

FUTURE PROOFING CONSTRUCTION

LIFE CYCLE ASSESSMENT OF BUILDINGS AND PRODUCTS

2016-2017

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WHAT ASPECTS OF A BUILDING CAN PRODUCE ENVIRONMENT IMPACT?

IS THE ENVIRONMENT ABLE TO ABSORB IT?

CAN WE MEASURE IT?

HOW CAN WE REDUCE/ELIMINATE IT?



INDEX

1. Thermodynamics. Relationship to building industry
2. Life cycle assessment (LCA)
3. ISO 14040. Methodology for LCA
4. CEN/TC 350. Sustainability of construction Works
5. Environmental Product Declarations (EPD)
6. Case study. Carbon emissions due to timber product imports in the UK

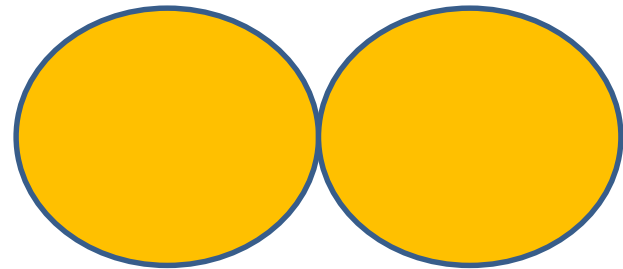
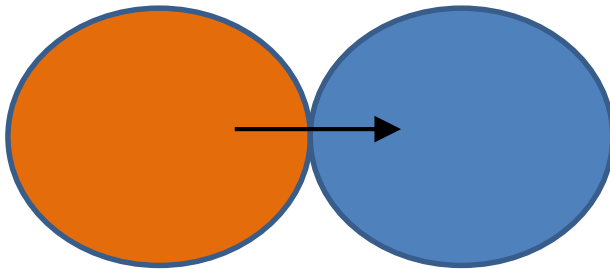


1. THERMODYNAMICS

ZERO LAW

When two bodies with different temperature get in contact, they tend to balance.

The body with the highest temperature gives to the other one until balance





1. THERMODYNAMICS

FIRST LAW

If work is produced or heat exchange is produced over a system , the system will change.

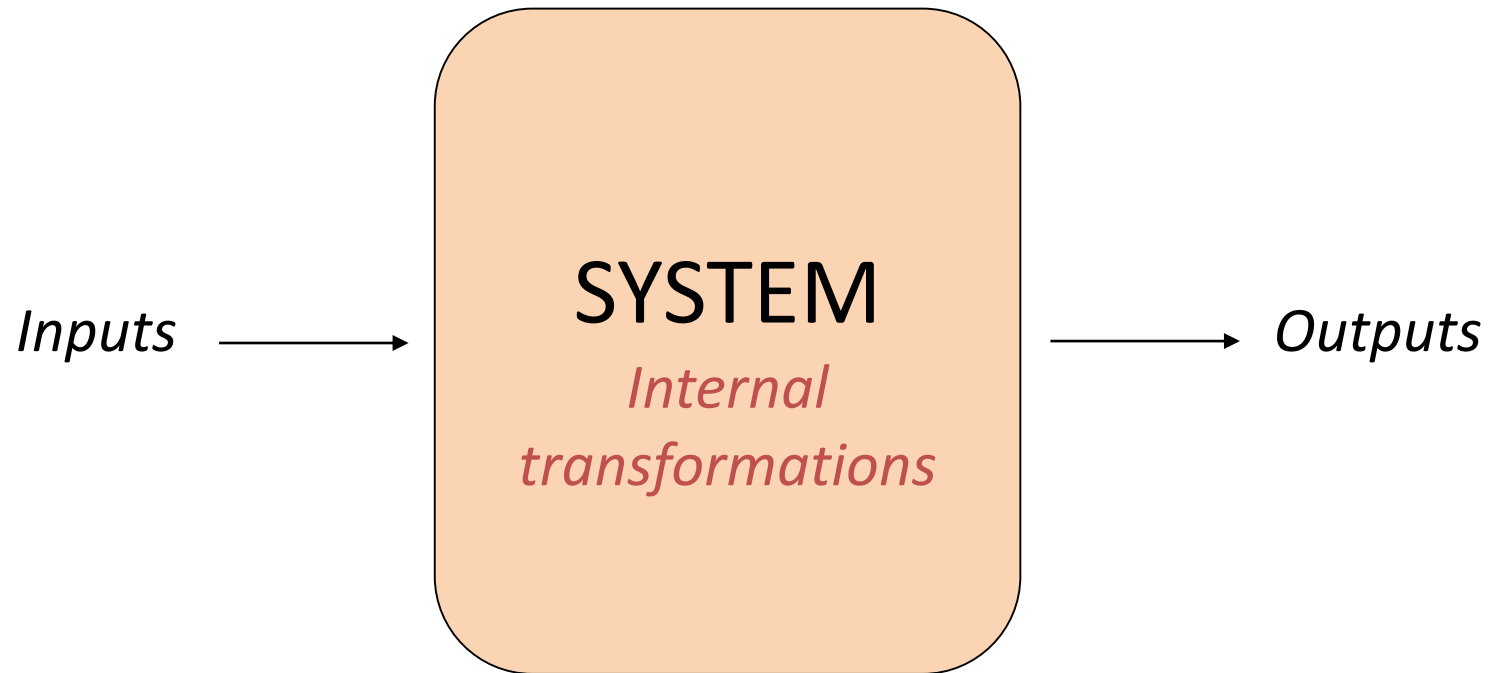
Principle of Energy Conservation

$$E_{in} - E_{out} = \Delta E_{system}$$



1. THERMODYNAMICS

DEFINITION OF A SYSTEM



Not self-sufficient systems

Internal transformations always tend to organise

Always happen with an external support

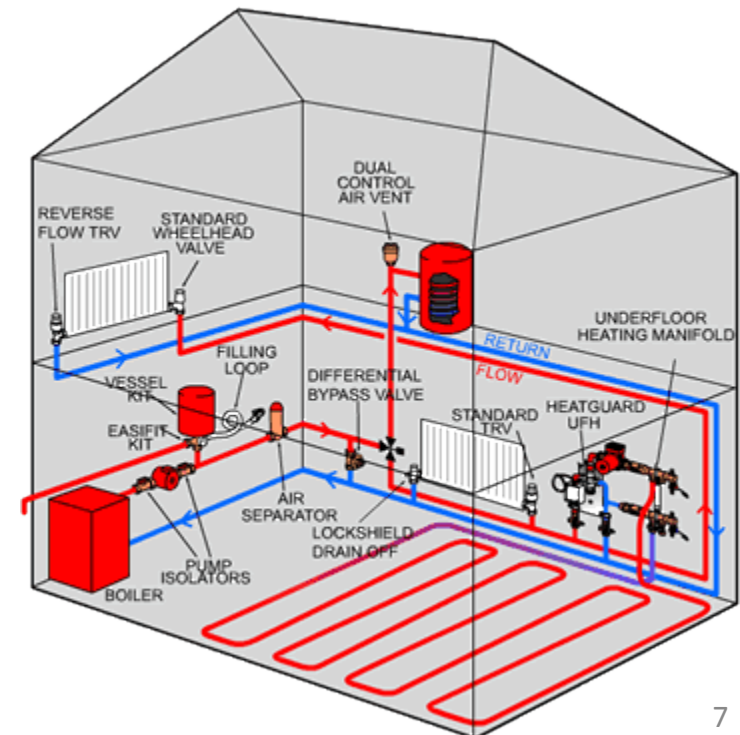


1. THERMODYNAMICS

SECOND LAW: ENTROPY

Efficiency of a system

An efficient system tends towards zero, but never gets it





1. THERMODYNAMICS

EXISTING SYSTEMS

Open systems

Interchange of mass and energy (e.g. a car)

Close systems

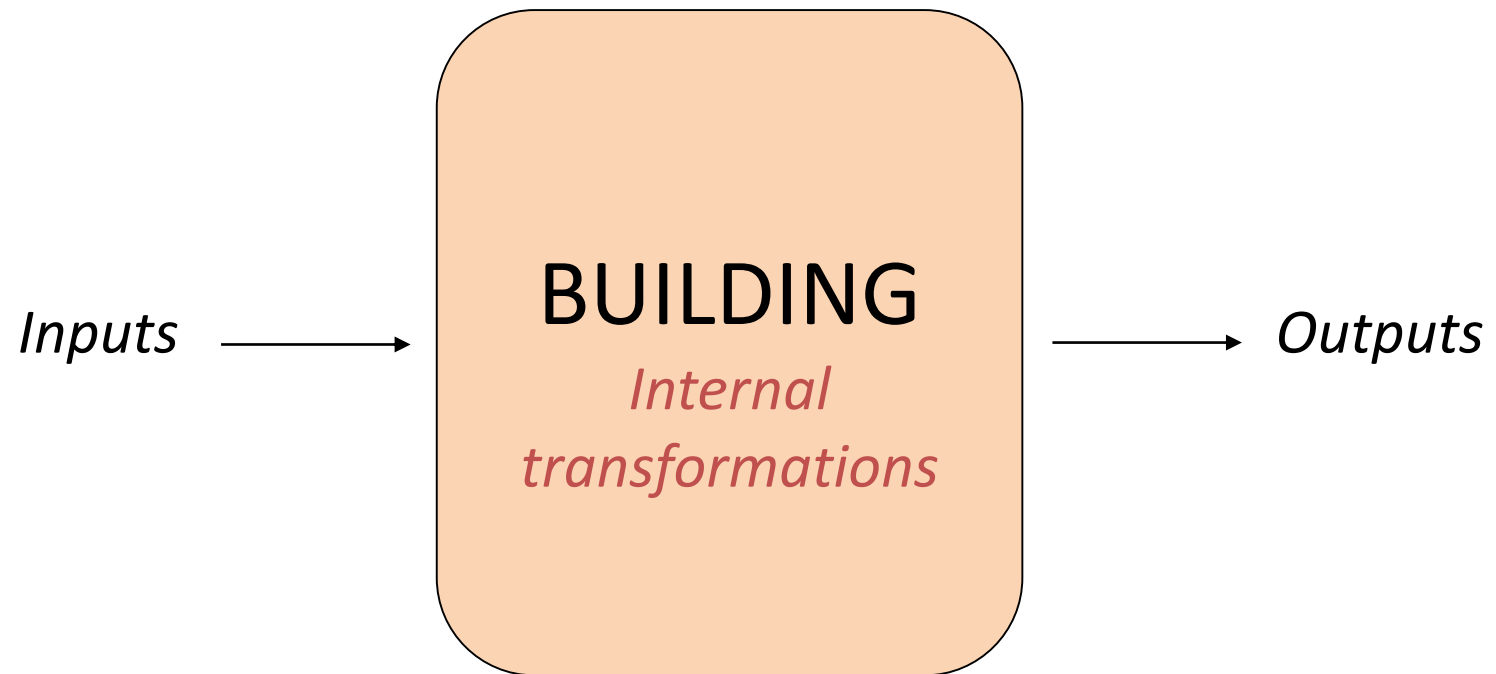
They only interchange energy (e.g. a mill)

Isolated systems

There is no interchange (they don't exist in Nature)



1. THERMODYNAMICS





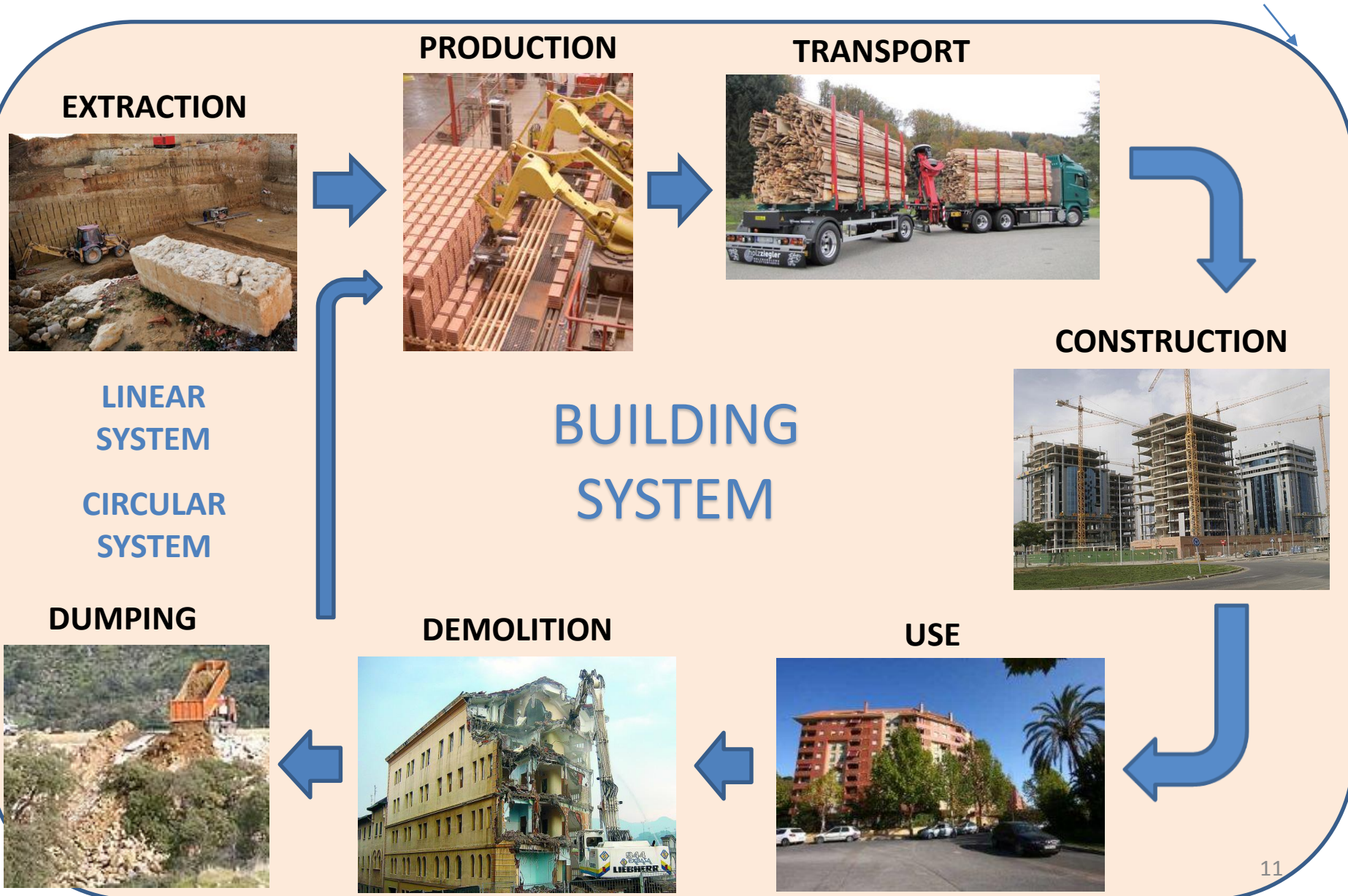
EXAMPLE: BUILDINGS AND OTHER CONSTRUCTIONS

Following this explanation, what can we learn about buildings?

- Our buildings will never be self-sufficient
- They will always need external support, and there will always be losses
- We can improve efficiency, but never get to zero energy
- We can use kinder energies, materials, processes...
but we always have environmental impact

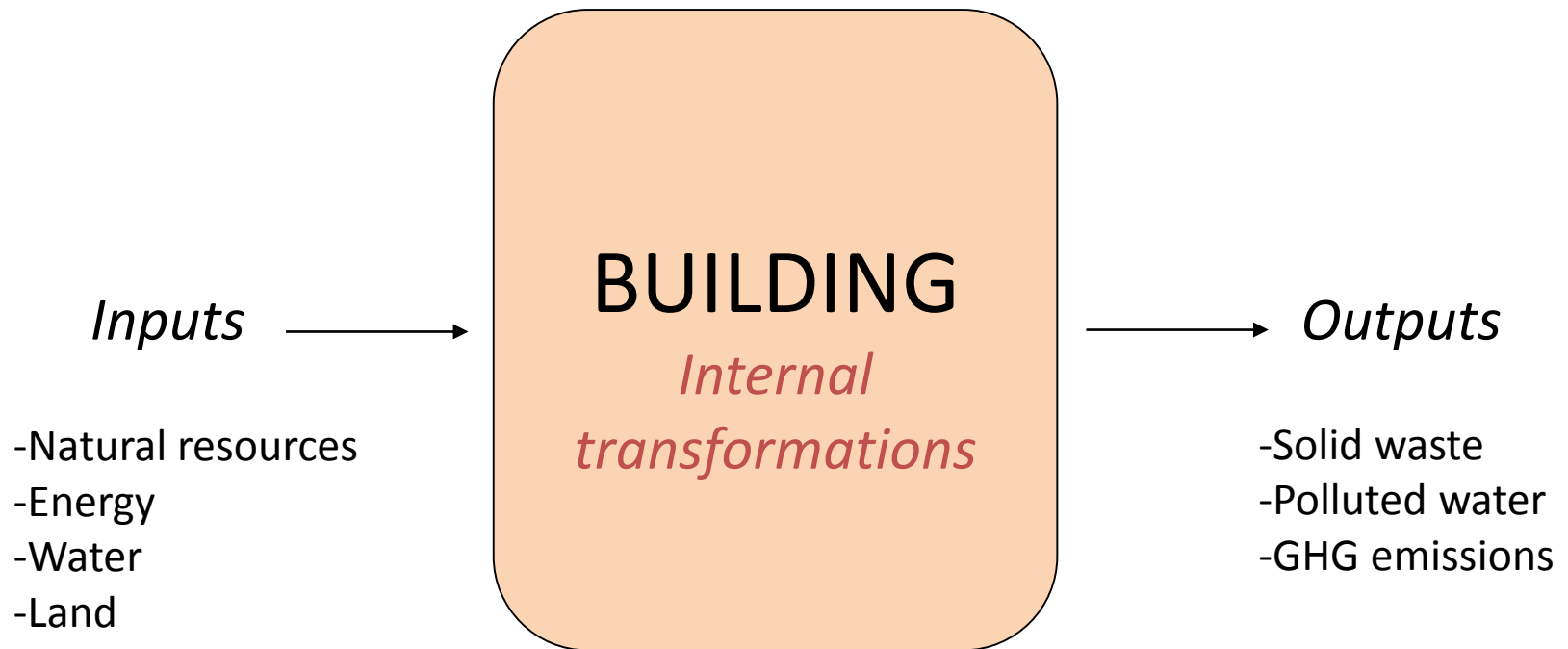


SYSTEM BOUNDARY





1. THERMODYNAMICS





LIFE CYCLE ASSESSMENT

ISO 14040

“Compilation and evaluation of the inputs, outputs and potential environmental impacts of a product system throughout its life cycle”

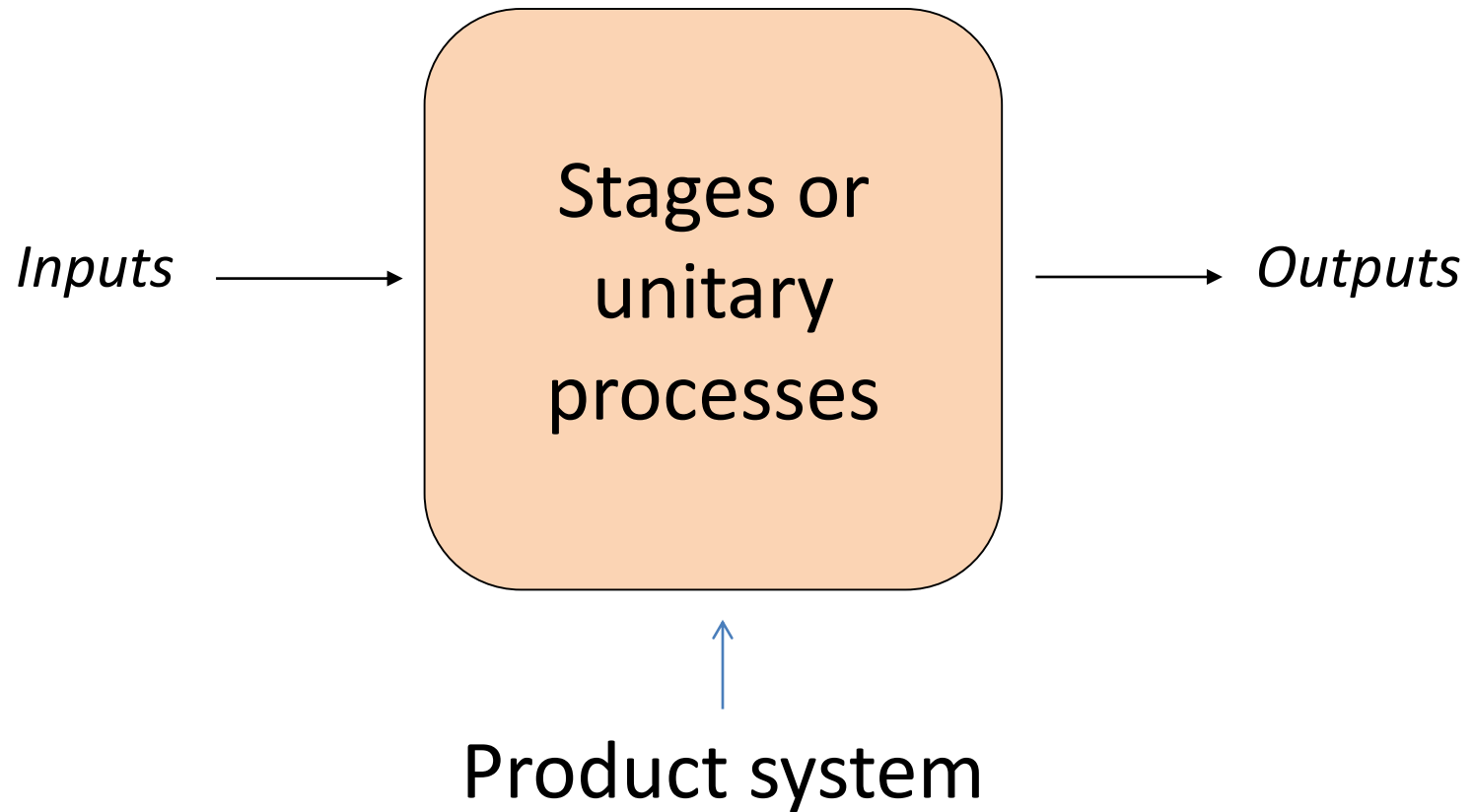
From cradle to grave

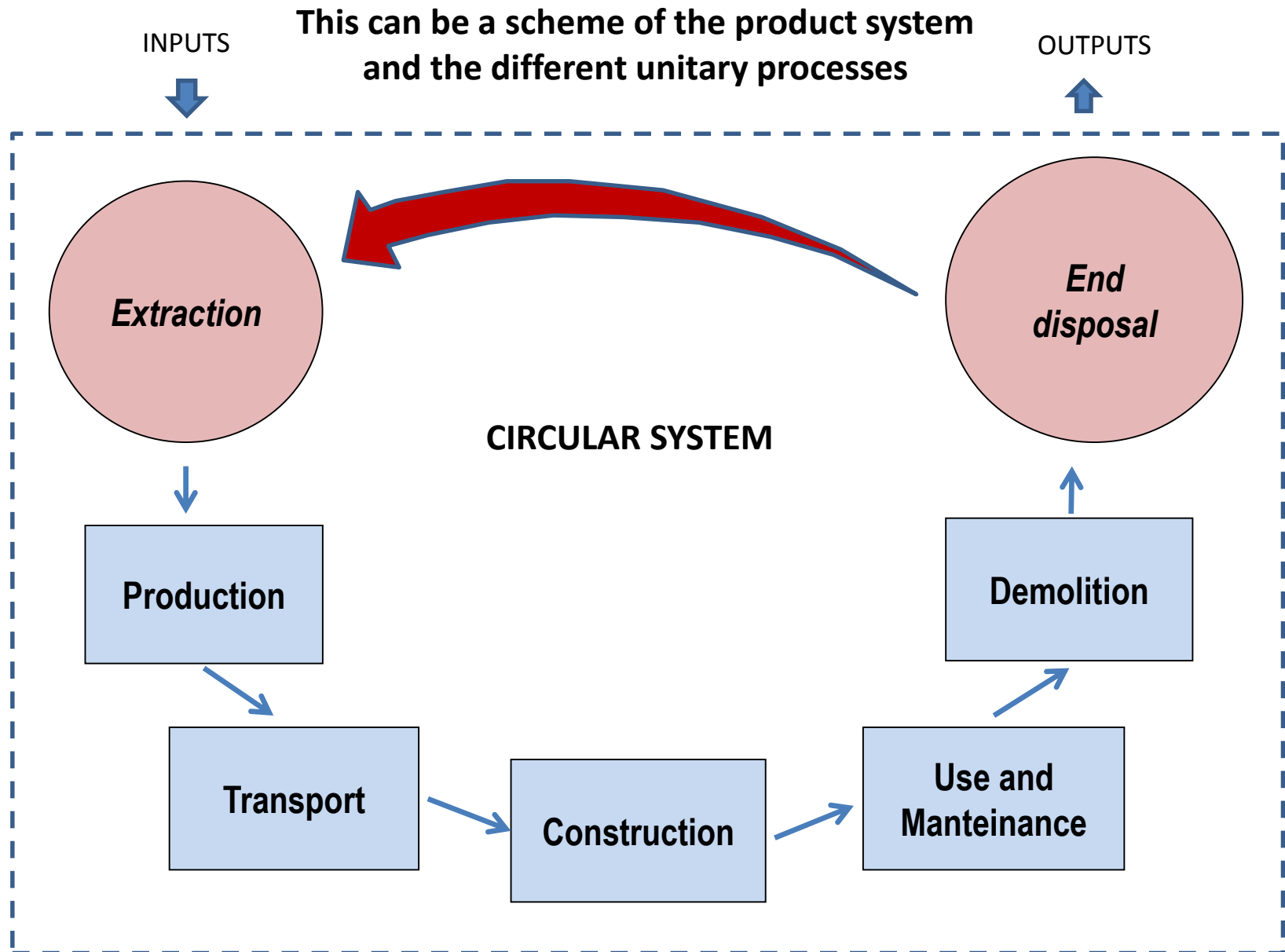
- Services
- Software
- Hardware
- Processed materials



LIFE CYCLE ASSESSMENT

ISO 14040







LIFE CYCLE ASSESSMENT

ISO 14040

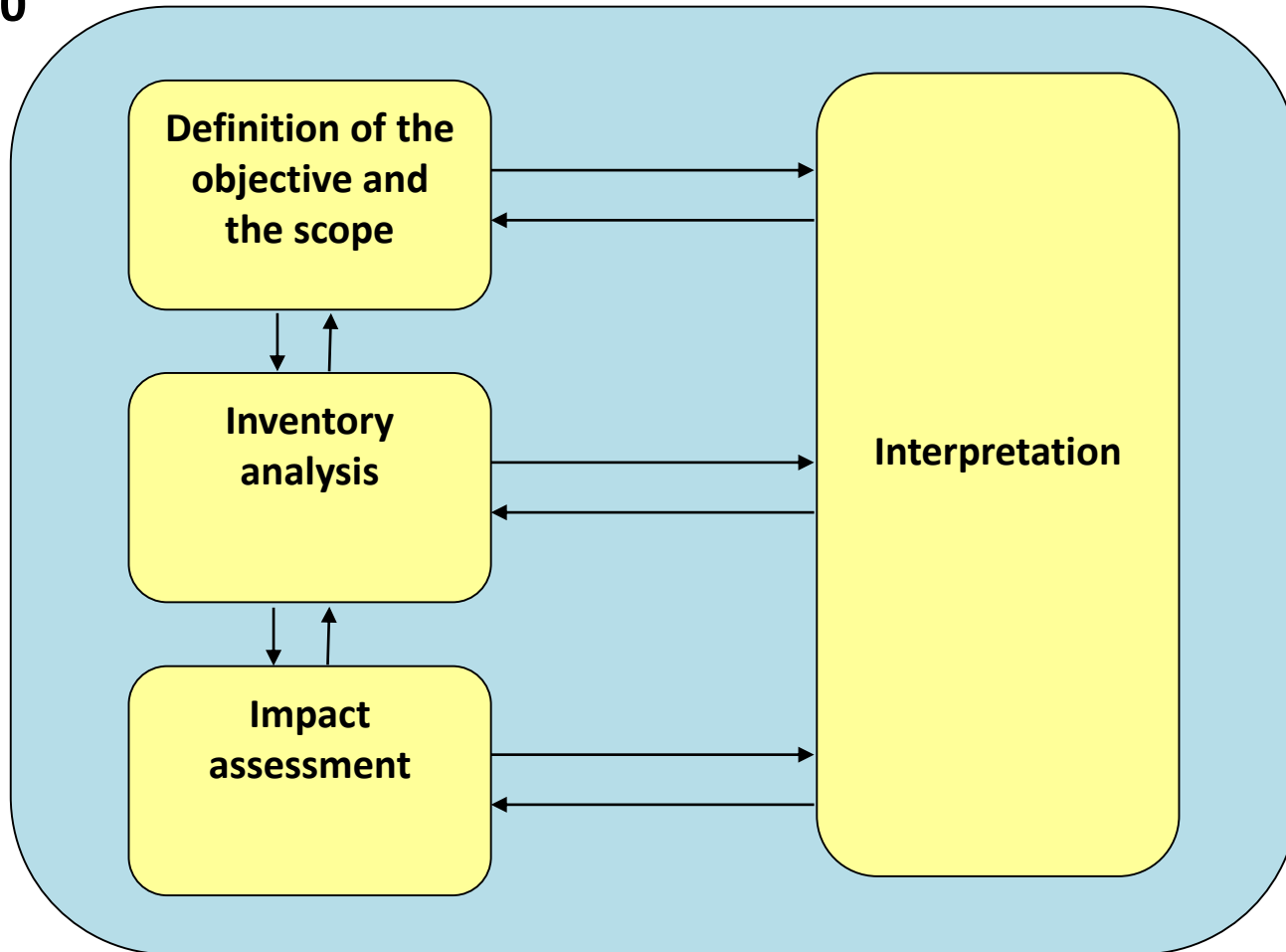
Applications

- Identification of the processes that most contribute to environmental impact
- Comparison between different options
- Be a guide for strategic planning in the long term
- Assessment on the effects over natural resources
- Introduction to product designers in material production and environmental comparison



LIFE CYCLE ASSESSMENT

ISO 14040



Study of Life Cycle Inventory does not include the “Impact assessment”



LIFE CYCLE ASSESSMENT

ISO 14040

Methodology

- Definition of the objective and the scope

The objective:

- Expected application
- Reasons for this study
- Expected public
- Public use of the results



LIFE CYCLE ASSESSMENT

ISO 14040

Methodology

- Definition of the objective and the scope

The scope:

- Product system
- Functions of the product system
- Functional unit
- System limits
- Assignment procedures
- Impact categories and methodology for impact assessment
- Requirements related to data
- Assumptions and limitations
- Type of critical review
- Type and format for the required report



LIFE CYCLE ASSESSMENT

ISO 14040

Methodology

- Analysis of life cycle inventory (LCI)

Compilation of the data and estimation procedures

Quantification of inputs and outputs of the product system

Important:

- Data compilation
- Data estimation
- Assignment of emissions (outputs) flow



LIFE CYCLE ASSESSMENT

ISO 14040

Methodology

- Life cycle impact assessment (LCIA)

Selection of impact categories, category indicators and characterization models



Results classification of LCI



Results estimation for the category indicator (characterization)



LIFE CYCLE ASSESSMENT

ISO 14040

Methodology

- Interpretation

Relationship and analysis of data from the LCI and the impact assessment

The results must be according to the objective and scope defined

- Obtain conclusions
- Explain limitations
- Give recommendations



CEN/TC 350. SUSTAINABILITY OF CONSTRUCTION WORKS

European standardisation system

Sustainability assessment: environmental, social and economical

Functional equivalent: defined by owner and/or regulations

This is the comparison basis to develop different situations

Conceptual level	Owners and regulations requirements				
	Integrated behaviour of building				
	Environmental	Social	Economical	Technical	Operational
Framework level	EN 15643-1 Sustainability assessment of buildings – General framework			Technical characteristics	Use/Operation
	EN 15643-2 Framework for the assessm. of environmental performance	EN 15643-3 Framework for the assessment of social performance	EN 15643-4 Framework for the assessment of economic performance		
Building level	EN 15978 Assessment of environmental performance	EN 16309 Assessment of social performance	EN 16627 Assessment of economical performance		
Product level	EN 15804 Environmental Product declarations (EPD)	At present, the technical information related to some aspects of social and environmental performance are included in EN 15804 to form part of EPDs.			
	EN 15942 Communication format business-to-business				
	CEN/TR 15941 Methodology for selection and use of generic data				



CEN/TC 350. SUSTAINABILITY OF CONSTRUCTION WORKS

Framework level	BS EN 15643-1:2010
	BS EN 15643-2:2011
	BS EN 15643-3:2012
	BS EN 15643-4:2012
Building level	BS EN 15978:2011
	BS EN 16309:2014+A1:2014
	BS EN 16627:2015
Product level	BS EN 15804:2012+A1:2013
	BS EN 15942:2011
	PD CEN/TR 15941:2010



Sustainability of construction works. CEN/TC 350

EN 15643

Information of the building life cycle									Additional information beyond the life cycle
A1-A3 Product stage	A4-A5 Construction stage		B1-B7 Use stage				C1-C4 End of life stage		D Benefits and loads beyond the system limit
A1 Supply of raw materials A2 Transport A3 Production	A4 Transport	A5 Construction/installation process	B1 Use	B2 Maintenance	B3 Reparation	B4 Substitution	B5 Restoration		Potential to reuse , recuperate and recycle
			B6 Use of energy in-service				C1 Demolition/deconstruction	C2 Transport	
			B7 Use of water in-service					C3 Waste treatment	
								C4 Dumping	



CEN/TC 350. SUSTAINABILITY OF CONSTRUCTION WORKS

Possibilities of assessment

- New buildings
- Existing buildings
- Construction materials
- Construction systems
- Instalations



CEN/TC 350. SUSTAINABILITY OF CONSTRUCTION WORKS

Environmental Product Declarations

Defined in EN 15804 for building products

Example:

EPD Creavit

**Vitreous China Ceramic
Sanitaryware**

PDF





What advantages and disadvantages can you see working with EPDs?

How can EPDs make the construction industry evolve?



ICABE 2016 London

**18th International Conference on
Architecture and Built Environment**

Climate Change Impact Due to Timber Product Imports in the UK

**Juan A. Ferriz-Papi
Allan L. Nantel
Talib E. Butt**



Buildings consume between 40-50% of energy in the world
(different authors referring to different countries and regions)

The building sector has the most potential for delivering significant and cost-effective GHG emission reductions
(UNEP SBCI)

The energy consumption assessment should be made through a life cycle approach
(UNEP SBCI)



EXTRACTION



PRODUCTION



TRANSPORT



CONSTRUCTION



DUMPING



DEMOLITION



USE



BUILDING LIFE CYCLE



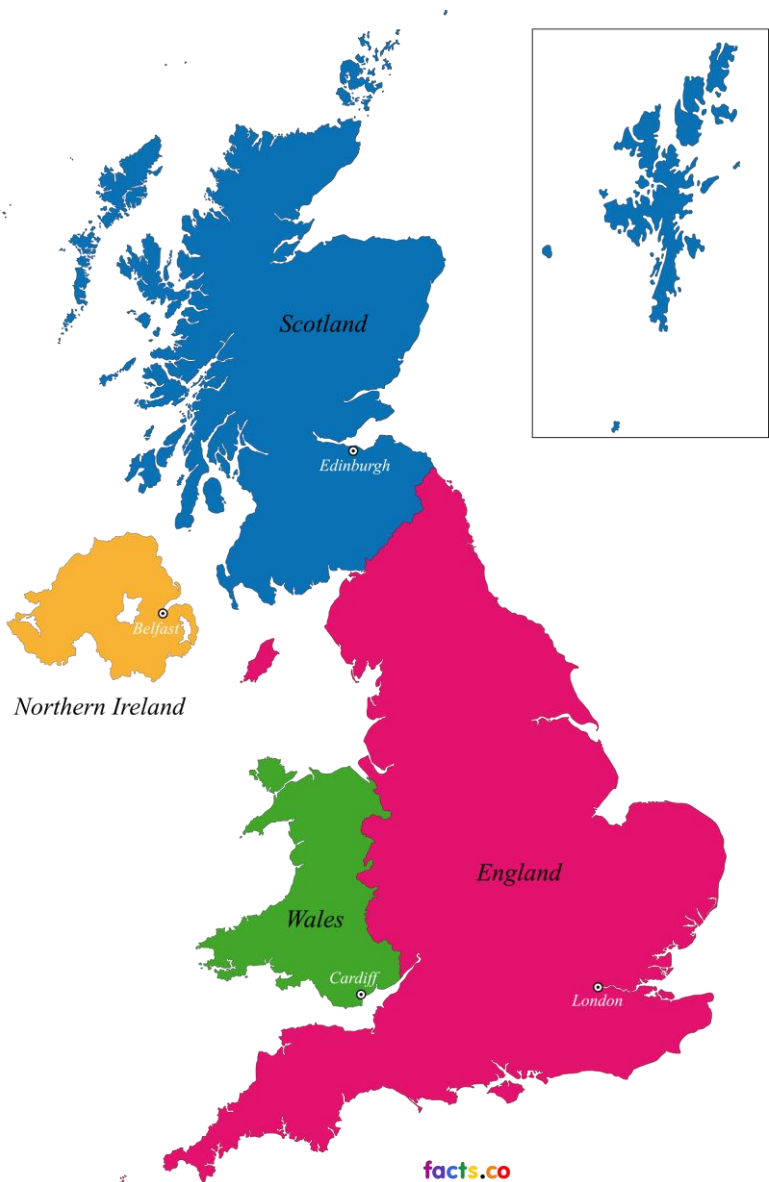
TIMBER INDUSTRY IN THE UK

Between 2002 and 2014, construction has regularly consumed 60% or more of all sawn softwood used.
(Forestry Commission)

The UK is one of the world's largest importers of Wood and Wood products.

Nearly 80% of sawn softwood used in UK construction is imported.
(The Structural Engineer)

Sawn Wood is one of the top-5 imported construction materials in the UK
(National Statistics)



TIMBER



CONSTRUCTION



IMPORTS



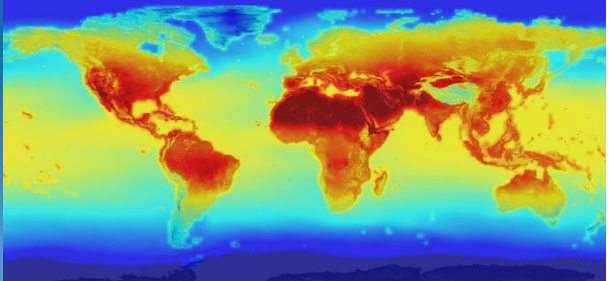
TRANSPORT



CO₂ EMISSIONS



CLIMATE CHANGE





AIM

Analyze climate change impact due to transport of timber products consumed in the UK.

OBJECTIVES

Estimation of carbon footprint due to timber product imports in the UK.

- Establishment of methodology
- Consideration of different timber products
- Calculation of carbon factor due to transport



QUESTIONS

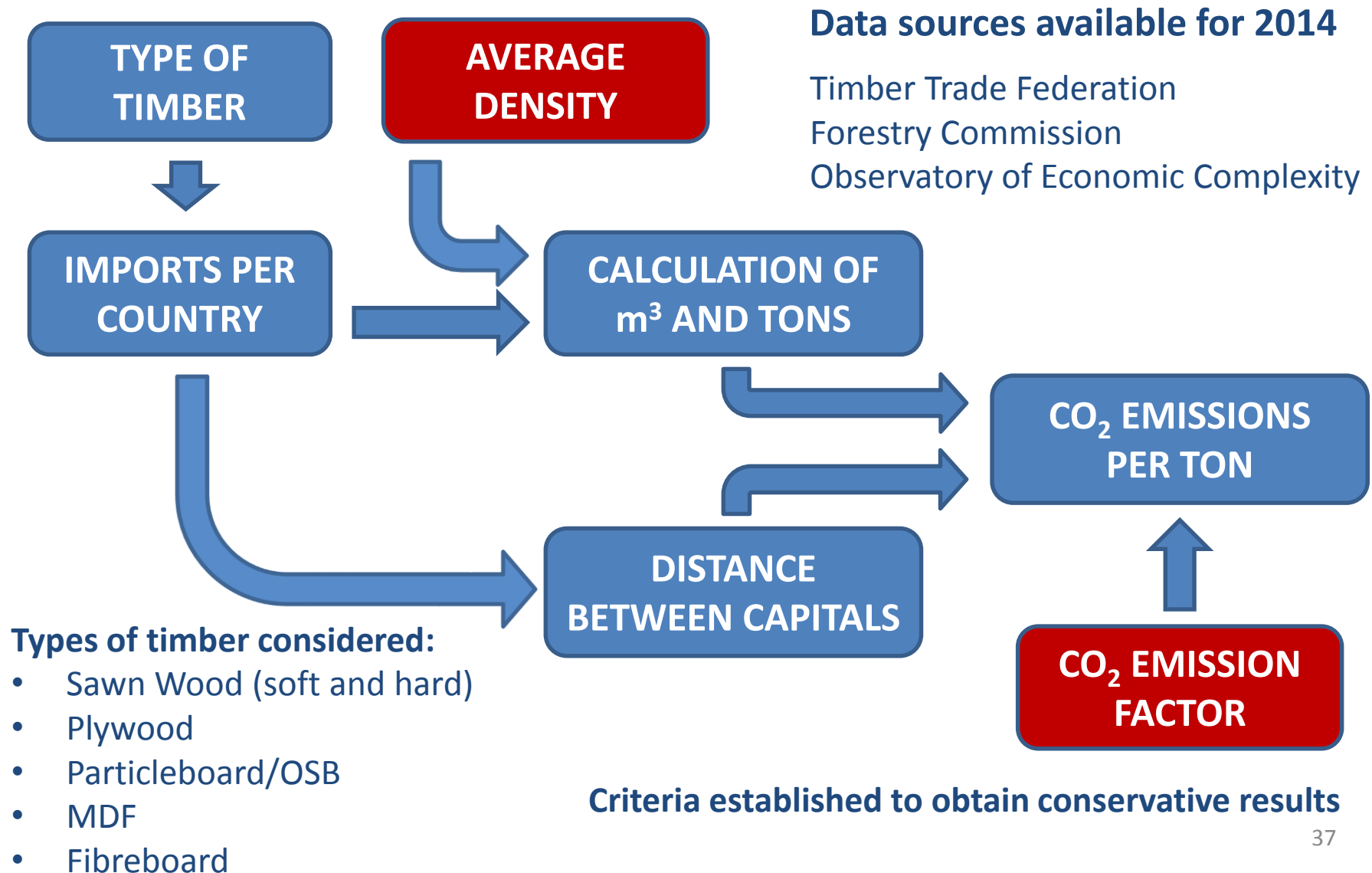
What relationship does this research work have with LCA?

What stage/s are we assessing?

What inputs/outputs are we working?

Why is it important? What conclusions can we obtain?

How can we calculate it?





AVERAGE DENSITY

Consideration of different product densities in each type
(TRADA, TFF)

Calculation of average density

CO₂ EMISSION FACTOR

Consideration of different means of transport
Weighting according to volume of goods transported
(Eurostat)

Use of CO₂ emissions per ton kilometre
(European Forest Institute)

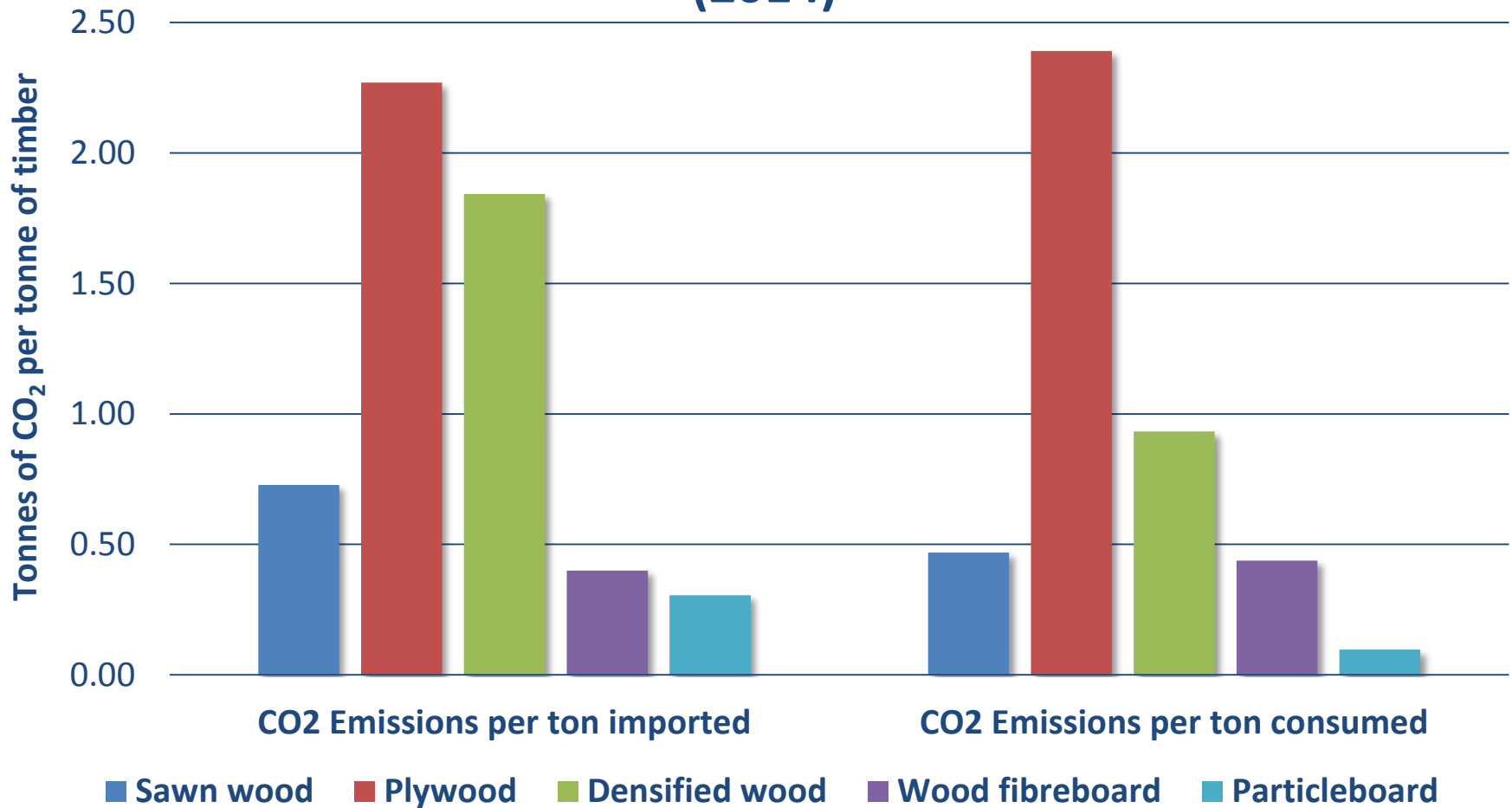


CO₂ EMISSIONS PRODUCED DUE TO TRANSPORT (2014)

TYPE	CONSUMPTION	IMPORTS	PERCENTAGE	CO ₂ Emissions per tonne imported	CO ₂ Emissions per tonne consumed
Sawn wood	9,968,000	6,425,000	64%	0.73	0.47
Plywood	1,328,000	1,399,000	105%	2.27	2.39
Densified wood	1,322,000	669,000	51%	1.84	0.93
Wood fibreboard	171,000	187,000	109%	0.40	0.44
Particleboard	3,081,000	980,000	32%	0.31	0.10

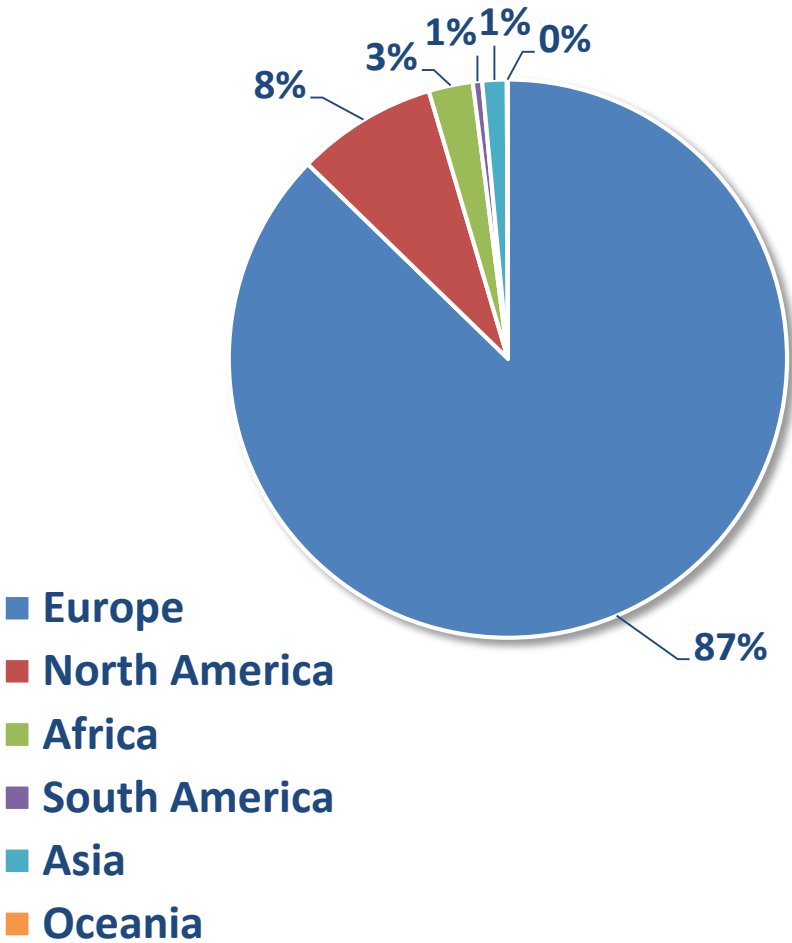


CO₂ EMISSIONS PRODUCED DUE TO TRANSPORT (2014)

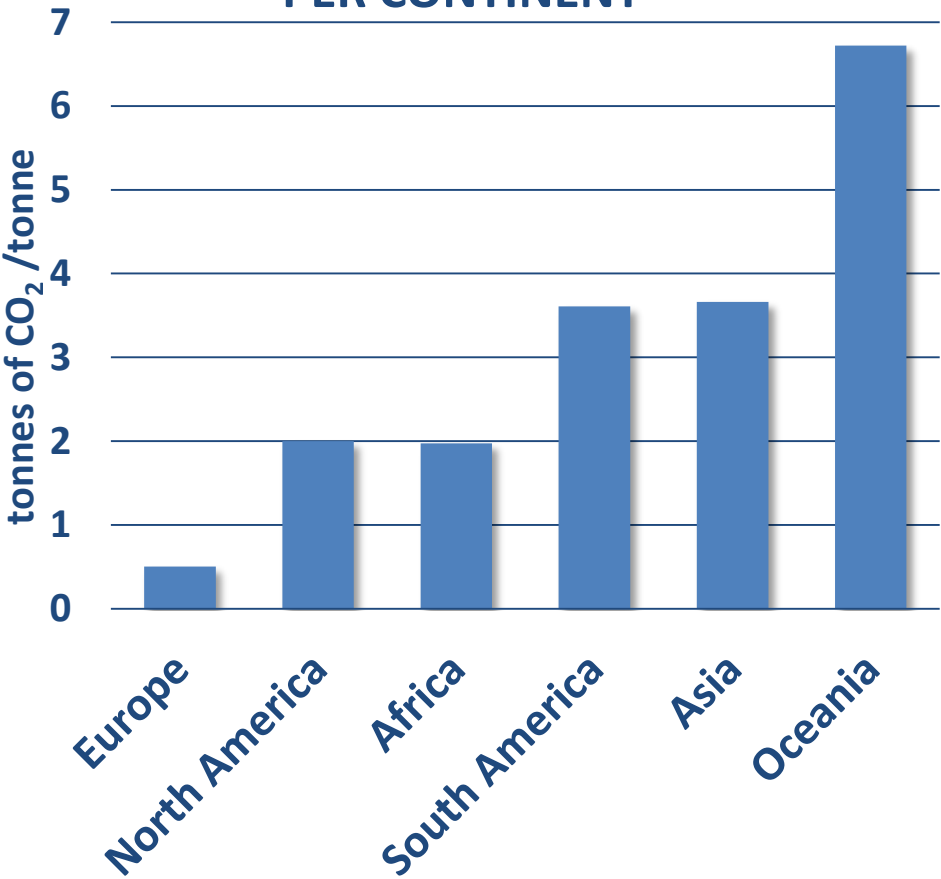




UK SAWNWOOD IMPORTS PERCENTAGE PER CONTINENT (2014)



CO₂ EMISSIONS/TONNE OF UK SAWNWOOD IMPORTS PER CONTINENT





COMPARING TO OTHER STAGES IN THE LIFE CYCLE

TYPE		CRADLE TO GATE (ICE – SERT – University of Bath)	TRANSPORT (per kg imported)
Sawn wood	Hardwood	$0.24_{fos} + 0.63_{bio}$	0.47 kg CO ₂ /kg
	Softwood	$0.20_{fos} + 0.39_{bio}$	
Plywood		$0.45_{fos} + 0.65_{bio}$	2.39 kg CO ₂ /kg
Densified wood (HB)		$0.58_{fos} + 0.51_{bio}$	0.93 kg CO ₂ /kg
Wood fibreboard (MDF)		$0.39_{fos} + 0.35_{bio}$	0.44 kg CO ₂ /kg
Particleboard		$0.54_{fos} + 0.32_{bio}$	0.10 kg CO ₂ /kg
Oriented Strand Board		$0.45_{fos} + 0.54_{bio}$	



Timber is a good environment material due to its low carbon footprint.

- Low manufacturing
- Carbon storage
- Importance of sustainable production

Timber transport in the UK has much higher impact in climate change than production.

- Very high volume of imports

Accountings for this impact have not still been considered in the life cycle of timber properly.

- Not reflected in databases



This impact must be considered and reduced if we want to fight against climate change. Some recommendations can be as follows:

- Reducing volume of imports
- Improving local timber production and timber industry
- Sustainable production
- Recycling
- Innovation (new products)

A first approach has been developed for this carbon accountings in timber imports.

- Basis for further research
 - To go deeper in the methodology applied
 - To analyse this impact and reduce it

**Thank you
very much
for your attention**

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Y Drindod Dewi Sant
University of Wales
Trinity Saint David