

ECBCS IEA ANNEX 57

Terms, Definitions and System Boundaries of Embodied Energy and of Embodied CO₂ / GHG Emissions (EEC)

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Topics and Trends

“embodied energy”, “carbon footprint” and “embodied carbon”

- The calculation and assessment of embodied energy looks back on a long history. This started in the seventies with the first references dated back to 1920 (embodied coal).
- Originally, it was an issue for scientists - today more and more representatives from business and politics are interested in the subject.



Topics and Trends

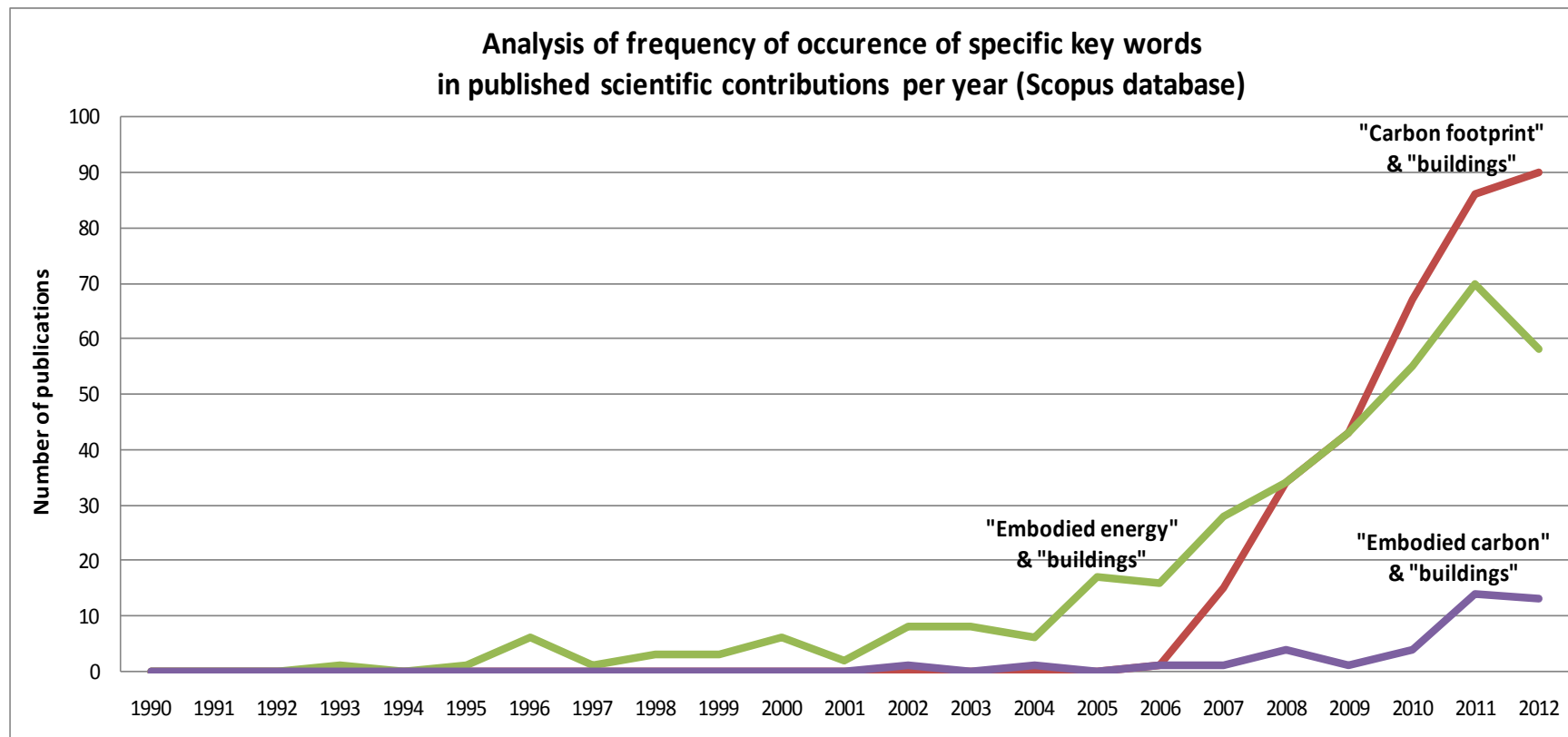
“embodied energy”, “carbon footprint” and “embodied carbon”

- In the beginning, the greater part of research was related to “**embodied energy**” – linked to the *question of resources protection*
- More recently, “**carbon footprint**” has started winning an incredible popularity as an easy to understand and measure indicator among stakeholders coming mainly from industry – linked to the *question of climate change mitigation*
- “**embodied carbon**” as a *partial carbon footprint* has also started gaining importance in construction industry



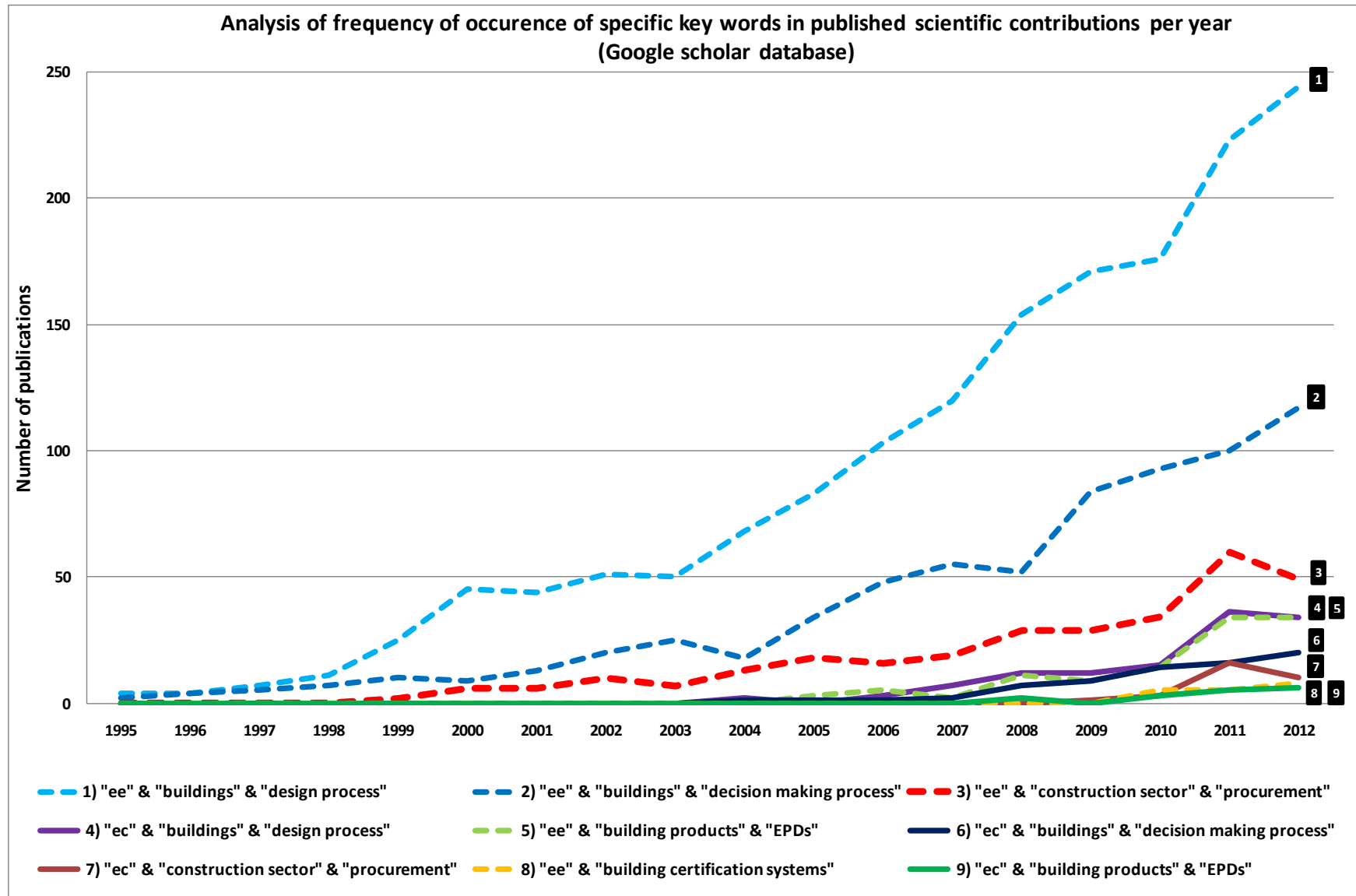
Topics and Trends

“embodied energy”, “carbon footprint” and “embodied carbon”



Topics and Trends

different decision making situations



Topics and Trends

different decision making situations

- The **different target groups** have **various needs** and are related to **different decision making situations** - such as

- * *Design of buildings*
- * *Procurement*
- * *Sustainability assessment*
- * *Selection of building products*
- * *Development of support frameworks*
- * *others*

as far as the “embodied energy” and “embodied CO2 emissions/ GWP” is concerned.



Actor/Object of Assessment Matrix

Object of assessment	Macroeconomic level	Sector / branch	Building stock	Buildings/ constructed assets	Construction products	Processes
Group of Actors						
Government						
Investors						
Contractors						
Designers						
Manufacturers						
Energy supply						

TRENDS IN LITERATURE

different decision making situations

Examples of existing guidance for different groups:

- quantity surveyors (RICS, 2012)
- construction product manufacturers - EPDs (EN 15804)
- Public authorities (WRAP, 2011)
- etc...



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Existing definitions of EE

Some Examples:

Source	Definition	System boundary
Crowther, 1999	"The <i>embodied energy</i> of the building can be defined as the total energy required in the creation of a building, including the direct energy used in the construction and assembly process, and the indirect energy, that is required to manufacture the materials and components of the buildings."	Cradle to Handover
SIA 2032, 2010	<i>Grey energy</i> is "the total amount of nonrenewable primary energy required for all upstream processes from the raw materials extraction to the production, construction and disposal including the necessary transport. This is also indicated as cumulative non-renewable energy consumption." (translated)	Cradle to Grave
European Commission, 2012	<i>Embedded energy</i> is defined as the "energy use linked to the manufacturing of construction products".	Cradle to Gate

Implications

- But still there is a lot of confusion around the issue of EEC partly owing to the fact that there are **no clear and commonly accepted definitions, system boundaries and indicators**.
- The **spectrum of definitions** ranges from accounting only **for initial embodied energy** and CO₂ emissions or GWP to accounting for the **whole life cycle** plus sometimes even the recycling and **recovery credits**...



Main Questions

When assessing the “embodied energy” and “embodied CO₂ emissions/ GWP” impacts, questions that need to be asked are:

(1) How to describe the **object of assessment** and **the system boundaries** in a complete way in relation to:

- a) the **included building parts** ?
- b) the **included life cycle stages** ?

(2) What **indicators** should be used in related to:

- a) “embodied energy” ?
- b) “embodied CO₂ emissions/ GWP” ?



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Object of Assessment – Building Components Covered by the Analysis

Recommendation: In the context of IEA Annex 57 the object of assessment is the building and its life cycle

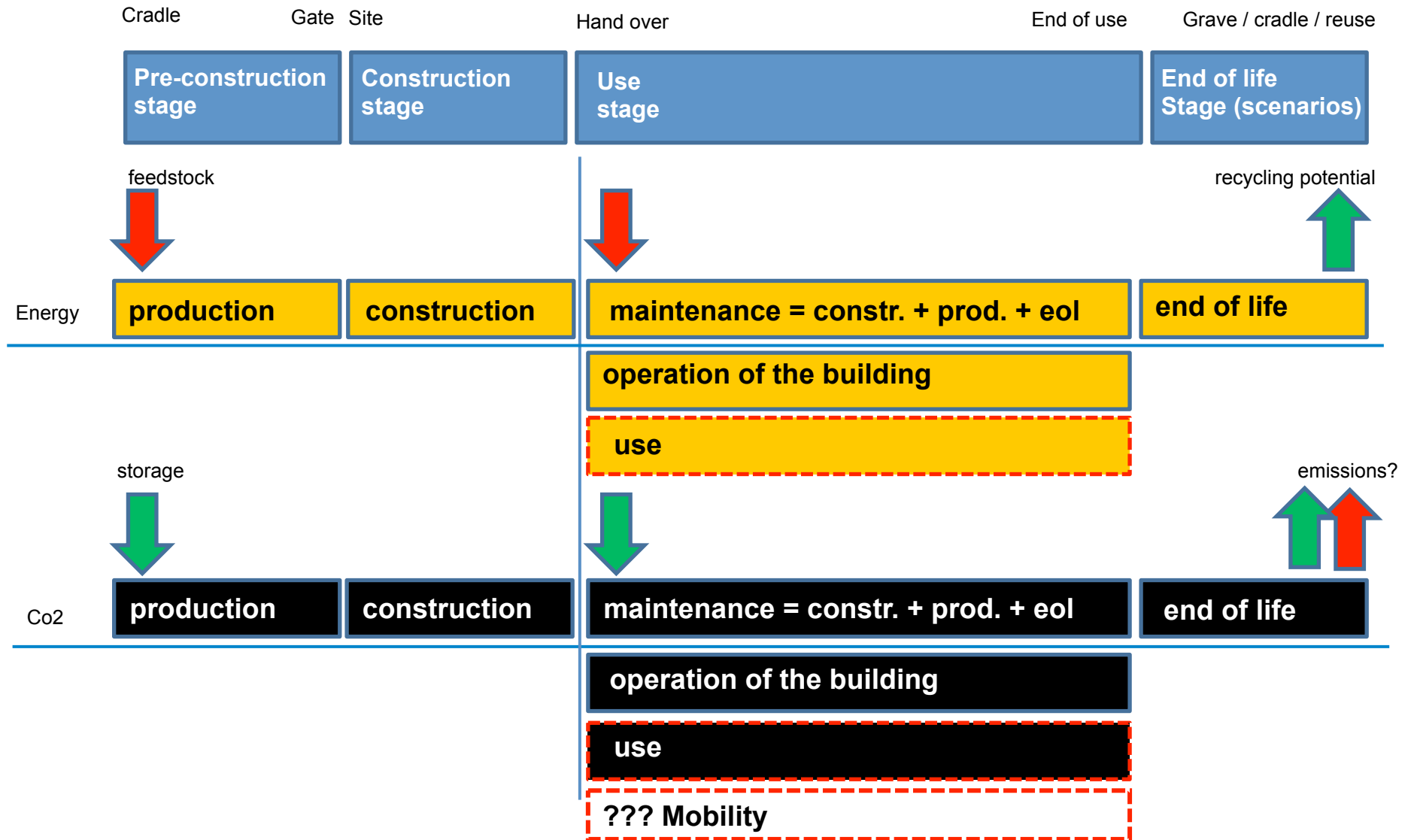
Building Components	Critical Elements included in initial calculations	
Facilitating Works		
Substructure	Foundations	X
	Basement retaining walls	X
	Ground floor construction	X
Superstructure	Frame	X
	Upper floors	X
	Roof	X
	Stairs and ramps	
	External walls	X
	Windows and external doors	X
	Internal walls and partitions	X
	Internal doors	
Internal finishes	Wall finishes	
	Floor finishes	
	Ceiling finishes	
Fittings, furnishings and equipment		x
Building Services (e.g. HVAC systems)		x

List of building components that can be included in any “embodied energy” and “embodied CO₂/ GWP” analysis. The critical elements according to Annex 57 are crossed.

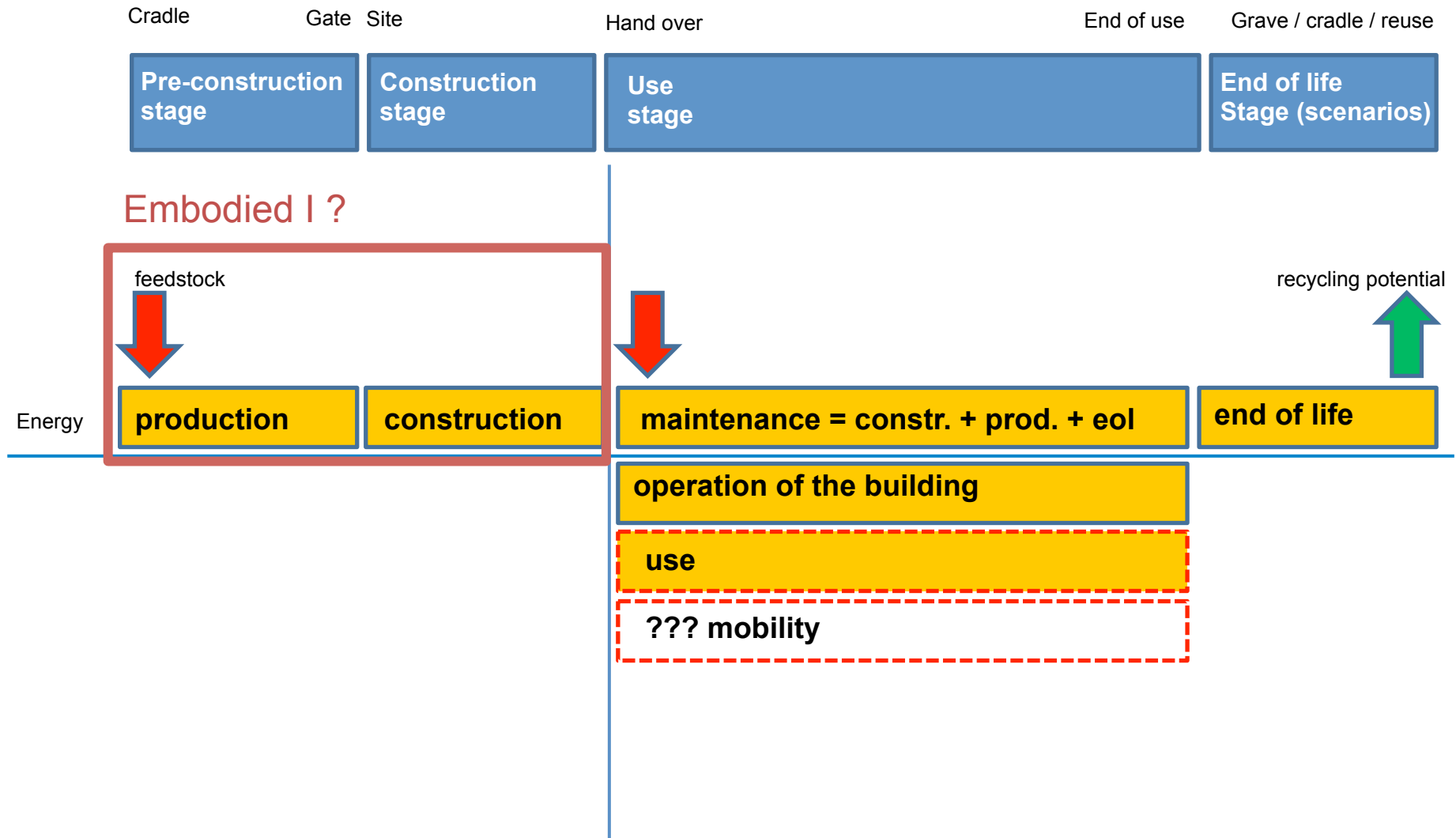
At the minimum the included building parts must be declared in a transparent way.

The issue of cut-off-rules needs further discussion.

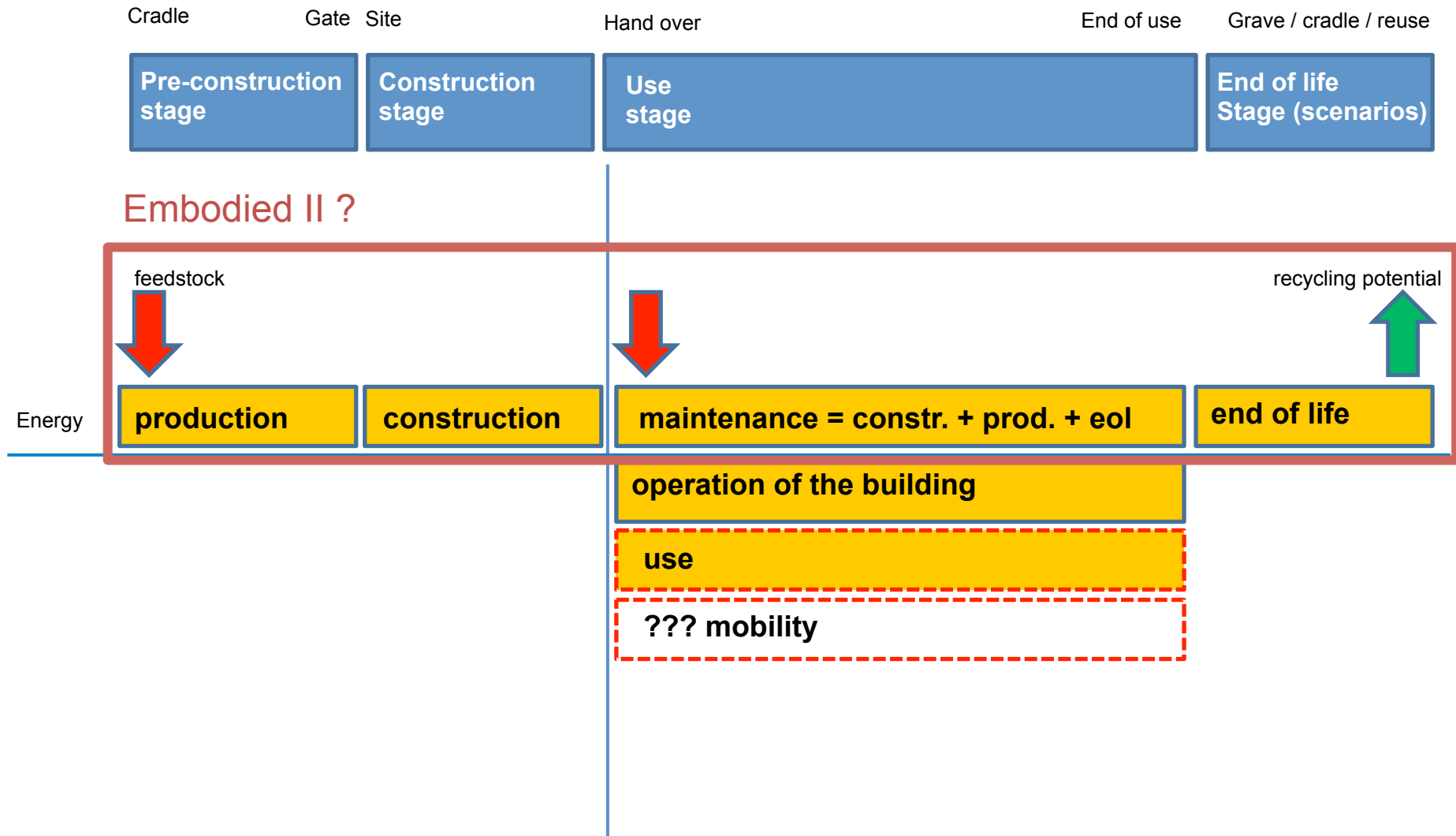
So...what means “embodied” ?



So...what means “embodied” ?



So...what means “embodied” ?



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Recommendations for System Boundaries

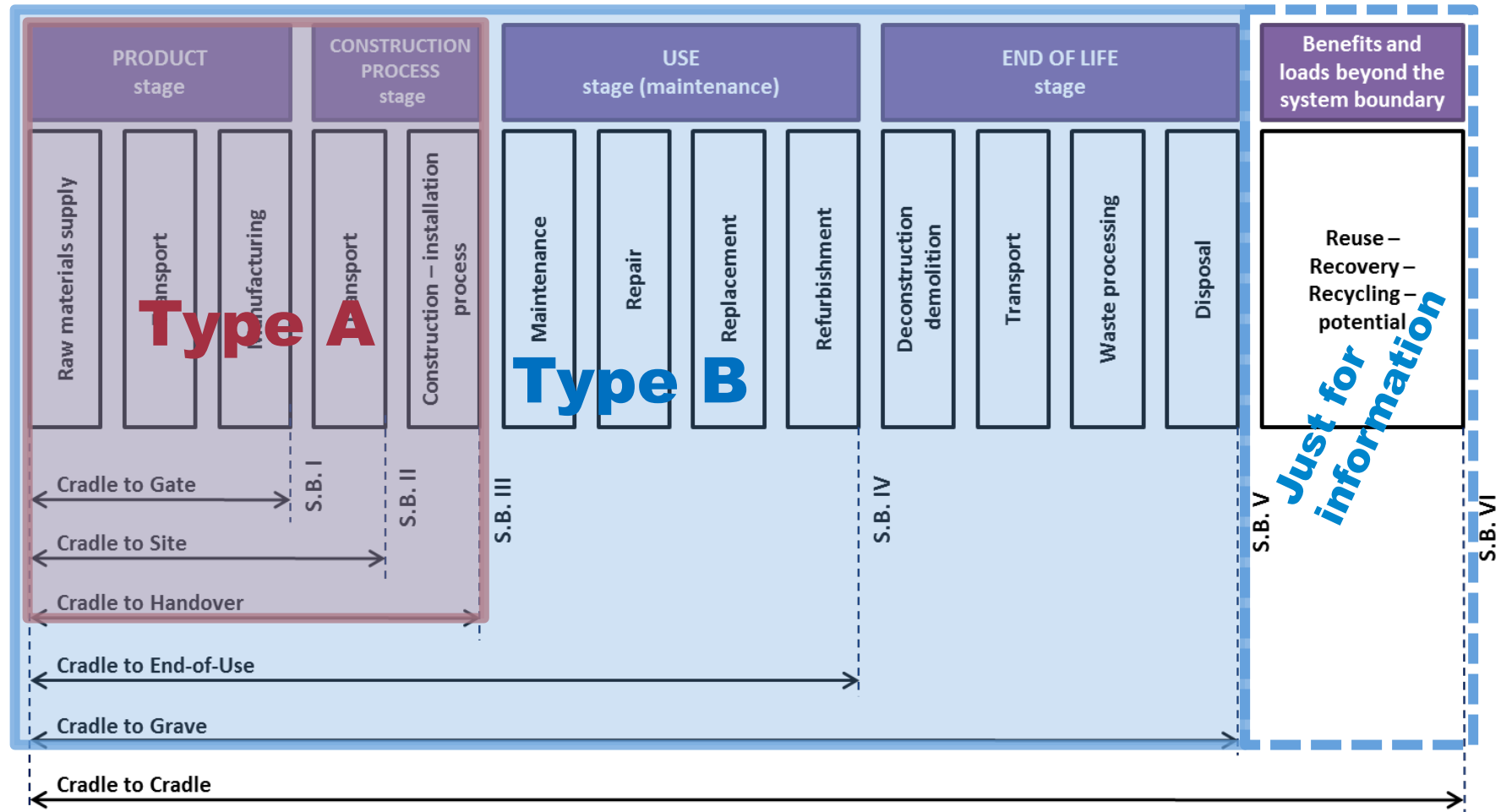
- **Recommendation:** to use 2 different system boundary types to be used when calculating “embodied energy” and “embodied CO₂ emissions/ GWP”:
 - a) ***Cradle to Handover*** – to be used **at the minimum**, as it represents the initial embodied energy and CO₂ emissions/ GWP of the whole building,
 - b) ***Cradle to Grave*** (in addition module D concept according to EN 15978:2011) as additional information – this system boundary is **the most complete from the theoretical point of view** and is in line with the series of the European standards developed by the CEN TC 350 group.



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Typology of the Building's Life Cycle and System Boundaries

Recommendation: Proposed model for system boundary description and selection



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Recommendations for the Use of Different Indicators - EE

KEY INFORMATION: EMBODIED ENERGY	
Also known as	Embodied energy, Embedded energy, Gray energy, Cumulative energy demand, Fossil Fuel Depletion, Abiotic Depletion (Energy/Fossil Fuels)
Definition	<u>Embodied energy</u> is the total amount of non-renewable primary energy required for direct and indirect processes related to the creation of the building, its maintenance and end-of-life. In this sense the forms of energy included in the embodied energy are the initial energy, the recurrent energy and the end of life energy of the building. (Type 1B)
Target	Protection of non-renewable energy resources
Indicators	<p style="text-align: center;"><u>Type 1B:</u></p> <p style="text-align: center;"><i>Non-renewable primary energy</i></p>
System boundaries	<p><i>System boundary type V - “Cradle to Grave” with feedstock energy included</i></p> <p>Module D - Benefits and loads beyond the life cycle of the building (e.g. recycling potential) will be reported separately.</p>
Unit	MJ/m ² (BGF) *year (50)

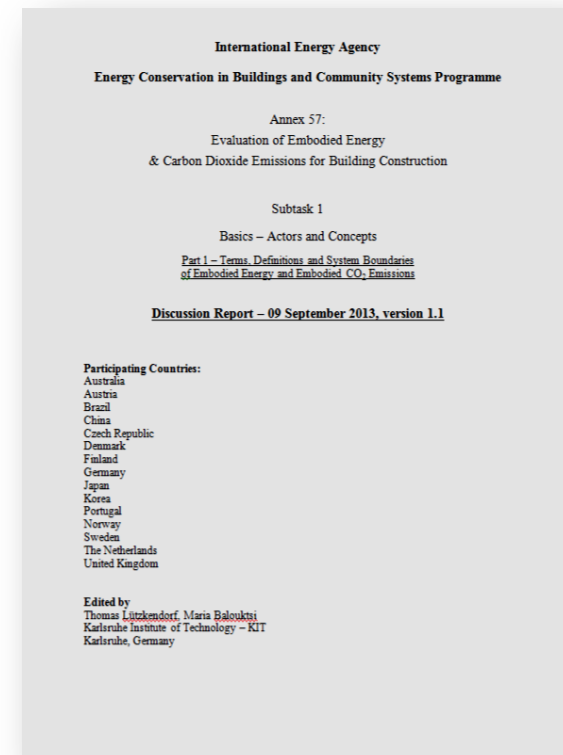
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Recommendations for the Use of Different Indicators - EC

KEY INFORMATION: EMBODIED CO ₂ EMISSIONS/ GWP	
Also known as	Embodied CO ₂ emissions, Embodied carbon, Carbon Footprint, Climate Change, Global Warming, or Global Warming Potential (GWP), Embedded Carbon, ECO ₂ .
Area of protection	Environment
Definition	<i>Embodied CO₂ emissions/ GWP</i> is the cumulative quantity of greenhouse gases (CO ₂ , methane, nitric oxide, and other global warming gases), which are produced during the direct and indirect processes related to the creation of the building, its maintenance and end-of-life. This is expressed as CO ₂ equivalent that has the same greenhouse effect as the sum of GHG emissions.” (Type 1B)
Indicator	<p style="text-align: center;"><u>Type 1B:</u></p> <p style="text-align: center;"><i>Global Warming Potential (GWP 100)</i></p>
System boundaries	<p><i>System boundary type V - “Cradle to Grave” with non-fuel related emissions included</i> (e.g. due to chemical effects)</p> <p>Module D - Benefits and loads beyond the life cycle of the building should be reported separately.</p> <p>Carbon sequestration is excluded.</p>
Unit	kgCO ₂ eq./m ² *year (50)

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- All this information is already included in the first part of a larger report
- The indicators recommended here are already used for the actor's specific case studies (worked out by ST4)



Hand over to some reports and case studies

