Embodied Carbon in Construction & The London 2012 Olympics

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Embodied Carbon
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Embodied Carbon

Context

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Sustainable Development

There are over 200 definitions of sustainability – Sara Parkins, 2000

"Meeting the needs of the present without compromising the ability of future generations to meet their own needs"

Brundtland Report, 1987

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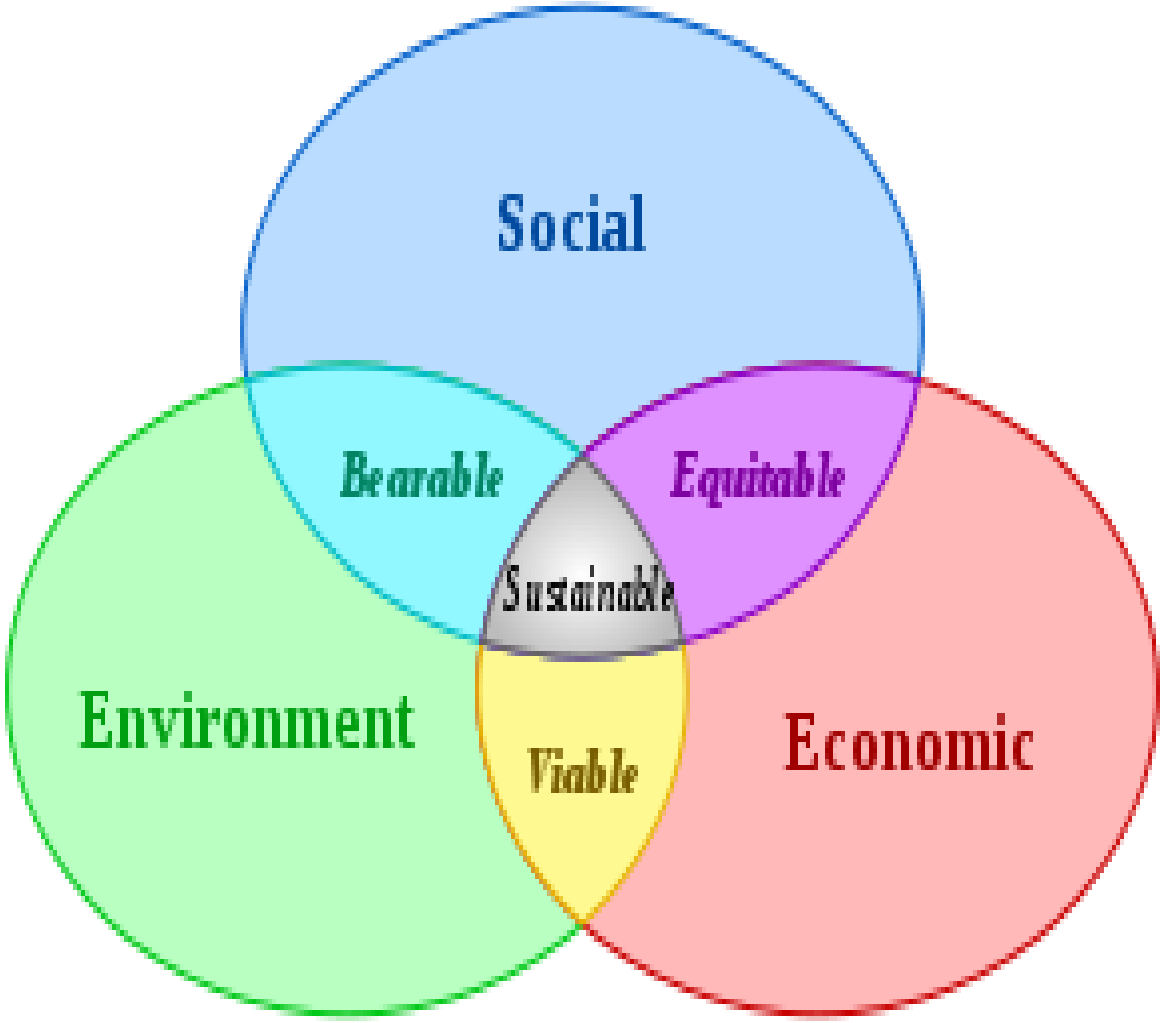
Sustainability – The 3 Pillars



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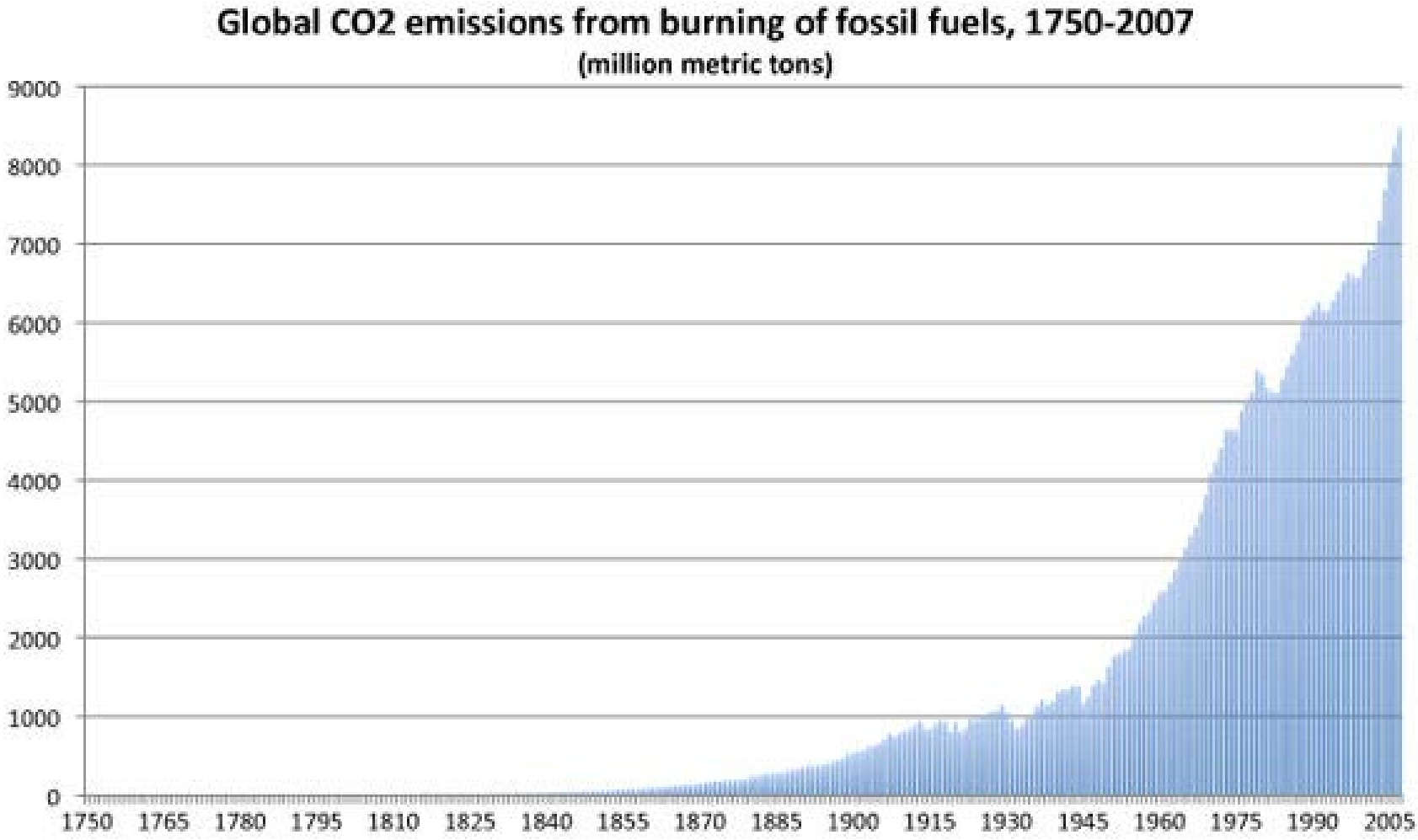
Worldwide CO_2 Emissions - Total

- Worldwide GHG emissions rapidly rising



Introducing Embodied Carbon

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Embodied Energy (EE) & Embodied Carbon (EC)

Embodied Energy (Carbon) may be taken as…

…the primary energy consumed (carbon released) to extract, process, transport, and fabricate a product (or activity).

All inputs must be traced back to **The Cradle…**

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Embodied Carbon – From the Cradle…

Material Refining

The Cradle =
The earth, or ground

Transport

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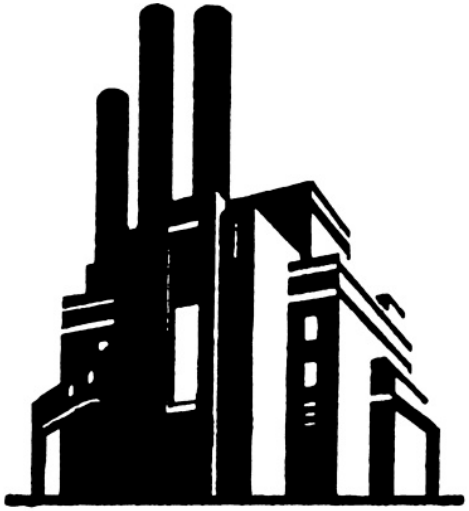
From the Cradle….

…..to (Factory) Gate

Factories: Fabrication, assembly…etc



More transport

Products

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….and to (Construction) Site

Construction Site

Packaging

Distribution

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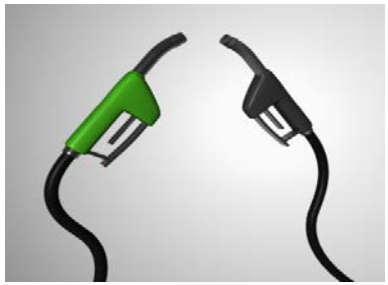
….On-Site Carbon



Power

Assembly Activities

Waste =
embodied carbon of waste
+ waste management

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A Life Cycle Perspective
The Life Cycle of a Building

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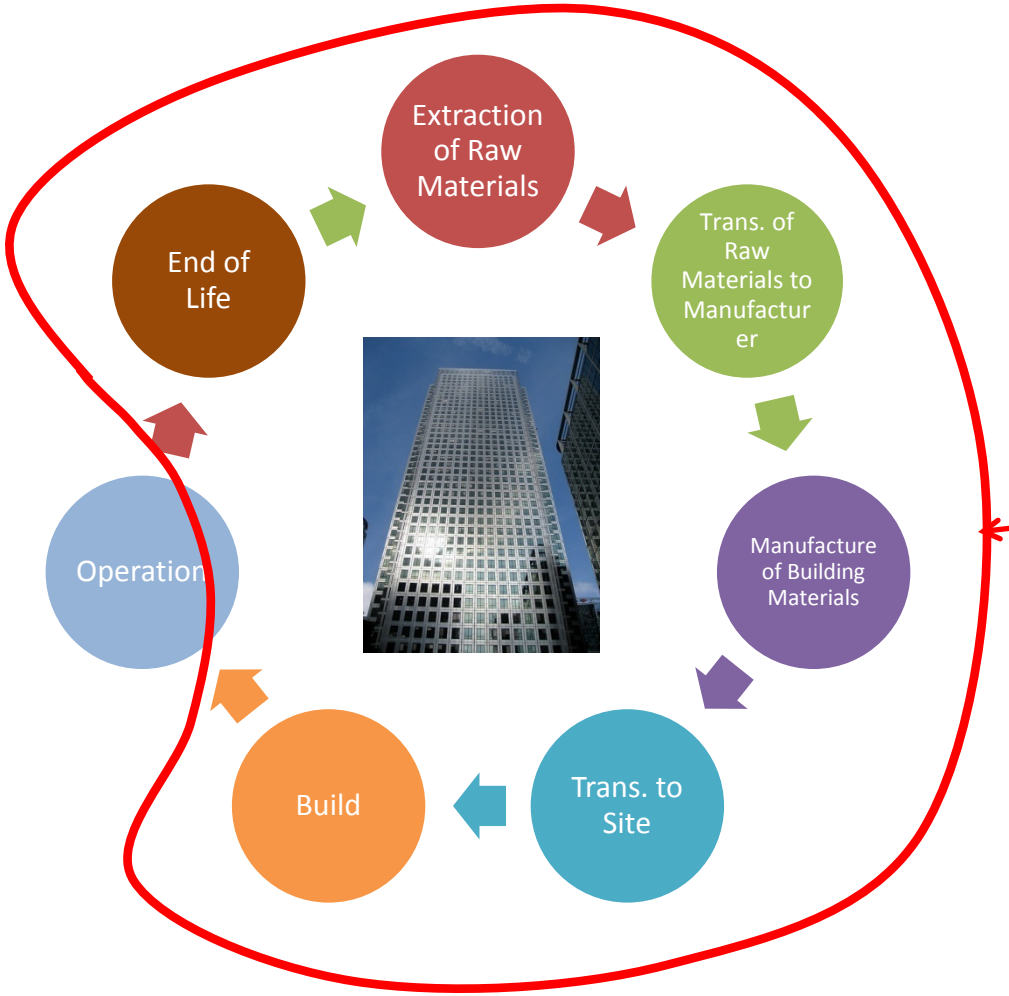
A Life Cycle Perspective
The Life Cycle of a Building



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Embodied & Operational Carbon

- **Embodied Carbon of a House =**

  ~ 500 kg CO_2 per m^2

  – ~ 22 yrs op. Carbon (exc. applian.)
- **Office = ~ 500-1,000 kg CO_2 per m^2**

  – 20-35% of the “Whole Life Carbon”
- **Decarbonisation of electricity**

  – embodied carbon could become 50% more significant when electricity decarbonisation considered

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Embodied Carbon

London 2012 Olympics: A Legacy

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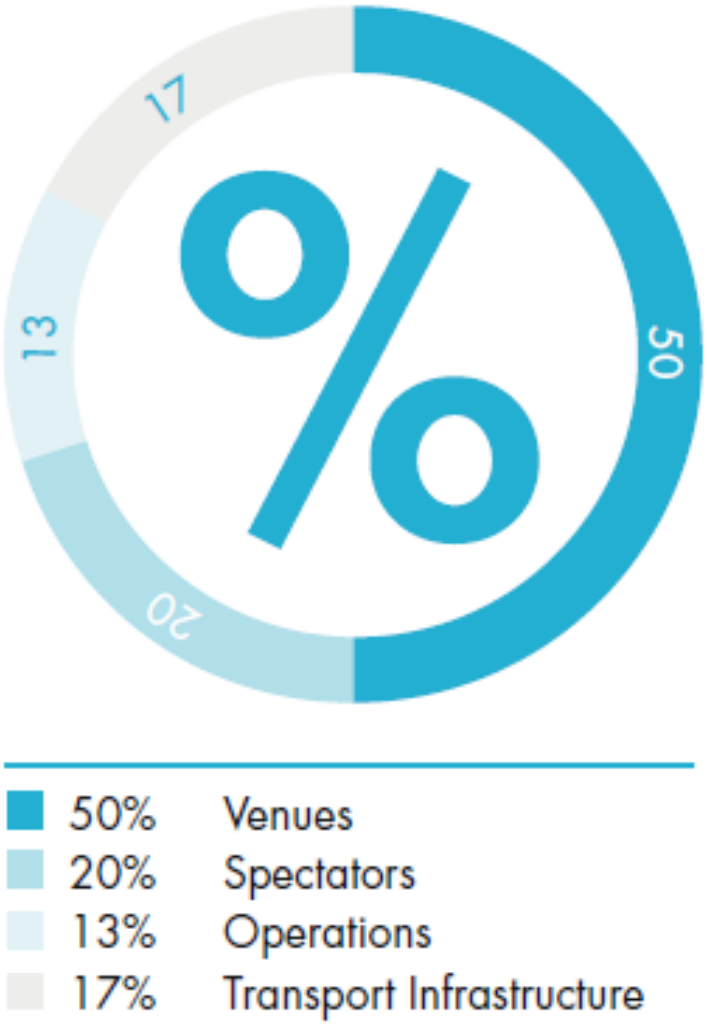
2012 Olympics

- Breakdown of carbon footprint of the Olympics
- More than 2/3 of the carbon occurs before the games has even started
  - 50% venues
  - 17% transport infrastructure
- Embodied carbon therefore key to reducing carbon impact of Olympics



London 2012 – Embodied Carbon

- Despite no specific targets on embodied carbon there were still considerable savings achieved in the construction, e.g.
  - Low carbon concrete
  - Dematerialisation
  - Temporary structures
  - Case Study: Olympic Stadium

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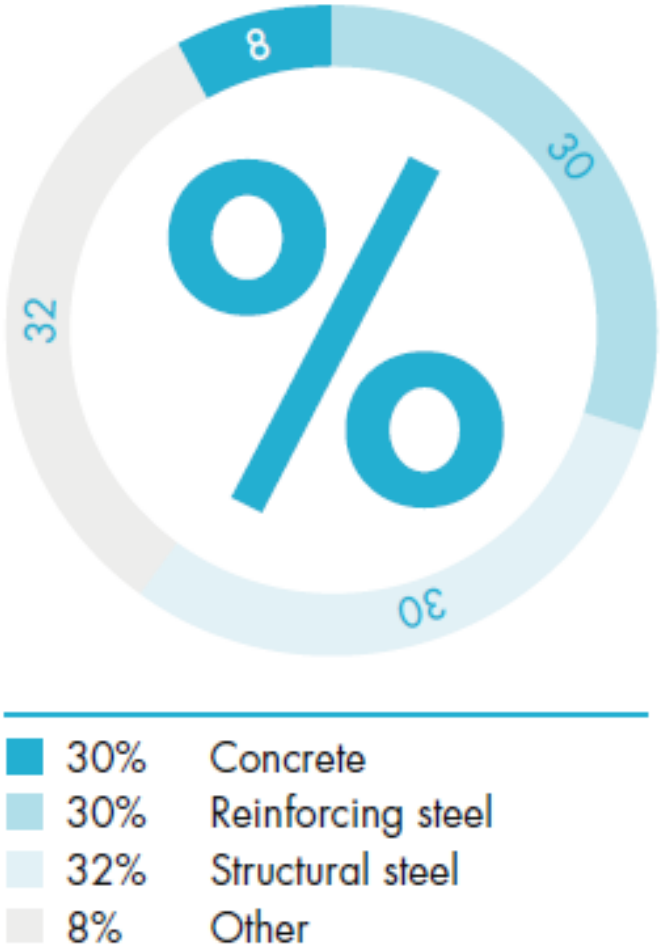
Low Carbon Concrete

- Concrete and steel are typically the main contributors to embodied carbon assessments
  - For Olympics over 90%
- Concrete normally = #1 quick win
  - Ground granulated blast furnace slag (ggbs)
    - Up to 80% cement replacement
  - Pulverised fuel ash (pfa / fly ash)
    - Up to 40% cement replacement

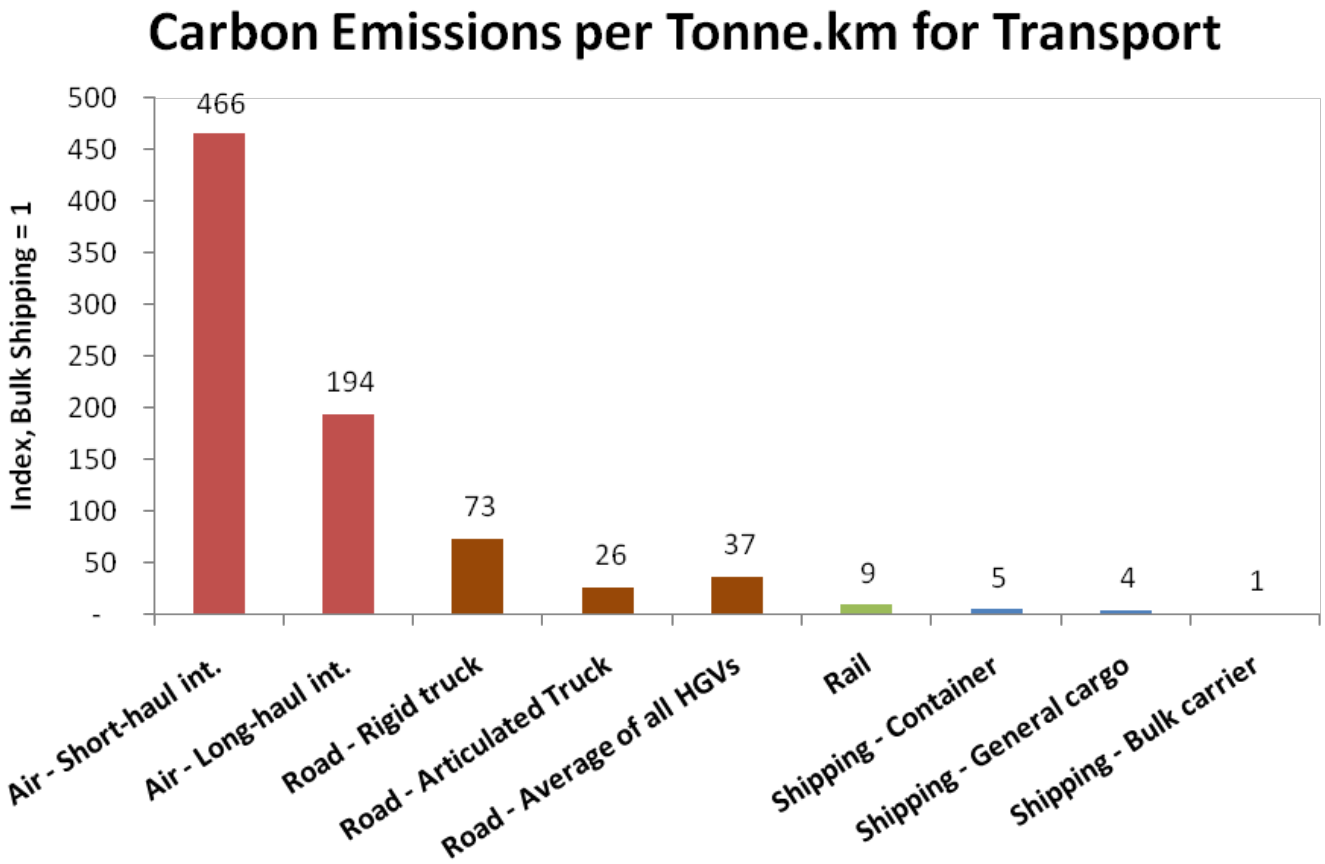


Low Carbon Concrete

Left: Concrete finish quality issues at 70 per cent GGBS replacement
Right: Approved finish surface, achieved without any rework at 40 per cent GGBS replacement and 76 per cent coarse aggregate replacement

Greening Supply Chains
Sensible Transport Strategies

- locating the ready mix concrete plant on site eliminated 60,000 heavy vehicle movements.



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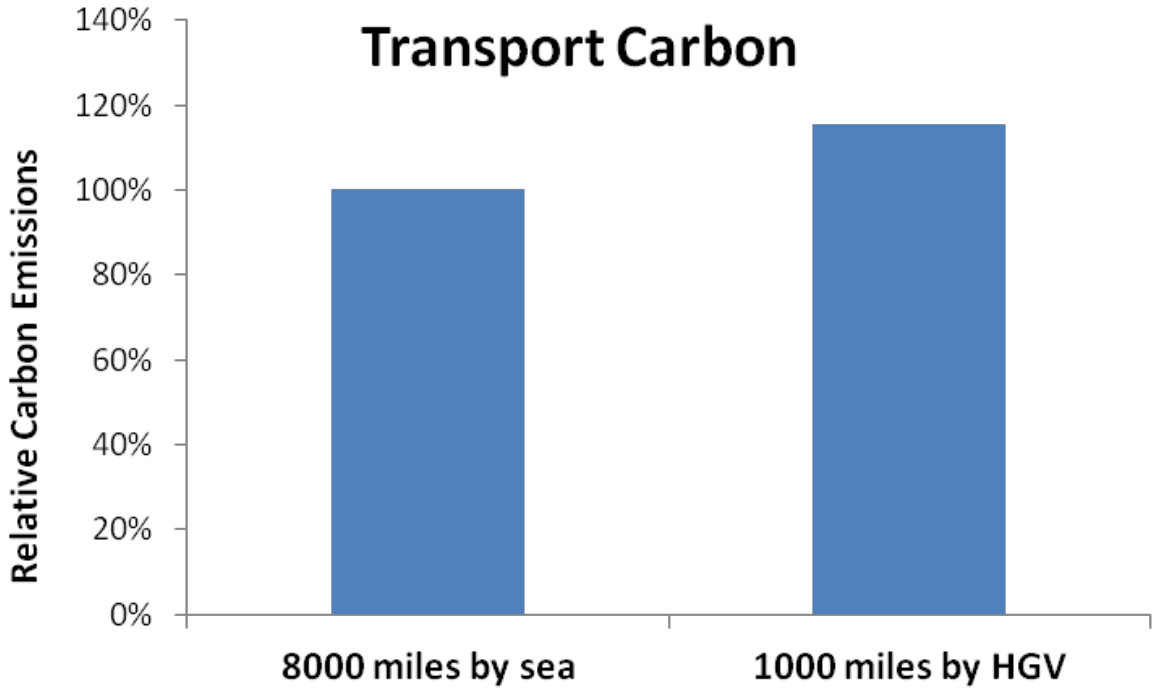
Greening Supply Chains

- Which is lower transport carbon:
  1. Steel from India = 8,000 miles
  2. Steel from Hungary = 1,000 miles



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Case Study: Olympic Stadium

- Large savings in design – both mass and embodied carbon
- Innovative steel cable-net structure supports the fabric roof and the sports lighting >> dematerialisation
- Surplus steel from gas pipeline project used on roof

	Preliminary scheme Stage C – December 2006		Final scheme Stage C – April 2008	
	Mass	Embodied carbon	Mass	Embodied carbon
Materials	kt	kt CO_2	kt	kt CO_2
Concrete	207	24	102	14
Reinforcing steel	18	30	8	14
Structural steel	10	18	10	18
Other	229	4	116	2
Total	464	76	236	48

Olympic Stadium

- Embodied carbon reduction of Olympic Stadium = **28,000 tonnes CO_2**
- Equivalent carbon to:
  - **Drive around the Earth 5,800 times**
  - **Construct 580 new UK houses** (embodied carbon)
  - **Power 800,000 TVs** for 2 hrs a day for a whole year
- And this is just benefit from the Olympic Stadium

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Summary

- Embodied carbon: **Once emitted its too late**, it cant be undone, it cant be improved
- **Its more important than you think** and was more important than the ODA realised when they started
- **Large embodied carbon savings were achieved** on the Olympics through their wider sustainable development objectives

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Closing Thought - A Rhetorical Question…

Which of these is the more sustainable way of transporting people and goods?

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Thank You!

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