

## **SUPPORTING INFORMATION**

### **Evaluation and modelling of part-load performance of coal-fired power plant with post-combustion CO<sub>2</sub> capture**

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# 1 POWER PLANT MODEL VALIDATION

**Table S-1: Validation of the base load prediction of the coal-fired power plant model developed in Aspen Plus**

Stream number	Pressure (bar)			Temperature (°C)			Mass flow rate (kg/s)			
	Literature	Model	Deviation	Literature	Model	Deviation	Literature	Model	Deviation	
<b>Coal/bottom ash</b>										
1	1.030	1.030	0.0%	33.0	33.0	0.0%	58.6	60.3	2.9%	
2	1.013	1.013	0.0%	1050.0	1050.0	0.0%	1.9	2.0	3.3%	
<b>Air/flue gas</b>										
3	1.013	1.013	0.0%	33.0	33.0	0.0%	634.5	654.3	3.1%	
4	1.040	1.040	0.0%	35.9	35.8	0.3%	634.5	654.3	3.1%	
5	1.030	1.030	0.0%	258.5	270.2	4.5%	634.5	654.3	3.1%	
6	1.010	1.010	0.0%	1921.4	1922.4	0.1%	691.1	704.8	2.0%	
7	1.010	1.010	0.0%	1070.8	1070.8	0.0%	691.1	704.8	2.0%	
8	1.005	1.005	0.0%	921.8	921.8	0.0%	691.1	704.8	2.0%	
9	1.005	1.005	0.0%	547.6	555.7	1.5%	691.1	704.8	2.0%	
10	1.000	1.000	0.0%	319.0	319.0	0.0%	691.1	704.8	2.0%	
11	1.000	1.000	0.0%	122.4	122.4	0.0%	691.1	715.5	3.5%	
12	1.060	1.060	0.0%	130.0	130.0	0.0%	691.1	715.5	3.5%	
<b>Water/steam</b>										
13	308.70	308.70	0.0%	279.6	279.7	0.0%	550.7	550.7	0.0%	
14	294.70	294.70	0.0%	341.0	344.9	1.1%	550.7	550.7	0.0%	
15	263.20	263.20	0.0%	480.0	478.9	0.2%	550.7	550.7	0.0%	
16	242.20	242.20	0.0%	537.0	537.0	0.0%	550.7	550.7	0.0%	
17	44.30	44.30	0.0%	288.7	287.9	0.3%	466.2	466.3	0.0%	
18	42.00	42.00	0.0%	565.0	565.0	0.0%	466.2	466.3	0.0%	
19	66.80	66.80	0.0%	340.0	339.8	0.1%	36.2	36.2	0.1%	
20	44.30	44.30	0.0%	288.7	287.9	0.3%	48.3	48.2	0.3%	
21	21.00	21.00	0.0%	459.9	455.9	0.9%	14.4	14.8	2.5%	
22	6.10	6.10	0.0%	295.4	290.4	1.7%	19.2	19.5	1.3%	
23	2.98	2.98	0.0%	215.6	210.1	2.6%	31.4	31.4	0.1%	
24	2.90	2.98	2.8%	215.6	210.1	2.6%	346	342.6	1.0%	
25	0.64	0.64	0.0%	87.6	87.6	0.0%	14.1	14.0	0.7%	
26	0.27	0.27	0.0%	66.7	66.7	0.0%	13.5	13.7	1.8%	
27	0.10	0.10	0.0%	46.4	46.4	0.0%	318.5	314.9	1.1%	
28	0.10	0.10	0.0%	46.4	46.4	0.0%	429.5	429.0	0.1%	
29	11.90	11.90	0.0%	46.5	46.5	0.1%	429.5	427.1	0.6%	
30	308.70	308.70	0.0%	193.9	193.3	0.3%	550.7	550.7	0.0%	
31	11.90	11.90	0.0%	381.1	375.4	1.5%	22.4	22.5	0.6%	
32	2.03	2.03	0.0%	33.0	33.0	0.0%	18992.8	18874.2	0.6%	
33	1.03	1.03	0.0%	43.0	43.0	0.0%	18992.8	18874.2	0.6%	

## 2 PART-LOAD OPERATION DATA

Table S-2: Part-load prediction of the coal-fired power plant model

Stream number	80%			60%			40%		
	Pressure (bar)	Temperature (°C)	Flow rate (kg/s)	Pressure (bar)	Temperature (°C)	Flow rate (kg/s)	Pressure (bar)	Temperature (°C)	Flow rate (kg/s)
<b>Coal/bottom ash</b>									
1	1.030	33.0	48.5	1.030	33.0	37.4	1.030	33.0	26.4
2	1.013	1050.0	1.6	1.013	1050.0	1.2	1.013	1050.0	0.9
<b>Air/flue gas</b>									
3	1.013	33.0	616.7	1.013	33.0	583.1	1.013	33.0	537.2
4	1.040	35.8	616.7	1.040	35.8	583.1	1.040	35.8	537.2
5	1.030	254.3	616.7	1.030	237.8	583.1	1.030	221.2	537.2
6	1.010	1735.5	657.4	1.010	1500.2	614.4	1.010	1235.1	559.4
7	1.010	938.0	657.4	1.010	799.4	614.4	1.010	662.8	559.4
8	1.005	813.6	657.4	1.005	707.6	614.4	1.005	610.8	559.4
9	1.005	511.7	657.4	1.005	477.0	614.4	1.005	451.6	559.4
10	1.000	298.1	657.4	1.000	278.5	614.4	1.000	258.1	559.4
11	1.000	110.2	665.4	1.000	98.6	618.7	1.000	86.9	560.7
12	1.060	117.8	665.4	1.060	105.9	618.7	1.060	94.1	560.7
<b>Water/steam</b>									
13	254.17	266.0	435.1	203.63	249.8	325.9	156.20	229.8	223.1
14	245.68	335.4	435.1	198.98	329.9	325.9	154.00	331.7	223.1
15	214.36	474.7	435.1	168.12	475.6	325.9	124.09	489.7	223.1
16	191.71	537.0	435.1	144.08	537.0	325.9	98.97	537.0	223.1
17	36.22	294.5	375.1	28.12	301.9	285.8	20.15	311.1	199.0
18	33.86	563.8	375.1	25.71	556.9	285.8	17.72	542.8	199.0
19	54.14	345.5	24.9	41.62	351.8	16.0	29.4	359.3	9.0
20	36.22	294.5	35.1	28.12	301.9	24.1	20.15	311.1	15.1
21	17.08	456.5	11.2	13.06	451.8	8.0	9.07	440.5	5.0
22	5.06	293.6	14.8	3.94	292.2	10.6	2.78	285.3	6.8
23	2.48	213.4	24.7	1.94	212.8	20.5	1.38	207.3	11.5
24	2.48	213.4	283.6	1.94	212.8	222.3	1.38	207.3	159.5
25	0.52	82.2	10.7	0.41	81.6	7.7	0.30	80.0	4.6
26	0.22	62.4	8.3	0.18	57.7	4.0	0.14	53.0	1.2
27	0.10	46.4	264.7	0.10	46.4	210.6	0.10	46.4	153.7
28	0.10	46.4	346.6	0.10	46.4	265.3	0.10	46.4	185.9
29	9.83	149.3	346.6	7.62	140.1	265.2	5.36	128.0	185.9
30	254.17	183.6	435.1	203.63	171.8	325.9	156.20	156.9	223.1
31	9.83	378.2	17.3	7.62	375.8	12.5	5.36	367.5	8.0

### 3 PERFORMANCE INDICATORS FOR RETROFIT CASES

Table S-3: Key performance indicators for Case 1

Percent of base load	40%	60%	80%	100%
<b>Key parameters</b>				
Gross power output (MW <sub>el</sub> )	196.51	306.57	417.46	528.55
Net power output (MW <sub>el</sub> )	159.78	259.41	360.06	461.07
Net efficiency (% <sub>HHV</sub> )	22.32	25.61	27.40	28.24
Reboiler duty (MW <sub>th</sub> )	293.78	413.00	531.41	644.83
Steam extraction rate (kg/s)	118.04	170.49	224.24	277.38
<b>HP turbine inlet</b>				
Pressure (bar)	99.18	144.17	191.72	242.20
Temperature (°C)	537.00	537.00	537.00	537.00
Mass flow rate (kg/s)	223.34	325.97	435.17	550.48
<b>IP turbine inlet</b>				
Pressure (bar)	18.15	25.94	33.89	41.84
Temperature (°C)	542.79	556.90	563.80	565.00
Mass flow rate (kg/s)	200.08	286.40	375.26	465.75
<b>LP turbine inlet</b>				
Pressure (bar)	0.57	0.66	0.70	0.71
Temperature (°C)	285.31	252.00	225.60	202.70
Mass flow rate (kg/s)	53.66	66.67	75.91	82.19

Table S-4: Key performance indicators for Case 2

Percent of base load	40%	60%	80%	100%
<b>Key parameters</b>				
Gross power output (MW <sub>el</sub> )	187.77	279.56	369.89	460.80
Net power output (MW <sub>el</sub> )	151.03	232.33	312.33	393.08
Net efficiency (% <sub>HHV</sub> )	21.10	22.93	23.77	24.07
Reboiler duty (MW <sub>th</sub> )	293.78	413.00	531.41	644.83
Steam extraction rate (kg/s)	111.01	155.26	199.59	243.22
<b>HP turbine inlet</b>				
Pressure (bar)	98.97	144.06	191.73	242.20
Temperature (°C)	537.00	537.00	537.00	537.00
Mass flow rate (kg/s)	223.07	325.83	435.16	550.63
<b>IP turbine inlet</b>				
Pressure (bar)	17.72	25.71	33.90	42.00
Temperature (°C)	542.80	556.90	563.80	565.00
Mass flow rate (kg/s)	198.95	285.75	375.25	466.27
<b>LP turbine inlet</b>				
Pressure (bar)	0.54	0.72	0.88	1.00
Temperature (°C)	212.3	215.2	214.2	207.80
Mass flow rate (kg/s)	59.17	80.13	98.76	114.78

**Table S-5: Key performance indicators for Case 3**

<b>Percent of base load</b>	<b>40%</b>	<b>60%</b>	<b>80%</b>	<b>100%</b>
<b>Key parameters</b>				
Gross power output (MW <sub>ei</sub> )	183.84	270.35	354.30	438.66
Net power output (MW <sub>ei</sub> )	163.91	260.09	356.82	453.86
Net efficiency (% <sub>HHV</sub> )	22.90	25.67	27.15	27.79
Reboiler duty (MW <sub>th</sub> )	293.78	413.00	531.41	644.83
Steam extraction rate (kg/s)	117.34	169.13	222.09	274.41
<b>HP turbine inlet</b>				
Pressure (bar)	98.97	144.05	191.73	242.20
Temperature (°C)	537.00	537.00	537.00	537.00
Mass flow rate (kg/s)	223.07	325.80	435.17	550.66
<b>IP turbine inlet</b>				
Pressure (bar)	17.72	25.71	33.90	41.84
Temperature (°C)	542.80	556.90	563.80	565.00
Mass flow rate (kg/s)	198.95	285.73	375.25	466.29
<b>LP turbine inlet</b>				
Pressure (bar)	0.49	0.61	0.71	0.76
Temperature (°C)	214.2	216.2	215.4	208.40
Mass flow rate (kg/s)	53.55	67.69	78.55	86.58