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WELCOME TO THE JUNE ISSUE OF MODERN BUILDING SERVICES

This month has an interesting focus on Commissioning, with contributions from the Commissioning Specialists Association (CSA). Plus, we delve into Smart Buildings and a selection of articles are written with the installer in mind.

I trust you will have an enjoyable read through all the technical pieces which have been kindly and thoughtfully provided by our many knowledgeable contributors.

Page 18 looks at how to reduce equipment's costs while maintaining quality construction outcomes. We also revisit retrofitting of UK historical buildings.

Dr Rob Lamb shares a very in-depth piece on a highly successful plant optimisation for a sustainable future on page 22.

Modern Building Services (MBS), including myself and several of the team will be at Installer Live again this year. My appointments diary is filling up quickly but if you haven't been in touch to arrange a visit to your stand, you can contact me on **julietl@warnersgroup.co.uk** Alternatively, come along to our stand for a coffee and chat.

If you'd like to discuss contributing a technical piece to the next issue, please contact myself on **julietl@warnersgroup.co.uk**

Juliet Loiselle

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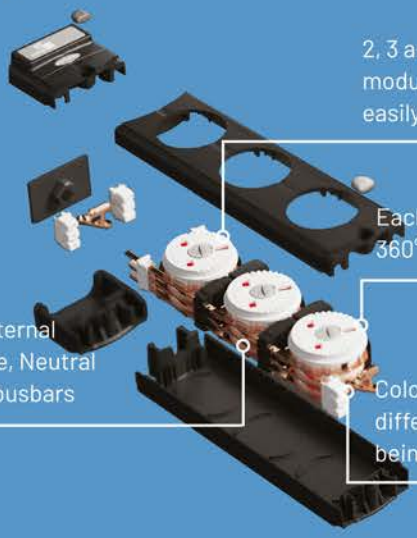

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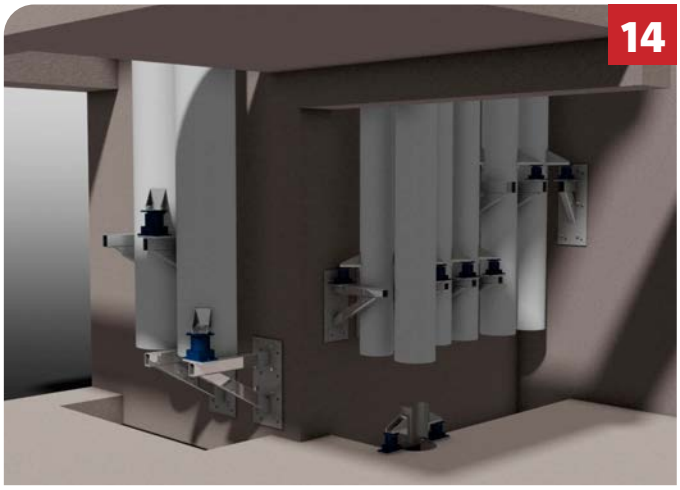

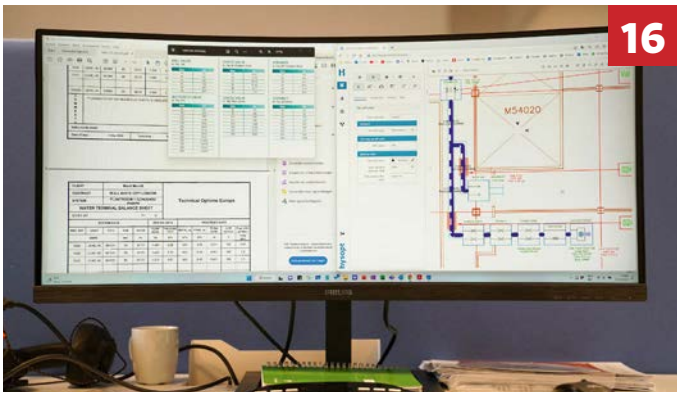

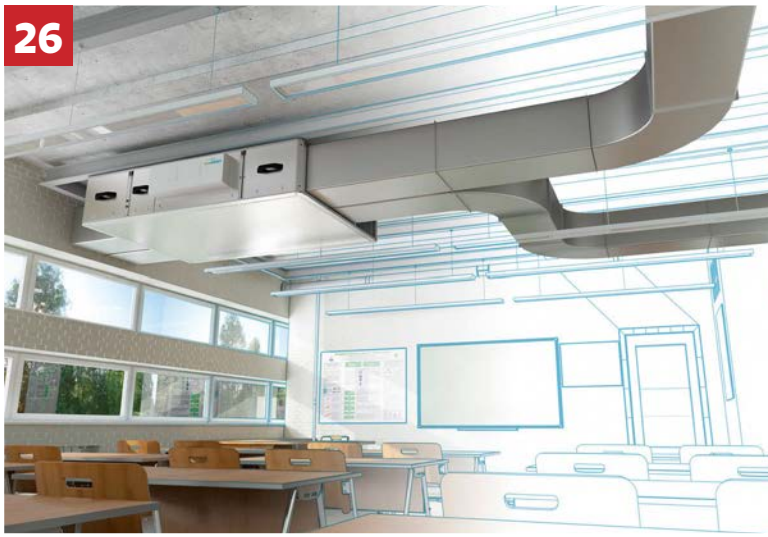

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Net Zero will make the UK 'warmer and richer'

The MP who signed the UK's Net Zero pledge into law has told an industry podcast that adapting buildings will deliver economic growth and better quality of life.

Former energy minister Chris Skidmore OBE, who chaired the government's independent Net Zero review, said building services had driven major social change in the past and could do so again.

He was a guest on the latest Building Engineering Services Association (BESA) podcast with the Association's chief executive David Frise and two representatives from heat pump manufacturer Mitsubishi Electric - head of sustainability Martin Fahey and Net Zero Design Manager Chris Newman.

Skidmore pointed out that, in the four years since the UK's pledge became law, more than 90% of global GDP had been committed to net zero work.

He cited the adoption of central heating that transformed qualify of life in the 60s and 70s as an example of how the building engineering sector had driven major change in the past.

He said the government should be focused on what was needed to give the UK a competitive edge and create policy certainty for businesses, so they will make the right investment decisions.

www.thebesa.com/besa-podcast

Low carbon heating apprentices get King's approval

The Building Engineering Services Association (BESA) has welcomed the selection of low carbon heating and sustainable engineering qualifications for special recognition in honour of the coronation of King Charles III.

Low Carbon Heating Technician (level 3) and Installation Electrician and Maintenance Electrician (level 3) were among six apprenticeships chosen for royal recognition because of their importance to the low carbon economy, according to the Department for Education (DfE).

"These apprenticeships are the gold-standard for green skills training, encouraging more people to take up the opportunity to gain the skills to build an exciting career in the green industry while meeting the needs of employers and boosting economic growth," it said.

The official Coronation emblem can be used by training providers, employers, and government offices to promote the apprenticeships, which also include Sustainability Business Specialist (level 7), and Corporate Responsibility and Sustainability Practitioner (level 4).

The King's commitment to renewable energy and sustainability is widely recognised and the apprenticeships selected were all designed by employers working with the Institute for Apprenticeships and Technical Education (IfATE), who considered the impact of each occupation on the environment and future workforce.

BESA said it was particularly pleased to see such high-profile recognition for low carbon heating. The apprenticeship aims to give students a firm grasp of the fundamentals needed to improve the overall performance of the built environment, including energy efficiency and the use of emerging technologies.

www.theBESA.com

MBS makes a visit to full working trials of an energy storage solution

Modern Building Services (MBS), along with an additional 50 invited guests, attended an event to showcase the potential of the pioneering EnergiVault® energy storage solution, which is designed to support the global decarbonisation of cooling and deliver cost savings for industrial processes and commercial buildings.

The patented cold thermal energy storage (CTES) system from Lancashire-based Organic Heat Exchangers (O-Hx) is undergoing full working trials at the Alnwick site of Quotient Sciences, a drug development and manufacturing accelerator, and has already delivered significant benefits and savings after being installed alongside an existing chilled water system.

The charger's ice crystallisers charge the battery by converting up to 60% of the system's heat transfer fluid (HTF), a water/glycol mix, into spherical ice crystals a fraction of a millimetre in diameter, each surrounded by a film of organic material. This ice slurry acts as the phase change material (PCM), resulting in a massive increase of the surface area over which the thermal transfer takes place. The thermal battery has very high discharge rates, unlike solid ice technologies, and unlimited charge-discharge cycles with zero battery degradation.

In addition to accessing electricity at its cheapest, the optimisation engine also enables the system to take advantage of periods of low carbon intensity on the grid, when more of the power is produced from renewable sources, resulting in reduced impact on the environment.

Operating data from the trial reveals that EnergiVault® will handle 30% of the Quotient Sciences site's 500MWh per year cooling demand at a basic level of operation, utilising ToU shifting to avoid high electrical tariffs. This has resulted in a 27% cost saving to date through load shifting and chiller efficiency benefits. When operating at its full potential, O-Hx calculates that savings significantly in excess of this will be available for the majority of sites, with potential for more than 60% saving against site cooling costs and reduction of CO_2 emissions.

MBS, along with the other invited guests were able to examine the installed system, with live dashboard feeds demonstrating charge and discharge rates, energy consumption and further key data sets. They were also challenged to test the cooling capabilities of the ice slurry.

Armorduct joins BEAMA

Armorduct, a manufacturer of standard and bespoke cable management systems, has joined BEAMA to help develop the trade association's next best practice guide for cable containment design, specification and installation.

Says Dave Taylor, Technical Manager for Armorduct, "This next best practice guide will be a significant document because since the last version in 2014 there have some big changes in the standards.

"Large volumes of cabling run through buildings to provide both electrical and data connections but the heat of fire can cause cable housings to fail and hidden cables to fall and become a hazard.

"Since 2019 you have to adequately support all cables using non-combustible fixings to prevent premature collapse in the event of a fire, not just those on escape routes.

"It means that specifiers and installers must select high quality products that will perform if there is a fire. This guide will provide advice on preventing such premature collapse."

Armorduct will also be involved in two further working groups as part of the cable management cable tray and trunking group. One will be involved in product fire resistance testing and the other in the development of the revised product standard BS EN 50085.

www.armorduct.com

E.ON leads consortium to pilot heat and energy as a service

In a bid to strengthen and enhance the UK's emerging green finance market, E.ON has partnered with Energy Systems Catapult and Heatio to develop two green finance products to promote greater uptake of energy efficiency and low carbon heating measures.

The project has been supported by the Department for Energy Security & Net Zero (DESNZ), through its Net Zero Innovation Portfolio (NZIP), as part of the department's Green Home Finance Accelerator (GHFA). The GHFA was established to provide innovation funding for the development of green finance products which can enable uptake of home energy efficiency and low carbon heating measures.

The funding will provide the consortium with the opportunity to innovate an underdeveloped green finance market model which can be replicated nationally beyond the lifetime of the programme.

Heat as a Service (HaaS)

Research by Energy Systems Catapult on the DESNZ-funded Electrification of Heat Demonstration Project highlighted how UK consumers were often put off by the upfront capital cost and the perceived lifetime running cost of a low carbon heating solution.

Heat as a Service would remove the upfront costs associated with installing, operating, and repairing low carbon heating solutions. Initial costs would be covered by a financial provider and paid back by the consumer over an agreed long-term period.

The consortium's development and piloting of HaaS will focus on the removal of upfront costs associated with the purchase and installation of a heat pump. A wraparound care package to include ongoing optimisation, servicing, maintenance, and breakdown support, will be developed as part of the HaaS project.

To further enhance the offering available to consumers the consortium will develop a series of simple 'heat packages' to make HaaS an attractive offering for customers, helping to encourage their adoption and to act as a replicable model throughout the UK energy market.

The Department for Energy Security and Net Zero provides dedicated leadership focused on delivering security of energy supply, ensuring properly functioning markets, greater energy efficiency and seizing the opportunities of net zero to lead the world in new green industries.

www.es.catapult.org.uk

PEOPLE

ELCO Heating Solutions appoints new Area Sales Manager for East Anglia

Andy Madden has joined ELCO Heating Solutions as the Area Sales Manager for the East Anglia region. He brings a wealth of experience to the role, which will see him strengthening key relationships with consultants and contractors in the commercial heating sector.

Reporting to Andreea Manoiu, Andy is based in the Norwich area and will be responsible for presenting CPDs to ELCO's core customer base, as well as encouraging them to use the company's Hybrid Systems Wizard. This is in addition to driving specifications of ELCO's commercial heat pumps, high efficiency boilers, network heating units and hot water products.

Andy joins ELCO having worked in the commercial heating and hot water sector since 2008, while he spent the 12 years prior to that working as an aircraft propulsion technician for the RAF. He also has a wealth of qualifications, including an ONC and HNC in engineering.

www.elco.co.uk

New CEO of Lorne Stewart Facilities

Mark Sutcliffe has been appointed new CEO of Lorne Stewart Facilities.

Mark has been in the facilities management industry for more than two decades where he has worked in many different environments, providing facilities management and property operations across traditional FM contracts in both the public and private sectors and also public finance initiatives.

Prior to joining the facilities industries, Mark served as a Warfare Officer in the Royal Navy. Mark has a passion for 'Making the difference' and this forms the fabric of his strategy for Lorne Stewart Facilities."

ARMD appoints Kevin North as Sales Director

ARMD, the total tool protection system, has appointed Kevin North as its new Sales Director as it expands its team ready for growth. Highly experienced in the trade sector, Kevin has previously worked with Thomson Local, Rated People, Plentific and Checkatrade. Kevin is also a former electrician and is now helping to protect them, and other trades, from the scourge of tool theft.

Kevin joins ARMD with a mission to form partnerships with retailers, trade associations, builders' merchants, manufacturers and other companies in contact with tradespeople. His appointment is part of an expansion following a successful funding round as well as the field trials and launch of the game changing ARMD Guard smart van alarm and tracker system.

www.armd.uk

Scott Tallon Walker Announces New Executive Chairman and Managing Director

Scott Tallon Walker Architects (STW), a leading architecture and urban design company with offices in Ireland and the UK, announces the appointment of Michael Tallon as Executive Chairman of its Board of Directors. Michael will be succeeded as Managing Director by Ronan Phelan.

Michael Tallon, who has served as Managing Director since 1989, will continue to provide oversight and stewardship of the business in his role as Executive Chairman. Ronan Phelan takes on the role of Managing Director. Ronan, who joined STW in 1997 and is on the board of Directors since 2008, brings a wealth of experience to the role and will focus on delivering innovation and sustainable design solutions across all sectors within the Scott Tallon Walker business.

www.stwarchitects.com

BCIS appoints chairman in support of mission to manage construction costs and carbon

The Building Cost Information Service (BCIS) has officially appointed new chairman Colin Smith, who will support the business's expansion as it helps the construction industry to manage costs, reduce carbon and mitigate risk.

Smith joins BCIS with 40 years of experience working in companies which specialise in providing data to the construction industry and has previously served as a chairman, CEO and director for market-leading technology businesses in the UK, Germany, the USA and Australia.

His role will include guiding BCIS on its journey as it helps the construction industry to make more informed choices, backed by data and forecasts, in terms of carbon and building costs, as well as launching it into global markets.

Smith has a long track record of working in the global construction software sector and is also an angel investor in BCIS. Operating mainly in the role of chairman in recent years, he has held C-level positions in market-leading technology businesses since the early 1990s.

www.bcis.co.uk

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Commissioning Engineers Association

Does the increased use of automatic balancing valves spell the end of a need for Commissioning Engineers?

Surely, self-balancing valves and automatic balancing valves means there is no longer any need for a commissioning engineer? Wrong! In this article, Tony Anderson, Technical Manager at the Commissioning Specialists' Association's (CSA) explains why the commissioning engineer's role is in fact more important than ever.

Commissioning a system that contains 'automated valves' should be quick and pain free for the commissioning engineer, according to most of the sales literature. However, as most commissioning engineers know this is rarely the case. Over the last 20 years 'automated valves' have become the front runners in the commissioning valve market. CFRs, DPCVs, PICVs and EPICV/EPIVs (see the explanation below) are just a few of the types available, each having their own sophisticated characteristics that can offer huge benefits in hydraulic applications. When installed using variable flow pumps with a suitable system flow strategy 'automated can maximise flow efficiency, greatly reduce operational costs and offer enormous energy savings to end users compared with a traditional fixed-flow system. This translates into significant benefits over the operational life-span of the system.

From the off, it's worth noting the terms 'automated' and 'self-balancing' as used in sales brochures largely refer to how the valves operate and control water flow after they have been set-up and commissioned.

Using caution

As a specialised component, one of the key challenges with automated valves is getting the system to a commissioned state that allows the valves to perform as per the design intent. Designers should use caution when assigning the pumping strategy around automated valves to ensure that the entire system is maintainable and lends itself to being flushed correctly. There are numerous examples where 'temporary' by-pass loops had to be installed retrospectively around the automated valve or component, as the energy-efficient design model did not allow for suitable flushing and back-flushing of all system components. This is a lengthy and costly addition to each project. It is no coincidence that, in nearly every example, the commissioning team was not appointed until the hydraulic installations were at an advanced stage.

Specialist care is required when performing the pre-commissioning cleaning of systems that contain automated valves. It is possible that each automated valve has a specific flushing mode or dedicated flushing bypass installed; however, this is rarely found to be the case on-site. CFRs of the removable-cartridge type, for example, will have to have been bypassed or have their cartridges fully removed in order to achieve flushing velocities; the BSRIA standard flushing velocity or design +10% will not be achievable with the cartridge in place. Careful handling must be undertaken if removing and storing these cartridges to ensure these are not damaged and that they are correctly identified and re-installed in their original location and orientation. Most types of DPCVs must also be completely isolated during the initial flushing exercise. Alterations made to the system needs to be reinstated to be recorded, and the system needs to be reinstated to 'fullflow' condition before commissioning activities can commence. Proving the system has been reinstated and that control valves and flow cartridges are re-installed back to their original positions is a pivotal verification step on these types of systems.

The importance of pre-commissioning cleaning, again highlights the benefits of engaging a specialist commissioning engineer's perspective at the design stage, as they can offer advice on the installation, chemical cleaning, commissioning and maintenance requirements of these valves and the system as a whole. Small →

changes, additions or alterations at design stage can make significant operational and maintenance savings in the long term.

What are the advantages of automated valaes

So what advantages do 'automated valves' offer to the commissioning of a system? A traditional proportional-balancing exercise on a fixed-flow system over a large circuit could mean revisiting and adjusting individual commissioning valves two or three times. The second and third times are the fine-tuning exercise, as excess flow from around the circuit can change the flow characteristics within a leg that has already been proportionally balanced. On an 'automated circuit' with automated valves on multiple branches, after a branch has been balanced there is no need for a second or third fine-tuning exercise. On a balanced branch with an automated valve set-up, the CFR, for example, would operate by limiting the maximum flow to this branch. Alternatively, a DPCV would counteract excessive pressure fluctuations by maintaining a constant pressure in the branch, regardless of what happens in the rest of the circuit.

The real benefit to the commissioning of a system with automated valves comes after this initial balance and set-up phase, as such valves can save a great deal of time by eliminating the need for fine tuning. Conversely, the commissioning engineer has to invest time in setting up the valve up in the first instance and then perform a varying-flow proving exercise. This involves the engineer being able to demonstrate that when different parts of the hydraulic circuit have been isolated, design flowrates in other parts of the circuit are maintained. This step proves that the variable-flow strategy works across the entire system.

Nowadays, buildings can contain numerous automated valves or combinations of different types of automated valves installed in various parts of the same system. The criticality for the commissioning engineer therefore shifts to understanding how the various valves are intended to interact and operate as a complete system, not simply how each valve operates individually. The clearest path to successfully commissioning and maintaining these systems is making sure the knowledge of how each hydraulic system is intended to be chemically cleaned, operated and maintained is shared between designer, installer, commissioning engineer and future maintenance teams.

With designers continually striving to produce the most energy-efficient solution to heating and cooling needs, the complexity of variable-flow models is forever increasing. As automated valves form an integral part of how each of these intricate design models operate, a specialist commissioning engineer should 'automatically' be selected at the earliest opportunity to help transform them into a fully functioning reality on-site.

Acronyms explained:

CFR:	Constant flow regulator
DPCV:	Differential pressure control valves
PICV:	Pressure independent control valves
ePICV:	Electrically operated pressure independent control valve
ePIV:	Electrically operated pressure independent valve

More information can be found at **www.csa.org.uk**

CTS Commissioning Technical Services

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To feature in the next
Commissioning Specialists Association
issue please contact **Victoria Liddington** on 01778 395029
or email **victoria.liddington@warnersgroup.co.uk'**

Are **expansion loops** and **expansion joints** obsolete?

Adam Fox, Director at Mason UK, argues that these two methods have major drawbacks for vertical pipe runs and that supporting the pipes on springs is a far more effective solution to the problem presented by thermal movement.

Supporting pipe risers subject to thermal expansion and contraction in multistorey buildings can present major challenges for design engineers and installers. The traditional methods for allowing and supporting movement are expansion loops or expansion joints.

All pipes expand when they get hotter and shrink when they get colder. The rates of expansion vary depending on the material. For example; the rate of expansion in stainless steel is approximately 10mm/10m/100 degrees Fahrenheit. In other words, if you have a stainless-steel pipe that is ten metres long and it was 70 degrees Fahrenheit, raise the temperature by 100 degrees and the pipe would grow approximately 10mm longer. For plastic pipes, the movement is tremendous in comparison – an additional 86mm in the scenario above.

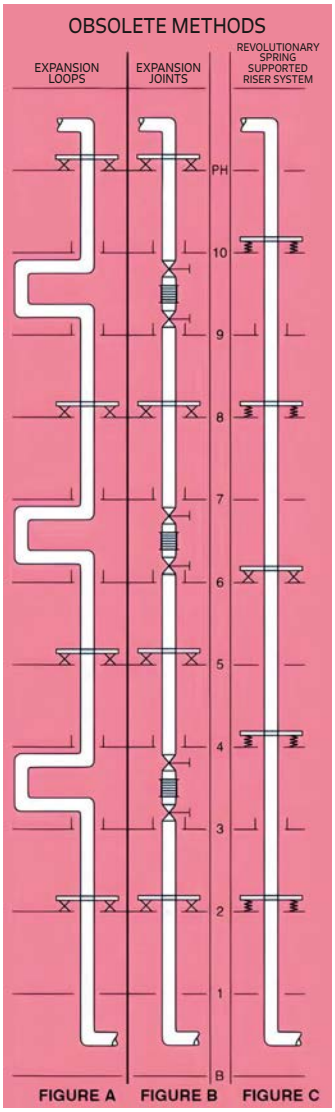
On the face of it, these might seem like small amounts, but the problems created by this movement should not be underestimated. Even one tenth of a millimetre in change can lift a pipe off from a support, meaning that support is no longer doing its job. If a pipe is clamped and therefore cannot move, you introduce the risk of buckling and pipe failure, potentially leading to flooding and enormous costs.

Given you cannot prevent expansion of the pipe, how do you deal with this problem? Firstly, it is important to adopt a holistic approach. By that I mean you need a concerted design effort that looks at the entire pipe system or pipe run. The two traditional approaches to this problem are a system of expansion loops, or a system of expansion joints. I'll explain briefly how they work, before telling you why they provide a suboptimal solution at best.

Expansion loops and expansion joints

Figure A shows a system of expansion loops, supported by anchors either side of the loop. During expansion, the loop bends and stresses the pipe, but it accepts the movement. Figure B depicts a system of expansion joints. Here you locate bellows between each anchor point that act as an expansion compensator, absorbing the forces generated by thermal expansion.

The system of expansion loops has multiple drawbacks. Firstly, once the pipe goes into or out of the riser chase and into the building, it is occupying valuable, rentable space. Secondly, each loop has four elbows and two additional vertical runs that are adding resistance to flow. This means you require a higher horsepower pump and greater energy consumption to deliver the same volume of water.



The expansion joints may allow the engineer to keep the riser straight, but potential failure becomes a major issue. If an expansion joint fails, it means not only the loss of heating or cooling, but a high possibility of extensive water or steam damage. The expansion joints must also remain accessible for periodic inspections; something that is not always possible. Finally, both these systems require multiple anchor points which present the engineer with a difficult task, as the load at each point is indeterminate.

The alternative is springs

As a supplier of expansion joints, you might find it strange that we would question their efficacy. However, while expansion joints are ideal for horizontal pipe runs in many applications, for the scenario described in this article there is a superior alternative. Supporting the pipe run on springs is both more affordable and more effective. I will try and illustrate the basic concept here, using the scenario of a vertical pipe run in a multistorey building. However, the same concept can also be applied in horizontal pipe runs where appropriate.

The spring support system typically uses a single anchor — located as close as possible to the middle of the riser — to direct the pipe to expand away or contract toward the anchor point. Alternatively, the system can be designed as totally free-standing and without any anchor point, but control is far more difficult to achieve in these circumstances.

The number of spring mounts may vary, depending on the desired load distribution. Importantly, you can calculate the load at each support point. The engineer will know the load at the installation phase, when empty, when full, and when operating at different temperature extremes. This allows you to calculate which type of spring mount to select, and pre-compress it to the correct level during the installation phase.

The spring mounts are pre-compressed to a carefully calculated "initial deflection" rating, to resist the anticipated load when water enters the system. It is during this stage of the installation, where the pipe is empty, that the anchor has to resist the most force, the uplift force presented by the springs. When the pipe is full and the system is operating, the load on the anchor point is neutral, as the spring forces pushing up, and the combined weight of the water and pipe pushing down, negate each other.

If the pipe were to expand, the spring mounts above the anchor lose deflection while those below would gain deflection. Again, the system remains in balance with the load at the anchor zero. The system also performs perfectly from an acoustic point of view, as the springs effectively absorb any vibration. As the anchor is neutral during operation, this means it does not operate as a significant vibration transmission path.

If you read any of the literature online about dealing with expansion in pipe systems, you would be led to believe that your only options were either expansion loops or expansion joints. Both these systems have major drawbacks and for scenarios, like the one described in this article, they will soon become obsolete. There is an alternative system, developed by us, which involves supporting the pipe on a system of springs.

More information can be found at **www.mason-uk.co.uk**

How can Digital Twins help decarbonise large HVAC installations on the road to **Net Zero**?

Several dozen percent in savings; on the potential of Digital Twins and the importance of hydraulics in large HVAC installations

by **Roel Vandenbulcke**, CEO and founder of Hysopt

As the climate situation becomes more acute and the need for decisive action ever more urgent, all sorts of sustainability initiatives are springing up, mostly spurred on by the Green Deal and the general legislative framework that emerges from it. Understandably, the focus is often first on a number of quick wins that require little investment or do not involve any fundamental choices, such as more sustainable forms of lighting or simply turning down the heating by a degree. But what about the low-hanging fruit when it comes to decisions in complex and costly matters with potentially far-reaching consequences. Think, for example, of the heating and cooling of large buildings such as schools, hospitals, office buildings and public institutions.

Indeed, when it comes to this specific issue there is an ever-increasing range of different technological solutions and integrated options, such as:

- Cogeneration units
- Heat pumps
- Heat networks

On top of that, circumstances on the energy markets change all the time, making decisions even harder as there are so many factors in play.

CHP Systems

Take CHPs (Combined Heat and Power) for example, whichproduce electricity as a useful by-product of heat generation. At one point these CHP systems made a lot of sense as they were a win-win option at a time when both electricity costs and carbon emissions were high. However, this changed a few years ago, when carbon emissions associated with electricity imported from the grid fell more than 50% due to a changing generation mix (virtually no coal, less gas and lots more renewables such as wind and solar). As a result, the lowest operating cost option for CHP no longer delivered carbon savings, leaving many energy managers with a dilemma as the electrification of heat (via technologies such as heat pumps) or development of heat networks connected to low-carbon energy sources (such as heat from waste) brought new opportunities for decarbonization. As such, cost vs carbon increasingly became a trade-off, where the lowest carbon forms of heat (and cooling) are not necessarily the lowest cost options.

The situation in the Ukraine and the resulting energy crisis have made matters even worse in this regard, jeopardising our entire energy supply chain, bringing great uncertainty and volatility to the markets and forcing us to redraw any existing plans. Unfortunately, this has often meant a return to non-renewable forms of energy such as nuclear and fossil, with a resolution seemingly not in sight.

Increased complexity = increased sensitivity

This increased complexity of solutions and the array of different options on offer has effects further down the line too, as in turn it complicates the correct hydraulic design, integration and adjustment of HVAC installations. This area in particular is one that is increasingly misunderstood, yet crucial for efficient operation, especially in larger installations. "As cooling and heating systems become more complex, with different types of heat sources side by side, the importance of an adequate hydraulic design and control strategy too increases. Even with established technologies like cogeneration, for instance, we

find that this design and control strategy often causes plants to perform sub-optimally, resulting in efficiency losses of up to tens of percent. That is the so-called 'performance gap'", states Roel Vandenbulcke. "Reducing the operating temperature is not merely a matter of replacing gas boilers with heat pumps, but something that needs to be considered as early as the planning and design phase."

Informed decisions thanks to simulations and fundamental physics

It is in this design phase that digital twins can make the difference. Digital twins are virtual replicas of a physical system, in this case an entire HVAC system or heat grid (where multiple buildings or campuses depend on the same source) in a digital model. Although the concept is not new, the technology is only recently gaining traction thanks to accelerated digitisation and the rise of the Internet of Things (IoT).

Specifically for HVAC installations, a digital twin will look at the fundamental laws of physics to understand how a design will perform. This allows simulation of how a design or system will perform 'in real life'. This offers significant advantages and, in particular, makes it possible to estimate how multiple, complex solutions will perform - both in terms of consumption and emissions - across different buildings, each with its own heat demand, occupancy and distribution technology.

"In a nutshell, a digital model of an HVAC installation gives facility managers and owners real insights regarding the performance of their system, and allows the impact of multiple designs or modifications to be objectively compared. As such, a digital twin helps organisations to make the right technical and financial investment decisions, reducing risk by making the most informed possible choice from different quantified scenarios", Roel Vandenbulcke continues.

Quantifying performance through KPIs

In an HVAC design, energy consumption, carbon emissions and investment costs should be as low as possible; conversely, thermal comfort should be as high as possible. With a digital twin providing dynamic simulations of system performance, multiple conceptual designs can be objectively compared against a range of KPIs such as annual energy consumption, energy cost, carbon emissions, comfort level and capital investment.

A sensitivity analysis, performed automatically by the digital twin software, also allows the 'best' concept design to be refined for full optimisation, according to the primary focus of building owners and/or managers:

- Capital cost
- Carbon emissions
- Energy cost

A digital twin thus provides designers with a technical tool that encourages innovation, while giving their clients full transparency on what to expect, before making any investment decisions.

Bridging the performance gap

Furthermore, by using iterative optimisation algorithms to select hydraulic components (pumps, valves, the right size pipes, heat exchangers and so on), digital HVAC twins fulfil another essential role, namely closing the so-called performance gap or 'performance gap' between the design and the actual performance of the physical plant.

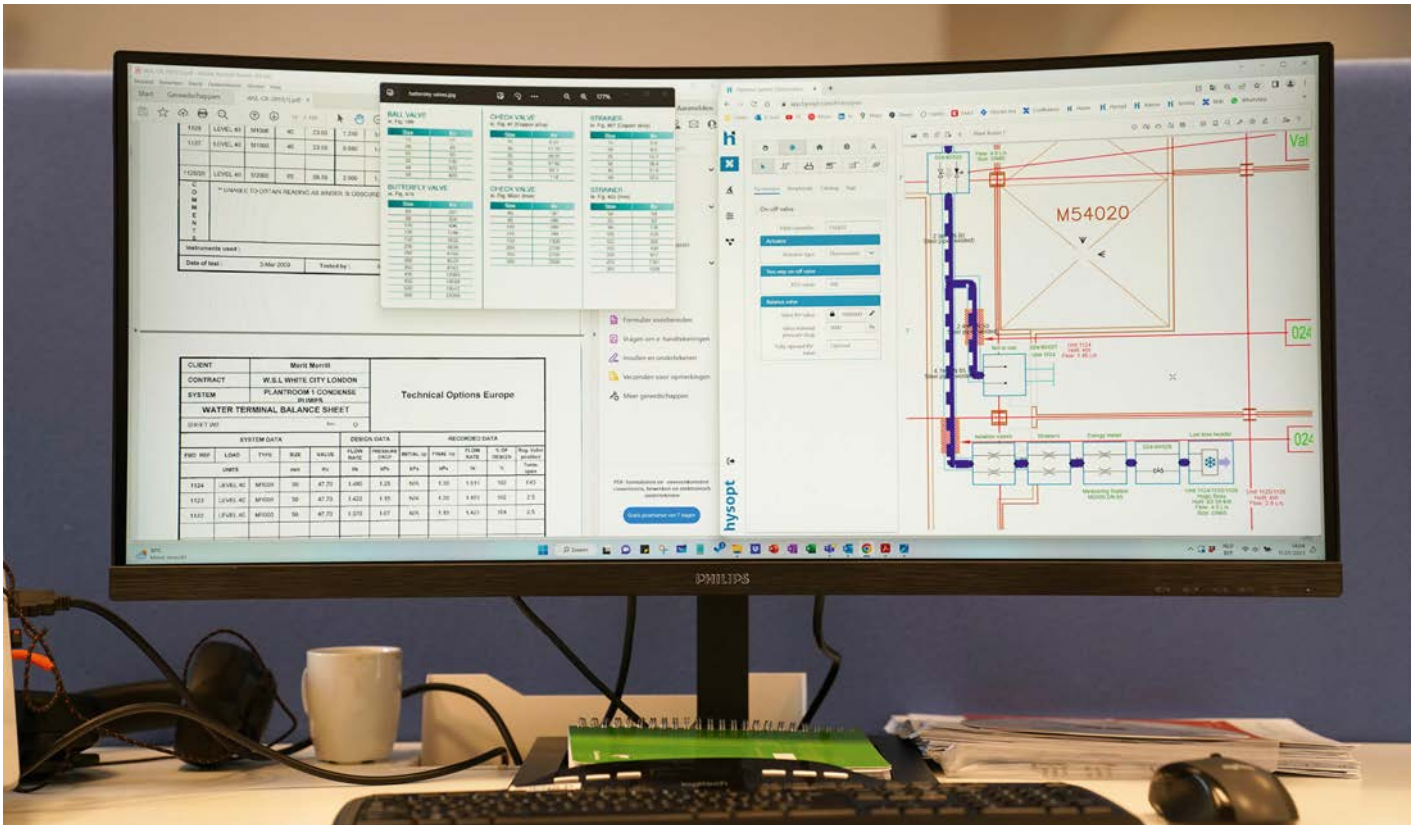
How is this possible?

Simple guesswork, 'rules of thumb', as well as the unnecessary safety margins associated with traditional design methods, are all eliminated. This has the added advantage of reducing the initial capital investment for a new system installation by up to 10%. What's more, all components are not only correctly selected and sized, the digital model also provides installers and technicians with information on how each component should be configured during installation and commissioning. This reduces on-site hours, avoids trial and error and ensures that the as-built design accurately matches the optimised as-design system.

A lifetime of enjoyment

It doesn't stop there. Even after commissioning the digital twin continues to prove its worth, as it evolves with the installation.That is, it can continue to inform and empower designers throughout its lifecycle in making informed, responsible decisions regarding upgrades, modifications and extensions. Icing on the cake: the added value provided by a digital twin can be considered cost-neutral because the annual savings on energy and/or capital investment mean that all costs are quickly recovered - even more so with recent energy prices.

More information can be found at **https://hysopt.com/**



Avoiding heat and pressure losses

Dave Lancaster, Senior Category Manager – Commercial at Uponor explains the importance of ensuring building services pipework is specified correctly and of choosing high quality pipe systems designed to minimise pressure and heat loss.

The design and specification of the building services pipework can have a significant impact on its performance and the experience of occupants, especially for large buildings.

Carefully considered design and specification of heating and water distribution system pipework is important in any building. However, where extensive pipework is required, the length of pipe and number of fittings means the impact of product choices is larger.

What are the key concerns?

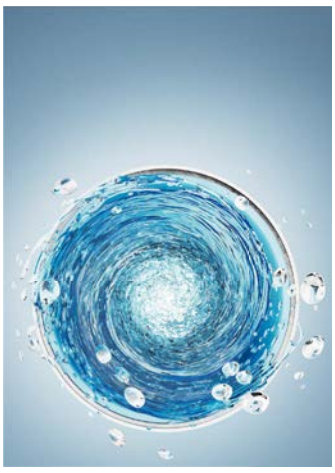
Among the biggest concerns with incorrectly specified or designed pipework is low water pressure. Low pressure is not only inconvenient for building users but can also lead to contamination issues, especially for drinking water supplies. Low pressure can result in the backflow of contaminated water into the supply pipework. This typically happens where pressures are higher within a water system than in the supply pipework and water is forced backwards.

There are also issues around heat loss or gain within the system. Maximising efficiency and performance are obviously a priority, especially with the changes to Part L introduced in June 2022, and the recent increases in energy prices. However, the hygiene of water supplies can also be a concern. Bacteria, including legionella, thrive in water at temperatures between 20°C and 45°C. That is why it is recommended that hot water is provided to the outlet above 50°C and cold water at below 20°C. While these temperatures may be achieved at the point of supply or where the water is stored, any heat losses or gains as it travels through the building must be avoided.

What are the causes?

Incorrect sizing of pipework is one of the biggest causes of pressure losses as well as heat losses and gains. Undersized pipework restricts the volume of water that can be supplied to the outlet, resulting in low pressure and flow rates. However, larger pipework significantly increases the volume of water in the system. If this does not match the levels of demand, the water may remain in the system for extended periods of time. This stagnation, and the possible heat gains that occur as a result, mean that there may be serious hygiene concerns where water remains in the system for more than the recommended three to five days.

The height of the building is a key consideration as, on average,



every three stories in height will reduce the pressure by almost 1 Bar. The distance from the point of supply to the point of use on each floor will also affect the pressures. Therefore, it is important for sufficient pressure to be created and maintained to not only supply the water to every floor but also sustain the necessary pressure to the water outlet.

Solving the issues of pressure and heat loss

The approach to pipe sizing will differ depending on the type of system. For example; different calculations are required for domestic and commercial properties. Best practice guidance can be drawn from a variety of sources including British Standards such as BS EN 806 and BS 8558, Part L of the Building Regulations and CIBSE guides – in particular CP1 (2020), the Code of Practice for Heat Networks. In addition, some leading plumbing system manufacturers provide software tools to help installers and specifiers calculate the correct sizing for pipework based on the specific products selected.

For final sections of pipework used to connect individual outlets, it is also valuable to consider the

use of small-bore pipework. By specifying pipe as small as 12 mm for these sections means a smaller volume of water is held in the pipework. As a result, the tap has to be run for a shorter time before hot water is supplied at the outlet. This improves the experience of users, increases energy efficiency and reduces water waste – helping to ensure compliance with the Part G requirement for a maximum water usage of 125 litres per person per day.

Pressure is also impacted by the combined effects of every component within the system including the pipe and fittings. Therefore, there are clear advantages to reducing the number of joints, connections and elbows wherever possible to minimise resistance.

Multilayer composite pipe

For many applications, multilayer composite pipe (MLCP), which is constructed from an aluminium core with internal and external layers of polyethylene, is ideal. This construction gives the pipework strength and durability as well as flexibility. MLCP is highly suitable for large-scale projects as, depending on the manufacturer, it is available in a range of coil lengths. For example, Uponor Uni-Pipe PLUS MLCP is available in coils of up to 500 metres.

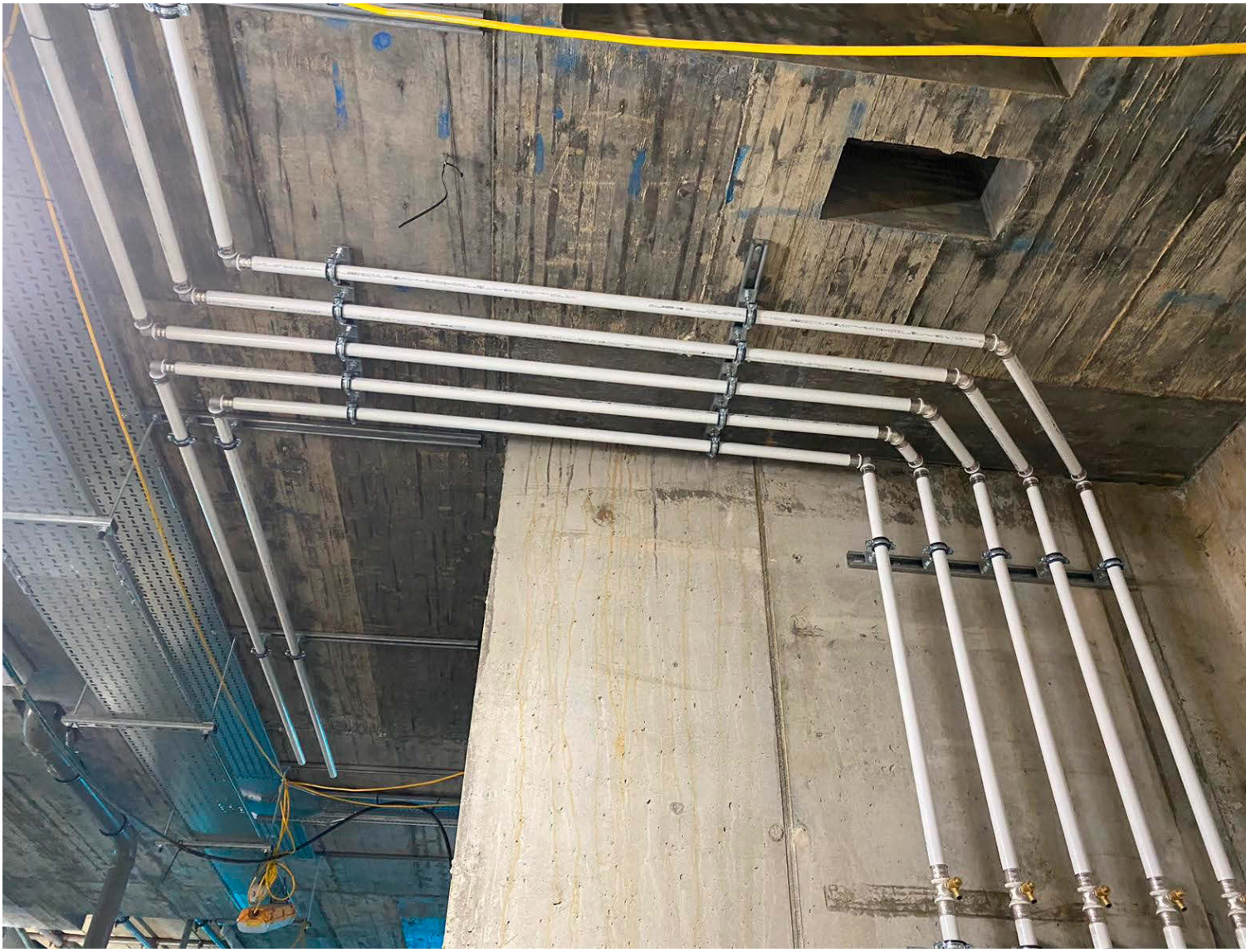
The flexibility of MLCP also means that it can be shaped either by hand or using handheld tools to create a bend rather than two sections being connected using an elbow joint. This not only speeds up installation, reduces costs and eliminates the potential for leaks but can also help maintain system pressure by minimising the number of connections. This is especially true for manifold plumbing schemes where the use of MLCP allows the number of fittings between the manifold and the point of use to be significantly reduced or even eliminated.

However, the choice of fittings is also important as this will impact the performance. While it may be tempting to select the lowest cost fittings, this can in fact be a poor investment. Selecting fittings that have been engineered with flow optimised designs can help maintain the performance of the system as a whole. For example, Uponor S-Press PLUS fittings achieve low zeta values (the measure of resistance) and up to a 60% reduction in pressure losses compared with other MLCP press connections.

Finally, heat losses and gains can be minimised in part through good design. For example; by keeping cold water pipework away from sources of heat. Insulation of pipework is also an important element of the installation. In appropriate areas of the building, this can be simplified through the use of pre-insulated MLCP. Coiled in lengths of up to 75m, the pre-insulated pipes can be quickly installed with continuous, unbroken insulation of up to 13mm with a constant vapour barrier.

The design and specification of system pipework can have a significant impact on the performance, especially with regard to minimising pressure losses. By reducing the number of connections and joints using MLCP and selecting high-quality, optimised fittings, installers and specifiers can help deliver the required performance and a positive user experience.

More information can be found at **www.uponor.com**



Retrofitting UK historical buildings: A path to achieving Net Zero

By **John Miles**, Business Development Director at Building Control Approved Inspector, Assent

As the world moves closer to global Net Zero targets, is retrofitting historical buildings the answer to achieving this?

In the UK, one-fifth of greenhouse gas emissions originate from buildings, with historic structures posing some of the most challenging obstacles to overcome. While retrofitting seems like a straightforward solution to making existing and heritage buildings sustainable, energy-efficient, and compliant, numerous barriers and challenges must be addressed to realise its full potential.

Building life cycles

Retrofitting UK historical buildings presents a complex challenge, often requiring the integration of modern services and equipment into old structures. While this process may not necessarily be cheaper than constructing a new building from scratch, it is crucial to consider the broader perspective and the building's existing state. Historical buildings embody a significant amount of energy and have a carbon footprint associated with their creation. Therefore, it is generally more environmentally advantageous to work with the existing structure rather than starting anew.

Although the cost of retrofitting may be higher, the long-term benefits in terms of the building's overall life cycle, efficiency, and environmental impact are substantial. A noteworthy project undertaken in collaboration with the University of Manchester serves as an exemplary case of extreme retrofitting. In this particular project, only the concrete frame of the original building remained intact. The project showcased the potential to reuse the disembodied carbon within the structure, thereby preserving and extending the building's life cycle. While this approach may not have been the cheaper alternative, it undoubtedly yielded a far greater positive environmental impact.

By retrofitting historical buildings and repurposing their existing elements, we can tap into the embodied energy and carbon of these structures, contributing to the achievement of net zero goals. Retrofitting allows us to honour the heritage and architectural significance of historical buildings while simultaneously reducing their environmental footprint.

Looking beyond the obvious

The scope of retrofitting extends beyond individual buildings to encompass a wide range of projects. From converting old mills into functional structures to repurposing farm buildings into contemporary dwellings, retrofitting presents immense opportunities for the UK. By collaborating with housing associations, efforts are underway to enhance the insulation of managed homes, while technologies like air source heat pumps and solar PV systems are increasingly employed to strengthen the retrofit output. ➜

Workforce shortages

A report by The National Trust, Peabody, Historic England, The Crown Estate, and Grosvenor highlighted the necessity for substantial growth in the low-carbon economy to support the UK's net zero goals. The construction industry, therefore, plays a pivotal role in transitioning to a green economy. This transition requires a significant increase in the industry's workforce, with the Construction Industry Training Board (CITB) estimating that around 350,000 additional workers will be needed in the late 2020s to achieve Net Zero in the built environment. Meeting such demands necessitates attracting new talent and retraining individuals already in the sector.

However, challenges arising from the pandemic and Brexit have led to skills shortages and labour supply issues in the construction industry since the beginning of 2021, exacerbating an already aging workforce. Specifically focusing on the skills gap in retrofitting historical buildings, an analysis by Capital Economics reveals that an additional 105,000 full-time workers would be required annually until 2050 to retrofit historic buildings, in addition to the existing 100,000 professionals associated with retrofitting historic properties. Without an adequate workforce, the industry and the UK as a whole risk falling behind on Net Zero targets, creating project backlogs, and losing invaluable cultural heritage as buildings remain non-compliant and uninhabitable.

Training and apprenticeships

A comprehensive program of specialised skills training is essential. Retrofitting historic buildings requires unique knowledge and expertise. To bridge the skills gap in the retrofit sector, it is crucial for the public and private sectors to come together. The Heritage and Carbon report recommended the establishment of a National Retrofit Strategy, which would represent a significant step forward in delivering consistent, standardised training for both new talents entering the sector and upskilling existing professionals in associated fields. Involving individuals with specific sector skills in the development of robust training programs is vital to create a long-term talent pipeline capable of meeting the UK's retrofit and green economy requirements.

Another avenue to explore is apprenticeships. Attracting and nurturing young talent presents a tremendous opportunity for the retrofitting industry, as apprentices can become invaluable assets to the sector and the future of construction in the UK.

Government incentives

To fully harness the potential of retrofitting, it is crucial for the government to incentivise such schemes. Greater emphasis should be placed on encouraging individuals to prioritise environmental impact over cost considerations. This can be achieved through tools like the Building Research Establishment Environmental Assessment Method (BREEAM), which assesses the sustainability and performance of buildings. Showcasing the benefits of the retrofit approach will help raise awareness and recognition of the value inherent in existing structures. Rather than resorting to the energy-intensive process of brick manufacturing, where tonnes of clay must be dug and fired, retrofitting allows us to make use of the materials already incorporated into the buildings around us.

The role of building control

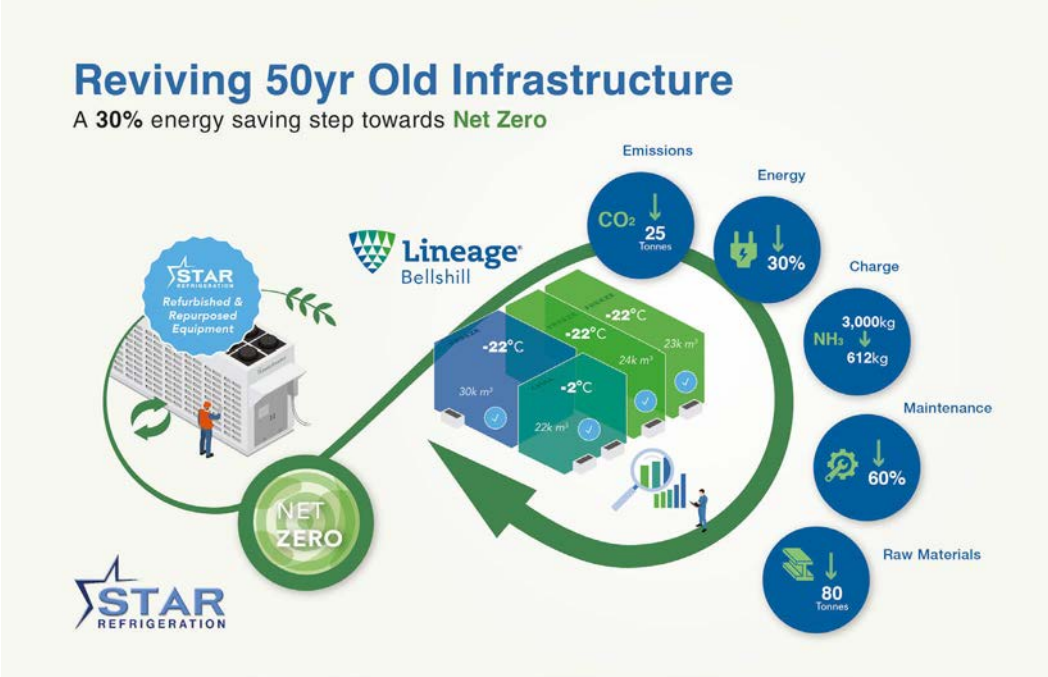
Given the intricate nature of retrofitting historical buildings, engaging with experienced building control providers at an early stage is vital. These specialists possess the knowledge and expertise required to navigate the complexities and meet the regulations and requirements associated with such projects. Contacting a provider only a month before the start of construction is far from ideal. Their insights and guidance are indispensable and should be sought as early as possible.

If the UK aims to achieve its Net Zero targets, retrofitting must play an integral role in the transition. Relying solely on new construction or the replacement of inefficient buildings is insufficient to meet the necessary pace and scale. To fully unlock the benefits of retrofitting, urgent attention must be directed towards addressing the skills challenges faced by the sector. Simultaneously, efforts should be made to raise awareness and promote the adoption of retrofitting practices based on their positive environmental impact. By embracing retrofitting as a key strategy, the UK can embark on a transformative journey towards a sustainable and energy-efficient future.

More information can be found at **www.assentbc.co.uk**

Reviving aging **infrastructure**

Lineage Logistics' successful plant optimisation for a sustainable future by **Dr Rob Lamb**, Group Sales and Marketing Director, Star Refrigeration.



It's estimated that the cold chain accounts for approximately 2–4% of UK GHG emissions. Data obtained from the UK Cold Chain Federation for 425 facilities registered with their Climate Change Agreement (CCA) Scheme during 2018 indicated that their energy consumption was around 3.5 TWh, with 96% of this being electricity. Considering there are almost 700 stores across the UK, the total energy consumed by this sector is likely to be closer to 5 TWh.

Over the last decade, the sector has made significant progress towards its commitment to the Climate Change Agreement, achieving a 16% improvement in energy efficiency since 2013 and exceeding the Government's target of 12% compared to the 2008 baseline. However, more could be achieved as only 56% of facilities reached their energy improvement targets between 2017 and 2018.

During 2019/20 the sector made a considerable energy efficiency improvement of 19% against the Government's target of 12% and the percentage of cold stores failing to meet the target was slightly improved from 56% in 2017/18. However, a considerable proportion of stores, totalling 52%, continue to fall short of achieving their energy objectives.

The Cold Chain Federation (CCF) are currently collecting performance data for the period 2021/22 for which the Government set an energy efficiency improvement target of 6.67%.

While the sector has shown significant progress in improving energy efficiency, recent benchmarking work conducted by Star Refrigeration indicated that even larger energy savings of between 30% and 85% are possible for new facilities (based on data collected from current Star customer installations). The research compared data for recent refrigeration installations with previous best practice figures published by the UK government and European wide research.

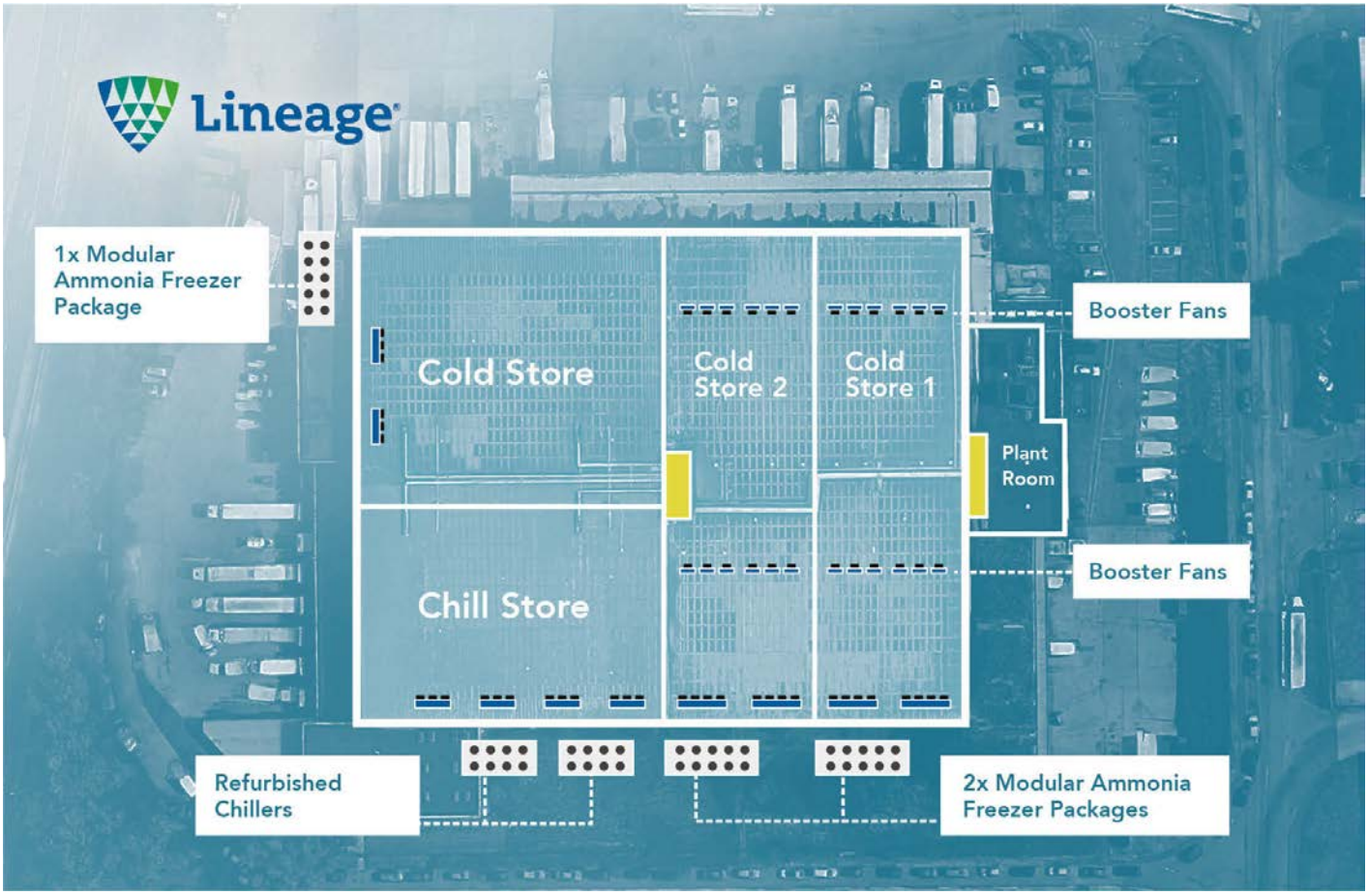
These savings can be achieved in new facilities through modern design, operational improvements, energy-reducing technology and the use of the latest construction materials. Existing facilities with old infrastructure may face further challenges, but improvements can still be made to contribute to the move to net zero.

Lead by example

Lineage Logistics' visionary cold store refurbishing shapes a sustainable path. An example of this is their facility in Bellshill, Scotland. Built in 1971, it comprises three cold store chambers operating at -22°C, a +2°C chill chamber and an ambient loading bay. Cooling was provided by the original ammonia-pumped recirculation system, including four reciprocating compressors, one screw compressor (a recent replacement for a previous fifth reciprocating compressor), an intercooler, a low-temperature surge drum and two evaporative condensers, which were located on the plant room roof. Eight evaporators with manual hot gas defrost provided cooling in each of the freezer and chill rooms.

The plant was becoming increasingly difficult to maintain, particularly regarding sourcing spare parts, the greater frequency of breakdowns and refrigerant leakage. These issues affected the plant's reliability and the risk of a large leak from the three-tonne ammonia charge system. Inherent inefficiency in plant components and the operation of one of the original freezer chambers at chill conditions contributed towards a high Specific Energy Consumption (SEC) of 30 to 35 kWh m-3 yr-1.

When looking at long-term solutions for the site, overhauling the existing system was considered but would require



the majority of the plant to be changed. Plus, the site would retain its large ammonia charge. The option of integrating new equipment operating on low carbon synthetic refrigerants was explored, but the phase-down of the fluids under the F-gas regulation raised concerns about their future viability.

Back in 2019, they had installed modular ammonia packages at their Great Haddon facility, near Peterborough, which demonstrated improved efficiency compared to traditional ammonia-pumped recirculation plants. The Azanefreezer technology achieved Specific Energy Consumption (SEC) figures of 10 to 11 kWhr m-3 yr-1 and the final assessment was positive. It was accepted that the age and condition of the Bellshill facility meant that similar SEC performance was not realistic but previous retrofit projects provided evidence that savings could be achieved.

Modular, low-charge ammonia refrigeration programme

A programme to replace the existing central plant with modular, low charge ammonia systems was developed to substitute the existing central plant for the cold store and chill chambers. The cold store would be directly cooled using ammonia and the chill store would use a glycol secondary circuit.

Ultimately, each of the three cold store chambers was fitted with a modular, low-charge ammonia package and two evaporators. Additionally, cold Stores 1 and 2 were also equipped with booster fans to support air circulation due to the length of these chambers. The chill store included four coolers that were connected to a common glycol loop and two ammonia chillers.

Chiller positioned on a new plinth at the side of the store during the installation phase.

Chill plant installation – circular economy

In an effort to reduce capital costs and improve sustainability through the use of circular economy principles, the chill plant installation used two ammonia chillers that were originally installed for a data centre application in 2007. Both chillers were refurbished and repurposed to provide cooling to the chill store. The refurbishment included overhauling the plate heat exchanger evaporators, screw compressor and replacing the obsolete PLC hardware.

A pump set shared by both chillers circulates glycol through the four air coolers inside the chill store. These coolers have a capacity of 66 kW each, based on a design air temperature of +1°C and glycol flow/return temperatures of -7.5°C/-2°C. Commissioning was completed in May 2021.

Freezer plant installation – heat recovery option

Retrofitting of the three cold store chambers was followed with installation of low-charge ammonia packaged systems, consisting of two economised screw compressors, a low-pressure receiver vessel, an air-cooled condenser, a four-way defrost valve, expansion valves and a stainless-steel electrical panel with a PLC controller. Liquid and wet return carbon steel pipework runs from each package to two aluminium tubes and fin air coolers which are mounted on the underside of the ceiling in each cold store.

Two of the three packages had been installed at a project in the south of England the year before but never put into operation. They were purchased and moved to the site to provide cooling to Chamber 1 and 2.

The plant serving Cold Store 3 was equipped with a fully welded plate and shell heat exchanger partial condenser. The condenser offers free heat recovery to generate warm glycol which is circulated through a break-loop and delivered to the underfloor heater mat glycol flow and return headers serving all four chambers.

As part of the project works, the client installed new insulated roofing panels on top of the existing cold store ceilings to provide better thermal performance and a reduction in air infiltration. Other energy-saving measures were also adopted by the site include LED lighting, door alarms and strip curtains. This further demonstrated the site's commitment to reducing energy consumption and carbon emissions.

The plants were commissioned over three months from June to August 2021, starting with Cold Store 1, then 2 and finally Cold Store 3.

Performance Analysis

A comparison of energy performance before and after the installation works was carried out using the site's energy meters, which showed a year-on-year reduction in power consumption. Weekly savings varied between 9% and 36%, with an average saving of 20%.

- The use of aluminium evaporator tubing and the low overfeed, low-pressure receiver system design which results in a 6 K approach between air on and ammonia evaporating temperature without the need for liquid pumps.
- All evaporator and condenser fans are EC type, varying speed and energy based on the cube law in proportion to cooling and heat rejection demand.
- Floating head pressure control which varies both fan speed and condensing temperature based on demand and ambient temperature.
- Fixed speed, economised screw compressors operating at 100% capacity at all times to maximise efficiency and avoid the 3% losses associated with inverter drives.
- An integrated PLC software that monitors the main energy-consuming components in the system and optimises performance by controlling the starting, stopping and speed of components based on ambient temperature and cooling demand.

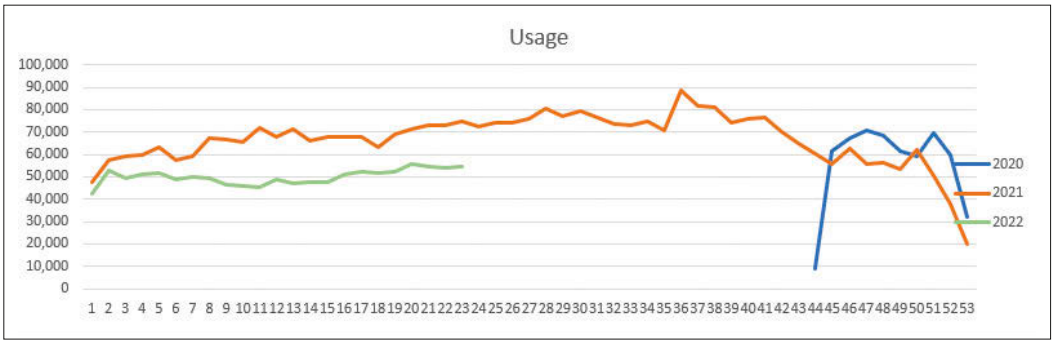
Since the installation of the new equipment, temperature compliance has been maintained across all four chambers and issues relating to plant reliability and refrigerant leakage have been eliminated. Annual maintenance spend has also been reduced by 60% due to improved reliability, the removal of spend on spares and the ability to monitor plant performance off-site. Water and associated water treatment chemicals have also been avoided by switching to air cooled condensers and health and safety has benefited from a reduction in ammonia charge from 3,000 kg to 612 kg spread across the five systems (180 kg per Azanefreezer and 36 kg per ammonia chiller).

Monitoring of ongoing plant performance

From both a commercial and environmental perspective, it is essential that performance is maintained into the future. To guarantee optimum operation over time, the performance management software, Ethos, was installed. The AI software exports data from a plant's control system to a cloud-based model. Here the data is analysed to identify deviations from optimal design conditions. This 'digital twin' approach enables a comparison of actual performance versus theoretical performance based on ambient and load conditions. Any differences in operation are reported and translated into remedial actions and projections of future energy consumption if no action is undertaken. This enables operators to understand the energy and financial implications of any changes made alongside energy and carbon savings estimates. Remedial work can then be monitored and improvements can be demonstrated.

Specific Energy Consumption (SEC) Forecasting

Since the completion of the Bellshill installation, the new ammonia chill and cold store packaged system PLC software has been enhanced to provide real-



Comparison of Site Energy Data for Weeks 1 to 23 of 2022 (green)vs 2021 (orange)

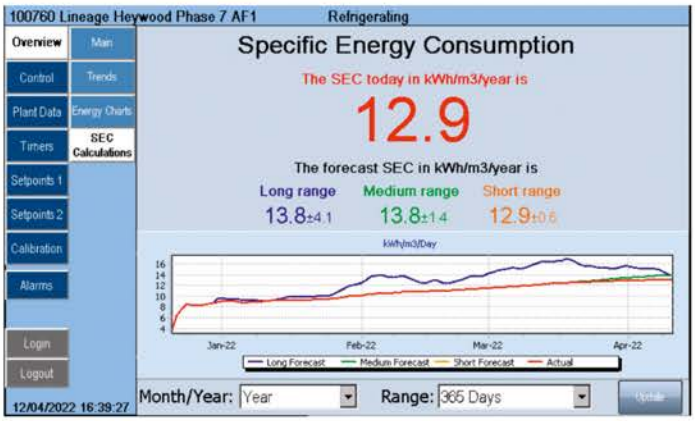


Figure 10. Screenshot of an SEC Prediction

time predictions of SEC. This takes 'kWhr yesterday' data from the plant and produces an annual SEC figure where 365 days of previous data is available. Short, medium, and long-range predictions are also generated based on smaller data sets of 10 days, 90 days and 270 days, respectively. Tolerance varies from +/-30% when using 10 days of data to +/-5% for 270 days.

The short and medium data sets provide a swift indication of recent changes in energy performance caused by changes in plant operation (e.g., setpoint changes), a deterioration in component performance (e.g., compressor wear) or changes to site operating practices (e.g., poor door management). This means that preventative measures can be quickly enacted to benefit the annual energy performance.

This software had been installed at another site within the estate and an example of the output can be seen in Figure 10. The long-range forecast shows the quick change in SEC prediction when changes were made in February and then in March.

The predicted SEC for Bellshill based on data collected from site is between 20 and 22 kWh m-3 yr-1, which represents an annual saving of 30% when compared to the previous central plant. Further improvement could also be possible through repair and replacement of the building fabric to reduce heat gains.

Conclusions

Retrofitting modern, low charge ammonia cooling technology to a 50-year-old facility has delivered both environmental and financial benefits while providing long term peace of mind with regard to operational reliability and operating costs. Reusing factory-refurbished refrigeration equipment has avoided the need for around 80 Tonnes of fresh raw material and prevented components from entering recycling and waste streams before end-of-life. This demonstrates good circular economy practice, highlighting its effectiveness for business, people, and the environment. The project has successfully demonstrated that energy improvements can be made in existing facilities through the implementation of modern, modular, low-charge ammonia packaged systems. An energy assessment has indicated savings of approximately 20% in the first part of 2022 and an algorithm has predicted this could be as high as 30%. Operating savings have been realised through reduced maintenance costs, elimination of water usage and treatment chemicals for evaporative condensers.

The site's total ammonia charge has been reduced from 3,000kg to 612kg, split across five modular systems, ensuring customer safety and that of the surrounding businesses.

The collection of data and the use of an algorithm to predict annual energy performance are providing early signs of performance drift, enabling swift action to be taken. This software can be applied to any control system where energy meters are fitted and be used to drive efficiency improvements. By doing so, companies will maintain their performance long into the future and contribute towards the UK's net zero targets.

More information can be found at **ww.star-ref.co.uk**

Smart Controls are key to unlocking better **building performance**

By **Caroline Radcliffe**, Commercial Product Manager, Nuaire

Modern buildings in the UK are being designed and constructed for greater efficiency, sustainability, and decarbonisation in line with the industry-wide net zero approach – and due to this shift, every installed system being considered is under the microscope in terms of its performance.

Ever increasing energy bills and tighter controls on emissions have led to stricter building regulations, raising the bar required to deliver sweeping improvements to the built environment.

Only Class C efficiency

However, 80% of buildings have already been built to old building regulations and only one in five buildings have a building management system (BMS) to regulate and control the inner workings of the building, resulting in most commercial buildings operating at just Class C energy efficiency.

A key focus for meeting targets in 2050 must be the refurbishment and refit of these buildings. The use of smart controls as part of the BMS could be one of the keys to unlocking better building performance.

The new building regulations (Part L and Part F) set out stricter building and infrastructure standards enforced to ensure that both older and new buildings will be more energy efficient and not contribute to climate change.

However, older working buildings pose complex efficiency issues; from overheating, ventilation effectiveness and heat retention. The majority of buildings in the UK rely on natural ventilation through high levels of air permeability, yet striving for more airtight properties means that building developers must carefully specify natural and background ventilation methods to provide adequate levels of air movement throughout the property. If ventilation cannot be achieved to standard through these methods, a continuous mechanical extract ventilation system should be installed.

Energy loss due to ventilation accounts for approximately one fifth of space-heating energy demand in an older, poorly insulated building. In a new energy efficient build for example; the high insulation levels mean that the proportion of space-heating demand due to ventilation increases to around a third. Equally, natural air infiltration alone can result, at times, in too little ventilation.

This leads to poor indoor air quality and other, more readily visible impacts, such as condensation and mould on indoor surfaces. The objective of a good ventilation strategy is, therefore, to provide a balance between energy efficiency and indoor air quality.

Regulations on building service systems

Approved Document Part L is designed to accelerate the progress to net zero carbon buildings. There are higher performance targets and a new emphasis on low carbon heating systems, but the regulations also state that building service systems should be provided with appropriate controls to enable the achievement of reasonable standards of energy efficiency in use.

Under normal circumstances, this legislation suggests that building systems should respond to the energy requirements of the space it serves. Each space should be considered its own separate control zone, and each separate control zone should be capable of independent timing and temperature control and, where appropriate, ventilation and air recirculation rate.

What can you specify

Today, consultants can specify ventilation units pre-installed with its own control system. This intelligent set up will manage the CO2, temperature, and humidity of its control zones, saving on install time and mitigating common installation problems.

These plug-and-play control panel solutions, such as Nuaire's ECOSMART Classic, provide a low voltage (0-10V) BMS interface, trickle and boost as standard and deliver successful energy control with demand control ventilation at the users' fingertips. Our ECOSMART control platform can also adapt to work with brands such as Trend and Johnson's, so is flexible for most builds.

UK falling behind

Despite Europe being the third largest energy consumer in the world and the world's largest energy importer, the UK is falling behind in the installation of smart control technology. The consequences are both near and far, with higher energy bills being faced by industrial consumers, and significant emissions experienced across the globe.

Only 80% of commercial buildings are operating at class C energy efficiency with timer-based programming rather than sensor-based, demand orientated activation when it comes to ventilation and cooling. Smart controls can provide impactful energy efficiency and cost savings with networked connectivity and site-specific controls that monitor trends to adapt to meet site requirements.

With the adoption of smart controls for these operations, buildings would see better indoor air quality and greater efficiencies in each season, from summer through to winter, with systems adapting to the need of the occupied space.

As an industry, we need to future proof our buildings by looking at the way the space is used and how it may need to adapt over time and only then can efficiencies be maintained.

More information can be found at **www.nuaire.co.uk**

Redefining **Smart Buildings**

An integrated approach with IoT Solutions by **Jacob Blackwell**, Business Development Manager, LMG

ThThe concept of smart buildings has recently seen a surge in interest, with many newer buildings now being built 'smart' as standard. Key stakeholders such as property developers, landlords, and facilities managers are acknowledging the advantages of smart buildings in boosting environmental and lowering energy and operational expenditure — in a range of spaces from offices to hotels. However, the journey towards a truly smart building still presents considerable challenges to be overcome.

Historically, traditional building management systems have functioned in isolation, resulting in inefficiencies and lost opportunities for optimisation. These systems have also failed to offer a comprehensive picture of a building's operations and performance, creating hurdles for owners and managers in decision-making processes.

An affordable solution to these problems has arrived with IoT technology - a familiar but still revolutionary force in the smart building industry. The recent introduction of SenseIQ, a comprehensive IoT services solution from LMG addresses the difficulties encountered by property developers and managers, who are now able to rapidly deploy an unprecedented layer of smartness to their existing and new buildings.

Inside the IoT-Enabled Smart Building

Implementing a building wide IoT network was once a costly and technically demanding undertaking, particularly for existing buildings. Now, however, integrated cloud-based solutions greatly ease the deployment of wireless IoT sensor networks, ensuring optimal device connectivity across various building services. This allows data to be consolidated into a single, real-time view for building owners and managers.

A wireless IoT solution like this typically consists of sensors, gateways, backhaul connectivity, and software for managing and displaying data, all packaged together — ensuring a smooth deployment without disrupting existing networks.

The key advantages

With an IoT platform implemented, the building owner or operator can begin to reap the benefits. This integrated system captures all of the meaningful data related to building performance and usage that was previously easily missed. The technology adds an entirely new dimension to a smart building's infrastructure, unlocking a multitude of possibilities for optimisation, enhancement and an improved occupant experience.

The incorporation of IoT technology can offer essential insights into many facets of building management. These include:

- Energy consumption: Data on power usage can be gathered and displayed in an intuitive interface for the building manager's analysis. The data can pinpoint areas of high consumption and help the building owner make informed decisions for improvements to align energy consumption with when and where it is needed. The data could also reveal instances of unnecessary energy use, allowing the building manager to enforce conservation measures.

- Indoor Air Quality (IAQ): A significant advantage is a deeper understanding of a building's IAQ. Installed sensors can provide information on CO2 and CO levels, humidity, dust, mould, VOC, and other airborne particles. This data allows the building manager to promptly identify and address any issues, ensuring compliance with industry and public standards and maintaining tenant wellbeing.

- Occupancy and space utilisation: Room and desk usage patterns can be easily discerned with IoT occupancy sensors. This data can help the building owner evaluate the building's layout efficiency and detect any issues, such as poor room layouts, leading to over or underutilised spaces. This data is also vital for implementing a room or desk booking system within the building, greatly enhancing occupant productivity and experience.

Progression of Smart Building Standards

The wealth of insights gathered makes it simpler for building owners and operators to align with building certifications like WELL2 and SmartScore, making their properties more appealing to potential occupants. This not only enhances the property's marketability but also sets the stage for higher rental and resale values, contributing to a significant return on investment further down the line.

In response to the increasing capabilities of IoT technology, building standards and certifications are constantly evolving. They are moving beyond a mere focus on energy efficiency and sustainability to more comprehensive metrics that take into account aspects such as occupant comfort, health, and productivity. This shift is a testament to the growing recognition of the importance of creating spaces that not only minimise environmental impact but also foster human well-being.

As such, the ability to monitor and optimise indoor air quality, lighting conditions, and thermal comfort – all made possible through IoT solutions – is becoming increasingly important.

The future of Smart Buildings

The advent of IoT solutions is truly game-changing, offering the chance to create a new breed of smart building — one that is technologically advanced and maximises efficiency, reduces costs, and significantly enhances occupant comfort and wellbeing. By fostering a healthier and more comfortable environment, these solutions can boost productivity, satisfaction, and overall user experience.

As we look into the future, the continuous evolution of IoT, coupled with advances in AI and ML, promises to bring about even more significant changes in the way we manage and interact with our buildings. These advancements, along with a sustained focus on sustainability, health, and wellbeing, will ensure that smart buildings continue to play an indispensable role in our lives.

For corporate landlords seeking to retain healthy, happy tenants, it's high time to embrace the latest developments in smart building technology. The worth of a building now extends beyond its physical infrastructure to the data and intelligence embedded within. The future of smart buildings has arrived, and they're set to become even smarter.

More information can be found at **www.lmgiq.com**

Digitised Buildings: What are they and why adopt?

Nick Robinson, Managing Partner at Beyond ESG, looks at how technological innovations are transforming our buildings, offering tangible commercial benefits that go beyond energy savings.

Connected by IoT and supported by data science, the modern digitised building boasts unparalleled levels of control and monitoring.

28% contribution to greenhouse gases - this was the latest figure published by the World Green Building Council who claimed this is the contribution of operational emissions from buildings. That's not including the construction and material downstream, which also adds a significant amount of carbon (11% of global emissions, resulting in 39% total). It's no surprise then that this issue has received a lot of attention. Thankfully, we're in the fourth industrial revolution, one of AI and smart technology, which opens up new realms of opportunity.

Unparalleled control

Enter digitised buildings. Connected by IoT and supported by data science, this enables unparalleled levels of control and monitoring, allowing for the optimisation of buildings across an array of metrics.

According to the latest figures, the global smart buildings market is projected to reach $328.62 billion by 2029, an annual growth rate of over 20 per cent. This equates to an estimated 250 million smart, digitised buildings by 2029 as demand grows for secure, energy-efficient developments. Currently around 90 per cent of smart building spending goes to non-residential commercial properties. There is of course consumer demand for this technology as well, driven by rising environmental concerns and energy costs, along with increased time spent at home, but the lion's share of smart infrastructure investment comes from the corporate world.

Reverting to the problem identified (i.e., 28% contribution of GHG), one useful case of connected buildings is improved energy efficiency. With the right infrastructure feeding the right data with the right level of control, we can optimise the use of lighting, heating and even improve air quality to provide the best working or shopping environments for our occupants.

Two simple examples of this are:

1. The optimisation of indoor temperature based on data from the outdoor environment and the occupancy levels of the building. i.e., if it's 30 degrees outside and people are working from home on a Monday, adjust the HVAC to run low and conserve energy.
2. The monitoring of rooms across an estate to measure occupancy and switch off or dim lighting based on usage. Most obviously this helps to switch off lights at night (where you'd be surprised at how much energy is wasted).

"monitoring indoor air quality should become standard practice in public spaces and urgent investment is needed".

These are two examples, but they range in complexity. At the heart of this capability is the building management system (BMS) - with this in place the opportunities are aplenty. Every property and its usage are unique; it's for experienced engineers and data scientists to assess the data and provide insight into where the best energy saving programs can be had.

Beyond energy saving

While energy saving is important and a timely problem, we shouldn't forget the wider benefits that connected buildings bring. Using the same level of control, we can optimise lighting to reduce problems like eye strain, and air quality to improve comfort and productivity. Stuffy humid office environments create frustration and distraction among staff, by taking control centrally this can be avoided. Chris Whitty, our Chief Medical Officer, said "monitoring indoor air quality should become standard practice in public spaces and urgent investment is needed".

Benefits stretch even further, with CAFM (computer aided facilities management) owners can take advantage of improved efficiencies in asset management, reducing optional costs and empowering internal teams to take control. For example; streamlining facilities management, with data from sites on asset performance we can distribute, track and complete work to be done in way that previously required significant internal headcount or external suppliers. In another example; we can use IoT technology such as vibration sensors to feedback data on when an asset is showing unusual signs of operation. Say hello to predictive maintenance. Downtime on major assets can often result in significant costs per day, if operators can get even a 24-hours heads up, this can avoid major costs to the business.

Insights from your infrastructure

Another key benefit, and one which few organisations are currently exploiting, comes from using data more strategically. Ultimately, this means using the data to better understand customers and their behaviour to inform decision making and deliver tangible insights that results in new revenue streams or increased incremental revenue.

For instance; in a retail environment, it is possible for organisations to use their smart infrastructure to:

1 See how people route around premises
2 Provide heat maps of the store, where are hot and cold areas
3 Measure customer engagement with products in-store
4 Measure detailed engagement in specific areas, such as new product launches
5 Count overall footfall, or footfall by specific locations

Once decisions are made as to what activities should be monitored, this new physical data is paired with internal data (sales, marketing, demographic, market share etc.) to build models that define relationships between engagement and conversion. Dashboards can then be developed to enable ongoing consumption and implementation of the insight.

In the retail environment, employing your smart infrastructure to drive insight fills a significant gap. Industry is great at understanding customers before and after they enter the premises but knowing what they do on-site has, until now, been more challenging. However, by digitising buildings through the use of smart infrastructure (funded by energy savings) it is now possible to answer questions such as:

1 Which products are my customers most engaged with?
2 What impact did my recent marketing campaign have on product engagement?
3 How effective is our signage?
4 Where is best to launch a new product?
5 How long do customers spend in store?
6 What is the best store formatting/layout?
7 Are we resourcing our stores optimally?
8 Are sales teams maximising opportunity or do we need to provide training?

Conclusions

Investment in digitised buildings offers several key benefits:

A smart, digitised building reduces energy costs by optimising when heating and cooling occurs across the estate. In most cases the costs savings pay for the investment.

A smart building enhances the health and well-being of employees by making buildings more comfortable, this in turn boosts productivity also resulting in a financial benefit for the organisation.

And finally, smart infrastructure helps businesses demonstrate their commitment to their Scope 1 emissions, which is important in the supply chain in terms of helping others with their Scope 3 emissions.

In summary, the benefits associated with connected buildings are vast and they will only grow as we see continued innovation in technology and processes. There's an immediate need to cut energy bills so the commercial benefits are there for the taking, but the long-term requirement of decarbonisation should be equally considered. The SBTi (Science Based Targets Initiative) has their framework for building decarbonisation out in July 2023, so keep a close eye on that. Aside from energy, our people are important assets, their requirements are increasing and the data on the effect of internal environments on their productivity is continuing to reinforce the importance of this focus.

More information can be found at **www.beyond-esg.co.uk**

Moving from **concept to reality**

By **Mark Sutcliffe**, CEO of Lorne Stewart Facilities Services

The term 'Smart Buildings' is no longer a phrase that simply conjures images out of science fiction movies.

We are well past proving the concept. Today, while exact definitions may vary somewhat depending on who you speak to, it's generally accepted that a smart building is a structure that uses technology to enable efficient and economical use of resources in the aim of creating spaces that support the safety and wellbeing of its users as well as the operational output of the organisations within the structure.

Although there are debates as to what and how much technology is needed to make a building 'smart', there can be no denying that these structures and their respective solutions impact many aspects of our home and working lives, from giving us the ability to control our central heating and lighting remotely to tracking how space is used inside offices.

What's more, the extent to which these solutions are embedded into society is only going to intensify. Worth around $80 billion in 2022, the global market for smart buildings is set to quadruple in size to well over $320 billion by 2029, growing at a rate of more than 22% a year.

Boost in demand

Several factors are at play which explain the boost in demand for smart building solutions.

Take the Covid pandemic and return to the workplace following periods of lockdown as an example. The reopening of commercial buildings has fuelled a surge in demand for smart technologies designed to create safe working environments. These include solutions to manage regular cleaning and sanitisation, proper ventilation, smart entry control, temperature and air quality measuring, and space optimisation. Additionally, as more people adopt a hybrid working model, technology has enabled organisations to monitor how their space is utilised throughout the working week, allowing them to begin to re-size their commercial estate according to demand.

At the same time, businesses are realising several key operational benefits of going smart. For example, control systems that oversee crucial building operations such as heating, ventilation and air conditioning (HVAC), as well as lighting and security, are offering the opportunity to lower costs, improve ESG credentials, support a healthier workplace and enhance occupant safety.

Achieving more with less

Ultimately, businesses are being attracted to smart building solutions because they enable them to achieve more with less by

leveraging automated, data-driven insights to make smarter decisions across a host of operational areas, including cleaning and asset upkeep. And in the context of the current inflationary environment and an acute labour crisis facing sectors such as facilities management, the role of technology is demonstrably important to viable building operations.

Another key factor is that such technologies are becoming more accessible, both in terms of cost to implement and the fact they are becoming normalised among the people working in and around them. As I referred to at the beginning, the Sci-Fi reaction to smart buildings is dissipating as more and more people realise that these solutions are not about a desire to oversee people in the work environment to assert control.

An example here is monitoring office use via desk sensors. Once, this may have appeared worrying to employees who feared being monitored by their employer – however, with communication around the key operational, safety and environmental benefits associated with these solutions vastly improved, acceptance has never been higher.

Sensors are the key to going smart

Indeed, many building management teams will already be utilising some kind of Building Management System (BMS) and/or Building Information Modelling (BIM) solution. Further, others will be leveraging computer aided facilities management (CAFM) tools which enable facility managers to plan, execute and monitor all activities that might fall under their remit, including reactive and planned (preventative) maintenance, space optimisation and management, room booking and a range of other building user services.

Whatever the formation of building blocks and software platforms in place, to truly go smart organisations need to fuel these systems and applications with data that is, as much as possible, in real time.

Internet of Things (IoT)-enabled sensors hold the key to this. By installing data sensor technology across key assets within buildings, managers can instantly extract real-time data on key elements of building performance; from room occupancy, air quality and temperature to waste management, energy usage and natural light coverage.

This information can unlock a range of major benefits. For example, real-time information on occupancy, temperature and humidity can enable facilities teams to adjust air conditioning and heating systems in rooms as and when they are needed, both saving energy and ensuring that optimal conditions are in place when the space is being used.

Air quality is another hugely important building performance metric. Here, sensors can detect levels of carbon dioxide and other toxins in particular spaces, the data being used to determine whether ventilation methods are effective or if other remedial steps need to be taken.

Keep the future in mind

IoT and technology can also enable more radical ways of delivering maintenance in buildings. In a world where engineer resources are growing scarce, it is becoming clear that reducing the workload on engineers is one of the solutions the facilities management industry must adopt to address this issue. One of the ways to achieve this is through Condition Based Maintenance (CBM). This concept sees the maintenance of smart assets being undertaken based on condition and the actual time that the asset is in use, rather than on a cyclical basis. CBM reduces the time engineers need to carry out planned maintenance, reduces cost and can also improve the effectiveness of an asset.

Retrofitting must be ramped up

It is also important to note that any building can become smart. While modern constructs and new builds are naturally being designed with smart technology in mind, key smart building technologies such as sensors and their accompanying Wi-Fi networks can be retrofitted into older assets.

If the UK is to meet its net zero objectives, retrofitting and decarbonising the current building stock is non-negotiable.

The built environment is commonly accepted to account for around 40% of our carbon footprint, with most that falling under operational carbon – in other words, the emissions associated with operating the building after it has been constructed. Add in the fact that 80% of the buildings that will be standing in 2050 are already built, and the need to press ahead with retrofitting becomes all the clearer.

Crucially, the process need not break the bank. Companies can start small with a few sensors focusing on a particular asset or metric to prove the concept before moving onto a wider rollout and benefitting from economies of scale.

Don't forget about people

While technology holds the key to unlocking the benefits of smart buildings, organisations must bring colleagues on this journey too.

Automating processes and incorporating new technologies to transform how things are done has, throughout history, been met with an inevitable sense of resistance. Indeed, human nature makes us cautious about change, especially if the connotations are perceived to be negative.

Companies therefore have an obligation to involve and listen to employees during major periods of change such as those brought about by retrofitting smart technologies into the workplace. In this instance, far from instilling concerns, smart technologies have the potential to greatly enhance the employee experience.

This needs to be communicated properly. Yes, we are enabling more to be done with less and are seeking to fill serious skills and labour gaps, but this is not about displacing people's jobs – on the contrary, there is a big opportunity to upskill and give people in the industry a digital leg-up.

As a sector, facilities management is well overdue a transition into the 21st century, with technology being leveraged to alleviate pressure on colleagues and make the industry more appealing to the younger, tech-savvy generations that will be leading our field in the future.

More information can be found at **www.lornestewartgroup.com**

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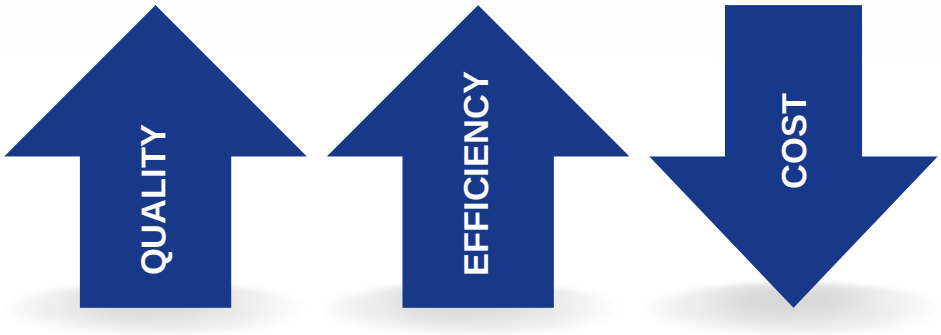

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Nuaire launches new smoke shaft system, AxTân

Global ventilation leader, Nuaire, announces new smoke shaft system, AxTân - the only fully-certified all-in-one shaft system as part of its AXUS axials range. The launch will strengthen the manufacturer's position and capability in the fire and smoke extract market by further fortifying its axials offering.

Unique in the market, AxTân has been overseen and developed with the UK's leading fire safety expert and Nuaire Axials Divisional Manager, Simon Plummer, and is the ONLY fully-certified shaft system - an all-in-one solution with skid, cowl and fan combined. This means it can be delivered straight to site and fitted as one whole unit, thus reducing time spent assembling on site as well as mitigating any installation issues.

AxTân hits a sweet spot in performance of 6m3/s and 300pa. It's high efficiency motors result in lower running costs, making it the optimum choice for any specification.

Nuaire's existing line of axial fans exceeds building legislation and is certified to EN12101 Pt3 2015. Each product line has been innovated extensively and the company now offers one of the largest ranges of axial fans on the market.

www.nuaire.co.uk

A handy little tool from Makita

Makita has added a handheld blower to its expanding LXT cordless collection. The versatile 18V DAS180 LXT Brushless Blower is the latest product from the leading power tool manufacturer that is also capable of inflating and deflating, simply by changing the nozzle tip.

The new 18V DAS180 LXT Blower is powered by a brushless motor with variable speed control. Suitable for a wide range of applications, from cleaning off workbenches, machinery, cleaning and blocked filters, through to inflating inner tubes and play pools, this handy tool makes a useful companion to any kit bag.

The body is designed with an ergonomic rubberised grip and weighs only 1.7kg, making this tool easy to operate with one hand. Despite its compact size, the unit is extremely powerful and offers a maximum sealed suction of 10.3kPa. Its 4-stage air volume settings deliver a blowing force of up to 2.8N with a maximum 200m/second air velocity and air volume of 1.1m3/min.

To find out more about Makita's range of power tools and equipment visit:
www.makitauk.com

EVO S boiler range from ACV provides a flexible option

ACV UK, stainless steel, hot water and heating specialist, is pleased to announce the introduction of its new EVO S wall-hung boiler range, which incorporates the latest stainless steel heat exchanger technology for energy efficiency and reliability.

Available in seven different outputs from 40 to 150kW, EVO S features a 5:1 turndown ratio and excellent low-class 6 NOx emissions across all models.

Designed for straightforward installation and maintenance to help optimise performance, the EVO S range is lightweight for its class with a compact design, with the flexibility to wall mount or install into a prefabricated floor-mounted frame. For larger buildings or those with more complex layouts, optional low height frame and header kits offer cascade ability, up to 900kW (exceptions apply) and modulation up to 30:1. Where required, the EVO S is LPG convertible out of the box with no additional kits on all models up to and including 120kW.

Backed by a five-year parts and labour warranty, and fully compliant with Building Regulations Part L, this versatile range of condensing boilers is approved for installation on multiple flue systems with all relevant components available to purchase.

www.acv.com/gb

Fernox announces drive to more sustainable packaging

Fernox has confirmed its market leading water treatment products will now be packed in 265ml and 500ml bottles manufactured from 30% recycled High Density Polyethylene (HDPE). This is an important milestone for the company, which has long been committed to product innovation and energy efficiency of heating systems. To expand on these innovations, it is now also focusing on the environmental impact of product packaging.

"Although the Fernox bottles will look and perform like our existing ones, the adoption of 30% recycled content will lower our overall use of virgin plastics," explained Greg Banham, Sales Director from Fernox. "However, there is always more to do. Sustainability is a work in progress, and we are continuously looking to improve our efforts in supply chain, logistics and overall environmental impact."

www.fernox.com

Fernox launches a dedicated filter for heat pump systems

Manufacturer Fernox has extended its portfolio with the new TF1 Sigma HP Filter, which has been specifically designed to protect air and ground source heat pumps. The filter provides a high quality option and unparalleled performance to help maintain the efficiency of new or retrofit installations.

As a pioneer of filter technology, Fernox has developed the new TF1 Sigma HP Filter to offer the best possible protection. The filter's unique shape allows for the efficient capture of system debris and the settlement of particles within the main body of the filter. Manufactured from engineering-grade polymer, the TF1 Sigma HP Filter provides excellent strength and hydrolysis resistance.

The Fernox TF1 Sigma HP Filter is supplied with 22mm or 28mm full-bore valves as standard. The design of these valves is crucial as it means that there is no restriction of flow through the filter assembly, ensuring the heat pump can maintain the required COP (Co-efficient of Performance).

Due to its double radial seal between the manifold and main filter body, the Fernox TF1 Sigma HP Filter is very flexible. Installation is quick and simple, enabling horizontal or vertical orientations or at any point around a full 360° pipework orientation.

www.fernox.com/product/tf1-sigma-hp-filter/

A touch of class: Stannah helps modernise historic entertainment venue

Lifts can be a regular challenge in heritage buildings, and Blackpool Winter Gardens is no ordinary building. First opened in 1878, this Grade II Listed 3,000-seater entertainment complex has entertained countless millions throughout the history of the popular Lancashire seaside resort town. Like any other building with more than one level, the requirement to safely and reliably transport people from one floor to another, especially those with limited mobility, is an essential one.

One of the lifts at the Blackpool Winter Gardens had been in desperate need of repair for a long time. The existing OTIS passenger lift dated back to somewhere around the 1950s was only safely able to carry 4 persons or a maximum load of 380 kg, and looked very dated with its plain oak panelling.

"Stannah was the ideal choice for the replacement of our Opera House passenger lift, which had been out of service for over 12 months. Working with Stannah has been so easy, and constant communication was kept from start to finish." Says Philip Jackson, Head of Maintenance, Winter Gardens Blackpool

55 years of Kalzip

Koblenz-based provider of aluminium and metal roofs, facades, and building envelopes celebrates its anniversary by looking back at milestones. Since 1968, Kalzip has been producing roof and facade systems on modern roll-forming equipment.

Originally introduced as a product name based on the first owner, the US company Kaiser-Aluminium, Kalzip has since established itself as the synonym for individually manufactured standing seam roofs internationally. With various innovative products and services, the company has been able to complete many prestigious projects in its 55-year history and thus record some milestones in its history. To properly honour the company's anniversary, there are plans for various things, including a temporarily modified logo, a history page, and the Premium Partner Award, which is the focus of the anniversary.

All employees are invited to celebrate 55 years of Kalzip at a big summer party at the headquarters in Koblenz, and the Premium Partner Meeting, including the award ceremony, is also dedicated to the anniversary.

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With airtight buildings on the rise, coupled with increasingly strict legislation and a higher focus on good indoor air quality, there is now a growing need for effective fresh air ventilation solutions.

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All our systems are designed to supply clean, fresh air into a building, whilst simultaneously extracting stale air, ensuring good indoor air quality for occupant wellbeing. These units are also able to recover valuable heat energy from inside the building, maximising energy efficiency and reducing running costs.

Mitsubishi Electric ventilation solutions offer:

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- Improved comfort through heat recovery
- Specific models for high humidity applications
- Commercial and Residential Lossnay solutions

For more information on our full range of ventilation solutions, visit: **les.mitsubishielectric.co.uk/ventilation**

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