Table S1 LCI Scenario A: PTA from isobutanol

	Process name input	Amount	Unit
Cultivation phases			
	Sweet corn {GLO}| market for sweet corn | Cut-off, U	8.9E+02	kg
Isobutanol production			
Input	Water, process, unspecified natural origin/kg	1.2E+03	kg
	Sulfuric acid {RER}| production | Cut-off, U	6.6E+00	kg
	Sodium hydroxide, without water, in 50% solution state {RER}| chlor-alkali electrolysis, membrane cell | Cut-off, U	9.9E+00	kg
	Ammonium sulfate, as N {RER}| ammonium sulfate production | Cut-off, U	2.6E+00	kg
	Phosphate fertiliser, as P2O5 {RER}| diammonium phosphate production | Cut-off, U	2.6E+00	kg
	Electricity, high voltage {RER}| market group for | Cut-off, U	3.9E+01	kWh
	Heat, district or industrial, natural gas {Europe without Switzerland}| heat production, natural gas, at industrial furnace >100kW | Cut-off, U	1.3E+03	MJ
Emission & Waste	Carbon dioxide, biogenic	6.1E+02	kg
	Heat, waste	9.3E+02	MJ
	Treatment, sewage, from residence, to wastewater treatment, class 2/CH U	4.4E-01	m^3
p-Xylene production			
Input	Heat, district or industrial, natural gas {Europe without Switzerland}| heat production, natural gas, at industrial furnace >100kW | Cut-off, U	8.2E+02	MJ
	Cooling energy {CH}| from natural gas, at cogen unit with absorption chiller 100kW | Cut-off, U	8.1E+02	MJ
	Electricity, high voltage {RER}| market group for | Cut-off, U	5.6E+01	MJ
Emission & Waste	Wastewater, average {Europe without Switzerland}| treatment of wastewater, average, capacity 1E9l/year | Cut-off, U	5.4E+01	kg
Oxidation to PTA			
Input	Oxygen	5.9E+01	kg
	Carbon dioxide, in air	3.5E-01	kg
	Acetic acid, without water, in 98% solution state {RER}| acetic acid production, product in 98% solution state | Cut-off, U	5.4E-01	kg
	Heat, district or industrial, natural gas {Europe without Switzerland}| heat production, natural gas, at industrial furnace >100kW | Cut-off, U	6.9E+02	MJ
Emission & Waste	Oxygen	1.5E+00	kg
	Carbon dioxide, biogenic	6.0E-01	kg
	Wastewater, average {Europe without Switzerland}| treatment of wastewater, average, capacity 1E9l/year | Cut-off, U	2.2E+01	kg

Table S2 LCI Scenario B: PTA from HMF and ethylene

	Process name input	Amount	Unit
Bio-ethylene production			
Input	Ethanol, without water, in 95% solution state, from fermentation {RoW}| ethanol production from maize | Cut-off, U	2.0E+01	kg
	Electricity, high voltage {RER}| market group for | Cut-off, U	2.1E+01	MJ
	Heavy fuel oil, burned in refinery furnace {Europe without Switzerland}| processing | Cut-off, U	6.6E+01	MJ
Emission	Methane	1.8E-02	kg
	Carbon monoxide	2.3E-03	kg
	Carbon dioxide	3.8E+00	kg
	NMVOC, non-methane volatile organic compounds, unspecified origin	1.3E-04	kg
	Sulfur dioxide	1.2E-03	kg
	Nitrogen oxides	1.8E-02	kg
	Dinitrogen monoxide	1.4E-04	kg
p-Xylene production			
Input	Sugar, from sugar beet {RoW}| beet sugar production | Cut-off, U	1.0E+02	kg
	Hydrogen, liquid {RER}| chlor-alkali electrolysis, membrane cell | Cut-off, U	2.9E+00	kg
	Water, cooling, unspecified natural origin, RER	2.7E+00	m^3
	Electricity, high voltage {RER}| market group for | Cut-off, U	3.4E+01	MJ
	Steam, in chemical industry {RER}| production | Cut-off, U	1.0E+03	kg
Emission & Waste	Carbon dioxide	2.3E+00	kg
	Wastewater, average {Europe without Switzerland}| treatment of wastewater, average, capacity 1E9l/year | Cut-off, U	4.7E+01	kg
Oxidation to PTA			
Input	Oxygen	5.9E+01	kg
	Carbon dioxide, in air	3.5E-01	kg
	Acetic acid, without water, in 98% solution state {RER}| acetic acid production, product in 98% solution state | Cut-off, U	5.4E-01	kg
	Heat, district or industrial, natural gas {Europe without Switzerland}| heat production, natural gas, at industrial furnace >100kW | Cut-off, U	6.9E+02	MJ
Emission & Waste	Oxygen	1.5E+00	kg
	Carbon dioxide, biogenic	6.0E-01	kg
	Wastewater, average {Europe without Switzerland}| treatment of wastewater, average, capacity 1E9l/year | Cut-off, U	2.2E+01	kg

Table S3 LCI Scenario C: PTA from orange peels

	Process name input	Amount	Unit
p-Cymene production			
Input	Orange peels	4.1E+03	kg
	Water, process, unspecified natural origin/kg	4.1E+02	kg
	Electricity, high voltage {RER}| market group for | Cut-off, U	3.6E+02	kWh
	Steam, in chemical industry {RER}| production | Cut-off, U	2.3E+02	kg
	Water, cooling, unspecified natural origin, RER	5.2E+01	m^3
Waste	Wastewater, average {Europe without Switzerland}| treatment of wastewater, average, capacity 1E9l/year | APOS, U	3.5E+03	kg
Avoided product	Composting of wastes	1.7E+04	kg
Oxidation to PTA			
Input	Oxygen	1.7E+01	kg
	Heat, district or industrial, natural gas {Europe without Switzerland}| heat production, natural gas, at industrial furnace >100kW | Cut-off, U	5.1E+01	MJ
	Cooling energy {CH}| from natural gas, at cogen unit with absorption chiller 100kW | Cut-off, U	3.3E+02	MJ
	Electricity, high voltage {RER}| market group for | Cut-off, U	4.8E+01	MJ
Emission & Waste	Wastewater, average {Europe without Switzerland}| treatment of wastewater, average, capacity 1E9l/year | Cut-off, U	7.3E+00	kg

Table S4 LCI Scenario D: PTA from crude oil

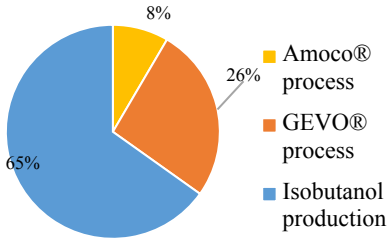
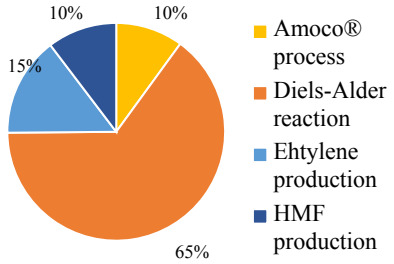
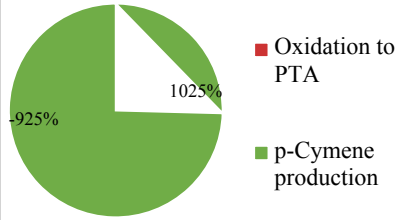
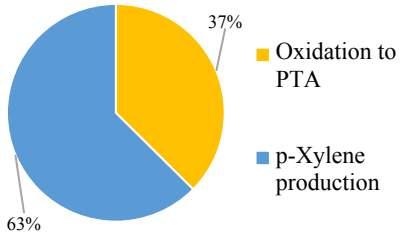
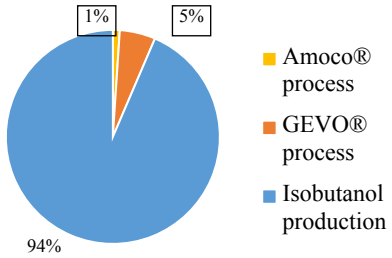
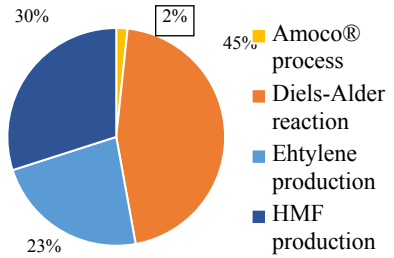
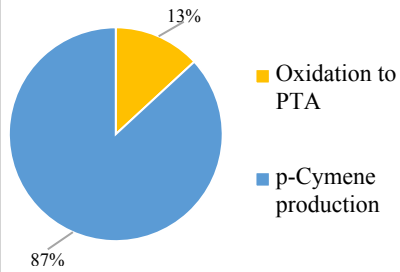
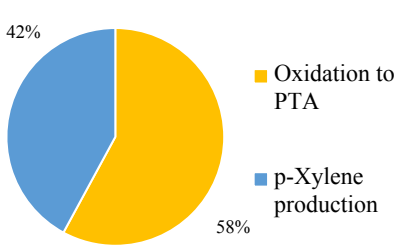
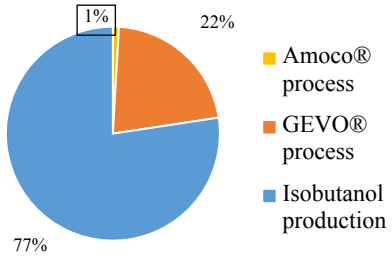
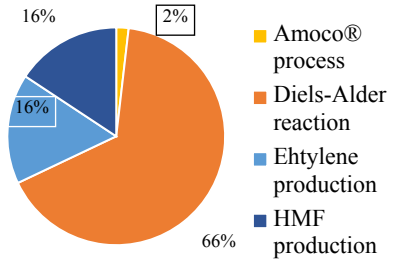
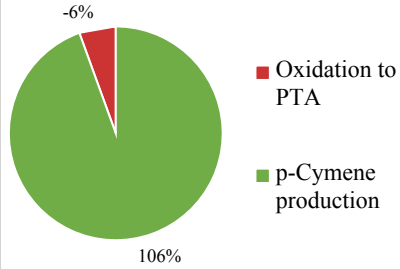
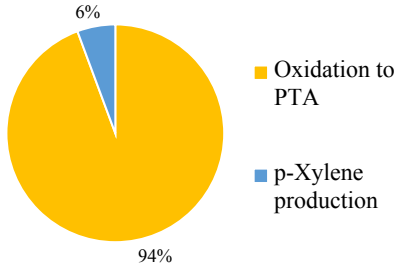
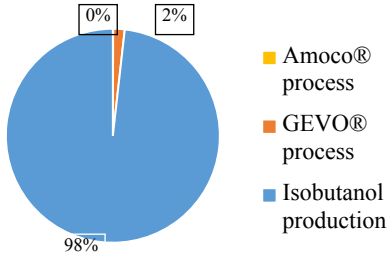
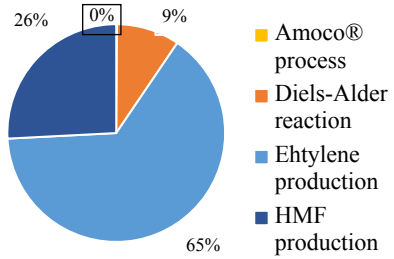
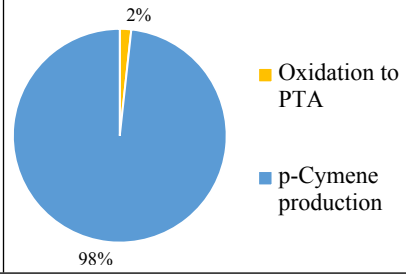
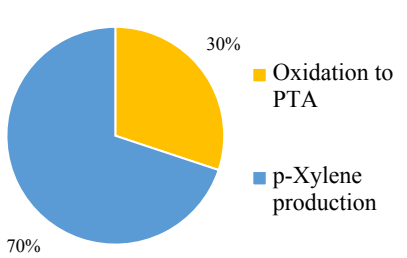
	Process name input	Amount	Unit
PTA production			
Input	Water, cooling, unspecified natural origin, RER	3.4E-01	m^3
	Acetic acid, without water, in 98% solution state {GLO}| market for | Cut-off, U	5.0E+01	kg
	Chemical factory, organics {GLO}| market for | Cut-off, U	4.0E-07	p
	Electricity, medium voltage {RER}| market group for | Cut-off, U	4.7E+02	kWh
	Heat, district or industrial, natural gas {RER}| market group for | Cut-off, U	4.6E+02	MJ
	Heat, district or industrial, other than natural gas {RER}| market group for | Cut-off, U	1.2E+03	MJ
	Nitrogen, liquid {RER}| market for | Cut-off, U	4.9E+01	kg
	Sodium hydroxide, without water, in 50% solution state {GLO}| market for | Cut-off, U	1.5E+00	kg
	Steam, in chemical industry {GLO}| market for | Cut-off, U	6.4E+02	kg
	Water, completely softened, from decarbonised water, at user {GLO}| market for | Cut-off, U	4.3E+02	kg
	Xylene {GLO}| market for | Cut-off, U	6.6E+02	kg
Emission & Waste	Hydrocarbons, aromatic	0.378	kg
	NMVOC, non-methane volatile organic compounds, unspecified origin	0.11	kg
	Particulates, < 2.5 um	0.02	kg
	Particulates, > 10 um	0.03	kg
	Particulates, > 2.5 um, and < 10um	0.04	kg
	Water/m3	0.22	m^3
	Average incineration residue {GLO}| market for | Cut-off, U	6.00	kg
	Hazardous waste, for underground deposit {GLO}| market for | Cut-off, U	0.20	kg

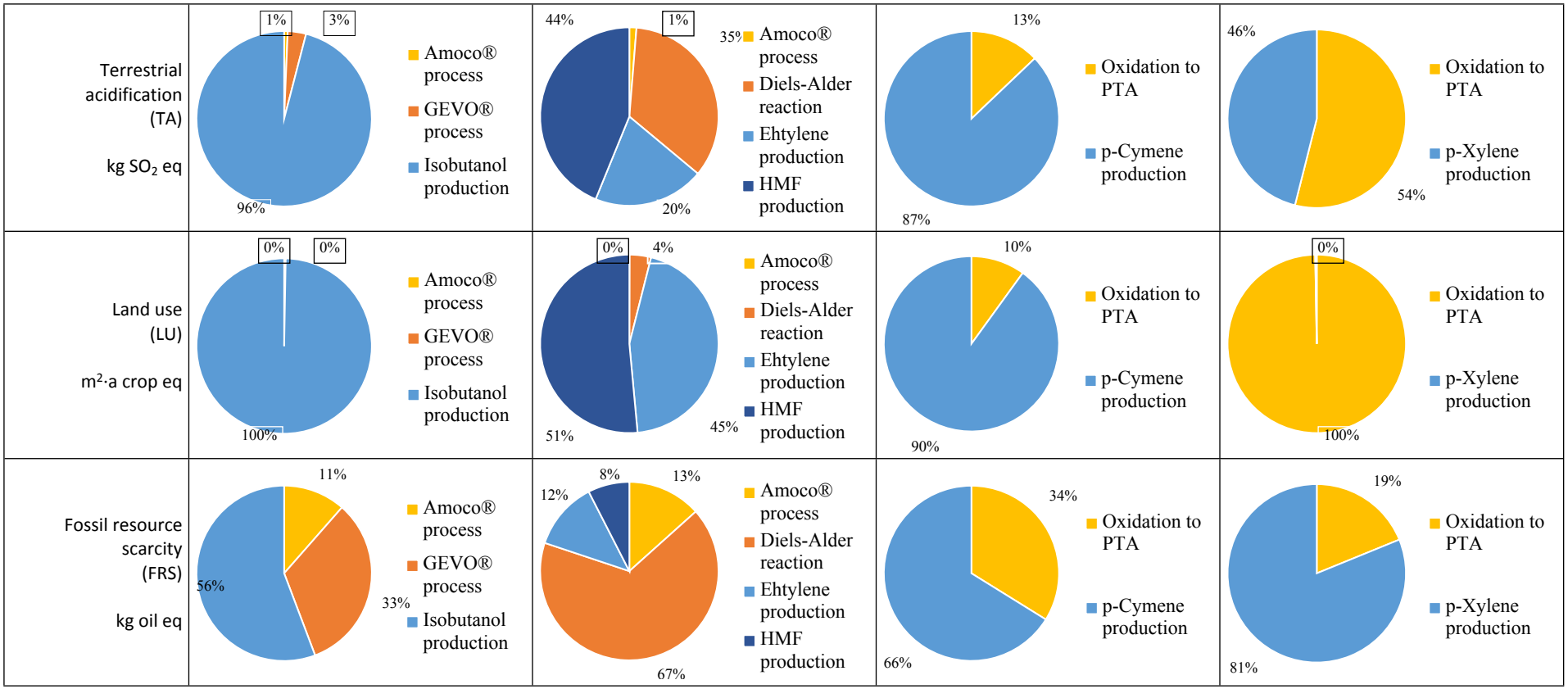
Table S5 Contribution analysis of the midpoint impacts of the scenarios (Cut-off >2%).

		Global warming kg CO_2 eq	Fine particulate matter formation kg PM2.5 eq	Human toxicity kg 1,4-DCB	Water consumption m^3	Terrestrial acidification kg SO_2 eq	Land use m^2·a crop eq	Fossil resource scarcity kg oil eq
Scenario A	**Total**	**5.8E+03**	**9.4E+00**	**2.5E+03**	**4.2E+02**	**4.3E+01**	**2.0E+03**	**1.7E+03**
Amoco® process	Heat, district or industrial, natural gas {Europe without Switzerland}| heat production, natural gas, at industrial furnace >100kW | Cut-off, U	4.9E+02	8.6E-02	1.4E+01	1.5E-01	2.5E-01	3.1E-01	1.9E+02
GEVO® process	Cooling energy {CH}| from natural gas, at cogen unit with absorption chiller 100kW | Cut-off, U	9.2E+02	3.0E-01	4.8E+02	6.5E+00	8.7E-01	2.5E+00	3.2E+02
	Heat, district or industrial, natural gas {Europe without Switzerland}| heat production, natural gas, at industrial furnace >100kW | Cut-off, U	5.6E+02	9.9E-02	1.6E+01	1.7E-01	2.9E-01	3.5E-01	2.2E+02
Isobutanol production	Sweet corn {GLO}| market for sweet corn | Cut-off, U	2.6E+03	7.9E+00	1.5E+03	4.0E+02	3.9E+01	2.0E+03	5.0E+02
	Phosphate fertiliser, as P2O5 {RER}| diammonium phosphate production | Cut-off, U	3.8E+01	1.4E-01	8.9E+01	2.4E+00	3.7E-01	7.8E+00	1.7E+01
	Sulfuric acid {RER}| production | Cut-off, U	6.9E+00	1.3E-01	2.6E+01	1.7E+00	4.3E-01	3.1E-01	9.8E+00
	Sodium hydroxide, without water, in 50% solution state {RER}| chlor-alkali electrolysis, membrane cell | Cut-off, U	7.9E+01	1.5E-01	1.2E+02	2.8E+00	3.7E-01	3.0E+00	1.9E+01
	Ammonium sulfate, as N {RER}| ammonium sulfate production | Cut-off, U	5.3E+01	5.7E-02	7.5E+01	1.9E-01	1.4E-01	2.1E+00	1.7E+01
	Heat, district or industrial, natural gas {Europe without Switzerland}| heat production, natural gas, at industrial furnace >100kW | Cut-off, U	8.7E+02	1.5E-01	2.5E+01	2.7E-01	4.5E-01	5.5E-01	3.4E+02
	Electricity, high voltage {RER}| market group for | Cut-off, U	1.7E+02	2.7E-01	1.3E+02	2.7E+00	7.5E-01	6.0E+00	4.2E+01
Scenario B	**Total**	**5.0E+03**	**5.9E+00**	**1.3E+03**	**1.9E+02**	**2.2E+01**	**1.0E+03**	**1.5E+03**
Amoco® process	Heat, district or industrial, natural gas {Europe without Switzerland}| heat production, natural gas, at industrial furnace >100kW | Cut-off, U	4.9E+02	8.6E-02	1.4E+01	1.5E-01	2.5E-01	3.1E-01	1.9E+02
Diels-Alder reaction	Steam, in chemical industry {RER}| production | Cut-off, U	2.8E+03	2.0E+00	3.2E+02	4.0E+00	5.9E+00	2.7E+01	8.8E+02
	Hydrogen, liquid {RER}| chlor-alkali electrolysis, membrane cell | Cut-off, U	3.3E+02	6.0E-01	4.9E+02	1.1E+01	1.5E+00	1.2E+01	7.9E+01
	Electricity, high voltage {RER}| market group for | Cut-off, U	4.1E+01	6.5E-02	3.2E+01	6.6E-01	1.8E-01	1.5E+00	1.0E+01
Ehtylene production	Heavy fuel oil, burned in refinery furnace {Europe without Switzerland}| processing | Cut-off, U	5.5E+01	2.0E-01	5.6E+00	1.1E-01	6.2E-01	9.4E-02	1.9E+01
	Maize grain {GLO}| market for | Cut-off, U	4.0E+02	8.8E-01	1.0E+02	1.1E+02	3.2E+00	4.6E+02	7.4E+01

	Electricity, medium voltage {RER}| market group for | Cut-off, U	6.1E+01	1.3E-01	2.9E+01	3.7E-01	2.2E-01	6.7E-01	1.4E+01
	Heat, district or industrial, natural gas {RER}| market group for | Cut-off, U	1.5E+02	3.2E-02	5.1E+00	8.0E-02	9.4E-02	1.0E-01	6.0E+01
HMF production	Sugar beet {RoW}| market for sugar beet | Cut-off, U	3.0E+02	1.4E+00	6.7E+01	4.5E+01	9.0E+00	5.3E+02	5.0E+01
	Electricity, high voltage {RER}| market group for | Cut-off, U	1.2E+02	2.6E-01	5.5E+01	7.0E-01	4.1E-01	1.3E+00	2.7E+01
	Transport, tractor and trailer, agricultural {GLO}| market for | Cut-off, U	1.8E+01	4.3E-02	4.7E+01	8.3E-02	8.2E-02	1.2E+00	4.8E+00
	Tap water {RoW}| market for | Cut-off, U	2.5E+00	5.2E-03	2.1E+00	4.2E+00	9.5E-03	4.3E-02	6.0E-01
Scenario C	**Total**	**4.7E+01**	**1.7E+00**	**-4.6E+03**	**2.1E+02**	**5.1E+00**	**3.2E+01**	**4.9E+02**
Oxidation to PTA	Cooling energy {CH}| from natural gas, at cogen unit with absorption chiller 100kW | Cut-off, U	3.9E+02	1.3E-01	2.0E+02	2.7E+00	3.7E-01	1.1E+00	1.4E+02
	Electricity, high voltage {RER}| market group for | Cut-off, U	6.0E+01	9.4E-02	4.7E+01	9.6E-01	2.7E-01	2.1E+00	1.5E+01
	Heat, district or industrial, natural gas {Europe without Switzerland}| heat production, natural gas, at industrial furnace >100kW | Cut-off, U	3.6E+01	6.4E-03	1.0E+00	1.1E-02	1.9E-02	2.3E-02	1.4E+01
p-Cymene production	Electricity, high voltage {RER}| market group for | Cut-off, U	6.7E+02	1.1E+00	5.3E+02	1.1E+01	3.0E+00	2.4E+01	1.7E+02
	Water, cooling, unspecified natural origin, RER	2.0E+00	1.0E-02	0.0E+00	2.2E+02	0.0E+00	1.0E-01	1.0E+00
	Avoided composting	-1.4E+03	2.4E-01	-5.4E+03	-1.3E+01	8.1E-01	2.0E+00	6.7E+01
	Steam, in chemical industry {RER}| production | Cut-off, U	2.8E+02	2.0E-01	3.1E+01	4.0E-01	5.9E-01	2.6E+00	8.7E+01
	Wastewater, average {Europe without Switzerland}| treatment of wastewater, average, capacity 1E9l/year | Cut-off, U	7.7E+00	1.8E-02	4.4E+01	-1.3E+01	5.7E-02	3.9E-01	1.6E+00
Scenario D	**Total**	**1.9E+03**	**1.9E+00**	**1.0E+03**	**2.7E+01**	**5.4E+00**	**2.8E+01**	**1.2E+03**
Oxidation to PTA	Steam, in chemical industry {GLO}| market for | Cut-off, U	2.1E+02	1.9E-01	3.2E+01	2.5E-01	5.3E-01	1.1E+00	6.1E+01
	Electricity, medium voltage {RER}| market group for | Cut-off, U	2.1E+02	3.3E-01	1.8E+02	3.4E+00	9.5E-01	7.5E+00	5.3E+01
	Nitrogen, liquid {RER}| market for | Cut-off, U	1.3E+01	2.0E-02	1.1E+01	6.0E-01	5.6E-02	4.5E-01	3.2E+00
	Acetic acid, without water, in 98% solution state {GLO}| market for | Cut-off, U	9.2E+01	1.6E-01	7.7E+01	2.3E+00	3.5E-01	1.5E+00	5.3E+01
	Heat, district or industrial, other than natural gas {RER}| market group for | Cut-off, U	1.1E+02	1.5E-01	2.5E+01	5.8E-01	4.6E-01	9.3E+00	2.9E+01
	Chemical factory, organics {GLO}| market for | Cut-off, U	6.9E+01	2.2E-01	5.7E+02	5.7E-01	4.8E-01	6.4E+00	1.5E+01
	Xylene {RER}| Cut-off, U	1.2E+03	7.8E-01	3.6E+00	1.9E+01	2.4E+00	0.0E+00	9.2E+02

Table S6 Contribution of the phases of the processes on the impacts of the scenarios.

Impact Category	Scenario A	Scenario B	Scenario C	Scenario D
Global warming (GW) kg CO_2 eq				
Fine particular matter formation (FPMF) kg PM2.5 eq				
Human toxicity (HT) kg 1,4-DCB				
Water consumption (WC) m^3				



General legend:

- Final oxidation steps (*Amoco process* and *Oxidation to PTA*)
- Transformations to p-Xylene (*GEVO process* and *Diels-Alder reaction*)
- Raw materials (*Isobutanol*, *Ethylene*, *HMF*, *p-Cymene* and *p-Xylene*)
- Negative impacts
- Positive impacts

Table S7 Comparison between PTA production scenarios in terms of ReCiPe 2016 Endpoint H/A – Characterization analysis

Impact category	Unit	Scenario A	Scenario B	Scenario C	Scenario D
Global warming – Human Health	DALY	$5.42 \cdot 10^{-3}$	$4.65 \cdot 10^{-3}$	$4.37 \cdot 10^{-5}$	$1.78 \cdot 10^{-3}$
Fine particulate matter formation	DALY	$5.90 \cdot 10^{-3}$	$3.70 \cdot 10^{-3}$	$1.10 \cdot 10^{-3}$	$1.23 \cdot 10^{-3}$
Human toxicity	DALY	$9.50 \cdot 10^{-4}$	$5.35 \cdot 10^{-4}$	$-1.39 \cdot 10^{-3}$	$4.70 \cdot 10^{-4}$
Water consumption – Human Health	DALY	$9.73 \cdot 10^{-4}$	$4.29 \cdot 10^{-4}$	$4.69 \cdot 10^{-4}$	$5.97 \cdot 10^{-5}$
Global warming – Terrestrial Ecosystems	species·yr	$1.64 \cdot 10^{-5}$	$1.40 \cdot 10^{-5}$	$1.33 \cdot 10^{-7}$	$5.37 \cdot 10^{-6}$
Terrestrial acidification	species·yr	$9.22 \cdot 10^{-6}$	$4.68 \cdot 10^{-6}$	$1.08 \cdot 10^{-6}$	$1.15 \cdot 10^{-6}$
Land use	species·yr	$1.74 \cdot 10^{-5}$	$9.23 \cdot 10^{-6}$	$2.83 \cdot 10^{-7}$	$2.48 \cdot 10^{-7}$
Water consumption – Terrestrial Ecosystems	species·yr	$5.91 \cdot 10^{-6}$	$2.61 \cdot 10^{-6}$	$2.85 \cdot 10^{-6}$	$3.63 \cdot 10^{-7}$
Fossil resource scarcity	USD2013	$5.79 \cdot 10^{2}$	$4.73 \cdot 10^{2}$	$1.27 \cdot 10^{2}$	$4.42 \cdot 10^{2}$

Table S8 Comparison between PTA production scenarios in terms of ReCiPe 2016 H/A – Single Score

Impact category	Unit	Scenario A	Scenario B	Scenario C	Scenario D
Total impact	**Pt**	**746.13**	**558.89**	**96.58**	**372.46**
Global warming	Pt	143.63	123.20	1.16	47.10
Fine particulate matter formation	Pt	116.94	73.34	21.73	24.42
Human toxicity	Pt	18.83	10.60	-27.53	9.31
Water consumption	Pt	32.35	14.26	15.60	1.99
Terrestrial acidification	Pt	20.39	10.35	2.39	2.55
Land use	Pt	38.58	20.43	0.63	0.55
Fossil resource scarcity	Pt	375.40	306.71	82.60	286.54

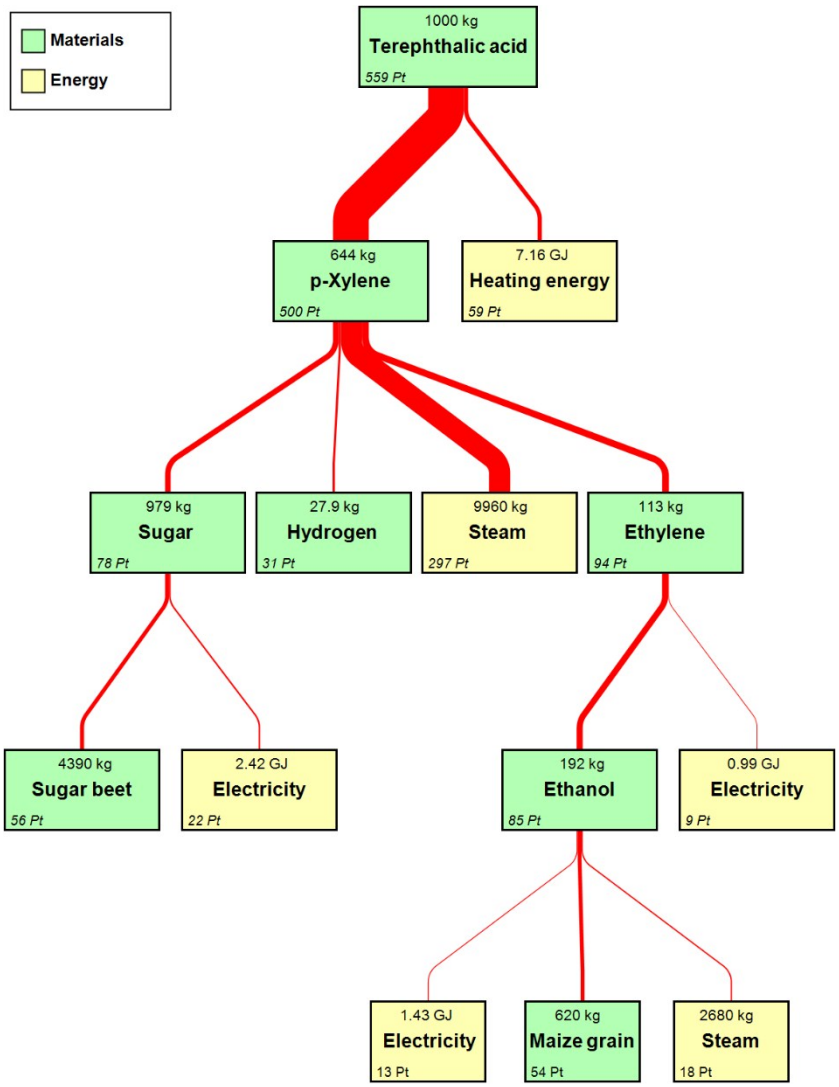


Fig. S1 Contribution analysis for Scenario B (ReCiPe 2016 H/A).

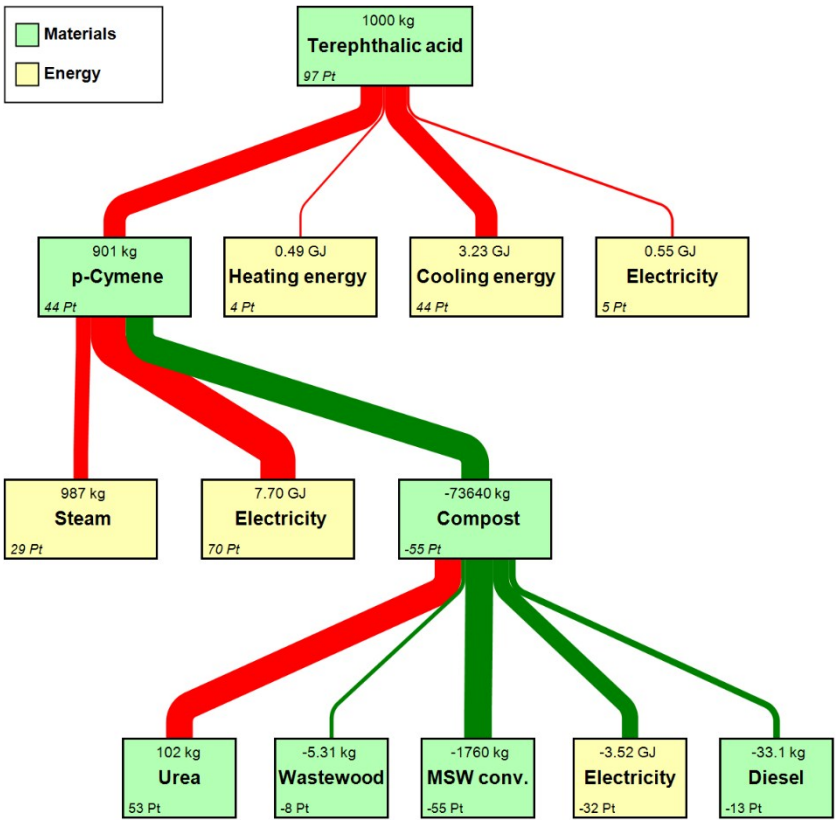


Fig. S2 Contribution analysis for Scenario C (ReCiPe 2016 H/A).

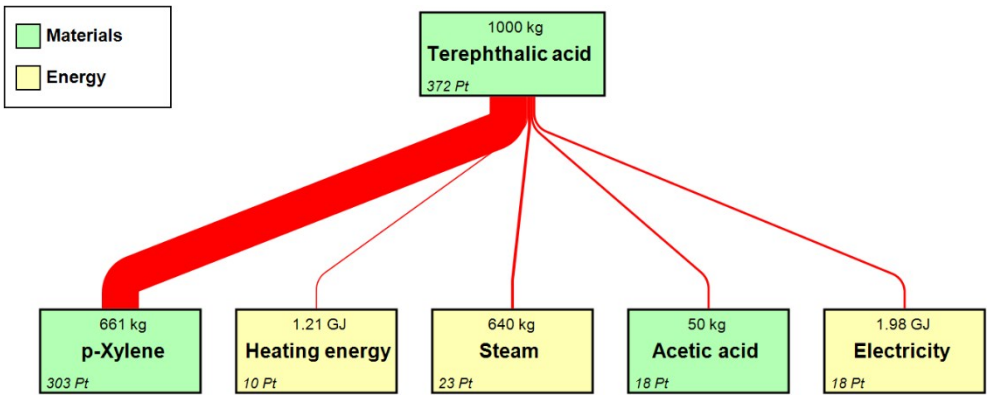


Fig. S3 Contribution analysis for Scenario D (ReCiPe 2016 H/A).

Table S9 Comparison of standard Scenario A and Scenario B with those with 50% waste biomass (ReCiPe 2016 H/A - Single Score).

Impact category	Unit	Scenario A	Scenario A_50%	Difference	Scenario B	Scenario B_50%	Difference
Total impact	**Pt**	**746.13**	**560.80**	**- 24.8%**	**558.89**	**504.75**	**- 9.7%**
Global warming	Pt	143.63	111.88	- 22.1%	123.20	114.57	- 7.0%
Fine particulate matter formation	Pt	116.94	67.83	- 42.0%	73.34	59.13	- 19.4%
Human toxicity	Pt	18.83	13.13	- 30.3%	10.60	9.64	- 9.1%
Water consumption	Pt	32.35	17.69	- 45.3%	14.26	8.72	- 38.9%
Terrestrial acidification	Pt	20.39	11.20	- 45.1%	10.35	7.48	- 27.7%
Land use	Pt	38.58	19.54	- 49.4%	20.43	10.67	- 47.8%
Fossil resource scarcity	Pt	375.40	319.53	- 14.9%	306.71	294.54	- 4.0%