

# **Appendix H**

## **Scale-up and comparison of design cases**

## Economic Comparison of the Cases

The table below is a breakdown of the installed capital cost for each of the six cases (not including the power plant, Case 7) with a fixed alcohol production requirement. The costs are for the x1 scale. The six cases are the following:

Case 1 - Texaco Gasification and Steam Reformation

Case 2 - Lurgi Gasification

Case 3 - Steam Reformation Only

Case 4 - Texaco Gasification Only

Case 5 - Shell Gasification Only

Case 6 - Shell Gasification and Steam reformation

(all Costs in MM\$)	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Cryogenic Oxygen Plant	89.3	212.7	--	109.0	103.3	49.4
Coal Preparation	40.8	77.5	--	51.4	31.9	19.5
Gasification	158.7	653.4	--	195.9	193.2	92.5
Slag Handling	3.0	--	--	3.7	3.6	2.2
Syngas Heat Recovery	4.6	--	--	5.6	5.4	3.3
Gas Turbines	45.0	356.4	45.0	45.1	44.9	44.9
Steam Turbines	22.1	46.8	9.9	25.4	25.8	17.9
Exhaust Gas Heat Recovery	9.9	29.6	11.1	8.9	8.7	11.0
Compressors	54.1	216.6	57.5	60.4	65.5	50.6
Rectisol	34.9	115.5	25.8	51.3	54.4	14.5
Claus	10.3	29.7	--	12.5	12.2	7.5
Beavon	2.2	6.4	--	2.7	2.6	1.6
Steam Reformer	15.9	--	90.3	--	--	27.8
Pressure Swing Adsorption	--	20.6	22.2	--	--	--
Sour Gas Shift Converter	--	--	--	4.4	4.3	--
Alcohol Synthesis	47.2	47.2	47.2	47.2	47.2	47.2
CO2 Removal	26.9	4.5	26.9	26.9	26.9	26.9
<b>Total</b>	<b>562.8</b>	<b>1817.1</b>	<b>335.9</b>	<b>650.3</b>	<b>629.9</b>	<b>416.6</b>

**Table H.1 Block Cost Breakdown for Varying Plant Capacities**

Case #1				
<i>Scale factor</i>	1	2	4	8
Cryo. Plant	89.33	161.55	323.10	626.82
<i># trains</i>	2	3	6	11
Coal Prep.	40.80	70.08	122.07	211.08
<i># trains</i>	3	6	12	23
Texaco Gasifier	156.70	274.22	548.43	1,057.69
<i># trains</i>	4	7	14	27
Slag Hand.	3.00	4.70	7.38	11.58
SGHR	4.57	7.18	11.26	17.67
Gas Turbines	45.03	71.65	143.31	286.61
<i># trains</i>	1	1	2	4
Steam Turbines	22.14	35.22	56.04	112.08
<i># trains</i>	1	1	1	2
EGHR	9.90	15.75	25.05	50.11
<i># trains</i>	1	1	1	2
Compressors	54.08	104.74	208.16	415.05
Rectisol	34.88	54.73	85.87	134.75
Claus	10.25	16.08	25.24	39.60
Beavon	2.21	3.46	5.44	8.53
Steam Reformer	15.85	27.60	48.05	83.67
Alcohol Syn.	47.21	69.85	103.33	152.86
CO2 Removal	26.86	42.15	66.14	103.78
<b>Total Cap. Cost</b>	<b>562.80</b>	<b>958.96</b>	<b>1,778.88</b>	<b>3,311.88</b>

Table H.2 Block Cost Breakdown for Varying Plant Capacities

Case 2				
<i>Scale factor</i>	1	2	4	8
Cryo. Plant	212.73	425.46	831.91	1,644.19
<i># trains</i>	4	8	15	29
Coal Prep.	77.53	121.66	190.91	299.57
Lurgi Gasifier	653.40	1,270.50	2,504.70	4,973.10
<i># trains</i>	18	35	69	137
Gas Turbines	356.41	688.46	1,351.19	2,675.89
<i># trains</i>	5	9	17	33
Steam Turbines	46.83	93.67	170.37	320.84
<i># trains</i>	1	2	3	5
EGHR	29.62	59.24	118.49	226.76
<i># trains</i>	1	2	4	7
Compressors	216.61	431.97	861.11	1,720.49
Rectisol	115.54	181.31	284.50	446.43
Claus	29.70	46.61	73.14	114.77
Beavon	6.40	10.04	15.75	24.72
P.S.A.	20.61	32.34	50.75	79.63
Alcohol Syn.	47.21	69.85	103.33	152.86
CO2 removal	4.54	7.12	11.18	17.54
<b>Total Cap. Cost</b>	<b>1,817.14</b>	<b>3,438.22</b>	<b>6,567.31</b>	<b>12,696.78</b>

Table H.3 Block Cost Breakdown for Varying Plant Capacities

Case #3				
Scale factor	1	2	4	8
Gas Turbines	45.02	71.63	143.26	286.51
# trains	1	1	2	4
Steam Turbines	9.93	15.80	25.14	40.01
# trains	1	1	1	1
EGHR	11.15	17.73	28.21	56.43
# trains	1	1	1	2
Compressors	57.47	112.68	224.02	446.69
Rectisol	25.78	40.45	63.47	99.60
Reformer	90.29	157.20	273.69	476.53
P.S.A.	22.18	34.80	54.61	85.69
Alcohol Syn.	47.21	69.85	103.33	152.86
CO2 removal	26.86	42.15	66.14	103.78
<b>Total Cap. Cost</b>	<b>335.89</b>	<b>562.28</b>	<b>981.38</b>	<b>1,748.10</b>

Table H.4 Block Cost Breakdown for Varying Plant Capacities

Case #4 Scale factor	1	2	4	8
Cryo. Plant	109.02	218.04	436.09	852.70
# trains	2	4	8	15
Coal Prep.	51.38	88.70	155.32	271.33
# trains	4	8	16	31
Tex. Gasifier	195.87	391.74	744.30	1,449.43
# trains	5	10	19	37
Slag hand.	3.66	5.74	9.00	14.13
SGHR	5.58	8.76	13.74	21.56
Gas Turbines	45.10	71.75	143.51	287.01
# trains	1	1	2	4
Steam Turbines	25.45	40.49	64.42	128.83
# trains	1	1	1	2
EGHR	8.91	14.18	22.57	45.13
# trains	1	1	1	2
Compressors	60.37	119.74	238.15	476.30
Rectisol	51.28	80.47	126.27	198.14
Claus	12.51	19.63	30.80	48.33
Beavon	2.69	4.23	6.63	10.41
Sour Gas Shift	4.38	6.87	10.78	16.92
Alcohol Syn.	47.21	69.85	103.33	152.86
CO2 removal	26.86	42.15	66.14	103.78
Total Cap. Cost	650.27	1,182.33	2,171.06	4,076.87

Table H.5 Block Cost Breakdown for Varying Plant Capacities

Case #5				
Scale factor	1	2	4	8
Cryo. Plant	103.26	206.52	394.19	788.37
# trains	2	4	7	14
Coal Prep.	31.87	50.02	78.48	123.16
Shell Gasifier	193.24	386.47	737.65	1475.30
# trains	2	4	7	14
Slag hand.	3.57	5.60	8.79	13.79
SGHR	5.45	8.55	13.41	21.05
Gas Turbines	44.92	71.47	142.94	285.88
# trains	1	1	2	4
Steam Power	25.81	41.06	65.33	130.67
# trains	1	1	1	2
EGHR	8.73	13.89	22.09	44.19
# trains	1	1	1	2
Compressors	65.47	127.77	253.09	503.60
Rectisol	54.42	85.39	133.99	210.25
Claus	12.21	19.16	30.07	47.18
Beavon	2.63	4.13	6.48	10.16
Sour Gas Shift	4.27	6.71	10.53	16.52
Alcohol Syn.	47.21	69.85	103.33	152.86
CO2 removal	26.86	42.15	66.14	103.78
Total Cap. Cost	629.92	1,138.72	2,066.51	3,926.76

**Table H.6 Block Cost Breakdown for Varying Plant Capacities**

Case 6				
<i>Scale factor</i>	1	2	4	8
Cryo. Plant	49.44	98.89	197.78	377.49
<i># trains</i>	1	2	4	7
Coal Prep.	19.45	30.52	47.90	75.16
Shell Gasifier	92.53	185.05	370.10	706.41
<i># trains</i>	1	2	4	7
Slag hand.	2.18	3.42	5.36	8.42
SGHR	3.32	5.22	8.19	12.85
Gas Turbines	44.92	71.48	142.95	285.91
<i># trains</i>	1	1	2	4
Steam Turbines	17.86	28.41	45.21	90.41
<i># trains</i>	1	1	1	2
EGHR	10.98	17.46	27.78	55.57
<i># trains</i>	1	1	1	2
Compressors	50.56	96.68	190.94	381.88
Rectisol	14.45	22.68	35.58	55.84
Claus	7.45	11.89	18.35	28.79
Beavon	1.61	2.52	3.95	6.20
Reformer	27.78	48.37	84.22	146.63
Alcohol Syn.	47.21	69.85	103.33	152.86
CO2 removal	26.86	42.15	66.14	103.78
<b>Total Cap. Cost</b>	<b>416.61</b>	<b>734.38</b>	<b>1,347.78</b>	<b>2,488.20</b>



**Table H.7 Block Cost Breakdown**

Case #7	
<i>Scale factor</i>	1
Cryo. Plant	152.63
<i># trains</i>	3
Coal Prep.	67.76
<i># trains</i>	6
Tex. Gasifier	274.22
<i># trains</i>	7
Slag hand.	4.44
SGHR	6.78
Gas Turbines	219.24
<i># trains</i>	3
Steam Turbines	52.62
<i># trains</i>	1
EGHR	45.78
<i># trains</i>	2
Compressors	72.22
Rectisol	62.30
Claus	15.20
Beavon	3.27
Sour Gas Shift	11.09
Alcohol Syn.	17.86
Total Cap. Cost	1,005.40

**Table H.8a Manufacturing Cost for Varying Plant Capacities \$/gal**

Scale	Case 1	Case 2	Case 3a	Case 3b	Case 4	Case 5	Case 6
x1	1.01	1.59	0.90	0.71	1.09	1.05	0.84
x2	0.86	1.42	0.80	0.62	0.98	0.94	0.76
x4	0.80		0.74	0.56	0.90	0.85	0.70
x8	0.75		0.69	0.52	0.84	0.80	0.66

**Table H.8b Manufacturing Cost for Varying Plant Capacities \$/L**

Scale	Case 1	Case 2	Case 3a	Case 3b	Case 4	Case 5	Case 6
x1	0.27	0.42	0.24	0.19	0.29	0.28	0.22
x2	0.23	0.37	0.21	0.16	0.26	0.25	0.20
x4	0.21		0.19	0.15	0.24	0.22	0.19
x8	0.20		0.18	0.14	0.22	0.21	0.17