Case Studies Guide

REDUCE ENERGY COSTS IN YOUR BUSINESS PREMISES

A Case Studies Report for Energy-Smart Upgrades for SME Building Owners and Occupiers

June 2025

ENACT

Enabling Business Energy Upgrades

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Executive summary

Context and Objectives

Ireland's small and medium enterprise (SME) commercial building stock represents a substantial part of the national energy landscape, with around 248,000 SMEs occupying a total of 109,000 commercial sector buildings. Only a smaller portion of these commercial buildings have undergone deep energy retrofits, indicating a large untapped potential for efficiency improvements. This study was undertaken in the context of Ireland's climate goals, rising energy costs, and new regulations that are pushing the SME property sector to improve energy performance. It aims to shed light on how and why Irish businesses are upgrading their premises, and what can be learned to accelerate energy renovations in the SME sector.

Methodology

The research used a case study approach based on a structured survey of SME business property renovations.

Data Collection: A comprehensive questionnaire was distributed via industry networks (e.g. Society of Chartered Surveyors Ireland and SEAI) and online channels, gathering detailed information on recent retrofit. In total, 29 survey responses were received; 23 of these were developed into in-depth case studies spanning various business types (retail, offices, hospitality, industrial, and others) across Ireland. Each case documents the building's characteristics, the energy upgrade measures implemented, costs, timeframes, and perceived outcomes. This provided both quantitative data (energy savings, costs, payback periods) and qualitative insights (challenges faced, motivations, co-benefits). It should be noted that participation was voluntary, which may introduce some selection bias (i.e. more proactive firms are represented. Nonetheless, the sample offers valuable real-world insights into SME renovations. The analysis distils common patterns and lessons from these cases to inform wider policy and practice.

Key Findings

- **Technical:** SMEs employed a broad range of energy efficiency measures tailored to their needs. Nearly all case studies implemented **lighting and HVAC upgrades**, often swapping outdated equipment for LED lighting, heat pumps, or modern ventilation systems – quick-win measures that are cost-effective and minimally disruptive. Many businesses also integrated **renewable energy**, especially solar PV arrays, to offset electricity use and cut carbon emissions. Deeper retrofits included **building fabric**

improvements (insulation, high-performance windows, air-tightness) mainly in older buildings, which achieved significant improvements in energy ratings and comfort. Overall, the case studies highlight that even targeted system upgrades can yield substantial energy savings, while comprehensive renovations deliver greater long-term benefits in efficiency and carbon reduction.

- **Financial:** The **investment costs** for renovations varied widely, from small upgrades under €20,000 to extensive projects exceeding €2 million. This range reflects the scale and depth of works, for example, simple lighting or boiler replacements versus full building overhauls. **Payback periods** (time to recover costs from energy savings) also ranged dramatically, from less than 1 year in the best cases to well over 60 years in deep retrofits. In general, modest interventions had short paybacks (often under 5 years), whereas comprehensive retrofits often exceeded typical business investment horizons (paybacks of 10+ years). Many of the **deeper projects were not financially justified by energy savings alone**, but companies pursued them by considering broader returns – leveraging grants, expecting improved property value, compliance with future standards, or enhanced brand image. This underscores that without external support or co-benefits, purely economic motivation for deep energy renovations can be low for SMEs.

- **Strategic Drivers:** Businesses often undertook renovations for strategic reasons beyond just cutting utility bills. **Commercial objectives** were a major factor – about 44% of projects were motivated by business goals such as attracting tenants, increasing asset value, or repositioning a property in the market. Another roughly one-third of renovations were driven by **sustainability and ESG commitments**, with companies aiming to reduce carbon footprints or meet corporate responsibility targets. The remainder had varied motivations: a subset saw the upgrade as part of a **business expansion or opportunity** (e.g. building extensions or showcasing capabilities), while others were prompted by desires to **improve aesthetics, comfort, or functionality** in ageing premises. These findings show that energy upgrades are often embedded in broader strategic decisions, combining financial reasoning with improvements to brand image, work environment, and regulatory readiness.

- **Challenges:** SME owners reported numerous barriers that can hinder or slow renovations. While financing is a well-recognised hurdle, the case studies reveal that challenges extend beyond just upfront costs. Approximately one-third of projects encountered financial or bureaucratic obstacles – for example, difficulties in navigating grant applications, limited access to capital, or slow approval processes. Another third faced technical and workforce issues, such as limited contractor availability or skill gaps in energy retrofit expertise, along with design constraints in older buildings (e.g. structural limits or heritage considerations). Additionally, around 20% of cases struggled with operational disruptions, where carrying out work in occupied, busy premises proved problematic. For instance, businesses in retail and hospitality often could only attempt shallow retrofits to avoid disturbing trading, necessitating the scheduling of work off-hours or in phases. These challenges highlight the need for solutions that make renovations more feasible for SMEs with limited time, knowledge, or flexibility.

Implications for Policy and Practice

The study's findings carry important implications for policymakers, industry professionals, and SME business owners aiming to scale up energy renovation in the commercial sector.

Policy Support: There is a clear need to strengthen support mechanisms that address the financial and technical barriers. Simplifying access to grants and providing **one-stop advisory services for SMEs** can greatly lower the entry hurdles for businesses to undertake retrofits. Incentive programs should not only focus on energy cost savings but also recognise and reward the broader benefits of deep renovations – for example, by factoring in **co-benefits** like comfort, resilience, and increased asset value into grant criteria.

Strategic Approaches: The results indicate that a flexible, phased renovation approach can help SMEs align energy upgrades with their business cycles and reduce disruption. For instance, policies could encourage using natural **trigger points** (such as vacancy periods or lease changes) to implement deeper measures and develop **disruption-mitigation toolkits** (guidance on phased works, night/weekend construction, etc.) to help businesses manage retrofits with minimal downtime.

Quality and Performance: To ensure effective outcomes, the sector must invest in skills and accountability. Setting standards or requirements for using **qualified retrofit professionals** (and linking grant eligibility to the same) would improve project quality and confidence. Moreover, monitoring actual building performance post-renovation is critical – measures like wider use of **Display Energy Certificates (DECs)** and energy audits alongside BER ratings can give a more accurate picture of results and build a data-driven case for renovations.

In summary, Ireland’s SME commercial property sector holds significant opportunities for energy renovation that can drive climate progress, cost savings, and business value. Achieving this potential will require integrated efforts: lowering financial and knowledge barriers, promoting long-term planning and innovation in retrofit solutions, and aligning policy incentives with real-world outcomes. By implementing these insights – from technical quick wins to strategic support frameworks – stakeholders can substantially accelerate the rate of energy upgrades in SME businesses, delivering benefits for companies, the economy, and the environment.

Acknowledgement

We would like to express our sincere gratitude to all the participants who contributed to our case study analysis, which enabled us to develop this deliverable for T2.3 (Case Studies). The insights, opinions, and experiences gained have been an invaluable source of information, helping us better understand the process and issues surrounding renovations of typical commercial buildings occupied by businesses in the small and medium sectors in Ireland. The project team would like to thank SEAI and the ENACT steering group for their continuous support. Furthermore, we would like to thank Construct Innovate for providing the project with additional case studies.

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1. Introduction

According to the Sustainable Energy Authority of Ireland (SEAI), retrofitting Ireland's commercial and public sector buildings is pivotal for achieving the nation's 2030 and 2050 decarbonisation targets. Beyond reducing greenhouse gas emissions, energy efficiency measures provide substantial environmental, health, social, and economic benefits that are often underappreciated. The built environment in Ireland accounts for approximately 37% of national greenhouse gas emissions, with around 23% originating from operational emissions, such as heating, cooling, and lighting, and 14% from embodied carbon associated with construction, maintenance, and end-of-life processes. This includes operational emissions from the commercial property sector, which encompasses an estimated 109,000 buildings.[1]

A survey carried out by the SEAI on the commercial building stock across Ireland suggests that even basic upgrades such as lighting, heating controls, and improved glazing with enhanced solar performance can lead to significant reductions in the energy consumed by the operation of the buildings.[2] Through practical experience, it has been observed that Small and Medium-sized Enterprises (SME) have the potential to cut down their energy expenses by around 30% through the adoption of energy through energy efficiency practices. Notably, a significant 10% reduction can be made without incurring substantial upfront capital costs.[3]

SEAI's roadmap for Ireland emphasises that decarbonising the building stock presents challenges at various levels. The strategy includes:

- **Addressing energy efficiency first through fabric upgrades:** Prioritising improvements to the building envelope, such as insulation and window upgrades, to reduce heating and cooling demand.

- **Reducing direct emissions from thermal energy by using low-carbon renewable heat technologies:** Transitioning from fossil fuel-based boilers to heating solutions like heat pumps and district heating systems that utilise renewable energy sources.

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[1] https://data.oireachtas.ie/ie/oireachtas/committee/dail/33/joint_committee_on_housing_local_government_and_heritage/reports/2022/2022-10-14_report-on-embodied-carbon-in-the-built-environment_en.pdf

[2] https://www.seai.ie/publications/Extensive-Survey-of-Commercial-Buildings-Stock-in-the-Republic-of-Ireland.pdf

[3] https://www.seai.ie/publications/SME-Guide-to-Energy-Efficiency.pdf

- **Establishing a pathway to achieve net-zero emissions across the building stock:** Developing long-term strategies and policies to guide the building sector towards complete decarbonisation by 2050.

1.1 Climate and Biodiversity Goals

Ireland was the second country in the world to declare a climate and biodiversity emergency in 2019.[4] The Irish declaration continues to recognise the interdependence between climate action and environmental protection. The country is already experiencing the effects of climate change, such as increased flooding, rising sea levels, and extreme weather events. This underscores the urgency of adopting proactive and far-reaching measures to build resilience across all sectors of the economy. The Irish government acknowledges that limiting global warming to 1.5°C will require rapid, systemic transformations in how we live, work, and build.

To support this transition, Ireland has committed to a 51% reduction in greenhouse gas emissions by 2030, as mandated by the Climate Action and Low Carbon Development (Amendment) Act 2021.[5] It sets a binding target of reducing national greenhouse gas (GHG) emissions by 51% by 2030 (compared to 2018 levels) and achieving climate neutrality by 2050. The built environment sector, encompassing residential, public, and commercial buildings, is a significant contributor to national emissions. In 2022, this sector accounted for 11.1% of Ireland's total greenhouse gas emissions.[6]

To address this, the government has set sector-specific limits under the Sectoral Emissions Ceilings, published in July 2022.[7] For commercial and public buildings, emissions are capped at 7 $MtCO_2e$ for 2021–2025 and reduced to 5 $MtCO_2e$ for 2026–2030. The overall sectoral reduction target by 2030 is to be 45% below 2018 levels.

Ireland's National Climate Action Plan 2024 (CAP2024) sets out the government's pathway for meeting these legally binding targets.[8] Key goals for the buildings sector include:

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[4] https://www.oireachtas.ie/en/debates/debate/dail/2019-05-09/32/
[5] https://www.irishstatutebook.ie/eli/2021/act/32/enacted/en/print
[6] https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/irelands-provisional-greenhouse-gas-emissions-1990-2022.php
[7] https://assets.gov.ie/static/documents/sectoral-emissions-ceilings-summary-report.pdf
[8] https://www.gov.ie/en/department-of-the-environment-climate-and-communications/publications/climate-action-plan-2024/

- **Energy Efficiency:** A 45% reduction in emissions from commercial and public buildings by 2030 is targeted, alongside a 40% reduction in residential buildings.

- **Renovations Goals:** Prioritising the fabric-first approach (insulation, windows, airtightness) and switching to low-carbon heating systems.

Complementing CAP24, the Long-Term Renovation Strategy (LTRS), submitted to the European Commission in 2020, sets forth ambitions for the commercial sector:[9]

- **By 2030:** One-third of commercial buildings to achieve a BER of B or higher.

- **By 2040:** Indicative milestone for two-thirds of commercial buildings to reach a BER of B or higher.

- **By 2050:** Indicative milestone for all commercial buildings to attain a BER of B or higher.

The Heat and Built Environment Taskforce, established in 2023, is instrumental in coordinating efforts to meet these targets, focusing on implementing energy efficiency measures across both residential and commercial buildings.[10]

These initiatives underscore Ireland's commitment to mitigating climate change impacts, such as increased flooding and extreme weather events, by enhancing the energy performance of its building stock and promoting sustainable practices.

1.2 Regulatory Drivers

The regulatory landscape in Ireland is evolving to support the decarbonisation of the built environment, aligning with both national objectives and European Union directives. Two primary regulatory domains influence commercial building retrofits: energy performance regulations and sustainable finance reporting obligations.

1.2.1 Energy Performance

The revised Energy Performance of Buildings Directive (EPBD), formally Directive (EU) 2024/1275, entered into force on 28 May 2024. Member States, including Ireland, are required to transpose the directive into national legislation by 29 May 2026.

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[9] https://assets.gov.ie/static/documents/irelands-long-term-renovation-strategy-2020.pdf
[10] https://www.gov.ie/en/department-of-the-environment-climate-and-communications/publications/heat-and-built-environment-taskforce/

Key provisions of the EPBD impacting commercial buildings include:

- **Minimum Energy Performance Standards (MEPS):** Mandating the renovation of the worst-performing 16% of non-residential buildings by 2030 and 26% by 2033.
- **Building Renovation Passports:** Introducing tools to guide staged renovation planning for individual buildings.
- **Whole-Life Carbon Assessments:** Requiring evaluations that encompass both operational and embodied emissions throughout a building's lifecycle.
- **Inclusive Renovation Financing:** Emphasising support for vulnerable users and Small and Medium-sized Enterprises (SMEs) to ensure equitable access to renovation initiatives.

Under the transposition of the EPBD into Irish law, these measures will be designed to accelerate the decarbonisation of Ireland's building stock, contributing to the national target of reducing greenhouse gas emissions by 51% by 2030, as outlined in the National Climate Action Plan 2024.

1.2.2 Sustainable Finance Regulatory

In addition to energy performance mandates, Ireland has integrated key European sustainable finance regulations into its national framework. These frameworks are increasingly shaping investment flows, risk management, and strategic planning for stakeholders in the commercial real estate sector, including both large corporations and SMEs.

Corporate Sustainability Reporting Directive (CSRD)

The CSRD was transposed into Irish law via the European Union (Corporate Sustainability Reporting) Regulations 2024, effective from 6 July 2024. It expands the scope and detail of sustainability reporting across the EU, requiring companies to disclose information in line with the European Sustainability Reporting Standards (ESRS).

Reporting obligations apply from financial years starting on or after 1 January 2024 for public interest entities previously subject to the Non-Financial Reporting Directive (NFRD).

Originally, the plan was that other large companies and listed SMEs would also be obliged to report from 1 January 2025 onwards (on a phased basis). However, as at the time of writing, the application of CSRD reporting to any other companies has been deferred for two years (i.e. the next wave of companies will start reporting in respect of financial years starting on or after

1 January 2027). In addition to the deferral, there is ongoing debate at the EU Parliament and EU Council in relation to simplification measures proposed by the European Commission. These measures will result in some companies falling out of the scope of reporting completely, and for those that remain within scope, the disclosure requirements should be simplified and reduced.

While SMEs were never within the scope of CSRD reporting, indirect exposure through supply chain requirements, investor expectations, and tenant demands means that it may be increasingly relevant to SMEs, especially those seeking funding, entering leasing arrangements, or serving larger clients who must report. Demonstrating ESG alignment may influence financing access, leasing decisions, and valuations for property owners and occupiers.

Sustainable Finance Disclosure Regulation (SFDR)

The SFDR, already in effect in Ireland, imposes mandatory ESG disclosure obligations on financial market participants, including asset managers, insurers, and pension funds. It requires firms to:[11]

- Integrate sustainability risks into investment decisions
- Disclose how ESG factors are considered at both the entity and product level

Although SFDR applies primarily to the financial sector, it has downstream effects on the real estate market. Investors are increasingly favouring assets, including commercial buildings, that meet environmental criteria, such as energy efficiency and climate resilience. This shift is creating market incentives for SMES and commercial property owners to enhance the sustainability performance of their properties.

1.3 Market and Economic Drivers

In addition to the compliance-based drivers, such as previously seen climate and energy regulations, opportunity-based drivers, like market and economic rationally for retrofitting, are increasingly compelling. A combination of financial incentives, market dynamics, and regulatory pressures drives them.

[11] https://www.centralbank.ie/docs/default-source/regulation/industry-market-sectors/funds/industry-communications/sustainable-finance-asset-management-sector-disclosures-investment-processes-risk-management.pdf?sfvrsn=996f9b1d_5

1.3.1 Risk of Asset Devaluation and Obsolescence

Buildings with poor energy performance are at heightened risk of becoming "stranded assets," facing reduced rental income and declining capital values. The Society of Chartered Surveyors Ireland (SCSI) highlights that office buildings with low Building Energy Ratings (BER) may become unlettable unless energy efficiency is improved.[12] SCSI's 2025 Real Cost of Retrofitting report indicates that retrofitting can increase rental income by 40% to 66%, enhancing asset value and marketability.

1.3.2 Operational Cost Savings

Energy efficiency measures can lead to significant reductions in operational costs. The SEAI notes that SMEs can achieve energy cost savings of up to 30%, with approximately 10% achievable without substantial capital investment.

1.3.3 Access to Green Financing

Financial institutions are increasingly offering green financing options, including preferential loan terms for energy-efficient upgrades. The EU Taxonomy and SFDR frameworks encourage investment in sustainable assets, making retrofitted buildings more attractive to investors seeking to meet ESG criteria.

1.3.4 Regulatory Compliance and Incentives

Compliance with evolving regulations, such as the EPBD, necessitates energy performance improvements in commercial buildings. Non-compliance may lead to penalties or reduced market competitiveness. Conversely, government incentives and grants are available to support retrofitting efforts, offsetting initial costs and improving return on investment.

1.3.5 Enhanced Marketability and Occupant Demand

There is a growing demand for energy-efficient buildings among tenants and buyers, driven by increased awareness of sustainability and operational cost savings. Retrofitted buildings often experience higher occupancy rates and tenant retention, contributing to stable income streams and reduced vacancy periods. Recent findings from the SCSI Commercial Property Market Monitor 2025 highlight this trend:[13]

- 54% of surveyors report increased occupier demand for energy-efficient office spaces.

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[12] https://scsi.ie/real-cost-of-retrofitting/
[13] https://scsi.ie/wp-content/uploads/2025/02/SCSI-Commercial-Property-Monitor-2025.pdf

- 71% anticipate growing demand for retrofitting, particularly in office properties.

These insights underscore the market's shift towards prioritising sustainability in commercial properties, reflecting the enhanced marketability and occupant demand for energy-efficient buildings.

2. Context and Renovation Landscape Overview

2.1 SME Property Sector Emissions and Energy Insights

SMEs constitute a significant portion of Ireland's commercial property sector, with approximately 248,344 SMEs operating across the country. The commercial building stock in Ireland comprises around 109,000 buildings, with a diverse range of energy efficiency levels. Notably, only 4% of these buildings have undergone deep retrofitting, indicating a significant opportunity for energy efficiency improvements within the SME sector. In 2023, the commercial services sector, which encompasses a substantial number of SMEs, experienced a 6.9% increase in energy demand, primarily driven by heightened activity in data centres and related services. Electricity and natural gas are the predominant energy sources for commercial buildings. In 2021, purchases of electricity and natural gas constituted 62% of total energy costs incurred by enterprises, underscoring the financial impact of energy consumption of commercial stock.

2.2 Definition of Energy Renovation and Non-Energy Renovations

Within the EU framework, energy renovations refer to physical interventions in a building that improve its energy performance by reducing primary energy demand. These include upgrades to thermal insulation, windows, HVAC systems, lighting, or other technical building systems. According to the report published by the EU Commission on building renovation activities, any modification to the building envelope or technical systems that results in measurable energy savings qualifies as an energy renovation.[14]

In contrast, non-energy renovations are works that do not lead to significant changes in energy consumption. These include repairs, aesthetic upgrades, safety improvements, or space modifications that do not affect energy performance. The report clarifies that non-energy renovations may involve structural repairs, re-roofing, or interior refurbishments that are unrelated to energy use.

[14] https://energy.ec.europa.eu/publications/comprehensive-study-building-energy-renovation-activities-and-uptake-nearly-zero-energy-buildings-eu_en

The Commission Recommendation (EU) 2019/786 emphasises the importance of clearly distinguishing energy renovations from other types of building work.[15]

However, discrepancies remain across EU Member States in how these definitions are applied in practice. The absence of harmonised legal definitions in the EPBD has led to varying national interpretations, particularly in distinguishing low-impact energy actions from non-energy renovations.

2.3 Renovation Depth in the Commercial Sector

Not all commercial buildings require the same measures or level of intervention when undergoing renovation. Some may achieve substantial energy savings through relatively minor upgrades, while others require significant changes to the building's energy-consuming systems to reach higher levels of performance. Therefore, renovations must be assessed and implemented by appropriately qualified professionals who can determine the building's condition and recommend suitable efficiency measures.

Renovation Depth reflects the extent to which a building's energy performance is improved. Renovation depth refers to the extent or magnitude of improvement in a building's energy performance following renovation. It typically captures how comprehensive and impactful the upgrades are — both in terms of energy savings and the scope of physical changes to the building.

It is most often expressed as the percentage reduction in primary energy consumption after renovation relative to its pre-renovation state. Based on one of the EU Commission's reports:[16]

- Light Renovation: Primary energy savings of 3 to 30%
- Medium Renovation: Primary energy savings of 30% to 60%
- Deep Renovation: Primary energy savings exceeding 60%

A Nearly Zero-Energy Building (NZEB) renovation is a further category aimed at aligning the building with national NZEB definitions. Though not tied to a fixed savings percentage, such renovations typically imply very high energy performance through comprehensive upgrades, including renewable energy integration.

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[15] https://op.europa.eu/publication-detail/-/publication/4a4ce303-77a6-11e9-9f05-01aa75ed71a1
[16] https://energy.ec.europa.eu/document/download/2b58c118-89c1-46b5-a450-0f2d5d215e2c_en?filename=1.final_report.pdf

In some EU studies, an additional category, Below-threshold renovation, denotes savings below 3%. This helps filter out negligible works when assessing the impact of national renovation policies.

The Renovation Depth is commonly calculated using:

$$Depth\ of\ Renovation\ (\%) = \frac{(Energy\ Use\ Before\ Renovation - \ Energy\ Use\ After\ Renovation)}{\text{Energy Use Before Renovation}} \times 100$$

For example, a building reducing its primary energy demand from 300 kWh/m²/year to 150 kWh/m²/year would achieve a renovation depth of 50%, placing it in the medium renovation category.

While energy savings are a useful indicator, relying solely on percentage reduction to classify renovation depth (e.g., “light, medium, deep”) has critical limitations. As acknowledged by the International Energy Agency (IEA) Annexe 56, European Commission Joint Research Centre (JRC), and the Buildings Performance Institute Europe (BPIE), the Renovation Depth is best understood as multi-dimensional, requiring consideration of technical scope, ambition, and building context, not just consumption metrics.[17] [18] [19]

The IEA Annex 56 highlights that renovations should be evaluated not only for their energy or carbon reduction potential but also based on cost-effectiveness, occupant comfort, and extent of physical interventions across building systems and envelope. Similarly, the JRC Science for Policy Report on regional renovation typologies emphasises the need for multi-criteria assessment frameworks to overcome the inconsistencies caused by varying national definitions and data gaps in actual energy performance tracking.

Frameworks such as the Smart Readiness Indicator (SRI) and Building Renovation Passport (BRP) go further by integrating aspects like digital systems, comfort, health, flexibility, and step-by-step planning toward deeper renovation targets. These evolving models collectively show that percentage-based thresholds alone may misrepresent the true impact of a

[17] https://www.iea-ebc.org/Data/publications/EBC_PSR_Annex_56.pdf
[18] https://publications.jrc.ec.europa.eu/repository/handle/JRC122143
[19] https://www.bpie.eu/wp-content/uploads/2017/09/Factsheet_D-170918_Final-2.pdf

renovation, especially when deeper systemic changes or innovative controls are in place that aren't reflected in simple energy data.[20]

2.4 Building Stock Obsolescence

Obsolescence in commercial property refers to the condition in which a building, or its components, no longer meets functional, economic, environmental, or regulatory expectations, even if the structure remains physically intact.[21] Unlike physical degradation alone, obsolescence is influenced by a combination of technical, economic, environmental, and market-related factors that evolve.

In the context of Ireland's ageing commercial building stock, obsolescence presents a strategic risk to asset owners and investors. Buildings may become outdated due to:[22]

- **Functional limitations** (e.g. poor thermal comfort, outdated HVAC systems)
- **Economic underperformance** (e.g. high vacancy rates, low rental yield)
- **Environmental misalignment** (e.g. poor BER ratings, high operational emissions)
- **Regulatory non-compliance** (e.g. inability to meet upcoming MEPS or EPBD thresholds)

Recent research analysing asset-level and corporate-level data from UK real estate investment portfolios further underscores the risk of obsolescence linked to poor energy performance.[23] The study found that approximately 6.9% of UK commercial real estate assets held by institutional funds were at risk of becoming stranded, primarily due to failure to meet Minimum Energy Efficiency Standards (MEES). This mirrors growing concern across European markets, including Ireland, where environmental misalignment is now recognised as a material risk to asset value and liquidity.

[20] https://build-up.ec.europa.eu/en/resources-and-tools/articles/how-epcs-are-shaping-new-developments-epbd-recast
[21] https://www.researchgate.net/publication/233429034_Understanding_obsolescence_A_conceptual_model_for_buildings
[22] https://www.researchgate.net/publication/254908377_Obsolescence_and_the_end_of_life_phase_of_buildings
[23] https://www.researchgate.net/publication/384012649_ESG_in_Commercial_Real_Estate_An_analysis_of_asset-level_and_corporate-level_data_for_UK_Funds_and_Real_Estate_Investment_Trusts_REITs

While these findings primarily reflect institutional portfolios, the implications are equally relevant for SMEs, particularly those operating in older or lower-rated buildings, which may face future compliance barriers, declining tenant interest, or reduced access to finance without proactive energy upgrades.

2.5 Regulated and Unregulated Energy in Business Operations

In the context of commercial building performance, understanding the distinction between regulated and unregulated energy is fundamental to evaluating actual operational efficiency. These two categories together represent the total energy demand of a building, yet they are often addressed separately in both design and retrofit strategies.

Regulated energy refers to the energy use associated with fixed, controllable building services governed by building usage. This includes systems such as:

- Space heating and cooling
- Domestic hot water production
- Ventilation
- Fixed lighting
- Fans and pumps

These are typically modelled during the design stage using standardised methodologies and form the basis for compliance with Building Energy Rating (BER) assessments and national energy performance standards.

In contrast, unregulated energy includes energy consumed by equipment and processes that fall outside the scope of building regulations. Common examples include:

- IT servers, computers, monitors, printers
- Commercial kitchen appliances
- Lifts and escalators
- Retail display lighting
- Personal or tenant-supplied equipment

Unregulated energy is heavily influenced by occupant behaviour, equipment selection, and building use patterns, and is often only assessed later in the design process via detailed energy modelling. As a result, it is frequently underrepresented in early-stage decision-making, despite its significant contribution to actual operational energy use, especially in high-usage sectors such as hospitality, retail, and IT-heavy office environments. For a truly holistic approach to building performance, energy management strategies must address both regulated and unregulated energy. Doing so ensures that operational savings are maximised, emissions reduction targets are achievable, and retrofit investments deliver full lifecycle value.

2.6 BER, Energy Audits and DEC

Assessing and improving the energy performance of commercial buildings in Ireland relies on two fundamental tools: the BER and the Energy Audit. While both aim to identify energy usage and highlight opportunities for efficiency improvements, they differ in scope, methodology, and regulatory purpose.

2.6.1 Building Energy Rating

The BER is a standardised, asset-based energy performance certification system for buildings, administered by the SEAI. It provides a visual rating scale from A1 (most efficient) to G (least efficient) and is required for most commercial buildings being sold or rented.

- The BER is calculated using the Non-Domestic Energy Assessment Procedure (NEAP), which models regulated energy consumption only, such as space heating, cooling, ventilation, hot water, and lighting.
- It reflects the theoretical efficiency of the building based on fixed building services and envelope performance but does not account for unregulated energy use such as equipment, occupant behaviour, or actual energy consumption.

The BER is often used as a benchmark by owners and investors to track renovation impact, asset quality, and compliance with policy targets.

2.6.2 Energy Audits

An Energy Audit, in contrast to BER, is a comprehensive evaluation of actual energy consumption, including both regulated and unregulated energy use. Required under the EU Energy Efficiency Directive (2012/27/EU) for large enterprises and recommended for SMEs, an audit typically involves:

- Detailed analysis of energy bills, sub-metering data, and site inspections
- Identification of all major energy-consuming systems, including equipment, processes, and tenant-driven loads
- Practical, costed recommendations for reducing energy use and improving operational efficiency

Energy audits can be carried out to IS 393, ISO 50002, or ASHRAE Level 1–3 standards, depending on the complexity and purpose. Together, the BER and energy audit offer complementary insights:

- BER assesses asset performance and is often used to demonstrate compliance.
- Audits assess actual performance, helping building managers identify operational inefficiencies and behavioural factors.

2.6.3 Display Energy Certificate (DEC)

The Display Energy Certificate (DEC) presents the actual energy performance of a building, expressed in kilowatt-hours per square metre per year (kWh/m²/year) for energy consumption. It is a valuable tool for promoting transparency, improving energy management, and encouraging energy-efficient practices in buildings.

The DEC highlights how efficiently a building is operating in practice, based on real energy data rather than design estimates. It supports facility managers and occupants in identifying opportunities to reduce energy use and carbon emissions.

Regular monitoring and public display of energy performance through DECs can help in aligning with national goals for sustainability and responsible resource use. Displaying the certificate in a visible location reinforces a building's commitment to environmental accountability and continuous improvement.

2.7 Energy Efficiency Measures

Improving the energy performance of commercial buildings typically involves a coordinated package of upgrades spanning the building envelope, mechanical and electrical (M&E) systems, and operational controls. However, as highlighted in IEA Annex 56 and the European Commission’s JRC reports, the depth and sequencing of these measures depend heavily on each building’s existing condition, ownership model, and occupancy profile. For example, in multi-tenant or protected structures, disruptive or high-cost interventions like deep envelope retrofits may not be feasible.[17] [18] While fabric improvements might remain a cornerstone of reducing baseline energy demand in certain energy renovations, their deployment must balance cost-effectiveness, technical constraints, and potential co-benefits such as comfort, health, and resilience.

2.7.1 Building Fabric Upgrades

Enhancing the building fabric, which includes the walls, roofs, floors, windows, and doors, is one of the measures for improving the energy performance, occupant comfort, and long-term value of commercial properties.

Thermal Transmittance and U-Values

Thermal resistance is commonly evaluated using the U-value, which expresses heat flow in watts per square metre per kelvin (W/m²K). It is basically the measure of how much heat passes through a material or assembly. Lower U-values correspond to better insulation performance. According to SEAI's Non-Domestic Energy Efficiency Retrofit Best Practice Guide and TGD Part L 2021, the following U-value thresholds are generally recommended for retrofitting commercial buildings in Ireland:

Building Element	**Target U-value (W/m²K)**
Roof	≤ 0.20
External Walls	≤ 0.27
Floors	≤ 0.25
Windows/Glazing	≤ 1.4–1.6

Table 1: U-value Thresholds

Note: The U-values listed above are based on cost-optimal analysis. They represent the most economically efficient levels of thermal performance, providing the best balance between upfront investment and long-term energy savings. Further improvement beyond these values typically results in diminishing returns and is generally not necessary unless driven by specific design goals or regulatory requirements.

Achieving these standards typically involves:

- Installing external or internal insulation systems (e.g. mineral wool, PIR, or wood fibre boards)

- Upgrading windows to double or triple-glazed units with low-emissivity coatings improves solar performance by minimising unwanted heat gain. This reduces the need for cooling and fan energy, enhancing energy efficiency and indoor comfort.
- Addressing thermal bridging at junctions and interfaces using insulated cavity closers and thermally broken systems

Airtightness

Airtightness improvements complement insulation by eliminating unintended air leakage, which can account for significant energy losses, especially in older commercial stock. Best practice methods include:

- Applying airtight membranes and vapour control layers (VCLs)
- Sealing service penetrations and junctions using tapes and gaskets
- Installing pressure-equalised window and curtain wall systems

Deeper building fabric upgrades may not always be the most practical or cost-effective starting point, especially in multi-tenanted, protected, or commercial buildings with tenants in situ, where disruption, cost, or moisture risks can limit feasibility. A targeted or phased approach may yield better returns in many cases.

2.7.2 HVAC and Building Services Upgrades

In many commercial settings, substantial efficiency gains can be achieved through upgrades to heating, cooling, ventilation, and control systems:

- Replacement of legacy boilers with high-efficiency heat pumps (e.g. air-to-water or VRF)
- Upgrading to mechanical ventilation with heat recovery (MVHR) with plate heat exchangers, thermal wheels and run-around-coils, or demand-controlled ventilation (DCV)
- Enhanced control through smart thermostats, zoning, and Building Management Systems (BMS)
- Upgrading of fans, pumps and booster sets to variable speed operation can lead to significant energy savings.

The recently launched SEAI Business Energy Upgrades Scheme provides grants for these specific measures. These upgrades are particularly effective when paired with envelope improvements, allowing downsizing of the plant and improved part-load operation.

2.7.3 Lighting and Controls

Lighting retrofits are often low-disruption, high-impact interventions in commercial spaces. Measures include:

- Full conversion to LED lighting
- Addition of occupancy sensors and daylight controls
- Integration with BEMS for scheduling and demand response

Lighting upgrades can significantly reduce electrical demand and are usually associated with short payback periods, especially in office, education, and retail sectors.

2.7.4 Other Key Measures and Emerging Practices

Complementary interventions that support or extend efficiency benefits include:

- On-site renewables such as rooftop solar PV for electricity generation or solar thermal for hot water, depending on the building application
- Smart metering and sub-metering to monitor usage, optimise scheduling, and improve tenant engagement
- Solar shading to manage overheating in glazed buildings

2.8 Co-benefits of Renovation

Co-benefits refer to the extra advantages that a renovation project can bring, going beyond the primary benefits of energy and cost savings. These additional benefits may encompass social, environmental, or economic aspects.[24]

Co-benefits stemming from renovation projects can be classified as either direct or indirect. Direct co-benefits are the immediate outcomes directly influenced by the project, like decreased energy consumption. On the other hand, indirect co-benefits are results caused by

[24] https://unfccc.int/sites/default/files/resource/0.2bRenewable%20Economics%20and%20Co-benefits.pdf

the project but not directly linked, such as increased property values. Quantifying some of the co-benefits can pose challenges due to their intangible or difficult-to-measure nature.

Most of the co-benefits resulting from renovation projects are likely to be observed across a significant majority, if not all, of the properties that undergo the renovation process. This is because many co-benefits are inherent to the improvements made during the renovation and are not specific to individual properties. The following are some of the co-benefits:[25]

- **Improved air quality:** Improved air quality: Renovations that improve ventilation and insulation can help to reduce air pollution levels inside the building. This can lead to improved health and well-being for employees, as well as reduced absenteeism and sick days.
- **Increased property value:** By improving the appearance and energy efficiency of a building, renovations can increase its overall property value, proving advantageous to businesses during potential sales or rentals.
- **Increased marketability:** Enhanced building aesthetics and energy efficiency through renovations make properties more appealing to potential tenants or buyers, enabling businesses to secure new occupants or complete property transactions more swiftly.
- **Increased employee retention:** A well-designed and comfortable workplace can help to attract and retain employees. This is because employees are more likely to be happy and productive in a space that is designed for their needs.
- **Improved productivity:** A well-designed and energy-efficient workplace can help to improve productivity for businesses. This is because employees are often more comfortable and productive in a space that is designed for their needs.
- **Enhanced Social Responsibility:** Improving the building through renovations enhances its social responsibility by bolstering its sustainability features. This not only increases its appeal to tenants, customers and investors but also signifies the building owner's commitment to sustainability.

[25] http://www.bpie.eu/wp-content/uploads/2018/11/Building-4-people_methodology2018.pdf

2.9 Energy Performance Gap

Despite advances in building modelling and energy standards, a persistent challenge in energy efficiency efforts is the Energy Performance Gap (EPG), the discrepancy between the predicted energy performance of a building (typically calculated during design or renovation planning) and its actual energy consumption once operational. This gap can be substantial, particularly in commercial buildings where unregulated energy use, occupant behaviour, control system mismanagement, and design execution issues play a significant role. Studies across Europe have shown that actual energy consumption in non-domestic buildings can exceed predicted values by 20–60%, even in buildings rated as energy efficient on paper.[26] [27]

Common drivers include:

- **Modelling Assumptions:** Tools like NEAP and PHPP rely on standardised time, occupancy and other usage profiles, and do not always reflect real operational conditions.
- **Unregulated Loads:** Equipment such as IT systems, lifts, and catering appliances is excluded from BER calculations and Part L of Building Regulations, despite their significant contribution to total energy use in commercial buildings.
- **Commissioning Gaps:** Poor commissioning of HVAC, lighting, and control systems can result in sub-optimal performance.
- **Occupant Behaviour:** Patterns of use, temperature set-points, and override of automated controls often differ from assumed baselines.
- **Build Quality:** The building quality may not match design intent, particularly in insulation continuity, airtightness, or system integration. This is particularly for buildings before the introduction of air tightness testing as a mandatory requirement for new dwellings under the revised Building Regulations that came into force in 2008.

The EPG presents a material risk in energy retrofit projects because it can:

- Undermine the anticipated savings and return on investment

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[26] https://www.researchgate.net/publication/261986659_The_building_energy_performance_gap_up_close_and_personal

[27] https://www.frontiersin.org/journals/mechanical-engineering/articles/10.3389/fmech.2015.00017/full

- Impact compliance with MEPS or ESG reporting metrics
- Lead to disillusionment among stakeholders, especially where financial or environmental performance was a key driver

3. Objective

This Case Study Analysis aims to provide valuable technical insights for SMEs and SME property owners who are considering renovating their properties. The objectives of this study go beyond addressing the economic aspects of renovation and aim to consider the environmental and social costs associated with renovating commercial properties, whenever possible.

Given the diversity of commercial properties in terms of size, activities, and usage, renovation approaches can vary based on the sector and location. For instance, renovating an office property in a city centre entails different costs and tasks compared to renovating a retail space in the same city centre area. Even within the same sector, specific aspects of renovation activities may differ. For example, the lighting requirements for an open-plan office would differ from those of a closed-plan office, despite being the same size. Location is also a factor influencing renovation decisions, considering factors such as weather conditions, material availability, and other location-specific considerations. However, the varied building application and cost-benefit analysis plays one of the major roles in choosing the renovation measures. Therefore, this study was aimed at exploring sector-specific insights when renovating SME properties.

Moreover, the cost, time, and nature of refurbishment works required to achieve a B2+ Building Energy Rating (or equivalent) can vary significantly depending on the property type, location, and the specific measures implemented. The study will, where possible, encompass the following objectives:

1. Sectoral insights – different property type insights in different locations
2. Analysis of cost & nature of refurbishment works
3. Insights on time taken to complete measures to bring to a B2+ BER (or cost optimal equivalent)
4. Estimate payback period (energy)
5. Identify disruption to the business
6. Insights on indoor air quality and co-benefits

4. Methodology

A survey was conducted as the primary methodology to collect the data and develop the case studies (CS) for analysis. The following steps were followed in sequence:

4.1 Survey Design and Development

A structured survey questionnaire was created based on initial interviews with two building surveying professionals, reflecting their experiences with commercial property renovation. This initial version was reviewed by a panel of four additional building surveying experts to ensure that the content was comprehensive and covered all the relevant areas of interest.

The survey was finalised based on their feedback and prepared in two formats: a Word document and an online version hosted on SurveyMonkey. Both formats were made available for respondents' convenience.

4.2 Data Collection and Case Study Development

The survey was distributed through the SCSI and ENACT project partners via multiple channels, including social media, direct email, newsletters, and follow-up phone calls. Data was collected through completed Word forms, SurveyMonkey responses, and direct phone interviews. In some instances, additional clarification was obtained by emailing respondents. Data for seven of the case studies were obtained through the information directory that SEAI holds for the different commercial renovation projects that have received grants under the Better Energy Community scheme. Furthermore, seven case studies were received from the Construct Innovate. From the 29 responses received, 23 were considered suitable for further review, with 15 of those ultimately selected for detailed case study development. These case studies reflect a broad mix of SME building types, sizes, and renovation strategies. Each case study was written based on the data collected and reviewed for key technical, financial, and operational factors. The case studies were formatted for consistency and sent for further analysis. The survey was distributed via email, direct phone calls, and LinkedIn promotions in partnership with the SCSI and ENACT. Outreach targeted approximately 32 stakeholders, with a mix of digital and direct engagement:

Metric	Value
Total Potential Respondents	32
Emails Sent	28
Phone Calls Made	55
LinkedIn Views (ENACT video)	2,139
Survey Clicks	57
Total Samples Received	29
Finalised for Review	23

Table 2: Case Study Dissemination

4.3 Survey Structure

The survey was divided into three main sections:

- **Section 1** - Captured respondent background and project context, including property type, building history, and consent details.
- **Section 2** - Focused on the technical scope of renovation, including U-values, emissions, and timelines.
- **Section 3** - Collected cost, grant, and payback-related financial information.

Instructions were provided at the beginning of the survey, and participants were offered the option to contact the SCSI project coordinator for clarification. The survey remained open for approximately three months. The questionnaire used for data collection is attached in **Appendix 1.**

4.4 Payback Calculation

The payback period was calculated for each case study where data were available. In some cases, the payback was already shared by the case study respondents; in others, it was estimated using the formula:

$$Payback\ Period = \frac{Total\ Renovation\ Cost\ (Including\ soft\ and\ hard\ costs)}{Annual\ Energy\ Cost\ Savings}$$

This approach provided a clear indication of the time required to recoup the renovation investment through energy savings. Shorter payback periods indicated higher financial feasibility, while longer ones warranted deeper evaluation. Where applicable, paybacks given by the survey respondents were adopted directly.

4.5 Renovation Depth Classification

This study employs a weighted multi-criteria scoring framework to classify the depth of building renovations. The model evaluates each case based on three core dimensions: Energy Savings (40%), BER Uplift (20%), and Scope of Works (40%). This approach reflects methodologies endorsed in EU policy literature, including the EPBD Recast (2024), BPIE, and technical guidance from the JRC.[28] [29] [17]

Energy savings are given the greatest weight, in line with EU definitions that classify "deep renovation" as achieving at least a 60% reduction in primary energy use. Medium-depth retrofits typically yield 30–60% savings, while shallow interventions fall below 30%. These thresholds are consistent with benchmarks published by the European Commission. [16]

The BER uplift serves as a proxy for building performance improvement, recognising that a substantial gain in energy rating, such as improving from a class F or G to A or B, typically reflects significant upgrades to building fabric and systems.

The scope of works is weighted equally with energy performance to account for the breadth of retrofit interventions. Deep renovations usually involve holistic upgrades across the building envelope and technical systems, often integrating on-site renewables. This dimension aligns with the findings as supported by research on energy retrofitting methodologies and the JRC Renovation Typology, which emphasise the importance of multi-measure packages in delivering transformative outcomes. [30] [17]

Each dimension was scored on a 0–2 scale (low, moderate, high), with the total weighted score determining renovation depth:

- **Light:** Score < 0.6
- **Medium:** Score 0.6–1.2

[28] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32024L1275
[29] https://www.bpie.eu/wp-content/uploads/2021/11/BPIE_Deep-Renovation-Briefing_Final.pdf
[30] https://doi.org/10.1016/j.enbuild.2012.08.018

- **Deep:** Score > 1.2

This scoring system accommodates the multidimensional nature of renovation depth. It avoids over-reliance on a single metric, particularly energy savings, by recognising projects that achieve significant technical upgrades or BER improvements, even in complex or constrained building contexts. It aligns with evolving EU frameworks such as the Smart Readiness Indicator (SRI), Building Renovation Passport, and IEA Annex 56, all of which underscore the need for holistic and ambition-sensitive classifications of renovation depth. The table with the analysed score can be found in **Appendix 2**.

4.6 Disruption and Co-Benefit Evaluation

While business disruption and co-benefits were not always quantified in numerical terms, qualitative data, including open-ended survey responses, case narratives, and follow-up interviews, were analysed thematically to derive meaningful insights. These dimensions, although not monetised, provide important contextual understanding that complements the energy and cost-focused analysis.

4.6.1 Disruption Level

Disruption was categorised as Low, Medium, or High, based on reported or inferred operational impact during renovation. The classification criteria are outlined below:

Disruption Level	Definition
Low	Renovation occurred while the building was vacant or during periods with minimal operational activity. No tenant displacement or notable business interruption was reported.
Medium	Renovation involved partial relocation of staff or temporary operational constraints. This may include phased work, access limitations, or short-term service disruptions.
High	Renovation caused significant business interruption, full relocation, or loss of tenants. Business continuity was materially affected during the renovation.

Table 3: Disruption Classification

This classification was applied using a combination of building occupancy status, reported delays, and qualitative descriptions.

4.6.2 Co-Benefits

Co-benefits were assessed using qualitative data from survey responses, project narratives, and interviews. While not systematically quantified or monetised, these insights provide critical contextual understanding that complements the energy and cost-focused analysis. To support consistent comparison across the dataset, co-benefits mentioned in individual case studies were harmonised and grouped into a standardised set of categories. This structure helps clarify common patterns and supports cross-case evaluation. The categories are:

Standardised Co-benefit Category	**Description**
Indoor Air Quality & Comfort	Improvements to ventilation, insulation, and thermal regulation, often through MVHR systems, passive materials, or heating upgrades.
Marketability & Tenant Appeal	Enhanced attractiveness of the property post-renovation, leading to quicker letting, improved occupancy, or increased rental potential.
Operational Efficiency & Monitoring	Reduction in operational energy/carbon, and enhanced building control through smart systems or upgraded HVAC/lighting.
Sustainability & ESG Alignment	Inclusion of renewable energy, natural materials, low-carbon systems, or alignment with organisational sustainability goals.
Historic or Cultural Preservation	Sensitive retrofitting that preserves or enhances a building's historic or cultural value, particularly in listed or period structures.
Educational or Demonstration Value	Use of the renovated building as a showcase or learning tool, e.g. for sustainability education or passive design demonstration.
Mobility & Access Improvements	Enhancements such as EV infrastructure, bike parking, or improved accessibility features.

Community Impact	Broader social benefits, such as community engagement, local job creation, or improved amenity access for surrounding areas.

Table 4: Standardised Co-benefits Category

In some instances, a single co-benefit could reasonably fall under more than one category (e.g., a solar PV installation contributing to both sustainability goals and operational efficiency). However, for consistency and clarity, each benefit was categorised under a single most relevant heading in the case study summaries.

4.7 Categorisation of Motivations and Challenges

As part of the qualitative analysis of the case studies, each project's underlying motivation and reported challenges were systematically categorised. This was done to identify recurring patterns, assess common drivers of retrofit activity, and understand the key barriers affecting project delivery across diverse building types and sectors.

The motivations were grouped into five thematic categories:

- **Commercial/Rental Strategy** – Projects aimed at increasing letability, rental income, or responding to tenant needs.
- **Sustainability/Energy Efficiency** – Driven by climate goals, ESG compliance, or operational energy savings.
- **Business Opportunity/Expansion** – Linked to new business models, change of use, or facility expansion.
- **Building Improvement** – Focused on enhancing comfort, aesthetics, or functionality.
- **Unknown/Other** – Where no clear motivation was recorded.

Challenges were similarly grouped into five categories:

- **Financial/Bureaucratic** – Issues related to funding access, grants, or administrative delays.
- **Regulatory/Utility Delays** – Including planning permission, fire safety certifications, or utility connections.
- **Workforce/Technical** – Labour shortages, contractor availability, or retrofit complexity.

- **Occupancy/Disruption** – Constraints arising from having to maintain business operations during works.

- **Unknown/Not Reported** – Where no specific challenges were detailed.

This categorisation enabled cross-case comparison and allowed the research to highlight sectoral trends, key enablers, and systemic obstacles. It also informed the development of targeted policy recommendations and retrofit support strategies for SMEs.

4.8 Methodological Limitations

Access to complete and verifiable data from case study owners was limited. This highlights a broader challenge within the SME retrofit sector: the absence of consistent post-renovation performance tracking and a reluctance to share sensitive financial or energy data. These constraints point to the need for more robust reporting requirements and stronger engagement mechanisms in future retrofit support schemes. These limitations include:

- **Incomplete Energy and BER Data:** Not all case studies provided full BER certificates, energy bills, or baseline consumption data. In such cases, proxies such as BER uplift, scope of measures, or qualitative insights were used to infer renovation depth and performance. This introduces a degree of subjectivity and limits quantitative precision.

- **Typology Classification:** Renovation depth (Light, Medium, Deep) was classified using a hybrid approach combining available energy savings, BER movement, and scope of works. While based on accepted EU thresholds, some cases were inferred through professional judgment where numeric data was lacking, limiting reproducibility.

- **Variation in Reporting Standards:** Data was collected through self-reported surveys, interviews, and SEAI project directories, which varied in completeness and technical detail. Some financial and technical figures may reflect estimates rather than verified post-occupancy audits.

- **Lack of Discounted Payback Analysis:** Although the importance of Discounted Payback Period is acknowledged, most cases rely on simple payback due to limited access to detailed cash flow timelines and discount rates. This may understate long-term financial viability for deep retrofits.

- **Energy Performance Gap Not Quantified:** Due to the absence of pre- or post-renovation energy data and operational data in some cases, the analysis could not assess the actual versus predicted energy use, a factor known to affect retrofit outcomes materially. This limits conclusions on realised savings.

- **Disruption and Co-Benefits Assessed Qualitatively:** Disruption levels and co-benefits were evaluated using thematic synthesis and stakeholder narratives rather than quantitative impact metrics, such as financial metrics. While valid for insight, these assessments are inherently interpretive.
- **Case Study Selection Bias:** The sample was limited to 23 cases selected based on data availability and voluntary response. This introduces potential bias towards projects with better documentation, funding support, or engaged ownership, and may not fully represent all SME renovations across Ireland.
- **Lack of Embodied Carbon Data:** While embodied carbon is discussed conceptually, the analysis and the data received primarily focus on operational performance. Hence, Whole-life carbon assessments were beyond the scope of this case study approach. However, as IEA Annex 56 notes, life cycle assessment (LCA) is essential to capture the full environmental impact of renovation, especially as operational emissions decline and embodied impacts become proportionally more significant. [18]

5. Overview of the Survey Responses

In total, 29 survey responses were considered suitable for detailed review, combining data collected through the ENACT project with additional case studies shared by the Construct Innovate initiative. These responses span a range of SME-owned and managed commercial buildings across Ireland, reflecting diverse property types, renovation strategies, funding structures, and levels of intervention.

Of these, 23 cases provided adequate data for structured comparison and inclusion in further analysis. Eight case studies originated from the original ENACT survey and seven from the SEAI database, while an additional seven cases were sourced through Construct Innovate interviews and reports.

Ref No.	Category	Function / Occupant Type	Location
CS01	Retail	Large Format Retail	Athlone
CS02	Retail	Large Format Retail	Kilkenny
CS03	Retail	Specialist Retail / Wholesale	Co. Dublin
CS04	Office	Urban Commercial Office	Dublin 12
CS05	Office	Creative / Specialist Office	Cloughjordan
CS06	Office	Urban Commercial Office	Dublin 2
CS07	Office	Rural Commercial Office	Tralee
CS08	Office	Creative / Specialist Office	Dublin 24
CS09	Office	Urban Commercial Office	Galway City
CS10	Office	Urban Commercial Office	Galway City
CS11	Office	Co-Working & Flexible Space	Loughrea
CS12	Office	Public Administration Office	Tullamore
CS13	Industrial	Logistics / Warehouse Facility	Dublin 24
CS14	Industrial	Logistics / Warehouse Facility	Mullingar
CS15	Industrial	Logistics / Warehouse Facility	Galway City

CS16	Hospitality	Community Recreation Facility	Clare
CS17	Hospitality	Hospitality – Urban Hotel	Limerick
CS18	Hospitality	Hospitality – Regional Hotel	Ashbourne
CS19	Hospitality	Hospitality – Resort	Wicklow
CS20	Hospitality	Community Recreation Facility	Loughrea
CS21	Hospitality	Retail / Foodservice Unit	Loughrea
CS22	Hospitality	Hospitality – Urban Hotel	Dublin 2
CS23	Education	Education Facility	Dublin 6

Table 5: Case Studies Collected

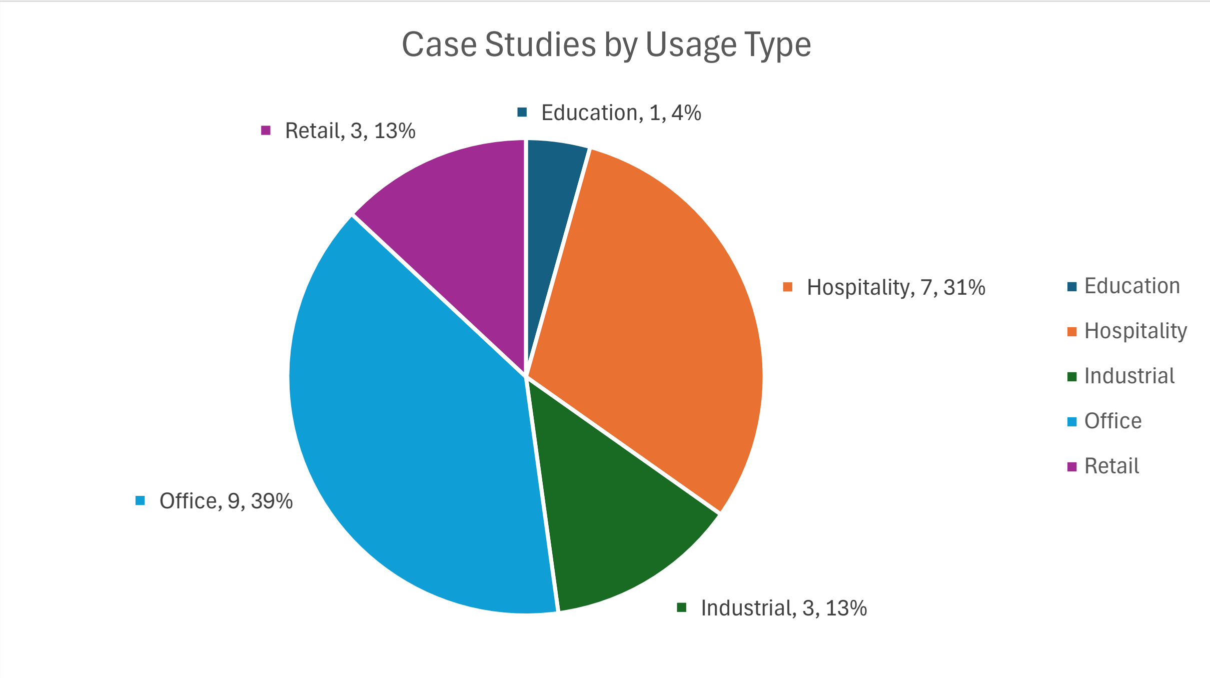

Figure 1: Case Studies by Building Usage Type

5.1 Key Observations

- **Sectoral spread**: Office buildings made up the largest portion of responses (approx. 40%), followed by hospitality, retail, education, and industrial properties.
- **Project scale**: Projects varied significantly in size, from micro-businesses to large-scale logistics centres and hotels.

- **Funding models**: Responses reflected a mix of funding types, including direct cash investment, SEAI and BEC grants, bank loans, and state support.
- **Energy performance**: Several projects reported significant BER improvements, though several cases lacked baseline or final BER data.
- **Disruption and co-benefits**: Though not shown in this summary table, disruption levels and non-energy benefits were addressed.

These case studies form the basis for the technical and financial analysis in the sections that follow, where they are evaluated in relation to renovation depth, cost-effectiveness, payback period, and broader operational impacts.

6. Case Studies and Analysis

After analysing and reviewing the responses, the SME properties were explored in more detail. Here's a summary of the case studies, highlighting the technical, financial aspects, and payback periods:

Case ID	Category	Function / Occupant Type	Building Use	Location	Size*	Duration of Works	BER Before	BER After	Energy Savings*	Funding Mode	Grants	Renovation Cost (€)*	Payback*	Disruption	Renovation Depth
CS01	Retail	Large Format Retail	Retail	Athlone	3,700 m²	Within 12 months	-	-	140,300 kWh	Private + SEAI Grants	Yes	€138,000 (Inc. VAT)	6 years	Low	Light
CS02	Retail	Large Format Retail	Retail	Kilkenny	1,060 m²	Within 12 months	-	-	263,000 kWh	Private + SEAI Grants	Yes	€345,000 (Inc. VAT)	7 years	Low	Medium
CS03	Retail	Specialist Retail / Wholesale	Food Logistics	Co. Dublin	8000 m²	Within 12 months	-	-	341,000 kWh	Private + SEAI Grants	Yes	€386,000 (Inc. VAT)	7 years	Low	Medium
CS04	Office	Urban Commercial Office	Office	Dublin 12	2,430 m²	5 months	D1	B2	-	Private + SEAI Grants	Yes	€414,000 (Exc. VAT)	4 years	Low (Vacant)	Deep
CS05	Office	Creative / Specialist Office	Office/Mixed-use	Cloughjordan	250 m²	Phased out over 3 years	G	B1	-	Private	Yes	€175,000 (Inc. VAT)	7 years	Low (Vacant)	Deep

CS06	Office	Urban Commercial Office	Office	Dublin 2	397 m²	Phased out over 10 months	F	B2	-	Private	No	€1,175,000 (Exc. VAT)	-	Low (Vacant)	Deep
CS07	Office	Rural Commercial Office	Office	Tralee	94 m²	Phased out over 12 months	C1	B1	11,500 kWh	Private + SEAI Grants	Yes	€155,000 (Exc. VAT)	63 years**	High	Deep
CS08	Office	Creative / Specialist Office	Office	Dublin 24	-	Phased out over 6 months	C3	A3	1,800 kWh/m2 /yr	Private + SEAI Grants	Yes	€1,371,000 (Exc. VAT)	34 years	Medium	Deep
CS09	Office	Urban Commercial Office	Office (multi-floor)	Galway City	1,307 m²	-	-	F-B2-C1	-	Private	-	€2,000,000 (Inc. VAT)	0 (Sold)	Low (Vacant)	Light
CS10	Office	Urban Commercial Office	Office	Galway City	3,200 m²	Phased out over 2 years	-	-	-	Private + SEAI Grants	Yes	€1,834,000 (Inc. VAT)	10 years	High	Medium
CS11	Office	Co-Working & Flexible Space	Co-working Hub	Loughrea	600 m²	5 months	-	-	-	Private + Other Grants	Yes	€447,000 (Inc. VAT)	10 years	Low (Vacant)	Light
CS12	Office	Public Administration Office	Office (Govt)	Tullamore	420 m²	5 months	E	A2	-	State Funded	No	€790,000 (Inc. VAT)	-	Low (Vacant)	Deep
CS13	Industrial	Logistics / Warehouse Facility	Warehouse	Dublin 24	2,400 m²	8 months	D2	B2, B3	-	Private	No	€1,146,000 (Exc. VAT)	14 years	Low (Vacant)	Medium

CS14	Industrial	Logistics / Warehouse Facility	Warehouse	Mullingar	43,400 m²	Within 12 months	-	-	730,200 kWh	Private + SEAI Grants	Yes	€2,093,000 (Inc. VAT)	6 years	Low	Deep
CS15	Industrial	Logistics / Warehouse Facility	Office + Warehouse	Galway City	5,815 m²	3 months (Approx.)	D2	D1	-	Private	No	€184,000 (Inc. VAT)	6 months	Low	Light
CS16	Hospitality	Community Recreation Facility	Leisure Centre	Clare	-	Phased out over 15 months	E	A2	-	Private + SEAI Grants	Yes	€2,150,000 (Exc. VAT for build cost)	-	Medium	Deep
CS17	Hospitality	Hospitality – Urban Hotel	Hotel	Limerick	8,760 m²	Within 12 months	-	-	206,400 kWh	Private + SEAI Grants	Yes	€108,000 (Inc. VAT)	4.5 years	Low	Light
CS18	Hospitality	Hospitality – Regional Hotel	Hotel	Ashbourne	4,879 m²	Within 12 months	-	-	371,000 kWh	Private + SEAI Grants	Yes	€383,000 (Inc. VAT)	8.5 years	Medium	Light
CS19	Hospitality	Hospitality – Resort	Golf Resort	Wicklow	11,800 m²	Within 12 months	-	-	2,365,000 kWh	Private + SEAI Grants	Yes	€1,920,000 (Inc. VAT)	9 years	Medium	Medium
CS20	Hospitality	Community Recreation Facility	Sports Club	Loughrea	550 m²	Phased out over 3 years	-	-	-	Private + Other Grants	Yes	€212,000 (Inc. VAT)	4 years	Medium	Medium
CS21	Hospitality	Retail / Foodservice Unit	Coffee Shop	Loughrea	60 m²	4 months	-	-	-	Private + Other Grants	Yes	€17,000 (Inc. VAT)	-	Low	Light

CS2 2	Hospitality	Hospitality – Urban Hotel	Hotel + Bar + Restaurant + Sports Bar	Dublin 2	-	-	-	-	-	Private + SEAI Grants	Yes	€1,600,000 (Inc. VAT)	5 years	Medium	Medium
CS2 3	Education	Education Facility	School	Dublin 6	250 m²	Phased out over 3 years	Exempt	Exempt	82,500 kWh	Private + SEAI Grants	Yes	€170,000 (Exc. VAT)	7 years	Medium	Deep

Table 6: Case Studies Comparison

*Figures are rounded off

** Payback includes the cost of building extension works

CS01 – Retail – Large Format Retail (Athlone)

Basic Project Details

- **Location:** Athlone (Rural)
- **Function / Occupant Type:** Large Format Retail
- **Ownership Type:** Not specified
- **Construction Year:** 2004
- **Size:** 3,700 m²
- **Occupancy:** Not specified

Energy Performance

- **BER Before:** Not specified
- **BER After:** Not specified
- **Energy Reduction Estimate:** 140,349 kWh (Approx. 17%, Gas and Electricity combined)
- **Renovation Depth:** Light Renovation (renewables and internal airflow enhancement)

Energy Upgrade Measures

- **Renewable Energy Integration:** Installed a 100 kW PV array for clean electricity generation.
- **HVAC Upgrade:** Installed destratification fans to improve internal airflow and reduce heating demand.

Project Timeline

- **Duration:** Within 12 months
- **Planning Permission:** Not specified
- **Additional approvals:** Not specified

Financial Details

- **Renovation Cost:** €137,725
- **Grants:** €41,317 (Better Energy Community scheme – 30% of project cost)
- **Funding Mode:** Private + SEAI Grants
- **Simple Payback Period:** ~6 years
-

Disruption Analysis

- **Occupancy During Works:** Not specified
- **Disruptive Factors:** Not specified
- **Overall Impact:** Not specified

Co-Benefits Assessment

Co-Benefit	Description	Impact
Operational Efficiency & Monitoring	PV system and airflow enhancements reduce ongoing operational energy demand	Medium
Sustainability & ESG Alignment	Supports shift towards renewable power and energy efficiency.	Medium
Indoor Air Quality & Comfort	Enhanced ventilation contributed to improved customer and staff experience.	Medium

Motivations: Not specified
Challenges: Not specified

CS02 – Retail – Large Format Retail (Kilkenny)

Basic Project Details
- **Location:** Kilkenny (Rural)
- **Function / Occupant Type:** Large Format Retail
- **Ownership Type:** Not specified
- **Construction Year:** 2005
- **Size:** 1,060 m²
- **Occupancy:** Not specified

Energy Performance
- **BER Before:** Not specified
- **BER After:** Not specified
- **Energy Reduction Estimate:** 262,574 kWh (Estimated around 44%)
- **Operational Carbon Saved:** ~95 tonnes CO_2 annually
- **Renovation Depth:** Medium Renovation (targeted refrigeration and HVAC upgrades)

Energy Upgrade Measures:
- **Refrigeration System Optimisation:** Comprehensive upgrade of eight refrigeration systems to enhance energy performance.
- **HVAC Upgrade:**
  - Installation of a new heat pump for improved space heating capabilities.
  - Includes deployment of a hot water heat recovery system to reuse waste heat from hot water systems. (Grouped here due to its contribution to thermal efficiency.)

Project Timeline
- **Duration:** Not specified
- **Planning Permission:** Not specified
- **Additional approvals:** Not specified

Financial Details
- **Renovation Cost:** €344,742
- **Grants:** €103,422.74 – Better Energy Community (30% of total cost)
- **Funding Mode:** Private + SEAI Grants
- **Simple Payback Period:** ~7 years

Disruption Analysis
- **Occupancy During Works:** Not specified
- **Disruptive Factors:** Not specified
- **Overall Impact:** Not specified

Co-Benefits Assessment

Co-Benefit	Description	Impact
Operational Efficiency & Monitoring	Advanced refrigeration system reduced energy consumption and improved reliability.	High
Sustainability & ESG Alignment	Deployment of a heat recovery system to reuse waste heat from hot water systems.	Medium

Motivations: Not specified
Challenges: Not specified

CS03 – Retail – Specialist Retail / Wholesale (Co. Dublin)

Basic Project Details

- **Location:** Co. Dublin (Rural)
- **Function / Occupant Type:** Specialist Retail / Wholesale
- **Ownership Type:** Not specified
- **Construction Year:** 2000
- **Size:** 8,000 m^2
- **Occupancy:** Medium (11–50) before and after renovation

Energy Performance

- **BER Before:** Not specified
- **BER After:** Not specified
- **Energy Reduction Estimate:** 340,682 kWh (Estimated around 22% energy saved annually)
- **Operational Carbon Saved:** 181 tonnes CO_2 annually
- **Renovation Depth:** Medium Renovation (energy system optimisation and envelope enhancements)

Energy Upgrade Measures

- **HVAC Upgrade:** VSD compressor installation for improved energy control and efficiency.
- **Fabric Upgrade:** Insulated partitioning of open areas for thermal zoning and better climate control.
- **Renewable Energy Integration:** Installation of a 150 kW solar PV system to reduce reliance on grid energy.
- **Refrigeration System Optimisation:** Rapid doors installed in 9 chill rooms to maintain temperature and reduce energy loss.

Project Timeline

- **Duration:** Not specified
- **Planning Permission:** Not specified
- **Additional Approvals:** Not specified

Financial Details

- **Renovation Cost:** €385,731
- **Grants:** €115,720– Better Energy Community (30% of total cost)
- **Funding Mode:** Private + SEAI Grants
- **Simple Payback Period:** ~7 years

Disruption Analysis

- **Occupancy During Works:** Not specified
- **Disruptive Factors:** Not specified
- **Overall Impact:** Not specified

Co-Benefits Assessment

Co-Benefit	Description	Impact
Operational Efficiency & Monitoring	Smart system controls and efficient lighting improved performance.	High
Sustainability & ESG Alignment	Waste heat recovery and system optimisation contributed to reduced emissions.	Medium

Motivations: Not specified
Challenges: Not specified

CS04 – Office – Urban Commercial Office (Dublin 12)

Basic Project Details

- **Location:** Dublin 12 (Urban)
- **Function / Occupant Type:** Office
- **Ownership Type:** Not specified
- **Construction Year:** 2005
- **Size:** 2,430 m²
- **Occupancy:** Vacant pre-renovation; post-renovation occupancy data not specified

Energy Performance

- **BER Before:** D1
- **BER After:** B2
- **Renovation Depth:** Deep Renovation

Energy Upgrade Measures

- **Fabric Upgrade:** General fit-out and interior redecoration including ceiling tiles, wall panels, and finishes. (While not directly energy-saving, improvements like ceiling tiles and raised floors can support thermal and acoustic performance.)
- **HVAC Upgrade:**
  - Installation of new Air Handling Unit and Air-to-Water Hydrobox for zoned heating and cooling.
  - Heat recovery ventilation, zoning controls, volume dampers, balanced airflow.
- **Lighting Upgrade:** Full upgrade to LED lighting, including emergency lighting.
- **Renewable Energy Integration:** Photovoltaic (PV) solar panel system installation for on-site clean energy.
- **Energy Management System:** Mechanical and Electrical Systems Upgrade (specifically zoning and control systems).
- **Sustainable Transport Infrastructure:** Electrical provision for future EV charging infrastructure.

Non-Energy Upgrade Measures:

- **Electrical Infrastructure:** Overhaul of M&E systems included significant electrical upgrades and reconfiguration.

Project Timeline

- **Duration:** 5 months
- **Planning Permission:** Not required
- **Additional Approvals:** Disability Access Certificate (DAC)

Financial Details

- **Construction Cost (Excl. VAT):** €872,985
- **Professional Fees (Excl. VAT):** €70,000
- **Energy Upgrade Cost (portion):** €414,260
- **Annual Energy Savings:** €102,360.00
- **Payback Period:** ~4 years
- **Funding Type:** Private + SEAI Grants
- **Grants:** BEC 2020 scheme (applied through third party)

Disruption Analysis

- **Occupancy During Works:** Vacant
- **Disruptive Factors:** None reported
- **Overall Impact:** Low Disruption (no tenants affected)

Co-Benefits Assessment

Co-Benefit	Description	Impact
Indoor Air Quality & Comfort	Full building-wide HVAC with heat recovery and air zone control	High
Marketability & Tenant Appeal	Premises upgraded to modern lettable standard	High
Operational Efficiency & Monitoring	Significant drop in carbon and improved building performance	High

Motivations: Commercial/Rental Strategy - Upgrade building up to current standards to allow for re-use of vacant premises.
Challenges: Not specified

CS05 – Office – Creative / Specialist Office (Cloughjordan, Co. Tipperary)

Basic Project Details

- **Location:** Cloughjordan, Co. Tipperary (Rural)
- **Function / Occupant Type:** Ground Floor Office with Residential on top (Traditional Period Building, c.1800)
- **Ownership Type:** Owner – Single Occupancy
- **Construction Year:** c.1800
- **Size:** 250 m^2
- **Occupancy:** Micro Enterprise (1–10 staff) before and after renovation

Energy Performance

- **BER Before:** G
- **BER After:** B1 (modelled performance or operational estimates suggest A2-level efficiency)
- **Renovation Depth:** Deep Renovation (Passive standard retrofit with renewables, fabric first approach)

Energy Upgrade Measures

- **Fabric Upgrade:**
  - Airtight taping, passive windows, diffusion membranes, breathable construction.
  - Usage of reclaimed timber, cork, lime render, cellulose and wood-fibre insulation.
  - Full internal refurbishment covering finishes and supports the thermal envelope improvements.
- **HVAC Upgrade:**
  - Installation of new Air source heat pump with radiant ceiling/floor/wall heating.
  - Upgrade of MVHR system with heat recovery.

Non-Energy Upgrade Measures:

- **Electrical Infrastructure:** Complete rewiring of office areas as part of the building's electrical system overhaul.

Project Timeline

- **Duration:** Phased over 3 years
- **Planning Permission:** Not required
- **Additional Approvals:** Not required

Financial Details

- **Renovation Cost (incl. VAT and owner labour):** €175,000
- **Funding Type:** Private
- **Grants:** Attempted SEAI heat pump grant (process was time-consuming)
- **Simple Payback Period:** ~7 years (excluding property value uplift)

Disruption Analysis

- **Occupancy During Works:** Vacant
- **Disruptive Factors:** Long phased duration due to limited contractor availability and grant processing delays
- **Overall Impact:** Medium Disruption (time and labour-intensive process)

Co-Benefits Assessment

Co-Benefit	Description	Impact
Indoor Air Quality & Comfort	MVHR system, breathable materials, low-toxicity finishes	High
Sustainability & ESG Alignment	Achieved near-passive performance using natural and reclaimed materials, renewable heating, and avoided fossil fuels entirely.	High
Historic or Cultural Preservation	Use of lime plaster, timber, and traditional construction	High

Motivations: Sustainability/Energy Efficiency - Provide a family home and business, and concern for climate change.
Challenges: Financial/Bureaucratic - Banks were reluctant to loan on the mixed-use property and issues regarding contractor attendance, cost, and lack of labour skills in traditional buildings lead to delays.

CS06 – Office – Urban Commercial Office (Dublin 2)

Basic Project Details

- **Location:** Dublin 2 (Urban)
- **Function / Occupant Type:** Office
- **Occupant/Owner Type:** Tenant – Multiple Occupancy
- **Construction Year:** 1990
- **Size:** 397 m²
- **Occupancy:** Small (0–10 staff) before and after renovation

Energy Performance

- **BER Before:** F
- **BER After:** B2
- **Energy Reduction Estimate:** Significant, based on BER uplift and fabric/system overhaul
- **Renovation Depth:** Deep Renovation (fabric, glazing, structural + M&E upgrades)

Energy Upgrade Measures

- **Fabric Upgrade:**
  - Facade insulation to enhance the thermal performance of the building envelope
  - Glazing upgrade with energy-efficient windows for improved insulation and daylighting
  - Roof structure replacement to support overall building integrity and envelope performance
  - Comprehensive interior retrofit enhancing spatial and energy efficiency
- **HVAC Upgrade:** Full renewal of mechanical systems as part of the internal M&E upgrade

Non-Energy Upgrade Measures:

- **Electrical Infrastructure:** Full electrical system renewal integrated into the internal fit-out

Project Timeline

- **Duration:** 10 months (phased)
- **Planning Permission:** Required
- **Additional Approvals:** Not required

Financial Details

- **Construction Cost (Excl. VAT):** €1,000,000
- **Professional Fees (Excl. VAT):** €175,000
- **Funding Type:** Private
- **Grants:** SEAI grant was not used; the process was explored and found to be time-consuming
- **Simple Payback Period:** Not specified

Disruption Analysis

- **Occupancy During Works:** Not specified
- **Disruptive Factors:** Not specified
- **Overall Impact:** Not specified

Co-Benefits Assessment

Co-Benefit	Description	Impact
Sustainability & ESG Alignment	Avoided demolition, resulting in 791 tonnes of carbon savings, highlighting circular economy practices	High
Marketability & Tenant Appeal	75% of the unit was successfully let post-renovation, indicating increased commercial appeal.	High
Operational Efficiency & Monitoring	Real-time electricity monitoring was enabled post-renovation, enhancing building management.	Medium
Indoor Air Quality & Comfort	Comprehensive upgrades improved indoor environmental quality and occupant experience.	High

Motivation: Commercial/Rental Strategy - The reason for the renovation was to attract new tenants and improve the energy efficiency of the property. The unit was vacant before commencement and was later quickly 75% let.
Challenges: Not specified

CS07 – Rural Commercial Office (Tralee)

Basic Project Details

- **Location:** Tralee (Rural)
- **Function / Occupant Type:** Rural Commercial Office
- **Owner Type:** Single Owner / Owner Occupancy
- **Construction Year:** Before 1841
- **Size:** Increased from 94 m² to 145 m² post-extension
- **Occupancy:** Small (0–10 staff) before and after renovation

Energy Performance

- **BER Before:** C1
- **BER After:** B1
- **Energy Reduction Estimate:** Energy consumption reduced from 13,900 kWh to 2,400 kWh; Annual savings: €2,454.56
- **Carbon Saved:** 4.41 tonnes of operational carbon prevented
- **Renovation Depth:** Deep Renovation (EnerPHit standard with extension and renewable integration)

Energy Upgrade Measures

- **Fabric Upgrade**
  - Full building fabric overhaul with deep insulation applied to floors, walls, roof, and windows using high-performance natural and synthetic materials
  - Triple-glazed window systems and upgraded rooflights to enhance thermal performance and daylighting
  - EnerPHit refurbishment applied to the two-storey front structure, indicating airtightness, insulation, and thermal bridging improvements in line with Passive House standards
- **Renewable Energy Integration**
  - Solar photovoltaic (PV) system installation for low-carbon on-site electricity generation

Note: Building went through major building extension and demolition activities which contribute to spatial changes but don't fall directly under energy upgrades.

Project Timeline

- **Duration:** 12 months (phased)
- **Planning Permission:** Not required
- **Additional approvals:** None

Financial Details

- **Renovation Cost:** €155,000 (ex VAT) – build only; in-house professional services. Cost includes the building extension expenses as well.
- **Grants:** EXEED Stage 1 – Design Grant
- **Funding Mode:** Private + SEAI Grants
- **Simple Payback Period:** ~63 years (Includes payback for building extension works. Payback for energy upgrades alone is unavailable)

Disruption Analysis

- **Occupancy During Works:** Not specified
- **Disruptive Factors:** Business relocated during construction, leading to minor economic costs but significant time loss due to moving.
- **Overall Impact:** Moderate disruption

Co-Benefits Assessment

Co-Benefit	Description	Impact
Sustainability & ESG Alignment	Demonstrates EnerPHit-level sustainable retrofit	High
Indoor Air Quality & Comfort	Enhanced indoor thermal performance through high-quality insulation	High
Operational Efficiency & Monitoring	Major reduction in operational energy and carbon use	High

Motivations: Business Opportunity/Expansion - To showcase in-house design and the benefits of passive house renovation. To provide a comfortable space for staff to work and collaborate.
Challenges: Occupancy/Disruption - The business had to rent alternative premises for the duration of the construction. This caused minimal economic costs but significant time costs in moving office twice and all associated issues.

CS08 – Office – Creative / Specialist Office (Dublin 24)

Basic Project Details
- **Location:** Dublin 24 (Urban)
- **Function / Occupant Type:** Creative / Specialist Office
- **Owner Type:** Single Owner / Owner Occupancy
- **Construction Year:** c. 1990
- **Size:** Not specified
- **Occupancy:** Small (11–50 staff) before and after renovation

Energy Performance
- **BER Before:** C3
- **BER After:** A3
- **Energy Reduction Estimate:** 1,800 kw/m^2/yr - 91% reduction in energy cost; operational carbon reduced by 92%
- **Renovation Depth:** Deep Renovation (envelope + systems + renewable + ESG-focused)

Energy Upgrade Measures
- **Fabric Upgrade:**
  - Roof insulation upgraded to enhance thermal performance
  - Wall insulation enhanced with loose-fill cavity insulation, Blowerproof liquid airtightness membrane, and foil-backed rigid board
  - All windows and doors upgraded for improved airtightness and thermal efficiency
- **HVAC Upgrade:**
  - Air source heat pumps installed for low-carbon space heating
  - Hybrid ventilation system implemented, incorporating zero embodied carbon elements for efficient, sustainable airflow
- **Lighting Upgrade:**
  - LED luminaires installed, equipped with daylight and occupancy sensors for optimal energy use
- **Renewable Energy Integration:** 30 kWp solar PV system installed to generate on-site renewable electricity
- **Sustainable Transport Infrastructure:**
  - EV chargers installed to support electric vehicle use
  - Bicycle parking and shower facilities added to promote active transport and sustainable commuting

Note: The renovation involved reception/toilet refurbishments and landscaping improvements enhance user experience and aesthetics but are not categorised under energy upgrades.

Project Timeline
- **Duration:** 6 months (phased)
- **Planning Permission:** Yes (for Solar PV and external bike parking)
- **Additional approvals:** None

Financial Details
- **Renovation Cost:** €1,273,696 (ex VAT for build cost) + €97,520 (ex VAT for professional fees)
- **Grants:** Communities Energy Grant Scheme 2022
- **Funding Mode:** Private + SEAI Grants
- **Simple Payback Period:** ~34 years

Disruption Analysis
- **Occupancy During Works:** Not specified
- **Disruptive Factors:** Not specified
- **Overall Impact:** Not specified

Co-Benefits Assessment

Co-Benefit	Description	Impact
Indoor Air Quality & Comfort	Meets WELL and CIBSE Guide A standards via new HVAC and air handling.	High
Sustainability & ESG Alignment	Project aligned with ESG corporate goals, enhancing value. 92% reduction in operational carbon.	High
Mobility & Access Improvements	Inclusion of bike parking and EV chargers	Medium
Operational Efficiency & Monitoring	91% reduction in annual energy cost.	High

Motivation: Sustainability/Energy Efficiency - To enhance property value and energy efficiency due to the ESG goals of the organisation.
Challenges: Financial/Bureaucratic - Delays on the project start date were caused by the delays on the deadlines for approval of the grants.

CS09 – Office – Urban Commercial Office (Galway City)

Basic Project Details

- **Location:** Galway City (Urban)
- **Function / Occupant Type:** Urban Commercial Office
- **Owner Type:** Landlord / Tenant
- **Construction Year:** 2001
- **Size:** 1,307 m²
- **Occupancy:** Not specified

Energy Performance

- **BER Before:** Not specified
- **BER After:** 1st Floor – F, Landlord Area – B2, 2nd Floor – C1, 3rd Floor – C3
- **Energy Reduction Estimate:** Not specified
- **Operational Carbon Saved:** Not specified
- **Renovation Depth:** Light Renovation (primarily interior and electrical fit-out)

Energy Upgrade Measures

- **Fabric Upgrade:** Installation of stud and glass partitions with integrated internal insulation to improve thermal comfort and spatial efficiency
- **Lighting Upgrade:** Full lighting system upgrade with energy-efficient LED fittings throughout the premises
- **HVAC Upgrade:** Installation of electric panel heaters and fan heaters to deliver efficient zonal heating across office floors
- **Electrical Infrastructure:** Included as part of lighting system and heater installations, though the primary electrical upgrade is reflected under Lighting

Project Timeline

- **Duration:** Not specified
- **Planning Permission:** Not applicable
- **Additional approvals:** Not applicable

Financial Details

- **Renovation Cost:** €2,000,000
- **Grants:** None
- **Funding Mode:** Private
- **Simple Payback Period:** 0 years (property sold immediately after renovation)
- **Additional details:**
  - **Rental Before:** €165,000 (some floors vacant)
  - **Rental After:** €440,000
  - **Property Value Before:** €2,500,000
  - **Property Value After:** €5,000,000

Disruption Analysis

- **Occupancy During Works:** Not specified
- **Disruptive Factors:** Not specified
- **Overall Impact:** Not specified

Co-Benefits Assessment

Co-Benefit	Description	Impact
Marketability & Tenant Appeal	Significant increase in post-renovation rental income and property value. Fit-out upgrades enabled full tenancy	High
Indoor Air Quality & Comfort	BER improvements on landlord and upper floors	Medium

Motivation: Commercial/Rental Strategy - Maximise potential rental income & property value
Challenges: Workforce/Technical - Technical challenges due to low ceiling heights and obtaining fire certs due to the age of the property

CS10: Office – Urban Commercial Office (Galway City)

Basic Project Details

- **Location:** Galway City (Urban)
- **Function / Occupant Type:** Urban Commercial Office
- **Owner Type:** Multi-Tenant Occupancy
- **Construction Year:** 2002
- **Building Usage:** Office
- **Size:** 3200 m²
- **Occupancy:** Medium (150 staff approx.)

Energy Performance

- **BER Before:** Not specified
- **BER After:** Not specified
- **Energy Reduction Estimate:** Not quantified (no specific energy savings figure provided; general efficiency upgrades and solar PV were installed)
- **Operational Carbon Saved:** Not provided in the case study
- **Renovation Depth:** Medium (Broad building fabric and systems upgrades - including addition of a floor, solar PV installation, mechanical ventilation, and lighting systems - suggest substantial intervention, but due to lack of quantified savings, conservatively categorised as Medium.)

Measures Taken

- **Fabric Upgrade**
    - Curtain walling added to two facades
    - Kingspan insulated roof installation to enhance building envelope performance
    - Structural addition of a new floor and reception porch supports spatial and thermal performance upgrades
- **Lighting Upgrade:** LED lighting installed throughout, with motion sensors in office spaces to reduce unnecessary energy use
- **Renewable Energy Integration**: 72-panel solar PV system installed to generate low-carbon electricity on-site
- **HVAC Upgrade**: Installation of a mechanical ventilation and air conditioning system for improved indoor climate control
- **Electrical Infrastructure**: Energy-efficient hand dryers installed in bathrooms as part of broader electrical efficiency improvements
- **Sustainable Transport Infrastructure**
    - EV charging stations installed
    - Secure-access bicycle shed constructed to support active transport options

Note: Works on interior redecoration and sanitaryware installations were carried out, which contribute to comfort and aesthetics but are not directly tied to energy upgrades.

Project Timeline

- **Duration:** 2 years (2017–2018)
- **Planning Permission:** Yes
- **Additional approvals:** Agreement with existing tenants for noise disturbances

Financial Details

- **Renovation Cost:** €1,834,000
- **Grants:** €8,000 (SEAI – Solar Panels)
- **Funding Mode:** Private (Loan) + SEAI Grants
- **Simple Payback Period:** ~10 years

Disruption Analysis

- **Occupancy During Works:** Building remained occupied; agreement in place with tenants
- **Disruptive Factors:** Noise and substantial construction disruption due to structural works (additional floor)
- **Overall Impact:** High (due to significant structural alterations, mitigated by weekend scheduling)

Co-Benefits Assessment

Co-Benefit Category	Description / Impact	Assessment
Indoor Air Quality & Comfort	Upgraded HVAC, LED lighting with motion sensors, and new interior finishes contribute to better comfort and energy-responsive design.	Medium–High
Energy Sustainability & ESG Alignment, Operational Efficiency & Monitoring	72-panel solar PV system reduces reliance on grid electricity and contributes to long-term operational resilience.	High
Mobility & Access Improvements	4 EV charging stations and a secure-access bike shed promote sustainable commuting and reduce emissions associated with staff transport.	High

Motivation: Commercial/Rental Strategy - Request from existing tenant for additional space, add value to building and energy savings

Challenges: Workforce/Technical - Technical challenges with adding an additional floor to a live building and Fire Regulations for planning permission due to buildings age.

CS11 – Office – Co-Working & Flexible Space (Loughrea, Co. Galway)

Basic Project Details

- **Location:** Loughrea, Co. Galway (Rural)
- **Function / Occupant Type:** Co-Working & Flexible Office Space
- **Owner Type:** Multi-Tenant Occupancy
- **Construction Year:** 2007
- **Size:** 600 m²
- **Occupancy:** Medium (approx. 65 occupants) before and after renovation

Energy Performance

- **BER Before:** Not specified
- **BER After:** Not specified
- **Energy Reduction Estimate:** Not quantified
- **Operational Carbon Saved:** Not specified
- **Renovation Depth:** Light Renovation (interior and services upgrade)

Energy Upgrade Measures

- **Fabric Upgrade:** Installation of new stud walls and glass partitions contributes to thermal zoning and internal spatial efficiency
- **Lighting Upgrade:** Full LED lighting retrofit with sensor-based controls in office spaces to reduce lighting energy demand
- **HVAC Upgrade:** Mechanical ventilation and air conditioning systems installed to improve air quality and thermal comfort
- **Sustainable Transport Infrastructure:** Installation of showers to support active travel (e.g., cycling or walking commuters)

Note: Carpet, painting, desks, furniture, and access control system were upgraded, which enhance comfort, usability, and security, but fall outside the energy upgrade scope.

Project Timeline

- **Duration:** Approx. 5 months
- **Planning Permission:** Yes
- **Additional approvals:** No

Financial Details

- **Renovation Cost:** €447,000 (Owner funds: €280,000 and Grants: €167,000)
- **Grants:** Galway Rural Development
- **Funding Mode:** Private + Grants
- **Simple Payback Period:** ~10 years

Disruption Analysis

- **Occupancy During Works:** Not specified
- **Disruptive Factors:** Minimal reported
- **Overall Impact:** Low disruption

Co-Benefits Assessment

Co-Benefit	Description	Impact
Mobility & Access Improvements	Installation of showers to support active travel users	High
Indoor Air Quality & Comfort	Ventilation system improved air quality and LED lighting	Medium
Community Impact	Introduction of flexible workspace supported local entrepreneurship	High

Motivations: Commercial/Rental Strategy - Potential opportunity for a co-working hub
Challenges: Regulatory/Utility Delays - Obtaining planning permission, took approximately 2 years to obtain and was granted on the 3rd attempt

CS12 – Office – Public Administration Office (Tullamore, Co. Offaly)

Basic Project Details

- **Location:** Tullamore, Co. Offaly (Suburban)
- **Function / Occupant Type:** Public Office
- **Owner Type:** Owner Occupied
- **Construction Year:** 2000
- **Size:** 420 m²
- **Occupancy:** Small (>50 occupants before and after renovation)

Energy Performance

- **BER Before:** E
- **BER After:** A2
- **Energy Reduction Estimate:** Not specified
- **Operational Carbon Saved:** Not specified
- **Renovation Depth:** Deep Renovation (significant energy systems and PV integration)

Energy Upgrade Measures

- **Fabric Upgrade:** Installation of new stud walls and glass partitions to improve space functionality and support zoning (indirect thermal benefits)
- **Lighting Upgrade:** LED lighting upgrades with sensors to improve energy efficiency through occupancy and daylight control
- **Renewable Energy Integration:** 300 m² of solar panels installed to generate on-site renewable electricity
- **HVAC Upgrade:** Mechanical ventilation and air conditioning systems installed to improve indoor air quality and thermal comfort
- **Sustainable Transport Infrastructure:** Shower facilities installed to support active travel initiatives (e.g., cycling, walking)

Note: Carpets, painting, decorating, office furniture, and access control systems are other measures carried out which are outside the scope of energy upgrades but may support overall user experience and operational efficiency.

Project Timeline

- **Duration:** 5 months
- **Planning Permission:** Not required
- **Additional approvals:** New Fire Certificate required

Financial Details

- **Renovation Cost:** €790,000
- **Grants:** Not specified
- **Funding Mode:** State Funded
- **Simple Payback Period:** Not specified

Disruption Analysis

- **Occupancy During Works:** Not specified
- **Disruptive Factors:** Minimal disruption noted
- **Overall Impact:** Low

Co-Benefits Assessment

Co-Benefit	Description	Impact
Indoor Air Quality & Comfort	High-efficiency lighting and ventilation systems installed	High
Sustainability & ESG Alignment	300 m² solar PV panels reduce energy from grid	High
Marketability & Tenant Appeal	Upgraded workspaces enhance usability and comfort	Medium

Motivations: Commercial/Rental Strategy - Need for Office space in town centre of Tullamore
Challenges: Very little due to the project starting on a blank canvas

CS13 – Industrial – Logistics / Warehouse Facility (Dublin 24)

Basic Project Details

- **Location:** Dublin (Suburban)
- **Function / Occupant Type:** Warehouse with Office Units
- **Owner Type:** Not specified
- **Construction Year:** 1978
- **Size:** 2400 m^2
- **Occupancy:** Vacant pre-renovation; Micro enterprise occupancy (11–50 staff) post-renovation

Energy Performance

- **BER Before:** D2
- **BER After:** B2 / B3
- **Renovation Depth:** Medium Renovation (Fabric & M&E upgrades)

Energy Upgrade Measures

- **Fabric Upgrade**
  - Roof replaced with Kingspan Quadcore composite panels, enhancing insulation and thermal performance
  - Single-glazed timber windows replaced with double-glazed uPVC for improved energy efficiency
  - Rear exit door and roller shutter replaced, likely contributing to improved airtightness and thermal control
  - Full interior refinishing supports occupancy comfort but has minimal direct energy impact
- **HVAC Upgrade**
  - Storage heaters replaced with electric panel heaters for zonal and potentially more efficient electric heating
- **Lighting Upgrade**
  - LED lighting installed as part of electrical works to reduce lighting energy consumption
- **Electrical Infrastructure**
  - Full electrical system rewiring
  - Upgraded life safety systems integrated into the building's electrical backbone

Project Timeline

- **Duration:** 8 months (250 days)
- **Planning Permission:** Not required
- **Additional Approvals:** Disability Access Certificate (DAC)

Financial Details

- **Construction Cost (Excl. VAT):** €1,054,463
- **Professional Fees (Excl. VAT):** €91,288
- **Funding Type:** Private (Loan)
- **Grants:** Not specified
- **Simple Payback Period:** ~14 years

Disruption Analysis

- **Occupancy During Works:** Vacant
- **Disruptive Factors:** Delays from ESB connection (6 weeks)
- **Overall Impact:** Low Disruption (no tenants affected)

Co-Benefits Assessment

Co-Benefit	Description	Impact
Indoor Air Quality & Comfort	Improved insulation, new glazing and panel heating	Medium
Marketability & Tenant Appeal	Units were rapidly let post-renovation	High
	Modernised appearance, compliance with safety standards	High

Motivation: Commercial/Rental Strategy - To attract new tenants. The units were vacant prior to commencement and were rapidly occupied/let post-completion of the works
Challenges: Regulatory/Utility Delays - Obtaining connections from ESB Networks delayed the project by 6 weeks

CS14 – Industrial – Logistics / Warehouse Facility (Mullingar)

Basic Project Details

- **Location:** Mullingar (Rural)
- **Function / Occupant Type:** Logistics / Warehouse Facility
- **Owner Type:** Not specified
- **Construction Year:** 1998
- **Size:** 43,400 m²
- **Occupancy:** Not specified before or after renovation

Energy Performance

- **BER Before:** Not specified
- **BER After**: Not specified
- **Energy Reduction Estimate:** 730,238 kWh (Estimated)
- **Operational Carbon Saved:** 448 tonnes CO_2 annually
- **Renovation Depth:** Deep Renovation (system and renewable energy upgrades)

Energy Upgrade Measures

- **HVAC Upgrade:** Replacement of gas boiler with a Variable Refrigerant Volume (VRV) system, offering high-efficiency, zoned heating and cooling
- **Renewable Energy Integration:** Installation of a 1200 kW solar PV system to supply substantial on-site renewable electricity

Project Timeline

- **Duration:** Within 12 months
- **Planning Permission:** Not specified
- **Additional approvals:** Not specified

Financial Details

- **Renovation Cost:** €2,092,770
- **Grants:** €627,831 – Better Energy Community (30% of total cost)
- **Funding Mode:** Private + SEAI Grants
- **Simple Payback Period:** ~6 years

Disruption Analysis

- **Occupancy During Works:** Not specified
- **Disruptive Factors:** Not specified
- **Overall Impact:** Not specified

Co-Benefits Assessment

Co-Benefit	Description	Impact
Sustainability & ESG Alignment	Significant emissions savings from large-scale solar PV and efficient heating	High
Operational Efficiency & Monitoring	Large PV system reduces reliance on grid electricity	High

Motivation: Not specified
Challenges: Not specified

CS15 – Industrial – Logistics / Warehouse Facility (Galway City)

Basic Project Details

- **Location:** Galway (Urban)
- **Function / Occupant Type:** Logistics / Warehouse Facility with Offices
- **Owner Type:** Multi-Tenant Occupancy
- **Construction Year:** 2001
- **Size:** 5,815 m^2
- **Occupancy:** Medium (51–250 staff) before and after renovation

Energy Performance

- **BER Before:** D2
- **BER After:** D1
- **Energy Reduction Estimate:** 23% reduction (chiller system)
- **Operational Carbon Saved:** Not specified
- **Renovation Depth:** Light Renovation (interior refurbishment, M&E systems upgrade)

Energy Upgrade Measures

- **Fabric Upgrade**
  - Soundproofing of canteen wall contributes to envelope performance (minor thermal/acoustic gain)
  - Other interior works (e.g. carpet installation, office demolition) are functional but not energy-related
- **Lighting Upgrade**: New LED lighting installed with PIR (Passive Infrared) sensors for occupancy-based control and energy savings
- **HVAC Upgrade**
  - Existing HVAC system disconnected and replaced with a new system (exact type unspecified but falls under HVAC improvements)
  - Chiller unit installation for controlled cooling and thermal comfort

Note: Fire, access control, alarm, intercom, and security systems are important upgrades were carried out but not categorized under energy upgrades

Project Timeline

- **Duration:** Approx. 12 weeks (March 2023 – May 2023)
- **Planning Permission:** No
- **Additional approvals:** No

Financial Details

- **Renovation Cost:** €184,283 (including €109,283 + €75,000 for chiller and installation)
- **Grants:** Not sought
- **Funding Mode:** Private
- **Simple Payback Period:** ~6 months

Disruption Analysis

- **Occupancy During Works:** Tenants temporarily relocated within other vacant spaces
- **Disruptive Factors:** Minimal due to effective internal relocation
- **Overall Impact:** Low disruption to operations

Co-Benefits Assessment

Co-Benefit	Description	Impact
Marketability & Tenant Appeal		Medium
Operational Efficiency & Monitoring	23% energy reduction from chiller upgrade	High
Indoor Air Quality & Comfort	Soundproofing and improved HVAC and lighting systems	Medium

Motivations: Commercial/Rental Strategy - Maximize rental footprint of the building and reduce energy usage
Challenges: Occupancy/Disruption - Management of relocation of tenants during renovation and getting tenants agreements

CS16 – Hospitality – Community Recreation Facility (Clare)

Basic Project Details

- **Location:** Clare (Rural)
- **Function / Occupant Type:** Community Recreation Facility (Leisure Centre)
- **Owner Type:** Single Owner / Owner Occupancy
- **Construction Year:** Originally 1950, with a 1996 addition
- **Size:** Not specified
- **Occupancy:** Small (11–50 occupants) before and after renovation

Energy Performance

- **BER Before:** E
- **BER After:** A2
- **Energy Reduction Estimate:** 56% reduction in energy running costs; 26% of electricity now produced onsite; operational carbon emissions decreased by 65%
- **Renovation Depth:** Deep Renovation (comprehensive services upgrade + renewable integration)

Energy Upgrade Measures

- **HVAC Upgrade**
    - Geothermal heat pump system installed using two 79 kW units and 15 boreholes (totaling 2,250 meters)
    - Biomass boiler cascade (300 kW + 100 kW) with a 10,000L buffer tank, using wood pellets as a renewable heating source
    - Mechanical Ventilation with Heat Recovery (MVHR) units installed for non-pool areas
    - Shower heat recovery systems (6 Recoup units) with 42% efficiency for reclaiming heat from waste water
- **Lighting Upgrade:** Retrofitting of 416 smart LED lights to improve energy efficiency and lighting control
- **Renewable Energy Integration:** Installation of a 137 kWp solar PV system, featuring 310 Longi 445W panels and 3 Solis inverters for significant on-site electricity generation

Project Timeline

- **Duration:** 15 months (phased)
- **Planning Permission:** Not specified
- **Additional approvals:** None

Financial Details

- **Renovation Cost:** €2,149,970 (ex VAT)
- **Grants:** 30% grant via Better Energy Communities 2020 scheme
- **Funding Mode:** Private + SEAI Grants
- **Simple Payback Period:** Not specified

Disruption Analysis

- **Occupancy During Works:** Not specified
- **Disruptive Factors:** Not specified
- **Overall Impact:** Not specified

Co-Benefits Assessment

Co-Benefit	Description	Impact
Indoor Air Quality & Comfort	Installation of a biomass boiler and new HVAC enhanced thermal comfort and consistent temperature control.	High
Sustainability & ESG Alignment	On-site renewables and low-carbon heating aligned with decarbonisation goals.	High
Operational Efficiency & Monitoring	Integration of smart controls improved operational performance and cost predictability.	High

Motivations: Building Improvement - To fully regenerate the building and facilities to current-day standards.
Challenges: Not specified

CS17 – Hospitality – Urban Hotel (Limerick)

Basic Project Details
- **Location:** Limerick (Urban)
- **Function / Occupant Type:** Hospitality – Urban Hotel
- **Owner Type:** Not specified
- **Construction Year:** 2009
- **Size:** 8,760 m²
- **Occupancy:** Not specified

Energy Performance
- **BER Before:** Not specified
- **BER After:** Not specified
- **Energy Reduction Estimate:** 206,431 kWh (Estimated)
- **Operational Carbon Saved:** 53 tonnes CO_2 annually
- **Renovation Depth:** Light Renovation (system-specific intervention)

Energy Upgrade Measures
- **HVAC Upgrade**: Heatstar Hybrid System installed for pool and spa heating, combining a heat pump with an ultra-efficient heat recuperator to optimize thermal efficiency and reduce energy consumption
- **Energy Management Systems**: Measurement and Verification (M&V) system implemented for real-time energy performance monitoring and optimisation, enabling data-driven energy management

Project Timeline
- Duration: Not specified
- Planning Permission: Not specified
- Additional approvals: Not specified

Financial Details
- **Renovation Cost:** €108,270
- **Grants:** €32,481 – Better Energy Community (30% of total cost)
- **Funding Mode:** Private + SEAI Grants
- **Simple Payback Period:** ~4.5 years

Disruption Analysis
- **Occupancy During Works:** Not specified
- **Disruptive Factors:** Not specified
- **Overall Impact:** Not specified

Co-Benefits Assessment

Co-Benefit	Description	Impact
Marketability & Tenant Appeal	Upgrades improved aesthetics and competitiveness in the urban hospitality sector.	High
Indoor Air Quality & Comfort	HVAC and envelope upgrades improved indoor conditions. Upgraded spa and pool heating may improve user experience.	Medium
Sustainability & ESG Alignment	Upgraded spa and pool heating may improve user experience.	Medium

Motivations: Not specified
Challenges: Not specified

CS18 – Hospitality – Regional Hotel (Ashbourne)

Basic Project Details

- **Location:** Ashbourne (Rural)
- **Function / Occupant Type:** Hospitality – Regional Hotel
- **Owner Type:** Not specified
- **Construction Year:** 2007
- **Size:** 4,879 m²
- **Occupancy:** Not specified

Energy Performance

- **BER Before:** Not specified
- **BER After:** Not specified
- **Energy Reduction Estimate:** 371,366 kWh (Estimated)
- **Operational Carbon Saved:** 87.80 tonnes CO_2 annually
- **Renovation Depth:** Light Renovation (targeted system upgrades)

Energy Upgrade Measures
HVAC Upgrade:

- Installation of 63 fan coil units and systems room controllers to enable zoned climate control and improve efficiency
- Electrical commissioning of upgraded Air Handling Units (AHUs) and fan coil systems for integrated operation
- Installation of a new 344.2 kW chiller to enhance cooling system efficiency and reliability

Project Timeline

- **Duration:** Not specified
- **Planning Permission:** Not specified
- **Additional approvals:** Not specified

Financial Details

- **Renovation Cost:** €382,837
- **Grants:** €114,851 – Better Energy Community (30% of total cost)
- **Funding Mode:** Private + SEAI Grants
- **Simple Payback Period:** ~8.5 years

Disruption Analysis

- **Occupancy During Works:** Not specified
- **Disruptive Factors**: Not specified
- **Overall Impact:** Not specified

Co-Benefits Assessment

Co-Benefit	Description	Impact
Indoor Air Quality & Comfort	HVAC and envelope improvements enhanced guest comfort.	High
Operational Efficiency & Monitoring	LED lighting and modernised controls reduced energy demand and improved reliability.	Medium

Motivations: Not specified
Challenges: Not specified

CS19 – Hospitality – Resort (Wicklow)

Basic Project Details

- **Location:** Wicklow (Rural)
- **Function / Occupant Type:** Hospitality – Resort
- **Owner Type:** Not specified
- **Construction Year:** 2002
- **Size:** 11,008 m²
- **Occupancy:** Not specified

Energy Performance

- **BER Before:** Not specified
- **BER After:** Not specified
- **Energy Reduction Estimate**: 2,365,199 kWh (Actual), 3,380,000 kWh (Estimated)
- **Operational Carbon Saved:** Not specified
- **Renovation Depth:** Medium Renovation (comprehensive mechanical system upgrades)

Energy Upgrade Measures
HVAC Upgrade

- Comprehensive upgrade of fan coil units and Air Handling Units (AHUs)
- Replacement and upgrade of existing heat pumps to improve heating performance
- Installation of advanced cooling controls to enhance temperature regulation
- Upgrade of pump systems to increase energy efficiency and operational reliability
- Installation of advanced control systems for heat pump operation optimisation

Energy Management Systems

- Monitoring and Verification (M&V) system installed to enable continuous tracking, measurement, and optimisation of energy usage

Project Timeline

- **Duration:** Not specified
- **Planning Permission:** Not specified
- **Additional approvals:** Not specified

Financial Details

- **Renovation Cost:** €1,920,295
- **Grants:** €576,089 – Better Energy Community (30% of total cost)
- **Funding Mode:** Private + SEAI Grants
- **Simple Payback Period:** ~9 years

Disruption Analysis

- **Occupancy During Works:** Not specified
- **Disruptive Factors:** Not specified
- **Overall Impact:** Not specified

Co-Benefits Assessment

Co-Benefit	Description	Impact
Sustainability & ESG Alignment	Biomass and ground source heat pump enabled carbon reductions.	High
Operational Efficiency & Monitoring	M&V system helped track and optimise post-renovation energy use.	Medium
Indoor Air Quality & Comfort	HVAC upgrades improved thermal comfort across guest areas.	Medium

Motivations: Not specified
Challenges: Not specified

CS20 – Hospitality - Community Recreation Facility (Loughrea, Co. Galway)

Basic Project Details

- **Location:** Loughrea, Co. Galway (Rural)
- **Function / Occupant Type:** Community Recreation / Sports Club Facility
- **Owner Type:** Member-Owned
- **Construction Year:** 1995–1997
- **Size:** 550 m²
- **Occupancy:** Small (> 50 staff) before and after renovation

Energy Performance

- **BER Before:** Not specified
- **BER After:** Not specified
- **Energy Reduction Estimate:** Solar panel system covers approximately 1/3 of annual usage
- **Operational Carbon Saved:** Not specified
- **Renovation Depth:** Medium Renovation (fabric upgrades, mechanical/electrical enhancements)

Energy Upgrade Measures

- **Fabric Upgrade**
  - Attic insulation added to improve thermal performance and reduce heating demand
  - Interior finishes (flooring, tiling, painting) enhance comfort but have limited direct energy impact
- **Lighting Upgrade:** Full LED lighting retrofit with motion sensors for occupancy-based energy control
- **Renewable Energy Integration:** Solar PV system installed, covering approximately one-third of annual electricity usage
- **HVAC Upgrade:** Two condensing boilers installed to improve heating efficiency
- **Electrical Infrastructure**
  - Replacement of towel dispensers with hand dryers to reduce paper waste and improve energy efficiency
  - General electrical upgrades supporting lighting and renewable installations
- **Sustainable Transport Infrastructure:** EV charging infrastructure added for electric buggies, supporting low-emission transport options

Note: Rainwater harvesting system and its integration with the sprinkler system contribute to water conservation rather than direct energy savings, but support overall sustainability goals

Project Timeline

- **Duration:** 3 years (non-consecutive works)
- **Planning Permission:** Not applicable
- **Additional approvals:** Not applicable

Financial Details

- **Renovation Cost:** €211,870 (after deducting grants)
- **Grants Received:** €36,000 (Solar Panels – €16,000, Attic Insulation – €4,000, Electric Buggies – €16,000)
- **Funding Mode:** Private + Other Grants (Membership Body Grants)
- **Simple Payback Period:** ~4 years

Disruption Analysis

- **Occupancy During Works:** Bar/Restaurant closed for 1 month
- **Disruptive Factors:** Minimal beyond short closure
- **Overall Impact:** Low to Moderate

Co-Benefits Assessment

Co-Benefit	Description	Impact
Operational Efficiency & Monitoring	Solar panels and LED lighting reduce overall energy demand	High
Sustainability & ESG Alignment	Rainwater harvesting and electric buggies promote green practices	Medium
Indoor Air Quality & Comfort	Facility upgrade improved user experience and appeal	High

Motivation: Sustainability/Energy Efficiency - Energy savings & update the outdated appearance
Challenges: Financial/Bureaucratic - Paperwork for grants didn't apply for grants as the feeling was, they would have to spend too much to qualify.

CS21 – Hospitality - Foodservice Unit (Loughrea, Galway)

Basic Project Details

- **Location:** Loughrea, Galway
- **Function / Occupant Type:** Coffee Shop
- **Owner Type:** Occupant (Lease/Rent)
- **Construction Year:** Not specified
- **Size:** 60 m²
- **Occupancy:** Small (12 occupants before, 40 after renovation)

Energy Performance

- **BER Before:** Not specified
- **BER After:** Not specified
- **Energy Reduction Estimate:** Not specified
- **Operational Carbon Saved:** Not specified
- **Renovation Depth:** Light Renovation (interior fit-out, plumbing, and compliance upgrades)

Energy Upgrade Measures

- **Fabric Upgrade**
    - Replacement of rotted wood with glass bi-fold doors, likely improving envelope integrity and daylighting (with some thermal impact)
    - Installation of fire-resistant walls for compliance (minimal direct energy impact)
    - Interior carpentry, plastering, and tiling contribute to finishes but not directly to energy performance
- **Electrical Infrastructure**
    - Electrical works including new spotlights and socket points
    - Complete rewiring of appliances to ensure modern, potentially more efficient electrical layout

Note:

- Works carried out includes plumbing works and radiator installation, which support thermal function but do not represent a full heating system upgrade (no boiler or HVAC system indicated)
- The project appears more oriented toward compliance, usability, and interior fit-out than energy upgrades

Project Timeline

- **Duration:** 4 months
- **Planning Permission:** No
- **Additional approvals:** Hoarding permission from the County Council

Financial Details

- **Renovation Cost:** €17,000
- **Grants:** GPA accountancy grant (amount not specified)
- **Funding Mode:** Private (Loan)
- **Simple Payback Period:** Not specified

Disruption Analysis

- **Occupancy During Works:** Not specified
- **Disruptive Factors:** Minimal disruption reported
- **Overall Impact:** Low

Co-Benefits Assessment

Co-Benefit	Description	Impact
Marketability & Tenant Appeal	Conversion of derelict space into vibrant coffee shop. Modern finishes, better layout, improved ambience	High
Mobility & Access Improvements	Fire resistance and accessibility measures implemented	Medium

Motivations: Building Improvement - Create a new and fresh aesthetic to the building and necessary renovation of derelict building.
Challenges: Workforce/Technical - Wait on supplies and workers, funding and council permission.

CS22 – Hospitality - Urban Hotel (Temple Bar, Dublin 2)

Basic Project Details

- **Location:** Temple Bar, Dublin (Urban)
- **Function / Occupant Type:** Hotel (4-star)
- **Owner Type:** Independent (Private)
- **Size**: Size Not specified. (142 Bedrooms + Restaurant, Bar, Sports Club)
- **Construction Year**: Not specified
- **Occupancy:** High-use hospitality facility (Guest and Public Access)

Energy Performance

- **BER Before:** Not specified
- **BER After:** Not specified
- **Energy Reduction Estimate:** 1.6 GW energy savings per annum
- **Operational Carbon Saved:** 231 tonnes CO2 annually
- **Renovation Depth:** Medium Renovation (major HVAC, ventilation, and BMS overhaul)

Energy Upgrade Measures

- **HVAC Upgrade**
  - Hybrid VRF systems installed for heating and cooling across 142 bedrooms
  - Upgraded Air Handling Units (AHUs) fitted with EC motors and thermal wheel heat recovery for efficient air circulation and heat retention
  - Integrated re-cooler heat pump technology to enhance energy-efficient climate control
- **Energy Management Systems**
  - Zoned ventilation controls using CO_2 sensors for demand-based airflow, optimizing energy use while maintaining air quality
  - Likely integration with Building Management System (BMS) for centralised control and energy optimisation
- **Electrical Infrastructure**
  - Fire alarm and emergency lighting systems upgraded as part of overall M&E integration
  - Electrical services likely upgraded in Reception, Bar, Restaurant, and Night Club areas as part of full fit-out
- **Note:**
  - Fit-out works (Reception, Bar, Restaurant, Night Club) and water services improvements were carried out and they support comfort and functionality but fall outside core energy upgrade categories
  - Sustainability and guest comfort are embedded in the project's design, aligning well with broader energy performance goals

Project Timeline

- **Duration:** 6 months
- **Planning Permission:** Not required
- **Other permission:** Crane and road closure permit

Financial Details

- **Renovation Cost:** €1,600,000
- **Grants:** SEAI Community Energy Grant (€400,000)
- **Funding Mode:** Private + SEAI Grants
- **Simple Payback Period**: ~5 years

Disruption Analysis

- **Occupancy During Works:** Hotel remained operational.
- **Disruptive Factors:** Managed via phased work, careful contractor access, and council-approved road closures.
  - Challenging access in a historical district.
  - Coordination with Dublin City Council for road closures and crane access.
  - Coordinated room closures on a phased basis, doing project floor by floor.
  - Works suspended on key dates to allow access to all rooms.
  - Ongoing public and staff safety considerations during project execution
- **Overall Impact**: Medium (due to live environment complexity)

Co-Benefits Assessment

Co-Benefit	Description	Impact
Operational Efficiency & Monitoring	Substantial reduction in energy use via VRF and heat recovery ventilation	High
Indoor Air Quality & Comfort	Enhanced thermal comfort and air quality through smart HVAC	High

Motivations: Sustainability/Energy Efficiency - Lower energy, cut carbon and save money and to provide greater guest comfort.

Challenges: Not specified

CS23 – Education - Education Facility (Dublin 6)

Basic Project Details

- **Location:** Dublin (Urban)
- **Function / Occupant Type:** Education Facility (School)
- **Owner Type:** Owner/Single Occupancy
- **Construction Year:** 1894 (operating as a school since 1922)
- **Size:** 250 m^2
- **Occupancy:** Medium (51–250 students) before and after renovation

Energy Performance

- **BER Before:** Exempt
- **BER After:** Exempt
- **Energy Reduction Estimate:** 82,468 kWh thermal savings reported; 6,650 $kgCO_2$ saved via solar PV
- **Renovation Depth:** Deep Renovation (fabric + system upgrades + renewables)

Energy Upgrade Measures

- **Fabric Upgrade**
  - New external doors and windows installed in science and classroom blocks to improve thermal performance and airtightness
  - Wall and roof insulation upgraded to enhance the building envelope and reduce heating/cooling demand
- **Lighting Upgrade:** Existing lighting fittings replaced with energy-efficient LED systems
- **HVAC Upgrade**
  - Upgraded heat pump system installed to provide efficient heating
  - Automatic opening vent replaced, contributing to controlled ventilation
- **Electrical Infrastructure:** Electrical socket upgrades support modern electrical loads and user functionality
- **Renewable Energy Integration:** 30 kWp Solarwatt PV system installed (ECO 375W panels) to generate on-site renewable electricity

Project Timeline

- **Duration:** Phased over 3 years
- **Planning Permission:** Not required
- **Additional approvals:** None required

Financial Details

- **Renovation Cost:** €170,074 (excluding VAT, including professional fees)
- **Grants:** €79,458 – Community Energy Grant 2022 (CEG 2022)
- **Funding Type:** Private + SEAI Grants
- **Simple Payback Period:** ~7 years (excluding property value uplift)

Disruption Analysis

- **Occupancy During Works:** Not specified
- **Disruptive Factors:** Not specified
- **Overall Impact:** Not specified

Co-Benefits Assessment

Co-Benefit	Description	Impact
Indoor Air Quality & Comfort, Operational Efficiency & Monitoring	Thermal and electrical upgrades, including insulation, LED lighting, and a heat pump, significantly improved comfort.	High
Educational or Demonstration Value	The visible solar PV array raised energy awareness among students and served as a live educational tool	Medium
Historic or Cultural Preservation	Maintained protected structure status while upgrading services	Medium

Motivation: Sustainability/Energy Efficiency - Upgrade of school facilities and for sustainability reasons.
Challenges: Not specified

7. Inference and Observations

Based on the case studies presented in the report, several inferences are drawn:

7.1 Analysis of Technical Details

7.1.1 Influence of Building Type, Condition and Location on Renovation Strategy

The diverse nature of renovations, spanning from offices and warehouses to a school and a leisure centre, demonstrates that the type significantly influences the renovation approach. The type of renovations and their costs vary widely depending on the building application type, renovation depth, and ultimate goals of the renovation, reflecting the diverse needs of different buildings and sectors. For example, an urban office space and a rural leisure centre have different technical requirements and face distinct challenges due to the building application. Urban offices focused more on HVAC, lighting and interior fit-outs, while rural or legacy buildings often required structural or envelope work due to poor fabric conditions. For instance, traditional stone or older warehouse structures required deeper retrofits to achieve moderate BER improvements, whereas newer or better-insulated buildings achieved higher energy savings through system-only upgrades. Mixed-use or historically constructed buildings (e.g., traditional stone structures) also demonstrated unique challenges due to planning restrictions or heritage considerations. Energy audits and professional engagement, such as the involvement of a conservation-accredited building surveyor or architect, were essential in tailoring technically sound and cost-effective interventions.

7.1.2 Common Measures

The case studies reveal a broad range of technical and operational measures applied across sectors. While the depth and scope varied, several interventions were frequently repeated, highlighting both regulatory drivers and practical energy-saving potential.

HVAC and Heating System Enhancements

Many buildings upgraded their HVAC systems, reflecting the high impact of heating, cooling and fan energy on energy consumption. This included installation of high-efficiency air source heat pumps, air handling units (AHUs), and chiller systems. Notable examples include:

- CS13 and CS08, which implemented major HVAC system enhancements, including new AHUs and air-to-water hydroboxes.
- CS16 and CS19 added ground source heat pumps and biomass boilers for thermal energy.

These upgrades improve internal temperature control, enhance comfort levels, and contribute significantly to energy savings and operational carbon reductions.

Lighting Upgrades

The transition to energy-efficient LED lighting systems was one of the most consistent measures across building types, and especially in office buildings. These systems often included daylight sensors, occupancy detection, and emergency lighting upgrades.

- CS04 and CS07 reported full LED lighting retrofits with automated controls.
- Other examples, such as CS11 and CS12 included lighting as part of integrated M&E upgrades.

This measure often delivers fast paybacks due to relatively low upfront costs and significant reductions in electricity usage.

Fabric Upgrades

Thermal fabric improvements, such as roof and wall insulation, triple-glazed windows, and airtightness treatments, were typically found in deeper retrofits.

- CS05 used natural, breathable materials in a traditional stone building, aiming for EnerPHit standards.
- CS06 and CS07 combined new insulation and glazing with structural upgrades to significantly improve building envelopes.

These interventions were essential in older or heritage buildings or buildings that were built before the introduction of Part L in 1997, aiming to achieve significant BER uplifts and reduce heat loss.

Renewable Energy Integration

Solar PV systems were the most common renewable energy measure, installed to offset electricity demand and reduce carbon emissions.

- CS14 featured a 1.2 MW solar PV installation.
- CS08 and CS16 also integrated large PV systems, often supported by grants.

Renewable integration often complements other measures and contributes to long-term decarbonisation goals.

Refrigeration System Optimisation

Retail and wholesale properties prioritised refrigeration system upgrades due to their high base loads.

- CS02 and CS03 implemented advanced systems, including rapid doors and heat recovery for chill rooms.

These improvements reduced peak demand and improved system reliability, leading to significant operational savings.

Energy Management Systems

While not widespread, several buildings implemented or upgraded Building Management Systems (BMS) or energy monitoring tools.

- CS19 added a dedicated Monitoring and Verification system.
- CS10 introduced real-time electricity tracking for tenants.

Such systems enhanced energy visibility and allow for performance optimisation post-renovation and allow energy improvements without extensive interventions.

Common Measures by Sector

A cross-sector analysis reveals distinct patterns in frequently adopted measures. For example, HVAC and lighting upgrades were widespread across nearly all sectors, while refrigeration system upgrades were common only in retail settings.

Sector	HVAC Upgrade	Lighting Upgrade	Fabric Upgrade	Renewable Energy Integration	Refrigeration System Optimisation	Energy Management Systems
Office	✓	✓	✓	✓		✓
Retail	✓	✓		✓	✓	
Industrial	✓		✓	✓		
Hospitality	✓	✓	✓	✓		✓
Education	✓	✓	✓	✓		

Table 7: Common Measures by SME Sector

7.1.3 BER and Energy Audit

Moreover, while BER provides a broad understanding of the regulated energy usage of the building, it falls short in capturing the intricate energy consumption patterns of businesses and doesn't always reflect the real usage pattern of the building. Unlike BER, an energy audit considers details of appliances, equipment and systems of any SME operations. For example, an industrial building with a poor BER can be improved to a better BER through insulation and HVAC improvements. However, relying solely on this rating overlooks the impact of outdated, energy-inefficient appliances and equipment in daily operations, which are unregulated and do not have a direct impact on the BER. Even with a B2 rating for the commercial premises, high energy consumption may persist due to the internal systems. CS04, CS14, CS17, and CS18 are examples where significant energy savings were achieved just by replacing the systems rather than addressing fabric measures. Hence, BER assessments, energy audits and Display Energy Certificate combinedly offer valuable yet distinct insights for commercial renovations:

- **BER Ratings** provide a standardised theoretical benchmark of a building's regulated energy performance and enable policy compliance, planning targets, and visibility in real estate transactions.
- **Energy Audits** dig deeper into actual consumption patterns, including unregulated loads (e.g., IT, refrigeration, appliances), helping uncover quick wins, prioritise high-impact interventions, and optimise energy use at the operational level.
- **Display Energy Certificate** shows the actual operational energy performance of the building or business.

Used independently, each provides benefits; BER helps guide long-term investment goals and policy alignment, while energy audits support granular, cost-effective measures. When combined, they offer a holistic picture of both the building fabric and operational energy dynamics.

It is also important to note that BER uplift alone was not used as the sole determinant of depth of renovation. For example, both CS13 and CS04 improved their BER ratings from the D range to B2. However, CS04 was classified as a Deep renovation due to its integration of renewable technologies (solar PV), full HVAC replacement, and advanced zone-based controls, aligning with the definition of a deep retrofit. In contrast, CS13 involved extensive envelope and lighting upgrades but lacked renewable integration or advanced mechanical systems. As such, it was more appropriately classified as a Medium renovation. This distinction reinforces the importance of evaluating renovation depth holistically, using both quantitative and qualitative indicators rather than relying solely on BER outcomes.

7.1.4 Underuse of DEC Limits Operational Insight and Performance Gap

Display Energy Certificates remain significantly underutilised as a performance metric. Unlike theoretical BER ratings or projected energy savings through energy audit, the DEC reflects actual operational performance, capturing real-world energy use post-renovation. This makes it a critical, but often overlooked tool for validating retrofit impact, particularly in occupied commercial buildings where usage patterns, controls, and user behaviour influence outcomes. The absence of DEC data in many case studies reviewed here limits the ability to assess post-retrofit performance drift, rebound effects, or underperformance, issues that are increasingly central to climate policy compliance and funding accountability.

7.1.5 Renovation Depth Patterns

The classification of renovation depth across the case studies, using a scoring system based on energy savings, BER improvement, and scope of works, reveals a diverse range of strategies and outcomes. Contrary to conventional assumptions, deep renovations in this dataset did not consistently correspond to longer payback periods or rely exclusively on fabric-first upgrades.

Deep Renovations (weighted score ≥1.2): These cases were characterised not just by significant energy savings or BER jumps (e.g., CS05, CS06, CS12), but also by comprehensive scope, envelope upgrades, HVAC overhauls, renewable integration, and in some cases, adoption of Passive House principles. Contrary to the assumption that deep renovations always entail long payback periods, several deep renovations (e.g., CS04, CS12) achieved moderate paybacks under seven years. This demonstrates that high-impact renovations can be both technically ambitious and economically viable, especially when grant funding is leveraged or works are phased over time.

Medium Renovations (score 0.6–1.2): These cases reflected targeted yet substantial upgrades. These projects often focused on mechanical and electrical systems (e.g., CS02, CS03, CS22), sometimes with moderate energy savings or partial BER gains. In cases like CS13 or CS19, scope breadth alone was sufficient to score medium, despite BER or energy data gaps. Interestingly, some medium projects had paybacks under 5 years (e.g., CS02), indicating a balance between ambition and economic return.

Light Renovations (score <0.6): These cases generally included narrow interventions such as lighting, ventilation upgrades, or minor M&E enhancements. These were common in retail, small office, and hospitality settings where disruption constraints (e.g., CS21, CS11) or occupancy limitations discouraged full-scale retrofits. Even when savings were measurable (e.g., CS01, CS18), the limited scope and modest impact on overall performance kept the classification light.

Overall, the study supports the use of a multi-criteria approach over simple energy percentage thresholds. The dataset shows that depth of renovation is multidimensional, depending not only on energy and BER outcomes but also on scope, building type, delivery constraints, and financial characteristics. Deep projects can be cost-effective and phased, while light projects may still yield useful gains where disruption or scale are constrained. For more details, please refer to **Appendix 2**.

7.2 Analysis of Financial Details

7.2.1 Cost to Achieve BER "B" Rating

Costs varied widely across the 23 case studies, ranging from under €20,000 to over €2 million, depending on size, scope, and strategy. Light retrofits (LEDs, HVAC upgrades, minor PV installations) were often completed for tens of euros per m², while deep fabric retrofits or full-service modernisations required hundreds to thousands of euros per m². Examples include:

- €17,000 for a small urban retail-to-cafe fit-out
- €1.15 million for a logistics/warehouse retrofit, including roofing and HVAC
- €1.37 million for a deep office retrofit to reach A3 BER
- €790,000 public retrofit achieving a good BER (State funded)

Generally, attaining a BER B rating or better requires not just individual system upgrades, but also a focus on fabric improvements along with several combined measures: envelope upgrades, mechanical systems, controls, and often renewables. In contrast, despite reducing energy use, some projects that focused solely on individual plant or lighting (e.g., chillers, heat pumps) tended not to achieve a BER B rating.

7.2.2 Payback Periods and Financial Feasibility

The payback periods, where available, varied greatly with some renovations. This variance suggests that while some renovations are financially feasible in the short to medium term, others may represent more of a long-term investment. It's crucial to highlight the differences in payback periods and the types of measures when comparing the renovation of a property from a low BER (e.g., G to B1) versus a moderate one (C1 to B1). The greater the difference in BERs before and after renovation, the more energy is theoretically saved relative to the investment made. Additionally, it is important to note the type and goal of renovations in these cases; for example, in CS07, the aim was to achieve an EnerPhit standard for long-term sustainability efforts. Simple payback periods (energy-only) ranged from <1 year to over 60 years:

- Fast payback (<5 years): Targeted lighting/HVAC retrofits (CS04, CS14)
- Moderate payback (5–10 years): PV + HVAC combos (CS16, CS01, CS02, CS03,)
- Long payback (>10 years): Deep retrofits or passive house/EnerPHit standards (CS07, CS12)

However, many long-payback projects were financially justified by broader co-benefits:

- Higher rental yields (CS10)
- Improved property value (CS17)
- Occupant comfort and air quality (CS08)
- Regulatory compliance and ESG alignment (CS12)

7.3 Other General Inferences

7.3.1 Project Duration and Business Disruption

Project durations ranged from 3 months to 3 years:

- Short-term (3–5 months): Interior-only or light system upgrades (CS21, CS11)
- Medium-term (6–12 months): Mixed envelope + system retrofits (CS04, CS07)
- Long-term (1–3 years): Phased upgrades, protected structures, or deep EnerPHit standards (CS05, CS19)

Business disruption was widely minimised through phasing, tenant relocation, or performing work during vacancy periods. Common disruption mitigation strategies included:

- Temporary relocation (CS07, CS10)
- Night/weekend construction (CS10)
- Renovating during tenant vacancy (CS13, CS04, CS23)

Notably, mixed-use or investor-led properties strategically leveraged vacancies to reduce downtime. Administrative delays (e.g., planning approval) occasionally extended project timelines significantly (CS11).

7.3.2 Motivation for Renovation

While the primary motivation for renovations often centres around enhancing energy savings, numerous case studies reveal deeper motivations. These extend beyond mere energy efficiency and encompass broader objectives such as sustainability goals. Whether driven by a desire to diminish the impact of climate change or to fulfil commitments to Environmental, Social, and Governance (ESG) reporting, these cases underscore the multifaceted and purpose-driven nature of renovation initiatives. Excluding the case studies where motivation data was not provided, the analysis showed that:

- 44% of the case study projects were driven by commercial or rental strategies, such as attracting tenants, repositioning assets, or increasing rental yield (e.g. CS13, CS06, CS10). These clearly show that the renovations were driven by the owner.
- Approximately 33% were motivated by sustainability or ESG objectives, including emissions reduction, Passive House targets, or corporate climate commitments (e.g. CS08, CS22, CS23).
- A smaller portion pursued renovations as a business opportunity or expansion, such as major extensions and to demonstrate the works as an example for clients (e.g. CS07).
- Others were motivated by aesthetic, comfort, or functional improvements, particularly where premises were outdated or underutilised (e.g. CS16, CS21).

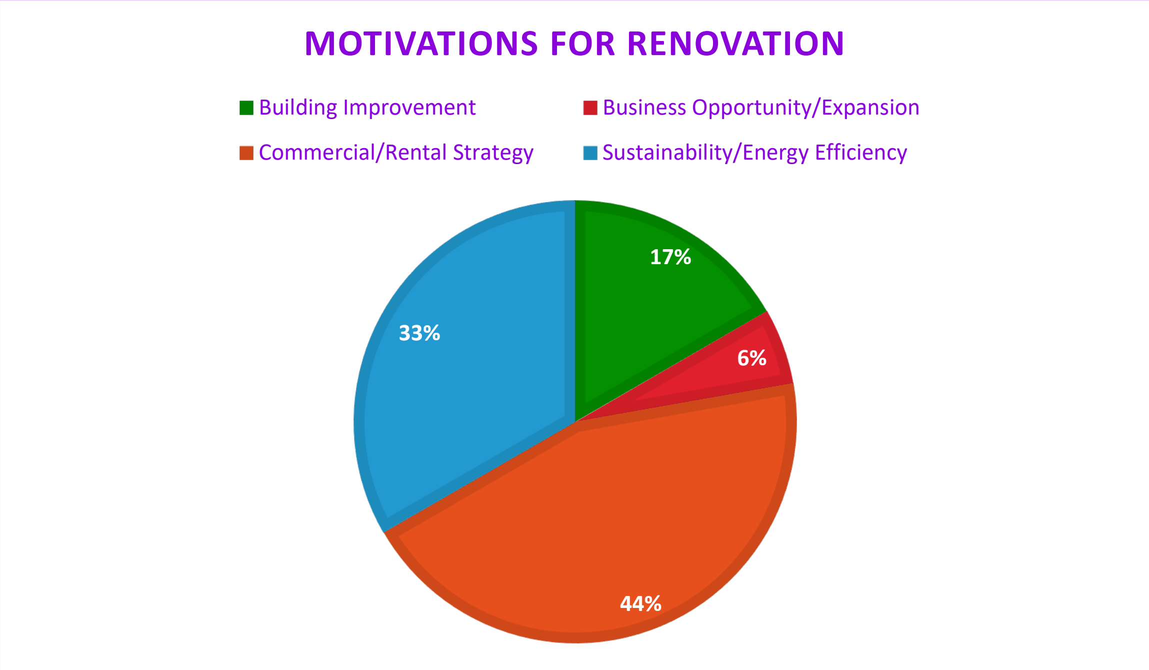

Figure 2: Motivations for Renovation

Note: This chart is based only on the subset of case studies that explicitly reported renovation motivations. Projects with missing or unspecified responses were excluded from this analysis.

7.3.3 Sustainability Patterns and Gaps

Sustainability was more prominently addressed, but with a narrow emphasis on energy performance and compliance. A clear trend emerged in favour of technological solutions such as solar PV systems, air source heat pumps, and MVHR (Mechanical Ventilation with Heat Recovery) units, which were widely adopted across offices, retail, hospitality, and industrial buildings. These interventions could have been typically motivated by energy cost savings, compliance with ESG mandates, or eligibility for grants, and were prevalent across many projects, including CS04, CS08, CS16, and CS03.

In contrast, sustainable or low-carbon building materials were rarely mentioned, appearing meaningfully only in a small number of owner-driven projects such as CS05 and CS07, where natural or reclaimed materials, breathable construction, and low embodied carbon practices were prioritised. These cases demonstrate a stronger commitment to environmental ethics but are exceptions rather than the norm. Across the broader sample, material sustainability was often a secondary consideration, if addressed at all.

This pattern suggests that commercial retrofits continue to prioritise operational energy performance over material circularity or environmental lifecycle thinking. While energy-efficient technologies are becoming standard, the use of biobased, reused, or recyclable materials, along with designs aligned to circular construction principles, remains an underutilised opportunity. Furthermore, embodied carbon, waste reduction, and biodiversity impacts were virtually absent from project documentation, even though they represent critical pillars of comprehensive sustainability.

Additional aspects like indoor air quality, occupant health, and well-being received limited but emerging attention. Some projects improved HVAC systems or referenced international frameworks like the WELL Standard (CS08), but these were exceptions rather than established practice. Even when ventilation and thermal comfort were improved, their co-benefits were not always captured systematically.

7.3.4 Placemaking

Across all the case studies analysed, placemaking, the design and adaptation of spaces to enhance usability, identity, and community value, was largely an understated or overlooked dimension. While the physical and functional upgrades in many projects contributed to improved building performance and interior quality, few projects explicitly engaged with placemaking as a goal or outcome. Where it did appear, it was typically incidental. For instance, CS11 and CS10 incorporated design elements like showers, bike parking, and EV charging points, which reflect responsiveness to evolving workplace needs and active travel infrastructure, core principles of placemaking. Similarly, CS21 transformed an unused butcher shop into a high-street café, contributing to urban regeneration and small-town vibrancy, albeit without a formal placemaking framework. However, most interventions focused strictly on energy or functional upgrades, with limited attention to broader spatial or community impacts. This reflects a missed opportunity to align retrofit strategies with local economic revitalisation, walkability, and social cohesion goals. In future projects, placemaking should be more deliberately embedded, especially for high-footfall urban and community-serving buildings.

7.4 Challenges For Commercial Renovations

An analysis of the reported barriers across the SME renovation case studies reveals that challenges extend beyond cost and include technical, regulatory, and logistical dimensions. Excluding the case studies where barrier information was not provided, the distribution of reported challenges is as follows:

- Around 30% of projects cited financial or bureaucratic barriers, such as grant application complexity, limited access to capital, or slow loan/grant processing (e.g. CS05, CS20).
- Another 30% faced technical or workforce-related issues, such as low contractor availability, design limitations in older buildings, or labour skill shortages (e.g. CS10, CS21).
- 20% experienced occupancy-related disruption, where ongoing business operations limited renovation scope or required tenant coordination (e.g. CS07, CS15).
- Another 20%, encountered regulatory or utility-related delays, including planning permission hurdles, fire safety certifications, or delays from utility providers (e.g. CS13, CS11).

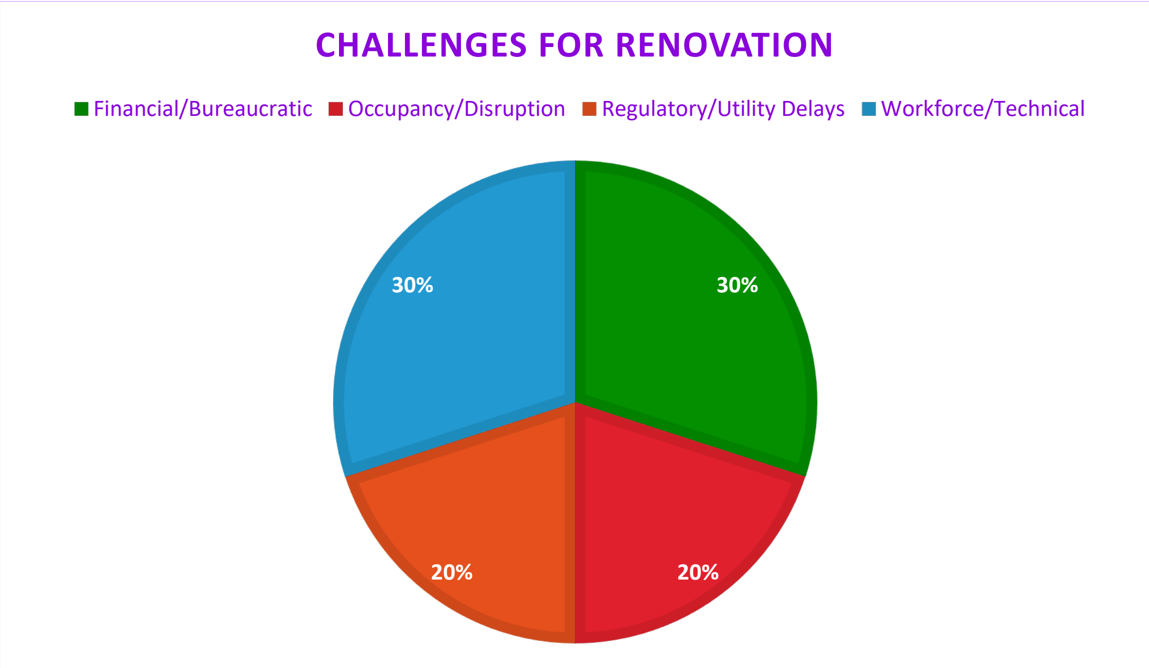

Figure 3: Challenges for Renovation
Note: These percentages reflect only the subset of case studies where renovation challenges were explicitly reported. Cases with no challenge data were excluded from this calculation.

7.4.1 Financial and Economic Barriers

Limited Financial Return from Deep Renovation

A consistent theme across the case studies is the unfavourable financial return of deep retrofits when assessed through the lens of direct energy savings alone. In most instances, commercial property owners faced high capital outlays for comprehensive renovations, often exceeding €1 million for medium-to-large offices or hotels, yet the projected simple payback periods ranged from 5 to 10+ years, even after accounting for grants, while typical business investment payback expectations tend to fall within a 3 to 5 year horizon. This mismatch in financial return timelines makes energy retrofits less attractive compared to other capital projects, contributing to the hesitation or deferral of deep renovation works by commercial property owners. For example, renovations in several office buildings (e.g. CS04, CS06, CS10) cost between €872k and €1.8 million, with payback periods exceeding 7–10 years, acting as a barrier. In contrast, owners are more likely to proceed with upgrades when costs are moderate (e.g. CS01, CS02) or when a short payback around or below 5 years could be achieved, as in CS15. Still, even in such cases, the investment only made sense when it overlapped with other business goals, like attracting tenants or increasing usable space.

Co-Benefits as Drivers

Crucially, non-energy economic drivers played a more decisive role in motivating retrofits than utility savings. Owners in CS15 and CS10 justified investment not on BER improvement, but on achieving greater rental income, increasing occupancy, or enhancing marketability. This further illustrates that the energy cost payback alone is often insufficient to drive action without a co-benefit rationale.

7.4.2 Technical Constraints and Execution Challenges

Influence of Building Age and Typology on Retrofit Feasibility

Building age and typology significantly influenced retrofit feasibility and the measures carried out. Projects involving older or historically sensitive buildings (e.g. CS05, CS07, CS23) encountered difficulties installing modern systems due to limited ceiling heights, poor existing insulation, or heritage fabric restrictions. In several cases, compliance with fire safety and disability access regulations created unexpected complications that either delayed or expanded the scope of the works.

Preference for Low-Disruption, High-Impact Measures

Across the board, fabric upgrades such as insulation and window replacements were frequently implemented, but comprehensive deep fabric interventions — including full wall insulation and thermal bridging remediation — were less common. These were typically reserved for older buildings or projects with ambitious performance goals (e.g., the EnerPHit standard in CS07). Instead, owners often prioritised lower-disruption and cost-effective interventions, such as:

- Targeted or lighter fabric upgrades (CS11, CS02, CS14)

- LED lighting retrofits (e.g., CS04, CS11, CS12)
- Solar PV installations (e.g., CS16, CS14, CS19)
- HVAC system enhancements (e.g., CS04, CS14, CS10)

Deep fabric upgrades often require higher capital expenditure, longer construction times, and significant disruption, especially in occupied or older buildings. These projects may involve decanting tenants, major structural interventions, or planning complications, all of which deter commercial owners, particularly SMEs. In contrast, system upgrades are less intrusive, easier to phase, and offer visible, often grant-eligible, returns.

However, beyond these constraints, the emphasis on system improvements also reflects deliberate, strategic decisions. In several projects, building age, energy audits, and professional advice led owners to focus on measures that offered strong returns with minimal disruption. This pragmatic approach still delivered significant gains in energy performance and occupant comfort, often through integrated packages of efficient technologies, without the complexity of full fabric overhauls.

Resource and Supply Chain Bottlenecks

Technical execution was often delayed due to supply chain disruptions and contractor availability, particularly in rural locations or projects requiring specialist trades. In CS07 and CS08, owners experienced delays sourcing insulation materials or securing skilled labour familiar with low-carbon or heritage-compatible techniques. For SMEs, these kinds of delays can pose significant financial risks, especially if premises must remain closed or construction is phased over longer-than-anticipated timelines.

Role of Building Occupancy and Layout in Retrofit Success

Projects like CS11 (co-working conversion) and CS12 (public office retrofit) progressed with relatively few technical difficulties. In both cases, the buildings were unoccupied during the works and featured flexible, open-plan layouts. This could have allowed for easier access, fewer constraints, and faster installation of new systems. These examples highlight a key insight: the initial condition of the building, particularly whether it is vacant or constrained by complex layouts, has a major bearing on the ease and speed of renovation.

Coordination Burden in Multi-Tenant Buildings

Where buildings were multi-tenant or partially occupied, coordination with occupants introduced an additional logistical burden. CS15 and CS10 required owners to negotiate relocations, manage disruption phasing, and maintain partial operations. These constraints not only slowed down the work but also limited the ambition of the retrofit, steering project teams away from deeper, more invasive improvements. This form of administrative coordination, distinct from regulatory hurdles, was nonetheless impactful. Owners had to balance energy goals with tenant satisfaction and lease obligations, often deferring upgrades that could jeopardise occupancy or trigger rent disputes.

7.4.3 Administrative and Policy Hurdles

Administrative complexity, particularly related to planning permission, compliance certificates, and grant processes, emerged as a drag on retrofit timelines and ambition across several case studies.

Delays Due to Planning Permission and Regulatory Compliance

Fire Safety Certificates and Disability Access Certificates (DACs) are essential regulatory requirements that ensure public safety in buildings. While they can introduce additional coordination steps, especially for SMEs unfamiliar with the processes, they are typically managed by professionals and do not pose major obstacles when planned early. Some case studies illustrate how planning-related approvals can extend timelines. For instance, CS11 (a co-working hub in Galway) faced a nearly two-year delay in securing planning permission, despite the construction itself taking only five months. The delay stemmed from two initial application rejections. Similarly, CS10, a commercial office project involving the addition of a new floor, had to comply with updated building codes, including more stringent fire safety regulations. This introduced extra complexity and cost during the planning phase. Even in smaller projects like CS21, approvals such as temporary hoarding permits were needed. Though these administrative steps may lengthen timelines modestly, they are a normal and necessary part of responsible renovation and are rarely a fundamental barrier when appropriately managed.

7.4.4 Behavioural and Market Factors

Business-Driven Motivations Over Energy Priorities

The primary motivations for renovation in the vast majority of case studies were business-oriented rather than energy-focused. For example:

- CS15 was undertaken to make space rentable.
- CS10 was motivated by a tenant's space requirements.
- CS11 was triggered by an opportunity to create a co-working business.

- CS21 was a complete rebranding and reuse of a vacant space for retail purposes.

These examples highlight how decisions to retrofit were shaped primarily by commercial opportunity, tenant demand, and property reuse, rather than any explicit focus on climate action or carbon performance. The value proposition for owners was clear in financial or operational terms, while energy outcomes were seen as incidental or a bonus.

Absence of Performance Verification

Another notable finding is the lack of post-renovation measurement, verification, or reporting on energy savings or carbon reductions. Without robust post-works monitoring, it becomes difficult to demonstrate the real-world benefits of efficiency investments, which in turn weakens both the internal and external case for similar actions in the future.

Risk Aversion and Minimalist Approaches

Some case studies also displayed risk aversion and project fatigue, especially when faced with uncertain outcomes or perceived administrative complexity. In these cases, even small retrofits were seen as a burden and opportunities for more substantial improvements were left unrealised.

7.4.5 Occupancy and Disruption Constraints

One of the clearest deterrents to deep renovation was the presence of ongoing operations or occupants in the building. Renovations in CS06, CS15, and CS10 were explicitly designed to minimise tenant disruption, e.g. by conducting works over weekends, relocating staff temporarily, or limiting works to specific zones. Sectoral differences further compound this issue. For instance, office-based SMEs have comparatively greater flexibility to implement remote working or staggered work patterns during renovations. In some cases (e.g. CS10), staff were temporarily relocated or worked off-site while construction was underway. This adaptability allows office retrofits to be phased more easily, enabling deeper upgrades when planned carefully. By contrast, retail, hospitality, and leisure sectors have far less flexibility. Their business models rely on physical presence and uninterrupted customer access. A closed retail unit or hotel during renovations means direct revenue loss. As seen in CS16 and CS21, such businesses face high opportunity costs if works workforce closure, even briefly. This often restricts them to narrower upgrade windows and favours surface-level improvements over disruptive energy retrofits.

Phased and Planned Works to Reduce Tenant Disruption

To mitigate disruption, these projects adopted phased or limited-scope renovation strategies:

- CS06 planned the works around existing tenancy, conducting upgrades on weekends or in isolated zones.
- CS15 temporarily relocated staff within the building during mechanical upgrades.
- CS10 involved tenant consultation and noise agreements to carry out a major expansion while maintaining occupancy.

CS22, a high-use hospitality facility located in Dublin's dense and historically sensitive Temple Bar area, illustrates the particular constraints faced by SMEs in the hospitality sector. The hotel remained fully operational throughout the retrofit, which included major HVAC upgrades, advanced ventilation controls, and smart building management systems. This required meticulous planning, phased execution, and close coordination with Dublin City Council for access, road closures, and crane operations. Despite being a medium typology renovation, the works were designed to minimise disruption to the public, guests and staff, favouring system-based energy improvements over more invasive building fabric interventions. This case study offers valuable lessons for similar SMEs operating in live environments, showing that deep energy retrofits can be achieved without full closure, provided there is careful phasing, strong project management, and early stakeholder engagement. It demonstrates how technical ambition can be balanced with operational continuity, particularly in sectors where service disruption has immediate financial consequences.

While such approaches successfully avoided complete shutdowns, they increase complexity and extend project durations. More critically, they constrain the range of feasible interventions, with owners favouring less invasive measures like HVAC, lighting, or electrical control systems. Deeper fabric upgrades, such as re-insulating walls or reconfiguring layouts, seemed to be avoided to limit disruption, even if they offered higher long-term energy benefits.

Vacant Buildings Enable Ambitious Upgrades

In contrast, projects that involved unoccupied or owner-controlled buildings, such as CS12 (a public administration retrofit) and CS05 (a creative office), were able to implement more extensive upgrades with minimal hindrance. These included:

- Roof and wall insulation
- Solar PV installation

- Mechanical ventilation and heating system overhauls

The absence of occupants meant no business continuity issues, allowing for faster timelines and deeper impact. These cases illustrate how vacancy, or full control over the property, removes many of the logistical constraints typically associated with deep retrofits.

8. Conclusion and Recommendations

The case studies presented in the report offer valuable insights into the complexities and nuances of building renovation projects. The diversity of properties, ranging from offices and warehouses to schools and recreational centres, highlights the influence of building type and location on renovation strategies. Costs varied significantly, underlining the need for SMEs to prepare for a wide range of potential expenses.

8.1 Strategic Planning and Phased Renovation Pathways

Building Context and Depth of Renovation Determine Renovation Strategy

Building application, age, and occupancy status strongly influenced renovation depth and strategy. Deep retrofits were more feasible in owner-occupied or vacant buildings, while light-to-medium upgrades dominated where disruption, tenant constraints, or fabric limitations prevailed. Traditional and historic buildings posed additional technical and regulatory hurdles. Moreover, while cost considerations shaped many decisions, several case studies demonstrated that pursuing cost-effective renovations, rather than strictly cost-optimal ones, can deliver greater long-term value, particularly when aligned with co-benefits like comfort, asset quality, and carbon reduction. This supports IEA Annex 56's recommendation to go beyond the narrow "cost-optimal" point when deeper interventions remain economically justified in comparison to a baseline.

Recommendation:

- Develop targeted renovation guidance by building typology.
- Promote sector-specific toolkits.
- Encourage early professional engagement (e.g. surveyors, architects and engineers, or conservation surveyors/architects for protected buildings, or professionals certified on hygrothermal design, BMS, and building conservation)
- Promote Building Renovation Passports (BRPs) to sequence work logically over time, especially for older or mixed-use buildings.
- Utilise BRPs and encourage SMEs to pursue the best feasible renovation measures on a phased basis, that are cost-effective relative to a baseline, even when they do not align with the "cost-optimal" point.

Phased Renovations Offer a Practical Pathway for SMEs

Budget constraints and disruption risks often led SMEs to phase retrofits over time. While limiting short-term ambition, this approach enabled progress toward deeper energy goals in manageable steps.

Recommendation:

- Institutionalise phased renovation planning through BRPs. Ensure these include cost forecasts, disruption strategies, and financing guidance.
- BRPs should be integrated into SEAI audit programs and linked to funding eligibility to incentivise adoption.

8.2 Energy Measures and Retrofit Interventions

Common Measures Reflect Low-Disruption, High-Impact Priorities

Lighting and HVAC upgrades were the most frequent interventions due to their cost-effectiveness, grant eligibility, and minimal disruption. Fabric upgrades for pre-Part L buildings, while crucial for long-term efficiency, were less common due to cost, complexity, and tenant occupancy. Retail prioritised refrigeration upgrades, and energy monitoring was growing but unevenly applied.

Recommendation:

- Establish technical benchmarks and sector-specific best practice guides.
- Utilise the data from BER assessments, Energy Audits, DECs, and case studies and aggregate them into a user-friendly database or online tool.
- Encourage SMEs to bundle low-disruption system upgrades (e.g. lighting, HVAC) with targeted fabric measures, where feasible, based on energy audit and cost-effective insights. This integrated approach enhances energy outcomes while mitigating disruption and promoting cost-effectiveness, particularly when implemented under phased plans or supported by funding schemes such as the Business Energy Upgrade Scheme (BEUS).
- While energy grants aim to reduce national energy use, future grant schemes should also account for operational disruption as a key barrier to uptake, especially among SMEs, by rewarding audit-led, integrated retrofit solutions that deliver meaningful savings while remaining feasible in live, service-based environments. This approach may enable broader participation and, ultimately, higher cumulative impact.

- Provide sector-specific case studies to illustrate ideal combinations of upgrades.

Energy Audit and BER Serve Complementary Roles

BERs provide asset-based regulatory benchmarks, but miss operational inefficiencies, as well as standardised usage profiles, especially in high-load SMEs (e.g. retail, industrial). Energy audits also provided valuable insights, particularly into unregulated loads and operational energy savings opportunities.

Recommendation:

- Incentivise dual assessment (BER + energy audit) for SME retrofits. As it better helps in tailoring the energy efficiency measures.
- Integrate findings of the BER and energy audits into BRPs for long-term planning and into funding applications to align design and operational strategies.
- Use audits to prioritise interventions with the highest operational return.

8.3 Performance Tracking and Quality Assurance

Addressing the Energy Performance Gap Requires Design and Post-Retrofit Oversight

While limited case study data precluded full performance gap analysis, industry research confirms a persistent disconnect between expected and actual energy outcomes, often due to unregulated loads, occupant behaviour, and installation quality.[31]

Recommendation:

- Adopt operational energy performance tracking tools such as Display Energy Certificates (DECs) and encourage NABERS-style design-for-performance protocols. Incentivise commissioning, user training, and post-renovation audits.
- Utilise DEC to better reflect real operational use and link monitoring to public databases.
- Implement a yearly post-project energy survey or measurement campaign, and award the SMEs with a recognition certificate or badge such as “Sustainable Energy Business”.

[31] https://www.esri.ie/system/files/publications/WP749_0.pdf

Renovation Strategy Must Shift from BER Compliance to Operational Excellence

Reliance on BER as a sole indicator of risk drives shallow, compliance-driven upgrades. The ENACT case studies and wider literature confirm the need to target real energy use and lifecycle emissions. Despite their relevance, Display Energy Certificates remain underutilised in Ireland's commercial building stock. DECs provide an essential measure of actual energy performance, unlike BERs, which reflect theoretical calculations. Without widespread adoption and mandates for private buildings as well, policymakers lack reliable post-retrofit data to assess impact or adjust strategies.

Recommendation:

- Reform the national renovation policy to prioritise actual performance. Combine BER with energy audits, DECs, and operational benchmarks.
- Track results via a public performance database and adjust grant criteria to reward real emissions reductions.
- Embedding DECs within renovation schemes, especially for grant recipients or high-occupancy SMEs, would help address the performance gap and also support a more accountable, outcome-based renovation strategy.

8.4 Financial Enablement and Advisory Support

Financial Feasibility Hinges on Grants and Co-Benefits

Deeper retrofits rarely met SME payback expectations on energy savings alone. However, they were often justified by broader co-benefits: rental yield increases, ESG positioning, regulatory compliance, tenant comfort, and enhanced asset valuation. Projects such as CS02, which achieved a 44% energy reduction via targeted system upgrades, highlight that cost-effective packages can yield a substantial impact and reach the baseline target even if not strictly "deep" by energy-only metrics.

Moreover, many impactful projects could not have proceeded without grants, yet uptake remained inconsistent due to complexity or awareness gaps. The evolving policy context, including the forthcoming EPBD Recast, further supports a shift from cost-optimality (least-cost compliance) to cost-effectiveness (value-driven, emissions-aligned renovations). As supported by IEA Annex 56, retrofit strategies should prioritise the most ambitious package of measures that remains cost-effective relative to a business-as-usual baseline, particularly when lifetime carbon reductions and social benefits are considered.

These findings support an urgent shift in renovation policy from a singular focus on energy savings toward carbon reduction as the primary performance metric. This includes both operational and embodied emissions, measured in absolute terms (e.g. $kgCO_2e/m^2/year$) and relative savings. Furthermore, renovation depth classifications should reflect sectoral realities, acknowledging that constrained-use buildings (e.g. retail, logistics) may not always reach 60% savings but can still deliver the maximum feasible carbon reductions. Such nuance ensures that all retrofit efforts are recognised for their contribution to national decarbonization goals.

Recommendation:

- Expand and simplify access to grants through dedicated SME one-stop advisory services.
- Require grant applicants to document co-benefits (e.g. comfort, resilience, business value) and lifecycle impact, not just short-term payback.
- Leverage SEAI data to develop anonymised case libraries showcasing how carbon impact and business outcomes can coexist.
- Use carbon intensity ($kgCO_2e/m^2/year$) as a standard evaluation metric to support carbon-aligned renovation decisions and grant eligibility. Prioritise integration into digital tools and national databases to support transparency and comparability.

8.5 Skills, Capacity, and Professional Standards

Qualified Professionals Improve Retrofit Outcomes

Successful outcomes relied on qualified professionals familiar with retrofit standards, thermal bridging, hygrothermal risks, and energy modelling. Poor design or installation risks undermining performance, resulting in the Energy Performance Gap and reduced occupant safety.

Recommendation:

- Set competency standards for retrofit technical advisors. Link SEAI grant eligibility to the use of qualified professionals. Develop training programs and certification schemes to ensure professionals advise on tailored cost cost-effective renovation and also the energy performance gap.

- Provide training for more contractors, professionals and labourers relating to SME renovation projects.

8.6 Occupancy Constraints and Implementation Tactics

Usage Type and Occupancy Status Heavily Influence Retrofit Feasibility

Occupied commercial buildings, especially in retail and hospitality, were significantly constrained in retrofit scope. In contrast, vacant or owner-controlled properties and offices facilitated more ambitious upgrades. Projects that maintained business continuity (via phasing or off-hours work) succeeded, but often at the cost of depth.

Recommendation:

- Design disruption-mitigation toolkits for SMEs, guidance on phased schedules, night/weekend works, etc. Embed these into the Building Renovation Passports and contractor guidelines.
- Use building vacancy or change-of-use as trigger points for deeper renovation incentives.
- Prioritise funding for projects adopting phased deep retrofit plans.

8.7 Commercial, Sustainability and Co-Benefits as Drivers

Business Motivations Shape Renovation Decisions

Many renovations were motivated by business opportunities and commercially driven (e.g. tenancy attraction, rebranding, increased asset value and rental value) rather than energy efficiency. Energy upgrades were often secondary benefits rather than primary drivers. Quantifying and publicising these benefits will help reframe retrofitting from a pure engineering exercise to a business improvement strategy.

Recommendation:

- Reframe retrofits as business-enhancing investments.
- Emphasise co-benefits, brand image, tenant appeal, and staff well-being in energy outreach campaigns.
- Encourage Green Leases to align incentives between landlords and tenants.

Sustainability and Placemaking Are Underutilised Opportunities

Most projects focused narrowly on energy savings. While renovation is inherently more sustainable than demolition and rebuild, aspects like embodied carbon, use of low-impact materials, and community value were rarely prioritised in practice.

Recommendation:

- Broaden sustainability criteria in retrofit evaluations.
- Incentivise biobased materials and placemaking in high-footfall areas.
- Encourage reporting on circularity, indoor environmental quality, and social value.

This report presented a comprehensive set of conclusions and recommendations derived from the analysis of SME building renovation case studies across Ireland. The findings reflect clear patterns in the motivations, challenges, and outcomes associated with commercial retrofitting, offering evidence-based guidance for enhancing the scale and effectiveness of renovation efforts.

Key strategic recommendations include the introduction of structured planning tools such as Building Renovation Passports, improved monitoring of actual energy performance through Display Energy Certificates and NABERS-style ratings, targeted financial and technical advisory support, more effective use of energy and renovation data, and alignment with forthcoming EU regulatory requirements. These measures are intended to be mutually reinforcing and collectively address the principal barriers identified. Effective implementation will require coordination across multiple stakeholders, including the Department of the Environment, Climate and Communications, SEAI, relevant professional bodies and SME representative organisations. A more systematic and integrated retrofit framework can support improved uptake of renovation measures, particularly those delivering higher energy savings and carbon reductions.

Given Ireland's national climate targets and the relatively low rate of deep renovations currently observed in the SME sector, these recommendations offer a practical path forward. Their adoption could enable a measurable increase in retrofit activity, contribute to emissions reduction commitments, and support the resilience and competitiveness of Ireland's commercial building stock.

Appendix

Appendix 1 - Case Study Questionnaire

ENACT – EXPEMPLAR CASE STUDIES

ENACT
Enabling Commercial Retrofit

IGBC IRISH GREEN BUILDING COUNCIL | SustainabilityWorks. DUBLIN CHAMBER SCSI Chartered property, land and construction surveyors OLLSCOIL NA GAILLIMHE UNIVERSITY OF GALWAY

ENACT Overview:

'ENACT' is an SEAI funded 3-year project 'enabling national action on commercial retrofit'. SCSI is partnering with IGBC, Sustainability Works, Dublin Chambers and University of Galway on ENACT. Commercial buildings are a substantial contributor to greenhouse gas emissions in Ireland. In the last few years, the operations of the commercial property sector have also undergone a marked change, with increased energy prices in particular driving demand for renovations. There are financial, technical, knowledge and behavioural challenges to overcome to pick the pace up of commercial retrofit/renovations within this sector. Through ENACT initiative, we want to enable the commercial sector to overcome those barriers to achieving targets and positively contributing to climate change.

Exemplar case studies of how the commercial sector has encountered and constructively dealt with these technical and financial issues will be used in a 'Technical Analysis' report, produced as a part of ENACT. Case studies that have encountered issues/sticking points at various stages are also keenly sought, as an imperative part of the process is to understand what these issues are and demonstrate how to overcome the issues. As part of this process, we are seeking exemplars to demonstrate best renovation practices in the office, retail, industrial, leisure/hospitality sectors in Ireland. We also welcome all feedback on this, positive and negative.

Case Study Exemplars:

Please submit your case studies to Aravindh Krishnan Ramesh (Project Coordinator) at aravindh@scsi.ie. Aravindh is available at 01-644-5520 to answer any queries. Eloise Heron (Project Lead) is also available to answer any queries that may occur and Aravindh will set up meetings as required upon request.

We are only seeking commercial property at this stage, and these properties must be occupied by less than 250 employees and cover a broad geographic location across Ireland (both urban and rural). Those provided must be:

A. Commercial properties
B. Have achieved a BER B+ rating, (or equivalent) following renovation works
C. Have photos accompanying submission showing (ideally) a before and after scenario
D. Detail the motivation behind the renovation trigger (and by whom, occupier, landlord/tenant/both)
E. Provide detailed analysis of the cost & nature of refurbishment works to bring to a B2+ BER
F. Provide insights on the time taken to complete the measures to bring the property to a B2+ BER
G. Estimate the renovation payback period (energy only, & energy + co-benefits such as air quality improvements)
H. Provide insights into grants applied for/not applied for (and the reasons why)

ENACT – EXPEMPLAR CASE STUDIES

I. Provide insights on savings into embodied & operational carbon emissions
J. Provide insights on indoor air quality improvements before and after
K. Provide insights into materials used, and delays encountered (or not encountered) re appointing contractors to carry out works/gain planning permission etc
L. Provide insights into any issues encountered re gaining occupation to carry out works/collaborating with landlord/tenant/ issues in that regard / associated costs incurred / any other technical issues.
M. The owner and/or occupier does not have to be named but should be asked if they would like to be mentioned.

Criteria	Detail	Additional Comments (if any)
Name/Address of Project:		
Size of property (sq. m) before and after as defined by SCSI code measuring practice (GIA/NIA etc) (https://scsi.ie/measuring-practice-guidance-notes/)		
BER Rating and Energy Intensity or equiv (current):		
Ber Rating and Energy Intensity or equiv (before):		
Original Structural Age: (for majority of the property) ▪ **2010 – New** ▪ **2000 – 2010** ▪ **1980 – 2000** ▪ **1940 – 1980** ▪ **1920 – 1940** ▪ **1900 - 1920** ▪ **1800 – 1920** ▪ **Prior to 1800**		
Location Category: (Rural, Urban or Suburban)		
Building Usage: (Office, Retail, Hospitality, Leisure, Industrial or Other (Please specify))		
Average Occupant/s' Size (prior to renovation): ▪ Micro (=<10 staff) ▪ Small (=<50 staff) ▪ Medium (=<250 staff)		
Ownership Type: (Please enter the appropriate one from the following) ▪ Owner/ single occupier ▪ Owner/ multi-occupancy ▪ Tenant - single occupancy		

▪ Tenants' multi-occupancy (how many) ▪ Real estate company owned. ▪ Investor owned		
Timeline of Works – please estimate time taken for works. Please indicate if works were phased and if so, estimate blocks of time for phasing.		
If available, please provide, per element, the U values (before and after the renovation,) for the floors, windows, doors, roofs, and walls of the property.		
Was any sustainability accreditation such as LEED/BREEAM considered/applied for/rejected? Please provide commentary if appropriate.		
What works were carried out, in brief?		
Duration of Works: (please detail)		
Materials used during renovation/ retrofit? (Please detail)		
Was the IGBC EPD database (or other) used?		
Was planning permission required? (Any issues with same?)		
Was any other statutory permission required? (Any issues with same?)		
Operational Carbon saved through renovation – please provide estimate of GHG emissions before and after renovation, if known.		
Embodied Carbon saved through renovation vs demolition and rebuilt (Please provide estimate of GHG emissions before and after renovation, if known)		

Were the principles of the RICS whole life carbon assessment PS (or other appropriate reference. LCA) **referenced during the renovation process?** (https://www.rics.org/profession-standards/rics-standards-and-guidance/sector-standards/building-surveying-standards/whole-life-carbon-assessment-for-the-built-environment)		
Was an energy audit carried out before and monitoring and verification carried out after?		
Air Quality comments (were these improved, please provide details.)		
Issues encountered appointing contractor/any other issues/delays?		
Estimated Direct Cost of Renovation/Retrofit works? (Excluding VAT, but including professionals' fees, please state separately)		
Grant (s) sought? Please provide details, including any issues encountered		
What was the funding mode/s for the renovation works? (exc grants)		
Estimated Cost of Disruption to Occupying Business/es: (this can be in financial terms or other)		
Payback Period: (Energy only) – (Please provide details of the payback period with ref to energy savings, and/or additional information on payback calculation)		
What was the motivation to renovate?		

Appendix 2 - Detailed Renovation Depth Justification Table

Case ID	BER Before	BER After	Energy Savings	Energy Score	BER Score	Scope Score	Total Score (Weighed Average)	Renovation Depth	Typology Justification
CS01	-	-	140,349 kWh	0	0	1	0.4	Light	This project achieved only a ~17% energy reduction (140,349 kWh/year) with upgrades – a 100 kW solar PV array and destratification fans to improve airflow. The scope was narrow (renewables + ventilation) and payback ~6 years, consistent with a shallow retrofit.
CS02	-	-	263,000 kWh	1	0	2	1.2	Medium	Although the absolute savings were sizable (262,574 kWh/year, ~95 t CO_2), the measures were targeted (upgrade of 8 refrigeration systems and a new heat pump with heat recovery) saving around 44% of the annual energy consumption. No envelope improvements or BER data were given. The payback was quick ~7 years, indicating a focus on specific high-return systems rather

									than a comprehensive overhaul; thus, a medium renovation is appropriate.
CS03	-	-	341,000 kWh	0	0	2	0.8	Medium	This case implemented a broader scope: HVAC optimisation (VSD compressor), envelope zoning (insulated partitions, rapid roll doors on 9 chill rooms), and a 150 kW solar PV system. The estimated annual energy saving (340,682 kWh) is substantial, around 22% of total annual energy consumption. While BER wasn’t specified, the diverse measures (fabric + systems + renewables) justify a medium-depth classification. The payback (~7 years) also suggests a moderate investment depth.
CS04	D1	B2	-	1	2	2	1.6	Deep	This project undertook a comprehensive systems overhaul (new AHUs, heat recovery ventilation, zoned controls, LED lighting, photovoltaic panels, etc.). BER improved from D1 to B2 – a notable uplift, though not reaching A. Annual energy savings (~€102k, ~512,000 kWh) were reported (implied by

									€102k/year saved) with an energy upgrade investment of ~€414k (yielding a long payback). The broad scope (HVAC, lighting, PV, BMS, even EV charging infrastructure) aligns with a deep renovation, despite only moderate BER gains.
CS05	G	B1	-	2	2	2	2	Deep	The retrofit was to Passive House/EnerPHit standards, with BER improving from G to B1 (modelled ~A2). A fabric-first approach (airtightness taping, natural insulation in walls/floors/roof, triple-glazed windows) plus renewable systems (heat pump, MVHR, solar) was implemented. This yielded near-passive performance and massive energy use reduction (from worst-in-class to ~A2 level) with a ~7-year payback. Potentially a deep retrofit.
CS06	F	B2	-	1	2	2	1.6	Deep	BER improved from F to B2 – a dramatic efficiency jump. The project addressed all major aspects: facade and roof insulation, window replacements, full interior

									refurbishment, and complete renewal of mechanical & electrical systems. Such extensive envelope and HVAC upgrades typically achieve deep energy cuts (though exact kWh savings aren't quantified beyond "significant"). Given the whole-building approach and major performance uplift, this is better classified as a deep renovation.
CS07	C1	B1	11,500 kWh	2	1	2	1.8	Deep	This was an EnerPHit-standard retrofit with an extension. BER only improved from C1 to B1, but the operational energy reduction was enormous – from 13,900 kWh to just 2,400 kWh annually (≈83% cut, saving ~€2,454 and 4.4 t CO_2/year). Measures included deep insulation of all fabric elements, triple-glazed windows, airtightness improvements, and a solar PV system. Such a drastic consumption drop and Passive House-level performance fully justify the deep classification.
CS08	C3	A3	1,800 kWh/m2/yr	1	2	2	1.6	Deep	A holistic retrofit achieving BER C3 to A3 with a 91% reduction in energy costs (and 92%

									carbon reduction). The project upgraded all facets: roof, wall and window insulation (achieving high airtightness), new heat pumps and hybrid ventilation, LED lighting with smart controls, plus 30 kW of solar PV and EV charging infrastructure. This comprehensive scope and ~90% energy/carbon savings clearly represent a deep renovation.
CS09	-	F-B2-C1	-	0	2	0	0.4	Light	This was primarily an interior fit-out with minimal energy-focused work. No energy savings were quantified; BER results varied per floor (only the landlord area improved to B2, while one floor remained F), indicating limited impact on performance. The upgrades centered on partitions, LED lighting, and small HVAC additions (panel heaters) to enable full occupancy. Financially, it was a flip: ~€2 million spent to modernize the space and immediately sell the property with 25% increased value (0-year payback). These characteristics align with a light renovation

									(mainly cosmetic/fit-out, with marginal energy benefit).
CS10	-	-	-	0	0	2	0.8	Medium	The project undertook broad upgrades – adding a new floor and entrance, installing curtain-wall facades, insulated roofing, LED lighting, mechanical ventilation/AC, a 72-panel solar PV array, EV chargers, etc. This scope is extensive. However, no specific energy savings or BER improvement were documented; the case study notes that due to lack of data it was “conservatively categorised as Medium”. Given the substantial interventions, it likely achieved significant efficiency gains, but in absence of quantified results, a medium classification is reasonable.
CS11	-	-	-	0	0	0	0	Light	Upgrades were modest and mostly interior-focused: new stud/glass partitions for layout, LED lighting with sensors, and a small HVAC addition for comfort. No energy savings were measured. The payback (~10 years on €447k, heavily grant-funded) suggests the primary

									aims were functional and aesthetic rather than major energy reduction. The renovation did not address the building envelope or major systems comprehensively, so “Light” is appropriate.
CS12	E	A2	-	1	2	2	1.6	Deep	BER jumped from E to A2, indicating a major performance leap. The retrofit focused on systems and renewables: a large 300 m² solar PV installation and new mechanical ventilation/air-conditioning systems, alongside LED lighting and some internal reconfiguration. Notably, traditional fabric upgrades were minimal (partitions for zoning only), but achieving an A2 rating from an E suggests drastic energy and carbon reductions (likely >60%). The significant investment (€790k, state-funded) and outcome align with a deep renovation classification.
CS13	D2	B2, B3	-	0	2	2	1.2	Medium	This project delivered a moderate retrofit of a warehouse/office: roof and windows were upgraded (new insulated panels, double-

									glazing) and old electric heaters were replaced with more efficient zonal ones. Lighting was also converted to LED. BER improved from D2 to about B2/B3 – a decent gain, but not reaching the top tiers. No renewables were added. The payback (~14 years on a mid-size budget) and scope indicate a medium-depth renovation (significant fabric and some system upgrades, but not a full deep retrofit).
CS14	-	-	730,200 kWh	2	0	2	1.6	Deep	The facility installed a 1,200 kW (1.2 MW) solar PV array and replaced gas heating with a high-efficiency VRV heat pump system. Estimated energy savings were 730,238 kWh/year (with 448 t CO_2 cut annually) – a very large reduction in operational energy. Although building fabric wasn't mentioned, the project achieved a major shift to on-site renewables and electrified heating, with a ~6-year payback. The scale of carbon and energy reduction (and the high investment ~€2.1 M)

									aligns better with a deep renovation, despite focusing on services rather than insulation.
CS15	D2	D1	-	0	0	0	0	Light	This was a limited retrofit primarily centered on a chiller/HVAC upgrade. Energy use fell by only ~23% (BER D2 to D1, a minor bump), and many works were non-energy cosmetic (office refit, etc.). The payback was extraordinarily fast (~6 months), indicating a one-off efficiency fix rather than a large capital deep retrofit. Given the narrow focus (targeted M&E upgrade plus minor interior works) and modest efficiency gain, it fits the profile of a light renovation more than a medium one.
CS16	E	A2	-	1	2	2	1.6	Deep	A major overhaul of the leisure facility's energy systems was done, yielding BER E to A2. Operational energy costs dropped ~56%, with 26% of electricity now produced on-site (137 kW solar PV array) and carbon emissions cut ~65%. The project integrated geothermal

									heat pumps (2×79 kW, 15 boreholes) and a biomass boiler cascade (400 kW) for renewable heating, plus MVHR ventilation and waste-water heat recovery. Lighting was fully upgraded to smart LEDs as well. Despite limited fabric changes, the comprehensive services and renewables upgrade transformed the energy profile, justifying deep renovation status.
CS17	-	-	206,400 kWh	1	0	0	0.4	Light	The intervention was system-specific – primarily a pool/spa heat recovery system and energy monitoring (Heatstar hybrid heat pump + recuperator). This yielded ~206,431 kWh/year savings (~53 t CO_2), which is notable in absolute terms but focused on one area (leisure center systems). BER wasn't given, implying the overall building rating saw little change. With a ~4.5-year payback (3.1 with grants) and a narrow scope, this aligns with a light renovation (tackling a single high-usage subsystem for quick gains).

CS18	-	-	371,000 kWh	1	0	0	0.4	Light	Upgrades were targeted to HVAC: installation of 63 new fan-coil units, controls, and a high-efficiency 344 kW chiller. This improved cooling/heating efficiency, saving ~371,366 kWh/year and 87.8 t CO_2. However, no envelope or broad improvements were made. The ~€383k investment had an 8.5-year payback (6.0 with grants), focusing on operational efficiency rather than a holistic retrofit. Given the limited scope (no insulation or renewable energy measures) and moderate percentage savings, it remains a light renovation targeting specific systems.
CS19	-	-	2,365,000 kWh	1	0	1	0.8	Medium	This project was a comprehensive mechanical upgrade across a large resort complex: multiple heat pumps (including ground-source) and control systems were upgraded or added, along with pump and cooling system improvements. This yielded massive absolute savings (actual ~2.37 GWh/year), though likely representing a moderate fraction of the

									resort's total consumption (~20–30% reduction). No mention of fabric upgrades or on-site PV; the focus was on replacing and optimizing HVAC plant. With a ~9-year simple payback on a €1.92 M investment, the effort goes beyond a quick fix, but without envelope or >50% savings it fits medium-depth – a major systems retrofit with significant (not maximal) gains
CS20	-	-	-	0	0	2	0.8	Medium	The renovation combined a few moderate measures: attic insulation, LED lighting, two high-efficiency boilers, and a solar PV array covering ~1/3 of the facility's annual energy use. These upgrades improved efficiency but did not overhaul the entire building. The project cost (net ~€212k after grants) was recoupable in ~4 years, indicating it targeted low-to-mid-level improvements. Given the partial fabric upgrade (only attic) and only one renewable system, this is appropriately a

									medium renovation – more than trivial changes, but not a deep retrofit.
CS21	-	-	-	0	0	0	0	Light	This was essentially an interior fit-out and compliance upgrade for a small café (60 m²) rather than an energy retrofit. Some minor energy-related improvements occurred (replacing a rotted wall with insulated glass doors, adding basic heating/plumbing and new wiring), but no data on energy savings was provided. The project's focus was on making a derelict space functional and up to code (fire safety, accessibility). With only marginal thermal benefits from these changes, the "Light" classification is correct.
CS22	-	-	-	1	0	1	0.8	Medium	The hotel underwent a major HVAC and control system overhaul: hybrid VRF heat/cool systems in all 142 rooms, upgraded AHUs with heat recovery wheels, CO_2-based demand-controlled ventilation, and a new BMS integration. These measures led to an

									impressive ~1.6 GWh annual energy saving (~231 t CO_2). However, no building fabric was retrofitted and the upgrades, while extensive, were confined to mechanical and electrical systems. The ~€1.6 M project (with €400k grant) paid back in ~5 years, reflecting high efficiency gains from systems alone. This breadth of HVAC/BMS improvements is rightly categorized as medium-depth (comprehensive systems retrofit without envelope changes).
CS23	Exempt	Exempt	82,500 kWh	2	0	2	1.6	Deep	This school retrofit addressed fabric, systems, and renewables. New doors/windows were installed, walls and roof were insulated, old heating was replaced with an efficient heat pump, and a 30 kWp solar PV system added. The building (a protected structure, BER-exempt) saw a reported annual saving of ~82,468 kWh (thermal) plus ~6.65 t CO_2 from PV – significant for a 250 m² school, likely indicating >50% energy reduction. The project's ~€170k cost (with ~47% grant) has a

									~7-year payback, showing a strong investment in energy efficiency. Given the comprehensive envelope and system upgrades (akin to a deep energy retrofit of an old building), this case merits deep classification.

Appendix 3 - Basics of Commercial Property Renovations

A number of approaches and strategies were followed in the different cases of commercial property renovations in the above study. However, predominantly most of them had a pattern followed in their journey of renovation and focused on some of the key areas when it came to energy conservation and efficiency. Here are some key aspects of energy renovations in the commercial sector that can as a guide for anyone who wishes to renovate their property:

- **Energy Audits and BER Assessments**

Before initiating any renovations, a thorough energy audit or BER is typically conducted to assess the current energy performance of the building and its operations. These assessments help identify areas of inefficiency, such as poor insulation, outdated HVAC systems, inefficient lighting, or outdated equipment.

- **Improved Insulation**

Upgrading insulation in walls, roofs, and windows helps minimise heat transfer, reducing the need for excessive heating or cooling.

Proper insulation ensures a more stable indoor temperature, improving comfort for occupants and reducing the workload on HVAC systems.

- **Efficient Lighting Systems**

Retrofitting traditional lighting with energy-efficient LED fixtures can significantly reduce energy consumption.

Incorporating lighting controls, such as occupancy sensors and daylight harvesting systems, ensures that lights are only used when needed.

- **HVAC System Upgrades**

Heating, ventilation, and air conditioning (HVAC) systems are often major contributors to energy consumption in commercial buildings.

Upgrading to more energy-efficient HVAC systems, implementing regular maintenance, and optimising control systems can lead to substantial energy savings.

- **Renewable Energy Integration**

Incorporating renewable energy sources, such as solar panels or wind turbines, can help generate clean and sustainable electricity on-site.

Some businesses may also explore the option of purchasing renewable energy credits or entering power purchase agreements with renewable energy providers.

- **Smart Building Technologies**

Implementing smart building technologies, including energy management systems and building automation, enables more precise control over energy usage.

Automated systems can adjust lighting, HVAC, and other building components based on occupancy, time of day, and external environmental conditions.

- **Water Conservation Measures**

Although Energy Efficiency has been the main goal of renovation in recent years owing to the increase in energy cost and various other factors, installing water-efficient fixtures and systems contributes to the overall sustainability of the property and can reduce the energy required for water heating.

- **Behavioural Changes and Employee Engagement**

Educating occupants and employees about energy-efficient practices and encouraging behavioural changes can complement physical renovations.

Awareness programs and incentives can motivate individuals to contribute to energy savings within the workplace.

- **Life Cycle Cost Analysis**

Evaluating the life cycle cost of various renovation options helps businesses make informed decisions by considering not only upfront costs but also long-term savings and discounted payback.

Glossary of Acronyms

Term	Full Form	Definition
AHU	Air Handling Unit	A component of HVAC systems that conditions and circulates air as part of a ventilation or cooling/heating system (blowing filtered air through ductwork).
BEUS	Business Energy Upgrade Scheme	A grant scheme administered by SEAI that supports SMEs in carrying out energy efficiency upgrades through fast-track funding for eligible measures like heating, lighting, and insulation.
BER	Building Energy Rating	An energy efficiency rating label for buildings in Ireland, graded from A (most efficient) to G (least efficient), indicating the building's energy performance.
BPIE	Building Performance Institute Europe	A European center of expertise and advocacy aiming to improve energy performance in buildings through research and policy guidance.
BRP	Building Renovation Passport	A structured, building-specific renovation roadmap that combines energy audits, upgrade history, and planned measures to guide deep energy retrofits over time.
CAPEX	Capital Expenditure	Upfront capital investment costs for acquiring or upgrading an asset or project (e.g. building retrofit costs).
CEG	Community Energy Grant	An SEAI grant scheme (often referenced with a year, e.g. CEG 2022) providing funding for community-based energy efficiency projects.

CIBSE	Chartered Institution of Building Services Engineers	A professional association offering guidance and standards for building services engineering (mechanical, electrical, HVAC systems design and operation).
CO_2	Carbon Dioxide	A naturally occurring greenhouse gas; often referenced in emissions context. In building projects, CO_2 reductions refer to cutting carbon emissions to mitigate climate change.
CO_2e	Carbon Dioxide Equivalent	A standardized metric for greenhouse gases, expressing the impact of various gases (methane, etc.) in terms of the amount of CO_2 that would produce the same warming effect.
CSRD	Corporate Sustainability Reporting Directive	An EU directive requiring large companies to report on sustainability metrics (environmental, social, governance aspects) with standardized disclosures.
DEC	Display Energy Certificate	A certificate showing the actual energy performance of a building based on metered consumption. In Ireland it can be found typically displayed in public buildings to promote transparency and awareness.
DPP	Discounted Payback Period	The time required to recoup an investment's cost considering the time value of money. In other words, the payback period when future savings are discounted to present value.
ENACT	Enabling National Action of Commercial Take-up of Retrofit	The name of the SEAI-funded project under which this report was developed, focused on accelerating commercial building energy renovations.
EnerPHit	*(Name of a retrofit standard)*	A certification standard by the Passive House Institute for retrofitting existing buildings to near *Passive House* performance levels, emphasizing very high energy efficiency in renovations.

EPBD	Energy Performance of Buildings Directive	European Union directive that sets requirements to improve building energy efficiency (e.g. renovation mandates, building energy codes, and certifications).
EPG	Energy Performance Gap	The discrepancy between a building's predicted energy performance (as designed or modeled) and its actual energy consumption in operation.
ESG	Environmental, Social, and Governance	A set of criteria for evaluating a company's operations with respect to sustainability and ethical impact. (In context, "ESG alignment" refers to meeting such sustainability goals to enhance value or compliance.)
ESRS	European Sustainability Reporting Standards	A collection of detailed reporting standards under the CSRD, which companies must use to disclose sustainability information in their annual reports.
EU	European Union	A political and economic union of 27 European countries, which implements directives and regulations (like EPBD, CSRD, etc.) that member states (including Ireland) must follow.
EV	Electric Vehicle	A vehicle powered by electricity (usually from batteries) rather than a conventional internal combustion engine.
EXEED	Excellence in Energy Efficient Design	An SEAI program and certification/grant scheme that promotes best-practice energy efficient design in projects. (Projects following the EXEED standard can receive grant support for implementing energy efficiency at the design stage.)
GHG	Greenhouse Gas	Any gas that traps heat in the atmosphere and contributes to the greenhouse effect. Common GHGs include CO_2, methane (CH_4), and others; reducing GHG emissions is key to climate action.

HVAC	Heating, Ventilation, and Air Conditioning	The collective term for a building's climate control systems – providing thermal comfort (heating/cooling) and fresh air circulation.
IGBC	Irish Green Building Council	A non-profit organisation promoting sustainable building practices in Ireland through education, advocacy, and certification programs aligned with national and EU climate goals.
IRR	Internal Rate of Return	A financial metric used to evaluate the profitability of an investment, defined as the discount rate that makes the net present value (NPV) of all future cash flows equal to zero.
ISO	International Organization for Standardization	An international standards-setting body. In energy context, *ISO* standards like ISO 50001 (energy management systems) provide frameworks for best practices and benchmarking.
kW	kilowatt	A unit of power equal to 1,000 watts. Often used to rate the capacity of engines, motors, or heating/cooling equipment (e.g. a 150 kW boiler).
kWh	kilowatt-hour	A unit of energy representing one kilowatt of power sustained for one hour. Used to measure energy consumption (e.g. a building uses X kWh per year).
kWp	kilowatt-peak	The peak power output of a solar photovoltaic system under standard test conditions. For example, a "30 kWp PV system" can produce 30 kW under ideal solar irradiance.
LED	Light Emitting Diode	An energy-efficient lighting technology that uses semiconductor diodes to emit light. LED lights consume significantly less electricity than traditional incandescent or fluorescent lamps for the same light output.

M&E	Mechanical and Electrical (services)	In building context, refers to the mechanical and electrical engineering systems, such as HVAC, plumbing, power, and lighting installations. (A "full M&E upgrade" means overhauling these systems.)
M&V	Measurement and Verification	Systems or processes to monitor, measure, and verify energy usage and savings over time. (Often used after energy upgrades to ensure projected savings are achieved.)
MEPS	Minimum Energy Performance Standards	Regulations that set minimum required energy efficiency levels for buildings or equipment. For example, MEPS can mandate upgrades of poor-performing buildings by certain dates.
MVHR	Mechanical Ventilation with Heat Recovery	A ventilation system that extracts stale air and draws in fresh air while transferring heat between the two airflows. This recovers heat that would otherwise be lost, improving efficiency and indoor air quality.
NEAP	Non-domestic Energy Assessment Procedure	The methodology/software used in Ireland to calculate the BER for non-residential buildings. NEAP is used by assessors to evaluate a building's energy performance (analogous to SAP for homes in the UK).
NFRD	Non-Financial Reporting Directive	A previous EU directive that required certain large companies to report on social and environmental performance. It has now been superseded by the broader CSRD requirements.
OPEX	Operational Expenditure	Ongoing costs of operating and maintaining an asset or business (as opposed to upfront capital costs). In building projects, OPEX includes expenses like energy bills, maintenance, and repair costs.
PHPP	Passive House Planning Package	A design tool (software and spreadsheet suite) used for planning and verifying Passive House and low-

		energy buildings. PHPP allows detailed energy modeling to ensure a building meets ultra-low energy targets.
PV	Photovoltaic	Relating to the conversion of sunlight into electricity (as in *solar PV* systems). A photovoltaic panel generates DC electricity when exposed to solar radiation.
SCSI	Society of Chartered Surveyors Ireland	The professional body for chartered surveyors in Ireland, providing standards, research, and guidance on property, land, and construction matters.
SEAI	Sustainable Energy Authority of Ireland	Ireland's national energy authority responsible for promoting sustainable energy policies and administering programs/grants for energy efficiency and renewable energy.
SFDR	Sustainable Finance Disclosure Regulation	An EU regulation requiring financial market participants (like asset managers and insurers) to disclose how they integrate ESG factors into their investments and products.
SMEs	Small and Medium-sized Enterprises	Businesses of a relatively small scale (typically defined by employee count and turnover thresholds). In this context, SMEs are a focus for energy improvements and support, as they may face unique barriers to retrofit uptake.
VAT	Value Added Tax	A consumption tax on goods and services. In this report, costs are sometimes listed *"(Exc. VAT)"* or *"(Inc. VAT)"*, meaning excluding or including the applicable VAT (in Ireland, standard VAT for construction is 23%).
VRV	Variable Refrigerant Volume	An HVAC technology that uses a variable-speed compressor to adjust the flow of refrigerant, providing precise temperature control across

		multiple indoor zones. (Also known as VRF – Variable Refrigerant Flow.)
VSD	Variable Speed Drive	An electronic drive that controls an electric motor's speed and torque by adjusting the power input frequency. VSDs (used in pumps, fans, compressors, etc.) save energy by running motors at the optimal speed for the current demand.
WELL	WELL Building Standard	A performance-based building certification focusing on human health and wellness in the built environment. *WELL* standards cover factors like air quality, water, light, fitness, comfort, and mental well-being in buildings.