Green Building Pay: Design. Productivity and Ecology

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Author of:

'Green Buildings Pay: Design, Productivity and Ecology'
published in 2013 by Routledge, UK
(Co- author Dr Emanuele Naboni)

Also author of 20 other books including:

- 'Rough Guide to Sustainability'
- 'Sustainable Housing'
- 'Sustainable Architecture'
- 'Green Architecture'

Key Research Questions explored via 45 cases in 4 countries

- What impact does energy design have upon health, wellbeing, staff productivity and company performance
- Does sustainability lead to technological innovation, changed client expectation and enhanced user experience
- What are the emerging green trends in architecure and engineering
- Are working environments (offices) and learning environments (schools) similar in terms of impacts

The Research Method

- Total cases 45 (since 1997)
- 90% commercial buildings, 10% educational
- 10 cases in USA and Canada, 3 in Denmark, remainder in UK
- Criteria for cases (high BREEAM or LEED score, architectural quality and evidence of innovation in design and engineering, client and architect feedback)
- Triangulation of data: Technical (design and engineering); Social (business and user), and Environmental (energy and ecology)

User survey

- Comfort and Control
  1. Can you control the environment of the workplace
  2. Are the controls understandable and do you have the knowledge
  3. When would you want to over-ride the BMS
- Experiential
  1. What do you like about the workplace environment
  2. What do you not like about it
  3. What 4 key words would you use to describe the workplace
- Impact
  1. Does the workplace environment give you a sense of wellbeing
  2. Does it matter where you work in the building
  3. Does the environment support your productivity, creativity or commitment
- Score

  What score out of 10 would you give the quality of the workplace environment

The debate: Daylight or Ventilation (which matters most)

- Daylight improves productivity (not just light)
- Diversified natural light keeps brain active (creative)
- Daylight improves learning
- Daylight improves wellbeing and health

- Ventilation improves concentration
- CO2 levels are critical to mental alertness
- Indoor air quality is the main health factor
- Increasing density of workplace puts pressure on Indoor Environmental Quality (IEQ) or IAQ

Poor IEQ: What the literature says

Negatives

- Absenteeism (short term such as colds)
- Absenteeism (long term such as depression)
- Poor staff retention and morale
- Poor company image
- Poor staff recruitment

Positives

- Improvement in productivity (offices)
- More commitment and creativity
- Better staff morale
- Better company image
- Better learning (schools) and healing (hospitals)

Identifying the critical relationships and sub-questions

- Bringing energy and health together
- Determining key factors- daylight, ventilation
- Identifying critical variables: temperature, air quality, acoustic quality

- Does design matter
- Does engineering matter
- Can health and well-being be maximised through good design and smart engineering
- What are the best technical solutions

Two types of environment studied

Workplace (Major area)

Key factors

- Ability to focus and think
- Ability to add value to firm
- Ability to work in a team

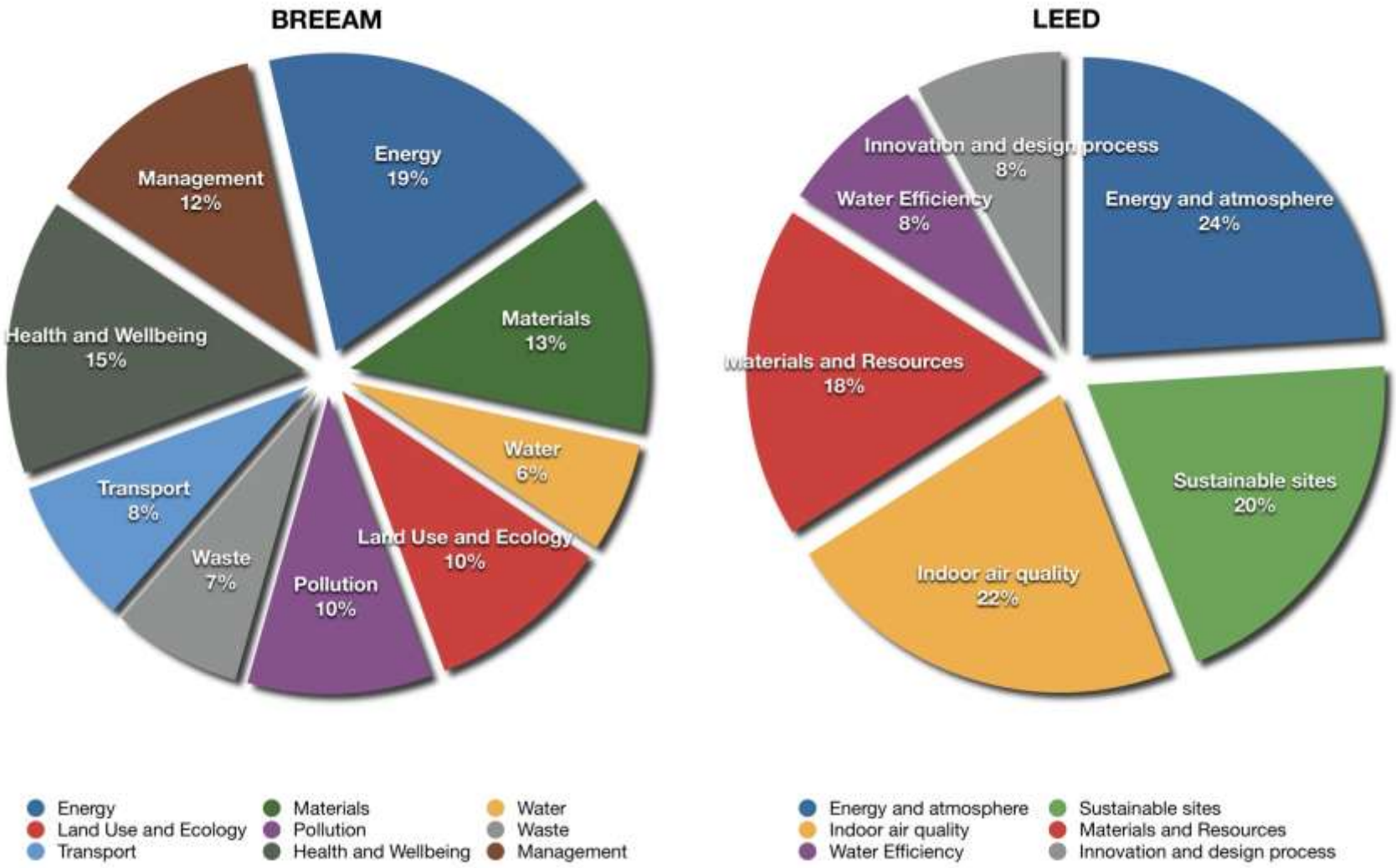
Education (Minor area)

Key factors

- Ability to learn
- Ability to teach
- Use of building as carrier of environmental messages

Testing the theory: The new cases

- Denmark – Ramboll HQ, VKR Holding HQ, Green Lighthouse
- UK- BDP offices, Wessex Water HQ, Woodlands Trust
- USA and Canada- Hearst Tower, Bank of America Tower, New York Times HQ, San Francisco Federal Building, Genzyme HQ, US Census Bureau, Kroon Hall Yale University, Manitoba Hydro


BREEAM
Energy
19%
Materials
13%
Water
6%
Land Use and Ecology
10%
Pollution
10%
Waste
7%
Transport
8%
Health and Wellbeing
15%
Management
12%
Energy
Land Use and Ecology
Transport
Materials
Pollution
Health and Wellbeing
Water
Waste
Management
LEED
Energy and atmosphere
24%
Sustainable sites
20%
Indoor air quality
22%
Materials and Resources
18%
Water Efficiency
8%
Innovation and design process
8%
Energy and atmosphere
Indoor air quality
Water Efficiency
Sustainable sites
Materials and Resources
Innovation and design process

Developing the knowledge: clients and architects

- 5 large architectural practices interviewed (CF Muller, Foster and Partners, BDP, SOM, HOK)
- Exploration of methods and simulation tools used in sustainable design and engineering
- Parallel interviews with building clients
- Scoping study via professional and practice websites
- BREEAM and LEED database (200,000 buildings certified)

Building Case Study 1: Ramboll Head office, Copenhagen

- Energy performce 79 kWh/m2/yr (equivalent to BREEAM Excellent or LEED Gold)
- 83kWh in use
- High level of staff satisfaction (8.5 out of 10)
- Key satisfaction points were (in order) daylight levels, indoor air quality, thermal comfort and ease of controls
- Key words used in user survey- inspiring, motivating, calm, comfortable, democratic
- Features most valued- atrium, controls, views and public transport

Ramboll HQ: key design features

- Different façade designs for different orientations
- Double ventilating façade on south and west elevations
- External screens and internal blinds for thermal and acoustic control
- Large central atrium for stack ventilation and MVHR
- Integrated design

Case study 2: BDP Office, Manchester

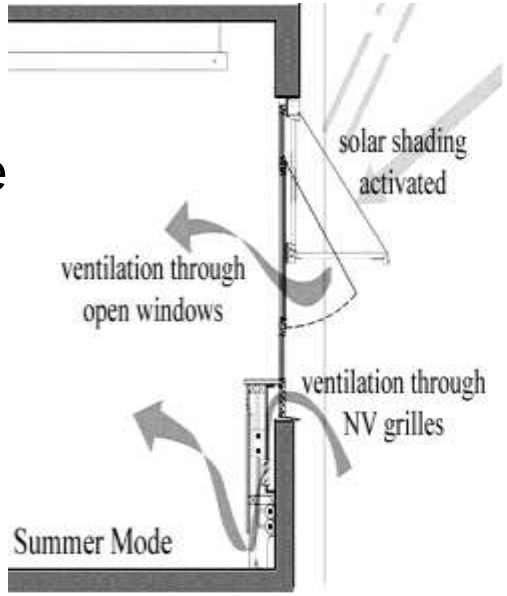
- High energy performance of 75kWh/m2/yr
- BREEAM Excellent
- High level of staff satisfaction 8.6 out of 10
- Annual staff turnover dropped from 21% (old building) to 11% (new building)
- Positive user comments included daylight quality, ambience of workplace environment, good air quality
- User reactions cited enhanced productivity, good image, commitment to company

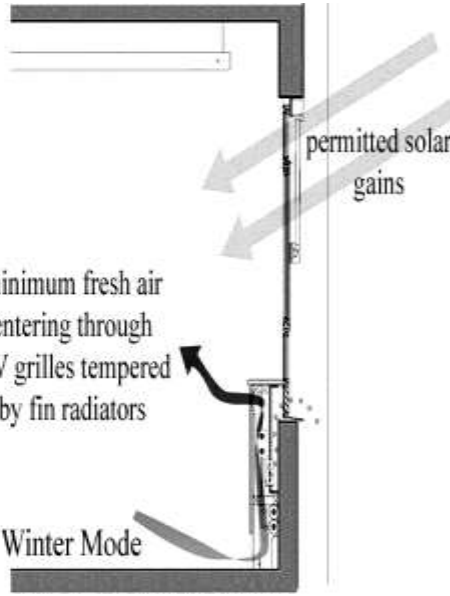
BDP office, Manchester: technical solution

- Metal clad double ventilating south façade with small windows
- Fully glazed north façade
- Extensive rooflights in top floor studio.
- Exposed concrete for night time cooling
- Passive mixed mode ventilation
- planted roof with water catchment

Case study 3: West End House, London

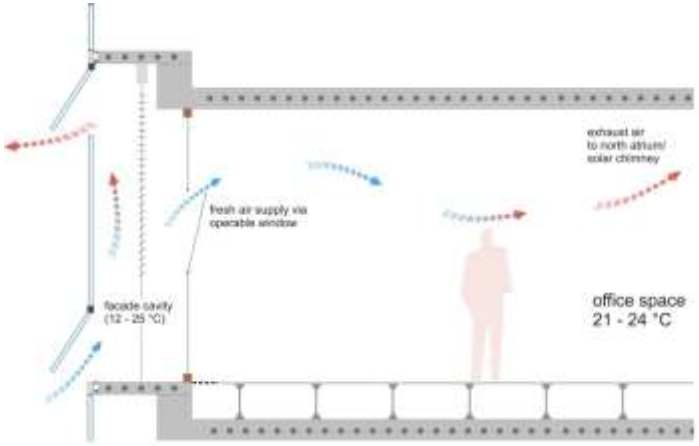
- High level of seasonal control of façade with occupant override
- Passive and active systems related to frequent sub-meters
- High level of occupant feedback citing thermal comfort, ease of control of workplace environment
- Negative point was air leakage through external grilles
- Productivity up by 9% over previous building by same company





Case study 4: Manitoba Hydro office, Canada

- Healthy, effective and adaptable office for 2,000 staff
- Building to demonstrate the company's energy expertise
- Emphasis on solar control in summer and thermal comfort in winter via double facade
- LEED Gold
- High level staff satisfaction



Case study 5: VKR offices, Denmark

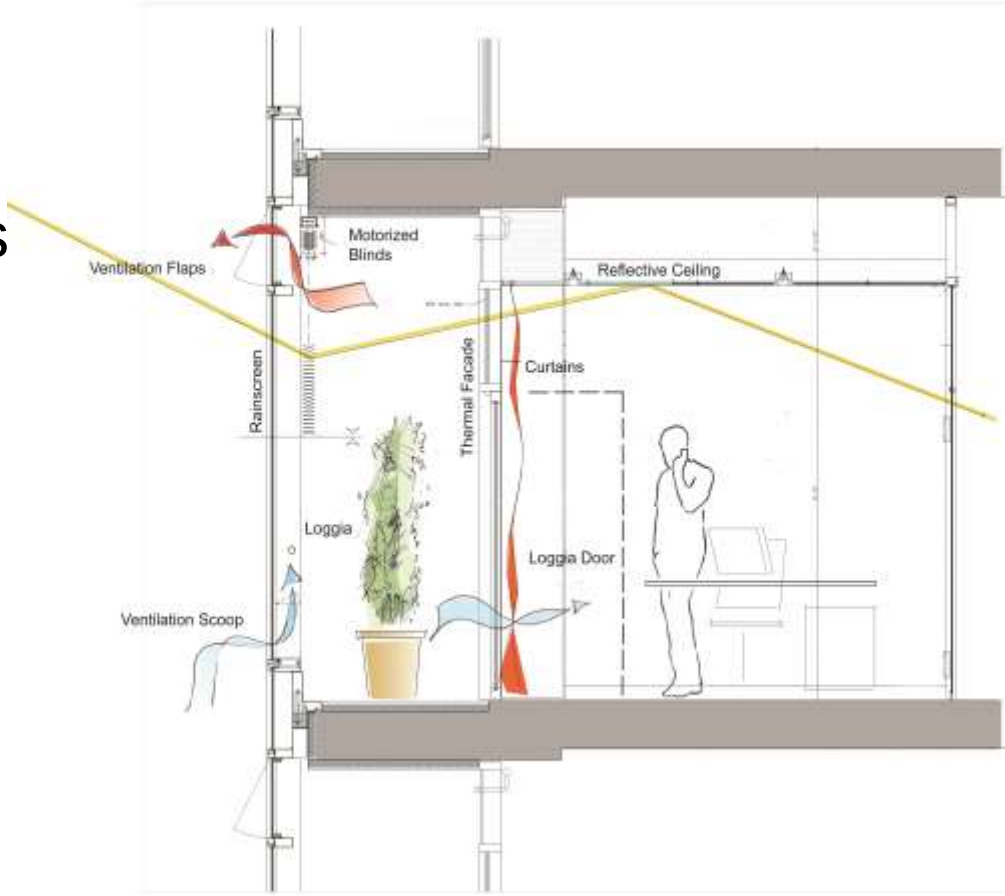
- Demonstration building to test Velux products
- 78kWh/m2/yr
- 68% daylight and natural ventilation through year
- 40% CO2 saving over Danish building standards
- Sensors regulating internal and external blinds
- 90% satisfied or very satisfied compared to 40% in previous building
- Daylight key to satisfaction and enhanced productivity (80%)
- staff retention high

Case study 6: Genzyme HQ, Boston

- Greenest office building in USA when built in 2004 (87kWh/m2)
- 72% of staff reported building made them feel more alert and productive
- Absenteeism down by 4-5 %
- Daylight in offices and sunlit atrium key feature in satisfaction levels
- Enhanced feeling of well-being
- Ecology and engineering design integration

Genzyme office: technical solution

- Double ventilating façade with solar shading and season variation
- Daylight shelves in offices
- Heliostat on roof to track sun for atrium
- Water used for internal cooling
- Planting used for noise and air quality improvement



Key Trends: Facades

- Facades are becoming more complex technically
- Façade costs (25%) have a big impact on energy costs (40%)
- Façade design is critical to thermal, acoustic and visual comfort and sense of wellbeing
- Façade design and control is critical factor to productivity
- Solar is biggest façade problem
- New engineering solutions are changing the architecture of commercial buildings

Changing façade design in UK, Denmark and USA

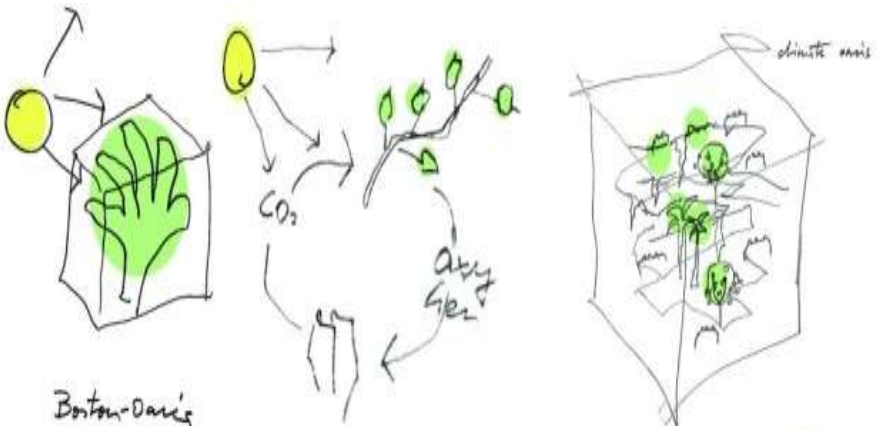
Key Trends: Atria

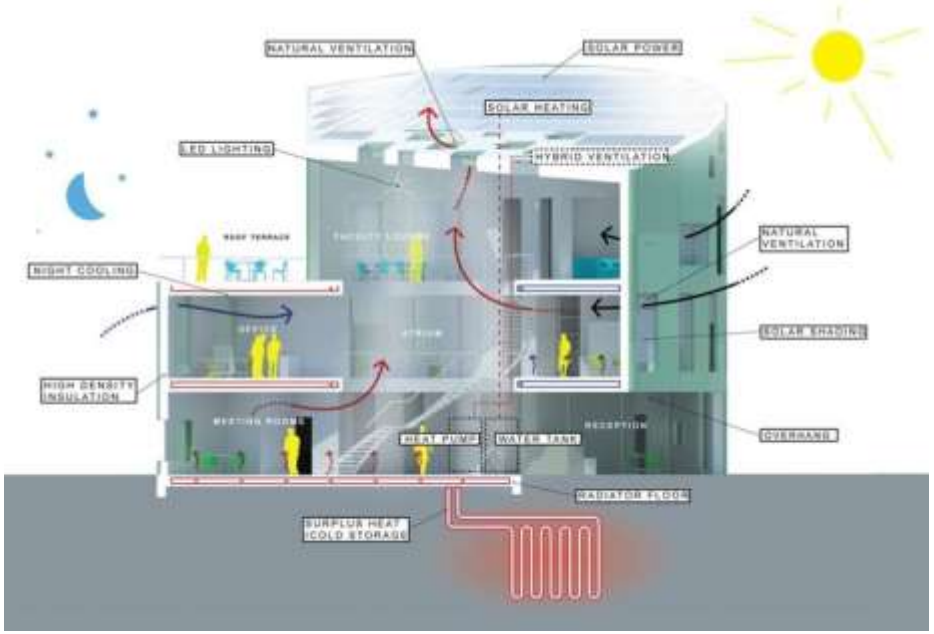
- Atrium-based design is increasingly employed
- Both cross and stack ventilation reduces air conditioning loads and improves perception of health and wellbeing
- Sunlit atria preferred to day-lit atria
- Atria are important social spaces which help with networking
- Atria are the ecological heart of big buildings

Atria for comfort, energy efficiency, thermal recovery and social gains

Ecology and nature

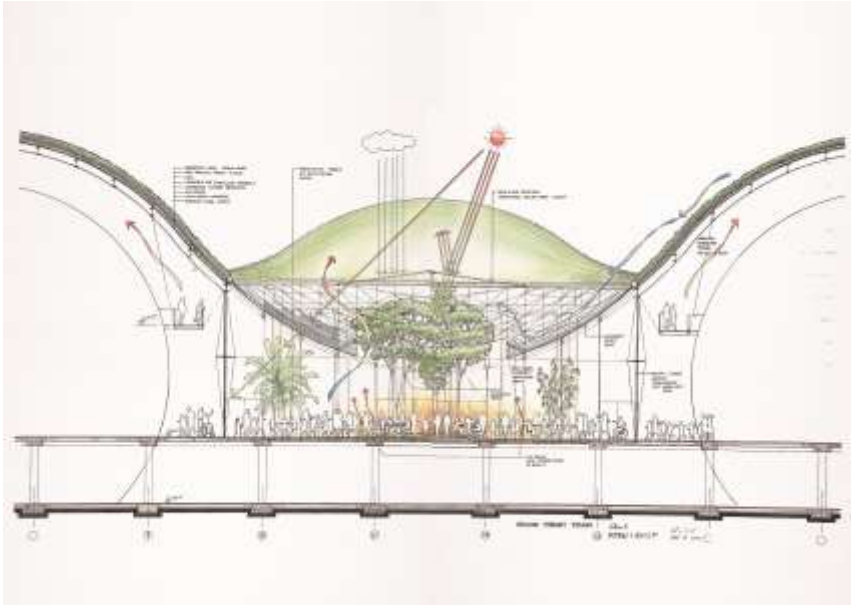
- Energy, health and ecology need integration
- Nature inside and out
- Biomorphism inspiring architecture and engineering





Key trends: Roofs

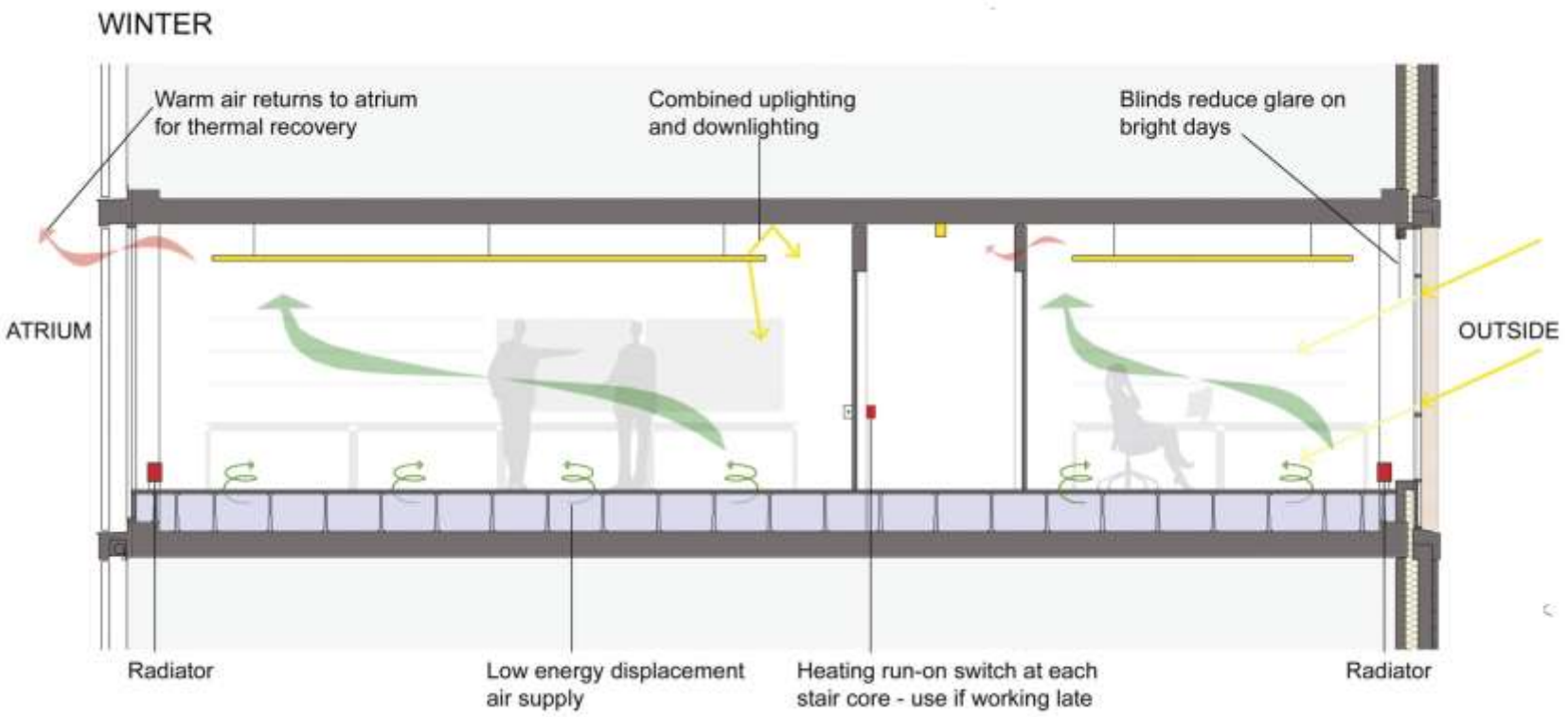
- Roofs are becoming more active architecturally
- Water, ecology and cooling are reshaping the engineering of roofs
- Roof design is key to energy efficiency



comfort and wellbeing

- Daylight and ventilation matter but natural preferred to air-con
- Maximising daylight in workplace improves performance especially in creative industries
- Workers prefer to control their own comfort levels
- Wellbeing is a combination of natural light, natural ventilation and natural materials
- Energy efficiency does not necessarily produce wellbeing

Example of good comfort and control

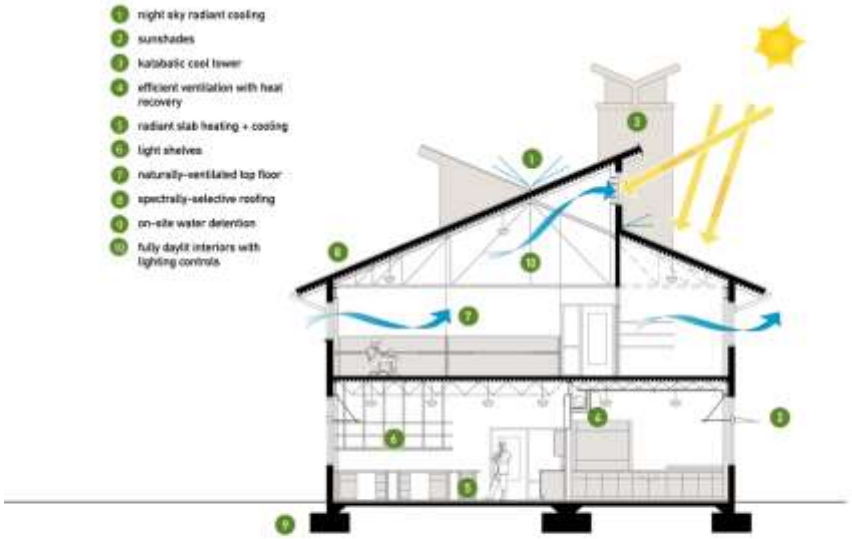


Life Cycle models

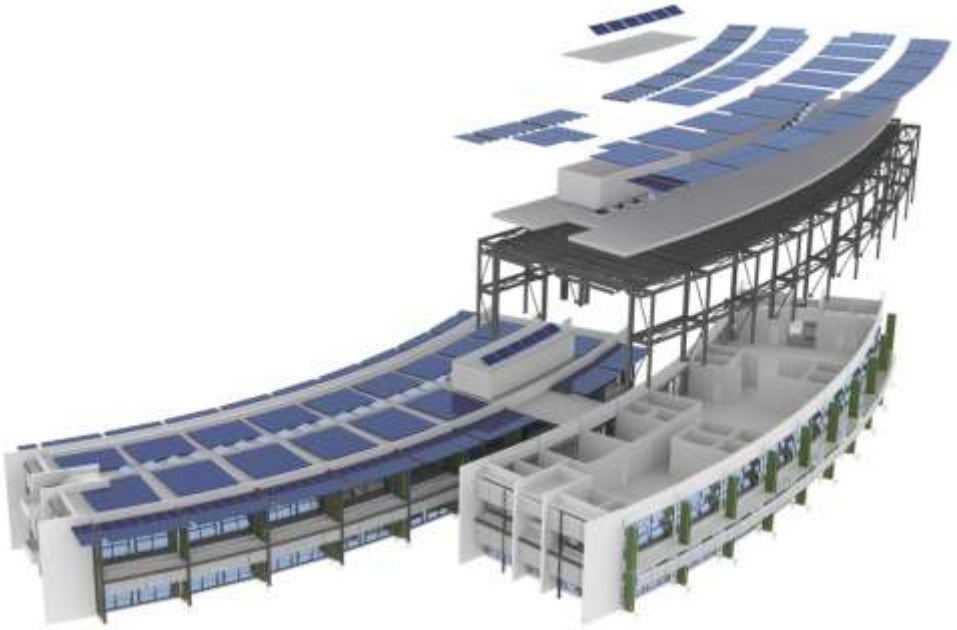
- Business benefits of enhanced productivity (4%) outweigh energy cost benefits by a factor of about 3 to 1 (at current energy prices)
- Image (of building) and marketing (of company) through sustainable design brings big business benefits (to company and community)
- Certification (BREEAM, LEED) increases the business and user benefits but not necessarily energy benefits
- Sustainability brings health and wellbeing benefits as long as design does not focus alone on energy efficiency
- Life cycle models must include users and their perception of productivity, health and wellbeing (staff costs 60% of company total costs)

Final thoughts on energy efficiency in office design

- Company performance is determined by staff productivity
- Productivity is determined by perceptions of comfort (not of energy efficiency)
- Wellbeing is the consequence of good ecological design
- Solar control is the biggest design problem in many modern offices
- Ensure management ethos, design approach and building engineering share same values



Let geometry, orientation and façade design solve solar problems (not air-conditioning)



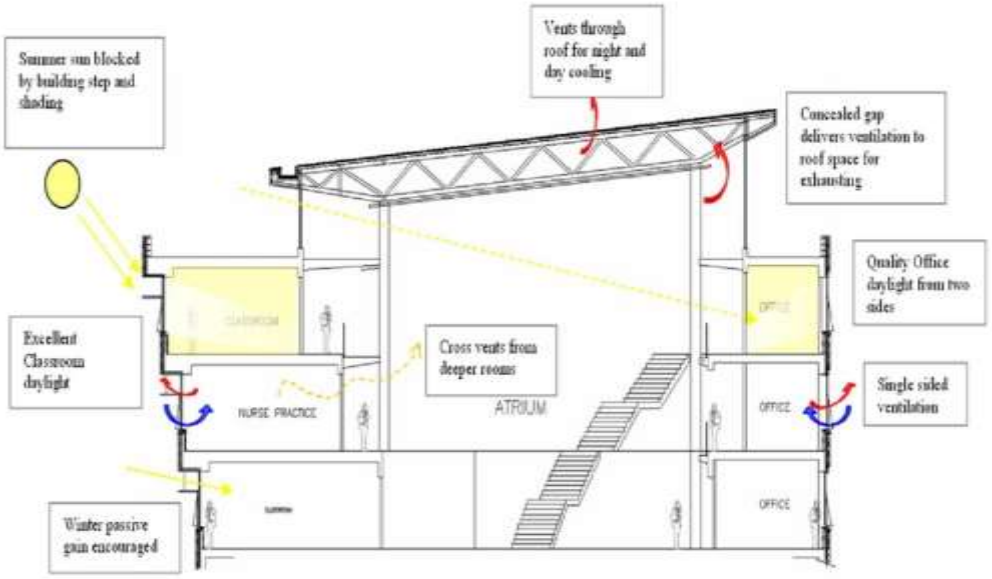
LEED and BREEAM have changed design approach

Educational buildings and Green schools

- 40 green schools and colleges surveyed over ten year period
- 2 school clusters- Hampshire and Essex (UK)
- 6 college and university buildings (4 in USA, 1 in UK, 1 in Denmark)
- Data employed included school performance tables, exam results, teacher interviews, high green certification
- Triangulation of data (eco-schools, pupil performance, teacher interviews)

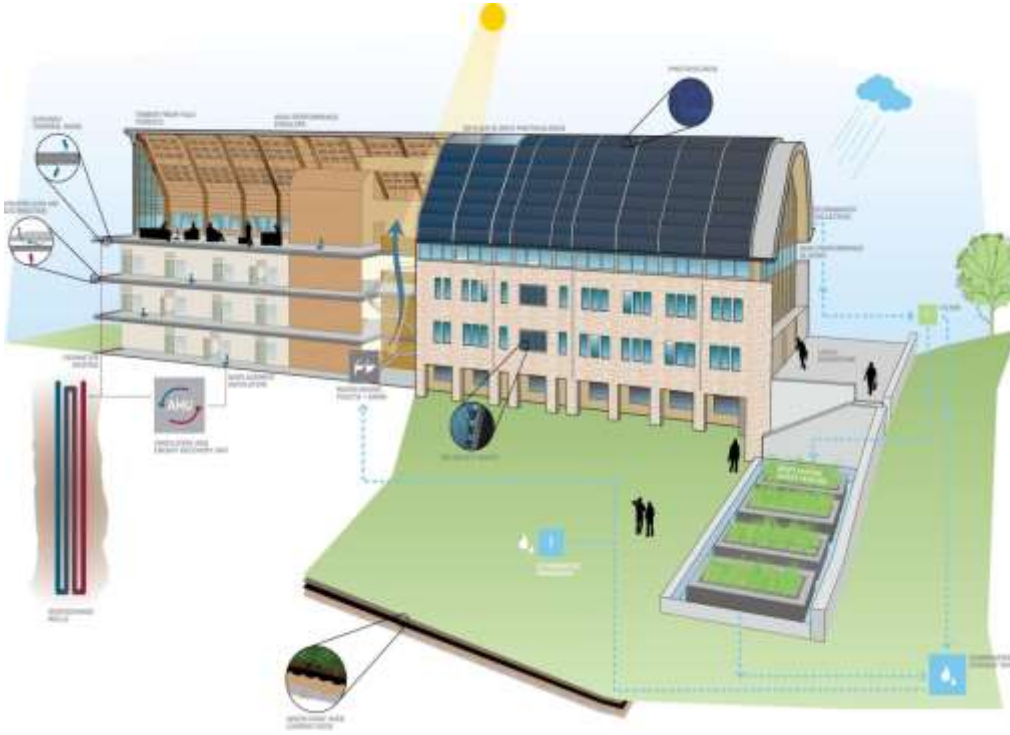
Some findings (schools)

- Learning enhanced by maximising daylight in classroom especially at early stages of child development (4% improvement)
- Solar control essential to avoid glare and overheating
- Daylight matters as much to learning as ventilation (which also matters)
- Fans disrupt teaching by masking spoken word
- Teacher satisfaction undermined by poor classroom environment
- Green schools and colleges led to better pupil learning and behaviour and better staff retention



Findings: University buildings

- Image of university enhanced by green buildings
- Sustainability can be tested on campus through building projects
- High green profiles encourage recruitment of top talent and best students, this leads to better education
- R and D begins on campus
- Green is about all resources, not just energy
- Top universities are also the greenest and leanest (Yale, Copenhagen)



Putting it all together

Sustainable design leads to 3 main benefits:

- **Building** has better life cycle costing, enhanced value over time, lower exposure to changing environmental legislation
- **Company** has better performance, better image, better staff retention
- **User** is more productive with less absenteeism, better health and wellbeing

The Equation: Green Buildings Pay when:

En+ Ec+ Ev = Users (c+ w+ h+ pr)

+

Company (i+ pe+ r)

+

Building (v+ lcc+ le+ id)

Where En (energy)

Ec (ecology)

Ev (environment)

Future thoughts

- Buildings of tomorrow will generate their own power and export the surplus
- Carbon neutral architecture depends on teamwork across professions.
- Growing urban densities will push buildings high- tall is the new challenge
- Innovation today is the key to solving tomorrow’s problems