Electronic Supplementary Information

Environmental feasibility of sustainable co-production of xylooligosaccharides and bioplastic from poplar sawdust

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Table S1. Parameter values for landfill and landfill gas recovery.

Parameter	Unit	Value
Fraction of degradable organic carbon that can decompose, DOC_f [1–4]		0.5
Landfill decay rate, k [1–5]		0.185
Methane correction factor, MCF [1–4]		1
Volume fraction of methane in landfill gas, F [1–4]		0.50
Average oxidation factor, OX [1–4]		0.05
Volume rate of CH_4 to CO_2 in landfill gas emissions [6]		1
Landfill gas recovery efficiency [7]	%	70
Power generation efficiency by landfill gas incineration [7]	%	30

Table S2. Life-cycle environmental impacts of 1 dry kg XOS.

		Feedstock Collection and Transportation	Pretreatment - Acetic Acid	Pretreatment - $CaCO_3$	XOS Production - NaOH	XOS Production - Sulfuric Acid	XOS Production - Other Materials	PLA Production - $CaCO_3$	PLA Production - Methanol	PLA Production - Other Materials	Energy Consumption	Water Consumption and Wastewater Treatment	Potential Benefit of Substituting Gypsum	Potential Benefit of Substituting PLA	**Total**
Acidification	S1	5.78E-06	1.23E-05	1.97E-06	4.25E-06	1.44E-05	1.50E-03	1.73E-04	1.97E-03	4.50E-02	4.39E-03	4.13E-03	-1.67E-02	-4.18E-02	-1.26E-03
(kg SO_2 eq)	S2	5.32E-06	3.49E-02	5.62E-03	1.11E-02	4.14E-02	9.15E-03	1.86E-04	2.16E-03	4.71E-02	5.95E-03	3.91E-03	-4.67E-02	-4.55E-02	6.94E-02
	S3	4.02E-06	4.48E-02	7.21E-03	1.44E-02	5.36E-02	1.15E-02	1.49E-04	1.74E-03	3.72E-02	5.88E-03	2.92E-03	-5.15E-02	-3.66E-02	9.15E-02
	S4	7.00E-06	1.12E-01	1.80E-02	3.61E-02	1.34E-01	2.72E-02	3.08E-04	3.65E-03	7.54E-02	1.10E-02	5.26E-03	-1.23E-01	-7.66E-02	2.23E-01
Carcinogenics	S1	1.78E-10	6.23E-10	1.29E-11	1.23E-13	9.88E-11	4.21E-08	1.39E-09	6.63E-08	3.29E-07	4.11E-08	4.41E-07	-2.32E-08	-8.25E-07	7.37E-08
(CTUh)	S2	1.64E-10	1.77E-06	3.68E-08	3.23E-10	2.84E-07	2.48E-07	1.49E-09	7.26E-08	3.39E-07	5.57E-08	4.17E-07	-6.50E-08	-8.99E-07	2.26E-06
	S3	1.24E-10	2.28E-06	4.73E-08	4.19E-10	3.67E-07	3.13E-07	1.19E-09	5.84E-08	2.66E-07	5.50E-08	3.11E-07	-7.17E-08	-7.22E-07	2.90E-06
		2.15E-10	5.68E-06	1.18E-07	1.05E-09	9.17E-07	7.35E-07	2.47E-09	1.23E-07	5.31E-07	1.03E-07	5.62E-07	-1.71E-07	-1.51E-06	7.09E-06
Ecotoxicity	S1	2.28E-02	3.69E-02	1.40E-03	2.09E-05	1.12E-01	6.28E+00	1.39E-01	5.60E+00	2.21E+02	3.22E+00	1.73E+01	-1.66E+00	-1.40E+02	1.12E+02
(CTUe)	S2	2.10E-02	1.05E+02	3.99E+00	5.49E-02	3.22E+02	3.75E+01	1.50E-01	6.13E+00	2.34E+02	4.36E+00	1.63E+01	-4.63E+00	-1.53E+02	5.72E+02
	S3	1.59E-02	1.35E+02	5.13E+00	7.11E-02	4.17E+02	4.73E+01	1.20E-01	4.94E+00	1.85E+02	4.31E+00	1.22E+01	-5.11E+00	-1.23E+02	6.83E+02
		2.77E-02	3.36E+02	1.28E+01	1.78E-01	1.04E+03	1.11E+02	2.48E-01	1.04E+01	3.80E+02	8.04E+00	2.20E+01	-1.22E+01	-2.57E+02	1.65E+03
Eutrophication	S1	2.10E-06	7.30E-06	4.07E-07	1.03E-07	3.56E-06	8.95E-04	2.56E-05	8.98E-04	1.77E-02	1.39E-03	2.20E-02	-1.95E-04	-3.01E-02	1.27E-02
(kg N e)	S2	1.93E-06	2.08E-02	1.16E-03	2.71E-04	1.02E-02	5.75E-03	2.76E-05	9.83E-04	1.76E-02	1.88E-03	2.08E-02	-5.45E-04	-3.28E-02	4.62E-02
	S3	1.46E-06	2.67E-02	1.49E-03	3.51E-04	1.32E-02	7.26E-03	2.20E-05	7.92E-04	1.37E-02	1.86E-03	1.55E-02	-6.01E-04	-2.63E-02	5.40E-02
	S4	2.54E-06	6.66E-02	3.71E-03	8.78E-04	3.30E-02	1.71E-02	4.56E-05	1.66E-03	2.64E-02	3.46E-03	2.80E-02	-1.43E-03	-5.51E-02	1.24E-01
Fossil fuel depletion	S1	5.20E-03	1.25E-02	1.27E-03	1.44E-03	3.73E-04	6.64E-01	2.94E-02	7.08E+00	5.60E+00	2.24E-01	7.07E-01	-1.96E-01	-2.43E+01	-1.01E+01
(MJ surplus)	S2	4.78E-03	3.55E+01	3.60E+00	3.77E+00	1.07E+00	3.87E+00	3.16E-02	7.75E+00	5.86E+00	3.03E-01	6.68E-01	-5.48E-01	-2.64E+01	3.54E+01
	S3	3.61E-03	4.55E+01	4.63E+00	4.88E+00	1.39E+00	4.87E+00	2.52E-02	6.24E+00	4.63E+00	3.00E-01	4.99E-01	-6.04E-01	-2.12E+01	5.12E+01
	S4	6.29E-03	1.14E+02	1.15E+01	1.22E+01	3.46E+00	1.14E+01	5.23E-02	1.31E+01	9.38E+00	5.59E-01	9.00E-01	-1.44E+00	-4.45E+01	1.30E+02
Global warming	S1	2.41E-03	2.62E-03	2.13E-03	8.12E-04	2.77E-04	2.76E-01	1.21E+00	9.81E-01	4.80E+00	9.21E-01	9.12E-01	-8.39E-02	-1.23E+01	-3.29E+00
($kgCO_2e$)	S2	2.22E-03	7.44E+00	6.08E+00	2.13E+00	7.95E-01	1.64E+00	1.30E+00	1.07E+00	5.03E+00	1.25E+00	8.63E-01	-2.35E-01	-1.34E+01	1.40E+01
	S3	1.68E-03	9.56E+00	7.80E+00	2.76E+00	1.03E+00	2.07E+00	1.04E+00	8.65E-01	3.97E+00	1.23E+00	6.44E-01	-2.59E-01	-1.08E+01	1.99E+01
	S4	2.92E-03	2.38E+01	1.95E+01	6.90E+00	2.57E+00	4.87E+00	2.16E+00	1.82E+00	8.05E+00	2.30E+00	1.16E+00	-6.16E-01	-2.26E+01	4.99E+01
Non carcinogenics	S1	6.05E-10	5.42E-10	4.33E-11	9.99E-12	1.80E-09	1.26E-07	2.83E-09	7.44E-08	4.46E-06	1.25E-07	2.17E-06	-5.90E-08	-2.17E-06	4.74E-06
(CTUh)	S2	5.57E-10	1.54E-06	1.23E-07	2.62E-08	5.16E-06	8.11E-07	3.04E-09	8.14E-08	4.58E-06	1.69E-07	2.06E-06	-1.65E-07	-2.36E-06	1.20E-05
	S3	4.20E-10	1.98E-06	1.58E-07	3.40E-08	6.69E-06	1.02E-06	2.43E-09	6.56E-08	3.60E-06	1.67E-07	1.54E-06	-1.82E-07	-1.90E-06	1.32E-05
	S4	7.33E-10	4.94E-06	3.95E-07	8.49E-08	1.67E-05	2.42E-06	5.04E-09	1.38E-07	7.18E-06	3.12E-07	2.77E-06	-4.33E-07	-3.97E-06	3.06E-05
Ozone depletion	S1	4.56E-11	1.01E-10	1.12E-11	3.52E-12	6.49E-12	2.55E-09	2.82E-10	7.21E-08	1.66E-07	7.86E-09	1.68E-07	-1.79E-09	-5.64E-07	-1.50E-07
(kg CFC-11 eq)	S2	4.20E-11	2.87E-07	3.19E-08	9.23E-09	1.86E-08	1.68E-08	3.04E-10	7.90E-08	1.73E-07	1.07E-08	1.58E-07	-5.02E-09	-6.15E-07	1.65E-07
	S3	3.17E-11	3.68E-07	4.10E-08	1.20E-08	2.41E-08	2.13E-08	2.42E-10	6.36E-08	1.37E-07	1.05E-08	1.18E-07	-5.54E-09	-4.94E-07	2.97E-07
	S4	5.53E-11	9.18E-07	1.02E-07	2.99E-08	6.02E-08	5.04E-08	5.03E-10	1.34E-07	2.77E-07	1.96E-08	2.13E-07	-1.32E-08	-1.03E-06	7.58E-07
Respiratory effects	S1	1.51E-06	1.80E-06	2.96E-07	1.83E-07	1.16E-06	1.79E-04	7.07E-05	3.04E-04	4.29E-03	7.58E-04	1.15E-03	-1.04E-03	-6.18E-03	-4.63E-04
(kg PM2.5 eq)	S2	1.39E-06	5.13E-03	8.42E-04	4.80E-04	3.33E-03	1.08E-03	7.61E-05	3.33E-04	4.48E-03	1.03E-03	1.09E-03	-2.91E-03	-6.73E-03	8.23E-03
	S3	1.05E-06	6.58E-03	1.08E-03	6.21E-04	4.32E-03	1.37E-03	6.07E-05	2.68E-04	3.54E-03	1.02E-03	8.15E-04	-3.22E-03	-5.40E-03	1.10E-02
	S4	1.83E-06	1.64E-02	2.70E-03	1.55E-03	1.08E-02	3.22E-03	1.26E-04	5.63E-04	7.17E-03	1.89E-03	1.47E-03	-7.65E-03	-1.13E-02	2.69E-02
Smog	S1	1.04E-04	1.37E-04	3.10E-05	4.80E-05	4.01E-05	1.40E-02	4.44E-03	3.89E-02	3.16E-01	6.55E-02	5.73E-02	-1.00E-02	-5.09E-01	-2.30E-02
(kg O_3 eq)	S2	9.55E-05	3.90E-01	8.83E-02	1.26E-01	1.15E-01	8.53E-02	4.77E-03	4.26E-02	3.28E-01	8.88E-02	5.42E-02	-2.80E-02	-5.55E-01	7.41E-01
	S3	7.20E-05	5.00E-01	1.13E-01	1.63E-01	1.49E-01	1.08E-01	3.81E-03	3.43E-02	2.59E-01	8.77E-02	4.04E-02	-3.09E-02	-4.45E-01	9.83E-01
	S4	1.26E-04	1.25E+00	2.83E-01	4.08E-01	3.72E-01	2.53E-01	7.90E-03	7.20E-02	5.21E-01	1.64E-01	7.29E-02	-7.36E-02	-9.33E-01	2.40E+00

Table S3. Life-cycle global warming potential of treating 1 dry t poplar sawdust.

	Feedstock Collection and Transportation	Pretreatment	XOS Production	PLA Production	Energy Consumption	Water Consumption and Wastewater Treatment	Potential Benefit of Substituting Gypsum	Potential Benefit of Substituting PLA	Landfill Gas Emissions	Potential Benefit of Substituting Electricity	**Total**
S1	0	0	13	322	42	42	-4	-567	0	0	-152
S2	0	676	229	370	62	43	-12	-671	0	0	698
S3	0	1151	388	390	82	43	-17	-714	0	0	1322
S4	0	1645	545	457	87	44	-23	-858	0	0	1898
Landfilling	0	0	0	0	0	0	0	0	2899	0	2899
Landfilling with landfill gas recovery	0	0	0	0	0	0	0	0	317	-345	-28

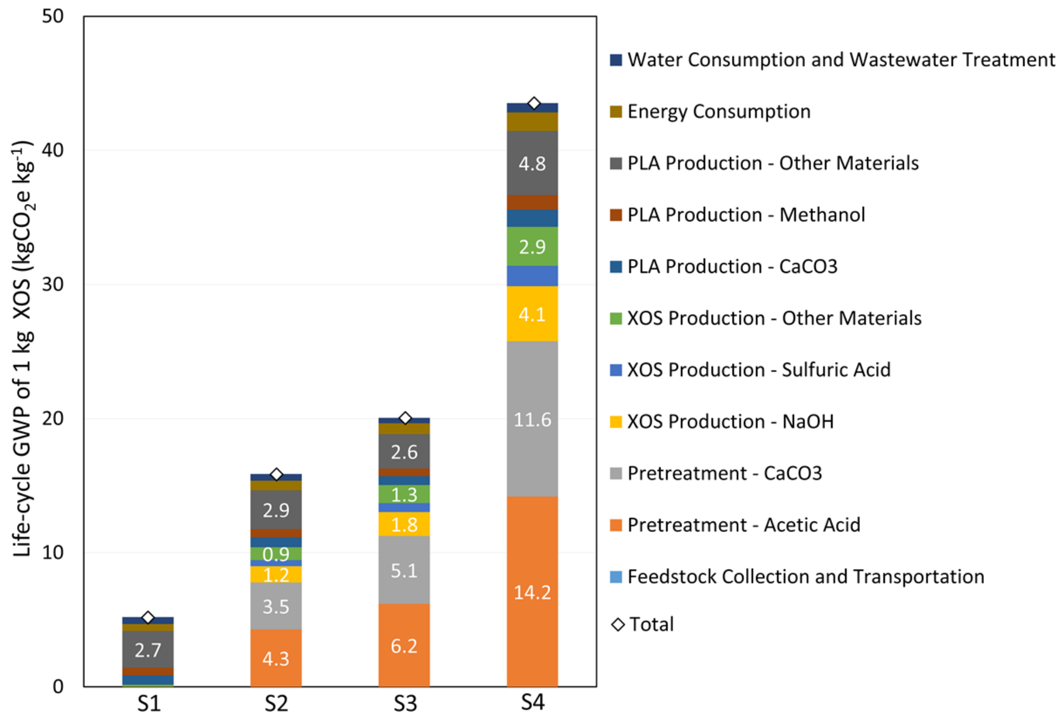

Fig. S1. The life-cycle global warming potential of 1 kg XOS in four scenarios by using economic allocation method.

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