CONDITIONS OF OPERATION

Reduce carbon but don't forget about comfort

Directives and standards to reduce energy in commercial buildings have set challenges for building services engineers to overcome. Complex design systems and modelling tools are now used to create new super-efficient installations with impressive results but, are they comfortable? Michael Curran (right), CIBSE Ireland and Head of Building Services, Energy and Utilities at the University of Galway investigates.

Faber and Kells' *Heating and Air Conditioning of Buildings*, eleventh edition, first published in 1936, emphasises the need for satisfactory environmental conditions within a building, whether for human comfort, material storage or support processes. The main factors that influence comfort for people relate broadly to the senses ... touch, vision, smell and hearing. Thus the design of the building services systems must provide a good thermal, aural and visual environment – fresh air and warmth or cooling; no unwanted noise or odours; and good lighting.

In surveys of user satisfaction within buildings' comfort issues, particularly temperature and air freshness, are among those rated as the most important aspects. The same studies show that dissatisfaction with the internal environment, particularly the thermal environment, is widespread with complaints of overheating in winter and coldness in air conditioned buildings in summer commonplace.

Therefore, the challenge for building services engineers and the design team is to ensure comfort conditions are met on all fronts. Design for non-domestic buildings can range from refurbishment of a 100-year old church to a new office block or hospital operating theatre. All have different conditions of operation.

It is important that designers and installers achieve design comfort levels set out by clients. Clients generally do not spend much attention on the heating systems in the project briefing document as it is assumed that designers will provide the staff with places to work efficiently. Badly-designed heating and ventilation systems can cause labour issues around sickness, absenteeism and lack of productivity.

The Chartered Institution of Building Services Engineers (CIBSE) provides numerous technical guidance and other benchmark documents outlining comfort conditions in buildings for heating, cooling and ventilation. Indeed, CIBSE guidance is referenced in Ireland's Building Regulations.

The challenges engineers face in designing heating systems

Although heating is often considered to be a simple, basic system, there are many options and permutations to be considered. Fundamentally, design for comfort in buildings has not changed since the original concepts were first used – a thermal source provides heat to a space and this is distributed through a piped system and emitted through a source within a room or space.

Climate change and adaption to the EU Energy Performance of Buildings Directive (EPBD) have set new standards for designers to achieve. The Irish Government's own targets to be carbon neutral by 2050, and the electrification of heating with the phasing out of fossil fuel use in buildings, has led to a number of key design questions which building service engineers now need to address. The following are just some of the many questions that need to be considered at design stage.

Correct sizing

Correct sizing, especially at part-load operation, is vitally important for commercial spaces following changed working and occupancy patterns since Covid-19.

Given the current requirements to limit energy consumption and CO2 production, good design of heating systems is essential to ensure that systems operate efficiently and safely, and that they make effective use of energy. Historically, there have been problems with the oversizing of heating systems. This can lead to inefficient operation, most notably at part-load operation; control problems; and a reduction in plant operating life. Energy consumption for oversized plant can be 50% more than is necessary.

Incorporating low-carbon options

The industry has entered a new era of space heating and is undergoing a rapid transition from carbon-intensive oil and gas boilers to renewable-based alternatives. Large-capacity heat pumps present a viable pathway to facilitate this transition, and district heating networks fuelled by data centres or large waste heat-producing plants can assist in the transition.

The fast pace of change and advancement of system integration should not be slowed by legislation and compliance around these new technologies. The EU and Ireland must ensure legislation is updated and enacted quickly if we are to meet 2030 targets

New design standards

New buildings are designed and built with NZEB, LEED, BREAM standards using the latest technologies, i.e. low and high temperature heat pumps; CHPs; led lighting; solar PV; and high-efficient glazing systems.

Building management systems (BMS) should be designed to realise the maximum efficiency of plant and equipment as per the conditions in the building. Overly complicated systems will be switched off and manually operated, negating any possible savings.

Retrofit and refurbishment

Currently, retrofit and refurbishment projects are installing low and high temperature air to water heat pumps, chillers, geothermal systems and biomass installations, and connecting them to large-scale buffer systems. Boilerhouses are increasing in size with new sub-circuited systems used to make buildings more flexible and user-friendly.

Heating systems' flow and returns are then connected to a number of different options, including low temperature radiators, underfloor heating, high temperature radiant panel heaters, unit heaters and fan coil systems.

Heat pump room in modern commercial building.

The designer must consider the building's existing structure and fabric and base the choice of heating system on that information. It is vital the design meets or exceeds the energy performance required, and that the optimum heat load for the building is selected. The primary heating source selected can be either single source or part of a bivalent system where the designer typically combines a heat pump and biomass system.

It is essential that the designer ensures the simplicity of the system, and that the solution guarantees reduced running and maintenance costs for the client. Complicated system designs will cause an increase in the operating and carbon reporting costs.

New standards and legalisation covering fossil fuels use, whole-life carbon, embodied carbon in services, and operational carbon in buildings have brought about changes to the approach of building services design. To reflect this, CIBSE has produced *TM65 Embodied carbon in building services: A calculation methodology (2021)* and *TM66 Creating a circular economy in the lighting industry (2021)*. Both documents are ideal when calculating carbon content related to a design. Building services engineers have a unique opportunity to transition from fossil fuel-based designs to renewable technologies, bivalent heating systems or electrified heating systems, all of which can achieve the target comfort levels.

Summary

In summary, as highlighted by Faber and Kells, it is important to ensure that systems designed for occupants are comfortable and manageable. If this is not achieved, then the buildings concerned won't meet the certification levels required and will be costly on many fronts for clients. ■