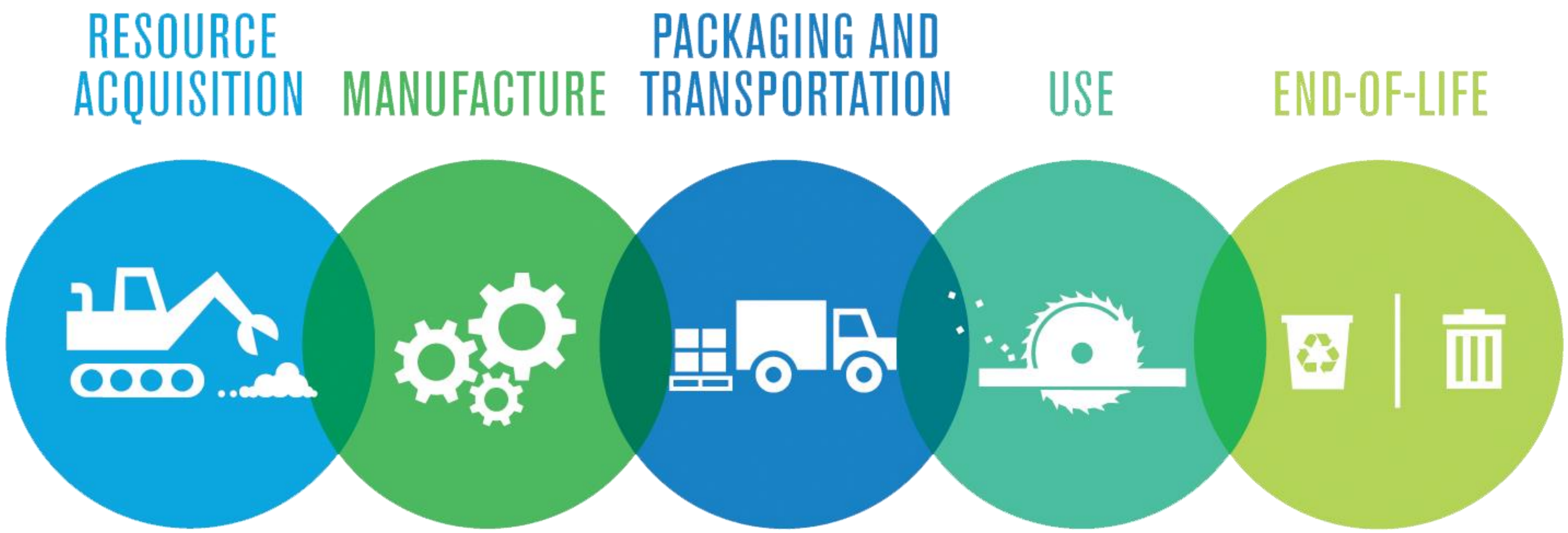


NECESSITY OF LCA: FOCUSSING ON EMBODIED CARBON AND ENERGY OF BUILDING MATERIALS

Prof. Pete Walker (UBATH)

Presentation outline:

Importance of embodied carbon and energy

Natural Building Materials

Two LCA case studies:

- BaleHaus (prefabricated straw bale housing)
- Rammed earth

Some thoughts for users of LCA data

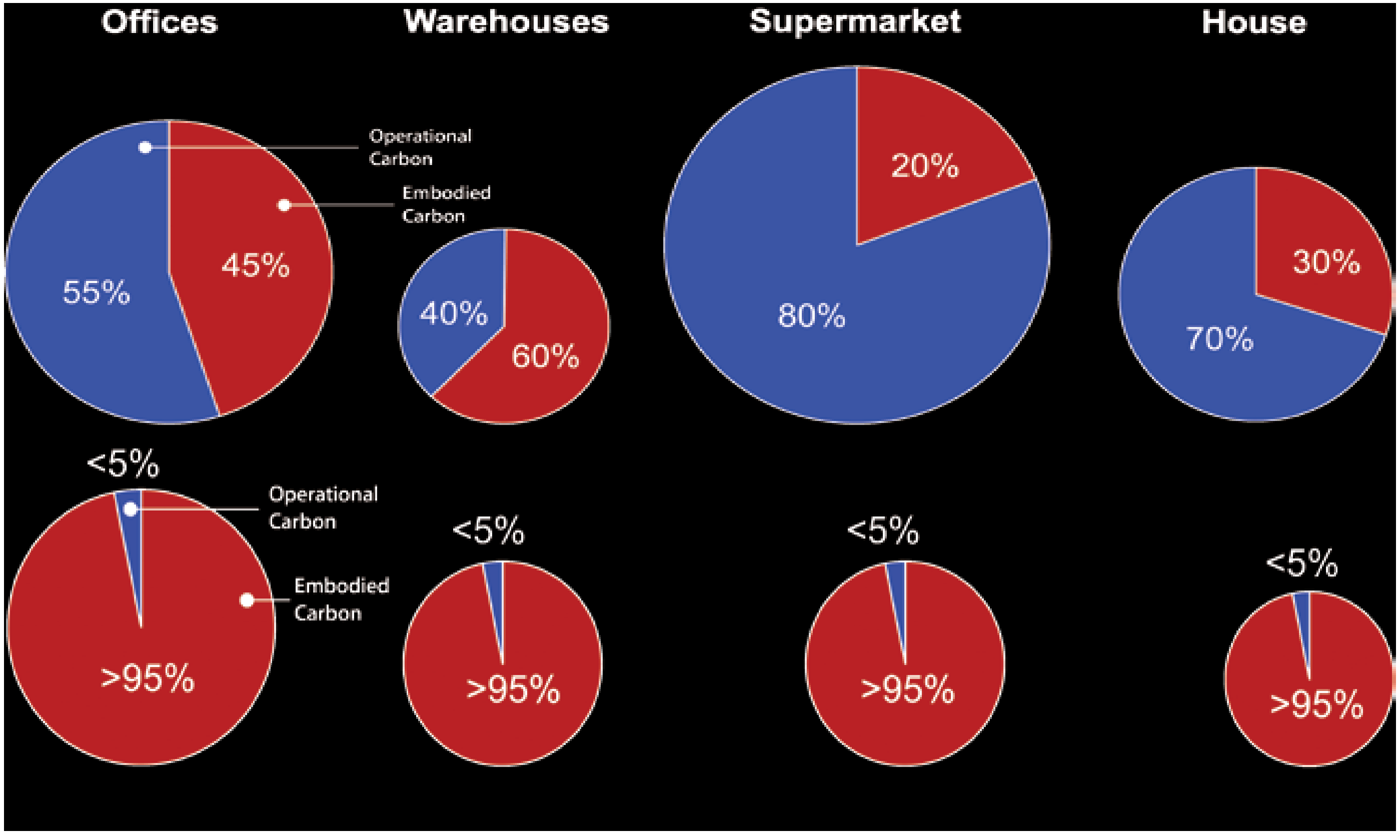
Importance of Embodied Carbon

- Total carbon contribution from existing and new **buildings is around 40-50% of the EU's footprint**, of which around one third of the total can be attributed to the housing sector.
- Construction industry is responsible for around **10% of all UK greenhouse gas emissions**.

Balance between Embodied Carbon and Operational Carbon

2010

2020 predicted



Ref. Sturgis Associates – Indicative whole life carbon emissions

The Inventory of Carbon and Energy (Hammond and Jones, University of Bath)

Material	Embodied energy: MJ/kg	Embodied carbon: kgC/kg
Bricks		
General	3	0·060
Limestone	0·85	–
Cement		
General	4·6 ± 2	0·226
Portland cement, wet kiln	5·9	0·248
Portland cement, semi-wet kiln	4·6	0·226
Portland cement, dry kiln	3·3	0·196
Portland cement, semi-dry kiln	3·5	0·202
Fibre cement	10·9	0·575
Mortar (1:3 cement:sand mix)	1·4	0·058
Mortar (1:4)	1·21	0·048
Mortar (1:0·5:4·5 cement:lime:sand mix)	1·37	0·053
Mortar (1:1:6 cement:lime:sand mix)	1·18	0·044
Mortar (1:2:9 cement:lime:sand mix)	1·09	0·039
Soil-cement	0·85	0·038
Concrete		
General (1:2:4 as used in construction of buildings under three storeys)	0·95	0·035
Precast concrete, cement:sand:aggregate	2	0·059
1:1:2 (high strength)	1·39	0·057
1:1·5:3 (used in floor slabs, columns and load-bearing structures)	1·11	0·043
1:2·5:5	0·84	0·030
1:3:6 (non-structural mass concrete)	0·77	0·026
1:4:8	0·69	0·022
Autoclaved aerated blocks (AACs)	3·5	0·076–0·102
Fibre-reinforced	7·75	0·123
Road and pavement	1·24	0·035
Road example	2085 MJ/m^2	51 kgC/m^2
Wood-wool reinforced	2·08	–
Glass		
General	15	0·232
Fibreglass (Glasswool)	28	0·417
Toughened	23·5	0·346
Steel		
General, 'typical' (42·3% recycled content)	24·4	0·482
General, primary	35·3	0·749
General, secondary	9·5	0·117
Bar & rod, 'typical' (42·3% recycled content)	24·6	0·466
Bar & rod, primary	36·4	0·730
Bar & rod, secondary	8·8	0·114
Engineering steel, secondary	13·1	0·185
Galvanised sheet, primary	39	0·768
Pipe, primary	34·4	0·736
Plate, primary	48·4	0·869
Section, 'typical' (42·3% recycled content)	25·4	0·485
Section, primary	36·8	0·757
Section, secondary	10	0·120
Sheet, primary	31·5	0·684
Wire	36	0·771
Stainless	56·7	1·676
Timber		
General	8·5	0·125
Glue laminated timber	12	–
Hardboard	16	0·234
MDF	11	0·161
Particle board	9·5	0·139
Plywood	15	0·221
Sawn hardwood	7·8	0·128
Sawn softwood	7·4	0·123
Veneer particleboard (furniture)	23	0·338

Table 2. Selected database[5] embodied energy and carbon coefficients

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Natural building materials:

Inorganic materials

- Natural stone
- Earth construction

Renewable plant based materials

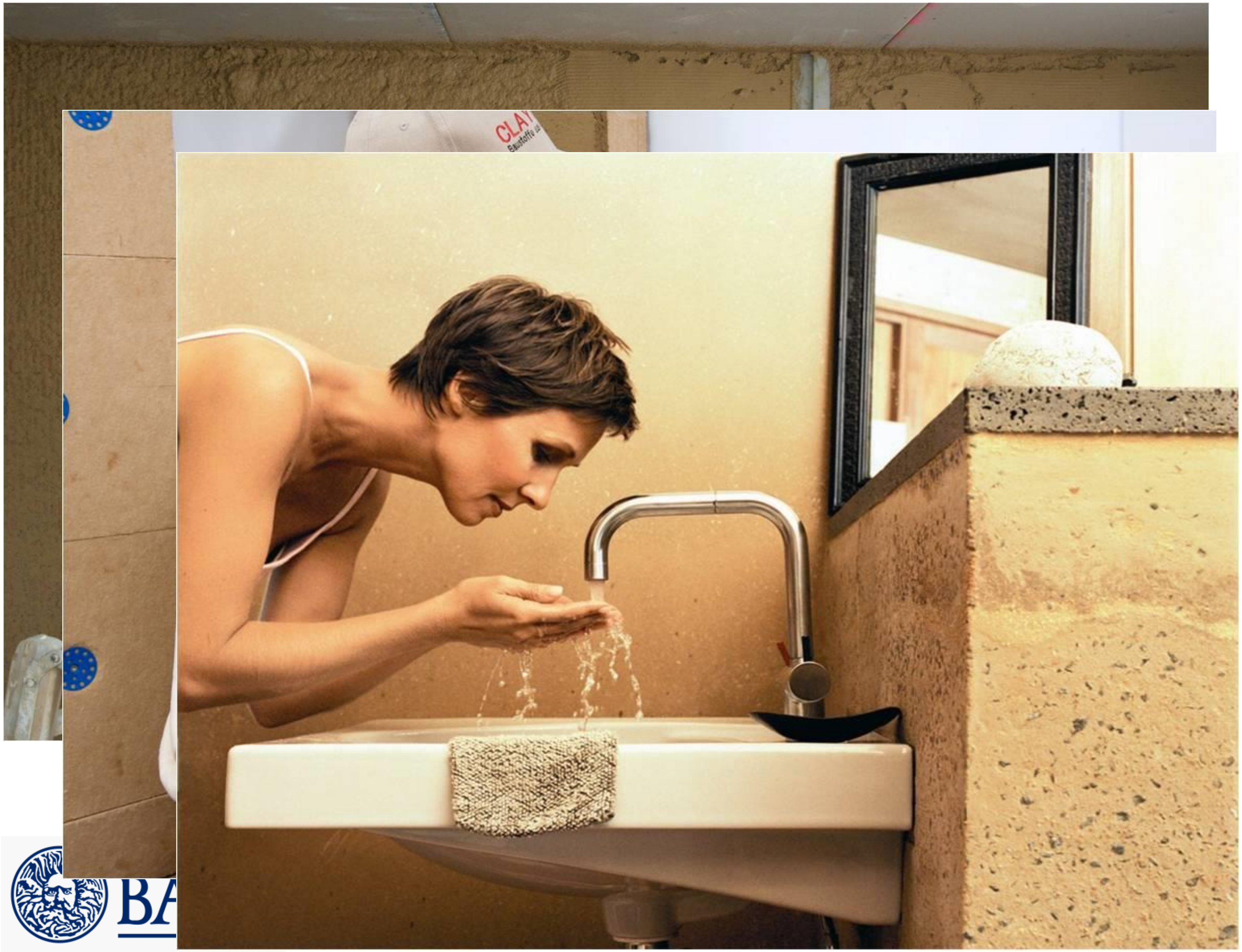
- Timber and wood based products
- Crop co-products: straw; hemp shiv
- Fibres: hemp; flax, sisal, kenaf
- Bamboo; reeds

Animal based products

- Sheep's wool
- Fibres (horse hair)
- Blood, casein, urine, excrement

Adobe

Rammed earth

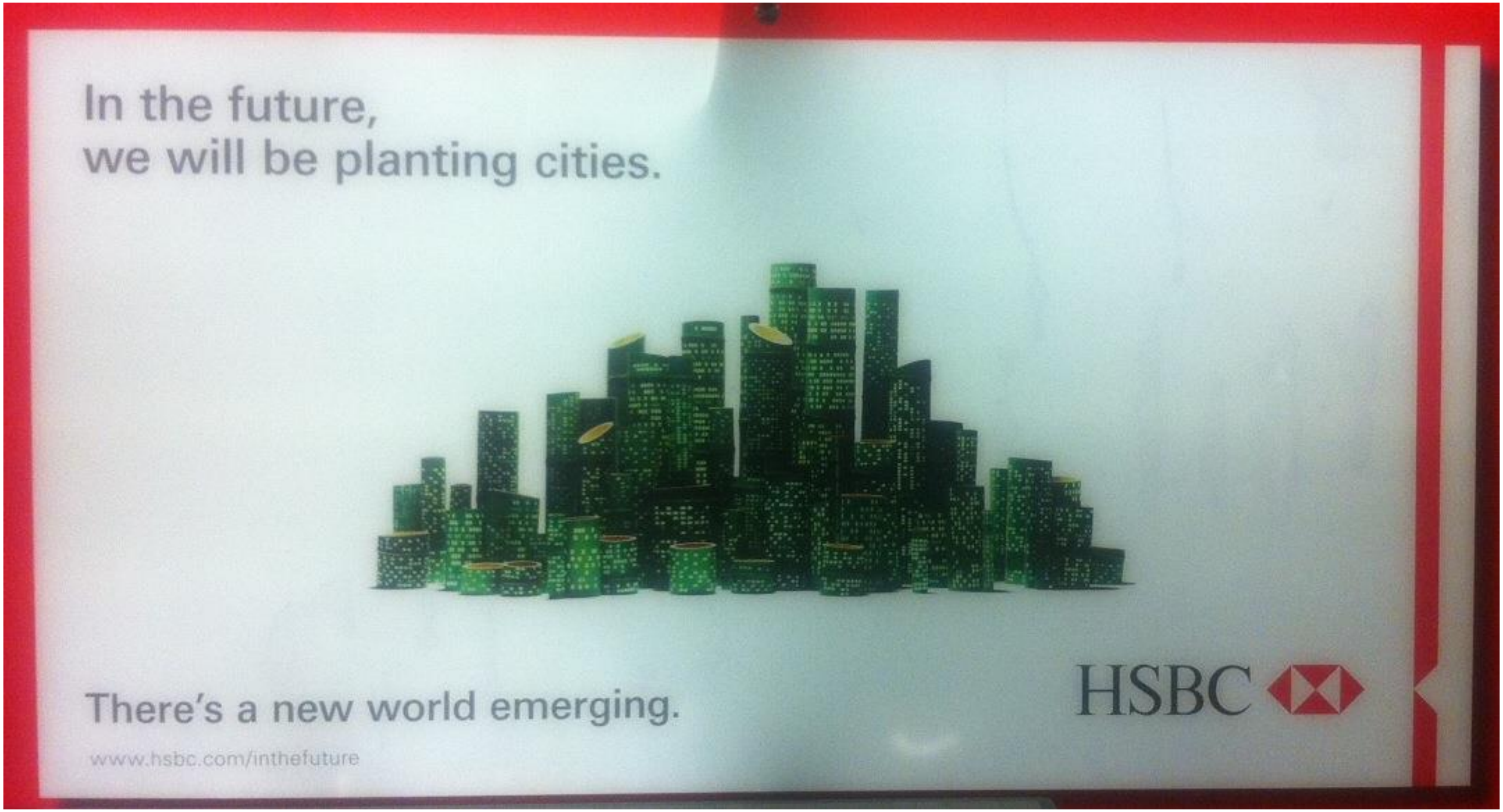


Clay plasters

Straw bale

Straw bale

Hemp-lime

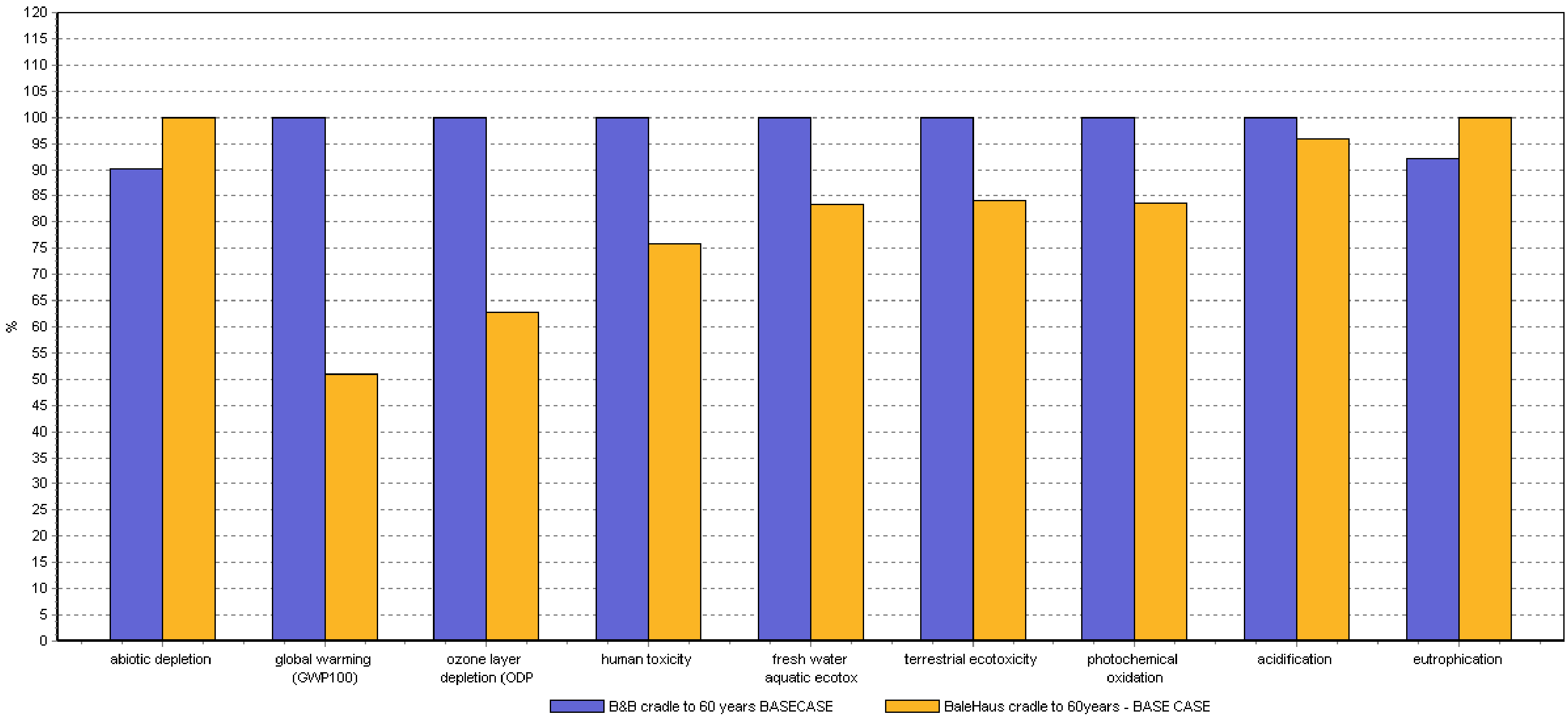

In the future,
we will be planting cities.
There's a new world emerging.
www.hsbc.com/inthefuture
HSBC

The attractions of using natural building materials include:

- Lower environmental impact (lower embodied carbon)
- Healthier buildings
- Improved building environmental performance
- Greater use of renewable resources
- Reduced waste

How can we be confident about these claims without LCA?

Balehaus


%
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70
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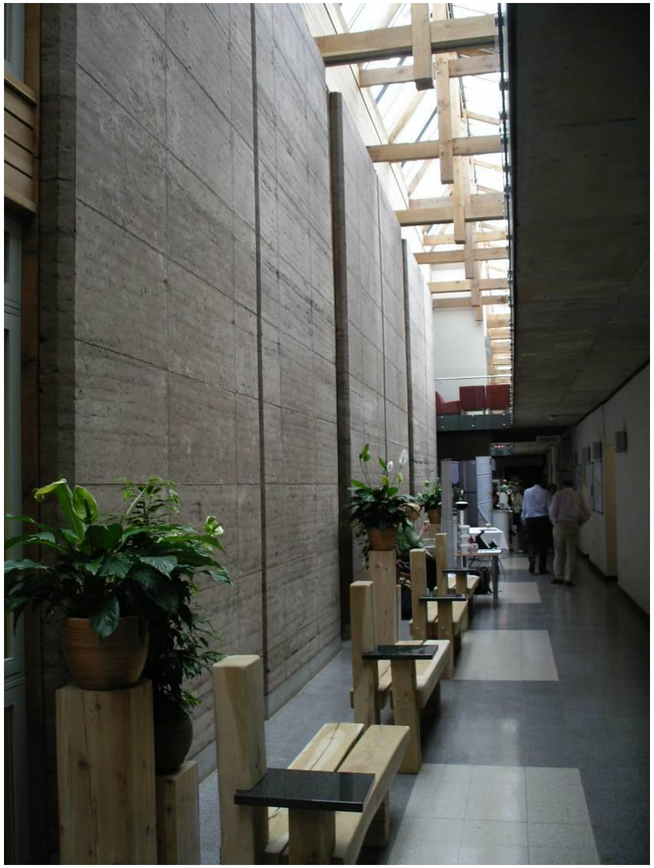
20
15
10
5
0
abiotic depletion
global warming (GWP100)
ozone layer depletion (ODP
human toxicity
fresh water aquatic ecotox
terrestrial ecotoxicity
photochemical oxidation
acidification
eutrophication
B&B cradle to 60 years BASECASE
BaleHaus cradle to 60years - BASE CASE

Outcomes:

- BaleHaus has a global warming potential that is almost half that of the conventional brick & block building during its construction and use.
- Most of the impacts arise during the use phase of both buildings. In BaleHaus, around 30% of the use-phase global warming potential is due to heating energy consumption, and 65% is due to working of equipment, lights, and use of domestic hot water.

Rammed earth



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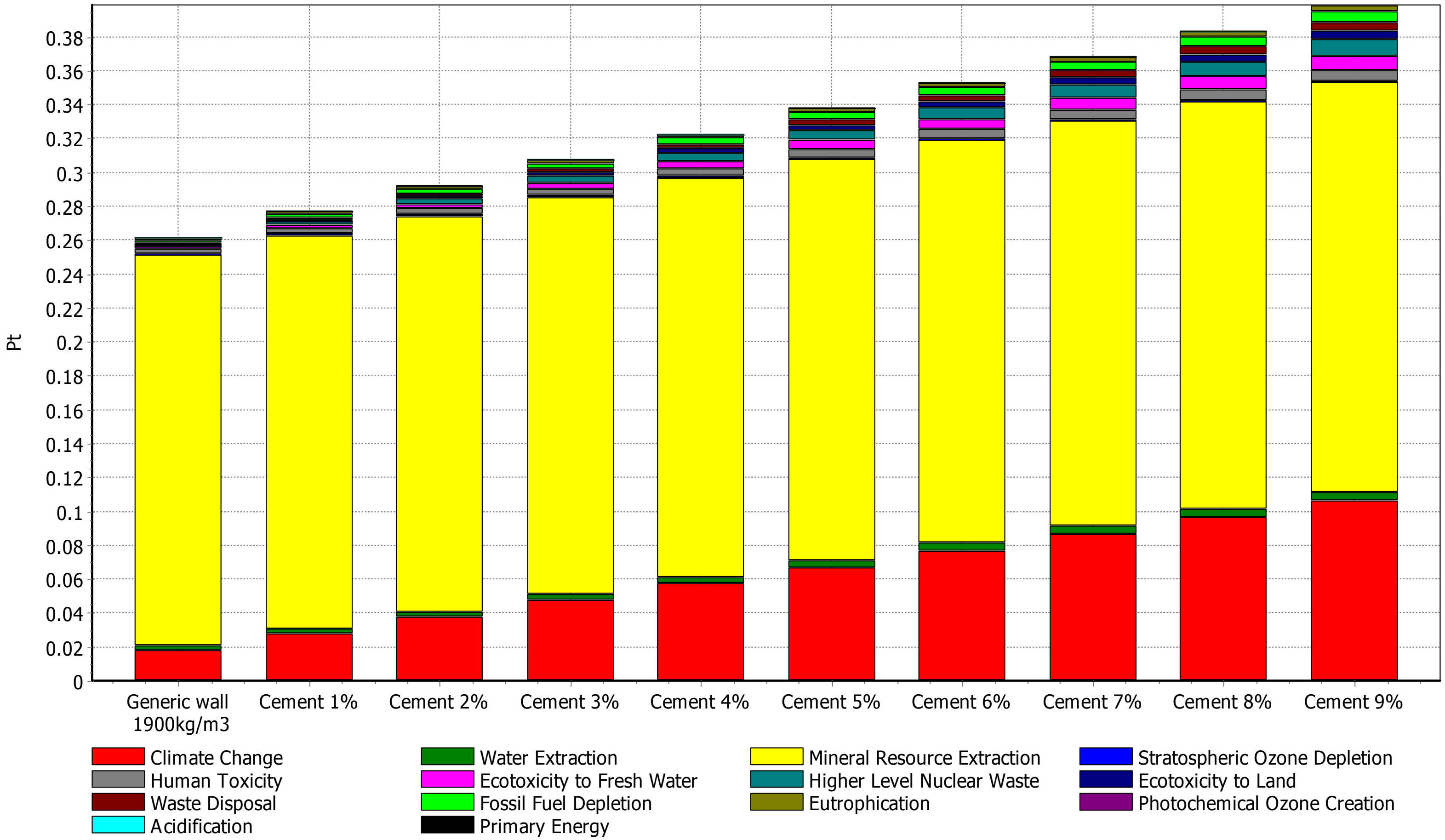

Comparing product stages; Method: BRE 2007 method v1.7 + AUB Impact +u+GWP V1.10 / European Ecopoints / single score

Athens, 19th May 2016

Use of LCA data:

- Access to reliable data for generic (early stage) decision-making remains a concern.
- Concerns about over simplification and transparency of LCA (Green Guide to Specification).
- Concerns about assumptions for building life-span and end of life scenarios.
- Cost of undertaking product LCA.
- Consistent baseline comparators needed.
- Sensitivity analysis of data suggests significant uncertainty over findings remains.
- Reliable light touch approach needed.
- The more processing a material undergoes, then the scope for greater impact.

Spot the difference…

Acknowledgements

Clare Lax (University of Bath)

Amelie Seguret (Imperial College)

ModCell Ltd

Ian Pritchett (Greencore Construction)

Manfred Lemke (Claytec)