Supplementary Information

Tunable hydrated deep eutectic solvents for efficient lignocellulose fractionation towards sustainable biorefineries

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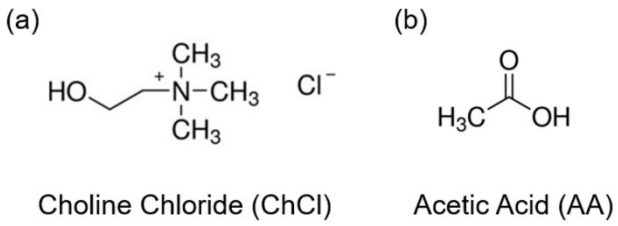

Fig. S1 The chemical structures. (a) choline chloride. (b) acetic acid.

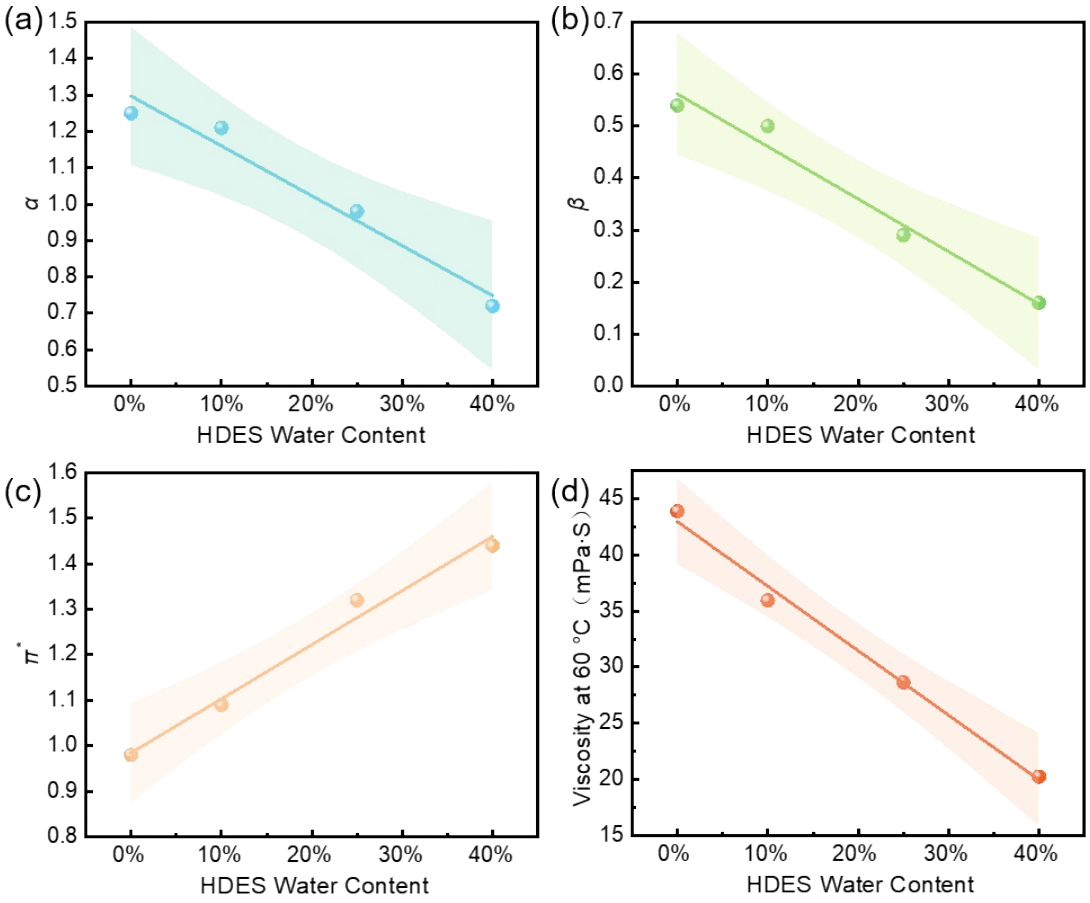

Fig. S2 Linear fittings of (a) α, (b) β, (c) π^*. (d) viscosity versus water content.

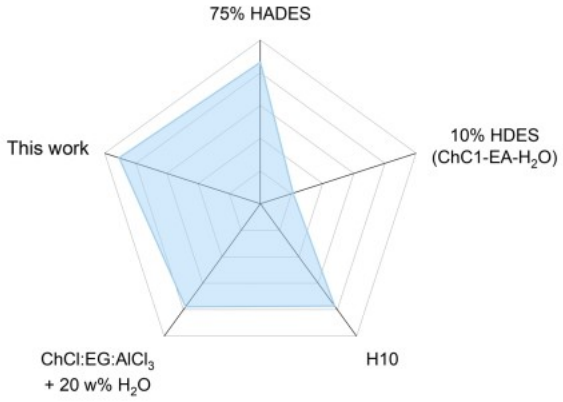

Fig. S3 Comparison of lignin removal efficiency between this work and other works.[1-4]

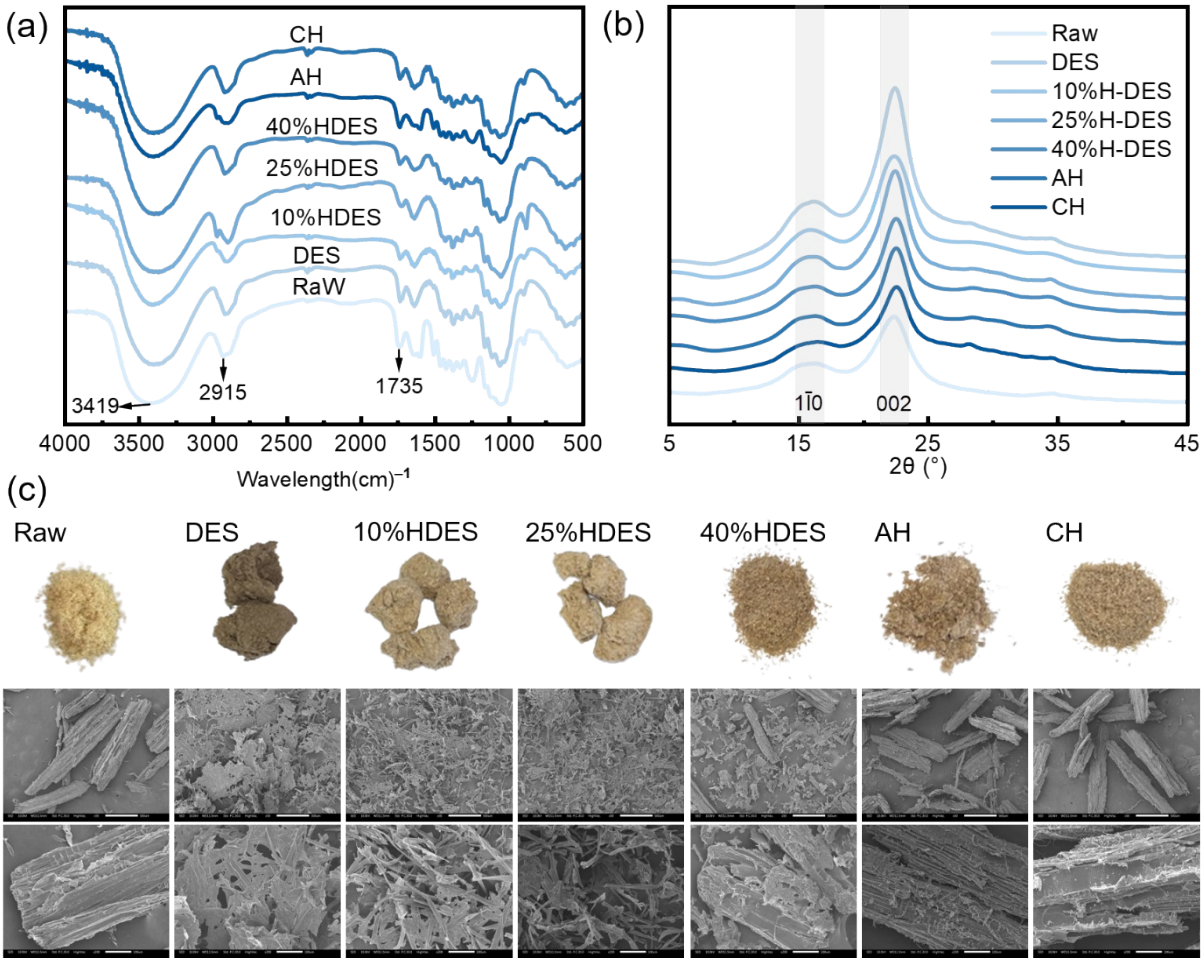

Fig. S4 Chemical and structural changes of the solid residues after pretreatment. (a) FTIR spectra. (b) XRD patterns. (c) optical photographs and SEM images.

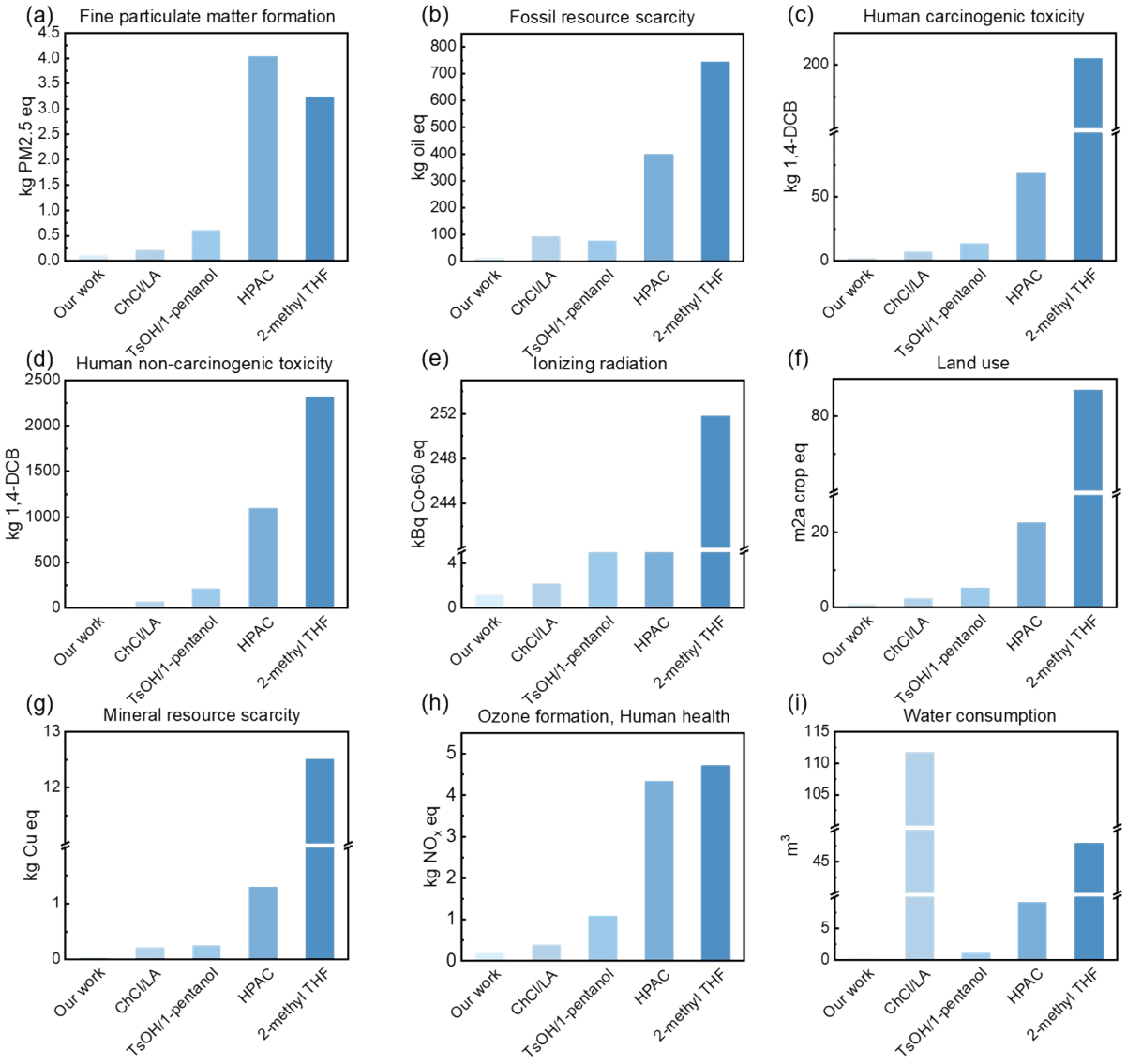

Fig. S5 Comparative assessment of the environmental impacts of 25% HDES and conventional pretreatment solvents (ChCl/LA, TsOH/1-pentanol, HPAC, 2-methyl THF). (a) Fine particulate matter formation. (b) Fossil resource scarcity. (c) Human carcinogenic toxicity. (d) Human non-carcinogenic toxicity. (e) Ionizing radiation. (f) Land use. (g) Mineral resource scarcity. (h) Ozone formation, Human health. (i) Water consumption.

Table1 The main characteristics of different solvents.

Sample	K-T			Viscosity at 60 °C (mPa·S)
	α	β	π^*	
DES	1.25	0.54	0.98	43.89
10%-HDES	1.21	0.50	1.09	35.95
25%-HDES	0.98	0.29	1.32	28.66
40%-HDES	0.72	0.16	1.44	20.23
AH	0.82	ND [a]	1.38	12.91
CH	ND [a]	0.26	1.53	15.16

Note: ND, not detected.

Table2 Pretreatment of 1 kg poplar wood for environmental impact.

	Unit	Total	Sodium acetate	ChCl	Deioni-zed water	Ethanol	AA	Ultraso-und	Vacuum filtration	Oscilla tion	Freeze-drying	Hydrot-hermal	Centrif-ugation	Water bath stirring	Rotary evapor-ation	Waste water	Waste residue
Global warming	kg CO_2 eq	7.49E+01	7.17E-04	1.24E-01	1.70E-03	5.03E-02	6.11E-02	6.60E-01	4.46E-01	2.57E+01	4.22E+01	8.43E-01	6.88E-02	1.65E+00	2.97E+00	6.07E-06	1.53E-03
Stratospheric ozone depletion	kg CFC11 eq	1.62E-05	5.08E-10	3.65E-08	1.34E-09	5.16E-09	3.15E-08	1.42E-07	9.60E-08	5.55E-06	9.10E-06	1.82E-07	1.48E-08	3.56E-07	6.40E-07	2.25E-11	1.05E-10
Ionizing radiation	kBq Co-60 eq	1.22E+00	6.53E-05	3.68E-03	1.34E-04	6.25E-04	4.75E-03	1.07E-02	7.21E-03	4.17E-01	6.84E-01	1.36E-02	1.11E-03	2.67E-02	4.81E-02	1.56E-06	2.65E-06
Ozone formation, Human health	kg NO_x eq	2.07E-01	1.73E-06	2.25E-04	4.05E-06	1.15E-04	1.43E-04	1.83E-03	1.23E-03	7.13E-02	1.17E-01	2.33E-03	1.90E-04	4.57E-03	8.23E-03	2.60E-08	2.24E-07
Fine particulate matter formation	kg $PM_{2.5}$ eq	1.15E-01	1.42E-06	1.56E-04	3.94E-06	5.02E-05	1.10E-04	1.02E-03	6.88E-04	3.97E-02	6.52E-02	1.30E-03	1.06E-04	2.55E-03	4.58E-03	1.70E-08	1.12E-07
Ozone formation, Terrestrial ecosystems	kg NO_x eq	2.08E-01	1.81E-06	2.41E-04	4.10E-06	1.32E-04	1.53E-04	1.83E-03	1.24E-03	7.15E-02	1.17E-01	2.34E-03	1.91E-04	4.58E-03	8.25E-03	2.64E-08	2.28E-07
Terrestrial acidification	kg SO_2 eq	2.59E-01	2.70E-06	3.50E-04	6.31E-06	1.37E-04	2.27E-04	2.28E-03	1.54E-03	8.89E-02	1.46E-01	2.91E-03	2.38E-04	5.70E-03	1.03E-02	5.15E-08	2.37E-07
Freshwater	kg P eq	1.48E-	3.26E-	2.73E-	8.33E-	1.99E-	2.38E-	1.30E-	8.80E-	5.08E-	8.34E-	1.66E-	1.36E-	3.26E-	5.87E-	1.81E-	3.44E-

eutrophication		02	07	05	07	05	05	04	05	03	03	04	05	04	04	08	08
Marine eutrophication	kg N eq	9.67E-04	2.50E-08	4.54E-05	6.37E-08	4.09E-07	1.54E-06	8.12E-06	5.48E-06	3.17E-04	5.20E-04	1.04E-05	8.46E-07	2.03E-05	3.66E-05	1.02E-07	1.03E-06
Terrestrial ecotoxicity	kg 1,4-DCB	6.79E+01	1.95E-03	2.31E-01	3.47E-03	8.99E-02	1.58E-01	5.96E-01	4.02E-01	2.33E+01	3.82E+01	7.61E-01	6.21E-02	1.49E+00	2.68E+00	2.94E-05	7.57E-05
Freshwater ecotoxicity	kg 1,4-DCB	2.36E+00	2.23E-05	2.33E-03	4.97E-05	7.62E-04	1.77E-03	2.08E-02	1.41E-02	8.12E-01	1.33E+00	2.66E-02	2.17E-03	5.21E-02	9.37E-02	7.41E-07	8.68E-04
Marine ecotoxicity	kg 1,4-DCB	3.01E+00	3.15E-05	3.35E-03	6.93E-05	1.10E-03	2.51E-03	2.65E-02	1.79E-02	1.04E+00	1.70E+00	3.39E-02	2.77E-03	6.64E-02	1.19E-01	9.70E-07	1.14E-03
Human carcinogenic toxicity	kg 1,4-DCB	2.31E+00	2.82E-05	2.84E-03	1.96E-04	1.14E-03	2.11E-03	2.04E-02	1.38E-02	7.95E-01	1.30E+00	2.60E-02	2.12E-03	5.09E-02	9.17E-02	1.58E-06	3.13E-05
Human non-carcinogenic toxicity	kg 1,4-DCB	2.40E+01	6.54E-04	7.16E-02	1.26E-03	2.52E-02	5.26E-02	2.11E-01	1.42E-01	8.21E+00	1.35E+01	2.69E-01	2.19E-02	5.26E-01	9.47E-01	3.62E-05	1.86E-02
Land use	m^2a crop eq	9.09E-01	1.31E-05	9.03E-04	2.49E-05	6.34E-04	1.04E-03	8.02E-03	5.41E-03	3.13E-01	5.13E-01	1.02E-02	8.36E-04	2.01E-02	3.61E-02	3.05E-07	6.03E-06
Mineral resource scarcity	kg Cu eq	4.06E-02	2.02E-06	2.37E-04	7.31E-06	1.01E-04	1.70E-04	3.55E-04	2.39E-04	1.38E-02	2.27E-02	4.53E-04	3.69E-05	8.86E-04	1.60E-03	2.54E-07	8.64E-08
Fossil resource scarcity	kg oil eq	1.47E+01	3.44E-04	8.01E-02	4.30E-04	3.68E-02	3.66E-02	1.28E-01	8.67E-02	5.01E+00	8.22E+00	1.64E-01	1.34E-02	3.21E-01	5.78E-01	1.21E-06	1.61E-05
Water consumpti	m^3	1.91E-01	1.86E-05	1.61E-03	1.12E-03	4.03E-04	1.60E-03	1.64E-03	1.11E-03	6.41E-02	1.05E-01	2.10E-03	1.71E-04	4.11E-03	7.40E-03	###### ##	6.62E-07

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