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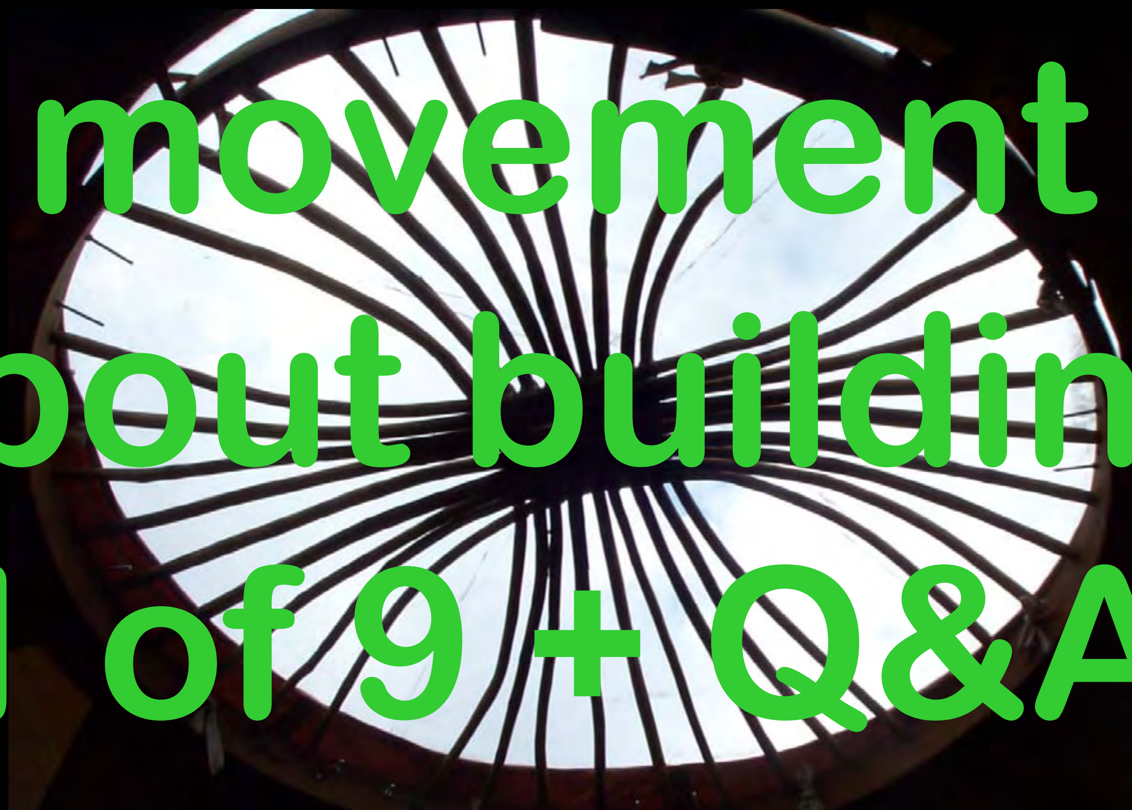

Air movement in & about buildings 1 of 9 + Q&As

 CPD in 10 parts


Hot air rises

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

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

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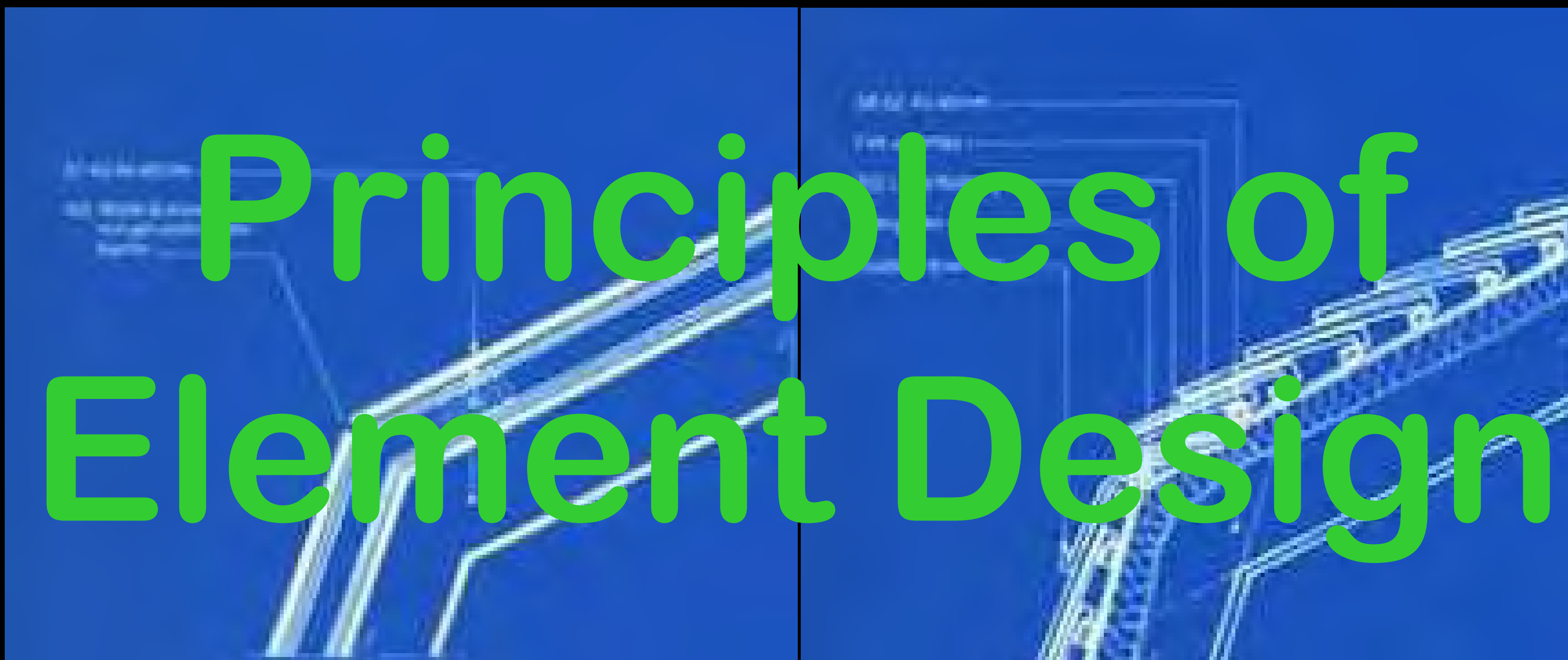
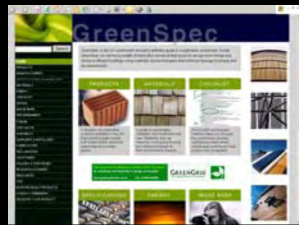


Principles of Element Design

Performance Specification

Performance Drawings



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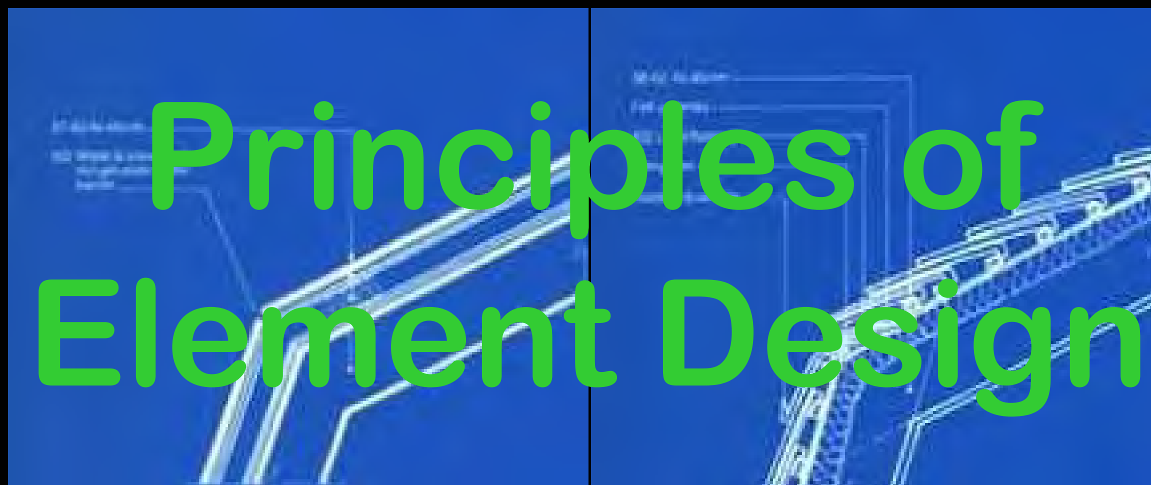

Principles of Element Design

Performance Specification

Performance Drawings

Another GreenSpec CPD seminar to consider

Being different

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- If you want to avoid conventional construction
- you need to understand what the elements of the building will be subject to during their life
- And then design the new elements or their methods of construction to meet these needs:
- E.g. Wind, dead and live loads, weather, occupation moisture, heat flow, vapour, etc.

Rubber Facade

- If a student designs a Museum of Pornography or Sadism & Masochism (yes, one student did sadly)
- And wants a rubber external skin, pvc ceilings and walls
- There are no points of reference, so they have to start from scratch
- They need to understand the principle of element design

The criteria for success

- The aims may also be very different to conventional buildings
- The Student may want the museum to be hot and sweaty
- This is the opposite to conventional building
- a whole new set of rules apply
- these need to be explored, understood and worked with

THIRD EDITION

PRINCIPLES OF element design

Peter Rich & Yvonne Dean

Architectural Press

ARCHITECTURE/DESIGN

PRINCIPLES OF element design THIRD EDITION

Peter Rich & Yvonne Dean

- **Unique in its approach to detail design**
- **Invaluable for both students and practising architects, builders and surveyors**
- **Completely updated in a convenient reference sheet format**

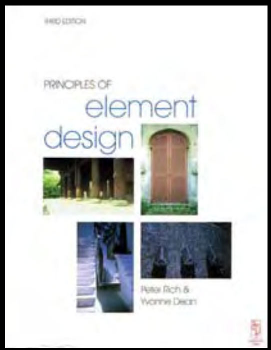
The construction of buildings is learnt through experience and the inheritance of a tradition in forming buildings over several thousand years. Successful construction learns from this experience which becomes embodied in principles of application. Though materials and techniques change, various elements have to perform the same function. **Principles of Element Design** identifies all the relevant elements and then breaks these elements down into all their basic constituents, making it possible for students to fully understand the given theory and principles behind each part. As all building projects are subject to guidance through the Building Regulations and British Standards, this book gives an immediate reference back to relevant information to help practitioners and contractors identify key documents needed.

Peter Rich AA Dipl (Hons) Architect, started his career with 14 years' experience as a qualified architectural technician. He then joined the AA School of Architecture, working with Bill Allen and John Bickerdike after his graduation, later becoming a partner of Bickerdike Allen Rich and Partners. He also taught building construction at the Bartlett School of Architecture, University College London, and architectural design at the Polytechnic of North London. He now acts as a Consultant.

Yvonne Dean B.A. (Hons) B.A. (Open) RIBA, is an architect, energy consultant and materials technologist. She also has 15 years' experience as a lecturer, travels widely and is a guest lecturer at many universities. She pioneered an access course for Women into Architecture and Building, which has been used as a template by others, and has been instrumental in helping to change the teaching of technology for architects and designers.

ISBN 0-7506-3113-9

Architectural Press
An imprint of Butterworth-Heinemann
http://www.bh.com

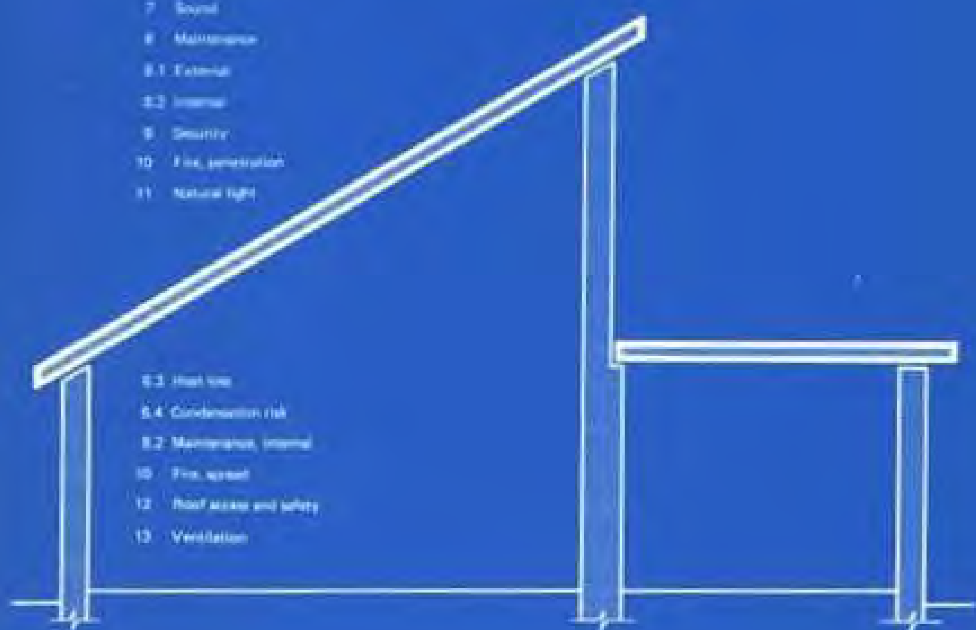


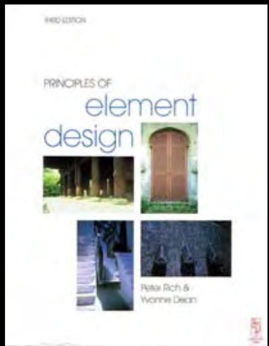
Roofs general factors

(see POED 9 and POED 10 for Flat roofs and POED 11 for Pitched roofs)

Key factors	Action	Counteraction
Gravity	Downward pull	Support
Wind	Massive force (suction), destructive, penetrative	Rigidity, resilience, sealing
Rain	Moisture deposition	Deflection, impervious skin, absorption and drainage, sealing
Snow	Moisture deposition, loading	Deflection, impervious skin, absorption and drainage, sealing
Sun	Temperature variation, movement, heat gain, chemical decomposition	Movement joints, insulation, shielding, invulnerable materials, reflection
Dirt and dust	Infiltration, deposition, surface pollution	Repulsion, exclusion, shielding, cleaning
Chemicals	Corrosion, disintegration, decomposition	Invulnerable materials, exclusion
Sound	Noise nuisance	Insulation

1 Roof form and type of weatherproof covering
2 Structural strength and stability
3 Weather shield
3.1 Rain
3.2 Snow
3.3 Wind
3.4 Sun
3.5 Dirt and dust
4 Drainage
5 Durability
6 Thermal performance
6.1 Thermal movement
6.2 Heat gain
6.3 Heat loss
6.4 Condensation risk
7 Sound
8 Maintenance
8.1 External
8.2 Internal
9 Security
10 Fire, penetration
11 Natural light





Windows general factors

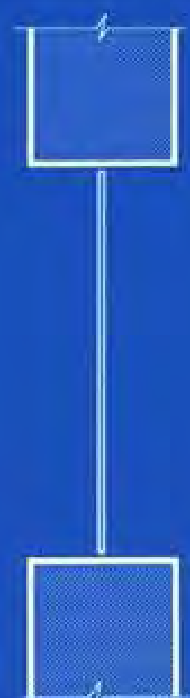
(see POED 17 for Specific factors)

A. "Hole in wall" type B. "Gap filling" type C. "Window wall" type

Key forces	Action	Counteraction
Gravity	Downward pull	Support
Wind	Motive force, destructive, penetrative	Rigidity, resilience, sealing
Rain	Moisture deposition	Deflection, impervious skin, absorption and drainage, sealing
Snow	Moisture deposition, loading	Deflection, impervious skin, absorption and drainage, sealing
Sun	Temperature variation, movement, heat gain, chemical decomposition	Movement joints, insulation, shielding, invulnerable materials
Dirt and dust	Infiltration, deposition, surface pollution	Repulsion, exclusion, shielding, cleaning
Chemicals	Corrosion, disintegration, decomposition	Invulnerable materials, exclusion
Sound	Noise nuisance	Insulation

Outside

1 General purpose of window
2 Daylight
3 Sunlight
4 Glare
5 Solar heat gain
6 Sound insulation
7 Fresh air and ventilation
8 Wind-driven rain and snow
9 Privacy from overlooking
10 Cleaning
11 Security
12 Insects

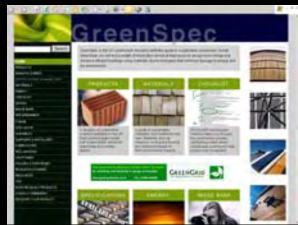


Inside

13 Views out and eye level
14 Thermal insulation and heat loss
15 Safety
16 Fire
17 Statutory window area
7 Statutory ventilation

Performance Design

- Establish the Performance requirements of the building
- Then design the elements to meet them
- E.g. What is the design life?
- This forces us to address durability
- And gives an opportunity to consider whole life costs and life cycle analysis



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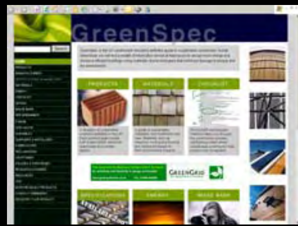
Design Responsibility

Another GreenSpec CPD seminar to consider

Performance Specification

- If the Project is Design & Build or the contract or package has Contractor's Design Portion
- The conventional designer passes the responsibility for the whole design or for completing the design
- to the 2nd party, the contractor's designer
- Its vitally important that all of the performance requirements are understood and communicated to the 2nd party
- And that the design solution is judged against them



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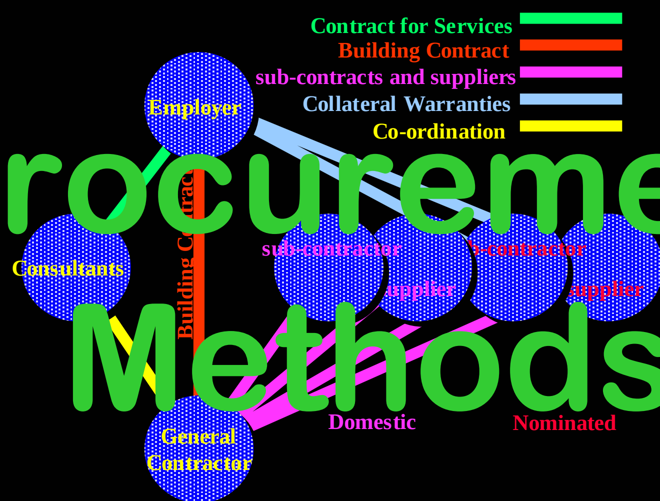
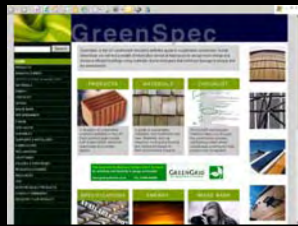
Procurement Methods



GC, D&B, MC, CM, DMC, BOOT

Another GreenSpec CPD seminar to consider



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Specification Responsibility

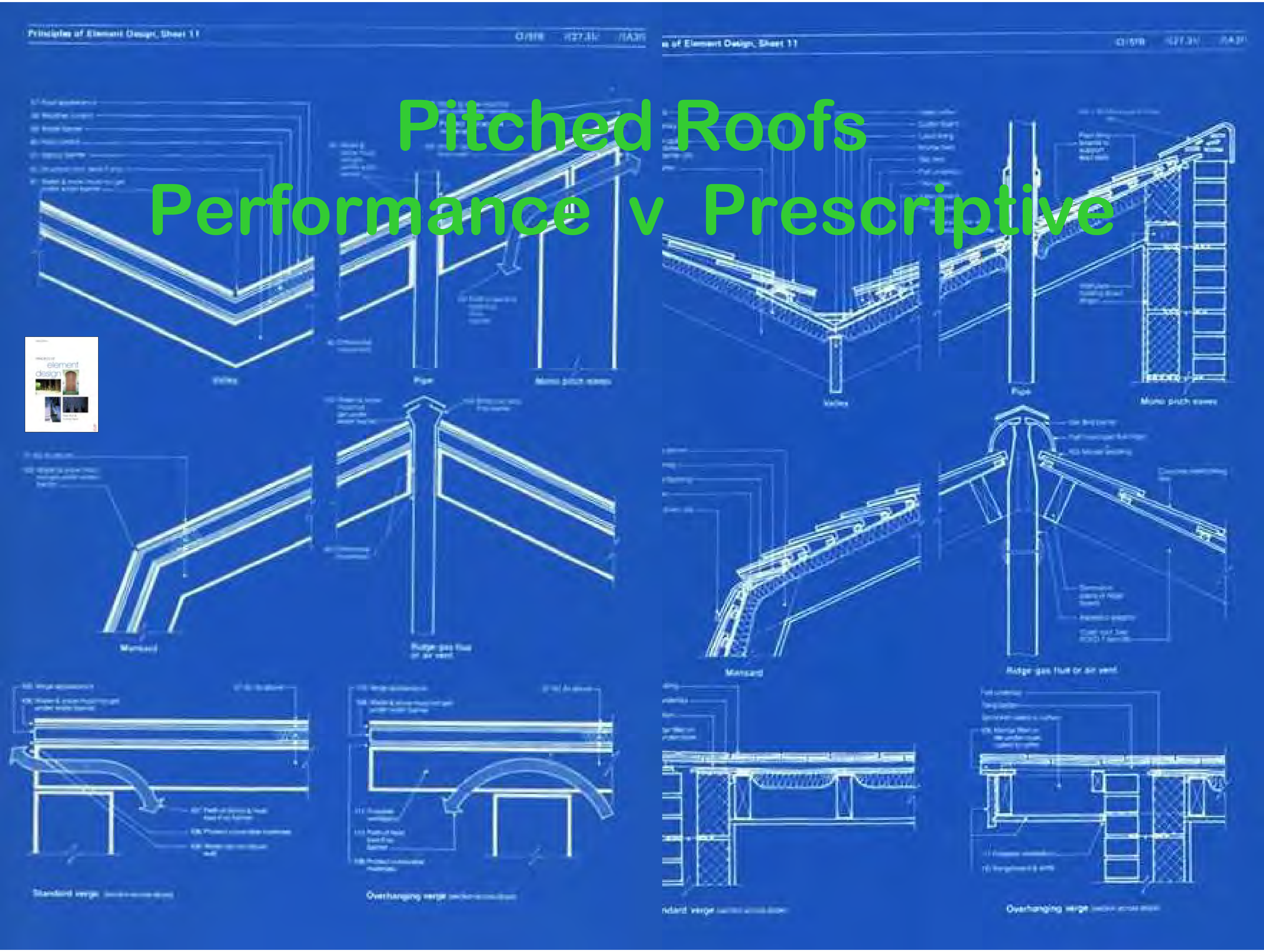
Changes with Procurement methods

Another GreenSpec CPD seminar to consider

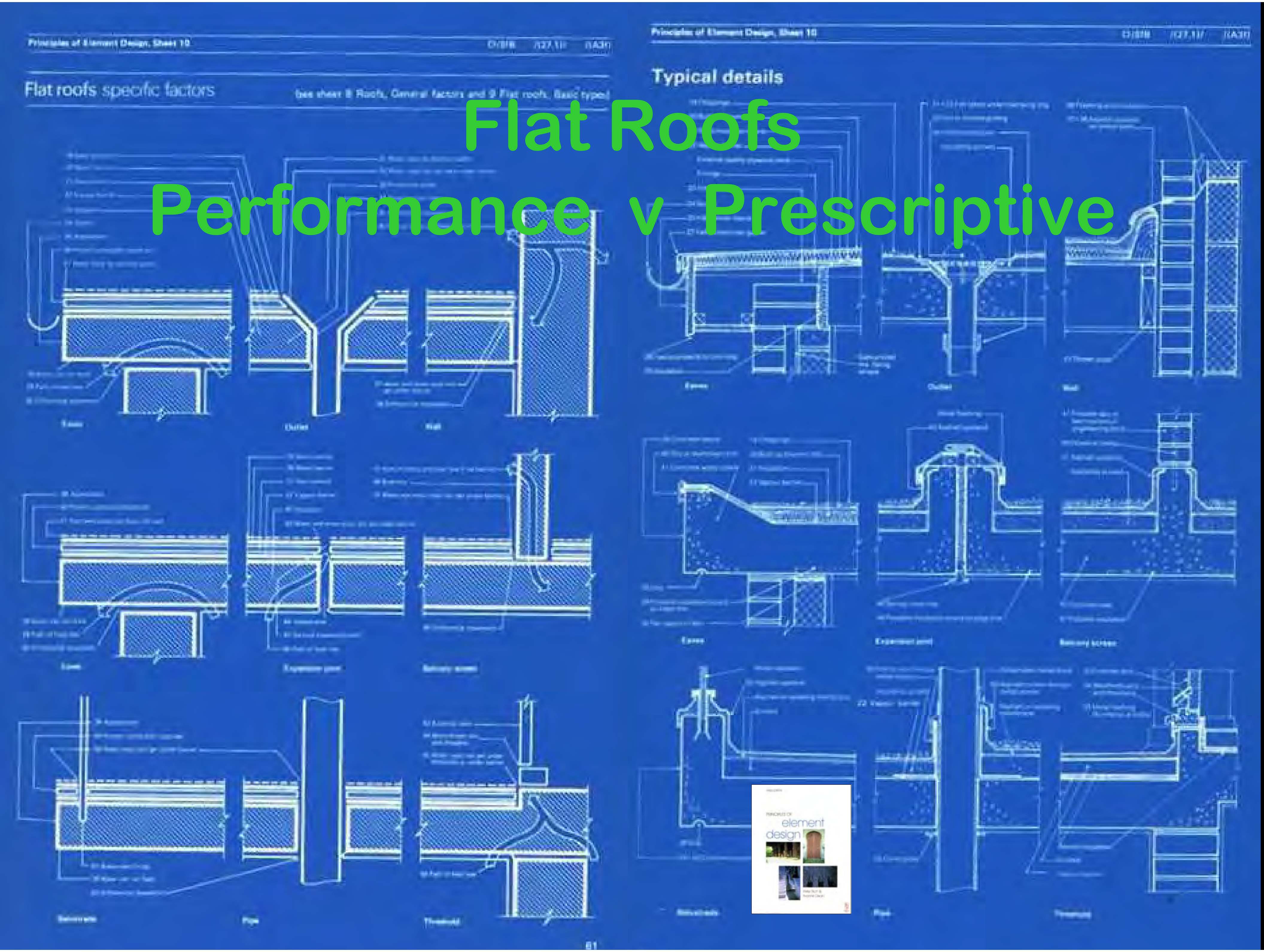
Performance Drawings

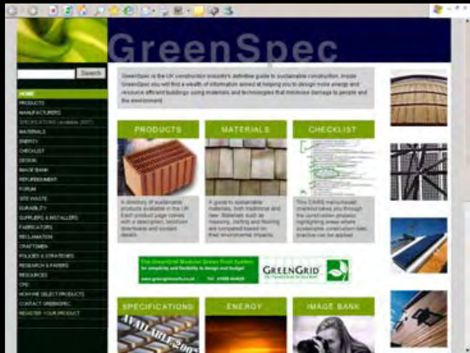
- Just as the specifications describe principles
- drawings should not be prescriptive either
- Internal and external profiles and primary structural elements
- Movements to be accommodated, any limitations
- Abutments and surrounds
- But not materials and no construction

Pitched Roofs
Performance v Prescriptive



Flat Roofs
Performance v Prescriptive





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Sustainability Checklist

On GreenSpec website

New Design Issues

- For most of the design professions and the construction industry as a whole
- Sustainability is completely new
- NGS GreenSpec has provided an easy starting point
- For each trade there is a list of prompts
- Avoid those, consider this, recycle these, etc.

GreenSpec Home Page

GreenSpec

U Ventilation/Air Conditioning Systems

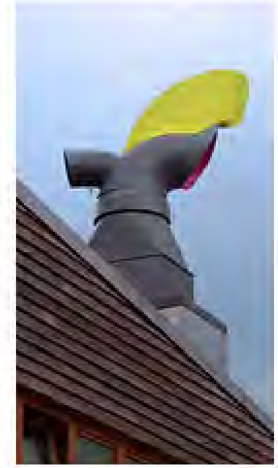
Contents

U10 General Ventilation Supply/Extract

CONSIDER:
• Passive ventilation systems - but heat recovery is essential.
• Wind pressure driven air in and out with heat recovery is good as it avoids mechanical assistance.

CHECKLIST CONTENTS:

U10 General Ventilation Supply/Extract



CONSIDER:

• Passive ventilation systems - but heat recovery is essential.
• Wind pressure driven air in and out with heat recovery is good as it avoids mechanical assistance.
• Passive or mechanical ventilation with heat recovery can extract heat from warm moist air to pre-warm fresh cool dryer incoming air.
• Overhead fans usually used for stirring warm air and driving it downwards may work in winter, but their use is doubtful in summer and will work against the stack effect used with passive ventilation in summer.

AIR AND WIND COOLING:

• The void below the building can be used to pre-cool the building overnight in summer through ventilation of the space or the floors themselves.

AVOID:

• Passive systems without heat recovery.
• Mechanical extraction without heat recovery.

U11 Toilet Ventilation

CONSIDER:

• Use wind driven air displacement systems with BedZED-type wind cowls

AVOID:

• Internal bathroom/toilets without windows/natural/passive ventilation.
• Mechanical ventilation except where smells/humidity will build up.

U12 Kitchen Ventilation

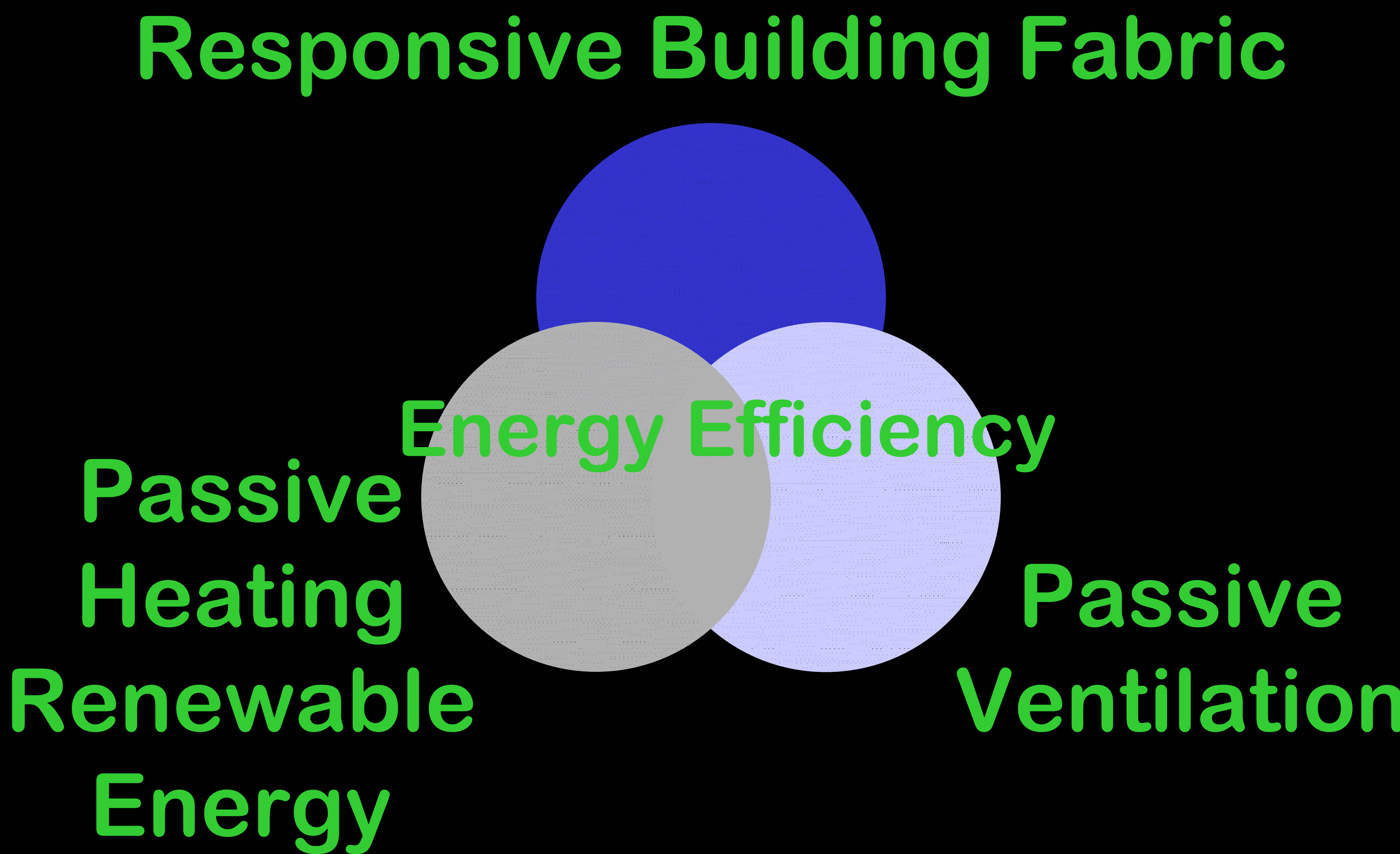
CONSIDER:

• Use wind driven air displacement systems with BedZED-type wind cowls

AVOID:

• Internal kitchens without windows/natural/passive ventilation.
• Mechanical ventilation except where smells/humidity will build up.

Integrated design

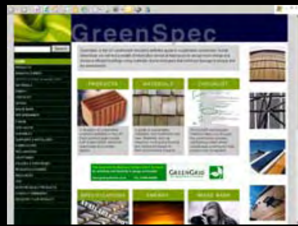


Fully Integrated Design

- Not only is it necessary to match up the building fabric with the method of heating and ventilation so they work well together
- Its is vitally important that the design disciplines work well individually on sustainability issues
- And that they work co-operatively towards a fully joined up design which works
- Moreover when the design works well it is vital to ensure that the designed building is constructed and not substituted or compromised by the constructor.

Integrated Design - half day seminar

- Building Regulations Part L of the, The Sustainable and Secure Buildings Act and the Code for Sustainable Homes,
- Professionals are encouraged to work closely across disciplines to address sustainable construction issues.
- Areas such as heating, ventilation and renewable energy technologies require a cross disciplinary approach to improve the chances of success.
- Lucy Pedler of The Green Register key drivers for sustainable construction and the 'circle of blame'.
- Celia Beeson (Sustainable City Team, Bristol City Council)
- James Howard (Urban Splash)
- Architect Craig White (White Design)
- Engineers - Andy Jarvis (Ernest Griffiths Consulting) and Tim Mander (Integral Structural Design).
- Reclaimed materials resourcer Nicole Lazerus (BioRegional) encouraging contractors to break out of their usual procurement routes.
- Contractor Andrew Pears (Kotuku) site waste management and reusing/recycling C&D materials.
- Jim Allen, Ellis and Moore engineers, moderator
- Opportunity to contribute to the discussion in breakout sessions
- Delegate feedback: "More of these seminars please!" "Brilliant mix of speakers"
- "Avoiding the pitfalls by listening to first-hand experience was very useful" "Do it again!"



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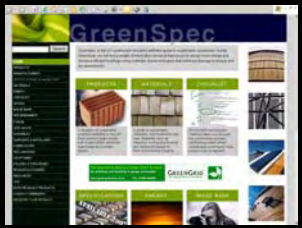
Green Solutions Energy Efficient Design

Commercial Green
Appropriate systems

Another GreenSpec CPD seminar to consider



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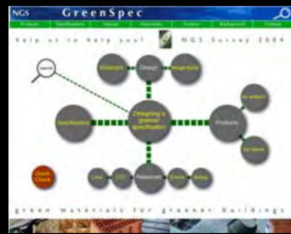
Energy Efficient Buildings Violet & Green Solutions

Another GreenSpec CPD seminar to consider



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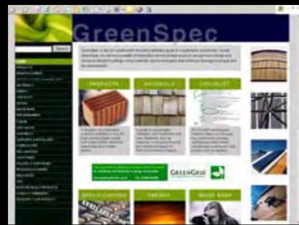
Specification Substitution

Case Lore, practices & pitfalls

Another GreenSpec CPD seminar to consider

Commercial Green

- Currently there are many technologies that are well understood but many are no longer suitable to tackle global warming
- We need to adopt new methods that are sufficiently well developed that their prices have reached commercial levels
- Some technologies are still immature and their prices reflect this
- Commercial Green is about finding the solutions that are for free:
  - e.g. natural ventilation and solar gains
- economic now:
  - e.g. Ground Source Heat Pumps & Solar Thermal hot water
- But not Photovoltaic: for some time yet unless an off-grid application.



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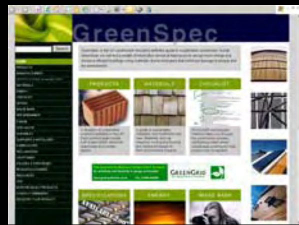
Commercial Green

© Andrew Pettifer
Gifford and Partners

Another GreenSpec CPD seminar to consider
And a paper on the website to read



COMMENDED
The UK eWell-Being Awards 2004
www.sustainit.org

www.greenspec.co.uk

Energy Refurbishment

Public and Private Housing
Industrial & Business Premises

Reduction in demand
Appropriate Improvements Appropriate
Commercial Installations

Another GreenSpec CPD seminar to consider

www.greenspec.co.uk

Extreme Energy Refurbishment

Emphasis on Energy

Another GreenSpec CPD seminar to consider

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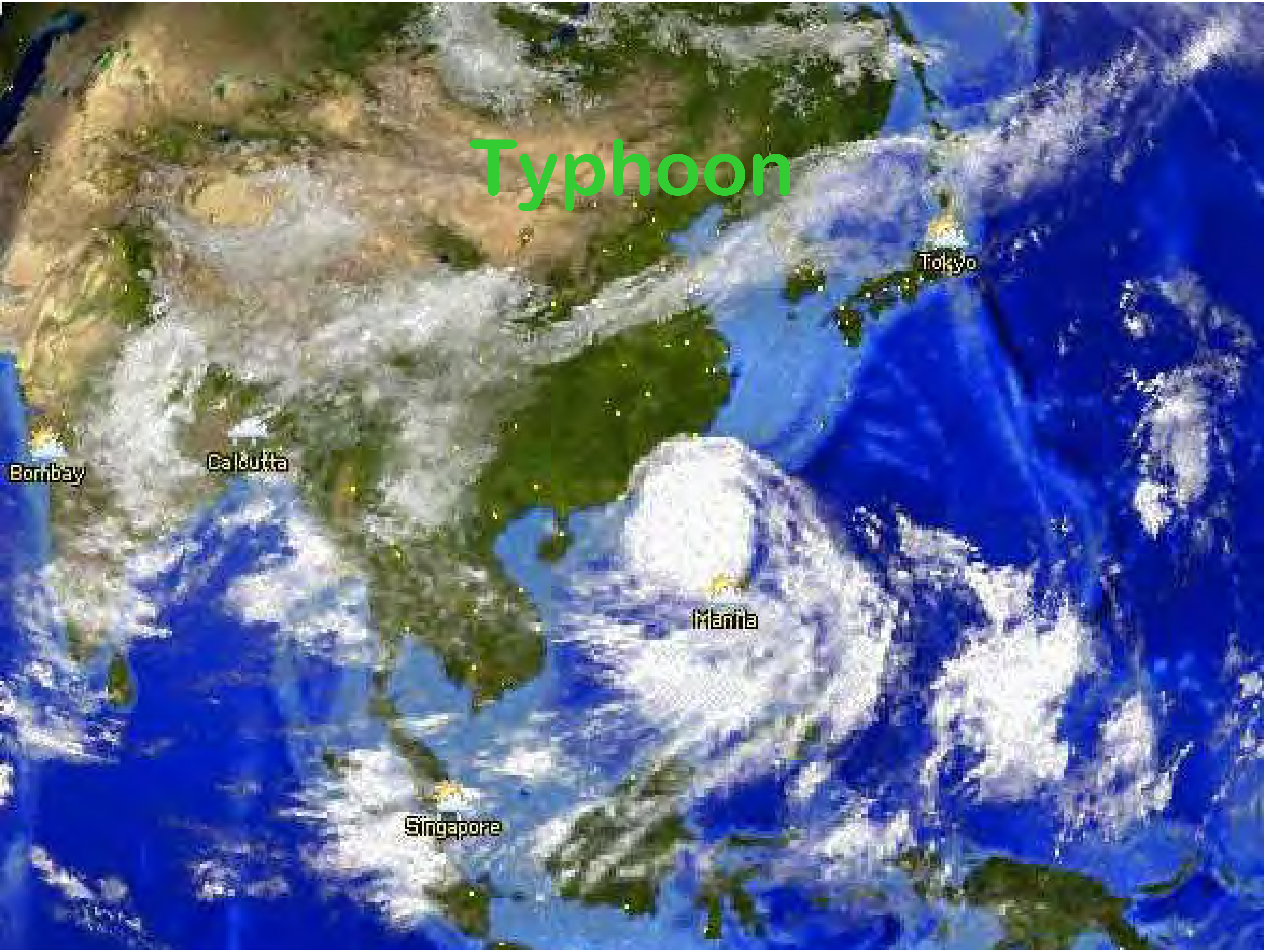
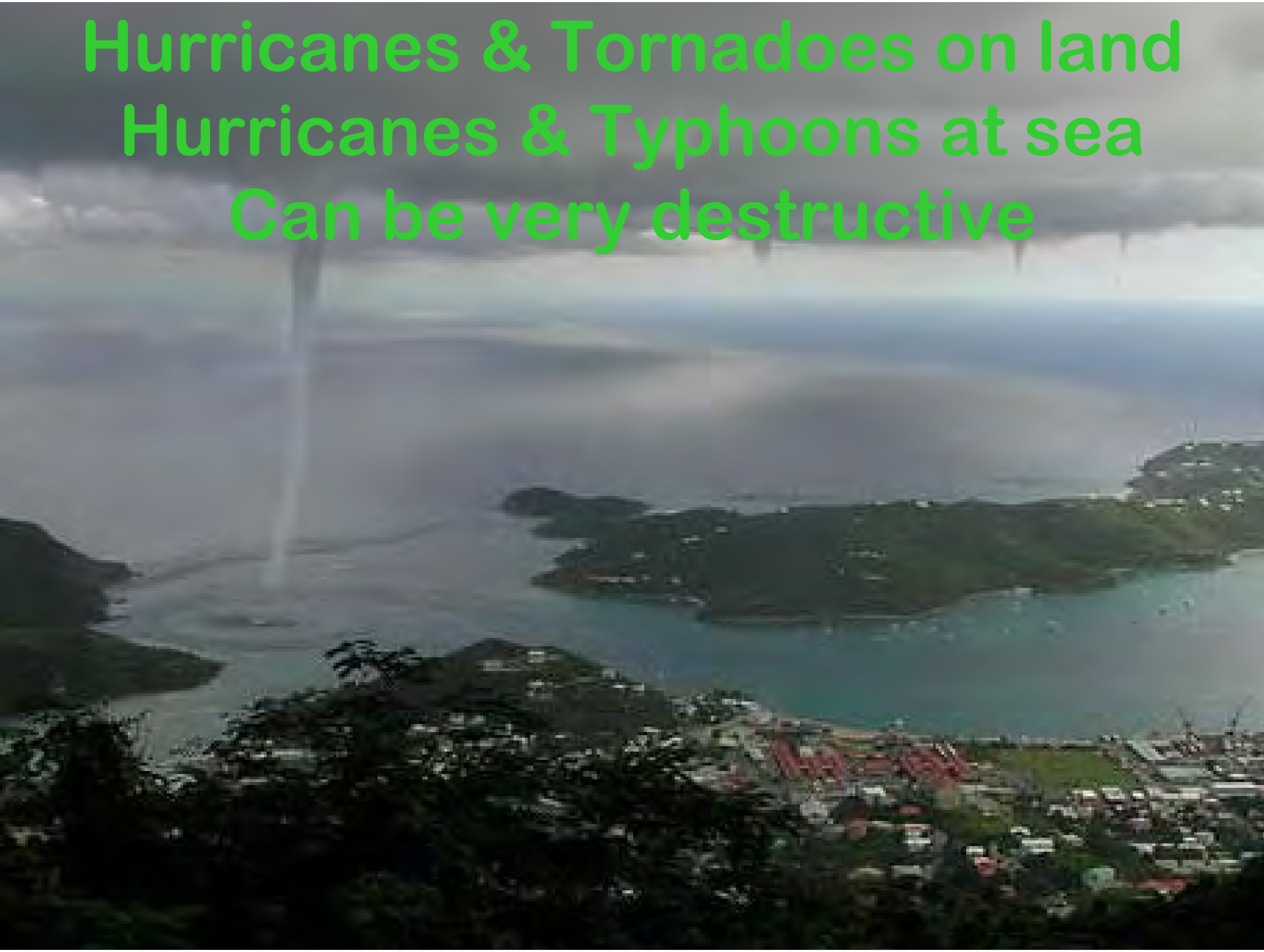
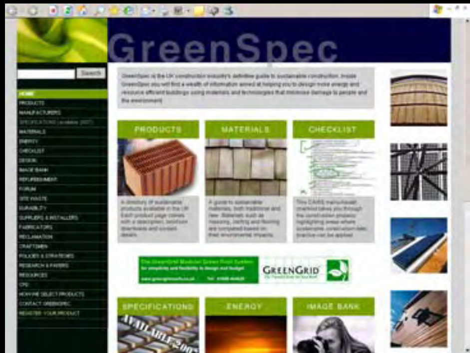
Climate is Changing


Weather
Moscow
Anchorage
45
Tokyo
30
Honolulu
Bombay
15
30
150
Manila
60
180
90
150
120
Rarotonga
15
30
Auckland
45

Typhoon



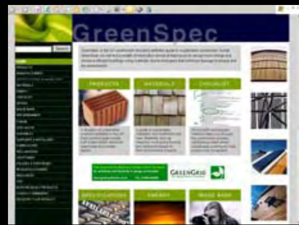

Hurricanes & Tornadoes on land
Hurricanes & Typhoons at sea
Can be very destructive



Climate Change

www.greenspec.co.uk

- As the climate changes it is anticipated that all natures forces we are familiar with will become more extreme:
- Stronger winds, dryer summers, wetter winters, more intense rainfall, etc.
- We need to design accordingly but also to try to mitigate the changes



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From Global Imperative To Material Choices

Another GreenSpec CPD seminar to consider

Global Warming

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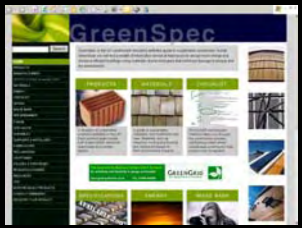
- The consequences are already showing up on a regular basis, not just across the world, but increasingly in Europe and the UK.



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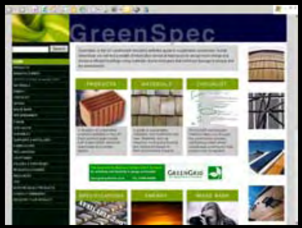
Consequences of no action

Another GreenSpec CPD seminar to consider

Future Proofing

- Reliance on fossil fuels which release carbon dioxide and other green house gasses is futile
- Multi-fuelled boilers that can change over to biomass and bio-diesel fuels as they become available is okay
- Making provision for the addition of renewable heat and energy generation will make their addition feasible and economical
- Not being reliant on the need for heating and cooling at all is better still



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Climate Change Readiness

Future Proofing

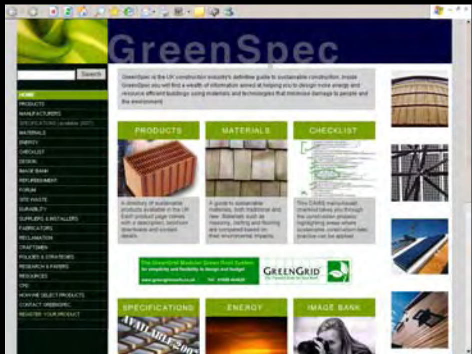
Another GreenSpec CPD seminar to consider

Test Yourself Part 1

- When would Performance Drawings be appropriate?
- How will climate change affect the elements that affect buildings?
- What things can be done to future proof buildings against climate change?

How did you do? Part 1

- In Design and Build or when the specialist subcontractor has to complete the design
- We can expect to see more extreme wind and weather patterns in the future
- Use of multi-fuel boilers and avoidance of need for heating and cooling



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Wind

Affects on buildings

Wind

- Wind can be very destructive
- Wind can be beneficial if we know how
- Wind brings clouds, rain and fresh cooling air
- We can use wind to dry crops and clothes
- Rain is good for crops, washing and a source for drinking water
- Wind can drive water pumps and turbines (electricity generators)

Barn doors opposite for wind to separate threshing from seed

Threshold holds thresh at door

Grain Barn

perforated walls let wind dry grain

Outskirts of Sandy Bedfordshire

Listed Grade I Barn
slot windows ventilate cattle stalls

Wiltshire

Untreated Unseasoned Unfinished Durable Species Boarding.
Tall plinth protects timber from ground water.
Irregular pavement protects from rain splash.
Wind & air dries timber

Aberystwyth Arts Centre: Architect: Smith Roberts: Peter N Roberts

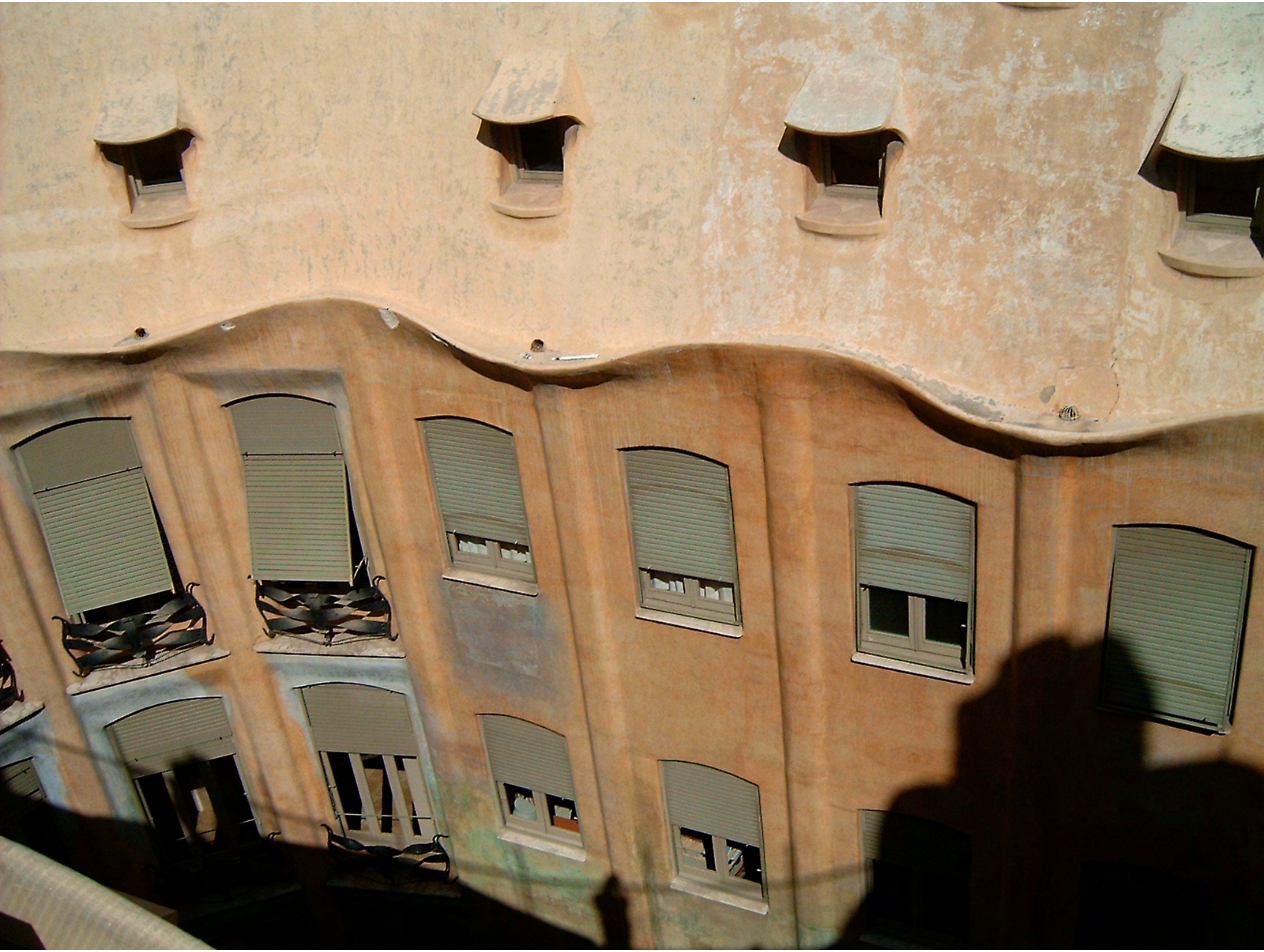
Wind shelter: Buildings

- Buildings create some shelter on the leeward side away from the wind
- But create strong winds around sides and down alleyways between
- Wind direction changes: sheltered spot moves
- Prevailing wind usually from SW in UK means shelter is usually on the NE
- Ensuring solar penetration into the sheltered spot is not always easy

Wind shelter: Courtyards

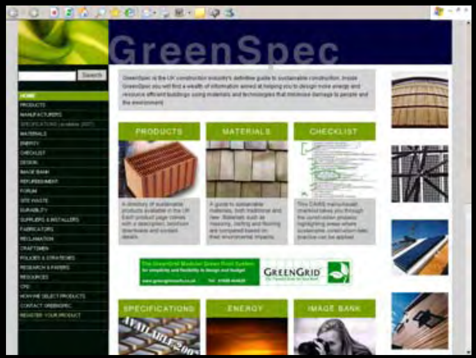
- Courtyards create shelter most of the time from most directions
- Courtyards need views out and they can provide routes for fresh air if too sheltered
- Air could become stagnant if too sheltered, too deep or two narrow
- Tall, small area courtyards are light wells used for light and ventilation

Courtyard Shelter & Sun penetration



Wind shelter: Towers

- Smaller buildings on the windward side of nearby Towers push the air flow up so it hits the tower and spreads in all directions
- The down drafts can be considerable stronger than the original wind
- Edie currents are set up around the edges of the tower
- Creating a hostile environment that can be dangerous for pedestrians
- Podium, Shelf, Skirts around the towers above pedestrian level will deflect much of the wind and create a comfortable place to walk and linger.



National Green Specification

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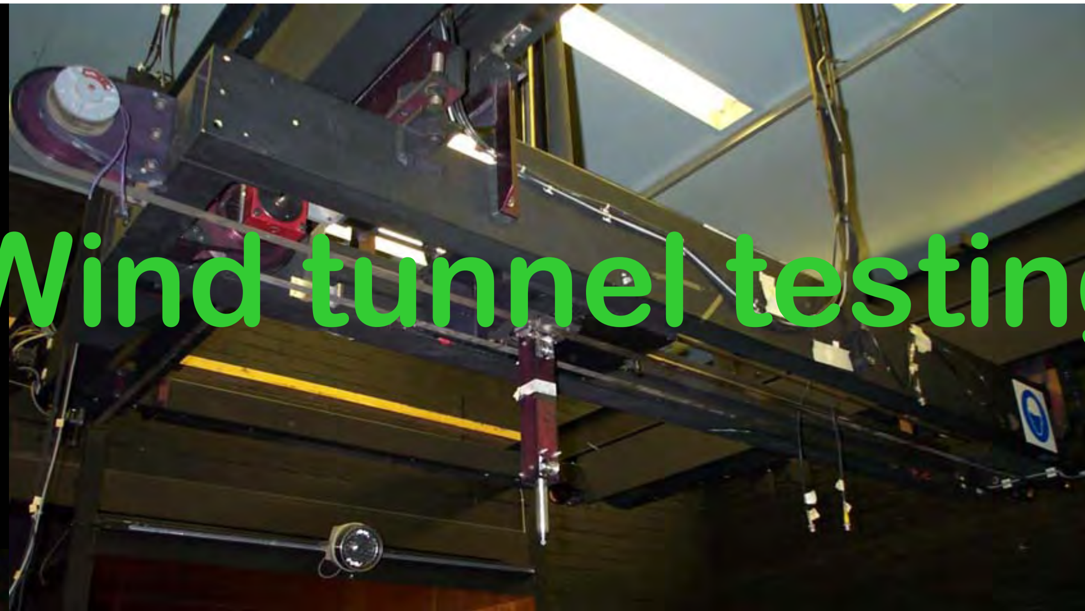
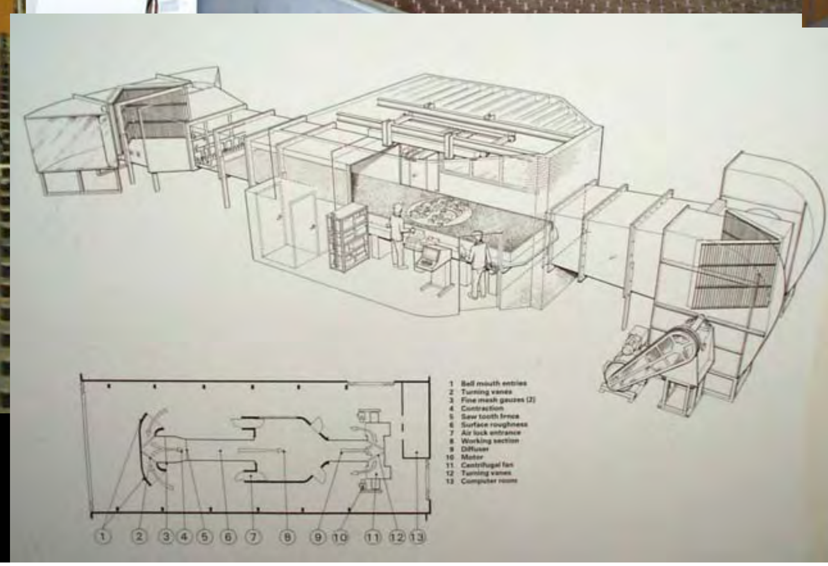
Wind Tunnel Testing

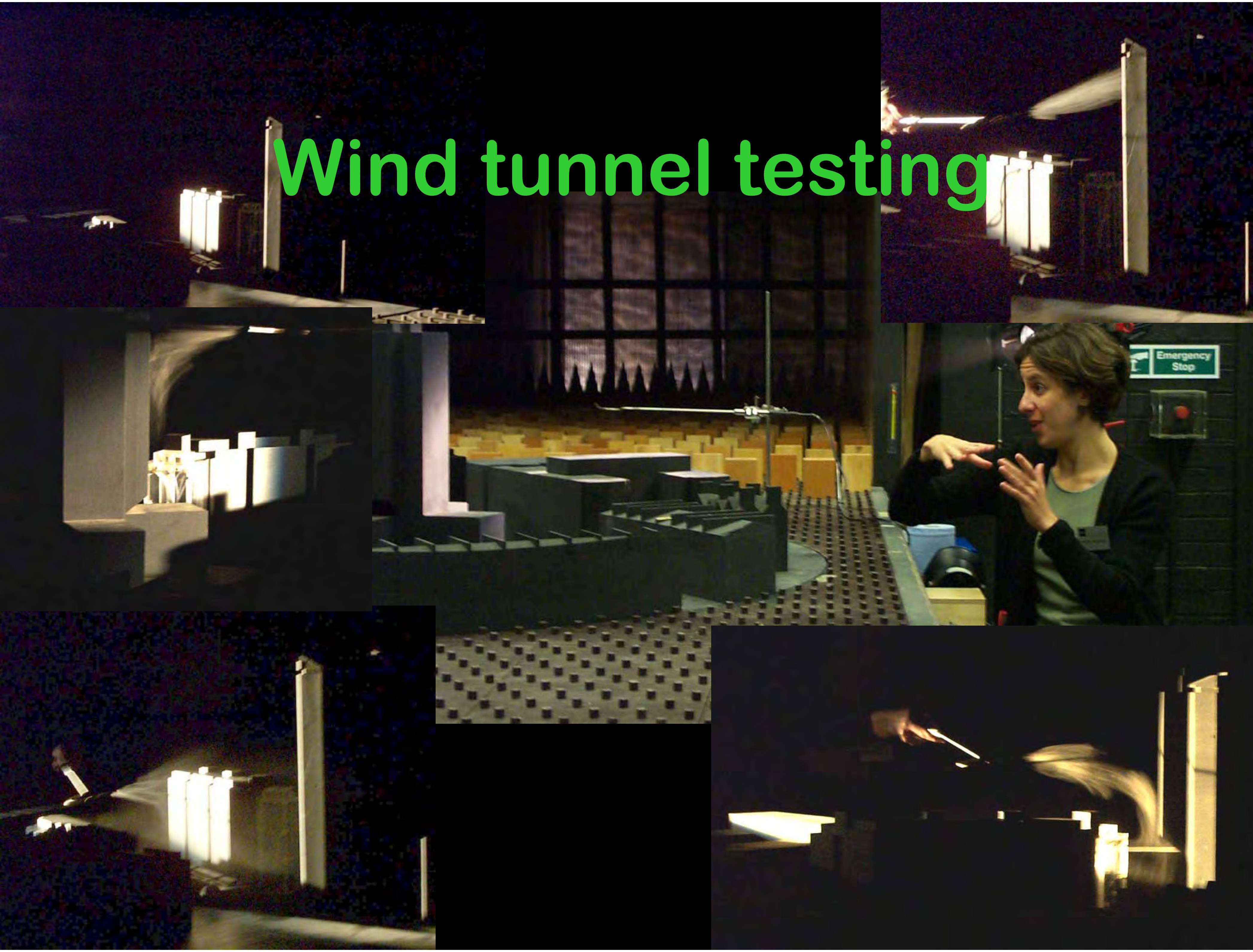
Renewable Energy: Wind

Wind tunnel testing



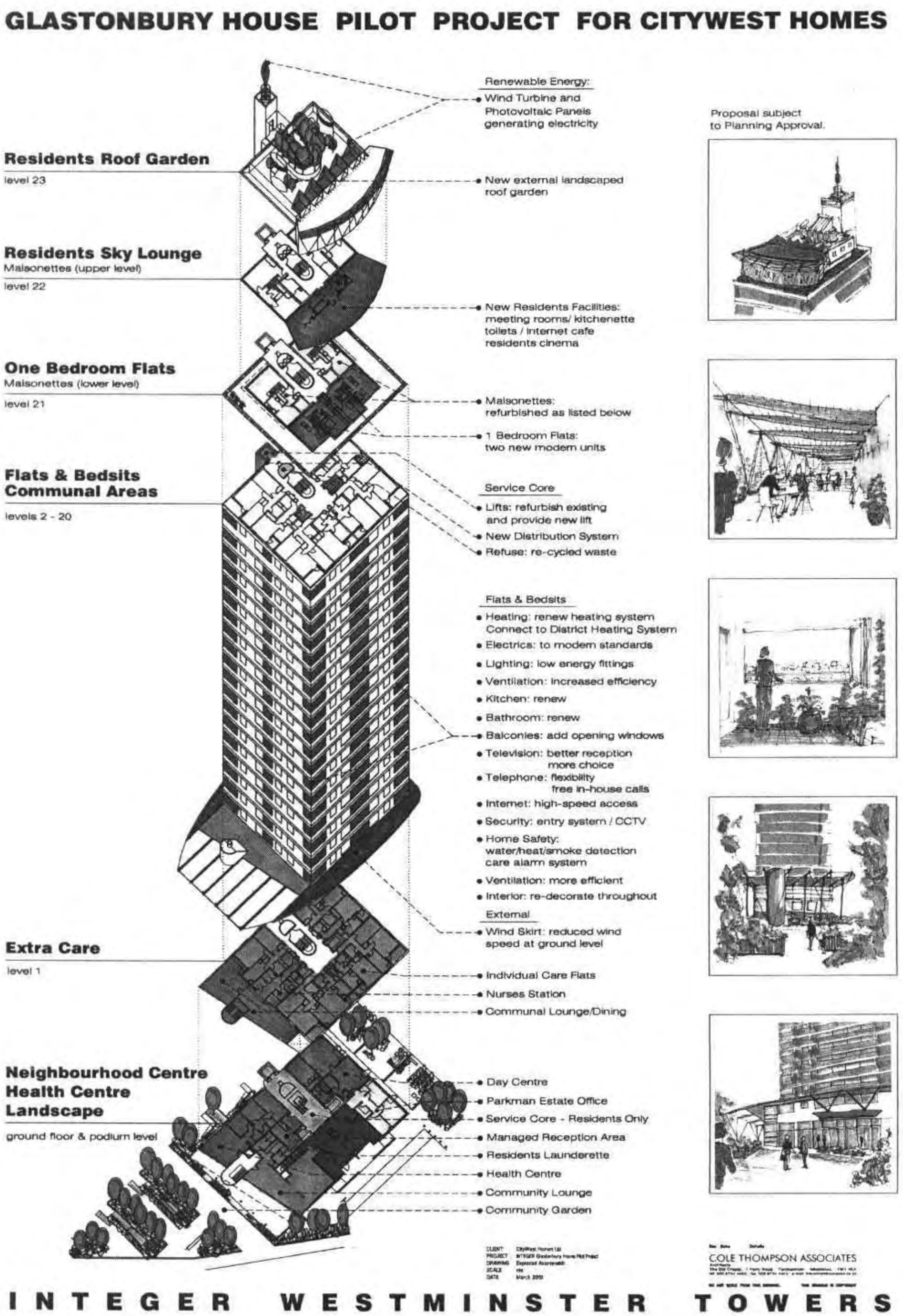


Wind tunnel testing



Towers: turbulence at ground level

Hostile Wind Conditions



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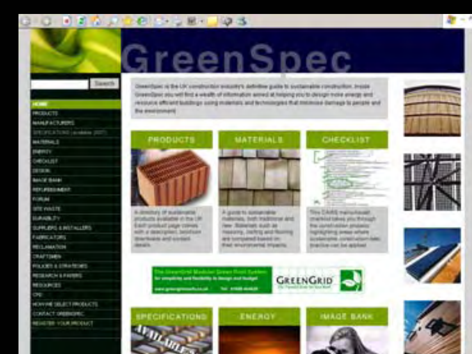
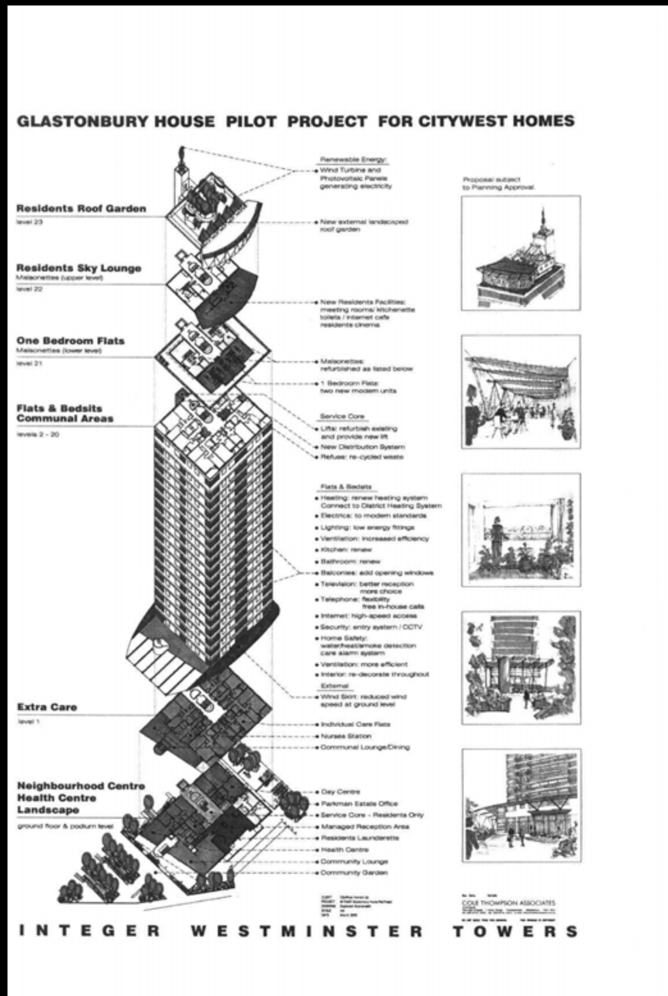
21st C Refurb

1NTEGER

Intelligent and Green 1960's Tower





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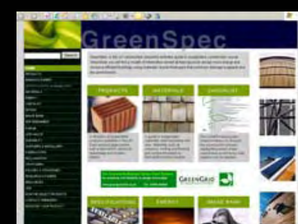


Another GreenSpec CPD seminar to consider

No corners
less resistance
less turbulence
less eddy
currents
No Shelf needed

Wind Orientation: UK

- SW prevailing wind from Atlantic Gulf Stream warm and/or wet, mild in winter
- Northerly cold winds in winter
- Easterly from Mainland Europe very cold and snow bearing in winter
- Southerly warm dry, occasionally sand bearing in summer

Wind orientation: Buildings

- Turn the building away from the northerly cold winds
- Less windows, doors and air bricks on the northerly side
- Well insulated and airtight walls to the northerly winds
- Courtyard buildings protect from the winds

Wind shelter: Landscape Trees

- Local trees, hedges and bushes have a sheltering effect on a building
- They are permeable so most wind passes through and some goes over and around
- It takes some of the pressure out of the wind without too much disturbance
- Deciduous trees to the east, south and west, coniferous to the north
- Fences being solid disturb the air flow

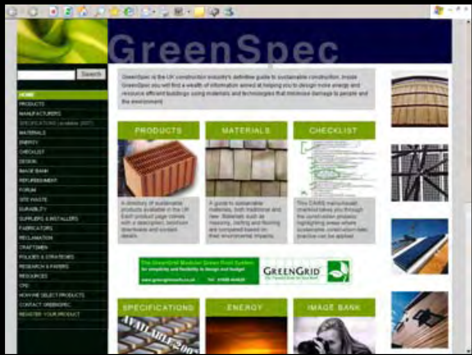
Wind shelter: Creepers & Vines

- Offer little effect on wind loading
- But create a micro-climate sheltering the wall
- Shelter from rain, wind and sun
- Haven for insects, spiders, bugs, birds

Micro-climate & Sheltered space

Trees: Wind shelter, summer solar shading, winter solar penetration

RHS Wakehurst Place Visitors Centre Walters & Cohen



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Wind Turbines

Wind turbines:

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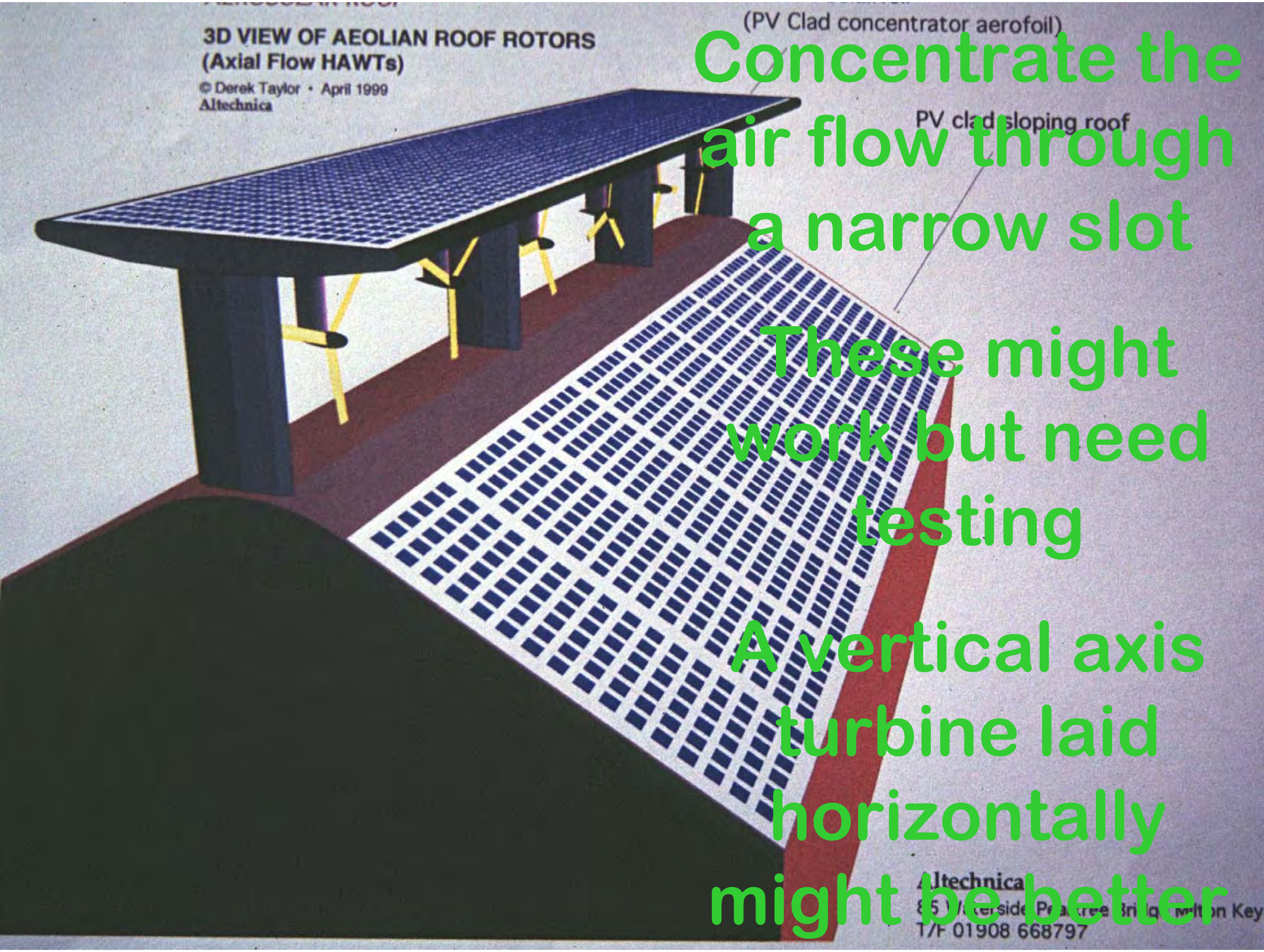
- Attached to building: rarely work efficiently
- Close to buildings: same applies
- Need to be outside of the bubble of displaced air around the building
- High enough or far enough away to receive clean undisturbed air flow

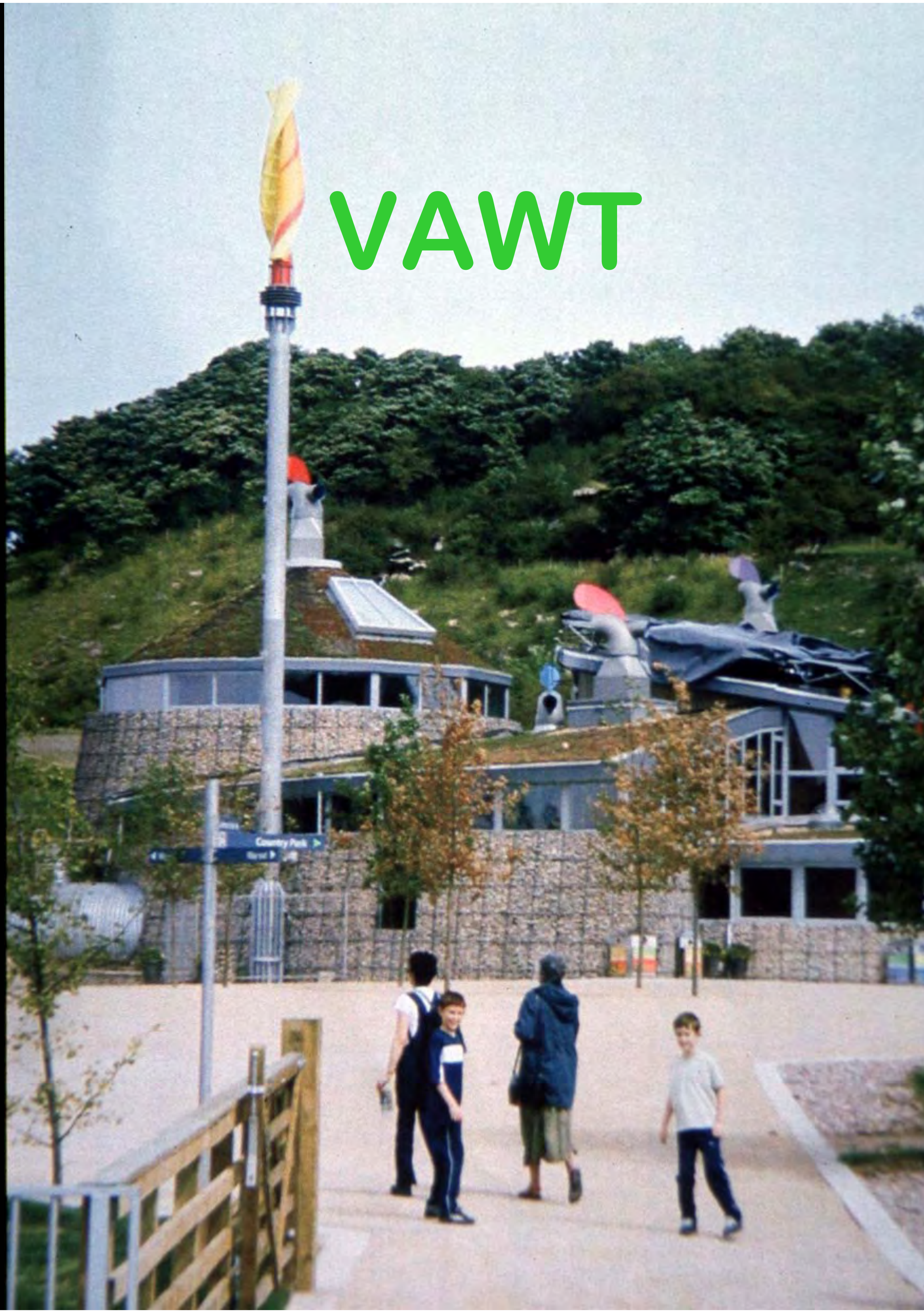
Wind turbines on buildings

Don’t work efficiently close to disturbed air flows

Wind turbine

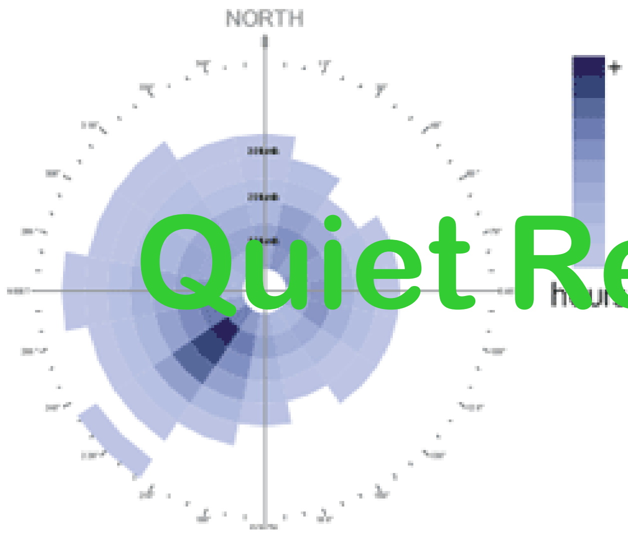
Wind turbine


3D VIEW OF AEOLIAN ROOF ROTORS
(Axial Flow HAWTs)
© Derek Taylor • April 1999
Altechnica
(PV Clad concentrator aerofoil)
PV clad sloping roof
Concentrate the air flow through a narrow slot
These might work but need testing
A vertical axis turbine laid horizontally might be better
Altechnica
T/F 01908 668797


VAWT

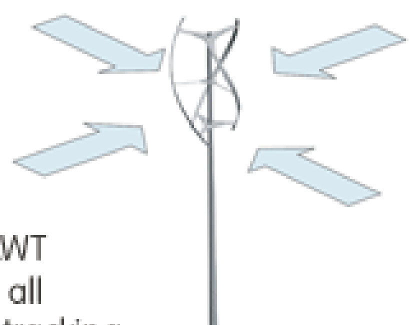

A Vertical Axis Wind Turbine on a tall post
Earth Centre
Doncaster

Quiet Revolution™ by XCO_2

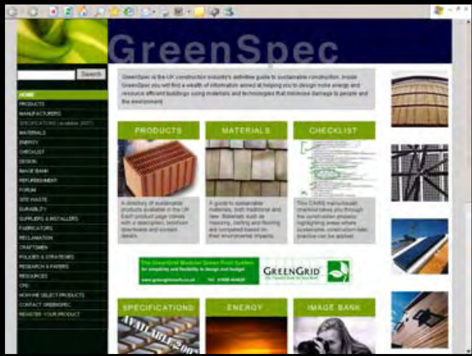


typical U.K. wind distribution

traditional HAWT
has to rotate to track wind



quiet**revolution** VAWT
collects wind from all
directions without tracking



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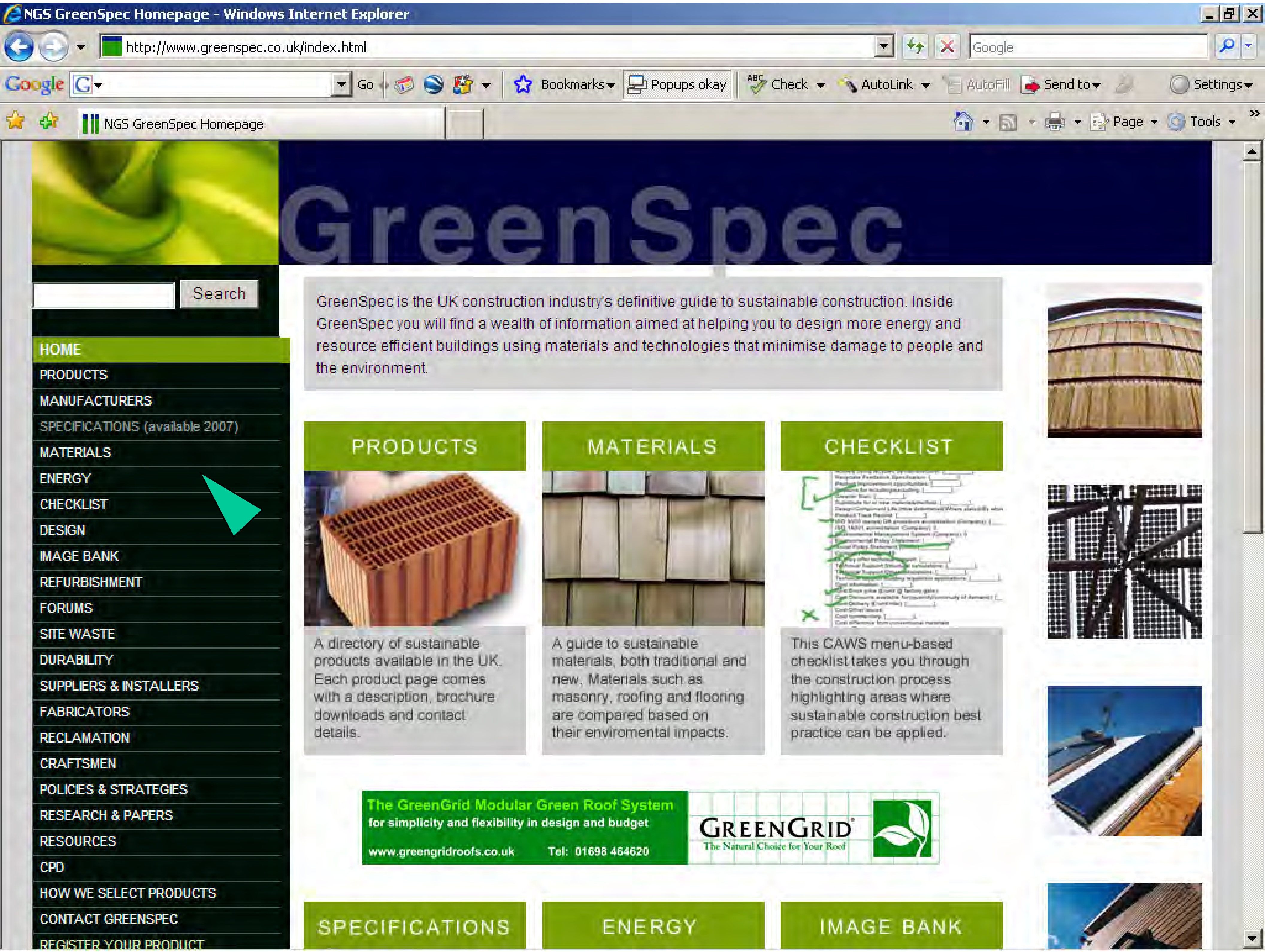
Renewable Energy: Wind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GreenSpec is the UK construction industry's definitive guide to sustainable construction. Inside GreenSpec you will find a wealth of information aimed at helping you to design more energy and resource efficient buildings using materials and technologies that minimise damage to people and the environment.
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PRODUCTS
A directory of sustainable products available in the UK. Each product page comes with a description, brochure downloads and contact details.
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A guide to sustainable materials, both traditional and new. Materials such as masonry, roofing and flooring are compared based on their enviromental impacts.
CHECKLIST
This CAWS menu-based checklist takes you through the construction process highlighting areas where sustainable construction best practice can be applied.
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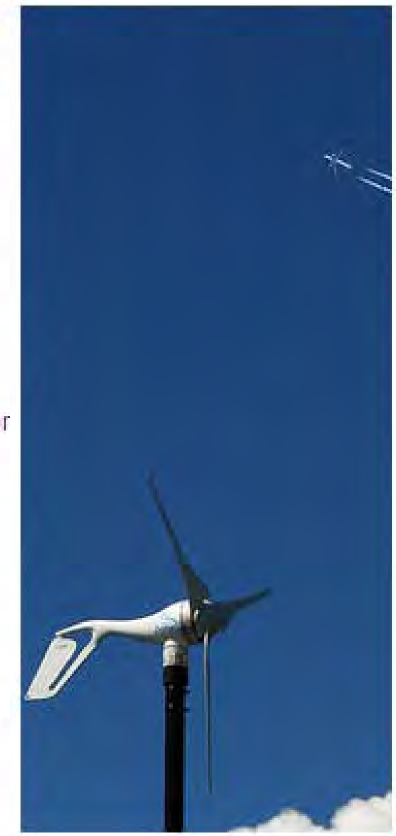
Energy - Contents

ENERGY CONTENTS

Small scale wind turbines 1 - 6kW

1 Introduction



Of all renewable energies, wind power holds the most promise to make a significant impact on reducing carbon output. The UK is the windiest area of Europe. Commercial windpower, produced by turbines rated at between 1 – 2.5 MW, currently accounts for around 2 GW capacity in the UK. This is expected to expand to 8GW by 2010. The Sustainable Development Commission further estimates that a combination of onshore and offshore generation could theoretically produce a 'practical' maximum of 150,000 gigawatt hours. This figure is just less than half the 345,000 gigawatt hours consumed in the UK in 2005.

Whereas the dynamics of wind power generation are reasonably transparent at the large commercial scale, the same cannot be said for the domestic scale. The current market is marked by turbine performance claims and counter-claims. Most of the take-up of this generation of turbines has been from urban householders keen to cut their electricity bills and/or to do their 'bit' for climate change. The sad fact is that for many their first experience of 'micro generation' has been anything but happy with actual performances often dramatically undershooting expectations.

If used appropriately, domestic wind turbines can generate useful electricity that would otherwise be drawn from the grid - thus reducing the carbon footprint.

For the majority of property owners living in urban areas, installing wind turbines on or close to buildings with overall windspeeds of less than 5m/s is probably not a realistic proposition. Electricity generation will be disappointing and pay-back periods are likely to recede into the distant future.

2 Siting

• **wind power $\propto$ wind speed^3** (eg 2x the wind speed provides 8x the power)

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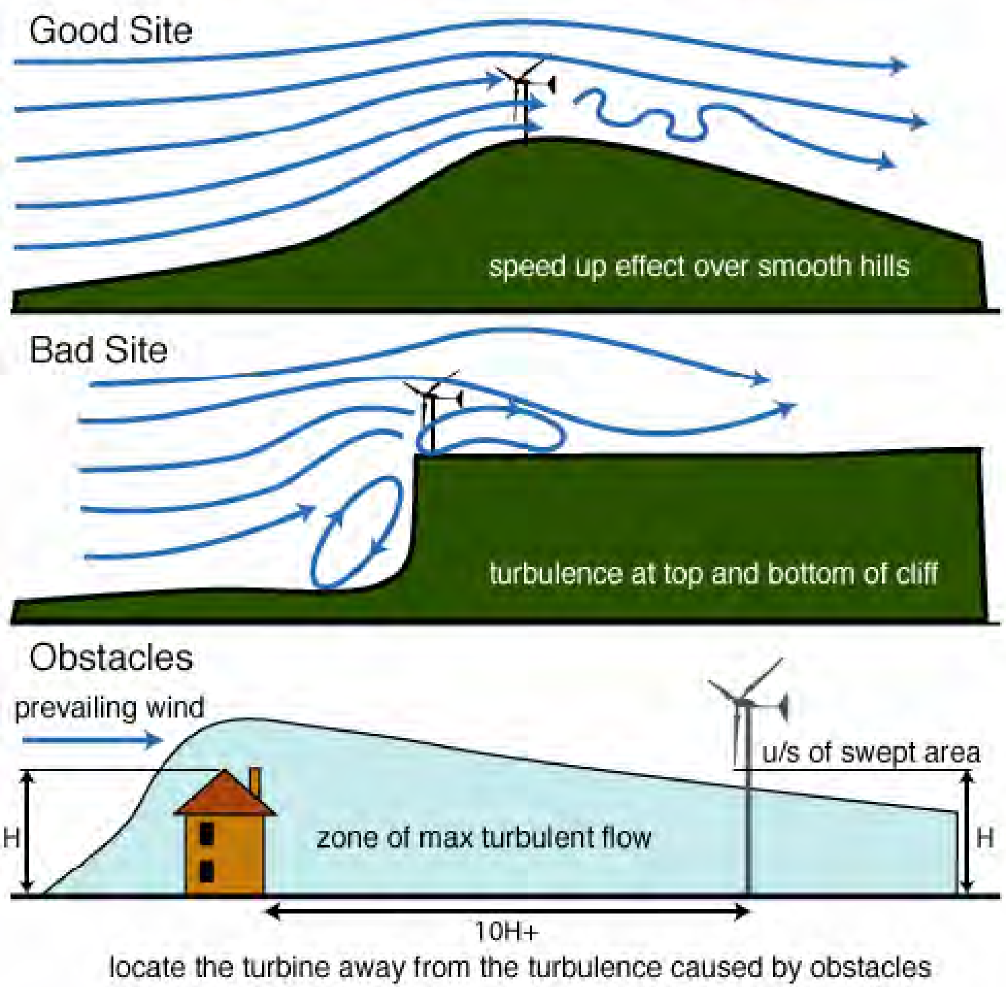
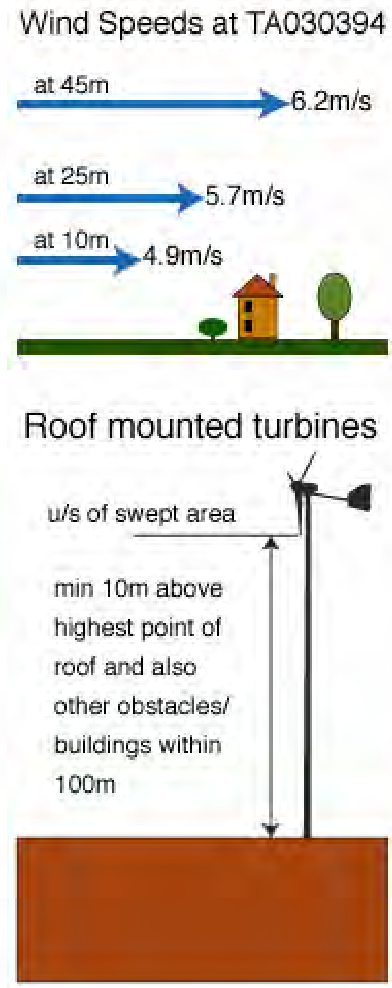




3 Turbine output

Determined by:

1 Quantity of wind at hub height

• Overall windspeeds for a particular site can be found here at the DTI wind data site. Note that these speeds are an overall average for the area. Particular sites can vary according to local topography.

• Frequency Distribution: The number of hours that the wind blows at different speeds. This distribution will be different for each site. When calculating output a mathematical function known as

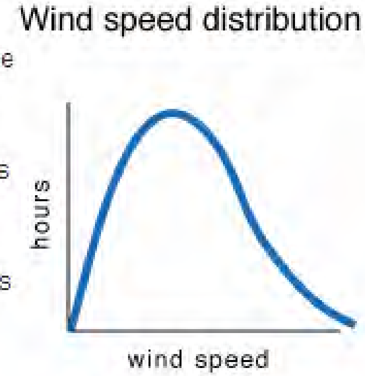
Wind speed distribution

1 Quantity of wind at hub height

• Overall windspeeds for a particular site can be found here at the DTI wind data site. Note that these speeds are an overall average for the area. Particular sites can vary according to local topography.

• Frequency Distribution: The number of hours that the wind blows at different speeds. This distribution will be different for each site. When calculating output a mathematical function known as the 'Raleigh Distribution' is used (The Raleigh distribution is a special case of the Weibull distribution which is commonly used for approximating the wind speed probability distribution.

• When designing for an obstacle-rich environment, the height of the obstacles effectively represents ground level for wind speed calculations.



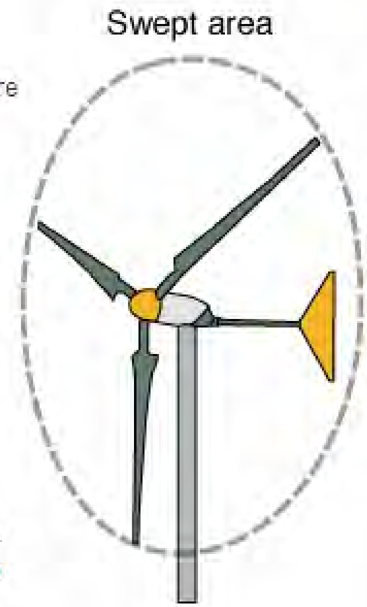
2 Quality of wind

• Obstacles cause turbulence. Turbulence reduces the efficiency of a turbine.

• Ensure that the turbine is set at a height above ground level to avoid turbulence.

• Consider too the direction from which the prevailing wind flows. Obstacles in the path of the prevailing wind are more important to avoid than obstacles in other areas of the wind rose.

• When finely calculating turbine output the nature of the landscape over which the wind travels is considered. This is known as 'Roughness'. It is rated in terms of class with values from 0 to 4 where the sea's surface is '0' and a landscape with many trees and buildings is '4'.



3 Losses due to yaw

• Consider the site's proclivity to wind gusting. Conventional turbines need to turn into the wind to function. Gusts of wind can move a turbine (yaw) erratically around its axis but do little to generate power. Worse, they can seriously contribute to mechanical failure.

4 Swept area of the rota

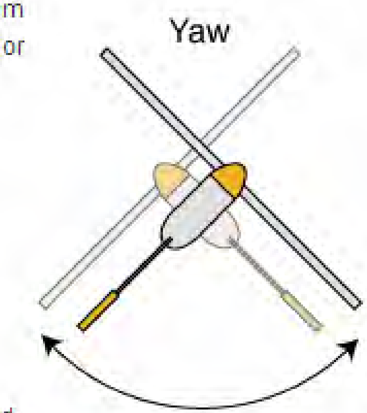
• The swept area of the rota determines the energy capture of the turbine.

• note that the area is not necessarily linked to the size of the generator – the generator cannot generate more power than the rotor can capture. This should be considered when examining manufacturers' output claims.

5 The efficiency of the blade design.

• The maximum efficiency of a turbine in capturing energy from the wind is determined by Betz' Law. The law states that a design can only convert a maximum of 59% of the kinetic energy in the wind to mechanical energy.

• The efficiency of the turbine is determined by the design of the rotor blade. In practice the maximum efficiency obtainable at optimal rotation speed (the aerodynamic power coefficient) is nearer 35% (or 0.35) with efficiency dropping off either side of that speed.



6 Efficiency of the generator

• Generators convert rotational to electrical energy. This process results in energy loss.

• The generator's resistance to the rotor implies that the rotor will only start spinning at a certain speed, this is known as the 'cut in' speed and is usually much lower than the optimal speed at which most power is generated.

7 Cabling losses

• Energy is always lost through transmission (a fact well-known about the national grid).

• Cabling should be carefully specified and designed to minimise losses over distance.

• There is a difference between cabling designed to deliver power to a battery and cabling designed to link in with a grid (ie either directly to a domestic distribution unit or larger grid).

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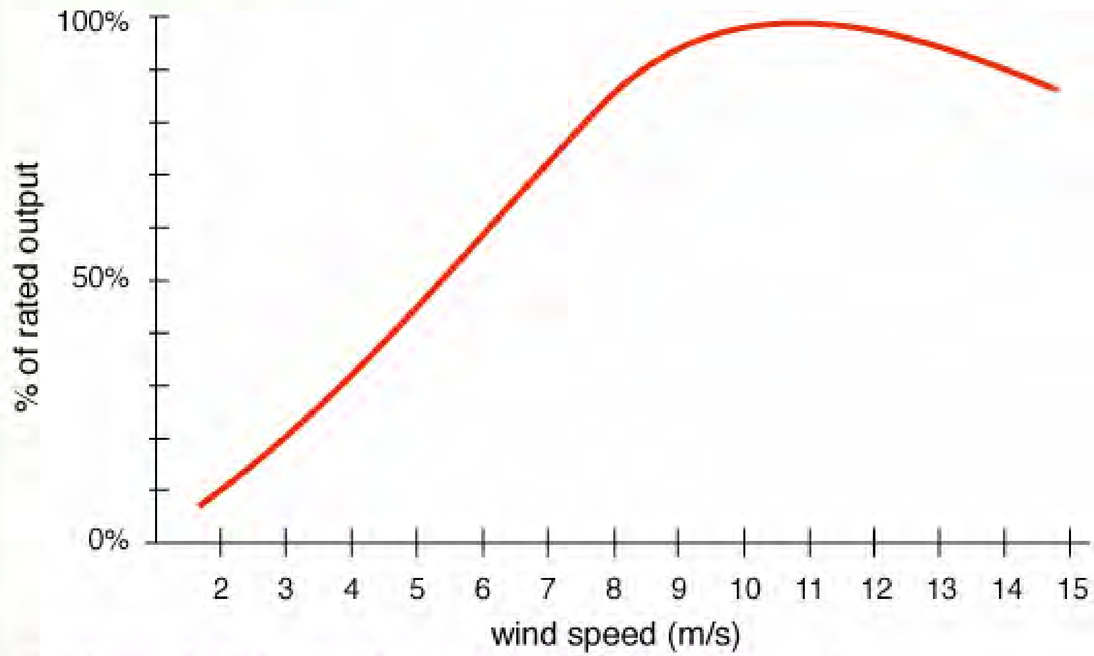
8 Conversion and conditioning losses

• Turbines connected to batteries energy a voltage regulator is used to prevent overcharging. Energy is lost both in this process and that of exporting the DC supply through an inverter for domestic AC use.
• Likewise turbines that are grid connected require the energy to pass through a grid controller, an isolator and then to a synchronous inverter – all leading to a reduction in energy delivered.

The 'Power Curve'

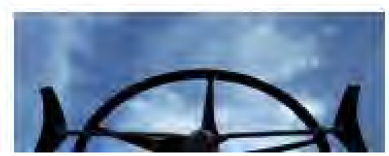


• To determine the likely output of any one turbine, a 'Power Curve' is used.
• The power curve illustrates the power output at a given wind speed.
• The power curve is distinctive for every model of wind turbine.
• A power curve should be calculated by an independent third-party.

Calculating the power output

A- Using the DWIA calculator

• For accurately determining the likely output from a turbine use the Danish Wind Industry Association's power calculator (www.windpower.org/en/tour/wres/guidep.htm). The calculator works by combining the turbine's power curve (above) with the distribution of wind speeds at a



Calculating the power output

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• Multiplying the average output by the number of hours in the year (8,766) will give the total energy output for an average year.

or B Using power output equation

• **Output** = CPoa x A x PA x G

Where:

- CPoa is the aerodynamic power coefficient (efficiency of the rotor to convert energy)
- A is the swept area of the blade
- PA is the power density of the wind = 0.6125 x S^3 where S is the wind speed in m/s
- G is the generator efficiency

• *Example:*

For a turbine with a 1.75 diameter rotor at a wind speed of 10m/s with a power coefficient of 0.35 (generous!) and a generator effiency of 90%:

Output = 0.35 x (3.1416 x $(1.75/2)^2$) x (0.6125 x 103) x 0.9 = 464W

Using the same equation but for a wind speed of 5m/s would give an output of 58W

• **Annual output** = output at average wind speed x 1.9 (wind speed variation function) x 8766 (hours in the year)

• *Example:*

Following on from the above example, the annual output for a turbine with 1.75 diameter rotor at an average overall windspeed of 5m/s would be:

Annual output = 58 x 1.9 x 8766 = 966,000 W or 966 kWhrs/pa

4 Assessing manufacturers' claims

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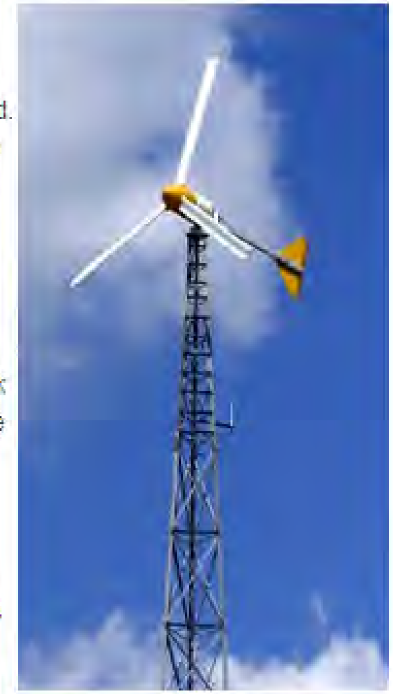

The output 'Rating'

• The turbine manufacturers rate their turbines as providing a certain output at a given wind speed. Some rating definitions are those wind speeds providing maximum output whilst others are less than maximum outputs at different wind speeds. There is no industry standard.
• The rating for a turbine is unlikely to be an indication of its actual energy production.

Checking the claimed output rating against the likely efficiency

We know from the above that the maximum practical efficiency is around 35%. Most turbines work at efficiencies of between 22% - 31% at 10m/s and between 17% - 26% at speeds of 12m/s. If we take the manufacturers output rating for a given wind speed and insert it into the above output equation and calculate the assumed efficiency, we can judge the manufacturer's claim.

• *Example:*
If a manufacturer of a 1.75m diameter turbine claims a rating of 1kW for a wind speed of 12.5m/s, we can easily determine his assumed efficiency:
CPoa (Efficiency) = Output / A x PA x G
= 1000/(3.1416 x (1.75/2)2) x (0.6125 x 12.53) x 0.9
or 38%

38% is a long way off from the circa 26% max. expected from others at the same wind speed!

Checking the annual % of household electricity consumption

By calculating the annual expected actual output from a wind turbine, it is then but a short step to be able to determine the likely percentage of household electricity consumption that the turbine will provide.

• *Example:*
Taking the above example of a 1.75m diameter turbine. We have calculated, given generous parameters, that the turbine could be expected to provide around 966 kWhrs/pa at an average overall windspeed of 5m/s. Let us assume that the annual domestic consumption is around 5,000 kWhrs/pa. Then the % of annual consumption to be reasonably achieved would be:

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966/5000 x 100 = 19%

This can be easily compared with the manufacturer's claim.

Costs and Savings

a Darius rotor

• The installed costs of small scale turbines can vary from around £2,500 for a 1.5kW rated turbine though to around £5,000 for a 5kW.
• The payback time is the amount of time it takes to pay for the installation through electricity saved from the grid – a time after which electricity becomes free. The payback time is depends on the initial installation cost, the price of electricity and the power output from the turbine.

Example:
Taking the above example of a 1.75m diameter turbine generating a realistic 966 kWhrs/pa at an average wind speed of 5m/s and given the current cost of electricity at around 12 pence per kWh the payback time would be calculated as follows:

966 x 0.12 = £115 saved per year (excluding maintenance)
Therefore the number of years required to payback = £2,500 / 115 = 21 years.

21 years might be close to or exceed the life expectancy of the turbine.

• However, it should be noted that this calculation is based on current purchase and installation costs along with current electricity prices.
- Higher average wind speeds would reduce the pay back period.
- In the near future unit costs are expected to reduce and electricity costs are likely to rise.

Wind Tubine products

L742 wind turbines / generators - including Windsave, Iskra and Swift turbines

Downloads

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Downloads

• Wind Power in the UK - *Sustainable Development Commission, 2005* (pdf)
• Small Wind Energy Systems - *British Wind Energy Association, 2006* (pdf)
• Potential for Microgeneration, Study and Analysis - *DTI, 2005* (pdf)

Further information

• British Wind Energy Association
• Danish Wind Industry Association - everything you ever wanted to know about wind energy

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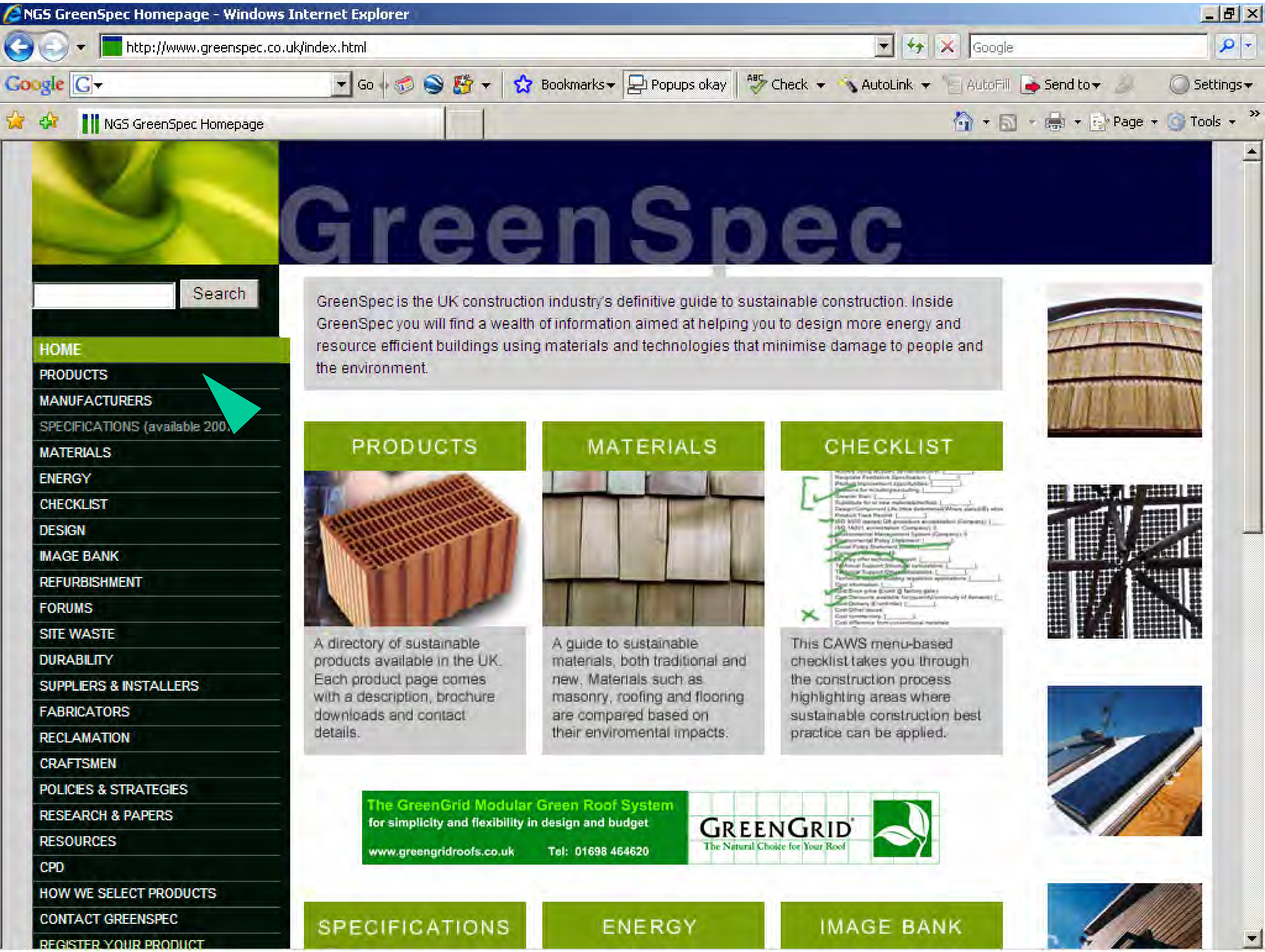
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L3 Structural and space division
L4 Access, barrier and circulation

L742 Transformation devices

wind turbines / generators

Manufacturer	Product	Type	
Swift Turbines	Swift Rooftop Wind Energy System	1.5kW wind turbine	✓
Iskra	Iskra AT5-1	5kW wind turbine	✓
Windsave	Windsave	1kW wind turbine	✓

photovoltaic cells / coverings, modules, glazing

roof coverings

Manufacturer	Product	Type	
Atlantis	Sunslates	PV slate, 13.3W output per tile	✓
Uni-Solar	Solar Shingles	PV slate, 17W output per tile	✓
solarcentury	C21e: Solar electric roof tiles	PV slate, 52W output per tile	✓

modules

Manufacturer	Product	Type	
Sanyo	HIP-200, HIP-205, HIP-210	PV modules, monocrystalline, 200, 205 & 210W ratings	✓
Sharp	80W, 123W, 160W, 165W PV modules	PV modules, polycrystalline, 80, 123, 160 & 165W ratings	✓
	'175W & 185W PV' modules	PV modules, monocrystalline, 175 & 185W ratings	✓
solarcentury	Solar Electric 'Sunstation'	PV roof module system for domestic use	✓
Uni-Solar	Framed Solar Modules	freestanding PV framed modules 62W & 124W ratings	✓
	Flexible Solar Laminate	flexible PV laminate with a 5, 11 & 32W ratings	✓
Kaneka	Kaneka 60W	Roof-mounted PV thin-film module, 60W rating	✓

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Iskra AT5-1

5kW wind turbine

The energy capture of the Iskra AT5-1 turbine is unusually high at low wind speeds, thus making wind energy generation feasible at locations where the average wind speed is low.

At a particular location, the wind speed will vary about an annual mean value. The expected energy yields for the AT5-1 at various annual mean wind speeds (AMWS) have been estimated, based on the measured power curve.

Figures show that the the performance of the AT5-1 exceeds that of other machines in its class. Put into perspective, the annual electricity consumption of a medium size home is in the region of 4 to 6 MWh. This is equivalent to a daily consumption of 11 to 16 kWh.

Clearly, therefore, an AT5-1 wind turbine is capable of keeping domestic or small commercial premises fully supplied with electricity. It can also make a substantial contribution to the needs of larger consumers, such as farms, visitor's centres, campsites etc. '

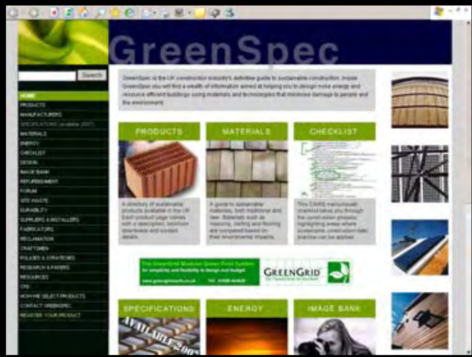
Manufacturer's evidence rating:*	★
Material/s:	blade: glass-plastic composite
Environmental statement:	yes
BRE Ecopoints:	unrated
BRE Environmental profile:	unrated
Other environmental standards:	none
3rd party accreditation:	none
3rd party product endorsement:	none
Reusability / Recyclability:	partly recyclable
% of post consumer waste:	unknown
Life expectancy	unknown

Test Yourself Part 2

- How can wind be exploited in buildings
- How can wind turbulence be avoided around tower block bases
- What are the pitfalls of wind turbines attached to buildings
- When and where are vertical axis wind turbines the better choice

How did you do? Part 2

- Opening up the building for passive ventilation, cross flows to refresh the air and remove moisture
- Podium, Shelf, Skirts around the base above pedestrians
- Being too close the building inside the turbulence bubble, efficiency drops off
- In urban area, disturbed air, wind coming from all direction



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Natural Ventilation

using wind & air movement

External Wind loading

- Prevailing wind direction and magnitude
- Wind driven rain index (rain carried in wind)
- External pressures on elevations:
  - +ve & -ve
- For every action there is an equal and opposite reaction
- Internal suction correspond to external pressures and visa versa

Internal Wind Pressure Buffeting

- Internal pressures on walls and partitions
- Doors shutting in breeze, bang into frame, force held by walls
- Stability posts in tall slender walls
- Wind posts in internal and external walls
- Air leaky joints around posts
- Waste of cut blockwork either side

Deliberate Ventilation to rooms

- UK By-Laws (in the past)
- To Control humidity
  - Airbricks & hit/miss grilles (close/open)
  - Into Larders (food stores)
  - Into habitable (living and bed) rooms
  - Into Kitchens, WCs, lobbies and Bathrooms
- To supply combustion air to fires
  - Airbricks

Ventilated cavities

- Traditionally construction ventilated to avoid condensation
- Flat Roof void
- Attic space
- Ground floor voids under timber floor
- Cavity walls: Weep holes and Air Bricks
- Control humidity and moisture content of materials around the cavity

Layered Construction: Simplifies details and avoids interfaces: Ventilation zone above insulation. Don't puncture Damp proof membrane, Gas proof membrane, Vapour barrier, Breather membrane & Air tightness layer. Add services zones to avoid complications

Aberystwyth Arts Centre: Architect: Smith Roberts: Peter N Roberts

Moisture in materials

- The air is full of spores and pollen from fungi and plants
- They land on surfaces or materials
- If the Relative Humidity (RH) of the air is high the moisture content of those materials may rise
- Timber above 20 % moisture content is at risk of the spores growing on the surfaces
- Once growing the spores turn to fruiting bodies feeding off the timber
- Timber in buildings is not vigorously living, nature does not like waste so it tries to reduce the dead timber and return it to nutrients for nature

Moisture and Health

- Those same spores create mould on surfaces of absorbent materials that are kept moist
- Mould releases more spores which can affect the respiratory system in humans
- Unventilated bathrooms, showers and bedrooms are prone
- Ventilation is important and it can solve many ills

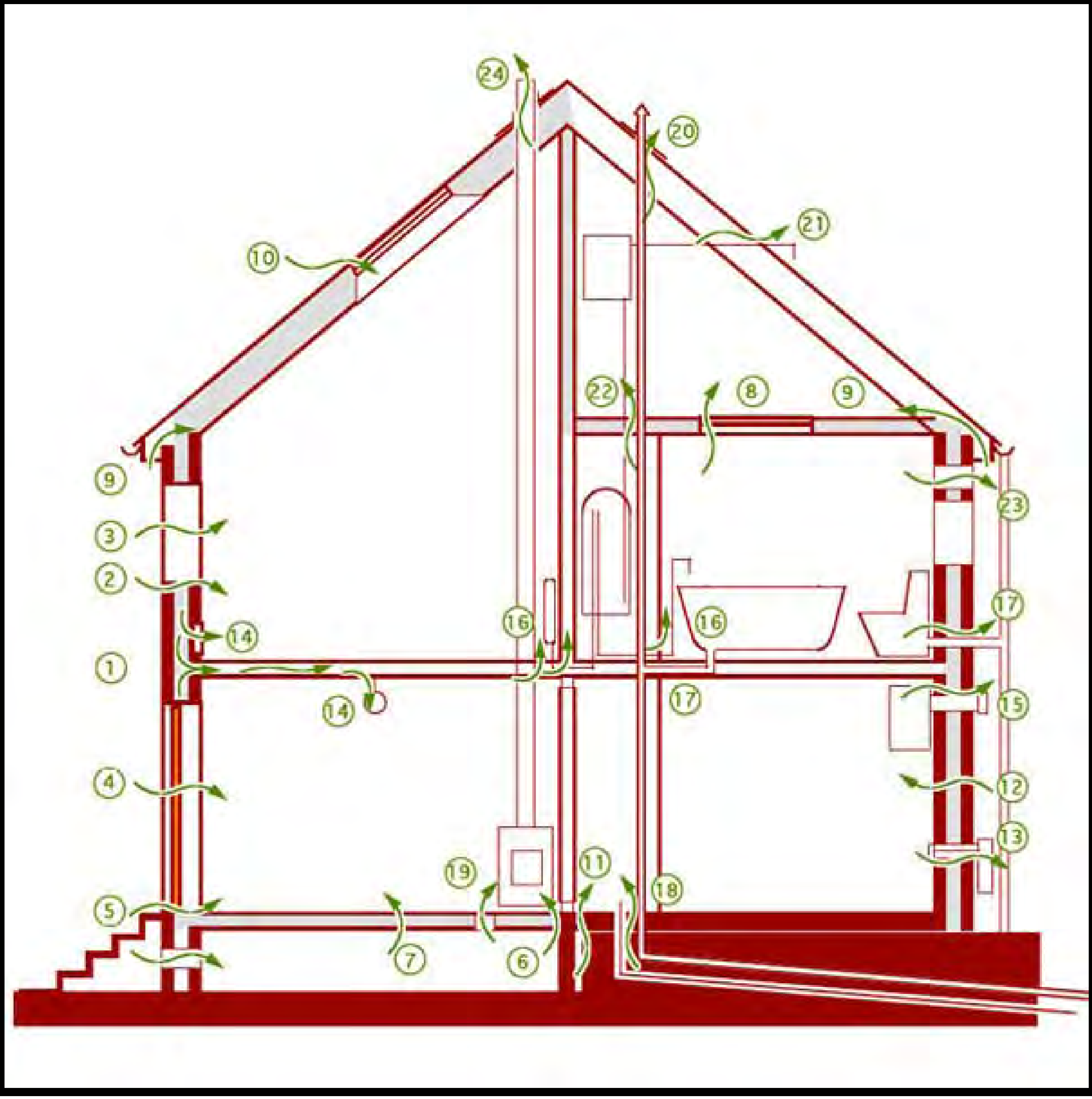
Ventilation today

- In addition to ventilating moisture today we have other issues
- We use so many synthetic materials, adhesives, finishes and cleaning agents in buildings today
- They off-gas chemicals into the air which can affect air quality and health
- Sick Building Syndrome is one result.

Leaky construction

- Cavity wall construction (open perpends)
- Plasterboard dry-linings to walls and ceilings with cavities behind
- Plasterboard and metal or timber stud partitions
- Decorative linings to walls
- Cladding to external walls
- Tiled and slated roofs (but sarking boards in Scotland, sarking felt in England)

Leaky Buildings

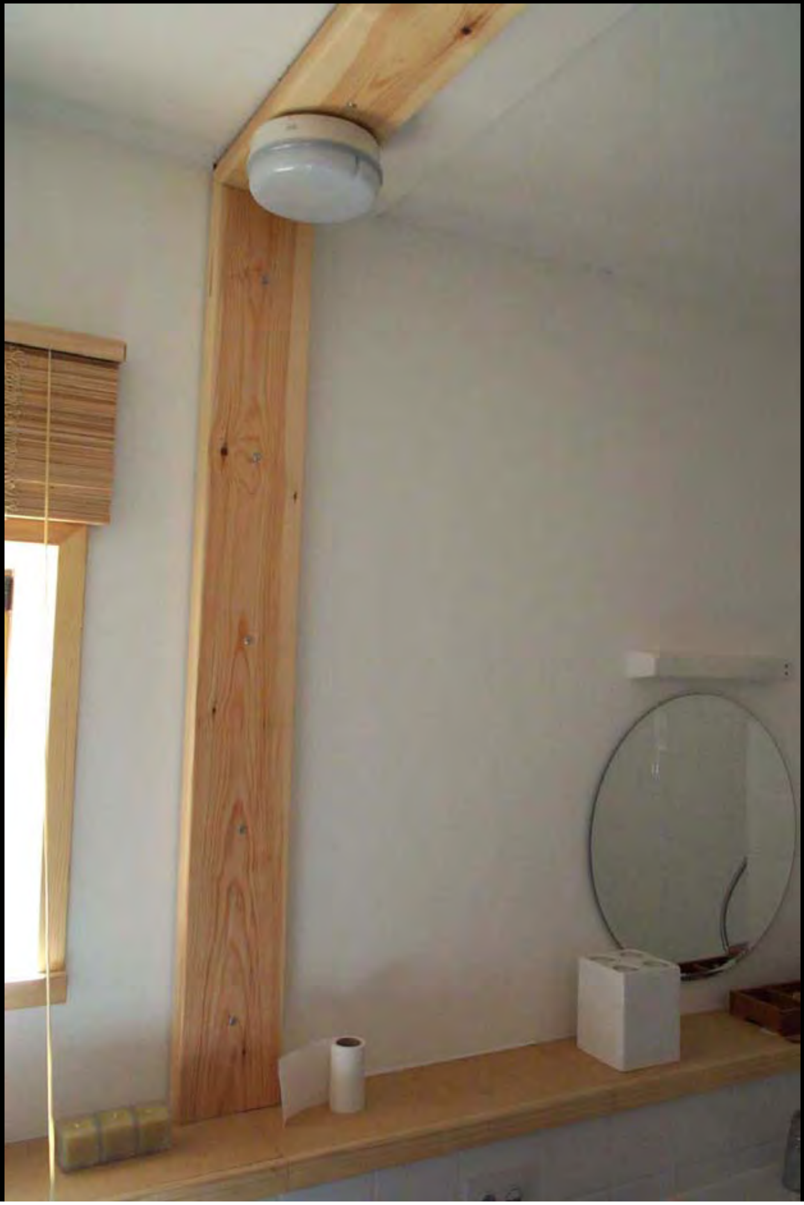


Surface mounted service ducts:

Use hollow skirting, dado & services cover But form a pathway for air leakage.

Traditional method may be more airtight but:

Avoid chasing masonry
Avoid noise
Avoid masonry dust
Avoid exclusion zones
Avoid waste materials
Avoid conduits
Avoid Rendering-in
Avoid Plastering over



Brownfield site ventilation

- Methane from biodegrading organic waste in backfill
- Petro-chemicals from prior use
- Hydro-carbons from prior use
- Ventilated cavity below buildings allow removal before entry into building
- Gas Proof Membrane in floors
- Often combination Damp Proof Membrane
- Cigarette smokers must take care with stubs
- Methane is combustible


Brownfield gas ventilation boards

Radon Ventilation

- Radio-active granite e.g. in west country
- Releases radioactivity into air
- Ventilated cavity below buildings allow removal before entry into building
- Radon Barrier: Gas Proof Membrane in floors
- Often combination Damp Proof Membrane

Combustion Air: Fire Places

- Victorians designed leaky buildings to provide combustion air to open fires
- The heat of the fire draws air up chimney and draws fresh cold air in through doors, windows and airbricks
- Chimneys include a throat, a narrowing of the flue above the fire which causes the warm air to pass through the narrowing at higher speed than the flue above
- Know as the Venturi effect it is an effective measure to prevent back draft pushing smoke back into the room

Combustion Air: Boilers

- Air demand is known from boiler manufacturer data
- Air bricks or louvres or gap under doors
- Additional air bricks to ventilate the room, inefficient boilers loose heat to the room
- Some flues radiate heat to the room
- Walls between Plant room and other room are effectively external walls, insulate accordingly

Build-tight ventilate-right

- Do not build leaky buildings to prevent humidity build up and condensation
- This will only squander heat energy uncontrollably as well
- Do build airtight buildings and then purposefully ventilate them in a controlled way
- Choose passive or active ventilation over mechanical and air-conditioning

Design of Barriers

- We design Damp proof membranes (DPM), Damp proof courses (DPC) & their junctions
- We specify vapour barriers (VB) but fail to detail them and fail to police them on site
- We fail to design airtightness layers (ATL) and its many contributing materials, layers and junctions
- We need to red line the VB/ATL on drawings
- We expect our inadequacies to be corrected by the builder
- Actually don't think about it

Workmanship: often poor

- Buttered, tip and tailed joints in masonry
- Inaccurate cutting of insulation materials
- Inaccurate fitting of insulation materials
- Gaps in insulation, around edges and abutments
- Unsealed laps in barrier sheets
- Incomplete seals in laps
- Missing barrier sheets
- Wind damaged barrier sheets
- Punctured barrier sheets
- Service penetrations not resealed

Locational Assembly: oversized compress, offer up & release

- If rafter spacing and insulation size correspond
- No waste
- Do they?

Airtight construction

- Wet trades often are
- External Render
- Internal Plaster or plaster skim on board
- Parge Coat (British Gypsum Ltd. have one)
- Insitu Concrete
- Vapour Barriers in timber construction (can be)
- Airtightness layers (new to industry)

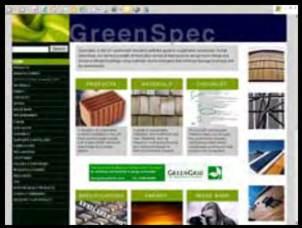
Open Materials

- Open cell glass and rock mineral fibre insulation
- No fines concrete blockwork (open interstices)
- Rainscreen Cladding (open joints)
- Gabion walls & Dry stone walling (linked interstices)
- Straw bale walls (high-setting on harvester)
- Permeable pavement (oxygen for microbes)
- Butted floor boards and loose T&G boards
- Micro-porous paints and stains
- Breather Membranes
- Breathing sheathing boards

Open materials/construction


Gabions using new bricks 3 colours and random
Retail development Gateshead

Adobe, Welwyn Garden City Proctor & Matthews Gabion Walls



COMMENDED
The UK eWell-Being Awards 2004
www.sustainit.org

www.greenspec.co.uk

Gabions Trapions & Matresses

D41 Crib walls/Gabions/Reinforced earth Construction & Materials

Another GreenSpec CPD seminar to consider

Rainscreen

- Rainscreen cladding works on the principle that the outer layer of cladding catches most of the wind and rain
- The open joints permit some air and rain to pass through
- a second line of defence a Damp Proof Membrane over the wall surface
- Stops the rain and wind wetting the wall


Rainscreen
cladding

Open Joint Weather boarding using Rainscreen principles breaks up the pressure of the wind on the glazing behind

Earth Centre Doncaster

Pressure Equalisation

- Rainscreen cladding benefits from the principle that air passing through the joints will fill the void behind, build up pressure and then bounce back out
- Following air and rain will meet the air bouncing back out through the joints
- Less air and rain will pass through the joints and reach the rear wall

Pressure Equalisation

- Curtain walling can adopt the same principle where it has open drain holes to remove rain and condensation
- Pressure equalisation will occur when air entering one hole will push air out through other holes
- Some window manufacturers rely on air pressure entering the deep recess around the window to bounce air back to deflect further air entering the recess, avoiding the use of sealants

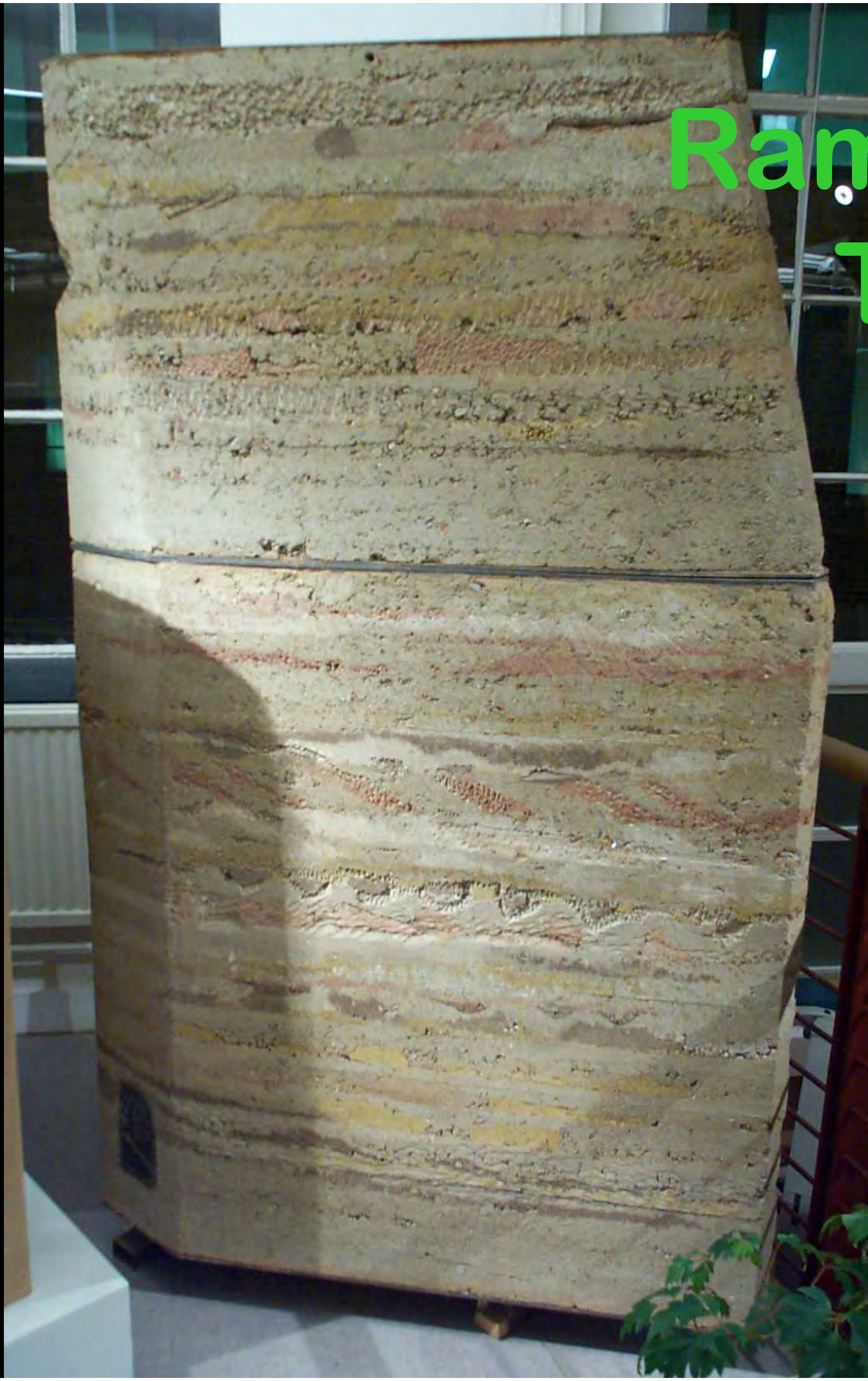
Pressure equalised doors invented for towers with high pressure winds at ground level

Closed Materials (potentially airtight)

- Structural Glass Assembly sealant jointed
- Metal sheet cladding
- Aircrete concrete blockwork (Closed cell matrix)
- Hemp-lime (but micro-porous fibres)
- Rammed earth walls
- Tongue & Groove Jointed boards
- Oil Paints (skin forming)
- Vapour barriers
  - Polyethylene e.g. polythene
  - Aluminium

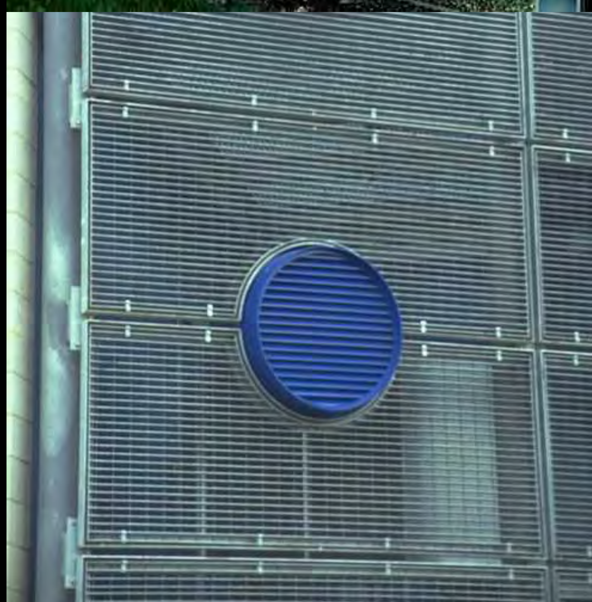
Rammed Earth walls: Thermal, acoustic & moisture mass Closed material

At Construction Resources



Rammed Earth walls: Chalk & Flint

Pines Caryx Conference Centre Dover



Closed glass balustrade Offers view and wind shelter.

Open Mesh offers view but little protection from wind

Greenwich Millennium Village and Oxford Science Park Architect: Proctor Matthews

Test Yourself Part 3

- Name some advantages of layered construction related to ventilation
- What is Venturi Principle?
- What are we trying to remove that relates to Sick Building Syndrome?

How did you do? Part 3

- Clear ventilation zone, uncomplicated eaves detail
- A narrowing in a flue which speeds up the air flow to resist air being blown back down
- Off-gassing from synthetic materials finishes and cleaning fluids

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Moisture Vapour and Condensation

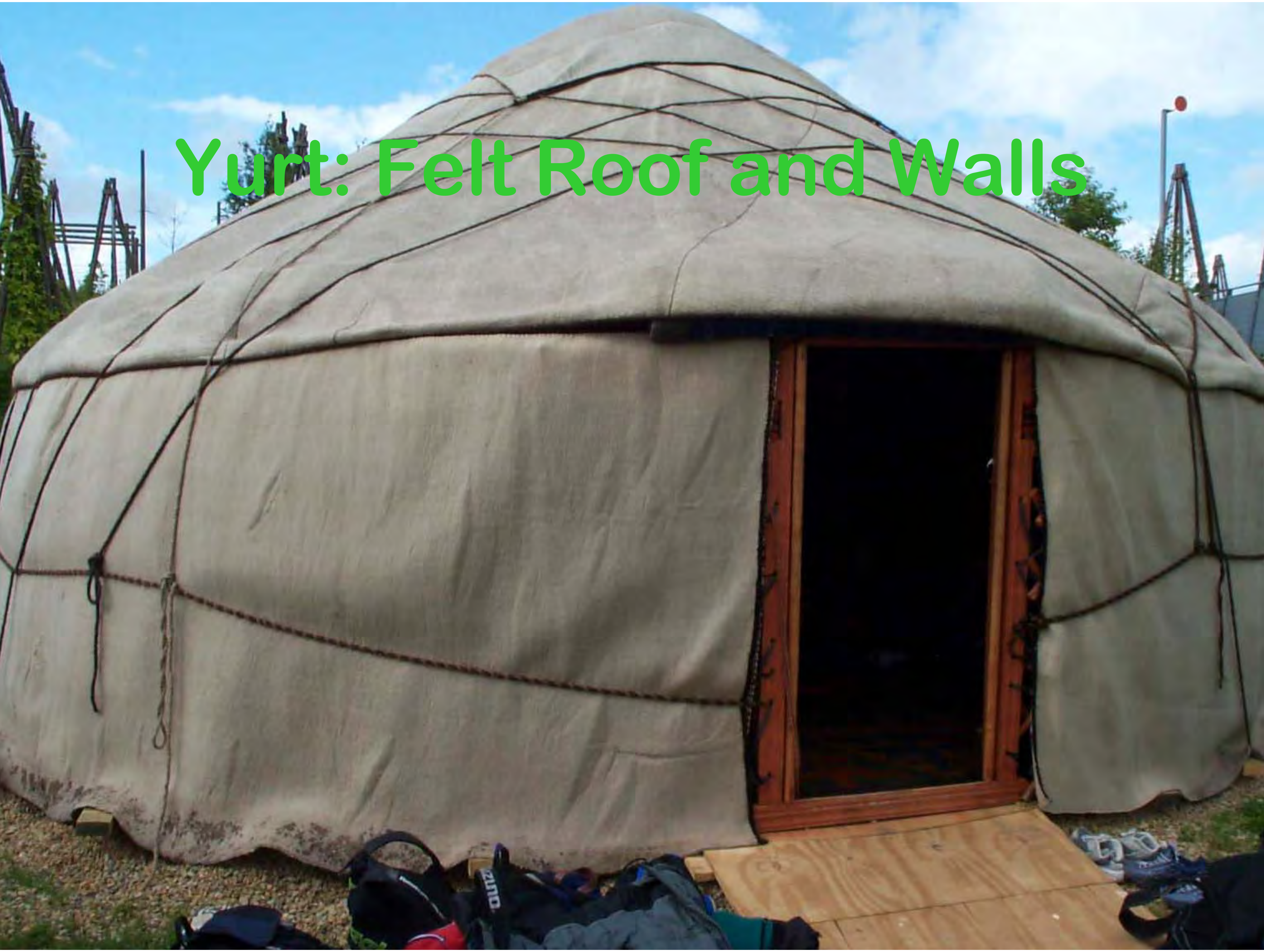
Moist air under pressure

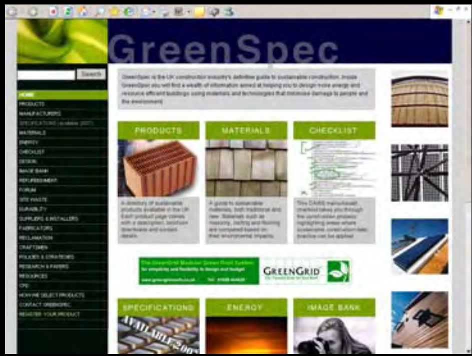
- Occupation of buildings
- Breathing, perspiring, bathing and boiling (clothes, water, food, bodies)
- Adds moisture to air, raising humidity
- When less humid outside, moisture laden air moves outwards through building fabric
- The moisture can be deposited in the fabric by interstitial condensation

Moisture Permeable Materials

- Traditional methods
- Lime: mortar, render, plaster, paints, crete
- Bricks, Blocks, mortar (not all)
- Earth: walls, mortar, plaster, render, paints
- Felt: Yurt roof and wall sheeting
- Micro-porous paints (but water repellent)
- New methods:
- Hemp-lime: insitu: walls, floors, roofs, insulation; blocks, screed,
- Moisture Mass (like thermal mass but for moisture)

Yurt: Felt Roof and Walls





Wick Effect

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- Building-in moisture absorbent materials can help to control moisture deposited from the air
- E.g. Straw bale above a shower
- Unfired clay bricks, blocks,
- Clay plaster, paint
- Moisture Mass

Condensation Eradication

- Don’t let the temperature in the construction drop below the temperature at which the air can no longer hold moisture
- If it does it will deposit the moisture
- Vapour resistance inside ideally 5 times more resistant than outside
    - Vapour Barriers (VB):5 - Breather Membrane (BM):1
- VB & BM used in timber frame constructions
- With hydrophobic materials that do not perform well when wet (above 3% MC)

Vapour Barriers (VB)

- Often polyethylene or aluminium
- High moisture vapour resistance
- 5 times more resistant than Breather Membrane
- Inside of the insulation
- Lapped and continuous sealed at joints
- Joints supported on members and battened
- Penetrations sealed: lights, switches, sockets, etc.
- Stops moist air getting into construction and into hydrophobic insulation

Vapour Check (VC)

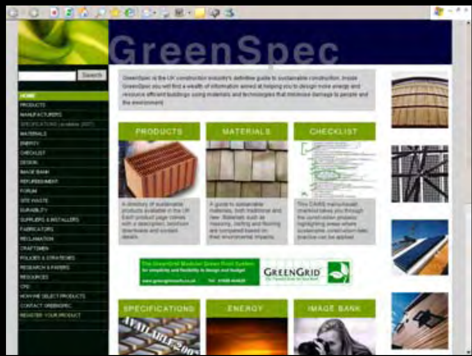
- In reality because of compromised construction, incomplete Vapour Barriers, leaky services penetration
- It is generally accepted that Vapour Barriers are not barriers
- We call them vapour checks because they slop down vapour entry not prevent it
- But they are likely to concentrate vapour passage into small spaces between frames with higher risk of problems

Air as insulation

- Air trapped in the spaces in the insulation
- Closed or open cells of foamed plastics or glass
- Air spaces between fibres
- Spaces between layers of multi-layer reflective insulation
- But fibre quilts act like a filter: air passes through, particulates may be held
- Needs a sheet on one or both sides to stop warm air passing through

Breather Membranes (BM)

- Often felt or brown building paper
- Low moisture vapour resistance
- 5 (or more) times less resistant than vapour barrier
- Outside of the insulation
- Lapped at joints over supports and battened
- Joints fastened on members
- Stops warm air being sucked out of open cell insulation into ventilation air stream



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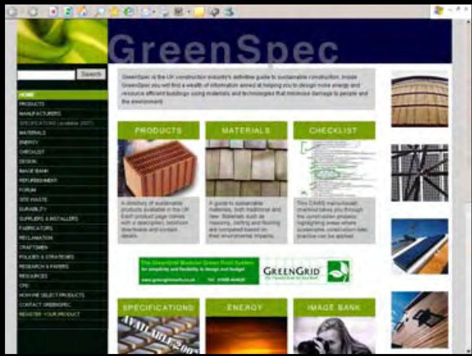
Thermal Insulation

CO_2 and Carbon reduction

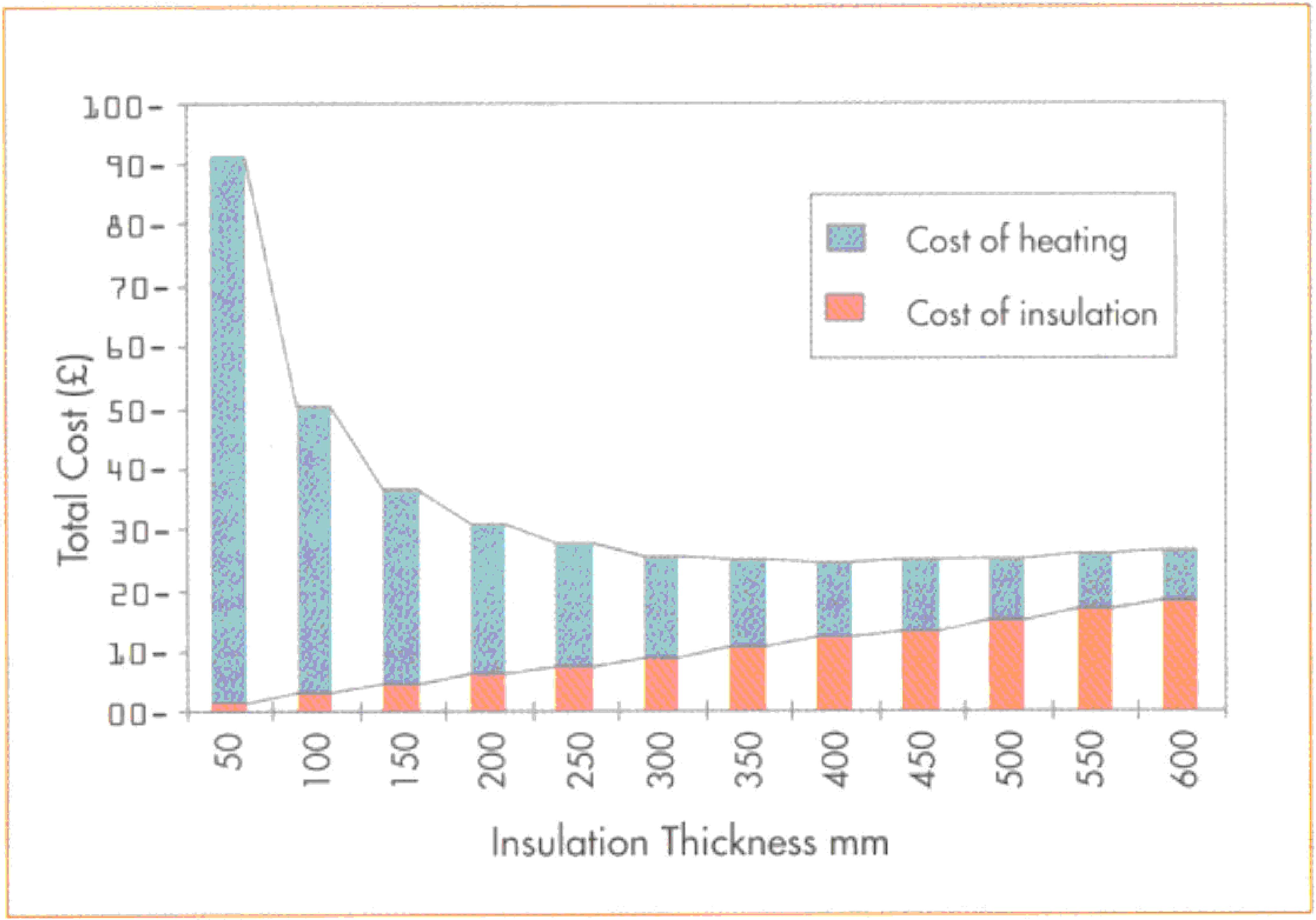
- Do not limit to complying with Building Regulations Approved Document L1A, L1B, L2A, L2B
- Set out to exceed Kyoto, EU or UK CO_2 targets
- Strive for Zero Carbon buildings now not 2016
- Insulation costs less than plant
- Reduce heating, cooling, ventilation and air-conditioning demands towards zero
- Windows: U value of 1.0 W/m2.K or better
- Walls: U value of 0.1 W/m2.K or better
- Airtightness: less than 1, not 10 of Building Regulations



Insulation

www.greenspec.co.uk

- Insulation Insulation Insulation
- Spend money on cheap insulation
- Save money on heating and cooling plant
- Save money on heating and cooling bills



Total Cost (£)
100
90
80
70
60
50
40
30
20
10
00
Cost of heating
Cost of insulation
50
100
150
200
250
300
350
400
450
500
550
600
Insulation Thickness mm

50 mm. cavity
is history

300 mm. is
optimum

Ties and
tie spacings
may change

BedZED Beddington Sutton Architect: Dr Bill Dunster


Long ties and deep reveals For 300 mm. insulation

Hydrophobic Insulation in timber frame

- Glass and rock mineral wool thermal and acoustic insulation
- If used in dry construction e.g. timber frame wall the moisture content of the wall is expected to be low
- However compromised vapour barriers (VB) are only a Vapour check (VC) and some moisture will enter the construction
- Hydrophobic materials in these conditions will absorb moist air and water
- The moisture will occupy the air spaces and prevent the insulation from acting as insulation
- Its performance drops off unless it can loose the moisture
- High resin content and non absorbent materials offer resistance to moisture uptake into the fibre so it remains in the airspaces.
- 1:5 ration is critical to the moisture passing through driven by warm air
- If the insulation holds the water it can hold the water against timber sections

Zero Fossil Fuel
Energy Development
High thermal mass
cavity walls and floors
Low U values
Rock Mineral Fibre
Long 2 part cavity ties

BedZED Beddington Sutton Architect: Dr Bill Dunster

Zero Fossil Fuel
Energy Development

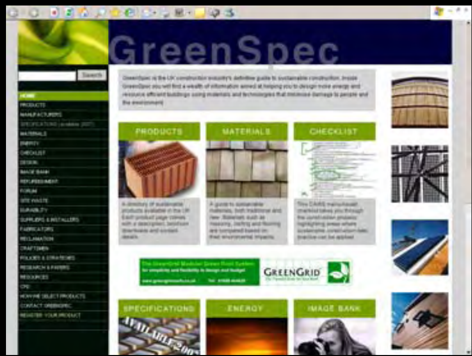
High thermal mass
cavity walls, roofs
and floors

Low U values
300 mm.
Rock Mineral Fibre
Long 2 part cavity ties

BedZED Beddington Sutton Architect: Bill Dunster

Hydrophobic Insulation in masonry

- Glass and rock mineral wool thermal and acoustic insulation
- If used in wet construction e.g. masonry cavity wall the moisture content of the wall is expected to be 3% MC
- Rainwater can pour down the inside face of the external leaf
- Hydrophobic materials in these conditions will absorb moist air and water
- The water will occupy the air spaces and prevent the insulation from acting as insulation
- Its performance drops off unless it can loose the water
- High resin content can offer some resistance to water uptake
- Fibre orientation or disorientation can discourage capillary attraction into the depth of the insulation
- Allegedly the insulation keeps the moisture close to the exposed surface



Other Topics

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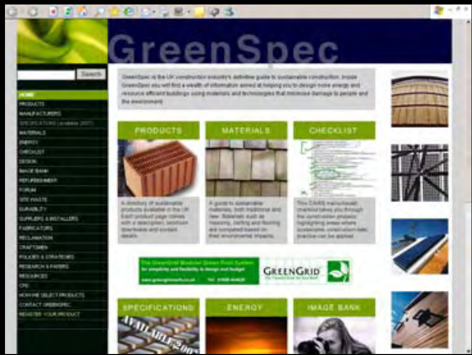
- r and k values
- U values
- Thermal Mass
- G values
- Decrement (heat passage over time through insulation and thermal mass)
- When NGS know enough: another CPD



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Breathing Construction

Breathing Construction (BC)

- Breathing Walls: well known for some time
- BRE recently accepted roofs as well
- Opposite to traditional timber frame with VB and BM which prevent moisture entry and passage
- BC permits moisture into and through construction
- No vapour barrier
- Rock and glass mineral wool not suitable
- Requires airtightness layer (ATL), hygroscopic insulation and breathing sheathing board (BSB)
- 1:5 rule is less important moisture passes both ways

Compromised Breathing Construction (CBC)

- Blurring of the boundaries between Breathing Walls and traditional timber frame
- Uses polyethylene Vapour Barrier VB or Vapour Check VC inside
- It resists moisture entry and passage
- Rock and glass mineral wool are used
- Breather membrane BM outside
- 1:5 rule applies

EVT NEWS

Issue 5 winter 2001

Not For Luddites

You've probably heard it many times before: "This software will change your life." And guess what? It doesn't. But every so often, something comes along that lives up to its claims. Every so often a step change development causes a fundamental difference to our everyday work and becomes a 'must have' tool. Photocopiers, fax machines, word processors, e-mail.

Imagine

This is TIMEFRAME

Ultimate Compatibility

Walls, Floors and Roofs

In This Issue

Fillcrete Unveils TRADIS-2

Fillcrete has unveiled the latest version of its award-winning TRADIS range of factory manufactured wall panels, floor cassettes and roof plates. The new TRADIS-2 design features improved airtightness, and a service zone for cable runs and pipework that is now incorporated into the structural frame, thereby simplifying the design and delivering cost reductions by negating the need for additional battens.

Simplified Design

Cost Savings

Fifth Award for TRADIS

Contract Journal

EVT
Enhanced Vapour Transfer ™

Enhanced Vapour Transfer (EVT) and rainscreen

Hygroscopic insulation maintain their performance even when wet

Vapour and water released when conditions permit

No need for Vapour Barrier

Use vapour permeable construction

5:1 ratio VR inside:outside and an air tightness layer

Construction Resources Showrooms Southwark London

Airtightness layer (ATL)

- Usually recycled paper sheet e.g. Pro Clima DB+
- High resistance to air passage
- Low resistance to moisture passage
- Can absorb moisture on one face & release it on the other
- Inside of thermal insulation
- Lapped and sealed at joints over supports
- Joints fastened on supports and battened
- Stops warm air leakage out of the building
- Allows moisture through into hygroscopic insulation which can tolerate it and then out of the building
- Used in Breathing construction

Enhanced Airtightness layer (ATL)

- All of the characteristics and applications of ATL
- Variable resistance to moisture passage
- Size of micro-pores varies with the seasons
- Material: ________
- E.g. Pro Clima Intello
- Study:
  - Study Calculating Potential Freedom From Structural Damage Of Thermal Insulation Structure in Timber Built systems

Hygroscopic Insulation

- Any natural plant based material: hemp, straw, flax, coconut husk, cellulose, sheep's wool, grass, etc.
- Air trapped in material is what makes insulation work
- Water does not work in the same way
- Moisture laden air or interstitial condensation occupies the space that air would
- Stops hydrophobic insulation from insulating
- Hygroscopic insulation absorbs the moisture into the fibre leaving the air spaces to insulate
- Releases the moisture when conditions are right and it leaves the construction and building

Hygroscopic Thermal Insulation

- Newspaper
- Flax
- Hemp
- Sheep's wool
- Cellulose

Construction Resources Showrooms Southwark London

Hygroscopic Insulation: Sheep's Wool


Second Nature (UK) Ltd

BBA BRITISH BOARD OF AGRÉMENT TECHNICAL APPROVALS FOR CONSTRUCTION

Designated by Government to issue European Technical Approvals

Agrément Certificate No 02/3950

THERMAFLEECE

Isolation thermale

Wärmedämmung

Product

- THIS CERTIFICATE RELATES TO THERMAFLEECE, THERMAL INSULATION BATTS FOR USE IN DWELLINGS AND BUILDINGS WITH SIMILAR TEMPERATURE AND HUMIDITY CONDITIONS.
- The batts are for use in: loft applications between joists in ventilated and unventilated lofts under pitched roofs and between rafters for tiled or slated pitched roofs designed and constructed in accordance with the relevant clauses of BS 5534-1 : 1997, and timber-frame wall applications between studding with a weather-resistant cladding, and a ventilated and drained cavity.

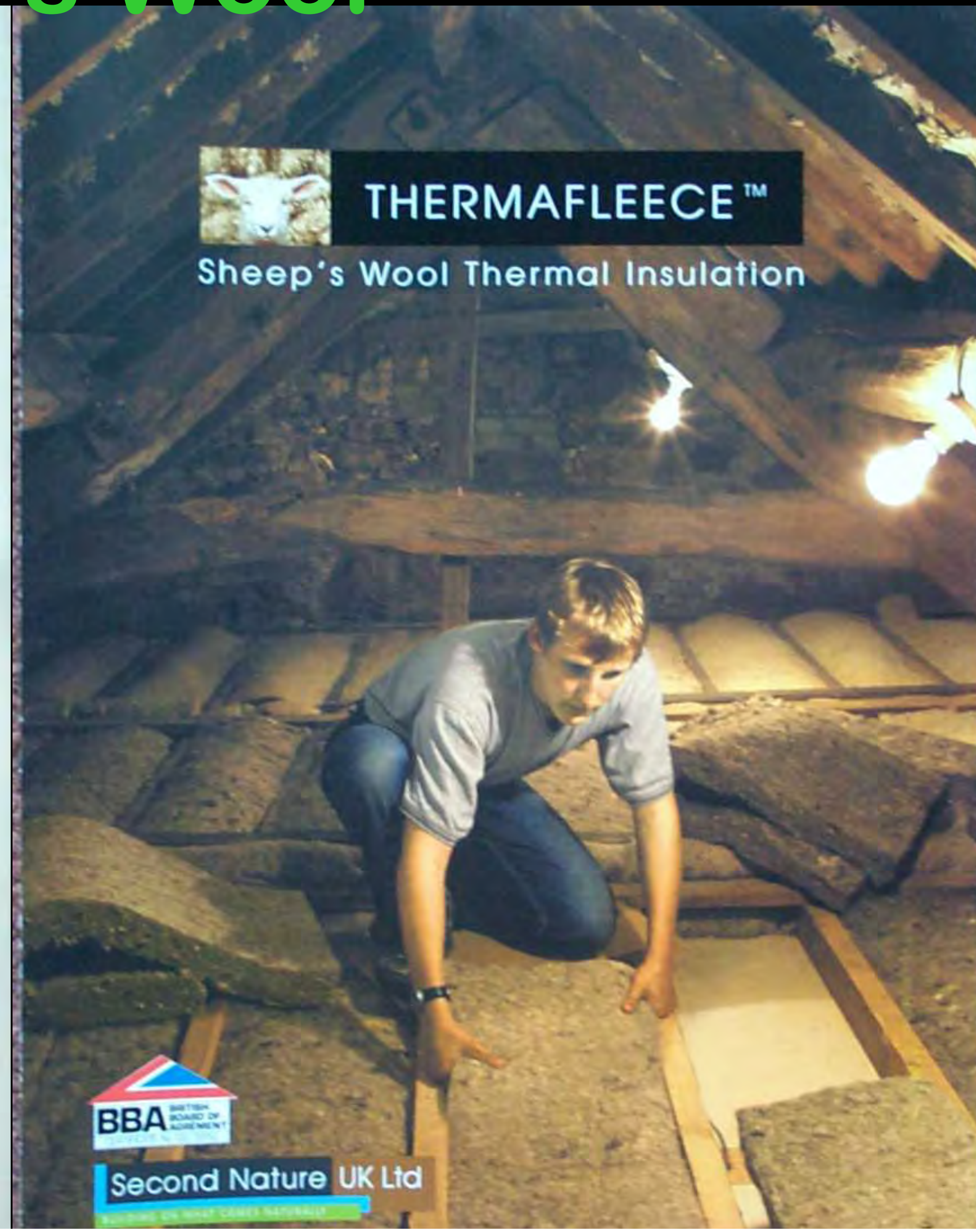
Regulations — Detail Sheet 1

1 The Building Regulations 2000 (as amended) (England and Wales)

The Secretary of State has agreed with the British Board of Agrément the aspects of performance to be used by the BBA in assessing the compliance of insulation with the Building Regulations. In the opinion of the BBA, Thermafleece, if used in accordance with the provisions of this Certificate, will meet or contribute to meeting the relevant requirements.

General

Requirement	B3	Internal fire spread (structure)
Comment		Lofts, roofs and walls incorporating the product can meet this Requirement. See the Behaviour in relation to fire section of the relevant Detail Sheet.
Requirement	L1	Conservation of fuel and power in dwellings
Requirement	L2	Conservation of fuel and power in buildings other than dwellings
Comment		The product can meet or contribute to meeting this Requirement. See the Thermal insulation section of the relevant Detail Sheet.
Requirement	Regulation 7	Materials and workmanship
Comment		The product is acceptable. See the Durability section of the



Sheep's wool

www.greenspec.co.uk

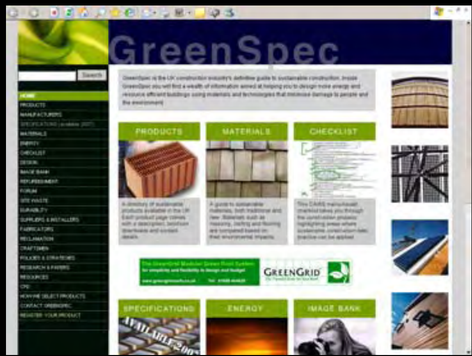
- When on the sheep's back they are kept warm
- Hygroscopicity absorbs moisture and the insulating effect is maintained
- Sheep's wool has other characteristics whereby it warms up when wet
- But I do not know enough to explain

Breathing Sheathing Boards (BSB)

- Usually cellulose fibre board
  - some with bitumen impregnation
  - some with cellulose's own natural resins
- E.g. Panelvent
- Low moisture resistance
- Airtight: stops warm air being dragged out of insulation into ventilation air stream
- Moisture permeable: Breathing
- Some with racking strength, some not
- Fixed butt jointed to timber framing sections

Breathing Sheathing Boards (BSB)

- Wheat Straw fibre board
- e.g. invotek strawboard www.invotek.co.uk
- Bound with fibre's own natural resins
- Low moisture resistance
- Airtight: stops warm air being dragged out of insulation into ventilation air stream
- Moisture permeable: Breathing
- Racking strength: _____
- Fixed butt jointed to timber framing sections



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Airtight & Permeable finishes

Paints & Stains

- Oil based paints form skins and usually act like vapour barriers in both directions
- Once paint fails say on an edge or corner it will let wet in, which will them travel inside the pores of the timber
- If the moisture is warmed the vapour tries to move to outside but the paint film traps the moisture inside
- The wood can start to rot and the paint film is likely to be compromised and fail early
- Consider micro-porous paints and high build stains which resist water intake but allow any moisture out
- Consider more resistant finish inside, less resistant finish outside to encourage moisture outwards

Materials Protection:

Full hbmpp scheme
No absorbent surfaces
Pallet
Stability bracing
Corner & edge Protection
Moisture control

But:

Rain Cover needed
Not Remote storage
Not off the ground
Not JIT but JIC
How many doors to push over the windows?

BedZED Beddington Sutton Architect: Bill Dunster

Test Yourself

www.greenspec.co.uk

- Part 4
- Where can you use Hydrophobic insulation?
- Where can Hygroscopic insulation be used?
- How does Hygroscopic insulation work when in damp conditions?

How did you do?

www.greenspec.co.uk

- Part 4
- Hydrophobic in dry wall construction and even in external cavity walls
- Hygroscopic in breathing walls
- Hygroscopic insulation absorbs moisture into the fibre leaving the airspace to insulate

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Airtightness & Testing

Off-site and on-site

Airtightness Testing

- Off-site:
  - Full scale mock-up
  - Weather, wind and structural distortion
- On-site:
  - Air leakage testing

Off-site full scale mock-up testing

- Test the design for appearance
- Test method & sequence of assembly and interfaces
- Test weather resistance of construction
- Sprague pipes: rain simulation
- WWII Merlin engine: wind simulation
- Air suction: to pull air and water in through leaky joints

Wind Simulation +ve pressure

Mock-up of elevation

Rain Simulation

Back of chamber: -ve pressure

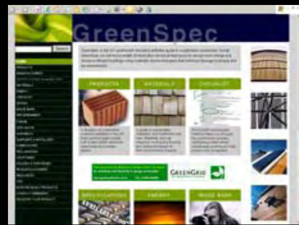
Deflection monitoring

Inspection for leaks

Detected Leaks: Windows went well beyond design limit before leaking

Feedback into design/workmanship

- Observe, analyse, resolve
- Propose solutions, record
- Communicate, inform,
- Redesign if required
- Commit to improve workmanship where weak



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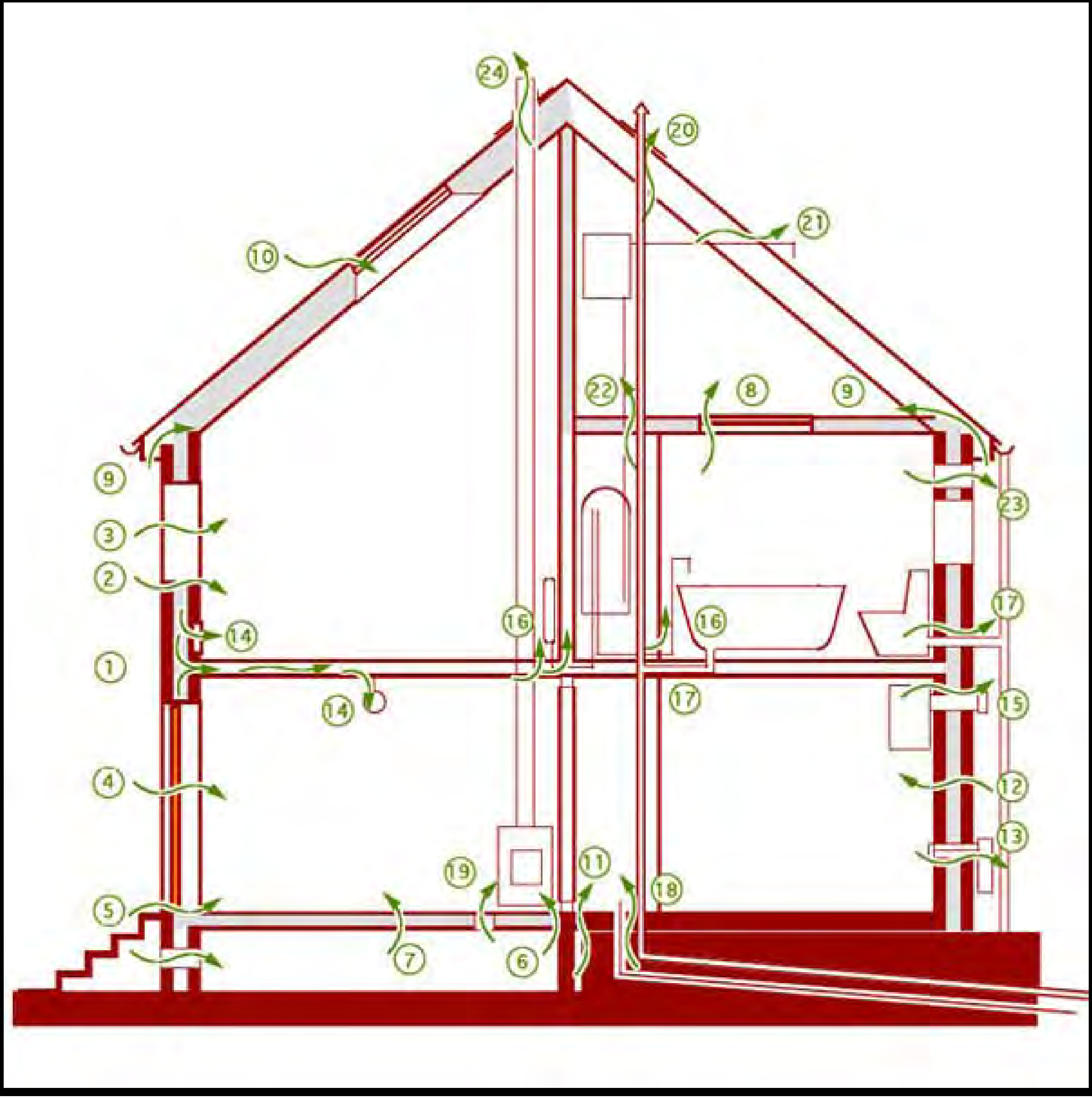
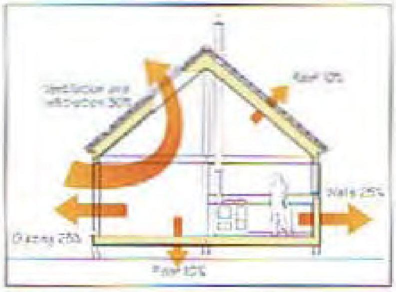
Airtightness

Regulation, Energy loss, Testing, Sealing, Construction

Another CPD seminar to consider

Leaky Buildings



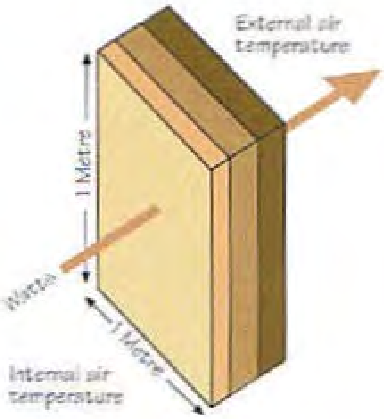


8.8

Fabric, ventilation and infiltration losses

Fabric losses – the U-value

Heat is conducted through the fabric of the house and lost to the outside air b radiation and convection. The U-value is a measure of how many watts (rate of flo of energy) pass through one square metre of construction for every degre difference in temperature between the inside and the outside. So a U-value c 6.0W/m²K (that of a single-glazed window) will mean that six watts will be escapin through each square metre of glass when the temperature difference is on degree. If it is 20°C in the house and 0°C outside, then the heat loss is 20x6=120W pe square metre. Double-glazing roughly halves the heat loss, and so has a U-value c 3.0W/m²K. The lower the U-value, the better the insulation.



8.9

Location	Construction	U-value (W/m²K)
Roof	Uninsulated loft	2.00
	with 100m insulation	0.30
	Room in the roof 200mm (2002 UK)	0.20
	Loft with 250mm insulation (2002 UK)	0.16
	Superinsulated 300mm insulation	0.12
Wall	Solid brick 225mm	2.20
	Uninsulated cavity brick	1.30
	Uninsulated cavity lightweight block	0.96
	Cavity of timber frame wall with 50mm insulation	0.45
	with 100mm insulation (2002 UK)	0.35
	Superinsulated 250mm insulation	0.14
Floor	Timber floor uninsulated	0.83
	with 150mm insulation (2002 UK)	0.25
	Superinsulated 250mm insulation	0.14
	Solid floor uninsulated (average house)	0.70
	with 100mm insulation (2002 UK)	0.25
	Superinsulated 200mm insulation	0.15
Timber window	Single-glazed	4.80
	Double-low-E 12mm airspace (2002 UK)	2.00
	Double-low-E Argon fill 16mm airspace	1.70
	Triple-low-E Argon fill or double super low-E	1.30

8.10

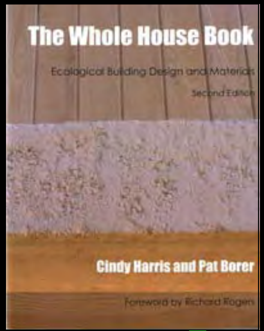
Terms used for U-value

W = watts, the rate of energy loss
m² = square metres
K = temperature in degrees Kelvin, each degree being the same as the familiar degrees Celsius or centigrade.

Fig 8.8 The proportions of heat loss from a typical house

Fig 8.9 U-value is the rate of heat loss in watts per square metre of construction multiplied by the temperature difference

Fig 8.10 Some typical U-values



50% of heat loss is through the insulating building fabric and 50% through air leakage

Air Tightness

National Green Specification

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- In past related to:
  - Windows and doors
  - Ground Floor Floorboards
  - Roof spaces (except Scotland, boarded)
- Now relates to:
  - Inadequately designed buildings
  - Badly built building fabric
  - Due to lack of understanding or training

On-site Airtightness Testing

- Seal up the building openings
- Pump air in
- Reach a preset +ve pressure
- How much air is needed to maintain the pressure?
- = Air leakage rate
- Building Regulations permit 10 we struggle to achieve it
- 8 is a leaky building unusable in windy weather, due to air noise and drafts
- Europeans aim for 0.1-0.3

Airtightness Testing:
Big buildings

Airtightness Testing: Small buildings

Panel in door opening includes fan, sucks air out air infiltration through leaks

Smoke wand highlights leaks

8.12

8.13

ventilation, and are followed by a section on breathable con

Airtightness

beneficial energy saving measures available, both in financ

windows and how effective they are – at least until the glue

construction. To create a low-energy house, great care mus

All new houses should be pressure tested for air infiltration

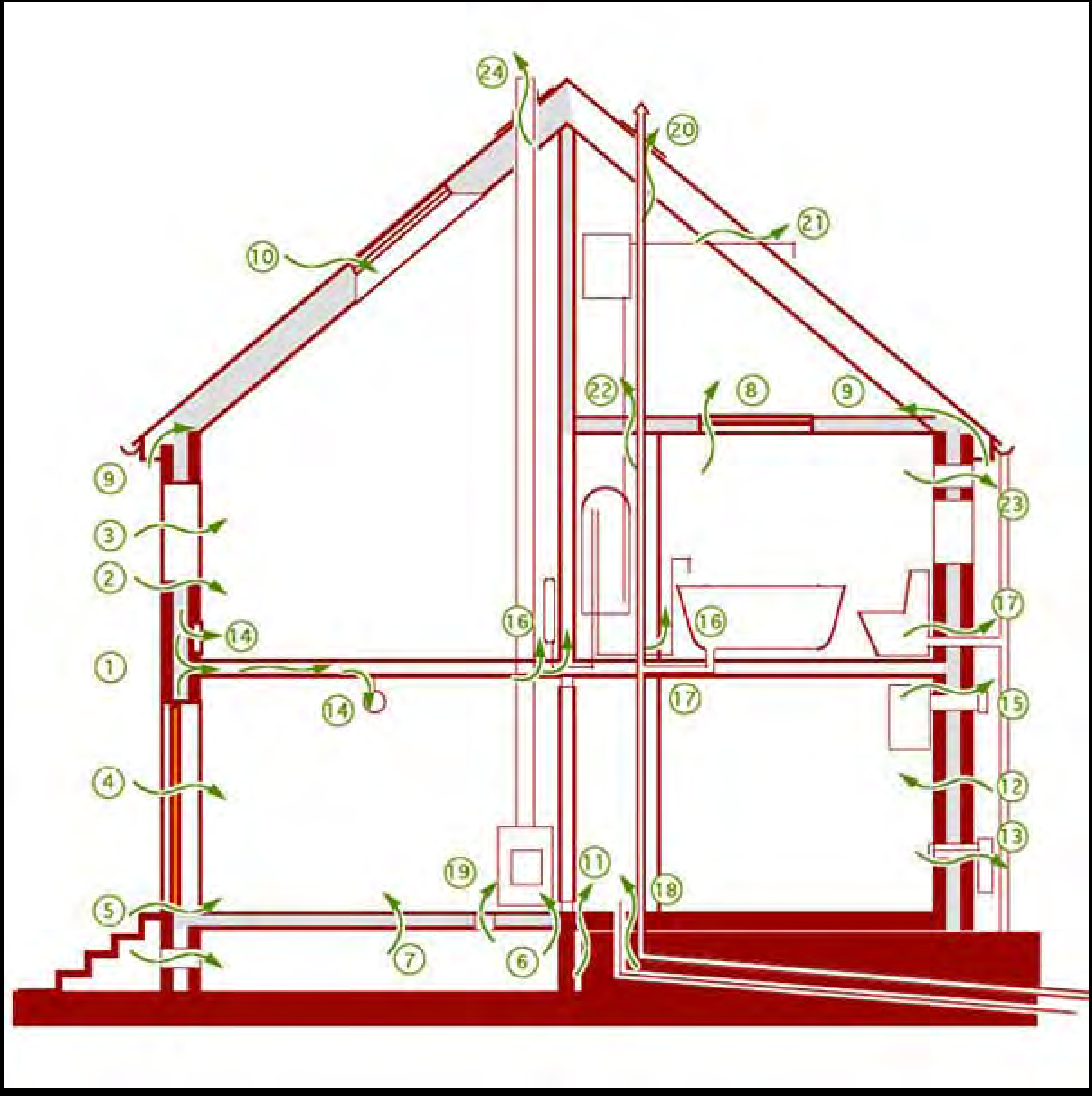
to a temporary front door and de-pressurising the ho

atmospheric pressure. It is then very instructive to walk around

construction: under the skirting boards, through cracks betw

performance is measured in cubic metres of air movement

Leaky Buildings



Vulnerable details

- Skirting:
  - Where are the slip layers and vapour barriers?
  - Do they lap and are they bonded?
- Floor level:
  - Do joists bear in walls how are they sealed?
  - mortar shrinks, consider joist hangers
- Light fittings:
  - Are they sealed or just a hole?

Timing of testing

- Has an impact on construction sequence and programme
- Test building structure and building fabric
- Envelop substantially complete
- No finishes yet
- No cavities behind linings to complicate leak finding
- Test and fix leaks in the structure and fabric
- Then complete the finishes
- All sealants hidden behind finishes

Sealants?

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- Use to seal the leaks?
- Benign type of sealant?
- Linseed oil putty is natural plant extract but not appropriate
- Oils will leach out into absorbent materials

Foamed insulation?

- Use to seal the leaks?
- Petrochemical: non-renewable
- Blowing agent: ZODP Zero Ozone Depletion Potential essential

Air leakage

- Building Regulations Approved Document:
  - L1A, L1B, L2A, L2B Thermal Insulation
    - Robust Details
    - Thermal insulation avoiding Cold bridging
    - Airtightness? Possibly
  - E Acoustic Insulation
    - Robust Details
    - Acoustic detailing
    - (contributes to airtightness if addressing external walls)

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Cold bridges

- Not normally an air passage out through construction but a thermal conduction route
- Usually solid materials with low insulation performance in contact with each other
- Forming a chain from inside to outside
- Usually load-bearing elements
- E.g. Foamglas Perinsul load-bearing recycled glass thermal insulation into base of walls

Acoustic bridges

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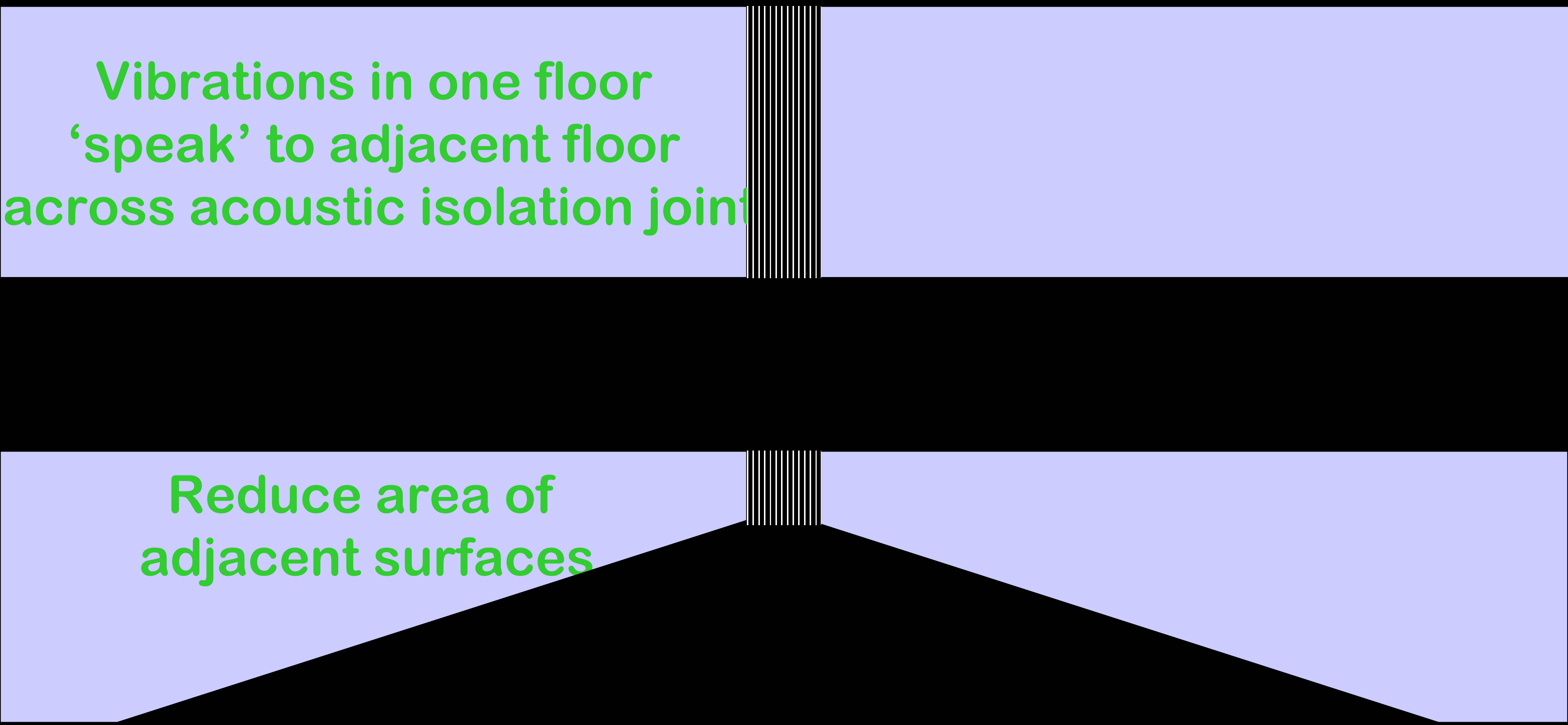
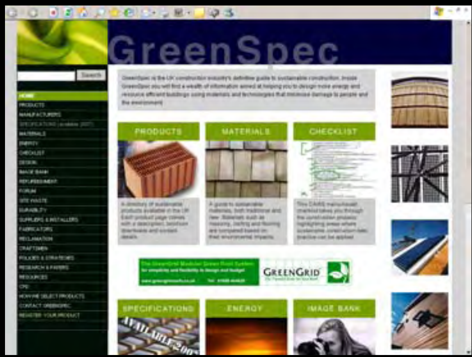
- air passage through construction linking between rooms or from inside to outside
- Acoustic conduction route
- Surfaces either side of a gap can also talk to each other
- Reduce floor edge thickness at isolation joints

Airborne sound transmission





Flanking Sound

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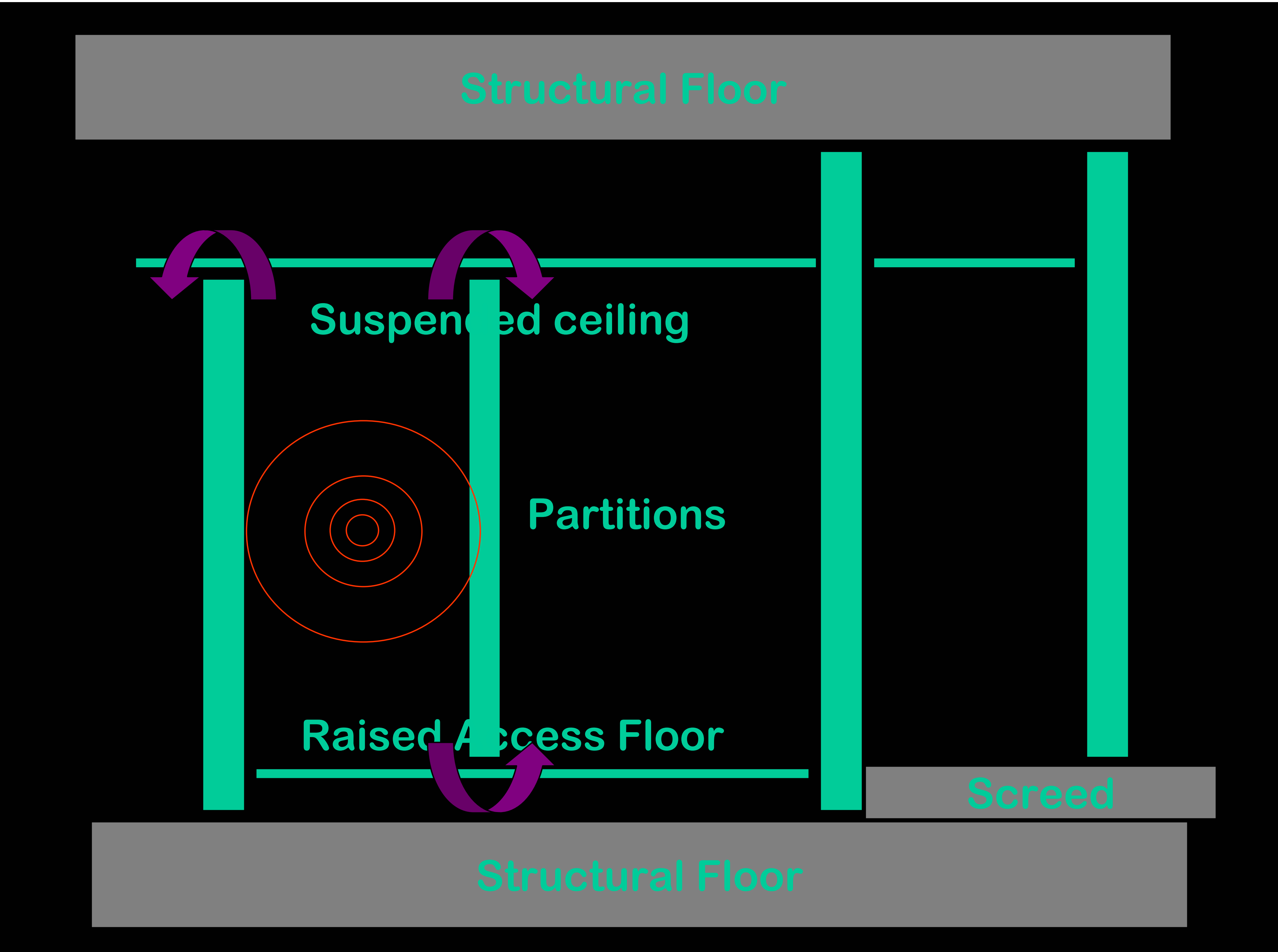
- Air paths around barriers
- Partitions are barriers, but sound can flank around them behind wall linings, over ceilings and below floors
- Barriers are needed in those cavities, aligned with the partitions
- They usually need density or air tightness to be effective

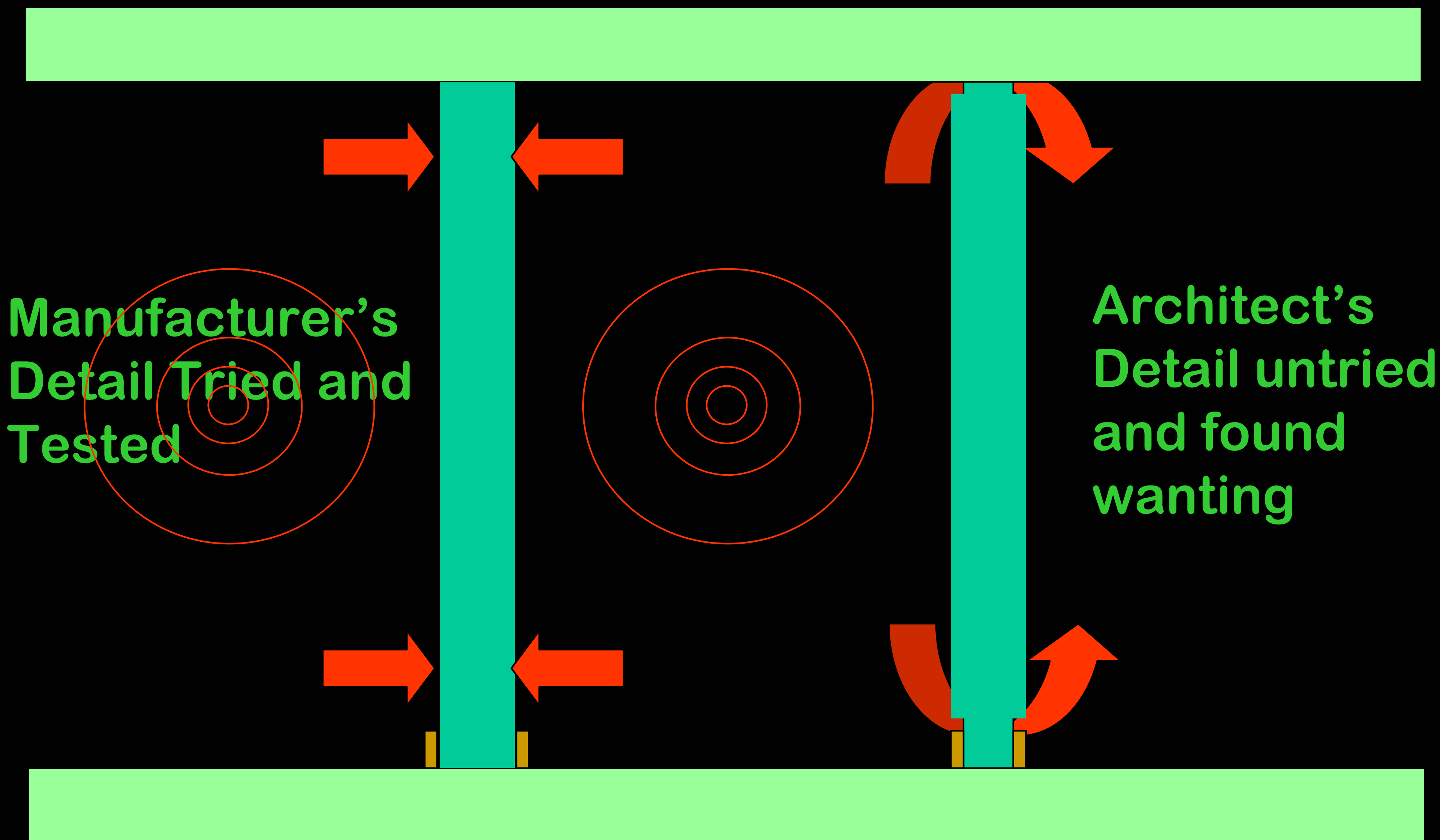


Structural Floor
Suspended ceiling
Partitions
Raised Access Floor
Screed
Structural Floor

Hiccup Details

- Flash-gaps
- Usually happens when we modify the manufacturer's standard details
- Diminish the performance of elements
- Hiccups meeting hiccups can lead to problems and have been know to make holes through elements
- Fire, Acoustics, Airtightness

Hiccup Details (flash gaps)



Fire, Acoustics and Airtightness

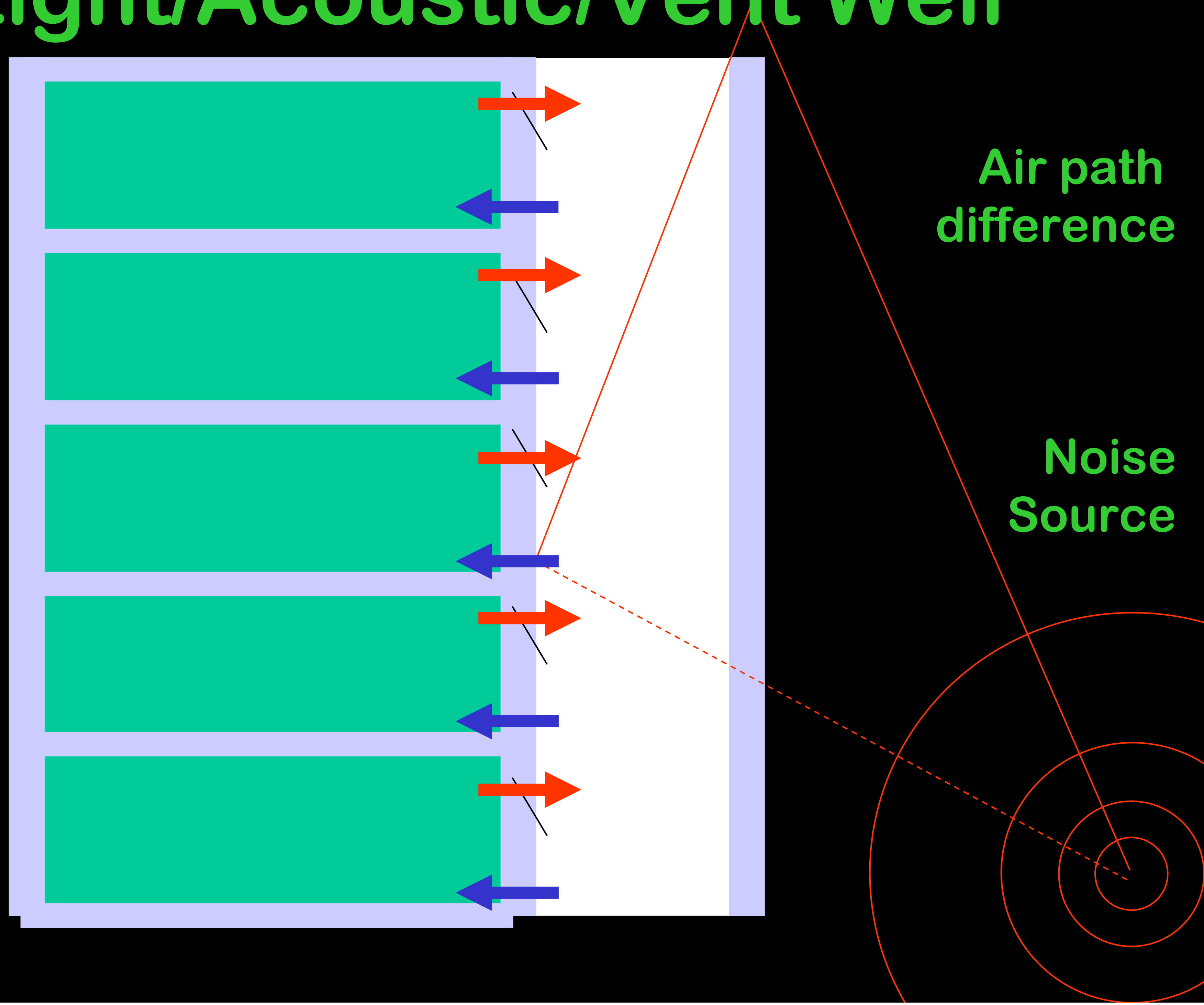
Robust Details v Airtightness

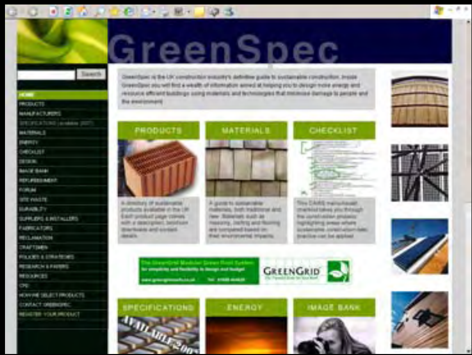
- Address thermal cold bridging
- Address acoustic bridging & flanking
- But do not address airtightness specifically
- Buildings complying with Robust details fail Airtightness testing
- BRE recently tested many buildings complying with Robust Details
- 30% failed airtightness test

Nat Vent/Acoustic Wells

- Urban areas with high traffic noise create problems for natural ventilation of buildings
- Wells within the building offer long air path difference acoustic performance and an opportunity for natural ventilation from rooms to the well
- The well may include staircases
- Discourage them as smoking places

Light/Acoustic/Vent Well





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Building Elements

Doors

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- Victorian buildings: leaky including doors
- 10 air changes per hour (1ac every 6 minutes)
- Trickle venting and no control
- Can be upgraded or refurbished
- Modern doors are higher performance
- Door with 10,000 mm2 opening e.g. letter flap = Window (B Regs)

Reclaimed Timber Doors

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L20 Doors/sets BWF-Certifire & FIRAS

Warrington Fire

Another GreenSpec CPD seminar to consider

Lobby or Porch

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- A second line of defence at doors
- External Porch of Internal Lobby
- Wind shelter, airlock (rarely effective) solar trap,
- Retrofit to buildings

Windows

- Victorian Buildings: leaky including windows
- 10 air changes per hour (1ac every 6 minutes)
- Trickle venting and no control
- Vertical sliding sash (unique to UK)
- Le Corbusier was impressed by them
- Heat out at top
- Cool in at bottom
- Half open at top or bottom
- Can be upgraded or refurbished


Vertical Sliding Sash Windows
Conservation
Quality
Refurbishment
Reading Oracle Site 2-4 London Rd. 7 Bridges Hs. Architect: Haskoll & Co.

Window and door refurbishment

- Victorian timber windows and doors 100 years old, why stop now?
- If in good state of repair consider upgrading with new DGSU and modify beads or frame
- If the Conservation Officer permits it
- Companies specialise in timber window refurbishment/upgrade
- Insitu or at factory
- Phased working to suit programme

Draft proofing VS Sash

Modern alternative

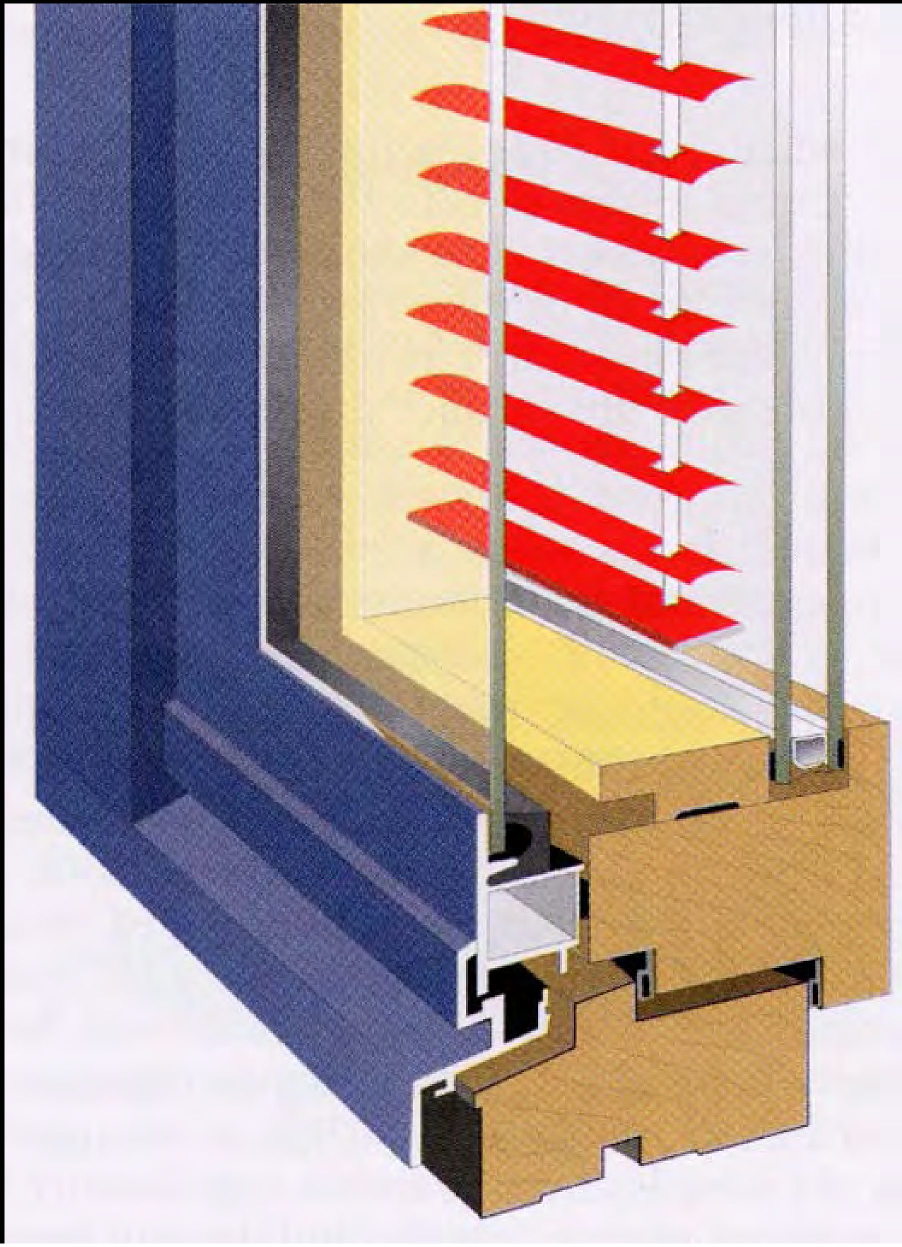
- Timber: 60 years with maintenance regime
- Timber/Aluminium composite:
- Vulnerable bottom bead and sills or outer casement in aluminium
- 60 years with maintenance regime
- Usually Scandinavian manufacture

High performance windows (and doors):

- < 1.0 W/m2K
- Low E coatings
- Gas filled DGSU & TGSU
- Double casement
- Solar shading blinds in cavity
- Trickle ventilation
- Controllable by occupant

High Performance Windows

- Aluminium outer casement
- Timber inner casement
- Treble glazed
- Dust free sun blinds



Reduce demand for all resources used by building

- Envelope Airtightness (build tight)
  - < 1 ach @ 50 Pa
- Appropriate ventilation (ventilate right)
  - 0.5 – 1.0 ac/h air change per hour
  - Heat recovery
  - Wind driven
  - Well controlled


Vertical
Sliding Sash &
Sunscreens
Modern
interpretation
at Arup
Solihull
Office

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L10 Windows

Hardwood (Oak?)

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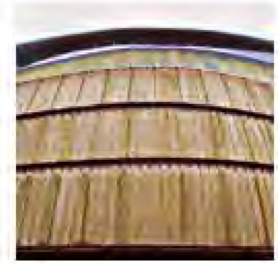

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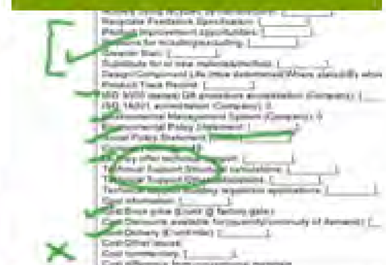

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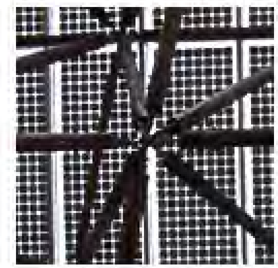

SPECIFICATIONS

ENERGY

IMAGE BANK

• generous ceiling heights and roof pods for natural ventilation and maximised daylighting • occupant control • excellent air-tightness • exposed thermal mass for passive cooling • visual and direct links between all floors and with the surrounding landscape • internal spatial flexibility

The bespoke timber facade consists of cladding with louvre timber shutters in Western Red Cedar controlling solar gain. Members of staff have manual and motorised control of the shutters and windows.





Arups, Solihull - Windows Internet Explorer
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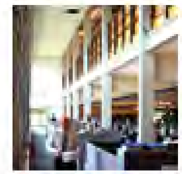


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Window Frame Material Comparison

Window frame materials compared

Key issues

Heat loss v Manufacturing impacts on the environment

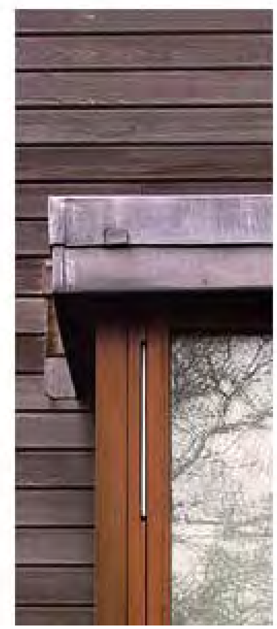
• Heat lost through the window frame in its use phase (operational energy) is likely to have a much greater environmental impact in the frame's life cycle than any impact generated through its production phase.

• It is important to choose a material with the least conductivity.

• Wood is the least conductive material followed by PVC and metal.

Wood, durability and environmental impact

The choosing of wood, its treatment and maintenance are crucial in reducing a window frame's environmental impact:



• Specify FSC sourced timber

• Transport adds embodied energy. Try and source UK timber whenever possible.

• For both hard and softwoods ensure that the specification explicitly excludes the use of sapwood.

• Painting wood adds significantly to its environmental impact. Either specify a naturally durable species that doesn't need treating or select a treatment with low impact.

• If the wood is to be treated/painted, ensure that this is done in the factory prior to site. Factory painted frames double the period before the need to repaint.

• Be careful to avoid damage to frames on site. Ensure that they are not used as formwork in wall openings.

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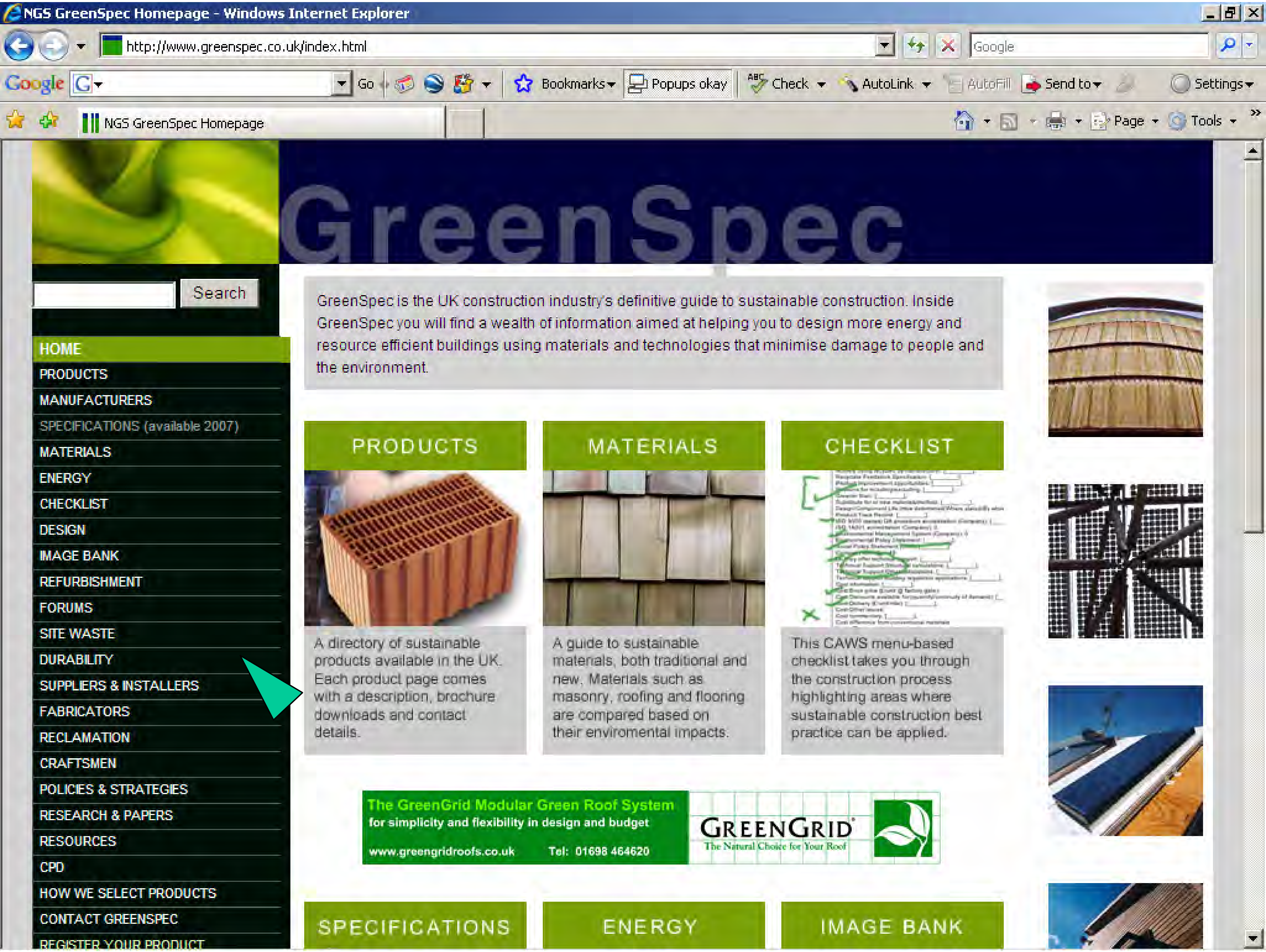
Durability & WLC
Window Ventilation



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DURABILITY CONTENTS
Timber cladding
Prefabricated structural panels
Steel fire protection

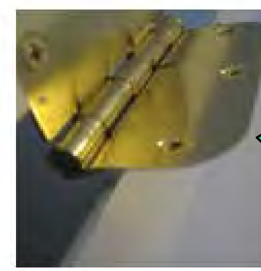
Durability - Contents

Introduction

These articles, by Peter Mayer of *Building LifePlans*, are based on the premise that for any component the market supplies a range of options with different whole life performance and cost consequences. Whole life costs are influenced by durability – component replacement interval, maintenance activities and frequency as well as costs. Other whole life performance factors which make an impact on cost are addressed as applicable, for example thermal or energy efficiency.
For each component type:

- Common component options are described by the criteria which are expected to determine durability in the UK
- Indicative service lives are listed
- Key design, installation and maintenance criteria to maximise whole life performance are identified
- Pointers are given to further good practice guidance
- Generic whole life costs for the common component choices over a 60 year period are tabulated.

The longer the whole life performance and lower the whole life cost the better a component performs from a sustainability perspective.



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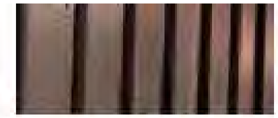

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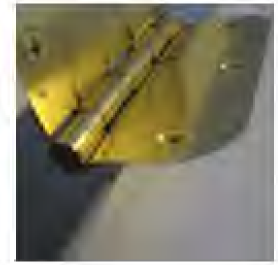

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Durability - Offices - natural ventilation

Natural ventilation not only makes financial sense but also offers a sustainable solution to environment management. **Peter Mayer** of *Building LifePlans* examines the whole-life costs.

Introduction

Naturally ventilated offices have 25% – 50% lower annual energy costs than air-conditioned offices. A recent British Council for Offices report on office sustainability undertaken by multidisciplinary consultant Arups, suggests natural ventilation has a payback period of two-and-a-half years.

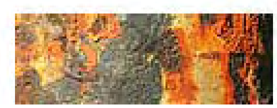
Getting the right system and strategy for an office requires careful design and management to take into account a multitude of factors. These include:

• **External environment** Temperature and rainfall regimes, cloud cover, wind direction and speed.

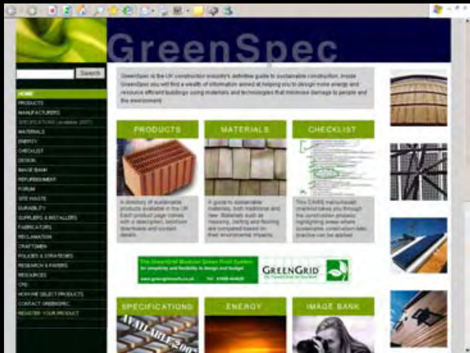
• **Office building issues** Thermal mass, shape, height, layout of partitions etc, internal wall reflectance, usage patterns, internal energy input, ventilation rate required. and required ventilation rates.

• **Window issues** Area, orientation, glazing system, window and shading.

Design guidance may be based on BS 5925, *Code of Practice for Natural Ventilation*. There is also a wealth of information on natural ventilation strategies, detailing and energy efficiency from organisations such as CIBSE and BRE.



Large deep plan offices or where external traffic noise levels are unacceptably high or where security is a risk may preclude the use of opening windows. Stack ventilation may be an alternative in these cases..



Finishes:

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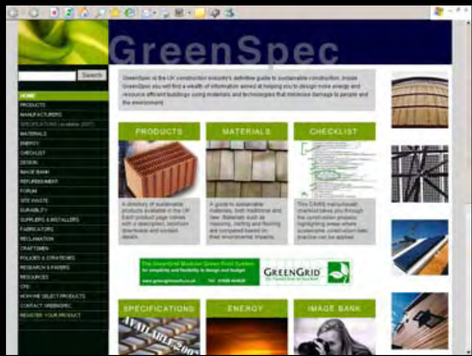
- Consider High Performance Micro-porous finish to all faces
- Full build up to all faces especially face in contact with masonry
- Coat before installing or reinstalling
- Forest Stewardship Council (FSC) certified wood and ply



Trickle vents

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- Usually associated with windows and roof windows, can be in doors too.
- Must be within reach to ensure they can be used easily and controllable
- Not permanently open and out of reach
- Windows without them have great potential to loose considerable energy when left ajar.
- And could be less secure in this state

Cat Flaps

- 20,000 mm2 or more, hole in the wall
- Air leakage excessively high
- Destroy all efforts to make an airtight building if flapping in wind
- Consider:
- cat collar electronic key releases otherwise held-closed flap to control leakage
- lobby with two flaps, cat occupies space blocking air flow, but would cats use them?

Bin Chutes

- In Australia they have a chute over the kitchen sink
- straight to the bins fixed to the wall outside
- Okay in a warm climate assuming there is smell seal
- BedZED planned to have them but too complicated and abandoned

Soil, Waste and Vent pipes

- Small amounts of Air from bathrooms and kitchens is drawn into waste pipes
- Air admittance valves draw air into Soils stacks with no vent to roof level
- Sewer gas is prevented from leaking back into the room

Hot or cold air hand dryers

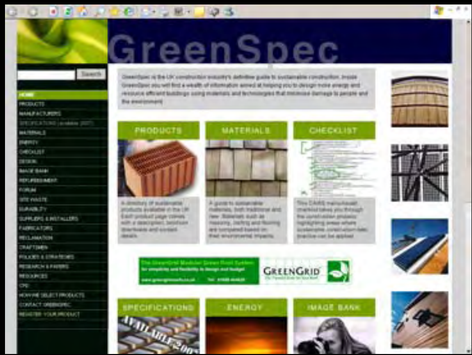
- Move air around and add heat
- They squander electricity made at 25% efficiency
- They fail to dry your hands unless you have all day and no queues behind you
- Avoid specifying them if you can
- Don't position over radiators (convectors) avoid rust
- Dyson's Blade uses unheated blade of 400 mph air to blast water from hands
- Much better energy efficiency
- Will be on the market soon

Test Yourself Part 5

- How much heat is lost through air leakage?
- At what stage should air testing be carried out?
- How is a house air tested?
- What happens when architects interfere with manufacturer's standard details?

How did you do? Part 5

- 50%
- External envelope substantialy complete, no finishes
- Seal up opening, connect fan suck out air and smoke wand identify leaks
- Often acoustic, fire and airtightness performance integrity compromised



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Passive Ventilation

Passive & Stack Effect

Passive Ventilation

- Passive ventilation can be in numerous forms
- Cross ventilations using open windows and doors on both sides of a building and prevailing winds driving fresh air through
- Venetians use windows close to and either side of the corners of buildings to catch air currents in a tight urban environment
- Stack effect to draw air from warm interiors and draw cooler air in to replace it
- Lift and stair shafts have ventilation at their heads to release smoke this can add to the ventilation but probably is uncontrolled

Yurt: Roof vent

Passive stack ventilation

Passive Stack Ventilation

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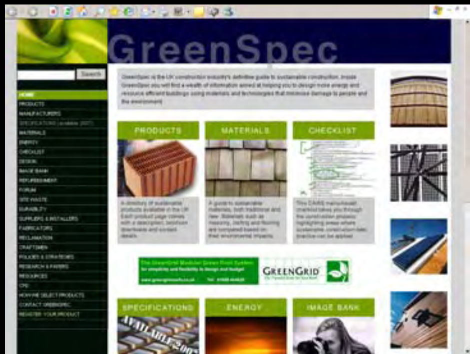
Active Ventilation

Air pressure driving passive ventilation



Active ventilation

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- Using Passive ventilation principles
- Adding controls and actuators to open and close valves, flaps and vents
- Harnessing the power of nature (wind pressure) to drive the passive systems

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Environmental Building

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- Shorne Wood
- BedZED
- Attenborough Centre

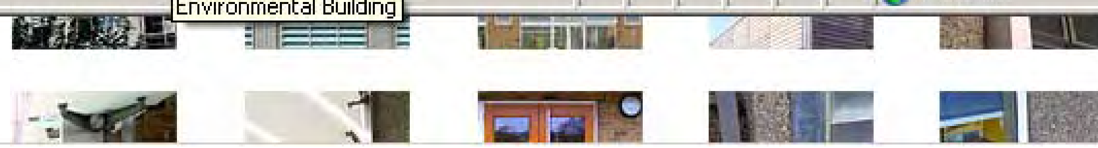

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Image Bank - Content

	Shorne Wood	Lee Evans Partnerships bravura display of structural timberwork using locally sourced sweet chestnut forms the essence of this visitor's centre at Shorne Wood Country Park set in the Kent Downs.
	BedZED	Bill Dunster's triumphant realisation of a sustainable urban live/work community.The development comprises of 82 homes, 18 work/live units for the Peabody Trust in the London Borough of Sutton.
	Attenborough Centre	Groundworks Architects RIBA Award winning exemplar building for the Attenborough Nature Centre. This visitors centre is located in a flooded gravel pit and features a wood frame and cladding along with solar panels and a water heat pump.
	Kingsmead School	White Design's all-wood primary school in Northwich caters for 150 children. It features natural ventilation and lighting, super-insulation, rainwater harvesting and use of photovoltaic and solar panels along with a bio-mass boiler heating system.
	Environmental Building	The BRE's offices at Garston is used to demonstrate all of the characteristics and attributes of what new "Green" building technologies have to offer.
		


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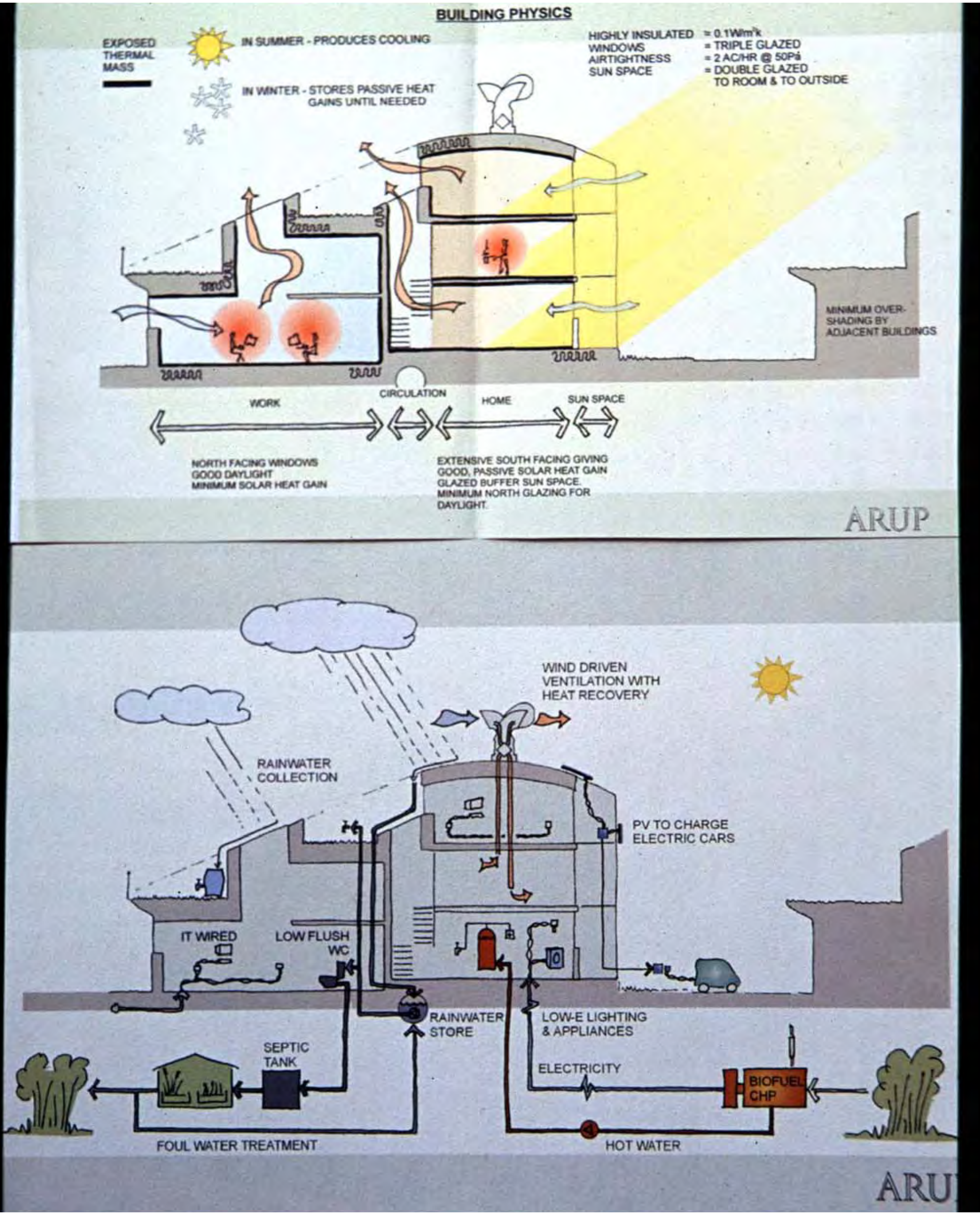


Wind pressure pushes fresh air in driving stale air out, with heat exchange to prevent heat loss

BedZED

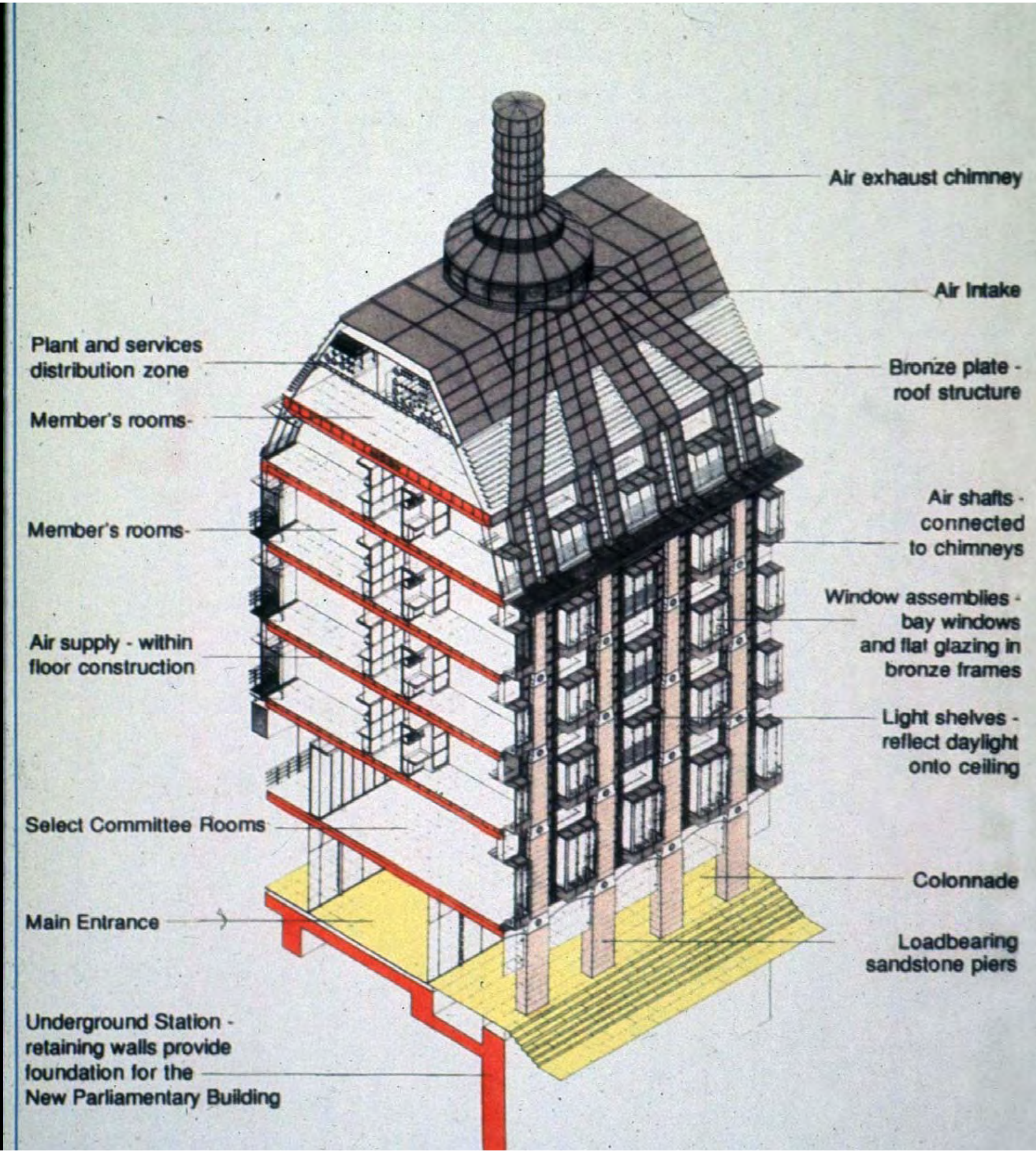
Active ventilation:

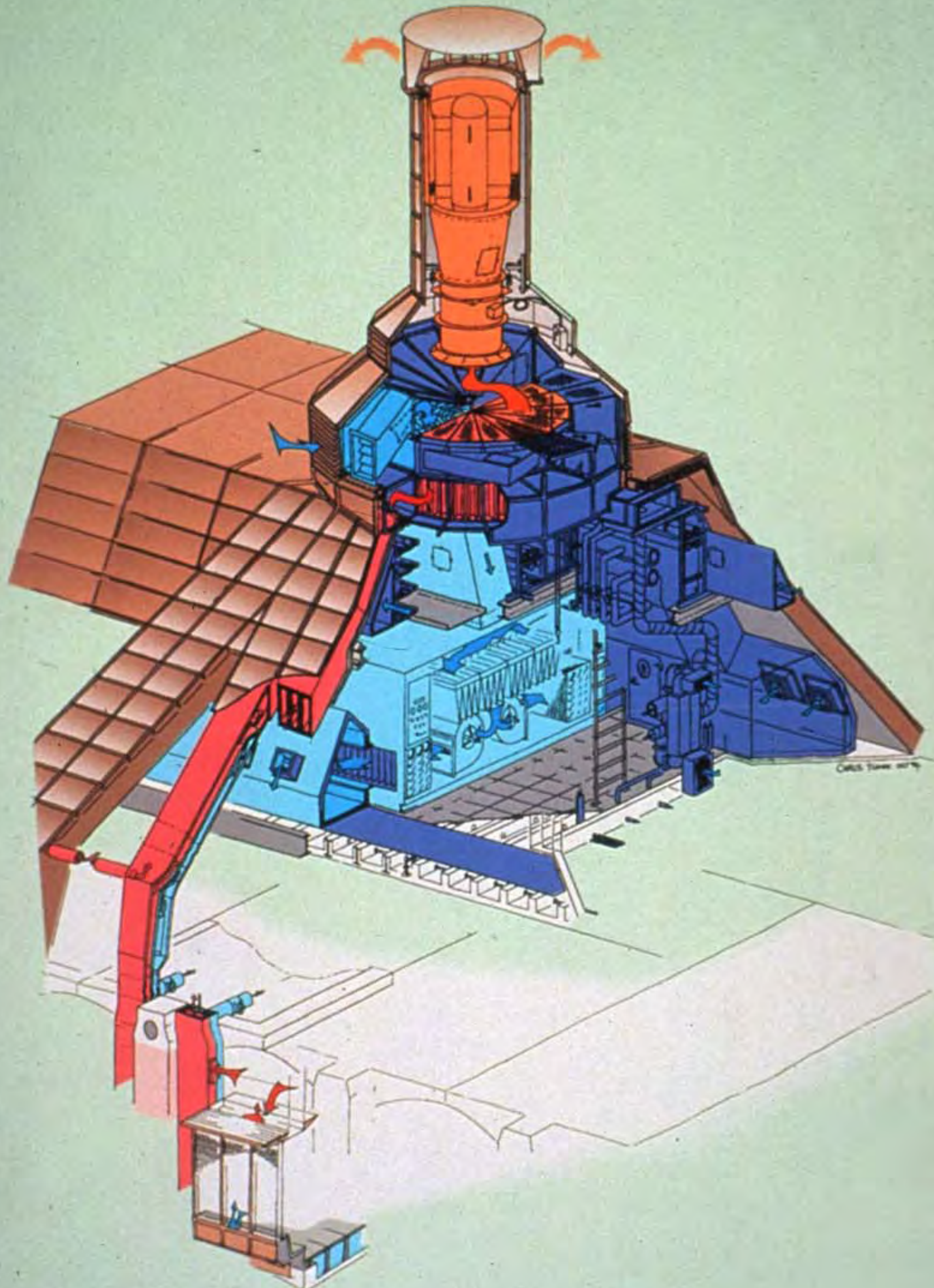
wind captured pushed into building, driving air out,

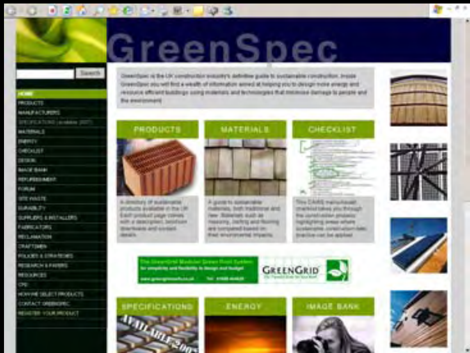
heat transferred where they pass

BedZED

Jubilee Campus Nottingham Uni


Air exhaust chimney
Air Intake
Plant and services distribution zone
Bronze plate - roof structure
Member's rooms-
Air shafts - connected to chimneys
Member's rooms-
Window assemblies - bay windows and flat glazing in bronze frames
Air supply - within floor construction
Light shelves - reflect daylight onto ceiling
Select Committee Rooms
Colonnade
Main Entrance
Loadbearing sandstone piers
Underground Station - retaining walls provide foundation for the New Parliamentary Building





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Stack Effect

Stack effect

- Chimney stacks are a route from the building interior to exterior at high level
- With a source of heat at the base the warmed less dense air will be buoyant and rise to high level
- Cooler air will be drawn in to replace the warmed air leaving by the chimney
- Once the flow is started this effect is self propelling
- A venturi throating makes this irresistible
- This is called the stack effect and it can be exploited in designs to ventilate buildings

Stack effect Brick Kilns: Often lime making in widespread cottage industry

Chimneys use stack effect

Cooling Towers: stack effect but not to be confused with building ventilation


Chimneys are part of UK history and
a part of our psyche


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Stack Vents to car parking

Staircase void can play its part in the stack effect

Need air in at bottom and air out at top

Roof lights, windows & vents

- High level rooflights are an essential part of passive ventilation using the stack effect without the chimney
- They need to be well insulated to minimise winter heat loss
- They are best controlled to ensure optimum performance: i.e. once a temperature is reached then open to get the stack effect off to a good start


Iron age round house
Castle Henlly S. Wales


Perimeter ventilation, cooking and heating fire and vented apex

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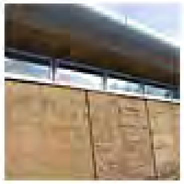
Downland Gridshell
Interger Millenium House
Eden Visitor Centre





Eden Project - Windows Internet Explorer

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Eden Project

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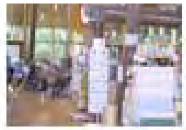
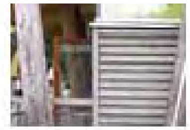
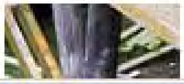
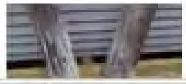
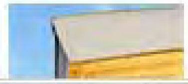
Stack effect: Rooms
Opening Rooflights and windows

Interger Millenium House
Eden Visitor Centre



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Double click to change security settings

Stack effect: circulation areas needs low level perimeter air in

National Trust HQ Swindon

Chimneys replaced by Passivent at Greenwich Millennium Village

Humidity Actuated Vents

- Passivent closed normally
- Humidity sets off vent to open and release air
- Using stack effect the humid hot air rises up the vent pipe to evacuate at high level externally

Sun Pipes & Passive Vents

- Sunpipes bring daylight and sunlight to the interior of building with no windows
- Add concentric ventilation duct
- Include valves
- But heat recovery from ventilation not normally available
- Modern substitute for the light well and chimney

Stack ventilator/sun pipe

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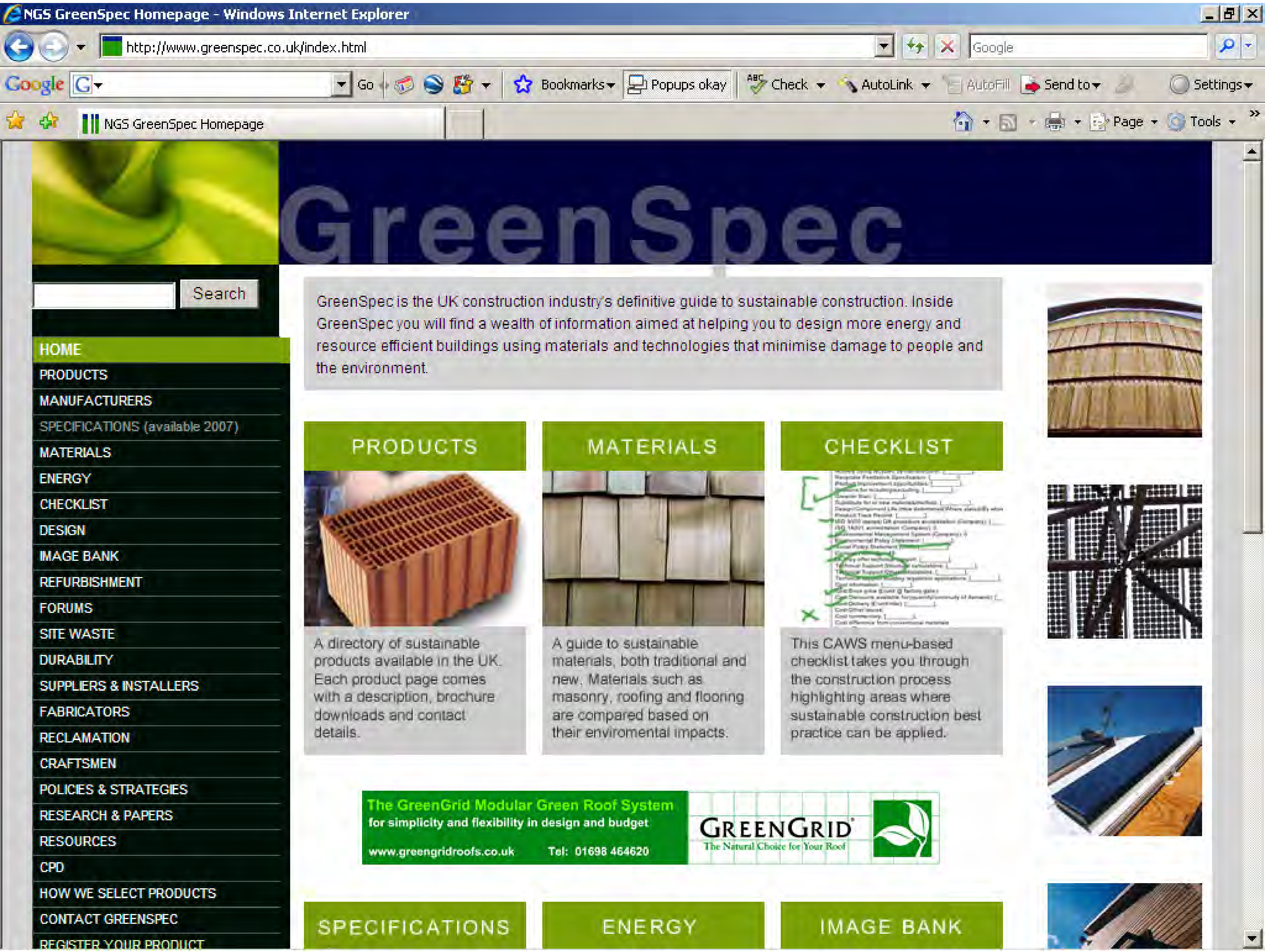
GreenSpec Products

Ventilation and light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GreenSpec is the UK construction industry's definitive guide to sustainable construction. Inside GreenSpec you will find a wealth of information aimed at helping you to design more energy and resource efficient buildings using materials and technologies that minimise damage to people and the environment.
PRODUCTS
A directory of sustainable products available in the UK. Each product page comes with a description, brochure downloads and contact details.
MATERIALS
A guide to sustainable materials, both traditional and new. Materials such as masonry, roofing and flooring are compared based on their enviromental impacts.
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This CAWS menu-based checklist takes you through the construction process highlighting areas where sustainable construction best practice can be applied.
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- L2 Complete construction entities
- L3 Structural and space division
- L4 Access, barrier and circulation

L753 Impelling Equipment

natural ventilation / extraction

Manufacturer	Product	Type	
Monodraught	Windcatcher	passive stack ventilation system	✓

Key

product / equipment with climate change reduction potential

Monodraught 'Windcatcher'

Passive stack ventilation system

Windcatcher technology provides natural ventilation without any moving parts. Using compartmentalised vertical vents, fresh air is brought into the room and stale warm air expelled using the natural effects of the wind.

The system works through normal atmospheric properties where warm air rises and decreases the air pressure within a room so that cooler air falls into the room. This is a subtle change in air pressure and it produces only enough airflow to make the room comfortably fresh.

Stale and stagnant air is extracted by the wind blowing onto the wind-ward side of the windcatcher, with the stuffy air going out through the leeward side of the ventilation stack.'

Manufacturer's evidence rating:*	★
Material/s:	unknown
Environmental statement:	none
BRE Ecopoints:	unrated
BRE Environmental profile:	unrated
Other environmental standards:	none
3rd party accreditation:	none
3rd party product endorsement:	none
Reusability / Recyclability:	unknown
% of post consumer waste:	unknown
Life expectancy	unknown
Substitute for or new materials / method:	mechanical ventilation
Editors' comments:	

PRODUCTS CONTENTS
L2 Complete construction entities
L3 Structural and space division
L4 Access, barrier and circulation
L5 Coverings, claddings, linings
L6 General purpose fabric
L7 Services
L8 Fixtures and furnishing

Life expectancy	unknown
Substitute for or new materials / method:	mechanical ventilation
Editors' comments:	
Country/s of manufacture:	UK
UK distribution location:	Buckinghamshire
Downloads:	Product brochure
Product specification clause:	-
Work sections:	-
Manufacturer:	Monodraught Ltd.
Address:	Halifax House, Cressex Business Park, High Wycombe, Bucks HP12 3SE
Telephone:	01494 897700
Email:	info@monodraught.com
Website:	www.monodraught.com
Available direct:	yes
Suppliers:	Monodraught
Alternative products:	Ventilation
Further information:	
Information last updated:	Monday 24th, July 2006

The product has been selected on the above average performance in the following areas:

-	Abiotic depletion	-	Acidification
✓	Global warming	-	Eutrophication
-	Ozone layer deplection	-	Solid Waste
-	Human toxicity	-	Radioactivity
-	Fresh water aquatic ecotoxicity	-	Minerals extraction
-	Terrestial exotoxicity	-	Water extraction
-	Photochemical oxidation		

*Note:

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L414 Rooflights

sunpipes

Manufacturer	Product	Type	🌍	⌂	♻
Monodraught	SunPipe	sun pipe	✓		
	SunCatcher	combined sun pipe & passive stack ventilation system (domestic size)	✓		

Key

🌍 product / equipment with climate change reduction potential
⌂ sustainable product
♻ product with recycled content

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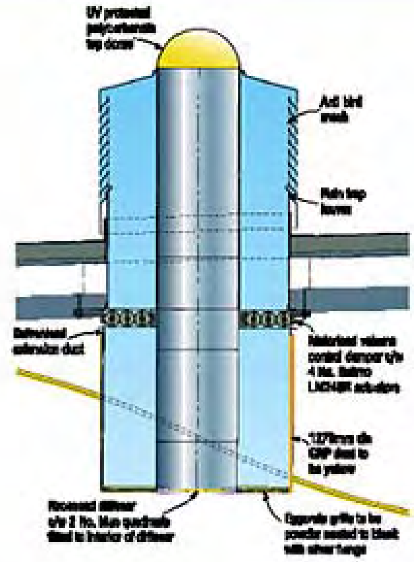
Monodraught 'SunCatcher'

Combined sun pipe & passive stack ventilation system (domestic size)

Monodraught SunCatchers provide a most satisfactory solution of combining natural light and natural ventilation in one composite unit.

The Monodraught SunCatcher system provides controlled natural ventilation as well as providing all the benefits of natural daylight. Any prevailing wind pressure carries a continuous fresh air supply through weather protected louvres on the windward side of the system at roof level. The wind movement is encapsulated by internal quadrants which turns the wind through 90° forcing air down through internal ducts into the room below, slightly pressurising the internal space. Warm, stale air is expelled from the room by the Passive Stack ventilation principle of differential temperatures and the natural buoyancy of air movement. Manual or motorised motors at the base of the system control the rate of ventilation. The central SunPipe is integrated into the system and conveys natural daylight to the same room
or internal space.'

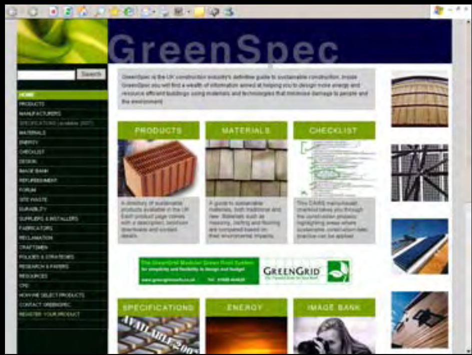
Manufacturer's evidence rating:*	★
Material/s:	includes aluminium, polycarbonate and nylon
Environmental statement:	none
BRE Ecopoints:	unrated
BRE Environmental profile:	unrated
Other environmental standards:	none
3rd party accreditation:	none
3rd party product endorsement:	none
Reusability / Recyclability:	aluminium is recyclable
% of post consumer waste:	unknown
Life expectancy	unknown



3rd party product endorsement:	none
Reusability / Recyclability:	aluminium is recyclable
% of post consumer waste:	unknown
Life expectancy	unknown
Substitute for or new materials / method:	lighting systems & mechanical ventilation
Editors' comments:	
Country/s of manufacture:	UK
UK distribution location:	Buckinghamshire
Downloads:	Product brochure
Product specification clause:	-
Work sections:	-
Manufacturer:	Monodraught Ltd.
Address:	Halifax House, Cressex Business Park, High Wycombe, Bucks HP12 3SE
Telephone:	01494 897700
Email:	info@monodraught.com
Website:	www.monodraught.com
Available direct:	yes
Suppliers:	Monodraught
Alternative products:	Natural lighting
Further information:	
Information last updated:	Monday 24th, July 2006

The product has been selected on the above average performance in the following areas:

-	Abiotic depletion	-	Acidification
✓	Global warming	-	Eutrophication
-	Ozone layer deplection	-	Solid Waste
-	Human toxicity	-	Radioactivity
-	Fresh water aquatic ecotoxicity	-	Minerals extraction
-	Terrestial exotoxicity	-	Water extraction
-	Photochemical oxidation		



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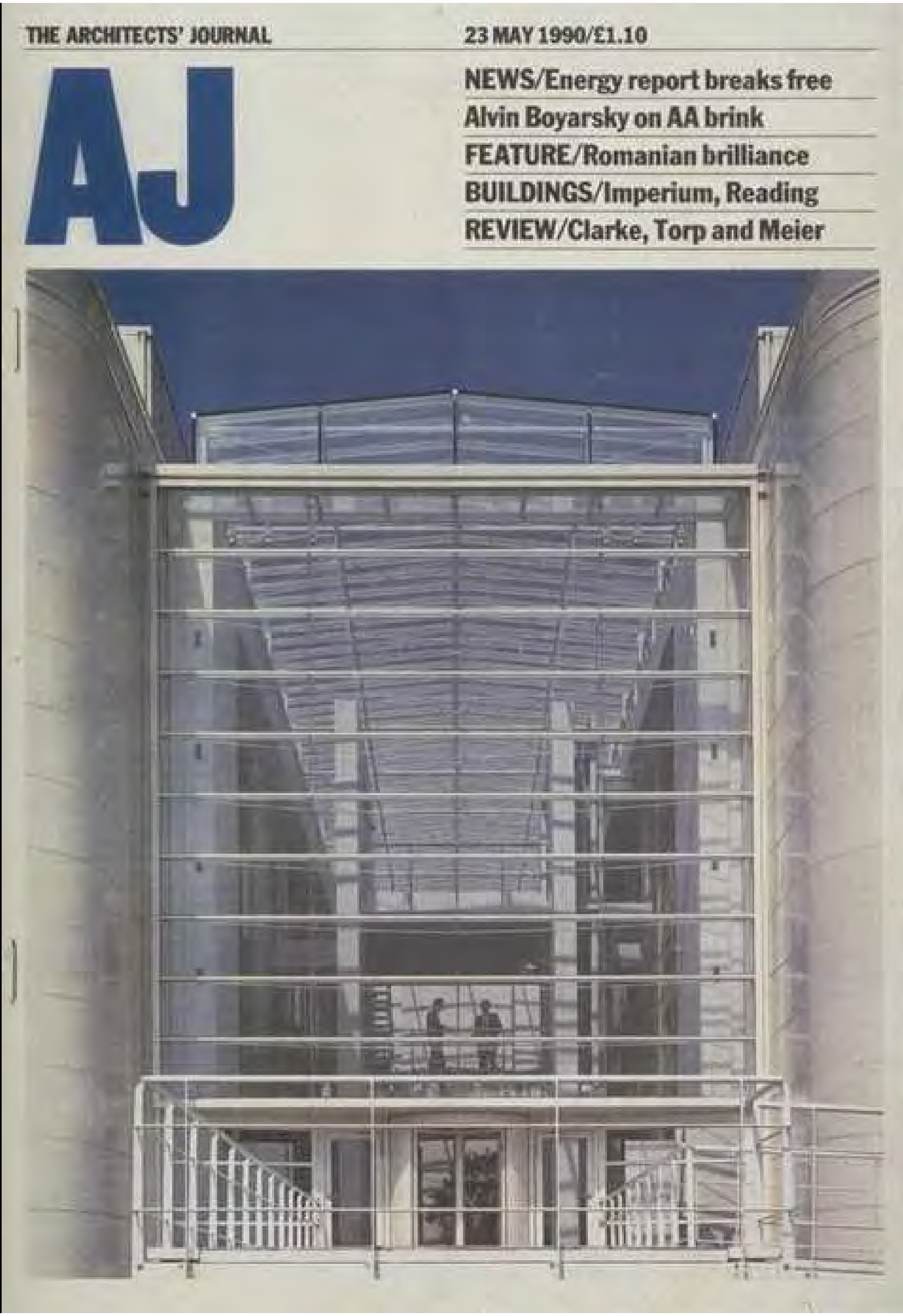
Atrium & Atria

Atrium

- Atrium could be described as Courtyard with roof
- They provide the usual wind shelter, some sun penetration and added opportunities:
- The help to minimise the heat loss from walls that face the courtyard by preventing the rising heat being lost to the sky
- They allow those walls to be open to the atrium
- The Atrium may also include walkways and balconies adjacent to the atrium
- There will be implications for fire strategy of building
- They may have smoke vents at high level and replacement air vents at low level
- These may act as cooling vents in hot weather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FEATURE/Romanian brilliance
BUILDINGS/Imperium, Reading
REVIEW/Clarke, Torp and Meier


Imperium
Reading
Bennetts Associates

Atrium, Left: offices, Right: Open Plan

Devonshire Building Newcastle

Sometimes Lift Cars add to air movement

or lift shafts lose heat via permanent vents

Atria in 3 parts
helix at the edge of
the building
In 3 zones
7 stories each.
Casements in façade
or in pavement

Test Yourself

- Part 6
- What are the necessary parts of Stack effect?
- Stack effect has been exploited for many centuries name an early example
- How can stack effect be used today

How did you do?

- Part 6
- A vertical space or duct with heat or heat source at bottom, exit for air at top and entry for air at bottom
- Iron age fort roundhouse
- To remove hot air from buildings by permitting cool air in to replace hot stale air which rises through high level vents

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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

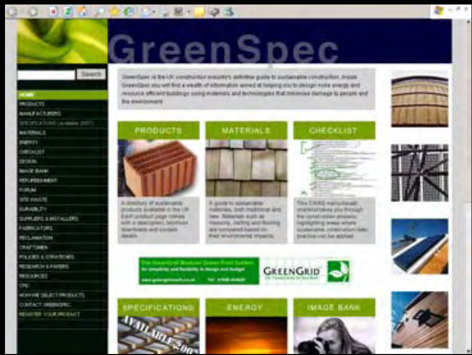
- Face Housing at sun to collect the heat
- Morning sun for waking
- Avoid sleeping rooms heating in afternoon and evening
- Offices generate heat so do not need to face the sun

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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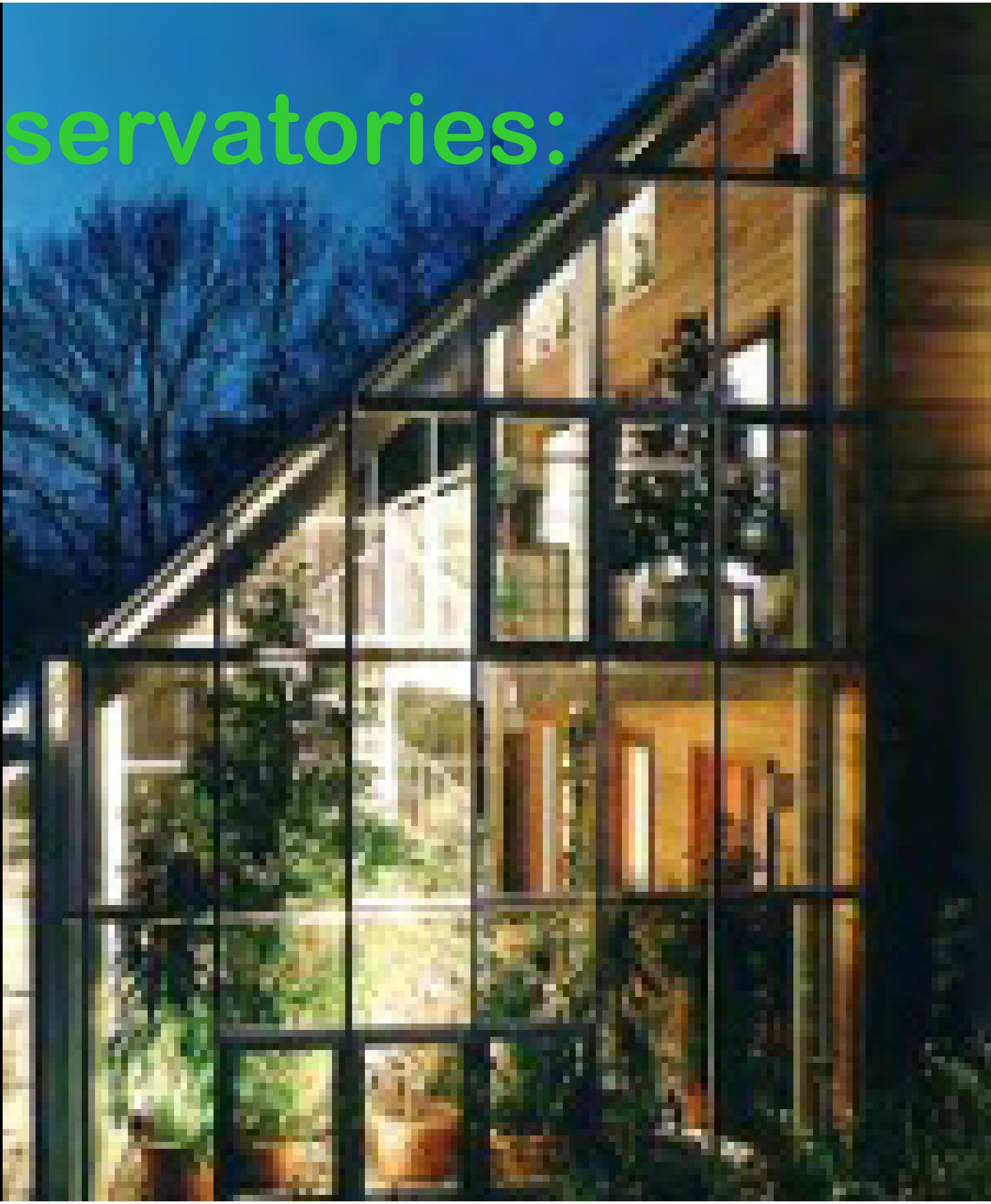
Conservatories

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

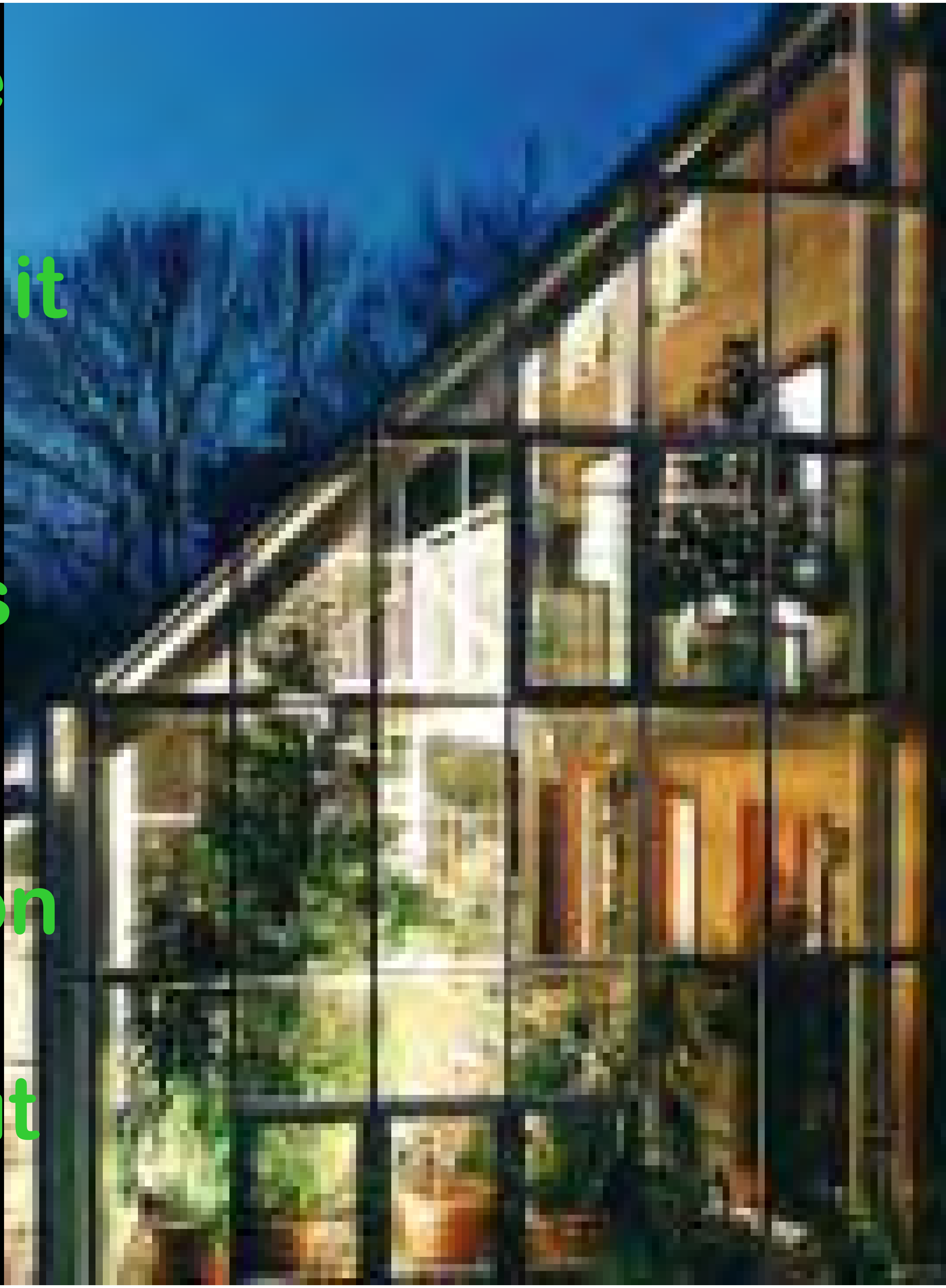
1NTEGER house conservatory at BRE is not all that it could be

Single glazed

No thermal mass back wall,

open to living accommodation on top floor.

Just sheltered out door space



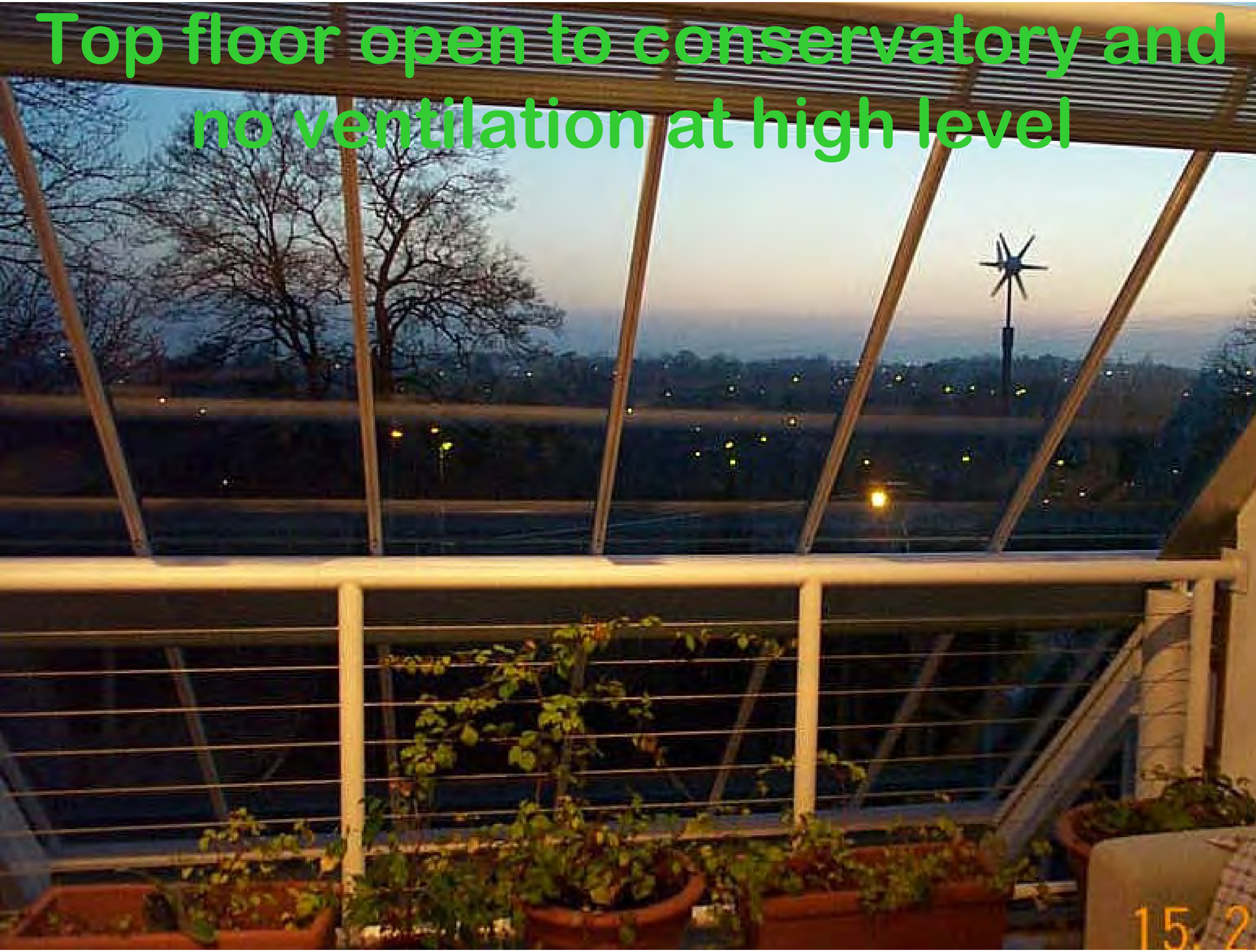
Opening vents in side walls of conservatory but only half way up the height of the conservatory


15. 2. 2001

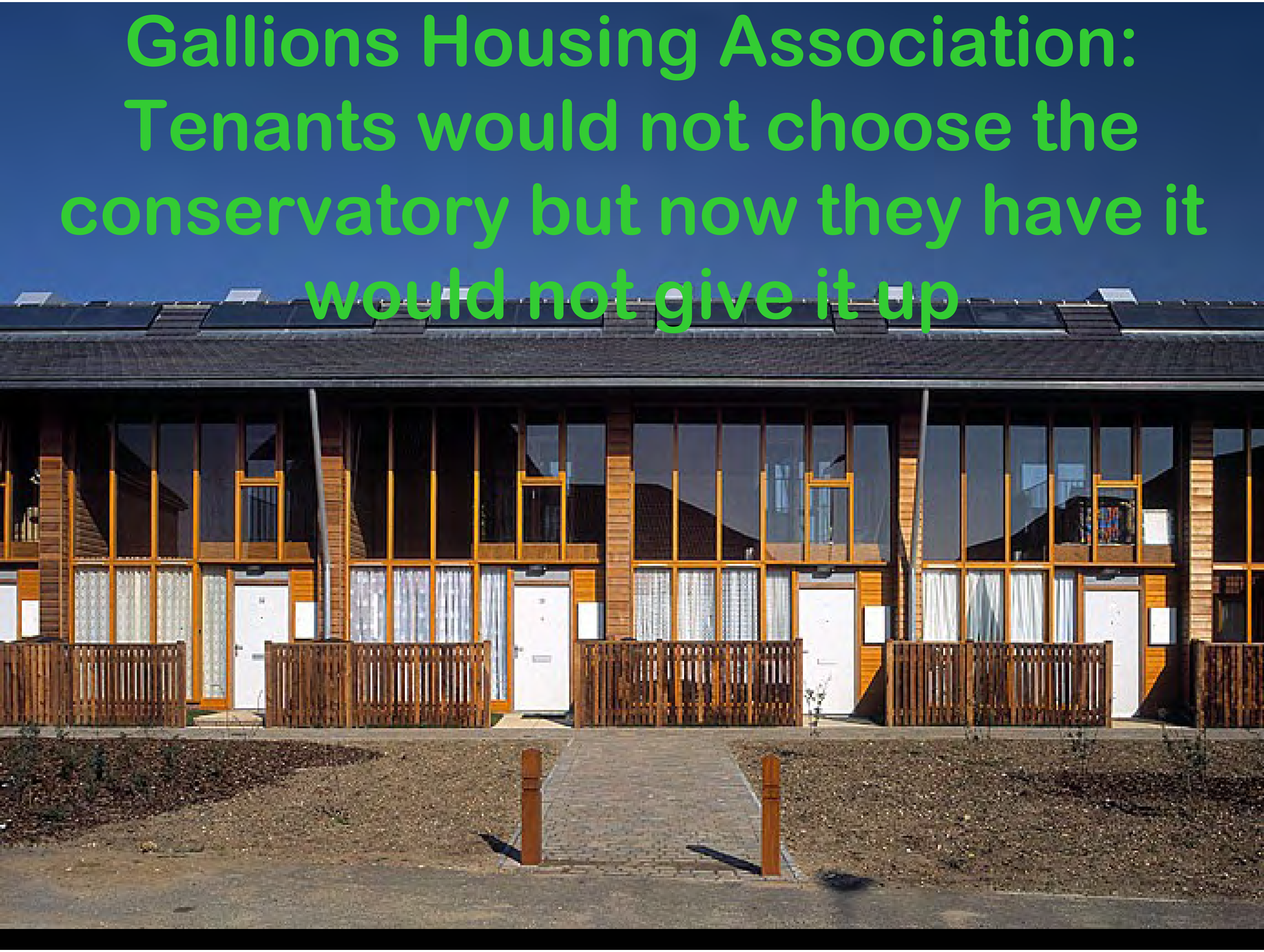
No vents on the slope
some PV and ST panels
inadequate for the job?

Internal Solar shading over whole of slope

Control via internet


Top floor open to conservatory and
no ventilation at high level
15. 2

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

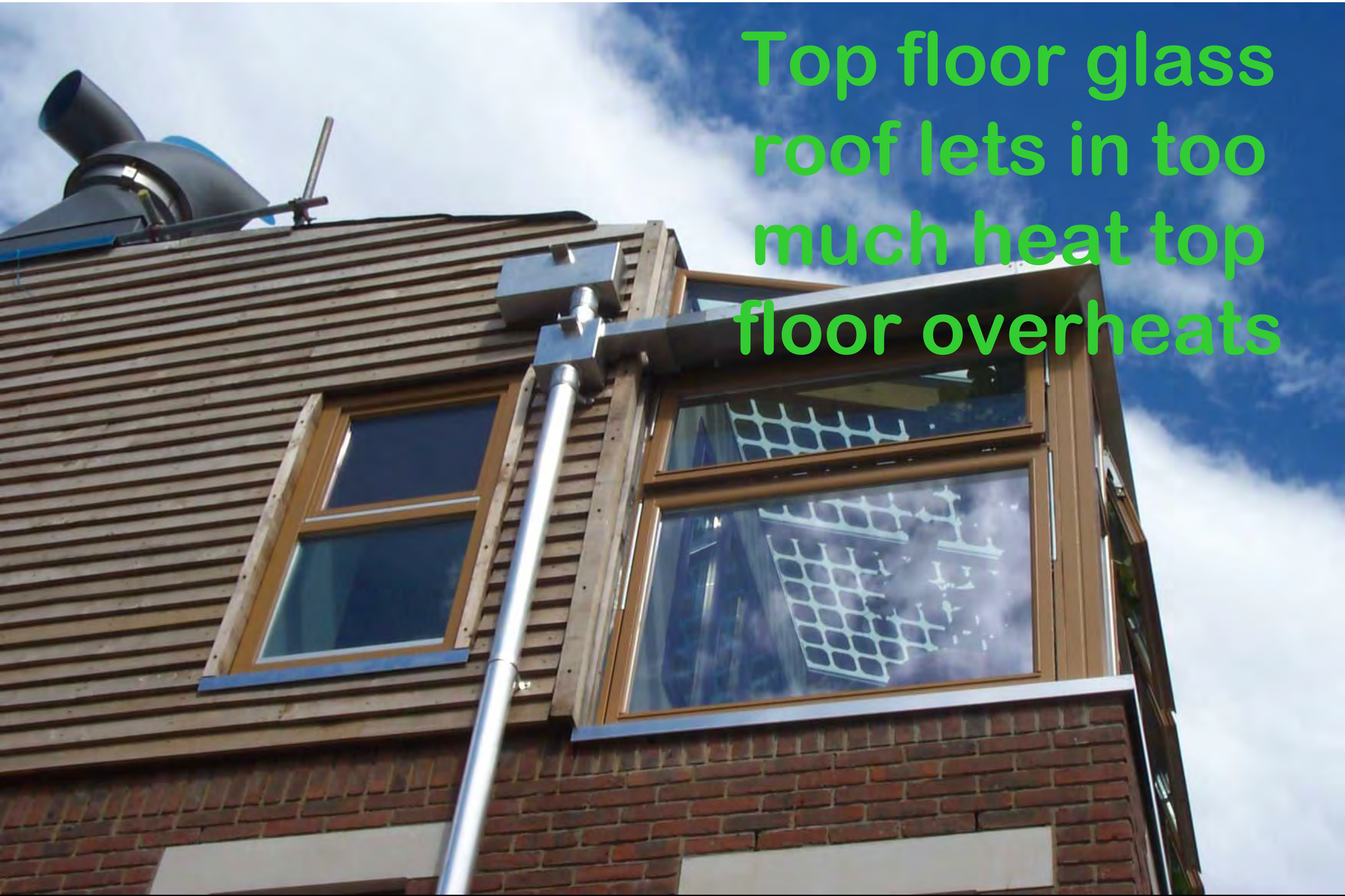
- Conservatories are double glazed and Low Emissivity coated to allow the heat in, prevent it escaping and trap the heat for use
- Doors and windows from conservatory to house are triple glazed Low E for the same reason
- The doors and windows are closed not letting any heat from building out into conservatory
- 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

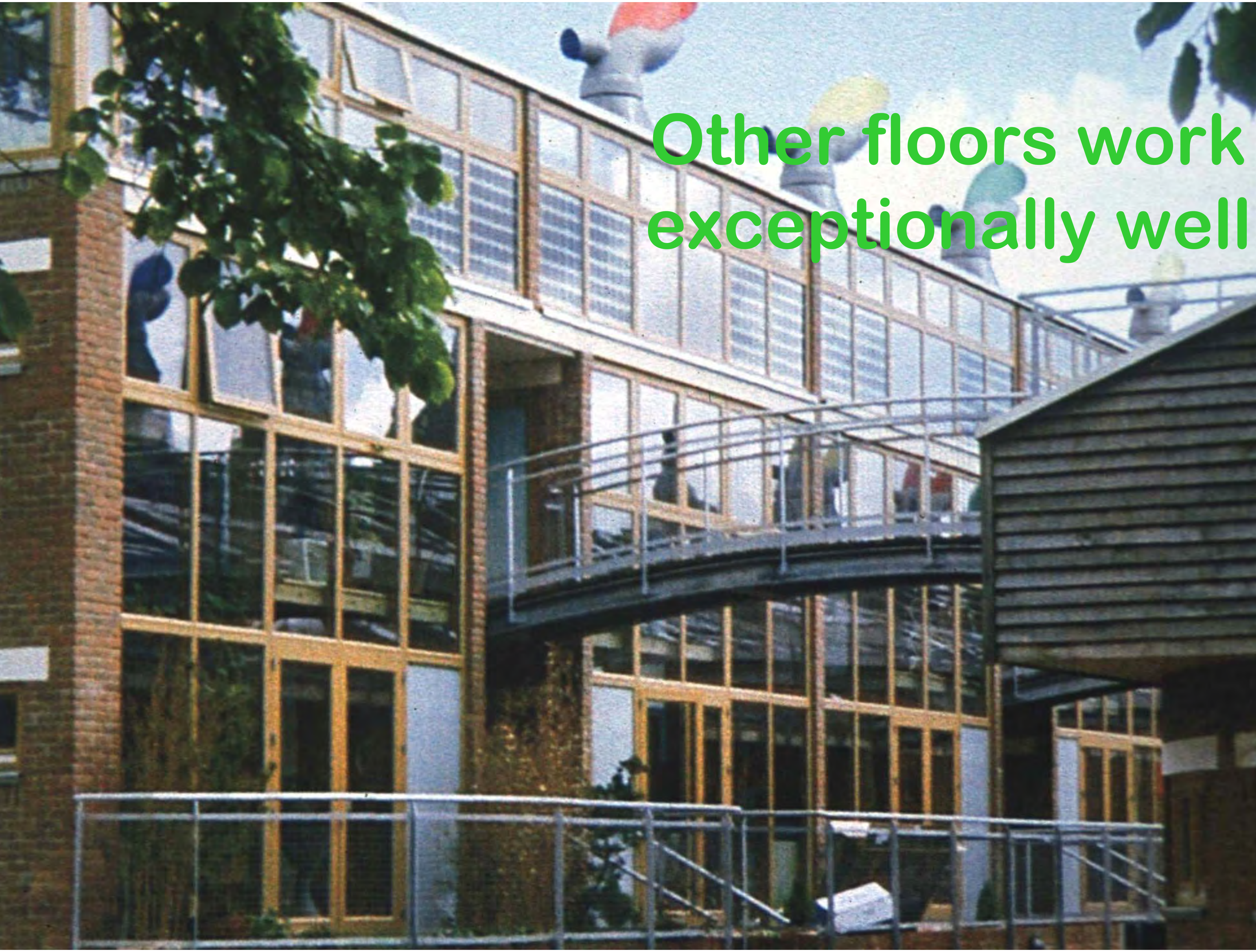
Green Houses and Conservatories: Winter

- 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

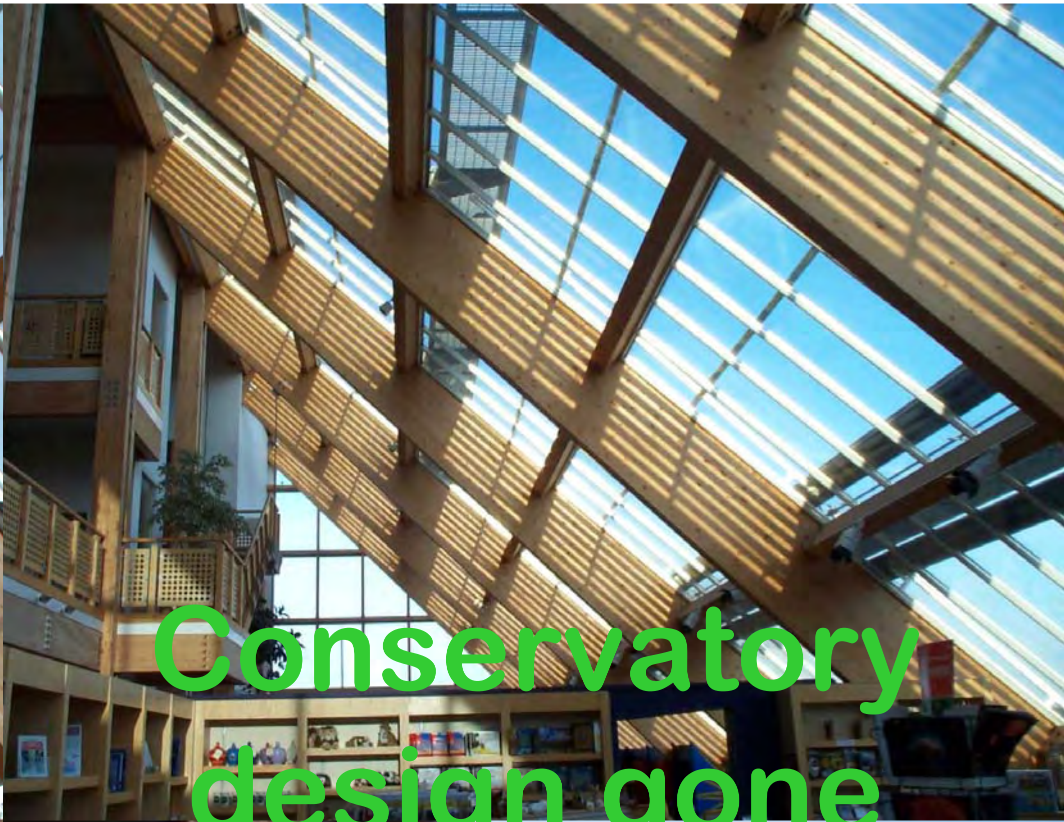

Top floor glass roof lets in too much heat top floor overheats


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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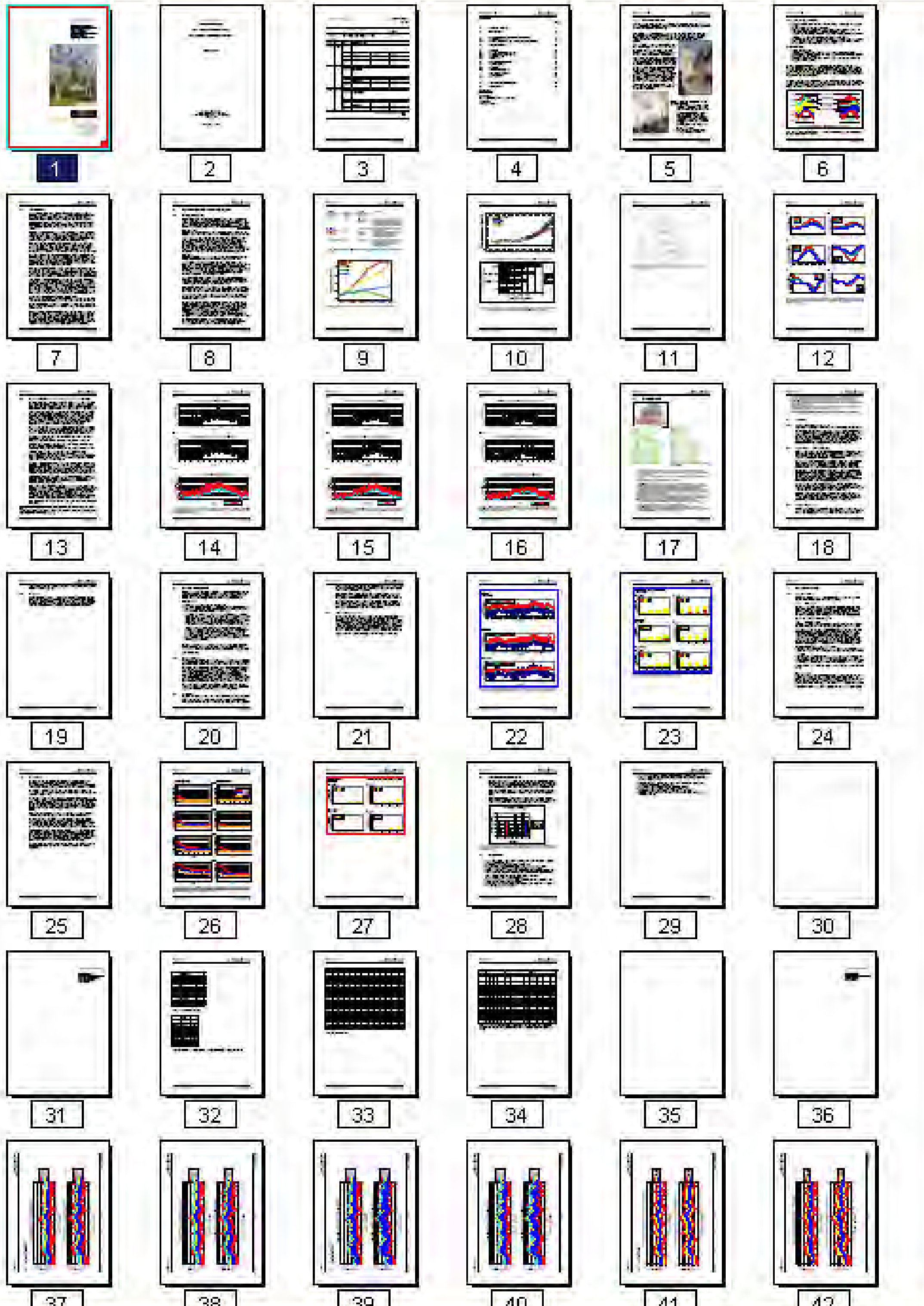
Thermal Mass

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

bdaZEDfactory

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 ▾ ×

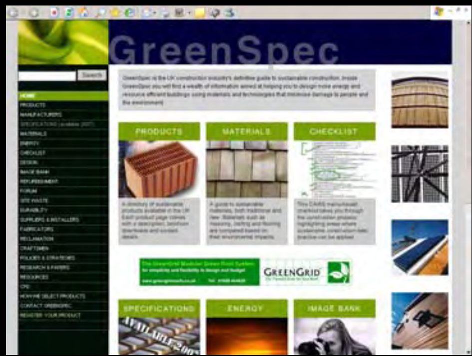
The Concrete Centre™

Thermal Mass for Housing

CONCRETE SOLUTIONS FOR THE CHANGING CLIMATE

Exploiting thermal mass

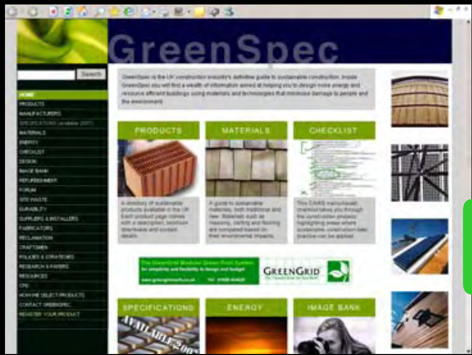
- If the building has high thermal mass and its surfaces are exposed
- they can be exploited in both heating and cooling
- In winter the mass can be heated in the day the heat stored for exploitation in the night
- In summer the mass can be cooled in the night and exploited in the day



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



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Hollow core floors

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

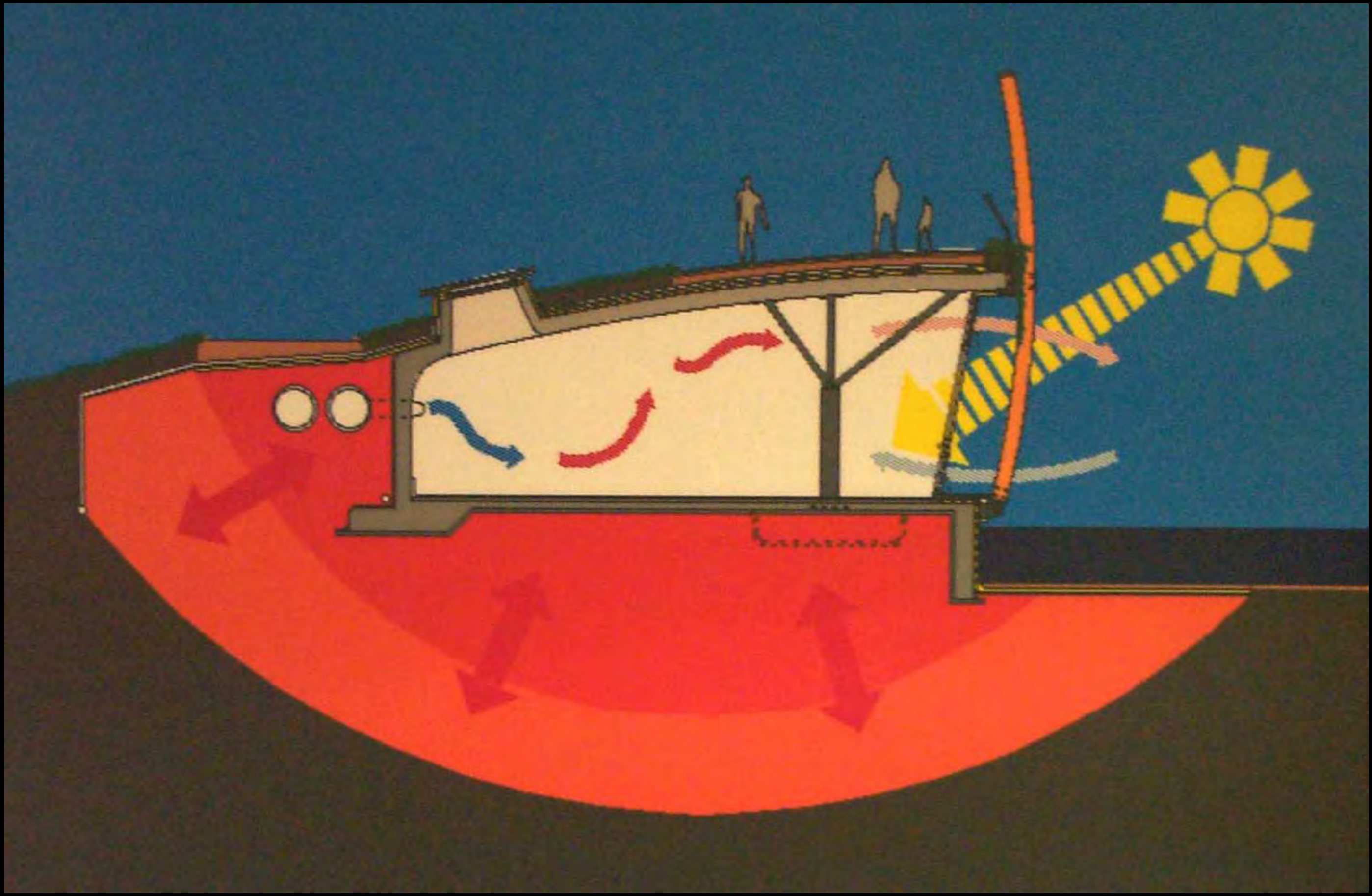
Overnight Purge Cooling

- 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

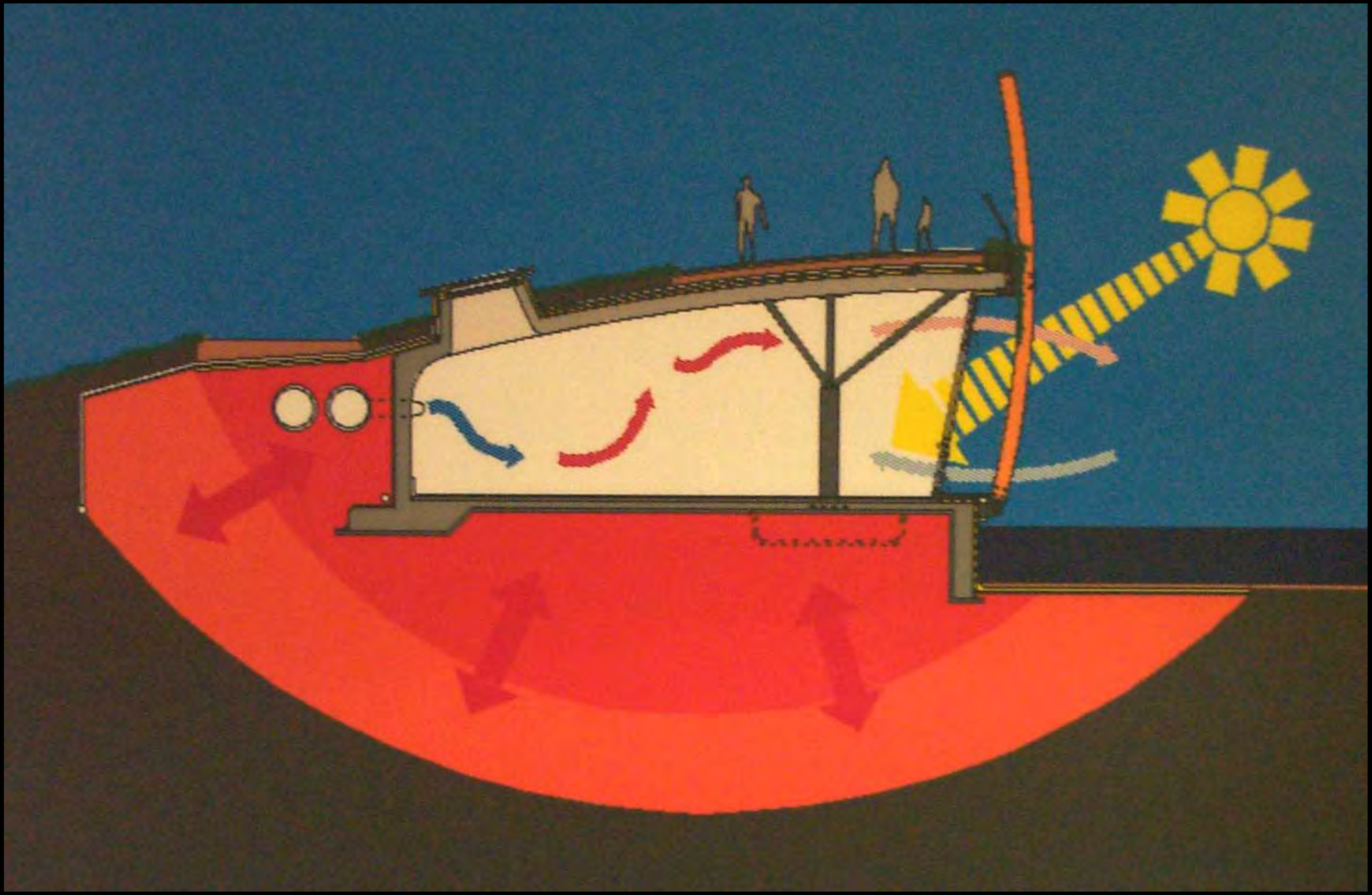
Zero Energy Development



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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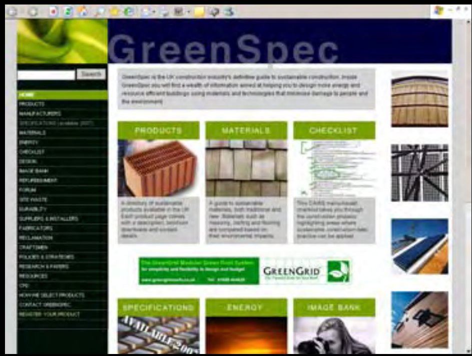
ZED Zero Energy Development

Hockerton HHP

BedZED

Mile End Park

Another GreenSpec CPD seminar to consider



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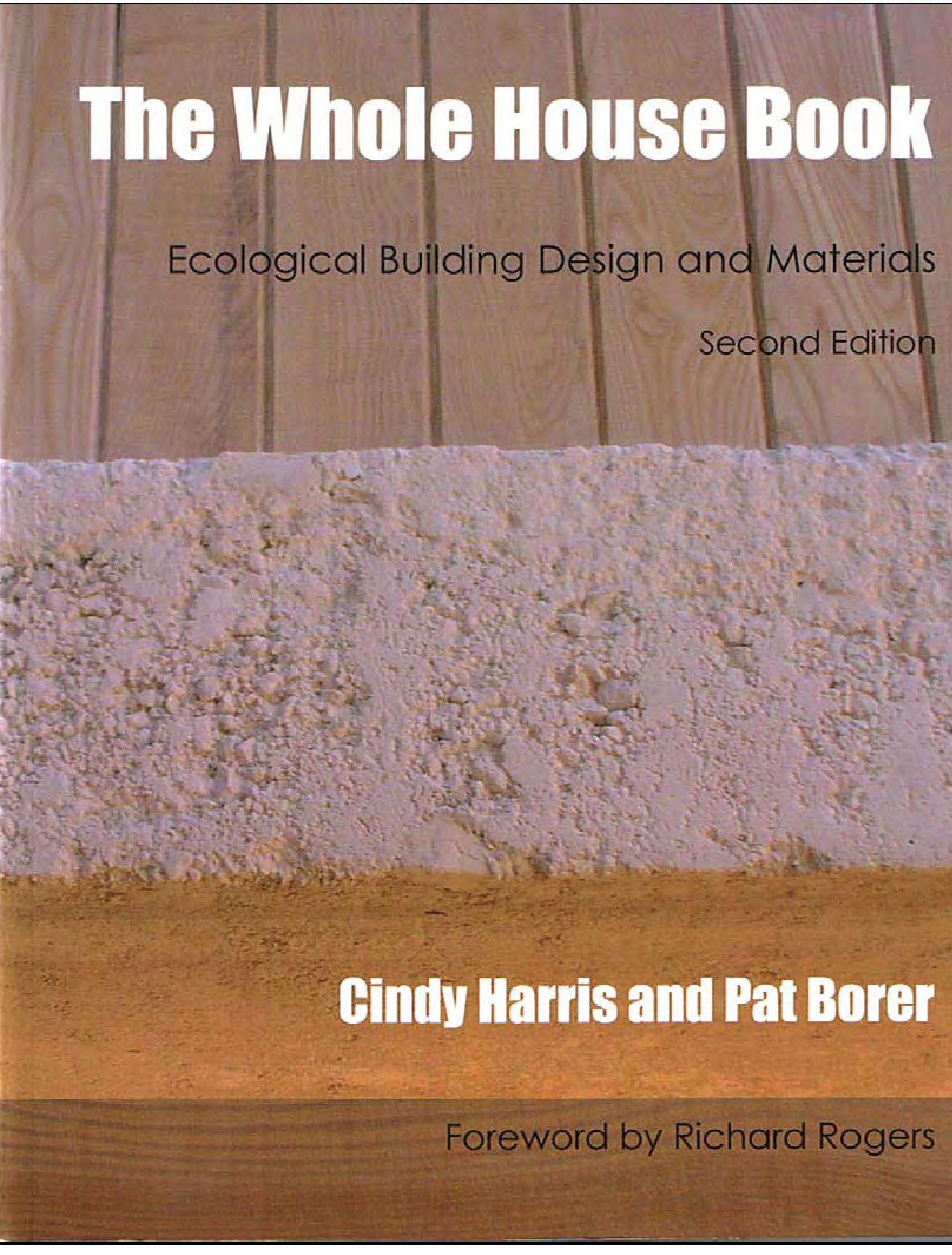
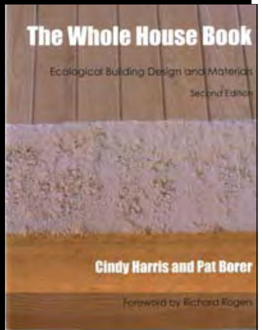
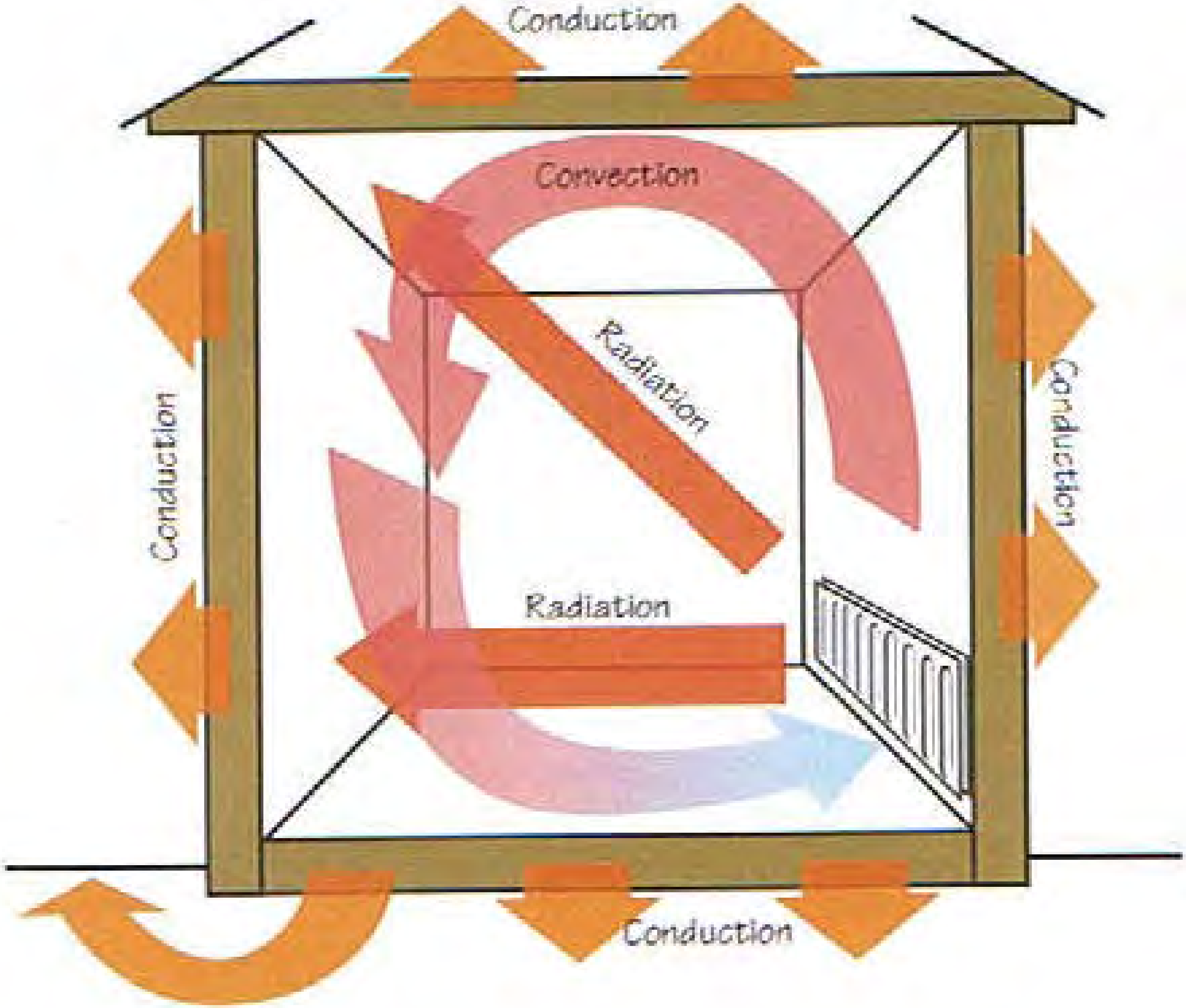
Conduction
Convection
Radiation
Conduction

Radiators (Convectors)



Publisher: CAT Centre for Alternative Technology Publications
2nd edition
ISBN: 1-90217-522-0
£35 (worth it)


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

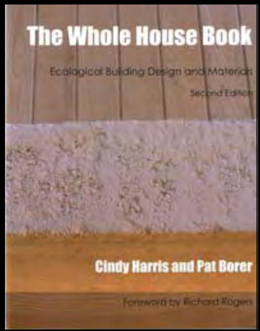
- Available in ceiling, walls and floors
- Ceilings usually electric (avoid)
- Walls and floors usually piped hot water
- Low temperature compared to radiators (convectors)
- Radiate heat at objects in the space to warm them directly
- They in turn may radiate heat too
- No heat gradients

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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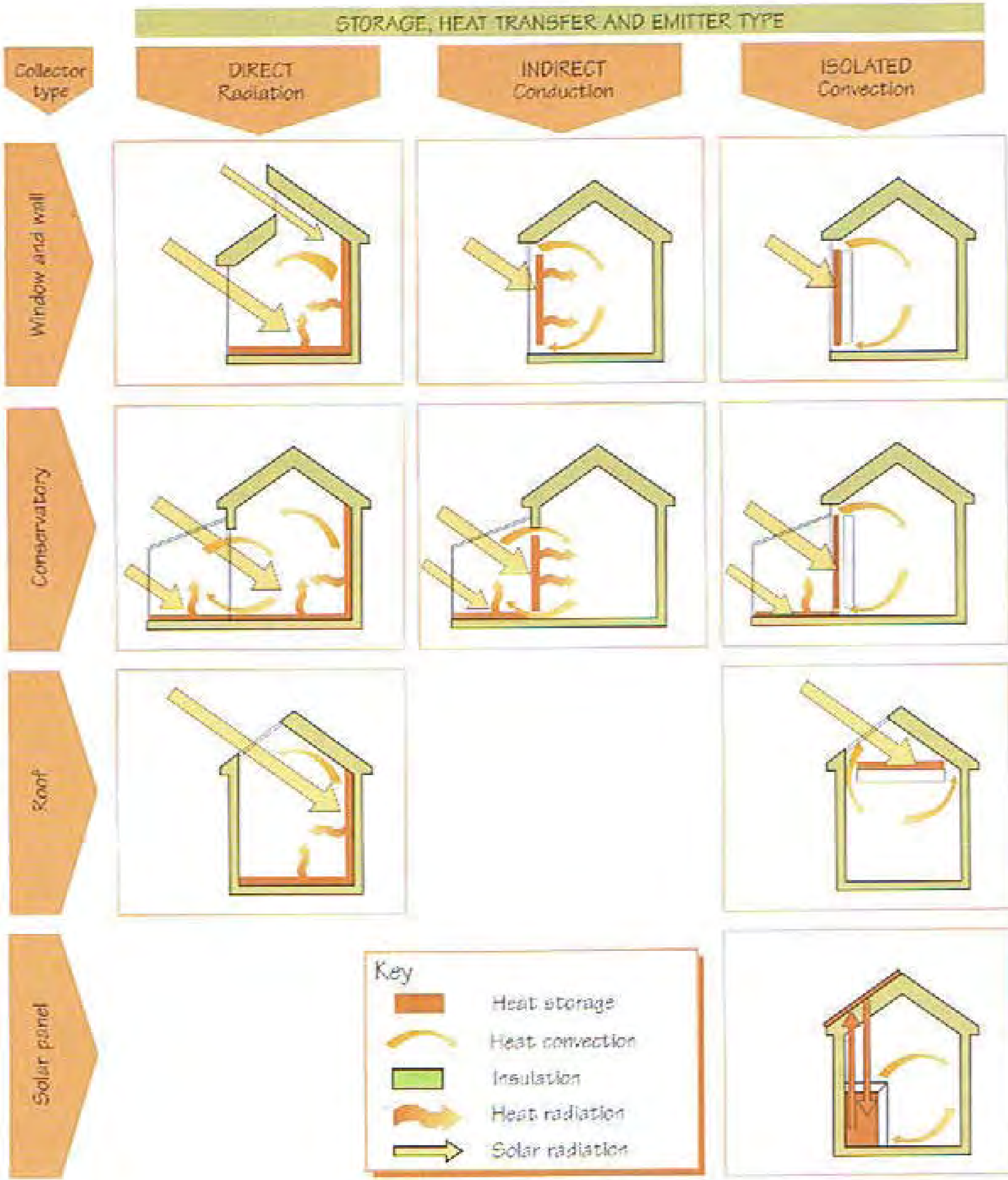
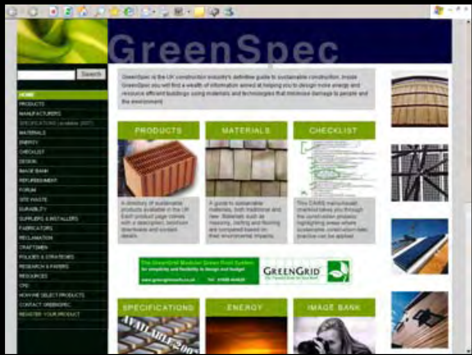

STORAGE, HEAT TRANSFER AND EMITTER TYPE
Collector type
DIRECT Radiation
INDIRECT Conduction
ISOLATED Convection
Window and wall
Conservatory
Roof
Solar panel
Key
Heat storage
Heat convection
Insulation
Heat radiation
Solar radiation

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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Solar Shading

Used to shade or permit sun passage

Solar shading:
Common in mainland Europe
Will become more important in the UK if only we knew how

100% glazed façade requires 100% air conditioned office

Operational Energy

Passive solar control avoids mechanical ventilation and air-conditioning in summer

City Place, Gatwick

Wessex Water

Solar shading on west & north faces

just the same, but sun paths different

GreenSpec

Environmental Building - Windows Internet Explorer

http://www.greenspec.co.uk/html/imagebank/jspw3_pop.htm?.._v_w_d_.._v_w_d_images_v_w_d_imagebank_v_w_d_BREEnviro_v_w_d_BRE1.jpg,812,1,,0,E

HOME
PRODUCTS
MANUFACTUR
SPECIFICATIO
MATERIALS
ENERGY
CHECKLIST
DESIGN
IMAGE BANK
REFURBISHME
FORUMS
SITE WASTE
DURABILITY
SUPPLIERS & I
FABRICATORS
RECLAMATION
CRAFTSMEN
POLICIES & ST
RESEARCH & I
RESOURCES
CPD
HOW WE SELE
CONTACT GRE
REGISTER YO

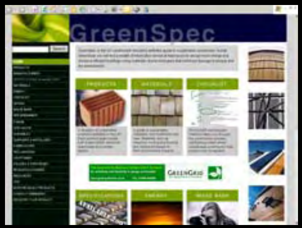
Done

Environmental Building

Internet

100%

IMAGE BANK (
Shorne Wood
BedZED



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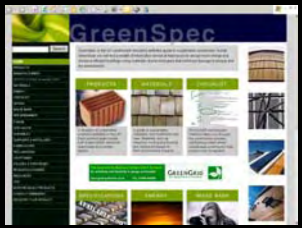
Solar Shading or Brise Soleil

L15 External Solar Shading

Another GreenSpec CPD seminar to consider



COMMENDED
The UK
eWell-Being
Awards 2004
www.sustainit.org

www.greenspec.co.uk

Alternative Solar Shading

In all its forms

Another GreenSpec CPD seminar to consider

Solar Shading: Trees

- Trees also create shelter from the sun in the summer
- Deciduous trees drop leaves in autumn and allow sun to pass in the winter
- Trees can protect from summer solar gains and permit winter solar gains
- Solar gains can be manipulated to create internal air movement and exploited thermally


Deciduous tree belts in winter

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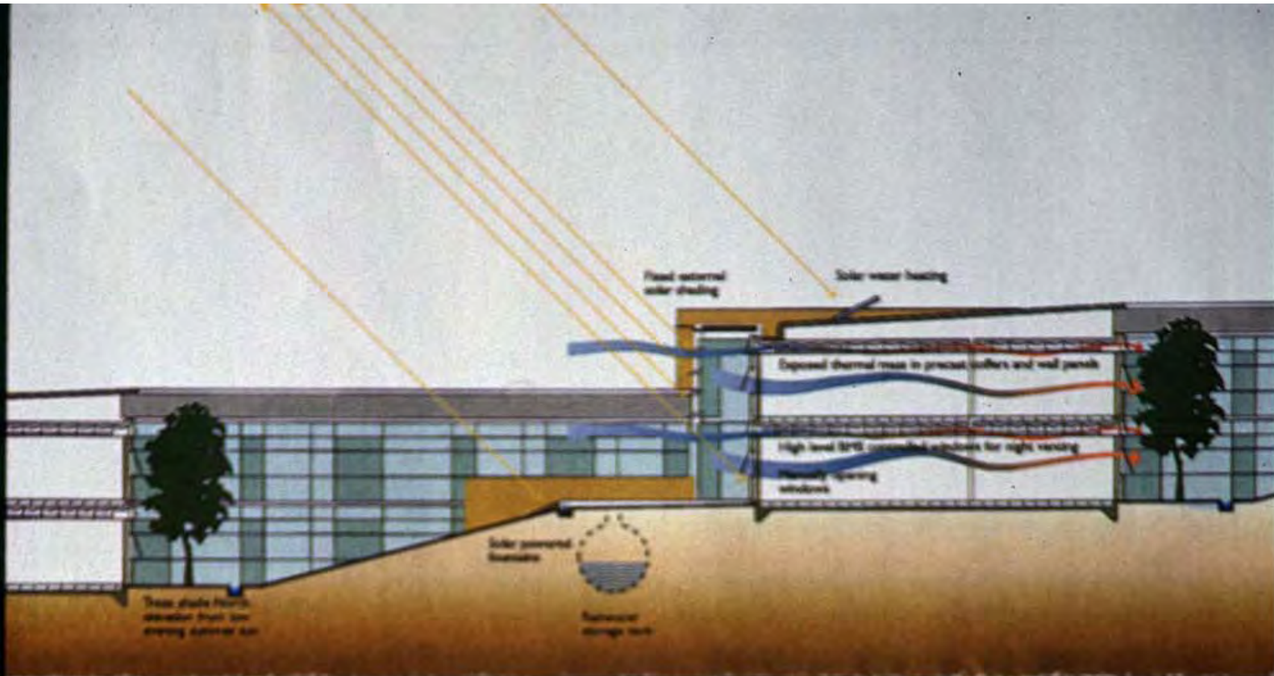
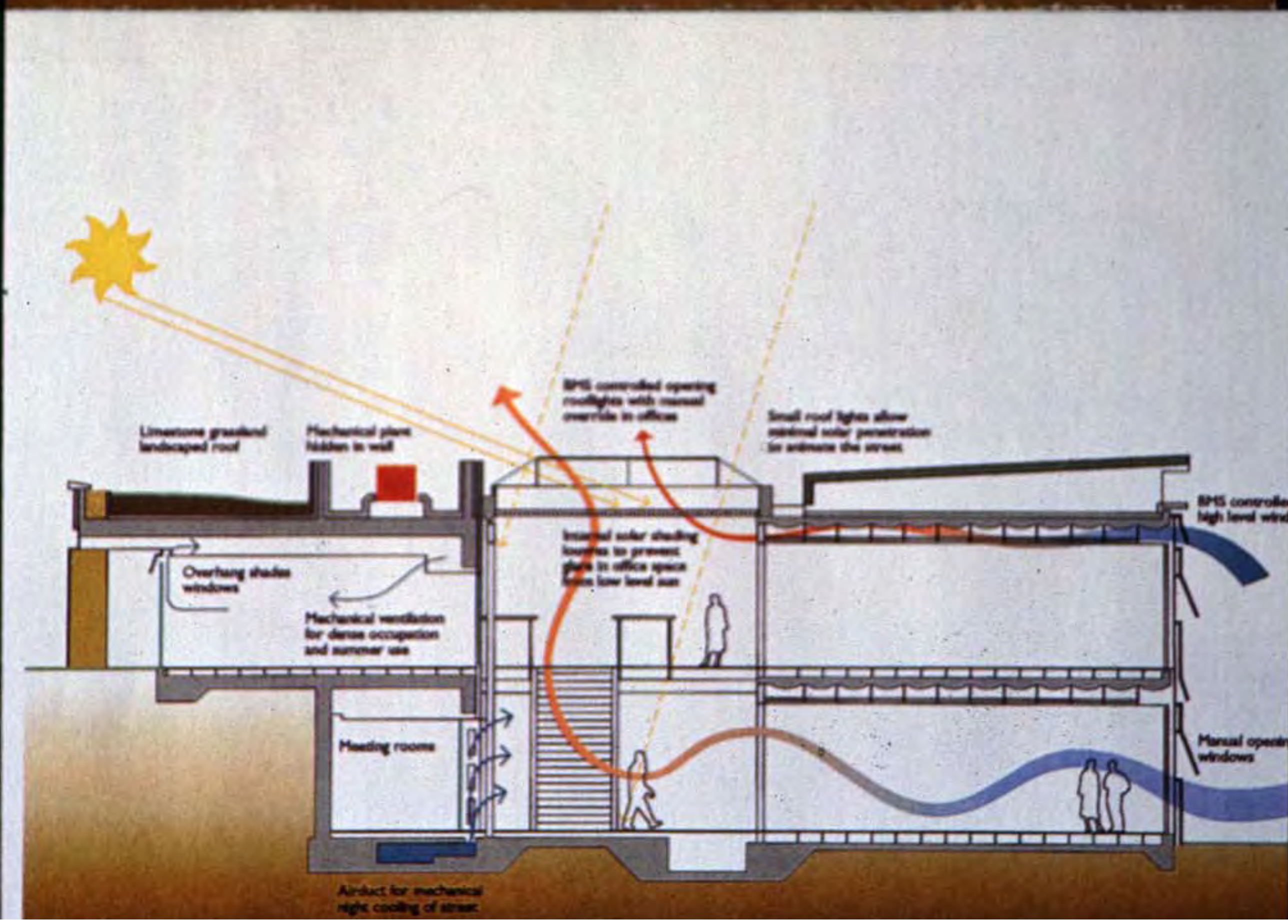
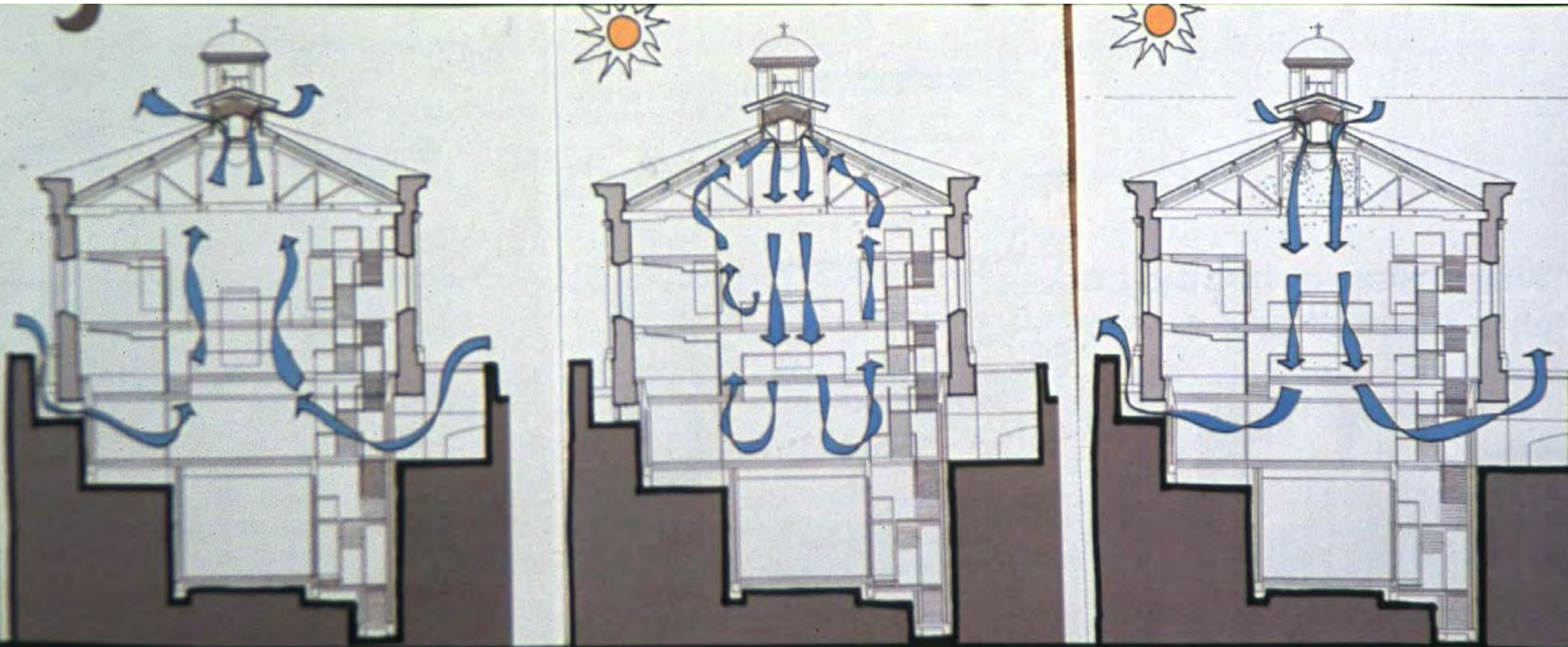
Thermal Mass Passive and active cooling





Wessex Water: Bennetts Associates

Cross ventilation or cooling via atrium



Sophistication in ventilation is possible with controlled vents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Environmental Building - Windows Internet Explorer
http://www.greenspec.co.uk/html/imagebank/jspw3_pop.htm?.._v_w_d_.._v_w_d_images_v_w_d_imagebank_v_w_d_BREEnviro_v_w_d_BRE1.jpg,812,1,,0,E
BRE Environment Building
HOME
PRODUCTS
MANUFACTUR
SPECIFICATIO
MATERIALS
ENERGY
CHECKLIST
DESIGN
IMAGE BANK
REFURBISHME
FORUMS
SITE WASTE
DURABILITY
SUPPLIERS &
FABRICATORS
RECLAMATION
CRAFTSMEN
POLICIES & ST
RESEARCH &
RESOURCES
CPD
HOW WE SELE
CONTACT GRE
REGISTER YO
IMAGE BANK
Shorne Wood
BedZED
Done
Environmental Building
Internet
100%

Solar shading

Passive stacks


Office Corridor Open plan


Top Floor

Perforated Floor slab support beams

Floor slabs

Air passages


3D view of floor soffit

www.greenspec.co.uk

Fluid Dynamics

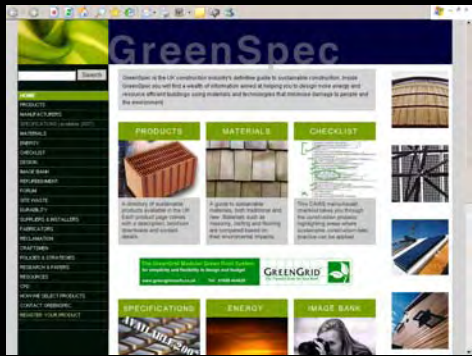
Understanding how a building works or solving problems that arise

Conventional Mechanical Engineers

- Do not understand: passive ventilation stack effect and what can go wrong
- They are actively discouraging these techniques
- And opting for the safe understood mechanical ventilation, heating and cooling or air conditioning
- So prove the design first

Computer simulation

- This is possible
- but there have been examples of computer simulation not working in reality



Fluid dynamics

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- Method of predicting air movement in buildings especially those with atrium
- Like wind tunnel testing but with liquids and smaller scale
- Test models in water tanks with heat input & coloured liquids to highlight movement
- Identify weakness in design
- Prompt and test possible solutions


sity College London.
Night Time Air Flow Regimes 8.00pm - 4.00am
ciation,
Building.


University College London, Bloomsbury
Aldwyck Housin
Passively Ventilate
Houghton Hall

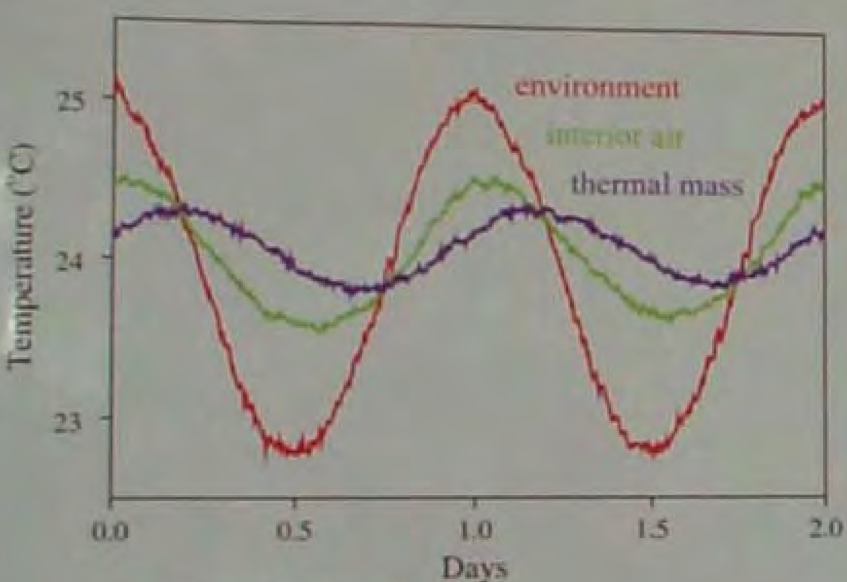
UNIVERSITY OF CAMBRIDGE

Ventilation of a Building with Thermal Mass

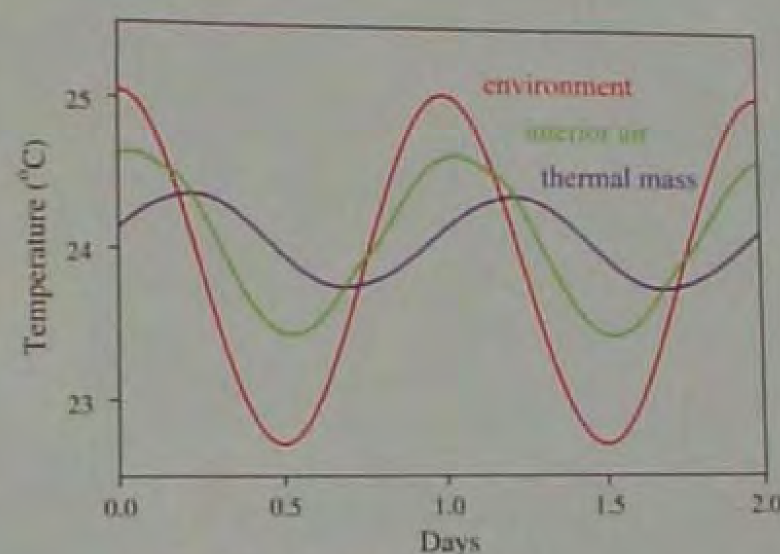
Joanne Holford and Andrew Woods (BP Institute, Madingley Rise, Cambridge, UK)

Time evolution

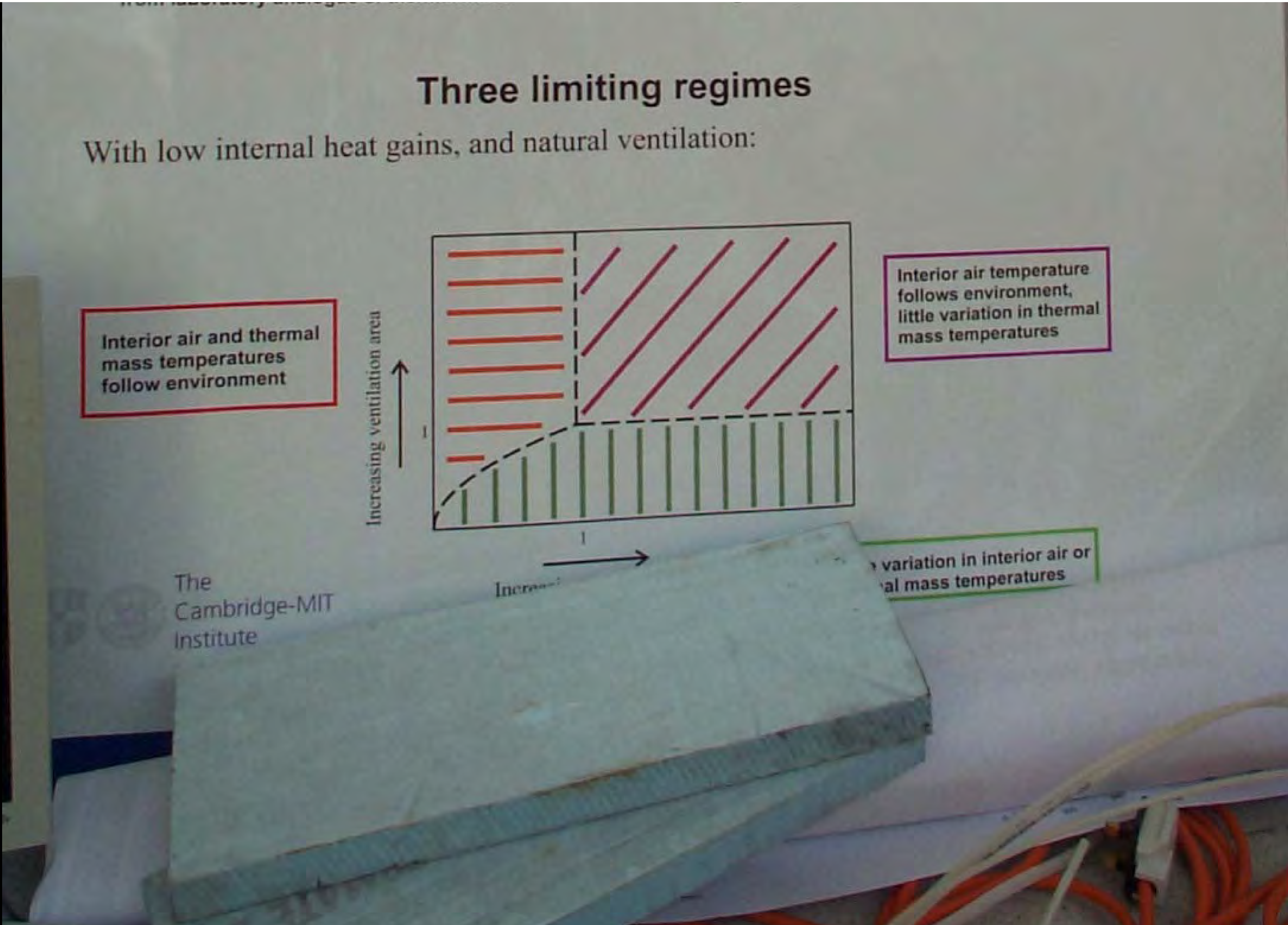
- Heat stored in a building's structure buffers interior air temperature.
- Can reduce energy use and CO_2 emissions by mechanical cooling and heating.

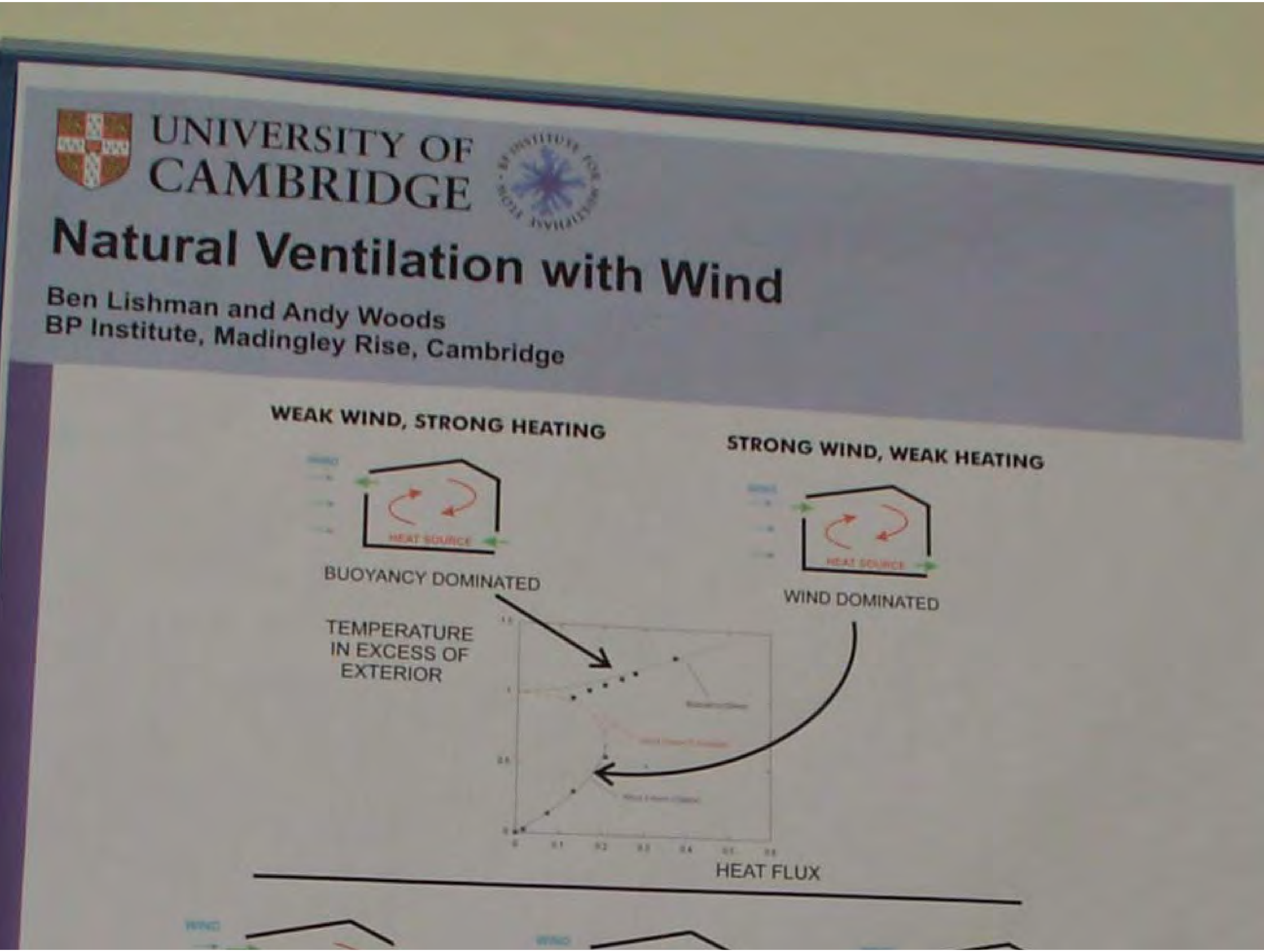


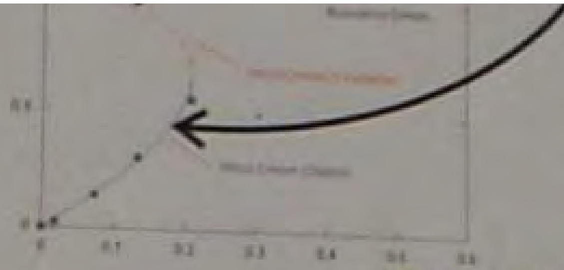
Experimental results, from laboratory analogue of thermal mass.



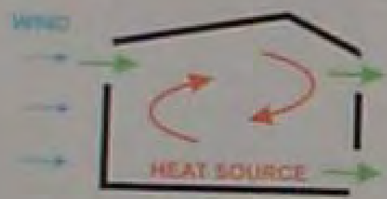
Numerical results, neglecting thermal capacity of interior air.


Three limiting regimes
With low internal heat gains, and natural ventilation:
Interior air and thermal mass temperatures follow environment
Interior air temperature follows environment, little variation in thermal mass temperatures
variation in interior air or
al mass temperatures
Increasing ventilation area
1
1
The Cambridge-MIT Institute


UNIVERSITY OF CAMBRIDGE
Natural Ventilation with Wind
Ben Lishman and Andy Woods
BP Institute, Madingley Rise, Cambridge
WEAK WIND, STRONG HEATING
HEAT SOURCE
BUOYANCY DOMINATED
STRONG WIND, WEAK HEATING
HEAT SOURCE
WIND DOMINATED
TEMPERATURE
IN EXCESS OF
EXTERIOR
HEAT FLUX



HEAT FLUX

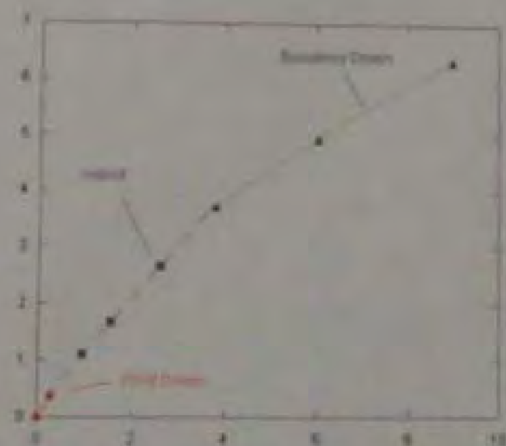


WIND: STRONG WIND, WEAK HEATING

HYBRID: MODERATE WIND, MODERATE HEATING

BUOYANCY: WEAK WIND, STRONG HEATING

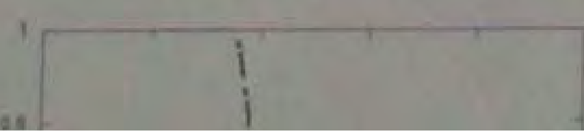
TEMPERATURE IN EXCESS OF EXTERIOR



HEAT FLUX

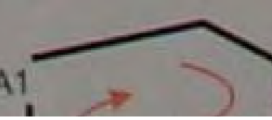
CONTROL SYSTEM (CONCEPT)

AREA RATIO



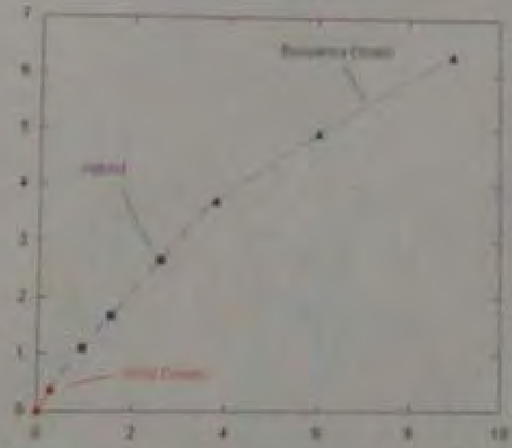
Dimensionless area

A1



A2

TEMPERATURE
IN EXCESS OF
EXTERIOR

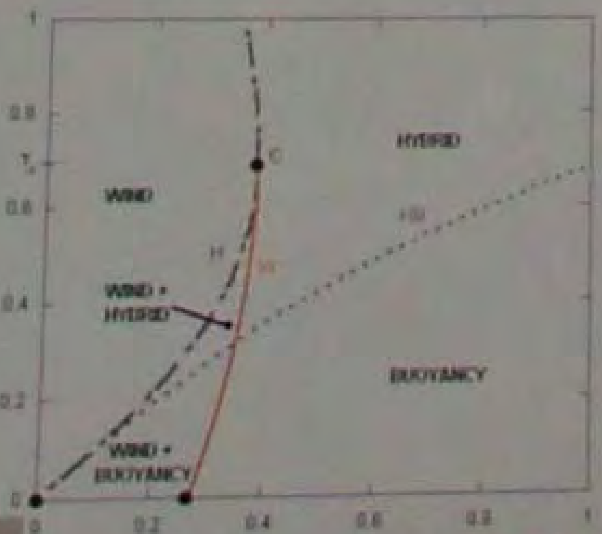


HEAT FLUX

CONTROL SYSTEM (CONCEPT)

AREA
RATIO

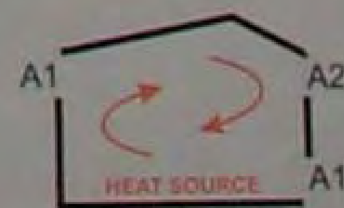
A2/A1



HEATING

Dimensionless area

$\alpha = A2/A1$



The
Cambridge-MIT
Institute

Lower floors can ventilate into atrium blocking upper floor air upper floor over heats.

More window ventilation on upper floor can over come this.

Lower floor can short circuit back into upper floor not into atrium, feeding hot stale air to an already hot stale space

Test Yourself Part 8

- When would a building be purged of heat?
- How can atrium help to cool buildings?
- What can go wrong with atrium cooling effect?

How did you do? Part 8

- Overnight in summer to remove heat using cool night air
- Air from floors can be drawn from the floors to the atrium using stack effect
- Air from lowest floors can block the air from upper floors or short circuit into the upper floors

www.greenspec.co.uk

Mechanical Ventilation

Mechanical Ventilation

- If open windows are not practical
- E.g. Urban traffic noise
- E.g. Agricultural smells
- E.g. Sea Breezes too strong
- Push cool fresh air in distribute at floor level
- Displaces hot air that moves up out of its way
- Draw hot stale air out

Atrium & Mechanical ventilation

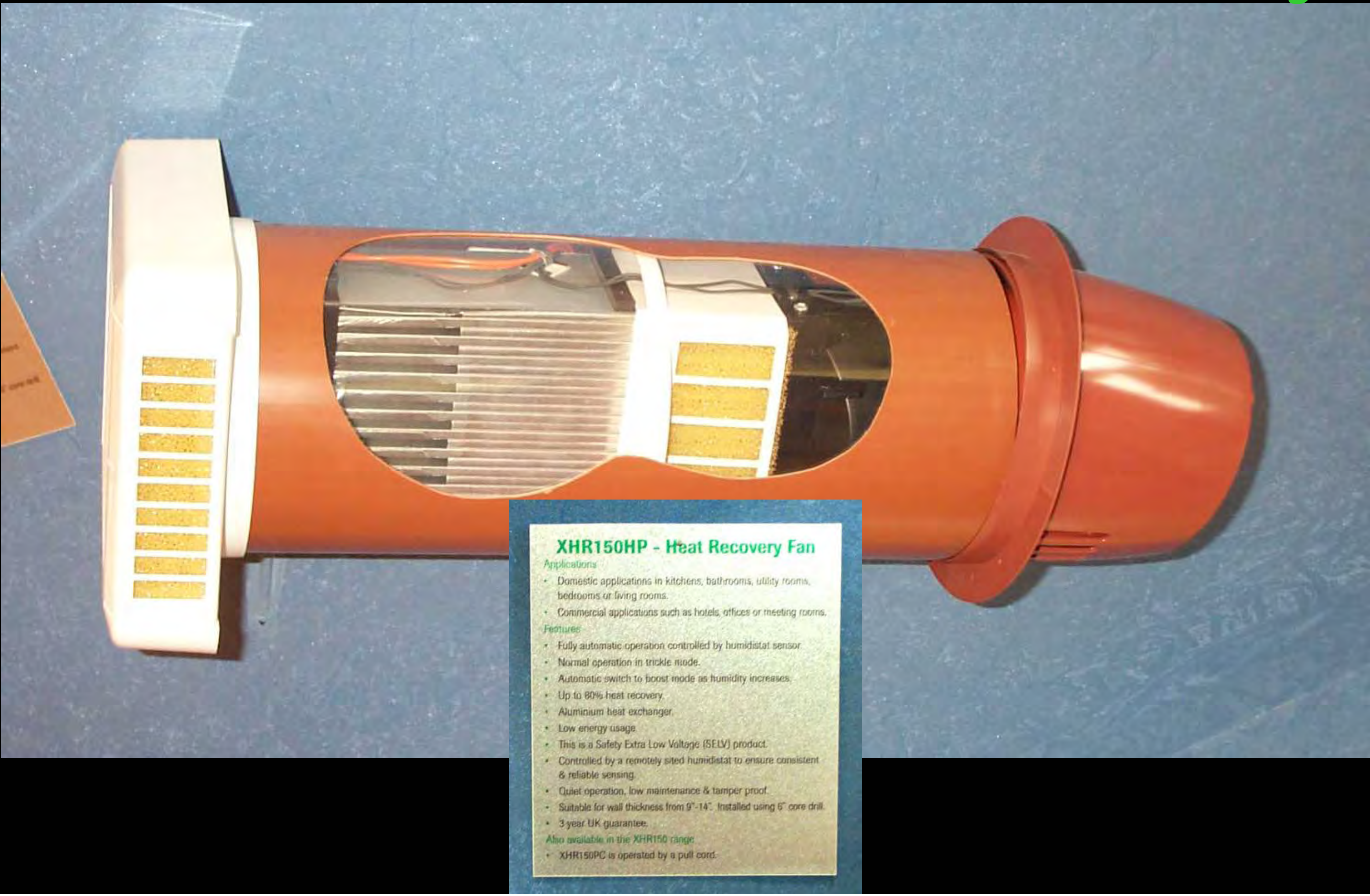
Fabric Ducting
Air permeable
Distributed widely
No concentrated drafts

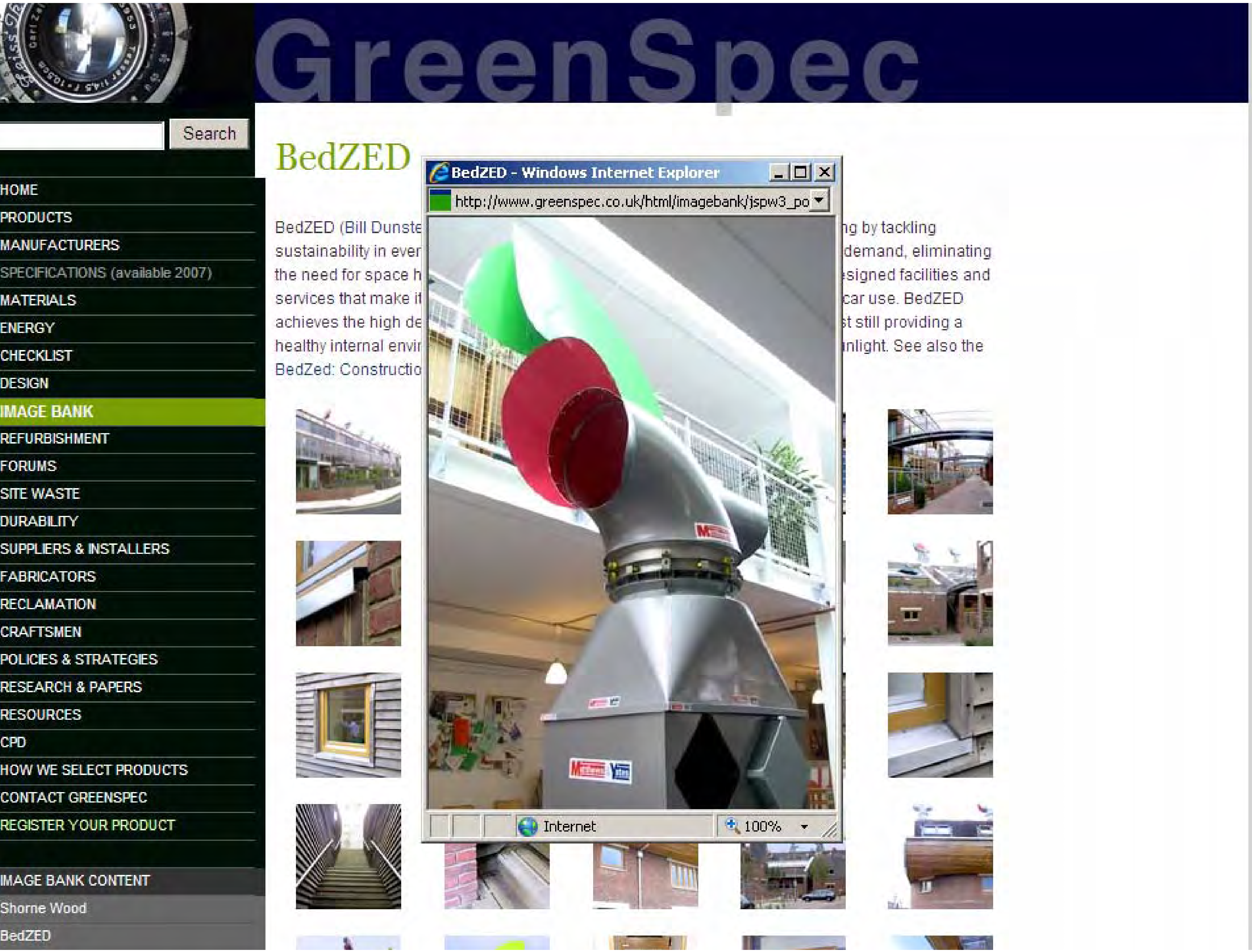
Laboratory Cabinet Extraction of hazardous chemical gases and products of combustion

Mech Vent with Heat Recovery

- Hot stale air is pushed out of the building but that waste heat energy
- Cold fresh air is drawn in and it takes energy to warm it
- Steel the heat out of the outgoing air
- Transfer it to the incoming air
- Heat exchanger in a cross over chamber where the two air do not mix but pass through many thin walled ducts
- Duct walls are low insulating, transparent, conductive, plastic skins 1 – 2 mm. thick.

Bathroom extract & Heat Recovery

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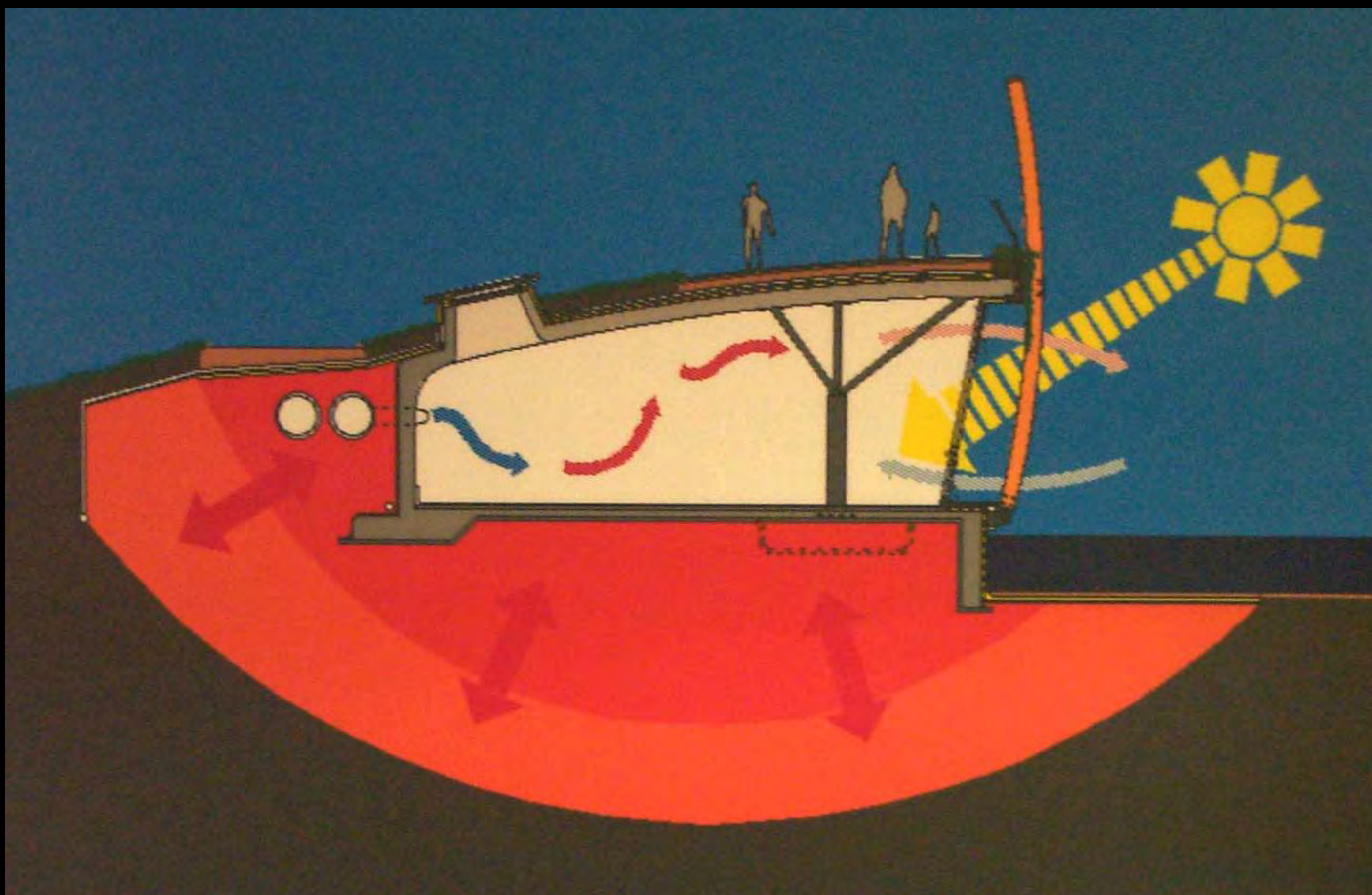
Zero Energy Development



Heat exchange into rear earth from pipes, air flow is reversed to draw the heat out again

Mile End Road Park

Whole House Ventilation

- At Hockerton HHP bungalow
- one pipe in, one pipe out, valves along length to each space
- 225 mm. dia clay pipe, flexible joint, hung from soffit over corridor space
- 100 watt fan with heat recovery.
- Efficient fan essential,
- Airtight building essential
- Heat recovery essential
- More complicated in 2 storey house

8.18

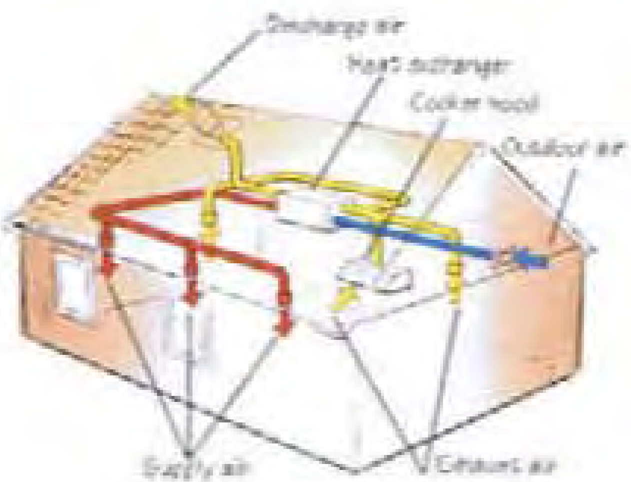
A – Stack ventilation ducts are installed in those rooms where most moisture is generated, i.e. the kitchen and bathroom.

B – Air inlets are installed in walls or windows of all other rooms.

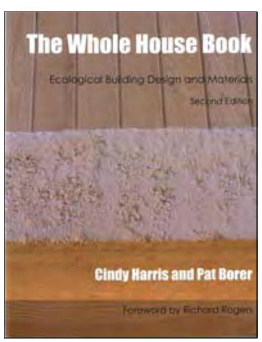
C – Air transfer grilles are installed (through doors etc.) to permit air flow through all rooms.

D – The stack effect creates an air flow through the vertical ducts, thus extracting moist polluted air. During cold weather conditions this causes fresh air to be drawn in through the inlets, which is automatically distributed throughout the whole house.

8.19



8.20



bedrooms it will normally be sufficient to have – and the Building Regulations require it for new build and renovation – a draught-free, closeable ventilator, usually in the form of a trickle ventilation slot built into a window head.

Passive stack ventilation

We must be able to ventilate well those areas of a house that cause most of the airborne pollution: the kitchen and bathroom. Since warm air rises, if these room contain pipes (of 100-150mm diameter) running from the ceilings to a roof opening ventilation will be automatic and increase with the polluting activities. This is calle passive (no fans) stack ventilation. Ideally, replacement fresh air will come via conservatory or other buffer space (ventilation preheat), or through other rooms. prevent ventilation when it is not required, stacks should be fitted with humidi controlled valves so ventilation will only occur when there is a potential dampne problem.

Electric fans are also sometimes fitted if it is judged that passive ventilation alo

+ve pressure whole house heating relies on leaky building

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Air-conditioning

Avoid if possible

Air Conditioning

- Avoid at all costs (shoot the letting agent)
- Design walls, glazing, solar shading to not need air conditioning
- But if you have to have it (e.g. Art gallery)
- then use Green Tariff Electricity or PV
- link to Ground Source Coolth Pumps
- Switch from air-conditioning to ventilation when A-C is not needed.

Air conditioning of inadequately insulated buildings: Rural areas Why not passive ventilation?

Air conditioning of inadequately insulated buildings adding to the heat island effect of cities.
push heat out below open windows!

Comfort conditions

- Bankers in the city on dealer floors
- 8 computers each emitting heat under desk
- Heat rooms then need air conditioning
- Cold head and hot legs
- Flaking by the end of the day
- Need Champaign showers to cool off

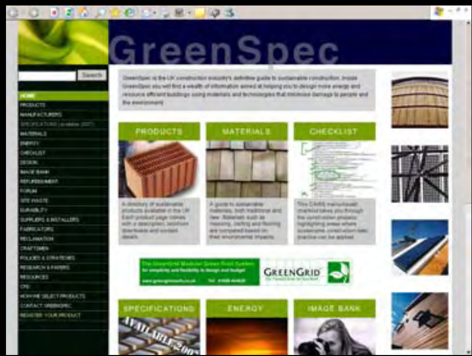
Air conditioning v IT heating

Test Yourself Part 9

- Why is mechanical ventilation better than Air-conditioning?
- What opportunities are there for having mixed mode Mechanical ventilation and air-conditioning in the same building?
- How is mechanical ventilation best introduced?
- How does heat recovery work in mechanical ventilation?

How did you do? Part 9

- Far less energy needed to push air than to heat, cool and humidify it
- Ventilation most of the time and air conditioning during performances ore when exhibits warrant it.
- Cool air in at low level to displace hot air rising
- Steal the heat from stale air outgoing to heat the fresh air incoming



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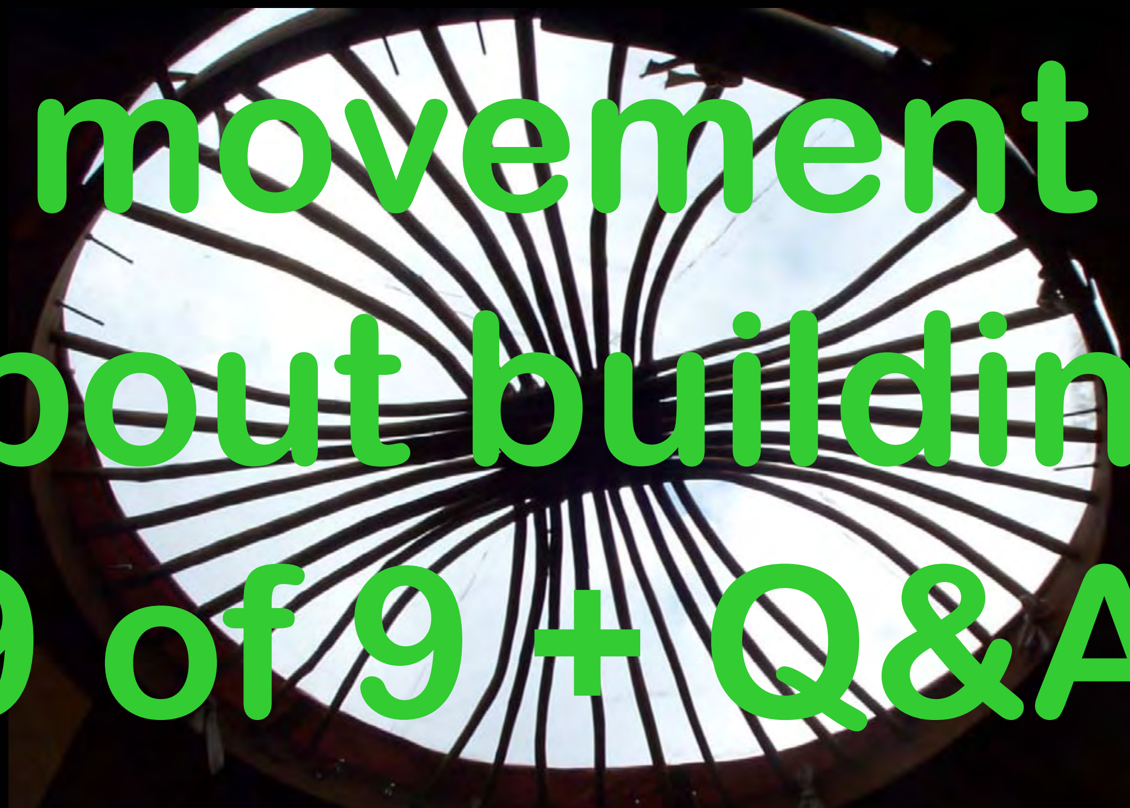

Air movement in & about buildings 9 of 9 + Q&As

 CPD in 10 parts