

Run: 1 - CO2 Avoidance Costs

Summary of Options CO2 Avoidance Costs For Existing Coal Power Plant Baseline

Natural gas price set so the same power costs for replacement NGCC or PC both without CCS & no CO2 tax

Case Number	CO2 Mitigation Options - all built at old PC site	Net MWe	New Capital mid-2008 Millions	constant \$ /kWe	Net Efficiency % HHV	CO2 Emissions mt/MWhe	CO2 Avoidance \$/mt CO2	Power Cost mid-2008 \$/MWh
O-PC	Baseline Paid-off Old Coal Plant - no CCS sub PC with FGD size set to NGCC MW	543	Paid off	Paid off	33.6%	0.95	Baseline	\$ 36.8
O-PC-C1	Old PC & ST with new Post CCS add-on new small BT ST + MHI amine CO2 scrubber	398	\$ 528	\$ 1,325	24.7%	0.13	\$ 74	\$ 97.9
O-PC-C2	Old PC + upgrade & new Post CCS add-on rebuild SH/RH + sub ST/gen & MHI amine scrubber	418	\$ 755	\$ 1,807	25.9%	0.12	\$ 79	\$ 102.4
NGCC	Replacement NGCC - no CCS "F" class NGCC with SCR no CO2 Capture	543	\$ 540	\$ 993	50.7%	0.36	\$ 67	\$ 76.2
NGCC-C	Replacement NGCC with Post CO2 Capture "F" class GT with MHI amine CO2 scrubber	463	\$ 836	\$ 1,805	43.3%	0.06	\$ 83	\$ 110.7
N-PC	Rebuild SC-PC Power Plant - no CCS Supercritical PC + FGD & SCR - not CO2 Capture	630	\$ 1,354	\$ 2,151	39.0%	0.82	\$ 302	\$ 76.2
N-PC-C	Rebuild SC-PC with Post CO2 Capture Supercritical PC with MHI amine CO2 Scrubber	499	\$ 1,765	\$ 3,537	30.9%	0.10	\$ 111	\$ 130.8
N-OPC-C	Rebuild SC-PC with Oxyfuel CO2 Capture Supercritical PC with oxygen & flue gas recycle	485	\$ 1,644	\$ 3,389	30.1%	0.07	\$ 104	\$ 128.0
IGCC-C	Repower H2-IGCC Pre-comb CO2 Capture HP GE Gasifier with quench, CO shift & H2/N2-fired GE 7FB GT	517	\$ 1,667	\$ 3,224	32.0%	0.08	\$ 94	\$ 119.5

Does not account for power replacement of net drop from the original **543 MWe** plus shorter remaining life of the old PC

Input Capital Cost Variables

General Facilities for rebuild/retrofit at existing PC site	25%	of New Installed Process unit capital	existing site saving???
Engineering, Startup & Working Cap	15%	of New Installed Process unit capital	
Contingencies	10%	of New Installed Process unit capital	
Inflation adjustment from mid-2004 dollars	650	Ch. Eng. index for mid-2008	constant \$
Location adjustment	115%	of U.S. Gulf Coast costs to cover extra 10% for CCS risk	

Note: this analysis does not include owner's costs or allowance for funds during construction (AFDC) being capitalized

Input Operating Cost Variables

Average annual capacity factor of all options at	85%	NG can be lower due to its higher marginal dispatch cost	
Capital charges (if capitalize AFDC, lower for same return)	15.0%	/yr of total capital or	6.67 yr capital payback
Non-Fuel O&M Costs	4.5%	/yr of total capital less	1.0% for NGCC
Illinois Bit in Midwest min. shipping	\$ 2.00	per million Btu HHV or	\$ 48.43 per mt raw coal
Same coal input for all coal cases set at O-PC = NGCC	174.5	mt/hr raw coal design or	1,613 Mwt HHV coal input
Breakeven NG price for NGCC= N-PC both wo CCS & no CO2 tax	\$ 7.65	per million Btu HHV	NG prices should go up if CO2 tax
Breakeven NG price will likely change if high enough CO2 tax to make CO2 capture cost effective			
Natural gas input set to fill 2-7FB GT at	3,654	million Btu/hr HHV	1,071 Mwt HHV NG input
CO2 pipeline, injection & monitoring, high due to old PC locations	\$ 15.00	/mt ton CO2 or	\$ 0.79 per 1,000 scf HP CO2
Limestone minimal shipping	\$ 30	/mt	
"what if" minimal gypsum or sulfur byproduct credits	\$ (5.00)	/mt gypsum or	\$ (26.88) /mt sulfur equivalent
"what if" NOx emissions requires purchased credits at	\$ 2,000	/mt as NO2	
"what if" SO2 emissions requires purchased credits at	\$ 1,000	/mt SO2	
"what if" Hg emissions requires purchased credits at	\$ 20,000	/lb Hg	
CO2 emissions tax at zero to calculate CO2 Avoidance Cost	\$ -	/mt CO2 or	\$ - per mt carbon equivalent

Must set CO2 emissions tax at zero to calculate CO2 avoidance costs, thus all CCS cases have much high power costs

CO2 avoidance is the lowest CO2 tax where paying the tax or reducing CO2 emissions (with NG or CCS) are the same power costs

Case: O-PC Continued
Economic Estimate of Baseline Old Exiting Paid-off Subcritical PC Boiler with Bit Coal

Capital Cost Estimates	Units of Flow	Flow Rates		Trains	Baseline Unit	Unit Capital	Multi train or Size/cost exp factor	Adjusted unit cost	unit capital costs	
		Actual	ISOdesign						\$ Million	\$/kWe
Coal & limestone handling & storage	mt/d coal & limestone	5,961	7,153	1	\$6,000	10,000	0.70	6,634	47	87
Flue gas dry milling dilute pneumatic feed	mt/d raw coal	5,458	7,096	4	\$3,000	1,774	0.85	2,437	17	32
Sub-critical PC Boilers	Bit.									
Sub-critical PC Boilers	kWt heat exchange	1,400,624	1,540,686	1	\$100	1,400,000	0.85	99	152	280 \$
Selective Cat. Reduction NOx control	kg mol/h raw flue gas	80,966	89,063	1	\$0	80,000	0.70	0	0	0 per lb/h
FGD - wet limestone absorber	kg mol/h raw flue gas	80,966	89,063	1	\$500	80,000	0.70	484	43	79 steam
FGD - forced oxidation to gypsum	mt/d gypsum	865	1,038	1	\$10,000	750	0.70	9,071	9	17
ESP	kg mol/h raw flue gas	80,966	89,063	1	\$75	80,000	0.70	73	6	12
Subcritical reheat steam turbine & gen	kWe ST gross	593,314	622,980	1	\$210	500,000	0.80	201	125	231
Installed process unit costs									401	738
General Facilities		25% of Installed Process unit capital							100	185
Engineering, Startup & Working Cap		15% of Installed Process unit capital							60	111
Contingencies		10% of Installed Process unit capital							40	74
U.S. Gulf Coast Reference \$2004 Baseline Unit Capital Cost									601	1,107
Inflation adjustment to	650 Ch.E. index change for mid-2008			from	444 Ch.E index mid 2004\$	baseline			880	1,621
Location adjustment to	115% of U.S. Gulf Coast Construction costs for				Total Site Specific Capital Costs				1,012	1,865 For O&M

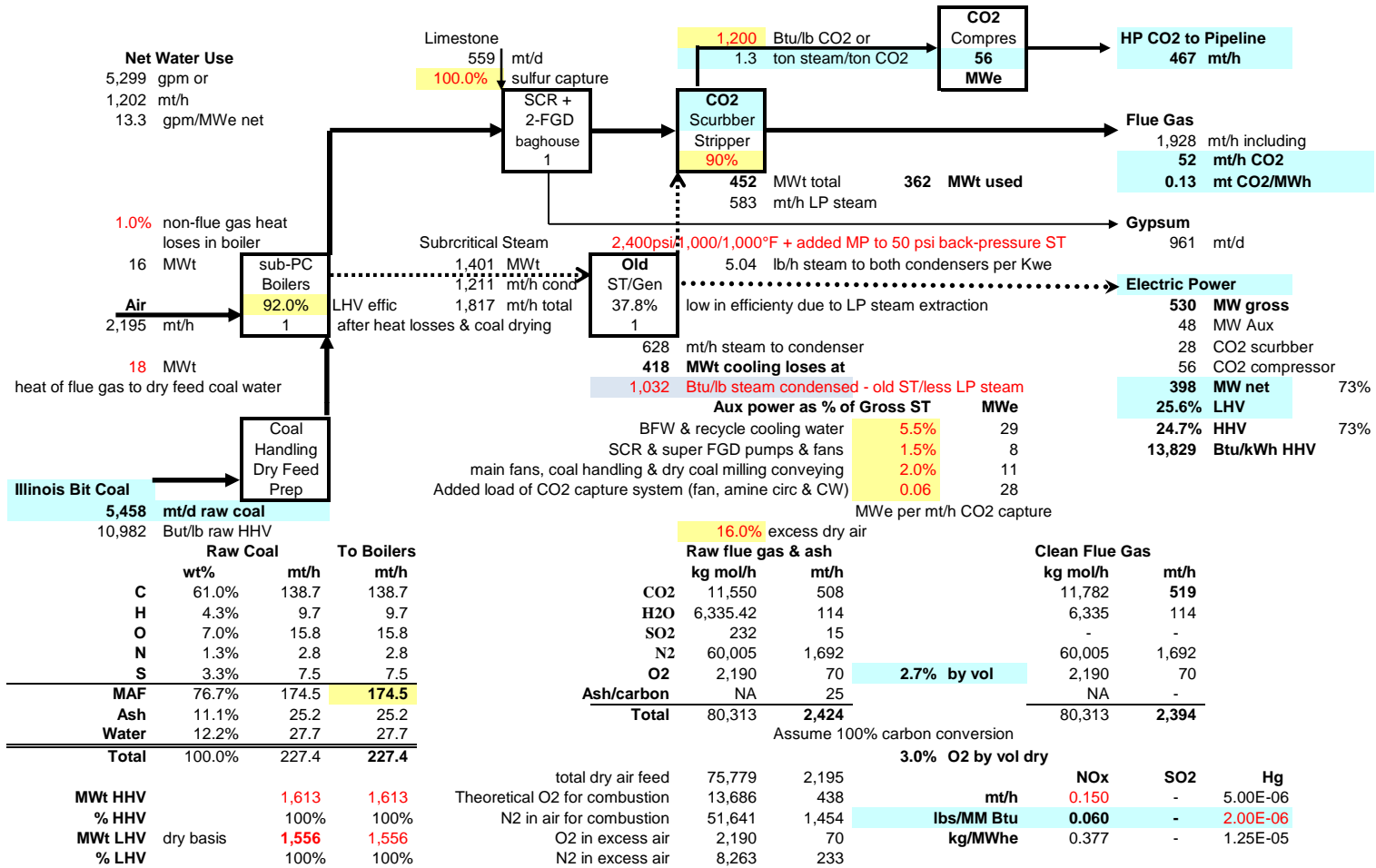
Product Cost Estimate	average annual capacity factor of	85%	or	4.0E+06 MWh per year	unit cost	
					\$ Million/yr	\$/MWh
Capital charges	Assume paid-off	0.0%	/yr of total capital or	Assume paid-off	0.0	-
Non-Fuel O&M Costs		4.5%	/yr of total capital		45.5	11.3
Fuel	Illinois Bit in MidWest min. shipping	\$ 2.00	per million Btu HHV of	\$ 48.43 /mt raw coal	82.0	20.3
Limestone	minimal shipping	\$ 30	/mt		4.7	1.2
"what if" minimal gypsum byproduct credits		\$ (5.00)	/mt gypsum or	\$ (26.88) /mt sulfur equivalent	(1.3)	(0.3)
"what if" NOx emissions requires purchased credits at		\$ 2,000	/mt as NO2		8.9	2.2
"what if" SO2 emissions requires purchased credits at		\$ 1,000	/mt SO2		6.4	1.6
"what if" Hg emissions requires purchased credits at		\$ 20,000	/lb Hg or		2.5	0.6
"what if" CO2 emissions requires purchased credits at		\$ -	/mt CO2 or \$ - per mt carbon equivalent		0.0	-
Net revenues required at above assumptions					148.7	36.8

Can vary the above CO2 tax to calculate at what carbon tax it becomes cheaper to do something

Case: O-PC-C1

Mass & Energy Flow Diagram of old PC Boiler & St/gen with just add-on CO2 Post Combustion CO2 Capture

Basis: 600 feet elevation of U.S. Midwest to 1.00 bar (14.5 psia), 15°C (59°F), recycle cooling tower water - 57 mbar (1.7 inch Hg or 96°F) condenser



Source: SFA Pacific, Inc.

Client Private

March 3, 2009

Case: O-PC-C1Continued
Economic Estimate of Old PC Boiler & st/gen with just Add-on Post Combustion CO2 Capture

Capital Cost Estimates	Units of Flow	Flow Rates		Trains	Baseline	Unit Capital	Multi train or	Adjusted	\$ Million	unit	
		Actual	ISOdesign		Unit cost	Train Size	Size/cost exp factor	unit cost		capital costs	
Coal & limestone handling & storage	mt/d coal & limestone	6,017	7,220	1	\$0	10,000	0.70	0	0	0 old	
Flue gas dry milling dilute pneumatic feed	mt/d raw coal	5,458	7,096	4	\$0	1,774	0.85	0	0	0 old	
Sub-critical PC Boilers	Bit. kWt heat exchange	1,400,624	1,540,686	1	\$0	1,400,000	0.85	0	0	0 old	
Selective Cat. Reduction NOx control	kg mol/h raw flue gas	80,313	88,344	1	\$400	80,000	0.70	388	34	86 new	
max recovery FGD - wet limestone absorber	kg mol/h raw flue gas	80,313	88,344	1	\$0	80,000	0.70	0	0	0 old	
Caustic trace SO2 removal	kg mol/h raw flue gas	80,313	88,344	1	\$200	80,000	0.70	194	17	43 new	
FGD - gypsum oxidizer & handling	mt/d gypsum	961	1,153	1	\$0	750	0.70	0	0	0 old	
Bag house	kg mol/h raw flue gas	80,313	88,344	1	\$0	80,000	0.70	0	0	0 old	
CO2 scrubber	kg mol/h raw flue gas	80,313	88,344	1	\$750	64,400	0.70	682	60	151 new	
CO2 stripper	kg mol/h CO2 stripped	10,395	11,435	1	\$1,500	5,717	0.80	1,306	15	37 new	
CO2 compressor	kWe driver	56,002	61,603	4	\$1,050	15,401	0.85	853	53	132 new	
old ST/gen + new MP to BP-LP ST/gen	kWe ST no extraction	529,887	622,980	1	\$50	500,000	0.80	48	30	75 new	
Installed process unit costs									209	525	
General Facilities	25% of Installed Process unit capital				Saving due to existing PC site				52	131	
Engineering, Startup & Working Cap	15% of Installed Process unit capital								31	79	
Contingencies	10% of Installed Process unit capital								21	52	
U.S. Gulf Coast Reference \$2004 Baseline Unit Capital Cost									313	787	
Inflation adjustment to	650 Ch.E. index change for mid-2008	from		444 Ch.E index mid 2004\$ baseline					459	1,153	
Location adjustment to	115% of U.S. Gulf Coast Construction costs for					Total Site Specific Capital Costs				528	1,325

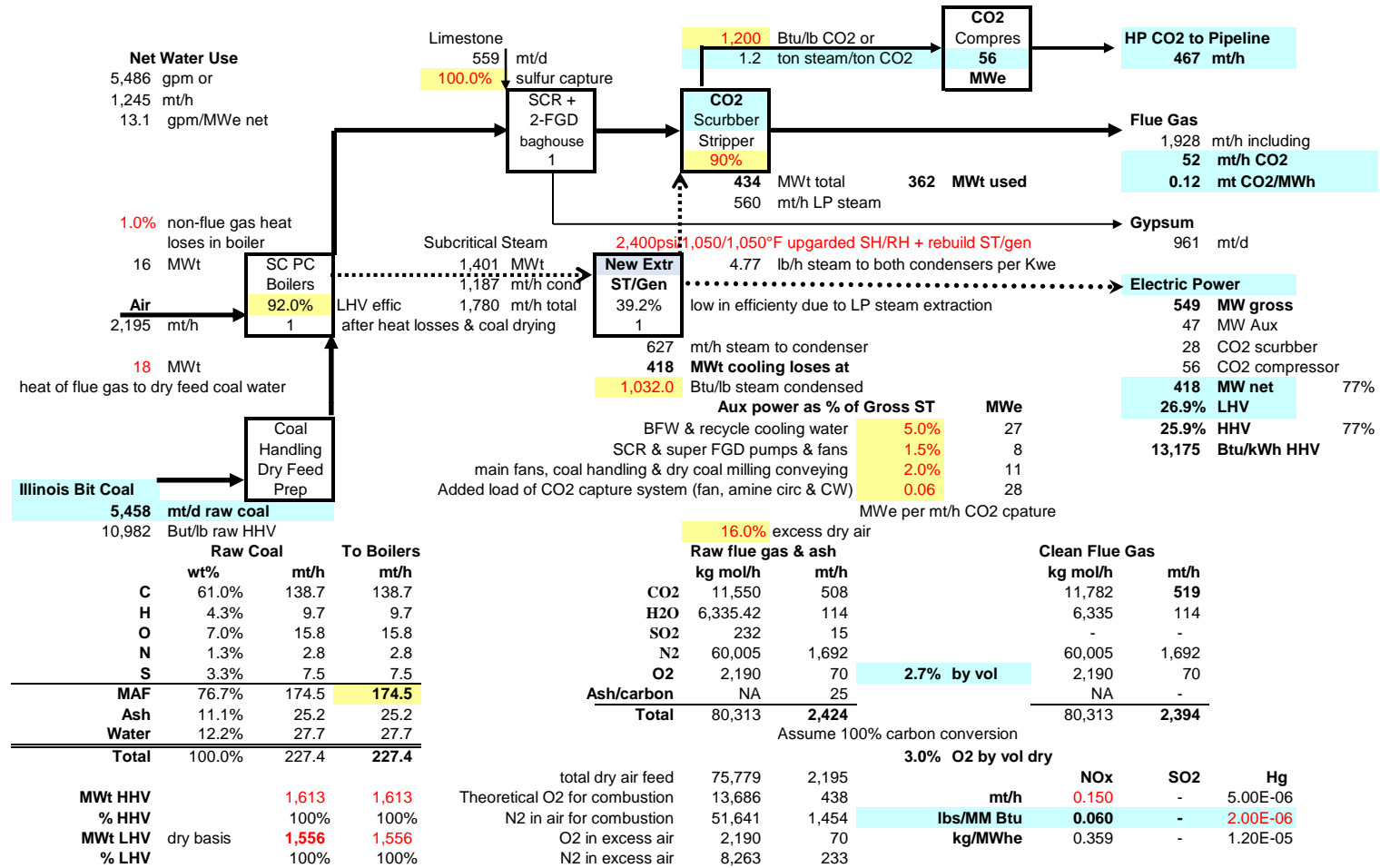
Product Cost Estimate	average annual capacity factor of	85%	or	3.0E+06 MWh per year	\$ Million/yr	unit cost
Capital charges	Key variable	15.0%	/yr of total capital or	6.67 yr capital payback	79.2	26.7
Non-Fuel O&M Costs		4.5%	/yr of total new capital + 100% of old PC capital		69.3	23.4
Fuel	Illinois Bit in Midwest min. shipping	\$ 2.00	per million Btu HHV of	\$ 48.43 /mt raw coal	82.0	27.7
HP CO2 pipeline & injection costs (or credit if for EOR)		\$ 15.00	/mt ton CO2 or	\$ 0.79 per 1,000 scf	52.1	17.6
Limestone	minimal shipping	\$ 30	/mt		5.2	1.8
"what if" minimal gypsum byproduct credits		\$ (5.00)	/mt gypsum or	\$ (26.88) /mt sulfur equivalent	(1.5)	(0.5)
"what if" NOx emissions requires purchased credits at		\$ 2,000	/mt as NO2		2.2	0.8
"what if" SO2 emissions requires purchased credits at		\$ 1,000	/mt SO2		0.0	-
"what if" Hg emissions requires purchased credits at		\$ 20,000	/lb Hg or	\$ 44 million per mt mercury emissions	1.6	0.6
"what if" CO2 emissions requires purchased credits at		\$ -	/mt CO2 or	\$ - per mt carbon equivalent	0.0	-
Net revenues required at above assumptions					290.2	97.9

CO2 avoidance cost \$ 74 /mt CO2 or \$ 272 /mt C equiv from old PC baseline - (\$/MWh ccs - \$/MWh b) / (mt CO2/MWh b - mt CO2/MWh ccs)

Case: O-PC-C2

Mass & Energy Flow Diagram of old PC Boiler with new ST/gen for add-on CO2 Post Combustion CO2 Capture + steam upgrades

Basis: 600 feet elevation of U.S. Midwest to 1.00 bar (14.5 psia), 15°C (59°F), recycle cooling tower water - 57 mbar (1.7 inch Hg or 96°F) condenser



Source: SFA Pacific, Inc.

Client Private

March 3, 2009

Case: O-PC-C2 Continued
Economic Estimate of Old PC Boiler with Add-on Post Combustion CO2 Capture + steam upgrades

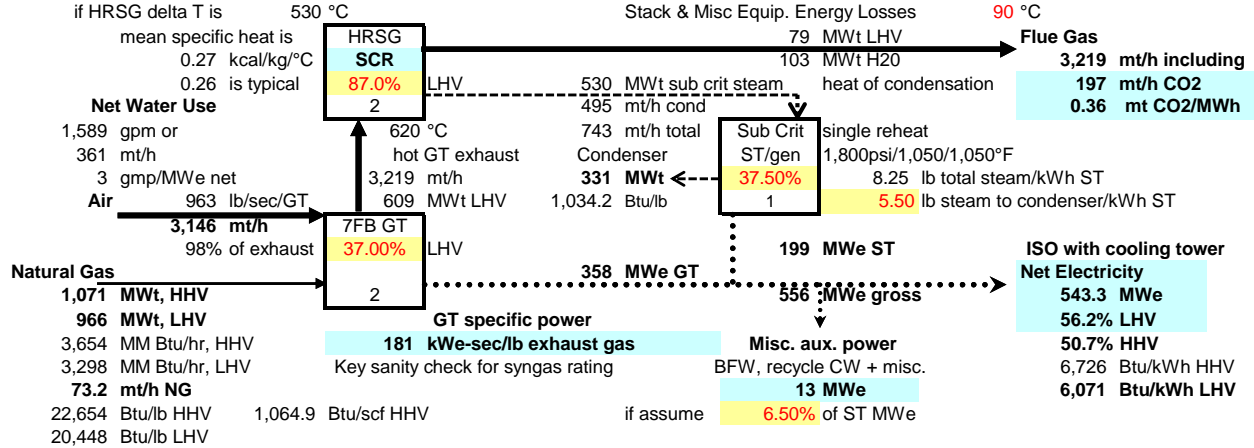
Capital Cost Estimates	Units of Flow	Flow Rates		Trains	Baseline	Unit Capital	Multi train or	Adjusted	\$ Million	unit	
		Actual	ISOdesign		Unit cost	Train Size	Size/cost exp factor	unit cost		capital costs	
Coal & limestone handling & storage	mt/d coal & limestone	6,017	7,220	1	\$0	10,000	0.70	0	0	0 old	
Flue gas dry milling dilute pneumatic feed	mt/d raw coal	5,458	7,096	4	\$0	1,774	0.85	0	0	0 old	
Old PC Boilers + new SH/RH Bit.	kWt heat exchange	1,400,624	1,540,686	1	\$20	1,400,000	0.85	20	30	73 upgrade	
Selective Cat. Reduction NOx control	kg mol/h raw flue gas	80,313	88,344	2	\$400	80,000	0.70	388	34	82 new	
max recovery FGD - wet limestone absorber	kg mol/h raw flue gas	80,313	88,344	2	\$0	80,000	0.70	0	0	0 old	
Caustic trace SO2 removal	kg mol/h raw flue gas	80,313	88,344	2	\$200	80,000	0.70	194	17	41 new	
FGD - gypsum oxidizer & handling	mt/d gypsum	961	1,153	2	\$0	750	0.70	0	0	0 old	
Bag house	kg mol/h raw flue gas	80,313	88,344	2	\$0	80,000	0.70	0	0	0 old	
CO2 scrubber	kg mol/h raw flue gas	80,313	88,344	2	\$750	64,400	0.70	682	60	144 new	
CO2 stripper	kg mol/h CO2 stripped	10,395	11,435	2	\$1,500	5,717	0.80	1,306	15	36 new	
CO2 compressor	kWe driver	56,002	61,603	4	\$1,050	15,401	0.85	853	53	126 new	
Rebuild reheat extraction ST & gen	kWe ST no extraction	548,568	622,980	2	\$150	500,000	0.80	144	89	214 rebuild	
									Installed process unit costs	299	715
General Facilities	25% of Installed Process unit capital				Saving due to existing PC site				75	179	
Engineering, Startup & Working Cap	15% of Installed Process unit capital								45	107	
Contingencies	10% of Installed Process unit capital								30	72	
									U.S. Gulf Coast Reference \$2004 Baseline Unit Capital Cost	448	1,073
Inflation adjustment to	650 Ch.E. index change for mid-2008 from				444 Ch.E index mid 2004\$ baseline				657	1,571	
Location adjustment to	115% of U.S. Gulf Coast Construction costs for				Total Site Specific Capital Costs				755	1,807	

Product Cost Estimate	average annual capacity factor of	85%	or	3.1E+06 MWh per year	\$ Million/yr	unit cost
Capital charges	Key variable	15.0%	/yr of total capital or	6.67 yr capital payback	113.3	36.4
Non-Fuel O&M Costs		4.5%	/yr of total new capital + 65% of old PC capital		63.6	20.4
Fuel Illinois Bit in Midwest min. shipping		\$ 2.00	per million Btu HHV of	\$ 48.43 /mt raw coal	82.0	26.4
HP CO2 pipeline & injection costs (or credit if for EOR)		\$ 15.00	/mt ton CO2 or	\$ 0.79 per 1,000 scf	52.1	16.7
Limestone minimal shipping		\$ 30	/mt		5.2	1.7
"what if" minimal gypsum byproduct credits		\$ (5.00)	/mt gypsum or	\$ (26.88) /mt sulfur equivalent	(1.5)	(0.5)
"what if" NOx emissions requires purchased credits at		\$ 2,000	/mt as NO2		2.2	0.7
"what if" SO2 emissions requires purchased credits at		\$ 1,000	/mt SO2		0.0	-
"what if" Hg emissions requires purchased credits at		\$ 20,000	/lb Hg or	\$ 44 million per mt mercury emissions	1.6	0.5
"what if" CO2 emissions requires purchased credits at		\$ -	/mt CO2 or	\$ - per mt carbon equivalent	0.0	-
Net revenues required at above assumptions					318.6	102.4

CO2 avoidance cost \$ 79 /mt CO2 or \$ 290 /mt C equiv from old PC baseline - (\$/MWh ccs - \$/MWh b) / (mt CO2/MWh b - mt CO2/MWh ccs)

Case: NGCC NGCC Replacement Repowering of Old PC at Existing Site for CO2 Reduction

Basis: 600 feet elevation of U.S. Midwest to 1.00 bar (14.5 psia), 15°C (59°F), recycle cooling tower water - 57 mbar (1.7 inch Hg or 96°F) condenser
Elevation is 2% GT ISO capacity derating but no efficiency losses plus additional 0.42% capacity & 0.42% efficiency losses from SCR back pressure
Recycle cooling tower water increases internal power, SCR slightly reduces HRSG heat recovery efficiency



Natural Gas				GT exhaust flue gas assuming 163.0% excess dry air				NOx Emissions of	
	Vol %	kg mol/h	mt/h	Vol% wet	kg mol/h	mt/h		ppmv NOx in dry gas @	
CH4	88.25%	3,625	58	O2	12.5%	14,103	451	13.5% O2 dry vol	
C2H6	9.75%	401	12	H2O	7.5%	8,452	152	0.024 mt/h as NO2	
CO2	1.00%	41	2	CO2	4.0%	4,467	197	0.015 lbs NO2/MM Btu	
N2	1.00%	41	1	N2	76.1%	85,902	2,419	0.044 kg/MWhe	
Total	100.00%	4,107.8	73		100.0%	112,924	3,219		

same feedrate for all NG cases			2% of GT exhaust mass low		
MWt HHV	MWt LHV dry basis	HHV/LHV	m/h total dry air feed	Theoretical O2 for combustion	N2 in air for combustion
1,071	966.4	1.108	108,616	8,652	32,647
			3,146	277	919
				14,103	451
				53,214	1,498

Capital Cost Estimate	Units of Flow	Flow Rates			Multi train & Baseline Unit Capital				\$ Million	\$/kWe net
		Actual	ISOdesign	Trains	Unit cost	Train Size	Size/cost exp factor	Adjusted unit cost		
Gas turbines & gen - dry Low-NOx	kWe GT gross	357,553	366,300	2	\$300	183,150	0.85	270	99	182
HRSG installed	kWt heat to steam	529,662	556,145	2	\$90	278,072	0.85	81	45	83
SCR NOx control in HRSG	kg mol/h raw flue gas	112,924	124,217	2	\$150	62,108	0.80	131	16	30
Subcritical reheat steam turbine & gen.	kWe ST gross	198,623	214,200	1	\$210	500,000	0.80	249	53	98
Installed process unit costs									214	393
General Facilities		25% of Installed Process unit capital			Saving due to existing PC site				53	98
Engineering, Startup & Working Cap		15% of Installed Process unit capital							32	59
Contingencies		10% of Installed Process unit capital							21	39
U.S. Gulf Coast Reference \$2004 Baseline Unit Capital Cost									320	590
Inflation adjustment to	650 Ch.E. index change for mid-2008 from				444 Ch.E index mid 2004\$ baseline				469	864
Location adjustment to	115% of U.S. Gulf Coast Construction costs for				Total Site Specific Capital Costs				540	993

Product Cost Estimate	average annual capacity factor of	85%	See notes below	4.05E+06 MWh/yr	\$ Million/yr	\$/MWh
Capital charges assuming		15.0%	/yr of total capital or	6.67 yr capital payback	80.9	20.0
Non-Fuel O&M Costs		4%	/yr of total capital (use higher % for coal units)		18.9	4.7
Fuel	Natural gas	\$ 7.65	per million Btu HHV	See notes below	208.1	51.5
"what if" NOx emissions requires purchased credits at		\$ 2,000	/mt as NO2		0.4	0.1
"what if" CO2 emissions requires purchased credits at		\$ -	/mt CO2 or \$ - per mt carbon equivalent		0.0	-
Gross revenues required at above assumptions					308.3	76.2

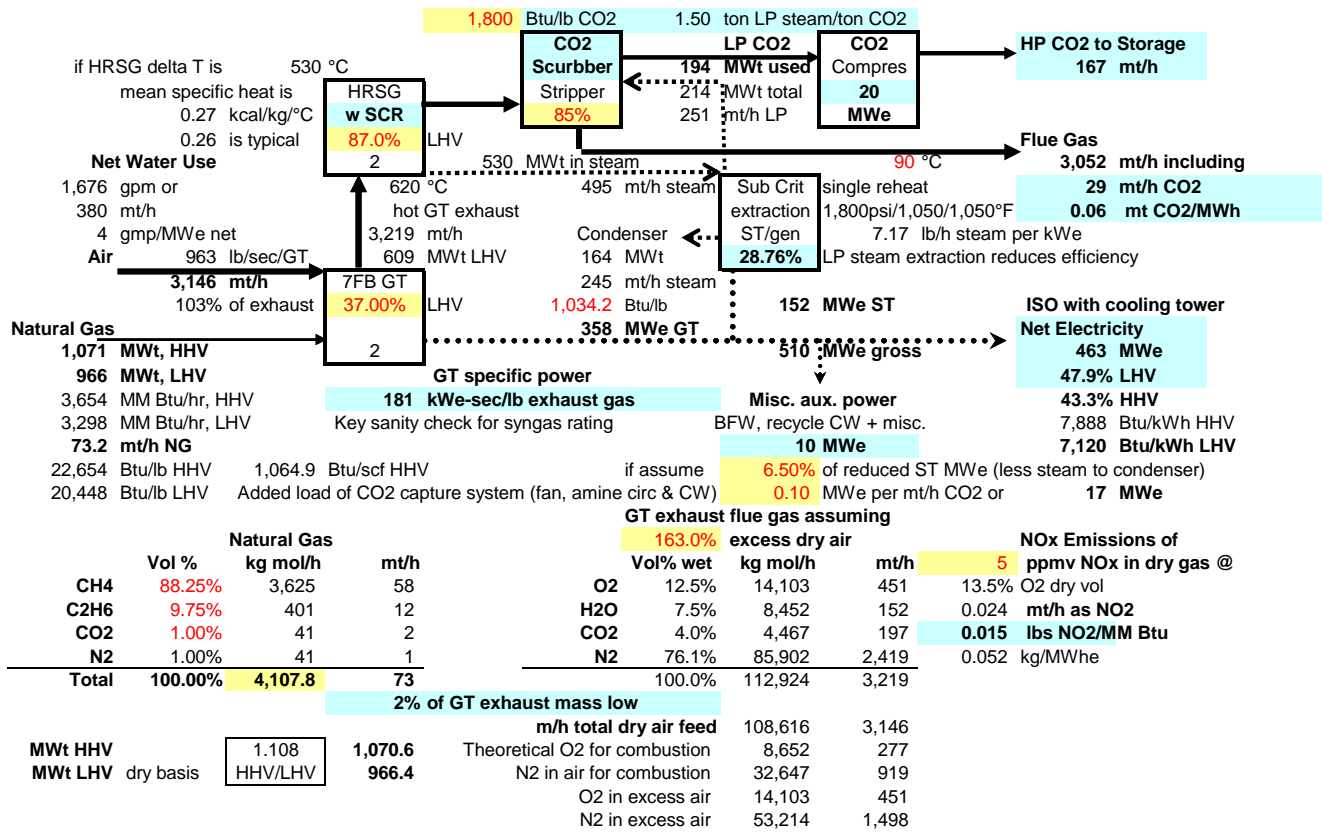
NG price so no CCS NGCC CO2 avoided cost is same as lowest CCS

CO2 avoidance cost \$ 67 /mt CO2 or \$ 244 /mt C equiv from old PC baseline - (\$/MWh ccs - \$/MWh b) / (mt CO2/MWh b - mt CO2/MWh ccs)

Case: NGCC-C

NGCC Replacement Repowering of Old PC at Existing Site plus Post-Combustion CO2 Capture

Basis: ISO conditions of sea level (1.013 bar), 15°C, LHV with recycle cooling tower - 76 mbar (2.25 inch or 105°F) condenser



Capital Cost Estimate	Units of Flow	Flow Rates		Baseline Unit Capital		Multi train & Adjusted		\$ Million	\$/kWe net
		Actual	ISOdesign	Unit cost	Train Size	Size/cost exp factor	unit cost		
Gas turbines & gen - dry Low-NOx	kWe GT gross	357,553	366,300	\$300	183,150	0.85	270	99	214
HRSG installed	kWt heat to steam	529,662	556,145	\$90	278,072	0.85	81	45	97
SCR NOx control in HRSG	kg mol/h raw flue gas	112,924	124,217	\$150	62,108	0.80	131	16	35
CO2 scurbber	kg mol/h raw flue gas	112,924	124,217	\$750	62,108	0.80	653	81	175
CO2 stripper	kg mol/h CO2 stripped	3,797	4,177	\$2,500	2,088	0.80	2,176	9	20
CO2 compressor	kWe driver	20,054	22,059	\$1,050	11,029	0.85	946	21	45
Subcritical reheat extraction ST & gen.	kWe ST if no extraction	152,345	214,200	\$235	500,000	0.80	278	60	129
Installed process unit costs								331	715
General Facilities	25% of Installed Process unit capital		Saving due to existing PC site				83	179	
Engineering, Startup & Working Cap	15% of Installed Process unit capital						50	107	
Contingencies	10% of Installed Process unit capital						33	71	
U.S. Gulf Coast Reference \$2004 Baseline Unit Capital Cost								497	1,072
Inflation adjustment to	650 Ch.E. index change for mid-2008		from		444 Ch.E index mid 2004\$ baseline		727	1,569	
Location adjustment to	115% of U.S. Gulf Coast Construction costs for				Total Site Specific Capital Costs		836	1,805	

Product Cost Estimate	average annual capacity factor of	85%	See notes below	3.45E+06 MWh/yr	\$ Million/yr	\$/MWh
Capital charges assuming		15.0%	/yr of total capital or	6.67 yr capital payback	125.4	36.4
Non-Fuel O&M Costs		4%	/yr of total capital		29.3	8.5
Fuel	Natural gas	Key variable	\$ 7.65 per million Btu HHV	See notes below	208.1	60.3
HP CO2 pipeline & injection costs (or credit if for EOR)		\$ 15.00	/mt ton CO2 or	\$ 0.79 per 1,000 scf	18.7	5.4
"what if" NOx emissions requires purchased credits at		\$ 2,000	/mt as NO2		0.4	0.1
"what if" CO2 emissions requires purchased credits at		\$ -	/mt CO2 or \$ - per mt carbon equivalent		0.0	-
Gross revenues required at above assumptions					381.8	110.7

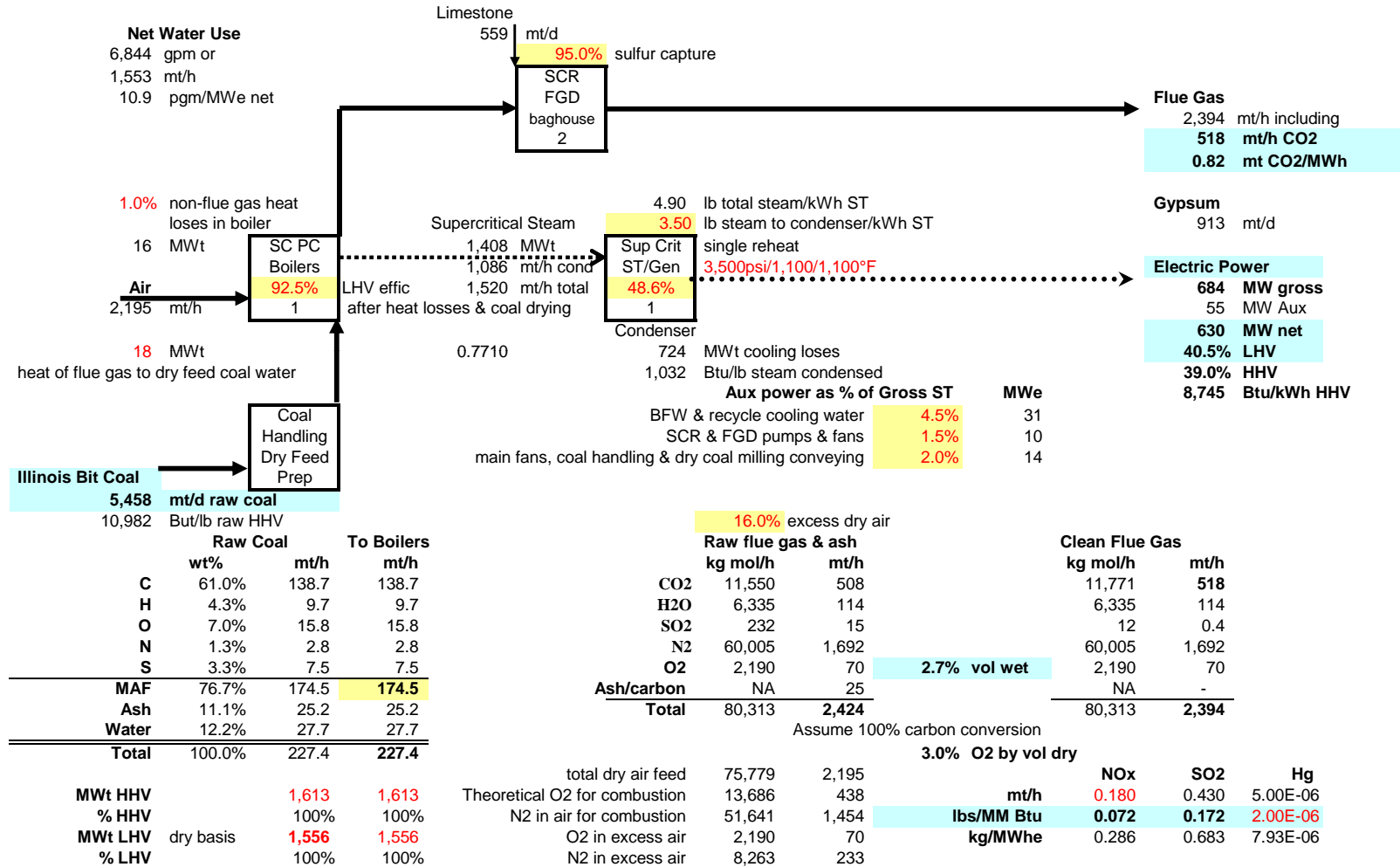
CO2 avoidance cost \$ 83 /mt CO2 or \$ 305 /mt C equiv from old PC baseline - (\$/MWh ccs - \$/MWh b) / (mt CO2/MWh b - mt CO2/MWh ccs)

Assuming the same annual load factor for NGCC and coal-based power is questionable due to the much higher marginal load dispatch costs of NGCC. Was only done here to show relative "break-even" capital loaded economics for the NG price at which new baseload coal & NGCC power costs are the same.

Case: N-PC

Mass & Energy Flow Diagram Replacement Supercritical PC Boiler at Old PC Site for CO2 Reduction

Basis: 600 feet elevation of U.S. Midwest to 1.00 bar (14.5 psia), 15°C (59°F), recycle cooling tower water - 57 mbar (1.7 inch Hg or 96°F) condenser



Case: N-PC Continued
Economic Estimate of Baseline Replacement Supercritical PC Boiler at Old PC Site for CO2 Reduction

Capital Cost Estimates	Units of Flow	Flow Rates		Trains	Multi train or			Adjusted unit cost	unit capital costs		
		Actual	ISOdesign		Baseline Unit Capital	Size/cost	exp factor		\$ Million	\$/kWe	
Coal & limestone handling & storage	mt/d coal & limestone	6,017	7,220	1	\$1,000	10,000	0.70	1,103	8	13 saving	
Flue gas dry milling dilute pneumatic feed	mt/d raw coal	5,458	7,096	4	\$1,000	1,774	0.85	812	6	9 saving	
Supercritical PC Boilers Bit.	kWt heat exchange	1,408,236	1,549,060	1	\$130	1,400,000	0.85	128	198	315 \$ 83	
Selective Cat. Reduction NOx control	kg mol/h raw flue gas	80,313	88,344	1	\$400	80,000	0.70	388	34	54 per lb/h	
New FGD - wet limestone absorber	kg mol/h raw flue gas	80,313	88,344	1	\$600	80,000	0.70	582	51	82 saving?	
New FGD - gypsum oxidizer & handling	mt/d gypsum	913	1,096	1	\$30,000	750	0.70	26,775	29	47 saving?	
New Bag house	kg mol/h raw flue gas	80,313	88,344	1	\$100	80,000	0.70	97	9	14 saving?	
Supercritical reheat ST & gen	kWe ST gross	684,403	718,623	1	\$300	500,000	0.80	279	201	318	
Installed process unit costs									536	852	
General Facilities	25% of Installed Process unit capital				Saving due to existing PC site				134	213 saving?	
Engineering, Startup & Working Cap	15% of Installed Process unit capital								80	128	
Contingencies	10% of Installed Process unit capital								54	85	
U.S. Gulf Coast Reference \$2004 Baseline Unit Capital Cost									804	1,277	
Inflation adjustment to	650 Ch.E. index change for mid-2008	from		444 Ch.E index mid 2004\$ baseline					1,178	1,870	
Location adjustment to	115% of U.S. Gulf Coast Construction costs for					Total Site Specific Capital Costs				1,354	2,151

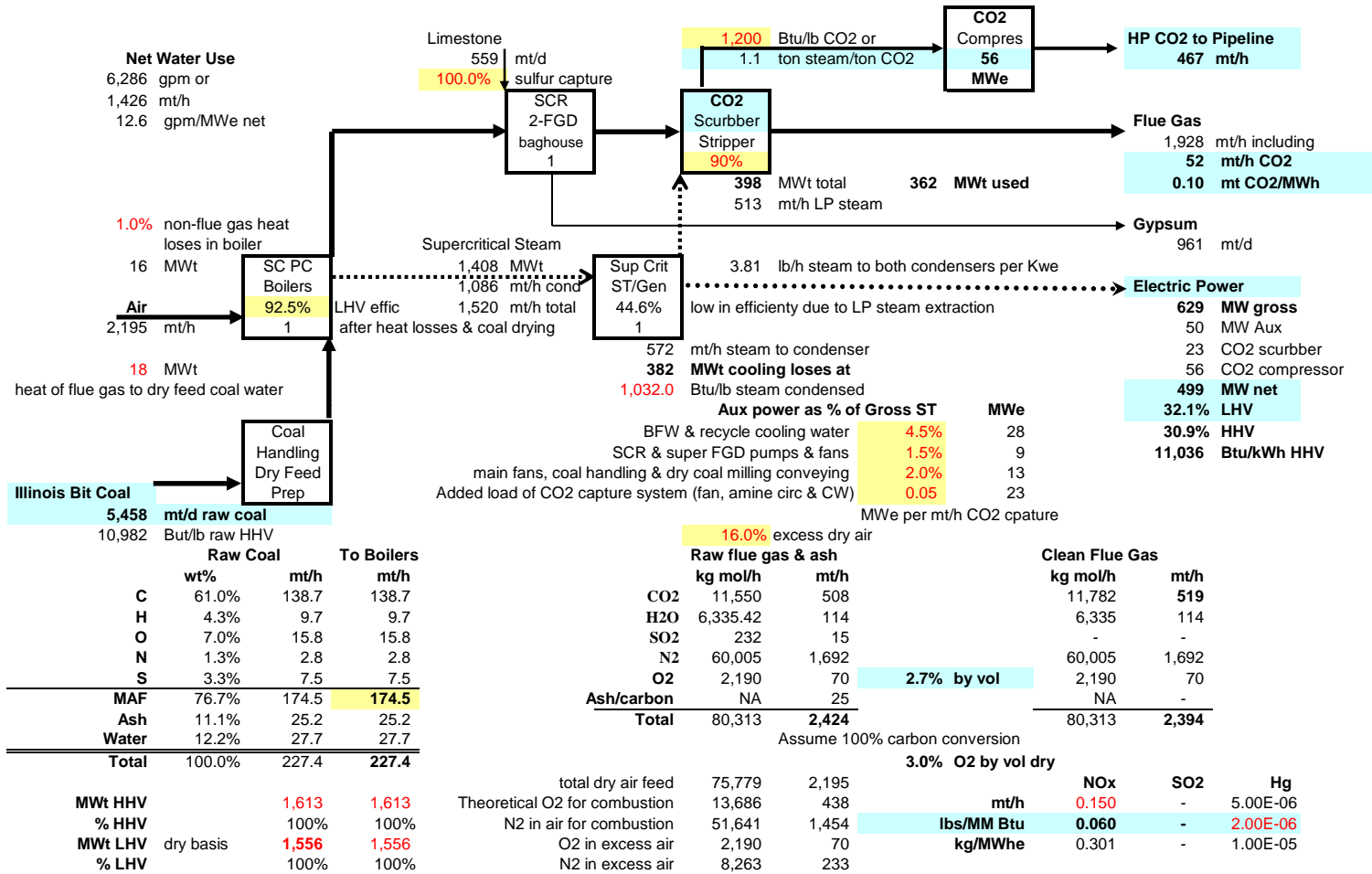
Product Cost Estimate	average annual capacity factor of	85%	or	4.7E+06 MWh per year	\$ Million/yr	unit cost \$/MWh
Capital charges	Key variable	15.0%	/yr of total capital or	6.67 yr capital payback	203.1	43.3
Non-Fuel O&M Costs		4.5%	/yr of total capital		60.9	13.0
Fuel	Illinois Bit in Midwest min. shipping	\$ 2.00	per million Btu HHV of	\$ 48.43 /mt raw coal	82.0	17.5
Limestone	minimal shipping	\$ 30	/mt		5.2	1.1
"what if" minimal gypsum byproduct credits		\$ (5.00)	/mt gypsum or	\$ (26.88) /mt sulfur equivalent	(1.4)	(0.3)
"what if" NOx emissions requires purchased credits at		\$ 2,000	/mt as NO2		2.7	0.6
"what if" SO2 emissions requires purchased credits at		\$ 1,000	/mt SO2		3.2	0.7
"what if" Hg emissions requires purchased credits at		\$ 20,000	/lb Hg or	\$ 44 million per mt mercury emissions	1.6	0.3
"what if" CO2 emissions requires purchased credits at		\$ -	/mt CO2 or	\$ - per mt carbon equivalent	0.0	-
Net revenues required at above assumptions					357.4	76.2

CO2 avoidance cost \$ 302 /mt CO2 or \$ 1,108 /mt C equiv from old PC baseline - (\$/MWh ccs - \$/MWh b) / (mt CO2/MWh b - mt CO2/MWh ccs)

Case: N-PC-C

Mass & Energy Flow Diagram of Replacement Supercritical PC Boiler with CO2 Post Combustion CO2 Capture

Basis: 600 feet elevation of U.S. Midwest to 1.00 bar (14.5 psia), 15°C (59°F), recycle cooling tower water - 57 mbar (1.7 inch Hg or 96°F) condenser



Case: N-PC-C Continued
Economic Estimate of Replacement Supercritical PC Boiler with Post Combustion CO2 Capture

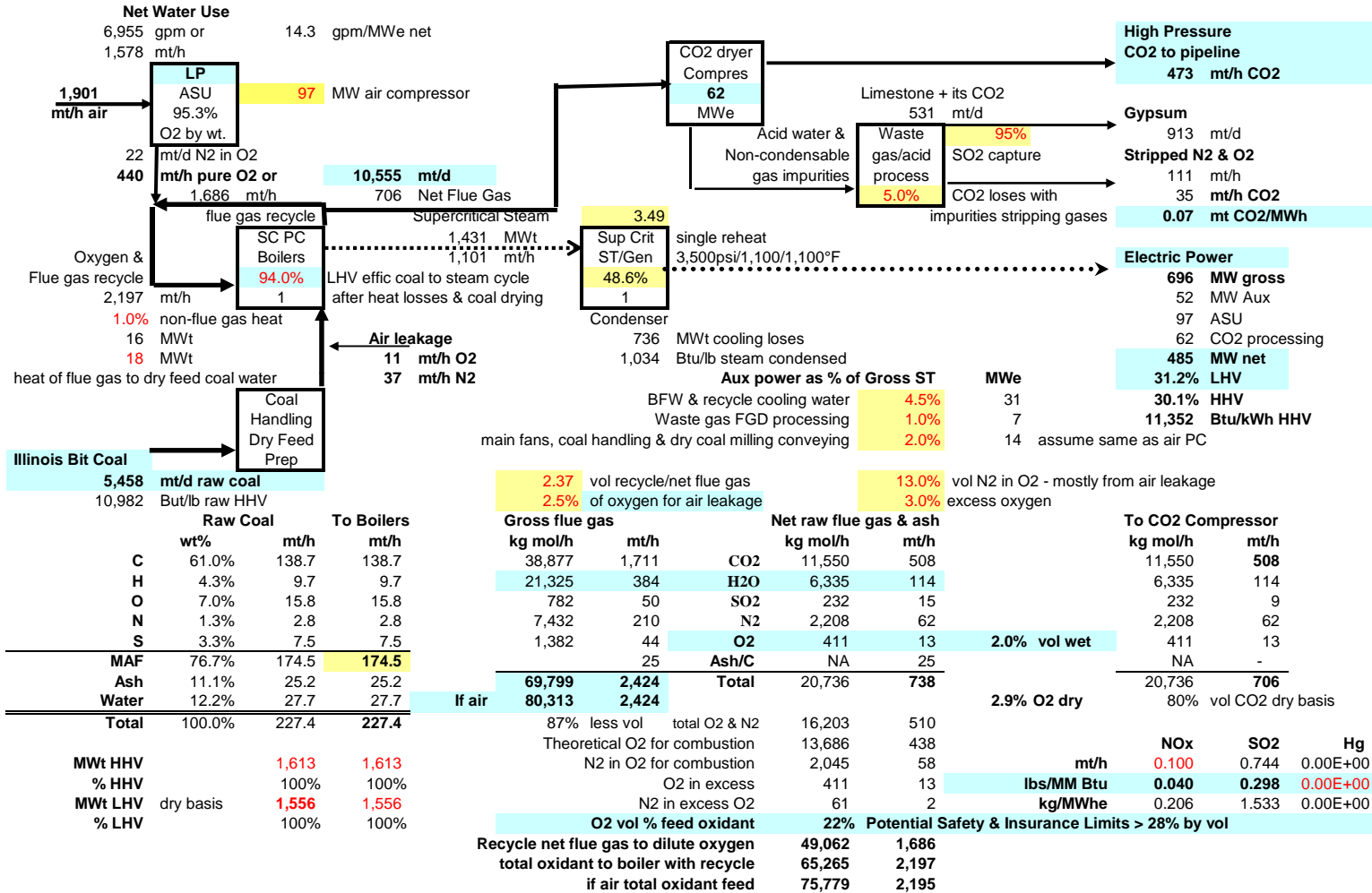
Capital Cost Estimates	Units of Flow	Flow Rates		Trains	Multi train or			Adjusted unit cost	\$ Million	unit capital costs	
		Actual	ISOdesign		Baseline Unit cost	Unit Capital Train Size	Size/cost exp factor			\$/kWe	\$/kWe
Coal & limestone handling & storage	mt/d coal & limestone	6,017	7,220	1	\$1,000	10,000	0.70	1,103	8	16	saving
Flue gas dry milling dilute pneumatic feed	mt/d raw coal	5,458	7,096	4	\$1,000	1,774	0.85	812	6	12	saving
Oxy Supercritical PC Boilers Bit.	kWt heat exchange	1,408,236	1,549,060	1	\$130	1,400,000	0.85	128	198	398	\$ 83
Selective Cat. Reduction NOx control	kg mol/h raw flue gas	80,313	88,344	1	\$400	80,000	0.70	388	34	69	per lb/h
max recovery FGD - wet limestone absorber	kg mol/h raw flue gas	80,313	88,344	1	\$600	80,000	0.70	582	51	103	steam
Caustic trace SO2 removal	kg mol/h raw flue gas	80,313	88,344	1	\$200	80,000	0.70	194	17	34	
FGD - gypsum oxidizer & handling	mt/d gypsum	961	1,153	1	\$30,000	750	0.70	26,366	30	61	
Bag house	kg mol/h raw flue gas	80,313	88,344	1	\$100	80,000	0.70	97	9	17	
CO2 scrubber	kg mol/h raw flue gas	80,313	88,344	1	\$750	64,400	0.70	682	60	121	
CO2 stripper	kg mol/h CO2 stripped	10,395	11,435	1	\$1,500	5,717	0.80	1,306	15	30	
CO2 compressor	kWe driver	56,002	61,603	4	\$1,050	15,401	0.85	853	53	105	
Supercritical reheat extraction ST & gen	kWe ST no extraction	628,586	718,623	1	\$325	500,000	0.80	302	217	435	note
Installed process unit costs									699	1,401	
General Facilities	25% of Installed Process unit capital				Saving due to existing PC site				175	350	
Engineering, Startup & Working Cap	15% of Installed Process unit capital								105	210	
Contingencies	10% of Installed Process unit capital								70	140	
U.S. Gulf Coast Reference \$2004 Baseline Unit Capital Cost									1,048	2,101	
Inflation adjustment to	650 Ch.E. index change for mid-2008 from				444 Ch.E index mid 2004\$ baseline				1,535	3,076	
Location adjustment to	115% of U.S. Gulf Coast Construction costs for				Total Site Specific Capital Costs				1,765	3,537	

Product Cost Estimate	average annual capacity factor of	85%	or	3.7E+06 MWh per year	\$ Million/yr	unit cost \$/MWh	
Capital charges	Key variable	15.0%	/yr of total capital or	6.67	yr capital payback	264.7	71.3
Non-Fuel O&M Costs		4.5%	/yr of total capital			79.4	21.4
Fuel Illinois Bit in Midwest min. shipping		\$ 2.00	per million Btu HHV of	\$ 48.43	/mt raw coal	82.0	22.1
HP CO2 pipeline & injection costs (or credit if for EOR)		\$ 15.00	/mt ton CO2 or	\$ 0.79	per 1,000 scf	52.1	14.0
Limestone minimal shipping		\$ 30	/mt			5.2	1.4
"what if" minimal gypsum byproduct credits		\$ (5.00)	/mt gypsum or	\$ (26.88)	/mt sulfur equivalent	(1.5)	(0.4)
"what if" NOx emissions requires purchased credits at		\$ 2,000	/mt as NO2			2.2	0.6
"what if" SO2 emissions requires purchased credits at		\$ 1,000	/mt SO2			0.0	-
"what if" Hg emissions requires purchased credits at		\$ 20,000	/lb Hg or	\$ 44	million per mt mercury emissions	1.6	0.4
"what if" CO2 emissions requires purchased credits at		\$ -	/mt CO2 or	\$ -	per mt carbon equivalent	0.0	-
Net revenues required at above assumptions						485.9	130.8

CO2 avoidance cost \$ 111 /mt CO2 or \$ 406 /mt C equiv from old PC baseline - (\$/MWh ccs - \$/MWh b) / (mt CO2/MWh b - mt CO2/MWh ccs)

Case: N-OPC_C Mass & Energy Flow Diagram of Replacement Oxyfuel Supercritical PC Boiler for CO2 Capture

Basis: 600 feet elevation of U.S. Midwest to 1.00 bar (14.5 psia), 15°C (59°F), recycle cooling tower water - 57 mbar (1.7 inch Hg or 96°F) condenser
Assume CO2 rich flue gas recycle to get the same mass flow through PC boiler as traditional air combustion (make heat transfer similar)



Case: N-OPC-C Continued
Economic Estimate of Replacement Oxyfuel Supercritical PC Boiler for CO2 Capture

Note Assumptions for special oxyfuel PC design and massive ASU can greatly impact results

100% \$/kWt of conventional air PC boiler & same mass flow assuming (MWt = mass x cp x delta T)

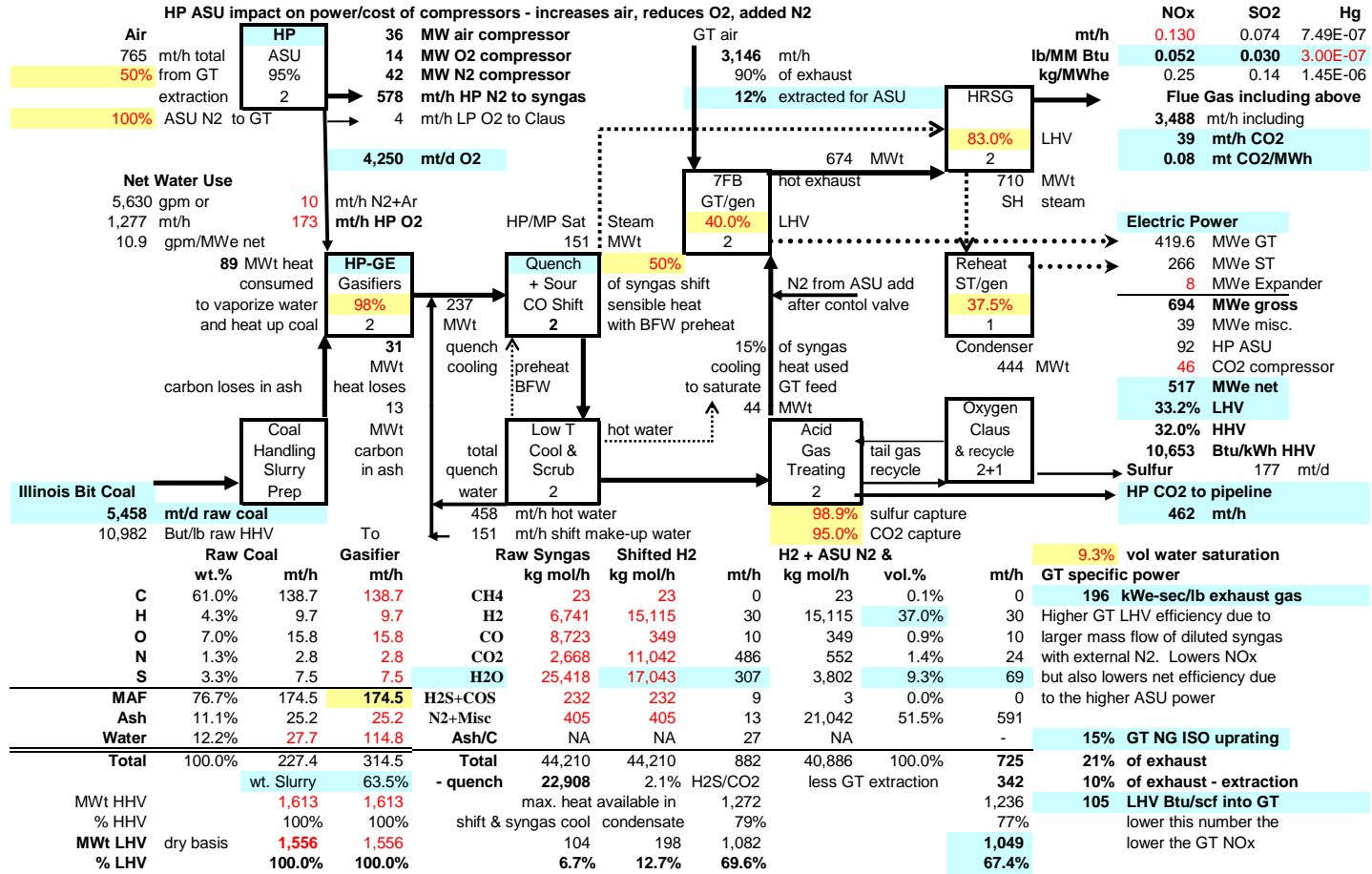
Capital Cost Estimates	Units of Flow	Flow Rates		Trains	Baseline Unit Capital		Multi train or Size/cost exp factor	Adjusted unit cost	unit capital costs	
		Actual	ISOdiesel		Unit cost	Train Size			\$ Million	\$/kWe
Coal handling & storage	mt/d coal & limestone	5,458	6,550	1	\$1,000	10,000	0.70	1,135	7	15 saving
Flue gas dry milling dilute pneumatic feed	mt/d raw coal	5,458	7,096	4	\$1,000	1,774	0.85	812	6	12 saving
Special Oxyfuel Supercritical PC Boilers	kWt heat exchange	1,431,072	1,574,180	1	\$140	1,400,000	0.85	138	217	446 \$ 89
New Bag house	kg mol/h raw flue gas	69,799	76,779	1	\$100	80,000	0.70	101	8	16 per lb/h
LP ASU air compressor	kW driver	96,756	101,594	3	\$410	33,865	0.90	367	37	77 steam
Big LP ASU cold box	mt/d O2	10,555	11,083	3	\$9,500	3,694	0.90	8,512	94	194
CO2 compressor with impurity stripper	kW driver	61,514	61,514	4	\$1,100	15,379	0.85	893	55	113
Impurity gas & acid processing	kg mol/h raw gas	3,428	3,771	1	\$1,500	80,000	0.70	3,750	14	29
gypsum reactors & handling	mt/d gypsum	913	1,096	1	\$30,000	750	0.70	26,775	29	60
Supercritical reheat steam turbine & gen	kWe ST gross	695,501	730,276	1	\$300	300,000	0.80	251	183	378
Installed process unit costs									651	1,342
General Facilities	25% of Installed Process unit capital				Saving due to existing PC site				163	336
Engineering, Startup & Working Cap	15% of Installed Process unit capital								98	201
Contingencies	10% of Installed Process unit capital								65	134
U.S. Gulf Coast Reference \$2004 Baseline Unit Capital Cost									976	2,013
Inflation adjustment to	650 Ch.E. index change for mid-2008	from		444 Ch.E index mid 2004\$ baseline				1,430	2,947	
Location adjustment to	115% of U.S. Gulf Coast Construction costs for			Total Site Specific Capital Costs				1,644	3,389	

Product Cost Estimate	average annual capacity factor of	85%	or	3.6E+06 MWh per year	\$ Million/yr	unit cost \$/MWh	
Capital charges	Key variable	15.0%	/yr of total capital or	6.67	246.6	68.3	
Non-Fuel O&M Costs		4.5%	/yr of total capital		74.0	20.5	
Fuel	Illinois Bit in MidWest min. shipping	\$ 2.00	per million Btu HHV of	\$ 48.43 /mt raw coal	82.0	22.7	
Limestone	minimal shipping	\$ 30	/mt		0.0	-	
HP CO2 pipeline & injection costs (or credit if for EOR)		\$ 15.00	/mt ton impure CO2 or	\$ 0.64 per 1,000 scf	52.9	14.6	
"what if" minimal gypsum byproduct credits		\$ (5.00)	/mt gypsum or	\$ (26.88) /mt sulfur equivalent	(0.0)	(0.0)	
"what if" NOx emissions requires purchased credits at		\$ 2,000	/mt as NO2		1.5	0.4	
"what if" SO2 emissions requires purchased credits at		\$ 1,000	/mt SO2		5.5	1.5	
"what if" Hg emissions requires purchased credits at		\$ 20,000	/lb Hg or	\$ 44 million per mt mercury emissions	0.0	-	
"what if" CO2 emissions requires purchased credits at		\$ -	/mt CO2 or	\$ - per mt carbon equivalent	0.0	-	
Net revenues required at above assumptions						462.5	128.0

CO2 avoidance cost \$ 104 /mt CO2 or \$ 380 /mt C equiv from old PC baseline - (\$/MWh ccs - \$/MWh b) / (mt CO2/MWh b - mt CO2/MWh ccs)

Case: IGCC-C Mass & Energy Flow Diagram for Replacement GE-IGCC Precombustion for CO2 Capture

Basis: 600 feet elevation of U.S. Midwest to 1.00 bar (14.5 psia), 15°C (59°F), recycle cooling tower water - 57 mbar (1.7 inch Hg or 96°F) condenser
HP ASU - all N2 to GT syngas uprate 7FB to 232 MW ISO (-2% for 600 feet to 227 MWe) & reduce NOx without SCR to about 15 ppmv



Source: SFA Pacific, Inc.

Client Private

March 3, 2009

Case Case IGCC-C Continued

Economic Estimate of Replacement GE IGCC Precombustion for CO2 Capture

Capital Cost Estimates	Units of Flow	Flow Rates		Trains	Multi train or			Adjusted unit cost	\$ Million	unit capital costs	
		Actual	ISOdesign		Unit cost	Train Size	Size/cost exp factor			\$/kWe	saving
Coal handling & storage	mt/d raw coal	5,458	6,550	1	\$1,000	10,000	0.70	1,135	7	14	saving
Wet coal milling & slurry prep/feed	mt/d raw coal	5,458	7,096	4	\$2,500	1,774	0.85	2,031	14	28	
HP ASU air compressor	kW driver	36,354	38,172	2	\$430	19,086	0.90	401	15	30	
HP ASU cold box	mt/d O2	4,250	4,463	2	\$10,850	2,231	0.90	10,123	45	87	
HP ASU O2 compressors	kW driver	14,047	14,749	2	\$1,400	7,375	0.90	1,306	19	37	
HP ASU N2 compressors	kW driver	41,605	43,685	2	\$450	21,843	0.90	420	18	35	
GE Quench Gasifier @ 70 atm.	kg mol/h raw syngas	22,908	25,199	2	\$3,000	12,600	0.90	2,799	71	136	
Sour CO shift 2-stage	kg mol/h raw syngas	44,210	48,631	2	\$700	24,315	0.80	609	30	57	
Sour CO shift heat recovery	kWt heat exchange	151,189	166,308	2	\$100	83,154	0.85	90	15	29	
Low T cooling, scrubbing & COS convert,	kg mol/h dry syngas	27,166	29,883	2	\$1,700	14,941	0.80	1,480	44	86	
HP Selective AG Absorbers Selexol	kg mol/hr dry feed gas	27,166	29,883	2	\$2,250	14,941	0.80	1,959	59	113	
Selective AG Stripper high CO2 Selexol	kg mol/hr acid gas	10,720	13,936	2	\$2,000	6,968	0.80	1,741	24	47	
O2 Claus & tail gas recycle	mt/d sulfur 20% feed	177	318	3	\$75,000	106	0.80	60,206	19	37	
CO2 compressor	kWe driver	46,167	50,784	4	\$1,000	12,696	0.85	812	41	80	
H2 expander to 30 atm.	kWe expander	8,005	8,405	2	\$800	4,202	0.85	721	6	12	
GT/gen if air extraction + 10% NG rating	kWe GT gross	419,608	366,300	2	\$360	183,150	0.85	324	119	230	
HRSG & extra superheater	kWt heat exchange	559,140	587,097	2	\$100	293,549	0.85	90	53	102	
Subcritical reheat steam turbine & gen.	kWe ST gross	266,373	279,692	1	\$210	300,000	0.80	213	60	115	
Installed process unit costs									660	1,277	
General Facilities	25% of Installed Process unit capital				Saving due to existing PC site				165	319	
Engineering, Startup & Working Cap	15% of Installed Process unit capital								99	191	
Contingencies	10% of Installed Process unit capital								66	128	
U.S. Gulf Coast Reference \$2004 Baseline Unit Capital Cost									990	1,915	
Inflation adjustment to	650 Ch.E. index change for mid-2008 from				444 Ch.E index mid 2004\$ baseline				1,449	2,803	
Location adjustment to	115% of U.S. Gulf Coast Construction costs for				Total Site Specific Capital Costs				1,667	3,224	

Product Cost Estimate	average annual capacity factor of	Key variable	85%	or	3.8E+06 MWh per year	unit cost			
						\$ Million/yr	\$/MWh		
Capital charges			15.0%	/yr of total capital or	6.67	yr capital payback	250.0	64.9	
Non-Fuel O&M Costs			4.5%	/yr of total capital			75.0	19.5	
Fuel		Illinois Bit in Midwest min. shipping	\$ 2.00	per million Btu HHV of	\$ 48.43	/mt raw coal	82.0	21.3	
HP CO2 pipeline & injection costs (or credit if for EOR)			\$ 15.00	/mt ton CO2 or	\$ 0.79	per 1,000 scf	51.6	13.4	
"what if" minimal sulfur byproduct credits			\$ (26.88)	/mt sulfur or	\$ (5.00)	/mt gypsum equivalent	(1.5)	(0.4)	
"what if" NOx emissions requires purchased credits at			\$ 2,000	/mt as NO2			1.9	0.5	
"what if" SO2 emissions requires purchased credits at			\$ 1,000	/mt SO2			0.6	0.1	
"what if" Hg emissions requires purchased credits at			\$ 20,000	/lb Hg or	\$ 44	million per mt mercury emissions	0.2	0.1	
"what if" CO2 emissions requires purchased credits at			\$ -	/mt CO2 or	\$ -	per mt carbon equivalent	0.0	-	
Net revenues required at above assumptions								459.8	119.5

CO2 avoidance cost \$ **94** /mt CO2 or \$ **346** /mt C equivalent based on existing old coal power plants baseline
 (\$/MWh ccs - \$/MWh b) / (mt CO2/MWh b - mt CO2/MWh ccs)