Environmental considerations for biobased materials in modern methods of construction

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Where we are…

- Governmental demand for greater sustainability
  - Easiest target – housing (the Built Environment)
  - Reducing Greenhouse gas emissions (PAS 2050)
- Greater role of independent consultants
  - Prepare tools to make assessment easier
- Tangible evaluation of performance increase
  - Useful for builders, architects, specifiers, government
- Demonstrate best practice in construction

Demonstrable methods

- Sustainability is a complex & political agenda
- Still working towards an agreed international consensus
- Likely to always change depending upon context

- No single tool for measuring sustainability
- Industry using many tools/methods/systems;
  - Life Cycle Assessment (LCA)
  - BREEAM or equivalent
  - Carbon Labelling & Footprinting
  - Whole Life Costing (WLC)
  - Environmental Product Declarations (EPD's)
  - Many others…

Construction panels can incorporate plywood, OSB, MDF and fibrous insulation. Picture courtesy Welsh School of Architecture

BREEAM

Building Research Establishment Environment Assessment Method

Certification Scheme

Voluntary

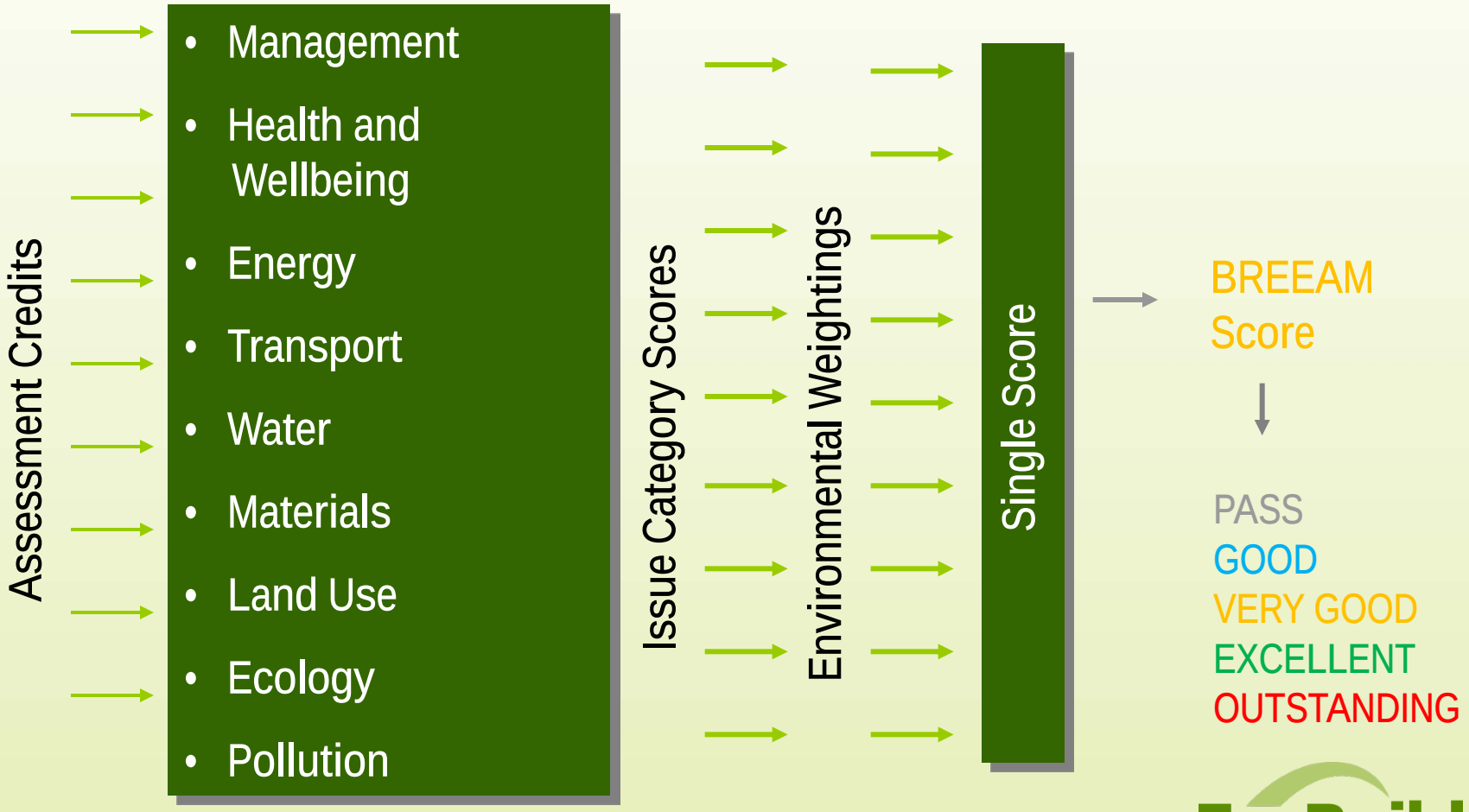
Independent and credible

Holistic

Customer focussed

Credits based

BREEAM - scoring



Level of attainment

Rating	2006 Scheme	2008 and 2011 Scheme
Pass	25	30
Good	40	45
Very good	55	55
Excellent	70	70
Outstanding	N/A	85

Living planet centre UK (Wilmott Dixon)

Many other national assessment tools exist

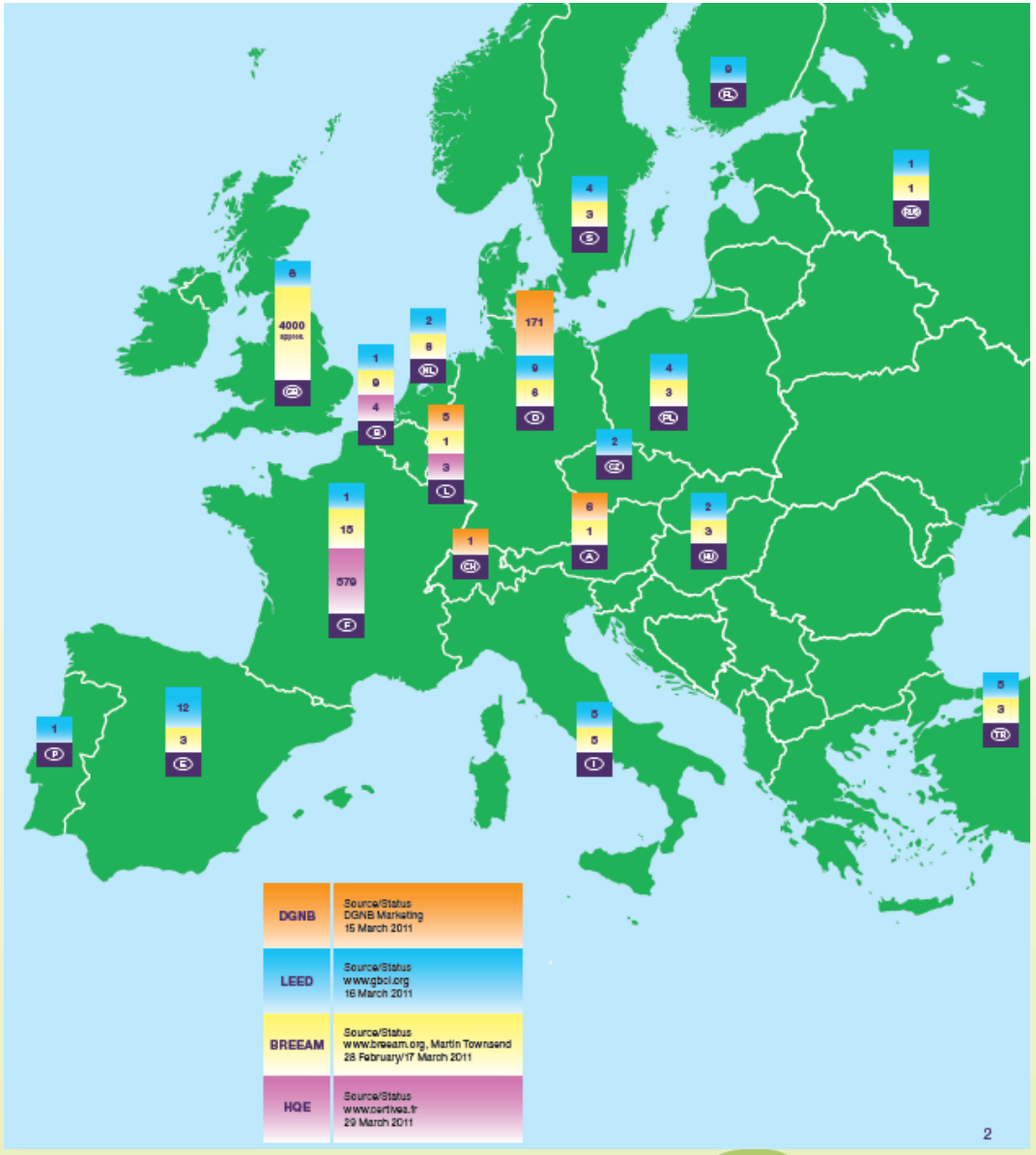
Australia:	Nabers / Green Star
Brazil:	AQUA / LEED Brasil
Canada:	LEED Canada/ Green Globes
China:	GB Evaluation standard for green building
Finland:	PromisE
France:	HQE and Carbon Site
Germany:	DGNB
Hong Kong:	HKBEAM
India:	GRIHA (national green rating)/ LEED India
Israel:	SI-5281
Italy:	Protocollo Itaca

Many other tools exist

Mexico:	LEED Mexico
Netherlands:	BREEAM Netherlands
New Zealand:	Green Star NZ
Portugal:	Lider A
Singapore:	Green Mark and Construction Quality Assessment System (CONQUAS â)
South Africa:	Green Star SA
South Korea:	Greening Building System
Spain:	VERDE
UAE:	Estidama
UK:	BREEAM/ Code for Sustainable Homes
US:	LEED

European context

- BREEAM gaining more acceptance across EU
- Still demand for LEED, DGNB and HQE
- Numbers increasing, as are countries with certified buildings



Comparison of some methods

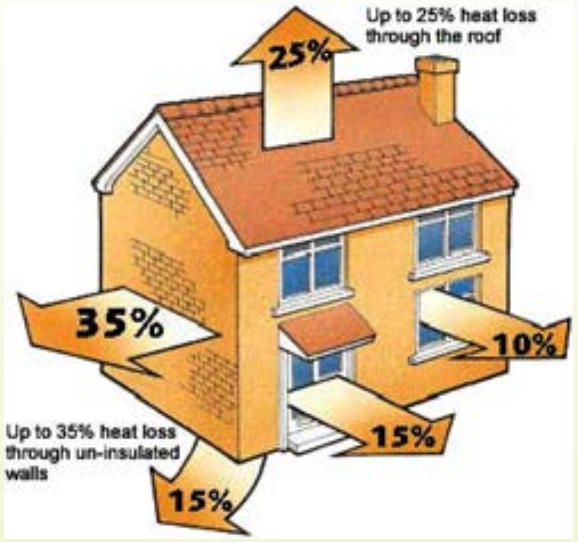
BREEAM	LEED	DGNB	HQE
• Management • Health & well being • Energy • Transport • Water • Materials • Waste • Land use & ecology • Pollutants • Innovation	• Sustainable site • Water efficiency • Energy & atmosphere • Materials & resources • Indoor environmental quality • Innovation & design process	• Ecological quality • Economical quality • Socio-cultural quality • Process quality • Site use	• Eco-constrcution • Eco-management • Comfort • Health

No two assessment methods are the same – differing criteria and weightings

Improved materials

- Better building envelopes
  - Save energy
  - Save money
  - Meet new requirements

- Minimise thermal bridging



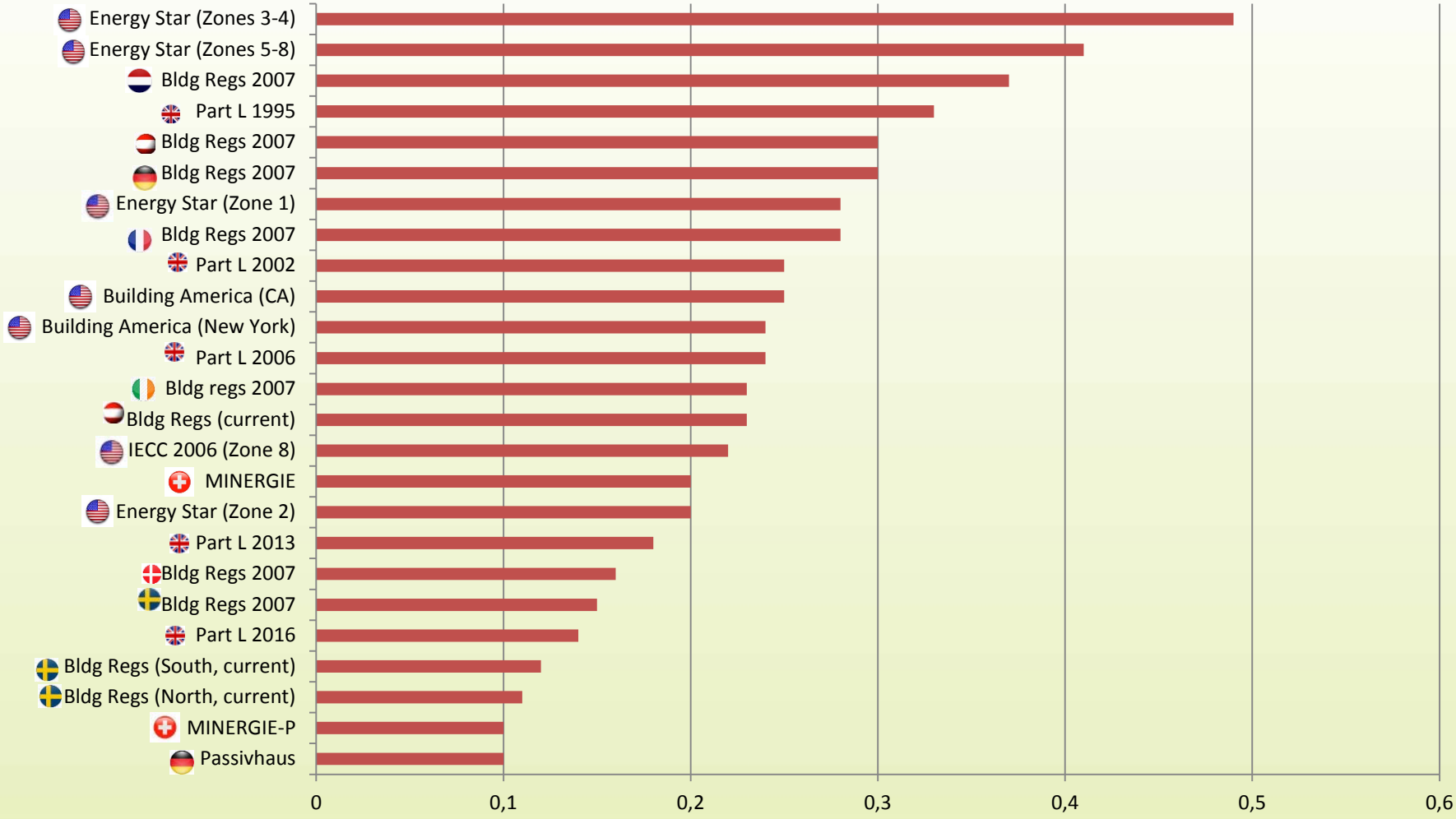
http://www.nansulate.com/images/heat-loss.jpg

Comparison of building elements

Exposed Building element	UK Part L (2013)	Passivhaus	SE Build Regs	DK Build Regs	NO Build Regs
Roof systems	0.20	0.15	0.15	0.25	0.13
Walls	0.30	0.15	0.18	0.40	0.24
Floor	0.25	0.15	0.15	0.30	0.22
Windows, doors and rooflights (timber or PVC)	2.0	0.8	1.2-1.5	2.0	1.0
Airtightness ($m^3/(hr.m^2)$)	10	<1.0	0.8	5.4	3.5

From: International comparison of energy standards in building regulations for non-domestic buildings: Denmark, Finland, Norway, Scotland, and Sweden. BRE report to Scottish Govt 2008
http://www.scotland.gov.uk/resource/doc/217736/0113670.pdf

Changes in U value requirements



Possible wall unit solutions

	Basic Building Regulations	Enhanced	Enhanced (High Thermal Mass)	Timber High Insulation	Low Emissions
Wall System	89x44 Timber kit	145x44 Timber kit	145x44 Timber kit	194x44 stud	300 web stud
Wall insulation	Sheathing ply / 90mm glass fibre Service zone / 25mm Crown Polyfoam Linerboard	Panelvent/ 145mm cellulose (Warmcell) /OSB internal Service zone Plasterboard	35mm Isolair wood-fibre board/ 145mm sheep's wool/ Paneline Service zone /Plasterboard	60mm Pavatherm wood-fibre board/ 194mm sheep's wool /Paneline Service zone/ Plasterboard	Panelvent/ 300mm cellulose (Warmcell)/ OSB internal Service zone/ Plasterboard
U Value	0.25	0.24	0.2	0.14	0.12

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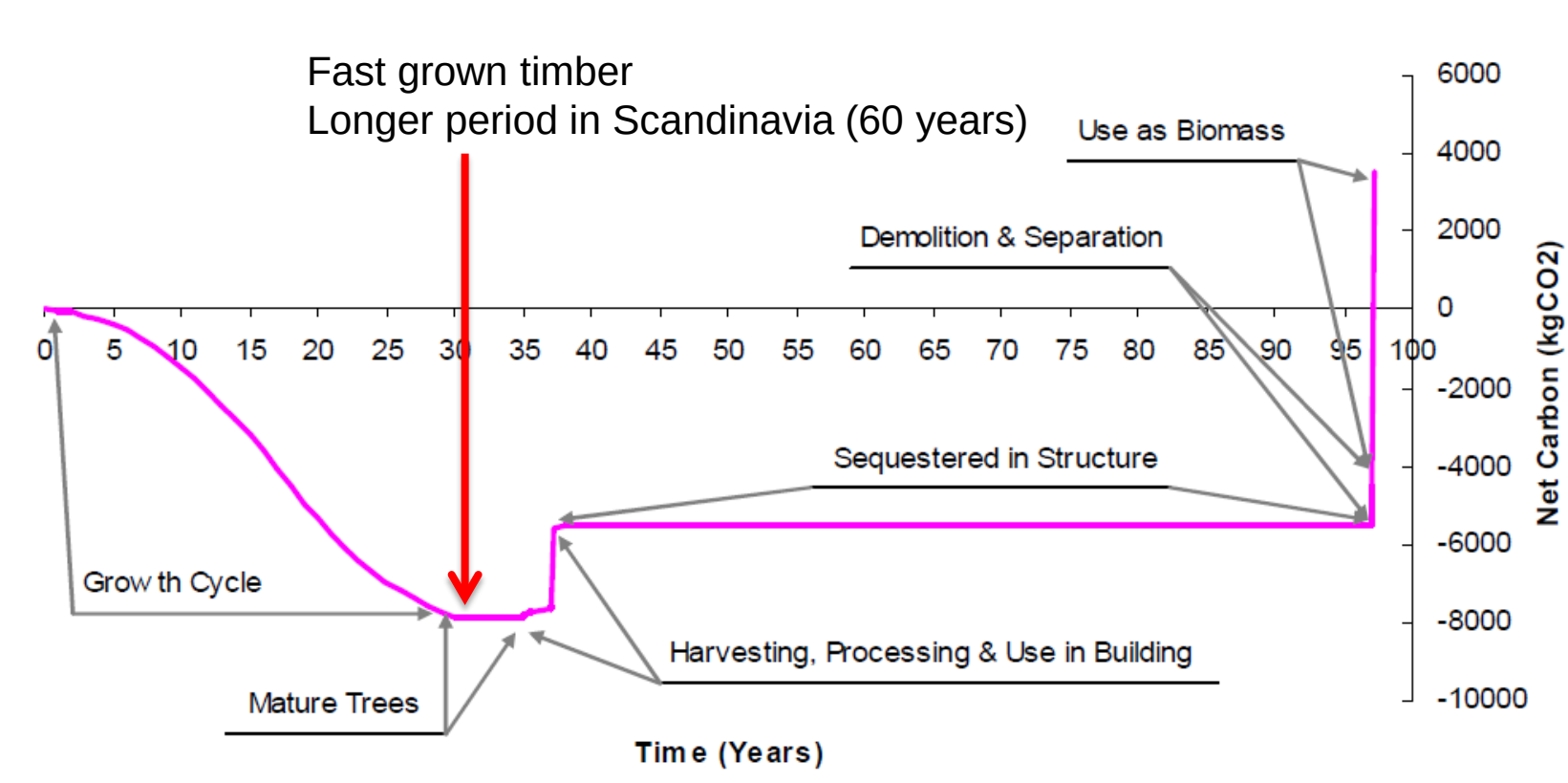
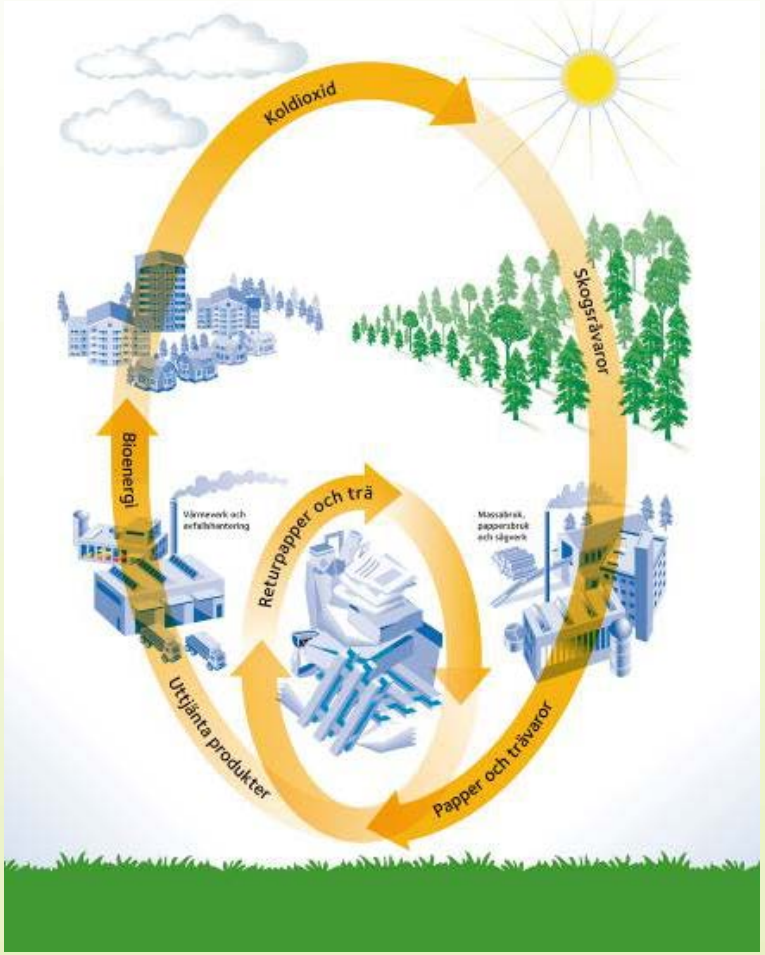
Level	Part L 2002	Part L 2006	MINERGIE	Part L 2016	Current Swedish regulations

The carbon issue



€CO2 project

- Understanding of carbon efficiency in buildings.
- Defining technical potential and obstacles for the use of wood in carbon efficient construction.
- Case studies from industrial partners in Sweden, Finland, Germany, Austria and Italy.
- A Wood Wisdom Net project.

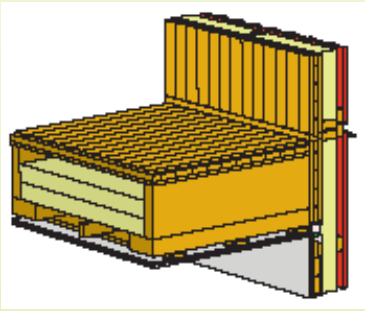


Wälluden case study

- A four-storey multi-family building in Växjö, Sweden.
- Built in 1995-1996.
- Cradle-to-grave LCA of eight alternative designs:
  - Original designs in wood and concrete-wood hybrid.
  - Three re-designs with different building systems.
  - Each re-design under conventional and Passive House requirements.

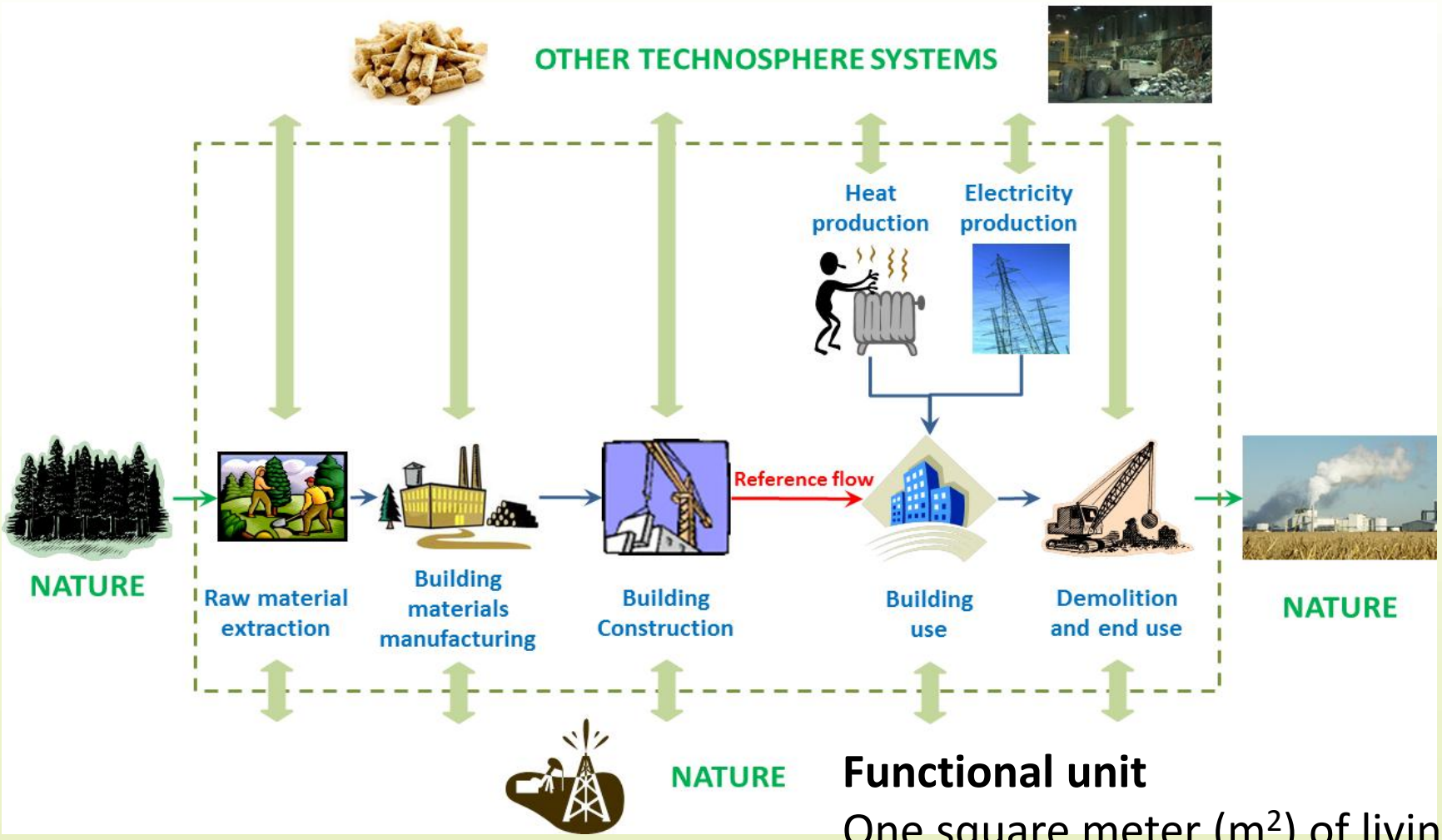
Volume elements

Column-beam structure



Structural elements

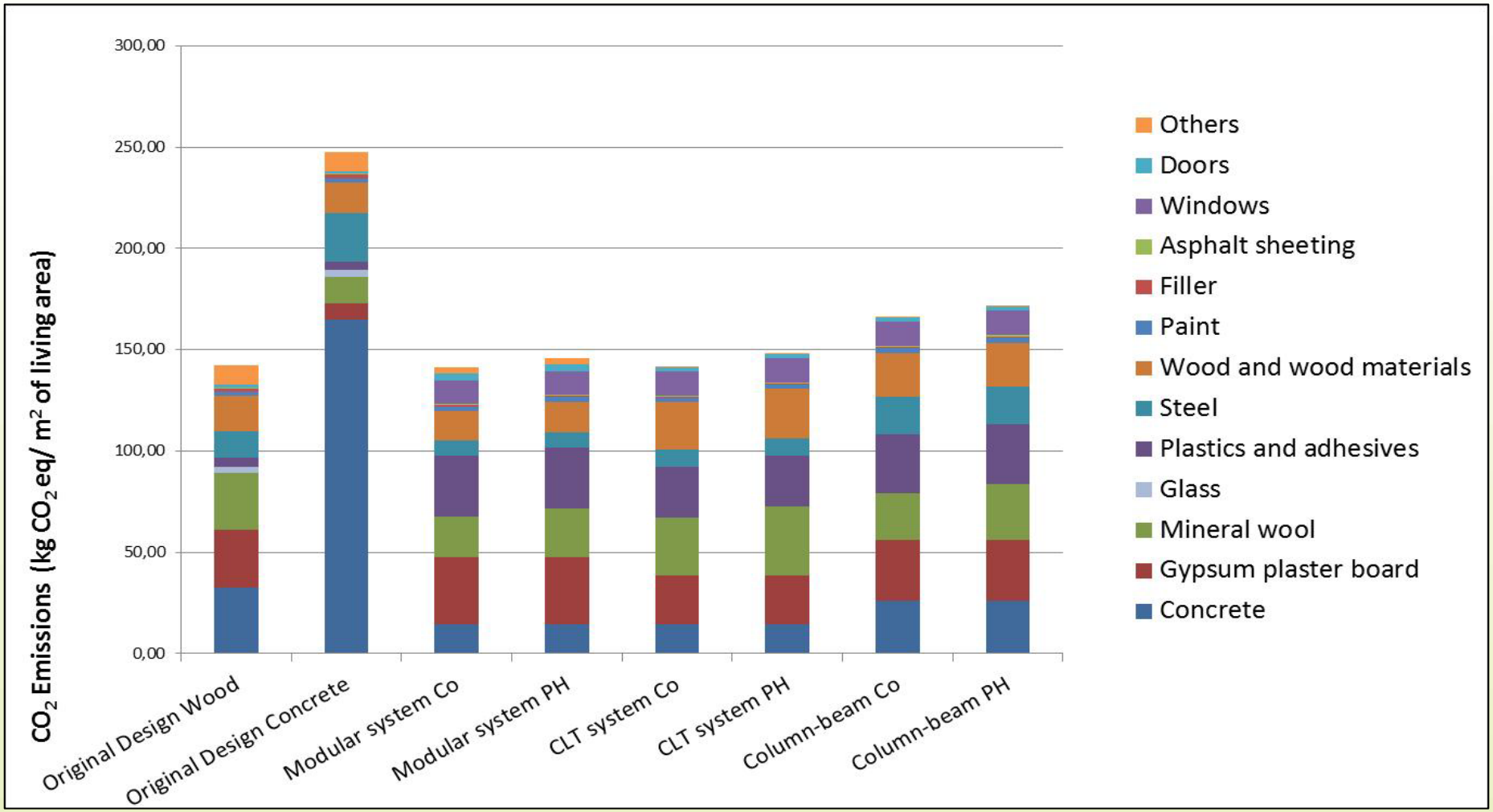
The studied system



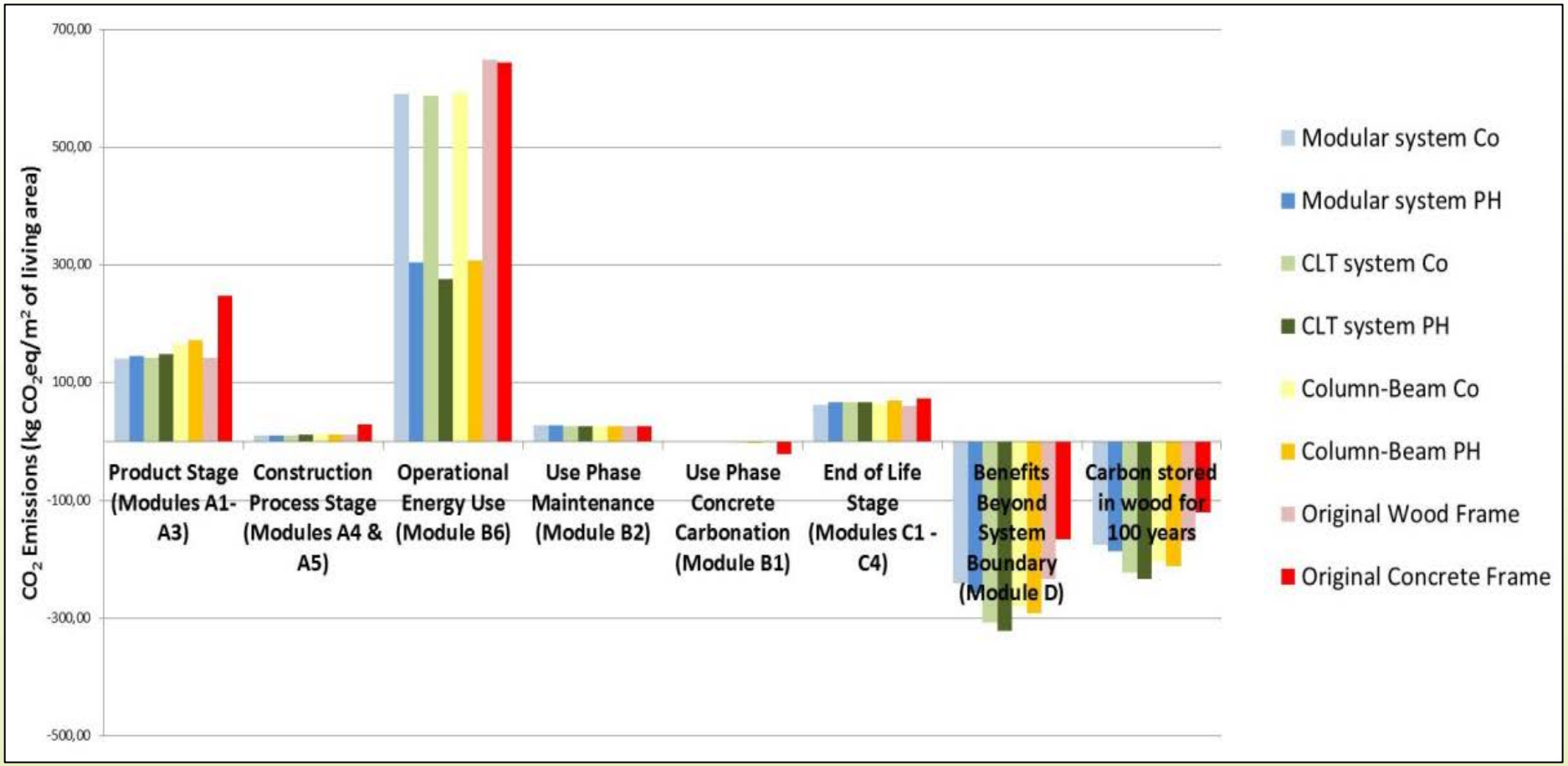
Functional unit

One square meter (m^2) of living area for one hundred years

Results – fossil CO_2 emissions from production



Results – life cycle fossil CO_2 emissions



Conclusions related to the LCA

- More wood, higher fossil carbon footprint decreasing potential.
- Low influence from the choice of building system.
- Use phase dominates, mostly influenced by the energy efficiency standard and energy supply system.
- For energy efficient designs or buildings supplied from renewable energy, production and end of life are more relevant and the benefits from using more wood are higher.
- Benefits from passive house designs are higher than associated impacts.

Challenges for the use of LCA in design

- The difference among design alternatives is key to define the scope of the assessment.
- There is a “competence” gap between designers and the practice of LCA.
- There is a “competence” gap between designers and the use of ready-made LCA tools.
- There is a lot of data for products and energy, but little for construction activities and building elements.
- There are uncertainties over service life of buildings and materials.

Future research: eco2data

- Developing of ready-to-use “Carbon values” for different building types in wood.
- Developing of ready-to-use “Carbon values” for wood construction activities.
- Developing of BIM compatible tools for the use of these “Carbon values” in the design process.
- Recommendations for public procurement in the construction sector.

Conclusions

- Range of tools available for assessing building products
- Biobased products have distinct advantages
- Need to ensure these are promoted correctly
- Designers/end users need better information
- No simple answer – best promotion achieved through a range of different tools.

The future….