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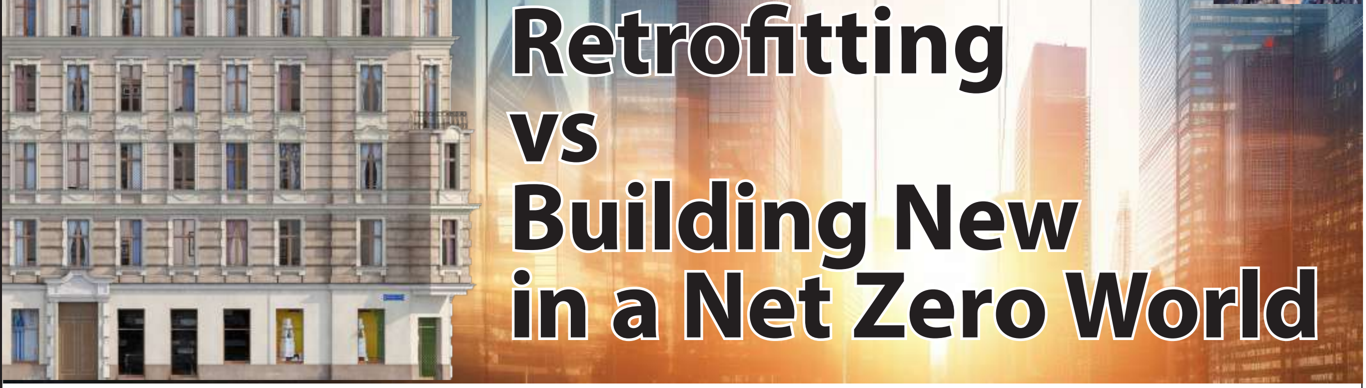

Retrofitting vs Building New in a Net Zero World

The buildings sector represents 40% of Europe's energy demand. Positively the sector's intensity in carbon emissions per metre squared has dropped, and investments in building energy efficiency have gone up; however, growth is outpacing efforts (UNEP, 2022). In the UK, construction, demolition and excavation account for 60% of material use and waste generation. This calls for urgent action and a fundamental shift in the way we are designing and delivering building projects, challenging current construction practices and the extensive use of natural resources.

To get to net zero, radical reductions in carbon emissions from the building sector need to be achieved; we simply cannot afford to continue the pace of demolishing and building new. A circular economy system, where materials never become waste and nature is regenerated, offers huge opportunities to minimise impact and protect our natural resources.

The decision between retrofitting or building new is not always an easy one and can be quite challenging to reach. Building owners and professionals in the building sector will need to consider several different parameters to help them in the decision-making process:

1. Structural integrity

First and foremost, the structural integrity of the existing building needs to be reviewed. To ensure a retrofit is feasible, confidence needs to be gained that the structure of the building is sound and will support a deep retrofit and an extension of the building's lifespan. However, even in cases when the structural integrity has been compromised, there may be solutions to consider, such as underpinning to strengthen foundations and other remedial actions; and therefore, retrofit shouldn't be discarded too soon.

2. Operational energy

Questions like, "How low is low energy demand for a retrofitted building?", "How does this compare to a new build?" and "What does best practice look like?" will need to be addressed.

There are building standards and guidelines such as EnerPhit for deep retrofitting and LETI/RIBA 2030 to support climate emergency design and ensure very low energy demands and high thermal comfort levels for building occupants. For example, a new building built under the Passivhaus standard can achieve 15 kWh/(m^{2}a) for heating while a retrofitted building under the EnerPhit standard can achieve 20 kWh/(m^{2}a).

The reason for this difference is because some building elements such as the orientation of the building, structural characteristics and thermal bridges cannot be changed in a retrofit project. However, energy demands can still be minimised and performance levels can be very close for both options.

Thermal performance of the building envelope is only one element affecting operational energy. Heat decarbonisation is high on the agenda for many building owners. The strategic approach would be to tackle both thermal performance and heat decarbonisation together. Significantly reducing energy demands will ensure a smooth transition from traditional fossil fuel-based heating systems to electrified low carbon/renewable systems. This is also an opportunity to think long-term regarding the adaptation of buildings to a changing climate and the continuously increasing cooling energy demands in the UK.

3. Carbon

Carbon emissions resulting from

the operational energy use is only one part that needs to be considered. When addressing the carbon impact as part of the decision-making process, it is important to look at the whole life carbon of the different options. That will include "cradle to gate" embodied carbon which refers to the emissions associated with the production of building materials, from raw material extraction to the manufacturing, transportation and end of life emissions. A whole life carbon (WLC) assessment such as the one under RICS Professional Standard should be followed.

4. Lifespan and adaptation

In most cases, building owners need to take a decision regarding the future of a building when the building is close to the end of its life or when there is considerable investment needed to rectify issues. The extended lifespan is another important decision-making criterion to be considered when compared to the lifespan of a newbuild. In addition, adaptation to climate change needs to be considered for both options.

5. Internal layouts and size

Since its construction, the way the building is used has likely dramatically changed. The reasons vary from a growing business that needs more space for staff and collaborators, to the reduced space demand because of hybrid and remote working, to new ways of collaborative working requiring more open plan than cellular offices. Both options of retrofitting and building new need to be fit for purpose and fit for the future.

For retrofitted options, changing internal layouts can be challenging and some compromises might need to be made. This can also impact the new standards regarding floor to ceiling height that might need some creative thinking to improve internal space conditions. Exposing services on the ceiling is one way of addressing this, when floor to ceiling height is lower than aspired, which will give a more industrial look to the space. Great example of a retrofitted building that adopted such an approach is the Entopia building of the Cambridge Institute for Sustainability Leadership.

6. Maintenance

Maintenance requirements both day-to-day and longer term is another parameter to consider for both options when choosing materials and building systems. With an ever-growing demand on new skills and the market adapting at a slower pace, the skills gap is growing fast. A durable design will therefore lead to improved resilience and a longer lasting asset.

7. Circular economy

Adopting circular economy principles, irrespective of the decision, will ensure responsible sourcing of materials, minimising waste that can lead to reduced long-term costs, designing for adaptation and disassembly; while retaining the materials' value to allow them to be reused.

More and more tools are now being developed to help designers integrate circularity in projects; from measuring the circularity of your design, working out the percentage of recycled content in materials and products, testing various material options to identify where savings can be made as well as different scenarios for reducing the end-of-life impact.

Another area to apply circular economy principles is when choosing furniture for your space; from the use of repurposed furniture giving them another life, to incorporating modular elements and designing for disassembly and life extension.

For newbuild options, a survey to identify opportunities for materials to be recovered and reused in the new structure needs to be planned early on.

Gaining traction in this space, platforms for circular management, reuse of building materials, fixtures and furniture, refurbishing and renting office furniture as well as software and tools to help incorporate circular economy and wider sustainability into the design process can be found under the UK Green Building Council Solutions.

8. Decanting and disruption

Decanting and minimising disruption is another parameter to review for both options. Strategies for alternative temporary accommodation and phasing of the project, while construction activities are taking place, can minimise disruption and impact to operations but they could also have a significant impact on the overall cost of the project.

9. Cost

No doubt cost is an important factor when the two options are being considered. Whole life carbon needs to be assessed along with whole life costs to support decision making.

The weighted factors against the above criteria may vary between different decision-makers. However, it's important that any decision is backed by a thorough feasibility analysis that has considered all the above.

In both cases, a sustainability strategy needs to be developed with strong ambitious targets very early on to guide decision-makers and ensure sustainability is embedded into all work stages of the project.

For inspiration, **best practice and award-winning examples of retrofit projects** include the 1930's telephone exchange Entopia building that now hosts Cambridge Institute for Sustainability Leadership. Entopia has achieved BREEAM Outstanding, the Passivhauss 'EnerPHit' standard, and WELL (Gold) and is expected to reduce whole life carbon emissions by 80% across the building's assumed 100-year lifespan, compared to a standard office refurbishment. Park Hill Phase 2, a refurbishment with increased fabric efficiency of an iconic Grade II Listed estate in Sheffield is designed to deliver an 87% reduction in operational emissions and a 55% improvement in whole life embodied carbon compared to a good practice new build.

For **best practice new build**, the Forge is the first commercial building designed in line with the UK Green Building Council's definition of net zero and the first office to be built using the highly sustainable platform approach to design for manufacture and assembly (P-DfMA). The Enterprise Centre at the University of East Anglia achieved Passivhaus and BREEAM Outstanding and reduced embodied carbon by 65% compared to a conventional higher education building at the time by using reclaimed/recycled and local materials.

The Enterprise Centre

Author's profile:

Nopi is an engineer by background with more than 15 years of experience in sustainability. At BAS, she is responsible for the strategic delivery of the net zero programme and leads the Net Zero Team. Her special focus is decarbonising the BAS infrastructure, transport and logistics, and supply chain activities in Cambridge and Antarctica. Nopi is a member of the EMA Steering Group.

The **Enterprise Centre** is an innovative dual purpose teaching building and business hub. At the time of completion, it was the largest Passivhaus building in the UK and its design has gone on to confirm other Passivhaus major scale buildings. Constructed from materials such as timber, local thatch and reclaimed materials, it was completed in 2015. The average energy consumption in the first three years was lower than initially predicted and has remained consistent over the nine years since completion. This is evidenced by consistently achieving an energy certificate rating of DEC A annually.

A full life-cycle analysis study was completed during construction of the building, with an annual prediction of 446 $kgCO_2e/m^2$ emissions over the 100-year cycle, for which the building was designed. That figure is approximately 20% of a conventional university building. In 2021, the embodied carbon methodology and modelling were revisited to incorporate advancements in the field and ensure accuracy of the figures. Although the building was designed in 2012-2013 and completed in 2015, it does meet the 2030 RIBA and LETI targets, including biogenic storage.

In terms of practical and demonstrable achievements, the building's primary energy demand is less than 47 kWh/m annually and airtightness is under 0.21 ach/h @50 Pa. Annual energy consumption figures compare positively even against the University's next most sustainable building, which has an energy demand of 102 kWh/m annually. The excellent energy efficiency of the building means that utility bills are 90% less than a comparable building, with photovoltaic roof tiles providing 23% of the building's energy demand.