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Supporting Information

Techno-economic analysis of a solar-powered biomass electrolysis pathway for coproduction of hydrogen and value-added chemicals

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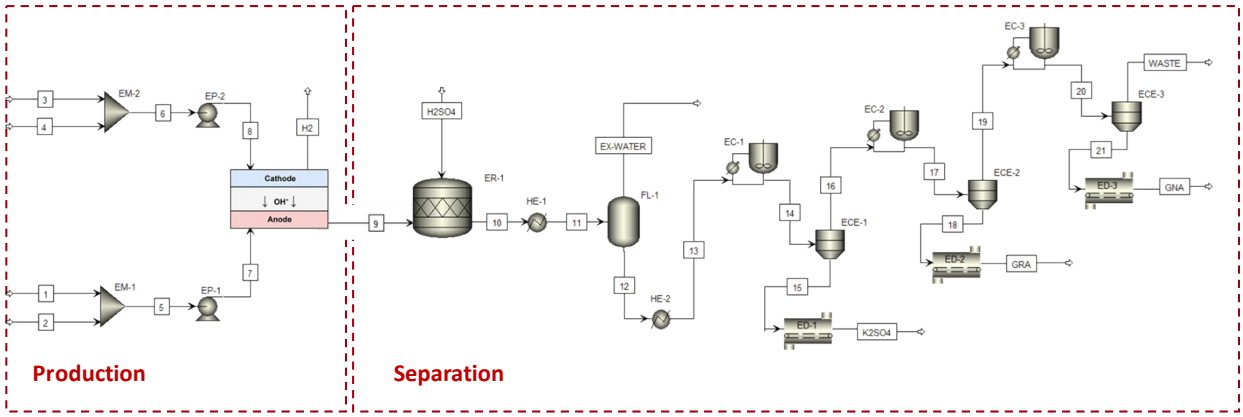

Figure S1. Process flow diagram of electrocatalytic oxidation of glucose to H_2 and chemicals (GRA, GNA and K_2SO_4).

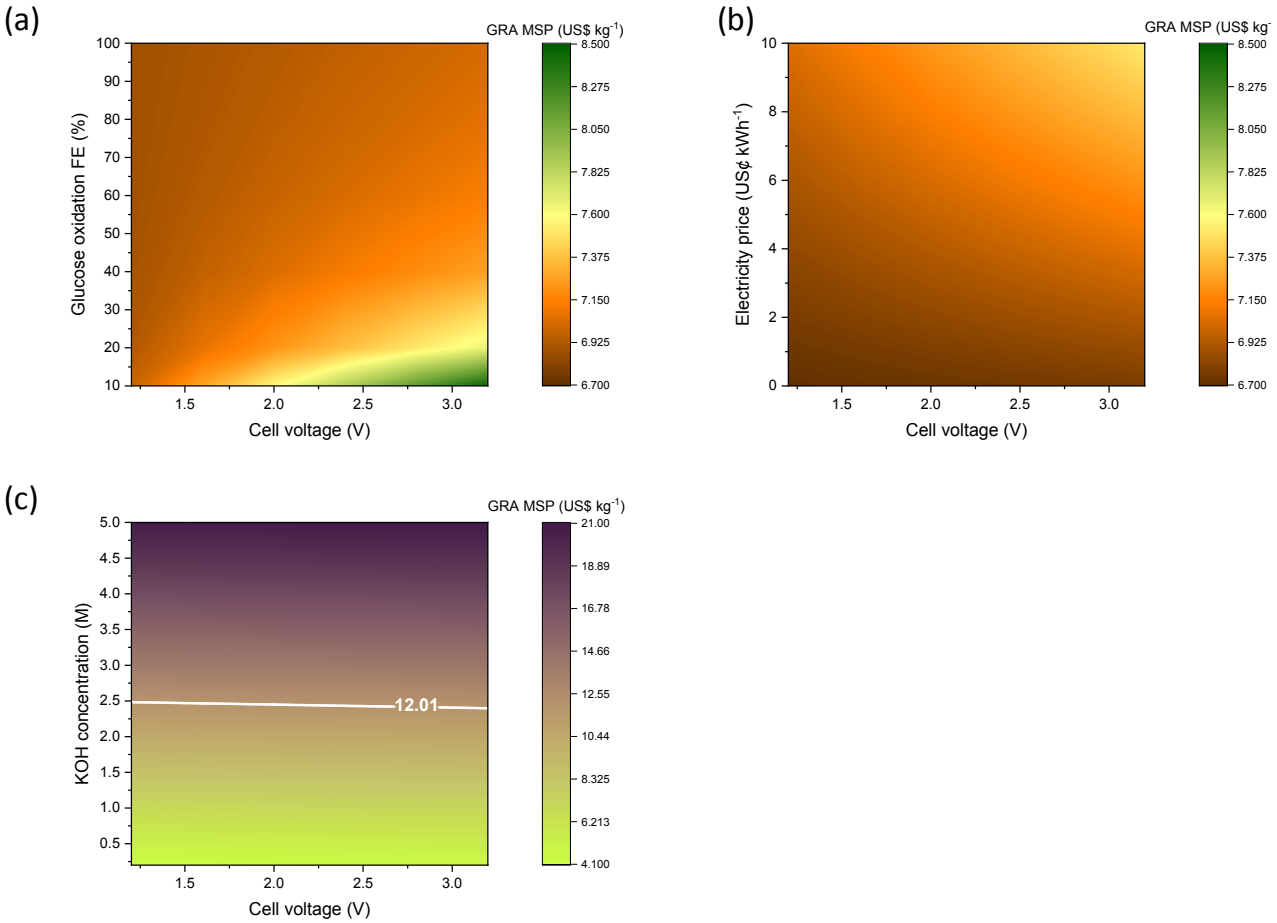

Figure S2. Electrolysis performance contour plots showing the dependence of MSP of GRA on GRA selectivity, glucose conversion, operating current density and cell voltage. The solid white line depicts the current market price of GRA at ~ US$12 kg^{-1}.

Table S1. Base case results for the system analysed.

	CAPEX distribution	
Electrolyzer	US$3,769,059.56	9.42 %
Other equipment	US$19,749,600.00	49.36 %
PV capital	US$3,739,242.31	9.35 %
Indirect costs	US$1,646,306.17	4.11 %
Contingency	US$5,780,841.61	14.45 %
Land	US$123,497.00	0.31 %
Working capital	US$5,202,757.45	13.00 %
Total capital	US$40,011,304.08	100.00 %
	OPEX distribution	
Raw material	US$118,893,333.33	81.97 %
Electrolyzer OPEX	US$1,185,605.93	0.82 %
Electricity for separation	US$245,412.96	0.17 %
Steam	US$22,494,750.18	15.51 %
Cooling water	US$11,224.91	0.01 %
Staff/labour	US$2,100,000.00	1.45 %
PV O&M	US$107,078.30	0.07 %
Total OPEX	US$145,037,405.60	100.00 %
	Revenue distribution	
GNA	US$14,000,000.00	9.24 %
H_2	US$1,382,400.00	0.91 %
K_2SO_4	US$6,285,714.29	43.74 %
O_2	US$304,761.90	0.20 %
CO_2	US$105,600.00	0.07 %
GRA	US$69,456,036.94	45.84 %
Total revenue	US$151,534,513.13	100.00 %

Table S2. Optimistic case results for the system analysed.

	CAPEX distribution	
Electrolyzer	US$1,168,577.67	3.57 %
Other equip	US$19,005,500.00	58.07 %
PV capital	US$2,040,469.63	6.23 %
Indirect costs	US$1,412,185.44	4.31 %
Contingency	US$4,725,346.55	14.44 %
Land	US$73,497.00	0.38 %
working capital	US$4,252,811.89	12.99 %
Total capital	US$32,728,388.17	100.00 %
	OPEX distribution	
Raw material	US$11,097,824.81	71.85 %
Electrolyzer OPEX	US$537,635.35	3.48 %
Electricity for separation	US$245,137.49	1.59 %
Steam	US$1,397,098.50	9.05 %
Cooling water	US$9,397.80	0.06 %
Staff/labour	US$2,100,000.00	13.60 %
PV O&M	US$58,431.63	0.38 %
Total OPEX	US$15,445,525.58	100.00 %
	revenue distribution	
GNA	US$1,555,555.56	7.51 %
H_2	US$597,333.33	2.89 %
K_2SO_4	US$4,091,710.76	19.76 %
O_2	US$26,337.45	0.13%
CO_2	US$82,133.33	0.40%
GRA	US$14,349,459.21	69.31%
Total revenue	US$20,702,529.63	100.00%

Table S3. Discounted cash flow analysis for the base case.

Operation	Year	Investment (US$)	Revenue (US$)	Cost (US$)	[a] Depreciation (US$)	Profit before tax (PBT) (US$)	Taxes paid (on PBT) (US$)	Net profit after-tax (US$)	Cash flow (US$)	Discounted Cash Flow (US$)	Cumulative DCF (US$)
-2	**0**	-$123,497.00							-$123,497.00	-$123,497.00	-$123,497.00
-1	**1**	-$17,342,524.82							-$17,342,524.82	-$15,765,931.65	-$15,889,428.65
0	**2**	-$22,545,282.26							-$22,545,282.26	-$18,632,464.68	-$34,521,893.34
1	**3**		$151,534,513.13	$145,037,405.60	$3,121,654.47	$3,375,453.06	$1,313,051.24	$2,062,401.82	$5,184,056.29	$3,894,858.22	-$30,627,035.12
2	**4**		$151,534,513.13	$145,037,405.60	$3,121,654.47	$3,375,453.06	$1,313,051.24	$2,062,401.82	$5,184,056.29	$3,540,780.20	-$27,086,254.92
3	**5**		$151,534,513.13	$145,037,405.60	$3,121,654.47	$3,375,453.06	$1,313,051.24	$2,062,401.82	$5,184,056.29	$3,218,891.09	-$23,867,363.83
4	**6**		$151,534,513.13	$145,037,405.60	$3,121,654.47	$3,375,453.06	$1,313,051.24	$2,062,401.82	$5,184,056.29	$2,926,264.63	-$20,941,099.21
5	**7**		$151,534,513.13	$145,037,405.60	$3,121,654.47	$3,375,453.06	$1,313,051.24	$2,062,401.82	$5,184,056.29	$2,660,240.57	-$18,280,858.64
6	**8**		$151,534,513.13	$145,037,405.60	$3,121,654.47	$3,375,453.06	$1,313,051.24	$2,062,401.82	$5,184,056.29	$2,418,400.52	-$15,862,458.12
7	**9**		$151,534,513.13	$145,037,405.60	$3,121,654.47	$3,375,453.06	$1,313,051.24	$2,062,401.82	$5,184,056.29	$2,198,545.92	-$13,663,912.20
8	**10**		$151,534,513.13	$145,037,405.60	$3,121,654.47	$3,375,453.06	$1,313,051.24	$2,062,401.82	$5,184,056.29	$1,998,678.11	-$11,665,234.08
9	**11**		$151,534,513.13	$145,037,405.60	$3,121,654.47	$3,375,453.06	$1,313,051.24	$2,062,401.82	$5,184,056.29	$1,816,980.10	-$9,848,253.98
10	**12**		$151,534,513.13	$145,037,405.60	$3,121,654.47	$3,375,453.06	$1,313,051.24	$2,062,401.82	$5,184,056.29	$1,651,800.09	-$8,196,453.89
11	**13**		$151,534,513.13	$145,037,405.60		$6,497,107.53	$2,527,374.83	$3,969,732.70	$3,969,732.70	$1,149,890.16	-$7,046,563.73
12	**14**		$151,534,513.13	$145,037,405.60		$6,497,107.53	$2,527,374.83	$3,969,732.70	$3,969,732.70	$1,045,354.69	-$6,001,209.04
13	**15**		$151,534,513.13	$145,037,405.60		$6,497,107.53	$2,527,374.83	$3,969,732.70	$3,969,732.70	$950,322.45	-$5,050,886.59
14	**16**		$151,534,513.13	$145,037,405.60		$6,497,107.53	$2,527,374.83	$3,969,732.70	$3,969,732.70	$863,929.50	-$4,186,957.09
15	**17**		$151,534,513.13	$145,037,405.60		$6,497,107.53	$2,527,374.83	$3,969,732.70	$3,969,732.70	$785,390.45	-$3,401,566.64
16	**18**		$151,534,513.13	$145,037,405.60		$6,497,107.53	$2,527,374.83	$3,969,732.70	$3,969,732.70	$713,991.32	-$2,687,575.32
17	**19**		$151,534,513.13	$145,037,405.60		$6,497,107.53	$2,527,374.83	$3,969,732.70	$3,969,732.70	$649,083.02	-$2,038,492.31
18	**20**		$151,534,513.13	$145,037,405.60		$6,497,107.53	$2,527,374.83	$3,969,732.70	$3,969,732.70	$590,075.47	-$1,448,416.84
19	**21**		$151,534,513.13	$145,037,405.60		$6,497,107.53	$2,527,374.83	$3,969,732.70	$3,969,732.70	$536,432.25	-$911,984.59
20	**22**	$3,592,001.96	$151,534,513.13	$145,037,405.60		$6,497,107.53	$2,527,374.83	$3,969,732.70	$7,561,734.66	$928,928.66	**$16,944.07**

[a] 10-year straight line depreciation method

Table S4. The calculation for single-pass product accumulation/concentration

Fixed current density (A/cm^2)	0.20
selectivity to glucose oxidation	50%
selectivity to GRA	50%
GRA partial current density (A/cm^2 or C/s/cm^2)	0.05
GNA partial current density (A/cm^2 or C/s/cm^2)	0.05
water (tons/year)	1904761.905
Real electrolyte flow rate (tons/min)	3.78
Total electrolyte flow rate (L/min)	3779.289494
Area of electrolyser (cm^2)	12140085.66
Faradays constant (C/mole e$^-$)	96480
convert coulombs to mole of electrons (mole e$^-$/sec/cm^2)	5.1824E-07
convert mole of electrons to mole GRA (mole GRA/sec/cm^2)	8.6374E-08
convert to grams of GRA (grams GRA/sec/cm^2)	1.8151E-05
convert to volume using density (mL/sec/cm^2)	9.5529E-06
single pass GRA flux (mL/min/cm^2)	5.7318E-04
single-pass GRA volume flow rate (mL/min)	6958.403
convert coulombs to mole of electrons (mole e$^-$/sec/cm^2)	5.1824E-07
convert mole of electrons to mole GNA (mole GRA/sec/cm^2)	2.5912E-07
convert to grams of GNA (grams GNA/sec/cm^2)	5.0829E-05
convert to volume using density (mL/sec/cm^2)	4.1191E-05
GNA flux (mL/min/cm^2)	2.4714E-03
GNA volume flow rate (mL/min)	30003.437
total product volume flow rate (mL/min)	36961.840
product accumulation (%)	**0.9780%**

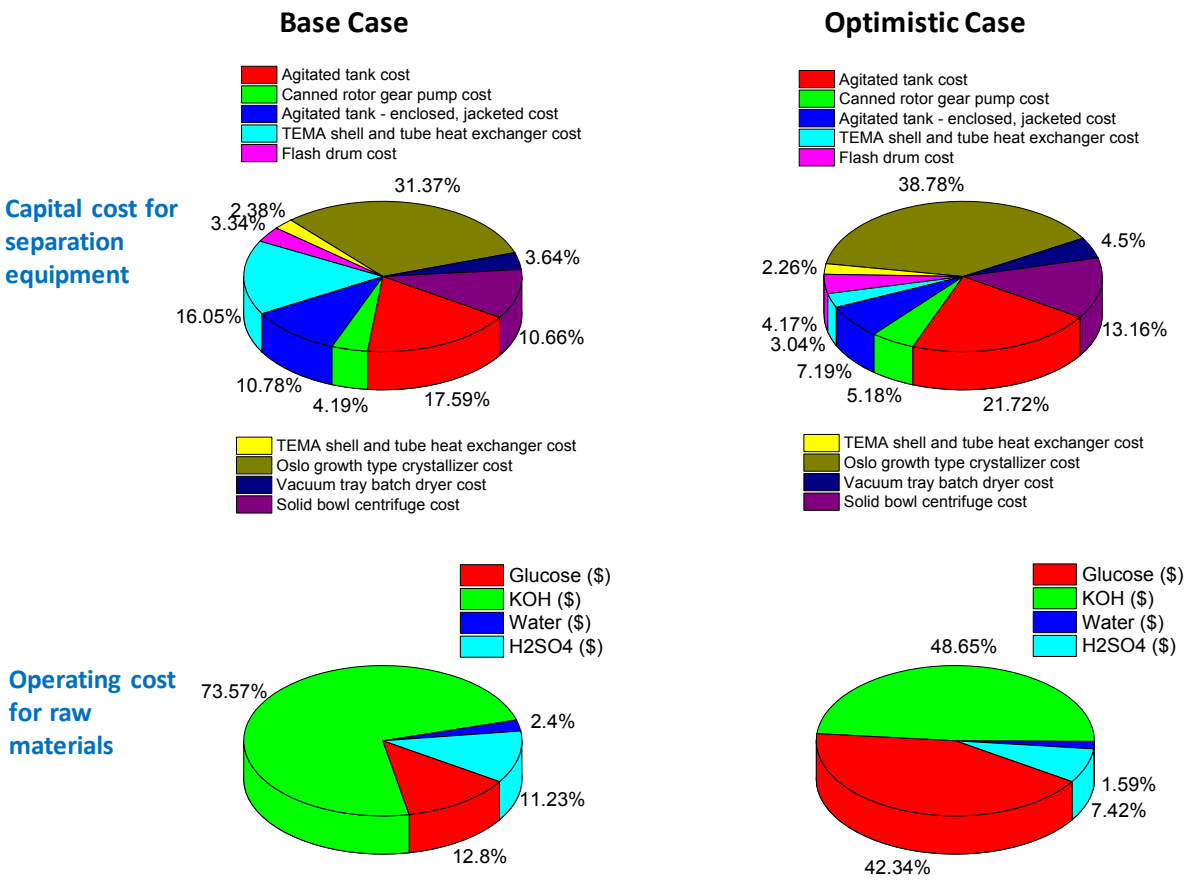

Figure S3. Breakdown of the capex for separation equipment and opex of raw material costs using base case and optimistic assumptions. Note: The neutralizer reactor is an agitated tank -enclosed, jacketed.