Electronic Supplementary Material (ESI) for Green Chemistry.

Towards a Low-Carbon Future: Exploring Green Urea Synthesis for Sustainable Agriculture

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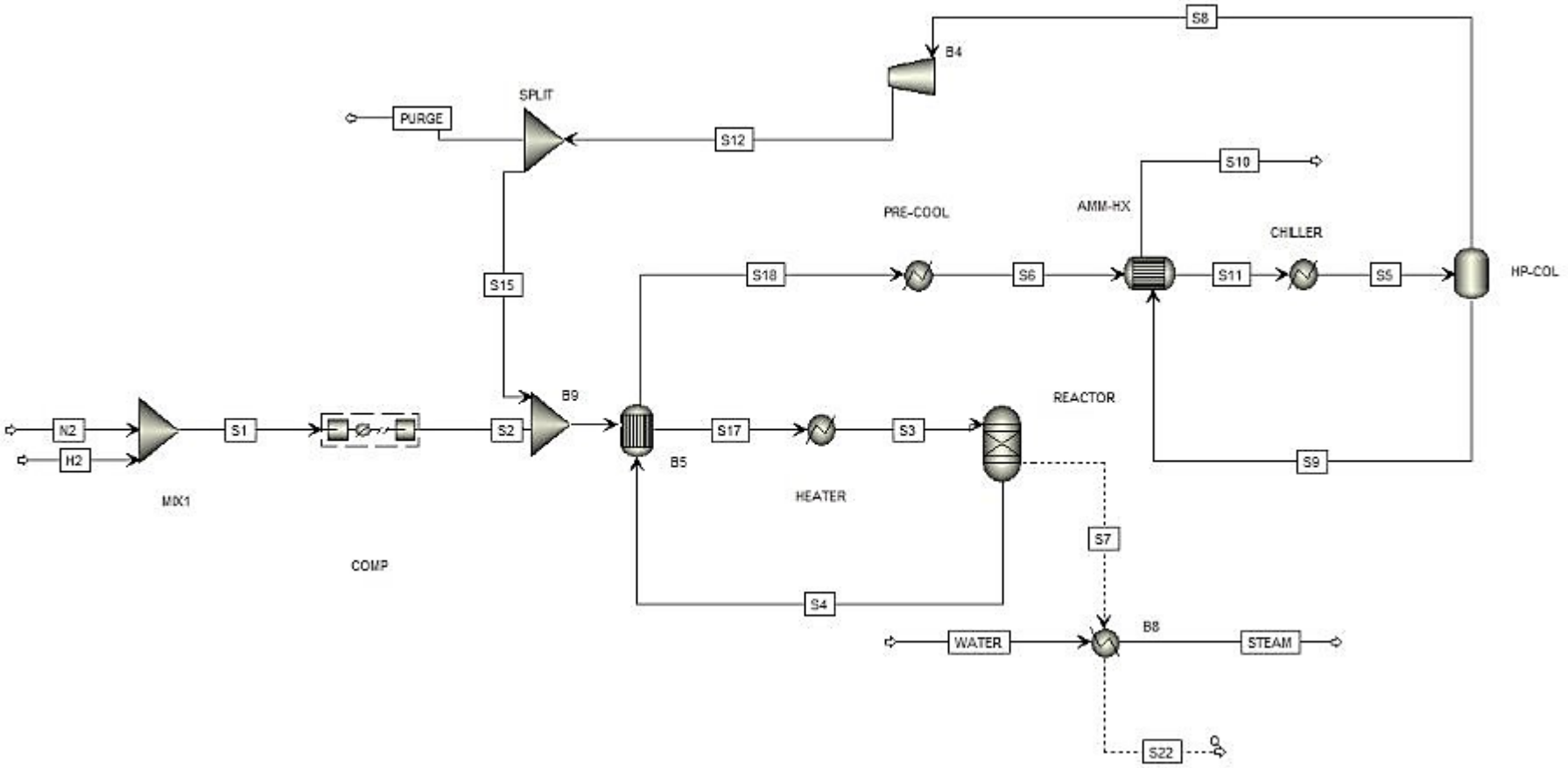

Fig. S1. Aspen plus model for ammonia synthesis.

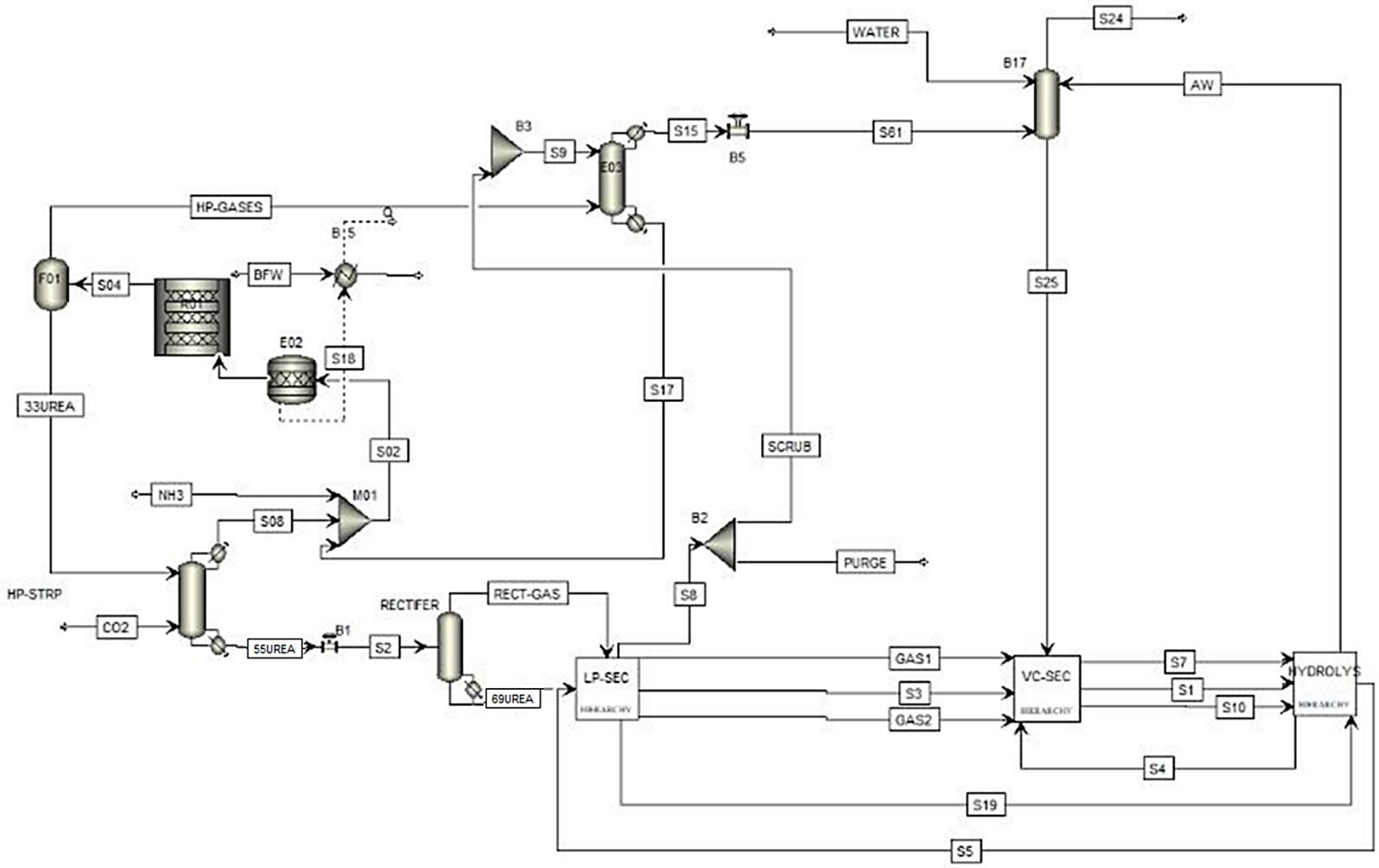

Fig. S2. Aspen plus model for urea synthesis: High pressure section.

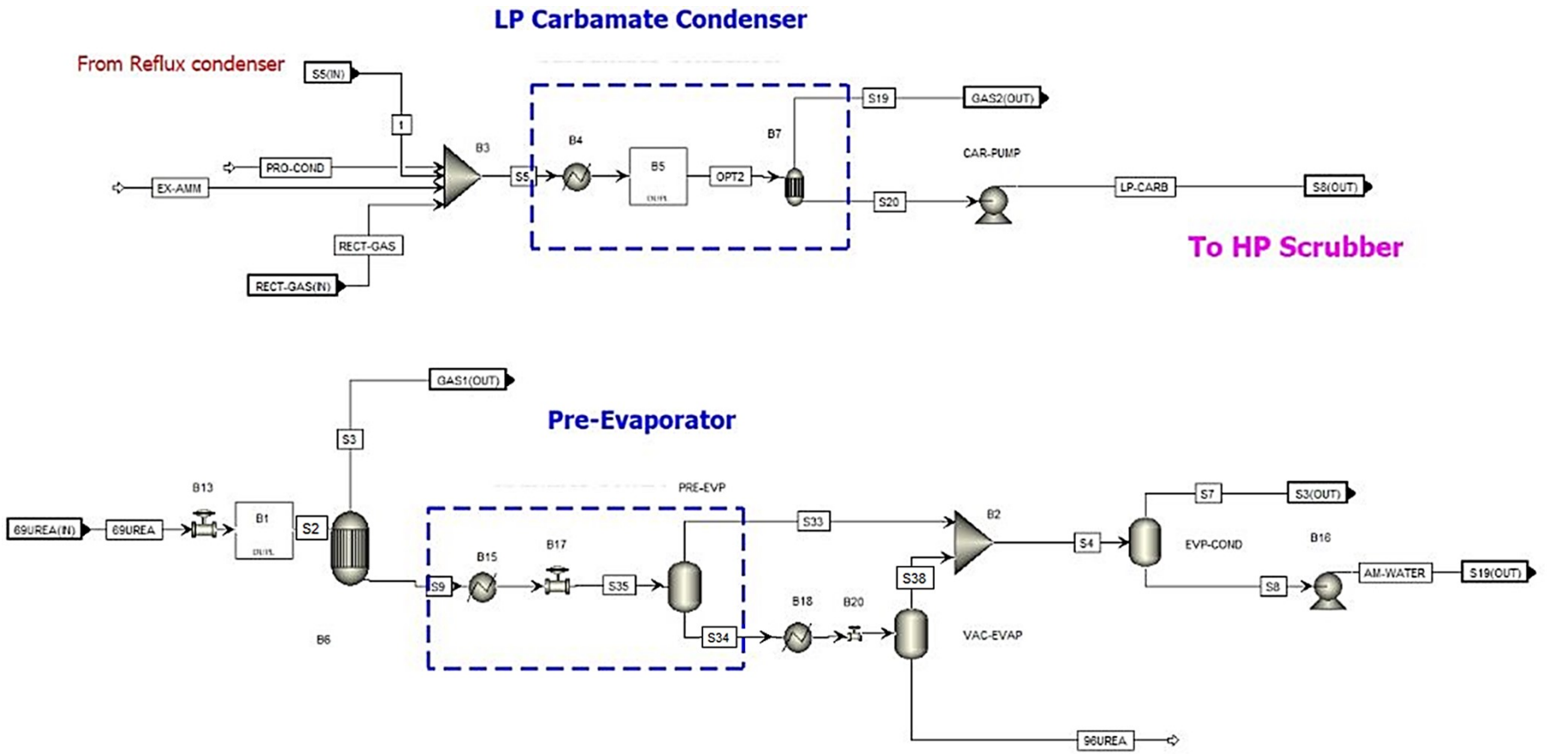

Fig. S3. Aspen plus model for urea synthesis: Low pressure section.

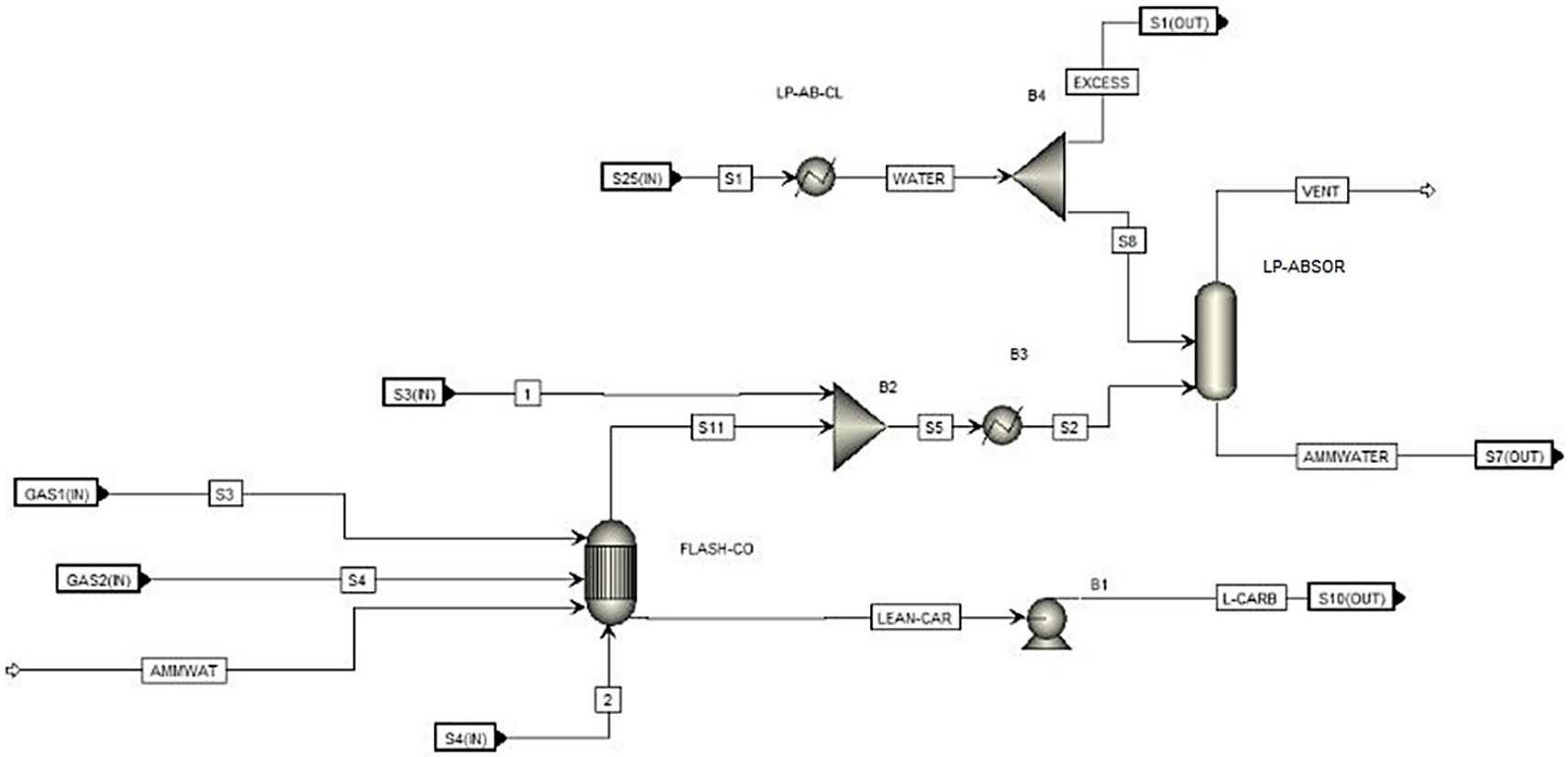

Fig. S4. Aspen plus model for urea synthesis: Evaporation section.

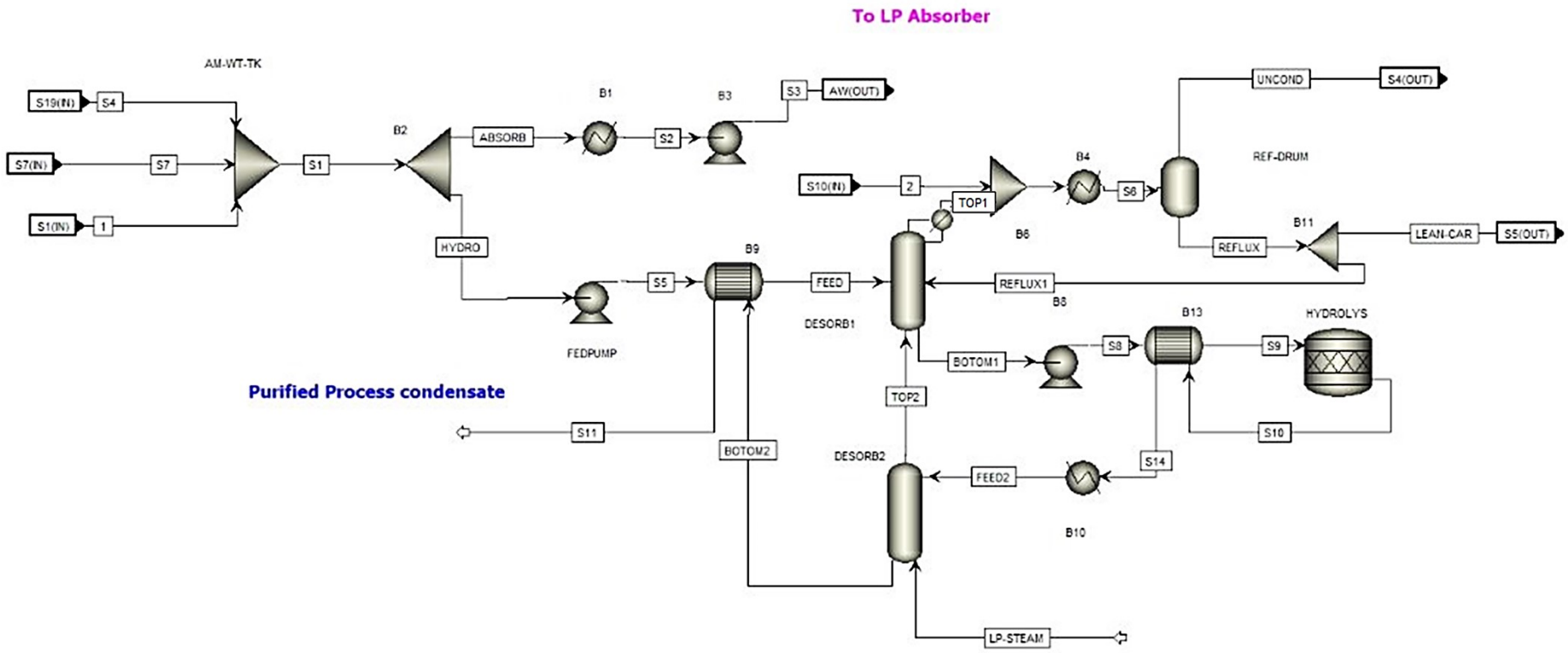

Fig. S5. Aspen plus model for urea synthesis: Hydrolysis section.

Table S1. Summary of technical and operating parameters for key unit operations.

Unit Operations	Technical Parameters
Air separation unit	
Air compressor	Inlet pressure = 1 bar Outlet pressure = 7.1 bar Duty = 2.77 MW Cooling duty = -2.77 MW No. of stages = 2
Air cooler	Duty = -3.28 MW Area = 146 m^2 Utility = Nitrogen from low pressure column
High pressure column	No. of stages = 25 Distillate rate = 3,830 kg/h Condenser and duty = Total and -0.48 Reboiler and duty = None Operating pressure = 7.1 bar Top stage temperature = -174°C Bottom stage temperature = -172°C
Low pressure column	No. of stages = 20 Distillate rate = 28,300 kg/h Condenser and duty = Total and -4.68 MW Reboiler and duty = Kettle type and 4.12 MW Operating pressure = 1 bar Top stage temperature = -196°C Bottom stage temperature = -185°C
Ammonia synthesis	
Compressor	Inlet pressure = 3 atm Outlet pressure = 147 bar Duty = 18.29 MW Cooling duty = 18.16 MW No. of stages = 5
Pre-heater	Outlet temperature = 380°C

	Operating pressure = 147 bar Duty = 37.18 MW
Fired heater	Outlet temperature = 450°C Operating pressure = 147 bar Duty = 6.49 MW
Ammonia reactor	Reactions = 3 Hydrogen + 2 Nitrogen $\longrightarrow$ 2 Ammonia Conversion = 35% Operating temperature = 450°C Operating pressure = 147 bar Cooling Duty = 29.75 MW
Ammonia chiller	Inlet temperature = 19°C Outlet temperature = -45°C Operating pressure = 147 bar Cooling Duty = 10.05 MW
Ammonia separator	Operating temperature = -45°C Operating pressure = 147 bar Ammonia recovery = 97.5 wt.%
Urea Synthesis – HP section	
Urea reactor	Reactions = 2 Ammonia + Carbon dioxide $\longrightarrow$ Ammonium carbamate Ammonium carbamate $\longrightarrow$ Carbon dioxide + 2 Ammonia Ammonium carbamate $\longrightarrow$ Urea + 2 Water Urea + 2 Water $\longrightarrow$ Ammonium carbamate Residence time – 0.3 hr. Operating temperature – 183°C
HP carbamate condenser	Reactions = 2 Ammonia + Carbon dioxide $\longrightarrow$ Ammonium carbamate Conversion = 40% Coolig Duty = 32.53 MW Operating temperature = 167°C
HP stripper	No. of stages = 10 Condenser and duty = None Reboiler and duty = None Side heating duty = 24.4 MW Operating pressure = 138 bar

	Top stage temperature = 168.2°C Bottom stage temperature = 185.3°C
HP scrubber	No. of stages = 5 Distillate rate = 3,439 kg/h Condenser and duty = None Reboiler and duty = Kettle type & 3.72 MW Operating pressure = 138 bar Top stage temperature = 104.85°C Bottom stage temperature = 166.5°C
MP absorber	No. of stages = 5 Distillate rate = 3390 kg/h Condenser and duty = None Reboiler and duty = None Operating pressure = 4 bar Top stage temperature = 26°C Bottom stage temperature = 27°C
Urea Synthesis – LP section	
Rectifier	No. of stages = 5 Distillate rate = 27,084 kg/h Condenser and duty = None Reboiler and duty = Kettle type & 12.79 MW Operating pressure = 4 bar Top stage temperature = 130°C Bottom stage temperature = 175°C
LP Carbamate condenser	Duty = -15.87 MW Utility = Cooling water
Pre-evaporator	Duty = 0.37 MW Utility = LP steam
Urea Synthesis – Evaporation section	
Flash condenser	Duty = -2.97 MW Utility = Cooling water
Evaporator condenser	Duty = -12.23 MW

	Utility = Cooling water
Vacuum evaporator	Duty = 10.47 MW Utility = LP steam
LP absorber	No. of stages = 5 Venting = 614 kg/h Condenser and duty = None Reboiler and duty = None Operating pressure = 1 bar Top stage temperature = 43°C Bottom stage temperature = 43°C
Urea Synthesis – Hydrolysis section	
1st desorber	No. of stages = 15 Venting = 7,390 kg/h Condenser and duty = None Reboiler and duty = None Operating pressure = 2.6 bar Top stage temperature = 133°C Bottom stage temperature = 135°C
2nd desorber	No. of stages = 22 Venting = 9,235 kg/h Condenser and duty = None Reboiler and duty = None Operating pressure = 3 bar Top stage temperature = 139°C Bottom stage temperature = 143°C
Hydrolyser	Reactions = Urea + Water $\longrightarrow$ Carbon dioxide + 2 Ammonia Ammonium carbamate $\longrightarrow$ Carbon dioxide + 2 Ammonia Conversion = 100% and 95% respectively. Duty = 15.93 MW Residence time = 1 h. Operating temperature = 210°C Operating pressure = 20 bar Utility = HP steam

Table S2. Area-wise installed costs for key equipment [1,2].

Equipment	Cost (million USD)	References	Equipment	Cost (million USD)	References
Air separation unit			**Urea synthesis – Evaporation section**		
K-101	6.53	Aspen	E-204	0.53	Aspen
E-102	0.17	Aspen	P-202	0.19	Aspen
C-101	1.20	Aspen	E-205	0.28	Aspen
C-102	3.07	Aspen	E-206	0.29	Aspen
Ammonia synthesis			P-203	0.04	Aspen
K-102	17.69	Aspen	A-202	0.20	Aspen
K-103	1.51	Aspen	**Urea synthesis – Hydrolysis section**		
E-103	1.45	Aspen	E-208	0.13	Aspen
F-101	6.90	Aspen	E-209	0.19	Aspen
R-101	21.56	[1]	E-210	0.10	Aspen
E-104	1.56	Aspen	E-211	0.35	Aspen
E-105	0.47	Aspen	C-202	0.38	Aspen
E-106	2.58	Aspen	C-203	0.47	Aspen
Urea synthesis – HP section			R-202	0.38	Aspen
R-201	2.64	Aspen	P-204	0.05	Aspen
K-201	7.99	Aspen	P-205	0.08	Aspen
V-201	0.81	Aspen	P-206	0.07	Aspen
S-201	0.91	Aspen	V-205	0.16	Aspen
A-201	0.25	Aspen			
E-201	0.94	[2]			
S-202	0.83	Aspen			
Urea synthesis – LP section					
E-202	0.28	Aspen			
P-201	0.05	Aspen			
C-201	0.97	Aspen			
V-203	0.42	Aspen			

E-203	0.35	Aspen

Table S3. Techno-economic model parameters to calculate total capital investment. ISBL = Inside battery limit

Factor	Value
Total direct cost (TDC)	
Warehouse	4% of ISBL
Site development	9% of ISBL
Additional Piping	4.5% of ISBL
Total indirect cost (TIDC)	
Prorateable costs	10% of TDC
Field expenses	10% of TDC
Home office and construction	20% of TDC
Project contingency	10% of TDC
Other costs	10% of TDC
Total capital investment (TCI)	
Fixed capital investment (FCI)	TDC+TIDC
Working capital (WC)	5% of FCI
Land	6% of (Installed costs)

Table S4. Chemical and utilities prices used to estimate total cost of manufacturing.[3][4][5]

Parameter	Value
Chemicals (USD/t)	
Hydrogen	4000
Carbon dioxide	50
Utilities (USD/MWh)	
Cooling water	1.01
Refregrant 1	32.04
Refregrant 2	11.99
Fired Heater	15.30

LP Steam	6.84
MP Steam	9.00
Power	68.20
Wastewater Treatment (USD/m^3)	
Cost	0.04
Labour Cost (USD/y)	
Per person salary	60,000
Products (USD/t)	
Urea	620
Oxygen	170

Table S5. Assumed parameters for techno-economic model.

Parameter	**Value**
Cost basis year	2022 dollar values
Plant life	30 years
Depreciation of general plant	7 yrs
Discount rate	10% per year
Tax rate	30% per year
Construction period	2 years
Operating hours per yr	8000

Table S6. Unit-specific inventory for conventional urea synthesis scaled per kg of urea.

	SMR based hydrogen production[6]	**Nitrogen production**	**Ammonia synthesis**	**Urea synthesis - HP section**	**Urea synthesis - LP section**	**Urea synthesis - Evaporation section**	**Urea synthesis - Hydrolysis section**
Utilities (kWh)							
Steam	-	-	1.09×10^{-01}	3.48×10^{-01}	7.62×10^{-04}	2.15×10^{-02}	1.86×10^{-01}
Refregrant	-	8.99×10^{-02}	1.69×10^{-01}	-	-	-	-
Power + Cooling	6.56×10^{-02}	4.83×10^{-02}	3.07×10^{-01}	1.17×10^{-01}	7.10×10^{-03}	8.89×10^{-04}	1.74×10^{-03}
Natural gas	3.68×10^{-01}	-	-	-	-	-	-

Raw material (kg)							
Fresh Water	8.56×10^{-01}	-	-	-	-	-	-
Treated water	8.56×10^{-01}						
Hydrogen		-	1.04×10^{-01}	-	-	-	-
Nitrogen		-	4.83×10^{-01}	-	-	-	-
Ammonia		-	-	5.74×10^{-01}	1.23×10^{-04}	-	-
Carbon dioxide		-	-	8.18×10^{-01}	-	-	-
Air	2.67	6.43×10^{-01}	-	-	-	-	-
Potassium hydroxide		-	-	-	-	-	-
Steam	8.56×10^{-01}	-	-	-	-	-	-
MEA							
By-product (kg)							
Oxygen	-	1.34×10^{-01}	-	-	-	-	-
Water emissions (kg)							
Wastewater	9.01×10^{-01}	-	-	-	-	-	-
Fugitive emissions (kg)							
Nitrogen	2.01	1.05×10^{-02}	1.30×10^{-02}	9.40×10^{-05}	-	3.26×10^{-02}	-
Argon	3.41×10^{-02}	6.00×10^{-03}	-	-	-	-	-
Oxygen	5.57×10^{-02}	1.34×10^{-01}	-	5.74×10^{-05}	-	4.85×10^{-03}	-
Carbon dioxide	9.76×10^{-01}	-	-	1.01×10^{-02}	-	2.12×10^{-02}	-
Ammonia	-	-	2.27×10^{-04}	1.42×10^{-06}	-	9.05×10^{-07}	-
Water	4.11×10^{-01}	-	-	3.97×10^{-04}	-	2.86×10^{-04}	-
Hydrogen	-	-	2.81×10^{-03}	-	-	-	-
Sulfur dioxide	9.04×10^{-07}	-	-	-	-	-	-
NOx	2.32×10^{-05}	-	-	-	-	-	-
Particulate matter < 2.5	3.49×10^{-06}	-	-	-	-	-	-
Carbon mono-oxide	3.34×10^{-06}	-	-	-	-	-	-
MEA	-	-	-	-	-	-	-

Transportation	300 km

Table S7. Unit-specific inventory for green hydrogen-based urea synthesis scaled per kg of urea.

	Green hydrogen production	**Nitrogen production**	**Ammonia synthesis**	**Carbon dioxide capture unit** [5]	**Urea synthesis - HP section**	**Urea synthesis - LP section**	**Urea synthesis - Evaporation section**	**Urea synthesis - Hydrolysis section**
Utilities (kWh)								
Steam	-	-	1.09×10^{-01}	3.04	3.48×10^{-01}	7.62×10^{-04}	2.15×10^{-02}	1.86×10^{-01}
Refregrant	-	8.99×10^{-02}	1.69×10^{-01}	-	-	-	-	-
Power + Cooling	5.22	4.83×10^{-02}	3.07×10^{-01}	1.43×10^{-02}	1.17×10^{-01}	7.10×10^{-03}	8.89×10^{-04}	1.74×10^{-03}
Natural gas		-	-	-	-	-	-	-
Raw material (kg)								
Fresh Water	-	-	-	3.12×10^{-02}	-	-	-	-
Treated water	9.39×10^{-01}			-				
Hydrogen		-	1.04×10^{-01}	-	-	-	-	-
Nitrogen	3.02×10^{-05}	-	4.83×10^{-01}	-	-	-	-	-
Ammonia	-	-	-	-	5.74×10^{-01}	1.23×10^{-04}	-	-
Carbon dioxide	-	-	-	-	8.18×10^{-01}	-	-	-
Air	-	6.43×10^{-01}	-	-	-	-	-	-
Potassium hydroxide	1.98×10^{-04}	-	-	-	-	-	-	-
Steam	1.14×10^{-02}	-	-	-	-	-	-	-
MEA	-	-	-	7.54×10^{-05}	-	-	-	-
By-product (kg)								
Oxygen	-	1.34×10^{-01}	-	-	-	-	-	-
Water emissions (kg)								
Wastewater	9.01×10^{-01}	-	-	-	-	-	-	-

Fugitive emissions (kg)								
Nitrogen	2.01	1.05×10^{-02}	1.30×10^{-02}	-	9.40×10^{-05}	-	3.26×10^{-02}	-
Argon	3.41×10^{-02}	6.00×10^{-03}	-	-	-	-	-	-
Oxygen	5.57×10^{-02}	1.34×10^{-01}	-	-	5.74×10^{-05}	-	4.85×10^{-03}	-
Carbon dioxide	9.76×10^{-01}	-	-	-	1.01×10^{-02}	-	2.12×10^{-02}	-
Ammonia	-	-	2.27×10^{-04}	-	1.42×10^{-06}	-	9.05×10^{-07}	-
Water	4.11×10^{-01}	-	-	-	3.97×10^{-04}	-	2.86×10^{-04}	-
Hydrogen	-	-	2.81×10^{-03}	-	-	-	-	-
Sulfur dioxide	9.04×10^{-07}	-	-	-	-	-	-	-
NOx	2.32×10^{-05}	-	-	-	-	-	-	-
Particulate matter < 2.5	3.49×10^{-06}	-	-	-	-	-	-	-
Carbon mono-oxide	3.34×10^{-06}	-	-	-	-	-	-	-
MEA	-	-	-	1.73×10^{-05}	-	-	-	-
Transportation	300 km							

Table S8 Complete material and energy balance of urea production process.

Stream*	**NH_3 Input**	**CO_2 input**	**HP carbamate condenser Inlet**	**HP carbamate condenser outlet**	**Urea reactor outlet**	**HP scrubber Inlet**		**HP scrubber outlet**	
	NH_3	**CO_2**	**S02**	**S03**	**S04**	**HP-Gases**	**S9**	**S17**	**S15**
Temperature (℃)	34	100	145.79	167	183	183	78.24	166.52	104.85
Pressure (bar)	156.9	138.27	138.27	138.27	138.27	138.27	138.27	138.27	138.27
Energy (MW)	0.34	6.49	-32.53	-	-	3.72		-	-
Mass flow (kg/h)	33000	47000	201523.03	201523.03	201523.03	18749.88	32091.38	47402.11	3439.15
Composition (wt%)									
Urea	0	0	0.09	0.09	29.01	0.09	0.08	0.09	0
Carbamate	0	0	13.39	53.04	26.47	0.02	51.87	56.85	0
CO_2	0	94.50	34.12	11.76	5.54	42.41	0.01	1.90	36.26

NH_3	100	0	42.33	25.03	20.22	42.61	4.04	10.07	0.59
H_2O	0	0.90	8.95	8.95	17.62	3.20	44.00	31.02	0.55
N_2	0	4.00	0.97	0.97	0.97	10.12	0	0.05	54.50
O_2	0	0.60	0.16	0.16	1.55	0.09	0	0.03	8.10
Stream	**MP absorber Inlet**		**MP absorber outlet**		**Urea to HP stripper**	**HP Stripper outlet**		**Rectifier outlet**	
	S61	**AW+(Water)**	**S25**	**S24**	**33 Urea**	**55 Urea**	**S08**	**Rect-Gas**	**69 Urea**
Temperature (℃)	77.46	25.04+(45.00)	26.90	25.93	183.00	168.23	185.30	130.36	174.78
Pressure (bar)	5.07	3.92+(3.92)	3.92	3.92	138.27	138.27	138.27	4.12	4.12
Energy (MW)	-	-	-	-	-	24.40		12.79	
Mass flow (kg/h)	3439.15	85192.51+(3000)	68911.72	3390.01	182772.56	108651.88	121120.64	27084.03	81567.84
Composition (wt%)									
Urea	0	3.90+(0)	3.72	0	31.98	53.67	0.11	0.06	71.47
Carbamate	0	0.20+(0)	0.25	0	29.19	12.20	0.02	0	0
CO_2	36.26	0.04+(0)	0.04	36.00	1.76	2.18	56.02	36.32	0
NH_3	0.59	0.01+(0)	0.02	0	17.92	2.48	39.25	31.30	0
H_2O	0.55	95.85+(100)	95.96	0.48	19.10	29.46	2.75	32.28	28.53
N_2	54.50	(0)+(0)	0	55.30	0.03	0.01	1.60	0.02	0
O_2	8.10	(0)+(0)	0	8.22	0.02	0	0.25	0.01	0
Stream	**LP carbamate condenser outlet**		**Atmospheric separator inlet**	**Atmospheric separator outlet**		**Pre-evaporator outlet**		**Vacuum evaporator outlet**	
	S20	**S19**	**S2**	**S9**	**S3**	**S34**	**S33**	**96 Urea**	**S38**
Temperature (℃)	74	74	132.26	132.27	132.27	95.11	95.11	138.85	138.85
Pressure (bar)	3.24	3.24	1.30	1.30	1.30	0.38	0.38	0.29	0.29
Energy (MW)	-15.87					-0.37			
Mass flow (kg/h)	33780.39	18.42	81567.84	77411.32	4156.52	74861.40	2549.92	59674.01	15187.39
Composition (wt%)									
Urea	0.08	4.57	71.47	75.29	0.46	77.84	0.24	96.31	5.30
Carbamate	51.87	0	0	0	0	0	0	0	0
CO_2	0.01	0	0	0	0	0	0	0	0

NH_3	4.04	0	0	0	0.01	0	0	0	0
H_2O	44.00	95.43	28.53	24.71	99.53	22.16	99.76	3.69	94.7
N_2	0	0	0	0	0	0	0	0	0
O_2	0	0	0	0	0	0	0	0	0
Stream	**LP absorber inlet**		**LP absorber outlet**		**First Desorber inlet**			**First Desorber outlet**	
	S8	**S2**	**Vent**	**AMMWATER**	**Feed**	**Reflux 1**	**Top 2**	**Top 1**	**Bottom 1**
Temperature (℃)	40.00	47.90	42.57	42.89	117.00	40.00	138.69	132.72	135.41
Pressure (bar)	1.96	0.98	0.98	0.98	3.96	3.56	3.96	3.63	3.63
Energy (MW)	-	-	-	-	-	-	-	-	-
Mass flow (kg/h)	13782.34	626.04	613.79	13794.60	20798.71	6707.68	9234.90	7390.24	29351.05
Composition (wt%)									
Urea	3.72	0	0	3.72	3.90	0.14	0	0	2.79
Carbamate	0.25	0	0	0.25	0.20	0.91	0	0	0.35
CO_2	0.04	93.83	94.84	0.08	0.04	0.15	7.12	9.13	0
NH_3	0	0.13	0.01	0.02	0.01	7.52	8.80	13.73	1.04
H_2O	95.96	4.58	3.72	95.92	95.85	91.28	84.09	77.14	95.81
N_2	0	0.90	0.88	0	0	0	0	0	0
O_2	0	0.56	0.54	0	0	0	0	0	0
Stream	**Hydrolyzer inlet**	**Hydrolyzer outlet**	**Second Desorber inlet**		**Second Desorber outlet**				
	S9	**S10**	**Feed 2**	**LP-Steam**	**Top 2**	**Bottom 2**			
Temperature (℃)	200.00	210.00	148.00	142.90	138.69	143.20			
Pressure (bar)	19.61	19.61	19.61	3.92	3.96	3.96			
Energy (MW)	15.93	-	-	-	-	-			
Mass flow (kg/h)	29351.05	29351.06	29351.06	8000.00	28116.16	9234.90			
Composition (wt%)									
Urea	2.79	0	0	0	0	0			
Carbamate	0.35	0.02	0.02	0	0	0.02			
CO_2	0	2.24	2.24	0	7.12	0			
NH_3	1.04	2.77	2.77	0	8.80	0			

H_2O	95.81	94.98	95.98	100	84.09	99.98
N_2	0	0	0	0	0	0
O_2	0	0	0	0	0	0

* Refer to process flow diagrams (Figure S1-S5) for more details about the process streams.

Table S9. Comparative environmental assessment results for conventional and gree urea synthesis.

Impact category	**Unit**	**Conventional urea synthesis**	**Green hydrogen-based urea synthesis**
Abiotic depletion	kg Sb eq	1.99×10^{-05}	1.55×10^{-05}
Abiotic depletion (fossil fuels)	MJ	2.89×10^{01}	1.80×10^{01}
Global warming (GWP100a)	kg CO2 eq	1.64	1.38
Ozone layer depletion (ODP)	kg CFC-11 eq	9.55×10^{-08}	8.98×10^{-08}
Human toxicity	kg 1,4-DB eq	1.25	7.84×10^{-01}
Freshwater aquatic ecotoxicity	kg 1,4-DB eq	8.20×10^{-01}	7.98×10^{-01}
Marine aquatic ecotoxicity	kg 1,4-DB eq	1.68×10^{03}	1.45×10^{03}
Terrestrial ecotoxicity	kg 1,4-DB eq	1.93×10^{-03}	1.73×10^{-03}
Photochemical oxidation	kg C2H4 eq	3.31×10^{-04}	2.48×10^{-04}
Acidification	kg SO2 eq	7.49×10^{-03}	4.50×10^{-03}
Eutrophication	kg PO4--- eq	2.27×10^{-03}	1.51×10^{-03}

Table S10. Stagewise breakdown of environmental assessment results for green hydrogen-based urea synthesis. ADP: Abiotic depletion potential; AFFDP = Fossil fuel depletion potential; GWP = Global warming potential; ODP = Ozone depletion potential; HTP = Human toxicity potential; FWAETP = Freshwater aquatic ecotoxicity potential; MAETP = Marine aquatic ecotoxicity potential; TEP = Terrestrial ecotoxicity potential; PCOP = Photochemical oxidation potential; ACP = Acidification potential; EP = Eutrophication potential.

Impact category	**Green hydrogen production**	**Nitrogen production**	**Ammonia synthesis**	**Carbon dioxide capture unit**	**Urea synthesis - HP section**	**Urea synthesis - LP section**	**Urea synthesis - Evaporation section**	**Urea synthesis - Hydrolysis section**	**Transportation**	**Infrastructure**
ADP (kg Sb eq.)	1.33×10^{-05}	4.32×10^{-07}	1.07×10^{-06}	3.57×10^{-07}	1.16×10^{-07}	6.60×10^{-09}	1.29×10^{-09}	5.60×10^{-09}	1.32×10^{-07}	1.16×10^{-07}
AFFDP (MJ)	2.82	6.61×10^{-01}	3.73	6.66	2.45	5.72×10^{-02}	1.04×10^{-01}	8.47×10^{-01}	6.19×10^{-01}	6.31×10^{-03}

GWP (kg CO_2eq.)	2.48×10^{-01}	5.53×10^{-02}	3.29×10^{-01}	4.19×10^{-01}	1.95×10^{-01}	5.11×10^{-03}	2.83×10^{-02}	5.67×10^{-02}	4.22×10^{-02}	6.05×10^{-04}
ODP (kg CFC-11eq.)	2.69×10^{-08}	2.60×10^{-09}	1.12×10^{-08}	3.87×10^{-08}	2.64×10^{-09}	1.47×10^{-10}	3.22×10^{-11}	1.55×10^{-10}	7.45×10^{-09}	3.84×10^{-11}
HTP (kg 1,4-DBeq.)	4.74×10^{-01}	3.24×10^{-02}	1.75×10^{-01}	4.47×10^{-02}	3.26×10^{-02}	1.91×10^{-03}	3.09×10^{-04}	1.07×10^{-03}	1.63×10^{-02}	5.11×10^{-03}
FWAETP (kg 1,4-DBeq.)	4.97×10^{-01}	2.62×10^{-02}	2.04×10^{-01}	2.53×10^{-02}	3.29×10^{-02}	1.99×10^{-03}	2.53×10^{-04}	5.17×10^{-04}	6.91×10^{-03}	2.73×10^{-03}
MAETP (kg 1,4-DBeq.)	6.91×10^{02}	7.11×10^{01}	4.76×10^{02}	5.59×10^{01}	1.23×10^{02}	7.41	1.00	2.45	1.47×10^{01}	3.77
TEP (kg 1,4-DBeq.)	7.66×10^{-04}	1.06×10^{-04}	5.32×10^{-04}	8.78×10^{-05}	1.66×10^{-04}	$9.79E\times10^{-06}$	$1.51E\times10^{-06}$	4.85×10^{-06}	5.20×10^{-05}	4.61×10^{-06}
PCOP (kg C_2H_4 eq.)	7.48×10^{-05}	9.32×10^{-06}	6.94×10^{-05}	4.68×10^{-05}	3.06×10^{-05}	8.69×10^{-07}	1.15×10^{-06}	9.20×10^{-06}	5.53×10^{-06}	2.78×10^{-07}
ACP (kg SO_2 eq.)	1.35×10^{-03}	1.94×10^{-04}	1.56×10^{-03}	5.38×10^{-04}	5.61×10^{-04}	2.11×10^{-05}	1.76×10^{-05}	1.22×10^{-04}	1.37×10^{-04}	5.96×10^{-06}
EP (kg PO_4 eq.)	5.13×10^{-04}	7.84×10^{-05}	5.79×10^{-04}	9.17×10^{-05}	1.79×10^{-04}	9.06×10^{-06}	3.30×10^{-06}	1.82×10^{-05}	3.11×10^{-05}	2.24×10^{-06}

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