Supplementary Information

Autocatalytic Depolymerization for Polyester Blended Textiles Waste

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Materials and methods

Materials: PET polyester powder was purchased from Dongguan Tesulang Co., Ltd. in China, with a diameter of 150 μm. Antibacterial agent SH-ANTI408 was purchased from Luyi Tanwei Industrial Co., Ltd. in Shanghai, China, and its main component is Zinc Pyrithione (ZPT). Ethanol, ethylene glycol, polyethylene glycol, tannic acid, chitosan, 4,4-bis (4-hydroxyphenyl) valeric acid (BHPVA), methacryloyloxyethyltrimethyl ammonium chloride (TMAEMC), polyhexamethylene biguanide hydrochloride (PHMB), N,N-dimethylformamide (DMF), dimethyl sulfoxide (DMSO), and deuterated DMSO were all purchased from Aladdin, polyhexamethylene biguanide hydrochloride was purchased from adamas, and all reagents were not further purified for use. Discarded clothing is collected and provided by the institute of special protective textile materials of Jiangnan University.

Characterization.

High performance liquid chromatography (HPLC): The waters alliance e2695 high performance liquid chromatograph, equipped with 2998 PDA full wavelength detector and waters symmetry C18 (4.6 mm×250 mm) column, was used for detection at 254 nm wavelength; The mobile phase was an equal volume of methanol water mixture with isocratic elution. The flow rate was 0.25 ml/min and the injection volume was 10 μL. the BHET yield was quantitatively calculated by external standard method at the flow rate of 0.25 ml/min and the injection volume of 10 μL.

Fourier transform infrared spectrometer (FTIR): The Thermo Nicolet IS10 Fourier Transform Infrared (FTIR) spectrometer, equipped with a diamond ATR (Attenuated Total Reflectance) accessory, was used to analyze the chemical structure changes of degradation products and the structure of blended textiles. The scanning range was set from 400 to 4000 cm^{-1}, with a resolution of 4 cm^{-1}. A total of 32 scans were performed for each sample. After subtracting the air background, the samples were directly placed in the ATR attachment for testing.

Nuclear magnetic resonance (NMR): 20 mg of sample was dissolved in 0.55 mL of deuterated DMSO and analyzed by ^1H NMR using Bruker advance III HD 400 MHz fully digital nuclear magnetic resonance spectrometer.

X-ray diffractometer (XRD): The powder sample was ground and flattened on a low-background sample holder. The crystal structure was analyzed by scanning in the 2θ range of 5° to 80° using a Bruker D2 Phaser desktop X-ray diffractometer.

Scanning electron microscope (SEM): Hitachi Regulus 8100 cold field emission scanning electron microscope was used to observe the microstructure of the samples.

Matrix-assisted laser desorption/ionization time of flight mass spectrometry (MALDI-TOF MS): The sample was dissolved in DMF solvent, mix 1 μL sample with 1 μL HCCA matrix, then the mixture was analyzed by MicroFlex LT/SH MALDI-TOF mass spectrometer (mass range ≥ 500 kDa, 337 nm nitrogen laser, frequency 1-60 Hz) for determination.

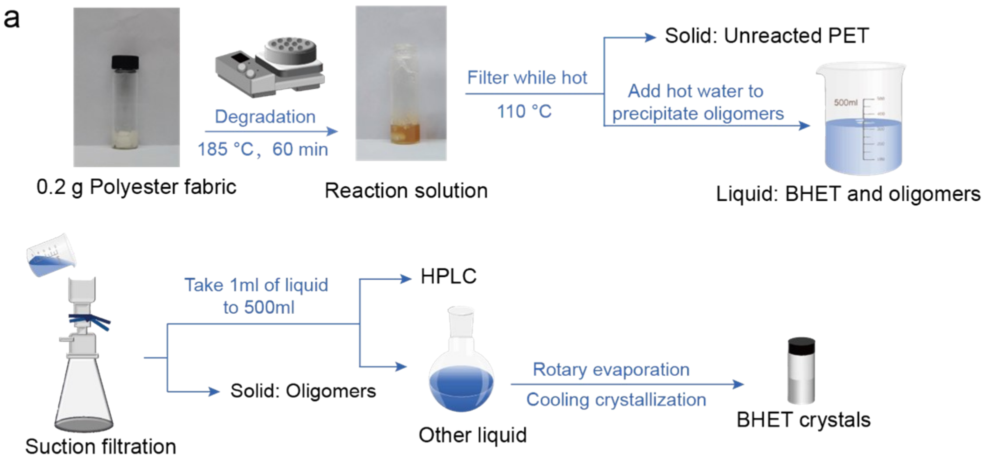
Inductively coupled plasma mass spectrometry (ICP-MS) was used to determine the content of metal ions in the product.

Comprehensive life-cycle assessment (LCA) of PET recycling.

The recycling process was simulated using Aspen Plus V11 with the POLYSL model. We evaluated the impacts of the entire process on factors, such as human health, ecosystems, and resources using OpenLCA (Version, 1.10.3). We emphasize that the primary objective of the LCA was to compare the relative environmental impacts between conventional PET disposal methods and our proposed recycling process. While updates to the background database may influence the absolute values, the comparative trends and overarching conclusions are expected to remain valid. Our system boundary encompasses recycling framework, including collection and transportation and encompassing depolymerization. To gain a broader understanding of the environmental impacts in different global contexts, we evaluated the environmental impacts in two different geographical regions (China and Europe), with a specifically focusing on NREU and GWP. The chemical recycling processes were simulated on an industrial scale with an annual treatment of 100,000 tons of waste PET, using Aspen Plus V11 to obtain the mass balance and energy consumption. More details on the data and assumptions we applied in the LCA analysis are documented in the Supplementary Note 1 section.

Details of techno-economic analysis (TEA).

The Aspen Process Economic Analyzer V11 was used to determine the capital and operating costs for conventional chemical plants. Minimum selling price (MSP), i.e., the selling price of the product when the net present value is zero. Heat integration for BHET monomer production was performed using Aspen Energy Analyzer (Aspen Technology 2019). Scenario analysis of key process parameters was performed to account for uncertainties. Additional TEA assumptions are provided in Supplementary Note 2.



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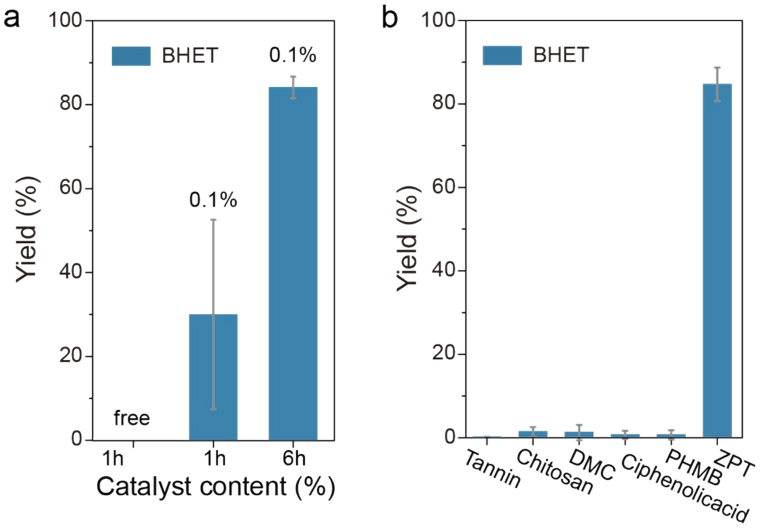

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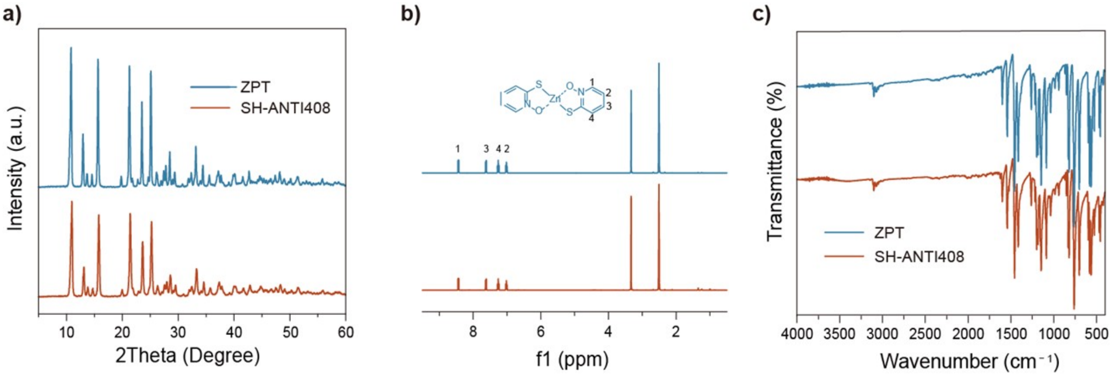

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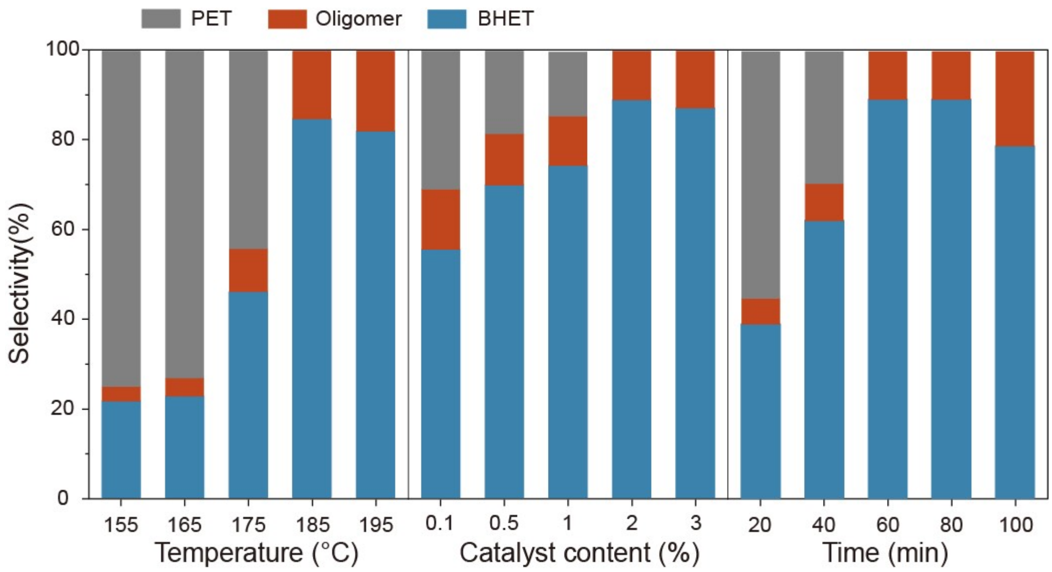

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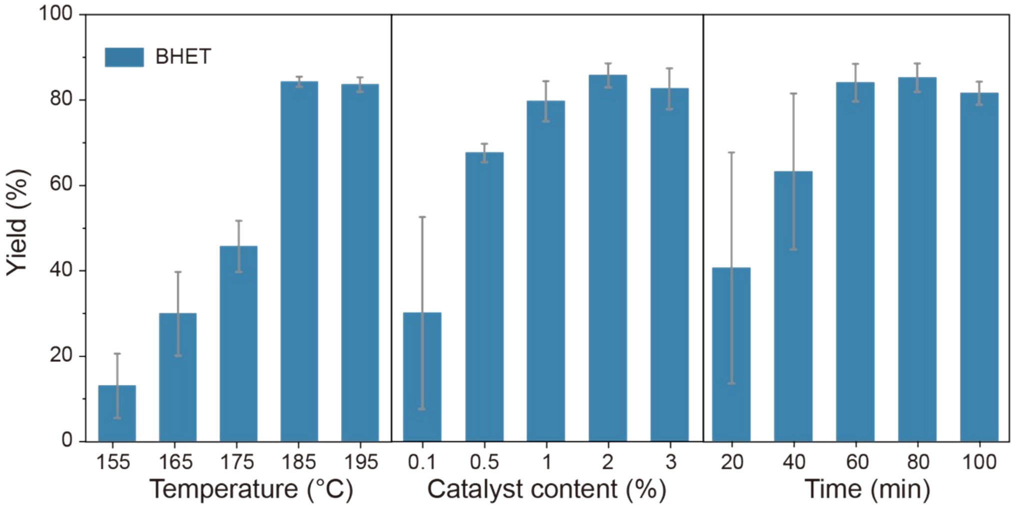

Figure S5. Optimizing glycolysis performance of PET over ZPT. Conditions: PET waste (0.2 g), ZPT (0.1 mg, 1 mg, 2 mg, 4 mg, and 6 mg), EG (1 g), temperature (155°C, 165°C, 175°C, 180°C, and 195°C), time (20 min, 40 min, 60 min, 80 min and 120 min).

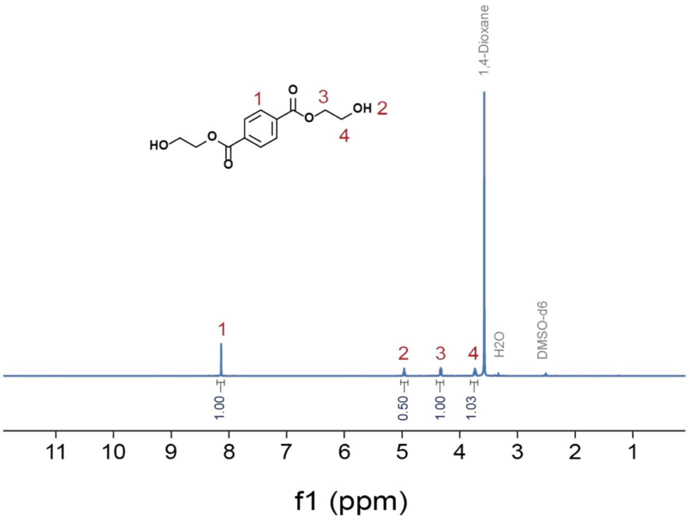

Figure S6. ^{1}H NMR spectrum of a BHET recorded in DMSO-d_6.

^{1}H NMR (400 MHz, DMSO-d_6, δ): 8.11 (s, 4H, CH), 4.99 (t, 2H; OH), 4.32 (t, 4H; O–CH_2), 3.72 (q, 4H; CH_2–OH)

The single signal observed at δ=8.11 ppm corresponds to the four symmetric aromatic protons of the benzene ring. Additionally, the triplet peak at δ=4.32 ppm and the quartet peak at δ=3.72 ppm represents the methylene protons of COO-CH_2 and CH_2-OH, respectively. The triplet peak at δ=4.99 ppm indicates the presence of protons from the hydroxyl group. The integrated peak area ratios of these signals are 1.00 : 0.50 : 1.00 : 1.03 (Aromatic H : OH : COO-CH2 : CH2-OH), which are in excellent agreement with the theoretical values for pure BHET (1.00 : 0.50 : 1.00 : 1.00).

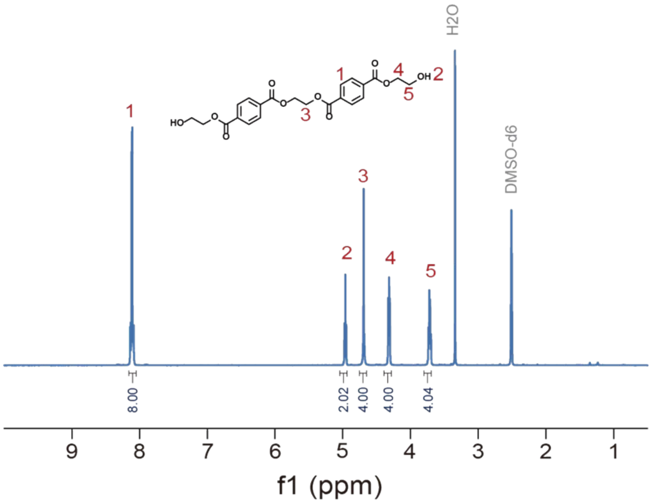

Figure S7. ^{1}H NMR spectrum of a dimer recorded in DMSO-d_6.

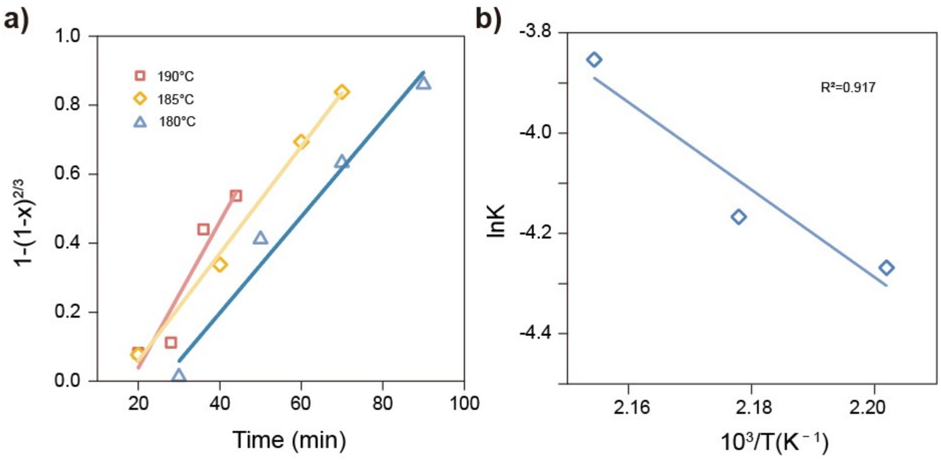

Figure S8. (a) Effect of temperature on the rate of PET glycolysis for ZPT. (b) Arrhenius plots of the rate constant of PET glycolysis for ZPT.

Note: Kinetics of the PET glycolysis. The depolymerization kinetics of polymers are usually considered to be first order.

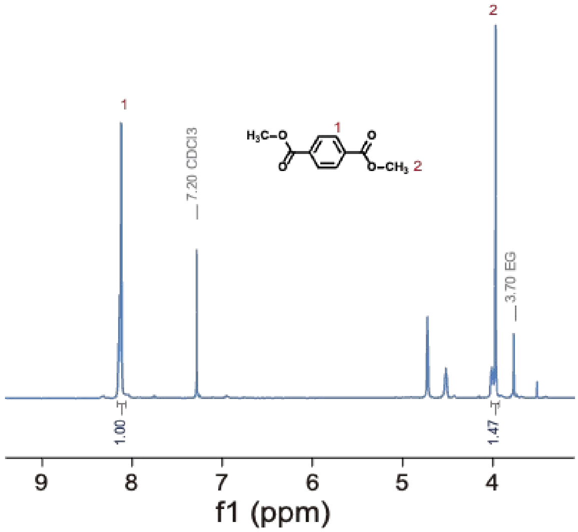

Figure S9. ^{1}H NMR spectrum of a DMT recorded in $CDCl_3$.

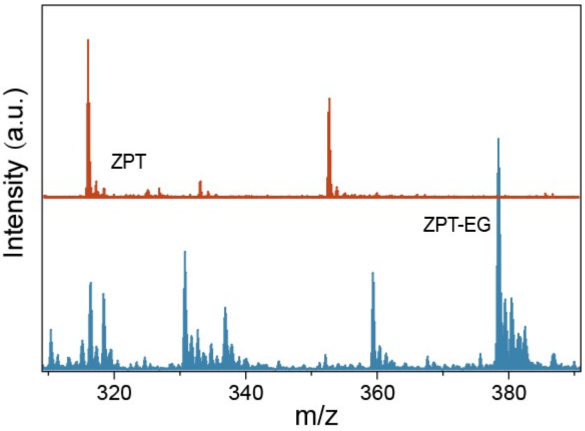

Figure S10. Comparison of the experimental mass spectra of pristine ZPT and ZPT-EG species formed in ethylene glycol.

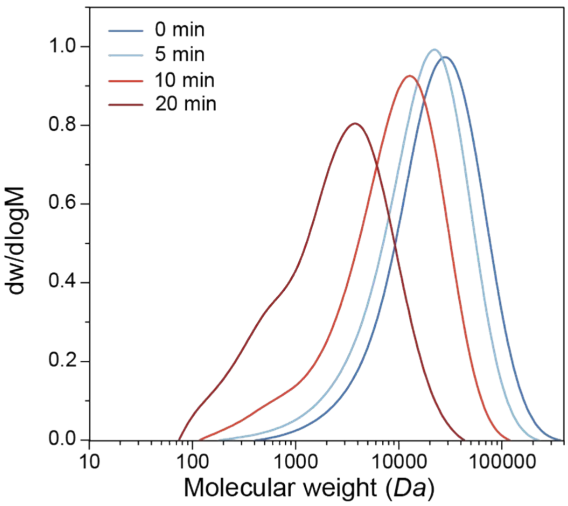

Figure S11. Gel permeation chromatography (GPC) of different reaction times over PET depolymerization.

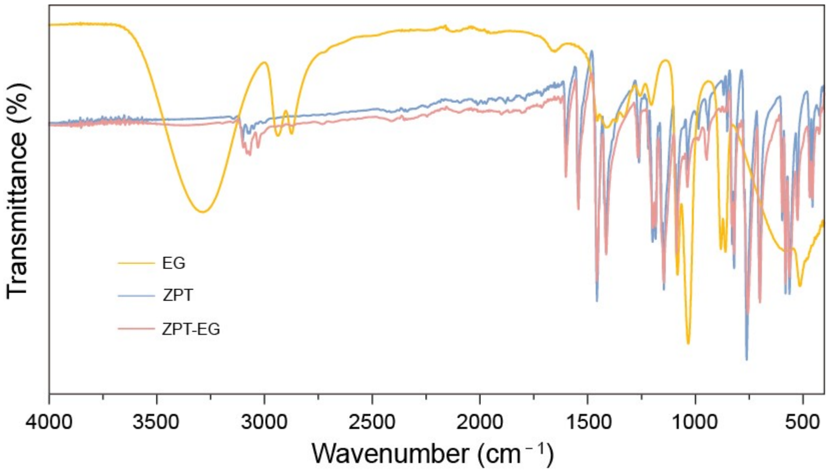

Figure S12. Comparison of the experimental fourier transform infrared spectroscopy spectra of pristine ZPT and ZPT-EG species formed in ethylene glycol.

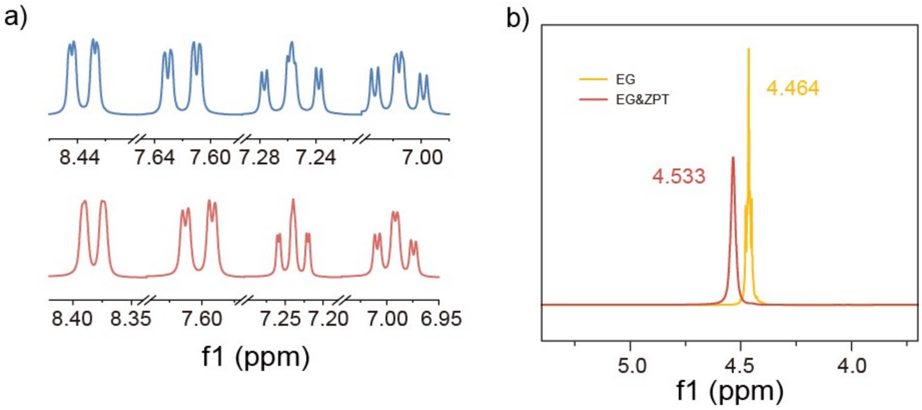

Figure S13. Comparison of the experimental local ^{1}H NMR spectra of (a) pristine ZPT (b) EG and ZPT-EG species formed in ethylene glycol.

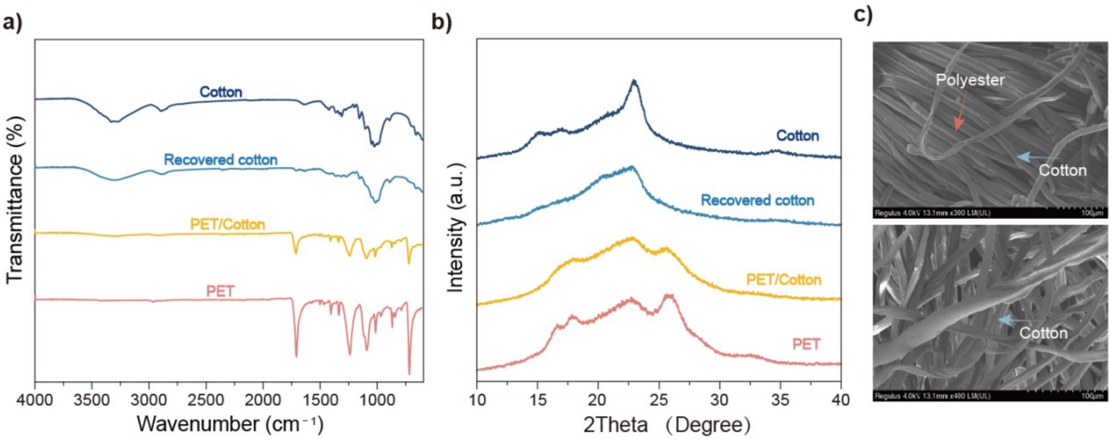

Figure S14. (a) ATR-FTIR spectra, (b) XRD patterns and (c) SEM of blended PET/Cotton before and after treatment. Reaction conditions: 0.2 g of Fiber/Cotton (PET/Cotton=75/25), 1 g of EG, 0.004 g of ZPT, 185 °C, 1 h.

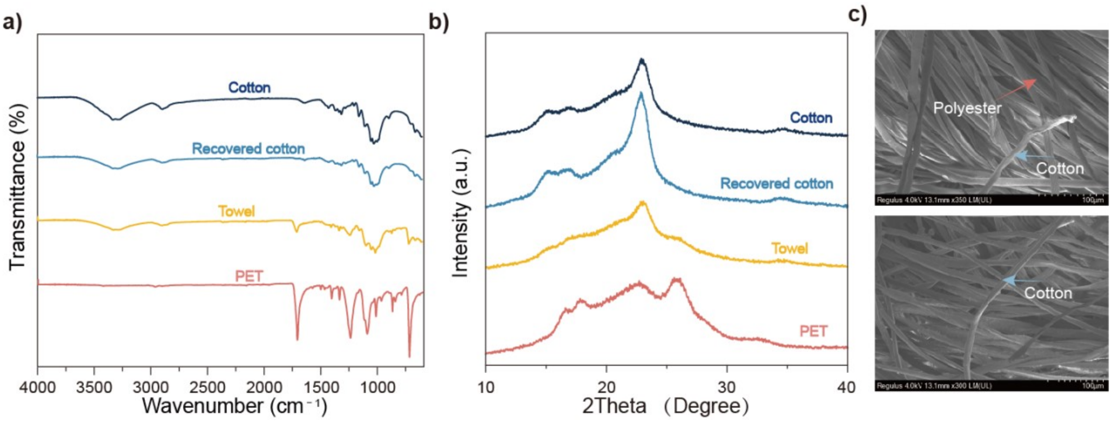

Figure S15. (a) ATR-FTIR spectra, (b) XRD patterns, and (c) SEM of towel before and after treatment. Reaction conditions: 0.2 g of Towel (PET/cotton=50/50), 1 g of EG, 0.004 g of ZPT, 185 °C, 1 h.

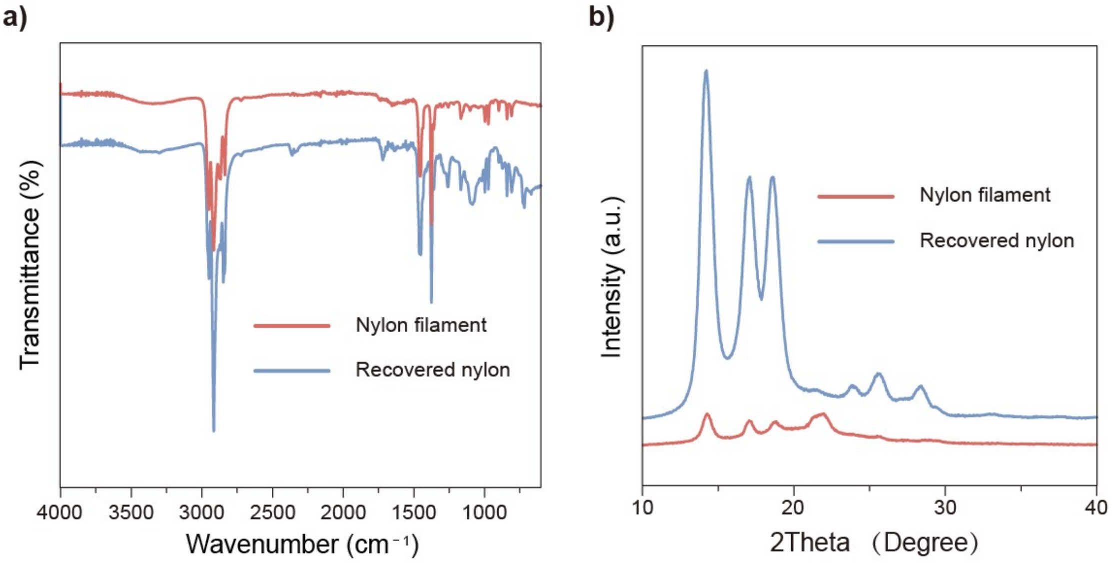

Figure S16. (a) ATR-FTIR spectra, and (b) XRD patterns of blended textile PET/Nylon before and after treatment. Reaction conditions: 0.2 g of PET/Nylon (70/30), 1 g of EG, 0.004 g of ZPT, 185 °C, 1 h.

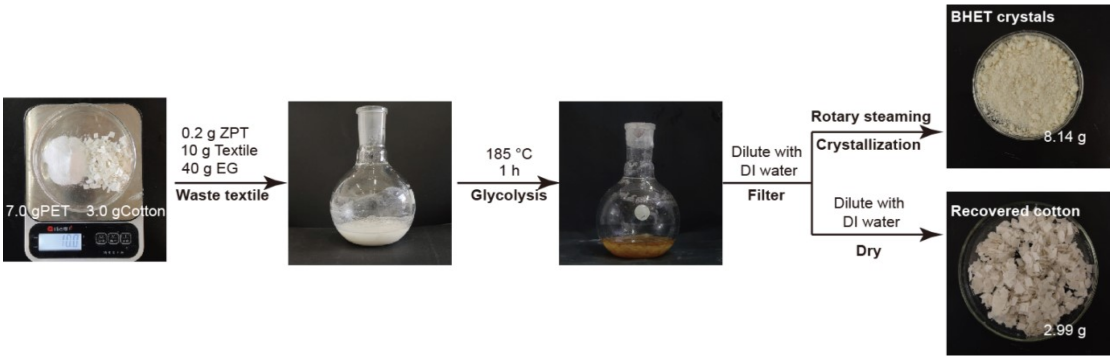

Figure S17. Flow chart of 10 g scale-up experiment. Reaction conditions: 10 g of mixed textile (PET/Cotton=70/30), 40 g of EG, 0.2 g of ZPT, 185 °C, 1 h.

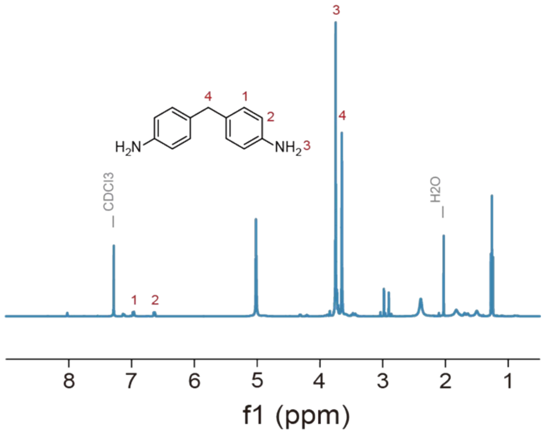

Figure S18. ^{1}H NMR spectrum of a MDA recorded in $CDCl_3$.

In the primary stage targeting the polyester/spandex blend, the reaction temperature was initially maintained at 160 °C to selectively melt the spandex component. This molten spandex was mechanically separated from the intact polyester fabric directly within the reactor, permitting the subsequent glycolysis of the PET fraction to proceed without interference.

The isolated spandex fraction was then independently reacted with EG at 200 °C for 1 hour, during which the mixture transitioned to a brownish-yellow hue. Upon cooling the mixture to room temperature, the resultant polyol component spontaneously solidified, forming a distinct upper coagulated layer. The lower liquid phase was carefully decanted into a separate beaker. To isolate the target diamine, a 0.1 mol/L aqueous hydrochloric acid solution was added dropwise until the system reached a pH of 4. This acidified mixture was stirred for 30 minutes and subsequently filtered to yield a transparent solution. The acidic filtrate was then carefully neutralized back to pH 7 using a 0.1 mol/L aqueous sodium hydroxide solution. Finally, the solvent water was removed via rotary evaporation, and the resulting solid residue was dried in a vacuum oven at 60 °C for 8 hours to yield the pure 4,4-methylenedianiline (MDA) monomer.

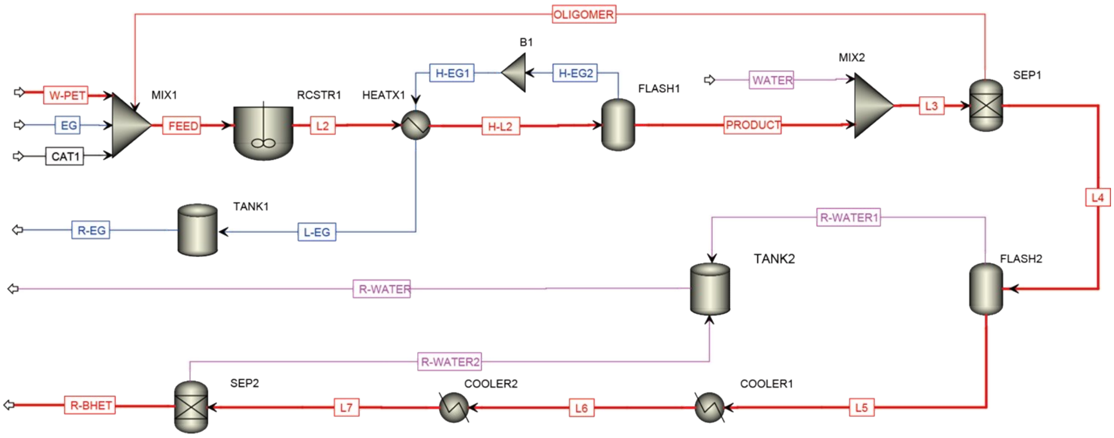

Figure S19. Flowsheet diagram from Aspen model for PET glycolysis Case 1.

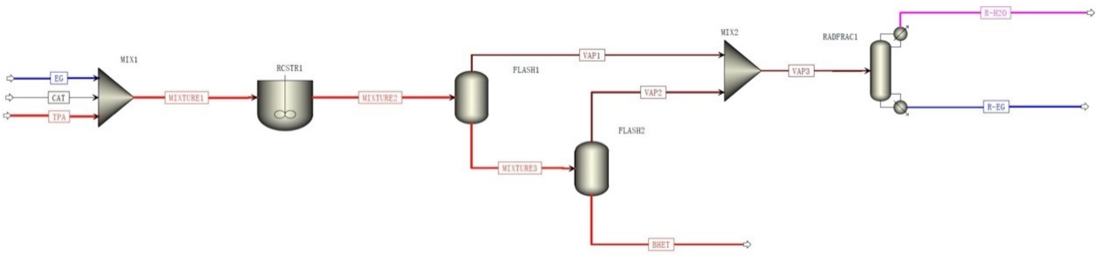

Figure S20. Flowsheet diagram from Aspen model for the petroleum-based TPA synthesis route.

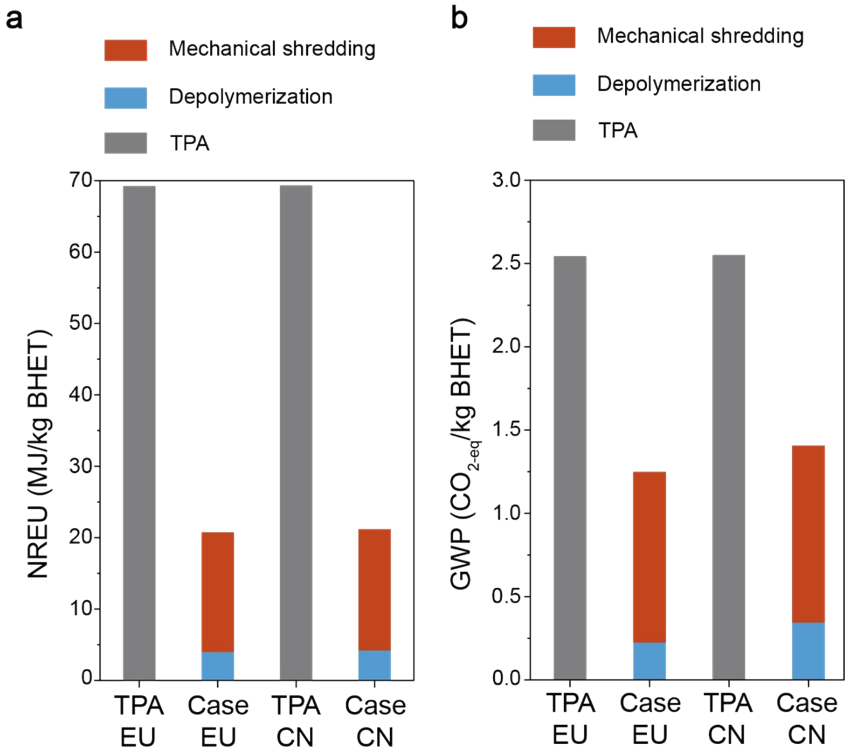

Figure S21. Comparison of (a) non-renewable energy use (NREU) and (b) global warming potential (GWP). TPA route refers to the BHET production route based on fossil-derived TPA via esterification.

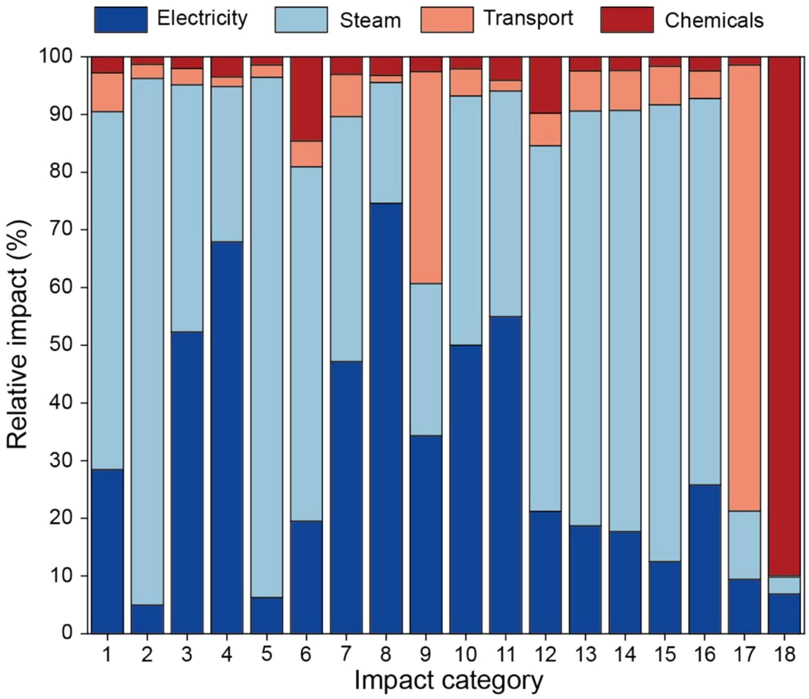

Figure S22. Contribution analysis of LCA across 18 impact categories (EU: Europe).

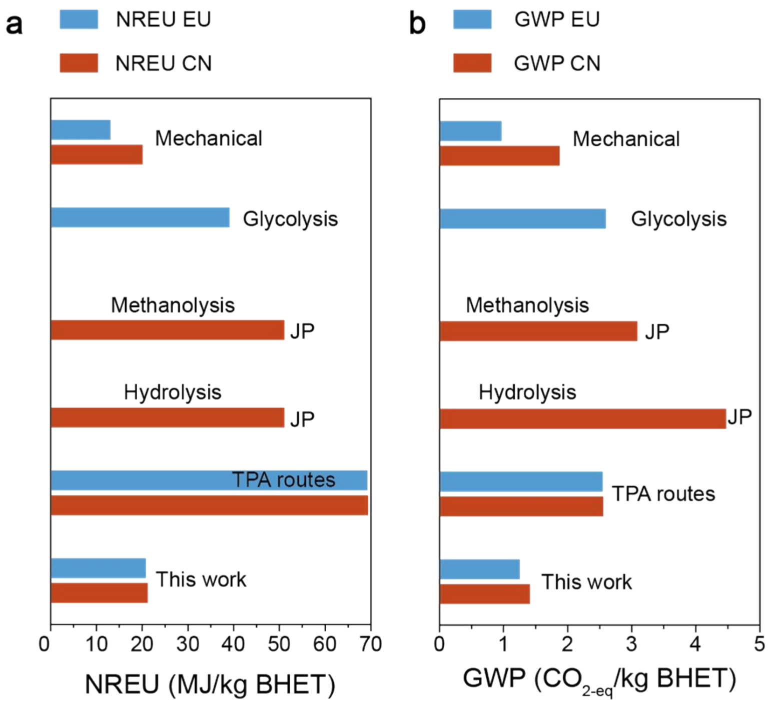

Figure S23. (a, b) Comparison of NREU and GWP in different routes for PET textiles glycolysis. EU: Europe, CN: China, JP: Japan.

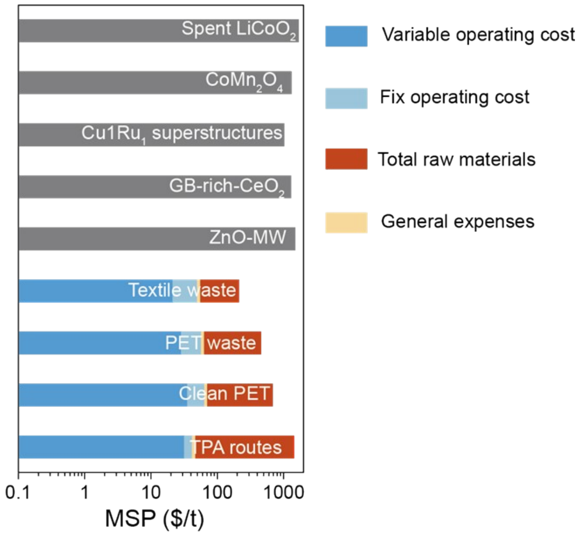

Figure S24. Comparison of minimum selling prices based on TPA routes, clean PET, waste PET, PET textiles, and references.

Table S1. Glycolysis effect of different antibacterial agents on PET.

Entry	Catalyst	t (min)	PET conv. (%)	BHET yield (%)	Oligomer yield (%)
1	Tannin	60	0.04	0.14 0.15 0.22	3.98
2	Chitosan	60	0.01	0.16 2.02 2.14	1.08
3	TMAEMC	60	0.08	0.18 0.23 3.4	4.1
4	BHPVA	60	0.07	0.07 0.19 1.8	5.36
5	PHMB	60	0.05	0.09 0.09 2.01	3.05
6	ZTP	60	0.99	81.31 83.74 89.28	10.9

Reaction conditions: PET waste (0.2 g), antibacterial agents (4 mg), ethylene glycol (1 g), temperature (185 °C), time (1 h).

Table S2. Optimization of catalytic glycolysis of PET.

Entry	Temp. (°C)	t (min)	m_{cat}/m_{PET} (mg/g)	PET conv. (%)	BHET yield (%)	Oligomer yield (%)
1	185	20	4/0.2	44.72	14.38 38.93 68.66	5.80
2	185	40	4/0.2	70.40	45.56 62.14 82.23	8.26
3	185	60	4/0.2	100	81.26 82.05 89.28	10.71
4	185	80	4/0.2	100	83.24 83.64 89.26	10.72
5	185	100	4/0.2	100	78.85 82.04 84.27	21.15
6	185	60	0.2/0.2	69.10	13.02 21.38 55.59	13.51
7	185	60	1/0.2	81.5	65.77 67.09 70.00	11.5
8	185	60	2/0.2	85.7	74.39 81.07 83.24	11.06
9	185	60	4/0.2	100	83.90 84.54 89.10	10.9
10	185	60	6/0.2	100	77.75 83.17 87.25	12.75
11	185	360	0.2/0.2	100	81.36 84.64 86.41	13.59
12	155	60	4/0.2	24.83	8.22 8.90 21.59	3.24
13	165	60	4/0.2	26.76	22.70 25.68 41.00	4.06
14	175	60	4/0.2	55.76	39.34 46.09	9.68

					51.31	
15	185	60	4/0.2	100	82.73 84.71 84.88	15.12
16	195	60	4/0.2	100	82.07 83.01 85.33	17.93

Reaction condition: PET waste (0.2 g), ZPT(4 mg), EG (1 g,), temperature (185 °C), time (1 h).

Table S3. Comparison of the STY value of different catalysts for PET glycolysis.

	Catalyst	Temp. (°C)	t (min)	m_{cat} (g)	BHET yield (%)	STY $g_{BHET}\ g_{cat}^{-1}\ h^{-1}$
	This work	185	60	0.004	89.2	58.87
		185	72	0.002	87.6	119.89
		185	60	0.0005	56.4	740.83
Lower glycolysis temperature	Cyanamide[1]	150	480	0.1	80.2	2.65
	Cyanamide[1]	160	480	0.1	86.7	2.84
	$[bmim]_2[CoCl_4]$[2]	170	240	1	78.0	1.29
	$[amim][ZnCl_3]$[3]	175	75	0.5	80.8	8.47
Same glycolysis temperature	Mn_2LCl_2[4]	180	252	0.002	92.7	313.62
	DP ZIF-8[5]	180	240	0.02	76.1	25.17
	Cobalt Nanoparticles[6]	180	180	0.06	77.1	22.64
	1Mn/Zn[7]	180	150	0.025	93.6	99.06
	ZnVI[8]	180	240	0.003	91.2	30.10
	PIL-Zn$(OAc)_2$[9]	180	20	0.3	91.4	60.80
	NH_4HCO_3[10]	180	360	0.02	84.7	1.78
	TBD : MSA [11]	180	180	0.25	89.9	0.79
	r-Zn–MOF74–NT[12]	190	60	0.001	78.4	1037.17
	Pro/Zn$(Ac)_2$[13]	190	60	0.1	87.2	57.55
	Cyanamide[1]	190	150	0.1	95.2	10.05
	ZnO–Fe_3O_4 HMNAs[14]	190	30	0.1	92.3	72.61
	ZIF8–Fe_3O_4 HMNAs[14]	190	20	0.1	85.2	101.55
	GB-rich CeO_2[15]	190	15	0.02	93.4	46.95
	[Bmim]OH[16]	190	120	0.1	71.8	9.39
	$[C_6TMG]Cl/ZnCl_2$[17]	195	70	0.5	93.0	10.61
	Fe_3O_4-CP[18]	195	120	0.005	93.5	123.69
EG critical temperature	CeO_2–Fe_3O_4 HMNAs[14]	197	45	0.1	75.6	50.03
	Ch/Zn(2:1)[19]	196	150	0.04	94.2	12.44
	ZnO-Waved[20]	210	45	0.005	95.0	167.57
	Fe_3O_4 Nanodispersions[21]	210	30	0.12	93.4	123.03
	PW12@ UiO-67[22]	240	60	0.002	95.0	314.19
PET melting temperature	$ZnMn_2O_4$ [23]	260	60	0.01	92.2	92
	GO-Mn_3O_4 [24]	300	80	0.01	96.4	64.2
	γ-Fe_2O_3 [25]	300	60	0.05	90	26.4

Table S4. Comparison of the TOF value of different catalysts for PET glycolysis.

Catalyst	Temp. (°C)	T (min)	BHET yield (%)	TOF (h^{-1})
	185	60	89.2	73.63
This work	185	60	87.6	149.96
	185	60	56.4	926.62
Cyanamide[1]	190	150	95.1	1.66
[amim][$ZnCl_3$][3]	175	75	80.8	9.81
Mn_2LCl_2[4]	180	252	92.7	675.39
1Mn/Zn[7]	180	150	93.6	1032.2
NH_4HCO_3[10]	180	360	84.7	0.55
ZnO-Waved[21]	210	45	95.0	53.70
[Bmim]OH[16]	190	120	71.2	5.8
[Ch][OAc][26]	180	240	85.2	3.62
$[Ch]_3$[PO4][27]	180	240	82	1.17
TBD[28]	190	10.2	95.0	57
[Mmim][OAc][29]	185	120	34	0.69
$Zn(OAc)_2.2H_2O$[30]	198	480	88	4.57
$CoCl_2.6H_2O$[30]	190	180	65	26.85
$MnCl_2.4H_2O$[30]	190	180	48	16.49
$ZrCl_4$[30]	190	180	69	27.92
$Ni(COD)_2$[30]	190	180	55	26.26
$Cu(OAc)_2$[30]	190	20	30.09	14.23

Table S5. Linear regression results for the data in Figure S5.

Temp. (°C)	equation	R^2	Ea(KJ mol-1)	R^2
185	y=0.0212x-0.3851	0.9046		
180	y=0.0155x-0.2509	0.9958	72.27	0.917
175	y=0.014x-03607	0.975		

Table S6. Catalytic performance of different kinds of PET textile and mixed textile.

Entry	Textiles-type	t (min)	PET conv. (%)	BHET yield (%)	Oligomer yield (%)
1	Pure polyester textile	60	100	89.3	10.7
2	Quick drying clothes	60	100	86.7	13.3
3	Purple textile	60	100	87.2	12.8
4	Light green textile	60	100	90.5	9.5
5	Blue gown	60	100	88.8	11.2
6	Black gown	60	100	87.9	12.1
7	65% Cotton +30% Polyester + 5% Spandex	60	100	86.5	13.5
8	Fiber/Cotton	60	100	87.6	12.4
9	Towel	90	100	86.4	13.6
10	PET/Nylon	90	100	88.7	11.3
11	PET/Spandex	180	100	80.3	19.7
12	PET/Cotton	60	100	87.90	12.10

Reaction conditions: PET waste (0.2 g), ZPT (4 mg), ethylene glycol (1 g), temperature (185 °C).

Note 1. Goal and scope of life cycle assessment (LCA).

In this study, the environmental impact of PET recycling was evaluated using LCA. The pre-treatment processes of PET waste were assumed to be consistent with the established protocols for mechanical recycling. In terms of allocation, our study adopts the “cut-off” rule. This principle delineates the original plastic's lifecycle as distinct and separate from that of the recycled plastic, ensuring an independent evaluation of each lifecycle. These form the basis of our “prospective processes”. The functional unit for this LCA is defined as 1 kg of *r*-BHET in Aspen Plus.

The impact assessment was carried out using the professional software OpenLCA 1.10.3. The assessment methods were IPCC 2021 for GWP and Cumulative Energy Demand for non-renewable energy use (NREU). “Background process” data were sourced from the database ecoinvent V.3.10.

Table S7. Goal and scope of LCA.

Goal	
Reason and scope	1. Focus on human health, resource and ecosystem. 2. To assess the global warming potential (GWP) and Non-renewable energy use (NREU) of PET recycling, TPA-based production routes and compare it with published commercial depolymerization protocols in Europe or China (Figure 5 in main text)
Audience	Industrial stakeholders, the research community, and the public
Application	Provide technical support for polyester plastic carbon emission reduction policies and circular economy
Intention to use results in comparative studies	Yes, the results are to be compared and disclosed to the public through this article's publication
Scope	
Product system	The PET waste glycolysis section with the recycled BHET production is based on EU and CN.
Functional unit	1 kg of recycled BHET.
System boundary	Cradle-to-factory gate, See Figure S13
Allocation	PET waste cut-off, all environmental effects are allocated to recycled BHET chips.
Assumptions	(1) The pre-treatment discharge of waste PET is consistent with the mechanical method (2) This system deals with 12, 500 kg waste PET/per hour over 8,000 hours/per year (3) This system is located in Europe or China
Requirements on data and quality	Foreground material and energy consumption data were obtained from simulation in Aspen Plus and the background processes were chosen based on Ecoinvent V.3.10 in Open LCA 1.10.3.
LCIA methodology	IPCC 2021 for GWP; Cumulative Energy Demand for NREU;
Impact categories assessed	1. Global Warming Potential (GWP, 100a), kg CO_2 equivalent; 2. Non-renewable energy use (NREU), MJ;
Limitations	In addition to the above-mentioned assumptions, the following aspects are not assessed: plant construction and equipment maintenance.

Table S8. NREU values of each raw material of PET glycolysis used in the Open LCA.

Process	Value	Unit	Location
Zinc pyrithione	32.1862	MJ per kg	Global of the world
Ultrapure water production	0.05960	MJ per kg	Europe
	0.07874		Rest of the world
Market for tap water	0.00617	MJ per kg	Europe without Switzerland
	0.01534		Rest of the world
Market for ethylene glycol	53.00610	MJ per kg	Global of the world
Market group for electricity, low voltage	9.15115	MJ per kWh	Europe without Switzerland
	10.22484		China
Heat production, natural gas, at boiler modulating	1.13333	MJ per MJ	Europe without Switzerland
	1.13628		Rest of the world
Transport, freight, lorry >32 metric ton	1.49960	MJ per t*km	Europe
	45.49327	MJ per kg	Rest of the world

Table S9. GWP values of each raw material of PET glycolysis used in the Open LCA.

Process	**Value**	**Unit**	**Location**
Zinc pyrithione	1.7138	kg $CO_{2\text{-eq}}$ per kg	Global of the world
Ultrapure water production	0.00300	kg $CO_{2\text{-eq}}$ per kg	Europe
	0.00606		Rest of the world
Market for tap water	0.00034	kg $CO_{2\text{-eq}}$ per kg	Europe without Switzerland
	0.00106		Rest of the world
Market for ethylene glycol	2.01648	kg $CO_{2\text{-eq}}$ per kg	Global of the world
Market group for electricity, low voltage	0.41694	kg $CO_{2\text{-eq}}$ per kWh	Europe without Switzerland
	1.05271		China
Heat production, natural gas, at boiler modulating	0.06964	kg $CO_{2\text{-eq}}$ per MJ	Europe without Switzerland
	0.07065		Rest of the world
Transport, freight, lorry >32 metric ton	0.08599	kg $CO_{2\text{-eq}}$ per t*km	Europe
	0.08889		Rest of the world

Table S10. LCA results of case-CN recycling route.

Country	Impact category	Reference unit	Mechanical shredding	Depolymerization	Total
CN	Fine particulate matter formation	kg PM2.5 eq	0.00035	0.00036	0.00071
	Fossil resource scarcity	kg oil eq	0.09112	0.35681	0.45791
	Freshwater ecotoxicity	kg 1,4-DCB	0.00808	0.00770	0.01578
	Freshwater eutrophication	kg P eq	0.00004	0.00004	0.00008
	Global warming	kg CO_2 eq	0.34624	1.09510	1.44134
	Human carcinogenic toxicity	kg 1,4-DCB	0.01100	0.02881	0.03980
	Human non-carcinogenic toxicity	kg 1,4-DCB	0.12972	0.12632	0.25604
	Ionizing radiation	kBq Co-60 eq	0.00398	0.00691	0.01088
	Land use	m^2a crop eq	0.00478	0.00206	0.00684
	Marine ecotoxicity	kg 1,4-DCB	0.01059	0.01019	0.02078
	Marine eutrophication	kg N eq	0.00000	0.00000	0.00001
	Mineral resource scarcity	kg Cu eq	0.00021	0.00058	0.00079
	Ozone formation, Human health	kg NO_x eq	0.00065	0.00066	0.00130
	Ozone formation, Terrestrial ecosystems	kg NO_x eq	0.00066	0.00070	0.00136
	Stratospheric ozone depletion	kg CFC11 eq	0.00000	0.00000	0.00000
	Terrestrial acidification	kg SO_2 eq	0.00079	0.00088	0.00167
	Terrestrial ecotoxicity	kg 1,4-DCB	0.81460	0.14433	0.95893
	Water consumption	m^3	0.00058	0.01805	0.01863

Table S11. LCA results of case-EU recycling route.

Country	Impact category	Reference unit	Mechanical shredding	Depolymerization	Total
EU	Fine particulate matter formation	kg PM2.5 eq	0.00017	0.00026	0.00043
	Fossil resource scarcity	kg oil eq	0.07320	0.35811	0.43131
	Freshwater ecotoxicity	kg 1,4-DCB	0.00862	0.00733	0.01595
	Freshwater eutrophication	kg P eq	0.00008	0.00004	0.00012
	Global warming	kg CO_2 eq	0.22759	1.05359	1.28118
	Human carcinogenic toxicity	kg 1,4-DCB	0.00956	0.02386	0.03342
	Human non-carcinogenic toxicity	kg 1,4-DCB	0.13406	0.11450	0.24856
	Ionizing radiation	kBq Co-60 eq	0.03759	0.01625	0.05383
	Land use	m^2a crop eq	0.00418	0.00178	0.00596
	Marine ecotoxicity	kg 1,4-DCB	0.01130	0.00969	0.02098
	Marine eutrophication	kg N eq	0.00001	0.00000	0.00001
	Mineral resource scarcity	kg Cu eq	0.00024	0.00051	0.00075
	Ozone formation, Human health	kg NO_x eq	0.00025	0.00054	0.00079
	Ozone formation, Terrestrial ecosystems	kg NO_x eq	0.00026	0.00059	0.00085
	Stratospheric ozone depletion	kg CFC11 eq	0.00000	0.00000	0.00000
	Terrestrial acidification	kg SO_2 eq	0.00041	0.00076	0.00117
	Terrestrial ecotoxicity	kg 1,4-DCB	0.78489	0.11837	0.90327
	Water consumption	m^3	0.00132	0.01828	0.01960

Table S12. Comparative LCA results of case-CN recycling route and the petroleum-based TPA synthesis route.

Country	Impact category	Reference unit	petroleum-based TPA synthesis route	r-BHET/TPA synthesis route (%)
CN	Fine particulate matter formation	kg PM2.5 eq	0.00313	22.68371
	Fossil resource scarcity	kg oil eq	1.44837	31.61554
	Freshwater ecotoxicity	kg 1,4-DCB	0.08746	18.04253
	Freshwater eutrophication	kg P eq	0.00054	14.81481
	Global warming	kg CO_2 eq	2.65215	54.3461
	Human carcinogenic toxicity	kg 1,4-DCB	0.15110	26.34017
	Human non-carcinogenic toxicity	kg 1,4-DCB	1.69936	15.06685
	Ionizing radiation	kBq Co-60 eq	0.09467	11.49255
	Land use	m^2a crop eq	0.02886	23.70062
	Marine ecotoxicity	kg 1,4-DCB	0.11429	18.18182
	Marine eutrophication	kg N eq	0.00007	14.28571
	Mineral resource scarcity	kg Cu eq	0.00866	9.1224
	Ozone formation, Human health	kg NO_x eq	0.00539	24.11874
	Ozone formation, Terrestrial ecosystems	kg NO_x eq	0.00568	23.94366
	Stratospheric ozone depletion	kg CFC11 eq	0.00001	0
	Terrestrial acidification	kg SO_2 eq	0.00686	24.34402
	Terrestrial ecotoxicity	kg 1,4-DCB	4.73728	20.24221
	Water consumption	m^3	0.04499	41.4092

Table S13. Comparative LCA results of case-EU recycling route and the petroleum-based TPA synthesis route.

Country	Impact category	Reference unit	petroleum-based TPA synthesis route	r-BHET/TPA synthesis route (%)
EU	Fine particulate matter formation	kg PM2.5 eq	0.00311	13.82637
	Fossil resource scarcity	kg oil eq	1.44615	29.82471
	Freshwater ecotoxicity	kg 1,4-DCB	0.08716	18.29968
	Freshwater eutrophication	kg P eq	0.00053	22.64151
	Global warming	kg CO_2 eq	2.64341	48.46694
	Human carcinogenic toxicity	kg 1,4-DCB	0.14828	22.53844
	Human non-carcinogenic toxicity	kg 1,4-DCB	1.69219	14.68866
	Ionizing radiation	kBq Co-60 eq	0.09478	56.79468
	Land use	m^2a crop eq	0.02874	20.73765
	Marine ecotoxicity	kg 1,4-DCB	0.11388	18.42211
	Marine eutrophication	kg N eq	0.00007	14.89971
	Mineral resource scarcity	kg Cu eq	0.00862	8.7007
	Ozone formation, Human health	kg NO_x eq	0.00537	14.71136
	Ozone formation, Terrestrial ecosystems	kg NO_x eq	0.00566	15.01767
	Stratospheric ozone depletion	kg CFC11 eq	0.00001	0
	Terrestrial acidification	kg SO_2 eq	0.00684	17.10526
	Terrestrial ecotoxicity	kg 1,4-DCB	4.72598	19.11286
	Water consumption	m^3	0.04502	43.53621

Table S14. Cradle-to-gate LCA results contribution analysis of PET glycolysis, functional unit = 1 kg BHET flakes. In the context of EU.

Impact category	Reference unit	Electricity	Steam	Transport	Chemicals
Fine particulate matter formation	kg PM2.5 eq	28.46	62.03	6.72	2.79
Fossil resource scarcity	kg oil eq	4.99	91.31	2.39	1.32
Freshwater ecotoxicity	kg 1,4-DCB	52.29	42.82	2.87	2.02
Freshwater eutrophication	kg P eq	67.94	26.93	1.61	3.52
Global warming	kg CO_2 eq	6.27	90.16	2.16	1.40
Human carcinogenic toxicity	kg 1,4-DCB	19.53	61.43	4.43	14.61
Human non-carcinogenic toxicity	kg 1,4-DCB	47.19	42.44	7.33	3.04
Ionizing radiation	kBq Co-60 eq	74.63	20.92	1.24	3.21
Land use	m^2a crop eq	34.32	26.36	36.76	2.57
Marine ecotoxicity	kg 1,4-DCB	49.99	43.23	4.66	2.12
Marine eutrophication	kg N eq	54.96	39.12	1.82	4.10
Mineral resource scarcity	kg Cu eq	21.23	63.34	5.67	9.76
Ozone formation, Human health	kg NO_x eq	18.71	71.90	6.97	2.42
Ozone formation, Terrestrial ecosystems	kg NO_x eq	17.69	73.01	6.92	2.38
Stratospheric ozone depletion	kg CFC11 eq	12.52	79.14	6.72	1.62
Terrestrial acidification	kg SO_2 eq	25.80	66.94	4.82	2.44
Terrestrial ecotoxicity	kg 1,4-DCB	9.46	11.78	77.33	1.42
Water consumption	m^3	6.92	2.87	0.27	89.94

Table S15. Cradle-to-gate LCA results contribution analysis of PET glycolysis, functional unit = 1 kg BHET flakes. In the context of CN.

Impact category	Reference unit	Electricity	Steam	Transport	Chemicals
Fine particulate matter formation	kg PM2.5 eq	44.63	44.54	4.33	6.50
Fossil resource scarcity	kg oil eq	8.85	86.81	2.29	2.05
Freshwater ecotoxicity	kg 1,4-DCB	48.48	42.83	3.01	5.69
Freshwater eutrophication	kg P eq	48.60	35.64	2.78	12.98
Global warming	kg CO_2 eq	14.47	81.31	1.99	2.23
Human carcinogenic toxicity	kg 1,4-DCB	20.10	51.98	3.82	24.10
Human non-carcinogenic toxicity	kg 1,4-DCB	43.10	41.54	7.40	7.96
Ionizing radiation	kBq Co-60 eq	29.86	43.46	4.91	21.76
Land use	m^2a crop eq	39.10	23.14	32.16	5.60
Marine ecotoxicity	kg 1,4-DCB	46.11	43.24	4.82	5.84
Marine eutrophication	kg N eq	32.76	50.21	2.76	14.28
Mineral resource scarcity	kg Cu eq	15.92	59.21	5.59	19.28
Ozone formation, Human health	kg NO_x eq	44.51	47.20	4.46	3.84
Ozone formation, Terrestrial ecosystems	kg NO_x eq	42.81	48.87	4.53	3.80
Stratospheric ozone depletion	kg CFC11 eq	13.46	74.37	6.30	5.87
Terrestrial acidification	kg SO_2 eq	42.41	49.64	3.60	4.35
Terrestrial ecotoxicity	kg 1,4-DCB	11.84	11.65	72.86	3.65
Water consumption	m^3	2.82	2.51	0.30	94.36

Table S16. LCA results in glycolysis of post-consumer PET textiles, functional unit = 1 kg recycled BHET.

Section	**China**		**Europe**	
	NREU	GWP	NREU	GWP
Mechanical shredding	4.2589	0.34624	4.04499	0.22759
PET glycolysis	16.85866	1.05840	16.63373	1.01844
Total	21.11756	1.40464	20.67872	1.24603

Units: NREU: MJ/kg recycled BHET; GWP: kg CO_2-eq/kg recycled BHET.

Table S17. LCA results in TPA route to produce BHET (TPA synthesis route), functional unit = 1 kg the petroleum-based TPA synthesis route.

Section	**China**		**Europe**	
	NREU	GWP	NREU	GWP
Virgin BHET	69.26206	2.54919	69.16224	2.54065

Units: NREU: MJ/kg virgin BHET; GWP: kg CO_2-eq/kg virgin BHET.

Table S18. Material and energy input-output of collection, transport, and pretreatment of waste polyester textile, functional unit = 1 kg BHET flakes.

Items	Quantity	Unit
Input:		
Waste transparent PET textiles	1088	kg
Transportation distance	400	km
Electricity, low voltage	229.84	kWh
Heat (from natural gas)	2066.87	MJ
Output:		
By-products (e.g., bottle caps, labels)	88	kg
PET flakes	1000	kg

The feedstock considered in this study refers to polyester-rich textiles, with a contaminant content of approximately 8%.

Table S19. Mass balance of post-consumer PET textiles glycolysis.

Para.	CAT1	EG	FEED	H-EG1	H-EG2	H-L2	L2	L3
Temp./°C	25.00	180.00	179.72	197.66	110.00	196.00	180.00	99.87
Press/kPa	101.33	101.33	101.33	101.33	0.01	101.33	101.33	101.33
Mass flow (kg/h)	125.00	50000.00	63090.45	46918.56	46918.56	63090.45	63090.45	93028.91
W-PET (kg/h)	0.00	0.00	12500.51	0.00	0.00	0.51	0.51	0.51
Water (kg/h)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76857.00
EG (kg/h)	0.00	50000.00	50000.00	46129.15	46129.15	46139.93	46139.93	10.78
BHET (kg/h)	0.00	0.00	0.00	76.86	76.86	15448.26	15448.26	15371.42
CAT1 (kg/h)	125.00	0.00	125.00	0.00	0.00	125.00	125.00	125.00
OLI-PET (kg/h)	0.00	0.00	464.94	712.55	712.55	1376.76	1376.76	664.20

CAT1: zinc pyrithione

Table S19. Mass balance of post-consumer PET textiles glycolysis (continued).

Para.	L4	L5	L6	L7	L-EG	OLIGOMER	PRODUCT	R-BHET
Temp./°C	99.87	100.00	25.00	4.00	197.54	99.87	110.00	4.00
Press/kPa	101.33	88.50	101.33	101.33	101.33	101.33	0.01	101.33
Mass flow (kg/h)	92563.46	23374.90	23374.90	23374.90	46918.56	465.45	16171.91	15570.67
W-PET (kg/h)	0.00	0.00	0.00	0.00	0.00	0.51	0.51	0.00
Water (kg/h)	76857.00	7670.19	7670.19	7670.19	0.00	0.00	0.00	0.00
EG (kg/h)	10.78	9.04	9.04	9.04	46129.15	0.00	10.78	0.00
BHET (kg/h)	15371.42	15371.41	15371.41	15371.41	76.86	0.00	15371.42	15371.41
CAT1 (kg/h)	125.00	125.00	125.00	125.00	0.00	0.00	125.00	0.00
OLI-PET (kg/h)	199.26	199.25	199.25	199.25	712.55	464.94	664.20	199.25

CAT1: zinc pyrithione

Table S19. Mass balance of post-consumer PET textiles glycolysis (continued).

Para.	**R-EG**	**R-WATER**	**R-WATER1**	**R-WATER2**	**W-PET**	**WATER**
Temp./°C	197.54	100.03	100.00	4.00	25.00	99.00
Press/kPa	101.33	101.33	88.50	101.33	101.33	101.33
Mass flow (kg/h)	46918.56	76992.79	69188.56	7804.23	12500.00	76857.00
W-PET (kg/h)	0.00	0.00	0.00	0.00	12500.00	0.00
Water (kg/h)	0.00	76857.00	69186.81	7670.19	0.00	76857.00
EG (kg/h)	46129.15	10.78	1.74	9.04	0.00	0.00
BHET (kg/h)	76.86	0.00	0.00	0.00	0.00	0.00
CAT1 (kg/h)	0.00	125.00	0.00	125.00	0.00	0.00
OLI-PET (kg/h)	712.55	0.01	0.01	0.00	0.00	0.00

CAT1: zinc pyrithione

Table S20. Mass balance of petroleum-based TPA synthesis route.

Para.	**BHET**	**CAT**	**EG**	**MIXTURE1**	**MIXTURE2**	**MIXTURE3**
Temp./°C	195.00	25.00	25.00	25.00	195.00	130.80
Press/kPa	8.11	101.33	101.33	101.33	111.46	101.33
Water (kg/h)	4.83	0.00	0.00	0.00	2196.93	870.00
EG (kg/h)	104.26	0.00	9080.17	9080.17	1511.05	1435.24
CAT2 (kg/h)	3.04	3.04	0.00	3.04	3.04	3.04
BHET (kg/h)	15480.96	0.00	0.00	0.00	15501.99	15501.99
TPA (kg/h)	0.00	0.00	0.00	10129.80	0.00	0.00

CAT2: $Co(OAc)_2$.

Table S20. Mass balance of petroleum-based TPA synthesis route (continued).

Para.	**R-EG**	**R-H2O**	**TPA**	**VAP1**	**VAP2**	**VAP3**
Temp./°C	177.45	100.02	25.00	130.80	195.00	171.80
Press/kPa	101.33	101.33	101.33	101.33	8.11	101.33
Water (kg/h)	23.74	2168.36	0.00	1326.92	865.17	2192.10
EG (kg/h)	1406.80	0.00	0.00	75.81	1330.99	1406.80
CAT2 (kg/h)	0.00	0.00	0.00	0.00	0.00	0.00
BHET (kg/h)	21.03	0.00	0.00	0.00	21.03	21.03
TPA (kg/h)	23.74	2168.36	0.00	1326.92	865.17	2192.10

CAT2: $Co(OAc)_2$.

Table S21. Details of the utilities with post-consumer PET textiles glycolysis and petroleum-based TPA synthesis route.

Unit processes used	**Type of utility used**	**Initial and final state of utility**	
		Initial	Final
COOLING	Water	20°C; 1.00 atm; liquid phase	24°C; 1.00 atm; liquid phase
L-STEAM	Low-pressure steam	125°C; 2.29 atm; gaseous phase	124°C; 2.22 atm; gaseous phase
M-STEAM	Medium-pressure steam	190°C; 8.86 atm; gaseous phase	189°C; 8.65 atm; gaseous phase
H-STEAM	High-pressure steam	250°C; 84.80 atm; gaseous phase	249°C; 83.67 atm; gaseous phase
ELECT	Electricity		

Table S22. Utility of post-consumer PET textiles glycolysis.

Unit processes used	Type of utility used	Quantity	Function
RCSTR1	High pressure steam	741.03 kg/h	Heating
FLASH1	High pressure steam	17917.49 kg/h	Heating
FLASH2	Low pressure steam	71336.96 kg/h	Heating
COOLER1	Water	269410.68 kg/h	Cooling
COOLER2	Electricity	330.32 kWh	Cooling

Table S23. Utility of virgin BHET route.

Unit processes used	Type of utility used	Quantity	Function
RCSTR1	High pressure steam	2676.44 kg/h	Heating
FLASH2	High pressure steam	3146.16 kg/h	Heating
RADFRAC1	Water	163921 kg/h	Cool the top fraction
	High pressure steam	1075.2 kg/h	Heat the tower kettle

Table S24. Energy balance of post-consumer PET textiles glycolysis.

Equipment	**RCSTR1**	**FLASH1**	**COOLER1**	**COOLER2**	**FLASH2**
Cost (MJ/h)	1274.07	30806.00	-4499.59	-1189.15	156362.00

Table S25. Energy balance of virgin BHET route.

Equipment	RCSTR1	FLASH2	RADFRAC1	
			Condenser	Reboiler
Cost (MJ/h)	4601.67	5409.27	-3421.97	1848.61

Note 2. Techno-economic analysis (TEA) analysis

To investigate the economic feasibility of this process for PET recycling, we carried out a techno-economic analysis using a model adapted from that of Aspen simulation. The processing capacity of the plant is 100,000 tons of waste PET per year. Table S24 summarize the model used to calculate the plant-gate levelized cost of processing PET. All economic results are reported on a 2025 cost basis. The prices of input chemicals and products are listed in the Tables S25-36.

List of assumptions made for the calculations:

1. The capacity factor is expected to be operational on any given day and is assumed to be 0.9, which means the plant will be operational 21.9 hours per day.
2. In the depolymerization stage of waste PET, input chemicals include PET, catalyst, EG, and water. The output products include *r*-BHET and EG.
3. The capital costs of glycolysis and distillation equipment are dependent on the recycling of PET.
4. The catalyst is derived directly from the fabric, and it's extremely low loading, coupled with the fact that no recovery process is required, renders the associated cost virtually negligible.
5. Both operation and maintenance costs are based on actual usage and unit price.
6. Utility cost is based on the unit price of public works simulated by aspen software.

7 Transportation cost is based on shipping distance and price.

8. The clean PET flakes could be obtained at \$0.66/kg based on the average mixed bale PET cost in recent years. The price of PET waste (\$0.39/kg) was assumed to be 40% of virgin PET. (https://jiage.molbase.cn/hangqing/PET). The PET waste textiles could be obtained at \$0.13/kg (https://www.chinacace.org/news/view?id=14859).

Table S26. Total equipment cost of PET recycling.

Items	**Equipment Cost [$]**
Grinder	8000
COOLER2	22300
HEATX1	30500
FLASH1	1404200
FLASH2	44400
2-Sep	19100
RCSTR1	520500
COOLER1	22300
1-Sep	31200
Total	2102500

Table S27. Total equipment cost of petroleum-based TPA synthesis route.

Items	**Equipment Cost [$]**
RCSTR1	535400
RADFRAC1	172300
FLASH2	20100
FLASH1	20100
Total	747900

Table S28. Total direct cost, total indirect cost, and total capital investment cost of clean PET, PET wastes, and textile waste recycling.

Items	Notes	Value [$]
Equipment cost	The cost of equipment	2,102,500
Equipment installation	0.47 * Equipment cost	988,175
Instrumentation and control	0.36 * Equipment cost	756,900
Piping	0.68 * Equipment cost	1,429,700
Electrical/heating installation	0.19 * Equipment cost	399,475
Utility	Buildings construction + Site development + Service facilities + Delivery	1,892,250
Total Direct cost (TDC)	**Sum of above items**	**7,569,000**
Engineering and supervision	0.10 * TDC	756,900
Construction fee	0.10 * TDC	756,900
Legal expenses	0.03 * TDC	227,070
Project Contingency	0.10 * TDC	75,690
Construction labor cost	0.15 * TDC	1,135,350
Other Cost (Start-Up, Permits)	0.10 * TDC	756,900
Total Indirect Cost (TIC)	**Sum of above items**	**3,708,810**
Fixed Capital Investment (FCI)	TDC+TIC	11,277,810
Land	0.10 * FCI	1,127,781
Working Capital	0.05 * FCI	563,891
Total Capital Investment (TCI)	**FCI + Land + Working capital**	**12,969,482**

Table S29. Variable operating cost, fix operating cost, general expenses and total raw materials of clean PET, PET wastes, and textile waste recycling.

Items	Notes	Value [$]		
Operating labor	Operating hours * hourly wage * workers	900,000		
Operating supervision	0.15 * Operating labor	135,000		
Maintenance and repair	0.06 * FCI	676,669		
Operating supplies	0.15 * Maintenance and repair	101,500		
Laboratory charges	0.15 * Operating labor	20,250		
Royalties	0.03 * Total product cost	2,517,163	1,679,781	780,370
Variable operating cost	**Sum of above items**	**4,350,582**	**3,513,200**	**2,613,789**
Property tax	0.02 * FCI	225,556		
Insurance	0.01 * FCI	112,778		
Rent	0.08 * FCI	902,225		
Depreciation	0.20 * FCI	2,255,562		
Fix operating cost	**Sum of above items**	**3,496,121**		
Administration	0.20 * Operating labor	180,000		
Distribution and selling Research and development	0.05 * (Variable operating costs + Fix operating costs)	392,335	350,466	305,496
Research and development	0.04 * (Variable operating costs + Fix operating costs)	313,868	280,373	244,396
General expenses	**Sum of above items**	**886,203**	**810,839**	**729,892**
Raw materials	Clean PET, PET waste, textile waste	66,000,000	39,000,000	10,000,000
Chemicals	Zinc pyridyl thione	185,714		
Tap water	For cooling	926,940		
Steam	As an energy carrier, for heating	3,733,386		
Electricity	For all the process using electricity	1,766,500		
Transportation	For transporting waste raw materials	2,560,000		
Total raw materials	**Sum of above items**	**75,172,540**	**48,172,540**	**19,172,540**

Table S30. Total direct cost, total indirect cost, and total capital investment cost of TPA route to produce BHET.

Items	Notes	Value [$]
Equipment cost	The cost of equipment	747,900
Equipment installation	0.47 * Equipment cost	351,513
Instrumentation and control	0.36 * Equipment cost	269,244
Piping	0.68 * Equipment cost	508,572
Electrical/heating installation	0.19 * Equipment cost	142,101
Utility	Buildings construction + Site development + Service facilities + Delivery	673,110
Total Direct cost (TDC)	**Sum of above items**	**2,692,440**
Engineering and supervision	0.10 * TDC	269,244
Construction fee	0.10 * TDC	269,244
Legal expenses	0.03 * TDC	80,773
Project Contingency	0.10 * TDC	26,924
Construction labor cost	0.15 * TDC	403,866
Other Cost (Start-Up, Permits)	0.10 * TDC	269,244
Total Indirect Cost (TIC)	**Sum of above items**	**1,319,296**
Fixed Capital Investment (FCI)	TDC+TIC	4,011,736
Land	0.10 * FCI	401,174
Working Capital	0.05 * FCI	200,587
Total Capital Investment (TCI)	**FCI + Land + Working capital**	**4,613,496**

Table S31. Variable operating cost, fix operating cost, general expenses of TPA route to produce BHET.

Items	Notes	Value [$]
Operating labor	Operating hours * hourly wage * workers	900,000
Operating supervision	0.15 * Operating labor	135,000
Maintenance and repair	0.06 * FCI	240,704
Operating supplies	0.15 * Maintenance and repair	36,106
Laboratory charges	0.15 * Operating labor	20,250
Royalties	0.03 * Total product cost	2,605,863
Variable operating cost	**Sum of above items**	**3,937,923**
Property tax	0.02 * FCI	80,235
Insurance	0.01 * FCI	40,117
Rent	0.08 * FCI	320,939
Depreciation	0.20 * FCI	802,347
Fix operating cost	**Sum of above items**	**1,243,638**
Administration	0.20 * Operating labor	180,000
Distribution and selling Research and development	0.05 * (Variable operating costs + Fix operating costs)	259,078
Research and development	0.04 * (Variable operating costs + Fix operating costs)	207,262
General expenses	**Sum of above items**	**646,340**
Chemicals	TPA, EG, catalyst	171,164,619
Tap water	For cooling	563,888
Steam	As an energy carrier, for heating	208,728
Total raw materials	**Sum of above items**	**171,937,235**

Table S32. Total direct cost, total indirect cost, land, working capital and total capital investment cost of PET waste recycling.

Items	**Value (Million $)**
Total Direct cost (TDC)	7.57
Total Indirect Cost (TIC)	3.71
Land	1.13
Working Capital	0.56
Total Capital Investment (TCI)	12.97

Table S33. Total direct cost, total indirect cost, land, working capital and total capital investment cost of TPA route to produce BHET.

Items	**Value (Million $)**
Total Direct cost (TDC)	2.69
Total Indirect Cost (TIC)	1.32
Land	0.40
Working Capital	0.20
Total Capital Investment (TCI)	4.61

Table S34. Utility operation cost of clean PET recycling.

Items	**Value ($/year)**	**Yield (t/year)**	**Unit production cost ($/t)**
Variable operating cost	4350582	122971	35.38
Fix operating cost	3496121		28.43
General expenses	886203		7.21
Total raw materials	75172540		611.31
Total production cost	83905447		682.32

Table S35. Utility operation cost of PET waste recycling.

Items	**Value ($/year)**	**Yield (t/year)**	**Unit production cost ($/t)**
Variable operating cost	3513200	122971	28.57
Fix operating cost	3496121		28.43
General expenses	810839		6.59
Total raw materials	48172540		391.74
Total production cost	55992700		455.33

Table S36. Utility operation cost of textile waste recycling.

Items	**Value ($/year)**	**Yield (t/year)**	**Unit production cost ($/t)**
Variable operating cost	2613789	122971	21.26
Fix operating cost	3496121		28.43
General expenses	729892		5.94
Total raw materials	19172540		155.91
Total production cost	26012342		211.53

Table S37. Utility operation cost of TPA route to produce BHET.

Items	**Value ($/year)**	**Yield (t/year)**	**Unit production cost ($/t)**
Variable operating cost	3,937,923	123,848	31.8
Fix operating cost	1,243,638		10.0
General expenses	646,340		5.2
Total raw materials	171,937,235		1388.3
Total production cost	177,765,137		1435.3

Table S38. MSP of PET recycling, TPA route to produce BHET, and literature.

Items	**Value (\$/t)**
PET recycling	682.32 (clean PET)
	455.33 (PET waste)
	211.53 (textile waste)
TPA route to produce BHET	1435.3
ZnO-MW[15]	1495.7
GB-richCeO_2[32]	1290
Cu_1Ru_1 superstructures[33]	1020
$CoMn_2O_4$[34]	1312
Spent $LiCoO_2$[35]	1679

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