SPECIAL REPORT: ENERGY TECHNOLOGY

We must learn how to design and construct genuinely efficient buildings if we are to stand any chance of hitting carbon reduction targets, warns **Doug King**

Conservation beats generation

ENGINEERING-LED: the Green Office building in Leeds

UK construction faces an unprecedented challenge in delivering zero-carbon buildings to meet current government targets. The need to reduce fossil fuel dependency is urgent and undeniable, but this means making real advances in energy efficiency.

It is no longer justifiable to simply bolt eco-bling – visible but ill-considered renewable energy – on to conventional, energy-hungry building designs. Unless the construction industry learns the new skills necessary to design genuinely efficient buildings, the transition to a low-carbon economy simply will not happen.

In the 21st century buildings must evolve to meet emerging challenges of climate change and energy security. To conserve diminishing fossil fuel supplies we will have to cut down on waste and inefficiency. The need for sustainable buildings is more pressing than ever.

Our national goal is to achieve an 80 per cent reduction in carbon emissions across the UK by 2050. Buildings presently account for 45 per cent of carbon emissions and the government has stated that all new buildings must be zero carbon from 2019, with homes leading in 2016.

To save carbon it is first necessary to understand how it arises. Energy consumed by heating, ventilation and air conditioning typically accounts for about 55 per cent of carbon emissions and artificial lighting another 20 per cent. These emissions are measured and regulated under the building regulations, BREEAM and other assessments. This is the portion of the building's carbon footprint that its designers can influence. The remaining 25 per cent of emissions arise primarily from the use of office equipment.

Minimising the need for artificial forms of conditioning is paramount in developing low-carbon designs. Electric lighting is fantastically inefficient, converting about 90 per cent of electrical energy into heat and only 10 per cent into light. Reliance on electric lighting often leads to the additional need for air conditioning, compounding the energy dependence.

The building envelope provides the primary means of controlling the internal environment, keeping out the weather, providing insulation against heat losses and gains, but also admitting daylight and beneficial warmth from the sun.

Building structures are incredibly durable; our cities are replete with examples of historic buildings still in daily use. If buildings we design today are to be sustainable then they must still be useful in 50 or 100 years. Thus, we must make the durable parts, the structure and envelope, work as hard as possible in controlling the internal climate to avoid reliance on mechanical systems that consume energy, wear out and have to be replaced.

The UK has many examples of energy-efficient, and therefore low-carbon, buildings, but surprisingly few of them have been built in the past decade. The Elizabeth Fry Building at East Anglia University and the Environmental Office at the Building Research Establishment near Watford are still among the lowest-carbon buildings in the UK, despite both having been designed and built in the 1990s.

Common features of such buildings are the extensive use of daylight to reduce the need for artificial lighting and cooling and the use of heavyweight construction and insulation to regulate the flow of heat through the building.

In many cases there is enough heat generated by the activities and occupants of office buildings to keep them comfortably warm with little need for additional energy. The trick is to retain the heat within the building rather than wasting it.

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A recent example of energy-conservative design is the Green Office in Leeds. This building was commissioned by developer Innovate Property to demonstrate a step change in commercial office design. The building, designed by RIO Architects and King Shaw Associates, achieved the highest BREEAM environmental score ever awarded. The success of the project stems from the attention to resource conservation throughout the design and construction.

The early engagement of the environmental engineer allowed the building to be designed from first principles with every aspect being assessed for its contribution to reducing carbon emissions. This engineering-led exercise produced an optimum solution for environmental performance without reliance on renewable energy.

The building is mechanically ventilated and comfort cooled, yet has energy consumption equivalent to good practice naturally ventilated offices. The structure of the building is harnessed by creating a thermal labyrinth within the concrete floor slabs that captures unwanted heat and stores it for later re-use. The regulated carbon emissions from the building are some 80 per cent lower than previous standard specification.

Buildings like the examples given here highlight the benefits of a proper engineering design approach. Energy-conservative design can provide a substantial proportion of the carbon savings required to meet our goals. With this magnitude of saving, the use of renewable energy systems on buildings becomes meaningful and can help make the final step to zero carbon.

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