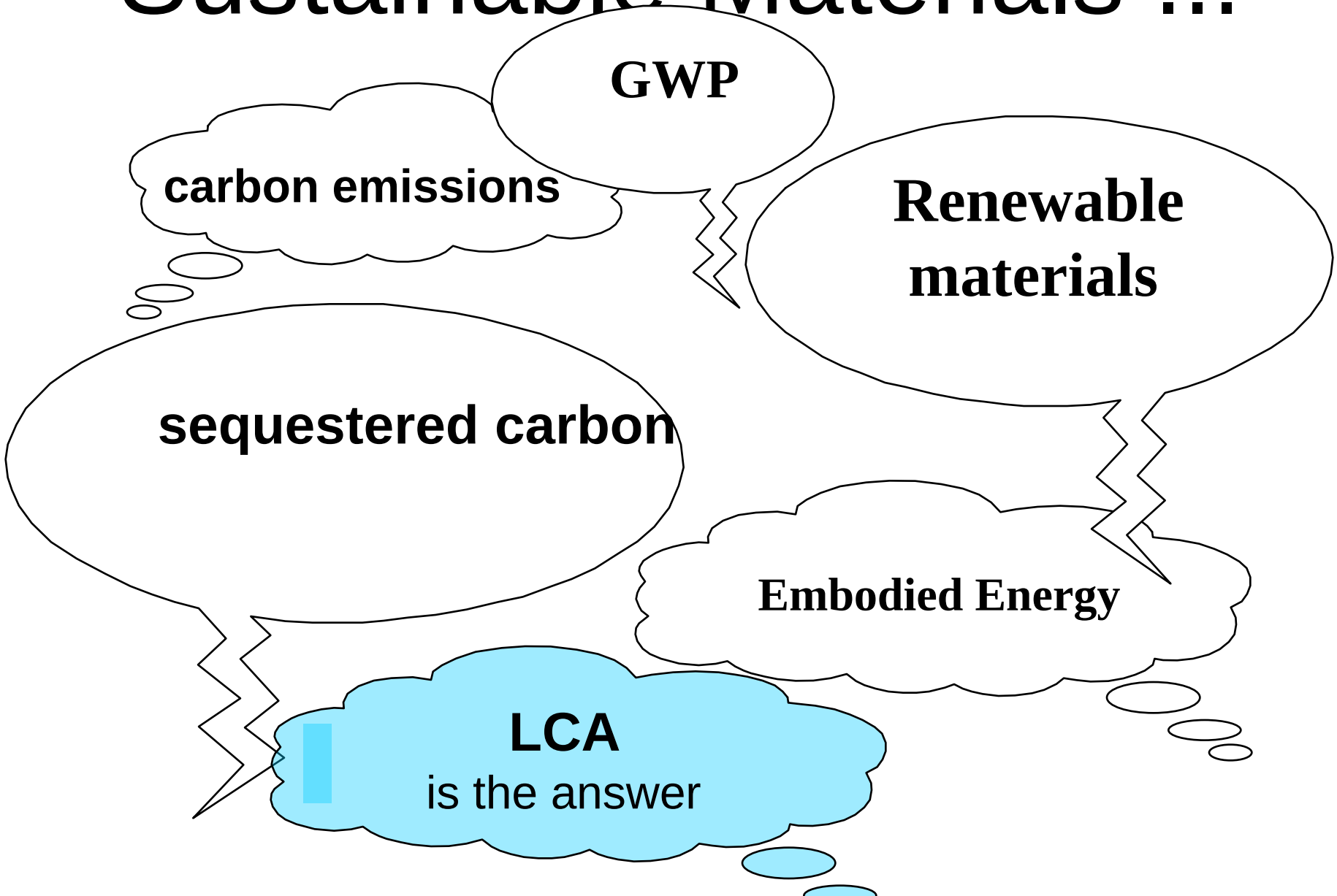
Low Carbon Design & Construction

Kevin McCartney

NEES Final Conference

Umea March 2014

Sustainable Materials …



Life Cycle Assessment (LCA)

"Designers are not qualified to properly assess and understand the full implication of LCA"

Anderson, Shiers, Steele, (2009) *The Green Guide to Specification"*
IHS BRE Press

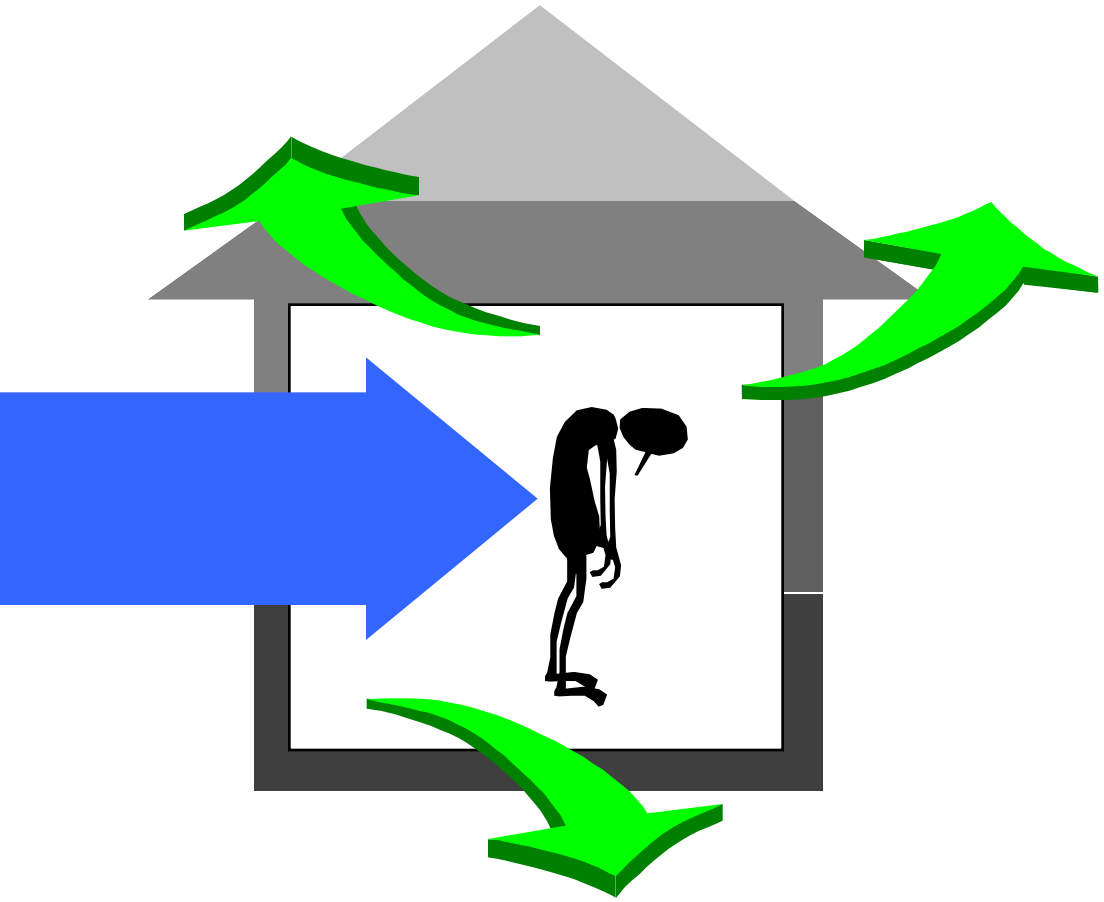
Principles of low carbon design

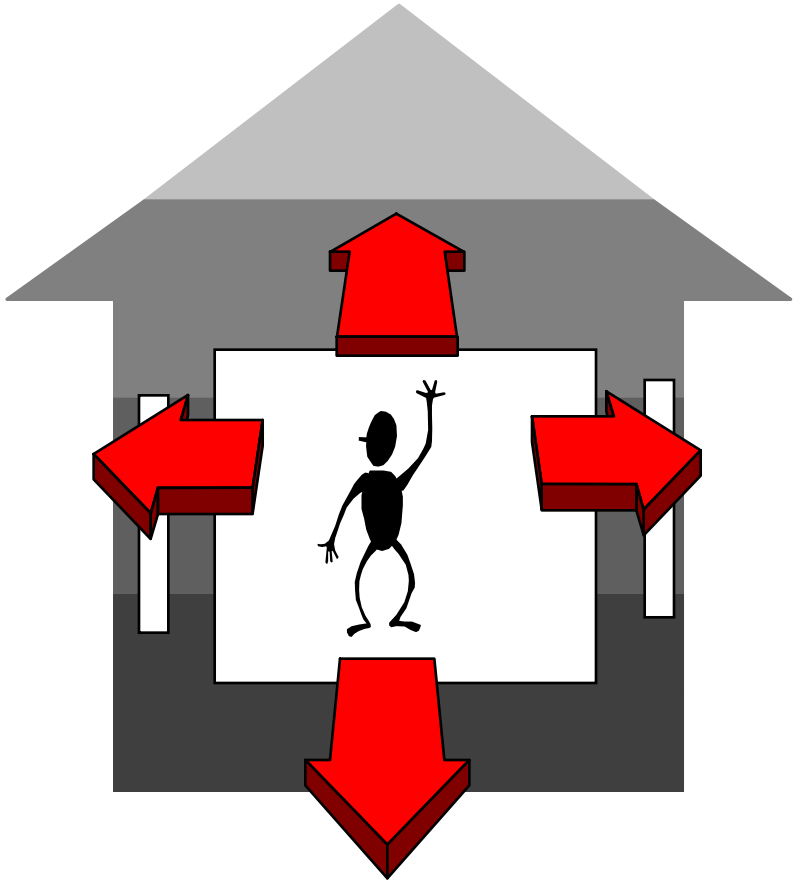
- ?
- ?
- ?
- ?
- ?

‘OPERATIONAL’ energy

Loss of heat through building fabric requires a balancing input of heat to maintain occupant comfort. This requires fuel combustion which causes CO_2 emissions.

Reduce Operational Energy

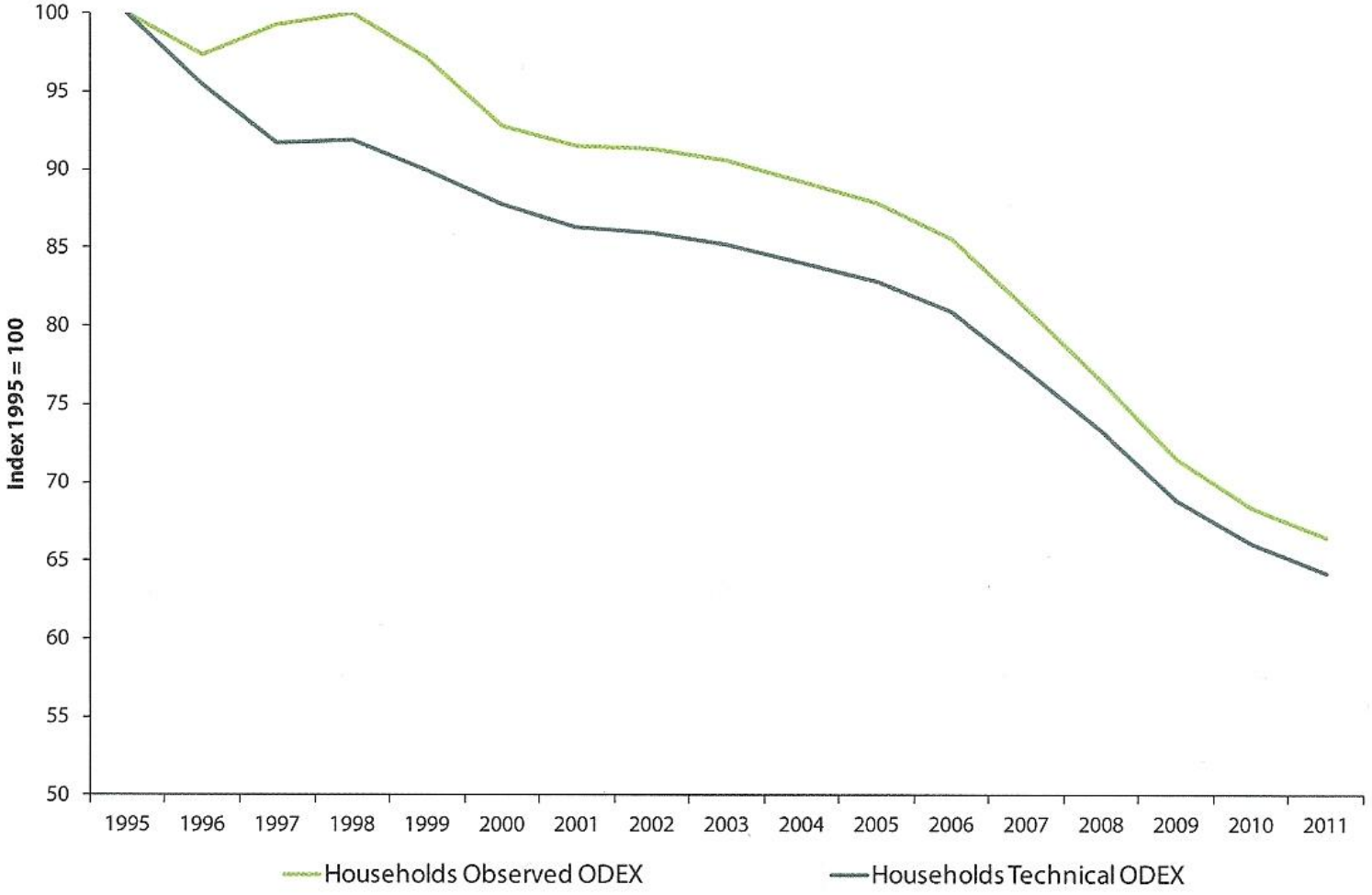




Cut uncontrolled ventilation heat loss & cut fabric heat loss

Energy efficiency in Irish dwellings improved by 2.5% per year from 1995-2011

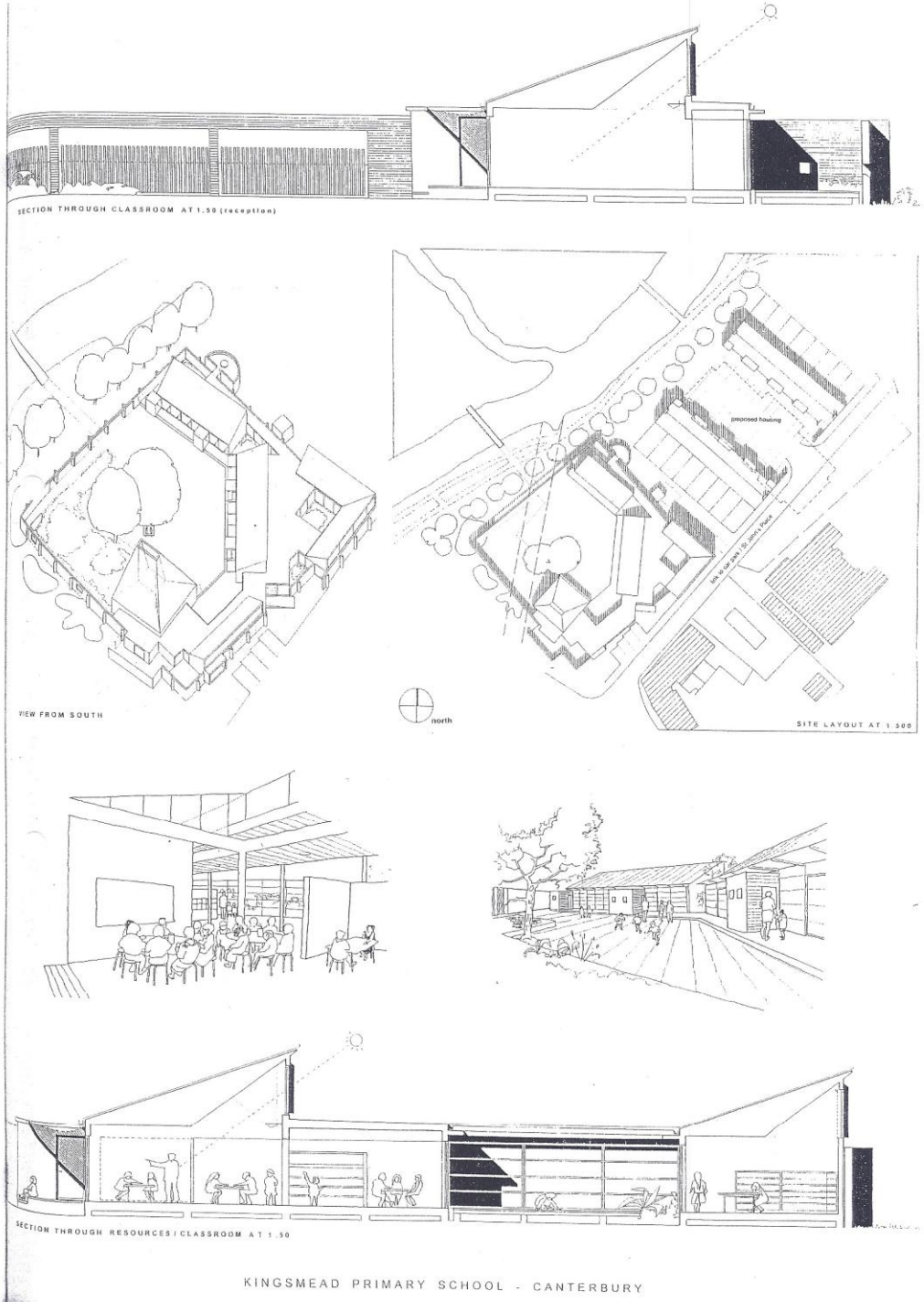
Figure 73 *Household ODEX 1995 - 2011*



Source: Energy in Ireland 1990-2011, 2012 Report SEAI, p80

Principles of Low Carbon Design

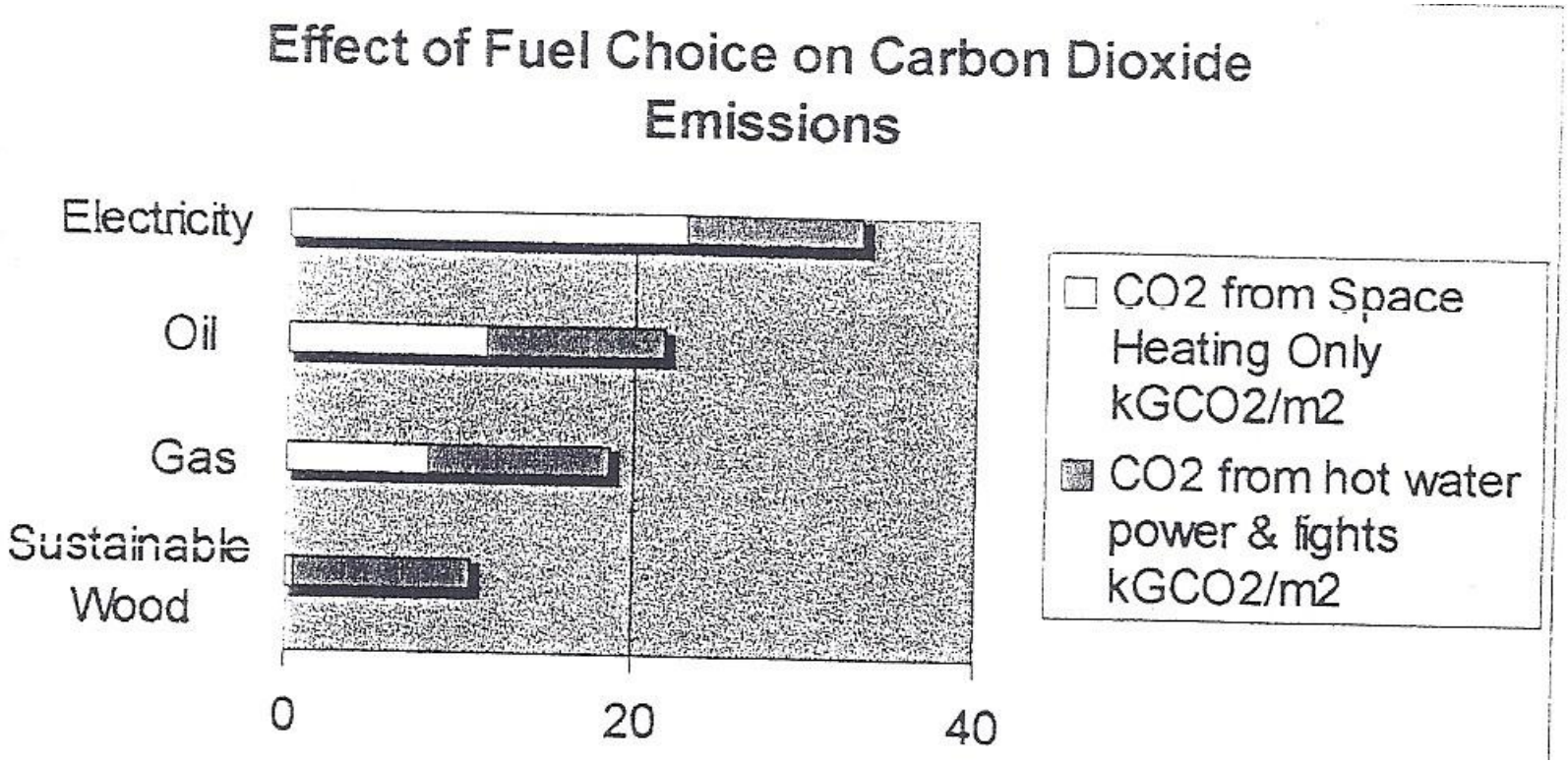
1. Minimise fuel demand



Kingsmead Primary School Canterbury

(Sir Colin Stansfield Smith, John Pardy, Kevin McCartney)

Joint Winner, RIBA International Competition for 2001
Sustainable School Design,

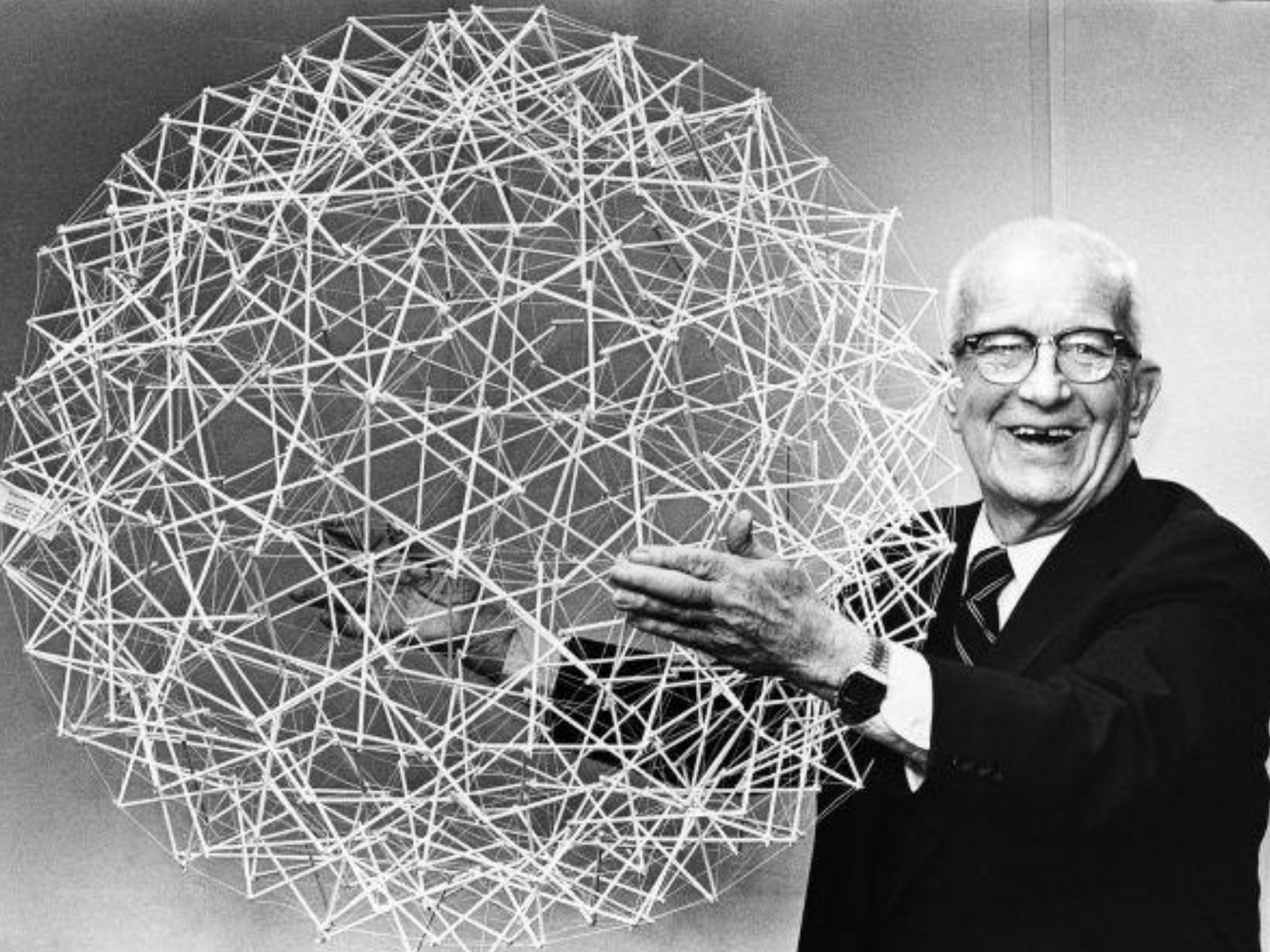


Wood chip boilers were specified for Kingsmead school. This reduced CO_2 emissions by as much as 68% compared with electric heating, and by 42% compared with high efficiency GAS boilers (McCartney, 2001)

Principles of Low Carbon Design

1. Minimise fuel demand
2. Select fuels with low carbon coefficient

How much does your building weigh?

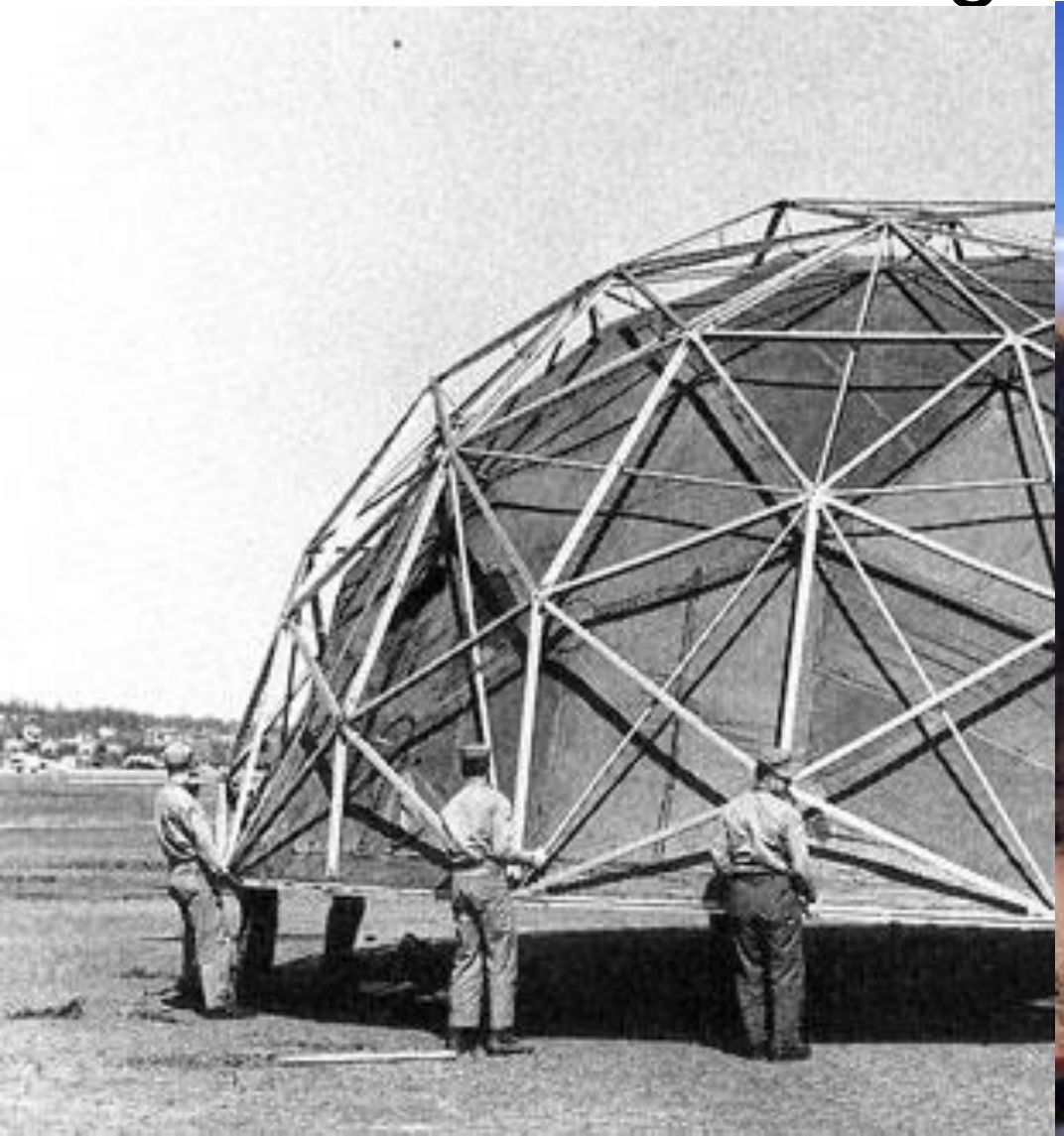


Ohio Institute of Historic Structures

Buckminster Fuller proposal for a city-scale dome providing controlled micro-climate


“to make the world work for 100% of humanity,
in the shortest possible time, through spontaneous cooperation
without ecological offense or disadvantage of anyone". BF
Bamboo Institute: Ignacio Platas
Shortlisted for Buckminster Fuller Challenge Prize, 2009

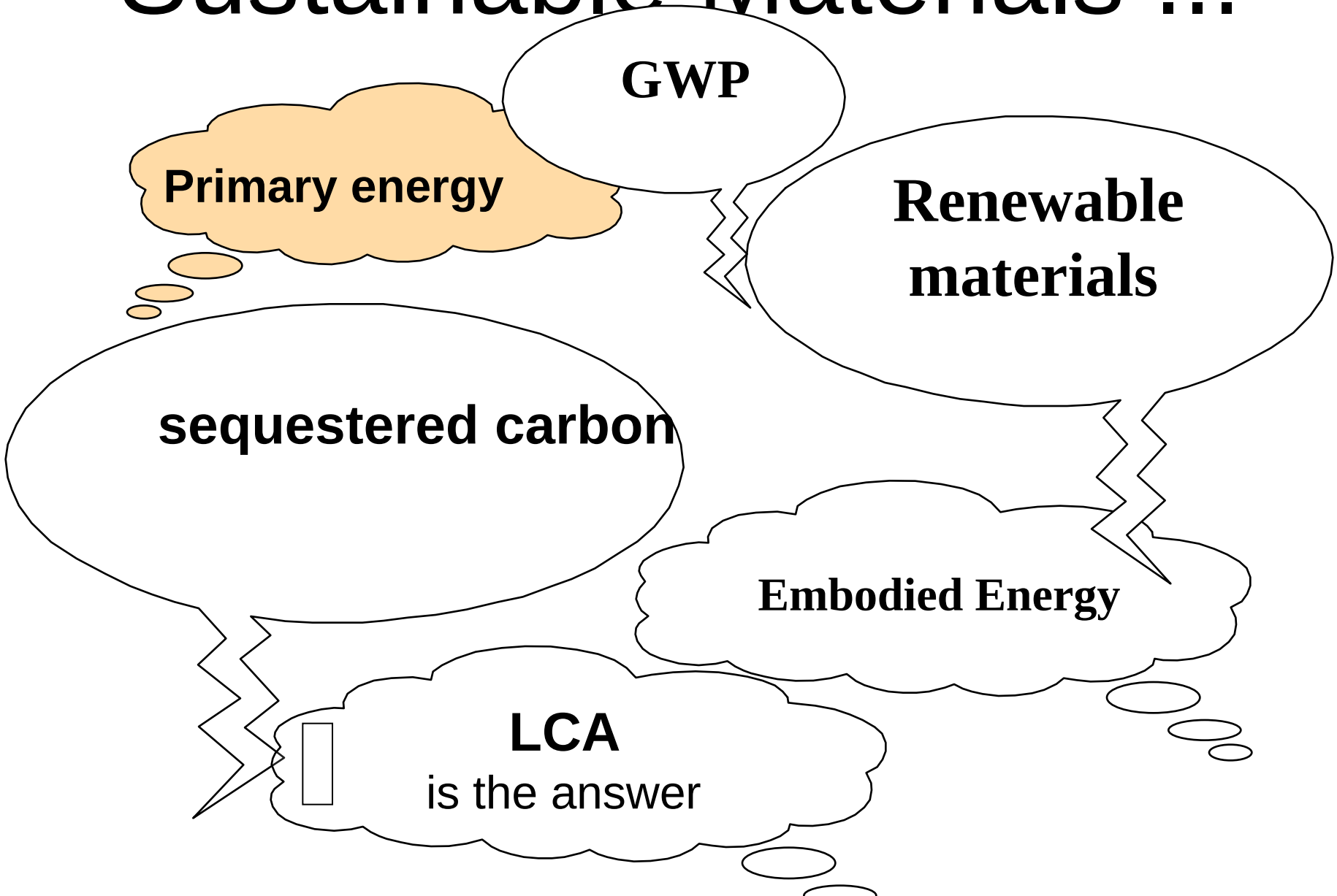
How much does your building weigh?

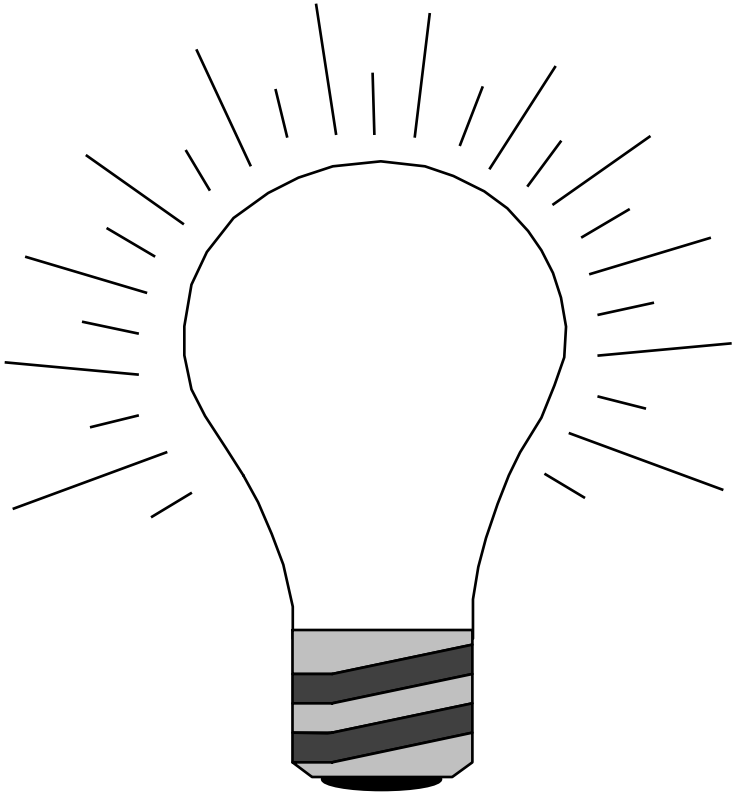


Principles of Low Carbon Design

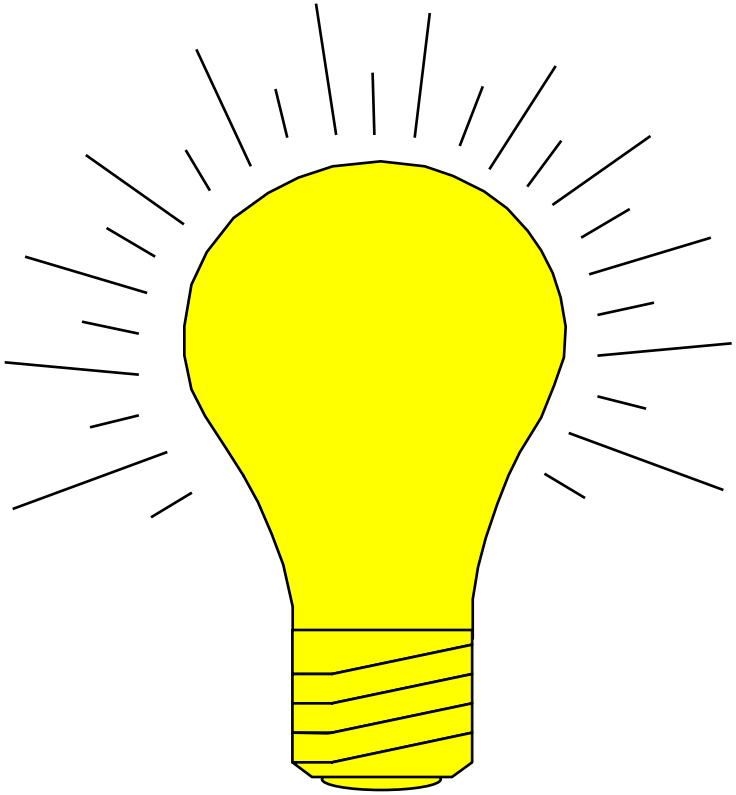
1. Minimise fuel demand
2. Select fuels with low carbon coefficient
3. Use less material/appropriate durability

Sustainable Materials ...



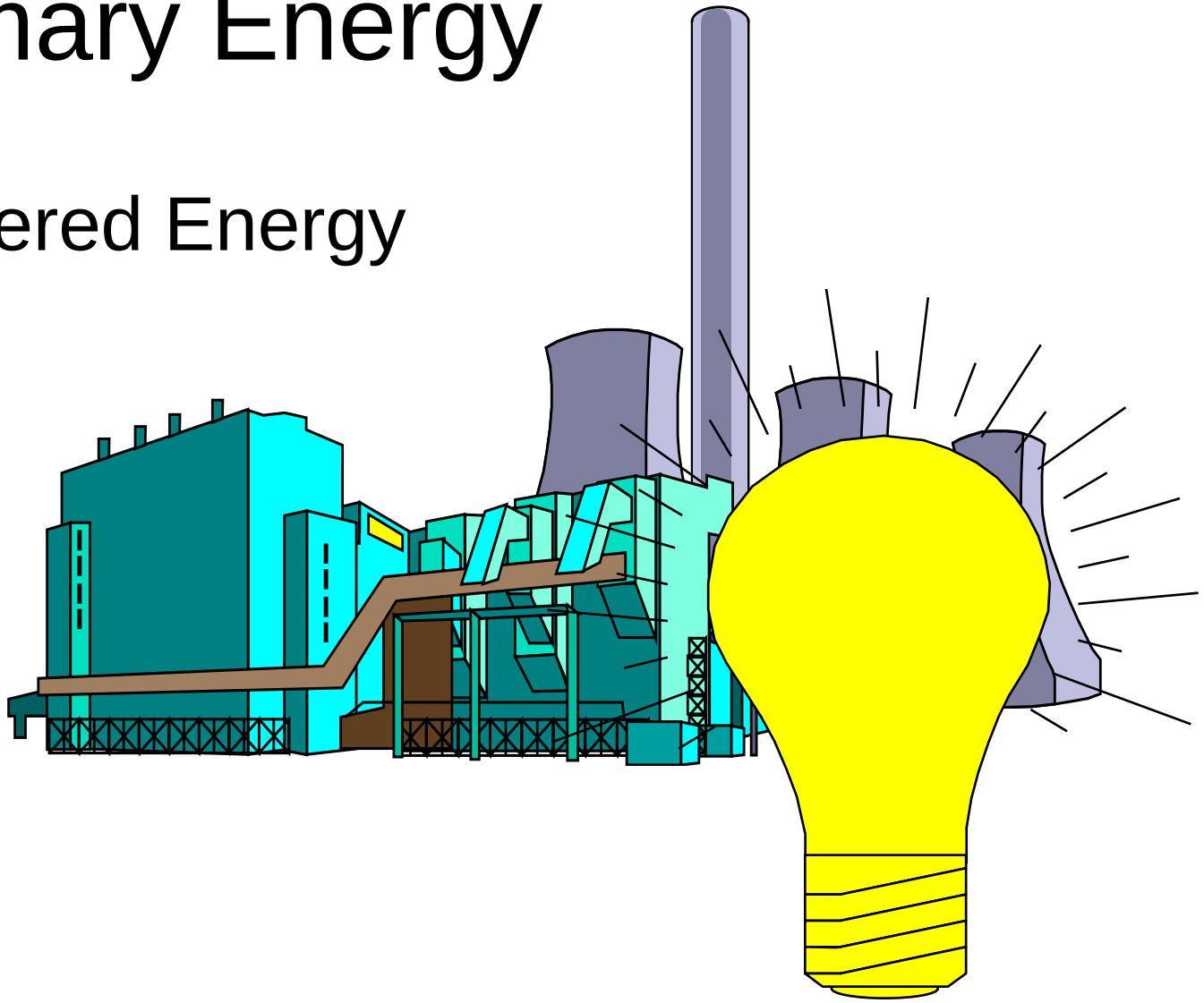


Delivered Energy

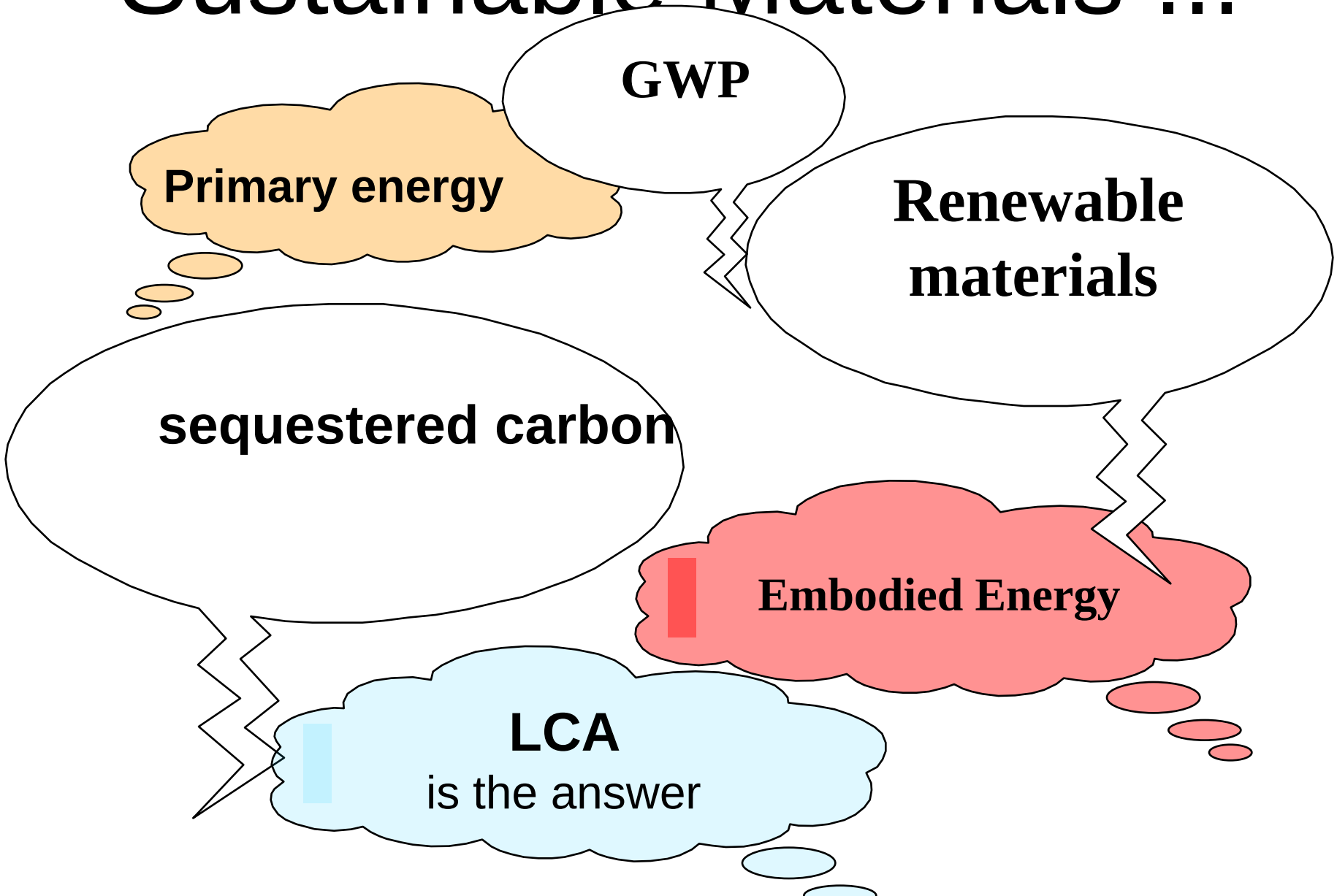


Primary Energy

Delivered Energy

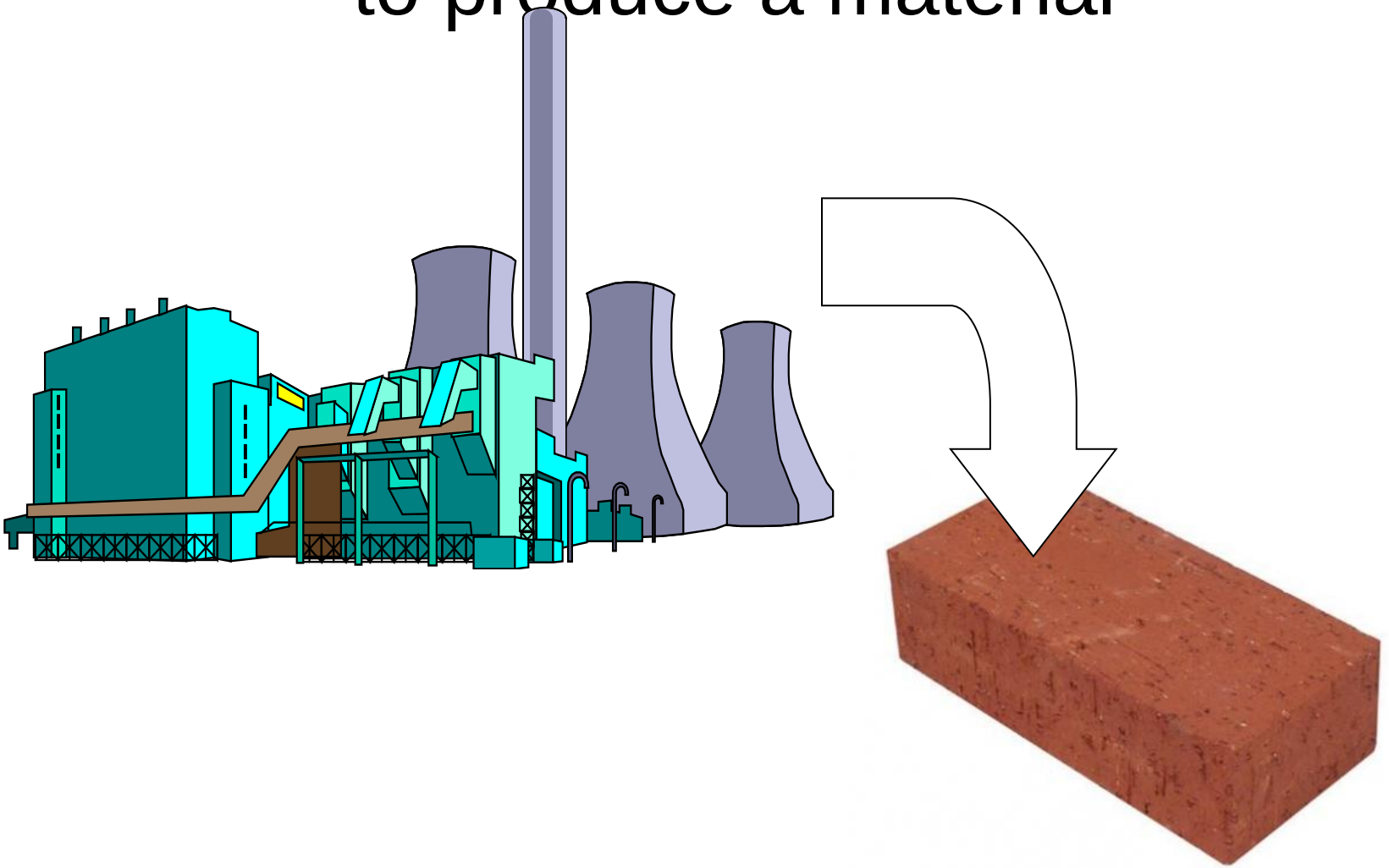


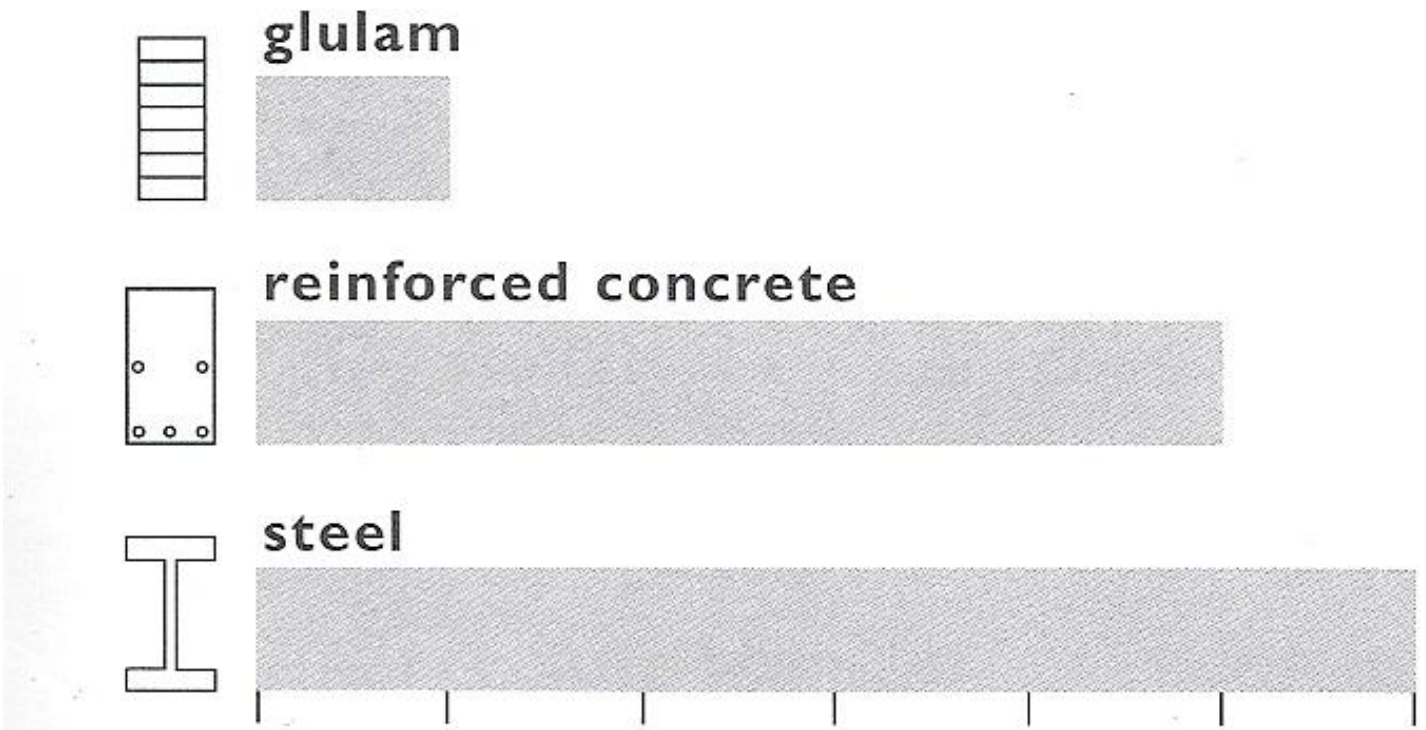
Sustainable Materials …



Embodied Energy (EE)

The total primary energy required to produce a material

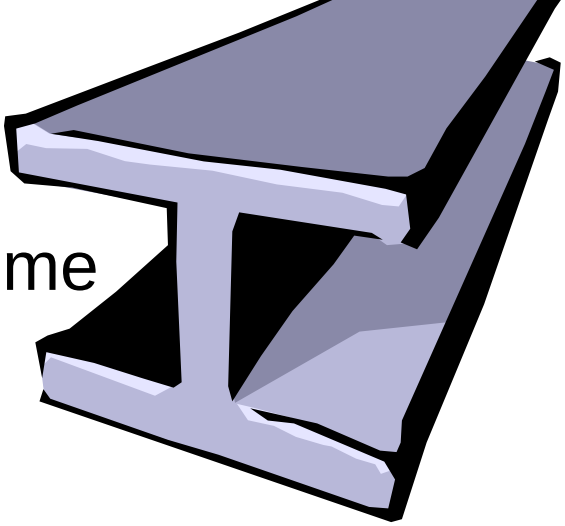




Comparison of Embodied Energy in glulam timber, concrete and steel beams of the same strength.
Steel has 6 times more Embodied Energy than glulam timber.

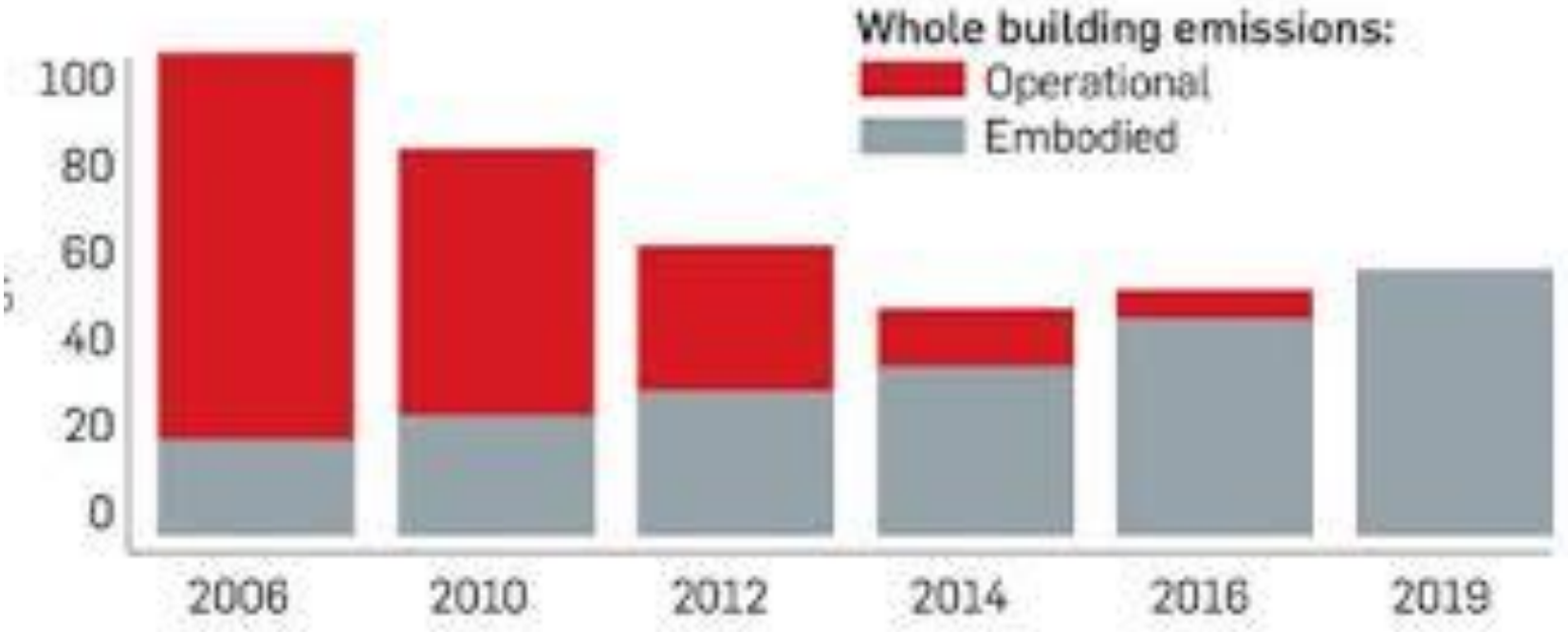
Graph:. Culture of Timber, McCartney, 1995. Data: Baird & Chan, 1983, NZ.

- **Non- Renewable Material**
  - Finite: extracted once
    or developed over a long period of time
    e.g. stone, minerals, steel



- **Renewable Material**
  - Sequesters Carbon:
    One Kilogram of dried timber can contain 1.8 Kilograms of $C0_2$eq/kg stored as Carbon or a negative GWP -1.8 Kg$C0_2$eq/kg [5]

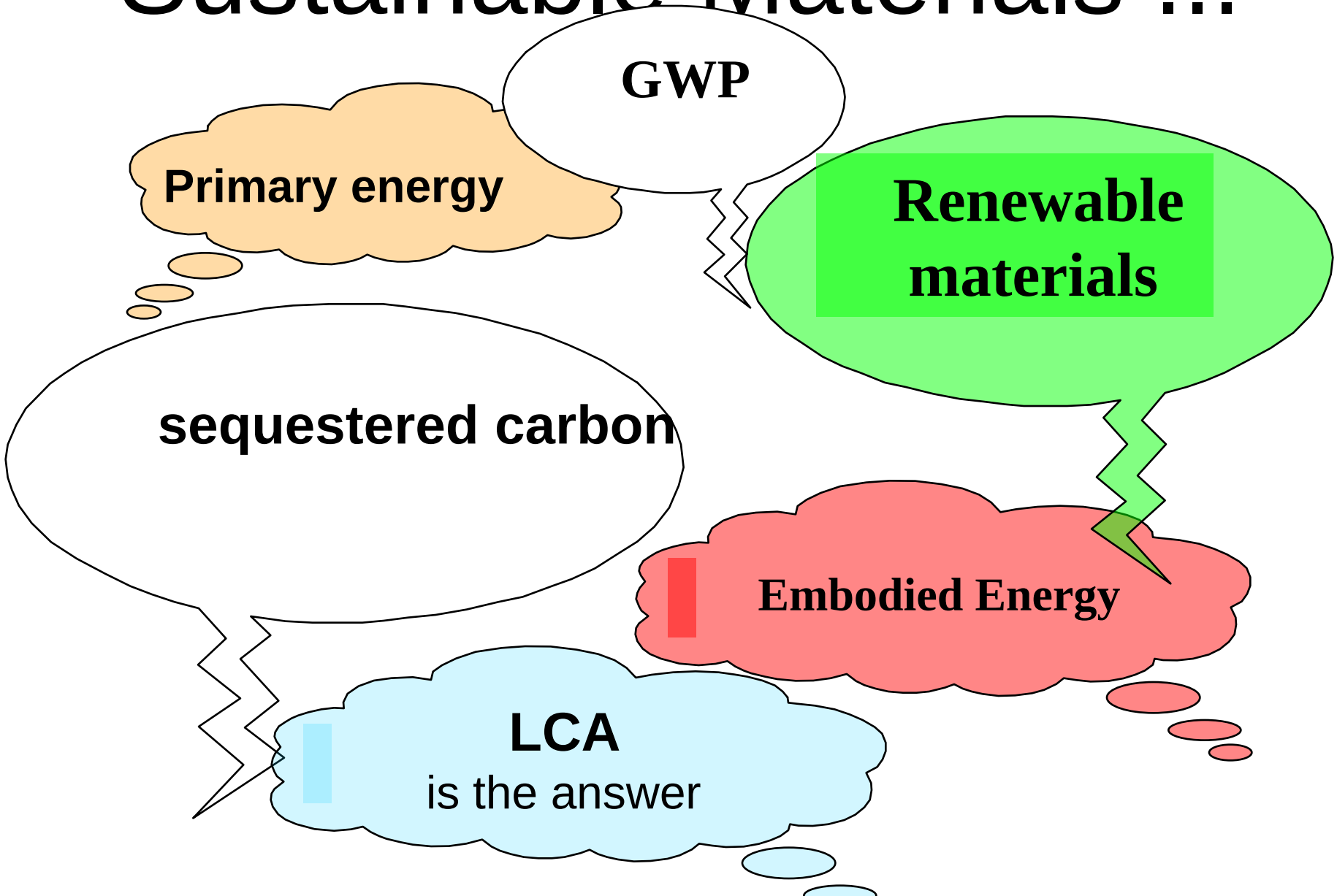
Embodied energy will be dominant contributor to carbon emissions



PBA's graph shows that embodied rather than operational carbon will soon become the dominant factor in reducing new buildings' carbon footprints. New building regulations in 2016 will enforce the need for all new homes to be zero carbon from that date - with non-residential to follow by 2019.

Building Design 1/5/2013

Sustainable Materials ...



RENEWABLE VERSUS NON RENEWABLE BUILDING FABRIC

A COMPARATIVE STUDY ON THE EFFECT OF MATERIAL CHOICE
ON THE EMBODIED ENERGY AND GLOBAL WARMING POTENTIAL
OF LOW ENERGY BUILDINGS (2011)

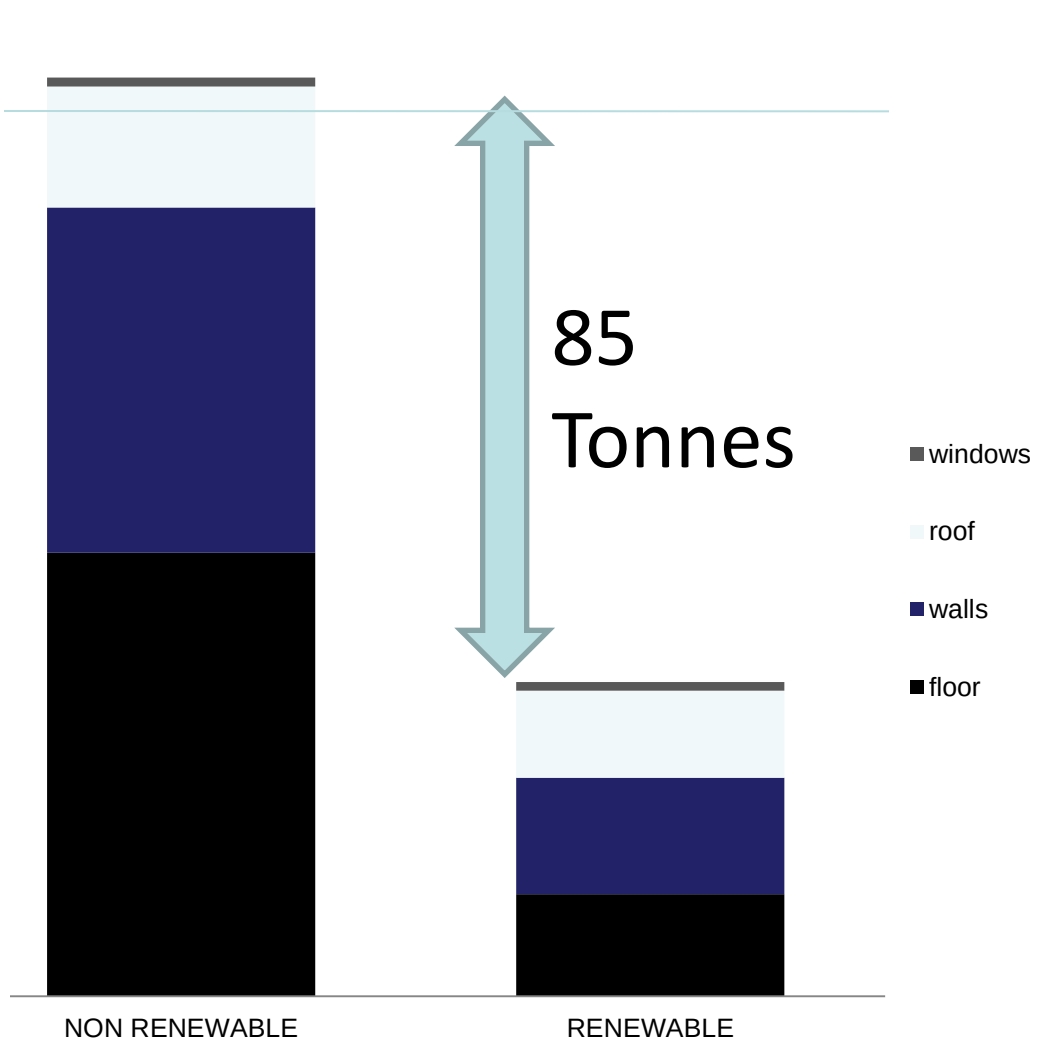
by

Minka McInerney & Simon Tucker

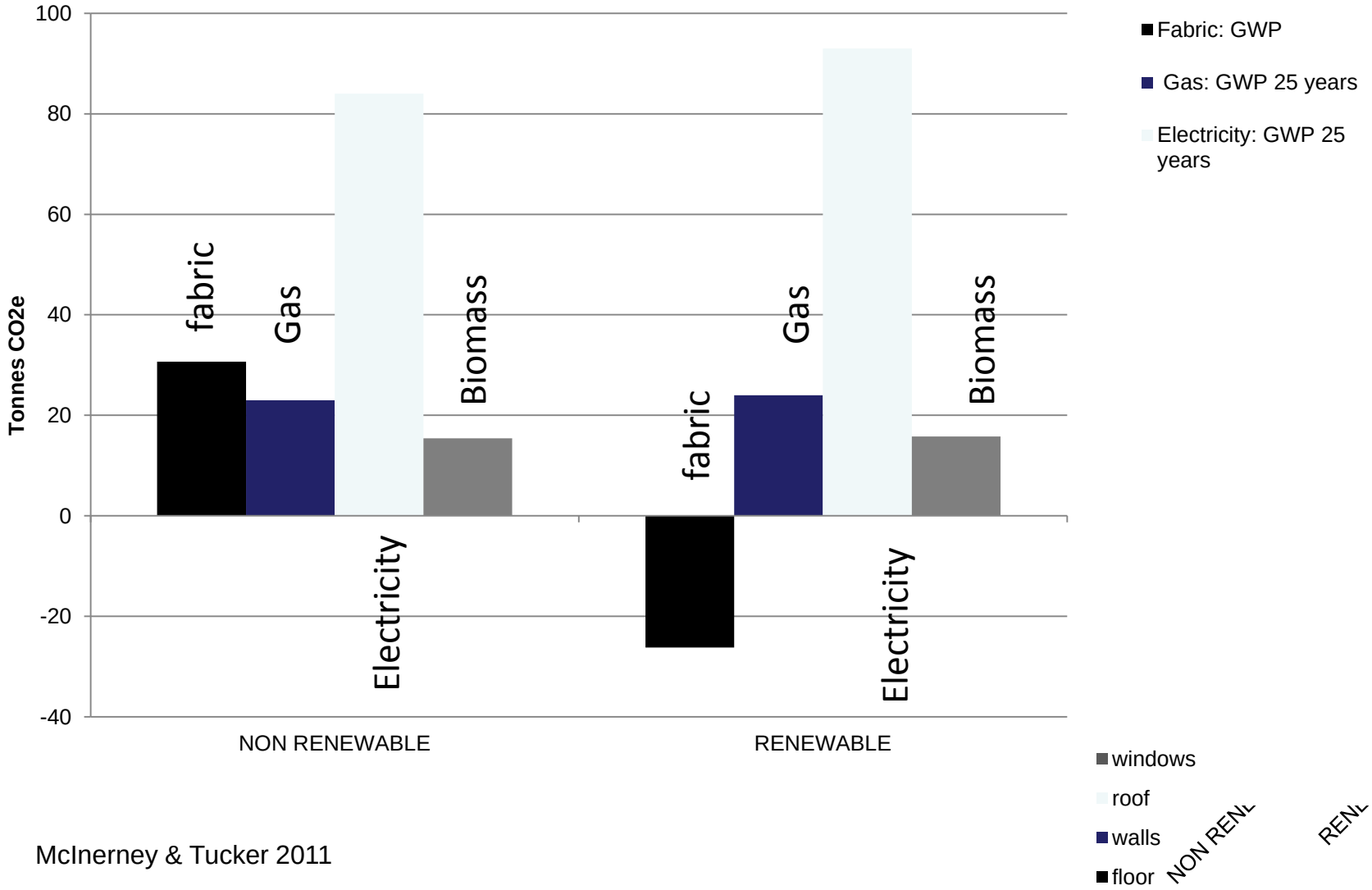
McInerney & Tucker 2011

Weight Comparison

How much does your building weigh?



Global Warming Potential Comparison fabric & operational energy 25 yrs

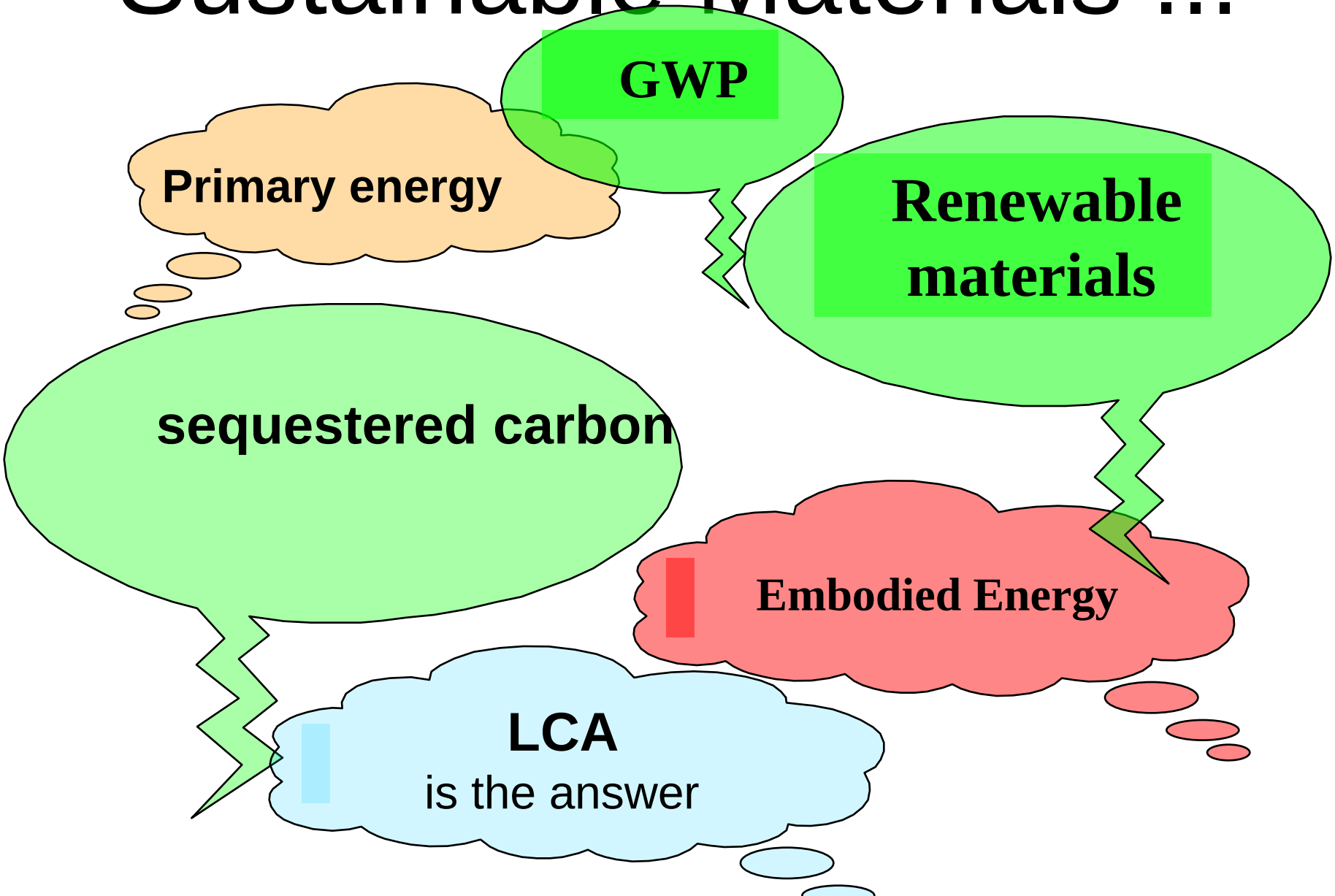


McInerney & Tucker 2011

Principles of Low Carbon Design

1. Minimise fuel demand
2. Select fuels with low carbon coefficient
3. Use less material/appropriate durability
4. Select low embodied energy materials

Sustainable Materials ...



Global Warming Potential (GWP)

The metric adopted by the IPCC to assess and compare the impact of Green House Gases

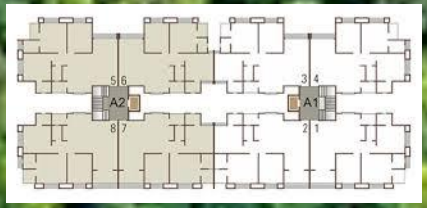
- **Embodied Carbon:** positive GWP of material production – a function of energy generation
- **Sequestered Carbon:** negative GWP of the Carbon stored in plant based renewable materials

Carbon Dioxide Absorption

1 square metre of forest
can absorb 1 kg/year

ECOLOGICAL FOOTPRINT:

UK schools in UK`1990s required a forest area 40-80 times their floor area to absorb their operating energy CO_2 emissions



Principles of Low Carbon Design

1. Minimise fuel demand
2. Select fuels with low carbon coefficient
3. Use less material/appropriate durability
4. Select low embodied energy materials
5. Select materials which sequester carbon