BUILDING GREEN

Did you know that in the UK, buildings account for approximately 50% of our total annual CO_2 emissions?! These emissions are produced during their construction, operation and demolition.

Sara McGowan is a Mechanical Building Services Engineer with the consultant engineering firm Arup. It's her job to make sure that new buildings are designed so that they can be run in an energy-efficient and green way – like the brand new City Hall building in London. At the same time she has to make sure that the building is fit for purpose, and that the people inside it are happy – that it's not too hot or too cold, and that the humidity levels aren't too high to be comfortable.

Designing new buildings is not an easy matter, there are lots of factors to take into consideration…

KEEPING THE HUMANS HAPPY

Inhabited buildings – including homes – need three things:

A HEATING SYSTEM eg. radiators and boilers to make sure the place doesn't get too cold in winter.

A COOLING SYSTEM so that the inhabitants don't overheat during the summer. This could consist of eg. chillers that produce cold water for cooling units in the building.

A VENTILATION SYSTEM is needed to provide a fresh air supply for the people using the building. This could be as simple as opening the windows, but in some buildings this isn't possible, so a

mechanical ventilation system will be required. At certain times of the year this air may need to be heated (using the hot water from the boilers) or cooled (using the cold water from the chillers).

HOW TO DESIGN A GREEN BUILDING

The FORM or SHAPE of the building is key. Different shapes have different advantages and disadvantages. For example, some building forms are easy to ventilate naturally simply by opening the windows, but in tall buildings, it can be difficult to open the windows as it can get very windy 30 floors up in a building like Canary Wharf Tower!

The ORIENTATION of the building in relation to the Sun is crucial too. The Sun is a powerful source of energy, and the way the building faces will determine how much of the energy hitting the building actually gets inside each part of the building.

For example, in an office, we could consider using more glass on the North facing side of the building as the solar radiation hitting the north is much lower, while we might want to limit the amount of glass on the west side as low afternoon sun can cause too much heat gain in the building.

The FAÇADE, or outside, of the building is important too – and it's not just about looks!

In winter, there's natural heat loss through a building's façade. And conversely in summer there's a heat ***gain*** through the façade. These are two of the most significant elements of the total energy used by the building. And the extent of both of these is dependent on the materials used.

In terms of heat gain, for an energy efficient building we want to try to minimise the solar gain in the summer while considering beneficial gain in the winter.

To minimise the gain, we need to consider any shading systems that are being used, the amount of glazing in the building, and the type of glass that is being used.

Peoplebuilding, Hemel uses a motorised external louvre system to provide shading to the building. The louvres are controlled using a sensor that detects solar intensity. The control system then decides whether the blinds should be closed, and what angle they should be closed to.

Picture: Fletcher Priest Architects - Hayes Davidson

PASSIVE SYSTEMS

The next things to think about are passive systems, - in other words, systems that require no power, such as natural ventilation, thermal mass and shading systems.

ACTIVE SYSTEMS

The last thing to do is add active systems, systems that require additional power, such as motorised shading systems.

These systems can be costly and complex – which is why it's important to be as clever as possible when deciding on the form and orientation of the building. You can save yourself a load of energy and money at the outset if you get these elements right.

MATERIALS

The type of material the building's made of can affect the amount of heat loss in the winter. The smaller the heat loss, the better, as less energy has to be used in keeping the building warm. So we want to

minimise the use of materials that conduct a lot of heat and use insulating materials as much as possible.

City Hall has a façade that it is very efficient in terms of heat loss.

The façade is made up of high performance double glazed units combined with highly insulated solid panels.

This means that the façade works extremely well, combating both heat loss and solar gain.

Picture: Nigel Young

We also want to choose construction methods and details that aren't 'leaky' – making sure that there are no gaps around doors or windows that will letcold air into the building…

Beddington Zero Energy Development (BedZed) has a highly efficient construction which not only reduces heat loss to a level where heating is not required, it also has an extremely 'air tight' construction. A lot of time was spent by the designers, working with the builders, to ensure that the construction details weren't 'leaky'.

Another thing to consider when choosing the materials used in the construction of the building is the mass - how heavy/dense the material is. For example in a building with a lot of glass, the internal environment will reacting very quickly to changes in the outside temperature – imagine a greenhouse.

A heavyweight construction, e.g. high density concrete or stone, will result in a far more stable internal environment as the concrete will lessen the effect of changes in outside temperature. Imagine being inside an old church or a castle on a summer's day – even if it's really hot outside, it still feels cool inside. The same is true in the winter – even when it's really cold outside, it will feel warmer inside. Imagine being inside St Paul's cathedral, or a pyramid!

We can use this effect inside the building too, by choosing the right materials. Exposed concrete ceilings or walls can be used to absorb heat. During day excess heat in the space, for example from the internal gains, is absorbed by mass. This heat will then be released later in the day when the temperature in the space starts to drop.

Richard Davies& Arup

This effect can also be used to cool the space. Cold air is passed over the mass, cooling it down. This is often done over night in the summer. The cold slab will then absorb more heat during the day.

Paul McMullin

The New Parliamentary Building, Portcullis House, uses thermal mass as part of the environmental control strategy, as does the Jubilee Campus in Nottingham.

NATURAL VENTILATION

At its simplest, natural ventilation is openable windows and when using natural ventilation we take advantage of the fact that hot air rises! Using natural ventilation means that we don't need to mechanically ventilate a building, which saves energy.

We can either use a temperature or a pressure differences to drive a natural ventilation system.

When you open the windows in your house, you are naturally ventilating the room. Air will enter at low level, heat up, rise and leave at high level or through a window on the other side of the house if the wind is blowing. Even termites have even worked out how to use natural ventilation to keep their mounds cool!

As you can see Designing an energy efficient building requires us to combine many different, at times conflicting, design principles. It's this that presents us with the challenges and opportunities that make designing buildings such an exciting and rewarding experience.