Feedstock Impact on an IGCC Plant with CO_2 Capture

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Ron Herbanek, Jayesh Shah
ConocoPhillips

Satish Gadde, Jay White
WorleyParsons

INTRODUCTION

The prospect of regulating CO_2 emissions places IGCC as the technology of choice for new (stationary) solid fuel power generation:

- CO_2 capture is an integral part of the configuration
- Pre-combustion capture is currently proven/demonstrated technology (unlike post-combustion capture)
- Addition of CO Shift presents no technology challenges
- CO_2 compression is advantaged by reduced pressure ratio
- Majority of uncertainty lies in regulatory/economic aspects of CO_2 transmission and sequestration (i.e. non-technical aspects)

OBJECTIVES

Demonstrate the overall performance of an IGCC plant with CO_2 capture, employing various feedstock, in terms of:

- Net output
- Net heat rate
- % CO_2 Capture
- TIC (relative)
- COE (relative)

Evaluate Gulf Coast vs. Mine Mouth to assess the relative impact of:

- Feedstock transportation cost
- Regional labor rate
- Site conditions

Factors held constant include:

- Plant configuration
- Base load operation
- CO_2 emission level
- Cost estimating basis
- Economic assumptions

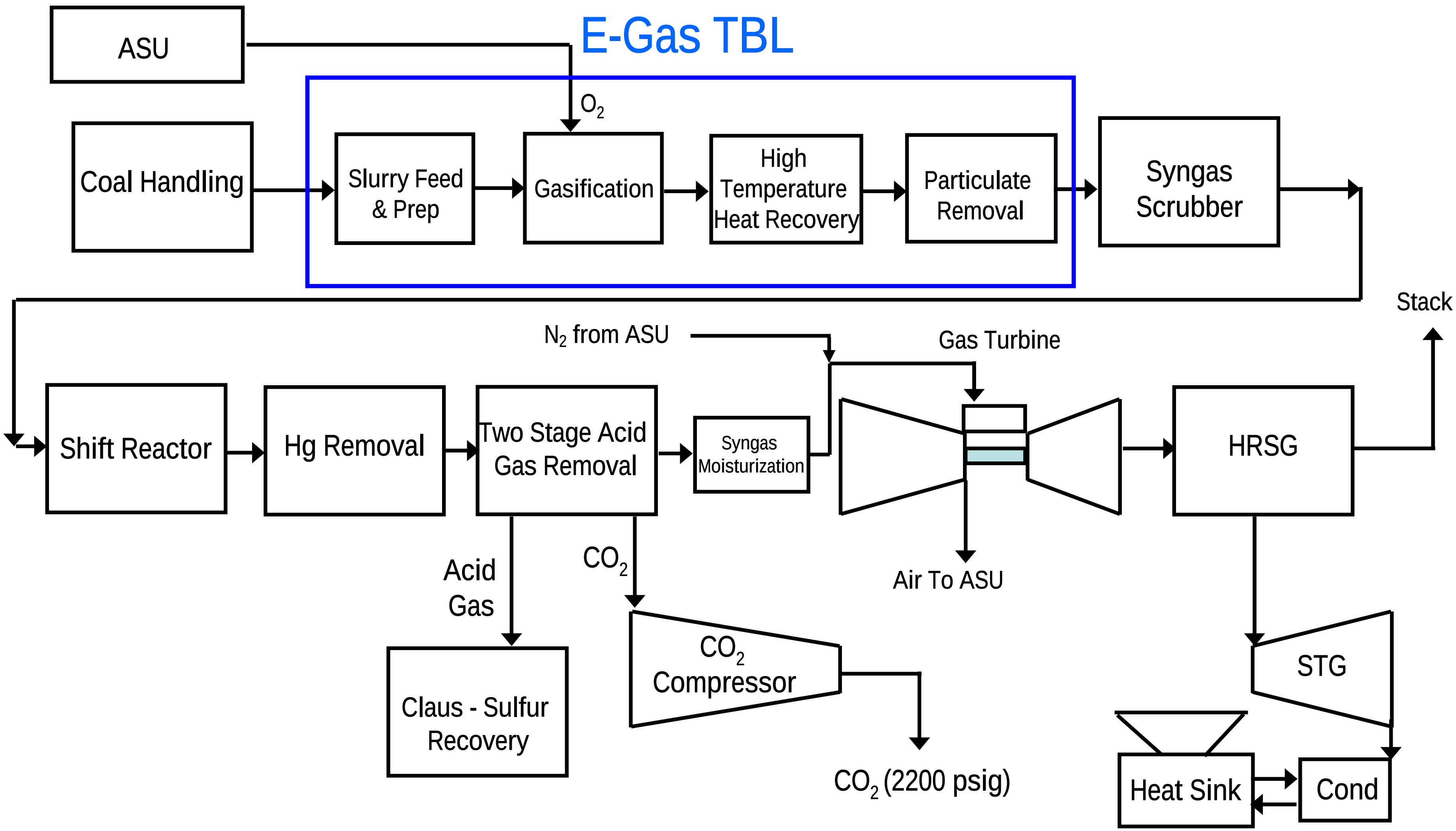
FEEDSTOCK COMPARISON

	Ultimate Analysis, A.R. (Wt%)	Petcoke	Pitt #8	Utah Bit.	IL #6	50/50 Lignite - Petcoke	PRB
increasing →	Moisture	6.0	6.8	8.1	14.2	19.8	27.3
← increasing	Carbon	81.8	71.7	69.6	60.1	59.0	51.3
	Hydrogen	3.4	4.8	4.7	4.2	3.0	3.5
	Nitrogen	1.4	1.3	1.2	1.1	1.2	0.7
	Sulfur	6.6	2.9	0.5	3.1	2.8	0.2
	Oxygen	0.2	4.9	9.9	7.8	6.4	12.5
	Ash	0.6	7.6	10.0	9.5	8.1	4.5
← increasing	HHV, A.R. (Btu/lb)	~13,500	~12,950	~11,600	~10,800	~10,400	~8,800

OVERALL DESIGN BASIS

- Integrated ASU (40-50%)
- E-Gas™ gasification - full slurry quench mode
- Single stage CO shift w/ bypass
- 3 column Selexol™ AGR
- 2 x 1 power block
- GTG w/ N_2 dilution plus SG moisturization (achieve blended fuel LHV = 130 Btu/scf)
- STG throttle; 1800 psia/1050 F/1050 F
- Heat sink = wet cooling tower
- CO_2 emission level = 1100 lb/MWh net (NGCC "footprint")
- CO_2 compression to 2200 psig @ battery limit (no sequestration)

SIMPLIFIED BFD



SITE SPECIFIC – DESIGN BASIS

Mine Mouth Cases

Feedstock	Reference Location	Elevation, ft AMSL	Avg. Annual Ambient, F	Distance to GC, miles	Regional Labor Rate [1]
Petcoke	Beaumont, TX	0	59	0	1.0
Pitt #8	Charleston, WV	939	50	911	1.24
Utah Bit.	Provo, UT	4,448	49	1,743	1.15
IL #6	Decatur, IL	679	48	940	1.26
50/50 Lignite -Petcoke	Longview, TX	330	57	201	1.0
PRB	Casper, WY	5,338	40	1,472	1.15

[1] Relative all-in labor rate (base + burden & benefits + construction indirects)

GULF COAST CASES – PLANT PERFORMANCE SUMMARY

	Petcoke	Pitt #8	Utah Bit.	IL #6	50/50 Lignite - Petcoke	PRB
Feed Rate, TPD	4,947	5,256	6,005	6,584	7,038	8,388
Gross Power, MW	729	745	750	757	761	781
Aux Load, MW	159	140	150	154	159	170
Net Power, MW	570	605	600	604	602	611
Net Heat Rate, Btu/kWh (HHV)	9,753	9,412	9,651	9,807	10,224	10,060
% CO_2 Capture [1]	49.1	42.3	44.8	45.4	47.6	49.0

[1] expressed on the basis of combusted carbon in the feedstock @ 1100 lb CO_2 / MWh net

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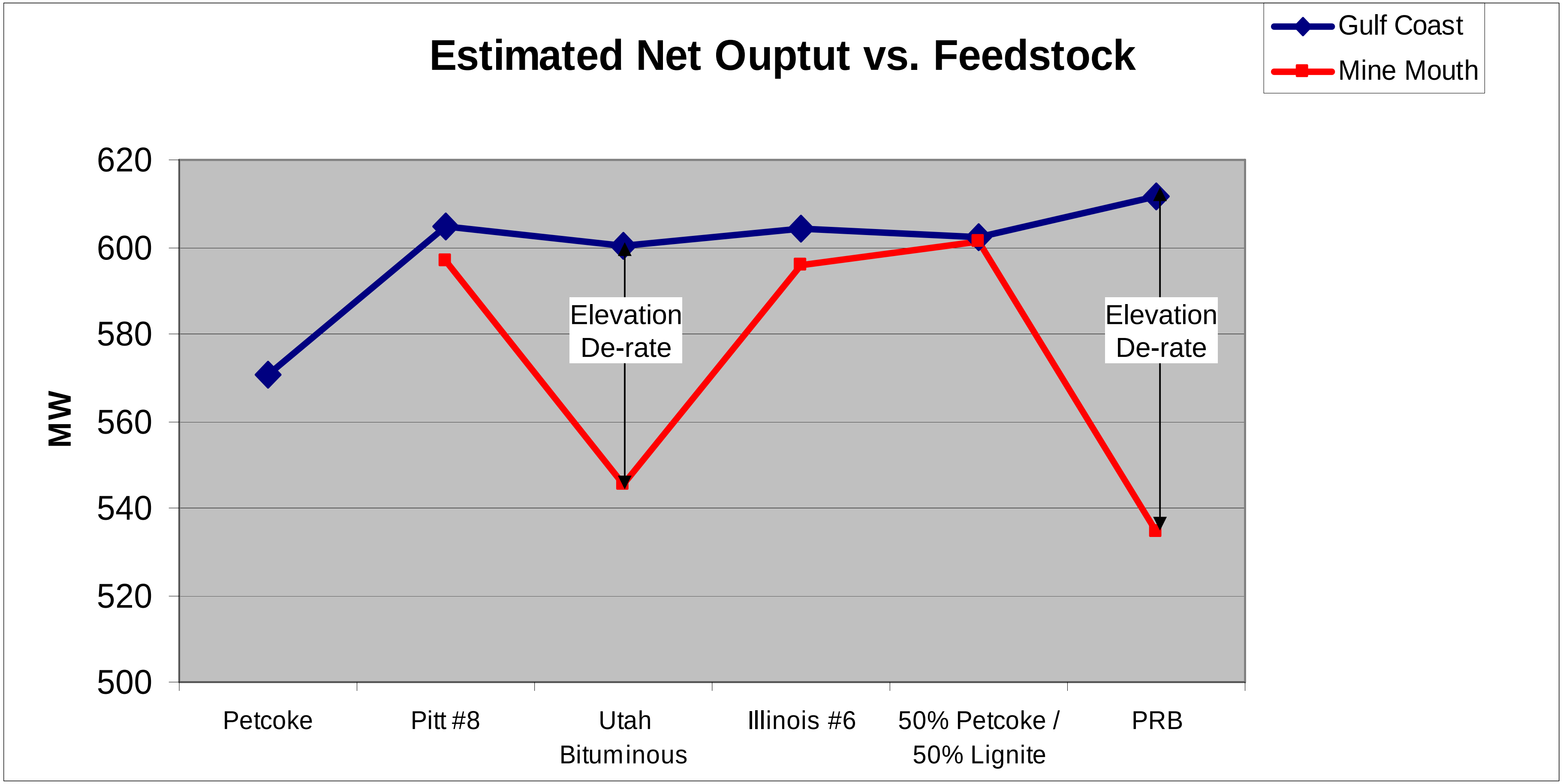
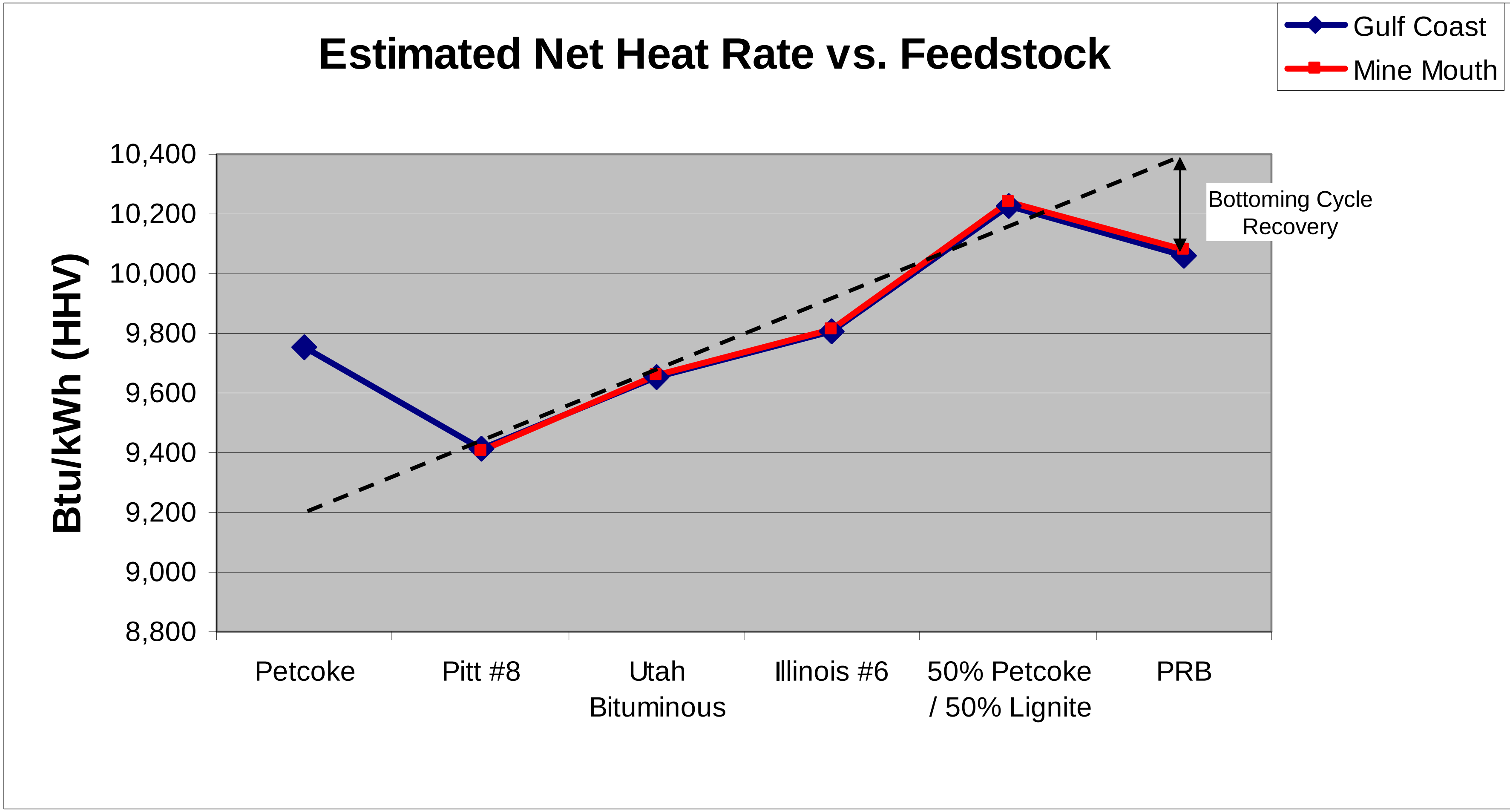
MINE MOUTH CASES – PLANT PERFORMANCE SUMMARY

	Pitt #8	Utah Bit.	IL #6	50/50 Lignite - Petcoke	PRB
Feed Rate, TPD	5,182	5,459	6,497	7,034	7,667
Gross Power, MW	735	685	748	761	711
Aux Load, MW	139	138	152	160	160
Net Power, MW	596	546	596	601	551
Net Heat Rate, Btu/kWh (HHV)	9,405	9,657	9,811	10,239	10,196
% CO_2 Capture [1]	41.9	45.2	45.4	47.6	49.4

[1] expressed on the basis of combusted carbon in the feedstock @ 1100 lb CO_2 / MWh net



Estimated Net Ouptut vs. Feedstock
Gulf Coast
Mine Mouth
MW
620
600
580
560
540
520
500
Elevation De-rate
Elevation De-rate
Petcoke
Pitt #8
Utah Bituminous
Illinois #6
50% Petcoke / 50% Lignite
PRB



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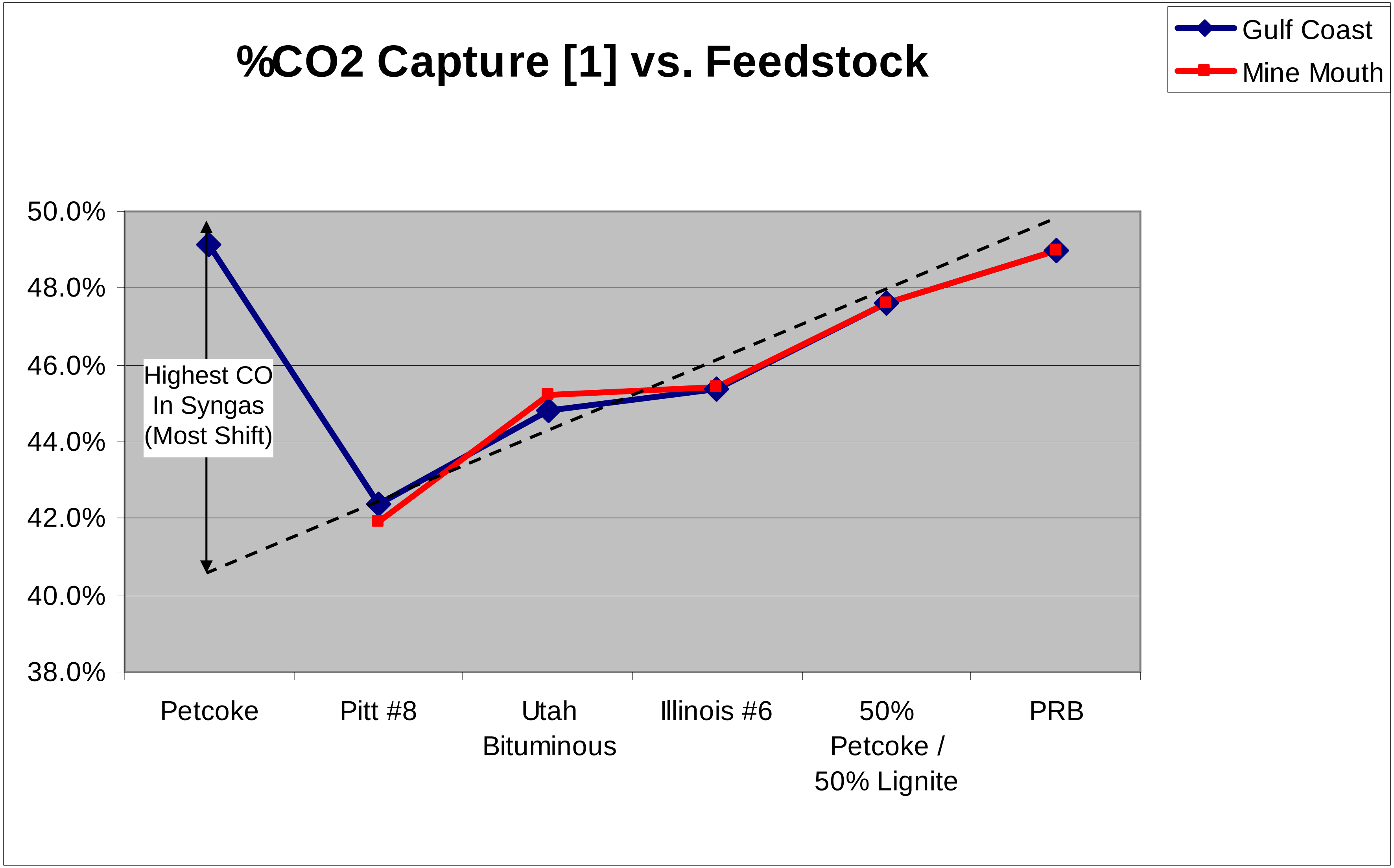


[1] expressed on the basis of combusted carbon in the feedstock @ 1100 lb CO2 / MWh net

ECONOMIC BASIS

Capital Cost

- Equipment & bulks factored @ process block level
- EPC cost including indirects & regional labor rate
- 20% profit & contingency
- Owner's costs including escalation & contingency

Schedule – 5 yr project, COD = 2014

O&M – 4% EPC cost

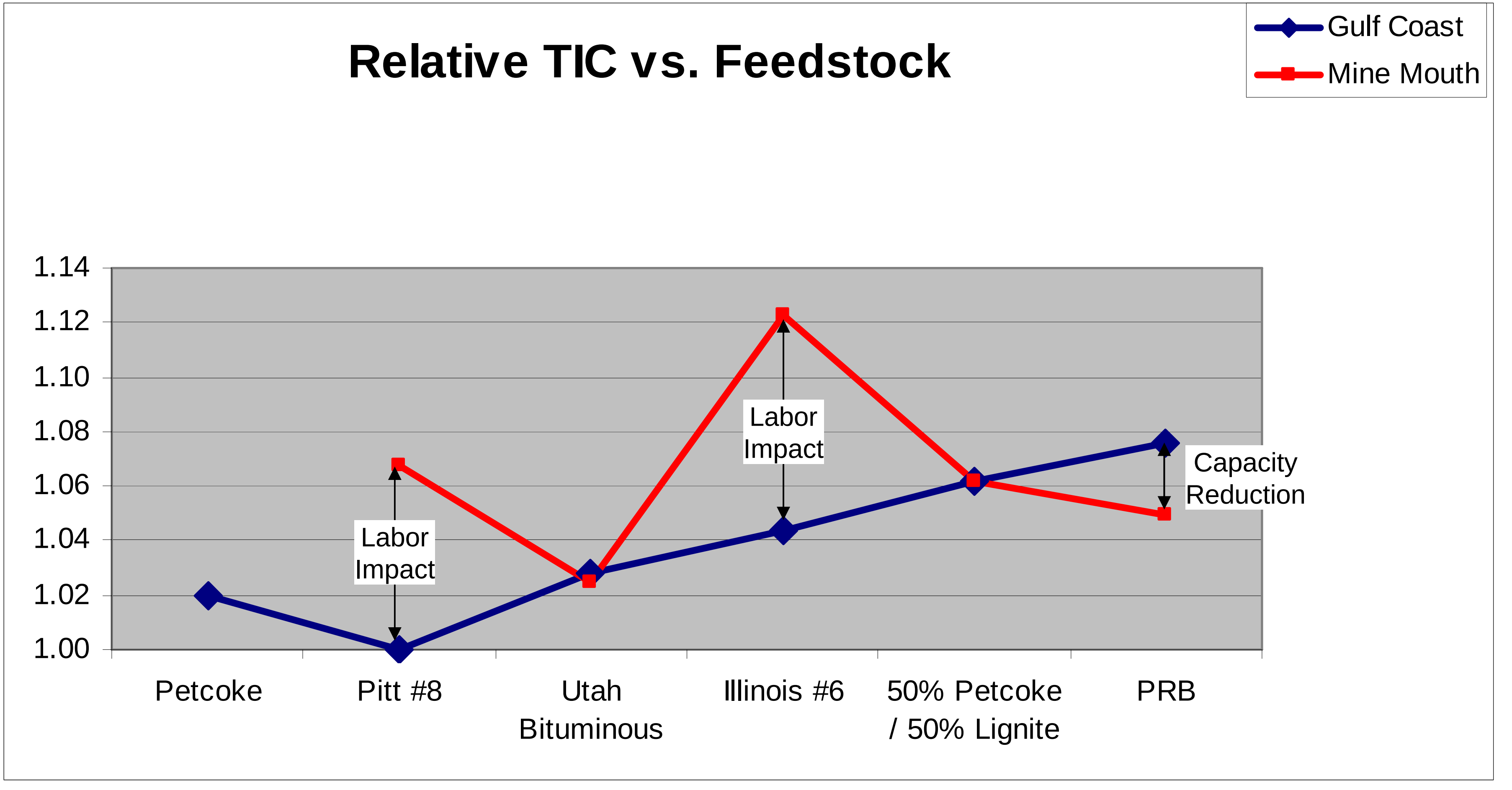
Financial Assumptions

- COE back-calculated to achieve 10% IRR
- 3% escalation
- 10% interest rate on 100% debt
- Sulfur = $ 50/ton, no credit for slag
- 37% tax rate

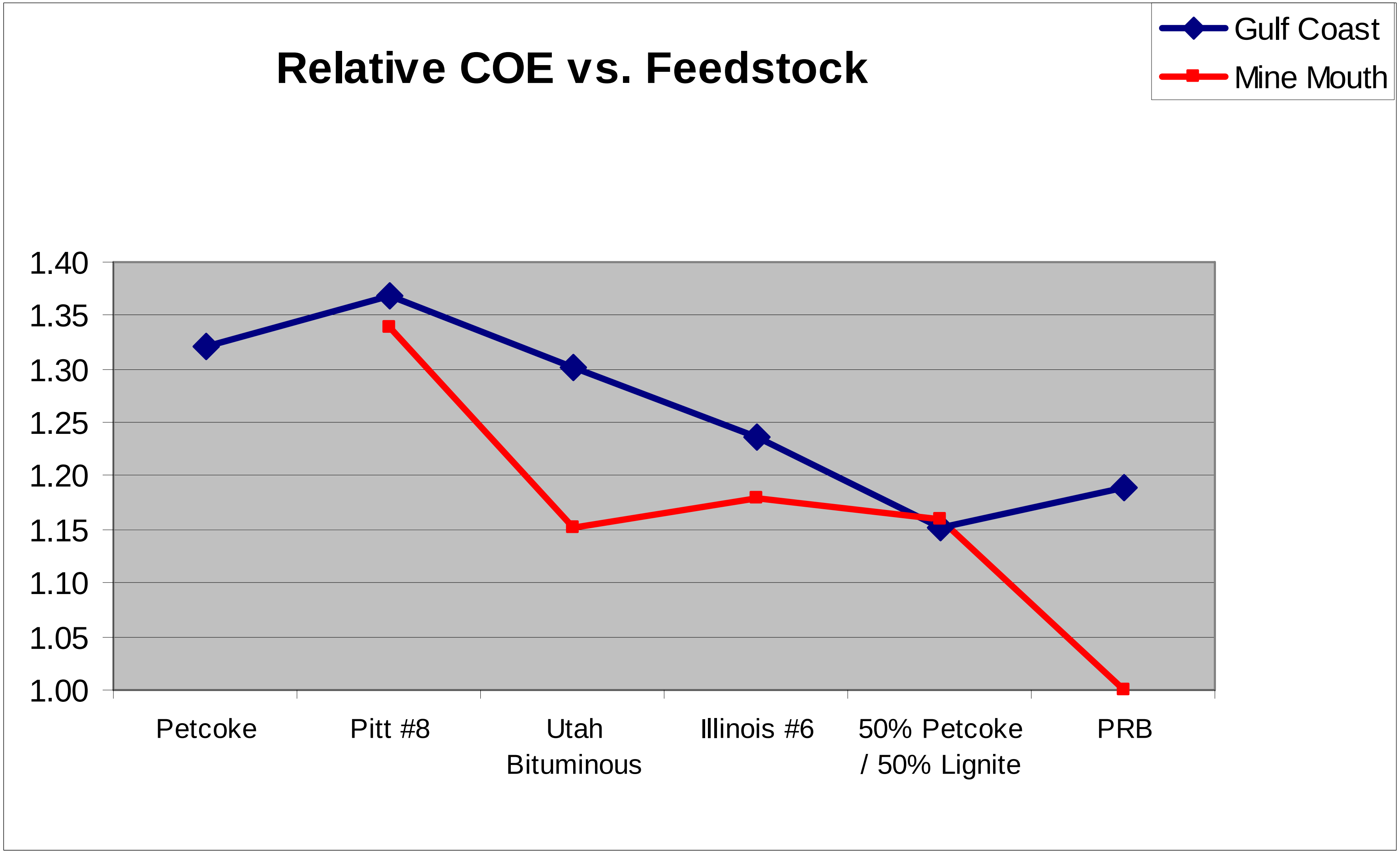
Feedstock Costs (2008)

Feedstock	Petcoke	Pitt #8	Utah Bit	IL #6	50/50 blend [3]	PRB
$/ton [1]	$ 110.00	$ 141.00	$ 63.00	$ 65.00	$ 21.25	$ 11.35
$/MMBtu	$ 4.07	$ 5.44	$ 2.72	$ 3.01	$ 1.45	$ 0.64
$/ton (delivered) [2]	$ 116.91	$ 172.31	$ 122.90	$ 97.30	$ 28.16	$ 61.93
$/MMBtu (delivered)	$ 4.33	$ 6.64	$ 5.31	$ 4.50	$ 1.92	$ 3.52

[1] pricing: coal; SNL Energy Coal Report, Lignite; NETL Study 2004 (Contract #DE-AM26-99FT404665)
[2] transportation cost from DOT- BTS Table 3-17 for Class I rail 2006
[3] Lignite component only



Relative TIC vs. Feedstock
Gulf Coast
Mine Mouth
1.14
1.12
1.10
1.08
1.06
1.04
1.02
1.00
Labor Impact
Labor Impact
Capacity Reduction
Petcoke
Pitt #8
Utah Bituminous
Illinois #6
50% Petcoke / 50% Lignite
PRB



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CONCLUSIONS

- Transportation cost impact is ≥ mine mouth performance impact on COE.
- Feedstock impact on capital cost is ≤ 15% across the range at both Gulf Coast and mine mouth locations
- Plant performance trends (power, heat rate) with CO2 capture are reasonably predictable and rational
- CO2 capture required to meet the emissions target is highly feedstock dependant, and does not vary appreciably with plant performance at site conditions
- Lower quality feedstock generates lower COE