

SUSTAINABLE OFFICE DESIGN

UNLOCKING PERFORMANCE & PRODUCTIVITY

Sustainable office design is an exciting area of architecture and building which is beginning to reach the mainstream. And there's a good reason that 'green' or sustainable buildings are also known as 'high performance buildings': they not only tend to save on running costs, there is also growing evidence that they can increase productivity and well-being for occupants through improved lighting and air quality.

By Beatrice K Otto

Beatrice Otto is an author on the topic of sustainability and has worked on projects, seminars and workshops on sustainable business, design and architecture in Europe and China. She currently works for the World Business Council for Sustainable Development.

Where office buildings have been designed or refurbished to be more sustainable, productivity gains in terms of better quality of work and reduced absenteeism can often dwarf the reductions in energy bills. Refits which are more sustainable can therefore yield faster returns on investment than is commonly expected.

WHAT WE WILL COVER

SUSTAINABLE OFFICE DESIGN & BUILDINGS

WHAT ARE THE BENEFITS?

WHAT SHOULD I LOOK FOR?

AIR

LIGHT

ENERGY

WATER

MATERIALS

GOVERNMENT RESPONSES

OVERVIEW OF SUSTAINABILITY

WHERE CAN I DIG DEEPER?

SUSTAINABLE OFFICE DESIGN & BUILDINGS

WHAT'S IT ALL ABOUT?

“Technology and the growth of computers allow you a much freer palette as an architect. Also, the study of nature and the way plants grow is more and more available. Bring these things together and there is quite a strong human response. Combine with a better understanding of materials, then we are in for a much richer phase of architecture.”

Nicholas Grimshaw

People & Planet

Sustainable design creates products, places, processes and systems which optimise human well-being now and in the future without compromising the well-being of the planet.

Architecture is one of the most exciting, visible and burgeoning areas for sustainable design with a rich array of techniques, systems, technologies and materials already in place that can drastically reduce the effects buildings have on the environment while bringing about a step change in comfort and efficiency. Buildings can be self sufficient in energy, purifying their own air, and treating at least some of their own waste.

Performance & Productivity

Sustainable office design can deliver higher performance in energy and other resource use, and higher productivity in human terms. People simply work, see and think better in offices that have more natural lighting, fresher and cleaner air, and where they have more control over their immediate lighting or temperature levels. At a practical level, it simultaneously minimises the:

- number
- amount
- volume
- weight
- toxicity
- and use of materials, energy and water

while maximising the use of materials, energy and other components that are:

- clean and safe
- renewable
- easy to repair, reuse, recycle or refurbish
- and benign towards the environment

FIRST PRINCIPLES

Health, Wealth & Happiness

Optimising well-being involves thinking about the personal, physical, social, cultural and economic effects of buildings. Hospitals can consider the curative effects of light, colour, and air quality on human health and spirit. Residential and public buildings can reduce crime and social isolation or disaffection. Schools can improve the concentration and commitment of pupils by responding to their human needs. Workplaces can hugely enhance productivity by being designed with occupants in mind.

Slow the Flow

Currently, materials tend to flow down a one-way street. We extract, process, use, throw away. Most things we use (including buildings) come with serious baggage in energy, materials and emissions. By using materials that have been reclaimed or recycled, and by designing for durability and adaptability (the two go hand in hand), we can slow the flow, ideally to a trickle.

Reduce the Use

Water, energy, materials, components. Find ways to lighten your footprint. For example, you could use a lighter material, or consider lightweight structures that retain strength but reduce material density; particleboard with a honeycomb structure has a high strength to weight ratio; metal can be produced in a foam structure rather than a solid state.

Loop the Loop

Conventional life cycle analysis looks at 'cradle to grave' (extraction to disposal), but this is shifting towards closed loop thinking, what McDonough Braungart Design Chemistry (MBDC) calls 'cradle to cradle'. This includes renewable materials or energy, such as plastics based on plants rather than petroleum (bioplastics or biopolymers), or materials that are easily recycled; recycled aluminium uses 95% less energy than the virgin stuff.

From Product to Performance

“Total financial benefits of green buildings are over 10 times the average initial investment required. Energy savings alone exceed the average increased cost of building green. The relatively large impact of productivity and health gains reflects the fact that the direct and indirect cost of employees is far larger than the cost of construction or energy. Even small changes in productivity and health translate into large financial benefits.”

The Lawrence Berkeley Laboratory and Capital E Group cost benefit analysis of green building for 40 Californian government agencies (www.cap-e.com)

“We can reduce our energy use by 80 percent with no reduction in our quality of life.”

Paul Hawken

Author of The Ecology of Commerce

Sustainable design takes a step back and considers results or benefits rather than products. Most products are a means to an end; by focusing on the end, we can rethink the means. BP was an oil company until it decided that it wanted to deliver energy, of which oil is only one form. Amory Lovins, a champion of improved performance in office buildings, talks about buying 'coolth' (the opposite of warmth) instead of air-conditioners. A synonym for 'sustainable building' is 'high performance building'. Keep that in mind, it's where all sustainable design roads should converge.

Hydro Building Systems has developed TEmotion ('T' meaning 'technology' and 'Emotion' referring to the good feeling we get from elegant, integrated solutions. TEmotion is an external cladding system in aluminium and glass which contains an all-in-one package for heating, cooling, ventilation, lighting and sun-screening, creating the potential to reduce primary energy consumption by about 40%.

Of Systems & Simplicity

Sustainable design integrates systems and functions and designs out duplicating or conflicting elements. It works best where it optimises a whole system by designing 'out' things that don't need to be there. Optimising parts of a system would mean buying a more energy-efficient air conditioner. Optimising the system would create a simplifying cascade which might look like this:

- lighting provides a large part of the demand for 'coolth'
- improve natural lighting, both in quality and quantity
- install dimmable lighting and individual controls
- reduce artificial lighting (and, incidentally, energy use)
- plant deciduous trees outside – their summer leaves prevent direct sunlight heating up the building, their winter shedding lets sun contribute heat
- reassess the demand for coolth
- install some passive ventilation systems
- now decide if you still need air conditioning; you might, but probably a great deal less than if you had upgraded existing equipment without looking at the whole system.

The Master Designer

Biomimicry is the study of nature applied to design and innovation. Nature has been trying things out for millennia and scientists and designers are learning how to apply these lessons from the molecular level to entire systems.

Interface's best selling carpet, Entropy, came about when a designer noticed the random beauty of autumn leaves on a forest floor. This randomness was incorporated into the patterning of carpet tiles, reducing installation waste to 1%, and increasing ease of replacing tiles, whilst appealing aesthetically to customers.

In materials, spider silk has more tensile strength, relative to its weight, than steel. It's been said that if you expanded a spider web to the size of a fishnet, its resilience and strength would allow it to stop a Boeing in mid-flight. FTL Studio mimics the tensile strength of spider silk in its elegant, flexible, lightweight structures.

Fun with Factoids

- According to the DTI, non-renewable energy consumed in building services accounts for about 50% of UK carbon dioxide emissions.
- Construction generally accounts for about 45% of the total global flow of raw materials (China uses 47% of the world's cement).
- Envirowise has found that as much as 10% of construction materials on sites were never used.

WHAT ARE THE BENEFITS?

PERFORMANCE & PRODUCTIVITY

"A minimal upfront investment of about two percent of construction costs typically yields life cycle savings of more than ten times the initial investment."

California Sustainable Building Task Force

The chief, tempting benefits of making your office more sustainable are:

- lower running costs due to virtuous circles of energy and material savings
- rising productivity due to happier and healthier employees

They go hand in hand though productivity gains often dwarf reductions in running costs. There is growing evidence that even where the initial costs are higher than conventional design, the payback, for example through reduced energy bills, can be fairly fast. When gains in productivity are factored in, the payback can be very fast – staff costs usually hugely outweigh energy costs, so a small gain in productivity can translate into a heftier financial gain.

"The growth of green building is driven partly by energy efficiency and other cost savings but also by the need of businesses to attract the best employees. These buildings can make very attractive workplaces."

Christine Ervin
President & CEO, US Green Building Council

“We started using the building in June 1993. Eighteen months later the absentee rate for employees working in the new facility was 40% lower than for those performing the same jobs in an older VeriFone building next door, and productivity was up more than 5%. Workers in the new building proclaimed the demise of end-of-day headaches and end-of-week sluggishness. They loved the natural light and said the air was so fresh they felt as if they were working in a forest.”

William R. Pape, co-founder of VeriFone

In addition, there are reduced liabilities from current or projected environmental legislation, such as the Landfill Tax or Climate Change Levy. There are government issued carrots as well as sticks, such as the **Enhanced Capital Allowance Scheme** which allows businesses to claim 100% first year capital allowances on investments in energy saving products or technologies.

HOW DO I BEGIN?

TEN TOP TIPS

Choose a Champion

Sustainability is a cross-functional idea touching most key business functions, yet is quite a hazy notion to those who haven't been exposed to it. To prevent its wafting through people's minds without engaging them it needs a champion, someone who 'gets it', and has the status, authority and persuasiveness to bring people on board, such as the CEO or head of communications, for example.

Shift Mindsets

Indifference to sustainable design is usually based on misconceptions that sustainability is somehow about suffering and cost. Properly done, it's quite the opposite, but whether you are the designer or the client, you may have to draw on some shining examples to demonstrate that it can improve quality of life and work.

Create a Dream Team

Whether you're a designer or client, start with a team. Sustainable design needs a range of skills and perspectives. At a functional level, daylighting and dimming systems need great coordination to work properly, and so it makes sense to involve lighting designers, contractors, equipment manufacturers and building operators. At a business level, an office redesign is a great opportunity to invite the productivity giant in – burgeoning evidence points to leaps in well-being and productivity while drastically reducing energy and other costs. Not for nothing are sustainable buildings also called 'high performance buildings'.

“So what have we learned? Within the company, we’re learning the extraordinary motivating power of a constructive environmental stance. We’re learning that there is no trade-off between profits and pollution.”

Sir John Browne
Chairman of BP

“The design concept, as William McDonough puts it, had ‘taken the filters out of the pipes and put them where they belong – in the designers’ heads’. Everything that shouldn’t be in the process had been eliminated by design.”

Hawkins, Lovins & Lovins
Natural Capitalism

Paint a Picture

Sustainability, once people know what it is, is a rare beast because it can inspire them in unexpected ways. Scandia, the Swedish hotel chain, took 5,000 employees on a sustainability trip and were astounded at the effect it had in galvanising overall enthusiasm for performance improvement.

If you are the client, involve all employees in the design (or redesign) of the office. Give them a glimpse of what a sustainable office can look and feel like. There are some wonderful examples of workplaces which have fresh air, natural lighting and are a delight to work in.

Joined up Thinking

See your office as a whole system, not a series of components. Integrating systems, such as lighting, heating and cooling, is key. If you consider air conditioning without looking at lighting, you will miss the chance to reduce air conditioning. Look for what shouldn’t be there, as well as what should.

Think Before You Leap

Some 80% of design costs are determined at the design and concept stage. By spending more time in the thinking zone, you could save costly rethinking later. Think twice, what to design in: integration, synergies, multi-functionality, and what to design out: superfluity, complexity, compound inefficiencies, waste.

Measure Your Footprint

Look at your current ventilation and thermal control, plus lighting and energy use. Also think about the impact of work patterns – if most employees drive or use public transport, for example. Use carbon calculation tools to get a better sense of your overall environmental footprint. Reducing the footprint often means reducing costs.

Track Your Footprint

Designing an office with sparkling sustainability features may miss a trick if you don’t follow through on maintenance and monitoring. Even with energy efficient systems, it has been found that more regular monitoring and tweaking of controls can yield surprising additional cost savings.

Invite Ideas

Companies with internal competitions for sustainability ideas have usually reaped far more in savings and other benefits than they aimed for. Dow Chemical began an annual competition for wringing out new efficiencies that would save money and resources. They set tough criteria with short paybacks, but found that the number and quality of projects increased over time as employees got into the swing of generating and implementing ideas.

Keep it Simple, Stupid

People can be overwhelmed by the quantity and complexity of sustainability concepts (not to mention the jargon). Choose or create a definition that works for you and stick to it. Procter & Gamble struggled to engage managers until they adopted the UK Government's definition around creating quality of life for all, now and in the future. It was something people could relate to and act on.

WHAT SHOULD I LOOK FOR?

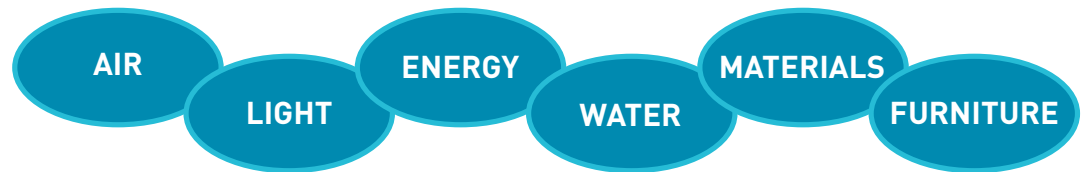
BASIC ELEMENTS

To design a more sustainable office, there are a few basic elements. If you are the client, then ask designers and contractors to deliver on this Wishlist, and look at the relevant sections in more detail.

Element	Optimal	Minimal
AIR	fresh air and thermal comfort, using natural ventilation	pollution, particulates and emissions, use of mechanical air conditioning
LIGHT	individual control of lighting levels for different tasks & evenly diffused natural light	glare and shadow contrasts, use of energy intensive artificial light
ENERGY	use of energy efficient measures or equipment, energy saving mechanisms, devices and behaviour, and if possible renewable energy	use of energy, especially from non-renewable resources
WATER	use of rain or recycled water, and water saving devices	use of water
MATERIALS	use of renewable, recycled or recyclable, lightweight, durable and non-polluting materials	use of materials, particularly non-renewable, energy intensive, non-recyclable, toxic or polluting materials
FURNITURE	easily maintained, refurbished or reconfigured, using materials as above	use of high emission materials, from non-renewable resources or cannot be recycled

Interlocking Elements

Bear in mind these are interlocking building blocks, with a great deal of mutual impact. An upholstery fabric big on 'outgassing' (noxious emissions) will affect air quality. More daylight will reduce the need for artificial light which will cut energy use and the demand for cooling. Some materials use or pollute a lot of water in their manufacture, and so on.



Some other things to consider:

Adaptability

DEFRA's refurbished Nobel House in London was designed to provide flexible workspace that can adapt to DEFRA's future needs.

www.defra.gov.uk

In addition, an ability to reconfigure office space to meet future needs as the business evolves will reduce the necessity of major refits if the business is reorganised. This can be achieved through:

- modular furniture
- raised floors so that furniture can be moved and workstations reconnected without a spaghetti mess of wiring
- modular cooling capacity to allow for changing levels of occupancy
- refurbishment – some companies allow you to change the upholstery, or table tops, for example, extending their useful life and allowing a 'makeover' without starting from scratch
- avoiding styles that will quickly date

Dim the Din

Noise can profoundly affect concentration and contentment and can be mitigated through:

- moving office equipment with its constant whirrs, hums, clicks and clunks, into a space away from people's desks by networking printing, fax and other facilities
- sound absorbing materials
- use of white sound to reduce background noise

Procter & Gamble's large open plan offices in Geneva are almost silent due to the isolation of office equipment and the use of white noise.

Sticks and Carrots

The government provides a range of incentives (and disincentives) to encourage business to become more sustainable. Examples are the Climate Change Levy and Landfill Tax (sticks) and The Enhanced Capital Allowances Scheme (carrot). The Carbon Trust provides an overview of incentives, including grants and other mechanisms, which amount to £1.3 billion a year.

AIR

BREATHE EASY

Fresh Air, Perfect Temperature

DEFRA's Nobel House refurbishment uses ammonia chillers – which boast zero climate change effects – to cool internal rooms lacking cross ventilation. A combined heat and power (CHP) generator was installed, providing 20% of the building's electricity needs while using waste heat to warm the building in winter, to provide hot water, and to provide cooling, via absorption chillers, to computer rooms all year. The building is also naturally ventilated.

Maintaining or improving air quality and thermal comfort can have a striking effect on staff health, alertness, well-being and productivity through:

- maximising individual control
- reducing heat gain, by using lighter coloured exterior surfaces to reflect sunlight from the building, shading devices, or increased daylight
- buildings that breathe – using natural ventilation as far as possible
- low-emission furniture, materials, paints and so on
- greenery, both indoors and outdoors for shading and air purification

Maximise Individual Control

Energy use drops and productivity rises when people have more control over temperature and lighting levels. This can be as basic as allowing people to open and close windows, as well as more sophisticated sensors and controls.

West Bend Mutual Insurance Company in Wisconsin found that productivity rose by 16% due to a new sustainable building, of which 4-6% was attributed to allowing individual control of temperature, air flow, lighting and white noise. Energy costs dropped 40%. Complaints about temperature levels dropped from 40 per day (calculated to cost US\$25 per call) to two per week.

Reduce Heat Gain

Materials can reduce the need for air conditioning, whether due to their physical form, their chemical composition, or their colour, since lighter colours reflect the sun's heat. Lawrence Berkeley National Laboratory has shown that roofs painted in pale pigments can strongly reduce heat gain and air conditioning needs of buildings.

You like your employees to multitask, so ask the same of materials used in office (re)design. Degussa's Radiance is an interior paint that helps keep interior temperatures steady, reducing energy consumption for cooling and heating by up to 15%. Other wonder-paints include exterior paints that reduce heat gain from the sun, and Millennium Chemical's Ecopaint which helps reduce outside pollution by working with sunlight to neutralise smog.

Buildings That Breathe

Maximise natural ventilation and thermal regulation, such as through rooftop stack-assisted ventilation, or displacement ventilation, which allows air to pick up heat at floor level, taking it out the building via ducts or vents as it rises. Or look into wind towers mimicking ancient cooling systems in the Middle East, such as the Monodraught Windcatcher.

In the spirit of biomimicry, Loughborough, Cambridge and SUNY universities are studying termite mounds. Even in the desert, these mounds are models of self-regulating heat and ventilation. Tunnels and air conduits retain stable temperatures and moisture levels while wind energy drives air through the tunnels from the outside.

"A tree planted near a city building saves ten times as much carbon dioxide as a tree planted in the forest because it reduces the energy used for air conditioning and helps to cool the city. Trees provide shade and soak up ground-water which then transpires through the leaves and further cools the air. A single properly watered tree can transpire 40 gallons of water a day through its leaves, off-setting the heat from eg 100 100-watt bulbs burning 8 hours a day."

Joseph Romm
Cool Companies

Go Green to be Cool and Clean

Greenery, inside and outside, can have a dramatic effect on air quality and cooling.

- Green roofs - Chicago's City Hall has a 20,000 square foot green roof which has reduced air conditioning and heating costs by about US\$6,000 per year. It keeps the building cool in summer beneath a moist layer, and in winter provides additional insulation. Green roofs such as the Ford factory in Dearborn also have a role to play in storm water absorption, preventing drainage systems from being overwhelmed.
- Hanging gardens - the Aichi Expo 2005 planted a four-storey high vertical garden, called the Bio-lung, with roses, moss, vines and other plants to absorb CO₂, release oxygen and help cool the surroundings, reducing the so-called 'heat island' effect of built up areas.

- Leafy shading - planting deciduous trees near buildings can help with temperature regulation. Their summer leaves provide shade from the sun, while in winter the sun's heat can reach the building. Trees also lower the ambient outside temperature.

Tax Incentives

The Enhanced Capital Allowance Scheme allows you to claim 100% capital allowance for the first year of an investment in energy efficient technologies or products, including:

- automatic monitoring and targeting
- boilers
- combined heat and power (CHP)
- compact heat exchangers
- heat pumps for space heating
- HVAC zone controls
- warm air and radiant heaters

LIGHT

LET THERE BE LIGHT

“Designing the work environment to increase productivity requires first asking employees what they want. Compaq repeatedly surveyed and interviewed its workers to find out how they felt about their current workplaces and what they would like to see in a new facility. The single most common response concerned daylighting. People want as much natural light as possible in their office and would like to be able to see outside.”

Joseph Romm
Cool Companies

“Carnegie Mellon University’s ‘Intelligent Workplace’ is quantifying productivity improvements for retrofits. For example, design improvements to a 100,000 sq ft workspace with 500 employees: improved lighting design would add \$370,000 to the initial cost of the workplace, yet would add \$680,000 in value in energy savings and other reduced operating costs. Yet this is dwarfed by the fact that efficient lighting could provide a productivity benefit of up to \$14.6 million.”

Joseph Romm, Cool Companies, p. 6

Lighting can have a massive impact on well-being, alertness and productivity. Artificial light is also a major source of energy consumption in itself and in the demand it creates for cooling. To improve comfort and reduce energy use, you can:

- maximise the quantity and quality of daylight
- minimise glare from both natural and artificial light sources
- install dimmable lighting with individual controls for personal preference and different tasks
- use energy efficient lighting where possible

Natural, Diffuse Light

Maximise daylighting through windows, clerestories and redirecting systems which can extend daylight deeper into the building than the usual 3-4 metre light perimeter provided by normal windows. This reduces energy use and heat generation, cutting down the need for cooling systems – creating a virtuous spiral of energy savings.

Examples include:

“California Steel Industries refit 11 workstations in its Drafting Engineering Department. After the upgrade they measured the light levels at every workstation over a 6-day period. Light levels varied with task, age, and personal preferences, but averaged 36-38 foot-candles for computers and 55-57 for drafting – much lower than standard design practice would suggest and much lower than the original levels of lighting. Many used as little as 20 foot-candles for computer work and 30 for drafting work. The personal lighting controls brought overall energy savings to more than 60%.”

Joseph Romm
Cool Companies

- **light pipes** which bring light from the roof to an interior room – they look like ceiling lights, only the light source is solar
- **light shelves** fitted in windows can reduce glare at the perimeter and increase lighting at the interior, reducing the need for artificial lighting and the contrast of glare and shade which is hard on the eyes. A school in Brazil found that learning improved by about 26% after light shelves were fitted in classrooms, creating evenly diffused natural light.
- **shading devices** to reduce direct sunlight, glare and heat.

Recreational Equipment Incorporated (REI) believes that the daylighting used in its flagship store results in customers lingering longer, for 1.5 to 2 hours per visit. They have consequently made daylighting a standard feature of all new stores. This applies to refits too: companies which have experimented by refitting one half of a premises to allow more daylight noticed that productivity – and sales – went up in the half with more natural lighting.

Dim the Switch

Giving people control over lighting levels at their desks, in response to different tasks or personal preferences, leads to improvements in accuracy and alertness, and tends to lower overall lighting loads and costs. The tendency is to choose lower levels of light than designers would normally allow for.

Energy Efficiency

Choosing energy efficient lighting can have a significant impact on the overall energy use of an office. Sensors can monitor light and occupancy levels so that artificial lighting is never too bright or competing with sunlight, or wasted on empty rooms.

Nobel House, a DEFRA office in London recently refurbished to meet the highest BREEAM sustainability rating (Excellent), uses a solar controlled smart system that dims electric lights automatically as natural light levels rise.

Fun with Factoids

- Lighting consumes about 40% of electricity in commercial buildings.
- Another 10% goes to cool the heat generated by lighting.
- Lighting electricity can be reduced by up to 90%.

ENERGY

REDUCE THE USE

“How many people are aware that in the developed world buildings consume half the energy we generate and are responsible for half the CO2 emissions?”

Norman Foster

The government’s Energy White Paper sets a number of goals and targets, including:

- a reduction in CO2 emissions of 60% by 2050
- with a 20% reduction by 2010
- 10% of the UK’s energy supply to come from renewable sources by 2010

Energy Efficient Equipment

From light bulbs to printers. For example, ceiling or whole building fans can provide a temperature reduction as high as 9°F while using 10% of the electricity needed for air conditioning.

Energy Saving Equipment

Occupancy sensors that switch off lights in empty rooms, photosensors that dim artificial lighting if not needed, and dimming systems and individual controls can all reduce energy use. In addition monitoring devices for heating and cooling systems can make a big difference to energy performance.

Energy Saving Culture

Instill an energy saving culture so that people don’t leave computers on all night. Standby mode can use more power than actual operation over the lifetime of a piece of equipment. The OECD has calculated that standby mode accounts for 5-10% of domestic electricity consumption.

“A 90% efficient co-generation system at the Chicago Convention Center saved \$1 million a year in energy costs and cut carbon dioxide emissions in half.”

Joseph Romm
Cool Companies

“Efficiency is free.
Ask for more.”

Lee Eng Lock
Singaporean efficiency genius

Energy Demand

Maximising natural light and ventilation to reduce the need for artificial lighting and cooling can lead to a huge reduction in energy use, particularly if combined with energy efficient systems.

The refurbished Deutsche Bank office in Appold Street used clever design to double the population of the building from 900 to 1,800, greatly reducing the energy consumption per head. Designing for density does not mean packing them in like sardines, it means using space intelligently. Some building projects which have much higher population densities actually look and feel more spacious... even to the occupants!

Reduce the need for heating through insulation, though more is not necessarily better. Research has shown that cavity wall insulation more than 50mm thick, and roof insulation more than 250mm thick (as required by UK regulations) doesn't yield notable decreases in fuel or emissions.

Embodied Energy

Embodied energy is the energy that went into making or transporting something. Aim to source materials, fixtures, furniture or equipment designed to reduce energy use in manufacture, or even offering carbon neutral options. Try to avoid sourcing things that have travelled four times around the world.

Cool Carpet is a recent innovation at Interface, allowing customers to buy a carbon neutral option. The programme offsets greenhouse gas emissions which can affect climate change. Since the programme began in 2003, they have sold 15 million square yards of Cool Carpet, off-setting 250,000 tonnes of carbon dioxide, the equivalent of taking 58,000 cars off the road for a year. The programme won the US Environmental Protection Administration (EPA) Climate Protection Award in 2003.

Renewables

Consider the installation of renewable energy sources such as solar panels or vertical wind turbines. The headquarters of Condé Nast in New York produces nearly 10% of its electricity from photovoltaic and hydrogen fuel cells.

Reduce Your Carbon Footprint

Encourage the use of public transport, bike, or car pooling for travel to and from the office, or investigate carbon offsets for your business activities. DEFRA's Nobel House office provides bicycle space for 10% of occupants. Alternatively, invest in communications equipment that reduces the need for air travel, such as video conferencing.

The refitting of Accenture's offices in Plantation Place was carbon neutral. By specifying carbon neutrality as part of the brief to designers, you can help promote sustainable design and fitting out of offices.

Fun with Factoids

To stabilise carbon concentrations at around 550 parts per million by 2050 will mean using half the energy per dollar of output compared to 2002, an improvement in economic efficiency of 1.5% per year, 20% higher than has been achieved over the last 30 years.

Pathways to 2050: Energy & Climate Change, WBCSD, 2005

WATER

The manufacturing processes used by DesignTex are so clean that the water effluent is safe to drink. The story goes that the water inspectors, finding the water cleaner coming out than going in, wondered if their instruments were faulty.

REDUCE THE USE & LOOP THE LOOP

The basic principles of sustainable water use are conservation and recycling, which leads into grey-water (water that can be used for non-drinking purposes such as watering gardens or flushing toilets) and rainwater use.

Conservation

Conservation can be direct and indirect. Indirectly, you could have your brochures printed using a waterless process such as Pureprint, or install Interface carpets that have changed their pattern printing processes to reduce water use in manufacture, by 81% for modular carpet and 52% for broadloom. Or you could take the direct conservation approach and install low flush toilets and waterless urinals: urine is 96% water, and yet we use great quantities of water to flush it away.

- Waterless urinals using various sealants and water repellent coatings offer a waterless, odourless alternative, also saving costs in installation, piping and maintenance.
- Dual flush and ultra low flush toilets – conventional toilets use about 23 litres of water per flush, whereas ultra low flush toilets use six.

Beacon Press devised Pureprint, a dry printing process which removes the need for water and isopropanol alcohol, known to be environmentally harmful. The waterless and alcohol-free process also produces 12.3% waste compared to 17.5% in conventional printing. In addition to being a much cleaner process, it offers sharper reproduction, increased ink densities, and brighter, clearer and more consistent colours.

“The Fulton County Health Center in Ohio used almost 3 million gallons of water a year in its air conditioning systems. Maintenance staff now use condensate water from two air handlers to help cool the water in the cooling tower basin, rather than sending it down the drain. The retrofit was done in winter when the air conditioning was switched off. The cost of materials was US\$ 300 and the work took less than 40 hours. The refit is expected to save about 1 million gallons a year.”

Mike Hurd

‘Cooling tower uses recycled water’,
Buildings, March 2006, p. 68.

- Reduced flow taps and sensors that switch the tap on only in the presence of hands, so avoiding the huge wastage of taps left running or dripping.

Recycling

Water can be recycled, such as using the grey-water from hand-washing to flush toilets or water the garden. Rainwater can be harvested through porous paving or gently sloping surfaces that allow run-off to be collected - the refurbishment of the BP building in St. James’s Square installed a rainwater harvesting system. It can then be used to water gardens or flush toilets, or for cooling systems.

Fun with Factoids

- Only 2.5% of water is fresh, of which 68% is trapped in glaciers and ice packs. 30% is in groundwater, and 0.3% is in freshwater lakes and rivers.
- The Environment Agency says rainwater harvesting could replace 55% of treated water in domestic use and 85% in commerce and industry.
- Toilet flushing can use 30-40% of water in non-industrial buildings.

MATERIALS

IT’S A MATERIAL WORLD

Making its material footprint smaller, DEFRA’s refurbished offices at Nobel House in London recycled about 750 tonnes of material, saving some 3,000 cubic metres of landfill. 70% of the construction waste was recycled or reused, and materials sourced for the fit out were on average 50% recycled. Waste timber was made into chipboard for use in other buildings. 40 tonnes of old carpet tiles were donated to charity for reconditioning and reuse and redundant office equipment and furniture was donated to charity for reuse. Suppliers were asked to deliver products on re-useable pallets. 90% of the timber was certified as sustainable by FSC and PEFC. Sheep’s wool was used for insulation because of its biodegradable and non-toxic nature. Combined with natural ventilation and other energy saving measures led to the building winning BREEAM’s top rating of Excellent.

DEFRA’s approach to refurbishment covers some of the key elements of sourcing materials or products. Similarly, the refurbishment of BP’s offices in St. James’s Square managed to recycle 85% of its construction waste. Keep in mind:

- **Life cycle** – has it been designed to be robust, easily maintained or repaired, do its components use renewable, recycled (or recyclable) materials?
- **Energy** – what is its energy consumption in manufacturing, transport and use?
- **Emissions** – what is its greenhouse gas (GHG) footprint? Does the supplier mitigate their GHG emissions? Does it give off harmful emissions such as volatile organic compounds (VOCs)?

- **Water** – how much water was used in manufacturing?
- **Toxicity** – is it safe?
- **Weight** – could you use a lighter material or one with less volume, reducing transport impacts?

Ask suppliers some of these questions – even if they can't give perfect answers, just asking the questions will help create a demand and increase awareness of the issues.

Interface is arguably one of the world's most sustainable companies. Their CEO had an epiphany on the road to Damascus, deciding that Interface would strive to be the world's first sustainable company, e.g.:

- Reclamation – the ReEntry™ programme reclaims old carpets and has diverted 85 million pounds of materials from landfill in 10 years. The company mines these discards for their raw materials, such as their GlasBac®RE, a backing made from reclaimed and recycled carpet backing.
- Air quality – water based adhesives with very low volatile organic compounds (VOC) emissions
- Renewables – increasing use of renewable energy for manufacturing, and the use of corn or starch based polymers, so called biopolymers or bioplastics
- Waste – a goal of zero waste

Fun with Factoids

- Bamboo grows in 4-5 years – it is stronger than steel, can have 8m overhangs in buildings, and stores 40 times more carbon than pine.
- Schmidt-Bleek estimates that, on average, industrial products carry an ecological rucksack (the invisible impacts of their production) of about 30 times their own weight.
- Construction produces 19% of the UK's total annual waste (about 90 million tonnes) and 21% of hazardous waste.
- 30 million tonnes of that waste is off-cuts; 9.4 million is temporary works such as site hoardings and formwork; 2.9 million tonnes is simply due to damage.
- Manufacture and distribution of construction materials accounts for about 10% of the UK's CO2 emissions.

FURNITURE

DURABLE & DATELESS

Many of the things to look out for in materials apply to furniture. In addition, consider:

- **Life cycle** – has it been designed to be robust, easily maintained or repaired, using renewable, recycled (or recyclable) materials? Can it be refurbished to extend its useful life?
- **Desirability** – will its design endure in both aesthetics and functionality?
- **Modularity** – can it be reconfigured if you reorganise the office? Flexibility in office configuration can avoid regular refits.
- **Energy** – what is its energy consumption in manufacturing and transport?
- **Emissions** – what is its greenhouse gas (GHG) footprint? Does the manufacturer mitigate GHG emissions? Do components have harmful emissions such as volatile organic compounds (VOCs)?
- **Water** – how much water was used in manufacturing?

Deutsche Bank's refitted offices in Appold Street, London, used furniture from elsewhere in their estate.

DEFRA's Nobel House refurbishment donated any redundant furniture to a charity for redistribution.

There are several well known office furniture designers and manufacturers with impressive sustainability track records on design, process, maintenance and service, and recycling or refurbishment.

Herman Miller's mission is to 'contribute to a better world by pursuing sustainability and environmental wisdom'. They do this AND win awards for the beauty and ergonomics of their designs. Their Perfect Vision targets the year 2020 for zero landfill and hazardous waste. They provide quite detailed life cycle descriptions of their products, covering issues such as:

- durability and ease of maintenance, repair or disassembly
- recycled or recyclable materials
- low volatile organic compound (VOC) emitting paints and finishes
- returnable or recyclable packaging
- manufacturing processes, including air, water, energy use and emissions, waste, health and safety
- contribution to LEED accreditation

Steelcase's Please chair has 30% fewer components than its pre-2004 model. It has also been improved by 16% due to reduced weight and packaging. It can be upgraded and adapted since the fabrics, headrests and armrests can be added or removed. And it's easy to maintain.

Steelcase uses recycled materials where possible, and avoids hazardous materials such as PVC, chrome, mercury, lead, or flame-retardants. They also simplify designs to reduce the number and weight of components. Their plastics are marked for recycling, and they provide environmental performance statements for products.

Wilkhahn is also committed to making its products and processes sustainable. Water-based systems for lacquering wooden surfaces has led to a 90% reduction in solvent use and emissions have been reduced by 21% through 'spot gluing' upholstery.

Herman Miller's Aeron chair has a breathable membrane which helps to keep the body at ambient temperature. Normal foam and fabric backing will increase body temperature and so the need for cooling. It's also 94% recyclable and comprises 66% recycled materials.

Materials include biopolymers and lightweight sandwich boards, such as paper honeycomb from recycled paper. And like Herman Miller, they design for durability in aesthetics as much as in functionality – their furniture will look good, and not 'dated', even after 10 years or more.

Fun with Factoids

- Zody (Haworth) has won the Cradle to Cradle Gold award for its use of recyclable or mulchable fabrics and components, being 98% recyclable.
- Caper (Herman Miller) is almost 100% recyclable and has 21% recycled materials. It's easy to assemble and to take apart for recycling.
- Think (Steelcase) has 44% recycled materials and is 99% recyclable, taking about 5 minutes to disassemble with a screwdriver.

GOVERNMENT RESPONSES

WHAT WILL THEY HIT ME WITH (NEXT)?

In the last 10-15 years there has been a proliferation of policies, conventions, frameworks, directives and regulations governing sustainable development, with an emphasis on the environment, energy, carbon and climate change issues.

Since buildings are responsible for about 40% of EU final energy consumption, improving their energy efficiency could reduce their carbon emissions by 22%. This has led to the EU Directive on Energy Performance of Buildings which became national law in January 2006. The Directive will create a common methodology for calculating the integrated energy performance of buildings and requires minimum standards for energy performance in new (and some existing) buildings, as well as energy certification for all buildings and inspections of boilers and heating and cooling systems.

Part L paragraph

Another EU Directive, on end use energy efficiency and energy services, sets a target for a 9% cut in energy use from 2008 to 2017. It will become national law in May 2008.

The UK government has mandated that all new government buildings must achieve high ratings on the Building Research Establishment's Environmental Assessment Method (BREEAM): Excellent for new buildings and Very Good for existing buildings. Since public buildings comprise about 40% of the construction industry's work, the impact could be significant.

GLOSSARY

WHAT DOES IT ALL MEAN?

A lightening quick tour of the jargon:

Biomimicry – science studying nature as a sourcebook for designing new materials, structures, processes and systems. A cornucopia of ideas and well-tested techniques.

Carbon credits – buying the right to produce carbon emissions from those whose production is below an agreed threshold.

Carbon neutral – operating in a way that does not produce net carbon emissions. This can be through making your own emissions ‘neutral’, or through ‘off-setting’, buying carbon credits from others.

Carbon footprint – the CO₂ emissions you produce relative to any given activity or output.

Carbon off-sets – similar to credits, off-setting your carbon emissions could involve investing in a forest conservation project somewhere to mitigate the effect of your activities on climate change.

Climate change – the signals coming from the planet that human activity may have pushed things too far. Often referred to as ‘global warming’ although this suggests that things can only get warmer and doesn’t allow for the rag-bag of climatic changes that could emerge from high concentrations of CO₂ and other greenhouse gases.

Climate neutral – having no negative effect on climate change.

Closed loop – the art of creating systems, from factory to global trading, that mimic ecosystems by moving from a linear to a circular flow of materials and energy. Think of a lake rather than a river.

Cradle to cradle – another term for closed loop, and a broader notion of life cycle thinking than the formerly used ‘cradle to grave’.

Daylighting – maximising natural light through windows and other means such as light pipes (bringing natural light from the roof) and light shelves (bringing natural light from windows deeper into the building than the normal 3-4 metre perimeter). Daylighting reduces the need for artificial lighting and with it the demand for cooling. There’s also growing evidence that humanoids like natural light and are more alert, content and productive than in artificial light.

Dematerialisation – reducing the ratio of materials to results, by using fewer or lighter materials, or finding new business models that put the emphasis on selling performance or benefits, rather than products.

Dimming controls – the ability to raise or lower lighting levels. Evidence suggests that people use lower levels of lighting than conventional wisdom has imposed on them, triggering considerable reductions in energy use.

Displacement ventilation – capitalising on the fact that heat rises to create ventilation systems that take excess heat up and out of vents or ducts in the roof.

Eco-efficiency – linking environmental and economic efficiency, this is a key strategy on the road to sustainability, but in itself will not lead there as it doesn't address some underlying systemic flaws in our production systems. Still worth pursuing alongside other strategies.

Ecological rucksack – the invisible (to the user) 'baggage' carried by most products in the form of the energy, materials and negative environmental effects that went into their manufacture and transport. This baggage can be hundreds or even thousands of times greater than the product itself.

Ecosystem services – the realisation that ecosystems provide many irreplaceable services to us free of charge, such as pollination by bees, flood prevention, air cooling and cleaning, soil conservation or water filtration. People are beginning to see the huge cost benefits of preserving these services. One example: New York State realised that fertiliser run-off was polluting its water supply and that it would cost billions less if they bought up rural land around the watershed and paid farmers an annual subsidy NOT to cultivate the land, than if they invested in conventional water treatment facilities. DuPont found that investing in wetland development acted as a water treatment buffer which not only encouraged biodiversity (and good brand reputation) but cost about 25% of the conventional treatment route.

Emissions trading – using market mechanisms to reduce carbon or other undesirable emissions. The EU Emissions Trading Scheme has quadrupled in value in a year to US\$ 10 billion. It will soon be expanded to include new industries. The US has been trading sulphur dioxide for years and US companies have voluntarily established the Chicago Climate Exchange for a range of greenhouse gases.

End of life – the idea that products have a linear life, and once it's over, they die. This is being challenged by the notion that products, or at least components, can be reincarnated in many forms to create a series of productive loops.

End of pipe – closing the stable door after the horse has bolted. Only the first step towards sustainability since eventually we should design problems out of the system, rather than trying to clean them up.

Factor 4, 10 or 20 – reducing resource intensity (energy and materials) for a given outcome. To become sustainable the world needs to aim for Factor 10, that is the same results for 10% of the input. This means a bigger factor of improvement for developed countries, something like Factor 20.

Global warming – a commonly used term for ‘climate change’ (see above). ‘Global warming’ suggests a universal rise in temperature, whereas some parts of the globe may become cooler as the knock-on effects of climate change kick in. Hence, ‘climate change’ is probably more accurate in that it allows for a range of effects, including extreme weather events such as flooding, hurricanes and drought, and some regions potentially becoming cooler.

Greenhouse gas – a cocktail of gases, of which CO₂ is the most well known, which can trigger a rise in average temperatures.

Heat gain – the way a building heats up such as absorbing sunlight, creating a need for cooling. By using pale surfaces, trees, natural lighting, or other heat reflecting means, heat gain can be reduced and with it the cooling load.

High performance buildings – a synonym for sustainable building, recognising that sustainable design leads to buildings using fewer resources and less energy with greater well-being and productivity.

Industrial ecology – (re)designing industrial systems to act like ecosystems in a closed loop manner. This allows the ‘waste’ from one industry or process to be the feedstock of another. Also known as ‘industrial symbiosis’.

Life cycle thinking or design – considering the whole impact of a product or process, not just the bits you see. This could include labour issues, the energy and water that went into production, transport implications, manufacturing, use and disposal. The aim is to extend the useful life of products and components, ideally creating a closed loop system. There are hundreds of tools in ‘Life Cycle Analysis’ or ‘Life Cycle Assessment’ which let you measure impacts of materials or products.

Micro-generation – generating power in situ, within a building or neighbourhood. As well as creating renewable energy, micro-generation provides resilience – lots of mini ‘power-plants’ mean large scale black-outs are less likely, and they are more elusive as terrorist targets than big power plants.

Natural ventilation – fresh air and comfortable temperatures without machinery, relying rather on the physics of air flow and heat to create buildings that self-regulate.

Negawatts – when buildings become self-sufficient in energy, anything they produce that is surplus to their needs can be fed into the grid, so-called negawatts, that is, using a negative amount of energy.

Passive ventilation – similar to natural ventilation, passive meaning without machinery.

Rebound effect – making something more efficient can sometimes lead to increased consumption overall. For example, if people know that light bulbs are energy efficient, they may be more likely to leave them on, creating greater energy consumption than conventional bulbs. Therefore worth monitoring the use of more efficient systems.

Resource productivity – yielding more performance or benefit per unit of material or energy input.

Sustainable – all systems (including social, environmental, economic and cultural) flourishing harmoniously without waste, degradation, suffering or superfluity. The best of all possible worlds, but at least partially attainable if we apply the grey matter.

Whole building design – the integrated approach to making buildings more sustainable, allowing you to optimise the system and so simplify the parts of it.

Zero waste – an explicit goal of some organisations, together with ‘zero emissions’.

OVERVIEW OF SUSTAINABILITY

WHAT'S IN A WORD?

People & Planet

“Our biggest challenge in the new century is to take the idea that seems abstract – sustainable development – and turn it into a daily reality for all the world’s people.”

Kofi Annan
UN Secretary General

The official, text-book definition of sustainable development (or ‘sustainability’) suggests holding up the edifice by the three ‘pillars’ of the environment, the economy and society.

This works in principle and even practice, but isn’t an easy trio to digest conceptually, and nor does it readily engage the imagination. Yet sustainability can appeal to our instinctive admiration for systems or solutions that stun us with their elegant response to complexity. The UK government, recognising that the standard language didn’t have people begging for more, came up with a warmer definition most people can relate to.

“At the heart of sustainable development is the simple idea of ensuring a better quality of life for everyone, now and for generations to come.”

UK Government
Strategy for Sustainable Development, 1999

The essence, then, is to bring about a mode of living and working that allows humanity to flourish in a flourishing natural environment, that irons out inequities between countries and regions, without compromising future flourishing. It ‘converges human and natural flourishing so they work for rather than against one other over the long term’.

Planet & Poverty

The midwife of ‘sustainable development’ was a collective realisation that we couldn’t keep living as we were, ‘borrowing’ resources from poorer regions and future generations. The tipping point in terms of sustainability came recently, when we crossed a line from living within our ecological means to overspending accumulated natural capital and even selling off the family silver. In the 1960s we were at about 70% of carrying capacity (the human footprint the earth can bear without potentially triggering irreversible consequences). The US National Academy of Sciences has confirmed that we are now at about 120%. Do the maths.

The warp and woof of weaving towards sustainability (it isn't a straight path) is to simultaneously bring our collective overspend back within ecological, biodiversified budget, adapting to or repairing damage already done, while addressing inequities which mean that roughly 20% of the world's population consumes 80% of resources.

The Millennium Ecosystem Assessment, drawing on about 1,400 experts in 95 countries, has found that ecosystems have been changed more in the last 50 years by human activity than at any comparable time in history. About two thirds of the ecosystems they looked at were degraded or being used unsustainably, and 0.5% of natural habitats are being lost each year, mostly to farmland.

<http://www.millenniumassessment.org/en/index.aspx>

Balancing the Budget

Tipping the budget into credit, buildings can already be designed that are not merely 90% less resource consuming, but which can be net producers of energy and clean air, feeding their surplus energy into the communal grid.

Government Responses

The UN Framework Convention on Climate Change (the clunkily acronymed UNFCCC) was signed in 1992 and provides a non-binding target to stabilise global greenhouse gas emissions (GHG). The Convention established a yearly Conference of Parties, the so-called COP.

The Kyoto Protocol was adopted in 1997 and became legally binding in 2005 after Russia ratified, bringing the emissions represented by signatories to 61% of the global total. The treaty provides targets for developed countries to reduce their greenhouse gas emissions by 2008-2012 against a 1990 baseline year.

- EU target is minus 8% against 1990 figures
- the UK, responsible for about 2.3% of global carbon emissions, has a target of 12.5%
- the UK government has committed a minimum 60% reduction in carbon emissions from a 1997 base, by 2050

Kyoto also allows for 'flexible mechanisms' such as the Clean Development Mechanism whereby developed countries gain 'credits' for investing in carbon-reducing projects in developing countries. Such market mechanisms have been adopted by the EU through its Emissions Trading Scheme, launched in 2005.

Fun with Factoids

- The UN Development Programme estimates that if the whole world were to have a similar lifestyle to that of developed countries today, it would need the resources of 5.5 earth planets.
- The Intergovernmental Panel on Climate Change estimates that an increase in average temperatures of 2-4 degrees will bring more extreme weather events, leading to sea level rises and threatening sensitive ecosystems such as coral reefs.
- Access to clean water is a major concern in developing countries. 5,500 children die each day from diseases caused by water or food polluted with bacteria.
UNICEF, UN Environment Programme & World Health Organisation, Children in the New Millennium, 2002.
- Climate related disasters occurred twice as often in Europe during the 1990s as in the 1980s with an average annual cost of US\$11 billion.
Impacts of Europe's Changing Climate (http://reports.eea.eu.int/climate_report_2_2004).

WHERE CAN I SURF MORE?

SUSTAINABLE DESIGN & BUILDINGS

General

<http://www.advancedbuildings.org/>

A superb source of briefings on a range of sustainable building topics such as lighting and daylighting, finishes and furnishings, heating and cooling, water use and heating, building automation systems, energy efficiency, stormwater management, and air quality. A great place to start learning.

subscribe-greenclips@listserv.energy.wsu.edu

Greenclips is an excellent clippings service from the world of sustainable architecture.

<http://www.rmi.org/sitepages/pid97.php>

RMI Solutions is the newsletter of the dynamic and influential Rocky Mountain Institute (itself housed in a sustainable building). Their website is full of delights on the topics of energy efficiency, retrofits and sustainable architecture in general.

<http://www.time.com/2002/greencentury/enarchitecture.html>

Buildings that breathe, by Richard Lacayo, is an inspiring article on how the 'best of the new architecture uses nature rather than fighting it'.

<http://www.metropolismag.com/cda/sustainable.php>

Metropolis Magazine has a section devoted to sustainable design, with often excellent articles.

<http://www.greenbuildings.santa-monica.org/mainpages/pdf.html>

Provides an index of PDF files on a wide range of sustainable building topics.

<http://www.architecture2030.org>

Launched by Edward Mazria, Architecture 2030 provides a challenge and an impetus for making all buildings carbon neutral by 2030. Yes, it can be done.

<http://www.greenblue.org/about.html>

GreenBlue promotes the cradle to cradle approach to sustainable design, whereby everything from buildings to the economy function on a circular basis, without generating waste, and even restoring previous degradation. A pleasure to navigate, this site simplifies the concept of closed loop thinking.

<http://www.ccc.govt.nz/TargetZero/ResourceAndWasteSpecific/>

Before the First Pour: Energy efficient design for commercial buildings is a superb, short introduction to the subject. It is part of a series, including design guides for commercial building fit-outs, retrofits and new build, both large and small. Very short, these guides help create a suitable design brief.

<http://www.greenbuilder.com/sourcebook/>

A clear guide to several key aspects of sustainable buildings, such as water, energy, materials and solid waste.

<http://www.wbdg.org/>

The down-to-earth Whole Buildings Design Guide provides an outline of sustainable building concepts and products.

<http://www.dti.gov.uk/sectors/construction/sustainability/page13691.html>

Building Better Quality of Life: A strategy for more sustainable construction gives the government's eye view of what is needed to make buildings sustainable.

<http://www.bre.co.uk/>

The authoritative Building Research Establishment is a key player in making the UK building sector more sustainable. It does research, dispenses advice, disseminates information and develops tools.

<http://www.dti.gov.uk/sectors/construction/sustainability/page13691.html>

The DTI's web-page on sustainable construction provides clear information on key government initiatives.

<http://www.BuildingGreen.com/go/suite>

A subscription based on-line resource that provides practical information with a database of high performance case studies.

<http://www.sbicouncil.org/>

Website of the Sustainable Buildings Industry Council.

<http://www.greenbuilding.ca/>

The International Initiative for a Sustainable Built Environment includes an annual Global Conference on Sustainable Building and Construction.

<http://www.aecb.net/>

The Association for Environment Conscious Building is a member-based organisation, providing training, articles and conferences. It has a straightforward Eco Fact Sheet which can be downloaded, covering energy, pollution, water and biodiversity.

<http://www.cabe.org.uk/>

The Commission for Architecture and the Built Environment (CABE) website has a section on sustainability.

<http://www.iea.org/G8/efficiency.htm>

Provides access to the International Energy Agency's project on energy efficiency in buildings (and other things).

Tools

<http://www.msdcg.umn.edu/MSDG/guide2.html>

This clear and easy-to-use design guide from the University of Minnesota takes you through a process of selecting sustainable design strategies and documenting your actions.

http://www.eere.energy.gov/buildings/tools_directory/subjects_sub.cfm

The tool of tools, with a directory of hundreds of tools on building performance, materials, components, equipment, HVAC and lighting systems, air quality, you name it. You can search by subject or country. All you ever wanted to know about tools, but were afraid to ask.

<http://www.sust.org/gateway/>

The Ecological Design Gateway provides information on all aspects of sustainable design for buildings and access to about 400 websites.

<http://www.sbis.info/>

The Sustainable Building Information System provides knowledge and links to relevant other sources. You can search websites for technologies, buildings, documents, methods and tools, people and organisations, projects, policies and programmes.

<http://www.breeam.org/>

<http://www.breeam.org/offices.html>

The Building Research Establishment Environmental Assessment Method (BREEAM) can be used to assess both new and existing buildings. Its widely used *BREEAM for Offices* specifically assesses the environmental performance of office buildings.

<http://www.usgbc.org/>

Leadership in Energy & Environmental Design (LEED™) Green Building Rating System. LEED is one of the leading systems for rating sustainable buildings, devised by the US Green Building Council. It has several levels depending on the number of credits achieved in various categories:

- LEED New Construction (LEED-NC) aimed at new buildings
- LEED Commercial Interiors (LEED-CI) is for the design of tenant fit outs in leased office space
- LEED Existing Buildings (LEED-EC) concerns the performance of existing buildings and can cover upgrades in the systems and operation of buildings even if the building is not substantially changed

<http://archrecord.construction.com/features/green/archives/0506edit-1.asp>

How is LEED faring after five years in use is a good overview of where LEED is leading.

<http://www.bfrl.nist.gov/oae/bees.html>

Building for Environmental and Economic Sustainability (BEES) helps assess about 200 building products, both generic and branded.

<http://www.greenseal.org/>

Provides some very clear and concise guides to specifying a range of materials and products, including particleboard and medium density fibreboard, carpet, lighting, occupancy sensors, office supplies and other office relevant products.

<http://www.building.co.uk/>

The magazine Building has a section on sustainability, including a Sustainable Toolkit with guidance and reports on legislation and other issues, as well as a 'carbon coach' to help you assess your carbon reduction needs.

Conferences

<http://energyefficiency.jrc.cec.eu.int/html/IECB06.htm>

International Conference on Improving Energy Efficiency in Commercial Buildings.

<http://www.bp-congress.de/>

Building Performance Congress.

<http://www.greenbuilding.ca/>

Global Conference on Sustainable Building and Construction.

Awards

<http://www.building.co.uk/>

The magazine Building has a section on sustainability, including an annual award for sustainable building design, including Sustainable Designer of the Year, Sustainable Client of the Year, Sustainability Innovation Award, Sustainable Building of the Year and others.

<http://www.eu-greenlight.org/Notice-Board/news.htm>

An annual award from the EU's GreenLight programme.

WHAT ARE THE BENEFITS?

Cost Savings

http://southwest.construction.com/features/archive/0410_feature5.asp

Green construction cost effective argues just that.

<http://www.envirowise.gov.uk/>

Envirowise provides a plethora of guides, case studies, checklists, workshops and other services to help companies cut costs by reducing their environmental impacts and energy use. Many of the materials are relevant to office design and management.

Productivity

http://www.galtglobalreview.com/careers/office_design_part2.htm

Why office design matters looks at the link between office design and human productivity.

<http://www.arc.cmu.edu/cbpd/iw/index.html>

The Robert L. Preger Intelligent Workplace project is a 'living laboratory' of what it takes to make a workplace work for you, rather than against.

<http://www.buildinggreen.com/menus/subtopics.cfm?TopicID=5>

Productivity and green buildings is published in Environmental Building News, October 2004.

<http://www.officeproductivity.co.uk/>

The Office Productivity Network aims to help managers understand how the design of their office environments can affect productivity.

<http://www.time.com/2002/greencentury/enarchitecture.html>

Buildings that breathe is an inspiring article on how the 'best of the new architecture uses nature rather than fighting it'.

http://www.cityofseattle.net/light/conservesustainability/studies/cv5_sp.htm

High performance buildings deliver productivity improvements offers testimonials to back this up.

Incentives

<http://www.thecarbontrust.co.uk/>

Quantifying the UK's Incentives for Low Carbon Investment, by the Carbon Trust, provides a guide to the incentives, worth about £1.3 billion, provided by government to encourage business and consumers to tackle carbon emissions.

<http://www.eca.gov.uk/etl/homepage.asp>

The Enhanced Capital Allowance Scheme permits you to claim 100% first year capital allowances for investments in energy saving technologies and products which are on the Energy Technology List. This website gives the list, together with tools and criteria to help with applications.

<http://www.ltcs.org.uk/>

http://www.opsi.gov.uk/si/si1996/Uksi_19961527_en_1.htm

The Landfill Tax is a fiscal incentive to minimise waste, which will increase until it reaches £35 per tonne.

<http://www.defra.gov.uk/environment/waste/aggregates/index.htm>

The Aggregates Levy aims to encourage the use of recycled aggregates by taxing virgin aggregates at £1.60 per tonne.

<http://www.dti.gov.uk/energy/sources/sustainable/microgeneration/lcbp/page30472.html>

The Low Carbon Buildings Programme supercedes the Clear Skies programme, and provides grants for renewable energy micro-generation projects, including for business.

WHAT SHOULD I LOOK FOR?

General

<http://www.advancedbuildings.org/>

This is a superb source of briefings on a range of sustainable building topics such as lighting and daylighting, finishes and furnishings, heating and cooling, water use and heating, building automation systems, energy efficiency, stormwater management, and air quality. A great place to start learning.

<http://www.hosted-fabermaunsell.com/sdc/>

Sustainable Construction: Practical Guidance for Planners and Developers is a great introduction to sustainable building, covering key drivers, the planning framework, measures, costs and benefits of sustainable design, training materials for mixed planning and development groups.

<http://www.mfe.govt.nz/publications/sus-dev/office-fitouts-dec05/office-fitouts-dec05.pdf>

One of the most concise yet comprehensive guides to sustainable office design, *A Guide to Sustainable Office Fit-Outs* can be downloaded free. A real step-by-step How To guide, covering paint, cabling and wiring, Heating, Ventilation & Cooling (HVAC) systems, lighting, glazing, materials, water, energy, furniture, noise and safety. It provides excellent technical checklists and things to ask for and to avoid. Jargon-free language!

<http://www.gaiagroup.org/>

The Gaia Group's free-to-download *Client's Guide to Sustainable Offices* is an aide to specifying sustainable office design.

<http://www.metropolismag.com/cda/sustainable.php>

The sustainability section of the Metropolis Magazine.

http://www.safeclimate.net/business/measuring/WRI_CO2Guide.pdf

Working 9 to 5 on Climate Change: An Office Guide is a step-by-step guide in the plainest language, with checklists and examples to help office managers reduce the environmental impact of the workplace. It can be downloaded, and is worth distributing around the office.

<http://archrecord.construction.com/features/green/archives/0502edit-1.asp>

The art and science of peace and quiet is a wonderfully well-written, concise yet comprehensive introduction to dampening noise in buildings.

AIR

General

<http://archrecord.construction.com/features/green/archives/0105dirt-1.asp>

Here's the dirt on green housekeeping is a short, clear piece which considers the maintenance and monitoring procedures and systems needed to keep the indoor environment healthy.

<http://archrecord.construction.com/resources/conteduc/archives/0604edit-1.asp>

Robo buildings: Pursuing the interactive envelope is an entry to the world of smart building envelopes that incorporate ventilation and daylighting to the benefit of occupants and the environment.

<http://epb1.lbl.gov/EPB/home.html>

The Energy Performance of Buildings Group looks mostly at air movement and resulting distribution of energy, pollution and fresh air.

<http://www.arc.cmu.edu/cbpd/iw/index.html>

The Intelligent Workplace has suggestions for air and temperature controls, sensors and natural ventilation.

<http://www.ashrae.org/>

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) is known for setting standards in HVAC energy use.

http://www.wbdg.org/design/emp_hvac.php

Energy Master Planning for HVAC Systems in Existing Buildings is another good starting point, which puts sustainable heating, cooling and ventilation in the framework of The Natural Step.

Tools

<http://www.wbdg.org/design/naturalventilation.php>

Provides an overview of several natural ventilation analysis tools such as Airpak, Flovent, Fluent and Star-CD.

Ventilation

<http://www.wbdg.org/design/naturalventilation.php>

An excellent, jargon-free overview of natural ventilation by Andy Walker of the National Renewable Energy Laboratory.

<http://www.greenbuildings.santa-monica.org/envelope/envventilation.html>

A brief overview of techniques for maximising natural ventilation.

<http://archrecord.construction.com/features/green/archives/0509edit-1.asp>

Commercial buildings open their windows is a wonderfully clear introduction to natural ventilation via windows.

<http://www.ecbcs.org/>

The Energy Conservation in Buildings and Community Systems Programme (ECBCS) is an International Energy Agency initiative to improve the energy efficiency of buildings, with various research projects including Control Strategies for Hybrid Ventilation in New and Retrofitted Office Buildings.

<http://www.sunpipe.co.uk/>

The company that produces the Monodraught Windcatcher, a rooftop ventilation system that eliminates air conditioning, and the Sola-Vent which combines light piping and solar powered ventilation.

<http://www.scienceinpublic.com/freshinnovators/2004/chrisfield/chrisfield.htm>

The Silenceair has the appearance of a transparent brick which allows natural ventilation while blocking outside noise by up to 85%.

Heating & Cooling

<http://www.azsolarcenter.com/design/pas-1.html>

Passive Solar Heating & Cooling Manual can be downloaded free, and is a perfect introduction to the subject with clear diagrams and language.

<http://www.ashrae.org/>

American Society of Refrigeration and Air-Conditioning Engineers (ASHRAE), *ASHRAE Handbook of Fundamentals*, Chapter 26 looks at natural and fan-forced ventilation.

Indoor Air Quality

<http://eetd.lbl.gov/ied/viaq/>

To tap research on ventilation rates and technologies, indoor volatile organic compounds (VOCs), sick building syndrome and particles and other pollution.

<http://www.dc.lbl.gov/IHP/>

Access to a bibliography of 900 papers (many with abstracts) for the Indoor Health and Productivity Project.

<http://www.buildinggreen.com/menus/subtopics.cfm?TopicID=5>

The subscription-based Building Green has a section on Indoor Environmental Quality.

LIGHT

Daylighting

<http://www.wbdg.org/design/daylighting.php>

A short, sweet introduction to the benefits and concepts of designing for maximum daylight.

<http://windows.lbl.gov/>

Has sections on Glazing Materials, Window Properties, and Commercial Performance.

<http://www.enermodal.com/Canadian/pdf/DaylightingGuideforCanadianBuildingsFinal6.pdf>

Daylighting Guide for Canadian Commercial Buildings (August 2002) can be freely downloaded from the website of the Public Works and Government Services of Canada. Fairly concise and readable, it also provides some brief case studies.

http://windows.lbl.gov/comm_perf/Default.htm

Links to the Daylighting in Commercial Buildings Sourcebook and Daylighting The New York Times Headquarters Building.

<http://windows.lbl.gov/daylighting/designguide/designguide.html>

Tips for Daylighting.

<http://windows.lbl.gov/daylighting/default.htm>

Considers light redirecting systems.

<http://www.eere.energy.gov/buildings/tech/lighting/>

A straightforward tour of daylighting, under this section on energy efficient lighting.

<http://www.sunpipe.co.uk/>

The company that produces the Sunpipe, an aluminium light pipe for bringing daylight into a building interior, and the Sola-Vent which combines light piping and solar powered ventilation.

<http://www.solatube.com/>

Another maker of light pipes, or 'miracle skylights'.

Lighting

<http://www.wbdg.org/design/efficientlighting.php>

A short, sweet guide to energy efficient lighting, well illustrated and clearly written. A good starting point.

<http://www.wbdg.org/design/electriclighting.php>

A short, sweet guide to electric lighting controls, such as photosensors and occupancy sensors, which can make a big difference to productivity levels (up) and energy bills (down).

<http://btech.lbl.gov/>

The Lawrence Berkeley National Laboratory does wide ranging research on windows, daylighting, lighting systems, and commercial buildings systems.

<http://lighting.lbl.gov/>

They also have a Lighting Research Group addressing these issues:

http://lighting.lbl.gov/lh_main.html

The Human Factors research team considers how lighting affects productivity.

http://lighting.lbl.gov/lc_main.html

Linked to productivity is the capacity to improve control of lighting. The Control and Communications research is considering how digital technologies can be applied to building lighting controls.

<http://www.light-link.com/>

Lightsearch is a source for lighting products and manufacturers.

<http://www.arc.cmu.edu/cbpd/iw/index.html>

The Intelligent Workplace has suggestions for lighting and lighting controls.

<http://www.eere.energy.gov/buildings/tech/lighting/>

A straightforward tour of various forms of energy efficient lighting. A good place to start.

<http://www.eu-greenlight.org/>

Website of the EU's Greenlight Programme, aimed at encouraging more energy efficient lighting. It has an annual award, and also an e-newsletter.

http://www.eu-greenlight.org/What-to-do/Choose-Options/l_all.htm

The EU's Greenlight Programme also has an excellent overview of energy efficient lights and a guide to action.

Superwindows

<http://windows.lbl.gov/>

Has sections on Glazing Materials, Window Properties, and Commercial Performance.

<http://www.efficientwindows.org/>

Provides a wide-ranging introduction to technologies around energy efficient windows and tools for selecting them, including a detailed glossary and access to superwindow information. Although quite US-oriented, it's still valuable to a European.

ENERGY

General

<http://www.eere.energy.gov/buildings/>

The clear and comprehensive *Low Energy Building Design Guidelines* can be downloaded from the Federal Energy Management Programme. One of the best overviews of how to reduce energy consumption, including costs, benefits, lighting and other strategies, design and analysis tools, case studies and further resources.

<http://www.ecbcs.org/>

The Energy Conservation in Buildings and Community Systems Programme is an International Energy Agency initiative to improve the energy efficiency of buildings, with various research projects.

<http://www.tcpa.org.uk/>

Sustainable Energy by Design (January 2006), produced by the Town & Country Planning Association, is aimed mostly at sustainable energy for community design. A good overview of policy, legislation and technologies surrounding sustainable energy, and includes excellent case studies and graphics.

<http://www.dti.gov.uk/energy/policy-strategy/energy-white-paper/page21223.html>

<http://www.dti.gov.uk/files/file10719.pdf>

The government's White Paper on Energy, published in 2003.

Tools

<http://www.iea.org/>

The International Energy Agency's Annex 31 looks at how energy assessment life cycle analysis tools can be used to reduce the energy impacts of buildings, inside and out.

<http://www.wbdg.org/design/naturalventilation.php>

Provides an overview of several energy management tools such as DOE-2 and Energy Plus.

<http://www.envirowise.gov.uk/>

Envirowise has a plethora of materials: guides, case studies, checklists and reports that can help companies reduce their energy use.

<http://www.safeclimate.net/>

Helps companies figure out how to reduce their climatic impacts. Its materials can be customised for internal education purposes.

<http://www.gocarbonzero.org/>

Go Zero allows you to tot up and off set your carbon emissions through planting trees. Tree planting and forest conservation are sensible stop-gaps on the road to sustainability.

<http://www.building.co.uk/>

The magazine Building has a section on sustainability, including a 'carbon coach' to help you reduce your carbon emissions.

Conservation

http://www.eere.energy.gov/femp/procurement/eep_computer.cfm

Simple tips on how to buy energy efficient computers.

<http://eetd.lbl.gov/pubs/39466.pdf>

The User Guide to Power Management in PCs and Monitors can be downloaded free.

<http://www.80plus.org/>

A forum bringing together electricity utilities, the computer industry and consumers to bring energy efficiency to computers and servers.

<http://www.eere.energy.gov/buildings/highperformance/>

Straightforward guidance on reducing the energy consumption of office equipment.

Renewables

<http://www.xco2.com/>

This designer of beautiful, compact, vertical wind turbines also helps companies reduce their carbon footprint.

<http://www.azsolarcenter.com/design/pas-1.html>

Passive Solar Heating & Cooling Manual can be downloaded free, and is a perfect introduction to the subject with clear diagrams and language.

<http://www.nrcan.gc.ca/redi>

Solar Water Heating Systems: A buyer's guide is a short guide that can be downloaded from the website of Natural Resource Canada. Although intended for domestic water heating, it has some relevance to commercial building use.

http://www.canren.gc.ca/prod_serv/index.asp?Cald=137&PgId=742

Heating Your Building with Solar Energy: Efficient, Simple and Cost Effective is a short guide that can be downloaded free.

WATER

General

http://southwest.construction.com/features/archive/0410_feature11.asp

Greening your site, a short article which looks at how low impact techniques can maximise water conservation.

<http://www.greenbuilder.com/sourcebook/>

A clear guide to several key aspects of sustainable buildings, including a section on water.

<http://www.advancedbuildings.org/>

This is a superb source of briefings on a range of sustainable building topics including water use, conservation, recycling and heating, and stormwater management. A great place to start learning.

http://www.advancedbuildings.org/main_t_plumbing_ultra_flow_toilets.htm

A simple summary of the pros and cons of ultra low flush (6 litre) toilets.

<http://www.interflush.co.uk/>

A device for reducing water use in flushing.

<http://www.ukrha.org/>

UK Rainwater Harvesting Association.

MATERIALS

General

<http://www.greenbuilder.com/sourcebook/>

A clear guide to several key aspects of sustainable buildings, including a section on building materials.

<http://www.corrim.org/reports/>

The Consortium for Research on Renewable Industrial Materials has some useful fact sheets and reports on product selection, renewable materials (particularly wood or wood-based) and other subjects relevant to construction.

Tools

<http://transstudio.com/tm/index.htm>

Transmaterial is a joy to behold, taking you through a range of new materials. Although not specifically 'sustainable' materials, many of them come with environmental features which are briefly outlined. There is also a richly illustrated book of the same name.

<http://www.epa.gov/opptintr/epp/tools/toolsuite.htm>

A set of tools on environmentally preferable purchasing, including a database of products and services, a training tool, information on sustainability conferences.

http://www.csbr.umn.edu/materials_database.html

A database of sustainable materials provided by the Center for Sustainable Building Research.

http://www.eere.energy.gov/buildings/tools_directory/subjects_sub.cfm

This is the mother of all tools, providing a directory to hundreds of different tools concerning analysis of building performance, with a section dedicated to materials and components.

<http://www.bfrl.nist.gov/oae/bees.html>

Building for Environmental and Economic Sustainability (BEES) is a tool that helps assess about 200 building products, both generic and branded.

<http://www.environmentalchoice.com/English/ECP%20Home/>

The EcoLogo of the Canadian government, this site allows you to assess a wide range of building materials and products, including flooring, heating and cooling, paints and finishes and raw materials.

<http://www.greenspec.co.uk/>

An excellent on-line resource for specifying more sustainable materials and products.

<http://www.wrap.org.uk/>

The Waste & Resources Action Programme, funded by government, aims to create markets for recycled materials. In 2005 it began a programme focused specifically on the collection and reprocessing of plasterboard.

http://www.netregs.gov.uk/netregs/resources/278006/?version=1&lang=_e

Access to the government's Pollution Prevention Guidelines, including chemicals, construction, forestry, and wood products.

<http://www.sust.org/directory/>

A directory of sustainable building materials that are indigenous to Scotland.

<http://www.bc.bangor.ac.uk/>

Website of the Biocomposites Centre which develops plant-based composite materials for industrial use, including a project looking at plant-based MDF. They have a newsletter to which you can sign up.

<http://www.ecocomposite.org/>

Another organisation looking at the development of more sustainable composites, it includes a reading list.

Boards

<http://www.natural-building.co.uk>

The Natural Building Technologies website has a section on boards, plaster and render, including avoidance of the 'sick building syndrome' through breathable renders.

<http://www.corrim.org/reports>

The Consortium for Research on Renewable Industrial Materials has some reports on the life cycle of oriented strandboard, plywood and other related products.

<http://www.rebri.org.nz>

Easy guide to resource recovery: plasterboard is a two page fact sheet on what to do with waste plasterboard.

Carpets

<http://www.interfaceflooring.com/>

<http://www.interfacesustainability.com/>

Ceilings & Floorings

<http://www.armstrong.com/>

Armstrong Commercial Ceilings is known for a commitment to sustainability in its ceiling products, with an emphasis on recycled content and renewable resources. It also offers flooring.

<http://www.plyboo.com/>

Plyboo is a product made from a strong, light, fast-growing renewable resource: bamboo. It can be used for flooring (harder than many woods), panels or doors.

<http://www.buildinggreen.com/auth/article.cfm?fileName=150301a.xml>

Bamboo in construction: is the grass always greener? is an excellent overview of bamboo as a building material, looking at all aspects of its sustainability performance.

Paints & Finishes

<http://www.natural-building.co.uk/>

Paints & Ecology, by Neil May, is a readable, concise article on the ecological effects of paint.

Textiles

<http://www.dtex.com/>

Designtex is one of the main suppliers of fabrics designed for minimal environmental impact. Their Climatex Lifecycle started by designing 'out' as many chemicals as possible to create a fabric that can be composted. Climatex Lifeguard FR has the same mulchable qualities while meeting worldwide fire retardant safety codes. Eco Intelligent Polyester uses environmentally benign materials while Terratex is 100% recycled polyester.

Wood

<http://www.fsc-uk.org/>

The Forest Stewardship Council is the certifier par excellence of sustainable timber.

<http://www.woodforgood.com/>

Wood for Good also focuses on the sustainability of timber products.

<http://www.rebri.org.nz/>

Easy guide to resource recovery: wood is a two pager fact sheet on what to do with waste wood.

Waste & Recycling

<http://www.salvomie.co.uk/>

Helps you connect with recycled or reclaimed building materials.

<http://www.wrap.org.uk/>

Waste & Resources Action Programme helps find or create markets for recycled materials of all kinds.

<http://www.environment-agency.gov.uk/subjects/waste/1019330/>

Provides general guidance on waste produced by business, particularly if hazardous, including legislation.

GOVERNMENT RESPONSES

Directives & Legislation

<http://www.netregs.gov.uk/netregs/legislation/>

A good place to help you keep up with, and even ahead of, current and emerging legislation.

<http://www.diag.org.uk/>

http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_001/l_00120030104en00650071.pdf

EU Directive on Energy Performance in Buildings was implemented at national level in January 2006.

<http://www.legislation.hms.gov.uk/acts/acts2004/20040022.htm>

The Sustainable and Secure Buildings Act allows building regulations to consider sustainability more broadly to include not only environmental improvements, but also furthering sustainable development, and the reduction of crime.

<http://www.communities.gov.uk/buildingregs/>

The Update to Part L of building regulations came into force in December 2005 and sets standards to reduce CO2 emissions. It will look at overall CO2 emissions against a target value and will take into account any renewables used.

<http://www.carbontrust.co.uk/climatechange/policy/ccl.htm>

Climate Change Levy (CCL) became effective in 2001 as a price signal to reduce energy use and emissions in industry, commerce and the public sector. It's complemented by Climate Change Agreements in which energy intensive industries can negotiate an 80% discount on the CCL in return for meeting agreed targets to reduce carbon emissions.

http://www.carbontrust.co.uk/climatechange/policy/renewables_obligation.htm

The Renewables Obligation (RO) obliges electricity suppliers to source a growing proportion of their energy from renewable sources, with a target of 15% by 2015.

Codes & Standards

<http://www.dti.gov.uk/sectors/construction/sustainability/codesushomes/page13697.html>

Code for Sustainable Homes is described on the DTI's web-page on sustainable construction.

<http://www.defra.gov.uk/environment/energy/betterbuildings.htm>

There is also discussion about whether to develop a Code for Sustainable Buildings (CSB).

<http://www.greenguard.org/>

Greenguard certifies low emission products for the indoor environment, including adhesives, appliances, ceilings, cleaning systems, flooring, construction, insulation, office equipment, office furniture, panels and moveable walls, paint, textiles and wall coverings. Although a US standard, their Allowable Emission Levels provide a great benchmark for suppliers.

OVERVIEW OF SUSTAINABILITY

<http://www.sustainable-development.gov.uk/>

The government's mouthpiece on its sustainable development strategy.

<http://www.sustainable-development.gov.uk/progress/indicators/sdiyp.htm>

Sustainable Development Indicators in your Pocket 2005 is an excellent, comprehensive overview of sustainable development indicators and facts in the UK, compiled by the government and presented in a graphic-rich design, even though it isn't quite pocket-sized.

<http://www.wbcsd.org/>

Website of the World Business Council for Sustainable Development, a coalition of 190 multinational companies looking for ways to make business and sustainability work for each other. The website has been twice voted the best on-line resource on sustainable development and the organisation was also voted as second only to the EU in promoting sustainability over the next five years.

<http://www.millenniumassessment.org/en/index.aspx>

The Millennium Ecosystem Assessment brought together about 1,400 scientists from 95 countries and examined the state of the planet, looking at ecosystems, biodiversity, degradation and other issues including human impacts.

<http://www.designcouncil.org.uk/>

The Design Council's website has a section on sustainability, with an emphasis on design and a range of resources, short case studies, and regularly updated content on trends and other emerging issues.

<http://www.ipcc.ch/>

The International Panel on Climate Change (IPCC) – global authority on climate change.

<http://www.sd-commission.org.uk/pages/020506.html>

The Sustainable Development Commission was set up by the government as an independent advisory body.

WHERE CAN I DIG DEEPER?

There are hundreds of books on every one of the topics covered here. Below is just a tiny sampling, to give you a taster of what's out there, listed alphabetically by author.

Daylighting Performance and Design, Gregg Ander (Wiley, 2003), provides uncluttered language and clarity. ISBN 04712 62994.

The Green Guide to Specification, Jane Anderson & David Shiers (Blackwell Science Ltd, 2002), provides an easy introduction to the environmental performance of both interior and exterior construction materials. ISBN 06320 59613.

Biomimicry: Innovation Inspired by Nature, Janine Benyus (William Morrow, 1998), is a delight for the mind for anyone interested in seeing the potential of sustainable design, even if they don't think of biomimicry as being their thing. It is beautifully written, a rarity in this field, and is full of inspiring ideas and stories. ISBN 06881 60999.

Transmaterial: A catalog of materials that redefine our physical environment, Blake Brownell (ed) (Princeton Architectural Press, 2006), is a joy of a book for designers interested in exciting new materials. Although not specifically aimed at sustainable design, it provides an environmental summary for a large proportion of entries, which should remove any notion that sustainable design is about using recycled toilet rolls. Beautifully illustrated, with detailed information on properties and suppliers. You can also read about many of the entries on the website, but you won't have the tactile or visual pleasure of the book version. ISBN 15689 85630.

Sun, Wind & Light: Architectural Design Strategies, GZ Brown and Mark DeKay (John Wiley, 2001). A real inventory of approaches to heat, light, ventilation, energy and other elements of sustainable building. This is in the How To department and includes analysis techniques. Really for practitioners. ISBN 04713 48775.

Ten Shades of Green: Architecture and the Natural World, Peter Buchanan (The Architectural League of New York, 2005). Along with *Big & Green*, this is a great inspirer, bringing sustainable architecture to life through some excellent examples, opulently photographed and illustrated. A joyous way to impart the basic principles of sustainable building design. ISBN 03937 31898.

Rough Guide to Sustainability, Brian Edwards (RIBA Enterprises, 2005). An excellent, short, readable introduction to sustainable architecture, including drivers, policies and regulations, as well as techniques. Full of crisp illustrations and diagrams. A good starting point. ISBN 18594 61743.

The Eco-design Handbook: A Complete Sourcebook for the Home and Office, Alastair Fuad-Luke (Thames & Hudson, 2005). Bursting with colour illustration, this is a great book to dip into for ideas on materials and products of a sustainable bent. It also provides guidance and information on suppliers and other useful contacts. Although not aimed at buildings, some of the materials and furniture are relevant. ISBN 05002 85217.

Big & Green: Toward Sustainable Architecture in the 21st Century, edited by David Gissen (Princeton Architectural Press, 2002). A visual and conceptual feast, to read or give to people to trigger enthusiasm and inspiration. Suitable for all audiences, it covers Energy, Light & Air, Greenery, Water & Waste, Construction and Urbanism and includes interviews with some of the key movers and shakers in this field, such as Robert Fox or William McDonough. A coffee table book with guts and substance. ISBN 15689 83611.

The Distributed Workplace, edited by Andrew Harrison, Paul Wheeler and Carolyn Whitehead (Spon Press, 2004). Coming at it from a different angle, this is how to enable people to work in decentralised environments in a collaborative, flexible way by making the most of communications technologies. It has implications for energy use, transport and also employee well-being and productivity. ISBN 04153 18904.

Natural Capitalism: The Next Industrial Revolution, Hawken, Paul, Amory & Hunter Lovins (Earthscan, 2005) is the read-this-if-nothing-else introduction to sustainable design in its broadest sense. The chapters on building design and tunnelling through the cost barrier are particularly pertinent, the latter demonstrating that optimising a whole system, rather than its parts, can yield compound simplicities and savings. Highly readable and inspiring. ISBN 18440 71700.

Sustainable Construction: Green Building Design & Delivery, Charles J. Kibert (John Wiley, 2005). Excellent, solid, readable book for when you're ready to dig in seriously. Covers a wide range of issues, from tools and standards, to the design and building process, landscaping, water, energy and atmosphere, indoor air quality, materials use, commissioning and economic analysis of sustainable buildings. Full of information and as relevant to the practitioner as to the generalist. Although it covers technical issues, it's accessible. ISBN 04716 61139.

The Passive Solar Energy Handbook, Edward Mazria, is written by the architect who has just thrown down the gauntlet to his profession with the Architecture 2030 challenge to for all buildings to be carbon neutral by 2030. ISBN 08785 72600.

Cradle to Cradle: Remaking the Way We Make Things, William McDonough and Michael Braungart (North Point Press, 2002). A slim introduction to the cradle to cradle philosophy of going beyond merely being efficient to creating virtuous closed loops in production. Highly readable and inspiring, and though not specifically building oriented, it has transferable principles. ISBN 08654 75873.

Passive Building Design: A Handbook of Natural Climatic Control, Gernot Minke & Gerd Hauser Narendra (Elsevier, 1994). A classic introduction to natural ventilation and cooling in buildings. ISBN 04448 1745X.

Cool Companies: How the Best Businesses Boost Profits and Productivity by Cutting Greenhouse Gas Emissions, Joseph Romm (Earthscan, 1999). One of the best introductions to using sustainable design to unleash the productivity giant. The chapters on lighting, heating and ventilation are the most pertinent. Gives scores of examples of refits to commercial buildings which had short payback times and productivity gains that exceeded all expectations. It also provides some straightforward How To advice. ISBN 18538 36559.

Introduction to Architectural Science: The Basis of Sustainable Design, Steven Szokolay (Architectural Press, 2004). If you started with the Rough Guide to Sustainability, you might try this one when you're ready to dig in deeper. It's getting into the nitty-gritty how-to stuff, with a particular emphasis on Heat, Light and Sound. Only for practitioners, but well presented and illustrated, and avoids feeling like a textbook. ISBN 07506 58495.

Smart & Sustainable Built Environments, Jay Yang (ed) (Blackwell Publishing, 2005) covers a range of state of the art methods and technologies, including emerging tools and approaches. There are several chapters specifically relevant to sustainable office design: technical solutions, reducing energy related emissions, the increasing costs of commercial buildings once emissions trading is factored in, and raised floor systems for office fit-outs. Many other chapters are also relevant. ISBN 14051 24229.