

ELECTRONIC SUPPLEMENTARY INFORMATION

Integrated strategy for catalytic co-production of jet fuel range alkenes, tetrahydrofurfuryl alcohol, and 1,2- pentanediol from lignocellulosic biomass

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A. Process simulation

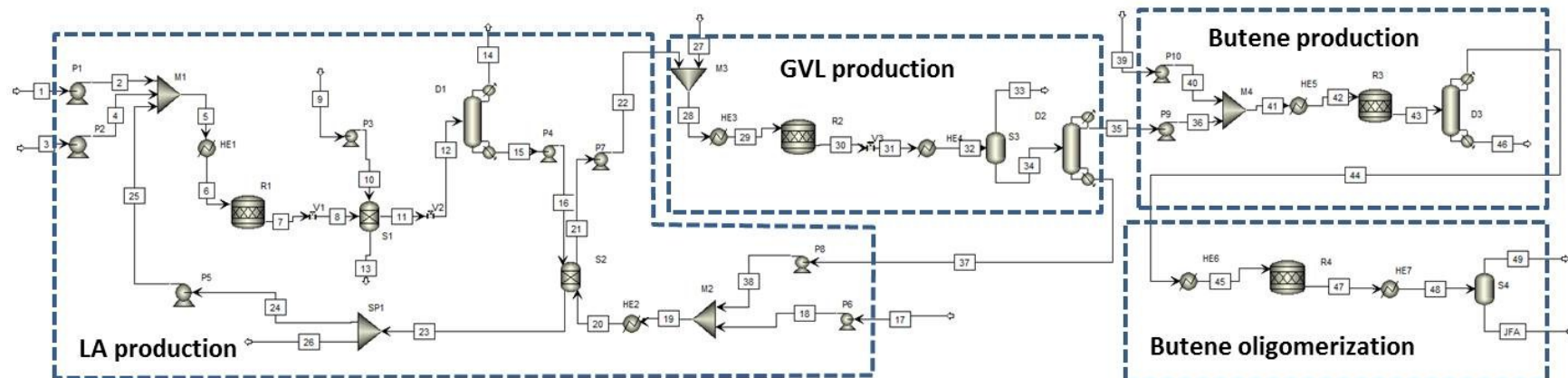


Figure S.1 Detailed process flow diagram of the C₆ conversion step

Table S.1 Detailed mass and energy balance of the C₆ conversion step

Streams	1	6	7	11	15	20	21	29	30	34	35	42	43	44	47	JFA
Mass flow [t per day]																
C ₆	820	820	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lignin	360	360	360	0	0	0	0	0	0	0	0	0	0	0	0	0
H ₂ O	954	1933	1976	5170	165	0	0	0	40	29	29	135	135	0	0	0
C ₅	12	12	12	0	0	0	0	0	0	0	0	0	0	0	0	0
Xylose	20	39	39	37	37	0	0	0	0	0	0	0	0	0	0	0
FF	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
SBP	0	0	0	0	0	879	879	879	879	871	1	1	1	0	0	0
SA	0	95	95	91	91	0	0	0	0	0	0	0	0	0	0	0
Humins	0	0	394	0	0	0	0	0	0	0	0	0	0	0	0	0
LA	0	14	288	277	277	5	254	254	5	5	0	0	0	0	0	0
FA	0	1	110	106	4	0	1	1	0	0	0	0	0	0	0	0
CO ₂	0	0	0	0	0	0	0	0	1	0	0	0	88	88	88	5
H ₂	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0
GVL	0	0	0	0	0	0	0	0	206	203	202	202	2	0	0	0
MTHF	0	0	0	0	0	0	0	0	8	5	5	5	5	0	0	0
C ₄ H ₈	0	0	0	0	0	0	0	0	0	0	0	0	112	112	1	1
C ₈ H ₁₆	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	32
C ₁₂ H ₂₄	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	29
C ₁₆ H ₃₂	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	28
C ₂₀ H ₄₀	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	21
Total flow [t per day]	2167	3275	3275	5682	574	884	1134	1139	1139	1112	237	343	343	200	200	115
Temperature [K]	298	423	423	352	383	473	436	493	493	425	394	648	648	379	443	373
Pressure [bar]	1	34	34	9	1	16	16	34	34	1	1	35	35	35	35	35
Enthalpy flow [MW]	438	743	749	1712	100	2	32	29	32	32	28	50	49	16	18	4

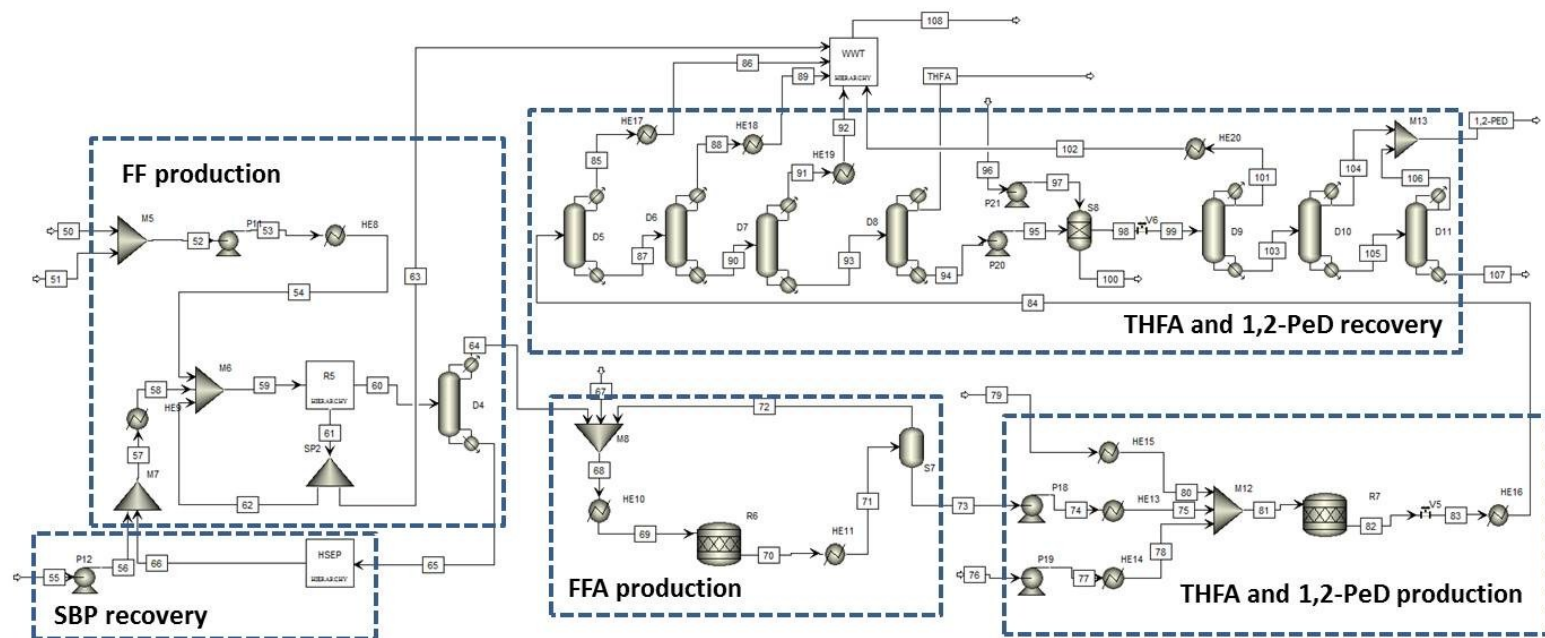


Figure S.2 Detailed process flow diagram of the C₅ conversion step

Table S.2 Detailed mass and energy balance of the C₅ conversion step (design A)

Streams	50	59	60	64	69	70	73	81	82	87	90	93	94	98	103	105	107	THFA	1,2-PeD
Mass flow [t per day]																			
Xylose	484	491	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HCl	0	118	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NaCl	0	189	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H ₂ O	9152	32145	0	0	0	0	0	2269	2269	1361	136	1	0	87	0	0	0	1	0
SBP	0	4939	4939	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FF	17	37	255	255	257	5	3	3	3	0	0	0	0	0	0	0	0	0	0
FFA	0	0	0	0	77	330	252	252	0	0	0	0	0	0	0	0	0	0	0
SA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H ₂	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0
Humins	0	0	96	0	0	5	5	5	8	8	8	8	8	0	0	0	0	0	0
THFA	0	0	0	0	0	0	0	0	193	192	190	188	4	4	0	0	0	184	0
1,2-PeD	0	0	0	0	0	0	0	0	65	65	65	65	64	62	62	6	3	1	59
1,4-PeD	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0	0
HMFA	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0	0
Total flow [t per day]	9653	37920	5291	255	348	348	261	2541	2541	1628	401	264	78	154	63	8	4	186	59
Temperature [K]	303	443	443	435	453	453	393	393	393	374	377	451	485	366	484	486	488	440	483
Pressure [bar]	1	10	1	1	1	1	1	30	30	1	1	1	1	9	1	1	1	1	1
Enthalpy flow [MW]	1683	5685	17	4	5	7	8	413	419	258	37	12	4	19	3	0	0	8	3

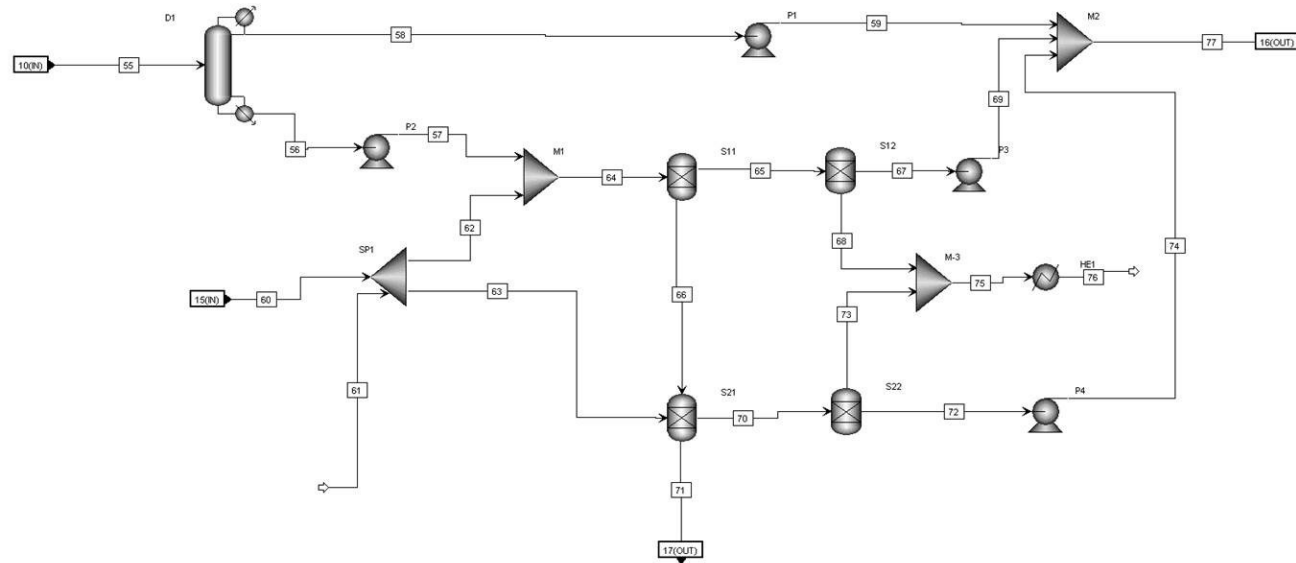
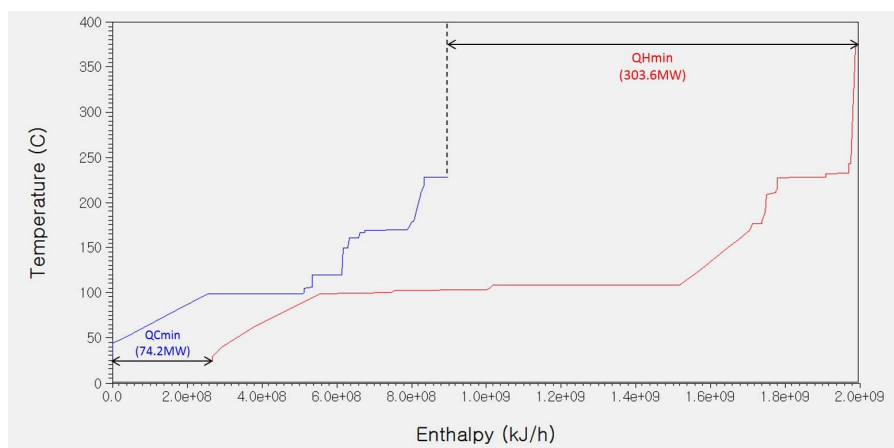


Figure S.3 Detailed process flow diagram of the SBP recovery for C₅ conversion step

Table S.3 Detailed mass and energy balance of the SBP recovery for C₅ conversion step

Streams	109	112	110	119	120	121	122	125	127	132
Mass flow [t per day]										
Xylose	0	0	0	0	0	0	0	0	0	0
HCl	0	0	0	0	0	0	0	0	0	0
NaCl	0	0	0	0	0	0	0	0	0	0
H ₂ O	0	0	0	1121	1013	108	0	305	0	0
SBP	4930	4058	869	869	835	34	835	34	34	4927
FF	0	0	0	0	0	0	0	0	0	0
FFA	0	0	0	0	0	0	0	0	0	0
H ₂	0	0	0	0	0	0	0	0	0	0
Humins	96	0	96	96	0	96	0	0	0	0
THFA	0	0	0	0	0	0	0	0	0	0
1,2-PeD	0	0	0	0	0	0	0	0	0	0
1,4-PeD	0	0	0	0	0	0	0	0	0	0
HMFA	0	0	0	0	0	0	0	0	0	0
Total flow [t per day]	5026	4058	967	2088	1848	238	835	336	34	4927
Temperature [K]	503	502	506	449	449	449	449	434	434	493
Pressure [bar]	1	1	1	1	1	1	1	1	1	1
Enthalpy flow [MW]	3	0	3	201	179	22	1	54	0	1

B. Heat integration



Stream No.	Process streams	Inlet T [K]	Outlet T [K]	Enthalpy [kJ/h]
1	Pretreatment 218→520A	101.0	100.0	588134
2	Pretreatment 502→501	41.0	95.0	69059329
3	Pretreatment 520A→520	100.0	30.0	11267412
4	Pretreatment 256→240	81.6	50.0	7552880
5	Pretreatment 250→251	50.0	38.0	402408
6	Pretreatment 214→217	61.8	190.0	103275098
7	C ₆ conversion 5→6	307.0	423.0	55104008
8	C ₆ conversion 6→7	423.5	423.0	11792596
9	C ₆ conversion 12→14	373.8	373.3	365307
10	C ₆ conversion 12→15	382.1	382.6	495618318
11	C ₆ conversion 19→20	501.4	473.0	2815345
12	C ₆ conversion 28→29	433.3	493.0	7435898
13	C ₆ conversion 31→32	456.0	425.0	7276699
14	C ₆ conversion 34→35	394.3	393.8	56759155
15	C ₆ conversion 34→37	501.6	502.1	63275479
16	C ₆ conversion 41→42	353.3	648.0	25486065
17	C ₆ conversion 42→43	647.5	648.0	1490114
18	C ₆ conversion 43→44	379.8	379.3	20520800
19	C ₆ conversion 43→46	517.1	517.6	5170134
20	C ₆ conversion 44→45	379.3	443.0	815026
21	C ₆ conversion 45→47	443.5	443.0	5873977
22	C ₆ conversion 47→48	443.0	373.0	1163098
23	C ₅ conversion 53→54	303.7	443.0	248978513
24	C ₅ conversion 57→58	493.6	443.0	27220005
25	C ₅ conversion 59→60	443.5	443.0	105539854
26	C ₅ conversion 60→64	435.1	434.6	27264953
27	C ₅ conversion 60→65	502.3	502.8	64705953
28	C ₅ conversion 109→112	502.4	501.9	63314399
29	C ₅ conversion 109→110	506.0	506.5	63339917
30	C ₅ conversion 130→131	449.0	434.0	4199909
31	C ₅ conversion 68→69	404.0	453.0	1370765
32	C ₅ conversion 69→70	453.5	453.0	7081795

Utility streams	Inlet T [K]	Outlet T [K]	Cp [kJ/kg°C]
Cooling water	298.2	308.2	4.2
Refrigerated water	277.6	287.6	4.2
Low pressure steam	421.7	420.7	2121.2
Thermal fluid	673.1	672.1	206.0

Stream No.	Process streams	Inlet T [K]	Outlet T [K]	Enthalpy [kJ/h]
33	C ₅ conversion 70→71	453.0	393.0	7381501
34	C ₅ conversion 74→75	394.8	393.2	37970
35	C ₅ conversion 77→78	299.2	393.2	37617027
36	C ₅ conversion 79→80	298.2	393.2	655298
37	C ₅ conversion 81→82	393.7	393.2	20450641
38	C ₅ conversion 83→84	373.5	373.5	8779467
39	C ₅ conversion 84→85	373.7	373.2	104100473
40	C ₅ conversion 84→87	373.3	373.8	189912901
41	C ₅ conversion 85→86	373.2	318.2	94598867
42	C ₅ conversion 87→88	373.7	373.2	127667383
43	C ₅ conversion 87→90	376.8	377.3	243606623
44	C ₅ conversion 88→89	373.2	318.2	127536512
45	C ₅ conversion 90→91	373.7	373.2	9242584
46	C ₅ conversion 90→93	450.5	451.0	23590162
47	C ₅ conversion 91→92	373.2	318.2	14149002
48	C ₅ conversion 93→THFA	440.7	440.2	11886190
49	C ₅ conversion 93→94	484.4	484.9	12010764
50	C ₅ conversion 99→101	373.8	373.3	8530826
51	C ₅ conversion 99→103	483.0	483.5	9545896
52	C ₅ conversion 103→104	483.7	483.2	2210147
53	C ₅ conversion 103→105	485.5	486.0	2210221
54	C ₅ conversion 105→106	483.8	483.3	331127
55	C ₅ conversion 105→107	487.9	488.4	331188
56	C ₅ conversion 101→102	373.3	318.2	872702

Figure S.4 Composite curve for the design A (obtained using ASPEN Energy Analyzer); minimum temperature difference (ΔT_{\min}) is 10 K. The estimated total minimum area requirement (A_{\min}) is 87836 m². The total minimum hot/cold utility requirement ($Q_{H\min}/Q_{C\min}$) is 303.6/74.2 MW.

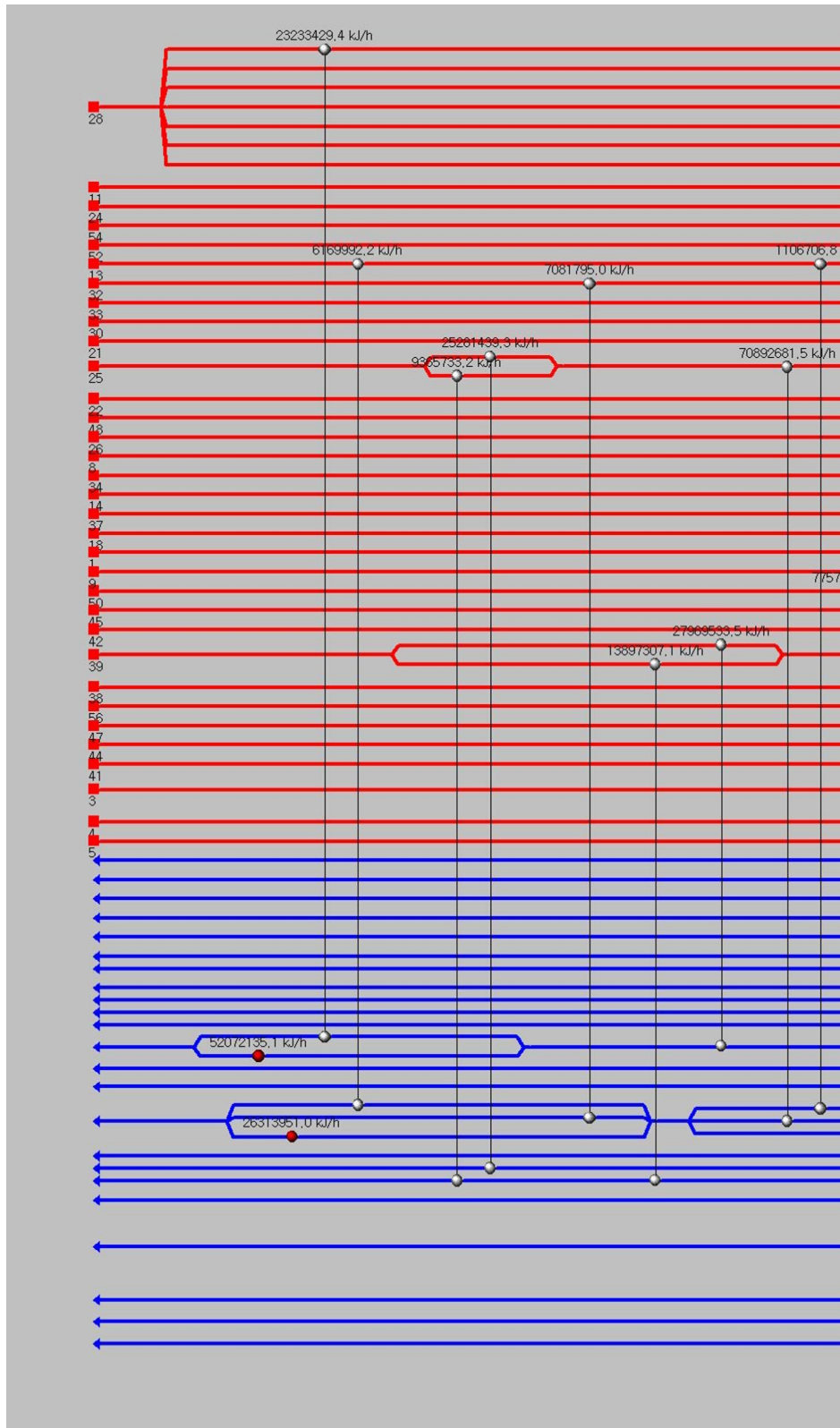
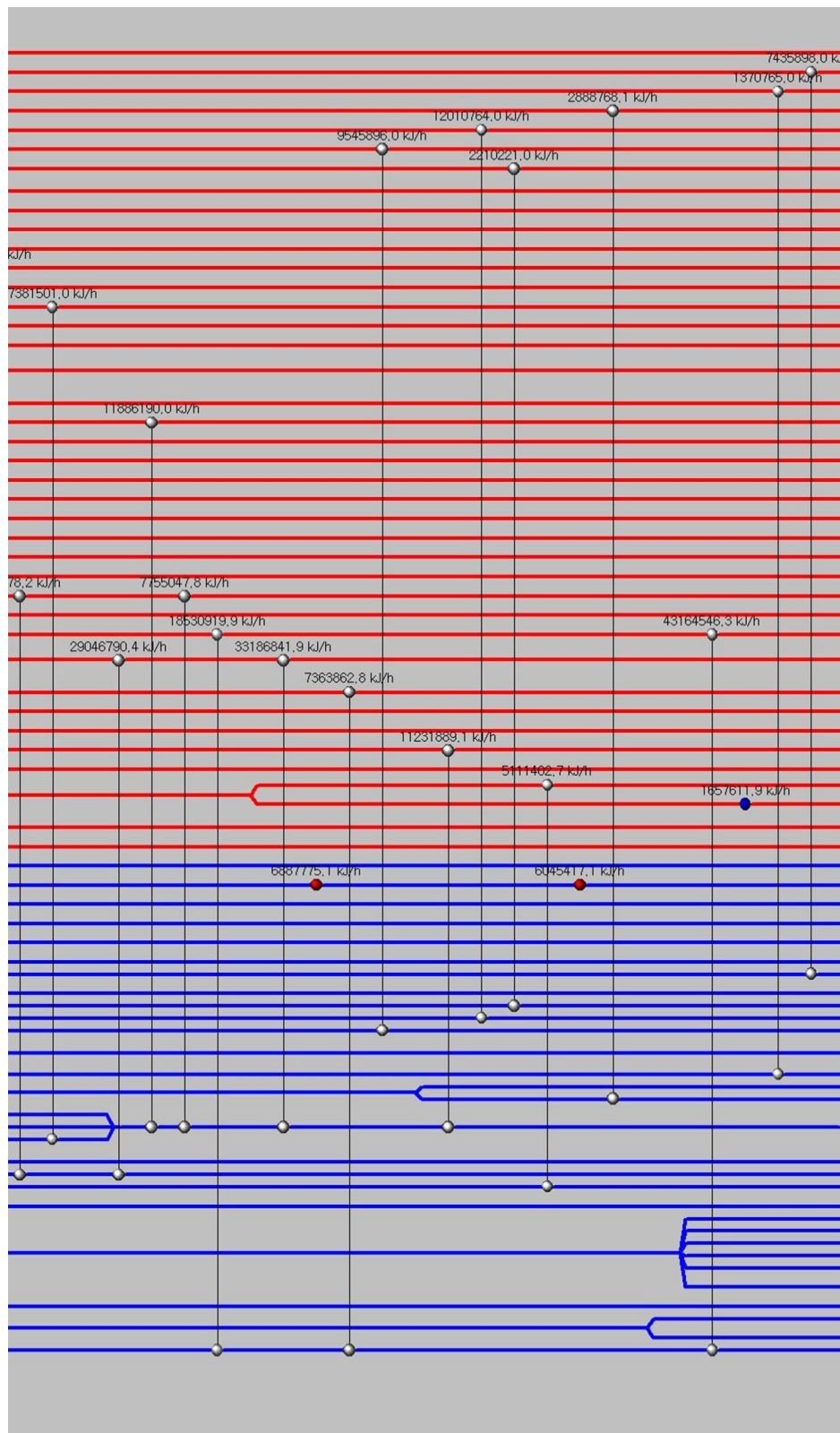
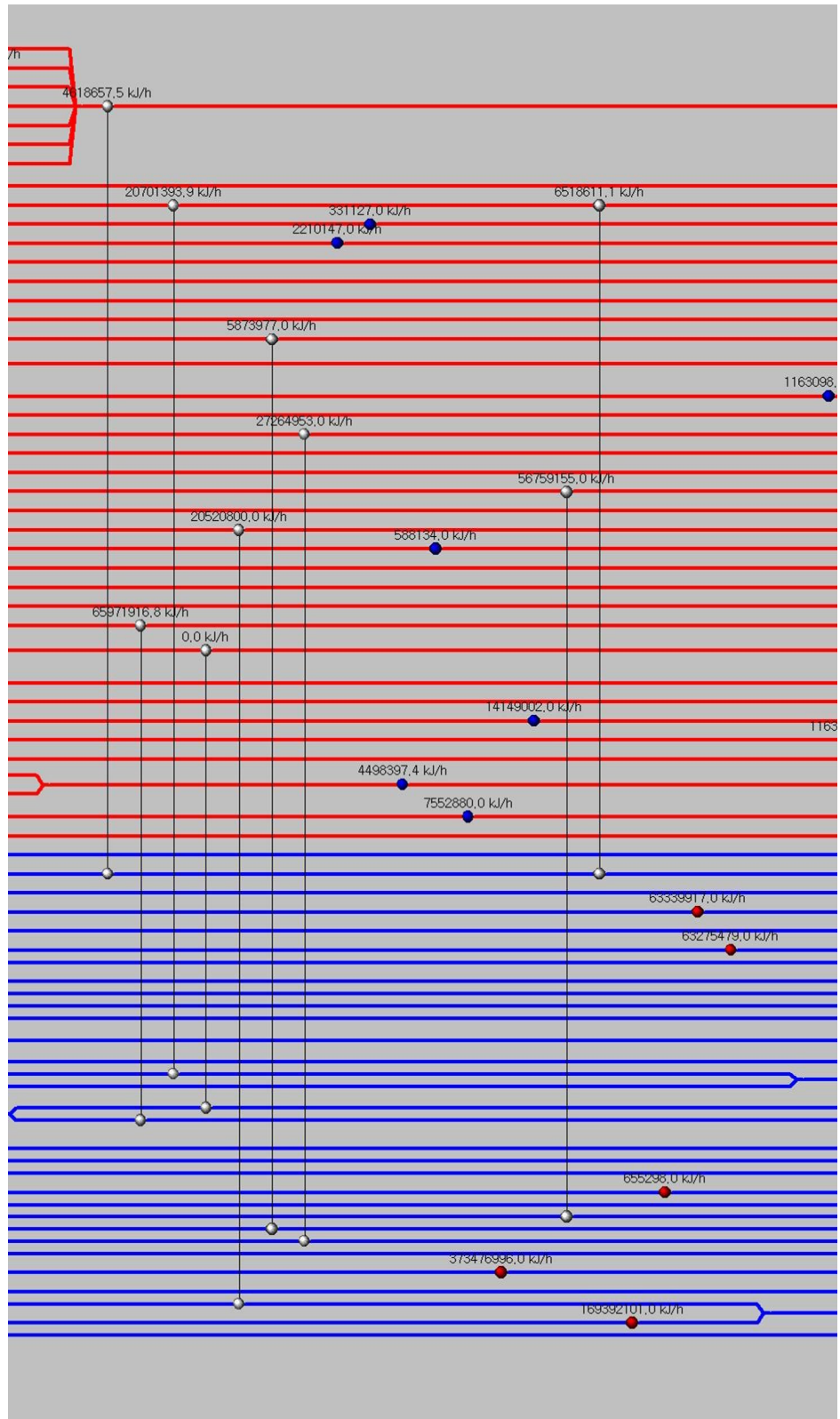
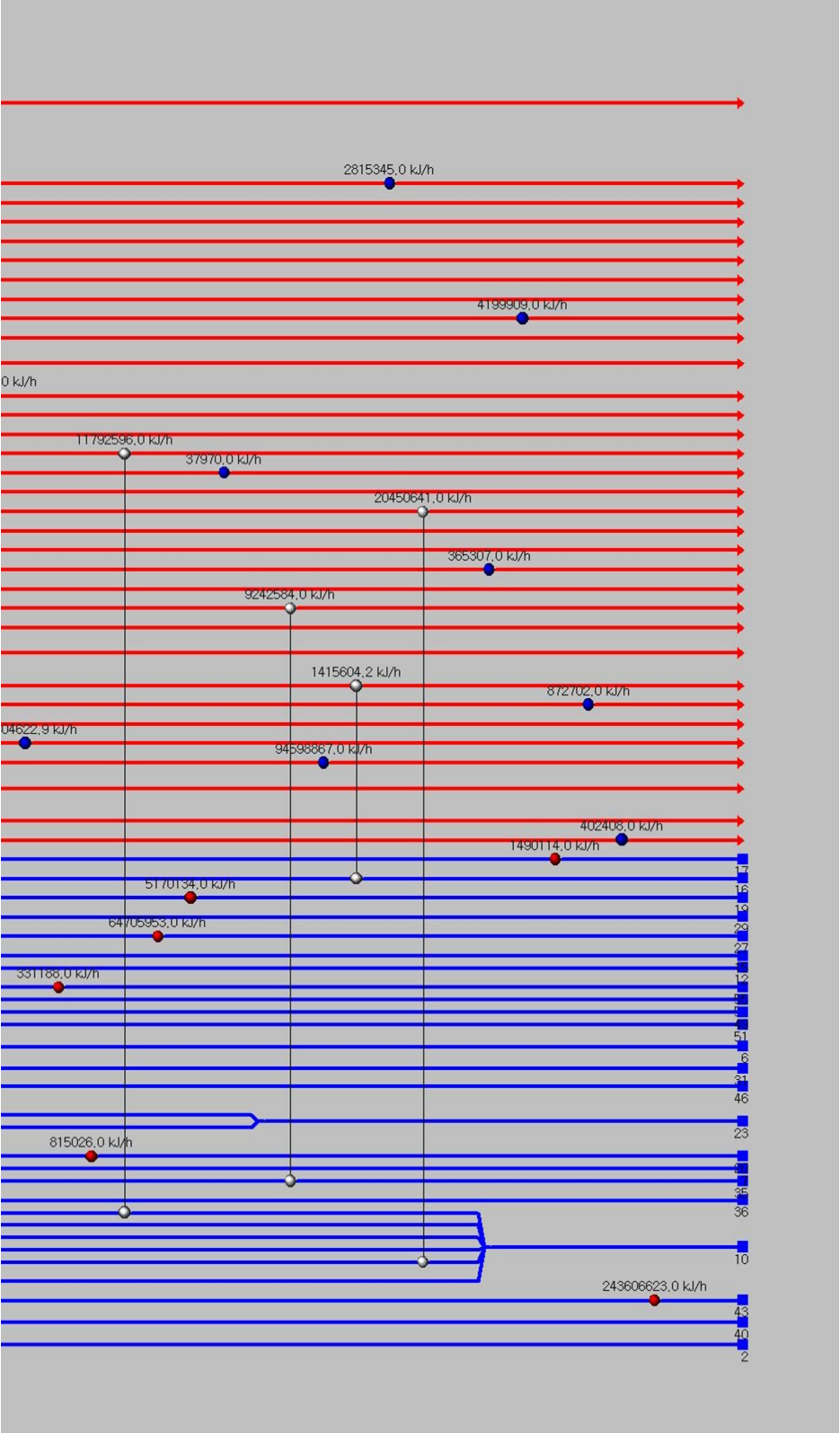


Figure S.5 Grid diagram for the design A







C. Economic evaluation

1. Reactor sizing and costing

Table S.4 Installed costs of reactor for the design A

Reactor	Scaling stream flow (kg/hr)	New stream flow (kg/hr)	Size ratio	# of unit	Original equipment cost (per unit)	Scaling exponent	Scaled cost (per unit)	Installation factor	Installed cost (\$)
R-1 ^a	27,292	27,292	1.00	10	5,017,797	0.67	5,640,491	1.12	56,404,913
R-2 ^a	3,163	3,163	1.00	15	71,360	0.67	200,643	2.81	3,009,640
R-3 ^a	562	562	1.00	15	118,390	0.67	267,320	2.26	4,009,799
R-4 ^a	519	519	1.00	9	370,644	0.67	575,359	1.55	5,178,229
R-5 ^b	227,642	225,712	0.99	7	571,588	0.67	857,381	1.50	6,001,670
R-6 ^a	346	346	1.00	42	57,414	0.67	151,937	2.65	6,381,373
R-7 ^a	10,589	10,589	1.00	10	1,529,913	0.67	1,913,282	1.25	19,132,819

^a Taken from Aspen Process Economic Analyzer.

^b Taken from study by Xing. *et al.* (Xing et al., 2010)

2. Total capital investment

Table S.5 Project cost worksheet including total direct cost and total capital investment for the design A

Sub-processing steps			Installed costs (\$)
Biomass handling*			25,777,913
Pretreatment			37,262,462
LA production			68,329,351
GVL production			7,283,705
Butene production			5,704,115
Butene oligomerization			5,372,459
FF production			8,348,812
SBP recovery			2,322,068
FFA production			6,427,182
THFA and 1,2-PeD production			19,512,726
THFA and 1,2-PeD recovery			12,207,542
Heat production			36,442,338
Wastewater treatment			18,251,920
Storage			1,895,811
Utility			14,691,857
Total installed cost			244,052,346
Warehouse	4.0%	of ISBL [#]	6,910,817
Site development	9.0%	of ISBL [#]	15,549,338
Additional piping	4.5%	of ISBL [#]	7,774,669
Total direct cost (TDC)			274,287,170
Prorateable expenses	10.0%	of TDC	27,428,717
Field expenses	10.0%	of TDC	27,428,717
Home office & construction fee	20.0%	of TDC	54,857,434
Project contingency	10.0%	of TDC	27,428,717
Other costs (Start-Up, Permits, etc.)	10.0%	of TDC	27,428,717
Total indirect cost			164,572,302
Fixed capital investment (FCI)			438,859,472
Land			1,848,000
Working capital	5.0%	of FCI	21,942,974
Total capital investment (TCI)			462,650,445
*Biomass handling not included in this calculation.			
[#] Inside-battery-limits (ISBL) equipment costs include pretreatment, conversion and recovery steps.			

3. Fixed operating cost

Table S.6 Fixed operating cost worksheet including labor, maintenance, and insurance costs for the design A

Labor and supervision	Salary	# required	Cost (\$ per year)
Plant manager	141,569	1	141,569
Plant engineer	67,414	2	134,828
Maintenance supervisor	54,894	1	54,894
Maintenance technician	38,522	12	462,266
Lab manager	53,931	1	53,931
Lab technician	38,522	2	77,044
Lab tech-enzyme	38,771	2	77,044
Shift supervisor	46,227	4	184,906
Shift operators	38,522	20	770,443
Shift oper-enzyme	38,771	8	308,177
Yard employees	26,966	4	107,862
Clerks and secretaries	34,670	3	104,010
Total salaries			2,500,000
Labor burden (90%)			2,200,000
Total labor cost			4,700,000
Other overhead			Annual cost (\$)
Maintenance	3.0% of ISBL [#]		5,183,113
Property insurance	0.7% of FCI [*]		3,072,016
Total fixed operating cost			12,961,382
[#] Inside-battery-limits (ISBL) equipment costs include pretreatment, conversion and recovery steps.			
[*] Fixed capital investment			

4. Discounted Cash Flow

Table S.7 Discounted cash flow for the design A

Year	-2	-1	0	1	2	3	4	5	6	7	8	9	10
Capital investment	14,043,503	105,326,273	56,174,012										
Land	1,848,000												
Working capital			21,942,974										
Loan payment				39,241,802	39,241,802	39,241,802	39,241,802	39,241,802	39,241,802	39,241,802	39,241,802	39,241,802	39,241,802
Loan interest payment	1,685,220	14,324,373	21,065,255	21,065,255	19,611,131	18,040,677	16,344,587	14,512,810	12,534,491	10,397,906	8,090,394	5,598,282	2,906,800
Loan principal	21,065,255	179,054,664	263,315,683	245,139,136	225,508,465	204,307,341	181,410,127	156,681,135	129,973,824	101,129,929	69,978,521	36,335,001	0
THFA sales				85,385,866	97,583,846	97,583,846	97,583,846	97,583,846	97,583,846	97,583,846	97,583,846	97,583,846	97,583,846
JFA sales				39,001,785	44,573,469	44,573,469	44,573,469	44,573,469	44,573,469	44,573,469	44,573,469	44,573,469	44,573,469
1,2-PeD sales				43,155,270	49,320,308	49,320,308	49,320,308	49,320,308	49,320,308	49,320,308	49,320,308	49,320,308	49,320,308
Total annual sales				167,542,921	191,477,624	191,477,624	191,477,624	191,477,624	191,477,624	191,477,624	191,477,624	191,477,624	191,477,624
Feedstock cost				51,564,911	58,931,326	58,931,326	58,931,326	58,931,326	58,931,326	58,931,326	58,931,326	58,931,326	58,931,326
Baghouse bags				466,183					466,183				
Other variable costs				54,345,111	57,968,119	57,968,119	57,968,119	57,968,119	57,968,119	57,968,119	57,968,119	57,968,119	57,968,119
Fixed operating costs				12,961,382	12,961,382	12,961,382	12,961,382	12,961,382	12,961,382	12,961,382	12,961,382	12,961,382	12,961,382
Total product cost				119,337,587	129,860,827	129,860,827	129,860,827	129,860,827	130,327,010	129,860,827	129,860,827	129,860,827	129,860,827
Annual depreciation													
General Plant													
MACRS method (7yr)				14.290%	24.490%	17.490%	12.490%	8.930%	8.920%	8.930%	4.460%		
Depreciation charge				57,505,408	98,551,956	70,382,757	50,261,900	35,935,850	35,895,608	35,935,850	17,947,804		
Remaining value				344,911,725	246,359,769	175,977,013	125,715,113	89,779,263	53,883,654	17,947,804	0		
Steam plant (heat production)													
MACRS method (20yr)				3.750%	7.219%	6.677%	6.177%	5.713%	5.285%	4.888%	4.522%	4.462%	4.461%
Depreciation charge				1,366,588	2,630,772	2,433,255	2,251,043	2,081,951	1,925,978	1,781,301	1,647,923	1,626,057	1,625,693
Remaining value				35,075,750	32,444,978	30,011,723	27,760,680	25,678,729	23,752,751	21,971,450	20,323,527	18,697,470	17,071,778
Remaining value				379,987,476	278,804,747	205,988,736	153,475,792	115,457,992	77,636,406	39,919,254	20,323,527	18,697,470	17,071,778
Net revenue				-31,731,917	-59,177,063	-29,239,892	-7,240,734	9,086,186	10,794,537	13,501,739	33,930,676	54,392,458	57,084,304
Losses forward					-31,731,917	-90,908,979	-120,148,872	-127,389,605	-118,303,420	-107,508,883	-94,007,144	-60,076,468	-5,684,010
Taxable income				-31,731,917	-90,908,979	-120,148,872	-127,389,605	-118,303,420	-107,508,883	-94,007,144	-60,076,468	-5,684,010	51,400,294
Income tax				0	0	0	0	0	0	0	0	0	17,990,103
Annual cash flow				8,963,532	22,374,995	22,374,995	22,374,995	22,374,995	21,908,812	22,374,995	22,374,995	22,374,995	4,384,892
Discount factor	1.21	1.10	1.00	0.91	0.83	0.75	0.68	0.62	0.56	0.51	0.47	0.42	0.39
Annual present value				8,148,666	18,491,731	16,810,665	15,282,423	13,893,112	12,366,953	11,481,910	10,438,100	9,489,182	1,690,566
TPI + Interest	21,267,835	131,615,711	99,182,241										
NPV			0										

Year	11	12	13	14	15	16	17	18	19	20
Capital investment										
Land										
Working capital										
Loan payment										
Loan interest payment										
Loan principal										
THFA sales	97,583,846	97,583,846	97,583,846	97,583,846	97,583,846	97,583,846	97,583,846	97,583,846	97,583,846	97,583,846
JFA sales	44,573,469	44,573,469	44,573,469	44,573,469	44,573,469	44,573,469	44,573,469	44,573,469	44,573,469	44,573,469
1,2-PeD sales	49,320,308	49,320,308	49,320,308	49,320,308	49,320,308	49,320,308	49,320,308	49,320,308	49,320,308	49,320,308
Total annual sales	191,477,624	191,477,624	191,477,624	191,477,624	191,477,624	191,477,624	191,477,624	191,477,624	191,477,624	191,477,624
Feedstock cost	58,931,326	58,931,326	58,931,326	58,931,326	58,931,326	58,931,326	58,931,326	58,931,326	58,931,326	58,931,326
Baghouse bags	466,183					466,183				
Other variable costs	57,968,119	57,968,119	57,968,119	57,968,119	57,968,119	57,968,119	57,968,119	57,968,119	57,968,119	57,968,119
Fixed operating costs	12,961,382	12,961,382	12,961,382	12,961,382	12,961,382	12,961,382	12,961,382	12,961,382	12,961,382	12,961,382
Total product cost	130,327,010	129,860,827	129,860,827	129,860,827	129,860,827	130,327,010	129,860,827	129,860,827	129,860,827	129,860,827
Annual depreciation										
General Plant										
MACRS method (7yr)										
Depreciation charge										
Remaining value										
Steam plant (heat production)										
MACRS method (20yr)	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%	4.462%	4.461%
Depreciation charge	1,626,057	1,625,693	1,626,057	1,625,693	1,626,057	1,625,693	1,626,057	1,625,693	1,626,057	1,625,693
Remaining value	15,445,721	13,820,028	12,193,971	10,568,278	8,942,221	7,316,528	5,690,471	4,064,778	2,438,721	813,029
Remaining value	15,445,721	13,820,028	12,193,971	10,568,278	8,942,221	7,316,528	5,690,471	4,064,778	2,438,721	813,029
Net revenue	59,524,557	59,991,104	59,990,740	59,991,104	59,990,740	59,524,921	59,990,740	59,991,104	59,990,740	59,991,104
Losses forward	0	0	0	0	0	0	0	0	0	0
Taxable income	59,524,557	59,991,104	59,990,740	59,991,104	59,990,740	59,524,921	59,990,740	59,991,104	59,990,740	59,991,104
Income tax	20,833,595	20,996,886	20,996,759	20,996,886	20,996,759	20,833,722	20,996,759	20,996,886	20,996,759	20,996,886
Annual cash flow	40,317,019	40,619,910	40,620,038	40,619,910	40,620,038	40,316,891	40,620,038	40,619,910	40,620,038	40,619,910
Discount factor	0.35	0.32	0.29	0.26	0.24	0.22	0.20	0.18	0.16	0.15
Annual present value	14,130,869	12,942,755	11,766,178	10,696,492	9,724,114	8,774,130	8,036,458	7,305,848	6,641,701	6,037,891
TPI + Interest										
NPV										

Year	21	22	23	24	25	26	27	28	29	30
Capital investment										
Land										-1,848,000
Working capital										-21,942,974
Loan payment										
Loan interest payment										
Loan principal										
THFA sales	97,583,846	97,583,846	97,583,846	97,583,846	97,583,846	97,583,846	97,583,846	97,583,846	97,583,846	97,583,846
JFA sales	44,573,469	44,573,469	44,573,469	44,573,469	44,573,469	44,573,469	44,573,469	44,573,469	44,573,469	44,573,469
1,2-PeD sales	49,320,308	49,320,308	49,320,308	49,320,308	49,320,308	49,320,308	49,320,308	49,320,308	49,320,308	49,320,308
Total annual sales	191,477,624	191,477,624	191,477,624	191,477,624	191,477,624	191,477,624	191,477,624	191,477,624	191,477,624	191,477,624
Feedstock cost	58,931,326	58,931,326	58,931,326	58,931,326	58,931,326	58,931,326	58,931,326	58,931,326	58,931,326	58,931,326
Baghouse bags	466,183					466,183				
Other variable costs	57,968,119	57,968,119	57,968,119	57,968,119	57,968,119	57,968,119	57,968,119	57,968,119	57,968,119	57,968,119
Fixed operating costs	12,961,382	12,961,382	12,961,382	12,961,382	12,961,382	12,961,382	12,961,382	12,961,382	12,961,382	12,961,382
Total product cost	130,327,010	129,860,827	129,860,827	129,860,827	129,860,827	130,327,010	129,860,827	129,860,827	129,860,827	129,860,827
Annual depreciation										
General Plant										
MACRS method (7yr)										
Depreciation charge										
Remaining value										
Steam plant (heat production)										
MACRS method (20yr)	2.231%									
Depreciation charge	813,029									
Remaining value	0									
Remaining value	0									
Net revenue	60,337,585	61,616,797	61,616,797	61,616,797	61,616,797	61,150,614	61,616,797	61,616,797	61,616,797	61,616,797
Losses forward	0	0	0	0	0	0	0	0	0	0
Taxable income	60,337,585	61,616,797	61,616,797	61,616,797	61,616,797	61,150,614	61,616,797	61,616,797	61,616,797	61,616,797
Income tax	21,118,155	21,565,879	21,565,879	21,565,879	21,565,879	21,402,715	21,565,879	21,565,879	21,565,879	21,565,879
Annual cash flow	40,032,459	40,050,918	40,050,918	40,050,918	40,050,918	39,747,899	40,050,918	40,050,918	40,050,918	40,050,918
Discount factor	0.14	0.12	0.11	0.10	0.09	0.08	0.08	0.07	0.06	0.06
Annual present value	5,409,609	4,920,094	4,472,813	4,066,193	3,696,539	3,335,065	3,054,991	2,777,265	2,524,786	2,295,260
TPI + Interest										-1,363,426
NPV										

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