Supplementary Materials

Table S1. Stoichiometry and kinetic equations of the anaerobic digestion for bioCH_4 production [1,2].

Conversion steps	Stoichiometry	Kinetic equations
Enzymatic hydrolysis		
Carbohydrate hydrolysis	$(C_6H_{10}O_5)_{is} \rightarrow Y_c\ (C_6H_{10}O_5)_s + (1 - Y_c)\ (C_6H_{10}O_5)_{in}$	$R_S = k\ S$
Protein hydrolysis	$(\text{Protein})_{is} \rightarrow Y_p\ (\text{Amino acids}) + (1 - Y_p)\ (\text{Protein})_{in}$	$R_S = k\ S$
Bacterial steps		
Acidogenic glucose degrading	$(C_6H_{10}O_5)_3 + 0.1115\ NH_3 \rightarrow 0.1115\ C_5H_7NO_2 + 0.744\ C_2H_4O_2 + 0.5\ C_3H_6O_2 + 0.4409\ C_4H_8O_2 + 0.6909\ CO_2 + 0.0254\ H_2O$	$\mu = \mu_{max}(T)\ \left(\frac{1}{1 + \frac{K_s}{[(C_6H_{10}O_5)_s]}}\right)$
Lipolytic	$C_{57}H_{104}O_6 + 1.90695\ H_2O + 0.04071\ NH_3 + 0.0291\ CO_2 \rightarrow 0.04071\ C_5H_7NO_2 + 0.941843\ C_3H_6O_2 + 3\ C_{18}H_{34}O_2$	$\mu = \mu_{max}(T)\ \left(\frac{1}{1 + \frac{K_s}{[GTO]}}\right)$
Long chain fatty acids (LCFA)-degrading	$C_{18}H_{34}O_2 + 7.7401\ H_2O + 4.0834\ CO_2 + 0.2537\ NH_3 \rightarrow 0.2537\ C_5H_7NO_2 + 8.6998\ C_2H_4O_2 + 3.4139\ CH_4$	$\mu = \mu_{max}(T)\ \left(\frac{1}{1 + \frac{K_{s,LCFA}}{[LCFA]} + \frac{[LCFA]}{K_{i,LCFA}}}\right)$
Amino acid-degrading	$CH_{2.03}O_{0.6}N_{0.3}S_{0.001} + 0.3006\ H_2O \rightarrow 0.017013\ C_5H_7NO_2 + 0.29742\ C_2H_4O_2 + 0.02904\ C_3H_6O_2 + 0.022826\ C_4H_8O_2 + 0.013202\ C_5H_{10}O_2 + 0.07527\ CO_2 + 0.28298\ NH_3 + 0.001\ H_2S$	$\mu = \mu_{max}(T)$
Propionate-degrading	$C_3H_6O_2 + 0.06198\ NH_3 + 0.314\ H_2O \rightarrow 0.06198\ C_5H_7NO_2 + 0.9345\ C_2H_4O_2 + 0.6604\ CH_4 + 0.1607\ CO_2$	$\mu = \mu_{max}(T)\ \left(\frac{1}{1 + \frac{K_s}{[C_3H_6O_2]}}\right)\ \left(\frac{1}{1 + \frac{[C_2H_4O_2]}{K_{i,C2H4O2}}}\right)$

Butyrate-degrading	$C_4H_8O_2 + 0.0653\ NH_3 + 0.5543\ CO_2 + 0.8038\ H_2O \rightarrow 0.0653\ C_5H_7NO_2 + 1.8909\ C_2H_4O_2 + 0.4452\ CH_4$	$\mu = \mu_{max}(T)\left(\frac{1}{1+\frac{K_s}{[C_4H_8O_2]}}\right)\left(\frac{1}{1+\frac{[C_2H_4O_2]}{K_{i,C2H4O2}}}\right)$
Valerate-degrading	$C_5H_{10}O_2 + 0.0653\ NH_3 + 0.5543\ CO_2 + 0.8045\ H_2O \rightarrow 0.0653\ C_5H_7NO_2 + 0.8912\ C_2H_4O_2 + 0.02904\ C_3H_6O_2 + 0.4454\ CH_4$	$\mu = \mu_{max}(T)\left(\frac{1}{1+\frac{K_s}{[C_5H_{10}O_2]}}\right)\left(\frac{1}{1+\frac{[C_2H_4O_2]}{K_{i,C2H4O2}}}\right)$
Acetoclastic methanogenic	$C_2H_4O_2 + 0.022\ NH_3 \rightarrow 0.022\ C_5H_7NO_2 + 0.945\ CH_4 + 0.945\ CO_2 + 0.066\ H_2O$	$\mu = \mu_{max}(T)\left(\frac{1}{1+\frac{K_s}{[C_2H_4O_2]}}\right)\left(\frac{1}{1+\frac{[NH_3]}{K_{i,NH3}}}\right)$

Table S2. Details of life cycle inventory database for FW-based GM production in China [3].

Scenario	Base case	Wind	Photovoltaic	Hydro
FW	FW collection in lower-middle income country			
Heat	Heat, district or industrial, natural gas {GLO}| market group for | APOS, U			
Electricity	Electricity, high voltage {CN}| market group for | APOS, U	Electricity, high voltage {CN-BJ}| electricity production, wind, >3MW turbine, onshore | APOS, U	Electricity, low voltage {CN-BJ}| electricity production, photovoltaic, 570kWp open ground installation, multi-Si | APOS, U	Electricity, high voltage {CN-BJ}| electricity production, hydro, run-of-river | APOS, U

References

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3. Wernet, G.; Bauer, C.; Steubing, B.; Reinhard, J.; Moreno-Ruiz, E.; Weidema, B. The ecoinvent database version 3 (part I): overview and methodology. *The International Journal of Life Cycle Assessment* **2016**, *21*, 1218-1230.