BAMB
BUILDINGS AS MATERIAL BANKS

6-7 February 2019

BUILDINGS AS MATERIAL BANKS

a pathway for a circular future

SBE19Brussels - RESEARCH DAYS

#BAMBimpact
www.bamb2020.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 642384

Keynote lecture 1

Mass flow in the life cycle of buildings a topic and its context

Thomas Lützkendorf
Karlsruhe Institute of Technology

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SBE 19 Brussels – final event & starting point

Buildings As Material Banks – A Pathway For A Circular Future

SBE19 BRUSSELS - BAMB-CIRCPATH

5-7 February 2019
Brussels, Belgium
www.bamb2020.eu

Let us have a deeper look …

http://lr.one.un.org/content/dam/unct/lesotho/img/SDGs_logos.jpg

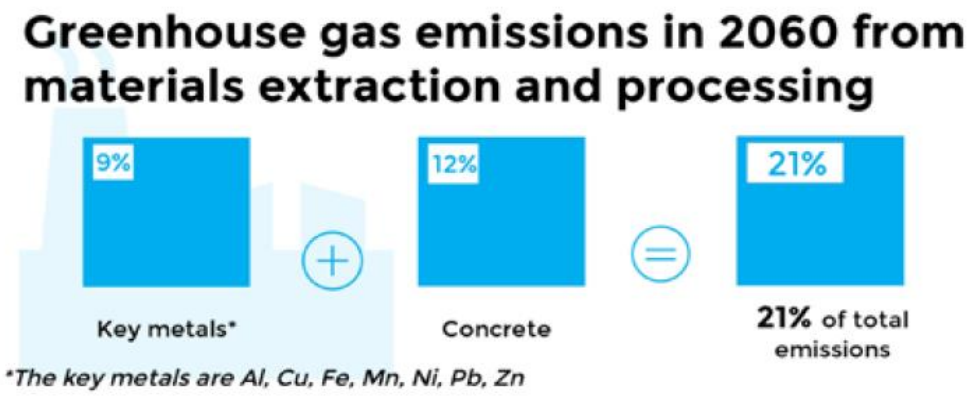
SDG 12 Responsible consumption and production

Targets	Indicators
12.2 By 2030, achieve the **sustainable management and efficient use of natural resources**	**12.2.1** **Material footprint**, material footprint per capita, and material footprint per GDP **12.2.2** Domestic **material consumption**, domestic material consumption per capita, and domestic material consumption per GDP
12.5 By 2030, substantially **reduce waste generation** through prevention, reduction, recycling and reuse	**12.5.1** National **recycling rate**, tons of material recycled

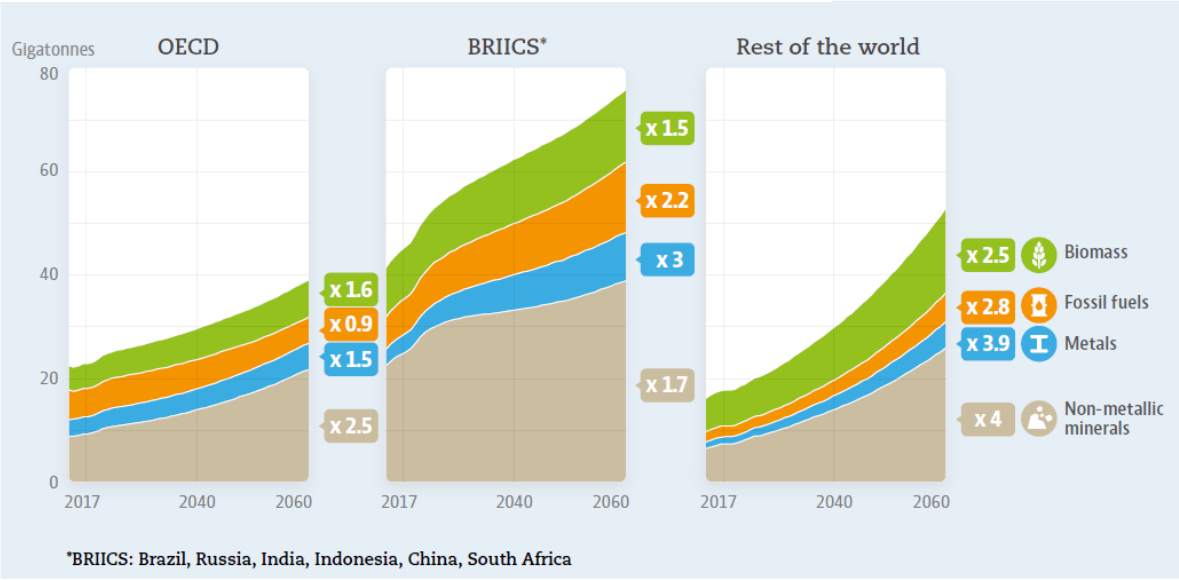
SDG 11 Sustainable Cities and Communities

Targets	Indicators
11.6 By 2030**, reduce the adverse per capita environmental impact of cities**, including by paying special attention to air quality and **municipal and other waste management.**	**11.6.1** Proportion of urban solid waste regularly collected and with adequate final discharge out of total urban solid waste generated, by cities.
11.c Support least developed countries in building sustainable and resilient buildings **utilizing local materials.**	**11. c.1** Proportion of financial support to the least developed countries that is allocated to the construction and retrofitting of sustainable, resilient and **resource-efficient buildings** utilizing **local materials**

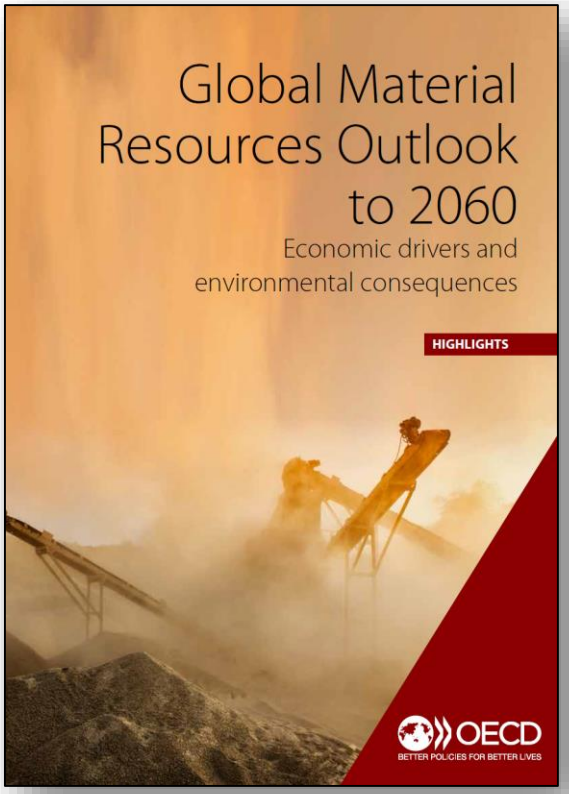
Information on international situation and trends available



Material use rises for all material groups



https://www.oecd.org/environment/waste/highlights-global-material-resources-outlook-to-2060.pdf



EC Strategies, Roadmaps, Frameworks …

Roadmap to a Resource Efficient Europe
(COM(2011) 0571)

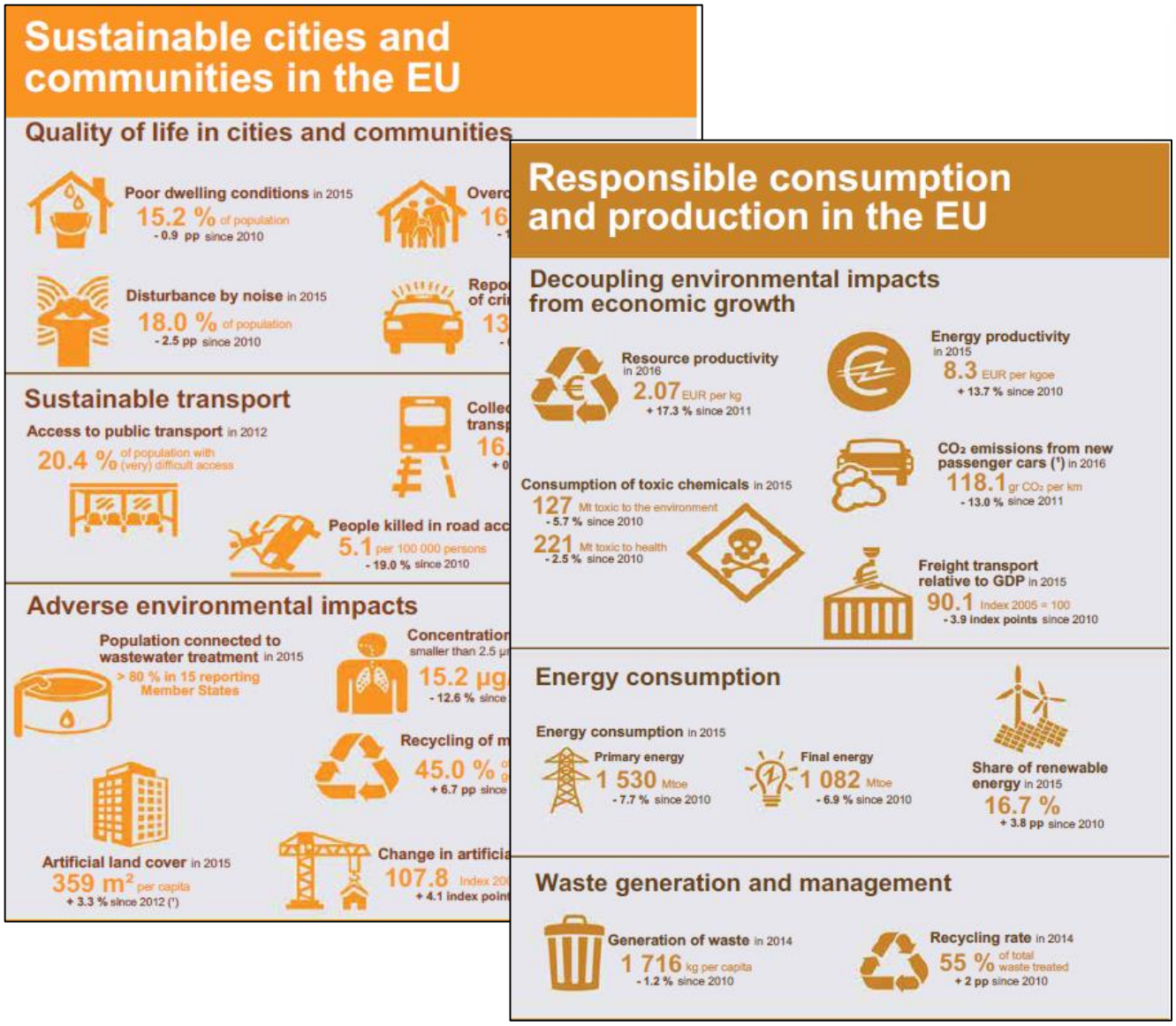
Strategy on the Sustainable Use of Natural Resources
(COM(2005) 0670)

Waste Framework Directive
(2008/98/EC)

Thematic Strategy on the Prevention and Recycling of Waste
(COM(2005) 0666)

Next steps for a sustainable European future - European action for sustainability
(COM(2016) 739)

Sustainable development on European level



https://ec.europa.eu/eurostat/documents/3217494/8461633/KS-04-17-780-EN-N.pdf/f7694981-6190-46fb-99d6-d092ce04083f

CPR Construction Products Regulation

Basic requirements for construction works

- Mechanical resistance and stability
- Safety in case of fire
- Hygiene, health and the environment
- Safety and accessibility in use
- Protection against noise
- Energy economy and heat retention
- **Sustainable use of natural resources**

4.4.2011 EN Official Journal of the European Union L 88/5

REGULATION (EU) No 305/2011 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 9 March 2011
laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC
(Text with EEA relevance)

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

(4) Member States have introduced provisions, including requirements, relating not only to safety of buildings and other construction works but also to health, dura-

The construction works must be designed, built and demolished in such a way that the use of natural resources is sustainable and in particular ensure the following:
(a) ***reuse or recyclability*** *of the construction works, their materials and parts after demolition;*
(b) ***durability*** *of the construction works;*
(c) ***use of environmentally compatible raw and secondary materials*** *in the construction works.*

https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:088:0005:0043:EN:PDF

Level(s) – EU framework of sustainability indicators

Information that can be reported:

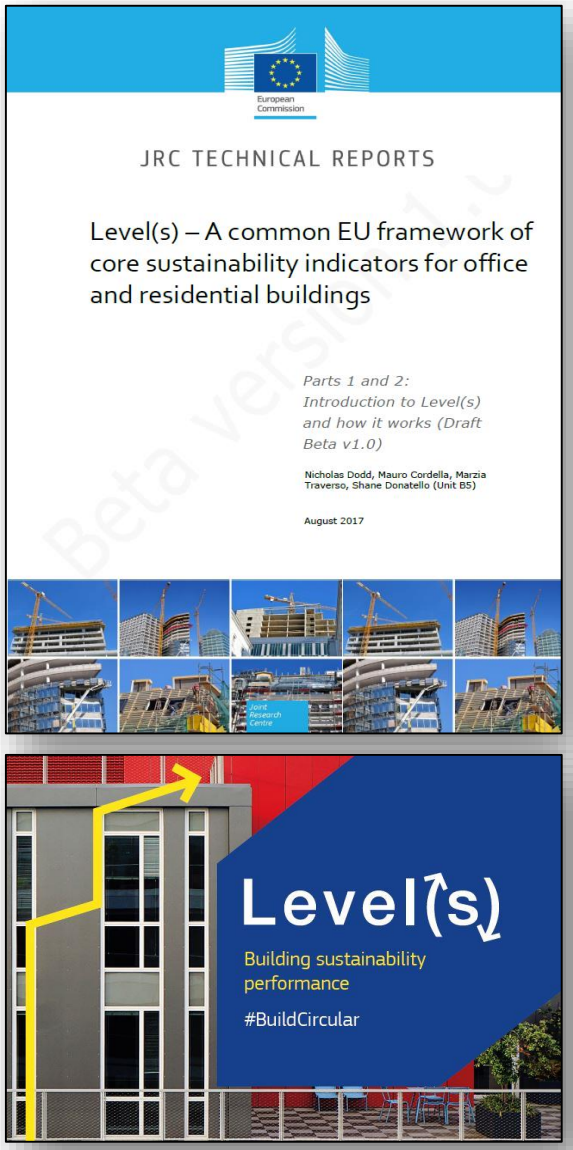
- Bill of quantities – specifies the elements
- Bill of materials – describes the materials
- Reporting - mass of each type of material
- Reporting - main material types (EUROSTAT)

  **** Metal materials***

  **** Non-metallic mineral materials***

  **** Fossil energy materials***

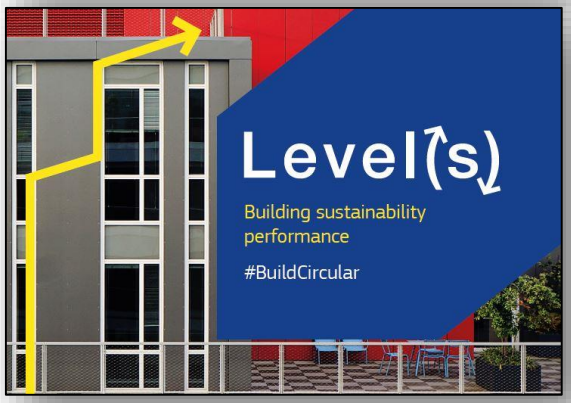
  **** Biomass based materials***



http://publications.jrc.ec.europa.eu/repository/bitstream/JRC109285/jrc109285_171205_levels_eu_framework_of_building_indicators_parts_1_and_2_pubsy_version_b1.0.pdf

Level(s) – EU framework of sustainability indicators

Macro objectives	Description
Thematic area: Life cycle environmental performance	
1. Greenhouse gas emissions along a buildings life cycle	Minimise the total greenhouse gas emissions along a buildings life cycle, from cradle to cradle, with a focus on emissions from building operational energy use and embodied energy.
2. Resource efficient and circular material life cycles	Optimise the building design, engineering and form in order to support lean and circular flows, extend long-term material utility and reduce significant environmental impacts.
3. Efficient use of water resources	Make efficient use of water resources, particularly in areas of identified long-term or projected water stress.
Thematic area: Health and comfort	
4. Healthy and comfortable spaces	Create buildings that are comfortable, attractive and productive to live and work in and which protect human health.
Thematic area: Cost, value and risk	
5. Adaptation and resilience to climate change	Futureproof building performance against projected future changes in the climate, in order to protect occupier health and comfort and to sustain and minimise risks to property values.
6. Optimised life cycle cost and value	Optimise the life cycle cost and value of buildings to reflect the potential for long term performance improvement, inclusive of acquisition, operation, maintenance, refurbishment, disposal and end of life.

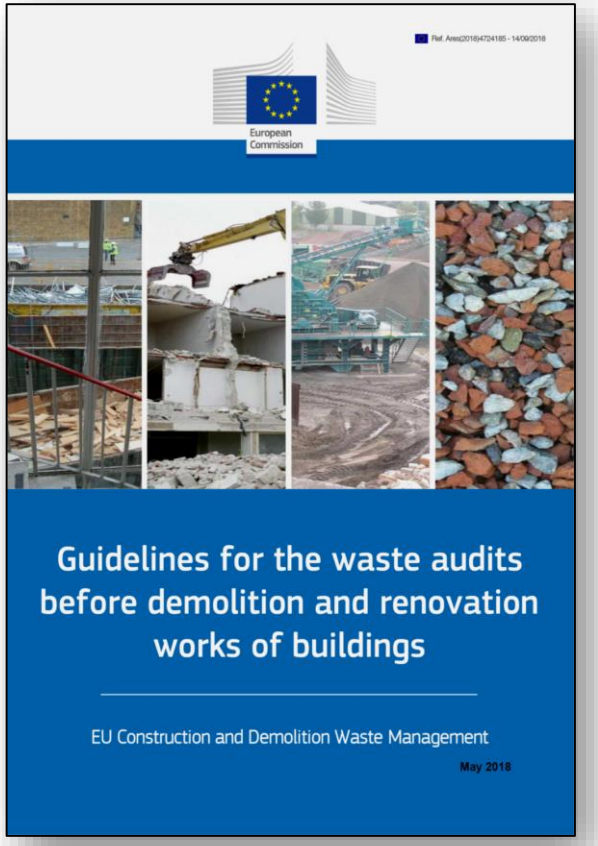


Inventory of materials as part of waste audits

Assessment of materials aims to present reliable data about the **type and amount of demolition waste.** Materials assessment should be complemented with the consideration of the ease of **recovery** of these materials.

The materials assessment should include:

- **Type of material & waste code (Eural code)**
- **Quantification**
- **Inventory of elements for deconstruction & reuse**
- **Location of (waste) materials**
- **Quality of the materials**
- **Reusability**



http://ec.europa.eu/environment/waste/construction_demolition.htm

Activities of European Commission

ENVIRONMENT

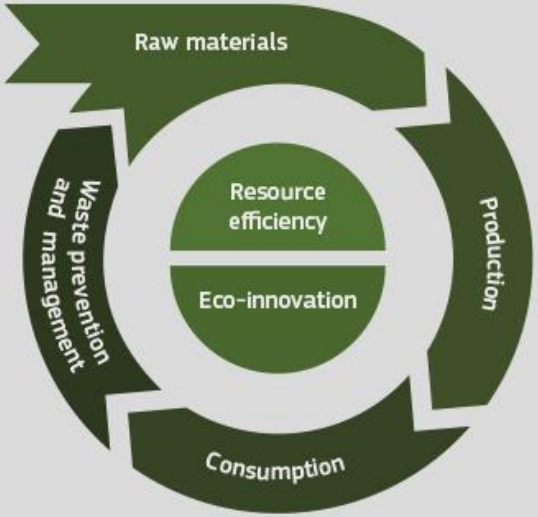
European Commission

European Commission > Environment

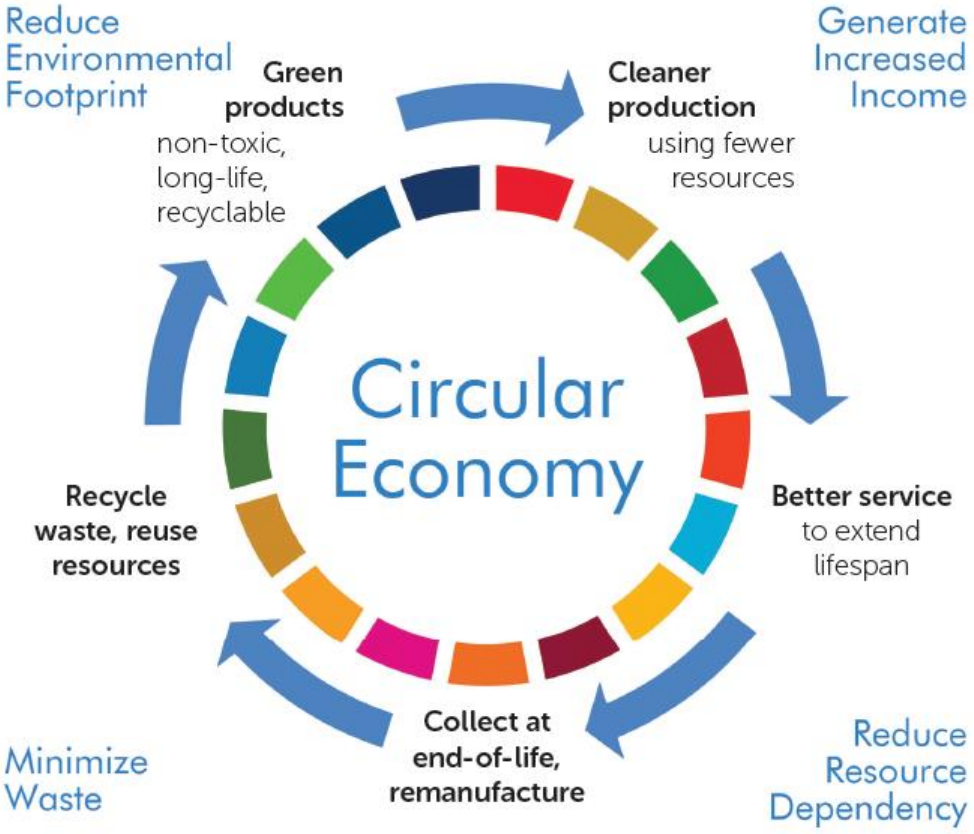
Home | About us | Policies | Funding | Legal compliance | News & outreach

- Green growth and circular economy
- Circular Economy Package
- Resource efficiency
- Eco-innovation
- Raw materials
- Production
- Consumption
- Waste prevention and management
- The Circular Economy tools and instruments

Green growth and circular economy

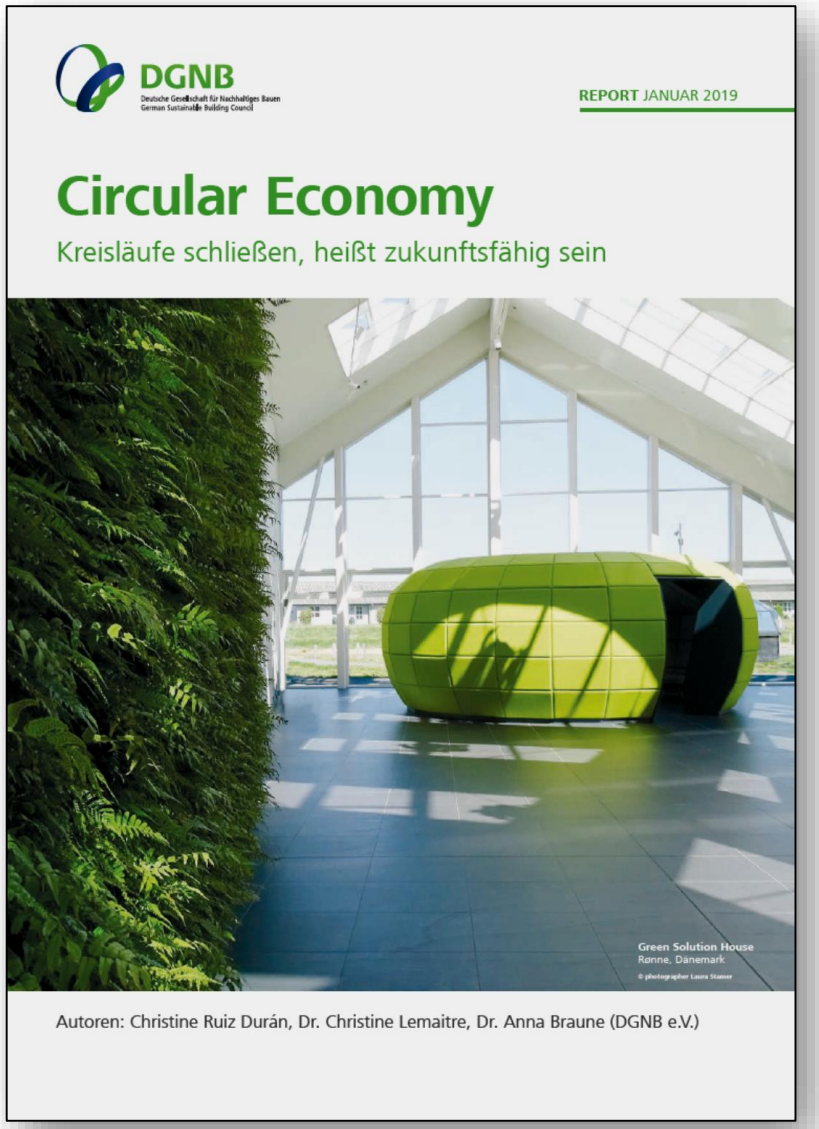


Circular Economy – a hot topic in industry



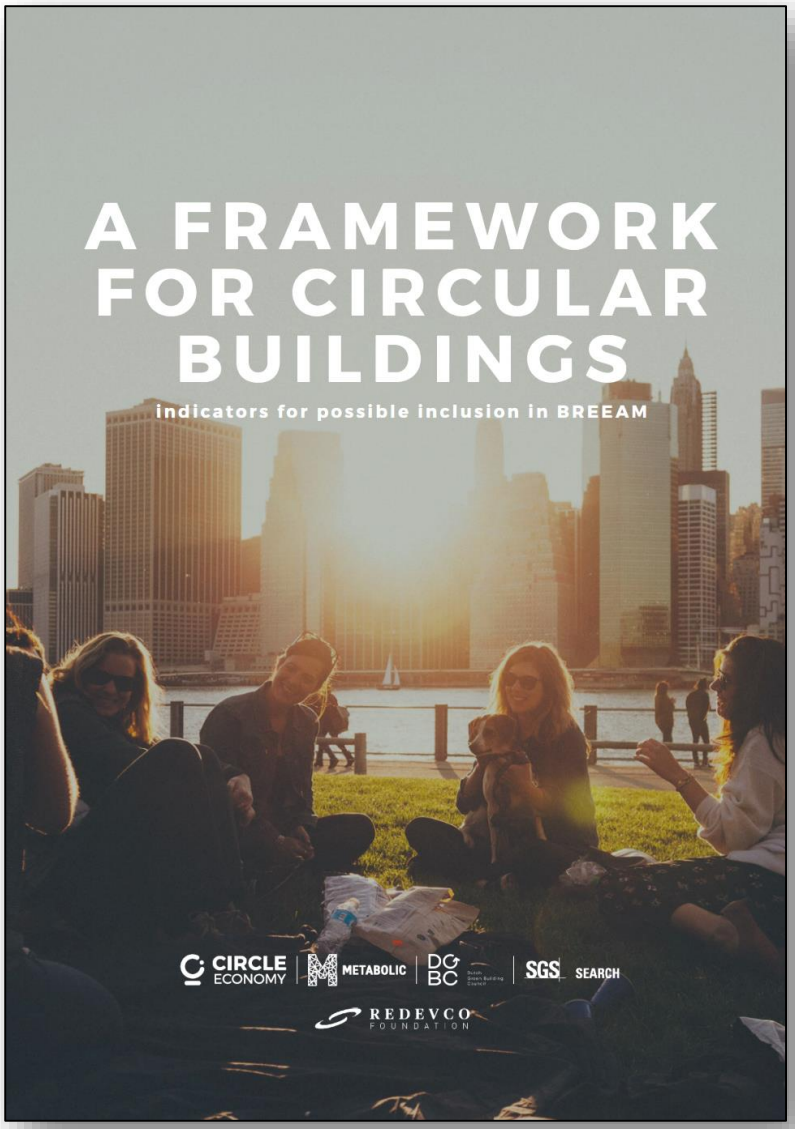
https://www.unido.org/sites/default/files/2017-07/Circular_Economy_UNIDO_0.pdf

From Circular Economy to “Circular Buildings” ?



https://static.dgnb.de/fileadmin/de/dgnb_ev/Services/Broschuerenbestellung/DGNB_Report_Circular_Economy_DE.pdf

https://www.circle-economy.com/wp-content/uploads/2018/10/A-Framework-For-Circular-Buildings-BREEAM-report-20181007-1.pdf



Many terms and concepts – one target ?

- Green buildings
- Smart buildings
- Resilient buildings
- Robust buildings
- Healthy buildings
- High performance buildings
- Low energy buildings
- Affordable buildings
- **Circular buildings**
- ….

Buildings, able to contribute to a more sustainable development

&

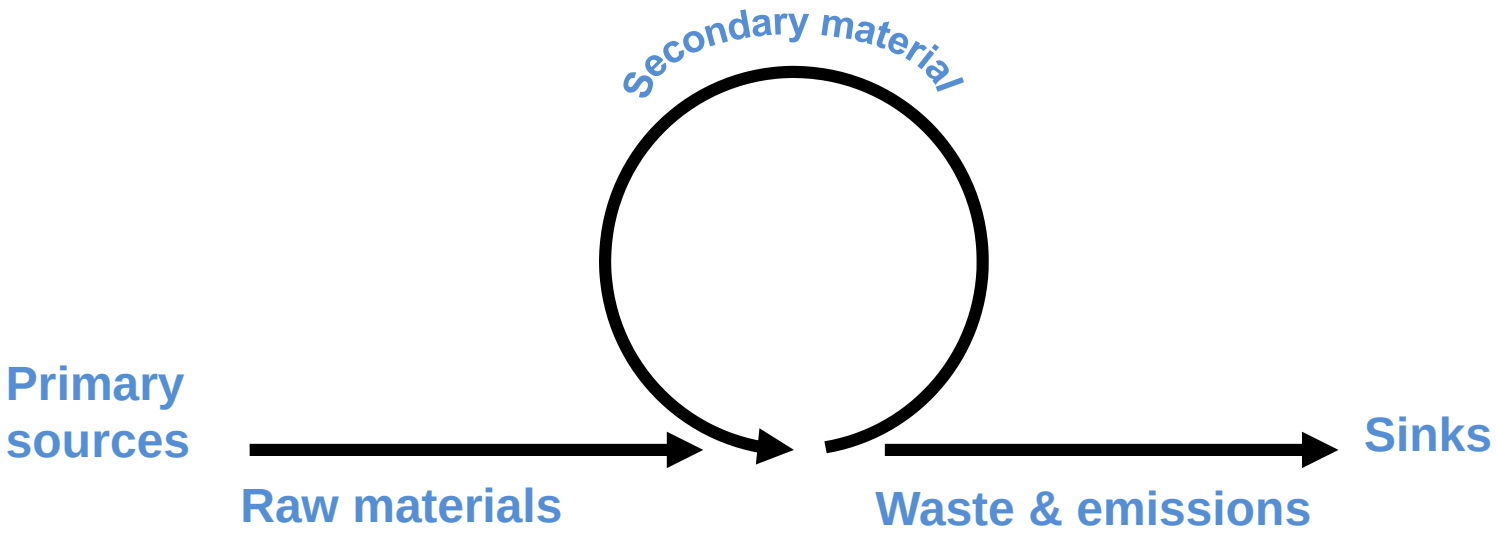
Actors, able to overtake responsibility for environment and society

Circular Building – a re-translation to characteristics

“Circular building”- related characteristics as parts of a technical performance:

- **Functionality**
- **Flexibility**
- **Adaptability**
- **Maintainability**
- **Durability**
- **De-constructability**
- **Re-usability**
- **Recycleability**

Close and slow down the cycles …



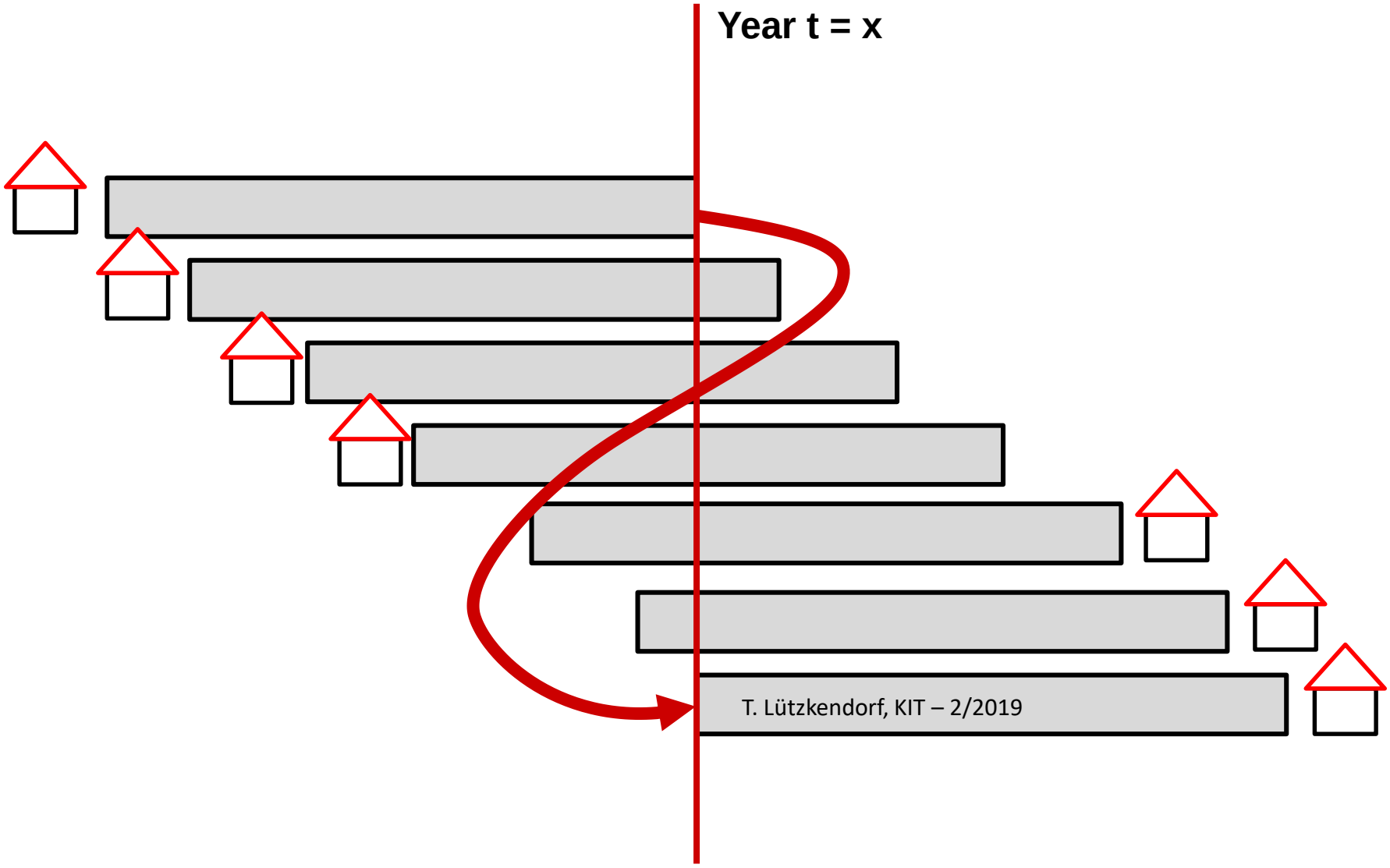
… on:

macro-economic level

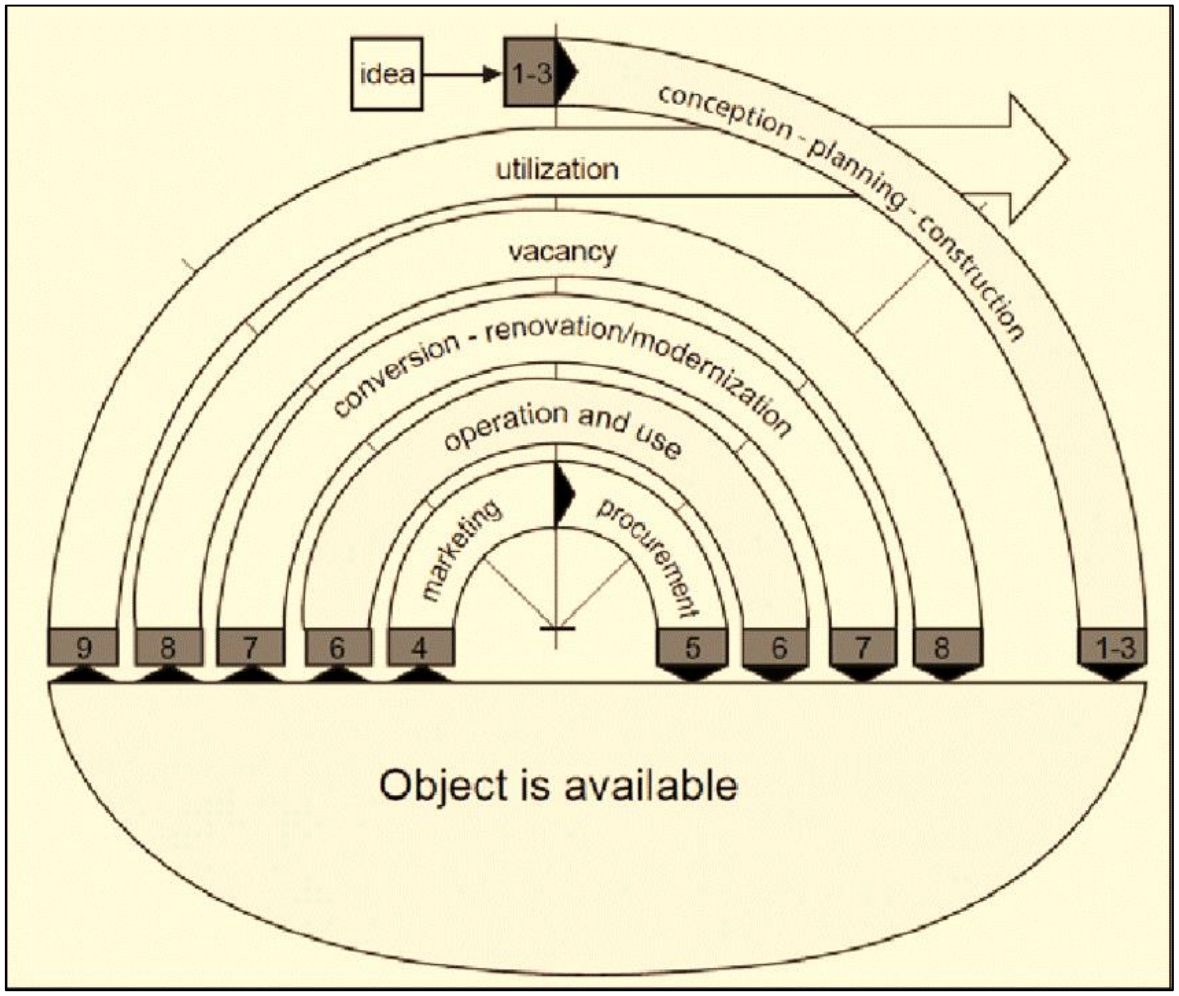
national building stock level

regional building stock level

Building stock level



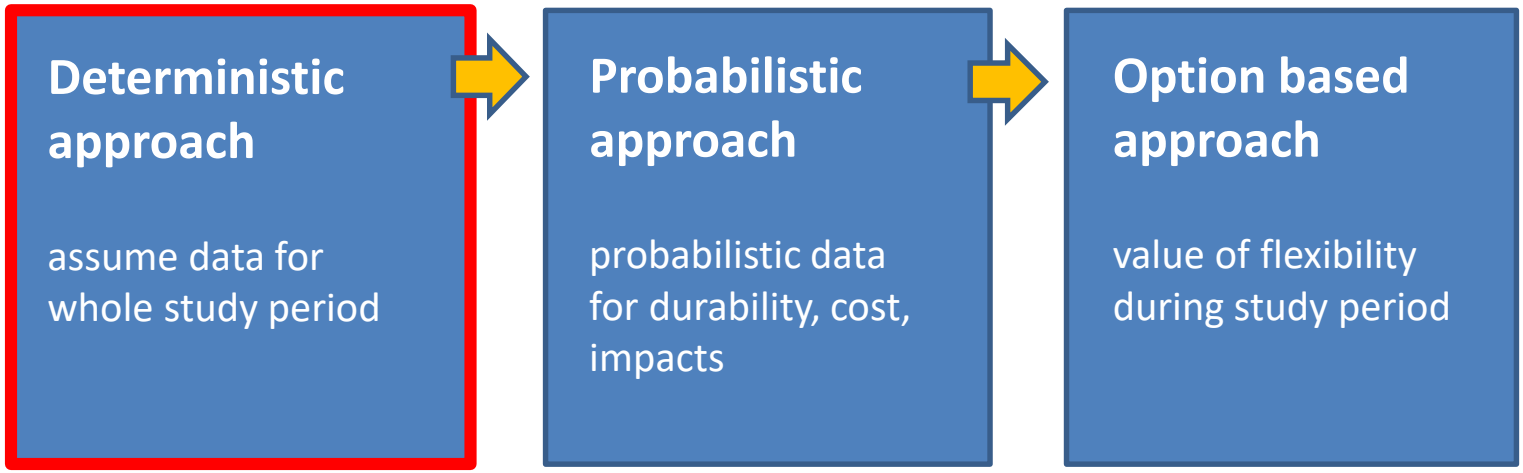
How to define a life cycle of a building?



GEFMA 100-1, 2004

Different possibilities for a life cycle of a building in real life.

What are the use cases ….. ?



Application for LCC & LCA
Conventions required
Possible to establisch benchmarks
Sustainability assessment

Dealing with uncertainties
Probabilities

Possibilities for action
Scenarios
Decision support

Defined scenario

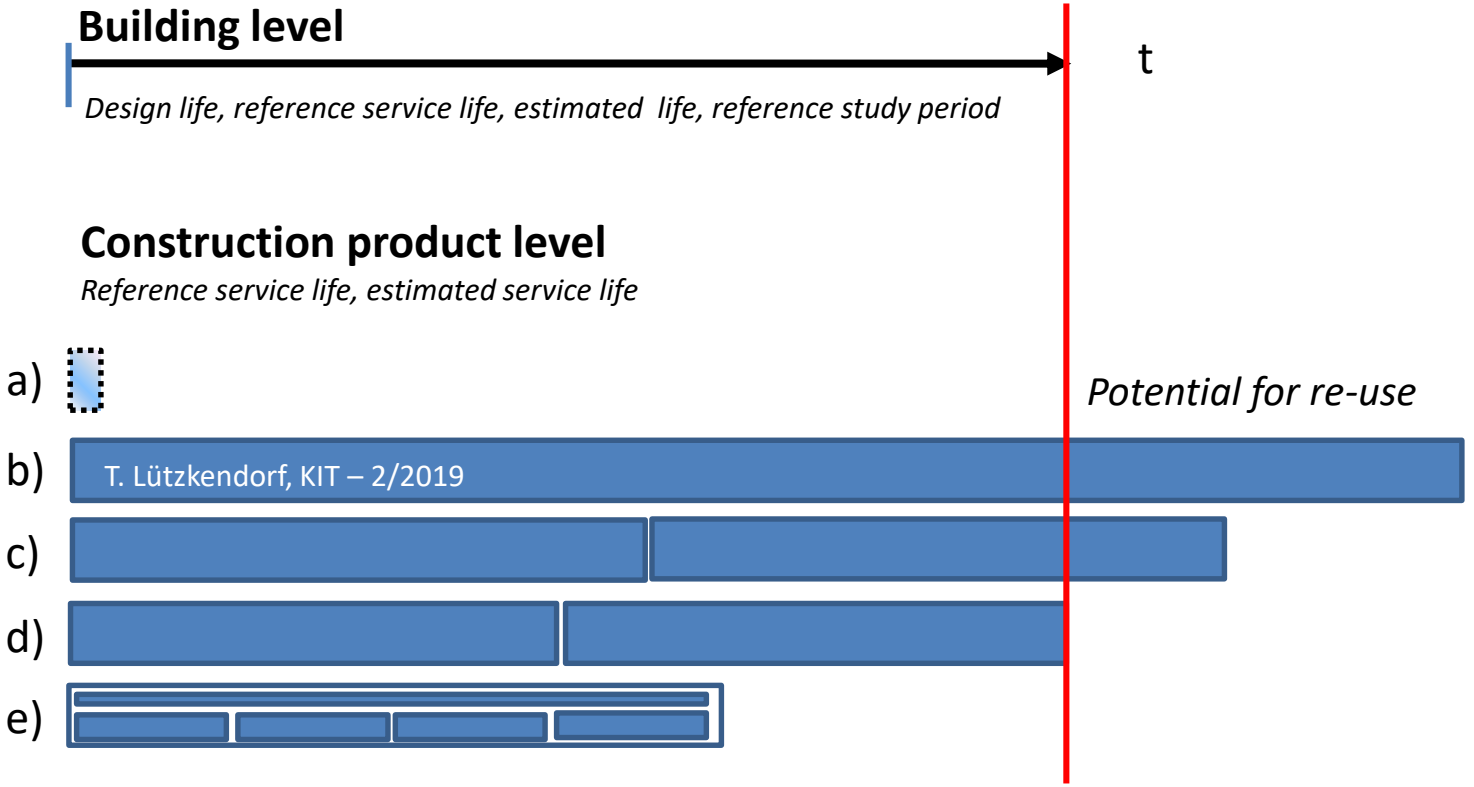
Dealing with uncertainties in a scenario

Likelihood of various scenarios and consequences

See also: Fawcett, W.; Hughes, M.; Krieg, H.; Albrecht, S.; Vennström, A.: Flexible strategies for l
uncertainry.
Building Research & Information (2012), 40(5). 545-557 & CILECCRA project

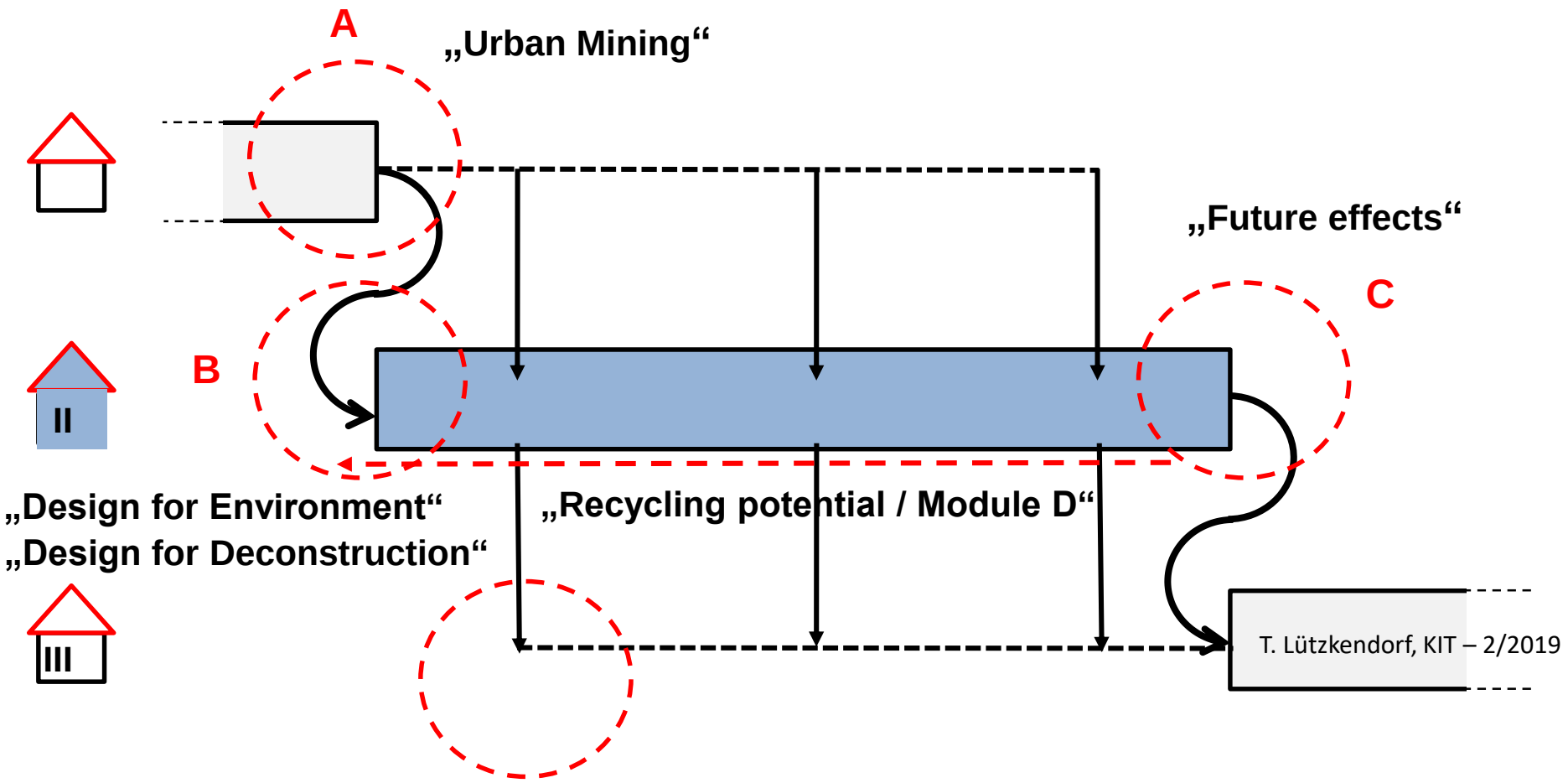
A deterministic approach is a pre-condition for LCA-benchmarks.

Life cycle of buildings vs. life cycle of products

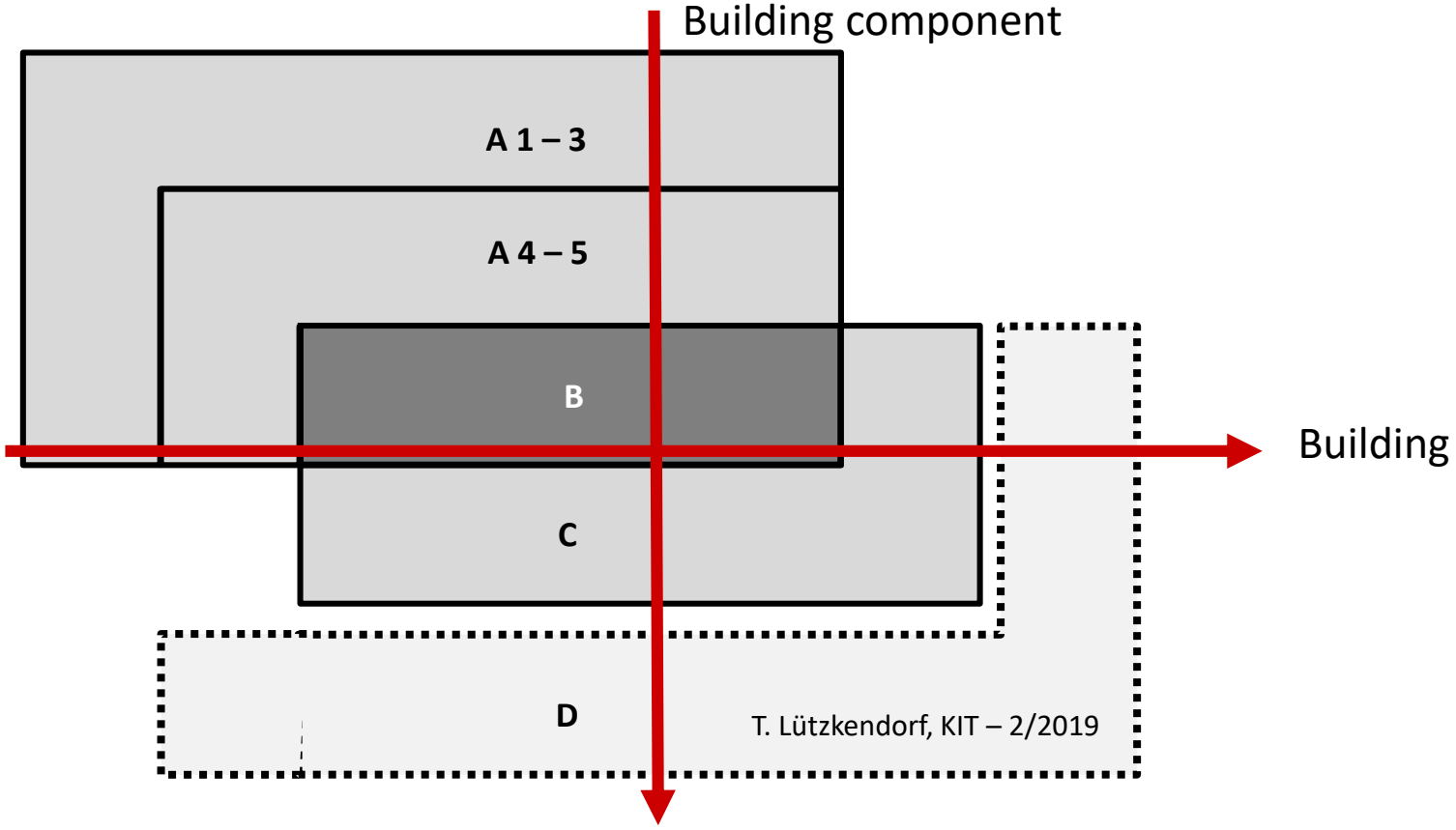


a) Construction products and auxiliary materials that lose their physical identity
b) Construction products with long service life and re-use potential
c) Products that need to be replaced - with re-use potential
d) Products that need to be replaced - with no re-use potential
e) (complex) products whose components must be replaced

What can we do and when?



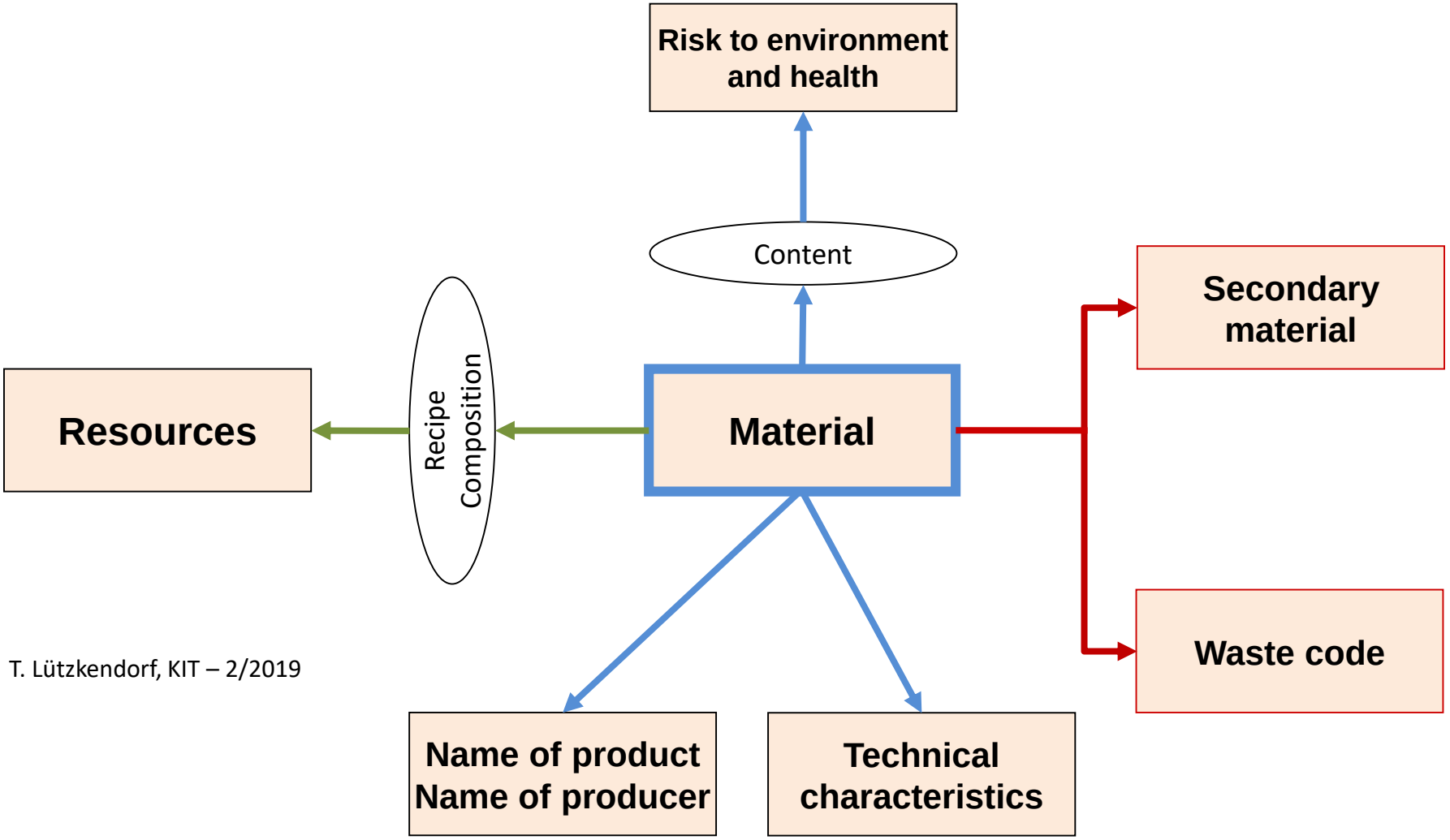
Is there a need to adopt the model of a life cycle ?



Who likes to know something about materials ?

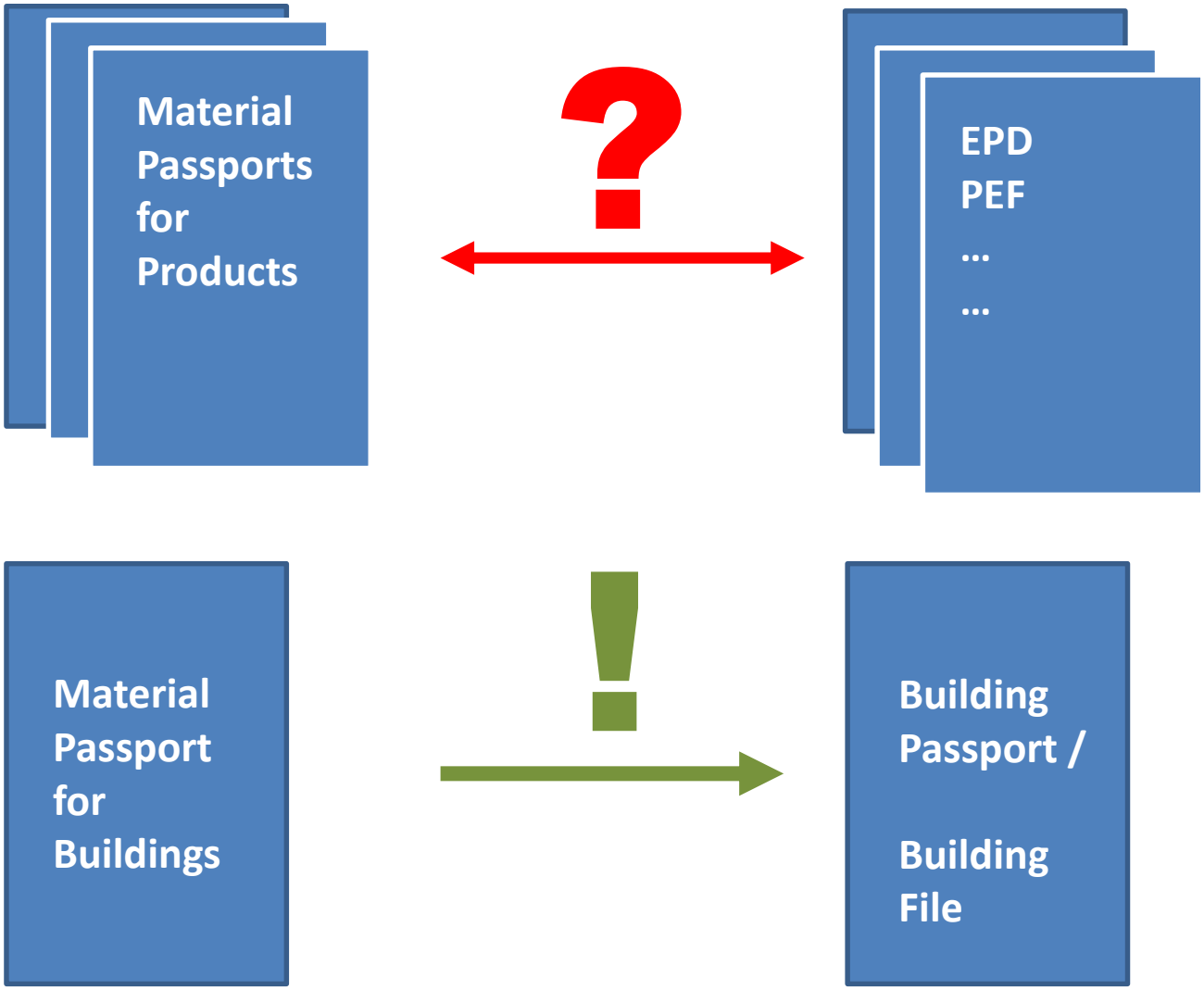
Actor group	Information need
Facility manager	Point in time of replacement
Valuation professional	Risks to the environment/health
LCA specialist	Quantities & types of materials
Building authority	Main building materials
Demolition company	Material quantities/waste code
Policy maker	Material flows/ national balance
…	…
…	…
…	…

What do we like to know about materials?

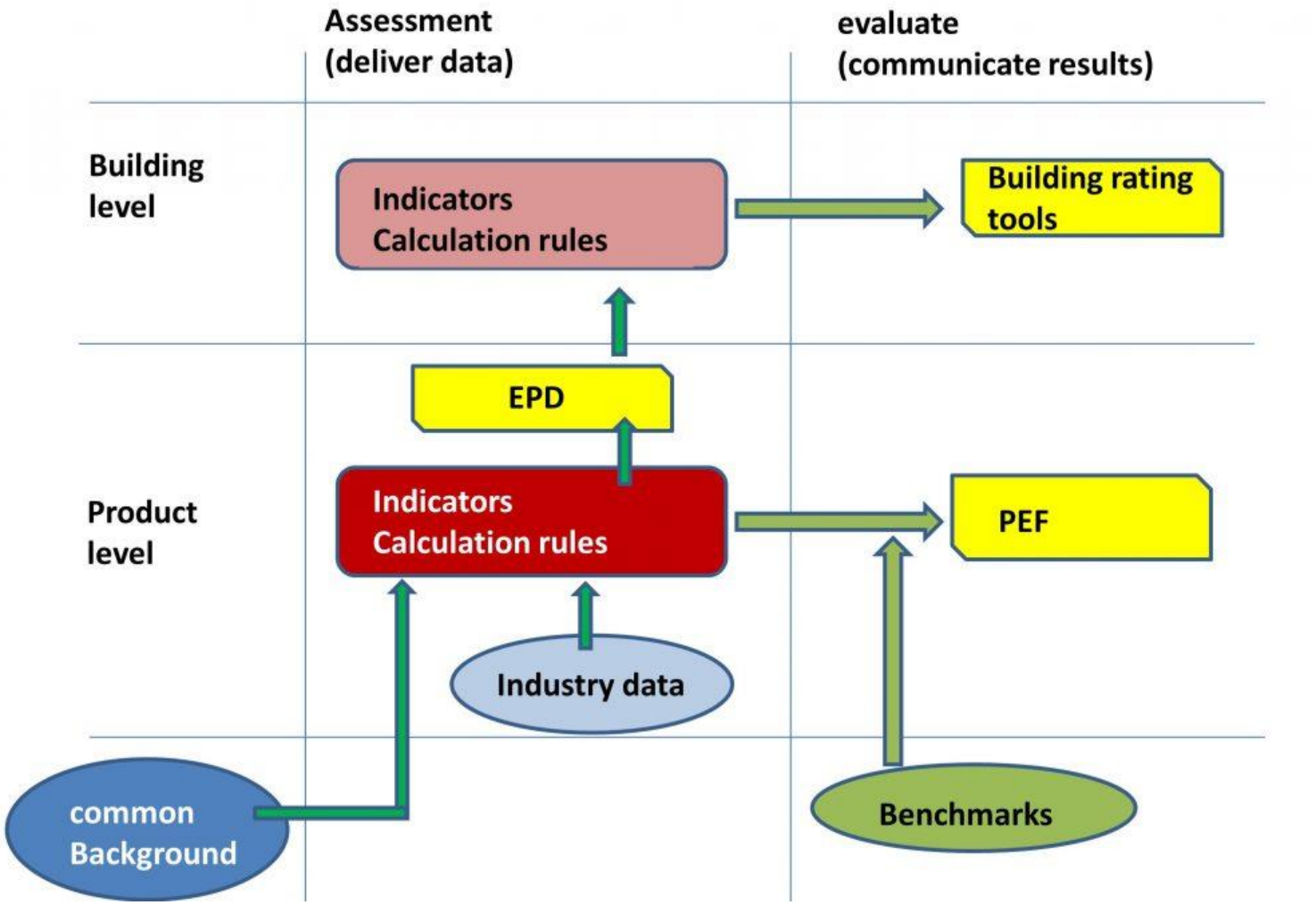


T. Lützkendorf, KIT – 2/2019

Passports, passports, passports ….



EPD versus / and PEF



PEF & EPD – selected core indicators in addition to GWP

Indicator		CF neu	CF alt
Depletion of abiotic resources-mineral elements[a]	Abiotic depletion potential for non-fossil resources (ADP-elements)	kg Sb eq.	
Depletion of abiotic resources-fossil fuels[a]	Abiotic depletion potential for fossil resources (ADP-fossil fuels)	MJ, net calorific value	
Acidification	Accumulated Exceedance, Acidification potential (AP)	mol H+ eq.	kg SO_2 eq
Ozone Depletion	Depletion potential of the stratospheric ozone layer, (ODP)	kg CFC 11 eq.	
Eutrophication terrestrial	Accumulated Exceedance, Eutrophication potential, (EP terrestrial)	mol N eq.	
Eutrophication aquatic freshwater	Fraction of nutrients reaching freshwater end compartment Eutrophication potential, (EP freshwater)	kg $(PO_4)^{3-}$ eq.	kg $(PO_4)^{3-}$ eq
Eutrophication aquatic marine	Fraction of nutrients reaching fresh-water end compartment Eutro-phication potential, (EP marine)	kg N eq.	
Photochemical ozone creation	Formation potential of tropospheric ozone, (POCP);	kg Ethene eq.	
Water scarcity	User deprivation potential (deprivation-weighted water consumption)	m^3 world eq. deprived	

E. Schmincke

ADP versus EUROSTAT-typology for materials

Abiotic Resource Depletion

- ***ADP fossil fuels***
- ***ADP elements***

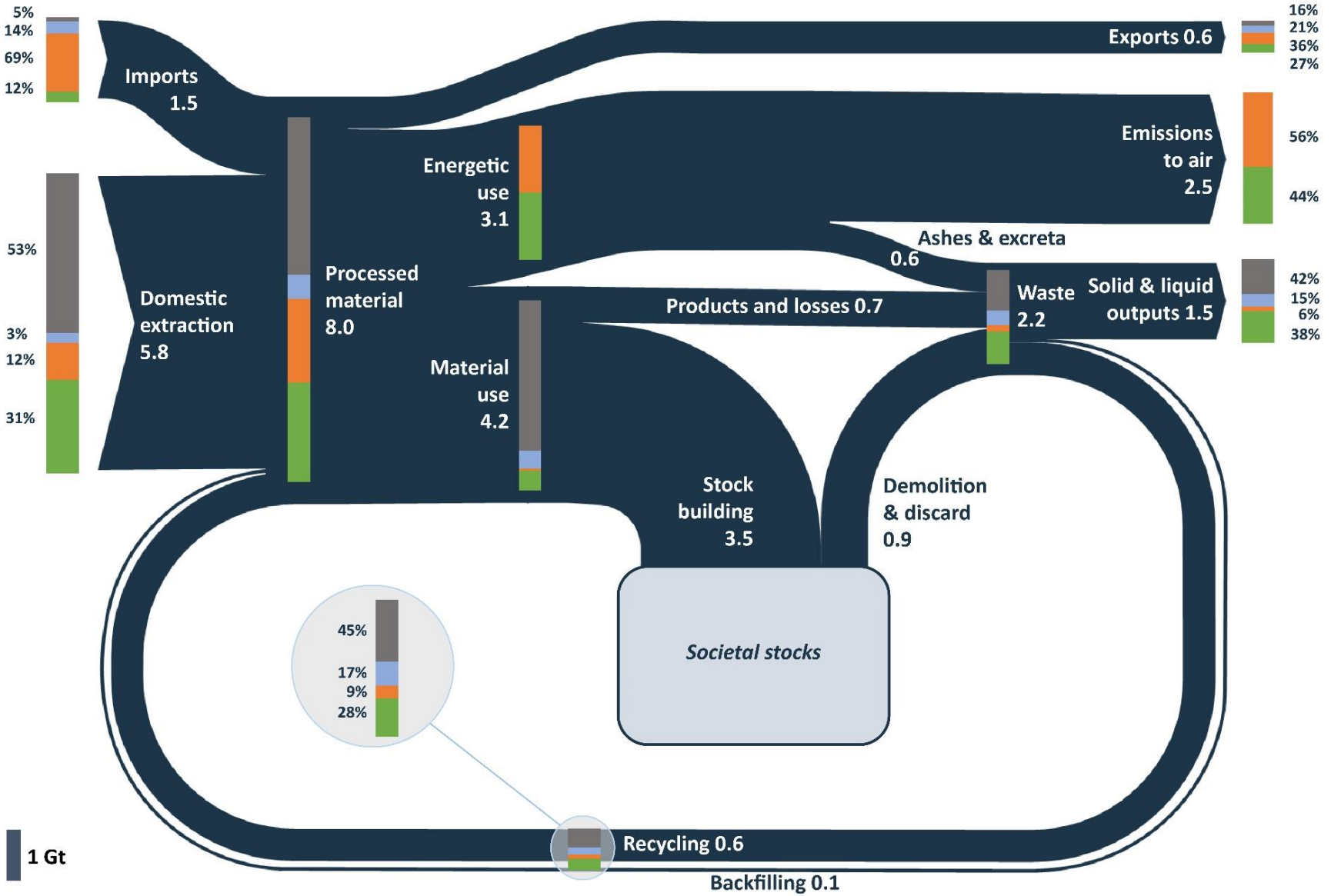
- ➢ Sustainability assessment
- ➢ B2B communication
- ➢ Scarcity-approach

EUROSTAT-Typology

- ***Fossil energy materials***
- ***Non-metallic mineral materials***
- ***Metal materials***
- ***Biomass based materials***

- ➢ Statistics
- ➢ Resource management
- ➢ Un-assessed

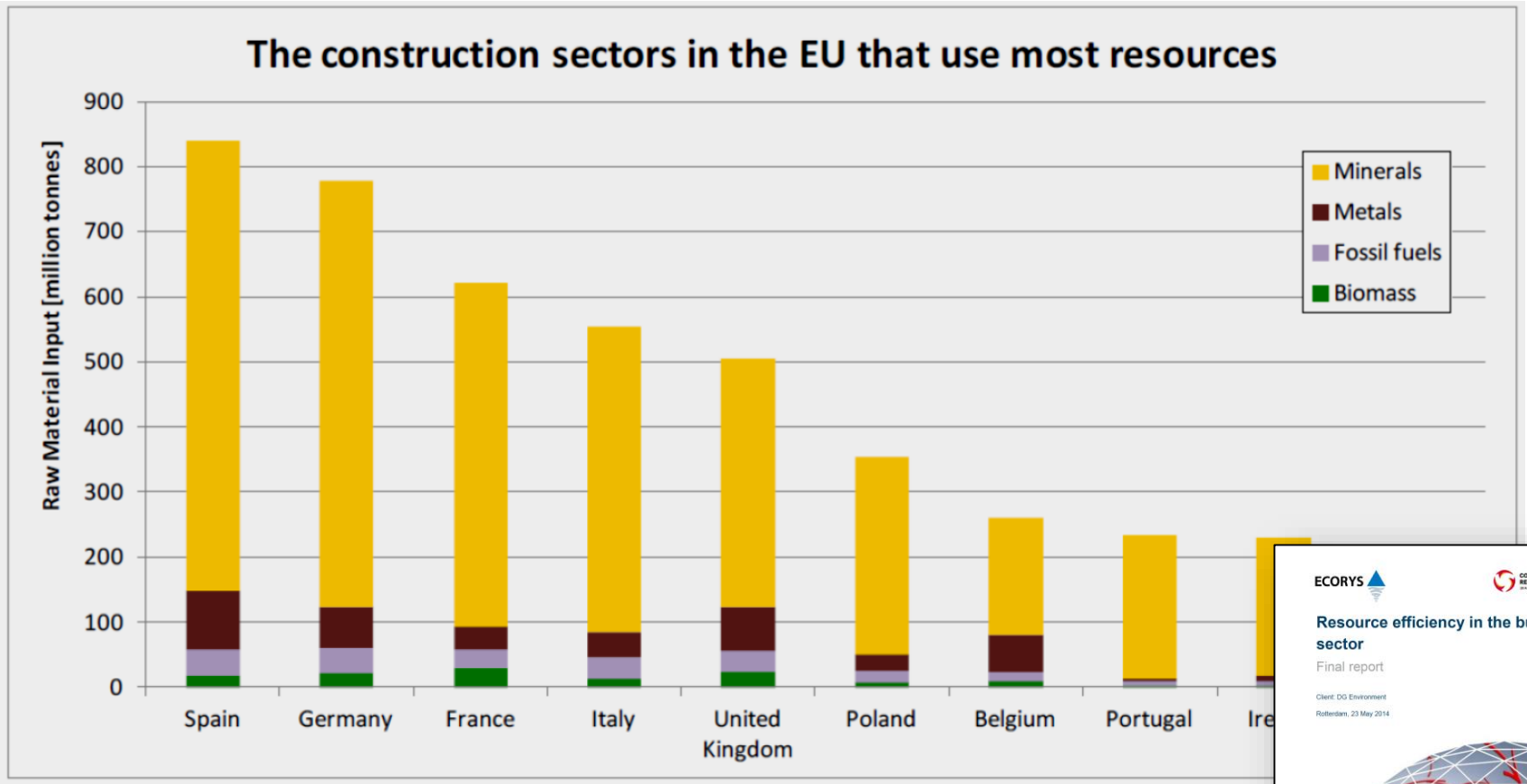
Mass flow in Europe 2014 – enlarging the stocks



Material flows true to scale in Gt/year (billion tons/year) in 2014 — Non-metallic minerals — Metal ores — Fossil energy materials/carriers — Biomass

Note: Numbers may not sum up to total due to rounding.

Input of resources into the construction sector

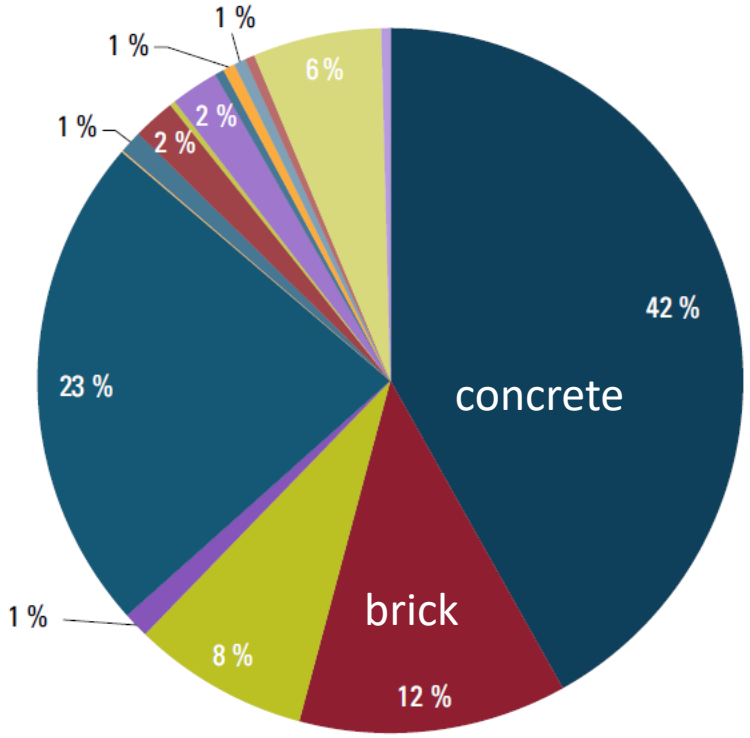


Source: BIO IS, 2013[13].

file:///C:/Users/sc1715/Desktop/Zwischenlager/BAMB2019%20Brüssel/Resource%20efficiency%20in%20the%20building%20sector.pdf

Input, stock, output – building stock Germany 2010

INPUT 121 Mio. t



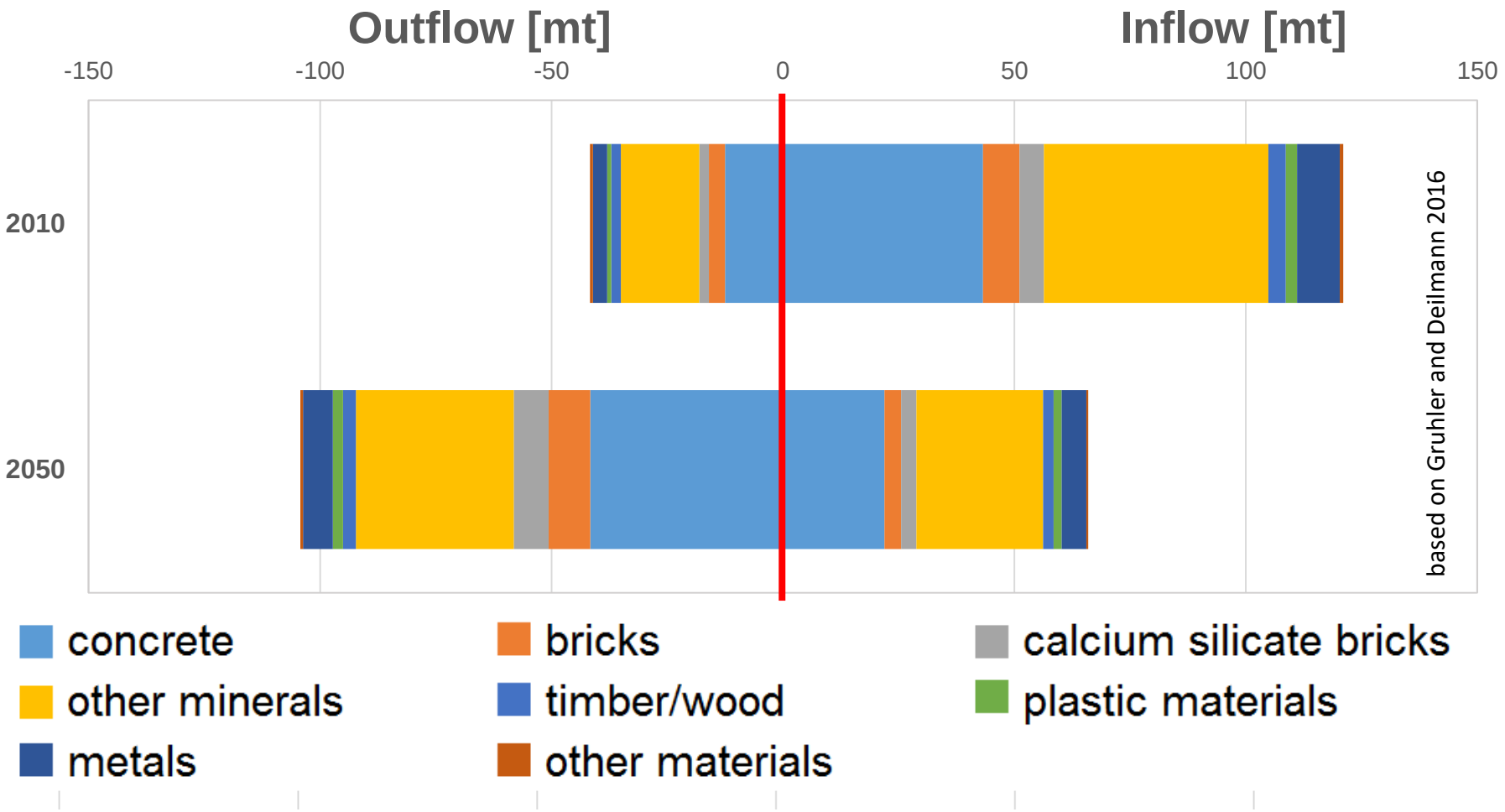
Stock 15.256 Mio. t

- Beton
- Ziegel
- Kalksandstein
- Porenbeton
- Sonst. Mineralisches (inkl. Bodenbelägen)
- Gipskarton
- Sonstige Gipsprodukte
- Bau-/Konstruktionsholz
- Sonstiges Holz (inkl. Bodenbelägen)
- Flachglas
- Mineralische Dämmstoffe
- Kunststoff-Dämmstoffe
- Kunststoff-Fenster/-Türen
- Sonstige Kunststoffe (inkl. Belägen und Leitungen)
- Metalle (inkl. Leitungen)
- Sonstige Stoffe (inkl. Leitungen und Beläge)

OUTPUT 42 Mio. t

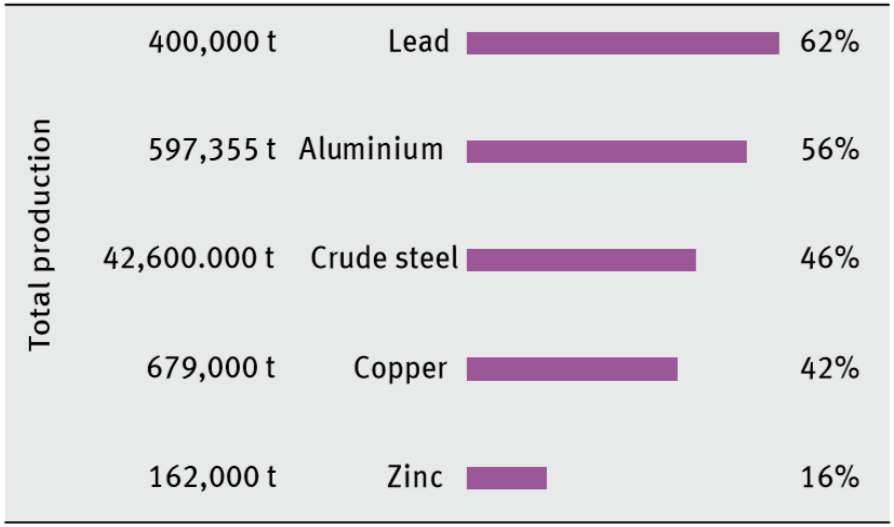
https://www.bbsr.bund.de/BBSR/DE/Veroeffentlichungen/ZukunftBauenFP/2017/band-06-dl.pdf;jsessionid=F50D199E6FC8459C3F67ABC39F7A4C5F.live21304?__blob=publicationFile&v=2

Trends for input and output in the building stock - Germany



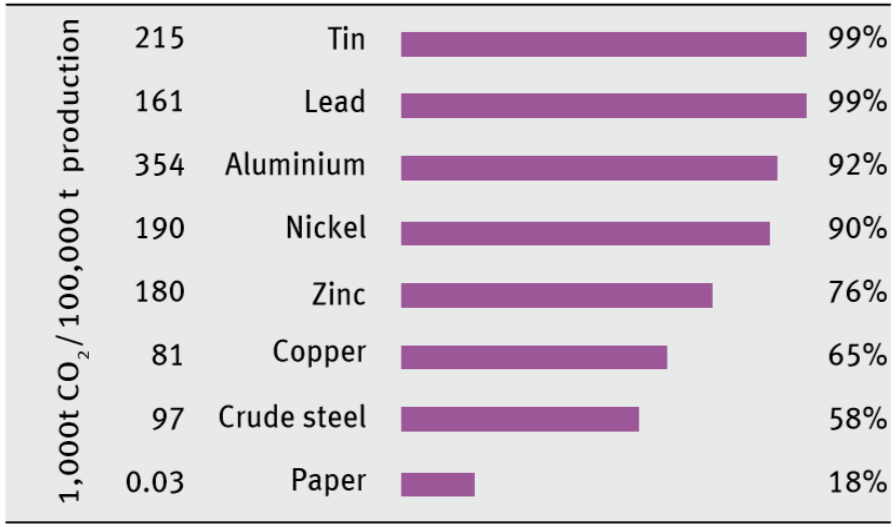
Effects of recycling

Share of secondary raw materials in the production of selected metal ores in Germany, 2013



Source: BGR, 2014

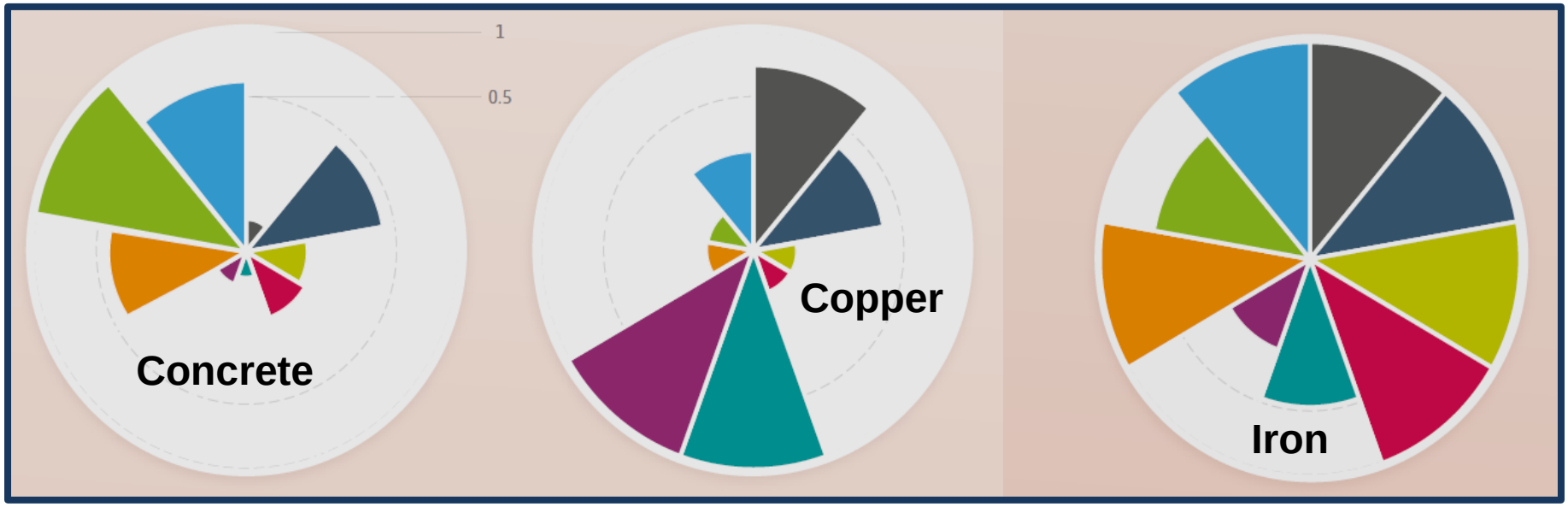
Potential CO_2-savings through recycling, 2008



Source: BIR, 2009

file:///C:/Users/sc1715/Desktop/Zwischenlager/Eindhoven/161025_ressourcenbericht_en.pdf

Save materials - reduce impacts to global environment



Acidification
Corrosive impact of pollutants (SO_2; NOx) on soil, water, ecosystems, buildings.

Climate Change
Radiative forcing of GHGs causing rising temperatures, sea level rise, extreme weather events.

Cumulative energy demand
Total energy use along the production chain.

Eutrophication
Impacts of nutrients (N, P) on soil and water quality affecting ecosystems and drinking water.

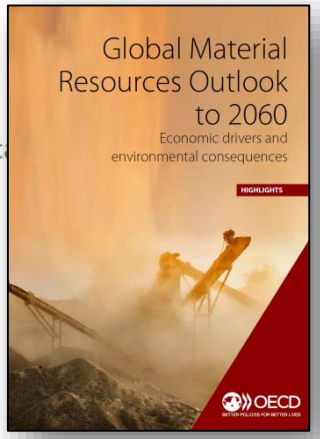
Freshwater aquatic ecotoxicity
Impacts of toxic substances on freshwater aquatic ecosystems.

Human toxicity
Impacts of toxic substances on human health, either by inhalation or via the food chain.

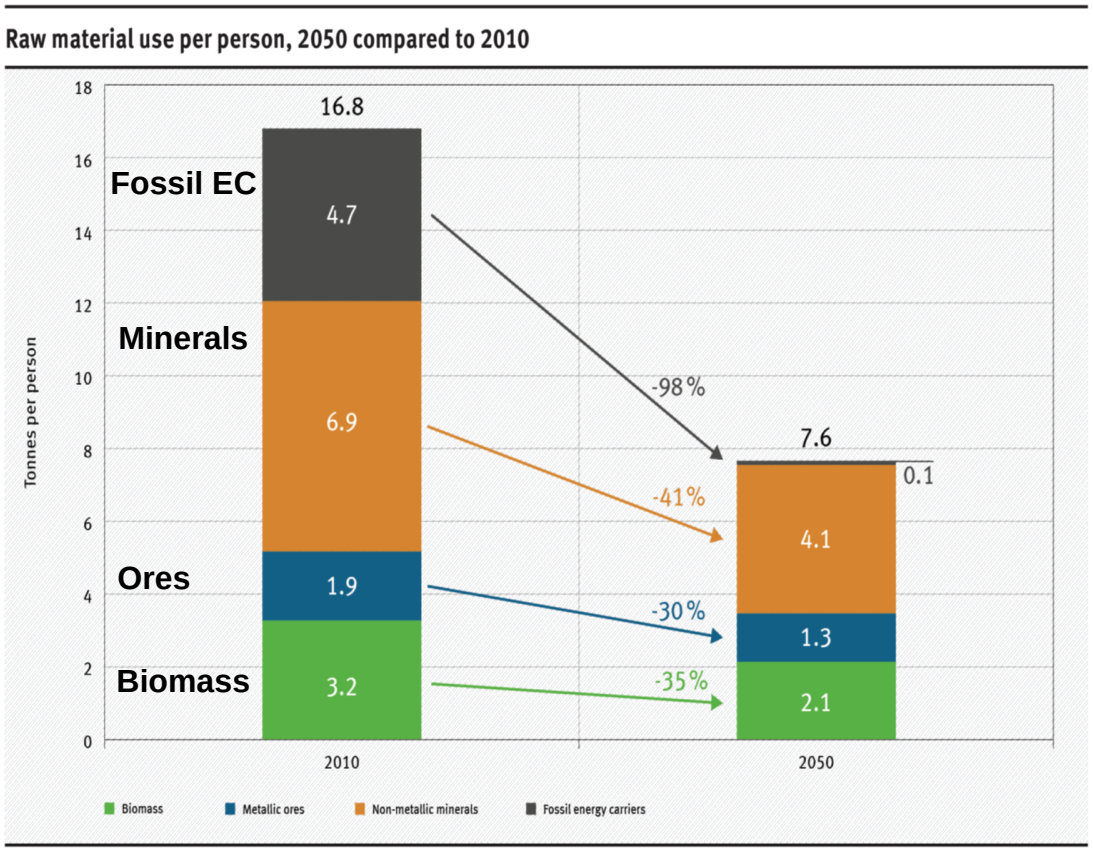
Land use
Land surface used to produce the resource.

Photochemical oxidation
Impacts of tropospheric ozone from air pollut
(VOC, CO), sometimes visible as smog.

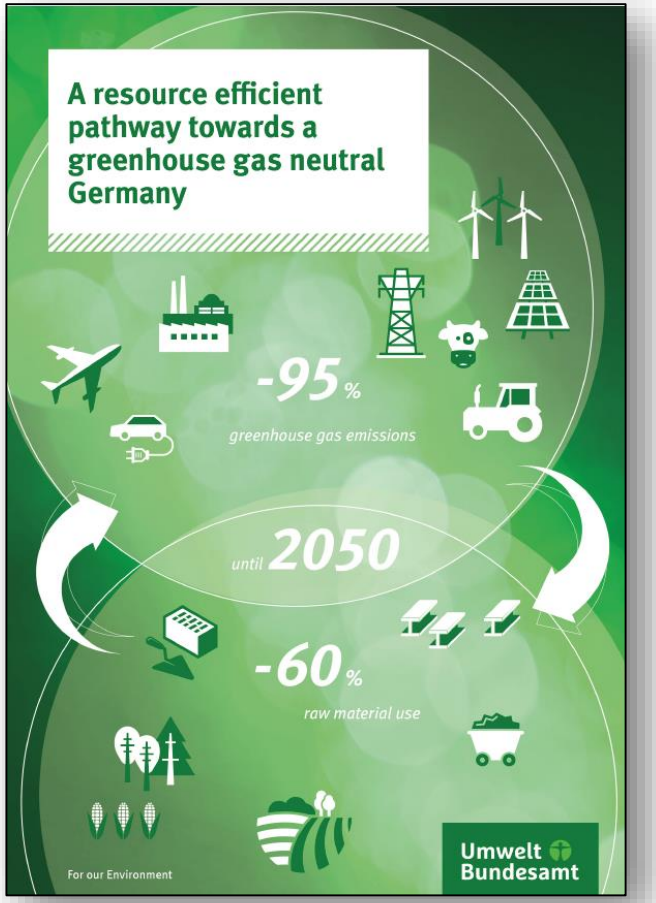
Terrestrial ecotoxicity
Impacts of toxic substances on terrestrial ecosystems.



Targets for reduction of raw material use in 2050 - Germany

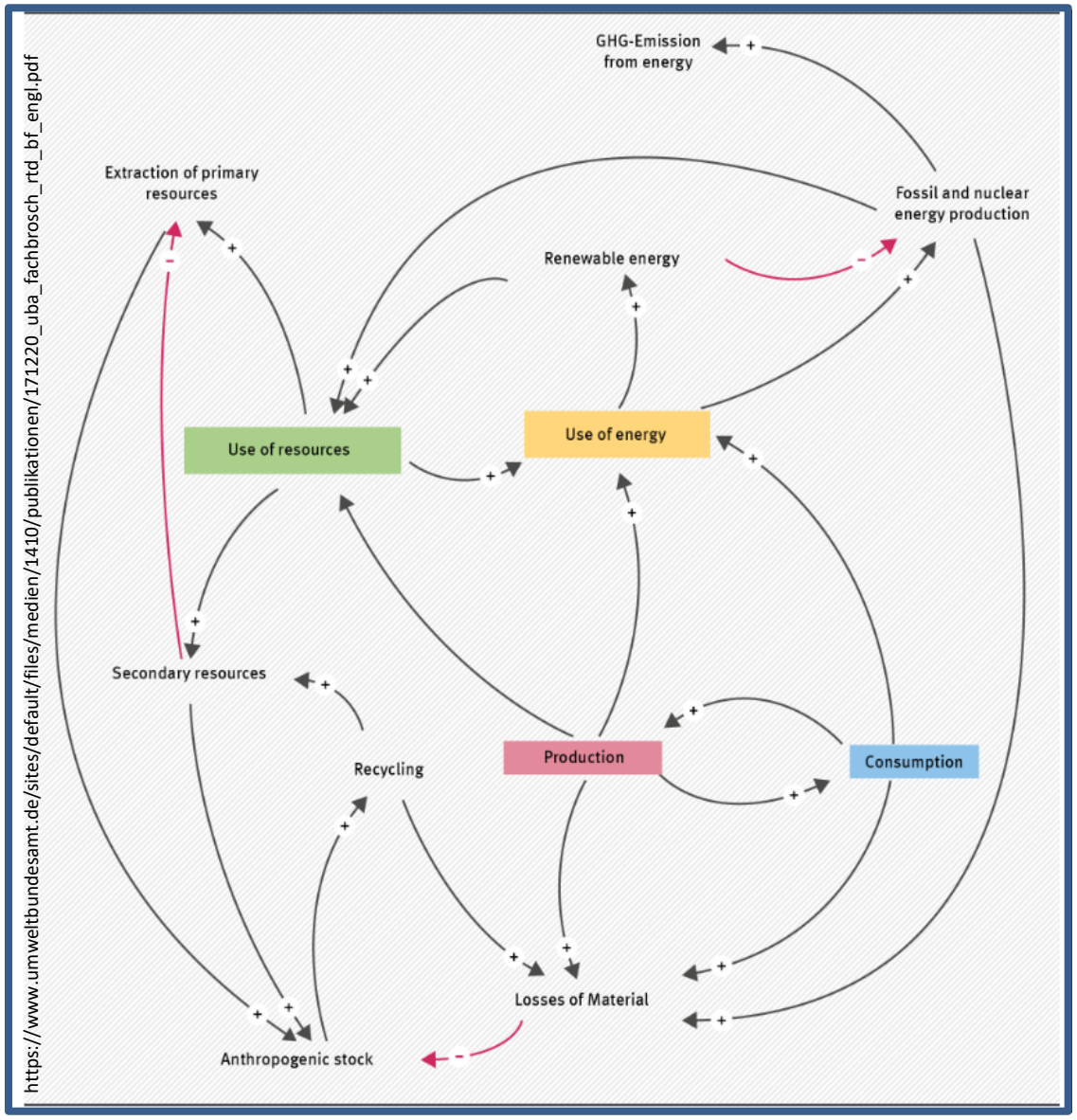


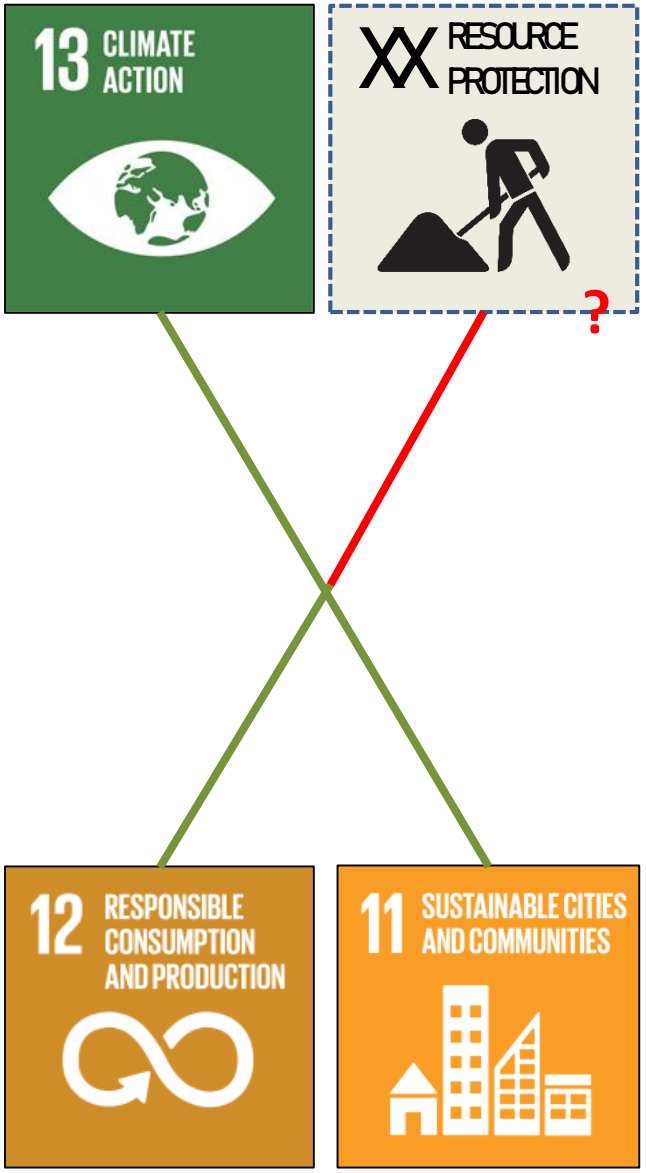
Source: own illustration of model calculation



https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikation en/171220_uba_fachbrosch_rtd_bf_engl.pdf

Link between resource efficiency and climate protection





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