

**Run: 2 - CO2 tax**  
**Summary of CO2 Options with CO2 Tax For Existing Coal Power Plant Baseline**

Natural gas price & CO2 tax set for triple point of same power costs for: Old PC & new NGCC without CCS + coal with CCS

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/MWe	CO2 Avoidance \$/mt CO2	Power Cost mid-2008 \$/MWh
O-PC	Baseline Paid-off Old Coal Power Plant sub PC with FGD size set to NGCC MW	543	Paid off	Paid off	33.6%	0.95	Baseline	\$ 107.5
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	\$ 0	\$ 107.5
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	\$ 5	\$ 111.6
NGCC	Replacement NGCC - no CCS "F" class NGCC with SCR no CO2 Capture	543	\$ 540	\$ 993	50.7%	0.36	\$ 0	\$ 107.5
NGCC-C	Replacement NGCC with Post CO2 Capture "F" class GT with MHI amine CO2 scrubber	463	\$ 836	\$ 1,805	43.3%	0.06	\$ 15	\$ 120.7
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	\$ 228	\$ 137.3
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	\$ 36	\$ 138.5
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	\$ 23	\$ 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	\$ 20	\$ 125.1

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

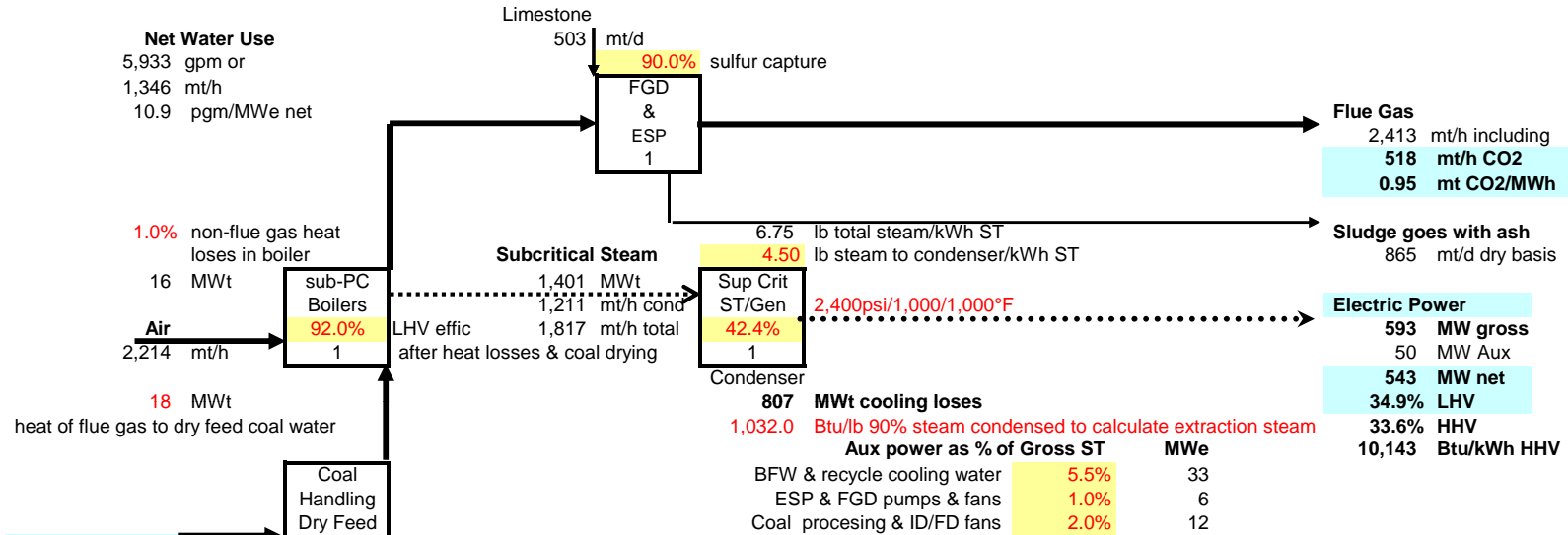
**Input Operating Cost Variables**

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. coal price 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
<b>Breakeven NG price NGCC wo CCS = O-PC-C1 = O-PC wo CCS</b>	<b>\$ 8.31</b>	per million Btu HHV	<b>NG prices should go up if CO2 tax</b>
<b>Breakeven NG price will likely change if high enough CO2 tax to make CO2 capture cost effective</b>			
Natural gas input set to fill 2-7FB GT NGCC 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	
<b>Lowest CO2 avoidance costs (O-PC-C1) entered as a CO2 tax</b>	<b>\$ 74.20</b>	/mt CO2 or	\$ 272.07 per mt carbon equivalent
<b>CO2 avoidance cost for O-PC-C1 is the lowest CO2 tax where added CCS is the same power cost as O-PC just paying the CO2 tax</b>			

## Case: O-PC

### Mass & Energy Flow Diagram of Baseline Existing Old Subcritical PC Boiler with Bit Coal

**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 typical 400-600 MWe gross old PC units build in the early 1970s with old ESP & wet FGD to sludge**



Raw Coal			To Boilers			Raw flue gas & ash			Clean Flue Gas		
	wt%	mt/h		mt/h		kg mol/h	mt/h		kg mol/h	mt/h	
C	61.0%	138.7		138.7	CO2	11,550	508		11,759	518	
H	4.3%	9.7		9.7	H2O	6,335.42	114		6,335	114	
O	7.0%	15.8		15.8	SO2	232	15		23	0.9	
N	1.3%	2.8		2.8	N2	60,522	1,706		60,522	1,706	
S	3.3%	7.5		7.5	O2	2,327	74	2.9% vol wet	2,327	74	
MAF	76.7%	174.5	174.5	same feedrated for all cases	Ash/carbon	NA	25		NA	-	
Ash	11.1%	25.2	25.2		Total	80,966	2,443		80,966	2,413	
Water	12.2%	27.7	27.7								
<b>Total</b>	<b>100.0%</b>	<b>227.4</b>	<b>227.4</b>								

	total dry air feed	76,433	2,214			
Theoretical O2 for combustion		13,686	438		NOx	0.600
N2 in air for combustion		51,641	1,454		SO2	0.860
O2 in excess air		2,327	74		Hg	7.49E-06
N2 in excess air		8,779	247		lbs/MM Btu	0.240
					kg/MWhe	1.105
						1.584
						1.38E-05

Assume 100% carbon conversion  
 3.1% O2 by vol dry

**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	Multi train or			Adjusted		unit capital costs		
		Actual	ISOdesign		Unit cost	Train Size	Size/cost exp factor	unit cost	\$ 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		
<b>Sub-critical PC Boilers</b>	<b>Bit.</b>											
Sub-critical PC Boilers	kWt heat exchange	1,400,624	1,540,686	1	\$100	1,400,000	0.85	99	152	280	\$ 57	
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		
<b>Installed process unit costs</b>									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		
									<b>U.S. Gulf Coast Reference \$2004 Baseline Unit Capital Cost</b>		601	1,107
Inflation adjustment to	650	Ch.E. index change for mid-2008			444	Ch.E index mid 2004\$ baseline			880	1,621		
Location adjustment to	115%	of U.S. Gulf Coast Construction costs for			<b>Total Site Specific Capital Costs</b>				<b>1,012</b>	<b>1,865</b>	For O&M	

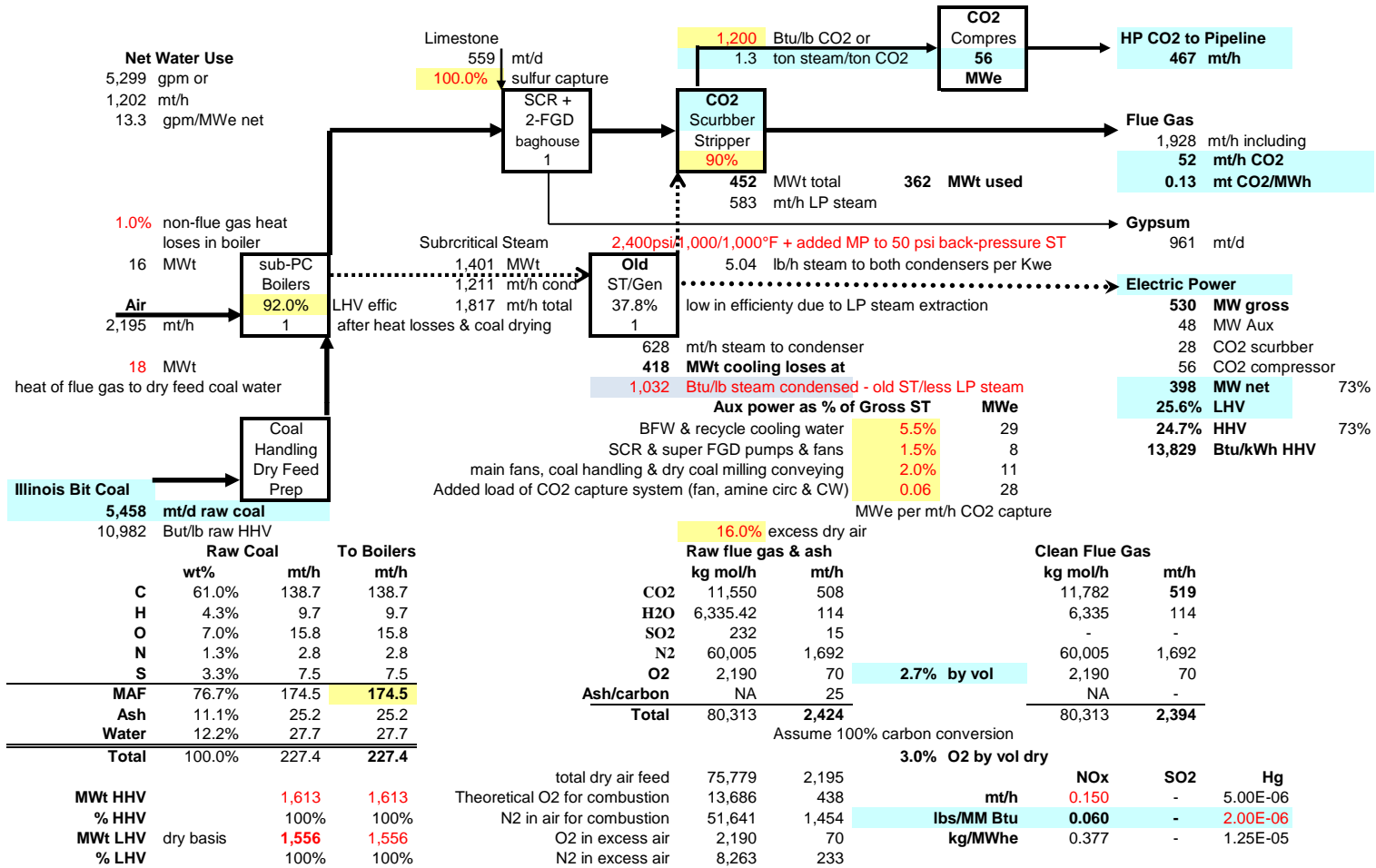
Product Cost Estimate	average annual capacity factor of	85%	or	4.0E+06 MWh per year	\$ Million/yr	unit cost \$/MWh	
Capital charges	Assume paid-off	0.0%	/yr of total capital or	Assume paid-off	0.0	-	
Non-Fuel O&M Costs		4.5%	/yr of total capital		45.5	11.3	
Fuel	Illinois Bit in MidWest min. shipping	\$ 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		\$ 74.20	/mt CO2 or \$ 272.07 per mt carbon equivalent		285.9	70.7	
<b>Net revenues required at above assumptions</b>						<b>434.6</b>	<b>107.5</b>

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-C1 Continued**  
**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	unit cost	\$ Million	unit
		Actual	ISOdesign		Unit cost	Train Size	Size/cost exp factor				capital costs
Coal & limestone handling & storage	mt/d coal & limestone	6,017	7,220	1	\$0	10,000	0.70	0	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	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	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	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	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	43 new
FGD - gypsum oxidizer & handling	mt/d gypsum	961	1,153	1	\$0	750	0.70	0	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	0 old
CO2 scrubber	kg mol/h raw flue gas	80,313	88,344	1	\$750	64,400	0.70	682	60	151	151 new
CO2 stripper	kg mol/h CO2 stripped	10,395	11,435	1	\$1,500	5,717	0.80	1,306	15	37	37 new
CO2 compressor	kWe driver	56,002	61,603	4	\$1,050	15,401	0.85	853	53	132	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	75 new
<b>Installed process unit costs</b>										<b>209</b>	<b>525</b>
General Facilities		25% of Installed Process unit capital			<b>Saving due to existing PC site</b>					<b>52</b>	131
Engineering, Startup & Working Cap		15% of Installed Process unit capital								31	79
Contingencies		10% of Installed Process unit capital								21	52
<b>U.S. Gulf Coast Reference \$2004 Baseline Unit Capital Cost</b>										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			<b>Total Site Specific Capital Costs</b>					<b>528</b>	<b>1,325</b>

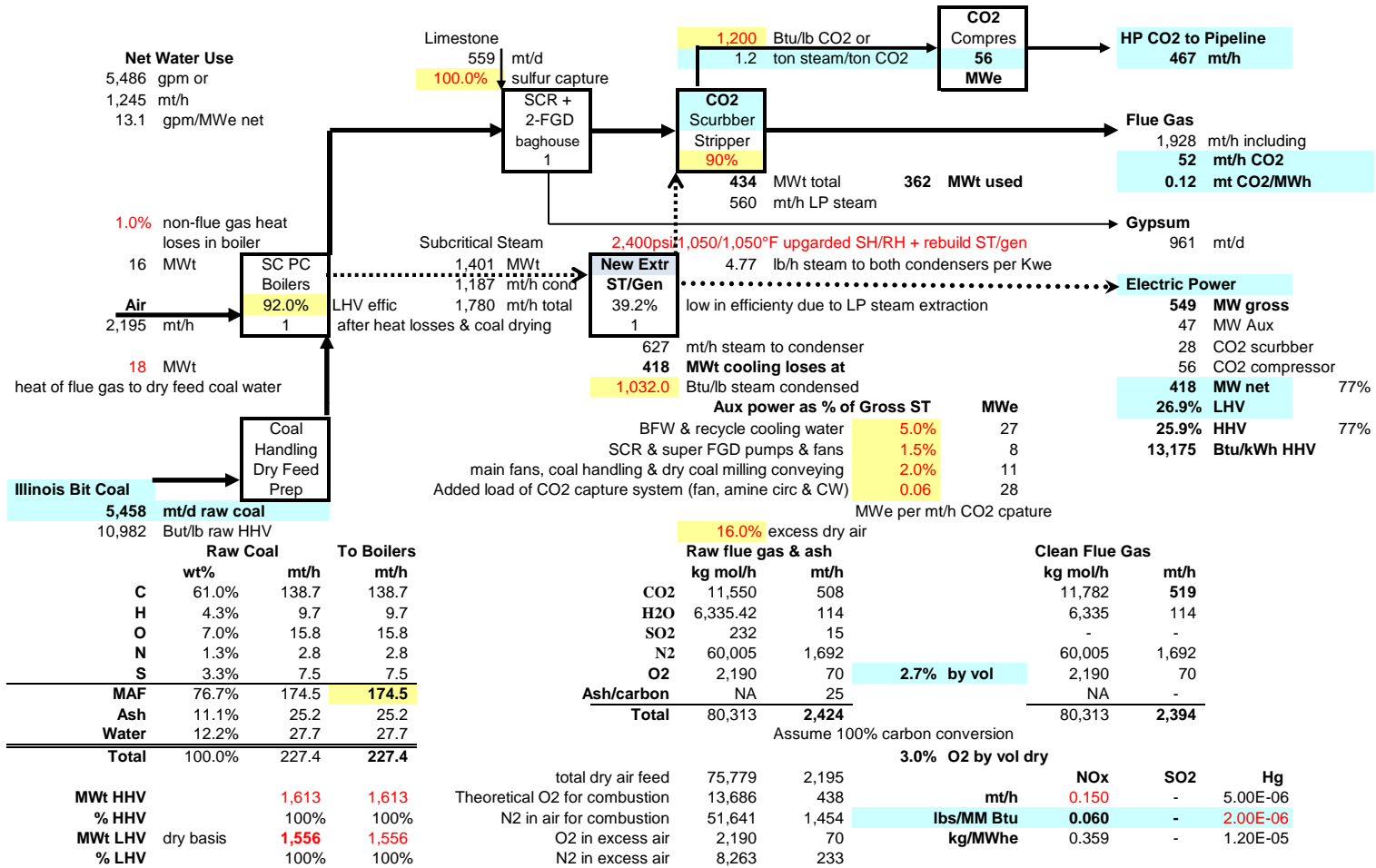
Product Cost Estimate	average annual capacity factor of	85%	or	3.0E+06 MWh per year	\$ Million/yr	unit cost
Capital charges	Key variable	15.0%	/yr of total capital or	6.67 yr capital payback	79.2	26.7
Non-Fuel O&M Costs		4.5%	/yr of total new capital + 100% of old PC capital		69.3	23.4
Fuel	Illinois 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		\$ 74	/mt CO2 or	\$ 272.07 per mt carbon equivalent	28.6	9.7
<b>Net revenues required at above assumptions</b>					<b>318.8</b>	<b>107.5</b>

**CO2 avoidance cost** \$ 0 /mt CO2 or \$ 0 /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 plus steam upgrade

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 plus steam upgrades**

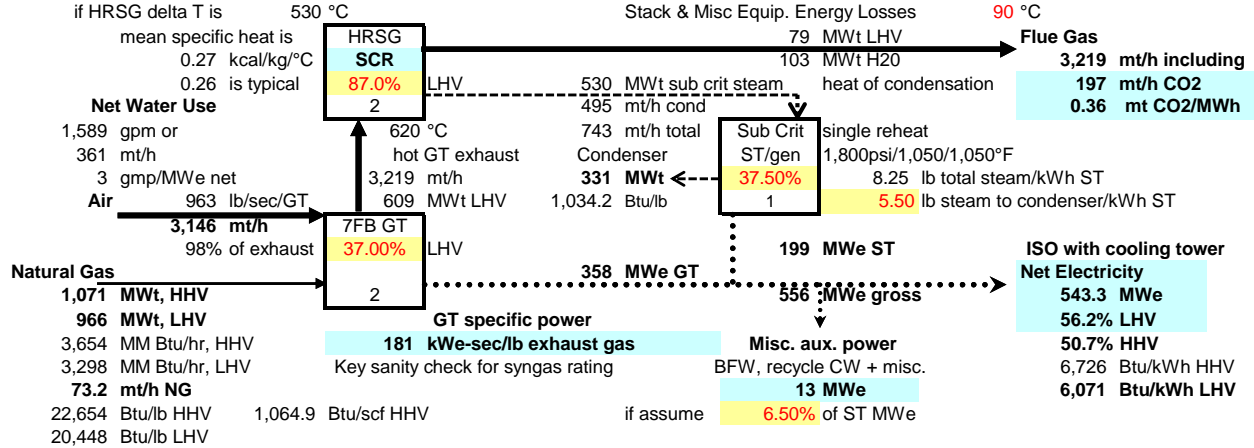
Capital Cost Estimates	Units of Flow	Flow Rates		Trains	Multi train or			Adjusted unit cost	\$ Million	unit capital costs	
		Actual	ISOdesign		Baseline Unit cost	Unit Capital Train Size	Size/cost exp factor			\$/kWe	
Coal & limestone handling & storage	mt/d coal & limestone	6,017	7,220	1	\$0	10,000	0.70	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
<b>Installed process unit costs</b>									<b>299</b>	<b>715</b>	
General Facilities		25% of Installed Process unit capital			<b>Saving due to existing PC site</b>				<b>75</b>	179	
Engineering, Startup & Working Cap		15% of Installed Process unit capital							45	107	
Contingencies		10% of Installed Process unit capital							30	72	
<b>U.S. Gulf Coast Reference \$2004 Baseline Unit Capital Cost</b>									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			<b>Total Site Specific Capital Costs</b>				<b>755</b>	<b>1,807</b>	

Product Cost Estimate	average annual capacity factor of	85%	or	3.1E+06 MWh per year	\$ Million/yr	unit cost \$/MWh				
<b>Capital charges</b>	<b>Key variable</b>	<b>15.0%</b>	/yr of total capital or	<b>6.67</b>	yr capital payback	<b>113.3</b>	<b>36.4</b>			
Non-Fuel O&M Costs		<b>4.5%</b>	/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		\$ 74	/mt CO2 or	\$ 272.07	per mt carbon equivalent	28.6	9.2			
<b>Net revenues required at above assumptions</b>									<b>347.2</b>	<b>111.6</b>

**CO2 avoidance cost** \$ 5 /mt CO2 or \$ 18 /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				NOx Emissions of			
	Vol %	kg mol/h	mt/h	Vol% wet	kg mol/h	mt/h	Vol% dry	kg mol/h	mt/h	ppmv NOx in dry gas @	
CH4	88.25%	3,625	58	O2	12.5%	14,103	13.5%	14,103	451	13.5% O2 dry vol	
C2H6	9.75%	401	12	H2O	7.5%	8,452	0.024	8,452	152	0.024 mt/h as NO2	
CO2	1.00%	41	2	CO2	4.0%	4,467	0.015	4,467	197	0.015 lbs NO2/MM Btu	
N2	1.00%	41	1	N2	76.1%	85,902	0.04	85,902	2,419	0.04 kg/MWh	
<b>Total</b>	<b>100.00%</b>	<b>4,107.8</b>	<b>73</b>		<b>100.0%</b>	<b>112,924</b>			<b>3,219</b>		

Natural Gas				m/h total dry air feed			
	Vol %	kg mol/h	mt/h				
CH4	88.25%	3,625	58	Theoretical O2 for combustion		8,652	277
C2H6	9.75%	401	12	N2 in air for combustion		32,647	919
CO2	1.00%	41	2	O2 in excess air		14,103	451
N2	1.00%	41	1	N2 in excess air		53,214	1,498
<b>Total</b>	<b>100.00%</b>	<b>4,107.8</b>	<b>73</b>				

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	
									<b>Installed process unit costs</b>	214	393
									<b>Saving due to existing PC site</b>	53	98
General Facilities		25% of Installed Process unit capital							32	59	
Engineering, Startup & Working Cap		15% of Installed Process unit capital							21	39	
Contingencies		10% of Installed Process unit capital									
<b>U.S. Gulf Coast Reference \$2004 Baseline Unit Capital Cost</b>									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				<b>Total Site Specific Capital Costs</b>				<b>540</b>	<b>993</b>	

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	\$ 8.31	per million Btu HHV	See notes below	226.2	55.9
"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		\$ 74.20	/mt CO2 or \$ 272.07 per mt carbon equivalent		108.6	26.9
<b>Gross revenues required at above assumptions</b>					<b>435.0</b>	<b>107.5</b>

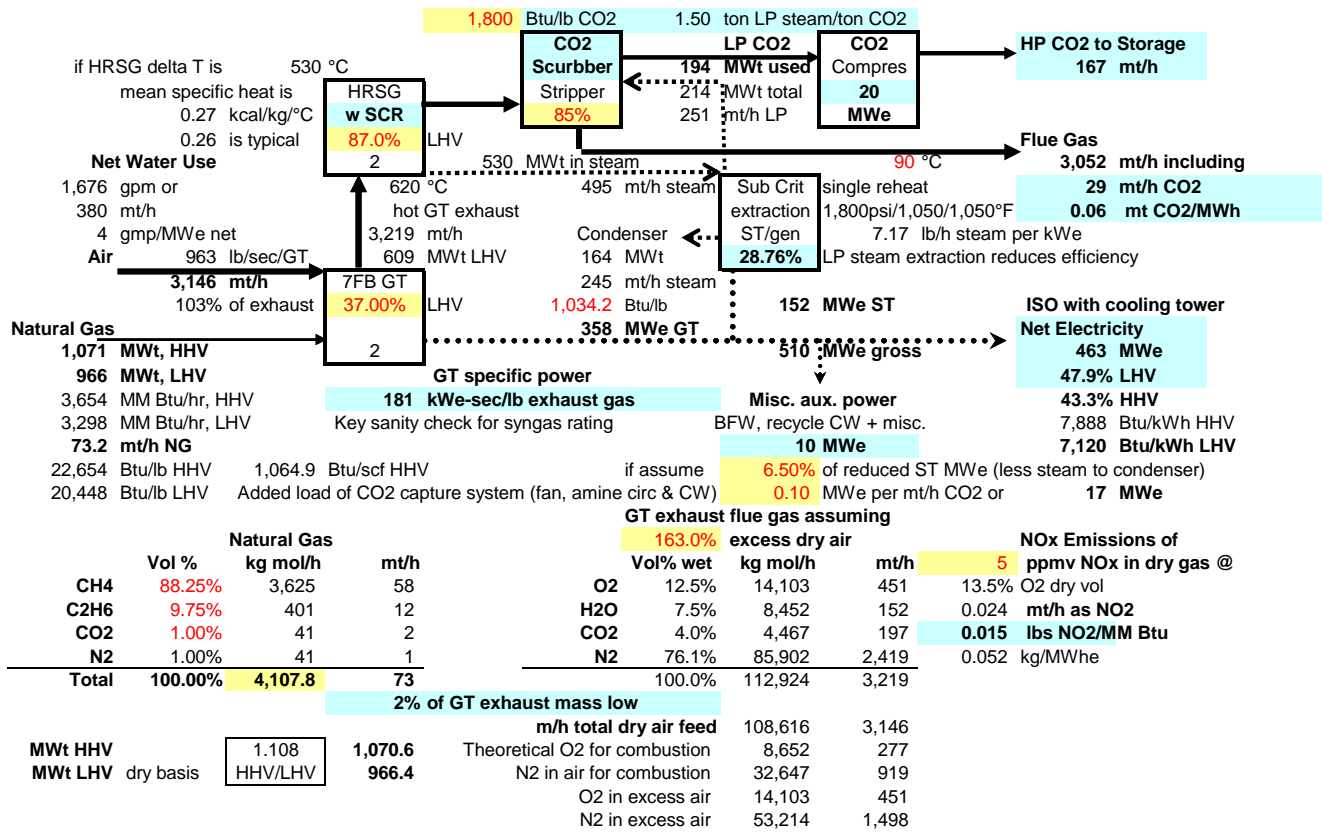
NG price so no CCS NGCC CO2 avoided cost is same as lowest CCS

CO2 avoidance cost \$ 0 /mt CO2 or \$ 0 /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 with Post 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 scrubber	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
<b>Installed process unit costs</b>								<b>331</b>	<b>715</b>
General Facilities	25% of Installed Process unit capital		<b>Saving due to existing PC site</b>				<b>83</b>	<b>179</b>	
Engineering, Startup & Working Cap	15% of Installed Process unit capital						50	107	
Contingencies	10% of Installed Process unit capital						33	71	
<b>U.S. Gulf Coast Reference \$2004 Baseline Unit Capital Cost</b>								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			<b>Total Site Specific Capital Costs</b>			<b>836</b>	<b>1,805</b>	

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 <b>Natural gas</b>	<b>Key variable</b>	\$ 8.31	per million Btu HHV	<b>See notes below</b>	226.2	65.6
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		\$ 74.20	/mt CO2 or \$ 272.07 per mt carbon equivalent		16.3	4.7
<b>Gross revenues required at above assumptions</b>					<b>416.2</b>	<b>120.7</b>

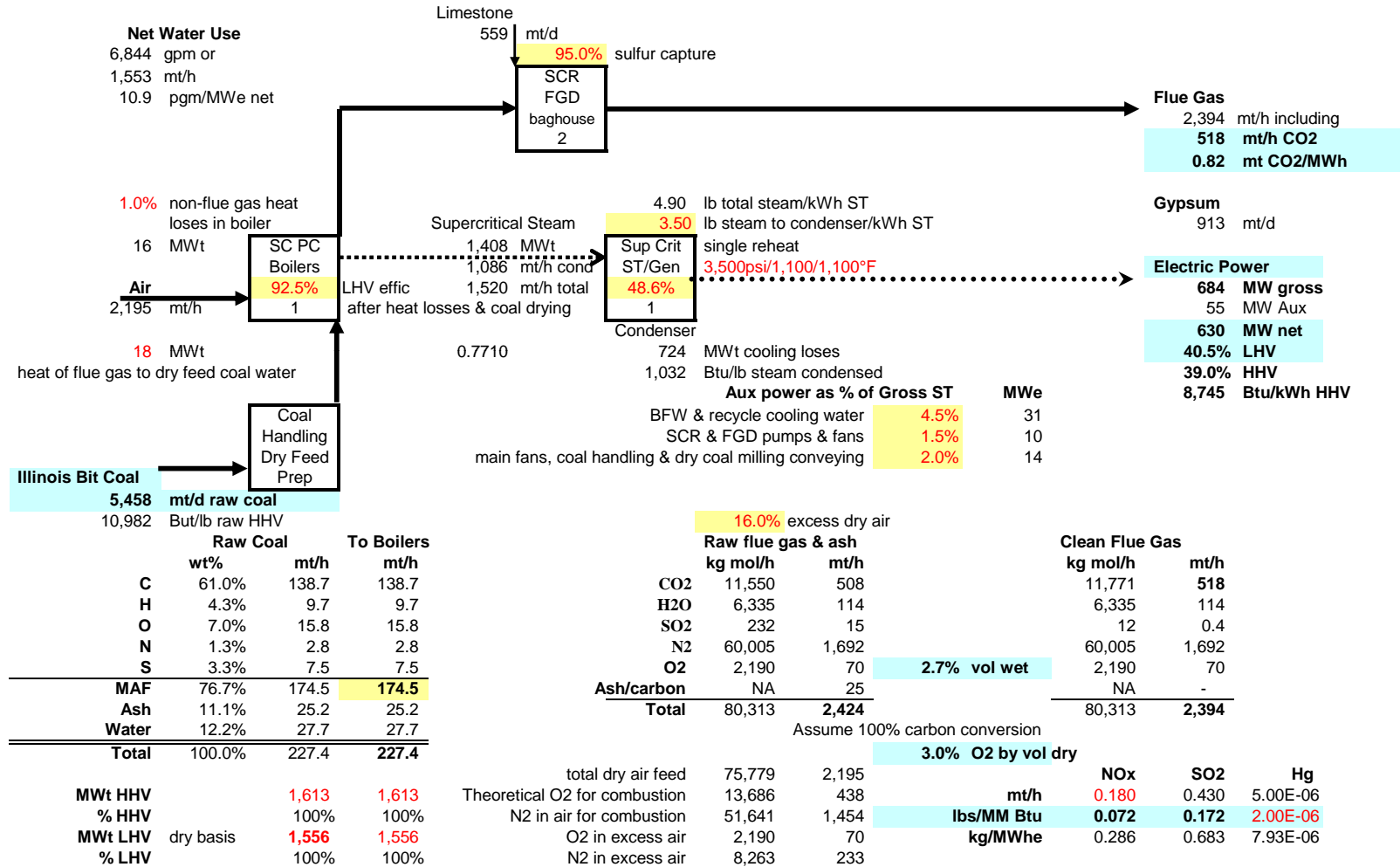
**CO2 avoidance cost \$ 15 /mt CO2 or \$ 54 /mt C equiv from old PC baseline - (\$/MWh ccs - \$/MWh b) / (mt CO2/MWh b - mt CO2/MWh ccs)**

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
<b>Supercritical PC Boilers Bit.</b>	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?
<b>Supercritical reheat ST &amp; gen</b>	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				<b>Saving due to existing PC site</b>				134	213 saving?
Engineering, Startup & Working Cap	15% of Installed Process unit capital								80	128
Contingencies	10% of Installed Process unit capital								54	85
<b>U.S. Gulf Coast Reference \$2004 Baseline Unit Capital Cost</b>									804	1,277
<b>Inflation adjustment to</b>	650 Ch.E. index change for mid-2008 from				444 Ch.E index mid 2004\$ baseline				1,178	1,870
<b>Location adjustment to</b>	115% of U.S. Gulf Coast Construction costs for				<b>Total Site Specific Capital Costs</b>				1,354	2,151

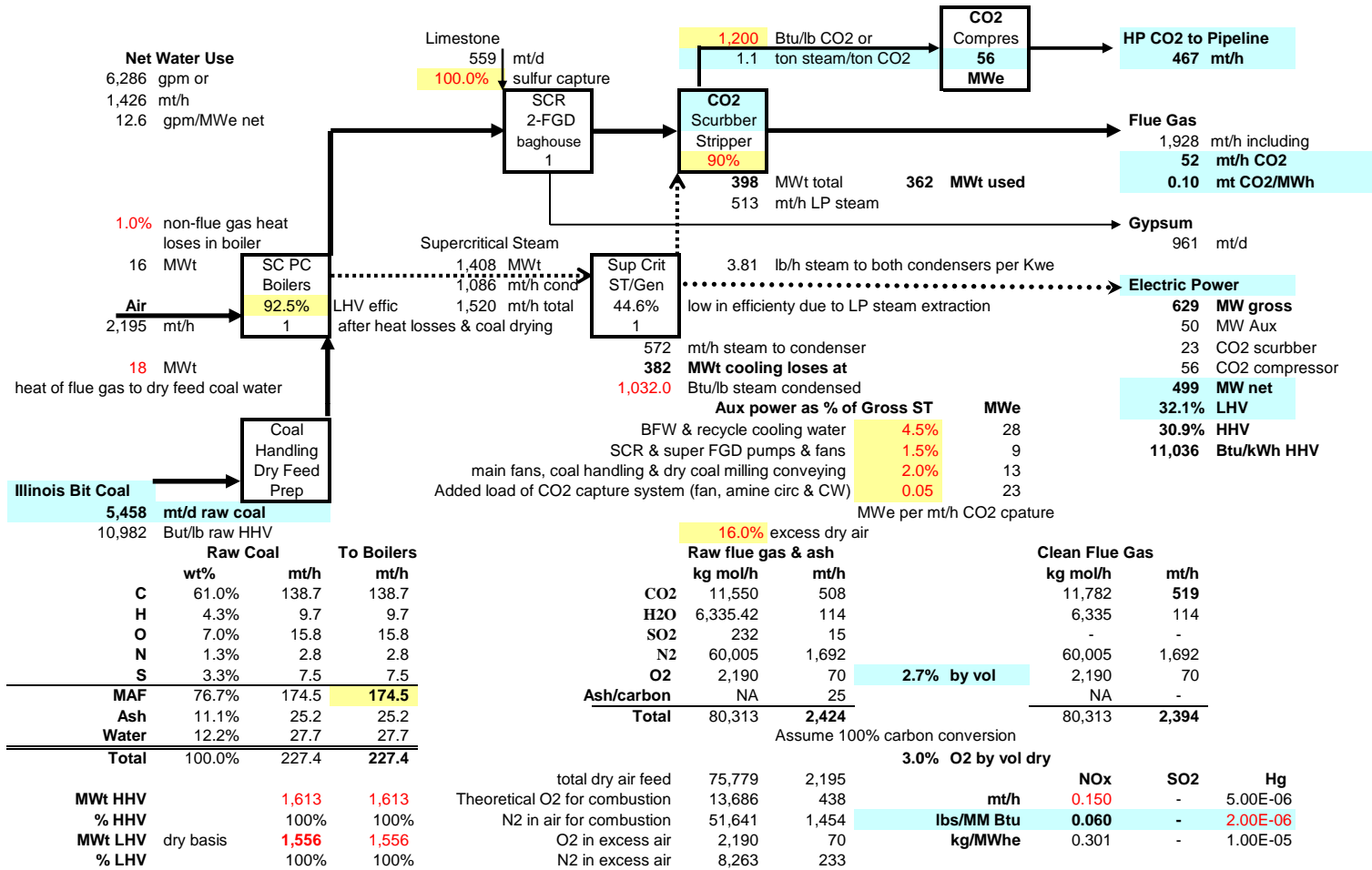
Product Cost Estimate	average annual capacity factor of	85%	or	4.7E+06 MWh per year	\$ Million/yr	unit cost \$/MWh
<b>Capital charges</b>	<b>Key variable</b>	15.0%	/yr of total capital or	6.67 yr capital payback	203.1	43.3
Non-Fuel O&M Costs		4.5%	/yr of total capital		60.9	13.0
Fuel	<b>Illinois Bit in Midwest min. shipping</b>	\$ 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		\$ 74.20	/mt CO2 or	\$ 272.07 per mt carbon equivalent	286.2	61.0
<b>Net revenues required at above assumptions</b>					<b>643.6</b>	<b>137.3</b>

**CO2 avoidance cost** \$ 228 /mt CO2 or \$ 836 /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**

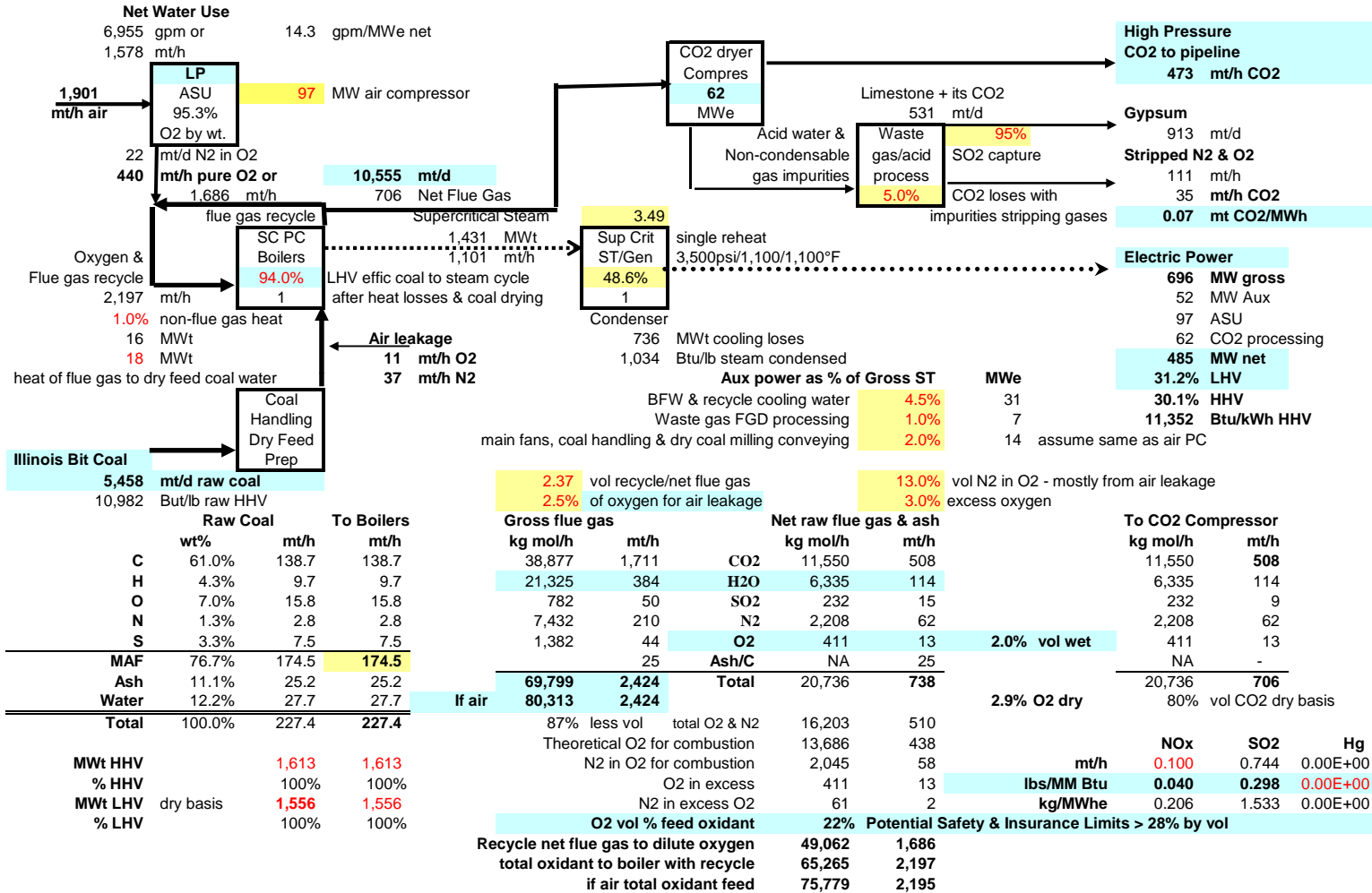
Capital Cost Estimates	Units of Flow	Flow Rates		Trains	Multi train or			Adjusted unit cost	\$ Million	unit capital costs	
		Actual	ISOdesign		Baseline Unit cost	Unit Capital Train Size	Size/cost exp factor			\$/kWe	\$/kWe
Coal & limestone handling & storage	mt/d coal & limestone	6,017	7,220	1	\$1,000	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
<b>Installed process unit costs</b>									<b>699</b>	<b>1,401</b>	
General Facilities	25% of Installed Process unit capital				<b>Saving due to existing PC site</b>				<b>175</b>	350	
Engineering, Startup & Working Cap	15% of Installed Process unit capital								105	210	
Contingencies	10% of Installed Process unit capital								70	140	
<b>U.S. Gulf Coast Reference \$2004 Baseline Unit Capital Cost</b>									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				<b>Total Site Specific Capital Costs</b>				<b>1,765</b>	<b>3,537</b>	

Product Cost Estimate	average annual capacity factor of	85%	or	3.7E+06 MWh per year	\$ Million/yr	unit cost \$/MWh	
<b>Capital charges</b>	<b>Key variable</b>	<b>15.0%</b>	/yr of total capital or	<b>6.67</b>	yr capital payback	<b>264.7</b>	<b>71.3</b>
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		\$ 74	/mt CO2 or	\$ 272.07	per mt carbon equivalent	28.6	7.7
<b>Net revenues required at above assumptions</b>						<b>514.5</b>	<b>138.5</b>

**CO2 avoidance cost** \$ 36 /mt CO2 or \$ 134 /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)

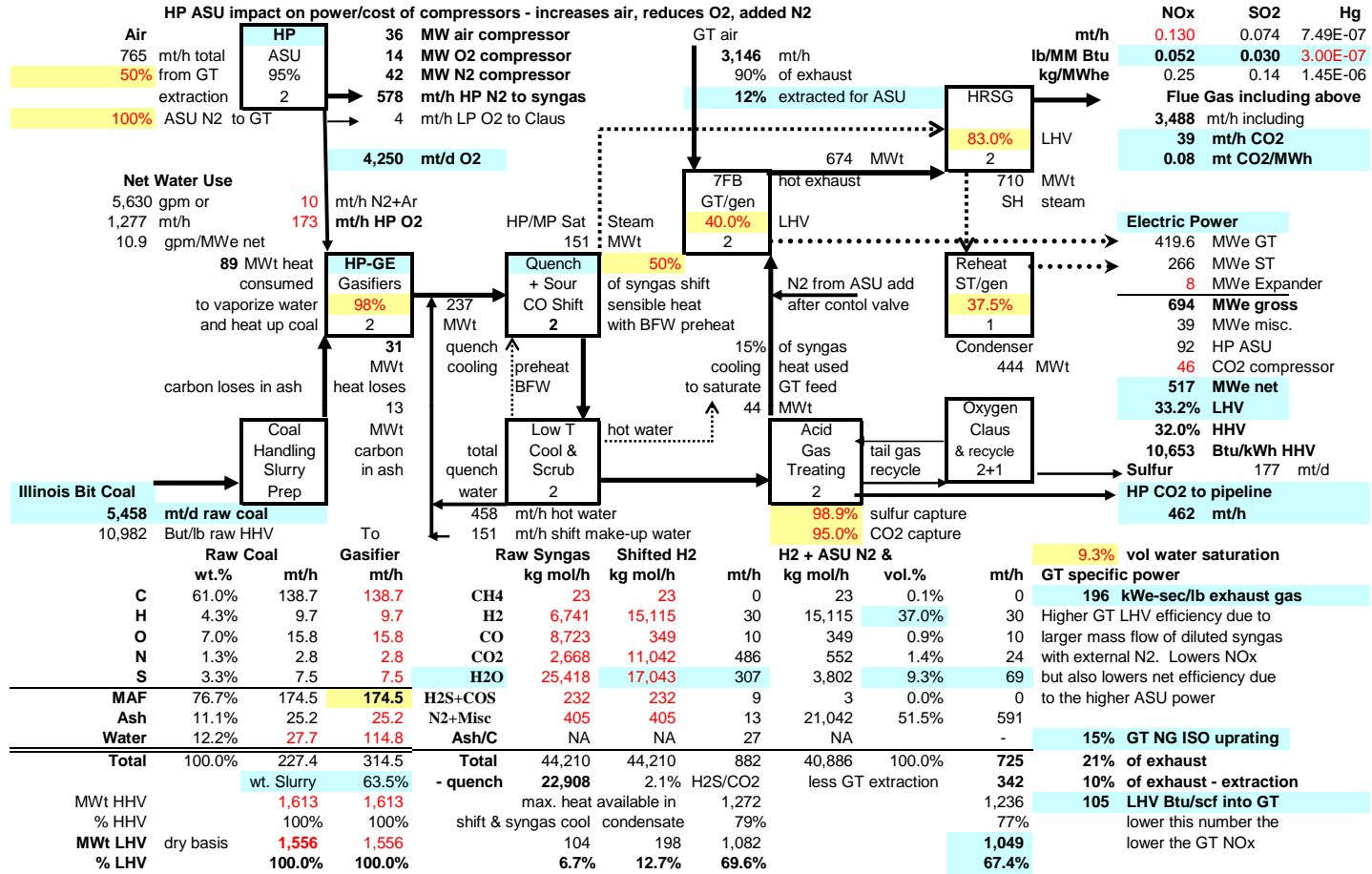
Capital Cost Estimates	Units of Flow	Flow Rates			Baseline Unit Capital			Adjusted unit cost	unit capital costs		
		Actual	ISOdiesel	Trains	Unit cost	Train Size	Size/cost exp factor		\$ Million	\$/kWe	
Coal handling & storage	mt/d coal & limestone	5,458	6,550	1	\$1,000	10,000	0.70	1,135	7	15 saving	
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 steam	
LP ASU air compressor	kW driver	96,756	101,594	3	\$410	33,865	0.90	367	37	77	
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	
<b>Installed process unit costs</b>									651	<b>1,342</b>	
<b>General Facilities</b>		<b>25%</b> of Installed Process unit capital			<b>Saving due to existing PC site</b>				163	336	
Engineering, Startup & Working Cap		<b>15%</b> of Installed Process unit capital							98	201	
Contingencies		<b>10%</b> of Installed Process unit capital							65	134	
<b>U.S. Gulf Coast Reference \$2004 Baseline Unit Capital Cost</b>									976	2,013	
<b>Inflation adjustment to</b>	<b>650</b> Ch.E. index change for mid-2008	from			<b>444</b> Ch.E index mid 2004\$ baseline				1,430	2,947	
<b>Location adjustment to</b>	<b>115%</b> of U.S. Gulf Coast Construction costs for				<b>Total Site Specific Capital Costs</b>				<b>1,644</b>	<b>3,389</b>	

Product Cost Estimate	average annual capacity factor of	85%	or	3.6E+06 MWh per year	\$ Million/yr	unit cost \$/MWh
<b>Capital charges</b>	<b>Key variable</b>	<b>15.0%</b> /yr of total capital or		<b>6.67</b> yr capital payback	<b>246.6</b>	<b>68.3</b>
Non-Fuel O&M Costs		<b>4.5%</b> /yr of total capital			74.0	20.5
Fuel <b>Illinois Bit in MidWest min. shipping</b>		<b>\$ 2.00</b> per million Btu HHV of		<b>\$ 48.43</b> /mt raw coal	82.0	22.7
Limestone minimal shipping		<b>\$ 30</b> /mt			0.0	-
HP CO2 pipeline & injection costs (or credit if for EOR)		<b>\$ 15.00</b> /mt ton impure CO2 or		<b>\$ 0.64</b> per 1,000 scf	52.9	14.6
"what if" minimal gypsum byproduct credits		<b>\$ (5.00)</b> /mt gypsum or		<b>\$ (26.88)</b> /mt sulfur equivalent	(0.0)	(0.0)
"what if" NOx emissions requires purchased credits at		<b>\$ 2,000</b> /mt as NO2			1.5	0.4
"what if" SO2 emissions requires purchased credits at		<b>\$ 1,000</b> /mt SO2			5.5	1.5
"what if" Hg emissions requires purchased credits at		<b>\$ 20,000</b> /lb Hg or		<b>\$ 44</b> million per mt mercury emissions	0.0	-
"what if" CO2 emissions requires purchased credits at		<b>\$ 74</b> /mt CO2 or		<b>\$ 272.07</b> per mt carbon equivalent	<b>0.0</b>	<b>0.0</b>
<b>Net revenues required at above assumptions</b>					<b>462.5</b>	<b>128.0</b>

**CO2 avoidance cost** \$ 23 /mt CO2 or \$ 85 /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: IGCC-CContinued

## 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		Baseline Unit cost	Train Capital	Size/cost exp factor			\$ Million	\$/kWe
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	
<b>GE Quench Gasifier @ 70 atm.</b>	kg mol/h raw syngas	22,908	25,199	2	<b>\$3,000</b>	<b>12,600</b>	0.90	2,799	<b>71</b>	<b>136</b>	
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	<b>\$2,250</b>	14,941	0.80	1,959	<b>59</b>	<b>113</b>	
Selective AG Stripper high CO2 Selexol	kg mol/hr acid gas	10,720	13,936	2	<b>\$2,000</b>	6,968	0.80	1,741	<b>24</b>	<b>47</b>	
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	<b>419,608</b>	<b>366,300</b>	2	<b>\$360</b>	183,150	0.85	324	<b>119</b>	<b>230</b>	
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	
<b>Installed process unit costs</b>									<b>660</b>	<b>1,277</b>	
<b>General Facilities</b>	<b>25%</b> of Installed Process unit capital				<b>Saving due to existing PC site</b>				<b>165</b>	<b>319</b>	
Engineering, Startup & Working Cap	<b>15%</b> of Installed Process unit capital								99	191	
Contingencies	<b>10%</b> of Installed Process unit capital								66	128	
<b>U.S. Gulf Coast Reference \$2004 Baseline Unit Capital Cost</b>									<b>990</b>	<b>1,915</b>	
<b>Inflation adjustment to</b>	<b>650</b> Ch.E. index change for mid-2008 from				<b>444</b> Ch.E index mid 2004\$ baseline				1,449	2,803	
<b>Location adjustment to</b>	<b>115%</b> of U.S. Gulf Coast Construction costs for				<b>Total Site Specific Capital Costs</b>				<b>1,667</b>	<b>3,224</b>	

Product Cost Estimate	average annual capacity factor of	85%	or	3.8E+06 MWh per year	unit cost					
					\$ Million/yr	\$/MWh				
<b>Capital charges</b>	<b>Key variable</b>	<b>15.0%</b>	/yr of total capital or	<b>6.67</b>	yr capital payback	<b>250.0</b>	<b>64.9</b>			
Non-Fuel O&M Costs		<b>4.5%</b>	/yr of total capital			75.0	19.5			
Fuel	<b>Illinois Bit in Midwest min. shipping</b>	<b>\$ 2.00</b>	per million Btu HHV of	<b>\$ 48.43</b>	/mt raw coal	82.0	<b>21.3</b>			
HP CO2 pipeline & injection costs (or credit if for EOR)		<b>\$ 15.00</b>	/mt ton CO2 or	<b>\$ 0.79</b>	per 1,000 scf	51.6	13.4			
"what if" minimal sulfur byproduct credits		<b>\$ (26.88)</b>	/mt sulfur or	<b>\$ (5.00)</b>	/mt gypsum equivalent	<b>(1.5)</b>	<b>(0.4)</b>			
"what if" NOx emissions requires purchased credits at		<b>\$ 2,000</b>	/mt as NO2			1.9	0.5			
"what if" SO2 emissions requires purchased credits at		<b>\$ 1,000</b>	/mt SO2			0.6	0.1			
"what if" Hg emissions requires purchased credits at		<b>\$ 20,000</b>	/lb Hg or	<b>\$ 44</b>	million per mt mercury emissions	0.2	0.1			
"what if" CO2 emissions requires purchased credits at		<b>\$ 74.20</b>	/mt CO2 or	<b>\$ 272.07</b>	per mt carbon equivalent	21.7	5.7			
<b>Net revenues required at above assumptions</b>									<b>481.5</b>	<b>125.1</b>

**CO2 avoidance cost**    \$ 20 /mt CO2 or \$ 74 /mt C equivalent    based on existing old coal power plants baseline  
 (\$/MWh ccs - \$/MWh b) / (mt CO2/MWh b - mt CO2/MWh ccs)