The European Commission's science and knowledge service

Joint Research Centre

Webinar: Getting started with indicator 1.2 Life cycle GWP

DG JRC B5

6th November 2018

European Commission

Outline

- Part 1: Level(s) part 3 guidance on life cycle GWP
- Part 2: Basic steps in making a life cycle GWP calculation
- Part 3: Options available in terms of CO2 factors and LCI data
- Part 4: More advanced options for modelling life cycle GWP

Part 1: Level(s) part 3 guidance on life cycle GWP

the Level(s) documentation

Part 1

Introduction to the framework

What it is, how it is envisaged to be used, its scope, at which stages in a building project and its life cycle.

Part 2

Basic introduction to the indicators and tools

The common metrics and life cycle tools, units of measurement, scope and boundaries, reference standards.

Part 3

How to carry out a performance assessment

Guidance on the calculation methods, reporting formats for results, the Level 2 rules, the advanced aspects of Level 3, taking into account factors that influence risk and value.

The Level(s) common framework

Macro-objective 1:
Greenhouse gas emissions along a buildings life cycle

Macro-objective 2:
Resource efficient and circular material life cycles

Macro-objective 3:
Efficient use of water resources

Macro-objective 4:
healthy and comfortable spaces

Macro-objective 5:
Adaptation and resilience to climate change

Macro-objective 6:
Optimised life cycle cost and value

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The Level(s) common framework

Macro-objective 1:
Greenhouse gas emissions along a buildings life cycle

Life cycle environmental performance

Macro-objective 1:
Greenhouse gas emissions along a buildings life cycle

- **1.1 Use stage energy performance** (kWh/m²/yr)
- **1.2 Life cycle Global Warming Potential** (CO_2 eq./m²/yr)

Macro-objective 2:
Resource efficient and circular material life cycles

- **2.1 Life cycle tool: Building bill of materials** (kg)
- **2.2 Life cycle tools: Lifespan, adaptability and deconstruction scenarios**
- **2.3 Construction & demolition waste and materials** (kg/m²)

Overarching assessment tool

- **2.4 Life cycle tool: Cradle to cradle Life Cycle Assessment (LCA)** (impact/m²/yr)

Macro-objective 3:
Efficient use of water resources

- **3.1 Use stage water consumption** (m³/occupant/yr)

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Overview of indicator 1.2 life cycle GWP

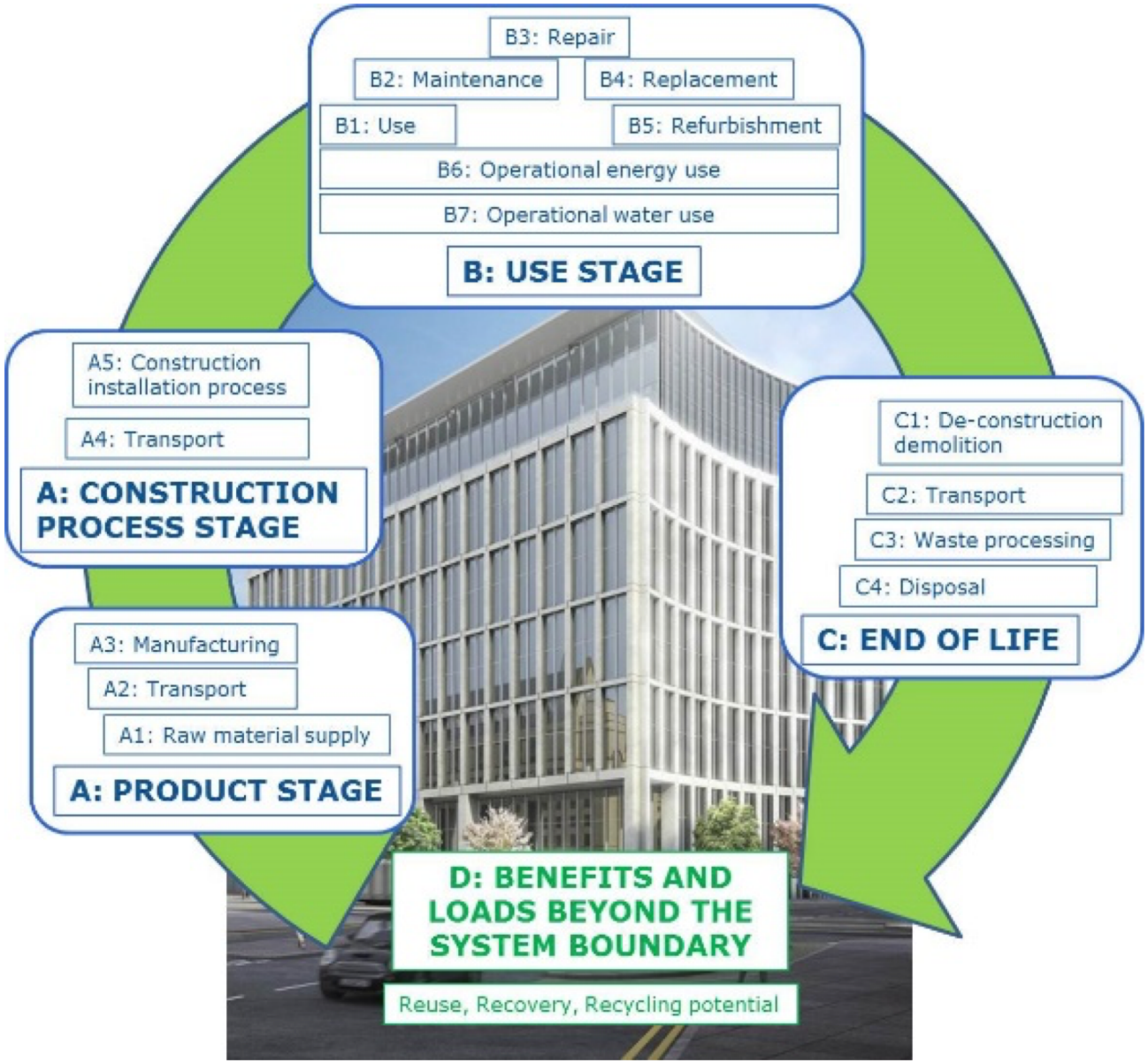
Aim:

- Quantify and reduce greenhouse gas (GHG) emissions associated with a building's life cycle
- **kg CO_2 equivalents/m^2/yr** (useful floor area) for each life cycle stage

LCA focused on GWP characterisation:

- Reference to functional equivalency of buildings (what, how much/long/well
- Boundary: Evolution of the building from cradle to cradle

The Building's Life Cycle



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Calculation methods and reference standards

Methodological framework:

- ISO 14040/44 (2006) → LCA phases
- EN 15804 (2012) and 15978 (2011) → LCA for construction products and buildings
- ISO 14067 (2018) and **ISO 16745 (2017)** → Carbon footprinting of products and **buildings (NEW)**
- PEF Category Rules Guidance (2017) → more specific guidance on LCA
- Technical references from existing schemes, data and tools

  http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf

Part 3 ➔ Simplified and detailed rules + Reporting (3 accounting category flows: fossil, biogenic, land-related emissions)

How can it be used in building projects?

Project life cycle:

- Design tool for the ex-ante assessment of building options/scenarios → design optimisation
- Post-ante assessment during the completion/monitoring phase

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Using it at different levels

Level 1:

- Not LCA experts
- Learning tool for promoting harmonised quantification and understanding of key contributions to overall carbon footprint of buildings
- Balance between **simplification** (lifecycle stages and building elements) and coherence (interpretation)

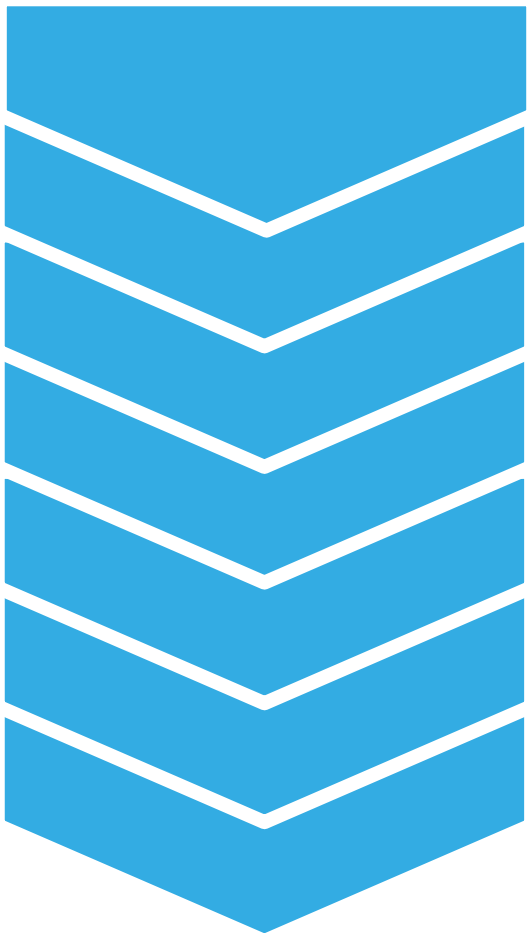
Level 2:

- Reporting on environmental performance of buildings
- Provision of a reference measurement and reporting framework (all life cycles in principle, cut-off rules, EPDs)
- Minimum data quality requirements and critical review

Level 3:

- Integrating 'carbon performance' for design optimisation
- Most advanced use ('all' elements, cut-off rules, data quality, critical review)
- Alternative scenarios may be assessed

the steps in making an assessment



Step 1: Choose the indicators and tools

Step 2: Choose the Level of assessment

Step 3: Define the building

Step 4: Follow the guidance and rules

Step 5: Complete the reporting format

Step 6: Determine valuation influence and reliability

Step 7: Finalise and submit

Basic reporting format

Building description

Parameter	Office buildings
Location	
Climate zone	Select
Project type	Select
Year of construction	
Original year of construction	
Service life or holding period	
Building form	Select
	If other describe here
Property schedule	
Floor area measurement	
Market segment -International base definition -Metropolitan base definition	Select Select
Servicing	
Conditions of use	
Projected occupancy density	
Projected pattern of occupation	
Assumed void rate	

Parameter	Residential buildings
Location	
Climate zone	Select
Project type	Select
Year of construction	
Original year of construction	
Service life or holding period	
Building form	Select If other describe here
Property schedule	
Floor area measurement	
Market segment	Select
Servicing	
Conditions of use	
Projected occupancy density	n/a
Projected pattern of occupation	n/a
Assumed void rate	

Basic reporting format

Indicators and Tools	Project Stages			
	Design Stage	Implementation stage	Completion and handover stage	Operation and occupation stage
Indicator 1.1 Use stage energy performance	not used	not used	not used	not used
Indicator 1.2 Life cycle Global Warming Potential	Level 1	not used	not used	not used
Indicator 2.1 Life cycle tools: Building bill of	not used	not used	not used	not used
Ind.2.2 - Scenario 1 Building and elemental service life planning	not used	not used	not used	not used
Ind.2.2 - Scenario 2 Design for adaptability and refurbishment	not used	not used	not used	not used
Ind.2.2 - Scenario 3 Design for deconstruction, reuse and recyclability	not used	not used	not used	not used
Indicator 2.3 Construction and demolition waste	not used	not used	not used	not used
Indicator 3.1 Total water consumption	not used	not used	not used	not used
Indicator 4.1 Indoor air quality	not used	not used	not used	not used
Indicator 4.2 Time outside of thermal comfort range	not used	not used	not used	not used
Indicator 5.1 Life cycle tools: scenarios for projected future climatic conditions	not used	not used	not used	not used
Indicator 6.1 Life cycle costs	not used	not used	not used	not used
Indicator 6.2 Value creation and risk factors	used	not used	not used	not used
LCA Overarching assessment tool: Cradle to cradle Life Cycle Assessment (LCA)	not used	not used	not used	not used
Generate reporting sheets				

Calculations to be made separately

Basic reporting format

Add scenario | Delete scenario

Global Warming Potential for each life cycle stage							
Scenario	Indicator	Unit	Product (A1-3)	Construction process (A4-5)	Use stage (B1-7)	End of life (C1-4)	Benefits and loads beyond the system boundary (D)
	(1) GWP - fossil	kg CO_2 eq					
	(2) GWP - biogenic	kg CO_2 eq					
	GWP – GHGs (1+2)	kg CO_2 eq					
	(3) GWP – land use and land	kg CO_2 eq					
	GWP – overall (1+2+3)	kg CO_2 eq					

Checklist	Additional Info (write directly or attach files)
Those in RED are optional for Level 1: •Objectives, users and audience •Min scope covered •System boundaries and cut-off rules •Consistency with energy and water modelling •Consistency with scenario modelling •Data sources •Software •LCIA methods •Calculation of data quality index •Interpretation •Critical review	

Evaluation scenario/option(s)
Project stage

Additional info/notes

Part 2: Basic steps in making a life cycle GWP calculation

Calculation methodology

1. Goal, scope and scenario definition (= building description)
2. Life cycle stages modelling, divided into building's modules (e.g. B6)
3. Mass and energy balances → mass and energy flows incl. direct GHG emissions (e.g. from combustion)
4. Life Cycle Inventory (LCI) data → Quantify indirect GHG emissions (embodied in materials and energy carriers)
5. Interpretation stage: critical analysis of results, of what they mean and not

Linked indicators and life cycle tools

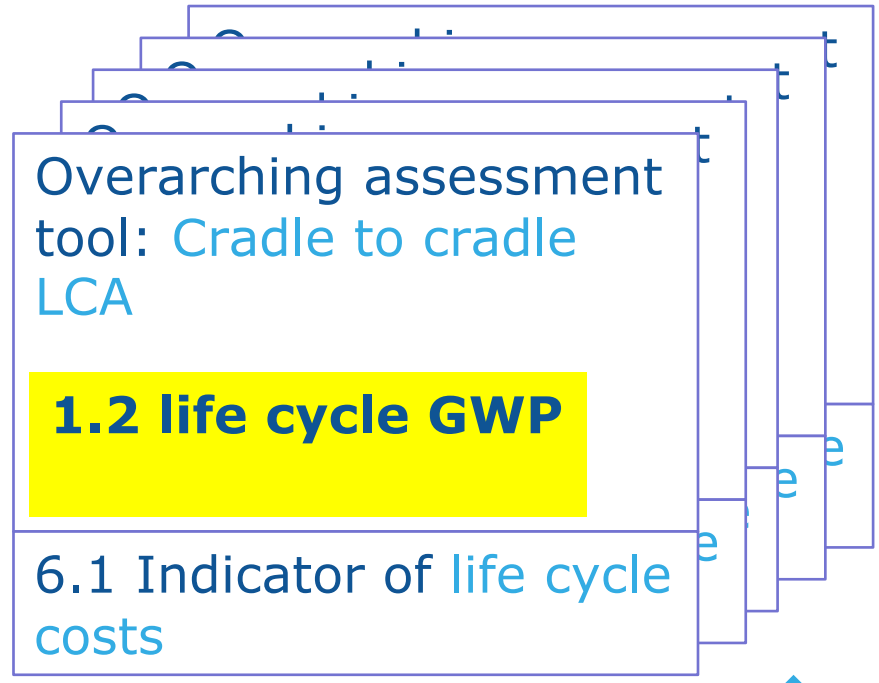
1.1 Indicator of use stage energy performance

2.1 Building bill of materials (BoM)

2.3 Waste

3.1 Indicator of use stage water consumption

Other input (e.g. LCI, CF)



2.2 Life cycle tools which focus on resource efficiency:

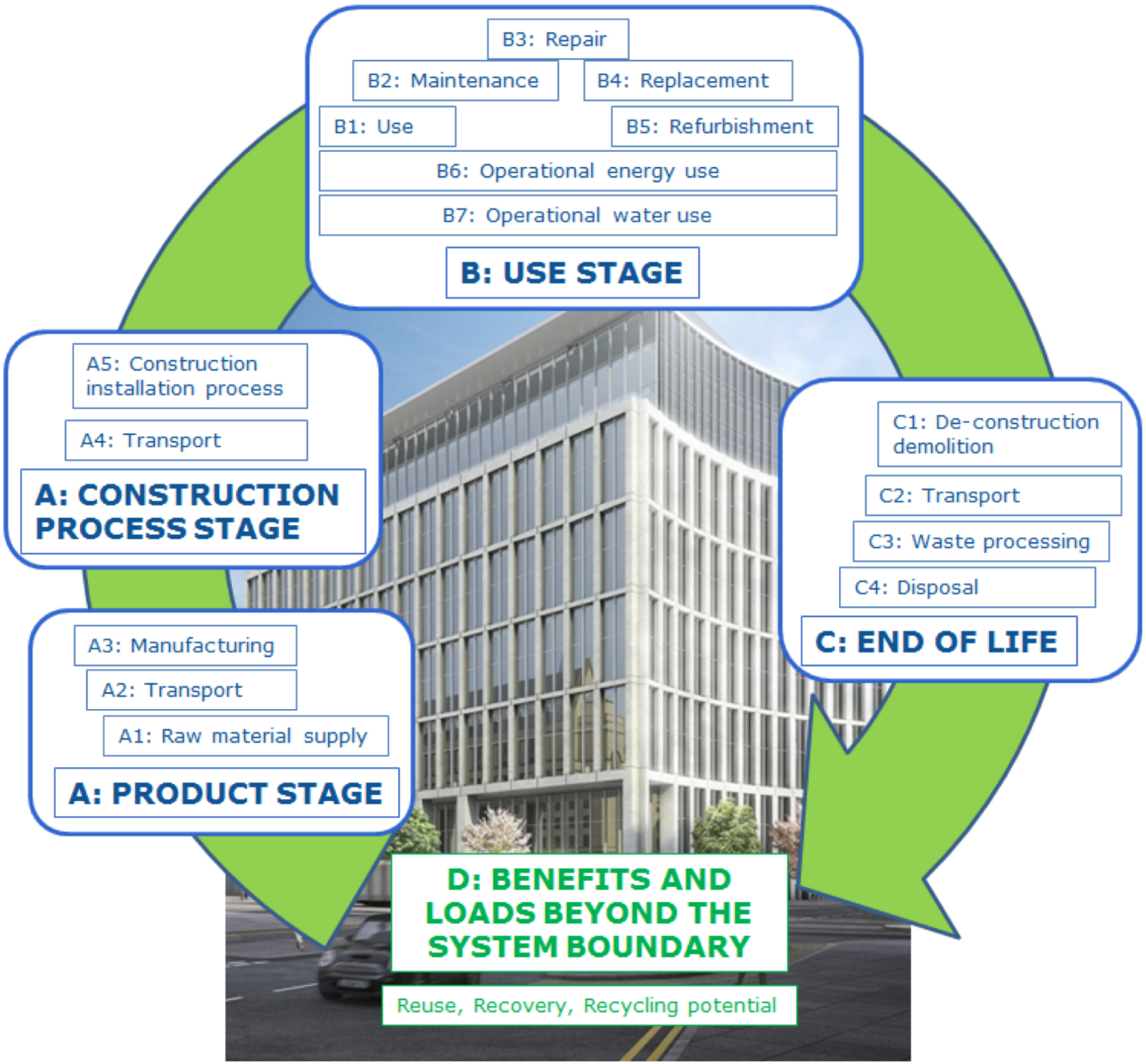
- Scenario 1: Building and elemental service life planning
- Scenario 2: Design for adaptability and refurbishment
- Scenario 3: Design for deconstruction, reuse and recyclability

5.1 Life cycle tools: scenarios for projected future climatic conditions

Simplified assessment rules

- Challenging compilation of sufficient life cycle inventory data
- Design professionals may not have the expertise to make meaningful assumptions and choices
- Simplified life cycle modelling possible (Levels 1 and 2):
  - ✓ minimum life cycle boundaries and scope of building elements
  - ✓ focus on life stages in which material use and environmental impacts will have taken place upon completion of the building, and will be directly influenced by design decisions
  - ✓ results shall clearly be reported as based on an 'incomplete life cycle'
- Assumptions and limitations to be reflected in the interpretation stage

Full Life Cycle



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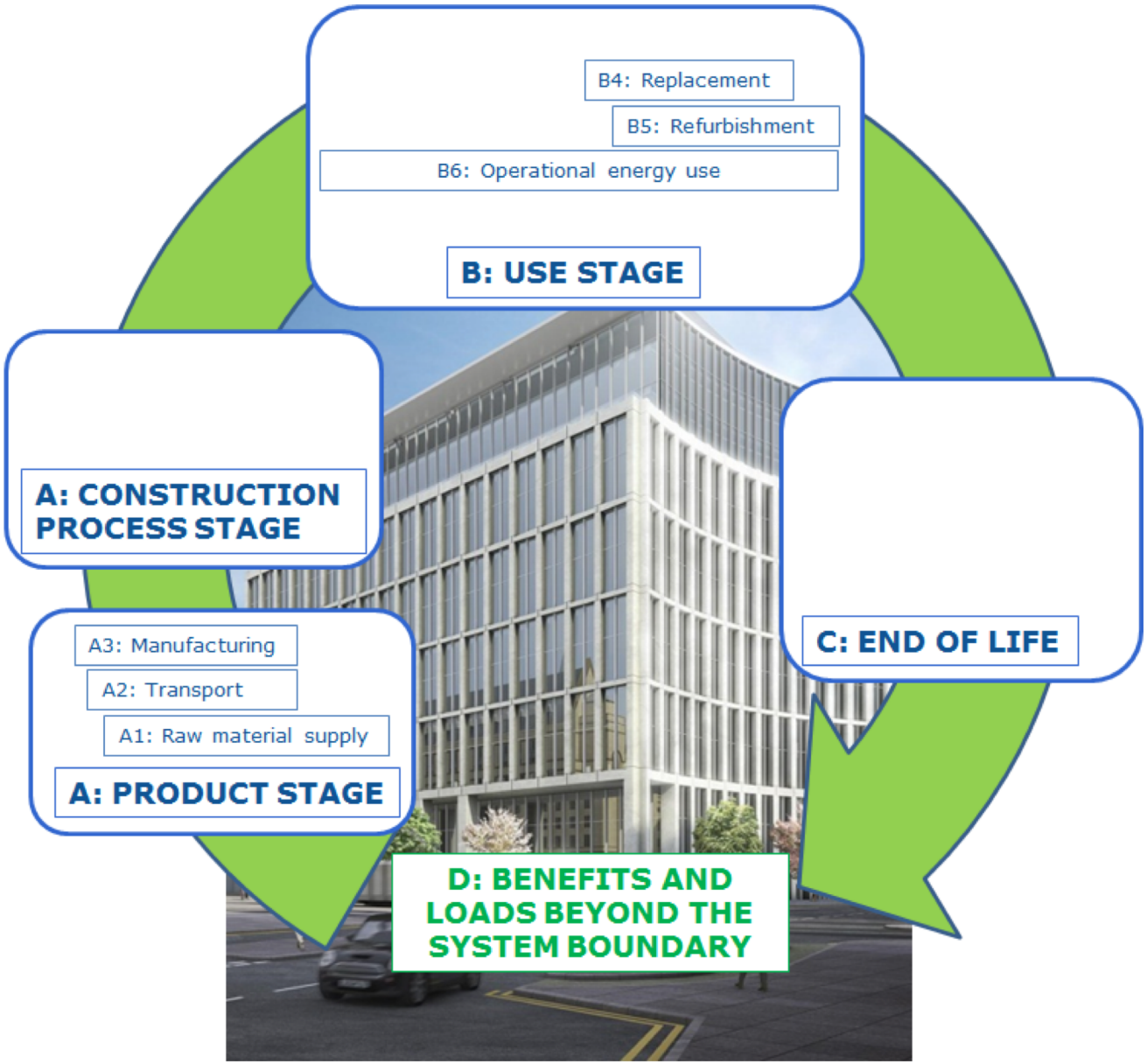
Simplified reporting option 1: 'incomplete life cycle: product stage, calculated energy performance and projected service life'



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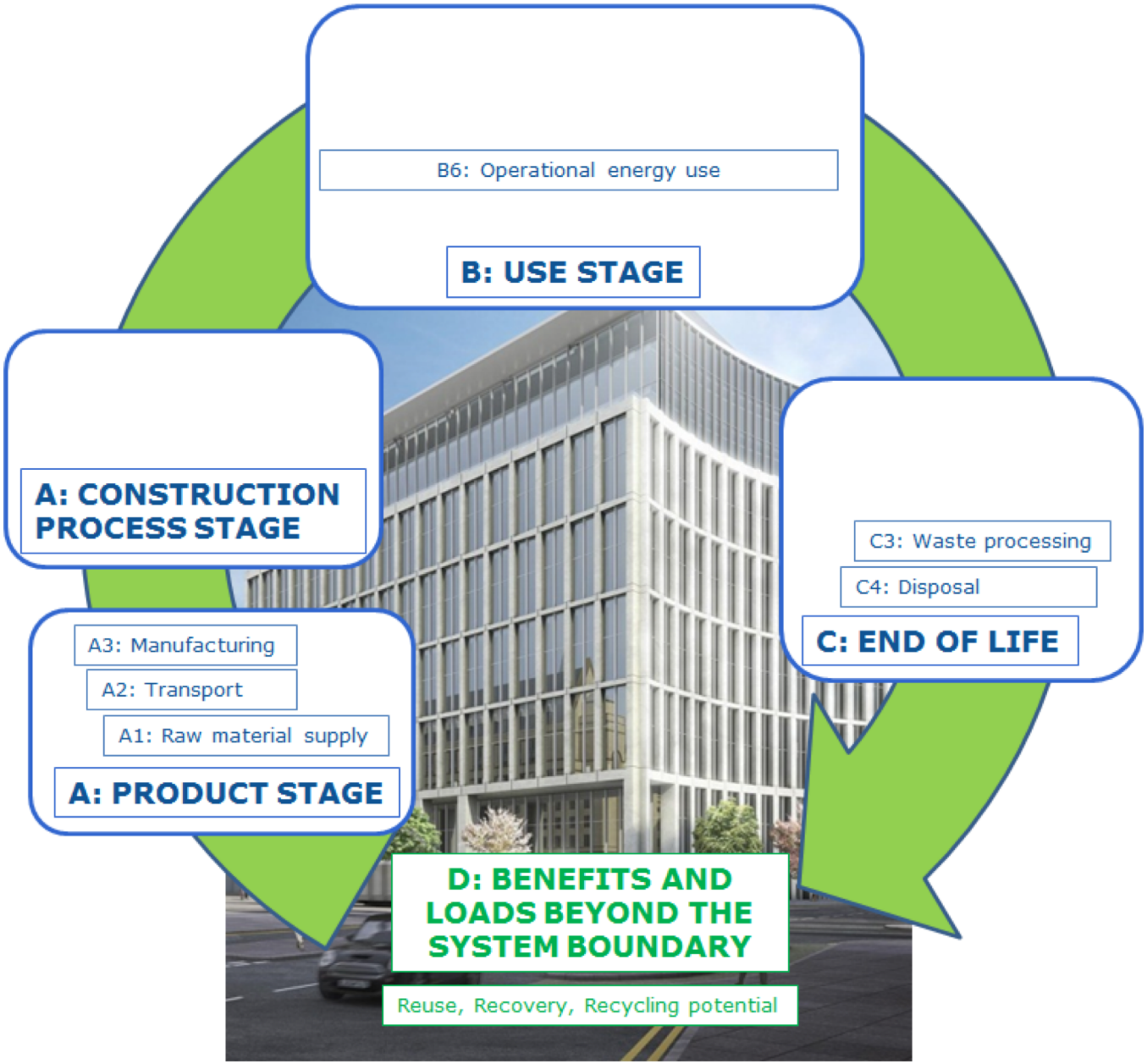
Simplified reporting option 2: 'incomplete life cycle: product stage, calculated energy performance and the building material bank'



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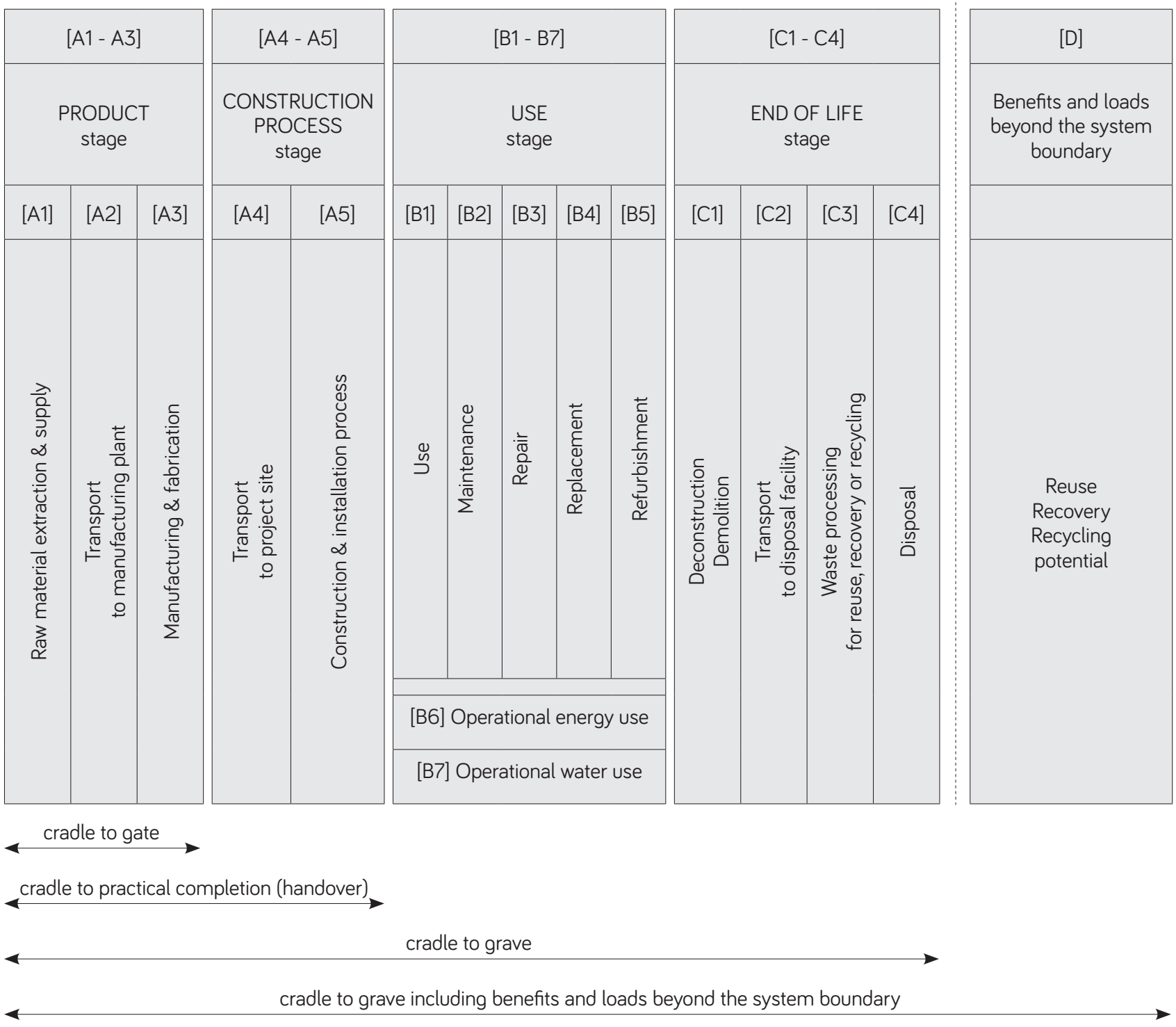
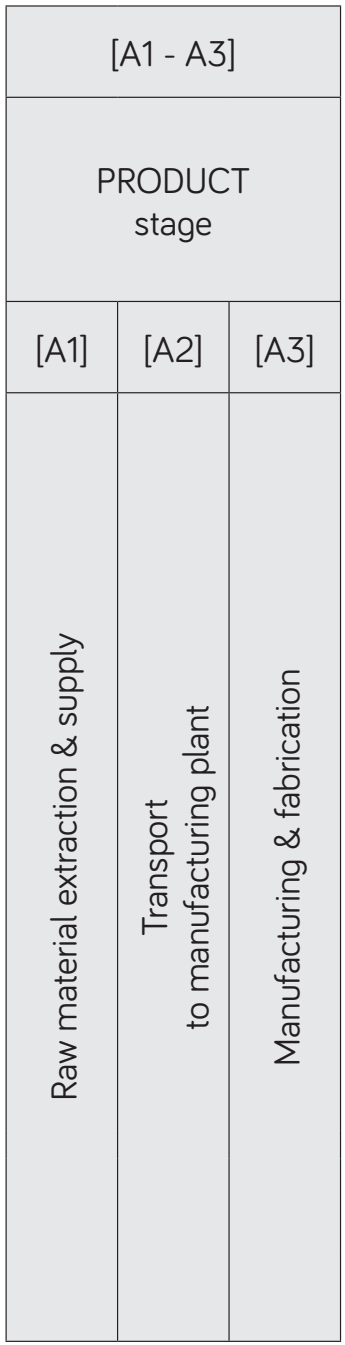
Whole life cycle GWP

$$GWP_{b,life\text{-}cycle} = GWP_{b,\ A1\text{-}A3} + GWP_{b,A4} + GWP_{b,A5} + GWP_{b,B1\text{-}B5} + GWP_{b,B6} + GWP_{b,C1\text{-}C4} + GWP_{b,D}$$

$GWP_{b,life\text{-}cycle}$	**Building life-cycle GWP (kg_{CO2e}/m^2)**
$GWP_{b,A1\text{-}A3}$	Building products GWP (kg_{CO2e}/m^2)
$GWP_{b,A4}$	Building transport GWP (kg_{CO2e}/m^2)
$GWP_{b,A5}$	Building construction GWP (kg_{CO2e}/m^2)
$GWP_{b,B1\text{-}B5}$	Building embodied use stage GWP (kg_{CO2e}/m^2)
$GWP_{b,B6}$	Building operational energy use GWP (kg_{CO2e}/m^2)
$GWP_{b,C1\text{-}C4}$	Building end of life GWP (kg_{CO2e}/m^2)
$GWP_{b,D}$	Building benefits and loads GWP (kg_{CO2e}/m^2)


[A1 - A3]
PRODUCT stage
[A1]
Raw material extraction & supply
[A2]
Transport to manufacturing plant
[A3]
Manufacturing & fabrication
[A4 - A5]
CONSTRUCTION PROCESS stage
[A4]
Transport to project site
[A5]
Construction & installation process
[B1 - B7]
USE stage
[B1]
Use
[B2]
Maintenance
[B3]
Repair
[B4]
Replacement
[B5]
Refurbishment
[B6] Operational energy use
[B7] Operational water use
[C1 - C4]
END OF LIFE stage
[C1]
Deconstruction Demolition
[C2]
Transport to disposal facility
[C3]
Waste processing for reuse, recovery or recycling
[C4]
Disposal
[D]
Benefits and loads beyond the system boundary
Reuse
Recovery
Recycling
potential
cradle to gate
cradle to practical completion (handover)
cradle to grave
cradle to grave including benefits and loads beyond the system boundary

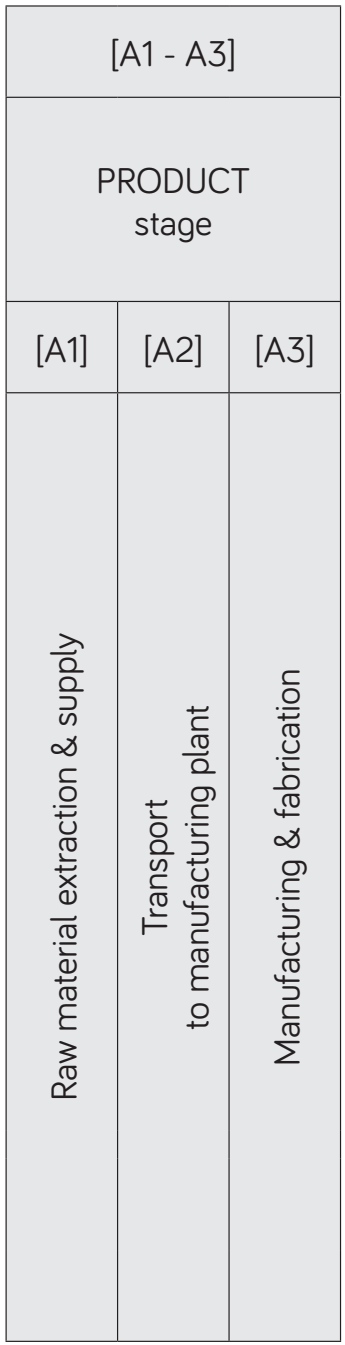


$GWP_{b,A1\text{-}A3}$ = Building products GWP (kg_{CO2e}/m^2)
= Material quantity x Material characterisation factor

BoQ
BIM

EPDs
Databases
Tools

Bill of Quantities	**Technical Specifications**	**Composition**
100 m^2 of foundation	Strength: 50 MPa	• 1 m^3/m^2 of unreinforced concrete with strength of 50 MPa and density of 2370 kg/m^3 (of which, cement: 200 kg/m^3). • 10 kg/m2 of light-grade steel
10 columns	Strength of each column: 20 MPa	• 0.5 m^3/column of reinforced concrete with strength of 20 MPa and density of 2420 kg/m^3 (of which, cement: 290 kg/m^3, steel: 30 kg/m^3)
10 window units	Area of each unit: 3m^2 U: 1.5 W/m^2K	• Aluminium, 5 kg/unit • Plastic (PA), 0.1 kg/unit • Glass, 2.5 kg/unit
10 doors	Area of each door: 1 m^2 Thickness: 19 mm	• Hardwood (0.8 kg/dm^3), 15.2 kg/unit



$GWP_{b,A1\text{-}A3}$ = Building products GWP (kg_{CO2e}/m^2)
= Material quantity x Material characterisation factor

BoQ
BIM

EPDs
Databases
Tools

Bill of Materials	**without considering the expected lifetime of the building's elements**	
Metals	1200 kg	Steel, 1000 kg (foundation) Steel, 150 kg (columns) Aluminium, 50 kg
Non-metallic mineral materials	248975 kg	Concrete, 237000 kg (foundation) Concrete, 11950 kg (columns) Glass, 25 kg
Fossil energy materials	1 kg	Plastic (PA), 1 kg
Biomass based materials	152 kg	Hardwood, 152 kg

Minimum scope of building parts and related building elements

Shell (substructure and superstructure)

- ✓ Foundations (substructure)
- ✓ Load-bearing structural frame
- ✓ Non-load-bearing elements
- ✓ Facades
- ✓ Roof
- ✓ Parking facilities

Core (fittings, furnishings and services)

- ✓ Fittings and furnishings
- ✓ In-built lighting system
- ✓ Energy system
- ✓ Ventilation system
- ✓ Sanitary systems
- ✓ Other systems

External works

- ✓ Utilities
- ✓ Landscaping

Contribution of Bill of Materials to 1.2

Indicator 2.1

1. Compile the Bill of Quantities (elements): A BoQ is compiled
2. Identify the basic composition of each building element: A breakdown in mass of the main materials that each building element is made up of should be compiled.
3. Identify the technical specification of each building element: This technical information will, later, if there is a lack of specific data from manufacturers, enable the selection of representative data from within a generic life cycle inventory database.
4. Aggregation by material: The materials should be aggregated to obtain the mass for each type of material, as well as the four material types accounted for by Eurostat:
   - ✓ Metal materials
   - ✓ Non-metallic mineral materials
   - ✓ Fossil energy materials
   - ✓ Biomass based materials

BOM x Characterization Factors ➔ contribution to indicator 1.2

[A1 - A3]		
PRODUCT stage		
[A1]	[A2]	[A3]
Raw material extraction & supply	Transport to manufacturing plant	Manufacturing & fabrication

$GWP_{b,A1\text{-}A3}$ = Building products GWP (kg_{CO2e}/m^2)
= Material quantity x Material characterisation factor

↓ BoQ
BIM

↓ EPDs
Databases
Tools

Summary of
Environmental Product Declaration

Central Concrete

Mix 340PG9Q1

San Jose Service Area

EF V2 Gen Use P4000 3" Line 50% SCM

Performance Metrics

28-day compressive strength	4,000 psi
Slump	4.0 in

Environmental Impacts

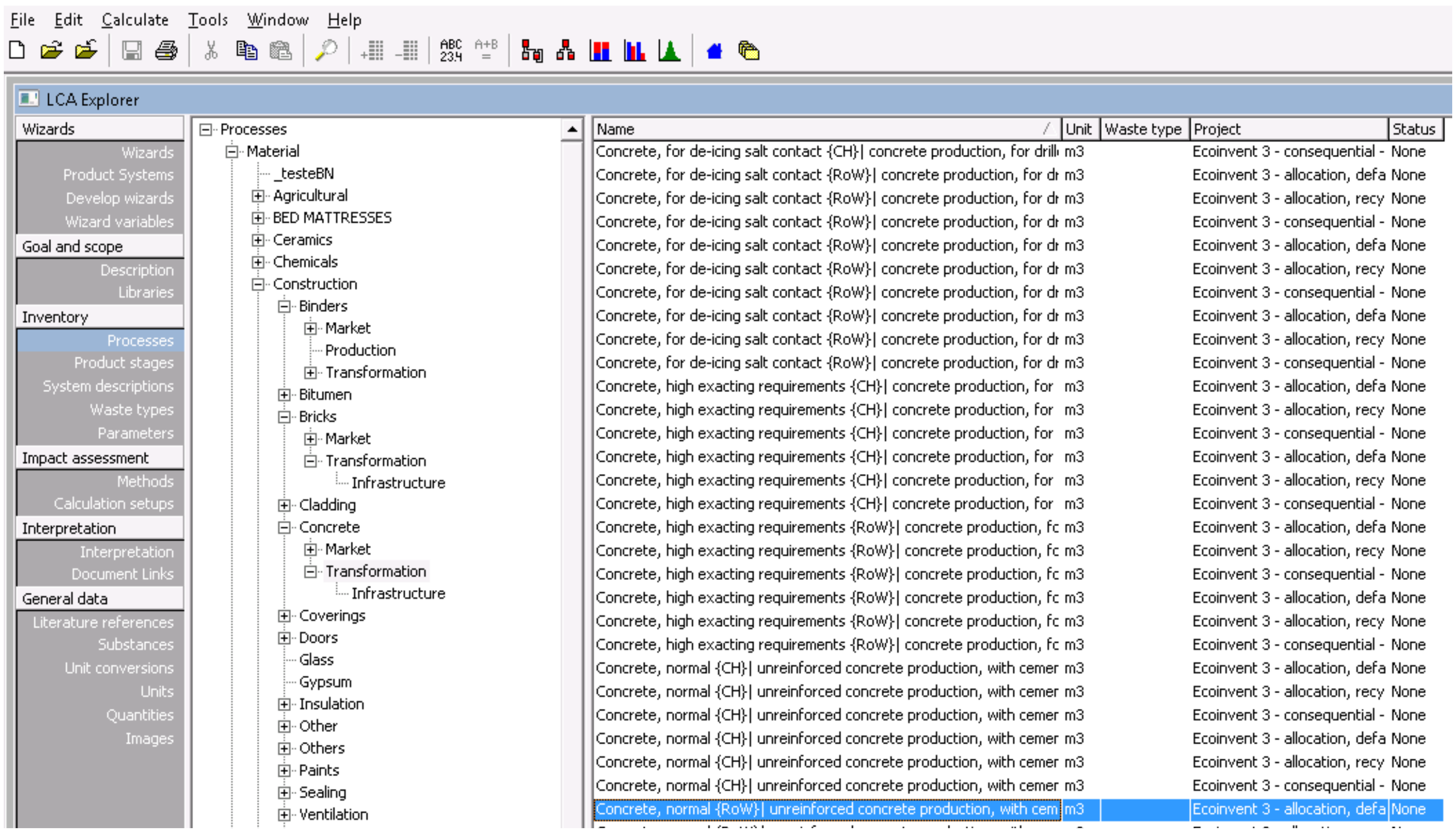
Impact name	Unit	Impact per m3	Impact per cyd
Total primary energy consumption	MJ	2,491	1,906
Concrete water use (batch)	m3	6.66E-2	5.10E-2
Concrete water use (wash)	m3	8.56E-3	6.55E-3
Global warming potential	kg CO2-eq	271	207
Ozone depletion	kg CFC-11-eq	5.40E-6	4.14E-6
Acidification	kg SO2-eq	2.26	1.73
Eutrophication	kg N-eq	1.31E-1	1.00E-1
Photochemical ozone creation	kg O3-eq	46.6	35.7

[A1 - A3]		
PRODUCT stage		
[A1]	[A2]	[A3]
Raw material extraction & supply	Transport to manufacturing plant	Manufacturing & fabrication

$GWP_{b,A1-A3}$ = Building products GWP (kg_{CO2e}/m^2)
= Material quantity x Material characterisation factor

↓ BoQ
BIM

↓ EPDs
Databases
Tools



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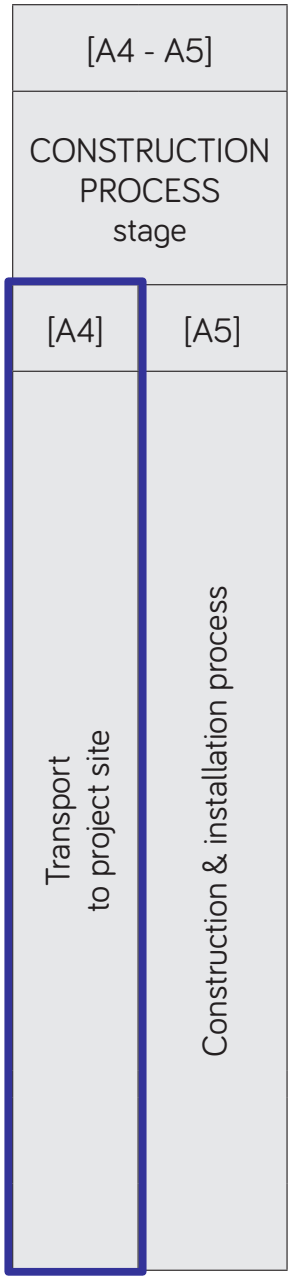
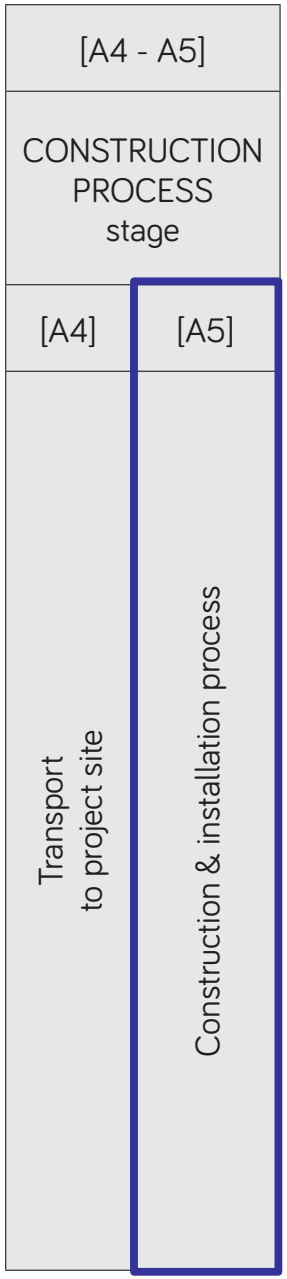


$GWP_{b,A4}$ = Building transport GWP (kg_{CO2e}/m^2)

= Material mass x transport distance x transport characterisation factor

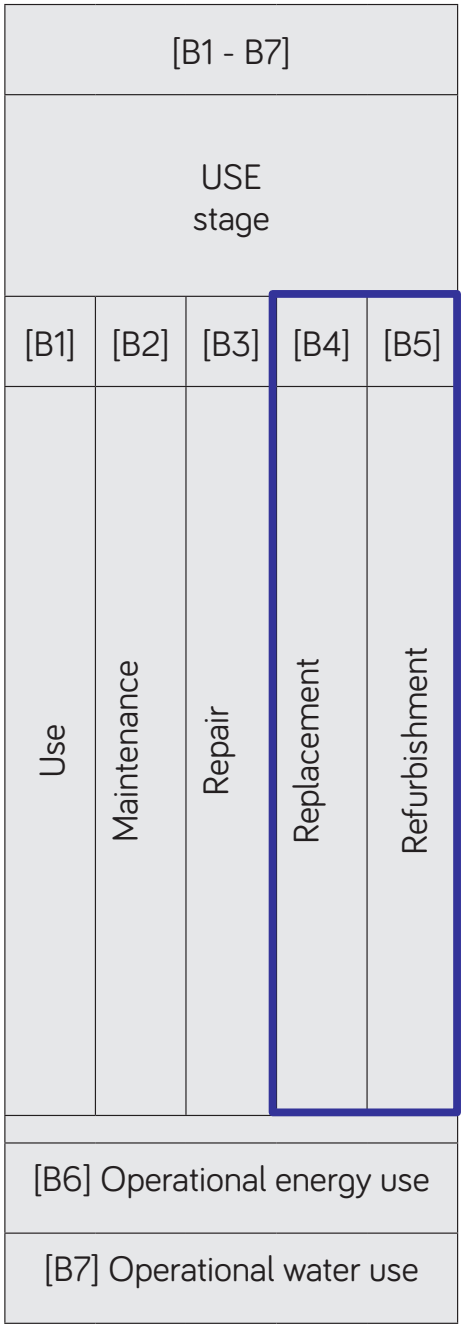
Transportation Mode	Factor	Unit
AirFreight: Short-haul international	2.31277	kg_{CO2e}/tkm
AirFreight: Long-haul international	1.27944	kg_{CO2e}/tkm
RailFreight: Diesel / Electric	0.02601	kg_{CO2e}/tkm
RoadFreight: All rigids - UK average	0.21249	kg_{CO2e}/tkm
RoadFreight: All artics - UK average	0.0855	kg_{CO2e}/tkm
RoadFreight: ALL HGVs - UK average	0.11364	kg_{CO2e}/tkm
RoadFreight: Van <3.5t	0.557671248	kg_{CO2e}/tkm
ShipFreight: Bulk carrier	0.003518	kg_{CO2e}/tkm
ShipFreight: General cargo	0.013155	kg_{CO2e}/tkm

Example UK (DEFRA)



$GWP_{b,A5}$ = Building construction GWP (kg_{CO2e}/m^2)

- Site monitoring data: Diesel 2.68 kg_{CO2e}/l - Electricity 0.46 kg_{CO2e}/kWh
- Construction waste
- Example BRE Targets: 1400kg_{CO2e}/£100k
- Example Environmental Agency tool: 0.01 kg_{CO2e}/£



$GWP_{b,B1-B5}$ = Building embodied use stage GWP (kg_{CO2e}/m^2)

60 years reference

Building part	Building elements/components	Expected lifespan
Roof	Roof coverings	30 years
Superstructure	Internal partitioning and dry lining	30 years
Finishes	Wall finishes: Render/Paint	30/10 years respectively
	Floor finishes Raised Access Floor [RAF]/Finish layers	30/10 years respectively
	Ceiling finishes Substrate/Paint	20/10 years respectively
FF&E	Loose furniture and fittings	10 years
	Heat source, e.g. boilers, calorifiers	20 years
	Space heating and air treatment	20 years
	Ductwork	20 years

Example UK (RICS)

$GWP_{b,B1-B5}$ = Building operational energy use

GWP (kg_{CO2e}/m^2)

Indicator 1.1 guidance

- *Design stage*: simplified modelling for building permitting or advanced simulation
- *Use stage*: monitoring

Building end of life GWP (kg_{CO2e}/m^2)

- *Deconstruction*
  = average rates for example 3.4 kg_{CO2e}/m^2
- *Transport emissions*
  = mass of waste to be transported x distance to disposal site x transport factor
- *Waste processing emissions*
  = mass of waste x C3 factors from EPDs
- *Disposal (landfill or incineration) emissions*
  = average rates for example 0.016 kg_{CO2e}/kg_{waste} from Ökobaudat

[D]

Benefits and loads beyond the system boundary

Reuse
Recovery
Recycling potential

Benefits and loads beyond the system boundary

Module D = benefits & loads beyond the system

- *Benefits* e.g. avoided production of primary material
- *Loads* e.g. processes needed for recycling materials

Part 3: Options available in terms of CO2 factors and LCI data

Toolkit of guidance and support

Dynamic list:

- Software tools and data for LCA
- + specific tools for GHGs
- http://susproc.jrc.ec.europa.eu/Efficient_Buildings/documents.html

In general:

- Heterogeneous level of experience across Europe
- Specific and verified LCA data (EPDs) is more reliable
- Databases are important resources

➔ Link to Member State or pan EU initiatives (work ongoing)

Non-exhaustive list of LCA software tools which can be used for carrying-out the LCA of a building (e.g. for design optimisation or certification)		
Name	Link	Tool
Athena (Canada)	http://www.athenasmi.org/our-software-data/impact-estimator/	Building-specific
BEES (USA)	http://www.nist.gov/el/economics/BEESSoftware.cfm/	Building-specific
Bilan Produit ADEME	http://www.ademe.fr/internet/bilan_produit/login.asp	Generic
COCON (France)	http://eosphere.fr/COCON-comparaison-solutions-constructives-confort.html	Building-specific
Eco-bat (Switzerland)	http://www.eco-bat.ch/index.php?option=com_content&task=blogcategory&id=14&Itemid=30	Building-specific
EcoCalculator (Canada)	http://www.athenasmi.org/tools/ecoCalculator/	Building-specific
EcoEffect (Sweden)	http://www.ecoeffect.se/	Building-specific
ECO-QUANTUM (The Netherlands)	http://www.ivam.uva.nl/?id=2&L=1	Building-specific
ECOSOFT (Austria)	http://www.ibo.at/en/ecosoft.htm	Building-specific
EIME	http://www.codde.fr/page.php?rubrique=20	Generic
ELODIE (France)	http://www.elodie-cstb.fr/default.aspx	Building-specific
envest 2 (UK)	http://envestv2.bre.co.uk/	Building-specific
EQUER (France)	http://www.izuba.fr/logiciel/equer	Building-specific
GaBi	http://www.gabi-software.com	Generic
GaBi-Build-IT (Germany)	http://www.pe-international.com/sweden/services-solutions/green-building/building-lca/	Building-specific
GreenCalc+ (The Netherlands)	http://www.greencalc.com/	Building-specific
LEGEP (Germany)	http://www.legep-software.de/	Building-specific
OpenLCA	http://www.openlca.org/index.html	Generic
SimaPro	http://www.pre-sustainability.com	Generic
SBS (Germany)	http://www.sbs-onlinetool.com	Building-specific
TEAM	https://ecobilan.fr	Generic
Umberto	http://www.umberto.de/en/	Generic
Available certification schemes in Europe		
BREEAM (British system for the labelling of buildings)	http://www.breeam.org/	
DGNB (German system for the labelling of buildings)	http://www.dgnb.de/dgnb-ev/de/	
HQE (French system for the labelling of buildings)	http://assohqe.org/hqe/spip.php?rubrique45	
VERDE (Spanish system for the labelling of buildings)	http://www.gbce.es/pagina/certificacion-verde	

Non-exhaustive list of LCA and EPD databases for the construction sector	
ACLCA Product Category Rules (USA)	http://lcacenter.org/product-category-rule.aspx
ASTM EPD (USA) (Verified ISO 21930)	https://www.astm.org/CERTIFICATION/EpdAndPCRs.html
Australasian EPD	http://www.epd-australasia.com/
Base carbone ADEME (France)	http://www.basecarbone.fr/
Bau EPD (Austria)	http://www.bau-epd.at/en/building-materials-with-transparency/
Bauteil Katalog (Swiss)	http://www.bauteilkatalog.ch/ch/fr/catalogueconstruction.asp
BRE Environmental Profiles (UK) (ISO 21930)ISO	https://www.bre.co.uk/Environmental_Profiles.html
BRE Verified EN 15804 EPD (UK)	http://www.bre.co.uk/greenguide/page.jsp?id=558
CSA EPD (Canada) (Verified ISO 21930)	http://www.csaregistries.ca/epd/about_epd_pcrs_e.cfm
DAP construcción (Spain)	http://www.csostenible.net/index.php/es/sistema_dapc
DAP Habitat (Portugal)	http://daphabitat.pt/?page_id=461
DIOGEN (France)	www.diogen.fr
Ecoinvent	http://www.ecoinvent.org/database/database.html
ELCD	http://eplca.jrc.ec.europa.eu/ELCD3/index.xhtml?stock=default
EPD Danmark (Denmark)	http://www.epddanmark.dk/site/index.html
EPD Italy	http://www.epditaly.it/
EPD Latin America	https://www.epd-americalatina.com/
EPD Norge (Norway)	http://www.epd-norge.no/category.php?categoryID=386
EPD Turkey	http://www.epdturkey.org/
ESUCO (Europe)	http://www.dgnb-international.com
European Aluminium EPD Programme	http://european-aluminium.eu/resource-hub/building-products-epd-programme/
FDES (FR) Unverified EPD to EN 15804	http://www.fdes-eco-construction.com/ensavoirplus/fdes/quest-ce-quune-fdes
Gabi Database	
GEDNet Global Environmental Declarations Network (Global)	http://gednet.org/
Global EPD (Spain)	https://www.en.aenor.es/aenor/certificacion/mambiente/globalepd.asp
Green Book Live: Environmental Profiles (UK)	http://www.greenbooklive.com/search/scheme.jsp?id=9
IBO LCA database (Austria)	http://www.ibo.at/en/index.htm
IBU (Germany)	http://bau-umwelt.de/hp474/Umwelt-Produktdeklarationen-EPD.htm
IERE Earthsure EPD (USA) (Verified (ISO 14025)	https://iere.org/programs/earthsure/
INIES FDES (France)	http://www.inies.fr/IniesConsultation.aspx
International EPD (Sweden)	http://www.environdec.com/Epd-Search/?Category=6196
ITB-EPD (Poland)	
Leitfaden database (Luxembourg)	http://www.crtib.lu/de/leitfaden-fuer-nachhaltiges-bauen
Minnesota Building Materials Database (USA)	http://www.buildingmaterials.umn.edu/materials.html
MRPI (NL) (Verified EN 15804 not publicly available)	http://www.mrpi.nl/
MRPI (The Netherlands)	http://www.mrpi.nl/Deelnemers/Certificaten/tabid/71/ctl/CustomersDocumentDetails/mid/399/VendorID/1/language/en-US/Default.aspx
NSF EPD (USA) (Verified ISO 14025)	http://www.nsf.org/newsroom/nsf-international-verifies-first-environmental-product-declaration-for-wate
Ökobau.dat (Germany)	http://oekobaudat.de/datenbank/browser-oekobaudat.html
PEP-EcoPassport (Building related) (Verified ISO 14025)	http://www.pep-ecopassport.org/
PEP Ecopasseport (France)	http://www.pep-ecopassport.org/
PlasticsEurope (Europe)	http://www.plasticseurope.org/plastics-sustainability/life-cycle-thinking/epd-reports.aspx
SCS EPD (USA) (Verified ISO 14025)	
SCS EPD (USA) (Verified ISO 21930)	
SCS Global Services (USA)	https://www.scsglobalservices.com/
The Athena Institute database (Canada)	http://www.athenasmi.org/our-software-data/overview/
UL Environment USA	http://industries.ul.com/environment
WorldSteel (Global)	http://www.worldsteel.org/?action=programs&id=62
ZAG EPD (Slovenia)	http://www.zag.si/en/

Calculation tools and data

Tools:

- **Freely available** (*e.g. OpenLCA*) vs. **commercial price** (*e.g.* Carbon Footprint Ltd, CarbonScopeData™, *GaBi, SimaPro*) software tools
- **Simplified** (e.g. excel-based, IT interface) vs. more **complex** tools (*e.g. GaBI, OpenLCA, Simapro*)
- **Generic** (*e.g. GaBi, SimaPro*) vs. **building-specific** software tools (e.g. BEES, ATHENA, ELODIE and SB Tool)
- **Full LCA** vs c**arbon-specific** tools (e.g. Carbon Footprint Ltd, CarbonScopeData™)

Data:

- **Freely available** (e.g. ELCD) vs. **commercial price** (e.g. Bauteil katalog, Ecoinvent, GaBi) database
- **Specific** (e.g. Bauteil katalog, EPDs) or **generic** (e.g. Ecoinvent, GaBi) data for construction products and materials

Where to find factors?

Environmental Product Declarations (EPDs)

More accurate than generic LCA data

Databases

Used when primary data related to product not available

LCA software

Used by LCA experts or LCA beginners when LCA data of product or similar product is not available and more precise/accurate data is required

Databases

	Building-specific	Cost	User-friendly	Robustness
	Specific	Partially costly	User-friendly but not in English	Comprehensive
ecoinvent	Generic	Commercial	Requires LCIA understanding	Third party verified
ÖKOBAUDAT PORTAL NACHHALTIGES BAUEN	Specific	Open-source	User-friendly but not in English	Comprehensive
GaBi Software PRODUCT SUSTAINABILITY	Generic	Commercial	Requires LCA understanding	Black box
INVENTORY OF CARBON & ENERGY (ICE)	Specific	Open-source	User-friendly	Comprehensive No update since 2011

N.B.: Examples, not recommendations, see dynamic list

Databases

INVENTORY OF CARBON & ENERGY (ICE)

INVENTORY OF CARBON & ENERGY (ICE) SUMMARY										
Materials	Embodied Energy & Carbon Coefficients									Comments
	EE - MJ/kg			EC - kgCO2/kg			EC - kgCO2e/kg			EE = Embodied Energy, EC = Embodied Carbon
Concrete										
General	0.75			0.100			0.107			It is strongly recommended to avoid selecting a 'general' value for concrete. Selecting data for a specific concrete type (often a ready mix concrete) will give greater accuracy, please see material profile. Assumed cement content 12% by mass.
16/20 Mpa	0.70			0.093			0.100			Using UK weighted average cement (more representative of 'typical' concrete mixtures).
20/25 MPa	0.74			0.100			0.107			
25/30 MPa	0.78			0.106			0.113			
28/35 MPa	0.82			0.112			0.120			
32/40 MPa	0.88			0.123			0.132			
40/50 MPa	1.00			0.141			0.151			
% Cement Replacement - Fly Ash	0%	15%	30%	0%	15%	30%	0%	15%	30%	Note 0% is a concrete using a CEM I cement (not typical)
GEN 0 (6/8 MPa)	0.55	0.52	0.47	0.071	0.065	0.057	0.076	0.069	0.061	Compressive strength designation C6/8 Mpa. 28 day compressive strength under British cube method of 8 MPa, under European cylinder method 6 MPa. Possible uses: Kerb bedding and backing. Data is only cradle to factory gate but beyond this the average delivery distance of ready mix concrete is 8.3 km by road (see Ref. 244).

Databases

ÖKOBAUDAT -> 1. Mineral building products -> 1.4 Mortar and Concrete

1.4.01 Ready mixed concrete
1.4.02 Mortar (masonry)
1.4.03 Screed dry mortar
1.4.04 Renders and plasters
1.4.05 Adhesive and adhesive mortar

Total number of datasets: 1218 as of 05.11.2018

European Commission

Databases

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Total number of datasets: 1218 as of 05.11.2018

ÖKOBAUDAT -> 1. Mineralische Baustoffe -> 1.4 Mörtel und Beton -> 1.4.01 Beton

Beton der Druckfestigkeitsklasse C 20/25	HTML - XML
Beton der Druckfestigkeitsklasse C 25/30	HTML - XML
Beton der Druckfestigkeitsklasse C 30/37	HTML - XML
Beton der Druckfestigkeitsklasse C 35/45	HTML - XML
Beton der Druckfestigkeitsklasse C 45/55	HTML - XML
Beton der Druckfestigkeitsklasse C 50/60	HTML - XML

Databases

ÖKOBAUDAT -> 1. Mineral building products -> 1.4 Mortar and Concrete

- 1.4.01 Ready mixed concrete
- 1.4.02 Mortar (masonry)
- 1.4.03 Screed dry mortar
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Beton der Druckfestigkeitsklasse C 35/45	HTML - XML
Beton der Druckfestigkeitsklasse C 45/55	HTML - XML
Beton der Druckfestigkeitsklasse C 50/60	HTML - XML

Parameter zur Beschreibung der Umweltwirkungen

Indikator	Einheit	Herstellun A1-A3	Transport A4	Einbau A5	Nutzung B1	Instandha B2	Reparatur B3	Ersatz B4	Umbau/Er B5	Abbruch C1	Transport C2	Abfallbeha C3	Recycling D
Globales Erwärmungs (GWP)	kg CO_(2)-Äq.	334.7	14.8	1.35	0	0	0	0	0	3.02	0.47	1.38	-23.08
Abbau Potential der stratosphäris Ozonschicht (ODP)	kg CFC11-Äq.	9.56E-7	7.94E-10	3.06E-9	0	0	0	0	0	1.63E-14	2.65E-11	7.45E-11	-9.57E-8

Databases

Search in Activity Name, Reference Product Names and Synonyms

concrete

System Model

- ○ **Undefined**
- ◉ **Allocation, cut-off by classification**

  This system model subdivides multi-product activities by allocation, based on a physical properties, economic, mass or other properties. By-products of waste treatment processes are cut-off, as are all by-products classified as recyclable. Markets in this model include all activities in proportion to their current production volume.

- ○ **Allocation at the point of substitution**
- ○ **Substitution, consequential, long-term**

Databases

ecoinvent

Search in Activity Name, Reference Product Names and Synonyms

concrete

System Model

- ○ **Undefined**
- ◉ **Allocation, cut-off by classification**

This system model subdivides multi-product activities by allocation, based on a physical properties, economic, mass or other properties. By-products of waste treatment processes are cut-off, as are all by-products classified as recyclable. Markets in this model include all activities in proportion to their current production volume.

- ○ **Allocation at the point of substitution**
- ○ **Substitution, consequential, long-term**

14	☐	concrete production 35MPa, RNA only	concrete, 35MPa [m3]	RoW	01.01.2006 - 31.12.2016	ready-mix concrete//ready mixed concrete	PDF UPR LCI LCIA
15	☐	concrete production 50MPa, RNA only	concrete, 50MPa [m3]	CA-QC	01.01.2006 - 31.12.2016	ready-mix concrete//ready mixed concrete	PDF UPR LCI LCIA
16	☑	concrete production 50MPa, RNA only	concrete, 50MPa [m3]	RoW	01.01.2006 - 31.12.2016	ready-mix concrete//ready mixed concrete	PDF UPR LCI LCIA

Databases

Unit Process Exchanges				
Name	**Amount**	**Unit**	**Uncertainty**	**SD**
Reference Products				
+ concrete, 50MPa	1	m3		
By-product/Waste				
To Environment				
From Environment				
From Technosphere				

+ ReCiPe Midpoint (E) w/o LT

+ ReCiPe Midpoint (H)

+ ReCiPe Midpoint (H) w/o LT

+ ReCiPe Midpoint (I)

+ selected LCI results

+ selected LCI results, additional

+ TRACI

Databases

Unit Process Exchanges				
Name	**Amount**	**Unit**	**Uncertainty**	**SD**
Reference Products				
+ concrete, 50MPa	1	m3		
By-product/Waste				
To Environment				
From Environment				
From Technosphere				

+ **ReCiPe Midpoint (E) w/o LT**
– **ReCiPe Midpoint (H)**
+ agricultural land occupation
+ climate change
+ fossil depletion
+ freshwater ecotoxicity
+ freshwater eutrophication
+ human toxicity

Databases

Unit Process Exchanges				
Name	**Amount**	**Unit**	**Uncertainty**	**SD**
Reference Products				
+ concrete, 50MPa	1	m3		
By-product/Waste				
To Environment				
From Environment				
From Technosphere				
+ ReCiPe Midpoint (E) w/o LT				
– ReCiPe Midpoint (H)				
+ agricultural land occupation				
– climate change				
GWP100	343.86	kg CO2-Eq		
+ fossil depletion				
+ freshwater ecotoxicity				
+ freshwater eutrophication				
+ human toxicity				

LCA software

	Building-specific	Cost	User-friendly	Robustness
GaBi Software PRODUCT SUSTAINABILITY	Generic	Commercial	Complex full LCA	Black box
openLCA	Generic	Open-source	Complex full LCA	Comprehensive
SimaPro	Generic	Commercial	Complex full LCA	Referencing sources
Athena Impact Estimator for Buildings	Building-specific	Open-source	Simple IT interface	Black box
elodie	Building-specific	Commercial	Complex full LCA	Referencing sources
One Click LCA	Building-specific	Commercial	LCA made easy	Using regional databases

N.B.: Examples, not recommendations, see dynamic list

Software

ATHENA® EcoCalculator for assemblies

TOTAL IMPACTS BY BUILDING COMPONENT	Primary Energy (MJ) TOTAL	GWP (tonnes) TOTAL	Weighted Resource Use (tonnes) TOTAL	Air Pollution Index TOTAL	H2O Pollution Index TOTAL
COLUMNS & BEAMS	0	0	0	0	0.00
INTERMEDIATE FLOORS	0	0	0	0	0.00
EXTERIOR WALLS	0	0	0	0	0.00
WINDOWS	0	0	0	0	0.00
INTERIOR WALLS	0	0	0	0	0.00
ROOF	0	0	0	0	0.00
WHOLE BUILDING	0	0	0	0	0.00

C. EXTERIOR WALLS

ATHENA ASSEMBLY EVALUATION TOOL v2.3—Toronto Low-Rise Building

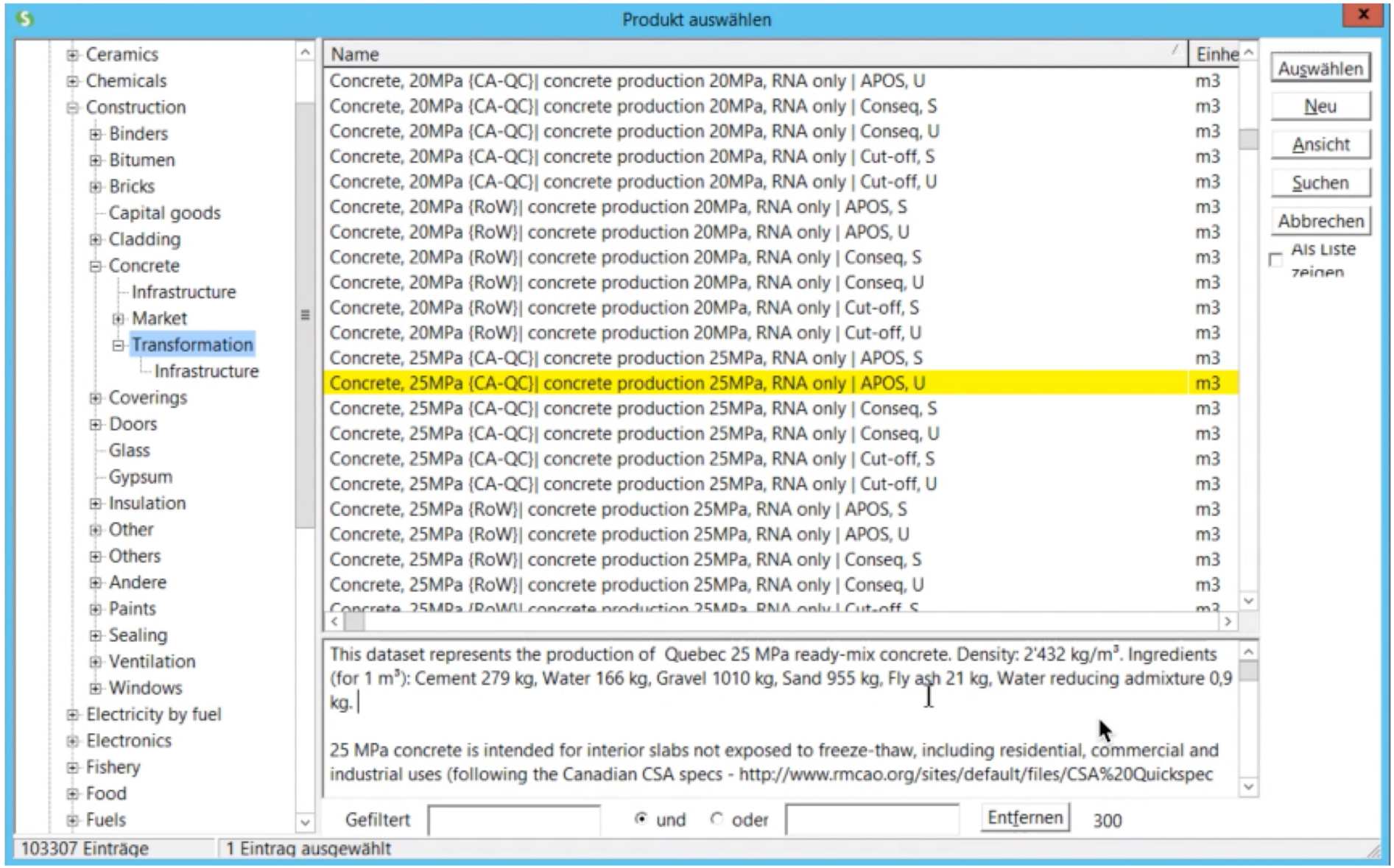
IN THE YELLOW CELLS BELOW, ENTER THE AREA (in m^2) THAT EACH ASSEMBLY IS USED IN YOUR BUILDING

		Assembly R-value	m^2	Percentage of total	Primary Energy per m^2 (MJ)	GWP per m^2 (kg)	Weighted Resource Use per m^2 (kg)	Air Pollution Index per m^2	H2O Pollution Index per m^2
Average:					1421.11	88.76	319.71	18.36	7.43
8" CONCRETE BLOCK									
1	Concrete block, brick cladding rigid insulation, vapor barrier	21.80	0		2254.83	113.76	256.98	27.99	0.0198
2	Concrete block, steel cladding, rigid insulation, vapor barrier	21.61	0		2519.28	208.41	190.63	37.45	47.3227
3	Concrete block, stucco cladding rigid insulation, vapor barrier	21.11	0		1530.64	88.82	213.63	16.79	0.0310
4	Concrete Block, EIFS, vapor barrier	16.51	0		1227.71	72.38	136.73	14.51	0.0131
5	Concrete Block, precast cladding, rigid insulation, vapor barrier	21.00	0		1464.18	93.18	301.72	16.58	0.0557
6	Concrete block, brick cladding rigid insulation, vapor barrier gypsum board, latex paint	22.36	0		2394.08	118.17	275.66	29.89	0.0198
7	Concrete block, steel cladding rigid insulation, vapor barrier gypsum board, latex paint	22.17	0		2658.52	212.82	209.30	39.35	47.3227
8	Concrete block, stucco cladding rigid insulation, vapor barrier gypsum board, latex paint	21.67	0		1669.89	93.23	232.30	18.69	0.0310
9	Concrete block, EIFS, vapor barrier, gypsum board, latex paint	17.07	0		1366.95	76.79	155.41	16.41	0.0131
	Concrete block, precast cladding, rigid								

WELCOME & HOW-TO | COLUMNS AND BEAMS | INTERMEDIATE FLOORS | **EXTERIOR WALLS** | WINDOWS | INTERIOR WALLS | ROOFS

Software

SimaPro



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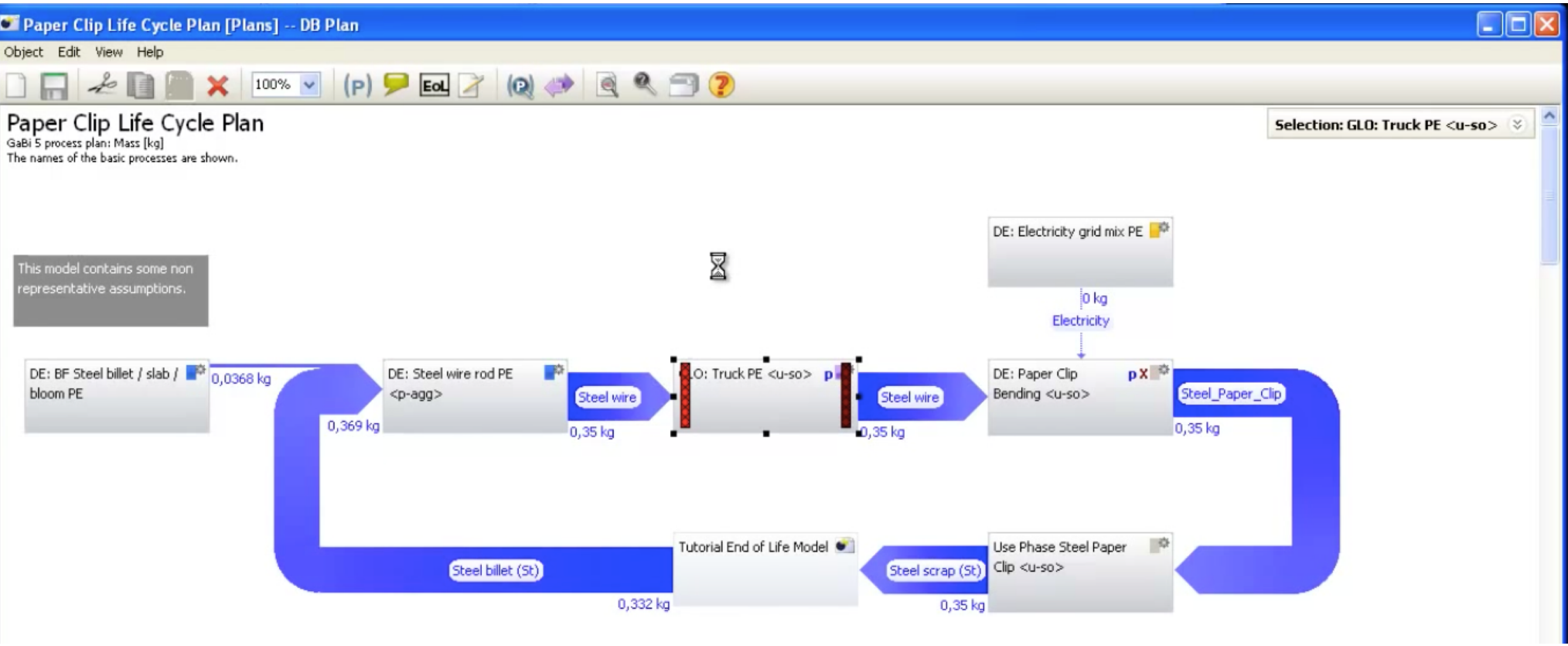
Software

GaBi Software
PRODUCT SUSTAINABILITY



European Commission

Finland

Environmental Classification PromisE 2015

- Material consumption: total use of raw materials
- Recycling rate of building materials
- Service life design
- Level of adaptability
- Waste management

Where can we find data?

- Green Building Council in Finland
- OneClickLCA (LCA software developed in Finland)
- RTS EPD (Finland) EN 15804 verified
- EPD Norge (Norway) EN 15804 verified
- International EPD and IVL Swedish Environmental Research Institute (Sweden)

Spain

VERDE NE 2015

- Service-life optimization
- Use of renewable energy for construction materials
- Renewable energy for materials transportation
- Planning of a selective demolition strategy
- Construction waste management
- Distinction between construction material impacts and energy consumption
- Space efficiency
- Development an implementation of a maintenance plan
- Construction costs

Where can we find data?

- DAP construcción
- SOFIAS (Institute of Construction Torroja)
- BEDEC, CYPE for VERDE evaluations
- TCQ, CYPE and OneClickLCA is used

Italy

Protocollo Itaca

- Reuse of existing structures
- Recycled/recovered materials
- Renewable materials
- Local materials
- Recyclable or demountable materials
- Certified materials

Where can we find data?

- EPD Italy EN 15804 verified
- If EPD not available, EcoInvent, Gabi, Ökobaudat, INIES used
- Little data on end-of-life

Poland

LEED, BREEAM, DGNB, HQE

- Poland uses American, British, German, and French certification systems

Where can we find data?

- Polish Building Research Institute (ITB) provides an EPD database of construction products EN 15804 certified
- No electronic, user-friendly version
- Waste regulation and construction code, data defined by producer

Slovenia

Pilot project Level(S)

- Knauf Insulation Experience Centre

Where can we find data?

- ZAG EPD EN 15804 verified
- If EPD not available, EcoInvent, Gabi, Ökobaudat used
- Little data on end-of-life

Steps for Member States

What do I do now ?

- National Green Building Council or National provider
- If material EPD is available: use EPD (geographical reference)
- Generic databases & LCA software

No budget	**LCA expert**	**Budget**	**Budget & time**
Open-source	Open-source	Commercial	Commercial
User-friendly	LCA software	Stripped-down	Hire LCA expert
Databases		LCA software	Comparison / Uncertainty

Part 4: More advanced options for modelling life cycle GWP

Advanced assessment rules

- Mainly an issue for performance reporting in the public domain (Level 2), as well as for design optimization (Level 3)
- More comprehensive assessment
- Methodological choices:
  - Reference modules
  - Building elements and cut-off rules for the system boundary definitions
- Definition of scenarios
- **Data quality index >2**
  - Technological/Geographical/Time-related representativeness of data
  - Precision/uncertainty
  - Rating for hot-spots
- **Critical review** + Statement on limitations on assessment

Emissions characterisation factors

Substance	Compartment	GWP 100
Carbon dioxide (fossil)	Air emission	1
Carbon dioxide (biogenic, non-renewable)	Air emission	1
Carbon dioxide (biogenic)	Resource from air	0
Carbon dioxide (biogenic)	Air emission	0
Carbon monoxide (fossil)	Air emission	1.57
Carbon monoxide (biogenic)	Air emission	0
Methane (fossil)	Air emission	25
Methane (biogenic)	Air emission	22.25
Carbon dioxide (land use change)	Resource from air	-1
Carbon dioxide (land use change)	Air emission	1

Specific carbon cycle related issues:

- '**Biomass** carbon neutrality' approach
- Credits from 'temporary carbon storage' are to be excluded, emissions as emitted `now' (no discount factor)
- Non'-regenerative use of biomass = fossil
- Net emission in case of carbon emissions of GHGs different from CO2 (based on stochiometry)
- Land use (PAS 2050:2011/2012)

System boundaries and cut off rules

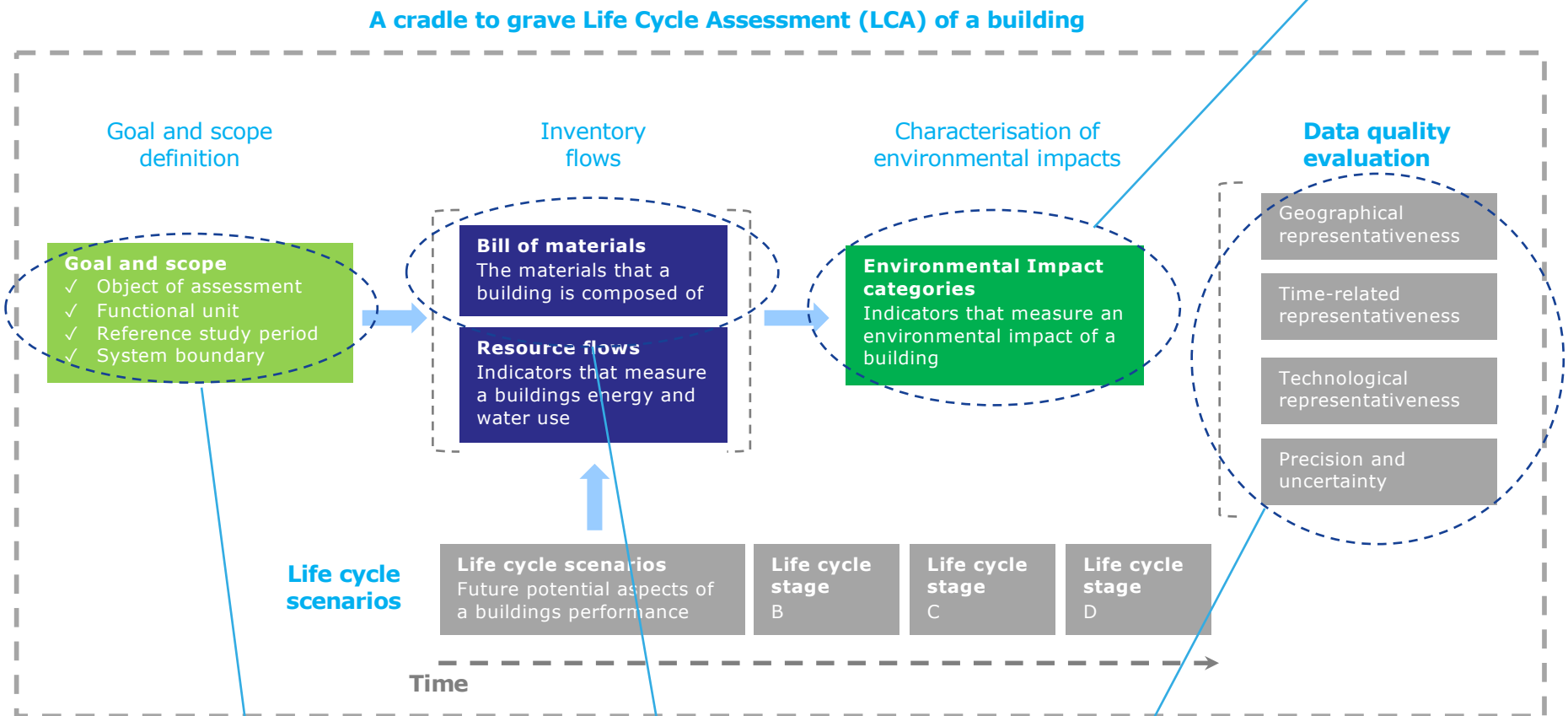
- > 95% of BOM (in terms of mass and GWP), no exclusion of material flows >1%
- > 95% of material/energy flows, no exclusion of flows >1%
- EPDs compliant with EN 15804

Module D

- Benefits (e.g. avoided production of primary material) and loads (e.g. processes needed for recycling materials) beyond the system
- Avoid double counting
- If reuse/recycling of secondary material is reported in A1-A3, not to reconsider it in D
- e.g. if 100 kg of material is to be recycled that contains 30% of secondary materials, then only 70 kg have to be considered

Using life cycle tools

How carbon cycle is represented in the calculations and scenarios



Consistent and representative scope definition

Accurate representation of the Bill of Materials

Accurate modelling of the production and use stages

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Assessment of alternative scenarios

Life cycle tools 2.2:

- Building / elemental service life planning
- Design for adaptability and refurbishment / for deconstruction, reuse and recycling

  - Offices: flexibility within the office market including change of use

  - Residential: changing family/personal circumstances, change of use

Life cycle tool 5.1:

- Scenarios for future climate conditions in 2030/2050

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Design for adaptability and refurbishment

To ensure consistency specific rules shall be followed:

- Reference assumptions: Client defined intended service life.
- Scenario definition: Property market expert input
- GWP modelling of the design option(s): The implications of adaptability measures for life cycle stage B5
- Changes of use: to reflect the new use as a second service life period.

Design for deconstruction, reuse and recycling

To ensure consistency specific rules shall be followed:

- Reference assumptions: to reflect as accurately as possible existing local practices.
- Scenario definition: demolition contractor or waste management specialist input
- GWP modelling of the design option(s): The implications of deconstruction measures for life cycle stage C1-4/D

Indicator 6.2: Valuation influence and reliability rating of reported results

Specifically directed at investors and valuers, but may be used by all building professionals.

1. Potential positive influence on value and risk management

   ✓ Increased revenues: market recognition and lower void rates
   ✓ Reduced costs: operational, maintenance, repair and/or replacement
   ✓ Reduced risk: future increases in overheads or loss of income

1. Transparency in understanding the reliability of results

   ✓ Technical basis for the performance assessment
   ✓ Technical capability of performance assessors
   ✓ Independent verification of the assessment

Reliability rating of the assessment
Data quality Evaluation

Data:

- Foreground (e.g. the consumption of electricity during the use stage) vs. background (e.g. the production and supply of grid electricity) processes
- Primary (site-specific and directly measured) vs. secondary data
- Variable representativeness and accuracy
- Particularly important for Levels 2 and 3

PEF-inspired evaluation matrix

- Technology, Geography, Time, Uncertainty
- Main contributions to total impacts (hot-spots)
- DQI = ((TeR+GR+TiR)/3+U)/2
- DQI overall = Σi (DQI hot-spot,i x Contribution hot-spot,i) / Σi (Contribution hot-spot,i)

Rating aspect	***Brief description of each aspect***	**Rating score**			
		0	**1**	**2**	**3**
Technological representativeness	Degree to which the dataset reflects the true population of interest regarding technology (e.g. the technological characteristics, including operating conditions)	No evaluation made	The data used does not reflect satisfactorily the technical characteristics of the system (e.g. Portland Cement, without other specifications)	The data used reflects partially the technical characteristics of the system (e.g. Portland Cement type II, without further specifications)	The data used reflects the technical characteristics of the system (e.g. Portland Cement type II B-M)
Geographical representativeness	Degree to which the dataset reflects the true population of interest regarding geography (e.g. the given location/site, region, country, market, continent)	No evaluation made	The data used refer to a totally different geographic context (e.g. Sweden instead of Spain)	The data used refers to a similar geographic context (e.g. Italy instead of Spain)	The data used refers to the specific geographic context (e.g. Spain)
Time-related representativeness	Degree to which the dataset reflects the specific conditions of the system being considered regarding the time/age of the data (e.g. the given year compared to the reference year of the analysis)	No evaluation made	There are more than 6 years between the validity of the data used and the reference year to which the data applies.	There are between 2 and 4 years between the validity of the data used and the reference year to which the data applies.	There are less than 2 years between the validity of the data used and the reference year to which the data applies.
Uncertainty	Qualitative expert judgment or relative standard deviation expressed as a percentage.	No evaluation made	Modelled/similar data is used. Accuracy and precision of the data has been estimated qualitatively (e.g. by expert judgment of suppliers and process operators)	Modelled/similar data is used which is considered to be satisfactorily accurate and precise with the support of a quantitative estimation of its uncertainty (e.g. representative data from trade associations for which a sensitivity analysis has been carried out).	Site specific and validated data is used which is considered to be satisfactorily accurate and precise (e.g. window system for which a verified EPD is available) The allocation hierarchy has been respected.

Data quality result is complemented by:

✓ Rating of professional capability

Rating aspect	Rating score			
	0	**1**	**2**	**3**
Technical capability of the personnel carrying out the assessment	*No formal training and limited experience in using the calculation method*	*Formal training or some applied experience in using the calculation method*	*Formal training and some applied experience in using the calculation method*	*Formal training and significant applied experience in using the calculation method*

✓ Rating of independent verification

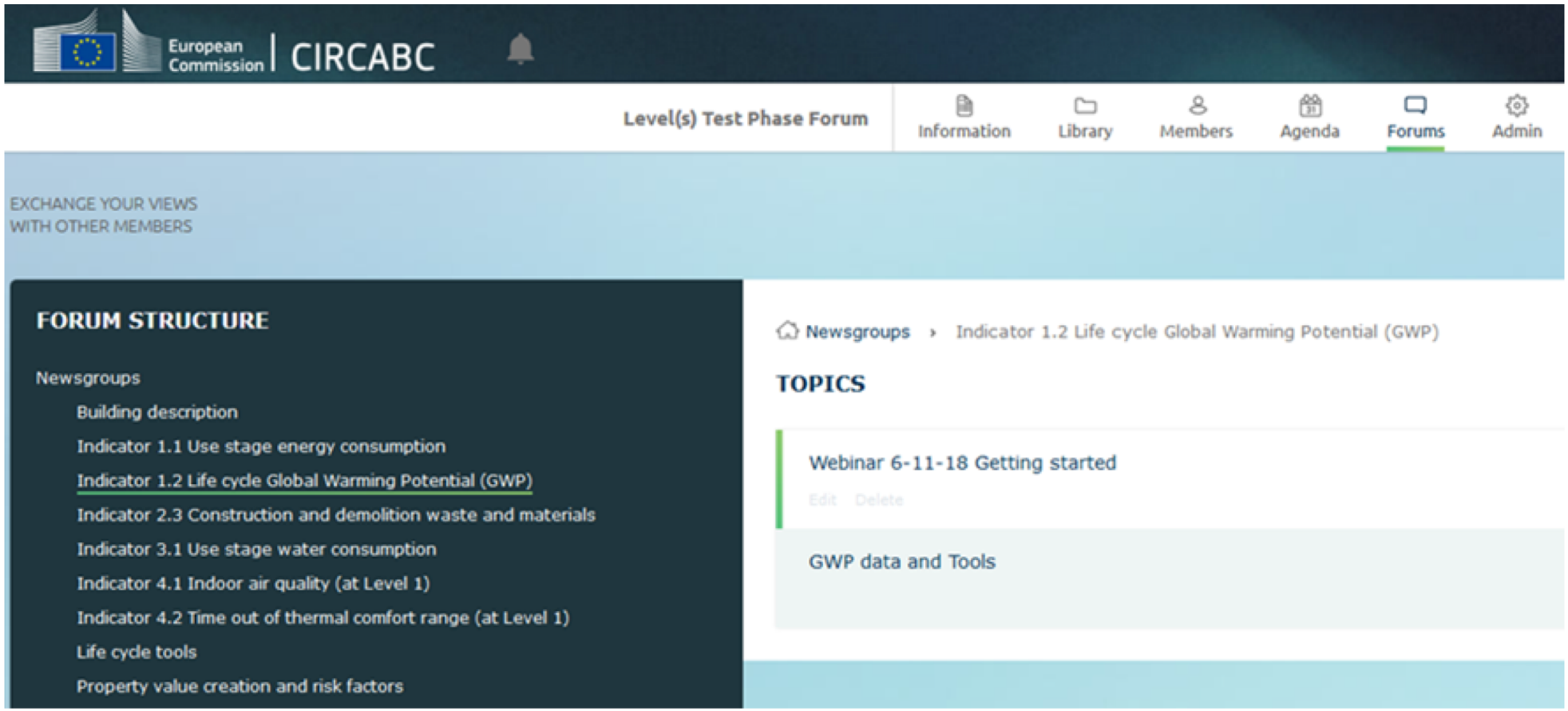
Rating aspect	Rating score			
	0	**1**	**2**	**3**
Independent verification of the assessment	*Self-declaration of the performance assessment results*	*Peer review of the input data and calculation steps*	*Third party auditing and verification of the calculation steps*	*Third party auditing and verification of the process data, life cycle inventory data and calculation steps*

Reliability ratings for each performance assessment			
Indicator or scenario	1. Technical reliability rating	2. Professional capabilities rating	3. Independent verification rating
Indicator 1.1 Use stage energy performance: - 1.1.1 Primary energy demand - 1.1.2 Delivered energy demand	0.0	0.0	0.0
Indicator 1.2 Life cycle Global Warming Potential	1.0	2.0	3.0
Tool 2.1 Life cycle tools: Building bill of materials			
Tool 2.2 - Scenario 1 Building and elemental service life planning			

Rating key	
	Rating aspect not addressed
	Low
	Medium
	High

Q&A

Discussion and questions can continue in the CIRCABC Forum…



European Commission

More information

Download the Level(s) Beta v1.0 documentation

http://susproc.jrc.ec.europa.eu/Efficient_Buildings/documents.html

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