

Supplementary Materials

Table S1. Fixed capital estimate summary (2020 prices in US\$).

Fixed capital cost estimation		Cost (\$)			
		Scenario 1	Scenario 2	Scenario 3	Scenario 4
A. Total Plant Direct Cost (TPDC)					
1.	Equipment Purchase Cost	2,169,000	1,706,000	3,314,000	3,614,000
2.	Installation	1,617,000	792,000	1,763,000	1,866,000
3.	Process Piping	759,000	597,000	1,160,000	1,265,000
4.	Instrumentation	868,000	683,000	1,326,000	1,446,000
5.	Insulation	65,000	51,000	99,000	108,000
6.	Electrical	217,000	171,000	331,000	361,000
7.	Buildings	976,000	768,000	1,491,000	1,626,000
8.	Yard Improvement	325,000	256,000	497,000	542,000
9.	Auxiliary Facilities	434,000	341,000	663,000	723,000
TPDC		7,429,000	5,365,000	10,646,000	11,551,000
B. Total Plant Indirect Cost (TPIC)					
10.	Engineering	1,857,000	1,341,000	2,661,000	2,888,000
11.	Construction	2,600,000	1,878,000	3,726,000	4,043,000
TPIC		4,457,000	3,219,000	6,388,000	6,931,000
C. Total Plant Cost (TPC = TPDC+TPIC)					
TPC		11,886,000	8,584,000	17,033,000	18,482,000
D. Contractor's Fee & Contingency (CFC)					
12.	Contractor's Fee	594,000	429,000	852,000	924,000
13.	Contingency	1,189,000	858,000	1,703,000	1,848,000
CFC = 12+13		1,783,000	1,288,000	2,555,000	2,772,000
E. Direct Fixed Capital Cost (DFC = TPC+CFC)					
DFC		13,669,000	9,871,000	19,588,000	21,254,000
F. Working Capital		141,000	113,000	277,000	259,000
G. Startup Cost		683,000	494,000	979,000	1,063,000
Total Investment (E+F+G)		14,493,000	10,478,000	20,845,000	22,576,000

Note: Scenario 1: Direct CHP generation from wood sawdust and shavings; Scenario 2: Wood pellet production without CHP; Scenario 3: Production of pellets and CHP from steam-exploded wood; Scenario 4: Production of pellets and CHP from torrefied wood.

Table S2. Profitability analysis (2020 prices (US\$) for direct CHP generation from wood sawdust and shavings (scenario 1).

Estimation of economic indices	Cost /Revenue item	Values
A.	Direct Fixed Capital	\$13,669,000
B.	Working Capital	\$141,000
C.	Startup Cost	\$683,000
D.	Up-Front R&D ¹	\$0
E.	Up-Front Royalties	\$0
F.	Total Investment (A+B+C+D+E)	\$14,493,000
G.	Investment Charged to This Project	\$14,493,000
H.	Revenue/Credit/Savings Rates	
	LP-Steam (Main Revenue)	146,741 tonne /year
	HP-Steam (Revenue)	46,957 tonne /year
	Std Power (Revenue)	3,384,611 kW-h/year
	Std Power (Savings)	4,896,453 kW-h/year
I.	Revenue/Credit/Savings Price	
	LP-Steam (Main Revenue)	\$12.00 /tonne
	HP-Steam (Revenue)	\$20.00 /tonne
	Std Power (Revenue)	\$0.10 /kW-h
	Std Power (Savings)	\$0.10 /kW-h
J.	Revenues/Credits/Savings	
	LP-Steam (Main Revenue)	\$1,760,890 /year
	HP-Steam (Revenue)	\$939,142 /year
	Std Power (Revenue)	\$338,461 /year
	Std Power (Savings)	\$489,645 /year
	1 Total Revenues	\$3,038,493 /year
	2 Total Savings	\$489,645 /year
K.	Annual Operating Cost (AOC)	
	1 Actual AOC	\$4,242,000 /year
	2 Net AOC (K1-J2)	\$3,752,408 /year
L.	Unit Production Cost /Revenue	
	Unit Production Cost	\$28.91 /tonne MP ²
	Net Unit Production Cost	\$25.57 /tonne MP
	Unit Production Revenue	\$20.71 /tonne MP
M.	Gross Profit (J1-K2)	\$-714,000 /year
N.	Taxes (40%)	\$0 /year
O.	Net Profit (M-N + Depreciation)	\$585,000 /year
Gross Margin	-23.50 %	
Return On Investment	4.03 %	
Payback Time	24.79 years	

¹ Research and development, ² Main product

Table S3. Cash flow analysis (US\$000) for direct CHP generation from wood sawdust and shavings (scenario 1).

Year	Capital investment	Sales revenues	Operating cost	Gross profit	Depreciation	Taxable income	Taxes	Net profit	Net cash flow
1	-4,101	0	0	0	0	0	0	0	-4,101
2	-5,608	1,823	3,919	-2,096	1,299	0	0	-797	-6,405
3	-4,101	2,735	4,161	-1,427	1,299	0	0	-128	-4,229
4	0	3,038	4,242	-1,204	1,299	0	0	95	95
5	0	3,038	4,242	-1,204	1,299	0	0	95	95
6	0	3,038	4,242	-1,204	1,299	0	0	95	95
7	0	3,038	4,242	-1,204	1,299	0	0	95	95
8	0	3,038	4,242	-1,204	1,299	0	0	95	95
9	0	3,038	4,242	-1,204	1,299	0	0	95	95
10	0	3,038	4,242	-1,204	1,299	0	0	95	95
11	0	3,038	4,242	-1,204	1,299	0	0	95	95
12	0	3,038	2,943	95	0	95	38	57	57
13	0	3,038	2,943	95	0	95	38	57	57
14	0	3,038	2,943	95	0	95	38	57	57
15	0	3,038	2,943	95	0	95	38	57	57
16	0	3,038	2,943	95	0	95	38	57	57
17	0	3,038	2,943	95	0	95	38	57	57
18	0	3,038	2,943	95	0	95	38	57	57
19	0	3,038	2,943	95	0	95	38	57	57
20	824	3,038	2,943	95	0	95	38	57	881

Table S4. Profitability analysis (2020 prices in US\$) for wood pellet production without CHP (scenario 2).

Estimation of economic indices	Cost /Revenue item	Values
A.	Direct Fixed Capital	\$9,871,000
B.	Working Capital	\$113,000
C.	Startup Cost	\$494,000
D.	Up-Front R&D ¹	\$0
E.	Up-Front Royalties	\$0
F.	Total Investment (A+B+C+D+E)	\$10,478,000
G.	Investment Charged to This Project	\$10,478,000
H.	Revenue/Credit/Savings Rates	
	Wood Pellets (Main Revenue)	72,000 tonne /year
I.	Revenue/Credit/Savings Price	
	Wood Pellets (Main Revenue)	\$120 /tonne
J.	Revenues/Credits/Savings	
	Wood Pellets (Main Revenue)	\$8,640,000 /year
K.	Annual Operating Cost (AOC)	
	AOC	\$3,192,000 /year
L.	Unit Production Cost /Revenue	
	Unit Production Cost	\$44.33 /tonne MP ²
	Unit Production Revenue	\$120 /tonne MP
M.	Gross Profit (J-K)	\$5,448,000 /year
N.	Taxes (40%)	\$2,179,000 /year
O.	Net Profit (M-N + Depreciation)	\$4,207,000 /year
Gross Margin	63.06 %	
Return On Investment	40.15 %	
Payback Time	2.49 years	

¹Research and development, ² Main product

Table S5. Cash flow analysis (US\$000) for wood pellet production without CHP (scenario 2).

Year	Capital investment	Sales revenues	Operating cost	Gross profit	Depreciation	Taxable income	Taxes	Net profit	Net cash flow
1	- 2,961	0	0	0	0	0	0	0	-2,961
2	- 4,062	5,184	2,875	2,309	938	2,309	924	2,323	-1,739
3	- 2,961	7,776	3,112	4,664	938	4,664	1,865	3,736	774
4	0	8,640	3,192	5,448	938	5,448	2,179	4,207	4,207
5	0	8,640	3,192	5,448	938	5,448	2,179	4,207	4,207
6	0	8,640	3,192	5,448	938	5,448	2,179	4,207	4,207
7	0	8,640	3,192	5,448	938	5,448	2,179	4,207	4,207
8	0	8,640	3,192	5,448	938	5,448	2,179	4,207	4,207
9	0	8,640	3,192	5,448	938	5,448	2,179	4,207	4,207
10	0	8,640	3,192	5,448	938	5,448	2,179	4,207	4,207
11	0	8,640	3,192	5,448	938	5,448	2,179	4,207	4,207
12	0	8,640	2,254	6,386	0	6,386	2,554	3,832	3,832
13	0	8,640	2,254	6,386	0	6,386	2,554	3,832	3,832
14	0	8,640	2,254	6,386	0	6,386	2,554	3,832	3,832
15	0	8,640	2,254	6,386	0	6,386	2,554	3,832	3,832
16	0	8,640	2,254	6,386	0	6,386	2,554	3,832	3,832
17	0	8,640	2,254	6,386	0	6,386	2,554	3,832	3,832
18	0	8,640	2,254	6,386	0	6,386	2,554	3,832	3,832
19	0	8,640	2,254	6,386	0	6,386	2,554	3,832	3,832
20	607	8,640	2,254	6,386	0	6,386	2,554	3,832	4,439

Table S6. Profitability analysis (2020 prices in US\$) for production of pellets and CHP from steam-exploded wood (scenario 3).

Estimation of economic indices	Cost /Revenue item	Values
A.	Direct Fixed Capital	\$19,588,000
B.	Working Capital	\$277,000
C.	Startup Cost	\$979,000
D.	Up-Front R&D ¹	\$0
E.	Up-Front Royalties	\$0
F.	Total Investment (A+B+C+D+E)	\$20,845,000
G.	Investment Charged to This Project	\$20,845,000
H.	Revenue/Credit/Savings Rates	
	Steam-treated Pellets (Main Revenue)	53,543 tonne /year
	LP-Steam (Revenue)	53,075 tonne /year
	HMF (Revenue)	200 tonne /year
	Furfural (Revenue)	782 tonne /year
	Std Power(Savings)	2,431,553 kW-h/year
I.	Revenue/Credit/Savings Price	
	Steam-treated Pellets (Main Revenue)	\$144 /tonne
	LP-Steam (Revenue)	\$12 /tonne
	HMF (Revenue)	\$1000 /tonne
	Furfural (Revenue)	\$800 /tonne
	Std Power(Savings)	\$0.10 /kW-h
J.	Revenues/Credits/Savings	
	Steam-treated Pellets (Main Revenue)	\$7,710,124 /year
	LP-Steam (Revenue)	\$636,894 /year
	HMF (Revenue)	\$199,974 /year
	Furfural (Revenue)	\$625,948 /year
	Std Power(Savings)	\$243,155
	1 Total Revenues	\$9,172,941 /year
	2 Total Savings	\$243,155 /year
K.	Annual Operating Cost (AOC)	
	1 Actual AOC	\$7,047,000 /year
	2 Net AOC (K1-J2)	\$6,803,000 /year
L.	Unit Production Cost /Revenue	
	Unit Production Cost	\$131.61 /tonne MP ²
	Net Unit Production Cost	\$127.06 /tonne MP
	Unit Production Revenue	\$171.32 /tonne MP
M.	Gross Profit (J1-K2)	\$2,370,000 /year
N.	Taxes (40%)	\$948,000 /year
O.	Net Profit (M-N + Depreciation)	\$3,283,000 /year
	Gross Margin	25.83%
	Return On Investment	15.75 %
	Payback Time	6.35 years

¹Research and development, ² Main product

Table S7. Cash flow analysis (US\$000) for production of pellets and CHP from steam-exploded wood (scenario 3).

Year	Capital investment	Sales revenues	Operating cost	Gross profit	Depreciation	Taxable income	Taxes	Net profit	Net cash flow
1	- 5,877	0	0	0	0	0	0	0	-5,877
2	- 8,112	5,504	6,532	- 1,029	1,861	0	0	832	-7,280
3	- 5,877	8,256	6,918	1,338	1,861	1,338	535	2,664	-3,213
4	0	9,173	7,047	2,126	1,861	2,126	851	3,137	3,137
5	0	9,173	7,047	2,126	1,861	2,126	851	3,137	3,137
6	0	9,173	7,047	2,126	1,861	2,126	851	3,137	3,137
7	0	9,173	7,047	2,126	1,861	2,126	851	3,137	3,137
8	0	9,173	7,047	2,126	1,861	2,126	851	3,137	3,137
9	0	9,173	7,047	2,126	1,861	2,126	851	3,137	3,137
10	0	9,173	7,047	2,126	1,861	2,126	851	3,137	3,137
11	0	9,173	7,047	2,126	1,861	2,126	851	3,137	3,137
12	0	9,173	5,186	3,987	0	3,987	1,595	2,392	2,392
13	0	9,173	5,186	3,987	0	3,987	1,595	2,392	2,392
14	0	9,173	5,186	3,987	0	3,987	1,595	2,392	2,392
15	0	9,173	5,186	3,987	0	3,987	1,595	2,392	2,392
16	0	9,173	5,186	3,987	0	3,987	1,595	2,392	2,392
17	0	9,173	5,186	3,987	0	3,987	1,595	2,392	2,392
18	0	9,173	5,186	3,987	0	3,987	1,595	2,392	2,392
19	0	9,173	5,186	3,987	0	3,987	1,595	2,392	2,392
20	1,256	9,173	5,186	3,987	0	3,987	1,595	2,392	3,648

Table S8. Profitability analysis (2020 prices in US\$) for production of pellets and CHP from torrefied wood (scenario 4).

Estimation of economic indices		Cost /Revenue item	Values
A.		Direct Fixed Capital	\$21,254,000
B.		Working Capital	\$259,000
C.		Startup Cost	\$1,063,000
D.		Total Investment (A+B+C+D+E)	\$22,576,000
E.		Investment Charged to This Project	\$22,576,000
F.		Revenue/Credit/Savings Rates	
		Torrefied Pellets (Main Revenue)	46,837 tonne /year
		HP-Steam (Revenue)	14,876 tonne /year
		LP-Steam (Revenue)	546,488 tonne /year
		Acetic acid (Revenue)	2,589 tonne /year
		Furfural (Revenue)	4,568 tonne /year
		Std Power(Savings)	2,062,124 kW-h/year
G.		Revenue/Credit/Savings Price	
		Torrefied Pellets (Main Revenue)	\$140 /tonne
		HP-Steam (Revenue)	\$20 /tonne
		LP-Steam (Revenue)	\$12 /tonne
		Acetic acid (Revenue)	\$1200 /tonne
		Furfural (Revenue)	\$800 /tonne
		Std Power(Savings)	\$0.10 /kW-h
H.		Revenues/Credits/Savings	
		Torrefied Pellets (Main Revenue)	\$6,557,175 /year
		HP-Steam (Revenue)	\$297,552 /year
		LP-Steam (Revenue)	\$557,854 /year
		Acetic acid (Revenue)	\$3,106,497 /year
		Furfural (Revenue)	\$3,654,703 /year
		Std Power(Savings)	\$206,212
	1	Total Revenues	\$14,173,752 /year
	2	Total Savings	\$206,212 /year
I.		Annual Operating Cost (AOC)	
	1	Actual AOC	\$7,168,000 /year
	2	Net AOC (I1-H2)	\$6,962,000 /year
J.		Unit Production Cost /Revenue	
		Unit Production Cost	\$153.04 /tonne MP ¹
		Net Unit Production Cost	\$148.63 /tonne MP
		Unit Production Revenue	\$302.62 /tonne MP
K.		Gross Profit (H1-I2)	\$7,212,000 /year
L.		Taxes (40%)	\$2,885,000 /year
M.		Net Profit (K-L + Depreciation)	\$6,346,000 /year
		Gross Margin	50.88 %
		Return On Investment	28.11 %
		Payback Time	3.56 years

¹ Research and development, ² Main product

Table S9. Cash flow analysis (US\$000) for production of pellets and CHP from torrefied wood (scenario 4).

Year	Capital investment	Sales revenues	Operating cost	Gross profit	Depreciation	Taxable income	Taxes	Net profit	Net cash flow
1	-6,367	0	0	0	0	0	0	0	-6,367
2	-8,749	8,504	6,726	1,779	2,016	1,779	711	3,083	-5,665
3	-6,367	12,756	7,053	5,773	2,016	5,703	2,281	5,438	-929
4	0	14,174	7,162	7,012	2,016	7,012	2,805	6,223	6,223
5	0	14,174	7,162	7,012	2,016	7,012	2,805	6,223	6,223
6	0	14,174	7,162	7,012	2,016	7,012	2,805	6,223	6,223
7	0	14,174	7,162	7,012	2,016	7,012	2,805	6,223	6,223
8	0	14,174	7,162	7,012	2,016	7,012	2,805	6,223	6,223
9	0	14,174	7,162	7,012	2,016	7,012	2,805	6,223	6,223
10	0	14,174	7,162	7,012	2,016	7,012	2,805	6,223	6,223
11	0	14,174	7,162	7,012	2,016	7,012	2,805	6,223	6,223
12	0	14,174	5,146	9,028	0	9,028	3,611	5,417	5,417
13	0	14,174	5,146	9,028	0	9,028	3,611	5,417	5,417
14	0	14,174	5,146	9,028	0	9,028	3,611	5,417	5,417
15	0	14,174	5,146	9,028	0	9,028	3,611	5,417	5,417
16	0	14,174	5,146	9,028	0	9,028	3,611	5,417	5,417
17	0	14,174	5,146	9,028	0	9,028	3,611	5,417	5,417
18	0	14,174	5,146	9,028	0	9,028	3,611	5,417	5,417
19	0	14,174	5,146	9,028	0	9,028	3,611	5,417	5,417
20	1,320	14,174	5,146	9,028	0	9,028	3,611	5,417	6,737

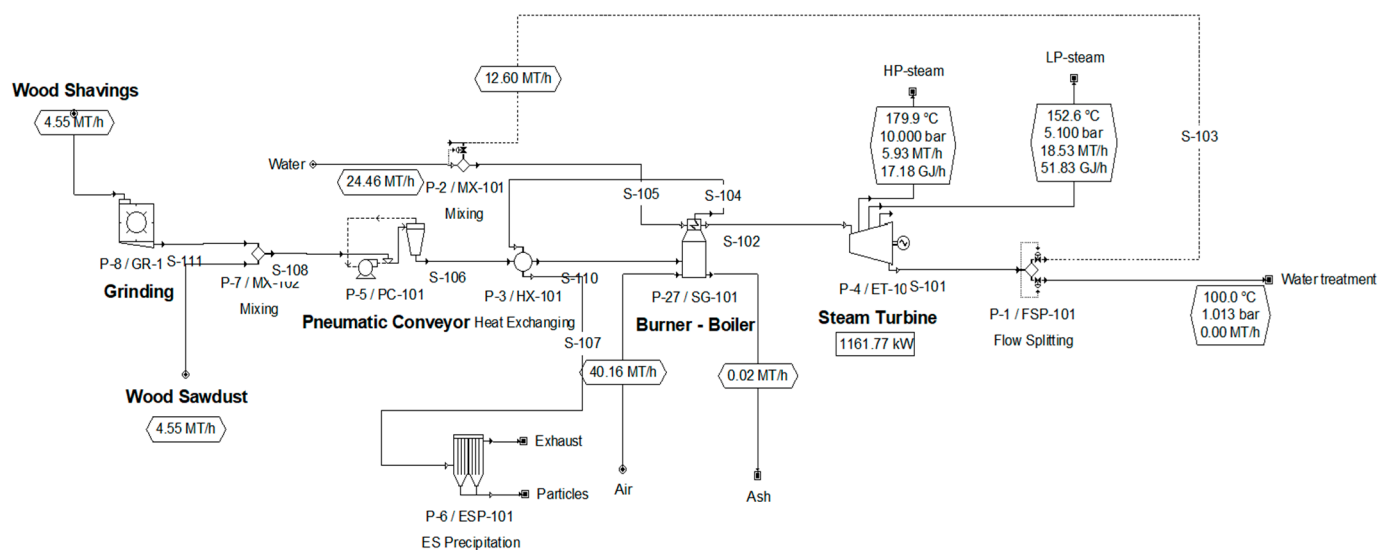


Figure S1. Process flow diagram for heat and electricity production from wood sawdust (scenario 1).

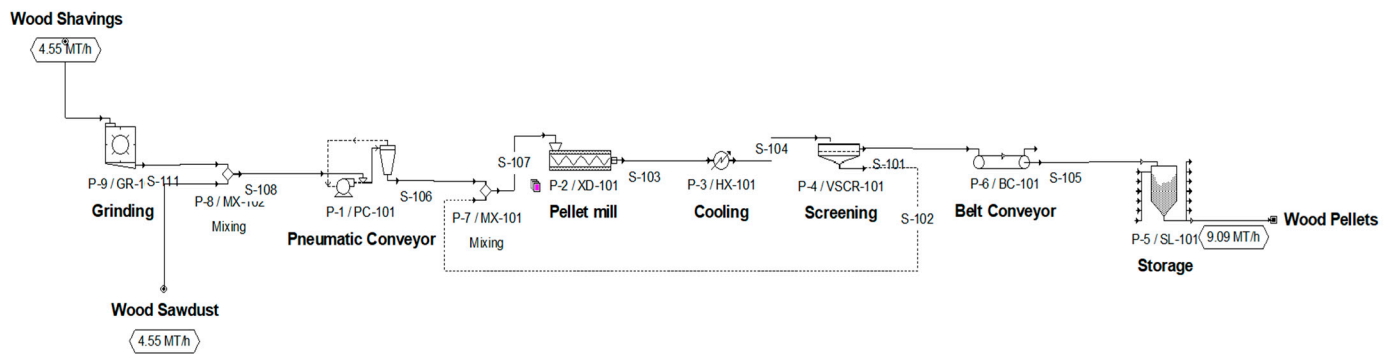


Figure S2. Process flow diagram for producing wood pellets from sawdust (scenario 2).

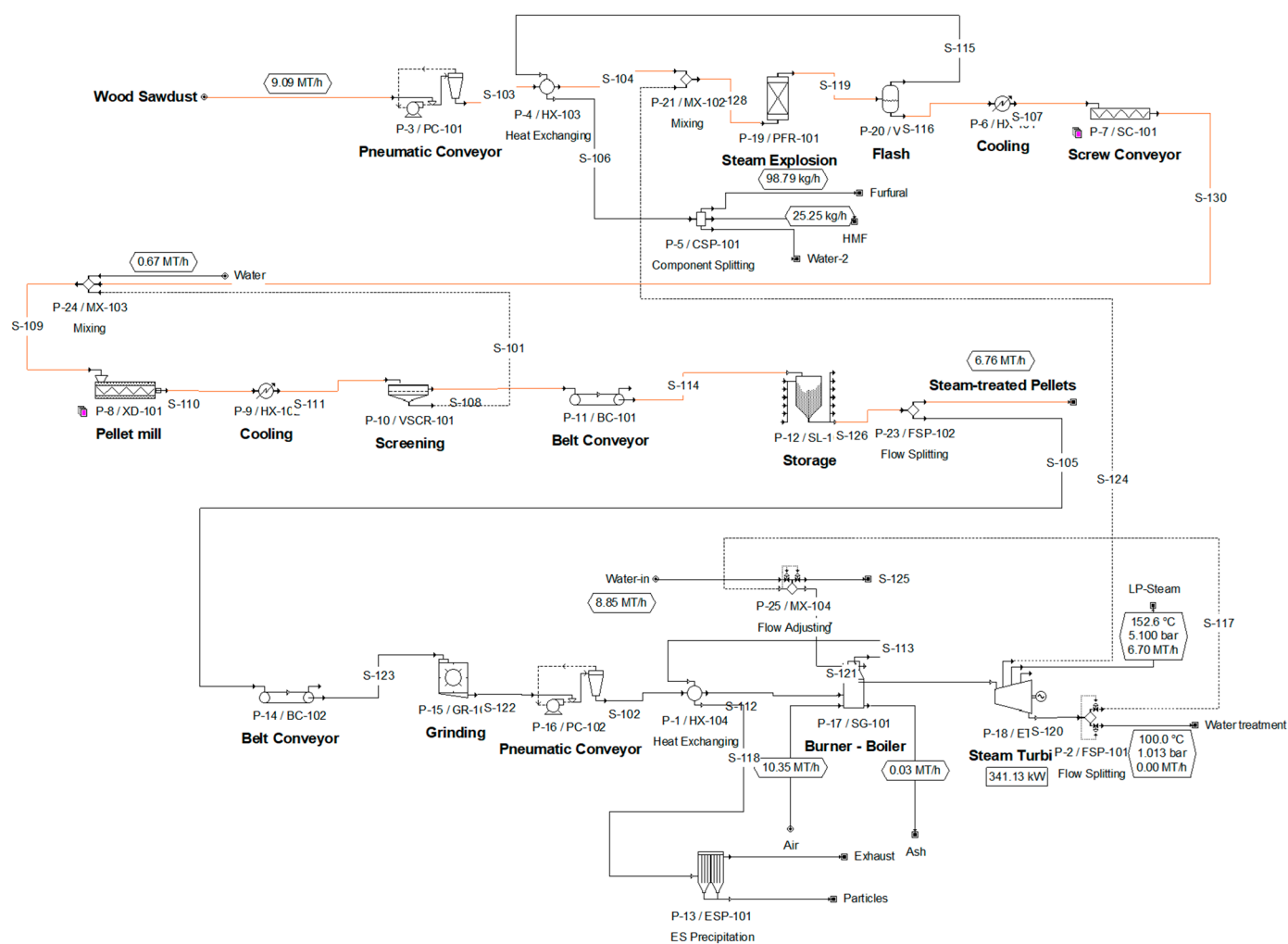


Figure S3. Process flow diagram for heat and electricity production from a portion (25%) of steam treated wood pellets (scenario 3).

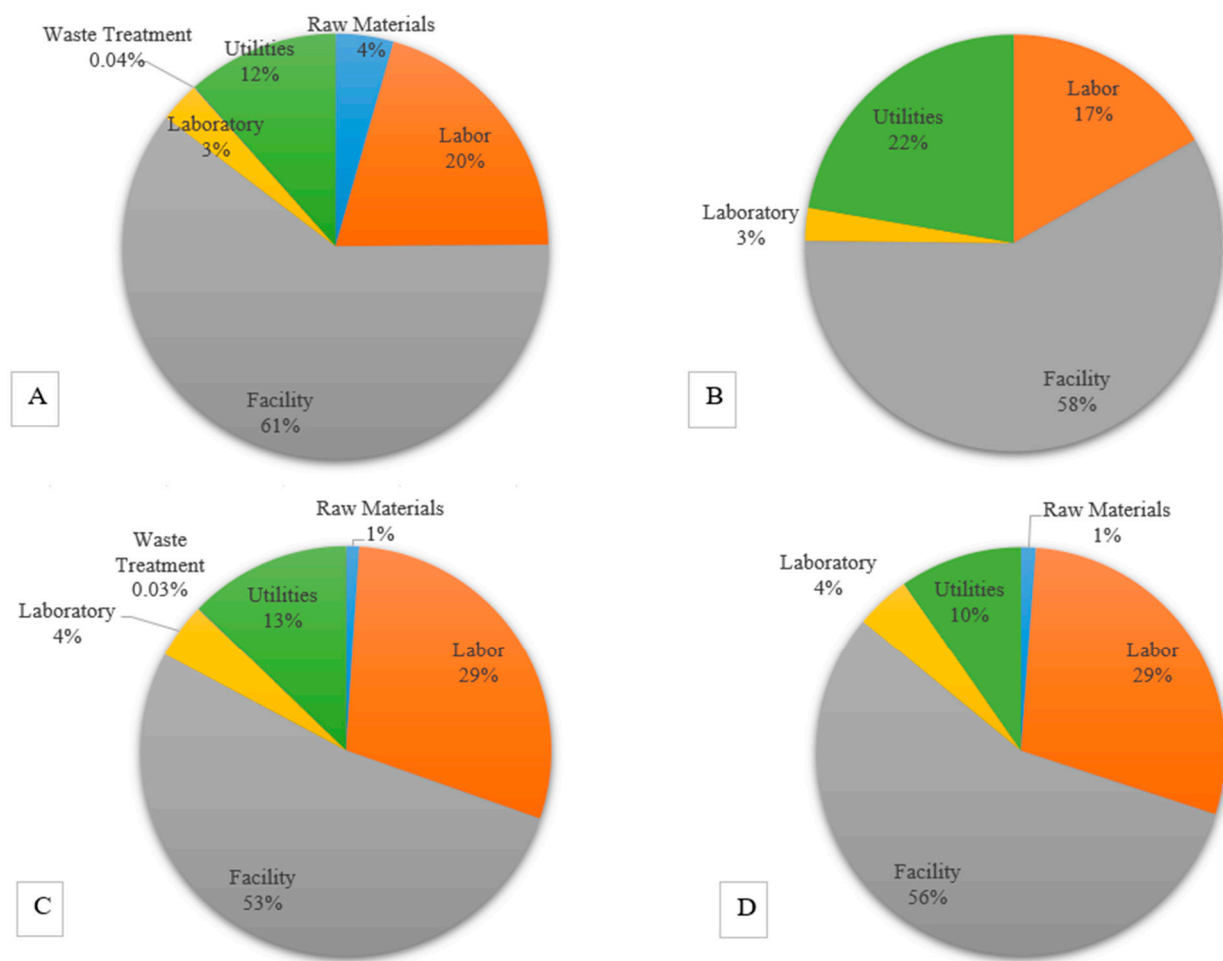


Figure S4. Contribution of each item to the annual operating cost (2020 prices (US\$)). Scenario 1: Direct CHP generation from wood sawdust and shavings (A); Scenario 2: Wood pellet production without CHP (B); Scenario 3: Production of pellets and CHP from steam-exploded wood (C); Scenario 4: Production of pellets and CHP from torrefied wood (D).