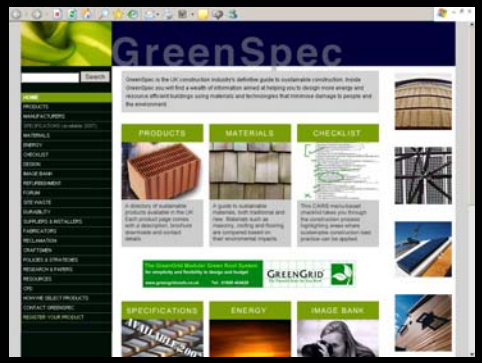

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Air movement in & about buildings 7 of 9 + Q&As

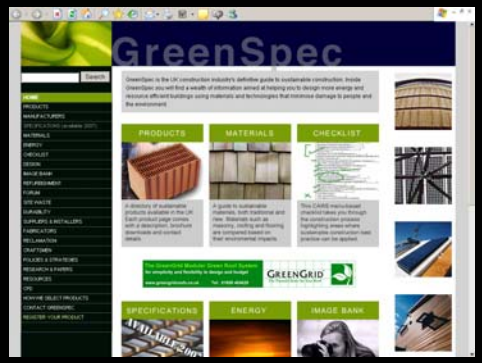
© NGS GreenSpec 2007 CPD in 10 parts

GreenSpec CPD Seminar Series

- Educational Objective:
  - Comprehensive introduction to subject: from wind to air-conditioning and a lot more in between
  - emphasis on environmentally sustainable solutions
  - design primer: addressing principles and solutions
  - technically rich: materials, construction, services & testing
  - Related GreenSpec CPD Seminars indicated
  - Questions and answers for each subtopic in file 10
- Audience:
  - Architecture Students Part 1 Year 2
  - CPD update for all levels of experience & knowledge
- Delivery:
  - 3 to 4 hours depending upon audience participation
  - Reading 1 hour
  - 26 subject breaks to enable subdivision

Air Movement in Buildings: 7 of 9 Sub-topics in 10 separate files

- Principles of Element Design
- Climate Change
- Wind
- Wind Tunnel Testing
- Wind Turbines
- Natural Ventilation
- Moisture Vapour & Condensation
- Thermal Insulation
- Breathing Construction
- Airtightness
- Wind & Airtightness Testing
- Building Elements
- Passive Ventilation
- Active Ventilation
- Stack Effect
- Atrium
- Solar Orientation & Solar Gain
- Conservatories
- Thermal mass
- Conduction, Convection, Radiation
- Solar Shading
- Thermal mass, Passive and active cooling
- Fluid dynamics
- Mechanical Ventilation
- Air-Conditioning
- Questions and Answers



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Solar Orientation & Solar Gain

Face the sun and capture free energy

Solar Orientation: Northern Hemisphere

- Easterly early morning sun rise
- Southern sun at the peak of the day
- Westerly evening setting sun
- Northerly sky is source of good daylight in the day

Solar orientation: Buildings

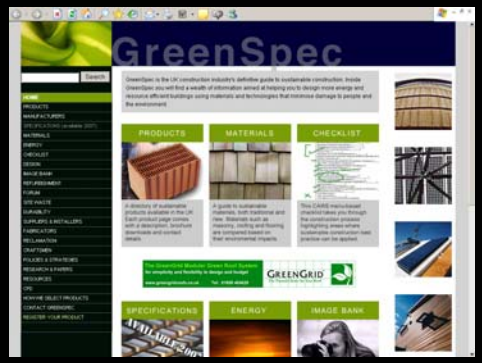
- Face Housing at sun to collect the heat
- Morning sun for waking
- Avoid sleeping rooms heating in afternoon and evening
- Offices generate heat so do not need to face the sun

Solar shelter: Landscape Trees

- Local trees, hedges and bushes can have a solar shading effect on a building
- Deciduous trees to the east, south and west, coniferous to the north
- In winter with leaves dropped sun passes through trees and low angle penetrates deep into the building
- In summer the high angle of the sun offers some shelter if solar shading is available

Wind shelter: Creepers & Vines

- Offer some protection form heat of sun
- Create a micro-climate sheltering the wall
- Shelter from rain, wind and sun
- Haven for insects, spiders, bugs, birds



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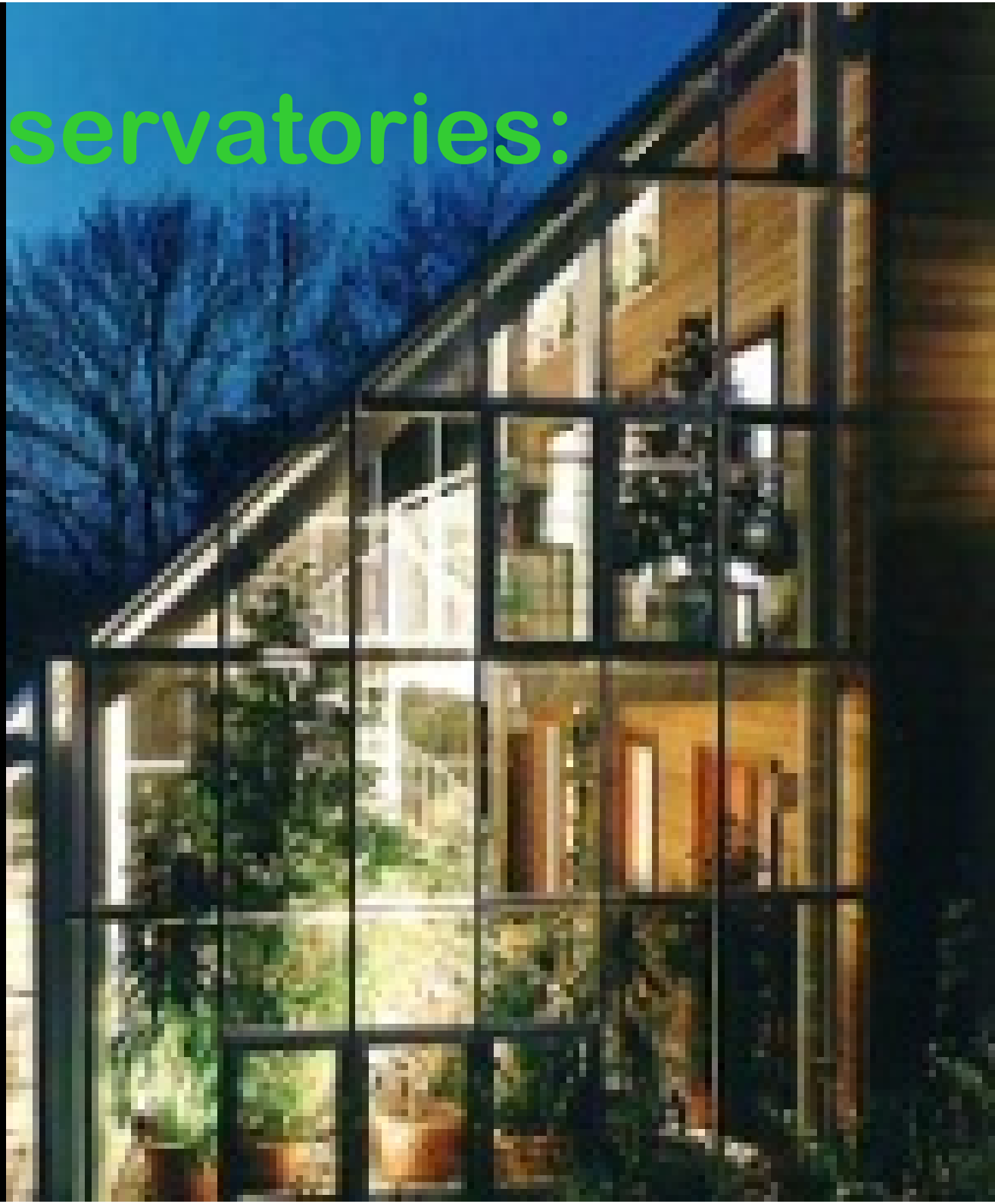
Conservatories

Source of free heat

Green Houses and Conservatories: Summer

- Glass permit the passage of the rays from the sun to warm the interior
- This can be exploited in winter or released in summer
- Victorians understood the need for opening vents in the roofs to release the heat in the summer, high enough to exploit the stack effect, catch any breeze and ensure heads do not cook
- Most PVC conservatories only have windows in the sides, a real problem

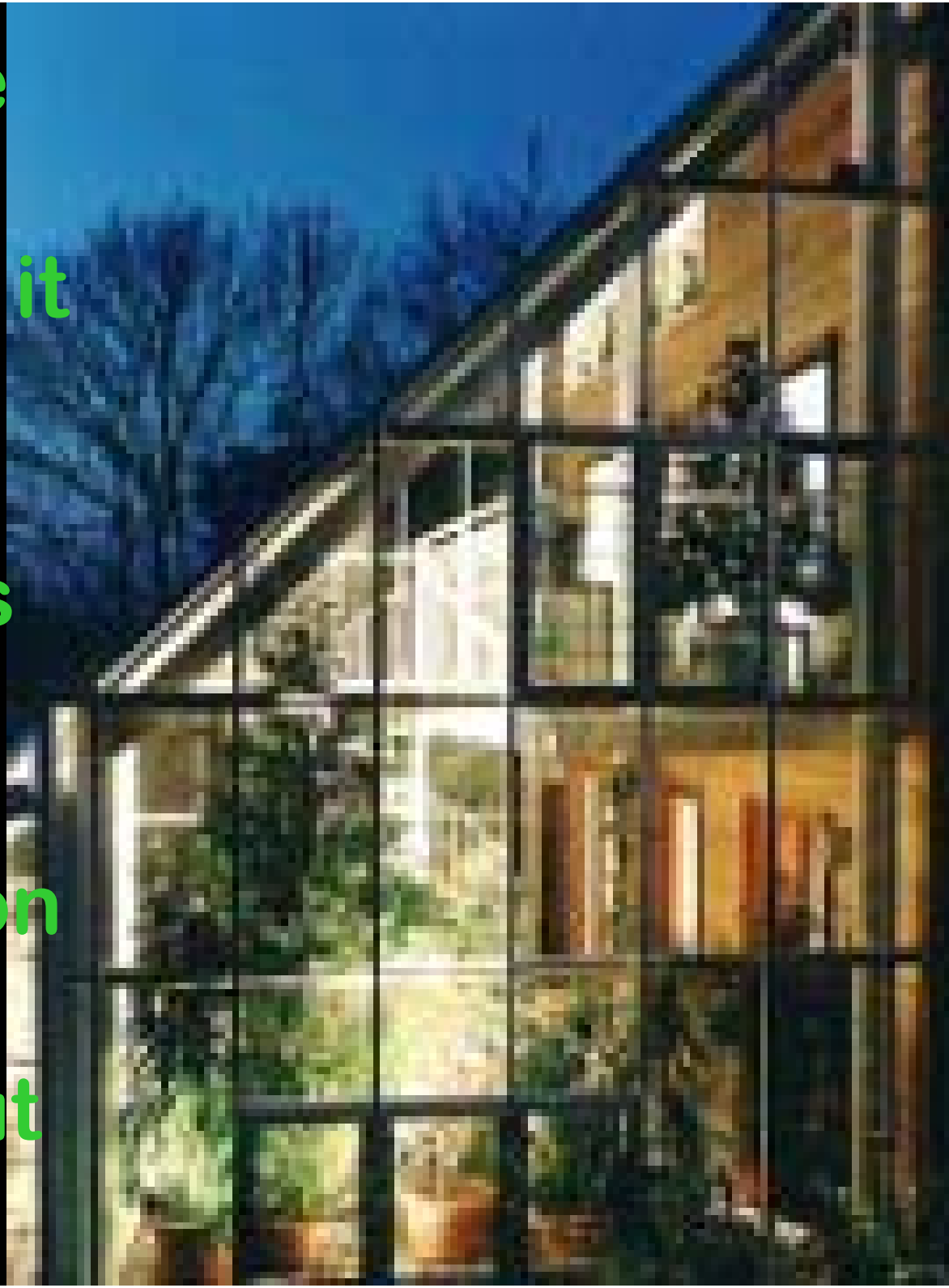
Conservatories:



No hope then

- 90% of UK conservatories have heating installed
- In terms of fuel use they are like a gushing tap over a gulley
- Significant number have no doors or windows to separate from the rest of the house
- Despite Building Regs. requirement

1NTEGER house conservatory at BRE is not all that it could be
Single glazed
No thermal mass back wall,
open to living accommodation on top floor.
Just sheltered out door space



Opening vents in side walls of conservatory but only half way up the height of the conservatory

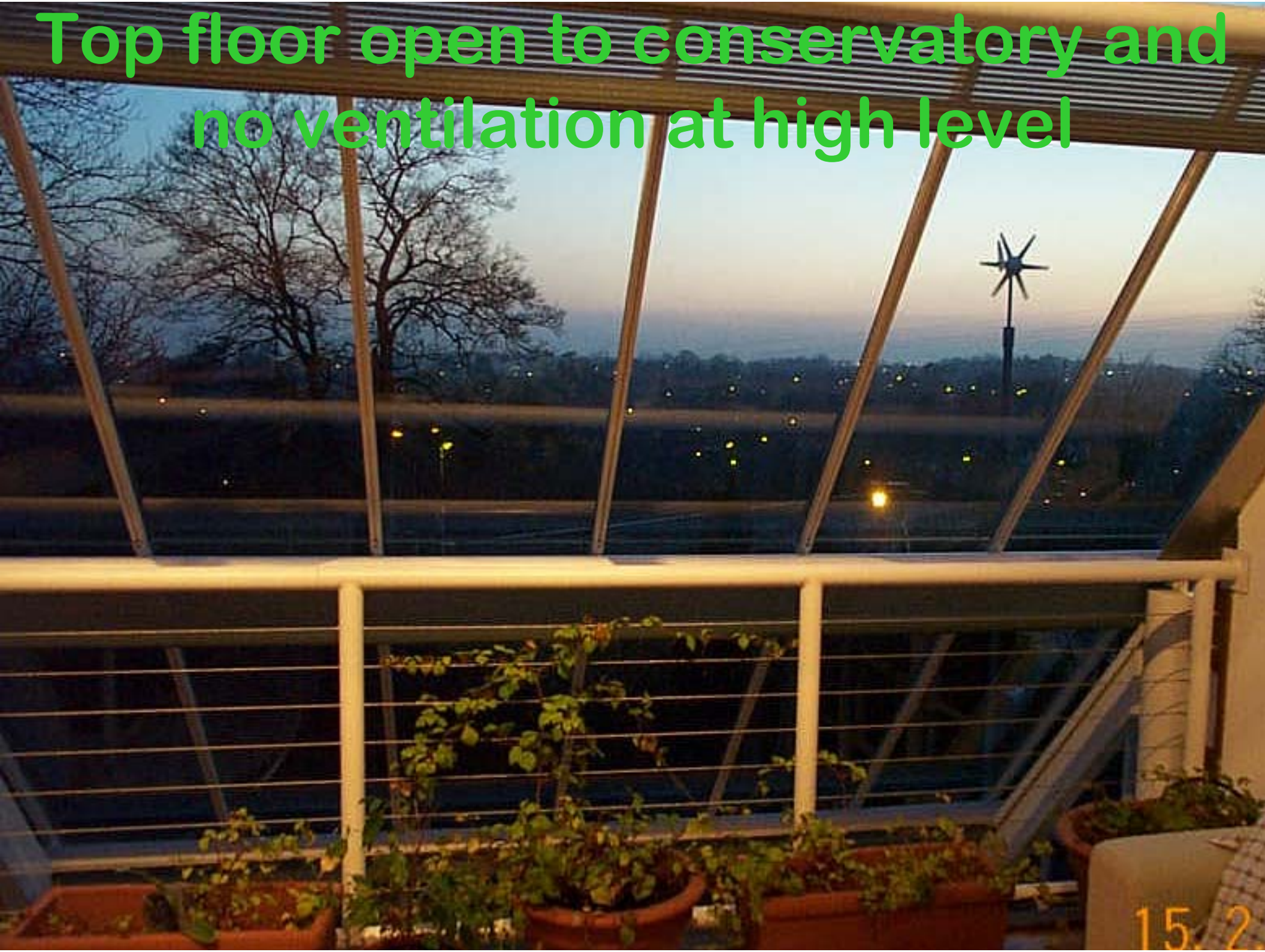
15. 2. 2001

No vents on the slope
some PV and ST panels inadequate for the job?

Internal Solar shading over whole of slope

Control via internet

Top floor open to conservatory and no ventilation at high level



Gallions Housing Association: Tenants would not choose the conservatory but now they have it would not give it up

Zero Energy Development

Reduce demand for artificial light and heating:
Outdoor living
Conservatory life
sunny warm cave to retreat to in the cold of night

Hockerton Newark Nottinghamshire

Hot house
in the middle
of winter
Ventilation
for summer
No heating
Solar gain
Exposed
thermal mass
Windows and
Doors to house

Hockerton & BedZED

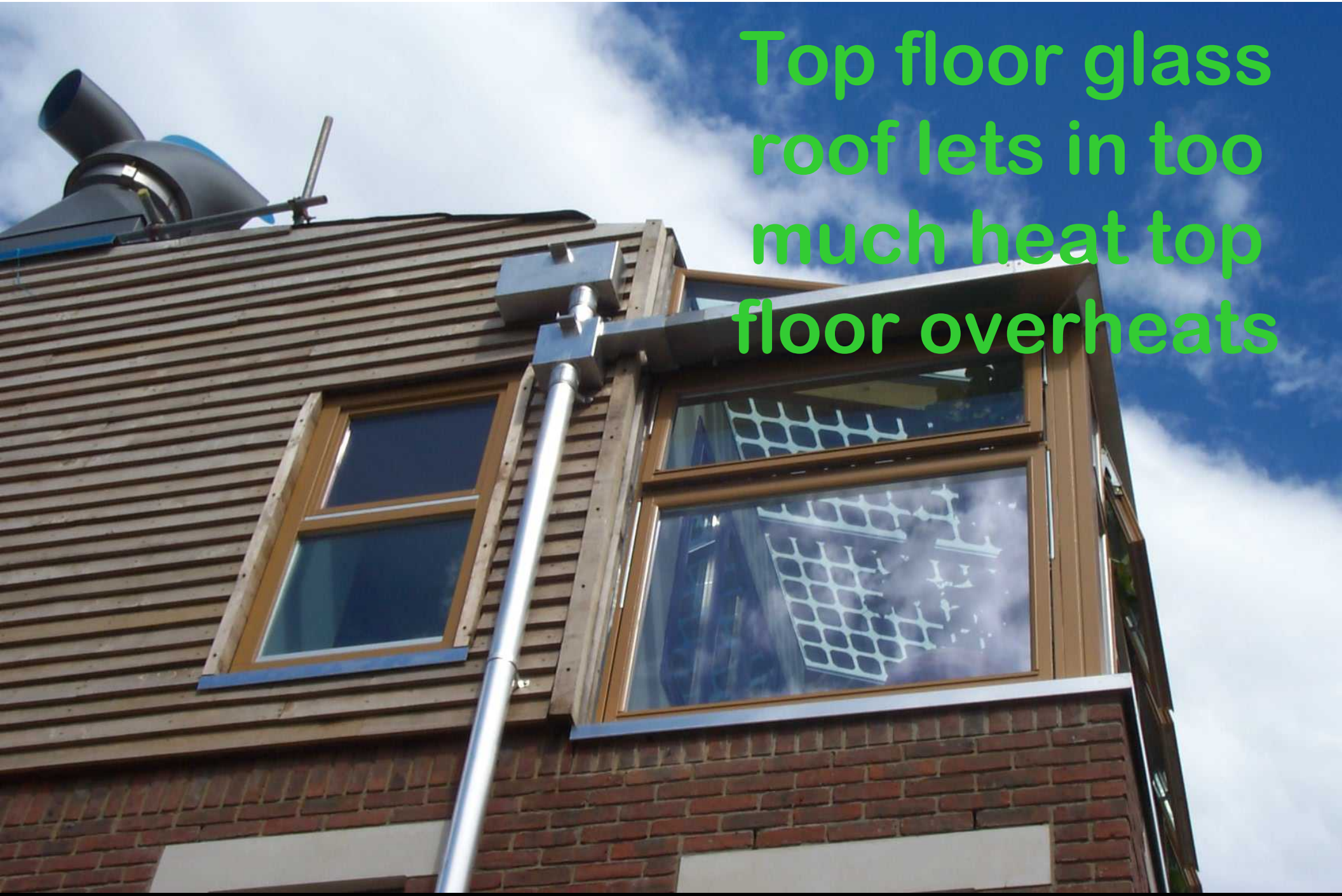
- Conservatories are double glazed and Low Emissivity coated to allow the heat in, prevent it escaping and trap the heat for use
- Doors and windows from conservatory to house are triple glazed Low E for the same reason
- The doors and windows are closed not letting any heat from building out into conservatory
- Until the conservatory is hot enough then windows and doors are opened to let a burst of heat into the building to heat up the fabric

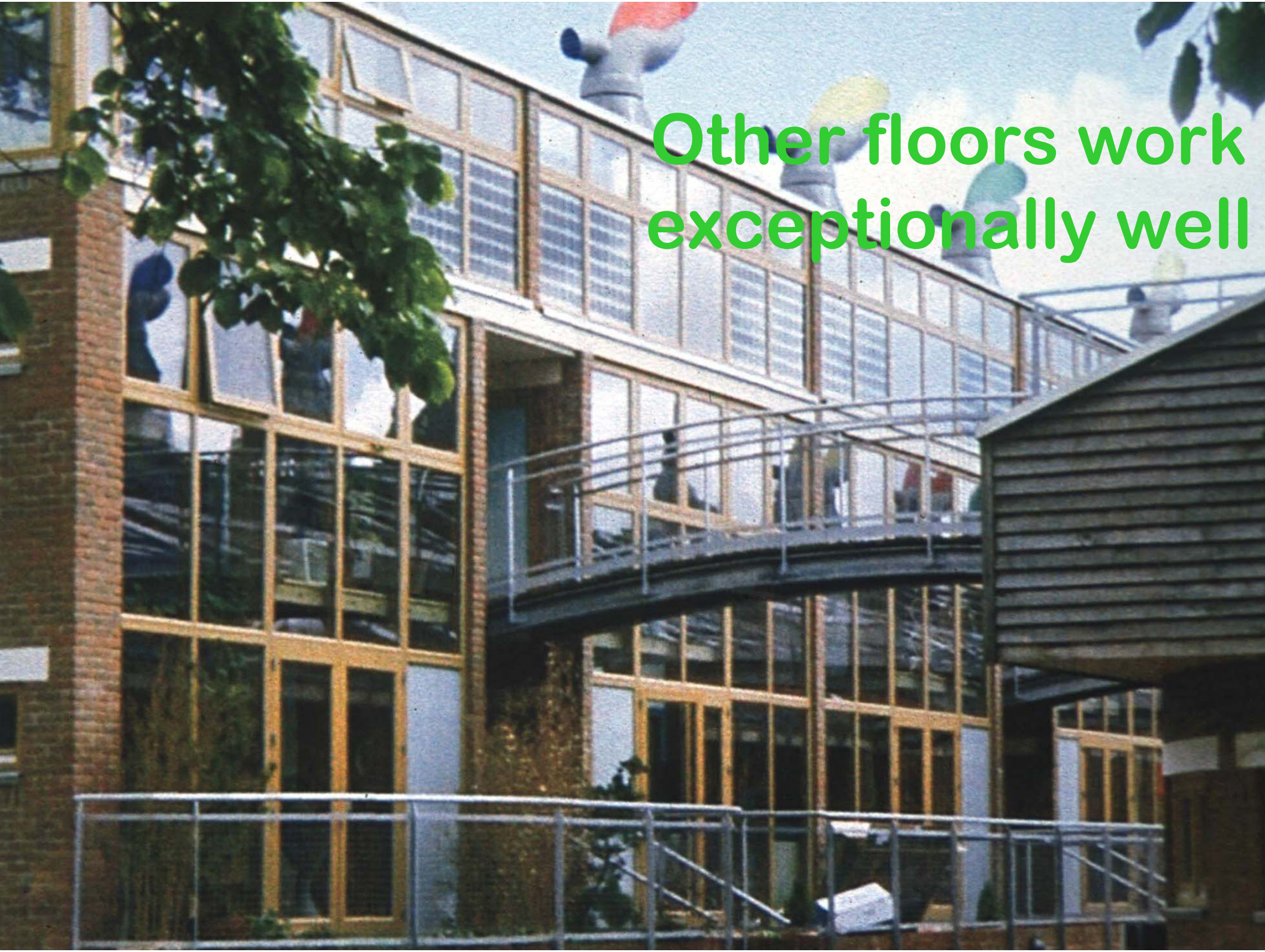
Green Houses and Conservatories: Winter

- Thermal mass is where the construction materials are usually dense, close to the surface have large surface area, can absorb and store heat
- Conservatories can capture heat in sunny but cold weather
- Intelligent use of thermal mass in floors and rear walls can exploit the captured heat by storing it and saving it until the sun has disappeared and release it to warm the occupants of the conservatory.

Lean-to Conservatories: warm the house for free

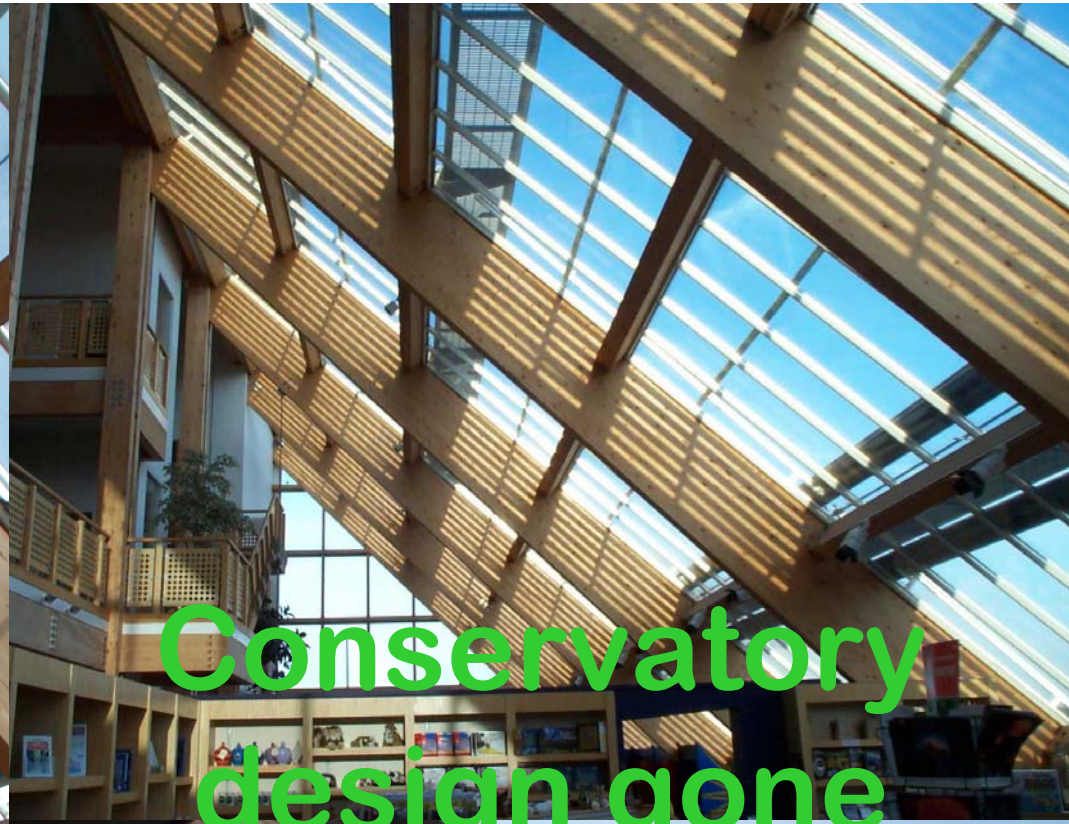
- Once a conservatory attached to a building is warmed
- it can than be used to heat the interior of the attached building by opening doors and windows between them to let the heat into the building
- The building's thermal mass can be warned and heat stored for release into the building later after the sun has gone


Top floor glass roof lets in too much heat top floor overheats


Other floors work
exceptionally well

Sunroom on South face captures the sun

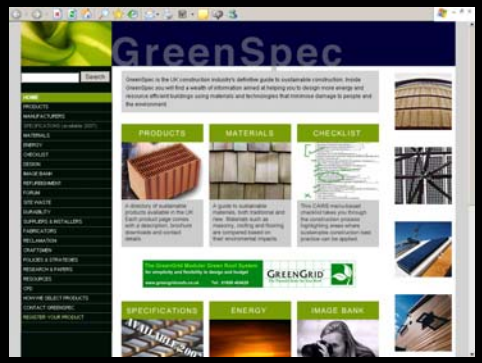
Heavy building elements store the heat and release it later



Conservatory design gone wrong

Conservatory Gone Wrong

- No boundary between conservatory and accommodation beyond
- No thermal mass wall to old the heat
- No entry or exit ventilation in glazed roof
- Solar shading essential externally
- Tenant fitted Air Conditioning



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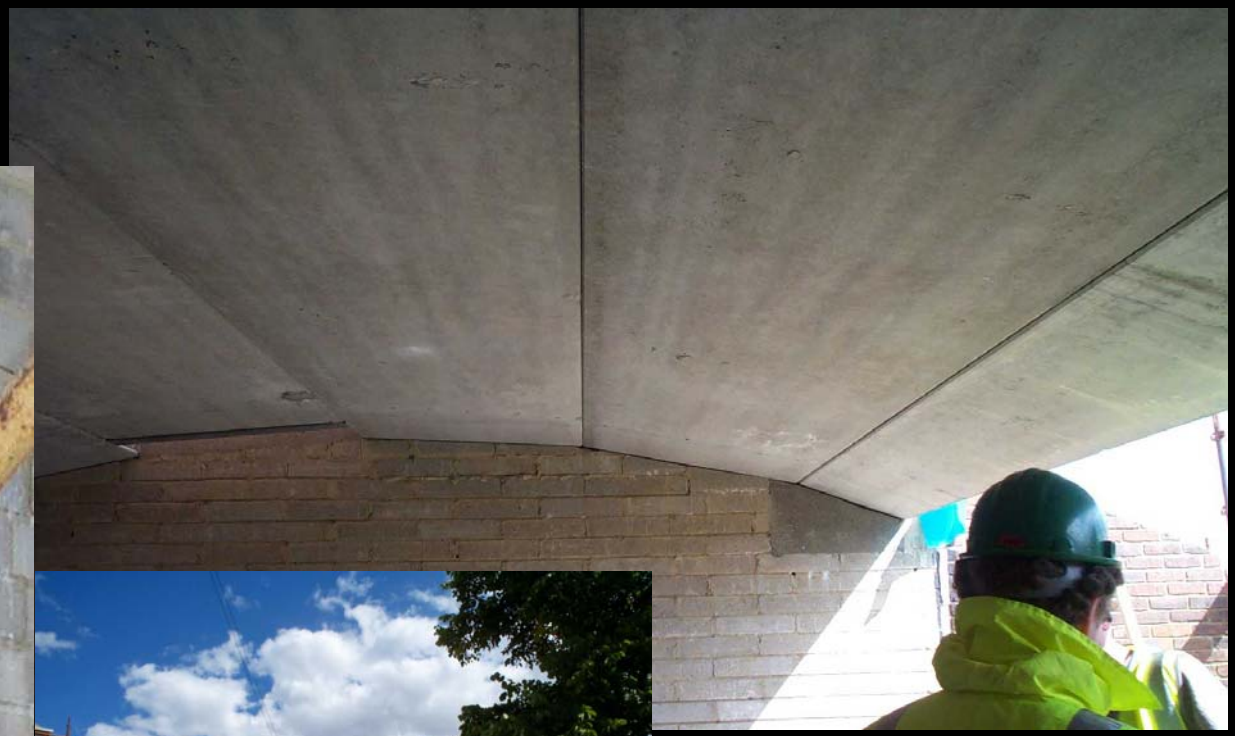
Thermal Mass

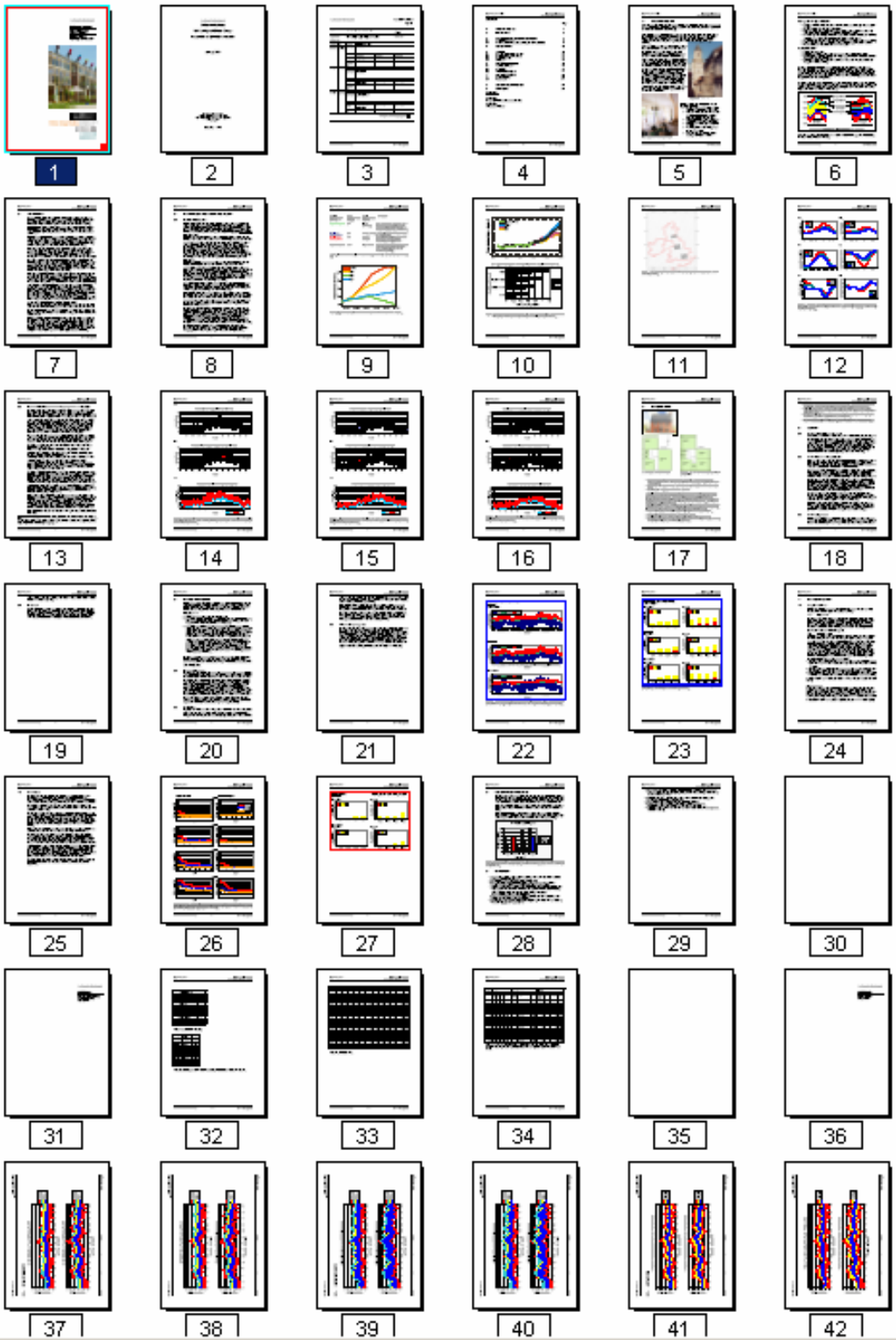
Ventilation, warmth and coolth



High Thermal Mass at surfaces fairfaced brick, block and plank

Heat movement in buildings

- ARUP/B Dunster Report on need for Thermal mass in buildings to cope with climate change global warming
- Recommend internal doors are self closing to hold heat energy where it is created or collected
- All partitions to be insulated
- Then actively move heat wherever you may want it or leave it where it is



ArupResearch+Development

Bill Dunster Architects

UK Housing and Climate Change

Heavyweight vs. lightweight construction

bda zedfactory

Feilden Clegg Bradley Architects LLP

RIBA

ARUP

8.26 x 11.69 in

http://www.greenspec.co.uk/documents/whitepapers/MB_Thermal%20Mass%20for%20Housing.pdf#search='passive%20ventilation'

Options

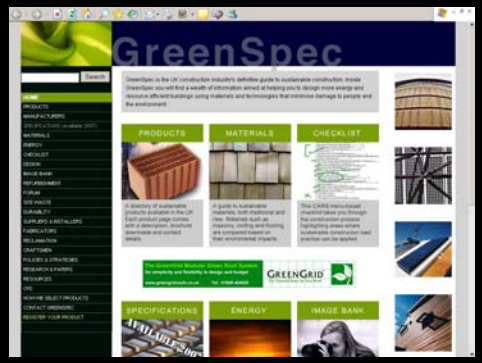
The Concrete Centre

Thermal Mass for Housing

CONCRETE SOLUTIONS FOR THE CHANGING CLIMATE

Exploiting thermal mass

- If the building has high thermal mass and its surfaces are exposed
- they can be exploited in both heating and cooling
- In winter the mass can be heated in the day the heat stored for exploitation in the night
- In summer the mass can be cooled in the night and exploited in the day

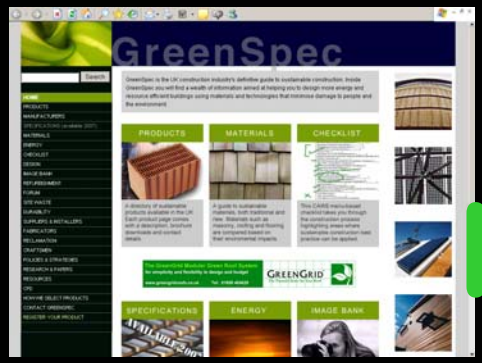


Thermal mass

www.greenspec.co.uk

- Large surface areas are best
- Thickness closest to surface is used in daily cycles,
- Full thicknesses and more used over annual cycles
- Higher density material is best
- Exposed to the space not hidden above ceilings or below floors
- Exposed to the sun's rays is good
- Embedded pipes can be exploited to move warmth and coolth around building or into storage

© NGS 2004-7 Air Movement In Buildings



Hollow core floors

www.greenspec.co.uk

- Product Reference: Termadeck
- Precast concrete plank floors with hollow cores and pathway through cores
- Connected to ventilation system
- Cooling from the inside out

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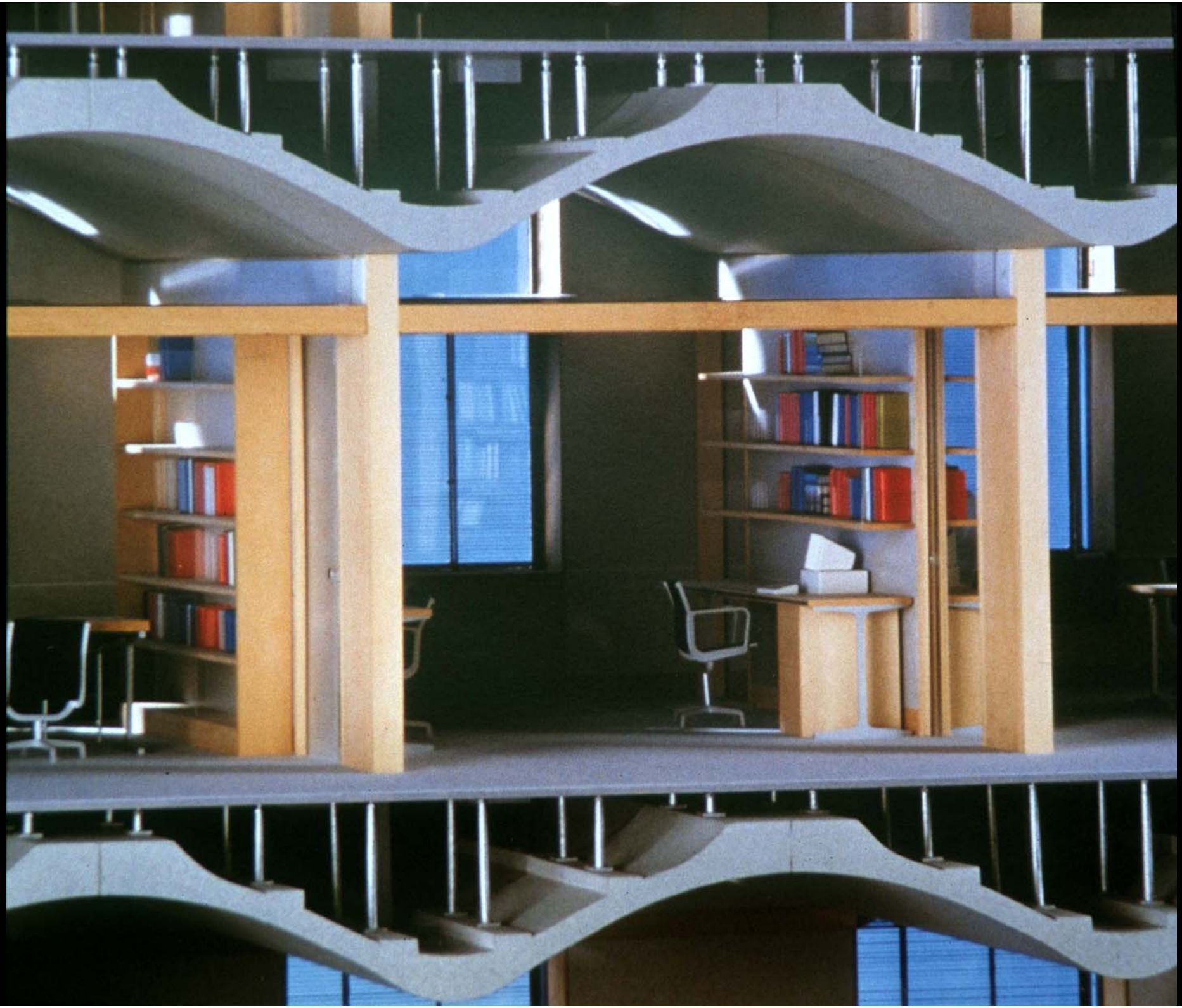


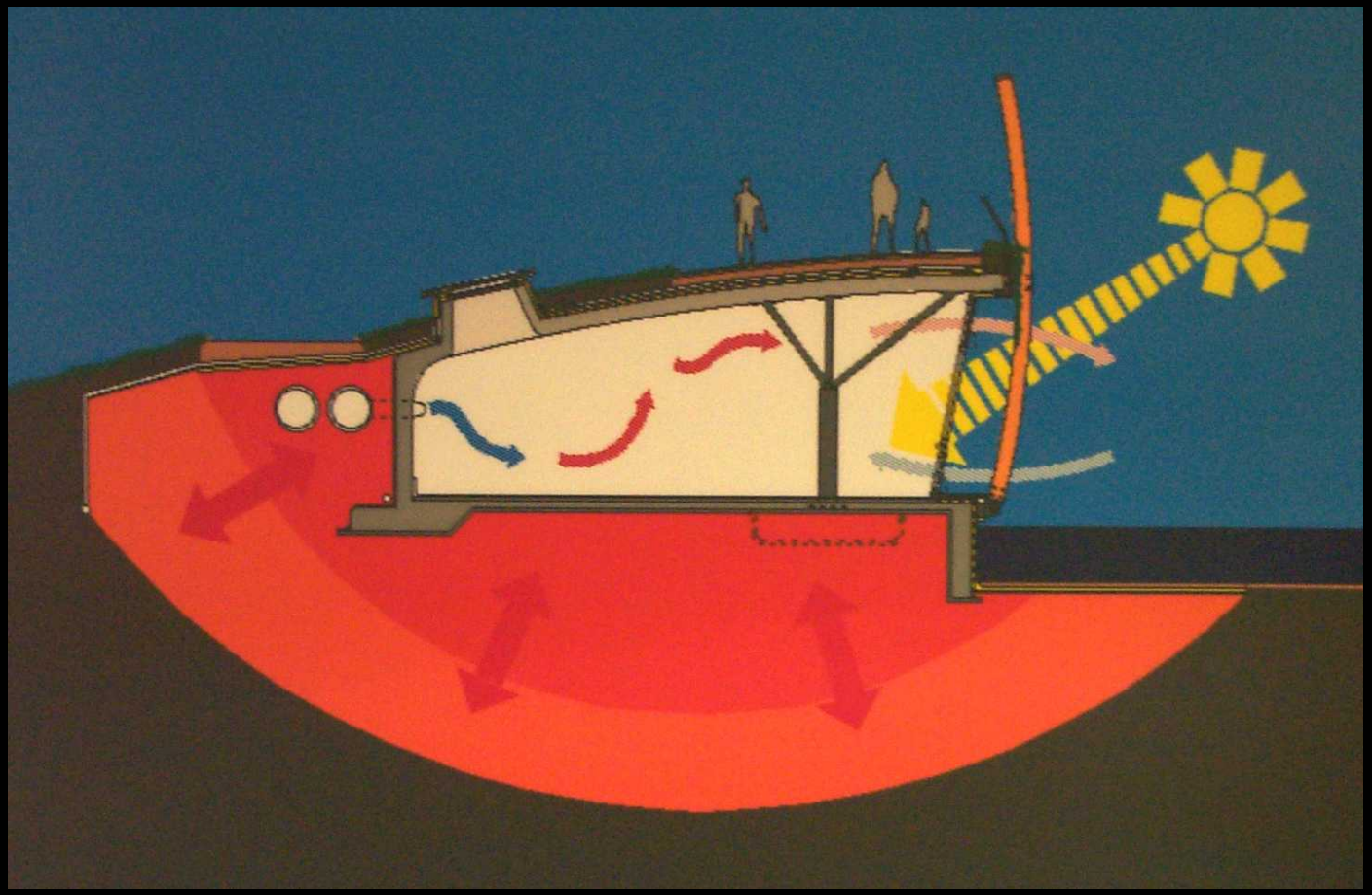
Overnight Purge Cooling

- By passively cross ventilating a building during the summer nights
- the exposed building mass can be purged the of its heat and cooled
- This allows the occupants arriving in the morning to benefit from the added coolth
- As the day warms the mass will absorb heat given off by the people and computers, etc.
- Helping keep the building lower than ambient temperature to the benefit of occupants

Inter seasonal thermal storage

- Remove collect solar energy and store it over year cycled
- Remotely in rock or salt thermal stores
- Transferred by piped liquid
- Or remove thermal insulation under and behind building and sun will heat floor and then earth below
- The heat will store for 6 months and then warm the building for 6 months

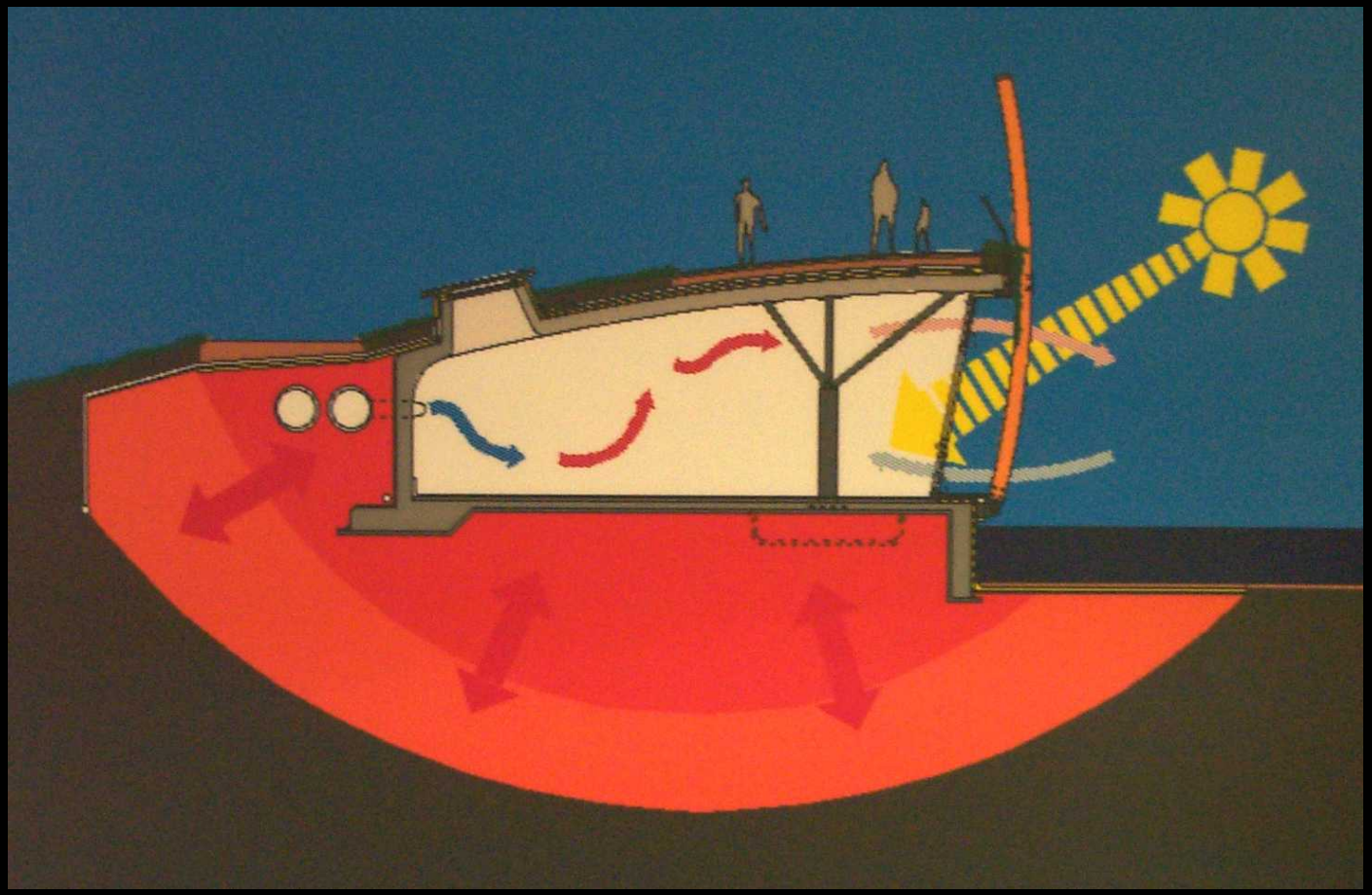
Zero Energy Development



Zero Energy Development Use of thermal mass of earth to store heat for 6 months

Mile End Road Park

Zero Energy Development



Heat transfer in soil 1m/mth
6m insulation boards at perimeter
6 months of heat storage

Mile End Road Park

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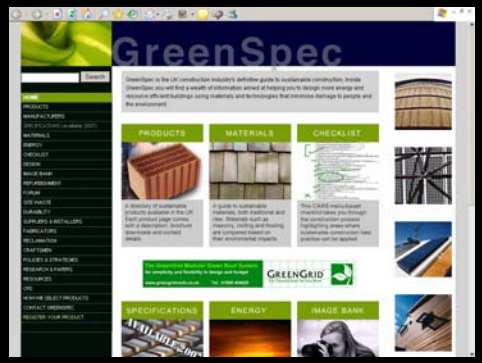
ZED Zero Energy Development

Hockerton HHP

BedZED

Mile End Park

Another GreenSpec CPD seminar to consider



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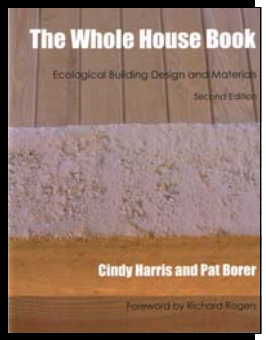
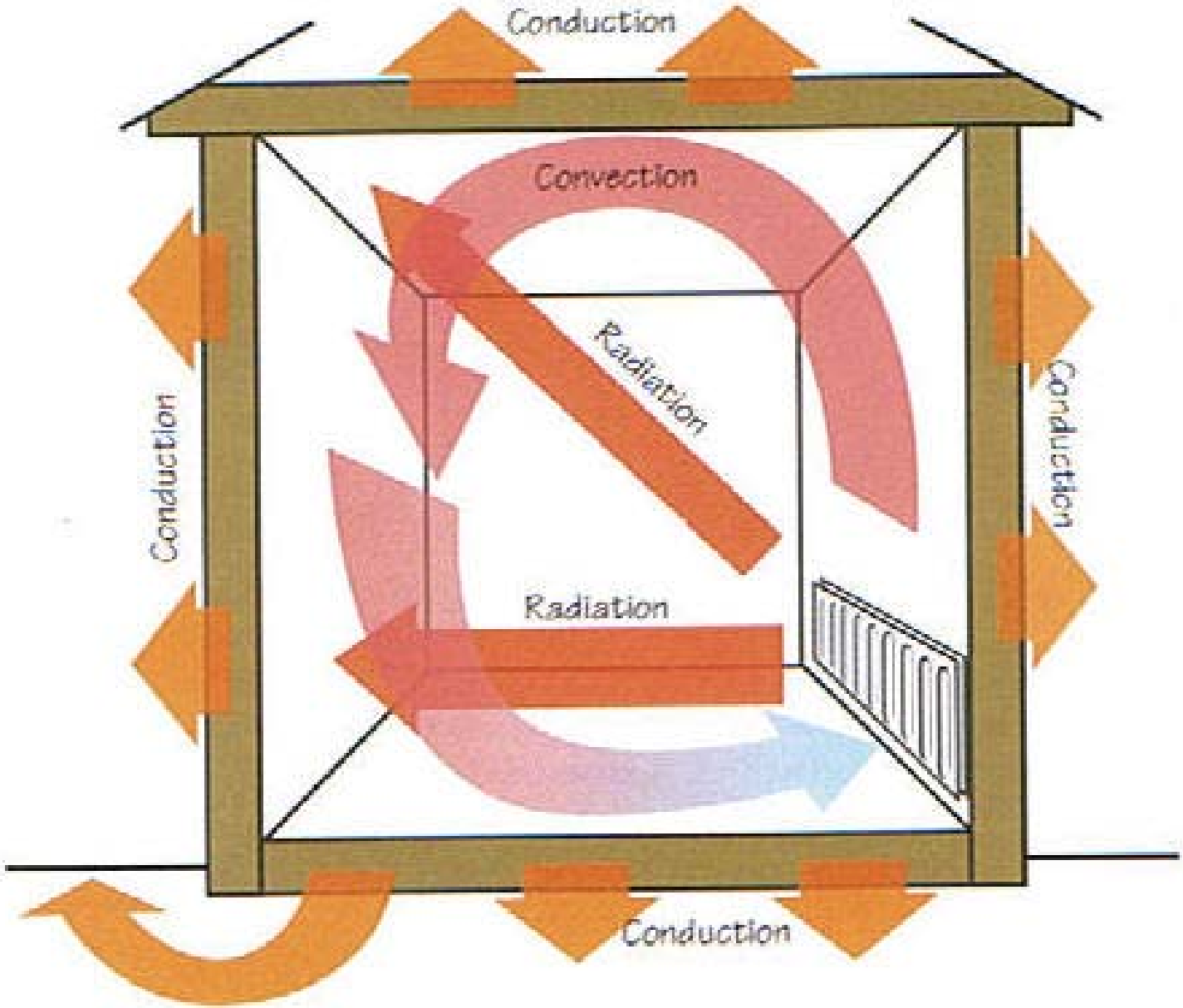
Conduction
Convection
Radiation
Conduction

Radiators (Convectors)


The Whole House Book
Ecological Building Design and Materials
Second Edition
Cindy Harris and Pat Borer
Foreword by Richard Rogers


Conduction
Convection
Radiation
Conduction
Conduction
Radiation
Conduction

Convection ‘Radiators’

- Radiators use conduction to bring the heat to the surface,
- Radiation to push some of the heat into the surrounding air
- Convection to push the warmed air upwards to circulate and warm the room
- Matt black radiators radiate more but still convect most of that heat
- Hot air rises, cool air displaces it

Losses behind Convection 'Radiators'

- Un-insulated solid external walls offer an easy way to heat the sky
- There are multilayer fabric insulation sheets and moulded plastic reflector sheets available
- install on the wall behind the 'radiator'
- Reflect more heat to allow convection to be more effective

‘Radiators’ in washrooms

- Never position radiators (convectors) under warm air hand dryers
- The combination of water droplets and warm air with break down the protective paint rapidly
- and the ‘radiator’ will rust easily

Radiators and Windows

- Traditionally we have fitted radiators under windows
- To warm the incoming cold air
- And warming the radiant coolth
- But we end up heating the external air and sky
- If hot air is escaping it wont be noticed
- Consider better insulated windows and trickle vents
- Position radiator away from windows
- If too much cold air is entering, it will be noticed and windows will be shut

Temperature Gradients

- Radiators use convection to warm air in spaces, warm air rises and cool air falls
- This creates temperature gradients in the spaces cool at your feet and warm at your head
- Cold feet may make you feel cold and hot head may make you feel hot
- Heat loss through high level windows and vents

Radiant Heating

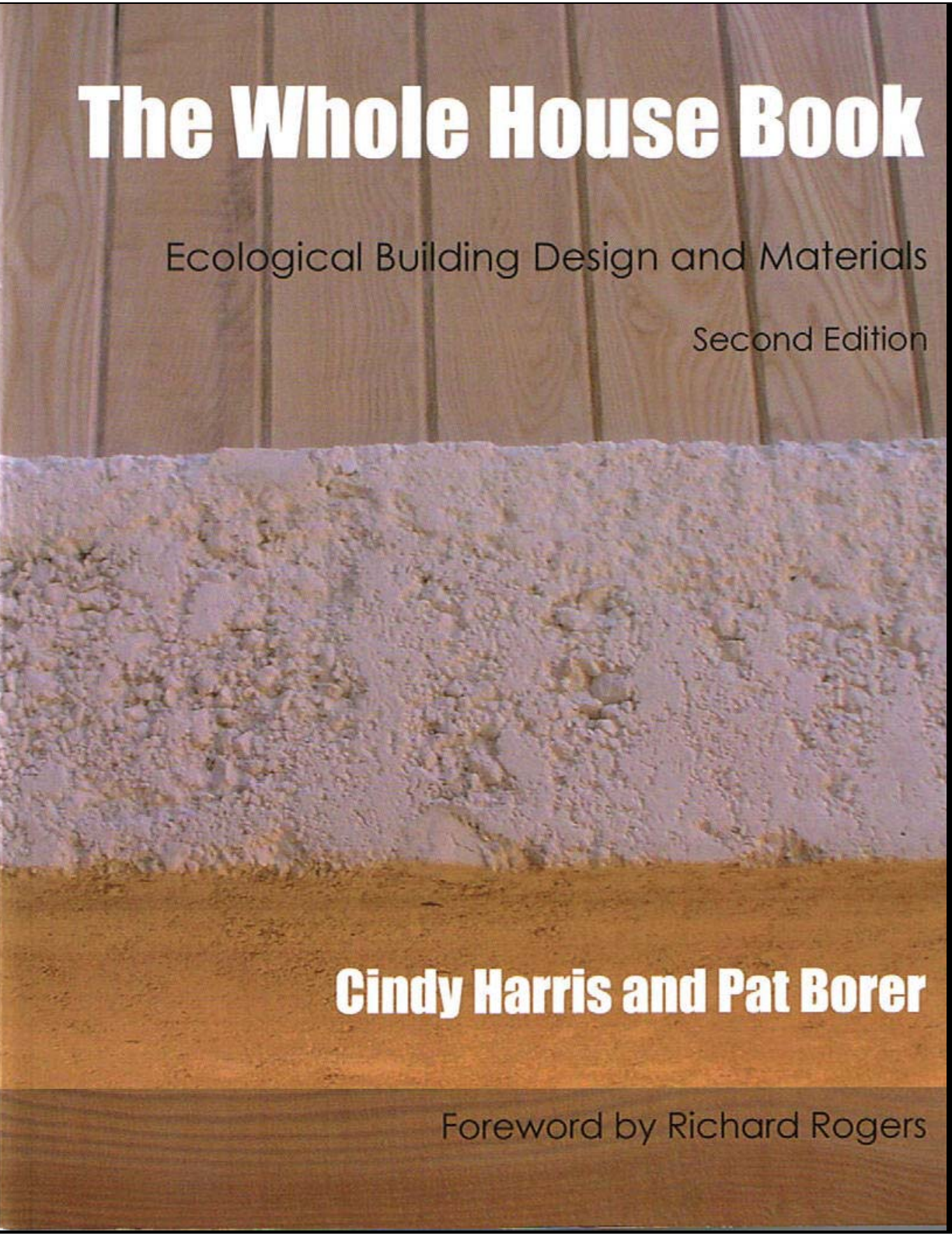
- Available in ceiling, walls and floors
- Ceilings usually electric (avoid)
- Walls and floors usually piped hot water
- Low temperature compared to radiators (convectors)
- Radiate heat at objects in the space to warm them directly
- They in turn may radiate heat too
- No heat gradients

Underfloor Radiant Heating (URH) and GSHP or ST Panels

- Radiant heating uses low grade heat
- LG Heat available from Ground Source Heat Pumps (GSHP) and Solar Thermal (ST) panels.
- And from modulating boilers designed to work with URH
- Some under-floor heating pipes can also be used for cooling

Exploiting Solar Gain

- Thermal mass can be positioned to exploit solar gains
- It can then be exploited to use the stored heat to warm the building once the sun has gone
- Many configurations are possible using conduction, radiation and/or convection

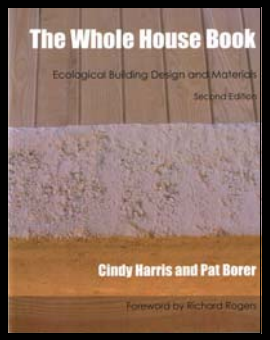


Publisher: CAT Centre for Alternative Technology

1st edition

ISBN: 1-898049-21-1

but 2nd edition is out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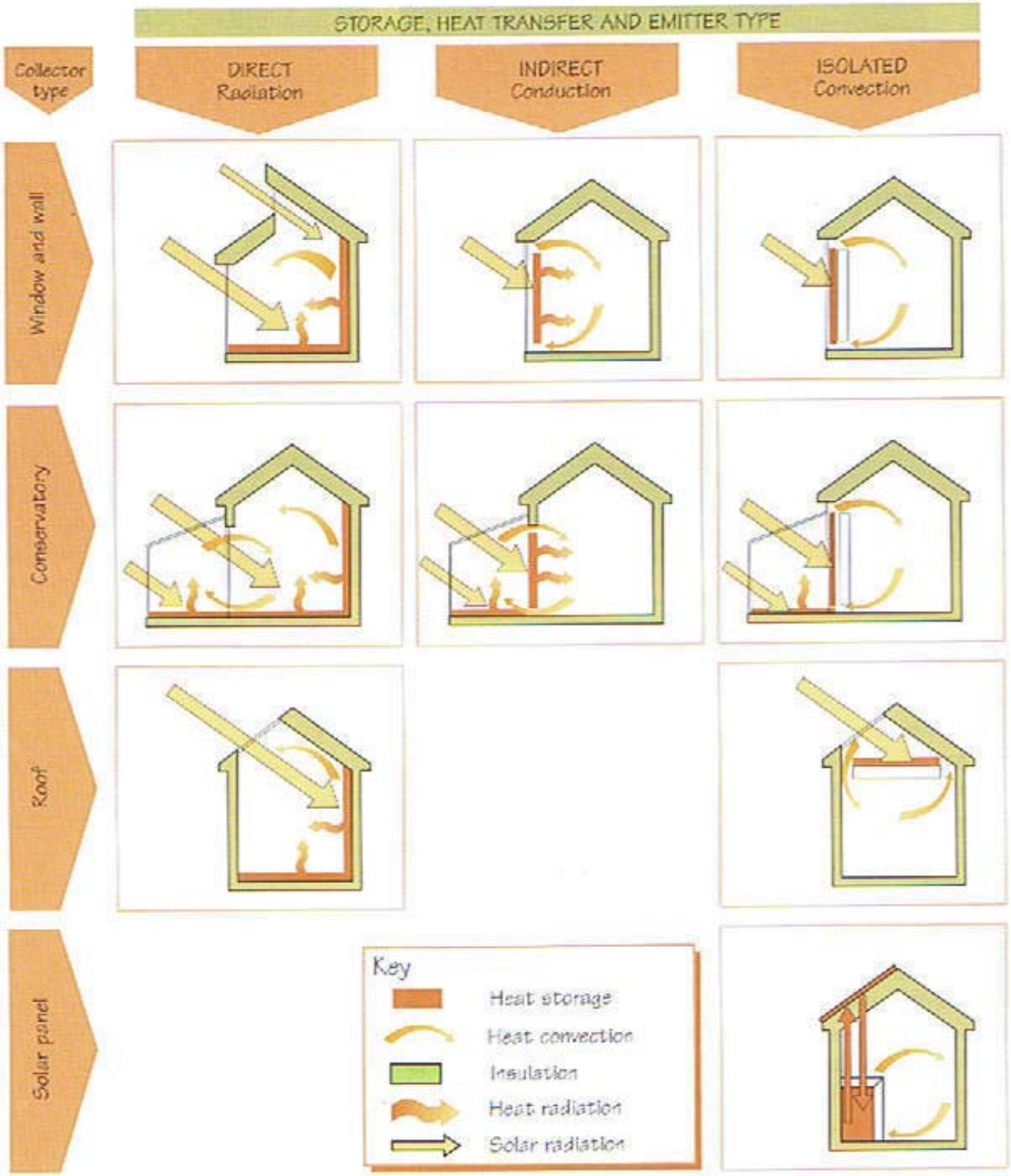
STORAGE, HEAT TRANSFER AND EMITTER TYPE
Collector type
DIRECT Radiation
INDIRECT Conduction
ISOLATED Convection
Window and wall
Conservatory
Roof
Solar panel
Key
Heat storage
Heat convection
Insulation
Heat radiation
Solar radiation

Test Yourself Part 7

- What are the ideal characteristics for thermal mass?
- How does Hockerton exploit Thermal mass?
- How is Mile End different from Hockerton?

How did you do Part 7

- High density, large surface area, exposed to passive heat gains from sun
- Traps sun in conservatory, heats up floor and back wall then warms up house interior
- Mile end stores the heat in the ground below and behind the building, insulation absent in floors is set beyond the building and soil

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