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Materials Science and Technology

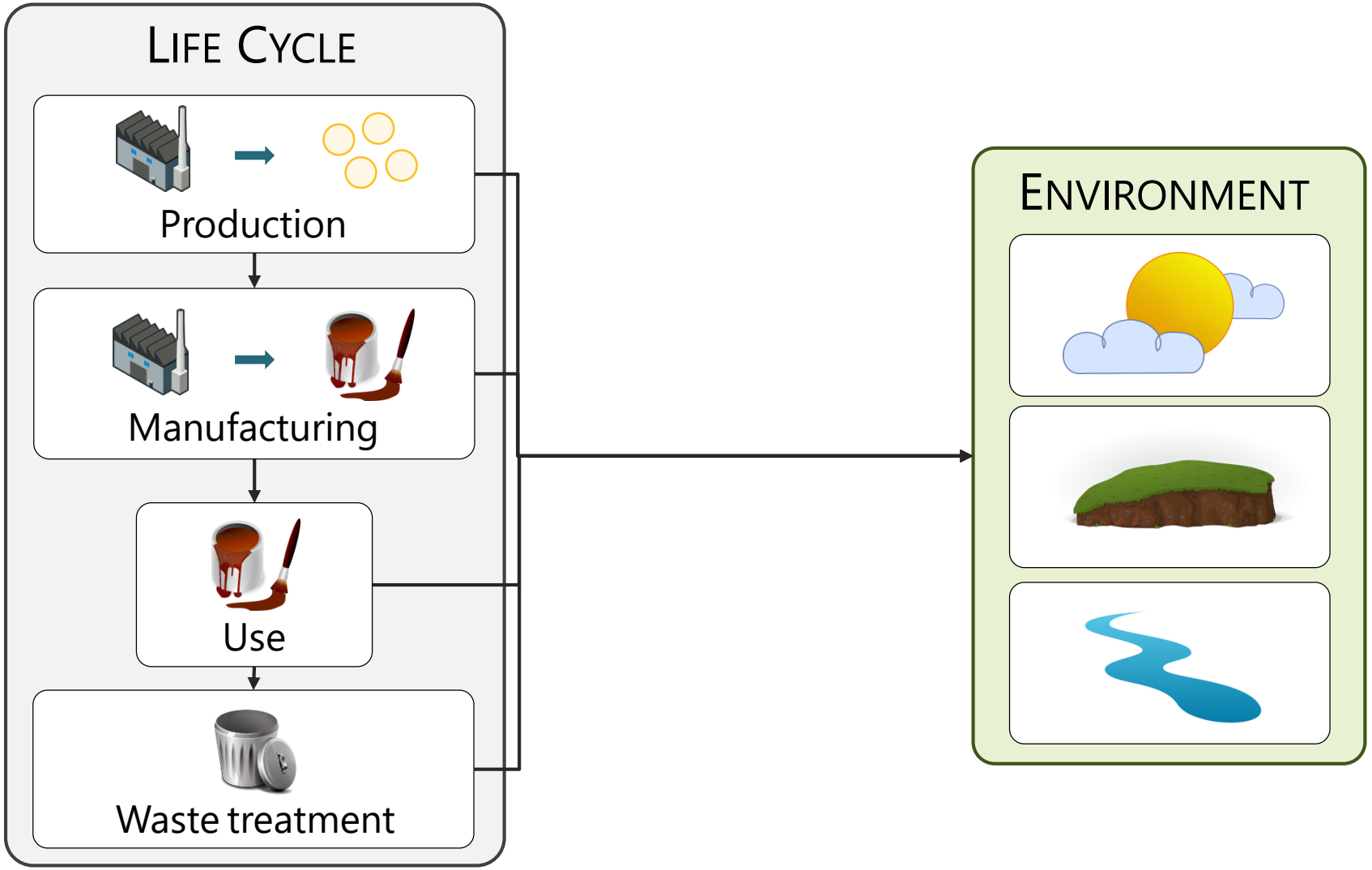
PROBABILISTIC ASSESSMENT OF ENM FLOWS TO WASTE TREATMENT AND THE ENVIRONMENT

Véronique Adam, Bernd Nowack

Empa – Swiss Federal Laboratories for Materials Science and Technology
St. Gallen, Switzerland

Sustainable Nanotechnology Organization Conference – 07.11.2017

Scope and objectives



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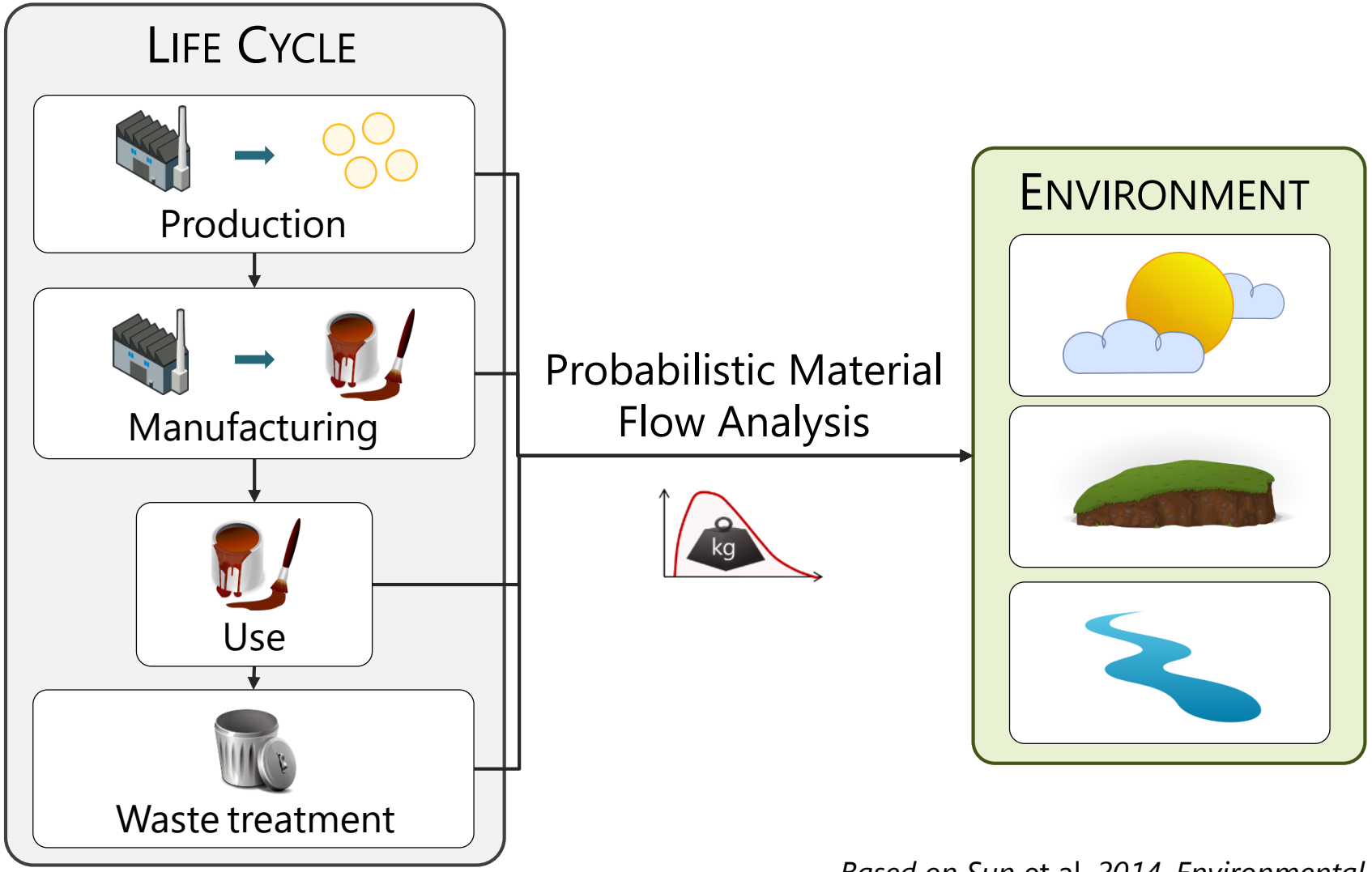

Based on Sun et al. *2014. Environmental Pollution*

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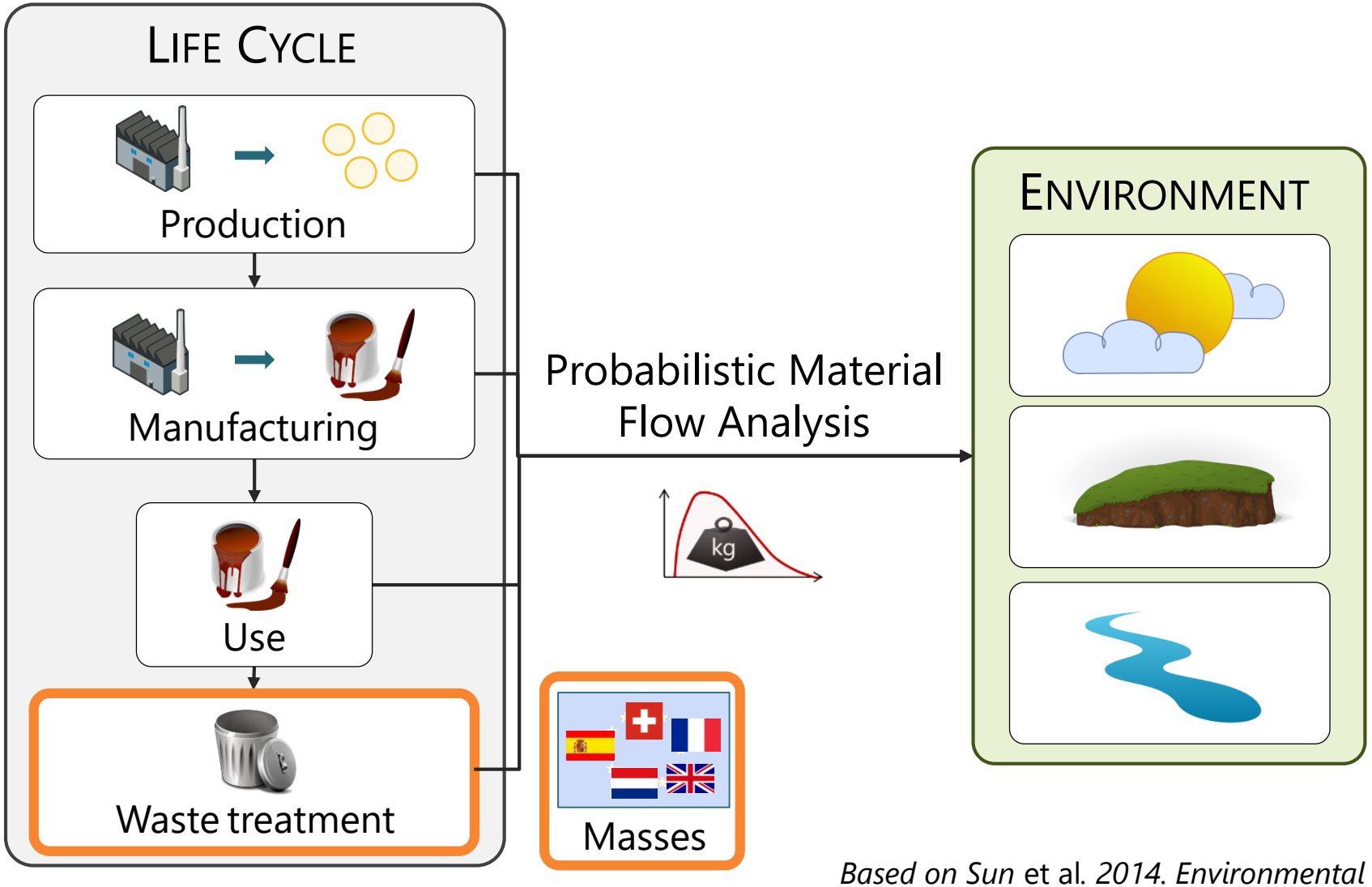

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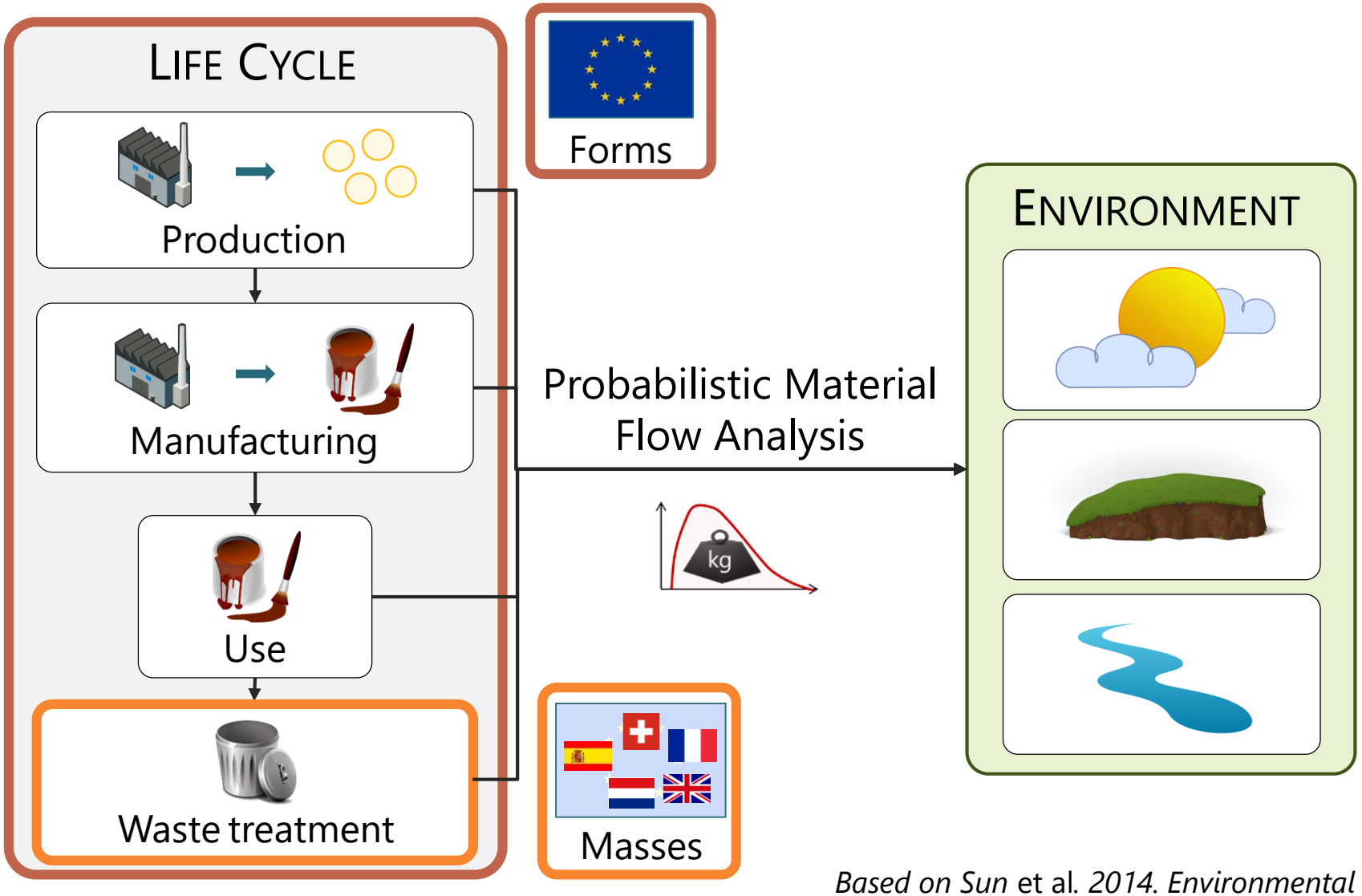

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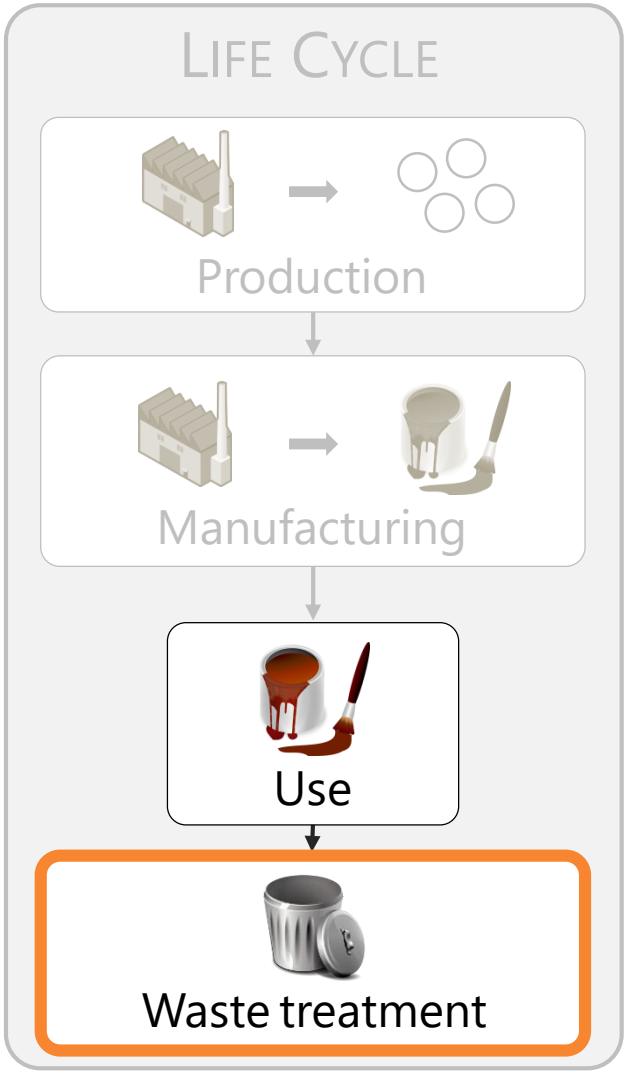
Mass Flows at National Scale



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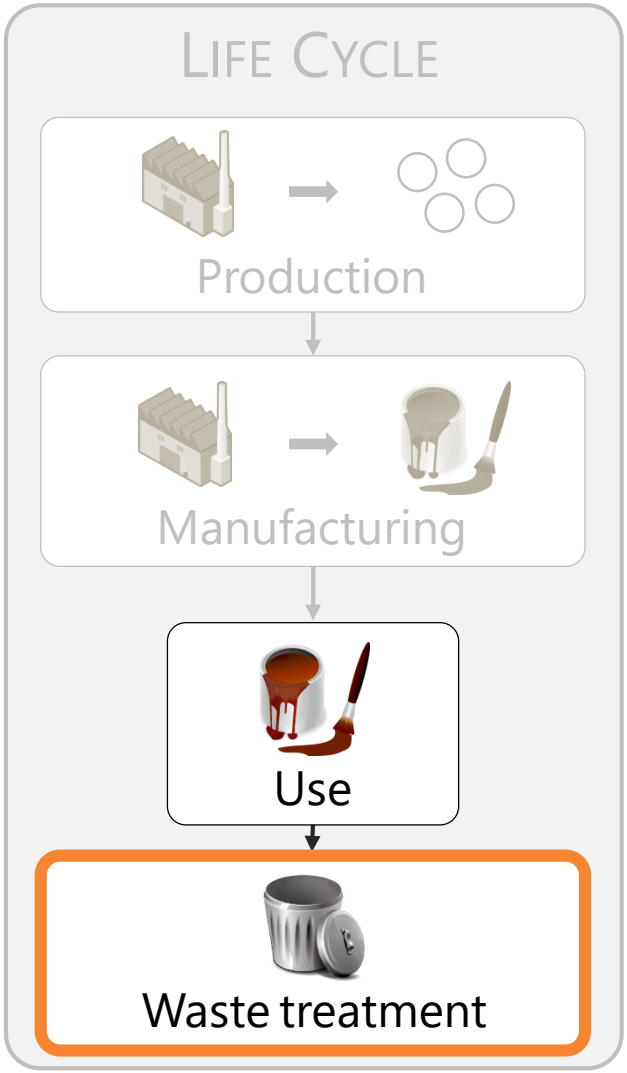

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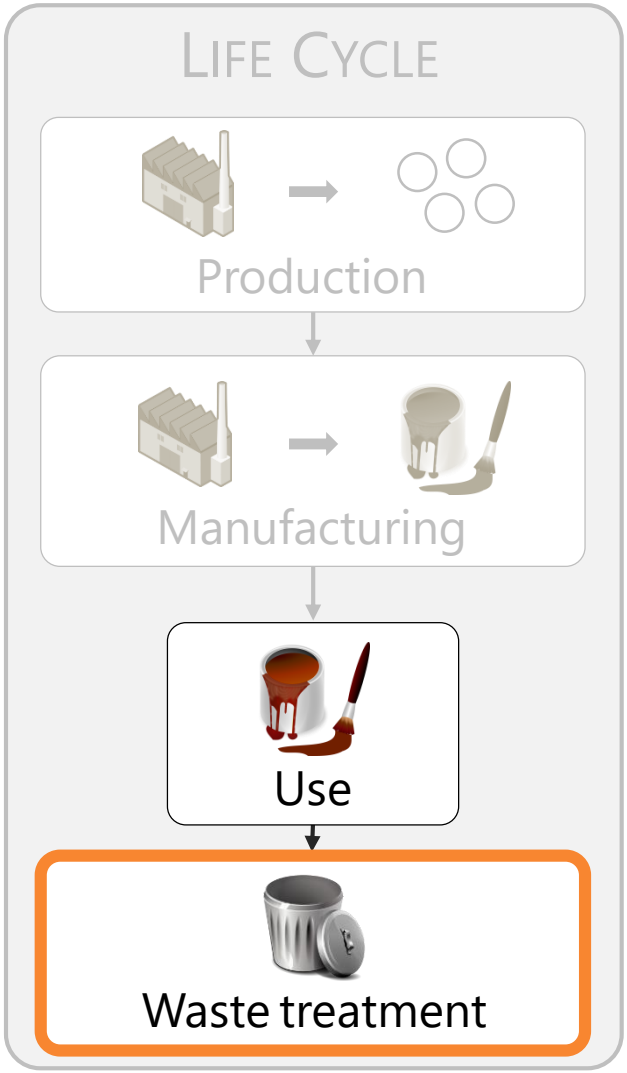

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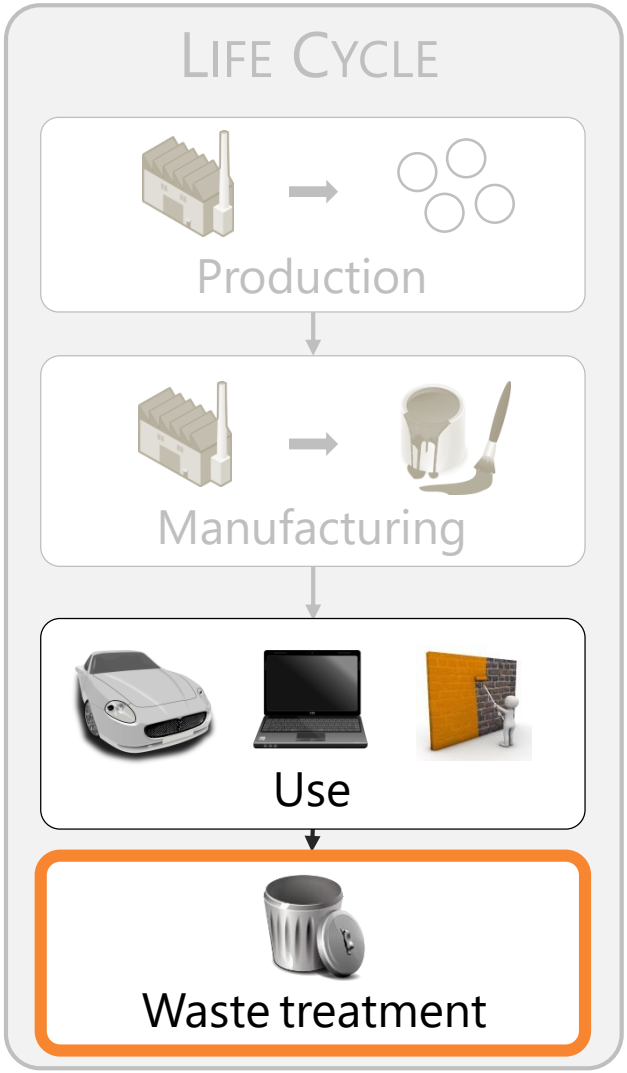

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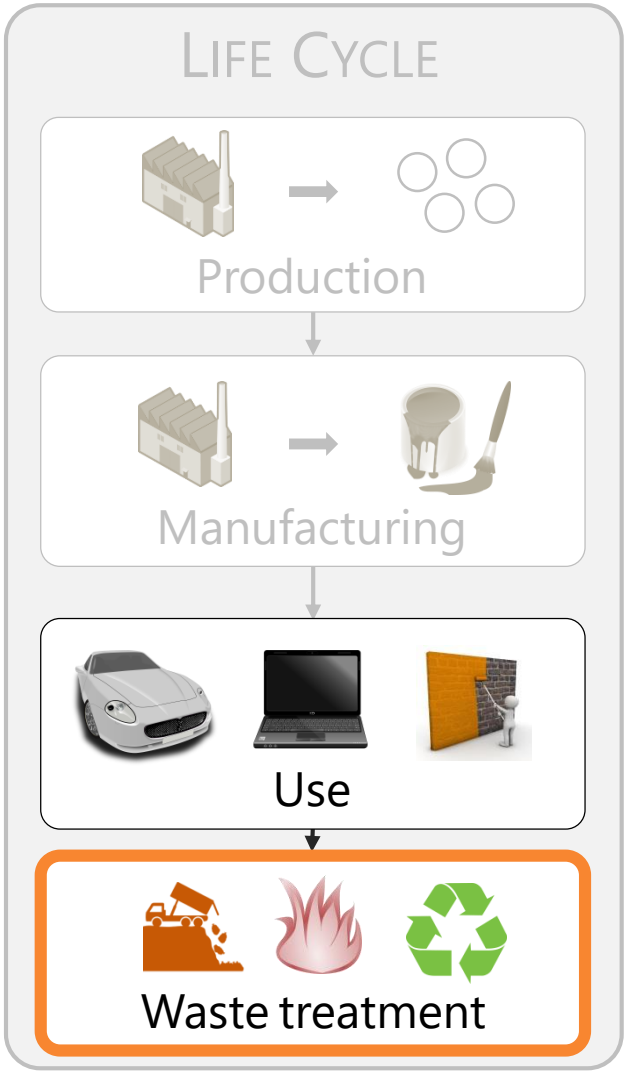

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Mass Flows at National Scale

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Various sources:

- Reports
- Personal communications
- Papers
- Eurostat

} Transfer coefficients

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France	Landfilling	Incineration	Recycling	Total
Packaging waste	16%	22%	62%	100%
Electronic waste	4%	6%	89%	100%

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Quality indicators:

Mass Flows at National Scale

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Quality indicators:

Geographical correlation

Temporal correlation

Reliability

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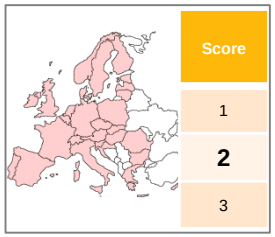
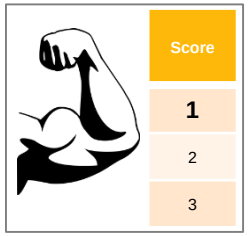
Score
1
2
3

Mass Flows at National Scale





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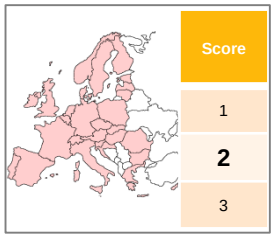

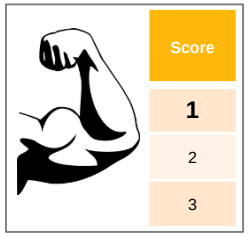

$$DQR = \frac{Geo + Temp + Rel + W_i \times 4}{i + 4}$$

$W_i = weakest\ score$

$i = number\ of\ indicators$

(EC, 2010)

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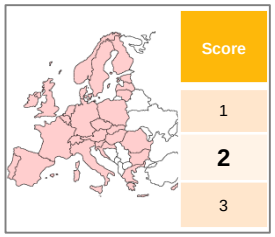

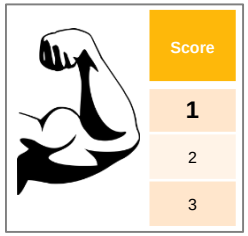

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Data Quality Ratio	Coefficient of Variation
1 ≤ DQR < 1.5	4.5%
1.5 ≤ DQR < 2.5	13.75%
2.5 ≤ DQR ≤ 3	41.5%

(Laner et al., 2015)

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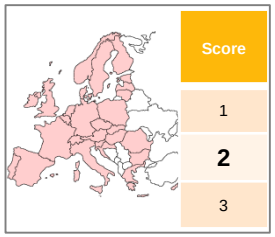

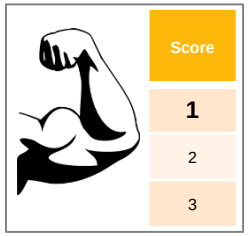

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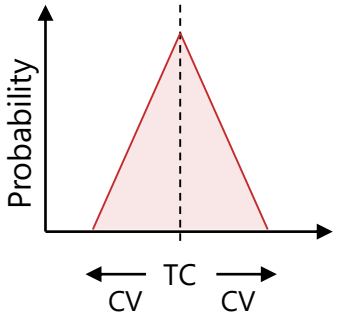

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Mass Flows at National Scale

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Production mass

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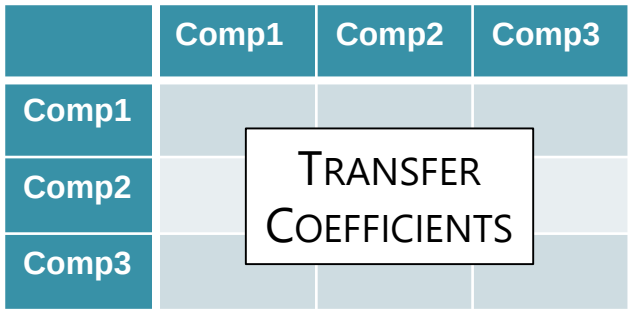

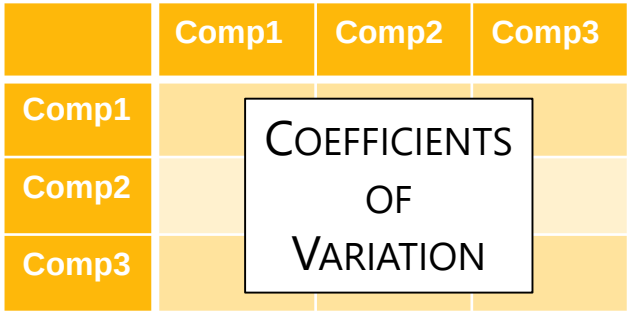

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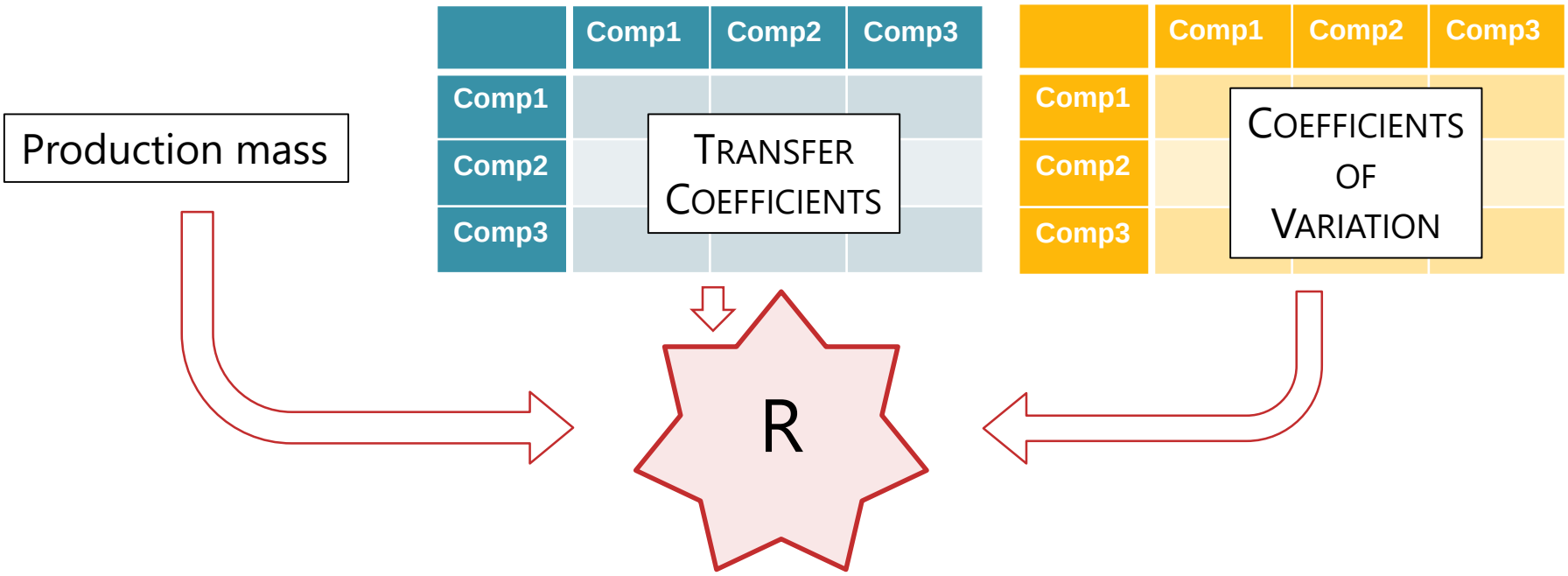

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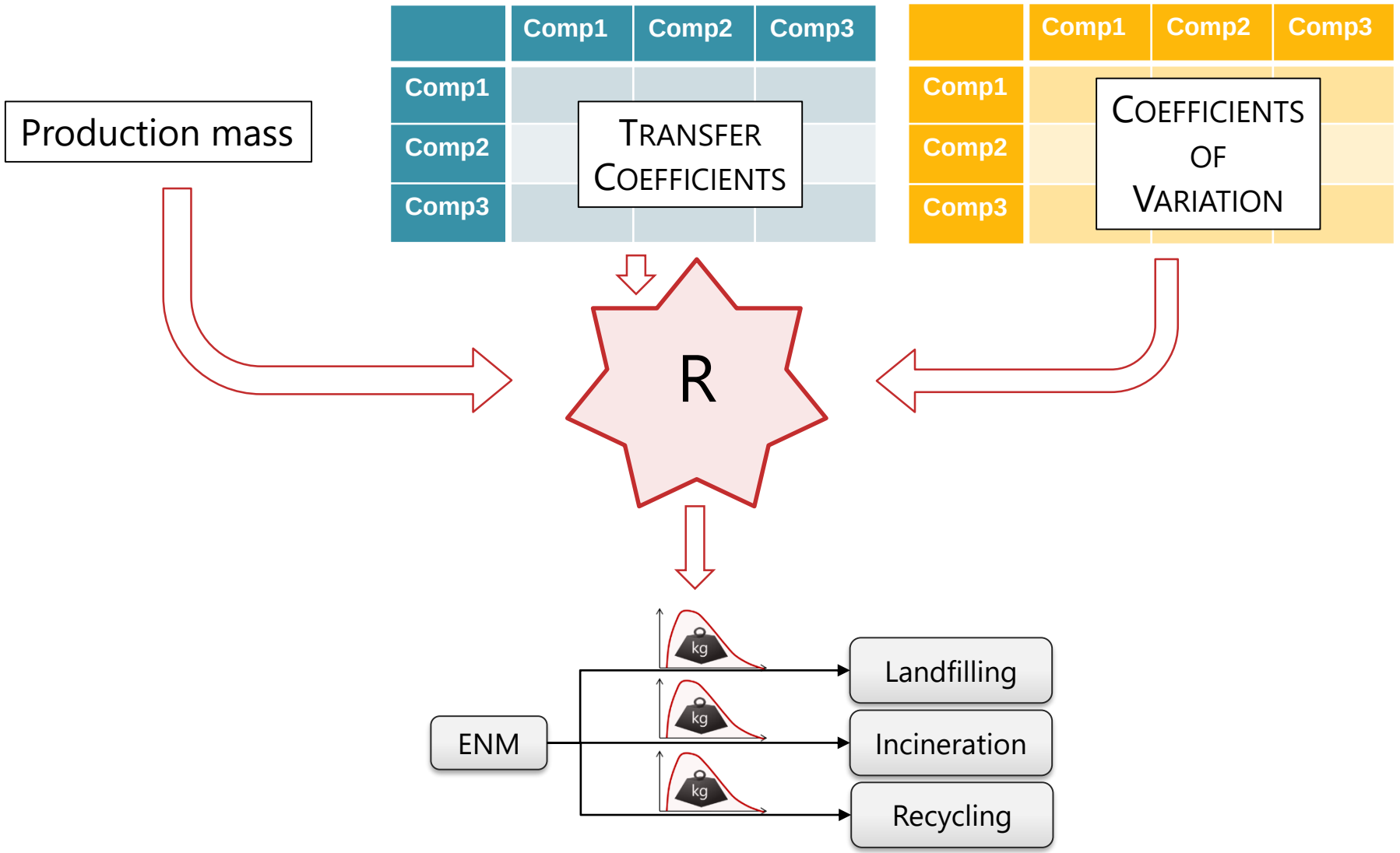
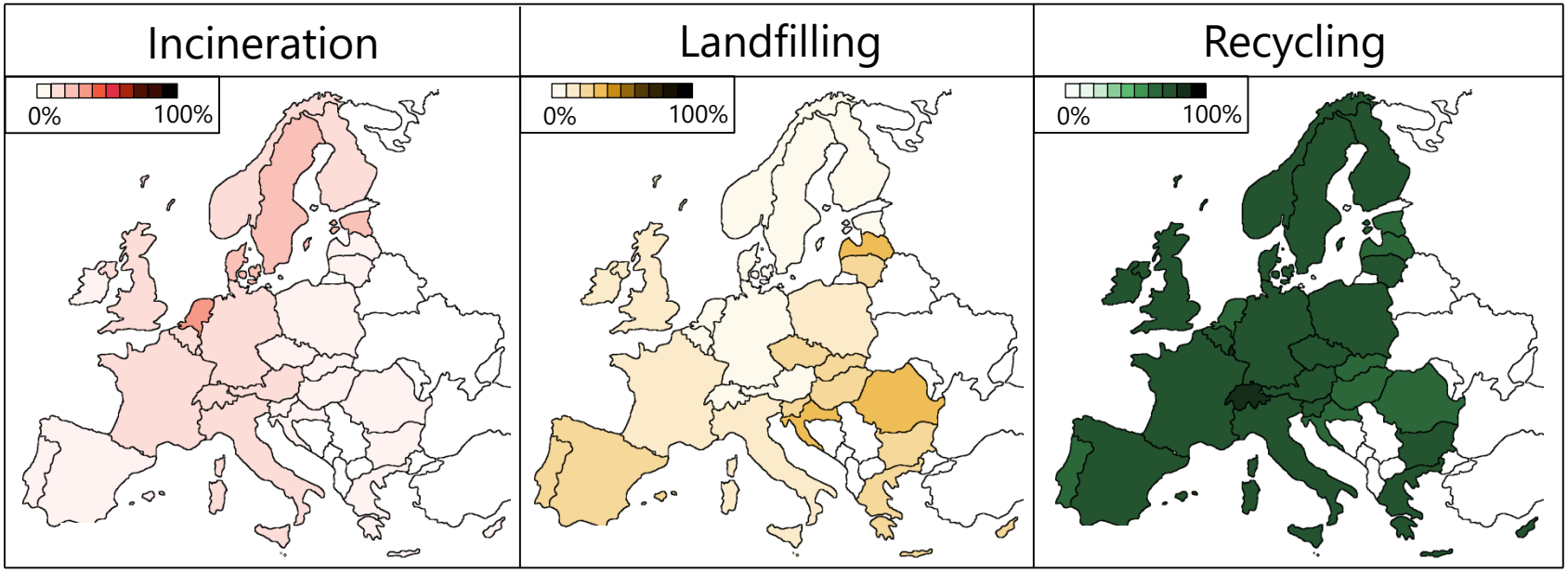


Mass Flows at National Scale

3’400 t nano-TiO_2 in solid waste in EU (mean)



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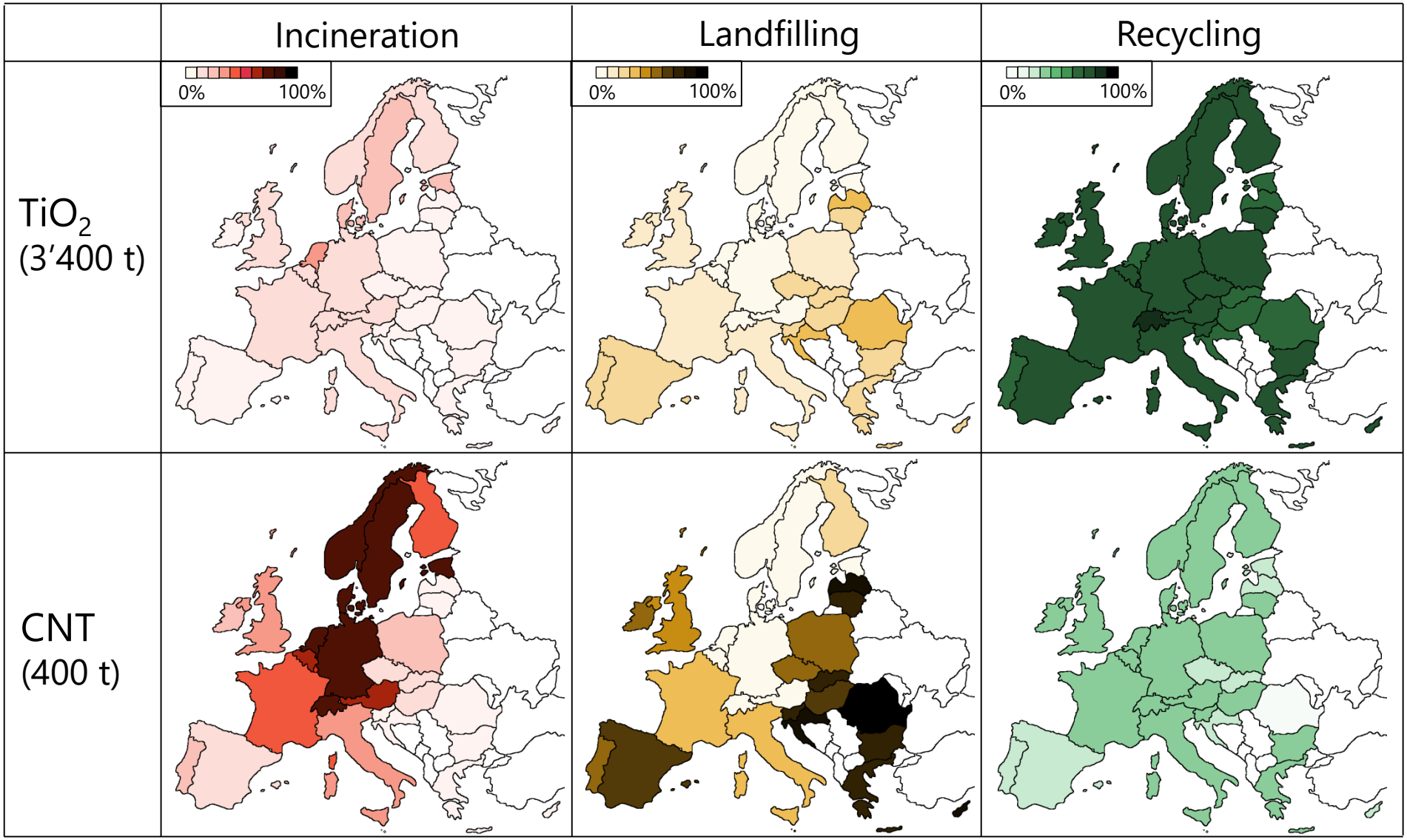

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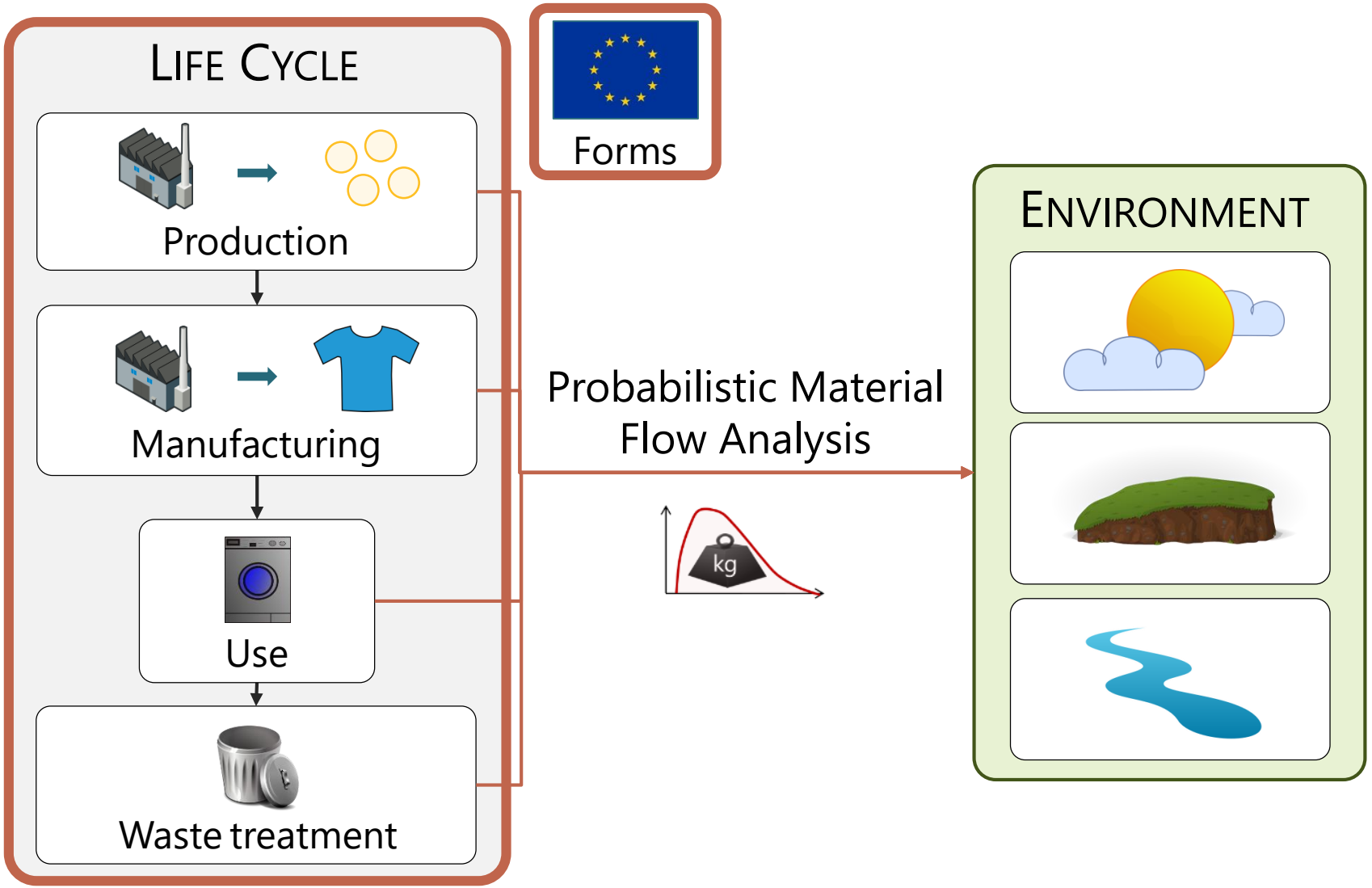
- Assess the **forms of releases**

Transformations at European Scale



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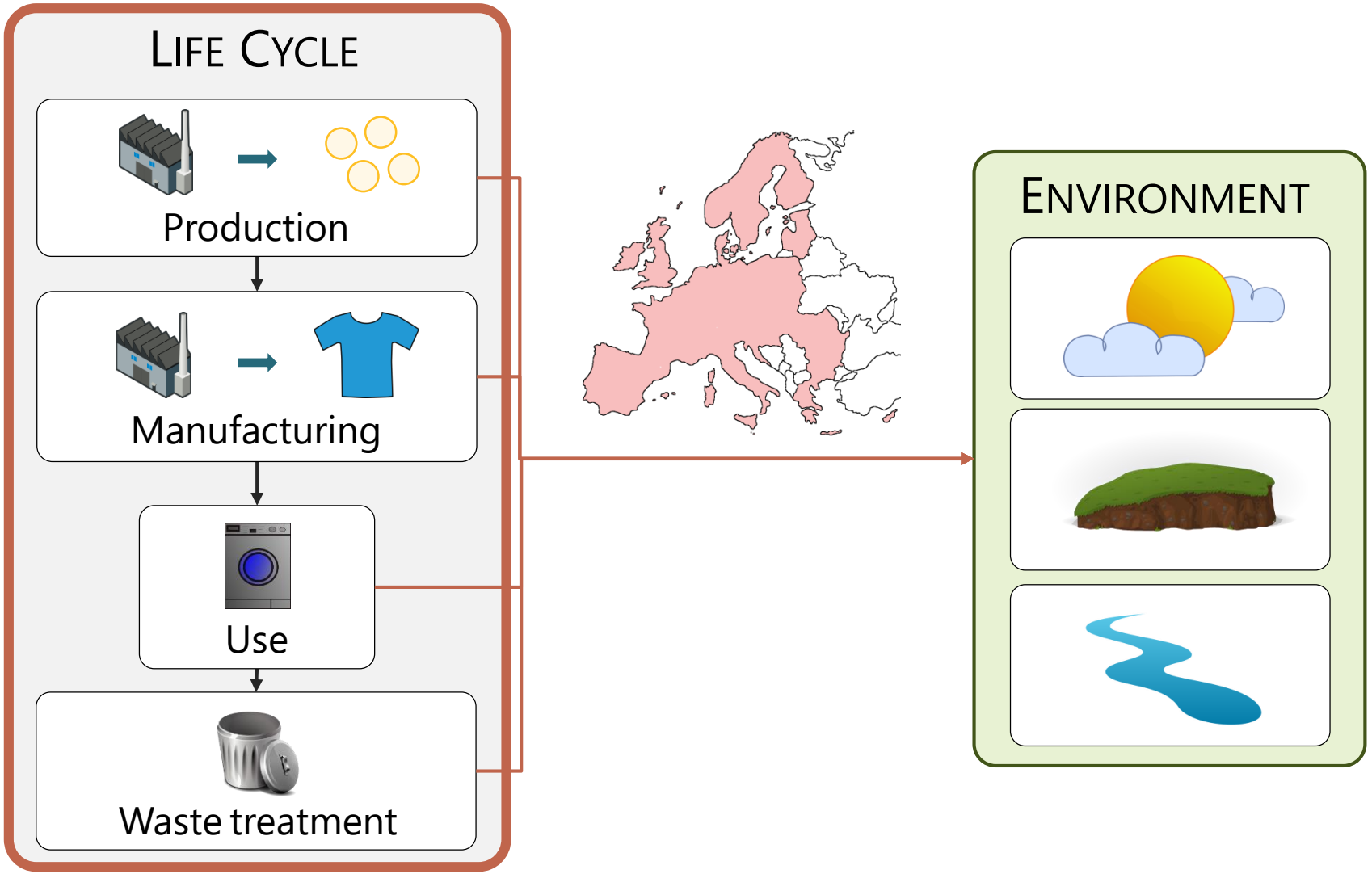

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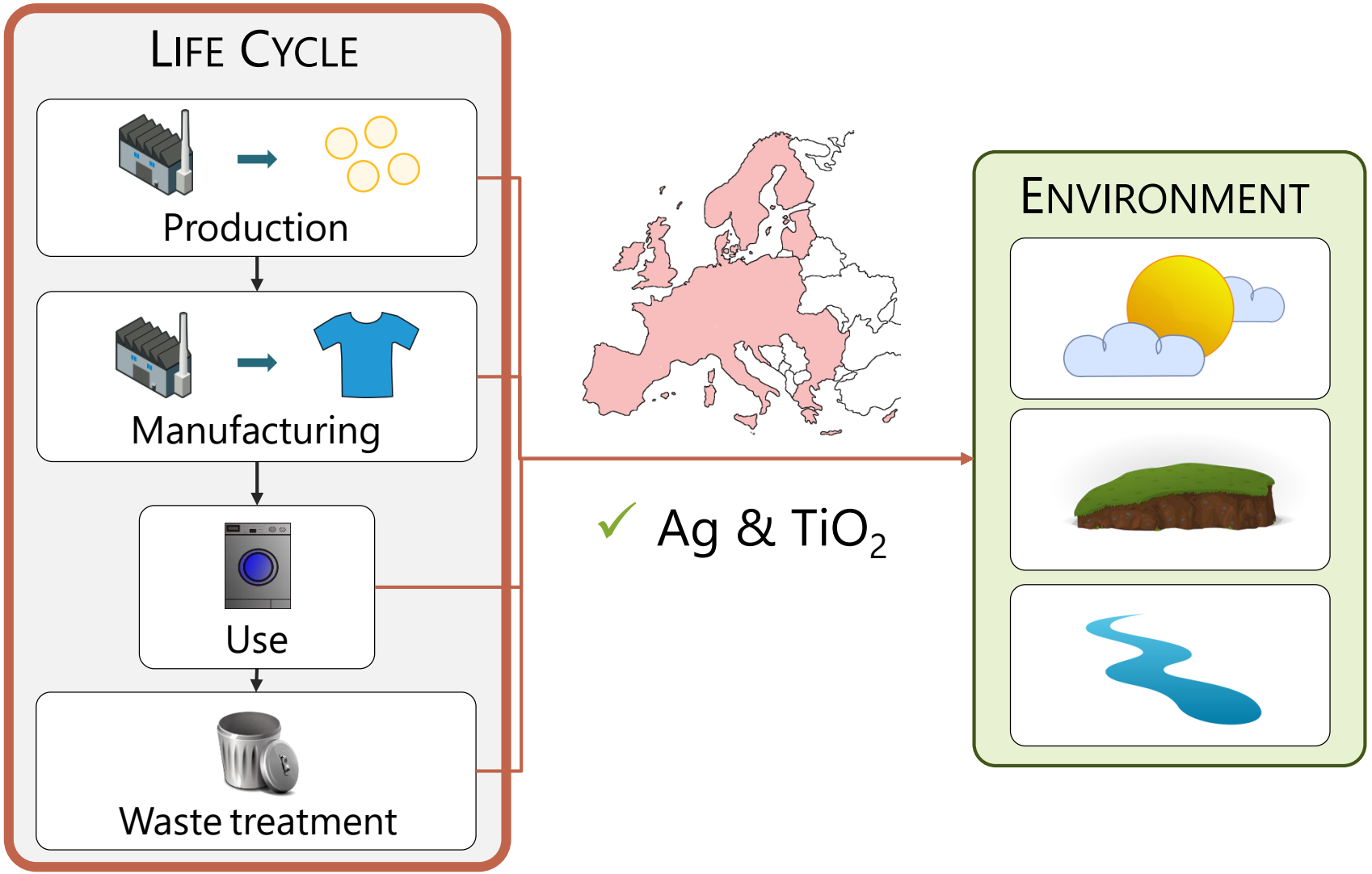

Transformations at European Scale

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5 forms

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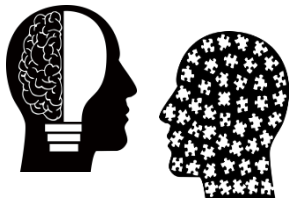

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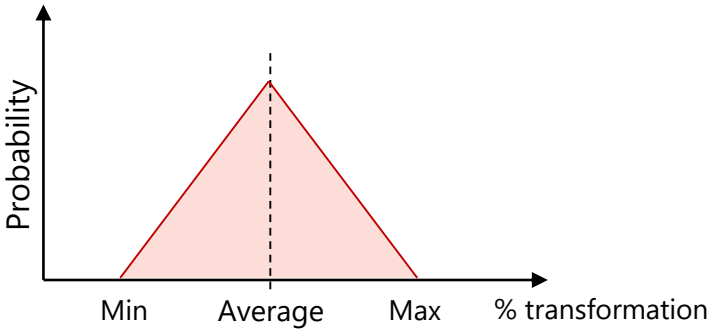
Probabilistic assessment

For each mass flow:



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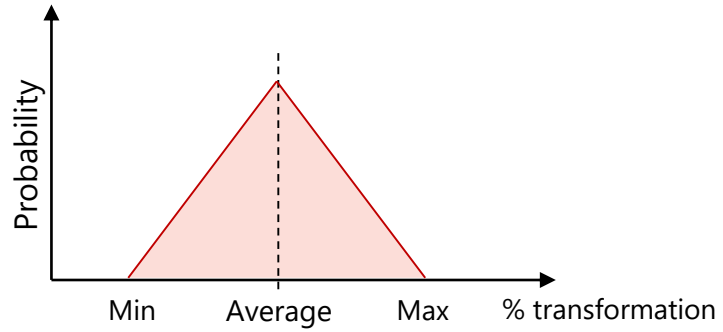

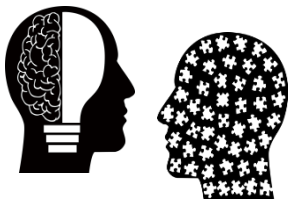

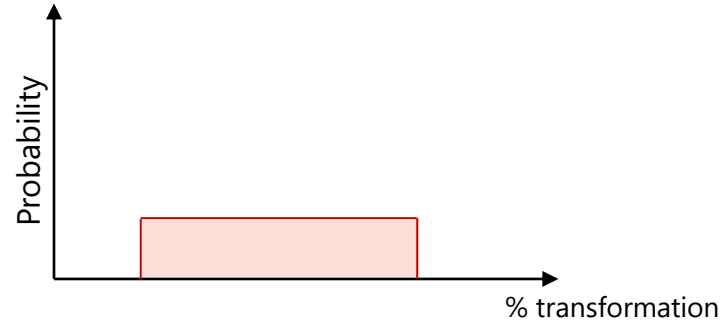

Transformations at European Scale

Product category (nano-Ag)	Share of production (%)	Source
Electronics & Appliances	38	
Textiles	25	
Cosmetics	10	
Food	7	
Cleaning agents	6	
MedTech	4	
Plastics	3	
Paints	3	
Metals	2	
Glass & Ceramics	0.6	
Filter	0.3	
Diapers	0.2	

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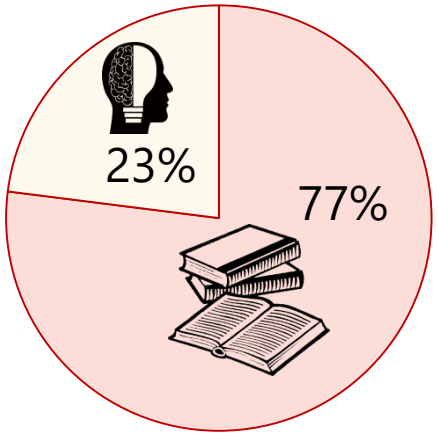
Of mass released during use:



Transformations at European Scale

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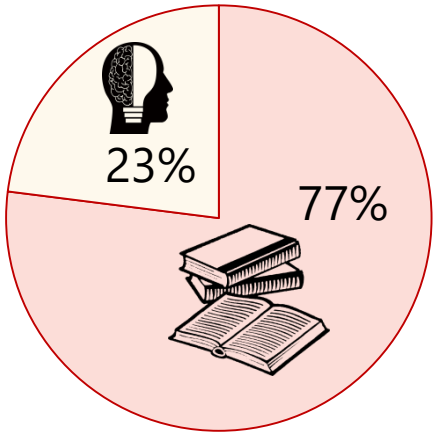

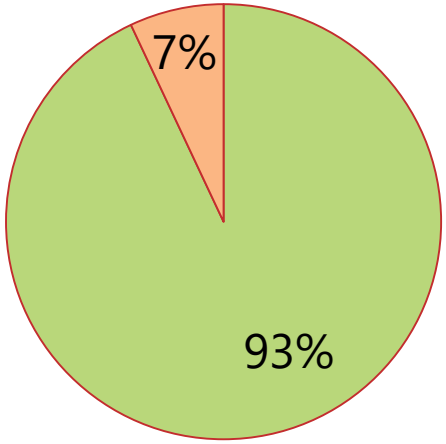

Transformations at European Scale

Product category (nano-TiO_2)	Share of production (%)	Source	Reliability
Cosmetics	59		
Paints	9		
Electronics & Appliances	7		
Cleaning agents	6		
Filters	6		
Plastics	4		
Coatings	4		
Glass & Ceramics	2		
Sporting goods	2		
Water treatment	0.7		
Food	0.4		
Textiles	0.3		
Spray	0.2		
Metals	0.1		
Cements	0.1		

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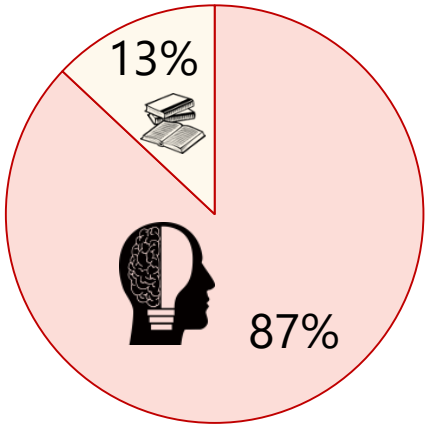
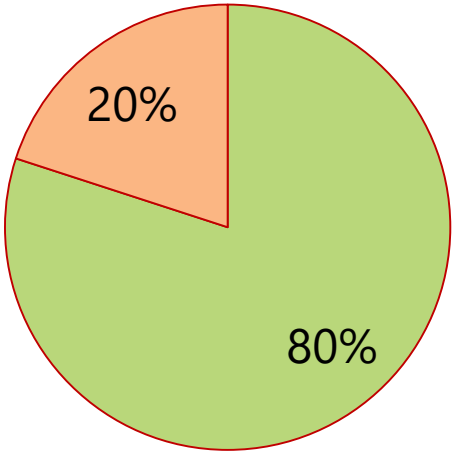
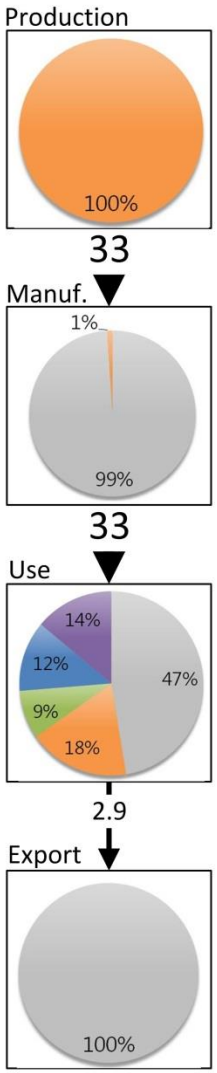
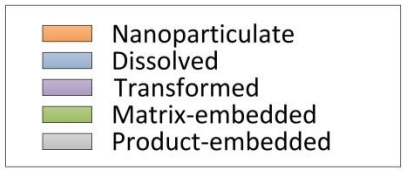




Transformations at European Scale

Nano-Ag (tons)





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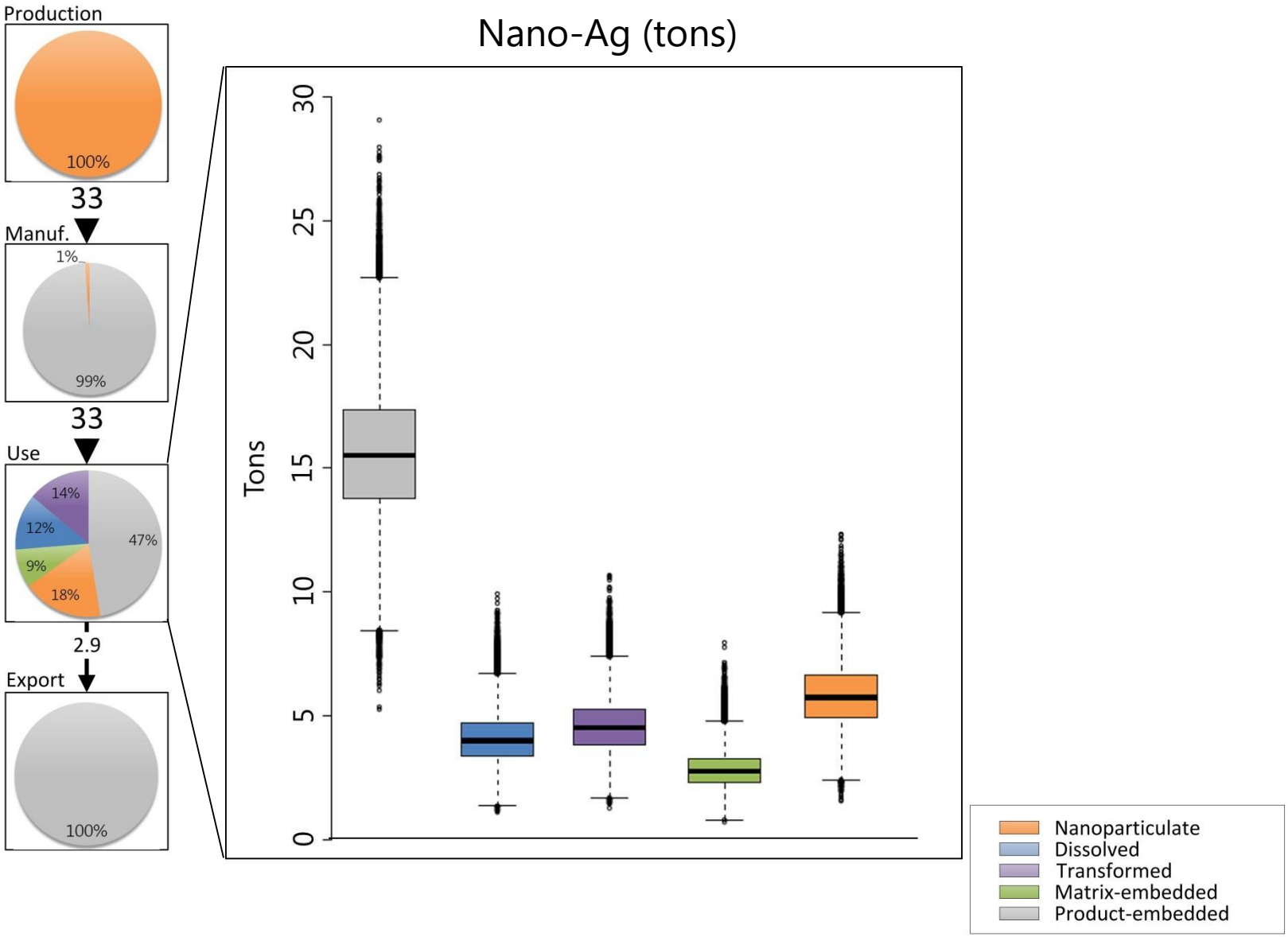
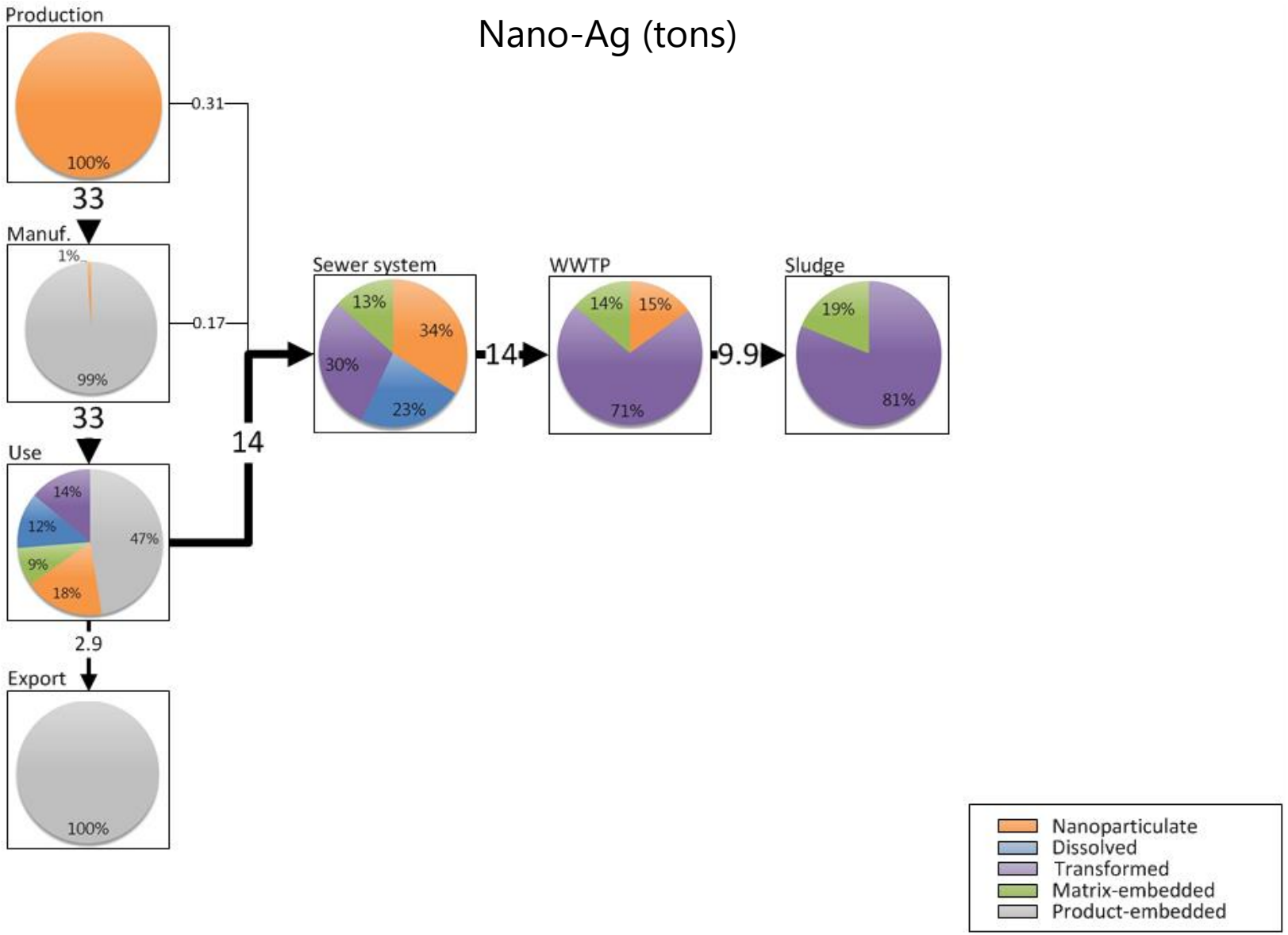


TRANSFORMATIONS AT EUROPEAN SCALE



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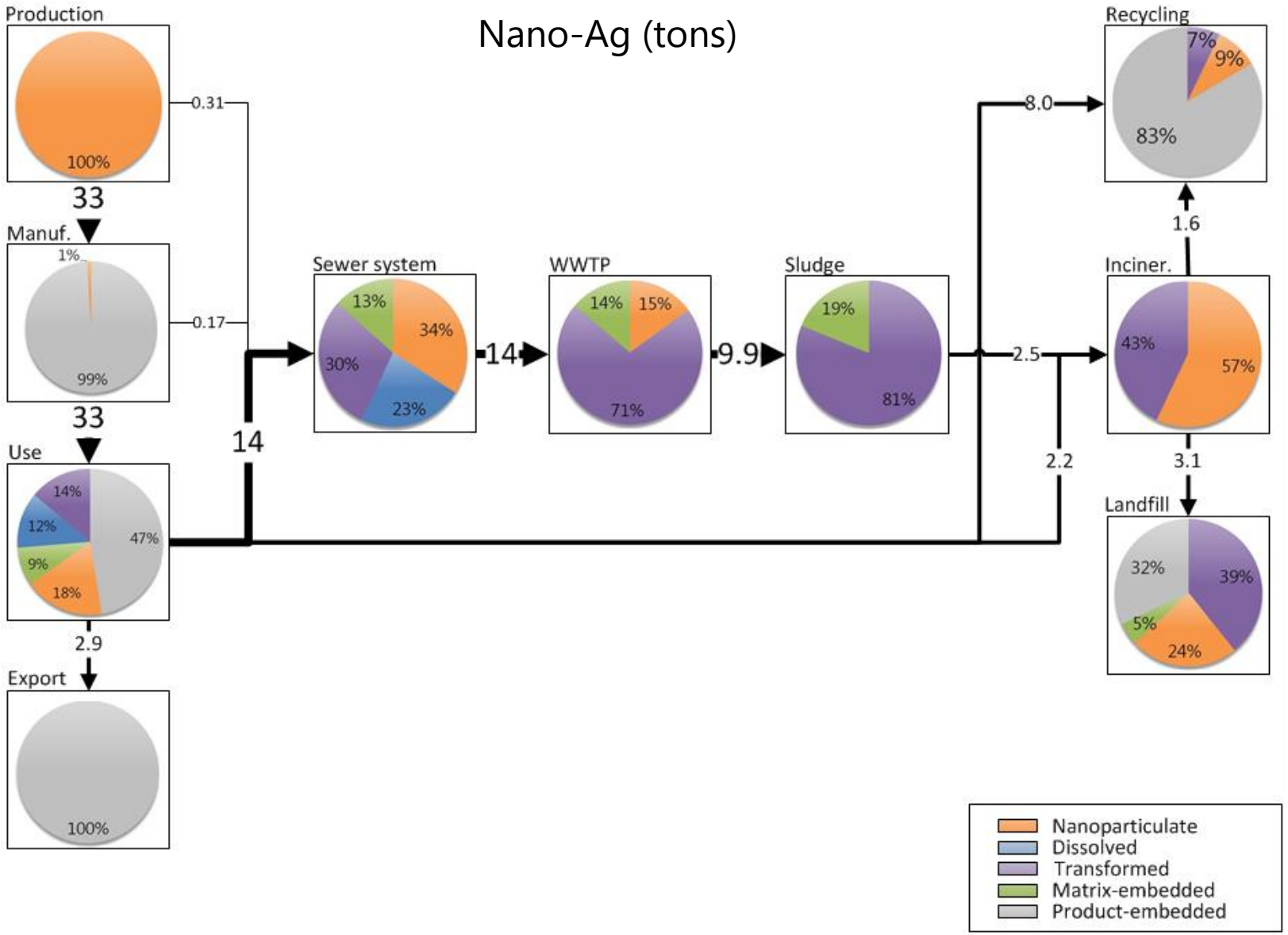

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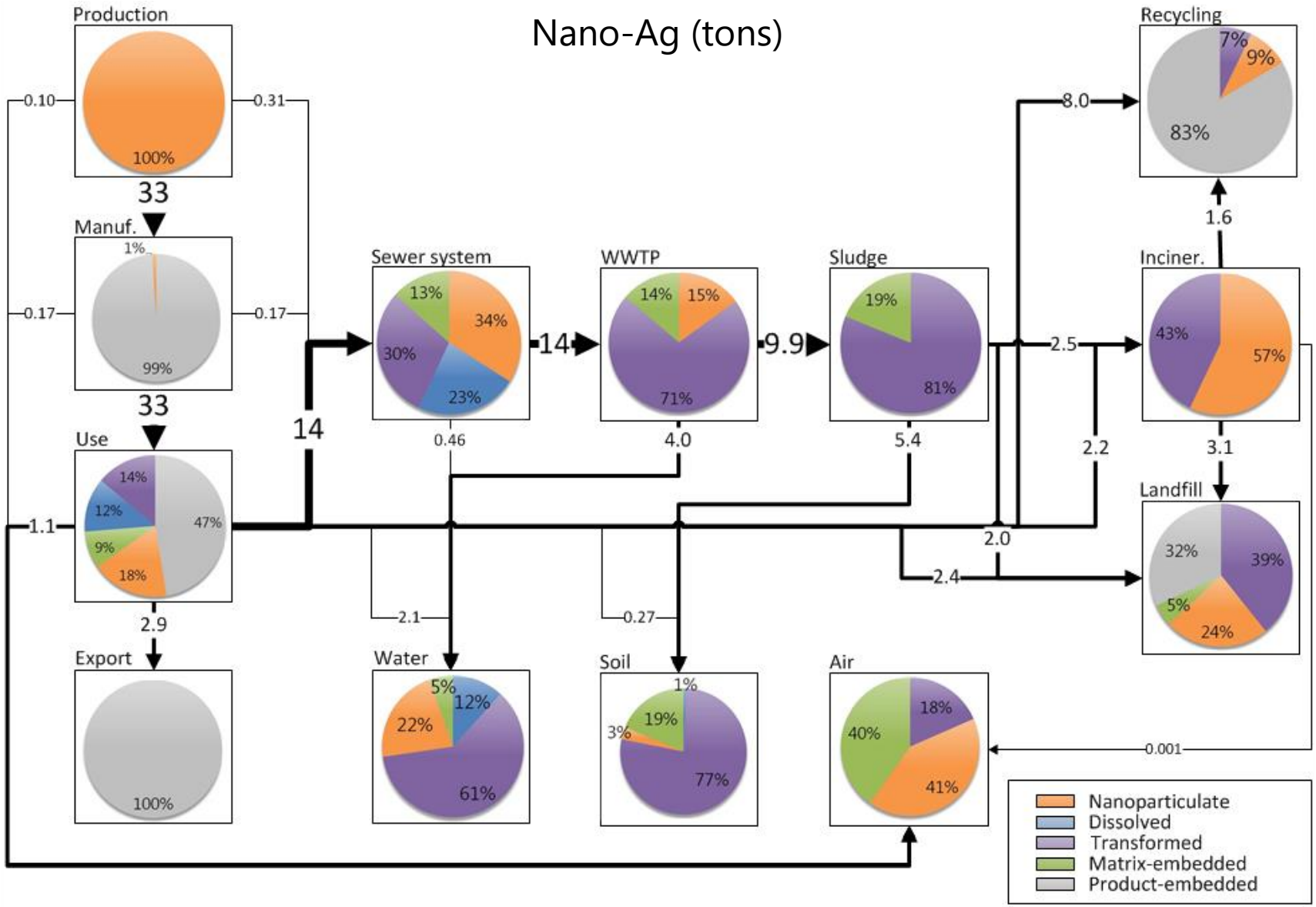

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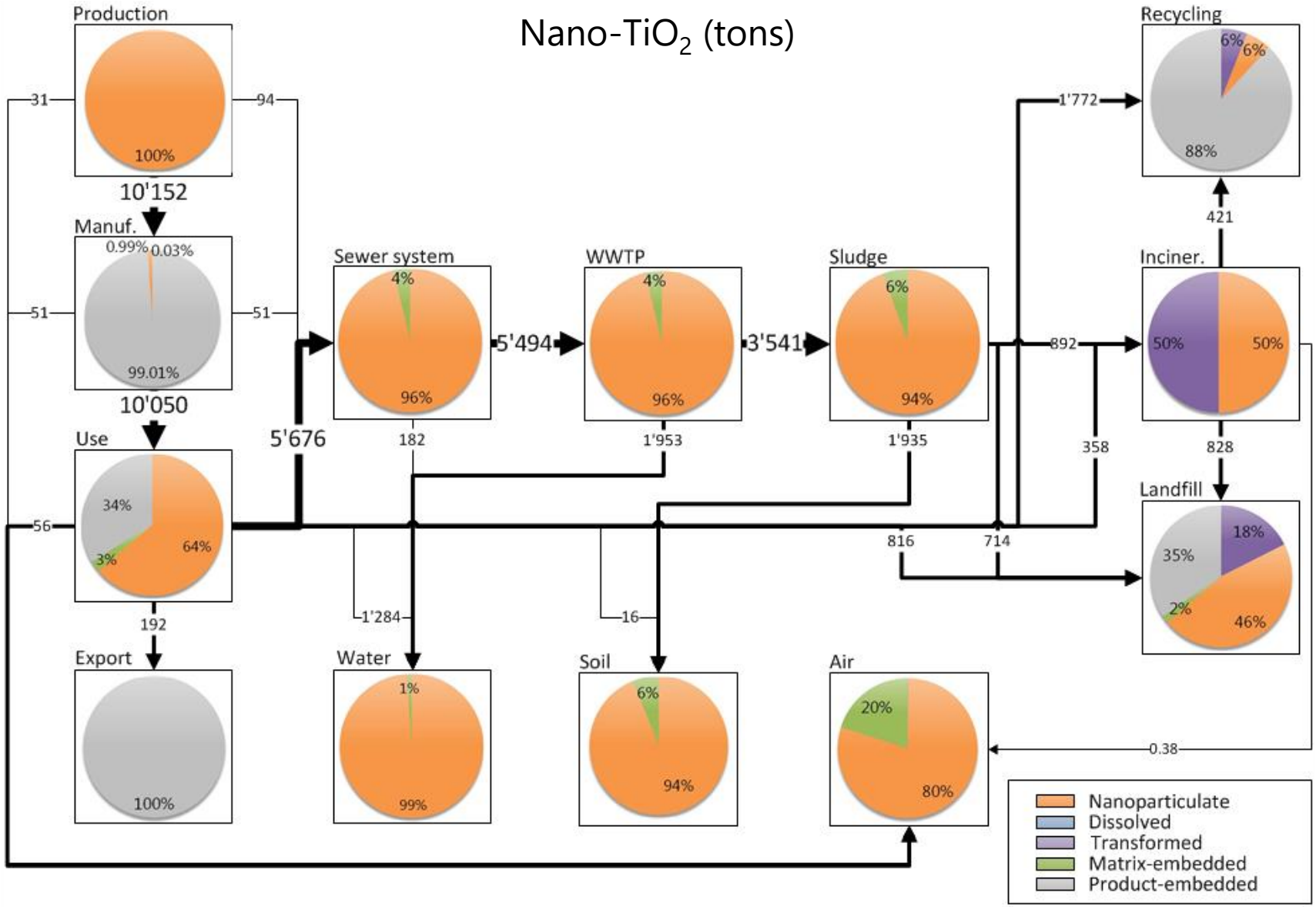

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  - No size distribution
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  - Masses and forms
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- Dynamic probabilistic modeling

THANK YOU!

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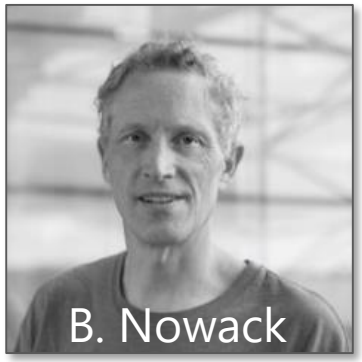
Materials Science and Technology

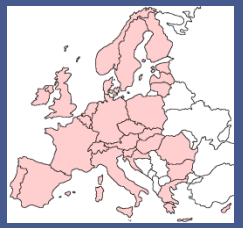
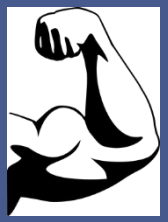

B. Nowack

A. Caballero

D. Wenger

Y. Wang

Waste Treatment Data: Method

Score			
1	Country considered	≥ 2014	Reports, communications, papers
2	Local data	2010 ≤ x < 2014	Eurostat
3	Different country	< 2010	Expert estimation