

Supplementary information

Inventory of country-specific emissions of engineered nanomaterials throughout the life cycle

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Country allocation of ENM production

Table S1: Nano-TiO₂ production percentages in European companies (C1 to C8). The countries that do not appear in the table do not produce nano-TiO₂.

Application and overall share of manufacturing (A)		Sunscreens & Cosmetics (76%)				Others (24%)						
Company		C1	C2	C3	C4	C2	C5	C3	C6	C7	C4	C8
Company production capacity at European level (B)		High	High	Medium	Low	High	High	Medium	Medium	Medium	Low	Low
Company contribution to European production (C = B / number of companies at same level)		40%	40%	15%	5%	40%	40%	5%	5%	5%	2.5%	2.5%
Contribution of plants in country to company European production (D = number of plants in country / European number of plants)	BEL								33%			
	CZE				100%						100%	
	DEU		27%			27%	100%		33%			
	ESP	100%	13%			13%						
	FIN		13%			13%						
	FRA		13%			13%				100%		
	GBR		13%			13%						
	ITA		13%			13%						
	NOR								33%			100%
	SVN			100%				100%				
Contribution of company to nano-ZnO production in country (A x C x D)	BEL								0.4%			
	CZE				4%						1%	
	DEU		8%			3%	10%		0.4%			
	ESP	30%	4%			1%						
	FIN		4%			1%						
	FRA		4%			1%				1%		
	GBR		4%			1%						
	ITA		4%			1%						
	NOR								0.4%			1%
	SVN			11%				1%				

Table S2: Nano-ZnO production percentages in European companies (C1 to C9). The countries that do not appear in the table do not produce nano-ZnO.

Application and overall share of manufacturing (A)		Sunscreens & Cosmetics (85%)					Others (15%)					
Company		C1	C2	C3	C4	C5	C3	C6	C7	C4	C8	C9
Company production capacity at European level (B)		High	High	High	Medium	Low	High	Medium	Medium	Medium	Low	Low
Company contribution to European production (C = B / number of companies at same level)		27%	27%	27%	19%	1%	80%	6%	6%	6%	0.5%	0.5%
Contribution of plants in country to company European production (D = number of plants in country / European number of plants)	BEL			33%			33%					
	CZE											100%
	DEU	20%	100%		100%			100%		100%		
	ESP										100%	
	FRA	20%				100%						
	GBR	20%							100%			
	ITA	20%										
	NLD	20%		33%			33%					
	NOR			33%			33%					
Contribution of company to nano-ZnO production in country (A x C x D)	BEL			8%			4%					
	CZE											0.1%
	DEU	4.5%	23%		16%			1%		1%		
	ESP										0.1%	
	FRA	4.5%				0.9%						
	GBR	4.5%							1%			
	ITA	4.5%										
	NLD	4.5%		8%			4%					
	NOR			8%			4%					

Table S3: Nano-Ag production percentages in European companies (C1 to C10). The countries that do not appear in the table do not produce nano-Ag.

Application and overall share of	Printed electronics (80%)	Other applications (20%)
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manufacturing (A)												
Company		C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C5
Company production capacity at European level (B)		Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Company contribution to European production (C = B / number of companies at same level)		14%	14%	14%	14%	14%	14%	14%	25%	25%	25%	25%
Contribution of plants in country to company European production (D = number of plants in country / European number of plants)	BEL	100%										
	DEU				100%	100%					100%	100%
	ESP							100%				
	FIN						100%					
	GBR			100%						100%		
	POL		100%						100%			
Contribution of company to nano-ZnO production in country (A x C x D)	BEL	11%										
	DEU				11%	11%					5%	5%
	ESP							11%				
	FIN						11%					
	GBR			11%						5%		
	POL		11%						5%			

Country distribution

Table S4: Surrogate variables chosen for country distribution for the manufacturing and consumption stages. Numbered entries are further explained below.

Application	Proxy for manufacturing stage	Proxy for consumption stage
Anti-bacterial coatings	GDP	GDP
Anti-bacterials	GDP	GDP
Cement	Cement production	GDP
Ceramic	PRODCOM_Glass and ceramics	Population
Cleaning agents	PRODCOM_Cleaning agents	Population
Cosmetics	Proxy sunscreen and cosmetics production	Proxy cosmetics use
Printing electronics	PRODCOM_Electronic printing	GDP
Electronics and appliances	PRODCOM_Electronics and appliances	GDP
Filters	PRODCOM_Filters	GDP
Food	PRODCOM_Food	Population
Glass	PRODCOM_Glass	Population
Medical	PRODCOM_Medical technolog	GDP
Paints and building surface treatments	PRODCOM_Paints and Coatings	ESIG paint consumption
Rubber, ceramic and plastic additives	GDP	Population
Small personal care items	GDP	Population
Solar	PRODCOM_Solar	GDP
Sunscreens	Proxy sunscreen and cosmetics production	Proxy sunscreen use
Textiles	PRODCOM_Textiles	Population

Explanation of PRODCOM codes used for manufacturing of specific applications

Table S5: Explanation of PRODCOM codes used for each application

Application	Selected PRODCOM codes
Cleaning agents	20412020, 20412030, 20412050, 20412090, 20413150, 20413240, 20413250, 20413260, 20413270, 20414330, 20414350, 20414370, 20414383, 20414389, 20414400
Electronics and appliances	26112220, 26112240, 26114070, 27511133, 27511135, 27511150, 27511170, 27511200, 27511200, 27511300, 28295000, 28298510, 28942150, 28942230, 28945210
Filters	28945210, 17124330, 17291200, 17291951, 22292630, 28291350, 28298250, 32995910
Food	100000Z1, 100000Z2, 10851100, 10851200, 10851300, 10851410, 10851900
Glass	20302130
Glass and ceramics	20302130, 20302150, 20302170
Medical technology	13202020, 21201380, 21202420, 21202430, 21202440, 21202460, 32501200, 32501311, 32501313, 32501315, 32501317, 32501370, 32502255, 32502259, 32502290, 32505010, 32505020, 32505030
Paints and Coatings	20301150, 20301170, 20301225, 20301229, 20301230, 20301250, 20301270, 20301290, 20302130, 20302150, 20302170, 20302213, 20302215, 20302240, 20302253, 20302255, 20302260, 20302273, 20302279, 20302350, 20302370, 20302450, 20302470
Solar	26112240
Textiles	14121120, 14121240, 14121250, 14122120, 14122130, 14122240, 14122250, 14123013, 14123023, 14131110, 14131120, 14131230, 14131260, 14131270, 14131310, 14131320, 14131430, 14131460, 14131470, 14131480, 14131490, 14132115, 14132130, 14132200, 14132300, 14132442, 14132444, 14132445, 14132448, 14132449, 14132455, 14132460, 14133115, 14133130, 14133200, 14133330, 14133470, 14133480, 14133542, 14133548, 14133549, 14133551, 14133561, 14133563, 14133565, 14133569, 14141100, 14141220, 14141230, 14141240, 14141310, 14141420, 14141430, 14141440, 14141450, 14142100, 14142220, 14142230, 14142240, 14142300, 14142430, 14142450, 14142460, 14142480, 14142489, 14142530, 14142550, 14142570, 14143000, 14191210, 14191230, 14191240, 14191250, 14191290, 14191300, 14191960, 14192210, 14192220, 14192230, 14192240, 14192250, 14192370, 14192396, 14193175, 14193190, 14193200, 14311033, 14311035, 14311037, 14311050, 14311090, 14391031, 14391032, 14391033, 14391061, 14391062, 14391071, 14391072, 14391090

Sludge management

Table S6: Transfer coefficients relating to sludge management (adapted from Eurostat¹)

Country	Year	% Landfill	% Incineration	% Agricultural use
Belgium	2010	0%	87%	13%
Bulgaria	2014	34%	0%	66%
Czechia	2014	14%	6%	79%
Denmark	2010	1%	31%	68%
Germany	2014	0%	70%	30%
Estonia	2009	90%	0%	10%
Ireland	2014	1%	0%	99%
Greece	2014	39%	38%	23%
Spain	2012	16%	4%	80%
France	2014	5%	27%	68%
Croatia	2014	95%	0%	5%
Italy	2010	57%	5%	39%
Cyprus	2014	0%	0%	100%
Latvia	2013	3%	0%	97%
Lithuania	2014	0%	0%	100%
Luxembourg	2012	0%	16%	84%
Hungary	2014	14%	74%	12%
Malta	2014	100%	0%	0%
Netherlands	2014	0%	100%	0%
Austria	2014	2%	73%	25%
Poland	2014	14%	38%	48%
Portugal	2012	10%	0%	90%
Romania	2014	91%	1%	8%
Slovenia	2014	2%	97%	1%
Slovakia	2014	21%	79%	0%
Finland	2012	20%	65%	15%
Sweden	2014	6%	4%	90%
United Kingdom	2012	0%	21%	78%
Norway	2014	18%	0%	83%
Switzerland	2013	0%	100%	0%

Normalised releases to soil and surface water

Table S7: References used to calculate normalised releases to soil and surface water.

Country	Total surface area	Freshwater surface
Austria	Eurostat ²	Eurostat
Belgium	Eurostat	Eurostat
Bulgaria	Eurostat	Eurostat
Switzerland	Steinmeier (2013) ³	Steinmeier (2013)
Cyprus	Eurostat	Eurostat
Czech Republic	Eurostat	Eurostat
Germany	Eurostat	Eurostat
Denmark	Eurostat	Eurostat
Spain	Eurostat	Eurostat
Estonia	Eurostat	Klein (2000) ⁴
Finland	Eurostat	Eurostat
France	Eurostat	Eurostat
United Kingdom	Eurostat	Eurostat
Greece	Eurostat	Eurostat
Croatia	Eurostat	Eurostat
Hungary	Eurostat	Eurostat
Ireland	Eurostat	Eurostat
Italy	Eurostat	Eurostat
Lithuania	Eurostat	Eurostat
Luxembourg	Eurostat	Eurostat
Latvia	Eurostat	Eurostat
Malta	Eurostat	Eurostat
Netherlands	Eurostat	Eurostat

Norway	Worldatlas ⁵	Worldatlas
Poland	Eurostat	Eurostat
Portugal	Eurostat	Eurostat
Romania	Eurostat	Eurostat
Slovakia	Eurostat	Eurostat
Slovenia	Eurostat	Eurostat
Sweden	Eurostat	Eurostat

Production, manufacturing and consumption results

Table S8: Overview of different information sources for applications of nanosized TiO₂ and their relative importance

Application	Future markets (2016)	Bund (n=61)	Danish (n=111)	Mean	Min	Max
Total personal care*	72%	75%	81%	76%	72%	81%
Sunscreens**	72%	64%	21%	57%	21%	64%
Cosmetics**		11%	60%	19%	11%	60%
Coatings*	20%	21%		14%	0%	21%
Paints and building surface treatments (e.g. photocatalytic, antimicrobial)	10%	5%		5%	0%	10%
Cement	3%	5%		3%	0%	5%
Glass	3%	5%		3%	0%	5%
Ceramic	3%	5%		3%	0%	5%
Rubber, ceramic and plastic additives	5%	2%		2%	0%	5%
Solar	1%			0.3%	0%	1%
Electronics and appliances	0.5%	2%	3%	2%	0.5%	3%
Cleaning agents	0.5%		2%	0.8%	0%	2%
Food	0.5%		14%	5%	0%	14%
Textiles	0.5%			0.2%	0%	0.5%

(*) This category represents the contribution of multiple applications from this table.

(**) Sources provide opposite results, therefore the mean is not used here. Most references identify sunscreens as the most important application. Hence, it is assumed that sunscreens account for 57% of the total personal care products.

Table S9: Applications of nanosized ZnO and their relative importance.

Application	Future markets (2016)	Min	Max
Total personal care	85%	43%	100%
Paints and lacquers (coatings)	13%	7%	20%
Antibacterial	2%	1%	3%

Table S10: Applications of nanosized Ag and their relative importance.

Application	Final	Min	Max
Electronic printing	80%	40%	100%
Medical (including wound dressing and coatings in medical devices)	9%	4.5%	13.5%
Anti-bacterial coatings (indoor use, long-lasting products that are applied on surfaces, also paints)	5%	2.5%	7.5%
Cosmetics and personal care (liquids and gel)	2%	1%	3%
Textiles	2%	1%	3%
Food	0.2%	0.1%	0.3%
Cleaning agents (short-lasting products)	0.2%	0.1%	0.3%
Appliances	0.2%	0.1%	0.3%
Small personal care items (non-liquids)	0.2%	0.1%	0.3%
Filters	0.2%	0.1%	0.3%

Table S11: Total estimated production of ENMs in Europe (EU28 + Norway + Switzerland) and distributions over countries (in percentage). Countries not mentioned are assumed to have no production of each of the three ENMs.

Country	Nano-TiO ₂	Nano-ZnO	Nano-Ag
Average European total (tonnes)	38900	7260	5
BEL	0.4%	12%	11%
CHE			5%
CZE	4.4%	0.1%	
DEU	21%	45%	33%
ESP	36%	0.1%	11%
FIN	6.0%		11%
FRA	6.8%	5.4%	
GBR	5.7%	5.5%	11%
ITA	5.7%	4.6%	
NLD		16%	
NOR	1.0%	12%	
POL			16%
SVN	13%		

Values have been rounded to maximum 2 significant digit. All columns add up to 100%.

Table S12: Total estimated manufacturing and consumption of ENMs in Europe (EU28 + Norway + Switzerland) and distributions over countries (in percentage).

Country	Manufacturing			Consumption		
	Nano-TiO ₂	Nano-ZnO	Nano-Ag	Nano-TiO ₂	Nano-ZnO	Nano-Ag
AUT	1.5%	1.5%	0.3%	1.6%	1.8%	2.2%
BEL	2.6%	2.9%	2.6%	2.5%	2.4%	2.7%
BGR	0.4%	0.4%	0.1%	0.6%	0.5%	0.3%
CHE	2.5%	2.4%	3.5%	1.5%	1.5%	3.4%
CYP	0.0%	0.0%	0.0%	0.3%	0.4%	0.1%
CZE	0.9%	0.9%	0.2%	1.9%	2.0%	1.1%
DEU	19%	19%	35.6%	11%	9.5%	19%
DNK	1.2%	1.2%	0.8%	1.1%	1.0%	1.7%
ESP	11%	8.7%	6.8%	14%	15%	7.1%
EST	0.2%	0.2%	0.0%	0.2%	0.2%	0.1%
FIN	1.0%	1.1%	0.9%	1.0%	0.9%	1.4%
FRA	16%	17%	7.3%	14%	14%	14%
GBR	12%	13%	16%	14%	14%	15%
GRC	0.8%	0.9%	0.2%	2.3%	2.4%	1.2%
HRV	0.5%	0.5%	0.1%	0.7%	0.7%	0.3%
HUN	0.7%	0.7%	0.3%	1.0%	0.8%	0.8%
IRL	0.9%	1.0%	2.6%	0.7%	0.7%	1.2%
ITA	13%	12%	13%	15%	16%	11%
LTU	0.3%	0.3%	0.2%	0.3%	0.3%	0.3%
LUX	0.7%	0.8%	0.0%	0.1%	0.1%	0.3%
LVA	0.2%	0.2%	0.0%	0.3%	0.2%	0.2%
MLT	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%
NLD	3.9%	3.7%	6.5%	2.9%	2.8%	4.4%
NOR	1.2%	1.2%	0.2%	1.2%	1.2%	2.4%
POL	4.4%	4.1%	1.8%	4.8%	4.5%	3.0%
PRT	1.3%	1.4%	0.5%	2.2%	2.3%	1.2%
ROU	1.3%	1.3%	0.4%	1.2%	0.9%	1.1%
SVK	0.5%	0.5%	0.1%	1.6%	1.7%	0.5%
SVN	0.2%	0.2%	0.0%	0.4%	0.4%	0.3%
SWE	2.0%	2.3%	0.2%	1.5%	1.6%	2.8%

Values have been rounded to maximum 2 significant digits. All columns add up to 100%.

Modelling results

Table S13: 25th quantiles, means and 75th quantiles of flows of nano-TiO₂ (tonnes)

		Austria			Belgium			Bulgaria		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	31	558	556	47	835	845	8	149	149
Import	Consumption	4	114	113	0	0	0	5	98	100
Production	Manufacturing	0	0	0	128	155	271	0	0	0
Production	Wastewater	0	0	0	0	3	3	0	0	0
Production	Air	0	0	0	0	0	0	0	0	0
Production	Export	0	0	0	0	0	0	0	0	0
Manufacturing	Consumption	107	556	669	167	954	1078	65	246	347
Manufacturing	Wastewater	0	1	1	0	1	1	0	0	0
Manufacturing	Air	0	0	0	0	0	0	0	0	0
Manufacturing	Recycling systems	0	1	1	0	1	1	0	0	0
Manufacturing	Export	0	0	0	0	34	77	0	0	0
Consumption	Wastewater	78	481	559	118	685	772	45	177	245
Consumption	Air	0	1	2	0	2	2	0	1	1
Consumption	Surface water	8	52	61	13	74	84	5	19	26
Consumption	Natural & urban soil	0	1	2	0	2	2	0	0	1
Consumption	Landfill	1	4	5	0	1	1	3	13	17
Consumption	Waste incineration plant	5	32	36	6	40	45	0	0	0
Consumption	Recycling systems	14	98	112	23	150	168	8	36	47
Wastewater	WWTP	77	466	543	116	663	749	45	171	239
Wastewater	Surface water	3	15	18	4	22	25	1	6	8
WWTP	Sludge	50	355	398	76	508	570	27	130	164
WWTP	Surface water	12	111	121	19	155	171	5	41	43
Sludge	Sludge-treated soil	12	87	98	10	68	76	18	86	108
Sludge	Landfill	1	7	8	0	0	0	10	44	59
Sludge	Waste incineration plant	39	261	295	69	440	495	0	0	0
		Switzerland			Cyprus			Czech Republic		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	58	983	1025	0	4	4	0	0	0
Import	Consumption	0	0	0	8	125	126	22	409	430
Production	Manufacturing	0	0	0	0	0	0	17	308	319
Production	Wastewater	0	0	0	0	0	0	2	34	35
Production	Air	0	0	0	0	0	0	0	0	0
Production	Export	0	0	0	0	0	0	77	1389	1442
Manufacturing	Consumption	33	575	595	5	4	5	165	307	596
Manufacturing	Wastewater	0	1	1	0	0	0	0	0	0
Manufacturing	Air	0	0	0	0	0	0	0	0	0
Manufacturing	Recycling systems	0	1	1	0	0	0	0	1	1
Manufacturing	Export	23	406	422	0	0	0	0	0	0
Consumption	Wastewater	24	412	427	9	93	94	130	514	727
Consumption	Air	0	1	1	0	0	0	0	2	2
Consumption	Surface water	2	45	47	1	10	10	14	56	77
Consumption	Natural & urban soil	0	1	1	0	0	0	0	1	2
Consumption	Landfill	0	0	0	1	7	7	9	38	51
Consumption	Waste incineration plant	1	22	23	0	0	0	2	11	14
Consumption	Recycling systems	5	93	96	2	19	19	20	94	125
Wastewater	WWTP	23	399	413	8	90	91	129	498	711
Wastewater	Surface water	1	13	13	0	3	3	4	16	24
WWTP	Sludge	16	304	311	6	69	69	82	378	497
WWTP	Surface water	3	95	99	1	21	23	15	120	122
Sludge	Sludge-treated soil	0	0	0	6	69	69	65	300	394
Sludge	Landfill	0	0	0	0	0	0	14	54	77
Sludge	Waste incineration plant	16	304	312	0	0	0	6	24	33

Table S13 (continued): 25th quantiles, means and 75th quantiles of flows of nano-TiO₂ (tonnes)

		Germany			Denmark			Spain		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	0	0	0	27	477	475	0	0	0
Import	Consumption	0	0	0	0	0	0	71	1593	1619
Production	Manufacturing	402	7271	7303	0	0	0	226	3868	3988
Production	Wastewater	7	164	167	0	0	0	14	283	293
Production	Air	0	0	0	0	0	0	0	0	0
Production	Export	13	865	888	0	0	0	593	10109	10457
Manufacturing	Consumption	215	3971	3998	23	422	426	1224	3853	5503
Manufacturing	Wastewater	1	19	19	0	1	1	0	5	5
Manufacturing	Air	0	0	0	0	0	0	0	0	0
Manufacturing	Recycling systems	0	5	6	0	0	0	0	10	10
Manufacturing	Export	174	3275	3322	0	55	61	0	0	0
Consumption	Wastewater	152	2850	2876	16	303	306	902	3907	5036
Consumption	Air	0	9	9	0	1	1	2	12	14
Consumption	Surface water	16	309	316	2	33	34	95	424	544
Consumption	Natural & urban soil	0	8	8	0	1	1	2	11	14
Consumption	Landfill	0	1	1	0	7	7	65	319	402
Consumption	Waste incineration plant	8	164	166	1	15	15	11	55	69
Consumption	Recycling systems	31	631	641	3	63	64	136	718	887
Wastewater	WWTP	150	2759	2774	16	293	296	895	3782	4942
Wastewater	Surface water	5	91	89	1	10	10	30	125	166
WWTP	Sludge	106	2095	2088	11	224	228	523	2876	3516
WWTP	Surface water	21	664	718	2	68	71	110	906	956
Sludge	Sludge-treated soil	32	638	636	8	152	155	417	2295	2807
Sludge	Landfill	0	0	0	0	3	3	108	460	591
Sludge	Waste incineration plant	75	1457	1460	4	70	71	27	121	154
		Estonia			Finland			France		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	4	62	65	0	0	0	346	6229	6341
Import	Consumption	1	18	18	0	0	0	0	0	0
Production	Manufacturing	0	0	0	20	341	353	190	158	191
Production	Wastewater	0	0	0	2	46	47	0	3	3
Production	Air	0	0	0	0	0	0	0	0	0
Production	Export	0	0	0	112	1913	1972	0	0	0
Manufacturing	Consumption	16	62	82	19	323	333	465	5605	5802
Manufacturing	Wastewater	0	0	0	0	1	1	1	8	9
Manufacturing	Air	0	0	0	0	0	0	0	0	0
Manufacturing	Recycling systems	0	0	0	0	0	0	0	5	5
Manufacturing	Export	0	0	0	0	17	25	9	770	849
Consumption	Wastewater	12	58	71	13	232	239	329	4020	4173
Consumption	Air	0	0	0	0	1	1	1	12	12
Consumption	Surface water	1	6	8	1	25	26	35	438	458
Consumption	Natural & urban soil	0	0	0	0	1	1	1	11	12
Consumption	Landfill	0	1	1	0	4	4	9	122	127
Consumption	Waste incineration plant	1	4	5	0	8	8	13	164	170
Consumption	Recycling systems	2	11	13	3	53	55	64	838	864
Wastewater	WWTP	11	56	69	13	224	231	323	3891	4034
Wastewater	Surface water	0	2	2	0	7	7	11	129	136
WWTP	Sludge	7	43	50	9	170	175	234	2967	3063
WWTP	Surface water	2	13	15	2	54	56	52	925	971
Sludge	Sludge-treated soil	1	4	5	1	25	26	158	2004	2070
Sludge	Landfill	6	38	46	2	34	35	13	149	155
Sludge	Waste incineration plant	0	0	0	6	111	115	66	813	848

Table S13 (continued): 25th quantiles, means and 75th quantiles of flows of nano-TiO₂ (tonnes)

		United Kingdom			Greece			Croatia		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	153	2578	2662	19	331	341	11	194	202
Import	Consumption	41	1134	1137	31	549	563	4	88	89
Production	Manufacturing	1146	2185	4256	0	0	0	0	0	0
Production	Wastewater	2	43	44	0	0	0	0	0	0
Production	Air	0	0	0	0	0	0	0	0	0
Production	Export	0	0	0	0	0	0	0	0	0
Manufacturing	Consumption	1879	4744	7381	195	329	651	64	193	286
Manufacturing	Wastewater	2	6	9	0	0	0	0	0	0
Manufacturing	Air	0	0	0	0	0	0	0	0	0
Manufacturing	Recycling systems	3	12	15	0	1	1	0	0	0
Manufacturing	Export	0	0	0	0	0	0	0	0	0
Consumption	Wastewater	1350	4216	6039	158	630	858	47	202	267
Consumption	Air	3	13	17	0	2	2	0	1	1
Consumption	Surface water	142	459	646	17	68	92	5	22	29
Consumption	Natural & urban soil	4	12	16	0	2	2	0	1	1
Consumption	Landfill	51	180	247	11	48	63	4	19	24
Consumption	Waste incineration plant	39	136	187	0	0	0	0	0	0
Consumption	Recycling systems	245	863	1184	28	128	166	7	38	48
Wastewater	WWTP	1334	4081	5895	157	610	839	47	195	261
Wastewater	Surface water	45	135	196	5	20	27	2	6	9
WWTP	Sludge	863	3108	4268	101	465	599	28	149	183
WWTP	Surface water	165	973	1027	19	145	152	6	47	50
Sludge	Sludge-treated soil	677	2434	3338	23	106	136	1	7	9
Sludge	Landfill	10	14	28	43	181	240	28	141	177
Sludge	Waste incineration plant	195	661	915	39	179	229	0	0	0
		Hungary			Ireland			Italy		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	17	289	300	21	368	378	158	2849	2940
Import	Consumption	4	94	97	0	0	0	40	1097	1090
Production	Manufacturing	0	0	0	0	0	0	1187	2187	4404
Production	Wastewater	0	0	0	0	0	0	2	43	44
Production	Air	0	0	0	0	0	0	0	0	0
Production	Export	0	0	0	0	0	0	0	0	0
Manufacturing	Consumption	79	288	386	16	295	304	1917	5017	7718
Manufacturing	Wastewater	0	0	0	0	0	0	2	6	9
Manufacturing	Air	0	0	0	0	0	0	0	0	0
Manufacturing	Recycling systems	0	1	1	0	0	0	3	13	16
Manufacturing	Export	0	0	0	2	73	75	0	0	0
Consumption	Wastewater	58	274	344	11	212	218	1374	4387	6260
Consumption	Air	0	1	1	0	1	1	3	13	18
Consumption	Surface water	6	30	37	1	23	24	144	477	671
Consumption	Natural & urban soil	0	1	1	0	1	1	4	12	17
Consumption	Landfill	4	22	27	0	8	8	39	144	197
Consumption	Waste incineration plant	1	4	5	0	4	4	38	140	191
Consumption	Recycling systems	9	50	61	2	47	49	265	941	1292
Wastewater	WWTP	58	266	336	11	205	211	1359	4247	6117
Wastewater	Surface water	2	9	11	0	7	7	45	140	202
WWTP	Sludge	34	203	241	8	156	159	883	3229	4458
WWTP	Surface water	8	63	68	2	49	52	166	1017	1060
Sludge	Sludge-treated soil	5	28	33	8	155	157	340	1252	1726
Sludge	Landfill	7	31	39	0	2	2	516	1832	2532
Sludge	Waste incineration plant	25	144	171	0	0	0	49	146	215

Table S13 (continued): 25th quantiles, means and 75th quantiles of flows of nano-TiO₂ (tonnes)

		Lithuania			Luxemburg			Latvia		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	6	113	115	16	278	288	4	74	75
Import	Consumption	1	23	23	0	0	0	1	25	26
Production	Manufacturing	0	0	0	0	0	0	0	0	0
Production	Wastewater	0	0	0	0	0	0	0	0	0
Production	Air	0	0	0	0	0	0	0	0	0
Production	Export	0	0	0	0	0	0	0	0	0
Manufacturing	Consumption	23	113	137	3	55	57	21	74	100
Manufacturing	Wastewater	0	0	0	0	0	0	0	0	0
Manufacturing	Air	0	0	0	0	0	0	0	0	0
Manufacturing	Recycling systems	0	0	0	0	0	0	0	0	0
Manufacturing	Export	0	0	0	13	223	230	0	0	0
Consumption	Wastewater	17	98	115	2	39	41	15	71	89
Consumption	Air	0	0	0	0	0	0	0	0	0
Consumption	Surface water	2	11	12	0	4	4	2	8	10
Consumption	Natural & urban soil	0	0	0	0	0	0	0	0	0
Consumption	Landfill	1	8	9	0	0	0	1	6	7
Consumption	Waste incineration plant	0	0	0	0	2	2	0	0	0
Wastewater	WWTP	17	95	111	2	38	39	15	69	87
Wastewater	Surface water	1	3	4	0	1	1	1	2	3
WWTP	Sludge	10	72	81	1	29	30	9	52	62
WWTP	Surface water	3	23	25	0	9	9	2	16	18
Sludge	Sludge-treated soil	10	72	81	1	24	25	9	51	60
Sludge	Landfill	0	0	0	0	0	0	0	1	2
Sludge	Waste incineration plant	0	0	0	0	5	5	0	0	0
Consumption	Recycling systems	3	20	23	0	9	9	3	14	17
		Malta			Netherlands			Norway		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	0	4	4	60	1097	1132	3	76	76
Import	Consumption	2	43	44	0	0	0	2	65	65
Production	Manufacturing	0	0	0	261	383	752	79	375	444
Production	Wastewater	0	0	0	0	8	7	0	7	8
Production	Air	0	0	0	0	0	0	0	0	0
Production	Export	0	0	0	0	0	0	0	0	0
Manufacturing	Consumption	4	4	5	229	1098	1384	139	449	556
Manufacturing	Wastewater	0	0	0	0	2	2	0	1	1
Manufacturing	Air	0	0	0	0	0	0	0	0	0
Manufacturing	Recycling systems	0	0	0	0	1	1	0	1	1
Manufacturing	Export	0	0	0	54	379	452	0	0	0
Consumption	Wastewater	4	34	36	160	788	988	99	369	446
Consumption	Air	0	0	0	0	2	3	0	1	1
Consumption	Surface water	0	4	4	17	86	106	10	40	48
Consumption	Natural & urban soil	0	0	0	0	2	3	0	1	1
Consumption	Landfill	0	3	3	0	1	1	0	1	1
Consumption	Waste incineration plant	0	0	0	9	52	63	6	25	30
Consumption	Recycling systems	1	6	7	29	167	203	17	77	92
Wastewater	WWTP	4	33	34	159	762	964	98	357	432
Wastewater	Surface water	0	1	1	5	25	31	3	12	14
WWTP	Sludge	3	25	26	96	584	696	57	273	325
WWTP	Surface water	1	8	8	21	178	192	13	85	94
Sludge	Sludge-treated soil	0	0	0	0	0	0	47	225	268
Sludge	Landfill	3	25	26	0	0	0	10	48	57
Sludge	Waste incineration plant	0	0	0	101	584	703	0	0	0

Table S13 (continued): 25th quantiles, means and 75th quantiles of flows of nano-TiO₂ (tonnes)

		Poland			Portugal			Romania		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	77	1334	1381	32	530	531	29	499	517
Import	Consumption	10	305	309	17	338	342	0	0	0
Production	Manufacturing	276	387	769	0	0	0	0	0	0
Production	Wastewater	0	8	7	0	0	0	0	0	0
Production	Export	0	0	0	0	0	0	0	0	0
Production	Air	0	0	0	0	0	0	0	0	0
Manufacturing	Consumption	560	1714	2335	213	528	861	28	487	507
Manufacturing	Wastewater	0	2	3	0	1	1	0	1	1
Manufacturing	Air	0	0	0	0	0	0	0	0	0
Manufacturing	Recycling systems	1	4	5	0	1	1	0	0	0
Manufacturing	Export	0	0	0	0	0	0	0	11	29
Consumption	Wastewater	398	1449	1882	160	621	846	20	349	365
Consumption	Air	1	4	5	0	2	2	0	1	1
Consumption	Surface water	41	157	203	17	68	91	2	38	40
Consumption	Natural & urban soil	1	4	5	0	2	2	0	1	1
Consumption	Landfill	22	92	115	10	42	55	2	35	36
Consumption	Waste incineration plant	4	17	21	4	17	23	0	0	0
Consumption	Recycling systems	69	296	372	25	114	147	3	63	65
Wastewater	WWTP	395	1403	1835	160	601	832	19	338	353
Wastewater	Surface water	13	46	59	5	20	27	1	11	12
WWTP	Sludge	243	1066	1333	97	460	581	14	258	266
WWTP	Surface water	51	337	363	18	142	150	3	80	83
Sludge	Sludge-treated soil	117	512	639	87	413	522	1	21	22
Sludge	Landfill	42	151	196	13	46	65	13	235	244
Sludge	Waste incineration plant	94	403	505	1	0	2	0	2	2
		Slovakia			Slovenia			Sweden		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	11	195	197	0	0	0	46	802	831
Import	Consumption	23	421	435	2	48	49	0	0	0
Production	Manufacturing	0	0	0	1	35	36	0	0	0
Production	Wastewater	0	0	0	5	97	99	0	0	0
Production	Air	0	0	0	0	0	0	0	0	0
Production	Export	0	0	0	275	4808	4931	0	0	0
Manufacturing	Consumption	124	195	391	16	35	57	34	612	633
Manufacturing	Wastewater	0	0	0	0	0	0	0	1	1
Manufacturing	Air	0	0	0	0	0	0	0	0	0
Manufacturing	Recycling systems	0	0	0	0	0	0	0	1	1
Manufacturing	Export	0	0	0	0	0	0	6	188	194
Consumption	Wastewater	103	441	586	12	60	76	24	439	454
Consumption	Air	0	1	2	0	0	0	0	1	1
Consumption	Surface water	11	48	63	1	6	8	3	48	50
Consumption	Natural & urban soil	0	1	2	0	0	0	0	1	1
Consumption	Landfill	6	31	40	1	4	5	0	0	0
Consumption	Waste incineration plant	1	5	7	0	0	0	1	23	24
Consumption	Recycling systems	18	87	110	2	13	16	5	99	103
Wastewater	WWTP	102	427	573	12	58	74	24	425	441
Wastewater	Surface water	3	14	18	0	2	2	1	14	14
WWTP	Sludge	64	325	411	7	44	53	16	324	330
WWTP	Surface water	13	102	107	2	14	14	3	101	105
Sludge	Sludge-treated soil	0	0	0	0	1	1	15	291	297
Sludge	Landfill	16	69	90	0	1	1	1	21	21
Sludge	Waste incineration plant	51	256	325	7	43	51	1	13	13

Table S14: 25th quantiles, means and 75th quantiles of flows of nano-ZnO (tonnes)

From	To	Austria			Belgium			Bulgaria		
		Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	16	101	113	0	0	0	6	27	31
Import	Consumption	1	25	28	0	0	0	1	9	10
Production	Manufacturing	0	0	0	35	184	205	0	0	0
Production	Wastewater	0	0	0	1	15	17	0	0	0
Production	Air	0	0	0	0	0	0	0	0	0
Production	Export	0	0	0	111	585	653	0	0	0
Manufacturing	Consumption	38	101	119	29	152	170	11	27	33
Manufacturing	Wastewater	0	0	0	0	0	0	0	0	0
Manufacturing	Air	0	0	0	0	0	0	0	0	0
Manufacturing	Export	0	0	0	0	31	36	0	0	0
Consumption	Wastewater	28	93	109	21	112	125	9	27	32
Consumption	Air	0	2	2	0	2	2	0	0	1
Consumption	Surface water	3	11	13	2	14	15	1	3	4
Consumption	Natural & urban soil	0	2	2	0	2	2	0	0	1
Consumption	Landfill	0	0	0	0	0	0	0	1	1
Consumption	Waste incineration plant	1	2	3	0	3	3	0	0	0
Consumption	Recycling	5	16	18	3	19	21	1	4	5
Wastewater	WWTP	28	90	106	24	127	142	8	26	31
Wastewater	Surface water	1	3	4	1	4	5	0	1	1
WWTP	Sludge	16	69	82	9	97	110	5	20	24
WWTP	Surface water	3	22	24	2	30	31	1	6	7
Sludge	Sludge-treated soil	4	17	20	1	13	15	3	13	16
Sludge	Landfill	0	1	2	0	0	0	2	7	8
Sludge	Waste incineration plant	12	50	61	8	84	96	0	0	0
From	To	Switzerland			Cyprus			Czech Republic		
		Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	31	167	188	0	0	0	11	55	61
Import	Consumption	0	0	0	5	25	28	12	72	81
Production	Manufacturing	0	0	0	0	0	0	6	5	6
Production	Wastewater	0	0	0	0	0	0	0	0	0
Production	Air	0	0	0	0	0	0	0	0	0
Production	Export	0	0	0	0	0	0	0	0	0
Manufacturing	Consumption	19	107	120	0	0	0	38	60	81
Manufacturing	Wastewater	0	0	0	0	0	0	0	0	0
Manufacturing	Air	0	0	0	0	0	0	0	0	0
Manufacturing	Export	9	60	68	0	0	0	0	0	0
Consumption	Wastewater	14	79	89	3	18	20	37	98	120
Consumption	Air	0	1	2	0	0	0	1	2	2
Consumption	Surface water	2	10	11	0	2	3	4	12	15
Consumption	Natural & urban soil	0	1	2	0	0	0	1	2	2
Consumption	Landfill	0	0	0	0	1	1	2	4	5
Consumption	Waste incineration plant	0	1	1	0	0	0	0	1	1
Consumption	Recycling	2	14	16	1	3	3	5	14	17
Wastewater	WWTP	14	77	86	3	18	20	36	95	117
Wastewater	Surface water	0	3	3	0	1	1	1	3	4
WWTP	Sludge	5	59	67	1	14	15	22	73	89
WWTP	Surface water	1	18	18	0	4	4	4	22	27
Sludge	Sludge-treated soil	0	0	0	1	14	15	17	58	70
Sludge	Landfill	0	0	0	0	0	0	3	10	13
Sludge	Waste incineration plant	6	59	67	0	0	0	1	5	6

Table S14 (continued): 25th quantiles, means and 75th quantiles of flows of nano-ZnO (tonnes)

		Germany			Denmark			Spain		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	0	0	0	16	84	93	108	588	661
Import	Consumption	0	0	0	0	0	0	66	458	516
Production	Manufacturing	218	1219	1359	0	0	0	4	5	5
Production	Wastewater	5	61	68	0	0	0	0	0	0
Production	Air	0	0	0	0	0	0	0	0	0
Production	Export	310	1810	2027	0	0	0	0	0	0
Manufacturing	Consumption	108	614	684	13	72	80	302	593	772
Manufacturing	Wastewater	0	2	2	0	0	0	0	1	1
Manufacturing	Air	0	0	0	0	0	0	0	0	0
Manufacturing	Export	98	603	676	0	12	14	0	0	0
Consumption	Wastewater	78	454	506	9	53	59	270	777	953
Consumption	Air	1	8	9	0	1	1	4	13	16
Consumption	Surface water	8	56	62	1	7	7	31	96	119
Consumption	Natural & urban soil	1	8	9	0	1	1	4	13	17
Consumption	Landfill	0	0	0	0	1	1	12	37	46
Consumption	Waste incineration plant	1	9	10	0	1	1	2	6	8
Consumption	Recycling	13	79	88	1	9	10	36	108	133
Wastewater	WWTP	90	512	570	9	51	57	263	753	923
Wastewater	Surface water	3	17	19	0	2	2	9	25	30
WWTP	Sludge	36	390	449	4	39	45	162	573	700
WWTP	Surface water	9	122	124	1	12	12	33	181	212
Sludge	Sludge-treated soil	11	119	136	3	27	30	130	457	559
Sludge	Landfill	0	0	0	0	1	1	29	92	113
Sludge	Waste incineration plant	26	272	312	1	12	14	7	24	30
		Estonia			Finland			France		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	3	13	14	14	75	83	138	795	888
Import	Consumption	0	0	0	0	0	0	0	0	0
Production	Manufacturing	0	0	0	0	0	0	252	359	523
Production	Wastewater	0	0	0	0	0	0	1	7	8
Production	Air	0	0	0	0	0	0	0	0	0
Production	Export	0	0	0	0	0	0	0	0	0
Manufacturing	Consumption	3	13	14	12	65	72	307	930	1137
Manufacturing	Wastewater	0	0	0	0	0	0	1	2	2
Manufacturing	Air	0	0	0	0	0	0	0	0	0
Manufacturing	Export	0	0	0	0	10	12	45	222	277
Consumption	Wastewater	2	10	11	9	48	53	225	688	842
Consumption	Air	0	0	0	0	1	1	4	12	14
Consumption	Surface water	0	1	1	1	6	7	26	85	103
Consumption	Natural & urban soil	0	0	0	0	1	1	3	12	14
Consumption	Landfill	0	0	0	0	0	0	3	10	12
Consumption	Waste incineration plant	0	0	0	0	0	0	4	13	16
Consumption	Recycling	0	1	2	2	9	10	35	110	135
Wastewater	WWTP	2	9	10	9	46	52	224	675	829
Wastewater	Surface water	0	0	0	0	2	2	7	22	28
WWTP	Sludge	1	7	8	3	35	40	137	514	629
WWTP	Surface water	0	2	2	1	11	11	28	162	182
Sludge	Sludge-treated soil	0	1	1	0	5	6	93	347	425
Sludge	Landfill	1	6	7	1	7	8	8	26	32
Sludge	Waste incineration plant	0	0	0	2	23	26	39	141	173

Table S14 (continued): 25th quantiles, means and 75th quantiles of flows of nano-ZnO (tonnes)

		United Kingdom			Greece			Croatia		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	94	526	586	13	65	72	7	33	37
Import	Consumption	6	141	155	17	97	109	1	14	16
Production	Manufacturing	221	367	515	0	0	0	0	0	0
Production	Wastewater	1	7	8	0	0	0	0	0	0
Production	Air	0	0	0	0	0	0	0	0	0
Production	Export	0	0	0	0	0	0	0	0	0
Manufacturing	Consumption	410	892	1165	39	65	92	15	33	41
Manufacturing	Wastewater	0	1	2	0	0	0	0	0	0
Manufacturing	Air	0	0	0	0	0	0	0	0	0
Manufacturing	Export	0	0	0	0	0	0	0	0	0
Consumption	Wastewater	304	765	976	42	120	148	12	35	41
Consumption	Air	5	13	17	1	2	3	0	1	1
Consumption	Surface water	35	94	120	5	15	18	1	4	5
Consumption	Natural & urban soil	5	13	17	1	2	3	0	1	1
Consumption	Landfill	6	15	20	1	4	5	0	1	2
Consumption	Waste incineration plant	4	11	15	0	0	0	0	0	0
Consumption	Recycling	47	122	155	6	19	24	2	5	6
Wastewater	WWTP	301	750	957	41	116	144	11	34	40
Wastewater	Surface water	10	25	32	1	4	5	0	1	1
WWTP	Sludge	186	571	717	25	88	108	7	26	31
WWTP	Surface water	37	178	205	5	27	32	1	8	9
Sludge	Sludge-treated soil	146	447	562	6	20	25	0	1	2
Sludge	Landfill	1	3	3	10	34	42	7	25	30
Sludge	Waste incineration plant	41	121	152	9	34	41	0	0	0
		Hungary			Ireland			Italy		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	10	50	56	14	70	77	102	537	599
Import	Consumption	0	7	8	0	0	0	16	262	293
Production	Manufacturing	0	0	0	0	0	0	192	304	431
Production	Wastewater	0	0	0	0	0	0	1	6	7
Production	Air	0	0	0	0	0	0	0	0	0
Production	Export	0	0	0	0	0	0	0	0	0
Manufacturing	Consumption	16	50	57	9	46	51	439	840	1139
Manufacturing	Wastewater	0	0	0	0	0	0	0	1	1
Manufacturing	Air	0	0	0	0	0	0	0	0	0
Manufacturing	Export	0	0	0	3	24	27	0	0	0
Consumption	Wastewater	12	42	48	6	34	38	334	814	1056
Consumption	Air	0	1	1	0	1	1	5	14	18
Consumption	Surface water	1	5	6	1	4	5	39	101	129
Consumption	Natural & urban soil	0	1	1	0	1	1	5	14	18
Consumption	Landfill	1	2	2	0	0	0	4	10	12
Consumption	Waste incineration plant	0	0	0	0	0	0	4	9	12
Consumption	Recycling	2	6	7	1	6	7	56	139	180
Wastewater	WWTP	12	41	47	6	33	37	329	796	1035
Wastewater	Surface water	0	1	2	0	1	1	11	26	34
WWTP	Sludge	6	31	37	2	25	29	206	609	780
WWTP	Surface water	1	10	10	1	8	8	40	188	219
Sludge	Sludge-treated soil	1	4	5	2	25	28	79	236	302
Sludge	Landfill	1	4	5	0	0	0	118	345	441
Sludge	Waste incineration plant	5	23	27	0	0	0	10	27	35

Table S14 (continued): 25th quantiles, means and 75th quantiles of flows of nano-ZnO (tonnes)

From	To	Lithuania			Luxemburg			Latvia		
		Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	4	19	21	11	54	60	2	12	14
Import	Consumption	0	3	3	0	0	0	0	4	4
Production	Manufacturing	0	0	0	0	0	0	0	0	0
Production	Wastewater	0	0	0	0	0	0	0	0	0
Production	Air	0	0	0	0	0	0	0	0	0
Production	Export	0	0	0	0	0	0	0	0	0
Manufacturing	Consumption	6	19	22	2	10	11	5	12	15
Manufacturing	Wastewater	0	0	0	0	0	0	0	0	0
Manufacturing	Air	0	0	0	0	0	0	0	0	0
Manufacturing	Export	0	0	0	9	44	49	0	0	0
Consumption	Wastewater	5	16	18	1	7	8	4	12	14
Consumption	Air	0	0	0	0	0	0	0	0	0
Consumption	Surface water	1	2	2	0	1	1	0	1	2
Consumption	Natural & urban soil	0	0	0	0	0	0	0	0	0
Consumption	Landfill	0	1	1	0	0	0	0	0	1
Consumption	Waste incineration plant	0	0	0	0	0	0	0	0	0
Consumption	Recycling	1	3	3	0	1	1	1	2	2
Wastewater	WWTP	4	16	18	1	7	8	4	11	13
Wastewater	Surface water	0	1	1	0	0	0	0	0	0
WWTP	Sludge	2	12	14	1	5	6	2	9	10
WWTP	Surface water	1	4	4	0	2	2	0	3	3
Sludge	Sludge-treated soil	2	12	14	0	4	5	2	8	10
Sludge	Landfill	0	0	0	0	0	0	0	0	0
Sludge	Waste incineration plant	0	0	0	0	1	1	0	0	0
		Malta			Netherlands			Norway		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	0	1	1	0	0	0	0	0	0
Import	Consumption	1	7	8	0	0	0	0	0	0
Production	Manufacturing	0	0	0	45	230	255	13	69	77
Production	Wastewater	0	0	0	2	22	24	1	16	17
Production	Air	0	0	0	0	0	0	0	0	0
Production	Export	0	0	0	164	848	939	134	706	785
Manufacturing	Consumption	1	1	1	33	172	192	12	67	75
Manufacturing	Wastewater	0	0	0	0	0	0	0	0	0
Manufacturing	Air	0	0	0	0	0	0	0	0	0
Manufacturing	Export	0	0	0	3	58	65	0	2	4
Consumption	Wastewater	2	6	7	24	128	142	9	50	56
Consumption	Air	0	0	0	0	2	2	0	1	1
Consumption	Surface water	0	1	1	3	16	17	1	6	7
Consumption	Natural & urban soil	0	0	0	0	2	2	0	1	1
Consumption	Landfill	0	0	0	0	0	0	0	0	0
Consumption	Waste incineration plant	0	0	0	1	3	3	0	2	2
Consumption	Recycling	0	1	1	4	22	24	1	8	9
Wastewater	WWTP	2	6	7	29	149	165	13	66	74
Wastewater	Surface water	0	0	0	1	5	5	0	2	2
WWTP	Sludge	1	4	5	11	113	129	5	51	58
WWTP	Surface water	0	1	1	3	36	36	1	16	16
Sludge	Sludge-treated soil	0	0	0	0	0	0	4	42	48
Sludge	Landfill	1	4	5	0	0	0	1	9	10
Sludge	Waste incineration plant	0	0	0	12	113	130	0	0	0

Table S14 (continued): 25th quantiles, means and 75th quantiles of flows of nano-ZnO (tonnes)

From	To	Poland			Portugal			Romania		
		Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	52	273	305	19	98	109	18	91	102
Import	Consumption	2	46	51	8	58	65	0	0	0
Production	Manufacturing	0	0	0	0	0	0	0	0	0
Production	Wastewater	0	0	0	0	0	0	0	0	0
Production	Air	0	0	0	0	0	0	0	0	0
Production	Export	0	0	0	0	0	0	0	0	0
Manufacturing	Consumption	93	273	317	46	98	123	12	65	72
Manufacturing	Wastewater	0	0	0	0	0	0	0	0	0
Manufacturing	Air	0	0	0	0	0	0	0	0	0
Manufacturing	Export	0	0	0	0	0	0	2	26	30
Consumption	Wastewater	69	236	273	39	115	140	9	48	53
Consumption	Air	1	4	5	1	2	2	0	1	1
Consumption	Surface water	8	29	34	5	14	17	1	6	7
Consumption	Natural & urban soil	1	4	5	1	2	2	0	1	1
Consumption	Landfill	2	7	9	1	5	6	0	2	3
Consumption	Waste incineration plant	0	1	1	1	2	2	0	0	0
Consumption	Recycling	11	38	44	5	16	20	1	7	8
Wastewater	WWTP	68	229	264	38	112	135	9	46	52
Wastewater	Surface water	2	8	9	1	4	4	0	2	2
WWTP	Sludge	36	175	207	23	85	103	3	35	40
WWTP	Surface water	8	54	59	5	27	31	1	11	11
Sludge	Sludge-treated soil	18	84	99	21	76	93	0	3	3
Sludge	Landfill	6	25	29	3	9	10	3	32	37
Sludge	Waste incineration plant	14	66	78	0	0	0	0	0	0
		Slovakia			Slovenia			Sweden		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	7	36	41	3	16	18	33	160	176
Import	Consumption	13	77	86	1	9	10	0	0	0
Production	Manufacturing	0	0	0	0	0	0	0	0	0
Production	Wastewater	0	0	0	0	0	0	0	0	0
Production	Air	0	0	0	0	0	0	0	0	0
Production	Export	0	0	0	0	0	0	0	0	0
Manufacturing	Consumption	25	36	52	8	16	21	21	107	119
Manufacturing	Wastewater	0	0	0	0	0	0	0	0	0
Manufacturing	Air	0	0	0	0	0	0	0	0	0
Manufacturing	Export	0	0	0	0	0	0	7	52	58
Consumption	Wastewater	28	84	103	6	19	23	15	80	88
Consumption	Air	0	1	2	0	0	0	0	1	2
Consumption	Surface water	3	10	13	1	2	3	2	10	11
Consumption	Natural & urban soil	0	1	2	0	0	0	0	1	2
Consumption	Landfill	1	3	3	0	0	1	0	0	0
Consumption	Waste incineration plant	0	0	1	0	0	0	0	1	1
Consumption	Recycling	4	13	16	1	3	4	3	14	16
Wastewater	WWTP	28	81	100	6	18	22	15	77	85
Wastewater	Surface water	1	3	3	0	1	1	0	3	3
WWTP	Sludge	17	62	76	4	14	17	6	59	67
WWTP	Surface water	3	19	22	1	4	5	1	18	19
Sludge	Sludge-treated soil	0	0	0	0	0	0	6	53	60
Sludge	Landfill	4	13	16	0	0	0	0	4	4
Sludge	Waste incineration plant	13	49	60	4	13	16	0	2	3

Table S15: 25th quantiles, means and 75th quantiles of flows of nano-Ag (tonnes)

		Austria			Belgium			Bulgaria		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	0.004	0.017	0.024	0.000	0.000	0.000	0.002	0.006	0.008
Import	Consumption	0.082	0.333	0.459	0.064	0.292	0.388	0.011	0.047	0.064
Production	Manufacturing	0.009	0.053	0.064	0.032	0.124	0.176	0.007	0.052	0.064
Production	Wastewater	0.000	0.001	0.001	0.002	0.012	0.015	0.000	0.001	0.001
Production	Export	0.000	0.000	0.000	0.114	0.476	0.648	0.000	0.000	0.000
Manufacturing	Consumption	0.019	0.068	0.099	0.038	0.122	0.186	0.012	0.057	0.075
Manufacturing	Wastewater	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Manufacturing	Recycling system	0.000	0.001	0.001	0.000	0.002	0.002	0.000	0.001	0.001
Manufacturing	Export	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Consumption	Wastewater	0.004	0.019	0.026	0.004	0.020	0.026	0.001	0.005	0.006
Consumption	Air	0.001	0.003	0.004	0.001	0.003	0.004	0.000	0.001	0.001
Consumption	Surface water	0.000	0.001	0.001	0.000	0.001	0.001	0.000	0.000	0.000
Consumption	Natural & urban soil	0.000	0.002	0.002	0.000	0.002	0.002	0.000	0.000	0.001
Consumption	Landfill	0.001	0.005	0.007	0.000	0.001	0.002	0.007	0.031	0.041
Consumption	Waste incineration plant	0.015	0.061	0.083	0.019	0.081	0.110	0.001	0.005	0.007
Consumption	Recycling system	0.077	0.310	0.429	0.075	0.306	0.422	0.014	0.061	0.082
Wastewater	WWTP	0.005	0.020	0.027	0.008	0.031	0.042	0.001	0.006	0.008
Wastewater	Surface water	0.000	0.001	0.001	0.000	0.001	0.001	0.000	0.000	0.000
WWTP	Sludge	0.004	0.017	0.022	0.006	0.026	0.035	0.001	0.005	0.006
WWTP	Surface water	0.000	0.003	0.003	0.000	0.005	0.005	0.000	0.001	0.001
Sludge	Sludge-treated soil	0.001	0.004	0.005	0.001	0.004	0.005	0.001	0.003	0.004
Sludge	Landfill	0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.002	0.002
Sludge	Waste incineration plant	0.004	0.012	0.018	0.006	0.023	0.034	0.000	0.000	0.000
		Switzerland			Cyprus			Czech Republic		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.009	0.013
Import	Consumption	0.000	0.000	0.000	0.005	0.019	0.026	0.042	0.168	0.231
Production	Manufacturing	0.048	0.182	0.258	0.007	0.052	0.064	0.013	0.052	0.062
Production	Wastewater	0.001	0.005	0.007	0.000	0.001	0.001	0.000	0.001	0.001
Production	Export	0.006	0.079	0.099	0.000	0.000	0.000	0.000	0.000	0.000
Manufacturing	Consumption	0.044	0.175	0.243	0.009	0.052	0.064	0.022	0.060	0.081
Manufacturing	Wastewater	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Manufacturing	Recycling system	0.001	0.002	0.003	0.000	0.001	0.001	0.000	0.001	0.001
Manufacturing	Export	0.000	0.004	0.020	0.000	0.000	0.000	0.000	0.000	0.000
Consumption	Wastewater	0.002	0.008	0.011	0.001	0.003	0.004	0.003	0.011	0.014
Consumption	Air	0.000	0.001	0.002	0.000	0.001	0.001	0.000	0.002	0.002
Consumption	Surface water	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.001	0.001
Consumption	Natural & urban soil	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.001	0.001
Consumption	Landfill	0.000	0.000	0.000	0.008	0.038	0.049	0.014	0.053	0.070
Consumption	Waste incineration plant	0.008	0.035	0.048	0.001	0.003	0.004	0.007	0.026	0.035
Consumption	Recycling system	0.032	0.129	0.178	0.005	0.024	0.031	0.037	0.135	0.184
Wastewater	WWTP	0.003	0.013	0.018	0.001	0.004	0.005	0.003	0.012	0.016
Wastewater	Surface water	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.001
WWTP	Sludge	0.003	0.011	0.015	0.001	0.004	0.004	0.002	0.010	0.013
WWTP	Surface water	0.000	0.002	0.002	0.000	0.001	0.001	0.000	0.002	0.002
Sludge	Sludge-treated soil	0.000	0.000	0.000	0.001	0.004	0.004	0.002	0.008	0.010
Sludge	Landfill	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.003
Sludge	Waste incineration plant	0.003	0.011	0.017	0.000	0.000	0.000	0.000	0.001	0.002

Table S15 (continued): 25th quantiles, means and 75th quantiles of flows of nano-Ag (tonnes)

From	To	Germany			Denmark			Spain		
		Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	0.034	0.281	0.337	0.012	0.045	0.063	0.000	0.000	0.000
Import	Consumption	0.000	0.000	0.000	0.055	0.229	0.312	0.175	0.778	1.033
Production	Manufacturing	0.624	1.714	2.410	0.022	0.052	0.070	0.094	0.354	0.501
Production	Wastewater	0.006	0.034	0.042	0.000	0.001	0.001	0.002	0.012	0.015
Production	Export	0.000	0.000	0.000	0.000	0.000	0.000	0.034	0.244	0.310
Manufacturing	Consumption	0.326	1.080	1.439	0.054	0.096	0.122	0.110	0.348	0.527
Manufacturing	Wastewater	0.001	0.002	0.003	0.000	0.000	0.000	0.000	0.000	0.000
Manufacturing	Recycling system	0.000	0.000	0.000	0.000	0.001	0.002	0.001	0.005	0.007
Manufacturing	Export	0.252	0.889	1.177	0.000	0.000	0.000	0.000	0.000	0.000
Consumption	Wastewater	0.014	0.052	0.068	0.005	0.016	0.020	0.012	0.054	0.072
Consumption	Air	0.002	0.008	0.011	0.001	0.002	0.003	0.002	0.009	0.011
Consumption	Surface water	0.001	0.003	0.004	0.000	0.001	0.001	0.001	0.003	0.004
Consumption	Natural & urban soil	0.001	0.005	0.006	0.000	0.001	0.002	0.001	0.005	0.006
Consumption	Landfill	0.000	0.001	0.001	0.001	0.002	0.002	0.069	0.282	0.386
Consumption	Waste incineration plant	0.068	0.233	0.307	0.030	0.094	0.124	0.025	0.103	0.140
Consumption	Recycling system	0.233	0.779	1.035	0.069	0.209	0.279	0.168	0.670	0.923
Wastewater	WWTP	0.024	0.085	0.113	0.005	0.016	0.021	0.016	0.064	0.088
Wastewater	Surface water	0.001	0.003	0.004	0.000	0.001	0.001	0.001	0.002	0.003
WWTP	Sludge	0.019	0.072	0.093	0.004	0.014	0.018	0.012	0.054	0.072
WWTP	Surface water	0.002	0.013	0.013	0.000	0.003	0.003	0.001	0.010	0.010
Sludge	Sludge-treated soil	0.006	0.022	0.028	0.003	0.009	0.012	0.010	0.043	0.058
Sludge	Landfill	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.009	0.017
Sludge	Waste incineration plant	0.017	0.050	0.070	0.002	0.004	0.007	0.001	0.002	0.005
		Estonia			Finland			France		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	0.000	0.001	0.001	0.000	0.000	0.000	0.102	0.387	0.554
Import	Consumption	0.005	0.021	0.029	0.041	0.171	0.228	0.451	1.893	2.570
Production	Manufacturing	0.007	0.052	0.063	0.008	0.034	0.046	0.043	0.052	0.057
Production	Wastewater	0.000	0.001	0.001	0.002	0.012	0.015	0.000	0.001	0.001
Production	Export	0.000	0.000	0.000	0.141	0.559	0.770	0.000	0.000	0.000
Manufacturing	Consumption	0.010	0.052	0.064	0.010	0.034	0.050	0.349	0.433	0.518
Manufacturing	Wastewater	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Manufacturing	Recycling system	0.000	0.001	0.001	0.000	0.000	0.001	0.002	0.006	0.008
Manufacturing	Export	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Consumption	Wastewater	0.001	0.004	0.004	0.002	0.010	0.013	0.035	0.112	0.145
Consumption	Air	0.000	0.001	0.001	0.000	0.002	0.002	0.006	0.018	0.023
Consumption	Surface water	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.006	0.008
Consumption	Natural & urban soil	0.000	0.000	0.000	0.000	0.001	0.001	0.003	0.010	0.013
Consumption	Landfill	0.001	0.005	0.006	0.002	0.008	0.010	0.049	0.151	0.196
Consumption	Waste incineration plant	0.008	0.039	0.049	0.006	0.026	0.035	0.103	0.316	0.411
Consumption	Recycling system	0.005	0.025	0.032	0.039	0.157	0.214	0.585	1.714	2.269
Wastewater	WWTP	0.001	0.004	0.006	0.005	0.021	0.028	0.037	0.110	0.144
Wastewater	Surface water	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.004	0.005
WWTP	Sludge	0.001	0.004	0.005	0.004	0.018	0.023	0.029	0.093	0.120
WWTP	Surface water	0.000	0.001	0.001	0.000	0.003	0.003	0.003	0.017	0.018
Sludge	Sludge-treated soil	0.000	0.000	0.000	0.001	0.003	0.003	0.020	0.063	0.081
Sludge	Landfill	0.001	0.003	0.004	0.001	0.004	0.005	0.003	0.005	0.008
Sludge	Waste incineration plant	0.000	0.000	0.000	0.003	0.012	0.017	0.012	0.025	0.038

Table S15 (continued): 25th quantiles, means and 75th quantiles of flows of nano-Ag (tonnes)

		United Kingdom			Greece			Croatia		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	0.041	0.239	0.305	0.002	0.009	0.013	0.002	0.006	0.008
Import	Consumption	0.000	0.000	0.000	0.047	0.189	0.261	0.011	0.045	0.062
Production	Manufacturing	0.267	0.599	0.849	0.013	0.053	0.062	0.012	0.052	0.062
Production	Wastewater	0.002	0.012	0.015	0.000	0.001	0.001	0.000	0.001	0.001
Production	Export	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Manufacturing	Consumption	0.277	0.807	1.084	0.022	0.061	0.082	0.016	0.057	0.072
Manufacturing	Wastewater	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Manufacturing	Recycling system	0.004	0.010	0.014	0.000	0.001	0.001	0.000	0.001	0.001
Manufacturing	Export	0.000	0.020	0.118	0.000	0.000	0.000	0.000	0.000	0.000
Consumption	Wastewater	0.012	0.039	0.051	0.003	0.012	0.016	0.001	0.005	0.006
Consumption	Air	0.002	0.006	0.008	0.000	0.002	0.003	0.000	0.001	0.001
Consumption	Surface water	0.001	0.002	0.003	0.000	0.001	0.001	0.000	0.000	0.000
Consumption	Natural & urban soil	0.001	0.004	0.005	0.000	0.001	0.001	0.000	0.000	0.001
Consumption	Landfill	0.034	0.101	0.134	0.015	0.059	0.079	0.015	0.056	0.073
Consumption	Waste incineration plant	0.039	0.117	0.155	0.003	0.012	0.016	0.001	0.005	0.006
Consumption	Recycling system	0.184	0.539	0.723	0.044	0.163	0.223	0.009	0.035	0.046
Wastewater	WWTP	0.017	0.050	0.067	0.003	0.013	0.017	0.001	0.006	0.007
Wastewater	Surface water	0.001	0.002	0.002	0.000	0.000	0.001	0.000	0.000	0.000
WWTP	Sludge	0.013	0.042	0.055	0.003	0.011	0.014	0.001	0.005	0.006
WWTP	Surface water	0.001	0.008	0.008	0.000	0.002	0.002	0.000	0.001	0.001
Sludge	Sludge-treated soil	0.010	0.033	0.043	0.001	0.002	0.003	0.000	0.000	0.000
Sludge	Landfill	0.001	0.000	0.001	0.002	0.004	0.007	0.001	0.005	0.006
Sludge	Waste incineration plant	0.004	0.009	0.013	0.001	0.004	0.006	0.000	0.000	0.000
		Hungary			Ireland			Italy		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	0.004	0.013	0.019	0.035	0.134	0.193	0.169	0.644	0.912
Import	Consumption	0.026	0.108	0.147	0.000	0.000	0.000	0.000	0.000	0.000
Production	Manufacturing	0.015	0.052	0.063	0.032	0.052	0.068	0.048	0.052	0.054
Production	Wastewater	0.000	0.001	0.001	0.000	0.001	0.001	0.000	0.001	0.001
Production	Export	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Manufacturing	Consumption	0.025	0.065	0.084	0.030	0.090	0.123	0.165	0.583	0.774
Manufacturing	Wastewater	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Manufacturing	Recycling system	0.000	0.001	0.001	0.001	0.002	0.003	0.002	0.009	0.011
Manufacturing	Export	0.000	0.000	0.000	0.031	0.094	0.129	0.000	0.104	0.158
Consumption	Wastewater	0.002	0.008	0.011	0.001	0.004	0.006	0.007	0.028	0.036
Consumption	Air	0.000	0.001	0.002	0.000	0.001	0.001	0.001	0.004	0.006
Consumption	Surface water	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.002	0.002
Consumption	Natural & urban soil	0.000	0.001	0.001	0.000	0.000	0.001	0.001	0.003	0.003
Consumption	Landfill	0.012	0.041	0.054	0.004	0.013	0.017	0.022	0.079	0.105
Consumption	Waste incineration plant	0.004	0.016	0.021	0.003	0.010	0.014	0.029	0.106	0.139
Consumption	Recycling system	0.031	0.104	0.139	0.020	0.061	0.084	0.101	0.362	0.479
Wastewater	WWTP	0.003	0.009	0.012	0.002	0.005	0.007	0.008	0.029	0.038
Wastewater	Surface water	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
WWTP	Sludge	0.002	0.008	0.010	0.001	0.005	0.006	0.007	0.024	0.032
WWTP	Surface water	0.000	0.001	0.001	0.000	0.001	0.001	0.001	0.004	0.005
Sludge	Sludge-treated soil	0.000	0.001	0.001	0.001	0.004	0.006	0.003	0.009	0.012
Sludge	Landfill	0.001	0.001	0.002	0.000	0.000	0.000	0.005	0.014	0.019
Sludge	Waste incineration plant	0.002	0.006	0.008	0.000	0.000	0.000	0.001	0.001	0.002

Table S15 (continued): 25th quantiles, means and 75th quantiles of flows of nano-Ag (tonnes)

		Lithuania			Luxemburg			Latvia		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	0.001	0.006	0.007	0.000	0.001	0.001	0.000	0.001	0.001
Import	Consumption	0.007	0.031	0.041	0.012	0.049	0.068	0.007	0.026	0.036
Production	Manufacturing	0.012	0.052	0.064	0.008	0.053	0.065	0.007	0.053	0.064
Production	Wastewater	0.000	0.001	0.001	0.000	0.001	0.001	0.000	0.001	0.001
Production	Export	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Manufacturing	Consumption	0.016	0.057	0.072	0.012	0.053	0.069	0.010	0.052	0.065
Manufacturing	Wastewater	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Manufacturing	Recycling system	0.000	0.001	0.001	0.000	0.001	0.001	0.000	0.001	0.001
Manufacturing	Export	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Consumption	Wastewater	0.001	0.004	0.005	0.001	0.005	0.006	0.001	0.004	0.005
Consumption	Air	0.000	0.001	0.001	0.000	0.001	0.001	0.000	0.001	0.001
Consumption	Surface water	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Consumption	Natural & urban soil	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
Consumption	Landfill	0.004	0.015	0.019	0.001	0.003	0.004	0.009	0.043	0.055
Consumption	Waste incineration plant	0.001	0.004	0.005	0.004	0.019	0.025	0.001	0.004	0.005
Consumption	Recycling system	0.016	0.063	0.081	0.017	0.073	0.097	0.006	0.027	0.035
Wastewater	WWTP	0.001	0.005	0.007	0.001	0.006	0.008	0.001	0.005	0.006
Wastewater	Surface water	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WWTP	Sludge	0.001	0.004	0.005	0.001	0.005	0.006	0.001	0.004	0.005
WWTP	Surface water	0.000	0.001	0.001	0.000	0.001	0.001	0.000	0.001	0.001
Sludge	Sludge-treated soil	0.001	0.004	0.005	0.001	0.004	0.005	0.001	0.004	0.005
Sludge	Landfill	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sludge	Waste incineration plant	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000
		Malta			Netherlands			Norway		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	0.000	0.000	0.000	0.077	0.296	0.418	0.001	0.004	0.005
Import	Consumption	0.001	0.005	0.006	0.000	0.000	0.000	0.096	0.383	0.534
Production	Manufacturing	0.006	0.052	0.064	0.040	0.052	0.062	0.011	0.052	0.064
Production	Wastewater	0.000	0.001	0.001	0.000	0.001	0.001	0.000	0.001	0.001
Production	Export	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Manufacturing	Consumption	0.011	0.051	0.063	0.072	0.233	0.311	0.018	0.056	0.079
Manufacturing	Wastewater	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Manufacturing	Recycling system	0.000	0.001	0.001	0.001	0.004	0.006	0.000	0.001	0.001
Manufacturing	Export	0.000	0.000	0.000	0.040	0.130	0.173	0.000	0.000	0.000
Consumption	Wastewater	0.001	0.003	0.003	0.003	0.011	0.015	0.005	0.021	0.028
Consumption	Air	0.000	0.000	0.001	0.001	0.002	0.002	0.001	0.003	0.004
Consumption	Surface water	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.001	0.002
Consumption	Natural & urban soil	0.000	0.0002	0.000	0.000	0.001	0.001	0.000	0.002	0.003
Consumption	Landfill	0.005	0.026	0.032	0.000	0.001	0.002	0.000	0.002	0.003
Consumption	Waste incineration plant	0.001	0.003	0.003	0.026	0.088	0.116	0.022	0.088	0.120
Consumption	Recycling system	0.005	0.024	0.029	0.040	0.130	0.173	0.083	0.321	0.447
Wastewater	WWTP	0.001	0.004	0.004	0.004	0.012	0.016	0.005	0.022	0.029
Wastewater	Surface water	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.001
WWTP	Sludge	0.001	0.003	0.004	0.003	0.010	0.014	0.004	0.018	0.024
WWTP	Surface water	0.000	0.001	0.001	0.000	0.002	0.002	0.000	0.003	0.003
Sludge	Sludge-treated soil	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.015	0.020
Sludge	Landfill	0.001	0.003	0.004	0.000	0.000	0.000	0.001	0.003	0.004
Sludge	Waste incineration plant	0.001	0.002	0.003	0.004	0.010	0.014	0.000	0.000	0.000

Table S15 (continued): 25th quantiles, means and 75th quantiles of flows of nano-Ag (tonnes)

		Poland			Portugal			Romania		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	0.000	0.000	0.000	0.002	0.013	0.016	0.001	0.011	0.013
Import	Consumption	0.091	0.384	0.520	0.041	0.167	0.229	0.038	0.155	0.213
Production	Manufacturing	0.019	0.077	0.107	0.016	0.052	0.067	0.015	0.052	0.066
Production	Wastewater	0.003	0.017	0.021	0.000	0.001	0.001	0.000	0.001	0.001
Production	Export	0.196	0.780	1.077	0.000	0.000	0.000	0.000	0.000	0.000
Manufacturing	Consumption	0.023	0.076	0.113	0.026	0.065	0.087	0.023	0.062	0.083
Manufacturing	Wastewater	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Manufacturing	Recycling system	0.000	0.001	0.001	0.000	0.001	0.001	0.000	0.001	0.001
Manufacturing	Export	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Consumption	Wastewater	0.005	0.022	0.029	0.003	0.011	0.015	0.003	0.010	0.014
Consumption	Air	0.001	0.004	0.005	0.000	0.002	0.002	0.000	0.002	0.002
Consumption	Surface water	0.000	0.001	0.002	0.000	0.001	0.001	0.000	0.001	0.001
Consumption	Natural & urban soil	0.000	0.002	0.003	0.000	0.001	0.001	0.000	0.001	0.001
Consumption	Landfill	0.025	0.108	0.144	0.013	0.049	0.065	0.048	0.173	0.234
Consumption	Waste incineration plant	0.012	0.053	0.071	0.009	0.032	0.042	0.003	0.012	0.016
Consumption	Recycling system	0.066	0.270	0.369	0.039	0.137	0.186	0.005	0.019	0.026
Wastewater	WWTP	0.009	0.038	0.052	0.003	0.012	0.016	0.003	0.011	0.015
Wastewater	Surface water	0.000	0.001	0.002	0.000	0.000	0.001	0.000	0.000	0.000
WWTP	Sludge	0.007	0.032	0.043	0.003	0.010	0.013	0.002	0.009	0.012
WWTP	Surface water	0.001	0.006	0.006	0.000	0.002	0.002	0.000	0.002	0.002
Sludge	Sludge-treated soil	0.003	0.016	0.021	0.002	0.009	0.012	0.000	0.001	0.001
Sludge	Landfill	0.002	0.005	0.008	0.001	0.001	0.002	0.003	0.009	0.013
Sludge	Waste incineration plant	0.004	0.012	0.019	0.000	0.000	0.001	0.000	0.000	0.000
		Slovakia			Slovenia			Sweden		
From	To	Q25	Mean	Q75	Q25	Mean	Q75	Q25	Mean	Q75
Import	Manufacturing	0.000	0.002	0.002	0.000	0.001	0.001	0.001	0.006	0.007
Import	Consumption	0.021	0.083	0.114	0.010	0.041	0.056	0.111	0.444	0.612
Production	Manufacturing	0.008	0.052	0.064	0.007	0.052	0.064	0.012	0.053	0.065
Production	Wastewater	0.000	0.001	0.001	0.000	0.001	0.001	0.000	0.001	0.001
Production	Export	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Manufacturing	Consumption	0.014	0.053	0.071	0.011	0.052	0.066	0.019	0.057	0.081
Manufacturing	Wastewater	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Manufacturing	Recycling system	0.000	0.001	0.001	0.000	0.001	0.001	0.000	0.001	0.001
Manufacturing	Export	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Consumption	Wastewater	0.001	0.007	0.009	0.001	0.004	0.006	0.006	0.024	0.032
Consumption	Air	0.000	0.001	0.001	0.000	0.001	0.001	0.001	0.004	0.005
Consumption	Surface water	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002
Consumption	Natural & urban soil	0.000	0.001	0.001	0.000	0.000	0.001	0.000	0.002	0.003
Consumption	Landfill	0.016	0.064	0.086	0.005	0.023	0.029	0.000	0.001	0.001
Consumption	Waste incineration plant	0.004	0.017	0.023	0.001	0.005	0.006	0.025	0.105	0.140
Consumption	Recycling system	0.011	0.047	0.063	0.013	0.060	0.079	0.094	0.364	0.501
Wastewater	WWTP	0.002	0.007	0.010	0.001	0.005	0.007	0.006	0.024	0.033
Wastewater	Surface water	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
WWTP	Sludge	0.001	0.006	0.008	0.001	0.005	0.006	0.005	0.021	0.027
WWTP	Surface water	0.000	0.001	0.001	0.000	0.001	0.001	0.000	0.004	0.004
Sludge	Sludge-treated soil	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.018	0.024
Sludge	Landfill	0.001	0.001	0.002	0.000	0.000	0.000	0.000	0.001	0.002
Sludge	Waste incineration plant	0.001	0.005	0.007	0.001	0.004	0.006	0.001	0.001	0.004

Table S16: Normalised releases to surface water. Values are in tonnes / km² of surface water (freshwater and a band of 10 m along the coastlines).

Country	Nano-TiO₂	Nano-ZnO	Nano-Ag
Austria	1.2E-01	2.5E-02	3.42E-06
Belgium	5.7E-01	1.1E-01	1.57E-05
Bulgaria	5.8E-02	9.2E-03	8.76E-07
Switzerland	1.0E-01	2.1E-02	2.03E-06
Cyprus	7.0E-01	1.5E-01	2.05E-05
Czech Republic	1.8E-01	3.5E-02	2.76E-06
Germany	1.6E-01	3.0E-02	2.91E-06
Denmark	1.6E-01	2.9E-02	7.21E-06
Spain	3.1E-01	6.5E-02	3.23E-06
Estonia	7.5E-03	1.3E-03	3.49E-07
Finland	2.5E-03	5.4E-04	1.46E-07
France	2.0E-01	3.6E-02	3.59E-06
United Kingdom	3.7E-01	7.0E-02	2.84E-06
Greece	1.4E-01	2.7E-02	1.73E-06
Croatia	1.1E-01	2.0E-02	1.46E-06
Hungary	5.2E-02	8.3E-03	5.13E-07
Ireland	4.6E-02	7.6E-03	5.85E-07
Italy	2.9E-01	5.6E-02	1.25E-06
Lithuania	2.8E-02	4.7E-03	7.57E-07
Luxembourg	1.8E+00	3.4E-01	1.25E-04
Latvia	1.8E-02	3.2E-03	6.95E-07
Malta	2.1E+00	3.9E-01	1.34E-04
Netherlands	7.4E-02	1.5E-02	7.70E-07
Norway	6.8E-03	1.2E-03	2.49E-07
Poland	1.0E-01	1.7E-02	1.51E-06
Portugal	1.9E-01	3.6E-02	2.42E-06
Romania	3.6E-02	5.1E-03	8.28E-07
Slovakia	3.0E-01	5.8E-02	1.80E-06
Slovenia	1.4E-01	4.6E-02	6.35E-06
Sweden	4.0E-03	7.6E-04	1.49E-07

Table S17: Normalised releases to soils. Values are in tonnes / km² of soil

Country	Nano-TiO₂	Nano-ZnO	Nano-Ag
Austria	1.1E-03	2.3E-04	7.27E-08
Belgium	2.3E-03	4.9E-04	1.99E-07
Bulgaria	7.8E-04	1.2E-04	2.73E-08
Switzerland	2.9E-05	3.4E-05	2.01E-08
Cyprus	7.5E-03	1.5E-03	4.34E-07
Czech Republic	3.9E-03	7.6E-04	1.16E-07
Germany	1.8E-03	3.6E-04	7.67E-08
Denmark	3.6E-03	6.5E-04	2.35E-07
Spain	4.7E-03	9.5E-04	9.72E-08
Estonia	1.0E-04	2.0E-05	1.65E-08
Finland	8.4E-05	2.0E-05	1.32E-08
France	3.7E-03	6.6E-04	1.35E-07
United Kingdom	1.0E-02	1.9E-03	1.52E-07
Greece	8.2E-04	1.7E-04	2.30E-08
Croatia	1.4E-04	3.3E-05	1.25E-08
Hungary	3.1E-04	5.1E-05	2.20E-08
Ireland	2.3E-03	3.7E-04	7.25E-08
Italy	4.3E-03	8.5E-04	4.06E-08
Lithuania	1.1E-03	1.9E-04	6.24E-08
Luxembourg	9.4E-03	1.8E-03	1.55E-06
Latvia	8.0E-04	1.4E-04	6.24E-08
Malta	3.0E-04	3.4E-04	9.65E-07
Netherlands	6.4E-05	6.5E-05	2.95E-08
Norway	7.4E-04	1.4E-04	5.59E-08
Poland	1.7E-03	2.9E-04	5.83E-08
Portugal	4.7E-03	8.9E-04	1.14E-07
Romania	9.4E-05	1.6E-05	8.49E-09
Slovakia	2.5E-05	3.0E-05	2.06E-08
Slovenia	3.7E-05	2.5E-05	2.49E-08
Sweden	7.1E-04	1.3E-04	4.88E-08

Product allocation for nano-Ag

Table S18: Comparison between product allocation in this study and two other studies

Country	Sun et al. 2016 ⁶	Giese et al. 2018 ⁷	This study
Textiles	25%	31%	2.4%
Cleaning agents	6%	1%	0.2%
Paints	3%		
Consumer electronics / Electronic printing	38%	65%	80%
Cosmetics	10%	0%	2.6%
Medical technology	4%	1%	9.3%
Plastics	3%	1%	
Food	7%	0%	0.2%
Glass and ceramics	1%		
Metals	2%	0.5%*	
Soil remediation	1%		
Filters		0.5%*	0.2%
Coatings		1%	4.9%

* in the original reference presented as Other (incl. metals, filters, ...) accounting for 1%, for comparison in this table presented as metals and filters with each 0.5% contribution.

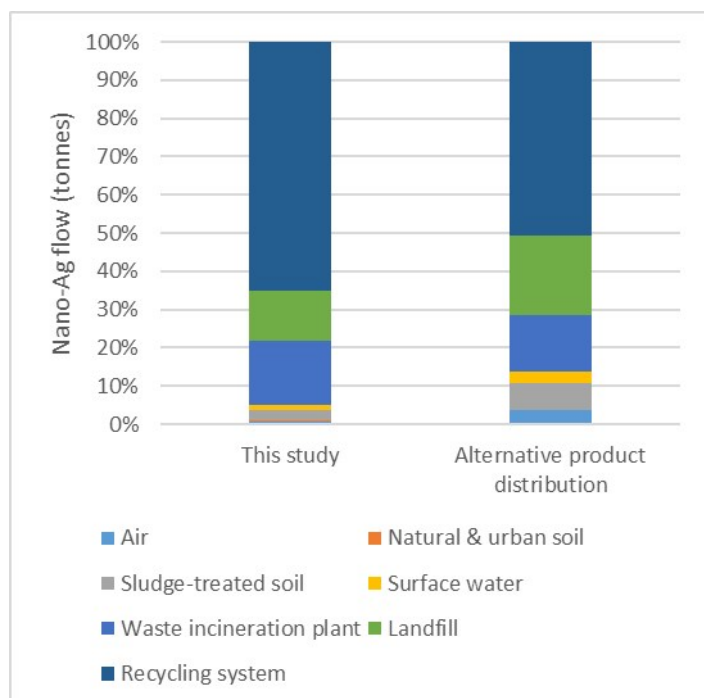


Figure S1 Modelled results of nano-Ag using the product distribution presented in this study and the product distribution presented by Giese et al. (2018)⁷

References

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