flowrate (kg/hr)	2,026,262	42,682	172,898	21,076	3,168	2,137,881	1,664,421	1,379,803	1,379,803	1,259,099	1,259,099
Solids Flowrate (kg/hr)	0	18,437	0	0	28,694	0	0	0	0	0	0
Temperature (°C)	181	15	15	167	57	57	593	354	593	38	39
Pressure (MPa, abs)	0.11	0.10	0.10	0.31	0.10	0.10	24.23	4.90	4.52	0.01	1.69
Enthalpy (kJ/kg)[A]	321.02	---	-46.80	177.65	---	297.66	3,476.62	3,082.88	3,652.22	1,985.85	165.59
Density (kg/m^3)	0.8	---	1,003.1	2.5	---	1.1	69.2	18.7	11.6	0.1	993.3
V-L Molecular Weight	29.743	---	18.015	29.029	---	28.855	18.015	18.015	18.015	18.015	18.015
V-L Flowrate (lb_{mol}/hr)	150,191	5,223	21,158	1,601	387	163,343	203,684	168,854	168,854	154,082	154,082
V-L Flowrate (lb/hr)	4,467,142	94,099	381,174	46,465	6,985	4,713,221	3,669,421	3,041,946	3,041,946	2,775,839	2,775,839
Solids Flowrate (lb/hr)	0	40,646	0	0	63,259	0	0	0	0	0	0
Temperature (°F)	357	59	59	333	135	135	1,100	669	1,100	101	103
Pressure (psia)	15.3	15.0	14.7	45.0	14.8	14.8	3,514.7	710.8	655.8	1.0	245.0
Enthalpy (Btu/lb)[A]	138.0	---	-20.1	76.4	---	128.0	1,494.7	1,325.4	1,570.2	853.8	71.2
Density (lb/ft^3)	0.052	---	62.622	0.154	---	0.067	4.319	1.165	0.722	0.004	62.009

Exhibit 5-3 Case 1A Performance summary

	Case 1A	Units
Plant Output		
Steam Turbine Power	580,400	kW_e
Total	**580,400**	kW_e
Auxiliary Load		
Coal Handling and Conveying	440	kW_e
Pulverizers	2,780	kW_e
Sorbent Handling & Reagent Preparation	890	kW_e
Ash Handling	530	kW_e
Primary Air Fans	1,300	kW_e
Forced Draft Fans	1,660	kW_e
Induced Draft Fans	7,050	kW_e
SCR	50	kW_e
Baghouse	70	kW_e
Wet FGD	2,970	kW_e
CO_2 Compression	0	kW_e
Miscellaneous Balance of Plant[2,3]	2,000	kW_e
Steam Turbine Auxiliaries	400	kW_e
Condensate Pumps	800	kW_e
Circulating Water Pumps	4,730	kW_e
Ground Water Pumps	480	kW_e
Cooling Tower Fans	2,440	kW_e
Transformer Losses	1,820	kW_e
Total	**30,410**	**kW_e**
Plant Performance		
Net Auxiliary Load	30,410	kW_e
Net Plant Power	549,990	kW_e
Net Plant Efficiency (HHV)	39.3%	
Net Plant Heat Rate (HHV)	9,165 (8,687)	kJ/kWhr (Btu/kWhr)
Coal Feed Flowrate	185,759 (409,528)	kg/hr (lb/hr)
Thermal Input[1]	1,400,162	kW_{th}
Condenser Duty	2,298 (2,178)	GJ/hr (MMBtu/hr)
Raw Water Withdrawal	20.1 (5,321)	m^3/min (gpm)
Raw Water Consumption	16.0 (4,227)	m^3/min (gpm)

1 - HHV of Illinois No. 6 coal is 27,135 kJ/kg (11,666 Btu/lb)
2 – Boiler feed pumps are turbine driven
3 – Includes plant control systems, lighting, HVAC, and miscellaneous low voltage loads

Exhibit 5-4 Case 1A water balance

	Water Demand	Internal Recycle	Raw Water Withdrawal	Process Water Discharge	Raw Water Consumption
	m^3/min (gpm)				
FGD Makeup	3.60 (951)	-	3.60 (951)	-	3.60 (951)
BFW Makeup	-	-	-	-	-
Cooling Tower	18.4 (4,863)	1.86 (492)	16.5 (4,370)	4.14 (1,094)	12.40 (3,277)
Total	**22.0 (5,813)**	**1.86 (492)**	**20.1 (5,321)**	**4.14 (1,094)**	**16.00 (4,227)**

Exhibit 5-5 Case 1A carbon balance

Carbon In		Carbon Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	118,411 (261,052)	Stack Gas	120,377 (265,385)
Air (CO2)	257 (567)	FGD Product	163 (358)
FGD Reagent	1,871 (4,124)		-
Total	**120,539 (265,744)**	**Total**	**120,539 (265,744)**

Exhibit 5-6 Case 1A sulfur balance

Sulfur In		Sulfur Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	4,656 (10,264)	Stack Gas	93 (205)
		FGD Product	4,563 (10,059)
Total	**4,656 (10,264)**	**Total**	**4,656 (10,264)**

Exhibit 5-7 Case 1A energy balance

	HHV	Sensible + Latent	Power	Total
Heat In GJ/hr (MMBtu/hr)				
Coal	5,041 (4,778)	4.2 (4.0)	-	5,045 (4,782)
Air	-	56.2 (53.2)	-	56.2 (53.2)
Raw Water Makeup	-	75.8 (71.8)	-	75.8 (71.8)
Lime	-	0.21 (0.20)	-	0.21 (0.20)
Auxiliary Power	-	-	109 (104)	109 (104)
TOTAL	**5,041 (4,778)**	**136.4 (129.3)**	**109 (104)**	**5,286 (5,011)**
Heat Out GJ/hr (MMBtu/hr)				
Bottom Ash	-	0.4 (0.4)	-	0.4 (0.4)
Fly Ash + FGD Ash	-	1.7 (1.7)	-	1.7 (1.7)
Flue Gas	-	636 (603)	-	636 (603)
Condenser	-	2,298 (2,178)	-	2,298 (2,178)
Cooling Tower Blowdown	-	30.8 (29.2)	-	30.8 (29.2)
*Process Losses**	-	*230 (218)*	-	*230 (218)*
Power	-	-	2,089 (1,980)	2,089 (1,980)
TOTAL	-	**3,197 (3,030)**	**2,089 (1,980)**	**5,286 (5,011)**

* Process losses are estimated to match the heat input to the plant.

Exhibit 5-8 Case 1A air emissions

	kg/GJ (lb/MMBtu)	tonne/yr (Ton/year)	kg/MWgross (lb/MWgross)
SO_2	0.037 (0.086)	1,385 (1,526)	0.320 (.71)
NOx	0.030 (0.070)	1,130 (1,245)	0.261 (.576)
Particulate	0.006 (0.0130)	210 (231)	0.049 (.107)
Hg	4.91E-7 (1.14E-6)	0.018 (0.020)	4.27E-6 (9.41E-6)
CO_2	87.5 (203.5)	3,284,245 (3,620,261)	760 (1,675)

Exhibit 5-9 Case 1A capital costs

	Client:	USDOE/NETL							Report Date:	2010-Jan-14	
	TOTAL PLANT COST SUMMARY										
	Case:	Case 1A - 1x550 MWnet SuperCritical PC									
	Plant Size:	550.0	MW,net	Estimate Type:		Conceptual		Cost Base (Jun)	2007	($x1000)	
Acct		Equipment	Material	Labor		Bare Erected	Eng'g CM	Contingencies		TOTAL PLANT COST	
No.	Item/Description	Cost	Cost	Direct	Indirect	Cost $	H.O.& Fee	Process	Project	$	$/kW
1	COAL & SORBENT HANDLING										
1.1	Coal Receive & Unload	$3,368	$0	$1,538	$0	$4,906	$438	$0	$802	$6,146	$11
1.2	Coal Stackout & Reclaim	$4,352	$0	$986	$0	$5,338	$467	$0	$871	$6,676	$12
1.3	Coal Conveyors	$4,046	$0	$976	$0	$5,022	$440	$0	$819	$6,282	$11
1.4	Other Coal Handling	$1,059	$0	$226	$0	$1,284	$112	$0	$209	$1,606	$3
1.5	Sorbent Receive & Unload	$135	$0	$41	$0	$175	$15	$0	$29	$219	$0
1.6	Sorbent Stackout & Reclaim	$2,176	$0	$399	$0	$2,574	$224	$0	$420	$3,218	$6
1.7	Sorbent Conveyors	$776	$168	$190	$0	$1,135	$98	$0	$185	$1,418	$3
1.8	Other Sorbent Handling	$469	$110	$246	$0	$825	$73	$0	$135	$1,032	$2
1.9	Coal & Sorbent Hnd.Foundations	$0	$4,136	$5,218	$0	$9,354	$879	$0	$1,535	$11,767	$21
	SUBTOTAL 1.	**$16,381**	**$4,414**	**$9,819**	**$0**	**$30,614**	**$2,747**	**$0**	**$5,004**	**$38,365**	**$70**
2	COAL & SORBENT PREP & FEED										
2.1	Coal Crushing & Drying	$1,929	$0	$376	$0	$2,305	$201	$0	$376	$2,881	$5
2.2	Coal Conveyor to Storage	$4,939	$0	$1,078	$0	$6,017	$526	$0	$981	$7,524	$14
2.3	Coal Injection System	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.4	Misc.Coal Prep & Feed	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.5	Sorbent Prep Equipment	$3,695	$159	$768	$0	$4,622	$402	$0	$754	$5,778	$11
2.6	Sorbent Storage & Feed	$445	$0	$171	$0	$616	$55	$0	$101	$771	$1
2.7	Sorbent Injection System	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.8	Booster Air Supply System	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.9	Coal & Sorbent Feed Foundation	$0	$478	$401	$0	$879	$81	$0	$144	$1,105	$2
	SUBTOTAL 2.	**$11,008**	**$637**	**$2,793**	**$0**	**$14,438**	**$1,265**	**$0**	**$2,356**	**$18,059**	**$33**
3	FEEDWATER & MISC. BOP SYSTEMS										
3.1	FeedwaterSystem	$18,623	$0	$6,016	$0	$24,638	$2,153	$0	$4,019	$30,810	$56
3.2	Water Makeup & Pretreating	$4,460	$0	$1,436	$0	$5,895	$557	$0	$1,291	$7,743	$14
3.3	Other Feedwater Subsystems	$5,701	$0	$2,409	$0	$8,111	$727	$0	$1,326	$10,163	$18
3.4	Service Water Systems	$874	$0	$476	$0	$1,350	$127	$0	$295	$1,772	$3
3.5	Other Boiler Plant Systems	$6,807	$0	$6,721	$0	$13,528	$1,285	$0	$2,222	$17,035	$31
3.6	FO Supply Sys & Nat Gas	$255	$0	$319	$0	$574	$54	$0	$94	$723	$1
3.7	Waste Treatment Equipment	$3,024	$0	$1,724	$0	$4,747	$462	$0	$1,042	$6,251	$11
3.8	Misc. Equip.(cranes,AirComp.,Comm.)	$2,709	$0	$828	$0	$3,536	$340	$0	$775	$4,652	$8
	SUBTOTAL 3.	**$42,453**	**$0**	**$19,927**	**$0**	**$62,380**	**$5,705**	**$0**	**$11,064**	**$79,149**	**$144**

Exhibit 5-9 Case 1A capital costs (Continued)

Acct		Equipment	Material	Labor		Bare Erected	Eng'g CM	Contingencies		TOTAL PLANT COST	
No.	Item/Description	Cost	Cost	Direct	Indirect	Cost $	H.O.& Fee	Process	Project	$	$/kW
4	PC BOILER										
4.1	PC Boiler & Accessories	$157,253	$0	$88,235	$0	$245,488	$23,891	$0	$26,938	$296,317	$539
4.2	SCR (w/4.1)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.3	Open	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.4	Boiler BoP (w/ ID Fans)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.5	Primary Air System	w/4.1	$0	w/4.1	$0	$0	$0	$0	$0	$0	$0
4.6	Secondary Air System	w/4.1	$0	w/4.1	$0	$0	$0	$0	$0	$0	$0
4.8	Major Component Rigging	$0	w/4.1	w/4.1	$0	$0	$0	$0	$0	$0	$0
4.9	Boiler Foundations	$0	w/14.1	w/14.1	$0	$0	$0	$0	$0	$0	$0
	SUBTOTAL 4.	**$157,253**	**$0**	**$88,235**	**$0**	**$245,488**	**$23,891**	**$0**	**$26,938**	**$296,317**	**$539**
5	FLUE GAS CLEANUP										
5.1	Absorber Vessels & Accessories	$55,471	$0	$11,942	$0	$67,413	$6,427	$0	$7,384	$81,224	$148
5.2	Other FGD	$2,895	$0	$3,280	$0	$6,175	$599	$0	$677	$7,452	$14
5.3	Bag House & Accessories	$15,622	$0	$9,914	$0	$25,536	$2,461	$0	$2,800	$30,797	$56
5.4	Other Particulate Removal Materials	$1,057	$0	$1,131	$0	$2,189	$212	$0	$240	$2,641	$5
5.5	Gypsum Dewatering System	$4,598	$0	$781	$0	$5,379	$512	$0	$589	$6,480	$12
5.6	Mercury Removal System	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
5.9	Open	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	SUBTOTAL 5.	**$79,643**	**$0**	**$27,049**	**$0**	**$106,692**	**$10,211**	**$0**	**$11,690**	**$128,593**	**$234**
5B	CO_2 REMOVAL & COMPRESSION										
5B.1	CO_2 Removal System	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
5B.2	CO_2 Compression & Drying	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	SUBTOTAL 5.	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
6	COMBUSTION TURBINE/ACCESSORIES										
6.1	Combustion Turbine Generator	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
6.2	Open	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
6.3	Compressed Air Piping	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
6.9	Combustion Turbine Foundations	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	SUBTOTAL 6.	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
7	HRSG, DUCTING & STACK										
7.1	Heat Recovery Steam Generator	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
7.2	HRSG Accessories	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
7.3	Ductwork	$8,675	$0	$5,574	$0	$14,249	$1,242	$0	$2,324	$17,816	$32
7.4	Stack	$8,721	$0	$5,103	$0	$13,824	$1,331	$0	$1,516	$16,671	$30
7.9	Duct & Stack Foundations	$0	$1,000	$1,137	$0	$2,137	$200	$0	$467	$2,804	$5
	SUBTOTAL 7.	**$17,397**	**$1,000**	**$11,814**	**$0**	**$30,211**	**$2,773**	**$0**	**$4,307**	**$37,291**	**$68**
8	STEAM TURBINE GENERATOR										
8.1	Steam TG & Accessories	$51,625	$0	$6,866	$0	$58,491	$5,606	$0	$6,410	$70,507	$128
8.2	Turbine Plant Auxiliaries	$347	$0	$744	$0	$1,091	$107	$0	$120	$1,317	$2
8.3	Condenser & Auxiliaries	$6,712	$0	$2,288	$0	$9,000	$861	$0	$986	$10,848	$20
8.4	Steam Piping	$15,895	$0	$7,837	$0	$23,732	$1,994	$0	$3,859	$29,585	$54
8.9	TG Foundations	$0	$1,089	$1,721	$0	$2,810	$266	$0	$615	$3,691	$7
	SUBTOTAL 8.	**$74,579**	**$1,089**	**$19,456**	**$0**	**$95,124**	**$8,833**	**$0**	**$11,990**	**$115,948**	**$211**

Exhibit 5-9 Case 1A capital costs (Continued)

Acct		Equipment	Material	Labor		Bare Erected	Eng'g CM	Contingencies		TOTAL PLANT COST	
No.	Item/Description	Cost	Cost	Direct	Indirect	Cost $	H.O.& Fee	Process	Project	$	$/kW
9	COOLING WATER SYSTEM										
9.1	Cooling Towers	$9,084	$0	$2,829	$0	$11,913	$1,139	$0	$1,305	$14,358	$26
9.2	Circulating Water Pumps	$1,887	$0	$116	$0	$2,003	$169	$0	$217	$2,389	$4
9.3	Circ.Water System Auxiliaries	$498	$0	$66	$0	$565	$54	$0	$62	$680	$1
9.4	Circ.Water Piping	$0	$3,950	$3,828	$0	$7,779	$728	$0	$1,276	$9,783	$18
9.5	Make-up Water System	$438	$0	$585	$0	$1,024	$98	$0	$168	$1,290	$2
9.6	Component Cooling Water Sys	$395	$0	$314	$0	$709	$67	$0	$116	$892	$2
9.9	Circ.Water System Foundations& Structures	$0	$2,346	$3,727	$0	$6,073	$575	$0	$1,330	$7,977	$15
	SUBTOTAL 9.	**$12,303**	**$6,296**	**$11,466**	**$0**	**$30,066**	**$2,830**	**$0**	**$4,475**	**$37,370**	**$68**
10	ASH/SPENT SORBENT HANDLING SYS										
10.1	Ash Coolers	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
10.2	Cyclone Ash Letdown	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
10.3	HGCU Ash Letdown	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
10.4	High Temperature Ash Piping	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
10.5	Other Ash Recovery Equipment	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
10.6	Ash Storage Silos	$590	$0	$1,818	$0	$2,408	$236	$0	$264	$2,909	$5
10.7	Ash Transport & Feed Equipment	$3,819	$0	$3,912	$0	$7,731	$739	$0	$847	$9,317	$17
10.8	Misc. Ash Handling Equipment	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
10.9	Ash/Spent Sorbent Foundation	$0	$140	$165	$0	$305	$29	$0	$67	$401	$1
	SUBTOTAL 10.	**$4,409**	**$140**	**$5,895**	**$0**	**$10,444**	**$1,004**	**$0**	**$1,178**	**$12,627**	**$23**
11	ACCESSORY ELECTRIC PLANT										
11.1	Generator Equipment	$1,598	$0	$260	$0	$1,858	$172	$0	$152	$2,182	$4
11.2	Station Service Equipment	$2,824	$0	$928	$0	$3,752	$351	$0	$308	$4,410	$8
11.3	Switchgear & Motor Control	$3,247	$0	$552	$0	$3,798	$352	$0	$415	$4,565	$8
11.4	Conduit & Cable Tray	$0	$2,035	$7,038	$0	$9,073	$878	$0	$1,493	$11,445	$21
11.5	Wire & Cable	$0	$3,841	$7,414	$0	$11,255	$948	$0	$1,830	$14,034	$26
11.6	Protective Equipment	$260	$0	$885	$0	$1,146	$112	$0	$126	$1,383	$3
11.7	Standby Equipment	$1,277	$0	$29	$0	$1,306	$120	$0	$143	$1,568	$3
11.8	Main Power Transformers	$8,335	$0	$172	$0	$8,507	$646	$0	$915	$10,068	$18
11.9	Electrical Foundations	$0	$311	$763	$0	$1,074	$103	$0	$235	$1,412	$3
	SUBTOTAL 11.	**$17,541**	**$6,187**	**$18,041**	**$0**	**$41,769**	**$3,682**	**$0**	**$5,617**	**$51,068**	**$93**
12	INSTRUMENTATION & CONTROL										
12.1	PC Control Equipment	w/12.7	$0	w/12.7	$0	$0	$0	$0	$0	$0	$0
12.2	Combustion Turbine Control	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
12.3	Steam Turbine Control	w/8.1	$0	w/8.1	$0	$0	$0	$0	$0	$0	$0
12.4	Other Major Component Control	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
12.5	Signal Processing Equipment	w/12.7	$0	w/12.7	$0	$0	$0	$0	$0	$0	$0
12.6	Control Boards,Panels & Racks	$450	$0	$270	$0	$720	$68	$0	$118	$906	$2
12.7	Distributed Control System Equipment	$4,543	$0	$794	$0	$5,337	$495	$0	$583	$6,415	$12
12.8	Instrument Wiring & Tubing	$2,463	$0	$4,885	$0	$7,348	$626	$0	$1,196	$9,170	$17
12.9	Other I & C Equipment	$1,284	$0	$2,913	$0	$4,197	$407	$0	$460	$5,064	$9
	SUBTOTAL 12.	**$8,739**	**$0**	**$8,862**	**$0**	**$17,601**	**$1,596**	**$0**	**$2,358**	**$21,555**	**$39**

Exhibit 5-9 Case 1A capital costs (Continued)

Acct		Equipment	Material	Labor		Bare Erected	Eng'g CM	Contingencies		TOTAL PLANT COST	
No.	Item/Description	Cost	Cost	Direct	Indirect	Cost $	H.O.& Fee	Process	Project	$	$/kW
13	IMPROVEMENTS TO SITE										
13.1	Site Preparation	$0	$50	$998	$0	$1,048	$104	$0	$230	$1,382	$3
13.2	Site Improvements	$0	$1,657	$2,058	$0	$3,715	$366	$0	$816	$4,897	$9
13.3	Site Facilities	$2,969	$0	$2,928	$0	$5,897	$581	$0	$1,296	$7,774	$14
	SUBTOTAL 13.	**$2,969**	**$1,707**	**$5,984**	**$0**	**$10,660**	**$1,052**	**$0**	**$2,342**	**$14,054**	**$26**
14	BUILDINGS & STRUCTURES										
14.1	Boiler Building	$0	$8,281	$7,282	$0	$15,564	$1,399	$0	$2,544	$19,507	$35
14.2	Turbine Building	$0	$11,828	$11,024	$0	$22,851	$2,060	$0	$3,737	$28,648	$52
14.3	Administration Building	$0	$586	$620	$0	$1,206	$109	$0	$197	$1,513	$3
14.4	Circulation Water Pumphouse	$0	$168	$134	$0	$301	$27	$0	$49	$378	$1
14.5	Water Treatment Buildings	$0	$566	$516	$0	$1,081	$97	$0	$177	$1,356	$2
14.6	Machine Shop	$0	$392	$264	$0	$656	$58	$0	$107	$821	$1
14.7	Warehouse	$0	$266	$267	$0	$532	$48	$0	$87	$668	$1
14.8	Other Buildings & Structures	$0	$217	$185	$0	$402	$36	$0	$66	$504	$1
14.9	Waste Treating Building & Str.	$0	$416	$1,262	$0	$1,678	$159	$0	$276	$2,112	$4
	SUBTOTAL 14.	**$0**	**$22,720**	**$21,552**	**$0**	**$44,272**	**$3,994**	**$0**	**$7,240**	**$55,506**	**$101**
	TOTAL COST	**$444,675**	**$44,192**	**$250,892**	**$0**	**$739,759**	**$69,584**	**$0**	**$96,558**	**$905,901**	**$1,647**
	Owner's Costs										
	Preproduction Costs										
	6 Months All Labor									$7,258	$13
	1 Month Maintenance Materials									$895	$2
	1 Month Non-fuel Consumables									$892	$2
	1 Month Waste Disposal									$235	$0
	25% of 1 Months Fuel Cost at 100% CF									$1,427	$3
	2% of TPC									$18,118	$33
	Total									**$28,826**	**$52**
	Inventory Capital										
	60 day supply of fuel and consumables at 100% CF									$12,944	$24
	0.5% of TPC (spare parts)									$4,530	$8
	Total									**$17,474**	**$32**
	Initial Cost for Catalyst and Chemicals									$0	$0
	Land									$900	$2
	Other Owner's Costs									$135,885	$247
	Financing Costs									$24,459	$44
	Total Overnight Costs (TOC)									**$1,113,445**	**$2,024**
	TASC Multiplier							(IOU, low-risk, 35 year)		1.134	
	Total As-Spent Cost (TASC)									**$1,262,647**	**$2,296**

Exhibit 5-10 Case 1A operation and maintenance costs

INITIAL & ANNUAL O&M EXPENSES					Cost Base (Jun):	2007
Case 1A - 1x550 MWnet SuperCritical PC					Heat Rate-net (Btu/kWh):	8,686
					MWe-net:	550
					Capacity Factor (%):	85
OPERATING & MAINTENANCE LABOR						
Operating Labor						
Operating Labor Rate(base):	34.65	$/hour				
Operating Labor Burden:	30.00	% of base				
Labor O-H Charge Rate:	25.00	% of labor				
Operating Labor Requirements(O.J.)per Shift:	1 unit/mod.		Total Plant			
Skilled Operator	2.0		2.0			
Operator	9.0		9.0			
Foreman	1.0		1.0			
Lab Tech's, etc.	2.0		2.0			
TOTAL-O.J.'s	14.0		14.0			
					Annual Cost	Annual Unit Cost
					$	$/kW-net
Annual Operating Labor Cost					$5,524,319	$10.044
Maintenance Labor Cost					$6,088,905	$11.070
Administrative & Support Labor					$2,903,306	$5.279
Property Taxes and Insurance					$18,118,017	$32.941
TOTAL FIXED OPERATING COSTS					**$32,634,546**	**$59.333**
VARIABLE OPERATING COSTS						
						$/kWh-net
Maintenance Material Cost					**$9,133,357**	**$0.00223**
Consumables	Consumption Initial Fill	/Day	Unit Cost	Initial Fill Cost		
Water (/1000 gallons)	0	3,884	1.08	**$0**	**$1,303,324**	**$0.00032**
Chemicals						
MU & WT Chem.(lbs)	0	18,799	0.17	$0	$1,009,427	$0.00025
Limestone (ton)	0	488	21.63	$0	$3,273,667	$0.00080
Carbon (Mercury Removal) (lb)	0	0	1.05	$0	$0	$0.00000
MEA Solvent (ton)	0	0	2,249.89	$0	$0	$0.00000
NaOH (tons)	0	0	433.68	$0	$0	$0.00000
H2SO4 (tons)	0	0	138.78	$0	$0	$0.00000
Corrosion Inhibitor	0	0	0.00	$0	$0	$0.00000
Activated Carbon (lb)	0	0	1.05	$0	$0	$0.00000
Ammonia (19% NH3) ton	0	74	129.80	$0	$2,960,869	$0.00072
Subtotal Chemicals				**$0**	**$7,243,963**	**$0.00177**
Other						
Supplemental Fuel (MBtu)	0	0	0.00	$0	$0	$0.00000
SCR Catalyst (m3)	w/equip.	0.31	5,775.94	$0	$553,798	$0.00014
Emission Penalties	0	0	0.00	$0	$0	$0.00000
Subtotal Other				**$0**	**$553,798**	**$0.00014**
Waste Disposal						
Fly Ash (ton)	0	381	16.23	$0	$1,919,038	$0.00047
Bottom Ash (ton)	0	95	16.23	$0	$479,759	$0.00012
Subtotal-Waste Disposal				**$0**	**$2,398,797**	**$0.00059**
By-products & Emissions						
Gypsum (tons)	0	759	0.00	$0	$0	$0.00000
Subtotal By-Products				**$0**	**$0**	**$0.00000**
TOTAL VARIABLE OPERATING COSTS				**$0**	**$20,633,239**	**$0.00504**
Fuel (ton)	0	4,914	38.18	**$0**	**$58,217,892**	**$0.01422**

Exhibit 5-11 Cost of electricity breakdown for Case 1A

TOC, $/kW	2024
COE w/o TS&M, $/MW	**58.9**
Capital, $/MW	31.7
Fixed, $/MW	8.0
Variable, $/MW	5.0
Fuel, $/MW	14.2

5.2 Case 1B

Exhibit 5-12 Case 1B Stream table

	1	2	3	4	5	6	7	8	9	10	11	12
V-L Mole Fraction												
Ar	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092	0.0000	0.0000	0.0087	0.0000	0.0087
CO_2	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0000	0.0000	0.1451	0.0000	0.1451
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	0.0099	0.0099	0.0099	0.0099	0.0099	0.0099	0.0099	0.0000	0.0000	0.0871	0.0000	0.0871
N_2	0.7732	0.7732	0.7732	0.7732	0.7732	0.7732	0.7732	0.0000	0.0000	0.7324	0.0000	0.7324
O_2	0.2074	0.2074	0.2074	0.2074	0.2074	0.2074	0.2074	0.0000	0.0000	0.0245	0.0000	0.0245
SO_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0021	0.0000	0.0021
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000	0.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	44,683	44,683	1,323	13,726	13,726	1,889	1,033	0	0	62,880	0	62,880
V-L Flowrate (kg/hr)	1,289,410	1,289,410	38,190	396,093	396,093	54,513	29,823	0	0	1,870,286	0	1,870,286
Solids Flowrate (kg/hr)	0	0	0	0	0	0	0	171,599	3,328	13,312	13,312	0
Temperature (°C)	15	19	19	15	25	25	15	15	15	169	15	169
Pressure (MPa, abs)	0.10	0.11	0.11	0.10	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10
Enthalpy (kJ/kg)[A]	30.23	34.36	34.36	30.23	40.78	40.78	30.23	---	---	327.50	---	309.04
Density (kg/m^3)	1.2	1.2	1.2	1.2	1.3	1.3	1.2	---	---	0.8	---	0.8
V-L Molecular Weight	28.857	28.857	28.857	28.857	28.857	28.857	28.857	---	---	29.744	---	29.744
V-L Flowrate (lb_{mol}/hr)	98,509	98,509	2,918	30,261	30,261	4,165	2,278	0	0	138,626	0	138,626
V-L Flowrate (lb/hr)	2,842,662	2,842,662	84,194	873,236	873,236	120,180	65,749	0	0	4,123,274	0	4,123,274
Solids Flowrate (lb/hr)	0	0	0	0	0	0	0	378,311	7,337	29,347	29,347	0
Temperature (°F)	59	66	66	59	78	78	59	59	59	337	59	337
Pressure (psia)	14.7	15.3	15.3	14.7	16.1	16.1	14.7	14.7	14.7	14.4	14.7	14.2
Enthalpy (Btu/lb)[A]	13.0	14.8	14.8	13.0	17.5	17.5	13.0	---	---	140.8	---	132.9
Density (lb/ft^3)	0.076	0.078	0.078	0.076	0.081	0.081	0.076	---	---	0.050	---	0.049
	A - Reference conditions are 32.02 F & 0.089 PSIA											

Exhibit 5-12 Case 1B Stream table (Continued)

	13	14	15	16	17	18	19	20	21	22	23
V-L Mole Fraction											
Ar	0.0087	0.0000	0.0000	0.0128	0.0000	0.0082	0.0000	0.0000	0.0000	0.0000	0.0000
CO_2	0.1451	0.0000	0.0000	0.0005	0.0004	0.1354	0.0000	0.0000	0.0000	0.0000	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	0.0871	1.0000	1.0000	0.0062	0.9995	0.1517	1.0000	1.0000	1.0000	1.0000	1.0000
N_2	0.7324	0.0000	0.0000	0.7506	0.0000	0.6808	0.0000	0.0000	0.0000	0.0000	0.0000
O_2	0.0245	0.0000	0.0000	0.2300	0.0000	0.0239	0.0000	0.0000	0.0000	0.0000	0.0000
SO_2	0.0021	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	62,880	2,189	8,856	671	162	68,382	70,355	57,535	57,535	54,642	54,642
V-L Flowrate (kg/hr)	1,870,286	39,444	159,544	19,470	2,928	1,973,238	1,267,466	1,036,502	1,036,502	984,384	984,384
Solids Flowrate (kg/hr)	0	17,031	0	0	26,507	0	0	0	0	0	0
Temperature (°C)	181	15	15	167	57	57	732	390	760	38	40
Pressure (MPa, abs)	0.11	0.10	0.10	0.31	0.10	0.10	34.47	4.90	4.35	0.01	1.69
Enthalpy (kJ/kg)[A]	321.12	---	-46.80	177.65	---	297.65	3,803.80	3,174.83	4,042.33	2,160.05	166.81
Density (kg/m^3)	0.8	---	1,003.1	2.5	---	1.1	81.3	17.3	9.2	0.1	993.2
V-L Molecular Weight	29.744	---	18.015	29.029	---	28.856	18.015	18.015	18.015	18.015	18.015
V-L Flowrate (lb_{mol}/hr)	138,626	4,827	19,524	1,479	358	150,756	155,106	126,842	126,842	120,464	120,464
V-L Flowrate (lb/hr)	4,123,274	86,959	351,735	42,923	6,455	4,350,245	2,794,284	2,285,095	2,285,095	2,170,195	2,170,195
Solids Flowrate (lb/hr)	0	37,547	0	0	58,437	0	0	0	0	0	0
Temperature (°F)	357	59	59	333	135	135	1,350	734	1,400	101	103
Pressure (psia)	15.3	15.0	14.7	45.0	14.8	14.8	5,000.0	710.8	630.8	1.0	245.0
Enthalpy (Btu/lb)[A]	138.1	---	-20.1	76.4	---	128.0	1,635.3	1,364.9	1,737.9	928.7	71.7
Density (lb/ft^3)	0.052	---	62.622	0.154	---	0.067	5.073	1.078	0.575	0.004	62.002

Exhibit 5-13 Case 1B Performance summary

	Case 1B	Units
Plant Output		
Steam Turbine Power	577,800	kW_e
Total	**577,800**	kW_e
Auxiliary Load		
Coal Handling and Conveying	420	kW_e
Pulverizers	2,570	kW_e
Sorbent Handling & Reagent Preparation	820	kW_e
Ash Handling	490	kW_e
Primary Air Fans	1,200	kW_e
Forced Draft Fans	1,540	kW_e
Induced Draft Fans	6,500	kW_e
SCR	40	kW_e
Baghouse	60	kW_e
Wet FGD	2,750	kW_e
CO_2 Compression	0	kW_e
Miscellaneous Balance of Plant[2,3]	2,000	kW_e
Steam Turbine Auxiliaries	400	kW_e
Condensate Pumps	620	kW_e
Circulating Water Pumps	4,080	kW_e
Ground Water Pumps	420	kW_e
Cooling Tower Fans	2,110	kW_e
Transformer Losses	1,800	kW_e
Total	**27,820**	**kW_e**
Plant Performance		
Net Auxiliary Load	27,820	kW_e
Net Plant Power	549,980	kW_e
Net Plant Efficiency (HHV)	42.5%	
Net Plant Heat Rate (HHV)	8,466 (8,025)	kJ/kWhr (Btu/kWhr)
Coal Feed Flowrate	171,599 (378,311)	kg/hr (lb/hr)
Thermal Input[1]	1,293,433	kW_{th}
Condenser Duty	1,968 (1,866)	GJ/hr (MMBtu/hr)
Raw Water Withdrawal	17.5 (4,618)	m^3/min (gpm)
Raw Water Consumption	13.9 (3,674)	m^3/min (gpm)

1 - HHV of Illinois No. 6 coal is 27,135 kJ/kg (11,666 Btu/lb)
2 – Boiler feed pumps are turbine driven
3 – Includes plant control systems, lighting, HVAC, and miscellaneous low voltage loads

Exhibit 5-14 Case 1B water balance

	Water Demand	Internal Recycle	Raw Water Withdrawal	Process Water Discharge	Raw Water Consumption
	m^3/min (gpm)				
FGD Makeup	3.32 (877)	-	3.32 (877)	-	3.32 (877)
BFW Makeup	-	-	-	-	-
Cooling Tower	15.9 (4,195)	1.72 (455)	14.2 (3,740)	3.57 (943)	10.59 (2,797)
Total	**19.2 (5,072)**	**1.72 (455)**	**17.5 (4,618)**	**3.57 (943)**	**13.91 (3,674)**

Exhibit 5-15 Case 1B carbon balance

Carbon In		Carbon Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	109,385 (241,153)	Stack Gas	111,201 (245,155)
Air (CO2)	237 (523)	FGD Product	150 (331)
FGD Reagent	1,728 (3,810)		-
Total	**111,351 (245,486)**	**Total**	**111,351 (245,486)**

Exhibit 5-16 Case 1B sulfur balance

Sulfur In		Sulfur Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	4,301 (9,482)	Stack Gas	86 (190)
		FGD Product	4,215 (9,292)
Total	**4,301 (9,482)**	**Total**	**4,301 (9,482)**

Exhibit 5-17 Case 1B energy balance

	HHV	Sensible + Latent	Power	Total
Heat In GJ/hr (MMBtu/hr)				
Coal	4,656 (4,413)	3.9 (3.7)	-	4,660 (4,417)
Air	-	51.8 (49.1)	-	51.8 (49.1)
Raw Water Makeup	-	65.8 (62.3)	-	65.8 (62.3)
Lime	-	0.19 (0.18)	-	0.19 (0.18)
Auxiliary Power	-	-	100 (95)	100 (95)
TOTAL	**4,656 (4,413)**	**121.7 (115.4)**	**100 (95)**	**4,878 (4,624)**
Heat Out GJ/hr (MMBtu/hr)				
Bottom Ash	-	0.4 (0.4)	-	0.4 (0.4)
Fly Ash + FGD Ash	-	1.6 (1.5)	-	1.6 (1.5)
Flue Gas	-	587 (557)	-	587 (557)
Condenser	-	1,968 (1,866)	-	1,968 (1,866)
Cooling Tower Blowdown	-	26.5 (25.1)	-	26.5 (25.1)
*Process Losses**	-	*214 (203)*	-	*214 (203)*
Power	-	-	2,080 (1,972)	2,080 (1,972)
TOTAL	-	**2,798 (2,652)**	**2,080 (1,972)**	**4,878 (4,624)**

* Process losses are estimated to match the heat input to the plant.

Exhibit 5-18 Case 1B air emissions

	kg/GJ (lb/MMBtu)	tonne/yr (Ton/year)	kg/MWgross (lb/MWgross)
SO_2	0.037 (0.086)	1,279 (1,410)	0.297 (.66)
NOx	0.030 (0.070)	1,043 (1,150)	0.243 (.535)
Particulate	0.006 (0.0130)	194 (214)	0.045 (.099)
Hg	4.91E-7 (1.14E-6)	0.017 (0.019)	3.96E-6 (8.73E-6)
CO_2	87.5 (203.5)	3,033,894 (3,344,296)	705 (1,555)

Exhibit 5-19 Case 1B capital costs

										Cost Base:	Jan 2007	
										Prepared:	4-Jan-12	
	Case:	NCC_AUSC									x $1, 000	
	Plant Size:	549.98	MW, net			Capital Charge Factor		0.85				
Acct No.	Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected Cost $	Eng'g CM H.O. & Fee Total	Process Cont. Total	Project Cont. Total	TOTAL PLANT COST $	$/kW	
1	COAL HANDLING SYSTEM											
1.1	Coal Receive & Unload	3,206	0	1,464	0	4,671	417	0	763	5,851	11	
1.2	Coal Stackout & Reclaim	4,144	0	939	0	5,082	445	0	829	6,356	12	
1.3	Coal Conveyors & Yd Crus	3,852	0	929	0	4,781	419	0	780	5,980	11	
1.4	Other Coal Handling	1,008	0	215	0	1,223	107	0	199	1,529	3	
1.5	Sorbent Receive & Unload	128	0	39	0	167	15	0	27	209	0	
1.6	Sorbent Stackout & Reclaim	2,068	0	379	0	2,447	213	0	399	3,059	6	
1.7	Sorbent Conveyors	738	160	181	0	1,079	93	0	176	1,347	2	
1.8	Other Sorbent Handling	446	104	234	0	784	69	0	128	981	2	
1.9	Coal & Sorbent Hnd.Foundations	0	3,938	4,967	0	8,905	836	0	1,461	11,203	20	
	SUBTOTAL 1.	**$15,590**	**$4,202**	**$9,347**	**$0**	**$29,138**	**$2,615**	**$0**	**$4,763**	**$36,516**	**$66**	
2	COAL PREP & FEED SYSTEMS											
2.1	Coal Crushing & Drying	1,831	0	357	0	2,187	191	0	357	2,735	5	
2.2	Prepared Coal Storage & Feed	4,687	0	1,023	0	5,710	499	0	931	7,140	13	
2.3	Slurry Prep & Feed	0	0	0	0	0	0	0	0	0	0	
2.4	Misc. Coal Prep & Feed	0	0	0	0	0	0	0	0	0	0	
2.5	Sorbent Prep Equipment	3,510	151	729	0	4,390	382	0	716	5,488	10	
2.6	Sorbent Storage & Feed	423	0	162	0	585	52	0	96	732	1	
2.7	Sorbent Injection System	0	0	0	0	0	0	0	0	0	0	
2.8	Booster Air Supply System	0	0	0	0	0	0	0	0	0	0	
2.9	Coal & Sorbent Feed Foundation	0	454	381	0	836	77	0	137	1,050	2	
	SUBTOTAL 2.	**$10,450**	**$606**	**$2,652**	**$0**	**$13,708**	**$1,201**	**$0**	**$2,236**	**$17,145**	**$31**	
3	FEEDWATER & MISC. BOP SYSTEMS											
3.1	Feedwater System	15,431	0	4,985	0	20,416	1,784	0	3,330	25,530	46	
3.2	Water Makeup & Pretreating	4,033	0	1,298	0	5,331	504	0	1,167	7,002	13	
3.3	Other Feedwater Subsystems	4,724	0	1,997	0	6,721	602	0	1,098	8,421	15	
3.4	Service Water Systems	791	0	430	0	1,221	115	0	267	1,603	3	
3.5	Other Boiler Plant Systems	5,549	0	5,479	0	11,028	1,048	0	1,811	13,887	25	
3.6	FO Supply Sys & Nat Gas	250	0	313	0	563	53	0	92	708	1	
3.7	Waste Treatment Equipment	2,734	0	1,559	0	4,293	418	0	942	5,653	10	
3.8	Misc. Power Plant Equipment	2,656	0	811	0	3,467	333	0	760	4,560	8	
	SUBTOTAL 3.	**$36,168**	**$0**	**$16,871**	**$0**	**$53,039**	**$4,857**	**$0**	**$9,468**	**$67,364**	**$122**	

Exhibit 5-19 Case 1B capital costs (Continued)

Acct No.	Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected Cost $	Eng'g CM H.O. & Fee Total	Process Cont. Total	Project Cont. Total	TOTAL PLANT COST $	TOTAL PLANT COST $/kW
4	PC BOILER & ACCESSORIES										
4.1	PC Boiler & Accessories	130,116	0	73,008	0	203,124	19,768	22,289	22,289	267,471	486
4.2	SCR (w/4.1)	0	0	0	0	0	0	0	0	0	0
4.3	Open	0	0	0	0	0	0	0	0	0	0
4.4	Boiler BoP (w/ ID Fans)	0	0	0	0	0	0	0	0	0	0
4.5	Primary Air System	w/4.1	0	w/4.1	0	0	0	0	0	0	0
4.6	Secondary Air System	w/4.1	0	w/4.1	0	0	0	0	0	0	0
4.8	Major Component Rigging	0	w/4.1	w/4.1	0	0	0	0	0	0	0
4.9	Boiler Foundations	0	w/14.1	w/14.1	0	0	0	0	0	0	0
	SUBTOTAL 4.	**$130,116**	**$0**	**$73,008**	**$0**	**$203,124**	**$19,768**	**$22,289**	**$22,289**	**$267,471**	**$486**
5A	FLUE GAS CLEANUP										
5.1	Absorber Vessels & Accessories	52,362	0	11,272	0	63,634	6,067	0	6,970	76,671	139
5.2	Other FGD	2,732	0	3,096	0	5,829	566	0	639	7,034	13
5.3	Bag House & Accessories	14,688	0	9,321	0	24,009	2,314	0	2,632	28,954	53
5.4	Other Particulate Removal Materials	994	0	1,064	0	2,058	200	0	226	2,483	5
5.5	Gypsum Dewatering System	4,391	0	746	0	5,137	489	0	563	6,188	11
5.6	Mercury Removal System	0	0	0	0	0	0	0	0	0	0
5.7	Open	0	0	0	0	0	0	0	0	0	0
	SUBTOTAL 5A.	**$75,167**	**$0**	**$25,499**	**$0**	**$100,666**	**$9,635**	**$0**	**$11,030**	**$121,330**	**$221**
5B	CO2 REMOVAL & COMPRESSION										
5B.1	CO2 Removal System	0	0	0	0	0	0	0	0	0	0
5B.2	CO2 Compression & Drying	0	0	0	0	0	0	0	0	0	0
	SUBTOTAL 5B.	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
6	COMBUSTION TURBINE/ACCESSORIES										
6.1	Combustion Turbine Generator	0	0	0	0	0	0	0	0	0	0
6.2	Combustion Turbine Accessories	0	0	0	0	0	0	0	0	0	0
6.3	Compressed Air Piping	0	0	0	0	0	0	0	0	0	0
6.4	Combustion Turbine Foundations	0	0	0	0	0	0	0	0	0	0
	SUBTOTAL 6.	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
7	HRSG, DUCTING & STACK										
7.1	Flue Gas Recycle Heat Exhchanger	N/A	0	N/A	0	0	0	0	0	0	0
7.2	SCR System	0	0	0	0	0	0	0	0	0	0
7.3	Ductwork	8,465	0	5,439	0	13,903	1,212	0	2,267	17,383	32
7.4	Stack	8,652	0	5,063	0	13,715	1,320	0	1,504	16,539	30
7.9	HRSG, Duct & Stack Foundations	0	992	1,128	0	2,120	198	0	464	2,782	5
	SUBTOTAL 7.	**$17,117**	**$992**	**$11,629**	**$0**	**$29,739**	**$2,731**	**$0**	**$4,235**	**$36,704**	**$67**
8	STEAM TURBINE GENERATOR										
8.1	Steam TG & Accessories	51,465	0	6,845	0	58,311	5,588	9,585	6,390	79,874	145
8.2	Turbine Plant Auxiliaries	346	0	741	0	1,087	106	0	119	1,313	2
8.3	Condenser & Auxiliaries	6,050	0	2,063	0	8,112	776	0	889	9,778	18
8.4	Steam Piping	12,957	0	6,389	0	19,346	1,625	0	3,146	24,117	44
8.9	TG Foundations	0	1,086	1,716	0	2,802	265	0	613	3,680	7
	SUBTOTAL 8.	**$70,819**	**$1,086**	**$17,753**	**$0**	**$89,658**	**$8,362**	**$9,585**	**$11,157**	**$118,762**	**$216**

Exhibit 5-19 Case 1B capital costs (Continued)

Acct No.	Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected Cost $	Eng'g CM H.O. & Fee Total	Process Cont. Total	Project Cont. Total	TOTAL PLANT COST $	TOTAL PLANT COST $/kW
9	COOLING WATER SYSTEM										
9.1	Cooling Towers	8,192	0	2,551	0	10,744	1,027	0	1,177	12,948	24
9.2	Circulating Water Pumps	1,662	0	102	0	1,764	149	0	191	2,104	4
9.3	Circ. Water System Auxiliaries	453	0	60	0	513	49	0	56	618	1
9.4	Circ. Water Piping	0	3,589	3,478	0	7,067	662	0	1,159	8,888	16
9.5	Make-up Water System	403	0	538	0	940	90	0	155	1,185	2
9.6	Component Cooling Water System	359	0	285	0	644	61	0	106	811	1
9.9	Circ. Water System Foundations	0	2,163	3,437	0	5,600	530	0	1,226	7,355	13
	SUBTOTAL 9.	**$11,069**	**$5,752**	**$10,451**	**$0**	**$27,271**	**$2,567**	**$0**	**$4,070**	**$33,909**	**$62**
10	ASH/SPENT SORBENT HANDLING SYS										
10.1	Ash Coolers	N/A	0	N/A	0	0	0	0	0	0	0
10.2	Cyclone Ash Letdown	N/A	0	N/A	0	0	0	0	0	0	0
10.3	HGCU Ash Letdown	N/A	0	N/A	0	0	0	0	0	0	0
10.4	High Temperature Ash Piping	N/A	0	N/A	0	0	0	0	0	0	0
10.5	Other Ash Recovery Equipment	N/A	0	N/A	0	0	0	0	0	0	0
10.6	Ash Storage Silos	564	0	1,739	0	2,303	226	0	253	2,782	5
10.7	Ash Transport & Feed Equipment	3,653	0	3,742	0	7,395	707	0	810	8,913	16
10.8	Misc. Ash Handling Equipment	0	0	0	0	0	0	0	0	0	0
10.9	Ash/Spent Sorbent Foundation	0	134	158	0	292	27	0	64	383	1
	SUBTOTAL 10.	**$4,218**	**$134**	**$5,639**	**$0**	**$9,991**	**$961**	**$0**	**$1,127**	**$12,078**	**$22**
11	ACCESSORY ELECTRIC PLANT										
11.1	Generator Equipment	1,594	0	259	0	1,853	172	0	152	2,177	4
11.2	Station Service Equipment	2,717	0	893	0	3,610	337	0	296	4,244	8
11.3	Switchgear & Motor Control	3,124	0	531	0	3,655	339	0	399	4,393	8
11.4	Conduit & Cable Tray	0	1,959	6,772	0	8,731	845	0	1,436	11,012	20
11.5	Wire & Cable	0	3,696	7,134	0	10,830	912	0	1,761	13,504	25
11.6	Protective Equipment	260	0	885	0	1,146	112	0	126	1,383	3
11.7	Standby Equipment	1,274	0	29	0	1,303	120	0	142	1,565	3
11.8	Main Power Transformers	8,335	0	172	0	8,507	646	0	915	10,068	18
11.9	Electrical Foundations	0	310	761	0	1,071	102	0	235	1,408	3
	SUBTOTAL 11.	**$17,305**	**$5,965**	**$17,436**	**$0**	**$40,706**	**$3,585**	**$0**	**$5,463**	**$49,754**	**$90**
12	INSTRUMENTATION & CONTROL										
12.1	PC Control Equipment	w/12.7	0	w/12.7	0	0	0	0	0	0	0
12.2	Combustion Turbine Control	N/A	0	N/A	0	0	0	0	0	0	0
12.3	Steam Turbine Control	w/8.1	0	w/8.1	0	0	0	0	0	0	0
12.4	Other Major Component Control	0	0	0	0	0	0	0	0	0	0
12.5	Signal Processing Equipment	W/12.7	0	w/12.7	0	0	0	0	0	0	0
12.6	Control Boards, Panels & Racks	445	0	267	0	711	67	0	117	895	2
12.7	Computer Accessories	4,491	0	785	0	5,276	489	0	577	6,342	12
12.8	Instrument Wiring & Tubing	2,435	0	4,830	0	7,265	619	0	1,183	9,066	16
12.9	Other I & C Equipment	1,269	0	2,880	0	4,149	402	0	455	5,007	9
	SUBTOTAL 12.	**$8,640**	**$0**	**$8,762**	**$0**	**$17,402**	**$1,578**	**$0**	**$2,789**	**$21,311**	**$39**

Exhibit 5-19 Case 1B capital costs (Continued)

Acct No.	Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected Cost $	Eng'g CM H.O. & Fee Total	Process Cont. Total	Project Cont. Total	TOTAL PLANT COST $	TOTAL PLANT COST $/kW
13	IMPROVEMENTS TO SITE										
13.1	Site Preparation	0	49	977	0	1,026	102	0	225	1,353	2
13.2	Site Improvements	0	1,621	2,014	0	3,635	359	0	799	4,792	9
13.3	Site Facilities	2,905	0	2,865	0	5,771	569	0	1,268	7,607	14
	SUBTOTAL 13.	**$2,905**	**$1,670**	**$5,855**	**$0**	**$10,431**	**$1,029**	**$0**	**$2,579**	**$13,752**	**$25**
14	BUILDINGS & STRUCTURES										
14.1	Boiler Building	0	8,236	7,243	0	15,479	1,391	0	2,531	19,401	35
14.2	Turbine Building	0	11,726	10,928	0	22,654	2,042	0	3,704	28,400	52
14.3	Administration Building	0	580	613	0	1,193	108	0	195	1,497	3
14.4	Circulation Water Pumphouse	0	154	122	0	276	25	0	45	346	1
14.5	Water Treatment Buildings	0	515	470	0	985	89	0	161	1,235	2
14.6	Machine Shop	0	388	261	0	649	58	0	106	812	1
14.7	Warehouse	0	263	264	0	527	48	0	86	660	1
14.8	Other Buildings & Structures	0	215	183	0	398	36	0	65	498	1
14.9	Waste Treating Building & Str.	0	412	1,249	0	1,661	158	0	273	2,092	4
	SUBTOTAL 14.	**$0**	**$22,488**	**$21,333**	**$0**	**$43,822**	**$3,953**	**$0**	**$7,166**	**$54,941**	**$100**
	Total Cost	**$399,563**	**$42,895**	**$226,236**	**$0**	**$668,694**	**$62,841**	**$31,874**	**$88,373**	**$851,037**	**$1,547**
	Owner's Costs										
	Preproduction Costs										
	6 Months All Labor									$6,893	$13
	1 Month Maintenance Materials									$809	$1
	1 Month Non-fuel Consumables									$809	$1
	1 Month Waste Disposal									$217	$0
	25% of 1 Months Fuel Cost at 100% CF									$1,318	$2
	2% of TPC									$17,021	$31
	Total									**$27,067**	**$49**
	Inventory Capital										
	60 day supply of fuel and consumables at 100% CF									$11,944	$22
	0.5% of TPC (spare parts)									$4,255	$8
	Total									**$16,199**	**$29**
	Initial Cost for Catalyst and Chemicals									$0	$0
	Land									$900	$2
	Other Owner's Costs									$127,656	$232
	Financing Costs									$22,978	$42
	Total Overnight Costs (TOC)									**$1,045,837**	**$1,902**
	TASC Multiplier							(IOU, high-risk, 35 year)		1.140	
	Total As-Spent Cost (TASC)									**$1,192,255**	**$2,168**

Exhibit 5-20 Case 1B operation and maintenance costs

	1B				Cost Base (Jun):	2007
					Heat Rate-net (Btu/kWh):	8,025
					MWe-net:	550
					Capacity Factor (%):	85
OPERATING & MAINTENANCE LABOR						
Operating Labor						
Operating Labor Rate(base):	34.65	$/hour				
Operating Labor Burden:	30.00	% of base				
Labor O-H Charge Rate:	25.00	% of labor				
Operating Labor Requirements(O.J.)per S	1 unit/mod.		Total Plant			
Skilled Operator	2.0		2.0			
Operator	9.0		9.0			
Foreman	1.0		1.0			
Lab Tech's, etc.	2.0		2.0			
TOTAL-O.J.'s	14.0		14.0			
					Annual Cost	Annual Unit Cost
					$	$/kW-net
Annual Operating Labor Cost					$5,524,319	$10.045
Maintenance Labor Cost					$5,503,972	$10.008
Administrative & Support Labor					$2,757,073	$5.013
Property Taxes and Insurance					$17,020,747	$30.948
TOTAL FIXED OPERATING COSTS					**$30,806,110**	$56.013
VARIABLE OPERATING COSTS						
						$/kWh-net
Maintenance Material Cost					**$8,255,957**	**$0.00202**
Consumables	Consumption Initial Fill	/Day	Unit Cost	Initial Fill Cost		
Water(/1000 gallons)	0	3,325	1.08	**$0**	**$1,115,787**	**$0.00027**
Chemicals		4.841				
MU & WT Chem. (lbs)	0	16,094	0.17	$0	$864,180	$0.00021
Limestone (ton)	0	451	21.63	$0	$3,024,128	$0.00074
Carbon (Mercury Removal) (lb)	0	0	1.05	$0	$0	$0.00000
MEA Solvent (ton)	0	0	2,249.89	$0	$0	$0.00000
NaOH (tons)	0	0	433.68	$0	$0	$0.00000
H2SO4 (tons)	0	0	138.78	$0	$0	$0.00000
Corrosion Inhibitor	0	0	0.00	$0	$0	$0.00000
Activated Carbon (lb)	0	0	1.05	$0	$0	$0.00000
Ammonia (19% NH3) (ton)	0	67.9	129.80	$0	$2,734,386	$0.00067
Subtotal Chemicals				**$0**	**$6,622,694**	**$0.00162**
Other						
Supplemental Fuel (MBtu)	0	0	0.00	$0	$0	$0.00000
SCR Catalyst (m3)	w/equip.	0.29	5,775.94	$0	$511,155	$0.00012
Emission Penalties	0	0	0.00	$0	$0	$0.00000
Subtotal Other				**$0**	**$511,155**	**$0.00012**
Waste Disposal						
Fly Ash (ton)	0	352.1674	16.23	$0	1,772,756.88	0.00043
Bottom Ash (ton)	0	88	16.23	$0	443,189.22	0.00011
Subtotal Waste Disposal				**$0**	**$2,215,946**	**$0.00054**
By-products & Emissions						
Gypsum (tons)	0	0	0.00	$0	$0	$0.00000
Subtotal By-products				**$0**	**$0**	**$0.00000**
TOTAL VARIABLE OPERATING COSTS				**$0**	**$18,721,539**	**$0.00457**
Fuel (ton)	0	4,540	38.18	**$0**	**$53,781,042**	**$0.01313**

Exhibit 5-21 Cost of electricity breakdown for Case 1B

TOC, $/kW	1902
COE w/o TS&M, $/MW	**57.0**
Capital, $/MW	31.7
Fixed, $/MW	7.5
Variable, $/MW	4.6
Fuel, $/MW	13.1

6 Case 2: Fluor Capture Technology

Results for a plant incorporating a representation of the Flour capture technology are presented. Exhibit 6-1 provides the block flow diagram for this case.

The following are the key points of Fluor capture technology:

- Commercially available, post combustion CO_2 capture
- Amine-based absorber technology
- Includes a polishing scrubber to reduce the flue gas SO_2 to approximately 10 ppmv
- Utilizes steam to remove CO_2 from solvent
- Utilizes a formulation of MEA and a proprietary corrosion inhibitor

Exhibit 6-1 Case 2 block flow diagram

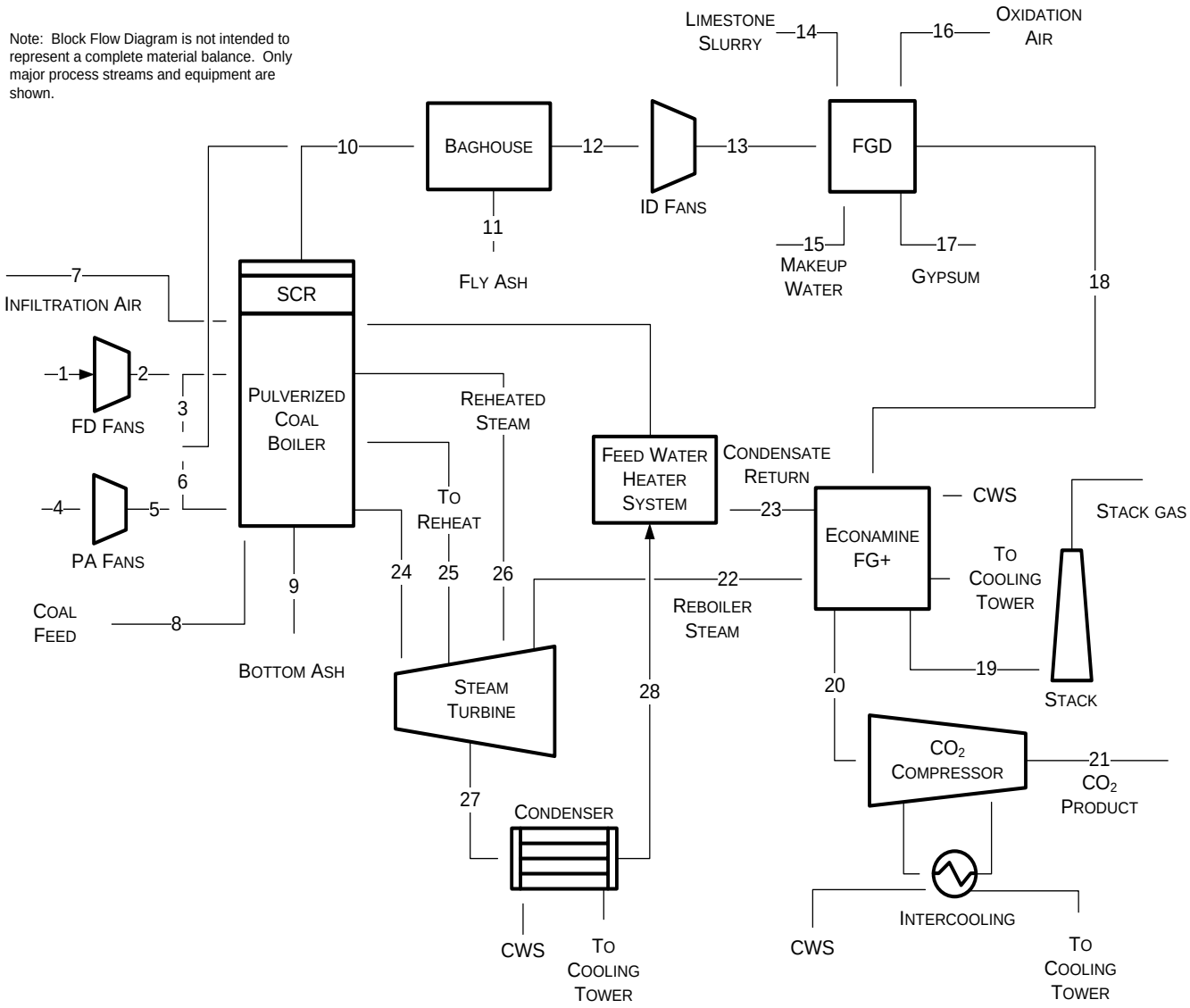


Exhibit 6-2 Case 2 Stream table

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
V-L Mole Fraction														
Ar	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092	0.0000	0.0000	0.0087	0.0000	0.0087	0.0087	0.0000
CO_2	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0000	0.0000	0.1450	0.0000	0.1450	0.1450	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	0.0099	0.0099	0.0099	0.0099	0.0099	0.0099	0.0099	0.0000	0.0000	0.0870	0.0000	0.0870	0.0870	1.0000
N_2	0.7732	0.7732	0.7732	0.7732	0.7732	0.7732	0.7732	0.0000	0.0000	0.7324	0.0000	0.7324	0.7324	0.0000
O_2	0.2074	0.2074	0.2074	0.2074	0.2074	0.2074	0.2074	0.0000	0.0000	0.0247	0.0000	0.0247	0.0247	0.0000
SO_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0021	0.0000	0.0021	0.0021	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000	0.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	66,876	66,876	1,990	20,544	20,544	2,818	1,546	0	0	94,107	0	94,107	94,107	3,385
V-L Flowrate (kg/hr)	1,929,852	1,929,852	57,422	592,830	592,830	81,325	44,605	0	0	2,799,052	0	2,799,052	2,799,052	60,975
Solids Flowrate (kg/hr)	0	0	0	0	0	0	0	256,652	4,977	19,910	19,910	0	0	25,966
Temperature (°C)	15	19	19	15	25	25	15	15	15	169	15	169	182	15
Pressure (MPa, abs)	0.10	0.11	0.11	0.10	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.11	0.10
Enthalpy (kJ/kg)[A]	30.23	34.36	34.36	30.23	40.78	40.78	30.23	---	---	327.40	---	308.96	322.83	---
Density (kg/m^3)	1.2	1.2	1.2	1.2	1.3	1.3	1.2	---	---	0.8	---	0.8	0.8	---
V-L Molecular Weight	28.857	28.857	28.857	28.857	28.857	28.857	28.857	---	---	29.743	---	29.743	29.743	---
V-L Flowrate (lb_{mol}/hr)	147,437	147,437	4,387	45,291	45,291	6,213	3,408	0	0	207,471	0	207,471	207,471	7,462
V-L Flowrate (lb/hr)	4,254,595	4,254,595	126,595	1,306,967	1,306,967	179,291	98,338	0	0	6,170,854	0	6,170,854	6,170,854	134,426
Solids Flowrate (lb/hr)	0	0	0	0	0	0	0	565,820	10,973	43,893	43,893	0	0	57,245
Temperature (°F)	59	66	66	59	78	78	59	59	59	337	59	337	360	59
Pressure (psia)	14.7	15.3	15.3	14.7	16.1	16.1	14.7	14.7	14.7	14.4	14.7	14.2	15.4	15.0
Enthalpy (Btu/lb)[A]	13.0	14.8	14.8	13.0	17.5	17.5	13.0	---	---	140.8	---	132.8	138.8	---
Density (lb/ft^3)	0.076	0.078	0.078	0.076	0.081	0.081	0.076	---	---	0.050	---	0.049	0.052	---
	A - Reference conditions are 32.02 F & 0.089 PSIA													

Exhibit 6-2 Case 2 Stream table (Continued)

	15	16	17	18	19	20	21	22	23	24	25	26	27	28
V-L Mole Fraction														
Ar	0.0000	0.0128	0.0000	0.0081	0.0108	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CO_2	0.0000	0.0005	0.0004	0.1350	0.0179	0.9961	0.9985	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	1.0000	0.0062	0.9996	0.1537	0.0383	0.0039	0.0015	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
N_2	0.0000	0.7506	0.0000	0.6793	0.9013	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
O_2	0.0000	0.2300	0.0000	0.0238	0.0316	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SO_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	13,485	975	250	102,548	77,286	12,511	12,481	44,922	44,922	126,511	103,236	103,236	49,304	49,304
V-L Flowrate (kg/hr)	242,941	28,289	4,498	2,956,531	2,177,293	549,344	548,802	809,288	809,288	2,279,133	1,859,826	1,859,826	888,227	888,227
Solids Flowrate (kg/hr)	0	0	40,138	0	0	0	0	0	0	0	0	0	0	0
Temperature (°C)	15	181	58	58	32	21	35	291	151	593	354	593	38	40
Pressure (MPa, abs)	0.10	0.31	0.10	0.10	0.10	0.16	15.27	0.51	0.92	24.23	4.90	4.52	0.01	1.69
Enthalpy (kJ/kg)[A]	-46.80	191.58	---	301.43	93.86	19.49	-211.71	3,045.10	636.31	3,476.62	3,081.81	3,652.22	2,115.77	166.72
Density (kg/m^3)	1,003.1	2.4	---	1.1	1.1	2.9	795.9	2.0	916.0	69.2	18.7	11.6	0.1	993.2
V-L Molecular Weight	18.015	29.029	---	28.831	28.172	43.908	43.971	18.015	18.015	18.015	18.015	18.015	18.015	18.015
V-L Flowrate (lb_{mol}/hr)	29,730	2,148	550	226,080	170,387	27,582	27,516	99,037	99,037	278,909	227,597	227,597	108,697	108,697
V-L Flowrate (lb/hr)	535,592	62,368	9,916	6,518,034	4,800,109	1,211,096	1,209,902	1,784,175	1,784,175	5,024,628	4,100,215	4,100,215	1,958,206	1,958,206
Solids Flowrate (lb/hr)	0	0	88,488	0	0	0	0	0	0	0	0	0	0	0
Temperature (°F)	59	357	136	136	89	69	95	556	304	1,100	668	1,100	101	103
Pressure (psia)	14.7	45.0	14.9	14.9	14.7	23.5	2,214.5	73.5	133.6	3,514.7	710.8	655.8	1.0	245.0
Enthalpy (Btu/lb)[A]	-20.1	82.4	---	129.6	40.4	8.4	-91.0	1,309.2	273.6	1,494.7	1,324.9	1,570.2	909.6	71.7
Density (lb/ft^3)	62.622	0.149	---	0.067	0.070	0.184	49.684	0.123	57.184	4.319	1.166	0.722	0.004	62.002

Exhibit 6-3 Case 2 Performance summary

	Case 2	Units
Plant Output		
Steam Turbine Power	662,800	kW_e
Total	**662,800**	kW_e
Auxiliary Load		
Coal Handling and Conveying	510	kW_e
Pulverizers	3,850	kW_e
Sorbent Handling & Reagent Preparation	1,250	kW_e
Ash Handling	740	kW_e
Primary Air Fans	1,800	kW_e
Forced Draft Fans	2,300	kW_e
Induced Draft Fans	11,120	kW_e
SCR	70	kW_e
Baghouse	100	kW_e
Wet FGD	4,110	kW_e
Econamine FG Plus Auxiliaries	20,600	kW_e
CO_2 Compression	44,890	kW_e
Miscellaneous Balance of Plant[2,3]	2,000	kW_e
Steam Turbine Auxiliaries	400	kW_e
Condensate Pumps	560	kW_e
Circulating Water Pumps	10,100	kW_e
Ground Water Pumps	910	kW_e
Cooling Tower Fans	5,230	kW_e
Transformer Losses	2,290	kW_e
Total	**112,830**	**kW_e**
Plant Performance		
Net Auxiliary Load	112,830	kW_e
Net Plant Power	549,970	kW_e
Net Plant Efficiency (HHV)	28.4%	
Net Plant Heat Rate (HHV)	12,663 (12,002)	kJ/kWhr (Btu/kWhr)
Coal Feed Flowrate	256,652 (565,820)	kg/hr (lb/hr)
Thermal Input[1]	1,934,519	kW_{th}
Condenser Duty	1,737 (1,646)	GJ/hr (MMBtu/hr)
Raw Water Withdrawal	38.1 (10,071)	m^3/min (gpm)
Raw Water Consumption	29.3 (7,733)	m^3/min (gpm)

1 - HHV of Illinois No. 6 coal is 27,135 kJ/kg (11,666 Btu/lb)
2 – Boiler feed pumps are turbine driven
3 – Includes plant control systems, lighting, HVAC, and miscellaneous low voltage loads

Exhibit 6-4 Case 2 water balance

	Water Demand	Internal Recycle	Raw Water Withdrawal	Process Water Discharge	Raw Water Consumption
	m^3/min (gpm)				
Econamine	0.14 (36)	-	0.14 (36)	-	0.14 (36)
FGD Makeup	5.07 (1340)	-	5.07 (1340)	-	5.07 (1,340)
BFW Makeup	-	-	-	-	-
Cooling Tower	39.4 (10,399)	6.45 (1703)	32.9 (8,696)	8.85 (2,339)	24.06 (6,357)
Total	**44.6 (11,774)**	**6.45 (1703)**	**38.1 (10,071)**	**8.85 (2,339)**	**29.27 (7,733)**

Exhibit 6-5 Case 2 carbon balance

Carbon In		Carbon Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	163,602 (360,680)	Stack Gas	16,632 (36,667)
Air (CO2)	355 (783)	FGD Product	274 (605)
FGD Reagent	2,635 (5,809)	CO2 Product	149,685 (329,999)
Total	**166,592 (367,272)**	**Total**	**166,592 (367,272)**

Exhibit 6-6 Case 2 sulfur balance

Sulfur In		Sulfur Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	6,433 (14,182)	FGD Product	6,304 (13,898)
		Stack Gas	2 (5)
		Econamine Polishing Scrubber/HSS	126 (278)
Total	**6,433 (14,182)**	**Total**	**6,433 (14,182)**

Exhibit 6-7 Case 2 energy balance

	HHV	Sensible + Latent	Power	Total
Heat In GJ/hr (MMBtu/hr)				
Coal	6,964 (6,601)	5.8 (5.5)	-	6,970 (6,606)
Air	-	77.6 (73.6)	-	77.6 (73.6)
Raw Water Makeup	-	143.4 (136.0)	-	143.4 (136.0)
Lime	-	0.29 (0.28)	-	0.29 (0.28)
Auxiliary Power	-	-	406 (385)	406 (385)
TOTAL	**6,964 (6,601)**	**227.2 (215.3)**	**406 (385)**	**7,598 (7,201)**
Heat Out GJ/hr (MMBtu/hr)				
Bottom Ash	-	0.6 (0.6)	-	0.6 (0.6)
Fly Ash + FGD Ash	-	2.4 (2.3)	-	2.4 (2.3)
Flue Gas	-	204 (194)	-	204 (194)
Condenser	-	1,737 (1,646)	-	1,737 (1,646)
CO2	-	-116 (-110)	-	-116 (-110)
Cooling Tower Blowdown	-	65.8 (62.3)	-	65.8 (62.3)
Econamine Losses	-	3,298 (3,126)	-	3,298 (3,126)
*Process Losses**	-	*19.8 (18.8)*	-	*19.8 (18.8)*
Power	-	-	2,386 (2,262)	2,386 (2,262)
TOTAL	**-**	**5,212 (4,940)**	**2,386 (2,262)**	**7,598 (7,201)**

* Process losses are estimated to match the heat input to the plant.

Exhibit 6-8 Case 2 air emissions

	kg/GJ (lb/MMBtu)	tonne/yr (Ton/year)	kg/MWgross (lb/MWgross)
SO_2	0.001 (0.002)	36 (40)	0.007 (.02)
NOx	0.030 (0.070)	1,561 (1,720)	0.316 (.697)
Particulate	0.006 (0.0130)	290 (319)	0.059 (.129)
Hg	4.91E-7 (1.14E-6)	0.025 (0.028)	5.16E-6 (1.14E-5)
CO_2	8.8 (20.4)	453,763 (500,188)	92 (203)

Exhibit 6-9 Case 2 capital costs

	Client:	USDOE/NETL							Report Date:	2010-Jan-14	
	TOTAL PLANT COST SUMMARY										
	Case:	Case 2 - 1x550 MWnet Super-Critical PC w/ CO2 Capture									
	Plant Size:	550.0	MW,net	Estimate Type:				Cost Base (Jun)	2007	($x1000)	
Acct		Equipment	Material	Labor		Bare Erected	Eng'g CM	Contingencies		TOTAL PLANT COST	
No.	Item/Description	Cost	Cost	Direct	Indirect	Cost $	H.O.& Fee	Process	Project	$	$/kW
1	COAL & SORBENT HANDLING										
1.1	Coal Receive & Unload	$4,115	$0	$1,880	$0	$5,995	$536	$0	$980	$7,510	$14
1.2	Coal Stackout & Reclaim	$5,318	$0	$1,205	$0	$6,523	$571	$0	$1,064	$8,158	$15
1.3	Coal Conveyors	$4,944	$0	$1,192	$0	$6,137	$538	$0	$1,001	$7,676	$14
1.4	Other Coal Handling	$1,294	$0	$276	$0	$1,569	$137	$0	$256	$1,963	$4
1.5	Sorbent Receive & Unload	$168	$0	$51	$0	$218	$19	$0	$36	$273	$0
1.6	Sorbent Stackout & Reclaim	$2,709	$0	$496	$0	$3,205	$279	$0	$523	$4,007	$7
1.7	Sorbent Conveyors	$967	$209	$237	$0	$1,413	$122	$0	$230	$1,765	$3
1.8	Other Sorbent Handling	$584	$137	$306	$0	$1,027	$91	$0	$168	$1,285	$2
1.9	Coal & Sorbent Hnd.Foundations	$0	$5,054	$6,376	$0	$11,430	$1,074	$0	$1,876	$14,379	$26
	SUBTOTAL 1.	**$20,098**	**$5,400**	**$12,019**	**$0**	**$37,517**	**$3,366**	**$0**	**$6,132**	**$47,015**	**$85**
2	COAL & SORBENT PREP & FEED										
2.1	Coal Crushing & Drying	$2,388	$0	$465	$0	$2,853	$249	$0	$465	$3,567	$6
2.2	Coal Conveyor to Storage	$6,113	$0	$1,334	$0	$7,447	$651	$0	$1,215	$9,313	$17
2.3	Coal Injection System	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.4	Misc.Coal Prep & Feed	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.5	Sorbent Prep Equipment	$4,617	$199	$959	$0	$5,774	$503	$0	$942	$7,219	$13
2.6	Sorbent Storage & Feed	$556	$0	$213	$0	$769	$68	$0	$126	$963	$2
2.7	Sorbent Injection System	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.8	Booster Air Supply System	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.9	Coal & Sorbent Feed Foundation	$0	$597	$501	$0	$1,098	$102	$0	$180	$1,380	$3
	SUBTOTAL 2.	**$13,673**	**$796**	**$3,473**	**$0**	**$17,942**	**$1,572**	**$0**	**$2,927**	**$22,442**	**$41**
3	FEEDWATER & MISC. BOP SYSTEMS										
3.1	Feedwater System	$22,860	$0	$7,384	$0	$30,244	$2,643	$0	$4,933	$37,820	$69
3.2	Water Makeup & Pretreating	$6,997	$0	$2,252	$0	$9,249	$875	$0	$2,025	$12,149	$22
3.3	Other Feedwater Subsystems	$6,998	$0	$2,958	$0	$9,956	$892	$0	$1,627	$12,475	$23
3.4	Service Water Systems	$1,372	$0	$746	$0	$2,118	$199	$0	$463	$2,780	$5
3.5	Other Boiler Plant Systems	$8,675	$0	$8,565	$0	$17,240	$1,638	$0	$2,832	$21,709	$39
3.6	FO Supply Sys & Nat Gas	$276	$0	$345	$0	$621	$59	$0	$102	$781	$1
3.7	Waste Treatment Equipment	$4,744	$0	$2,704	$0	$7,448	$725	$0	$1,635	$9,808	$18
3.8	Misc. Equip.(cranes,AirComp.,Comm.)	$2,930	$0	$895	$0	$3,825	$368	$0	$838	$5,031	$9
	SUBTOTAL 3.	**$54,851**	**$0**	**$25,849**	**$0**	**$80,700**	**$7,397**	**$0**	**$14,455**	**$102,552**	**$186**

Exhibit 6-9 Case 2 capital costs (Continued)

Acct		Equipment	Material	Labor		Bare Erected	Eng'g CM	Contingencies		TOTAL PLANT COST	
No.	Item/Description	Cost	Cost	Direct	Indirect	Cost $	H.O.& Fee	Process	Project	$	$/kW
4	PC BOILER										
4.1	PC Boiler & Accessories	$195,902	$0	$109,921	$0	$305,822	$29,763	$0	$33,559	$369,144	$671
4.2	SCR (w/4.1)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.3	Open	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.4	Boiler BoP (w/ ID Fans)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.5	Primary Air System	w/4.1	$0	w/4.1	$0	$0	$0	$0	$0	$0	$0
4.6	Secondary Air System	w/4.1	$0	w/4.1	$0	$0	$0	$0	$0	$0	$0
4.8	Major Component Rigging	$0	w/4.1	w/4.1	$0	$0	$0	$0	$0	$0	$0
4.9	Boiler Foundations	$0	w/14.1	w/14.1	$0	$0	$0	$0	$0	$0	$0
	SUBTOTAL 4.	**$195,902**	**$0**	**$109,921**	**$0**	**$305,822**	**$29,763**	**$0**	**$33,559**	**$369,144**	**$671**
5	FLUE GAS CLEANUP										
5.1	Absorber Vessels & Accessories	$70,185	$0	$15,109	$0	$85,294	$8,132	$0	$9,343	$102,768	$187
5.2	Other FGD	$3,663	$0	$4,150	$0	$7,813	$758	$0	$857	$9,428	$17
5.3	Bag House & Accessories	$20,190	$0	$12,813	$0	$33,003	$3,180	$0	$3,618	$39,801	$72
5.4	Other Particulate Removal Materials	$1,366	$0	$1,462	$0	$2,828	$274	$0	$310	$3,413	$6
5.5	Gypsum Dewatering System	$5,623	$0	$955	$0	$6,579	$626	$0	$720	$7,925	$14
5.6	Mercury Removal System	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
5.9	Open	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	SUBTOTAL 5.	**$101,027**	**$0**	**$34,490**	**$0**	**$135,517**	**$12,971**	**$0**	**$14,849**	**$163,336**	**$297**
5B	CO2 REMOVAL & COMPRESSION										
5B.1	CO2 Removal System	$207,807	$0	$63,097	$0	$270,904	$25,901	$54,181	$70,197	$421,183	$766
5B.2	CO2 Compression & Drying	$27,558	$0	$8,646	$0	$36,204	$3,462	$0	$7,933	$47,599	$87
	SUBTOTAL 5.	**$235,366**	**$0**	**$71,742**	**$0**	**$307,108**	**$29,363**	**$54,181**	**$78,130**	**$468,782**	**$852**
6	COMBUSTION TURBINE/ACCESSORIES										
6.1	Combustion Turbine Generator	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
6.2	Open	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
6.3	Compressed Air Piping	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
6.9	Combustion Turbine Foundations	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	SUBTOTAL 6.	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
7	HRSG, DUCTING & STACK										
7.1	Heat Recovery Steam Generator	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
7.2	HRSG Accessories	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
7.3	Ductwork	$9,165	$0	$5,889	$0	$15,054	$1,313	$0	$2,455	$18,822	$34
7.4	Stack	$8,376	$0	$4,901	$0	$13,277	$1,278	$0	$1,456	$16,011	$29
7.9	Duct & Stack Foundations	$0	$961	$1,092	$0	$2,052	$192	$0	$449	$2,693	$5
	SUBTOTAL 7.	**$17,541**	**$961**	**$11,881**	**$0**	**$30,383**	**$2,783**	**$0**	**$4,359**	**$37,526**	**$68**

Exhibit 6-9 Case 2 capital costs (Continued)

Acct		Equipment	Material	Labor		Bare Erected	Eng'g CM	Contingencies		TOTAL PLANT COST	
No.	Item/Description	Cost	Cost	Direct	Indirect	Cost $	H.O.& Fee	Process	Project	$	$/kW
8	STEAM TURBINE GENERATOR										
8.1	Steam TG & Accessories	$56,794	$0	$7,537	$0	$64,331	$6,165	$0	$7,050	$77,546	$141
8.2	Turbine Plant Auxiliaries	$382	$0	$819	$0	$1,202	$118	$0	$132	$1,451	$3
8.3	Condenser & Auxiliaries	$5,509	$0	$2,030	$0	$7,540	$722	$0	$826	$9,088	$17
8.4	Steam Piping	$21,469	$0	$10,585	$0	$32,054	$2,693	$0	$5,212	$39,959	$73
8.9	TG Foundations	$0	$1,200	$1,896	$0	$3,096	$293	$0	$678	$4,067	$7
	SUBTOTAL 8.	**$84,154**	**$1,200**	**$22,868**	**$0**	**$108,222**	**$9,991**	**$0**	**$13,898**	**$132,111**	**$240**
9	COOLING WATER SYSTEM										
9.1	Cooling Towers	$15,451	$0	$4,811	$0	$20,262	$1,938	$0	$2,220	$24,419	$44
9.2	Circulating Water Pumps	$3,219	$0	$248	$0	$3,467	$293	$0	$376	$4,136	$8
9.3	Circ.Water System Auxiliaries	$787	$0	$105	$0	$892	$85	$0	$98	$1,075	$2
9.4	Circ.Water Piping	$0	$6,243	$6,050	$0	$12,293	$1,151	$0	$2,017	$15,460	$28
9.5	Make-up Water System	$641	$0	$857	$0	$1,498	$144	$0	$246	$1,888	$3
9.6	Component Cooling Water Sys	$624	$0	$496	$0	$1,120	$106	$0	$184	$1,410	$3
9.9	Circ.Water System Foundations & Structures	$0	$3,698	$5,876	$0	$9,575	$906	$0	$2,096	$12,577	$23
	SUBTOTAL 9.	**$20,722**	**$9,941**	**$18,443**	**$0**	**$49,106**	**$4,622**	**$0**	**$7,236**	**$60,965**	**$111**
10	ASH/SPENT SORBENT HANDLING SYS										
10.1	Ash Coolers	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
10.2	Cyclone Ash Letdown	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
10.3	HGCU Ash Letdown	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
10.4	High Temperature Ash Piping	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
10.5	Other Ash Recovery Equipment	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
10.6	Ash Storage Silos	$706	$0	$2,175	$0	$2,881	$283	$0	$316	$3,480	$6
10.7	Ash Transport & Feed Equipment	$4,570	$0	$4,681	$0	$9,250	$885	$0	$1,014	$11,149	$20
10.8	Misc. Ash Handling Equipment	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
10.9	Ash/Spent Sorbent Foundation	$0	$168	$198	$0	$365	$34	$0	$80	$479	$1
	SUBTOTAL 10.	**$5,276**	**$168**	**$7,053**	**$0**	**$12,497**	**$1,202**	**$0**	**$1,410**	**$15,108**	**$27**
11	ACCESSORY ELECTRIC PLANT										
11.1	Generator Equipment	$1,727	$0	$280	$0	$2,008	$186	$0	$165	$2,358	$4
11.2	Station Service Equipment	$4,957	$0	$1,629	$0	$6,585	$616	$0	$540	$7,741	$14
11.3	Switchgear & Motor Control	$5,699	$0	$969	$0	$6,667	$618	$0	$729	$8,014	$15
11.4	Conduit & Cable Tray	$0	$3,573	$12,354	$0	$15,926	$1,542	$0	$2,620	$20,089	$37
11.5	Wire & Cable	$0	$6,742	$13,014	$0	$19,756	$1,664	$0	$3,213	$24,633	$45
11.6	Protective Equipment	$261	$0	$888	$0	$1,149	$112	$0	$126	$1,388	$3
11.7	Standby Equipment	$1,360	$0	$31	$0	$1,391	$128	$0	$152	$1,670	$3
11.8	Main Power Transformers	$11,209	$0	$189	$0	$11,398	$864	$0	$1,226	$13,488	$25
11.9	Electrical Foundations	$0	$342	$837	$0	$1,179	$113	$0	$258	$1,550	$3
	SUBTOTAL 11.	**$25,213**	**$10,656**	**$30,191**	**$0**	**$66,060**	**$5,843**	**$0**	**$9,029**	**$80,931**	**$147**

Exhibit 6-9 Case 2 capital costs (Continued)

Acct		Equipment	Material	Labor		Bare Erected	Eng'g CM	Contingencies		TOTAL PLANT COST	
No.	Item/Description	Cost	Cost	Direct	Indirect	Cost $	H.O.& Fee	Process	Project	$	$/kW
12	INSTRUMENTATION & CONTROL										
12.1	PC Control Equipment	w/12.7	$0	w/12.7	$0	$0	$0	$0	$0	$0	$0
12.2	Combustion Turbine Control	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
12.3	Steam Turbine Control	w/8.1	$0	w/8.1	$0	$0	$0	$0	$0	$0	$0
12.4	Other Major Component Control	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
12.5	Signal Processing Equipment	w/12.7	$0	w/12.7	$0	$0	$0	$0	$0	$0	$0
12.6	Control Boards,Panels & Racks	$516	$0	$309	$0	$825	$78	$41	$142	$1,085	$2
12.7	Distributed Control System Equipment	$5,207	$0	$910	$0	$6,117	$567	$306	$699	$7,689	$14
12.8	Instrument Wiring & Tubing	$2,823	$0	$5,599	$0	$8,422	$718	$421	$1,434	$10,995	$20
12.9	Other I & C Equipment	$1,471	$0	$3,339	$0	$4,810	$466	$241	$552	$6,069	$11
	SUBTOTAL 12.	**$10,017**	**$0**	**$10,157**	**$0**	**$20,174**	**$1,829**	**$1,009**	**$2,826**	**$25,838**	**$47**
13	IMPROVEMENTS TO SITE										
13.1	Site Preparation	$0	$56	$1,116	$0	$1,172	$116	$0	$258	$1,546	$3
13.2	Site Improvements	$0	$1,853	$2,301	$0	$4,154	$410	$0	$913	$5,477	$10
13.3	Site Facilities	$3,321	$0	$3,275	$0	$6,595	$650	$0	$1,449	$8,694	$16
	SUBTOTAL 13.	**$3,321**	**$1,909**	**$6,692**	**$0**	**$11,921**	**$1,176**	**$0**	**$2,620**	**$15,717**	**$29**
14	BUILDINGS & STRUCTURES										
14.1	Boiler Building	$0	$8,851	$7,784	$0	$16,635	$1,495	$0	$2,719	$20,849	$38
14.2	Turbine Building	$0	$12,808	$11,937	$0	$24,746	$2,230	$0	$4,046	$31,023	$56
14.3	Administration Building	$0	$643	$680	$0	$1,324	$120	$0	$217	$1,660	$3
14.4	Circulation Water Pumphouse	$0	$176	$139	$0	$315	$28	$0	$51	$395	$1
14.5	Water Treatment Buildings	$0	$887	$809	$0	$1,697	$153	$0	$277	$2,127	$4
14.6	Machine Shop	$0	$430	$289	$0	$719	$64	$0	$117	$901	$2
14.7	Warehouse	$0	$292	$292	$0	$584	$53	$0	$96	$732	$1
14.8	Other Buildings & Structures	$0	$238	$203	$0	$441	$40	$0	$72	$553	$1
14.9	Waste Treating Building & Str.	$0	$456	$1,384	$0	$1,840	$175	$0	$302	$2,317	$4
	SUBTOTAL 14.	**$0**	**$24,782**	**$23,519**	**$0**	**$48,301**	**$4,357**	**$0**	**$7,899**	**$60,557**	**$110**
	TOTAL COST	**$787,159**	**$55,813**	**$388,298**	**$0**	**$1,231,270**	**$116,235**	**$55,190**	**$199,329**	**$1,602,023**	**$2,913**

Exhibit 6-9 Case 2 capital costs (Continued)

Acct		Equipment	Material	Labor		Bare Erected	Eng'g CM	Contingencies		TOTAL PLANT COST	
No.	Item/Description	Cost	Cost	Direct	Indirect	Cost $	H.O.& Fee	Process	Project	$	$/kW
	Owner's Costs										
	Preproduction Costs										
	6 Months All Labor									$10,579	$19
	1 Month Maintenance Materials									$1,541	$3
	1 Month Non-fuel Consumables									$1,637	$3
	1 Month Waste Disposal									$325	$1
	25% of 1 Months Fuel Cost at 100% CF									$1,971	$4
	2% of TPC									$32,040	$58
	Total									**$48,094**	**$87**
	Inventory Capital										
	60 day supply of fuel and consumables at 100% CF									$18,563	$34
	0.5% of TPC (spare parts)									$8,010	$15
	Total									**$26,573**	**$48**
	Initial Cost for Catalyst and Chemicals									$2,496	$5
	Land									$900	$2
	Other Owner's Costs									$240,304	$437
	Financing Costs									$43,255	$79
	Total Overnight Costs (TOC)									**$1,963,644**	**$3,570**
	TASC Multiplier							(IOU, high-risk, 35 year)		1.140	
	Total As-Spent Cost (TASC)									**$2,238,554**	**$4,070**

Exhibit 6-10 Case 2 operation and maintenance costs

INITIAL & ANNUAL O&M EXPENSES					Cost Base (Jun):	2007
Case 2 - 1x550 MWnet Super-Critical PC w/ CO2 Capture					Heat Rate-net (Btu/kWh):	12,002
					MWe-net:	550
					Capacity Factor (%):	85
OPERATING & MAINTENANCE LABOR						
Operating Labor						
Operating Labor Rate(base):	34.65	$/hour				
Operating Labor Burden:	30.00	% of base				
Labor O-H Charge Rate:	25.00	% of labor				
Operating Labor Requirements(O.J.)per Shift:	1 unit/mod.		Total Plant			
Skilled Operator	2.0		2.0			
Operator	11.3		11.3			
Foreman	1.0		1.0			
Lab Tech's, etc.	2.0		2.0			
TOTAL-O.J.'s	16.3		16.3			
					Annual Cost $	Annual Unit Cost $/kW-net
Annual Operating Labor Cost					$6,444,907	$11.719
Maintenance Labor Cost					$10,481,104	$19.058
Administrative & Support Labor					$4,231,503	$7.694
Property Taxes and Insurance					$32,040,467	$58.260
TOTAL FIXED OPERATING COSTS					**$53,197,981**	**$96.731**
VARIABLE OPERATING COSTS						
						$/kWh-net
Maintenance Material Cost					**$15,721,656**	**$0.00384**
Consumables	Consumption Initial Fill	/Day	Unit Cost	Initial Fill Cost		
Water(/1000 gallons)	0	7,324	1.08	**$0**	**$2,457,806**	**$0.00060**
Chemicals						
MU & WT Chem.(lbs)	0	35,452	0.17	$0	$1,903,577	$0.00046
Limestone (ton)	0	687	21.63	$0	$4,610,586	$0.00113
Carbon (Mercury Removal) lb	0	0	1.05	$0	$0	$0.00000
MEA Solvent (ton)	1,028	1.46	2,249.89	$2,312,307	$1,017,164	$0.00025
NaOH (tons)	73	7.26	433.68	$31,484	$976,789	$0.00024
H2SO4 (tons)	69	6.93	138.78	$9,615	$298,293	$0.00007
Corrosion Inhibitor	0	0	0.00	$142,156	$6,769	$0.00000
Activated Carbon (lb)	0	1,741	1.05	$0	$567,144	$0.00014
Ammonia (19% NH3) ton	0	102	129.80	$0	$4,090,854	$0.00100
Subtotal Chemicals				**$2,495,562**	**$13,471,176**	**$0.00329**
Other						
Supplemental Fuel (MBtu)	0	0	0.00	$0	$0	$0.00000
SCR Catalyst (m3)	w/equip.	0.43	5,775.94	$0	$765,005	$0.00019
Emission Penalties	0	0	0.00	$0	$0	$0.00000
Subtotal Other				**$0**	**$765,005**	**$0.00019**
Waste Disposal						
Fly Ash (ton)	0	527	16.23	$0	$2,651,418	$0.00065
Bottom Ash (ton)	0	132	16.23	$0	$662,855	$0.00016
Subtotal-Waste Disposal				**$0**	**$3,314,273**	**$0.00081**
By-products & Emissions						
Gypsum (tons)	0	1,062	0.00	$0	$0	$0.00000
Subtotal By-Products				**$0**	**$0**	**$0.00000**
TOTAL VARIABLE OPERATING COSTS				**$2,495,562**	**$35,729,917**	**$0.00873**
Fuel (ton)	0	6,790	38.18	$0	**$80,434,598**	**$0.01964**

Exhibit 6-11 Cost of electricity breakdown for Case 2

TOC, $/kW	**3,570**
COE w/o TS&M, $/MW	**100.9**
Capital, $/MW	59.6
Fixed, $/MW	13.0
Variable, $/MW	8.7
Fuel, $/MW	19.6

7 Case 3: Enhanced Fluor Capture Technology

Results for a plant utilizing a representation of the Enhanced Flour capture technology as discussed in section 4.1.2 are presented. Exhibit 7-1 provides the block flow diagram for this case.

The following are the key points of the enhanced Fluor capture technology:

- Capable of achieving a reboiler stream requirement of 1,270 Btu/lb CO_2 (previously 1,530 Btu/lb CO_2)
- Reductions in auxiliary electrical power requirements and capital costs have also been achieved
- Advances based on:
    - Improved solvent formulation with an MEA concentration greater than 30 percent and improved corrosion inhibitors
    - Increased reaction rates (enabling less absorber packing and lower capital cost)
    - Higher solvent carrying capacity results in lower solvent circulation rates, stream requirements, and capital cost

Exhibit 7-1 Case 3 block flow diagram

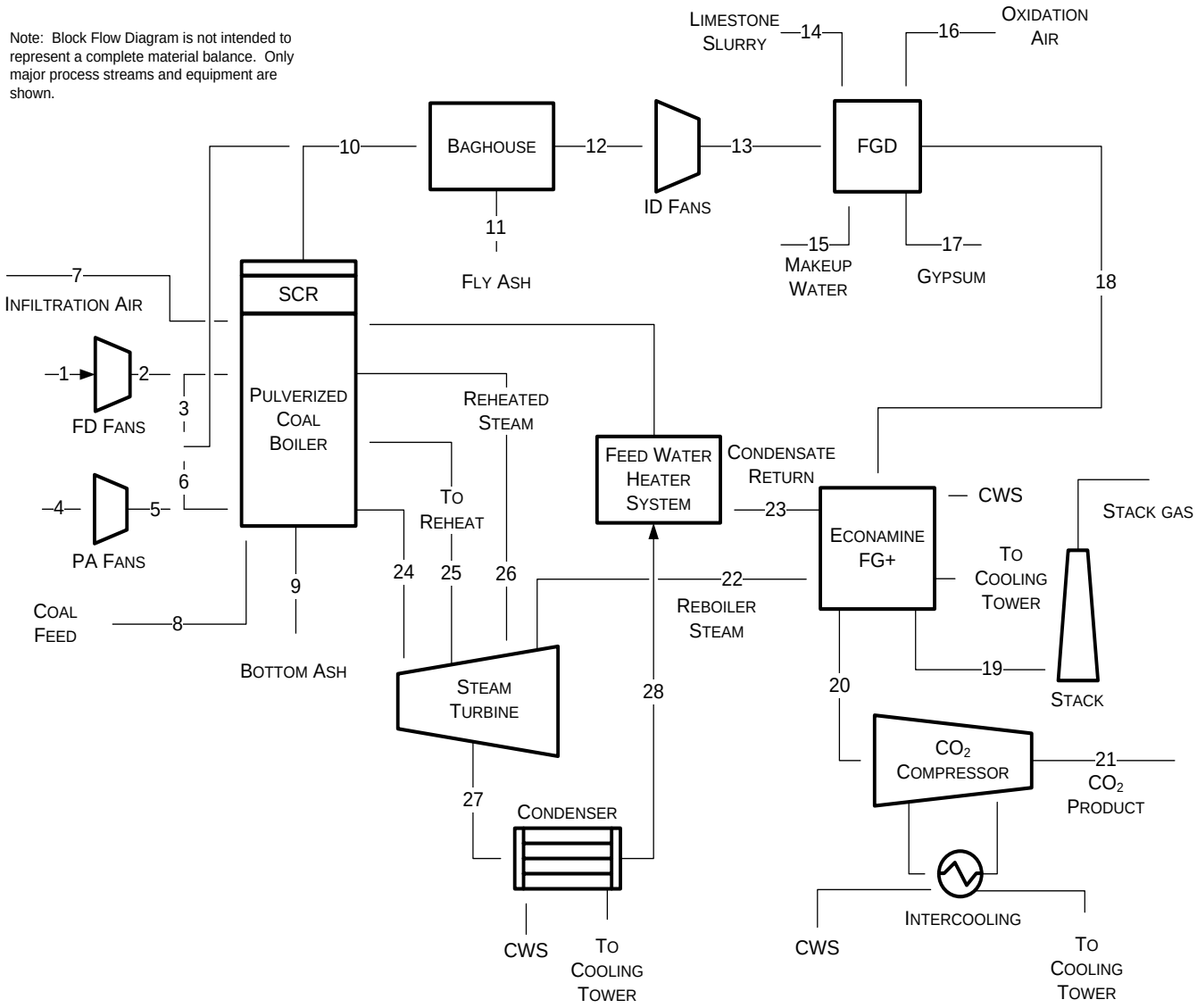


Exhibit 7-2 Case 3 Stream table

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
V-L Mole Fraction														
Ar	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092	0.0000	0.0000	0.0087	0.0000	0.0087	0.0087	0.0000
CO_2	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0000	0.0000	0.1450	0.0000	0.1450	0.1450	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	0.0099	0.0099	0.0099	0.0099	0.0099	0.0099	0.0099	0.0000	0.0000	0.0870	0.0000	0.0870	0.0870	1.0000
N_2	0.7732	0.7732	0.7732	0.7732	0.7732	0.7732	0.7732	0.0000	0.0000	0.7324	0.0000	0.7324	0.7324	0.0000
O_2	0.2074	0.2074	0.2074	0.2074	0.2074	0.2074	0.2074	0.0000	0.0000	0.0247	0.0000	0.0247	0.0247	0.0000
SO_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0021	0.0000	0.0021	0.0021	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000	0.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	63,824	63,824	1,899	19,606	19,606	2,690	1,475	0	0	89,812	0	89,812	89,812	3,349
V-L Flowrate (kg/hr)	1,841,767	1,841,767	54,801	565,772	565,772	77,613	42,569	0	0	2,671,294	0	2,671,294	2,671,294	60,334
Solids Flowrate (kg/hr)	0	0	0	0	0	0	0	244,938	4,750	19,001	19,001	0	0	24,719
Temperature (°C)	15	19	19	15	25	25	15	15	15	169	15	169	182	15
Pressure (MPa, abs)	0.10	0.11	0.11	0.10	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.11	0.10
Enthalpy (kJ/kg)[A]	30.23	34.36	34.36	30.23	40.78	40.78	30.23	---	---	327.40	---	308.96	322.83	---
Density (kg/m^3)	1.2	1.2	1.2	1.2	1.3	1.3	1.2	---	---	0.8	---	0.8	0.8	---
V-L Molecular Weight	28.857	28.857	28.857	28.857	28.857	28.857	28.857	---	---	29.743	---	29.743	29.743	---
V-L Flowrate (lb_{mol}/hr)	140,708	140,708	4,187	43,224	43,224	5,930	3,252	0	0	198,001	0	198,001	198,001	7,383
V-L Flowrate (lb/hr)	4,060,401	4,060,401	120,816	1,247,313	1,247,313	171,108	93,850	0	0	5,889,196	0	5,889,196	5,889,196	133,014
Solids Flowrate (lb/hr)	0	0	0	0	0	0	0	539,995	10,472	41,890	41,890	0	0	54,497
Temperature (°F)	59	66	66	59	78	78	59	59	59	337	59	337	360	59
Pressure (psia)	14.7	15.3	15.3	14.7	16.1	16.1	14.7	14.7	14.7	14.4	14.7	14.2	15.4	15.0
Enthalpy (Btu/lb)[A]	13.0	14.8	14.8	13.0	17.5	17.5	13.0	---	---	140.8	---	132.8	138.8	---
Density (lb/ft^3)	0.076	0.078	0.078	0.076	0.081	0.081	0.076	---	---	0.050	---	0.049	0.052	---
	A - Reference conditions are 32.02 F & 0.089 PSIA													

Exhibit 7-2 Case 3 Stream table (Continued)

	15	16	17	18	19	20	21	22	23	24	25	26	27	28
V-L Mole Fraction														
Ar	0.0000	0.0128	0.0000	0.0081	0.0108	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CO_2	0.0000	0.0005	0.0004	0.1351	0.0179	0.9961	0.9985	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	1.0000	0.0062	0.9996	0.1537	0.0383	0.0039	0.0015	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
N_2	0.0000	0.7506	0.0000	0.6793	0.9013	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
O_2	0.0000	0.2300	0.0000	0.0238	0.0316	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SO_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	12,734	913	236	97,848	73,741	11,940	11,911	35,621	35,621	120,750	98,499	98,499	53,856	53,856
V-L Flowrate (kg/hr)	229,411	26,510	4,260	2,821,044	2,077,415	524,270	523,755	641,731	641,731	2,175,344	1,774,495	1,774,495	970,240	970,240
Solids Flowrate (kg/hr)	0	0	38,244	0	0	0	0	0	0	0	0	0	0	0
Temperature (°C)	15	181	58	58	32	21	35	291	151	593	354	593	38	39
Pressure (MPa, abs)	0.10	0.31	0.10	0.10	0.10	0.16	15.27	0.51	0.92	24.23	4.90	4.52	0.01	1.69
Enthalpy (kJ/kg)[A]	-46.80	191.58	---	301.42	93.86	19.49	-211.71	3,045.10	636.31	3,476.62	3,081.96	3,652.22	2,111.17	166.38
Density (kg/m^3)	1,003.1	2.4	---	1.1	1.1	2.9	795.9	2.0	916.0	69.2	18.7	11.6	0.1	993.2
V-L Molecular Weight	18.015	29.029	---	28.831	28.172	43.908	43.971	18.015	18.015	18.015	18.015	18.015	18.015	18.015
V-L Flowrate (lb_{mol}/hr)	28,074	2,013	521	215,717	162,571	26,323	26,260	78,532	78,532	266,208	217,154	217,154	118,733	118,733
V-L Flowrate (lb/hr)	505,766	58,445	9,392	6,219,337	4,579,917	1,155,818	1,154,682	1,414,774	1,414,774	4,795,812	3,912,091	3,912,091	2,139,012	2,139,012
Solids Flowrate (lb/hr)	0	0	84,314	0	0	0	0	0	0	0	0	0	0	0
Temperature (°F)	59	357	136	136	89	69	95	556	304	1,100	669	1,100	101	103
Pressure (psia)	14.7	45.0	14.9	14.9	14.7	23.5	2,214.5	73.5	133.6	3,514.7	710.8	655.8	1.0	245.0
Enthalpy (Btu/lb)[A]	-20.1	82.4	---	129.6	40.4	8.4	-91.0	1,309.2	273.6	1,494.7	1,325.0	1,570.2	907.6	71.5
Density (lb/ft^3)	62.622	0.149	---	0.067	0.070	0.184	49.685	0.123	57.184	4.319	1.165	0.722	0.004	62.004

Exhibit 7-3 Case 3 Performance summary

	Case 3	Units
Plant Output		
Steam Turbine Power	654,200	kW_e
Total	**654,200**	kW_e
Auxiliary Load		
Coal Handling and Conveying	500	kW_e
Pulverizers	3,670	kW_e
Sorbent Handling & Reagent Preparation	1,190	kW_e
Ash Handling	700	kW_e
Primary Air Fans	1,720	kW_e
Forced Draft Fans	2,190	kW_e
Induced Draft Fans	10,610	kW_e
SCR	60	kW_e
Baghouse	90	kW_e
Wet FGD	3,920	kW_e
Econamine FG Plus Auxiliaries	16,400	kW_e
CO_2 Compression	42,840	kW_e
Miscellaneous Balance of Plant[2,3]	2,000	kW_e
Steam Turbine Auxiliaries	400	kW_e
Condensate Pumps	610	kW_e
Circulating Water Pumps	9,390	kW_e
Ground Water Pumps	850	kW_e
Cooling Tower Fans	4,860	kW_e
Transformer Losses	2,240	kW_e
Total	**104,240**	**kW_e**
Plant Performance		
Net Auxiliary Load	104,240	kW_e
Net Plant Power	549,960	kW_e
Net Plant Efficiency (HHV)	29.8%	
Net Plant Heat Rate (HHV)	12,085 (11,455)	kJ/kWhr (Btu/kWhr)
Coal Feed Flowrate	244,938 (539,995)	kg/hr (lb/hr)
Thermal Input[1]	1,846,224	kW_{th}
Condenser Duty	1,893 (1,794)	GJ/hr (MMBtu/hr)
Raw Water Withdrawal	35.8 (9,446)	m^3/min (gpm)
Raw Water Consumption	27.5 (7,273)	m^3/min (gpm)

1 - HHV of Illinois No. 6 coal is 27,135 kJ/kg (11,666 Btu/lb)
2 – Boiler feed pumps are turbine driven
3 – Includes plant control systems, lighting, HVAC, and miscellaneous low voltage loads

Exhibit 7-4 Case 3 water balance

	Water Demand	Internal Recycle	Raw Water Withdrawal	Process Water Discharge	Raw Water Consumption
	m^3/min (gpm)				
Econamine	0.13 (34)	0.0 (0)	0.13 (34)	0.00 (0)	0.13 (34)
FGD Makeup	4.84 (1278)	0.0 (0)	4.84 (1278)	0.00 (0)	4.84 (1,278)
BFW Makeup	0.36 (96)	0.0 (0)	0.36 (96)	0.00 (0)	0.36 (96)
Cooling Tower	36.6 (9,663)	6.15 (1624)	30.4 (8,039)	8.23 (2,173)	22.20 (5,866)
Total	**41.9 (11,070)**	**6.15 (1624)**	**35.8 (9,446)**	**8.23 (2,173)**	**27.53 (7,273)**

Exhibit 7-5 Case 3 carbon balance

Carbon In		Carbon Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	156,135 (344,218)	Stack Gas	15,873 (34,993)
Air (CO2)	333 (735)	FGD Product	255 (562)
FGD Reagent	2,508 (5,530)	CO2 Product	142,853 (314,937)
	-	Convergence Tolerance	-4 (-9)
Total	**158,976 (350,483)**	**Total**	**158,976 (350,483)**

Exhibit 7-6 Case 3 sulfur balance

Sulfur In		Sulfur Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	6,139 (13,535)	FGD Product	6,016 (13,264)
	-	Stack Gas	2 (5)
	-	Econamine Polishing Scrubber/HSS	120 (265)
Total	**6,139 (13,535)**	**Total**	**6,139 (13,535)**

Exhibit 7-7 Case 3 energy balance

	HHV	Sensible + Latent	Power	Total
Heat In GJ/hr (MMBtu/hr)				
Coal	6,611 (6,266)	5.5 (5.2)	-	6,616 (6,271)
Air	-	73.7 (69.8)	-	73.7 (69.8)
Raw Water Makeup	-	133.7 (126.8)	-	133.7 (126.8)
Lime	-	0.28 (0.26)	-	0.28 (0.26)
Auxiliary Power	-	-	385 (365)	385 (365)
TOTAL	**6,611 (6,266)**	**213.2 (202.1)**	**385 (365)**	**7,209 (6,833)**
Heat Out GJ/hr (MMBtu/hr)				
Bottom Ash	-	0.6 (0.5)	-	0.6 (0.5)
Fly Ash + FGD Ash	-	2.3 (2.2)	-	2.3 (2.2)
Flue Gas	-	169 (160)	-	169 (160)
Condenser	-	1,544 (1,463)	-	1,544 (1,463)
CO2	-	-110 (-105)	-	-110 (-105)
Cooling Tower Blowdown	-	61.6 (58.4)	-	61.6 (58.4)
Econamine Losses	-	3,163 (2,998)	-	3,163 (2,998)
*Process Losses**	-	*14.3 (13.5)*	-	*14.3 (13.5)*
Power	-	-	2,366 (2,242)	2,366 (2,242)
TOTAL	**-**	**4,844 (4,591)**	**2,366 (2,242)**	**7,209 (6,833)**

* Process losses are estimated to match the heat input to the plant.

Exhibit 7-8 Case 3 air emissions

	kg/GJ (lb/MMBtu)	tonne/yr (Ton/year)	kg/MWgross (lb/MWgross)
SO_2	0.001 (0.002)	34 (38)	0.007 (.02)
NOx	0.030 (0.070)	1,481 (1,633)	0.303 (.668)
Particulate	0.006 (0.0130)	275 (303)	0.056 (.124)
Hg	4.91E-7 (1.14E-6)	0.024 (0.027)	4.94E-6 (1.09E-5)
CO_2	8.8 (20.4)	430,741 (474,810)	88 (194)

Exhibit 7-9 Case 3 capital costs

	Client:	USDOE/NETL							**Report Date:**	2010-Jan-14	
	Project:	Bituminous Baseline Study									
	TOTAL PLANT COST SUMMARY										
	Case:	Case 3 - 1x550 MWnet Super-Critical PC w/ CO2 Capture (MEA Sensitivity)									
	Plant Size:	550.0	MW,net	**Estimate Type:**				**Cost Base (Jun)**	2007	($x1000)	
Acct		**Equipment**	**Material**	**Labor**		**Bare Erected**	**Eng'g CM**	**Contingencies**		**TOTAL PLANT COST**	
No.	**Item/Description**	**Cost**	**Cost**	**Direct**	**Indirect**	**Cost $**	**H.O.& Fee**	**Process**	**Project**	**$**	**$/kW**
1	COAL & SORBENT HANDLING										
1.1	Coal Receive & Unload	$3,998	$0	$1,826	$0	$5,823	$520	$0	$952	$7,295	$13
1.2	Coal Stackout & Reclaim	$5,166	$0	$1,171	$0	$6,337	$554	$0	$1,034	$7,925	$14
1.3	Coal Conveyors	$4,803	$0	$1,158	$0	$5,961	$522	$0	$973	$7,456	$14
1.4	Other Coal Handling	$1,257	$0	$268	$0	$1,525	$133	$0	$249	$1,907	$3
1.5	Sorbent Receive & Unload	$163	$0	$49	$0	$212	$19	$0	$35	$265	$0
1.6	Sorbent Stackout & Reclaim	$2,625	$0	$481	$0	$3,106	$270	$0	$506	$3,883	$7
1.7	Sorbent Conveyors	$937	$203	$230	$0	$1,369	$118	$0	$223	$1,710	$3
1.8	Other Sorbent Handling	$566	$133	$297	$0	$995	$88	$0	$162	$1,245	$2
1.9	Coal & Sorbent Hnd.Foundations	$0	$4,909	$6,192	$0	$11,101	$1,043	$0	$1,822	$13,966	$25
	SUBTOTAL 1.	**$19,514**	**$5,244**	**$11,671**	**$0**	**$36,429**	**$3,268**	**$0**	**$5,955**	**$45,652**	**$83**
2	COAL & SORBENT PREP & FEED										
2.1	Coal Crushing & Drying	$2,315	$0	$451	$0	$2,766	$241	$0	$451	$3,458	$6
2.2	Coal Conveyor to Storage	$5,927	$0	$1,294	$0	$7,221	$631	$0	$1,178	$9,030	$16
2.3	Coal Injection System	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.4	Misc.Coal Prep & Feed	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.5	Sorbent Prep Equipment	$4,471	$193	$929	$0	$5,593	$487	$0	$912	$6,991	$13
2.6	Sorbent Storage & Feed	$539	$0	$206	$0	$745	$66	$0	$122	$933	$2
2.7	Sorbent Injection System	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.8	Booster Air Supply System	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.9	Coal & Sorbent Feed Foundation	$0	$579	$486	$0	$1,066	$99	$0	$175	$1,339	$2
	SUBTOTAL 2.	**$13,252**	**$772**	**$3,366**	**$0**	**$17,391**	**$1,524**	**$0**	**$2,837**	**$21,753**	**$40**
3	FEEDWATER & MISC. BOP SYSTEMS										
3.1	FeedwaterSystem	$22,174	$0	$7,163	$0	$29,337	$2,564	$0	$4,785	$36,686	$67
3.2	Water Makeup & Pretreating	$6,639	$0	$2,137	$0	$8,776	$830	$0	$1,921	$11,526	$21
3.3	Other Feedwater Subsystems	$6,789	$0	$2,869	$0	$9,658	$865	$0	$1,578	$12,101	$22
3.4	Service Water Systems	$1,301	$0	$708	$0	$2,009	$189	$0	$440	$2,638	$5
3.5	Other Boiler Plant Systems	$8,379	$0	$8,272	$0	$16,651	$1,582	$0	$2,735	$20,968	$38
3.6	FO Supply Sys & Nat Gas	$273	$0	$341	$0	$613	$58	$0	$101	$772	$1
3.7	Waste Treatment Equipment	$4,501	$0	$2,566	$0	$7,066	$688	$0	$1,551	$9,305	$17
3.8	Misc. Equip.(cranes,AirComp.,Comm.)	$2,894	$0	$884	$0	$3,779	$363	$0	$828	$4,970	$9
	SUBTOTAL 3.	**$52,950**	**$0**	**$24,940**	**$0**	**$77,890**	**$7,138**	**$0**	**$13,939**	**$98,967**	**$180**

Exhibit 7-9 Case 3 capital costs (Continued)

Acct		Equipment	Material	Labor		Bare Erected	Eng'g CM	Contingencies		TOTAL PLANT COST	
No.	Item/Description	Cost	Cost	Direct	Indirect	Cost $	H.O.& Fee	Process	Project	$	$/kW
4	PC BOILER										
4.1	PC Boiler & Accessories	$189,629	$0	$106,401	$0	$296,030	$28,810	$0	$32,484	$357,324	$650
4.2	SCR (w/4.1)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.3	Open	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.4	Boiler BoP (w/ ID Fans)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.5	Primary Air System	w/4.1	$0	w/4.1	$0	$0	$0	$0	$0	$0	$0
4.6	Secondary Air System	w/4.1	$0	w/4.1	$0	$0	$0	$0	$0	$0	$0
4.8	Major Component Rigging	$0	w/4.1	w/4.1	$0	$0	$0	$0	$0	$0	$0
4.9	Boiler Foundations	$0	w/14.1	w/14.1	$0	$0	$0	$0	$0	$0	$0
	SUBTOTAL 4.	**$189,629**	**$0**	**$106,401**	**$0**	**$296,030**	**$28,810**	**$0**	**$32,484**	**$357,324**	**$650**
5	FLUE GAS CLEANUP										
5.1	Absorber Vessels & Accessories	$67,660	$0	$14,566	$0	$82,226	$7,839	$0	$9,006	$99,071	$180
5.2	Other FGD	$3,531	$0	$4,001	$0	$7,532	$731	$0	$826	$9,089	$17
5.3	Bag House & Accessories	$19,454	$0	$12,346	$0	$31,801	$3,065	$0	$3,487	$38,352	$70
5.4	Other Particulate Removal Materials	$1,317	$0	$1,409	$0	$2,725	$264	$0	$299	$3,289	$6
5.5	Gypsum Dewatering System	$5,469	$0	$929	$0	$6,398	$609	$0	$701	$7,708	$14
5.6	Mercury Removal System	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
5.9	Open	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	SUBTOTAL 5.	**$97,431**	**$0**	**$33,251**	**$0**	**$130,682**	**$12,508**	**$0**	**$14,319**	**$157,509**	**$286**
5B	CO_2 REMOVAL & COMPRESSION										
5B.1	CO_2 Removal System	$177,879	$0	$54,009	$0	$231,888	$22,171	$46,378	$60,087	$360,524	$656
5B.2	CO_2 Compression & Drying	$26,796	$0	$8,406	$0	$35,202	$3,367	$0	$7,714	$46,283	$84
	SUBTOTAL 5B.	**$204,675**	**$0**	**$62,416**	**$0**	**$267,091**	**$25,537**	**$46,378**	**$67,801**	**$406,807**	**$740**
6	COMBUSTION TURBINE/ACCESSORIES										
6.1	Combustion Turbine Generator	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
6.2	Open	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
6.3	Compressed Air Piping	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
6.9	Combustion Turbine Foundations	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	SUBTOTAL 6.	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
7	HRSG, DUCTING & STACK										
7.1	Heat Recovery Steam Generator	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
7.2	HRSG Accessories	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
7.3	Ductwork	$9,063	$0	$5,823	$0	$14,886	$1,298	$0	$2,428	$18,611	$34
7.4	Stack	$8,350	$0	$4,886	$0	$13,236	$1,274	$0	$1,451	$15,962	$29
7.9	Duct & Stack Foundations	$0	$958	$1,088	$0	$2,046	$192	$0	$448	$2,685	$5
	SUBTOTAL 7.	**$17,413**	**$958**	**$11,797**	**$0**	**$30,168**	**$2,764**	**$0**	**$4,326**	**$37,258**	**$68**
8	STEAM TURBINE GENERATOR										
8.1	Steam TG & Accessories	$56,268	$0	$7,467	$0	$63,735	$6,108	$0	$6,984	$76,827	$140
8.2	Turbine Plant Auxiliaries	$379	$0	$812	$0	$1,191	$116	$0	$131	$1,438	$3
8.3	Condenser & Auxiliaries	$5,837	$0	$2,151	$0	$7,988	$765	$0	$875	$9,629	$18
8.4	Steam Piping	$20,781	$0	$10,247	$0	$31,028	$2,607	$0	$5,045	$38,680	$70
8.9	TG Foundations	$0	$1,189	$1,879	$0	$3,069	$290	$0	$672	$4,031	$7
	SUBTOTAL 8.	**$83,265**	**$1,189**	**$22,556**	**$0**	**$107,010**	**$9,887**	**$0**	**$13,707**	**$130,605**	**$237**

Exhibit 7-9 Case 3 capital costs (Continued)

Acct		Equipment	Material	Labor		Bare Erected	Eng'g CM	Contingencies		TOTAL PLANT COST	
No.	Item/Description	Cost	Cost	Direct	Indirect	Cost $	H.O.& Fee	Process	Project	$	$/kW
9	COOLING WATER SYSTEM										
9.1	Cooling Towers	$14,675	$0	$4,570	$0	$19,245	$1,840	$0	$2,109	$23,194	$42
9.2	Circulating Water Pumps	$3,023	$0	$233	$0	$3,255	$275	$0	$353	$3,884	$7
9.3	Circ.Water System Auxiliaries	$754	$0	$100	$0	$854	$81	$0	$94	$1,029	$2
9.4	Circ.Water Piping	$0	$5,974	$5,789	$0	$11,763	$1,101	$0	$1,930	$14,794	$27
9.5	Make-up Water System	$613	$0	$819	$0	$1,433	$137	$0	$235	$1,805	$3
9.6	Component Cooling Water Sys	$597	$0	$475	$0	$1,072	$102	$0	$176	$1,350	$2
9.9	Circ.Water System Foundations& Structures	$0	$3,563	$5,661	$0	$9,224	$873	$0	$2,019	$12,116	$22
	SUBTOTAL 9.	**$19,662**	**$9,537**	**$17,647**	**$0**	**$46,846**	**$4,410**	**$0**	**$6,916**	**$58,171**	**$106**
10	ASH/SPENT SORBENT HANDLING SYS										
10.1	Ash Coolers	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
10.2	Cyclone Ash Letdown	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
10.3	HGCU Ash Letdown	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
10.4	High Temperature Ash Piping	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
10.5	Other Ash Recovery Equipment	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
10.6	Ash Storage Silos	$687	$0	$2,117	$0	$2,804	$275	$0	$308	$3,387	$6
10.7	Ash Transport & Feed Equipment	$4,448	$0	$4,556	$0	$9,004	$861	$0	$986	$10,851	$20
10.8	Misc. Ash Handling Equipment	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
10.9	Ash/Spent Sorbent Foundation	$0	$163	$192	$0	$356	$33	$0	$78	$467	$1
	SUBTOTAL 10.	**$5,135**	**$163**	**$6,865**	**$0**	**$12,163**	**$1,169**	**$0**	**$1,372**	**$14,705**	**$27**
11	ACCESSORY ELECTRIC PLANT										
11.1	Generator Equipment	$1,714	$0	$278	$0	$1,993	$185	$0	$163	$2,341	$4
11.2	Station Service Equipment	$4,791	$0	$1,574	$0	$6,366	$595	$0	$522	$7,483	$14
11.3	Switchgear & Motor Control	$5,508	$0	$936	$0	$6,445	$597	$0	$704	$7,746	$14
11.4	Conduit & Cable Tray	$0	$3,454	$11,941	$0	$15,395	$1,490	$0	$2,533	$19,418	$35
11.5	Wire & Cable	$0	$6,517	$12,580	$0	$19,097	$1,609	$0	$3,106	$23,811	$43
11.6	Protective Equipment	$261	$0	$888	$0	$1,149	$112	$0	$126	$1,388	$3
11.7	Standby Equipment	$1,352	$0	$31	$0	$1,383	$127	$0	$151	$1,660	$3
11.8	Main Power Transformers	$11,140	$0	$187	$0	$11,327	$859	$0	$1,219	$13,405	$24
11.9	Electrical Foundations	$0	$339	$830	$0	$1,168	$112	$0	$256	$1,536	$3
	SUBTOTAL 11.	**$24,767**	**$10,309**	**$29,247**	**$0**	**$64,322**	**$5,686**	**$0**	**$8,780**	**$78,788**	**$143**
12	INSTRUMENTATION & CONTROL										
12.1	PC Control Equipment	w/12.7	$0	w/12.7	$0	$0	$0	$0	$0	$0	$0
12.2	Combustion Turbine Control	N/A	$0	N/A	$0	$0	$0	$0	$0	$0	$0
12.3	Steam Turbine Control	w/8.1	$0	w/8.1	$0	$0	$0	$0	$0	$0	$0
12.4	Other Major Component Control	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
12.5	Signal Processing Equipment	w/12.7	$0	w/12.7	$0	$0	$0	$0	$0	$0	$0
12.6	Control Boards,Panels & Racks	$511	$0	$306	$0	$816	$77	$41	$140	$1,074	$2
12.7	Distributed Control System Equipment	$5,154	$0	$901	$0	$6,055	$561	$303	$692	$7,611	$14
12.8	Instrument Wiring & Tubing	$2,794	$0	$5,542	$0	$8,336	$710	$417	$1,420	$10,883	$20
12.9	Other I & C Equipment	$1,456	$0	$3,305	$0	$4,761	$462	$238	$546	$6,007	$11
	SUBTOTAL 12.	**$9,915**	**$0**	**$10,054**	**$0**	**$19,969**	**$1,811**	**$998**	**$2,798**	**$25,575**	**$47**

Exhibit 7-9 Case 3 capital costs (Continued)

Acct		Equipment	Material	Labor		Sales	Bare Erected	Eng'g CM	Contingencies		TOTAL PLANT COST	
No.	Item/Description	Cost	Cost	Direct	Indirect	Tax	Cost $	H.O.& Fee	Process	Project	$	$/kW
13	IMPROVEMENTS TO SITE											
13.1	Site Preparation	$0	$55	$1,103	$0	$0	$1,158	$115	$0	$255	$1,528	$3
13.2	Site Improvements	$0	$1,831	$2,274	$0	$0	$4,105	$405	$0	$902	$5,411	$10
13.3	Site Facilities	$3,281	$0	$3,235	$0	$0	$6,516	$642	$0	$1,432	$8,590	$16
	SUBTOTAL 13.	**$3,281**	**$1,886**	**$6,612**	**$0**	**$0**	**$11,779**	**$1,162**	**$0**	**$2,588**	**$15,529**	**$28**
14	BUILDINGS & STRUCTURES											
14.1	Boiler Building	$0	$8,791	$7,731	$0	$0	$16,522	$1,485	$0	$2,701	$20,708	$38
14.2	Turbine Building	$0	$12,699	$11,836	$0	$0	$24,535	$2,211	$0	$4,012	$30,758	$56
14.3	Administration Building	$0	$637	$673	$0	$0	$1,310	$119	$0	$214	$1,644	$3
14.4	Circulation Water Pumphouse	$0	$168	$134	$0	$0	$302	$27	$0	$49	$378	$1
14.5	Water Treatment Buildings	$0	$842	$768	$0	$0	$1,610	$145	$0	$263	$2,018	$4
14.6	Machine Shop	$0	$426	$286	$0	$0	$712	$63	$0	$116	$892	$2
14.7	Warehouse	$0	$289	$290	$0	$0	$578	$52	$0	$95	$725	$1
14.8	Other Buildings & Structures	$0	$236	$201	$0	$0	$437	$39	$0	$71	$547	$1
14.9	Waste Treating Building & Str.	$0	$452	$1,372	$0	$0	$1,825	$173	$0	$300	$2,298	$4
	SUBTOTAL 14.	**$0**	**$24,540**	**$23,290**	**$0**	**$0**	**$47,830**	**$4,315**	**$0**	**$7,822**	**$59,967**	**$109**
	TOTAL COST	**$740,888**	**$54,598**	**$370,114**	**$0**	**$0**	**$1,165,600**	**$109,989**	**$47,376**	**$185,644**	**$1,508,610**	**$2,743**
	BEC, Categories 1-12						**$1,105,992**					
	Owner's Costs											
	Preproduction Costs											
	6 Months All Labor										$10,153	$18
	1 Month Maintenance Materials										$1,457	$3
	1 Month Non-fuel Consumables										$1,478	$3
	1 Month Waste Disposal										$309	$1
	25% of 1 Months Fuel Cost at 100% CF										$1,882	$3
	2% of TPC										$30,172	$55
	Total										**$45,451**	**$83**
	Inventory Capital											
	60 day supply of fuel and consumables at 100% CF										$18,151	$33
	0.5% of TPC (spare parts)										$7,543	$14
	Total										**$25,694**	**$47**
	Initial Cost for Catalyst and Chemicals										$2,383	$4
	Land										$900	$2
	Other Owner's Costs										$226,291	$411
	Financing Costs										$40,732	$74
	Total Overnight Costs (TOC)										**$1,850,062**	**$3,364**
	TASC Multiplier								(IOU, high risk, 35 year)		1.140	
	Total As-Spent Cost (TASC)										**$2,109,071**	**$3,835**

Exhibit 7-10 Case 3 operation and maintenance costs

INITIAL & ANNUAL O&M EXPENSES				Cost Base (Jun):	2007
Case 3 - 1x550 MWnet Super-Critical PC w/ CO2 Capture (MEA Sensitivity)				Heat Rate-net (Btu/kWh):	11,455
				MWe-net:	550
				Capacity Factor (%):	85
OPERATING & MAINTENANCE LABOR					
Operating Labor					
Operating Labor Rate(base):	34.65	$/hour			
Operating Labor Burden:	30.00	% of base			
Labor O-H Charge Rate:	25.00	% of labor			
			Total		
Operating Labor Requirements(O.J.)|	1 unit/mod.		Plant		
Skilled Operator	2.0		2.0		
Operator	11.3		11.3		
Foreman	1.0		1.0		
Lab Tech's, etc.	2.0		2.0		
TOTAL-O.J.'s	16.3		16.3		
				Annual Cost	Annual Unit Cost
				$	$/kW-net
Annual Operating Labor Cost				$6,444,907	$11.719
Maintenance Labor Cost				$9,800,561	$17.820
Administrative & Support Labor				$4,061,367	$7.385
Property Taxes and Insurance				$30,172,197	$54.863
TOTAL FIXED OPERATING COSTS				**$50,479,031**	**$91.787**
VARIABLE OPERATING COSTS					
					$/kWh-net
Maintenance Material Cost				**$14,863,811**	**$0.00363**
Consumables	Consumption		Unit		
	Initial	/Day	Cost		
Water(/1000 gallons)	0	6,801	1.08	**$2,282,387**	**$0.00056**
Chemicals					
MU & WT Chem.(lb)	0	32,922	0.17	$1,767,714	$0.00043
Limestone (ton)	0	654	21.63	$4,389,274	$0.00107
Carbon (Mercury Removal) (lb)	0	0	1.05	$0	$0.00000
MEA Solvent (ton)	981	1.39	2,249.89	$971,338	$0.00024
NaOH (tons)	69	6.93	433.68	$932,782	$0.00023
H2SO4 (tons)	66	6.62	138.78	$284,854	$0.00007
Corrosion Inhibitor	0	0	0.00	$0	$0.00000
Activated Carbon(lb)	0	1,662	1.05	$541,593	$0.00013
Ammonia (28% NH3) ton	0	97	129.80	$3,904,140	$0.00095
Subtotal Chemicals				**$12,791,695**	**$0.00312**
Other					
Supplemental Fuel (MBtu)	0	0	0.00	$0	$0.00000
SCR Catalyst (m3)	w/equip.	0.41	5,775.94	$730,089	$0.00018
Emission Penalties	0	0	0.00	$0	$0.00000
Subtotal Other				**$730,089**	**$0.00018**
Waste Disposal					
Fly Ash (ton)	0	502	16.23	$2,524,978	$0.00062
Bottom Ash (ton)	0	125	16.23	$628,224	$0.00015
Subtotal-Waste Disposal				**$3,153,202**	**$0.00077**
By-products & Emissions					
Gypsum (tons)	0	1,013	0.00	$0	$0.00000
Subtotal By-Products				**$0**	**$0.00000**
TOTAL VARIABLE OPERATING COSTS				**$33,821,185**	**$0.00826**
Fuel(ton)	0	6,480	38.18	**$76,766,172**	**$0.01875**

Exhibit 7-11 Cost of electricity breakdown for Case 3

TOC, $/kW	**3,364**
COE w/o TS&M, $/MW	**95.5**
Capital, $/MW	56.1
Fixed, $/MW	12.3
Variable, $/MW	8.3
Fuel, $/MW	18.7

8 Case 4: MHI KS-1 Absorber Technology

Results for a plant with a representation of the MHI technology using KS-1 solvent as discussed in section 4.1.3 are presented. Exhibit 8-1 provides the block flow diagram for Case 4.

The following are the key points of the MHI KS-1 absorber technology:

- Utilize a low-pressure drop
- A polishing scrubber downstream of the wet FGD is needed to reduce SO_2 in the flue gas to minimize solvent degradation of KS-1
- CO_2 absorber is a rectangular packed column with two main sections:
    - The absorption section in the lower portion
    - The treated flue gas washing section in the upper portion
- Between the lower and upper portions, the flue gas is washed with water to minimize solvent losses
- The regenerator is a cylindrical packed column
- CO_2 is removed from rich solvent by use of low-pressure steam (298 °F, 50 psig)
- Requires 1,153 Btu of steam per lb of CO_2 product (compared to 1,526 Btu of steam per lb of CO_2 product in the Fluor capture technology of Case 2)

Exhibit 8-1 Case 4 block flow diagram

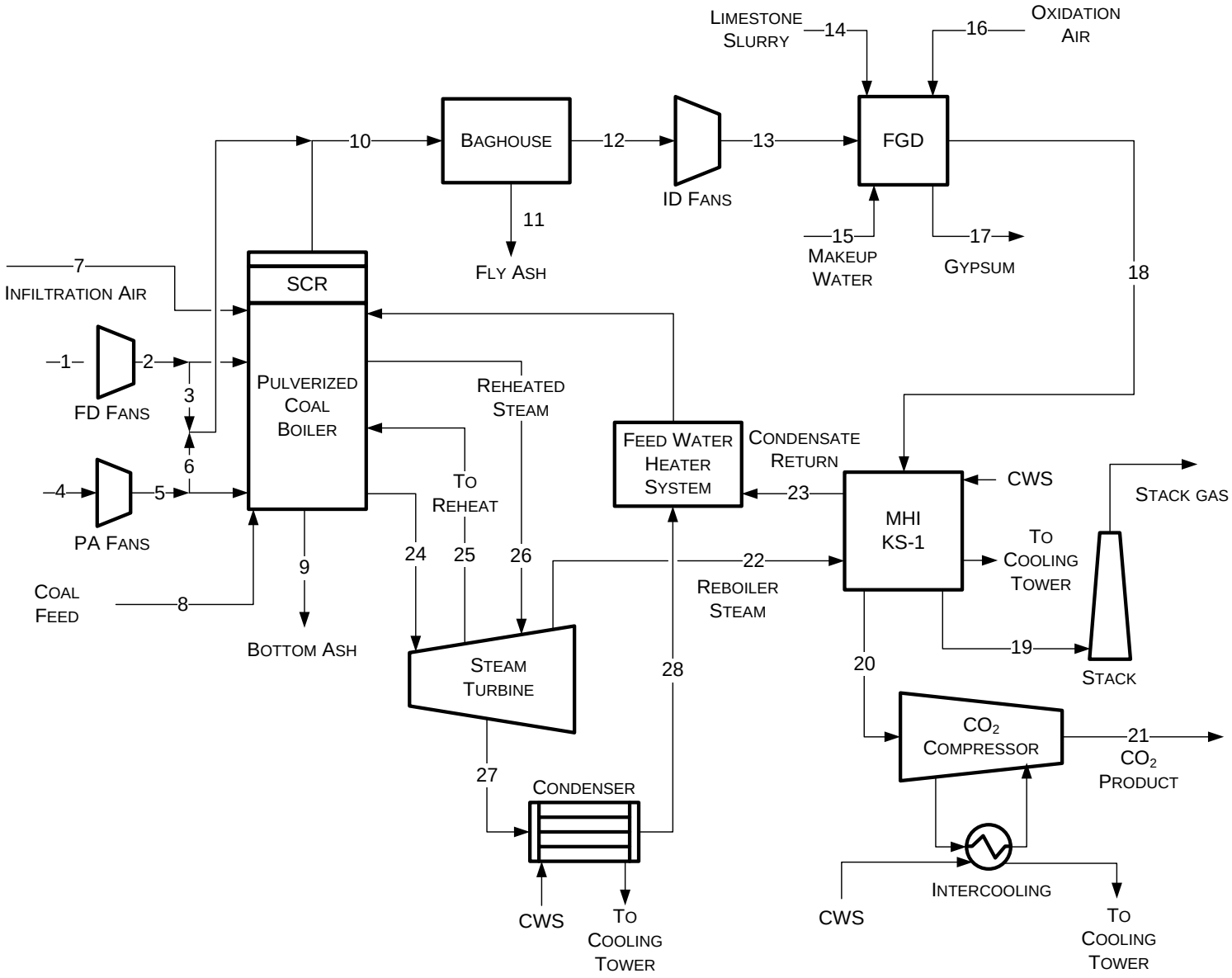


Exhibit 8-2 Case 4 Stream table

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
V-L Mole Fraction														
Ar	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092	0.0000	0.0000	0.0087	0.0000	0.0087	0.0087	0.0000
CO_2	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0000	0.0000	0.1450	0.0000	0.1450	0.1450	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	0.0099	0.0099	0.0099	0.0099	0.0099	0.0099	0.0099	0.0000	0.0000	0.0870	0.0000	0.0870	0.0870	1.0000
N_2	0.7732	0.7732	0.7732	0.7732	0.7732	0.7732	0.7732	0.0000	0.0000	0.7324	0.0000	0.7324	0.7324	0.0000
O_2	0.2074	0.2074	0.2074	0.2074	0.2074	0.2074	0.2074	0.0000	0.0000	0.0247	0.0000	0.0247	0.0247	0.0000
SO_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0021	0.0000	0.0021	0.0021	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000	0.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	62,649	62,649	1,864	19,245	19,245	2,640	1,448	0	0	88,158	0	88,158	88,158	3,168
V-L Flowrate (kg/hr)	1,807,852	1,807,852	53,792	555,353	555,353	76,184	41,784	0	0	2,622,097	0	2,622,097	2,622,097	57,079
Solids Flowrate (kg/hr)	0	0	0	0	0	0	0	240,420	4,663	18,650	18,650	0	0	24,214
Temperature (°C)	15	19	19	15	25	25	15	15	15	169	15	169	182	15
Pressure (MPa, abs)	0.10	0.11	0.11	0.10	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.11	0.10
Enthalpy (kJ/kg)[A]	30.23	34.36	34.36	30.23	40.78	40.78	30.23	---	---	327.39	---	308.96	322.83	---
Density (kg/m^3)	1.2	1.2	1.2	1.2	1.3	1.3	1.2	---	---	0.8	---	0.8	0.8	---
V-L Molecular Weight	28.857	28.857	28.857	28.857	28.857	28.857	28.857	---	---	29.743	---	29.743	29.743	---
V-L Flowrate (lb_{mol}/hr)	138,117	138,117	4,110	42,428	42,428	5,820	3,192	0	0	194,355	0	194,355	194,355	6,985
V-L Flowrate (lb/hr)	3,985,632	3,985,632	118,592	1,224,345	1,224,345	167,957	92,119	0	0	5,780,734	0	5,780,734	5,780,734	125,838
Solids Flowrate (lb/hr)	0	0	0	0	0	0	0	530,035	10,279	41,117	41,117	0	0	53,382
Temperature (°F)	59	66	66	59	78	78	59	59	59	337	59	337	360	59
Pressure (psia)	14.7	15.3	15.3	14.7	16.1	16.1	14.7	14.7	14.7	14.4	14.7	14.2	15.4	15.0
Enthalpy (Btu/lb)[A]	13.0	14.8	14.8	13.0	17.5	17.5	13.0	---	---	140.8	---	132.8	138.8	---
Density (lb/ft^3)	0.076	0.078	0.078	0.076	0.081	0.081	0.076	---	---	0.050	---	0.049	0.052	---
	A - Reference conditions are 32.02 F & 0.089 PSIA													

Exhibit 8-2 Case 4 Stream table (Continued)

	15	16	17	18	19	20	21	22	23	24	25	26	27	28
V-L Mole Fraction														
Ar	0.0000	0.0128	0.0000	0.0081	0.0109	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CO_2	0.0000	0.0005	0.0004	0.1351	0.0180	0.9961	0.9985	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	1.0000	0.0062	0.9996	0.1537	0.0327	0.0039	0.0015	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
N_2	0.0000	0.7506	0.0000	0.6793	0.9066	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
O_2	0.0000	0.2300	0.0000	0.0238	0.0318	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SO_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	12,607	895	232	96,044	71,960	11,720	11,692	31,785	31,785	118,528	96,672	96,672	55,846	55,846
V-L Flowrate (kg/hr)	227,126	25,968	4,176	2,769,033	2,031,518	514,601	514,093	572,609	572,609	2,135,311	1,741,581	1,741,581	1,006,081	1,006,081
Solids Flowrate (kg/hr)	0	0	37,489	0	0	0	0	0	0	0	0	0	0	0
Temperature (°C)	15	181	58	58	29	21	35	291	151	593	354	593	38	39
Pressure (MPa, abs)	0.10	0.31	0.10	0.10	0.10	0.16	15.27	0.51	0.92	24.23	4.90	4.52	0.01	1.69
Enthalpy (kJ/kg)[A]	-46.80	191.58	---	301.42	81.87	19.49	-211.71	3,045.10	636.31	3,476.62	3,082.02	3,652.22	2,109.46	166.26
Density (kg/m^3)	1,003.1	2.4	---	1.1	1.1	2.9	795.9	2.0	916.0	69.2	18.7	11.6	0.1	993.2
V-L Molecular Weight	18.015	29.029	---	28.831	28.231	43.908	43.971	18.015	18.015	18.015	18.015	18.015	18.015	18.015
V-L Flowrate (lb_{mol}/hr)	27,795	1,972	511	211,740	158,644	25,838	25,776	70,073	70,073	261,309	213,126	213,126	123,119	123,119
V-L Flowrate (lb/hr)	500,727	57,250	9,206	6,104,673	4,478,731	1,134,500	1,133,381	1,262,386	1,262,386	4,707,555	3,839,529	3,839,529	2,218,029	2,218,029
Solids Flowrate (lb/hr)	0	0	82,650	0	0	0	0	0	0	0	0	0	0	0
Temperature (°F)	59	357	136	136	84	69	95	556	304	1,100	669	1,100	101	103
Pressure (psia)	14.7	45.0	14.9	14.9	14.7	23.5	2,214.5	73.5	133.6	3,514.7	710.8	655.8	1.0	245.0
Enthalpy (Btu/lb)[A]	-20.1	82.4	---	129.6	35.2	8.4	-91.0	1,309.2	273.6	1,494.7	1,325.0	1,570.2	906.9	71.5
Density (lb/ft^3)	62.622	0.149	---	0.067	0.071	0.184	49.684	0.123	57.184	4.319	1.165	0.722	0.004	62.005

Exhibit 8-3 Case 4 Performance summary

	Case 4	Units
Plant Output		
Steam Turbine Power	651,700	kW_e
Total	**651,700**	kW_e
Auxiliary Load		
Coal Handling and Conveying	500	kW_e
Pulverizers	3,600	kW_e
Sorbent Handling & Reagent Preparation	1,170	kW_e
Ash Handling	690	kW_e
Primary Air Fans	1,690	kW_e
Forced Draft Fans	2,150	kW_e
Induced Draft Fans	10,420	kW_e
SCR	60	kW_e
Baghouse	90	kW_e
Wet FGD	3,850	kW_e
Econamine FG Plus Auxiliaries	16,300	kW_e
CO_2 Compression	42,050	kW_e
Miscellaneous Balance of Plant[2,3]	2,000	kW_e
Steam Turbine Auxiliaries	400	kW_e
Condensate Pumps	640	kW_e
Circulating Water Pumps	8,630	kW_e
Ground Water Pumps	770	kW_e
Cooling Tower Fans	4,460	kW_e
Transformer Losses	2,230	kW_e
Total	**101,700**	**kW_e**
Plant Performance		
Net Auxiliary Load	101,700	kW_e
Net Plant Power	550,000	kW_e
Net Plant Efficiency (HHV)	30.4%	
Net Plant Heat Rate (HHV)	11,861 (11,243)	kJ/kWhr (Btu/kWhr)
Coal Feed Flowrate	240,420 (530,035)	kg/hr (lb/hr)
Thermal Input[1]	1,812,172	kW_{th}
Condenser Duty	1,961 (1,858)	GJ/hr (MMBtu/hr)
Raw Water Withdrawal	32.2 (8,505)	m^3/min (gpm)
Raw Water Consumption	24.6 (6,508)	m^3/min (gpm)

1 - HHV of Illinois No. 6 coal is 27,135 kJ/kg (11,666 Btu/lb)
2 – Boiler feed pumps are turbine driven
3 – Includes plant control systems, lighting, HVAC, and miscellaneous low voltage loads

Exhibit 8-4 Case 4 water balance

	Water Demand	Internal Recycle	Raw Water Withdrawal	Process Water Discharge	Raw Water Consumption
	m^3/min (gpm)				
Econamine	-	-	-	-	-
FGD Makeup	4.74 (1253)	-	4.74 (1253)	-	4.74 (1,253)
BFW Makeup	-	-	-	-	-
Cooling Tower	33.6 (8,879)	6.16 (1627)	27.5 (7,252)	7.56 (1,997)	19.89 (5,255)
Total	**38.4 (10,132)**	**6.16 (1627)**	**32.2 (8,505)**	**7.56 (1,997)**	**24.64 (6,508)**

Exhibit 8-5 Case 4 carbon balance

Carbon In		Carbon Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	153,255 (337,869)	Stack Gas	15,580 (34,348)
Air (CO2)	332 (733)	FGD Product	245 (540)
FGD Reagent	2,457 (5,417)	CO2 Product	140,218 (309,128)
	-	Convergence Tolerance	1 (3)
Total	**156,044 (344,019)**	**Total**	**156,044 (344,019)**

Exhibit 8-6 Case 4 sulfur balance

Sulfur In		Sulfur Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	6,026 (13,285)	FGD Product	5,905 (13,019)
	-	Stack Gas	2 (5)
	-	Econamine Polishing Scrubber/HSS	118 (260)
Total	**6,026 (13,285)**	**Total**	**6,026 (13,285)**

Exhibit 8-7 Case 4 energy balance

	HHV	Sensible + Latent	Power	Total
Heat In GJ/hr (MMBtu/hr)				
Coal	6,524 (6,183)	5.5 (5.2)	-	6,529 (6,189)
Air	-	72.7 (68.9)	-	72.7 (68.9)
Raw Water Makeup	-	121.1 (114.8)	-	121.1 (114.8)
Lime	-	0.27 (0.26)	-	0.27 (0.26)
Auxiliary Power	-	-	366 (347)	366 (347)
TOTAL	**6,524 (6,183)**	**199.6 (189.1)**	**366 (347)**	**7,089 (6,720)**
Heat Out GJ/hr (MMBtu/hr)				
Bottom Ash	-	0.6 (0.5)	-	0.6 (0.5)
Fly Ash + FGD Ash	-	2.3 (2.1)	-	2.3 (2.1)
Flue Gas	-	166 (158)	-	166 (158)
Condenser	-	1,961 (1,858)	-	1,961 (1,858)
CO2	-	-109 (-103)	-	-109 (-103)
Cooling Tower Blowdown	-	56.2 (53.2)	-	56.2 (53.2)
Econamine Losses	-	2,323 (2,201)	-	2,323 (2,201)
*Process Losses**	-	*343.5 (325.6)*	-	*343.5 (325.6)*
Power	-	-	2,346 (2,224)	2,346 (2,224)
TOTAL	**-**	**4,743 (4,496)**	**2,346 (2,224)**	**7,089 (6,720)**

* Process losses are estimated to match the heat input to the plant.

Exhibit 8-8 Case 4 air emissions

	kg/GJ (lb/MMBtu)	tonne/yr (Ton/year)	kg/MWgross (lb/MWgross)
SO_2	0.001 (0.002)	34 (38)	0.007 (.02)
NOx	0.030 (0.070)	1,462 (1,611)	0.301 (.664)
Particulate	0.006 (0.0130)	271 (299)	0.056 (.123)
Hg	4.91E-7 (1.14E-6)	0.024 (0.026)	4.92E-6 (1.08E-5)
CO_2	8.8 (20.4)	425,065 (468,554)	88 (193)

Exhibit 8-9 Case 4 capital costs

									Cost Base:	Jan 2007	
									Prepared:	4-Jan-12	
	Case:	4								x $1, 000	
	Plant Size:	550.00	MW, net		Capital Charge Factor		0.85				
Acct No.	Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	TOTAL PLANT COST $	TOTAL PLANT COST $/kW
1	COAL HANDLING SYSTEM										
1.1	Coal Receive & Unload	3,952	0	1,805	0	5,757	514	0	941	7,212	13
1.2	Coal Stackout & Reclaim	5,107	0	1,157	0	6,264	548	0	1,022	7,834	14
1.3	Coal Conveyors & Yd Crus	4,748	0	1,145	0	5,893	516	0	961	7,371	13
1.4	Other Coal Handling	1,242	0	265	0	1,507	132	0	246	1,885	3
1.5	Sorbent Receive & Unload	161	0	48	0	209	18	0	34	262	0
1.6	Sorbent Stackout & Reclaim	2,598	0	476	0	3,074	268	0	501	3,843	7
1.7	Sorbent Conveyors	927	200	227	0	1,355	117	0	221	1,693	3
1.8	Other Sorbent Handling	560	131	294	0	985	87	0	161	1,233	2
1.9	Coal & Sorbent Hnd.Foundations	0	4,852	6,121	0	10,973	1,031	0	1,801	13,804	25
	SUBTOTAL 1.	**$19,295**	**$5,184**	**$11,538**	**$0**	**$36,017**	**$3,232**	**$0**	**$5,887**	**$45,136**	**$82**
2	COAL PREP & FEED SYSTEMS										
2.1	Coal Crushing & Drying	2,287	0	446	0	2,732	238	0	446	3,416	6
2.2	Prepared Coal Storage & Feed	5,855	0	1,278	0	7,133	624	0	1,164	8,920	16
2.3	Slurry Prep & Feed	0	0	0	0	0	0	0	0	0	0
2.4	Misc. Coal Prep & Feed	0	0	0	0	0	0	0	0	0	0
2.5	Sorbent Prep Equipment	4,412	190	916	0	5,518	480	0	900	6,898	13
2.6	Sorbent Storage & Feed	532	0	204	0	735	65	0	120	920	2
2.7	Sorbent Injection System	0	0	0	0	0	0	0	0	0	0
2.8	Booster Air Supply System	0	0	0	0	0	0	0	0	0	0
2.9	Coal & Sorbent Feed Foundation	0	573	481	0	1,053	98	0	173	1,323	2
	SUBTOTAL 2.	**$13,085**	**$763**	**$3,324**	**$0**	**$17,172**	**$1,505**	**$0**	**$2,802**	**$21,478**	**$39**
3	FEEDWATER & MISC. BOP SYSTEMS										
3.1	Feedwater System	21,854	0	7,059	0	28,914	2,527	0	4,716	36,156	66
3.2	Water Makeup & Pretreating	6,206	0	1,998	0	8,203	776	0	1,796	10,775	20
3.3	Other Feedwater Subsystems	6,691	0	2,828	0	9,518	853	0	1,556	11,926	22
3.4	Service Water Systems	1,217	0	662	0	1,878	177	0	411	2,466	4
3.5	Other Boiler Plant Systems	8,261	0	8,156	0	16,417	1,559	0	2,696	20,673	38
3.6	FO Supply Sys & Nat Gas	271	0	339	0	611	58	0	100	769	1
3.7	Waste Treatment Equipment	4,207	0	2,398	0	6,606	643	0	1,450	8,698	16
3.8	Misc. Power Plant Equipment	2,882	0	880	0	3,763	362	0	825	4,949	9
	SUBTOTAL 3.	**$51,589**	**$0**	**$24,321**	**$0**	**$75,910**	**$6,953**	**$0**	**$13,550**	**$96,413**	**$175**

Exhibit 8-9 Case 4 capital costs (Continued)

Acct No.	Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	TOTAL PLANT COST $	TOTAL PLANT COST $/kW
4	PC BOILER & ACCESSORIES										
4.1	PC Boiler & Accessories	187,222	0	105,050	0	292,272	28,444	0	32,072	352,788	641
4.2	SCR (w/4.1)	0	0	0	0	0	0	0	0	0	0
4.3	Open	0	0	0	0	0	0	0	0	0	0
4.4	Boiler BoP (w/ ID Fans)	0	0	0	0	0	0	0	0	0	0
4.5	Primary Air System	w/4.1	0	w/4.1	0	0	0	0	0	0	0
4.6	Secondary Air System	w/4.1	0	w/4.1	0	0	0	0	0	0	0
4.8	Major Component Rigging	0	w/4.1	w/4.1	0	0	0	0	0	0	0
4.9	Boiler Foundations	0	w/14.1	w/14.1	0	0	0	0	0	0	0
	SUBTOTAL 4.	**$187,222**	**$0**	**$105,050**	**$0**	**$292,272**	**$28,444**	**$0**	**$32,072**	**$352,788**	**$641**
5A	FLUE GAS CLEANUP										
5.1	Absorber Vessels & Accessories	66,923	0	14,407	0	81,331	7,754	0	8,908	97,993	178
5.2	Other FGD	3,492	0	3,958	0	7,450	723	0	817	8,990	16
5.3	Bag House & Accessories	19,187	0	12,177	0	31,364	3,022	0	3,439	37,825	69
5.4	Other Particulate Removal Materials	1,299	0	1,390	0	2,690	261	0	295	3,246	6
5.5	Gypsum Dewatering System	5,390	0	915	0	6,305	600	0	691	7,596	14
5.6	Mercury Removal System	0	0	0	0	0	0	0	0	0	0
5.7	Open	0	0	0	0	0	0	0	0	0	0
	SUBTOTAL 5A.	**$96,292**	**$0**	**$32,847**	**$0**	**$129,139**	**$12,360**	**$0**	**$14,150**	**$155,649**	**$283**
5B	CO2 REMOVAL & COMPRESSION										
5B.1	CO2 Removal System	199,756	0	60,652	0	260,408	24,897	52,082	67,477	404,864	736
5B.2	CO2 Compression & Drying	26,498	0	8,313	0	34,812	3,329	0	7,628	45,769	83
	SUBTOTAL 5B.	**$226,254**	**$0**	**$68,965**	**$0**	**$295,219**	**$28,227**	**$52,082**	**$75,106**	**$450,633**	**$819**
6	COMBUSTION TURBINE/ACCESSORIES										
6.1	Combustion Turbine Generator	0	0	0	0	0	0	0	0	0	0
6.2	Combustion Turbine Accessories	0	0	0	0	0	0	0	0	0	0
6.3	Compressed Air Piping	0	0	0	0	0	0	0	0	0	0
6.4	Combustion Turbine Foundations	0	0	0	0	0	0	0	0	0	0
	SUBTOTAL 6.	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
7	HRSG, DUCTING & STACK										
7.1	Flue Gas Recycle Heat Exhchanger	N/A	0	N/A	0	0	0	0	0	0	0
7.2	SCR System	0	0	0	0	0	0	0	0	0	0
7.3	Ductwork	9,023	0	5,797	0	14,820	1,292	0	2,417	18,529	34
7.4	Stack	8,340	0	4,880	0	13,220	1,273	0	1,449	15,942	29
7.9	HRSG, Duct & Stack Foundations	0	957	1,087	0	2,044	191	0	447	2,682	5
	SUBTOTAL 7.	**$17,363**	**$957**	**$11,764**	**$0**	**$30,084**	**$2,756**	**$0**	**$4,313**	**$37,153**	**$68**
8	STEAM TURBINE GENERATOR										
8.1	Steam TG & Accessories	56,143	0	7,450	0	63,593	6,095	0	6,969	76,656	139
8.2	Turbine Plant Auxiliaries	378	0	810	0	1,188	116	0	130	1,435	3
8.3	Condenser & Auxiliaries	5,975	0	2,202	0	8,177	783	0	896	9,856	18
8.4	Steam Piping	20,444	0	10,080	0	30,525	2,565	0	4,963	38,053	69
8.9	TG Foundations	0	1,187	1,875	0	3,062	290	0	670	4,022	7
	SUBTOTAL 8.	**$82,940**	**$1,187**	**$22,418**	**$0**	**$106,544**	**$9,848**	**$0**	**$13,629**	**$130,021**	**$236**

Exhibit 8-9 Case 4 capital costs (Continued)

Acct No.	Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	TOTAL PLANT COST $	TOTAL PLANT COST $/kW
9	COOLING WATER SYSTEM										
9.1	Cooling Towers	7,635	0	2,378	0	10,012	957	0	1,097	12,067	22
9.2	Circulating Water Pumps	2,810	0	216	0	3,026	256	0	328	3,610	7
9.3	Circ. Water System Auxiliaries	711	0	95	0	805	77	0	88	970	2
9.4	Circ. Water Piping	0	5,633	5,460	0	11,093	1,038	0	1,820	13,951	25
9.5	Make-up Water System	579	0	774	0	1,353	130	0	222	1,706	3
9.6	Component Cooling Water System	563	0	448	0	1,011	96	0	166	1,273	2
9.9	Circ. Water System Foundations	0	3,364	5,345	0	8,709	824	0	1,906	11,439	21
	SUBTOTAL 9.	**$12,298**	**$8,997**	**$14,714**	**$0**	**$36,009**	**$3,378**	**$0**	**$5,628**	**$45,015**	**$82**
10	ASH/SPENT SORBENT HANDLING SYS										
10.1	Ash Coolers	N/A	0	N/A	0	0	0	0	0	0	0
10.2	Cyclone Ash Letdown	N/A	0	N/A	0	0	0	0	0	0	0
10.3	HGCU Ash Letdown	N/A	0	N/A	0	0	0	0	0	0	0
10.4	High Temperature Ash Piping	N/A	0	N/A	0	0	0	0	0	0	0
10.5	Other Ash Recovery Equipment	N/A	0	N/A	0	0	0	0	0	0	0
10.6	Ash Storage Silos	691	0	2,130	0	2,821	277	0	310	3,407	6
10.7	Ash Transport & Feed Equipment	4,474	0	4,583	0	9,057	866	0	992	10,915	20
10.8	Misc. Ash Handling Equipment	0	0	0	0	0	0	0	0	0	0
10.9	Ash/Spent Sorbent Foundation	0	164	193	0	358	34	0	78	469	1
	SUBTOTAL 10.	**$5,165**	**$164**	**$6,906**	**$0**	**$12,235**	**$1,176**	**$0**	**$1,380**	**$14,792**	**$27**
11	ACCESSORY ELECTRIC PLANT										
11.1	Generator Equipment	1,712	0	278	0	1,990	184	0	163	2,337	4
11.2	Station Service Equipment	4,739	0	1,557	0	6,296	589	0	516	7,401	13
11.3	Switchgear & Motor Control	5,448	0	926	0	6,374	591	0	697	7,662	14
11.4	Conduit & Cable Tray	0	3,416	11,811	0	15,227	1,474	0	2,505	19,206	35
11.5	Wire & Cable	0	6,446	12,443	0	18,888	1,591	0	3,072	23,552	43
11.6	Protective Equipment	261	0	888	0	1,149	112	0	126	1,388	3
11.7	Standby Equipment	1,350	0	31	0	1,381	127	0	151	1,658	3
11.8	Main Power Transformers	11,074	0	186	0	11,261	854	0	1,211	13,326	24
11.9	Electrical Foundations	0	338	828	0	1,166	111	0	255	1,532	3
	SUBTOTAL 11.	**$24,585**	**$10,199**	**$28,948**	**$0**	**$63,732**	**$5,633**	**$0**	**$8,697**	**$78,062**	**$142**
12	INSTRUMENTATION & CONTROL										
12.1	PC Control Equipment	w/12.7	0	w/12.7	0	0	0	0	0	0	0
12.2	Combustion Turbine Control	N/A	0	N/A	0	0	0	0	0	0	0
12.3	Steam Turbine Control	w/8.1	0	w/8.1	0	0	0	0	0	0	0
12.4	Other Major Component Control	0	0	0	0	0	0	0	0	0	0
12.5	Signal Processing Equipment	W/12.7	0	w/12.7	0	0	0	0	0	0	0
12.6	Control Boards, Panels & Racks	509	0	305	0	814	77	40	140	1,071	2
12.7	Computer Accessories	5,138	0	898	0	6,036	560	302	690	7,587	14
12.8	Instrument Wiring & Tubing	2,785	0	5,525	0	8,310	708	415	1,415	10,849	20
12.9	Other I & C Equipment	1,452	0	3,295	0	4,747	460	238	544	5,989	11
	SUBTOTAL 12.	**$9,884**	**$0**	**$10,023**	**$0**	**$19,907**	**$1,805**	**$996**	**$2,789**	**$25,497**	**$46**

Exhibit 8-9 Case 4 capital costs (Continued)

Acct No.	Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	TOTAL PLANT COST $	TOTAL PLANT COST $/kW
13	IMPROVEMENTS TO SITE										
13.1	Site Preparation	0	55	1,100	0	1,155	115	0	254	1,523	3
13.2	Site Improvements	0	1,826	2,268	0	4,094	404	0	899	5,396	10
13.3	Site Facilities	3,272	0	3,227	0	6,499	641	0	1,426	8,566	16
	SUBTOTAL 13.	**$3,272**	**$1,881**	**$6,594**	**$0**	**$11,748**	**$1,159**	**$0**	**$2,579**	**$15,485**	**$28**
14	BUILDINGS & STRUCTURES										
14.1	Boiler Building	0	8,819	7,755	0	16,574	1,490	0	2,709	20,772	38
14.2	Turbine Building	0	12,733	11,868	0	24,601	2,217	0	4,021	30,839	56
14.3	Administration Building	0	639	675	0	1,314	119	0	215	1,648	3
14.4	Circulation Water Pumphouse	0	160	127	0	287	26	0	47	359	1
14.5	Water Treatment Buildings	0	794	724	0	1,518	137	0	247	1,901	3
14.6	Machine Shop	0	427	287	0	714	63	0	117	894	2
14.7	Warehouse	0	289	290	0	580	52	0	95	727	1
14.8	Other Buildings & Structures	0	236	201	0	438	39	0	72	549	1
14.9	Waste Treating Building & Str.	0	451	1,368	0	1,819	173	0	299	2,290	4
	SUBTOTAL 14.	**$0**	**$24,548**	**$23,295**	**$0**	**$47,843**	**$4,316**	**$0**	**$7,819**	**$59,978**	**$109**
	Total Cost	**$749,244**	**$53,880**	**$370,709**	**$0**	**$1,173,832**	**$110,793**	**$53,077**	**$190,400**	**$1,528,102**	**$2,778**
	Owner's Costs										
	Preproduction Costs										
	6 Months All Labor									$10,273	$19
	1 Month Maintenance Materials									$1,469	$3
	1 Month Non-fuel Consumables									$1,661	$3
	1 Month Waste Disposal									$308	$1
	25% of 1 Months Fuel Cost at 100% CF									$1,847	$3
	2% of TPC									$30,562	$56
	Total									**$46,121**	**$84**
	Inventory Capital										
	60 day supply of fuel and consumables at 100% CF									$17,694	$32
	0.5% of TPC (spare parts)									$7,641	$14
	Total									**$25,335**	**$46**
	Initial Cost for Catalyst and Chemicals									$14,172	$26
	Land									$900	$2
	Other Owner's Costs									$229,215	$417
	Financing Costs									$41,259	$75
	Total Overnight Costs (TOC)									**$1,885,103**	**$3,427**
	TASC Multiplier							(IOU, high-risk, 35 year)		1.140	
	Total As-Spent Cost (TASC)									**$2,149,018**	**$3,907**

Exhibit 8-10 Case 4 operation and maintenance costs

CASE 4 INITIAL & ANNUAL O&M EXPENSES					Cost Base (Jun):	2007
					Heat Rate-net (Btu/kWh):	11,243
					MWe-net:	550
					Capacity Factor (%):	85
OPERATING & MAINTENANCE LABOR						
Operating Labor						
Operating Labor Rate(base):	34.65	$/hour				
Operating Labor Burden:	30.00	% of base				
Labor O-H Charge Rate:	25.00	% of labor				
Operating Labor Requirements(O.J.)per S	1 unit/mod.		Total Plant			
Skilled Operator	2.0		2.0			
Operator	11.3		11.3			
Foreman	1.0		1.0			
Lab Tech's, etc.	2.0		2.0			
TOTAL-O.J.'s	16.3		16.3			
					Annual Cost $	Annual Unit Cost $/kW-net
Annual Operating Labor Cost					$6,444,907	$11.718
Maintenance Labor Cost					$9,992,169	$18.168
Administrative & Support Labor					$4,109,269	$7.471
Property Taxes and Insurance					$30,562,037	$55.567
TOTAL FIXED OPERATING COSTS					**$51,108,382**	$92.924
VARIABLE OPERATING COSTS						
						$/kWh-net
Maintenance Material Cost					**$14,988,254**	**$0.00366**
Consumables	Consumption Initial Fill	/Day	Unit Cost	Initial Fill Cost		
Water(/1000 gallons)	0	6,124	1.08	**$0**	**$2,055,018**	**$0.00050**
Chemicals		4.841				
MU & WT Chem. (lbs)	0	29,642	0.17	$0	$1,591,616	$0.00039
Limestone (ton)	0	641	21.63	$0	$4,299,470	$0.00105
Carbon (Mercury Removal) (lb)	0	0	1.05	$0	$0	$0.00000
KS-1 Solvent (ton)	2,138	1	8,500.00	$18,177,135	$3,225,994	$0.00079
NaOH (tons)	34	3.39	433.68	$14,702	$456,120	$0.00011
H2SO4 (tons)	61	6	138.78	$8,505	$263,852	$0.00006
Corrosion Inhibitor	0	0	0.00	$0	$0	$0.00000
Activated Carbon (lb)	0	1,540	1.05	$0	$501,661	$0.00012
Ammonia (19% NH3) (ton)	0	95.2	129.80	$0	$3,833,778	$0.00094
Subtotal Chemicals				**$18,200,341**	**$14,172,493**	**$0.00346**
Other						
Supplemental Fuel (MBtu)	0	0	0.00	$0	$0	$0.00000
SCR Catalyst (m3)	w/equip.	0.40	5,775.94	$0	$716,642	$0.00017
Emission Penalties	0	0	0.00	$0	$0	$0.00000
Subtotal Other				**$0**	**$716,642**	**$0.00017**
Waste Disposal						
Fly Ash (ton)	0	504	16.23	$0	2,537,059.30	0.00062
Bottom Ash (ton)	0	120	16.23	$0	604,061.74	0.00015
Subtotal Waste Disposal				**$0**	**$3,141,121**	**$0.00077**
By-products & Emissions						
Gypsum (tons)	0	145	0.00	$0	$0	$0.00000
Subtotal By-products				**$0**	**$0**	**$0.00000**
TOTAL VARIABLE OPERATING COSTS				**$18,200,341**	**$35,073,528**	**$0.00856**
Fuel (ton)	0	6,360	38.18	**$0**	**$75,350,249**	**$0.01840**

Exhibit 8-11 Cost of electricity breakdown for Case 4

TOC, $/kW	**3,427**
COE w/o TS&M, $/MW	**96.6**
Capital, $/MW	57.2
Fixed, $/MW	12.5
Variable, $/MW	8.6
Fuel, $/MW	18.4

9 MTR Membrane Technology (Cases 5A-5E)

Results for a plant using a representation of the MTR membrane separation as discussed in section 4.1.5. As shown in Exhibit 9-1, Case 5A is with supercritical steam cycle, Case 5B is with ultra supercritical steam cycle, and Case 5C is with advanced ultra supercritical steam cycle. Cases 5D and 5E include a representation of CO_2 shockwave compression and advanced ultra supercritical steam cycle at high and low-risk, respectively.

Exhibit 9-1 MTR case matrix

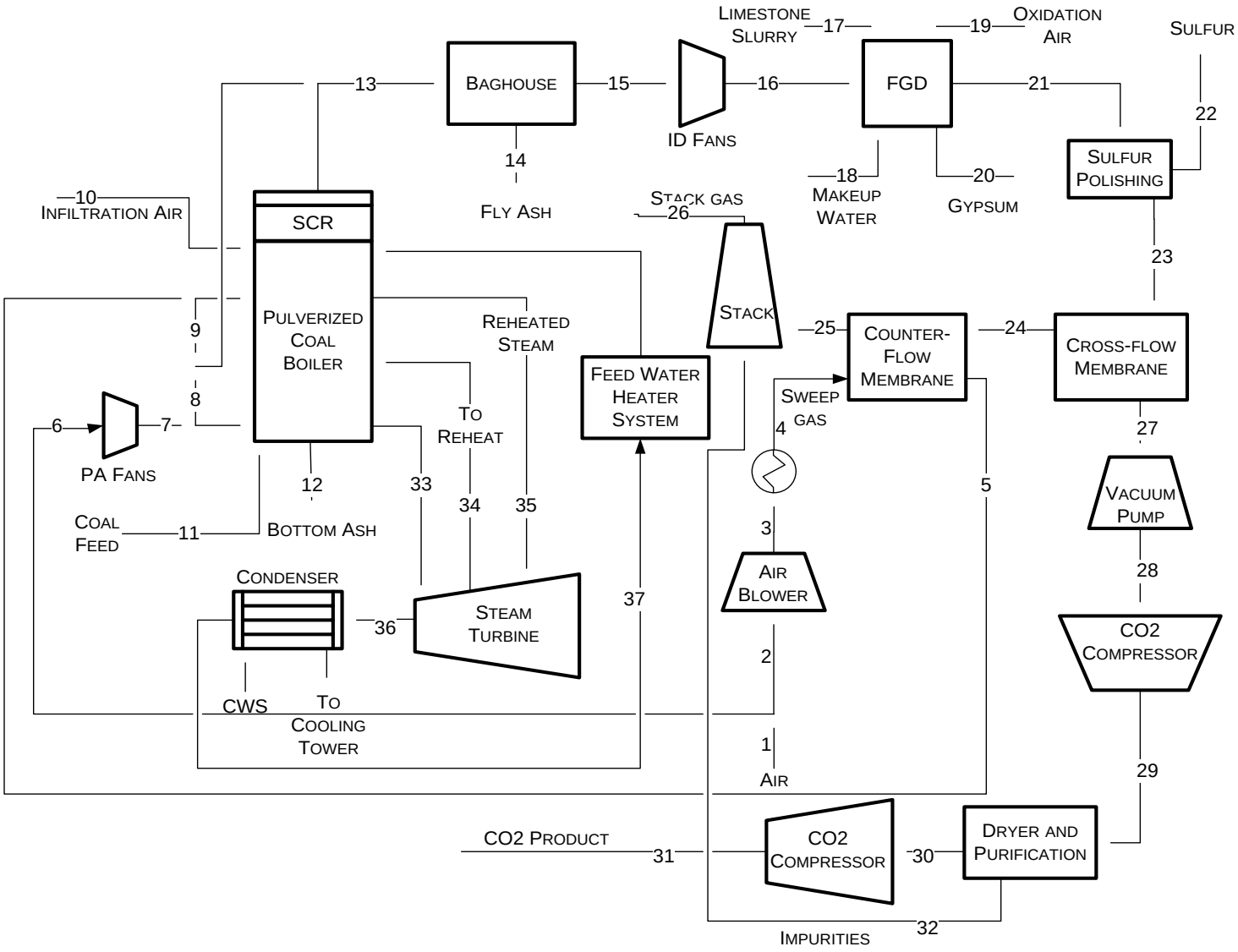
Case	Carbon Removal Technology	Boiler Technology psig/°F/°F	CO_2 Compression Technology	Plant Capacity Factor (%)	Financial Risk Assumption
5A	(MTR) Advanced CO_2 membrane	Supercritical 3500/1100/1100	Conventional	85	High-risk
5B	(MTR) Advanced CO_2 membrane	Ultra-supercritical 5000/1200/1200	Conventional	85	High-risk
5C	(MTR) Advanced CO_2 membrane	AUSC 5000/1350/1400	Conventional	85	High-risk
5D	(MTR) Advanced CO_2 membrane	AUSC 5000/1350/1400	Enhanced Shockwave Compression	85	High-risk
5E	(MTR) Advanced CO_2 membrane	AUSC 5000/1350/1400	Enhanced Shockwave Compression	85	Low-risk

The following are the key points of the MTR membrane technology:

- Eliminates the use of steam turbine extraction steam for CO_2 process operation
- Closely integrated with the plant boiler, requiring extensive flue gas recycle to the boiler
- Utilizes a compact, spiral-wound, polymeric membrane to separate CO_2 from the flue gas
- Consists of two membrane modules:
    - The first is a cross-flow module which removes approximately 50 percent of the CO_2
    - The second is a counter-flow module which utilizes boiler combustion air as membrane sweep gas to recover CO_2 that was not captured in the first module
- Requires the use of a vacuum pump to pull CO_2 through first module
- Requires a total of 1,500,000 m^2 of surface area

Exhibit 9-2 provides the block flow diagram for Cases 5A through 5E.

Exhibit 9-2 Cases 5A-5E block flow diagram



9.1 Case 5A

Exhibit 9-3 Case 5A Stream table

	1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
V-L Mole Fraction																			
Ar	0.0092	0.0092	0.0092	0.0092	0.0073	0.0092	0.0092	0.0092	0.0092	0.0073	0.0092	0.0000	0.0000	0.0073	0.0000	0.0073	0.0073	0.0000	0.0000
CO_2	0.0003	0.0003	0.0003	0.0003	0.1401	0.0003	0.0003	0.0003	0.0003	0.1401	0.0003	0.0000	0.0000	0.2233	0.0000	0.2233	0.2233	0.0000	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	0.0099	0.0099	0.0099	0.0099	0.0842	0.0099	0.0099	0.0099	0.0099	0.0842	0.0099	0.0000	0.0000	0.1286	0.0000	0.1286	0.1286	1.0000	1.0000
N_2	0.7732	0.7732	0.7732	0.7732	0.6096	0.7732	0.7732	0.7732	0.7732	0.6096	0.7732	0.0000	0.0000	0.6155	0.0000	0.6155	0.6155	0.0000	0.0000
O_2	0.2074	0.2074	0.2074	0.2074	0.1588	0.2074	0.2074	0.2074	0.2074	0.1588	0.2074	0.0000	0.0000	0.0235	0.0000	0.0235	0.0235	0.0000	0.0000
SO_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0017	0.0000	0.0017	0.0017	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	76,945	58,863	58,863	58,863	77,282	18,082	18,082	58,863	2,018	2,120	1,334	0	0	101,134	0	101,134	101,135	2,770	10,145
V-L Flowrate (kg/hr)	2,220,389	1,698,597	1,698,597	1,698,597	2,328,648	521,791	521,791	1,698,597	58,238	63,883	38,487	0	0	3,088,901	0	3,088,901	3,088,951	49,895	182,765
Solids Flowrate (kg/hr)	0	0	0	0	0	0	0	0	0	0	0	221,447	4,295	17,179	17,179	0	0	20,412	0
Temperature (°C)	15	15	26	50	50	15	25	15	25	50	15	15	15	172	15	172	199	15	15
Pressure (MPa, abs)	0.10	0.10	0.11	0.11	0.10	0.10	0.11	0.10	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.12	0.10	0.10
Enthalpy (kJ/kg)[A]	30.23	30.23	41.75	65.62	176.30	30.23	40.78	30.23	40.78	176.30	30.23	---	---	391.59	---	370.17	400.47	---	-46.80
Density (kg/m^3)	1.2	1.2	1.3	1.2	1.2	1.2	1.3	1.2	1.3	1.2	1.2	---	---	0.8	---	0.8	0.9	---	1,003.1
V-L Molecular Weight	28.857	28.857	28.857	28.857	30.132	28.857	28.857	28.857	28.857	30.132	28.857	---	---	30.543	---	30.543	30.543	---	18.015
V-L Flowrate (lb_{mol}/hr)	169,634	129,770	129,770	129,770	170,377	39,864	39,864	129,770	4,449	4,674	2,940	0	0	222,961	0	222,961	222,964	6,106	22,366
V-L Flowrate (lb/hr)	4,895,119	3,744,766	3,744,766	3,744,766	5,133,791	1,150,353	1,150,353	3,744,766	128,393	140,838	84,849	0	0	6,809,860	0	6,809,860	6,809,972	110,000	402,927
Solids Flowrate (lb/hr)	0	0	0	0	0	0	0	0	0	0	0	488,208	9,468	37,872	37,872	0	0	45,000	0
Temperature (°F)	59	59	80	122	122	59	78	59	78	122	59	59	59	341	59	341	391	59	59
Pressure (psia)	14.7	14.7	16.5	16.4	15.2	14.7	16.1	14.7	16.1	15.2	14.7	14.7	14.7	14.4	14.7	14.2	17.0	15.0	14.7
Enthalpy (Btu/lb)[A]	13.0	13.0	17.9	28.2	75.8	13.0	17.5	13.0	17.5	75.8	13.0	---	---	168.4	---	159.1	172.2	---	-20.1
Density (lb/ft^3)	0.076	0.076	0.082	0.076	0.073	0.076	0.081	0.076	0.081	0.073	0.076	---	---	0.051	---	0.050	0.057	---	62.622
	A - Reference conditions are 32.02 F & 0.089 PSIA																		

Exhibit 9-3 Case 5A Stream table (Continued)

	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
V-L Mole Fraction																			
Ar	0.0128	0.0000	0.0070	0.0000	0.0070	0.0089	0.0112	0.0110	0.0004	0.0008	0.0000	0.0000	0.0000	0.0050	0.0000	0.0000	0.0000	0.0000	0.0000
CO_2	0.0005	0.0003	0.2120	0.0000	0.2120	0.1437	0.0176	0.0203	0.4462	0.8364	1.0000	1.0000	1.0000	0.1049	0.0000	0.0000	0.0000	0.0000	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	0.0062	0.9997	0.1719	0.0000	0.1719	0.0713	0.0000	0.0142	0.5168	0.0941	0.0000	0.0000	0.0000	0.4592	1.0000	1.0000	1.0000	1.0000	1.0000
N_2	0.7506	0.0000	0.5859	0.0000	0.5859	0.7464	0.9342	0.9182	0.0352	0.0661	0.0000	0.0000	0.0000	0.4143	0.0000	0.0000	0.0000	0.0000	0.0000
O_2	0.2300	0.0000	0.0232	0.0000	0.0232	0.0295	0.0370	0.0363	0.0014	0.0026	0.0000	0.0000	0.0000	0.0164	0.0000	0.0000	0.0000	0.0000	0.0000
SO_2	0.0000	0.0000	0.0001	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	831	198	107,312	9	107,303	83,086	64,667	66,726	24,217	12,918	10,590	10,590	10,590	2,059	107,311	87,451	87,451	79,459	79,459
V-L Flowrate (kg/hr)	24,115	3,562	3,204,909	554	3,204,355	2,477,958	1,847,907	1,899,873	726,397	522,834	466,049	466,049	466,049	51,965	1,933,242	1,575,447	1,575,447	1,431,485	1,431,485
Solids Flowrate (kg/hr)	0	32,231	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Temperature (°C)	181	62	62	62	62	66	72	48	50	43	27	28	35	25	593	354	593	38	39
Pressure (MPa, abs)	0.31	0.12	0.12	0.12	0.12	0.11	0.10	0.10	0.02	0.10	2.32	1.06	15.27	1.06	24.23	4.90	4.52	0.01	1.69
Enthalpy (kJ/kg)[A]	191.58	---	324.70	37.63	324.75	175.28	73.20	71.63	834.65	119.36	-0.99	13.27	-212.35	15.71	3,476.62	3,082.37	3,652.22	2,181.56	165.22
Density (kg/m^3)	2.4	---	1.2	2.7	1.2	1.1	1.0	1.1	0.2	1.6	46.7	19.7	794.3	19.9	69.2	18.7	11.6	0.1	993.3
V-L Molecular Weight	29.029	---	29.865	64.065	29.863	29.824	28.576	28.473	29.995	40.473	44.010	44.010	44.010	25.234	18.015	18.015	18.015	18.015	18.015
V-L Flowrate (lb_{mol}/hr)	1,831	436	236,582	19	236,563	183,173	142,566	147,106	53,390	28,479	23,346	23,346	23,346	4,540	236,581	192,796	192,796	175,178	175,178
V-L Flowrate (lb/hr)	53,165	7,854	7,065,615	1,222	7,064,393	5,462,962	4,073,938	4,188,502	1,601,431	1,152,652	1,027,462	1,027,462	1,027,462	114,564	4,262,068	3,473,266	3,473,266	3,155,884	3,155,884
Solids Flowrate (lb/hr)	0	71,058	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Temperature (°F)	357	144	144	144	144	151	161	119	122	110	80	83	95	77	1,100	669	1,100	101	102
Pressure (psia)	45.0	16.7	16.7	16.7	16.7	15.7	14.7	14.7	2.9	14.7	336.9	153.2	2,214.5	153.2	3,514.7	710.8	655.8	1.0	245.0
Enthalpy (Btu/lb)[A]	82.4	---	139.6	16.2	139.6	75.4	31.5	30.8	358.8	51.3	-0.4	5.7	-91.3	6.8	1,494.7	1,325.2	1,570.2	937.9	71.0
Density (lb/ft^3)	0.149	---	0.077	0.167	0.077	0.072	0.063	0.067	0.014	0.100	2.917	1.229	49.586	1.245	4.319	1.165	0.722	0.004	62.011

Exhibit 9-4 Case 5A Performance summary

	Case 5A	Units
Plant Output		
Steam Turbine Power	686,500	kW_e
Total	**686,500**	kW_e
Auxiliary Load		
Coal Handling and Conveying	470	kW_e
Pulverizers	3,320	kW_e
Sorbent Handling & Reagent Preparation	980	kW_e
Ash Handling	630	kW_e
Primary Air Fans	1,590	kW_e
Air Blower Fans	5,630	kW_e
Induced Draft Fans	26,800	kW_e
SCR	60	kW_e
Vacuum Pump	30,110	kW_e
Baghouse	80	kW_e
Wet FGD	3,550	kW_e
CO_2 Compression	49,530	kW_e
Miscellaneous Balance of Plant[2,3]	2,000	kW_e
Steam Turbine Auxiliaries	400	kW_e
Condensate Pumps	900	kW_e
Circulating Water Pumps	7,510	kW_e
Ground Water Pumps	660	kW_e
Cooling Tower Fans	3,880	kW_e
Transformer Losses	2,440	kW_e
Total	**140,540**	**kW_e**
Plant Performance		
Net Auxiliary Load	140,540	kW_e
Net Plant Power	545,960	kW_e
Net Plant Efficiency (HHV)	32.7%	
Net Plant Heat Rate (HHV)	11,006 (10,432)	kJ/kWhr (Btu/kWhr)
Coal Feed Flowrate	221,447 (488,208)	kg/hr (lb/hr)
Thermal Input[1]	1,669,166	kW_{th}
Condenser Duty	2,893 (2,742)	GJ/hr (MMBtu/hr)
Raw Water Withdrawal	27.6 (7,281)	m^3/min (gpm)
Raw Water Consumption	21.0 (5,543)	m^3/min (gpm)

1 - HHV of Illinois No. 6 coal is 27,135 kJ/kg (11,666 Btu/lb)
2 – Boiler feed pumps are turbine driven
3 – Includes plant control systems, lighting, HVAC, and miscellaneous low voltage loads

Exhibit 9-5 Case 5A water balance

	Water Demand	Internal Recycle	Raw Water Withdrawal	Process Water Discharge	Raw Water Consumption
	m^3/min (gpm)				
FGD Makeup	3.88 (1026)	0.0 (0)	3.88 (1026)	0.00 (0)	3.88 (1,026)
BFW Makeup	0.00 (0)	0.0 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Cooling Tower	29.2 (7,727)	5.57 (1472)	23.7 (6,255)	6.58 (1,738)	17.10 (4,517)
CO2 Compression Knockout	0.0 (0)	3.48 (919)	0.0 (0)	0.00 (0)	0.00 (0)
FGD Dewatering	0.0 (0)	2.09 (553)	0.0 (0)	0.00 (0)	0.00 (0)
CO2 Capture Recovery	0.0 (0)	0.00 (0)	0.0 (0)	0.00 (0)	0.00 (0)
Total	**33.1 (8,753)**	**5.57 (1472)**	**27.6 (7,281)**	**6.58 (1,738)**	**20.98 (5,543)**

Exhibit 9-6 Case 5A carbon balance

Carbon In		Carbon Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	141,161 (311,207)	Stack Gas	16,256 (35,839)
Air (CO2)	312 (688)	FGD Product	102 (226)
FGD Reagent	2,071 (4,566)	CO2 Product	127,192 (280,411)
		Convergence Tolerance	-8 (-17)
Total	**143,544 (316,461)**	**Total**	**143,544 (316,461)**

Exhibit 9-7 Case 5A sulfur balance

Sulfur In		Sulfur Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	5,550 (12,237)	FGD Product	5,258 (11,591)
		Stack Gas	15 (34)
		Econamine Polishing Scrubber/HSS	277 (611)
Total	**5,550 (12,237)**	**Total**	**5,550 (12,237)**

Exhibit 9-8 Case 5A energy balance

	HHV	Sensible + Latent	Power	Total
Heat In GJ/hr (MMBtu/hr)				
Coal	6,009 (5,695)	5.0 (4.8)	-	6,014 (5,700)
Air	-	72.9 (69.1)	-	72.9 (69.1)
Raw Water Makeup	-	103.7 (98.3)	-	103.7 (98.3)
Lime	-	0.23 (0.22)	-	0.23 (0.22)
Auxiliary Power	-	-	506 (480)	506 (480)
TOTAL	**6,009 (5,695)**	**181.9 (172.4)**	**506 (480)**	**6,697 (6,347)**
Heat Out GJ/hr (MMBtu/hr)				
Bottom Ash	-	0.5 (0.5)	-	0.5 (0.5)
Fly Ash + FGD Ash	-	2.1 (2.0)	-	2.1 (2.0)
Flue Gas	-	136 (129)	-	136 (129)
Condenser	-	2,893 (2,742)	-	2,893 (2,742)
CO2	-	-99 (-94)	-	-99 (-94)
Boiler Heat Loss	-	53 (50)	-	53 (50)
Vacuum Pump Cooling	-	635 (602)	-	635 (602)
CO2 Compression Cooling	-	330 (312)	-	330 (312)
Cooling Tower Blowdown	-	49 (46)	-	49 (46)
*Process Losses**	-	226 (214)	-	226 (214)
Power	-	-	2,471 (2,342)	2,471 (2,342)
TOTAL	-	**4,225 (4,005)**	**2,471 (2,342)**	**6,697 (6,347)**

* Process losses are estimated to match the heat input to the plant.

Exhibit 9-9 Case 5A air emissions

	kg/GJ (lb/MMBtu)	tonne/yr (Ton/year)	kg/MWgross (lb/MWgross)
SO_2	0.005 (0.012)	240 (265)	0.044 (.10)
NOx	0.030 (0.070)	1,426 (1,572)	0.263 (.581)
Particulate	0.006 (0.0130)	265 (292)	0.049 (.108)
Hg	4.91E-7 (1.14E-6)	0.023 (0.026)	4.30E-6 (9.48E-6)
CO_2	9.9 (23.1)	469,617 (517,664)	87 (191)

Exhibit 9-10 Case 5A capital costs

											Cost Base:	Jan 2007
											Prepared:	10-Jan-12
		Case:	5A									x $1, 000
		Plant Size:	545.96	MW, net			Capital Charge Factor		0.85			
			Equipment		Labor		Bare	Eng'g CM	Process Cont.	Project Cont.		
Acct No.		Item/Description	Cost	Material Cost	Direct	Indirect	Erected	Total	Total	Total	$	$/kW
1		COAL HANDLING SYSTEM										
	1.1	Coal Receive & Unload	3,755	0	1,715	0	5,471	489	0	894	6,854	13
	1.2	Coal Stackout & Reclaim	4,853	0	1,100	0	5,953	521	0	971	7,445	14
	1.3	Coal Conveyors & Yd Crus	4,512	0	1,088	0	5,600	491	0	914	7,005	13
	1.4	Other Coal Handling	1,181	0	252	0	1,432	125	0	234	1,791	3
	1.5	Sorbent Receive & Unload	144	0	48	0	193	17	0	31	241	0
	1.6	Sorbent Stackout & Reclaim	2,329	0	476	0	2,805	244	0	457	3,506	6
	1.7	Sorbent Conveyors	831	200	227	0	1,259	109	0	205	1,573	3
	1.8	Other Sorbent Handling	502	131	294	0	927	82	0	151	1,160	2
	1.9	Coal & Sorbent Hnd.Foundations	0	4,589	5,789	0	10,378	975	0	1,703	13,055	24
		SUBTOTAL 1.	**$18,108**	**$4,921**	**$10,989**	**$0**	**$34,017**	**$3,052**	**$0**	**$5,560**	**$42,630**	**$78**
2		COAL PREP & FEED SYSTEMS										
	2.1	Coal Crushing & Drying	2,166	0	422	0	2,588	226	0	422	3,236	6
	2.2	Prepared Coal Storage & Feed	5,546	0	1,211	0	6,757	591	0	1,102	8,449	15
	2.3	Slurry Prep & Feed	0	0	0	0	0	0	0	0	0	0
	2.4	Misc. Coal Prep & Feed	0	0	0	0	0	0	0	0	0	0
	2.5	Sorbent Prep Equipment	3,955	190	916	0	5,061	440	0	825	6,327	12
	2.6	Sorbent Storage & Feed	476	0	204	0	680	60	0	111	852	2
	2.7	Sorbent Injection System	0	0	0	0	0	0	0	0	0	0
	2.8	Booster Air Supply System	0	0	0	0	0	0	0	0	0	0
	2.9	Coal & Sorbent Feed Foundation	0	541	454	0	994	92	0	163	1,250	2
		SUBTOTAL 2.	**$12,143**	**$731**	**$3,206**	**$0**	**$16,081**	**$1,409**	**$0**	**$2,623**	**$20,113**	**$37**
3		FEEDWATER & MISC. BOP SYSTEMS										
	3.1	Feedwater System	20,405	0	6,591	0	26,997	2,359	0	4,403	33,759	62
	3.2	Water Makeup & Pretreating	5,558	0	1,789	0	7,346	695	0	1,608	9,649	18
	3.3	Other Feedwater Subsystems	6,247	0	2,640	0	8,887	796	0	1,452	11,136	20
	3.4	Service Water Systems	1,089	0	593	0	1,682	158	0	368	2,208	4
	3.5	Other Boiler Plant Systems	7,668	0	7,570	0	15,238	1,447	0	2,503	19,188	35
	3.6	FO Supply Sys & Nat Gas	266	0	332	0	598	56	0	98	753	1
	3.7	Waste Treatment Equipment	3,768	0	2,148	0	5,916	576	0	1,298	7,790	14
	3.8	Misc. Power Plant Equipment	2,824	0	863	0	3,686	354	0	808	4,849	9
		SUBTOTAL 3.	**$47,824**	**$0**	**$22,526**	**$0**	**$70,350**	**$6,442**	**$0**	**$12,540**	**$89,332**	**$164**
4		PC BOILER & ACCESSORIES										
	4.1	PC Boiler & Accessories	166,977	0	93,691	0	260,668	25,368	0	28,604	314,640	576
	4.2	SCR (w/4.1)	0	0	0	0	0	0	0	0	0	0
	4.3	Open	0	0	0	0	0	0	0	0	0	0
	4.4	Boiler BoP (w/ ID Fans)	0	0	0	0	0	0	0	0	0	0
	4.5	Primary Air System	w/4.1	0	w/4.1	0	0	0	0	0	0	0
	4.6	Secondary Air System	w/4.1	0	w/4.1	0	0	0	0	0	0	0
	4.8	Major Component Rigging	0	w/4.1	w/4.1	0	0	0	0	0	0	0
	4.9	Boiler Foundations	0	w/14.1	w/14.1	0	0	0	0	0	0	0
		SUBTOTAL 4.	**$166,977**	**$0**	**$93,691**	**$0**	**$260,668**	**$25,368**	**$0**	**$28,604**	**$314,640**	**$576**

Exhibit 9-10 Case 5A capital costs (Continued)

Acct No.		Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	$	$/kW
5A		FLUE GAS CLEANUP					*					
	5.1	Absorber Vessels & Accessories	90,748	0	19,536	0	110,284	10,514	0	12,080	132,878	243
	5.2	Other FGD	4,736	0	5,366	0	10,102	981	0	1,108	12,191	22
	5.3	Bag House & Accessories	21,429	0	13,599	0	35,028	3,375	0	3,840	42,244	77
	5.4	Other Particulate Removal Materials	1,449	0	1,551	0	3,000	291	0	329	3,620	7
	5.5	Gypsum Dewatering System	4,907	0	833	0	5,740	546	0	629	6,915	13
	5.6	Mercury Removal System	0	0	0	0	0	0	0	0	0	0
	5.7	Open	0	0	0	0	0	0	0	0	0	0
		SUBTOTAL 5A.	**$123,268**	**$0**	**$40,886**	**$0**	**$164,154**	**$15,708**	**$0**	**$17,986**	**$197,848**	**$362**
5B		CO2 REMOVAL & COMPRESSION										
	5B.1	CO2 Removal System	41,537	0	107,019	0	148,556	14,203	29,711	38,494	230,965	423
	5B.2	CO2 Compression	29,234	0	9,171	0	38,405	3,673	0	8,416	50,493	92
		SUBTOTAL 5B.	**$70,771**	**$0**	**$116,190**	**$0**	**$186,961**	**$17,876**	**$29,711**	**$46,910**	**$281,458**	**$516**
6		COMBUSTION TURBINE/ACCESSORIES										
	6.1	Combustion Turbine Generator	0	0	0	0	0	0	0	0	0	0
	6.2	Combustion Turbine Accessories	0	0	0	0	0	0	0	0	0	0
	6.3	Compressed Air Piping	0	0	0	0	0	0	0	0	0	0
	6.4	Combustion Turbine Foundations	0	0	0	0	0	0	0	0	0	0
		SUBTOTAL 6.	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
7		HRSG, DUCTING & STACK										
	7.1	Flue Gas Recycle Heat Exhchanger	N/A	0	N/A	0	0	0	0	0	0	0
	7.2	SCR System	0	0	0	0	0	0	0	0	0	0
	7.3	Ductwork	8,846	0	5,684	0	14,530	1,267	0	2,370	18,166	33
	7.4	Stack	8,295	0	4,854	0	13,149	1,266	0	1,442	15,857	29
	7.9	HRSG, Duct & Stack Foundations	0	952	1,081	0	2,033	190	0	445	2,668	5
		SUBTOTAL 7.	**$17,141**	**$952**	**$11,619**	**$0**	**$29,712**	**$2,723**	**$0**	**$4,256**	**$36,690**	**$67**
8		STEAM TURBINE GENERATOR										
	8.1	Steam TG & Accessories	58,204	0	7,724	0	65,928	6,318	0	7,225	79,471	146
	8.2	Turbine Plant Auxiliaries	392	0	840	0	1,232	120	0	135	1,487	3
	8.3	Condenser & Auxiliaries	7,755	0	2,858	0	10,613	1,017	0	1,163	12,793	23
	8.4	Steam Piping	19,070	0	9,403	0	28,473	2,392	0	4,630	35,495	65
	8.9	TG Foundations	0	1,229	1,942	0	3,171	300	0	694	4,165	8
		SUBTOTAL 8.	**$85,421**	**$1,229**	**$22,766**	**$0**	**$109,417**	**$10,148**	**$0**	**$13,847**	**$133,411**	**$244**
9		COOLING WATER SYSTEM										
	9.1	Cooling Towers	12,544	0	3,906	0	16,451	1,573	0	1,802	19,826	36
	9.2	Circulating Water Pumps	2,493	0	192	0	2,685	227	0	291	3,203	6
	9.3	Circ. Water System Auxiliaries	649	0	87	0	736	70	0	81	886	2
	9.4	Circ. Water Piping	0	5,147	4,988	0	10,135	949	0	1,663	12,746	23
	9.5	Make-up Water System	528	0	705	0	1,233	118	0	203	1,554	3
	9.6	Component Cooling Water System	514	0	409	0	923	88	0	152	1,163	2
	9.9	Circ. Water System Foundations	0	3,095	4,917	0	8,012	758	0	1,754	10,524	19
		SUBTOTAL 9.	**$16,729**	**$8,242**	**$15,204**	**$0**	**$40,175**	**$3,783**	**$0**	**$5,945**	**$49,903**	**$91**

Exhibit 9-10 Case 5A capital costs (Continued)

Acct No.		Item/Description	Equipment Cost	Material Cost	Labor		Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total		
					Direct	Indirect					$	$/kW
10		ASH/SPENT SORBENT HANDLING SYS										
	10.1	Ash Coolers	N/A	0	N/A	0	0	0	0	0	0	0
	10.2	Cyclone Ash Letdown	N/A	0	N/A	0	0	0	0	0	0	0
	10.3	HGCU Ash Letdown	N/A	0	N/A	0	0	0	0	0	0	0
	10.4	High Temperature Ash Piping	N/A	0	N/A	0	0	0	0	0	0	0
	10.5	Other Ash Recovery Equipment	N/A	0	N/A	0	0	0	0	0	0	0
	10.6	Ash Storage Silos	656	0	2,020	0	2,676	263	0	294	3,233	6
	10.7	Ash Transport & Feed Equipment	4,245	0	4,348	0	8,593	822	0	941	10,356	19
	10.8	Misc. Ash Handling Equipment	0	0	0	0	0	0	0	0	0	0
	10.9	Ash/Spent Sorbent Foundation	0	156	183	0	339	32	0	74	445	1
		SUBTOTAL 10.	**$4,901**	**$156**	**$6,552**	**$0**	**$11,609**	**$1,116**	**$0**	**$1,310**	**$14,035**	**$26**
11		ACCESSORY ELECTRIC PLANT										
	11.1	Generator Equipment	1,761	0	286	0	2,047	190	0	168	2,404	4
	11.2	Station Service Equipment	5,451	0	1,791	0	7,242	677	0	594	8,512	16
	11.3	Switchgear & Motor Control	6,266	0	1,065	0	7,332	680	0	801	8,812	16
	11.4	Conduit & Cable Tray	0	3,929	13,584	0	17,513	1,696	0	2,881	22,090	40
	11.5	Wire & Cable	0	7,413	14,311	0	21,724	1,830	0	3,533	27,088	50
	11.6	Protective Equipment	261	0	888	0	1,149	112	0	126	1,388	3
	11.7	Standby Equipment	1,382	0	32	0	1,413	130	0	154	1,697	3
	11.8	Main Power Transformers	11,342	0	191	0	11,533	874	0	1,241	13,648	25
	11.9	Electrical Foundations	0	350	857	0	1,207	115	0	265	1,587	3
		SUBTOTAL 11.	**$26,462**	**$11,692**	**$33,005**	**$0**	**$71,160**	**$6,304**	**$0**	**$9,763**	**$87,226**	**$160**
12		INSTRUMENTATION & CONTROL										
	12.1	PC Control Equipment	w/12.7	0	w/12.7	0	0	0	0	0	0	0
	12.2	Combustion Turbine Control	N/A	0	N/A	0	0	0	0	0	0	0
	12.3	Steam Turbine Control	w/8.1	0	w/8.1	0	0	0	0	0	0	0
	12.4	Other Major Component Control	0	0	0	0	0	0	0	0	0	0
	12.5	Signal Processing Equipment	W/12.7	0	w/12.7	0	0	0	0	0	0	0
	12.6	Control Boards, Panels & Racks	530	0	318	0	848	80	42	146	1,116	2
	12.7	Computer Accessories	5,355	0	936	0	6,291	583	315	719	7,908	14
	12.8	Instrument Wiring & Tubing	2,903	0	5,759	0	8,662	738	433	1,475	11,309	21
	12.9	Other I & C Equipment	1,513	0	3,434	0	4,947	480	248	567	6,242	11
		SUBTOTAL 12.	**$10,302**	**$0**	**$10,447**	**$0**	**$20,749**	**$1,881**	**$1,038**	**$2,907**	**$26,575**	**$49**
13		IMPROVEMENTS TO SITE										
	13.1	Site Preparation	0	54	1,080	0	1,134	113	0	249	1,495	3
	13.2	Site Improvements	0	1,792	2,226	0	4,018	396	0	882	5,296	10
	13.3	Site Facilities	3,212	0	3,167	0	6,379	629	0	1,400	8,408	15
		SUBTOTAL 13.	**$3,212**	**$1,846**	**$6,473**	**$0**	**$11,531**	**$1,138**	**$0**	**$2,531**	**$15,199**	**$28**

Exhibit 9-10 Case 5A capital costs (Continued)

Acct No.		Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	$	$/kW
14		BUILDINGS & STRUCTURES										
	14.1	Boiler Building	0	8,778	7,719	0	16,497	1,483	0	2,696	20,675	38
	14.2	Turbine Building	0	12,639	11,779	0	24,418	2,201	0	3,991	30,610	56
	14.3	Administration Building	0	633	669	0	1,302	118	0	213	1,633	3
	14.4	Circulation Water Pumphouse	0	147	117	0	264	24	0	43	330	1
	14.5	Water Treatment Buildings	0	716	653	0	1,370	123	0	222	1,715	3
	14.6	Machine Shop	0	423	284	0	707	63	0	115	886	2
	14.7	Warehouse	0	287	288	0	574	52	0	94	720	1
	14.8	Other Buildings & Structures	0	234	199	0	434	39	0	71	544	1
	14.9	Waste Treating Building & Str.	0	446	1,353	0	1,799	171	0	295	2,265	4
		SUBTOTAL 14.	**$0**	**$24,302**	**$23,062**	**$0**	**$47,364**	**$4,273**	**$0**	**$7,741**	**$59,378**	**$109**
		Total Cost	**$603,260**	**$54,070**	**$416,616**	**$0**	**$1,073,946**	**$101,221**	**$30,749**	**$162,522**	**$1,368,438**	**$2,506**
		Owner's Costs									**$1,000**	**$/kW**
		Preproduction Costs										
		6 Months All Labor									9,742	18
		1 Month Maintenance Materials									1,344	2
		1 Month Non-fuel Consumables									1,529	3
		1 Month Waste Disposal									280	1
		25% of 1 Months Fuel Cost at 100% CF									1,701	3
		2% of TPC									27,369	50
		Total									**41,965**	**77**
		Inventory Capital										
		60 day supply of fuel and consumables at 100% CF									16,322	30
		0.5% of TPC (spare parts)									6,842	13
		Total									**23,164**	**42**
		Initial Cost for Catalyst and Chemicals									13,015	24
		Land									900	2
		Other Owner's Costs									205,266	376
		Financing Costs									36,948	68
		Total Overnight Costs (TOC)									**1,689,695**	**3,095**
		TASC Multiplier							(IOU, high-risk, 35 year)		1.14	
		Total As-Spent Cost (TASC)									**1,926,253**	**3,528**

Exhibit 9-11 Case 5A operation and maintenance costs

5A					Cost Base (Jun):	2007
					Heat Rate-net (Btu/kWh):	10,432
					MWe-net:	546
					Capacity Factor (%):	**85**
OPERATING & MAINTENANCE LABOR						
Operating Labor						
Operating Labor Rate(base):	34.65	$/hour				
Operating Labor Burden:	30.00	% of base				
Labor O-H Charge Rate:	25.00	% of labor				
Operating Labor Requirements(O.J.)per S	1 unit/mod.		Total Plant			
Skilled Operator	2.0		2.0			
Operator	11.3		11.3			
Foreman	1.0		1.0			
Lab Tech's, etc.	2.0		2.0			
TOTAL-O.J.'s	16.3		16.3			
					Annual Cost	Annual Unit Cost
					$	$/kW-net
Annual Operating Labor Cost					$6,444,907	$11.805
Maintenance Labor Cost					$9,141,899	$16.745
Administrative & Support Labor					$3,896,702	$7.137
Property Taxes and Insurance					$27,368,758	$50.130
TOTAL FIXED OPERATING COSTS					**$46,852,266**	$85.816
VARIABLE OPERATING COSTS						
						$/kWh-net
Maintenance Material Cost					**$13,712,849**	**$0.00337**
Consumables	Consumption Initial Fill	/Day	Unit Cost	Initial Fill Cost		
Water(/1000 gallons)	0	5,242	1.08	**$0**	**$1,759,261**	**$0.00043**
Chemicals		4.841				
MU & WT Chem. (lbs)	0	25,376	0.17	$0	$1,362,552	$0.00034
Limestone (ton)	0	540	21.63	$0	$3,624,370	$0.00089
Carbon (Mercury Removal) (lb)	0	0	1.05	$0	$0	$0.00000
MTR Membrane Replacement	1,500,000	967	15.00	$22,500,000	$4,500,000	$0.00111
NaOH (tons)	0	0	433.68	$0	$0	$0.00000
H2SO4 (tons)	0	0	138.78	$0	$0	$0.00000
Corrosion Inhibitor	0	0	0.00	$0	$0	$0.00000
Activated Carbon (lb)	0	0	1.05	$0	$0	$0.00000
Ammonia (19% NH3) (ton)	0	87.6	129.80	$0	$3,527,721	$0.00087
Subtotal Chemicals				**$22,500,000**	**$13,014,643**	**$0.00320**
Other						
Supplemental Fuel (MBtu)	0	0	0.00	$0	$0	$0.00000
SCR Catalyst (m3)	w/equip.	0.46	5,775.94	$0	$822,134	$0.00020
Emission Penalties	0	0	0.00	$0	$0	$0.00000
Subtotal Other				**$0**	**$822,134**	**$0.00020**
Waste Disposal						
Fly Ash (ton)	0	454	16.23	$0	2,287,729.06	0.00056
Bottom Ash (ton)	0	114	16.23	$0	571,932.26	0.00014
Subtotal Waste Disposal				**$0**	**$2,859,661**	**$0.00070**
By-products & Emissions						
Gypsum (tons)	0	145	0.00	$0	$0	$0.00000
Subtotal By-products				**$0**	**$0**	**$0.00000**
TOTAL VARIABLE OPERATING COSTS				**$22,500,000**	**$32,168,549**	**$0.00791**
Fuel (ton)	0	5,858	38.18	**$0**	**$69,404,019**	**$0.01707**

Exhibit 9-12 Cost of electricity breakdown for Case 5A

TOC, $/kW	**3,095**
COE w/o TS&M, $/MW	**88.2**
Capital, $/MW	51.6
Fixed, $/MW	11.5
Variable, $/MW	7.9
Fuel, $/MW	17.1

9.2 Case 5B

Exhibit 9-13 Case 5B Stream table

	1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
V-L Mole Fraction																			
Ar	0.0092	0.0092	0.0092	0.0092	0.0073	0.0092	0.0092	0.0092	0.0092	0.0073	0.0092	0.0000	0.0000	0.0073	0.0000	0.0073	0.0073	0.0000	0.0000
CO_2	0.0003	0.0003	0.0003	0.0003	0.1401	0.0003	0.0003	0.0003	0.0003	0.1401	0.0003	0.0000	0.0000	0.2233	0.0000	0.2233	0.2233	0.0000	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	0.0099	0.0099	0.0099	0.0099	0.0843	0.0099	0.0099	0.0099	0.0099	0.0843	0.0099	0.0000	0.0000	0.1286	0.0000	0.1286	0.1286	1.0000	1.0000
N_2	0.7732	0.7732	0.7732	0.7732	0.6095	0.7732	0.7732	0.7732	0.7732	0.6095	0.7732	0.0000	0.0000	0.6154	0.0000	0.6154	0.6154	0.0000	0.0000
O_2	0.2074	0.2074	0.2074	0.2074	0.1588	0.2074	0.2074	0.2074	0.2074	0.1588	0.2074	0.0000	0.0000	0.0235	0.0000	0.0235	0.0235	0.0000	0.0000
SO_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0017	0.0000	0.0017	0.0017	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	74,161	56,734	56,734	56,734	74,496	17,428	17,428	56,734	1,945	2,043	1,285	0	0	97,485	0	97,485	97,485	2,770	9,953
V-L Flowrate (kg/hr)	2,140,074	1,637,157	1,637,157	1,637,157	2,244,762	502,917	502,917	1,637,157	56,132	61,572	37,093	0	0	2,977,502	0	2,977,502	2,977,499	49,895	179,308
Solids Flowrate (kg/hr)	0	0	0	0	0	0	0	0	0	0	0	213,425	4,139	16,556	16,556	0	0	20,412	0
Temperature (°C)	15	15	26	50	50	15	25	15	25	50	15	15	15	172	15	172	199	15	15
Pressure (MPa, abs)	0.10	0.10	0.11	0.11	0.10	0.10	0.11	0.10	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.12	0.10	0.10
Enthalpy (kJ/kg)[A]	30.23	30.23	41.75	65.62	176.34	30.23	40.78	30.23	40.78	176.34	30.23	---	---	391.61	---	370.19	400.49	---	-46.80
Density (kg/m^3)	1.2	1.2	1.3	1.2	1.2	1.2	1.3	1.2	1.3	1.2	1.2	---	---	0.8	---	0.8	0.9	---	1,003.1
V-L Molecular Weight	28.857	28.857	28.857	28.857	30.133	28.857	28.857	28.857	28.857	30.133	28.857	---	---	30.543	---	30.543	30.543	---	18.015
V-L Flowrate (lb_{mol}/hr)	163,498	125,076	125,076	125,076	164,235	38,422	38,422	125,076	4,288	4,505	2,834	0	0	214,917	0	214,917	214,917	6,106	21,943
V-L Flowrate (lb/hr)	4,718,056	3,609,313	3,609,313	3,609,313	4,948,853	1,108,743	1,108,743	3,609,313	123,749	135,744	81,775	0	0	6,564,268	0	6,564,268	6,564,261	110,000	395,307
Solids Flowrate (lb/hr)	0	0	0	0	0	0	0	0	0	0	0	470,522	9,125	36,500	36,500	0	0	45,000	0
Temperature (°F)	59	59	80	122	122	59	78	59	78	122	59	59	59	341	59	341	391	59	59
Pressure (psia)	14.7	14.7	16.5	16.4	15.2	14.7	16.1	14.7	16.1	15.2	14.7	14.7	14.7	14.4	14.7	14.2	17.0	15.0	14.7
Enthalpy (Btu/lb)[A]	13.0	13.0	17.9	28.2	75.8	13.0	17.5	13.0	17.5	75.8	13.0	---	---	168.4	---	159.2	172.2	---	-20.1
Density (lb/ft^3)	0.076	0.076	0.082	0.076	0.073	0.076	0.081	0.076	0.081	0.073	0.076	---	---	0.051	---	0.050	0.057	---	62.622
	A - Reference conditions are 32.02 F & 0.089 PSIA																		

Exhibit 9-13 Case 5B Stream table (Continued)

	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
V-L Mole Fraction																			
Ar	0.0128	0.0000	0.0070	0.0000	0.0070	0.0089	0.0112	0.0110	0.0004	0.0008	0.0000	0.0000	0.0000	0.0050	0.0000	0.0000	0.0000	0.0000	0.0000
CO_2	0.0005	0.0003	0.2121	0.0000	0.2121	0.1438	0.0176	0.0203	0.4462	0.8365	1.0000	1.0000	1.0000	0.1050	0.0000	0.0000	0.0000	0.0000	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	0.0062	0.9997	0.1719	0.0000	0.1719	0.0714	0.0000	0.0142	0.5168	0.0941	0.0000	0.0000	0.0000	0.4593	1.0000	1.0000	1.0000	1.0000	1.0000
N_2	0.7506	0.0000	0.5858	0.0000	0.5858	0.7463	0.9343	0.9182	0.0352	0.0660	0.0000	0.0000	0.0000	0.4142	0.0000	0.0000	0.0000	0.0000	0.0000
O_2	0.2300	0.0000	0.0232	0.0000	0.0232	0.0295	0.0369	0.0363	0.0014	0.0026	0.0000	0.0000	0.0000	0.0164	0.0000	0.0000	0.0000	0.0000	0.0000
SO_2	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	801	198	103,445	2	103,443	80,089	62,326	64,312	23,354	12,458	10,212	10,212	10,212	1,985	95,236	75,797	75,797	70,958	70,958
V-L Flowrate (kg/hr)	23,258	3,562	3,089,324	156	3,089,168	2,388,643	1,781,038	1,831,137	700,524	504,228	449,434	449,434	449,434	50,099	1,715,705	1,365,503	1,365,503	1,278,334	1,278,334
Solids Flowrate (kg/hr)	0	32,227	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Temperature (°C)	181	62	62	62	62	66	72	48	50	43	27	28	35	25	649	328	649	38	39
Pressure (MPa, abs)	0.31	0.12	0.12	0.12	0.12	0.11	0.10	0.10	0.02	0.10	2.32	1.06	15.27	1.06	34.47	4.90	4.35	0.01	1.69
Enthalpy (kJ/kg)[A]	191.58	---	324.82	37.63	324.83	175.34	73.22	71.65	834.59	119.36	-0.99	13.25	-212.35	15.71	3,555.97	3,010.64	3,781.91	2,268.53	165.67
Density (kg/m^3)	2.4	---	1.2	2.7	1.2	1.1	1.0	1.1	0.2	1.6	46.7	19.7	794.3	20.0	93.2	19.9	10.4	0.1	993.3
V-L Molecular Weight	29.029	---	29.864	64.065	29.863	29.825	28.576	28.473	29.996	40.474	44.010	44.010	44.010	25.233	18.015	18.015	18.015	18.015	18.015
V-L Flowrate (lb_{mol}/hr)	1,766	436	228,058	5	228,053	176,566	137,406	141,783	51,487	27,465	22,514	22,514	22,514	4,377	209,960	167,104	167,104	156,436	156,436
V-L Flowrate (lb/hr)	51,274	7,854	6,810,794	344	6,810,449	5,266,057	3,926,517	4,036,966	1,544,392	1,111,632	990,833	990,833	990,833	110,449	3,782,483	3,010,420	3,010,420	2,818,245	2,818,245
Solids Flowrate (lb/hr)	0	71,048	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Temperature (°F)	357	144	144	144	144	151	161	119	122	110	80	83	95	77	1,200	622	1,200	101	103
Pressure (psia)	45.0	16.7	16.7	16.7	16.7	15.7	14.7	14.7	2.9	14.7	336.9	153.2	2,214.5	153.2	5,000.0	710.8	630.8	1.0	245.0
Enthalpy (Btu/lb)[A]	82.4	---	139.6	16.2	139.7	75.4	31.5	30.8	358.8	51.3	-0.4	5.7	-91.3	6.8	1,528.8	1,294.3	1,625.9	975.3	71.2
Density (lb/ft^3)	0.149	---	0.077	0.167	0.077	0.072	0.063	0.067	0.014	0.100	2.917	1.229	49.586	1.246	5.821	1.243	0.649	0.003	62.008

Exhibit 9-14 Case 5B Performance summary

	Case 5B	Units
Plant Output		
Steam Turbine Power	686,500	kW_e
Total	**686,500**	kW_e
Auxiliary Load		
Coal Handling and Conveying	470	kW_e
Pulverizers	3,200	kW_e
Sorbent Handling & Reagent Preparation	980	kW_e
Ash Handling	610	kW_e
Primary Air Fans	1,530	kW_e
Air Blower Fans	5,430	kW_e
Induced Draft Fans	25,830	kW_e
SCR	60	kW_e
Vacuum Pump	29,040	kW_e
Baghouse	80	kW_e
Wet FGD	3,430	kW_e
CO_2 Compression	47,770	kW_e
Miscellaneous Balance of Plant[2,3]	2,000	kW_e
Steam Turbine Auxiliaries	400	kW_e
Condensate Pumps	810	kW_e
Circulating Water Pumps	7,150	kW_e
Ground Water Pumps	630	kW_e
Cooling Tower Fans	3,700	kW_e
Transformer Losses	2,430	kW_e
Total	**135,550**	**kW_e**
Plant Performance		
Net Auxiliary Load	135,550	kW_e
Net Plant Power	550,950	kW_e
Net Plant Efficiency (HHV)	34.2%	
Net Plant Heat Rate (HHV)	10,512 (9,963)	kJ/kWhr (Btu/kWhr)
Coal Feed Flowrate	213,425 (470,522)	kg/hr (lb/hr)
Thermal Input[1]	1,608,698	kW_{th}
Condenser Duty	2,695 (2,554)	GJ/hr (MMBtu/hr)
Raw Water Withdrawal	26.2 (6,930)	m^3/min (gpm)
Raw Water Consumption	20.0 (5,275)	m^3/min (gpm)

1 - HHV of Illinois No. 6 coal is 27,135 kJ/kg (11,666 Btu/lb)
2 – Boiler feed pumps are turbine driven
3 – Includes plant control systems, lighting, HVAC, and miscellaneous low voltage loads

Exhibit 9-15 Case 5B water balance

	Water Demand	Internal Recycle	Raw Water Withdrawal	Process Water Discharge	Raw Water Consumption
	m^3/min (gpm)				
FGD Makeup	3.83 (1011)	0.0 (0)	3.83 (1011)	0.00 (0)	3.83 (1,011)
BFW Makeup	0.00 (0)	0.0 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Cooling Tower	27.9 (7,359)	5.45 (1439)	22.4 (5,920)	6.26 (1,655)	16.14 (4,265)
CO2 Compression Knockout	0.0 (0)	3.35 (886)	0.0 (0)	0.00 (0)	0.00 (0)
FGD Dewatering	0.0 (0)	2.09 (553)	0.0 (0)	0.00 (0)	0.00 (0)
CO2 Capture Recovery	0.0 (0)	0.00 (0)	0.0 (0)	0.00 (0)	0.00 (0)
Total	**31.7 (8,369)**	**5.45 (1439)**	**26.2 (6,930)**	**6.26 (1,655)**	**19.97 (5,275)**

Exhibit 9-16 Case 5B carbon balance

Carbon In		Carbon Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	136,047 (299,933)	Stack Gas	15,678 (34,565)
Air (CO2)	301 (663)	FGD Product	103 (227)
FGD Reagent	2,071 (4,566)	CO2 Product	122,658 (270,415)
		Convergence Tolerance	-21 (-45)
Total	**138,419 (305,162)**	**Total**	**138,419 (305,162)**

Exhibit 9-17 Case 5B sulfur balance

Sulfur In		Sulfur Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	5,349 (11,793)	FGD Product	5,256 (11,587)
		Stack Gas	15 (34)
		Econamine Polishing Scrubber/HSS	78 (172)
Total	**5,349 (11,793)**	**Total**	**5,349 (11,793)**

Exhibit 9-18 Case 5B energy balance

	HHV	Sensible + Latent	Power	Total
Heat In GJ/hr (MMBtu/hr)				
Coal	5,791 (5,489)	4.8 (4.6)	-	5,796 (5,494)
Air	-	70.3 (66.6)	-	70.3 (66.6)
Raw Water Makeup	-	98.7 (93.6)	-	98.7 (93.6)
Lime	-	0.23 (0.22)	-	0.23 (0.22)
Auxiliary Power	-	-	488 (463)	488 (463)
TOTAL	**5,791 (5,489)**	**174.0 (165.0)**	**488 (463)**	**6,453 (6,117)**
Heat Out GJ/hr (MMBtu/hr)				
Bottom Ash	-	0.5 (0.5)	-	0.5 (0.5)
Fly Ash + FGD Ash	-	2.0 (1.9)	-	2.0 (1.9)
Flue Gas	-	131 (124)	-	131 (124)
Condenser	-	2,695 (2,554)	-	2,695 (2,554)
CO2	-	-95 (-90)	-	-95 (-90)
Boiler Heat Loss	-	51 (48)	-	51 (48)
Vacuum Pump Cooling	-	613 (581)	-	613 (581)
CO2 Compression Cooling	-	318 (301)	-	318 (301)
Cooling Tower Blowdown	-	47 (44)	-	47 (44)
*Process Losses**	-	221 (210)	-	221 (210)
Power	-	-	2,471 (2,342)	2,471 (2,342)
TOTAL	-	**3,982 (3,774)**	**2,471 (2,342)**	**6,453 (6,117)**

* Process losses are estimated to match the heat input to the plant.

Exhibit 9-19 Case 5B air emissions

	kg/GJ (lb/MMBtu)	tonne/yr (Ton/year)	kg/MWgross (lb/MWgross)
SO_2	0.005 (0.012)	240 (265)	0.044 (.10)
NOx	0.030 (0.070)	1,374 (1,515)	0.254 (.560)
Particulate	0.006 (0.0130)	255 (281)	0.047 (.104)
Hg	4.91E-7 (1.14E-6)	0.022 (0.025)	4.14E-6 (9.14E-6)
CO_2	9.9 (23.1)	452,912 (499,250)	84 (184)

Exhibit 9-20 Case 5B capital costs

										Cost Base:	Jan 2007	
										Prepared:	13-Mar-12	
		Case:	5B								**x $1, 000**	
		Plant Size:	550.95	MW, net		Capital Charge Factor		0.85				
			Equipment		**Labor**		**Bare**	**Eng'g CM**	**Process Cont.**	**Project Cont.**		
Acct No.		**Item/Description**	**Cost**	**Material Cost**	**Direct**	**Indirect**	**Erected**	**Total**	**Total**	**Total**	**$**	**$/kW**
1		COAL HANDLING SYSTEM										
	1.1	Coal Receive & Unload	3,670	0	1,677	0	5,347	478	0	874	6,699	12
	1.2	Coal Stackout & Reclaim	4,744	0	1,075	0	5,818	509	0	949	7,276	13
	1.3	Coal Conveyors & Yd Crus	4,410	0	1,063	0	5,474	480	0	893	6,846	12
	1.4	Other Coal Handling	1,154	0	246	0	1,400	122	0	228	1,751	3
	1.5	Sorbent Receive & Unload	144	0	48	0	193	17	0	31	241	0
	1.6	Sorbent Stackout & Reclaim	2,329	0	476	0	2,805	244	0	457	3,506	6
	1.7	Sorbent Conveyors	831	200	227	0	1,259	109	0	205	1,573	3
	1.8	Other Sorbent Handling	502	131	294	0	927	82	0	151	1,160	2
	1.9	Coal & Sorbent Hnd.Foundations	0	4,494	5,669	0	10,163	955	0	1,668	12,785	23
		SUBTOTAL 1.	**$17,784**	**$4,826**	**$10,775**	**$0**	**$33,385**	**$2,995**	**$0**	**$5,457**	**$41,837**	**$76**
2		COAL PREP & FEED SYSTEMS										
	2.1	Coal Crushing & Drying	2,114	0	412	0	2,526	220	0	412	3,158	6
	2.2	Prepared Coal Storage & Feed	5,413	0	1,181	0	6,594	576	0	1,076	8,246	15
	2.3	Slurry Prep & Feed	0	0	0	0	0	0	0	0	0	0
	2.4	Misc. Coal Prep & Feed	0	0	0	0	0	0	0	0	0	0
	2.5	Sorbent Prep Equipment	3,955	190	916	0	5,061	440	0	825	6,327	11
	2.6	Sorbent Storage & Feed	476	0	204	0	680	60	0	111	852	2
	2.7	Sorbent Injection System	0	0	0	0	0	0	0	0	0	0
	2.8	Booster Air Supply System	0	0	0	0	0	0	0	0	0	0
	2.9	Coal & Sorbent Feed Foundation	0	529	444	0	973	90	0	160	1,223	2
		SUBTOTAL 2.	**$11,958**	**$719**	**$3,157**	**$0**	**$15,835**	**$1,388**	**$0**	**$2,583**	**$19,806**	**$36**
3		FEEDWATER & MISC. BOP SYSTEMS										
	3.1	Feedwater System	18,792	0	6,070	0	24,862	2,172	0	4,055	31,090	56
	3.2	Water Makeup & Pretreating	5,366	0	1,727	0	7,093	671	0	1,553	9,317	17
	3.3	Other Feedwater Subsystems	5,753	0	2,431	0	8,184	733	0	1,338	10,255	19
	3.4	Service Water Systems	1,052	0	572	0	1,624	153	0	355	2,132	4
	3.5	Other Boiler Plant Systems	7,011	0	6,922	0	13,933	1,323	0	2,288	17,544	32
	3.6	FO Supply Sys & Nat Gas	264	0	329	0	593	56	0	97	746	1
	3.7	Waste Treatment Equipment	3,638	0	2,074	0	5,712	556	0	1,254	7,521	14
	3.8	Misc. Power Plant Equipment	2,798	0	855	0	3,652	351	0	801	4,804	9
		SUBTOTAL 3.	**$44,673**	**$0**	**$20,981**	**$0**	**$65,654**	**$6,016**	**$0**	**$11,741**	**$83,411**	**$151**
4		PC BOILER & ACCESSORIES										
	4.1	PC Boiler & Accessories	160,803	0	90,227	0	251,029	24,430	0	27,546	303,006	550
	4.2	SCR (w/4.1)	0	0	0	0	0	0	0	0	0	0
	4.3	Open	0	0	0	0	0	0	0	0	0	0
	4.4	Boiler BoP (w/ ID Fans)	0	0	0	0	0	0	0	0	0	0
	4.5	Primary Air System	w/4.1	0	w/4.1	0	0	0	0	0	0	0
	4.6	Secondary Air System	w/4.1	0	w/4.1	0	0	0	0	0	0	0
	4.8	Major Component Rigging	0	w/4.1	w/4.1	0	0	0	0	0	0	0
	4.9	Boiler Foundations	0	w/14.1	w/14.1	0	0	0	0	0	0	0
		SUBTOTAL 4.	**$160,803**	**$0**	**$90,227**	**$0**	**$251,029**	**$24,430**	**$0**	**$27,546**	**$303,006**	**$550**

Exhibit 9-20 Case 5B capital costs (Continued)

Acct No.		Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	$	$/kW
5A		FLUE GAS CLEANUP					*					
	5.1	Absorber Vessels & Accessories	88,367	0	19,024	0	107,391	10,238	0	11,763	129,392	235
	5.2	Other FGD	4,611	0	5,226	0	9,837	955	0	1,079	11,871	22
	5.3	Bag House & Accessories	20,823	0	13,215	0	34,038	3,280	0	3,732	41,050	75
	5.4	Other Particulate Removal Materials	1,409	0	1,507	0	2,916	283	0	320	3,519	6
	5.5	Gypsum Dewatering System	4,906	0	833	0	5,740	546	0	629	6,915	13
	5.6	Mercury Removal System	0	0	0	0	0	0	0	0	0	0
	5.7	Open	0	0	0	0	0	0	0	0	0	0
		SUBTOTAL 5A.	**$120,117**	**$0**	**$39,805**	**$0**	**$159,922**	**$15,302**	**$0**	**$17,522**	**$192,747**	**$350**
5B		CO2 REMOVAL & COMPRESSION										
	5B.1	CO2 Removal System	41,060	0	106,780	0	147,840	14,135	29,568	38,309	229,852	417
	5B.2	CO2 Compression	28,606	0	8,974	0	37,580	3,594	0	8,235	49,409	90
		SUBTOTAL 5B.	**$69,666**	**$0**	**$115,754**	**$0**	**$185,420**	**$17,729**	**$29,568**	**$46,543**	**$279,261**	**$507**
6		COMBUSTION TURBINE/ACCESSORIES										
	6.1	Combustion Turbine Generator	0	0	0	0	0	0	0	0	0	0
	6.2	Combustion Turbine Accessories	0	0	0	0	0	0	0	0	0	0
	6.3	Compressed Air Piping	0	0	0	0	0	0	0	0	0	0
	6.4	Combustion Turbine Foundations	0	0	0	0	0	0	0	0	0	0
		SUBTOTAL 6.	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
7		HRSG, DUCTING & STACK										
	7.1	Flue Gas Recycle Heat Exhchanger	N/A	0	N/A	0	0	0	0	0	0	0
	7.2	SCR System	0	0	0	0	0	0	0	0	0	0
	7.3	Ductwork	8,768	0	5,633	0	14,402	1,256	0	2,349	18,006	33
	7.4	Stack	8,275	0	4,842	0	13,117	1,263	0	1,438	15,818	29
	7.9	HRSG, Duct & Stack Foundations	0	949	1,078	0	2,028	190	0	444	2,661	5
		SUBTOTAL 7.	**$17,043**	**$949**	**$11,554**	**$0**	**$29,547**	**$2,708**	**$0**	**$4,230**	**$36,485**	**$66**
8		STEAM TURBINE GENERATOR										
	8.1	Steam TG & Accessories	58,204	0	7,724	0	65,928	6,318	0	7,225	79,471	144
	8.2	Turbine Plant Auxiliaries	392	0	840	0	1,232	120	0	135	1,487	3
	8.3	Condenser & Auxiliaries	7,394	0	2,725	0	10,120	969	0	1,109	12,198	22
	8.4	Steam Piping	17,542	0	8,649	0	26,191	2,200	0	4,259	32,650	59
	8.9	TG Foundations	0	1,229	1,942	0	3,171	300	0	694	4,165	8
		SUBTOTAL 8.	**$83,532**	**$1,229**	**$21,880**	**$0**	**$106,641**	**$9,909**	**$0**	**$13,422**	**$129,971**	**$236**
9		COOLING WATER SYSTEM										
	9.1	Cooling Towers	12,122	0	3,775	0	15,897	1,520	0	1,742	19,159	35
	9.2	Circulating Water Pumps	2,391	0	184	0	2,575	218	0	279	3,072	6
	9.3	Circ. Water System Auxiliaries	629	0	84	0	713	68	0	78	859	2
	9.4	Circ. Water Piping	0	4,986	4,832	0	9,818	919	0	1,611	12,348	22
	9.5	Make-up Water System	512	0	685	0	1,197	115	0	197	1,508	3
	9.6	Component Cooling Water System	498	0	396	0	895	85	0	147	1,126	2
	9.9	Circ. Water System Foundations	0	3,005	4,775	0	7,781	736	0	1,703	10,220	19
		SUBTOTAL 9.	**$16,153**	**$7,991**	**$14,731**	**$0**	**$38,875**	**$3,660**	**$0**	**$5,757**	**$48,292**	**$88**

Exhibit 9-20 Case 5B capital costs (Continued)

Acct No.		Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	$	$/kW
10		ASH/SPENT SORBENT HANDLING SYS										
	10.1	Ash Coolers	N/A	0	N/A	0	0	0	0	0	0	0
	10.2	Cyclone Ash Letdown	N/A	0	N/A	0	0	0	0	0	0	0
	10.3	HGCU Ash Letdown	N/A	0	N/A	0	0	0	0	0	0	0
	10.4	High Temperature Ash Piping	N/A	0	N/A	0	0	0	0	0	0	0
	10.5	Other Ash Recovery Equipment	N/A	0	N/A	0	0	0	0	0	0	0
	10.6	Ash Storage Silos	642	0	1,979	0	2,622	257	0	288	3,167	6
	10.7	Ash Transport & Feed Equipment	4,158	0	4,259	0	8,417	805	0	922	10,145	18
	10.8	Misc. Ash Handling Equipment	0	0	0	0	0	0	0	0	0	0
	10.9	Ash/Spent Sorbent Foundation	0	153	180	0	332	31	0	73	436	1
		SUBTOTAL 10.	**$4,800**	**$153**	**$6,418**	**$0**	**$11,371**	**$1,093**	**$0**	**$1,283**	**$13,748**	**$25**
11		ACCESSORY ELECTRIC PLANT										
	11.1	Generator Equipment	1,761	0	286	0	2,047	190	0	168	2,404	4
	11.2	Station Service Equipment	5,366	0	1,763	0	7,129	666	0	585	8,380	15
	11.3	Switchgear & Motor Control	6,169	0	1,049	0	7,218	669	0	789	8,675	16
	11.4	Conduit & Cable Tray	0	3,868	13,374	0	17,242	1,669	0	2,837	21,747	39
	11.5	Wire & Cable	0	7,298	14,089	0	21,387	1,802	0	3,478	26,667	48
	11.6	Protective Equipment	261	0	888	0	1,149	112	0	126	1,388	3
	11.7	Standby Equipment	1,382	0	32	0	1,413	130	0	154	1,697	3
	11.8	Main Power Transformers	11,342	0	191	0	11,533	874	0	1,241	13,648	25
	11.9	Electrical Foundations	0	350	857	0	1,207	115	0	265	1,587	3
		SUBTOTAL 11.	**$26,281**	**$11,516**	**$32,528**	**$0**	**$70,325**	**$6,228**	**$0**	**$9,642**	**$86,194**	**$156**
12		INSTRUMENTATION & CONTROL										
	12.1	PC Control Equipment	w/12.7	0	w/12.7	0	0	0	0	0	0	0
	12.2	Combustion Turbine Control	N/A	0	N/A	0	0	0	0	0	0	0
	12.3	Steam Turbine Control	w/8.1	0	w/8.1	0	0	0	0	0	0	0
	12.4	Other Major Component Control	0	0	0	0	0	0	0	0	0	0
	12.5	Signal Processing Equipment	W/12.7	0	w/12.7	0	0	0	0	0	0	0
	12.6	Control Boards, Panels & Racks	528	0	316	0	844	80	42	145	1,111	2
	12.7	Computer Accessories	5,331	0	932	0	6,262	581	313	716	7,872	14
	12.8	Instrument Wiring & Tubing	2,890	0	5,732	0	8,622	735	431	1,468	11,256	20
	12.9	Other I & C Equipment	1,506	0	3,418	0	4,924	477	247	565	6,213	11
		SUBTOTAL 12.	**$10,255**	**$0**	**$10,399**	**$0**	**$20,653**	**$1,873**	**$1,033**	**$2,894**	**$26,452**	**$48**
13		IMPROVEMENTS TO SITE										
	13.1	Site Preparation	0	54	1,074	0	1,128	112	0	248	1,487	3
	13.2	Site Improvements	0	1,783	2,214	0	3,997	394	0	877	5,268	10
	13.3	Site Facilities	3,195	0	3,151	0	6,345	625	0	1,393	8,363	15
		SUBTOTAL 13.	**$3,195**	**$1,837**	**$6,439**	**$0**	**$11,470**	**$1,132**	**$0**	**$2,518**	**$15,119**	**$27**

Exhibit 9-20 Case 5B capital costs (Continued)

Acct No.		Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	$	$/kW
14		BUILDINGS & STRUCTURES										
	14.1	Boiler Building	0	8,766	7,709	0	16,475	1,481	0	2,693	20,648	37
	14.2	Turbine Building	0	12,612	11,755	0	24,367	2,196	0	3,983	30,546	55
	14.3	Administration Building	0	631	667	0	1,298	118	0	212	1,628	3
	14.4	Circulation Water Pumphouse	0	143	113	0	256	23	0	42	321	1
	14.5	Water Treatment Buildings	0	693	632	0	1,326	119	0	215	1,660	3
	14.6	Machine Shop	0	422	284	0	706	63	0	115	883	2
	14.7	Warehouse	0	286	287	0	573	52	0	94	718	1
	14.8	Other Buildings & Structures	0	234	199	0	433	39	0	71	542	1
	14.9	Waste Treating Building & Str.	0	444	1,348	0	1,793	170	0	294	2,257	4
		SUBTOTAL 14.	**$0**	**$24,231**	**$22,994**	**$0**	**$47,225**	**$4,260**	**$0**	**$7,719**	**$59,204**	**$107**
		Total Cost	**$586,259**	**$53,451**	**$407,642**	**$0**	**$1,047,353**	**$98,724**	**$30,601**	**$158,856**	**$1,335,533**	**$2,424**
		Owner's Costs									**$1,000**	**$/kW**
		Preproduction Costs										
		6 Months All Labor									9,600	17
		1 Month Maintenance Materials									1,311	2
		1 Month Non-fuel Consumables									1,499	3
		1 Month Waste Disposal									270	0
		25% of 1 Months Fuel Cost at 100% CF									1,639	3
		2% of TPC									26,711	48
		Total									**41,031**	**74**
		Inventory Capital										
		60 day supply of fuel and consumables at 100% CF									15,786	29
		0.5% of TPC (spare parts)									6,678	12
		Total									**22,463**	**41**
		Initial Cost for Catalyst and Chemicals									12,824	23
		Land									900	2
		Other Owner's Costs									200,330	364
		Financing Costs									36,059	65
		Total Overnight Costs (TOC)									**1,649,141**	**2,993**
		TASC Multiplier							(IOU, high-risk, 35 year)		1.14	
		Total As-Spent Cost (TASC)									**1,880,021**	**3,412**

Exhibit 9-21 Case 5B operation and maintenance costs

	5B				Cost Base (Jun):	2007
					Heat Rate-net (Btu/kWh):	9,963
					MWe-net:	551
					Capacity Factor (%):	**85**
OPERATING & MAINTENANCE LABOR						
Operating Labor						
Operating Labor Rate(base):	34.65	$/hour				
Operating Labor Burden:	30.00	% of base				
Labor O-H Charge Rate:	25.00	% of labor				
Operating Labor Requirements(O.J.)per S	1 unit/mod.		Total Plant			
Skilled Operator	2.0		2.0			
Operator	11.3		11.3			
Foreman	1.0		1.0			
Lab Tech's, etc.	2.0		2.0			
TOTAL-O.J.'s	16.3		16.3			
					Annual Cost	Annual Unit Cost
					$	$/kW-net
Annual Operating Labor Cost					$6,444,907	$11.698
Maintenance Labor Cost					$8,915,523	$16.182
Administrative & Support Labor					$3,840,107	$6.970
Property Taxes and Insurance					$26,710,666	$48.481
TOTAL FIXED OPERATING COSTS					**$45,911,203**	$83.331
VARIABLE OPERATING COSTS						
						$/kWh-net
Maintenance Material Cost					**$13,373,284**	**$0.00326**
Consumables	Consumption Initial Fill	/Day	Unit Cost	Initial Fill Cost		
Water(/1000 gallons)	0	4,990	1.08	**$0**	**$1,674,524**	**$0.00041**
Chemicals		4.841				
MU & WT Chem. (lbs)	0	24,154	0.17	$0	$1,296,923	$0.00032
Limestone (ton)	0	540	21.63	$0	$3,624,370	$0.00088
Carbon (Mercury Removal) (lb)	0	0	1.05	$0	$0	$0.00000
MTR Membrane Replacement	1,500,000	967	15.00	$22,500,000	$4,500,000	$0.00110
NaOH (tons)	0	0	433.68	$0	$0	$0.00000
H2SO4 (tons)	0	0	138.78	$0	$0	$0.00000
Corrosion Inhibitor	0	0	0.00	$0	$0	$0.00000
Activated Carbon (lb)	0	0	1.05	$0	$0	$0.00000
Ammonia (19% NH3) (ton)	0	84.5	129.80	$0	$3,402,881	$0.00083
Subtotal Chemicals				**$22,500,000**	**$12,824,174**	**$0.00313**
Other						
Supplemental Fuel (MBtu)	0	0	0.00	$0	$0	$0.00000
SCR Catalyst (m3)	w/equip.	0.44	5,775.94	$0	$792,460	$0.00019
Emission Penalties	0	0	0.00	$0	$0	$0.00000
Subtotal Other				**$0**	**$792,460**	**$0.00019**
Waste Disposal						
Fly Ash (ton)	0	438	16.23	$0	2,204,853.59	0.00054
Bottom Ash (ton)	0	110	16.23	$0	551,213.40	0.00013
Subtotal Waste Disposal				**$0**	**$2,756,067**	**$0.00067**
By-products & Emissions						
Gypsum (tons)	0	145	0.00	$0	$0	$0.00000
Subtotal By-products				**$0**	**$0**	**$0.00000**
TOTAL VARIABLE OPERATING COSTS				**$22,500,000**	**$31,420,509**	**$0.00766**
Fuel (ton)	0	5,646	38.18	**$0**	**$66,889,783**	**$0.01631**

Exhibit 9-22 Cost of electricity breakdown for Case 5B

TOC, $/kW	**2,993**
COE w/o TS&M, $/MW	**85.1**
Capital, $/MW	50.0
Fixed, $/MW	11.2
Variable, $/MW	7.7
Fuel, $/MW	16.3

9.3 Case 5C

Exhibit 9-23 Case 5C Stream table

	1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
V-L Mole Fraction																			
Ar	0.0092	0.0092	0.0092	0.0092	0.0073	0.0092	0.0092	0.0092	0.0092	0.0073	0.0092	0.0000	0.0000	0.0073	0.0000	0.0073	0.0073	0.0000	0.0000
CO_2	0.0003	0.0003	0.0003	0.0003	0.1402	0.0003	0.0003	0.0003	0.0003	0.1402	0.0003	0.0000	0.0000	0.2234	0.0000	0.2234	0.2234	0.0000	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	0.0099	0.0099	0.0099	0.0099	0.0840	0.0099	0.0099	0.0099	0.0099	0.0840	0.0099	0.0000	0.0000	0.1285	0.0000	0.1285	0.1285	1.0000	1.0000
N_2	0.7732	0.7732	0.7732	0.7732	0.6097	0.7732	0.7732	0.7732	0.7732	0.6097	0.7732	0.0000	0.0000	0.6156	0.0000	0.6156	0.6156	0.0000	0.0000
O_2	0.2074	0.2074	0.2074	0.2074	0.1588	0.2074	0.2074	0.2074	0.2074	0.1588	0.2074	0.0000	0.0000	0.0235	0.0000	0.0235	0.0235	0.0000	0.0000
SO_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0017	0.0000	0.0017	0.0017	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	71,176	54,450	54,450	54,450	71,479	16,726	16,726	54,450	1,867	1,961	1,234	0	0	93,542	0	93,542	93,542	2,770	9,584
V-L Flowrate (kg/hr)	2,053,933	1,571,258	1,571,258	1,571,258	2,154,080	482,674	482,674	1,571,258	53,872	59,094	35,599	0	0	2,857,324	0	2,857,324	2,857,322	49,895	172,665
Solids Flowrate (kg/hr)	0	0	0	0	0	0	0	0	0	0	0	204,833	3,972	15,890	15,890	0	0	20,412	0
Temperature (°C)	15	15	26	50	50	15	25	15	25	50	15	15	15	172	15	172	199	15	15
Pressure (MPa, abs)	0.10	0.10	0.11	0.11	0.10	0.10	0.11	0.10	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.12	0.10	0.10
Enthalpy (kJ/kg)[A]	30.23	30.23	41.75	65.62	175.97	30.23	40.78	30.23	40.78	175.97	30.23	---	---	391.31	---	369.90	400.19	---	-46.80
Density (kg/m^3)	1.2	1.2	1.3	1.2	1.2	1.2	1.3	1.2	1.3	1.2	1.2	---	---	0.8	---	0.8	0.9	---	1,003.1
V-L Molecular Weight	28.857	28.857	28.857	28.857	30.136	28.857	28.857	28.857	28.857	30.136	28.857	---	---	30.546	---	30.546	30.546	---	18.015
V-L Flowrate (lb_{mol}/hr)	156,917	120,041	120,041	120,041	157,584	36,875	36,875	120,041	4,116	4,323	2,720	0	0	206,225	0	206,225	206,225	6,106	21,130
V-L Flowrate (lb/hr)	4,528,146	3,464,032	3,464,032	3,464,032	4,748,934	1,064,114	1,064,114	3,464,032	118,768	130,280	78,483	0	0	6,299,322	0	6,299,322	6,299,316	110,000	380,661
Solids Flowrate (lb/hr)	0	0	0	0	0	0	0	0	0	0	0	451,579	8,758	35,031	35,031	0	0	45,000	0
Temperature (°F)	59	59	80	122	122	59	78	59	78	122	59	59	59	341	59	341	391	59	59
Pressure (psia)	14.7	14.7	16.5	16.4	15.2	14.7	16.1	14.7	16.1	15.2	14.7	14.7	14.7	14.4	14.7	14.2	17.0	15.0	14.7
Enthalpy (Btu/lb)[A]	13.0	13.0	17.9	28.2	75.7	13.0	17.5	13.0	17.5	75.7	13.0	---	---	168.2	---	159.0	172.1	---	-20.1
Density (lb/ft^3)	0.076	0.076	0.082	0.076	0.073	0.076	0.081	0.076	0.081	0.073	0.076	---	---	0.051	---	0.050	0.057	---	62.622
	A - Reference conditions are 32.02 F & 0.089 PSIA																		

Exhibit 9-23 Case 5C Stream table (Continued)

	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
V-L Mole Fraction																			
Ar	0.0128	0.0000	0.0070	0.0000	0.0070	0.0090	0.0112	0.0110	0.0004	0.0008	0.0000	0.0000	0.0000	0.0050	0.0000	0.0000	0.0000	0.0000	0.0000
CO_2	0.0005	0.0003	0.2122	0.0000	0.2122	0.1438	0.0176	0.0203	0.4470	0.8365	1.0000	1.0000	1.0000	0.1050	0.0000	0.0000	0.0000	0.0000	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	0.0062	0.9997	0.1714	0.0000	0.1714	0.0712	0.0000	0.0142	0.5159	0.0941	0.0000	0.0000	0.0000	0.4593	1.0000	1.0000	1.0000	1.0000	1.0000
N_2	0.7506	0.0000	0.5861	0.0000	0.5861	0.7465	0.9343	0.9182	0.0353	0.0660	0.0000	0.0000	0.0000	0.4142	0.0000	0.0000	0.0000	0.0000	0.0000
O_2	0.2300	0.0000	0.0232	0.0000	0.0232	0.0295	0.0369	0.0363	0.0014	0.0026	0.0000	0.0000	0.0000	0.0164	0.0000	0.0000	0.0000	0.0000	0.0000
SO_2	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	769	198	99,224	2	99,222	76,847	59,818	61,723	22,375	11,957	9,801	9,801	9,801	1,906	82,011	66,177	66,177	62,590	62,590
V-L Flowrate (kg/hr)	22,323	3,562	2,963,950	148	2,963,803	2,292,175	1,709,353	1,757,437	671,628	483,941	431,352	431,352	431,352	48,084	1,477,452	1,192,194	1,192,194	1,127,585	1,127,585
Solids Flowrate (kg/hr)	0	31,753	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Temperature (°C)	181	62	62	62	62	66	72	48	50	43	27	28	35	25	732	390	760	38	39
Pressure (MPa, abs)	0.31	0.12	0.12	0.12	0.12	0.11	0.10	0.10	0.02	0.10	2.32	1.06	15.27	1.06	34.47	4.90	4.35	0.01	1.69
Enthalpy (kJ/kg)[A]	191.58	---	323.94	37.59	323.96	174.89	73.10	71.53	832.72	119.36	-0.99	13.27	-212.35	15.71	3,803.80	3,174.83	4,042.33	2,363.67	166.30
Density (kg/m^3)	2.4	---	1.2	2.7	1.2	1.1	1.0	1.1	0.2	1.6	46.7	19.7	794.3	20.0	81.3	17.3	9.2	0.1	993.2
V-L Molecular Weight	29.029	---	29.871	64.065	29.870	29.828	28.576	28.473	30.017	40.474	44.010	44.010	44.010	25.233	18.015	18.015	18.015	18.015	18.015
V-L Flowrate (lb_{mol}/hr)	1,695	436	218,752	5	218,747	169,418	131,876	136,077	49,328	26,360	21,608	21,608	21,608	4,201	180,803	145,895	145,895	137,988	137,988
V-L Flowrate (lb/hr)	49,213	7,854	6,534,391	325	6,534,066	5,053,380	3,768,478	3,874,485	1,480,686	1,066,908	950,968	950,968	950,968	106,007	3,257,225	2,628,337	2,628,337	2,485,899	2,485,899
Solids Flowrate (lb/hr)	0	70,002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Temperature (°F)	357	144	144	144	144	151	161	118	122	110	80	83	95	77	1,350	734	1,400	101	103
Pressure (psia)	45.0	16.7	16.7	16.7	16.7	15.7	14.7	14.7	2.9	14.7	336.9	153.2	2,214.5	153.2	5,000.0	710.8	630.8	1.0	245.0
Enthalpy (Btu/lb)[A]	82.4	---	139.3	16.2	139.3	75.2	31.4	30.8	358.0	51.3	-0.4	5.7	-91.3	6.8	1,635.3	1,364.9	1,737.9	1,016.2	71.5
Density (lb/ft^3)	0.149	---	0.077	0.167	0.077	0.072	0.063	0.067	0.014	0.100	2.917	1.229	49.586	1.246	5.073	1.078	0.575	0.003	62.005

Exhibit 9-24 Case 5C Performance summary

	Case 5C	Units
Plant Output		
Steam Turbine Power	686,500	kW_e
Total	**686,500**	kW_e
Auxiliary Load		
Coal Handling and Conveying	460	kW_e
Pulverizers	3,070	kW_e
Sorbent Handling & Reagent Preparation	980	kW_e
Ash Handling	590	kW_e
Primary Air Fans	1,470	kW_e
Air Blower Fans	5,210	kW_e
Induced Draft Fans	24,790	kW_e
SCR	50	kW_e
Vacuum Pump	27,840	kW_e
Baghouse	80	kW_e
Wet FGD	3,290	kW_e
CO_2 Compression	45,850	kW_e
Miscellaneous Balance of Plant[2,3]	2,000	kW_e
Steam Turbine Auxiliaries	400	kW_e
Condensate Pumps	710	kW_e
Circulating Water Pumps	6,670	kW_e
Ground Water Pumps	580	kW_e
Cooling Tower Fans	3,450	kW_e
Transformer Losses	2,410	kW_e
Total	**129,900**	**kW_e**
Plant Performance		
Net Auxiliary Load	129,900	kW_e
Net Plant Power	556,600	kW_e
Net Plant Efficiency (HHV)	36.1%	
Net Plant Heat Rate (HHV)	9,986 (9,465)	kJ/kWhr (Btu/kWhr)
Coal Feed Flowrate	204,833 (451,579)	kg/hr (lb/hr)
Thermal Input[1]	1,543,934	kW_{th}
Condenser Duty	2,484 (2,355)	GJ/hr (MMBtu/hr)
Raw Water Withdrawal	24.4 (6,451)	m^3/min (gpm)
Raw Water Consumption	18.6 (4,908)	m^3/min (gpm)

1 - HHV of Illinois No. 6 coal is 27,135 kJ/kg (11,666 Btu/lb)
2 – Boiler feed pumps are turbine driven
3 – Includes plant control systems, lighting, HVAC, and miscellaneous low voltage loads

Exhibit 9-25 Case 5C water balance

	Water Demand	Internal Recycle	Raw Water Withdrawal	Process Water Discharge	Raw Water Consumption
	m^3/min (gpm)				
FGD Makeup	3.71 (981)	0.0 (0)	3.71 (981)	0.00 (0)	3.71 (981)
BFW Makeup	0.00 (0)	0.0 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Cooling Tower	26.0 (6,862)	5.27 (1392)	20.7 (5,470)	5.84 (1,543)	14.86 (3,927)
CO2 Compression Knockout	0.0 (0)	3.21 (847)	0.0 (0)	0.00 (0)	0.00 (0)
FGD Dewatering	0.0 (0)	2.06 (544)	0.0 (0)	0.00 (0)	0.00 (0)
CO2 Capture Recovery	0.0 (0)	0.00 (0)	0.0 (0)	0.00 (0)	0.00 (0)
Total	**29.7 (7,843)**	**5.27 (1392)**	**24.4 (6,451)**	**5.84 (1,543)**	**18.58 (4,908)**

Exhibit 9-26 Case 5C carbon balance

Carbon In		Carbon Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	130,570 (287,858)	Stack Gas	15,047 (33,174)
Air (CO2)	289 (637)	FGD Product	182 (402)
FGD Reagent	2,071 (4,566)	CO2 Product	117,723 (259,535)
		Convergence Tolerance	-23 (-51)
Total	**132,930 (293,061)**	**Total**	**132,930 (293,061)**

Exhibit 9-27 Case 5C sulfur balance

Sulfur In		Sulfur Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	5,134 (11,318)	FGD Product	5,045 (11,122)
		Stack Gas	15 (34)
		Econamine Polishing Scrubber/HSS	74 (163)
Total	**5,134 (11,318)**	**Total**	**5,134 (11,318)**

Exhibit 9-28 Case 5C energy balance

	HHV	Sensible + Latent	Power	Total
Heat In GJ/hr (MMBtu/hr)				
Coal	5,558 (5,268)	4.6 (4.4)	-	5,563 (5,273)
Air	-	67.4 (63.9)	-	67.4 (63.9)
Raw Water Makeup	-	91.9 (87.1)	-	91.9 (87.1)
Lime	-	0.23 (0.22)	-	0.23 (0.22)
Auxiliary Power	-	-	468 (443)	468 (443)
TOTAL	**5,558 (5,268)**	**164.2 (155.6)**	**468 (443)**	**6,190 (5,867)**
Heat Out GJ/hr (MMBtu/hr)				
Bottom Ash	-	0.5 (0.5)	-	0.5 (0.5)
Fly Ash + FGD Ash	-	2.0 (1.9)	-	2.0 (1.9)
Flue Gas	-	126 (119)	-	126 (119)
Condenser	-	2,484 (2,355)	-	2,484 (2,355)
CO2	-	-92 (-87)	-	-92 (-87)
Boiler Heat Loss	-	49 (46)	-	49 (46)
Vacuum Pump Cooling	-	586 (555)	-	586 (555)
CO2 Compression Cooling	-	305 (289)	-	305 (289)
Cooling Tower Blowdown	-	43 (41)	-	43 (41)
*Process Losses**	-	215 (203)	-	215 (203)
Power	-	-	2,471 (2,342)	2,471 (2,342)
TOTAL	-	**3,719 (3,525)**	**2,471 (2,342)**	**6,190 (5,867)**

* Process losses are estimated to match the heat input to the plant.

Exhibit 9-29 Case 5C air emissions

	kg/GJ (lb/MMBtu)	tonne/yr (Ton/year)	kg/MWgross (lb/MWgross)
SO_2	0.005 (0.013)	240 (265)	0.044 (.10)
NOx	0.030 (0.070)	1,319 (1,454)	0.244 (.537)
Particulate	0.006 (0.0130)	245 (270)	0.045 (.100)
Hg	4.91E-7 (1.14E-6)	0.022 (0.024)	3.98E-6 (8.77E-6)
CO_2	9.9 (23.1)	434,690 (479,163)	80 (177)

Exhibit 9-30 Case 5C capital costs

											Cost Base:	Jan 2007	
											Prepared:	13-Mar-12	
		Case:	5C									x $1, 000	
		Plant Size:	556.60	MW, net			Capital Charge Factor		0.85				
Acct No.		Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	$	$/kW	
1		COAL HANDLING SYSTEM											
	1.1	Coal Receive & Unload	3,578	0	1,634	0	5,212	466	0	852	6,530	12	
	1.2	Coal Stackout & Reclaim	4,624	0	1,048	0	5,672	496	0	925	7,093	13	
	1.3	Coal Conveyors & Yd Crus	4,299	0	1,037	0	5,336	468	0	871	6,674	12	
	1.4	Other Coal Handling	1,125	0	240	0	1,365	119	0	223	1,707	3	
	1.5	Sorbent Receive & Unload	144	0	48	0	193	17	0	31	241	0	
	1.6	Sorbent Stackout & Reclaim	2,329	0	476	0	2,805	244	0	457	3,506	6	
	1.7	Sorbent Conveyors	831	200	227	0	1,259	109	0	205	1,573	3	
	1.8	Other Sorbent Handling	502	131	294	0	927	82	0	151	1,160	2	
	1.9	Coal & Sorbent Hnd.Foundations	0	4,391	5,539	0	9,930	933	0	1,629	12,492	22	
		SUBTOTAL 1.	**$17,433**	**$4,722**	**$10,543**	**$0**	**$32,698**	**$2,933**	**$0**	**$5,345**	**$40,976**	**$74**	
2		COAL PREP & FEED SYSTEMS											
	2.1	Coal Crushing & Drying	2,057	0	401	0	2,458	214	0	401	3,074	6	
	2.2	Prepared Coal Storage & Feed	5,268	0	1,150	0	6,418	561	0	1,047	8,025	14	
	2.3	Slurry Prep & Feed	0	0	0	0	0	0	0	0	0	0	
	2.4	Misc. Coal Prep & Feed	0	0	0	0	0	0	0	0	0	0	
	2.5	Sorbent Prep Equipment	3,955	190	916	0	5,061	440	0	825	6,327	11	
	2.6	Sorbent Storage & Feed	476	0	204	0	680	60	0	111	852	2	
	2.7	Sorbent Injection System	0	0	0	0	0	0	0	0	0	0	
	2.8	Booster Air Supply System	0	0	0	0	0	0	0	0	0	0	
	2.9	Coal & Sorbent Feed Foundation	0	517	434	0	950	88	0	156	1,194	2	
		SUBTOTAL 2.	**$11,756**	**$707**	**$3,104**	**$0**	**$15,568**	**$1,364**	**$0**	**$2,540**	**$19,472**	**$35**	
3		FEEDWATER & MISC. BOP SYSTEMS											
	3.1	Feedwater System	16,950	0	5,475	0	22,425	1,960	0	3,658	28,043	50	
	3.2	Water Makeup & Pretreating	5,100	0	1,642	0	6,742	638	0	1,476	8,855	16	
	3.3	Other Feedwater Subsystems	5,189	0	2,193	0	7,382	661	0	1,207	9,250	17	
	3.4	Service Water Systems	1,000	0	544	0	1,544	145	0	338	2,027	4	
	3.5	Other Boiler Plant Systems	6,267	0	6,188	0	12,455	1,183	0	2,046	15,684	28	
	3.6	FO Supply Sys & Nat Gas	261	0	326	0	587	55	0	96	739	1	
	3.7	Waste Treatment Equipment	3,458	0	1,971	0	5,429	528	0	1,191	7,148	13	
	3.8	Misc. Power Plant Equipment	2,769	0	846	0	3,615	348	0	792	4,755	9	
		SUBTOTAL 3.	**$40,994**	**$0**	**$19,184**	**$0**	**$60,178**	**$5,518**	**$0**	**$10,804**	**$76,500**	**$137**	
4		PC BOILER & ACCESSORIES											
	4.1	PC Boiler & Accessories	144,927	0	81,319	0	226,246	22,018	24,826	24,826	297,918	535	
	4.2	SCR (w/4.1)	0	0	0	0	0	0	0	0	0	0	
	4.3	Open	0	0	0	0	0	0	0	0	0	0	
	4.4	Boiler BoP (w/ ID Fans)	0	0	0	0	0	0	0	0	0	0	
	4.5	Primary Air System	w/4.1	0	w/4.1	0	0	0	0	0	0	0	
	4.6	Secondary Air System	w/4.1	0	w/4.1	0	0	0	0	0	0	0	
	4.8	Major Component Rigging	0	w/4.1	w/4.1	0	0	0	0	0	0	0	
	4.9	Boiler Foundations	0	w/14.1	w/14.1	0	0	0	0	0	0	0	
		SUBTOTAL 4.	**$144,927**	**$0**	**$81,319**	**$0**	**$226,246**	**$22,018**	**$24,826**	**$24,826**	**$297,918**	**$535**	

Exhibit 9-30 Case 5C capital costs (Continued)

Acct No.		Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	$	$/kW
5A		FLUE GAS CLEANUP					*					
	5.1	Absorber Vessels & Accessories	85,771	0	18,464	0	104,235	9,937	0	11,417	125,590	226
	5.2	Other FGD	4,476	0	5,072	0	9,548	927	0	1,047	11,522	21
	5.3	Bag House & Accessories	20,163	0	12,796	0	32,960	3,176	0	3,614	39,749	71
	5.4	Other Particulate Removal Materials	1,365	0	1,460	0	2,825	274	0	310	3,409	6
	5.5	Gypsum Dewatering System	4,861	0	826	0	5,687	541	0	623	6,851	12
	5.6	Mercury Removal System	0	0	0	0	0	0	0	0	0	0
	5.7	Open	0	0	0	0	0	0	0	0	0	0
		SUBTOTAL 5A.	**$116,636**	**$0**	**$38,619**	**$0**	**$155,255**	**$14,856**	**$0**	**$17,011**	**$187,121**	**$336**
5B		CO2 REMOVAL & COMPRESSION										
	5B.1	CO2 Removal System	40,523	0	106,512	0	147,035	14,058	29,407	38,100	228,600	411
	5B.2	CO2 Compression	27,910	0	8,756	0	36,666	3,507	0	8,035	48,208	87
		SUBTOTAL 5B.	**$68,434**	**$0**	**$115,268**	**$0**	**$183,701**	**$17,565**	**$29,407**	**$46,135**	**$276,808**	**$497**
6		COMBUSTION TURBINE/ACCESSORIES										
	6.1	Combustion Turbine Generator	0	0	0	0	0	0	0	0	0	0
	6.2	Combustion Turbine Accessories	0	0	0	0	0	0	0	0	0	0
	6.3	Compressed Air Piping	0	0	0	0	0	0	0	0	0	0
	6.4	Combustion Turbine Foundations	0	0	0	0	0	0	0	0	0	0
		SUBTOTAL 6.	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
7		HRSG, DUCTING & STACK										
	7.1	Flue Gas Recycle Heat Exhchanger	N/A	0	N/A	0	0	0	0	0	0	0
	7.2	SCR System	0	0	0	0	0	0	0	0	0	0
	7.3	Ductwork	8,682	0	5,578	0	14,260	1,243	0	2,326	17,829	32
	7.4	Stack	8,253	0	4,829	0	13,082	1,259	0	1,434	15,776	28
	7.9	HRSG, Duct & Stack Foundations	0	947	1,076	0	2,022	189	0	442	2,654	5
		SUBTOTAL 7.	**$16,935**	**$947**	**$11,483**	**$0**	**$29,364**	**$2,692**	**$0**	**$4,202**	**$36,259**	**$65**
8		STEAM TURBINE GENERATOR										
	8.1	Steam TG & Accessories	58,204	0	7,724	0	65,928	6,318	10,837	7,225	90,308	162
	8.2	Turbine Plant Auxiliaries	392	0	840	0	1,232	120	0	135	1,487	3
	8.3	Condenser & Auxiliaries	7,002	0	2,581	0	9,583	918	0	1,050	11,551	21
	8.4	Steam Piping	15,799	0	7,790	0	23,589	1,982	0	3,836	29,406	53
	8.9	TG Foundations	0	1,229	1,942	0	3,171	300	0	694	4,165	7
		SUBTOTAL 8.	**$81,397**	**$1,229**	**$20,876**	**$0**	**$103,503**	**$9,639**	**$10,837**	**$12,940**	**$136,918**	**$246**
9		COOLING WATER SYSTEM										
	9.1	Cooling Towers	11,557	0	3,599	0	15,155	1,449	0	1,660	18,265	33
	9.2	Circulating Water Pumps	2,251	0	173	0	2,425	205	0	263	2,892	5
	9.3	Circ. Water System Auxiliaries	601	0	80	0	681	65	0	75	820	1
	9.4	Circ. Water Piping	0	4,764	4,617	0	9,382	878	0	1,539	11,799	21
	9.5	Make-up Water System	491	0	656	0	1,147	110	0	188	1,445	3
	9.6	Component Cooling Water System	476	0	379	0	855	81	0	140	1,076	2
	9.9	Circ. Water System Foundations	0	2,882	4,579	0	7,461	706	0	1,633	9,800	18
		SUBTOTAL 9.	**$15,376**	**$7,646**	**$14,083**	**$0**	**$37,105**	**$3,494**	**$0**	**$5,499**	**$46,099**	**$83**

Exhibit 9-30 Case 5C capital costs (Continued)

Acct No.		Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	$	$/kW
10		ASH/SPENT SORBENT HANDLING SYS										
	10.1	Ash Coolers	N/A	0	N/A	0	0	0	0	0	0	0
	10.2	Cyclone Ash Letdown	N/A	0	N/A	0	0	0	0	0	0	0
	10.3	HGCU Ash Letdown	N/A	0	N/A	0	0	0	0	0	0	0
	10.4	High Temperature Ash Piping	N/A	0	N/A	0	0	0	0	0	0	0
	10.5	Other Ash Recovery Equipment	N/A	0	N/A	0	0	0	0	0	0	0
	10.6	Ash Storage Silos	628	0	1,934	0	2,562	251	0	281	3,095	6
	10.7	Ash Transport & Feed Equipment	4,063	0	4,162	0	8,226	787	0	901	9,914	18
	10.8	Misc. Ash Handling Equipment	0	0	0	0	0	0	0	0	0	0
	10.9	Ash/Spent Sorbent Foundation	0	149	176	0	325	30	0	71	426	1
		SUBTOTAL 10.	**$4,691**	**$149**	**$6,272**	**$0**	**$11,113**	**$1,068**	**$0**	**$1,254**	**$13,435**	**$24**
11		ACCESSORY ELECTRIC PLANT										
	11.1	Generator Equipment	1,761	0	286	0	2,047	190	0	168	2,404	4
	11.2	Station Service Equipment	5,268	0	1,731	0	6,999	654	0	574	8,227	15
	11.3	Switchgear & Motor Control	6,057	0	1,029	0	7,086	657	0	774	8,517	15
	11.4	Conduit & Cable Tray	0	3,797	13,130	0	16,927	1,639	0	2,785	21,351	38
	11.5	Wire & Cable	0	7,165	13,832	0	20,997	1,769	0	3,415	26,181	47
	11.6	Protective Equipment	261	0	888	0	1,149	112	0	126	1,388	2
	11.7	Standby Equipment	1,382	0	32	0	1,413	130	0	154	1,697	3
	11.8	Main Power Transformers	11,342	0	191	0	11,533	874	0	1,241	13,648	25
	11.9	Electrical Foundations	0	350	857	0	1,207	115	0	265	1,587	3
		SUBTOTAL 11.	**$26,070**	**$11,312**	**$31,976**	**$0**	**$69,358**	**$6,140**	**$0**	**$9,501**	**$85,000**	**$153**
12		INSTRUMENTATION & CONTROL										
	12.1	PC Control Equipment	w/12.7	0	w/12.7	0	0	0	0	0	0	0
	12.2	Combustion Turbine Control	N/A	0	N/A	0	0	0	0	0	0	0
	12.3	Steam Turbine Control	w/8.1	0	w/8.1	0	0	0	0	0	0	0
	12.4	Other Major Component Control	0	0	0	0	0	0	0	0	0	0
	12.5	Signal Processing Equipment	W/12.7	0	w/12.7	0	0	0	0	0	0	0
	12.6	Control Boards, Panels & Racks	525	0	315	0	840	79	42	144	1,105	2
	12.7	Computer Accessories	5,302	0	927	0	6,228	577	312	712	7,829	14
	12.8	Instrument Wiring & Tubing	2,874	0	5,701	0	8,575	731	429	1,460	11,195	20
	12.9	Other I & C Equipment	1,498	0	3,400	0	4,898	475	245	562	6,180	11
		SUBTOTAL 12.	**$10,199**	**$0**	**$10,342**	**$0**	**$20,541**	**$1,862**	**$1,027**	**$2,878**	**$26,308**	**$47**
13		IMPROVEMENTS TO SITE										
	13.1	Site Preparation	0	53	1,064	0	1,117	111	0	245	1,474	3
	13.2	Site Improvements	0	1,767	2,194	0	3,961	391	0	869	5,221	9
	13.3	Site Facilities	3,166	0	3,122	0	6,288	620	0	1,380	8,288	15
		SUBTOTAL 13.	**$3,166**	**$1,820**	**$6,380**	**$0**	**$11,366**	**$1,121**	**$0**	**$2,495**	**$14,982**	**$27**

Exhibit 9-30 Case 5C capital costs (Continued)

Acct No.		Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	$	$/kW
14		BUILDINGS & STRUCTURES										
	14.1	Boiler Building	0	8,746	7,691	0	16,437	1,477	0	2,686	20,601	37
	14.2	Turbine Building	0	12,566	11,712	0	24,278	2,188	0	3,968	30,435	55
	14.3	Administration Building	0	628	664	0	1,292	117	0	211	1,621	3
	14.4	Circulation Water Pumphouse	0	137	109	0	245	22	0	40	308	1
	14.5	Water Treatment Buildings	0	661	603	0	1,265	114	0	205	1,584	3
	14.6	Machine Shop	0	420	282	0	702	62	0	115	879	2
	14.7	Warehouse	0	285	286	0	570	52	0	93	715	1
	14.8	Other Buildings & Structures	0	233	198	0	431	39	0	70	540	1
	14.9	Waste Treating Building & Str.	0	442	1,342	0	1,784	169	0	293	2,246	4
		SUBTOTAL 14.	**$0**	**$24,118**	**$22,887**	**$0**	**$47,005**	**$4,241**	**$0**	**$7,683**	**$58,928**	**$106**
		Total Cost	**$558,014**	**$52,651**	**$392,336**	**$0**	**$1,003,001**	**$94,512**	**$66,098**	**$153,112**	**$1,316,723**	**$2,366**
		Owner's Costs									**$1,000**	**$/kW**
		Preproduction Costs										
		6 Months All Labor									9,364	17
		1 Month Maintenance Materials									1,256	2
		1 Month Non-fuel Consumables									1,462	3
		1 Month Waste Disposal									259	0
		25% of 1 Months Fuel Cost at 100% CF									1,573	3
		2% of TPC									26,334	47
		Total									**40,250**	**72**
		Inventory Capital										
		60 day supply of fuel and consumables at 100% CF									15,207	27
		0.5% of TPC (spare parts)									6,584	12
		Total									**21,790**	**39**
		Initial Cost for Catalyst and Chemicals									12,598	23
		Land									900	2
		Other Owner's Costs									197,508	355
		Financing Costs									35,552	64
		Total Overnight Costs (TOC)									**1,625,320**	**2,920**
		TASC Multiplier							(IOU, high-risk, 35 year)		1.14	
		Total As-Spent Cost (TASC)									**1,852,865**	**3,329**

Exhibit 9-31 Case 5C operation and maintenance costs

	5C				Cost Base (Jun):	2007
					Heat Rate-net (Btu/kWh):	9,465
					MWe-net:	557
					Capacity Factor (%):	**85**
OPERATING & MAINTENANCE LABOR						
Operating Labor						
Operating Labor Rate(base):	34.65	$/hour				
Operating Labor Burden:	30.00	% of base				
Labor O-H Charge Rate:	25.00	% of labor				
Operating Labor Requirements(O.J.)per S	1 unit/mod.		Total Plant			
Skilled Operator	2.0		2.0			
Operator	11.3		11.3			
Foreman	1.0		1.0			
Lab Tech's, etc.	2.0		2.0			
TOTAL-O.J.'s	16.3		16.3			
					Annual Cost	Annual Unit Cost
					$	$/kW-net
Annual Operating Labor Cost					$6,444,907	$11.579
Maintenance Labor Cost					$8,537,982	$15.340
Administrative & Support Labor					$3,745,722	$6.730
Property Taxes and Insurance					$26,334,452	$47.313
TOTAL FIXED OPERATING COSTS					**$45,063,063**	$80.961
VARIABLE OPERATING COSTS						
						$/kWh-net
Maintenance Material Cost					**$12,806,973**	**$0.00309**
Consumables	Consumption Initial Fill	/Day	Unit Cost	Initial Fill Cost		
Water(/1000 gallons)	0	4,645	1.08	**$0**	**$1,558,757**	**$0.00038**
Chemicals		4.841				
MU & WT Chem. (lbs)	0	22,484	0.17	$0	$1,207,261	$0.00029
Limestone (ton)	0	540	21.63	$0	$3,624,370	$0.00087
Carbon (Mercury Removal) (lb)	0	0	1.05	$0	$0	$0.00000
MTR Membrane Replacement	1,500,000	967	15.00	$22,500,000	$4,500,000	$0.00109
NaOH (tons)	0	0	433.68	$0	$0	$0.00000
H2SO4 (tons)	0	0	138.78	$0	$0	$0.00000
Corrosion Inhibitor	0	0	0.00	$0	$0	$0.00000
Activated Carbon (lb)	0	0	1.05	$0	$0	$0.00000
Ammonia (19% NH3) (ton)	0	81.1	129.80	$0	$3,265,960	$0.00079
Subtotal Chemicals				**$22,500,000**	**$12,597,592**	**$0.00304**
Other						
Supplemental Fuel (MBtu)	0	0	0.00	$0	$0	$0.00000
SCR Catalyst (m3)	w/equip.	0.42	5,775.94	$0	$760,412	$0.00018
Emission Penalties	0	0	0.00	$0	$0	$0.00000
Subtotal Other				**$0**	**$760,412**	**$0.00018**
Waste Disposal						
Fly Ash (ton)	0	420	16.23	$0	2,116,089.21	0.00051
Bottom Ash (ton)	0	105	16.23	$0	529,022.30	0.00013
Subtotal Waste Disposal				**$0**	**$2,645,112**	**$0.00064**
By-products & Emissions						
Gypsum (tons)	0	145	0.00	$0	$0	$0.00000
Subtotal By-products				**$0**	**$0**	**$0.00000**
TOTAL VARIABLE OPERATING COSTS				**$22,500,000**	**$30,368,846**	**$0.00733**
Fuel (ton)	0	5,419	38.18	**$0**	**$64,196,892**	**$0.01549**

Exhibit 9-32 Cost of electricity breakdown for Case 5C

TOC, $/kW	**2,920**
COE w/o TS&M, $/MW	**82.4**
Capital, $/MW	48.7
Fixed, $/MW	10.9
Variable, $/MW	7.3
Fuel, $/MW	15.5

9.4 Case 5D

Exhibit 9-33 Case 5D Stream table

	1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
V-L Mole Fraction																			
Ar	0.0092	0.0078	0.0092	0.0092	0.0078	0.0078	0.0078	0.0078	0.0078	0.0078	0.0092	0.0000	0.0000	0.0074	0.0000	0.0074	0.0074	0.0000	0.0000
CO_2	0.0003	0.1153	0.0003	0.0003	0.1153	0.1153	0.1153	0.1153	0.1153	0.1153	0.0003	0.0000	0.0000	0.2264	0.0000	0.2264	0.2264	0.0000	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	0.0099	0.0566	0.0099	0.0099	0.0566	0.0566	0.0566	0.0566	0.0566	0.0566	0.0099	0.0000	0.0000	0.1167	0.0000	0.1167	0.1167	1.0000	1.0000
N_2	0.7732	0.6499	0.7732	0.7732	0.6499	0.6499	0.6499	0.6499	0.6499	0.6499	0.7732	0.0000	0.0000	0.6239	0.0000	0.6239	0.6239	0.0000	0.0000
O_2	0.2074	0.1704	0.2074	0.2074	0.1704	0.1704	0.1704	0.1704	0.1704	0.1704	0.2074	0.0000	0.0000	0.0238	0.0000	0.0238	0.0238	0.0000	0.0000
SO_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0017	0.0000	0.0017	0.0017	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	69,392	64,852	69,392	69,392	84,774	19,922	19,922	64,852	2,164	1,499	1,203	0	0	89,977	0	89,977	89,977	2,625	6,912
V-L Flowrate (kg/hr)	2,002,446	1,949,687	2,002,446	2,002,446	2,548,611	598,923	598,923	1,949,687	65,058	45,077	34,710	0	0	2,763,669	0	2,763,669	2,763,669	47,297	124,518
Solids Flowrate (kg/hr)	0	0	0	0	0	0	0	0	0	0	0	199,714	3,873	15,493	15,493	0	0	20,222	0
Temperature (°C)	15	50	20	50	50	50	57	50	57	50	15	15	15	172	15	172	201	15	15
Pressure (MPa, abs)	0.10	0.10	0.11	0.11	0.10	0.10	0.11	0.10	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.12	0.10	0.10
Enthalpy (kJ/kg)[A]	30.23	134.81	35.47	65.64	134.81	134.81	141.73	134.81	141.73	134.81	30.23	---	---	372.14	---	350.98	382.79	---	-46.80
Density (kg/m^3)	1.2	1.2	1.3	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	---	---	0.8	---	0.8	0.9	---	1,003.1
V-L Molecular Weight	28.857	30.064	28.857	28.857	30.064	30.064	30.064	30.064	30.064	30.064	28.857	---	---	30.715	---	30.715	30.715	---	18.015
V-L Flowrate (lb_{mol}/hr)	152,983	142,974	152,983	152,983	186,894	43,920	43,920	142,974	4,771	3,306	2,652	0	0	198,366	0	198,366	198,366	5,788	15,238
V-L Flowrate (lb/hr)	4,414,637	4,298,324	4,414,637	4,414,637	5,618,725	1,320,400	1,320,400	4,298,324	143,428	99,377	76,522	0	0	6,092,846	0	6,092,846	6,092,846	104,271	274,516
Solids Flowrate (lb/hr)	0	0	0	0	0	0	0	0	0	0	0	440,294	8,539	34,156	34,156	0	0	44,581	0
Temperature (°F)	59	122	68	122	122	122	134	122	134	122	59	59	59	342	59	342	395	59	59
Pressure (psia)	14.7	15.2	15.5	15.4	15.2	15.2	16.1	15.2	16.1	15.2	14.7	14.7	14.7	14.4	14.7	14.2	17.2	15.0	14.7
Enthalpy (Btu/lb)[A]	13.0	58.0	15.3	28.2	58.0	58.0	60.9	58.0	60.9	58.0	13.0	---	---	160.0	---	150.9	164.6	---	-20.1
Density (lb/ft^3)	0.076	0.073	0.079	0.071	0.073	0.073	0.076	0.073	0.076	0.073	0.076	---	---	0.051	---	0.051	0.058	---	62.622
	A - Reference conditions are 32.02 F & 0.089 PSIA																		

Exhibit 9-33 Case 5D Stream table (Continued)

	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
V-L Mole Fraction																			
Ar	0.0128	0.0000	0.0073	0.0000	0.0073	0.0091	0.0112	0.0112	0.0005	0.0008	0.0008	0.0000	0.0000	0.0114	0.0000	0.0000	0.0000	0.0000	0.0000
CO_2	0.0005	0.0017	0.2208	0.0000	0.2208	0.1462	0.0176	0.0174	0.5067	0.8365	0.8543	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	0.0062	0.9982	0.1376	0.0000	0.1377	0.0558	0.0000	0.0000	0.4512	0.0941	0.0748	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
N_2	0.7506	0.0001	0.6101	0.0000	0.6101	0.7589	0.9343	0.9345	0.0400	0.0660	0.0674	0.0000	0.0000	0.9509	0.0000	0.0000	0.0000	0.0000	0.0000
O_2	0.2300	0.0000	0.0241	0.0000	0.0241	0.0300	0.0369	0.0369	0.0016	0.0026	0.0027	0.0000	0.0000	0.0376	0.0000	0.0000	0.0000	0.0000	0.0000
SO_2	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	746	192	92,938	3	92,935	73,696	58,314	59,123	19,239	11,655	11,411	9,749	9,749	809	80,846	61,869	61,869	62,358	62,358
V-L Flowrate (kg/hr)	21,664	3,473	2,821,073	188	2,820,885	2,212,537	1,666,375	1,689,277	608,347	471,716	467,329	429,059	429,059	22,902	1,456,467	1,114,587	1,114,587	1,123,394	1,123,394
Solids Flowrate (kg/hr)	0	31,256	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Temperature (°C)	181	58	58	58	58	60	63	63	50	43	54	66	35	53	732	390	760	38	39
Pressure (MPa, abs)	0.31	0.11	0.11	0.11	0.11	0.11	0.10	0.10	0.02	0.10	1.24	1.24	15.26	1.24	34.47	4.90	4.69	0.01	1.69
Enthalpy (kJ/kg)[A]	191.58	---	263.63	34.60	263.65	144.06	63.96	63.80	698.61	119.36	49.88	47.00	-212.34	51.65	3,803.80	3,174.83	4,040.53	2,530.95	166.30
Density (kg/m^3)	2.4	---	1.3	2.7	1.3	1.2	1.0	1.0	0.2	1.6	20.8	20.3	794.2	13.0	81.3	17.3	10.0	0.0	993.2
V-L Molecular Weight	29.029	---	30.354	64.065	30.353	30.023	28.576	28.572	31.620	40.473	40.953	44.010	44.010	28.303	18.015	18.015	18.015	18.015	18.015
V-L Flowrate (lb_{mol}/hr)	1,645	424	204,892	6	204,886	162,471	128,561	130,345	42,415	25,695	25,158	21,493	21,493	1,784	178,235	136,398	136,398	137,476	137,476
V-L Flowrate (lb/hr)	47,760	7,656	6,219,401	414	6,218,986	4,877,809	3,673,728	3,724,219	1,341,176	1,039,956	1,030,285	945,912	945,914	50,491	3,210,960	2,457,243	2,457,243	2,476,661	2,476,661
Solids Flowrate (lb/hr)	0	68,907	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Temperature (°F)	357	136	136	136	136	139	145	145	122	110	130	151	95	127	1,350	734	1,400	101	103
Pressure (psia)	45.0	16.7	16.7	16.7	16.7	15.7	14.7	14.7	2.9	14.7	180.3	180.3	2,214.0	180.3	5,000.0	710.8	680.8	1.0	245.0
Enthalpy (Btu/lb)[A]	82.4	---	113.3	14.9	113.4	61.9	27.5	27.4	300.3	51.3	21.4	20.2	-91.3	22.2	1,635.3	1,364.9	1,737.1	1,088.1	71.5
Density (lb/ft^3)	0.149	---	0.079	0.169	0.079	0.073	0.065	0.065	0.015	0.100	1.300	1.268	49.583	0.812	5.073	1.078	0.621	0.003	62.005

Exhibit 9-34 Case 5D Performance summary

	Case 5D	Units
Plant Output		
Steam Turbine Power	681,900	kW_e
Total	**681,900**	kW_e
Auxiliary Load		
Coal Handling and Conveying	450	kW_e
Pulverizers	2,990	kW_e
Sorbent Handling & Reagent Preparation	970	kW_e
Ash Handling	570	kW_e
Primary Air Fans	1,190	kW_e
Air Blower Fans	3,020	kW_e
Induced Draft Fans	25,180	kW_e
SCR	50	kW_e
Vacuum Pump	25,590	kW_e
Baghouse	80	kW_e
Wet FGD	3,200	kW_e
CO_2 Compression	53,110	kW_e
Miscellaneous Balance of Plant[2,3]	2,000	kW_e
Steam Turbine Auxiliaries	400	kW_e
Condensate Pumps	710	kW_e
Circulating Water Pumps	6,220	kW_e
Ground Water Pumps	540	kW_e
Cooling Tower Fans	3,220	kW_e
Transformer Losses	2,400	kW_e
Total	**131,890**	**kW_e**
Plant Performance		
Net Auxiliary Load	131,890	kW_e
Net Plant Power	550,010	kW_e
Net Plant Efficiency (HHV)	36.5%	
Net Plant Heat Rate (HHV)	9,853 (9,339)	kJ/kWhr (Btu/kWhr)
Coal Feed Flowrate	199,714 (440,294)	kg/hr (lb/hr)
Thermal Input[1]	1,505,352	kW_{th}
Condenser Duty	2,663 (2,524)	GJ/hr (MMBtu/hr)
Raw Water Withdrawal	22.5 (5,938)	m^3/min (gpm)
Raw Water Consumption	17.0 (4,497)	m^3/min (gpm)

1 - HHV of Illinois No. 6 coal is 27,135 kJ/kg (11,666 Btu/lb)
2 – Boiler feed pumps are turbine driven
3 – Includes plant control systems, lighting, HVAC, and miscellaneous low voltage loads

Exhibit 9-35 Case 5D water balance

	Water Demand	Internal Recycle	Raw Water Withdrawal	Process Water Discharge	Raw Water Consumption
	m^3/min (gpm)				
FGD Makeup	2.87 (758)	0.0 (0)	2.87 (758)	0.00 (0)	2.87 (758)
BFW Makeup	0.00 (0)	0.0 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Cooling Tower	24.2 (6,406)	4.64 (1226)	19.6 (5,180)	5.45 (1,441)	14.16 (3,740)
CO2 Compression Knockout	0.0 (0)	2.35 (622)	0.0 (0)	0.00 (0)	0.00 (0)
FGD Dewatering	0.0 (0)	2.03 (536)	0.0 (0)	0.00 (0)	0.00 (0)
CO2 Capture Recovery	0.0 (0)	0.26 (68)	0.0 (0)	0.00 (0)	0.00 (0)
Total	**27.1 (7,163)**	**4.64 (1226)**	**22.5 (5,938)**	**5.45 (1,441)**	**17.02 (4,497)**

Exhibit 9-36 Case 5D carbon balance

Carbon In		Carbon Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	127,307 (280,664)	Stack Gas	12,326 (27,174)
Air (CO2)	282 (621)	FGD Product	217 (479)
FGD Reagent	2,052 (4,524)	CO2 Product	117,097 (258,156)
Total	**129,641 (285,809)**	**Total**	**129,641 (285,809)**

Exhibit 9-37 Case 5D sulfur balance

Sulfur In		Sulfur Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	5,006 (11,036)	FGD Product	4,908 (10,821)
		Stack Gas	3 (7)
		Econamine Polishing Scrubber/HSS	94 (207)
Total	**5,006 (11,036)**	**Total**	**5,006 (11,036)**

Exhibit 9-38 Case 5D energy balance

	HHV	Sensible + Latent	Power	Total
Heat In GJ/hr (MMBtu/hr)				
Coal	5,419 (5,136)	4.5 (4.3)	-	5,424 (5,141)
Air	-	65.7 (62.3)	-	65.7 (62.3)
Raw Water Makeup	-	84.6 (80.2)	-	84.6 (80.2)
Lime	-	0.23 (0.22)	-	0.23 (0.22)
Auxiliary Power	-	-	475 (450)	475 (450)
TOTAL	**5,419 (5,136)**	**155.1 (147.0)**	**475 (450)**	**6,049 (5,733)**
Heat Out GJ/hr (MMBtu/hr)				
Bottom Ash	-	0.5 (0.5)	-	0.5 (0.5)
Fly Ash + FGD Ash	-	1.9 (1.8)	-	1.9 (1.8)
Flue Gas	-	108 (102)	-	108 (102)
Condenser	-	2,663 (2,524)	-	2,663 (2,524)
CO2	-	-91 (-86)	-	-91 (-86)
Boiler Heat Loss	-	47 (45)	-	47 (45)
Vacuum Pump Cooling	-	448 (425)	-	448 (425)
CO2 Compression Cooling	-	43 (41)	-	43 (41)
Cooling Tower Blowdown	-	41 (38)	-	41 (38)
*Process Losses**	-	333 (316)	-	333 (316)
Power	-	-	2,455 (2,327)	2,455 (2,327)
TOTAL	-	**3,594 (3,407)**	**2,455 (2,327)**	**6,049 (5,733)**

* Process losses are estimated to match the heat input to the plant.

Exhibit 9-39 Case 5D air emissions

	kg/GJ (lb/MMBtu)	tonne/yr (Ton/year)	kg/MWgross (lb/MWgross)
SO_2	0.001 (0.003)	50 (55)	0.009 (.02)
NOx	0.030 (0.070)	1,286 (1,417)	0.239 (.527)
Particulate	0.006 (0.0130)	239 (263)	0.044 (.098)
Hg	4.91E-7 (1.14E-6)	0.021 (0.023)	3.90E-6 (8.61E-6)
CO_2	8.3 (19.4)	356,073 (392,503)	66 (146)

Exhibit 9-40 Case 5D capital costs

											Cost Base:	Jan 2007
											Prepared:	4-Jan-12
		Case:	5D									x $1, 000
		Plant Size:	550.01	MW, net		Capital Charge Factor		0.85				
Acct No.		Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	TOTAL PLANT COST $	TOTAL PLANT COST $/kW
1		COAL HANDLING SYSTEM										
	1.1	Coal Receive & Unload	3,522	0	1,609	0	5,131	459	0	838	6,428	12
	1.2	Coal Stackout & Reclaim	4,552	0	1,031	0	5,584	489	0	911	6,983	13
	1.3	Coal Conveyors & Yd Crus	4,232	0	1,021	0	5,253	460	0	857	6,570	12
	1.4	Other Coal Handling	1,107	0	236	0	1,343	117	0	219	1,680	3
	1.5	Sorbent Receive & Unload	143	0	48	0	192	17	0	31	240	0
	1.6	Sorbent Stackout & Reclaim	2,315	0	476	0	2,791	243	0	455	3,489	6
	1.7	Sorbent Conveyors	826	200	227	0	1,254	108	0	204	1,567	3
	1.8	Other Sorbent Handling	499	131	294	0	924	82	0	151	1,156	2
	1.9	Coal & Sorbent Hnd.Foundations	0	4,326	5,458	0	9,784	919	0	1,605	12,308	22
		SUBTOTAL 1.	**$17,198**	**$4,658**	**$10,400**	**$0**	**$32,256**	**$2,894**	**$0**	**$5,272**	**$40,422**	**$73**
2		COAL PREP & FEED SYSTEMS										
	2.1	Coal Crushing & Drying	2,023	0	394	0	2,418	211	0	394	3,023	5
	2.2	Prepared Coal Storage & Feed	5,181	0	1,131	0	6,311	552	0	1,029	7,892	14
	2.3	Slurry Prep & Feed	0	0	0	0	0	0	0	0	0	0
	2.4	Misc. Coal Prep & Feed	0	0	0	0	0	0	0	0	0	0
	2.5	Sorbent Prep Equipment	3,931	190	916	0	5,038	438	0	821	6,297	11
	2.6	Sorbent Storage & Feed	474	0	204	0	677	60	0	111	848	2
	2.7	Sorbent Injection System	0	0	0	0	0	0	0	0	0	0
	2.8	Booster Air Supply System	0	0	0	0	0	0	0	0	0	0
	2.9	Coal & Sorbent Feed Foundation	0	509	427	0	936	87	0	153	1,176	2
		SUBTOTAL 2.	**$11,609**	**$699**	**$3,072**	**$0**	**$15,380**	**$1,348**	**$0**	**$2,509**	**$19,237**	**$35**
3		FEEDWATER & MISC. BOP SYSTEMS										
	3.1	Feedwater System	16,784	0	5,421	0	22,205	1,940	0	3,622	27,767	50
	3.2	Water Makeup & Pretreating	4,809	0	1,548	0	6,356	601	0	1,391	8,349	15
	3.3	Other Feedwater Subsystems	5,138	0	2,171	0	7,310	655	0	1,195	9,159	17
	3.4	Service Water Systems	943	0	513	0	1,455	137	0	318	1,911	3
	3.5	Other Boiler Plant Systems	6,200	0	6,121	0	12,322	1,170	0	2,024	15,516	28
	3.6	FO Supply Sys & Nat Gas	259	0	324	0	583	55	0	96	734	1
	3.7	Waste Treatment Equipment	3,260	0	1,858	0	5,118	498	0	1,123	6,740	12
	3.8	Misc. Power Plant Equipment	2,752	0	841	0	3,592	345	0	788	4,725	9
		SUBTOTAL 3.	**$40,144**	**$0**	**$18,798**	**$0**	**$58,942**	**$5,402**	**$0**	**$10,557**	**$74,901**	**$136**

Exhibit 9-40 Case 5D capital costs (Continued)

Acct No.		Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	TOTAL PLANT COST $	TOTAL PLANT COST $/kW
4		PC BOILER & ACCESSORIES										
	4.1	PC Boiler & Accessories	143,493	0	80,514	0	224,007	21,801	24,581	24,581	294,969	536
	4.2	SCR (w/4.1)	0	0	0	0	0	0	0	0	0	0
	4.3	Open	0	0	0	0	0	0	0	0	0	0
	4.4	Boiler BoP (w/ ID Fans)	0	0	0	0	0	0	0	0	0	0
	4.5	Primary Air System	w/4.1	0	w/4.1	0	0	0	0	0	0	0
	4.6	Secondary Air System	w/4.1	0	w/4.1	0	0	0	0	0	0	0
	4.8	Major Component Rigging	0	w/4.1	w/4.1	0	0	0	0	0	0	0
	4.9	Boiler Foundations	0	w/14.1	w/14.1	0	0	0	0	0	0	0
		SUBTOTAL 4.	**$143,493**	**$0**	**$80,514**	**$0**	**$224,007**	**$21,801**	**$24,581**	**$24,581**	**$294,969**	**$536**
5A		FLUE GAS CLEANUP					*					
	5.1	Absorber Vessels & Accessories	84,202	0	18,127	0	102,329	9,756	0	11,208	123,293	224
	5.2	Other FGD	4,394	0	4,979	0	9,373	910	0	1,028	11,312	21
	5.3	Bag House & Accessories	19,580	0	12,426	0	32,006	3,084	0	3,509	38,599	70
	5.4	Other Particulate Removal Materials	1,326	0	1,418	0	2,744	266	0	301	3,311	6
	5.5	Gypsum Dewatering System	4,814	0	818	0	5,632	536	0	617	6,784	12
	5.6	Mercury Removal System	0	0	0	0	0	0	0	0	0	0
	5.7	Open	0	0	0	0	0	0	0	0	0	0
		SUBTOTAL 5A.	**$114,315**	**$0**	**$37,768**	**$0**	**$152,083**	**$14,552**	**$0**	**$16,664**	**$183,299**	**$333**
5B		CO2 REMOVAL & COMPRESSION										
	5B.1	CO2 Removal System	39,488	0	105,994	0	145,483	13,909	29,097	37,698	226,186	411
	5B.2	CO2 Compression	15,152	0	4,753	0	19,905	1,990	0	4,379	26,274	48
	5B.3	CO2 Intercooling	1,938	0	162	0	2,099	210	0	346	2,656	5
	5B.4	CO2 Compression Aftercooler	2,210	0	185	0	2,394	239	0	395	3,029	6
	5B.5	CO2 Drying	2,906	0	912	0	3,818	365	0	837	5,020	9
		SUBTOTAL 5B.	**$61,694**	**$0**	**$112,006**	**$0**	**$173,699**	**$16,714**	**$29,097**	**$43,655**	**$263,165**	**$478**
6		COMBUSTION TURBINE/ACCESSORIES										
	6.1	Combustion Turbine Generator	0	0	0	0	0	0	0	0	0	0
	6.2	Combustion Turbine Accessories	0	0	0	0	0	0	0	0	0	0
	6.3	Compressed Air Piping	0	0	0	0	0	0	0	0	0	0
	6.4	Combustion Turbine Foundations	0	0	0	0	0	0	0	0	0	0
		SUBTOTAL 6.	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
7		HRSG, DUCTING & STACK										
	7.1	Flue Gas Recycle Heat Exhchanger	N/A	0	N/A	0	0	0	0	0	0	0
	7.2	SCR System	0	0	0	0	0	0	0	0	0	0
	7.3	Ductwork	8,629	0	5,544	0	14,174	1,236	0	2,311	17,721	32
	7.4	Stack	8,239	0	4,821	0	13,060	1,257	0	1,432	15,750	29
	7.9	HRSG, Duct & Stack Foundations	0	945	1,074	0	2,019	189	0	442	2,649	5
		SUBTOTAL 7.	**$16,869**	**$945**	**$11,439**	**$0**	**$29,253**	**$2,682**	**$0**	**$4,185**	**$36,120**	**$66**

Exhibit 9-40 Case 5D capital costs (Continued)

Acct No.		Item/Description	Equipment Cost	Material Cost	Labor		Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	TOTAL PLANT COST	
					Direct	Indirect					$	$/kW
8		STEAM TURBINE GENERATOR										
	8.1	Steam TG & Accessories	57,912	0	7,537	0	65,449	6,272	10,758	7,172	89,651	163
	8.2	Turbine Plant Auxiliaries	390	0	835	0	1,225	120	0	135	1,480	3
	8.3	Condenser & Auxiliaries	7,336	0	2,704	0	10,040	962	0	1,100	12,102	22
	8.4	Steam Piping	15,641	0	7,712	0	23,354	1,962	0	3,797	29,113	53
	8.9	TG Foundations	0	1,223	1,932	0	3,155	298	0	691	4,145	8
		SUBTOTAL 8.	**$81,279**	**$1,223**	**$20,721**	**$0**	**$103,223**	**$9,614**	**$10,758**	**$12,895**	**$136,491**	**$248**
9		COOLING WATER SYSTEM										
	9.1	Cooling Towers	11,002	0	3,426	0	14,429	1,380	0	1,581	17,389	32
	9.2	Circulating Water Pumps	2,122	0	163	0	2,285	193	0	248	2,726	5
	9.3	Circ. Water System Auxiliaries	575	0	77	0	651	62	0	71	785	1
	9.4	Circ. Water Piping	0	4,556	4,416	0	8,972	840	0	1,472	11,284	21
	9.5	Make-up Water System	467	0	624	0	1,091	105	0	179	1,375	2
	9.6	Component Cooling Water System	455	0	362	0	817	78	0	134	1,029	2
	9.9	Circ. Water System Foundations	0	2,766	4,394	0	7,159	677	0	1,567	9,404	17
		SUBTOTAL 9.	**$14,622**	**$7,322**	**$13,462**	**$0**	**$35,405**	**$3,334**	**$0**	**$5,253**	**$43,992**	**$80**
10		ASH/SPENT SORBENT HANDLING SYS										
	10.1	Ash Coolers	N/A	0	N/A	0	0	0	0	0	0	0
	10.2	Cyclone Ash Letdown	N/A	0	N/A	0	0	0	0	0	0	0
	10.3	HGCU Ash Letdown	N/A	0	N/A	0	0	0	0	0	0	0
	10.4	High Temperature Ash Piping	N/A	0	N/A	0	0	0	0	0	0	0
	10.5	Other Ash Recovery Equipment	N/A	0	N/A	0	0	0	0	0	0	0
	10.6	Ash Storage Silos	613	0	1,889	0	2,503	246	0	275	3,023	5
	10.7	Ash Transport & Feed Equipment	3,970	0	4,066	0	8,036	768	0	880	9,685	18
	10.8	Misc. Ash Handling Equipment	0	0	0	0	0	0	0	0	0	0
	10.9	Ash/Spent Sorbent Foundation	0	146	172	0	317	30	0	69	416	1
		SUBTOTAL 10.	**$4,583**	**$146**	**$6,127**	**$0**	**$10,856**	**$1,044**	**$0**	**$1,225**	**$13,125**	**$24**
11		ACCESSORY ELECTRIC PLANT										
	11.1	Generator Equipment	1,754	0	285	0	2,039	189	0	167	2,395	4
	11.2	Station Service Equipment	5,303	0	1,742	0	7,045	659	0	578	8,282	15
	11.3	Switchgear & Motor Control	6,097	0	1,036	0	7,133	661	0	779	8,573	16
	11.4	Conduit & Cable Tray	0	3,822	13,216	0	17,039	1,650	0	2,803	21,491	39
	11.5	Wire & Cable	0	7,212	13,923	0	21,136	1,781	0	3,437	26,354	48
	11.6	Protective Equipment	261	0	888	0	1,149	112	0	126	1,388	3
	11.7	Standby Equipment	1,377	0	31	0	1,409	129	0	154	1,692	3
	11.8	Main Power Transformers	11,342	0	191	0	11,533	874	0	1,241	13,648	25
	11.9	Electrical Foundations	0	348	853	0	1,201	115	0	263	1,579	3
		SUBTOTAL 11.	**$26,133**	**$11,383**	**$32,167**	**$0**	**$69,683**	**$6,170**	**$0**	**$9,549**	**$85,401**	**$155**

Exhibit 9-40 Case 5D capital costs (Continued)

Acct No.		Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	TOTAL PLANT COST $	TOTAL PLANT COST $/kW
12		INSTRUMENTATION & CONTROL										
	12.1	PC Control Equipment	w/12.7	0	w/12.7	0	0	0	0	0	0	0
	12.2	Combustion Turbine Control	N/A	0	N/A	0	0	0	0	0	0	0
	12.3	Steam Turbine Control	w/8.1	0	w/8.1	0	0	0	0	0	0	0
	12.4	Other Major Component Control	0	0	0	0	0	0	0	0	0	0
	12.5	Signal Processing Equipment	W/12.7	0	w/12.7	0	0	0	0	0	0	0
	12.6	Control Boards, Panels & Racks	526	0	315	0	841	79	42	144	1,107	2
	12.7	Computer Accessories	5,312	0	928	0	6,240	579	312	713	7,844	14
	12.8	Instrument Wiring & Tubing	2,880	0	5,712	0	8,592	732	430	1,463	11,217	20
	12.9	Other I & C Equipment	1,501	0	3,406	0	4,907	476	246	563	6,192	11
		SUBTOTAL 12.	**$10,219**	**$0**	**$10,362**	**$0**	**$20,581**	**$1,866**	**$1,029**	**$2,883**	**$26,360**	**$48**
13		IMPROVEMENTS TO SITE										
	13.1	Site Preparation	0	53	1,060	0	1,113	110	0	244	1,468	3
	13.2	Site Improvements	0	1,759	2,185	0	3,944	389	0	866	5,199	9
	13.3	Site Facilities	3,153	0	3,109	0	6,262	617	0	1,374	8,253	15
		SUBTOTAL 13.	**$3,153**	**$1,812**	**$6,354**	**$0**	**$11,319**	**$1,117**	**$0**	**$2,485**	**$14,920**	**$27**
14		BUILDINGS & STRUCTURES										
	14.1	Boiler Building	0	8,737	7,683	0	16,420	1,476	0	2,684	20,580	37
	14.2	Turbine Building	0	12,546	11,693	0	24,238	2,185	0	3,962	30,385	55
	14.3	Administration Building	0	627	663	0	1,290	117	0	211	1,617	3
	14.4	Circulation Water Pumphouse	0	131	104	0	236	21	0	38	295	1
	14.5	Water Treatment Buildings	0	626	571	0	1,197	108	0	194	1,499	3
	14.6	Machine Shop	0	419	282	0	701	62	0	114	877	2
	14.7	Warehouse	0	284	285	0	569	51	0	93	714	1
	14.8	Other Buildings & Structures	0	232	198	0	430	39	0	70	539	1
	14.9	Waste Treating Building & Str.	0	440	1,334	0	1,774	168	0	291	2,233	4
		SUBTOTAL 14.	**$0**	**$24,042**	**$22,812**	**$0**	**$46,854**	**$4,227**	**$0**	**$7,658**	**$58,739**	**$107**
		Total Cost	**$545,309**	**$52,230**	**$386,002**	**$0**	**$983,542**	**$92,764**	**$65,465**	**$149,369**	**$1,291,141**	**$2,347**

Exhibit 9-40 Case 5D capital costs (Continued)

Acct No.	Item/Description	Equipment Cost	Material Cost	Labor		Bare Erected	Eng'g CM	Process Cont.	Project Cont.	TOTAL PLANT COST	
				Direct	Indirect		Total	Total	Total	$	$/kW
	Owner's Costs									**$1,000**	**$/kW**
	Preproduction Costs										
	6 Months All Labor									9,261	17
	1 Month Maintenance Materials									1,231	2
	1 Month Non-fuel Consumables									1,426	3
	1 Month Waste Disposal									249	0
	25% of 1 Months Fuel Cost at 100% CF									1,534	3
	2% of TPC									25,823	47
	Total									**39,524**	**72**
	Inventory Capital										
	60 day supply of fuel and consumables at 100% CF									14,845	27
	0.5% of TPC (spare parts)									6,456	12
	Total									**21,300**	**39**
	Initial Cost for Catalyst and Chemicals									12,383	23
	Land									900	2
	Other Owner's Costs									193,671	352
	Financing Costs									34,861	63
	Total Overnight Costs (TOC)									**1,593,780**	**2,898**
	TASC Multiplier							(IOU, high-risk, 35 year)		1.14	
	Total As-Spent Cost (TASC)									**1,816,909**	**3,303**

Exhibit 9-41 Case 5D operation and maintenance costs

5D					Cost Base (Jun):	2007
					Heat Rate-net (Btu/kWh):	9,339
					MWe-net:	550
					Capacity Factor (%):	**85**
OPERATING & MAINTENANCE LABOR						
Operating Labor						
Operating Labor Rate(base):	34.65	$/hour				
Operating Labor Burden:	30.00	% of base				
Labor O-H Charge Rate:	25.00	% of labor				
Operating Labor Requirements(O.J.)per S	1 unit/mod.		Total Plant			
Skilled Operator	2.0		2.0			
Operator	11.3		11.3			
Foreman	1.0		1.0			
Lab Tech's, etc.	2.0		2.0			
TOTAL-O.J.'s	16.3		16.3			
					Annual Cost	Annual Unit Cost
					$	$/kW-net
Annual Operating Labor Cost					$6,444,907	$11.718
Maintenance Labor Cost					$8,372,337	$15.222
Administrative & Support Labor					$3,704,311	$6.735
Property Taxes and Insurance					$25,822,813	$46.950
TOTAL FIXED OPERATING COSTS					**$44,344,369**	$80.625
VARIABLE OPERATING COSTS						
						$/kWh-net
Maintenance Material Cost					**$12,558,506**	**$0.00307**
Consumables	Consumption Initial Fill	/Day	Unit Cost	Initial Fill Cost		
Water(/1000 gallons)	0	4,275	1.08	**$0**	**$1,434,767**	**$0.00035**
Chemicals		4.841				
MU & WT Chem. (lbs)	0	20,695	0.17	$0	$1,111,231	$0.00027
Limestone (ton)	0	535	21.63	$0	$3,590,624	$0.00088
Carbon (Mercury Removal) (lb)	0	0	1.05	$0	$0	$0.00000
MTR Membrane Replacement	1,500,000	967	15.00	$22,500,000	$4,500,000	$0.00110
NaOH (tons)	0	0	433.68	$0	$0	$0.00000
H2SO4 (tons)	0	0	138.78	$0	$0	$0.00000
Corrosion Inhibitor	0	0	0.00	$0	$0	$0.00000
Activated Carbon (lb)	0	0	1.05	$0	$0	$0.00000
Ammonia (19% NH3) (ton)	0	79	129.80	$0	$3,181,392	$0.00078
Subtotal Chemicals				**$22,500,000**	**$12,383,246**	**$0.00302**
Other						
Supplemental Fuel (MBtu)	0	0	0.00	$0	$0	$0.00000
SCR Catalyst (m3)	w/equip.	0.41	5,775.94	$0	$731,523	$0.00018
Emission Penalties	0	0	0.00	$0	$0	$0.00000
Subtotal Other				**$0**	**$731,523**	**$0.00018**
Waste Disposal						
Fly Ash (ton)	0	408	16.23	$0	2,053,809.91	0.00050
Bottom Ash (ton)	0	96	16.23	$0	483,249.39	0.00012
Subtotal Waste Disposal				**$0**	**$2,537,059**	**$0.00062**
By-products & Emissions						
Gypsum (tons)	0	145	0.00	$0	$0	$0.00000
Subtotal By-products				**$0**	**$0**	**$0.00000**
TOTAL VARIABLE OPERATING COSTS				**$22,500,000**	**$29,645,101**	**$0.00724**
Fuel (ton)	0	5,284	38.18	**$0**	**$62,592,588**	**$0.01528**

Exhibit 9-42 Cost of electricity breakdown for Case 5D

TOC, $/kW	**2,898**
COE w/o TS&M, $/MW	**81.7**
Capital, $/MW	48.4
Fixed, $/MW	10.8
Variable, $/MW	7.2
Fuel, $/MW	15.3

9.5 Case 5E

Case 5E is identical to Case 5D in all process, performance, and costing measures. The sole difference between the cases is that Case 5D is a high-risk case and Case 5E is a low-risk case. This difference shows up in Exhibit 9-43 as a lower TASC cost ($3,286/kW in Case 5E versus $3,303/kW in Case 5D) and in Exhibit 9-44 as a lower COE ($78.7/MW in Case 5E versus $81.7/MW in Case 5D).

Exhibit 9-43 Case 5E capital costs

Acct No.	Item/Description	Equipment Cost	Material Cost	Labor		Bare Erected	Eng'g CM	Process Cont.	Project Cont.	TOTAL PLANT COST	
				Direct	Indirect		Total	Total	Total	$	$/kW
	Owner's Costs									**$1,000**	**$/kW**
	Preproduction Costs										
	6 Months All Labor									9,261	17
	1 Month Maintenance Materials									1,231	2
	1 Month Non-fuel Consumables									1,426	3
	1 Month Waste Disposal									249	0
	25% of 1 Months Fuel Cost at 100% CF									1,534	3
	2% of TPC									25,823	47
	Total									**39,524**	**72**
	Inventory Capital										
	60 day supply of fuel and consumables at 100% CF									14,845	27
	0.5% of TPC (spare parts)									6,456	12
	Total									**21,300**	**39**
	Initial Cost for Catalyst and Chemicals									12,383	23
	Land									900	2
	Other Owner's Costs									193,671	352
	Financing Costs									34,861	63
	Total Overnight Costs (TOC)									**1,593,780**	**2,898**
	TASC Multiplier							(IOU, low-risk, 35 year)		1.134	
	Total As-Spent Cost (TASC)									**1,807,347**	**3,286**

Exhibit 9-44 Cost of electricity breakdown for Case 5E

TOC, $/kW	**2,898**
COE w/o TS&M, $/MW	**78.7**
Capital, $/MW	45.4
Fixed, $/MW	10.8
Variable, $/MW	7.2
Fuel, $/MW	15.3

10 TDA Capture Technology (Cases 6A-6E)

Results for a plant with a representation of the TDA capture technology as discussed in section 4.1.4 are presented. As shown in Exhibit 10-1, Case 6A is with supercritical steam cycle, Case 6B is with ultra supercritical steam cycle, and Case 6C is with advanced ultra supercritical steam cycle. Cases 6D and 6E include a representation of an advanced CO_2 shockwave compression technology and advanced ultra supercritical steam cycle at high and low-risk, respectively.

Exhibit 10-1 TDA case matrix

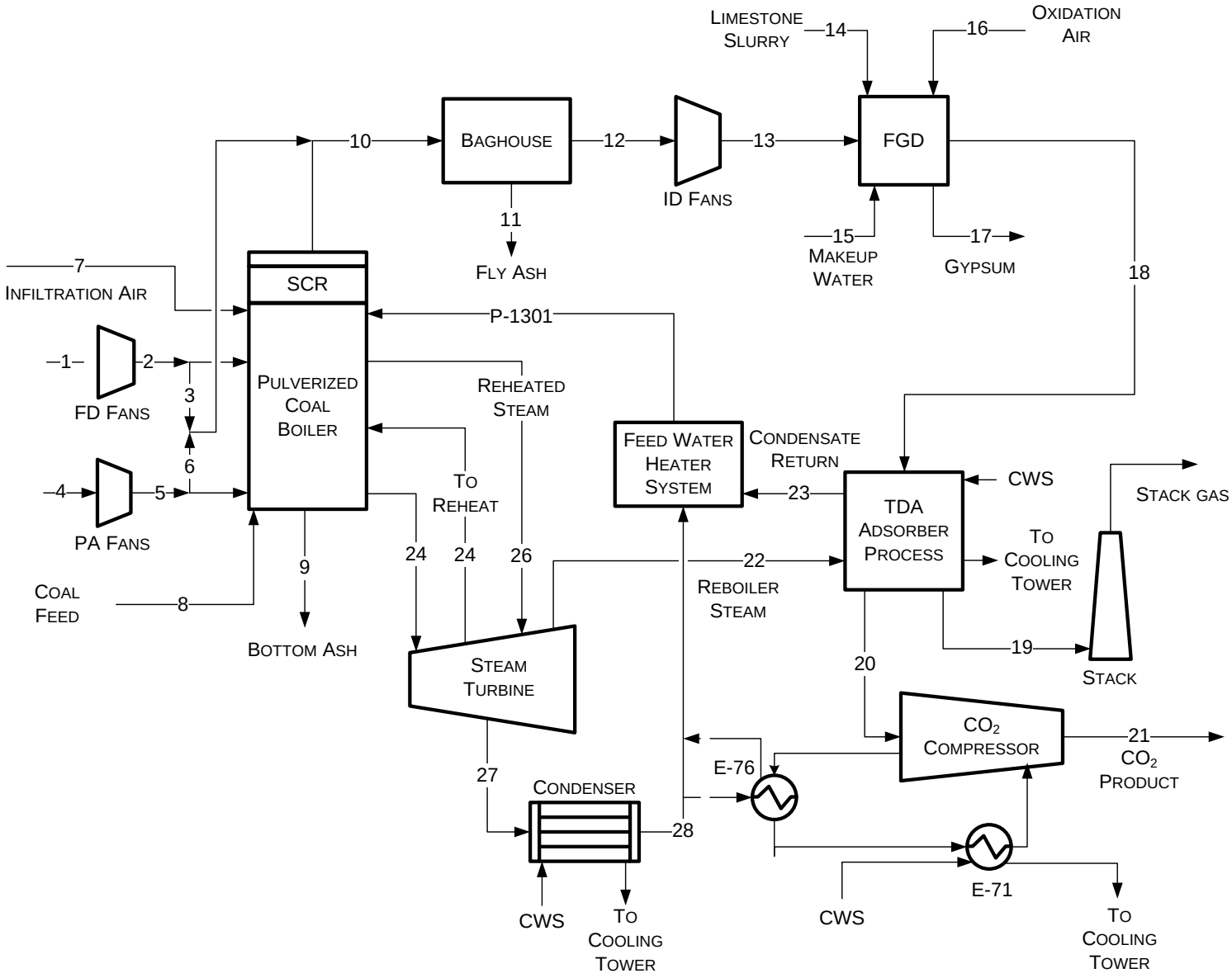
Case	Carbon Removal Technology	Boiler Technology psig/°F/°F	CO_2 Compression Technology	Plant Capacity Factor (%)	Financial Risk Assumption
6A	(TDA) Advanced CO_2 adsorber	Supercritical 3500/1100/1100	Conventional	85	High-risk
6B	(TDA) Advanced CO_2 adsorber	Ultra-supercritical 5000/1200/1200	Conventional	85	High-risk
6C	(TDA) Advanced CO_2 adsorber	AUSC 5000/1350/1400	Conventional	85	High-risk
6D	(TDA) Advanced CO_2 adsorber	AUSC 5000/1350/1400	Enhanced Shockwave Compression	85	High-risk
6E	(TDA) Advanced CO_2 adsorber	AUSC 5000/1350/1400	Enhanced Shockwave Compression	85	Low-risk

The following are the key points of the TDA adsorber technology:

- The steam turbine extraction rate is comparable to that of the CO_2 absorber technologies, but the extraction steam condition is low-grade (16 psia and 110°C)
- Utilizes an inorganic pelletized adsorbent to capture CO_2 from flue gas
- TDA adsorber is placed downstream of the FGD unit
- Flue gas is heated to adsorber operating temperature by a gas-to-gas heat exchanger followed by additional extraction steam preheating
- Adsorbent contacts the flue gas at low temperature (between 110 to 130°C)
- CO_2 and SO_2 are adsorbed on the pellet surfaces
- Adsorbent is regenerated by contact with low-pressure steam, under isothermal conditions
- Consumes 2.5 to 3.5 moles of steam per mole of CO_2 captured
- The raw CO_2 product requires purification to satisfy the CO_2 product specification

Exhibit 10-2 provides the block flow diagram for Cases 6A through 6E.

Exhibit 10-2 Cases 6A-6E block flow diagram



10.1 Case 6A

Exhibit 10-3 Case 6A Stream table

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
V-L Mole Fraction														
Ar	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092	0.0000	0.0000	0.0087	0.0000	0.0087	0.0087	0.0000
CO_2	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0000	0.0000	0.1450	0.0000	0.1450	0.1450	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	0.0099	0.0099	0.0099	0.0099	0.0099	0.0099	0.0099	0.0000	0.0000	0.0870	0.0000	0.0870	0.0870	1.0000
N_2	0.7732	0.7732	0.7732	0.7732	0.7732	0.7732	0.7732	0.0000	0.0000	0.7324	0.0000	0.7324	0.7324	0.0000
O_2	0.2074	0.2074	0.2074	0.2074	0.2074	0.2074	0.2074	0.0000	0.0000	0.0247	0.0000	0.0247	0.0247	0.0000
SO_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0021	0.0000	0.0021	0.0021	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000	0.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	59,805	59,805	1,779	18,372	18,372	2,520	1,382	0	0	84,157	0	84,157	84,157	2,967
V-L Flowrate (kg/hr)	1,725,801	1,725,801	51,351	530,148	530,148	72,726	39,887	0	0	2,503,085	0	2,503,085	2,503,085	53,449
Solids Flowrate (kg/hr)	0	0	0	0	0	0	0	229,504	4,451	17,804	17,804	0	0	23,371
Temperature (°C)	15	19	19	15	25	25	15	15	15	169	15	169	189	15
Pressure (MPa, abs)	0.10	0.11	0.11	0.10	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.11	0.10
Enthalpy (kJ/kg)[A]	30.23	34.36	34.36	30.23	40.78	40.78	30.23	---	---	327.39	---	308.96	329.44	---
Density (kg/m^3)	1.2	1.2	1.2	1.2	1.3	1.3	1.2	---	---	0.8	---	0.8	0.9	---
V-L Molecular Weight	28.857	28.857	28.857	28.857	28.857	28.857	28.857	---	---	29.743	---	29.743	29.743	---
V-L Flowrate (lb_{mol}/hr)	131,848	131,848	3,923	40,502	40,502	5,556	3,047	0	0	185,534	0	185,534	185,534	6,541
V-L Flowrate (lb/hr)	3,804,739	3,804,739	113,209	1,168,776	1,168,776	160,334	87,936	0	0	5,518,358	0	5,518,358	5,518,358	117,836
Solids Flowrate (lb/hr)	0	0	0	0	0	0	0	505,969	9,813	39,250	39,250	0	0	51,524
Temperature (°F)	59	66	66	59	78	78	59	59	59	337	59	337	371	59
Pressure (psia)	14.7	15.3	15.3	14.7	16.1	16.1	14.7	14.7	14.7	14.4	14.7	14.2	16.0	15.0
Enthalpy (Btu/lb)[A]	13.0	14.8	14.8	13.0	17.5	17.5	13.0	---	---	140.8	---	132.8	141.6	---
Density (lb/ft^3)	0.076	0.078	0.078	0.076	0.081	0.081	0.076	---	---	0.050	---	0.049	0.053	---
	A - Reference conditions are 32.02 F & 0.089 PSIA													

Exhibit 10-3 Case 6A Stream table (Continued)

	15	16	17	18	19	20	21	22	23	24	25	26	27	28
V-L Mole Fraction														
Ar	0.0000	0.0128	0.0000	0.0083	0.0074	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CO_2	0.0000	0.0005	0.0001	0.1377	0.0124	0.4999	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	1.0000	0.0062	0.9998	0.1369	0.3444	0.4715	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
N_2	0.0000	0.7506	0.0000	0.6927	0.6143	0.0277	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
O_2	0.0000	0.2300	0.0000	0.0243	0.0216	0.0010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SO_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	10,370	864	221	89,915	101,400	22,703	11,121	32,127	32,127	113,159	92,258	92,258	48,816	48,816
V-L Flowrate (kg/hr)	186,816	25,084	3,977	2,611,585	2,529,236	710,601	489,448	578,782	578,782	2,038,590	1,662,060	1,662,060	879,438	879,438
Solids Flowrate (kg/hr)	0	0	36,044	0	0	0	0	0	0	0	0	0	0	0
Temperature (°C)	15	181	56	56	110	144	43	291	98	593	354	593	38	40
Pressure (MPa, abs)	0.10	0.31	0.11	0.11	0.10	0.11	15.27	0.51	0.92	24.23	4.90	4.52	0.01	1.69
Enthalpy (kJ/kg)[A]	-46.80	191.58	---	271.68	757.58	845.57	-188.56	3,045.10	409.55	3,476.62	3,082.18	3,652.22	2,113.05	166.76
Density (kg/m^3)	1,003.1	2.4	---	1.1	0.8	1.0	723.6	2.0	960.1	69.2	18.7	11.6	0.1	993.2
V-L Molecular Weight	18.015	29.029	---	29.045	24.943	31.300	44.010	18.015	18.015	18.015	18.015	18.015	18.015	18.015
V-L Flowrate (lb_{mol}/hr)	22,862	1,905	487	198,229	223,549	50,052	24,518	70,829	70,829	249,473	203,395	203,395	107,621	107,621
V-L Flowrate (lb/hr)	411,858	55,301	8,768	5,757,560	5,576,012	1,566,607	1,079,048	1,275,996	1,275,996	4,494,322	3,664,216	3,664,216	1,938,829	1,938,829
Solids Flowrate (lb/hr)	0	0	79,463	0	0	0	0	0	0	0	0	0	0	0
Temperature (°F)	59	357	133	133	230	291	110	556	208	1,100	669	1,100	101	103
Pressure (psia)	14.7	45.0	15.7	15.7	14.8	15.6	2,214.5	73.5	133.6	3,514.7	710.8	655.8	1.0	245.0
Enthalpy (Btu/lb)[A]	-20.1	82.4	---	116.8	325.7	363.5	-81.1	1,309.2	176.1	1,494.7	1,325.1	1,570.2	908.4	71.7
Density (lb/ft^3)	62.622	0.149	---	0.072	0.050	0.061	45.175	0.123	59.940	4.319	1.165	0.722	0.004	62.002

Exhibit 10-4 Case 6A Performance summary

	Case 6A	Units
Plant Output		
Steam Turbine Power	650,900	kW_e
Total	**650,900**	kW_e
Auxiliary Load		
Coal Handling and Conveying	480	kW_e
Pulverizers	3,440	kW_e
Sorbent Handling & Reagent Preparation	1,130	kW_e
Ash Handling	660	kW_e
Primary Air Fans	1,610	kW_e
Forced Draft Fans	2,060	kW_e
Induced Draft Fans	14,680	kW_e
SCR	60	kW_e
Baghouse	90	kW_e
Wet FGD	3,670	kW_e
TDA CO2 removal Auxiliaries	12,000	kW_e
CO_2 Compression	50,060	kW_e
Miscellaneous Balance of Plant[2,3]	2,000	kW_e
Steam Turbine Auxiliaries	400	kW_e
Condensate Pumps	560	kW_e
Circulating Water Pumps	7,070	kW_e
Ground Water Pumps	700	kW_e
Cooling Tower Fans	3,660	kW_e
Transformer Losses	2,240	kW_e
Total	**106,570**	**kW_e**
Plant Performance		
Net Auxiliary Load	106,570	kW_e
Net Plant Power	544,330	kW_e
Net Plant Efficiency (HHV)	31.5%	
Net Plant Heat Rate (HHV)	11,441 (10,844)	kJ/kWhr (Btu/kWhr)
Coal Feed Flowrate	229,504 (505,969)	kg/hr (lb/hr)
Thermal Input[1]	1,729,892	kW_{th}
Condenser Duty	1,717 (1,627)	GJ/hr (MMBtu/hr)
Raw Water Withdrawal	29.1 (7,696)	m^3/min (gpm)
Raw Water Consumption	22.9 (6,059)	m^3/min (gpm)

1 - HHV of Illinois No. 6 coal is 27,135 kJ/kg (11,666 Btu/lb)
2 – Boiler feed pumps are turbine driven
3 – Includes plant control systems, lighting, HVAC, and miscellaneous low voltage loads

Exhibit 10-5 Case 6A water balance

	Water Demand	Internal Recycle	Raw Water Withdrawal	Process Water Discharge	Raw Water Consumption
	m^3/min (gpm)				
Econamine	-	-	-	-	-
FGD Makeup	4.01 (1059)	-	4.01 (1059)	-	4.01 (1,059)
BFW Makeup	-	-	-	-	-
Cooling Tower	27.5 (7,276)	2.42 (640)	25.1 (6,636)	6.19 (1,636)	18.93 (5,000)
Total	**31.6 (8,335)**	**2.42 (640)**	**29.1 (7,696)**	**6.19 (1,636)**	**22.94 (6,059)**

Exhibit 10-6 Case 6A carbon balance

Carbon In		Carbon Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	146,297 (322,529)	Stack Gas	15,145 (33,389)
Air (CO2)	317 (700)	FGD Product	260 (573)
FGD Reagent	2,371 (5,228)	CO2 Product	133,578 (294,490)
	-	Convergence Tolerance	2 (4)
Total	**148,985 (328,457)**	**Total**	**148,985 (328,457)**

Exhibit 10-7 Case 6A sulfur balance

Sulfur In		Sulfur Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	5,752 (12,682)	FGD Product	5,637 (12,428)
		Stack Gas	4 (8)
		Econamine Polishing Scrubber/HSS	111 (245)
Total	**5,752 (12,682)**	**Total**	**5,752 (12,682)**

Exhibit 10-8 Case 6A energy balance

	HHV	Sensible + Latent	Power	Total
Heat In GJ/hr (MMBtu/hr)				
Coal	6,228 (5,903)	5.2 (4.9)	-	6,233 (5,908)
Air	-	69.4 (65.8)	-	69.4 (65.8)
Raw Water Makeup	-	109.6 (103.9)	-	109.6 (103.9)
Lime	-	0.26 (0.25)	-	0.26 (0.25)
Auxiliary Power	-	-	384 (364)	384 (364)
TOTAL	**6,228 (5,903)**	**184.5 (174.8)**	**384 (364)**	**6,796 (6,441)**
Heat Out GJ/hr (MMBtu/hr)				
Bottom Ash	-	0.5 (0.5)	-	0.5 (0.5)
Fly Ash + FGD Ash	-	2.2 (2.0)	-	2.2 (2.0)
Flue Gas	-	1,916 (1,816)	-	1,916 (1,816)
Condenser	-	1,717 (1,627)	-	1,717 (1,627)
CO2	-	-92 (-87)	-	-92 (-87)
Cooling Tower Blowdown	-	46.0 (43.6)	-	46.0 (43.6)
Econamine Losses	-	1,774 (1,682)	-	1,774 (1,682)
*Process Losses**	-	*-911.2 (-863.7)*	-	*-911.2 (-863.7)*
Power	-	-	2,343 (2,221)	2,343 (2,221)
TOTAL	**-**	**4,452 (4,220)**	**2,343 (2,221)**	**6,796 (6,441)**

* Process losses are estimated to match the heat input to the plant.

Exhibit 10-9 Case 6A air emissions

	kg/GJ (lb/MMBtu)	tonne/yr (Ton/year)	kg/MWgross (lb/MWgross)
SO_2	0.001 (0.003)	59 (65)	0.011 (.03)
NOx	0.030 (0.070)	1,478 (1,629)	0.288 (.635)
Particulate	0.006 (0.0130)	274 (302)	0.053 (.118)
Hg	4.91E-7 (1.14E-6)	0.024 (0.027)	4.70E-6 (1.04E-5)
CO_2	8.9 (20.7)	437,512 (482,274)	85 (188)

Exhibit 10-10 Case 6A capital costs

											Cost Base:	Jan 2007	
											Prepared:	13-Mar-12	
			Case:	6A								x $1, 000	
			Plant Size:	544.33	MW, net			Capital Charge Factor		0.9			
				Equipment		Labor		Bare	Eng'g CM	Process Cont.	Project Cont.	TOTAL PLANT COST	
Acct No.			Item/Description	Cost	Material Cost	Direct	Indirect	Erected	Total	Total	Total	$	$/kW
1			COAL HANDLING SYSTEM										
	1.1		Coal Receive & Unload	3,839	0	1,754	0	5,593	500	0	914	7,007	13
	1.2		Coal Stackout & Reclaim	4,962	0	1,124	0	6,086	532	0	993	7,612	14
	1.3		Coal Conveyors & Yd Crus	4,613	0	1,112	0	5,726	502	0	934	7,162	13
	1.4		Other Coal Handling	1,207	0	257	0	1,464	128	0	239	1,831	3
	1.5		Sorbent Receive & Unload	157	0	47	0	204	18	0	33	255	0
	1.6		Sorbent Stackout & Reclaim	2,532	0	464	0	2,996	261	0	489	3,746	7
	1.7		Sorbent Conveyors	904	195	222	0	1,321	114	0	215	1,650	3
	1.8		Other Sorbent Handling	546	128	286	0	960	85	0	157	1,202	2
	1.9		Coal & Sorbent Hnd.Foundations	0	4,717	5,951	0	10,668	1,002	0	1,751	13,421	25
			SUBTOTAL 1.	**$18,760**	**$5,041**	**$11,218**	**$0**	**$35,019**	**$3,142**	**$0**	**$5,724**	**$43,885**	**$81**
2			COAL PREP & FEED SYSTEMS										
	2.1		Coal Crushing & Drying	2,218	0	432	0	2,650	231	0	432	3,313	6
	2.2		Prepared Coal Storage & Feed	5,678	0	1,239	0	6,918	605	0	1,128	8,651	16
	2.3		Slurry Prep & Feed	0	0	0	0	0	0	0	0	0	0
	2.4		Misc. Coal Prep & Feed	0	0	0	0	0	0	0	0	0	0
	2.5		Sorbent Prep Equipment	4,311	186	895	0	5,392	469	0	879	6,741	12
	2.6		Sorbent Storage & Feed	519	0	199	0	718	64	0	117	900	2
	2.7		Sorbent Injection System	0	0	0	0	0	0	0	0	0	0
	2.8		Booster Air Supply System	0	0	0	0	0	0	0	0	0	0
	2.9		Coal & Sorbent Feed Foundation	556	467	0	1,023	2,046	190	0	335	2,571	5
			SUBTOTAL 2.	**$13,283**	**$653**	**$2,766**	**$1,023**	**$17,725**	**$1,558**	**$0**	**$2,892**	**$22,176**	**$41**
3			FEEDWATER & MISC. BOP SYSTEMS										
	3.1		Feedwater System	21,166	0	6,837	0	28,004	2,447	0	4,568	35,018	64
	3.2		Water Makeup & Pretreating	5,780	0	1,861	0	7,641	723	0	1,673	10,036	18
	3.3		Other Feedwater Subsystems	6,480	0	2,739	0	9,219	826	0	1,507	11,551	21
	3.4		Service Water Systems	1,133	0	617	0	1,750	165	0	383	2,297	4
	3.5		Other Boiler Plant Systems	7,979	0	7,877	0	15,856	1,506	0	2,604	19,967	37
	3.6		FO Supply Sys & Nat Gas	268	0	335	0	604	57	0	99	760	1
	3.7		Waste Treatment Equipment	48	0	27	0	75	7	0	16	98	0
	3.8		Misc. Power Plant Equipment	2,849	0	870	0	3,719	358	0	815	4,892	9
			SUBTOTAL 3.	**$45,703**	**$0**	**$21,163**	**$0**	**$66,867**	**$6,088**	**$0**	**$11,665**	**$84,619**	**$155**
4			PC BOILER & ACCESSORIES										
	4.1		PC Boiler & Accessories	181,284	0	101,719	0	283,003	27,542	0	31,054	341,599	628
	4.2		SCR (w/4.1)	0	0	0	0	0	0	0	0	0	0
	4.3		Open	0	0	0	0	0	0	0	0	0	0
	4.4		Boiler BoP (w/ ID Fans)	0	0	0	0	0	0	0	0	0	0
	4.5		Primary Air System	w/4.1	0	w/4.1	0	0	0	0	0	0	0
	4.6		Secondary Air System	w/4.1	0	w/4.1	0	0	0	0	0	0	0
	4.8		Major Component Rigging	0	w/4.1	w/4.1	0	0	0	0	0	0	0
	4.9		Boiler Foundations	0	w/14.1	w/14.1	0	0	0	0	0	0	0
			SUBTOTAL 4.	**$181,284**	**$0**	**$101,719**	**$0**	**$283,003**	**$27,542**	**$0**	**$31,054**	**$341,599**	**$628**

Exhibit 10-10 Case 6A capital costs (Continued)

Acct No.		Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	TOTAL PLANT COST $	TOTAL PLANT COST $/kW
5A		FLUE GAS CLEANUP										
	5.1	Absorber Vessels & Accessories	58,052	0	12,497	0	70,549	6,726	0	7,727	85,002	156
	5.2	Other FGD	3,029	0	3,433	0	6,462	627	0	709	7,799	14
	5.3	Bag House & Accessories	18,504	0	11,743	0	30,248	2,915	0	3,316	36,479	67
	5.4	Other Particulate Removal Materials	1,254	0	1,342	0	2,595	252	0	285	3,132	6
	5.5	Gypsum Dewatering System	5,260	0	893	0	6,153	586	0	674	7,413	14
	5.6	Mercury Removal System	0	0	0	0	0	0	0	0	0	0
	5.7	Open	0	0	0	0	0	0	0	0	0	0
		SUBTOTAL 5A.	**$86,099**	**$0**	**$29,908**	**$0**	**$116,007**	**$11,105**	**$0**	**$12,711**	**$139,824**	**$257**
5B		CO2 REMOVAL & COMPRESSION										
	5B.1	CO2 Removal System	107,452	0	86,344	0	193,796	18,529	38,759	50,217	301,301	554
	5B.2	CO2 Compression & Drying	29,421	0	9,230	0	38,651	3,696	0	8,469	50,817	93
		SUBTOTAL 5B.	**$136,873**	**$0**	**$95,574**	**$0**	**$232,447**	**$22,225**	**$38,759**	**$58,686**	**$352,118**	**$647**
6		COMBUSTION TURBINE/ACCESSORIES										
	6.1	Combustion Turbine Generator	0	0	0	0	0	0	0	0	0	0
	6.2	Combustion Turbine Accessories	0	0	0	0	0	0	0	0	0	0
	6.3	Compressed Air Piping	0	0	0	0	0	0	0	0	0	0
	6.4	Combustion Turbine Foundations	0	0	0	0	0	0	0	0	0	0
		SUBTOTAL 6.	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
7		HRSG, DUCTING & STACK										
	7.1	Flue Gas Recycle Heat Exhchanger	N/A	0	N/A	0	0	0	0	0	0	0
	7.2	SCR System	0	0	0	0	0	0	0	0	0	0
	7.3	Ductwork	8,922	0	5,733	0	14,655	1,278	0	2,390	18,323	34
	7.4	Stack	8,315	0	4,865	0	13,180	1,269	0	1,445	15,894	29
	7.9	HRSG, Duct & Stack Foundations	0	954	1,084	0	2,037	191	0	446	2,674	5
		SUBTOTAL 7.	**$17,237**	**$954**	**$11,682**	**$0**	**$29,873**	**$2,737**	**$0**	**$4,280**	**$36,890**	**$68**
8		STEAM TURBINE GENERATOR										
	8.1	Steam TG & Accessories	53,419	0	7,089	0	60,508	5,799	0	6,631	72,937	134
	8.2	Turbine Plant Auxiliaries	360	0	771	0	1,130	111	0	124	1,365	3
	8.3	Condenser & Auxiliaries	5,467	0	2,015	0	7,482	717	0	820	9,019	17
	8.4	Steam Piping	19,856	0	9,791	0	29,647	2,491	0	4,821	36,959	68
	8.9	TG Foundations	0	1,131	1,786	0	2,917	276	0	639	3,832	7
		SUBTOTAL 8.	**$79,102**	**$1,131**	**$21,452**	**$0**	**$101,685**	**$9,393**	**$0**	**$13,034**	**$124,112**	**$228**
9		COOLING WATER SYSTEM										
	9.1	Cooling Towers	12,032	0	3,747	0	15,779	1,509	0	1,729	19,017	35
	9.2	Circulating Water Pumps	2,368	0	182	0	2,550	215	0	277	3,042	6
	9.3	Circ. Water System Auxiliaries	624	0	83	0	708	67	0	77	852	2
	9.4	Circ. Water Piping	0	4,950	4,797	0	9,746	912	0	1,599	12,258	23
	9.5	Make-up Water System	546	0	729	0	1,275	122	0	210	1,606	3
	9.6	Component Cooling Water System	495	0	393	0	888	84	0	146	1,118	2
	9.9	Circ. Water System Foundations	0	2,985	4,743	0	7,728	731	0	1,692	10,151	19
		SUBTOTAL 9.	**$16,065**	**$7,935**	**$14,674**	**$0**	**$38,674**	**$3,642**	**$0**	**$5,729**	**$48,045**	**$88**
10		ASH/SPENT SORBENT HANDLING SYS										
	10.1	Ash Coolers	N/A	0	N/A	0	0	0	0	0	0	0
	10.2	Cyclone Ash Letdown	N/A	0	N/A	0	0	0	0	0	0	0
	10.3	HGCU Ash Letdown	N/A	0	N/A	0	0	0	0	0	0	0
	10.4	High Temperature Ash Piping	N/A	0	N/A	0	0	0	0	0	0	0
	10.5	Other Ash Recovery Equipment	N/A	0	N/A	0	0	0	0	0	0	0
	10.6	Ash Storage Silos	669	0	2,061	0	2,730	268	0	300	3,298	6
	10.7	Ash Transport & Feed Equipment	4,331	0	4,436	0	8,767	838	0	961	10,566	19
	10.8	Misc. Ash Handling Equipment	0	0	0	0	0	0	0	0	0	0
	10.9	Ash/Spent Sorbent Foundation	0	159	187	0	346	32	0	76	454	1
		SUBTOTAL 10.	**$5,000**	**$159**	**$6,685**	**$0**	**$11,843**	**$1,139**	**$0**	**$1,336**	**$14,318**	**$26**

Exhibit 10-10 Case 6A capital costs (Continued)

Acct No.		Item/Description	Equipment Cost	Material Cost	Labor		Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	TOTAL PLANT COST	
					Direct	Indirect					$	$/kW
11		ACCESSORY ELECTRIC PLANT										
	11.1	Generator Equipment	1,646	0	267	0	1,913	177	0	157	2,247	4
	11.2	Station Service Equipment	4,836	0	1,589	0	6,425	601	0	527	7,552	14
	11.3	Switchgear & Motor Control	5,560	0	945	0	6,505	603	0	711	7,818	14
	11.4	Conduit & Cable Tray	0	3,486	12,052	0	15,538	1,504	0	2,556	19,599	36
	11.5	Wire & Cable	0	6,577	12,697	0	19,274	1,624	0	3,135	24,033	44
	11.6	Protective Equipment	261	0	888	0	1,149	112	0	126	1,388	3
	11.7	Standby Equipment	1,307	0	30	0	1,337	123	0	146	1,606	3
	11.8	Main Power Transformers	11,074	0	186	0	11,261	854	0	1,211	13,326	24
	11.9	Electrical Foundations	0	322	789	0	1,111	106	0	243	1,460	3
		SUBTOTAL 11.	**$24,685**	**$10,385**	**$29,444**	**$0**	**$64,513**	**$5,704**	**$0**	**$8,813**	**$79,030**	**$145**
12		INSTRUMENTATION & CONTROL										
	12.1	PC Control Equipment	w/12.7	0	w/12.7	0	0	0	0	0	0	0
	12.2	Combustion Turbine Control	N/A	0	N/A	0	0	0	0	0	0	0
	12.3	Steam Turbine Control	w/8.1	0	w/8.1	0	0	0	0	0	0	0
	12.4	Other Major Component Control	0	0	0	0	0	0	0	0	0	0
	12.5	Signal Processing Equipment	W/12.7	0	w/12.7	0	0	0	0	0	0	0
	12.6	Control Boards, Panels & Racks	512	0	307	0	819	77	41	141	1,077	2
	12.7	Computer Accessories	5,169	0	903	0	6,072	563	304	694	7,633	14
	12.8	Instrument Wiring & Tubing	2,802	0	5,558	0	8,360	713	418	1,424	10,915	20
	12.9	Other I & C Equipment	1,461	0	3,315	0	4,775	463	239	548	6,025	11
		SUBTOTAL 12.	**$9,944**	**$0**	**$10,083**	**$0**	**$20,027**	**$1,816**	**$1,002**	**$2,806**	**$25,650**	**$47**
13		IMPROVEMENTS TO SITE										
	13.1	Site Preparation	0	54	1,080	0	1,134	113	0	249	1,496	3
	13.2	Site Improvements	0	1,793	2,227	0	4,020	397	0	883	5,300	10
	13.3	Site Facilities	3,213	0	3,169	0	6,382	629	0	1,402	8,413	15
		SUBTOTAL 13.	**$3,213**	**$1,847**	**$6,476**	**$0**	**$11,537**	**$1,138**	**$0**	**$2,535**	**$15,210**	**$28**
14		BUILDINGS & STRUCTURES										
	14.1	Boiler Building	0	8,779	7,720	0	16,499	1,483	0	2,697	20,679	38
	14.2	Turbine Building	0	12,641	11,782	0	24,423	2,201	0	3,994	30,618	56
	14.3	Administration Building	0	633	669	0	1,302	118	0	213	1,633	3
	14.4	Circulation Water Pumphouse	0	142	113	0	254	23	0	42	319	1
	14.5	Water Treatment Buildings	0	743	678	0	1,421	128	0	232	1,781	3
	14.6	Machine Shop	0	423	284	0	708	63	0	116	886	2
	14.7	Warehouse	0	287	288	0	575	52	0	94	720	1
	14.8	Other Buildings & Structures	0	234	200	0	434	39	0	71	544	1
	14.9	Waste Treating Building & Str.	0	448	1,358	0	1,806	171	0	297	2,274	4
		SUBTOTAL 14.	**$0**	**$24,330**	**$23,091**	**$0**	**$47,421**	**$4,278**	**$0**	**$7,755**	**$59,454**	**$109**
		Total Cost	**$637,248**	**$52,434**	**$385,935**	**$1,023**	**$1,076,640**	**$101,508**	**$39,761**	**$169,021**	**$1,386,929**	**$2,548**

Exhibit 10-10 Case 6A capital costs (Continued)

Acct No.	Item/Description	Equipment Cost	Material Cost	Labor		Bare Erected	Eng'g CM	Process Cont.	Project Cont.	TOTAL PLANT COST	
				Direct	Indirect		Total	Total	Total	$	$/kW
	Owner's Costs									**$1,000**	**$/kW**
	Preproduction Costs										
	6 Months All Labor									$9,756	$18
	1 Month Maintenance Materials									$1,348	$2
	1 Month Non-fuel Consumables									$1,961	$4
	1 Month Waste Disposal									$349	$1
	25% of 1 Months Fuel Cost at 100% CF									$1,763	$3
	2% of TPC									$27,739	$51
	Total									**$42,916**	**$79**
	Inventory Capital										
	60 day supply of fuel and consumables at 100% CF									$17,662	$32
	0.5% of TPC (spare parts)									$6,935	$13
	Total									**$24,597**	**$45**
	Initial Cost for Catalyst and Chemicals									$17,463	$32
	Land									$900	$2
	Other Owner's Costs									$208,039	$382
	Financing Costs									$37,447	$69
	Total Overnight Costs (TOC)									**$1,718,291**	**$3,157**
	TASC Multiplier							(IOU, high-risk, 35 year)		1.14	
	Total As-Spent Cost (TASC)									**$1,958,852**	**$3,599**

Exhibit 10-11 Case 6A operation and maintenance costs

	6A				Cost Base (Jun):	2007
					Heat Rate-net (Btu/kWh):	10,844
					MWe-net:	544
					Capacity Factor (%):	**85**
OPERATING & MAINTENANCE LABOR						
Operating Labor						
Operating Labor Rate(base):	34.65	$/hour				
Operating Labor Burden:	30.00	% of base				
Labor O-H Charge Rate:	25.00	% of labor				
Operating Labor Requirements(O.J.)per S	1 unit/mod.		Total Plant			
Skilled Operator	2.0		2.0			
Operator	11.3		11.3			
Foreman	1.0		1.0			
Lab Tech's, etc.	2.0		2.0			
TOTAL-O.J.'s	16.3		16.3			
					Annual Cost $	Annual Unit Cost $/kW-net
Annual Operating Labor Cost					$6,444,907	$11.840
Maintenance Labor Cost					$9,164,826	$16.837
Administrative & Support Labor					$3,902,433	$7.169
Property Taxes and Insurance					$27,738,588	$50.959
TOTAL FIXED OPERATING COSTS					**$47,250,754**	$86.805
VARIABLE OPERATING COSTS						
						$/kWh-net
Maintenance Material Cost					**$13,747,239**	**$0.00339**
Consumables	Consumption Initial Fill	/Day	Unit Cost	Initial Fill Cost		
Water(/1000 gallons)	0	5,541	1.08	**$0**	**$1,859,424**	**$0.00046**
Chemicals		4.841				
MU & WT Chem. (lbs)	0	26,821	0.17	$0	$1,440,128	$0.00036
Limestone (ton)	0	618	21.63	$0	$4,149,843	$0.00102
Carbon (Mercury Removal) (lb)	0	0	1.05	$0	$0	$0.00000
TDA Adsobant System	1,456,705	4,989	5.00	$7,283,524	$7,738,744	$0.00191
NaOH (tons)	0	0	433.68	$0	$0	$0.00000
H2SO4 (tons)	0	0	138.78	$0	$0	$0.00000
Corrosion Inhibitor	0	0	0.00	$0	$0	$0.00000
Activated Carbon (lb)	0	1,467	1.05	$0	$477,906	$0.00012
Ammonia (19% NH3) (ton)	0	90.8	129.80	$0	$3,656,587	$0.00090
Subtotal Chemicals				**$7,283,524**	**$17,463,208**	**$0.00431**
Other						
Supplemental Fuel (MBtu)	0	0	0.00	$0	$0	$0.00000
SCR Catalyst (m3)	w/equip.	0.38	5,775.94	$0	$684,116	$0.00017
Emission Penalties	0	0	0.00	$0	$0	$0.00000
Subtotal Other				**$0**	**$684,116**	**$0.00017**
Waste Disposal						
Fly Ash (ton)	0	588.7542	16.23	$0	2,963,699.04	0.00073
Bottom Ash (ton)	0	118	16.23	$0	592,739.81	0.00015
Subtotal Waste Disposal				**$0**	**$3,556,439**	**$0.00088**
By-products & Emissions						
Gypsum (tons)	0	145	0.00	$0	$0	$0.00000
Subtotal By-products				**$0**	**$0**	**$0.00000**
TOTAL VARIABLE OPERATING COSTS				**$7,283,524**	**$37,310,426**	**$0.00921**
Fuel (ton)	0	6,072	38.18	**$0**	**$71,929,016**	**$0.01775**

Exhibit 10-12 Cost of electricity breakdown for Case 6A

TOC, $/kW	**3,157**
COE w/o TS&M, $/MW	**91.3**
Capital, $/MW	52.7
Fixed, $/MW	11.7
Variable, $/MW	9.2
Fuel, $/MW	17.7

10.2 Case 6B

Exhibit 10-13 Case 6B Stream table

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
V-L Mole Fraction														
Ar	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092	0.0000	0.0000	0.0087	0.0000	0.0087	0.0087	0.0000
CO_2	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0000	0.0000	0.1450	0.0000	0.1450	0.1450	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	0.0099	0.0099	0.0099	0.0099	0.0099	0.0099	0.0099	0.0000	0.0000	0.0870	0.0000	0.0870	0.0870	1.0000
N_2	0.7732	0.7732	0.7732	0.7732	0.7732	0.7732	0.7732	0.0000	0.0000	0.7324	0.0000	0.7324	0.7324	0.0000
O_2	0.2074	0.2074	0.2074	0.2074	0.2074	0.2074	0.2074	0.0000	0.0000	0.0247	0.0000	0.0247	0.0247	0.0000
SO_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0021	0.0000	0.0021	0.0021	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000	0.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	56,782	56,782	1,690	17,443	17,443	2,393	1,312	0	0	79,902	0	79,902	79,902	2,806
V-L Flowrate (kg/hr)	1,638,548	1,638,548	48,755	503,345	503,345	69,049	37,871	0	0	2,376,537	0	2,376,537	2,376,537	50,557
Solids Flowrate (kg/hr)	0	0	0	0	0	0	0	217,903	4,226	16,904	16,904	0	0	21,983
Temperature (°C)	15	19	19	15	25	25	15	15	15	169	15	169	189	15
Pressure (MPa, abs)	0.10	0.11	0.11	0.10	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.11	0.10
Enthalpy (kJ/kg)[A]	30.23	34.36	34.36	30.23	40.78	40.78	30.23	---	---	327.39	---	308.96	329.44	---
Density (kg/m^3)	1.2	1.2	1.2	1.2	1.3	1.3	1.2	---	---	0.8	---	0.8	0.9	---
V-L Molecular Weight	28.857	28.857	28.857	28.857	28.857	28.857	28.857	---	---	29.743	---	29.743	29.743	---
V-L Flowrate (lb_{mol}/hr)	125,182	125,182	3,725	38,455	38,455	5,275	2,893	0	0	176,153	0	176,153	176,153	6,187
V-L Flowrate (lb/hr)	3,612,379	3,612,379	107,486	1,109,685	1,109,685	152,228	83,491	0	0	5,239,367	0	5,239,367	5,239,367	111,460
Solids Flowrate (lb/hr)	0	0	0	0	0	0	0	480,395	9,317	37,266	37,266	0	0	48,465
Temperature (°F)	59	66	66	59	78	78	59	59	59	337	59	337	371	59
Pressure (psia)	14.7	15.3	15.3	14.7	16.1	16.1	14.7	14.7	14.7	14.4	14.7	14.2	16.0	15.0
Enthalpy (Btu/lb)[A]	13.0	14.8	14.8	13.0	17.5	17.5	13.0	---	---	140.8	---	132.8	141.6	---
Density (lb/ft^3)	0.076	0.078	0.078	0.076	0.081	0.081	0.076	---	---	0.050	---	0.049	0.053	---
	A - Reference conditions are 32.02 F & 0.089 PSIA													

Exhibit 10-13 Case 6B Stream table (Continued)

	15	16	17	18	19	20	21	22	23	24	25	26	27	28
V-L Mole Fraction														
Ar	0.0000	0.0128	0.0000	0.0083	0.0074	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CO_2	0.0000	0.0005	0.0001	0.1378	0.0124	0.4999	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	1.0000	0.0062	0.9998	0.1366	0.3442	0.4714	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
N_2	0.0000	0.7506	0.0000	0.6930	0.6145	0.0277	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
O_2	0.0000	0.2300	0.0000	0.0243	0.0216	0.0010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SO_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	9,780	821	208	85,339	96,244	21,553	10,559	29,568	29,568	98,925	78,821	78,821	41,547	41,547
V-L Flowrate (kg/hr)	176,194	23,822	3,754	2,479,015	2,400,835	674,638	464,709	532,684	532,684	1,782,166	1,419,982	1,419,982	748,475	748,475
Solids Flowrate (kg/hr)	0	0	34,016	0	0	0	0	0	0	0	0	0	0	0
Temperature (°C)	15	181	56	56	110	144	43	331	98	649	328	649	38	40
Pressure (MPa, abs)	0.10	0.31	0.11	0.11	0.10	0.11	15.27	0.51	0.92	34.47	4.90	4.35	0.01	1.69
Enthalpy (kJ/kg)[A]	-46.80	191.58	---	271.12	757.10	845.44	-188.56	3,128.17	409.55	3,555.97	3,010.64	3,781.91	2,217.66	167.71
Density (kg/m^3)	1,003.1	2.4	---	1.1	0.8	1.0	723.6	1.8	960.1	93.2	19.9	10.4	0.1	993.1
V-L Molecular Weight	18.015	29.029	---	29.049	24.945	31.301	44.010	18.015	18.015	18.015	18.015	18.015	18.015	18.015
V-L Flowrate (lb_{mol}/hr)	21,562	1,809	459	188,141	212,182	47,517	23,279	65,187	65,187	218,093	173,770	173,770	91,595	91,595
V-L Flowrate (lb/hr)	388,442	52,519	8,276	5,465,293	5,292,935	1,487,321	1,024,507	1,174,367	1,174,367	3,929,003	3,130,524	3,130,524	1,650,104	1,650,104
Solids Flowrate (lb/hr)	0	0	74,992	0	0	0	0	0	0	0	0	0	0	0
Temperature (°F)	59	357	133	133	230	291	110	629	208	1,200	622	1,200	101	104
Pressure (psia)	14.7	45.0	15.7	15.7	14.8	15.6	2,214.5	73.5	133.6	5,000.0	710.8	630.8	1.0	245.0
Enthalpy (Btu/lb)[A]	-20.1	82.4	---	116.6	325.5	363.5	-81.1	1,344.9	176.1	1,528.8	1,294.3	1,625.9	953.4	72.1
Density (lb/ft^3)	62.622	0.149	---	0.072	0.050	0.061	45.175	0.115	59.940	5.821	1.243	0.649	0.003	61.996

Exhibit 10-14 Case 6B Performance summary

	Case 6B	Units
Plant Output		
Steam Turbine Power	642,200	kW_e
Total	**642,200**	kW_e
Auxiliary Load		
Coal Handling and Conveying	470	kW_e
Pulverizers	3,270	kW_e
Sorbent Handling & Reagent Preparation	1,060	kW_e
Ash Handling	620	kW_e
Primary Air Fans	1,530	kW_e
Forced Draft Fans	1,950	kW_e
Induced Draft Fans	13,940	kW_e
SCR	60	kW_e
Baghouse	80	kW_e
Wet FGD	3,490	kW_e
TDA CO2 removal Auxiliaries	11,400	kW_e
CO_2 Compression	47,530	kW_e
Miscellaneous Balance of Plant[2,3]	2,000	kW_e
Steam Turbine Auxiliaries	400	kW_e
Condensate Pumps	470	kW_e
Circulating Water Pumps	6,550	kW_e
Ground Water Pumps	650	kW_e
Cooling Tower Fans	3,390	kW_e
Transformer Losses	2,200	kW_e
Total	**101,060**	**kW_e**
Plant Performance		
Net Auxiliary Load	101,060	kW_e
Net Plant Power	541,140	kW_e
Net Plant Efficiency (HHV)	32.9%	
Net Plant Heat Rate (HHV)	10,927 (10,356)	kJ/kWhr (Btu/kWhr)
Coal Feed Flowrate	217,903 (480,395)	kg/hr (lb/hr)
Thermal Input[1]	1,642,454	kW_{th}
Condenser Duty	1,540 (1,459)	GJ/hr (MMBtu/hr)
Raw Water Withdrawal	27.0 (7,131)	m^3/min (gpm)
Raw Water Consumption	21.3 (5,617)	m^3/min (gpm)

1 - HHV of Illinois No. 6 coal is 27,135 kJ/kg (11,666 Btu/lb)
2 – Boiler feed pumps are turbine driven
3 – Includes plant control systems, lighting, HVAC, and miscellaneous low voltage loads

Exhibit 10-15 Case 6B water balance

	Water Demand	Internal Recycle	Raw Water Withdrawal	Process Water Discharge	Raw Water Consumption
	m^3/min (gpm)				
Econamine	-	-	-	-	-
FGD Makeup	3.78 (1000)	-	3.78 (1000)	-	3.78 (1,000)
BFW Makeup	-	-	-	-	-
Cooling Tower	25.5 (6,736)	2.29 (604)	23.2 (6,131)	5.73 (1,515)	17.48 (4,617)
Total	**29.3 (7,735)**	**2.29 (604)**	**27.0 (7,131)**	**5.73 (1,515)**	**21.26 (5,617)**

Exhibit 10-16 Case 6B carbon balance

Carbon In		Carbon Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	138,902 (306,226)	Stack Gas	14,380 (31,702)
Air (CO2)	301 (664)	FGD Product	226 (498)
FGD Reagent	2,231 (4,918)	CO2 Product	126,827 (279,605)
	-	Convergence Tolerance	2 (4)
Total	**141,434 (311,808)**	**Total**	**141,434 (311,808)**

Exhibit 10-17 Case 6B sulfur balance

Sulfur In		Sulfur Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	5,462 (12,041)	FGD Product	5,352 (11,800)
		Stack Gas	4 (8)
		Econamine Polishing Scrubber/HSS	106 (233)
Total	**5,462 (12,041)**	**Total**	**5,462 (12,041)**

Exhibit 10-18 Case 6B energy balance

	HHV	Sensible + Latent	Power	Total
Heat In GJ/hr (MMBtu/hr)				
Coal	5,913 (5,604)	4.9 (4.7)	-	5,918 (5,609)
Air	-	65.9 (62.4)	-	65.9 (62.4)
Raw Water Makeup	-	101.6 (96.3)	-	101.6 (96.3)
Lime	-	0.25 (0.24)	-	0.25 (0.24)
Auxiliary Power	-	-	364 (345)	364 (345)
TOTAL	**5,913 (5,604)**	**172.7 (163.6)**	**364 (345)**	**6,449 (6,113)**
Heat Out GJ/hr (MMBtu/hr)				
Bottom Ash	-	0.5 (0.5)	-	0.5 (0.5)
Fly Ash + FGD Ash	-	2.1 (1.9)	-	2.1 (1.9)
Flue Gas	-	1,818 (1,723)	-	1,818 (1,723)
Condenser	-	1,540 (1,459)	-	1,540 (1,459)
CO2	-	-88 (-83)	-	-88 (-83)
Cooling Tower Blowdown	-	42.6 (40.4)	-	42.6 (40.4)
Econamine Losses	-	1,684 (1,596)	-	1,684 (1,596)
*Process Losses**	-	*-861.9 (-816.9)*	-	*-861.9 (-816.9)*
Power	-	-	2,312 (2,191)	2,312 (2,191)
TOTAL	-	**4,137 (3,921)**	**2,312 (2,191)**	**6,449 (6,113)**

* Process losses are estimated to match the heat input to the plant.

Exhibit 10-19 Case 6B air emissions

	kg/GJ (lb/MMBtu)	tonne/yr (Ton/year)	kg/MWgross (lb/MWgross)
SO_2	0.001 (0.003)	56 (62)	0.011 (.02)
NOx	0.030 (0.070)	1,403 (1,546)	0.277 (.611)
Particulate	0.006 (0.0130)	261 (287)	0.051 (.113)
Hg	4.91E-7 (1.14E-6)	0.023 (0.025)	4.52E-6 (9.97E-6)
CO_2	8.9 (20.7)	415,397 (457,897)	82 (181)

Exhibit 10-20 Case 6B capital costs

											Cost Base:	Jan 2007	
											Prepared:	13-Mar-12	
			Case:	6B								x $1, 000	
			Plant Size:	541.14	MW, net			Capital Charge Factor		0.9			
				Equipment		Labor		Bare	Eng'g CM	Process Cont.	Project Cont.	TOTAL PLANT COST	
Acct No.		Item/Description		Cost	Material Cost	Direct	Indirect	Erected	Total	Total	Total	$	$/kW
1		COAL HANDLING SYSTEM											
	1.1	Coal Receive & Unload		3,718	0	1,698	0	5,416	484	0	885	6,785	13
	1.2	Coal Stackout & Reclaim		4,805	0	1,089	0	5,894	516	0	961	7,371	14
	1.3	Coal Conveyors & Yd Crus		4,467	0	1,077	0	5,545	486	0	905	6,935	13
	1.4	Other Coal Handling		1,169	0	249	0	1,418	124	0	231	1,773	3
	1.5	Sorbent Receive & Unload		151	0	45	0	196	17	0	32	246	0
	1.6	Sorbent Stackout & Reclaim		2,435	0	446	0	2,881	251	0	470	3,602	7
	1.7	Sorbent Conveyors		869	188	213	0	1,270	110	0	207	1,587	3
	1.8	Other Sorbent Handling		525	123	275	0	923	82	0	151	1,155	2
	1.9	Coal & Sorbent Hnd.Foundations		0	4,566	5,759	0	10,325	970	0	1,694	12,989	24
		SUBTOTAL 1.		**$18,139**	**$4,877**	**$10,853**	**$0**	**$33,868**	**$3,039**	**$0**	**$5,536**	**$42,443**	**$78**
2		COAL PREP & FEED SYSTEMS											
	2.1	Coal Crushing & Drying		2,143	0	418	0	2,561	223	0	418	3,202	6
	2.2	Prepared Coal Storage & Feed		5,487	0	1,198	0	6,685	584	0	1,090	8,360	15
	2.3	Slurry Prep & Feed		0	0	0	0	0	0	0	0	0	0
	2.4	Misc. Coal Prep & Feed		0	0	0	0	0	0	0	0	0	0
	2.5	Sorbent Prep Equipment		4,143	179	860	0	5,182	451	0	845	6,478	12
	2.6	Sorbent Storage & Feed		499	0	191	0	690	61	0	113	864	2
	2.7	Sorbent Injection System		0	0	0	0	0	0	0	0	0	0
	2.8	Booster Air Supply System		0	0	0	0	0	0	0	0	0	0
	2.9	Coal & Sorbent Feed Foundation		538	451	0	989	1,979	183	0	324	2,486	5
		SUBTOTAL 2.		**$12,810**	**$630**	**$2,667**	**$989**	**$17,097**	**$1,503**	**$0**	**$2,790**	**$21,390**	**$40**
3		FEEDWATER & MISC. BOP SYSTEMS											
	3.1	Feedwater System		19,291	0	6,232	0	25,523	2,230	0	4,163	31,916	59
	3.2	Water Makeup & Pretreating		5,476	0	1,763	0	7,239	685	0	1,585	9,508	18
	3.3	Other Feedwater Subsystems		5,906	0	2,496	0	8,402	753	0	1,373	10,528	19
	3.4	Service Water Systems		1,073	0	584	0	1,658	156	0	363	2,176	4
	3.5	Other Boiler Plant Systems		7,214	0	7,122	0	14,335	1,362	0	2,355	18,052	33
	3.6	FO Supply Sys & Nat Gas		265	0	331	0	596	56	0	98	750	1
	3.7	Waste Treatment Equipment		45	0	26	0	71	7	0	16	93	0
	3.8	Misc. Power Plant Equipment		2,812	0	859	0	3,671	353	0	805	4,829	9
		SUBTOTAL 3.		**$42,083**	**$0**	**$19,412**	**$0**	**$61,495**	**$5,601**	**$0**	**$10,756**	**$77,852**	**$144**
4		PC BOILER & ACCESSORIES											
	4.1	PC Boiler & Accessories		165,108	0	92,643	0	257,751	25,084	0	28,284	311,119	575
	4.2	SCR (w/4.1)		0	0	0	0	0	0	0	0	0	0
	4.3	Open		0	0	0	0	0	0	0	0	0	0
	4.4	Boiler BoP (w/ ID Fans)		0	0	0	0	0	0	0	0	0	0
	4.5	Primary Air System		w/4.1	0	w/4.1	0	0	0	0	0	0	0
	4.6	Secondary Air System		w/4.1	0	w/4.1	0	0	0	0	0	0	0
	4.8	Major Component Rigging		0	w/4.1	w/4.1	0	0	0	0	0	0	0
	4.9	Boiler Foundations		0	w/14.1	w/14.1	0	0	0	0	0	0	0
		SUBTOTAL 4.		**$165,108**	**$0**	**$92,643**	**$0**	**$257,751**	**$25,084**	**$0**	**$28,284**	**$311,119**	**$575**

Exhibit 10-20 Case 6B capital costs (Continued)

Acct No.		Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	TOTAL PLANT COST $	TOTAL PLANT COST $/kW
5A		FLUE GAS CLEANUP										
	5.1	Absorber Vessels & Accessories	55,906	0	12,035	0	67,941	6,477	0	7,442	81,860	151
	5.2	Other FGD	2,917	0	3,306	0	6,223	604	0	683	7,510	14
	5.3	Bag House & Accessories	17,771	0	11,278	0	29,048	2,799	0	3,185	35,032	65
	5.4	Other Particulate Removal Materials	1,205	0	1,289	0	2,494	242	0	274	3,009	6
	5.5	Gypsum Dewatering System	5,074	0	862	0	5,936	565	0	650	7,151	13
	5.6	Mercury Removal System	0	0	0	0	0	0	0	0	0	0
	5.7	Open	0	0	0	0	0	0	0	0	0	0
		SUBTOTAL 5A.	**$82,872**	**$0**	**$28,770**	**$0**	**$111,642**	**$10,687**	**$0**	**$12,233**	**$134,562**	**$249**
5B		CO2 REMOVAL & COMPRESSION										
	5B.1	CO2 Removal System	107,452	0	86,344	0	193,796	18,529	38,759	50,217	301,301	557
	5B.2	CO2 Compression & Drying	28,520	0	8,947	0	37,467	3,583	0	8,210	49,260	91
		SUBTOTAL 5B.	**$135,972**	**$0**	**$95,292**	**$0**	**$231,263**	**$22,112**	**$38,759**	**$58,427**	**$350,561**	**$648**
6		COMBUSTION TURBINE/ACCESSORIES										
	6.1	Combustion Turbine Generator	0	0	0	0	0	0	0	0	0	0
	6.2	Combustion Turbine Accessories	0	0	0	0	0	0	0	0	0	0
	6.3	Compressed Air Piping	0	0	0	0	0	0	0	0	0	0
	6.4	Combustion Turbine Foundations	0	0	0	0	0	0	0	0	0	0
		SUBTOTAL 6.	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
7		HRSG, DUCTING & STACK										
	7.1	Flue Gas Recycle Heat Exhchanger	N/A	0	N/A	0	0	0	0	0	0	0
	7.2	SCR System	0	0	0	0	0	0	0	0	0	0
	7.3	Ductwork	8,812	0	5,662	0	14,474	1,262	0	2,360	18,096	33
	7.4	Stack	8,287	0	4,849	0	13,135	1,265	0	1,440	15,840	29
	7.9	HRSG, Duct & Stack Foundations	0	951	1,080	0	2,030	190	0	444	2,665	5
		SUBTOTAL 7.	**$17,098**	**$951**	**$11,590**	**$0**	**$29,639**	**$2,717**	**$0**	**$4,244**	**$36,600**	**$68**
8		STEAM TURBINE GENERATOR										
	8.1	Steam TG & Accessories	53,018	0	7,036	0	60,054	5,755	0	6,581	72,390	134
	8.2	Turbine Plant Auxiliaries	357	0	765	0	1,122	110	0	123	1,355	3
	8.3	Condenser & Auxiliaries	5,082	0	1,873	0	6,955	666	0	762	8,384	15
	8.4	Steam Piping	18,073	0	8,911	0	26,985	2,267	0	4,388	33,640	62
	8.9	TG Foundations	0	1,123	1,773	0	2,896	274	0	634	3,804	7
		SUBTOTAL 8.	**$76,530**	**$1,123**	**$20,359**	**$0**	**$98,012**	**$9,072**	**$0**	**$12,488**	**$119,572**	**$221**
9		COOLING WATER SYSTEM										
	9.1	Cooling Towers	11,396	0	3,549	0	14,945	1,429	0	1,637	18,012	33
	9.2	Circulating Water Pumps	2,216	0	171	0	2,386	202	0	259	2,847	5
	9.3	Circ. Water System Auxiliaries	594	0	79	0	673	64	0	74	811	1
	9.4	Circ. Water Piping	0	4,707	4,562	0	9,270	868	0	1,521	11,658	22
	9.5	Make-up Water System	521	0	696	0	1,218	117	0	200	1,534	3
	9.6	Component Cooling Water System	470	0	374	0	845	80	0	139	1,063	2
	9.9	Circ. Water System Foundations	0	2,850	4,528	0	7,378	698	0	1,615	9,692	18
		SUBTOTAL 9.	**$15,197**	**$7,557**	**$13,959**	**$0**	**$36,714**	**$3,458**	**$0**	**$5,445**	**$45,616**	**$84**
10		ASH/SPENT SORBENT HANDLING SYS										
	10.1	Ash Coolers	N/A	0	N/A	0	0	0	0	0	0	0
	10.2	Cyclone Ash Letdown	N/A	0	N/A	0	0	0	0	0	0	0
	10.3	HGCU Ash Letdown	N/A	0	N/A	0	0	0	0	0	0	0
	10.4	High Temperature Ash Piping	N/A	0	N/A	0	0	0	0	0	0	0
	10.5	Other Ash Recovery Equipment	N/A	0	N/A	0	0	0	0	0	0	0
	10.6	Ash Storage Silos	650	0	2,002	0	2,652	260	0	291	3,204	6
	10.7	Ash Transport & Feed Equipment	4,207	0	4,309	0	8,516	814	0	933	10,263	19
	10.8	Misc. Ash Handling Equipment	0	0	0	0	0	0	0	0	0	0
	10.9	Ash/Spent Sorbent Foundation	0	154	182	0	336	32	0	74	441	1
		SUBTOTAL 10.	**$4,857**	**$154**	**$6,493**	**$0**	**$11,504**	**$1,106**	**$0**	**$1,298**	**$13,908**	**$26**

Exhibit 10-20 Case 6B capital costs (Continued)

Acct No.		Item/Description	Equipment Cost	Material Cost	Labor		Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	TOTAL PLANT COST	
					Direct	Indirect					$	$/kW
11		ACCESSORY ELECTRIC PLANT										
	11.1	Generator Equipment	1,636	0	266	0	1,902	176	0	156	2,234	4
	11.2	Station Service Equipment	4,726	0	1,553	0	6,279	587	0	515	7,381	14
	11.3	Switchgear & Motor Control	5,434	0	924	0	6,357	589	0	695	7,641	14
	11.4	Conduit & Cable Tray	0	3,407	11,779	0	15,185	1,470	0	2,498	19,154	35
	11.5	Wire & Cable	0	6,428	12,409	0	18,837	1,587	0	3,064	23,487	43
	11.6	Protective Equipment	261	0	888	0	1,149	112	0	126	1,388	3
	11.7	Standby Equipment	1,301	0	30	0	1,331	122	0	145	1,598	3
	11.8	Main Power Transformers	11,006	0	185	0	11,192	849	0	1,204	13,244	24
	11.9	Electrical Foundations	0	319	783	0	1,103	105	0	242	1,450	3
		SUBTOTAL 11.	**$24,365**	**$10,154**	**$28,816**	**$0**	**$63,335**	**$5,598**	**$0**	**$8,644**	**$77,577**	**$143**
12		INSTRUMENTATION & CONTROL										
	12.1	PC Control Equipment	w/12.7	0	w/12.7	0	0	0	0	0	0	0
	12.2	Combustion Turbine Control	N/A	0	N/A	0	0	0	0	0	0	0
	12.3	Steam Turbine Control	w/8.1	0	w/8.1	0	0	0	0	0	0	0
	12.4	Other Major Component Control	0	0	0	0	0	0	0	0	0	0
	12.5	Signal Processing Equipment	W/12.7	0	w/12.7	0	0	0	0	0	0	0
	12.6	Control Boards, Panels & Racks	509	0	305	0	813	77	40	140	1,070	2
	12.7	Computer Accessories	5,134	0	897	0	6,031	559	302	689	7,581	14
	12.8	Instrument Wiring & Tubing	2,783	0	5,521	0	8,304	708	415	1,414	10,841	20
	12.9	Other I & C Equipment	1,451	0	3,292	0	4,743	460	238	544	5,984	11
		SUBTOTAL 12.	**$9,876**	**$0**	**$10,015**	**$0**	**$19,891**	**$1,804**	**$995**	**$2,787**	**$25,476**	**$47**
13		IMPROVEMENTS TO SITE										
	13.1	Site Preparation	0	54	1,070	0	1,124	112	0	247	1,483	3
	13.2	Site Improvements	0	1,777	2,207	0	3,984	393	0	875	5,252	10
	13.3	Site Facilities	3,184	0	3,140	0	6,324	623	0	1,389	8,337	15
		SUBTOTAL 13.	**$3,184**	**$1,830**	**$6,417**	**$0**	**$11,432**	**$1,128**	**$0**	**$2,512**	**$15,071**	**$28**
14		BUILDINGS & STRUCTURES										
	14.1	Boiler Building	0	8,759	7,702	0	16,461	1,479	0	2,691	20,632	38
	14.2	Turbine Building	0	12,595	11,739	0	24,334	2,193	0	3,979	30,506	56
	14.3	Administration Building	0	630	666	0	1,296	118	0	212	1,626	3
	14.4	Circulation Water Pumphouse	0	135	107	0	243	22	0	40	304	1
	14.5	Water Treatment Buildings	0	707	644	0	1,351	122	0	221	1,694	3
	14.6	Machine Shop	0	421	283	0	704	62	0	115	882	2
	14.7	Warehouse	0	286	286	0	572	52	0	94	717	1
	14.8	Other Buildings & Structures	0	233	199	0	432	39	0	71	541	1
	14.9	Waste Treating Building & Str.	0	445	1,351	0	1,796	171	0	295	2,262	4
		SUBTOTAL 14.	**$0**	**$24,211**	**$22,978**	**$0**	**$47,189**	**$4,257**	**$0**	**$7,717**	**$59,164**	**$109**
		Total Cost	**$608,092**	**$51,487**	**$370,264**	**$989**	**$1,030,832**	**$97,166**	**$39,754**	**$163,161**	**$1,330,913**	**$2,459**

Exhibit 10-20 Case 6B capital costs (Continued)

Acct No.	Item/Description	Equipment Cost	Material Cost	Labor		Bare Erected	Eng'g CM	Process Cont.	Project Cont.	TOTAL PLANT COST	
				Direct	Indirect		Total	Total	Total	$	$/kW
	Owner's Costs									**$1,000**	**$/kW**
	Preproduction Costs										
	6 Months All Labor									$9,512	$18
	1 Month Maintenance Materials									$1,290	$2
	1 Month Non-fuel Consumables									$1,890	$3
	1 Month Waste Disposal									$331	$1
	25% of 1 Months Fuel Cost at 100% CF									$1,674	$3
	2% of TPC									$26,618	$49
	Total									**$41,316**	**$76**
	Inventory Capital										
	60 day supply of fuel and consumables at 100% CF									$16,832	$31
	0.5% of TPC (spare parts)									$6,655	$12
	Total									**$23,487**	**$43**
	Initial Cost for Catalyst and Chemicals									$16,902	$31
	Land									$900	$2
	Other Owner's Costs									$199,637	$369
	Financing Costs									$35,935	$66
	Total Overnight Costs (TOC)									**$1,649,089**	**$3,047**
	TASC Multiplier								(IOU, high-risk, 35 year)	1.14	
	Total As-Spent Cost (TASC)									**$1,879,961**	**$3,474**

Exhibit 10-21 Case 6B operation and maintenance costs

	6B				Cost Base (Jun):	2007
					Heat Rate-net (Btu/kWh):	10,356
					MWe-net:	541
					Capacity Factor (%):	**85**
OPERATING & MAINTENANCE LABOR						
Operating Labor						
Operating Labor Rate(base):	34.65	$/hour				
Operating Labor Burden:	30.00	% of base				
Labor O-H Charge Rate:	25.00	% of labor				
			Total			
Operating Labor Requirements(O.J.)per S	1 unit/mod.		Plant			
Skilled Operator	2.0		2.0			
Operator	11.3		11.3			
Foreman	1.0		1.0			
Lab Tech's, etc.	2.0		2.0			
TOTAL-O.J.'s	16.3		16.3			
					Annual Cost	Annual Unit Cost
					$	$/kW-net
Annual Operating Labor Cost					$6,444,907	$11.910
Maintenance Labor Cost					$8,774,892	$16.216
Administrative & Support Labor					$3,804,950	$7.031
Property Taxes and Insurance					$26,618,260	$49.189
TOTAL FIXED OPERATING COSTS					**$45,643,009**	$84.346
VARIABLE OPERATING COSTS						
						$/kWh-net
Maintenance Material Cost					**$13,162,338**	**$0.00327**
Consumables	Consumption Initial Fill	/Day	Unit Cost	Initial Fill Cost		
Water(/1000 gallons)	0	5,135	1.08	**$0**	**$1,723,100**	**$0.00043**
Chemicals		4.841				
MU & WT Chem. (lbs)	0	24,854	0.17	$0	$1,334,545	$0.00033
Limestone (ton)	0	582	21.63	$0	$3,903,465	$0.00097
Carbon (Mercury Removal) (lb)	0	0	1.05	$0	$0	$0.00000
TDA Adsobant System	1,456,705	4,989	5.00	$7,283,524	$7,738,744	$0.00192
NaOH (tons)	0	0	433.68	$0	$0	$0.00000
H2SO4 (tons)	0	0	138.78	$0	$0	$0.00000
Corrosion Inhibitor	0	0	0.00	$0	$0	$0.00000
Activated Carbon (lb)	0	1,393	1.05	$0	$453,750	$0.00011
Ammonia (19% NH3) (ton)	0	86.2	129.80	$0	$3,471,341	$0.00086
Subtotal Chemicals				**$7,283,524**	**$16,901,845**	**$0.00419**
Other						
Supplemental Fuel (MBtu)	0	0	0.00	$0	$0	$0.00000
SCR Catalyst (m3)	w/equip.	0.36	5,775.94	$0	$649,529	$0.00016
Emission Penalties	0	0	0.00	$0	$0	$0.00000
Subtotal Other				**$0**	**$649,529**	**$0.00016**
Waste Disposal						
Fly Ash (ton)	0	558.9954	16.23	$0	2,813,897.79	0.00070
Bottom Ash (ton)	0	112	16.23	$0	562,779.56	0.00014
Subtotal Waste Disposal				**$0**	**$3,376,677**	**$0.00084**
By-products & Emissions						
Gypsum (tons)	0	145	0.00	$0	$0	$0.00000
Subtotal By-products				**$0**	**$0**	**$0.00000**
TOTAL VARIABLE OPERATING COSTS				**$7,283,524**	**$35,813,489**	**$0.00889**
Fuel (ton)	0	5,765	38.18	**$0**	**$68,293,338**	**$0.01695**

Exhibit 10-22 Cost of electricity breakdown for Case 6B

TOC, $/kW	**3,047**
COE w/o TS&M, $/MW	**88.0**
Capital, $/MW	50.9
Fixed, $/MW	11.3
Variable, $/MW	8.9
Fuel, $/MW	16.9

10.3 Case 6C

Exhibit 10-23 Case 6C Stream table

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
V-L Mole Fraction														
Ar	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092	0.0000	0.0000	0.0087	0.0000	0.0087	0.0087	0.0000
CO_2	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0000	0.0000	0.1450	0.0000	0.1450	0.1450	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	0.0099	0.0099	0.0099	0.0099	0.0099	0.0099	0.0099	0.0000	0.0000	0.0870	0.0000	0.0870	0.0870	1.0000
N_2	0.7732	0.7732	0.7732	0.7732	0.7732	0.7732	0.7732	0.0000	0.0000	0.7324	0.0000	0.7324	0.7324	0.0000
O_2	0.2074	0.2074	0.2074	0.2074	0.2074	0.2074	0.2074	0.0000	0.0000	0.0247	0.0000	0.0247	0.0247	0.0000
SO_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0021	0.0000	0.0021	0.0021	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000	0.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	54,826	54,826	1,631	16,842	16,842	2,310	1,267	0	0	77,150	0	77,150	77,150	2,699
V-L Flowrate (kg/hr)	1,582,126	1,582,126	47,076	486,012	486,012	66,672	36,566	0	0	2,294,698	0	2,294,698	2,294,698	48,623
Solids Flowrate (kg/hr)	0	0	0	0	0	0	0	210,396	4,080	16,321	16,321	0	0	21,194
Temperature (°C)	15	19	19	15	25	25	15	15	15	169	15	169	189	15
Pressure (MPa, abs)	0.10	0.11	0.11	0.10	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.11	0.10
Enthalpy (kJ/kg)[A]	30.23	34.36	34.36	30.23	40.78	40.78	30.23	---	---	327.39	---	308.96	329.43	---
Density (kg/m^3)	1.2	1.2	1.2	1.2	1.3	1.3	1.2	---	---	0.8	---	0.8	0.9	---
V-L Molecular Weight	28.857	28.857	28.857	28.857	28.857	28.857	28.857	---	---	29.743	---	29.743	29.743	---
V-L Flowrate (lb_{mol}/hr)	120,872	120,872	3,597	37,131	37,131	5,094	2,794	0	0	170,088	0	170,088	170,088	5,950
V-L Flowrate (lb/hr)	3,487,990	3,487,990	103,784	1,071,474	1,071,474	146,986	80,615	0	0	5,058,943	0	5,058,943	5,058,943	107,195
Solids Flowrate (lb/hr)	0	0	0	0	0	0	0	463,843	8,996	35,982	35,982	0	0	46,725
Temperature (°F)	59	66	66	59	78	78	59	59	59	337	59	337	371	59
Pressure (psia)	14.7	15.3	15.3	14.7	16.1	16.1	14.7	14.7	14.7	14.4	14.7	14.2	16.0	15.0
Enthalpy (Btu/lb)[A]	13.0	14.8	14.8	13.0	17.5	17.5	13.0	---	---	140.8	---	132.8	141.6	---
Density (lb/ft^3)	0.076	0.078	0.078	0.076	0.081	0.081	0.076	---	---	0.050	---	0.049	0.053	---
	A - Reference conditions are 32.02 F & 0.089 PSIA													

Exhibit 10-23 Case 6C Stream table (Continued)

	15	16	17	18	19	20	21	22	23	24	25	26	27	28
V-L Mole Fraction														
Ar	0.0000	0.0128	0.0000	0.0083	0.0074	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CO_2	0.0000	0.0005	0.0002	0.1378	0.0124	0.4996	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	1.0000	0.0062	0.9998	0.1364	0.3440	0.4717	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
N_2	0.0000	0.7506	0.0000	0.6931	0.6146	0.0277	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
O_2	0.0000	0.2300	0.0000	0.0243	0.0216	0.0010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SO_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	9,427	792	201	82,380	92,909	20,822	10,195	26,859	26,859	85,696	69,245	69,245	36,233	36,233
V-L Flowrate (kg/hr)	169,823	22,996	3,622	2,393,275	2,317,793	651,607	448,697	483,865	483,865	1,543,838	1,247,472	1,247,472	652,745	652,745
Solids Flowrate (kg/hr)	0	0	32,812	0	0	0	0	0	0	0	0	0	0	0
Temperature (°C)	15	181	56	56	110	144	43	414	98	732	390	760	38	40
Pressure (MPa, abs)	0.10	0.31	0.11	0.11	0.10	0.11	15.27	0.51	0.92	34.47	4.90	4.35	0.01	1.69
Enthalpy (kJ/kg)[A]	-46.80	191.58	---	270.73	756.76	846.08	-188.56	3,300.32	409.55	3,803.80	3,174.83	4,042.33	2,312.37	168.85
Density (kg/m^3)	1,003.1	2.4	---	1.1	0.8	1.0	723.6	1.6	960.1	81.3	17.3	9.2	0.1	993.0
V-L Molecular Weight	18.015	29.029	---	29.052	24.947	31.294	44.010	18.015	18.015	18.015	18.015	18.015	18.015	18.015
V-L Flowrate (lb_{mol}/hr)	20,782	1,746	443	181,617	204,830	45,905	22,477	59,213	59,213	188,927	152,660	152,660	79,880	79,880
V-L Flowrate (lb/hr)	374,396	50,697	7,984	5,276,268	5,109,858	1,436,547	989,208	1,066,739	1,066,739	3,403,579	2,750,205	2,750,205	1,439,057	1,439,057
Solids Flowrate (lb/hr)	0	0	72,337	0	0	0	0	0	0	0	0	0	0	0
Temperature (°F)	59	357	133	133	230	291	110	777	208	1,350	734	1,400	101	104
Pressure (psia)	14.7	45.0	15.7	15.7	14.8	15.6	2,214.5	73.5	133.6	5,000.0	710.8	630.8	1.0	245.0
Enthalpy (Btu/lb)[A]	-20.1	82.4	---	116.4	325.3	363.7	-81.1	1,418.9	176.1	1,635.3	1,364.9	1,737.9	994.1	72.6
Density (lb/ft^3)	62.622	0.149	---	0.072	0.050	0.061	45.175	0.100	59.940	5.073	1.078	0.575	0.003	61.990

Exhibit 10-24 Case 6C Performance summary

	Case 6C	Units
Plant Output		
Steam Turbine Power	642,200	kW_e
Total	**642,200**	kW_e
Auxiliary Load		
Coal Handling and Conveying	460	kW_e
Pulverizers	3,150	kW_e
Sorbent Handling & Reagent Preparation	1,020	kW_e
Ash Handling	600	kW_e
Primary Air Fans	1,480	kW_e
Forced Draft Fans	1,880	kW_e
Induced Draft Fans	13,460	kW_e
SCR	50	kW_e
Baghouse	80	kW_e
Wet FGD	3,370	kW_e
TDA CO2 removal Auxiliaries	11,000	kW_e
CO_2 Compression	45,900	kW_e
Miscellaneous Balance of Plant[2,3]	2,000	kW_e
Steam Turbine Auxiliaries	400	kW_e
Condensate Pumps	410	kW_e
Circulating Water Pumps	6,170	kW_e
Ground Water Pumps	610	kW_e
Cooling Tower Fans	3,190	kW_e
Transformer Losses	2,190	kW_e
Total	**97,420**	**kW_e**
Plant Performance		
Net Auxiliary Load	97,420	kW_e
Net Plant Power	544,780	kW_e
Net Plant Efficiency (HHV)	34.4%	
Net Plant Heat Rate (HHV)	10,480 (9,933)	kJ/kWhr (Btu/kWhr)
Coal Feed Flowrate	210,396 (463,843)	kg/hr (lb/hr)
Thermal Input[1]	1,585,864	kW_{th}
Condenser Duty	1,405 (1,331)	GJ/hr (MMBtu/hr)
Raw Water Withdrawal	25.5 (6,726)	m^3/min (gpm)
Raw Water Consumption	20.1 (5,299)	m^3/min (gpm)

1 - HHV of Illinois No. 6 coal is 27,135 kJ/kg (11,666 Btu/lb)
2 – Boiler feed pumps are turbine driven
3 – Includes plant control systems, lighting, HVAC, and miscellaneous low voltage loads

Exhibit 10-25 Case 6C water balance

	Water Demand	Internal Recycle	Raw Water Withdrawal	Process Water Discharge	Raw Water Consumption
	m^3/min (gpm)				
Econamine	-	-	-	-	-
FGD Makeup	3.65 (963)	-	3.65 (963)	-	3.65 (963)
BFW Makeup	-	-	-	-	-
Cooling Tower	24.0 (6,346)	2.21 (583)	21.8 (5,763)	5.40 (1,427)	16.41 (4,336)
Total	**27.7 (7,309)**	**2.21 (583)**	**25.5 (6,726)**	**5.40 (1,427)**	**20.06 (5,299)**

Exhibit 10-26 Case 6C carbon balance

Carbon In		Carbon Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	163,602 (360,680)	Stack Gas	13,884 (30,609)
Air (CO2)	355 (783)	FGD Product	215 (474)
FGD Reagent	2,635 (5,809)	CO2 Product	122,457 (269,971)
	-	Convergence Tolerance	2 (4)
Total	**136,558 (301,058)**	**Total**	**136,558 (301,058)**

Exhibit 10-27 Case 6C sulfur balance

Sulfur In		Sulfur Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	5,273 (11,626)	FGD Product	5,168 (11,393)
		Stack Gas	3 (8)
		Econamine Polishing Scrubber/HSS	102 (225)
Total	**5,273 (11,626)**	**Total**	**5,273 (11,626)**

Exhibit 10-28 Case 6C energy balance

	HHV	Sensible + Latent	Power	Total
Heat In GJ/hr (MMBtu/hr)				
Coal	5,709 (5,411)	4.8 (4.5)	-	5,714 (5,416)
Air	-	63.6 (60.3)	-	63.6 (60.3)
Raw Water Makeup	-	95.8 (90.8)	-	95.8 (90.8)
Lime	-	0.24 (0.23)	-	0.24 (0.23)
Auxiliary Power	-	-	351 (332)	351 (332)
TOTAL	**5,709 (5,411)**	**164.4 (155.9)**	**351 (332)**	**6,224 (5,899)**
Heat Out GJ/hr (MMBtu/hr)				
Bottom Ash	-	0.5 (0.5)	-	0.5 (0.5)
Fly Ash + FGD Ash	-	2.0 (1.9)	-	2.0 (1.9)
Flue Gas	-	1,754 (1,662)	-	1,754 (1,662)
Condenser	-	1,405 (1,331)	-	1,405 (1,331)
CO2	-	-85 (-80)	-	-85 (-80)
Cooling Tower Blowdown	-	40.1 (38.0)	-	40.1 (38.0)
Econamine Losses	-	1,627 (1,542)	-	1,627 (1,542)
*Process Losses**	-	*-831.0 (-787.6)*	-	*-831.0 (-787.6)*
Power	-	-	2,312 (2,191)	2,312 (2,191)
TOTAL	**-**	**3,912 (3,708)**	**2,312 (2,191)**	**6,224 (5,899)**

* Process losses are estimated to match the heat input to the plant.

Exhibit 10-29 Case 6C air emissions

	kg/GJ (lb/MMBtu)	tonne/yr (Ton/year)	kg/MWgross (lb/MWgross)
SO_2	0.001 (0.003)	54 (59)	0.011 (.02)
NOx	0.030 (0.070)	1,355 (1,493)	0.268 (.590)
Particulate	0.006 (0.0130)	252 (277)	0.050 (.110)
Hg	4.91E-7 (1.14E-6)	0.022 (0.024)	4.37E-6 (9.63E-6)
CO_2	8.9 (20.7)	401,085 (442,121)	79 (175)

Exhibit 10-30 Case 6C capital costs

											Cost Base:	Jan 2007
											Prepared:	13-Mar-12
		Case:	6C									**x $1, 000**
		Plant Size:	544.78	MW, net			Capital Charge Factor		0.9			
			Equipment		**Labor**		**Bare**	**Eng'g CM**	**Process Cont.**	**Project Cont.**	**TOTAL PLANT COST**	
Acct No.		**Item/Description**	**Cost**	**Material Cost**	**Direct**	**Indirect**	**Erected**	**Total**	**Total**	**Total**	**$**	**$/kW**
1		COAL HANDLING SYSTEM										
	1.1	Coal Receive & Unload	3,638	0	1,662	0	5,300	474	0	866	6,639	12
	1.2	Coal Stackout & Reclaim	4,702	0	1,065	0	5,767	505	0	941	7,212	13
	1.3	Coal Conveyors & Yd Crus	4,371	0	1,054	0	5,425	475	0	885	6,786	12
	1.4	Other Coal Handling	1,144	0	244	0	1,388	121	0	226	1,735	3
	1.5	Sorbent Receive & Unload	147	0	44	0	192	17	0	31	240	0
	1.6	Sorbent Stackout & Reclaim	2,379	0	436	0	2,815	245	0	459	3,519	6
	1.7	Sorbent Conveyors	849	184	208	0	1,241	107	0	202	1,550	3
	1.8	Other Sorbent Handling	513	120	269	0	902	80	0	147	1,129	2
	1.9	Coal & Sorbent Hnd.Foundations	0	4,467	5,635	0	10,102	949	0	1,658	12,709	23
		SUBTOTAL 1.	**$17,742**	**$4,771**	**$10,617**	**$0**	**$33,130**	**$2,973**	**$0**	**$5,415**	**$41,518**	**$76**
2		COAL PREP & FEED SYSTEMS										
	2.1	Coal Crushing & Drying	2,094	0	408	0	2,502	218	0	408	3,128	6
	2.2	Prepared Coal Storage & Feed	5,362	0	1,170	0	6,532	571	0	1,065	8,169	15
	2.3	Slurry Prep & Feed	0	0	0	0	0	0	0	0	0	0
	2.4	Misc. Coal Prep & Feed	0	0	0	0	0	0	0	0	0	0
	2.5	Sorbent Prep Equipment	4,046	174	840	0	5,060	440	0	825	6,326	12
	2.6	Sorbent Storage & Feed	487	0	187	0	674	60	0	110	844	2
	2.7	Sorbent Injection System	0	0	0	0	0	0	0	0	0	0
	2.8	Booster Air Supply System	0	0	0	0	0	0	0	0	0	0
	2.9	Coal & Sorbent Feed Foundation	526	441	0	967	1,935	179	0	317	2,431	4
		SUBTOTAL 2.	**$12,515**	**$616**	**$2,605**	**$967**	**$16,704**	**$1,469**	**$0**	**$2,726**	**$20,898**	**$38**
3		FEEDWATER & MISC. BOP SYSTEMS										
	3.1	Feedwater System	17,472	0	5,644	0	23,116	2,020	0	3,770	28,906	53
	3.2	Water Makeup & Pretreating	5,253	0	1,691	0	6,944	657	0	1,520	9,121	17
	3.3	Other Feedwater Subsystems	5,349	0	2,261	0	7,610	682	0	1,244	9,535	18
	3.4	Service Water Systems	1,030	0	560	0	1,590	150	0	348	2,088	4
	3.5	Other Boiler Plant Systems	6,477	0	6,395	0	12,872	1,223	0	2,114	16,209	30
	3.6	FO Supply Sys & Nat Gas	263	0	328	0	591	56	0	97	744	1
	3.7	Waste Treatment Equipment	43	0	25	0	68	7	0	15	89	0
	3.8	Misc. Power Plant Equipment	2,788	0	852	0	3,639	350	0	798	4,787	9
		SUBTOTAL 3.	**$38,675**	**$0**	**$17,755**	**$0**	**$56,430**	**$5,143**	**$0**	**$9,906**	**$71,479**	**$131**
4		PC BOILER & ACCESSORIES										
	4.1	PC Boiler & Accessories	149,424	0	83,842	0	233,267	22,702	25,597	25,597	307,162	564
	4.2	SCR (w/4.1)	0	0	0	0	0	0	0	0	0	0
	4.3	Open	0	0	0	0	0	0	0	0	0	0
	4.4	Boiler BoP (w/ ID Fans)	0	0	0	0	0	0	0	0	0	0
	4.5	Primary Air System	w/4.1	0	w/4.1	0	0	0	0	0	0	0
	4.6	Secondary Air System	w/4.1	0	w/4.1	0	0	0	0	0	0	0
	4.8	Major Component Rigging	0	w/4.1	w/4.1	0	0	0	0	0	0	0
	4.9	Boiler Foundations	0	w/14.1	w/14.1	0	0	0	0	0	0	0
		SUBTOTAL 4.	**$149,424**	**$0**	**$83,842**	**$0**	**$233,267**	**$22,702**	**$25,597**	**$25,597**	**$307,162**	**$564**

Exhibit 10-30 Case 6C capital costs (Continued)

Acct No.	Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	TOTAL PLANT COST $	TOTAL PLANT COST $/kW
5A	FLUE GAS CLEANUP										
5.1	Absorber Vessels & Accessories	54,501	0	11,733	0	66,233	6,315	0	7,255	79,803	146
5.2	Other FGD	2,844	0	3,223	0	6,067	589	0	666	7,322	13
5.3	Bag House & Accessories	17,291	0	10,974	0	28,265	2,724	0	3,099	34,088	63
5.4	Other Particulate Removal Materials	1,172	0	1,255	0	2,427	235	0	266	2,929	5
5.5	Gypsum Dewatering System	4,961	0	843	0	5,804	552	0	636	6,992	13
5.6	Mercury Removal System	0	0	0	0	0	0	0	0	0	0
5.7	Open	0	0	0	0	0	0	0	0	0	0
	SUBTOTAL 5A.	**$80,770**	**$0**	**$28,027**	**$0**	**$108,797**	**$10,415**	**$0**	**$11,921**	**$131,133**	**$241**
5B	CO2 REMOVAL & COMPRESSION										
5B.1	CO2 Removal System	107,452	0	86,344	0	193,796	18,529	38,759	50,217	301,301	553
5B.2	CO2 Compression & Drying	27,929	0	8,762	0	36,690	3,509	0	8,040	48,239	89
	SUBTOTAL 5B.	**$135,381**	**$0**	**$95,106**	**$0**	**$230,487**	**$22,038**	**$38,759**	**$58,257**	**$349,540**	**$642**
6	COMBUSTION TURBINE/ACCESSORIES										
6.1	Combustion Turbine Generator	0	0	0	0	0	0	0	0	0	0
6.2	Combustion Turbine Accessories	0	0	0	0	0	0	0	0	0	0
6.3	Compressed Air Piping	0	0	0	0	0	0	0	0	0	0
6.4	Combustion Turbine Foundations	0	0	0	0	0	0	0	0	0	0
	SUBTOTAL 6.	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
7	HRSG, DUCTING & STACK										
7.1	Flue Gas Recycle Heat Exhchanger	N/A	0	N/A	0	0	0	0	0	0	0
7.2	SCR System	0	0	0	0	0	0	0	0	0	0
7.3	Ductwork	8,738	0	5,614	0	14,352	1,251	0	2,341	17,944	33
7.4	Stack	8,267	0	4,838	0	13,105	1,262	0	1,437	15,803	29
7.9	HRSG, Duct & Stack Foundations	0	948	1,077	0	2,026	190	0	443	2,659	5
	SUBTOTAL 7.	**$17,006**	**$948**	**$11,529**	**$0**	**$29,483**	**$2,703**	**$0**	**$4,220**	**$36,406**	**$67**
8	STEAM TURBINE GENERATOR										
8.1	Steam TG & Accessories	53,103	0	7,047	0	60,150	5,765	9,887	6,591	82,393	151
8.2	Turbine Plant Auxiliaries	358	0	766	0	1,124	110	0	123	1,357	2
8.3	Condenser & Auxiliaries	4,779	0	1,761	0	6,540	626	0	717	7,883	14
8.4	Steam Piping	16,346	0	8,060	0	24,405	2,050	0	3,968	30,424	56
8.9	TG Foundations	0	1,124	1,776	0	2,900	274	0	635	3,810	7
	SUBTOTAL 8.	**$74,585**	**$1,124**	**$19,410**	**$0**	**$95,120**	**$8,826**	**$9,887**	**$12,035**	**$125,867**	**$231**
9	COOLING WATER SYSTEM										
9.1	Cooling Towers	10,932	0	3,404	0	14,337	1,371	0	1,571	17,278	32
9.2	Circulating Water Pumps	2,105	0	162	0	2,267	192	0	246	2,704	5
9.3	Circ. Water System Auxiliaries	571	0	76	0	647	62	0	71	780	1
9.4	Circ. Water Piping	0	4,528	4,389	0	8,917	835	0	1,463	11,215	21
9.5	Make-up Water System	503	0	672	0	1,176	113	0	193	1,482	3
9.6	Component Cooling Water System	453	0	360	0	812	77	0	133	1,023	2
9.9	Circ. Water System Foundations	0	2,750	4,369	0	7,119	674	0	1,559	9,351	17
	SUBTOTAL 9.	**$14,564**	**$7,278**	**$13,433**	**$0**	**$35,275**	**$3,322**	**$0**	**$5,236**	**$43,833**	**$80**
10	ASH/SPENT SORBENT HANDLING SYS										
10.1	Ash Coolers	N/A	0	N/A	0	0	0	0	0	0	0
10.2	Cyclone Ash Letdown	N/A	0	N/A	0	0	0	0	0	0	0
10.3	HGCU Ash Letdown	N/A	0	N/A	0	0	0	0	0	0	0
10.4	High Temperature Ash Piping	N/A	0	N/A	0	0	0	0	0	0	0
10.5	Other Ash Recovery Equipment	N/A	0	N/A	0	0	0	0	0	0	0
10.6	Ash Storage Silos	637	0	1,963	0	2,601	255	0	286	3,141	6
10.7	Ash Transport & Feed Equipment	4,125	0	4,225	0	8,350	798	0	915	10,064	18
10.8	Misc. Ash Handling Equipment	0	0	0	0	0	0	0	0	0	0
10.9	Ash/Spent Sorbent Foundation	0	151	178	0	330	31	0	72	433	1
	SUBTOTAL 10.	**$4,762**	**$151**	**$6,367**	**$0**	**$11,281**	**$1,085**	**$0**	**$1,273**	**$13,638**	**$25**

Exhibit 10-30 Case 6C capital costs (Continued)

Acct No.		Item/Description	Equipment Cost	Material Cost	Labor		Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	TOTAL PLANT COST	
					Direct	Indirect					$	$/kW
11		ACCESSORY ELECTRIC PLANT										
	11.1	Generator Equipment	1,638	0	266	0	1,904	177	0	156	2,237	4
	11.2	Station Service Equipment	4,652	0	1,528	0	6,180	578	0	507	7,265	13
	11.3	Switchgear & Motor Control	5,348	0	909	0	6,257	580	0	684	7,521	14
	11.4	Conduit & Cable Tray	0	3,353	11,593	0	14,946	1,447	0	2,459	18,852	35
	11.5	Wire & Cable	0	6,327	12,213	0	18,540	1,562	0	3,015	23,118	42
	11.6	Protective Equipment	261	0	888	0	1,149	112	0	126	1,388	3
	11.7	Standby Equipment	1,302	0	30	0	1,332	122	0	145	1,600	3
	11.8	Main Power Transformers	11,006	0	185	0	11,192	849	0	1,204	13,244	24
	11.9	Electrical Foundations	0	320	784	0	1,104	106	0	242	1,452	3
		SUBTOTAL 11.	**$24,208**	**$10,000**	**$28,398**	**$0**	**$62,606**	**$5,532**	**$0**	**$8,539**	**$76,676**	**$141**
12		INSTRUMENTATION & CONTROL										
	12.1	PC Control Equipment	w/12.7	0	w/12.7	0	0	0	0	0	0	0
	12.2	Combustion Turbine Control	N/A	0	N/A	0	0	0	0	0	0	0
	12.3	Steam Turbine Control	w/8.1	0	w/8.1	0	0	0	0	0	0	0
	12.4	Other Major Component Control	0	0	0	0	0	0	0	0	0	0
	12.5	Signal Processing Equipment	W/12.7	0	w/12.7	0	0	0	0	0	0	0
	12.6	Control Boards, Panels & Racks	506	0	303	0	809	76	40	139	1,065	2
	12.7	Computer Accessories	5,110	0	893	0	6,003	557	300	686	7,546	14
	12.8	Instrument Wiring & Tubing	2,770	0	5,495	0	8,265	704	413	1,407	10,790	20
	12.9	Other I & C Equipment	1,444	0	3,277	0	4,721	458	237	541	5,956	11
		SUBTOTAL 12.	**$9,830**	**$0**	**$9,968**	**$0**	**$19,798**	**$1,795**	**$990**	**$2,774**	**$25,357**	**$47**
13		IMPROVEMENTS TO SITE										
	13.1	Site Preparation	0	53	1,061	0	1,115	111	0	245	1,470	3
	13.2	Site Improvements	0	1,762	2,188	0	3,950	390	0	868	5,208	10
	13.3	Site Facilities	3,158	0	3,114	0	6,271	618	0	1,378	8,267	15
		SUBTOTAL 13.	**$3,158**	**$1,815**	**$6,364**	**$0**	**$11,336**	**$1,118**	**$0**	**$2,491**	**$14,946**	**$27**
14		BUILDINGS & STRUCTURES										
	14.1	Boiler Building	0	8,740	7,686	0	16,427	1,476	0	2,685	20,588	38
	14.2	Turbine Building	0	12,553	11,700	0	24,253	2,186	0	3,966	30,405	56
	14.3	Administration Building	0	627	663	0	1,291	117	0	211	1,619	3
	14.4	Circulation Water Pumphouse	0	130	104	0	234	21	0	38	293	1
	14.5	Water Treatment Buildings	0	680	620	0	1,300	117	0	213	1,629	3
	14.6	Machine Shop	0	420	282	0	701	62	0	115	878	2
	14.7	Warehouse	0	284	285	0	570	52	0	93	714	1
	14.8	Other Buildings & Structures	0	232	198	0	430	39	0	70	539	1
	14.9	Waste Treating Building & Str.	0	443	1,346	0	1,789	170	0	294	2,253	4
		SUBTOTAL 14.	**$0**	**$24,111**	**$22,883**	**$0**	**$46,994**	**$4,240**	**$0**	**$7,685**	**$58,919**	**$108**
		Total Cost	**$582,620**	**$50,815**	**$356,305**	**$967**	**$990,707**	**$93,359**	**$75,234**	**$158,074**	**$1,317,373**	**$2,418**

Exhibit 10-30 Case 6C capital costs (Continued)

Acct No.	Item/Description	Equipment Cost	Material Cost	Labor		Bare Erected	Eng'g CM	Process Cont.	Project Cont.	TOTAL PLANT COST	
				Direct	Indirect		Total	Total	Total	$	$/kW
	Owner's Costs									**$1,000**	**$/kW**
	Preproduction Costs										
	6 Months All Labor									$9,299	$17
	1 Month Maintenance Materials									$1,240	$2
	1 Month Non-fuel Consumables									$1,844	$3
	1 Month Waste Disposal									$320	$1
	25% of 1 Months Fuel Cost at 100% CF									$1,616	$3
	2% of TPC									$26,347	$48
	Total									**$40,666**	**$75**
	Inventory Capital										
	60 day supply of fuel and consumables at 100% CF									$16,298	$30
	0.5% of TPC (spare parts)									$6,587	$12
	Total									**$22,885**	**$42**
	Initial Cost for Catalyst and Chemicals									$16,553	$30
	Land									$900	$2
	Other Owner's Costs									$197,606	$363
	Financing Costs									$35,569	$65
	Total Overnight Costs (TOC)									**$1,631,553**	**$2,995**
	TASC Multiplier								(IOU, high-risk, 35 year)	1.14	
	Total As-Spent Cost (TASC)									**$1,859,970**	**$3,414**

Exhibit 10-31 Case 6C operation and maintenance costs

	6C				Cost Base (Jun):	2007
					Heat Rate-net (Btu/kWh):	9,933
					MWe-net:	545
					Capacity Factor (%):	**85**
OPERATING & MAINTENANCE LABOR						
Operating Labor						
Operating Labor Rate(base):	34.65	$/hour				
Operating Labor Burden:	30.00	% of base				
Labor O-H Charge Rate:	25.00	% of labor				
			Total			
Operating Labor Requirements(O.J.)per S	1 unit/mod.		Plant			
Skilled Operator	2.0		2.0			
Operator	11.3		11.3			
Foreman	1.0		1.0			
Lab Tech's, etc.	2.0		2.0			
TOTAL-O.J.'s	16.3		16.3			
					Annual Cost	Annual Unit Cost
					$	$/kW-net
Annual Operating Labor Cost					$6,444,907	$11.830
Maintenance Labor Cost					$8,433,333	$15.480
Administrative & Support Labor					$3,719,560	$6.828
Property Taxes and Insurance					$26,347,466	$48.363
TOTAL FIXED OPERATING COSTS					**$44,945,267**	$82.502
VARIABLE OPERATING COSTS						
						$/kWh-net
Maintenance Material Cost					**$12,650,000**	**$0.00312**
Consumables	Consumption Initial Fill	/Day	Unit Cost	Initial Fill Cost		
Water(/1000 gallons)	0	4,843	1.08	**$0**	**$1,625,223**	**$0.00040**
Chemicals		4.841				
MU & WT Chem. (lbs)	0	23,443	0.17	$0	$1,258,739	$0.00031
Limestone (ton)	0	561	21.63	$0	$3,763,275	$0.00093
Carbon (Mercury Removal) (lb)	0	0	1.05	$0	$0	$0.00000
TDA Adsobant System	1,456,705	4,989	5.00	$7,283,524	$7,738,744	$0.00191
NaOH (tons)	0	0	433.68	$0	$0	$0.00000
H2SO4 (tons)	0	0	138.78	$0	$0	$0.00000
Corrosion Inhibitor	0	0	0.00	$0	$0	$0.00000
Activated Carbon (lb)	0	1,345	1.05	$0	$438,116	$0.00011
Ammonia (19% NH3) (ton)	0	83.3	129.80	$0	$3,354,556	$0.00083
Subtotal Chemicals				**$7,283,524**	**$16,553,430**	**$0.00408**
Other						
Supplemental Fuel (MBtu)	0	0	0.00	$0	$0	$0.00000
SCR Catalyst (m3)	w/equip.	0.35	5,775.94	$0	$627,162	$0.00015
Emission Penalties	0	0	0.00	$0	$0	$0.00000
Subtotal Other				**$0**	**$627,162**	**$0.00015**
Waste Disposal						
Fly Ash (ton)	0	539.7355	16.23	$0	2,716,946.48	0.00067
Bottom Ash (ton)	0	108	16.23	$0	543,389.30	0.00013
Subtotal Waste Disposal				**$0**	**$3,260,336**	**$0.00080**
By-products & Emissions						
Gypsum (tons)	0	145	0.00	$0	$0	$0.00000
Subtotal By-products				**$0**	**$0**	**$0.00000**
TOTAL VARIABLE OPERATING COSTS				**$7,283,524**	**$34,716,151**	**$0.00856**
Fuel (ton)	0	5,566	38.18	**$0**	**$65,940,328**	**$0.01626**

Exhibit 10-32 Cost of electricity breakdown for Case 6C

TOC, $/kW	**2,995**
COE w/o TS&M, $/MW	**85.9**
Capital, $/MW	50.0
Fixed, $/MW	11.1
Variable, $/MW	8.6
Fuel, $/MW	16.3

10.4 Case 6D

Exhibit 10-33 Case 6D Stream table

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
V-L Mole Fraction														
Ar	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092	0.0000	0.0000	0.0087	0.0000	0.0087	0.0087	0.0000
CO_2	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0000	0.0000	0.1450	0.0000	0.1450	0.1450	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	0.0099	0.0099	0.0099	0.0099	0.0099	0.0099	0.0099	0.0000	0.0000	0.0870	0.0000	0.0870	0.0870	1.0000
N_2	0.7732	0.7732	0.7732	0.7732	0.7732	0.7732	0.7732	0.0000	0.0000	0.7324	0.0000	0.7324	0.7324	0.0000
O_2	0.2074	0.2074	0.2074	0.2074	0.2074	0.2074	0.2074	0.0000	0.0000	0.0247	0.0000	0.0247	0.0247	0.0000
SO_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0021	0.0000	0.0021	0.0021	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	1.0000	0.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	54,223	54,223	1,613	16,657	16,657	2,285	1,253	0	0	76,301	0	76,301	76,301	2,761
V-L Flowrate (kg/hr)	1,564,702	1,564,702	46,557	480,660	480,660	65,938	36,165	0	0	2,269,440	0	2,269,440	2,269,440	49,742
Solids Flowrate (kg/hr)	0	0	0	0	0	0	0	208,090	4,036	16,142	16,142	0	0	21,054
Temperature (°C)	15	19	19	15	25	25	15	15	15	169	15	169	189	15
Pressure (MPa, abs)	0.10	0.11	0.11	0.10	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.11	0.10
Enthalpy (kJ/kg)[A]	30.23	34.36	34.36	30.23	40.78	40.78	30.23	---	---	327.40	---	308.96	329.44	---
Density (kg/m^3)	1.2	1.2	1.2	1.2	1.3	1.3	1.2	---	---	0.8	---	0.8	0.9	---
V-L Molecular Weight	28.857	28.857	28.857	28.857	28.857	28.857	28.857	---	---	29.743	---	29.743	29.743	---
V-L Flowrate (lb_{mol}/hr)	119,541	119,541	3,557	36,722	36,722	5,038	2,763	0	0	168,215	0	168,215	168,215	6,087
V-L Flowrate (lb/hr)	3,449,578	3,449,578	102,642	1,059,674	1,059,674	145,367	79,731	0	0	5,003,258	0	5,003,258	5,003,258	109,662
Solids Flowrate (lb/hr)	0	0	0	0	0	0	0	458,759	8,897	35,588	35,588	0	0	46,416
Temperature (°F)	59	66	66	59	78	78	59	59	59	337	59	337	371	59
Pressure (psia)	14.7	15.3	15.3	14.7	16.1	16.1	14.7	14.7	14.7	14.4	14.7	14.2	16.0	15.0
Enthalpy (Btu/lb)[A]	13.0	14.8	14.8	13.0	17.5	17.5	13.0	---	---	140.8	---	132.8	141.6	---
Density (lb/ft^3)	0.076	0.078	0.078	0.076	0.081	0.081	0.076	---	---	0.050	---	0.049	0.053	---
	A - Reference conditions are 32.02 F & 0.089 PSIA													

Exhibit 10-33 Case 6D Stream table (Continued)

	15	16	17	18	19	20	21	22	23	24	25	26	27	28
V-L Mole Fraction														
Ar	0.0000	0.0128	0.0000	0.0083	0.0074	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CO_2	0.0000	0.0005	0.0002	0.1378	0.0124	0.5000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H_2O	1.0000	0.0062	0.9998	0.1363	0.3440	0.4714	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
N_2	0.0000	0.7506	0.0000	0.6933	0.6147	0.0277	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
O_2	0.0000	0.2300	0.0000	0.0243	0.0216	0.0010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SO_2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
V-L Flowrate (kg_{mol}/hr)	9,239	779	199	81,456	91,870	20,581	10,084	19,866	19,866	84,763	68,469	68,469	42,690	42,690
V-L Flowrate (kg/hr)	166,437	22,627	3,592	2,366,577	2,291,919	644,227	443,777	357,891	357,891	1,527,034	1,233,479	1,233,479	769,068	769,068
Solids Flowrate (kg/hr)	0	0	32,544	0	0	0	0	0	0	0	0	0	0	0
Temperature (°C)	15	181	56	56	110	144	43	414	98	732	390	760	38	40
Pressure (MPa, abs)	0.10	0.31	0.11	0.11	0.10	0.11	15.27	0.51	0.92	34.47	4.90	4.35	0.01	1.69
Enthalpy (kJ/kg)[A]	-46.80	191.58	---	270.49	756.84	845.38	-188.56	3,300.32	409.55	3,803.80	3,174.83	4,042.33	2,299.06	167.93
Density (kg/m^3)	1,003.1	2.4	---	1.2	0.8	1.0	723.6	1.6	960.1	81.3	17.3	9.2	0.1	993.1
V-L Molecular Weight	18.015	29.029	---	29.053	24.947	31.302	44.010	18.015	18.015	18.015	18.015	18.015	18.015	18.015
V-L Flowrate (lb_{mol}/hr)	20,368	1,718	439	179,579	202,538	45,373	22,231	43,797	43,797	186,871	150,947	150,947	94,115	94,115
V-L Flowrate (lb/hr)	366,931	49,884	7,919	5,217,410	5,052,816	1,420,277	978,362	789,014	789,014	3,366,533	2,719,357	2,719,357	1,695,506	1,695,506
Solids Flowrate (lb/hr)	0	0	71,748	0	0	0	0	0	0	0	0	0	0	0
Temperature (°F)	59	357	133	133	230	291	110	777	208	1,350	734	1,400	101	104
Pressure (psia)	14.7	45.0	15.7	15.7	14.8	15.6	2,214.5	73.5	133.6	5,000.0	710.8	630.8	1.0	245.0
Enthalpy (Btu/lb)[A]	-20.1	82.4	---	116.3	325.4	363.4	-81.1	1,418.9	176.1	1,635.3	1,364.9	1,737.9	988.4	72.2
Density (lb/ft^3)	62.622	0.149	---	0.072	0.050	0.061	45.175	0.100	59.940	5.073	1.078	0.575	0.003	61.995

Exhibit 10-34 Case 6D Performance summary

	Case 6D	Units
Plant Output		
Steam Turbine Power	650,600	kW_e
Total	**650,600**	kW_e
Auxiliary Load		
Coal Handling and Conveying	460	kW_e
Pulverizers	3,120	kW_e
Sorbent Handling & Reagent Preparation	1,010	kW_e
Ash Handling	600	kW_e
Primary Air Fans	1,460	kW_e
Forced Draft Fans	1,860	kW_e
Induced Draft Fans	13,310	kW_e
SCR	50	kW_e
Baghouse	80	kW_e
Wet FGD	3,330	kW_e
TDA CO2 removal Auxiliaries	10,900	kW_e
CO_2 Compression	54,550	kW_e
Miscellaneous Balance of Plant[2,3]	2,000	kW_e
Steam Turbine Auxiliaries	400	kW_e
Condensate Pumps	490	kW_e
Circulating Water Pumps	6,030	kW_e
Ground Water Pumps	600	kW_e
Cooling Tower Fans	3,120	kW_e
Transformer Losses	2,240	kW_e
Total	**105,610**	**kW_e**
Plant Performance		
Net Auxiliary Load	105,610	kW_e
Net Plant Power	544,990	kW_e
Net Plant Efficiency (HHV)	34.7%	
Net Plant Heat Rate (HHV)	10,361 (9,820)	kJ/kWhr (Btu/kWhr)
Coal Feed Flowrate	208,090 (458,759)	kg/hr (lb/hr)
Thermal Input[1]	1,568,483	kW_{th}
Condenser Duty	1,645 (1,559)	GJ/hr (MMBtu/hr)
Raw Water Withdrawal	24.9 (6,582)	m^3/min (gpm)
Raw Water Consumption	19.6 (5,186)	m^3/min (gpm)

1 - HHV of Illinois No. 6 coal is 27,135 kJ/kg (11,666 Btu/lb)
2 – Boiler feed pumps are turbine driven
3 – Includes plant control systems, lighting, HVAC, and miscellaneous low voltage loads

Exhibit 10-35 Case 6D water balance

	Water Demand	Internal Recycle	Raw Water Withdrawal	Process Water Discharge	Raw Water Consumption
	m^3/min (gpm)				
Econamine	-	-	-	-	-
FGD Makeup	3.61 (953)	-	3.61 (953)	-	3.61 (953)
BFW Makeup	-	-	-	-	-
Cooling Tower	23.5 (6,207)	2.19 (578)	21.3 (5,629)	5.28 (1,396)	16.02 (4,233)
Total	**27.1 (7,160)**	**2.19 (578)**	**24.9 (6,582)**	**5.28 (1,396)**	**19.63 (5,186)**

Exhibit 10-36 Case 6D carbon balance

Carbon In		Carbon Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	132,646 (292,435)	Stack Gas	13,732 (30,274)
Air (CO2)	288 (634)	FGD Product	222 (489)
FGD Reagent	2,136 (4,710)	CO2 Product	121,114 (267,011)
	-	Convergence Tolerance	2 (5)
Total	**135,070 (297,779)**	**Total**	**135,070 (297,779)**

Exhibit 10-37 Case 6D sulfur balance

Sulfur In		Sulfur Out	
	kg/hr (lb/hr)		kg/hr (lb/hr)
Coal	5,216 (11,498)	FGD Product	5,111 (11,268)
		Stack Gas	3 (7)
		Econamine Polishing Scrubber/HSS	101 (222)
Total	**5,216 (11,498)**	**Total**	**5,216 (11,498)**

Exhibit 10-38 Case 6D energy balance

	HHV	Sensible + Latent	Power	Total
Heat In GJ/hr (MMBtu/hr)				
Coal	5,647 (5,352)	4.7 (4.5)	-	5,651 (5,356)
Air	-	62.9 (59.6)	-	62.9 (59.6)
Raw Water Makeup	-	93.7 (88.9)	-	93.7 (88.9)
Lime	-	0.24 (0.23)	-	0.24 (0.23)
Auxiliary Power	-	-	380 (360)	380 (360)
TOTAL	**5,647 (5,352)**	**161.6 (153.2)**	**380 (360)**	**6,188 (5,865)**
Heat Out GJ/hr (MMBtu/hr)				
Bottom Ash	-	0.5 (0.5)	-	0.5 (0.5)
Fly Ash + FGD Ash	-	2.0 (1.9)	-	2.0 (1.9)
Flue Gas	-	1,735 (1,644)	-	1,735 (1,644)
Condenser	-	1,645 (1,559)	-	1,645 (1,559)
CO2	-	-84 (-79)	-	-84 (-79)
Cooling Tower Blowdown	-	39.3 (37.2)	-	39.3 (37.2)
Econamine Losses	-	1,318 (1,249)	-	1,318 (1,249)
*Process Losses**	-	*-809.1 (-766.9)*	-	*-809.1 (-766.9)*
Power	-	-	2,342 (2,220)	2,342 (2,220)
TOTAL	-	**3,846 (3,645)**	**2,342 (2,220)**	**6,188 (5,865)**

* Process losses are estimated to match the heat input to the plant.

Exhibit 10-39 Case 2 air emissions

	kg/GJ (lb/MMBtu)	tonne/yr (Ton/year)	kg/MWgross (lb/MWgross)
SO_2	0.001 (0.003)	53 (59)	0.010 (.02)
NOx	0.030 (0.070)	1,340 (1,477)	0.261 (.576)
Particulate	0.006 (0.0130)	249 (274)	0.049 (.107)
Hg	4.91E-7 (1.14E-6)	0.022 (0.024)	4.26E-6 (9.40E-6)
CO_2	8.9 (20.7)	396,687 (437,273)	77 (170)

Exhibit 10-40 Case 6D capital costs

									Cost Base:	Jan 2007	
									Prepared:	13-Mar-12	
	Case:	6D								x $1, 000	
	Plant Size:	544.99	MW, net		Capital Charge Factor		0.85				
Acct		Equipment		Labor		Bare	Eng'g CM	Process Cont.	Project Cont.	TOTAL PLANT COST	
No.	Item/Description	Cost	Material Cost	Direct	Indirect	Erected	Total	Total	Total	$	$/kW
1	COAL HANDLING SYSTEM										
1.1	Coal Receive & Unload	3,613	0	1,650	0	5,264	470	0	860	6,594	12
1.2	Coal Stackout & Reclaim	4,670	0	1,058	0	5,728	501	0	934	7,163	13
1.3	Coal Conveyors & Yd Crus	4,342	0	1,047	0	5,388	472	0	879	6,740	12
1.4	Other Coal Handling	1,136	0	242	0	1,378	120	0	225	1,723	3
1.5	Sorbent Receive & Unload	147	0	44	0	191	17	0	31	239	0
1.6	Sorbent Stackout & Reclaim	2,369	0	434	0	2,803	244	0	457	3,504	6
1.7	Sorbent Conveyors	845	183	207	0	1,235	107	0	201	1,543	3
1.8	Other Sorbent Handling	510	120	268	0	898	79	0	147	1,124	2
1.9	Coal & Sorbent Hnd.Foundations	0	4,438	5,598	0	10,036	943	0	1,647	12,625	23
	SUBTOTAL 1.	**$17,631**	**$4,740**	**$10,549**	**$0**	**$32,921**	**$2,954**	**$0**	**$5,381**	**$41,255**	**$76**
2	COAL PREP & FEED SYSTEMS										
2.1	Coal Crushing & Drying	2,079	0	405	0	2,484	217	0	405	3,106	6
2.2	Prepared Coal Storage & Feed	5,323	0	1,162	0	6,485	567	0	1,058	8,109	15
2.3	Slurry Prep & Feed	0	0	0	0	0	0	0	0	0	0
2.4	Misc. Coal Prep & Feed	0	0	0	0	0	0	0	0	0	0
2.5	Sorbent Prep Equipment	4,028	174	837	0	5,039	439	0	822	6,299	12
2.6	Sorbent Storage & Feed	485	0	186	0	671	60	0	110	840	2
2.7	Sorbent Injection System	0	0	0	0	0	0	0	0	0	0
2.8	Booster Air Supply System	0	0	0	0	0	0	0	0	0	0
2.9	Coal & Sorbent Feed Foundation	522	438	0	961	1,922	178	0	315	2,415	4
	SUBTOTAL 2.	**$12,438**	**$612**	**$2,590**	**$961**	**$16,600**	**$1,460**	**$0**	**$2,709**	**$20,769**	**$38**
3	FEEDWATER & MISC. BOP SYSTEMS										
3.1	Feedwater System	17,341	0	5,601	0	22,942	2,005	0	3,742	28,689	53
3.2	Water Makeup & Pretreating	5,173	0	1,665	0	6,838	647	0	1,497	8,982	16
3.3	Other Feedwater Subsystems	5,309	0	2,244	0	7,552	677	0	1,234	9,463	17
3.4	Service Water Systems	1,014	0	552	0	1,566	147	0	343	2,056	4
3.5	Other Boiler Plant Systems	6,424	0	6,343	0	12,767	1,213	0	2,097	16,077	29
3.6	FO Supply Sys & Nat Gas	262	0	327	0	589	56	0	97	741	1
3.7	Waste Treatment Equipment	43	0	24	0	67	7	0	15	88	0
3.8	Misc. Power Plant Equipment	2,780	0	849	0	3,629	349	0	796	4,774	9
	SUBTOTAL 3.	**$38,345**	**$0**	**$17,605**	**$0**	**$55,951**	**$5,099**	**$0**	**$9,820**	**$70,869**	**$130**

Exhibit 10-40 Case 6D capital costs (Continued)

Acct No.	Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	TOTAL PLANT COST $	TOTAL PLANT COST $/kW
4	PC BOILER & ACCESSORIES										
4.1	PC Boiler & Accessories	148,292	0	83,207	0	231,499	22,530	25,403	25,403	304,834	559
4.2	SCR (w/4.1)	0	0	0	0	0	0	0	0	0	0
4.3	Open	0	0	0	0	0	0	0	0	0	0
4.4	Boiler BoP (w/ ID Fans)	0	0	0	0	0	0	0	0	0	0
4.5	Primary Air System	w/4.1	0	w/4.1	0	0	0	0	0	0	0
4.6	Secondary Air System	w/4.1	0	w/4.1	0	0	0	0	0	0	0
4.8	Major Component Rigging	0	w/4.1	w/4.1	0	0	0	0	0	0	0
4.9	Boiler Foundations	0	w/14.1	w/14.1	0	0	0	0	0	0	0
	SUBTOTAL 4.	**$148,292**	**$0**	**$83,207**	**$0**	**$231,499**	**$22,530**	**$25,403**	**$25,403**	**$304,834**	**$559**
5A	FLUE GAS CLEANUP						*				
5.1	Absorber Vessels & Accessories	54,066	0	11,639	0	65,706	6,264	0	7,197	79,167	145
5.2	Other FGD	2,821	0	3,197	0	6,019	584	0	660	7,263	13
5.3	Bag House & Accessories	17,143	0	10,879	0	28,022	2,700	0	3,072	33,794	62
5.4	Other Particulate Removal Materials	1,163	0	1,244	0	2,407	233	0	264	2,904	5
5.5	Gypsum Dewatering System	4,936	0	838	0	5,775	550	0	632	6,957	13
5.6	Mercury Removal System	0	0	0	0	0	0	0	0	0	0
5.7	Open	0	0	0	0	0	0	0	0	0	0
	SUBTOTAL 5A.	**$80,129**	**$0**	**$27,798**	**$0**	**$107,927**	**$10,332**	**$0**	**$11,826**	**$130,085**	**$239**
5B	CO2 REMOVAL & COMPRESSION										
5B.1	CO2 Removal System	107,452	0	86,344	0	193,796	18,529	38,759	50,217	301,301	553
5B.2	CO2 Compression	12,753	0	4,001	0	16,753	1,675	0	3,686	22,114	41
5B.3	CO2 Intercooling	2,050	0	171	0	2,222	222	0	367	2,810	5
5B.4	CO2 Compression Aftercooler	3,480	0	291	0	3,771	377	0	622	4,770	9
5B.5	CO2 Drying	2,935	0	921	0	3,856	369	0	845	5,070	9
	SUBTOTAL 5B.	**$128,670**	**$0**	**$91,728**	**$0**	**$220,398**	**$21,172**	**$38,759**	**$55,736**	**$336,066**	**$617**
6	COMBUSTION TURBINE/ACCESSORIES										
6.1	Combustion Turbine Generator	0	0	0	0	0	0	0	0	0	0
6.2	Combustion Turbine Accessories	0	0	0	0	0	0	0	0	0	0
6.3	Compressed Air Piping	0	0	0	0	0	0	0	0	0	0
6.4	Combustion Turbine Foundations	0	0	0	0	0	0	0	0	0	0
	SUBTOTAL 6.	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
7	HRSG, DUCTING & STACK										
7.1	Flue Gas Recycle Heat Exhchanger	N/A	0	N/A	0	0	0	0	0	0	0
7.2	SCR System	0	0	0	0	0	0	0	0	0	0
7.3	Ductwork	8,715	0	5,599	0	14,314	1,248	0	2,334	17,897	33
7.4	Stack	8,261	0	4,834	0	13,096	1,261	0	1,436	15,792	29
7.9	HRSG, Duct & Stack Foundations	0	948	1,077	0	2,024	189	0	443	2,657	5
	SUBTOTAL 7.	**$16,976**	**$948**	**$11,510**	**$0**	**$29,434**	**$2,698**	**$0**	**$4,213**	**$36,345**	**$67**

Exhibit 10-40 Case 6D capital costs (Continued)

Acct No.	Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	TOTAL PLANT COST $	TOTAL PLANT COST $/kW
8	STEAM TURBINE GENERATOR										
8.1	Steam TG & Accessories	54,295	0	7,205	0	61,500	5,894	10,109	6,739	84,242	155
8.2	Turbine Plant Auxiliaries	366	0	783	0	1,149	112	0	126	1,387	3
8.3	Condenser & Auxiliaries	5,312	0	1,958	0	7,270	696	0	797	8,763	16
8.4	Steam Piping	16,221	0	7,998	0	24,219	2,035	0	3,938	30,192	55
8.9	TG Foundations	0	1,149	1,815	0	2,964	280	0	649	3,893	7
	SUBTOTAL 8.	**$76,193**	**$1,149**	**$19,759**	**$0**	**$97,102**	**$9,018**	**$10,109**	**$12,249**	**$128,478**	**$236**
9	COOLING WATER SYSTEM										
9.1	Cooling Towers	10,768	0	3,353	0	14,121	1,350	0	1,547	17,019	31
9.2	Circulating Water Pumps	2,065	0	159	0	2,224	188	0	241	2,653	5
9.3	Circ. Water System Auxiliaries	563	0	75	0	638	61	0	70	769	1
9.4	Circ. Water Piping	0	4,464	4,326	0	8,790	823	0	1,442	11,054	20
9.5	Make-up Water System	497	0	664	0	1,160	111	0	191	1,462	3
9.6	Component Cooling Water System	446	0	355	0	801	76	0	132	1,008	2
9.9	Circ. Water System Foundations	0	2,714	4,311	0	7,025	665	0	1,538	9,228	17
	SUBTOTAL 9.	**$14,339**	**$7,177**	**$13,243**	**$0**	**$34,760**	**$3,274**	**$0**	**$5,160**	**$43,194**	**$79**
10	ASH/SPENT SORBENT HANDLING SYS										
10.1	Ash Coolers	N/A	0	N/A	0	0	0	0	0	0	0
10.2	Cyclone Ash Letdown	N/A	0	N/A	0	0	0	0	0	0	0
10.3	HGCU Ash Letdown	N/A	0	N/A	0	0	0	0	0	0	0
10.4	High Temperature Ash Piping	N/A	0	N/A	0	0	0	0	0	0	0
10.5	Other Ash Recovery Equipment	N/A	0	N/A	0	0	0	0	0	0	0
10.6	Ash Storage Silos	629	0	1,939	0	2,569	252	0	282	3,103	6
10.7	Ash Transport & Feed Equipment	4,074	0	4,174	0	8,248	789	0	904	9,941	18
10.8	Misc. Ash Handling Equipment	0	0	0	0	0	0	0	0	0	0
10.9	Ash/Spent Sorbent Foundation	0	150	176	0	326	31	0	71	427	1
	SUBTOTAL 10.	**$4,704**	**$150**	**$6,289**	**$0**	**$11,143**	**$1,071**	**$0**	**$1,257**	**$13,471**	**$25**
11	ACCESSORY ELECTRIC PLANT										
11.1	Generator Equipment	1,667	0	271	0	1,938	180	0	159	2,276	4
11.2	Station Service Equipment	4,817	0	1,583	0	6,400	598	0	525	7,523	14
11.3	Switchgear & Motor Control	5,538	0	941	0	6,479	601	0	708	7,788	14
11.4	Conduit & Cable Tray	0	3,472	12,005	0	15,477	1,498	0	2,546	19,522	36
11.5	Wire & Cable	0	6,552	12,647	0	19,199	1,617	0	3,122	23,939	44
11.6	Protective Equipment	261	0	888	0	1,149	112	0	126	1,388	3
11.7	Standby Equipment	1,321	0	30	0	1,351	124	0	148	1,623	3
11.8	Main Power Transformers	11,074	0	186	0	11,261	854	0	1,211	13,326	24
11.9	Electrical Foundations	0	327	801	0	1,128	108	0	247	1,483	3
	SUBTOTAL 11.	**$24,679**	**$10,351**	**$29,354**	**$0**	**$64,383**	**$5,692**	**$0**	**$8,793**	**$78,868**	**$145**

Exhibit 10-40 Case 6D capital costs (Continued)

Acct No.	Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	TOTAL PLANT COST $	TOTAL PLANT COST $/kW
12	INSTRUMENTATION & CONTROL										
12.1	PC Control Equipment	w/12.7	0	w/12.7	0	0	0	0	0	0	0
12.2	Combustion Turbine Control	N/A	0	N/A	0	0	0	0	0	0	0
12.3	Steam Turbine Control	w/8.1	0	w/8.1	0	0	0	0	0	0	0
12.4	Other Major Component Control	0	0	0	0	0	0	0	0	0	0
12.5	Signal Processing Equipment	W/12.7	0	w/12.7	0	0	0	0	0	0	0
12.6	Control Boards, Panels & Racks	511	0	306	0	818	77	41	140	1,076	2
12.7	Computer Accessories	5,163	0	902	0	6,065	562	303	693	7,624	14
12.8	Instrument Wiring & Tubing	2,799	0	5,552	0	8,351	712	417	1,422	10,902	20
12.9	Other I & C Equipment	1,459	0	3,311	0	4,770	462	239	547	6,018	11
	SUBTOTAL 12.	**$9,932**	**$0**	**$10,071**	**$0**	**$20,003**	**$1,814**	**$1,000**	**$2,803**	**$25,620**	**$47**
13	IMPROVEMENTS TO SITE										
13.1	Site Preparation	0	53	1,059	0	1,112	110	0	244	1,467	3
13.2	Site Improvements	0	1,758	2,183	0	3,942	389	0	866	5,197	10
13.3	Site Facilities	3,151	0	3,107	0	6,258	617	0	1,375	8,249	15
	SUBTOTAL 13.	**$3,151**	**$1,811**	**$6,350**	**$0**	**$11,311**	**$1,116**	**$0**	**$2,485**	**$14,913**	**$27**
14	BUILDINGS & STRUCTURES										
14.1	Boiler Building	0	8,735	7,682	0	16,418	1,476	0	2,684	20,577	38
14.2	Turbine Building	0	12,542	11,689	0	24,231	2,184	0	3,962	30,378	56
14.3	Administration Building	0	627	663	0	1,289	117	0	211	1,617	3
14.4	Circulation Water Pumphouse	0	129	102	0	231	21	0	38	290	1
14.5	Water Treatment Buildings	0	670	611	0	1,281	115	0	210	1,606	3
14.6	Machine Shop	0	419	282	0	701	62	0	114	877	2
14.7	Warehouse	0	284	285	0	569	51	0	93	713	1
14.8	Other Buildings & Structures	0	232	198	0	430	39	0	70	538	1
14.9	Waste Treating Building & Str.	0	443	1,344	0	1,786	170	0	293	2,249	4
	SUBTOTAL 14.	**$0**	**$24,081**	**$22,855**	**$0**	**$46,936**	**$4,234**	**$0**	**$7,676**	**$58,846**	**$108**
	Total Cost	**$575,480**	**$51,019**	**$352,908**	**$961**	**$980,368**	**$92,463**	**$75,272**	**$155,511**	**$1,303,613**	**$2,392**

Exhibit 10-40 Case 6D capital costs (Continued)

Acct No.	Item/Description	Equipment Cost	Material Cost	Labor		Bare Erected	Eng'g CM	Process Cont.	Project Cont.	TOTAL PLANT COST	
				Direct	Indirect		Total	Total	Total	$	$/kW
	Owner's Costs									**$1,000**	**$/kW**
	Preproduction Costs										
	6 Months All Labor									$9,244	$17
	1 Month Maintenance Materials									$1,227	$2
	1 Month Non-fuel Consumables									$1,831	$3
	1 Month Waste Disposal									$308	$1
	25% of 1 Months Fuel Cost at 100% CF									$1,598	$3
	2% of TPC									$26,072	$48
	Total									**$40,281**	**$74**
	Inventory Capital										
	60 day supply of fuel and consumables at 100% CF									$16,138	$30
	0.5% of TPC (spare parts)									$6,518	$12
	Total									**$22,656**	**$42**
	Initial Cost for Catalyst and Chemicals									$16,466	$30
	Land									$900	$2
	Other Owner's Costs									$195,542	$359
	Financing Costs									$35,198	$65
	Total Overnight Costs (TOC)									**$1,614,655**	**$2,963**
	TASC Multiplier							(IOU, high-risk, 35 year)		1.14	
	Total As-Spent Cost (TASC)									**$1,840,707**	**$3,378**

Exhibit 10-41 Case 6D operation and maintenance costs

6D					Cost Base (Jun):	2007
					Heat Rate-net (Btu/kWh):	9,820
					MWe-net:	545
					Capacity Factor (%):	**85**
OPERATING & MAINTENANCE LABOR						
Operating Labor						
Operating Labor Rate(base):	34.65	$/hour				
Operating Labor Burden:	30.00	% of base				
Labor O-H Charge Rate:	25.00	% of labor				
Operating Labor Requirements(O.J.)per Shift:	1 unit/mod.		Total Plant			
Skilled Operator	2.0		2.0			
Operator	11.3		11.3			
Foreman	1.0		1.0			
Lab Tech's, etc.	2.0		2.0			
TOTAL-O.J.'s	16.3		16.3			
					Annual Cost	Annual Unit Cost
					$	$/kW-net
Annual Operating Labor Cost					$6,444,907	$11.826
Maintenance Labor Cost					$8,345,318	$15.313
Administrative & Support Labor					$3,697,556	$6.785
Property Taxes and Insurance					$26,072,267	$47.840
TOTAL FIXED OPERATING COSTS					**$44,560,048**	$81.763
VARIABLE OPERATING COSTS						
						$/kWh-net
Maintenance Material Cost					**$12,517,977**	**$0.00308**
Consumables	Consumption Initial Fill	/Day	Unit Cost	Initial Fill Cost		
Water(/1000 gallons)	0	4,739	1.08	**$0**	**$1,590,374**	**$0.00039**
Chemicals		4.841				
MU & WT Chem. (lbs)	0	22,940	0.17	$0	$1,231,748	$0.00030
Limestone (ton)	0	557	21.63	$0	$3,738,417	$0.00092
Carbon (Mercury Removal) (lb)	0	0	1.05	$0	$0	$0.00000
TDA Adsobant System	1,456,705	4,992	5.00	$7,283,524	$7,743,840	$0.00191
NaOH (tons)	0	0	433.68	$0	$0	$0.00000
H2SO4 (tons)	0	0	138.78	$0	$0	$0.00000
Corrosion Inhibitor	0	0	0.00	$0	$0	$0.00000
Activated Carbon (lb)	0	1,330	1.05	$0	$433,312	$0.00011
Ammonia (19% NH3) (ton)	0	82	129.80	$0	$3,318,312	$0.00082
Subtotal Chemicals				**$7,283,524**	**$16,465,630**	**$0.00406**
Other						
Supplemental Fuel (MBtu)	0	0	0.00	$0	$0	$0.00000
SCR Catalyst (m3)	w/equip.	0.35	5,775.94	$0	$620,258	$0.00015
Emission Penalties	0	0	0.00	$0	$0	$0.00000
Subtotal Other				**$0**	**$620,258**	**$0.00015**
Waste Disposal						
Fly Ash (ton)	0	528	16.23	$0	2,657,871.64	0.00065
Bottom Ash (ton)	0	96	16.23	$0	483,249.39	0.00012
Subtotal Waste Disposal				**$0**	**$3,141,121**	**$0.00077**
By-products & Emissions						
Gypsum (tons)	0	145	0.00	$0	$0	$0.00000
Subtotal By-products				**$0**	**$0**	**$0.00000**
TOTAL VARIABLE OPERATING COSTS				**$7,283,524**	**$34,335,359**	**$0.00846**
Fuel (ton)	0	5,505	38.18	**$0**	**$65,217,589**	**$0.01607**

Exhibit 10-42 Cost of electricity breakdown for Case 6D

TOC, $/kW	**2963**
COE w/o TS&M, $/MW	**83.7**
Capital, $/MW	49.4
Fixed, $/MW	11.0
Variable, $/MW	7.2
Fuel, $/MW	16.1

10.5 Case 6E

Case 6E is identical to Case 6D in all process, performance, and costing measures. The sole difference between the cases is that Case 6D is a high-risk case and Case 6E is a low-risk case. This difference shows up in Exhibit 10-43 as a lower TASC cost ($3,360/kW in Case 6E versus $3,378/kW in Case 6D) and in Exhibit 10-44 as a lower COE ($80.6/MW in Case 6E versus $83.7/MW in Case 6D).

Exhibit 10-43 Case 6E capital costs

Acct No.	Item/Description	Equipment Cost	Material Cost	Labor Direct	Labor Indirect	Bare Erected	Eng'g CM Total	Process Cont. Total	Project Cont. Total	TOTAL PLANT COST $	TOTAL PLANT COST $/kW
	Owner's Costs									**$1,000**	**$/kW**
	Preproduction Costs										
	6 Months All Labor									$9,244	$17
	1 Month Maintenance Materials									$1,227	$2
	1 Month Non-fuel Consumables									$1,831	$3
	1 Month Waste Disposal									$308	$1
	25% of 1 Months Fuel Cost at 100% CF									$1,598	$3
	2% of TPC									$26,072	$48
	Total									**$40,281**	**$74**
	Inventory Capital										
	60 day supply of fuel and consumables at 100% CF									$16,138	$30
	0.5% of TPC (spare parts)									$6,518	$12
	Total									**$22,656**	**$42**
	Initial Cost for Catalyst and Chemicals									$16,466	$30
	Land									$900	$2
	Other Owner's Costs									$195,542	$359
	Financing Costs									$35,198	$65
	Total Overnight Costs (TOC)									**$1,614,655**	**$2,963**
	TASC Multiplier							(IOU, low-risk, 35 year)		1.134	
	Total As-Spent Cost (TASC)									**$1,831,019**	**$3,360**

Exhibit 10-44 Cost of electricity breakdown for Case 6E

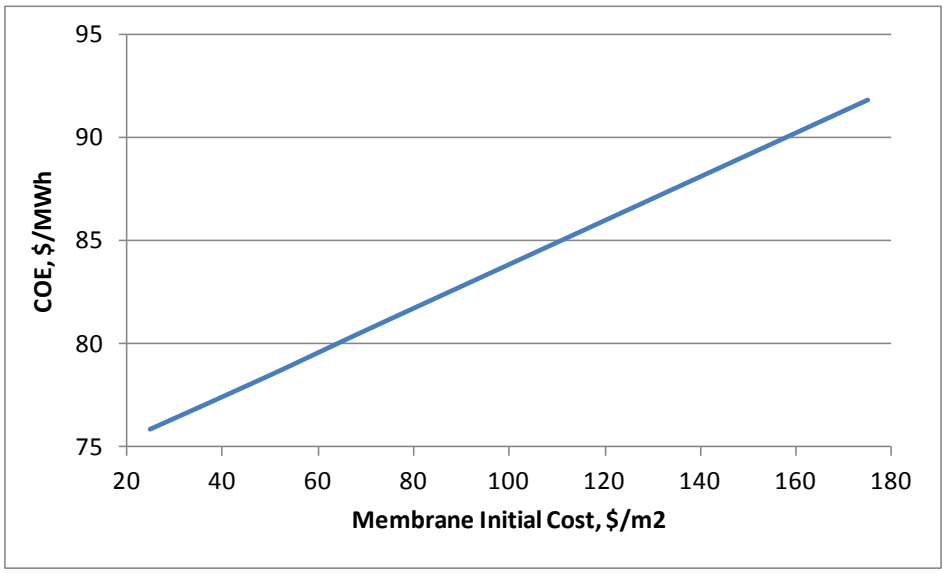
TOC, $/kW	**2963**
COE w/o TS&M, $/MW	**80.6**
Capital, $/MW	46.4
Fixed, $/MW	11.0
Variable, $/MW	7.2
Fuel, $/MW	16.1

11 Parameter Sensitivities

11.1 Membrane Cost

Exhibit 11-1 provides a chart that shows the effect of membrane cost on COE. The case selected for this sensitivity is Case 5D, the case with advanced ultra-supercritical steam and shockwave compression. The membrane installed cost for this case is $\$80/m^2$.

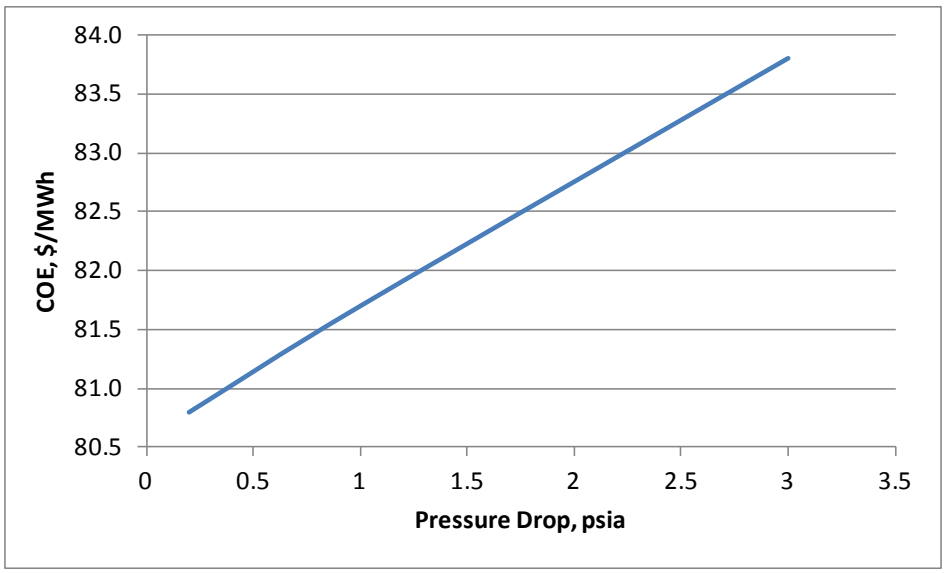
Exhibit 11-1 Impact of membrane initial cost on COE (case 5D)



11.2 Membrane Pressure Drop

Exhibit 11-2 provides a chart that demonstrates the impact of the pressure drop across the membrane on COE. The case selected for this sensitivity is Case 5D with an assumed pressure drop of 1 psi.

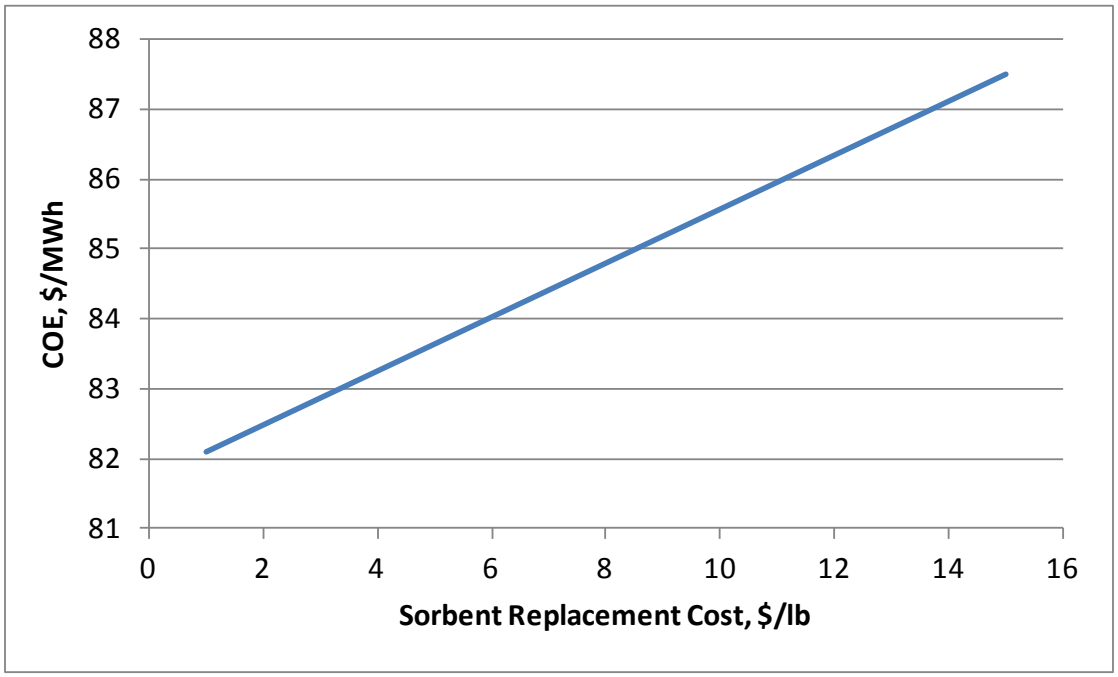
Exhibit 11-2 Impact of pressure drop on COE (case 5D)



11.3 Adsorbent Cost

Exhibit 11-3 provides a chart that demonstrates the impact of sorbent replacement cost on COE. The case selected for this sensitivity is Case 6D with an assumed adsorbent cost of $5/lb.

Exhibit 11-3 Impact of adsorbent replacement cost on COE (case 6D)



11.4 Steam Conditions versus COE

Exhibit 11-4 and Exhibit 11-5 provide a graph that demonstrates the impact of stream conditions on COE. The cases selected for this sensitivity are Cases 5A, B, and C and 6A, B, and C. The A cases are with supercritical steam, the B cases are with ultra-supercritical steam, and the C cases are with advanced ultra-supercritical steam. The use of ultra-supercritical steam case assumes no additional cost for the boiler or steam turbine. The advanced ultra-supercritical steam case assumes a 10% process contingency for the boiler and a 15% process contingency for the steam turbine.

Exhibit 11-4 Membrane Pathway: Impact of steam conditions on COE

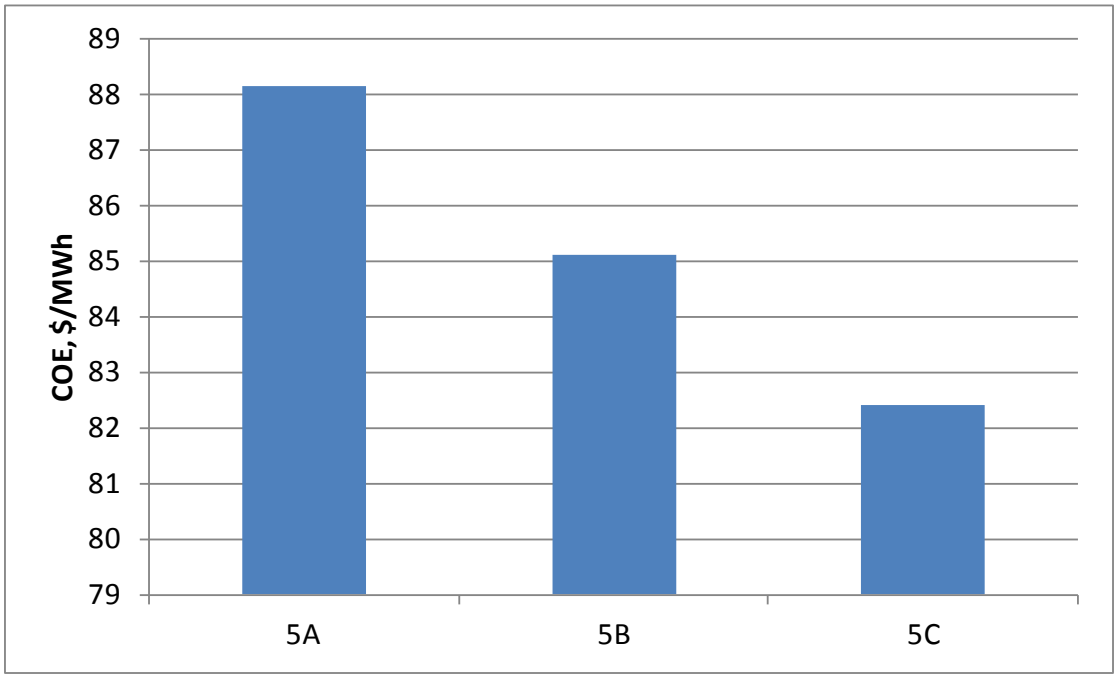
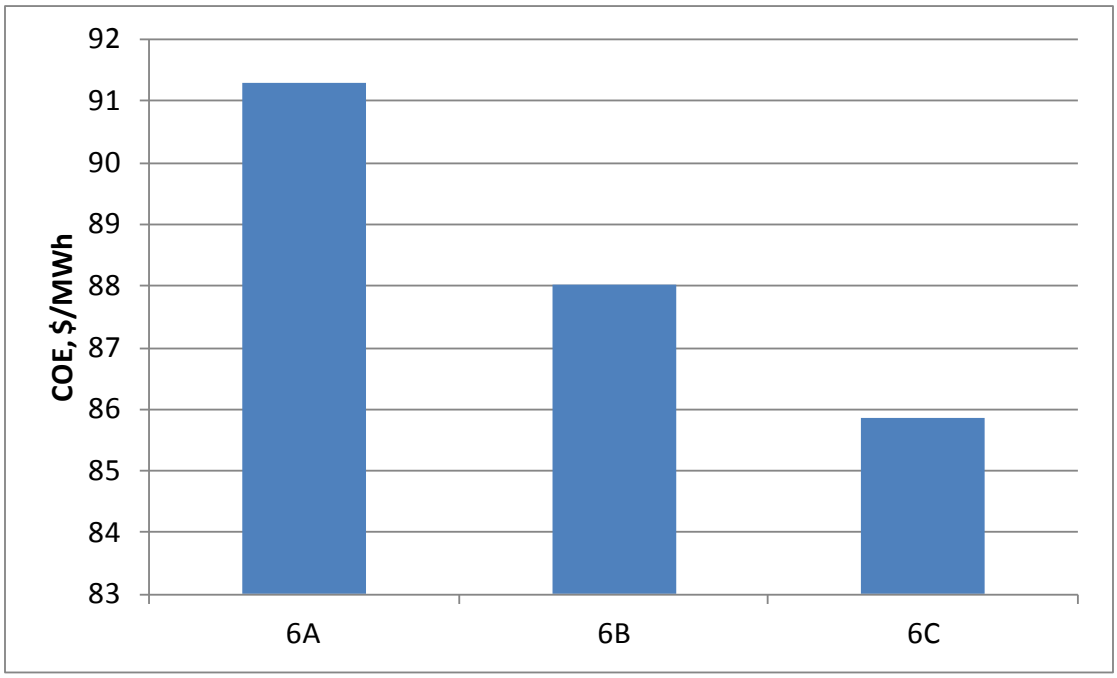


Exhibit 11-5 Adsorbent Pathway: Impact of steam conditions on COE



11.5 Capacity Factor

Exhibit 11-6 and Exhibit 11-7 provide a chart showing the impact that the capacity factor has on the COE. The cases selected for this sensitivity are Cases 5D and 6D. The plant capacity factor assumed for all the pathway cases is 85%.

Exhibit 11-6 Impact of capacity factor on COE (Case 5D)

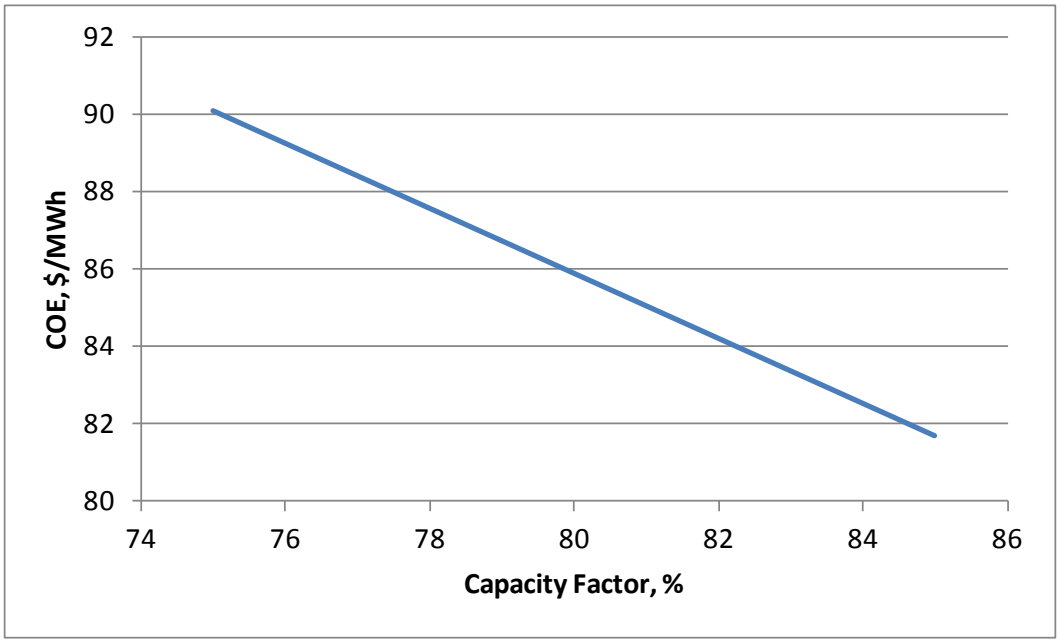
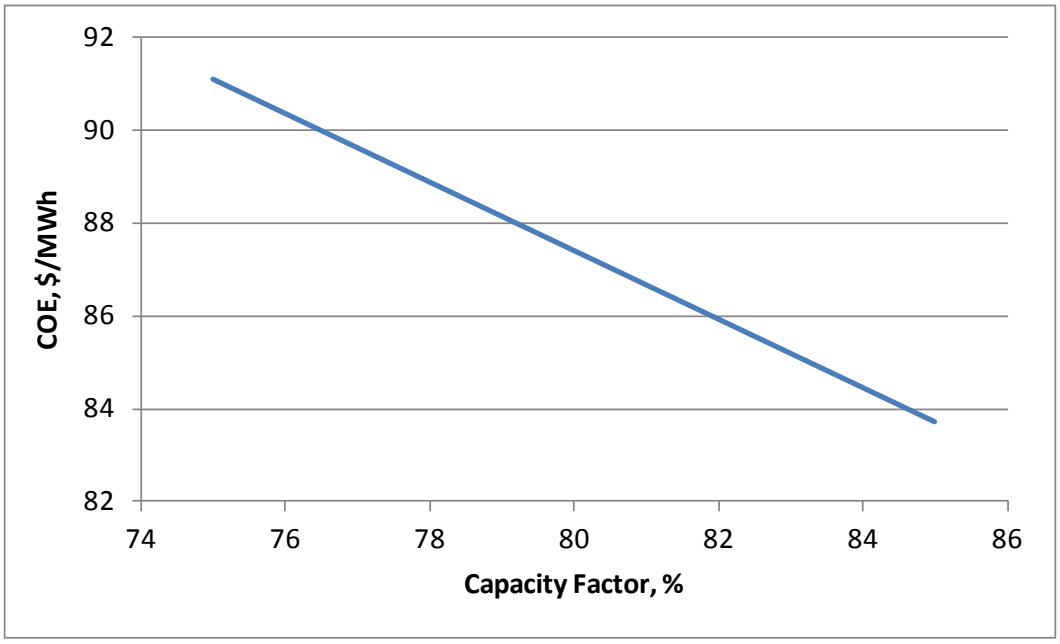


Exhibit 11-7 Impact of capacity factor on COE (case 6D)



12 Conclusion

This study concludes that a PC power plant utilizing an advanced CO_2 membrane technology (Case 5E), or an advanced CO_2 adsorbent technology (Case 6E), has the potential to meet the DOE 35-percent goal. The respective capture technology performance and cost for these cases assumes process design and operating parameters beyond current demonstrated performance. These cases also include advances in the steam conditions and CO_2 compression. Thus, meeting the goal will require advances in CO_2 capture technology, operating boiler and steam turbine steam conditions, and CO_2 compression technology. The results from the integrated system analyses provide information that will inform and guide technology development.

13 References

1. "Gas Turbines – Procurement – Part 2: Standard Reference Conditions and Ratings." ISO 3977-2:1997, and "Gas Turbines - Acceptance Tests." ISO 2314:1989. Edition 2. International Organization for Standardization. Geneva, Switzerland. http://www.iso.org/iso/en/xsite/copyright.html.
2. Black, James. "Cost and Performance Baseline for Fossil Energy Plants Volume 1: Bituminous Coal and Natural Gas to Electricity." November 2010. DOE/NETL-2010/1397.
3. North American Electric Reliability Council website. http://www.nerc.com/~gads/.
4. Hensley, John C. (Ed). "Cooling Tower Fundamentals." 2nd Edition. The Marley Cooling Tower Company. Mission, Kansas. 1985.
5. J. Elliott, G. Srinivas, and R. Copeland. "Post-Combustion CO_2 Capture with Alkalized Alumina." presented at the 2010 NETL CO_2 Capture Technology Meeting. Pittsburgh, PA. September 13-17, 2010.
6. Merkel, Tim C., Haiqing Lin, Xiaotong Wei, Richard Baker. "Power Plant Post-Combustion Carbon Dioxide Capture: An opportunity for membranes." Journal of Membrane Science. 359 (2010). pp 126–139.
7. Amo, K., et al. "Membrane Process to Capture Carbon Dioxide from Coal-Fired Power Plant Flue Gas." presented at the 2010 NETL CO_2 Capture Technology Meeting. Pittsburgh, PA. September 13-17, 2010.
8. "Ramgen Power Systems." presented at Workshop on Future large CO_2 Compression Systems. Gaithersburg, MD. March 2009.
9. Matuszewski, M. "Benefits of Ramgen Shock Compression Technology for CO_2 Compression." June 2009. DOE/NETL-2009/0629.
10. Reddy, Satish, "Econamine FG Plus^{SM} Technology for Post-combustion CO_2 Capture," 11th Meeting of the International Post-Combustion CO_2 Capture Network, May 20 – 21, 2008, Vienna, Austria