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THE BUILT ENVIRONMENT

Sustainability and Humanity's Habitat

Deep Dive Research Report 2024

Executive Summary

The built environment – our buildings, towns and cities – present challenges and opportunities when it comes to both climate change and social issues. As investors, we need to understand these dynamics so that we can allocate capital responsibly to drive positive changes alongside a financial return.

Environmental challenges, marked by rapid urbanisation and climate change, call for a shift towards sustainable urban planning. As our research has shown, the integration of green spaces, energy-efficient buildings and sustainable transportation is not just beneficial but essential. Improvements to the built environment can alleviate the urban heat island effect, reduce GHG emissions and conserve natural habitats, thereby contributing to both environmental conservation and enhanced urban living.

Social challenges, particularly the issues of inequality and access to basic needs, highlight the importance of equitable urban development. We must strive to create inclusive communities, where access to affordable housing, quality healthcare and efficient public transportation is not a privilege but a norm. Case studies used throughout the report are used to underscore the value of strategic development and innovative solutions in achieving these goals.

The built environment must be more than just functional; it needs to be adaptive, resilient and nurturing. As we look towards improving housing through sustainable practices, we have sought insights from academic institutions and UK housebuilders. These examples demonstrate how integrating energy-efficient technologies, renewable energy sources and smart design can significantly reduce the carbon footprint of residential buildings.

Moreover, the role of software, particularly in the form of digital twins, has emerged as a cornerstone in creating and managing sustainable urban spaces. The capabilities of these technologies in simulating, analysing and predicting the performance of infrastructure projects under various conditions are invaluable. They represent a leap forward in our ability to plan, build and maintain sustainable environments.

In this landscape of challenges and opportunities, investors play a critical role. By directing capital towards those companies helping to build sustainable urban development projects; supporting innovations in technology and healthcare; and endorsing policies that foster environmental and social sustainability, investors can be the catalysts for profound change. Investment in green infrastructure, sustainable housing and healthcare facilities, coupled with support for technological advancements, can create a ripple effect and lead to healthier, more resilient and inclusive communities.

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Introduction

The population of urban areas is increasing. As urbanisation accelerates at an unprecedented pace, the convergence of human aspirations, architectural ingenuity and environmental stewardship has never been more critical. The built environment has become humanity's habitat.

The 'Built Environment' refers to buildings, roads, infrastructure and other human-made features of our surroundings[1].

Human-made surroundings embody the way in which we live our lives. It is an expression of the way in which we live, work, play and travel: it includes places such as buildings, parks, green spaces and transportation systems. Together, these form neighbourhoods and cities.

Urbanisation is being driven by overall population growth (the number of humans on Earth is anticipated to exceed nine billion by 2050) and rural-urban migration. This means that a larger proportion of an increasing population will reside in cities. The global population balance switched from predominantly rural to predominantly urban in 2007. This marked the first time in human history that more people lived in urban areas than in rural ones[2]. According to the United Nations, the global urban population is projected to reach 68% by 2050. This means that the built environment is becoming ever more important.

The movement away from rural areas to expanding metropolises is driven by various factors, including demographic shifts, better economic opportunities, improved living conditions, access to education, healthcare and the perception of a better quality of life in cities.

Industrialisation has led to employment opportunities being centred in cities: this attracts those in search of work. This search for better jobs and higher incomes brings a wider array of social and cultural amenities, entertainment options, educational institutions and healthcare facilities. These factors attract people seeking a more cosmopolitan lifestyle, access to diverse social networks and vibrant urban cultures.

Efficient transportation systems, better connectivity, access to information and better services have contributed to the appeal of urban areas.

Yet urbanisation is a double-edged sword: due to unequal distribution of resources within urban spaces, marginalised communities often find themselves on the periphery of prosperity. Gentrification, displacement and environmental injustices that feature within the built environment show that it can be both a powerful instrument of inclusivity and also exclusion. Whilst urbanisation presents opportunities for economic development and improved quality of life for some, it also poses challenges such as increased pressure on infrastructure, services and the environment. The built environment consumes almost half the materials extracted globally every year and is a significant contributor to greenhouse gas (GHG) emissions[3]. Rethinking the way we design our urban centres can allow people to reap the benefits of city living, while also helping to tackle climate change.

In this Deep Dive, we will explore the intricate relationship between the built environment, urbanisation and sustainability.

We will first detail the challenges associated with the sustainable development of the built environment before reviewing perspectives and research from investee companies and academics. These organisations have innovative solutions in development to reduce the environmental footprint and enhance the social benefits of future building projects.

Improving the Built Environment

Addressing the environmental and social challenges of urbanisation needs sustainable urban planning; incorporating green spaces; promoting energy-efficient buildings; implementing efficient transportation systems; adopting renewable energy sources; and improving waste management practices. A comprehensive and integrated approach involving various stakeholders is required.

We have conducted a number of engagements with research institutions, academics and investee businesses. The purpose of the engagements explored below in the context of finding solutions for improving the built environment is to form part of our fact finding and have been included as case studies in this report. Businesses are developing solutions to the challenges posed by changing demographics and climate change in order to alleviate the resultant strain on the built environment. In conducting these meetings, we have gained a deeper insight into the different routes to achieving sustainable cities and sustainable buildings.

Climate Change Adaptation

Climate Change Adaptation involves adjusting to actual or expected future climate scenarios. The aim is to reduce the vulnerability of communities, regions, and activities to the effects of climate change. Adaptation strategies can include building flood defences, designing buildings to withstand higher temperatures and developing water-saving technologies. Climate change adaptation deals with the consequences of climate change by developing ways to live with its impacts.

Case study: Marshalls

We conducted an engagement call with Chris Harrop, OBE, Head of Sustainability at Marshalls. We aimed to gain insights into the company's sustainability initiatives, particularly focusing on their efforts in carbon reduction and climate change adaptation within the building materials sector.

Overview

Institution: Marshalls is a UK listed company that supplies hard landscaping, building and roofing products.

Challenge: Climate change presents significant challenges to the built environment, primarily through extreme weather events like floods, heatwaves and storms. Rising temperatures lead to increased cooling demands, stressing energy systems and exacerbating urban heat islands. These impacts require resilient and sustainable construction materials and practices to ensure the long-term viability and safety of built environments.

Solution: Marshalls' climate adaptation solutions focus on innovative building materials and technologies designed to help mitigate the impacts of climate change in urban environments. Key solutions include: Solar Reflective Index (SRI) products, adaptation through thermal mass in buildings, "rain garden" curb systems and permeable paving.

These adaptation solutions by Marshalls are aimed at making urban environments more resilient to the impacts of climate change, focusing on improving energy efficiency and water management, as well as reducing heat in built-up areas.

Detail

Marshalls, a company at the forefront of sustainable building practices, is actively implementing innovative strategies for climate change mitigation and adaptation. Central to their efforts is CarbonCure technology, where they inject recovered CO_2 into the curing chambers of concrete. This technique not only speeds up the curing process but crucially locks away CO_2 permanently within the concrete, effectively reducing their carbon footprint.

Marshalls is currently exploring how to scale up this technology and plans to incorporate it across their entire range of concrete products, including bricks, blocks, pipes, and paving. They are seeking certification from the Carbon Trust to validate this method as a means of permanent carbon removal, with the ambitious goal of offsetting and eliminating their emissions comprehensively.

In addition to their in-house innovations, Marshalls is committed to driving environmental responsibility throughout their supply chain. They have set a goal for 73% of their suppliers, measured by emissions, to establish Science-Based Targets (SBTs) by 2024. Marshalls is on track to meet this target earlier than anticipated, possibly by the end 2023. This initiative highlights their holistic approach to sustainability, extending beyond their direct operations to encompass their broader network of partners and suppliers.

Marshalls' dedication to climate adaptation is evident in their research and development efforts. They are focusing on creating products that not only mitigate the impacts of climate change but also enhance resilience to its effects. This includes developing a new range of products with high SRI ratings, aiming for an SRI of over 50. These products are designed to reflect sunlight and reduce heat absorption in urban areas, thereby reducing the reliance on air conditioning and improving the comfort of living spaces. They are also working on enhancing the thermal mass in buildings to naturally regulate indoor temperatures, keeping them cooler during hot summers and warmer in winters.

Another innovative product from Marshalls is the "Rain Garden" curb system. This system is designed to funnel rainwater into rain gardens, aiding efficient water management by directing water into the ground and helping cities to better manage water resources. Additionally, their permeable paving solutions are designed to absorb significant amounts of floodwater. This not only aids in flood prevention but also cleans the water as it passes through the sub-base, with the added benefit of providing a cooling effect underneath the paving.

Outcome

Marshalls' multifaceted approach, combining cutting-edge technology such as CarbonCure with a comprehensive commitment to supply chain sustainability and innovative product development, underscores their role as a leader in adapting the built environment to the challenges of climate change.

Addressing inequality

Inequality in the built environment often manifests in unequal access to resources such as clean water, sanitation, and energy-efficient buildings. This not only impacts the quality of life for disadvantaged groups but also affects environmental sustainability. For instance, poor housing conditions can lead to higher energy consumption and waste production.

Case study: PEARL

We visited the facility to see how psychology and neuroscience can play a role in overcoming the social challenges of inequality in the built environment.

Overview

Institution: PEARL (Person-Environment-Activity Research Laboratory) at University College London (UCL) is a research facility that delves into the intricate relationships between people, their environments and their activities. This large-scale lab, boasting 4,000 square meters of adaptable space and a height of 10 meters, is engineered to simulate real-world environments such as railway stations, high streets and town squares within its confines, providing researchers with the ability to control a multitude of variables.

Challenge: At PEARL, the primary goal is to challenge and refine the assumptions that underly our understanding of how cities function. Traditional models of urban systems are often based on general observations and cannot always capture the complexities of human behaviour. PEARL addresses this by allowing for detailed experimentation with environmental variables such as spacing, colour, lighting, and sound within a controlled setting, thereby yielding richer, more accurate data.

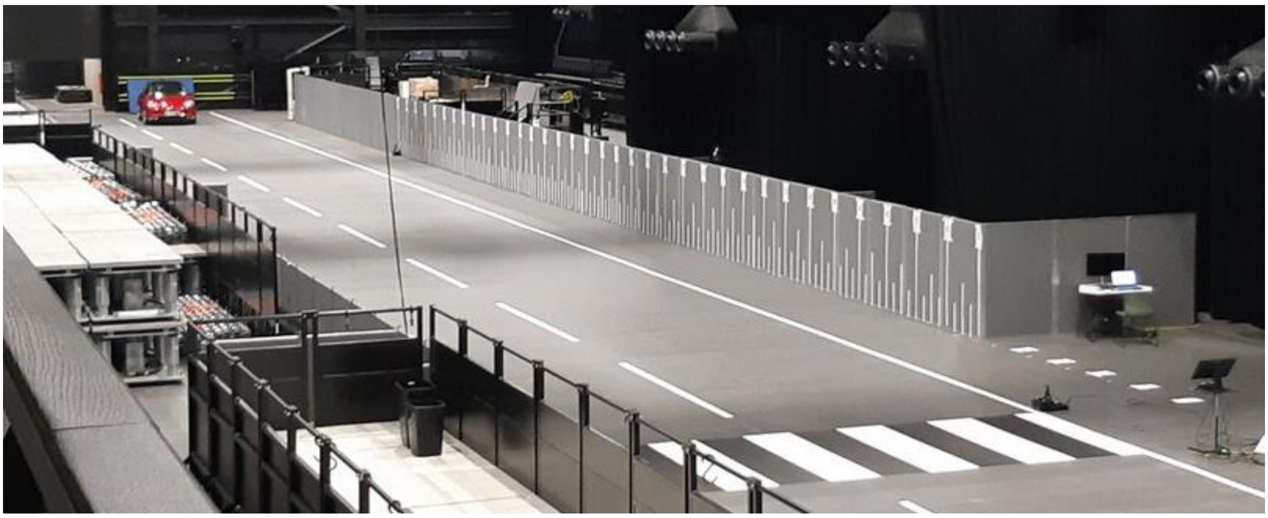
Solution: The facility's ability to create multisensory experiences, including variations in smell and sound, makes it an advanced tool for understanding and predicting how people will interact with different aspects of urban environments. Research at PEARL influenced major redesigns of shared spaces in London, including the selection of tactile paving to assist visually impaired and wheelchair users, thus guiding Transport for London towards more inclusive decision making.

Detail

A site visit to PEARL in Dagenham provided a comprehensive overview of this unique facility's role in understanding and improving the ways in which people interact with their environment. Since its opening in October 2022, PEARL has been at the forefront of the UK's research into infrastructure and cities, focusing on the built environment's impact on quality of life. The facility has been used to explore the inclusivity of urban spaces, including how individuals with dementia perceive their environment, informing the design of more navigable and dementia-friendly urban spaces.

The visit featured insights from Professor Nick Tyler and Barbara Pizzileo, who showcased PEARL's capabilities in simulating real-world conditions from darkness to intense sunlight, and controlling various sensory factors such as lighting, acoustics and even smells. This level of control enables a nuanced exploration of environmental effects on human behaviour and well-being.

PEARL's diverse research portfolio includes groundbreaking work on how dementia patients perceive sound; the false security induced by well-lit zebra crossings; and the quieter yet potentially hazardous noise levels of EVs. The facility is also pioneering the creation of alert sounds for e-scooters to reduce pedestrian surprise and conducting advanced lighting studies that could benefit the elderly.



The image above shows an experiment in progress at PEARL involving the visibility of pedestrians to oncoming vehicles at crossing points.

Collaborations with Network Rail and TFL highlights the practical applications of PEARL's research, with projects ranging from innovative train station lighting to improved bus signage and thermal comfort on public transport to cope with temperature extremes. Moreover, PEARL's work extends to the design of public spaces such as softer walkways, to enhance safety and physical comfort.

The facility has also made strides in healthcare, working with UCL Hospital to design better intensive care units.

Outcome

The site visit provided valuable insights into how the built environment affects people's health and wellbeing. PEARL's research is crucial for guiding the design of healthier, safer and more inclusive urban spaces. Their work in simulating diverse environmental conditions and analysing various factors like lighting, acoustics, and thermal comfort has real-world applications, influencing urban design and infrastructure development. This contributes to creating sustainable cities, aligning with the goals of investors focused on social and environmental impact.

Housebuilding

New housing developments must factor in social considerations alongside the importance of the environmental cost associated with the project. There is a need to promote energy efficiency and renewable energy integrations. Energy-efficient buildings, by adopting renewable energy sources and implementing smart grid technologies, can help reduce energy consumption and GHG emissions in urban areas. Encouraging energy-efficient design, promoting green building standards, and providing incentives for renewable energy installations can contribute to more sustainable built environment.

The Research

Case study: Energy House Laboratories

We visited this remarkable research facility to see how whole houses can be tested for their efficiency under repeatable conditions.

Overview

Institution: Energy House Laboratories (EHL) at the University of Salford is a research facility that helps businesses understand how effective their products and services are in lowering consumers' carbon footprint and reducing energy bills. The labs include the award-winning Salford Energy House, a whole Victorian house in a climate-controlled chamber, the Smart Meters Smart Homes Lab and the award-winning Energy House 2.0.

Challenge: Buildings are responsible for 39% of global energy related carbon emissions: 28% is from operational emissions with the energy needed for heat, cool and power, and the remaining 11% is from materials and construction[3]. Research at EHL helps to identify areas where emissions can be reduced when building and using residential properties.

Solution: Addressing crucial challenges in the built environment by testing and developing sustainable technologies and materials for new builds and retrofitting older homes. Their research focuses on improving energy efficiency, reducing carbon emissions and promoting smart, sustainable living. EHL's innovative facilities allow for comprehensive testing of new technologies under controlled conditions and accelerating progress towards low carbon and net zero housing design.

Detail

Professor Will Swan is the Director of Energy House Laboratories (EHL) at the University of Salford, where he has led the energy and buildings research for more than 10 years. The labs include:

- **Salford Energy House (Energy House 1)** - comprises an early 20th century two- bedroom terraced house within an environmental chamber allowing an accurate and rapid assessment of energy efficient retro fit technologies. It is a traditional construction: solid brick walls, suspended timber floors and single glazed windows with a conventional 'wet' heating system fired by a gas boiler.

  The environmental chamber can be used to simulate a wide variety of weather conditions with a temperature range from -12°C to +30°C. The chamber is also equipped with rigs to simulate wind, rain, snow and incident solar radiation. Throughout the chamber and the house there are over 200 monitoring points with real time data collection of parameters such as temperature, humidity, heat flux, and electricity and gas consumption.

  The facility underpins a range of research topics including:
    - building physics/performance
    - sensors/data collection
    - data analysis and visualisation human factors
    - smart meters and connected homes

- **The Thermal Measurement Laboratory** - providing a test research and development service to the insulation and construction industry for over 40 years. The Laboratory provides accurate and verifiable measurements of insulation performance of component building materials, which is essential for the realistic evaluation of carbon savings in the enormous areas of exposed elements in the built environment.

- **Smart Meters > Smart Homes** - the UK's first smart meter research laboratory. Smart meters technology is designed to help meet carbon reduction targets, put an end to estimated bills and help people save money. The smart meter sits at the heart of an increasingly complex smart home energy system made up of any combination of energy saving appliances, energy storage devices, EV chargers, smart speakers, sensors and wearable technology. The researchers help commercial customers to explore how products and services can get the best out of smart meters to help UK consumers use energy more efficiently and cost-effectively.

- **Energy House 2.0** - completed in February 2022, this facility is the largest of its type in the world. Whilst the first Energy House at Salford University was built to test retrofitting performance in typical UK houses, the 2.0

version is designed to be able to mimic environmental conditions experienced by housing stock and consumers throughout most of the world.

The chambers in Energy House 2.0 can recreate a wide variety of weather conditions with temperatures ranging between -20˚C to +40˚C with 0 to 100% humidity, as well as simulated wind, rain, snow and solar radiation. This range in temperature and weather is intended to provide the conditions experienced by 95% of Earth's population for 90% of the time. The only conditions that can't be simulated are extreme conditions such as tsunamis, hurricanes and earthquakes. There are two environmental chambers each able to accommodate two detached houses and will hopefully accelerate progress towards low carbon and net zero housing design.

New technologies are being trialled to see which are the most effective at lowering the emissions associated with homes and housing. The facilities allow tests to be conducted on whole buildings under repeatable conditions, compressing the time to test innovative technologies, where it would usually be two years in the field.

During the visit, attendees observed experiments in progress, including:

- **Vector Homes and Graphene in Construction**: Vector Homes is a startup which provides cradle-to-cradle, sustainable, modular and affordable smart homes from recycled materials. The company uses nanomaterials as part of the fabric of homes to improve their sustainability and efficiency. Vector uses research from the National Graphene Institute at the University of Manchester to help incorporate 2D materials to create efficient smart homes.

- **Mat Zero**: This humanitarian project aims to provide solar-powered heated mats for emergency accommodation, potentially saving millions for organisations while improving refugees' quality of life.

- **Thermocill**: Testing easy-to-fit window boards designed to reduce cold air entering homes, improving heating efficiency and reducing energy consumption.

- **Collaboration with Housebuilders**: EHL partners with property developers like Bellway, Barratt, Persimmon, and Saint-Gobain to test new technologies and materials in houses built to adhere to Future Home Standards.

- **Wondrwall**: A Manchester-based company offering smart home solutions, including energy storage systems, which can make homes net energy-zero.

Outcome

The site visit to the University of Salford highlighted the institution's cutting-edge work in testing and developing sustainable technologies for the built environment. This visit is significant for sustainable investing as it demonstrates EHL's role in advancing energy-efficient building practices and materials. Their research, particularly in areas like energy consumption reduction and smart housing solutions, aligns with the goals of sustainable investing by promoting environmentally responsible innovations. EHL's contributions are vital in reducing the carbon footprint of housing, making it a key player in the drive towards more sustainable and eco-friendly building practices.

The Company

Case study: Taylor Wimpey

Taylor Wimpey (TW) is engaged in the development of Net Zero Ready Homes, showcasing innovative and sustainable building practices at their Chiltern Woods project in Sudbury, Suffolk. We visited this project to understand how the company intends to use new technologies to align with the forthcoming Future Homes Standard (FHS). The FHS is a significant policy initiative in the UK aimed at significantly reducing carbon emissions from new homes. Scheduled to be implemented in 2025, it represents a key step in the UK's broader strategy to combat climate change and achieve its goal of net zero emissions by 2050.

Overview

Institution:	TW is a UK listed company that builds and delivers residential homes.
Challenge:	Residential buildings contribute to a significant portion of global GHG emissions. The urgency to reduce these emissions is paramount, as the residential sector needs to decrease its CO_2 emissions by about 6% annually to align with the 1.5°C pathway set by the Paris Agreement. TW's challenge is not just local but part of this global imperative to transform home construction and energy use, making homes more energy- efficient, sustainable, and adaptable to renewable energy sources.
Solution:	TW's approach addresses these challenges through a range of innovative technologies and nature-positive strategies. This includes the integration of biodiversity-promoting features like bug hotels and bee bricks, alongside energy-efficient building technologies such as heat pump cylinders, PV panels, and wastewater heat recovery systems. By focusing on a Fabric First Approach and smart home systems, TW's solutions aim to significantly reduce carbon emissions and increase the sustainability of their homes, paving the way for a more environmentally conscious future in home building and aligning with the goals of the FHS.

Detail

The site visit offered a comprehensive view into the construction of Net Zero Ready Homes, a pioneering initiative aligning with the FHS. This experience showcased TW's commitment to reducing carbon emissions and enhancing sustainability in the built environment.

This approach, complemented by technologies like Mechanical Ventilation with Heat Recovery (MVHR), ThermaSkirt heated skirting boards and underfloor heating, demonstrated a comprehensive strategy to reduce the need for conventional space heating.

The homes also incorporated smart technologies, such as the Wondrwall smart monitoring systems, which uses thousands of sensors for efficient energy management. This integration of smart tech with traditional building methods signified a forward-thinking approach to sustainable living.

Outcome

The site visit to Chiltern Woods was not just a showcase of innovative building technologies, it highlighted the importance of transforming residential construction to meet the challenges of climate change, emphasising that decarbonising homes is possible. With these efforts, TW is setting a precedent in the construction industry, demonstrating that sustainable, net zero ready homes are not just a concept, but a reality.

Note: The TW homes must be called "net zero ready" because the achievement of net zero status is reliant on the decarbonisation of the grid. Currently the use of fossil fuels in the UK energy mix prevents these homes from being truly net zero.

Access to basic needs

Access to high-quality primary healthcare is considered a basic human need. The location of primary healthcare facilities is a critical feature of communities and is connected with the overall well-being of residents.

Strategically placed healthcare facilities ensure accessibility for all members of the community. This is particularly vital in underserved areas where healthcare resources may be scarce. By having facilities within reasonable proximity, travel time and costs for patients are reduced, making it more likely that individuals will seek regular medical care and follow-up treatments. This is crucial for the management of chronic conditions, early detection of illnesses and maintaining consistent healthcare routines.

Furthermore, the presence of healthcare facilities within a community can significantly improve emergency response times. In situations where minutes can be lifesaving, having a facility nearby can make a crucial difference in outcomes. This proximity also fosters stronger relationships between healthcare providers and the community, leading to more personalised care and an understanding of the specific health needs and challenges of the area.

Another aspect to consider is the role of these facilities in community health education and promotion. When located within the community, they become more than just places for treatment. They transform into centres for health education, vaccination drives and public health initiatives. This promotes a culture of prevention and health awareness, which is key to long-term health improvements.

In economically disadvantaged areas, the availability of healthcare facilities within the community can play a significant role in reducing health disparities. It ensures that quality healthcare is not just a privilege for those living in more affluent or urban areas but is accessible to everyone, regardless of socioeconomic status.

Case study: Primary Health Properties

We conducted an engagement call with Jesse Putzel, the ESG Director at Primary Health Properties (PHP), to hear how social considerations play a role in site selection for their modern healthcare centres.

Overview

Institution: PHP is a real estate investment trust specialising in healthcare facilities. It primarily invests in healthcare accommodations in the UK and Ireland.

Challenge: A quarter of GP practices in England operate from outdated residential buildings, unsuitable for optimal healthcare delivery. Shifting healthcare professionals to state-of-the-art medical centres could potentially save NHS England approximately £39 million annually, particularly benefiting the most underprivileged regions in the UK. Inequality in health services leads to disparities in access, quality and outcomes. Marginalised groups often face barriers like cost and distance resulting in poorer health statuses. This exacerbates social inequities and hinders overall public health progress, making equitable healthcare a critical social and economic challenge.

Solution: PHP focuses on modernising primary care facilities and improving community health services. Their portfolio impacts around 6.0 million patients, enhancing healthcare accessibility and reducing secondary care costs. PHP actively manages its properties and assesses their social impact, contributing significantly to local health and economic benefits.

Detail

PHP's approach underscores social mobility and equal access to healthcare. PHP indicated that the company carefully considers health and socio-economic demographics in selecting development sites.

In order to enhance the company's social impact, a research partnership with King's College London (KCL) was established. The purpose was to explore the broader economic and social impacts of contemporary primary care centres. This study examined approximately 150 PHP medical centres constructed or renovated since 2009 throughout England. KCL assessed the change in A&E visitation rates at these centres, comparing them to national averages both before and after the completion of the buildings.

The findings revealed a notable decrease in the use of secondary healthcare services once these modern medical centres began operations, a trend especially pronounced in economically disadvantaged areas. The research highlighted significant cost savings: while an A&E visit costs about £180, a GP appointment is around £39, indicating a potential 75% reduction in expenses for the NHS (and the HSE in Ireland).

Looking ahead, PHP is planning more comprehensive research to quantify the social impacts of their investments with greater precision. Currently, the impact is measured in basic terms, such as the number of people assisted and the hours of support provided. PHP is keen on innovating these metrics to more accurately reflect their contribution to the health and wellbeing of communities where their properties are located.

Outcome

The call with PHP highlighted their strategic initiatives in enhancing healthcare access, supporting community development and promoting health equity through targeted investments and partnerships. These efforts are not only focused on the present but are also shaping PHP's future strategy to create a measurable and significant positive impact on community health and well-being.

The Role of Software

Software plays a crucial role in enhancing the sustainability of the built environment, particularly through the use of "digital twins". Digital twins are virtual replicas of physical buildings or infrastructure. These can be used to simulate different scenarios to test the resilience and sustainability of a built environment under various conditions, such as climate change impacts, helping in better planning and decision-making. Software is essential in creating and managing these digital models. They allow for detailed simulation and analysis of buildings, including energy consumption, material use and the impact of various environmental factors.

Note: Research at the PEARL facility is helping to improve digital twins by including human behaviour that is more reminiscent of that seen in the real world. This improves the reliability of the model.

Software can also provide predictive maintenance information. By predicting when and where maintenance is needed, software reduces waste and increases the lifespan of building components. This proactive approach is more sustainable than reactive maintenance.

Software acts as a key enabler in making the built environment more sustainable. It aids in efficient resource use, energy management, predictive maintenance and overall smart, sustainable planning and operation of buildings and infrastructure.

Case study: Bentley Systems

We conducted an engagement call with Bentley Systems to discuss how their digital twin technology and software solutions are being utilised to enhance sustainability in the built environment.

Overview

Institution: Bentley Systems, an infrastructure engineering software company. The Company offers solutions for infrastructure projects.

Challenge: Creating sustainable infrastructure projects requires adapting to diverse global sustainability demands and integrating decarbonisation into the building process. Ensuring climate resilience and maintaining structural integrity in the face of extreme weather events pose significant

Solution: Bentley Systems employs its iTwin Platform, a centralised digital twin solution, to address these challenges. This platform enables embodied carbon accounting and integrates various data sets for enhanced sustainability analysis.

Detail

Bentley Systems, a leader in infrastructure engineering software development, is steering the evolution of sustainable infrastructure through its innovative digital twin technology and software solutions.

A key aspect of Bentley's strategy is the iTwin Platform. This platform stands at the forefront of Bentley's efforts to enhance sustainability in the built environment, offering realistic virtual representations of physical assets.

Bentley's approach addresses the myriad challenges in creating sustainable infrastructure projects. By harnessing the iTwin Platform, Bentley facilitates embodied carbon accounting and comprehensive data analysis, driving significant advancements in environmental performance and efficiency.

The platform also aids in operational carbon management, enabling real-time monitoring and optimisation of energy and resource use in buildings. This technology plays a crucial role in ensuring that structures are not only designed sustainably but also operated efficiently throughout their lifecycle.

Bentley's initiatives extend to climate resilience, with solutions like advanced dam monitoring using the Internet of Things, sensors, and Artificial Intelligence, which contribute to the structural integrity and safety of infrastructure in the face of extreme weather events.

In addition, the company have entered into a partnership with Microsoft to offer a solution for clients that require carbon, water and waste reporting. This exemplifies their commitment to comprehensive sustainability solutions for their customers. This collaboration underscores Bentley's pivotal role in enhancing the sustainability of infrastructure projects, from conception and design to operation and maintenance.

Outcome

Our engagement illuminated Bentley's strategic and innovative approach for creating sustainable infrastructure projects, addressing the challenges of decarbonisation, climate resilience and operational efficiency. Additionally, we were able to explore customer trends and demands in sustainability-focused software solutions and how Bentley is adapting their product strategy and development roadmap to meet these evolving needs.

Indoor air ventilation

Heating, ventilation and air conditioning systems (HVAC) play an important role in improving indoor air quality by allowing for the flow of air into buildings. HVAC systems facilitate ventilation by enabling fresh air from outside to enter indoor spaces. This prevents the build-up of pollutants such as CO_2, VOCs and other airborne particles that affect human health and can lead to respiratory difficulties such as asthma and allergies. High-efficiency particulate air filters (HEPA) are able to filter out air particles such as dust, PM and mould spores. HVAC systems are also able to control and maintain temperatures in indoor environments, and well as managing humidity, which can also lower the spreading of mould and dust mites. This is crucial for the health, well-being and comfort of occupants as well as having a role in improving cognitive function.

Case study: Belimo

Belimo specialise in providing smart controls and devices for Heating, Ventilation, and Air Conditioning ("HVAC") systems that play a role in improving both indoor air quality and energy efficiency.

Overview

Institution: Belimo provide actuators, valves and sensors used in HVAC systems.

Challenge: Two-fold: the need to improve indoor air quality while lowering the energy use of HVAC systems. We spend around 90% of our time indoors so it is important to control and enhance indoor air quality. However, HVAC systems are responsible for 16% of global energy consumption.

Solution: Belimo's products enable HVAC systems to save up to 55% of energy usage in comparison with systems without controls. Consuming less energy means less fuel consumption and therefore reduced contribution to air pollution and climate change. Belimo's devices enable ventilation systems to control the flow of fresh air into buildings while their sensors enable the monitoring of air quality (such as CO_2 emissions and humidity in a room). This can play a significant role in improving the effectiveness of ventilation and air filtration. Belimo create healthier indoor environments that consume less energy.

Example of Belimo’s products in-use:

Belimo’s products, such as the 6-way valve was installed in Roche’s “building 2”, which forms part of their Group Headquarters. This product was used for Roche’s office areas as well as in laboratories that had to adhere to critical standards on indoor air quality.

Outcome

Belimo’s products helps tackle the issue brought about by the significant amount of energy that is needed to power HVAC systems: their smart controls and devices markedly lower energy consumption. The decarbonisation of these systems is crucial given the need to improve air quality in indoor environments.

Water Management

Water management in the built environment is critical in the face of global urbanisation and climate change. Effective water management strategies are essential for protecting communities from flooding, reducing pollution, and conserving precious water resources. As cities continue to expand, the "concretisation" of landscapes exacerbates challenges like surface runoff, urban heat islands, and water scarcity. Integrating innovative water management solutions into construction is crucial. These practices not only mitigate the adverse effects of excessive impermeable surfaces but also enhance urban resilience, support biodiversity, and promote healthier ecosystems within cityscapes.

Case study: Genuit Group

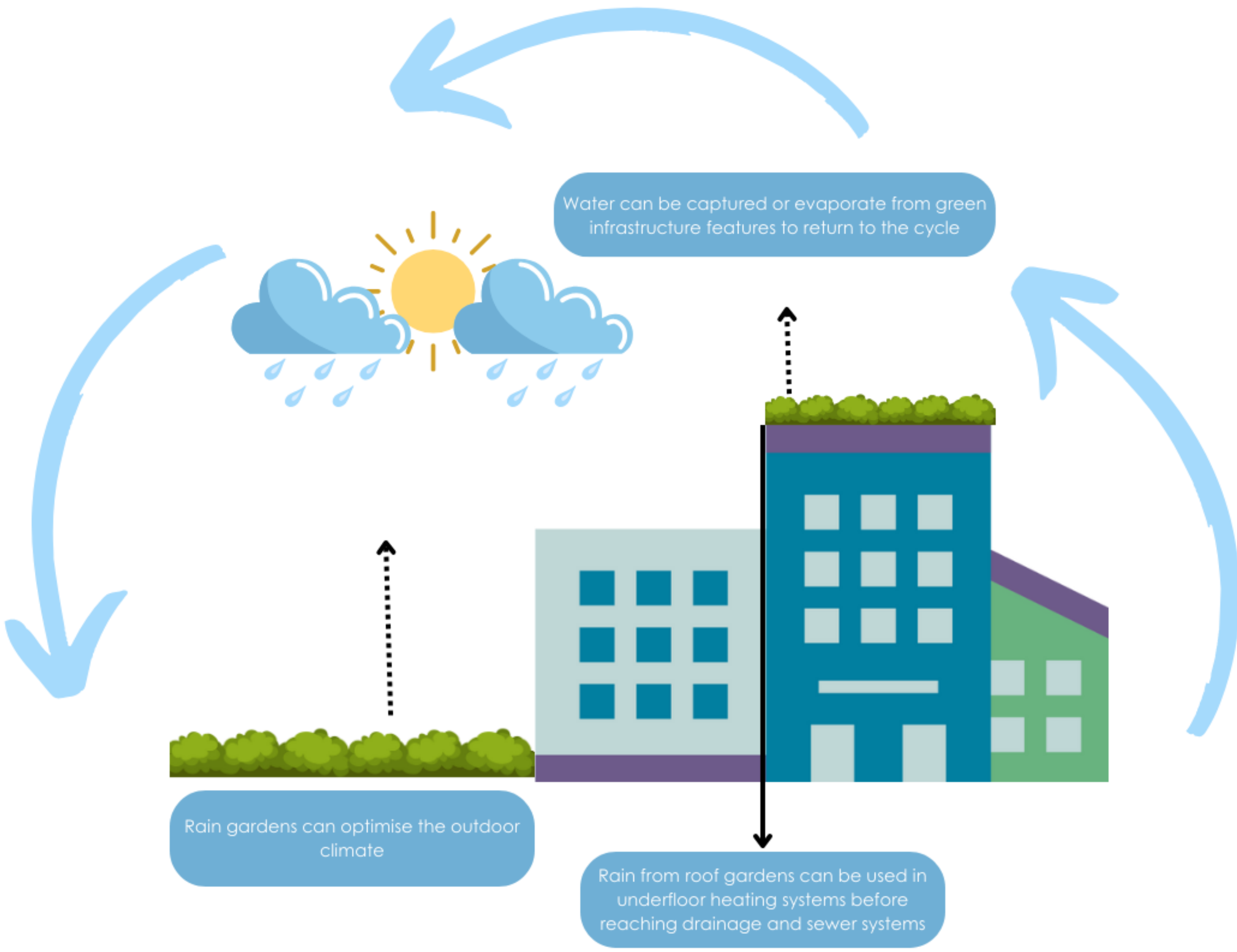
Genuit Group specialise in water and climate management solutions. The company is at the forefront of addressing urban "concretisation" and its impact on water management. This case study delves into Genuit Group's efforts to integrate sustainable water management solutions into the built environment.

Overview

Institution:	Genuit Group is a UK company that provides advanced water management and construction solutions, aiming to mitigate the environmental impact of urbanisation.
Challenge:	The phenomenon of concretisation refers to the widespread covering of the earth's surface with impermeable materials like concrete and other building materials in urban and suburban areas. This process is a hallmark of urbanisation and infrastructure development, characterised by the construction of buildings, roads and pavements. Concretisation prevents rainwater from naturally soaking into the ground. Heavy rainfall events quickly lead to runoff, overwhelming stormwater management systems and increasing the risk of urban flooding. This can cause significant damage to infrastructure and property, as well as pose risks to public safety.
Solution:	Genuit Group offers resilient drainage systems that manage stormwater and reduce flood risks, air purification technologies that improve indoor air quality and green infrastructure to alleviate the effects of urbanisation.

Detail

The diagram below is a conceptual representation of a sustainable urban water management system that Genuit hopes to create. It shows various elements that are part of green infrastructure which are designed to mimic the natural water cycle while addressing urban water management issues.



Genuit Group specialises in creating sustainable solutions for the built environment. Their particular focus is on water management but the company also supply products designed to improve air quality, green infrastructure and low-carbon construction.

In air quality management, Genuit Group's technologies like the Noxmaster ventilation system enhance indoor air quality by filtering out harmful nitrogen dioxides and particulate matter, which is particularly beneficial for residential properties situated along busy roads.

For green urbanisation, their products support the creation of green spaces within cities that are under pressure from increased population density. A notable project is the Arundel Gardens initiative, where water systems were retrofitted to alleviate flooding and provide essential water to magnolia trees, demonstrating the dual functionality of managing stormwater while supporting urban greenery.

Genuit stormwater management systems played a crucial role in the redevelopment of the iconic Coronation Street set, effectively handling high water tables and providing a solution for stormwater challenges. The project, undertaken at the popular ITV soap's new home at MediaCityUK, made use of storage technologies for the capture, treatment and controlled discharge of rainwater.

Genuit Group's commitment to the circular economy is reflected in their proactive approach to recycling and waste management. Aiming to be a zero-waste operation, they are increasing the use of recycled materials in their products, with the target of having 62% of their tonnage come from recycled plastics by 2025, and already achieving zero waste to landfill at several sites.

Their recycling initiatives are transforming plastics, which have traditionally been a pollutant, into durable components for construction and water management. This not only diverts plastics from landfills but also enhances the longevity and sustainability of built infrastructure.

Incorporating recycled plastics into their water management systems is a testament to their dedication to sustainability and reducing the environmental impact of construction materials. This approach contributes to the overall reduction of the carbon footprint of the built environment, aligning with global efforts towards sustainable development.

We have explored the role of plastics in the circular economy in our previous Deep Dive, available here.

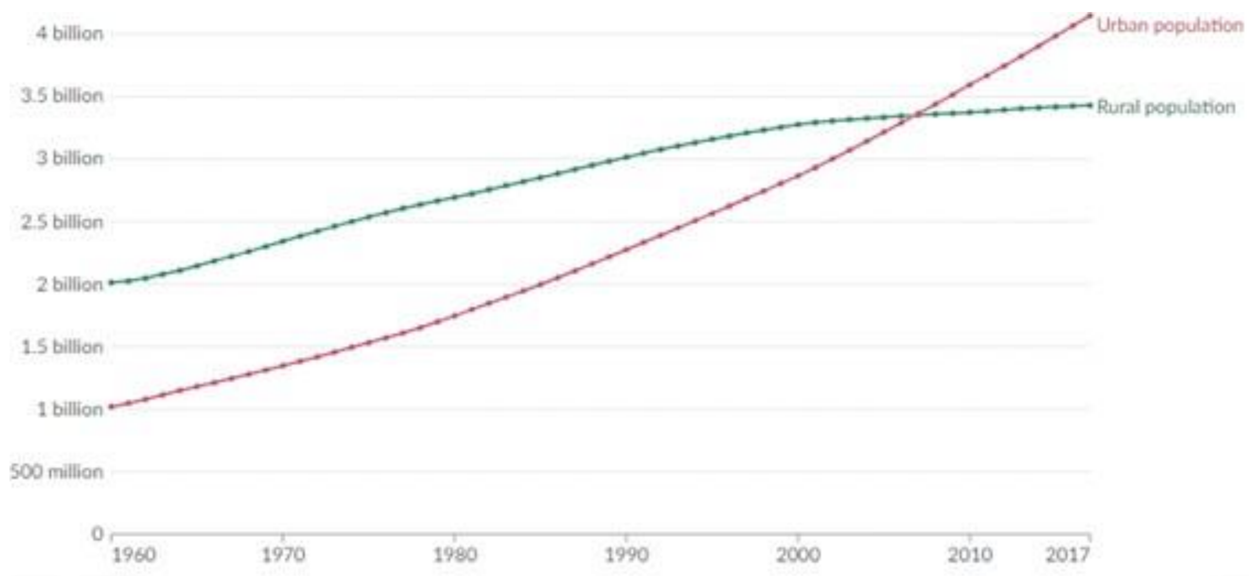
Outcome

Through its water management solutions, Genuit is making significant strides in creating more sustainable and resilient urban environments. Their work not only addresses the immediate challenges of concretisation but also promotes long-term sustainability by enhancing water conservation and supporting nature. Genuit Group's efforts exemplify how companies can contribute to solving the problems of the built environment, demonstrating that through thoughtful design and technology, urban areas can become more adaptable to climate change and less impactful on natural water cycles.

Understanding the environmental and social challenges associated with the built environment is crucial for contextualising and devising effective solutions. By examining these challenges, we gain insights into the relationship between human activity and the natural world. This understanding enables us to identify sustainable practices and innovations that reduce harm, enhance resilience and promote social equity. Recognising the broader implications of our design and development choices helps us create spaces that not only meet our immediate needs but also contribute to the long-term sustainability of our planet and the well-being of future generations.

Environmental Challenges

Urbanisation poses environmental challenges primarily due to the concentration of people, activities and infrastructure in limited areas. The rapid expansion of cities often leads to the overconsumption of natural resources, the destruction of habitats and increased pollution. As urban populations grow, the demand for housing, transportation and industry intensifies, often outpacing the ability to effectively manage the environmental impact of these activities.



The chart above shows the global population split between rural and urban areas. For the first time, in 2007, the urban population outstripped the rural. This trend is set to continue[5].

In this section, we will explore the pressure points created due to the construction and operation of buildings and infrastructure.

Operational and embodied carbon

The Built Environment has a significant impact on both humans and the environment. *The building and construction industry is responsible for almost 40% of global GHG emissions.* The decarbonisation of this industry is essential to global climate targets such as the Paris Agreement.

Emissions in the built environment can be separated into embodied carbon and operational carbon.

Embodied Carbon

What is embodied carbon?

Embodied carbon, also called embedded or upfront carbon, is the total carbon emissions that arise as a result of materials and construction methods used throughout the lifecycle of a building or infrastructure. It refers to the emissions used to source, extract, process, manufacture and transport materials, as well as the installation processes used and its eventual disposal. Therefore, embodied carbon is the carbon footprint of a building or infrastructure before it becomes operational, as well as the emissions associated with its eventual disposal.

Contributing materials

Contributors to embodied carbon are construction materials (for example, concrete, steel, glass, bricks) and the way in which they are produced. Raw materials processing, such as the energy intensive production of cement and steel, accounts for 30% of annual emissions from construction[6]. Half of global steel production is used in construction, which generates 7% of global GHG emissions.

Limiting embodied carbon emissions

Ways to prevent embodied carbon emissions include carrying out lifecycle assessments to identify alternative lower-carbon materials and construction practices; selecting local materials to reduce transportation emissions; the use of renewable energy to power manufacturing processes on-site; and adopting new and innovative methods to reduce the quantity of higher carbon materials needed. The design of buildings to incorporate flexible spaces can help to avoid future embodied carbon. The importance of retrofitting is high as 80% of buildings that will be around in 2050 already exist today[7].

Operational Carbon

What is operational carbon?

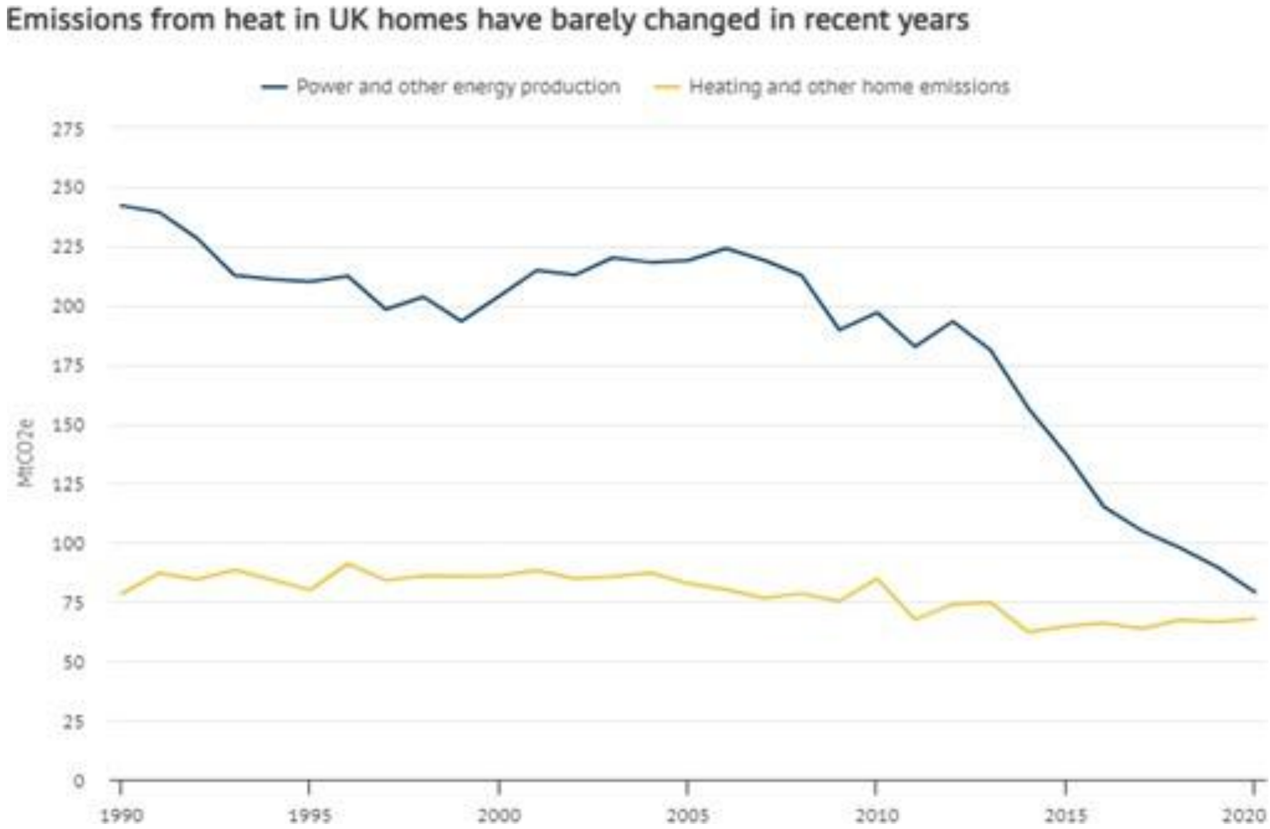
Operational carbon is the energy usage and subsequent GHGs emitted when the building is in-use. These emissions occur as a result of energy consumed in day-to-day activities such as keeping buildings heated, cooled, ventilated and with power and lighting. These operational emissions are predominantly powered by electricity, natural gas and more rarely from wood and fuel oil.

This table below outlines the sources of carbon emissions connected to the lifecycle of domestic and non-domestic buildings, as well as the infrastructure that supports them[8].

	Embodied Carbon	Operational Carbon (Regulated)	Operational Carbon (Unregulated)	F-Gas
Domestic Buildings	Embodied carbon from Construction, Maintenance & Demolition. Both domestic and consumption (imported) emissions.	Carbon from regulated energy uses: - Heating - Cooling - Ventilation & Pumps - Lighting - Hot Water	Carbon emission from unregulated energy uses: - Cooking - Appliances - Lifts - Small power / plug loads - IT servers	F-Gas leakage from refrigeration, heat pumps and air conditioning plant within buildings.
Non-Domestic Buildings				
Infrastructure		Carbon from the operation of infrastructure: - Street & public realm lighting - Communication networks - Water supply & treatment - Waste treatment	Not in scope (i.e. "User Carbon")	Not in scope

For both building types, it distinguishes between embodied carbon (from construction, maintenance and demolition); regulated operational carbon (from energy for heating or cooling, for example); unregulated operational carbon (from cooking and household appliances); and fluorinated gases (F-gases from cooling systems). In the case of infrastructure, the focus is on the carbon emissions from its operation, such as lighting and waste treatment, while unregulated operational carbon and F-gases are not considered in this context.

The operation of buildings accounts for the remaining 70% of annual emissions from the construction industry[6]. The majority of housing in the developed world is decades old, with a smaller proportion centuries old[9]. As a result, draughty doors and windows, coupled with poor insulation, means huge amounts of energy are needed to heat and cool these buildings. The UK is amongst the least energy efficient for housing in Europe: two thirds of housing stock in the UK is rated EPC D or worse. In the UK, burning gas for space and water heating accounts for almost a quarter of the UK's emissions, the majority of which is for residential buildings. This has remained largely unchanged since 1990[10].



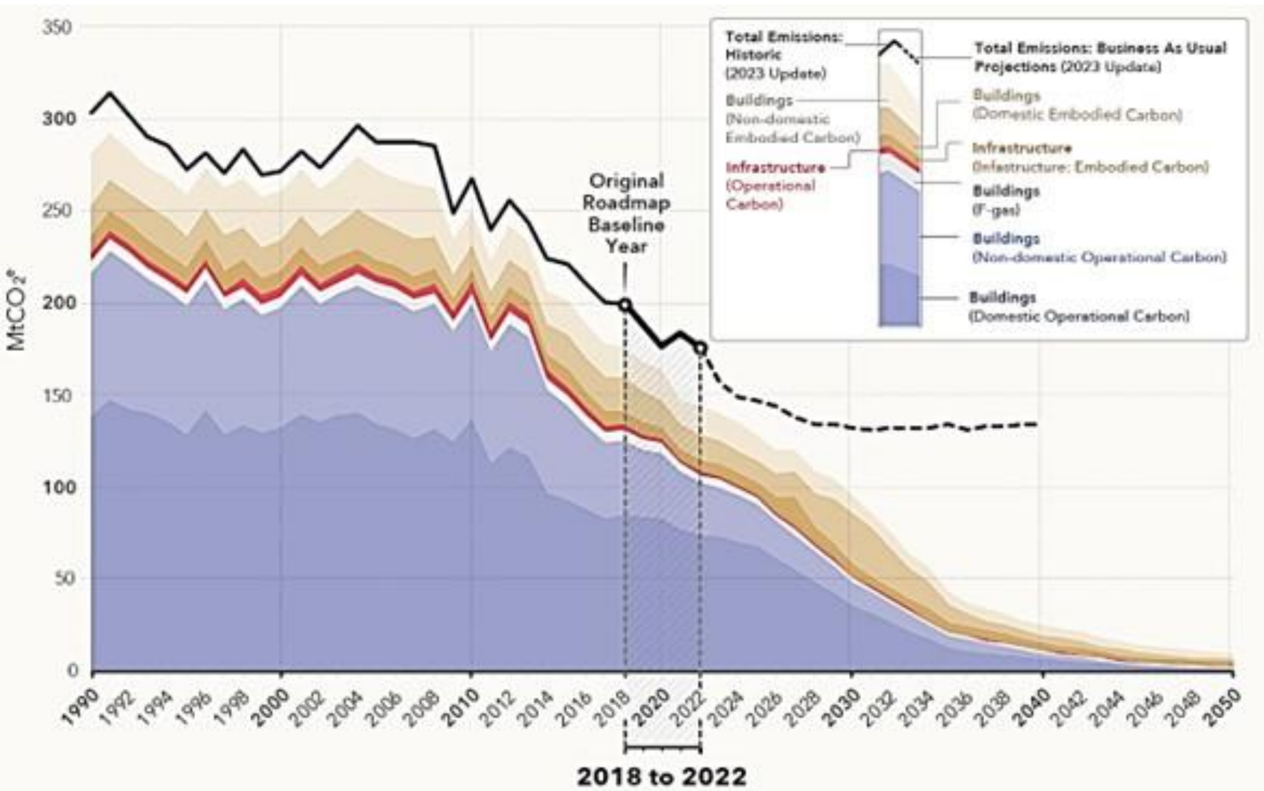
While the global energy consumption in inefficient buildings continues, more energy is wasted and more avoidable carbon emissions are released into the atmosphere. So the need for the construction of highly energy efficient buildings becomes ever more important. As technology develops, buildings become more operationally energy efficient. Alongside the decarbonisation of the source of our energy (with the shift to renewables in national grids), this means that a greater proportional carbon footprint will eventually come from embodied carbon. Tackling both operational and embodied carbon emissions is therefore fundamental to combatting the climate crisis.

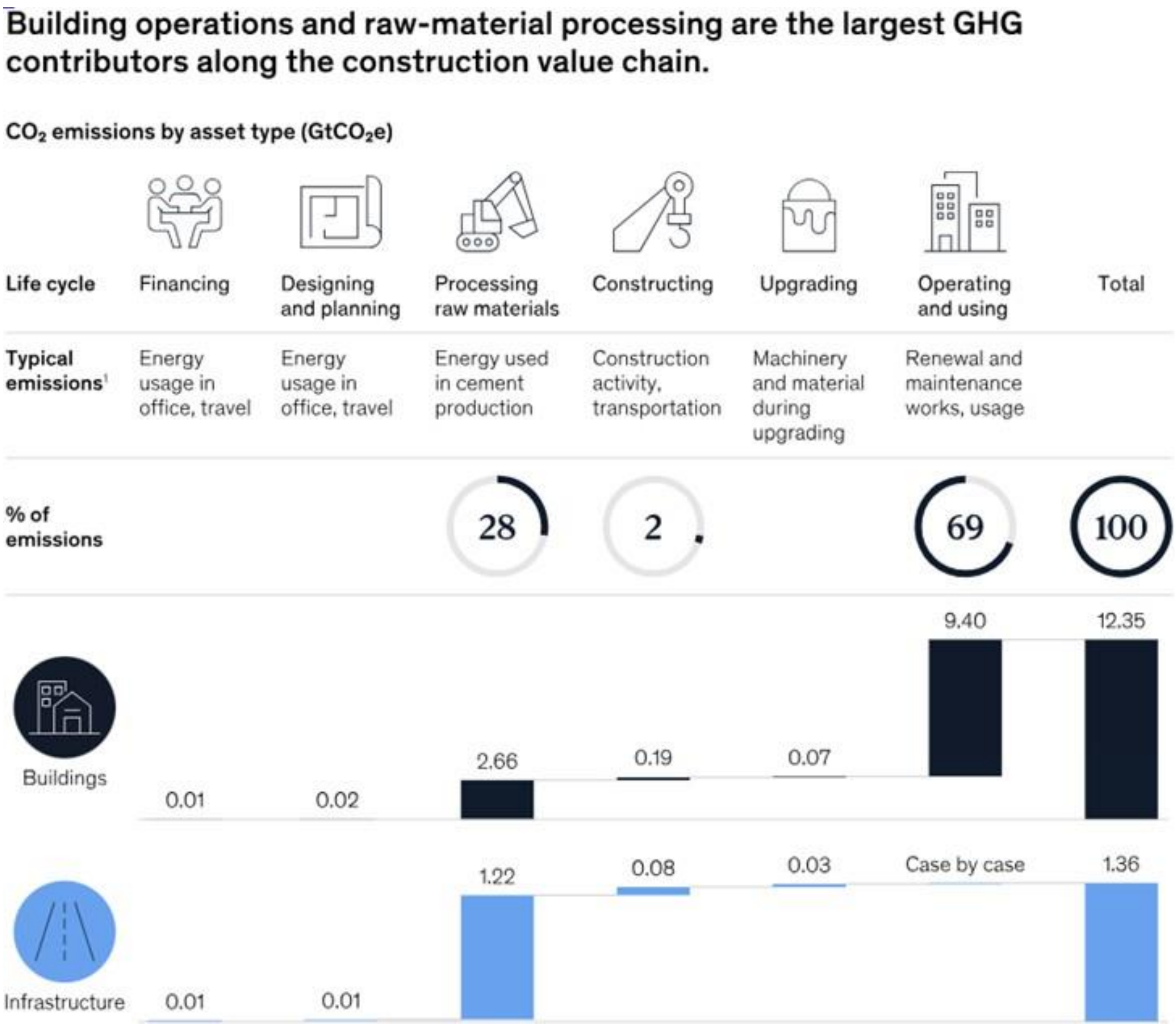
The UK Green Building Council (UKGBC) launched a roadmap detailing the actions needed by government and industry to get the UK built environment to net zero by 2050[11]. Their projections indicate that emissions from the construction sector, excluding those from surface transport, have fallen by approximately 30% over the past twenty years. The majority of this reduction has happened since 2010, primarily due to operational emissions dropping significantly. This decrease is mainly credited to the fast-paced decarbonisation of the electricity grid, as opposed to actual enhancements in building energy efficiency. Emissions related to the materials and processes involved in construction -embodied carbon- have seen a reduction of about 20%. This decline can be attributed to two main factors: a 40% decrease in the carbon footprint per unit of construction from 2000 to 2018 and a growth in construction volume, which only saw a downturn from 2007 to 2012 due to the economic crisis.

Current trends, based on existing government policy, suggest that without further action, the construction industry is on track to achieve only a 60% reduction in emissions from 1990 levels by 2050. This would leave about 115 million metric tons of carbon dioxide equivalent ($MtCO_2e$) in residual emissions that would need offsetting. This figure surpasses the Climate Change Committee's (CCC) anticipated offset capacity for the UK, which is estimated at 97 $MtCO_2e$ through land management and GHG removal technologies by 2050. These forecasts underscore the urgent need for a substantial overhaul within the built environment sector. System-wide changes are required to promote and facilitate the necessary shifts in building design, construction practices, operational efficiency and demolition procedures to meet net zero targets.

The Progress Report for this roadmap was published at the end of 2023. The corresponding graph can be seen below[12]. Emissions from the UK's construction sector have seen a 13% decrease since 2018, which falls below the 19% target identified as necessary by the roadmap. Far from meeting the expected reduction, the actual decrease has led to an 11 $MtCO_2e$ deficit.

The total emissions for 2022 were higher than the roadmap’s projections, mainly due to updated calculations regarding embodied carbon. These updates reflect that, historically, embodied carbon from 1990 to 2018 has been revised upwards to 67 $MtCO_2e$. This stems from international adjustments in GHG data, particularly in sectors like material and energy production in other countries, notably China's steel manufacturing. These changes were primarily due to altered figures in raw material extraction and production processes, with a significant portion indirectly linked to material production outside the UK.





The largest contributors to GHGs along the construction value chain, as can be seen in the image above, are in operational use and raw materials processing[6]. This is despite the drop in operational emissions recorded by the UKGBC.

Limiting operational carbon emissions

In order to reduce operational carbon emissions, improving the energy efficiency of buildings is crucial, such as by the installation of effective insulation, energy efficient lighting and the use of renewable energy sources (e.g. solar panels).

Retrofitting vs new builds

A real conundrum for the property market is whether to:

- knock down an existing building with poor operational energy efficiency to make way for a new highly operational energy efficient building, or;

- retrofit and continue to make use of the existing building to save the embodied carbon, but with recognising a ceiling on the amount of operational energy efficiency that can be achieved.

The debate centres around the embodied carbon of the existing building and whether all the construction materials, processing and installation of the new build will outweigh any benefits in the future operational efficiency of a new building.

As is widely understood, we have entered a crucial decade to combat climate change. Therefore, it is important to consider the trade-off of further upfront emissions for improved future operational energy efficiency, compared with re-using existing embodied carbon.

Retrofitting existing buildings and spaces allows for significant embodied carbon savings that would be foregone if knocked down. However, as can be seen in the above chart, the majority of emissions from buildings currently occur because of operational carbon consumption, as opposed to embodied carbon. As a result, there tends to be a higher awareness of the future operational energy use of homes, moving away from natural gas and towards electrification and greater efficiency. It is also important to bear in mind that some options to improve operational energy efficiency and consumption could take decades to accumulate, compared to making the best use of existing embodied carbon today.

Case study: Marks and Spencer (M&S)

M&S is not a company held in our portfolios but demonstrates the evaluation of the trade-off between upfront embodied emissions and future operational emission savings.

M&S had plans to demolish their 1920s art-deco flagship store in Oxford Street, alongside two adjacent buildings, to build a fresh new ten-storey retail and office space. While Westminster City Council initially granted M&S planning permission for this in 2021, their decision subsequently came under fire due to the significant embodied carbon held in the existing building. In July 2023, Secretary of State Michael Gove blocked this permission. According to SAVE Britain's Heritage, a British conservation charity, this would have instantly emitted 40,000 tonnes of CO_2 as a result of the new concrete and steel needed to construct the new design. On the other hand, M & S argued that this carbon release would have been offset after 11 years of its 120-year building life due to its high operational energy efficiency, consuming a quarter of the energy compared to its current structure[13]. M&S also stated that 95% of the existing building materials would be recovered, recycled, or reused upon completion, making it in the top 1% for sustainable performance of new buildings in London. As of the 13th of February 2024, M&S were set to challenge this case in Court.

Decarbonising the grid

Decarbonising the electricity grid is critical for creating a sustainable built environment, especially within urban areas that are key drivers of both economic activity and GHG emissions. Urban centres have a pivotal role in achieving net zero emissions goals. The International Energy Agency (IEA) emphasises that cities must undergo a transformative change to ensure resilient, smart and sustainable energy systems. This includes leveraging technology to manage energy consumption more efficiently and integrating renewable energy sources into the urban fabric[14].

The greening of the grid is a pivotal element in ensuring that buildings, which have transitioned to electricity from gas in pursuit of net zero status, actually achieve this goal. This is because the environmental impact of electrification hinges critically on the carbon intensity of the electricity source. Net zero buildings are designed to minimise or eliminate their net carbon emissions. If their electricity is derived from fossil fuel-based sources, the overall carbon footprint remains substantial. The transition to a green grid, primarily powered by renewable energy sources such as solar, wind, or hydroelectric power, is therefore essential. It not only reduces indirect emissions from buildings but also provides a consistent, sustainable energy supply that complements any on-site renewable energy generation. This shift is further supported by government policies and economic incentives, fostering a relationship between grid greening and building electrification. For example, in the UK, new energy efficiency standards for buildings are supported by investment in green industries and grid infrastructure[15,16].

The transition to green electricity is imperative as it reduces reliance on fossil fuels, thereby cutting down emissions from one of the most significant sectors contributing to urban carbon footprints. Renewable energy technologies, especially solar photovoltaics (PV) and wind, are set to play a significant role in this transition. The IEA's pathway for net zero by 2050 indicates an aggressive scale-up in solar and wind energy, suggesting annual additions of 630 gigawatts (GW) for solar PV and 390 GW for wind by 2030. The electrification of transportation and heating systems is also part of this pathway, with electric vehicles (EVs) projected to rise from around 5% to over 60% of global car sales by 2030[17].

The National Renewable Energy Laboratory (NREL) in the United States models similar ambitious growth, where wind and solar could provide 60% – 80% of electricity generation in a least-cost electricity mix by 2035[18]. This would necessitate a dramatic and sustained increase in installations of renewable generation capacity. In scenarios where 100% clean electricity is envisioned by 2035, the overall generation capacity could triple compared to 2020 levels. The drive towards net zero is further underpinned by the significant health and climate benefits associated with fewer emissions. Moreover, as our society increasingly adopts electric technologies, a green grid ensures that the resulting rise in electricity demand does not escalate carbon emissions, thus aligning with broader climate objectives.

Despite these ambitious targets and the clear benefits, reaching net zero emissions for electricity will require the conversion of pledges into concrete operational plans and strategies. As of April 2023, 130 countries, 126 regions and 246 cities had made net zero commitments for 2050[19]. Yet, the fulfilment of these commitments varies widely, with many lacking detailed strategies and plans. It highlights the necessity for national and local governments to collaborate on implementing innovative policy, financing and technological solutions to support inclusive, flexible and resilient net zero energy transitions in cities.

The sustainability of future cities heavily relies on the decarbonisation of the electricity grid, with green electricity acting as a cornerstone for a net zero emissions urban landscape. While the projected time horizons differ between regions, the general consensus points towards a need for rapid acceleration and implementation of renewable energy technologies and related infrastructure throughout this decade and beyond.

Circular Economy

While the built environment covers less than 2% of the world's surface, cities alone are responsible for the consumption of almost half of extracted resources globally. Over half the world lives in urban areas – that is, over 4 billion people. High-income countries, which amount to only 16% of the global population, are responsible disproportionally for over 33% of the planet's waste. In low-income countries, it is estimated that 93% of waste is disposed of illegally. Shifting to a circular economy should not be seen as a high-cost trade-off: by 2030, this repositioning to circular principles could be economically advantageous by up to USD 4.5 trillion. For Europe, analysis suggests a net annual economic benefit of EUR 1.8 trillion i.e. a 7% uplift in Gross Domestic Product (GDP)[20].

In the UK, excavation, construction and demolition account for 60% of material usage and waste[21]. Given the rise in construction materials costs in the UK due to higher inflation, the case to implement a circular approach into construction increases further. The construction industry currently adopts an unsustainable linear approach, where materials are extracted, processed, used and then disposed of [22].

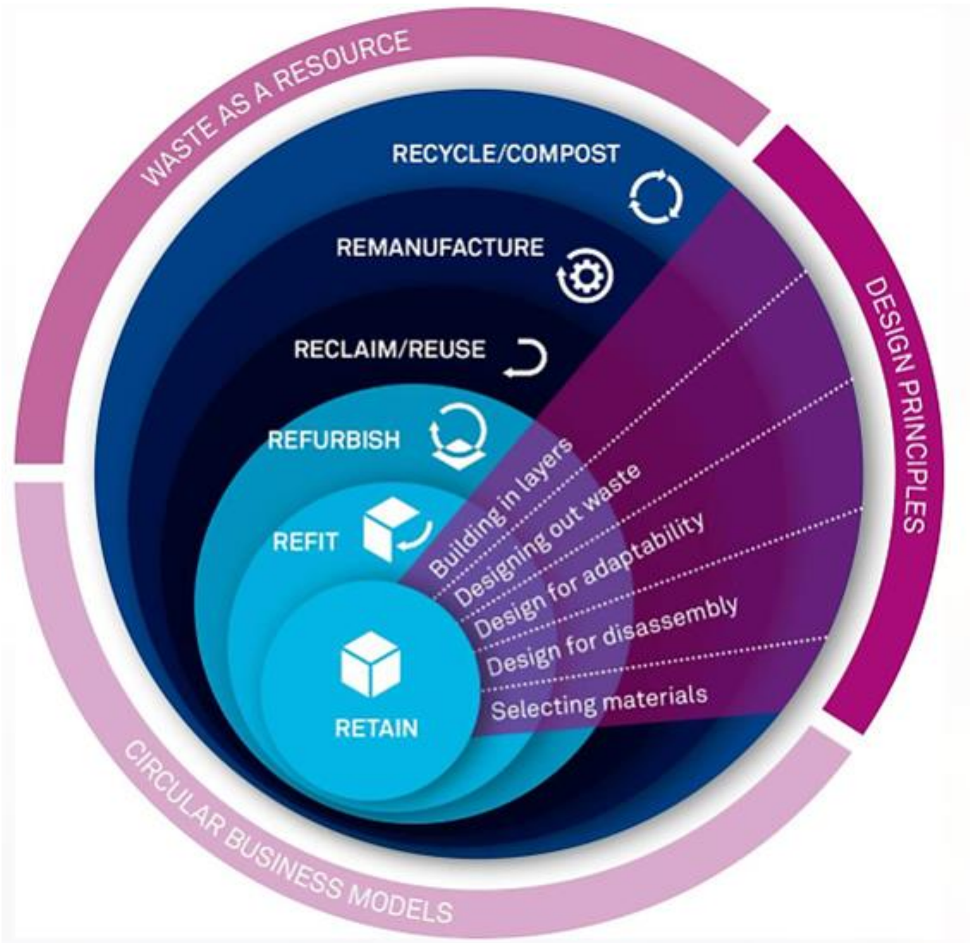
Shockingly, 90% of materials extracted globally are not brought in line with circular principles and instead are classified as waste. While UK government data estimates that 90% of waste from construction and demolition is recovered, the caveat here is that this refers mostly to materials such as concrete, brick and asphalt, which is then downcycled to be used as aggregates[23]. It is important that materials are also reclaimed to be re-used, and not just downcycled, to retain their value.

Inefficient use of finite resources leads to unnecessary, avoidable extraction and the release of carbon emissions. In addition to this, undue carbon emissions are released when buildings are demolished before their designed "*end of life*".

Responsible use of resources, such as limiting our use of raw materials, re-using materials (such as steel) and maximising opportunities to retrofit and repurpose buildings can play a pivotal role in upholding the principles of the circular economy to create a closed-loop system and lower resource consumption. Practically, this can be achieved by retaining the existing structure of buildings and incorporating future flexibility and adaptability into the design of buildings and spaces. Taking into consideration ongoing maintenance, as well as future disassembly and reconstruction, can help improve sustainability in the built environment, while importantly designing buildings with materials that can be re-used and recycled to help reduce waste and avoid diversion to landfill.

The need for a circularly economy within the built environment is driven by a growing demand for the world's raw materials, leading to increasing scarcity and exploitation of fragile ecosystems in their extraction.

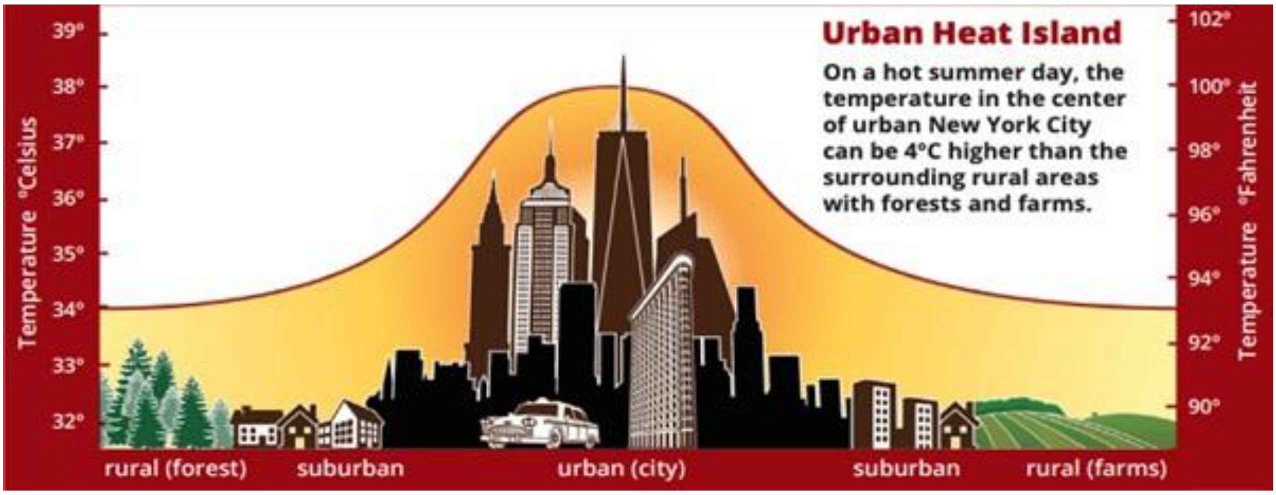
The UK's Royal Institution of Chartered Surveyors (RICS) is a professional body that promotes and enforces international standards in the valuation, management, and development of land, real estate, construction and infrastructure. Regarding the circular economy in the built environment, RICS provides insights and education on how the construction industry can shift from a linear "take, make, dispose" model to a more sustainable, circular approach. This involves designing and constructing buildings that are adaptable and reclaimable through easy disassembly, using, materials that can be reused or recycled, to create a regenerative built environment [24].



The infographic above illustrates how RICS advocates circular economy principles in the built environment, emphasising the importance of waste as a resource. It highlights a layered approach to material usage, where the core principle is to "retain" the original structure and materials. If retention isn't feasible, the next steps are to "refit" the existing components, followed by "refurbishing" to update or upgrade, then "reclaiming or reusing" parts elsewhere. If materials cannot be reused, "remanufacturing" them into new products is suggested. As a last resort, "recycling or composting" materials is supported. These practices are underpinned by design principles that focus on building in layers; minimising waste; choosing materials that are adaptable, disassemble and have a reduced environmental impact.

Urban Heat Islands

Anyone sweltering in the unrelenting city heat during summer heatwaves will be well aware of the phenomenon of "heat islands". The absence of vegetation in urban areas contributes to the establishment of the urban heat island, markedly increasing thermal stress for residents, driving morbidity and mortality during heatwaves[25]. Cities tend to have higher temperatures compared to surrounding rural areas due to the abundance of concrete, tarmac and buildings that absorb and retain heat. Greenery is an important mitigation and adaptation strategy to urban heat[26]. The urban heat island effect can worsen local air quality, negatively impact human health and increase energy demand for cooling.



Existing urban development approaches have created a vicious circle – as cities become more densely populated, the more this heat island effect is exacerbated. Summer energy demands due to increased use of air conditioning and fans leads to further heat generation. Temperatures climb even higher as a result, requiring ever more air conditioning. According to C40, a global network of nearly 100 mayors of the world's leading cities are united in action to confront the climate crisis. People living in more than 970 cities around the world regularly face temperatures above 35°C [27].

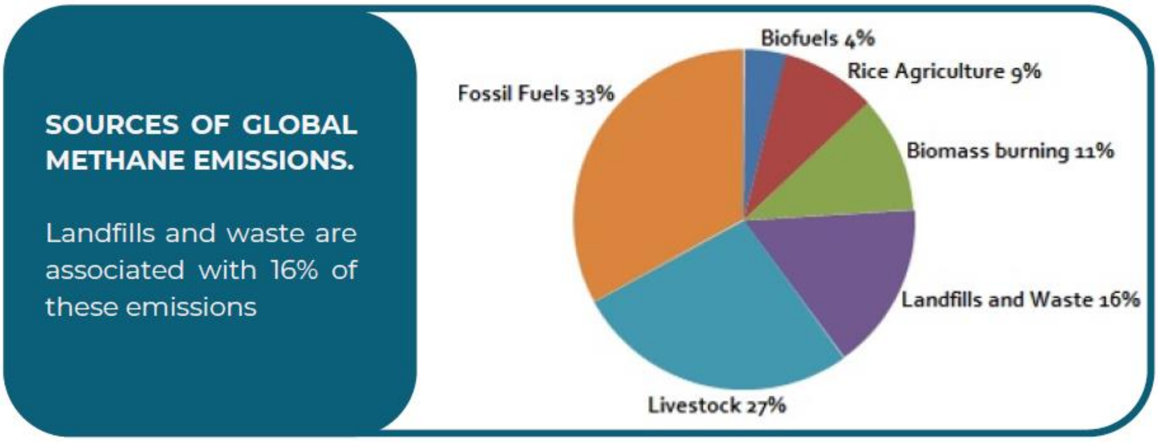
Case Study: Singapore

In dealing with the Urban Heat Island effect, Singapore has adopted innovative urban planning strategies. The city focuses on reducing heat absorption through increased urban greenery and the use of cool materials. Singapore's approach also includes crafting wind corridors to improve air circulation and optimising shade in urban areas. These efforts are part of a broader initiative to make the city more resilient to increasing temperatures and are informed by data-driven approaches and multi-sector collaboration. Singapore's comprehensive strategy serves as a model for other cities facing similar challenges[28].

Resource use and pollution

Even without the amplifying effect of heat islands increasing the need for cooling, cities and their supporting transport and energy infrastructure require significant amounts of energy to power buildings and industries. This demand for energy often leads to increased burning of fossil fuels, which releases GHGs into the atmosphere and contributes to climate change.

In addition to this inflated energy requirement, urban areas are often associated with higher levels of other air pollutants due to increased industrial activities and vehicle emissions. The concentration of pollutants such as particulate matter, nitrogen oxides, and volatile organic compounds (VOCs) can have adverse effects on human health and the environment, leading to respiratory problems, smog formation and damage to ecosystems. We will discuss the social and health challenges of increased pollution in subsequent sections of this report.



Water and Waste

Expanding cities can place a strain on water resources and lead to water pollution. Increased water consumption for domestic, industrial and agricultural purposes can deplete local water sources, leading to water scarcity. Urban areas also generate large amounts of waste due to increased population density and consumption patterns. Improper waste management practices can result in pollution of soil, water bodies and air. Urban runoff, containing pollutants like heavy metals, pesticides, and chemicals, can contaminate rivers, lakes, and groundwater, negatively impacting aquatic ecosystems and human health.

In the UK, aging infrastructure has led to Combined Sewer Overflows (CSOs) breaching their capacity and releasing untreated sewage into waterways. Our system of water management was built as a combined system to treat rainwater and sewage in the same way. As a result, heavy rainfall can overwhelm the system. CSO's were designed to prevent sewage works being inundated and towns from flooding with pressure build-up. As a consequence, during heavy rainfall, untreated sewage enters UK waterways. Understandably this has been a cause for concern and has led to close monitoring of these "Activation Incidents" - the industry term for the use of CSOs.

Landfills, while necessary for managing waste in urban areas, can have significant negative impacts on the environment. Landfills generate a considerable amount of pollution. As organic waste decomposes anaerobically, it produces methane, a potent GHG that contributes to global warming. Methane has a 100-year global warming potential 28 - 34 times that of CO_2. Measured over a 20-year period, that ratio grows to 84 - 86 times[29].

In addition to methane, the decomposition of waste in landfills releases noxious gases such as ammonia, sulphur dioxide and VOCs. These contribute to air pollution and can lead to respiratory problems and other health issues for nearby residents.

Additionally, leachate, a toxic liquid formed from the decomposition of waste, can seep into the soil and contaminate groundwater, potentially affecting nearby water sources such as rivers and streams, thus harming aquatic life. Even when landfills are no longer actively being used to manage waste, ongoing monitoring and maintenance is required. The leachate and gases emitted can continue to pose environmental and health risks for many years as they persist in the environment.

Case Study: Lake Amatitlán

The image above is entitled "The Dying Lake" and shows algal growth on Lake Amatitlán in Guatemala. Lake Amatitlán receives around 75,000 tonnes of waste from Guatemala City every year. Pollution from sewage and agricultural fertilisers leads to algal blooms that block out sunlight, killing any plants below. They also produce toxins that can poison humans and other animals. When the algal bloom dies, it sinks to the bottom and decomposes, depleting the dissolved oxygen available for fish and other animal life[30].

Nature Loss

As cities expand, natural habitats such as forests, wetlands, and grasslands are often destroyed or fragmented to make way for infrastructure and buildings. This loss of habitat can lead to the displacement and extinction of plant and animal species, disrupting ecosystems and reducing biodiversity. Overall, it is thought that future urban expansion could lead to 11 – 33 million hectares of natural habitat loss by 2100 and will disproportionately cause large natural habitat fragmentation[31].

Fragmentation occurs when a habitat is partially destroyed, resulting in smaller, isolated areas. This phenomenon is mainly caused by human activities. An example would be the construction of a road through a forest or wood. For the wildlife inhabiting these woods, the road becomes a formidable obstacle that they either have to cross or is impassable[32].

A once cohesive habitat becomes divided into two smaller habitats. This process has several detrimental effects on wildlife:

1. Loss of total habitat area: the reduced space negatively impacts species survival as there is less room for them to thrive.

2. Reduction in habitat quality: when a habitat is fragmented into smaller sections, the proportion of habitat edges increases. While some species can adapt well to these edge conditions, others struggle to survive in such environments. For instance, species that have evolved to thrive in the interior of a wood may find it difficult to cope at the habitat's edge, where conditions are significantly different.

3. Increased risk of extinction: the isolation of habitat patches makes it difficult for individual members of species to move between them, leading to inbreeding and a loss of genetic diversity. This, in turn, weakens the long-term health of the population, making it more susceptible to diseases and increasing the risk of extinction[33].

Twin Crises of Climate Change and Biodiversity Loss

In addition to the fragmentation caused by the expansion of cities and the development of the infrastructure needed to feed them, the removal of green spaces to make way for buildings exacerbates climate change. In quite literally paving the way for new and growing cities, we have to remove elements of the natural environment.

This land use change not only leads to habitat loss for animal and plant species but reduces the Earth's capacity to absorb carbon dioxide.

Social Challenges

The social and environmental challenges associated with urban expansion are not isolated from one another. Often the negative consequences of a particular problem will result in both environmental and social consequences. For example, inadequate public transportation infrastructure may exacerbate traffic and congestion and make it difficult for people to access jobs, schools, and essential services. In addition, increased traffic leads to pollution that results in poor environmental and health outcomes.

Air pollution

Air pollution is one of the greatest environmental risks to health.

By reducing air pollution levels, countries can reduce the burden of disease from strokes, heart disease, lung cancer, and both chronic and acute respiratory diseases, including asthma[34].

The importance of air quality

Air quality forms part of United Nations Sustainable Development Goal (UN SDG) 11, Sustainable Cities and Communities, citing the importance of reducing the negative environmental impact per capita of poor air quality in cities.

This is explored further in a later section of this report (The 2030 Agenda).

Goal 11	Target 11.6	Indicator 11.6.2
Make cities and human settlements inclusive, safe, resilient and sustainable	By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management	Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population weighted)

While company reporting on GHG emissions, alongside oversight by regulators, is becoming increasingly widely established, the understanding businesses have on how they are affecting and could improve air quality is sadly lacking. Reporting on air pollution tends to be at a national or local authority level, as opposed to a company level.

The World Health Organisation (WHO) describes air pollution as "contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere" [34].

Given the broad definition of what constitutes "air pollution", it is useful to define which pollutants are most detrimental to human health. These are detailed in the following table by ShareAction[35]:

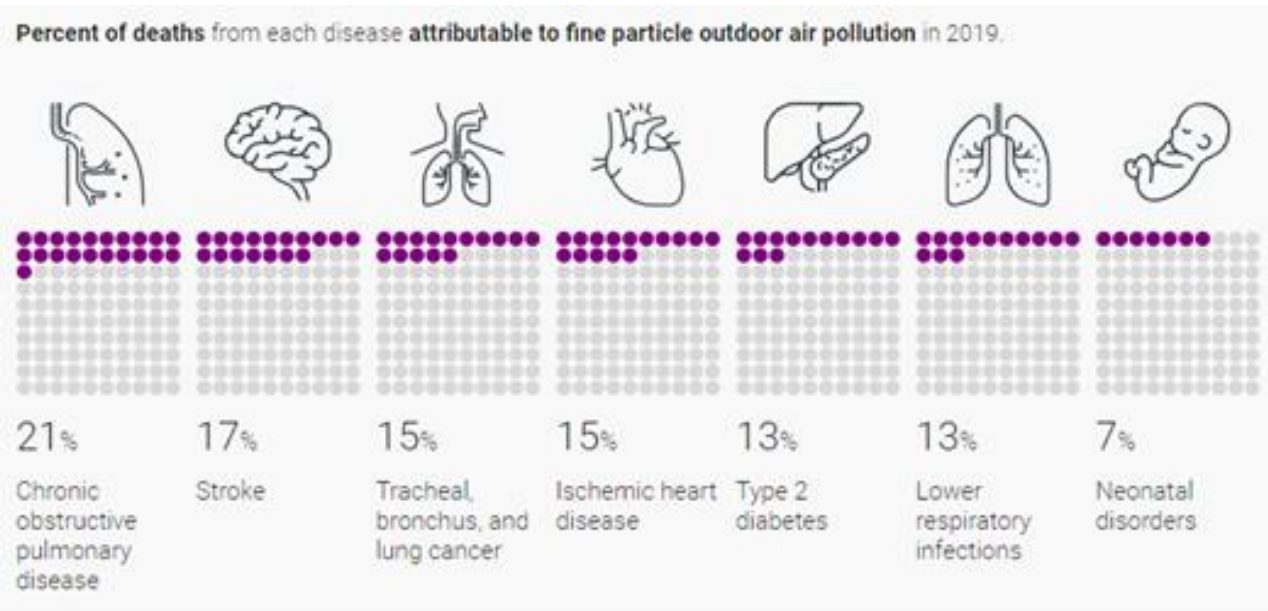
Air-pollutant type	What is it?	Health risks	WHO restricted?
PM2.5 (fine particles less than 2.5 micrometres in diameter)	Tiny particles of smoke, soot and dust in the air	Enters lungs and bloodstream to embed into organs. Causes various health issues, including cancer, stroke and heart disease	Yes
PM10 (coarse particles less than 10 micrometres in diameter)	Larger particles of smoke, soot and dust in the air	Causes breathing problems, especially for sufferers of lung conditions	Yes
O_3 (ground-level ozone)	Compounds created through reactions of other pollutants	Causes inflammation of the respiratory tract	Yes
SOx (sulphur oxides)	Chemicals released when burning fossil fuels	Constricts the respiratory airways	Yes
NOx (nitrogen oxides)	Compounds released when things burn	Exacerbates symptoms of those already suffering from lung or heart conditions	Yes
VOCs (volatile organic compounds)	Chemicals that easily evaporate into the air	Inflames the respiratory tract, eyes, nose and throat	No (forms O_3 and PM2.5)
CO (Carbon Monoxide)	Chemicals released when burning fossil fuels	Causes serious illness/death	Yes

Particulate matter (PM)

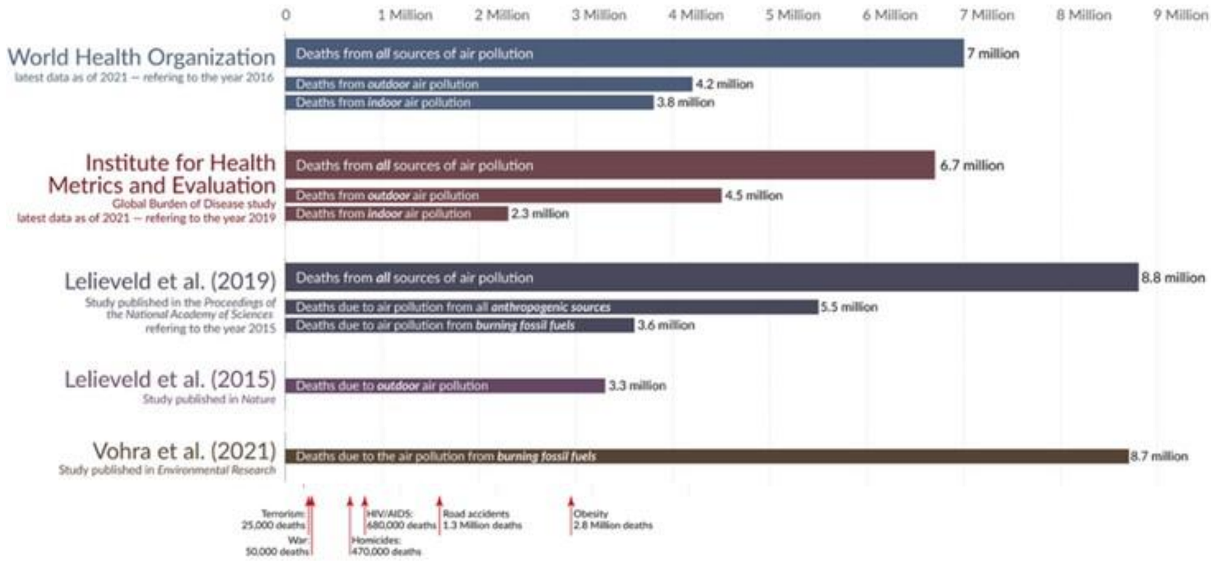
PM2.5 and PM10 refer to particulate matter, as defined in the table above. Premature deaths in Europe due to air pollutants are primarily caused by fine PM2.5[36].

Impact on human health

As a result of PM's minute size, these toxic chemical compounds and materials in the air can infiltrate into the bloodstream and be carried around the human body, having a serious and detrimental effect on health. This can lead to health issues and higher risk of death by increasing the likelihood of respiratory (e.g. pneumonia) and cardiovascular diseases (e.g. stroke and heart disease) as well as cancer (e.g. lung cancer)[37]. Exposure to high levels of fine PM drive vulnerabilities in other diseases such as diabetes and mental health issues, in addition to inhibiting cognitive development in children. *A staggering 20% of newborn deaths worldwide occur as a result of poor air quality*[38]. This accounts for 7% of all air pollution related deaths globally.



In 2019, 99% of the world's population were breathing in air that surpassed the WHO guideline limits, thereby containing substantial levels of pollutants. Air pollution is the biggest environmental factor leading to disease and early mortality. That is a higher number of deaths than from AIDs, tuberculosis and malaria combined[39]. The UN Environment Programme (UNEP) reports that air pollution causes one in nine deaths globally[35]. The United Nations Economic Commission for Europe (UNECE) identifies air pollution as the "world's largest environmental health threat, accounting for 7 million deaths around the world every year" [40].



The chart above presents estimates of global deaths due to air pollution, comparing various sources and studies[41]. WHO data, with the latest update from 2021 referencing 2016 figures, shows 7 million deaths from all air pollution sources. The Institute for Health Metrics and Evaluation, also updated as of 2021 but referring to 2019, indicates 6.7 million deaths from all sources. Different studies, like those by Lelieveld et al. in 2015 and 2019, and Vohra et al. in 2021, provide varying figures but all highlight significant mortality from air pollution. The chart also contrasts these figures with deaths from other causes like terrorism, HIV/AIDS, road accidents, and obesity for context.

As a consequence, a reduction in deaths and illness from hazardous chemicals in the air, in particular the mortality rate from air pollution, forms part of the UN SDGs.

Goal 3	**Target 3.9**	**Indicator 3.9.1**
Ensure healthy lives and promote well-being for all at all ages	By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination	Mortality rate attributed to household and ambient air pollution

Within the built environment, the principal forms of pollution in construction are air, noise and water[42]. Focusing on air pollution, this can be split into the outdoor environment (the construction of buildings) and indoor spaces (within buildings).

Outdoor air pollution

The WHO estimate that in 2019, 4.2 million deaths occurred prematurely as a result of poor outdoor air quality[43].

Cause of outdoor air pollution in construction

The construction industry is a leading cause of air pollution in the form of fine dust in many countries. Reasons for outdoor air pollution include demolition and clearing land in preparation for construction; heavy machinery and vehicle use on-site (e.g. use of bulldozers and excavators) often operating on diesel engines; and use of hazardous chemicals (e.g. paints, plastics and glues)[44]. The majority of PM emissions released during construction occurs throughout the earthwork and foundation phases. Particular contributors include the stacking of waste, hammer piling and the transportation of materials[44]. Water spraying to help mitigate the movement of dust was cited as an effective measure to lower PM emissions.

Transport is also a significant emitter of air pollution within the built environment. According to the 2019 London Atmospheric Emissions Inventory (LAEI), construction and transport account for 30% and 27% respectively of PM10 pollution in London[45].

While ultra-low emissions zones have reduced emissions from transport, the construction industry has seen its proportional contribution of PM10 emissions vastly increase.

Workers in the construction industry are particularly prone to lung cancer due to increased exposure to dusts, fibres and gases emitted from machinery. Local residents are also likely to be susceptible to the pollutants from construction sites given the worsened air quality in the surrounding area. This leads to likelihood of eventual, if not immediate, health issues[46].

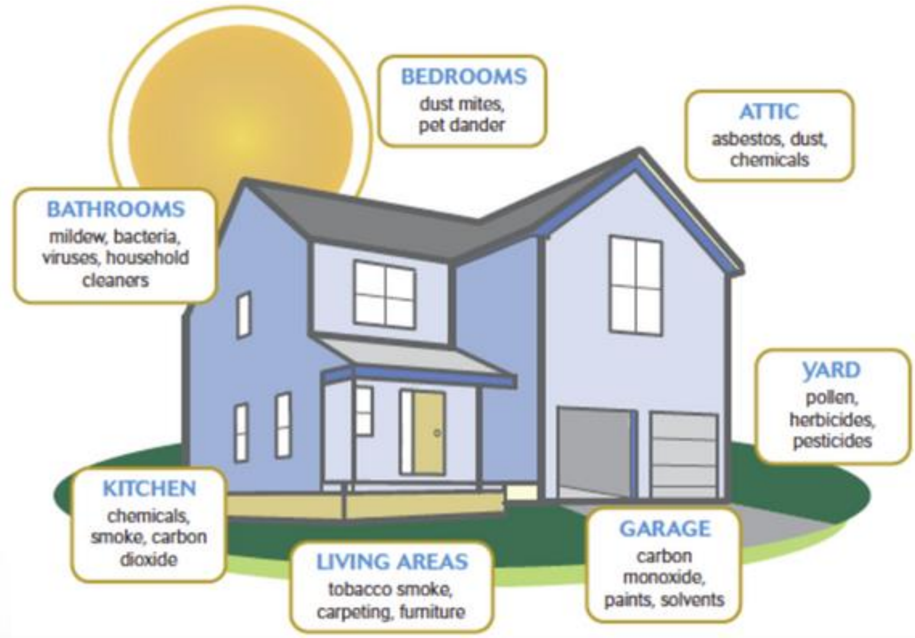
Indoor air pollution

According to the WHO, every year 3.2 million people die prematurely from indoor air pollution[47].

This is notably prevalent in developing countries where, due to low access to clean fuels (e.g. electricity, natural gas), solid fuels such as wood and coal are used to cook and heat buildings. This has the inadvertent consequence of jeopardising air quality with pollutants, such as carbon monoxides and fine particulate matter. The issues associated with poor air quality are exacerbated as many people spend long spans of time indoors (around 87% of our time)[48].

Other examples of indoor air pollution include smoke from tobacco (expelling over 7,000 chemicals, 70 of which are known to be carcinogenic), chemicals from cleaning products (many of which have volatile organic compounds "VOCs") and mould.

Inhaling smoke can have devastating effects on respiratory and cardiovascular health, which can lead to infections, asthma and cancer; inhalation of VOCs can lead to nausea; harm to the kidneys, liver and the central nervous system. Lastly, exposure to mould can lead to asthma, allergies and respiratory infections[49].



Appropriate ventilation of indoor spaces can help to prevent a build-up of air pollutants to hazardous levels. To loop the topic of air quality back to the circular economy, materials that are in line with circular principles tend to be non-toxic and more sustainable in terms of resource extraction.

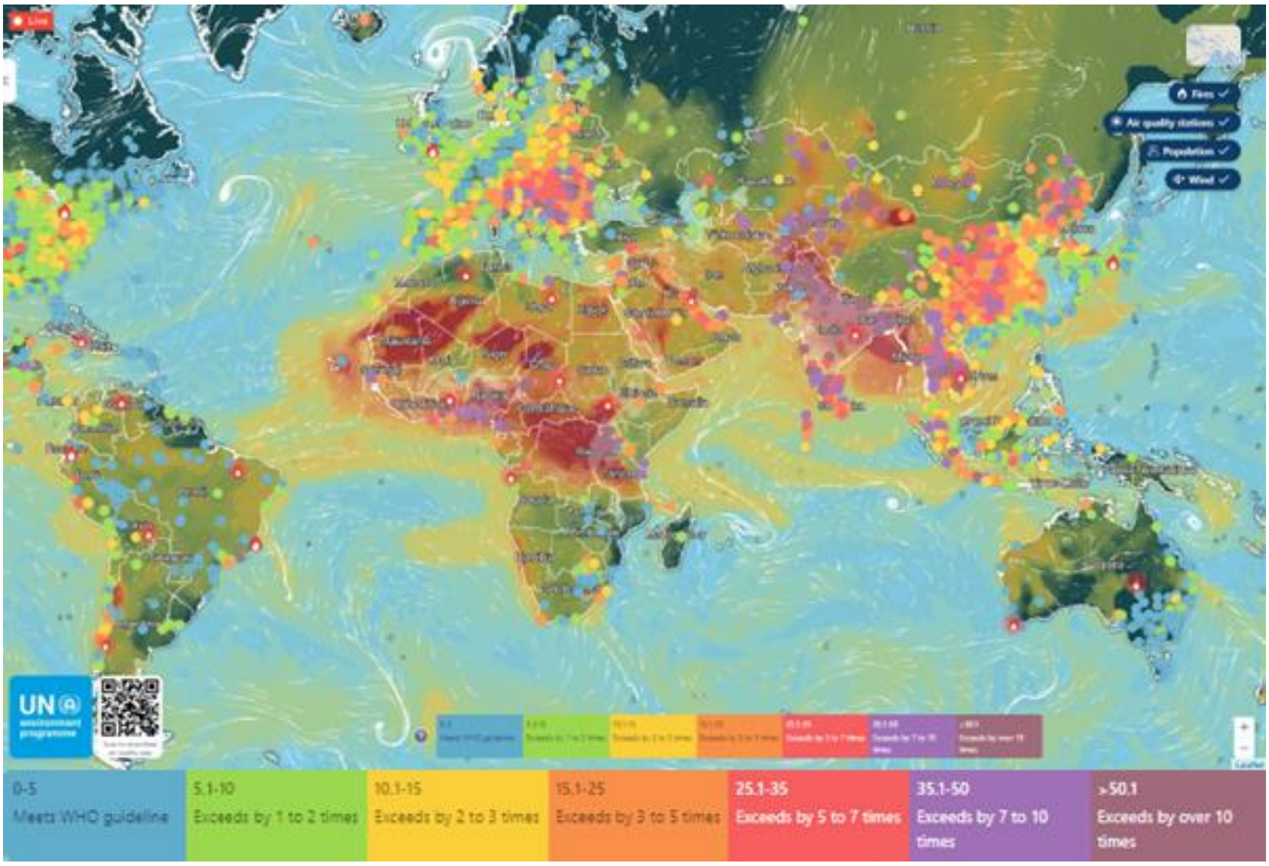
Productivity, and the economic and healthcare cost

The World Bank's analysis states that the health cost of air pollution amounts to $8.1 trillion annually, equal to 6.1% of global GDP[50]. The OECD estimate that forgone working days globally due to air pollution was 1.2 billion in 2015. This is projected to increase to 3.7 billion by 2060[51].

Workers in the UK are estimated to lose 3 million workdays due to poor health as a result of air pollution. Alongside the prevention of 17,000 premature deaths, this could be avoided if air quality were to be improved to levels set by the WHO. As a result, enhancing air quality is estimated to yield £1.6 billion annually for the UK economy, thereby increasing total production of the economy[52].

Geographical impact

Air pollution particularly affects low and middle-income countries, with 87% of deaths occurring in these countries. UNEP's worldwide real-time air pollution exposure, as of 22nd January 2024, estimates that currently: "84.9% (6,389,716,258 people) of the global population are experiencing ambient air quality that does not meet the WHO annual PM2.5 guideline. The 20 - 39 age group is currently most affected by air pollution" [53].



Across the EU, PM2.5 emissions have dropped 25% between 2005 and 2017. This is mainly as a result of advancement in the combustion methods for industry and residential heating, a decline in coal-use and a reduction in transport emissions. It is also important to note that, while exposure to fine particulate matter in developed countries in particular (such as the US and the UK) has vastly decreased, this does not take away from the need to continue to improve air quality in these regions: we are still breathing toxic air[54,55].

In 2018, 21 out of 31 European countries had PM2.5 emissions above the WHO's guidelines. In the same year, across the EU, outdoor air pollution in the form of PM2.5 was estimated to have caused between 168,000 and 346,000 premature deaths (amounting to 4-7% of all deaths in the EU that year). Poor health as a result of air pollution amounts to 3.9 million disability-adjusted life years (DALYs) in the EU annually[56].

Geographical links – outdoor air pollution:

In 2019, around four million people died due to exposure to the pollution of fine PM outdoor, with East Asia and Central Europe being affected to the largest extent. As a result of this fine PM pollution, deaths in China and India amounted to 1,423,633 and 979,682 people respectively that year; that is, 100 and 70 per 100,000 people. This compares with the UK and US of 14,449 and 47,787 deaths, or 21 and 15 deaths per 100,000 people respectively[39].

Geographical links – indoor air pollution:

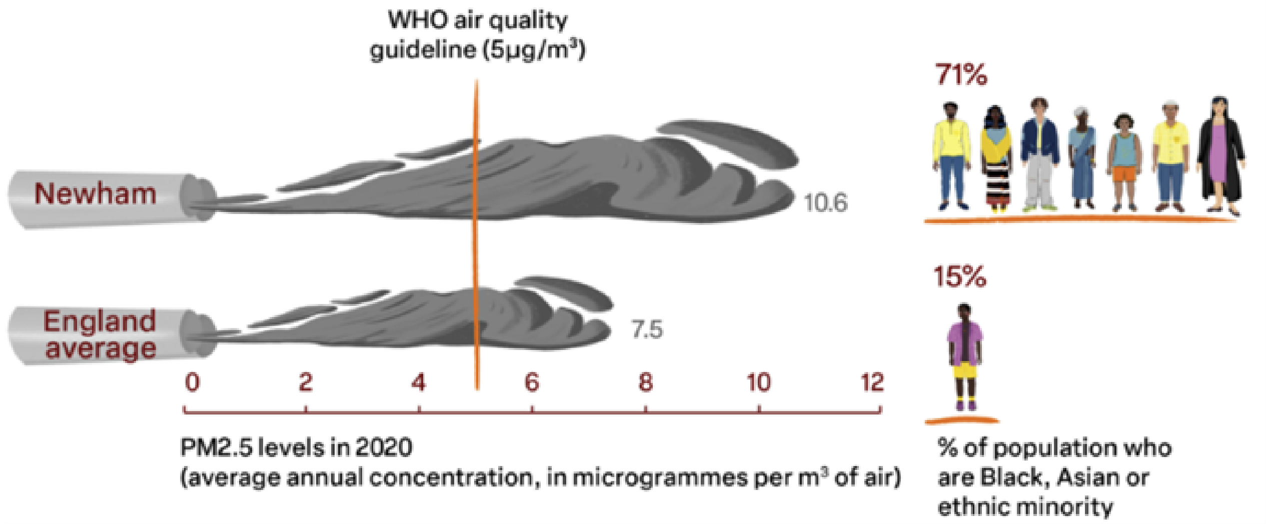
There is a marked split in terms of the environmental and health implications of poor indoor air quality between high-income countries and low-income countries: the issue is more prevalent for the latter. For example, the disparity is particularly evident when comparing death rates from indoor air pollution in Sub-Saharan Africa and Asia, versus the US (a 1,000-fold difference). However, it is important to note that annual premature deaths from poor indoor air quality, in virtually all countries, has decreased. This provides hope that we are better able to control levels of household pollutants[57].

Inequality

Just as there are discrepancies in the levels and effects of air pollution throughout the world, the social problems associated with the built environment are not equally felt amongst a city's residents.

A 2023 study found that in developed nations, such as the USA, air pollution intensifies social and economic disparities, particularly affecting ethnic minorities and lower income groups[58]. These communities experience greater exposure to pollutants due to factors such as outdoor work, proximity to heavy traffic and industrial sites and limited access to quality healthcare. This results in an increased risk of illness and mortality.

Research also suggests a racial disparity in PM2.5 exposure and a significant gap in air quality between low-income and affluent areas in Europe and the UK, with the most pronounced differences observed in London[59,60].



The figure above highlights Newham as having the highest levels of air pollution and the largest Black, Asian, and Minority Ethnic (BAME) population in England. It compares the average annual concentration of PM2.5 particles in the air during 2020. Newham's level is 10.6 micrograms per cubic meter, significantly above the England average of 7.5 and the WHO's air quality guideline of 5 micrograms per cubic meter. Alongside this data, the figure also shows that 71% of Newham's population are from a BAME background compared to 15% in the rest of England[61].

Urban expansion may also result in the development of segregated neighbourhoods based on socio-economic status. This segregation can lead to reduced social cohesion and limited opportunities for interaction and understanding between different social groups. In turn, marginalised groups and areas associated with socio-economic disadvantage are more likely to experience higher levels of pollution from waste and reduced green spaces[62]. For example, landfills are often disproportionately located in low-income communities, leading to environmental injustice. These communities bear a heavier burden of the negative impacts while often receiving little benefit from the services provided by the landfill[62]. Greenpeace reports that waste incinerators, often located in diverse communities, exacerbate the issue and affect over half the population in these areas[61].

To mitigate these negative impacts, it is essential to adopt more sustainable waste management practices such as reducing waste generation; promoting recycling and composting; and investing in more advanced waste treatment technologies. Additionally, efforts should be made to distribute the waste management infrastructure more equitably to avoid placing undue burdens on vulnerable communities.

As cities grow, the demand for housing increases, leading to rising property prices and rents. Some areas are gentrified as wealthier individuals move in and property values rise, which can displace longtime residents and disrupt established communities and social networks. Housing becomes unaffordable for lower-income individuals and families, leading to housing insecurity and homelessness[63].

Addressing these social challenges requires comprehensive urban planning and the creation of affordable housing options; investing in public transportation and infrastructure; fostering inclusive and diverse communities; preserving cultural heritage; promoting green spaces and recreational areas accessible to all residents. Collaboration between local governments, community organisations and the private entities that are involved with executing urban planning projects is essential to create sustainable, equitable and socially vibrant cities.

Transport

Transport is a key consideration when determining how both people and goods move around and interact with the built environment. The sustainability of transport and its infrastructure is vital to achieve the 2030 UN SDGs and align to the Paris Agreement. We must therefore consider the decarbonisation of transport and its implications on both the environment and people's health and well-being.

The Ellen MacArthur Foundation highlights transport as a significant global emitter of GHGs. *The transport sector is responsible for 21% of global GHG emissions,* largely due to 95% of the world's transport using fossil fuels as its energy source. The proportion of GHG emissions as a result of transport varies between 30% (for high-income countries) to under 3% (for the least developed countries). Road transport is responsible for around 75% of transport emissions globally with the number of vehicles set to double by 2050[64].

The chart above shows global CO_2 emissions from different transportation modes based on 2018 data. A large majority of transport emissions stem from road vehicles. Specifically, 45.1% of total transport CO_2 emissions come from passenger road vehicles (cars, motorcycles, buses, and taxis) and 29.4% from road freight (trucks and lorries). Aviation accounts for 11.6%, with the majority (81%) from passenger flights. Shipping contributes 10.6%, while rail is only 1%. Other transport means, like pipelines and off-road vehicles, account for a minor share of 2.2%[65].

Car dependency is linked to urban design as low-density development necessitates vehicle use for daily needs. Globally, the vast majority of cars have combustion engines, with EVs slowly increasing. A 4% decrease in car mileage in the UK would have more of an impact in lowering emissions than the electrification of the whole UK bus fleet[66]. Therefore, the switch away from car journeys towards reliable and affordable sustainable transport (public transport and active travel), designed into the built environment, is a key piece of the puzzle when looking for effective ways to reduce emissions[67]. To achieve the necessary net zero emissions by 2050, a significant rise in EV sales is required. However, high costs and inadequate charging infrastructure present obstacles[68]. Alternative solutions are essential such as sustainable urban planning.

A UK government report on decarbonising transport found that 58% of private car journeys in 2019 were under 5 miles, with 43% under 2 miles. This points to a significant opportunity to decarbonise these routes by switching to cycling or walking. This has prompted investment in initiatives that decarbonise transport through the design of the built environment, such as with increased cycle routes and pedestrian lanes, which promote active travel. This also includes safer bicycle routes and an increase in spaces to park bicycles. Public bicycle hire schemes offer a viable alternative to private vehicles in an affordable and accessible manner[69].

In addition to decarbonising transport, there are health benefits to facilitating active travel. Transportation significantly impacts health, contributing to air pollution-linked respiratory diseases and stress-inducing noise pollution. The rise in car usage also correlates with lifestyle diseases due to physical inactivity, such as diabetes and heart disease. Initiatives like Transport for London's Healthy Streets suggest that integrating physical activity into daily routines through sustainable travel can improve overall health and mitigate pollution[7]

The Importance of Placemaking

Placemaking is a collaborative process that aims to shape public spaces to improve the overall well-being of the community. It involves designing and managing our surroundings in order to create environments that promote health, happiness, and well-being. In the context of sustainability within the built environment, placemaking takes on a critical role as it seeks to balance the needs of the present with the well-being of future generations.

By prioritising sustainability, placemaking efforts focus on creating spaces that are environmentally responsible, economically viable, and socially inclusive. This includes using resources efficiently; preserving natural habitats; fostering community engagement; and promoting practices that reduce waste and pollution.

Effective placemaking can transform an ordinary space into a thriving hub of activity that is both inviting and resilient. It's about creating places where people want to live, work and play and where the natural environment is respected and integrated into the design. When done well, placemaking can lead to vibrant communities that are connected both socially and ecologically, contributing to the long-term sustainability of our built environment.

Implementing effective urban planning practices is crucial. This includes developing compact and mixed-use cities that promote walkability, reduce urban sprawl and minimise the need for long-distance commuting. Incorporating green spaces, preserving natural habitats and creating accessible public transportation systems can help reduce congestion, air pollution and energy consumption.

Prioritising sustainable modes of transportation, such as walking, cycling, and public transit, can help reduce traffic congestion, air pollution, and energy consumption. Developments that allow occupants to easily access efficient and well-connected public transportation systems and make use of non-motorised transport options can contribute to more sustainable and liveable cities.

The 2030 Agenda

The built environment is a key element in the pursuit of sustainable development. It is little wonder, therefore, that the United Nations (UN) identifies the improvement of cities and infrastructure as an important part of the 2030 Agenda (global priorities to be achieved before 2030).

The UN Sustainable Development Goals (UN SDGs) form part of this Agenda and provide a comprehensive blueprint that directly impacts the built environment by advocating for practices that ensure long-term environmental, economic, and social viability. The UN SDGs serve as a crucial call to action to address the design and construction of energy-efficient buildings, the development of sustainable infrastructure and the promotion of inclusive urbanisation that respects the planet's ecological boundaries. In so doing, they underscore the significance of planning, developing and managing cities and human settlements in a way that fosters sustainable growth and improves the quality of life for all.

The UN SDGs that we have identified as being the most pertinent to this topic are:

UN SDG 3 aims to ensure healthy lives and promote well-being for all ages, with a significant focus on reducing deaths and illnesses from air pollution. This goal intersects with the sustainability of the built environment through indoor and outdoor pollution reduction efforts. Better air quality through sustainable transport, green spaces and improved ventilation not only advance the aims of UN SDG 3, by mitigating air pollution and its health impacts, but also contribute to the overall sustainability and health of urban environments.

UN SDG 9 focuses on building resilient infrastructure, promoting inclusive and sustainable industrialisation, and fostering innovation. Infrastructure is the backbone of economies, and resilient infrastructure systems are fundamental to achieving many of the other UN SDGs. By advocating for sustainable industrialisation, SDG 9 directly impacts the built environment by encouraging the use of sustainable materials, the adoption of green technologies, and the implementation of environmentally friendly manufacturing processes.

UN SDG 11 seeks to make cities and human settlements inclusive, safe, resilient, and sustainable. This goal is integral to the built environment, considering that urban areas are expected to house an increasing majority of the global population. UN SDG 11's importance is amplified by the challenges of urban sprawl, pollution, and the need for equitable access to urban services. The goal encourages the development of public transport, green public spaces, and improved urban planning and management in a way that is participatory and sustainable. UN SDG 11 is a call to action for more thoughtful, community-focused, and resilient urban development, which is vital for the longevity and prosperity of cities around the world.

Using this global framework to identify investable themes…

We use the UN SDGs to identify companies that are contributing to global solutions and are therefore eligible for inclusion in our Montanaro Better World Impact Strategy. In particular, UN SDGs 11 and 9 align with our Green Economy and Innovative Technologies themes, whereas UN SDG 3 aligns with our Healthcare theme. This thematic alignment helps to select companies solving challenges associated with the built environment.

Conclusion

The Deep Dive Report has drawn attention to the pivotal role of sustainable urban development in addressing the dual challenges of environmental degradation and social inequality.

By championing the integration of green spaces, energy-efficient buildings, and equitable access to resources, we can mitigate the adverse effects of rapid urbanisation and climate change. Highlighting innovative practices from research institutions like the Energy House Laboratories and the use of innovative new urban planning strategies, we've illustrated practical solutions for reducing environmental footprints and enhancing community inclusivity.

The critical involvement of investors in supporting sustainable infrastructure and technology underscores the collective action needed to advance environmental conservation and social equity. As we move forward, a collaborative approach among all stakeholders is essential for creating a built environment that is not only resilient and adaptive but also nurturing, ensuring a sustainable and inclusive future for all.

Action Points for Montanaro…

1. Improvements in the Investment Process:

Enhance our ESG processes to include thorough evaluations of a company's long-term sustainability, potential for community impact and resilience to environmental changes. This step is crucial in identifying and mitigating risks associated with climate change and urbanisation. We have updated our ESG checklist to improve our analysis.

2. Engagement on Sustainable Urban Development:

Engage with investee companies to encourage them to adopt green building standards and inclusive urban planning principles. We also hope to establish alliances with other financial institutions to promote sustainable urban development. We have taken steps to initiate collaboration with like-minded peers on the PRI collaboration platform.

3. Better Data on Air Pollution:

When undertaking research to identify areas of weakness regarding air pollution within our Approved List of companies, we noticed that this was not an area that was included in the MSCI ESG Manager database. We struggled to find a comprehensive and comparable dataset regarding the release of air pollutants. As a consequence, we plan to contact MSCI to enquire about how this can be improved to provide investors with important information about the environmental footprints of their investee companies.

This ties in with our collaboration to the Long-term Investors in People's Health (LIPH) initiative. The group is coordinated by ShareAction and our participation thus far has aided our research into air quality. In early 2024, we met Ammar Khan, the Lead for their Corporate Campaign on Air Quality, following the publication of the organisation's Clearing the Air Report[71]. During this time, we considered how the industry could best tackle this issue. Given the lack of direct data on air quality metrics, focus was on assessing materiality with regards to which companies would be exposed to emissions contributing to air pollution. We also discussed future engagement with potential investee companies to bring awareness to this topic, with the hope for increased transparency and reporting on relevant air quality metrics.

We look forward to our continued engagement in this campaign with ShareAction towards improved and effective reporting and engagement with companies on air quality.

Appendix

The following comprise a selection of companies from our Approved List contributing to the evolving landscape of the built environment.

<table>
<tr><th>Climate Change Adaptation & Mitigation</th><th>Building Improvement & Efficiency</th></tr>
<tr><td>

- Advanced Drainage Systems
- Alfen
- Energy Recovery
- Marshalls
- Solaredge Technologies
- Terna Energy
- Terna-Rete Elettrica

</td><td>

- Azbil
- Belimo
- Derwent London
- Genuit
- Kingspan
- Sdiptech
- Taylor Wimpey
- Vistry

</td></tr>
<tr><th>Safety, Better Health & Basic Needs</th><th>Innovation & Digital Integration</th></tr>
<tr><td>

- Alarm.com
- Avon Protection
- Badger Meter
- Exponent
- Halma
- Idex
- Pennon
- Primary Health Properties
- Severn Trent
- United Utilities
- Xylem

</td><td>

- Ansys
- Bentley Systems
- Cognex Corporation
- Entegris
- Melexis
- Nova
- Spirax-Sarco Engineering
- Tyler Technologies
- Yaskawa Electric

</td></tr>
</table>

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About the front cover image:

The Dead River.

The photographer Joan del la Malla won the category of Wetlands: The Bigger Picture in the 2023 Wildlife Photographer of the year competition for this image of the polluted Ciliwung River winding through Indonesia's capital Jakarta.

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