Reducing the carbon footprint of buildings: materials and technologies

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Presentation

What do we need to reduce CO_2 too?

How can we deliver this cost effectively?

- Innovative materials
- The role of technology

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What is sustainable?

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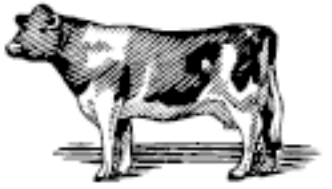
What's in the bank?

Cropland

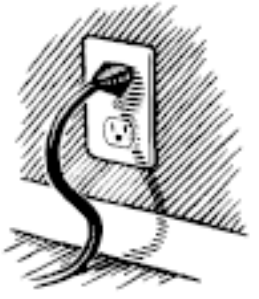


Grazing land

Fishing ground

Forest

"Carbon Land"



Built-up area

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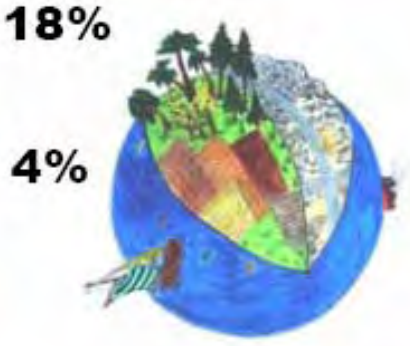
Our Ecological budget



11.2 billion hectares **6.5** billion people

1.8 global hectares per person

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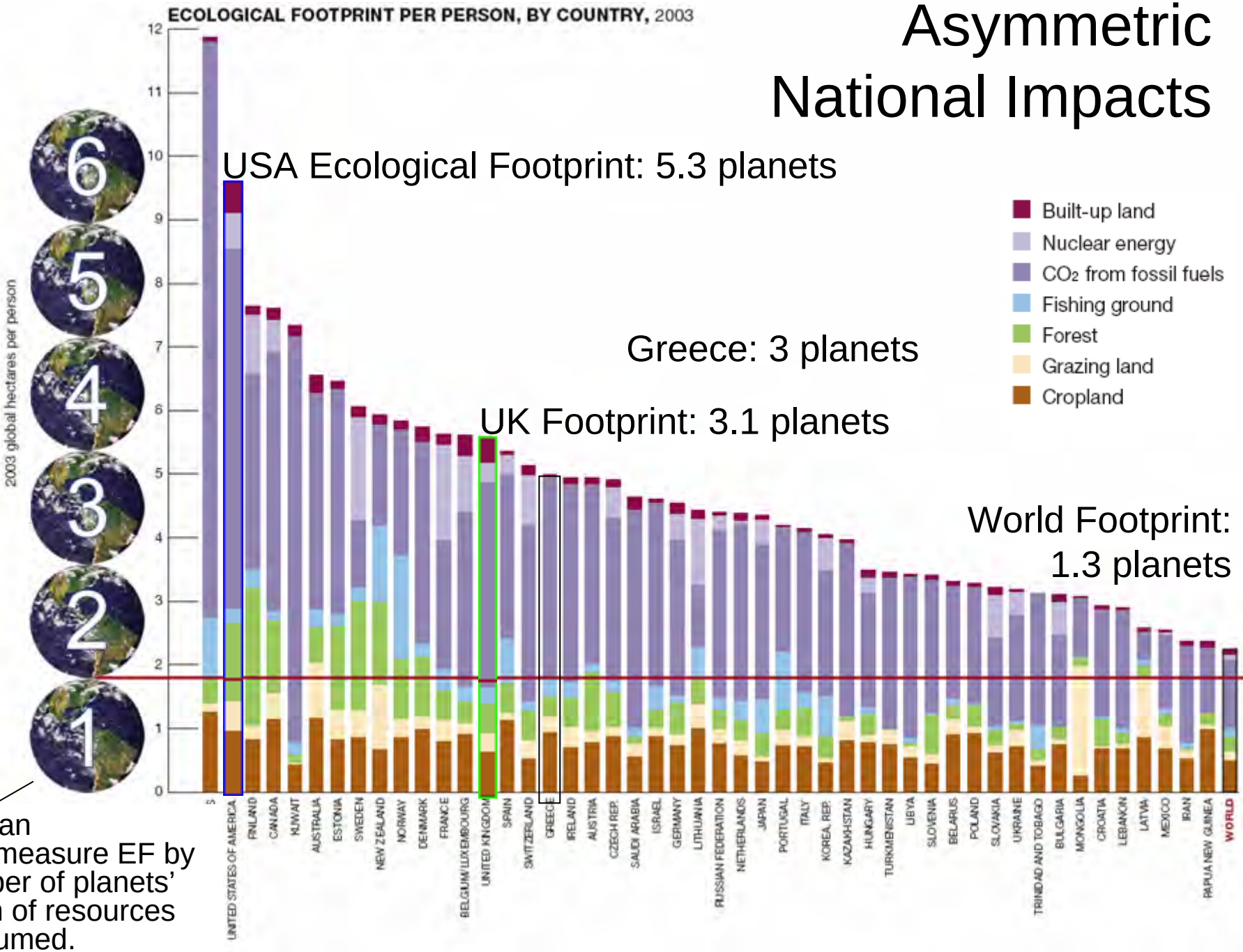
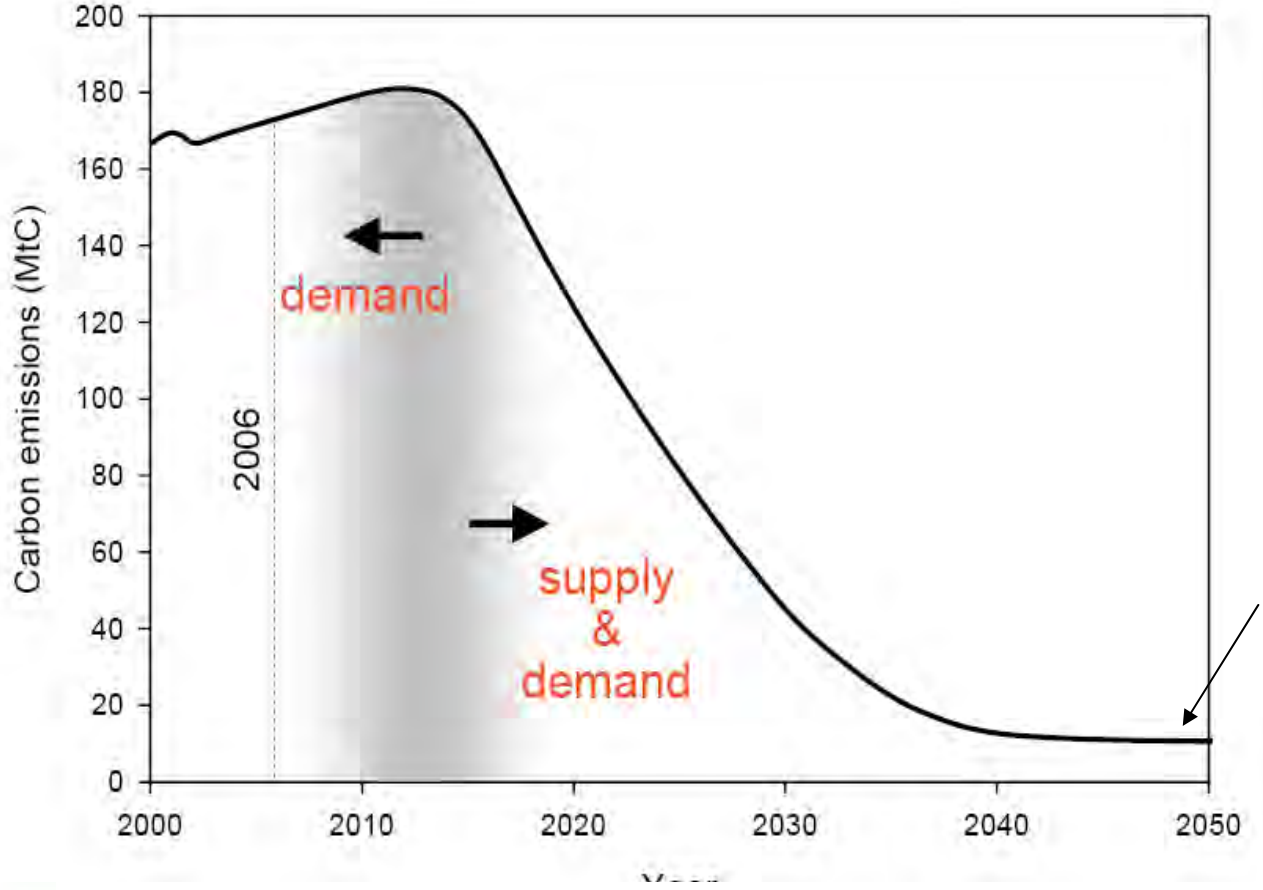
Asymmetric National Impacts



We can also measure EF by number of planets' worth of resources consumed.

What about CO_2 – the carbon budget

The budget (area under the graph) 2.4 Bi tonnes co2 by 2050



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Construction's impact

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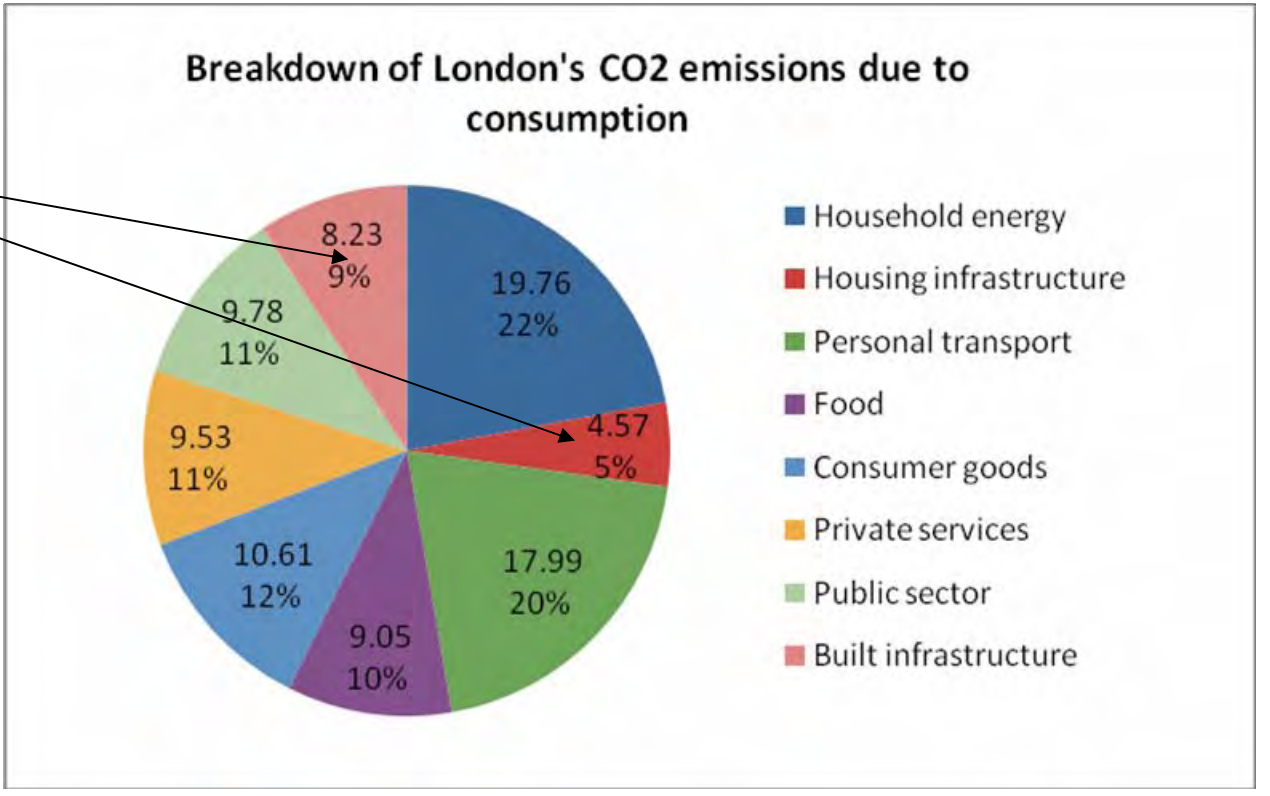
CO_2 of construction (London)

Buildings ~ 15%



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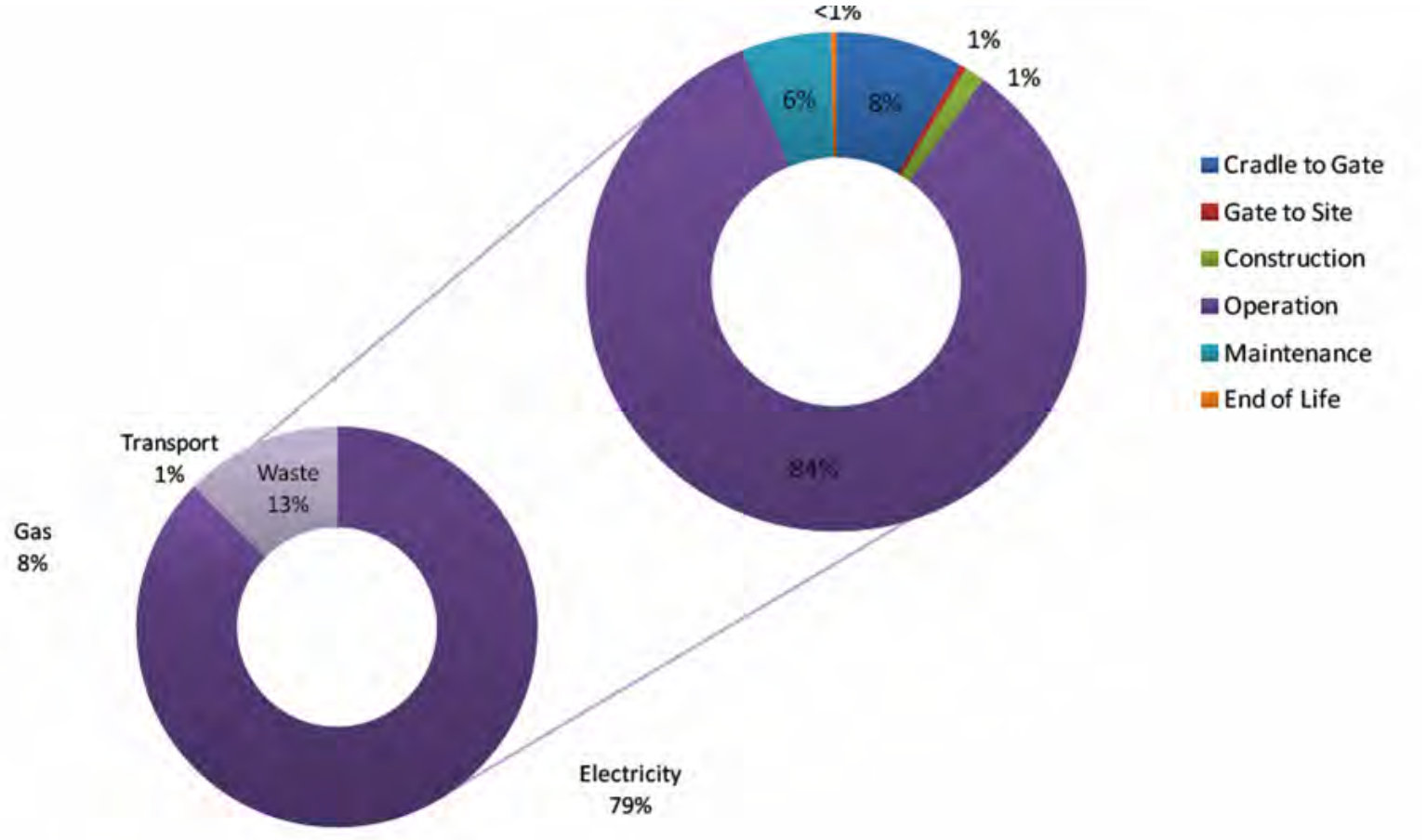
Operational versus embodied energy



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Reducing the impact

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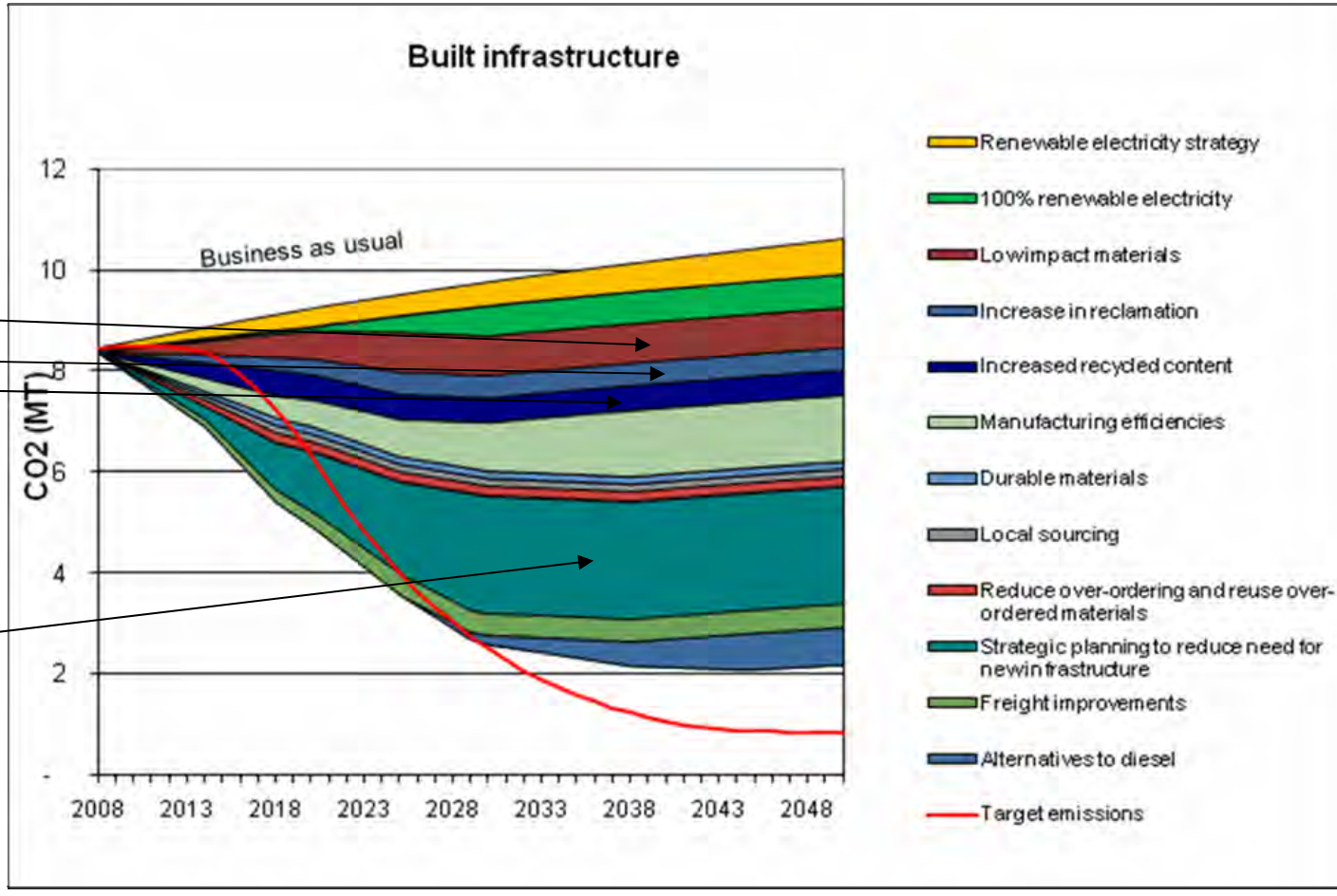
90% reduction

Lower impact materials

Build less



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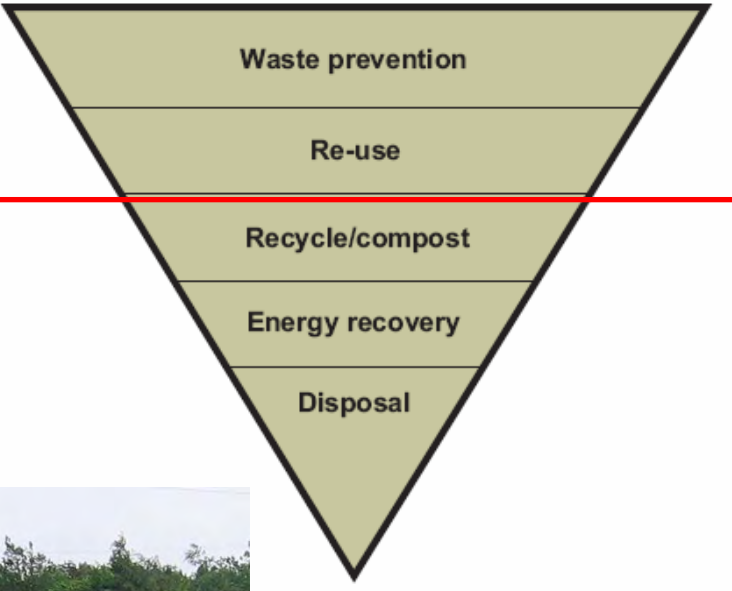
Few strategies

Measure	Saving (mi t CO_2 pa)	Assumptions
Build less	2.32	5% reduction across all sectors 40% reduction in water in line with reduced consumption 50% reduction in investment in roads, airports, retail and vehicles.
Low impact materials	0.78	10% saving of embodied CO_2 through low impact material choices by 2020.
Recycled content	0.50	Increased recycled content results in CO_2 saving of 9.6% by 2020
Reclamation	0.45	Increased reuse results in CO_2 savings of 5.5% by 2020.
Reduce over-ordering	0.20	Over-ordering reduced by 14%. 75% of the over-ordered materials reused or reclaimed elsewhere Overall CO_2 saving of 2.3% by 2020.
Local sourcing	0.15	Embodied CO_2 of all construction materials reduced by 2% through local sourcing by 2020.
Durable materials	0.15	Assume durable material choices result in CO_2 saving of 2% by 2020

Start at the top

Reclamation hierarchy for demolition materials
1. Minimise demolition waste
2. Re-use on site
3. Re-use off site
4. Recycle
5. Energy from waste
6. Landfill



Why reclaim?

Reclaimed is the highest form of recycling

- Massive untapped sustainable resource
- Diverting waste and closing the loop
- No energy intensive reprocessing

Bricks

- Embodied CO_2 – 878kgCO_2/tonne
- Crushed for reuse
- Replaces virgin material
- Saves 16kgCO_2/tonne as hardcore
- 98% resource expenditure

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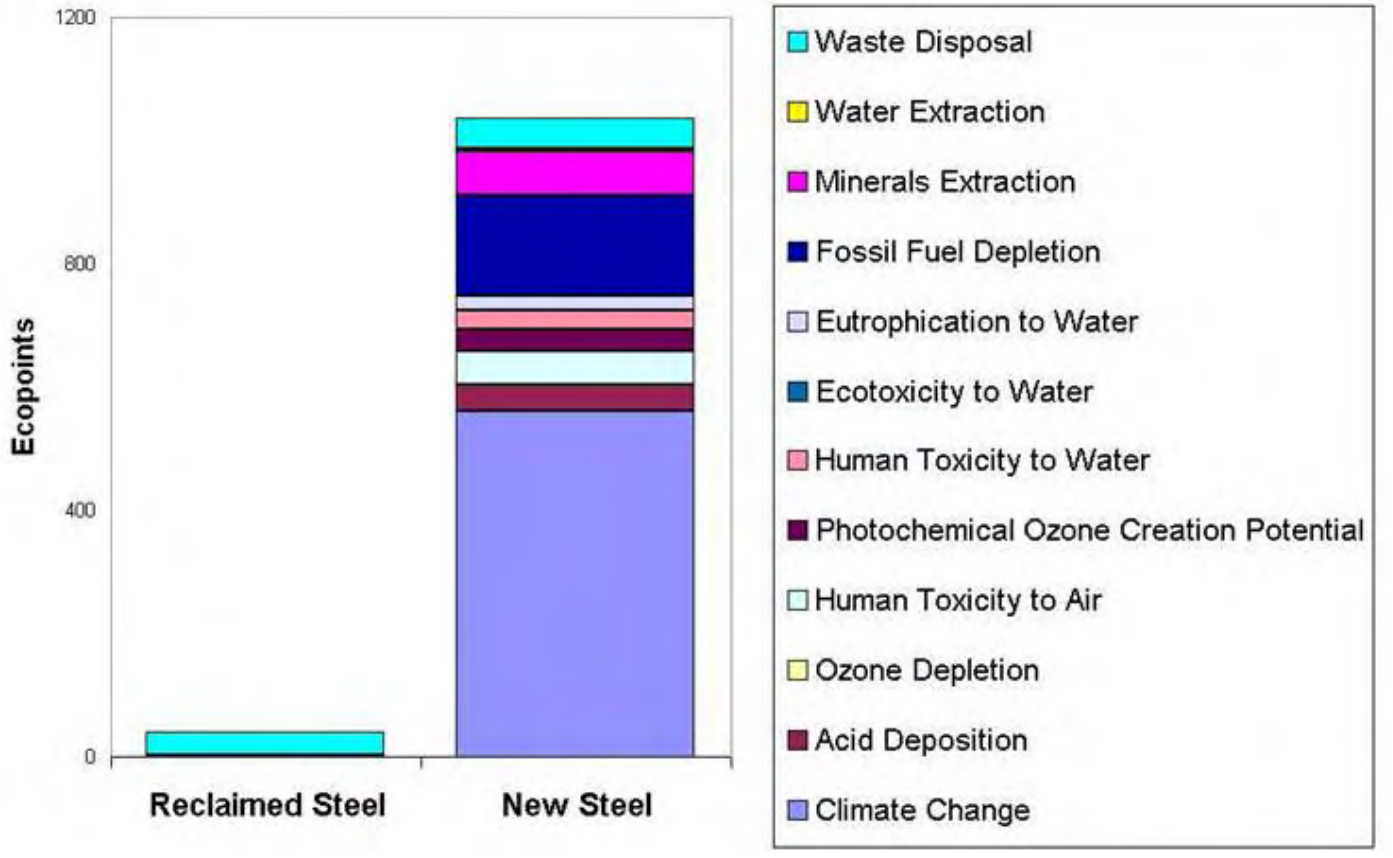
Reclaimed steel



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Reclaimed steel - BedZED

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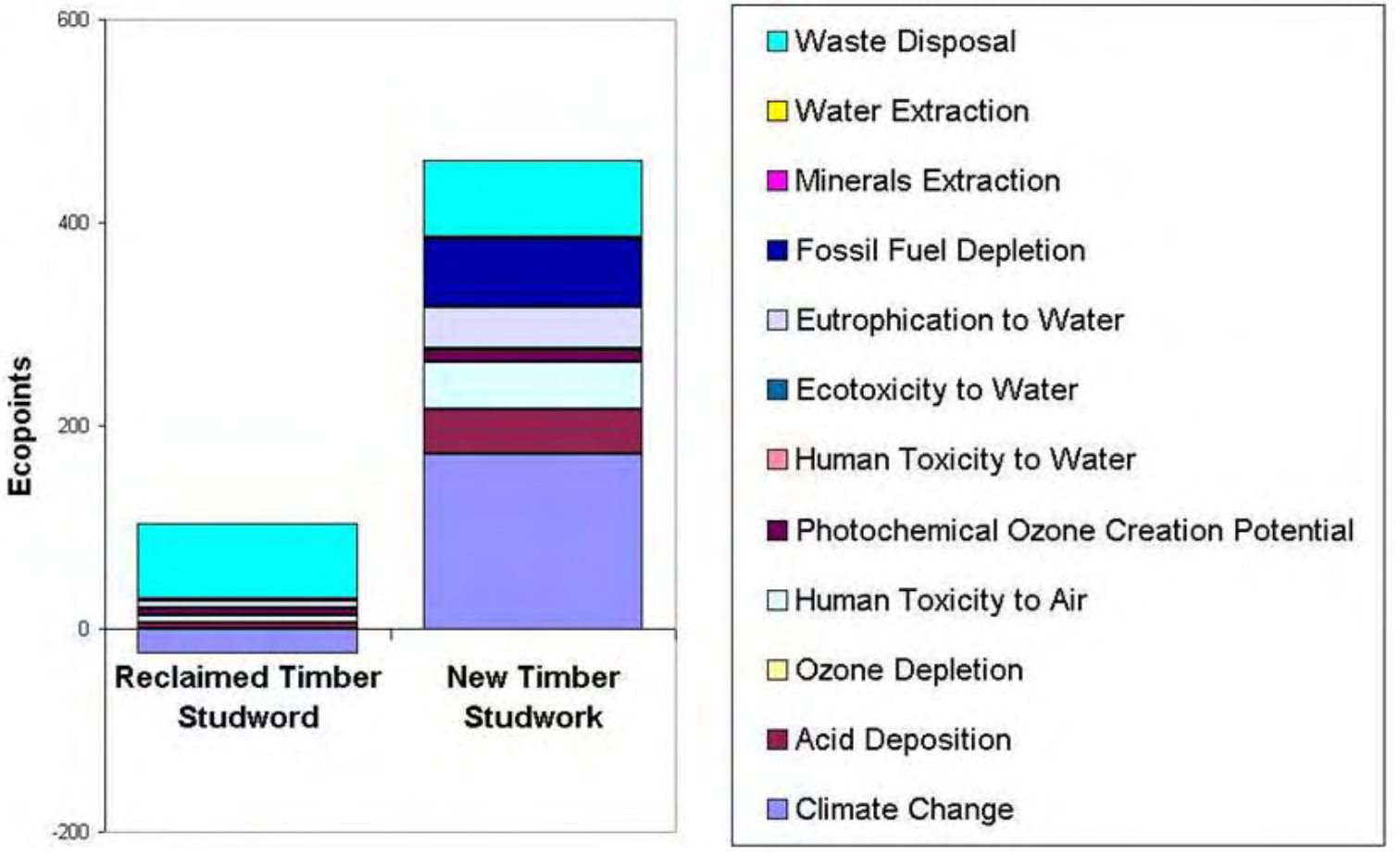
Reclaimed timber



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Reclaimed timber - studwork

Not structural or visible

54km at BedZED

Cost neutral

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Reclamation – the difficulties

New Wembley redevelopment:

Only M &E

Farnborough deconstruction:

Recycling cheaper than reclaimed?

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Reclamation – the savings

Material	Quantity estimate (tonnes)	Embodied CO2 (tonnes)	
		NEW	RECLAIMED
Concrete	1,908	229	206 (recycled)
Steel	600	1,163	23
Glass	1.3	1.5	1.5 (not possible)
M&E		60	1.2
Fit out items		60	1.2
Total:		1,513.5	232.9
Saving:			85%

Proposed development showing a greater than 80% embodied energy saving

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Building Material Reuse Centres

Key Opportunity?

Recycled – what's been done?

WRAP, case studies, using 'Quick win' approach

Type of project	Baseline/actual practice %	Cost neutral good practice %
Detached/terraced house	6 - 26	16-29
Commercial office	10* - 22	12*-30
School, hospital	12* - 20	15*-27
Road reconstruction	8 - 16	27-29
Bridge reconstruction	18 - 23	33-49

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What is practically achievable?

	Cost £'000,000	Price increase	% recycled by value
Standard materials	113.1	n/a	28.8%
Maximum recycled in most practical option	119.7	5.82%	65.5%
Maximum recycled without hard tiling	112.4	– 0.55%	64.3%
Maximum recycled w/o hard tiling and insulation	110.8	-2%	63.7%

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Practicalities

In many cases just a question of calling one supplier instead of another, e.g.

- Recycled fill material
- lightweight aggregates
- DPC
- Rubber decking
- Concrete roof tiles
- Cavity trays
- Insulation
- Glass blocks
- Ceiling tiles
- Timber alternatives from recycled plastics
- Wall and floor tiles
- Recycled carpets
- Rubber flooring
- Concrete kerbs
- Permeable paving

Cost issues

Cost penalty:

- Recycled glass insulation
- Recycled glass tiles
- Timber alternatives from recycled plastic

Cost neutral:

- Concrete
- Rubber decking
- Recycled newspaper insulation
- Concrete and rubber roof tiles
- Ceiling tiles
- Rubber flooring from recycled tyres
- Plasterboard with high recycled gypsum content

Cost beneficial:

- Recycled plastic beading and DPC
- Fill and aggregates
- Recycled carpet tiles
- Concrete kerbs
- Permeable paving

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Local materials

Bulk materials, concrete and fill, are generally sourced locally

Fit in with local vernacular

Approximate distance at which transport impact exceeds material saving:

Material	Distance (miles)
Reclaimed tile	100
Reclaimed slate	300
Reclaimed bricks	250
Recycled aggregates	150
Reclaimed timber (e.g. floor boards)	1000
Reclaimed steel products	2500
Reclaimed aluminium	7500

Local materials – case studies

Project name	Main local components	Distance saving	Cost implications
BedZED	Bricks	73 miles	None
	Blocks	84 miles	None
	Oak weatherboarding	3700 for oak 1400 for softwood	Lifetime saving on alternative cladding systems
	Structural steel	120 miles	
Earth Centre	Crushed concrete in the gabions	300	Cheaper than quarried limestone
	Reclaimed radiators	?	None

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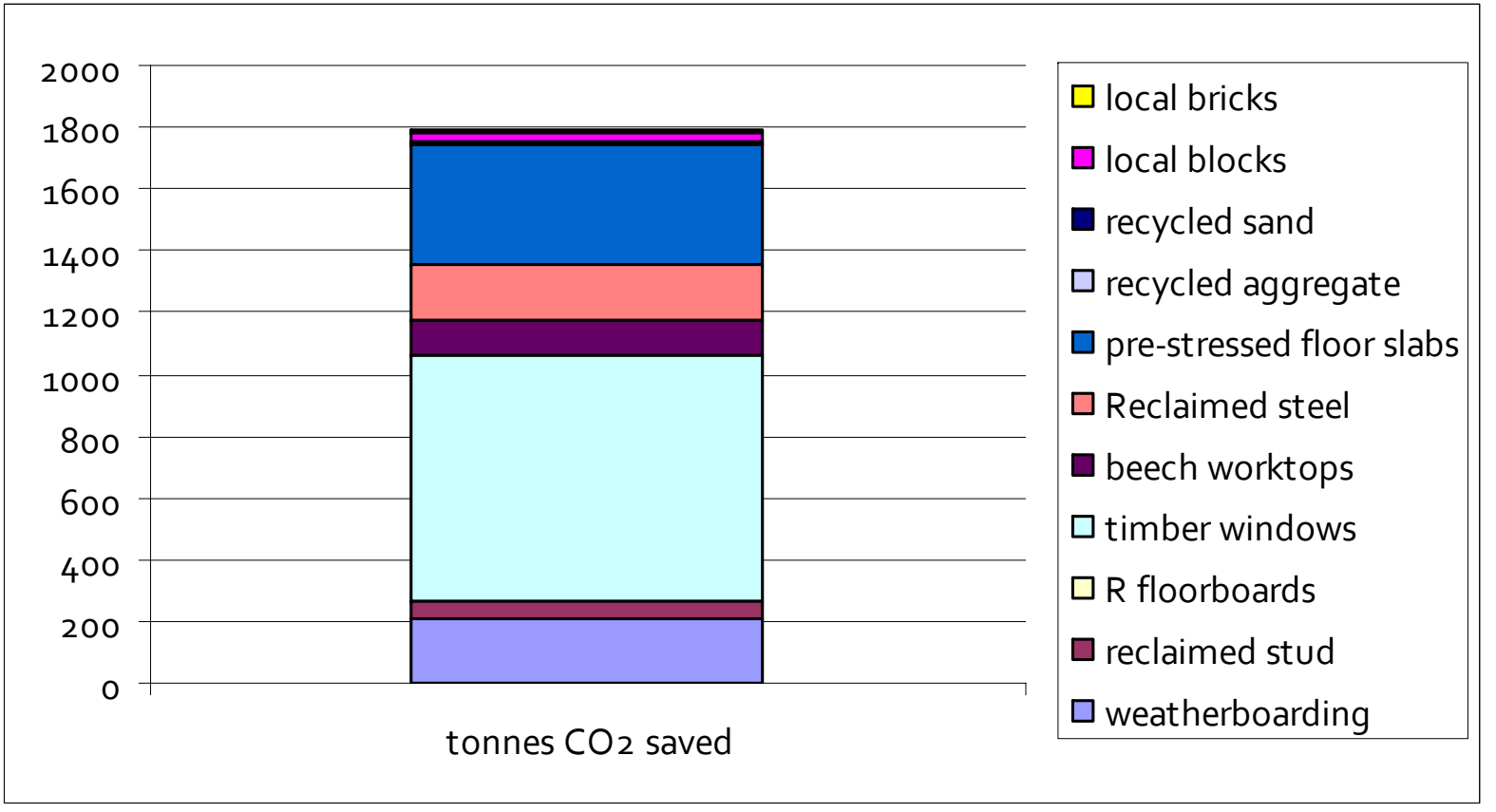
CO_2 saving - BedZED



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And what about concrete?

- Use less:
  - Reinforced concrete
- Cement replacement:
  - Pulverised fuel ash
  - GGBS
- Aggregate replacement
  - Demolition waste
  - China clay waste

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One Brighton

Credit Crest Nicholson BioRegional Quintain

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Green concrete – 100% recycled aggregate, 50% PFA (1/3rd less CO2 total)

Natural clay block

- 60% less embodied energy than concrete block

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Don’t forget timber

Certified materials: (independently) certified that the timber comes from a sustainable managed source.

Chain of Custody: the timber can be tracked from forest to shop floor – no chance of confusion

Many different schemes, FSC, PEFC, MTCC – varying integrity

FSC certified scheme > 50% FSC – low target to engage with developers

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Certified Timber – case studies

	Quantity timber	% FSC certified	Material cost	Price premium
Fairfax House	137 m^3	84% by volume	£26,000	~ 5%
Warwick House	336 m^3	> 90% (volume)		~ 15%
BedZED	570m^3 of non reclaimed	52% FSC 21% PEFC / FFCS		Plywood £26/sheet vs £16 Other wood ~ equal
Langholm Close		FSC certified		Zero
Ujima First Base		~ 60%		Zero
Metropolitan Housing		Aim 90% (volume)		

The role of technology

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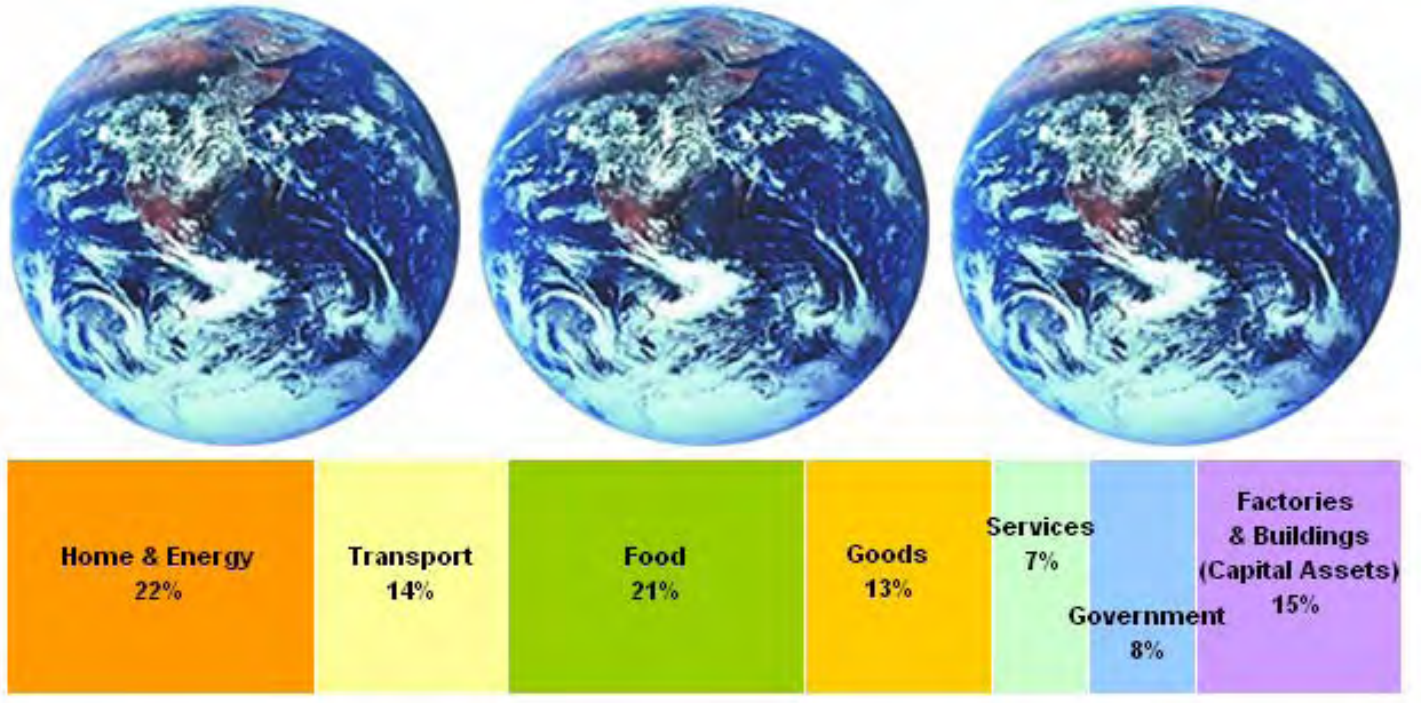
Breaking down the 3-planet challenge



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Carbon Savings @ BedZED:

5.1 tons CO2 per person p.a.

- 50% building design and renewable energy :
  - biomass CHP,
  - PV
  - in building efficiency/passive solar
- 44% of total carbon savings in ***lifestyles***:
  - food,
  - transport,
  - waste

1. Lifestyles *as important* as green buildings


60% reduction in hard standing
Lots of bicycles

Technology summary of BedZED

- Passive design – effective
- CHP – didn't work
- Black water recycling – effective but energy intensive
- Low car strategies – effective

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Technology – a doubled edge sword?

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Home cinemas….

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Rise of the machines

- 1970-2000:
  - Energy efficiency of appliances increased 2% a year
  - Energy consumption doubled…

Technology to support behaviour change

Transport:

- Planning and location
- Car clubs
- Home working / teleconference
- Intranet - http://www.onebrighton.net/

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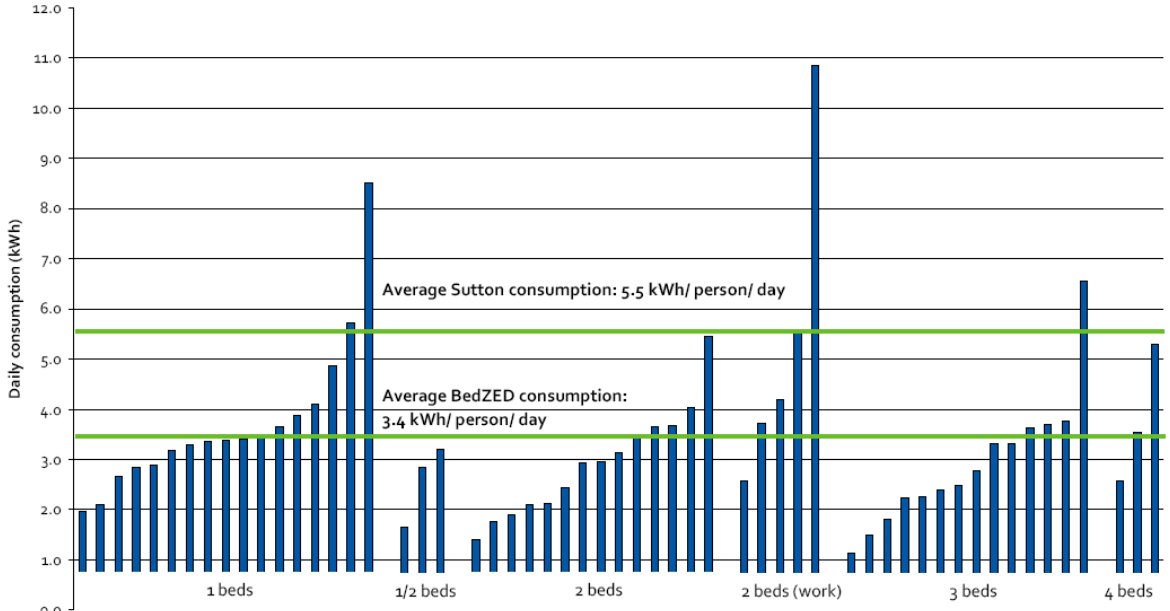
Technology to support behaviour change

Energy:

- Energy meters
- Real time feedback
- Comparisons / competitions
- Low energy appliances



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Technology to support behaviour change

Food and consumption

- Kitchen design
- Appliances
- Secure delivery
- Sharing facilities – laundry, tools lawn mowers

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Summary

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90% CO_2 savings in construction

90% saving in CO_2 in construction

- Start in design
  - Minimise infrastructure
  - Design out waste
- Good management practices
  - Minimise over ordering
  - Site management: reclamation, recycling

Technology:

- positive role – reduce demand and change behaviour
- negative role – unnecessary appliances

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