InnoRenew CoE
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How to perform research in the field of Life Cycle Assessment (LCA) with examples from the built environment

Erwin M. Schau, InnoRenew Centre of Excellence (CoE)

Invited lecture, 28 October 2020

University of Primorska, PhD study program Renewable Materials for Healthy Built Environments

Housekeeping rules

- Mute yourself when you are not speaking
- Remember to unmute yourself when you want to say something (e.g. have a question, or answer a question.)
- When answering a question, take into account that, in LCA, the reasoning for the answer and the interpretation of the answer are more important than the answer itself.

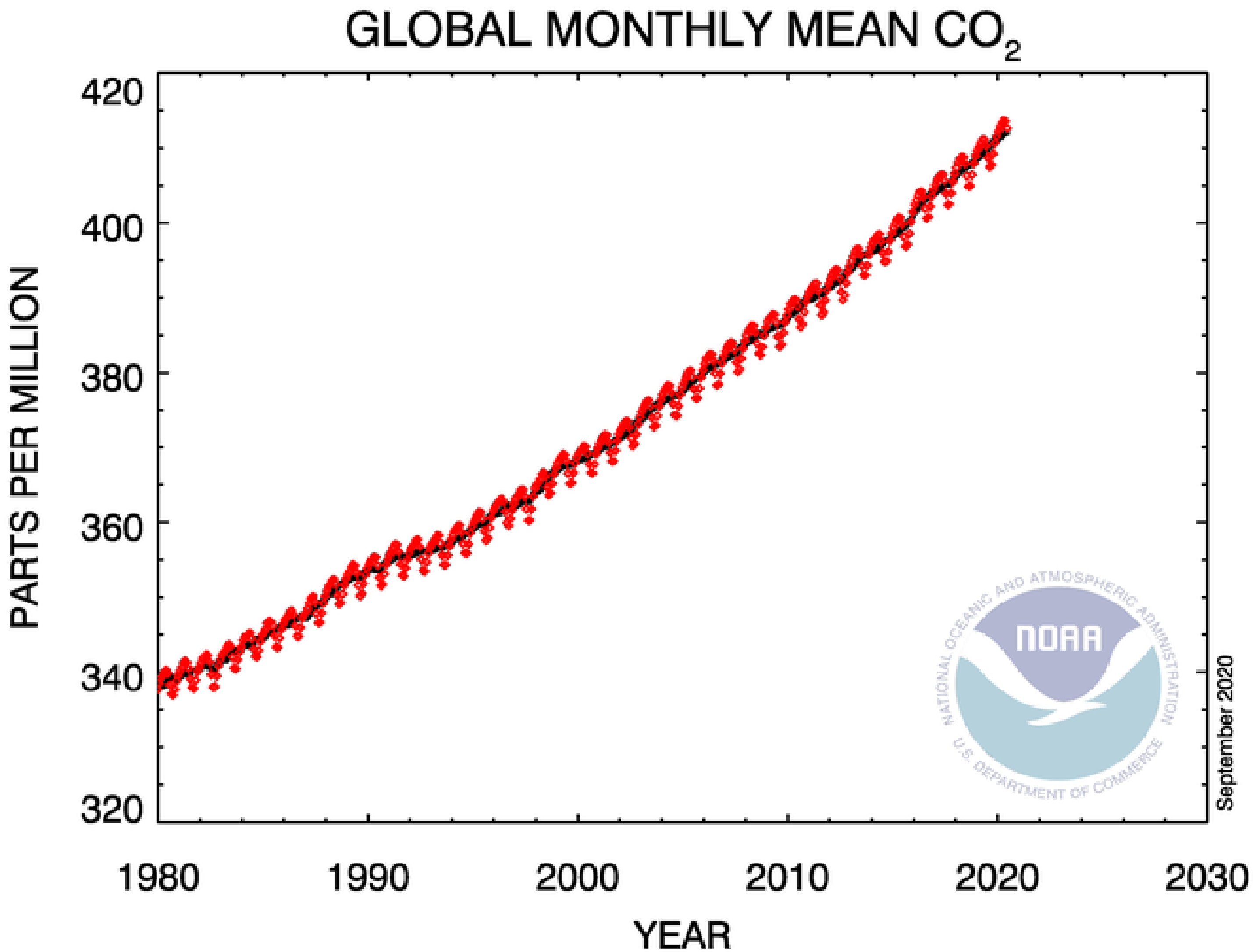
Roundtable introduction

- Who are you (name) ?
- Where are you coming from?
- What is your motivation for starting on a PhD project?

Outline

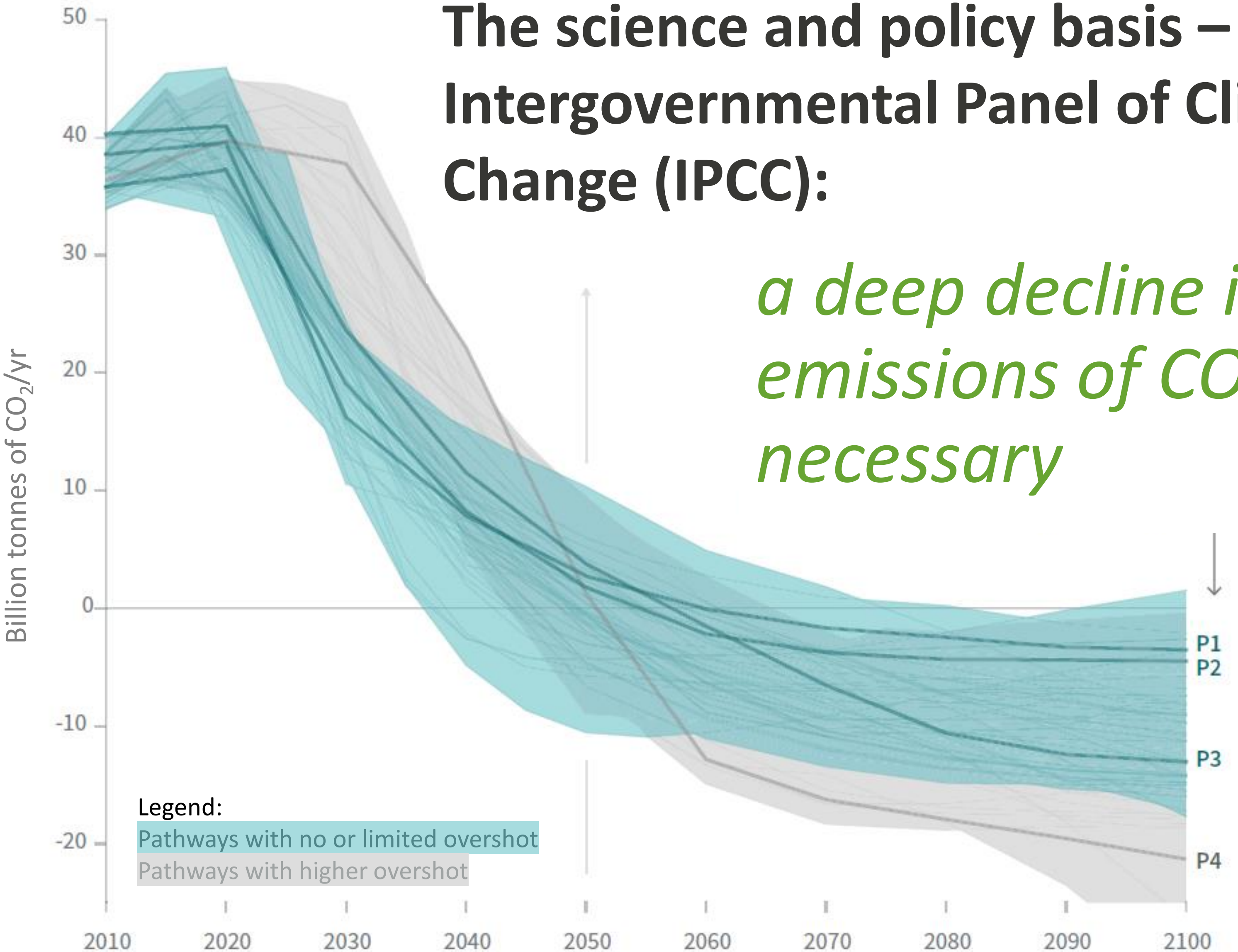
- Introduction
- Background
  - What is life cycle thinking and Life Cycle Assessment (LCA)?
  - Challenges to be solved by LCA and life cycle thinking
  - ISO 14040 and ISO 14044 on Environmental management, Life cycle assessment
    - 1) Goal and scope (objective), 2) Inventory analysis (data and materials), 3) Impact assessment (method and result), 4) Interpretation (discussion and conclusion)
- Examples
  - Example 1: A wooden house
  - Example 2: InnoRenew CoE research building in Izola
  - Example 3: Environmental comparison of wood, concrete and steel building materials
- Summary and outlook (with challenges to be solved?)
  - Other standards, methods and rules for LCA
    - Product Category Rules, EU Environmental Footprint (EF) (ILCD & PEFCR/OEFSR) and Database rules
  - Life cycle thinking for other dimensions of sustainability
    - Life Cycle Costing and Social LCA
  - Current research in LCA (with a focus on wood and other bio-based materials)

Climate change



The science and policy basis – Intergovernmental Panel of Climate Change (IPCC):

a deep decline in emissions of CO_2 is necessary



Source: IPCC, 2018

Our demand for energy and other resources is growing as well

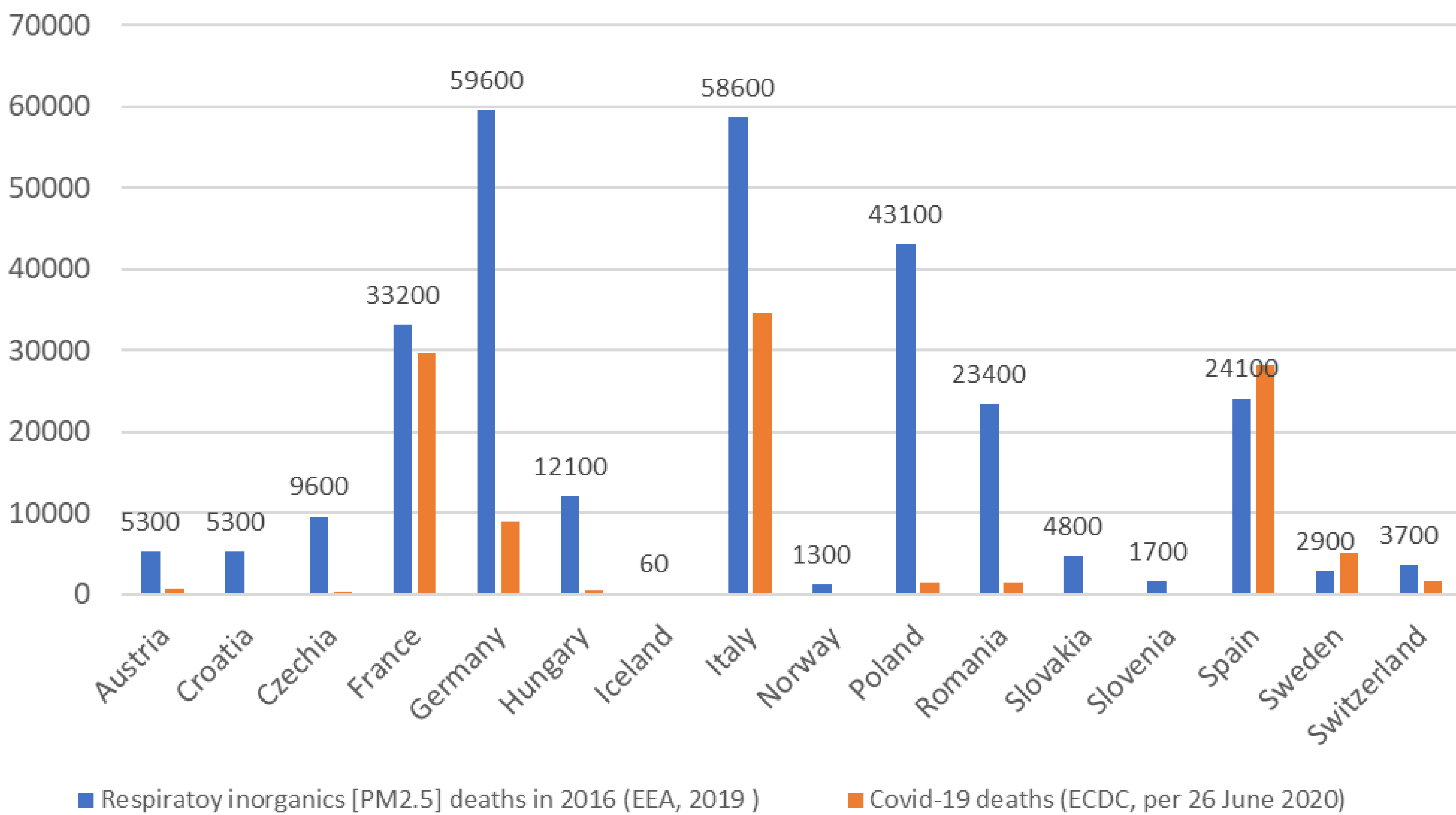
- "The health of ecosystems on which we and all other species depend is deteriorating more rapidly than ever. We are eroding the very foundations of our economies, livelihoods, food security, health and quality of life worldwide." IPBES Chair, Sir Robert Watson, 6 May 2019 in the „Global Assessment Report" from IPBES.

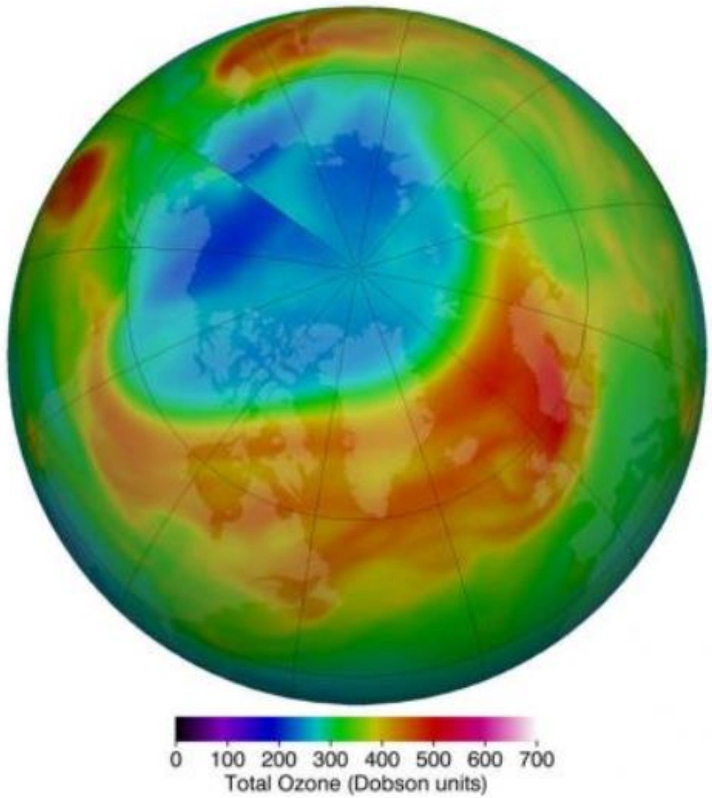
Jinning Li/Shutterstock.com

Ambient (outdoor) air pollution

- poses a major threat to health and climate
- accounts for an estimated 4.2 million premature deaths per year due to stroke, heart disease, lung cancer and chronic respiratory diseases (WHO, 2020)

Deaths by air pollution (PM2.5) and COVID-19 (first wave) in some European countries





Arctic ozone depletion reached record level

Tags: Ozone Environment

1 Published 1 May 2020

Depletion of the ozone layer, the shield that protects life on Earth from harmful levels of ultraviolet radiation, reached an unprecedented level over large parts of the Arctic this spring. This phenomenon was caused by the continuing presence of ozone-depleting substances in the atmosphere and a very cold winter in the stratosphere (the layer of the atmosphere between around 10 km and round 50 km altitude).

Latest WMO News

Source: WMO, 2020

Ehrlich equation

- I = P x A x T

- I = Impact
- P = Population
- A = Affluence (Consumption)
- T = Technology

Film about LCA of cheese

- https://youtu.be/XmFmXyChufs

(3:24 min)

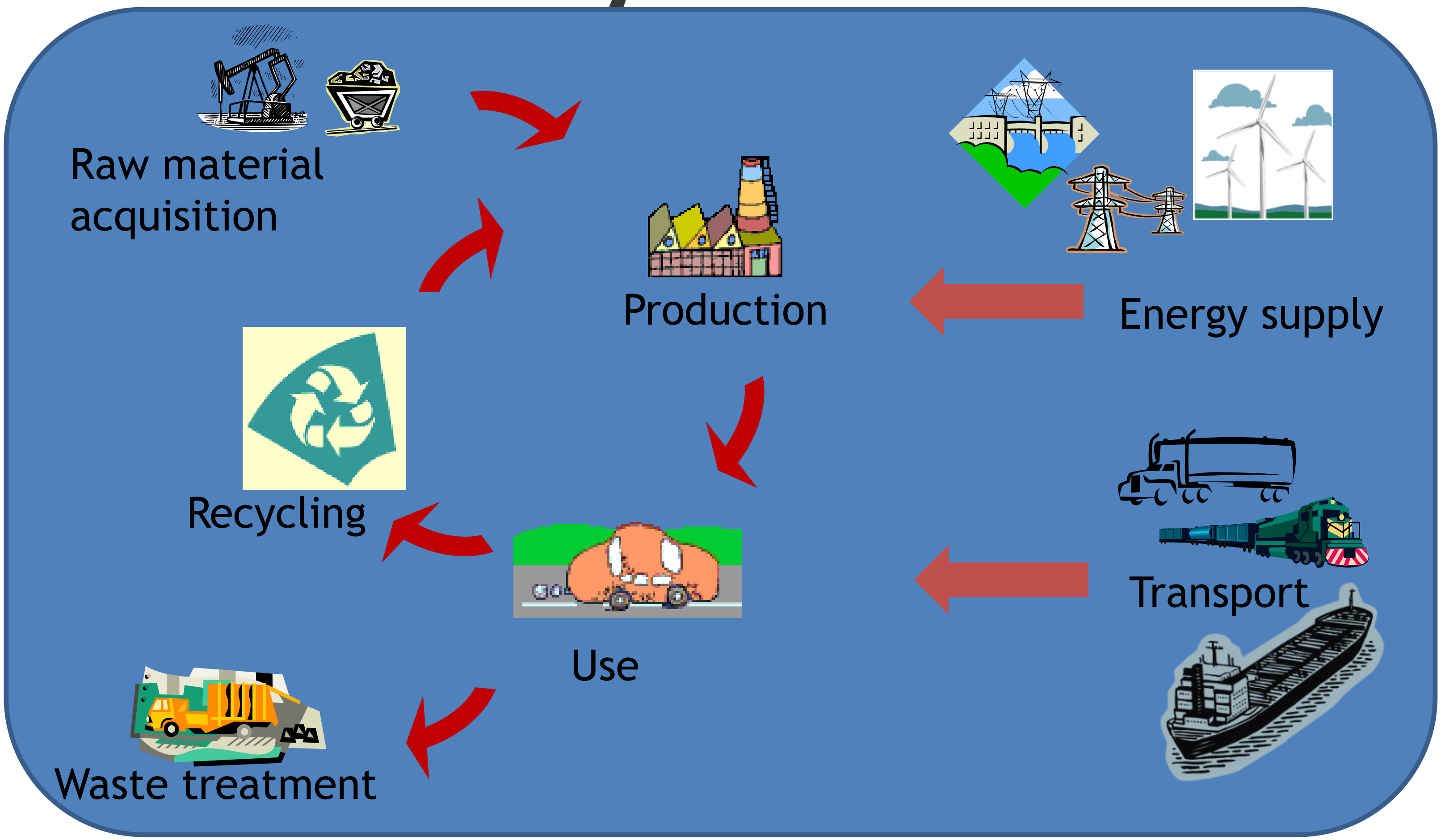
Exercise: Why apply LCA?

Exercise: Why apply LCA?

- Compare different alternative products or designs (eco-design)
- Material sourcing
- Ecolabeling
- Product stewardship
- Cleaner production
- Prioritize different investments
- Hot-spot analysis
- Stay ahead of the competitor and authorities/regulators

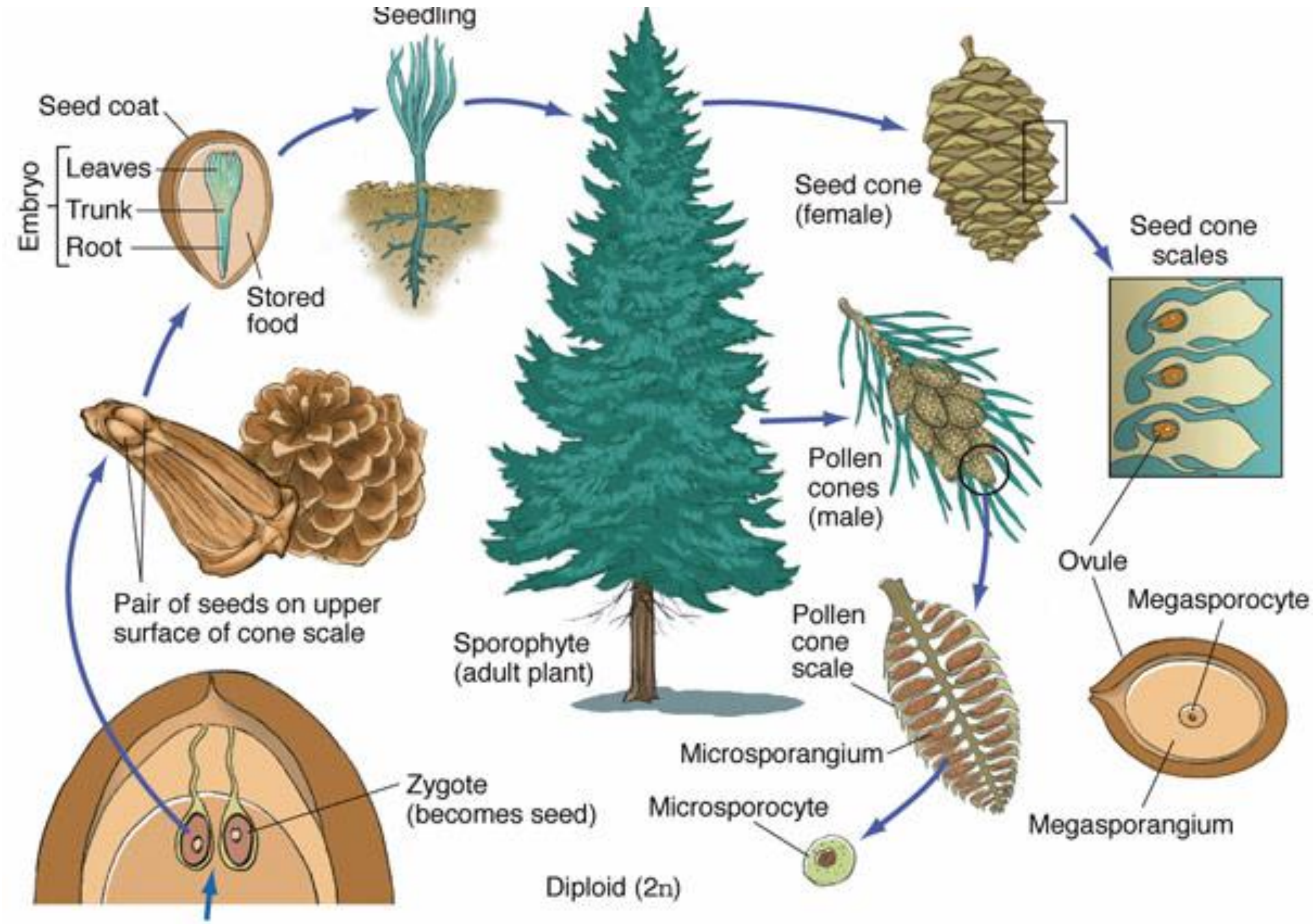
• Improve reputation among customers
• Better chances of winning public procurement contracts
• Access to green finance
• As a business opportunity to reduce cost, find new opportunities and develop better products
• Get higher prices for products
• Get to know the value chain better
• Save energy
• Lower environmental pollution

What is a life cycle and LCA?



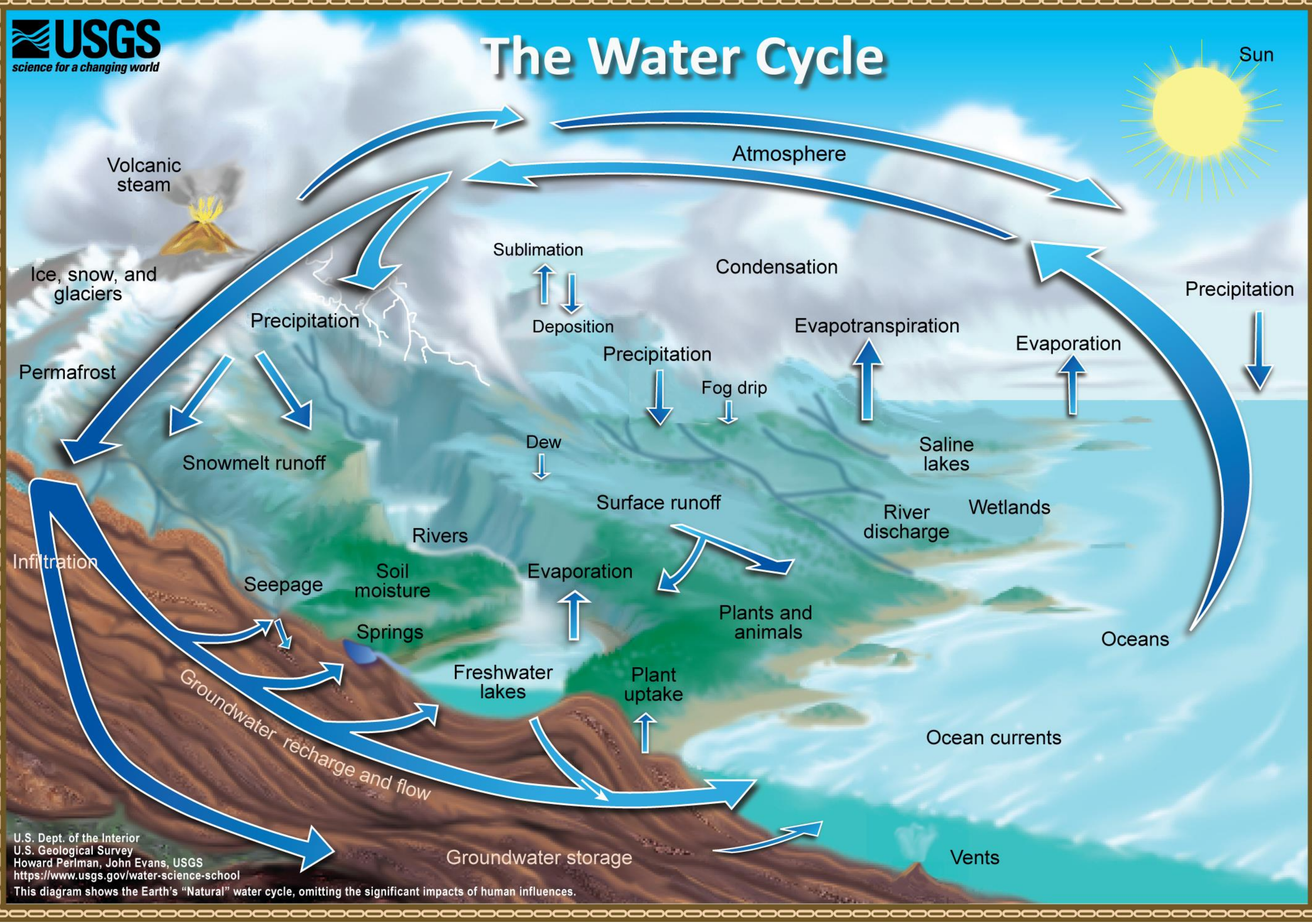
Point of departure: a life cycle

Normally in biology terms



Source: http://www.biographixmedia.com/biology/pine-tree-life-cycle.jpg

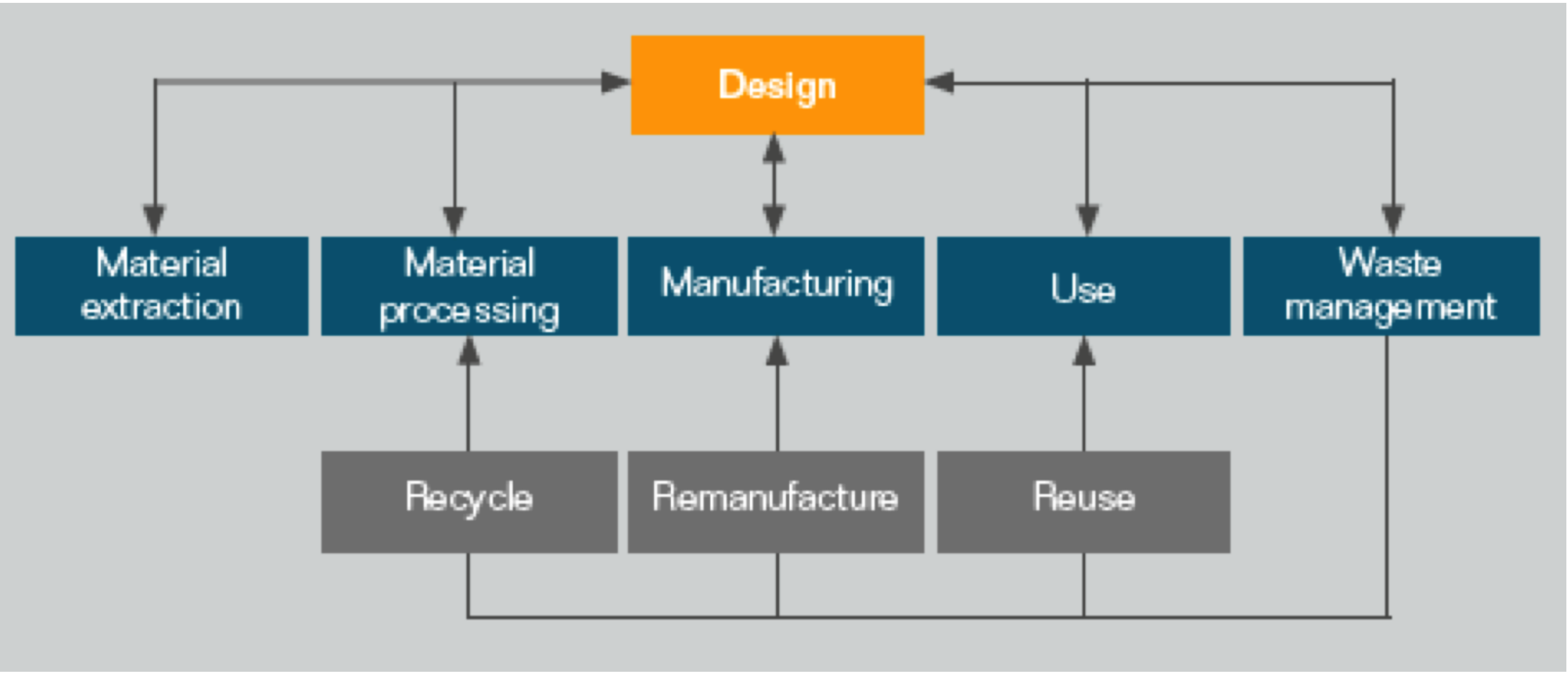
Slide from DiPietro, 2018



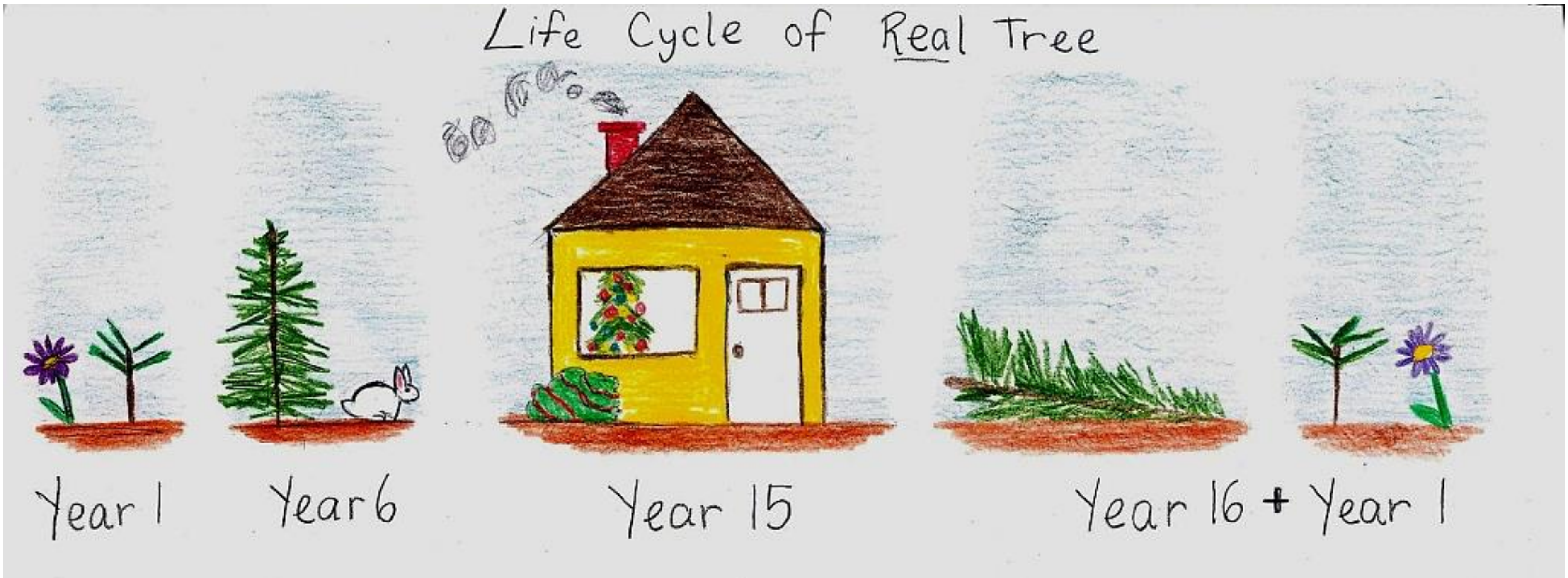
USGS
science for a changing world
The Water Cycle
Sun
Atmosphere
Volcanic steam
Ice, snow, and glaciers
Precipitation
Permafrost
Sublimation
Deposition
Condensation
Precipitation
Evapotranspiration
Evaporation
Precipitation
Fog drip
Snowmelt runoff
Dew
Saline lakes
Surface runoff
River discharge
Wetlands
Rivers
Infiltration
Seepage
Soil moisture
Evaporation
Plants and animals
Oceans
Springs
Freshwater lakes
Plant uptake
Groundwater recharge and flow
Ocean currents
Groundwater storage
Vents
U.S. Dept. of the Interior
U.S. Geological Survey
Howard Perlman, John Evans, USGS
https://www.usgs.gov/water-science-school
This diagram shows the Earth's "Natural" water cycle, omitting the significant impacts of human influences.

Definitions

- A life cycle of a product (a.k.a. “cradle to grave”) begins with raw materials production and extends to manufacture, use, transport and waste management



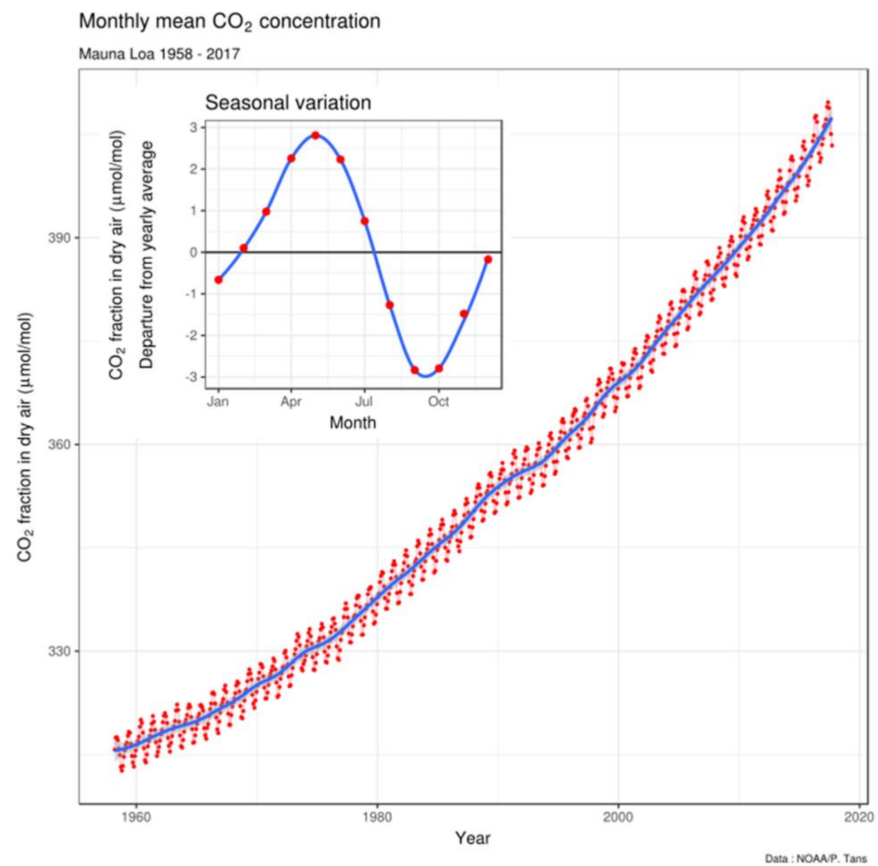
Slide from DiPietro, 2018



Slide from DiPietro, 2018

Why LCA?

- What is the impact of "business as usual"?
- Intuition not a sufficient framework for analysis!
- LCA = systematic method for comparing systemic impacts of products, organisations and policies

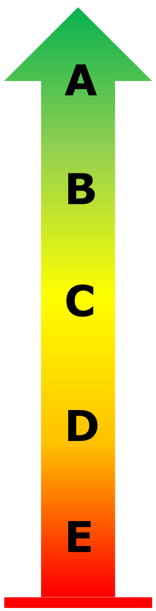


Slide from DiPietro, 2018

What can LCA deliver?

- The potential impact of several different environmental or healt impacts, like
  - climate change / carbon footprint
  - water use / water footprint
  - emissions to the environment (air, soil and water)
    - Eutrophication, accidification, particulate matter/ respiratory inorganics, etc.
- Results are typically used for
  - hot-spot analysis
  - compare different alternative products or design

Benchmarking



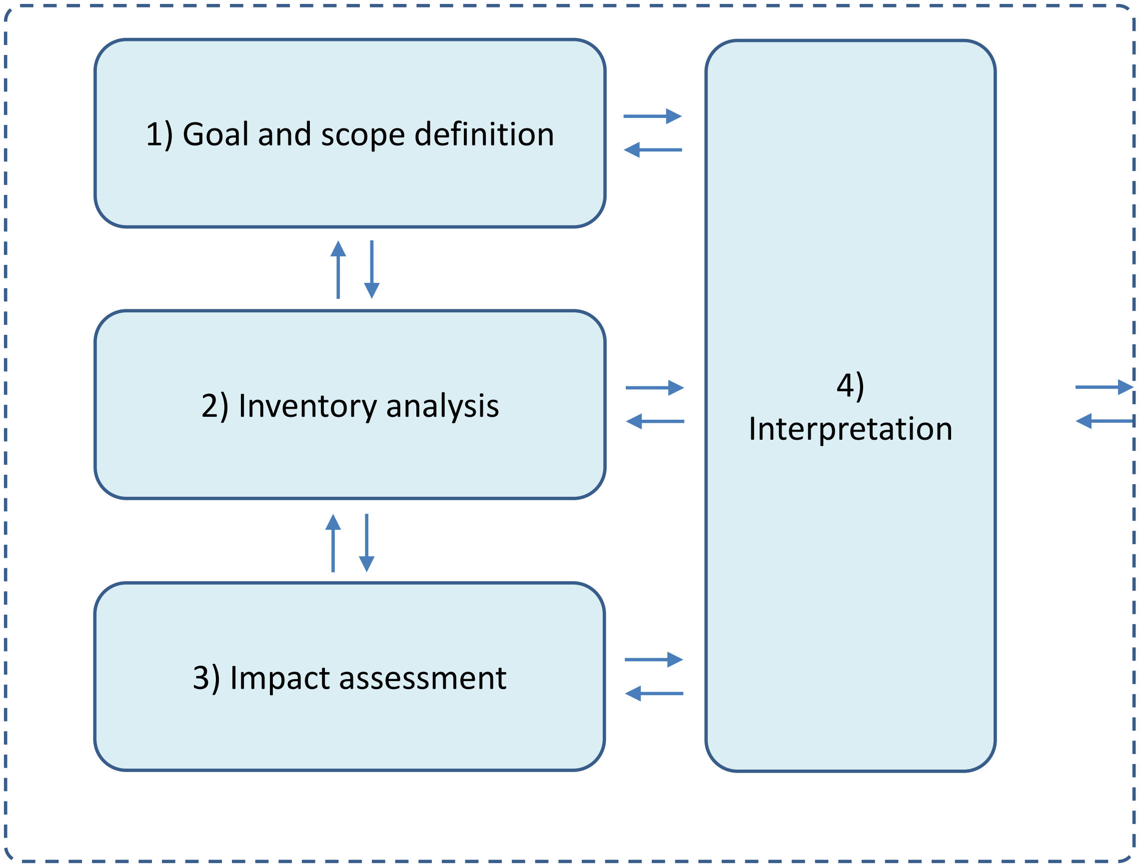
Best performing product

Benchmark:
representative or average product

Worst performing product

Based on Schau, Russo et al. 2017

LCA framework according to ISO 14040 and 14044 – Inventory analysis



Direct application:

- Product development and improvement
- Strategic planning
- Public policy-making
- Eco-labelling
- Marketing
- Others

What is needed?

- Goal and scope of the analysis
  - Function and lifetime of the product(s)
  - Topics to look at (environmental impact categories like climate change and accidification, etc.)
- Life cycle inventory – all input and output (materials and energy) for the product system under study
  - Starting point: Bill(s) of materials (BoM)
  - Production locations (for calculating transport distances)
  - Transport modes (ocean, inland water, rail or road)
  - Energy - use and sources
  - Background life cycle data (often comes together with the LCA software used for the modelling)

Goal and scope

- Goal definition – identifying purpose and target audience:
  - Why is this study performed?
  - Which question(s) is it intended to answer? and
  - For whom is it performed?

- Decision context and application
  - Weak point analysis of a specific product vs Green Public or Private Procurement
  - Monitoring environmental impacts of a nation vs Ecodesign of a product

EC,JRC,IES 2010, ILCD handbook, General guide for LCA – Detailed guidanc

Hauschild 2018 in Hauschild et al. Springer

Scope

- Defining the **functional unit (FU)**: a quantitative description of the function or service for which the assessment is performed, and the basis of determining the **reference flow** of product that scales the data collection
- Scoping the product system, deciding which activities and processes belong to the life cycle of the product that is studied
- Selecting
  - The assessment parameters, i.e. the impacts to be assessed in the study
  - The geographical and temporal boundaries and the level of technology that is relevant for the processes in the product system
- Identifying the need to perform critical review, in particular if the study is a comparative assertion intended to be disclosed to the public

Hauschild 2018 in Hauschild et al. Springer

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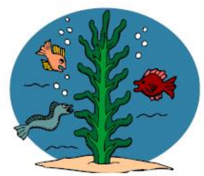
Typical impacts to be assessed

CLIMATE CHANGE



EUTROPHICATION

HUMAN TOXICITY

ACIDIFICATION

OZONE DEPLETION

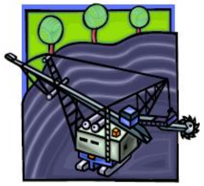
ECOTOXICITY

IONISING RADIATION

PHOTOCHEMICAL OZONE FORMATION

LAND USE

WATER DEPLETION



RESOURCE DEPLETION

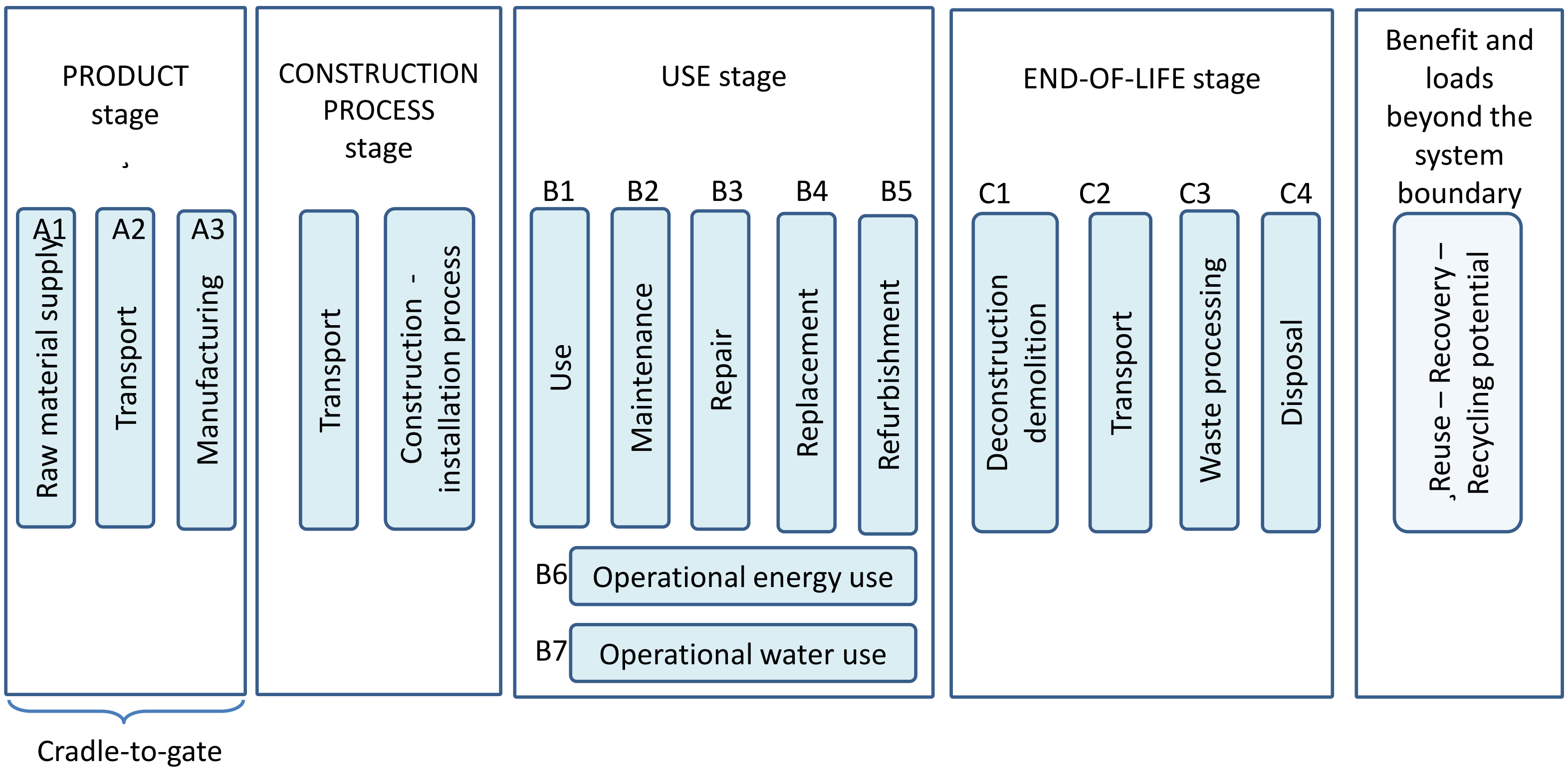
European Commission 2017, Better Regulation Toolbox, Tool #64. Life Cycle Analysis.

Impacts often missing

- Noise – some LCA impact assessment methods (e.g. swiss ecoscarcity) take very roughly outdoor noise from road and rail traffic into account

- Impacts on biodiversity
  - some impact categories indirectly take that into account, which one?

System boundary according to EN 15804



Inventory analysis

- Collecting physical flows for the product system
  - Input
    - Resources (incl. water)
    - Materials
    - Semi-products and products
  - Output
    - Emissions
    - Waste and wastewater
    - Valuable products
- In all processes identified
- Flows scaled according to reference flow
  - Determined from the functional unit
- Results of inventory analysis: life cycle inventory (LCI)
  - List of quantified physical elementary flows

Hauschild 2018 in Hauschild et al. Springer

Inventory analysis in practice

- Starting point: Bill of Materials (BoM)
- Use of databases
- Most common LCI databases:
  - EcoInvent
  - GaBi
  - US
  - ELCD

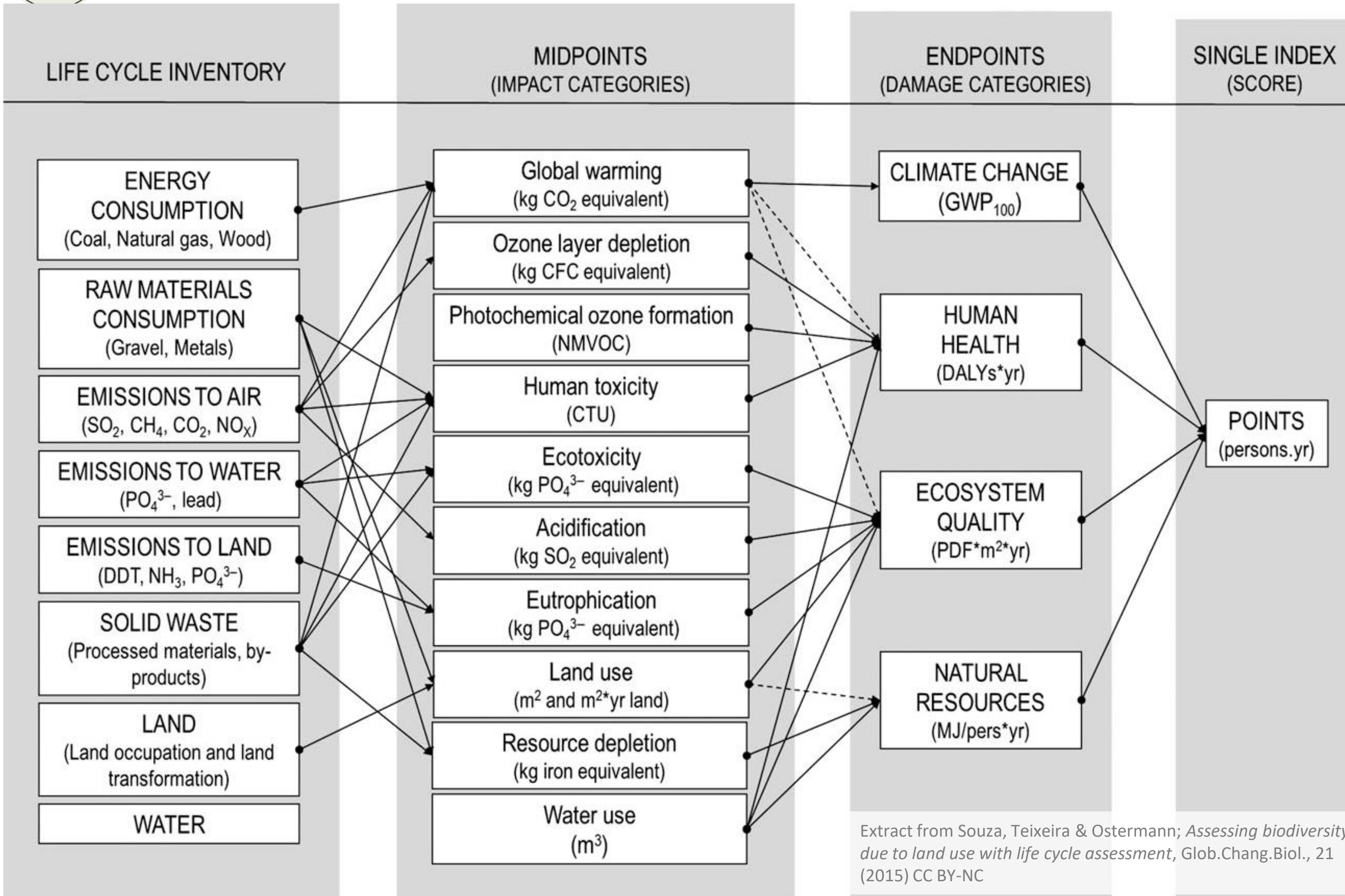
Hauschild 2018 in Hauschild et al. Springer

Classification

- ISO 14040 def:

- *Assignment of life cycle inventory results to the selected impact categories*

(from goal and scope)



Extract from Souza, Teixeira & Ostermann; *Assessing biodiversity loss due to land use with life cycle assessment*, Glob.Chang.Biol., 21 (2015) CC BY-NC

Characterisation

- ISO 14044:

- *Calculation of category indicator results*

With the help of characterisation factors

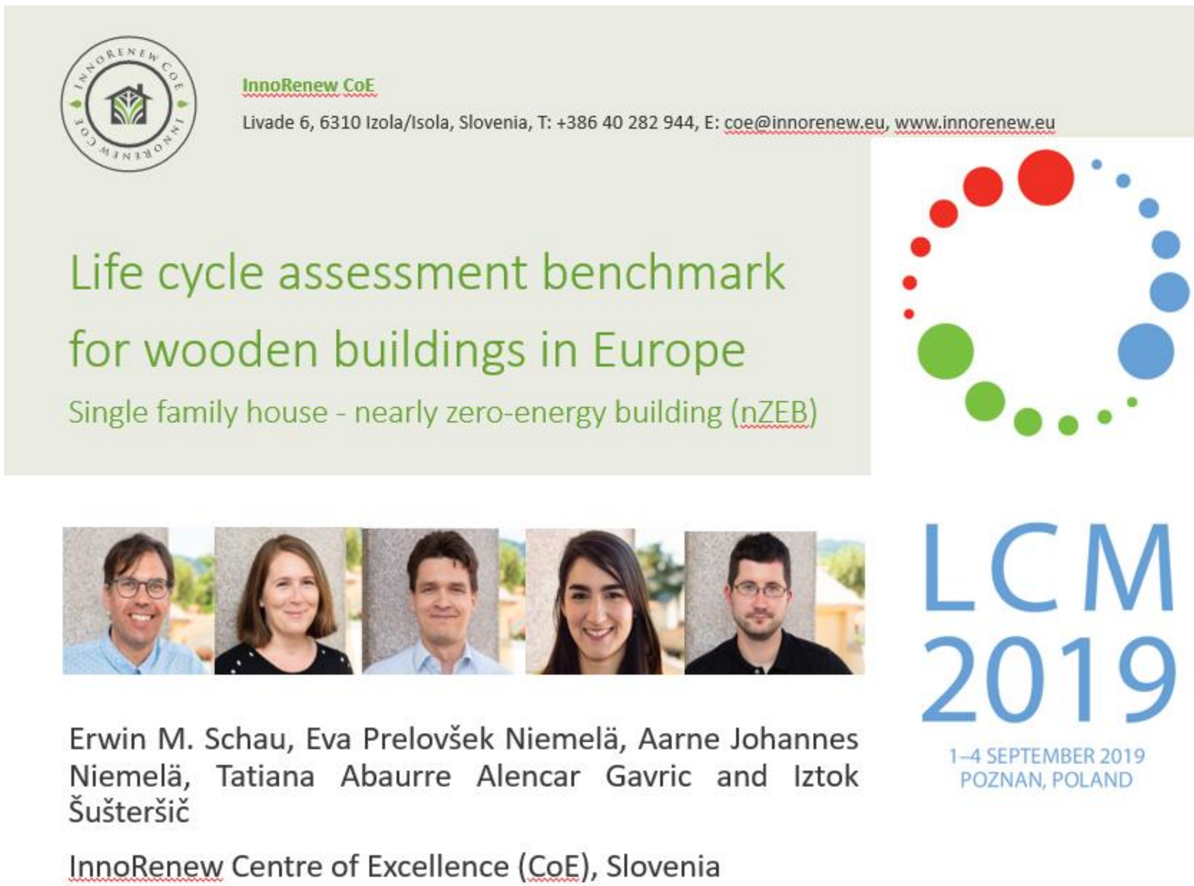
Normalisation and weighting

- Normalisation
  - Calculation of the relative magnitude relative to a reference (e.g. the whole world or a person)
- Weighting
  - Based on value choice; convert and eventually aggregate the normalised results into unitless results to be able to compare across different impact categories

Interpretation according to ISO 14044

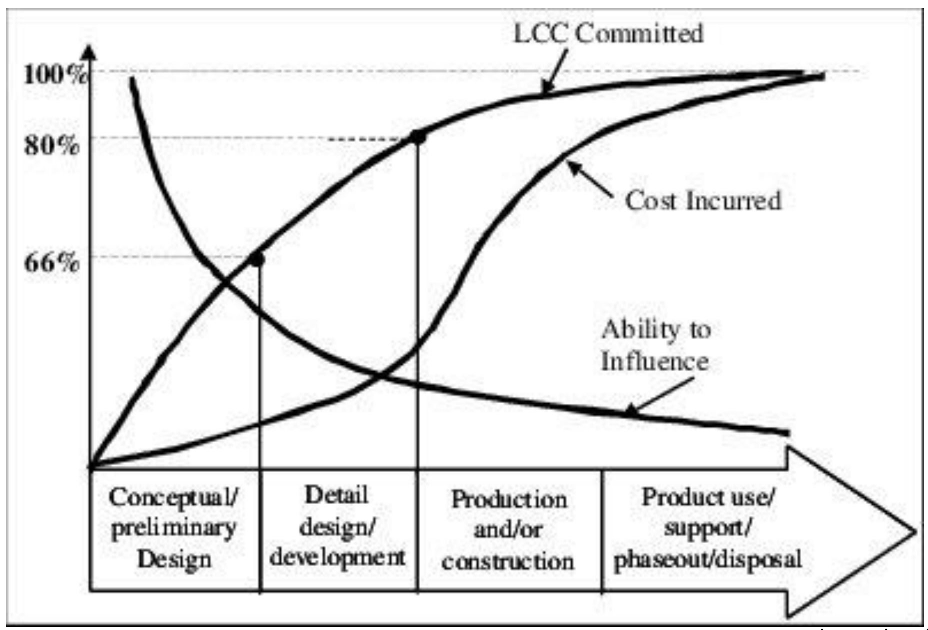
- Identification of significant issues
- Evaluation of completeness, sensitivity and consistency
- Conclusion, limitations and recommendation

Example 1: A house
Case study based on an LCA of a single family house



Goal: Benchmark for wooden building

- For use in the early planning phase of new buildings
  - when changes and environmental optimization still can be done for a reasonable cost



Based on Fabrycky, 1991

Scope:

- Typical wooden single family house
  - In Europe (EU28 + Norway)
  - Construction in 2020
  - Size of 100 m^2
  - Average of 2.36 inhabitants
  - 100 years of use before deconstruction

Goal and scope (cont.) and functional unit

- Environmental Footprint* of a typical wooden residential building that could be used as a reference for other house designs

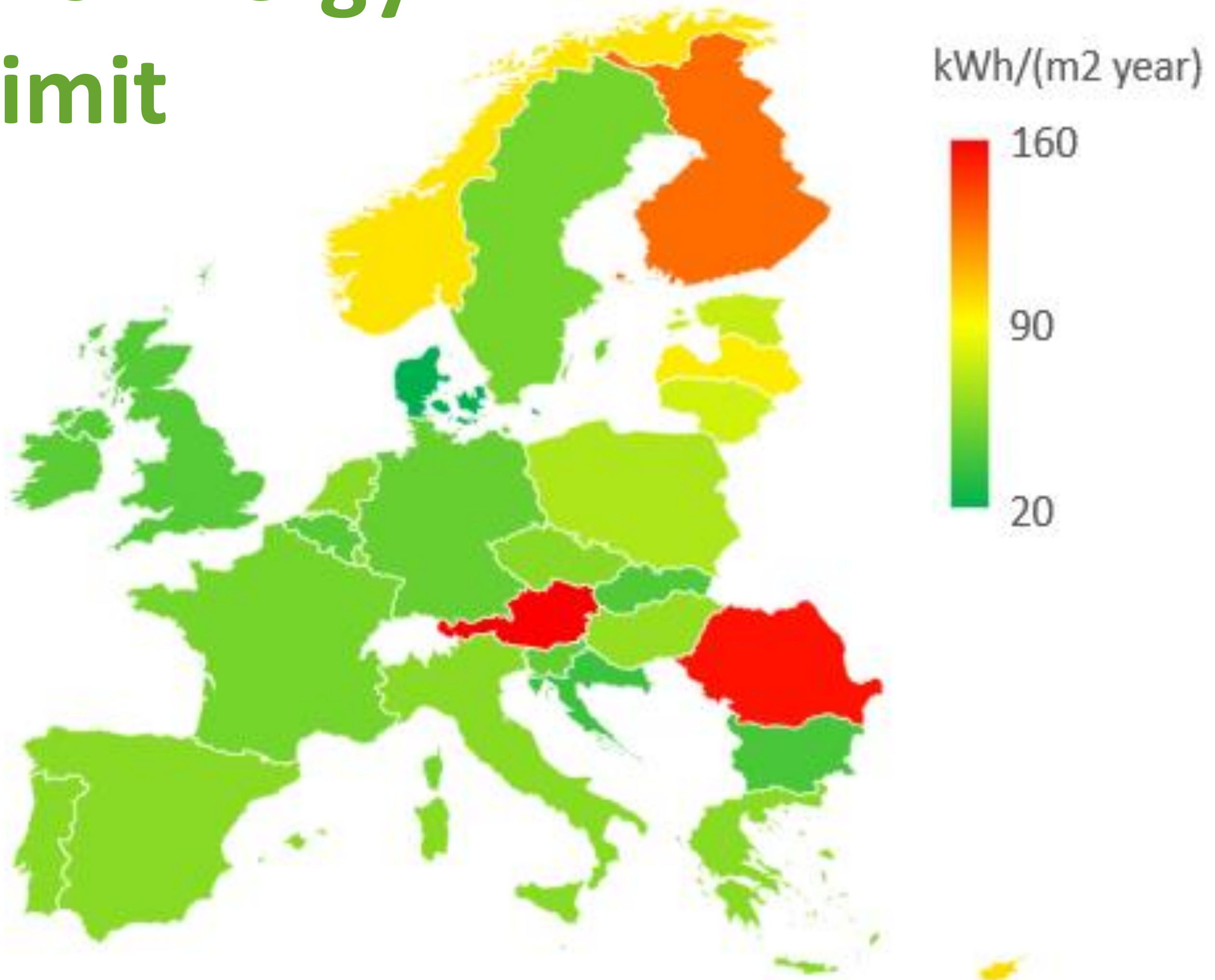
- Functional unit is one dwelling with a 100-year lifetime
  - Results are given as per m^2 per year

* An Environmental Footprint is here an LCA that builds on the EU recommended method for doing LCA in a European context and is aligned with EN 15804 (the European standard for building products LCAs)

Example 1: A house – Method and data

Nearly-Zero Energy Building limit

Required or recommended by 2021



Source: Own calculations based on BPIE (2015), D'Agostino et al (2016), European Commission (2016), Kurnitski & Ahmed (2018) NRW ÖkoZentrum (2019) and estimates. Map: Bing © GeoNames, HERE, MSFT

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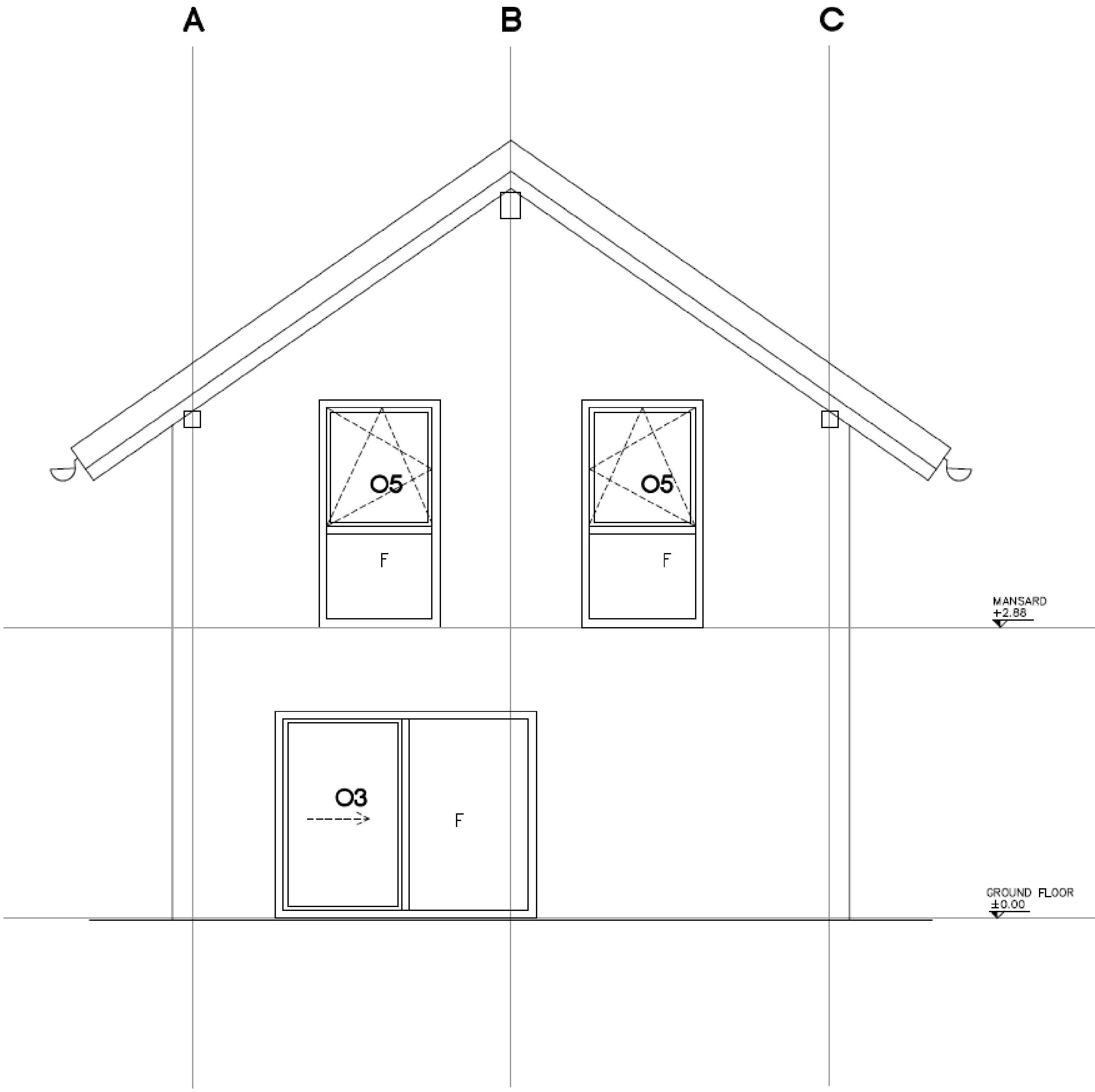
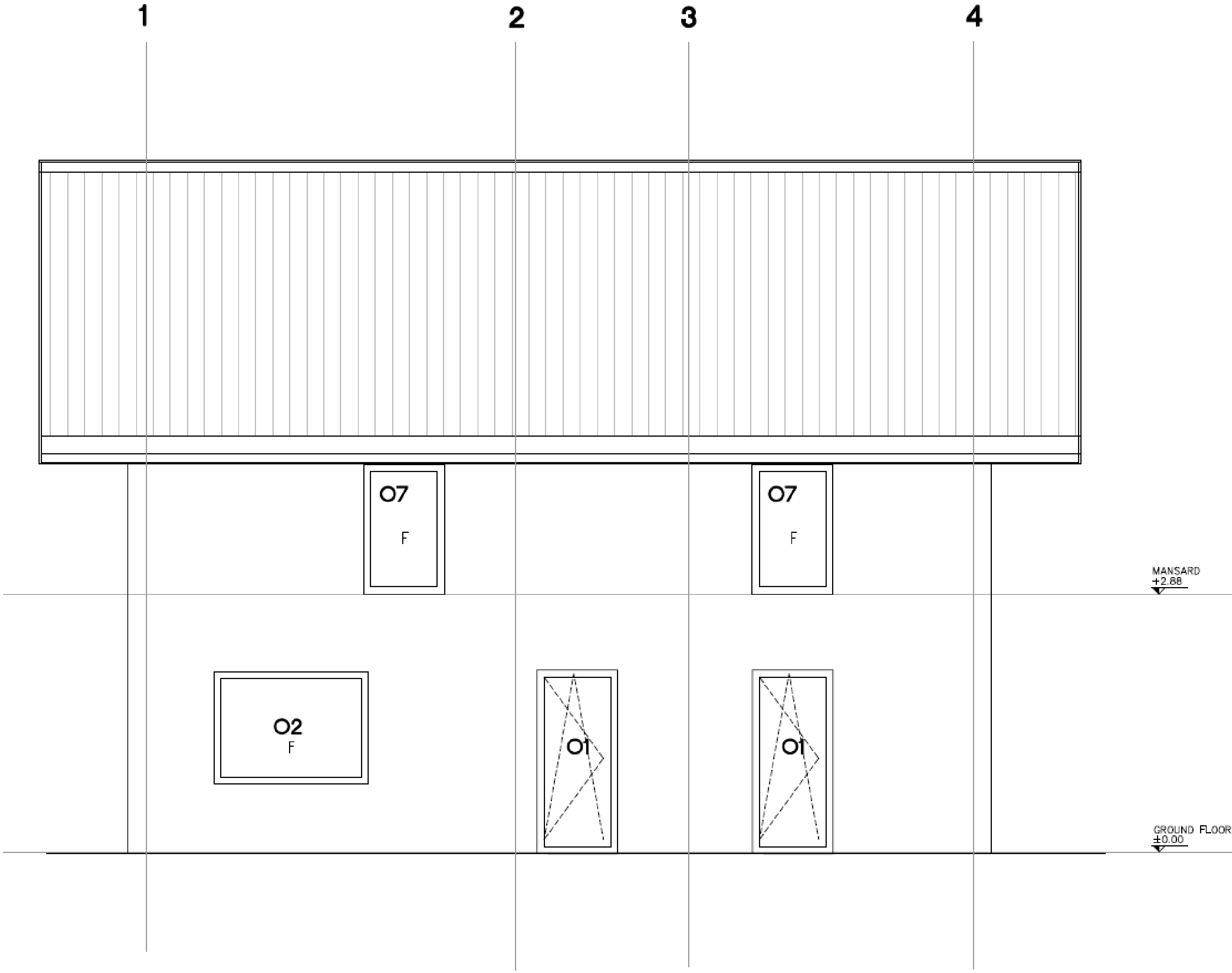
Reference house design



FACADE WEST



FACADE SOUTH

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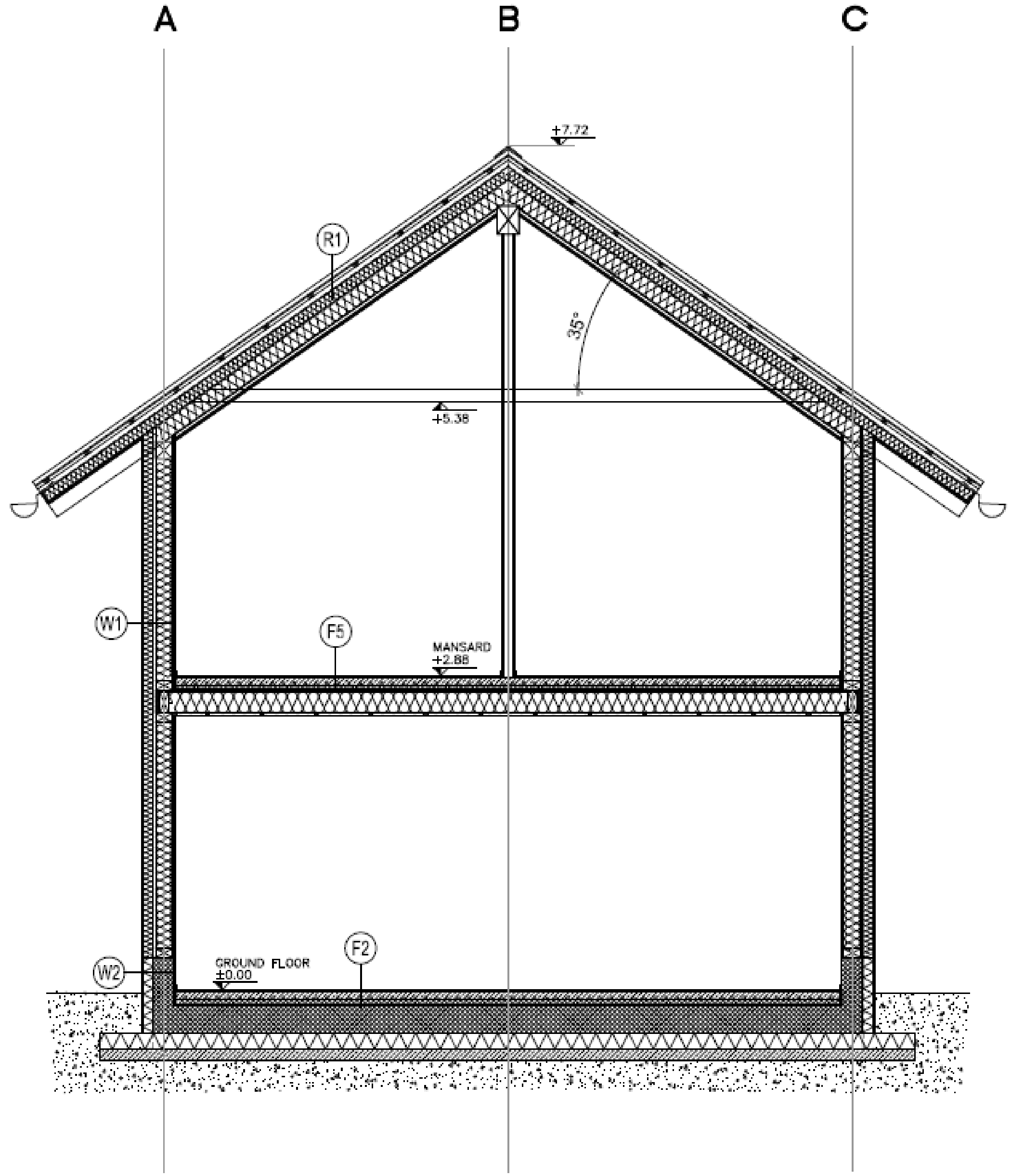
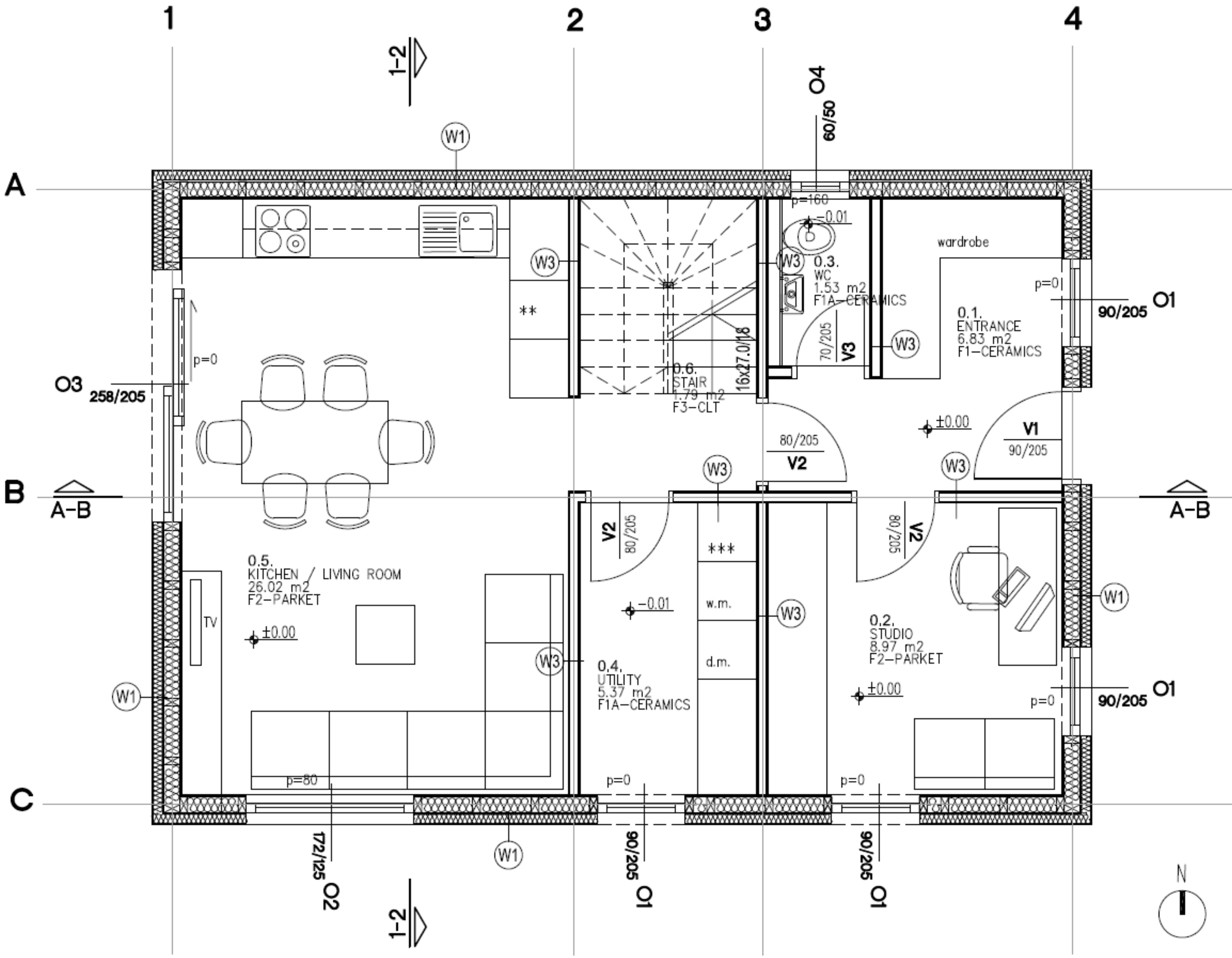


SECTION 1-2



GROUND FLOOR: 50,51 m2

LCA modelling

- Follows closely the data and method of the benchmark for environmental impact of housing in Europe - Basket of Products Consumer Footprint indicator for housing (Baldassarri et al 2017, Lavagna et al 2018)

Building and Environment 145 (2018) 260–275

Contents lists available at ScienceDirect

Building and Environment

journal homepage: www.elsevier.com/locate/buildenv

Benchmarks for environmental impact of housing in Europe: Definition of archetypes and LCA of the residential building stock

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Benchmark
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ABSTRACT

This study describes the results of Life Cycle Assessment (LCA) applied to 24 statistically-based dwelling archetypes, representative of the EU housing stock in 2010. The aim is to quantify the average environmental impacts related to housing in Europe and to define reference values (baseline scenario) for policies development. The average environmental impacts have been calculated taking into consideration the number of dwellings (clustered per typology, year of construction and climate zone) related to each representative model. System boundaries include production, construction, use (energy and water consumption), maintenance/replacement, and end-of-life phases of each dwelling. The environmental life cycle impact assessment was carried out using the ILCD method. EU average annual environmental impact per person, per dwelling, and per m^2 were calculated. Results show that the average life cycle greenhouse gases emissions related to housing per person per year are 2.62 t CO_2eq and related to a representative dwelling per year are of 6.36 t CO_2eq. The use phase (energy and water consumption) is the most relevant one, followed by the production and the maintenance/replacement phases. Single-family houses are responsible for the highest share of impacts related to housing in Europe. The same type of building has different impacts in different climatic zones, due to the differences in the need for space heating. In general, electricity use and space heating are the activities that contribute more to the overall impacts. The final results could be used as a baseline scenario for testing eco-innovation scenarios and setting targets toward impact reduction.

1. Introduction

The built environment is one of the main drivers of environmental impacts in Europe and represents one of the most important areas of intervention for reducing emissions and consumptions of resources.

In recent years, several European policy initiatives, such as the Europe 2020 Strategy and the Resource-efficient Europe flagship [1], identified the built environment as one of the strategic areas. As a result, there are many guidelines and European directives on the construction sector, in particular those related to the reduction of energy consumption in the use phase of buildings (which contributed to 41% of EU energy consumption in 2010). These directives aim to reduce the overall environmental impacts of buildings. However, the main policies tend to focus only on the most impacting phase (use phase) and on the most known drivers of impacts (such as energy and CO_2 emissions) without checking the effects of the promoted strategies on the entire life cycle of the impacts and considering a variety of environmental impacts. The risk, in fact, is to create burden shifting among the life cycle phases and among the different impacts.

During the years, several requirements were defined to improve the energy performance of buildings (e.g. increase of thermal resistance), through the 2002 and 2010 Energy Performance of Buildings Directive (EPBD) [2–4] and the 2012 Energy Efficiency Directive [5]. Nonetheless improving the energy performance of buildings toward Zero Energy Buildings, the impacts derived from the production of building materials and equipment can overcome the impacts related to the use phase. It should be emphasized that not all the energy efficiency strategies, including the regulatory ones, lead to an overall reduction of the environmental impacts. In fact, while in old buildings the ratio of impacts between the production of materials and the impact of energy consumption on the use phase is 1:10, in low-energy buildings the embodied energy can represent the 45% of the lifecycle energy [6,7].

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Available online 07 September 2018

European Commission

JRC TECHNICAL REPORTS

Consumer Footprint

Basket of Products indicator on Housing

Catia Baldassarri, Karen Allacker, Francesca Reale, Valentina Castellani, Serenella Sala

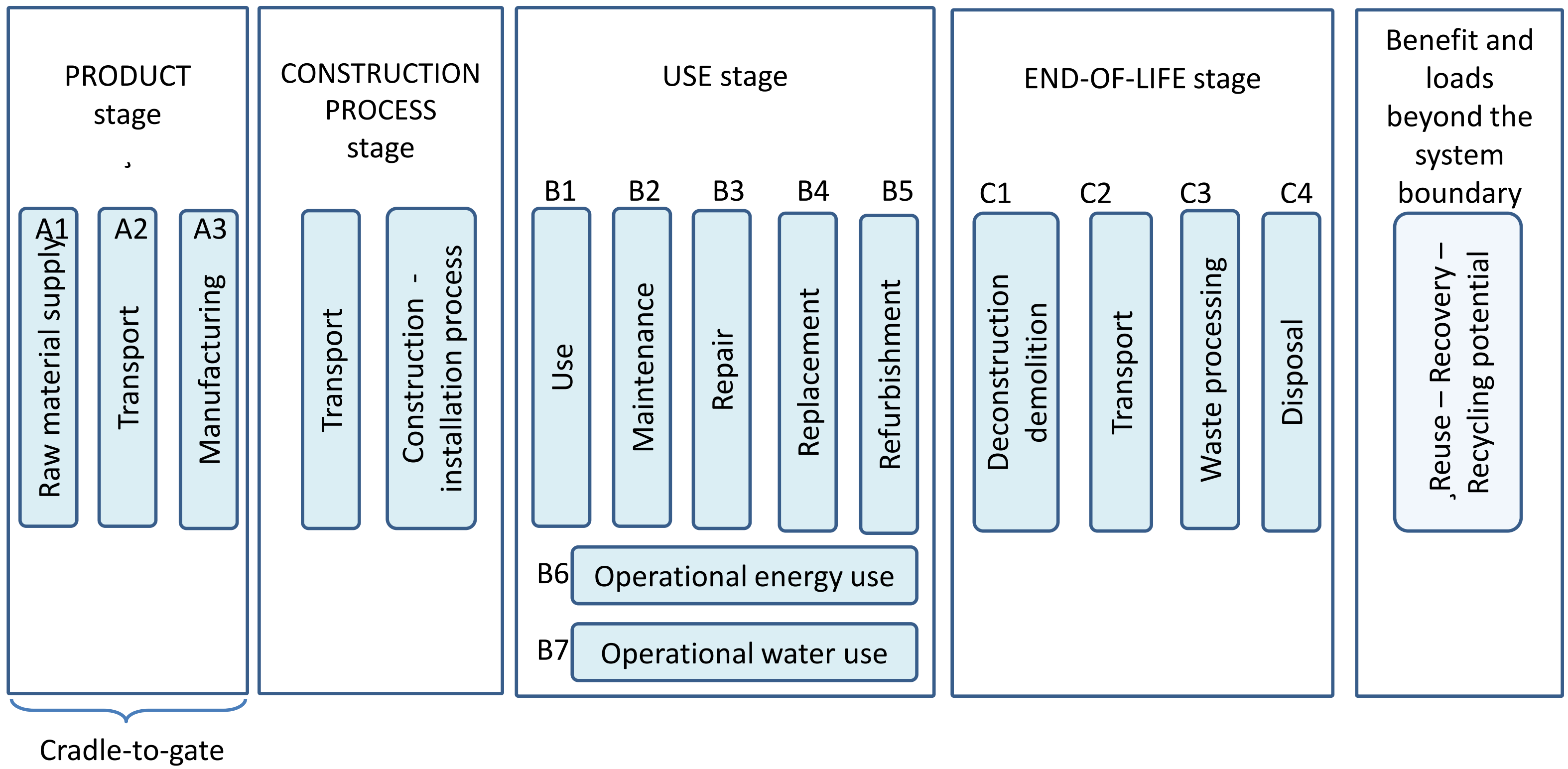
2017

Data – building the life cycle inventory

Example of data collection

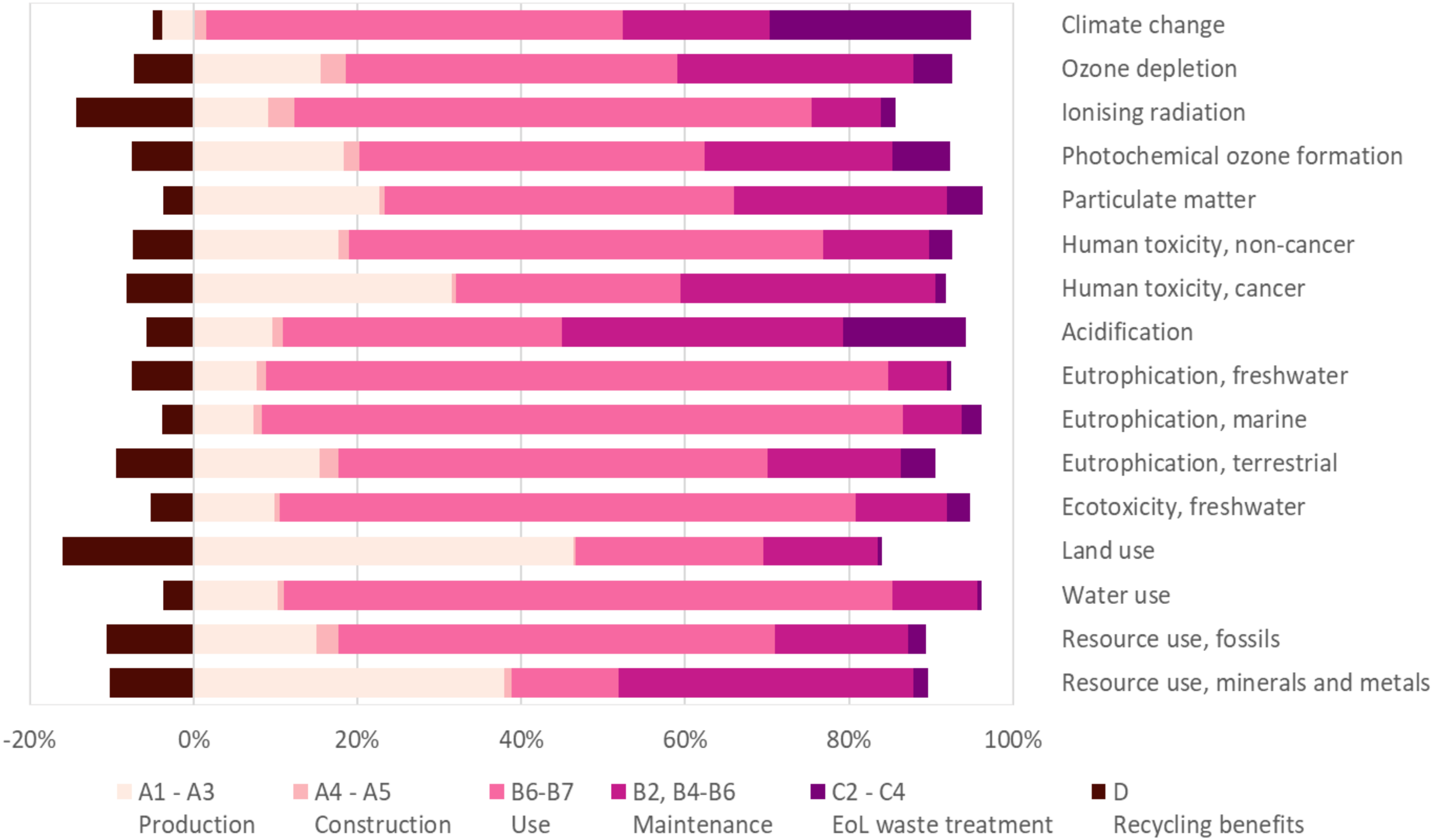
W3 - inner walls:	**Quantity**	**Unit**	**Volume [m³]**	**Density [kg/m3]**	**Mass [kg]**
gypsum plasterboards - 1,25 cm*2 = 2,5 cm	92.54	m^2	2.313	900	2082.1
load bearing construction profiles - 6/10 cm - 10 cm	1.85	m^3	1.851	420	777.3
stone wool (between wooden construction) - 10 cm	9.25	m^3	9.254	30	277.6
gypsum plasterboards- 1,25 cm*2 = 2,5 cm	92.54	m^2	2.313	900	2082.1

System boundary according to EN 15804



Example 1: A house - Results

Characterised results – EN15804 A2 & EF 3.0



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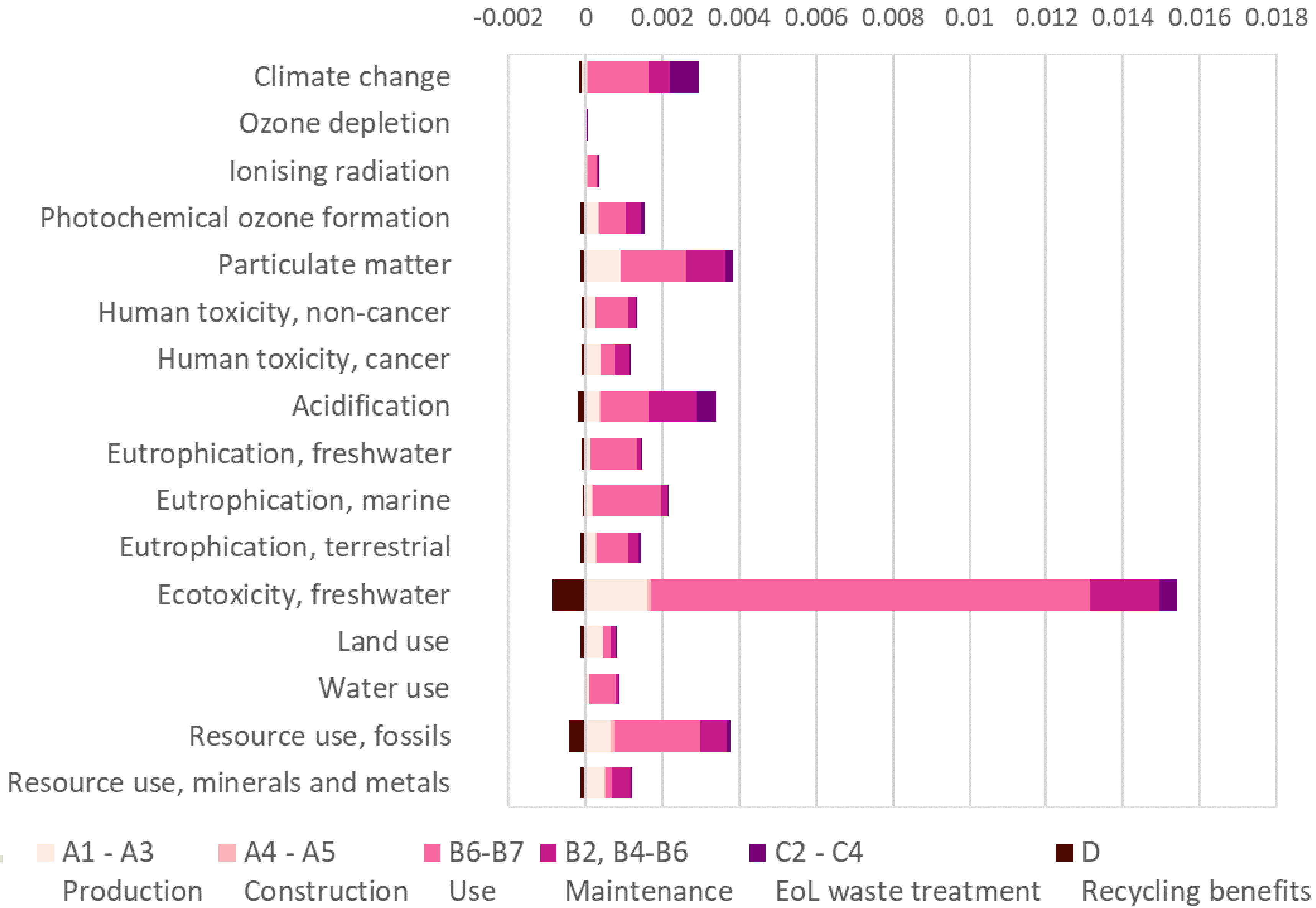
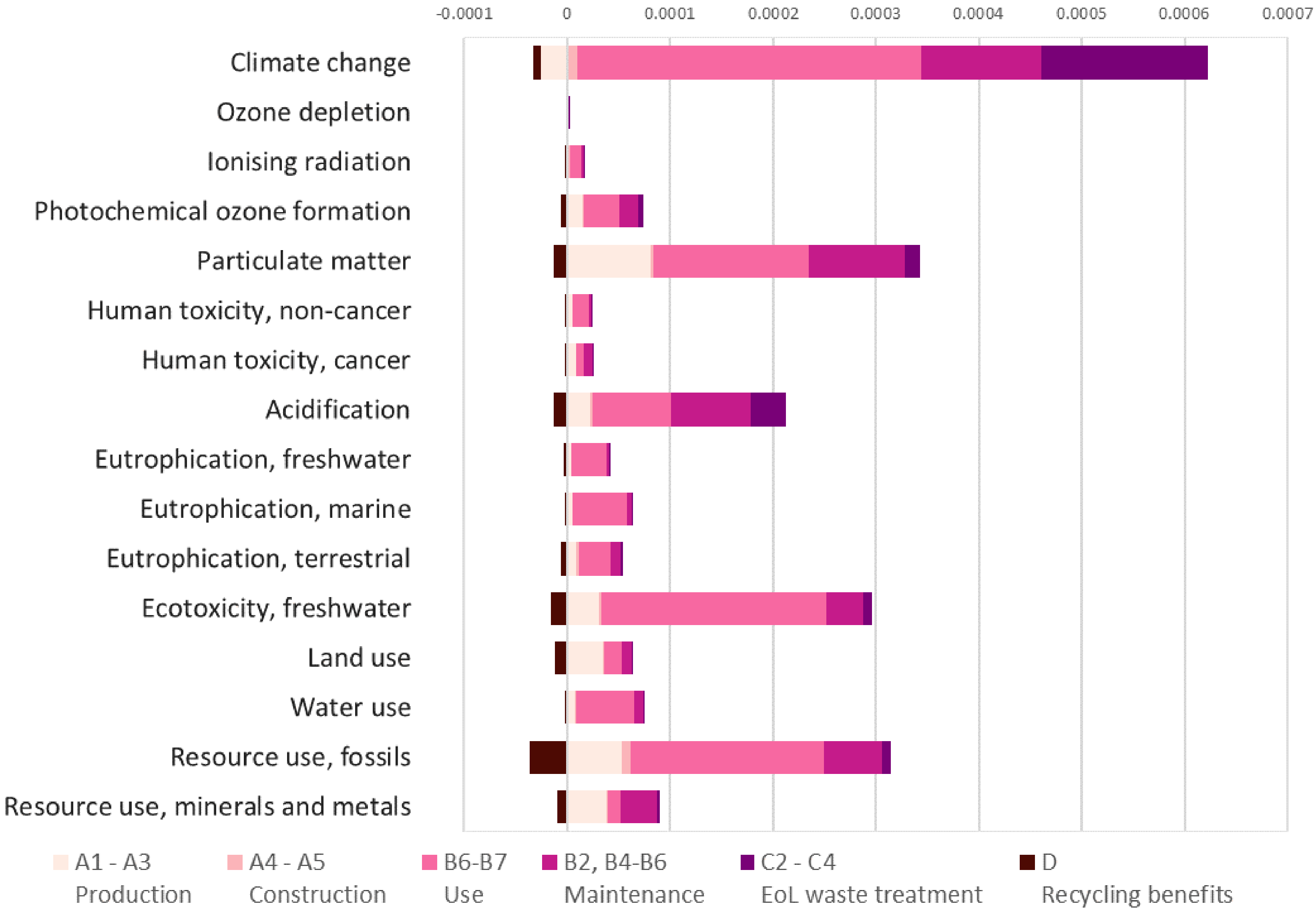
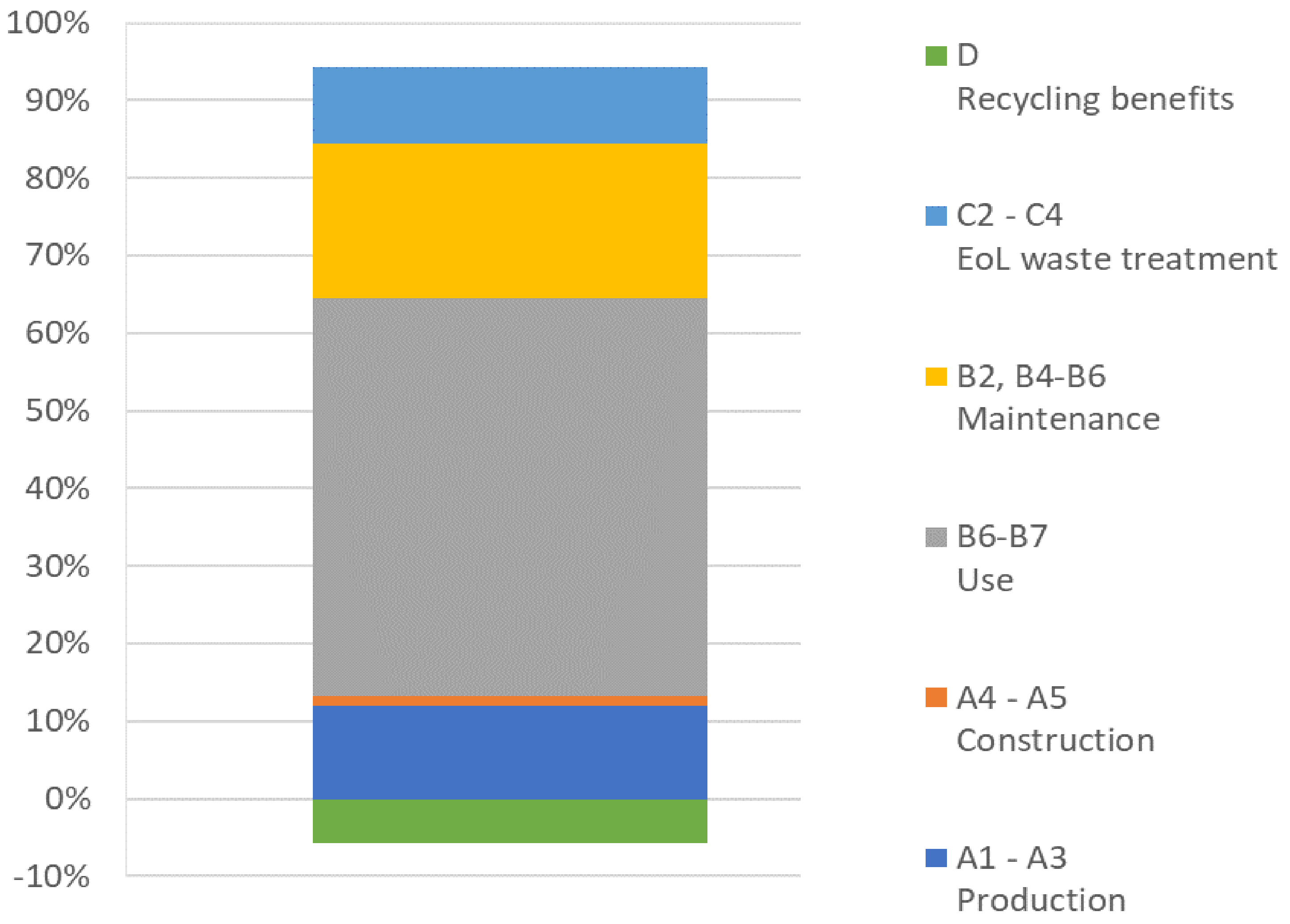
Normalised results – Global 2010



Weighted results – EN15804A2/EF 3.0



Weighted results

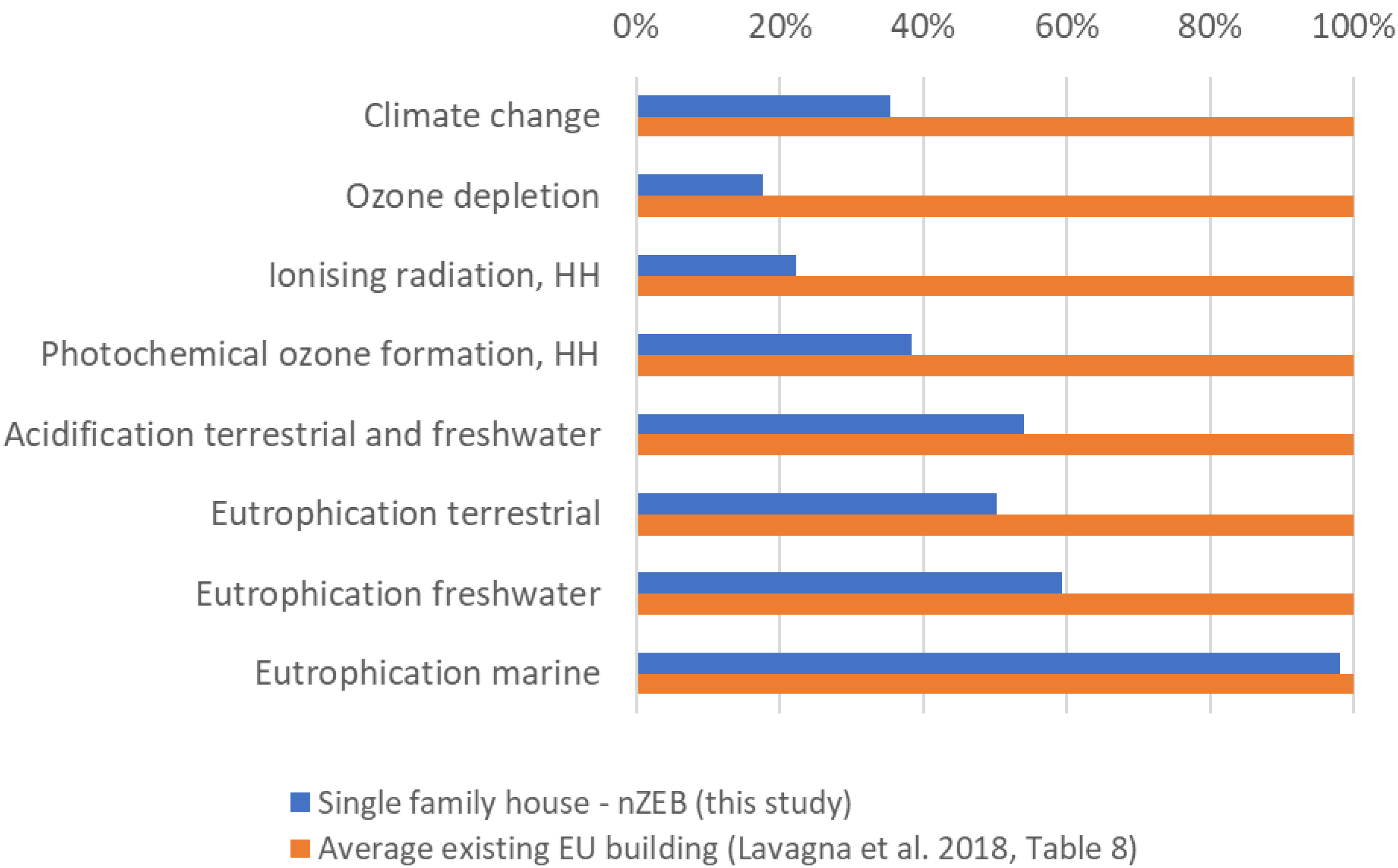


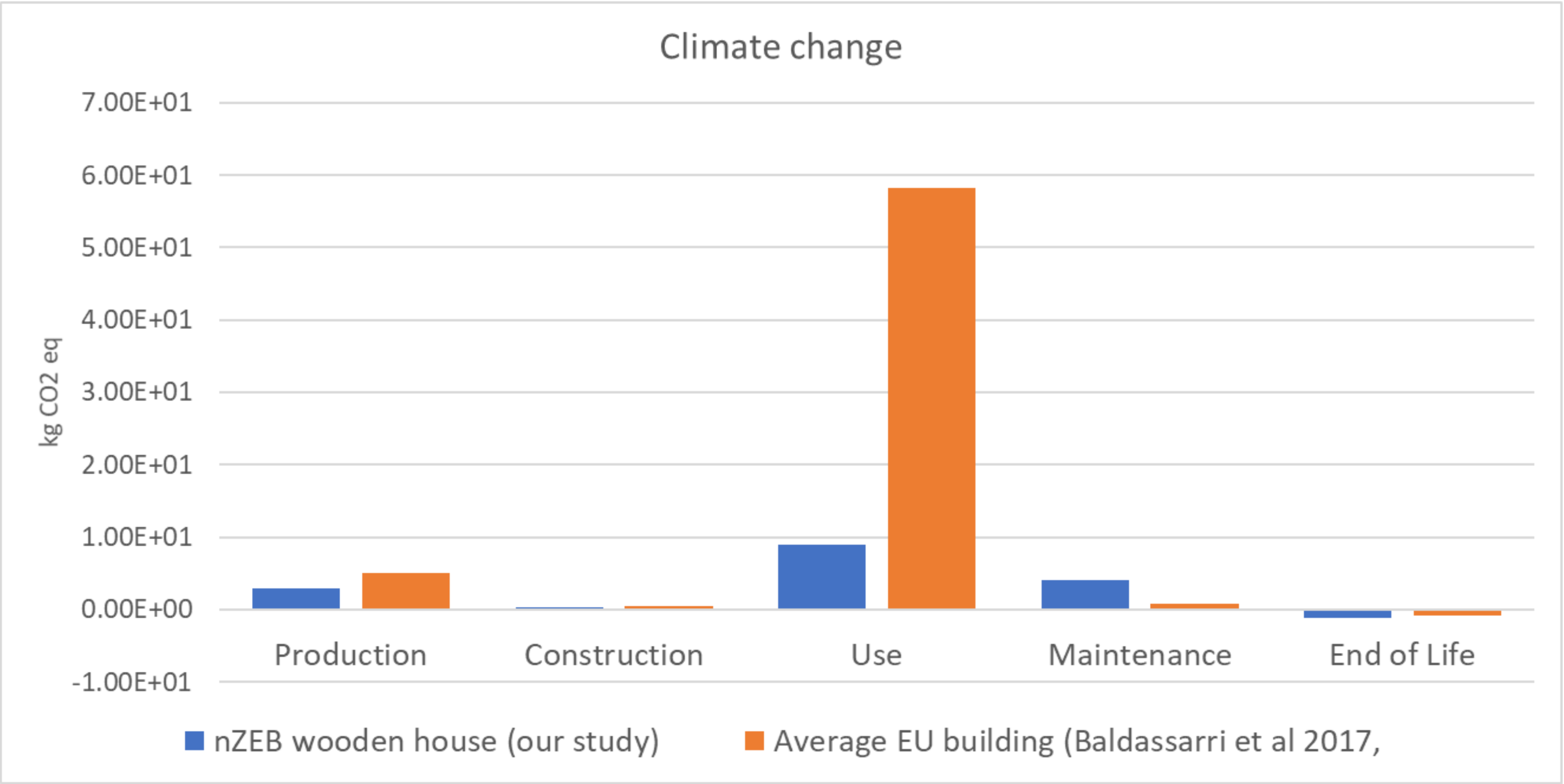
LCA results of the nZEB building

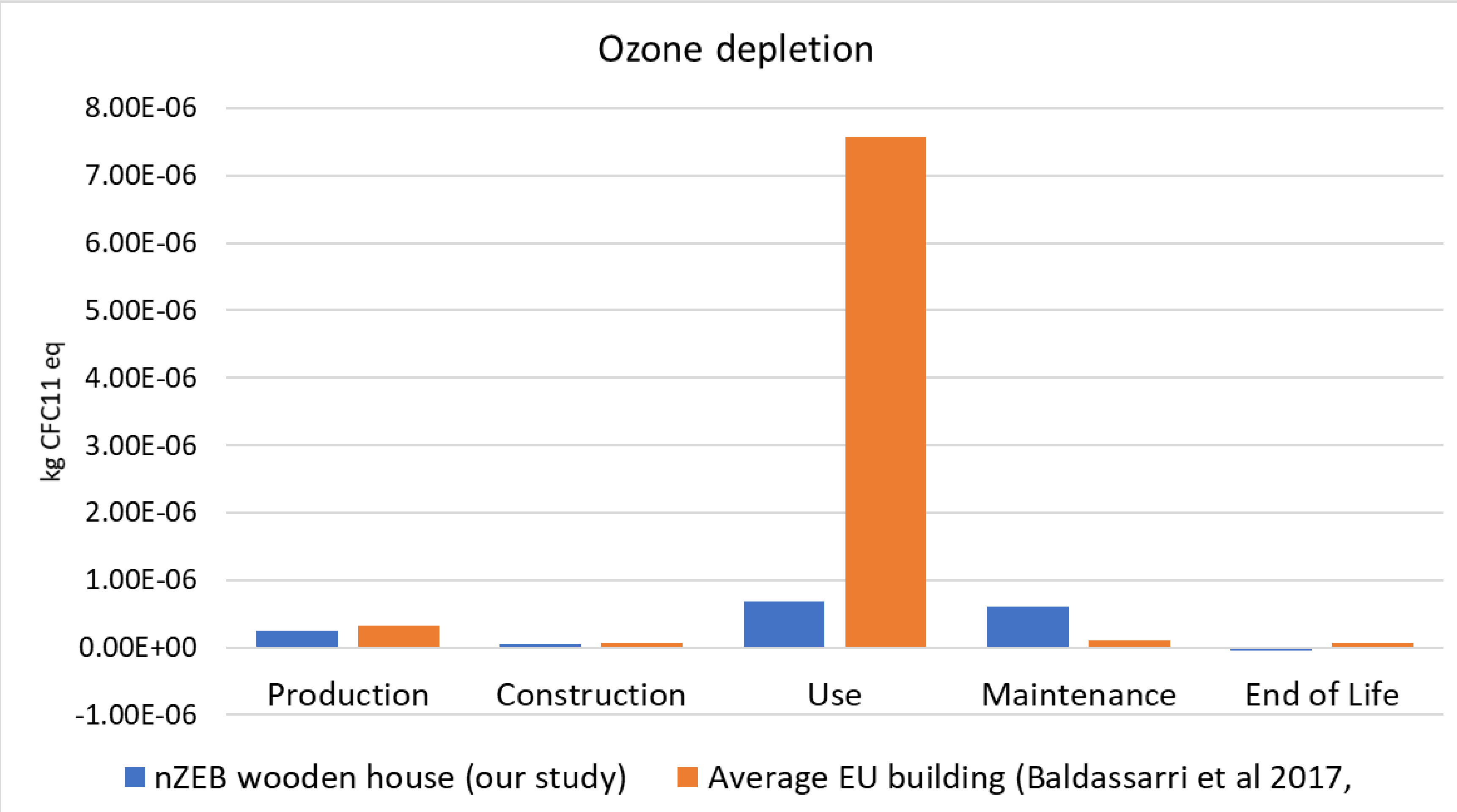
- The reference building fulfils the nearly-zero energy building requirement in all European countries, except Denmark. Better insulation or energy harvesting (e.g. solar roof) might be required here.
- The energy use for heating and water is still the main contributor, but it has been considerably reduced with the new reference wooden building design.
- Maintenance contributes more than module A (Production A1-A3 and Construction/Installation A4-A5) over 100 years.
- Our single family house nZEB-design represents a considerable (≈ 50 %) reduction compared to an average existing EU building in most impact categories investigated.

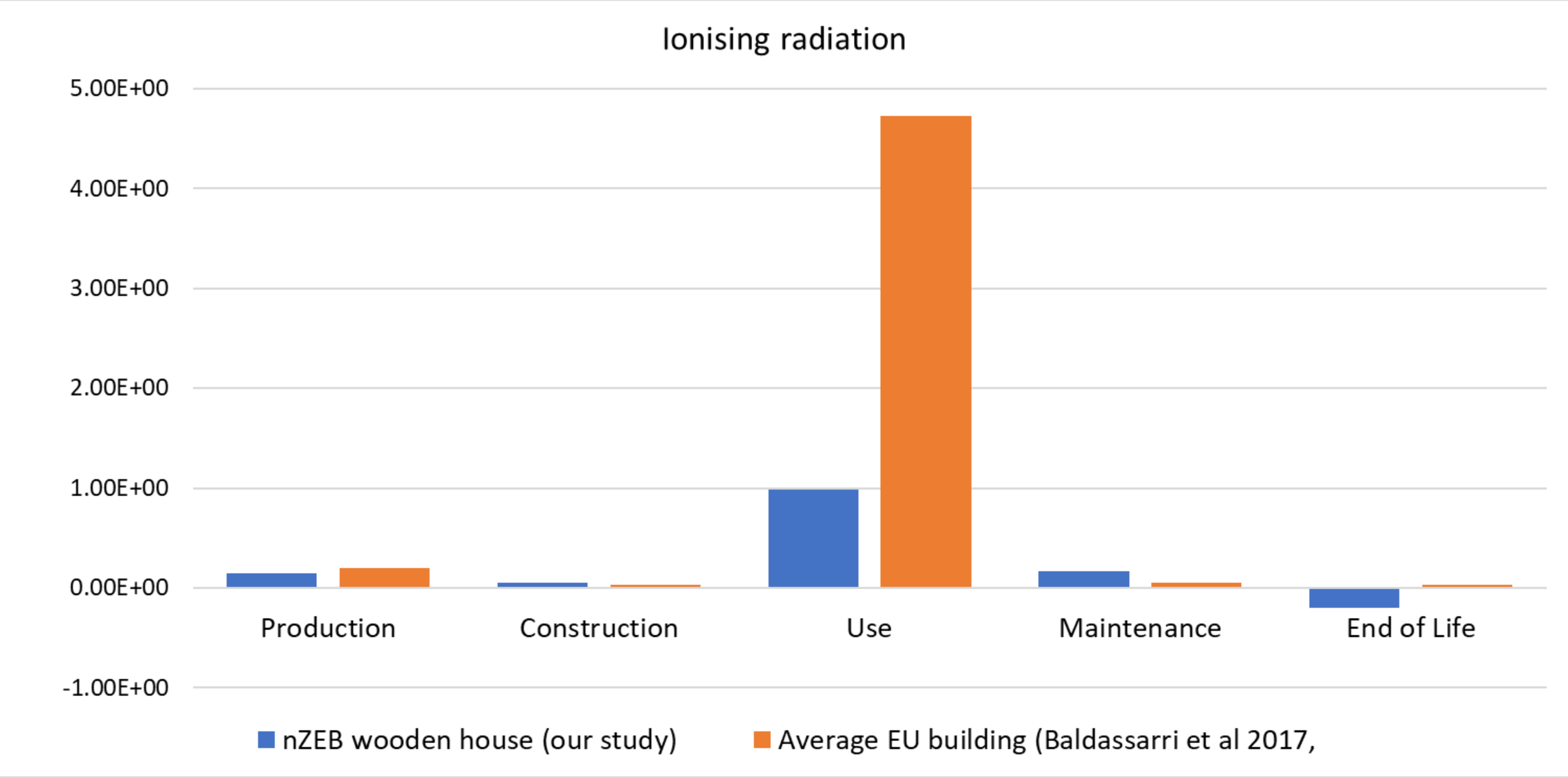
Comparison

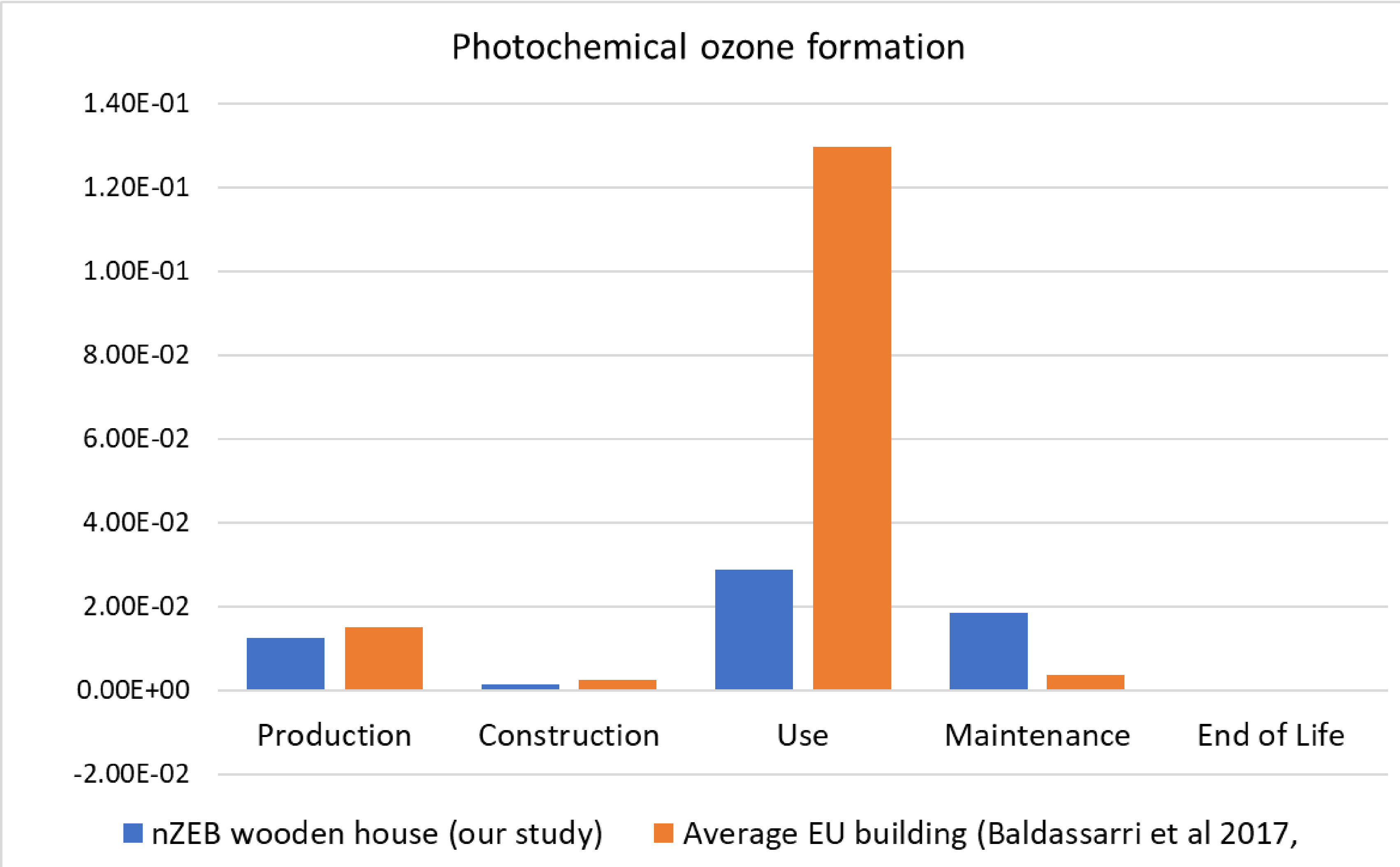
Our wooden single family house nZEB vs. average existing EU residential building

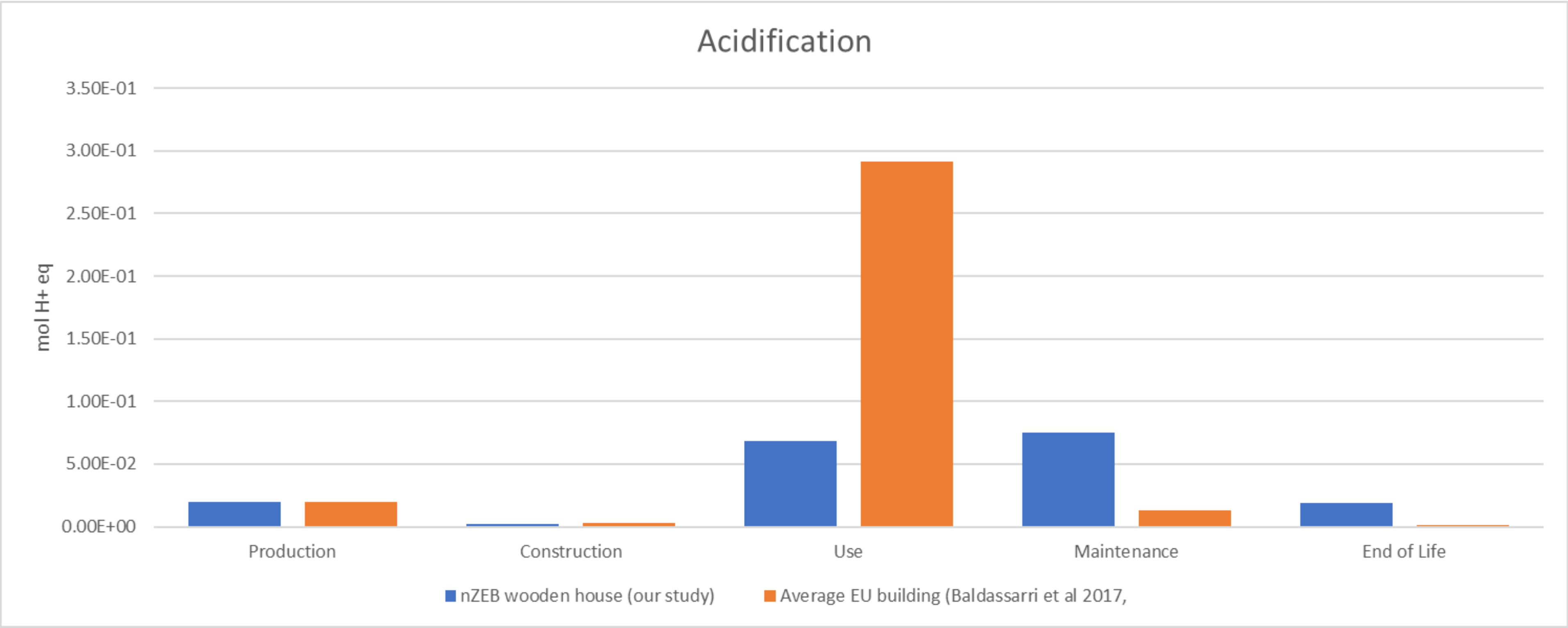


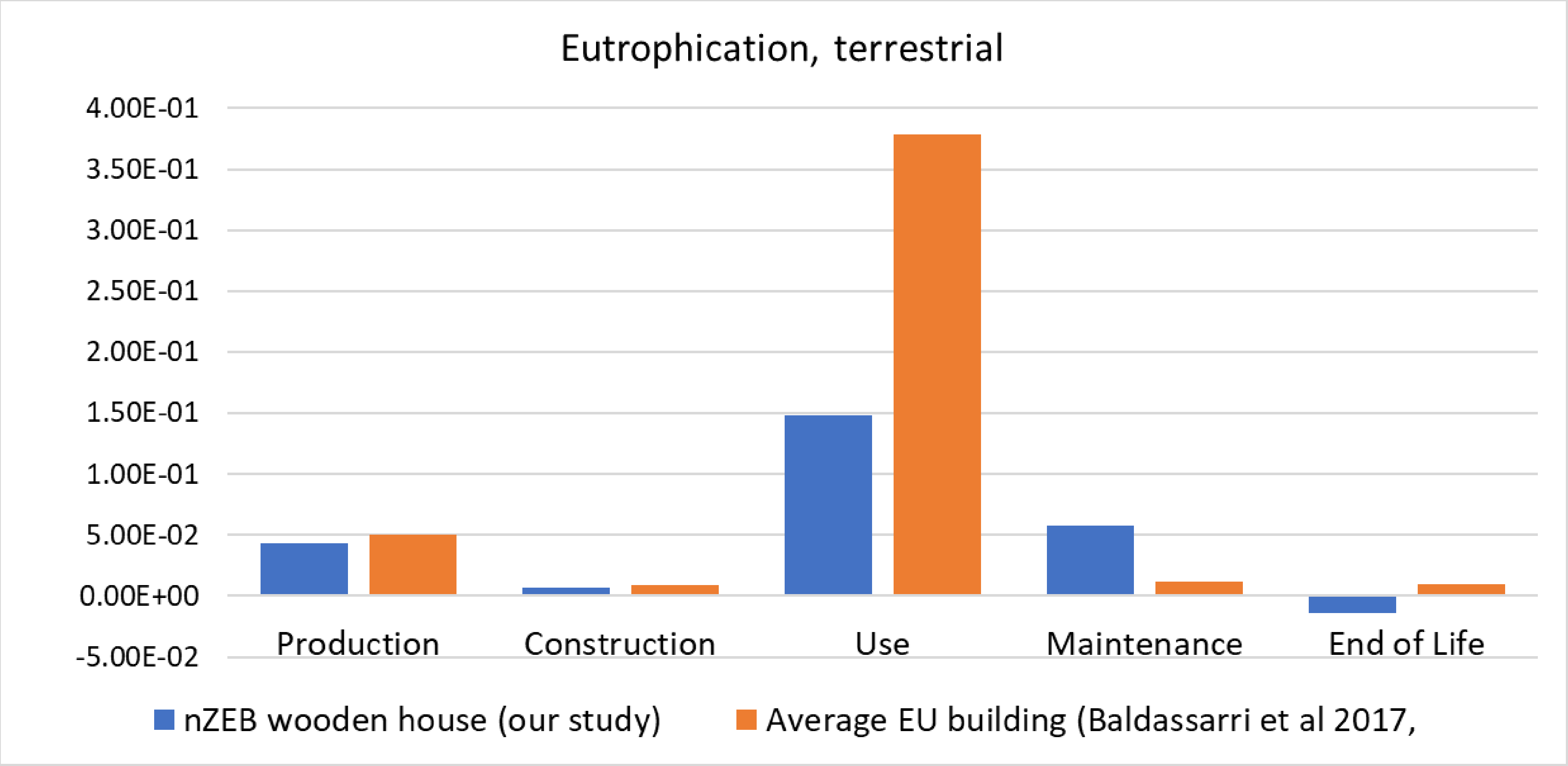

Climate change
7.00E+01
6.00E+01
5.00E+01
4.00E+01
3.00E+01
2.00E+01
1.00E+01
0.00E+00
-1.00E+01
kg CO2 eq
Production
Construction
Use
Maintenance
End of Life
nZEB wooden house (our study)
Average EU building (Baldassarri et al 2017,

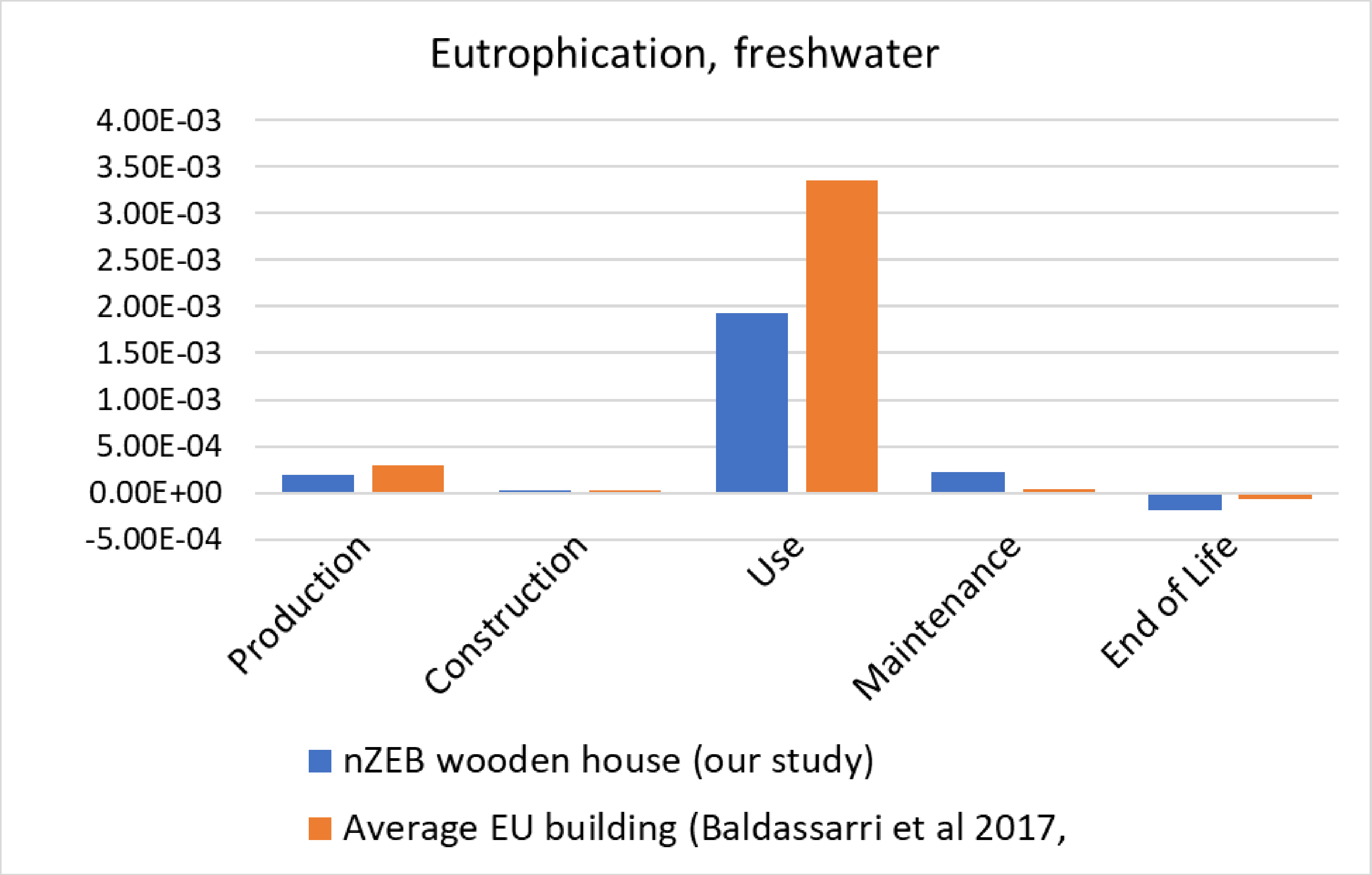

Ozone depletion
kg CFC11 eq
8.00E-06
7.00E-06
6.00E-06
5.00E-06
4.00E-06
3.00E-06
2.00E-06
1.00E-06
0.00E+00
-1.00E-06
Production
Construction
Use
Maintenance
End of Life
nZEB wooden house (our study)
Average EU building (Baldassarri et al 2017,

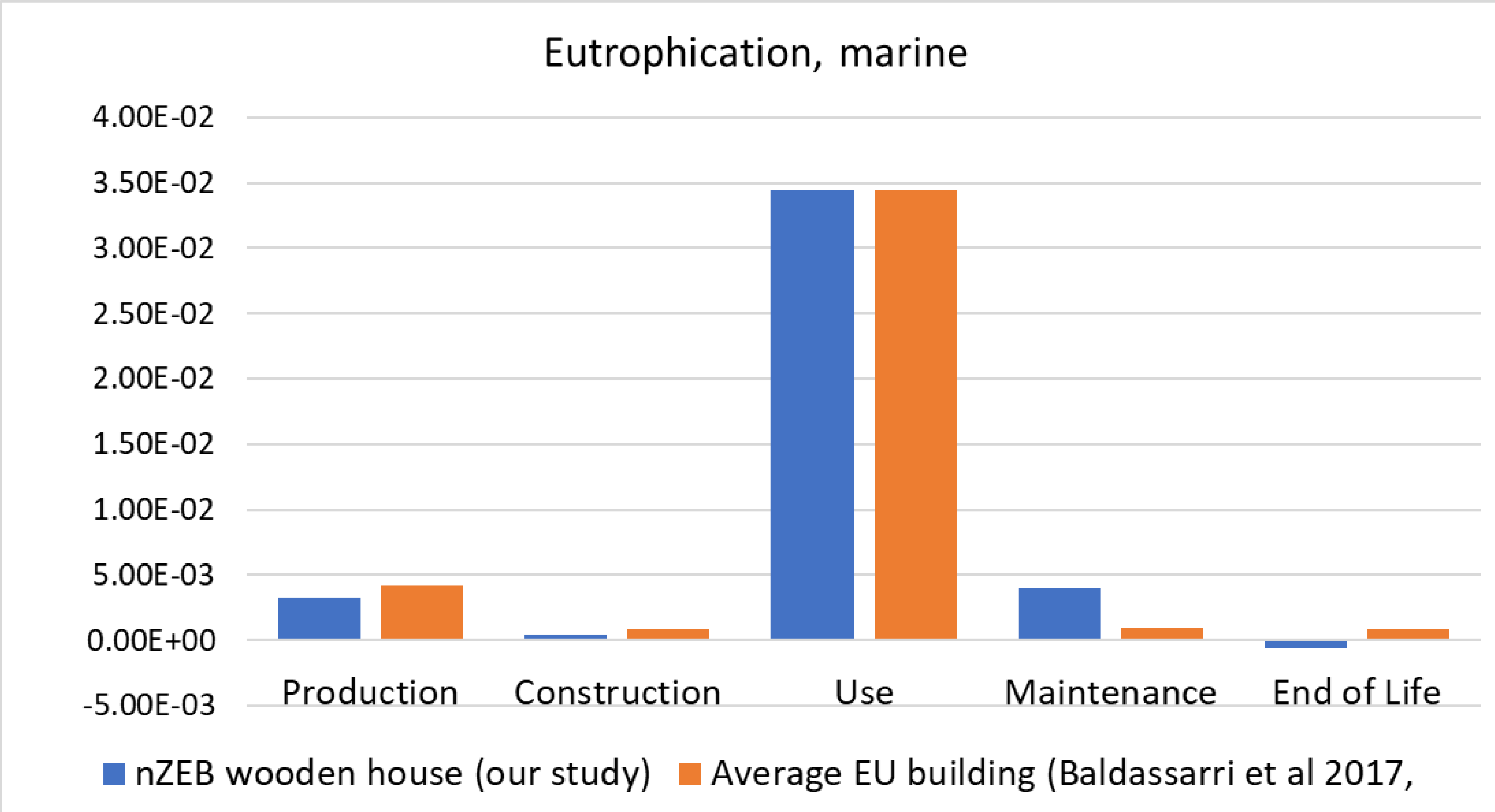

Ionising radiation
5.00E+00
4.00E+00
3.00E+00
2.00E+00
1.00E+00
0.00E+00
-1.00E+00
Production
Construction
Use
Maintenance
End of Life
nZEB wooden house (our study)
Average EU building (Baldassarri et al 2017,

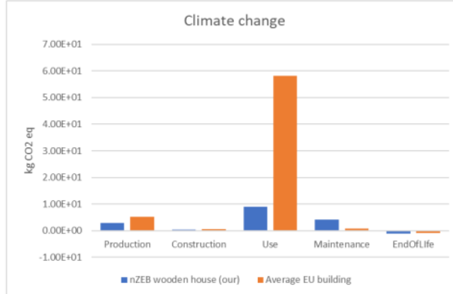

Photochemical ozone formation
1.40E-01
1.20E-01
1.00E-01
8.00E-02
6.00E-02
4.00E-02
2.00E-02
0.00E+00
-2.00E-02
Production
Construction
Use
Maintenance
End of Life
nZEB wooden house (our study)
Average EU building (Baldassarri et al 2017,

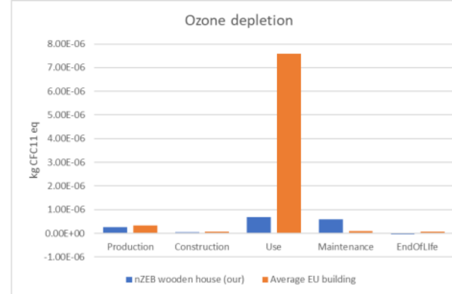

Acidification
mol H+ eq
3.50E-01
3.00E-01
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
Production
Construction
Use
Maintenance
End of Life
nZEB wooden house (our study)
Average EU building (Baldassarri et al 2017,

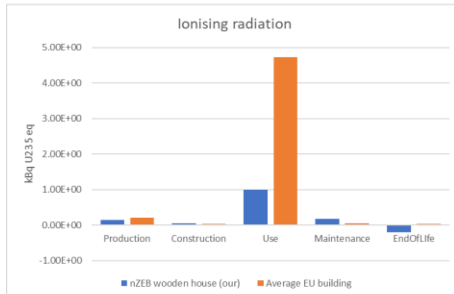

Eutrophication, terrestrial
4.00E-01
3.50E-01
3.00E-01
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
-5.00E-02
Production
Construction
Use
Maintenance
End of Life
nZEB wooden house (our study)
Average EU building (Baldassarri et al 2017,

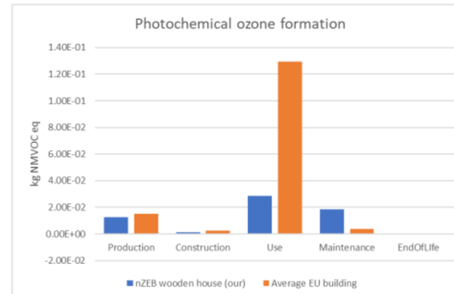

Eutrophication, freshwater
4.00E-03
3.50E-03
3.00E-03
2.50E-03
2.00E-03
1.50E-03
1.00E-03
5.00E-04
0.00E+00
-5.00E-04
Production
Construction
Use
Maintenance
End of Life
nZEB wooden house (our study)
Average EU building (Baldassarri et al 2017,

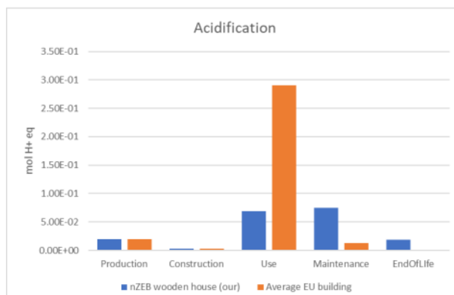

Eutrophication, marine
4.00E-02
3.50E-02
3.00E-02
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
-5.00E-03
Production
Construction
Use
Maintenance
End of Life
nZEB wooden house (our study)
Average EU building (Baldassarri et al 2017,

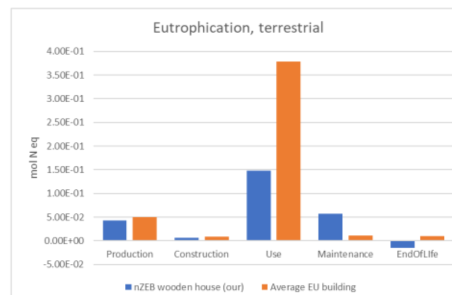

Climate change
kg CO2 eq
7.00E+01
6.00E+01
5.00E+01
4.00E+01
3.00E+01
2.00E+01
1.00E+01
0.00E+00
-1.00E+01
Production
Construction
Use
Maintenance
EndOfLIfe
nZEB wooden house (our)
Average EU building

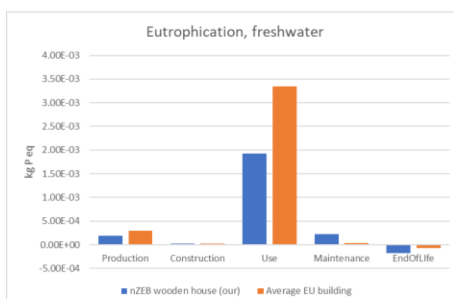

Ozone depletion
kg CFC11 eq
8.00E-06
7.00E-06
6.00E-06
5.00E-06
4.00E-06
3.00E-06
2.00E-06
1.00E-06
0.00E+00
-1.00E-06
Production
Construction
Use
Maintenance
EndOfLIfe
nZEB wooden house (our)
Average EU building

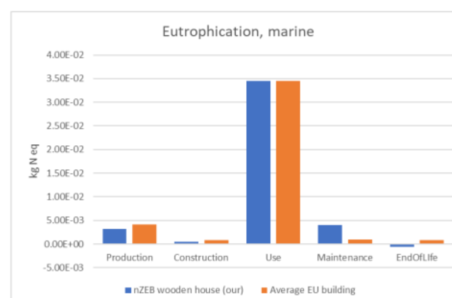

Ionising radiation
kBq U235 eq
5.00E+00
4.00E+00
3.00E+00
2.00E+00
1.00E+00
0.00E+00
-1.00E+00
Production
Construction
Use
Maintenance
EndOfLIfe
nZEB wooden house (our)
Average EU building


Photochemical ozone formation
kg NMVOC eq
1.40E-01
1.20E-01
1.00E-01
8.00E-02
6.00E-02
4.00E-02
2.00E-02
0.00E+00
-2.00E-02
Production
Construction
Use
Maintenance
EndOfLIfe
nZEB wooden house (our)
Average EU building

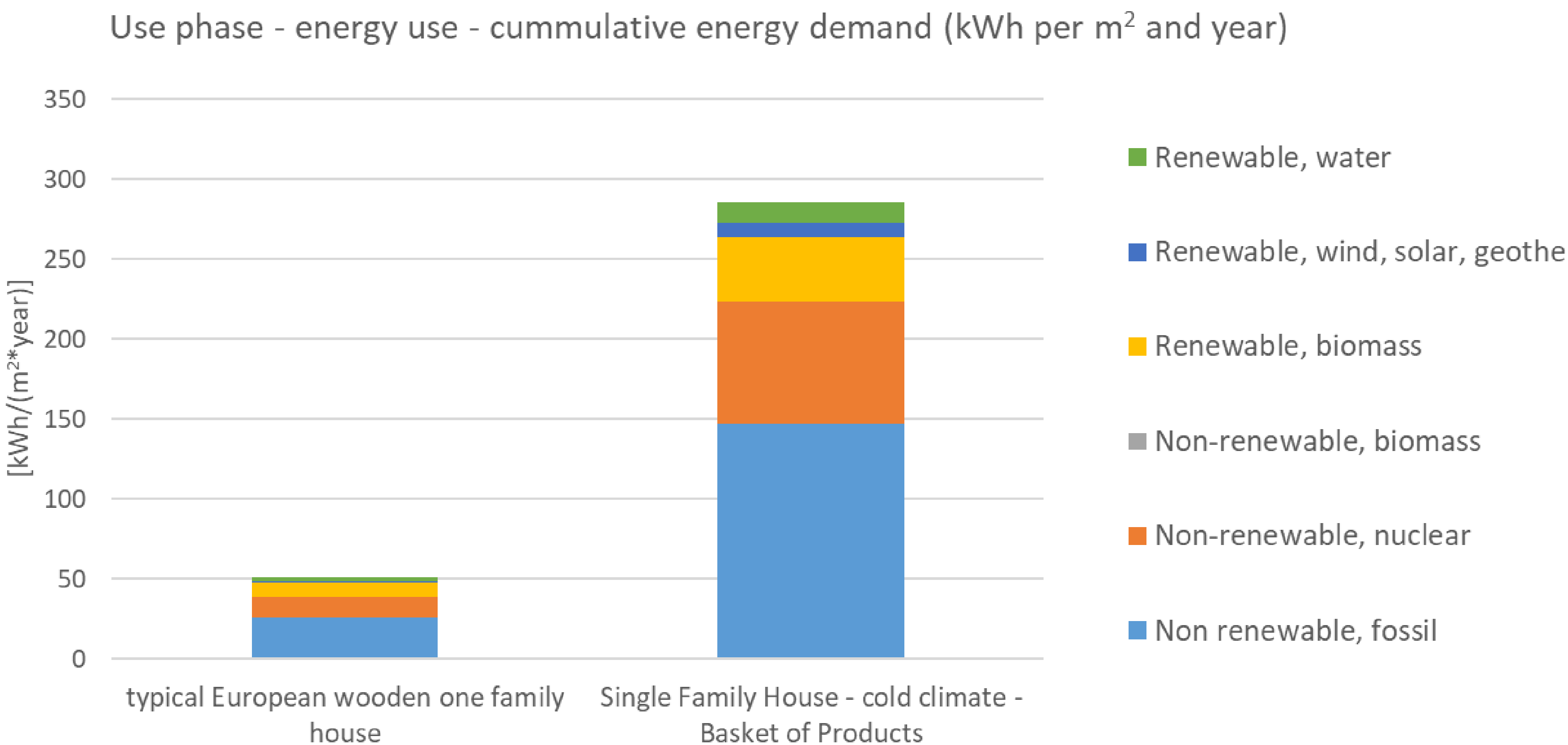

Acidification
mol H+ eq
3.50E-01
3.00E-01
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
Production
Construction
Use
Maintenance
EndOfLIfe
nZEB wooden house (our)
Average EU building


Eutrophication, terrestrial
mol N eq
4.00E-01
3.50E-01
3.00E-01
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
-5.00E-02
Production
Construction
Use
Maintenance
EndOfLIfe
nZEB wooden house (our)
Average EU building


Eutrophication, freshwater
kg P eq
4.00E-03
3.50E-03
3.00E-03
2.50E-03
2.00E-03
1.50E-03
1.00E-03
5.00E-04
0.00E+00
-5.00E-04
Production
Construction
Use
Maintenance
EndOfLIfe
nZEB wooden house (our)
Average EU building


Eutrophication, marine
kg N eq
4.00E-02
3.50E-02
3.00E-02
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
-5.00E-03
Production
Construction
Use
Maintenance
EndOfLIfe
nZEB wooden house (our)
Average EU building

Comparison, use stage – Energy use



(our study)

(Lavagna et al. 2018)

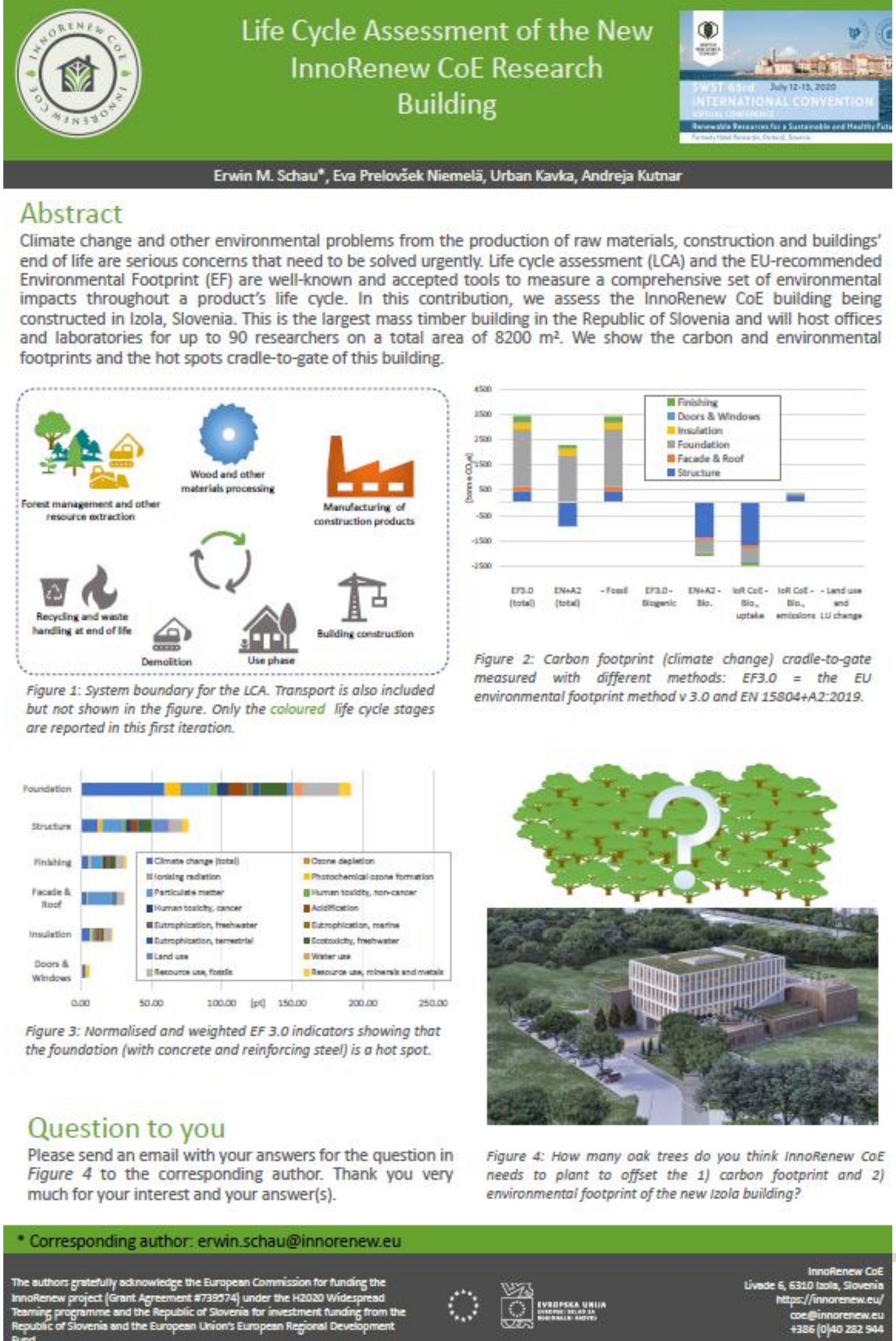
What could be the research question?

What could be the research question?

- How to improve the communication of LCA results of wooden single family houses?
- What is the average impact of a wooden single family house in Europe?
- How to improve the life cycle environmental impact of housing in Europe?

Example 2: LCA of the InnoRenew CoE building

- Goal
  - Assess how many trees InnoRenew CoE needs to plant to offset the environmental impact of the new research building in Izola, Slovenia
  - Assess environmental life cycle impact of the different building components
  - Find environmental hotspots



www.innorenew.eu

Life cycle assessment (LCA) of the new InnoRenew CoE research building

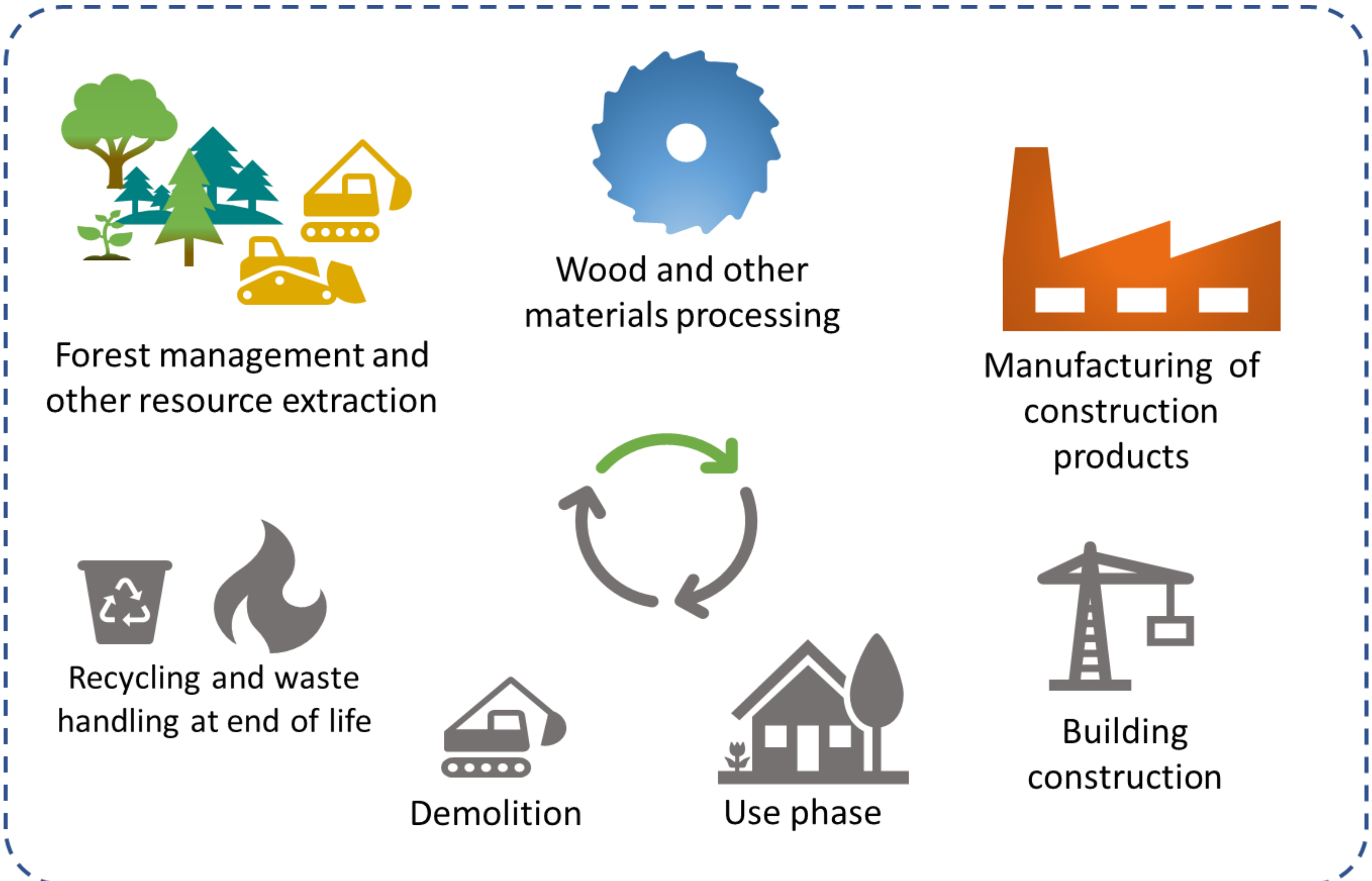
- 90 researchers
- Total area of 8200 m^2

- Foundation (garage, ground floor) of (reinforced) concrete
- Green roof and glass
- Rest of building mainly wood

- Poster:
  Schau EM, Prelovšek Niemelä E, Kavka U, & Kutnar A (2020) *Life Cycle Assessment of the New InnoRenew CoE Research Building* (LeVan-Green S, Ed) *Society of Wood Science and Technology (SWST) 63rd International Convention*. Porterož, Slovenia

The new InnoRenew CoE building in Izola (Slovenia)

System boundaries – cradle to gate

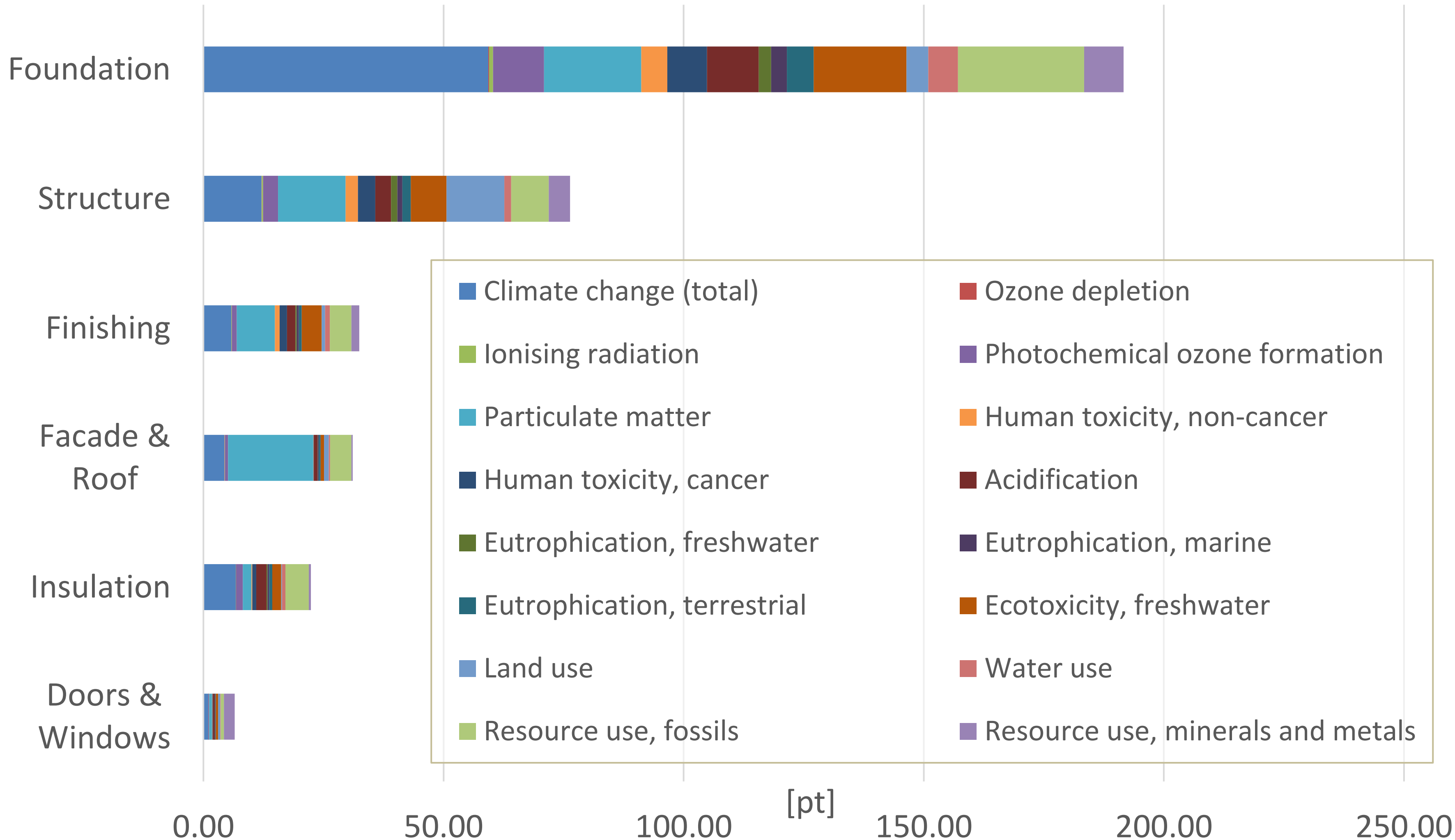


Example 2: InnoRenew CoE building – Methods and data

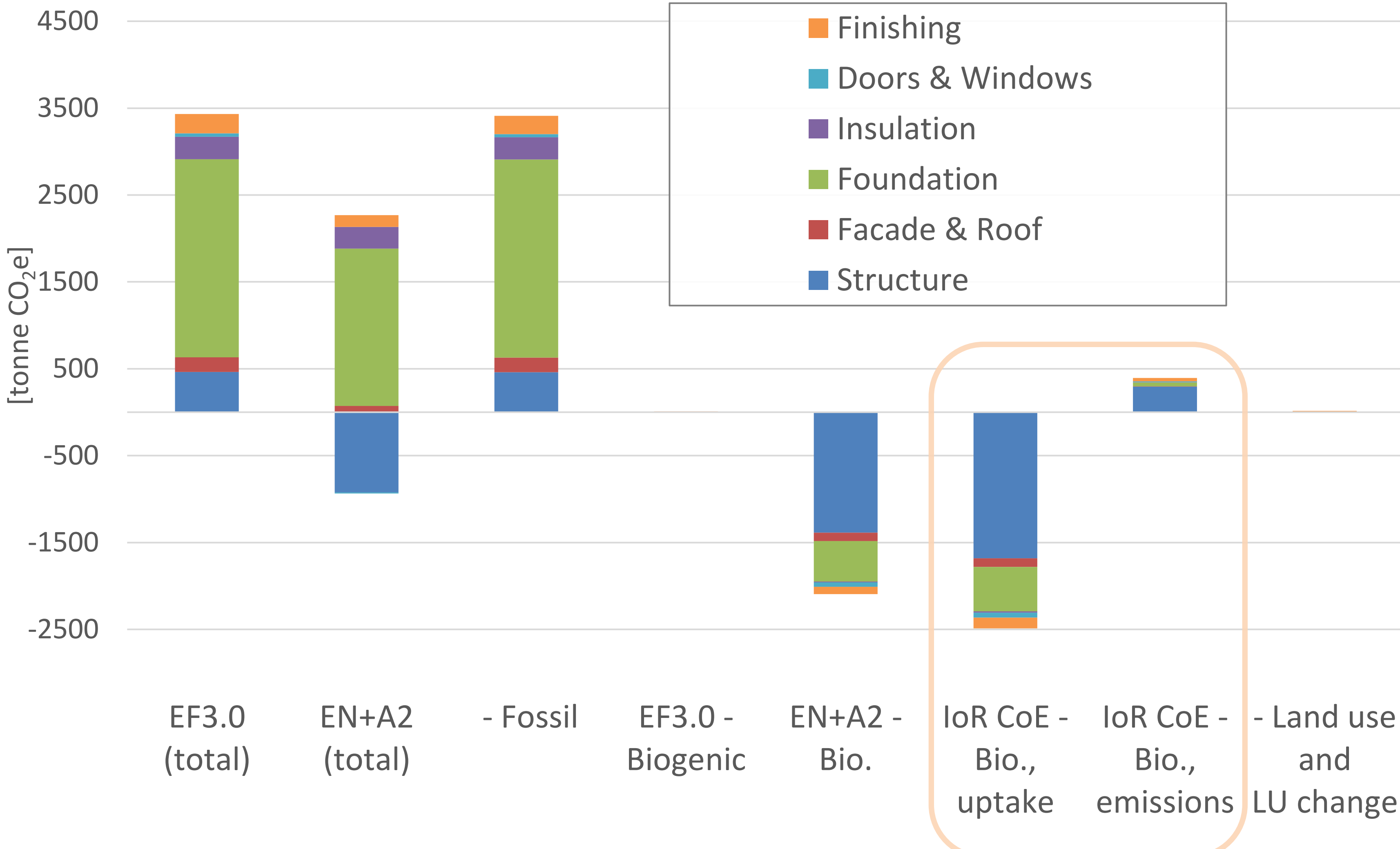
- Data
  - Starting point: Material list from the procurement documents
  - EcoInvent database
- Method
  - Screening LCA / cradle-to-gate (so far)

Example 2: InnoRenew CoE building – Results

Results - *Normalised and weighted EF 3.0 indicators*



Carbon footprint of the new InnoRenew CoE building

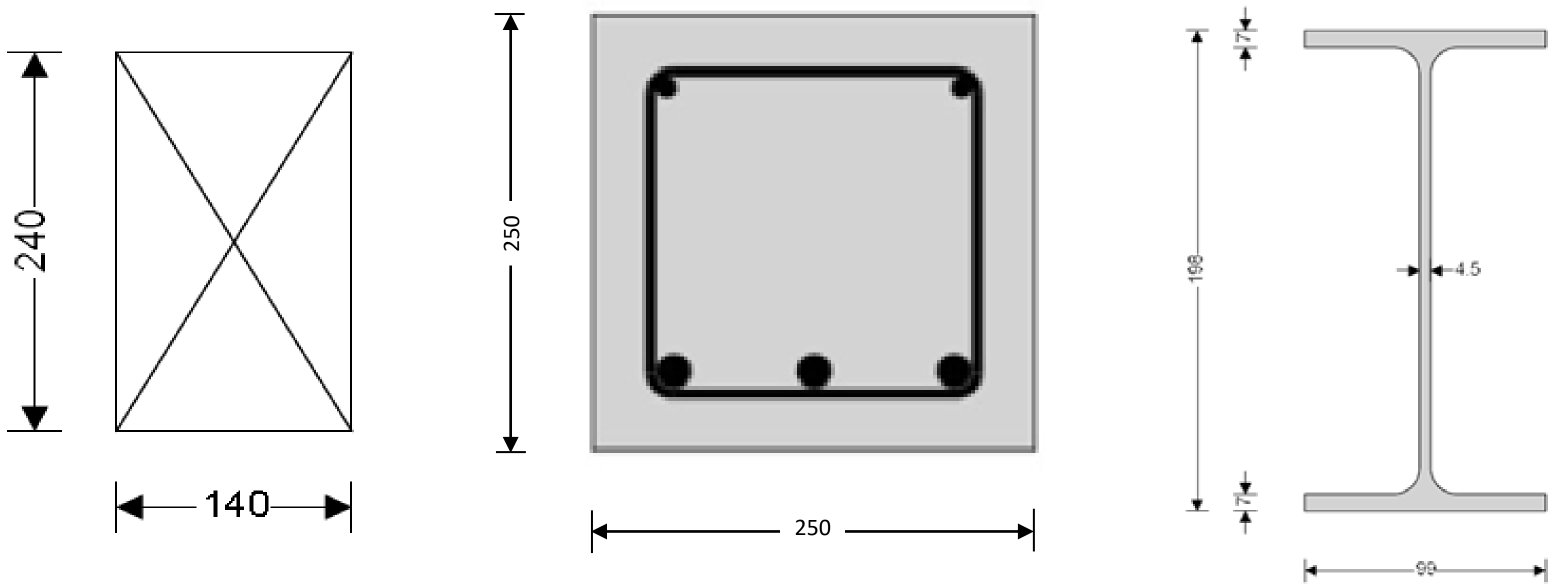


What could be the research question?

What could be the research question?

- How to improve the communication of LCA results of buildings?
- What is the environmental impact of the new InnoRenew CoE building in Izola, Slovenia?
- What are the cradle-to-gate hotspots of the new InnoRenew CoE building in Izola, Slovenia?

Example 3: Environmental comparison of building materials



Wood   Reinforced concrete   Steel

Adapted from Lu & al, 2017

Example 3: Goal

- Compare the life cycle environmental impacts of wood to concrete and steel in buildings.

Example 3: Method and data

- Data: Slovenian data where available, elsewhere generic data from EcoInvent
- Method: ISO 14040/44 LCA and EN 15804(2013)

Example 3: Results

- Only preliminary results for now
  - The functional unit is essential

- In general, I would say it depends on
  - Life cycles taken into account
  - End of life scenario
  - Timing of emissions (LCA usually do not take time into account)
  - Which impact categories you look at

Research question

Research question

- Under which circumstances is wood/concrete/steel environmentally preferable over steel/wood/concrete?
- Where are the environmental hotspots of wood/concrete/steel compared to steel/wood/concrete?

Summary and outlook

– Other standards, methods and rules for LCA
- Product Category Rules (ISO 14025/EN 15804)
  – Increases data availability for doing LCA of built environment
  – Communication tool
- EU Environmental Footprint (EF) (ILCD & PEFCR/OEFSR)
  – To increase comparability between different studies
  – Communication tool
- Database rules, like ILCD or EcoInvent
  – To ensure data conformity

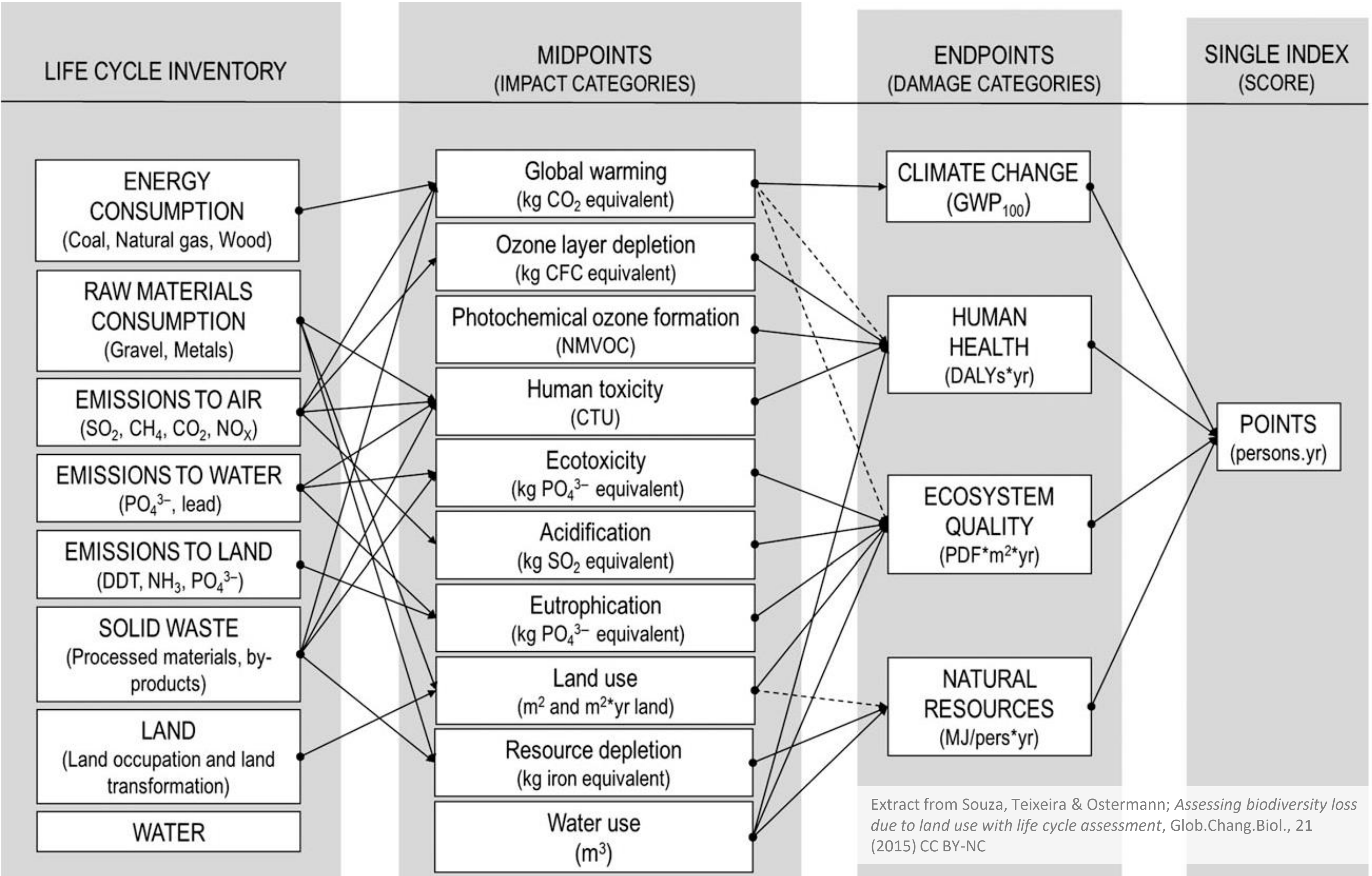
Current interest for LCA in research on building products

- How to simplify/automate and speed up the life cycle assessments of buildings?
- How to make tools available in the design process?
- How to make life cycle data available?

Current interest for LCA in research on wood products

- Environmental impacts of new (treatment) techniques applied on or by applying wood
  - e.g. thermally modified wood
- Environmental impacts on construction parts of wood or whole buildings
- Environmental assessment of wood products compared to other material with same or similar function

Impact assessment methods

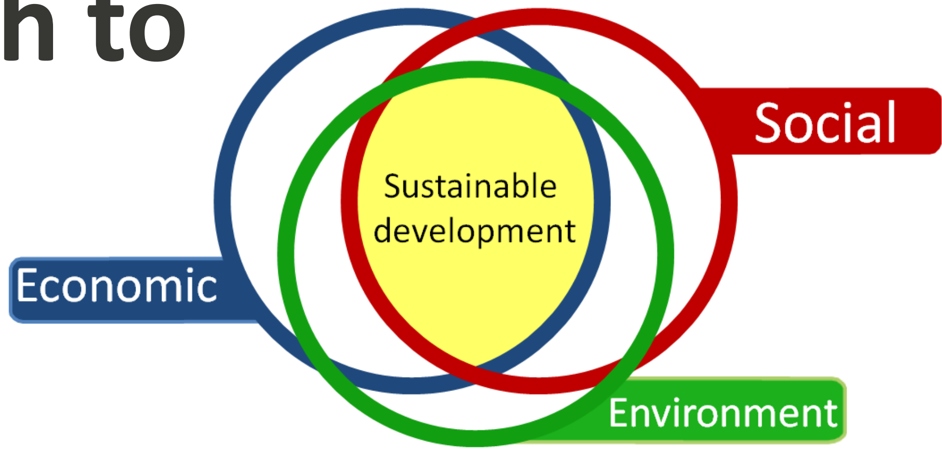


Extract from Souza, Teixeira & Ostermann; *Assessing biodiversity loss due to land use with life cycle assessment*, Glob.Chang.Biol., 21 (2015) CC BY-NC

Current research interest in LCA related to wood

- Impact from tree or forest growth on the climate (usually climate neutrality is used, but not necessarily true)
- Impacts on biotic resources and biodiversity
- Developing more specific product category rules (ISO14025/CEN 350/EU Env Footprint) for various wood products

Life cycle approach to sustainability



- Includes
  - – Social (S-LCA) and
  - – Economic (life cycle costing – LCC)
- In addition to environmental LCA

Based on (Schau et al, 2011)

Thank you for your attention.
I am at your disposal for any question.

Acknowledgments: The author gratefully acknowledge the European Commission for funding the InnoRenew project (Grant Agreement #739574) under the H2020 Widespread-Teaming programme, and the Republic of Slovenia (investment funding from the Republic of Slovenia and the European Union’s European Regional Development Fund).

Further readings

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- ECDC, 2020: COVID-19 situation update worldwide, as of 4 May 2020, Last visited 4 May 2020: https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases
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- Perlman, H and Evans, J 2019. The Water Cycle, in the The USGS Water Science School, USGS Downloaded 10 May 2020 from; https://www.usgs.gov/media/images/water-cycle-natural-water-cycle
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- Schau EM, Russo C, Michalopoulos G, Polo Palomino JA, Pant R (2017). Benchmark and performance classes in the European Environmental Footprint (EF) - Learnings from the Product EF Category Rules (PEFCR) on olive oil, The 8th International Conference on Life Cycle Management (LCM2017), Luxembourg, 4 September 2017 (oral presentation)
- WMO, 2020; Arctic ozone depletion reached record level, News 1 May 2020; World Meteorological organization, downloaded 10 May 2020 from https://public.wmo.int/en/media/news/arctic-ozone-depletion-reached-record-level,