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:

Dr. Meike Sauerwein, Lecturer, The Hong Kong University of Science and Technology

Moderator: Mr. Felix LAM

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

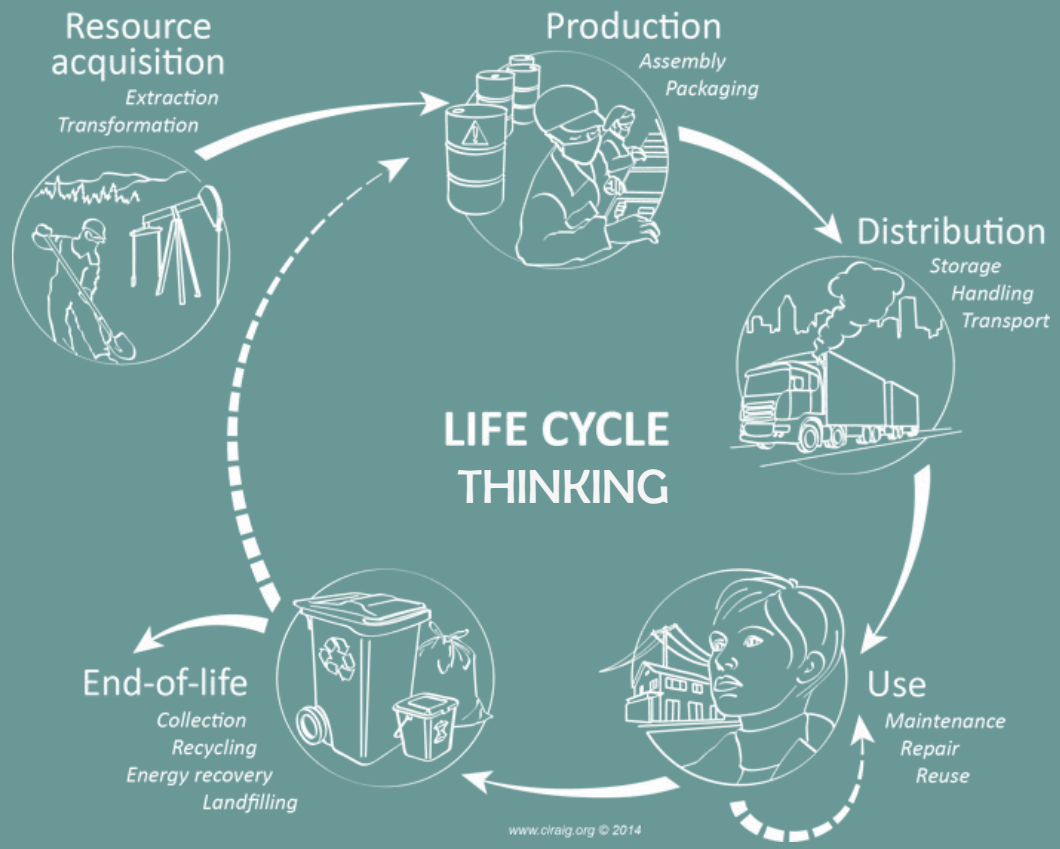
MOVING TOWARDS NET ZERO?

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

Dr. Meike Sauerwein

meike@ust.hk

6. April 2022



YOUR EXPECTATIONS

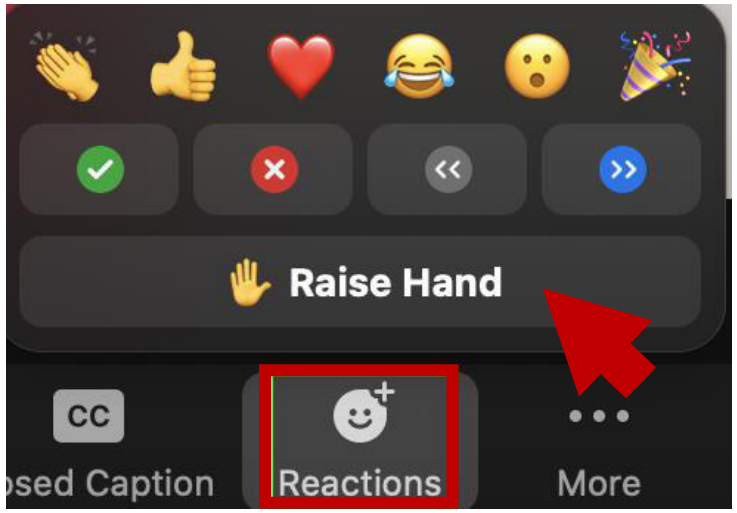
Mentimeter

- 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?

Go to: menti.com
Login Code:
81 30 05 9

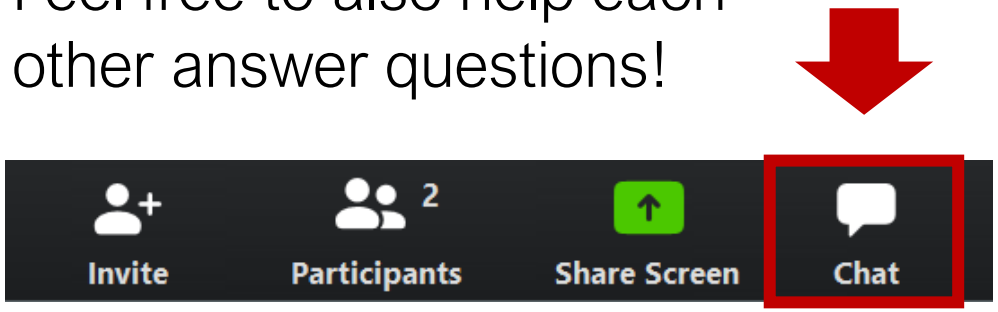
ANY QUESTIONS?

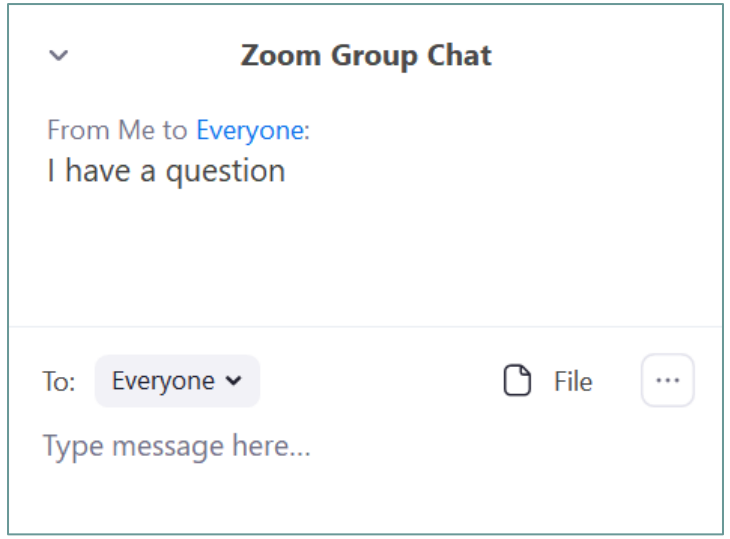
Feel free to raise your hand and ask at any time.



Chat

Ask & answer questions or leave comments in the chat. Feel free to also help each other answer questions!



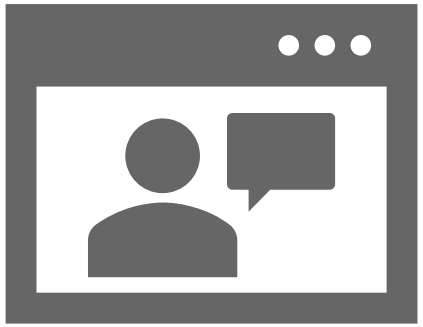


…TO MAKE THINGS EASIER FOR ME ☺

Please rename yourself so that ZOOM shows

1. your **preferred name** (how you want me to call you) and
2. your **organizations name**

e.g., M. Sauerwein (HKUST), or Meike (HKUST)



Since we are all interested in low carbon solutions:
Feel free to leave your video off while I am talking,
but I would appreciate if you cold **turn it on for breakout rooms**.

OUTLINE

PART 1 - TODAY

- 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

I planned for 2 short breaks in between – but feel free to let me know if you prefer to have less/more/longer/shorter ones

OUTLINE

PART 2 - FRIDAY

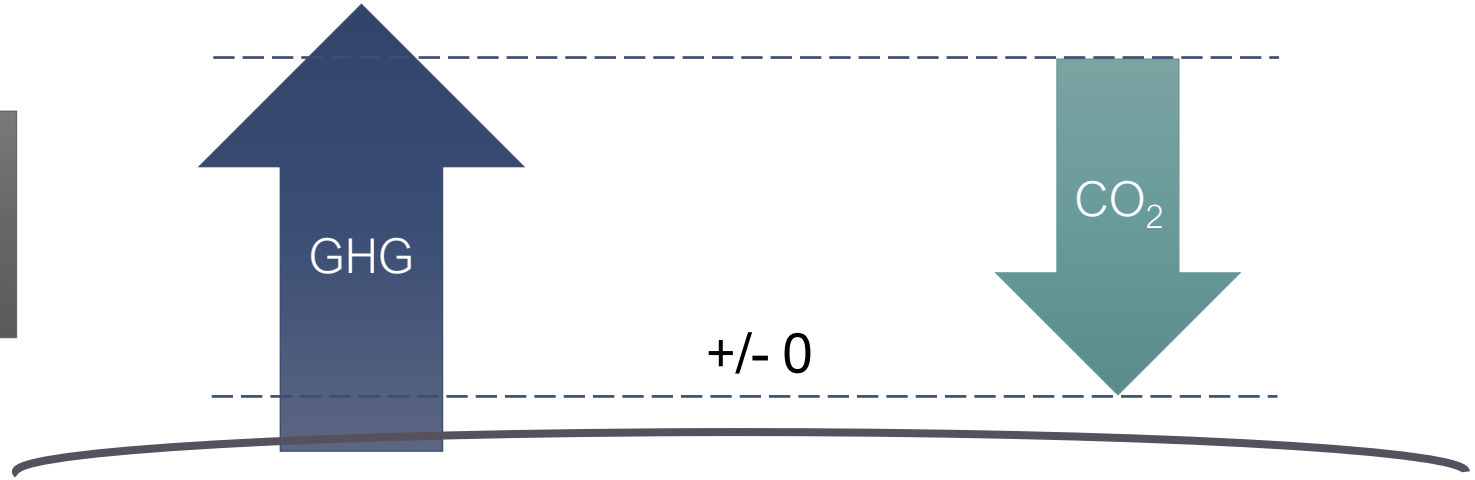
- Life Cycle Assessment Methodology
  - Recap and linkage to key frameworks and ISO standards
  - Discuss benefits and limitations
- Life Cycle Assessment Tools & Applications
  - Examples of common uses of LCA
  - Using LCA results – what to pay attention to?
- Life Cycle Costing
  - Key concept and examples

Feel free to ask about / suggest specific topics – I'll try my best to include what interests you ☺

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.

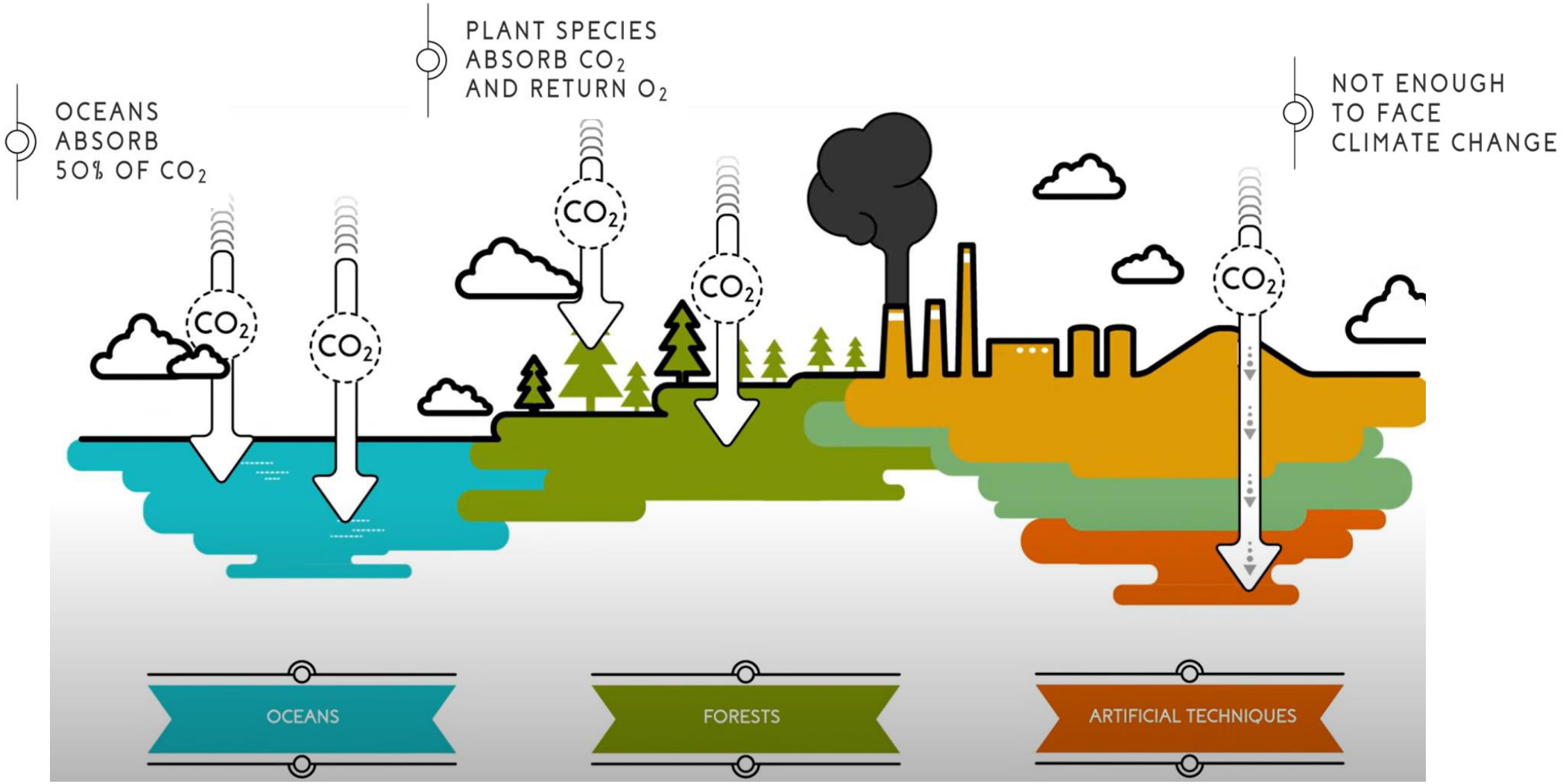
~60 $GtCO_2$-eq
Global net anthropogenic GHG emissions in 2019



*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

WHAT IS NET ZERO?

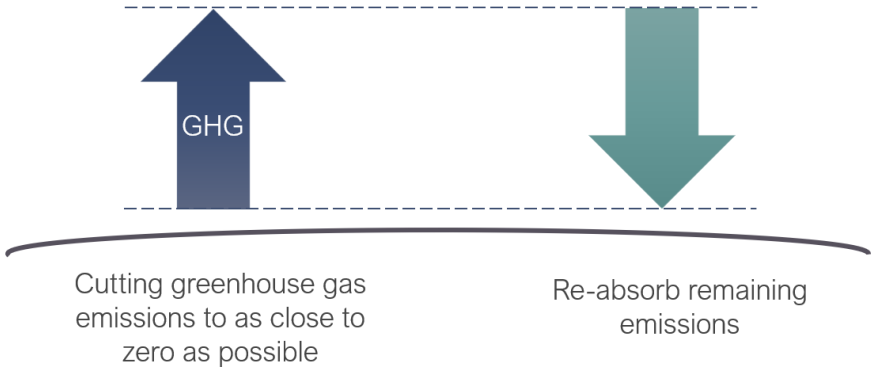


Source: https://www.youtube.com/watch?v=OoW2PlvMpZs

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.

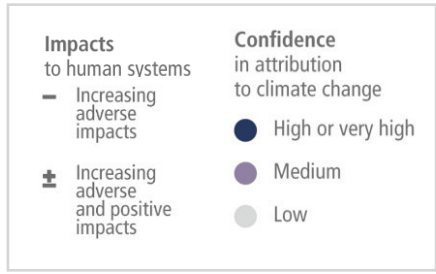
Current national climate plans – for all 193 Parties to the Paris Agreement taken together – **would lead to an increase of 14%** in global greenhouse gas emissions by 2030, compared to 2010 levels.

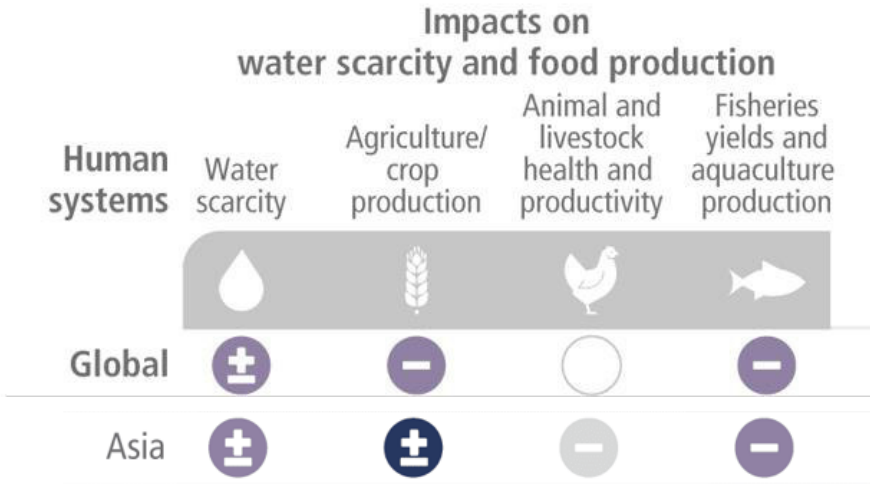
Source: United Nations – Climate Action; https://www.un.org/en/climatechange/net-zero-coalition

Need for accurate quantification techniques!

CLIMATE CHANGE IMPACTS

Pathways with the near-term emissions characteristics,
lead to a median **global warming of 2.4°C - 3.5°C by 2100**





Source: IPCC AR6, WG II and III; Climate Change 2022, Impacts, Adaptation and Vulnerability & Mitigation of Climate Change;
https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_FinalDraft_FullReport.pdf
https://report.ipcc.ch/ar6wg3/pdf/IPCC_AR6_WGIII_FinalDraft_FullReport.pdf

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 (halve emissions before 2030 and achieve net-zero emissions before 2050)

- Organizations disclose emissions annually and monitor progress on reaching the target.
- By March 2022 1,326 companies have put in place science-based targets in line with net zero

How many of these do you think are from Hong Kong?

*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

COMPANIES THAT COMMITTED TO SCIENCE-BASED TARGETS

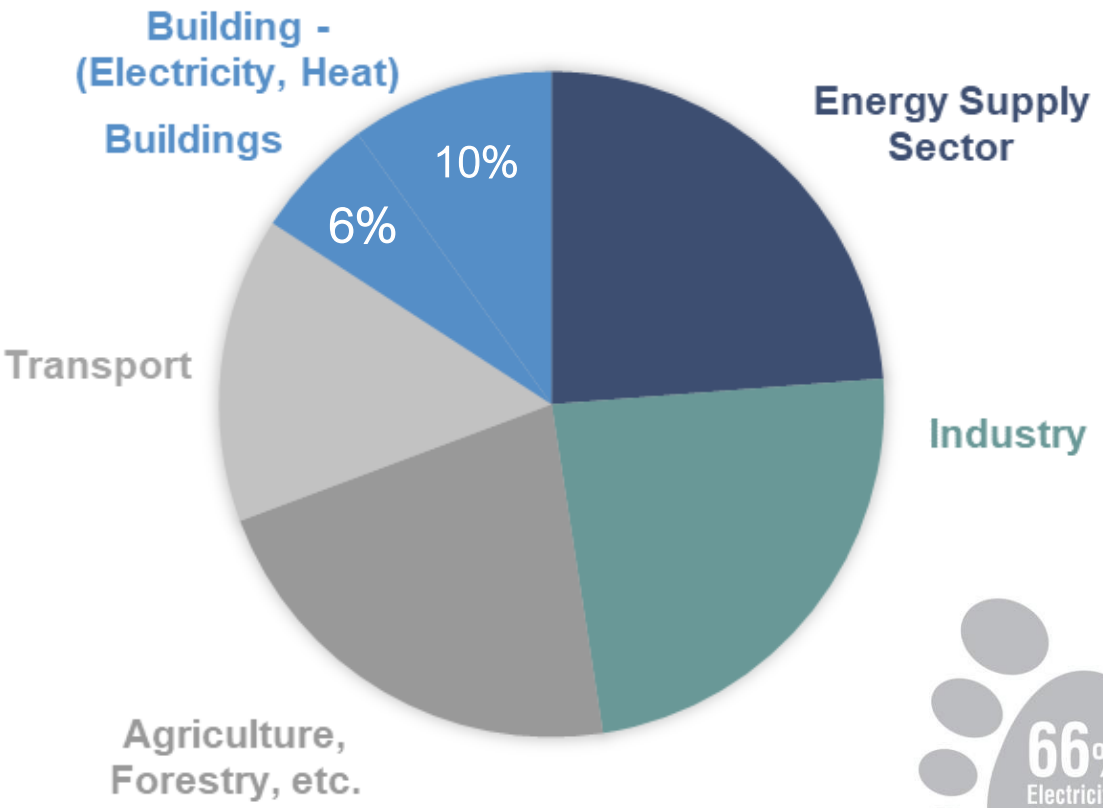
CORPORATE EXAMPLES

City Developments Limited (CDL)*	Singapore	Real Estate
HeidelbergCement AG	Germany	Construction Materials
Mitsubishi Estate Co.,Ltd.*	Japan	Real Estate
Salzgitter AG*	Germany	Mining - Metals (Iron, Aluminium, Other Metals)
Schüco International KG	Germany	Building Products
Sumitomo Forestry Co., Ltd	Japan	Homebuilding
Frasers Property Commercial Management Pte Ltd	Singapore	Real Estate
FUJI SASH CO.,LTD.	Japan	Construction Materials

43 Japanese, 10 Singaporean, 5 South Korean, 1 from Hong Kong (as of March 2022)

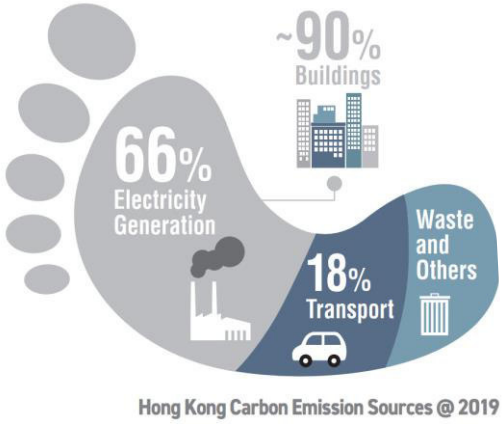
Source: UN Global Compact, 2022 Business Leaders Taking Action; https://www.unglobalcompact.org/take-action/events/climate-action-summit-2019/business-ambition/business-leaders-taking-action

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% 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

‘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/

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

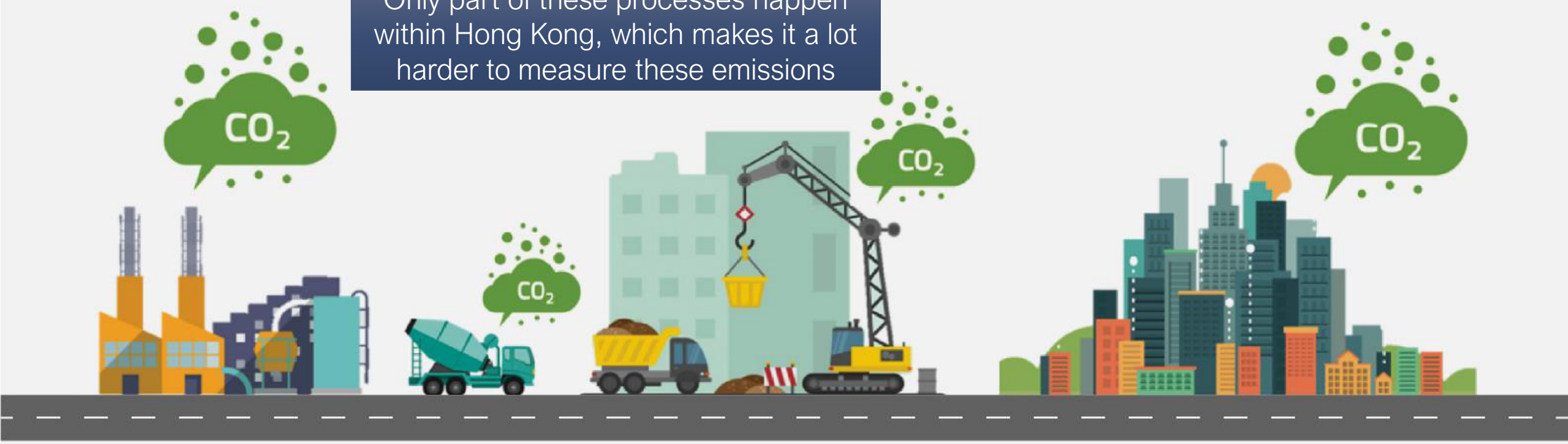
e.g., Eating, Doing laundry…

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)

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



‘Upfront’ Embodied Carbon

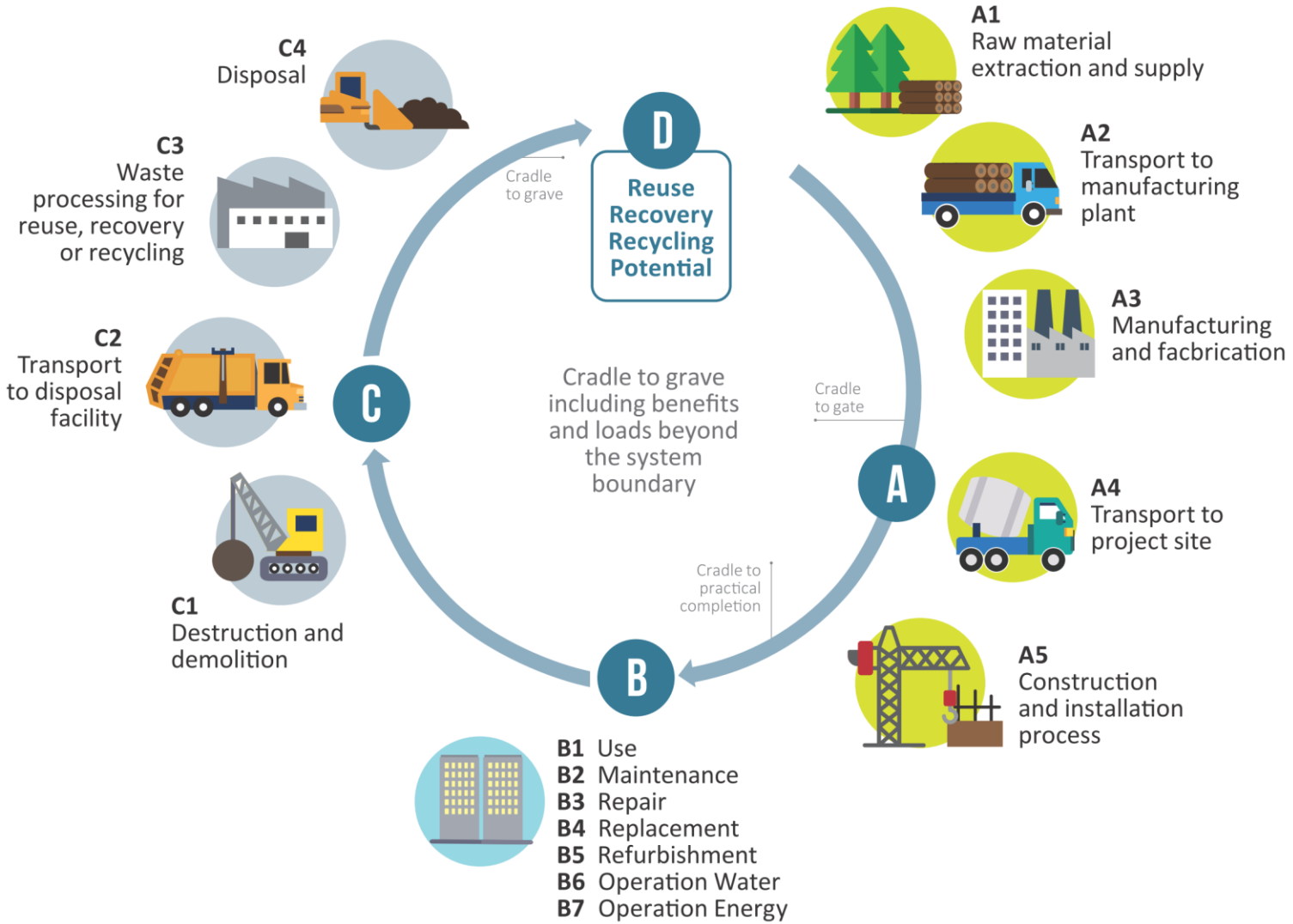
Manufacturing, transportation, and installation of construction materials

Operational Carbon

Building energy consumption

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

BUILDING LIFE CYCLE



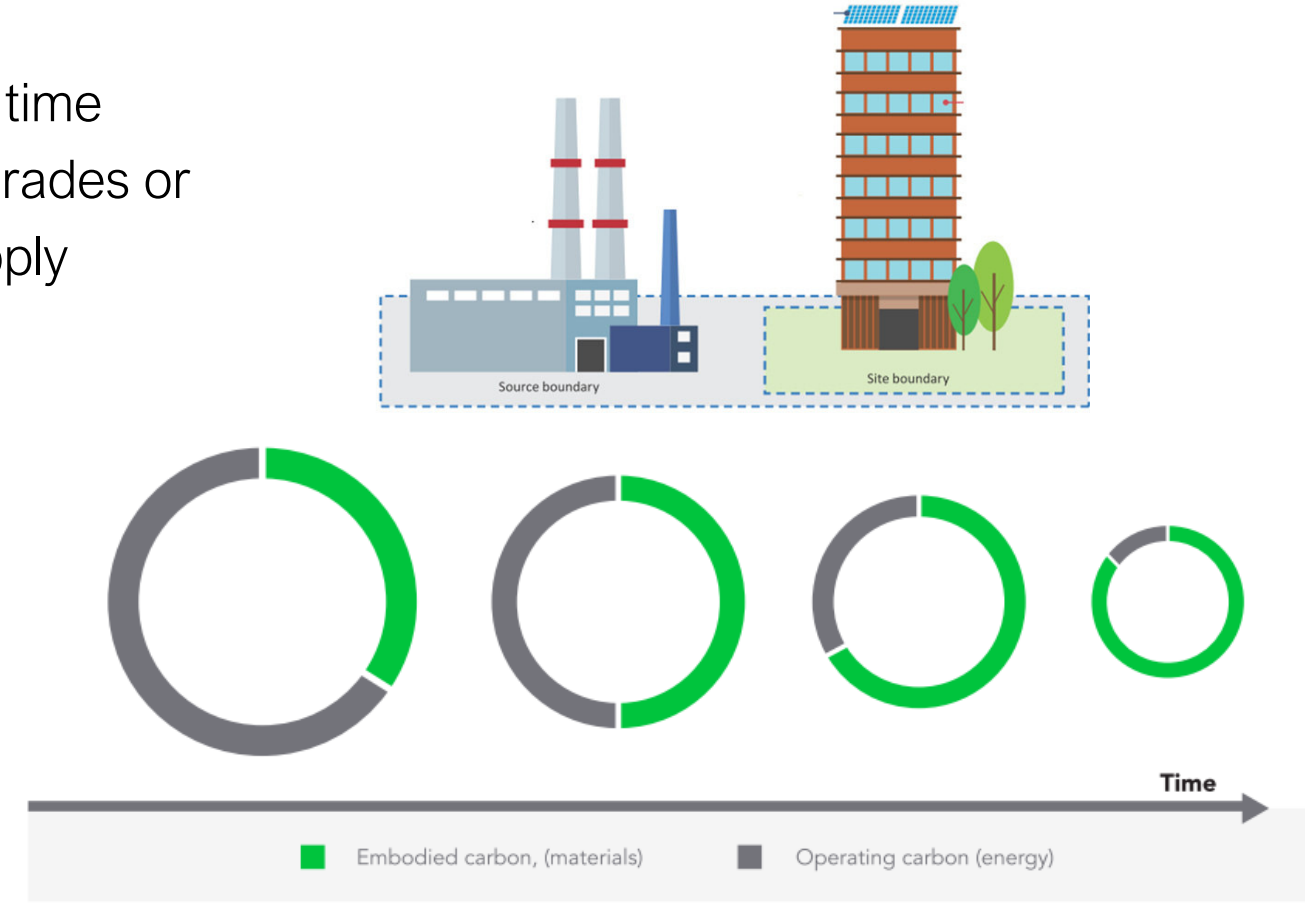
Source: Civic Exchange, HKGFA, 2020: Decarbonising Hong Kong Buildings Policy Recommendations and Next Steps

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

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.

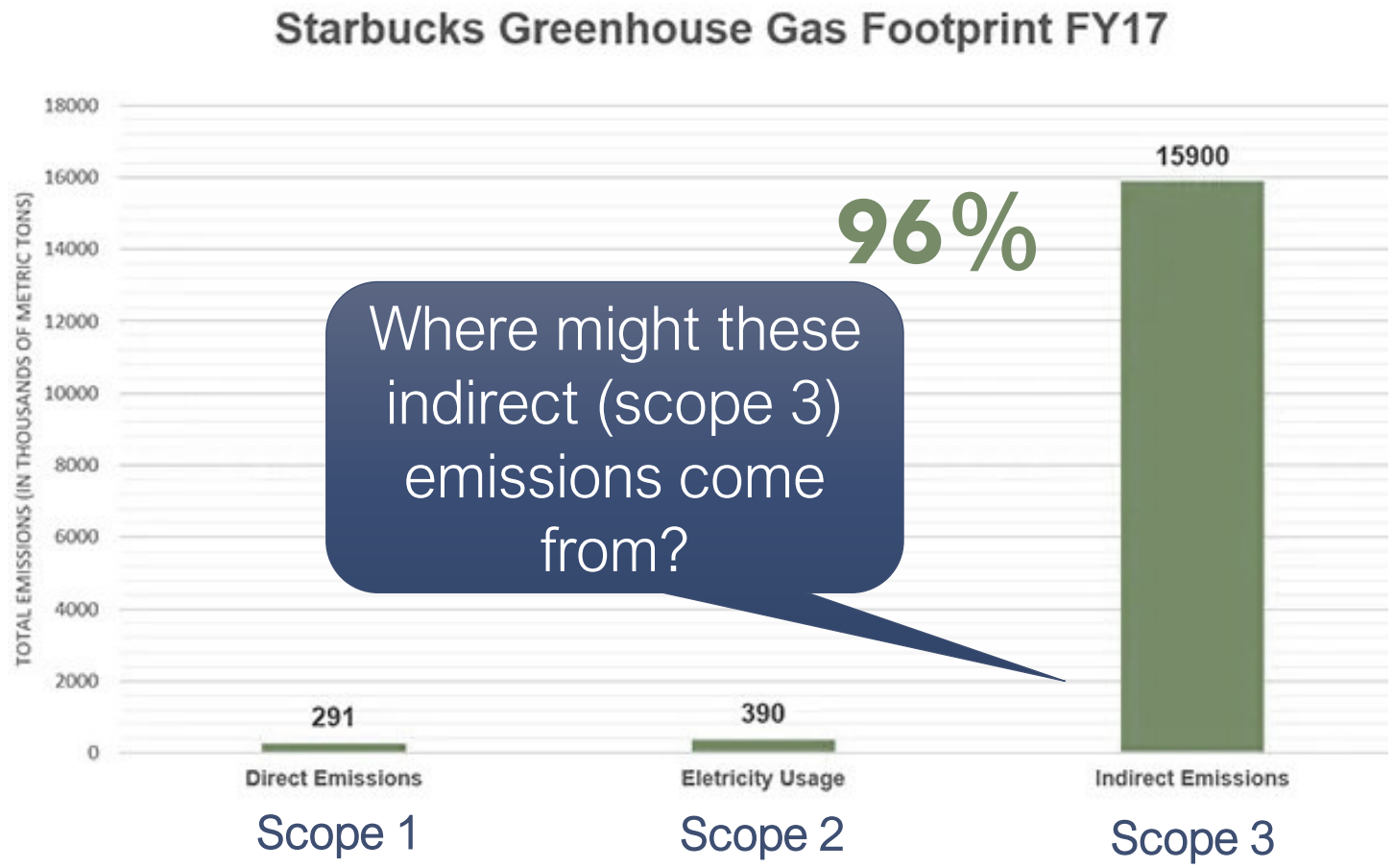
Source: CDP, 2018: How can companies address their scope 3 greenhouse gas emissions?
https://www.cdp.net/en/articles/companies/how-can-companies-address-their-scope-3-greenhouse-gas-emissions

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.



SCOPE 3 EMISSIONS

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

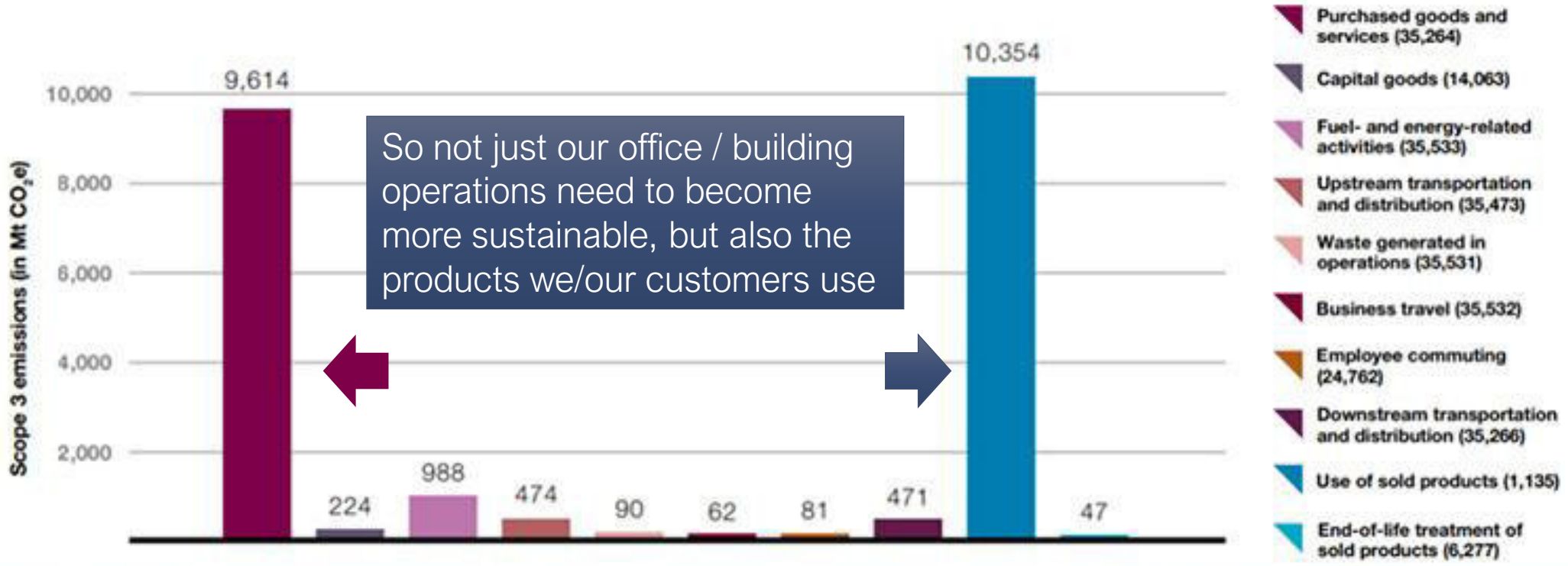


Figure 1. Scope 3 emissions estimated by CDP for 35,533 companies per emission source in year 2014. The number of companies for which each type of Scope 3 emissions was calculated is presented in parentheses for each sector.

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

ACTIVITY 1 – DISCUSSION

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

Group discussion in Breakout rooms

10 min

Take notes on the shared google slide
(access link on the zoom chat)

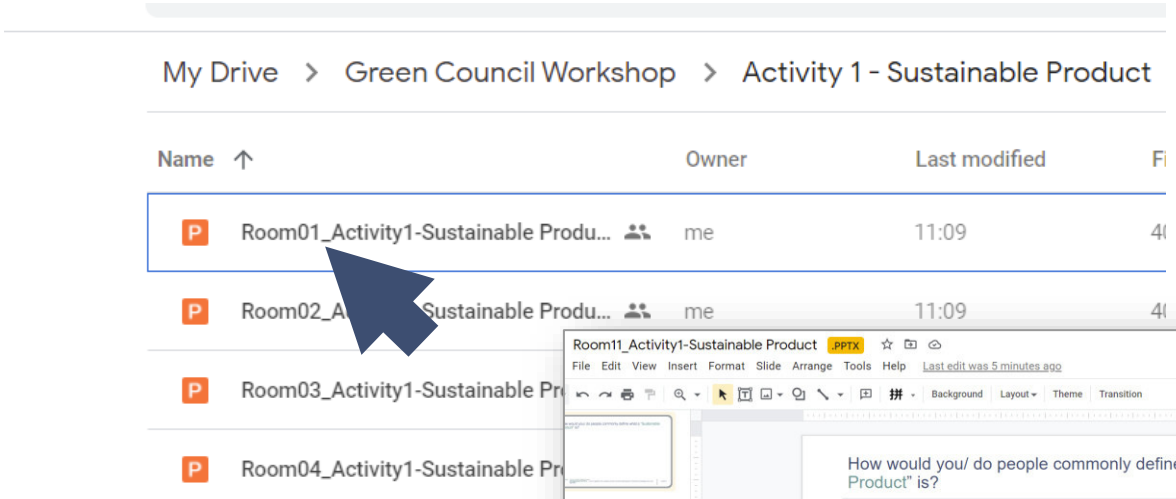
ACTIVITY 1

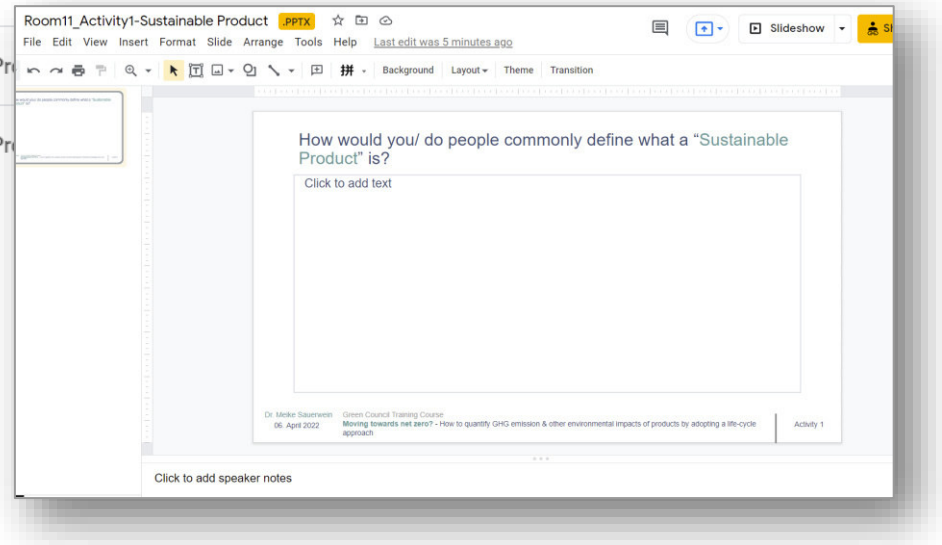
INSTRUCTIONS

https://bit.ly/3LI8ZBi

Each room has their own note sheet on google drive → see link on the chat

Please only edit the sheet that matches with **your room number**





IN THE BREAKOUT ROOM…

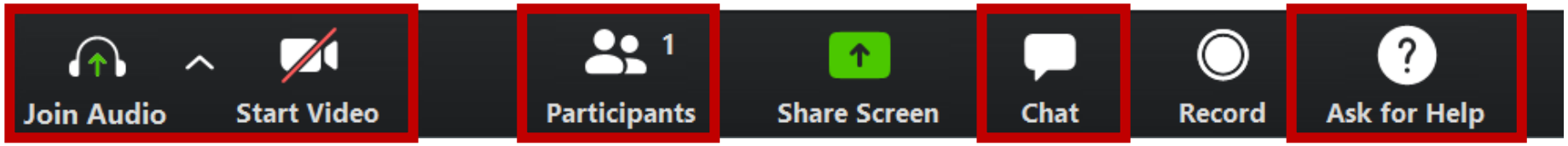
Facilitators are indicated with an “F” in front of their name.
He/she should

- Encourage everyone to briefly introduce themselves
- take the lead to start the discussion and ensure that at least one room member is taking notes

Need Help from Host?

Please don't click unless you have to :)

Say hi to each other
w/mics + cam

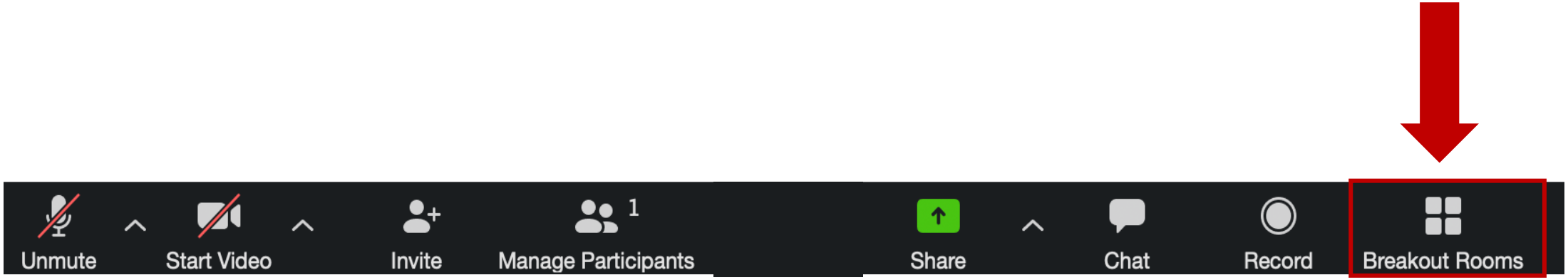


Find out who are your roommates

Chat with your roommates or share links

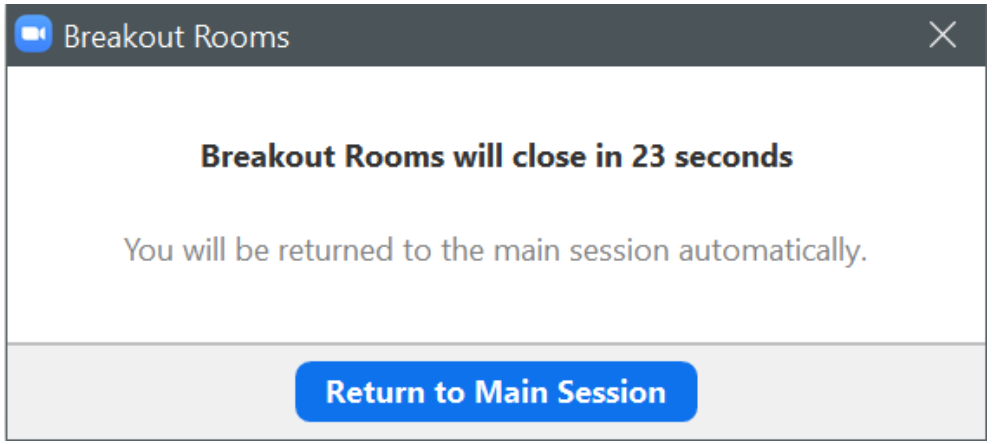
WHAT IF YOU ACCIDENTALLY LEAVE A BREAKOUT ROOM?

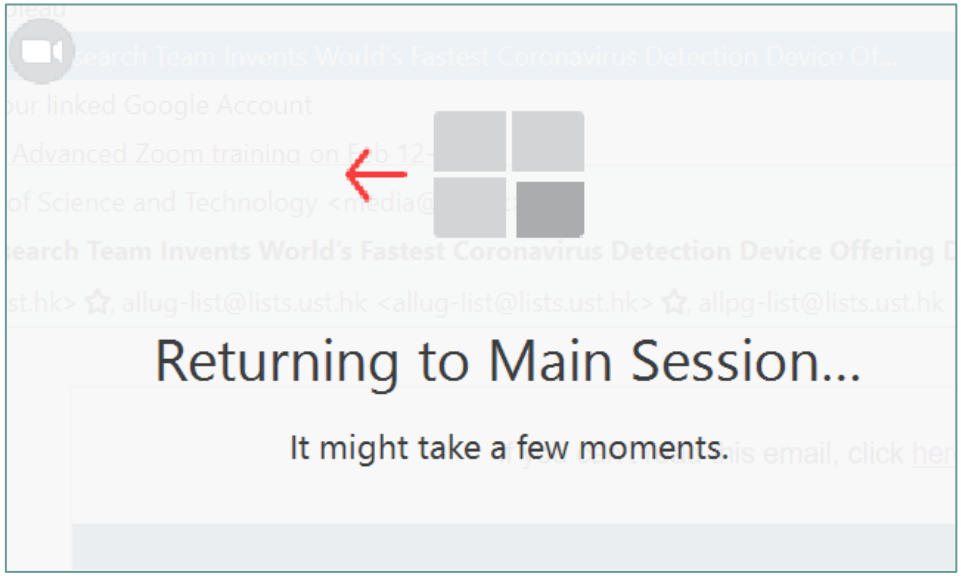
Click here to go back into your room



WHEN TIME IS UP

- you will see





- Wrap up within the time allowed, or
- Click **Return to Main Session** to leave the room immediately

ACTIVITY 1 – DISCUSSION

- How would you/ do people commonly define what a "Sustainable Product" is?
- What makes it difficult to come up with a clear definition?

Group discussion in Breakout rooms

10 min

Take notes on the shared google slide
(access link on the zoom chat)

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)

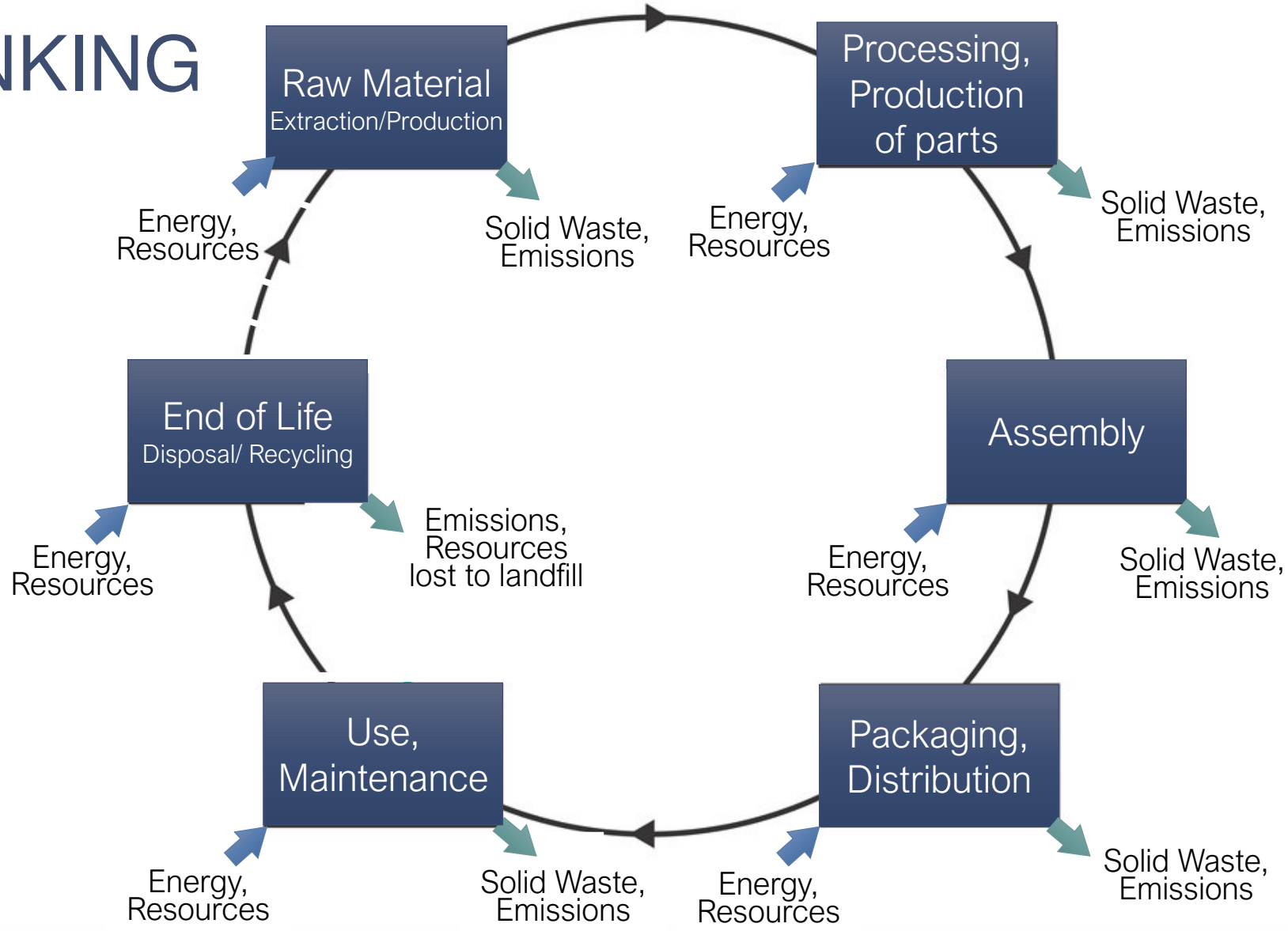
LIFE CYCLE THINKING

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.

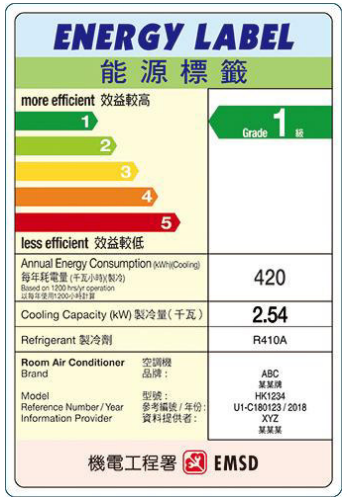


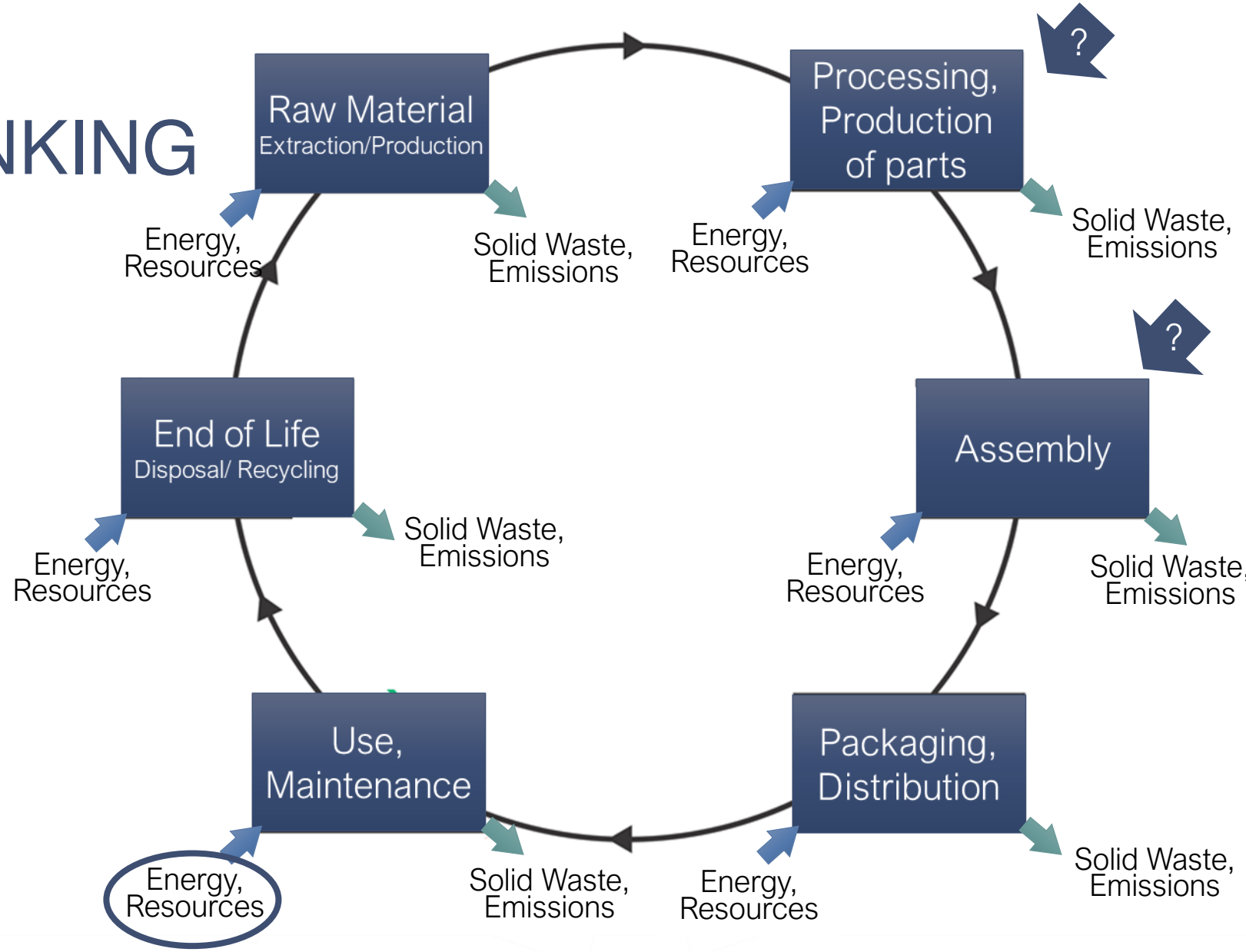
Source: The Life cycle Initiative
https://www.lifecycleinitiative.org/starting-life-cycle-thinking/what-is-life-cycle-thinking/

LIFE CYCLE THINKING

BENEFITS

Reduces the narrow focus
on just one or two stages.



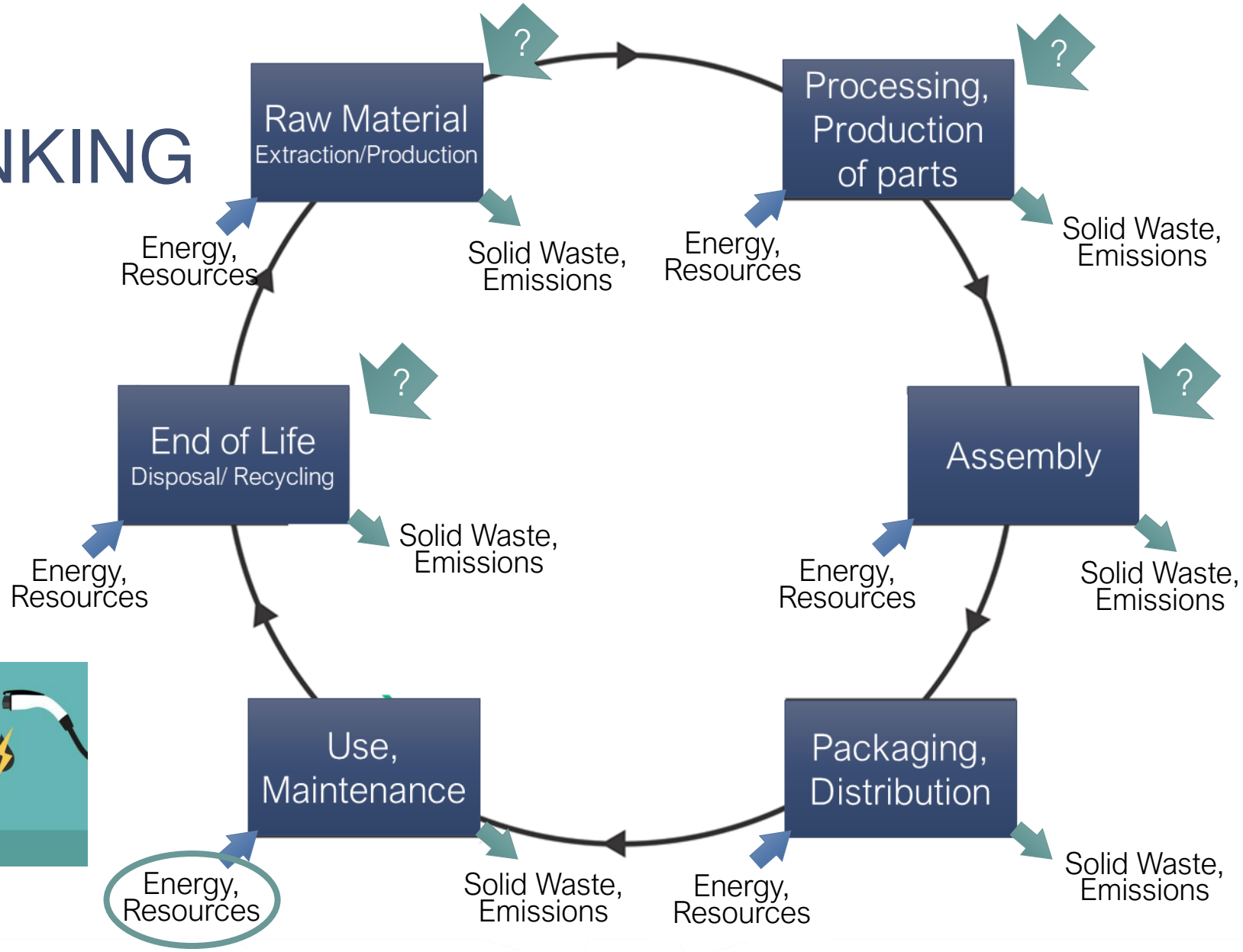


Source: The Life cycle Initiative
https://www.lifecycleinitiative.org/starting-life-cycle-thinking/what-is-life-cycle-thinking/

LIFE CYCLE THINKING

BENEFITS

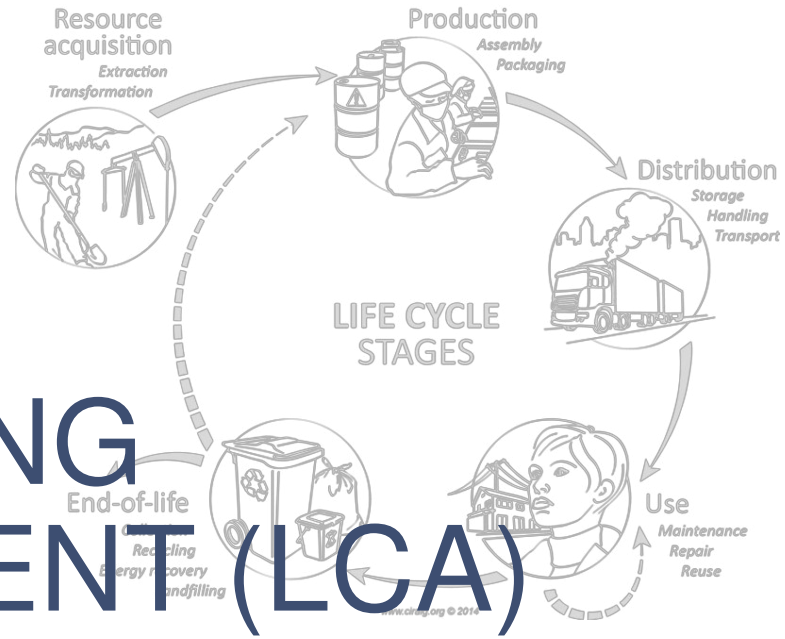
Indicates how changes in one life cycle stage affect the resource use and emissions from other life cycle stages.



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

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

SHORT BREAK
UNTIL 15:23



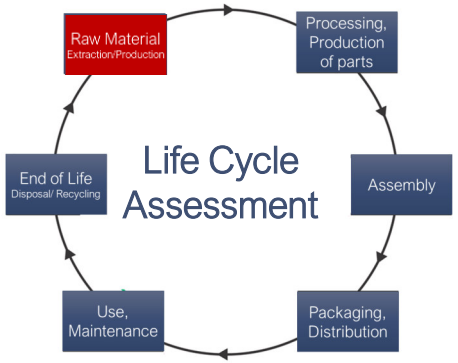
FROM LIFE CYCLE THINKING TO LIFE CYCLE ASSESSMENT (LCA)

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

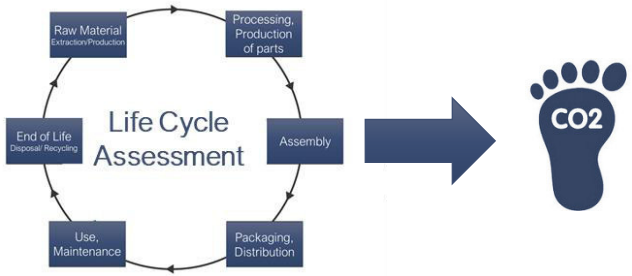


Hot Spot:
Process that causes significant impacts

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

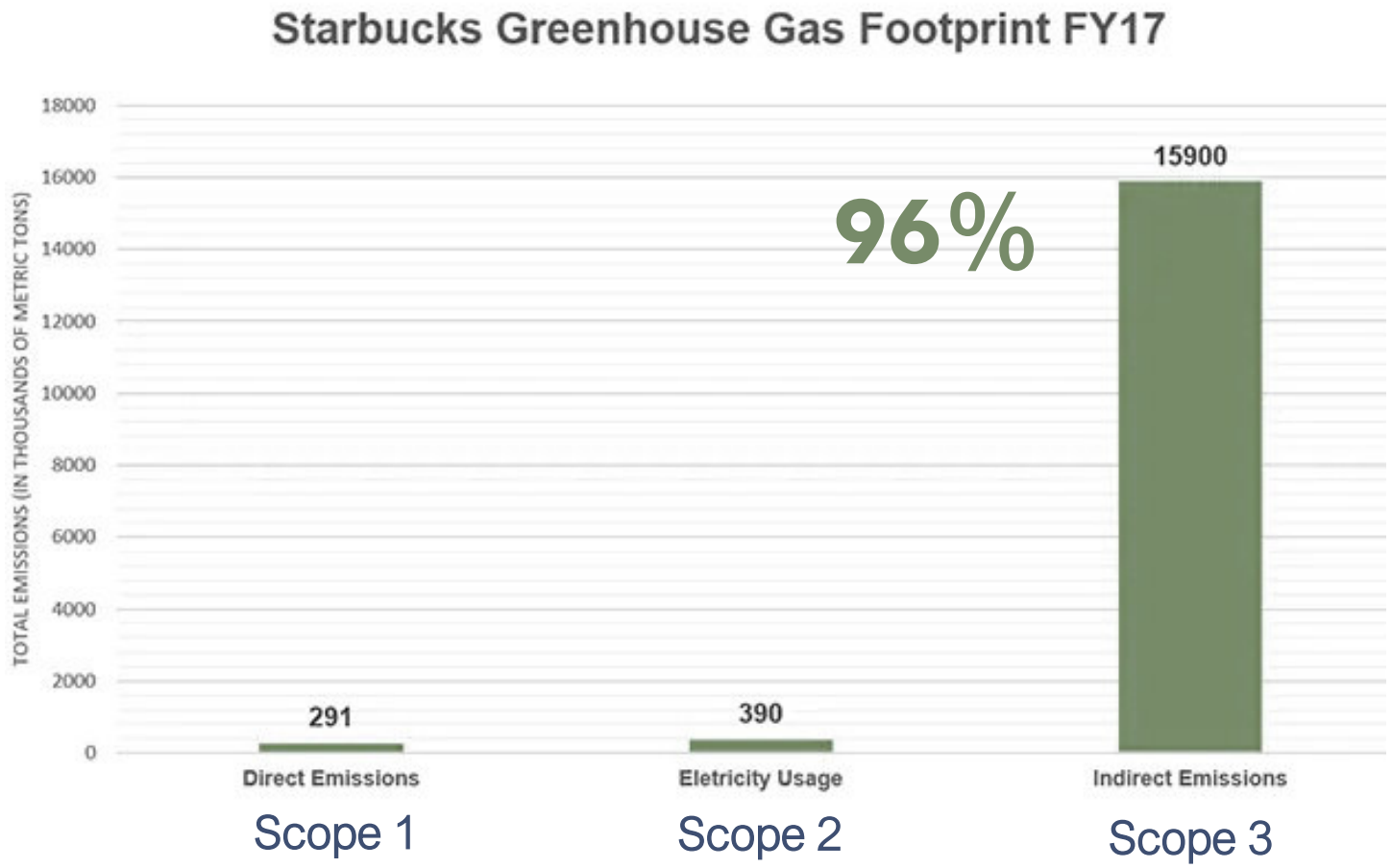
→ *LCA can tell which product has a lower footprint and is accordingly more sustainable*

SCOPE 3 EMISSIONS

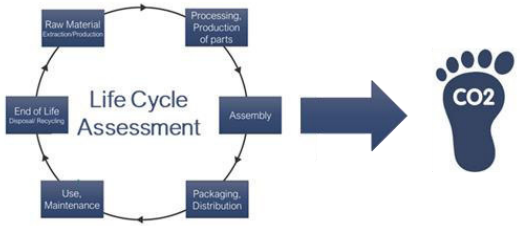
EXAMPLE: STARBUCKS

2030 Goals:

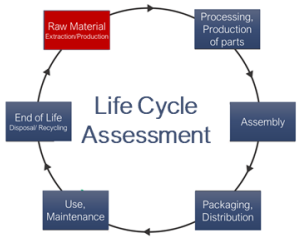
50% absolute reduction
in **scope 1, 2 and 3**
greenhouse gas (GHG) emissions
representing all of Starbucks direct
operations and value chain.



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

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?**

1 liter of milk

Identical function but different material flows.

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

COMPARING APPLES & PEARS?

Life Cycle Assessment can help to **assess environmental impacts of products**
even if these products are made from very different raw materials or through very different processing steps

as long as they fulfill the same function

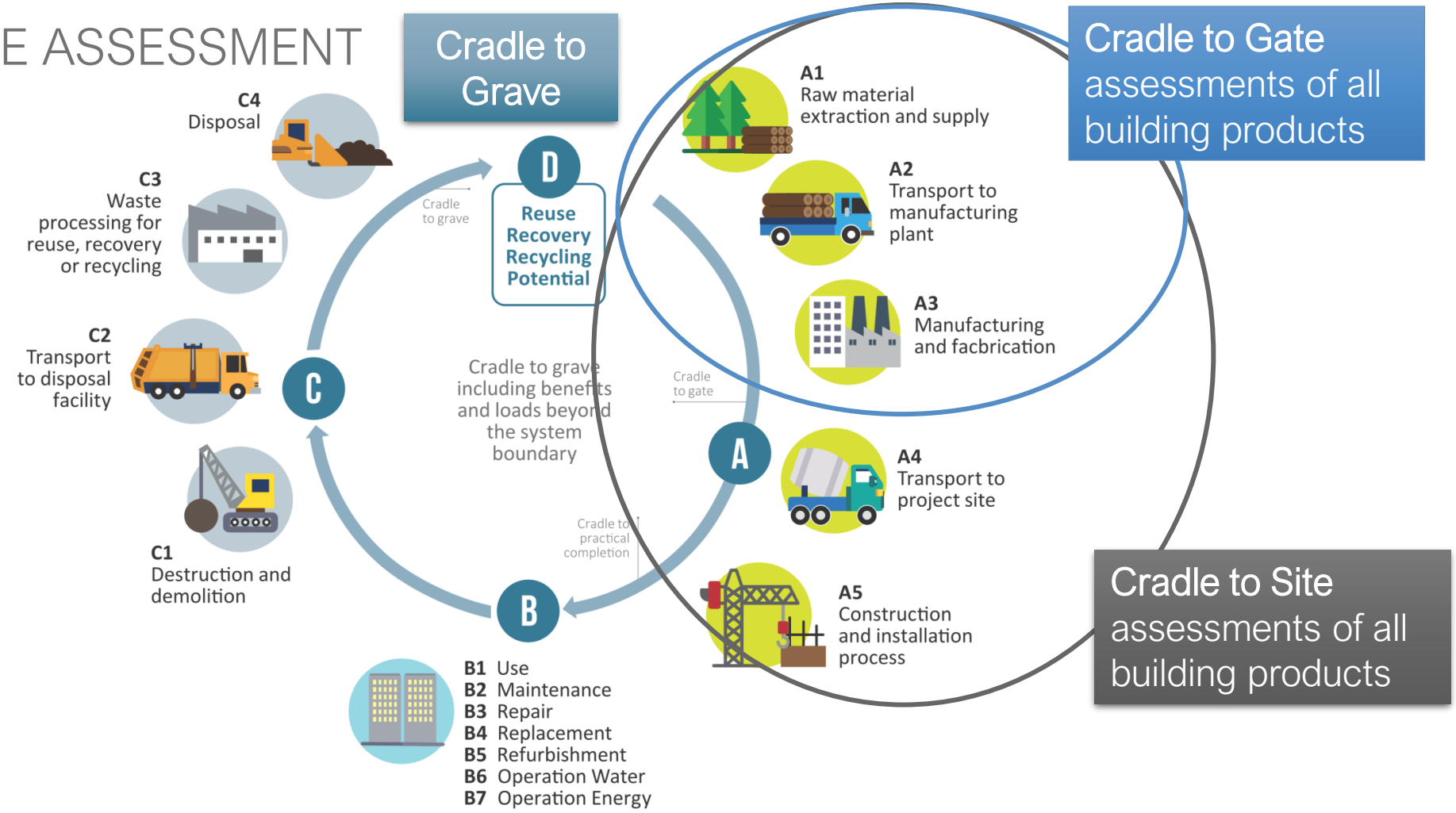
COMMON LCA TERMINOLOGY

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

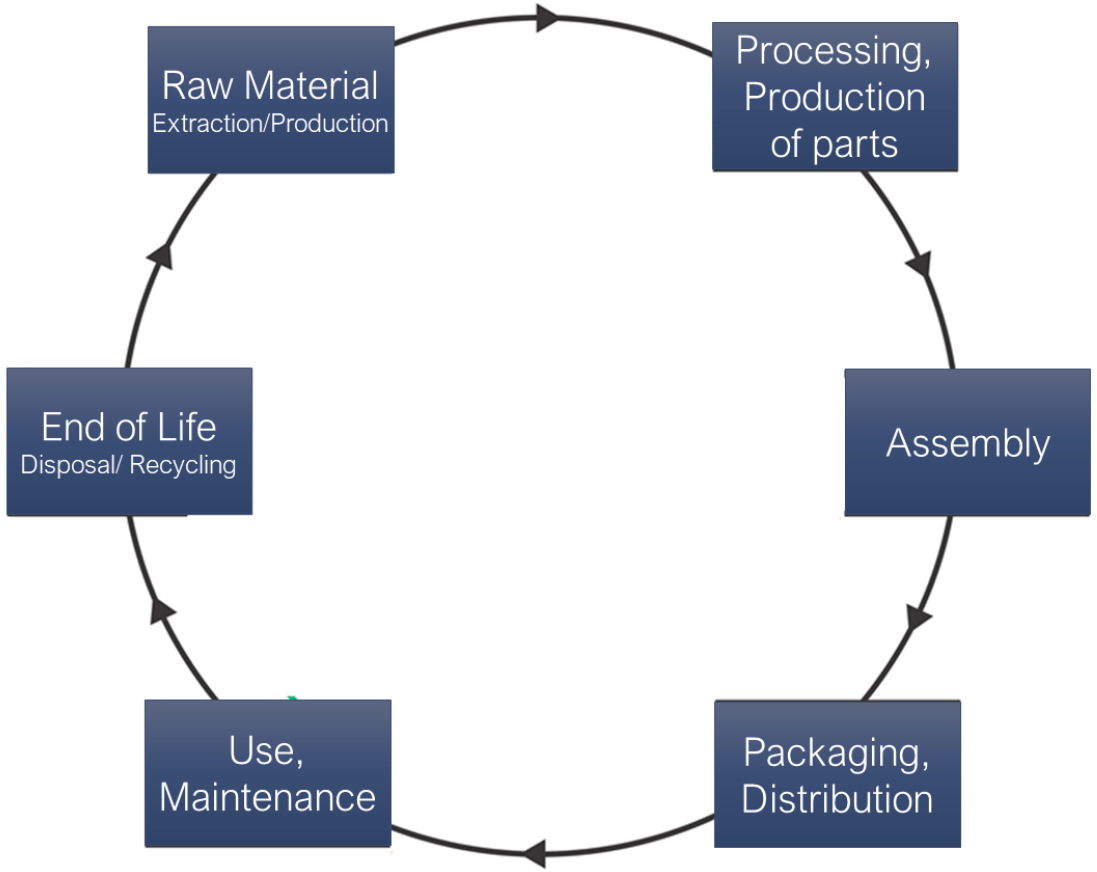


Source: Civic Exchange, HKGFA, 2020: Decarbonising Hong Kong Buildings Policy Recommendations and Next Steps

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)?



ACTIVITY 2

Mapping Life Cycle Processes of Milk

Group activity in Breakout rooms

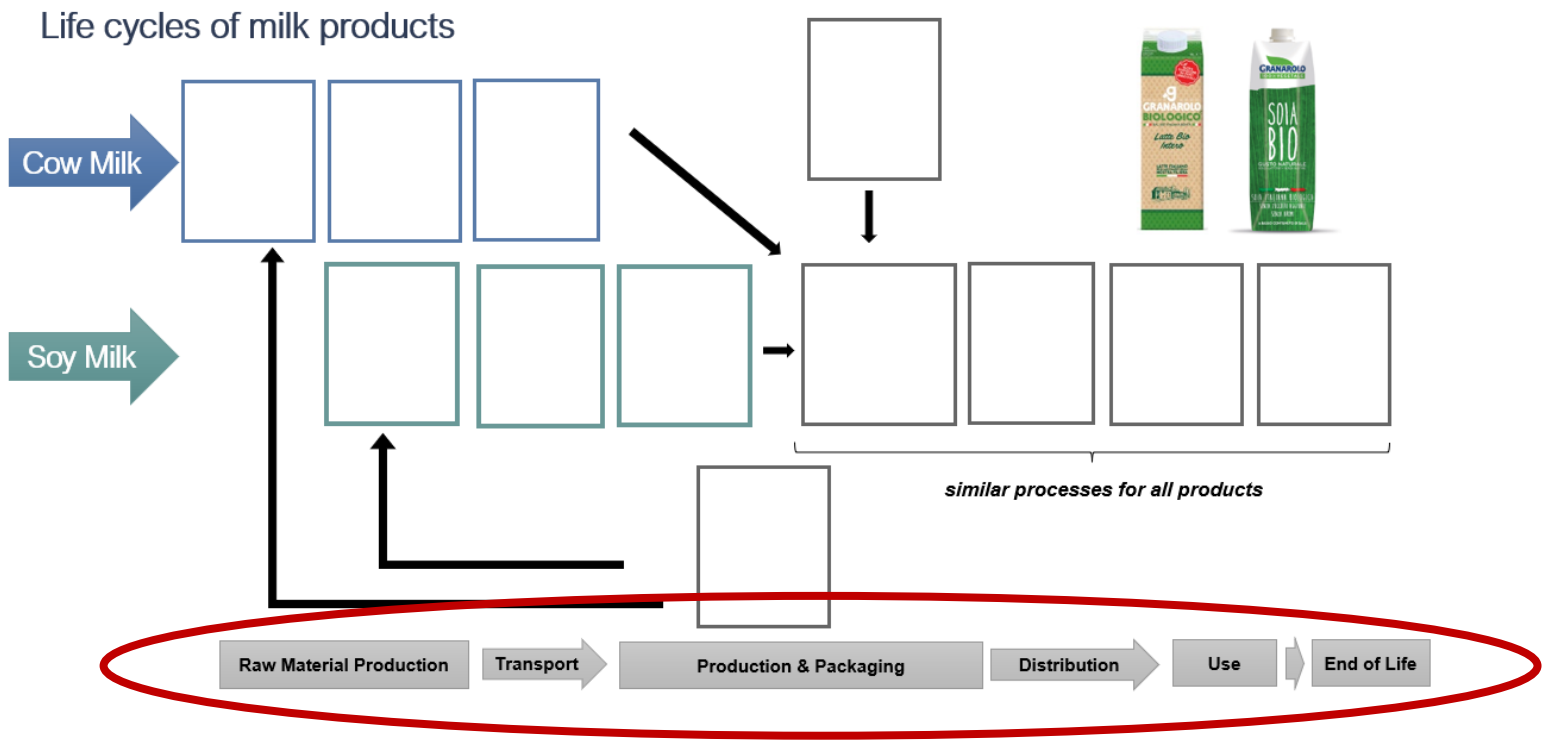
7 min

Files can be found on the shared google slide
(access link on the zoom chat)

ACTIVITY - MAPPING LIFE CYCLE PROCESSES

On that file you can find a map that shows the different life cycle stages of milk (grey boxes):

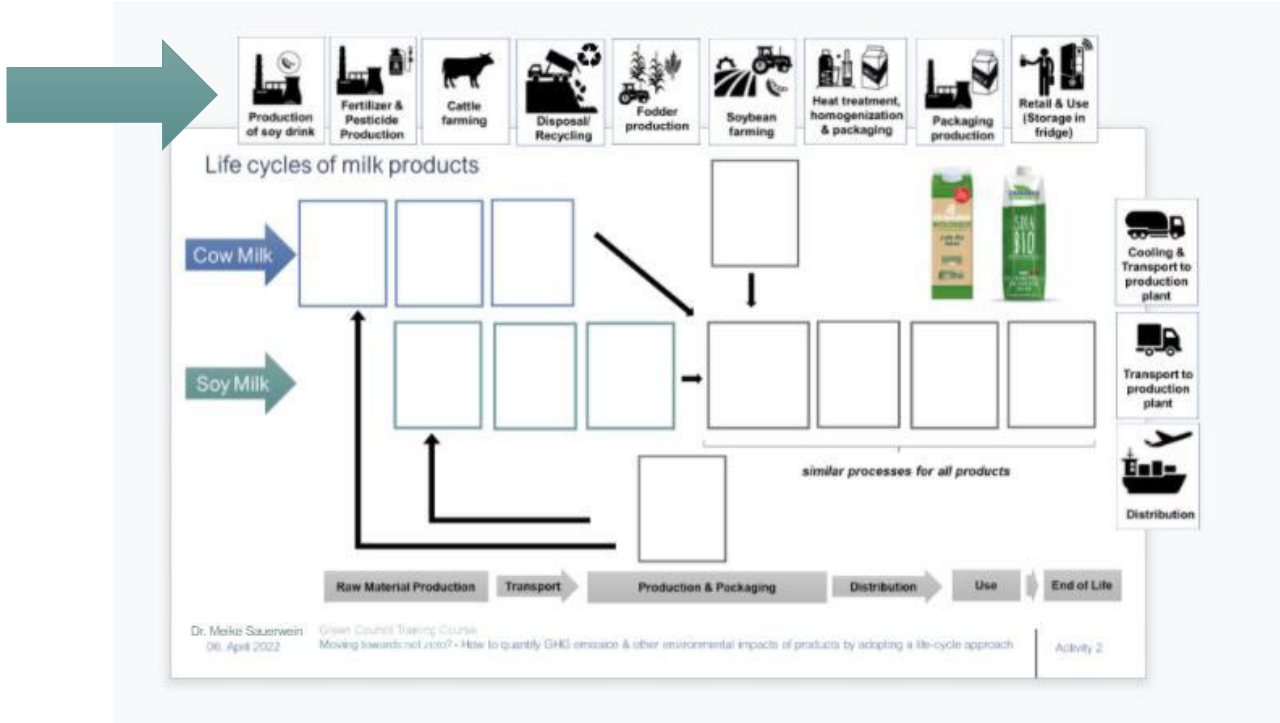
- Raw material production
- Transport
- Production & Packaging
- Distribution
- Use and End of Life

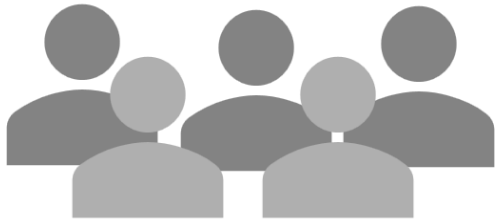


ACTIVITY - MAPPING LIFE CYCLE PROCESSES

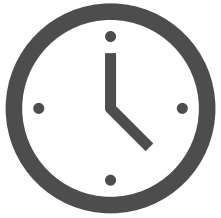
The life cycle processes for cow and soy milk are listed around the map.

As a group, please work together and discuss the right sequence of the processes into the right order





Work in groups



7 min

Life cycles of milk products

Cow Milk

Soy Milk

Fodder production

Cattle farming

Cooling & Transport to production plant

Packaging production

Soybean farming

Transport to production plant

Production of soy drink

Heat treatment, homogenization & packaging

Distribution

Retail & Use (Storage in fridge)

Disposal/ Recycling

similar processes for all products

Fertilizer & Pesticide Production

Raw Material Production → Transport → Production & Packaging → Distribution → Use → End of Life

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

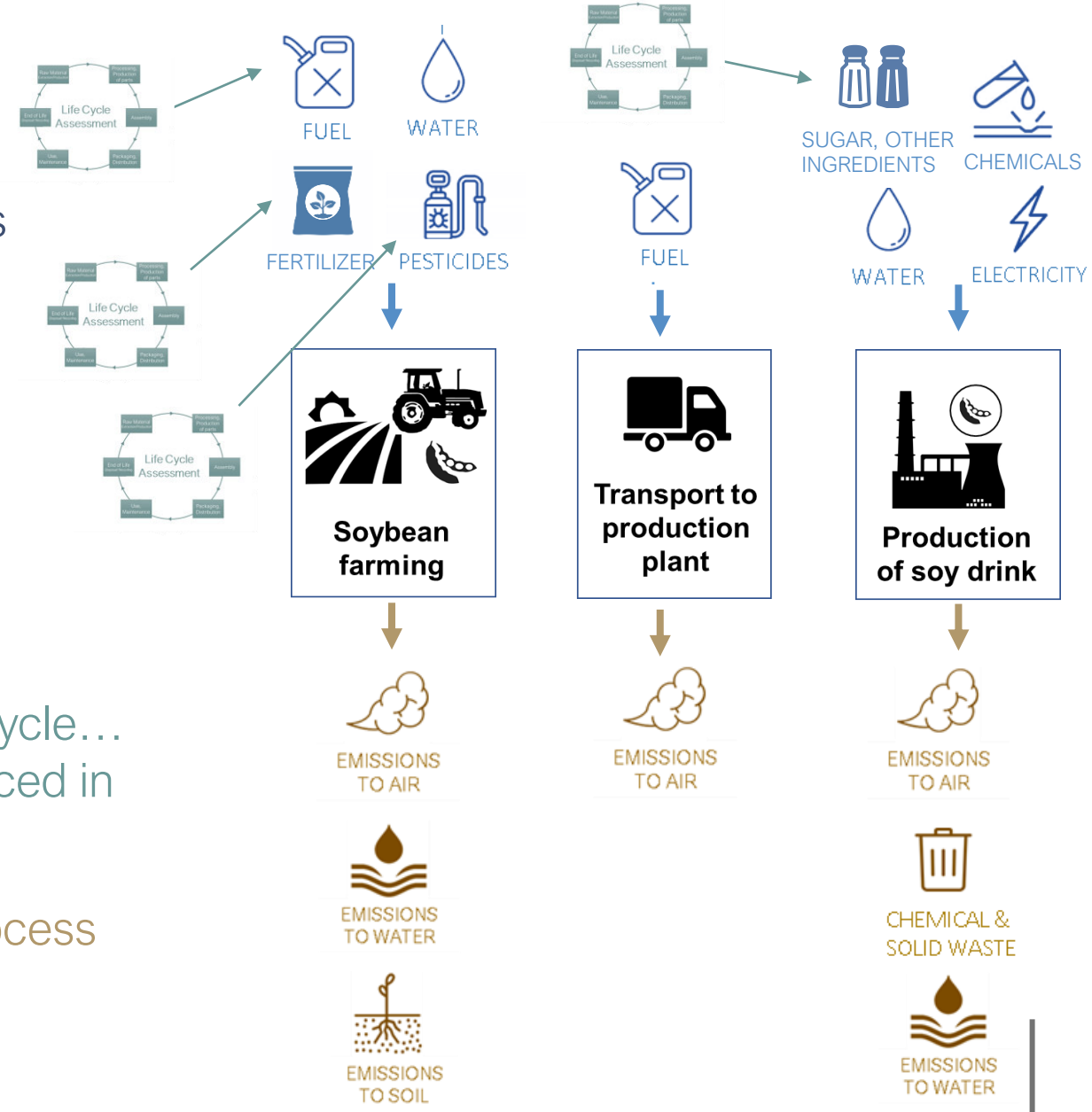
Collecting primary data for each process

- 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?



SHORT BREAK
UNTIL 16:08

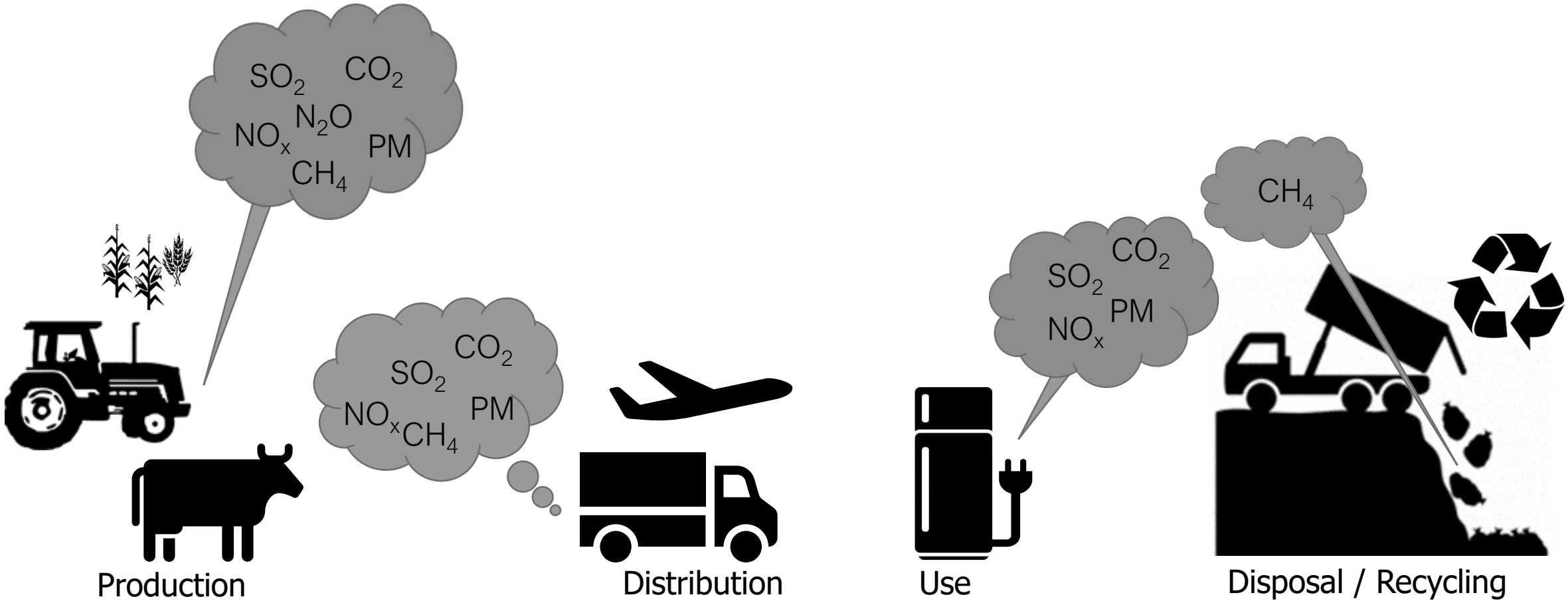
LIFE CYCLE ASSESSMENT OF MILK

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

CLASSIFICATION INTO ENVIRONMENTAL CATEGORIES

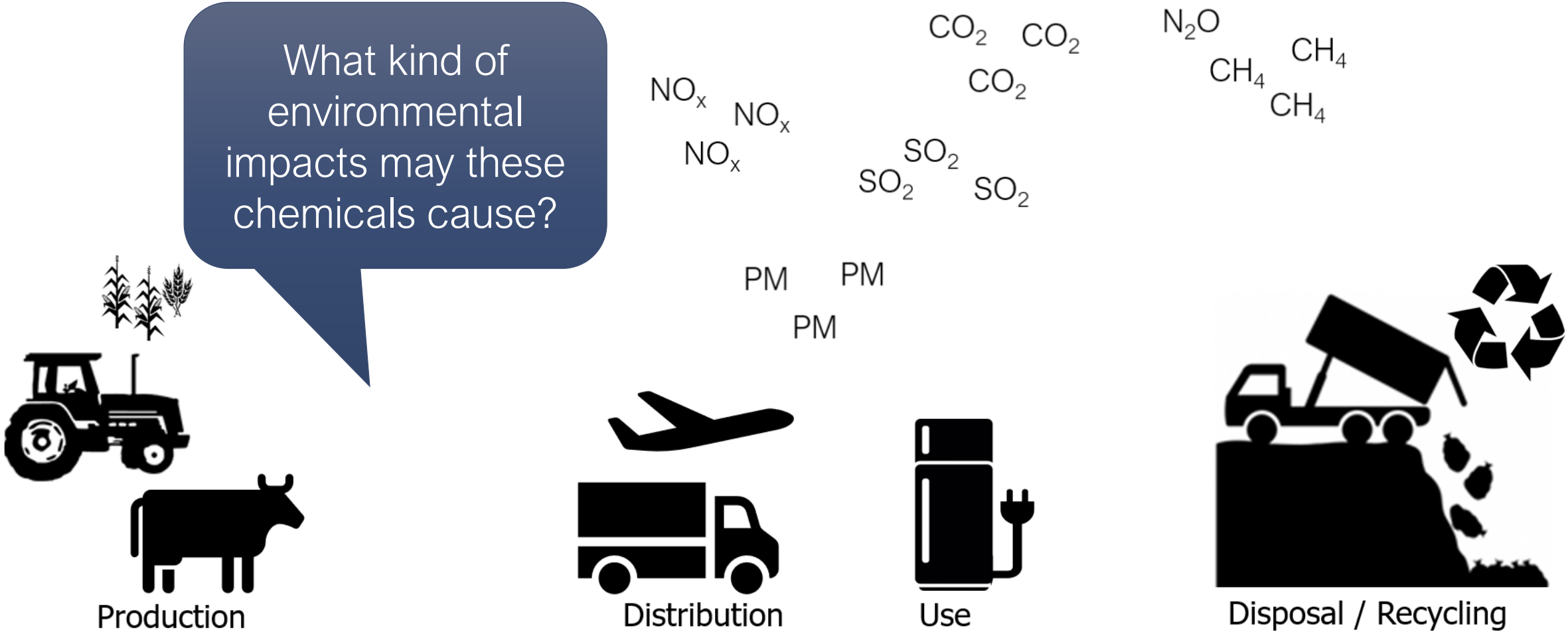
CLASSIFYING THE TYPE OF POTENTIAL IMPACT (DAMAGE), A SPECIFIC EMISSION COULD CAUSE IN THE ENVIRONMENT



Source: ISO 14044

CLASSIFICATION INTO ENVIRONMENTAL CATEGORIES

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

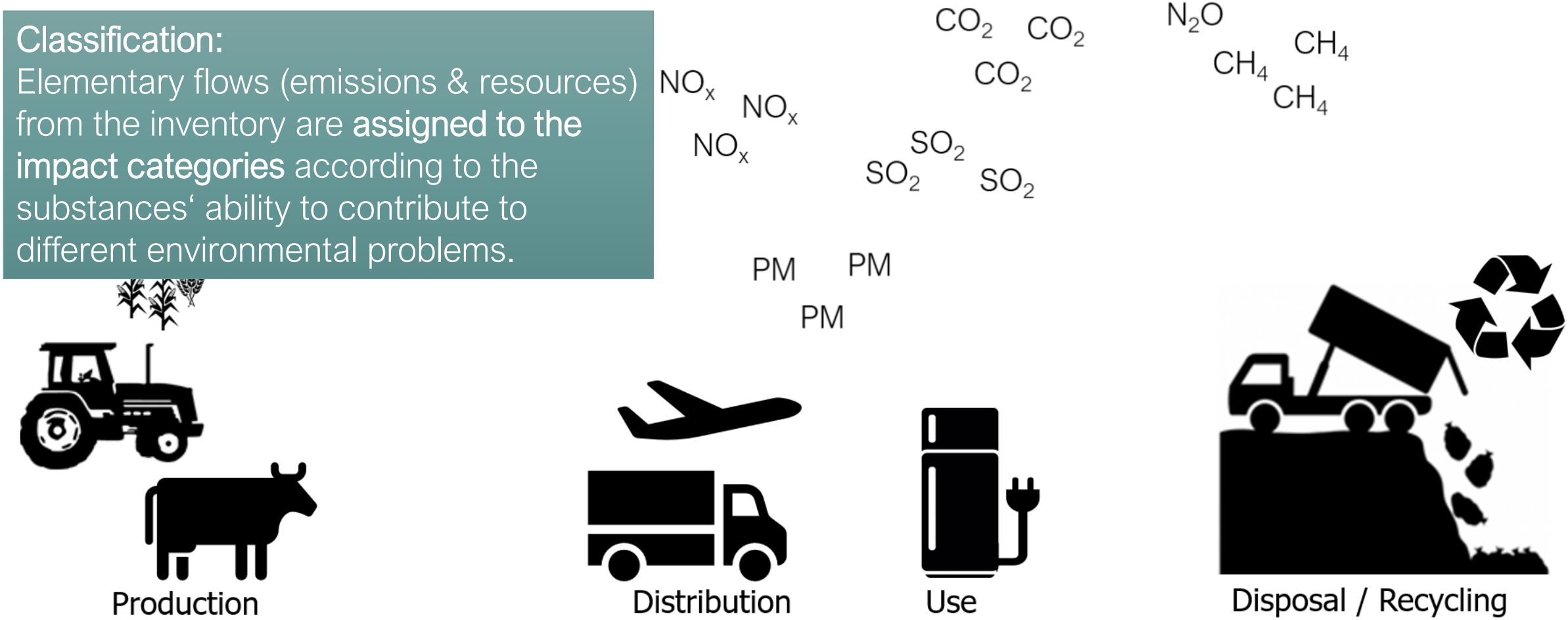


Source: ISO 14044

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.

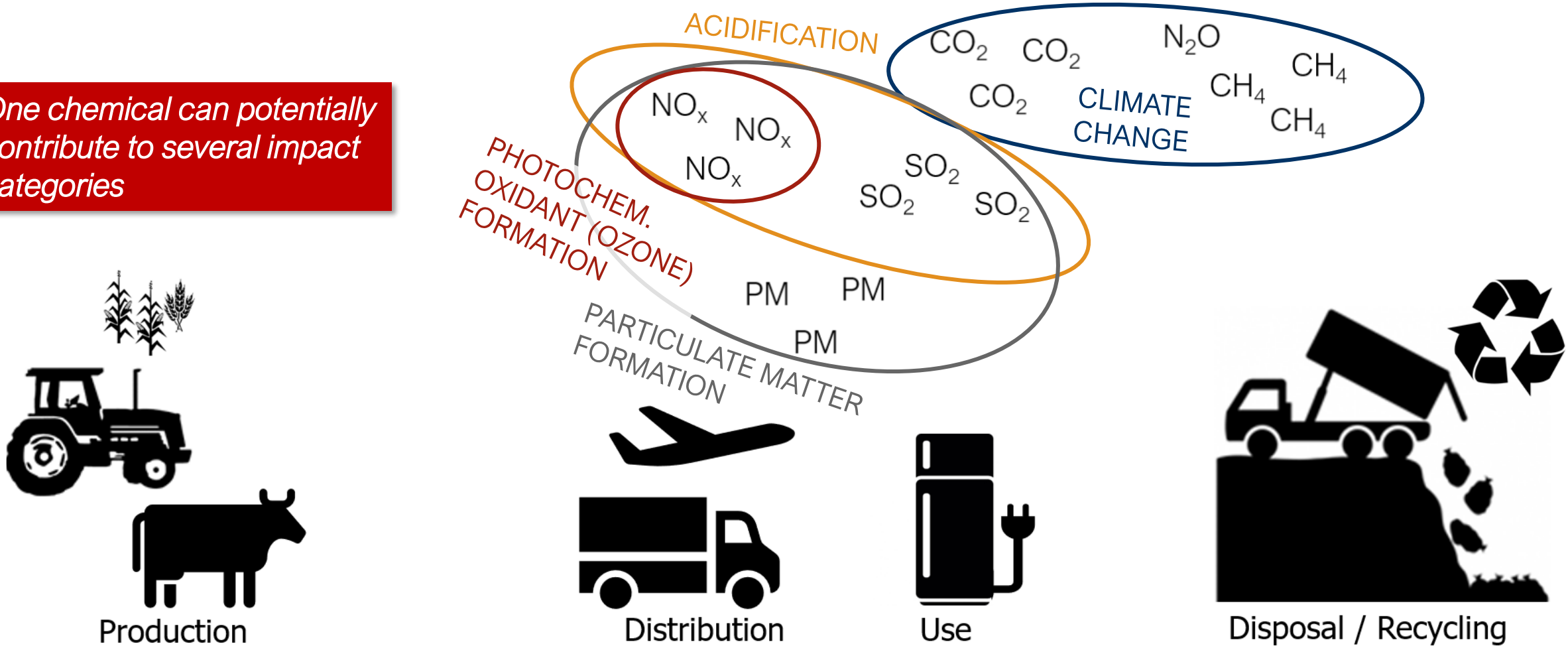


Source: ISO 14044

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

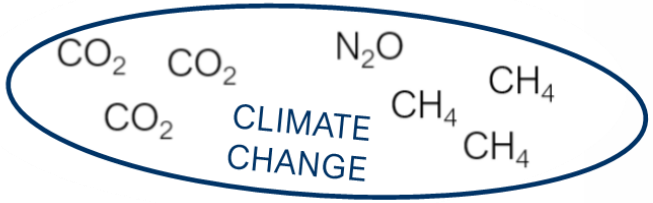
LIFE CYCLE ASSESSMENT OF MILK

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

CHARACTERIZATION – QUANTIFYING THE POTENTIAL IMPACT OF A GROUP OF CHEMICALS

Example: Greenhouse Gas Emissions



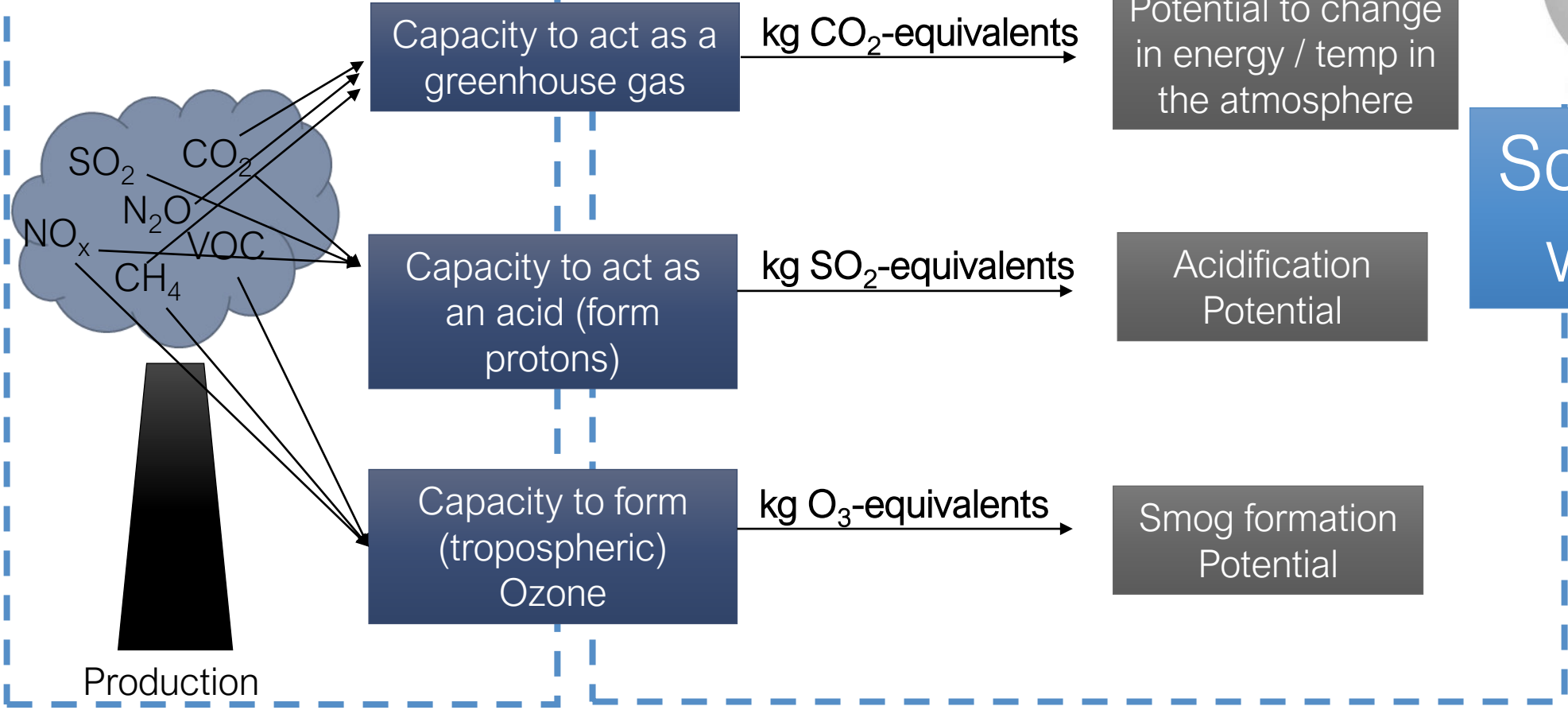
Characterization: Calculating how strongly a certain chemical contributes to the potential environmental damage.

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

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

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

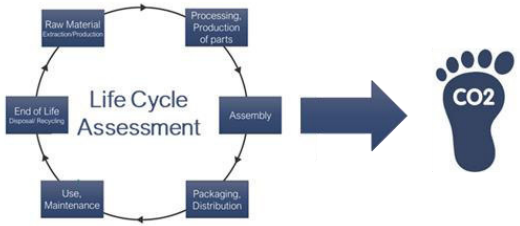
LIFE CYCLE IMPACT ASSESSMENT CATEGORIES

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

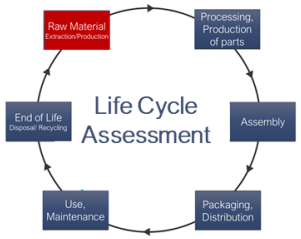
LCIA Methods	CML	EDIP	EF	EPD	ILCD	IMPACT	ReCiPe	TRACI
Global warming	kg CO_2 eq	kg CO_2 eq	kg CO_2 eq	kg CO_2 eq	kg CO_2 eq	kg CO_2 eq	kg CO_2 eq	kg CO_2 eq
Acidification	kg SO_2 eq	m^2	mol H+ eq	kg SO_2 eq	mol H^+ eq	kg SO_2 eq	kg SO_2 eq	kg SO_2 eq
Ozone depletion	kg CFC-11 eq	kg CFC-11 eq	kg CFC-11 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*

BACK TO MILK



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



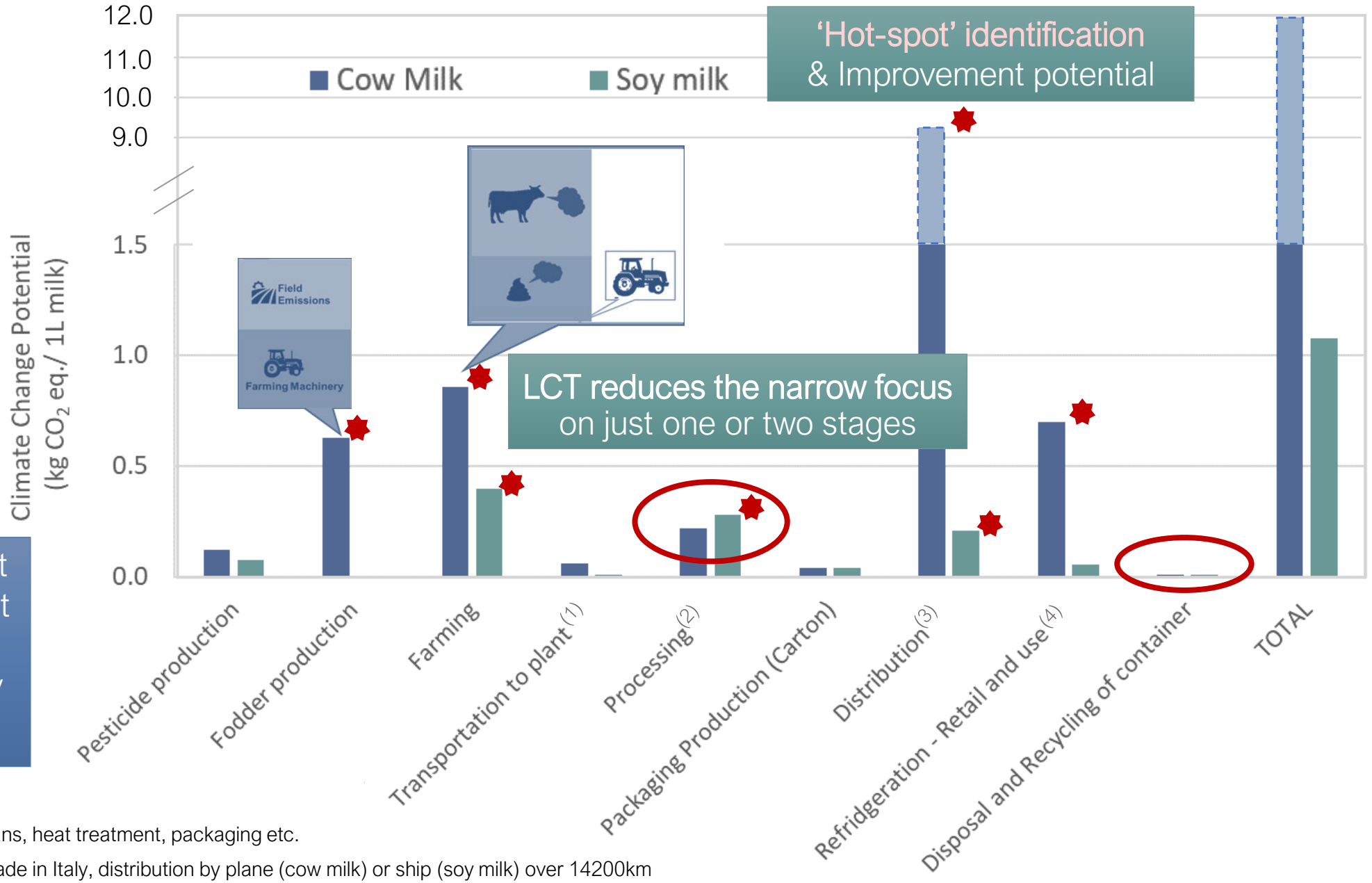
Hot Spot:
Process that causes significant impacts

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

Cow Milk

Soy Milk

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)

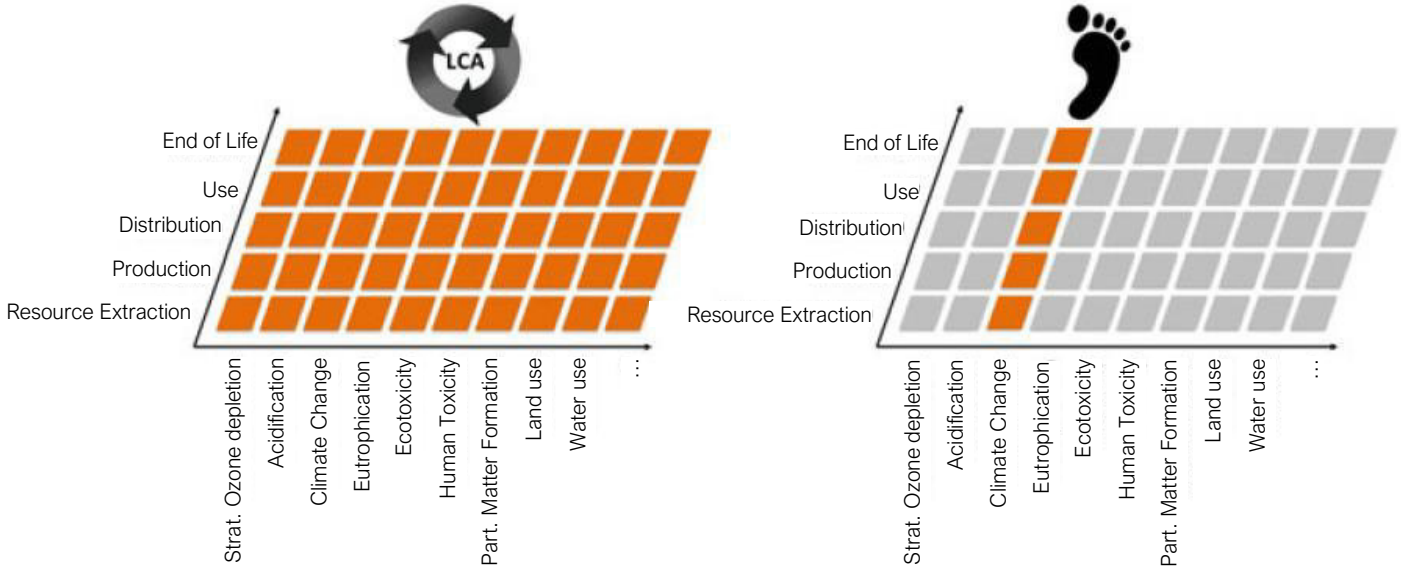
(1) Truck 100km

(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

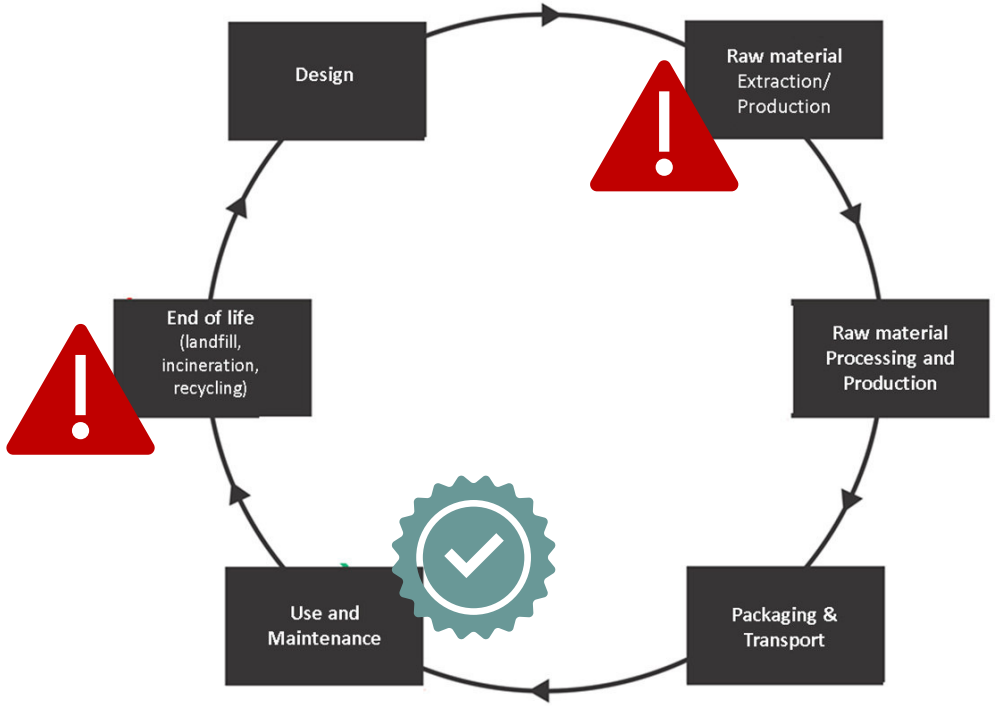


- LCA is a tool at allows quantification of a variety of different environmental categories
- This can help to **avoid burden-shifting** from one category to another, *e.g., making reductions in carbon footprint but increasing toxicity impacts*

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

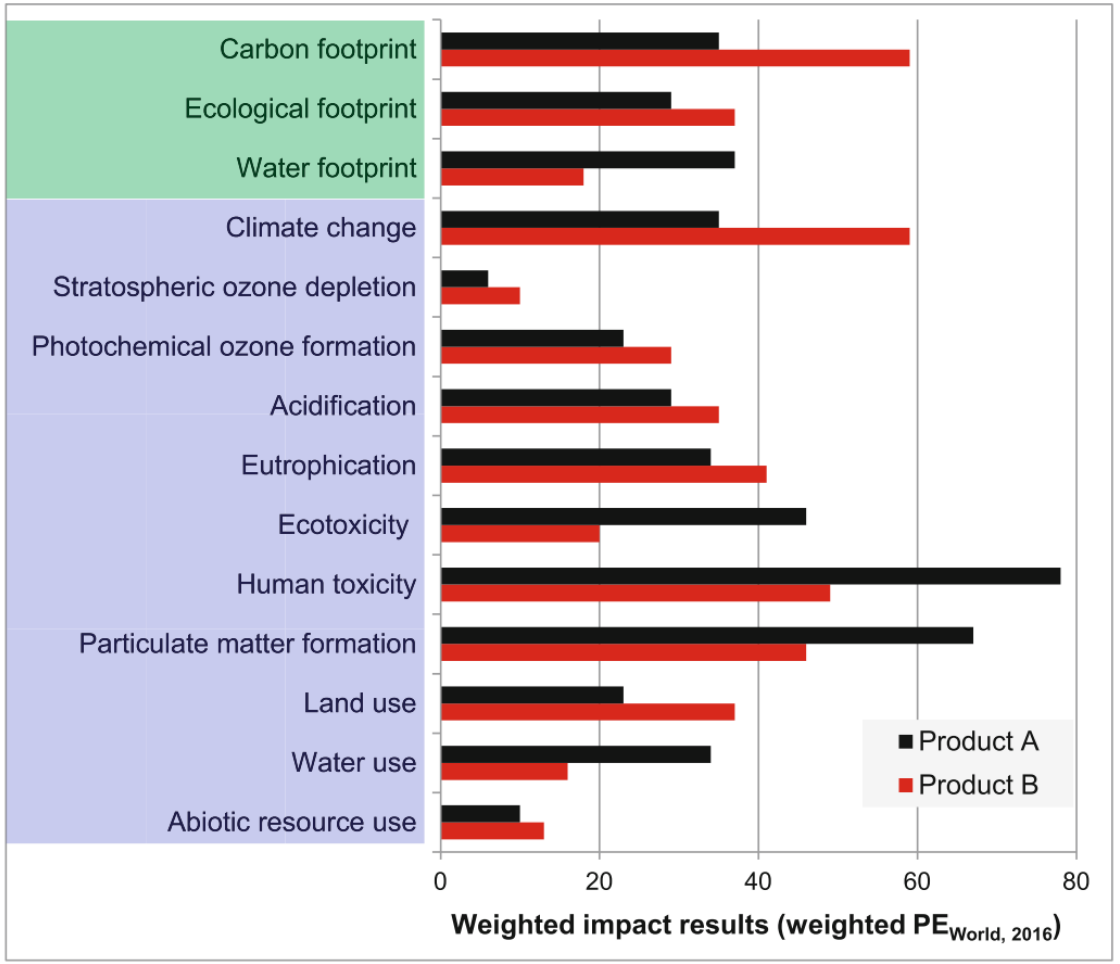


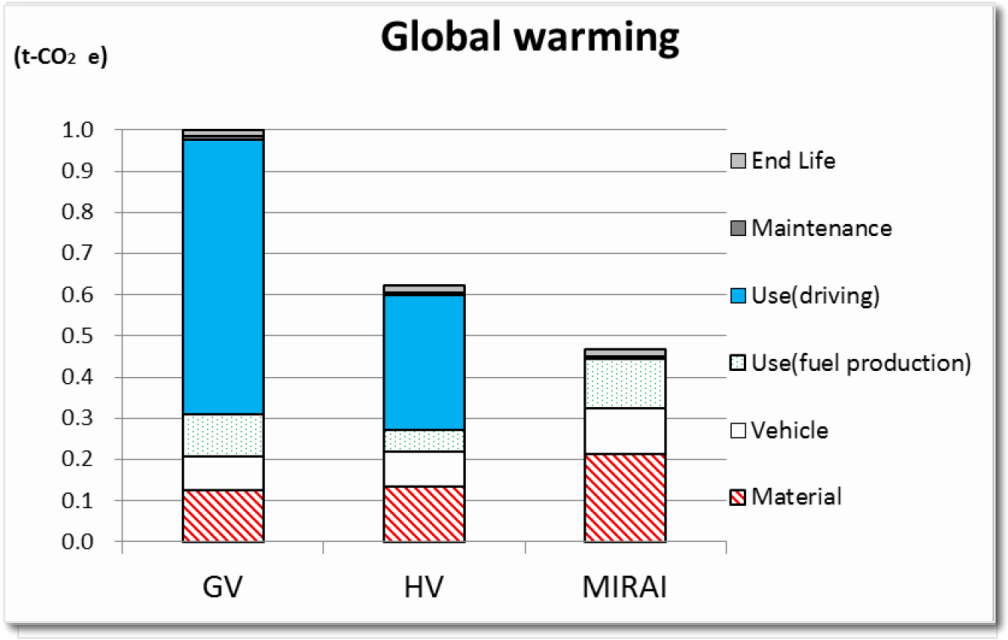
Fig. 10.5 Comparing two products, which alternative would you choose? Examples of footprints are indicated in *green shading*; impact categories commonly assessed in LCA are indicated in *blue shading*

Source: Hauschild et al. 2018: Life Cycle Assessment

LIFE CYCLE ASSESSMENT IN PRACTICE

Automobile Industry

we internally feedback analysed results,[…]
to our development divisions to help improve future models.'




TOYOTA

The MIRAI

Life Cycle Assessment Report

for communication

Comparative Life Cycle Assessment

TÜVRheinland CERTIFIED

www.tuv.com ID 0000045605

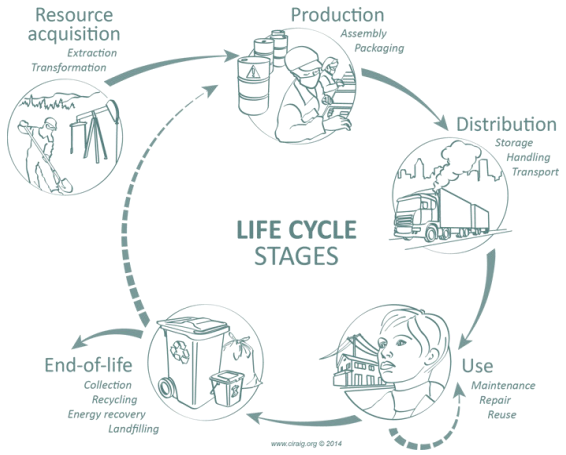
Fuel Cell Electric Vehicle

Company name:	Toyota Motor Corporation
Responsible person:	Junji Tokieda
LCA analysts:	Tamaki Ozawa, Takuya Yoshida
Under the supervision of:	Satoshi Aida, Lisa Oya
Report date:	2015.6.10
Conformed standard:	ISO 14040(2006) and ISO 14044(2006)
Critical reviewer:	Dominik Müller, TÜV Rheinland LGA Products GmbH

1

Source: Toyota, The MIRAI Life Cycle Assessment for communication
https://global.toyota/pages/global_toyota/sustainability/esg/challenge2050/challenge2/life_cycle_assessment_report_en.pdf

Key Takeaways Life Cycle Thinking

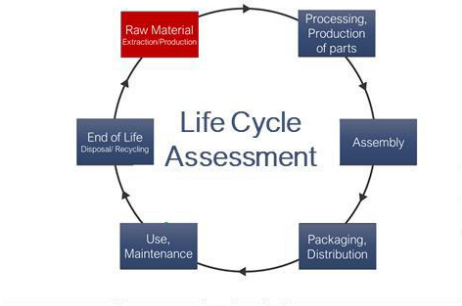


Life Cycle Thinking

- **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.**

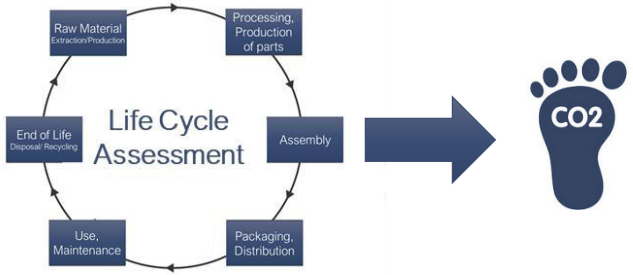
Key Takeaways Life Cycle Assessment

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

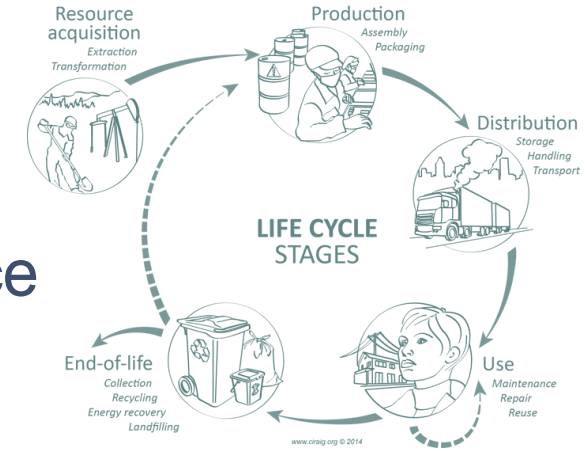


Hot Spot:
Process that causes significant impacts

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.

THANK YOU FOR YOUR ATTENTION!

Feel free to stay and ask question or continue earlier discussions

Contact

Dr. Meike Sauerwein, Lecturer

Division of Environment and Sustainability, HKUST

Email: meike@ust.hk

See you for Part 2 on Friday!

Green Council Training Course

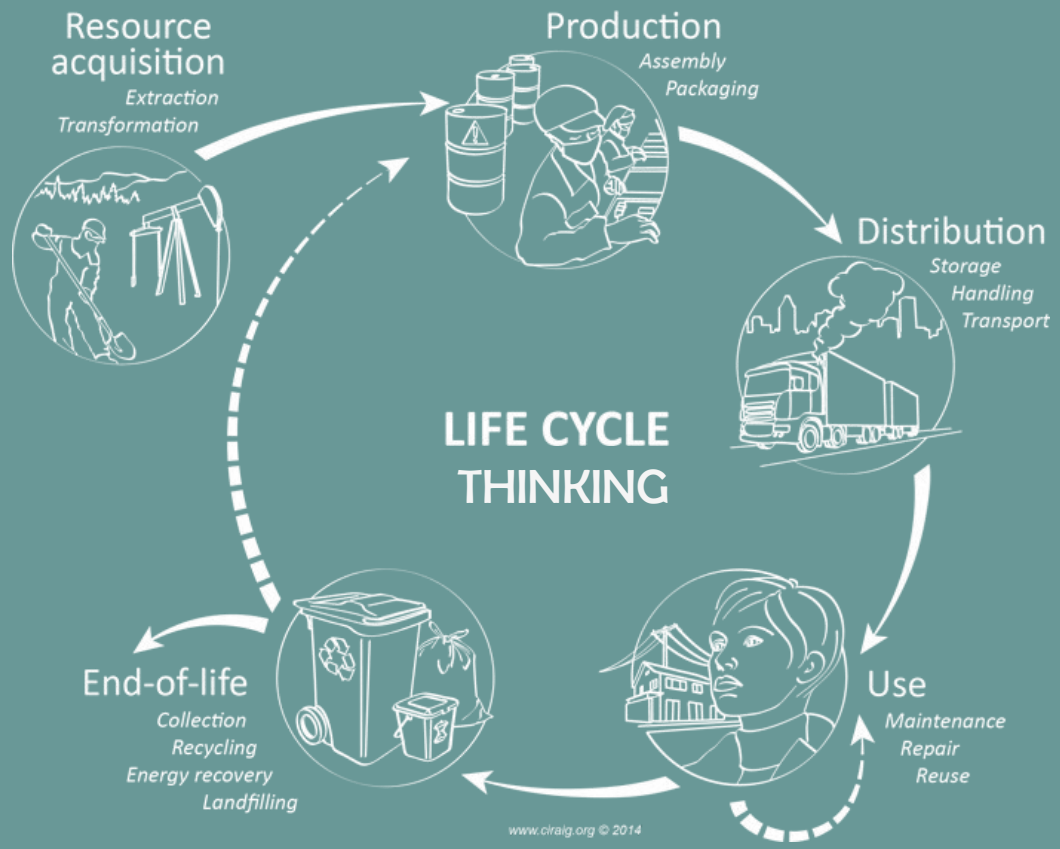
MOVING TOWARDS NET ZERO?

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

Dr. Meike Sauerwein

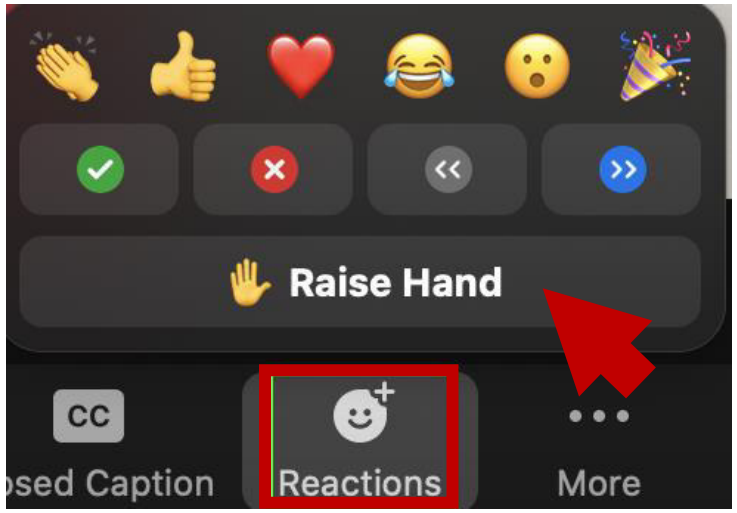
meike@ust.hk

8. April 2022



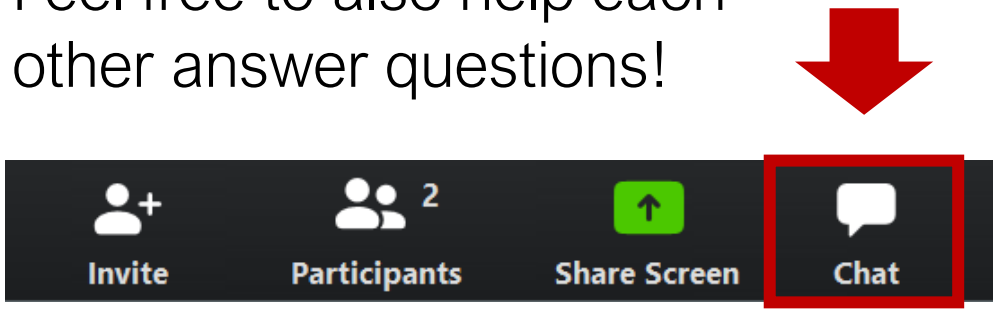
ANY QUESTIONS?

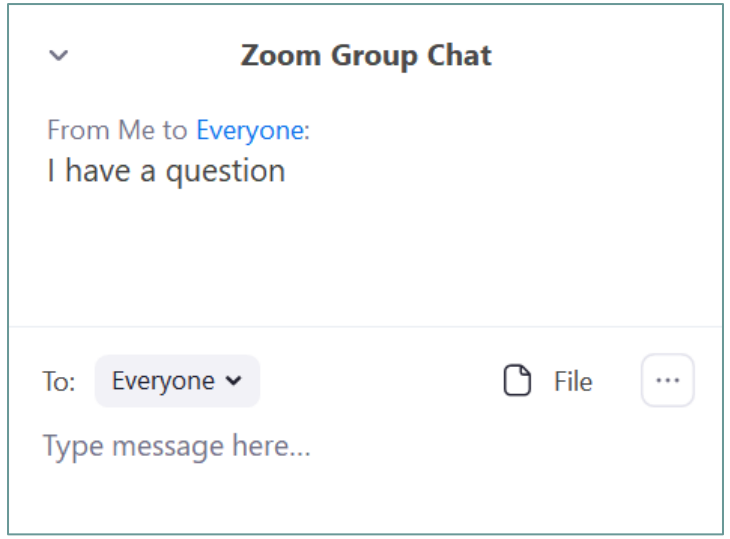
Feel free to raise your hand and ask at any time.



Chat

Ask & answer questions or leave comments in the chat. Feel free to also help each other answer questions!



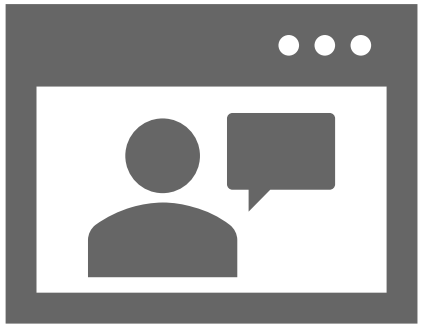


…TO MAKE THINGS EASIER FOR ME ☺

Please rename yourself so that ZOOM shows

1. your **preferred name** (how you want me to call you) and
2. your **organizations name**

e.g., M. Sauerwein (HKUST), or Meike (HKUST)



Since we are all interested in low carbon solutions:
Feel free to leave your video off while I am talking,
but I would appreciate if you cold **turn it on for breakout rooms**.

OUTLINE

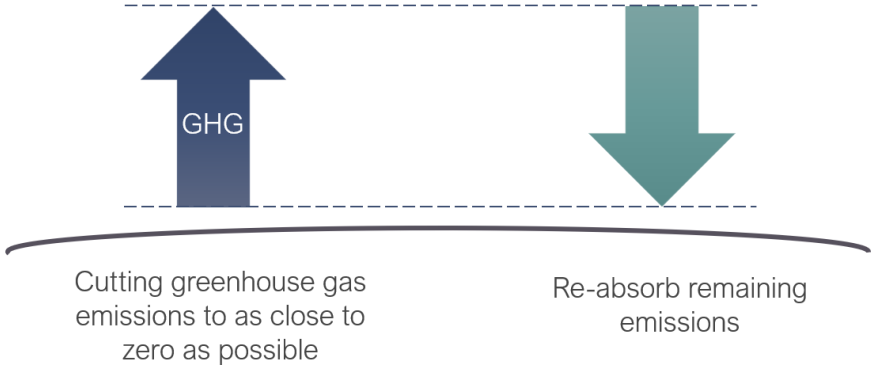
PART 2

- 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
  - Key concept and examples

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

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

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

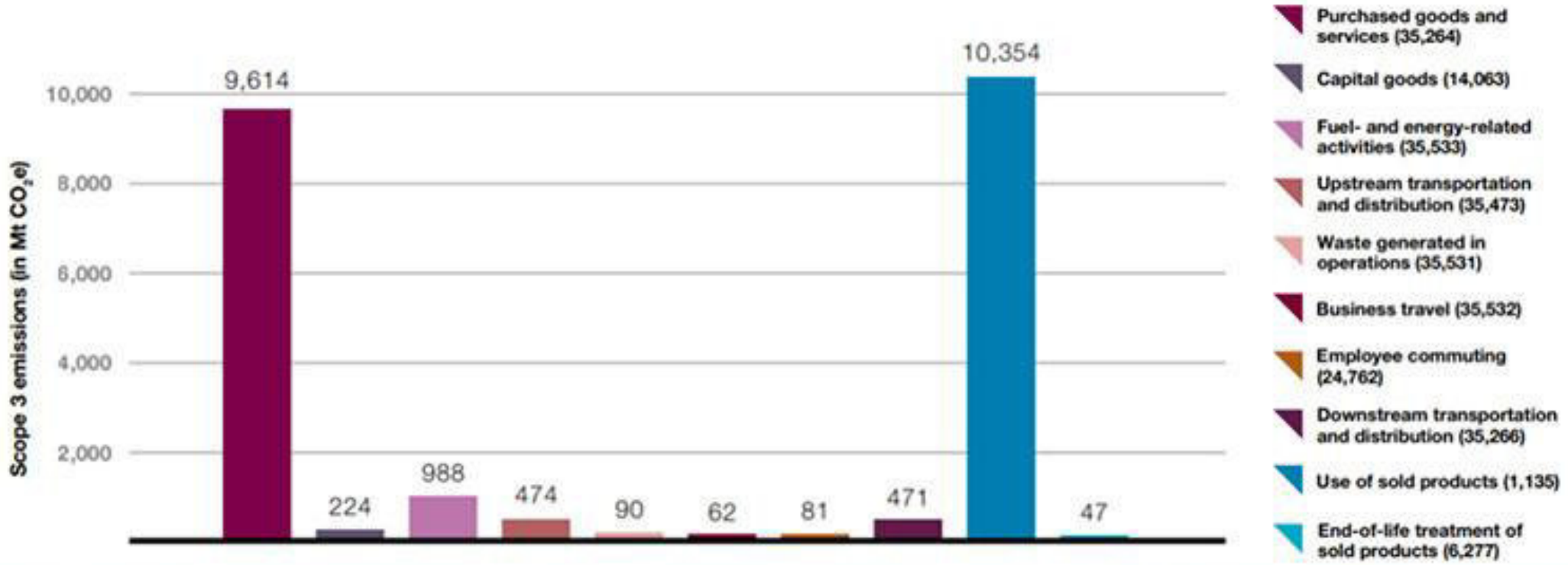


Figure 1. Scope 3 emissions estimated by CDP for 35,533 companies per emission source in year 2014. The number of companies for which each type of Scope 3 emissions was calculated is presented in parentheses for each sector.

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

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)

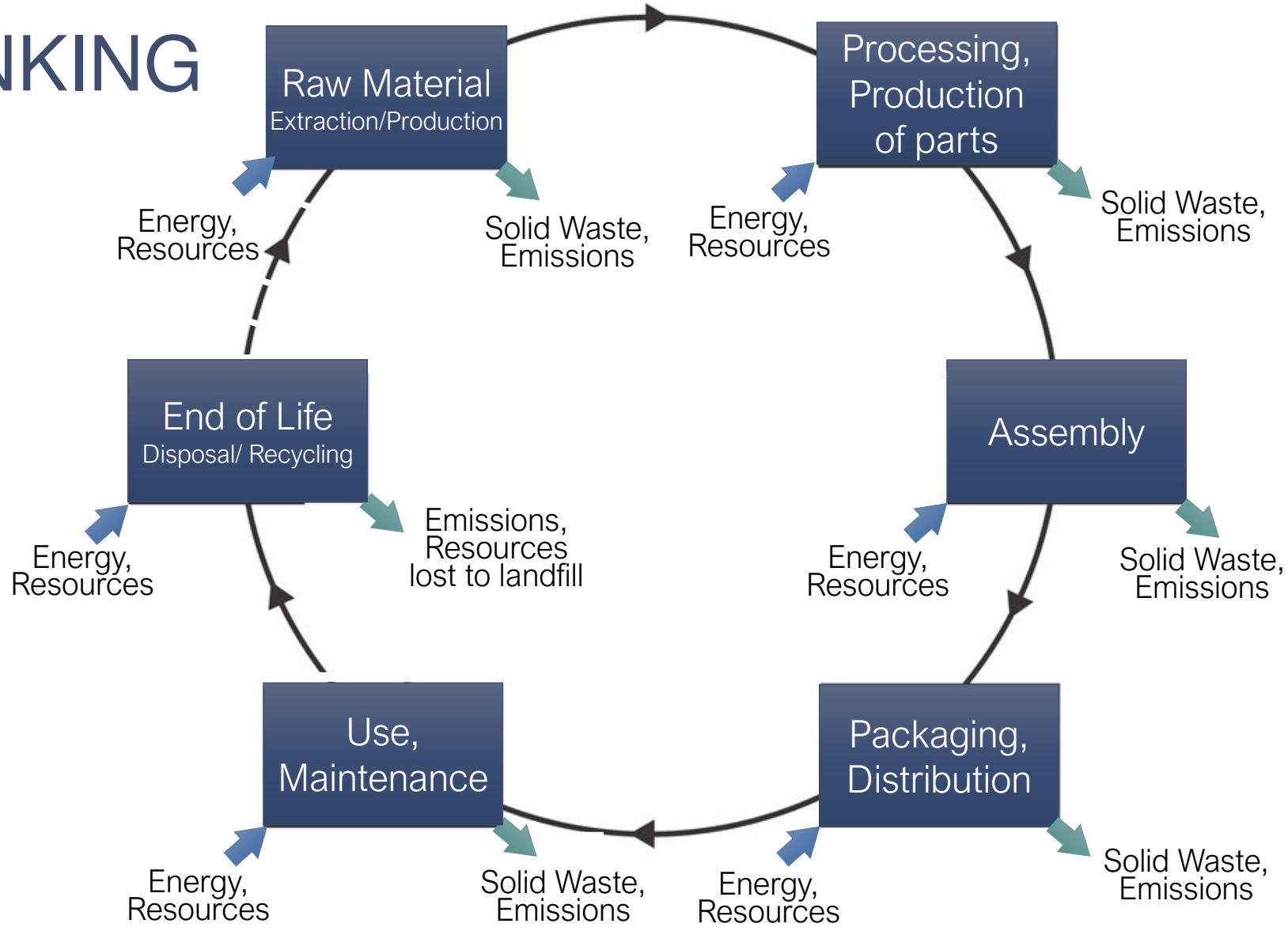
LIFE CYCLE THINKING

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.

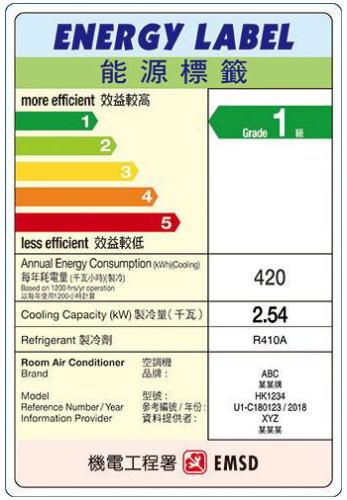


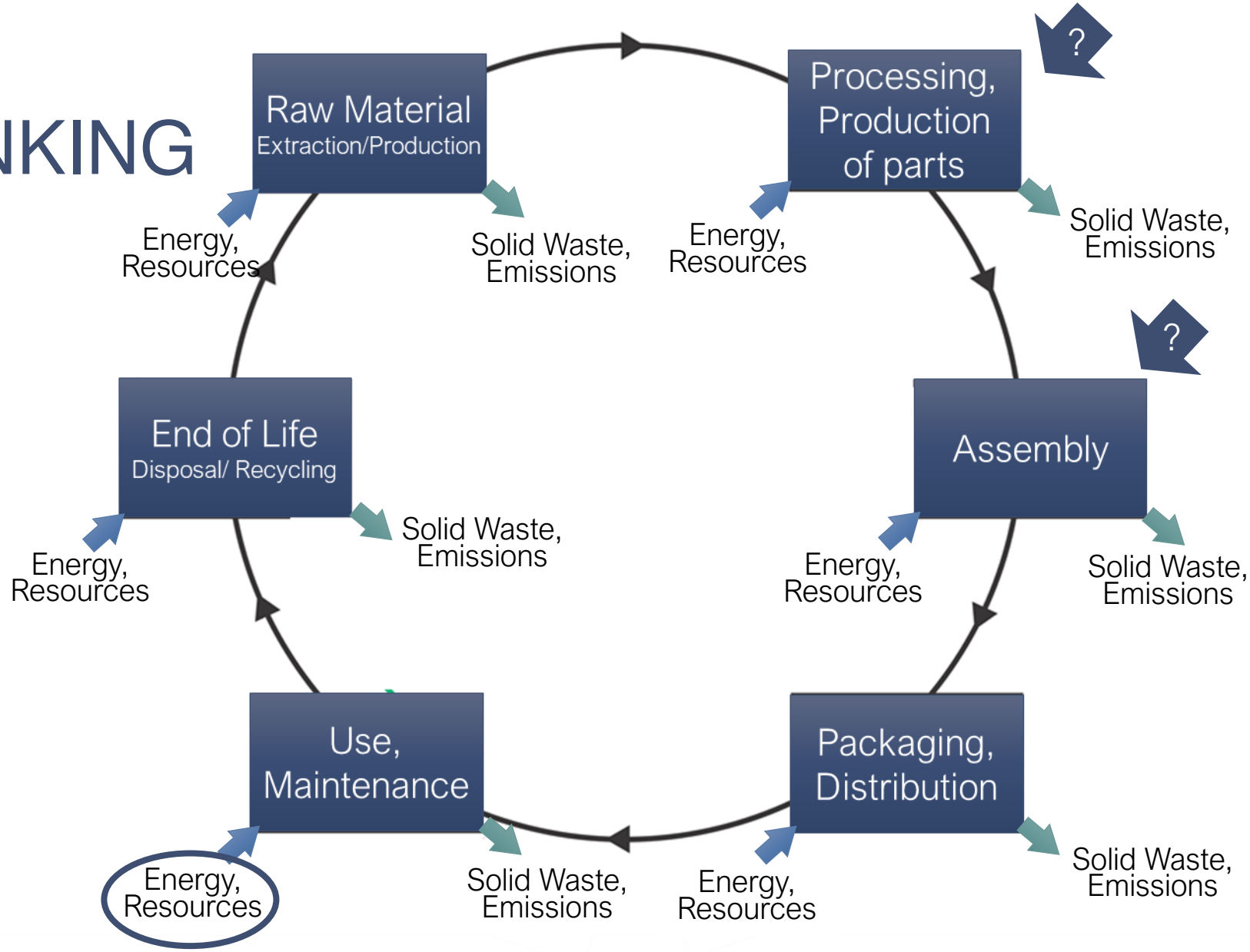
Source: The Life cycle Initiative
https://www.lifecycleinitiative.org/starting-life-cycle-thinking/what-is-life-cycle-thinking/

LIFE CYCLE THINKING

BENEFITS

Reduces the narrow focus
on just one or two stages.



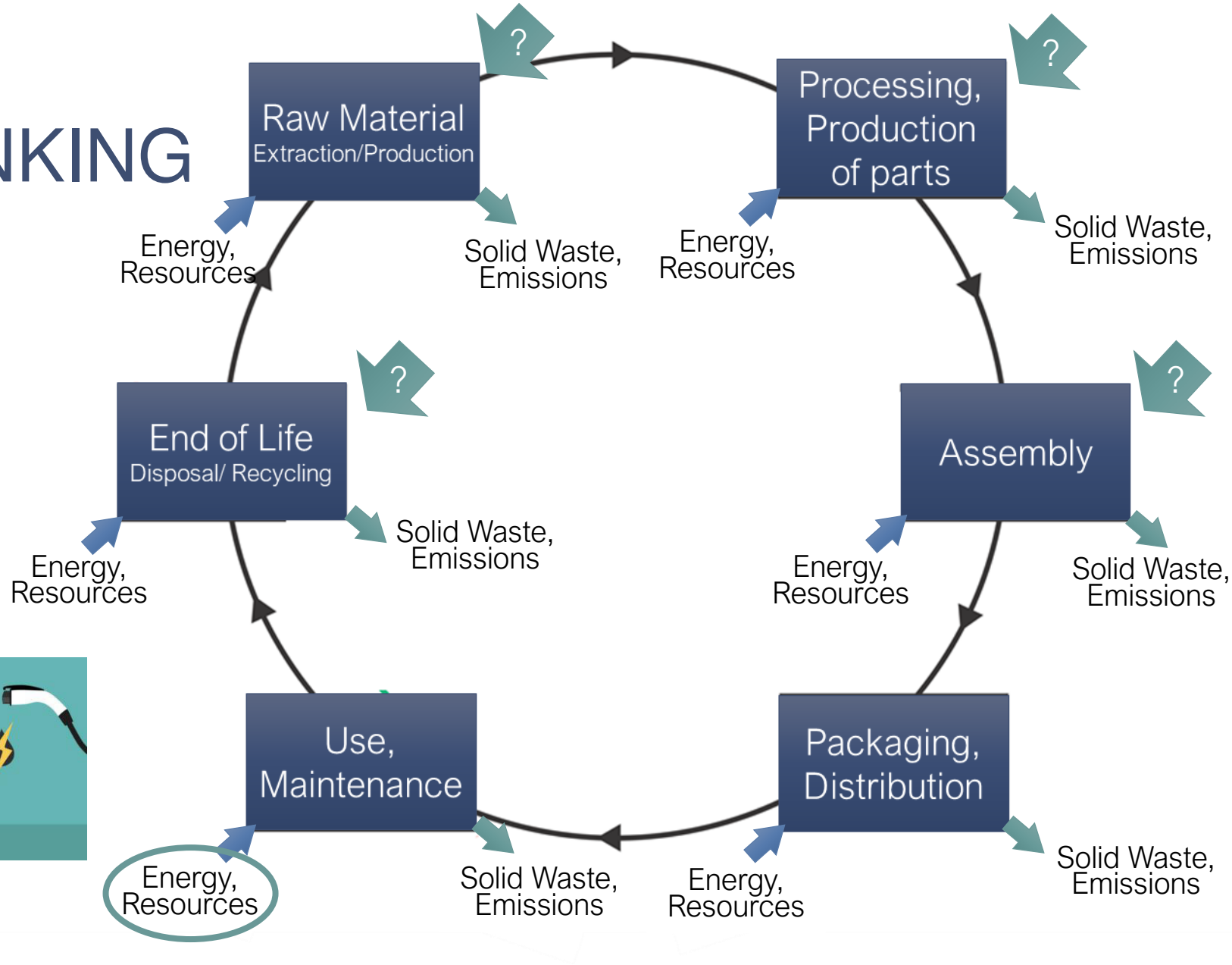


Source: The Life cycle Initiative
https://www.lifecycleinitiative.org/starting-life-cycle-thinking/what-is-life-cycle-thinking/

LIFE CYCLE THINKING

BENEFITS

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

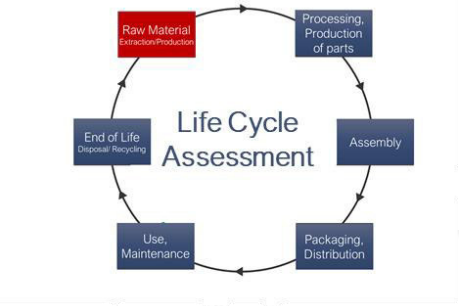


Source: The Life cycle Initiative
https://www.lifecycleinitiative.org/starting-life-cycle-thinking/what-is-life-cycle-thinking/

LIFE CYCLE ASSESSMENT

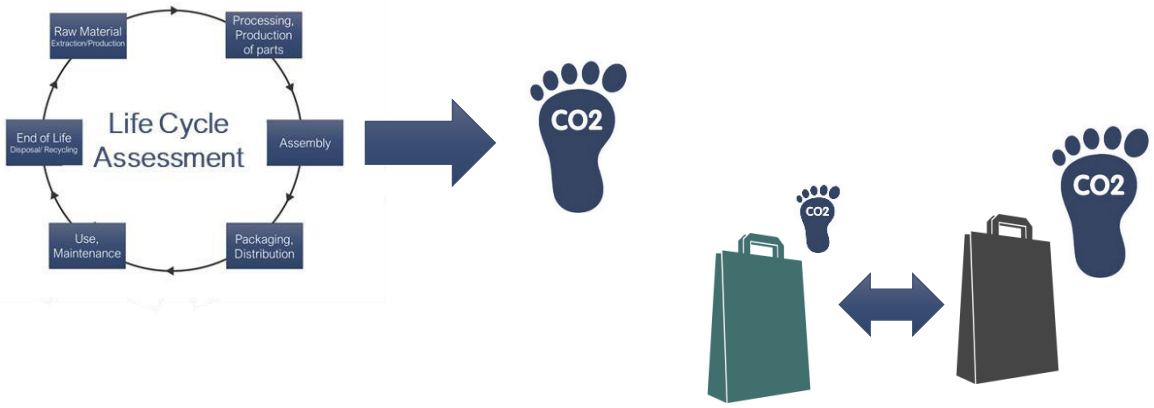
QUANTIFICATION OF ENVIRONMENTAL IMPACTS ALONG THE LIFE CYCLE

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

THE FIRST LCA

COCA COLA 1969

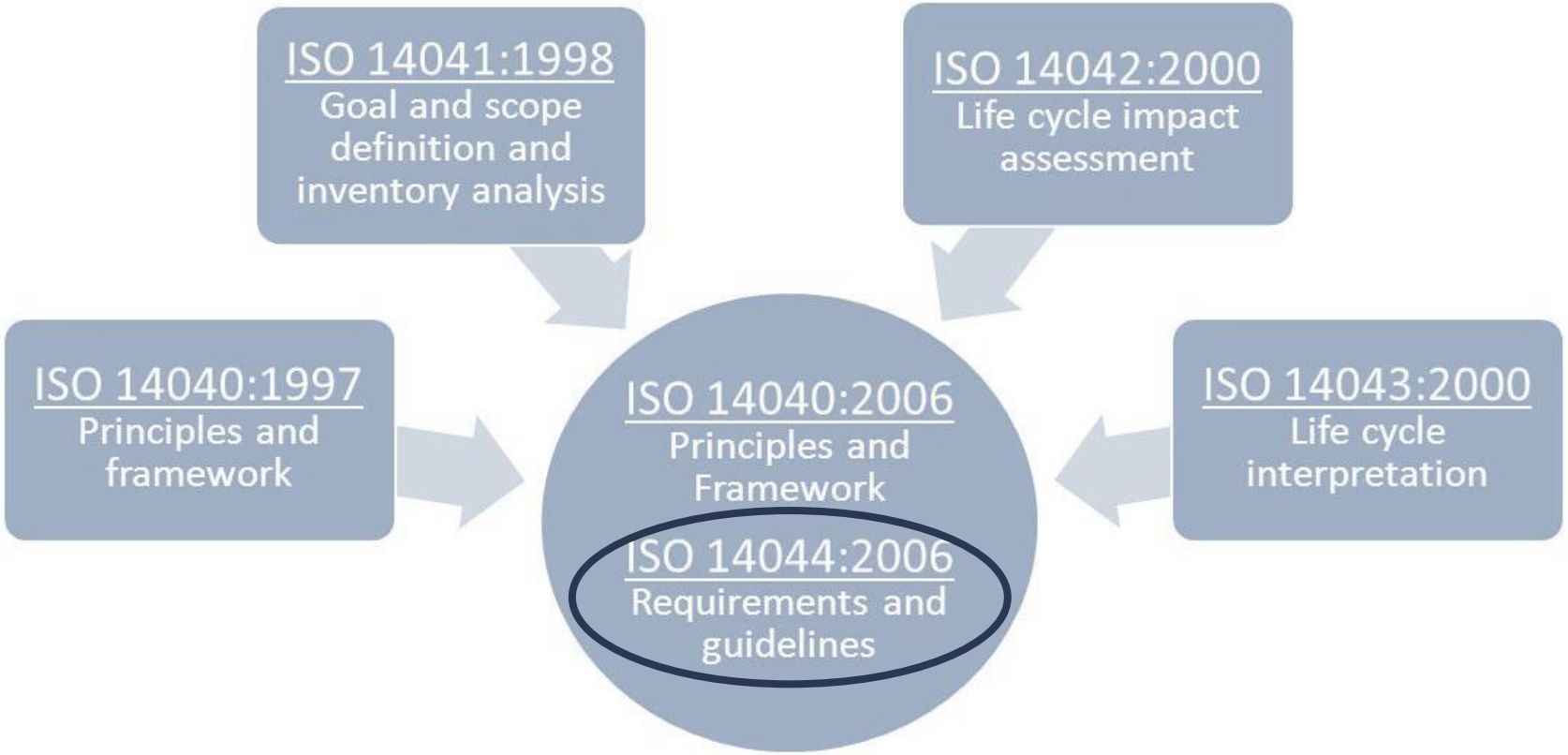
- Result: Contrary to expectation
- Study never published, Validity questioned
- Arguments over methodologies and comparability

→ Call for standardization process

English

International Organization for Standardization

When the world agrees



Source: https://www.iso.org/developing-standards.html; http://slideplayer.com/slide/3381938/

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

International Organization for Standardization

When the world agrees

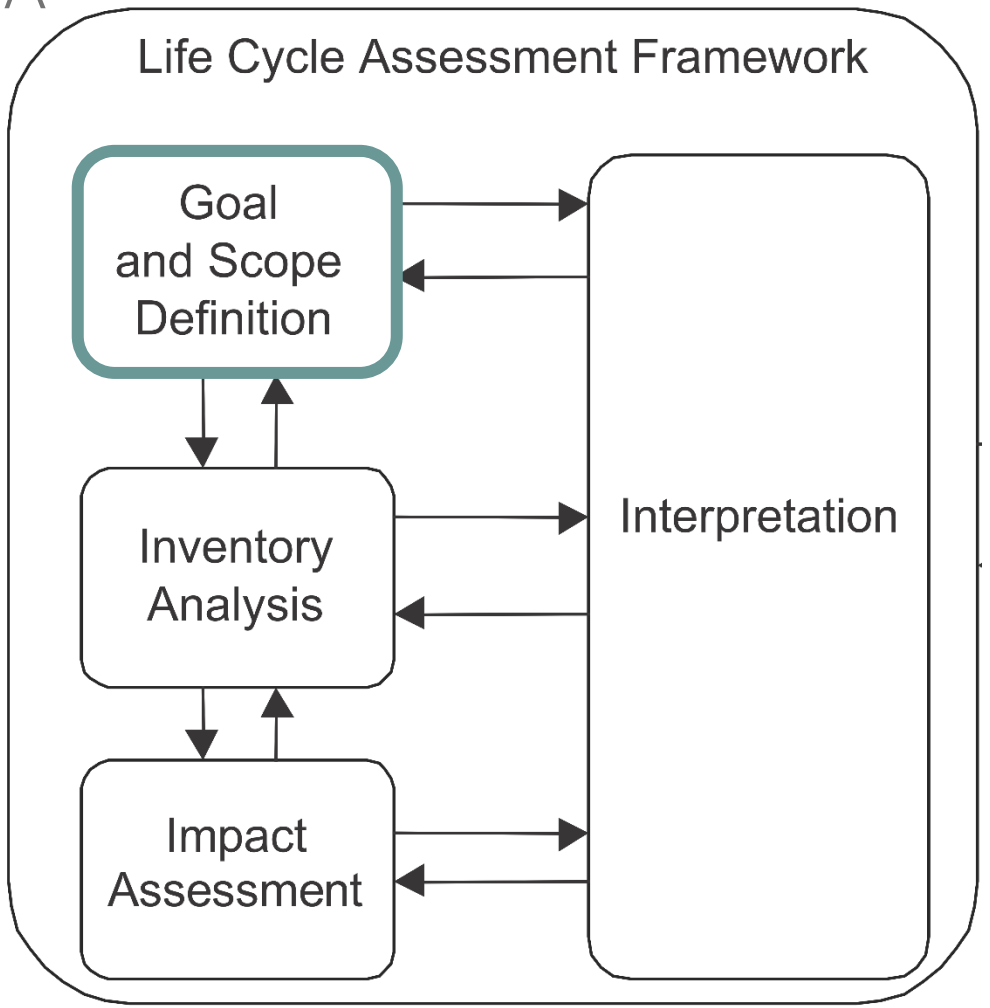
ISO 14040 & 14044

1. Scope
2. Normative references (ISO 14044)
3. Terms and definitions
4. General description of LCA
   - Principles; Phases; Key features; General concepts of product systems
5. Methodological framework
6. Reporting
7. Critical review

Source: ISO 14040:2006 & ISO 14044:2006

LCA - METHODOLOGICAL FRAMEWORK

THE FOUR PHASES OF LCA



Source: ISO 14040:2006 & ISO 14044:2006

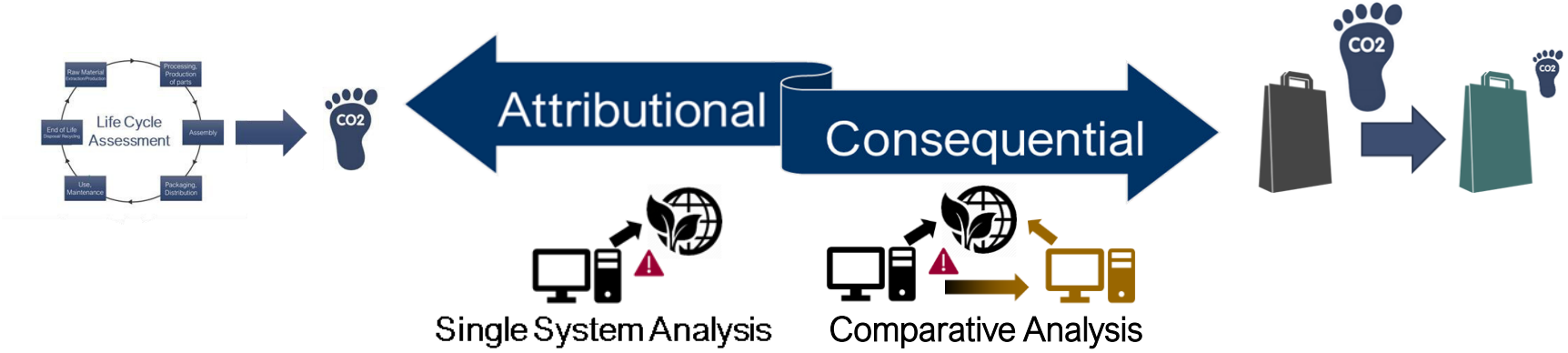
GOAL STATEMENT

LCA PHASES

1. **Goal** & Scope
2. LCI - Life Cycle Inventory
3. LCIA - Life Cycle Impact Assessment
4. Interpretation

1. **Reasons for conducting the study** *(why is the study done?)*
2. **Intended applications of the results** *(describes what a study does)*

- Identifying the parts of a product system that contribute most to its environmental impact *(i.e. " hotspot identification").*
- Evaluating improvement potentials from changes in product designs *(analysis and ' what-if ' scenarios in eco-design).*



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

GOAL STATEMENT

LCA PHASES

1. **Goal** & Scope
2. LCI - Life Cycle Inventory
3. LCIA - Life Cycle Impact Assessment
4. Interpretation

1. **Reasons for conducting the study** *(why is the study done?)*
2. **Intended applications of the results** *(describes what a study does)*
   - Identifying the parts of a product system that contribute most to its environmental impact *(i.e. " hotspot identification").*
   - Evaluating improvement potentials from changes in product designs *(analysis and ' what-if ' scenarios in eco-design).*
   - Comparing environmental impacts of specific goods or services.
   - Documenting the environmental performance of products *(e.g. in marketing using environmental product declarations or other types of product environmental footprints).*
   - Developing criteria for an eco-label.
   - Developing policies that consider environmental aspects.

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

GOAL STATEMENT

LCA PHASES

1. **Goal** & Scope
2. LCI - Life Cycle Inventory
3. LCIA - Life Cycle Impact Assessment
4. Interpretation

1. Reasons for conducting the study
2. Intended applications of the results
3. Audience - for whom are the results intended?

   e.g., consumers, consumer organisations, companies (internal: managers, product developers, etc. or external B2B), government, NGOs, …

   Determines: which details of the study should be documented, the technical level of reporting & interpretation of results
4. Comparative studies to be disclosed to the public *(follow ISO standard)*

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

MINI-EXERCISE I

GOAL STATEMENT – TOYOTA MIRAI

What is the GOAL of Toyota for doing LCA for their MIRAI model?

- Intended applications of the results?
- Target Audience?
- Any limitations, conflicts of interest or biases?

TOYOTA

The MIRAI

Life Cycle Assessment Report

for communication

Company name:	Toyota Motor Corporation
Responsible person:	Junji Tokieda
LCA analysts:	Tamaki Ozawa, Takuya Yoshida
Under the supervision of:	Satoshi Aida, Lisa Oya
Report date:	2015.6.10
Conformed standard:	ISO 14040(2006) and ISO 14044(2006)
Critical reviewer:	Dominik Müller, TÜV Rheinland LGA Products GmbH

1

Source: Toyota, The MIRAI Life Cycle Assessment for communication
https://global.toyota/pages/global_toyota/sustainability/esg/challenge2050/challenge2/life_cycle_assessment_report_en.pdf

MINI-EXERCISE I

GOAL STATEMENT – TOYOTA MIRAI

What is the GOAL of Toyota for doing LCA for their MIRAI model?

- Intended applications of the results?
- Single system or comparative analysis?
- Target Audience?

What to pay attention to?

Dr. Meike Sauerwein
08. April 2022

1. Goal of the Study

Background

There are multiple kinds of powertrains which show outstanding environmental performance in reduction of emissions and pollutants during use phase of vehicles. However assessment of the environmental performance should consider all impacts throughout life cycle of a vehicle from cradle to grave. On release of the world first volume production fuel cell vehicle the "MIRAI", TOYOTA conduct life cycle assessment (hereinafter referred to as "LCA") over the comparable gasoline and gasoline hybrid vehicles as reference models.

Objectives

We have been conducting LCA for all our passenger vehicles and components from 1997, and observed all of them achieve better environmental performance than their predecessors. The summary of the results have been transparently displayed in each brochure to potential customers and to the public.

Now we release the results of the "MIRAI", compared with the relevant reference models, GV and GV hybrid. This time, the assessment procedures are substantially focused on its unique conditions in its powertrain the "Fuel Cell" and the energy source "Hydrogen". We consider the impacts of sources of the hydrogen used to propel the "MIRAI" as well as the fuel cell components' efficiency, its constitution of materials and production processes. (Environmental gains of fuel cell vehicles, whose energy source is hydrogen, depend on how the hydrogen is produced and transported and how effectively it is converted. We are considering the multiple options of hydrogen sources from fossil fuels to renewable energy, transportation methods, on-site or off-site.)

Target audience

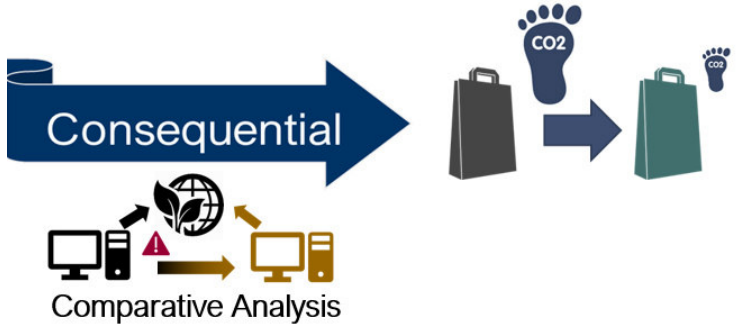
The results will be used to communicate externally not only with customers but also with hydrogen suppliers and governmental organizations of each region. Simultaneously, we internally feedback analysed results, such as what material or process has big impact on total vehicle life to our development divisions to help improve future models.

GOAL STATEMENT

EXAMPLE: TOYOTA MIRAI

Intended applications of results

- Supporting marketing / performance claims
- Inform decisions by stakeholders
- Improve product or process design



Comparison with “relevant reference models, Gasoline Vehicles and GV hybrid

Target audience

*‘The results will be used to **communicate externally** not only with **customers** but also with **hydrogen suppliers and governmental organizations** of each region. Simultaneously, we internally feedback analysed results,[…] to our development divisions to **help improve future models**.’*


TOYOTA

The MIRAI

Life Cycle Assessment Report

for communication

https://www.toyota-global.com/sustainability/environment/low_carbon/lca_and_eco_actions/pdf/life_cycle_assessment_report.pdf

FUNCTIONAL UNIT

LCA PHASES

1. Goal & **Scope**
2. LCI - Life Cycle Inventory
3. LCIA - Life Cycle Impact Assessment
4. Interpretation

- The functional unit is **a measure of the function of the studied system**
  - Provides a reference to which the inputs and outputs can be related
  - Enables comparison of two essentially different systems that fulfil the same unit function (offer the same service)

- Examples
  - The functional unit for a paint system may be defined as the amount of paint needed to cover 1m^2 surface protected for 10 years (e.g. 2L of paint)
  - The functional unit for power generation systems may be defined as 1kWh of electricity

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

FUNCTIONAL UNIT

Why do we need to define a functional unit

LCA PHASES

1. Goal & **Scope**
2. LCI - Life Cycle Inventory
3. LCIA - Life Cycle Impact Assessment
4. Interpretation

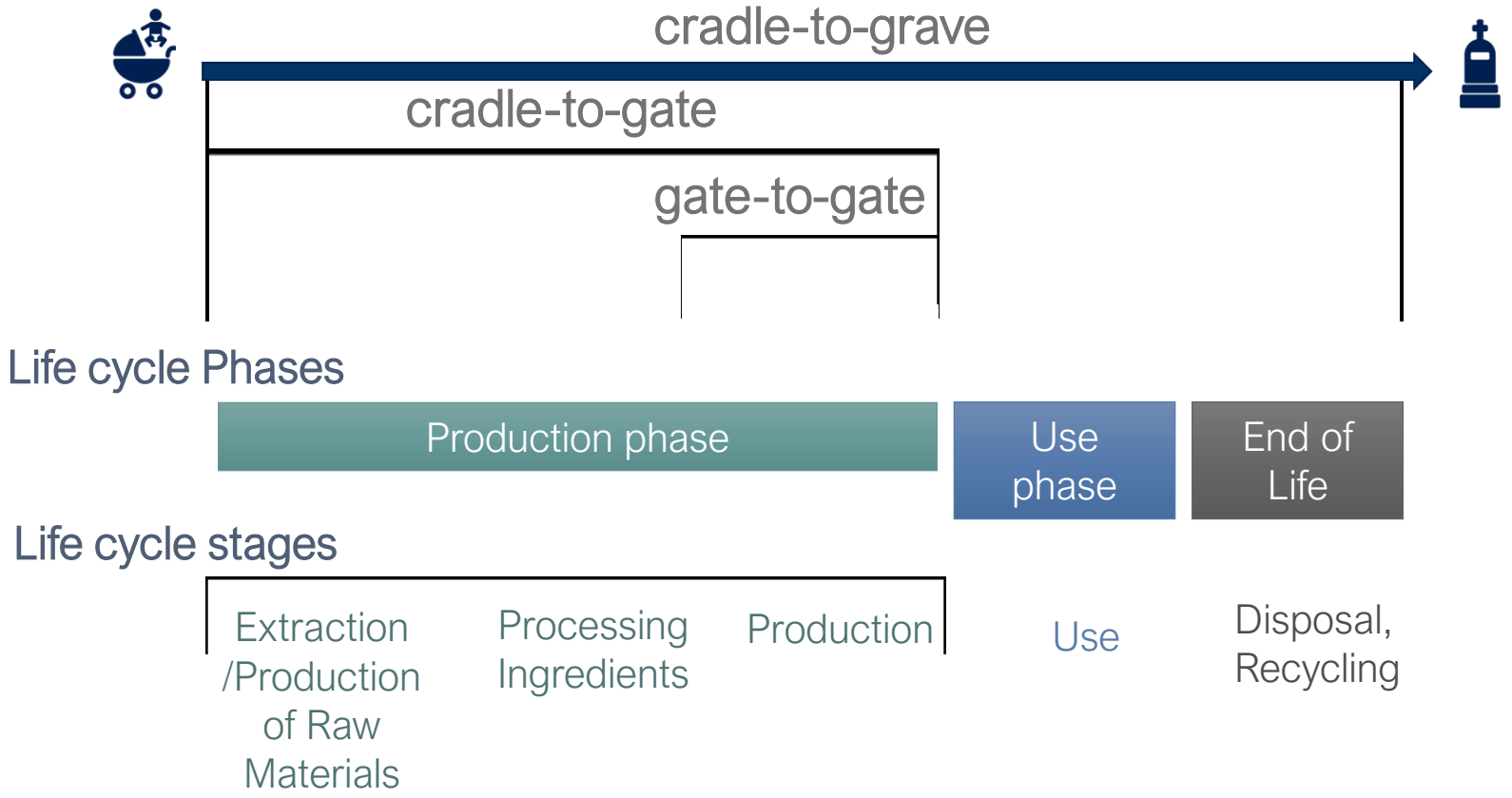
Functional Unit:
1 liter of milk

- **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

SCOPE OF THE ASSESSMENT

SYSTEM BOUNDARY



LCA PHASES

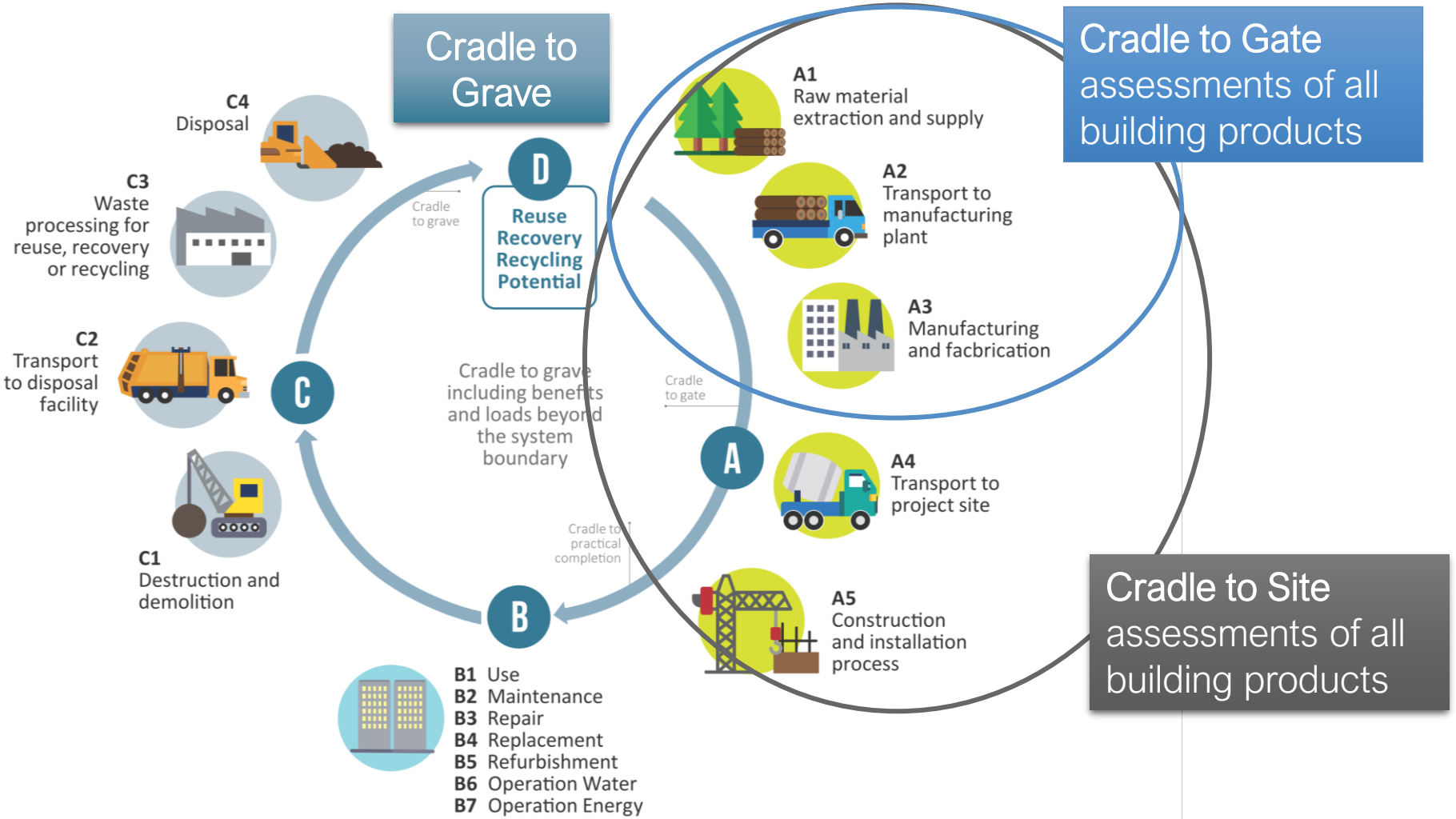
1. Goal & **Scope**
2. LCI - Life Cycle Inventory
3. LCIA - Life Cycle Impact Assessment
4. Interpretation

SCOPE OF THE ASSESSMENT

SYSTEM BOUNDARY

LCA PHASES

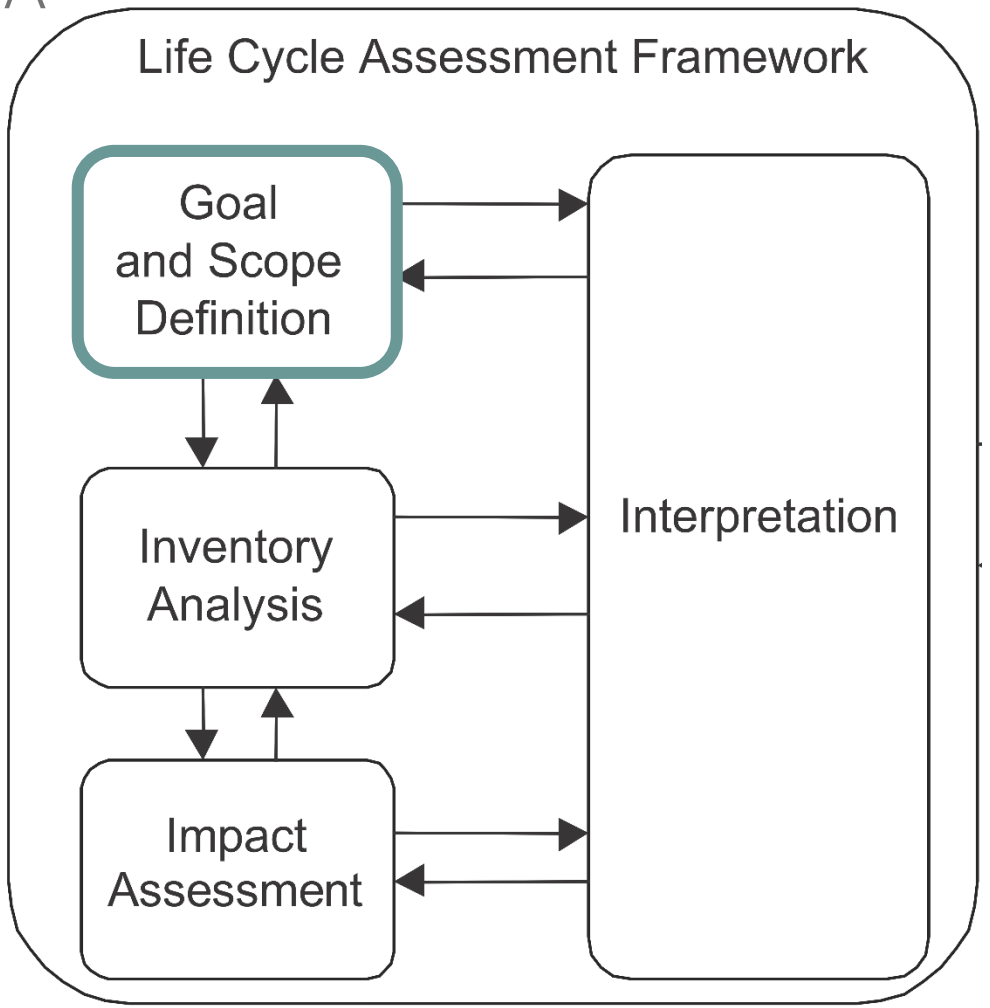
1. Goal & **Scope**
2. LCI - Life Cycle Inventory
3. LCIA - Life Cycle Impact Assessment
4. Interpretation



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

LCA - METHODOLOGICAL FRAMEWORK

THE FOUR PHASES OF LCA



Source: ISO 14040:2006 & ISO 14044:2006

LIFE CYCLE INVENTORY

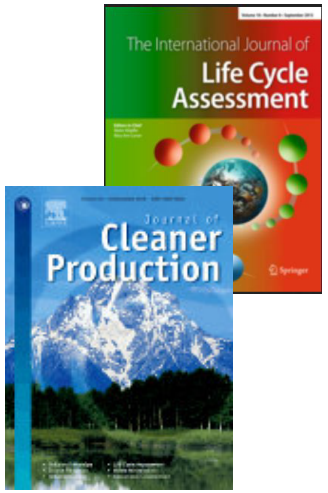
DATA SOURCES

Primary Data

- Process data
- Governmental statistics
- Surveys
- …

Secondary data (Background data)

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



Soy milk

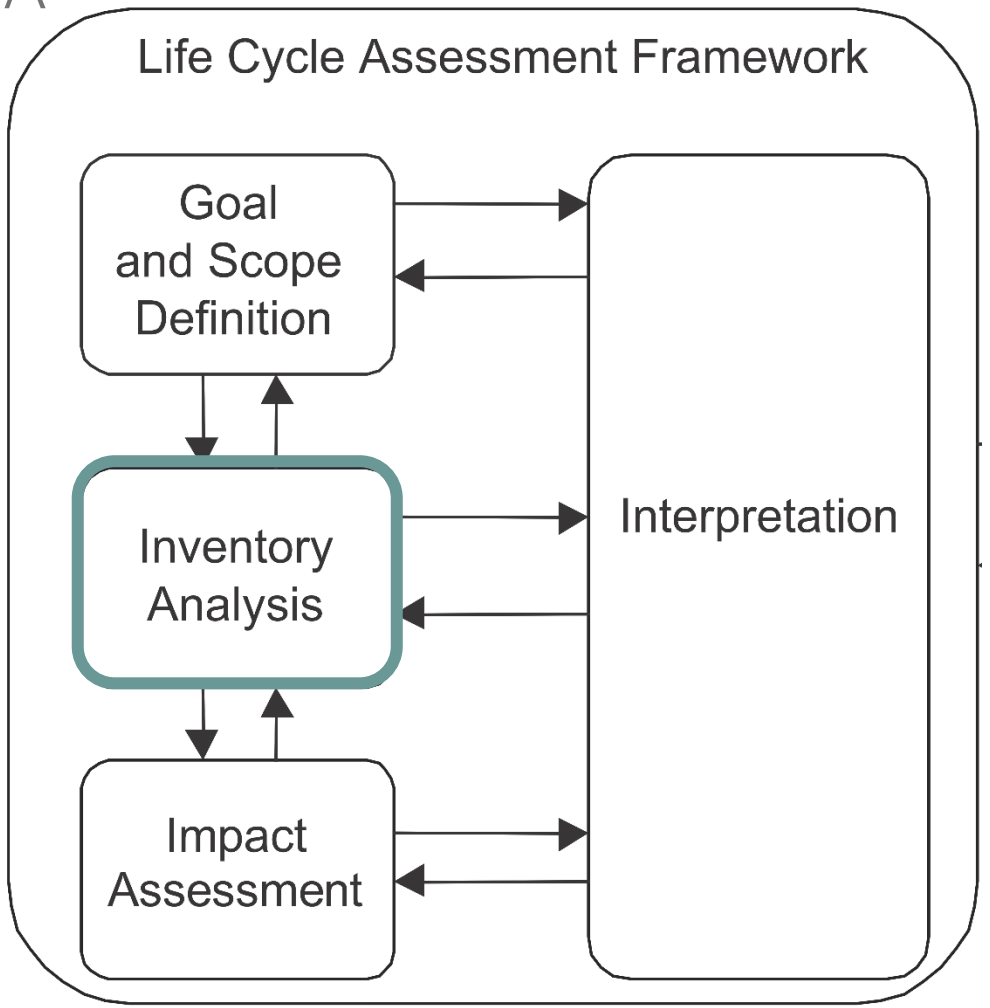
LIFE CYCLE INVENTORY

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

LCA - METHODOLOGICAL FRAMEWORK

THE FOUR PHASES OF LCA



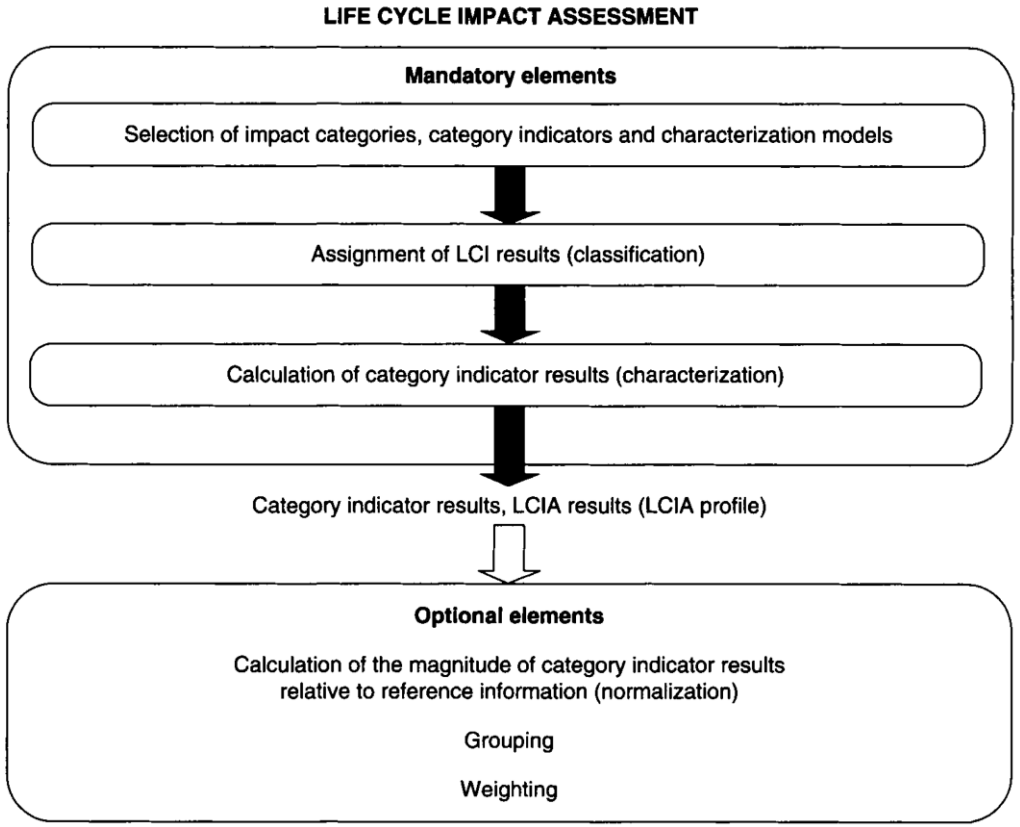
Source: ISO 14040:2006 & ISO 14044:2006

LIFE CYCLE IMPACT ASSESSMENT (LCIA)

LCA PHASES

1. Goal & Scope
2. LCI - Life Cycle Inventory
3. LCIA - Life Cycle Impact Assessment
4. Interpretation

1. Classification (mandatory)
2. Characterization (mandatory)
3. Normalization (optional)
4. Weighting (optional)



LCIA - Life Cycle Impact Assessment

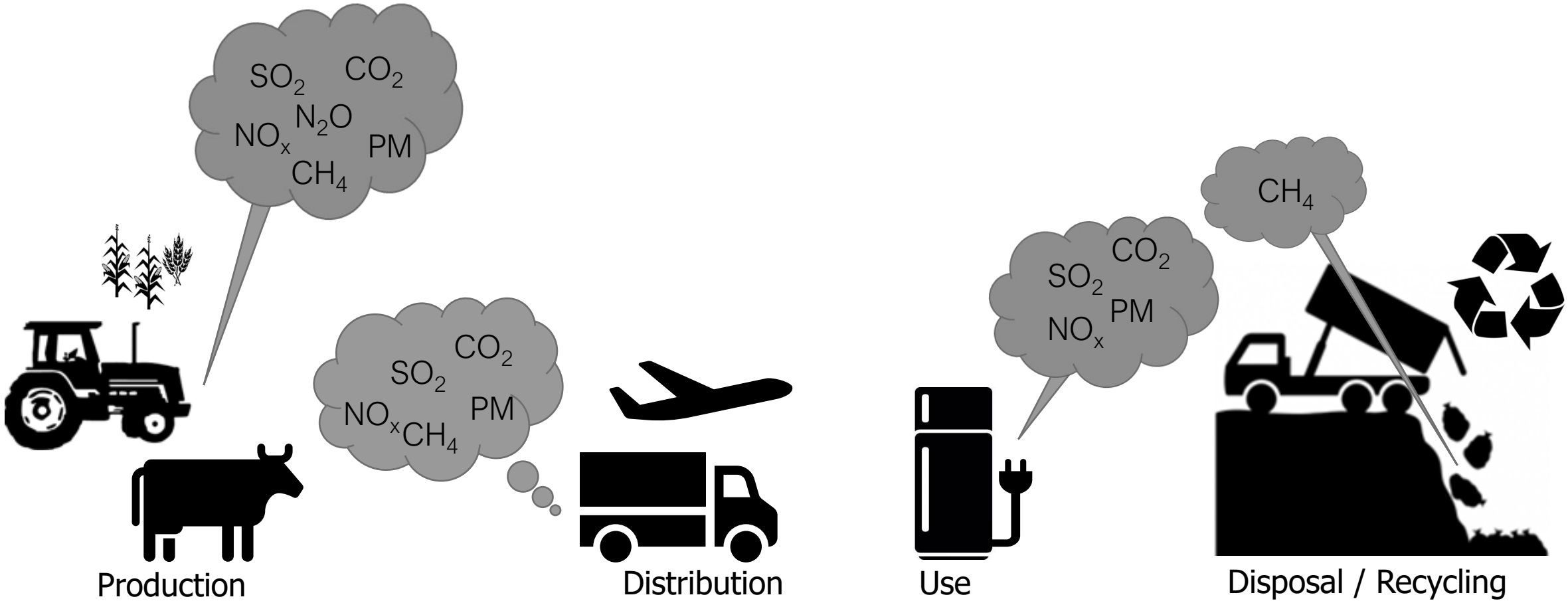
CLASSIFICATION

Dr. Meike Sauerwein

08. April 2022

CLASSIFICATION INTO ENVIRONMENTAL CATEGORIES

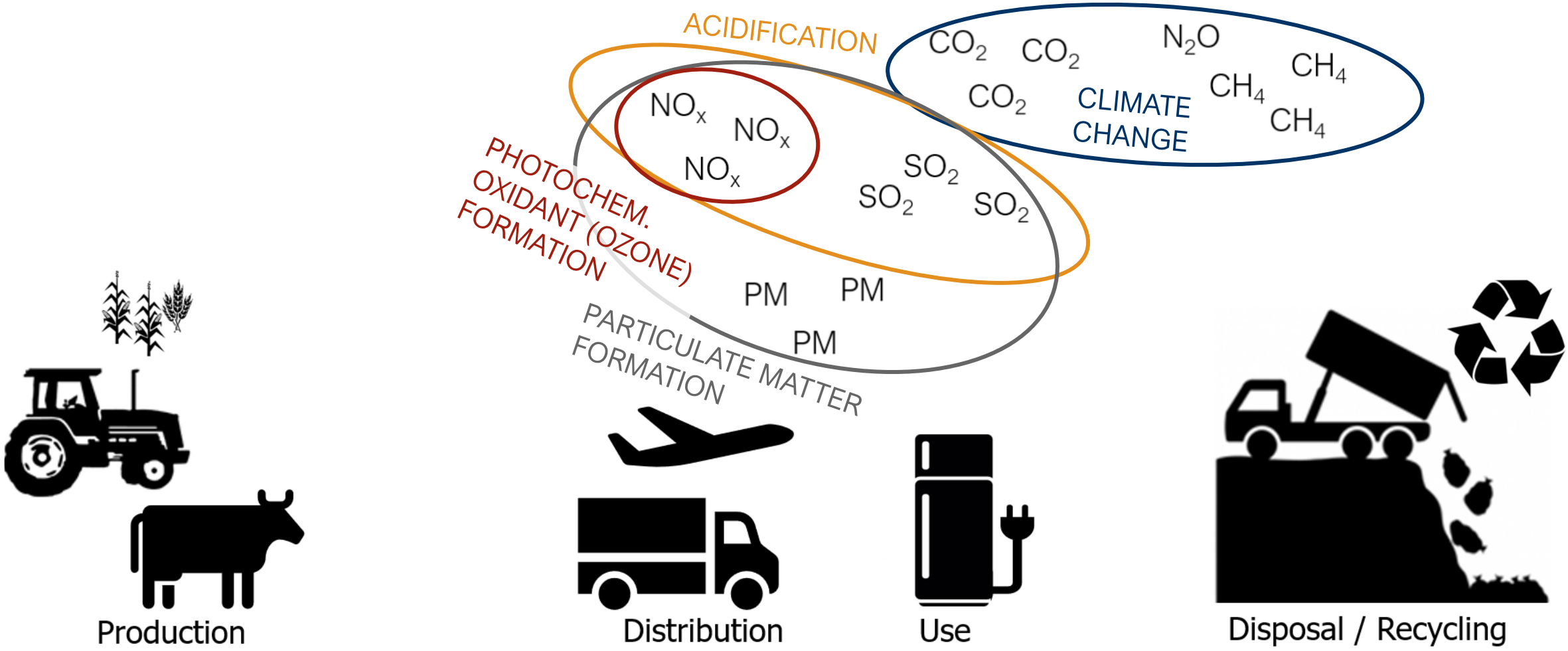
CLASSIFYING THE TYPE OF POTENTIAL IMPACT (DAMAGE), A SPECIFIC EMISSION COULD CAUSE IN THE ENVIRONMENT



Source: ISO 14044

CLASSIFICATION INTO ENVIRONMENTAL CATEGORIES

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



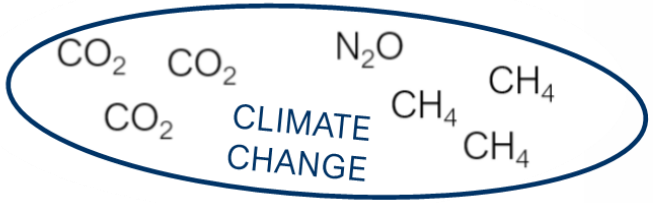
Source: ISO 14044

LCIA - Life Cycle Impact Assessment

CHARACTERIZATION

CHARACTERIZATION – QUANTIFYING THE POTENTIAL IMPACT OF A GROUP OF CHEMICALS

Example: Greenhouse Gas Emissions

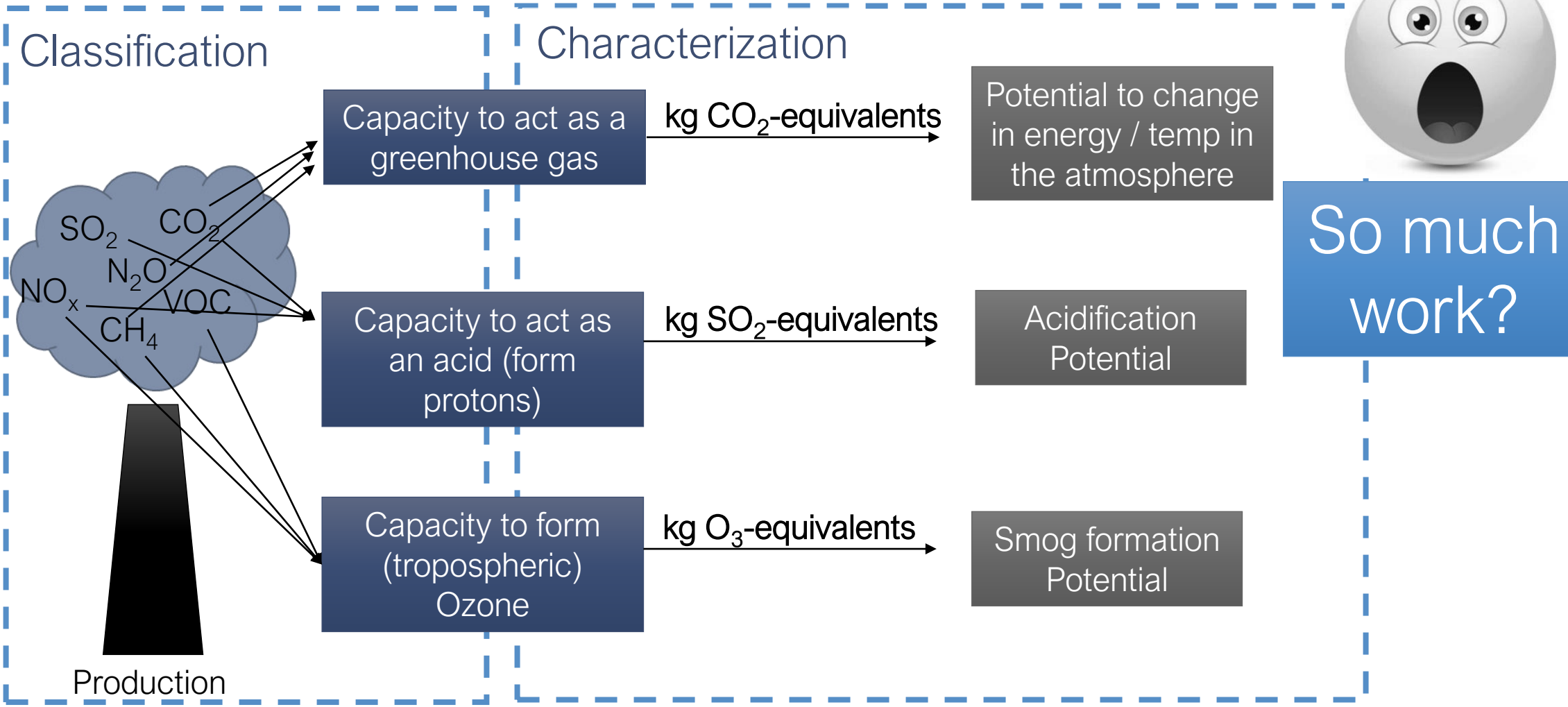


Calculating how strongly a certain chemical contributes to the potential environmental damage.

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

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

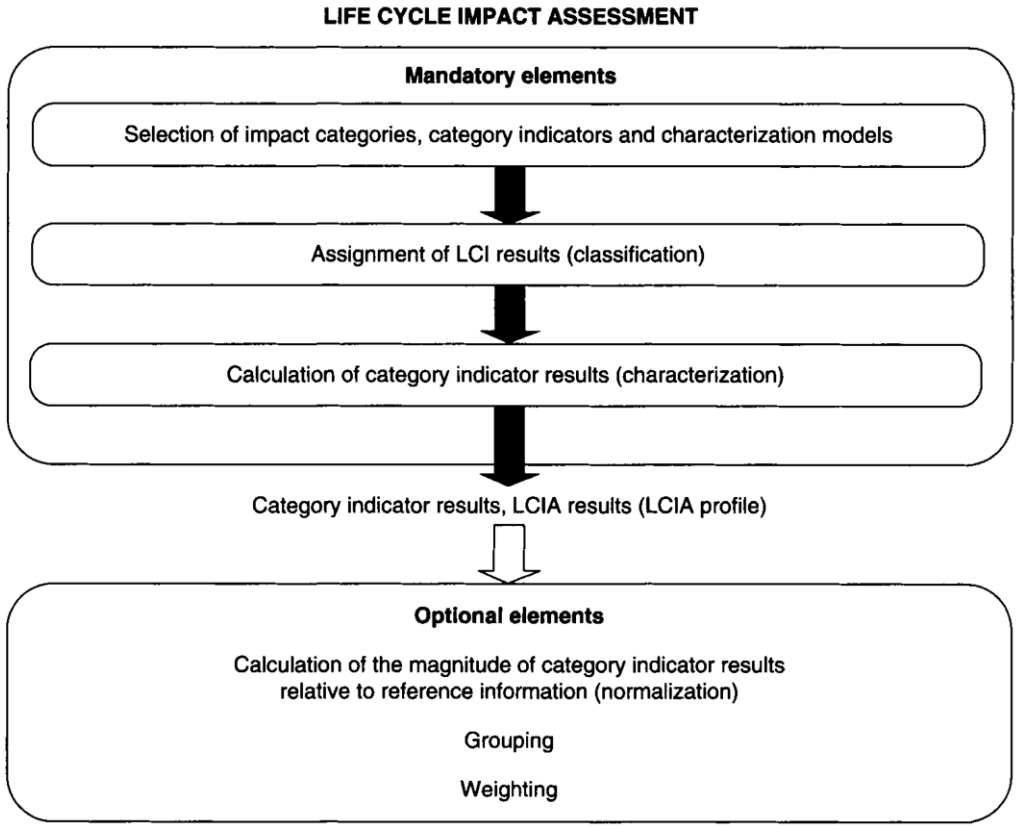
- SimaPro
  - Most widely adopted; produced by Pre Consultants (Netherlands)
  - Comes preloaded with many databases
  - Can model whole product systems using aggregated or disaggregated datasets
- GaBi
  - Very popular LCA software produced by Sphera
  - Comes with GaBi database and other databases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

LIFE CYCLE IMPACT ASSESSMENT (LCIA)

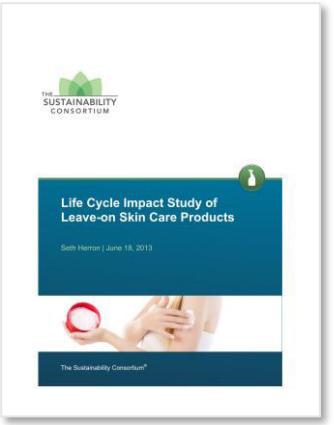
LCA PHASES

1. Goal & Scope
2. LCI - Life Cycle Inventory
3. LCIA - Life Cycle Impact Assessment
4. Interpretation

1. Classification (mandatory)
2. Characterization (mandatory)
3. Normalization (optional)
4. Weighting (optional)

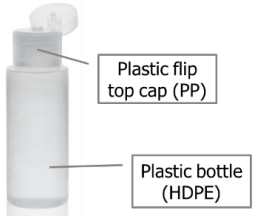


REFERENCE LITERATURE



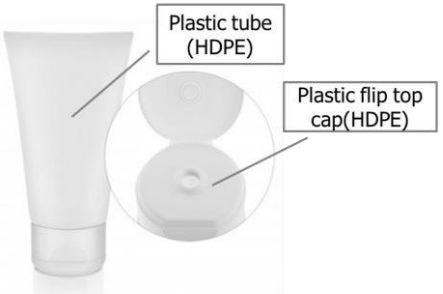
Case Study: The Sustainability Consortium, 2013:
Life Cycle Impact Study of Leave-on Skin Care Products


https://www.shefinds.com/files/2016/02/HandsLotion.jpg



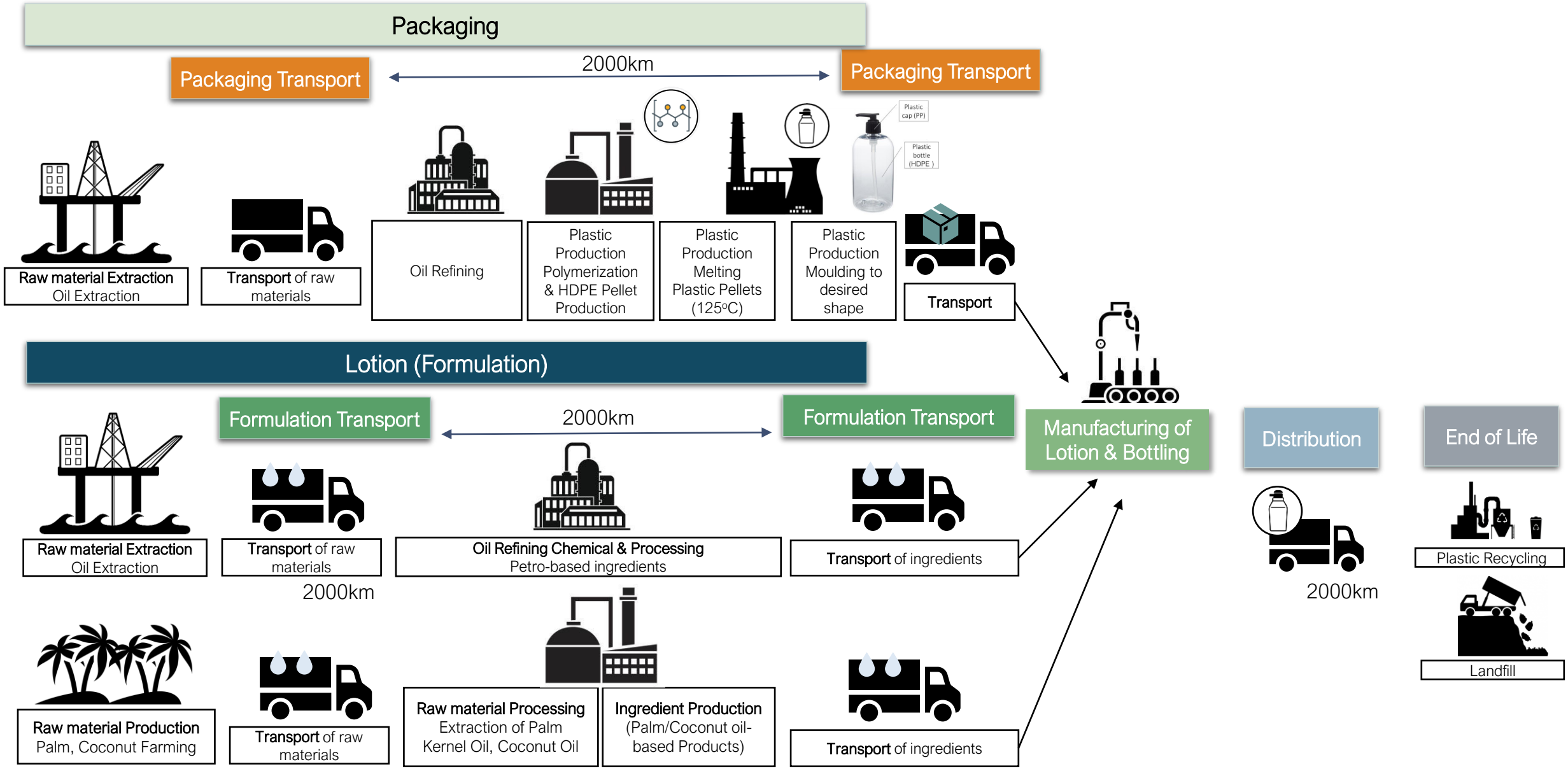
Small Plastic Packaging

Glass Packaging

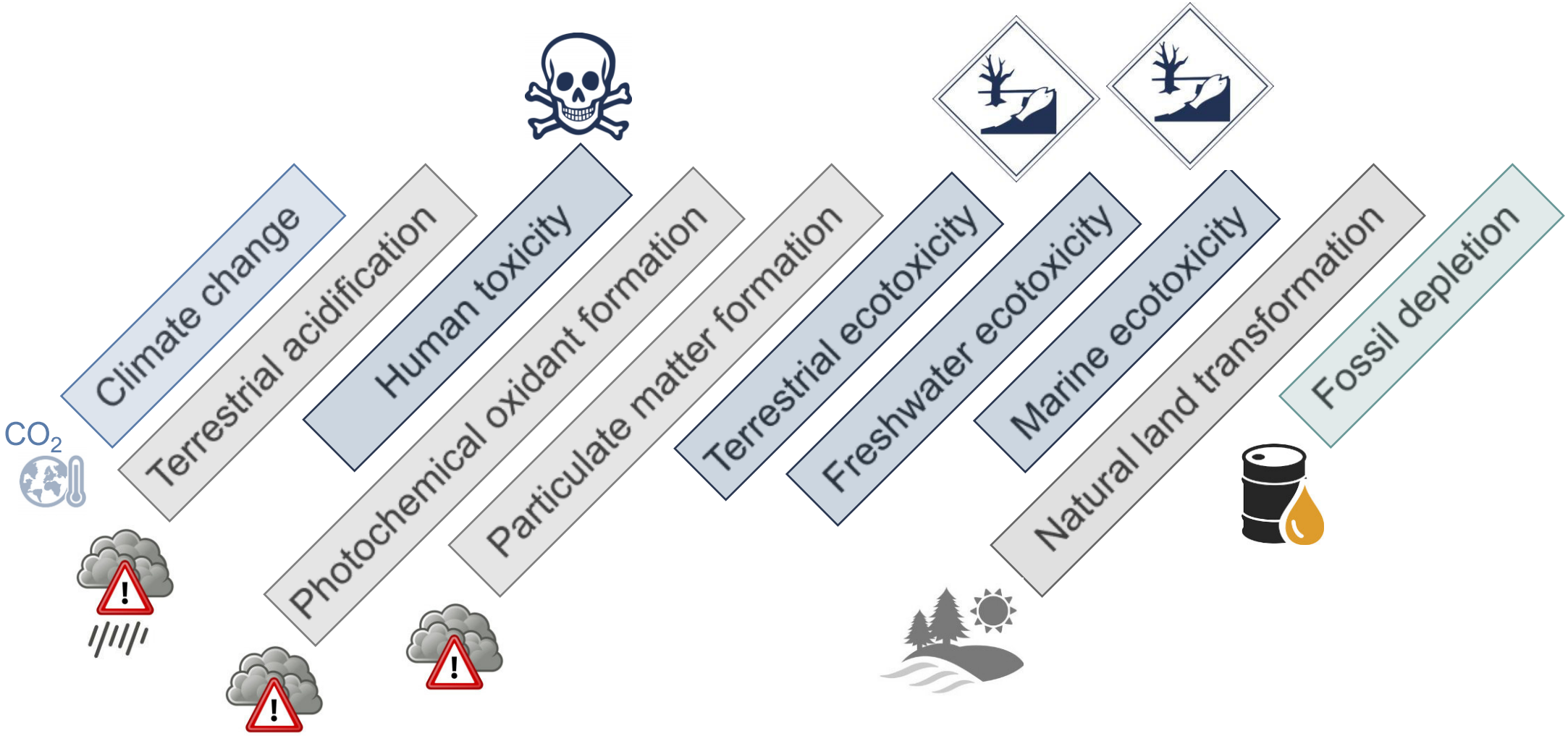


Med Packaging

Large Plastic Packaging


Packaging
Packaging Transport
2000km
Packaging Transport
Raw material Extraction
Oil Extraction
Transport of raw materials
Oil Refining
Plastic Production Polymerization & HDPE Pellet Production
Plastic Production Melting Plastic Pellets (125°C)
Plastic Production Moulding to desired shape
Plastic cap (PP)
Plastic bottle (HDPE)
Transport
Lotion (Formulation)
Formulation Transport
2000km
Formulation Transport
Manufacturing of Lotion & Bottling
Distribution
End of Life
Raw material Extraction
Oil Extraction
Transport of raw materials
Oil Refining Chemical & Processing
Petro-based ingredients
Transport of ingredients
2000km
Plastic Recycling
Raw material Production
Palm, Coconut Farming
Transport of raw materials
Raw material Processing
Extraction of Palm Kernel Oil, Coconut Oil
Ingredient Production
(Palm/Coconut oil-based Products)
Transport of ingredients
Landfill

ENVIRONMENTAL IMPACT CATEGORIES



ACTIVITY

LCA – RESULTS OF LOTION & PACKAGING

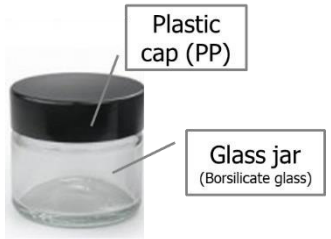
Supplementary Product Info provided on link

10 min

1. Which life cycle processes produce the highest Environmental Impacts (hotspots). Which processes seem negligible?
2. What has larger impacts – the lotion or the packaging?

Groups 1-5:
Lotion in Plastic Packaging

Groups 6+:
Lotion in Glass Packaging



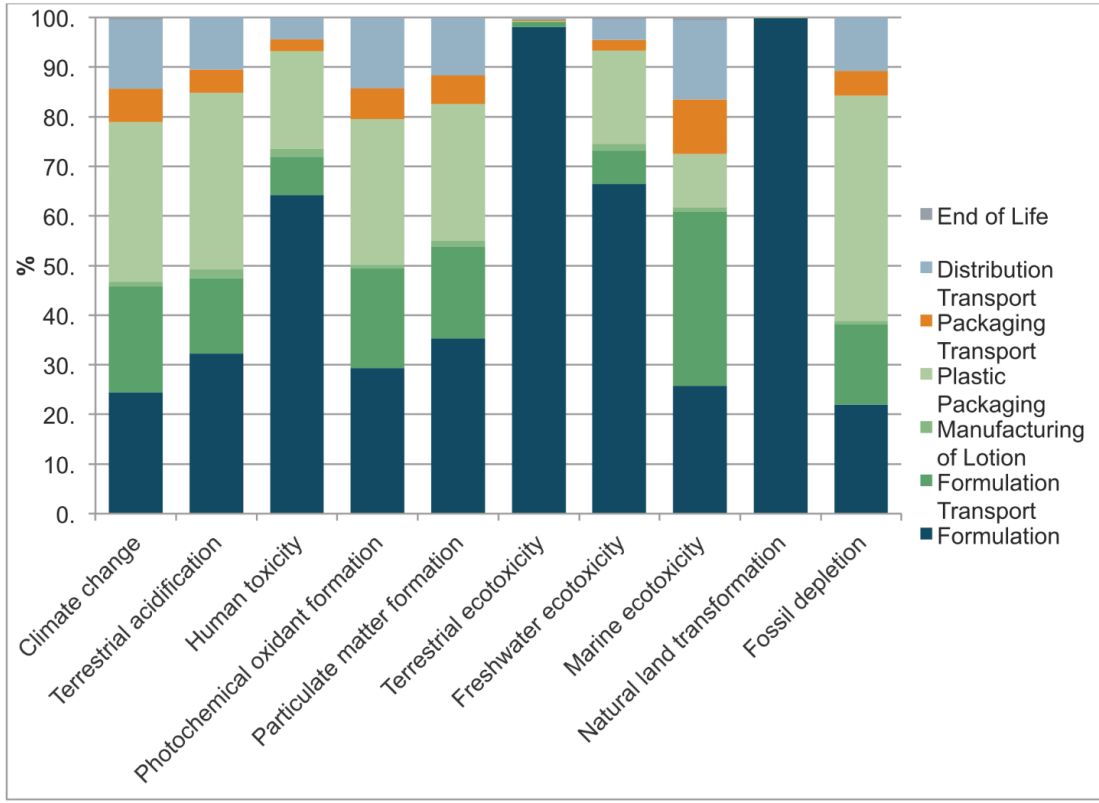
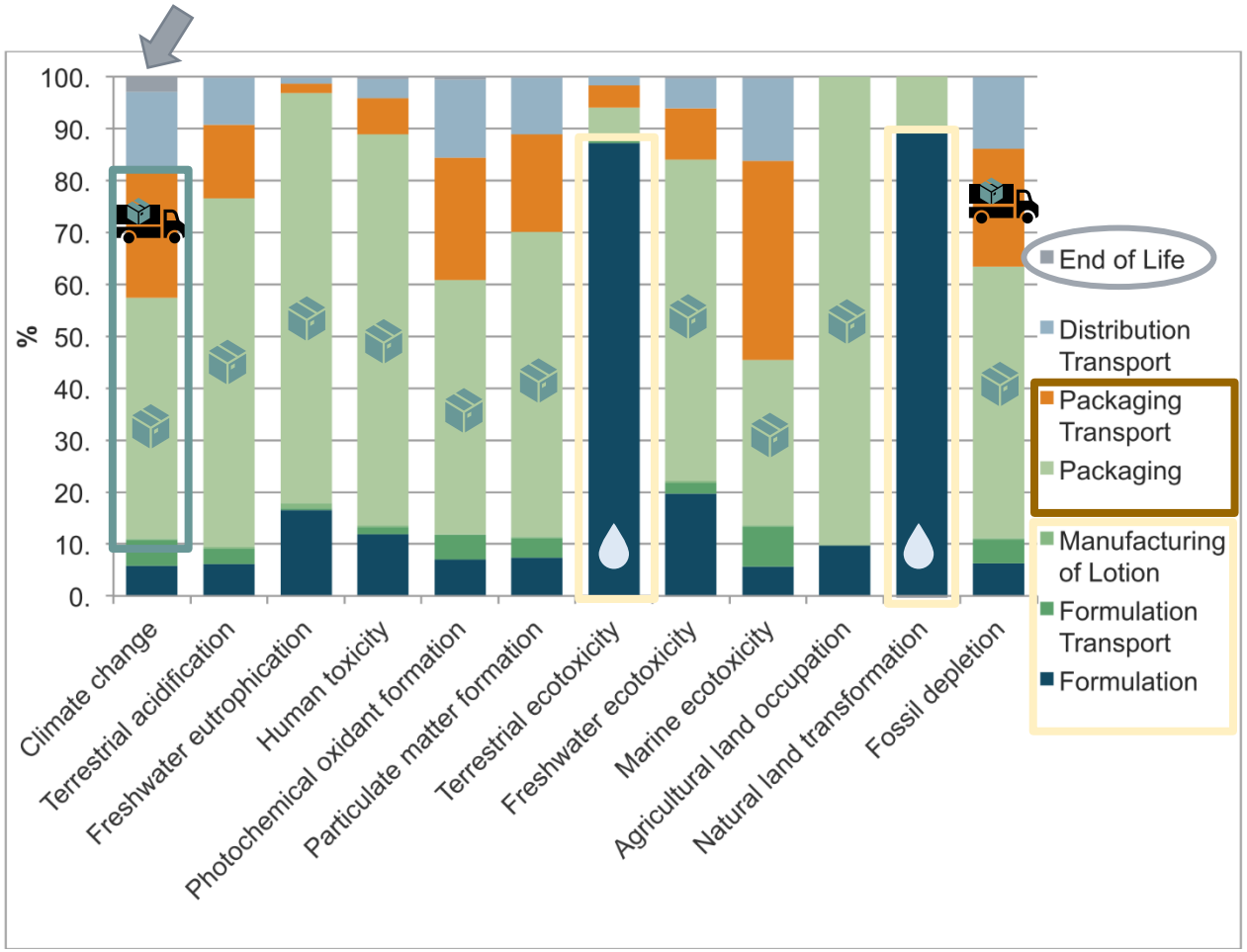


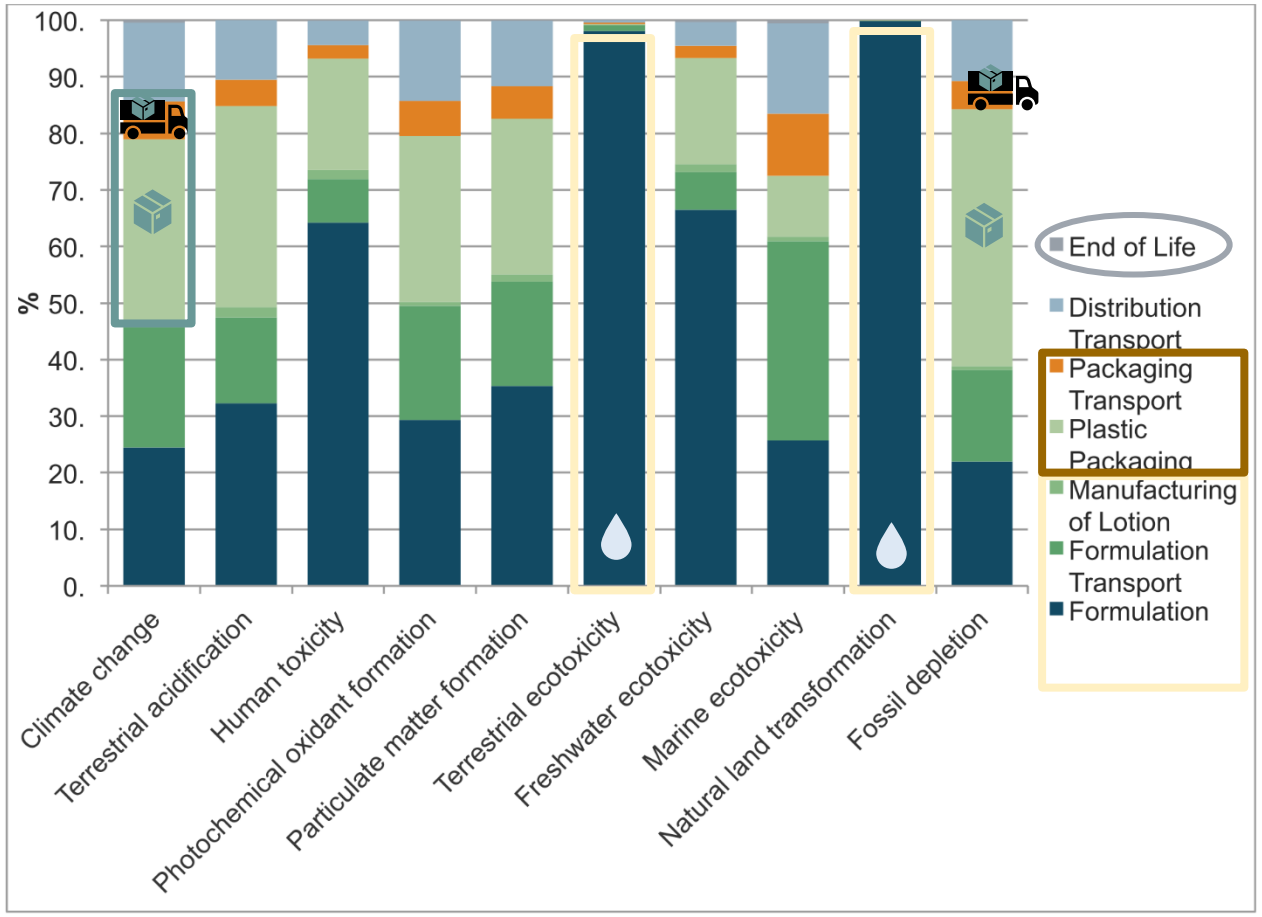
Figure 9: Characterized Results for Large Plastic Packaged Lotion

Dr. Meike Sauerwein
08. April 2022

~15 mL lotion
69 g packaging
Product to Package ratio: 0.22



~620 mL lotion
161 g packaging
Product to Package ratio: 3.85



Dr. Meike Sauerwein
08. April 2022

BREAK
UNTIL 15:48

LCIA - Life Cycle Impact Assessment

NORMALIZATION

LCIA – RESULTS (AFTER CLASSIFICATION AND CHARACTERIZATION)

EXAMPLE: LCA OF SKIN CARE PRODUCTS (SMALL GLASS PACKAGED LOTION)

Which life cycle process has the highest impacts (hotpots)?

Impact category	Climate change	Terrestrial acidification	Freshwater eutrophication
Unit	kg CO2 eq	kg SO2 eq	kg P eq
Formulation	1.20E-02	5.70E-05	5.70E-07
Formulation Transport	1.00E-02	2.60E-05	1.20E-08
Manufacturing of Lotion	5.20E-04	3.30E-06	3.10E-08
Glass Packaging	9.60E-02	6.20E-04	2.70E-06
Packaging Transport	5.10E-02	1.30E-04	6.10E-08
Distribution Transport	3.10E-02	8.30E-05	3.70E-08
End of Life	6.10E-03	1.80E-06	9.20E-09

(based on ReCiPe midpoint impact assessment methodology)
The Sustainability Consortium, 2013: Life Cycle Impact Study of Leave-on Skin Care Products

LCIA – RESULTS (AFTER CLASSIFICATION AND CHARACTERIZATION)

EXAMPLE: LCA OF SKIN CARE PRODUCTS (SMALL GLASS PACKAGED LOTION)

Which life cycle process has the highest impacts (hotpot)?

Impact category	Climate change	Terrestrial acidification	Freshwater eutrophication
Unit	kg CO2 eq	kg SO2 eq	kg P eq
Formulation	0.01	0.0001	0.00000057
Formulation Transport	0.01	0.0000	0.00000001
Manufacturing of Lotion	0.00	0.0000	0.00000003
Glass Packaging	0.10	0.0006	0.00000270
Packaging Transport	0.05	0.0001	0.00000006
Distribution Transport	0.03	0.0001	0.00000004
End of Life	0.01	0.0000	0.00000001

Source: The Sustainability Consortium, 2013: Life Cycle Impact Study of Leave-on Skin Care Products (assessment based on ReCiPe midpoint impact assessment methodology)

NORMALISATION APPROACHES AND METHODS

EXAMPLES: INTERNAL NORMALIZATION

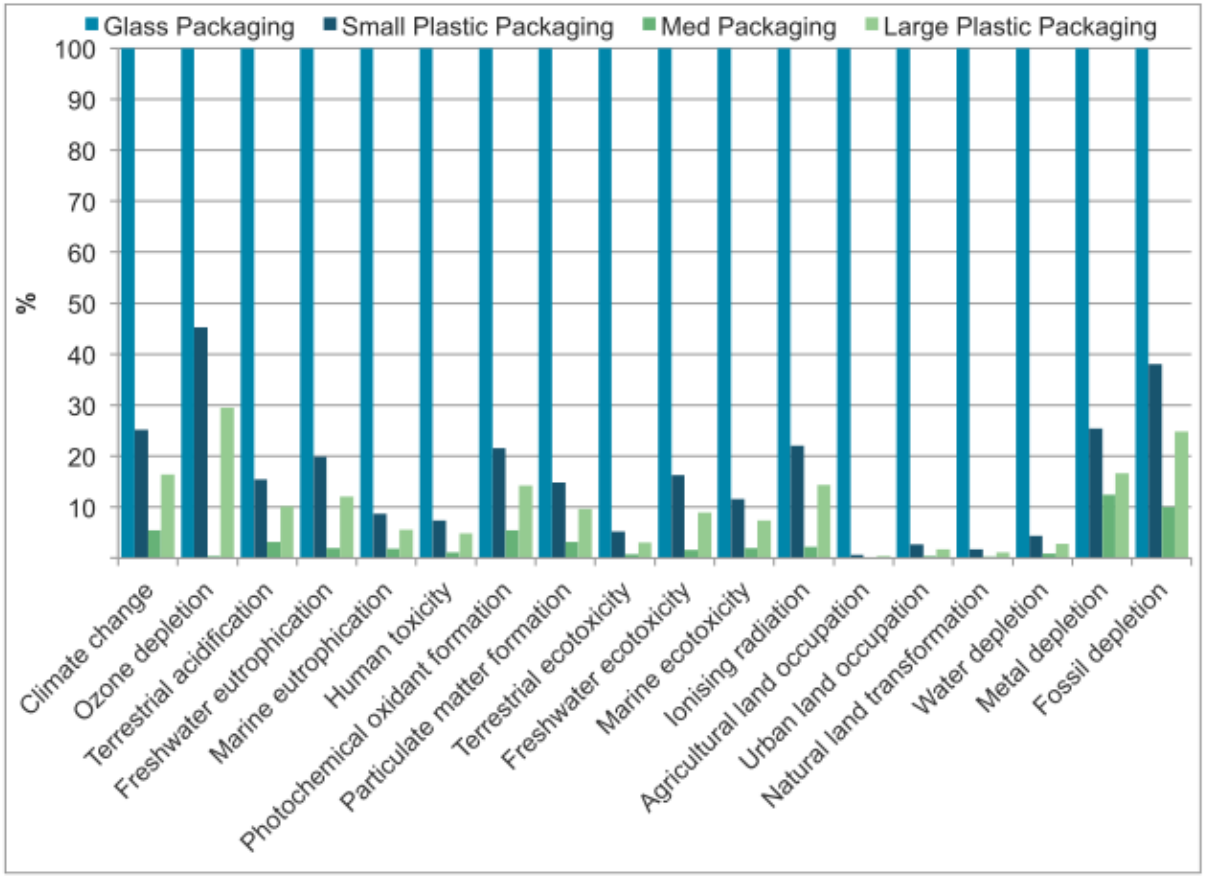
Normalization: dividing the results by a factor in order to convert the results to a common scale.

Approach	Principle	Method	Definition	Sources and examples
Internal normalisation	Impacts are normalised with references linked to the alternative(s)[a] assessed in the study	Division by baseline	Characterised indicator results for several alternatives are divided by the scores obtained for one alternative (=baseline).	Laurent and Hauschild (2015); Norris (2001)
		Division by maximum	Characterised indicator results for several alternatives are divided by the scores obtained for the alternative with the highest score in each impact category	Laurent and Hauschild (2015); Norris (2001) Norris and Marshal (1995)
		Division by sum	Characterised indicator results for several alternatives are divided by the sum of the scores obtained for all alternatives	Laurent and Hauschild (2015); Norris (2001); Norris and Marshal (1995)
		Outranking normalisation	Use of pairwise comparisons to evaluate the significance of mutual differences from characterised indicator results and to reflect impact categories with critical differences between alternatives. The method is non-linear.	Prado-Lopez et al. (2014)

NORMALIZATION

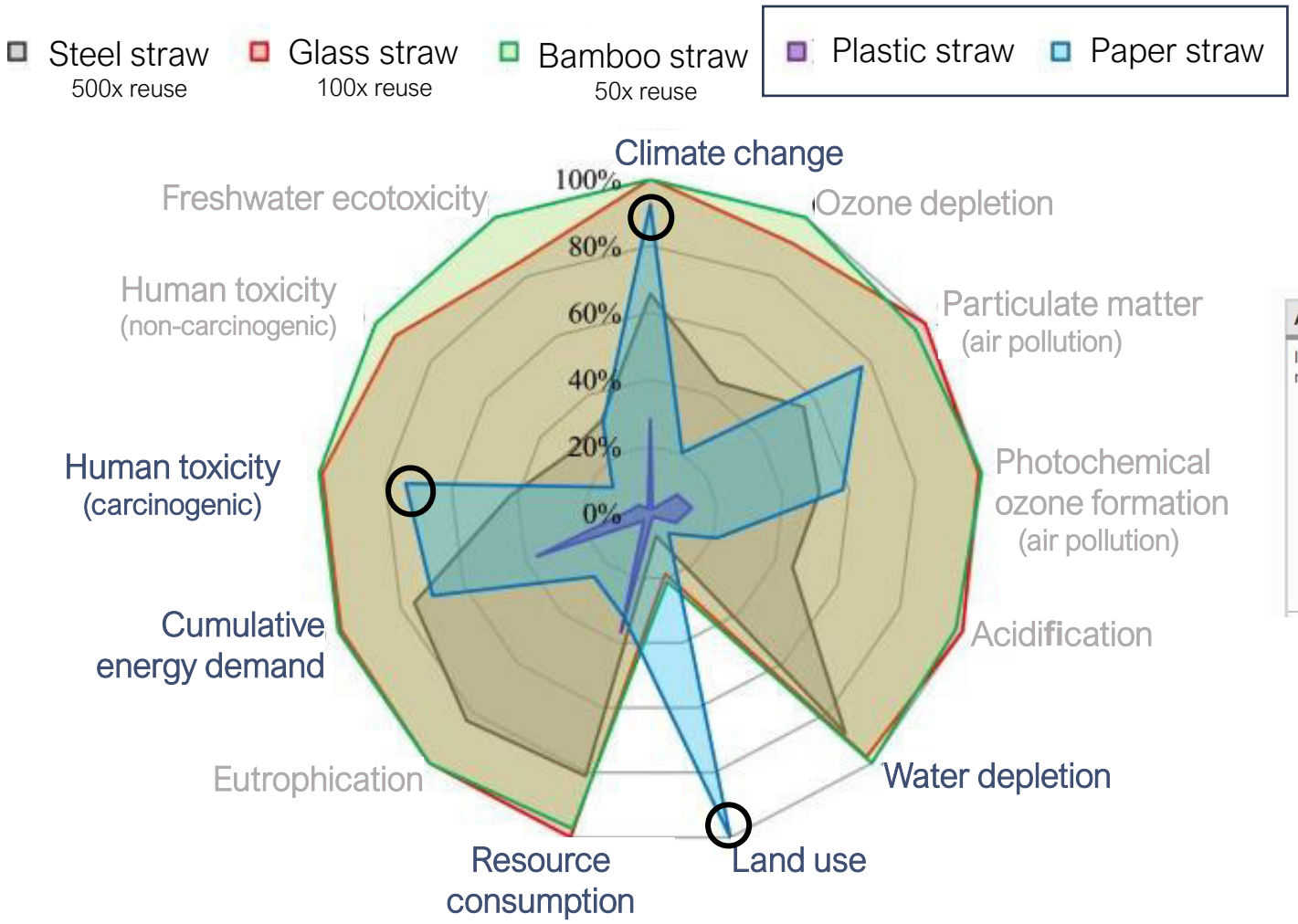
EXAMPLE - INTERNAL NORMALIZATION

For studies that are comparing several alternatives



Approach	Principle	Method	Definition	Sources and examples
Internal normalisation	Impacts are normalised with references linked to the alternative(s)[a] assessed in the study	Division by baseline	Characterised indicator results for several alternatives are divided by the scores obtained for one alternative (=baseline).	Laurent and Hauschild (2015); Norris (2001)
		Division by maximum	Characterised indicator results for several alternatives are divided by the scores obtained for the alternative with the highest score in each impact category	Laurent and Hauschild (2015); Norris (2001) Norris and Marshal (1995)
		Division by sum	Characterised indicator results for several alternatives are divided by the sum of the scores obtained for all alternatives	Laurent and Hauschild (2015); Norris (2001); Norris and Marshal (1995)
		Outranking normalisation	Use of pairwise comparisons to evaluate the significance of mutual differences from characterised indicator results and to reflect impact categories with critical differences between alternatives. The method is non-linear.	Prado-Lopez et al. (2014)

ENVIRONMENTAL IMPACTS OF DRINKING STRAWS



- Comparative analysis of systems – in each environmental impact category the product with highest emissions is used for normalization (=100%)

Approach	Principle	Method	Definition
Internal normalisation	Impacts are normalised with references linked to the alternative(s)[a] assessed in the study	Division by baseline	Characterised indicator results for several alternatives are divided by the scores obtained for one alternative (=baseline).
		Division by maximum	Characterised indicator results for several alternatives are divided by the scores obtained for the alternative with the highest score in each impact category
		Division by sum	Characterised indicator results for several alternatives are divided by the sum of the scores obtained for all alternatives
		Outranking normalisation	Use of pairwise comparisons to evaluate the significance of mutual differences from characterised indicator results and to reflect impact categories with critical differences between alternatives. The method is non-linear.

Source: Zanghelini et al. 2020: Comparative life cycle assessment of drinking straws in Brazil, Journal of Cleaner Production

NORMALISATION APPROACHES AND METHODS

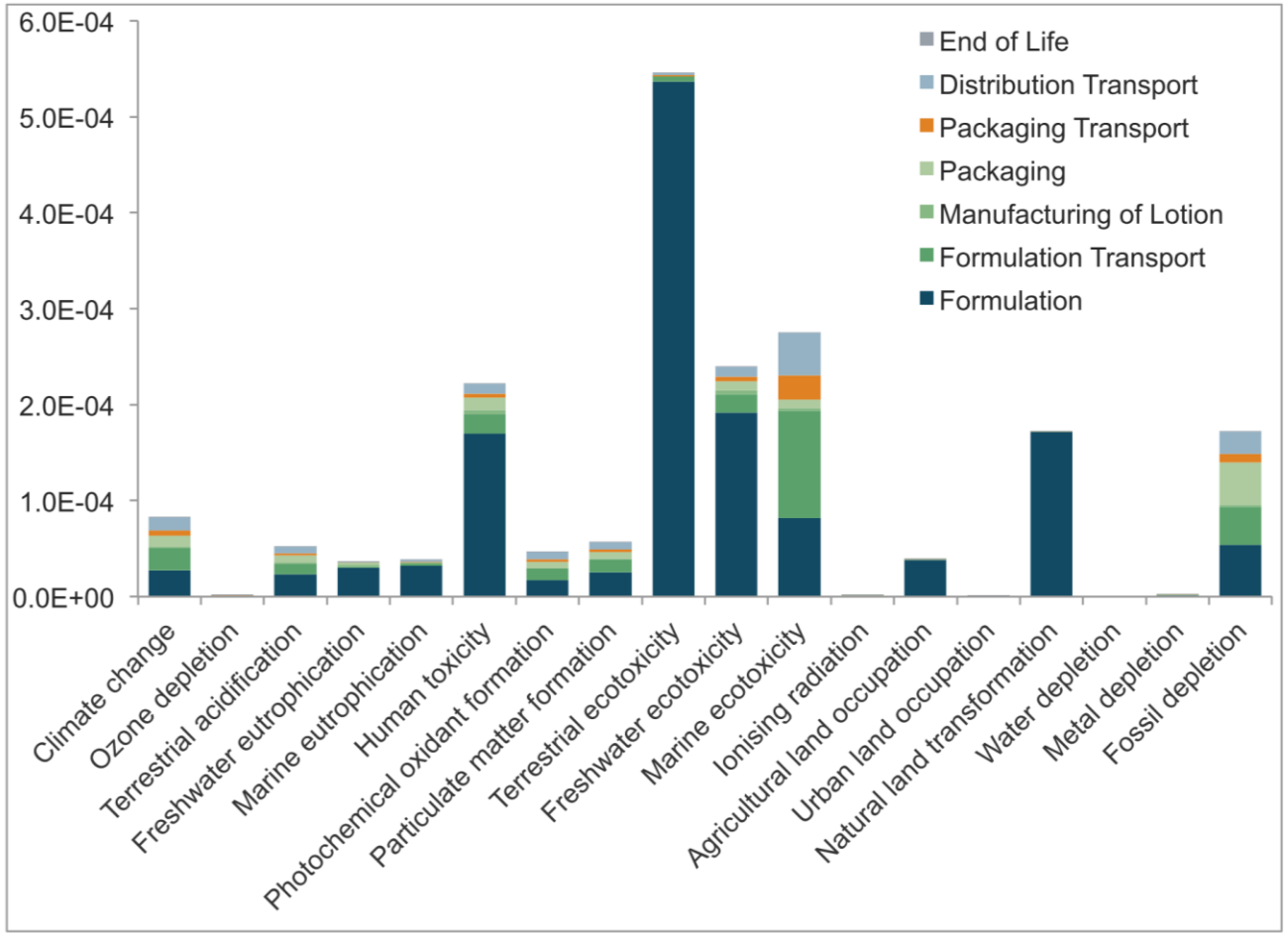
EXAMPLES OF EXTERNAL NORMALIZATION

Approach	Principle	Method	Definition	Sources and examples
External normalisation	Impacts are normalised with references that are external and thus independent of the object of the LCA.	Global normalisation	Characterised indicator results of the system(s) under study are divided by the characterised indicator results of the total activities taking place in the world over the reference duration (assumed balance between consumption and production)	Huijbregts et al. (2003); Itsubo et al. (2015); Sleeswijk et al. (2008); Stranddorf et al. (2005)
		Production-based, territorial systems	Characterised indicator results of the system(s) under study are divided by the characterised indicator results associated with all territorial activities in a region or country, including its exports but excluding its imports, thus accounting for all environmental flows that take place within the physical or geographical boundaries of that region/country over the reference duration	Bare et al. (2006); Breedveld et al. (1999); Cucurachi et al. (2014); Dahlbo et al. (2013); Foley and Lant (2009); Huijbregts et al. (2003); Itsubo et al. (2015); Itsubo et al. (2012); Itsubo et al. (2004); Kim et al. (2013); Laurent and Hauschild (2015); Laurent et al. (2011a); Laurent et al. (2011b); Lautier et al. (2010); Lundie et al. (2007); Ryberg et al. (2014); Sala et al. (2015); Sleeswijk et al. (2008); Stranddorf et al. (2005); Strauss et al. (2006); Wenzel et al. (1997)
		Consumption-based, territorial systems	Characterised indicator results of the system(s) under study are divided by the characterised indicator results associated with the total territorial consumption of a region/country, including its imports but excluding its exports. It thus accounts for the environmental flows from all upstream and downstream processes needed to support the consumption activities of that region/country over the reference duration, including those that occur outside its physical or geographical boundaries as a consequence of the activities taking place within that region or nation.	Breedveld et al. (1999); Dahlbo et al. (2013); Laurent and Hauschild (2015)

Source: Pizzol et al. 2017: Normalisation and weighting in life cycle assessment: *quo vadis*?, Int. Journal of LCA
Roesch et al. 2020: Normalization and weighting: the open challenge in LCA, Int. Journal of LCA

NORMALIZATION

EXAMPLE - EXTERNAL NORMALIZATION



Impact assessment

The ReCiPe midpoint impact assessment methodology (world normalization, hierarchist perspective) ReCiPe World Midpoint Hierarchist is used to normalize and characterize the results.

- 'World' refers to the impact potential of the average global citizen person per year as a normalization reference unit.

Source: The Sustainability Consortium, 2013: Life Cycle Impact Study of Leave-on Skin Care Products (assessment based on ReCiPe midpoint impact assessment methodology)

LCIA - Life Cycle Impact Assessment

WEIGHTING

LCIA – RESULTS (AFTER CLASSIFICATION AND CHARACTERIZATION)

EXAMPLE: LCA OF SKIN CARE PRODUCTS (SMALL GLASS PACKAGED LOTION)

Impact category	Unit	Total	Formulation	Formulation	Manufacturing	Glass	Packaging	Distribution	End of Life
Impact category		**Climate change**		**Terrestrial acidification**		**Freshwater eutrophication**			
Unit		**kg CO2 eq**		**kg SO2 eq**		**kg P eq**			
Formulation		0.01		0.0001		0.00000057			
Formulation Transport		0.01		0.0000		0.00000001			
Manufacturing of Lotion		0.00		0.0000		0.00000003			
Glass Packaging		0.10		0.0006		0.00000270			
Packaging Transport		0.05		0.0001		0.00000006			
Distribution Transport		0.03		0.0001		0.00000004			
End of Life		0.01		0.0000		0.00000001			
Photochemical oxidant forma	kg NMVOC	7.9E	5E-05	3.8E-05	1.3E-06	3.9E-04	1.8E-04	1.2E-04	4.4E-06
Partic matte			1.2E-05	8.0E-07	1.8E-04	5.9E-05	3.4E-05	6.7E-07	
Terrestrial ecotoxicity	kg 1,4-DB eq	2.6E-04	2.2E-04	2.2E-06	3.5E-08	1.5E-05	1.1E-05	4.3E-06	9.7E-09

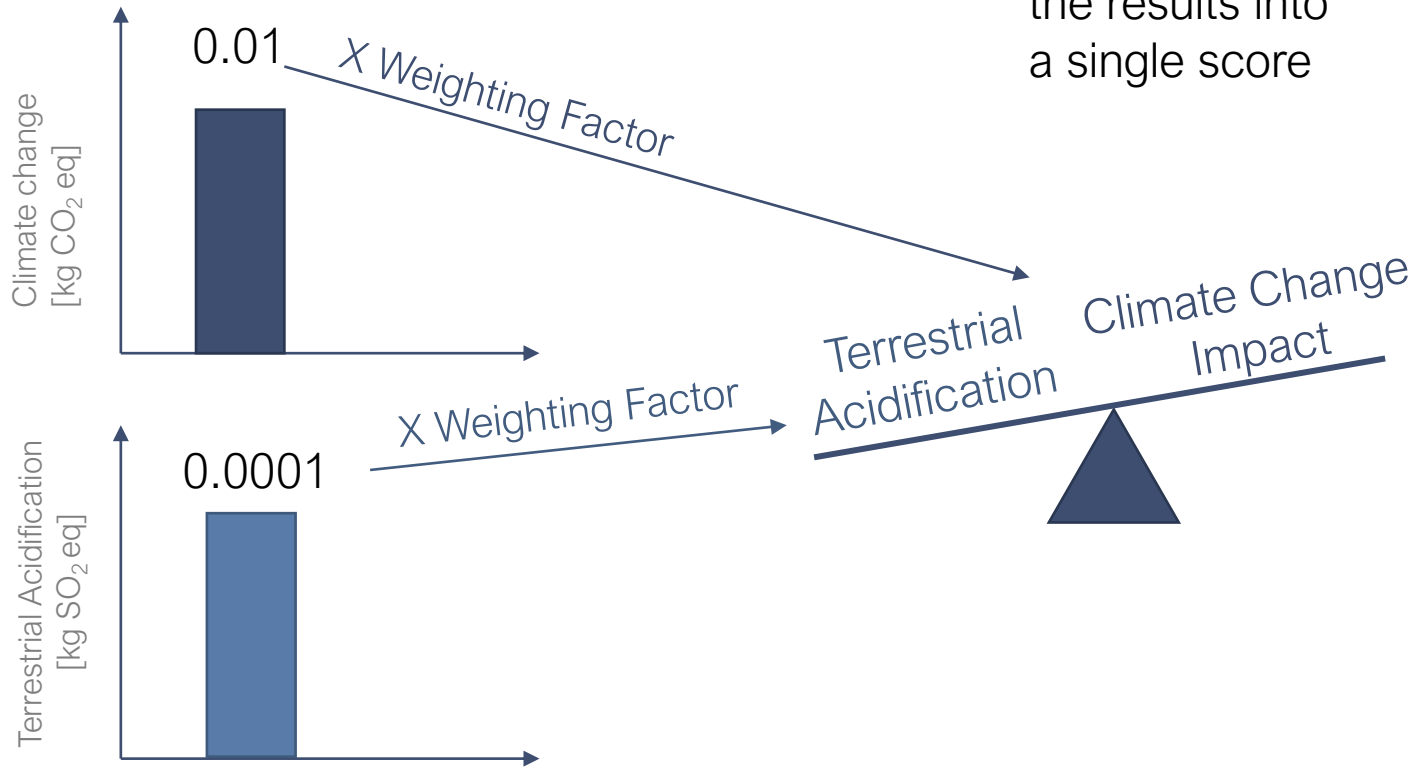
Is 0.1 kg CO_2eq worse than 0.006 kg SO_2eq?

(based on ReCiPe midpoint impact assessment methodology)
The Sustainability Consortium, 2013: Life Cycle Impact Study of Leave-on Skin Care Products

LCIA METHODOLOGIES

WEIGHTING

Can be used to consolidate the results into a single score



Weighting (optional)

A *weighting scheme* is a set of factors that ranks the relative importance of each impact category. You can consult a weighting scheme to decide how much importance to assign to each impact category. If you want to produce a single environmental "score" from your results, you can multiply each impact with its weighting factor and sum the results to produce a single value.

Weighting is a controversial practice because it adds subjective judgment to quantitative analysis. For this reason, weighting is not commonly performed in LCAs. That being said, it should be noted that an analysis that only considers carbon or GWP takes the form of a weighting scheme that assigns 100% of the weight to carbon and zero to other impacts.

Sources: Roesch et al. 2020: Normalization and weighting: the open challenge in LCA, Int. Journal of LCA
Pizzol et al. 2017: Normalisation and weighting in life cycle assessment: *quo vadis*?, Int. Journal of LCA
Carbon Leadership Forum, 2019: **Life Cycle Assessment of Buildings: A Practice Guide**
https://carbonleadershipforum.org/wp-content/uploads/2019/05/CLF-LCA-Practice-Guide_2019-05-23.pdf

CHALLENGES AND OPPORTUNITIES OF NORMALIZATION AND WEIGHTING

- Normalization and weighting are optional steps in LCA
- Can be crucial for providing **support information to decision-makers**, allowing them to **avoid subjective weighting of different environmental impacts**
- The main **criticism** regarding normalization is the bias due to the choice of normalization references → may change the conclusions drawn from the LCA
- But they are still frequently applied in practice for
  - identifying "important" impact categories,
  - understanding the meaning of results by comparing with more familiar references
  - solving tradeoffs between results

Pizzol et al. 2017: Normalisation and weighting in life cycle assessment: *quo vadis*?, Int. Journal of LCA
Roesch et al. 2020: Normalization and weighting: the open challenge in LCA, Int. Journal of LCA

LIMITATIONS OF LIFE CYCLE ASSESSMENTS

- 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 - impossible task
- 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 system
- "Best estimate" - Principle
  - LCA models based on the average performance and don't consider risk events

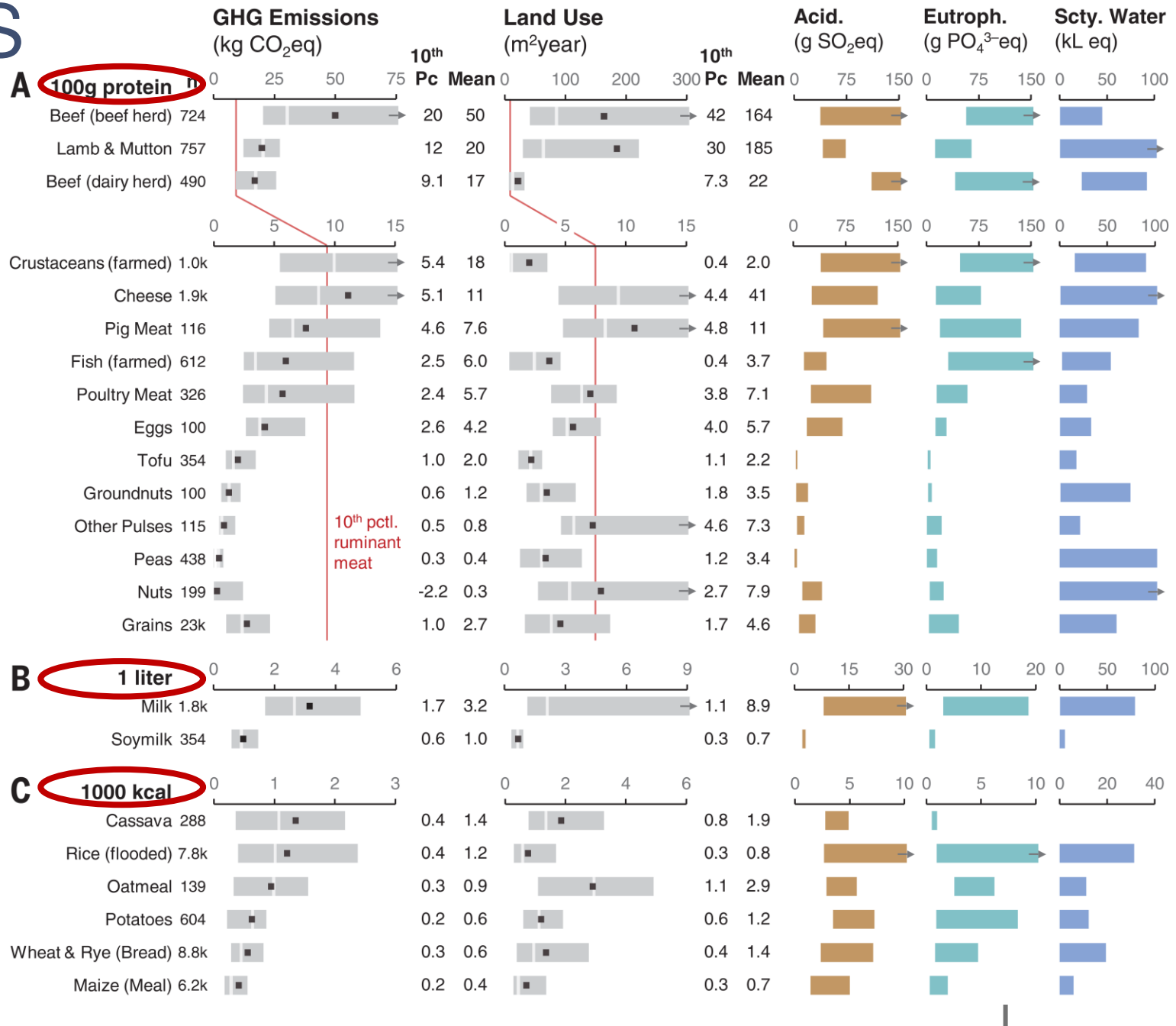
  e.g. nuclear power appears environmentally friendly in LCA as the risk of a nuclear disaster is not considered
- LCA doesn't by default show where (globally) how much of which emissions occur *(but regionalization approaches become popular)*
- Comparison shows what is a "better product" not what's sustainable
- 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
- Published reports may not be comparable or incomplete
  e.g. publishing only GHG emission, setting boundaries arbitrarily, different functional units

Sources: Baldwin, 2012: Sustainability in the Food Industry – Chapter 5;
Reisch and Thøgersen, 2015: Handbook of research on sustainable consumption – Chapter 9;
Shao, 2016: Are present sustainability assessment approaches capable of promoting sustainable consumption? A cross-section review on information transferring approaches

LCA LIMITATIONS

COMPARABILITY OF RESULTS

e.g.,
Differences in functional units



WHO USES LIFE CYCLE ASSESSMENT - AND WHY?

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**.

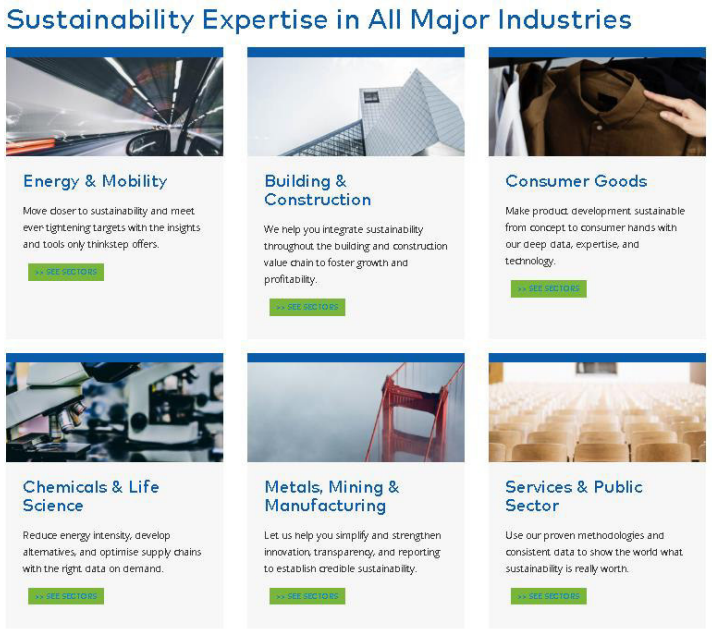


Table 2. Environmental impact categories taken into account by companies surveyed.

	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

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 and 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. PRODUCT LIFE CYCLE ASSESSMENT

IDENTIFYING HOTSPOTS & AREAS FOR IMPROVEMENT

CHICKEN
SUPPLY CHAIN HOTSPOTS

THE SUSTAINABILITY CONSORTIUM™

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.

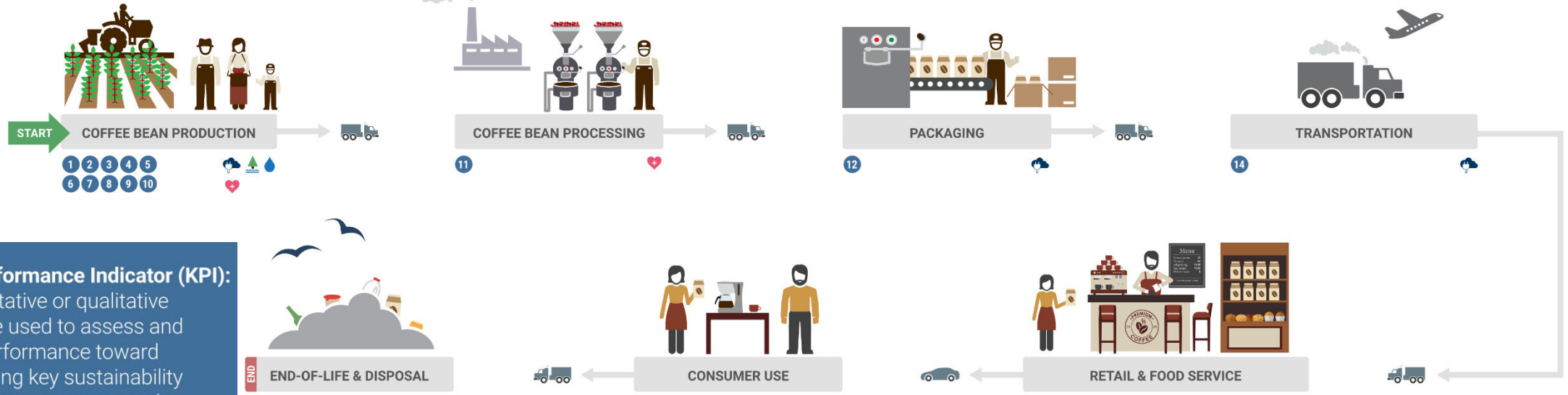
9 **Energy consumption - Processing:** Processing and cooking chicken uses electricity can lead to climate change and pollution.

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

COFFEE
SUPPLY CHAIN KEY PERFORMANCE INDICATORS

2. FORMULATION OF KEY PERFORMANCE INDICATORS

THE SUSTAINABILITY CONSORTIUM™



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

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.

Setting Targets based on KPI (for suppliers) to improve

↓

Support for follow up **actions**

↓

Regular **checks on Process**

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

08. April 2022

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

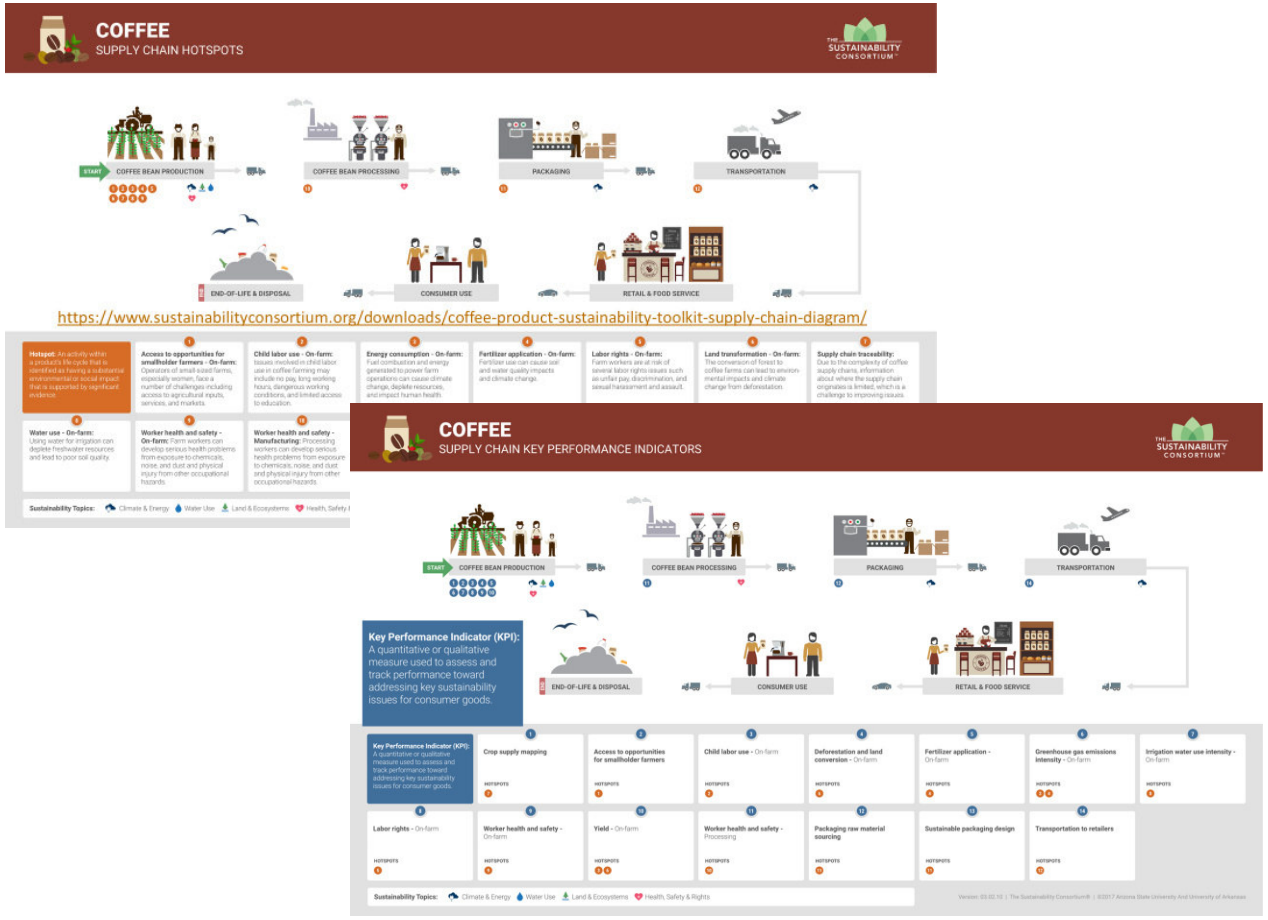
CLOTHING, FOOTWEAR, AND TEXTILES

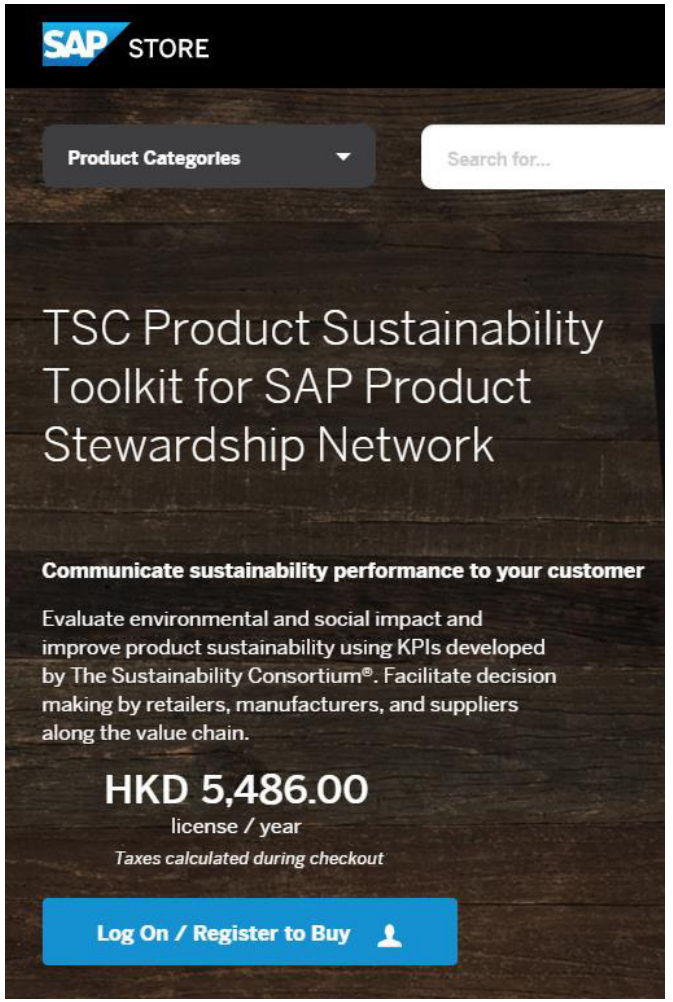
HOME AND PERSONAL CARE

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

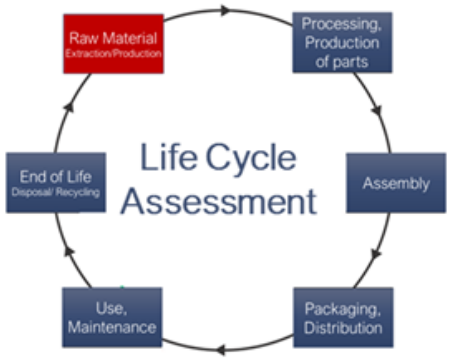
Topic	Initiation year and/or geographical scope
LCA as a knowledge tool in policy formulation	
Environmental technologies action plan (ETAP)	2004; EU
Integrated product policy (IPP)	2003; EU
Directive on the eco-design of energy using products (EuP)	2005; EU
Strategy for the sustainable use of natural 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)

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



Hot Spot:
Process that causes significant impacts

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

VOLUNTARY ECO-LABELS

EXAMPLE: ECO-LABEL BY EUROPEAN COMMISSION

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

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

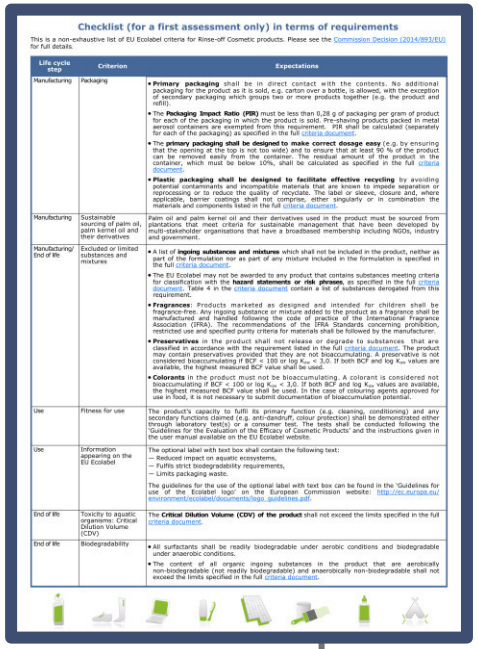
Rinse-off Cosmetic Products

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 (CO_2) 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	20.65	20.65

Including water release from the washing machine.

(*)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

08. April 2022

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/

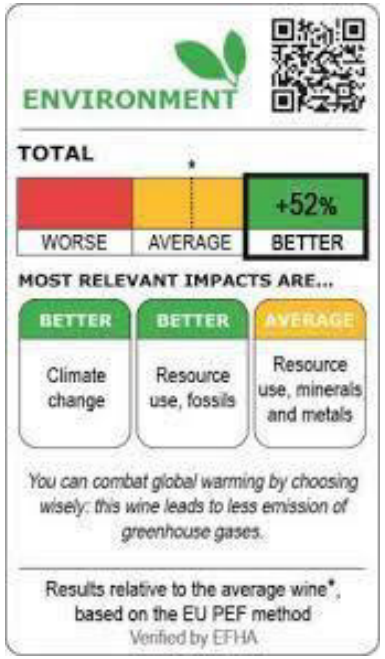
VOLUNTARY STANDARDS FOR BUSINESSES

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

CONSTRUCTION

LIFE CYCLE ASSESSMENT IN PRACTICE

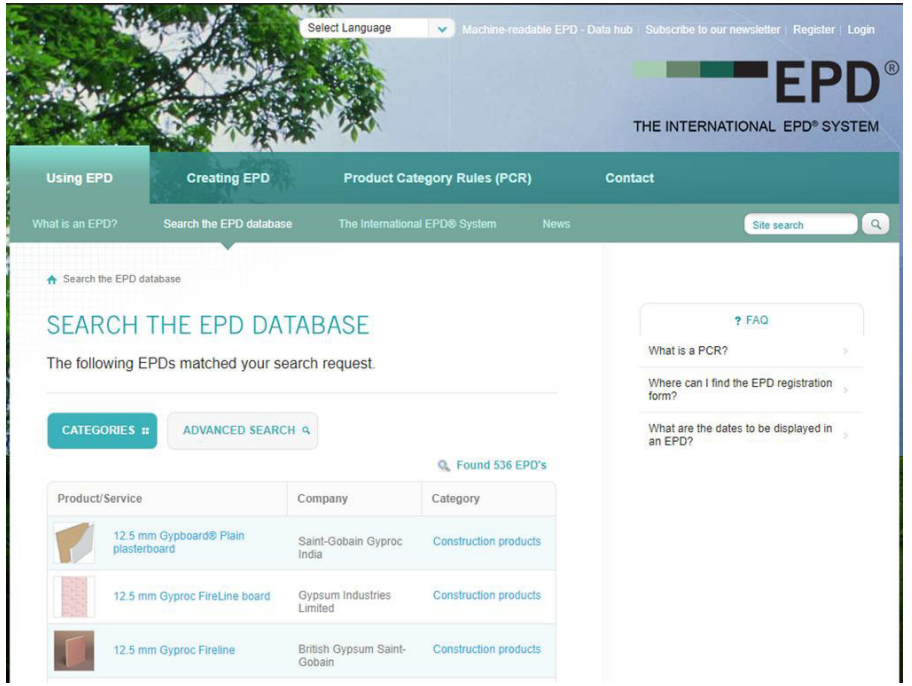
ENVIRONMENTAL PRODUCT DECLARATIONS (EPD) (TYPE III ECO-LABELS)

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/

LIFE CYCLE ASSESSMENT IN PRACTICE

CONSTRUCTION INDUSTRY

International EPD® System
Type III: ISO 14025

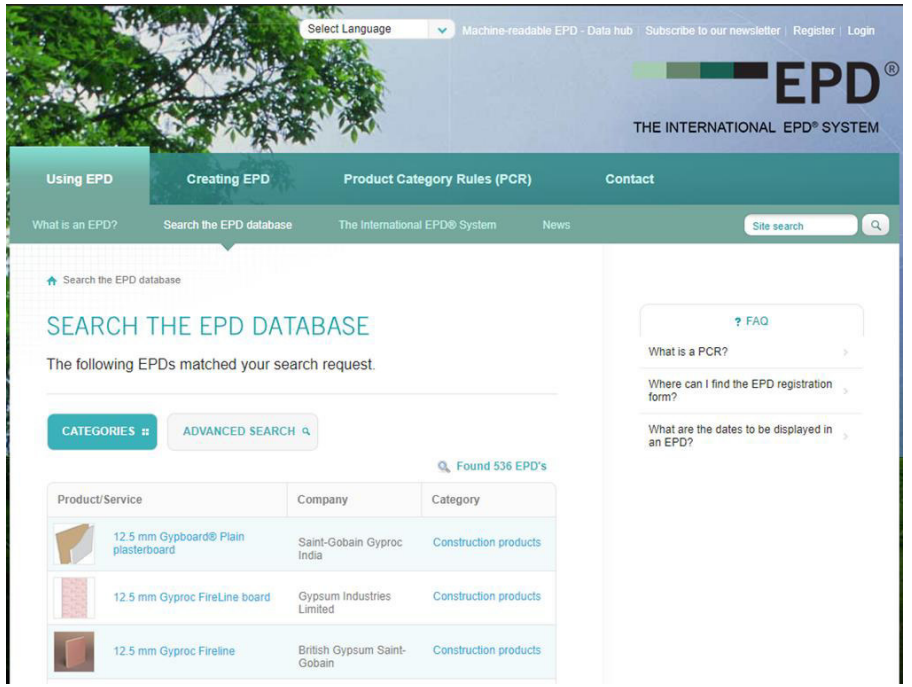
Environmental Product Declarations (EPD)

- 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/

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

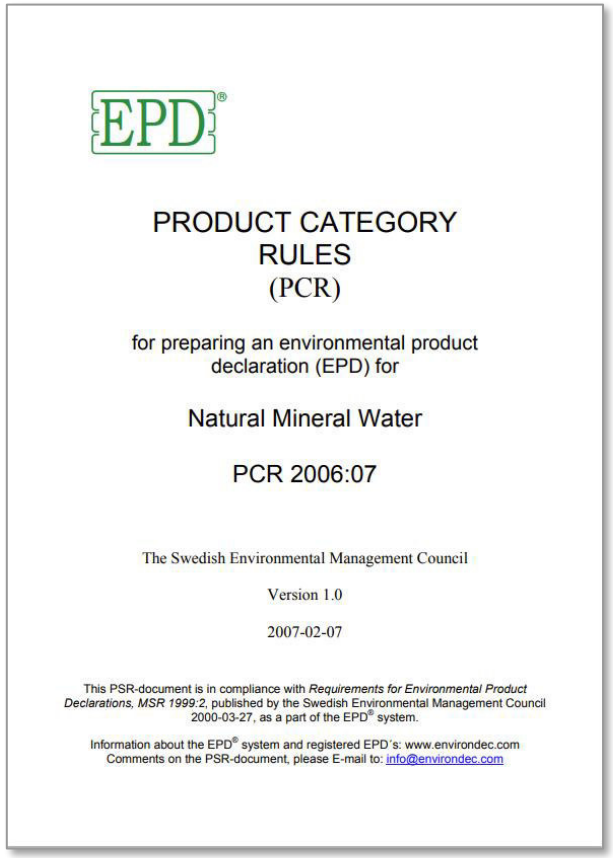
PRODUCT CATEGORY RULES

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

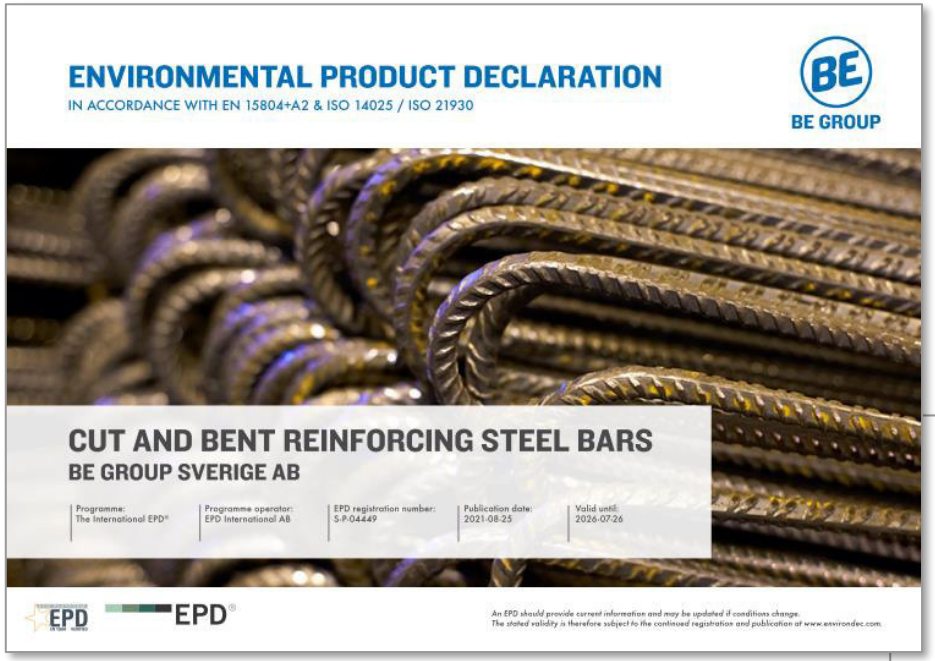
This PSR-document is in compliance with *Requirements for Environmental Product Declarations, MSR 1999:2*, published by the Swedish Environmental Management Council 2000-03-27, as a part of the EPD® system.

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

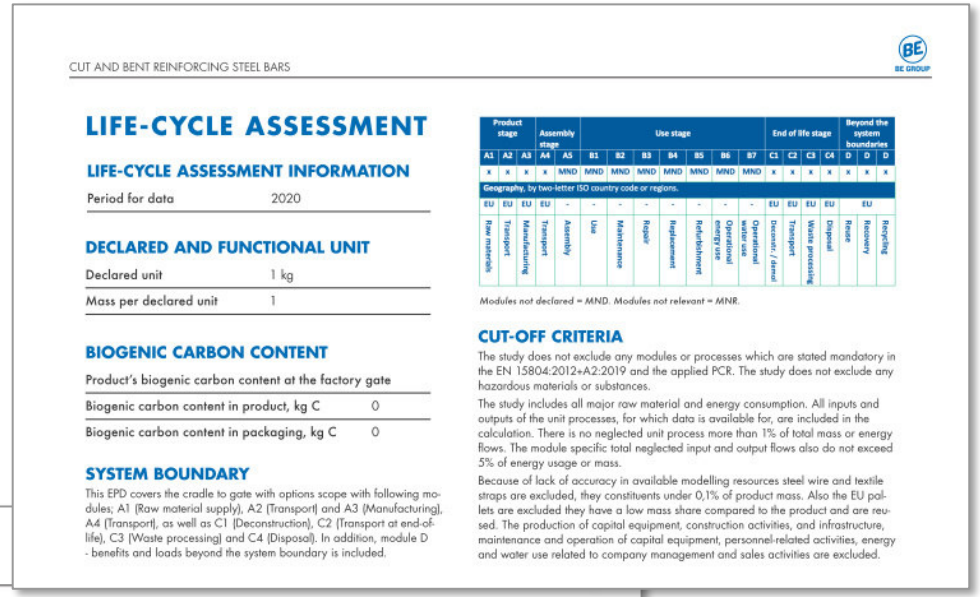
BE GROUP

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

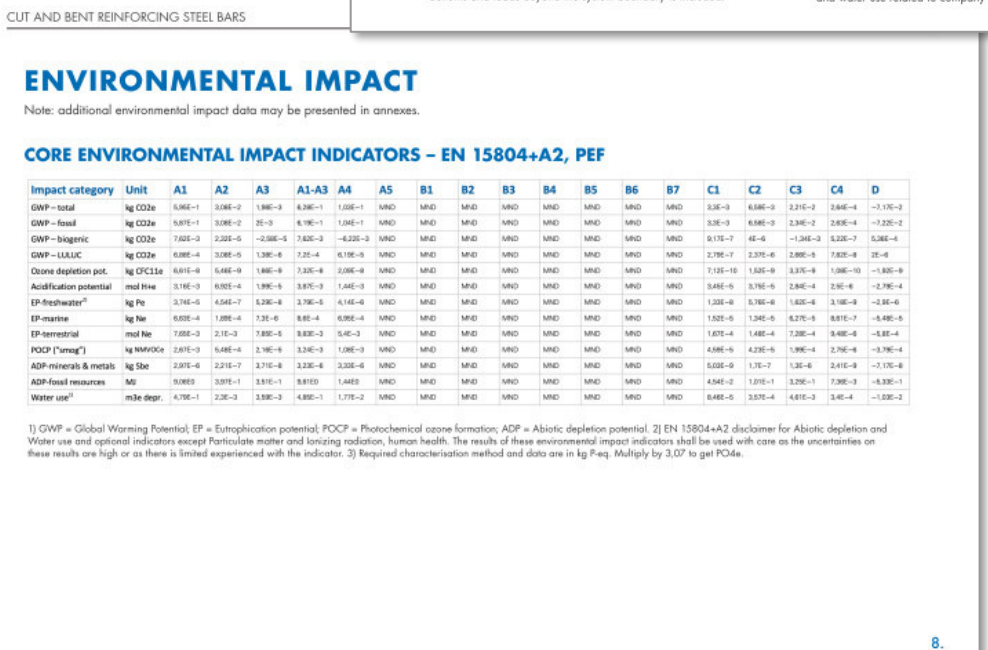
Modules not declared = MND. Modules not relevant = MNR.

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	5,96E−1	3,08E−2	1,98E−3	6,29E−1	1,03E−1	MND	MND	MND	MND	MND	MND	MND	MND	3,3E−3	6,58E−3	2,21E−2	2,64E−4	−7,17E−2
GWP – fossil	kg CO2e	5,87E−1	3,08E−2	2E−3	6,19E−1	1,04E−1	MND	MND	MND	MND	MND	MND	MND	MND	3,3E−3	6,58E−3	2,34E−2	2,63E−4	−7,22E−2
GWP – biogenic	kg CO2e	7,62E−3	2,32E−5	−2,59E−5	7,62E−3	−6,22E−3	MND	MND	MND	MND	MND	MND	MND	MND	9,17E−7	4E−6	−1,34E−3	5,22E−7	5,26E−6
GWP – LULUC	kg CO2e	6,88E−4	3,08E−5	1,38E−6	7,25E−4	6,15E−5	MND	MND	MND	MND	MND	MND	MND	MND	2,79E−7	2,37E−6	2,69E−5	7,82E−8	2E−6
Ozone depletion pot.	kg CFC11e	6,61E−8	6,48E−9	1,66E−9	7,32E−8	2,05E−8	MND	MND	MND	MND	MND	MND	MND	MND	7,12E−10	1,52E−9	3,37E−8	1,08E−10	−1,92E−8
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	3,79E−5	2,84E−4	2,5E−6	−2,79E−4
EP-freshwater[2]	kg Pe	2,74E−5	4,54E−7	5,29E−8	2,79E−5	6,14E−6	MND	MND	MND	MND	MND	MND	MND	MND	1,22E−8	5,78E−8	1,62E−6	3,15E−9	−2,9E−6
EP-marine	kg Ne	6,03E−4	1,09E−4	7,3E−6	8,8E−4	6,09E−4	MND	MND	MND	MND	MND	MND	MND	MND	1,52E−6	1,34E−6	8,27E−6	8,81E−7	−6,48E−5
EP-terrestrial	mol Ne	7,65E−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	3,48E−6	−5,8E−4
POCP ("smog")	kg NMVOCe	2,67E−3	5,48E−4	2,19E−6	3,24E−3	1,08E−3	MND	MND	MND	MND	MND	MND	MND	MND	4,58E−6	4,23E−6	1,99E−4	2,79E−8	−3,79E−4
ADP-minerals & metals	kg Sbe	2,97E−6	2,21E−7	3,71E−8	3,23E−6	3,32E−6	MND	MND	MND	MND	MND	MND	MND	MND	5,02E−9	1,7E−7	1,3E−6	2,41E−8	−7,17E−8
ADP-fossil resources	MJ	9,08E3	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	7,38E−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	8,46E−5	3,57E−4	4,61E−3	3,4E−4	−1,03E−2

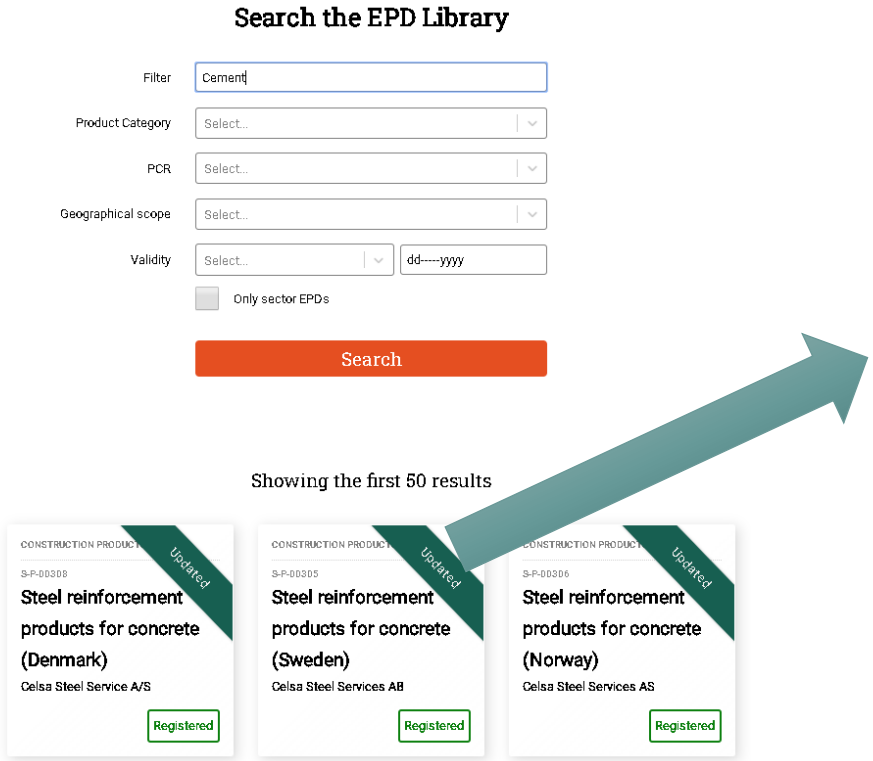
1) GWP = Global Warming Potential; EP = Eutrophication potential; POCP = Photochemical ozone formation; ADP = Abiotic depletion potential. 2) EN 15804+A2 disclaimer for Abiotic depletion and Water use and optional indicators except Particulate matter and Ionizing radiation, human health. The results 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.

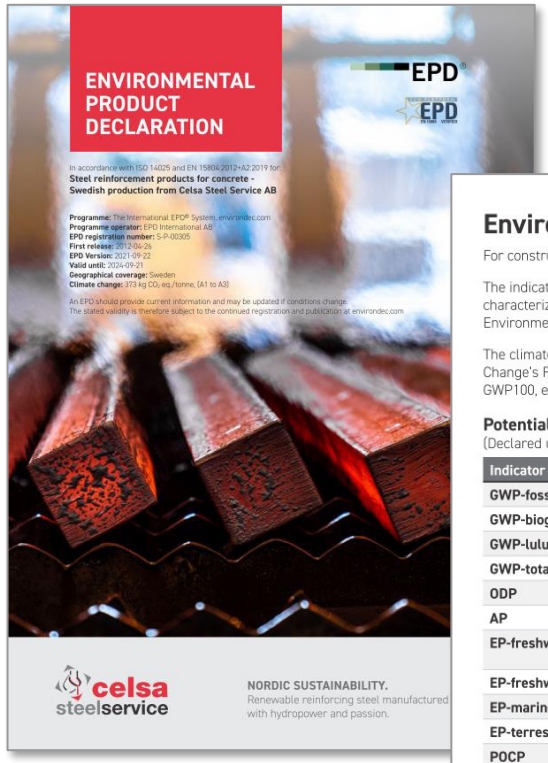
8.

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

EPD DATABASES: LCA REPORTS OF BUILDING MATERIALS

EXAMPLE: EPD REPORT: CEMENT





Environmental Information

For construction services, the total value of A1-A3 shall be replaced with the total value of A1-A5.

The indicators, with one exception, are calculated with the characterisation factors published by the Joint Research Centre (ILCD 2013, characterization factors according to EC-JRC EF3.0, 2019), as they can be accessed in GaBi (Sphera Solutions GmbH) in the data set Environmental quantities/EN15804+A2.

The climate impact indicator GWP-GHG is calculated with characterisation factors published in the Intergovernmental Panel on Climate Change's Fifth Assessment Report (IPCC AR5) as they can be accessed in GaBi in the data set Environmental quantities/IPCC AR5/ GWP100, excl. biogenic carbon.

Potential environmental impact – mandatory indicators according to EN 15804
(Declared unit Per tonne of reinforcement products)

Indicator	Unit	A1	A2	A3	Tot.A1-A3	A4	C1	C2	C3	C4	D
GWP-fossil	kg CO_2 eq.	319	53,3	0,567	373	13,8	0,345	17,8	0	0	123
GWP-biogenic	kg CO_2 eq.	23,9	1,07	0,0806	25	33,4	0,00358	4,06	0	0	0,571
GWP-luluc	kg CO_2 eq.	0,211	0,0406	0,000271	0,252	0,00835	0,00274	0,17	0	0	0,0247
GWP-total	kg CO_2 eq.	343	54,4	0,65	398	47,2	0,35	22	0	0	124
ODP	kg CFC 11 eq.	1,69E-06	6,37E-15	5,84E-17	1,69E-06	5,51E-09	6,63E-17	4,11E-15	0	0	1,52E-14
AP	mol H^+ eq.	1,06	0,931	0,00334	1,99	0,283	0,00338	0,0236	0	0	0,305
EP-freshwater	kg PO_4^{3-} eq.	0,0159	7,48E-05	3,28E-07	0,0159	4,38E-04	3,05092E-06	1,89E-04	0	0	1,35E-04
EP-freshwater	kg P eq.	0,00517	2,44E-05	1,07E-07	0,00519	1,43E-04	9,95E-07	6,17E-05	0	0	4,39E-05
EP-marine	kg N eq.	0,428	0,471	0,00171	0,901	0,148	0,00164	0,00782	0	0	0,0642
EP-terrestrial	mol N eq.	4,64	5,16	1,87E-02	9,82	1,6	0,0181	0,0921	0	0	0,68
POCP	kg NMVOC eq.	1,16	1,27	0,00496	2,43	0,386	0,0048	0,0207	0	0	0,232
ADP-minerals & metals*	kg Sb eq.	1,13E-04	2,08E-06	6,32E-09	1,15E-04	1,76E-06	2,98E-08	1,85E-06	0	0	4,52E-05
ADP-fossil*	MJ	2520	733	0,453	3253	230	4,49	278	0	0	1140
WDP	m^3	100	0,1	1,E-04	100	1,7	0,003	0,2	0	0	6

**Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties of these results are high or as there is limited experience with the indicator.*
1) ADP-fossil as defined by EN15804+A2 includes uranium and is thus equal to the resource indicator PENRE.

Source: https://www.environdec.com/library
EPD, Steel reinforcement products for concrete (Sweden)

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	

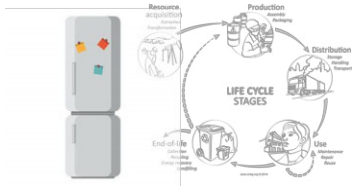
https://lcadatabase.com/

LIFE CYCLE ASSESSMENT (LCA) & TOOLS

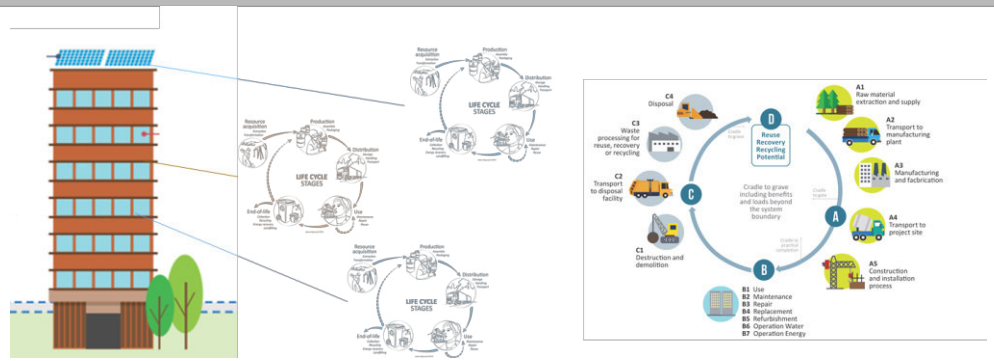
Product LCA ⟷ Building LCA

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 EPD

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 Product Databases (EPDs)

COMPARISON OF BUILDING LCA TOOLS

Embodied Carbon Calculators

Data from Environmental Product Declarations

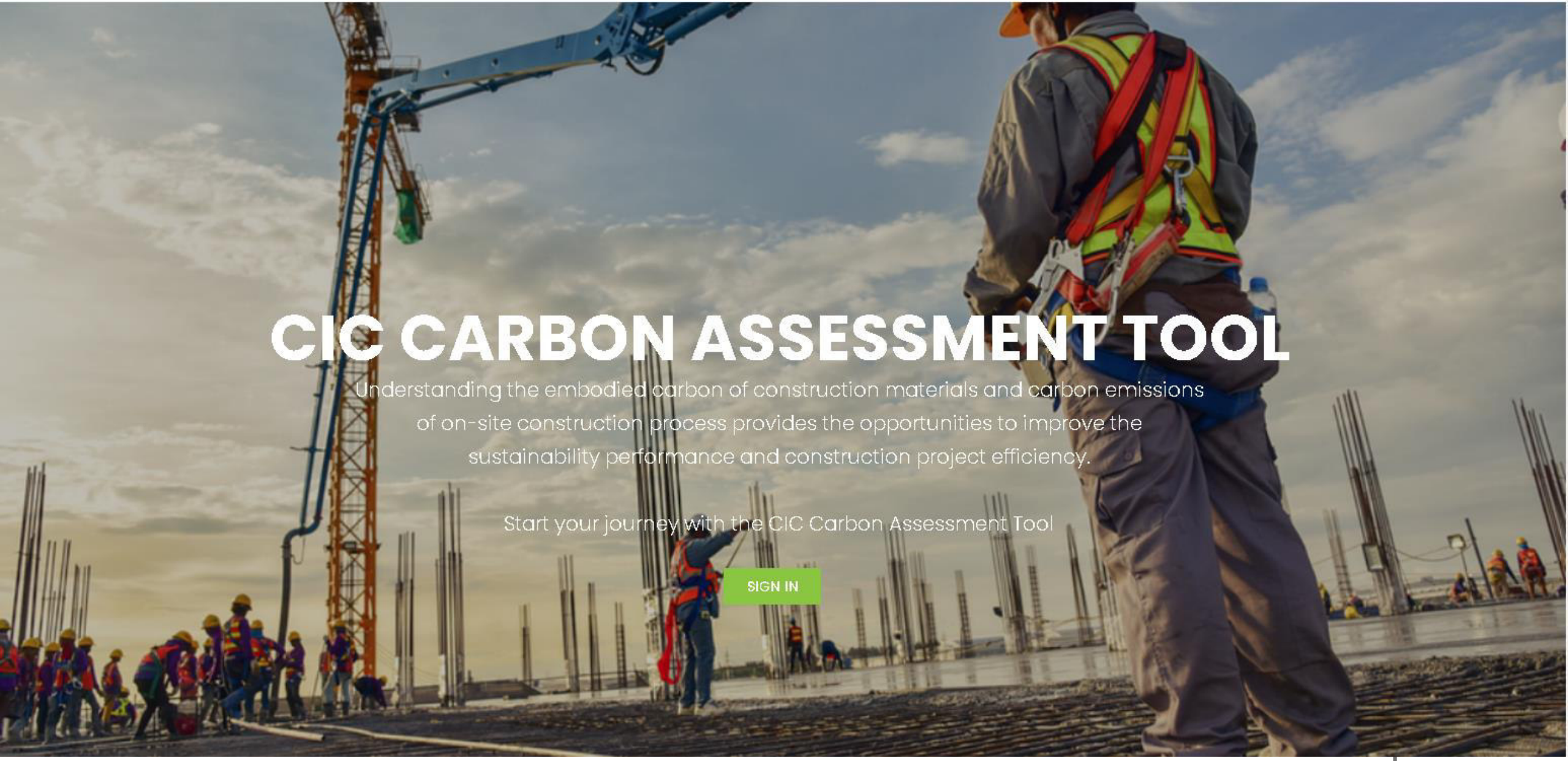
CIC Carbon Assessment Tool
建造業議會碳評估工具

EC3
Embodied Carbon in Construction Calculator (EC3) tool

Life Cycle Assessment Tools

One Click LCA

Athena Sustainable Materials Institute



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.

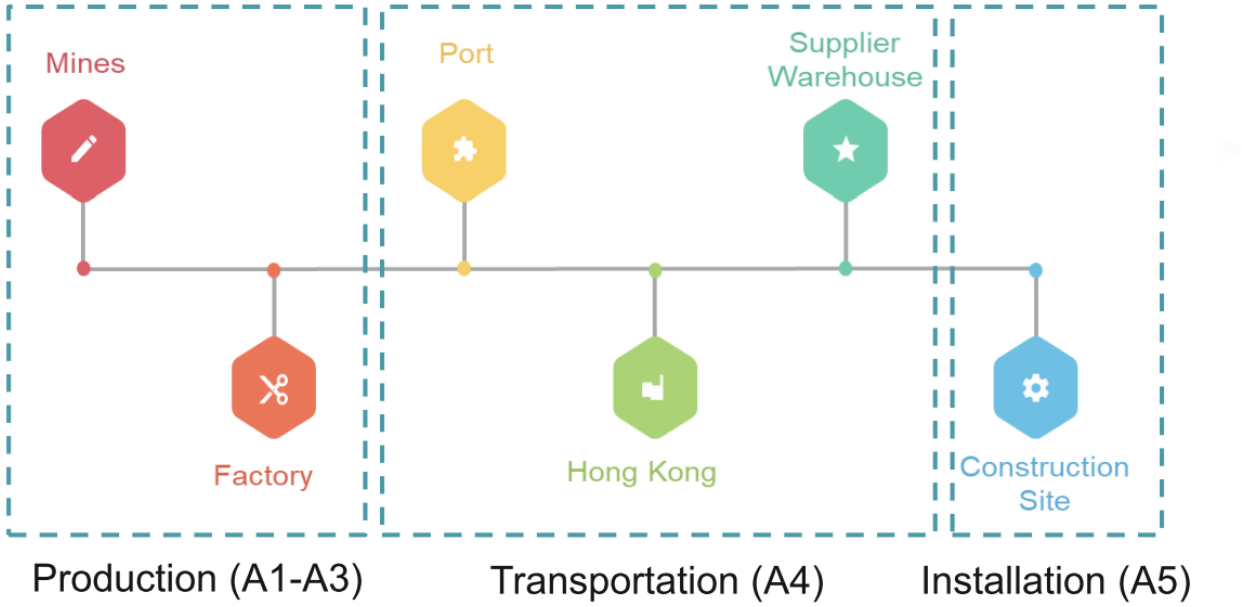
Start your journey with the CIC Carbon Assessment Tool

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

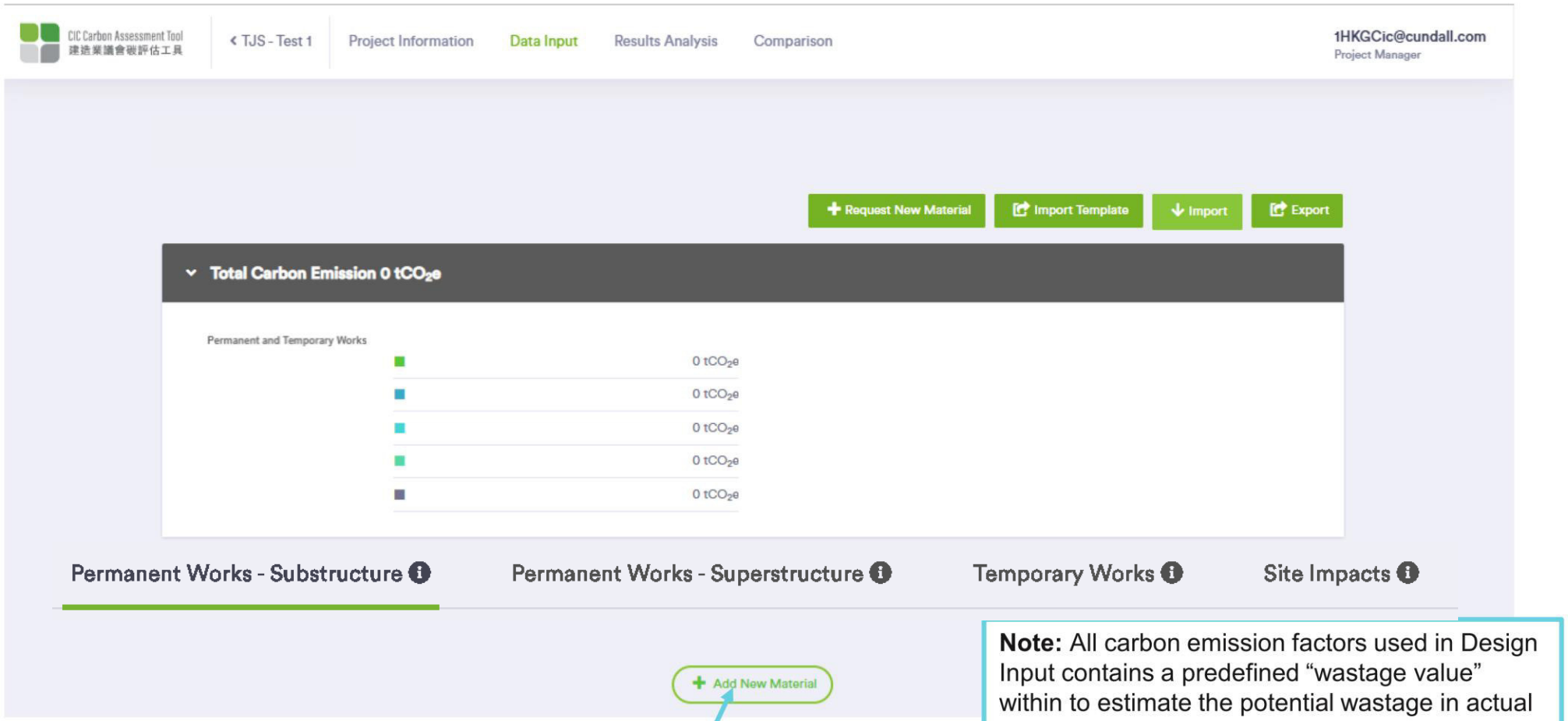
Dr. Meike Sauerwein

Data Input – Front Page

- ‘Permanent Works – Substructure’

The software will allow you to choose:

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



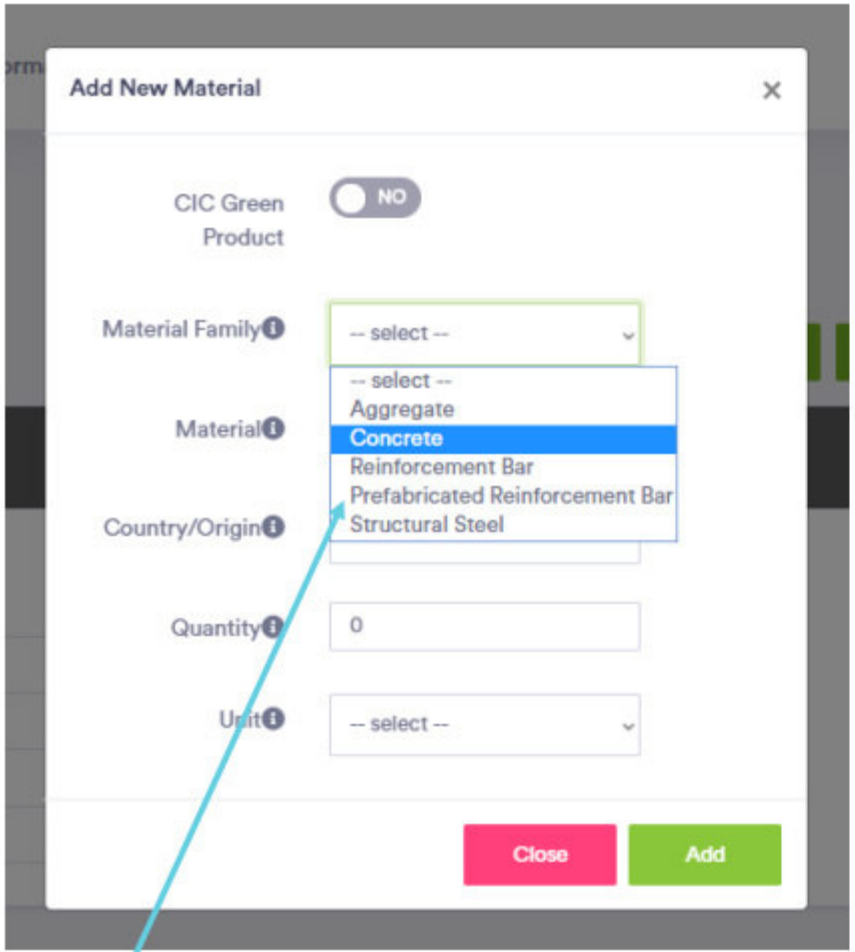
“**Add New Field**” is the button to click to add the materials to the project

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

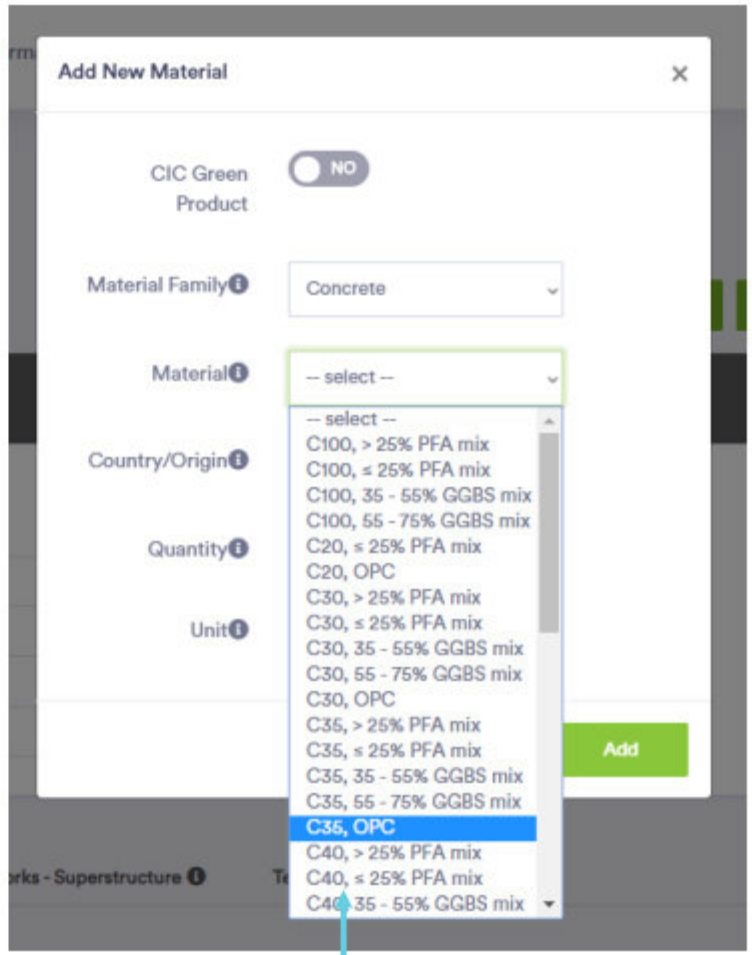
Note: All carbon emission factors used in Design Input contains a predefined “wastage value” within to estimate the potential wastage in actual construction operation. This “wastage value” does not exist in the construction stage’s database.

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)]

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

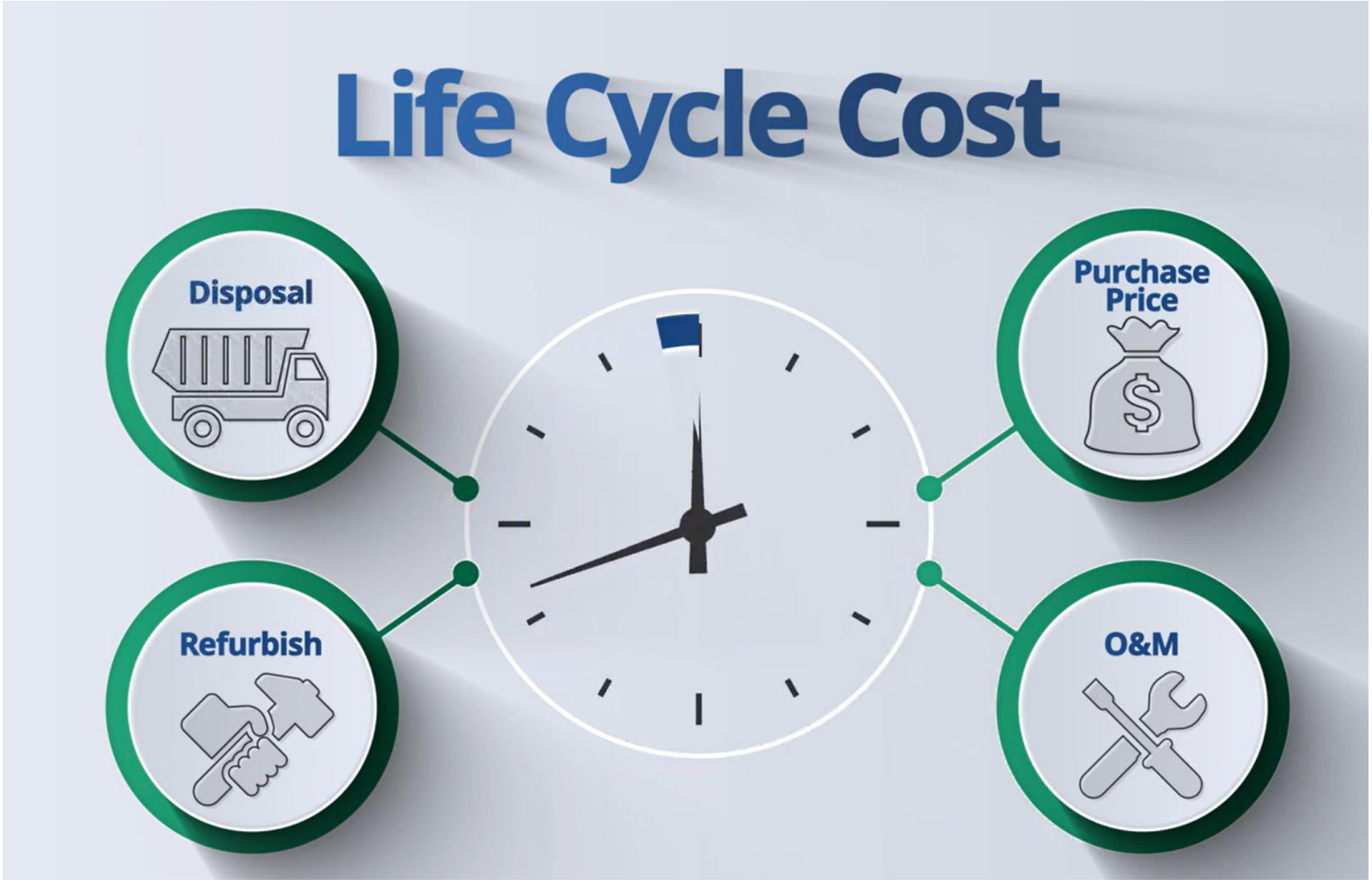
Site Impacts

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

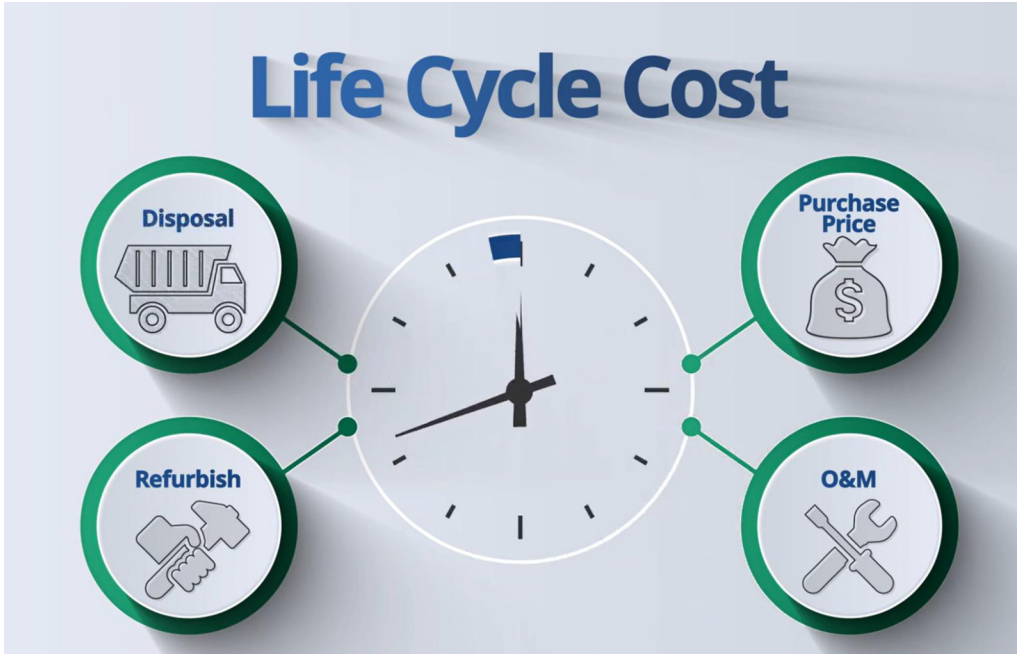
LIFE CYCLE COSTING


Life Cycle Cost
Disposal
Purchase Price
Refurbish
O&M

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)



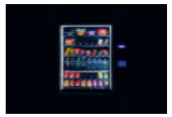
Source: https://ec.europa.eu/environment/gpp/lcc.htm

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.

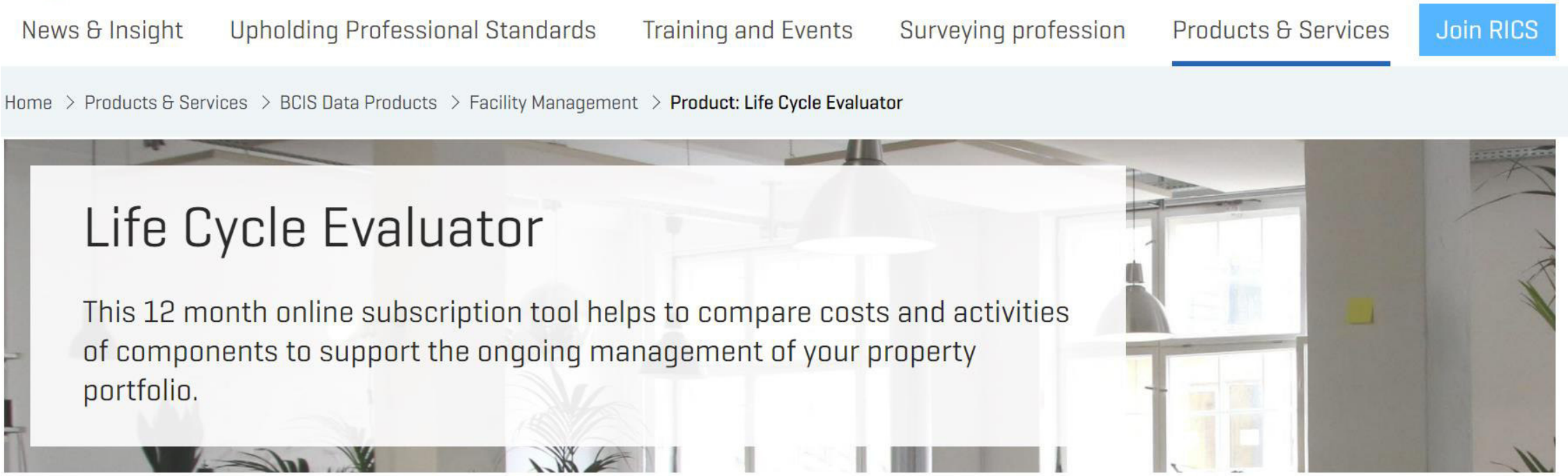
- Identify **cost drivers**
  - some can be easily included in LCC calculations, such as energy consumption.
  - Others -such as durability might be relevant from an economic point of view but are more difficult to quantify in terms of how much they increase the product's lifespan.
- Besides cost drivers, **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

TOOLS

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



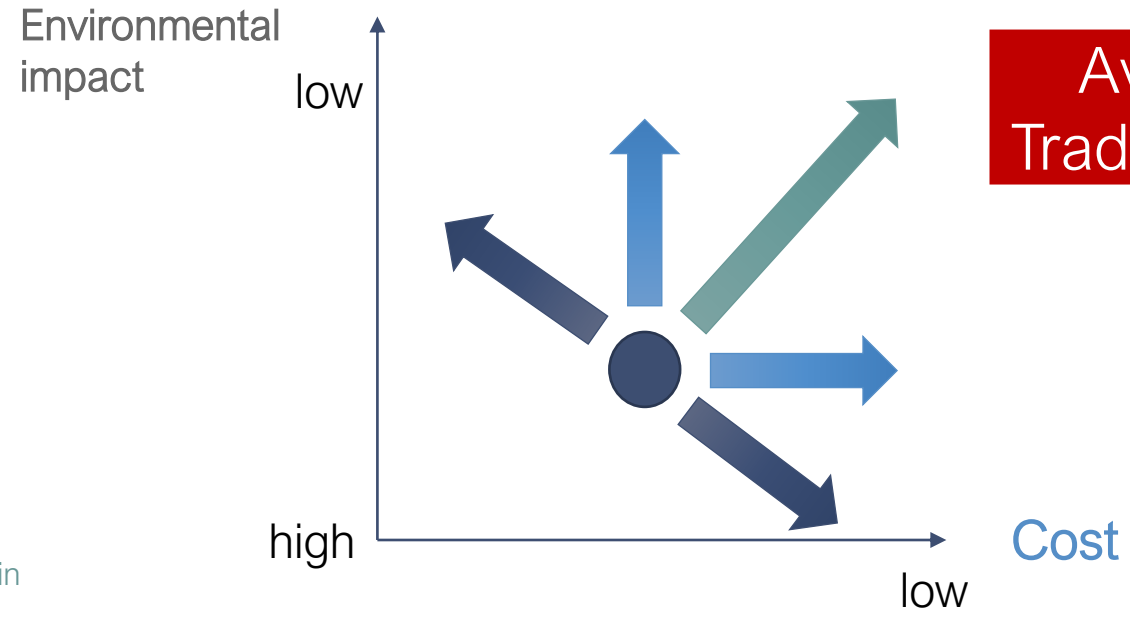
Source: https://www.rics.org/en-hk/products--services/data-products/facilities-management/life-cycle-evaluator/

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

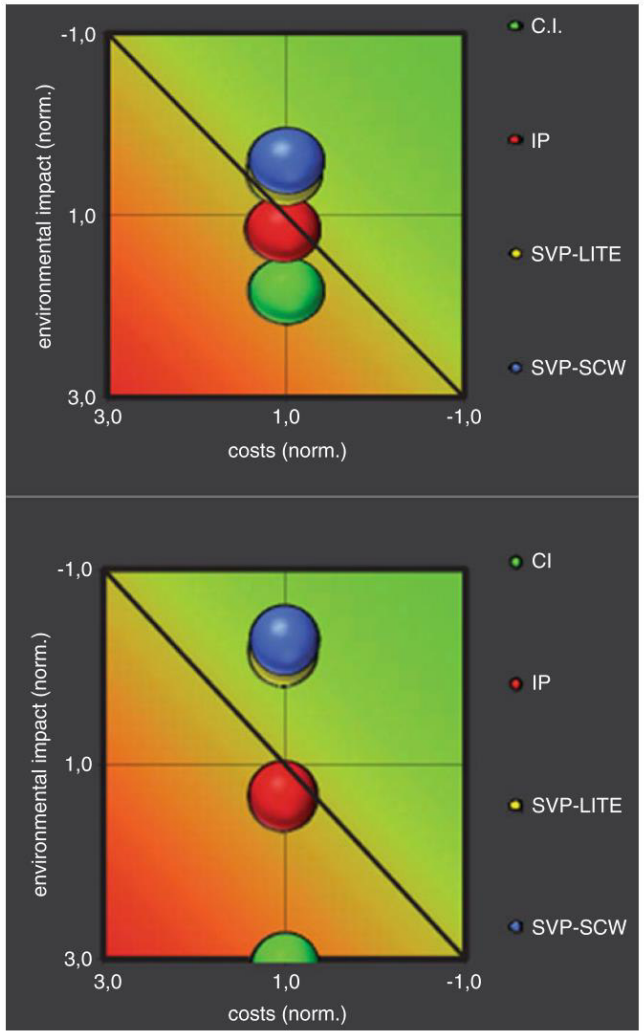
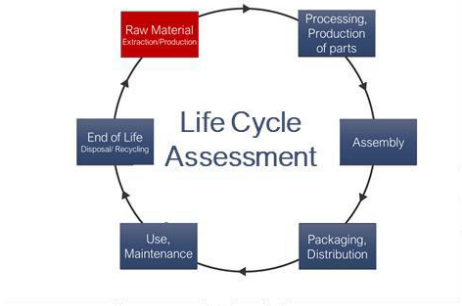


Fig. 4.8 The eco-efficiency portfolio comparison (*upper*, base case; *lower*, scenario with Indonesian electricity mix)

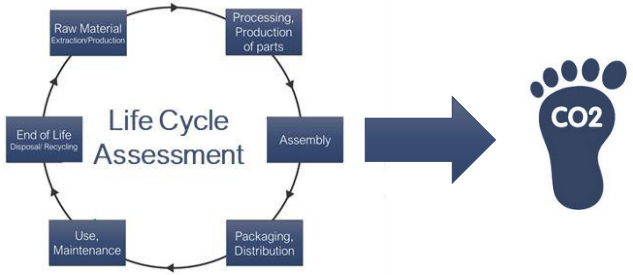
Key Takeaways Life Cycle Assessment

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

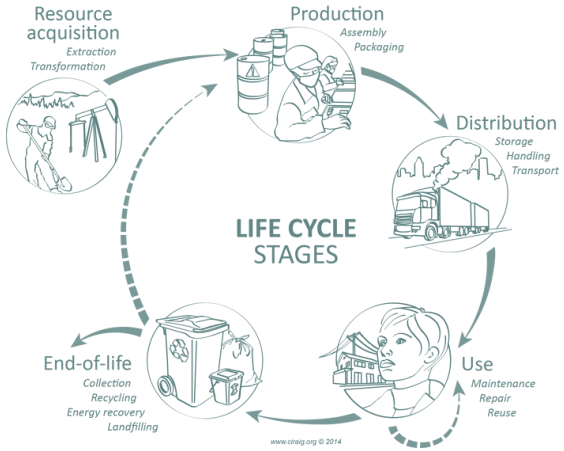


Hot Spot:
Process that causes significant impacts

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

Contact

Dr. Meike Sauerwein, Lecturer

Division of Environment and Sustainability, HKUST

Email: meike@ust.hk