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Supplementary Information

Emergy Evaluation of Different Straw Reuse Technologies in Northeast China. *Sustainability*, 2015, *7*, 11360-11377.

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Table S1. Emergy analysis of straw-biogas production cases.

No.	Item	Raw data				
		Case 1	Case 2	Case 3	Case 4	Case 5
Natural ecosystem renewable resources (R)						
1	Straw J/year	4.70×10^{12}	6.90×10^{12}	7.11×10^{12}	4.16×10^{12}	9.13×10^{11}
2	Underground water J/year	3.65×10^{9}	-	-	1.28×10^{10}	-
3	Water g/year	-	5.61×10^{9}	1.65×10^{8}	2.20×10^{7}	-
4	Biogas J/year	8.28×10^{11}	-	-	-	-
Social economic system purchased inputs (F)						
5	Building & equipment $/year	6.09×10^{3}	-	-	-	3.09×10^{2}
6	Steel $/year	1.75×10^{6}	-	-		
7	Nutritional agents $/year	9.27×10^{4}	1.09×10^{5}	-	-	-
8	Pretreatment agent $/year	-	4.23×10^{3}	-	-	-
9	J/year	1.08×10^{11}	5.78×10^{10}	7.92×10^{11}	7.20×10^{10}	4.25×10^{8}
10	Labor J/year	1.84×10^{10}	-	-	-	-
11	Lablor $/year	-	4.65×10^{3}	-	5.81×10^{4}	-
12	Coal J/year	4.82×10^{11}	6.36×10^{12}	2.95×10^{11}	4.82×10^{11}	8.92×10^{10}
13	Maintenance $/year	6.05×10^{2}	1.61×10^{3}	1.46×10^{3}	4.83×10^{3}	1.02×10^{2}
14	Investment $/year	-	3.01×10^{4}	4.98×10^{4}	2.41×10^{4}	9.29×10^{3}
15	Desulfurizing agent kg/year	-	1.00×10^{3}	-	-	-
16	Microbial agents $/year	-	-	-	-	6.58×10^{2}
17	Urea $/year	-	-	-	-	3.36×10^{2}
18	Government subsidies $/year	-	-	-	-	1.61×10^{2}
19	Oil $/year	-	-	-	-	1.44×10^{2}

Table S1. *Cont.*

No.	Item	Raw data				
		Case 1	Case 2	Case 3	Case 4	Case 5
System yield (Y)						
20	Biogas J/year	2.79×10^{12}	2.52×10^{12}	5.18×10^{12}	-	-
21	Nitrogenous fertilizer g/year	6.58×10^{5}	-	4.49×10^{6}	-	-
22	Phosphate fertilizer g/year	3.29×10^{5}	-	2.81×10^{6}	-	-
23	Potash fertilizer g/year	4.94×10^{5}	-	-	-	-
24	Biogas residue g/year	-	-	1.58×10^{6}	-	-
25	Biogas fertilizer g/year	-	4.56×10^{09}	-	-	-

USD to CNY Exchange Rare is 6.1428 in this study, based on 2014 average.

Table S2. Emergy analysis of straw-based power generation system.

NO.	Item	Raw data				
		Case 1	Case 2	Case 3	Case 4	Case 5
Natural ecosystem renewable resources (R)						
1	Straw J/year	2.12×10^{15}	2.56×10^{15}	1.58×10^{12}	2.90×10^{13}	2.64×10^{15}
2	Cooling water \$/year	-	4.79×10^{6}	-		
3	Cooling water J/year	3.35×10^{14}	-	7.93×10^{13}	2.76×10^{15}	3.11×10^{10}
4	Air m^3/year	5.31×10^{8}	4.43×10^{8}	1.59×10^{5}	3.56×10^{8}	6.03×10^{3}
5	Electricity J/year	1.50×10^{10}	1.67×10^{13}	2.52×10^{12}	7.87×10^{13}	5.40×10^{10}
Social economic system purchased inputs (F)						
6	Fixed-asset \$/year	1.61×10^{7}	4.16×10^{7}	6.95×10^{4}	3.15×10^{6}	2.01×10^{7}
7	Labor & welfare \$/year	-	1.90×10^{6}	5.79×10^{4}	2.44×10^{5}	2.41×10^{5}
8	Investment, operating & maintenance \$/year	3.02×10^{6}	1.93×10^{6}	8.04×10^{4}	3.22×10^{6}	4.82×10^{3}
9	Fossil energy \$/year	-	-	1.21×10^{5}	-	1.05×10^{5}
10	Government subsidies \$/year	7.97×10^{5}	3.15×10^{5}	-	-	-
11	Limestone t/year	1.92×10^{5}	9.24×10^{5}	6.60×10^{4}	9.24×10^{5}	1.92×10^{5}
System yield (Y)						
12	Electricity J/year	4.86×10^{14}	1.34×10^{14}	2.45×10^{13}	1.11×10^{9}	2.84×10^{8}
13	GHG emission reduction \$/year	4.04×10^{5}	1.35×10^{6}	-	1.34×10^{11}	1.50×10^{8}

USD to CNY Exchange Rare is 6.1428 in this study, based on 2014 average.

Table S3. Emergy analysis of straw-briquetting system.

NO.	Item	Raw data				
		Case 1	Case 2	Case 3	Case 4	Case 5
Natural ecosystem renewable resources (R)						
1	Straw J/year	1.80×10^{14}	1.00×10^{13}	1.20×10^{13}	3.14×10^{14}	1.38×10^{14}
Social economic system purchased inputs (F)						
2	Investment\$/year	3.38×10^{4}	2.00×10^{4}	1.80×10^{4}	6.50×10^{4}	3.50×10^{4}
3	Electricity J/year	4.50×10^{12}	1.69×10^{12}	1.55×10^{12}	1.90×10^{13}	4.50×10^{12}
4	Labor\$/year	5.65×10^{4}	2.41×10^{3}	3.05×10^{3}	1.01×10^{5}	5.72×10^{4}
5	Mold\$/year	2.94×10^{3}	1.56×10^{3}	1.48×10^{3}	4.26×10^{3}	2.85×10^{3}
6	Lubricant oil J/year	1.46×10^{11}	7.55×10^{8}	7.04×10^{8}	3.06×10^{11}	1.52×10^{11}
System yield (Y)						
7	Briquette J/year	1.64×10^{11}	8.90×10^{10}	9.05×10^{10}	4.00×10^{12}	1.60×10^{11}

USD to CNY Exchange Rare is 6.1428 in this study, based on 2014 average.

Table S4. Emergy analysis of straw-ethanol production system.

NO.	Item	Raw data				
		Case 1	Case 2	Case 3	Case 4	Case 5
Natural ecosystem renewable resources (R)						
1	Straw J/year	5.62×10^{12}	2.12×10^{12}	1.66×10^{9}	3.00×10^{11}	1.66×10^{9}
2	Water g/year	7.69×10^{13}	3.07×10^{13}	2.49×10^{12}	6.40×10^{11}	2.79×10^{12}
Social economic system purchased inputs (F)						
3	Investment \$/year	5.43×10^{3}	6.61×10^{3}	2.80×10^{4}	1.47×10^{7}	3.01×10^{4}
4	Fossil energy J/year	3.50×10^{15}	3.27×10^{15}	1.58×10^{12}	1.44×10^{11}	2.42×10^{12}
5	Labor & maintenance \$/year	1.77×10^{6}	7.88×10^{5}	3.31×10^{4}	2.88×10^{6}	3.31×10^{4}
6	Cellulase \$/year	2.86×10^{9}	1.52×10^{8}	1.00×10^{5}	8.04×10^{6}	1.03×10^{5}
7	Chemical reagent \$/year	9.29×10^{7}	4.15×10^{7}	1.51×10^{4}	6.91×10^{6}	3.14×10^{4}
8	Sulfuric acid \$/year	9.98×10^{7}	1.14×10^{7}	-	9.32×10^{6}	7.36×10^{4}
System yield (Y)						
9	Ethanol J/year	3.06×10^{16}	1.70 × 1016	8.90×10^{12}	1.48×10^{15}	8.90×10^{12}

USD to CNY Exchange Rare is 6.1428 in this study, based on 2014 average.

Table S5. Emergy analysis of straw-gasification system.

NO.	Item (unit)	Raw data				
		Case 1	Case 2	Case 3	Case 4	Case 5
Natural ecosystem renewable resources (R)						
1	Straw g/year	1.83×10^{9}	1.50×10^{9}	2.00×10^{9}	1.20×10^{9}	1.30×10^{9}
2	Straw gas J/year				1.05×10^{12}	-
3	Wood tar \$/year				2.62×10^{4}	-
Social economic system purchased inputs (F)						
4	Fixed-asset \$/year	5.21×10^{4}	2.46×10^{4}	2.17×10^{4}	1.20×10^{4}	4.82×10^{3}
5	Electricity J/year	5.26×10^{10}	5.40×10^{10}	1.80×10^{11}	-	2.63×10^{10}
6	Labor \$/year	3.94×10^{3}	2.25×10^{3}	8.55×10^{3}	-	2.89×10^{3}
7	Maintenance \$/year	3.22×10^{3}	1.93×10^{3}	5.62×10^{2}	-	9.00×10^{2}
8	Government subsidies \$/year	-	6.59×10^{3}	-	-	1.29×10^{4}
9	Variable cost \$/year				3.38×10^{4}	-
System yield (Y)						
10	Straw gas J/year	6.38×10^{12}	5.25×10^{12}	7.00×10^{12}	2.62×10^{12}	5.62×10^{12}
11	Straw carbon J/year	-	-	9.37×10^{12}	5.36×10^{12}	-
12	Wood tar \$/year				2.09×10^{4}	-

USD to CNY Exchange Rare is 6.1428 in this study, based on 2014 average.

Table S6. Transformity of straw reuse cases.

NO.	Item (unit)	Transformity (sej/unit)
1	Investment(Variable and Fixed-asset, government subsidies) $/year	4.94×10^{12} sej/$ [1]
2	Building & equipment $/year	4.94×10^{12} sej/$ [1]
3	Maintenance $/year	4.94×10^{12} sej/$ [1]
4	Labor J/year	3.80×10^{05} sej/J [3]
5	Labor $/year	4.94×10^{12} sej/$ [3]
6	Nutritional agents $/year	4.94×10^{12} sej/$ [1]
7	Chemical reagent $/year	4.94×10^{12} sej/$ [1]
8	Pretreatment agent $/year	1.40×10^{9} sej/$ [1]
9	Desulfurizing agent kg/year	3.08×10^{12} sej/kg [1]
10	Microbial agents $/year	4.94×10^{12} sej/$ [3]
11	Urea $/year	4.94×10^{12}sej/$ [3]
12	Steel $/year	1.40×10^{9} sej/$ [5]
13	Limestone t/year	3.46×10^{12} sej/t [3]
14	Mold $/year	5.87×10^{12} sej/$ [5]
15	Fossil energy $/year	4.94×10^{12} sej/$ [1]
16	Coal J/year	4.00×10^{4} sej/J [1]
17	Oil $/year	4.94×10^{12} sej/$ [1]
18	Lubricant oil J/year	6.60×10^{4} sej/J [5]
19	Electricity J/year	2.67×10^{5} sej/J [1]
20	Water g/year	4.65×10^{5} sej/g [1]
21	Underground water J/year	4.10×10^{4} sej/J [2]
22	Cooling water $/year	4.94×10^{12} sej/$ [2]
23	Cooling water J/year	1.90×10^{4} sej/J [2]
24	Straw J/year	2.70×10^{4} sej/J [5]
25	Straw g/year	4.37×10^{9}sej/g [5]
26	Wood tar $/year	4.94×10^{12}sej/$ [1]
27	Nitrogenous fertilizer g/year	4.62×10^{9} sej/g [4]
28	Phosphate fertilizer g/year	1.78×10^{10} sej/g [4]
29	Potash fertilizer g/year	2.96×10^{9} sej/g [4]
30	Biogas residue g/year	4.62×10^{9} sej/g [4]
31	Biogas fertilizer g/year	4.62×10^{9} sej/g [4]
32	GHG emission reduction $/year	4.94×10^{12} sej/$ [1]
33	Briquette J/year	6.60×10^{4} sej/J [5]
34	Biogas J/year	2.48×10^{5} sej/J [5]
35	Air m^3/year	6.68×10^{10} sej/m^3 [5]
36	Straw gas J/year	3.44×10^{4} sej/J [5]
37	Straw carbon J/year	3.44×10^{4} sej/J [5]
38	Ethanol J/year	4.57×10^{5} sej/J [5]
39	Straw gas J/year	3.44×10^{4} sej/J [5]

USD to CNY Exchange Rare is 6.1428 in this study, based on 2014 average.

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