GREEN COUNCIL
環保促進會

Training Course:
Moving towards net zero? – How to quantify GHGs emission and other environmental impacts of products by adopting a life-cycle approach

Instructor:

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Lecturer, The Hong Kong University of Science and Technology

Remarks: This material/event is funded by the Professional Services Advancement Support Scheme of the Government of the Hong Kong Special Administrative Region. Any opinions, findings, conclusions or recommendations expressed in this material/any event organised under this project do not reflect the views of the Government of the Hong Kong Special Administrative Region or the Vetting Committee of the Professional Services Advancement Support Scheme.

Green Council Training Course

MOVING TOWARDS NET ZERO?

How to quantify GHG emission & other environmental impacts of products by adopting a life-cycle approach?

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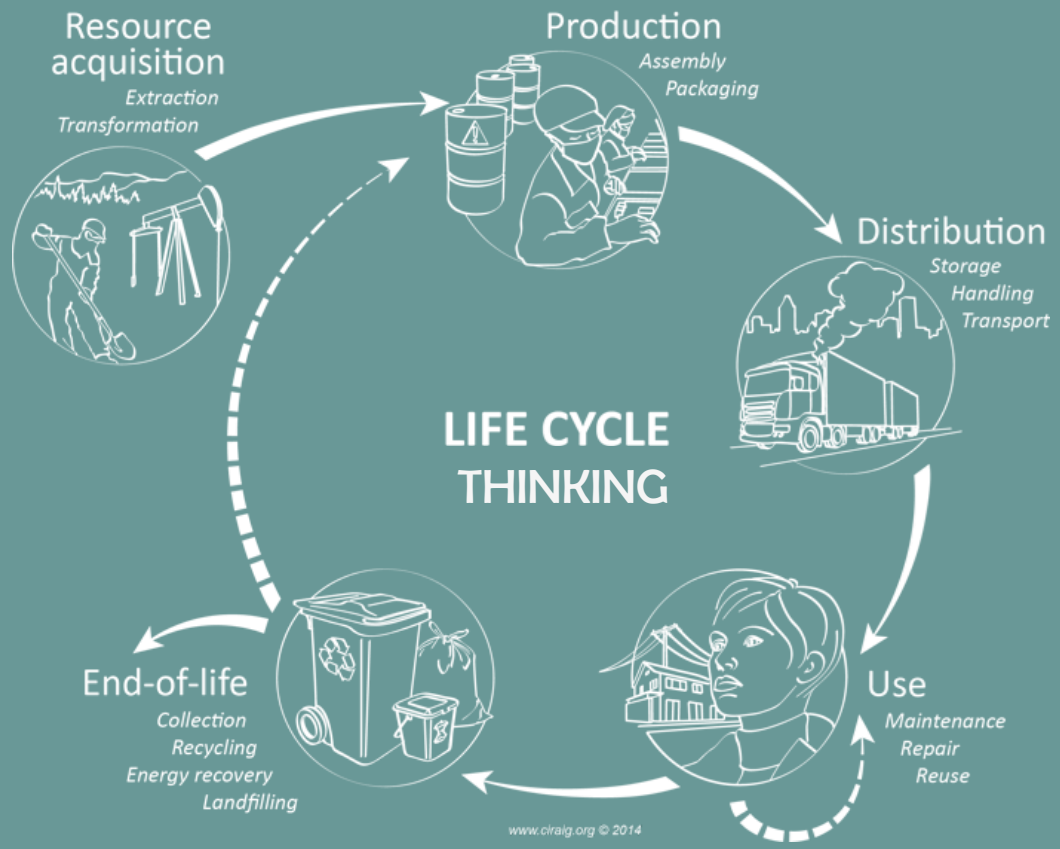
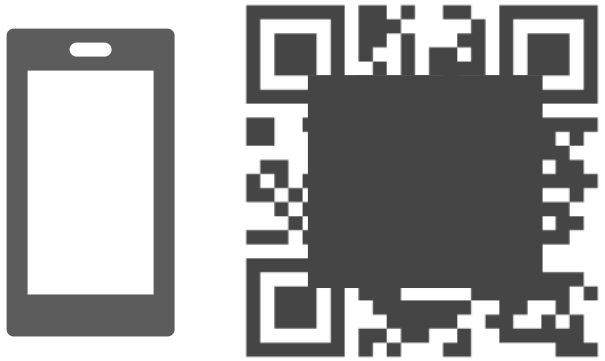
10. February 2023



YOUR EXPECTATIONS

Mentimeter

- How much do you know about Life Cycle Thinking / Assessment?
- What aspects are you most interested in?
- Are there specific questions/topics you'd like to get answered/addressed in this workshop?



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Login Code:
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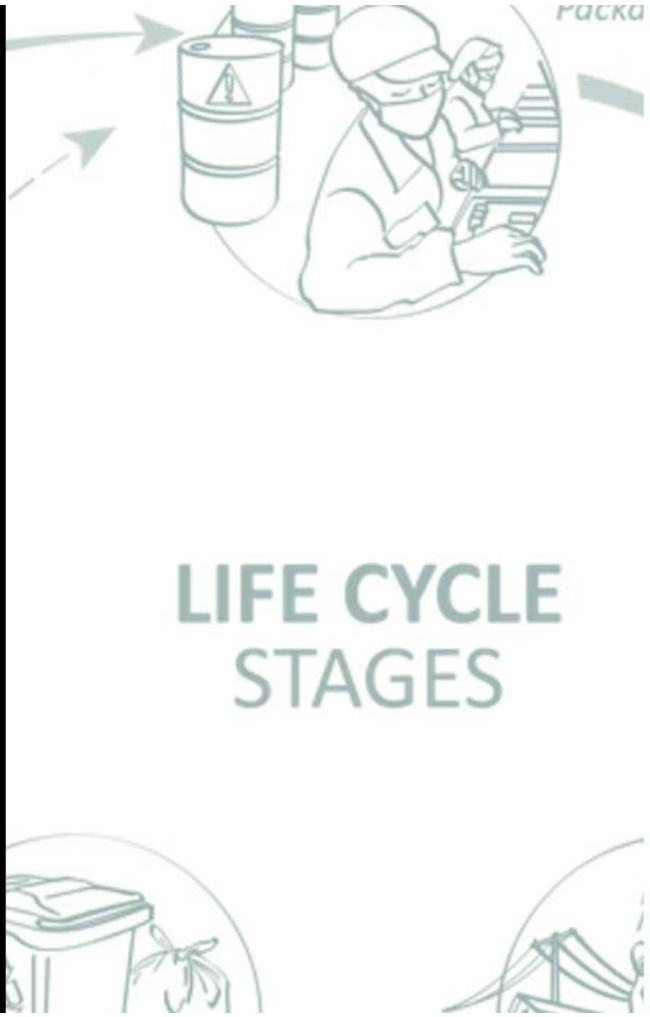
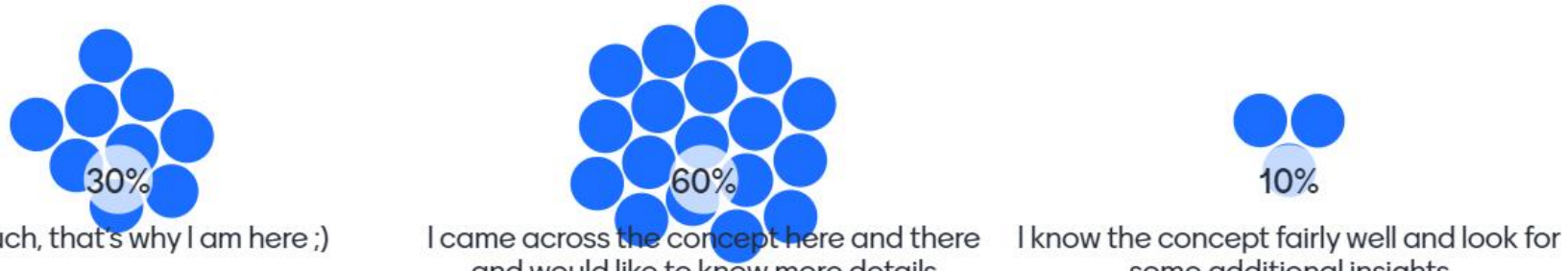


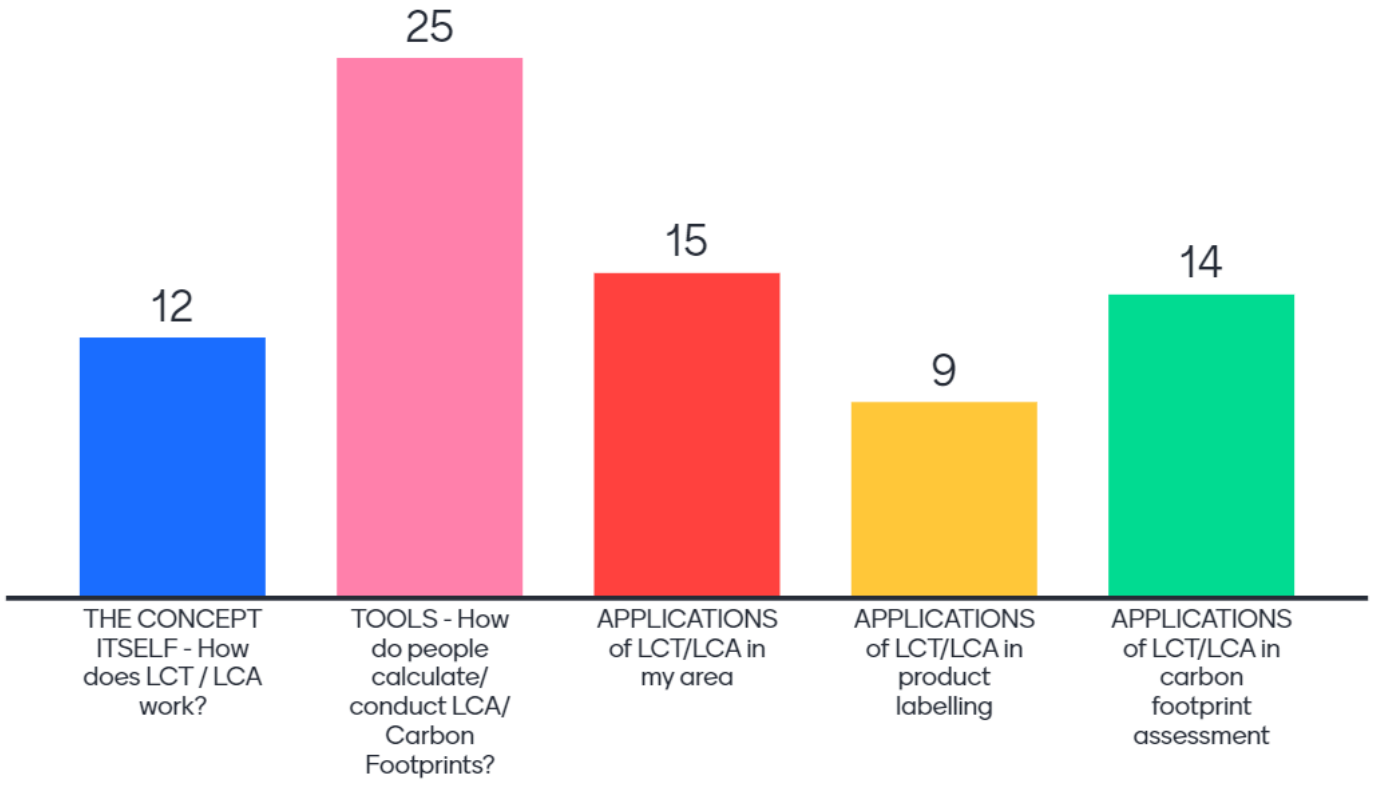
How much do you know about Life Cycle Thinking / Assessment?

Mentimeter



What aspects are you most interested in?

Mentimeter



OUTLINE

- What is Net Zero?
- Science Based Targets & Scope 3 Emissions
- What is a Sustainable Product?
- Life Cycle Thinking Concept
  - Why is it so useful in the discussion about product sustainability?
- Life Cycle Assessment Methodology
  - Using a daily-life example to walk you through the steps of an LCA
- Wrap-up

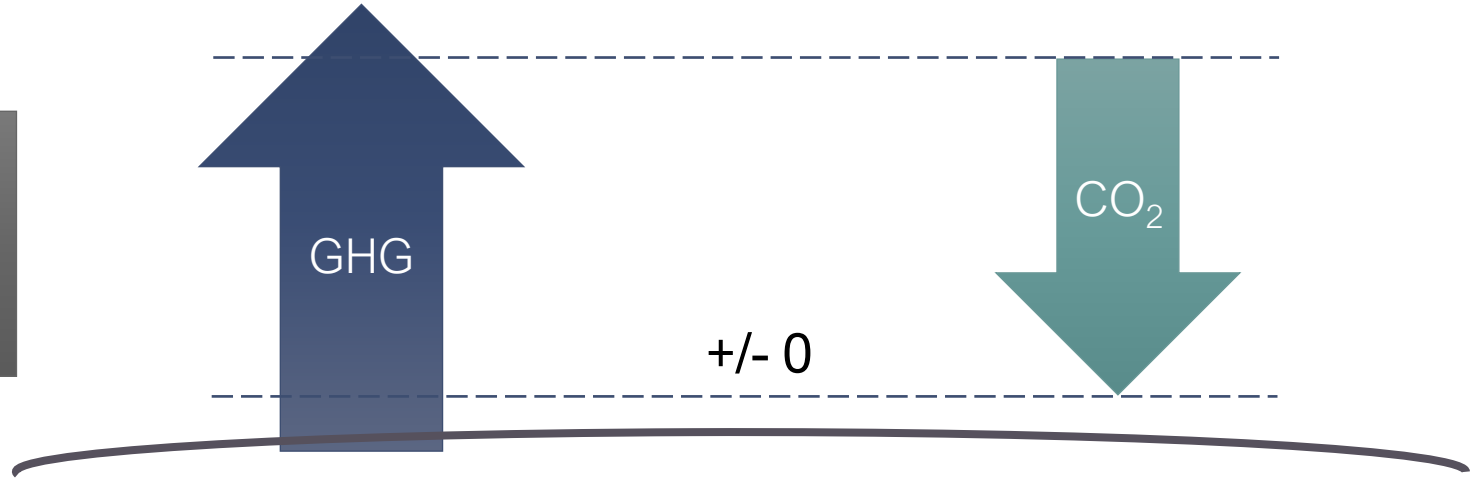
NET ZERO?

Source: https://net0.com/blog/companies-with-net-zero-targets

WHAT IS NET ZERO?

TO KEEP GLOBAL WARMING TO NO MORE THAN 1.5°C EMISSIONS NEED TO BE REDUCED BY 45% BY 2030 AND REACH NET ZERO BY 2050.

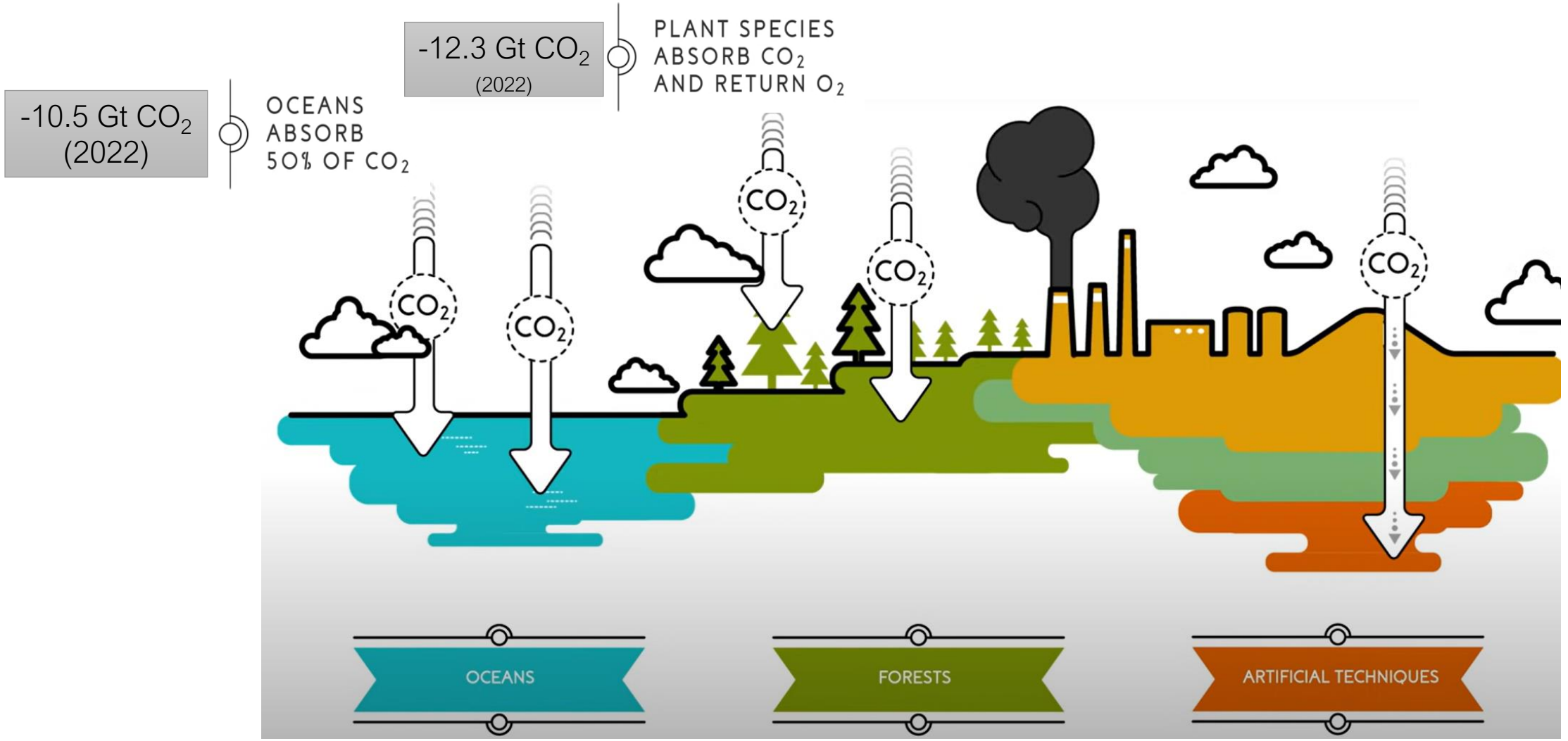
~40 Gt CO_2-eq
(40.6 billion t CO_2-eq)
Global net anthropogenic GHG emissions in 2022*



*estimate of remaining carbon budget from 2020 onwards for limiting warming to 1.5°C is 500 Gt CO_2 (1150 Gt CO_2 for 2 °C)

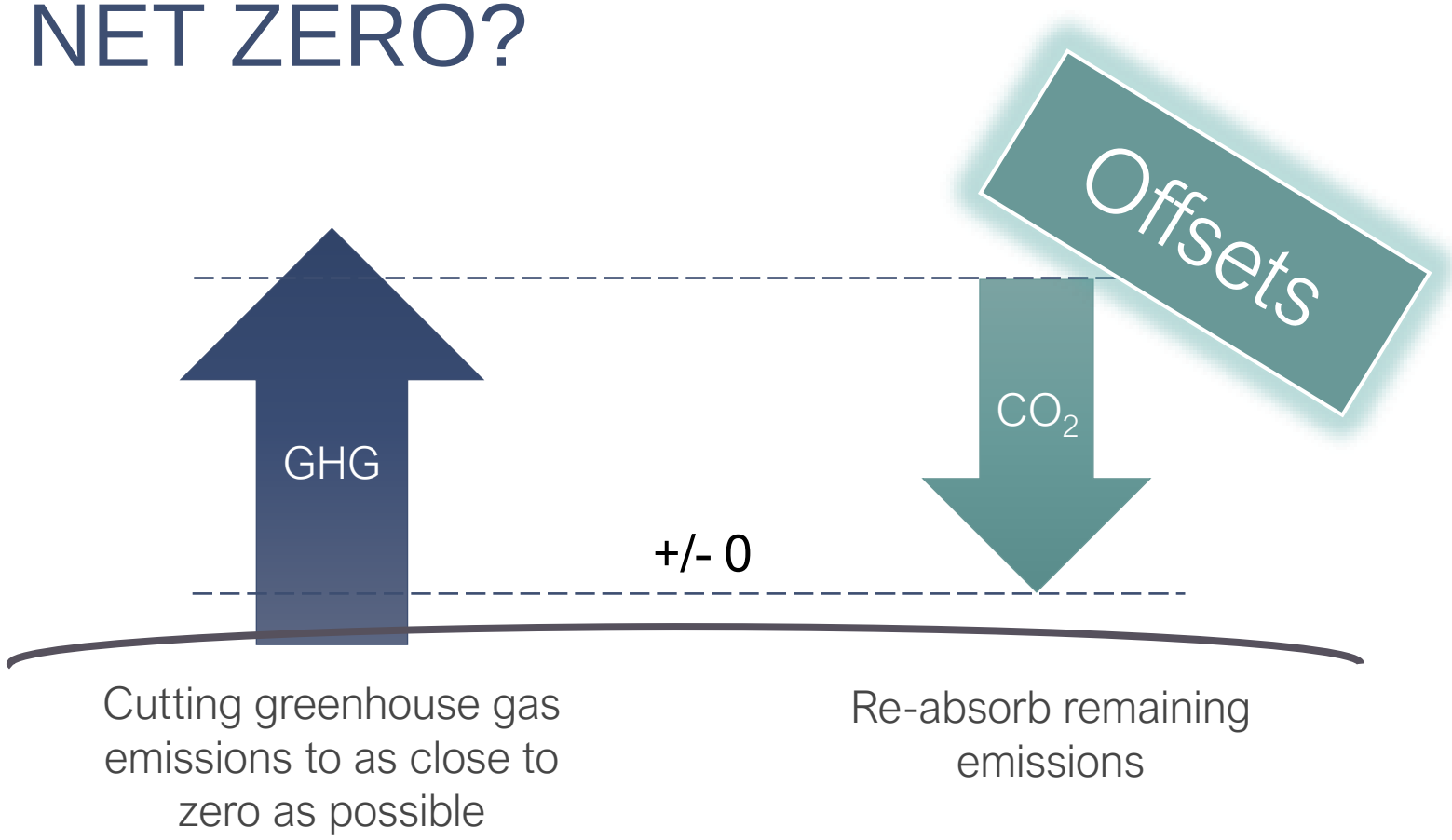
Source: United Nations – Climate Action; https://www.un.org/en/climatechange/net-zero-coalition
IPCC AR6, WG III; Climate Change 2022, Mitigation of Climate Change;
https://report.ipcc.ch/ar6wg3/pdf/IPCC_AR6_WGIII_FinalDraft_FullReport.pdf
https://globalcarbonbudget.org/carbonbudget/

WHAT IS NET ZERO?



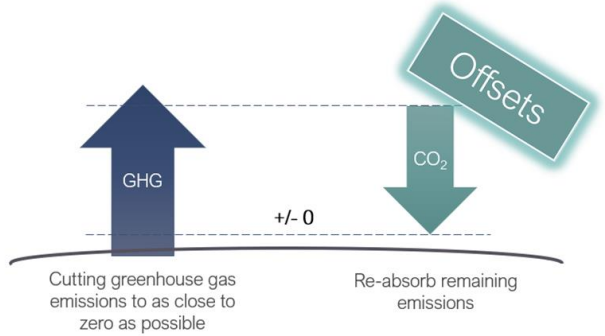
Source: https://www.youtube.com/watch?v=OoW2PlvMpZs

WHAT DO COMPANIES HAVE TO DO TO BECOME NET ZERO?



OFFSETS

Carbon offsets fund specific projects that either lower CO_2 emissions, or "sequester" CO_2, meaning they take some CO_2 out of the atmosphere and store it.



Offsets can mask insufficient efforts from firms to cut their own emissions, …

"Businesses want to do the right thing and it's heartening to see so many firms aiming for early Net Zero dates. But poor-quality offsets are crowding out high-integrity ones."

Many businesses have named ambitious 'Net Zero' dates but achieving them through an over-reliance on offsets is undermining the economy-wide transition.

Sources: Climate Change Committee (2022) - Business use of offsets risks delaying Net Zero
MIT Carbon Portal – Carbon Offsets

SCIENCE BASED TARGETS INITIATIVE (SBTi)

- The **Science Based Targets initiative*** (SBTi) is enabling companies and financial institutions globally to set ambitious emissions reductions targets in line with the latest climate science

  Minus 1/2 emissions before 2030

  Net-zero emissions before 2050

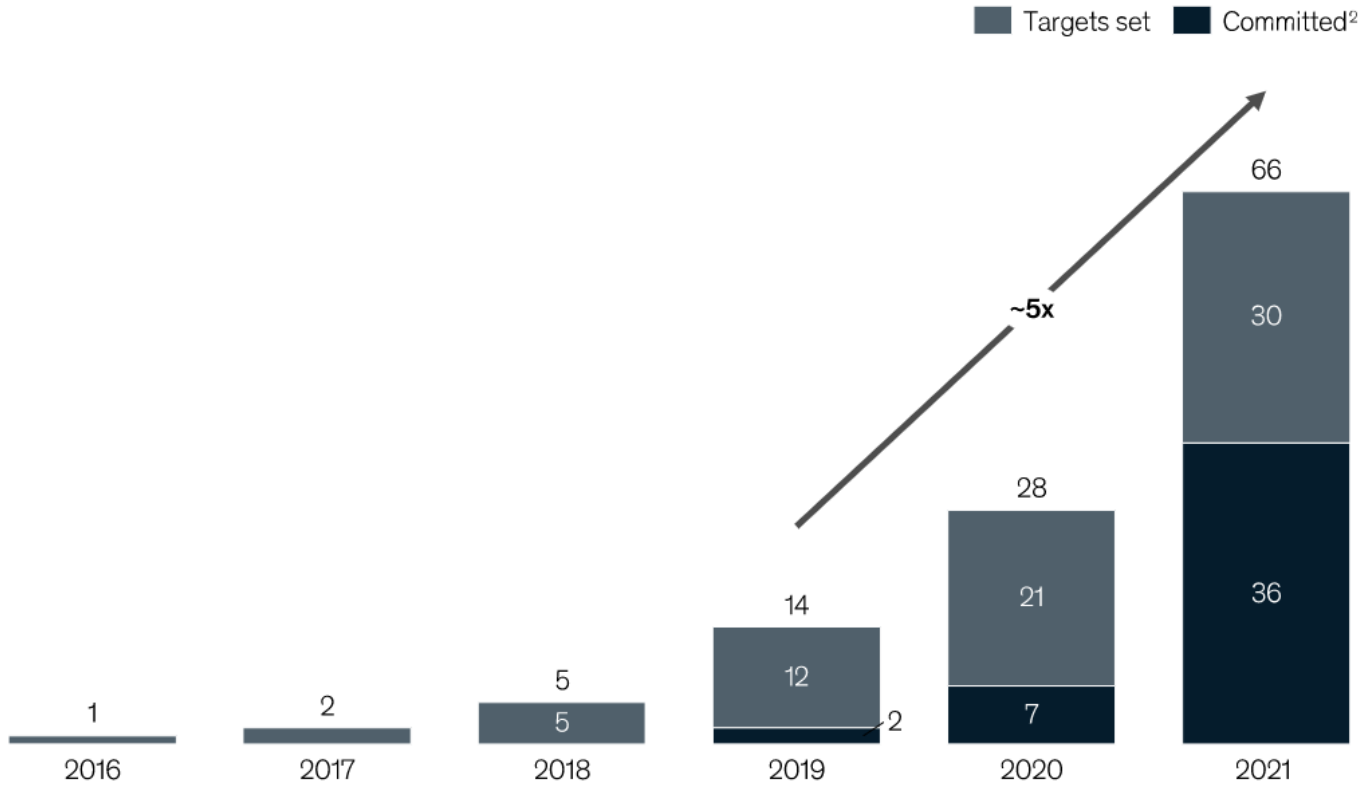
- Organizations disclose emissions annually and monitor progress on reaching the target.

*a collaboration between CDP, the United Nations Global Compact, World Resources Institute (WRI) and the World Wide Fund for Nature (WWF) and one of the We Mean Business Coalition commitments

Source: https://sciencebasedtargets.org/resources/files/SBT-Commitment-Letter.pdf
https://sciencebasedtargets.org/resources/files/SBTi-criteria.pdf

Globally, retailers are increasingly setting science-based targets to add credibility and accountability to their sustainability efforts.

Global retailers[1] setting science-based targets each year, # of companies



[1] Defined here as what the Science Based Targets initiative (SBTi) calls "retailing" and "food and staple retailing" companies.
[2] The SBTi refers to "committed" as having submitted a letter establishing intent to set a science-based target. Targets must be submitted and approved within 24 months of committing.

Source: Science Based Targets initiative

Source: McKinsey (2022): Climate sustainability in retail: Who will pay?

COMPANIES THAT COMMITTED TO SCIENCE-BASED TARGETS

SELECTION OF CORPORATE EXAMPLES

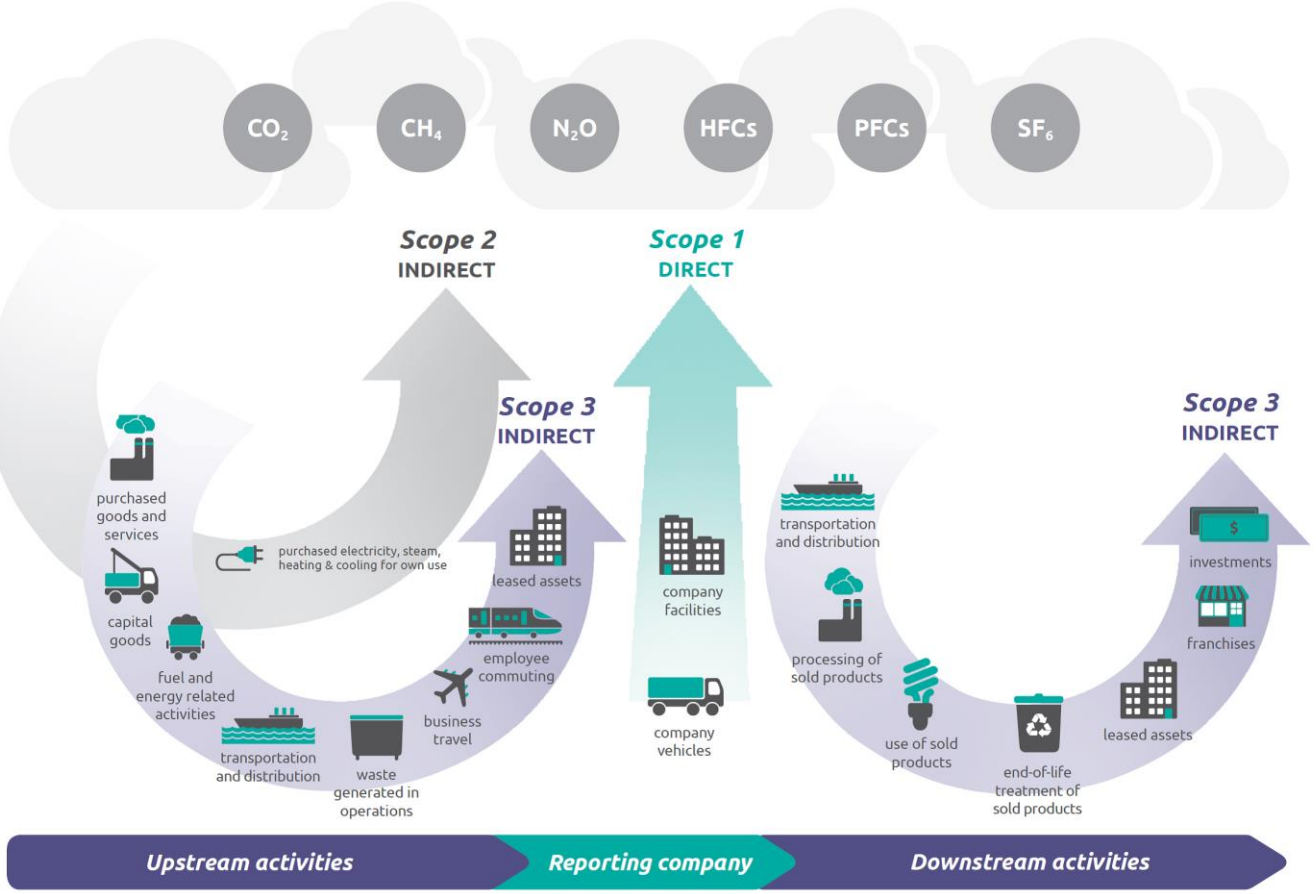
COMPANY/FINANCIAL INSTITUTION	TARGETS			ORGANIZATION TYPE	
	NEAR TERM	LONG TERM	NET-ZERO		
Swire Properties Limited ★ Hong Kong, China, Asia	1.5°C	-	COMMITTED	Company	VIEW MORE
Sino Land Company Limited ★ Hong Kong, China, Asia	COMMITTED	-	COMMITTED	Company	VIEW MORE
New World Development Company Limited ★ Hong Kong, China, Asia	1.5°C	-	COMMITTED	Company	VIEW MORE
Nan Fung Property Management Holdings Limited ★ Hong Kong, China, Asia	COMMITTED	-	COMMITTED	Company	VIEW MORE

Source: https://sciencebasedtargets.org/companies-taking-action#table

SCOPE 3 EMISSIONS

INDIRECT UPSTREAM & DOWNSTREAM EMISSIONS THAT OCCUR IN THE VALUE CHAIN

(EXCLUDING INDIRECT EMISSIONS ASSOCIATED WITH POWER GENERATION (SCOPE 2))



SCIENCE BASED TARGETS

DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

If scope 3 emissions represent >40% of a company's overall emissions, the SBTi requires they set a target to cover this impact.

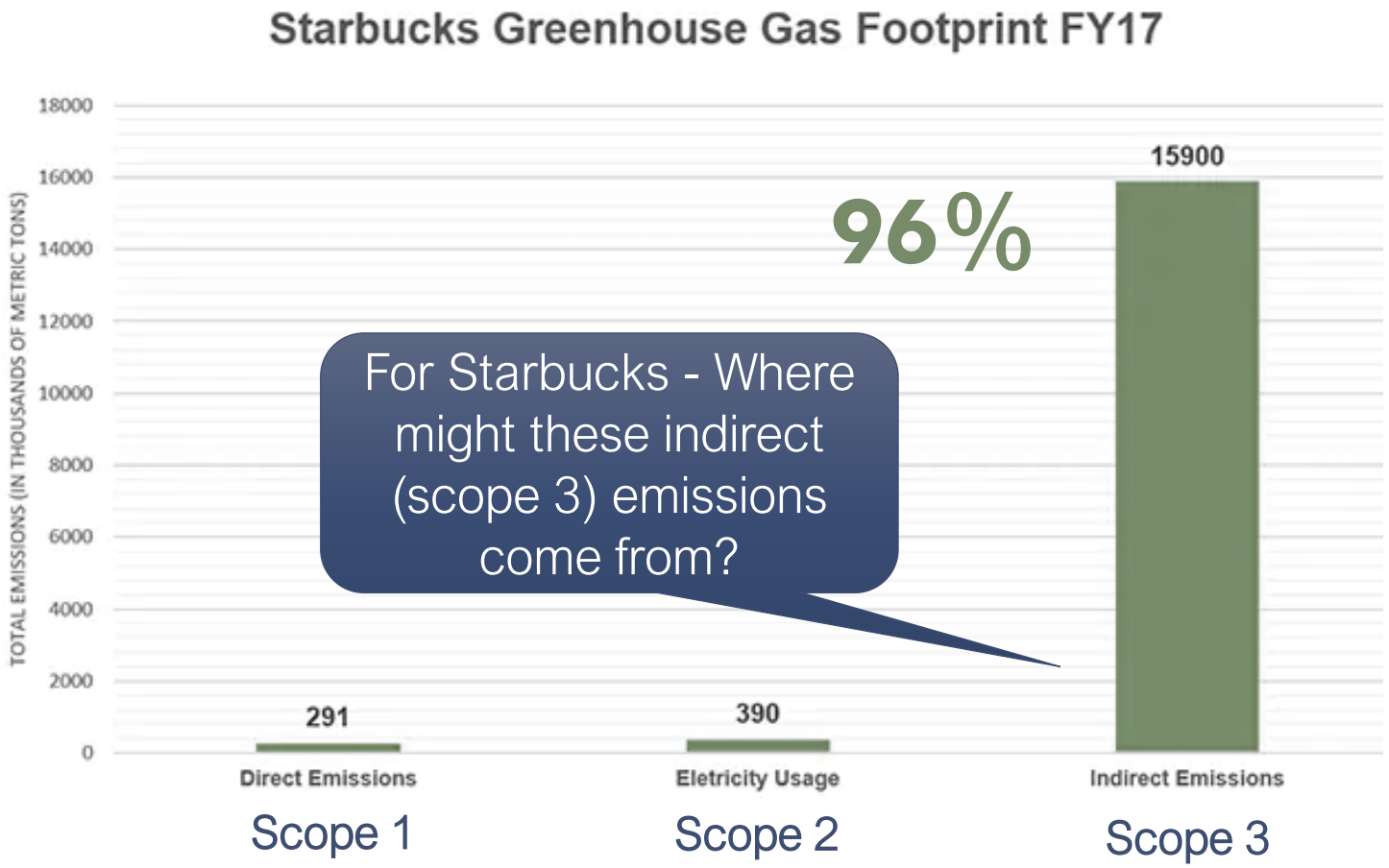
Source: CDP, 2018: How can companies address their scope 3 greenhouse gas emissions? https://www.cdp.net/en/articles/companies/how-can-companies-address-their-scope-3-greenhouse-gas-emissions

SCOPE 3 EMISSIONS

EXAMPLE: STARBUCKS

2030 Goals:

50% absolute reduction
in **scope 1, 2 and 3**
greenhouse gas (GHG) emissions
representing all of Starbucks direct
operations and value chain.



Source: Starbucks, graphic old, no longer available online

SCOPE 3 EMISSIONS

FOR MOST SECTORS, THE LARGEST SOURCES OF A COMPANY'S EMISSIONS LIE UP- AND/OR DOWNSTREAM OF THEIR CORE OPERATIONS.

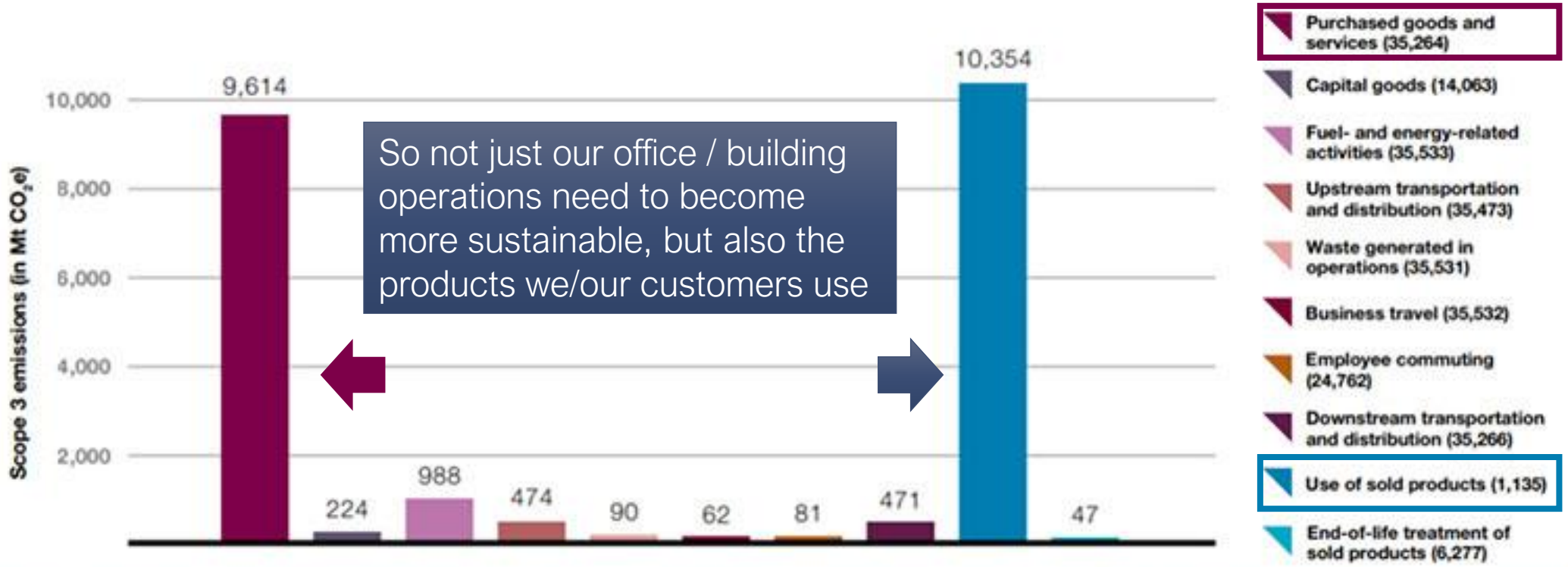


Figure 1. Scope 3 emissions estimated by CDP for 35,533 companies per emission source in year 2014. The number of companies for which each type of Scope 3 emissions was calculated is presented in parentheses for each sector.

Source: CDP, 2018: How can companies address their scope 3 greenhouse gas emissions? https://www.cdp.net/en/articles/companies/how-can-companies-address-their-scope-3-greenhouse-gas-emissions

DISCUSSION

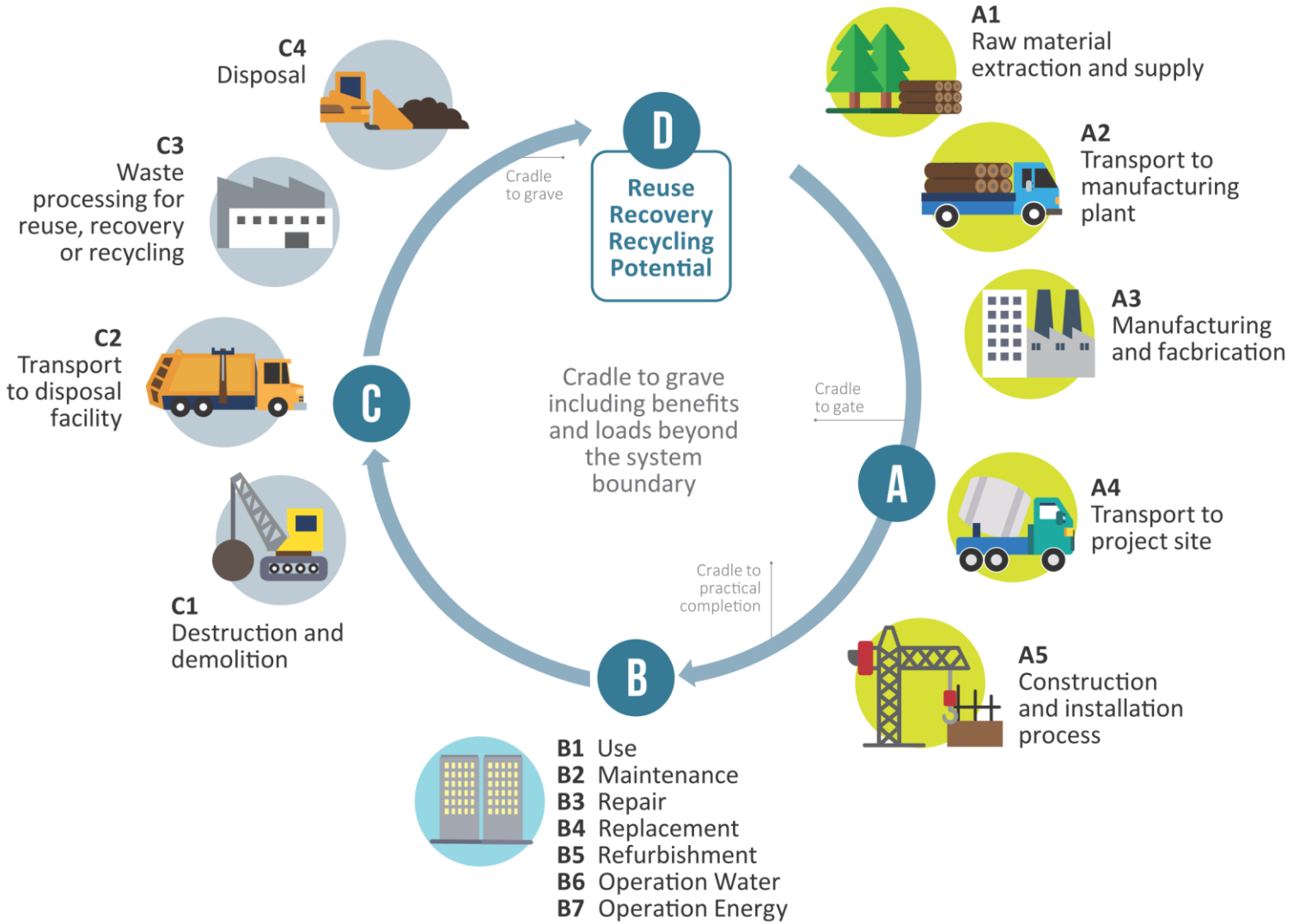
Scope 1,2,3 and Science Based Targets for Carbon reduction

- which one have you come across / is your institution working on?
- What are your experiences?

Group discussion

5 min

BUILDING LIFE CYCLE



Source: Civic Exchange, HKGFA, 2020: Decarbonising Hong Kong Buildings Policy Recommendations and Next Steps

LIFE CYCLE STAGES OF A PRODUCT

Raw material Production

Processes: e.g., Farming, Mining, Oil extraction, …

Ingredient Manufacturing & Processing

Production

Process: e.g., Food Processing, Product Assembly, Chemical Processing, …

Packaging & Transport

End of Life

e.g., Landfill, Recycling, …

End of Life

e.g., Wastewater Treatment

Use

e.g., Eating, Doing laundry…

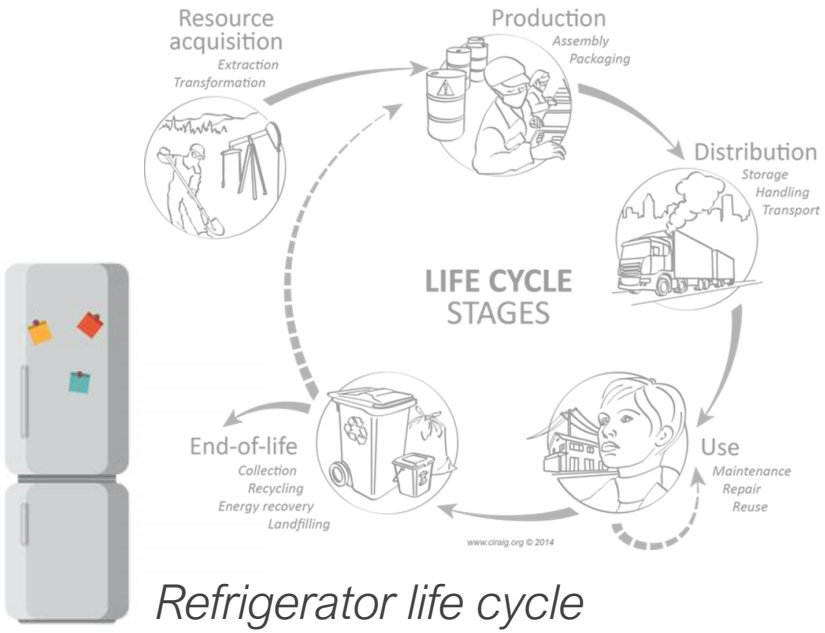
Retail

Every product goes through these life cycle stages but undergoes different processes

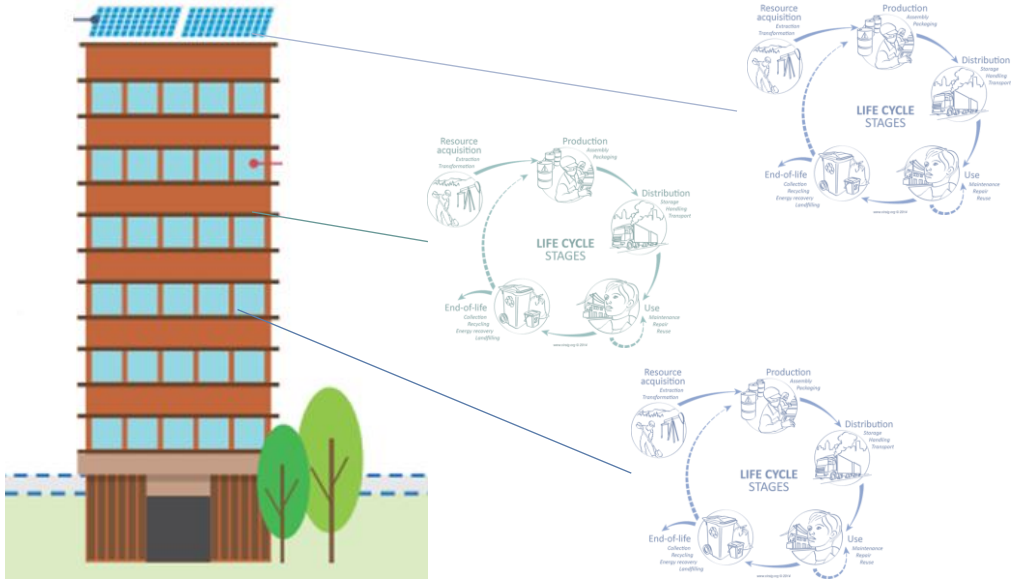
Example: Life Cycle of a washing detergent,
Source: The Sustainability Consortium ; https://www.sustainabilityconsortium.org/product-categories/ (retrieved Oct 2018, no longer available online)

PRODUCT LCA vs. BUILDING LCA

PRODUCT LCA VS BUILDING LCA



Refrigerator life cycle

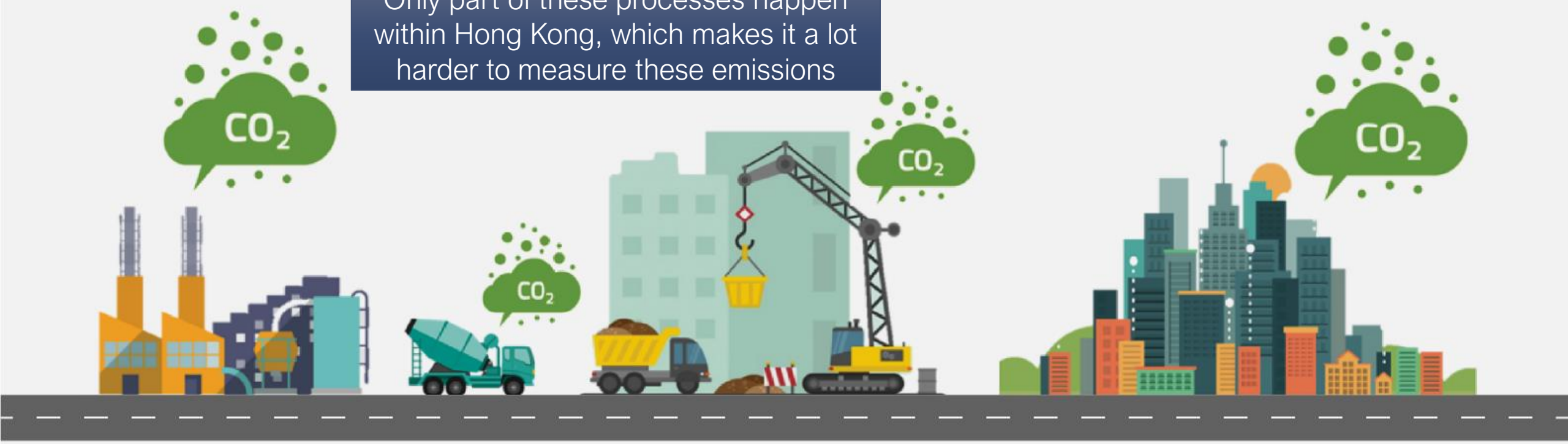


Building life cycle

- Single product-system, based on one or more materials

- Large compilation of product-systems
- Calculation of building life cycle impacts based on a variety of building materials life cycle impacts

Only part of these processes happen within Hong Kong, which makes it a lot harder to measure these emissions



‘Upfront’ Embodied Carbon

Manufacturing, transportation, and installation of construction materials

Operational Carbon

Building energy consumption

Source: Carbon Leadership Forum
https://carbonleadershipforum.org/the-carbon-challenge/

EMBODIED VS OPERATIONAL CARBON

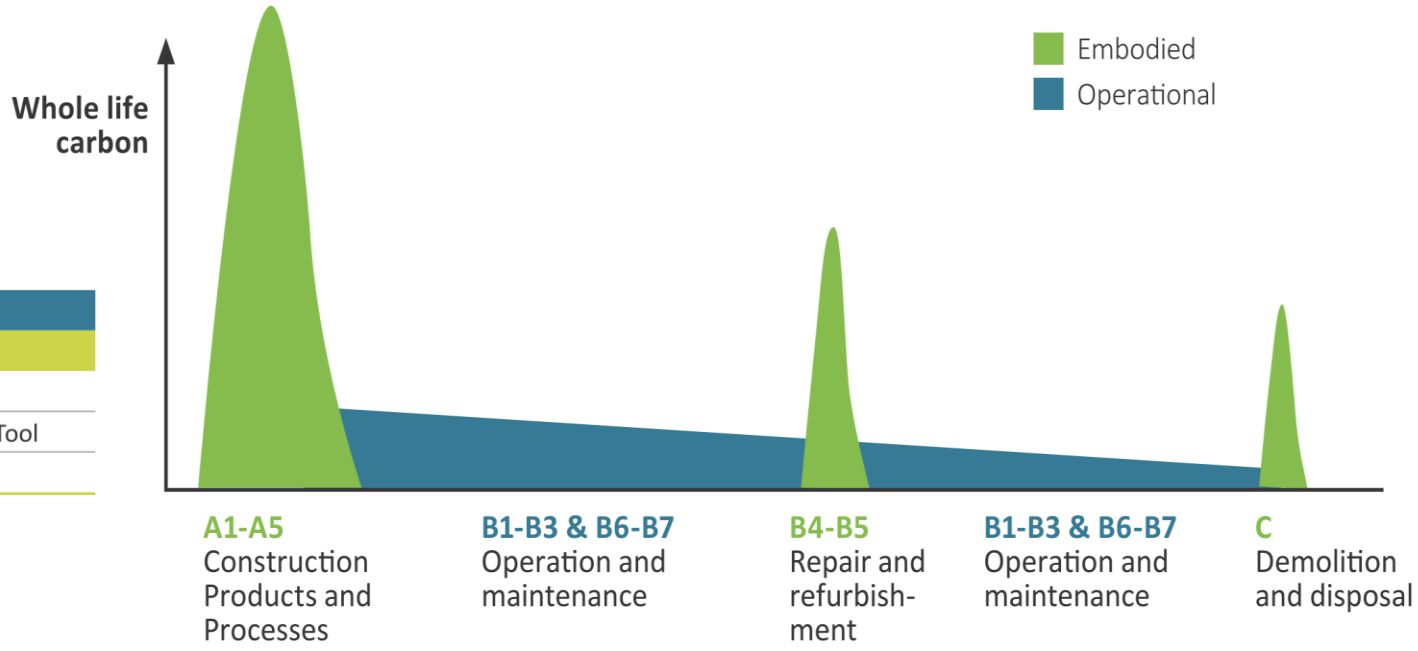
The longer the lifespan of a building, the less embodied emissions contribute to the overall percentage

(emissions concentrated at the initial stages of the building's lifecycle)

Estimated Embodied Carbon for Different Building Types

Building Types	Estimated Embodied Carbon	Source
Hong Kong		
High-Rise Residential	38% (Housing Authority, 2013)	Kai Tak Public Housing
All Buildings	35% (CIC, 2014)	CIC Carbon Assessment Tool
Zero-Carbon Building	25% (Li, 2013)	Zero-Carbon Building

Embodied and Operational carbon emissions timeline



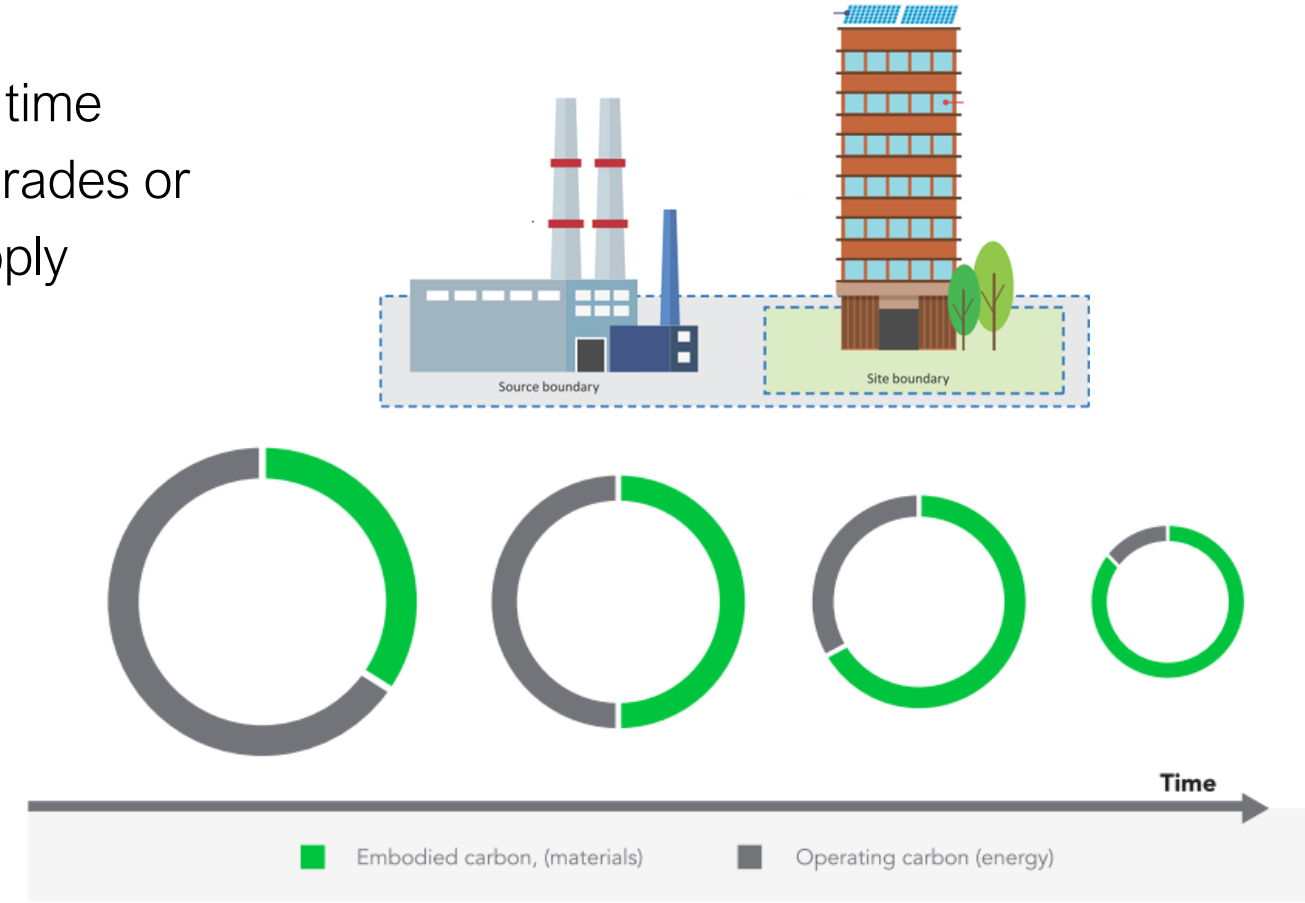
Source: Civic Exchange, HKGFA, 2020: Decarbonising Hong Kong Buildings Policy Recommendations and Next Steps

EMBODIED VS OPERATIONAL CARBON

IMPORTANCE OF EMBODIED CARBON GROWS AS OPERATIONAL ENERGY DECARBONIZES

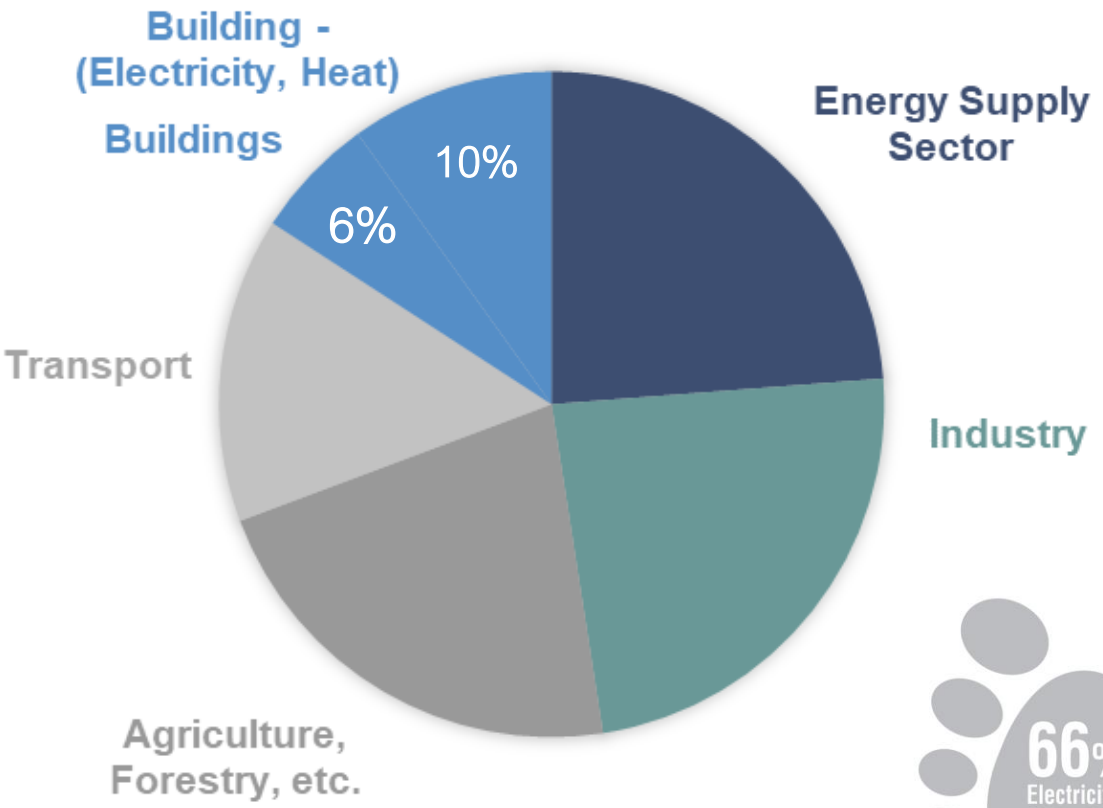
- While operational carbon can reduce over time
  e.g., due to building energy efficiency upgrades or decarbonization efforts of local energy supply

- Embodied carbon is released before the building is even in use
  - **Emissions are locked in place** as soon as a building is built
  - Emissions **depend largely on energy system** at **the source location**



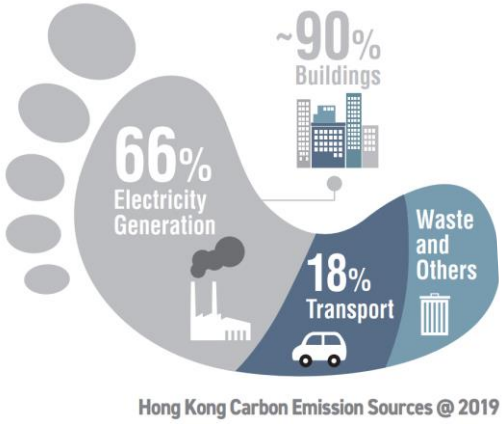
Sources: Civic Exchange, HKGFA, 2020: Decarbonising Hong Kong Buildings Policy Recommendations and Next Steps
One Click LCA Ltd, 2018: The Embodied Carbon Review

GLOBAL NET ANTHROPOGENIC GHG EMISSIONS



Globally buildings generate 16% of annual greenhouse gas emissions.

- 10% from electricity and heat for building operations – existing & new buildings
- 6% Buildings – incl. embodied carbon mostly due to new construction



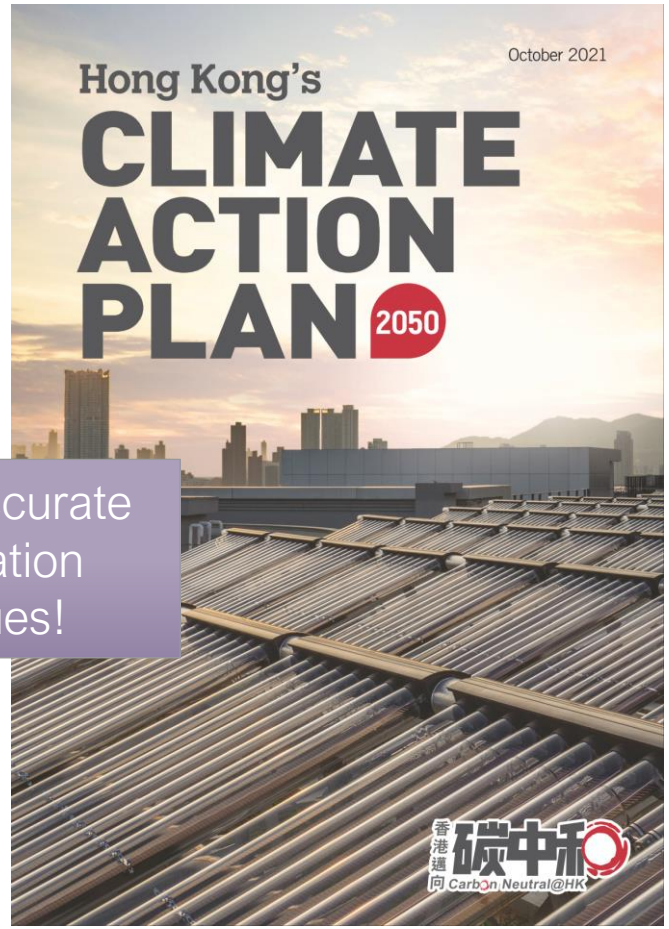
Hong Kong Carbon Emission Sources @ 2019

In Hong Kong about 60-70% of annual greenhouse gas emissions originate from the building sector

Sources: IPCC AR6, WG III; Climate Change 2022, Mitigation of Climate Change; https://report.ipcc.ch/ar6wg3/pdf/IPCC_AR6_WGIII_FinalDraft_FullReport.pdf
Civic Exchange, HKGFA, 2020: Decarbonising Hong Kong Buildings Policy Recommendations and Next Steps

HONG KONG'S DECARBONIZATION TARGET

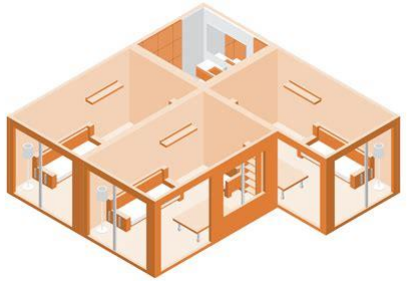
ACHIEVE CARBON NEUTRALITY BEFORE 2050

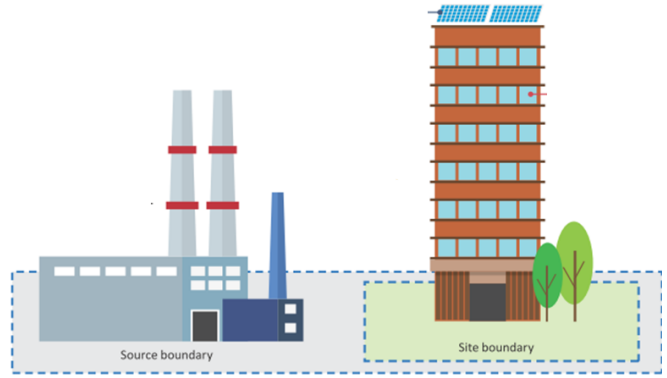


Need for accurate quantification techniques!

How to reduce?

- *"…choice of design and construction methods should […] **reduce embodied carbon emissions** during the construction process."*





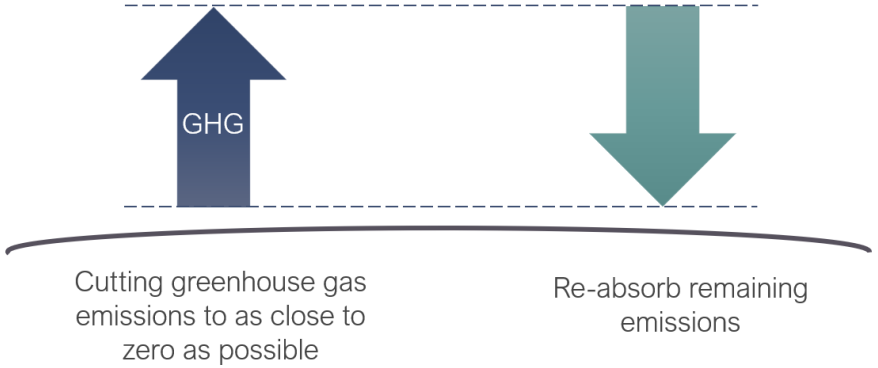
- *"Modular Integrated Construction (MiC) method […] by carrying out most of the operations at construction sites in **off-site prefabrication yards**, thereby simplifying the construction process and reducing construction wastes."*

Source: Hong Kong's CLIMATE ACTION PLAN 2050 (2021)

ARE WE ON TRACK TO REACH NET ZERO BY 2050?

TO KEEP GLOBAL WARMING TO NO MORE THAN 1.5°C EMISSIONS NEED TO BE REDUCED BY 45% BY 2030 AND REACH NET ZERO BY 2050.

China, the United States, & the European Union have **set a net-zero target,** covering about **76% of global emissions.**



Commitments made by governments to date fall far short of what is required.

Current national climate plans – for all 193 Parties to the Paris Agreement taken together – **would lead to an increase of 14%** in global greenhouse gas emissions by 2030, compared to 2010 levels.

Source: United Nations – Climate Action; https://www.un.org/en/climatechange/net-zero-coalition

DISCUSSION

- How would you/ do people commonly define what a “Sustainable Product” is?
- What makes it difficult to give a clear definition?

Group discussion

10 min

You can take notes on your printout

DISCUSSION - SUSTAINABLE PRODUCT

- How would you/ do people commonly define what a “Sustainable Product” is?

- What makes it difficult to give a clear definition?

LIFE CYCLE STAGES OF A PRODUCT

Raw material Production

Processes: e.g., Farming, Mining, Oil extraction, …

Ingredient Manufacturing & Processing

Production

Process: e.g., Food Processing, Product Assembly, Chemical Processing, …

Packaging & Transport

End of Life

e.g., Landfill, Recycling, …

End of Life

e.g., Wastewater Treatment

Use

e.g., Eating, Doing laundry…

Retail

Environmental Impacts (Resource use and Emissions) occur at every stage in the life cycle

Example: Life Cycle of a washing detergent,
Source: The Sustainability Consortium ; https://www.sustainabilityconsortium.org/product-categories/ (retrieved Oct 2018, no longer available online)

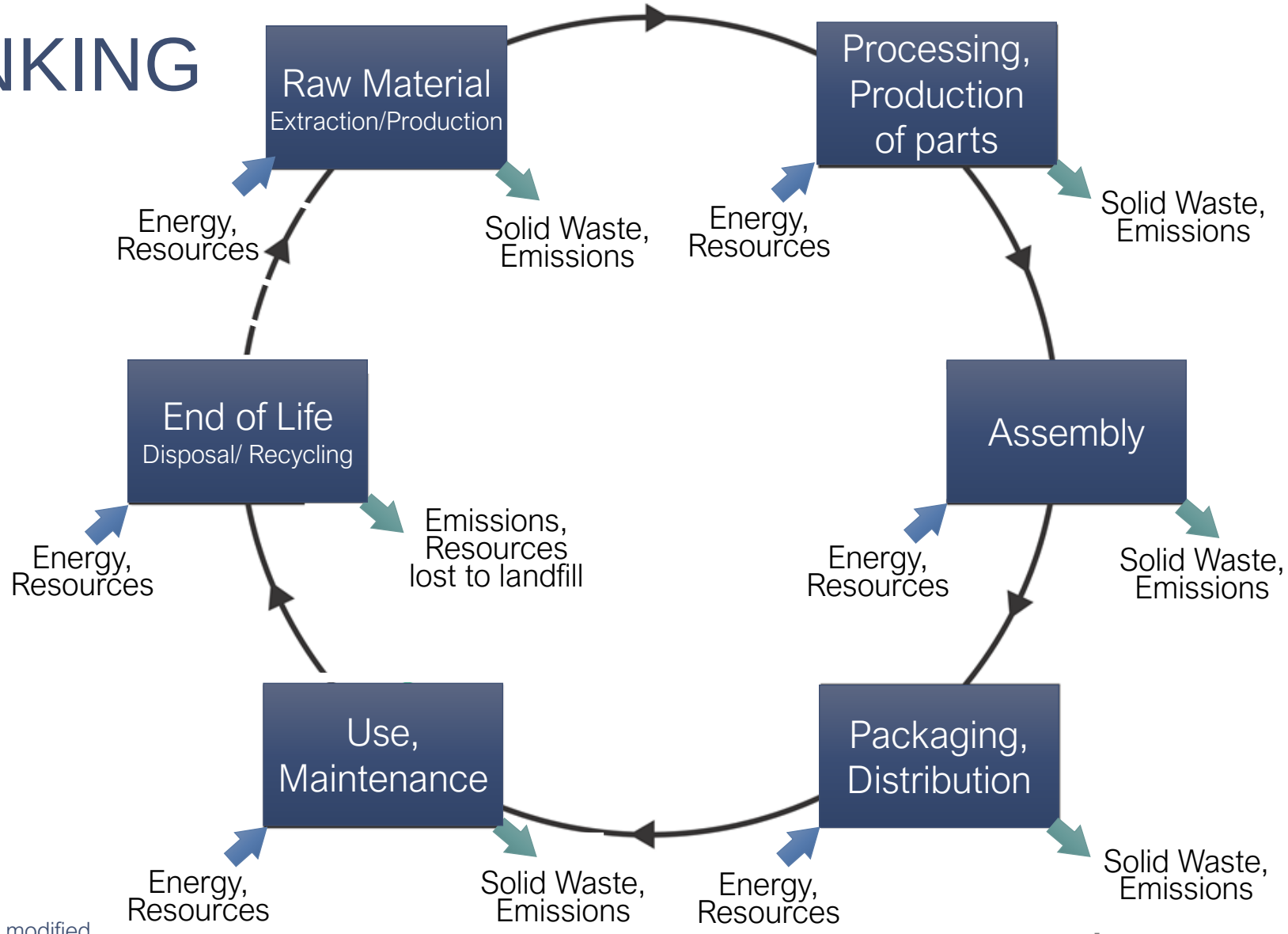
LIFE CYCLE THINKING

CONCEPT

Life cycle thinking helps to systematically identify a product's

- resource use (incl. financial resources)
- emissions (waste) to the environment (environmental impacts)

at ALL lifecycle stages.

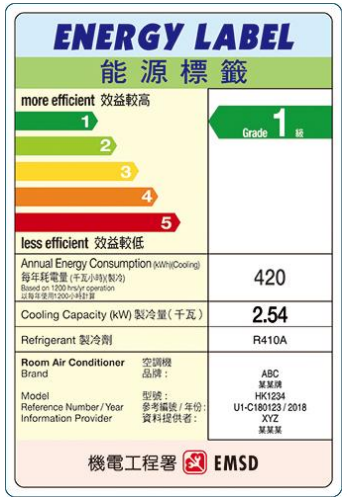


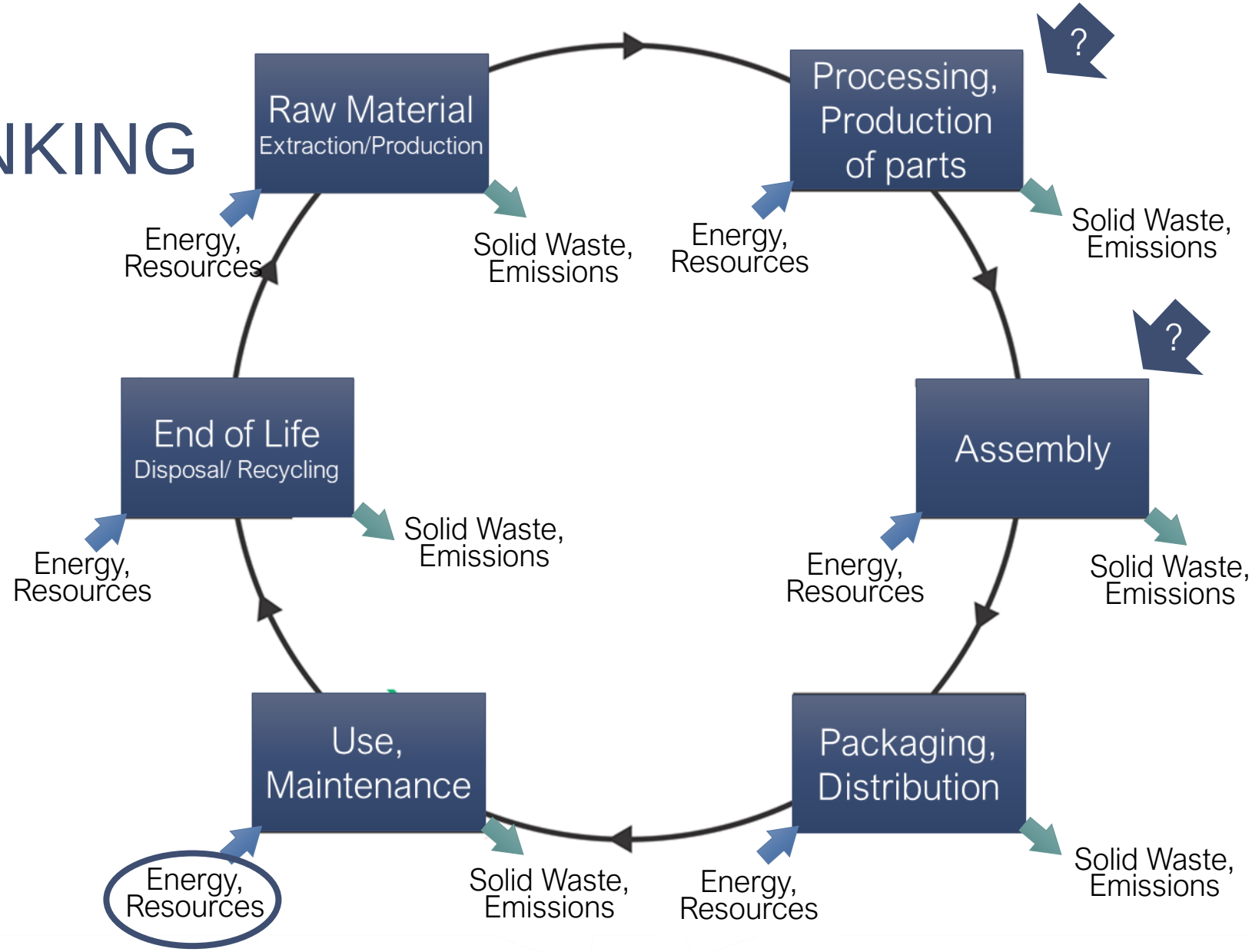
Source: The Life cycle Initiative, modified
https://www.lifecycleinitiative.org/starting-life-cycle-thinking/what-is-life-cycle-thinking/

LIFE CYCLE THINKING

BENEFITS

Reduces the narrow focus
on just one or two stages.



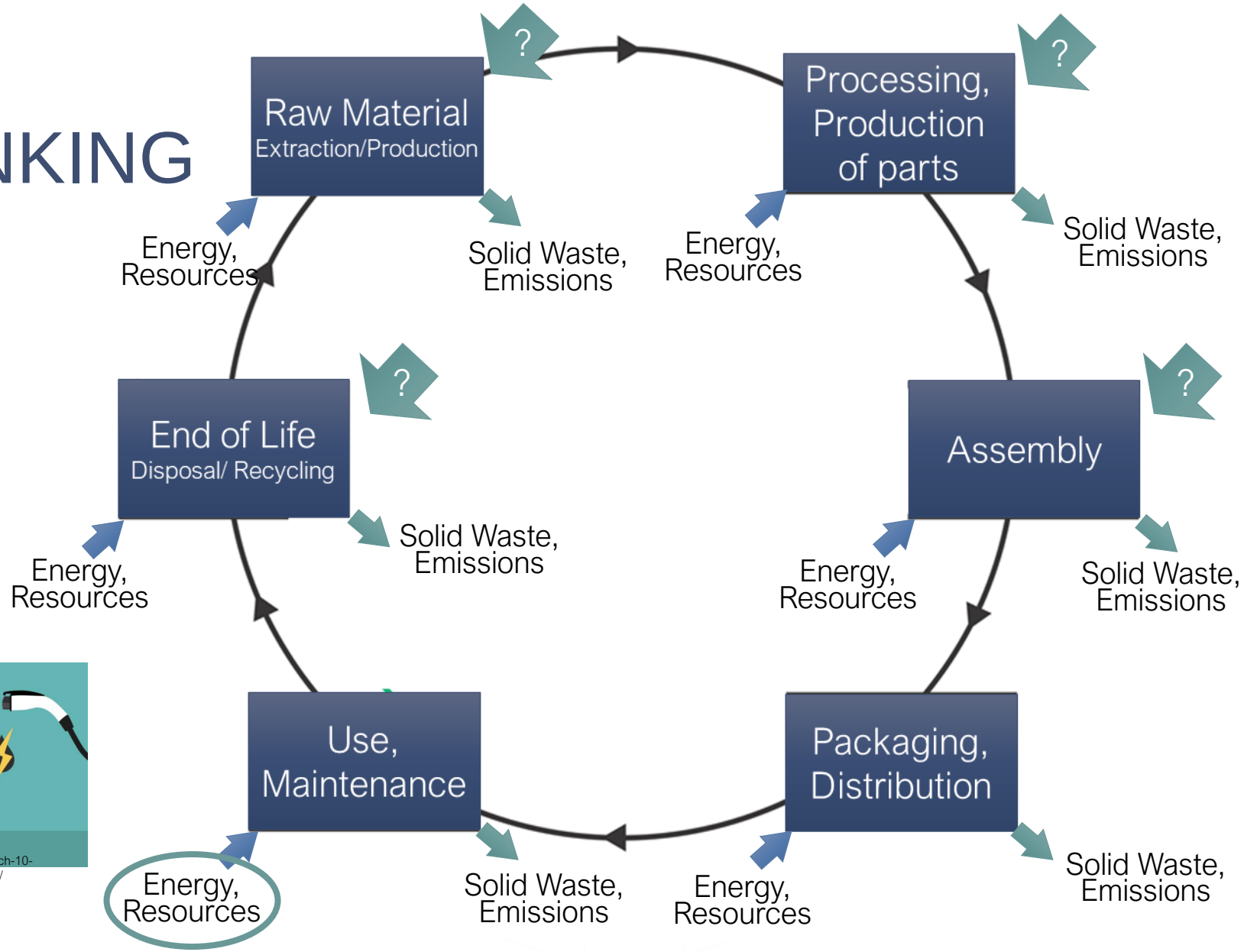


Source: The Life cycle Initiative, modified
https://www.lifecycleinitiative.org/starting-life-cycle-thinking/what-is-life-cycle-thinking/

LIFE CYCLE THINKING

BENEFITS

Indicates how changes in one life cycle stage affect the resource use and emissions from other life cycle stages.



Which Life Cycle Stages would be affected if we switch from ICE to EV cars?

https://ulupono.com/newsletter-listing/march-10-2021/mythbusting-gas-vs-electric-vehicles/

Source: The Life cycle Initiative, modified
https://www.lifecycleinitiative.org/starting-life-cycle-thinking/what-is-life-cycle-thinking/

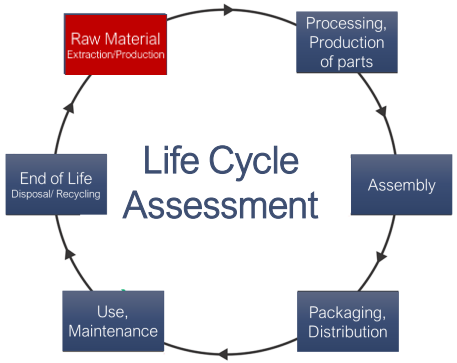
FROM LIFE CYCLE THINKING TO LIFE CYCLE ASSESSMENT (LCA)

QUANTIFICATION OF ENVIRONMENTAL IMPACTS ALONG THE LIFE CYCLE

reveals **quantities of energy and material flows,** as well as the **kind & degree of environmental emissions**

WHAT CAN LCA TELL ABOUT PRODUCT SUSTAINABILITY?

1. IDENTIFY HOT SPOTS WITHIN A PRODUCT'S LIFE CYCLE

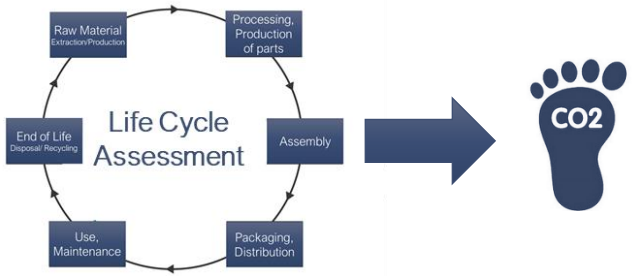


Hot Spot:
Process that causes significant impacts

Reveals which life cycle stage is most resource intensive or where most severe emissions happen

→ *LCA can indicate which process changes could yield significant positive improvement*

2. IDENTIFY TOTAL IMPACTS THAT OCCUR ALONG A PRODUCT'S LIFE CYCLE (ECO-FOOTPRINT OF A PRODUCT)



Comparative: What would be the better alternative?

Reveals total resource requirements & emissions from all life cycle stages

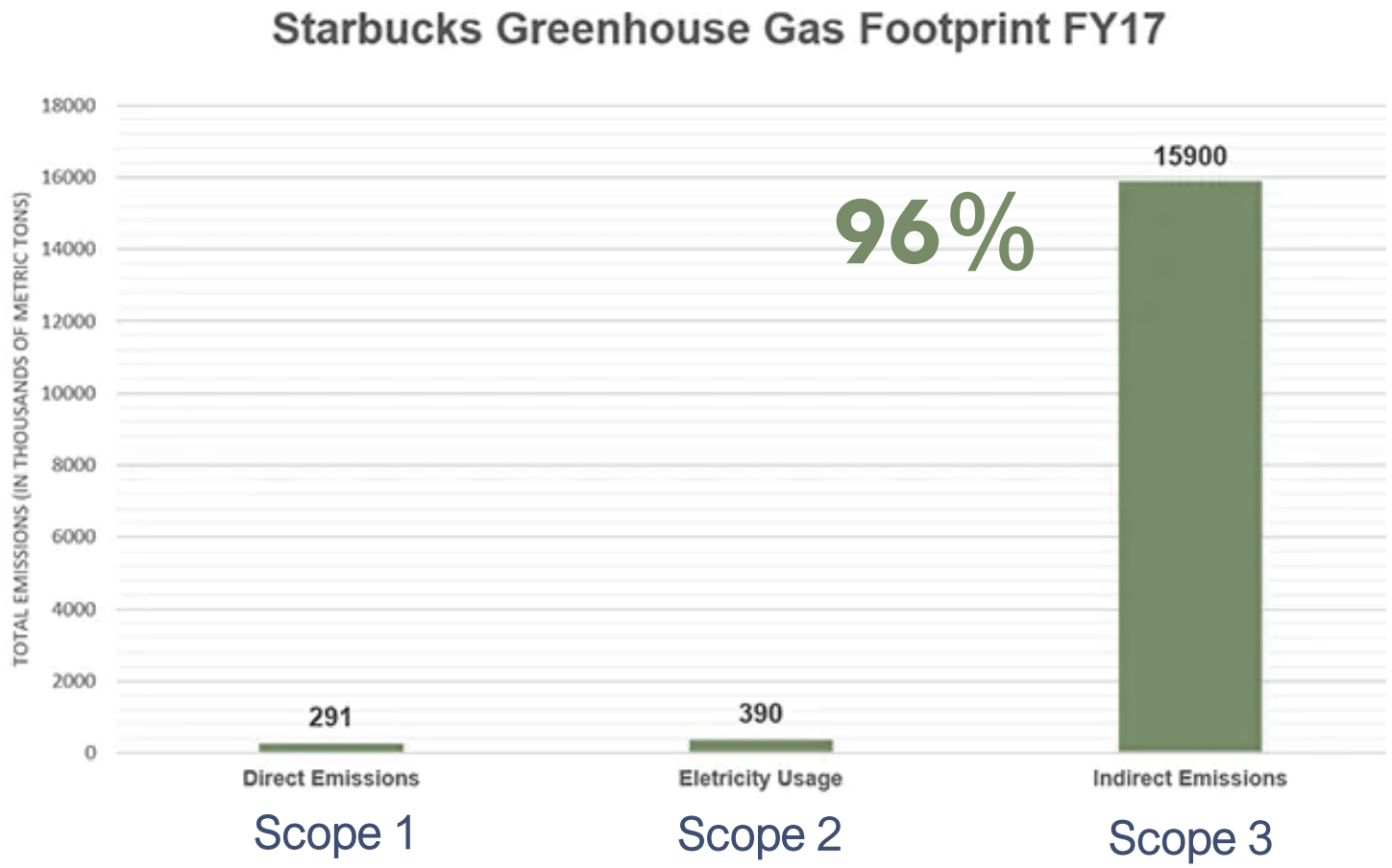
→ *LCA can tell which product has a lower footprint and is accordingly more sustainable*

SCOPE 3 EMISSIONS

EXAMPLE: STARBUCKS

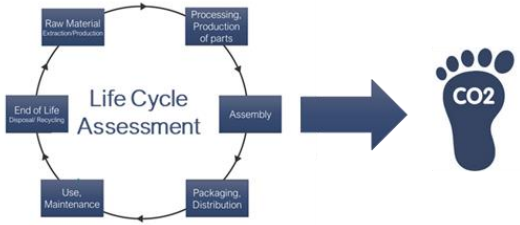
2030 Goals:

50% absolute reduction
in **scope 1, 2 and 3**
greenhouse gas (GHG) emissions
representing all of Starbucks direct
operations and value chain.

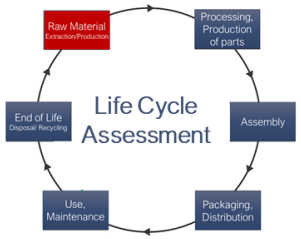


Source: Starbucks, graphic old, no longer available online

CRADLE TO GRAVE LCA OF MILK



- **Which milk** causes the least greenhouse gas emissions (has the **lower carbon footprint**)?



Hot Spot:
Process that causes significant impacts

- What are the **hotspots** in the **different milk life cycles**?

Cow Milk

Soy Milk

Source: EPD, 2016, Granarolo, EPD Organic soy drink, EPD, 2018, Granarolo, EPD Organic pasteurized whole milk

COMPARING APPLES & ORANGES?

Life Cycle Assessment can quantify environmental impacts of different products. But how to assess and compare seemingly different products?

It’s possible as long as they **fulfill the same function**

LIFE CYCLE ASSESSMENT ALLOWS THE COMPARISON ENVIRONMENTAL IMPACTS OF DIFFERENT PRODUCTS

Major ingredient: Apple

What is the function they both fulfil?

How much of each should we compare?
e.g., 170g apple with 170g of chocolate bar?

Major ingredients: 25 g sugar, 13 g peanuts, 5 g cocoa, 5 g milk powder, vegetable oils, vanilla extract, …

- **Function:** serve as a **snack** in between meals
- **Functional Unit:** 1 medium sized apple (170g) vs. 1 bar (50g) of caramel-peanut chocolate

→ Assessment of impacts of **materials required to fulfill such a functional unit** (**reference flows**)

FUNCTIONAL UNIT

WHY DO WE NEED TO DEFINE A FUNCTIONAL UNIT

Functional Unit:
1 liter of milk

- **Functional unit**: comparison of products on the basis of *equivalent function*, for example: comparison of 2 packaging systems for 100 litres of milk by (a) 100 disposable cartons or (b) 1 reusable bottle ; instead of comparison of 1 carton and 1 bottle.
- Functional unit is basis for comparison

Source: ISO 14044:2006 – Chapter 4.2.2 Goal of the study; Hauschild et al. 2018 – Chapter 7

LIFE CYCLE ASSESSMENT OF MILK

STEP1: DEFINE THE FUNCTIONAL UNIT

Identical function but different material flows.

1. What is the **function, how much of it do we want to compare,** and what type and **kind of material (ingredients) do we need to fulfil it**?

Functional unit:
1 liter of milk

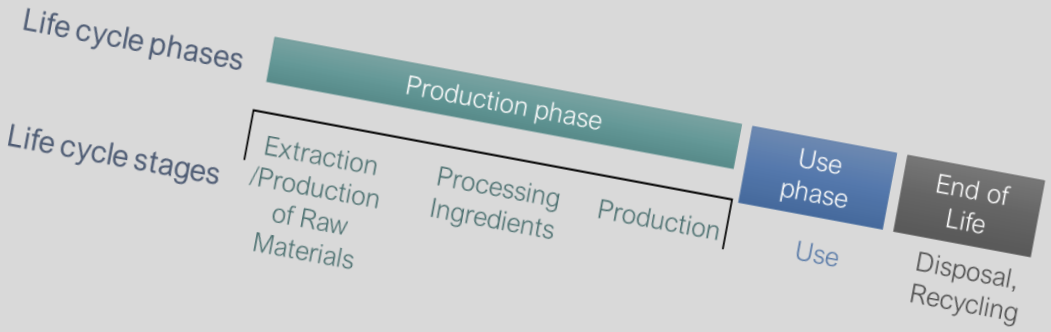
Ingredients: Whole milk

Nutrients (per 100mL)	
Carbon Hydrates/ Sugar	5.0 g
Proteins	3.3 g
Fat	3.7 g
Calories	67 kcal
Calcium	120mg

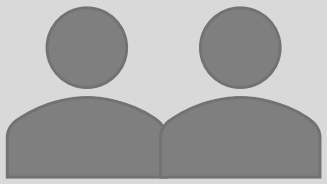
Ingredients: Water, organic soya beans, sugar, dietary fiber, natural flavors

Nutrients (per 100mL)	
Carbon Hydrates/ Sugar	0.5g
Proteins	3.6g
Fat	2.1g
Calories	35 kcal

ACTIVITY/DISCUSSION



Scope of the LCA study



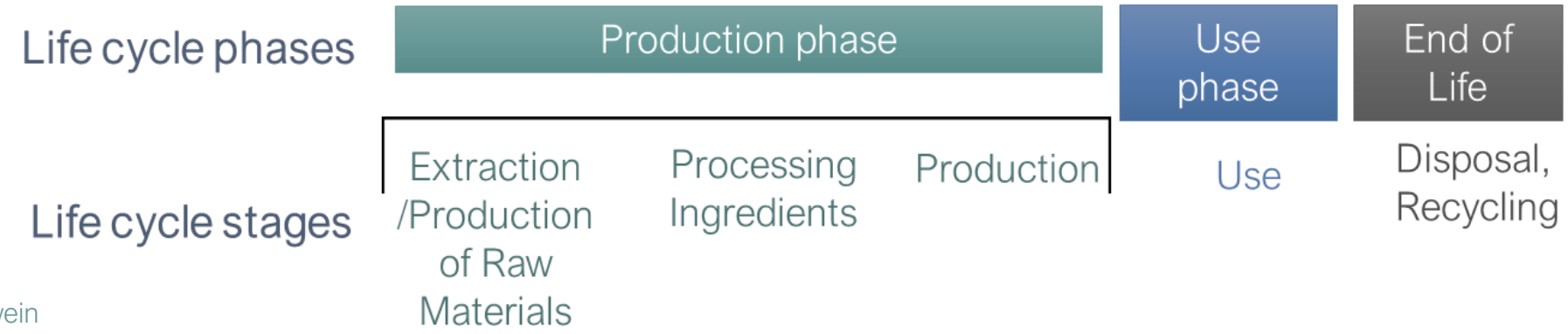
In pairs

5 min

Draw onto your printout

Draw into the graphic: Which stages/phases are covered in these 5 terminologies?

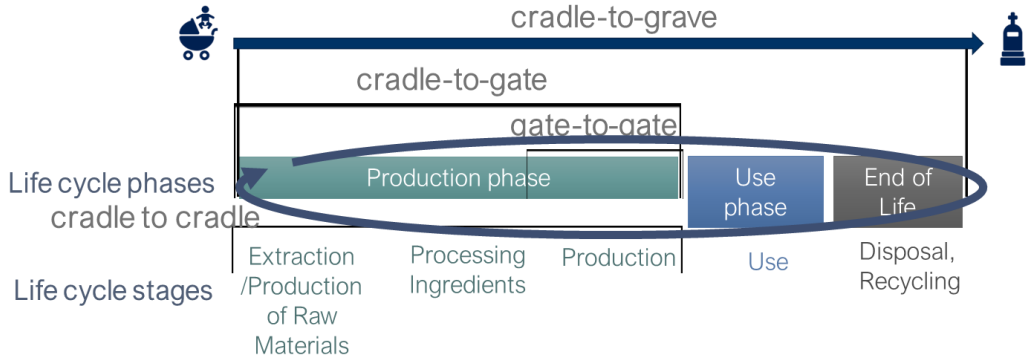
Cradle-to-grave, Cradle-to-gate, Cradle-to-cradle, Gate-to-gate, Well-to-wheel



COMMON LCA TERMINOLOGY

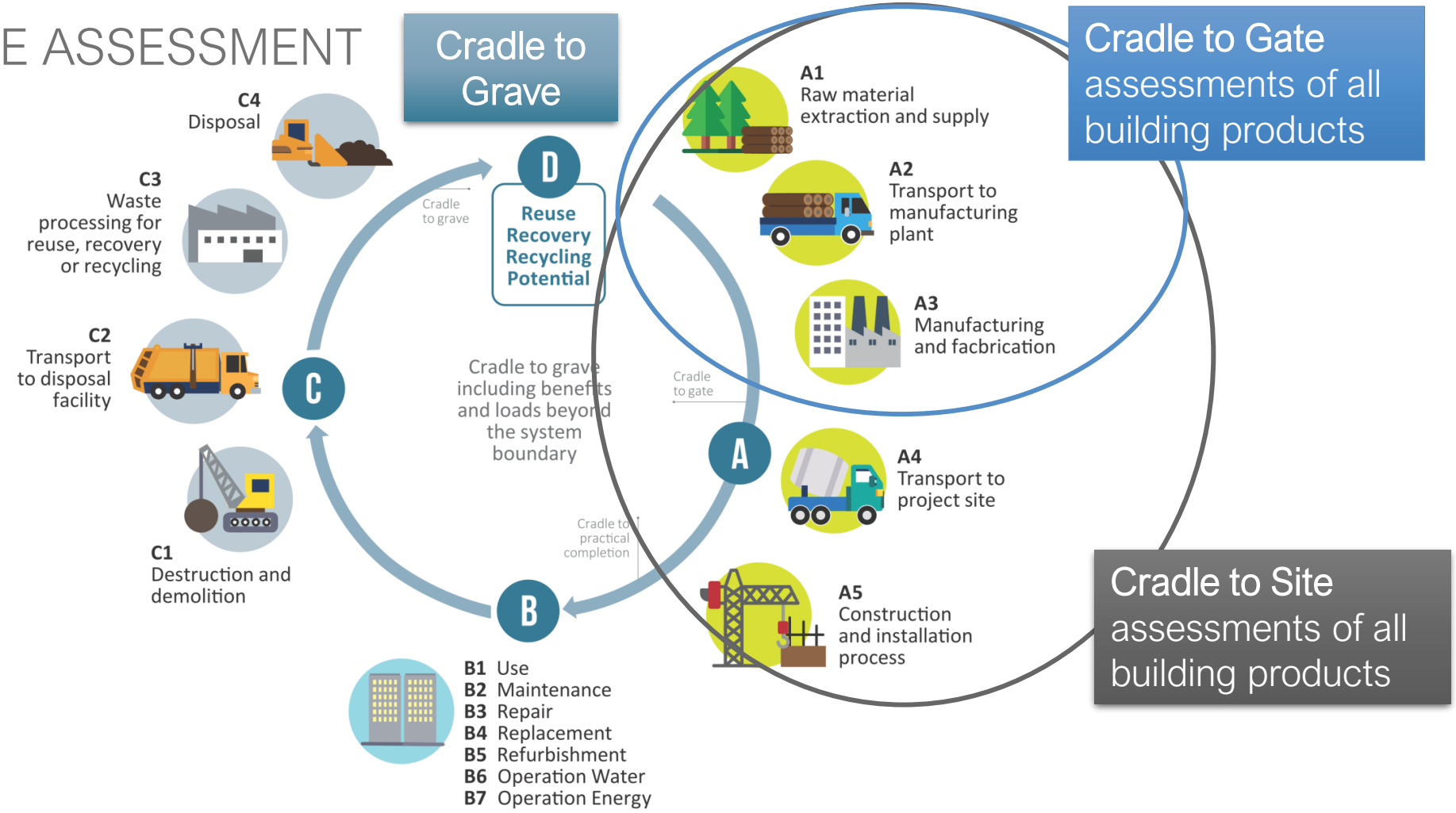
SCOPE

- Cradle-to-grave: Scope includes end-of-life disposition of the product/material
- Cradle-to-gate: LCA boundaries include material acquisition, processing, transportation, and manufacturing (factory gate), but not product uses or disposal
- Cradle-to-cradle: Scope includes the entire material cycle, including recycling
- Gate-to-gate: Partial LCA looking at a single added process or material in the product chain
- Well-to-wheel: Application of fuel cycles to transportation vehicles



BUILDING LIFE CYCLE

SCOPE OF THE ASSESSMENT

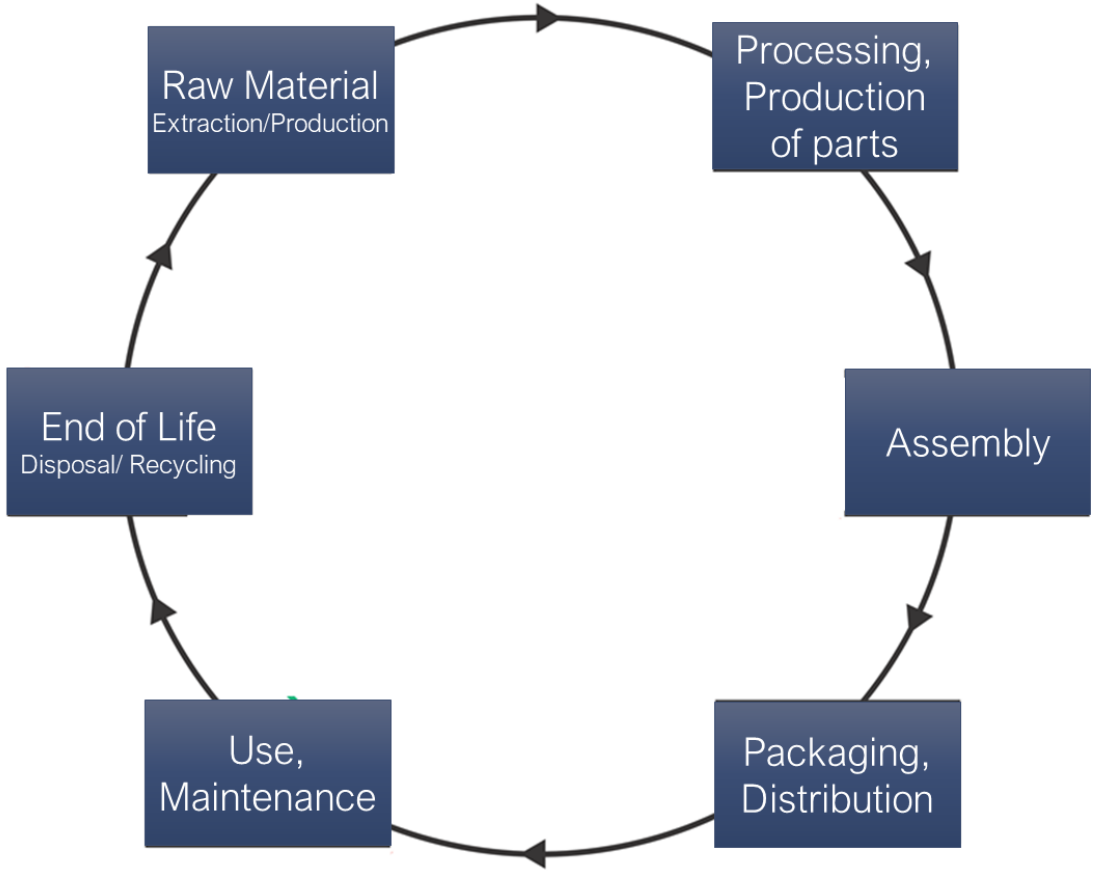


Source: Civic Exchange, HKGFA, 2020: Decarbonising Hong Kong Buildings Policy Recommendations and Next Steps

LIFE CYCLE ASSESSMENT OF MILK

STEP BY STEP

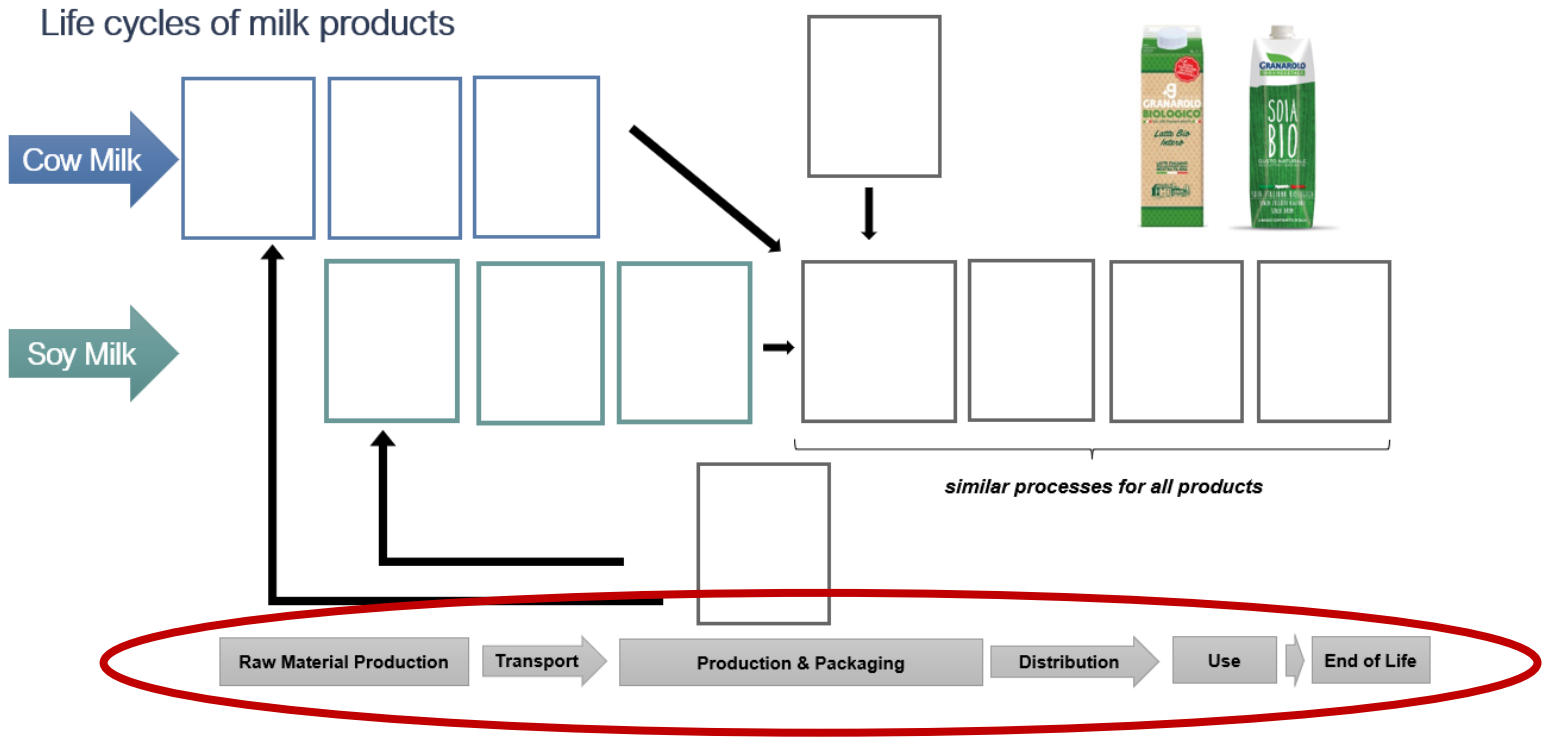
1. What is the **function, how much of it do we want to compare,** and what type and **kind of material (ingredients) do we need to fulfil it**?
2. What are the **processes** involved in **each life cycle stage** of the product system(s)?



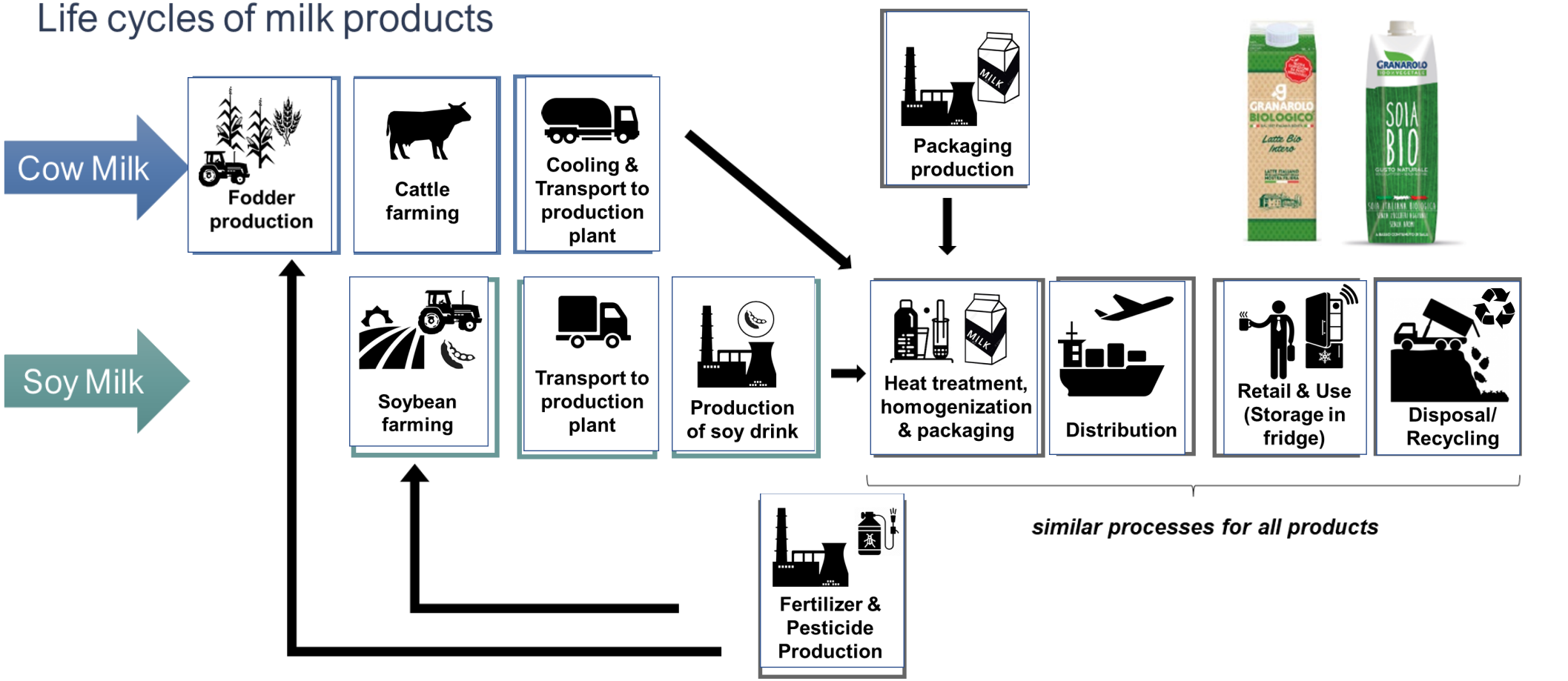
MAPPING LIFE CYCLE PROCESSES

On that file you can find a

- Raw material production
- Transport
- Production & Packaging
- Distribution
- Use and End of Life



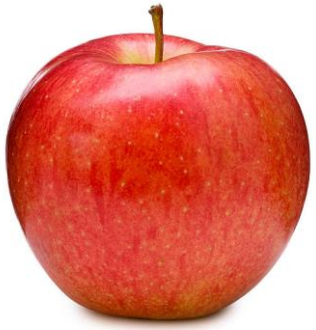
Life cycles of milk products

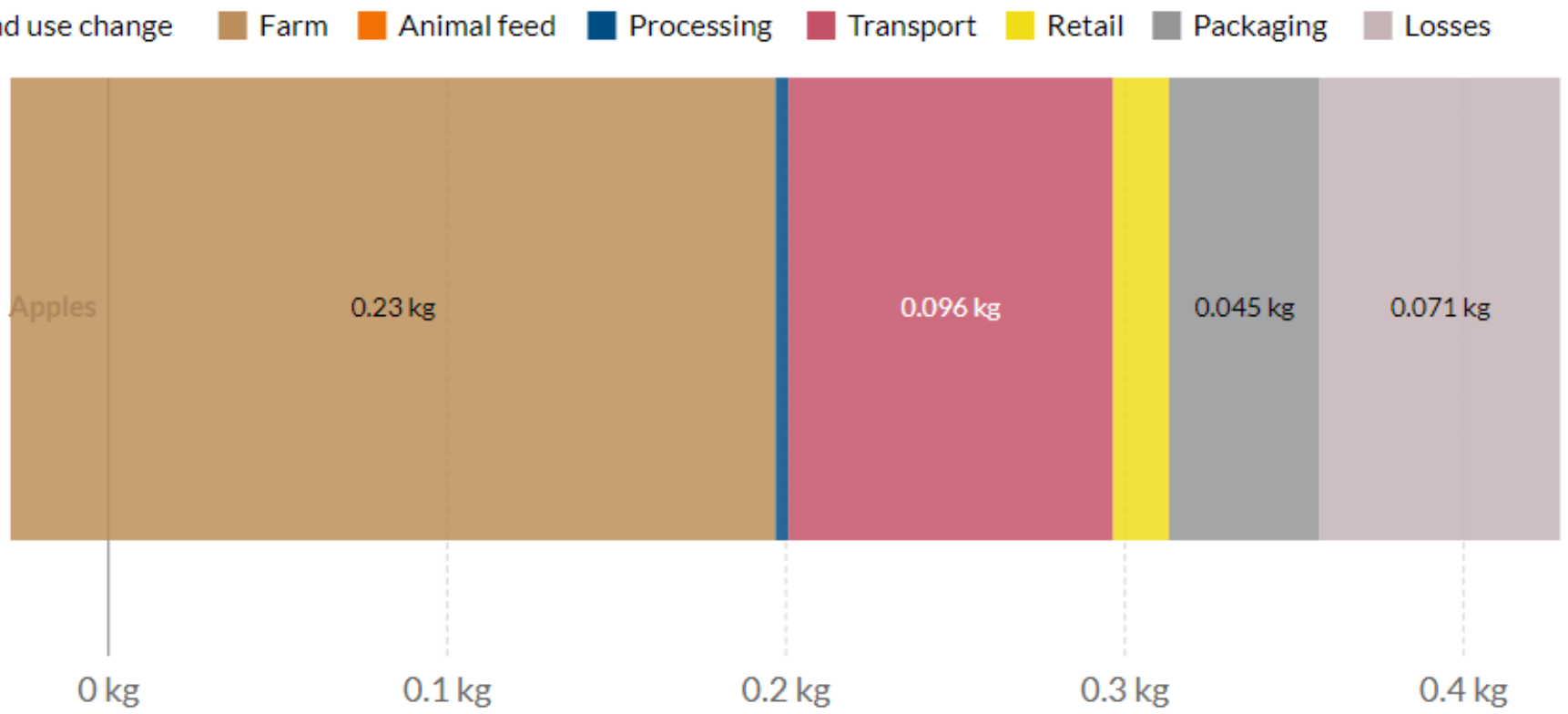


Dr. Meike Sauerwein
10. February 2023

DIFFERENT LIFE CYCLE HOTSPOTS

EXAMPLE: GREENHOUSE GAS EMISSIONS FROM APPLE LIFE CYCLES





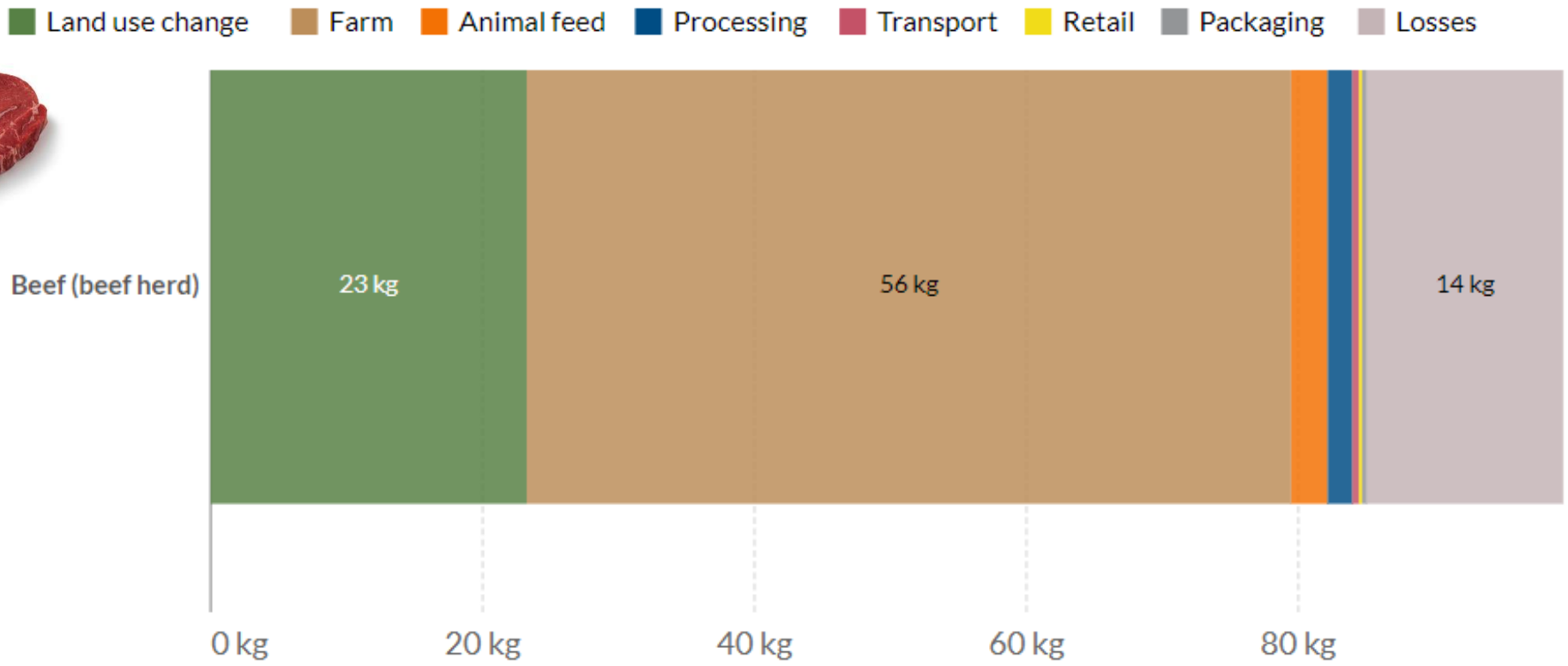
1kg apples
→ 0.43kg CO_2eq.

Source: Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. Science.
Note: Greenhouse gases are weighted by their global warming potential value (GWP100). GWP100 measures the relative warming impact of one molecule of a greenhouse gas, relative to carbon dioxide, over 100 years.
OurWorldInData.org/environmental-impacts-of-food • CC BY

Source: https://ourworldindata.org/grapher/food-emissions-supply-chain?country=~Apples

LIFE CYCLE HOTSPOTS

EXAMPLE: GREENHOUSE GAS EMISSIONS FROM BEEF LIFE CYCLES



Source: Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. Science.
Note: Greenhouse gases are weighted by their global warming potential value (GWP100). GWP100 measures the relative warming impact of one molecule of a greenhouse gas, relative to carbon dioxide, over 100 years.
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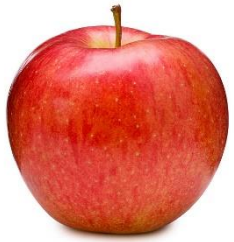
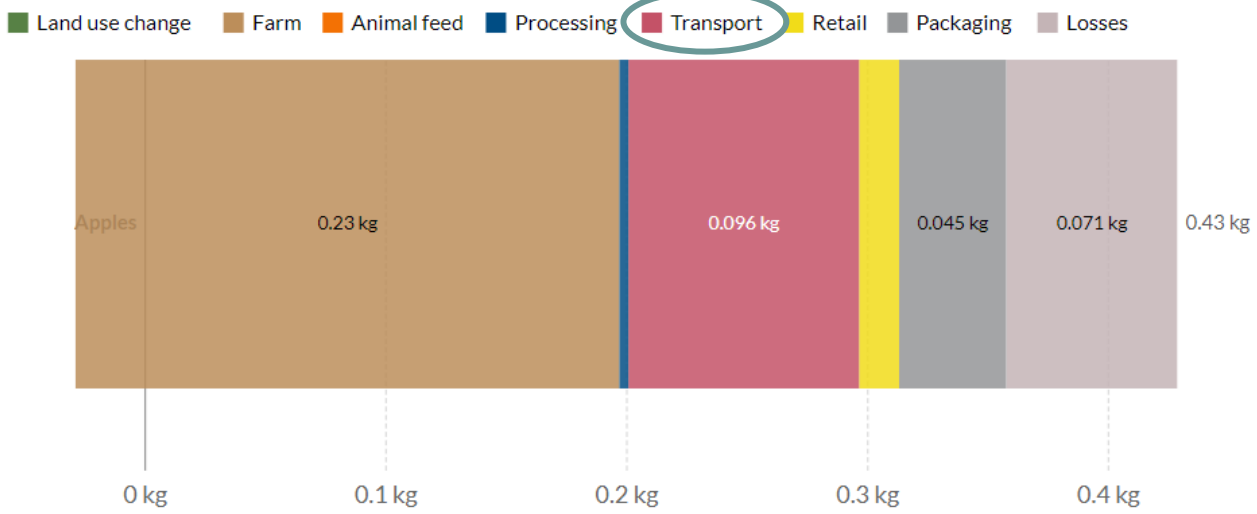
1kg beef
→ 99 kg CO_2eq.

Source: https://ourworldindata.org/grapher/food-emissions-supply-chain?country=~Apples

SIMILAR PRODUCTS - DIFFERENT LIFE CYCLE HOTSPOTS





Source: Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. Science.
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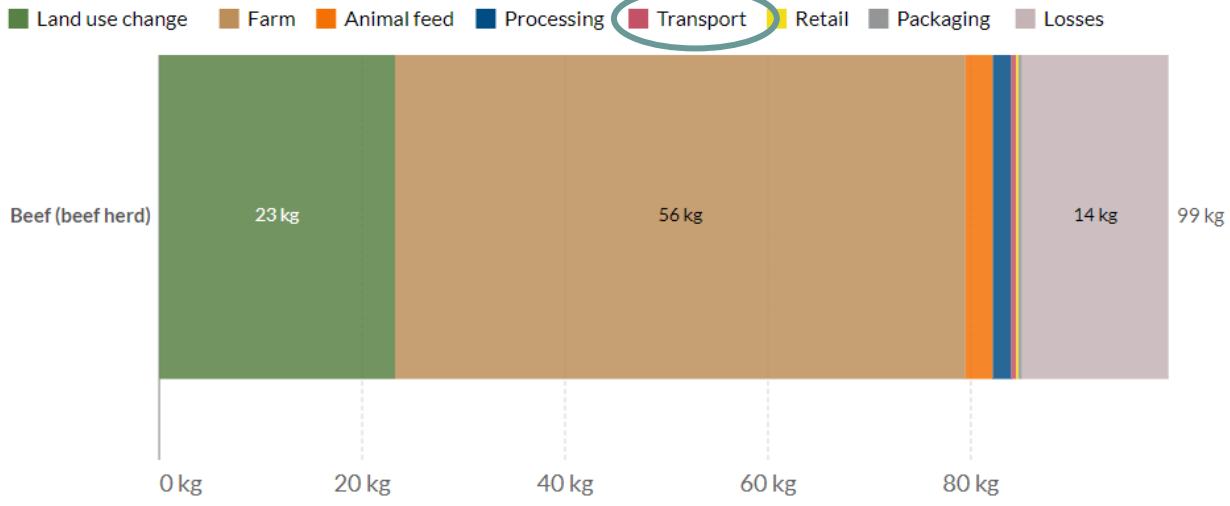

Source: Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. Science.
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OurWorldInData.org/environmental-impacts-of-food • CC BY

Source: https://ourworldindata.org/grapher/food-emissions-supply-chain?country=~Apples

LIFE CYCLE ASSESSMENT OF MILK

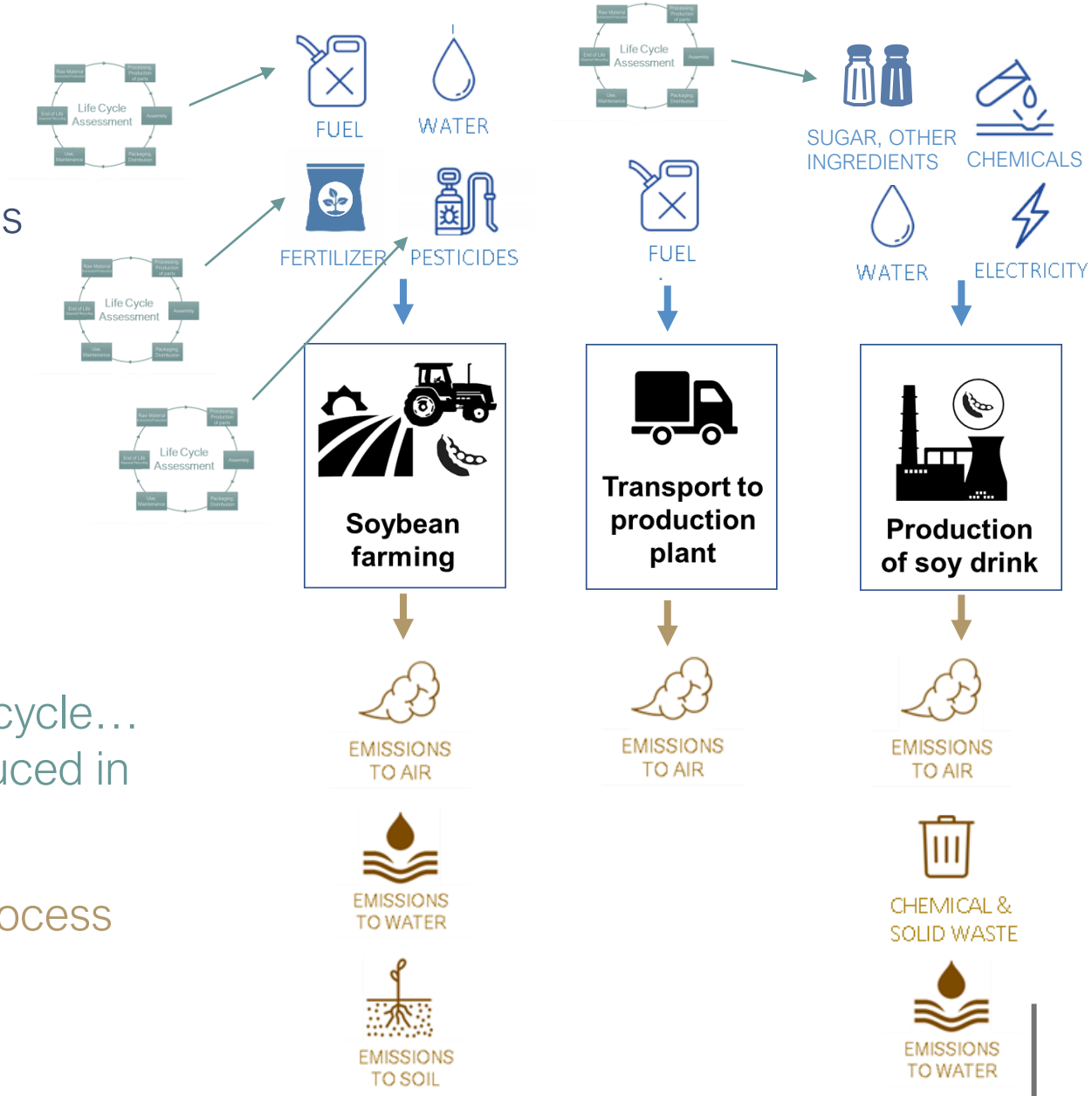
STEP BY STEP

1. What is the **function, how much of it do we want to compare,** and what type and **kind of material (ingredients) do we need to fulfil it**?
2. What are the **processes** involved in **each life cycle stage** of the product system(s)?
3. **Inventory** - What **resources** go into each stage? What amount?
   e.g., electricity, water, amounts of chemicals, etc.
4. **Inventory** - Which **emissions** are **released** at each stage? Amount?
   e.g., concentration of chemicals in wastewater & air, solid waste, etc.

DATA COLLECTION FOR RESOURCE & EMISSION INVENTORY

Collecting primary data for each process

- How much electricity
- How much fuel
- How much water
- …
- How much other products (e.g. pesticides, fertilizer, chemicals)



BUT WAIT… these also have a life cycle…

→What if the materials are all produced in different countries/ by different manufacturers?

→How do I know about all these process emissions?

LIFE CYCLE INVENTORY

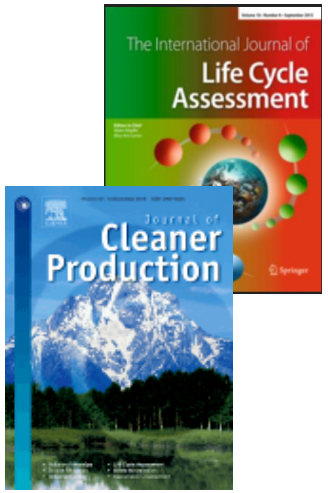
DATA SOURCES

Primary Data

- Process data
- Governmental statistics
- Surveys
- …

Secondary data (Background data)

- Life Cycle Databases
- Published LCA reports (academic literature or reports following ISO 14044)



LIFE CYCLE INVENTORY

DATABASES

- Ecoinvent
  - Around 18000 LCI datasets,
  - aggregated and disaggregated
- GaBi Professional
  - Over 2500 datasets, mostly aggregated
- European reference Life Cycle Database (ELCD)
  - Less than 200 datasets
- Chinese Life Cycle Database
  - About 600 LCI datasets for key materials, chemicals, energy systems, transport, and waste.
  - http://www.itke.com.cn
- Many others

LIFE CYCLE ASSESSMENT OF MILK

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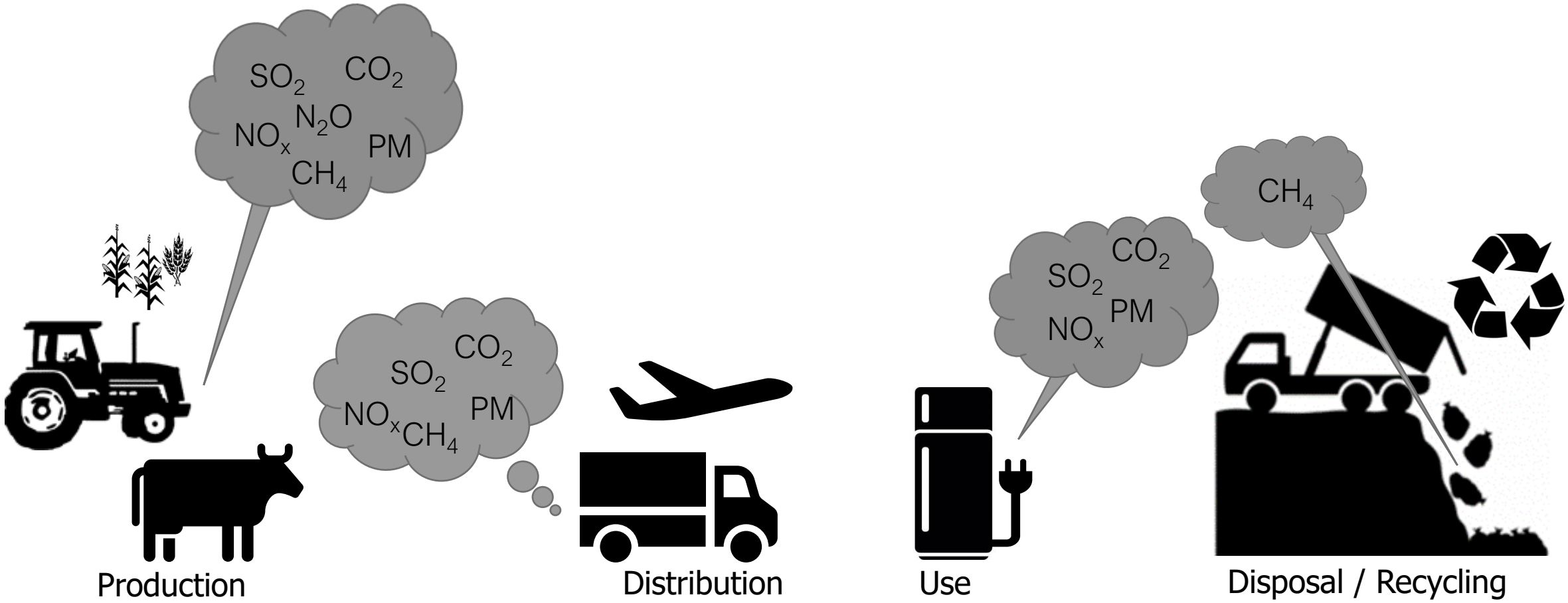
5. **Classifying** the **type of potential impact** (damage), a specific emission could cause in the environment

CLASSIFICATION INTO ENVIRONMENTAL CATEGORIES

CLASSIFYING THE TYPE OF POTENTIAL IMPACT (DAMAGE), A SPECIFIC EMISSION COULD CAUSE IN THE ENVIRONMENT



Source: ISO 14044

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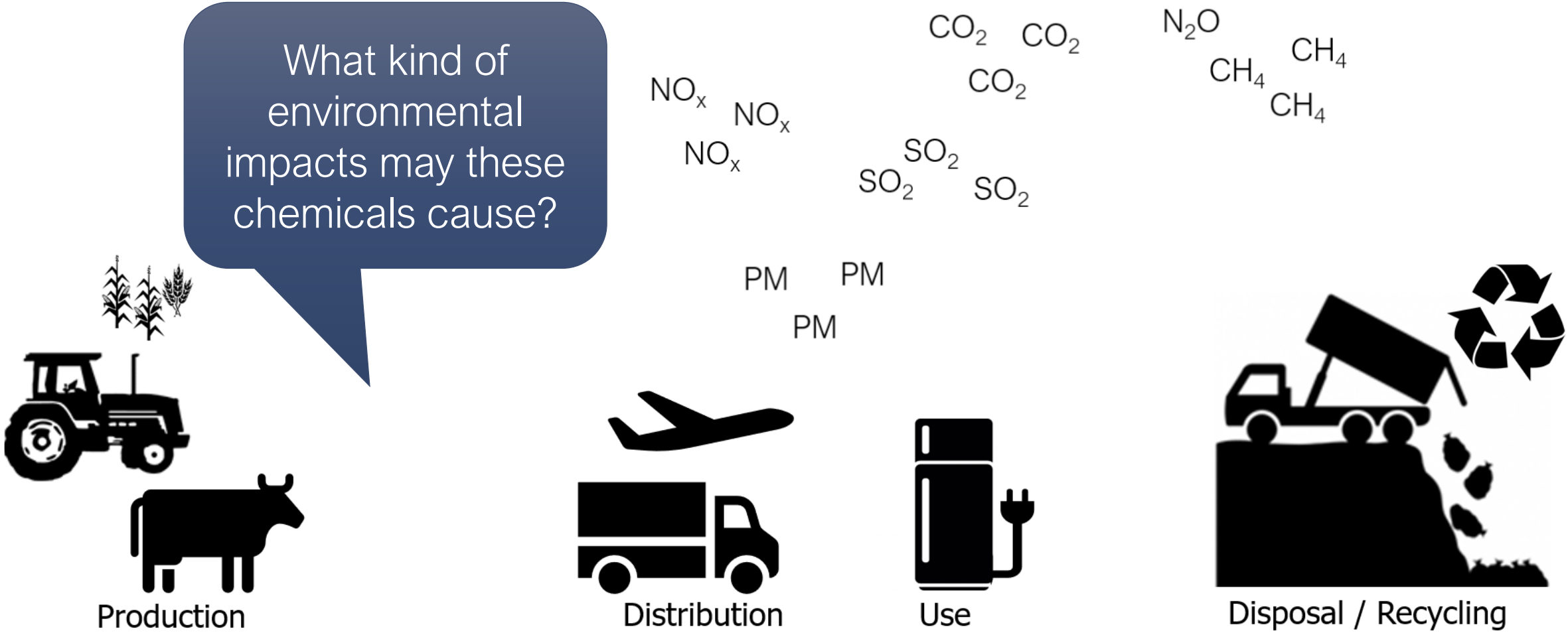
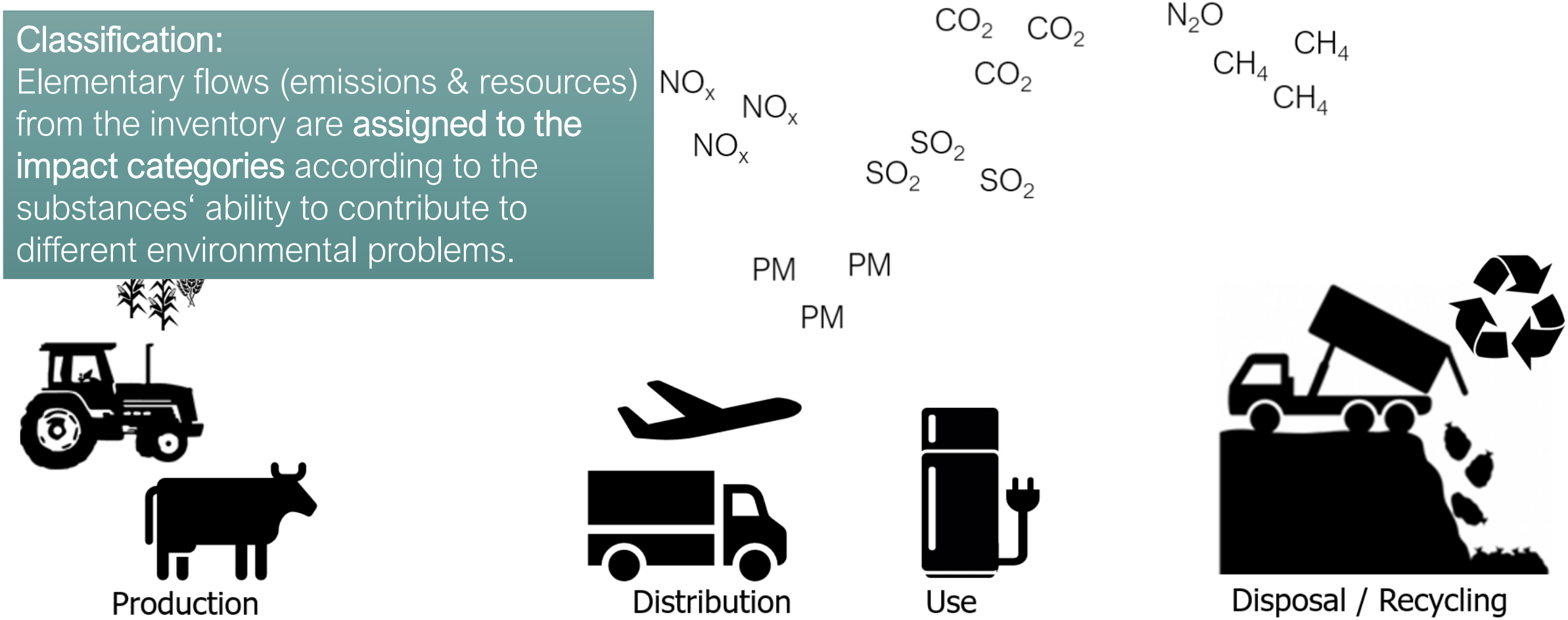


Source: ISO 14044

CLASSIFICATION INTO ENVIRONMENTAL CATEGORIES

CLASSIFYING THE TYPE OF POTENTIAL IMPACT (DAMAGE), A SPECIFIC EMISSION COULD CAUSE IN THE ENVIRONMENT

Classification:
Elementary flows (emissions & resources) from the inventory are **assigned to the impact categories** according to the substances‘ ability to contribute to different environmental problems.

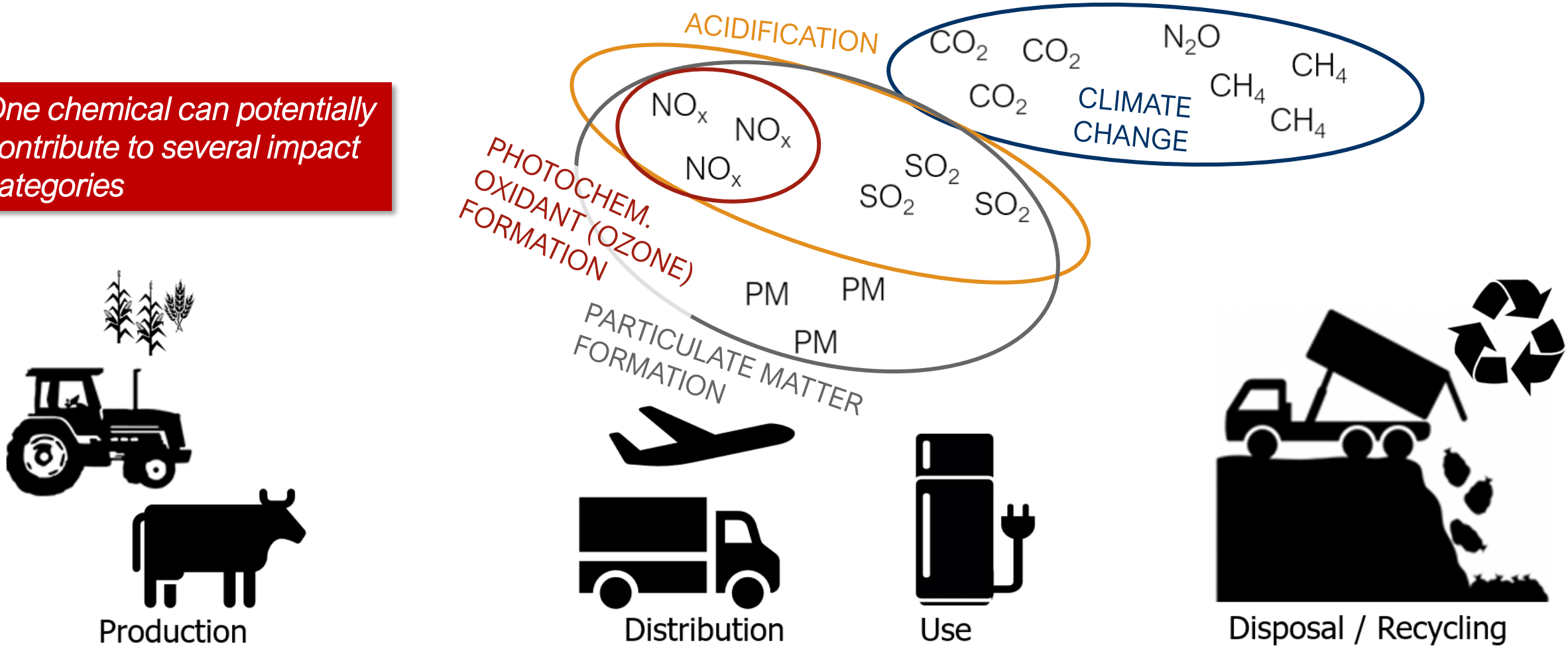


Source: ISO 14044

CLASSIFICATION INTO ENVIRONMENTAL CATEGORIES

CLASSIFYING THE TYPE OF POTENTIAL IMPACT (DAMAGE), A SPECIFIC EMISSION COULD CAUSE IN THE ENVIRONMENT

One chemical can potentially contribute to several impact categories



Source: ISO 14044

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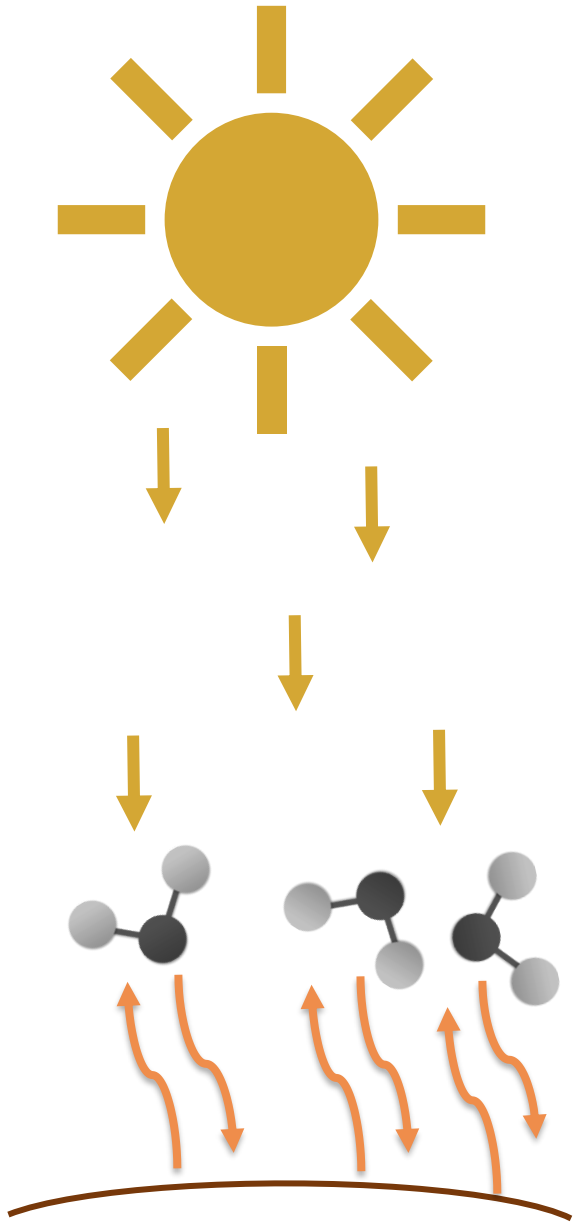
   e.g., concentration of chemicals in wastewater & air, solid waste, etc.
5. **Classifying** the **type of potential impact** (damage), a specific emission could cause in the environment
6. **Characterizing** (quantifying) environmental Impacts

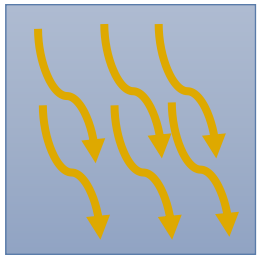
GLOBAL WARMING

- Greenhouse gasses can absorb & re-emit ‘heat’
- Molecules vibrate but don’t break → can repeat the same process over and over again

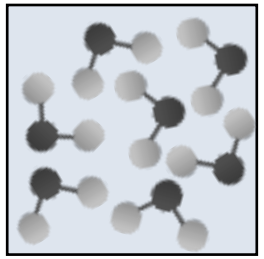


CHARACTERISTICS OF GREENHOUSE GASES

Long atmospheric Lifetime
The longer the gas persists, the more it can absorb and reemit heat



Strong absorption
(The more energy the molecule absorbs, the more effective it will be in warming.)



High gas concentration in the atmosphere

Global warming potential
Measure of how much energy the emissions of 1 kg a gas will absorb over a given period of time, relative to the emissions of 1 kg carbon dioxide (CO_2).

		GWP time horizon		
Gas	Lifetime, yr	20 yr	100 yr	500 yr
Carbon Dioxide, CO_2	~100	1	1	1
Methane, CH_4	12	72	25	7.6
Nitrous Oxide, N_2O	114	289	298	153
CFC-12, CCl_2F_2	100	11,000	10,900	5,200
HFC-23, CHF_3	270	12,000	14,800	12,200
HFC-134a, CH_2FCF_3	14	3,830	1,430	435
Sulfur Hexafluoride, SF_6	3,200	16,300	22,800	32,600

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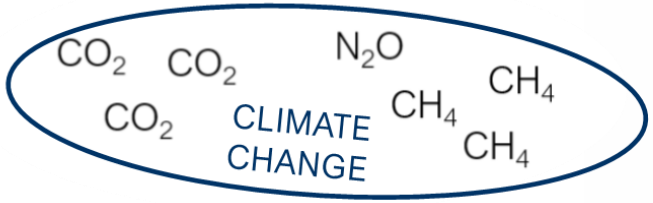
10. February 2023

Sources: https://www.acs.org/content/acs/en/climatescience/greenhousegases/properties.html
https://www.epa.gov/ghgemissions/understanding-global-warming-potentials; IPCC Report ARS5-Chapter 8

CHARACTERIZATION – QUANTIFYING THE POTENTIAL IMPACT OF A GROUP OF CHEMICALS

Example: Greenhouse Gas Emissions

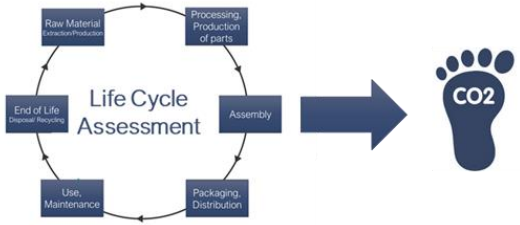


Characterization: Calculating how strongly a certain chemical contributes to the potential environmental damage.

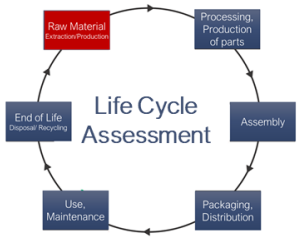
Inventory Value	*	Characterization factor (Climate Change)	=	Impact Potential
25 kg CO_2	*	1	=	25 [kg CO_2-Equivalent]
2 kg CH_4	*	25	=	50 [kg CO_2-Equivalent]
…	*	…	=	…
			Total:	75 [kg CO_2-Equivalent]

1 kg CH_4 is equivalent to the impact of 25 kg CO_2

MILK – CARBON FOOTPRINT - RESULTS



- **Which milk** causes the least greenhouse gas emissions (has the **lower carbon footprint**)?



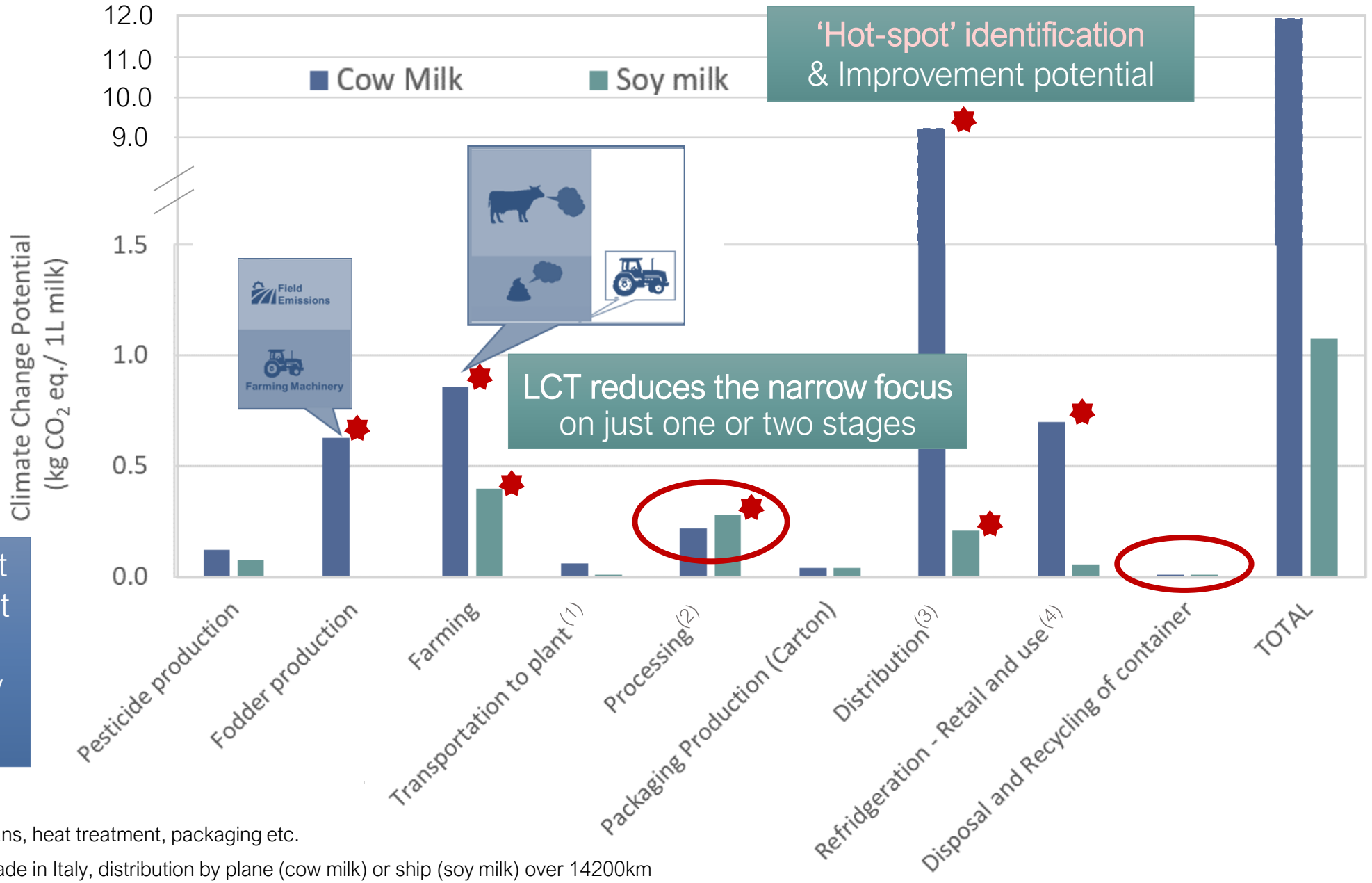
Hot Spot:
Process that causes significant impacts

- What are the **hotspots** in the **different milk life cycles**?

Cow Milk

Soy Milk

Greenhouse gas emissions from1L of milk



Hot Spot:
Process that causes significant impacts

Impacts from different products and different life cycle processes can differ significantly
e.g., distribution (plane vs ship, packaging carton vs glass)

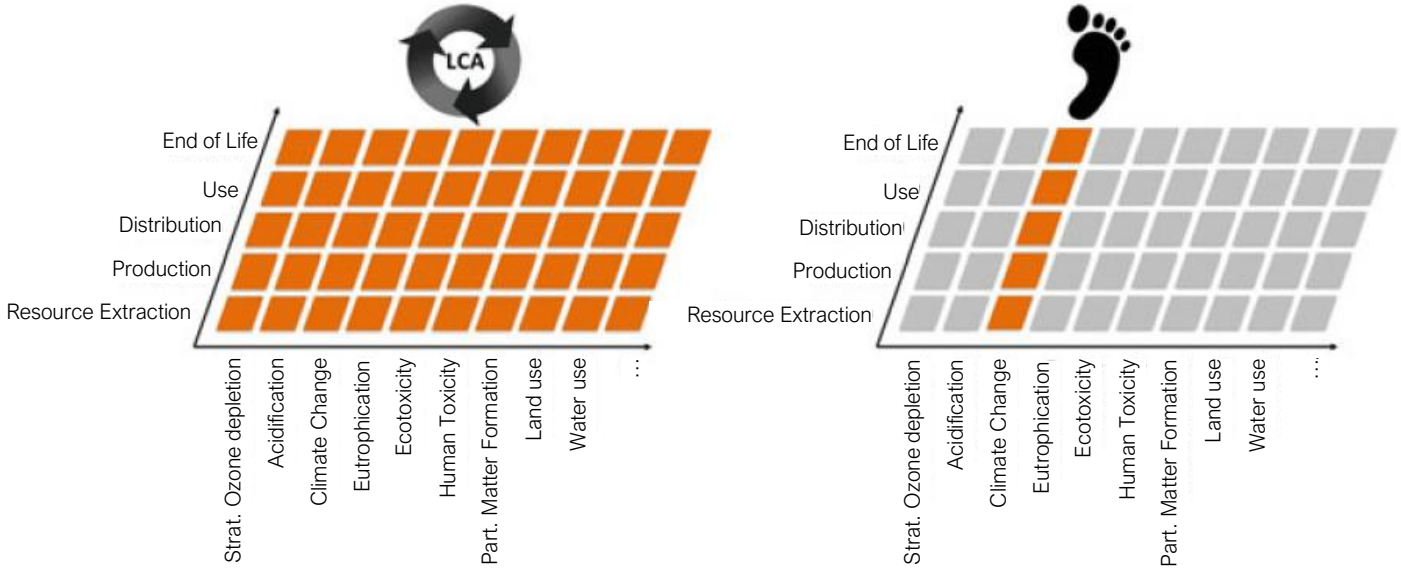
(1) Truck 100km

(2) Production incl milling of soy beans, heat treatment, packaging etc.

(3) Both milks are assumed to be made in Italy, distribution by plane (cow milk) or ship (soy milk) over 14200km

(4) Storage: Fridge for 13 days for cow milk, 1 day for soy milk (cooled after opening)

BUT LIFE CYCLE ASSESSMENT IS NOT ONLY ABOUT CO_2 & GREENHOUSE GAS EMISSIONS

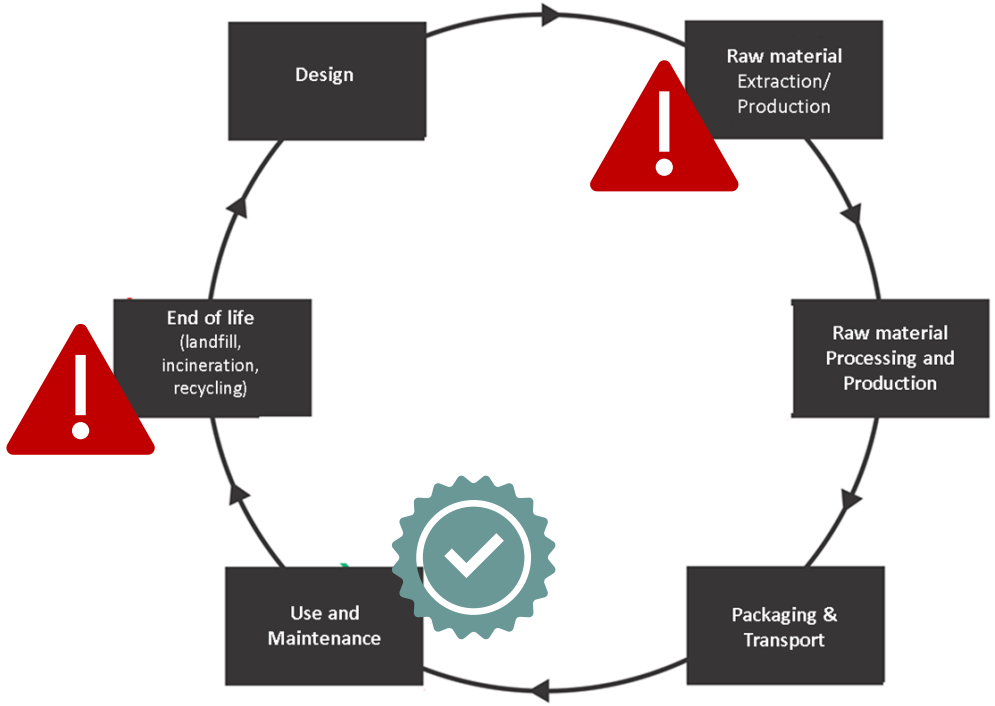


- LCA is a tool at allows quantification of a variety of different environmental categories
- This can help to **avoid burden-shifting** from one category to another, *e.g., making reductions in carbon footprint but increasing toxicity impacts*

Source: Hauschild et al. 2018: Life Cycle Assessment

LCA - HOTSPOTS & TRADE-OFFS

Improvements in one life cycle stage or one environmental category may worsen the impacts in another life cycle stage or environmental category.



Source: Hauschild et al. 2018: Life Cycle Assessment

LCA - TRADE-OFFS

Improvements in one life cycle stage or one environmental category may worsen the impacts in another life cycle stage or environmental category

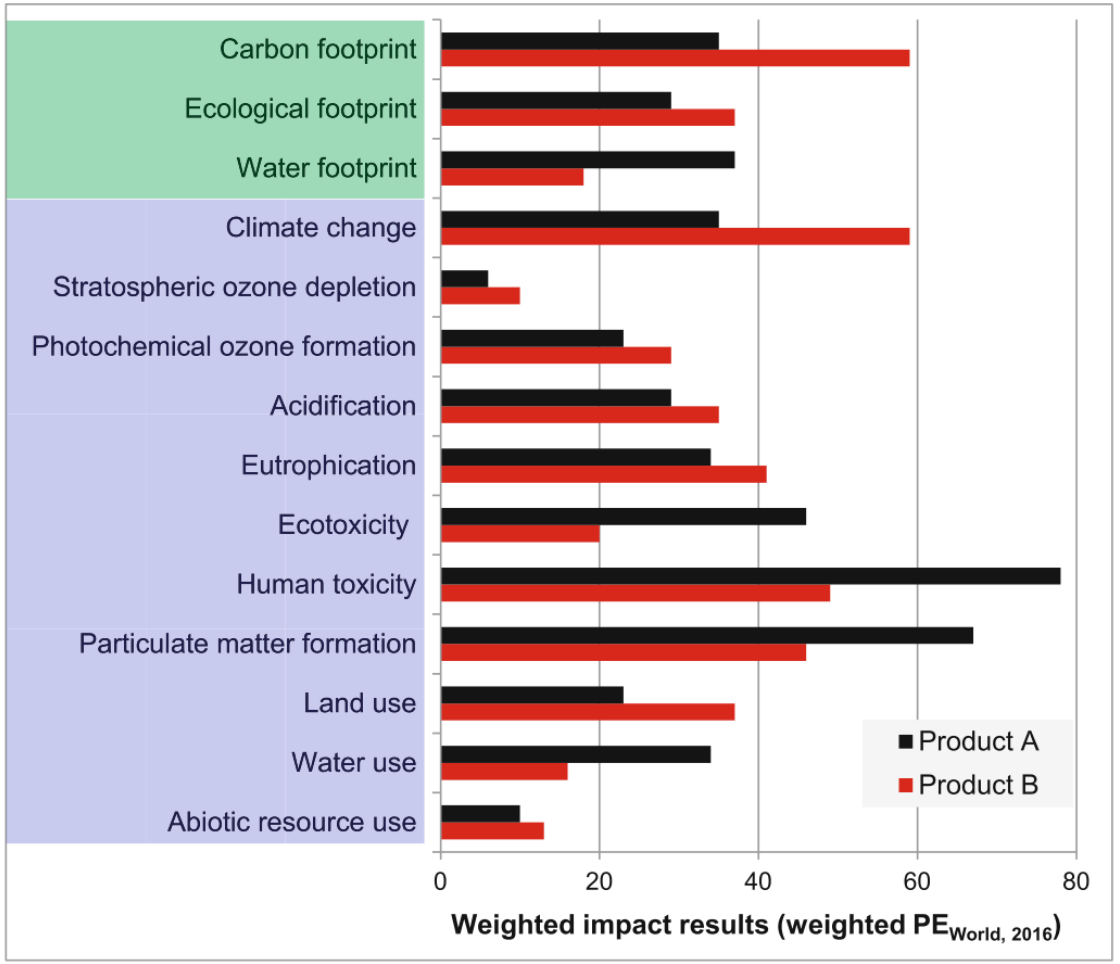
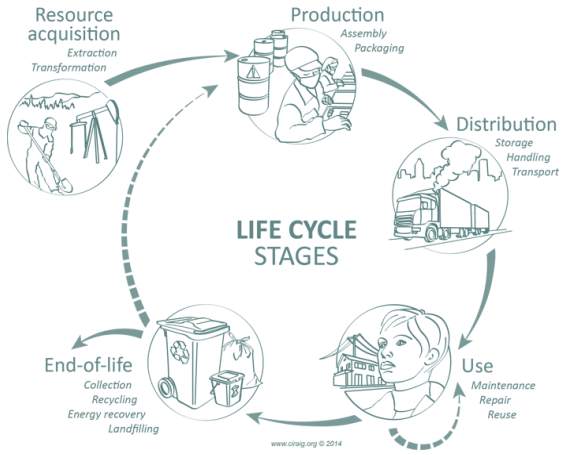


Fig. 10.5 Comparing two products, which alternative would you choose? Examples of footprints are indicated in *green shading*; impact categories commonly assessed in LCA are indicated in *blue shading*

Source: Hauschild et al. 2018: Life Cycle Assessment

Key Takeaways Life Cycle Thinking

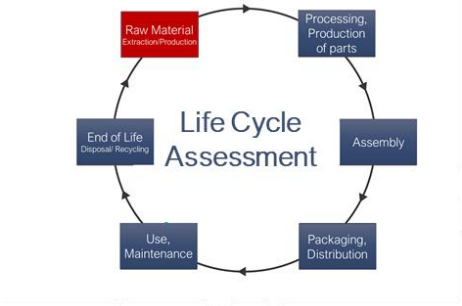


Life Cycle Thinking

- **considers environmental impacts** (Life Cycle Assessment) and cost (Life Cycle Costing) & **at all life cycle stages**
- **reduces the narrow focus** on just one or two stages
- indicates how **changes in one life cycle stage affect** the resource use and emissions from **other life cycle stages.**

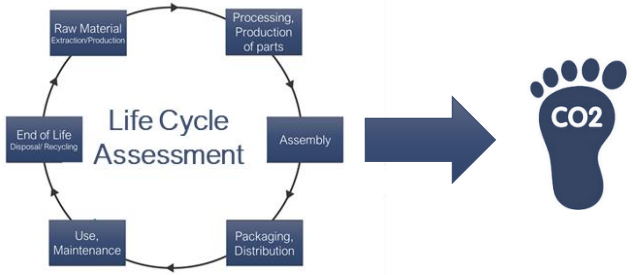
Key Takeaways Life Cycle Assessment

1. Identify HOT SPOTS within a product's life cycle

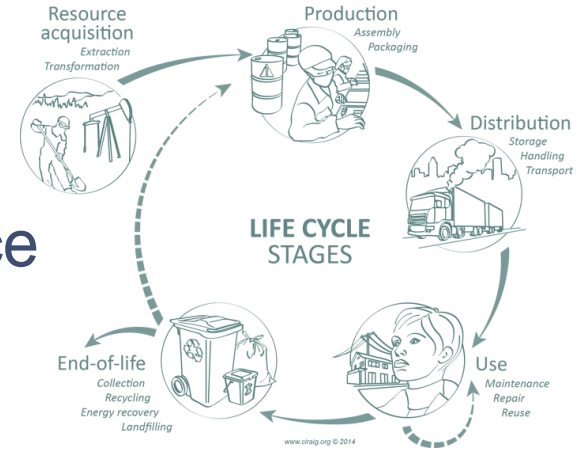


Hot Spot:
Process that causes significant impacts

2. Identify TOTAL IMPACTS that occur along a product's life cycle (eco-footprint of a product)



Key Takeaways Life Cycle Assessment



Life Cycle Assessment

- reveals the **full picture of a product's environmental performance** & allows a quantitative **comparison of products** & judgement about **product sustainability**
- helps to identify
  - **where excessive resource used** & excessive **emissions /waste** created
  - material/processes/product options **with lower environmental impacts**
- Is a **commonly used tool to quantify environmental impacts** along the life cycle, applied in various areas incl. product design, manufacturing and environmental labelling, marketing, etc.

PART 2

OUTLINE

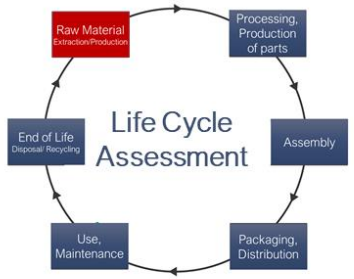
PART 2

- Life Cycle Assessment Methodology
  - Recap and linkage to key frameworks and ISO standards
  - How are LCA results commonly displayed?
  - Discuss benefits and limitations of LCA
- Life Cycle Assessment Tools & Applications
  - Examples of common uses of LCA
  - Using LCA results – what to pay attention to?
- Life Cycle Costing
  - Basic concepts

LIFE CYCLE ASSESSMENT

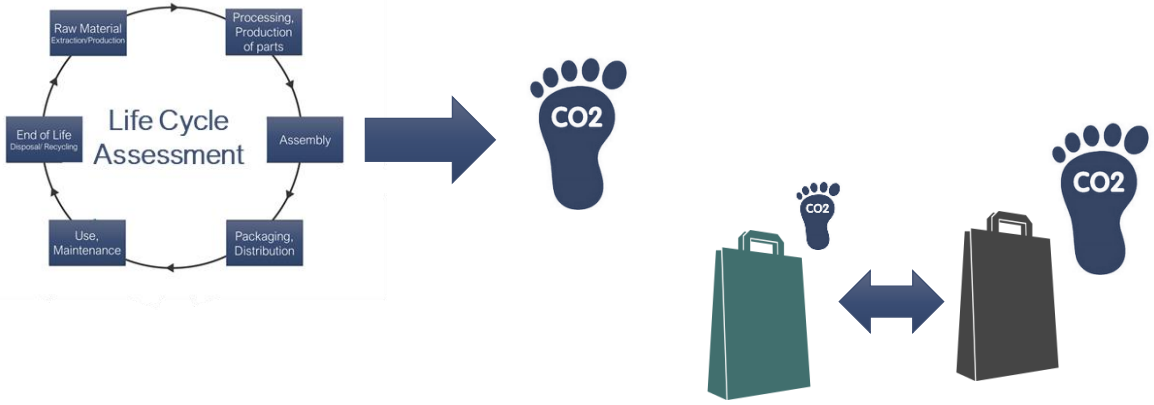
QUANTIFICATION OF ENVIRONMENTAL IMPACTS ALONG THE LIFE CYCLE

1. IDENTIFY HOT SPOTS WITHIN A PRODUCT'S LIFE CYCLE



Hot Spot:
Process that causes significant impacts

2. IDENTIFY TOTAL IMPACTS THAT OCCUR ALONG A PRODUCT'S LIFE CYCLE (ECO-FOOTPRINT OF A PRODUCT)



THE FIRST LCA

1969

RE-USEABLE GLASS BOTTLE

VS

DISPOSABLE PLASTIC BOTTLE

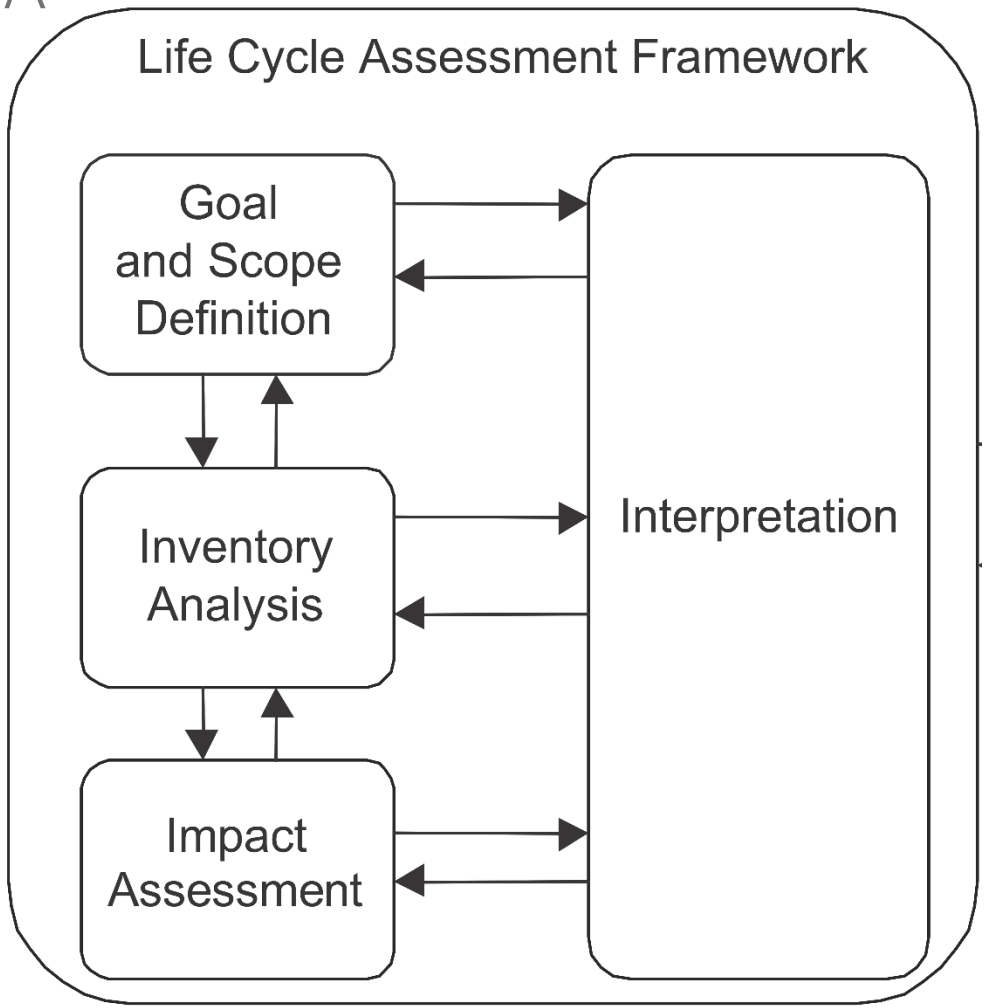
End of Life

Material choice

Hunt et al. (1996) : LCA — How it came about — Personal reflections on the origin and the development of LCA in the USA, Intern. Journal of Life Cycle Assessment

LCA - METHODOLOGICAL FRAMEWORK

THE FOUR PHASES OF LCA

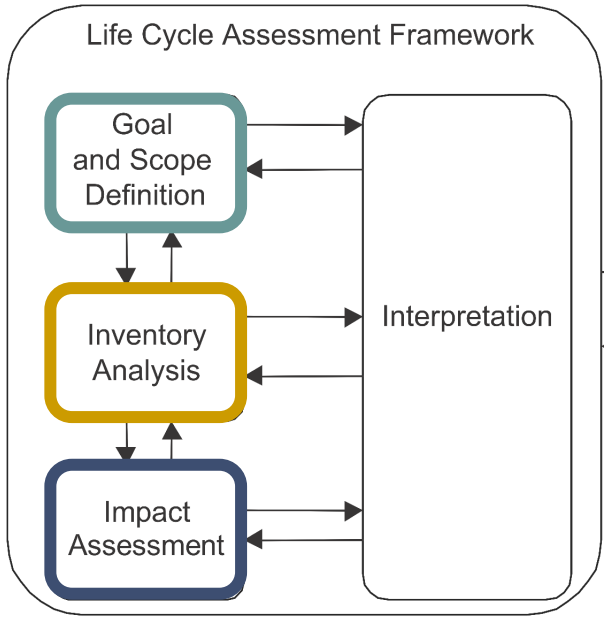


Source: ISO 14040:2006 & ISO 14044:2006

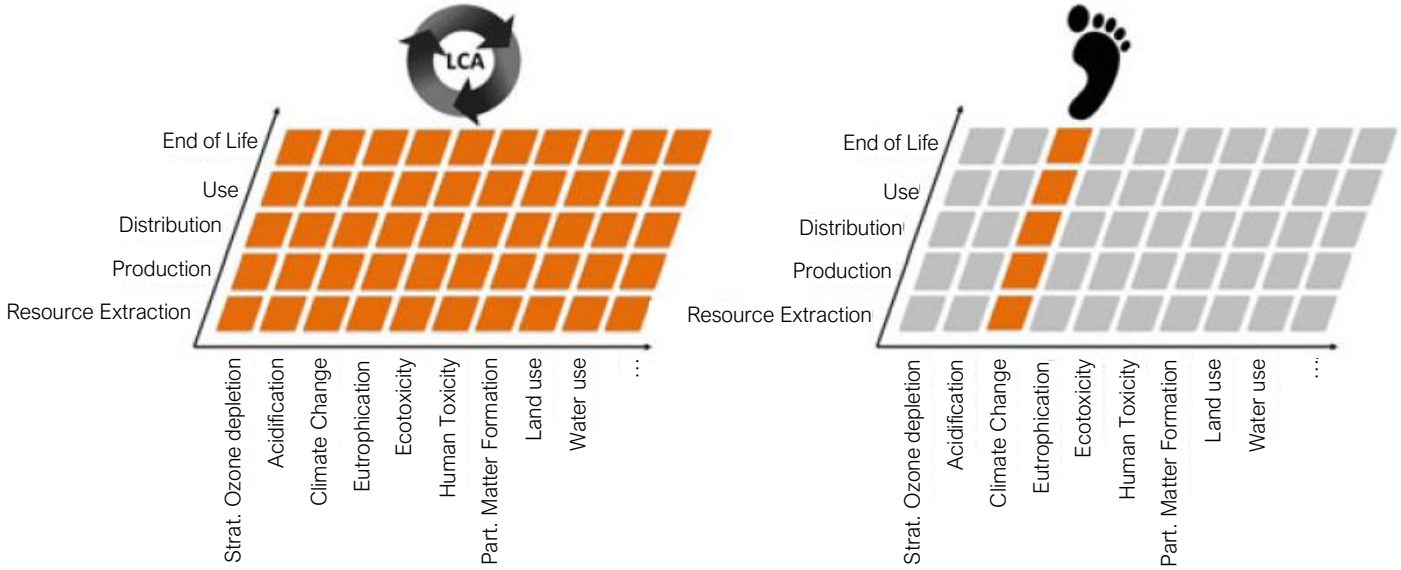
LIFE CYCLE ASSESSMENT OF MILK

STEP BY STEP

1. What is the **function, how much of it do we want to compare,** and what type and **kind of material (ingredients) do we need to fulfil it**?
2. What are the **processes** involved in **each life cycle stage** of the product system(s)?
3. **Inventory** - What **resources** go into each stage? What amount?
   e.g., electricity, water, amounts of chemicals, etc.
4. **Inventory** - Which **emissions** are **released** at each stage? Amount?
   e.g., concentration of chemicals in wastewater & air, solid waste, etc.
5. **Classifying** the **type of potential impact** (damage), a specific emission could cause in the environment
6. **Characterizing** (quantifying) environmental Impacts



BUT LIFE CYCLE ASSESSMENT VS. CARBON FOOTPRINT



- LCA is a tool at allows quantification of a variety of different environmental categories including carbon footprinting

Source: Hauschild et al. 2018: Life Cycle Assessment

LIFE CYCLE IMPACT ASSESSMENT CATEGORIES

Despite the importance of global warming due to greenhouse gas emissions
- keep in mind that these are not the only impacts

Greenhouse Effect

Ozone Depletion

Particulate Matter, Smog

Acid Rain & Soil acidification

Human-Toxicity

Ecotoxicity

Eutrophication

Impacts from EMISSIONS

Land use

Minerals, Fossil fuel depletion

Fresh water depletion

RESOURCE Depletion

LIFE CYCLE IMPACT ASSESSMENT CATEGORIES

Table 1. Selected LCIA methods and impact categories. Metrics of impact categories are shown for each LCIA method.

LCIA Methods	CML	EDIP	EF	EPD	ILCD	IMPACT	ReCiPe	TRACI
Global warming	kg CO_2 eq	kg CO_2 eq	kg CO_2 eq	kg CO_2 eq	kg CO_2 eq	kg CO_2 eq	kg CO_2 eq	kg CO_2 eq
Acidification	kg SO_2 eq	m^2	mol H+ eq	kg SO_2 eq	mol H^+ eq	kg SO_2 eq	kg SO_2 eq	kg SO_2 eq
Ozone depletion	kg CFC-11 eq	kg CFC-11 eq	kg CFC-11 eq	kg CFC-11 eq	kg CFC-11 eq	kg CFC-11 eq	kg CFC-11 eq	kg CFC-11 eq
Eutrophication	kg PO_4 eq	kg P	kg P eq	kg PO_4 eq	kg P eq	kg PO_4 P-lim	kg P eq	kg N eq
Energy consumption	MJ		MJ	MJ		MJ primary	kg oil eq	MJ surplus
Resource	kg Sb eq	PR2004	kg Sb eq	kg Sb eq	kg Sb eq		kg Cu eq	
Smog	kg C_2H_4 eq	per.ppm.h	kg NMVOC eq	kg NMVOC	kg NMVOC eq	kg C_2H_4 eq	kg NO_x eq	kg O_3 eq
Water depletion			m^3 depriv.	m^3 eq	m^3 water eq		m^3	
Human toxicity (Cancer)	kg 1,4-DB eq	person	CTUh		CTUh	kg C_2H_3Cl eq	kg 1,4-DCB	CTUh
Particulate matter			disease inc.		kg PM2.5 eq	kg PM2.5 eq	kg PM2.5 eq	kg PM2.5 eq
Ecotoxicity (Freshwater)	kg 1,4-DB eq	m^3	CTUe		CTUe	kg TEG water	kg 1,4-DCB	CTUe
Land use			Pt		kg C deficit	m^2org.arable	m^2a crop eq	

Source: Dong et al. 2021: Developing Conversion Factors of LCIA Methods for Comparison of LCA Results in the Construction Sector, *Sustainability*

ACTIVITY
Interpreting LCA results

In pairs

10 min

Feel free to take notes on handout

LCA RESULTS

- How many materials are compared?
- Scope?
- Which life cycle stages?
- Which environmental categories?
- What unit?
- Which one is the best/worst?

Figure 9: GWP per each life cycle stage

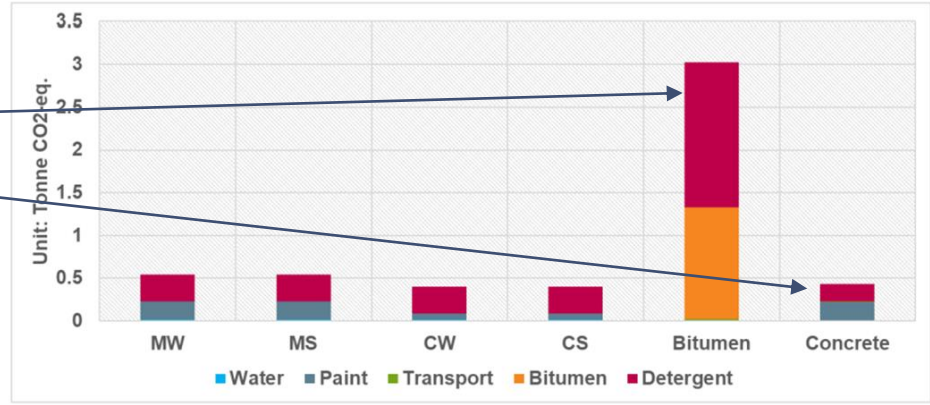


Figure 10: Breakdown of GWP for the maintenance phase only

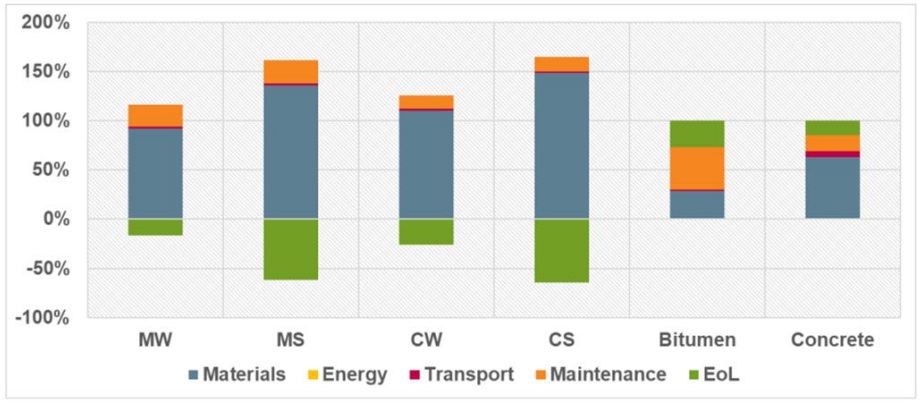


Figure 11: Cradle to grave GWP contribution per category

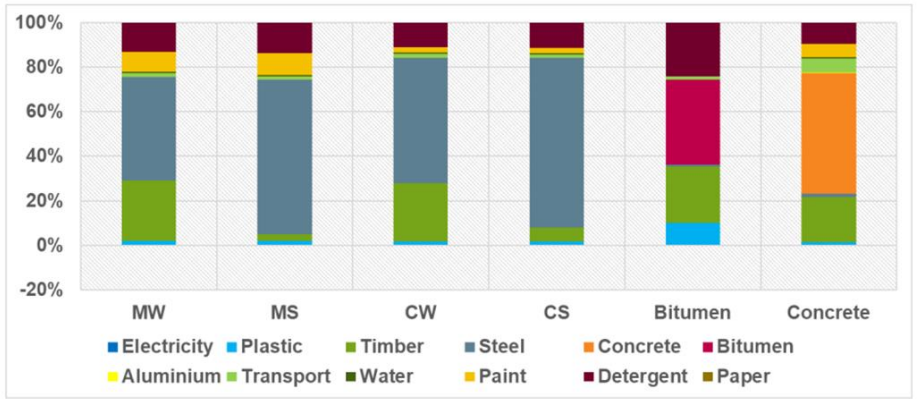


Figure 12: Cradle to grave GWP contribution per material

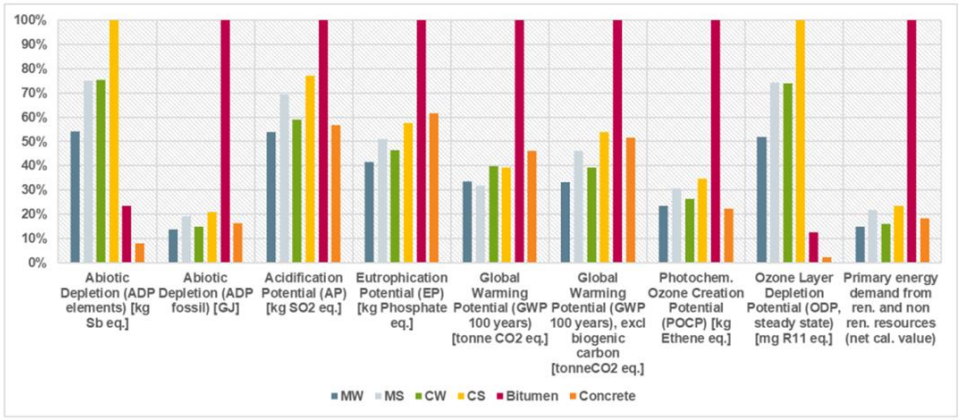
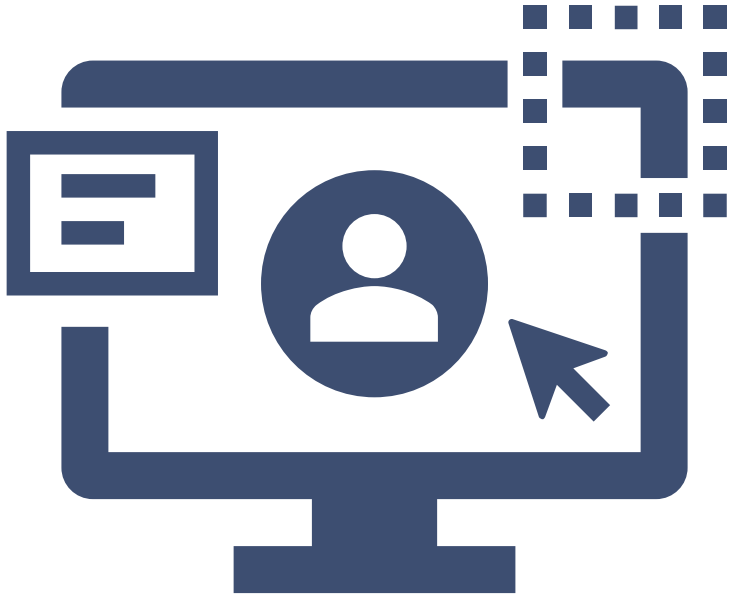


Figure 8: Cradle to grave environmental impacts for each roof design

- MW = Monterrey steel solution with wood batten
- MS = Monterrey steel solution with steel batten
- CW = Classic steel solution with wood batten
- CS = Classic steel solution with steel batten.

Source: https://worldsteel.org/wp-content/uploads/Life-cycle-assessment-Environmental-assessment-of-roofing-systems.pdf

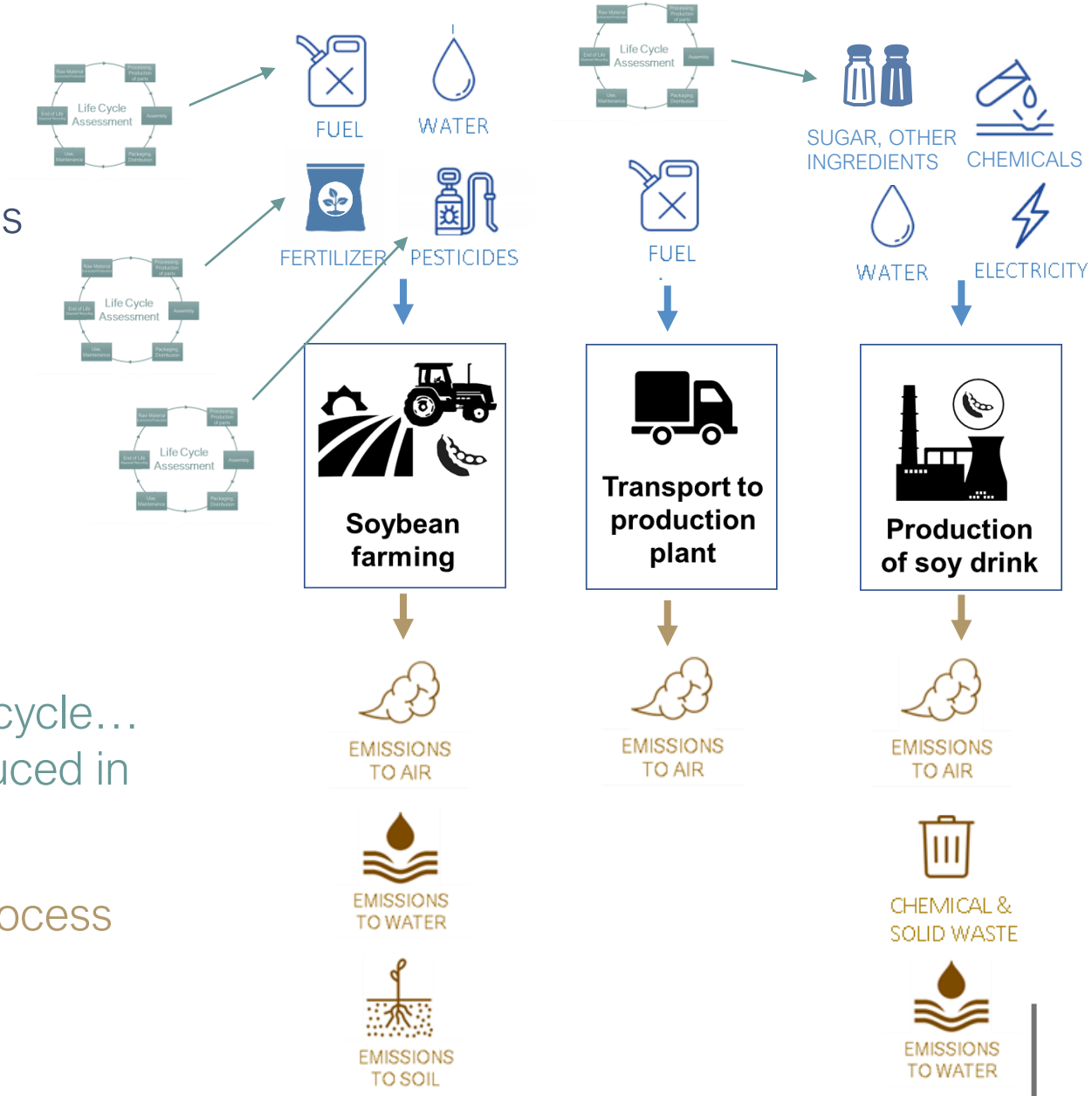
LCA -TOOLS



DATA COLLECTION FOR RESOURCE & EMISSION INVENTORY

Collecting primary data for each process

- How much electricity
- How much fuel
- How much water
- …
- How much other products (e.g. pesticides, fertilizer, chemicals)



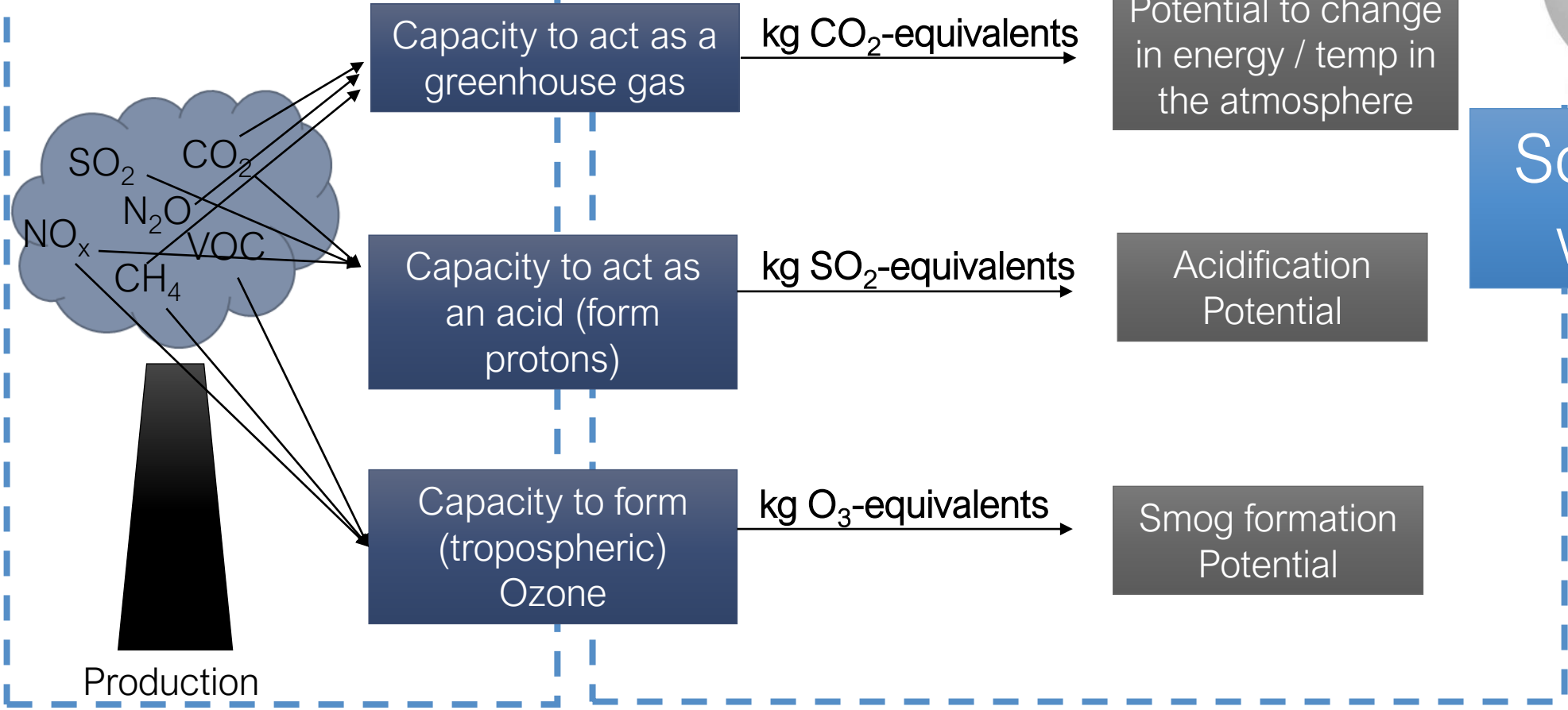
BUT WAIT… these also have a life cycle…

→What if the materials are all produced in different countries/ by different manufacturers?

→How do I know about all these process emissions?

CLASSIFICATION & CHARACTERIZATION OF POTENTIAL ENVIRONMENTAL IMPACTS

So much work?



Related reference: eplca.jrc.ec.europa.eu/uploads/ILCD-Handbook-LCIA-Background-analysis-online-12March2010.pdf

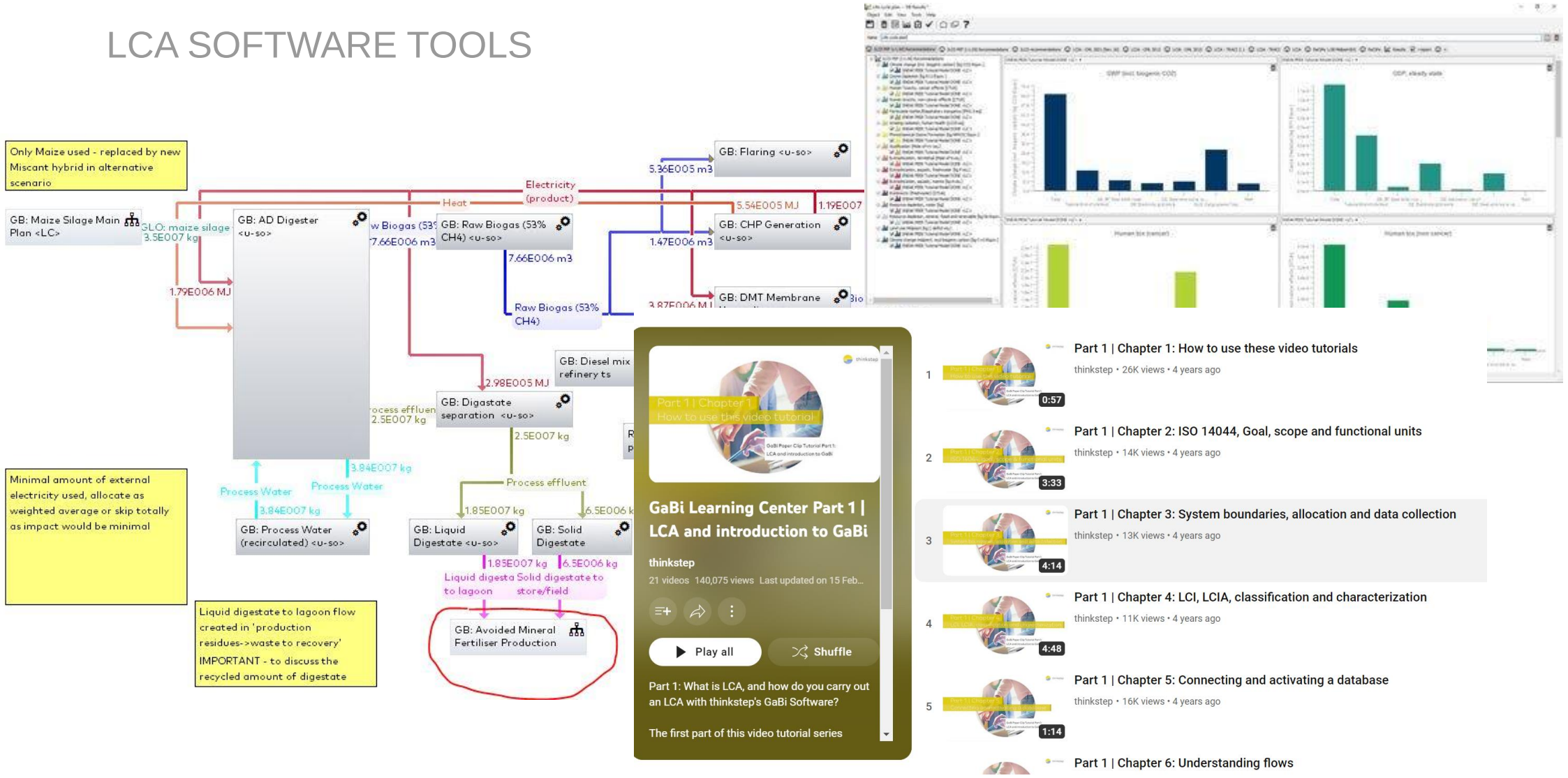
WHAT ARE COMMON LCA TOOLS?

LCA SOFTWARE TOOLS

- SimaPro
  - Most widely adopted; produced by Pre Consultants (Netherlands)
  - Comes preloaded with many databases
  - Can model whole product systems using aggregated or disaggregated datasets
- GaBi
  - Very popular LCA software produced by Sphera
  - Comes with GaBi database and other databases can be purchased
- Open LCA
  - Open source software produced by Green Delta (German Consultancy)
- Other include Umberto, Quantis Suite, Brightway2, etc.

GABI (SPHERE)

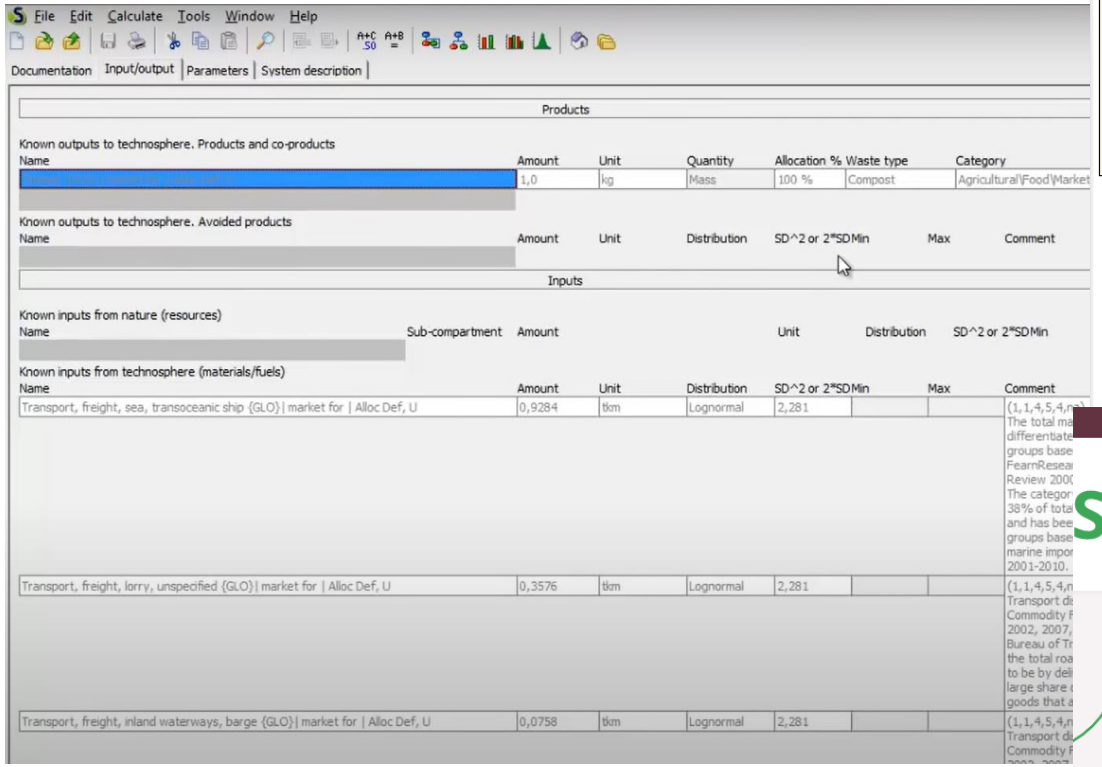
LCA SOFTWARE TOOLS

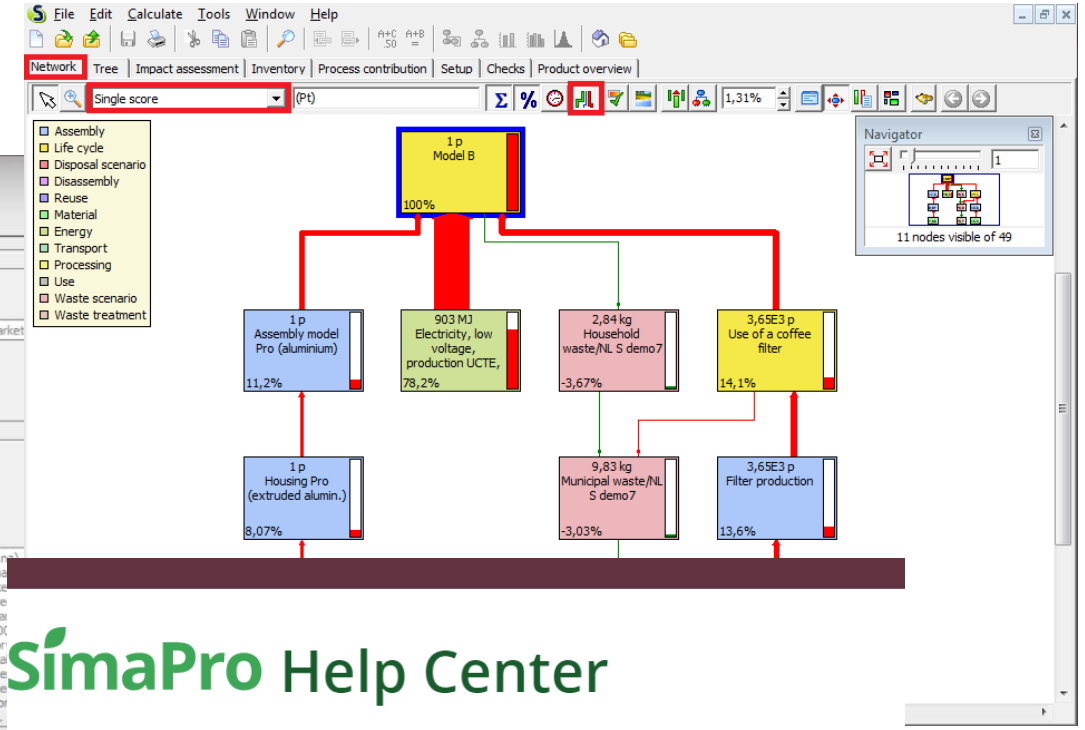


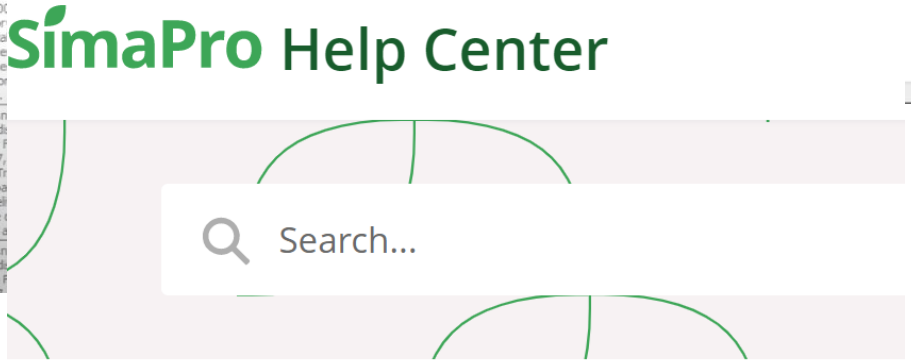
Source: Research Gate Blog Post – 2020

SIMAPRO (PRE-CONSULTING)

LCA SOFTWARE TOOLS







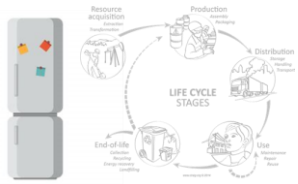
SimaPro Tutorial

LIFE CYCLE ASSESSMENT (LCA) & TOOLS

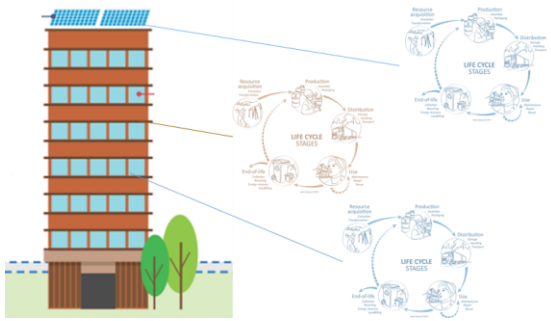
Product LCA ⟷ Building LCA

Life Cycle Stages

Raw material Production | Ingredient/Material Processing + Production | Packaging & Transport | Use | End of Life



- Single product-system, based on one or more materials



- Compilation of product-systems

Software

openLCA | SimaPro | thinkstep GaBi

- Calculation of Product Impacts → publish as LCA report

CIC Carbon Assessment Tool 建造業議會碳評估工具 | One Click LCA | EC3 Embodied Carbon in Construction Calculator (EC3) tool | Athena Sustainable Materials Institute

- Calculation of Building Impacts based on many product LCAs results consolidated in a database

COMPARISON OF BUILDING LCA TOOLS

Embodied Carbon Calculators

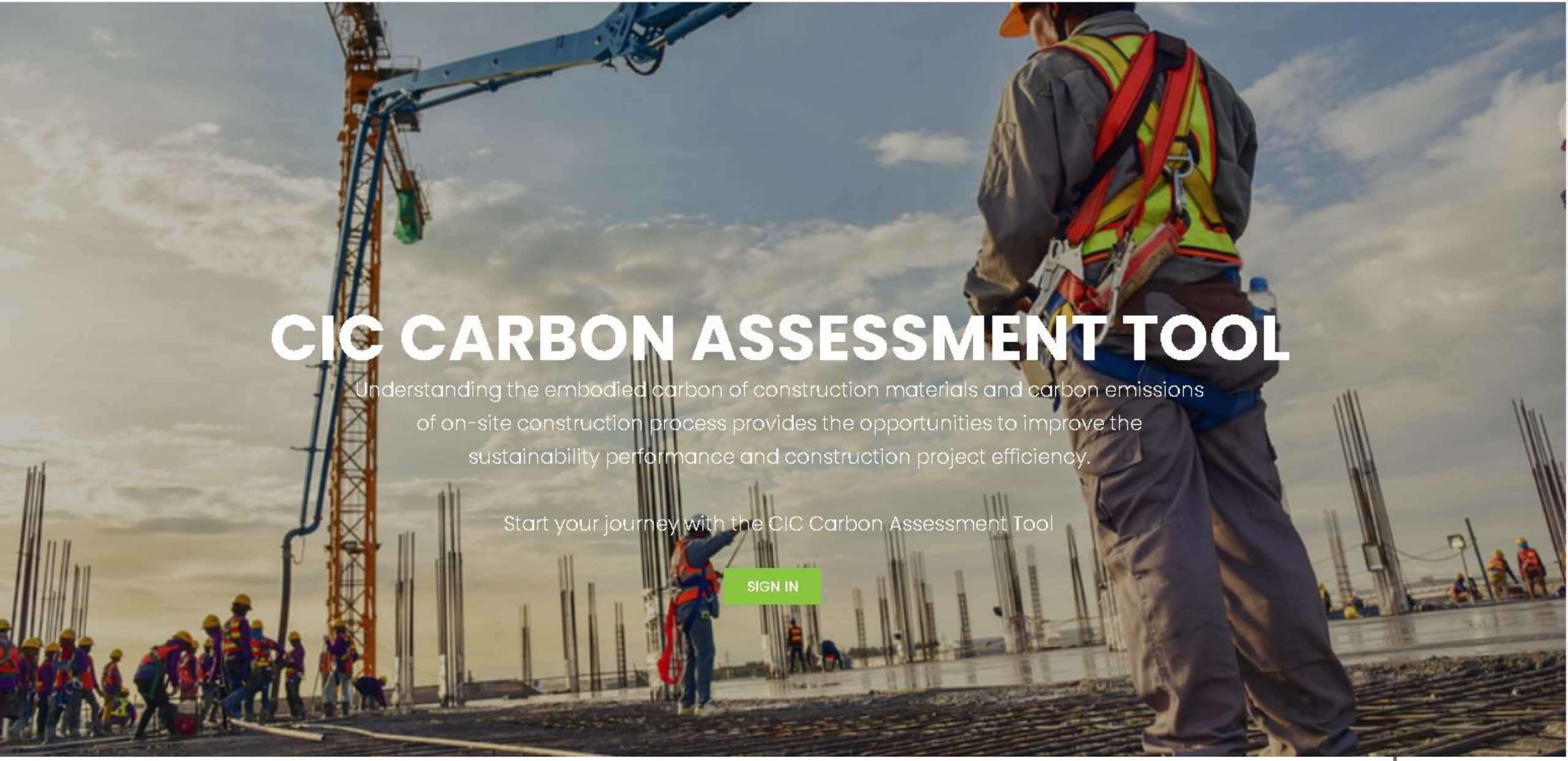
CIC Carbon Assessment Tool
建造業議會碳評估工具

Embodied Carbon in Construction Calculator (EC3) tool

Life Cycle Assessment Tools

One Click LCA

Athena Sustainable Materials Institute



CIC CARBON ASSESSMENT TOOL

Understanding the embodied carbon of construction materials and carbon emissions of on-site construction process provides the opportunities to improve the sustainability performance and construction project efficiency.

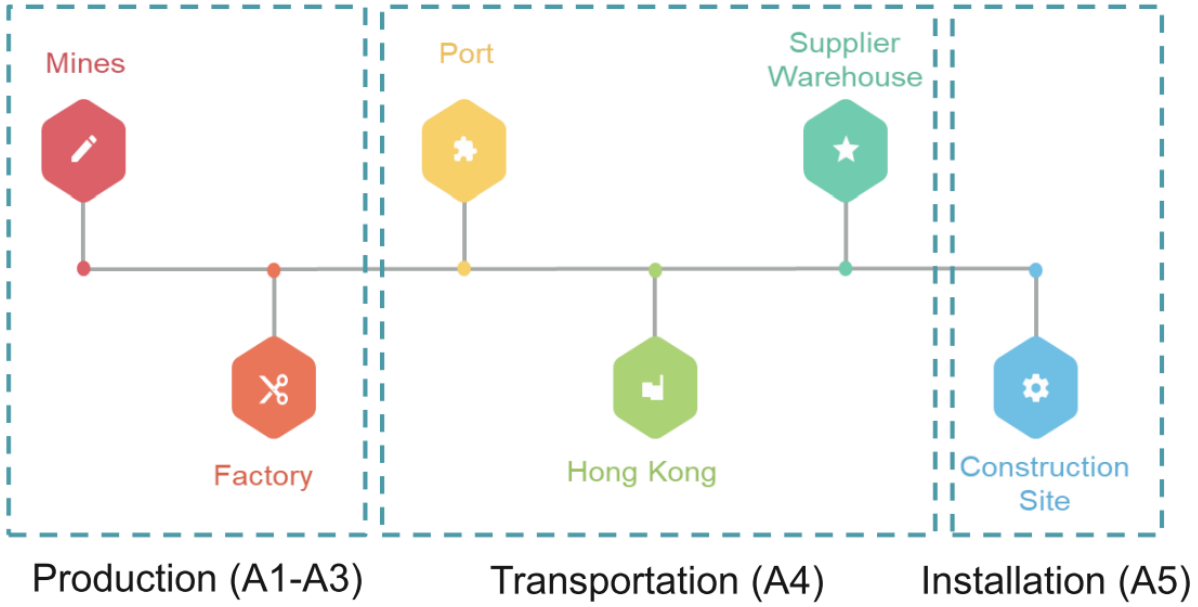
Start your journey with the CIC Carbon Assessment Tool

SIGN IN

CIC-CARBON ASSESSMENT TOOL

SCOPE OF THE TOOL

The scope of the Tool is **Cradle to Site** (A1 to A5) and is based on the ISO 14025:2010 (Environmental Labels and Declarations -Type III Environmental Declarations - Principles and Procedures



CIC-CAT

INPUT CATEGORIES

PERMANENT WORKS

SUPERSTRUCTURE

SUBSTRUCTURE

Aggregate
Concrete
Reinforcement Bar
Prefabricated Reinforcement Bar
Structural Steel
Prefabricated Structural Steel

Electricity
Town Gas
Fuel Consumption
Water
C&D Waste

SITE IMPACTS

TEMPORARY WORKS

Concrete
Reinforcement Bar
Structural Steel
Timber Formwork
Metal Formwork
Metal Hoarding
Timber Hoarding
Bamboo Scaffolding
Metal Scaffolding

Dr. Meike Sauerwein
10. February 2023

ACTIVITY
CIC Carbon Calculator Tool

Idividually

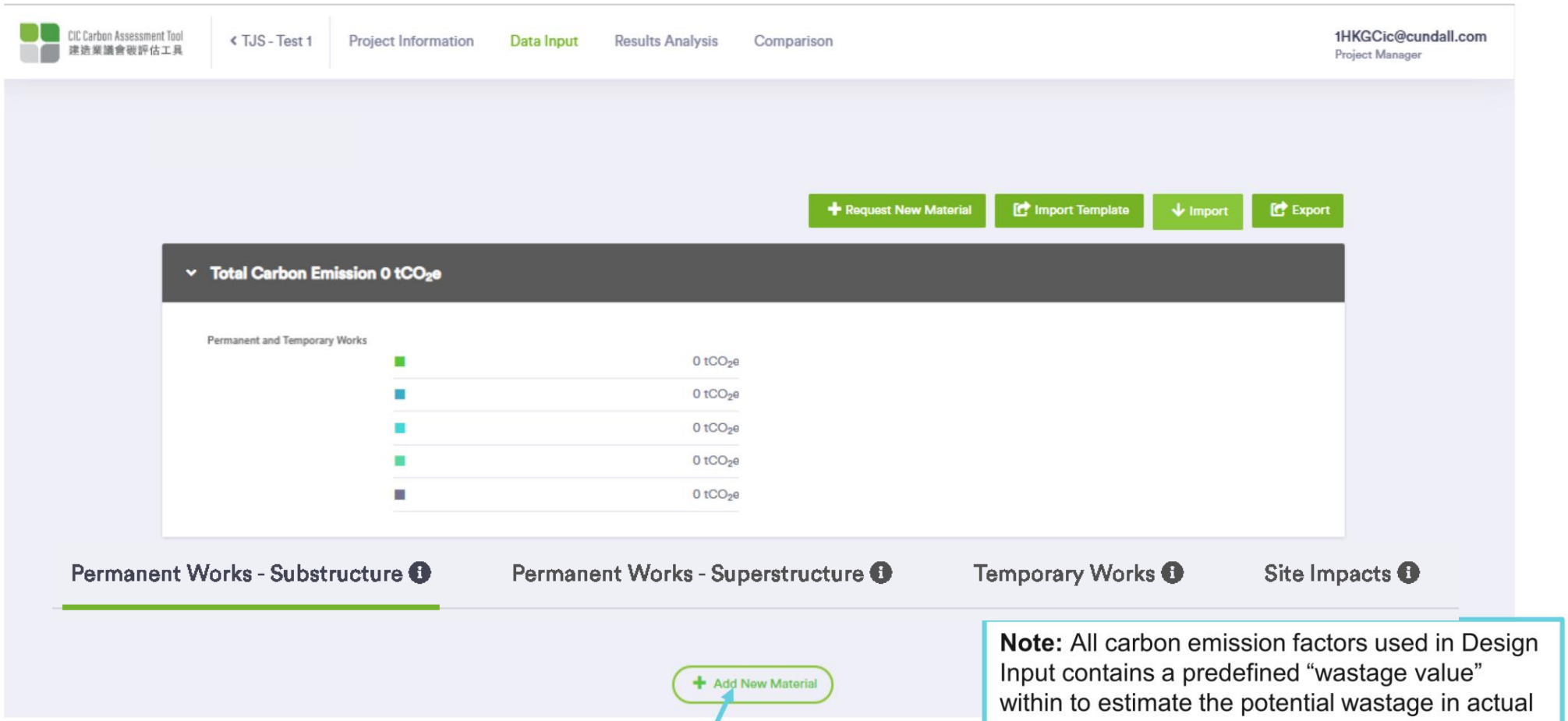
10 min

Data Input – Front Page

- ‘Permanent Works – Substructure’

The software will allow you to choose:

- Material Family
- Material
- Country/Origin
- Quantity
- Unit



“**Add New Field**” is the button to click to add the materials to the project

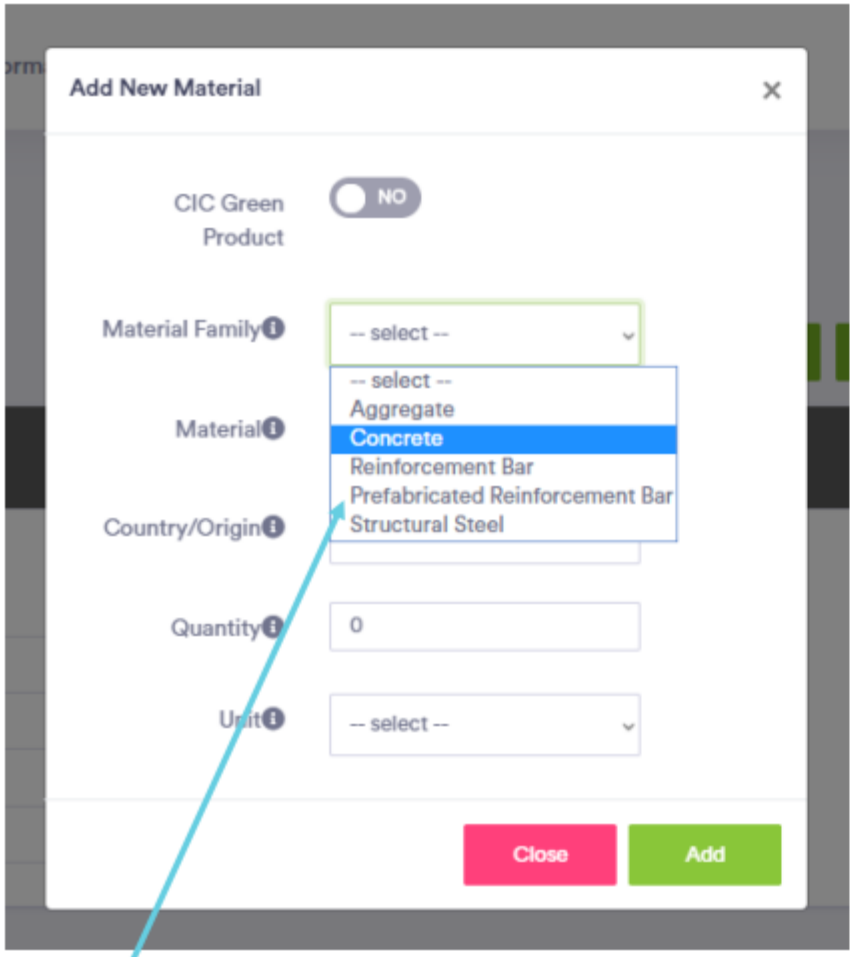
The number will be total for the project and split into Substructure and Superstructure

Note: All carbon emission factors used in Design Input contains a predefined “wastage value” within to estimate the potential wastage in actual construction operation. This “wastage value” does not exist in the construction stage’s database.

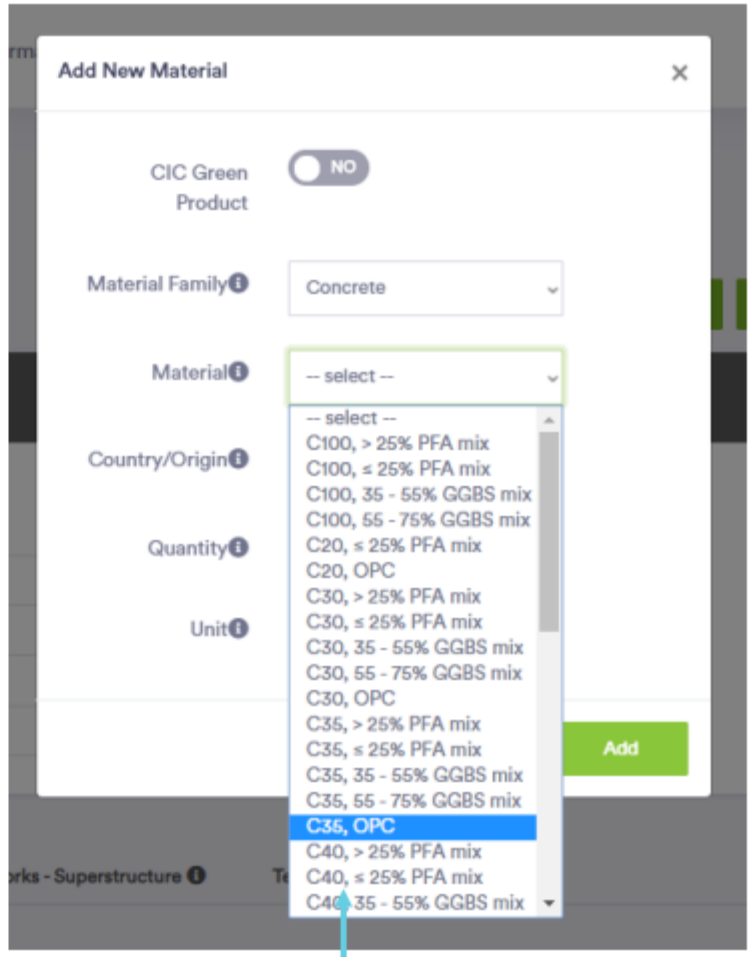
Dr. Meike Sauerwein
10. February 2023

CONSTRUCTION INDUSTRY COUNCIL 建造業議會

Data Input - Material



Select the **material family** from the pre-defined drop down list



Select the type/**specification** of the material from the pre-defined drop down list

If the **type/specification** for the material is unknown, please select the **Average or Unknown** option provided

[CIC CAT User Guide (2019)]

Dr. Meike Sauerwein
10. February 2023

CONSTRUCTION INDUSTRY COUNCIL 建造業議會

Monthly Carbon Emission 5,706 tCO_2e

Permanent and Temporary Works

Concrete	3,591 (67%) tCO_2e
Prefabricated Reinforcement Bar	950 (18%) tCO_2e
Precast Concrete	719 (13%) tCO_2e
Reinforcement Bar	91 (2%) tCO_2e
	0 tCO_2e

Site Impacts

C&D Waste	325.2 (92%) tCO_2e
Refrigerant	28.6 (8%) tCO_2e
Electricity	1.1 (0%) tCO_2e
Town Gas	0 (0%) tCO_2e
	0 tCO_2e

Permanent Works - Substructure | Permanent Works - Superstructure | Temporary Works | Site Impacts

Edit

WHO USES
LIFE CYCLE ASSESSMENT
- AND WHY?

LCA APPLICATIONS

LIFE CYCLE ASSESSMENT IN PRACTICE

In 2010, the Finnish Environment Institute published a report on the **adoption of LCA** in 20 global corporations from **multiple sectors**.

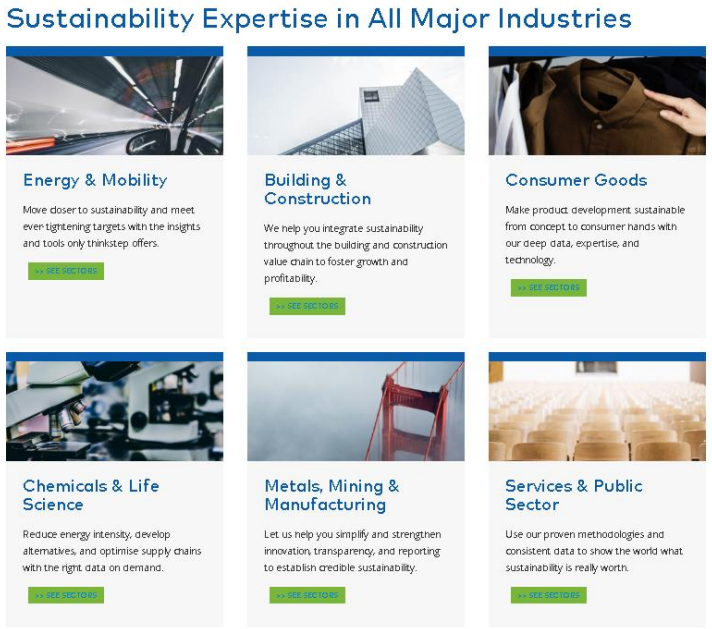


Table 2. Environmental impact categories taken into account by companies surveyed.

	Energy consumption	Climate change	Acidification	Eutrophication	Material depletion	Phochemical ozone formation	Ozone depletion	Waste problem	Eco-toxicity	Human toxicity	Water reserve impacts	Land use	Biodiversity
BASF	■	■	■	■	■	■	■	■	■	■	■	■	
Bombadier Transportation	■	■	■	■	■	■	■	■	■				
Continental	■	■	■	■	■								
Daimler	■	■	■	■	■	■							
Electrolux	■	■	■	■	■	■	■	■					
GE	■	■	■	■	■	■	■	■	■	■	■	■	
GlaxoSmithKline	■	■	■	■	■	■							
Interface	■	■	■	■	■	■	■	■			■		
KONE	■	■	■	■		■	■						
Nestle Waters	■	■	■	■	■	■	■	■	■	■	■	■	
Procter & Gamble	■	■	■	■		■	■	■	■	■	■		
Siemens	■	■	■	■	■	■				■			
Unilever	■	■	■	■	■	■		■	■		■		
Vattenfall	■	■	■	■	■	■	■	■	■		■	■	■
Vestas	■	■	■	■	■		■	■	■	■			
Xerox	■	■						■					

Sources: Nygren & Antikainen (2010) Use of life cycle assessment in global companies. *Reports of the Finnish Environment Institute.*
Life Cycle Assessment (2018): Theory and Practice, Part I – Chapter 4;
M. Z. Hauschild, R. K. Rosenbaum, S. I.Olsen (Ed.); Springer International Publishing

APPLICATION OF LCA

RETAIL

LIFE CYCLE ASSESSMENT IN PRACTICE

RETAIL

Walmart has committed to science-based targets for emissions reduction, including achieving zero emissions in their operations by 2040 and engaging suppliers through the Project Gigaton™ initiative to reduce or avoid supply chain emissions by 1 billion metric tons by 2030.

Walmart suppliers report their emissions reductions activities through

- disclosure to CDP
- project Gigaton Account

Provision of various calculation tools incl.

- Waste Reduction Model & Waste diversion calculator (U.S. EPA),
- Life cycle assessment tool COMPASS (for packaging)
- Design-for-recyclability calculator
- National FARM Program Environmental Stewardship Module (FARM ES) tool
- Fertilizer calculator
- Etc.

*Scope 3 is estimated to represent 95% of Walmart's full scope 1, 2, and 3 emissions

Source: https://corporate.walmart.com/esgreport/esg-issues/climate-change
Walmart Sustainability Hub, 2021, Project Gigaton Accounting Methodology

1. LCA AND HOTSPOT IDENTIFICATION

EXAMPLE: CHICKEN MEAT

Hotspot: An activity within a product's life cycle that is identified as having a substantial environmental or social impact that is supported by significant evidence.

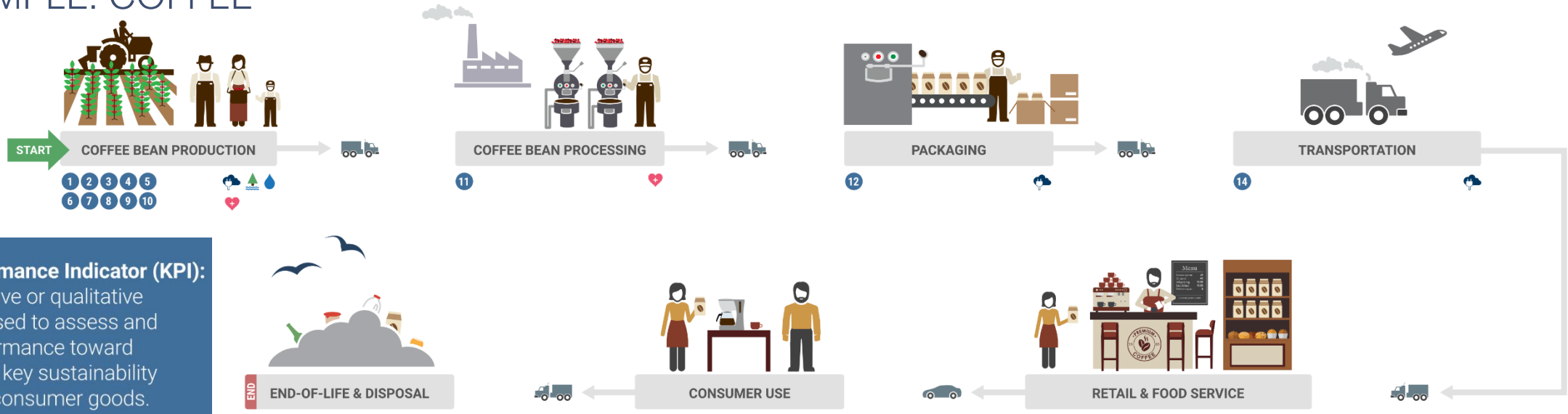
1. **Air quality - Animal farm operations:** Chicken manure releases ammonia that can cause air quality issues for workers and communities.
2. **Animal welfare:** Chickens may face health issues related to proper housing, nutrition, handling, transportation, and slaughter.
3. **Antibiotic use - Animal farm operations:** Chickens may need antibiotics to treat disease but overuse can cause antibiotic resistance in humans and affect the environment.
4. **Energy consumption - Animal farm operations:** Chicken housing operations use electricity and fuel, which can lead to climate change and pollution.
5. **Environmental impacts - Feed cultivation:** Improper management of soil, fertilizer, pesticides, water, and energy to grow feed can cause pollution and affect workers, communities, climate, and natural resources.
6. **Labor rights - Animal farm operations:** Workers, especially women and migrants, may face labor issues including unfair pay.
7. **Manure management - Animal farm operations:** Chicken manure releases greenhouse gases and can cause water pollution and climate change.
8. **Worker health and safety - Animal farm operations:** Workers may be exposed to dust, chemicals, or other hazards on the farm.
9. **Energy consumption - Processing:** Processing and cooking chicken uses electricity can lead to climate change and pollution.

Sustainability Topics: Climate & Energy | Water Use | Land & Ecosystems | Health, Safety & Rights | Animal Welfare

2. FORMULATION OF KEY PERFORMANCE INDICATORS

THE SUSTAINABILITY CONSORTIUM™

EXAMPLE: COFFEE



Key Performance Indicator (KPI): A quantitative or qualitative measure used to assess and track performance toward addressing key sustainability issues for consumer goods.

Key Performance Indicator (KPI): A quantitative or qualitative measure used to assess and track performance toward addressing key sustainability issues for consumer goods.	1 **Crop supply mapping** HOTSPOTS 7	2 **Access to opportunities for smallholder farmers** HOTSPOTS 1	3 **Child labor use** - On-farm HOTSPOTS 2	4 **Deforestation and land conversion** - On-farm HOTSPOTS 6	5 **Fertilizer application** - On-farm HOTSPOTS 4	6 **Greenhouse gas emissions intensity** - On-farm HOTSPOTS 3 4	7 **Irrigation water use intensity** - On-farm HOTSPOTS 8
	8 **Labor rights** - On-farm HOTSPOTS 5	9 **Worker health and safety** - On-farm HOTSPOTS 9	10 **Yield** - On-farm HOTSPOTS 3 6	11 **Worker health and safety** - Processing HOTSPOTS 10	12 **Packaging raw material sourcing** HOTSPOTS 11	13 **Sustainable packaging design** HOTSPOTS 11	14 **Transportation to retailers** HOTSPOTS 12

Sustainability Topics: Climate & Energy | Water Use | Land & Ecosystems | Health, Safety & Rights

Supplier Surveys and Measuring Progress

Setting Targets based on KPI (for suppliers) to improve

↓

Support for follow up **actions**

↓

Regular **checks on Process**

Key Performance Indicators

QUESTION	RESPONSE OPTION
1. Crop Supply Mapping For what percentage of your crop supply can you identify the country, region, or farm of origin?	**A.** We are unable to determine at this time. **B.** The following percentages represent the origins of our crop supply: **B1.**_____% is the portion of our crop supply for which we are unable to determine the origin. **B2.**_____% is the portion of our crop supply for which we have identified the country of origin. **B3.**_____% is the portion of our crop supply for which we have identified the region of origin. **B4.**_____% is the portion of our crop supply for which we have identified the farm of origin.
2. Access to Opportunities for Smallholder Farmers What percentage of your smallholder farmer-sourced crop supply, by mass, was sourced from smallholder farmers that are supported by a program to increase opportunities for agricultural training, inputs, and services?	**A.** Not applicable. We do not source our supply from smallholder farmers. **B.** We are unable to determine at this time. **C.** The following percentage of our smallholder farmer-sourced crop supply, by mass, was sourced from smallholder farmers that are supported by a program to increase opportunities for agricultural training, inputs, and services: **C1.**_____%.
3. Child Labor Use - On-farm	**A.** We are unable to determine at this time.

3. Child Labor Use - On-farm

What are the outcomes of the risk assessments for the worst forms of child labor performed on your crop supply?

A. We are unable to determine at this time.

B. The following percentages, by mass purchased, represent the outcomes of our risk assessment(s) for the worst forms of child labor for our crop supply:

B1._____% of crop supply came from low-risk countries with corrective actions taken for any known high-risk sites.

B2._____% of crop supply came from high-risk countries that have high-risk sites for which we took corrective actions.

5. Fertilizer Application - On-farm

What was the nitrogen use intensity and phosphorus surplus associated with fertilizer application on the fields where your crops were produced?

A. We are unable to determine at this time.

B. We are able to report the following for our crop supply:

B1._____ kg nitrogen per metric tonne of crop harvested.

B2._____% of our crop supply, by mass, is represented by the number reported in B1.

B3._____ kg phosphorus surplus per metric tonne of crop harvested.

B4._____% of our crop supply, by mass, is represented by the number reported in B3.

B4._____% of our crop supply, by mass, is represented by the number reported in B3.

Dr. Meike Sauerwein
10. February 2023

Source: https://www.sustainabilityconsortium.org/tsc-downloads/coffee-product-sustainability-toolkit-supply-chain-diagram/?wpdmdl=20838&ind=1505429607600

LIFE CYCLE ASSESSMENT IN PRACTICE

RETAIL

- Identify hotspots (bottlenecks) of environmental impacts of products
- Selection of relevant indicators to measure sustainability performance of a product

Objective

*The assessment tool includes a set of **key performance indicators** (KPIs), along with a proposed method of scoring products against these indicators.*

Target group

*Retailers [...] may voluntarily use this tool to independently evaluate product sustainability, with scores intended to remain confidential between **retailer and supplier.***

KPI Table of Contents

PACKAGING			60 points
#	KPI TITLE	POINTS	PAGE #
1.	Design, policy, and goals	5	2
2a/b.	Sustainable sourcing	15/10	4/8
3.	Attribute communication		
4.	Recyclability – Improving		
5.	Recyclability – Sales pack		
6.	Stewardship list chemical		

HUMAN HEALTH			130 points
#	KPI TITLE	POINTS	PAGE #
1.	Worker health and safety – Manufacturing	20	31
2.	Fragrance management	15	33
3.	Formulation – Stewardship list chemical management	-	35
4.	Formulation – Chemical selection	15	38
5.	Formulation – Stewardship list chemical usage	-	41
6.	Chemical footprint	15	44
7.	Risk assessment and product safety	15	46
8.	Ingredient disclosure to manufacturers	15	48

Source: https://www.sustainabilityconsortium.org/projects/bpc-rating-system/
https://www.sustainabilityconsortium.org/wp-content/uploads/2018/04/TSC%C2%AE-BPC-Product-Sustainability-Rating-System.pdf

The items we consume, which include food, beverage, and agriculture, make up a large percentage of our consumer goods purchases. These are items we rely on daily for our nutrition and consumption for ourselves and our families.

Sustainability issues within these items tend to have similar hotspots: deforestation, biodiversity, labor rights, animal welfare, packaging, and many more. The production of these items directly affect not just the planet, but the people that work to bring these items to a retail store online or near you.

THESIS®
PRODUCT FINDER

Click through the food, beverage, and agriculture items below to explore the many sustainability issues present their supply chain. TSC members are working daily to mitigate these hotspots to help us create more sustainable products. In addition, TSC works with global companies to help tackle both food waste and hunger along with our commodity mapping program that uses trade route data to help companies see where their commodities like coffee, beef, and barley originate.

GENERAL MERCHANDISE

FOOD, BEVERAGE, AND AGRICULTURE

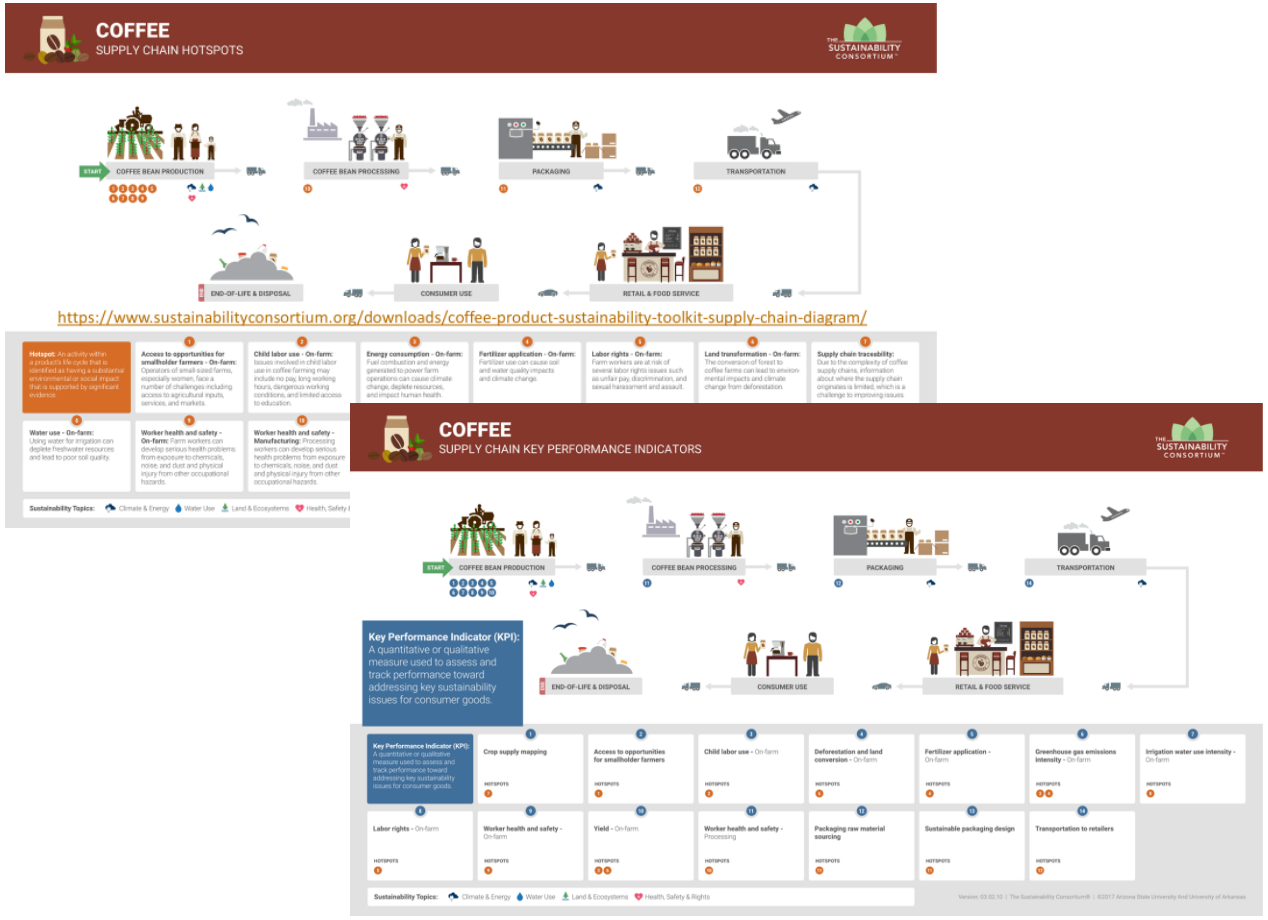
CLOTHING, FOOTWEAR, AND TEXTILES

HOME AND PERSONAL CARE

Source: https://sustainabilityconsortium.org/thesis-product-finder/

LIFE CYCLE ASSESSMENT IN PRACTICE

TSC PRODUCT SUSTAINABILITY TOOLKIT



https://www.sapstore.com/solutions/99039/TSC-Product-Sustainability-Toolkit-for-SAP-Product-Stewardship-Network
https://www.sustainabilityconsortium.org/downloads/coffee-product-sustainability-toolkit-supply-chain-diagram/

APPLICATION OF LCA

POLICY MAKING

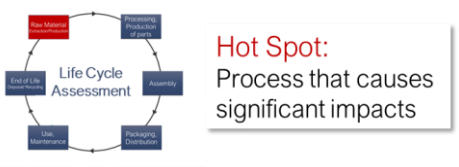
Table 4.1 Examples of LCA applications at different stages of the policy cycle

Topic	Initiation year and/or geographical scope
LCA as a knowledge tool in policy formulation	
Environmental technologies action plan (ETAP)	2004; EU
Integrated product policy (IPP)	2003; EU
Directive on the eco-design of energy using products (EuP)	2005; EU
Strategy for the sustainable use of natural resources	2005
Sustainable production and consumption action plan (SCP)	2007; EU
Biofuels	Germany
Application of pesticides	Costa Rica
Supporting the implementation of information based instruments: LCA & policy implementation	
Eco-labelling	Various countries
Environmental product declarations (EPD)	Various countries
Strategic environmental assessment directive	2004
Public procurement	EU, Japan
Construction products directive	1989; EU
Ordinance on the avoidance and recovery of packaging wastes	Germany
Waste management	France, Mexico, japan
LCA as a tool for policy evaluation	
Thematic strategy on prevention and recycling of waste & Waste framework directive	2005; EU
Waste oil directive	2000; EU

Life Cycle Assessment (2018): Theory and Practice, Part I – Chapter 4; M. Z. Hauschild, R. K. Rosenbaum, S. I.Olsen (Ed.); Springer International Publishing

LIFE CYCLE ASSESSMENT IN PRACTICE

ECO-LABELLING (GOVERNMENTAL POLICY)



Hot Spot:
Process that causes significant impacts

Life cycle approach guarantees that the products' **major environmental impacts** are **reduced in comparison to similar products** on the market.

Methodology

- Development of **LCA based benchmarks and product performance criteria in each product category**
- Manufacturers provide data / test results about their products
- Comparison with benchmark criteria → if product does sufficiently well (in hotspot categories) it is **awarded a label**

Source: http://ec.europa.eu/environment/ecolabel/eu-ecolabel-for-consumers.html

VOLUNTARY ECO-LABELS

EXAMPLE: ECO-LABEL BY EUROPEAN COMMISSION

EU Ecolabel
www.ecolabel.eu

Cleaning Up

- Dishwasher Detergents
- Hand Dishwashing Detergents
- Hard Surface Cleaning Products
- Indoor Cleaning Services
- Industrial and Institutional Automatic Dishwasher Detergents
- Industrial and Institutional Laundry Detergents
- Laundry Detergents

Clothing and textiles

Coverings

Do-It-Yourself

Electronic Equipment

Furniture

Gardening

Lubricants

Other Household Items

Paper Products

Personal care products

Rinse-off Cosmetic Products

Once it's on your products, the EU Ecolabel guarantees

- Reduced impact on aquatic ecosystems
- Fulfilment of strict biodegradability requirements
- Limited packaging waste

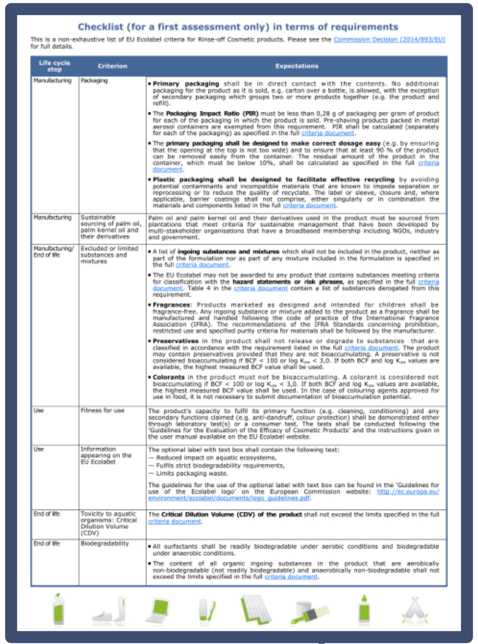
Rinse-off Cosmetic Products

Current criteria	Commission Decision of 9 December 2014 Corrigendum IT
Valid until	31 December 2021 Validity prolonged Commission Decision of 19 October 2019
Application pack (valid until November)/ User manual	User Manual Calculation sheet DID LIST 2016
Revision	Ongoing. Please click here for more information
Miscellaneous	2016 version of the Detergent Ingredient Database (DID-list) Part A 2016 version of the Detergent Ingredient Database (DID-list) Part B Technical background report
Criteria in a nutshell	Rinse-off cosmetic products fact sheets

What the producer needs to do to obtain the label

LCA-Results

LCA-Hotspots – Fact sheets



Sources: http://ec.europa.eu/environment/ecolabel/products-groups-and-criteria.html
https://ec.europa.eu/environment/ecolabel/documents/Rinse-off%20Cosmetics%20factsheet.pdf

EU PRODUCT ENVIRONMENTAL FOOTPRINT (PEF)

EU Ecolabel
www.ecolabel.eu

reducing with the Carbon Trust

The carbon footprint of this loaf is 1.0kg (50g per slice) and we have committed to reduce it.

The carbon footprint of this product is the total carbon dioxide (CO2) and other greenhouse gases emitted from the ingredients, baking, distribution, consumption and disposal of the loaf and packaging.

carbon-label.com

Lyreco

LYRECO LAUNDRY LIQUID EVALUATION

Lyreco Laundry Liquid is a product in the Lyreco Hygiene range.

SCORING METHODOLOGY

A PEFCR for the Laundry Liquid detergents products category was designed by a committee of industry experts and validated by a steering committee chaired by the EC.

This PEFCR makes possible to evaluate the environmental performance of a Laundry Liquid detergent, according to a defined functional unit. This score is the results of the weighted impact evaluation of all environmental indicators at each stages of the product lifecycle.

The score is defined on a common usage basis: 1 dose of product per 1 wash.

It is expressed in micropoints (µpt) and compared with the score of a representative Laundry Liquid detergent (with EU average characteristics). The closer this score is to zero, the less impact it has on the environment.

Lyreco Laundry Liquid is more environmentally friendly that the average laundry liquid with a score of 12.6 vs 18 µpt/dose.

LIFECYCLE ASSESSMENT

Except for the End-of-life, Lyreco Laundry Liquid performs better than the representative product at each stage of the lifecycle. For the Raw material stage, which is one of the most important one, Lyreco product particularly performs in comparison with the average product. This is also the case for the Manufacturing process.

50% less impact in the Raw Material category: 4.58 vs 8.10 µpts/dose

—

30% less impact on the Manufacturing process category: 0.30 vs 0.46 µpts/dose

LIFECYCLE COMPARED RESULTS (in µpt/dose)*

	LYRECO DETERGENT	REPRESENTATIVE PRODUCT
RAW MATERIAL	4.58	8.1
PACKAGING	0.77	2.05
MANUFACTURING	0.3	0.46
DISTRIBUTION	0.69	1.22
END-OF-LIFE	6.24	6.13
TOTAL	**12.58**	**17.95**
USE PHASE Including water release from the washing machine.	20.65	20.65

(*)The detailed results of the environmental performance of the Lyreco product ("PEF report" certified by trusted third party EY) can be asked at: group.qss@lyreco.com

40% GLOBAL WARMING

18% RESOURCE USE (FOSSILS)

8% PARTICULATE MATTER

ENVIRONMENTAL INDICATORS

In a detailed evaluation, Climate change, Resource usage (fossils) and Particulate matter are the most impacted environmental indicators.

KEY ENVIRONMENTAL PERFORMANCE FACTORS

Less detergents required to wash 4.5 kg of textiles

Lower amount of chemical

Chemical used are less impacting

NEXT STEPS

Continuous improvement

Encourage our suppliers to adopt the EU PEF methodology

Promote EU PEF to our customers

Dr. Meike Sauerwein
10. February 2023

VOLUNTARY STANDARDS FOR BUSINESSES

EU PRODUCT ENVIRONMENTAL FOOTPRINT

“

“The European Commission (EC) developed the product environmental footprint (PEF) method to support valid product comparisons”

Source: https://www.youtube.com/watch?v=xTXtGpRyxUk
https://pre-sustainability.com/solutions/consulting/sustainable-products/product-environmental-footprint/

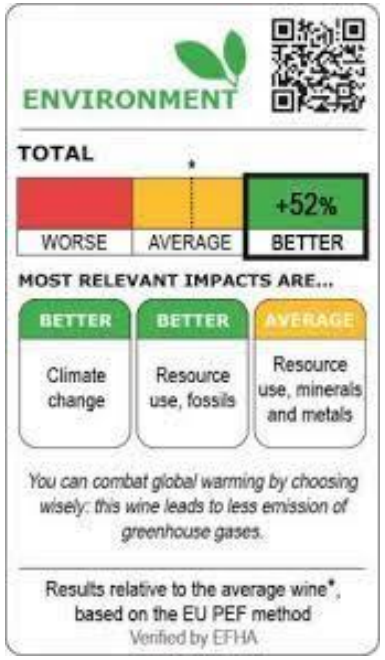
VOLUNTARY STANDARDS FOR BUSINESSES

EU PRODUCT ENVIRONMENTAL FOOTPRINT

- The European commission in collaboration with LCA consultants and companies from specific industries, initiated projects to **conduct LCA of representative market products**
- **Based on those they develop Product Environmental Footprint Category Rules** (PEFCR) - a **guideline how to conduct LCA** for different product groups, to allow comparability

- This includes the provision of a **variety of data sets** and simpler calculation tools to enable life-cycle based calculations on a product level which would normally very expensive and data-intensive

- Assessment **results in a Report / Label** that indicates by how many % the product is better than the benchmark products



*generic PEF method available for product types without PEF CR

Source: https://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR_en.htm#final

22 March 2022

Sustainable Products Initiative – A new digital product passport

SPI | Sustainable Products Initiative

The European Commission gears up to launch its Sustainable Products Initiative (SPI) on 30 March. The introduction of digital product passports is expected as one of the highlights.

Source: https://ecostandard.org/news_events/sustainable-products-initiative-a-new-digital-product-passport/

Digital Product Passport

On the EU digital product passport

The fact that products should carry a passport is not new, and definitely not new in GS1. The real change is that this is happening through legislation and by leveraging both green and digital transformations.

The regulation states that "the product passport means a set of data specific to a product that includes the information (specified in the delegated act) and that is accessible via electronic means through a data carrier".

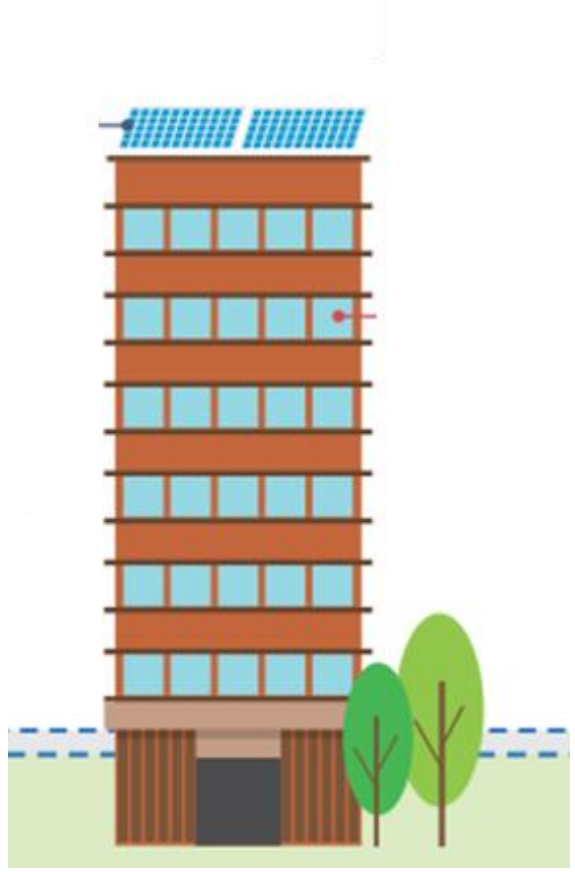
Under the new regulation, the product passport shall:

- ensure that actors along the value chain, including consumers, economic operators, and competent national authorities, can access product information relevant to them
- improve traceability of products along the value chain
- facilitate the verification of product compliance by competent national authorities
- include the necessary data attributes to enable the tracking of all substances of concern throughout the lifecycle of the products covered

Source: https://gs1.eu/activities/digital-product-passport/on-the-eu-digital-product-passport/

APPLICATION OF LCA

CONSTRUCTION



LIFE CYCLE ASSESSMENT IN PRACTICE

CONSTRUCTION INDUSTRY

International EPD® System
Type III: ISO 14025

Environmental Product Declarations (EPD)

- Supporting / verify performance claims
- Product Certification e.g. used in building assessment schemes

https://www.youtube.com/watch?v=v6sJrp443Hg
https://www.environdec.com/What-is-an-EPD/Applications/Building-assessment-schemes/

LIFE CYCLE ASSESSMENT IN PRACTICE

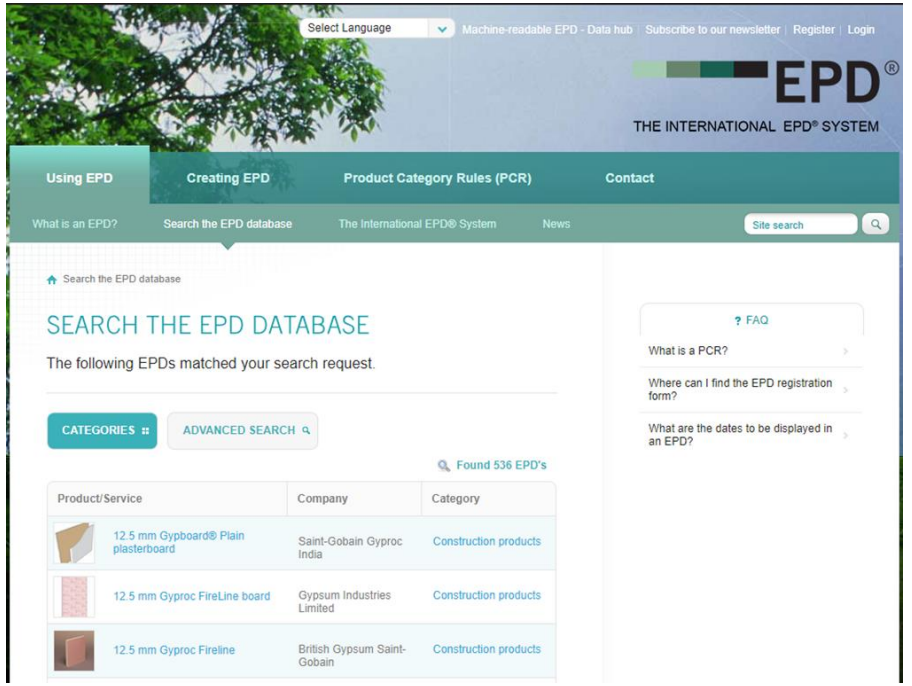
ENVIRONMENTAL PRODUCT DECLARATIONS (EPD) (TYPE III ECO-LABELS)

Quantified environmental information on the life cycle of a product embedded in a system to verify and register EPDs and maintain a publicly-available library of EPDs.

E.g. building industry increasingly use LCA based information for their environmental impact communication

The EPDs

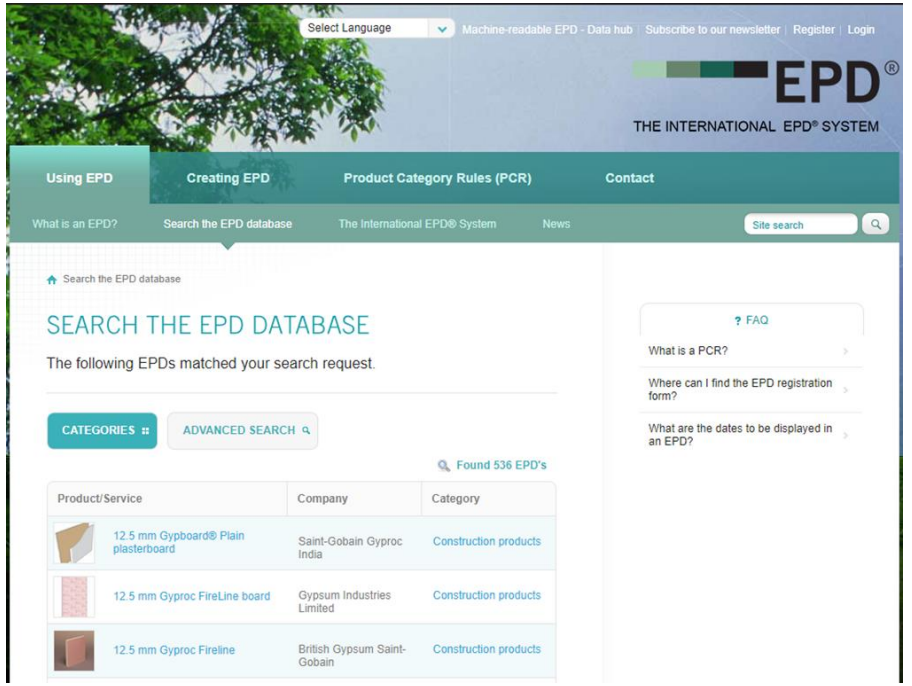
- Are used in marketing and communication and demonstrate a company's responsibility for sustainability impacts
- Provide information that can directly be used to quantify impacts in building assessment schemes.



Source: https://www.environdec.com/What-is-an-EPD/Applications/Building-assessment-schemes/

ENVIRONMENTAL PRODUCT DECLARATION (EPD)

- Life Cycle Assessments of products (particularly popular for construction materials) reported in a standardized format
- **Based on ISO standard ISO 14025 (Environmental Product Declaration)**
- **Follow Product Category Rules:** ‘standardized LCA recipe’



Sources: https://www.environdec.com/library, Presentation by Anthony Park, 2020

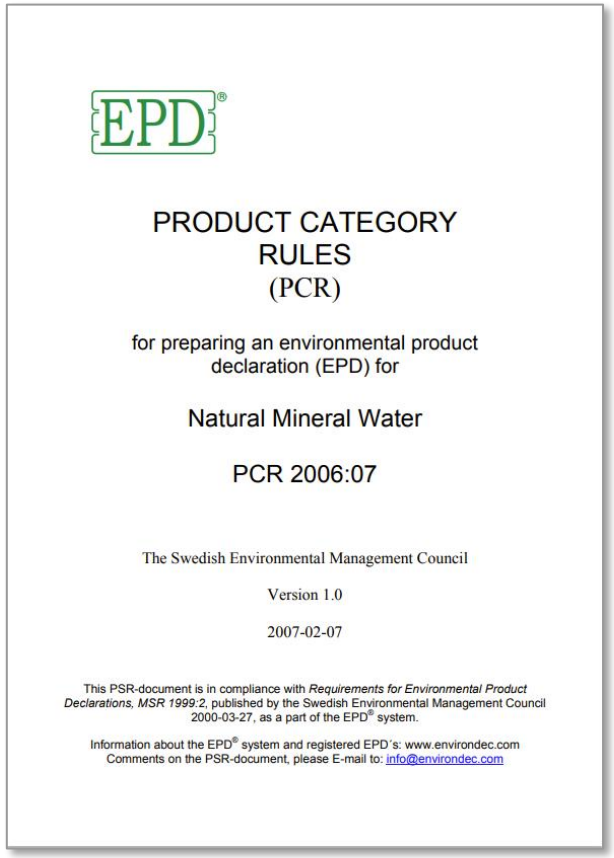
PRODUCT CATEGORY RULES

THE COOK-BOOK FOR MAKING LCA-BASED ENVIRONMENTAL PRODUCT DECLARATIONS

A PCR is a copyrighted document that is part of the EPD "cookbook" and contains the recipe to create a high-quality EPD for the product category you are interested in.

The PCR provides the instructions for how the life-cycle assessment (LCA) should be conducted. It sets out what you need to consider, including but not limited to:

- System boundaries, i.e. which processes and stages of the product's life cycle need to be considered
- Declared/functional unit: the amount, weight and service life of the product being assessed
- How to define e.g. the use phase and end-of-life options
- What impact categories need to be assessed in addition apart from the standard set as described in our General Program Instructions (GPI)



EPD®

PRODUCT CATEGORY RULES (PCR)

for preparing an environmental product declaration (EPD) for

Natural Mineral Water

PCR 2006:07

The Swedish Environmental Management Council

Version 1.0

2007-02-07

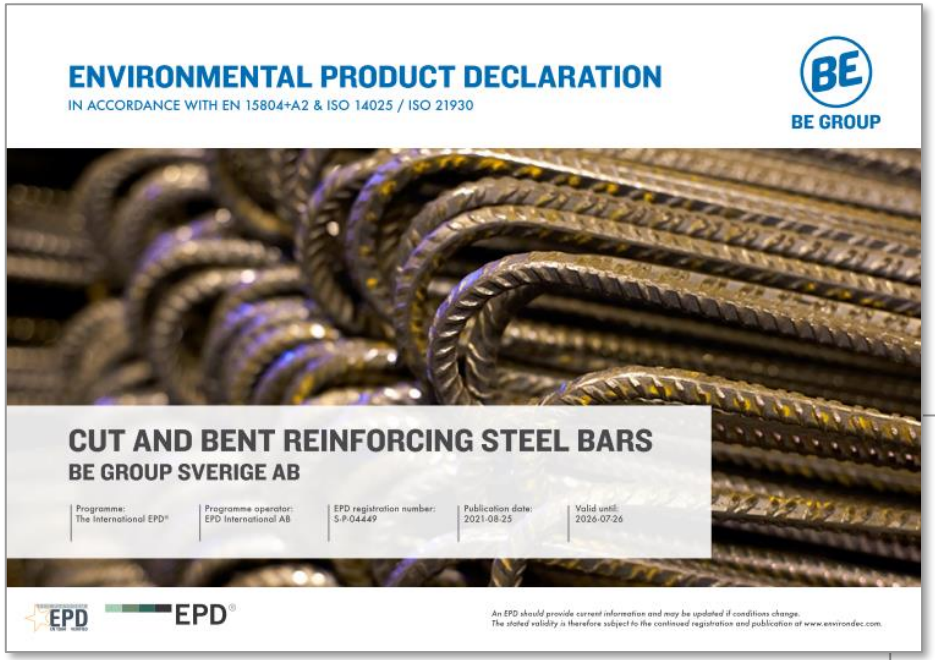
This PSR-document is in compliance with *Requirements for Environmental Product Declarations, MSR 1999:2*, published by the Swedish Environmental Management Council 2000-03-27, as a part of the EPD® system.

Information about the EPD® system and registered EPD's: www.environdec.com
Comments on the PSR-document, please E-mail to: info@environdec.com

Sources: https://www.environdec.com/library
https://www.environdec.com/product-category-rules-pcr/the-pcr

EPD DATABASES: LCA REPORTS OF BUILDING MATERIALS

EXAMPLE: EPD REPORT: STEEL



ENVIRONMENTAL PRODUCT DECLARATION

IN ACCORDANCE WITH EN 15804+A2 & ISO 14025 / ISO 21930

BE GROUP

CUT AND BENT REINFORCING STEEL BARS

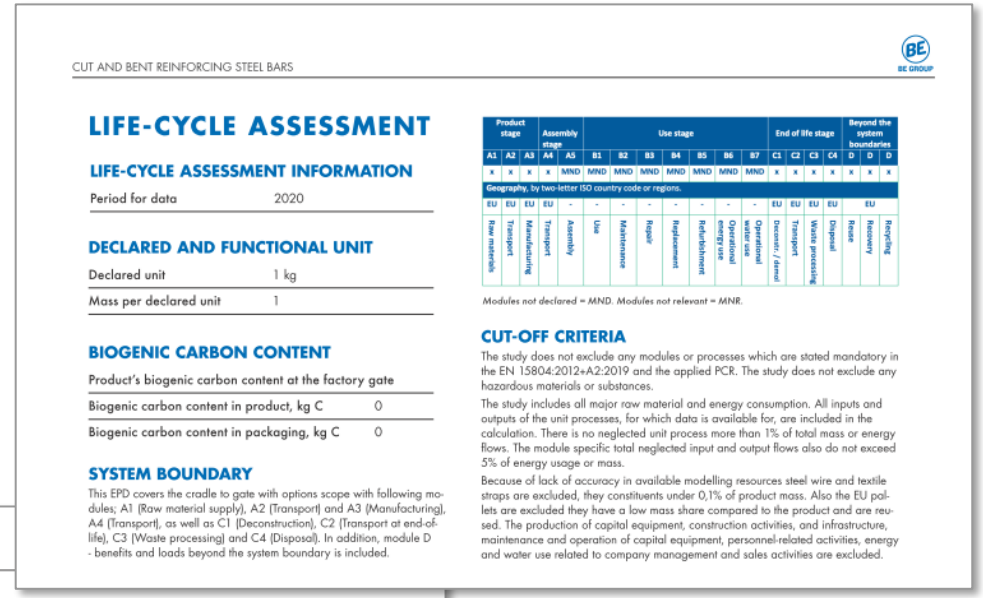
BE GROUP SVERIGE AB

Programme:	Programme operator:	EPD registration number:	Publication date:	Valid until:
The International EPD®	EPD International AB	S-P-04449	2021-08-25	2026-07-26

EPD

EPD®

An EPD should provide current information and may be updated if conditions change.
The stated validity is therefore subject to the continued registration and publication at www.environdec.com.



CUT AND BENT REINFORCING STEEL BARS

BE GROUP

LIFE-CYCLE ASSESSMENT

LIFE-CYCLE ASSESSMENT INFORMATION

Period for data	2020

DECLARED AND FUNCTIONAL UNIT

Declared unit	1 kg
Mass per declared unit	1

BIOGENIC CARBON CONTENT

Product's biogenic carbon content at the factory gate	
Biogenic carbon content in product, kg C	0
Biogenic carbon content in packaging, kg C	0

SYSTEM BOUNDARY

This EPD covers the cradle to gate with options scope with following modules; A1 (Raw material supply), A2 (Transport) and A3 (Manufacturing), A4 (Transport), as well as C1 (Deconstruction), C2 (Transport at end-of-life), C3 (Waste processing) and C4 (Disposal). In addition, module D - benefits and loads beyond the system boundary is included.

Product stage			Assembly stage		Use stage							End of life stage				Beyond the system boundaries	
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D	D
x	x	x	x	MND	MND	MND	MND	MND	MND	MND	MND	x	x	x	x	x	x
Geography, by two-letter ISO country code or regions.																	
EU	EU	EU	EU	-	-	-	-	-	-	-	-	EU	EU	EU	EU	EU	
Raw materials	Transport	Manufacturing	Transport	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstr. / demol	Transport	Waste processing	Disposal	Reuse	Recovery	Recycling

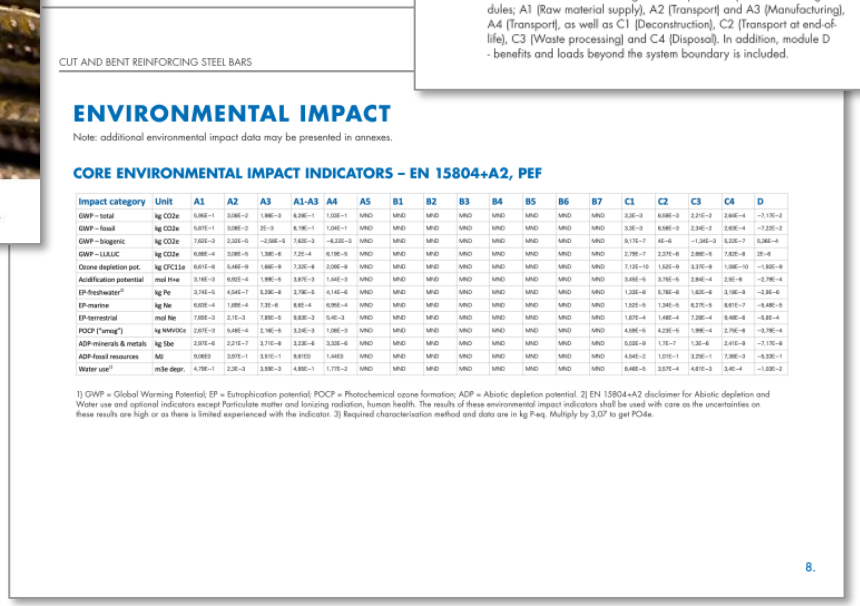
Modules not declared = MND. Modules not relevant = MNR.

CUT-OFF CRITERIA

The study does not exclude any modules or processes which are stated mandatory in the EN 15804:2012+A2:2019 and the applied PCR. The study does not exclude any hazardous materials or substances.

The study includes all major raw material and energy consumption. All inputs and outputs of the unit processes, for which data is available for, are included in the calculation. There is no neglected unit process more than 1% of total mass or energy flows. The module specific total neglected input and output flows also do not exceed 5% of energy usage or mass.

Because of lack of accuracy in available modelling resources steel wire and textile straps are excluded, they constituents under 0,1% of product mass. Also the EU pallets are excluded they have a low mass share compared to the product and are reused. The production of capital equipment, construction activities, and infrastructure, maintenance and operation of capital equipment, personnel-related activities, energy and water use related to company management and sales activities are excluded.



CUT AND BENT REINFORCING STEEL BARS

ENVIRONMENTAL IMPACT

Note: additional environmental impact data may be presented in annexes.

CORE ENVIRONMENTAL IMPACT INDICATORS – EN 15804+A2, PEF

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP – total	kg CO2e	5,95E−1	3,08E−2	1,94E−3	6,29E−1	1,03E−1	MND	MND	MND	MND	MND	MND	MND	MND	3,3E−3	6,68E−3	2,21E−2	2,64E−4	−7,17E−2
GWP – fossil	kg CO2e	5,97E−1	3,08E−2	2E−3	6,19E−1	1,04E−1	MND	MND	MND	MND	MND	MND	MND	MND	3,3E−3	6,68E−3	2,34E−2	2,63E−4	−7,22E−2
GWP – biogenic	kg CO2e	7,02E−3	2,32E−5	−2,56E−5	7,02E−3	−6,22E−3	MND	MND	MND	MND	MND	MND	MND	MND	9,17E−7	4E−6	−1,34E−3	5,22E−7	5,36E−4
GWP – LULUC	kg CO2e	6,88E−4	3,08E−5	1,38E−6	7,2E−4	6,19E−5	MND	MND	MND	MND	MND	MND	MND	MND	2,79E−7	2,37E−6	2,66E−5	7,82E−8	2E−6
Ozone depletion pot.	kg CFC11e	6,61E−8	6,46E−9	1,68E−9	7,32E−8	2,09E−8	MND	MND	MND	MND	MND	MND	MND	MND	7,12E−10	1,62E−9	3,37E−9	1,08E−10	−1,82E−9
Acidification potential	mol H+e	3,16E−3	6,92E−4	1,89E−5	3,87E−3	1,44E−3	MND	MND	MND	MND	MND	MND	MND	MND	3,45E−5	3,78E−5	2,84E−4	2,5E−6	−2,79E−4
EP-freshwater[2]	kg Pe	2,74E−5	4,54E−7	5,23E−8	2,79E−5	4,14E−6	MND	MND	MND	MND	MND	MND	MND	MND	1,22E−8	5,78E−8	1,82E−8	2,18E−9	−2,9E−6
EP-marine	kg Ne	6,02E−4	1,08E−4	7,3E−6	8,85E−4	6,09E−4	MND	MND	MND	MND	MND	MND	MND	MND	1,52E−5	1,34E−5	6,27E−5	8,81E−7	−8,48E−5
EP-terrestrial	mol Ne	7,05E−3	2,1E−3	7,85E−5	9,83E−3	5,4E−3	MND	MND	MND	MND	MND	MND	MND	MND	1,67E−4	1,48E−4	7,28E−4	9,48E−6	−9,8E−4
POCP ("smog")	kg NMVOCe	2,61E−3	5,44E−4	2,19E−5	3,24E−3	1,29E−3	MND	MND	MND	MND	MND	MND	MND	MND	4,59E−5	4,23E−5	1,99E−4	2,77E−6	−3,79E−4
ADP-minerals & metals	kg Sbe	2,07E−6	2,21E−7	3,71E−8	2,33E−6	3,03E−6	MND	MND	MND	MND	MND	MND	MND	MND	5,03E−9	1,7E−7	1,3E−6	2,41E−9	−7,17E−8
ADP-fossil resources	MJ	9,08E0	3,97E−1	3,51E−1	9,81E0	1,44E0	MND	MND	MND	MND	MND	MND	MND	MND	4,54E−2	1,01E−1	3,25E−1	7,39E−3	−8,33E−1
Water use[3]	m3e depr.	4,79E−1	2,3E−3	3,59E−3	4,85E−1	1,77E−2	MND	MND	MND	MND	MND	MND	MND	MND	8,48E−5	3,57E−4	4,81E−3	3,4E−4	−1,03E−2

1) GWP = Global Warming Potential; EP = Eutrophication potential; POCP = Photochemical ozone formation; ADP = Abiotic depletion potential. 2) EN 15804+A2 disclaimer for Abiotic depletion and Water use and optional indicators except Particulate matter and Ionizing radiation, human health. The results of these environmental impact indicators shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator. 3) Required characterisation method and data are in kg P-eq. Multiply by 3,07 to get PO4e.

8.

Sources: https://www.environdec.com/library
EPD, Cut and Bent Reinforcing Steel Bars

EPD DATABASES / LIBRARIES

DIGITAL ENVIRONMENTAL HUB FOR GLOBAL CONSTRUCTION PRODUCTS

GloCoMDat

Global Construction Products EPD/LCA Database

The data sets follow the international standards and norms and are used for building LCA software, green public procurement (GPP), etc.

Show 10 entries — Showing 1 to 10 of 4,744 entries filtered from 4,758 records — Reset Table

EPD Product Name	Unit	Classification	Country/ Region	Valid Until	EPD Type	EPD Owner	Database	View
3D Fiberglass (LSP - FG)	1.0 m2	Mineral building products / Bricks, blocks and elements / Natural cut stone	TR	2025	Specific Dataset	AKDO-Silkar Madencilik San. ve Tic. AS.	GloCoMDat TurCoMDat	
3M Baseboard and Multi-use Adhesive	1.0 kg	Mineral building products / Mortar and Concrete / Concrete additive	BE	2024	Specific Dataset			
3M P3000 High Performance Wood Floor Adhesive (2 x 3.5 kg bags in a pail)	1.0 m2	Mineral building products / Mortar and Concrete / Adhesive and adhesive mortar	WEU	2024	Specific Dataset	3M Company Europe	GloCoMDat EUCoMDat	
3M P3000 High Performance Wood Floor Adhesive (600 ml sausage)	1.0 m2	Mineral building products / Mortar and Concrete / Adhesive and adhesive mortar	WEU	2024	Specific Dataset	3M Company Europe	GloCoMDat EUCoMDat	
3M QS 2000 B 24 kV moulded rubber splice kit	1.0 Piece	Plastics / Sealing materials / Rubber	FR	2021	Specific Dataset	3M Company Europe	GloCoMDat EUCoMDat	

https://lcadatabase.com/

COMPARISON OF BUILDING LCA TOOLS

Embodied Carbon Calculators

Data from Environmental Product Declarations

CIC Carbon Assessment Tool
建造業議會碳評估工具

EC3
Embodied Carbon in Construction Calculator (EC3) tool

Life Cycle Assessment Tools

One Click LCA

Athena Sustainable Materials Institute

Dr. Meike Sauerwein
10. February 2023

LIMITATIONS OF LCA

LCA LIMITATIONS

THE ELUSIVE BENCHMARK

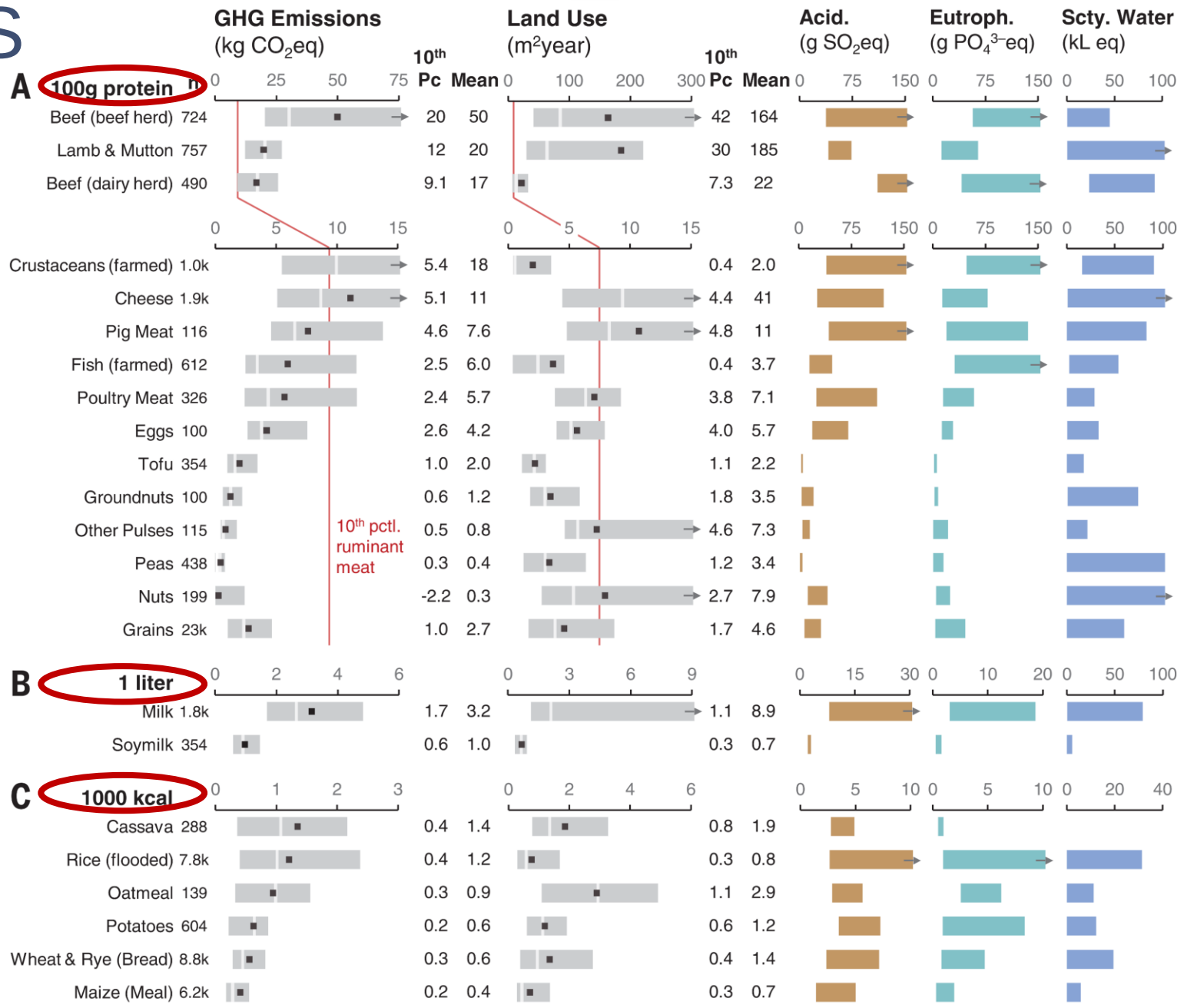
LCA Comparison shows what is a **“better product” not** what’s **sustainable**

LCA LIMITATIONS

COMPARABILITY OF RESULTS

Published reports may not be comparable

e.g. different functional units

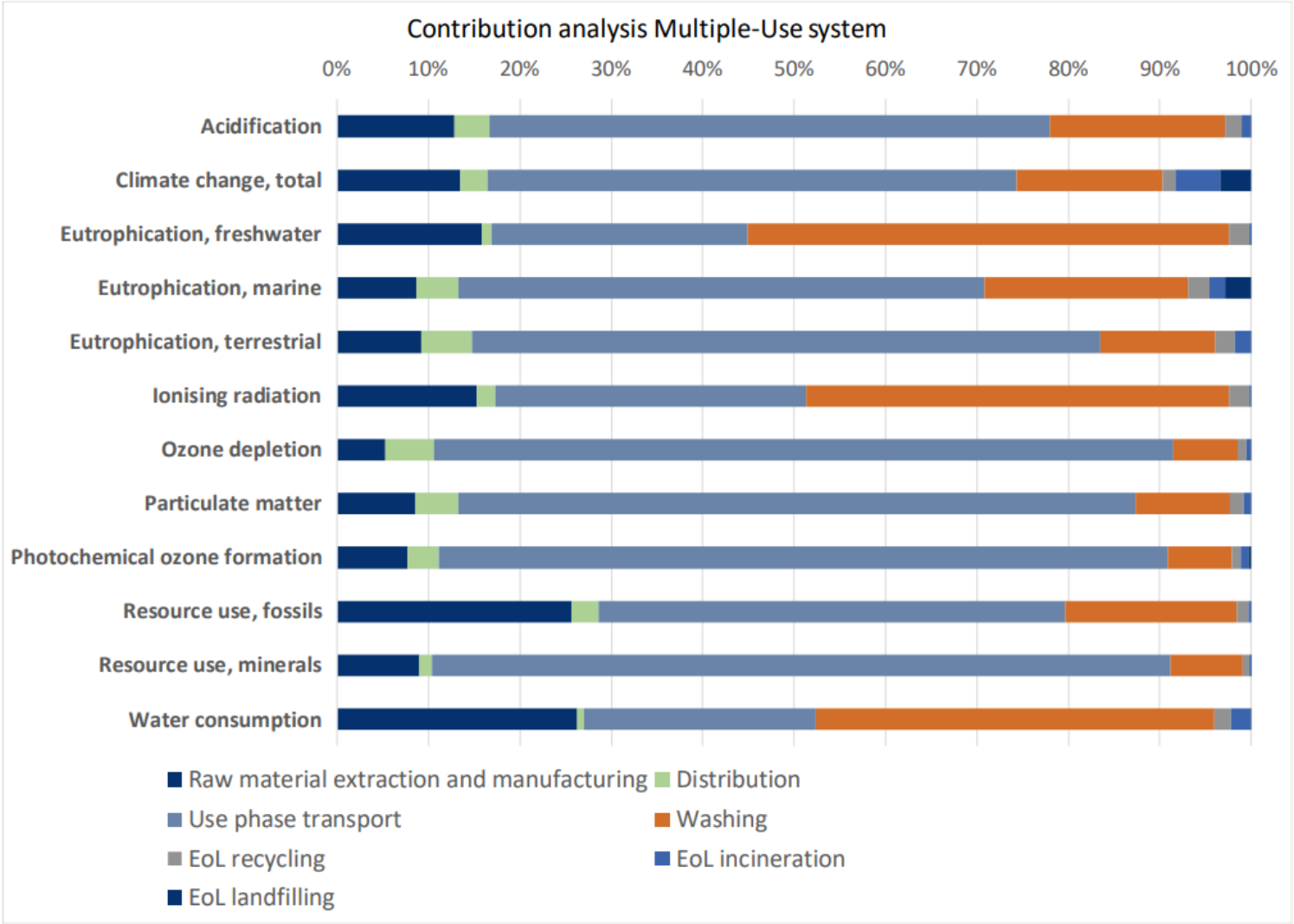


LCA LIMITATIONS

COMPARABILITY OF RESULTS

Published reports may not be comparable

e.g., setting boundaries & process inclusion / exclusion



Source; Ramboll 2022: COMPARATIVE LIFE CYCLE ASSESSMENT (LCA) SINGLE-USE AND MULTIPLE-USE TABLEWARE SYSTEMS FOR TAKE-AWAY SERVICES IN QUICK SERVICE RESTAURANTS

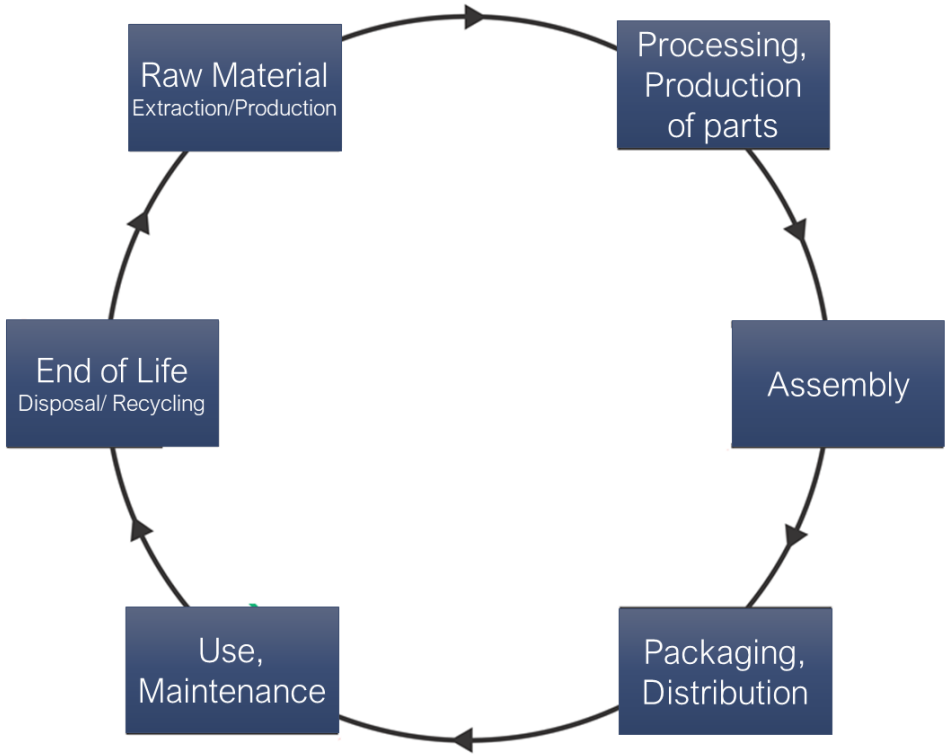
LCA LIMITATIONS

RESULTS ARE NOT UNIVERSALLY TRUE

LCA results not universally true for all different locations, times, societies

→ comparability can be low

e.g., environmental performance of EV depends on local electricity grid

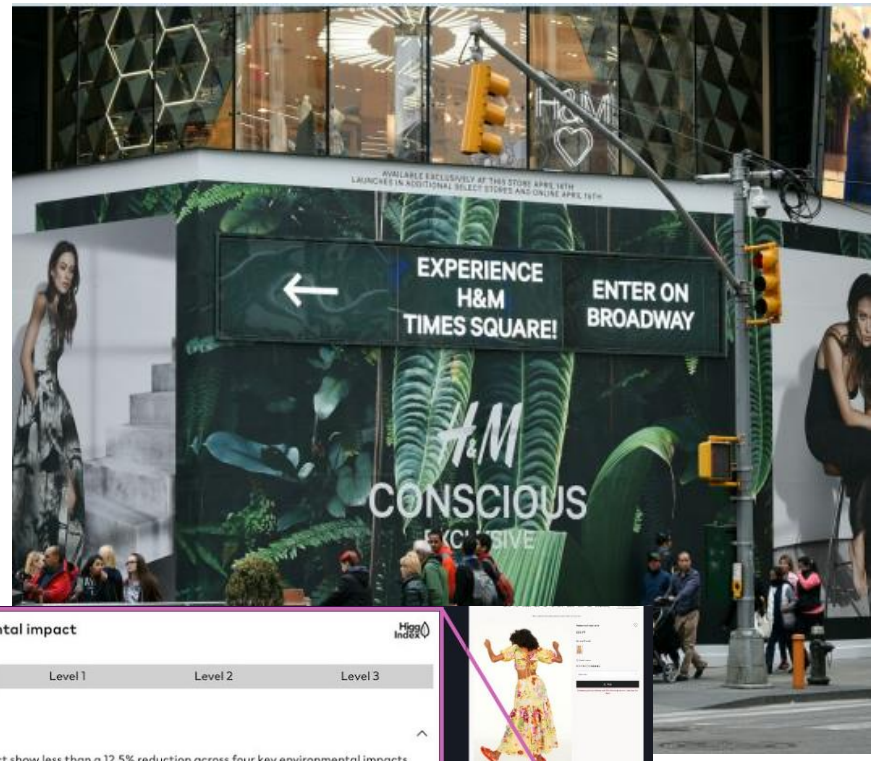


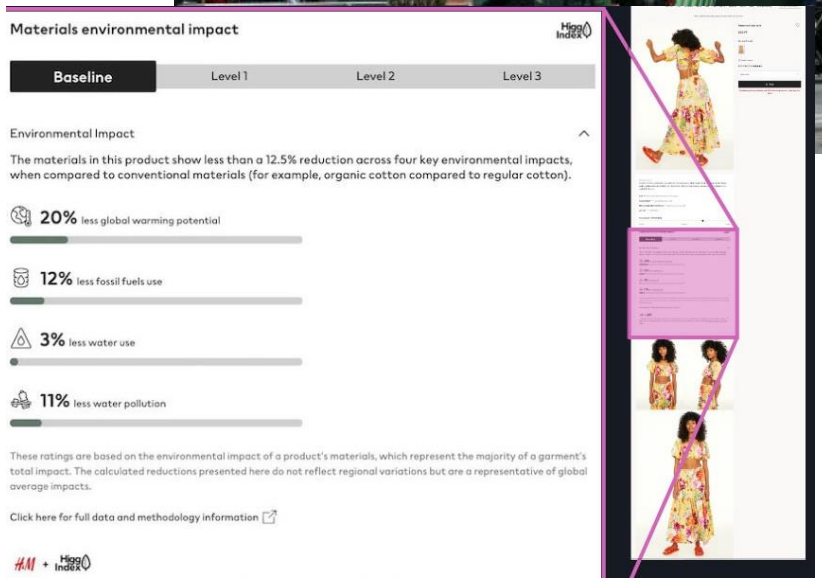
LCA LIMITATIONS

ALL YOU NEED IS DATA, DATA, DATA

- **Hugh amount of high-quality data required**
  - data can be inadequate, lacking or confidential
    → assumptions necessary
  - time & resource & cost intensive
    → Doing LCA for millions of products – an impossible task?

- **Datasets can be outdated / not representative / incomplete -** Example organic cotton H&M





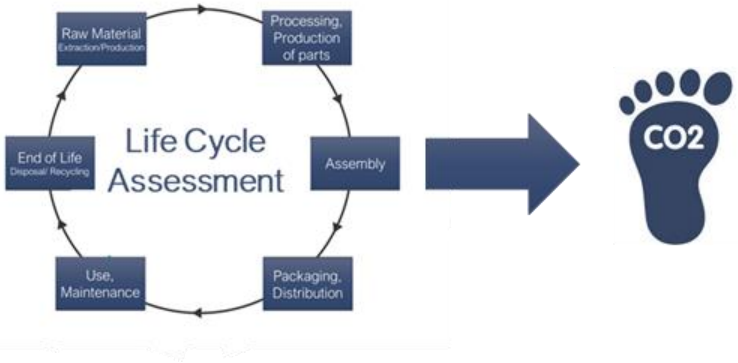
Source: https://qz.com/2180075/hm-showed-bogus-environmental-higg-index-scores-for-its-clothing

Source: Commodore v. H&M Hennes & Mauritz LP 2022; BATES KASSATLY and BAUMANN-PAUL (2022): The great Greenwashing Machine Part 2: The Use And Misuse of Sustainability Metrics In Fashion

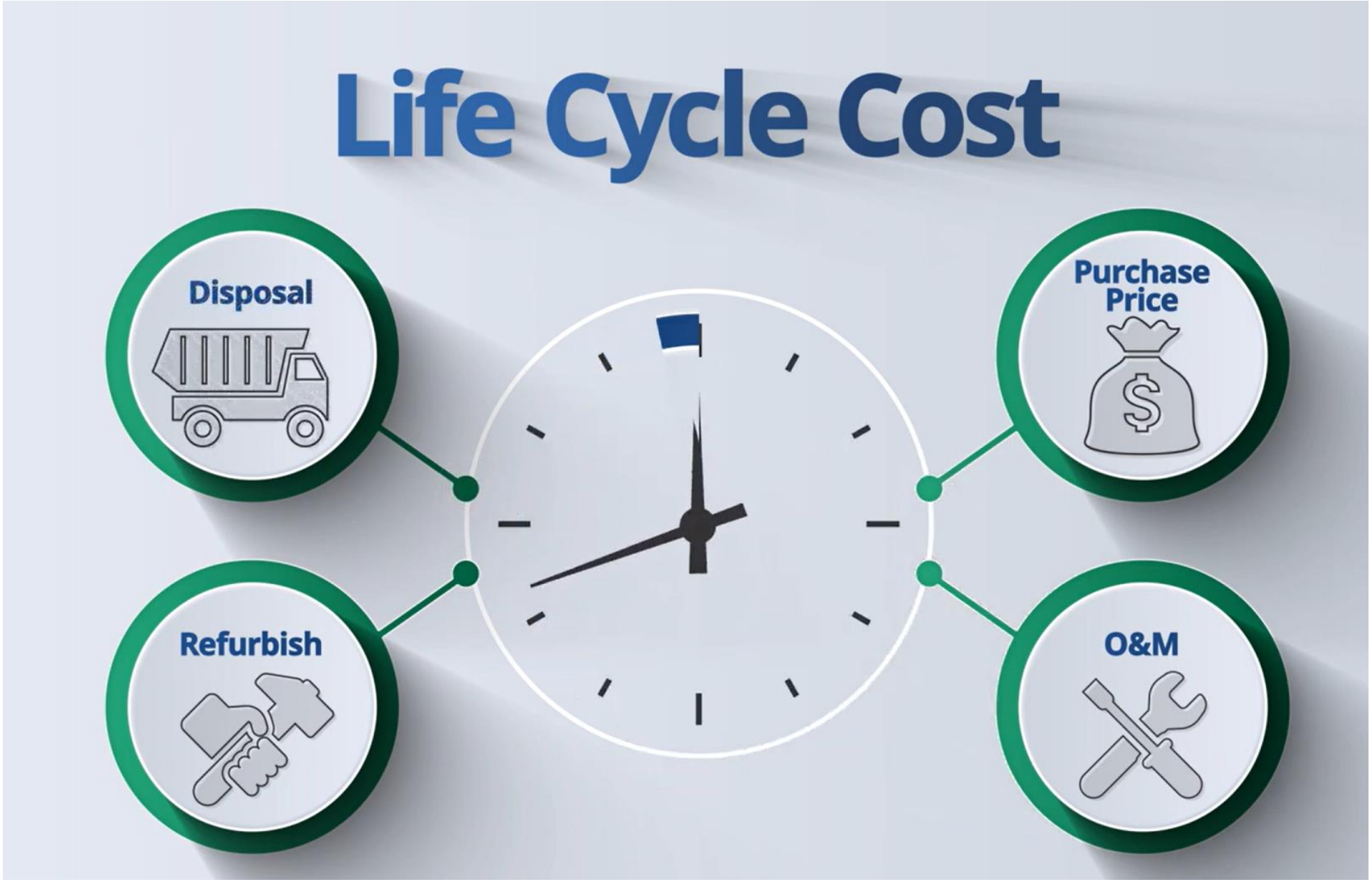
LCA LIMITATIONS

JUST AN ANALYSIS TOOL

LCA itself is just an analysis tool to evaluate and track performance & **doesn't require the analyst to take action nor guarantees that the right action will be taken** to improve the sustainability performance of products/processes and services



LIFE CYCLE COSTING

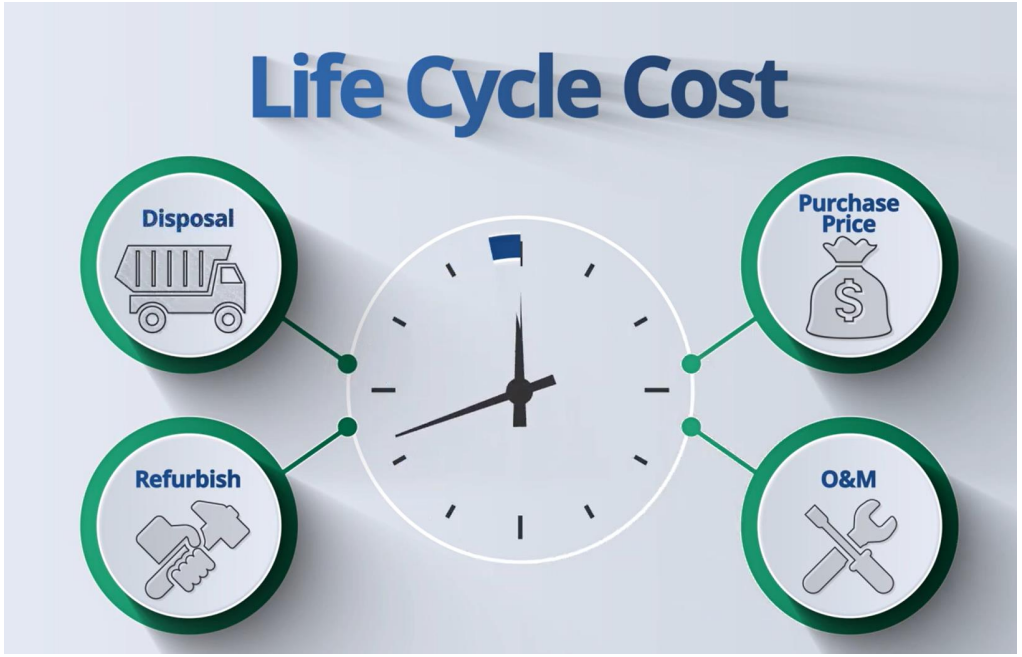


https://www.youtube.com/watch?v=leploo_Kv84

LIFE-CYCLE COSTING (LCC)

Life-cycle costing (LCC) means considering all the costs that will be incurred during the lifetime of the product, work or service:

- **Purchase price** and all associated costs (delivery, installation, insurance, etc.)
- **Operating costs,** including energy, fuel and water use, spares, and maintenance
- **End-of-life costs** (such as decommissioning or disposal) **or residual value** (i.e. revenue from sale of product)



Source: https://ec.europa.eu/environment/gpp/lcc.htm

LIFE CYCLE ASSESSMENT / COSTING

EXAMPLES: TOOLS DEVELOPED BY THE EUROPEAN COMMISSION

The European Commission has developed a series of sector specific LCC calculation tools which aim to facilitate the use of LCC amongst public procurers.

Vending Machines
- User Guide
- LCC Tool

Imaging Equipment
- User Guide
- LCC Tool

Computers and Monitors
- User Guide
- LCC Tool

Indoor Lighting
- User Guide
- LCC Tool

BEFORE TENDERING

To assess the LCC of the current situation and roughly evaluate different solutions to help guide pre-tendering market engagement activities, or to narrow down different technological solutions.

DURING TENDERING

To compare offers during the evaluation and award of contracts, as foreseen in Directives

AFTER TENDERING

To evaluate the performance of the awarded solution in comparison to the previous situation or other offers, to monitor and communicate results and help prepare future tenders.

- Identify **cost drivers**
  - some can be easily included in LCC calculations, such as energy consumption.
  - Others -such as durability might be relevant from an economic point of view but are more difficult to quantify in terms of how much they increase the product's lifespan.
- Besides cost drivers, **basic parameters** for the LCC need to be defined (evaluation period, discount rate, your electricity cost, etc.).

Source: https://ec.europa.eu/environment/gpp/lcc.htm

LIFE CYCLE COSTING

COSTS ARE ACCUMULATED OVER A LIFESPAN

Monetary flows occur at different times.

→ This complicates the analysis for two reasons.

1. **prices change due to the market dynamics**

   *Car example: all costs associated with a car (steel, labour, fuel, plastics, taxes etc.), are change from year to year. → In the long run there is a sustained **increase in the general price of goods***

   →In LCC one would like to compare costs based on a chosen reference year and therefore all costs needs to be adjusted to that year when doing the comparison. This is done by **using inflation rates**.

2. **people are likely to have a time preference**, and often **prefer to spend money later rather than now**.
   - LCC accounts for this comparison of comparing future and present costs by using **discounting**. Discounting essentially weights impacts by assigning a lower weight to costs in the future than present costs.

LIFE CYCLE COSTING (LCC)

- Conventional LCC (financial LCC): original method, and in many ways synonymous with Total Cost of Ownership.
- Environmental LCC is **aligned with environmental LCA** in terms of system boundaries, functional unit, and methodological steps.
- Societal LCC includes **monetarization of other externalities**, including both environmental impacts and social impacts (less developed)

Table 15.2 Comparison of the different variants of life cycle costing

	Conventional LCC	Environmental LCC	Societal LCC
Goal	The assessment of all life cycle costs that are directly covered by the main producer or user in the product life cycle	The assessment of all life cycle costs that are directly covered by all stakeholders connected to the product life cycle	The assessment of all life cycle costs that are covered by anyone in the society
Definition of the life cycle	Economic lifetime, often excluding end-of-life	Complete life cycle	Complete life cycle
Perspectives	Mainly one stakeholder, either manufacturer or user	One or more stakeholders connected to the life cycle	Anyone in the society, often governments
Reference unit	Product or project	Functional unit	functional unit
Types of costs	Internal costs of one stakeholder, focusing mainly on acquisition and ownership costs	Internal costs of stakeholders connected to the life cycle, plus external costs and benefits expected to be internalised such as CO_2 taxes	Internal costs of all actors plus external costs, i.e. impacts that production or consumption have on third parties
Adjustment to inflation	Yes	Yes	Yes
Discounting of results	Consistent, with discount factors ranging between 5 and 10%	No. Discounting the results of the LCC would make the analysis inconsistent with the steady-state assumption of LCA (see Sect. 15.5 on discounting)	Consistent but usually low discount factors (<3%)
Consistent with LCA?	No	Yes, but with a risk of double counting the monetarised environmental impacts	No, due to risk of double counting and inconsistencies with the quasi-dynamic approach in sLCC (see Hunkeler et al. (2008))
Standards	Multiple standards, including ISO 15663, IEC 60300-3-3, BS 3843, AS/NZS 4536, ISO 15686	None, but follows the LCA standards ISO 14040/14044	Currently no standards

Hauschild et al. 2018 - Life Cycle Assessment – Chapter 15

CONVENTIONAL LIFE CYCLE COSTING

- only internal costs are considered
  → Total Cost of Ownership (TCO)

- Activity-Based-Costing (ABC)
  → hotspot identification

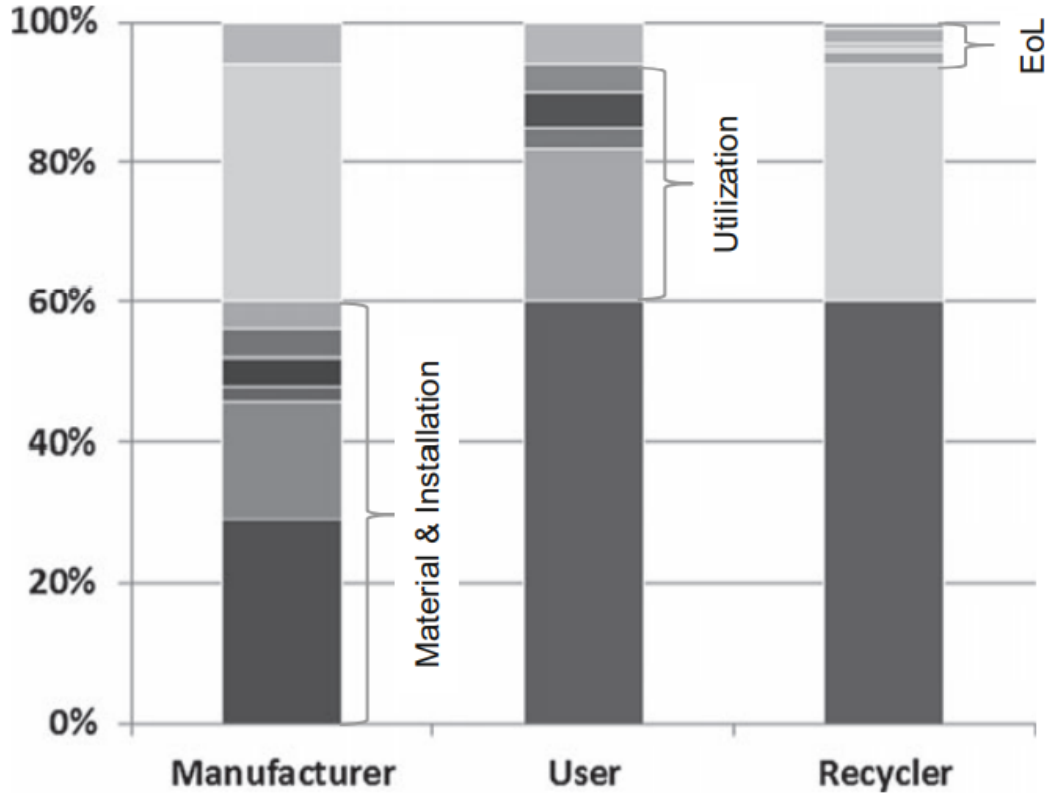
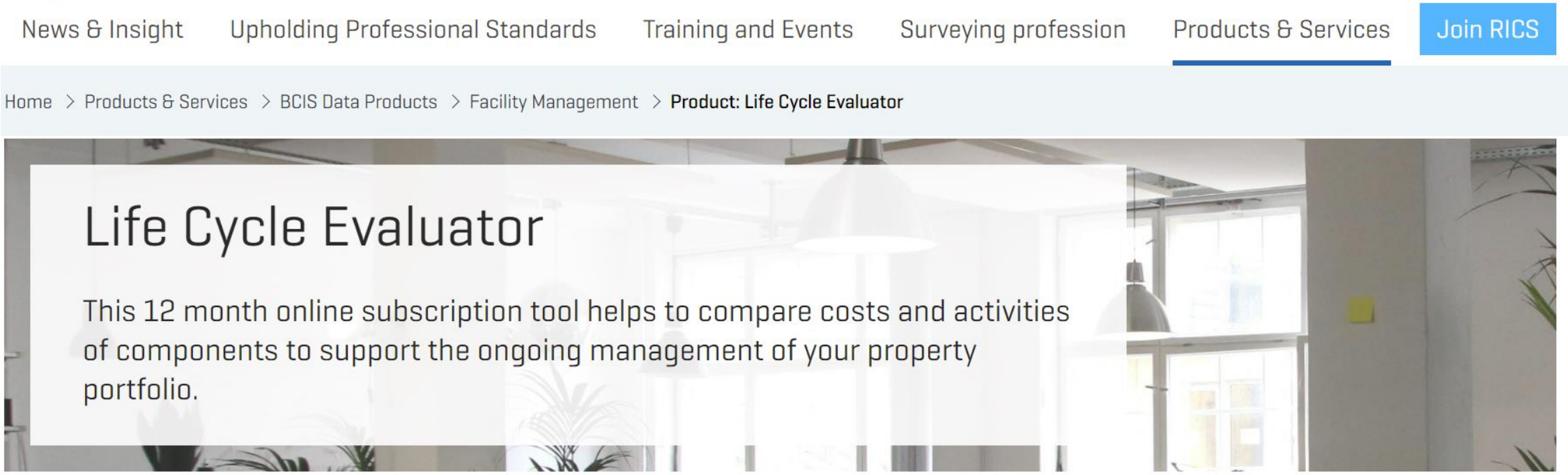


Fig. 15.1 Different level of details for different actors in life cycle costing of a passenger car

LIFE CYCLE COSTING

TOOLS

Have you / has your organization been applying Life Cycle Costing?
In what context?



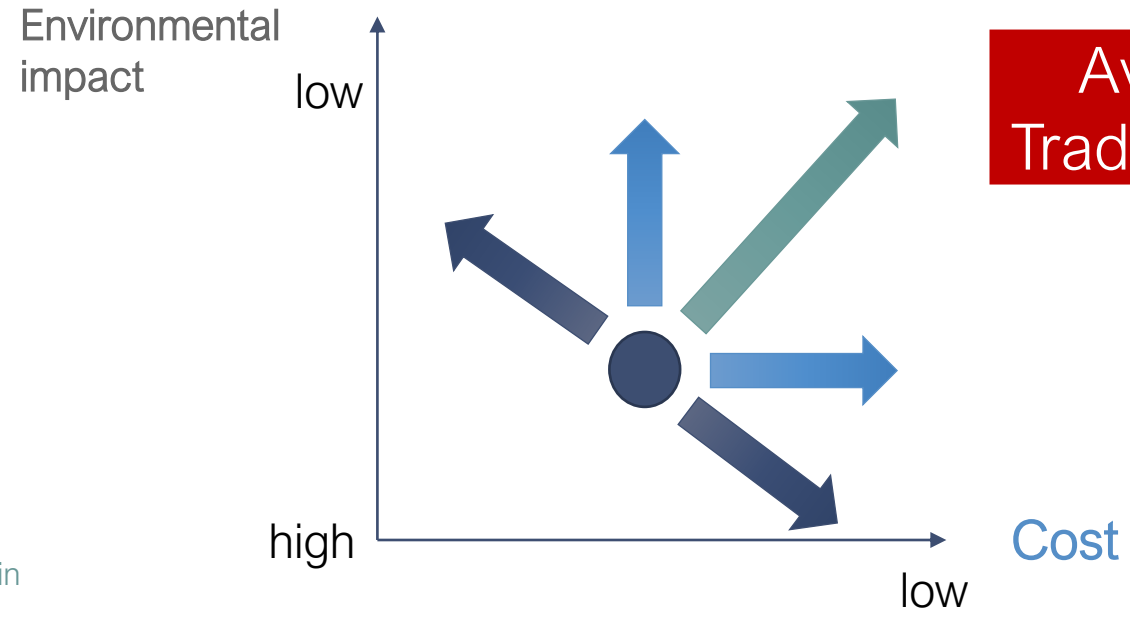
Source: https://www.rics.org/en-hk/products--services/data-products/facilities-management/life-cycle-evaluator/

LIFE CYCLE COSTING IN PRACTICE

CHEMICAL INDUSTRY

– EXAMPLE: BASF (ECO-EFFICIENCY TOOL)

- Comparing Environmental Performance with Cost (Life Cycle Costing) → *Portfolio Graph*
- Aggregate different environmental impacts into one score (index)



Avoid Trade-Offs

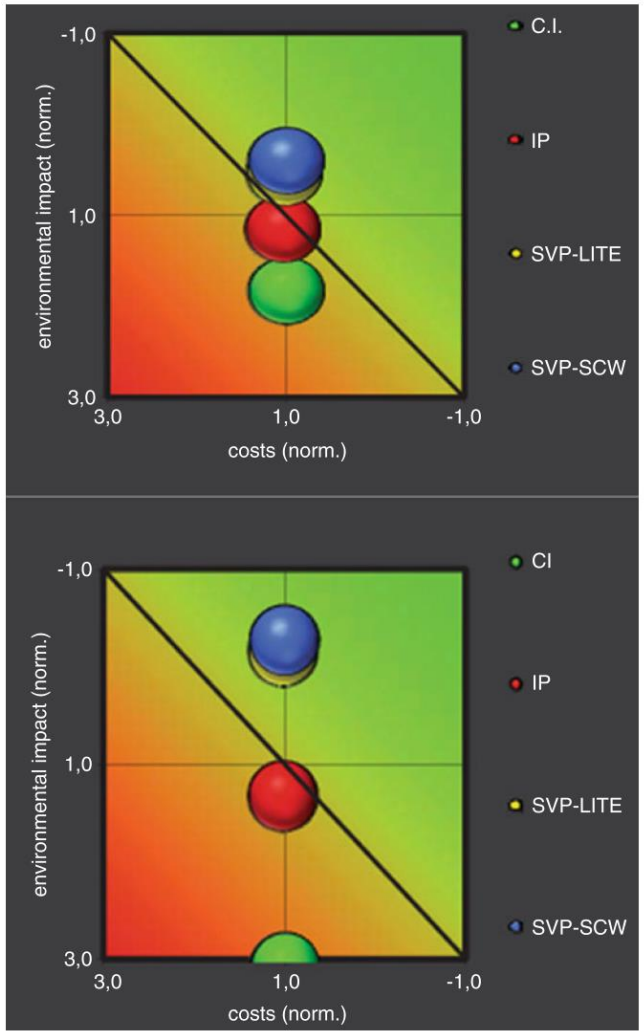
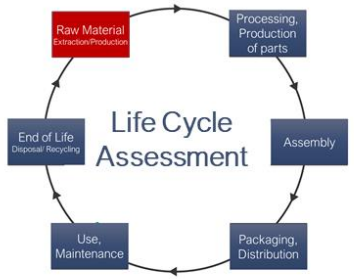


Fig. 4.8 The eco-efficiency portfolio comparison (*upper*, base case; *lower*, scenario with Indonesian electricity mix)

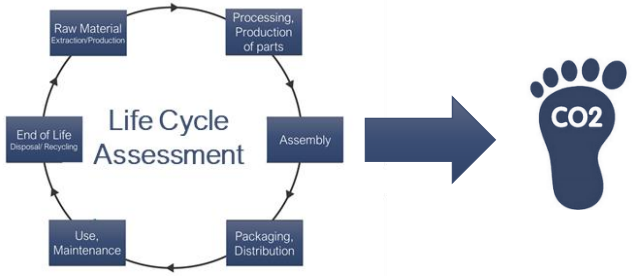
Key Takeaways Life Cycle Assessment

1. Identify HOT SPOTS within a product's life cycle

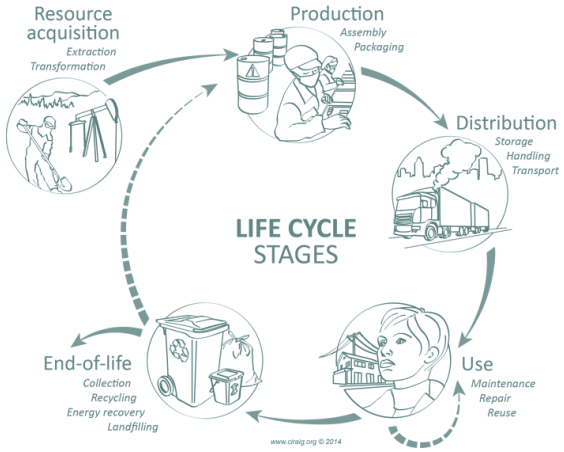


Hot Spot:
Process that causes significant impacts

2. Identify TOTAL IMPACTS that occur along a product's life cycle (eco-footprint of a product)



Key Takeaways Life Cycle Assessment



- There is a **growing demand for quantification of impacts** and disclosure, esp. of carbon emissions along the product/ building life cycle
- Trends point into the direction that corporates have to consider their supply chain emissions
- LCA is a mature tool, yet
  - new, simplified applications are developed by various institutions to make LCA more accessible
  - applications of LCA expand to more and more sectors

THANK YOU FOR YOUR ATTENTION!

Feel free to stay and ask question or continue earlier discussions

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