Sustainable buildings and projects: best practice from Europe

Dr Jacqueline Glass Loughborough University

Dr Katie Williams Oxford Brookes University

'Energy 2003': Sustainable Building Design track

Monday 18 August 2003

Today’s presentation

- Introductions
- 1: Achieving sustainable urban design at the development project scale
- 2: The contribution of cement and concrete to a more sustainable built environment
- Q&A and discussion

Introductions

- Dr Williams: Oxford Centre for Sustainable Development, Oxford Brookes University

- Dr Glass: Department of Civil & Building Engineering, Loughborough University

Acknowledgements

PORTLAND CEMENT ASSOCIATION

With thanks to:

- Portland Cement Association
- Environmental Council of Concrete Organizations (www.ecco.org)

Overview

- European experience in the areas of sustainable urban design and building construction
- **Sustainability:** '... the need to ensure that development meets needs of the present without compromising the ability of future generations to meet their own needs'.
- "**Triple bottom line**": the combination of economic, environmental and social concerns.

- A range of levels that require a range of responses:
- ***Global*** ➡ ***National*** ➡ ***Local*** ➡ ***Personal***

Achieving sustainable urban design at the development project scale

Dr Katie Williams

BA(Hons) DipUD DipUP MSc(EnvDes) PhD

MRTPI

Reader in Sustainable Cities

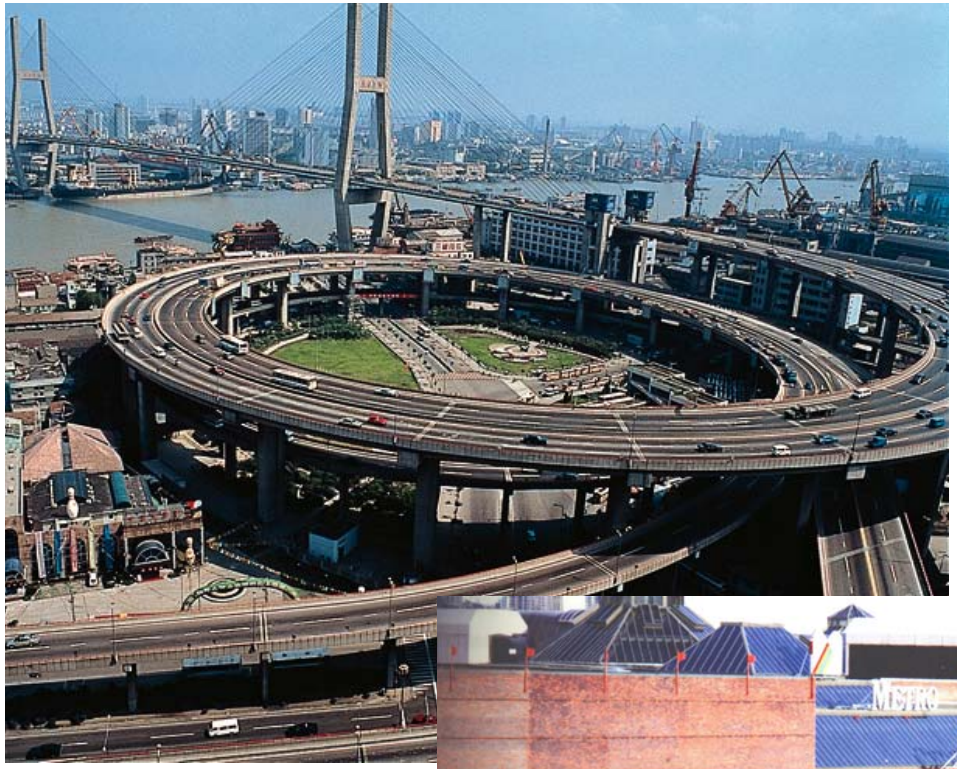
Oxford Brookes University

About the presentation

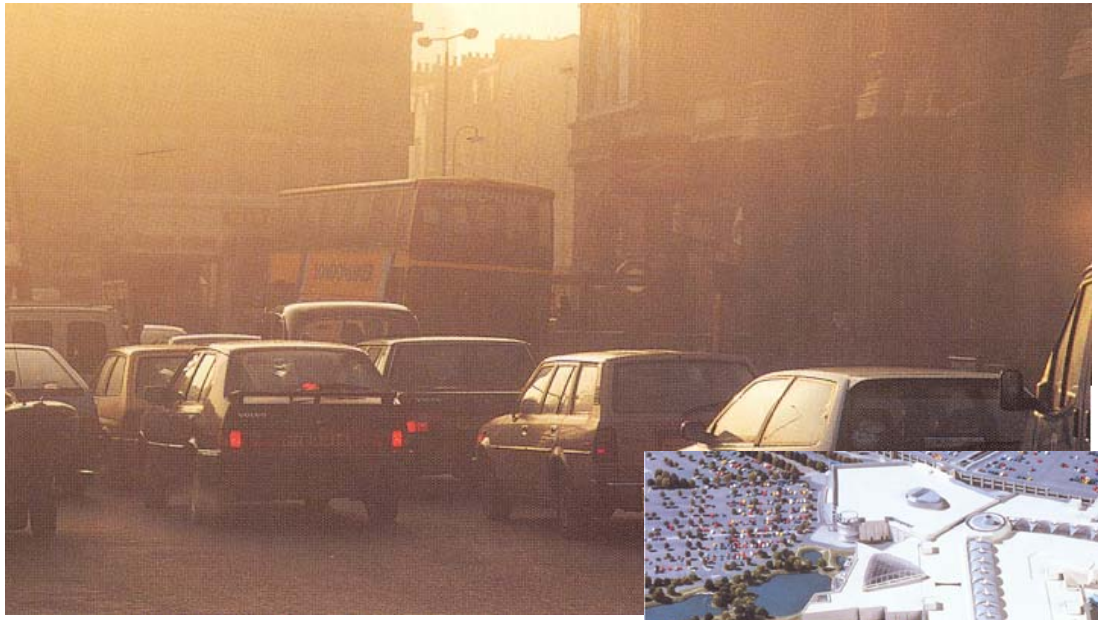
- What is sustainable urban design?
- What is the extent of sustainable design in Europe?
- What is driving change towards sustainability?
- What works and what doesn’t? (examples, and summary)

What is sustainable urban design?

It isn’t this……



METRO
CENTER

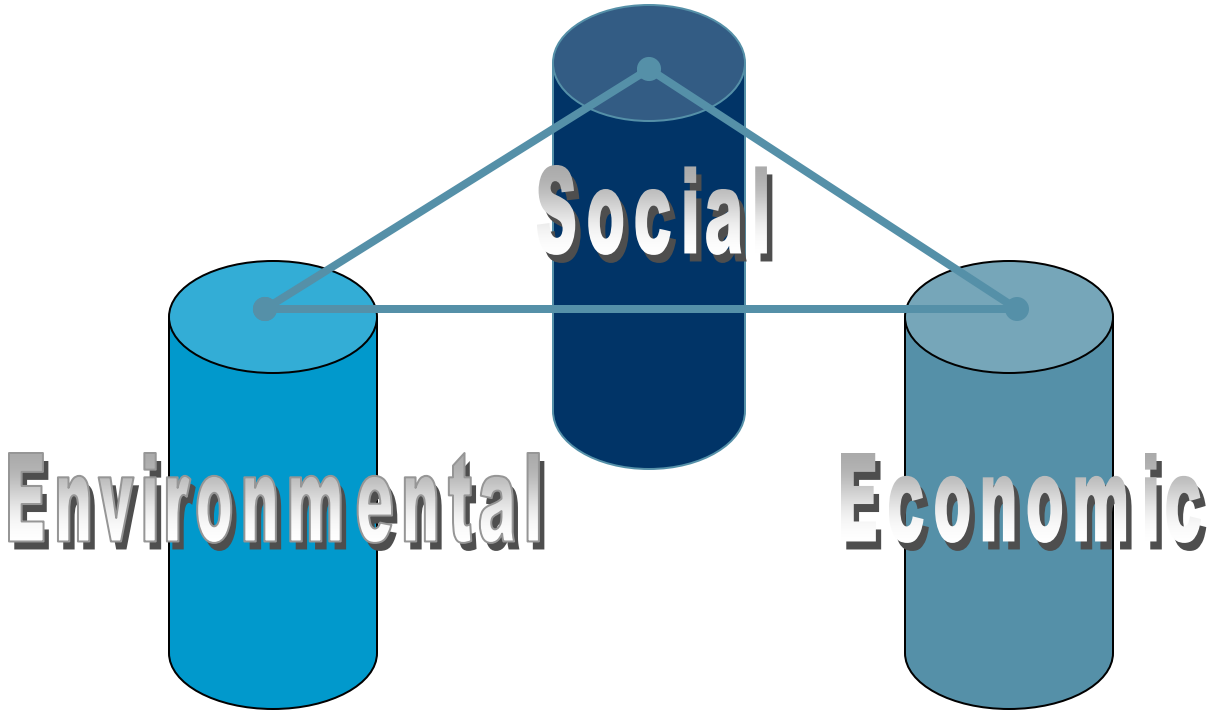


GREAT NORTHERN RAILWAY COMPANY'S GOODS WAREHOUSE

What is sustainable urban design?

Design which meets sustainability objectives

What is sustainable urban design?



What is sustainable urban design?

- Environmental objectives
  - maximise energy efficiency
  - conserve resources
  - minimise pollution/damage to the environment
  - conserve wildlife habitats
- Economic objectives
  - support local economy
  - provide employment opportunities
- Social objectives
  - improve the quality of life
  - promote social equity

What is sustainable urban design?

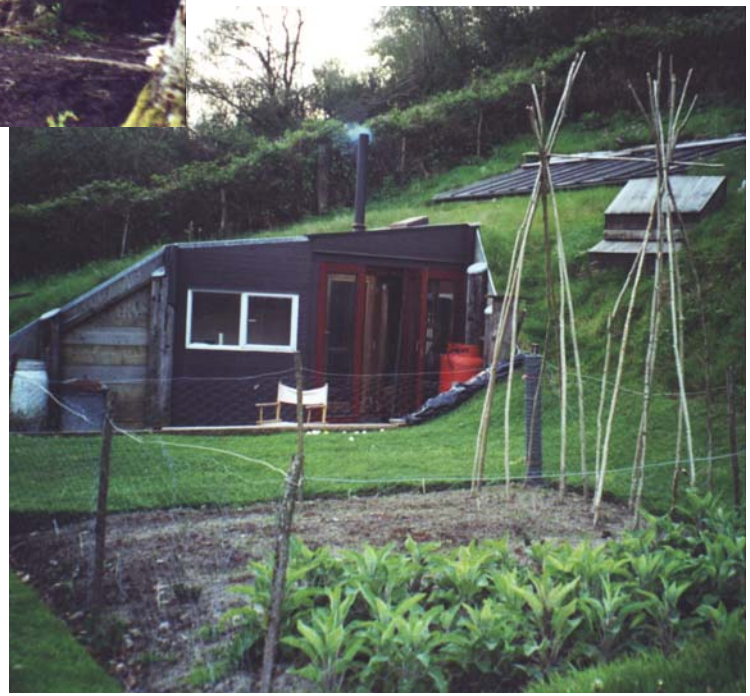
- Each ‘sustainable design’ will be specific to the site
- There is no ‘one size fits all’ design solution
- Urban designers need to be able to:
  - assess each site
  - understand sustainability objectives
  - turn objectives into design solutions for that site

What is sustainable urban design?

- At the development site scale this means that all stages should be sustainable:
  - location, land use and clean up
  - master planning - layout, mix of uses
  - construction processes and materials
  - end uses
  - development processes
- These stages are all interlinked

So what do sustainable designs look like?

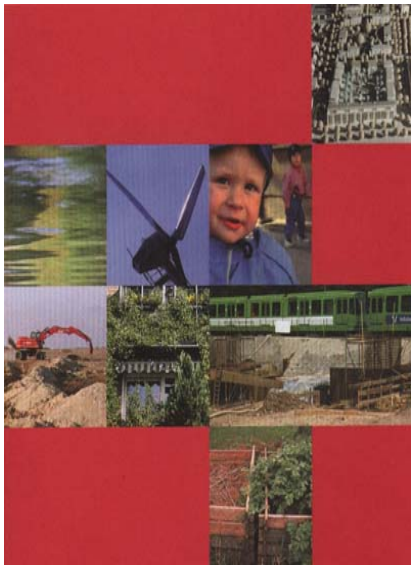
Low tech, small scale eco-living, UK

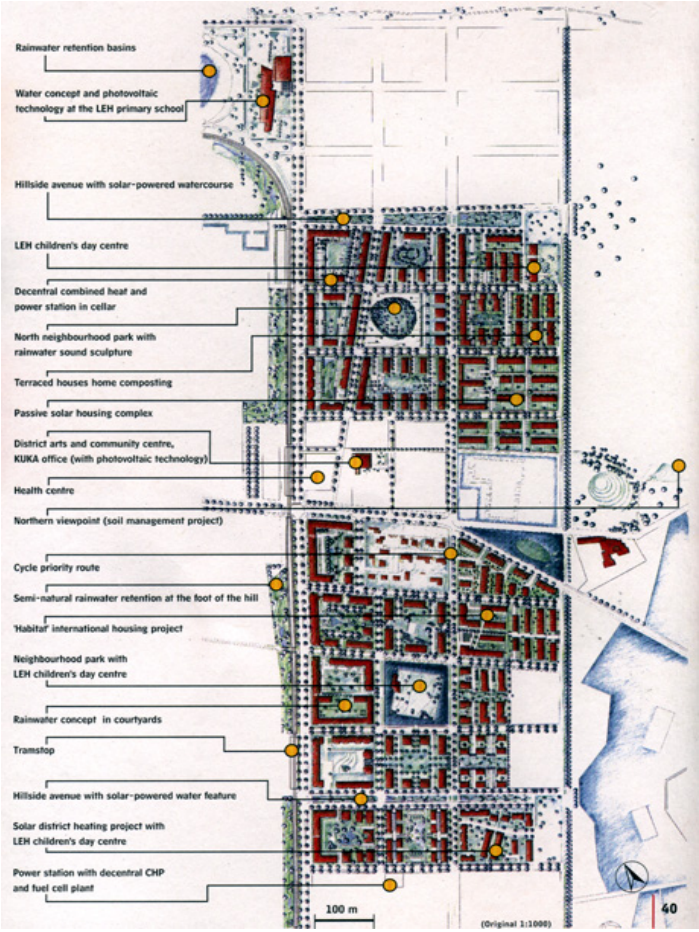


Eco-homes, UK

Medium-tech, medium scale (Bed-zed scheme, UK)

Sustainable new settlements, high and low tech e.g. Kronsberg, Germany





Eland House,
London, UK

Expo ‘98 HQ, Lisbon,
Portugal

‘Green’ high rise
commercial
buldings

The ‘flower tower’

(Bill Dunster, Architect)

What is the extent of sustainable design in Europe?

- Impossible to quantify accurately, research evidence is mixed
  - Headline indicators do not include this measure
  - Our own research shows regional differences in the UK
- Few completed large scale schemes
  - less than 50 in Europe
- More activity in individual ‘green’ buildings
  - over 280 ‘green’ commercial buildings in UK - Green buildings account for 40% of all office space built since 1996

What is driving change towards sustainability?

Top down

- Global conventions and EU Directives on climate change, biodiversity and spatial development
- UK Strategy for Sustainable Development (1994, 1999) with measurable indicators
- Planning policies and building regulations, planning policy guidance on transport, housing, local plans, The Urban White Paper, Sustainable Communities Programme (2003)
- BUT these policies are hard to enforce because sustainability is such a complex issue - no legal precedent

What is driving change towards sustainability?

Bottom-up

- Industry and professionals - mainly in response to predicted tightening-up of regulations and professional requirements (e.g. RTPI, RIBA) - or cost issues (e.g. green offices - 0.6% saving in capital costs, 19% saving in running costs)
- Clients - especially from housing organisations and local government (major clients in Europe)
- Local policy - Municipal plans, LA21 (over 80% of European local councils have an LA21 strategy)
- Pressure groups - have third party rights

What works and what doesn’t?

The Millennium Village
Greenwich, London, UK

Overview

- Urban brownfield location 13ha (Borough, 11th most deprived in the UK)
- Mixed use scheme (housing, retail, education and health facilities, riverside walks, public space, employment)
- £278 billion
- 1400 homes (20% social housing)
- Government and private sector partnership

The Millennium Village

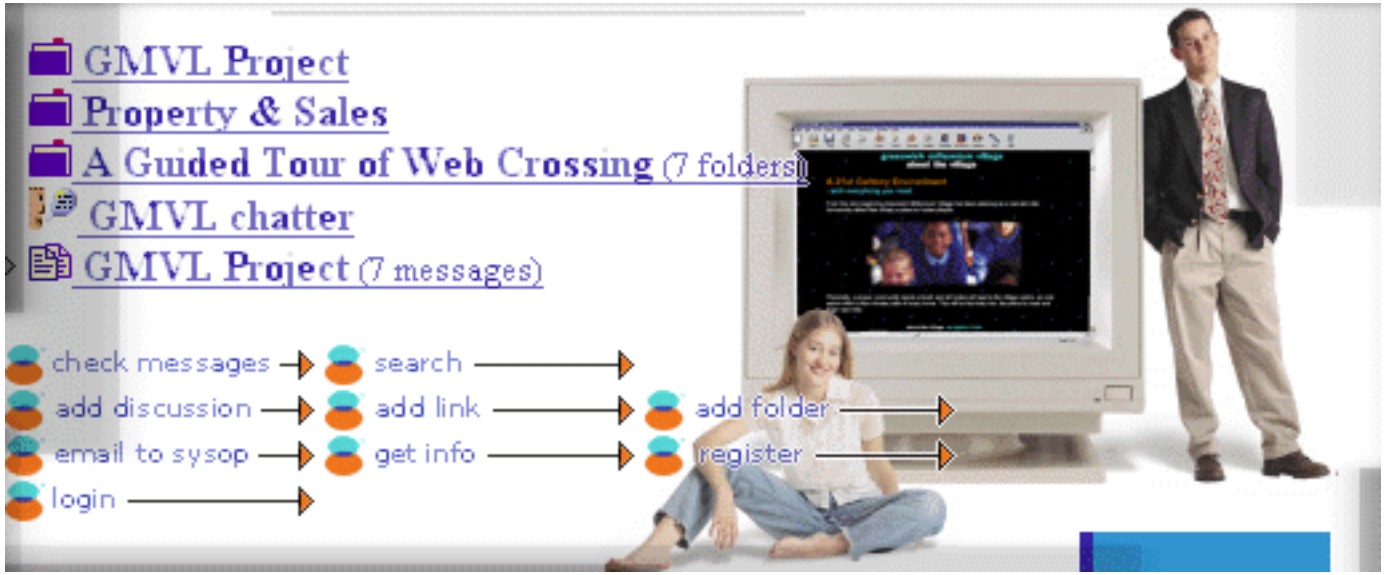
Greenwich, London, UK

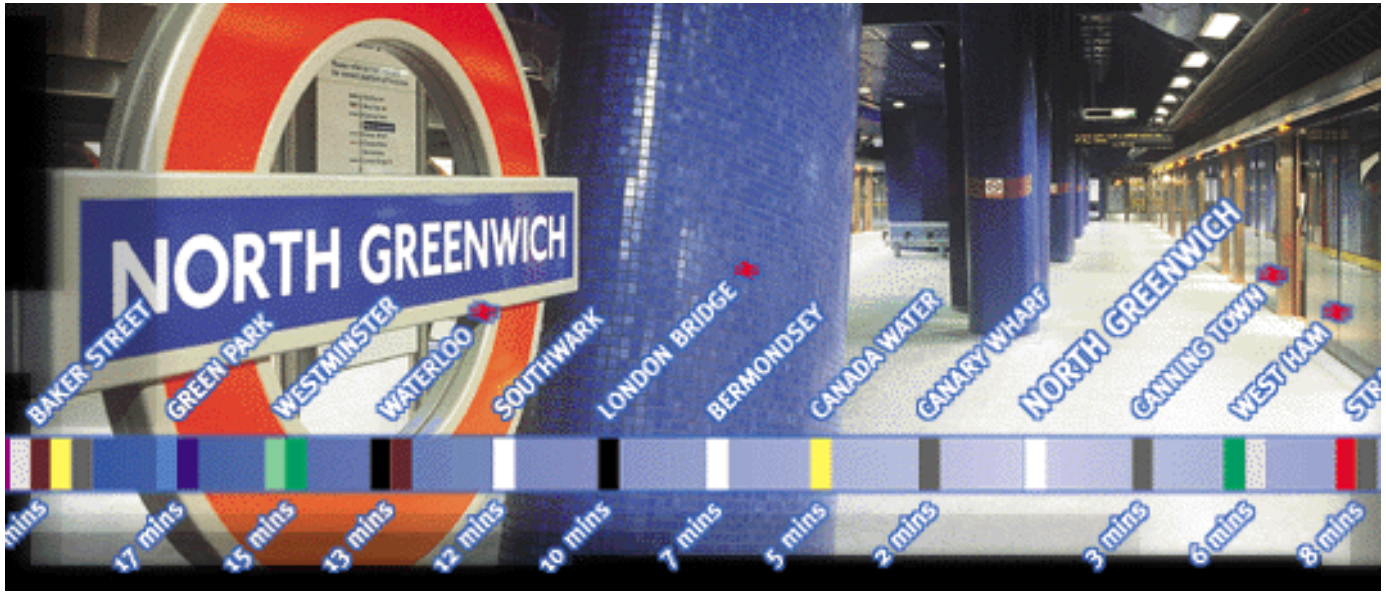
Sustainability features

- mixed use, tenure
- high density
- network of green corridors, wetlands
- 25% reduction in construction time
- uses recycled materials
- low embodied energy in construction (-50%)
- low waste in construction (-50%)
- CHP plant
- intelligent energy systems
- grey water system
- recycling for run-off water
- light transit
- pedestrian friendly
- reduced parking

The Greenwich Peninsula, London

Greenwich Millennium Village


GMVL Project
Property & Sales
A Guided Tour of Web Crossing (7 folders)
GMVL chatter
GMVL Project (7 messages)
check messages
search
add discussion
add link
add folder
email to sysop
get info
register
login


NORTH GREENWICH
BAKER STREET
GREEN PARK
WESTMINSTER
WATERLOO
SOUTHWARK
LONDON BRIDGE
BERMONDSEY
CANADA WATER
CANARY WHARF
NORTH GREENWICH
CANNING TOWN
WEST HAM
17 mins
15 mins
13 mins
12 mins
10 mins
7 mins
5 mins
2 mins
3 mins
6 mins
8 mins

ON THE PARK

Completed housing at Greenwich

The Millennium Village

Assessment

- Mixed tenure may not be achieved
- Some ‘hitches’ with new components
- HTA architects withdrew because sustainable design elements being ignored by developers
- As a demonstration project it is successful, more Millennium Villages planned in the UK - Leeds and Manchester
- Genuine catalyst for regeneration
- People want to live there - selling well
- Most ‘green targets’ have been met - home owners see reductions of 15% in water consumption and 50% in energy costs
- Development interests still working together to solve problems

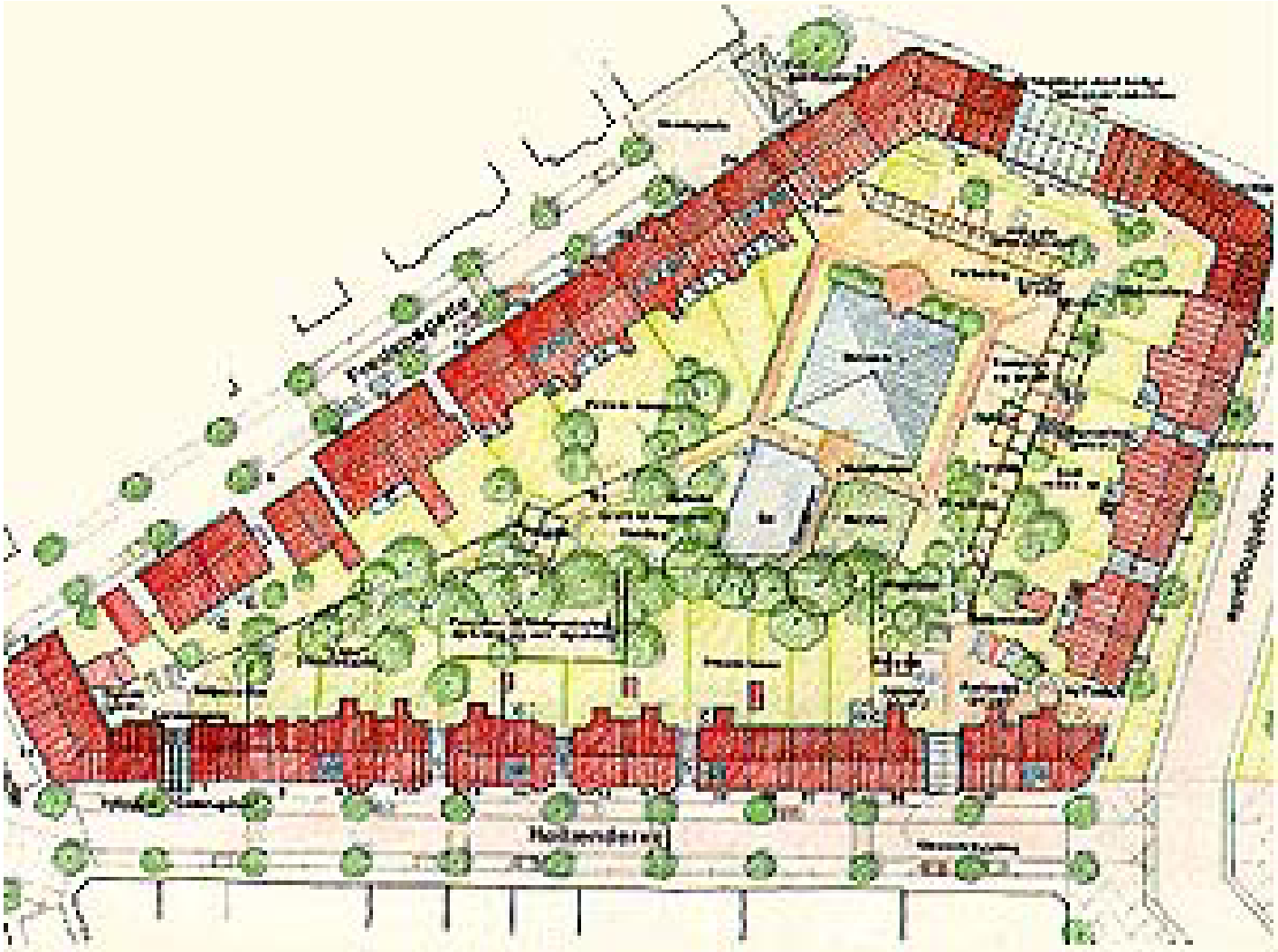
Kolding, Denmark

- Initiated by the municipal authority
- Small scale - 129 dwellings
- Refurbishment scheme, of an urban block, with 2 infill buildings
- New units added on flat roof

Kolding, Denmark

Sustainability features

- Refurbishment
- Recycled materials
- Concentrates on water system
- Water recycling
- Grey water
- Household water recycling
- Car pool
- Participatory process



Plan of the Kolding refurbishment

Kolding, Denmark

Assessment

- Limited social mix
- Not economical without state subsidy
- Well-liked by residents (in fact rents have increased)
- Amount of materials recycled has increased X7
- Acts as an educational resource
- Waste has been cut by 50%
- Water recycling is very effective

Bo01, Malmö, Sweden

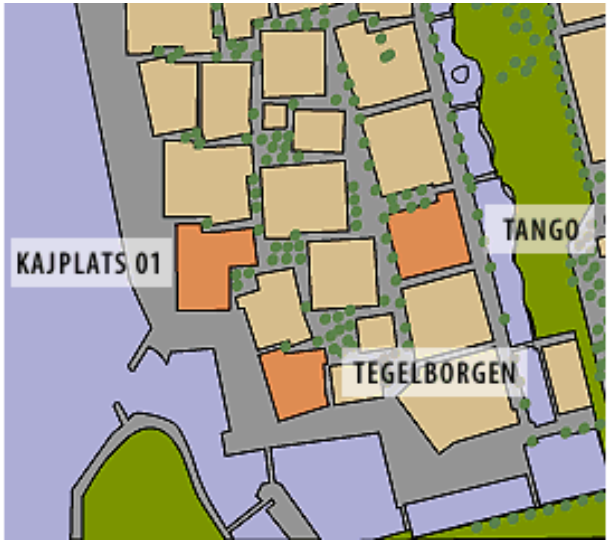
Overview

- New district ‘City of Tomorrow’ - Shipyard site
- 800 apartments, 200 houses,1500 inhabitants (30 ha)
- Aim to take precedents from typical European cities and promote urban development on a human scale, with high artistic quality
- Part of EC programme ‘Campaign for Take-off’ and of European Housing Expo
- Funded by EC and industry

Bo01, Sweden

Sustainability features

- brownfield site - near city centre
- integrated master planning - urban parks, variety of housing types
- 100% locally produced renewable energy (sun, wind and water - sea - power)
- range of demonstration buildings - simple house, sustainabuilding, energy factory
- district cooling
- well insulated building envelopes
- waste separating and digesting systems
- facilities for cycling and walking, car use restricted, car pools
- biogas and electricity used for public transport
- ‘intelligent’ home living services e.g. for lights, information



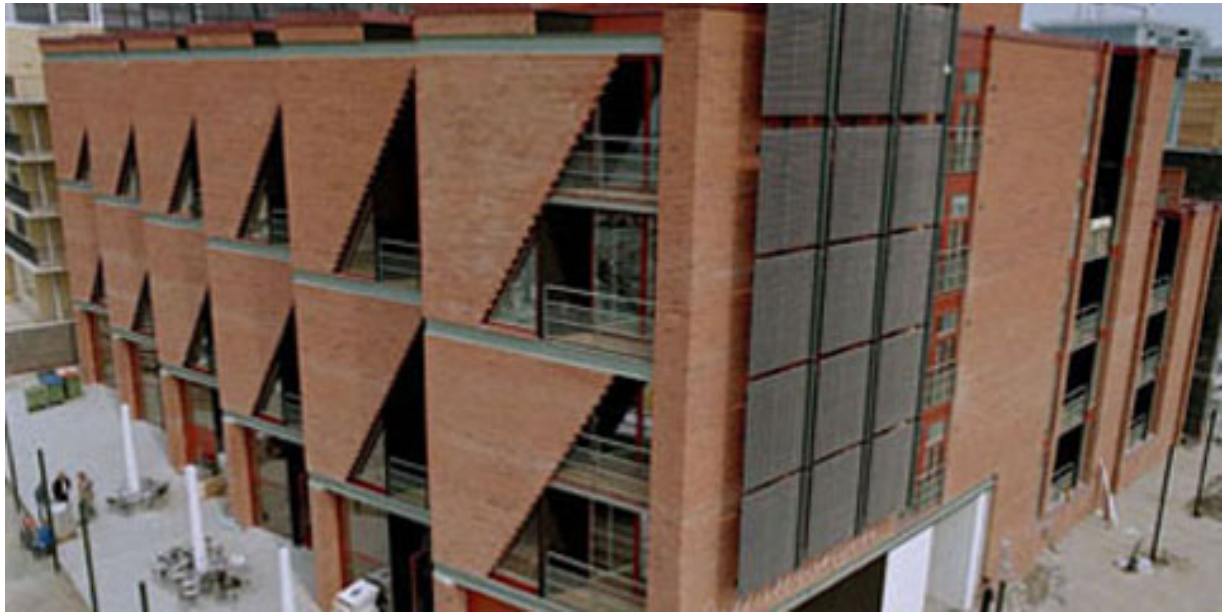
Bo01, Malmo, Sweden

Architects' visions
for Bo01

Masterplan for Bo01

Construction in
Bo01, 2000

Housing blocks, Bo01



Bo01, Sweden

Assessment

- Needed subsidies (EC and industry)
- Focuses mainly on environmental sustainability - less concerned with social and economic
- Has revitalised former industrial site
- Zero environmental damage (emissions) in energy use
- Reduced energy costs for residents
- High demand for homes
- Successful demonstration project

What works and what doesn't?

Successful schemes have:

- A variety of initiators (and funders) - now private sector
- World class spatial master planners and designers
- Highly skilled teams that talk to each other - and input knowledge early (sustainability is not an 'add-on goodie') - non-integration could preclude certain elements such as SUDS, 'cool' communities, sustainable land remediation
- Participatory design processes, includes end users
- Long-term management plans and interests

A final word

- Still relatively few examples of sustainable urban design in Europe
- But a movement for change - in individual schemes and general development practice
- Still significant barriers to overcome (culture, skills, caution, cost)
- The battle has been won in policy, now practice needs to catch up

The contribution of cement and concrete to a more sustainable built environment

Dr Jacqueline Glass

BAHons, DipArch, DipBRS, PhD, CertHE, ILTM.

Lecturer in Architectural Engineering,
Loughborough University

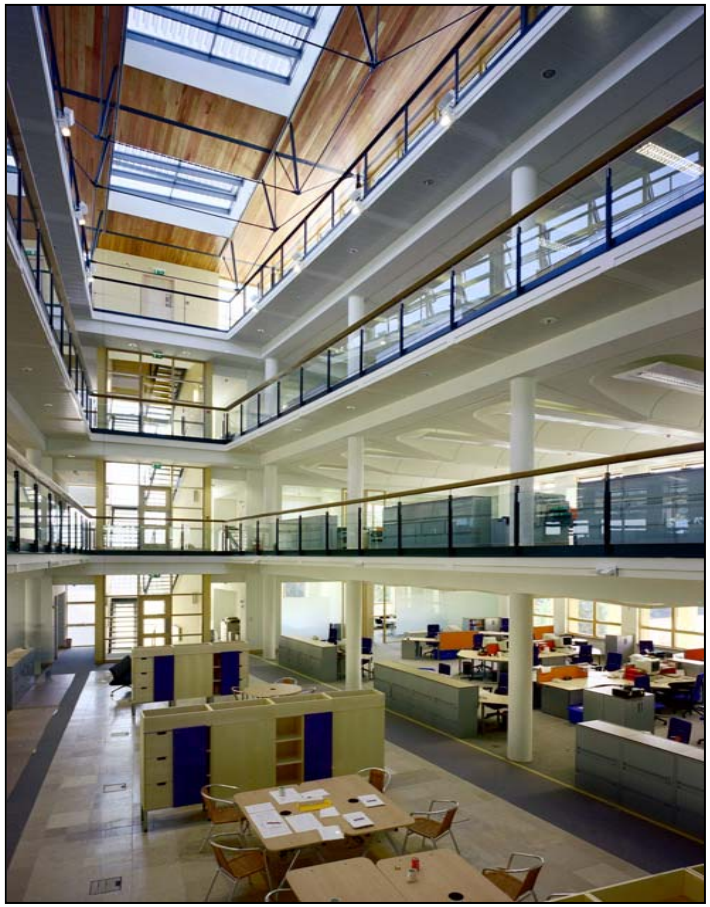
This presentation

- Context and industry issues
- Concrete in the built environment
- Specific examples
- Getting the balance right
- What are the main messages?

- Q&A and discussion

About this presentation

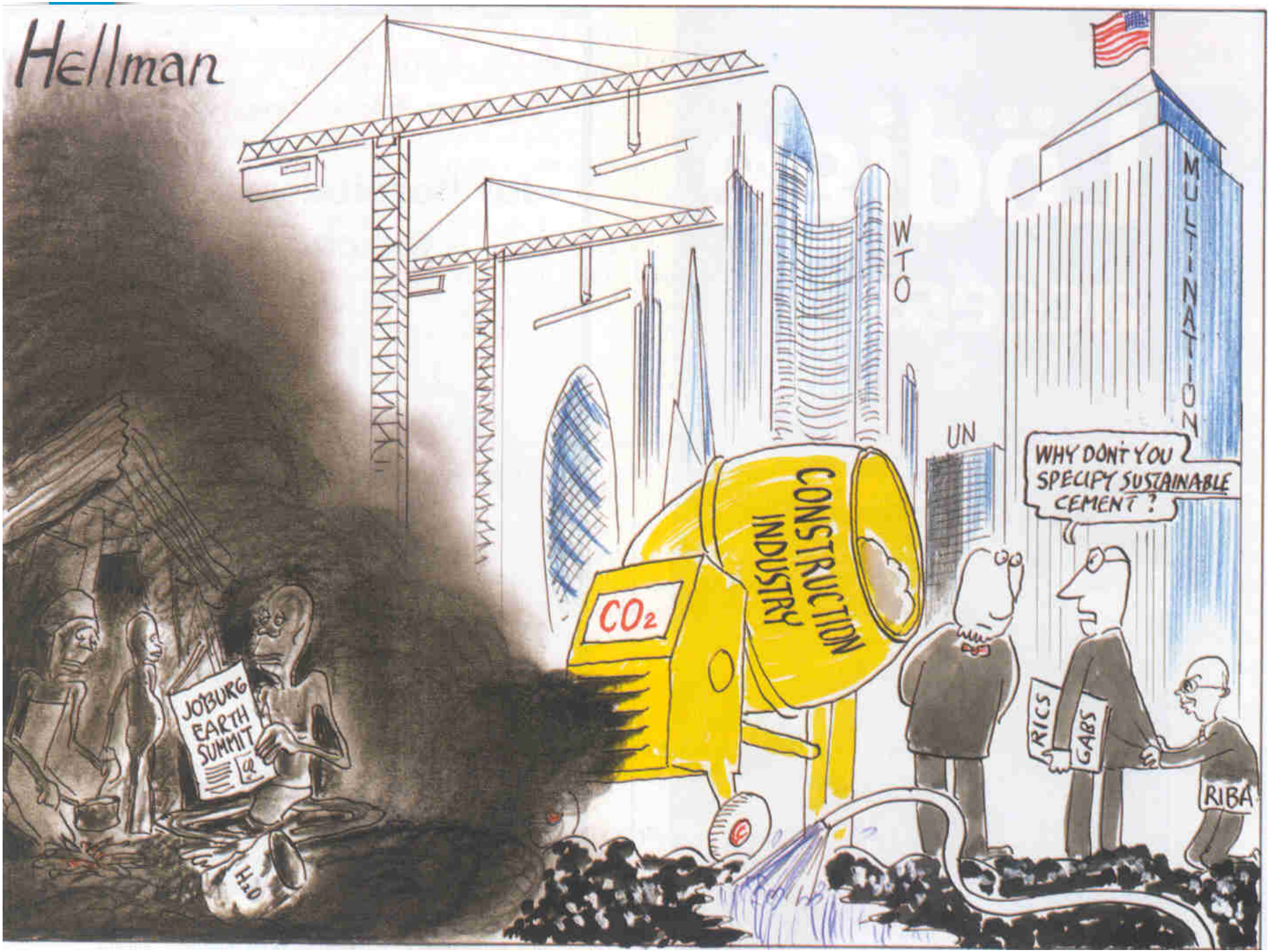
- **How can we make best <u>environmental</u> use of concrete and address economic and social sustainability?**
- **European perspective** on responsible construction and use of buildings.
- **Range of opportunities** to most effectively utilise the energy and carbon dioxide 'invested' in Portland cement.
- **The critical balance.**



Canon HQ, Surrey (courtesy of the Concrete Society).

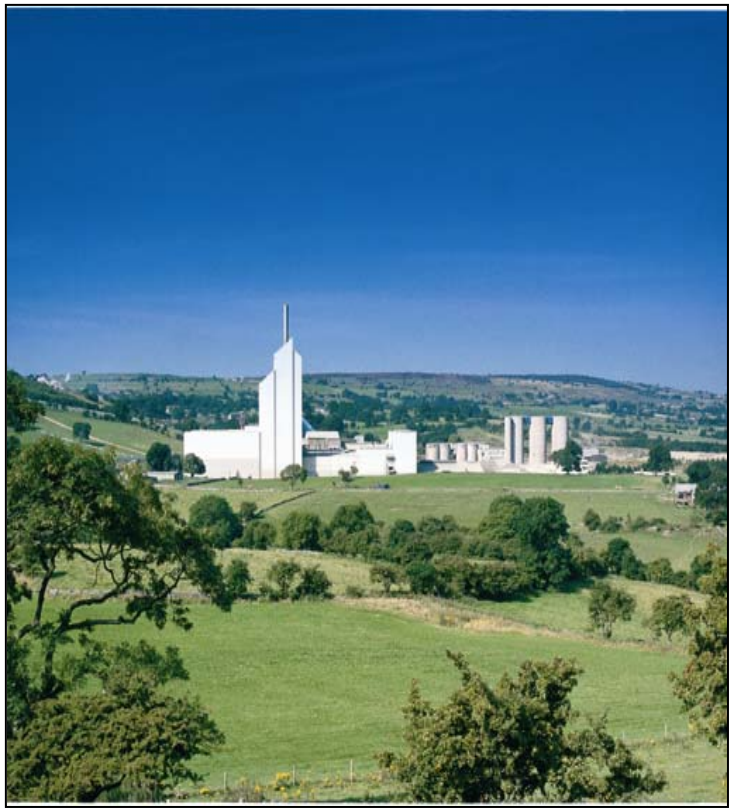
UK cement and concrete

An overview of the political and regulatory issues affecting the cement and concrete industry.


Hellman
WTO
MULTINATION
UN
CONSTRUCTION INDUSTRY
CO_2
WHY DON'T YOU SPECIFY SUSTAINABLE CEMENT?
RICS
GABS
RIBA
JO'BURG EARTH SUMMIT
H_2O

UK cement and concrete

- **Cement usage** stands at ≈14Mt p.a., which equates to 250kg/person/p.a.
- The UK cement and concrete industry is worth £5bn p.a.
- Cement is energy intensive: 2.1% of UK CO_2.
- All UK plants certified to ISO 14001, most have EMAS.
- Commitment to improve **energy efficiency** by 25.6%, exceeding government and Kyoto targets significantly.



Cement works, Staffordshire (courtesy of Lafarge Cement UK).

More ‘sticks’ than ‘carrots’?

- **Climate Change Levy**: aims to save 2Mt carbon via energy efficiency. Emissions Trading Scheme will also save 2Mt.
- **Aggregates Tax**: tax on sand, gravel and rock for commercial exploitation.
- **Sector sustainability strategy** for cement and concrete is under development.
- **WBCSD** ‘Toward A Sustainable Cement Industry’ project (www.wbcsdcement.org).

Restored quarry, Derbyshire (courtesy of Lafarge Cement UK).

The operating context

An overview of the policies and initiatives that are driving forward environmental improvement.

Global context

- **Kyoto Protocol**: (carbon-focused) UK government target to reduce CO_2 by 20%, higher than its Kyoto commitment of 12.5%.
- **Policy instruments** (regulatory, economic and information tools) to achieve such targets.
- Many sectors undertaking **voluntary initiatives** (e.g. concrete, engineering, motor industry).

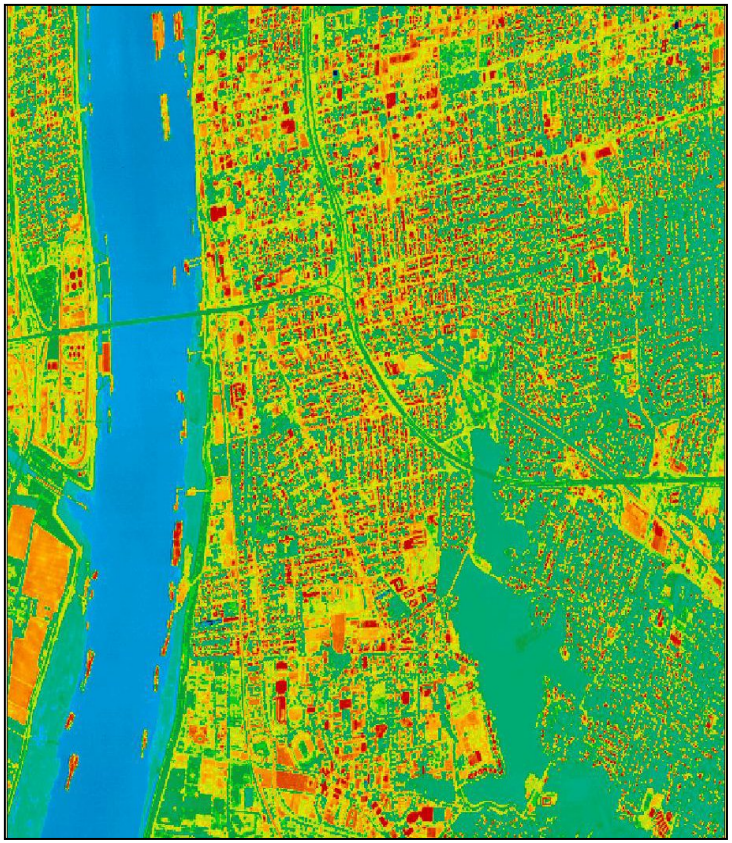


Image of an urban heat island (courtesy of NASA).

European context

- **EC Directive** on the Energy Performance of Buildings to improve energy efficiency. **Target = 22% energy saving** in residential and public buildings.
- Buildings in use consume about 50% of all UK energy (60 Mt CO_2 per annum).
- UK's new Building Regulations, Part L (Energy Efficiency); set to improve energy efficiency by 25-30% and reduce CO_2 from buildings by 2%.

BedZED development, Surrey (courtesy of Peabody Trust).

UK context

- Government has introduced **sustainability strategies** for development and construction.
- **'Best practice'** initiatives on construction and use.
- 180 nominated innovative **Demonstration Projects** from homes to offices.
- Environmental indicators for sustainable construction and environmental measurement methods; **BREEAM** scale often used (similar to LEED).

St George's Wharf, London (courtesy of St George plc).

The critical balance

- **A basket of environmental indicators gives us a holistic hierarchy (largest impact first):**

- 1. Society and transport (getting to work)
- 2. Development of the built environment
- 3. In-use occupancy and refurbishment
- 4. Construction impacts

- **We must specify, design and construct to offset environmental impacts associated with the use phase of a structure.**
- These are of a far greater importance than a simple choice between materials.

Built environment

- **Cool communities**: pale coloured concrete helps prevent urban overheating.
- **Cement remediation**: in-situ treatment of ‘brownfield’, contaminated sites.
- **Concrete streetscapes**: needs 40% less lighting energy; heat exchanging surfaces and pollution-absorbing paving.
- **Sustainable urban drainage systems** (SUDS) use permeable, re-usable concrete blocks.

Fabric energy storage (1)

- **FES**: use of concrete to better manage internal temperatures. Useful for buildings in which max. occupancy coincides with max. heat (e.g. offices, schools).
- **Air conditioning can be reduced or removed**, resulting in capital cost savings of 5-20%.
- Energy savings year on year: **£185,000 p.a.** (for a 32,000m^2 office building) and about **50% less CO_2.**

Lloyd's Register of Shipping (courtesy of RRP/AHA).

Fabric energy storage (2)

- Modern buildings can overheat: lightweight envelopes offer just 6-10 W/m^2 of cooling.
- **Concrete elements are exposed to the interior to enhance cooling capacity.**

- Passive FES: exposed soffits + night purging (15-20 W/m^2)
- Active FES: controllable systems of ducted air (25-35 W/m^2 and beyond).

Toyota HQ, Surrey (photos courtesy of Barry Bulley).

Whole-life performance

- **IAQ**: inert concrete surfaces do not contribute to ‘sick building syndrome’; health improvements reported in ‘greener’ buildings.
- **Air-tightness**: concrete up to 10 times better than lightweight envelopes.
- **Service life**: fire, sound and durability qualities mean longevity.
- **Aim for enhanced adaptability within flexible, column-free spaces.**

Lloyd’s of London (courtesy of Ove Arup).

‘Greening’ the material

- **Embodied energy**: concrete = **1.5-2.5 GJ/m²** and structural steel = 2.6-2.9 GJ/m², but the main impact is in the use of the structure:
- For a 4-6 storey office building, the operational energy is **70 GJ/m²**.
- Focus should thus be on energy efficiency and improved durability, but we can do more:
- **Industrial ecology:** incorporate potential waste materials as part of the mix to improve performance.

Using blended cements

- **PFA** (pulverised fuel ash; fly ash) from coal-burning power stations, can replace up to 25-40% by mass.
- **GGBS** (ground granulated blastfurnace slag; GBFS) from iron/steel production, used at levels >65%.

- **Why use them?**
- Performance benefits: denser, less permeable matrix, increased concrete strength, better flowability.
- **To reduce environmental impact of concrete: substitute up to 18% of OPC to reduce energy by 25%, and CO_2 by 17%.**

Using PFA in concrete

- **Canary Wharf, HQ5**: offices in London Docklands; 300,000m^3 concrete used.
- **PFA prevents overheating (>70°C) in mass pours and improves flowability.**
- **30 storey 'jump form' cores**; C60 concrete with 23% PFA replacement; 25N @ 24 hours for cycle times.
- 'Podium' (raft, basement and retaining structures): C40 concrete with 40% PFA.

Concrete cores under construction.

Using GGBS in concrete

- **Showcase:** an award-winning building with many environmental features from photovoltaics to borehole cooling.
- Active concrete **FES** for the office wing, which features a serpentine precast soffit.
- **All of the concrete** in the frame and foundations contained **GGBS** in a landmark example of re-use for waste materials.

Environmental building, Watford (courtesy of BRE).

Further options

- **Minimising waste**: e.g. total recovery systems at ready-mixed depots and self-compacting concrete.
- **Aggregates**: sensible to consider recycled materials (e.g. 2,000 tonnes used at the Earth Centre).
- **Reinforcement**: UK-produced rebar made from 100% recycled steel.
- **Alternative fuels**: a cement kiln can utilise one million tyres per annum.

Achieving the balance

- The context of **sustainability** is impelling many European countries towards ‘better’ buildings.
- **Getting the balance right** depends on people understanding that good environmental performance in service is critical.

A more sustainable built environment **can include concrete**, provided we specify, design and construct wisely.

A final thought

<u>The 1/5/200 rule*:</u>

Factor 1: robust, long-lasting structure

Factor 5-10: life-cycle energy savings

Factor 200: satisfied, comfortable people

A commercial view of sustainability from Peter Rogers, Stanhope plc (a leading UK property developer).

OXFORD BROOKES UNIVERSITY

Loughborough University

PORTLAND CEMENT ASSOCIATION

Thank you for listening

Any questions?