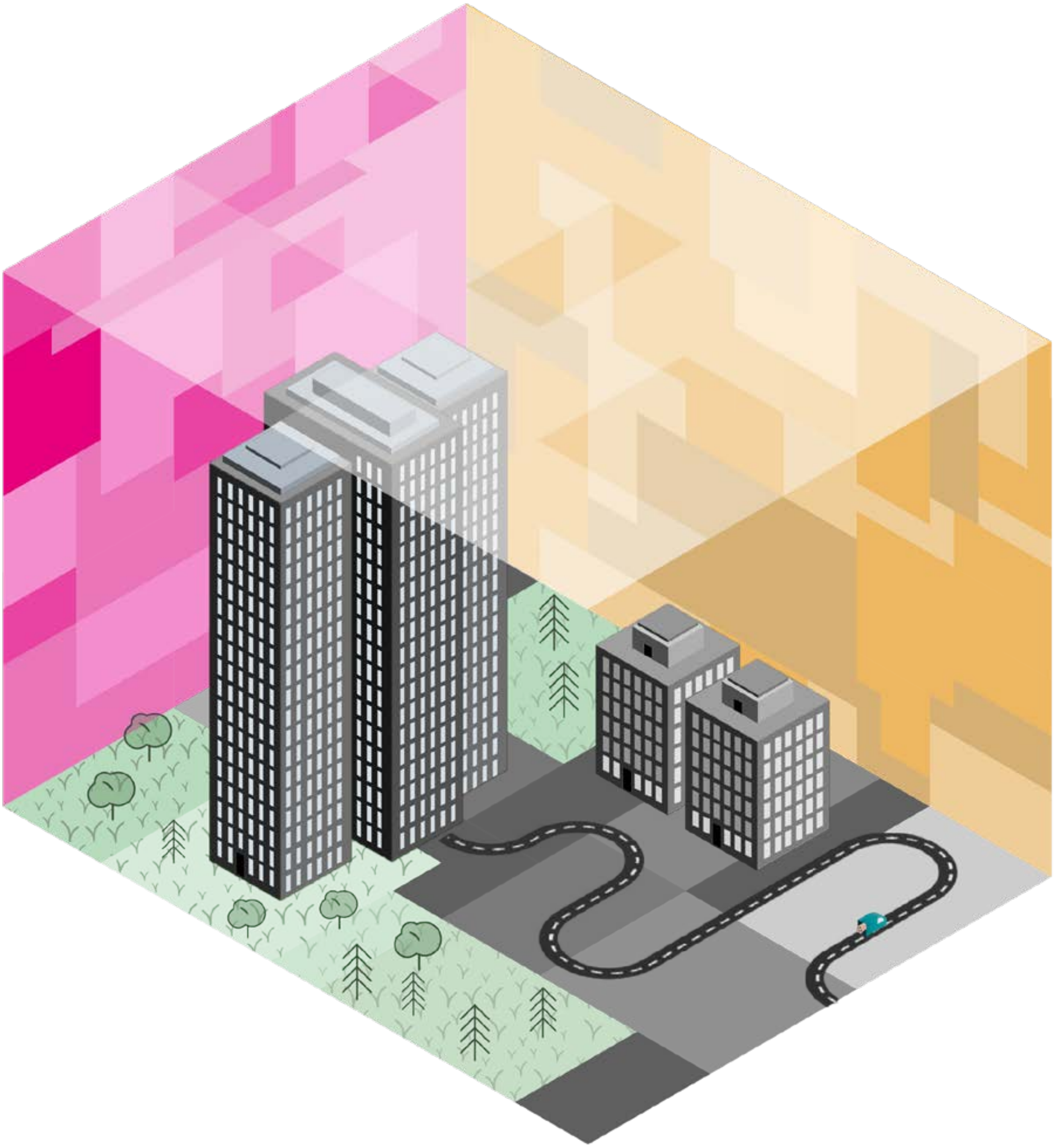
Delivering Net Zero:

Key Considerations for Commercial Retrofit



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Foreword

There is an urgent need to increase the pace at which we are retrofitting the UK's commercial real estate. Doing so will allow us to meet net zero targets whilst simultaneously supporting the Paris Climate Agreement's commitment to limiting global temperature increase to 1.5 degrees Celsius.

Demand for sustainable space is surging, with occupiers driving towards net zero targets and investors responding to market expectations and increasing regulation – not only to avoid 'brown discount' and risk of stranded assets, but increasingly acknowledging the need to act to secure a global sustainable future.

Collaboration across the sector is now key to drive towards this common purpose.

JLL estimates that, in order to meet global emissions standards by 2050, the rate at which we're repurposing our commercial building stock needs to increase to around 5% annually[1]. In the UK, this means that the pace of office redevelopment needs to at least double from levels seen over the last ten years, while delivering a step change to achieve the 59% reduction in energy use needed by 2050[2].

This publication provides insight into the key considerations for commercial retrofit established by key cross-industry stakeholders, from designers through to building managers, with a view to supporting your work when you plan your next commercial retrofit project.

Along with retrofit case study projects, the established key considerations showcase how we and others have approached the challenge of commercial retrofit to deliver successful projects that begin to address the issues with our existing building stock.

The publication includes retrofit definitions, key considerations and supporting case studies - outlining a method for approaching retrofit projects and setting out clear definitions to help give clarity to the industry in establishing best practice approaches.

It is imperative that we begin seriously addressing our existing building stock on our journey to decarbonising the UK built environment.

We need to act now.

David Bownass, Head of UK Net Zero Design Consulting, JLL

Executive Summary

UKGBC's Advancing Net Zero Programme is catalysing the construction and property industry to take the initiative and lead our transition towards net zero for the UK's built environment. Our approach in securing this support has been the development of the Net Zero Carbon Buildings Framework Definition and supporting projects.

Whilst to date the focus has been largely on new net zero carbon projects, this publication, and others to follow will bring commercial retrofit into sharp focus, promoting the important conversation around our existing built assets and providing a level of clarity and consistency to the approaches required to decarbonise them.

This guide is aimed at industry professionals and stakeholders including architects, engineers, planners and facilities managers, as well as landlords and building owners who are involved in the scoping, planning, delivery, and management of commercial retrofits. Any group that has the intention of supporting the successful delivery of net zero-focused retrofit projects will benefit from the following guidance.

DEFINITIONS

To date, the lack of consistency and clarity within the industry around the key definitions associated with retrofit has contributed to a difficulty in establishing best practice approaches to support net zero carbon alignment. To help resolve this issue, drawing from both established industry thinking and discussions with built environment professionals, the following definitions have been established to provide a level of clarity and consistency to commonly accepted retrofit types.

Light retrofit: focus on performance optimisation, basic remodelling, replacement, or adaptation of existing building elements which tend to focus on a single aspect or feature (lighting upgrades, optimisation of building controls and operation, etc).

Deep retrofit: focus on significant works of size or scale that result in a fundamental change to the building structure and/or services. This can be represented as a collection of light retrofit enhancements or individually disruptive measures, such as major plant replacement.

KEY CONSIDERATIONS

As the costs associated with meeting net zero goals become clearer, it is essential that property owners and key stakeholders are provided with a transparent picture of their potential return on investment as well as the benefits of opting for a net zero focused retrofit versus standard practice. The following 10 key consideration areas have been established to support this:

1. **Understanding the building** to help inform the most appropriate decision making on the project.
2. **Assessing what is required:** An assessment appropriately tailored to the size and scale of the retrofit is essential to identify key areas of focus.
3. **Making the business case:** A balanced case must consider a broad range of drivers not only to illustrate the need for retrofit but also its potential benefits for owners and occupiers.
4. **Barriers and opportunities:** The potential barriers should be understood to identify ways to overcome them, and opportunities identified to best capitalise on them.
5. **Performance targets:** For retrofits where full building energy modelling and verification is planned, a clearly defined set of performance targets will both focus the decision-making process and provide clear benchmarks to track project performance.
6. **Establishing a standardised, scalable approach to multiple building or portfolio retrofits** to support consistency and efficient implementation of low carbon measures.
7. **Building management and optimisation:** The existing building's operational optimisation is a critical first step in the retrofitting process.
8. **Low carbon building services and energy efficient fabric upgrades:** Understanding the condition of the existing building will help identify a hierarchy of low carbon options to pursue.
9. **Materials and circular thinking:** Reducing embodied carbon and promoting the circularity of construction materials and products is key to establishing a low carbon asset.
10. **Monitoring and performance verification:** To ensure low carbon benefits are realised, measurement, recording and evaluation of data should take place to verify the effectiveness of the retrofit measures.

Drawing from established industry thinking and discussions with built environment professionals this guide has assembled key information to support and guide the significant efforts needed to achieve our net zero ambitions.

Contents

Introduction

The UK's non-domestic building stock currently represents 23% of built environment operational carbon emissions[3]. In a 2016 energy efficiency survey for England and Wales, the top 5 energy consuming sectors were identified as offices, retail, industrial, health, and hospitality, contributing 71% of total non-domestic energy consumption[4].

For the UK to meet the carbon trajectory set out in the UKGBC's Whole Life Carbon Roadmap, an overall 59% reduction in energy consumption in the office sector is required by 2050[5]. The Better Buildings Partnership's (BBP) Real Estate Environmental Benchmark (REEB) illustrates the scale of the challenge for the sector, with the latest 2020 snapshot revealing that 97% fall short of the UKGBC 2035-2050 target energy use intensities and 65% fall short of the 2020-2025 targets[6].

With approximately 70% of the UK's non-residential building stock constructed before the year 2000[7], if energy and carbon targets are to be achieved, and the UK's 2050 net zero targets realised, significant energy efficiency and embodied carbon reductions are needed. As a result, much of the sector will have to undergo some form of retrofit by 2050.

The scale and type of retrofit will define the approach to reducing operational and embodied carbon. While light retrofits tend to focus on a specific aspect or building component, for deep retrofits, the importance lies in considering whole life carbon impacts (embodied and operational carbon), irrespective of the lack of current regulation. As work progresses towards retrofitting all our existing building assets to achieve our net zero carbon aspirations, attention must shift towards whole life carbon to successfully inform the retrofit decision-making process.

PURPOSE

All commercial real estate owners and investors will be grappling with the complex and potentially costly actions they need to take to mitigate and adapt to the consequences of climate change, and ultimately report on how they're doing so through the Climate Related Financial Disclosures framework[8].

This guide is primarily aimed at supporting landlords and building owners, as well as their multiple advisors and suppliers including architects, engineers, planners and facilities managers, all of whom will need to be involved in the scoping, planning, delivery, and management of commercial retrofits. Any group that has the intention of supporting the successful delivery of net zero-focused retrofit projects will benefit from the following guidance.

It is recommended that the guidance contained in this report is referred to at critical stages of an asset's lifecycle such as:

- By fund managers when considering whether to acquire an existing asset in contemplating what works might be required to bring it in line with net zero carbon standards – and in particular when comparing the return on investment (ROI) and carbon implications of acquiring an existing asset and repositioning it versus embarking on a new construction.
- By asset and property managers when preparing a planned maintenance schedule and capital expenditure budget for the asset.
- By facilities managers managing the day-to-day operation of the building to ensure appropriate decision-making takes place relating to their planned preventative maintenance work and the asset's future decarbonisation targets.
- By planners, architects, engineers and designers when advising on the potential for repositioning an asset – ranging from light to deep retrofit options, and the extent to which either or both can achieve the investor's net zero carbon goals.
- By valuers, banks and insurers when considering the medium-long term risk exposure of an investor client by asking them to disclose the asset's net zero carbon transition plan.

Retrofitting our existing commercial buildings is critical to meeting the UK's net zero carbon targets. This guide outlines the key considerations when retrofitting commercial projects as we target net zero carbon.

SCOPE AND CREATION

This guide summaries the fundamental considerations for retrofit projects to support the drive towards net zero carbon in our existing commercial building stock. It includes:

- Definitions for light and deep retrofits
- 10 key considerations for net zero carbon focused retrofits projects to support net zero pathways and goals
- Real-world case studies, exemplifying the importance of these considerations and the benefits low carbon focused retrofits can have in the advancing net zero goals.

In creating this guide, the UKGBC brought together built environment professionals with a broad range of backgrounds and experience working in commercial retrofit. An advisory group was formed meeting at regular intervals throughout its development providing strategic input helping to shape the overarching content.

UKGBC also sought to feed-in views from stakeholders within its wider membership group, including architects, engineers, developers, and asset management teams to form the publication's review group. This group brought their practical, real-world experience and understanding of the industry-wide issues relating to commercial retrofit, feeding in, and helping to enhance the content and so value to industry.

Defining Retrofit

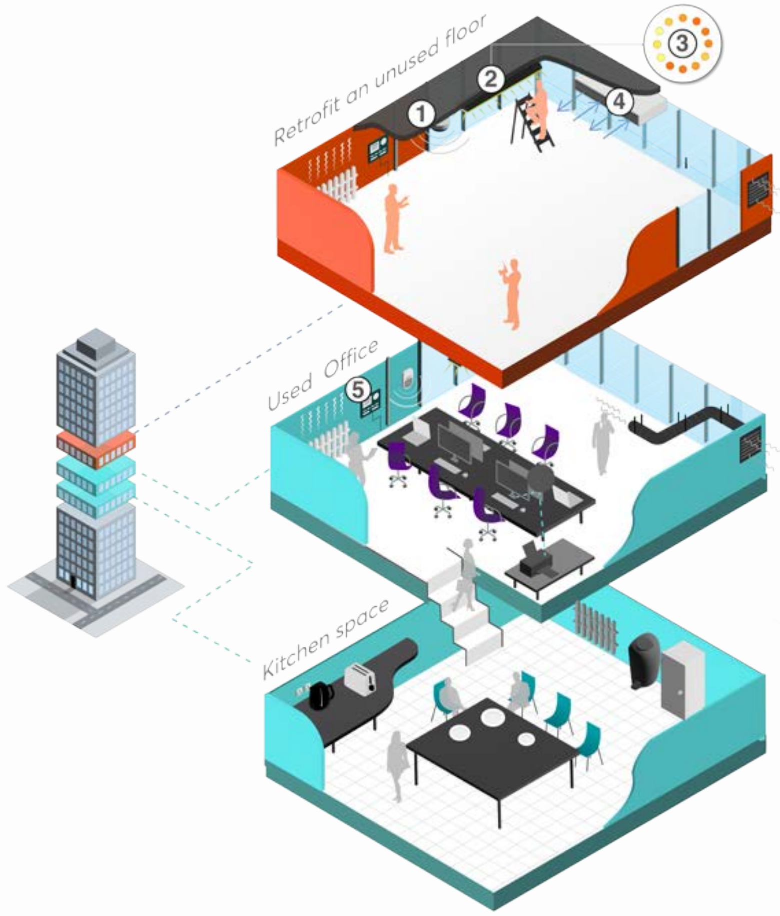
To date there has been a lack of consistency and clarity within the industry around the key definitions associated with retrofit. This has contributed to difficulty in establishing best practice approaches to support net zero carbon alignment.

Light retrofit

Definition: Light retrofit focuses on performance optimisation, basic remodelling, replacement, or adaptation of existing building elements which tend to focus on a single aspect or feature (e.g., lighting upgrades, optimisation of building controls and operation, etc).

Measures which could fall under the scope of a light retrofit include works involving energy efficient equipment and packaged MEP replacement and upgrades (Fan coil units, radiators, pipework).

This type of retrofit is characterised by flexibility and limiting disruption to the building occupants, typically carried out while areas of the building are still operational or where only temporary shutdown of building power is required. They can focus on selected elements or span the entire building, carried out as a set of rolling retrofit measures within a programme as part of the building's asset management plan, or as a standalone, one-off initiative. In all cases, both the operational and embodied carbon impact of the measures should be modelled to inform decision-making as to the most viable alternatives.



Key

Floor status	Features		People
Floors with disruption	(1) Occupancy sensing	(4) Packaged MEP (Fan coil unit)	Building user
Working floors	(2) Lighting and controls upgrades	(5) Optimised building controls	Contractors & facilities managers
	(3) Circadian lighting	(6) Low energy office appliances	

Illustration of key light retrofit interventions

Selecting and incorporating measures that support reductions in operational and embodied carbon over the whole life of the building while quantifying that benefit in a consistent and comparable way can be challenging. To help resolve this issue, drawing from both established industry thinking and discussions with built environment professionals, the following definitions aim to provide a level of clarity and consistency to commonly accepted light and deep retrofit types. These definitions offer a simple classification that may develop to become more granular as more detailed definitions are required in the future.

Deep retrofit

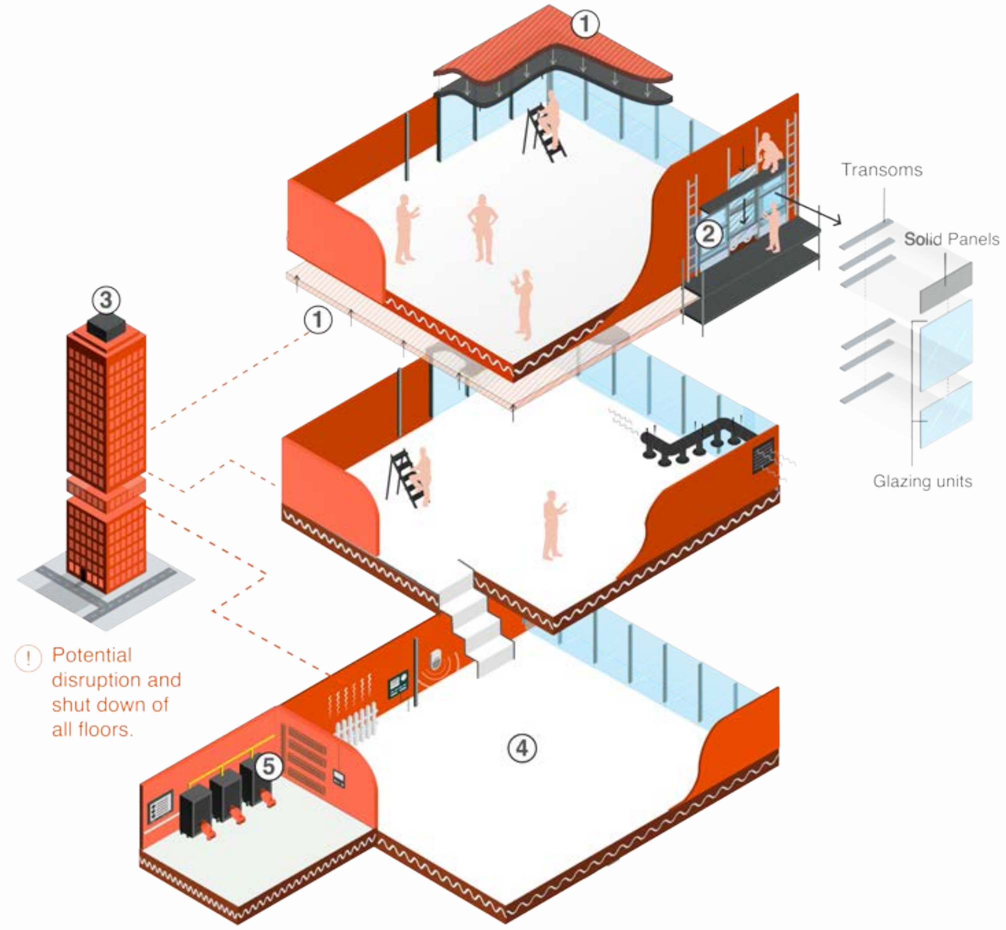
Definition: Deep retrofit focuses on significant works of size or scale that result in a fundamental change to the building structure and/or services. This can be represented as a collection of light retrofit enhancements or individually disruptive measures, such as major plant replacement.

This type of retrofit is characterised by its scale and its significant impact on the building structure and/or services, often requiring building occupants to vacate to allow the full shutdown of power and building services during the project.

Tending to focus on providing large energy savings necessary to bring the asset up to date with current energy and operational standards, these types of retrofits can be one-off projects or part of a phased upgrade process. They consider the whole building and all the processes involved, thereby requiring life cycle assessment methodologies, and as a result can offer multiple benefits beyond energy, carbon and cost savings.

Measures which could fall under the scope of a deep retrofit include works to substructure (insulation of floors and retaining walls), superstructure, including façade and roof elements (increased air tightness, windows, and thermal bridges), and central MEP upgrades (efficient air handling units, replacement of gas-fired boilers, and improvements to riser insulation).

Note: A major refurbishment can be considered a type of deep retrofit.



Key

Floor status	Features		People
Floors with disruption	(1) Floor and ceiling insulation upgrades	(4) Complete building floor retrofit	Building user
	(2) Façade replacement	(5) Major plant replacement	Contractors & facilities managers
	(3) Building services/core riser insulation		

Illustration of key deep retrofit interventions

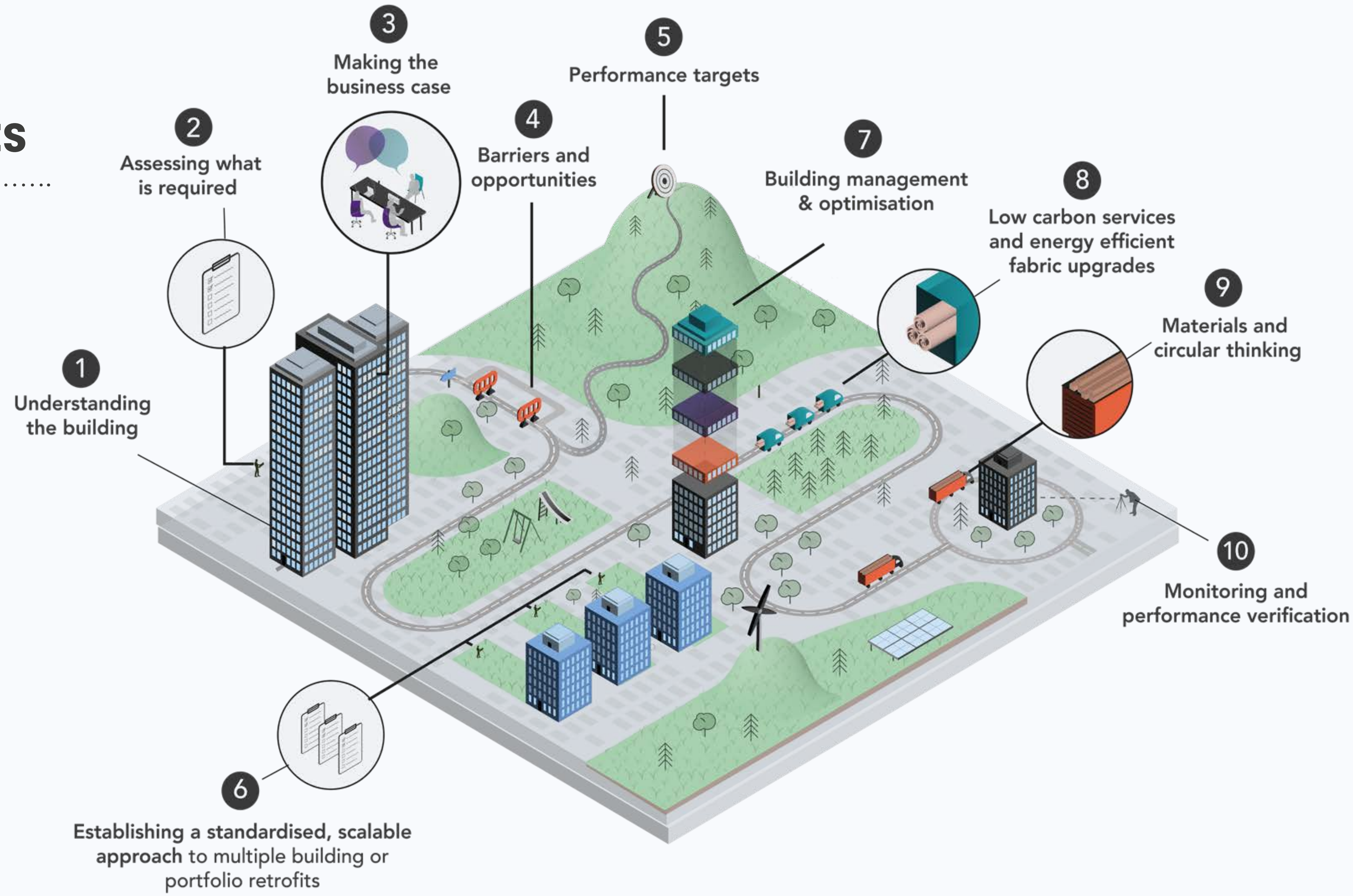
Key Considerations for Low Carbon Commercial Retrofits

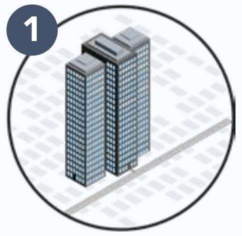
As the costs associated with meeting net zero goals become clearer, it is essential that property owners and key stakeholders involved in projects are provided with a full and transparent picture - not only of their return on investment, but also the benefits of opting for a net zero focused retrofit versus standard practice.

To ensure the benefits are realised over the whole life of the building, there must be a strong business case, clarity of scope and approach, and a clear preference for the low carbon, net zero focussed solution, measurement, and verification. Using pre-agreed targets will enable tracking and ultimately, assessment of whether the anticipated benefits of the project have been realised.

This section of the guide details 10 key considerations to support net zero pathways.

Each section begins with a brief description and justification of the consideration. This is followed by supplementary information providing more context and reinforcing the importance of the consideration to realising a low carbon commercial retrofit.





Understanding the building

Understanding the building is a key first step to help inform the most appropriate decision making on the project. Key areas of focus include:

» **Understanding the original use of the asset through collection of metered data:** This should include current energy consumption and greenhouse gas (GHG) emissions data associated with the building operation to help understand the existing building performance and quantify the benefits of improvement measures.

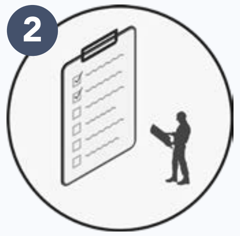
» **Appraising the useful life of all plant and components within the existing building:** In doing so, the most appropriate decisions can be made around their replacement cycle.

» **Understanding the boundaries of operational control** between the owner and occupiers to help identify the most appropriate response through building systems management and maintenance once a building is in operation.

» **Understanding a building's context to identify potential opportunities or constraints:** This could include identifying the limitations associated with a listed building or conservation area ensuring the most appropriate measures are implemented.

» **Evaluating underperformance risk of the existing asset:** This should include both technical and financial underperformance metrics to ensure risks are sufficiently mitigated, increasing confidence in the success of the desired project outcomes.

» **Understanding the building's intended operation to ensure it can meet its as-designed performance:** Details of the building's planned operation should be clearly communicated and disseminated to all the relevant future stakeholders to help ensure it will be operated as intended.



Assessing what is required

An assessment appropriately tailored to the size and scale of the retrofit is essential to identify key areas of focus. Key areas of focus include:

» **Establishing a baseline to measure retrofit performance improvements against:** This should consider the remaining useful life of all building components and anticipated regulatory changes, for example the phase-out of gas boilers. All measures should be assessed against the baseline to establish the scale of their impact.

» **Assessing the scope of the retrofit (see 'Defining Retrofit' section) to ensure the most appropriate considerations are made:**

– *Light retrofit:* This will often form part of the planned preventative maintenance programme and not require a whole building assessment.

– *Deep retrofit:* Where appropriate, this will require a comprehensive assessment of the existing building to establish the priority measures.

» **Early assessment to establish the most applicable type of low carbon solutions to tailor to the specific needs and targets of the project and client:** Ideally all proposed retrofit measures should be considered as part of a whole building retrofit assessment and form part of the asset management plan to ensure optimum operational energy and embodied carbon reductions.

» **Long term planning for all types of retrofit:** This will ensure present and future works are fully coordinated, identifying, and mitigating any risks to achieve their maximum potential in energy and carbon savings.

The importance of considering whole life carbon in commercial retrofit

WHAT IS WHOLE LIFE CARBON?

Whole life carbon considers a building's entire carbon impacts throughout its lifecycle. This includes emissions from the construction and associated manufacturing processes, operation over the entire lifespan, and end of life impacts from replacement of materials and components, reuse and recycling, and demolition and disposal.

One source of further information is the RICS professional statement on Whole Life Carbon Assessment for the Built Environment.

WHY IS IT IMPORTANT?

Whole life carbon analysis will ensure the retrofit decision-making process considers the potential pathways to achieving net zero.

It is not only about specifying low embodied carbon materials but ensuring chosen measures work together to provide the best possible strategy to achieve net zero carbon aspirations.

WHOLE LIFE CARBON ASSESSMENT

A full whole life carbon assessment should consider whole building impacts associated with retrofit on building fabric, systems, operation, and changes to layout. This ensures a holistic response acknowledging both immediate priority measures as well as the long-term net zero target objectives.

Industry guidance such as "PAS2038:2021 Retrofitting non-domestic buildings for improved energy efficiency" cover a comprehensive set of requirements ranging from managing the retrofit process from inception to completion, assessment, design and specification of measures, preparation of medium-term improvement plans, installation testing and handover of measures as well as fine tuning of the performance and evaluation of retrofitted buildings.

Making the business case

A balanced case must consider a broad range of drivers not only to illustrate the need for retrofit but also its potential benefits for owners and occupiers. Key areas of focus include:

» **Taking account of changes to existing and forthcoming regulation:** Current regulatory drivers include the UK Government's Minimum Energy Efficiency Standards (MEES) and the intention to raise the lettable threshold for non-domestic MEES to EPC B by 2030*.

» **Accounting for operational energy and embodied carbon impacts:** A key aspect of the business case will be to quantify future operational energy savings from increased efficiency, as well as lowering carbon offset or neutralising costs by lowering the embodied carbon associated with the proposed measures.

» **Establishing the level of underperformance of the existing building:** Considering wider aspects of value creation, carefully planned and executed retrofit works can lead to reduced maintenance costs, increased occupant health, wellbeing and productivity, fewer repairs, and greater attractiveness of the asset to green finance providers, insurers, investors and JV partners. These aspects should all be considered against their original performance in the existing building.

» **Increases to asset value and potential rental income:** Operational cost savings from reduced maintenance should be quantified to support the case. As occupational demand for low carbon assets surges, landlords and investors should see low and net zero carbon retrofit works enhancing their ability to let the asset, reduce voids, strengthen relationships with customers, and thereby future-proof the value of their assets.

* It should be noted that MEES based on EPCs are likely to be phased out with the introduction of in-use energy performance-based rating schemes between 2022-2029, including mandatory energy disclosure, associated minimum performance standards and fiscal incentives[13]. Should such aspects not be considered when planning a retrofit, there is a significant risk of increased obsolescence and of building becoming stranded assets.

Barriers & opportunities

The potential barriers should be understood to identify ways to overcome them, and opportunities identified to best capitalise on them. Key areas of focus include:

BARRIERS

» **Understanding the project limitations and barriers:** Early identification of limitations and barriers will help the project team address these and overcome them as early as possible in the retrofit process.

» **The unintended impacts of carrying out work in phases:** e.g., air tightness targets may be more difficult to achieve if the envelope upgrades take place at different stages.

» **The transition risks associated with not taking appropriate action in both the short and long-term:** Both regulatory and stranded asset related risks associated with not taking appropriate action should be considered to identify opportunities and drivers for low carbon retrofits.

OPPORTUNITIES

» **Defining the project ambition and identifying decarbonisation aspirations on a project-by-project basis:** Key opportunity areas should be prioritised according to their level of impact on energy and carbon reductions with a view to achieving net zero carbon targets.

» **Adopting a Design for Performance (DfP) philosophy to establish and embed into the project from the earliest possible stage:** Ideally this should include committing to incorporating ongoing monitoring and optimisation after the retrofit process is complete.

» **Ensuring clear lines of communication between all stakeholders are established as early as possible:** This will allow split incentives** to be identified and addressed, ensuring they do not become barriers to executing on retrofit.

» **The type and availability of funding accessible for decarbonising existing buildings:** Real estate lenders are increasingly offering loans based on the sustainable performance of an asset as demand for green finance increases.

**Split incentives describe significant behavioural factors between landlords and tenants. The benefits of energy savings accrue to the tenant and thus there is no incentive for the landlord to make the upfront investments in building efficiency[12].

Performance targets

For retrofits where full building energy modelling and verification is planned, a clearly defined set of upfront performance targets will both focus the decision-making process and provide clear benchmarks to track project performance. Key areas of focus include:

» **Establishing a clear framework for setting performance targets at an organisational level with specific target setting to follow, where such targets do not already exist:** Ideally the framework should consider factors including operational and embodied carbon as well as circular economy and health and wellbeing to ensure the most holistic approach.

» **Setting out clear performance targets and risks to be referred to throughout the process:** Emerging work to develop a net zero carbon buildings verification standard[9] is likely to lead to minimum Energy Use Intensity and embodied carbon targets for different asset types. These should provide a set of milestones along the pathway to reaching net zero at the asset level. In-use energy performance and embodied carbon targets should be set up-front and could be informed by:

a. *Regulatory requirements (e.g., MEES, etc).*

b. *Voluntary commitments and initiatives referring to industry recognised frameworks, such as NABERS UK, Carbon Risk - Real Estate Monitor (CRREM) and the UKGBC's Net Zero Carbon Buildings Framework Definition.*

» **Setting out and defining quantitative and qualitative performance targets** at the start of the project to track the effectiveness of building measures, validating the retrofit process (e.g., kWh/m^2 reductions for operational energy and $kgCO_2e/m^2$ for embodied carbon).

» **Specifying only best practice materials and products:** Where performance target setting and verification is not applicable to the retrofit, high quality, low carbon materials and products should be prioritised within the specification.

Establish an approach

Establishing a standardised, scalable approach to multiple building or portfolio retrofits to support consistency and efficient implementation of low carbon measures. Key areas of focus include:

- **Establishing an assessment framework[10] to ensure the most suitable package of measures are chosen for the project.** Setting out a clear approach will encourage consistency through an organisation, setting a precedent for future retrofit works.
- **Developing a priority list of retrofit actions for deep retrofit informed by predictive energy modelling and lifecycle assessment.** Establishing a hierarchy of measures will ensure key concerns and individual project needs are addressed for all retrofit types. e.g., focussing on less disruptive changes first, or targeting measures with the highest energy reductions as a priority.
- **The iterative nature of retrofits and associated disruption to the building's operation.** Where possible work should be carried out in vacant periods/aligning with lease breaks to limit disruption to the building operation.
- **Drawing on existing asset management plans or developing new plans to encourage the forward-thinking necessary to ensure the most effective decisions are made.** Forward planning will ensure interventions that are made later in the phasing process do not negatively impact those changes made earlier on.

Building management and optimisation

The existing building's operational optimisation is a critical first step in the retrofitting process. Key areas of focus include:

- **Establishing the building operation under business-as-usual conditions** through metered data readings to identify potential areas for finetuning and optimisation.
- **Ensuring existing building systems and controls are fully optimised.**
- **Review of the existing service plant:** Where the performance of existing service plant allows, consideration should be given to retaining, reconditioning, and reuse prior to its replacement.
- **Re-evaluation of internal setpoints ahead of any planned maintenance changes:** By carefully widening the building's heating and cooling setpoints, thereby ensuring the movement of moisture is not compromised, it is possible to reduce building energy consumption and operational costs at no extra cost to the project.
- **A detailed review of the existing energy metering systems should be carried out to ensure satisfactory metering for performance monitoring and data recording:** This should include evaluating the condition of existing meters and calibration as part of the optimisation process.
- **Considering metering system upgrades** as per the NABERS UK guidelines with energy split between "base building" and "tenant spaces".
- **Setting out an operational plan as part of the wider retrofit programme:** To tackle the performance gap, an approach based on measurable performance outcomes should be pursued to ensure the design intent and performance aspirations are met, shifting from designing for compliance to a Design for Performance (DfP) approach.

Low carbon building services and energy efficient fabric upgrades

Low carbon building services and energy efficient fabric upgrades: Understanding the condition of the existing building will help identify a hierarchy of low carbon options to pursue. Key areas of focus include:

BUILDING SERVICES DESIGN:

- **Lighting design and controls** including daylight and occupancy sensing will not only reduce building loads but can also be tailored to enhance occupant comfort, more closely aligning with circadian rhythms.
- **Flexibility of space to accommodate changes to building usage and fluctuations in occupational density**, with priority given to hot desking, reducing inefficient space use and demand on building services. Preference should be given to variable ventilation systems linking to occupancy in flexible spaces ahead of traditional constant air volume systems.
- **Prioritisation of enhanced low carbon all-electric building services**, supporting the decarbonisation of heating and hot water through the electrification of the UK grid. When considering the replacement of variable refrigerant flow (VRF) or such systems, this includes ensuring F-gas leakage is properly managed.
- **Load shifting to support the electrification of existing building stock**. Measures such as the introduction of power storage systems and/or smart BMS systems will support the decarbonisation of the electricity grid.
- **Renewable energy technologies** as outlined within UKGBC's Renewable Energy Procurement & Carbon Offsetting guidance[11], should be a key focus to support net zero aspirations.

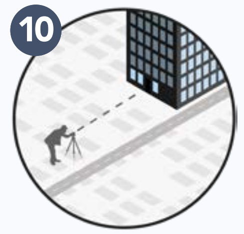
FABRIC DESIGN:

- **Establishing the quality of the façade through thermographic survey:** To be carried out on all building parts and retained façade elements to review performance as part of the remediation plan.
- **Identifying fabric measures to ensure a highly efficient building fabric:** Improved fabric performance aims to minimise the building's energy consumption through measures such as:
  - Improved roof, wall, and floor insulation
  - Improved HVAC insulation
  - Upgraded windows (double or triple glazed units) with solar control
  - Improved building air tightness
  - Introduction of mixed mode or natural ventilation
  - Integration of thermal mass
- **Verifying design proposals through the simulation process to ensure any unintended consequences are addressed and mitigated:** Daylight modelling and overheating assessments to be prioritised on any projects where changes are being proposed to the building fabric and services.
- **Embodied carbon associated with deep façade upgrades:** Where deep façade upgrades are the priority, whole life carbon assessment should be considered to ensure the embodied carbon and associated materials and processes for the retrofit are fully tracked.

Materials and circular thinking

Materials and circular thinking: Reducing embodied carbon and promoting the circularity of construction materials and products is key to establishing a low carbon asset. Key areas of focus include:

- **Whole life carbon (WLC) assessment and analysis of potential retrofit measures to identify priority impact areas:** Analysis should consider the potential pathways to achieving net zero and ensure the decision-making process facilitates this. It is not only about specifying low embodied carbon materials but also ensuring chosen measures work together to provide the best possible strategy to achieve net zero carbon aspirations.
- **Assessing and comparing embodied carbon impacts against operational energy savings as early as possible in the project to inform materials specification:** Assessment at the post-construction stage will help verify the impact of any changes to inform other projects, whilst building a clearer picture of the embodied carbon within a building's lifecycle.
- **Maximising retention and reuse of existing materials and building fabric:** Reducing demolition and any unnecessary building works should be a priority.
- **Salvage and reuse potential of building elements at their end of life and reduction of any on-site construction waste:** Where possible, priority should be given to reclaimed or remanufactured materials.
- **Materials selection and construction processes that seek to reduce the embodied carbon impacts over the lifecycle of the development:** Factors to consider include the footprint of raw materials and production, circularity in production (e.g., use of secondary materials in production) or refurbishment and reuse of materials, product multifunctionality and durability and resilience.
- **Future disassembly and adaptability to be built into the retrofit process to facilitate a circular approach:** Retrofitting with disassembly in mind will reduce the embodied carbon associated with single-use materials and ensure building components and materials are not wasted at their end-of-life.
- **Material passports and declarations such as Environmental Product Declarations (EPD's):** Priority must be given to materials and products with fully verified environmental credentials. Where feasible, locally sourced products should be sought out for their reduced transport-related emissions.



Monitoring & performance verification

To ensure low carbon benefits are realised, measurement, recording and evaluation of data should take place to verify the effectiveness of the retrofit measures. Key areas of focus include:

- **Outlining key performance indicators as part of the monitoring process to ensure building operation remains as intended at design, verified through the introduction of key performance indicators (KPI's) to the responsible stakeholders.**
- **Monitoring and reporting to enable the verification of progress against performance targets set at the start of the project:** Where feasible, it is encouraged that building performance (operational energy and embodied carbon) before and after the retrofit process is tracked. This should be done through WLC modelling and operational data to ensure the expected performance is achieved. In projects where initial targets are not set, continued monitoring of operational performance through metered readings should be prioritised to verify the impact of any measures.
- **Application of relevant industry frameworks and third-party certification as part of the measurement and evaluation process:** For instance, the industry backed Design for Performance initiative and certification systems such as NABERS UK with their focus on providing a reliable method for evaluating office energy usage.
- **Monitoring the performance of installed assets** directly to inform predictive and reactive maintenance, ensuring the expected performance of the retrofit is maintained.

Call to Action and Next Steps

The UK's non-domestic building stock currently represents 23% of built environment operational carbon emissions. Without immediate and continued action to improve the performance of our existing built assets, we will fail to achieve our net zero goals – both as a sector and as an economy.

Drawing from established industry thinking and discussions with built environment professionals this foundation-setting publication has outlined key information to support and guide the significant efforts needed to achieve our net zero ambitions. It provides a simple classification of commonly accepted retrofit types and outlines key considerations for net zero focused retrofits, providing examples of real-world case study projects.

Commercial real estate owners and investors, working closely with their multiple advisors, property managers, facility managers, valuers and lenders, as well as their project teams, can play their part in using retrofit to drive net zero carbon outcomes by:

» Setting targets based on energy intensity metrics for all assets in their portfolio with timelines and milestones towards achieving these through asset management and retrofit plans aligned with capex budgets. Targets should be set in line with industry / sector target trajectories – such as those soon to emerge from the net zero carbon buildings verification standard (currently under development).

» Establishing and implementing portfolio-wide strategies for transition away from fossil-fuels – aligned with planned retrofit works for each asset.

» Upskilling building facilities managers to ensure the best maintenance and retrofit packages are considered to ensure decarbonisation of building operation.

» Rolling out in-use energy monitoring and reporting for the entire building portfolio and commit to sharing energy data regularly and transparently with all tenants, disclosing on an annual basis the operational performance of assets.

» Disclosing the operational energy and carbon performance of all held properties (at asset level) across their portfolios (Funds) in annual reporting – alongside transition plans to net zero aligned with TCFD reporting requirements.

» Aligning their decision making with energy performance-based ratings and away from EPCs, ahead of the BEIS Performance-Based Rating Framework coming into effect.

» Prioritising retrofit of existing assets over demolition and new build – given the substantial savings on resource use and embodied carbon.

The UKGBC's Whole Life Carbon Roadmap also identified a number of key policy levers relevant to existing commercial building which will be important for Government to address. These include:

» The introduction of in-use energy performance-based rating schemes for non-domestic buildings in a phased approach between 2022-2029, including mandatory energy disclosure, associated minimum performance standards and fiscal incentives.

» Retention of proposals for use of MEES in the non-domestic sector in the short to medium term with a view to reviewing the need for MEES as a policy lever as energy performance rating schemes become established.

» The introduction and clear signposting of a 2030 cut-off date for the sales of gas and oil boilers.

» The removal of VAT on energy efficiency retrofit works (i.e. 0% VAT) where energy performance improvement targets are met (to incentivise energy efficiency improvements whilst retaining VAT revenue from general works).

NEXT STEPS

The advisory group involved in this guidance highlighted several areas considered vital in the advancement of net zero within the commercial retrofit sector. This included the need for further research and development focusing on the practical steps and implementation of the retrofit process, providing a clear reference point for the broad ranging stakeholders working on such projects.

Additionally, emphasis was placed on the need to establish industry-wide consistency on how to approach a commercial retrofit project and the need to have a platform for industry professionals and organisations to share their experiences and lessons learnt, with a view to upskilling the industry, ensuring we can meet our decarbonisation targets collectively.

This foundation guidance sets out to address the issue of establishing a level of consistency, but UKGBC will be producing further guidance to support the industry, focussing in more detail on the practical implications of achieving net zero focused commercial retrofits. For the latest information find out more by going to the UKGBC Advancing Net Zero website page.

UKGBC is committed to supporting transformational change in industry, working together for a better built environment. We hereby call upon all those involved in the commercial retrofit to process to submit your case study projects for inclusion in the UKGBC Solutions Library and consideration in the follow-up series of work, helping to support the conversation and build the case for commercial retrofit.

Value and benefits of retrofit beyond energy and carbon reduction

While the focus of the publication has very much been on the impact commercial retrofit has on energy and carbon, it should be acknowledged that members in both the advisory and review groups also provided insights on broader implications of retrofit and the related importance of these. The following summarises the key additional value areas that were highlighted through the development of the publication that should not be overlooked as part of the retrofit process:

Benefits of low carbon retrofit beyond reduced energy and carbon emissions: Wider benefits beyond reductions to energy and carbon emissions should be acknowledged when making the case for low carbon commercial retrofit. These well documented benefits include improvements to health and wellbeing, industry engagement, local economy, and advancements though supply chain engagement.

Social value impact: Increase to social value associated with the retrofitted development should be acknowledged as one of the broader areas to support your retrofit programme. The UKGBC's Framework for Defining Social Value1[14] acknowledges this and aims to characterise the impact people have on buildings, infrastructure, and places, providing guidance on defining social value of an individual project.

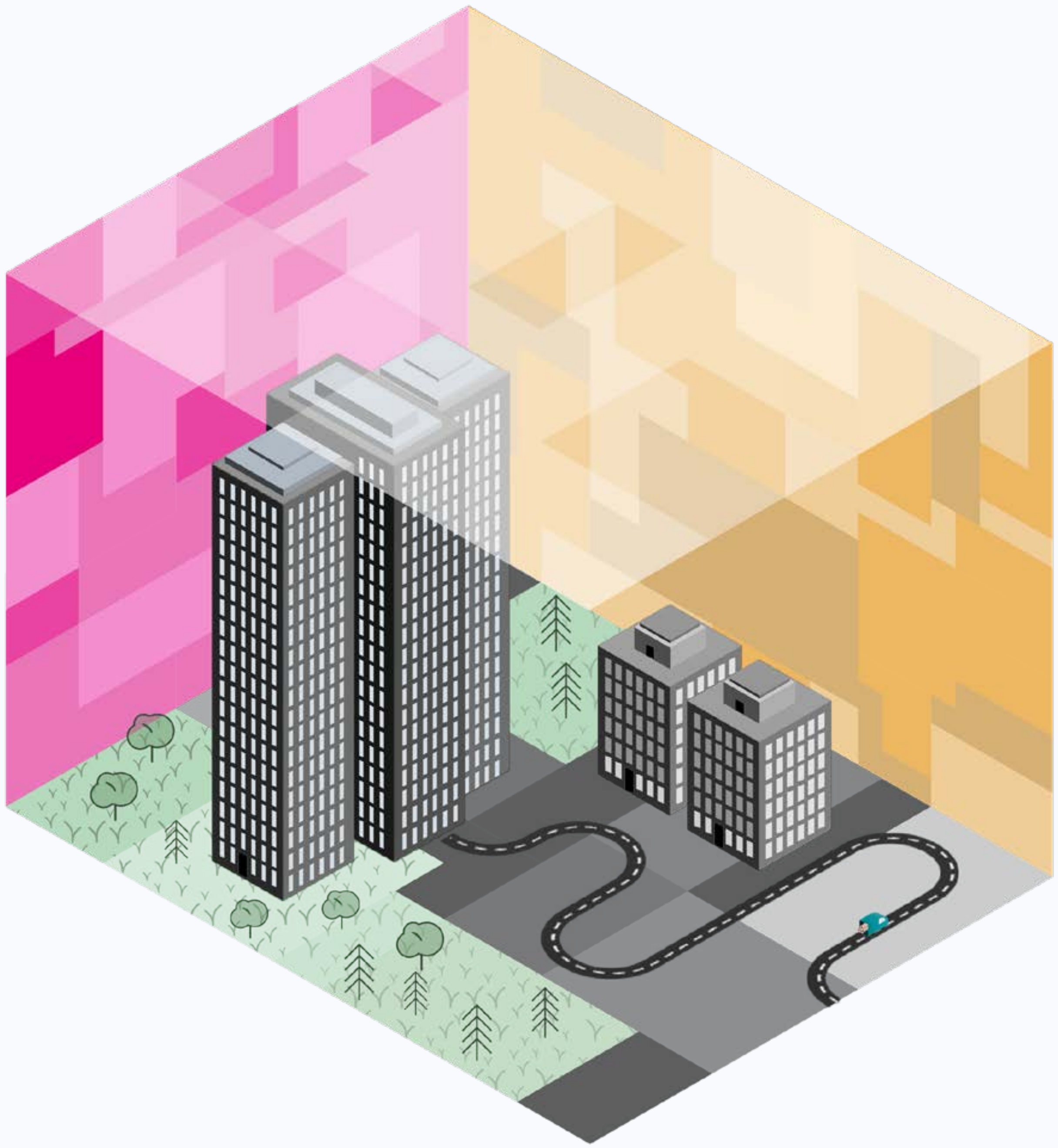
Facilitating industry innovation: Where significant change is required at both speed and scale, innovation will lead the way. The Construction Innovation Hub is an example of how this can look within the construction industry. In collaboration with over 300 organisations, industry bodies, policymakers, practitioners and academics, the Hub has been formed to drive innovation throughout the sector, with aims of addressing performance and productivity challenges.

The Construction Innovation Hub's Value Toolkit[15], developed in partnership with over 200 experts from across industry and government, seeks to redefine value and how it can be measured. The Toolkit enables value-based decision making focused on driving better social, environmental, and economic outcomes, improving industry's impact on current and future generations.

Real World Case Studies - Light and Deep Retrofits

Included throughout this section are a mixture of light and deep real-world retrofit projects. These projects either focussed on or contained aspects specific to achieving low carbon design and illustrate the benefits low carbon retrofits have in the advancement towards net zero goals.

While all key considerations were broadly relevant to each of the projects, those specifically relevant have been highlighted.



Deep retrofit

1 Triton Square, London

https://www.arup.com/projects/1-triton-square

OVERVIEW:

» Organisation: British Land/Arup

» Project name: 1 Triton Square

» Location: Camden, NW1, London

» Project stage: Completed 2021

1 Triton Square was designed by Arup in the 1990's with future regeneration in mind. Twenty years later, with the occupant's needs evolving over its lifespan, the building has been brought up to today's standards using a circular design approach.

HIGHLIGHTS

» The approach of removal, refurbishment, and reinstallation of over 3,500m^2 of façade has alone saved the project over 19,000 tons of carbon.

» Where possible the façade and superstructure has been retained, while three floors have been added, doubling the net office area, all without increasing the required plant space.

» Circular façade design was considered through the refurbishment of 3,500m^2 of glass panels. This involved the removal and transport of over 25,000 separate parts to a pop-up factory less than 30 miles away from the site, saving approximately 25,000 transport miles, with a cost saving of 66% compared to a new equivalent. Panels were inspected, deep cleaned, refurbished, and reinstalled.

» Over 70% of the cement needed was replaced with low carbon alternatives, using carbon fibre concrete wraps for the first time to strengthen existing columns rather than adding additional columns.

» Nearly 500m^2 of green roofs were incorporated to promote biodiversity at the site.

» Provision was made for 536 cycle spaces, lockers, and showers, encouraging active lifestyles and sustainable travel.

BUILDING PERFORMANCE

» Operational energy: 150 kWh/m^2/year (based on CIBSE TM54 calculations)

» Embodied carbon: 448 kgCO$_2$/m^2 (based on LCA assessment)

» EPC: Targeting B rating

» BREEAM: On track to achieve Outstanding rating

» 43% cost saving compared to a typical new build alternative

» 40,000t carbon saved vs a typical new build alternative

» 30% faster completion vs typical new build

SELECTED LESSONS LEARNT

"Once we identified that the existing frame at 1 Triton Square had capacity to take additional floors, our first port of call became a refurbishment, which immediately meant massive carbon savings. We then sought to re-use other parts of the building that would usually be replaced after a 20-year lease.

We worked closely with contractor Lendlease to dismantle, refurbish, and re-use the façade, saving extra carbon. Initially, we planned to return the façade to Germany, where it was manufactured, but we saved even more carbon and supported UK jobs by creating a pop-up factory here. This was the first time we'd followed circular economy principles on a façade and we're now taking learnings onto other projects."

Tim Downes -
Development Director, British Land

Case studies

Proposed deep retrofit
Williams House, Manchester

https://bruntwood.co.uk/our-locations/manchester/manchester-science-park/

OVERVIEW

» Organisation: Bruntwood

» Project name: Williams House

» Location: Manchester Science Park, M15, Manchester

» Project stage: Feasibility study

Williams House is a 1990s office space, set across circa 3,545m² (GIA). The office is located across two wings either side of a glazed central atrium. Based on a traditional brick construction with aluminium framed double glazing, the building is heated via natural gas boilers and adopts a predominantly natural ventilation strategy.

HIGHLIGHTS

Net Zero in Operation

Developed to assist managing and assessing their own assets, Bruntwood have developed their own route map for achieving net zero carbon in operation as follows:

1. Assess: Establish the scope and evaluate the baseline energy and carbon performance.
2. Reduce: Review options to reduce energy including optimising the fabric, building systems and controls.
3. Onsite: Assess how much energy can be generated onsite from renewable sources.
4. Offsite: Investigate a renewable energy contract from the grid or procuring an offsite renewable energy supply.
5. Offset: Review carbon offsets such as local carbon displacement projects or afforestation.
6. Outcome: Evaluate the outcomes and continue to monitor and report.

The route map has been adopted as part of the feasibility study into the Williams House retrofit and illustrates how a structured approach to retrofit focuses a project on its journey to net zero carbon and beyond.

RISK ASSESSMENT

As part of the study, risk assessment has also been prioritised as a means for identifying potential causes of increased energy consumption outside of the predicted values. Bruntwood's assessment process covers the following key risk elements:

» Change in operating hours

» Change in tenant activity

» Poor building energy management

» Extreme weather, comprising increasing summer temperatures

» Inefficient building servicing strategy

» Poor plant commissioning and reactive-only maintenance

» Building services operational efficiency below design

BUILDING PERFORMANCE

OPERATIONAL PERFORMANCE:

» Base build (existing building) - EUI - 127 kWh/m²/year (GIA)*

» Optimal combination - EUI - 61 kWh/m²/year (GIA)*

* Predicted values from the thermal modelling exercise carried out as part of the feasibility study.

SELECTED LESSONS LEARNT

The extent of improvements in performance seen for each proposed measure varied significantly. The feasibility study highlighted the following key findings:

» Minimal benefit was seen from insulating walls and roof (EUI reduction for walls = 3 kWh/m² and for roof= 1 kWh/m²)

» Improving air permeability alone reduced EUI by 19 kWh/m²

» Replacing windows, together with assumed air permeability improvement resulted in significant EUI reduction of 31 kWh/m²

» Replacing gas boilers with ASHP resulted in EUI reduction of 45 kWh/m²

» The proposed 26 kWp roof PV array provided significant opportunity, resulting in EUI reduction of 14 kWh/m²

Case studies

Deep retrofit
1 Exchange Square, London

https://1exchangesquare.com/our-vision/

OVERVIEW

» Organisation: Sweco

» Project name: 1 Exchange Square

» Location: City of London, WC2, London

» Project stage: RIBA Stage 4 Design

Located on the eastern side of the Broadgate Estate and Exchange Square, the original development was designed in 1987. Portions of today's façade are at their end of life with poorly insulated solid elements. The primary energy source is the outdated gas-fired boilers.

The original air conditioning system has undergone regular servicing through its lifespan, however its operation is highly inefficient without any heat recovery due to its age.

Project team: Client: PNBJ I / LaSalle Investment Management, Development Manager: M3 Consulting, Architect: Fletcher Priest Architects, Structural Engineer: Heyne Tillett Steel

TARGETS

» Operational energy (base building): 55 kWh/m²/year (GIA)

» Embodied carbon: 420 - 343 kgCO_2/m² GIA (A1-A5) Targeted range

» Benchmarking:

– BREEAM NC 2018 - Outstanding

– WELL Building Standard V2 - Platinum

» UGF (GLA): 0.35

» NABERS UK: 5-star rating

EXISTING BUILDING

» Due to high levels of air permeability, the existing building suffered from high heat loss resulting in thermal discomfort for occupants, poor ventilation systems and minor condensations issues.

» Glazing and window seals have reached the end of their life.

» Inefficient façades dated windows and plant equipment at the end of life have led to poor energy performance.

HIGHLIGHTS

Fabric

» 90% of the existing structure has been retained with a view to limit the project's embodied carbon impact.

» Upgrades to facade insulation are proposed, with the incorporation of triple glazed units with high thermal performance (low U-value).

» Upgrades are proposed to the building's air permeability, thermal bridging, and thermal line.

» 48% of the existing façade granite and associated supporting steelwork is proposed to be retained.

» Optimised window-wall ratio with passive solar control to reduce unwanted solar gains reducing reliance on perimeter cooling systems.

» Openable windows with smart technology for improved user control and wellbeing.

» Incorporation of green roofs (1,200m²) and blue roof (1,400m²) systems.

» Landscaped terraces provided on every level, 3,000m² in total, to improve occupant experience, promote wellbeing and provide a habitat for over 100 native species.

Services

» Full building services system upgrade to all electrical services, eliminating all use of fossil fuels.

» Building services design considers NABERS Design for Performance (DfP) with 5-star target rating.

» Ventilation to meet WELL Building Standards recommended levels.

» Smart BMS to control building operation and ensure optimised function.

» Machine learning based building energy optimisation tools to be implemented via digital twinning, ensuring all aspects of the building operation are carefully monitored and responded to effectively.

» Market leading end-of-trip facilities, achieving London plan targets.

BUILDING PERFORMANCE:

» Operational energy: 55 kWh/m²/year *

» Operational Carbon: 12.81 kgCO_2/m²/year *

» Operational carbon savings: 62.2%

» Embodied carbon (kgCO_2/m²): 420 - 343 (A1-A5)

* Predicted performance from energy modelling.

* Project is formally registered for Design for performance NABERS UK with target of 5* Rating.

SELECTED LESSONS LEARNT

» Whole life cycle carbon analysis has helped inform the building thermal insulation upgrade via a balance between embodied carbon and operational carbon via NABERS UK DfP.

» Thermal modelling analysis for "Predicted mean vote (PMV)" and the "Predicted percentage of dissatisfied (PPD)" sensitivity analysis helped inform the façade specification to ensure high levels of comfort and low-energy use.

» BRE's BREEAM 2014 Refurbishment and Fit-Out schemes fall short of high standards of future major refurbishment, and therefore BREEAM 2018 New Construction scheme offered an alternative for a holistic sustainability assessment.

» By reusing foundations and 90% of the structure, 6,798m³ of concrete was saved.

Light retrofit

Hygeria Building, London

https://lowcarbonalliance.co.uk/

OVERVIEW

- Organisation: Low Carbon Alliance
- Project name: The Hygeia Building
- Location: Harrow, HA1, London
- Project stage: Completed 2018

The retrofit of this 5-storey office building from the early 1990's was undertaken to address several key issues such as poor levels of control, tenant complaints of over-and under-heating, poor levels of fresh air ventilation and excessive CO_2 levels (above 1000ppm).

The air conditioning system, a 4-pipe fan coil unit (FCU) type based on a popular 1980's American style of heating and cooling, cooled only to the central zones using an excessive number of FCUs. The retrofit focused on controls optimisation with individual fan coil control replaced with group controls linked to room thermostats.

EXISTING BUILDING

- The existing building facilities management reported a high frequency of complaints relating to temperature and internal comfort, high energy use and excessive need for FCU repairs.
- Data recording was undertaken to measure internal temperature, air quality and humidity with results illustrating both declining air quality throughout the day and erratic temperature fluctuations, indicating a fundamental controls issue.
- It was also identified that the original design of the extract air system meant fresh air supply to the floorplates was being starved, resulting in the reported air quality issues.

HIGHLIGHTS

Group controllers connected to room thermostats were selected to mitigate the false temperature readings, preventing each FCU from working against its neighbour.

Once the extract air was diverted correctly, and effectively removed from the room, it was possible to pass all fresh air from the ceiling void through the FCUs and into the office space, eliminating issues of thermal comfort and air quality.

The resulting decrease in fresh air supply temperature removed the original control conflicts and reduced building's demand on boilers and chillers.

- Individual FCU control replaced with group controls, linking to room thermostats with +/- 2-degree adjustment.
- Exhaust duct extended from ceiling void onto ceiling grilles.
- Occupant comfort restored.
- Building performance
- Operational energy savings: 76,000 kWh electricity (metered)
- Operational energy savings: 55,000 kWh gas (metered)
- Energy Intensity: 204 kWh/m²/year
- Operational carbon: 43 $kgCO_2/m^2/year$
- Operational carbon savings (%): 10%
- EPC: Target of EPC D rating achieved
- BREEAM: In-Use Good rating achieved

SELECTED LESSONS LEARNT

- The landlord needed to challenge solutions offered by the incumbent FM providers to ensure the best building operation was achieved.
- The landlord was required to review 'Licence to Alter' requests with respect to services and energy use.
- The Landlord was required to digitise services plans and maintain these after the fit-out and improvement works were performed.

Case studies

Light retrofit

LightFi/ Knight Frank, London

https://www.ukgbc.org/solutions/case-study-improving-building-efficiencies-with-lightfi-sensors/

OVERVIEW:

- Organisation: LightFi/Knight Frank
- Project name: LightFi & Knight Frank - Energy Savings
- Location: Westminster, W1, London
- Project stage: In-progress, detailed design

Using LightFi's IoT sensor technology has enabled occupancy driven ventilation control in the 20,000m², multi-let office building in Central London, delivering energy savings while maintaining good indoor air quality and comfort.

HIGHLIGHTS

- The project began with a feasibility study leading into detailed design, and a phased approach to implementation:

1. IoT sensor installation and relevant controls refurbishment
2. hardware upgrades to existing infrastructure to enable dynamic control

- Integration of the technology helped deliver a pathway towards net zero with minimal disruption to the office operation.
- Benefits of monitoring actual occupancy and CO_2 levels as well as implementing suitable occupancy driven ventilation control strategies include increased energy efficiency, carbon reduction, improvement to wellbeing, productivity & thermal comfort.
- In addition to BMS integration, the LightFi IoT platform provides insights for pro-active FM interventions and improvements as well as tenant engagement and reassurance.
- Indoor air quality sensors and enabled control strategy provide data to manage and actively reduce COVID risk, in line with CIBSE guidelines.
- Phase 1 savings based on control refurbishment: 5% - 10% of electricity bill with a 0.5 – 1.5-year payback.
- Phase 2 savings based on control refurbishment & ventilation infrastructure upgrade: 11% - 24% of electricity bill with a 1.5 – 2.5-year payback.

BUILDING PERFORMANCE

- Operational energy savings per year: 30 - 60 kWh/m² (Estimated)
- Embodied carbon abatement per year: 12 - 24 $kgCO_2/m^2$ (Estimated)
- Occupancy driven ventilation control & indoor air quality monitoring to support additional scoring within BREEAM, DEC, WELL & RESET certification schemes.

SELECTED LESSONS LEARNT

- Low cost retrofit projects utilising LightFi system with the correct control strategy for the building typology can result in significant building performance improvement and energy savings.
- Specific control strategies have to the ability to reduce thermal discomfort issues. A completed project for British Gas's office building measured 41% reduction in cold complaints due to LightFi's occupancy driven ventilation control.
- Occupancy driven ventilation control can improve indoor air quality while also reducing energy consumption for a range of buildings with differing HVAC infrastructure.
- It is important to work alongside the building's engineers, integrators, and consultants to tailor the control strategy & infrastructure upgrades to that specific project.

Case studies

Deep retrofit (Fit out)

10 George Street, Edinburgh

https://www.overbury.com/

OVERVIEW:

- Organisation: Overbury/ JLL
- Project name: 10 George Street
- Location: Edinburgh, EH2, Scotland
- Project stage: Completed 2022

Overbury was appointed to carry out the fit out of two floors of the newly retrofitted 1,900m^2 office block in the heart of Edinburgh. The scope of works included full CAT B fit out, including mechanical and electrical alteration to integrate a smart office system.

The fit out is an innovative, modern, and environmentally considerate addition to the 30-year-old building that it sits within. The space includes a mixture of open plan working areas, focus booths and meeting rooms that utilise partitions to maximise flexibility.

TARGETS

- Embodied carbon: the client's aspirations were to reduce the embodied carbon of the fit out as far as possible from the tender stage design. Each fit out element specified at tender stage went through a full embodied carbon reduction process.
- Benchmarking:
  - SKA Rating - Gold

EXISTING BUILDING

10 George Street is a newly refurbished CAT A office space in the heart of Edinburgh. The Overbury fit out was carried out on two floors of the newly refurbished block.

HIGHLIGHTS

The major focus of the fit out was to reduce the embodied carbon from concept stages through to delivery. In order to deliver a lowest possible embodied carbon fit out, priority was given to reducing actual emissions ahead of utilising offsets.

The overall approach considered the following:

- Utilising CarboniCa as a design and reporting tool
- A knowledgeable management team
- A circular approach
- Choosing products with Environmental Product Declarations (EPDs) where possible
- Integrating carbon factors into value engineering
- Waste minimisation
- **Internal walls and partitions:** Where possible the design team aimed to keep the number of partitions to a minimum, reducing the overall embodied carbon. Where partitions were installed to separate meeting rooms these were predominantly glass, due to their functionality. The specified systems were demountable for reuse later.
- **Ceiling finishes:** Reuse of existing tiles were prioritised within the ceiling finishes package. Over 70% of the existing tiles were retained and integrated within the new fit out, alongside newly specified acoustic baffles to meet Arup's acoustic requirements.
- **Wall finishes:** A range of paints were analysed by the design team, comparing EPDs across several ranges, informing the lowest embodied carbon selection.
- **Stairs, ramps, and walkways:** Embodied carbon assessment highlighted the originally proposed steel staircase as the single largest contributor to the embodied carbon of the fit out. The Overbury team used the CarboniCa design tool to consider several options. Through the consultation process, it was agreed a full timber staircase with glass balustrades and only a small amount of steel for structural purposes would be chosen. Approximately 90% of the embodied carbon was removed when compared to the original, all-steel design.

Internal doors and screens: Fit out contained a mixture of timber and glass doors. Where glass doors were specified, they were demountable for ease of use elsewhere in the future.

Floor finishes: Focus was placed on specifying floor finishes with readily available EPDs and where possible carpets with take back schemes. All specified floor finishes had related EPDs, and vinyl was kept to a minimum. All raised access flooring was retained as part of the fit out. Where the new staircase was inserted into the space, all the removed raised access flooring was stored and used as spares to replace any damaged tiles. The extensive reuse of floor elements cut cradle to gate emissions (A1 – A4) by approximately 66%.

FF&E: A circular approach was adopted with regards to specification of office furniture. Through partner company, Rype Offices, Overbury was able to determine what furniture to upcycle and reuse with the remainder ethically disposed. All the task desking was retained as well as the office storage cabinets. Where possible, Rype Offices upcycled and reupholstered items in need of improvement in alignment with the high quality fit out. Over 50% of the furniture was reused within the fit out and any newly specified items were scrutinised via EPDs and manufacturers declarations.

BUILDING PERFORMANCE

Embodied carbon [Cradle to Gate - A1-A4 emissions]: 27 kgCO_2e/m^2 (Estimated via CarboniCa)

Embodied carbon [Cradle to Cradle - A1-D emissions]: 78 kgCO_2e/m^2 (Estimated via CarboniCa)

Embodied carbon savings through low carbon design: 44.47 tonnes CO_2e (Estimated via CarboniCa)

BENCHMARKING:

-SKA Rating - Gold

SELECTED LESSONS LEARNT

- Highlighted as part of the embodied carbon tracking and Overbury's role in overseeing the carbon reduction of the fit out, it became apparent that both mechanical and electrical equipment manufacturers still have work to do to catch up with the rest of the industry in terms of issuing embodied carbon data for their products and equipment.
- To better inform future fit out projects, early engagement with mechanical and electrical manufacturers will be prioritised to gather the relevant information using CIBSE's TM65 Embodied Carbon in Building Services methodology.

Light retrofit

4 - 5 Lochside Avenue, Edinburgh

https://knightpropertygroup.co.uk/development/4-5-lochside-avenue/

OVERVIEW:

- Organisation: Troup Bywaters + Anders
- Project name: 4-5 Lochside Avenue, Edinburgh Park
- Location: 4-5 Lochside Avenue, Edinburgh Park, EH12 9JD
- Project stage: Completed 2021

This project involved the comprehensive remodelling and refurbishment of an existing 3 storey standalone building which was originally constructed in 1998. It offers EPC B+ rated, fossil-fuel free office accommodation across 4,000m^2 along with a dedicated welfare block with lockers, showers, and drying area.

TARGETS

- Operational energy: Calculated as Whole Building: 88.8 kWh/m^2/year (GIA).
- Embodied carbon: No targets set, but comparable to typical reuse of building with an element of extension of 190-205 kgCO_2/m^2.

EXISTING BUILDING

TB+A inspected this building on behalf of Knight Property Group prior to them purchasing it in 2019. The existing building had gas-fired boilers providing LTHW to a partially retained permitter radiator heating system, air handling unit heater batteries and domestic hot water calorifier. Previous tenants had made significant changes including removal of some heating installations and provision of comfort cooling.

Through discussions with the client the opportunity was identified to undertake a full renewal of all MEP systems to enable conversion to a "fossil fuel free" building.

HIGHLIGHTS

The building has since been marketed as offering tenants high quality office space in an all-electric facility aligned to net zero policies. HVAC systems provided comprise heat recovery air handling units providing high standards of fresh air ventilation to BCO standards along with high efficiency heat recovery VRF heating/cooling.

- Comprehensively refurbished, net-zero aligned repurposed office accommodation with improved floor plates, circulation areas and lettability.
- Dedicated welfare block with lockers, showers, and drying area.
- Fossil-fuel-free, EPC B+ rated building with predicted 88.8 kWh/m^2/annum (GIA) total building emissions.
- All new high efficiency MEP installations along with 100m^2 of PV and 11 electric vehicle charging points.

BUILDING PERFORMANCE

- Operational energy: 88.8 kWh/m^2 (GIA)*.
- Embodied carbon: Not assessed but comparable to typical reuse of building with element of extension of 190-205 kgCO_2/m^2.
- Building has achieved an EPC B+ rating.

* Energy consumption based on predictive whole building energy modelling

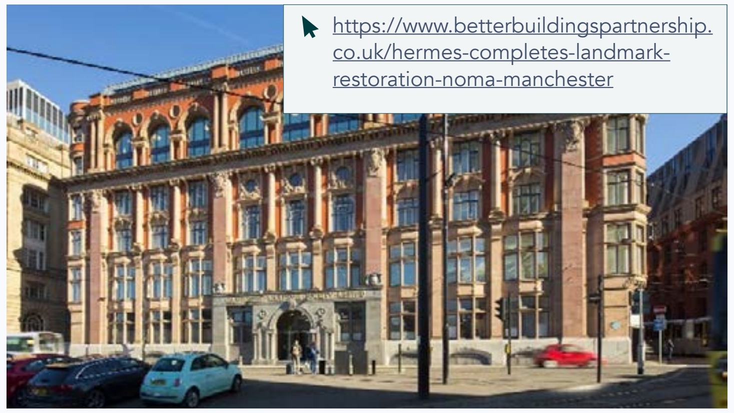
SELECTED LESSONS LEARNT

- Decision to go all-electric was the correct decision to make and was timely given new net-zero targets set and requirements for pathway to achieving carbon reduction levels across the construction sector.
- Existing buildings can be refurbished and provide high performing accommodation.
- Decision to refurbish rather than knock down aligns with need to reduce further carbon emissions as part of producing construction products (embodied carbon).

Case studies

Deep retrofit

Hanover House, Manchester



https://www.betterbuildingspartnership.co.uk/hermes-completes-landmark-restoration-noma-manchester

OVERVIEW:

- Organisation: Hermes Investment Management
- Project name: Hanover House
- Location: NOMA, Manchester
- Project stage: Completed 2019

Set within the NOMA masterplan in Manchester city centre, Hermes Investment Management and partners have completed the restoration of Hanover House, transforming the Grade II listed building into an exceptional Grade A office space, blending heritage with contemporary design.

Project team: Architect: Sheppard Robson, Contractor: Russells Construction, Property and project managers: Workman, Mechanical & electrical consultants: Crookes Walker Consulting, heritage consultant: Stephen Levrant Heritage Architecture, BREEAM: Carbon Credentials.

TARGETS

- Benchmarking:
  - BREEAM Very Good (Standard on all Hermes major refurbishment projects)

EXISTING BUILDING

Hanover House, completed in 1904, was built using the most advanced construction techniques of its time and remains an outstanding example of Edwardian baroque design. As the first part of the Listed Estate on NOMA to undergo major refurbishment, Hermes put a strong focus on understanding the heritage elements, analysing options to retain the original building characteristics.

HERITAGE

- Retaining and restoration of the original façade and character features including carved stone details, glazed tiles, sandstone window surrounds and coffered plastered ceilings.

ENERGY

- Internal double glazing installed to improve air tightness, window thermal performance and acoustics.
- Incorporation of roof insulation.
- Heating and cooling systems served by down flow units, distributing conditioned air below the floor.
- Metering to all office areas with units monitored and managed to reduce energy usage. This system can also be used to bill occupiers for their actual electricity, heat and coolth usage if areas are multi-let, encouraging energy efficiency amongst tenants.
- Ventilation incorporating variable speed drives and heat recovery, so incoming fresh air can be heated via the exhaust air supply.
- Energy saving features included as part of the Building Management System (BMS) include:
  - Heating and cooling controlled to operate at pre-programmed set points for individual office and retail areas.
  - Natural ventilation in the atrium used to dissipate excess heat once the internal temperature rises above a predetermined point, via the high-level smoke ventilation louvres.

SUSTAINABILITY

- More than 95% of construction waste recycled and diverted from landfill.
- Specification of low flow sanitary fittings throughout, reducing water consumption.
- External fabric wholly re-used in situ. New materials were selected with energy management certificates covering the supply chain process.
- Future proofing, with large, open floorplates that can be adapted by occupiers to suit their needs without significant building form alteration.

BENEFITS

- Extending the building's useful life, blending heritage with contemporary design.
- Improved energy efficiency, cutting costs and CO_2 emissions.
- Socio-economic benefits for society, by supporting local jobs and skills development, as well as providing attractive amenities and public realm.

BUILDING PERFORMANCE

- EPC: B rating (Originally E rating)

BENCHMARKING:

- BREEAM: Very Good (Offices 2008, Major Refurbishment)

SELECTED LESSONS LEARNT

- The Grade II listing meant that interventions such as new roofs and windows were not permitted. Therefore, to meet the client's aspiration of a Grade A space, areas of existing slate roof were dismantled, insulated, and re-laid, incorporating insulation to exceed current standards.
- Improved airtightness and thermal performance were achievable with the introduction of secondary glazing, reducing noise intrusion from the surrounding area whilst being sympathetic to the existing window casements.
- Manchester City Council wanted to retain and keep visible the original moulded ceilings details. Therefore, the design team was tasked with developing a HVAC solution that not only provided Grade A performance but also left the soffits relatively unobstructed. The engineering team was able to develop a solution that was concealed and routed below the floor. Unobtrusive lighting was specified, with up lighting chosen to emphasise the ceiling features and promote the different textures of the space.

Definitions

Transition risk: The risk associated with transitioning to a lower-carbon economy. This may entail extensive policy, legal, technology, and market changes to address mitigation and adaptation requirements related to climate change. Depending on the nature, speed, and focus of these changes, transition risks may pose varying levels of financial and reputational risks to organisations[16].

Stranded assets: assets that have suffered from unanticipated or premature write-downs, devaluation or conversion to liabilities. In recent years, the issue of stranded assets caused by environmental factors, such as climate change and society's attitudes towards it, has become increasingly high profile[17].

Materials passports: places to gather and organise data about materials contained within a building. For the design team, it captures information from surveys and other information sources. For operations teams, it provides a single location to record or link maintenance information[18].

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