

Rethinking Efficiency in Buildings

80%

of a building's
energy consumption
is accounted for by
heating and cooling

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Overview

According to the International Energy Agency, buildings account for 30% of final energy consumption and 28% of global energy related CO2 emissions (IEA, 2018). In light of these figures, it is clear that investing in decarbonising new and existing building stock is key to achieving climate objectives and economic recovery as a result of the Covid-19 pandemic.

Investment in a carbon-neutral future will lead to an increase in economic activity by retaining and creating jobs in the development and implementation of green energy products and services. In 2019 it was estimated that 7% of total global employment – or 220 million jobs – depended on investments in the building sector. That number is expected to grow as response to the climate crisis gathers pace in a bid to meet the target of net zero carbon emissions by 2050, a goal set by the UK government in response to the 2015 Paris Agreement on climate change.

Finding ways to make our buildings more energy efficient is a critical step in the journey to a decarbonised future. If we are to achieve this ultimate goal then the buildings of the future, both existing and new, will need to be made more climate-friendly, whilst maintaining comfort for the occupants. With this objective in mind, Danfoss believes the retrofit building sector presents a predominantly untapped opportunity to respond to climate change and has massive potential for energy savings. As heating and cooling accounts for up to 80% of a building's energy consumption, it makes sense to focus energy efficiency opportunities on this aspect of our existing buildings.

With a primary focus on the UK commercial building market, and the green renovation sector in particular, Danfoss will explore these opportunities and look at the various ways to reduce energy demand as we make the transition from fossil fuels to sustainable solutions for our heating and cooling supply.

We will consider the role of solutions such as district energy, sector coupling, heat pumps and demand-response, which can further increase efficiency and enable buildings to play an active role in the wider energy system. Measures that can be implemented now will also be evaluated, such as the optimisation of Heating, Ventilation and Air Conditioning (HVAC) systems and the use of digitalisation as part of intelligent control systems that have the potential to deliver significant energy savings with short payback times.

In analysing the concept of rethinking efficiency in buildings, Danfoss will assess some of the key trends and opportunities for making efficiencies. We will also consider the importance of clarity and consistency in the implementation of new energy standards to ensure a lasting transformation of our buildings.

“ In 2019, 220 million jobs depended on investments in the building sector. ”

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THIS IS WHERE A
NEW GENERATION OF
BUILDINGS STARTS

The Challenges

To achieve the ultimate goal of net zero carbon emissions (which means cutting emissions to a level where any remaining greenhouse gas releases are balanced out by absorbing an equivalent amount from the atmosphere) we will need to decarbonise every sector of the world economy, from buildings and manufacturing to industry and transport systems. That's a serious challenge.

At Danfoss, we believe buildings are a good starting point for the energy transition. We spend most of our time in buildings, whether that's working, learning, shopping, or simply living. It's not surprising, therefore, that these buildings consume a lot of energy. Most of the energy is used to maintain the right indoor temperature and air quality. This is controlled by heating, cooling and ventilation systems (HVAC), known collectively as technical building systems. When these systems aren't set up properly, or are poorly controlled, they use more energy – resulting in higher bills for consumers and increased CO2 emissions.

A comprehensive report by green energy consultancy, Ecofys, examines the challenges we face in our efforts to reduce carbon emissions from buildings. Compiled before the UK left the EU, the report presents some stark statistics, including:



of total EU energy consumption used to heat and cool our buildings



of an average household's energy bill spent on heating and cooling



people in the EU struggle to heat their homes



of the EU's carbon emissions comes from buildings



spent by EU citizens on space and water heating per year



EU citizens living in buildings with hazardous concentrations of pollutants due to inefficient ventilation



Click to watch "This is where a new generation of buildings starts"

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The Benefits

Proven technologies are already available to make the systems that heat, cool and ventilate our buildings more efficient, yet they are still missing in many. Danfoss believes that making improvements to optimise a building's HVAC system is the first step to unlocking the energy efficiency potential hidden behind the concrete, glass and steel.

**Download the
Ecofys report here**



Optimisation will make a building more energy efficient, comfortable, and convenient for those who own them and occupy them. It can also help to empower building users, whether it's an office or apartment block, to understand and manage their energy usage better, whilst maintaining a healthy and comfortable indoor environment that meets their needs. In addition, property owners, engineers and consultants will experience the benefits of reliable heating and cooling systems that are cost-efficient to run and easy to install and maintain, helping to increase property value and reduce complaints.

Furthermore, according to figures compiled for the Ecofys report, HVAC optimisation will have a positive impact on our planet by saving 156 Mt CO2 emissions – the equivalent of emissions produced by 82 million cars.

“The main finding of the report is that optimising Technical Building Systems can save on average 30% energy with a short payback time.”



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Trends & opportunities

As we emerge from the current public health crisis, there is a real opportunity for a 'green restart' in both the new build and renovation sector that can help rebuild economies, while simultaneously decarbonising them.

Whilst there is scope for efficiencies in all types of building, Danfoss has identified significant opportunities in three key areas, namely, offices, data centres and apartments.



Offices

Covid-19 has had a major impact on the working environment and many offices have stood empty while employees work from home to comply with travel restrictions and social distancing measures. Figures from the Office for National Statistics estimate that more than 40% of UK working adults have been home-working at some point during the pandemic and many believe that this trend, together with more flexible working, is likely to continue into the future.

Even in a post-Covid world, offices may never look the same again and some may face repurposing, possibly for residential accommodation, if they are deemed to be no longer viable for corporate use. The design and function of tomorrow's offices will need to be adapted to meet the changing needs of employers and their staff, while creating a healthy, hygienic and well ventilated environment will become even more important.

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British Land is aiming for 50% less carbon emissions from its developments by 2030.

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New technology is already assisting the design of building services that not only achieve optimum energy efficiency but also comply with Covid-19 safety requirements, including enhanced air filtration and multiple touchless features.

As well as demand for changes in response to the pandemic, some of the UK's leading commercial landlords have been setting new sustainability targets. British Land, for example, has intensified its focus on making the whole of its extensive portfolio, from mixed use campuses to retail and office assets, net zero carbon. The company is aiming for 50% less carbon emissions from its developments by 2030 and for 100% of all developments delivered after April 2020 to be net zero embodied carbon.

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Data Centers

Data centres, the brains and beating hearts of the internet, are consuming vast amounts of energy. Indeed, this power-hungry industry is responsible for three percent of global power consumption and it is estimated that, worldwide, they account for about two percent of total greenhouse gas emissions – a number that is on par with the airline industry. Research indicates that data centres experienced rapid growth in 2020, most likely fuelled by the pandemic: an increasing number of people have been working from home and with entertainment outlets closed during lockdowns, more leisure time has been spent watching TV and movie streaming services. Technological advancements are difficult to forecast, but several models predict that data centre energy usage could surpass more than 10 percent of the global electricity supply by 2030.



Key points

More than 80% of the electricity used in a data centre is transformed into heat that can be recovered and used in district heat networks.

The ReUseHeat project estimates that approximately 340TWh of heat could be recovered annually from 'unconventional' excess heat sources, such as data centres, metro stations, service sector buildings, and waste water treatment plants.

Given these predictions, it is time to go beyond Power Usage Effectiveness (PUE), effective water utilisation, heat recovery and reuse of energy are becoming the next key drivers for data centre owners/operators.

There are significant opportunities for this sector to reduce its impact on the environment through investment in renewable energy, for example, ensuring ideal thermal conditions around server installations, and optimising building services to keep energy consumption and CO2 emissions at a minimum. Data centres can also improve their sustainability by recycling heat generated by their servers to district heat networks as demonstrated at Amazon Web Services' recently completed data centre in Dublin. Recycled heat from the building will be supplied via the local council's new district heating company to help heat public sector buildings, offices and apartments in South Dublin.

Danfoss is at the forefront of decarbonising solutions for the data centre industry and has a wide portfolio and expertise to reduce direct and indirect CO2 emissions with lower-GWP refrigerants and energy effective solutions. Because we believe decarbonisation of this sector starts on the cooling side we have developed the technologies, including chillers and heat pumps featuring Danfoss Turbocor compressor technology, that allow data centres to be cooled up to 30% more efficiently. In addition, we have innovative solutions for recovering excess heat generated by data centres, and products that are optimised for operating conditions at higher temperatures, creating less need for cooling and thereby reducing the power required for this purpose.

An example of these pioneering developments in action can be seen at Danfoss headquarters in Nordborg, Denmark. In 2015, it was heated 100% by fossil fuel. In 2022, it will be CO2 neutral. And, in 2024, reused excess heat from Danfoss data centres will provide 25% of the overall heat supply for the 250,000 square metres of factories and offices.

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Apartment Buildings

Apartment block living is increasing, particularly in urban areas where land is at a premium and high-rise developments can provide more homes on a smaller footprint. Modern heating technology gives property owners and managers numerous ways to improve energy efficiency in their residential buildings. Making this investment, whether in new build or renovation projects, will enable a better return on investment, lower overall costs, greater comfort and safety, and reduced environmental impact.

This sector is also seeing a growing trend towards modular building and Modern Methods of Construction (MMC) to meet demand for housing at a faster pace than is possible using traditional building methods. Sustainability can be another key benefit of adopting MMC. In fact, the NHBC Foundation's 2018 MMC Study found that 53% of participating developers considered sustainability as a key factor in driving the uptake of MMC. Developers also cited the benefits of improved efficiency, reduced waste and the time (and energy) saved by offsite manufacturing.

Apart from ensuring optimum energy efficiency in the design and construction of new residential developments, many older multi-family buildings now require renovation to comply with updated efficiency standards. Such refurbishment programmes are an ideal way to improve the sustainability of these buildings and help residents reduce their energy consumption – and heating bills – without compromising comfort.

“ Many older multi-family buildings now require renovation to comply with updated efficiency standards. ”

In our opinion, making efficiencies in this sector requires a two-fold approach. Firstly, improving overall system efficiency by, for example, ensuring optimal hydronic balance and accurate temperature control, which can help reduce the overall cost of decarbonisation significantly.

The second, and potentially more challenging, approach is to make sure remaining energy demand is covered by more sustainable energy, such as heat pumps or connecting communities to new district heat networks. Needless to say, this will require a huge overhaul of heating systems in many existing residential buildings that currently rely on carbon-intensive systems.

*Watch
“Rethinking
Efficiency in
Buildings”*



Solutions & applications

Buildings need to maintain a precise balance between dynamic growth and sustainable management. Whether it's an office, data centre, supermarket or apartment block, building services technology must adapt to changing market needs and regulations.

At Danfoss, we are engineering energy efficient and digital solutions that enable new and existing buildings to be more sustainable and reduce emissions, without compromising on comfort.

Our innovative solutions can be used in renovation or new build projects, are easy to install and can achieve considerable savings on energy bills. Some of the applications we cover include:



Air handling units (AHU)

Danfoss control valves and actuators for AHU ensure the best indoor comfort established in the most energy efficient way. They accurately control the water (heated or cooled) flow into the AHU so the exhaust air temperature matches the desired temperature.



Heat Pumps

Heat Pumps will play a key role, not only in large scale heating and cooling for apartment buildings and offices, but also for heat recovery in data centres, for example, when connected to a local heat/district energy network.

Innovative products such as the Turbocor compressor from Danfoss can help these applications achieve greater levels of efficiency.

Chillers

Energy consumption is a key driver for building owners when it comes to chillers. Depending on the building size, type, and use, as well as the surrounding climate, Danfoss can offer different options for chiller designs to provide the best all round value.



Connected systems

Digitalisation, remote access and Internet of Things (IoT) trends are increasingly important in HVAC applications. They drive the development of smart buildings and offer a significant energy efficiency increase by improving system performance based on building data. Danfoss offers different internet-connectable systems and simple solutions for HVAC optimisation – a low cost measure for reducing energy demand and easily retrofitted in existing buildings.

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Optimising HVAC systems can lead to energy savings of 30%.
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Close control systems

Danfoss solutions for air conditioning systems ensure precise close control for high reliability, better humidity and temperature control in IT cooling, in server rooms or data centres.



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HVAC optimisation

With an average of 50% share in the energy costs, modern HVAC systems need to provide the highest level of comfort at the lowest possible operation costs. One of the most cost-effective measures to reduce energy demand right now is by optimising HVAC systems which, on average, can lead to energy savings of 30% and with a short payback time of 2 - 4 years.

Energy efficiency can be further increased with smart solutions such as demand-response, while digitalisation can be used to control heating and cooling as part of intelligent control systems that have access to accurate, real-time data. At Danfoss, we call the digitalisation of these systems HVAC 4.0 and are already engineering HVAC 4.0 for the smart buildings of today and tomorrow.

The combination of Danfoss AB-QM pressure independent balancing and control valves (PICV) and our NovoCon S digital actuators is a good example of the increasing digitalisation in HVAC. Typically, terminal units such as fan coil units, chilled beams or radiant panels, provide heating and/or cooling in each room of a building.

Depending on the size of the building this may require hundreds or even thousands of control valves and actuators for temperature control. Using the latest Danfoss digital actuators and PICVs provides the buildings' BMS with real-time HVAC data, via BMS networks or Cloud-based solutions, while dynamic hydronic balancing ensures optimal energy efficiency, and comfort, throughout the building.



Heat recovery and sector coupling

Sector coupling is the interconnecting of different energy consuming sectors – buildings (heating and cooling), transport, and industry – with the power producing sector. By turning commercial buildings into flexible energy providers we can bridge the gap between supply and demand, reduce costs for consumers and help system operators to integrate renewables to cover remaining energy needs in the most efficient way.

Heat recovery from commercial refrigeration systems, in particular, has gained much interest in recent years and Danfoss offers solutions to maximise this efficiency opportunity. With the introduction of CO₂ as a refrigerant, supermarkets can utilise the surplus heat from CO₂ refrigeration units to heat space and domestic water – either in their own buildings or by feeding into a local district heating system.

A number of schemes have been developed in recent years to make better use of exhaust heat from data centres, like the AWS project in Dublin mentioned previously. Heat can be recovered and run through a heat exchanger that both cools the data centre and heats up water. The heated water is delivered to large-scale heat pumps and then be used to supply heat via a district energy network to local businesses, public sector buildings and homes.



District energy

Today, the district energy sector is facing big challenges but numerous opportunities lie ahead as well. The sector plays a major role in the Paris Agreement as it is acknowledged as one of the enablers of the decarbonisation process. District energy is also part of trends such as sector integration (or coupling), the circular economy and digitalisation.

The challenges are primarily on the district heating utilities' side and are mainly connected to integrating various renewable energy sources, providing more transparency and new services to customers, as well as the constantly expanding district energy network that has to be optimised and refurbished.

Although there are still challenges to be overcome, some of the first schemes to benefit from this sector have had very positive outcomes. These include a project to design and deliver a district-wide heating network to provide cheaper and greener heat to over 1,000 homes plus community buildings in north London, using unwanted heat from the London Underground.

Danfoss was delighted to be directly involved in providing a custom-designed Heat Exchanger Sub-Station which successfully connects one of the public buildings to the new heat network.

At Danfoss, we believe district energy has a key role to play in the green transformation of the built environment. Studies show that a 35% district heating share (up from today's 2%), together with sector integration, which could cover at least 29% of the district heat production (Heat Roadmap UK – www.heatroadmap.eu). It is for this reason that we have established what we call the District Energy Academy by Danfoss.

This series of online events and webinars is aimed at energy professionals who want to learn more about this emerging sector, understand its potential to tackle climate change, discover how to build network models for feasibility studies, and plan network extensions and renovations.

Going forward

Although we were starting to forge a road towards carbon neutrality, annual efficiency improvements have actually been slowing down in recent years. To address the slow-down in retrofit efficiencies it is clear that we must accelerate the modernisation of existing building stock or we will not meet the 2050 decarbonisation target.

In support of this endeavour, Danfoss is working with cross-sector coalitions like the Three Percent Club. This collaboration of governments and supporting organisations is committed to putting the world back on the path to a three per cent annual efficiency improvement by supporting countries and cities in developing energy-efficient buildings and sustainable district heating and cooling systems.

Danfoss firmly believes that the 'energy efficiency first' principle should form the backbone of our investment in a low-carbon world. Optimising the efficiency of HVAC systems in existing buildings through better balance and control has been shown to be one of the most cost-effective ways to improve efficiency. And the smart solutions that can help put us on a fast track to highly efficient, connected buildings are available today from forward-thinking manufacturers like Danfoss.

From digitalised pressure controllers that automatically and dynamically balance a heat network, through to the application of artificial intelligence in solutions like Danfoss Leanheat, our existing buildings can be transformed and made ready to take full advantage of district heat networks by lowering temperatures.



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In response to the pandemic, a new requirement for additional ventilation will be proposed to improve indoor air quality in buildings such as offices and gyms, reducing the risk of any potential infections being spread indoors.

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New standards

Whilst we may have the tools to unlock the energy saving potential of existing buildings we also need a clear framework for action, supported by legislation that sets high energy efficiency standards for retrofits and new buildings and introduces measures to increase the overall renovation rate.

In the UK, the Future Buildings Standard proposes a long-awaited uplift in Part L (conservation of fuel and power) efficiency standards and considers updating Part F (ventilation) of the Building Regulations.

The changes to Part L and Part F will look at setting new standards for work done to existing buildings and recommend measures to tackle overheating in some new residential buildings, which can be caused by poorly balanced heating systems.

In response to the pandemic, a new requirement for additional ventilation will be proposed to improve indoor air quality in high-risk non-domestic buildings such as offices and gyms, reducing the risk of any potential infections being spread indoors.

Amid calls for greater clarity and consistency in regulations and standards, the UK government is planning to put stringent transitional arrangements in place to provide all developers with certainty about the new energy performance requirements they will need to meet. At Danfoss, we welcome this commitment and the prospect of rigorous new efficiency standards that are properly communicated and enforced.

The potential to achieve energy transition is within our grasp, so let's not go back to what we had but work together to provide highly efficient buildings that are net zero carbon ready, better for the environment and fit for the future.

Download the other whitepapers in our series on Net Zero:

[Residential Heating: The journey to Net Zero](#)

[The challenge of Net Zero for the heating sector](#)

For more information on how Danfoss is getting ready for Net Zero click below or contact us at Danfoss Climate Solutions UK:

[Rethinking efficiency in buildings has never been more relevant, check out this overview to see why](#)

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The Danfoss logo, featuring the brand name in a stylized, cursive script font.