GreenDelta

sustainability consulting + software

Moving towards a bio-based wood painting sector: preliminary insights from the LIFE-BIOPAINT project

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Bio-based chemicals and paints: sustainability issues

Paints and coating sector, is one of the most regulated sector in Europe...

uses petrochemical derivatives as raw materials, which are often also toxic (e.g., acrylic acid and styrene)

releases NMVOC (50% of total EU emissions) during manufacturing and application: workers enter in contact with harmful chemicals[1]

industrial waste are mainly hazardous waste[2]

1. Emission Inventory Guidebook, EEA, 2016 | 2. DG-ENV, 2010

LIFE-BIOPAINT - towards bio-based wood paints

LIFE-BIOPAINT project

EU the Life Programme

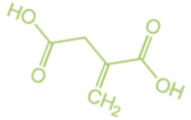
Project partners: ivm Chemicals coatings & polymers technologies GreenDeLTa

AIM:

promote bio-based solutions to substitute hazardous petroleum derivatives in the painting sectors

HOW:

- Development of an innovative and safer closed-loop production process for Bio-Based Paints (BBPs) for wood coatings
- Formulation of innovative BBPs (focus on itaconic acid) overcoming the current technical issues and gaps



Expected benefits from LIFE-BIOPAINTS

Substitution of toxic petroleum-based raw materials

Lower harmful emissions during production and application

sustainability

reduction in use of petroleum-based product, waste elimination, energy reduction, elimination of VOC emissions during the process

reduction of health risks for workers

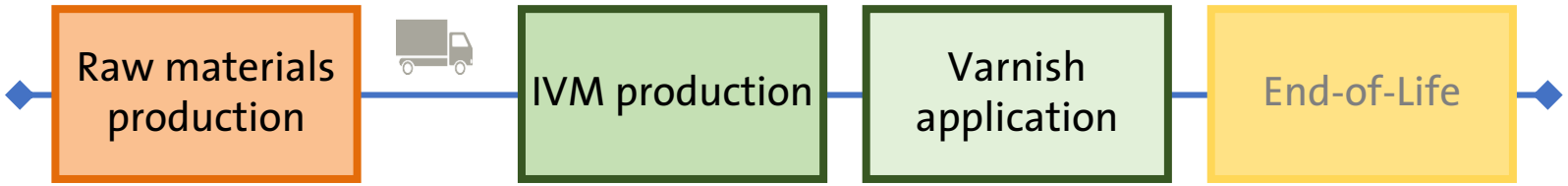
$

improvement in the wood coating sector and other sectors (e.g., consumer electronics, food & beverage and packaging), increase in production efficiency, reduction in costs

How is sustainability assessed in the LIFE-BIO-PAINT project

Sustainability Assessment - overview

- System under investigation -



- Current plant
- New closed-loop plant

- Conventional varnish
- Bio-Based varnish

Sustainability Assessment - overview

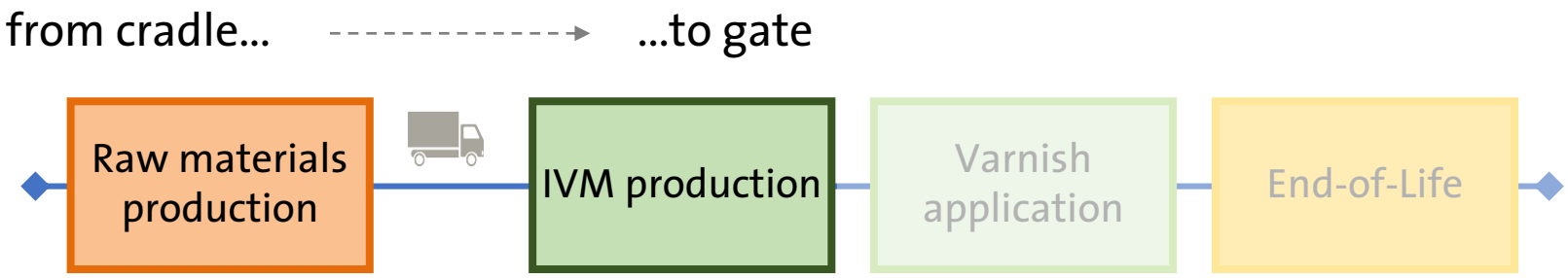
- Methodological approach -

	sustainability dimensions	object of the analysis
Life Cycle Assessment (LCA)		 products
site-specific Environmental Impact Assessment (EIA)		 production plant
Socio-Economic Analyses		 market and other sectors

Preliminary results - LCA

LCA – overview

STEP	GOAL
LCA 1 - baseline	LCA of the baseline scenario: conventional production in IVM production plants
LCA 2 – bio-based	LCA of the newly formulated bio-based (BB) product(s) produced with the new production process
LCA 3 - comparison	- Baseline vs. bio-based scenario - laboratory vs. pilot scale - comparison with other existing wood coating and competing products



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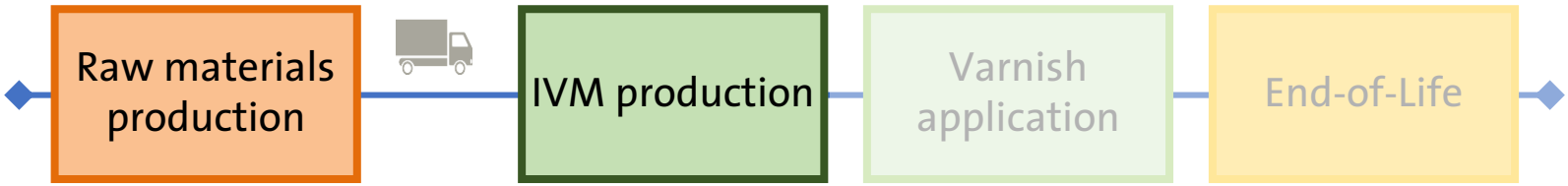
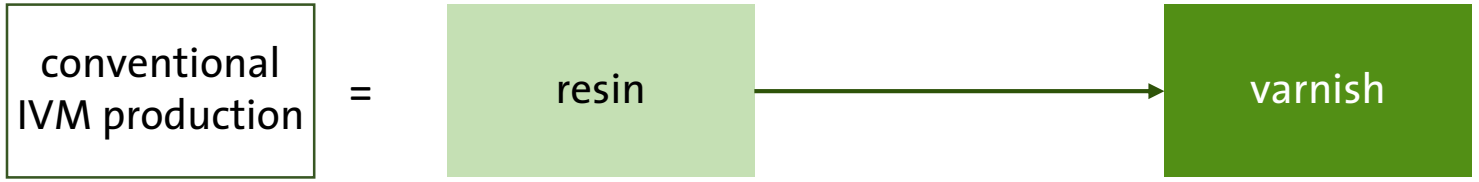
from cradle... ----------→ ...to gate



LCA 1 – baseline scenario



product formulations:

Ingredient	resin
glycerine	8%
pentaerythritol	8%
ethylene glycol	5%
castor oil	6%
fumaric acid	10%
phthalic anhydride	23%
acrylic oligomer	20%
butyl acetate	20%

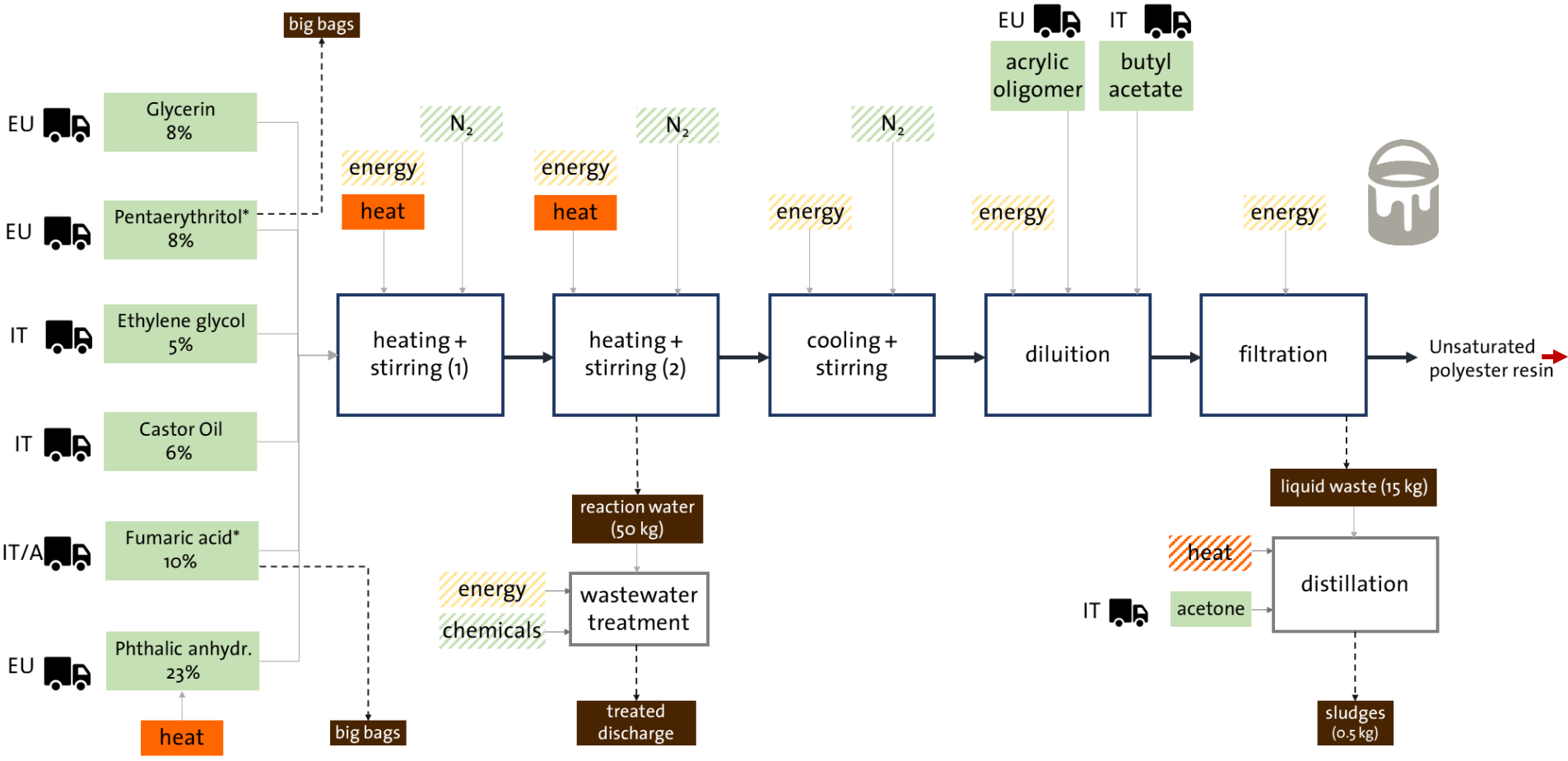
Ingredient	varnish
unsaturated resin	**60%**
xylene	15%
butyl acetate	15%
calcium carbonate	9%
additives	1%

functional unit:

1 kg of resin
1 kg of varnish

LCA 1 – baseline scenario

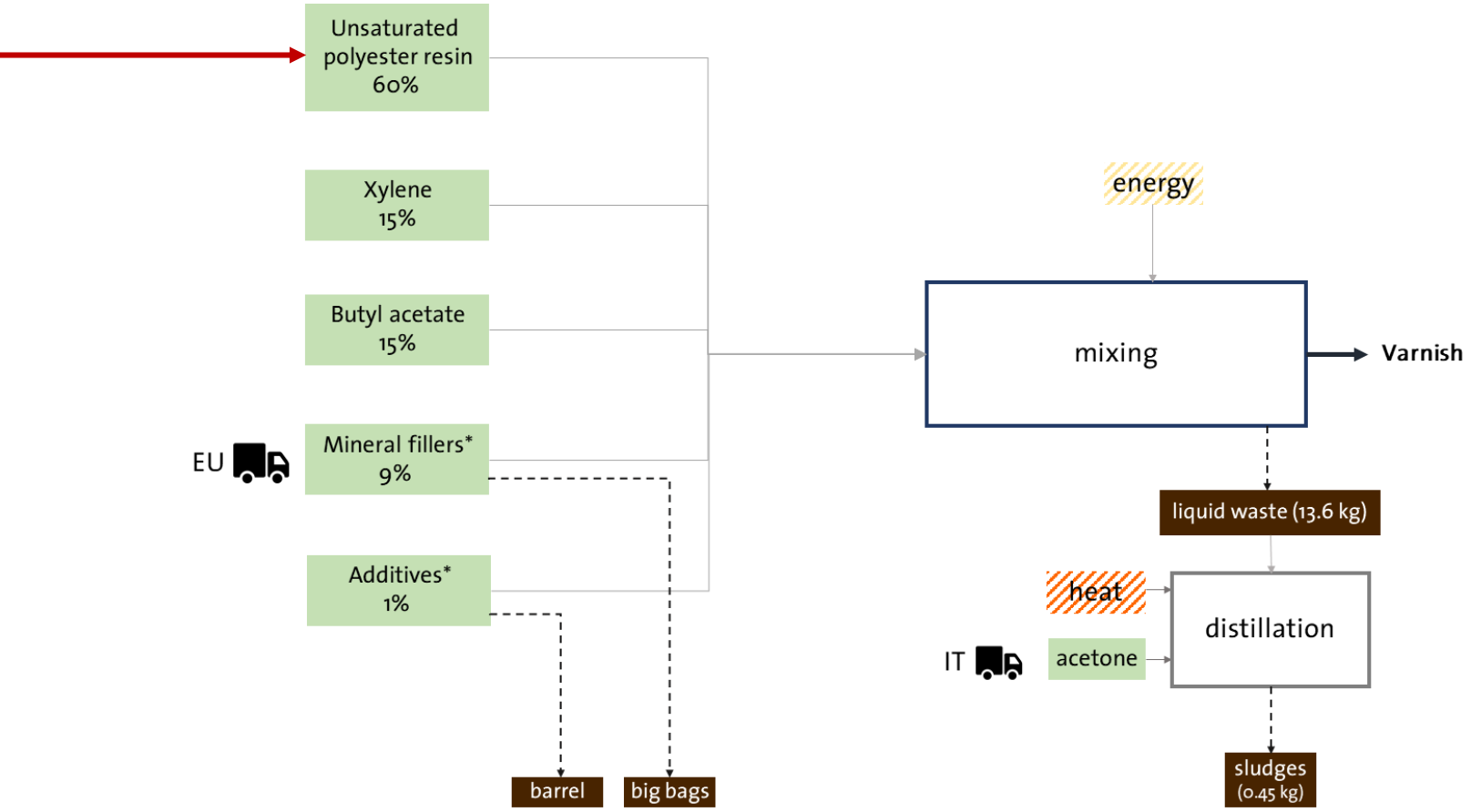
- Resin production – flow chart



* with big bags

LCA 1 – baseline scenario

- Varnish production – flow chart



* with big bags or barrels

LCA 1 – baseline scenario

- LCI: preliminary results -

Primary data: from IVM

- Raw material – amount, origin and transportation means
- Energy requirements (electricity and heat) – aggregated
- Waste flows (solid and wastewater)

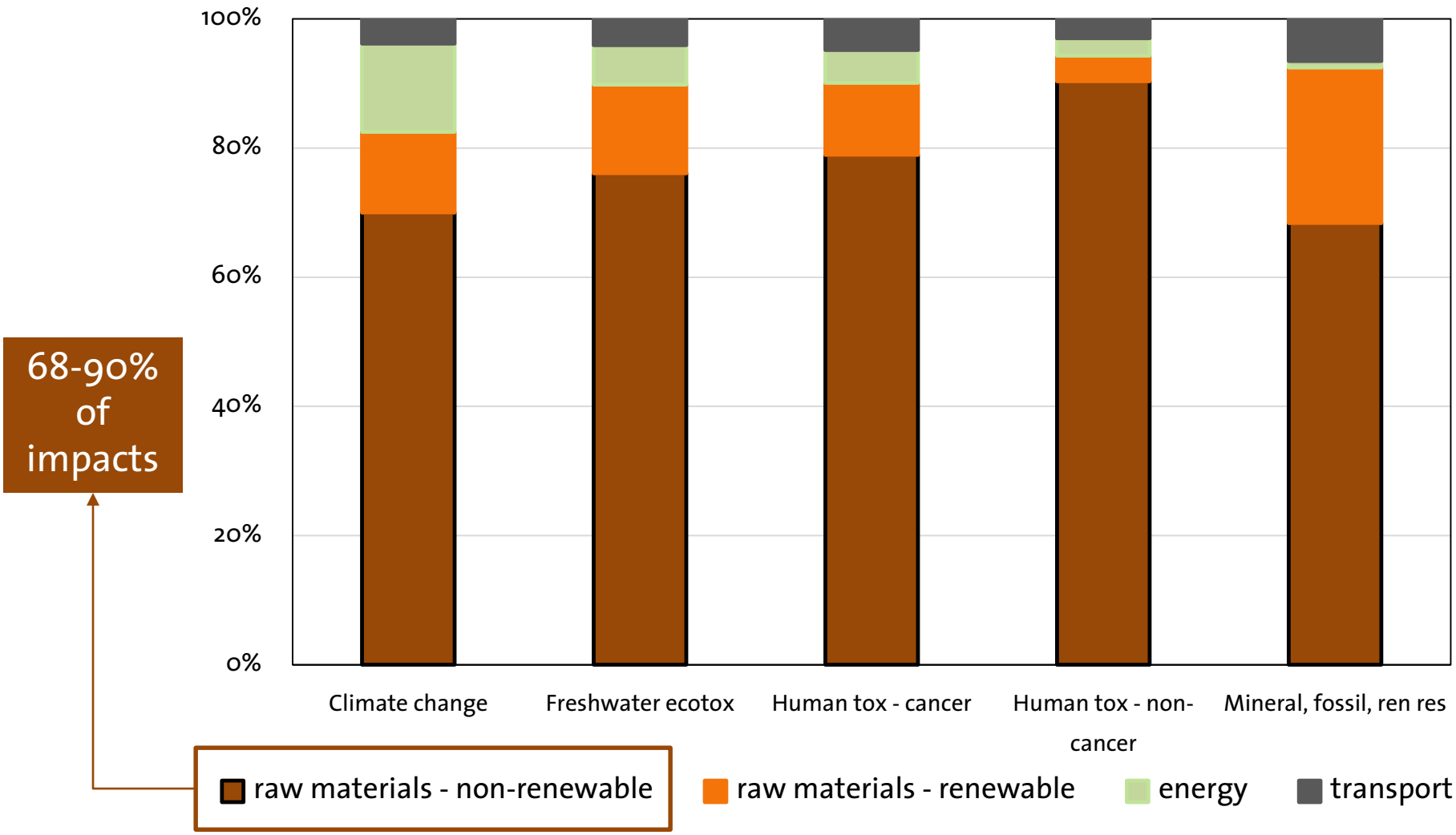
Need improvements:

- Air emissions from IVM production plants
- Waste destination
- Specific raw materials (e.g., fumaric acid)
- Process disaggregation

Secondary data: ecoinvent 3.5 cut-off

LCA 1 – baseline scenario

- LCIA- **Method:** ILCD 2011 Midpoint +

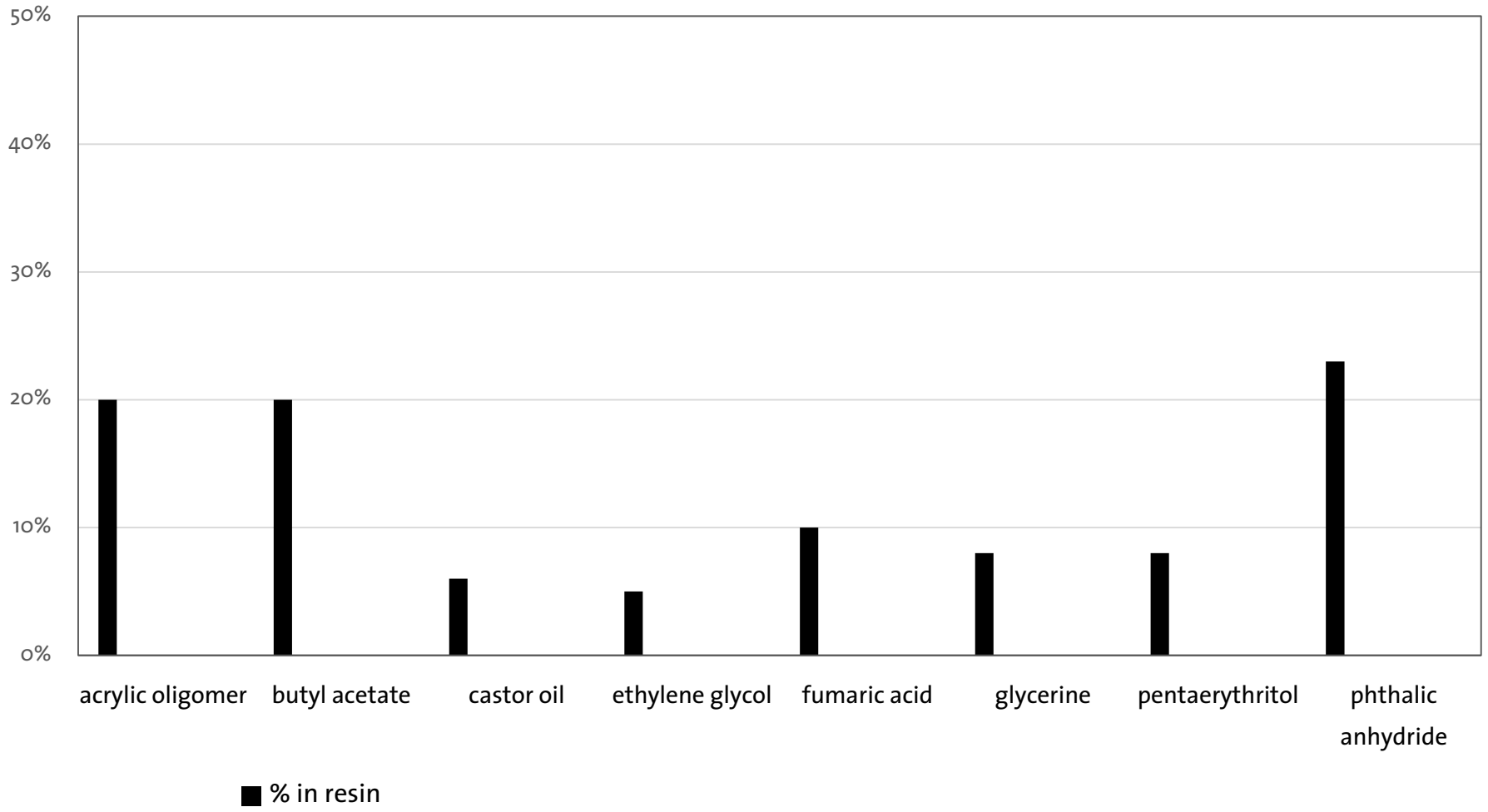


68-90% of impacts

Category selection – hotspot analysis and focus of the project

LCA 1 – baseline scenario

- LCIA- main raw materials: mass vs. Impact contribution



LCA 1 – baseline scenario

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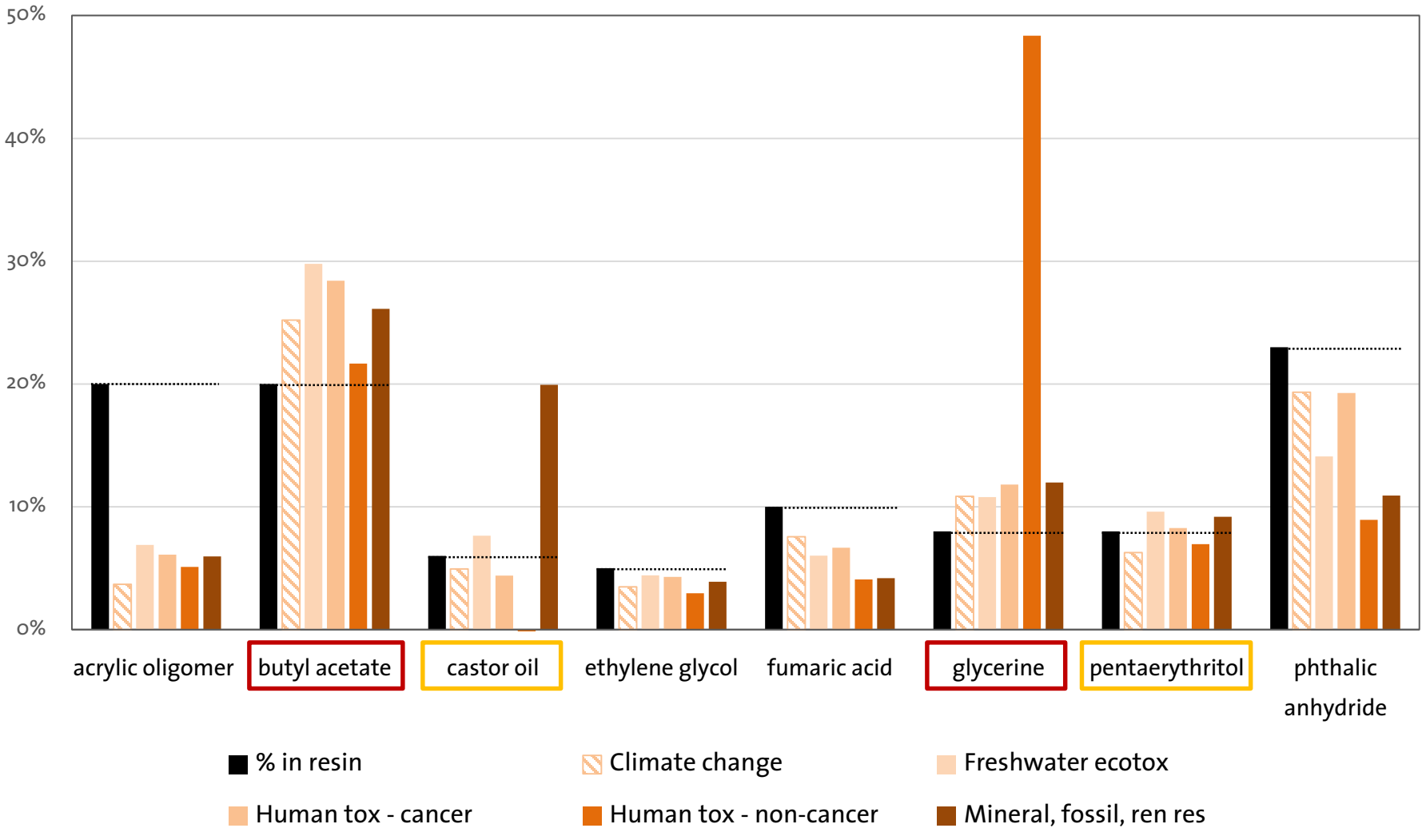
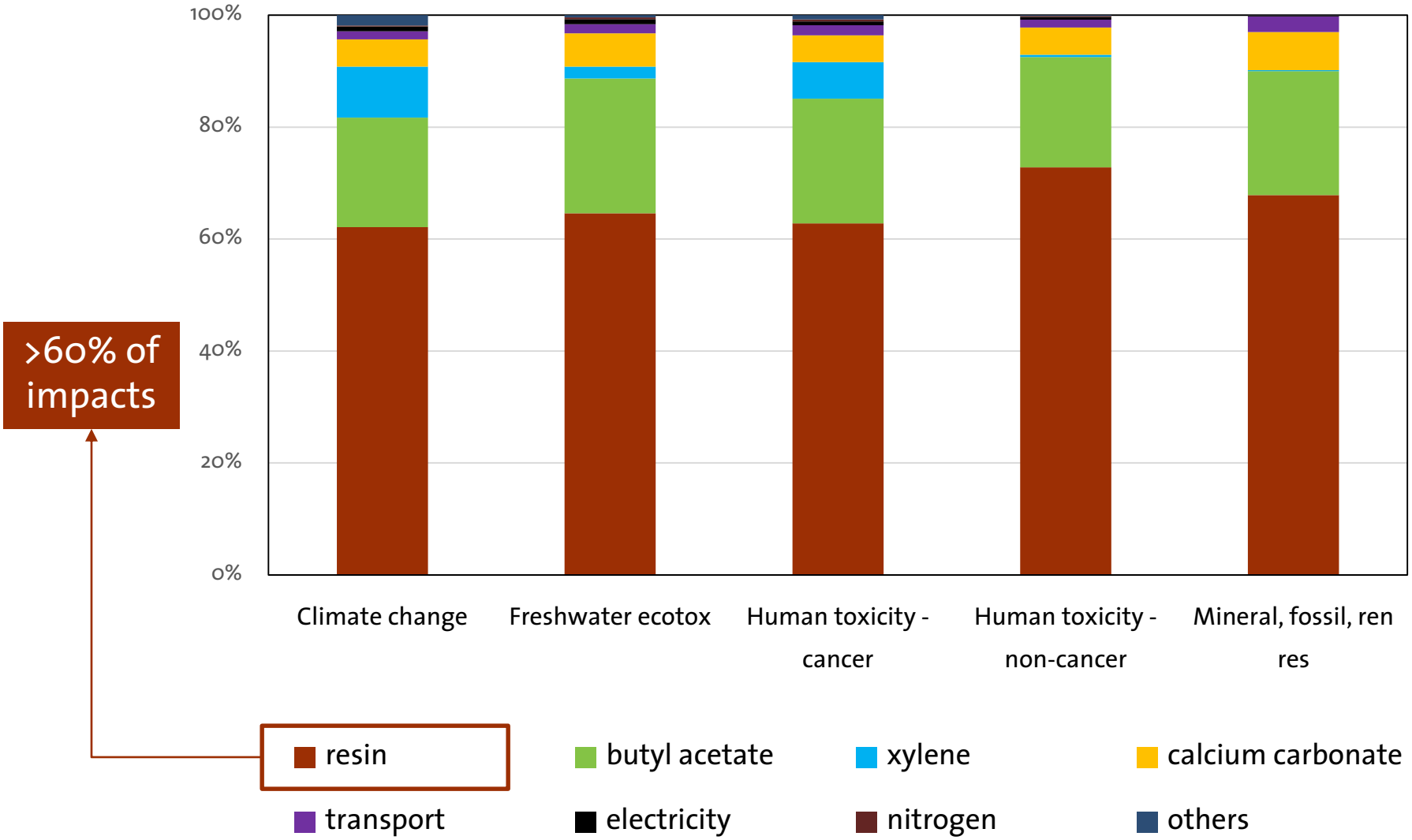


LCA 1 – baseline scenario

- LCIA- varnish: role of resin



LCA 1 – baseline scenario

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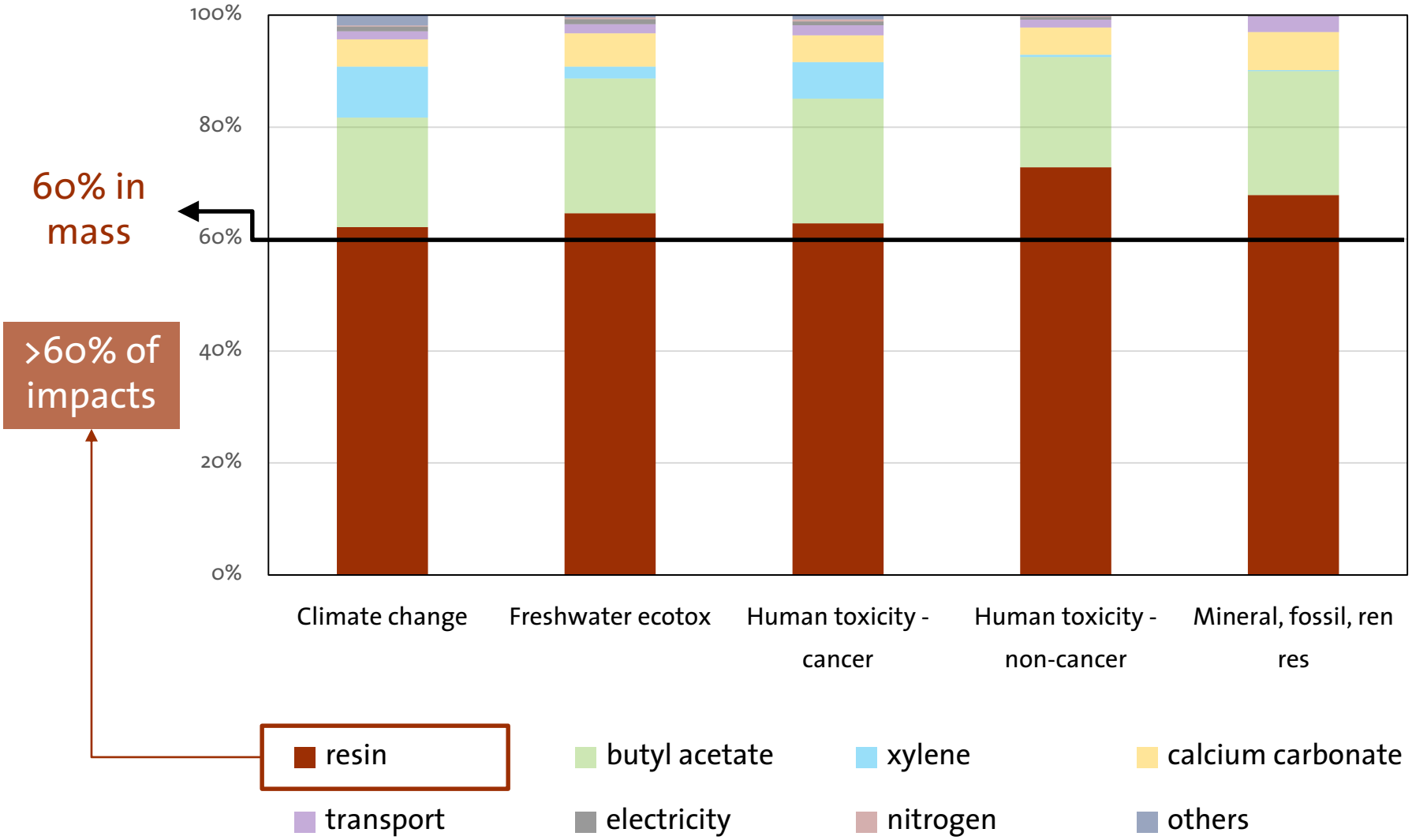
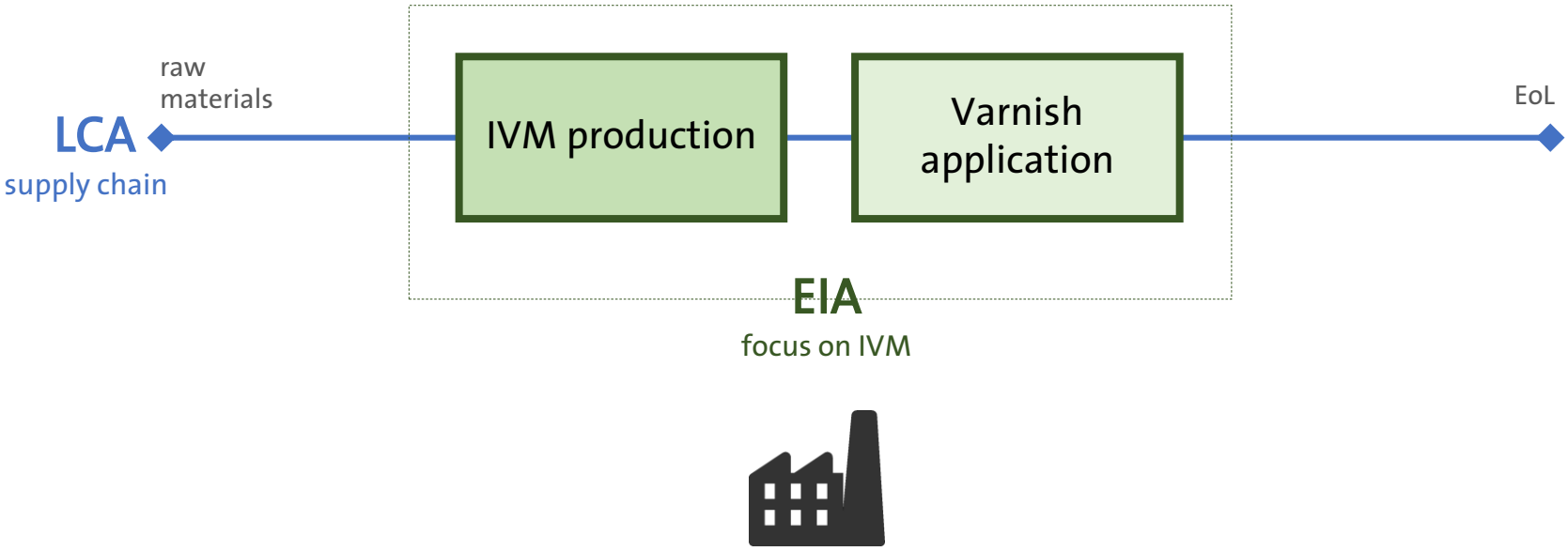


Preliminary results - EIA

EIA

LIFE-BIOPAINT – main outputs:

- construction of a new production plant
- new products on the market



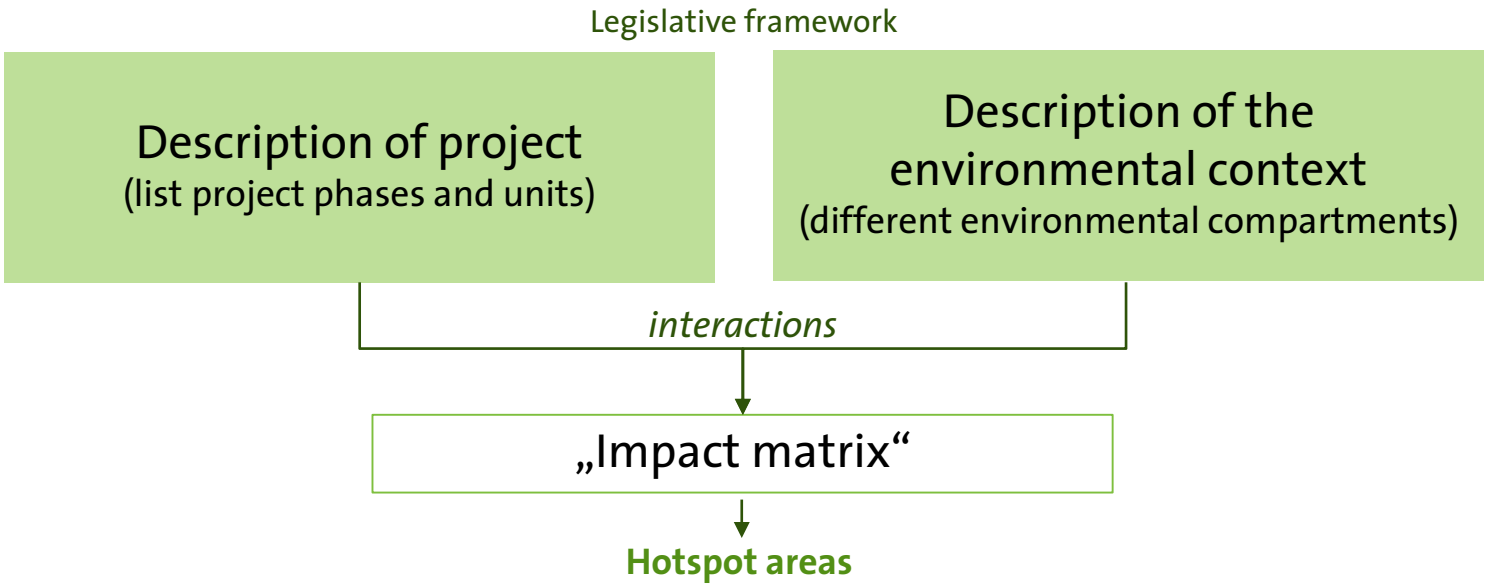
Eu Directive 85/337/CEE → D.L.vo n. 152/2006 (Italy) - Annex III:
Produzione di pesticidi, prodotti farmaceutici, pitture e vernici, elastomeri e perossidi, per insediamenti produttivi di capacita' superiore alle **10.000 t/anno** di materie prime lavorate.
Impianti per la produzione di pesticidi, prodotti farmaceutici, pitture e vernici, elastomeri e perossidi, per insediamenti produttivi di capacita' superiore alle **35.000 t/anno** di materie prime lavorate.

EIA – developed methodology

1

2

3



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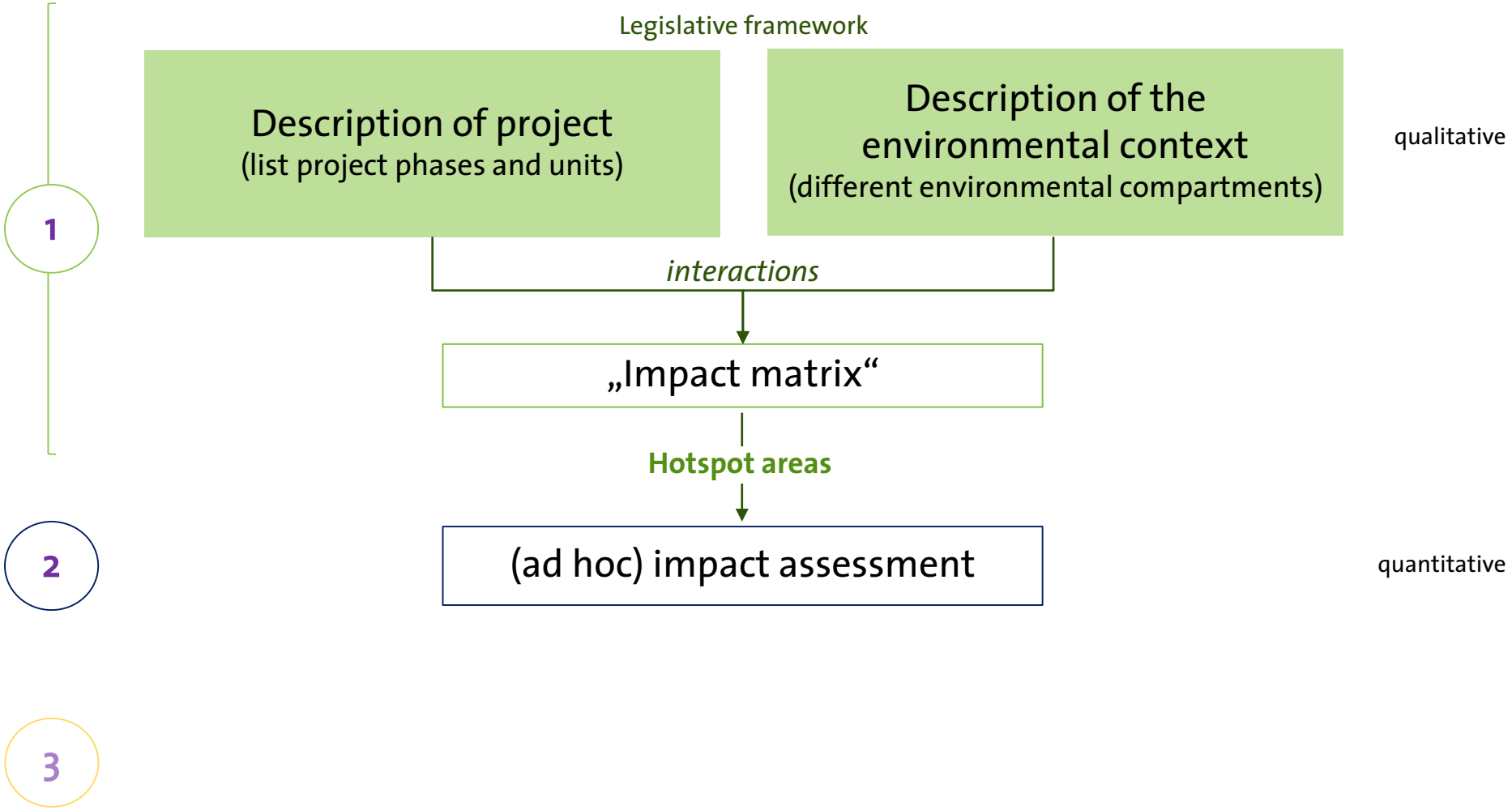
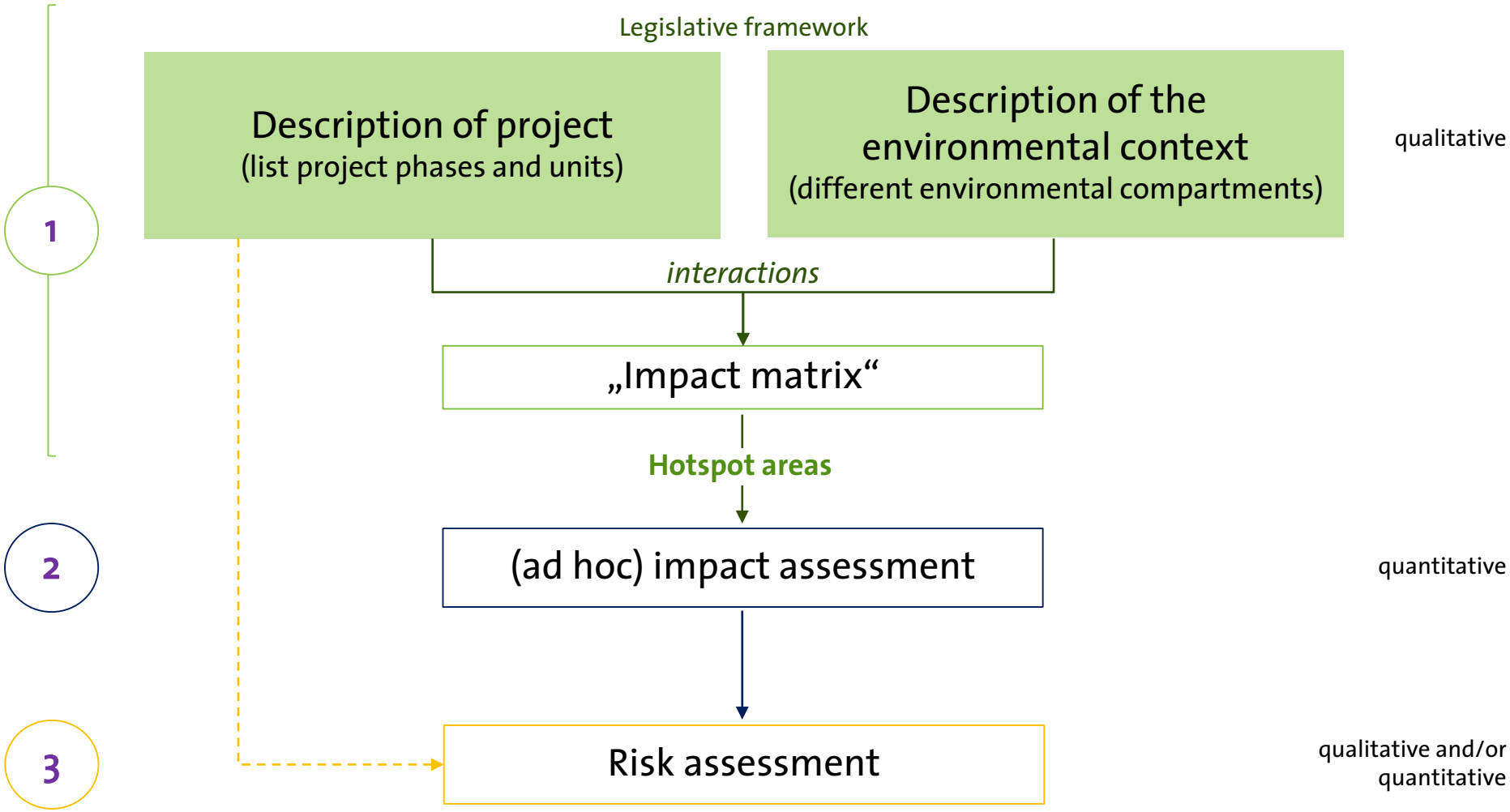


EIA – developed methodology



EIA – preliminary outcomes

Identification of hotspot areas

Table including (preliminary):

1

Project components	Specific actions	Valuable environmental components	impact	duration	spatial extention	time	(qualitative significance)

2

EIA – preliminary outcomes

Identification of hotspot areas

Table including (preliminary):

1

Project components	Specific actions	Valuable environmental components	impact	duration	spatial extention	time	(qualitative significance)

Raw materials - Toxicology

2

Chemical	Dangerous to health	Dangerous to environment	Flammable
Acetone	H319, H336	VOC	H225
Acrylic oligomers	H315, H317, H318, H319	H400, H410, H411	
Acrylate polymers	H302, H315, H317, H318, H319, H335	H400, H411, H412	
Acrylic acid	H302, H312, H314, H318, H332	H400	H226
Fumaric acid	H319		
Maleic anhydride	H302, H314, H317, H334		
Itaconic acid	H315, H319, H335		
Glycols	H302, H373		

Indoor and outdoor air emissions

INDOOR:
- Data from IVM
- Literature review on assessment methods

OUTDOOR:
- Data from IVM
- Diffusion models (suitable for nearly-zero wind conditions)

LIFE-BIOPAINT – wrap-up

Challenges

- LCA -

- Data collection (multidisciplinary team, different perspectives)

- BASELINE SCENARIO:
  - Background data: availability of data about specific raw materials
  - Primary data availability: IVM is new to LCA→ missing or aggregated data

- BIO-BASED SCENARIO:
  - Modelling realistic bio-based supply chains – several possible scenarios
  - Assessing innovative products (not yet existing)

- EIA -

- Defining ad-hoc methodology
- Data collection

Thank you!

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Next steps

- LCA -

- BASELINE SCENARIO:
  - Refine and detail the system model
  - Integrate new collected data

- BIO-BASED SCENARIO:
  - continue with the literature review on BB raw materials
  - start data collection on laboratory experiments

- EIA -

- Data collection on air emissions (outdoor and indoor)
- Testing of identified models for air emissions diffusion

LCIA results - resin

RESIN	ILCD 2011 Midpoint		Europe			
Name	Impact result	Unit	Normalized results	Weighted results (Pt)	Rank - hotspot	Contrib. to total impact
Human toxicity, cancer effects	1.11E-07	CTUh	0.00301	0.0002	1	30%
Freshwater ecotoxicity	1.53E+01	CTUe	0.00175	0.00012	2	18%
Human toxicity, non-cancer effects	8.23E-07	CTUh	0.00154	0.0001	3	15%
Mineral, fossil & ren resource depletion	1.00E-04	kg Sb eq	0.001	6.66E-05	4	10%
Freshwater eutrophication	6.90E-04	kg P eq	0.00047	3.12E-05	5	5%
Particulate matter	1.59E-03	kg PM2.5 eq	0.00042	2.80E-05	6	4%
Acidification	1.52E-02	molc H+ eq	0.00032	2.13E-05	7	3%
Climate change	2.80E+00	kg CO2 eq	0.0003	2.02E-05	9	3%
Photochemical ozone formation	9.60E-03	kg NMVOC eq	0.0003	2.02E-05	8	3%
Marine eutrophication	4.84E-03	kg N eq	0.00029	1.91E-05	10	3%
Terrestrial eutrophication	3.69E-02	molc N eq	0.00021	1.40E-05	11	2%
Ionizing radiation HH	2.33E-01	kBq U235 eq	0.00021	1.38E-05	12	2%
Water resource depletion	1.00E-02	m3 water eq	0.00012	8.20E-06	13	1%
Land use	3.05E+00	kg C deficit	4.08E-05	2.72E-06	14	0%
Ozone depletion	3.19E-07	kg CFC-11 eq	1.48E-05	9.84E-07	15	0%