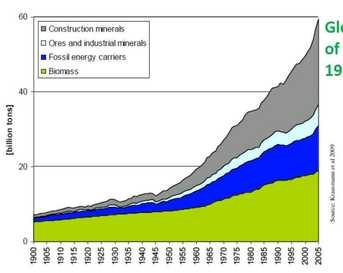
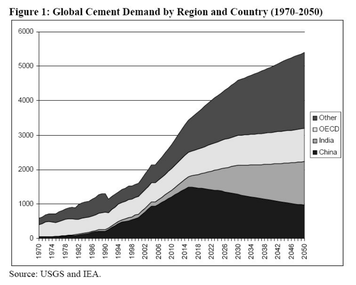
Materials

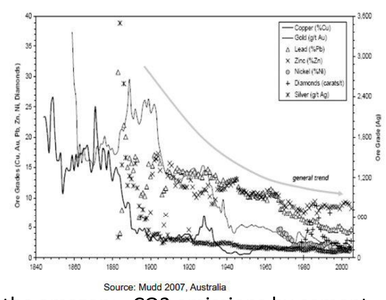
Considerations with choosing and application of materials

The earth contains many resources, which become available for mankind in different ways: via long-term geological processes concentrations of metals have been formed, for minerals geo-biological processes are a main process, and others are fast growing in bio ecological systems, on the basis of solar energy (renewable sources). Though they all renew in a short or long timeframe , there are no additions to the total: the earth resources are a fixed amount. What varies is the concentrations in which they are to be found, and the energy to invest to makes them fit for human use.



Global use of materials 1900-2005





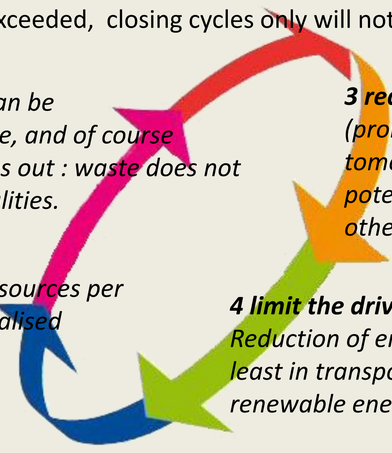
From left to right: Global total increase material use, (grey is building materials) , causes also a growing use of fossil energy; Deforestation in the amazon; CO2 emissions by cement production: 6% of global total emissions, increasing towards 10-12%; Decrease metal fraction in ores; in energy need to mine metals increases exponentially .

"The only way to sustain resource use (incl energy) is in closed cycle operation"

Since the limits in resource use have already been exceeded, closing cycles only will not be enough. There are 4 main steps to address:

1 close the cycle
Entering the cycle will only be resources that can be recovered/regenerated during the period of use, and of course bringing everything back in what normally goes out : waste does not exist, only resources in different forms and qualities.

2 decrease volume in cycle
(same performance with less resources) using less resources per functional unit, but not in th least by replacing materialised functions with immaterial services.



3 reduce speed in the cycle
(prolong the use of resources/ goods in the cycle)This provides more tome for recovery of the stock or the system, en and enlarges the potential of the stock. (renovating instead of demolishing and) in other words prolong lifetime (and with low maintenance needs)

4 limit the driving energy
Reduction of energy in all process steps: production, but not in the least in transport distances: preferred is local materials, and renewable energy where possible.

"Sustainable materials do not exist. It's the use of materials which can be sustainable, sustainable inn the meaning of maintainable, continuous use of stock, in time and space use."

Applications/products:
If material use cannot be avoided, it's a matter of selecting he proper material with the right specifications, with a minimal recovery load , meaning: investment in materials and energy for processing and or compensation of the use during operation time. Which could be expressed in the amount of material per functional unit per year of service . When reusing material or recycling, prolongs the functional time service, under addition of new investments (energy, labour, additional material (-loss), etc)

Municipal office Den Bosch: 6 re-used buildings combined , plus flex concept : 750 working places for 1500 employed. (1) ; Gaudi, bricks used sideways (2). Roof Frankfurt stadium from cloth (3). Masonry with lime cement (3), Construction with concrete plates from demolished apartment blocks (4). Portal in wood (5).

Materials and recycling
Recycling is always good, but not by definition without environmental : it depends how long it has been in use before (impact per year) , and how much energy is involved to make it fit for re-use

Materials and energy generation
To use materials for energy generation is destruction of "quality". Mass remains mass is the principle. (also for biomass!) First a useful function, burning for energy can if needed always later, the energy potential does not get lost!

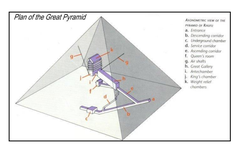
Materials and properties
Materials should be used in cases where their property use can be maximized . Its about delivering a function with the least material input, ie impact.

Materials , metals and renewability
All materials are (in principle) renewable : it's the route by which this materializes that differs: Wood regrows in relative short periods. Metals renew over millions of years , via seawater (dissolved) and tectonics new deposits will form in the earth crust . The "restore" route can be shortened , for instance by filtering directly metal ions from seawater. The (solar) energy needed for this process, is in fact a measure for depletion (if not restored) . Compare this with Solar energy invested in the (re-) growth of wood, ie trees. (see also MAXergy poster and docs)

Materials and use
The longer the material or a product is in functional use, the lower the source impact. (materials per year to provide the service) There is always a time relation. Which is spread over years , and the earth or mankind has more time and or power to recover from the impacts , direct or indirect.

Materials and properties
Materials should be chosen according to a best fit with their properties. Its all about providing a certain function with the least material input ie material impact.

A average Dutch semidetached house weighs around 1 ton / m2 useful floor . If a house lasts 50 years, it has a resource claim in the materials cycle of 20 kg/m2-year. If the house lasts 100 years this reduces to 10 kg/m2 useful floor. (plus some maintenance load) (this is the quantitate approach there is also a qualitative approach (see MAXergy and other methodologies)



For comparison: The pyramid of Cheops in Egypt weighs around 24000 ton / m2 useful floor area. (only 250 m2 useful floor) The pyramid has been serving 4500 years now, which claims 5,3 ton /m2-year….

More background in:
Rovers R. 2009, Material-neutral building: Closed Cycle Accounting for building Construction, paper SASBE conference, Delft, The Netherlands 2009
Rovers R. Et all, 2010, 0-material building: space time analyses, Sustainable Building 2010 conference Maastricht
Rovers R. et all, 2011 , Designing for only energy: suboptimisation. PLEA conference 2011 Louvain la neuve, Belgium
Rovers R. , 2012 , Evaluation of 0-materials house design , PLEA conference 2012, Lima, Peru.
Contact: Ronald Rovers: r.rovers@sustainablebuilding.info

RiBuilT THE CONCEPT OF ZERO

SBS Centre

2 floor beams compared

met versie 1.0							
steel and wood beam adapted for comparable load (carry floor section)							
m2 (-year)		Emb Land, Ren. Energy based				without return or prim. harvest EL	Embodied energy
	kg	EL-harvest	EL -emb.energy	EL-return energy	TOTAL EL-RE	is only EL from EE	in MJ
steel beam	18	0,002	255	19130681,00	**19130936,0**	255	630
wood beam	11,3	23,8	33,4	0	**57,2**	33,4	83,25

In MAXergy methodology we compare a steel and a wooden beam as part of a flooring construction (function) . The table shows primary land use for mining/growing resources, land use to generate energy for the energy embodied in the processing, (based on PV generation) and energy investments to regain iron ions (as compensation for the stock) De cycle is this calculated as if closed.

If only embodied energy is compared (in MJ) , wood comes out as most effective as well. By the way, also side effects ('Rucksack") show this difference. In the processing of wood there is 9,6 kg non renewable material involved, as well as 83 kg of water and 3.8 kg of air, For the iron beam this is respectively 160 kg, 1062 kg and 9,5 kg.

5 options for the function: harvesting wind energy: 1 massive steel, popular since the steel industry promoted this in the first place. 2 A tower by the Russian engineer Shukow: showing 100 years ago that an open construction could be effective, in this case for a water tower. 3 In Belgium wind turbines with an open tower line up along the motorway, much less material required. 4 but it can be even better: In Germany in 2013 a wind turbine construction completely form wood was build: the TimberTower. 5 are we there yet? For towers yes, but not for turbines: these will become flying turbines: on a cable high in the air: constant energy flow, nearly no material investments…!

Practical rules as guidelines, in order of importance (see also illustrations on the right)

1 Is a solution without materials possible? (different organization, like laundry shops instead of individual laundry machines; car sharing, replacing private cars and garages; re-using an empty building; sharing spaces?

2 solution with lesser materials possible? (carport instead of closed garage, flat foundation instead of pole foundation?

3 use or renewable materials and or bio based products: (is a 100% bio based building possible?)

4 use re-used products or recycled materials (Concrete with 80% recycled fraction is possible!)

5 choose minerals, metals or plastics carefully, only there where the specifications can not be met otherwise

6 use as much a possible local available resources and products (also to create a local economy)