Reducing emissions through energy efficiency

Key issues to address in designing and operating buildings

The burning of fossil fuels has a major impact on the environment. The CO_2 emitted from burning fossil fuels is widely acknowledged to be causing global climate change, and improving energy efficiency will help reduce global warming. Burning less fossil fuel also results in reduced emissions of the pollutants that contribute to acid rain.

Energy use in buildings is responsible for almost half the CO_2 emissions in the UK. The energy bill for most existing commercial and public buildings could be reduced by at least 20% using cost effective measures. New buildings and major refurbishment represent even greater potential. New low-energy buildings consume 50% less energy than existing buildings and 20% less than typical new buildings.

Electricity use is a key issue, since its generation produces high levels of CO_2 emissions, and electricity consumption is rising, often due to IT equipment and air conditioning. While electricity is efficient at the point of use, low efficiency at power stations means that it can produce 2 to 3 times the CO_2 emissions per delivered unit of energy than the direct use of fossil fuels. Electricity is also more expensive per unit of delivered energy.

Under the Kyoto protocol, the UK government is committed to reducing the emission of greenhouse gases to 12.5% below 1990 levels by the year 2010, and has set a more stringent internal target to reduce it by 20% by 2010. The recently published Energy White Paper sets out even more challenging goals for further reductions by 2020, which it proposes to achieve in large measure through greater energy efficiency of both new and existing stock supported by the greater use of renewable energy (see CIBSE Briefing 9). The Royal Commission for Environmental Pollution has set a target for reducing emissions by 60% by the year 2050.

The government has also introduced a range of measures to deliver reductions in emissions, some of which have a direct impact on the building and property industries. These include the Climate Change Levy, Enhanced Capital Allowances (see CIBSE Briefing 4) and the 2002 Building Regulations Part L (see CIBSE Briefing 1). Further measures will be required to implement the new EU Directive on Energy Performance of Buildings (see CIBSE Briefing 6).

All building professionals have a responsibility to reduce emissions through energy efficiency at the design stage and right through the operational life of the building. This briefing describes some of the major factors in achieving energy efficient buildings, summarised from the guidance contained in CIBSE Guide F: *Energy efficiency in buildings*.

An energy efficient building provides the required internal environment and services with minimum energy use in a cost effective and environmentally sensitive manner.

This briefing was written by Phil Jones of Building Energy Solutions, specialist in building energy management issues

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Designing buildings

In new-build and major refurbishment situations, it is the very early decisions that determine whether or not the building will be energy efficient. The design team needs to take an integrated approach to provide designs that are responsive to the external climate whilst still meeting the needs of the occupants. Designers need to ensure that a requirement for energy efficiency is included in the client's brief, backed up by targets for energy consumption (kW·h/m^2 p.a.) and power density (W/m^2) alongside any intentions to include particular energy efficient equipment such as CHP or variable speed drives. Review the project in relation to these targets and criteria as the design progresses and compare with best practice benchmarks. Further information is available in CIBSE Guide F: *Energy efficiency in buildings*, in the *Low Carbon Toolkit* contained on the CIBSE Members' CD-ROM, and from the Action Energy website (www.actionenergy.co.uk). The Action Energy advice scheme, *Design Advice*, may also provide guidance, which is initially free.

Energy efficient design is unlikely to be achieved without an integrated design team. A multi-disciplinary team should be appointed early to ensure good interaction between the disciplines. Use of targets and life cycle costing throughout the project can help promote this teamwork.

Keep energy demand to a minimum through careful design of built form and services using renewable energy sources, ambient energy and passive solutions. Minimise uncontrolled air infiltration ('build tight—ventilate-right'). Using the ventilation design hierarchy (see Figure 1), beginning with natural ventilation or mixed-mode approaches, make every effort to avoid the need for air conditioning, while ensuring that the internal conditions are appropriate. Air conditioning is not always necessary and adds to capital and maintenance costs, and typically adds around 50% to energy consumption.

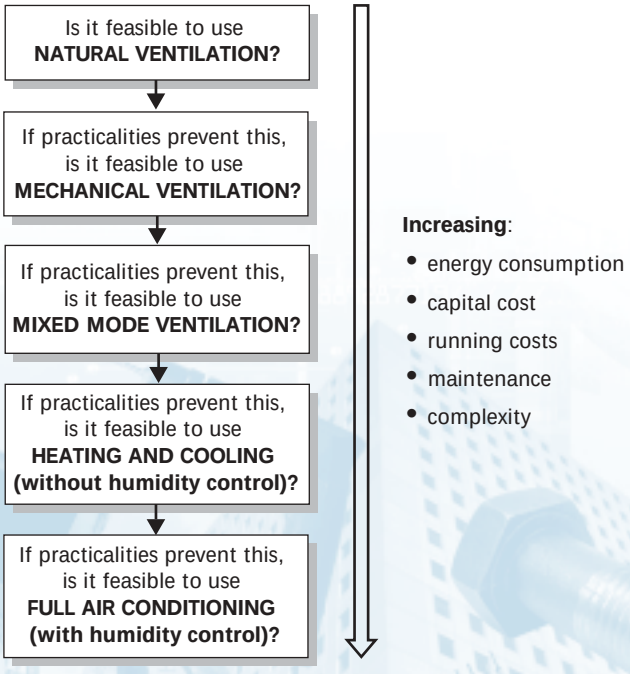

Figure 1 Ventilation hierarchy

Designers should minimise requirements for services by optimising heat gains, natural ventilation and daylighting. Also, by minimising distribution losses, using thermal storage, heat recovery, and free cooling. Services can also be minimised by challenging assumptions to avoid over provision — are design margins excessive or design parameters too tight? Select the most efficient plant and avoid oversizing. Building services spend most of their life at part-load so consider the efficiency under those conditions.

Good controls can improve comfort and reduce energy consumption. Designers should introduce energy efficient controls, which operate systems efficiently, safely and economically.

- Controls should be robust and flexible with simple overrides that default to 'OFF'.
- Avoid large systems operating needlessly due to small, local demands such as server rooms — seek a good balance between central controls and local occupant controls.

Both management and systems should be responsive to occupant needs, as occupants feel more comfortable when they can control their own comfort levels. Good selection of zones to meet the requirements of different areas underpins comfort, flexibility and energy efficiency. Variable speed drives, particularly on fans and pumps, can prevent energy wastage driving against balancing valves/dampers. Conflicting controls should be avoided, in particular simultaneous heating and cooling. Even a well designed system can perform badly with poor controls.

Design buildings that are easy to operate and understand. Make commissioning, maintenance, and management simple and they will all get done well, underpinning energy efficiency. Keep solutions simple and eliminate potential failure pathways.

Ensure complete handover to managers, operators and occupants, with thorough commissioning, possibly involving post occupancy evaluations, to guarantee systems operate correctly. Support this with good documentation (Part L2 now requires a building energy log-book, see CIBSE TM31: *Building energy log books*) to clearly show the design intent.

Operating and upgrading buildings

Building managers should always be seeking opportunities for improving existing buildings. Simple changes in management procedures should be the first line of attack followed by a 'technical fix' approach that may require investment. Ensure that the introduction of energy saving technologies does not go against the overall design intent. Improving general maintenance, building alteration and refurbishment are all key opportunities to improve energy efficiency. An extensive list of energy saving measures is provided in CIBSE Guide F and in Action Energy publications.

Energy efficient operation can usually be improved through better management, policy, maintenance, monitoring and control at little capital cost. It is essential to implement clear management and maintenance

policies and encourage correct use of the building by the occupants. This is underpinned through a good understanding of the building. Managers, engineers, operators and occupants should all be provided with suitable documentation (i.e. a building energy log book) to ensure they understand the design intent and how the building is meant to function.

A key part of any ongoing energy campaign is to make someone responsible for energy use, i.e. appoint an energy manager. A strong element of feedback should be introduced to improve understanding from previous good and bad experience. The energy manager might begin by checking fuel bills but gradually introduce a monitoring and targeting system to provide more sophisticated performance data. Appropriate metering improves information and enables faults to be detected rapidly. Establishing targets and reporting structures enables performance to be monitored against targets. Comparison of in-use performance of buildings with appropriate benchmarks can help to achieve best practice energy efficiency.

Our responsibilities

Building designers and operators have a responsibility to minimise adverse effects on the external environment. This can be achieved by minimising emissions, selecting materials and fuels that are less environmentally harmful and utilising renewable sources as much as possible.

There is a strong interaction between the building envelope, building services and the way people use buildings (see Figure 2). Building designers and operators need to take account of these human factors as they are the biggest influence on future energy consumption yet the least understood. Above all KEEP IT SIMPLE as over-sophisticated plant with complex controls leads to poor management and high energy use. Be aware that parallel systems like most renewable energy, heat recovery and CHP installations can be disabled without any noticeable effect on the internal conditions provided.

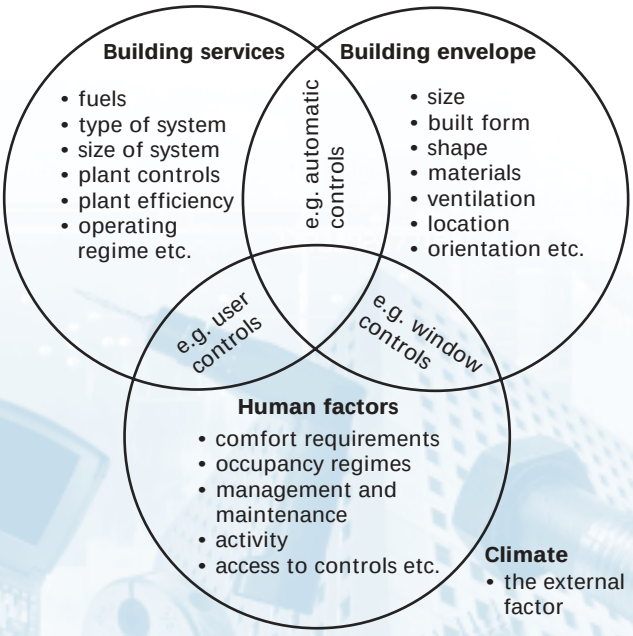

Figure 2 Factors that influence energy consumption

Energy efficient buildings need not cost any more to build than a 'conventional, building (see Action Energy Good Practice Case Study GPCS 405: *Developing and managing sustainable offices — demonstrating that sustainable offices are commercially viable*). Integration of the fabric and services design can present opportunities to reduce capital cost. For example, the cost of external shading can be offset by minimising or avoiding air conditioning plant.

Investment in energy efficiency should be treated on the same basis as any other financial decision, and should have no more onerous conditions placed upon it than any other investment. The appraisal of energy saving measures should always take into account the wider benefits such as improvements in comfort and the environment. This can be achieved using a life-cycle costing approach. See CIBSE TM30: *Improved life cycle performance of mechanical ventilation systems* for further details.

Energy efficiency leads to better buildings

Well-run buildings — the virtuous circle

A high standard of energy efficiency is a good indication of high management standards. Efficiently run buildings tend to have design and operational arrangements which produce good staff relations and satisfied occupants (see CIBSE TM22: *Energy assessment and reporting format*)

The most obvious benefit of energy efficiency is lower running costs, amounting to relatively large savings over the life of the building. However, reduced emissions and less use of natural resources have now become more important long term benefits. Improving energy efficiency can also lead to better buildings with greater comfort, a better working environment, more satisfied occupants and improved productivity as spin-off benefits. Providing better buildings will enhance the standing of building professionals, resulting in greater customer satisfaction and a greener image. Energy efficiency is *the* key route to reducing emissions from buildings leading to significant benefits for government, building professionals, clients, owners and occupants.

Barriers to energy efficient design

There is currently no incentive for the design team to routinely 'design-out' energy systems. Where professional fees are linked to the overall value of the capital works there is a perverse incentive acting against design teams which seek to maximise energy efficiency and minimise the cost of building services systems. Building professionals owe their clients a duty of care which should include care to ensure that the optimum design is produced which delivers the required comfort conditions whilst also achieving the minimum environmental impact.

Energy loans for small businesses

To help small businesses invest in energy efficiency measures, Action Energy offers small and medium sized enterprises (SMEs), that have been trading for at least twelve months, interest-free energy loans of between £5000 and £50 000 to fund the cost of buying energy equipment. The loans are totally interest-free, and repayable over four years. The loan can cover the project cost, including, for example, installation and commissioning – not just the capital cost of the equipment.

Where can I find out more?

- *Energy efficiency in buildings* CIBSE Guide F (London: Chartered Institution of Building Services Engineers) (2003)
- *Energy assessment and reporting methodology* CIBSE TM22 (London: Chartered Institution of Building Services Engineers) (1999)
- *Improved life cycle performance of mechanical ventilation systems* CIBSE TM30 (London: Chartered Institution of Building Services Engineers) (2003)
- *Building energy log book* CIBSE TM31 (London: Chartered Institution of Building Services Engineers) (2003)
- *Part L (2002)* CIBSE Briefing 1 (London: Chartered Institution of Building Services Engineers) (2003) (available from www.cibse.org)
- *Code for lighting* (London: Chartered Institution of Building Services Engineers) (2002)
- *Understanding building integrated photovoltaics* TM 25 (London: Chartered Institution of Building Services Engineers) (2002)
- *The Enhanced Capital Allowance Scheme* CIBSE Briefing 2 (London: Chartered Institution of Building Services Engineers) (2003) (available from www.cibse.org)
- *The Energy Performance of Buildings Directive* CIBSE Briefing 6 (London: Chartered Institution of Building Services Engineers) (2003) (available from www.cibse.org)
- The Energy White Paper is available (in summary and full versions) on the Department of Trade and Industry website: www.dti.gov.uk/energy/whitepaper/index.shtml
- The text of the EU Directive may be downloaded from: (http://europa.eu.int/eur-lex/en/lif/reg/en_register_121020.html)
- *Developing and managing sustainable offices — demonstrating that sustainable offices are commercially viable* Good Practice Case Study GPCS 405 (Action Energy (0800 585794)) (2003) (available from www.actionenergy.org.uk)

Website addresses

- Chartered Institution of Building Services Engineers (CIBSE): www.cibse.org
- Action Energy: www.actionenergy.org.uk (for details of Action Energy interest free loans for SMEs see: www.actionenergy.org.uk/energyloans or telephone 0800 585794)