hibernia RKD

Towards Net-Zero Whole Life Carbon Emissions

Lessons from an Irish Case Study
1 Cumberland Place

This report explores the journey of a renovated office building towards net zero carbon emissions.

It begins by introducing the global and national challenge facing the built environment to decarbonise, followed by a brief overview of the case study building itself: Hibernia Real Estate Group's 1 Cumberland Place in Dublin.

The net zero carbon building landscape is then laid out by comparing the different operational and embodied carbon definitions and targets. The case study's measured and rated operational performance results are then investigated and compared to these.

A preliminary embodied carbon analysis has also been conducted to estimate the carbon emissions associated with renovating the structure and skin.

The study found that 1 Cumberland Place...

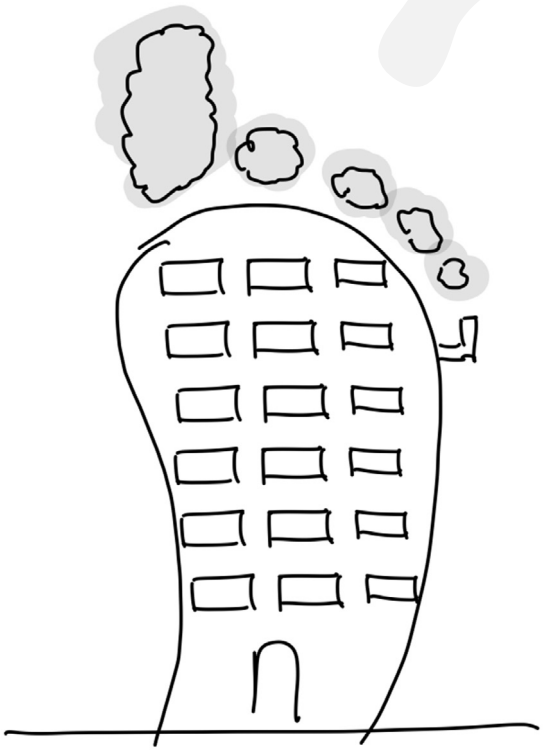
1. ...now has a rated performance which is within the best performing 5% of Irish office buildings, and is hence EU **taxonomy aligned** under the "Acquisition and ownership of buildings" activity.

2. ...now has a **rated** primary energy demand **44% lower** than the average office building.

3. ...now has a **measured** primary energy demand **58% lower** than the average office building, as of 2022.

4. ...has an estimated **embodied carbon** footprint **66% lower** than that of a new office building.

5. ...is continuing to improve year-on-year through detailed **post occupancy evaluation** with **further reductions** expected at the end of 2023 following the installation of more energy reduction measures. Plans for further decarbonisation through occupier engagement, full electrification and on-site renewable installations are under investigation.



The Built Environment's Carbon Footprint

The United Nation's latest global status report for buildings and construction estimated that the operation and construction of the global built environment accounted for **37%** of process- and energy-related emissions in 2022.[1]

This figure is matched at a national level, with a recent study quantifying Ireland's built environment to be 37% of its national emissions.[5]

Under a *do-nothing* scenario this figure will increase – both globally and nationally. The Organisation for Economic Co-operation and Development (OECD), for example, is predicting a doubling in global demand for materials by 2060[6] (much of which is used in construction) while the International Energy Agency (IEA) predicts a 75% increase in global floor area by 2050 – from ~244 to ~427 billion m².[7]

Ireland's Climate Action Plan cites a figure of 12% for the built environment [2]. But this only includes on-site combustion of fossil fuels in buildings. It does not account for the carbon emissions associated with electricity consumption, or embodied carbon and is hence not aligned with the World Green Building Council (WGBC) [3], the United Nations Environment Programme (UNEP) [1] or the European Commission's [4] understanding of the built environment.

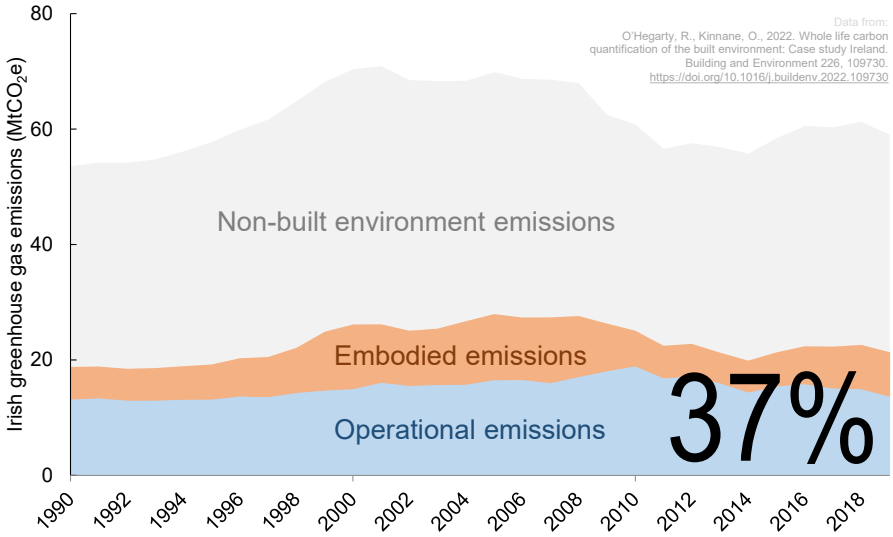


Figure 1. Whole life carbon emissions from the Irish Built Environment.

A similar upward trend is expected in Ireland with the National Development Plan (NDP) proposing considerable capital investment in building and infrastructure (in particular housing)[8] to counter the under investment in construction over the past decade – a period of time which saw the population increase by almost the same amount as the previous decade (Figure 2).

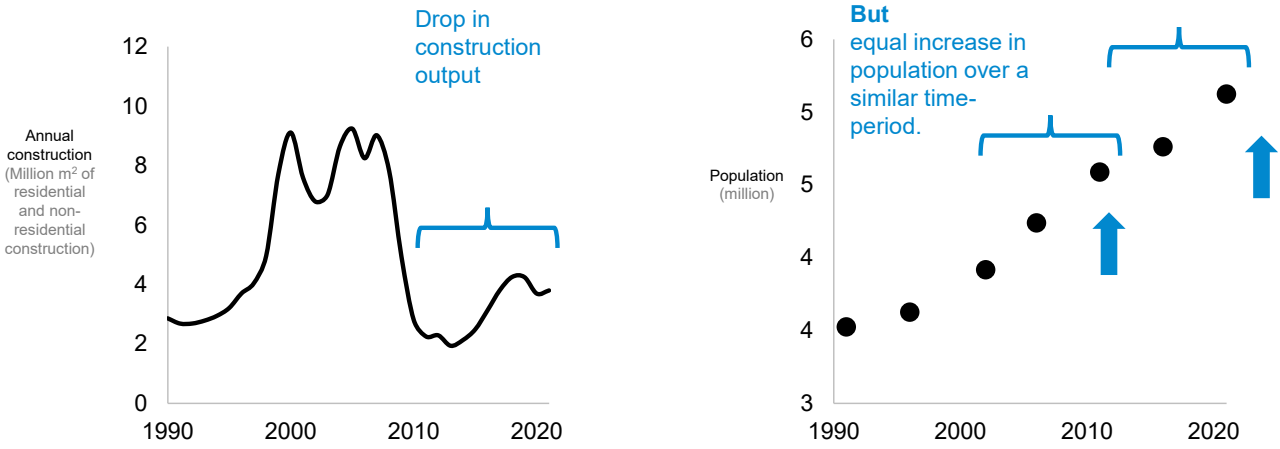


Figure 2. Embodied carbon drivers for Ireland – A drop in past annual construction and increase in population. Data taken from the CSO and work that used the CSO's data [5,10–14].

The population of reland, unlike Europe as a whole, is set to increase to 2050 and beyond (Figure 3) according to the United Nation's Population Division.[9]

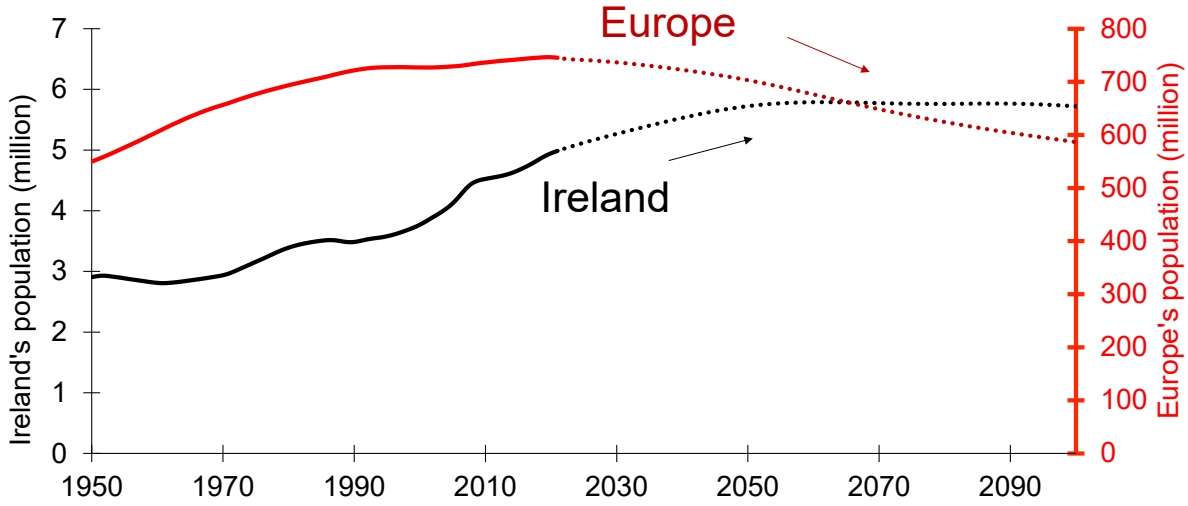


Figure 3. Population predictions Ireland vs. Europe [9].

Visualising a Path to Zero

The already-significant contribution of the built environment to national and global emission inventories, coupled with the projected growth of the sector, presents an unprecedented decarbonisation challenge.

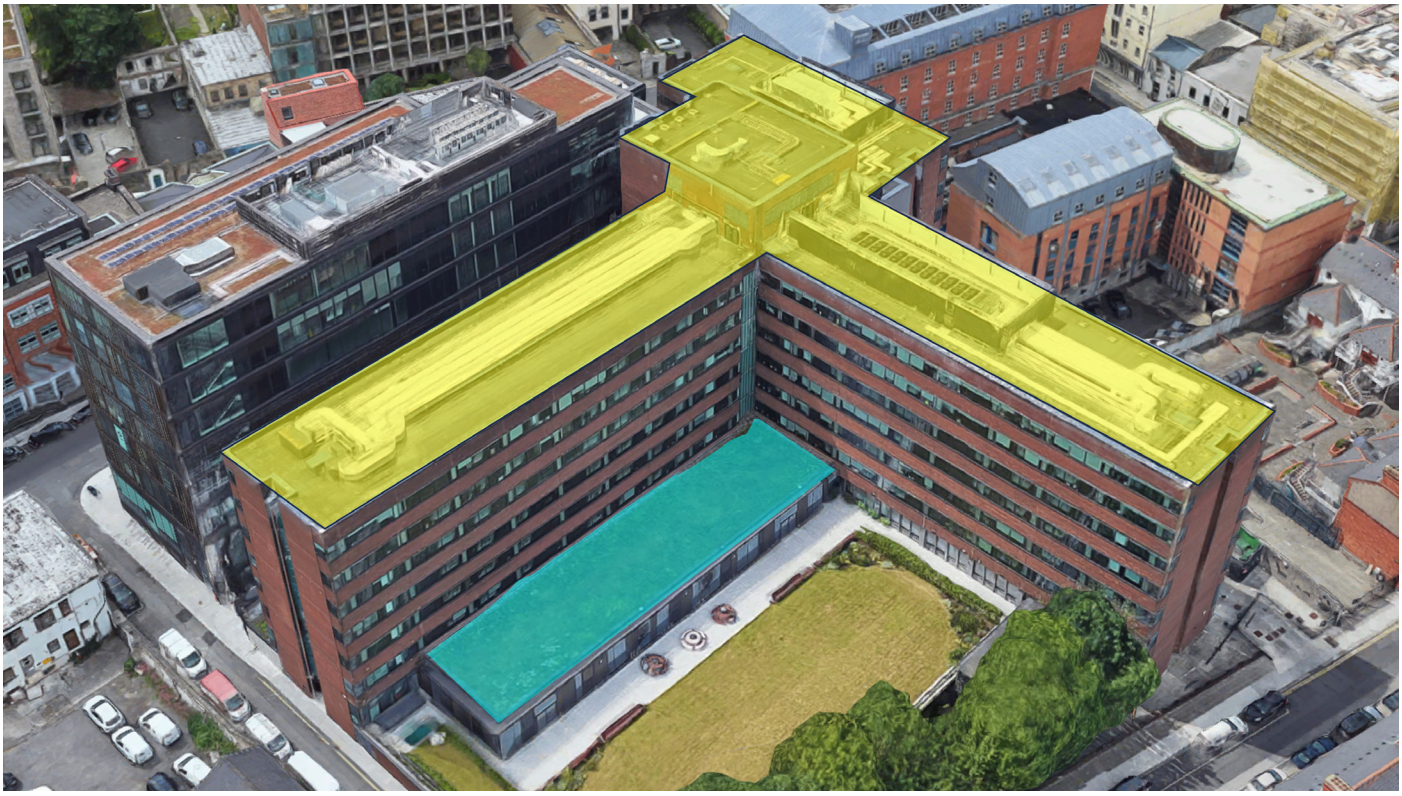


Figure 4. 1 Cumberland Place. Image adapted from Google Maps. Yellow area (existing) Green (added in 2016).

The scale of the challenge is difficult to comprehend and its magnitude risks de-motivating those who are best equipped to address it.

This report aims to visualise a decarbonisation path through the lens of an office renovation case study – Hibernia's 1 Cumberland Place.

The building is located on the junction of Bass Place and Fenian Street in Dublin City. The building was originally constructed in the early 1970s, although significant refurbishment and some extension works were undertaken in 2016. It comprises seven storeys over lower ground level totalling 11,999m² of lettable floor space and a Gross Internal Area (GIA) of 13,497m². It is a reinforced concrete framed structure with external facades predominately comprising of red brick, laid in a common bond. Single storey extensions to both the front and rear elevations were constructed in 2016, these primarily comprise architectural cladding panels with glazed curtain walling and steel structure. The front entrance / main reception is shared with the neighbouring property, 2 Cumberland Place, and comprises a combination of seamless glazed curtain walling with perforated steel cladding panels

and metal fins. Car parking for up to 70 cars is provided at lower ground level to the rear of the development.

The refurbishment incorporated modern and energy efficient technologies such as heat recovery ventilation, LED lighting and power factor correction, as evidenced by the "B2" Building Energy Rating (BER). A "Platinum" Leadership in Energy and Environmental Design (LEED) rating was awarded to the property in May 2017.

In 2022, additional improvements were made to the building's operations with the implementation of CoolPlanet's Operating System (OS) which enabled the centralisation and visualisation of Hibernia's decarbonisation metrics (energy, water, waste, emissions, etc.) into one platform. This consolidation of data allows for scope 1, 2 and 3 carbon emission tracking, hotspot identification, and finally, decarbonisation action. CoolPlanet's OS was implemented in parallel with Symphony Energy's digital engineering technology which focused specifically on reducing the energy consumption – and hence carbon emissions. Symphony's technology deployed a combination of sensors and optimisation software to capitalise on the existing Heating Ventilation and Air Conditioning (HVAC) system's underutilised components. It uses the additional hardware (including sensors and motorised dampers) and patented algorithms to optimise cooling and heating loads based on real-time demand, maximising heat recovery and managing the system through the Symphony Cloud. Initial results from the Symphony system are presented in this work with data from CoolPlanet's OS.

The majority of the plant serving the offices is located within the lower ground level and roof level, this includes the main occupier and landlord electrical distribution boards, air handling units, chillers, boilers, cold water storage, generator, hot water cylinders and circulating pumps.

1 Cumberland Place's key sustainability merit is the fact it achieved its operational performance status as a refurbishment. A full suite of off-the-shelf technologies are not available when undergoing a refurbishment. The challenge to achieve operational carbon emission targets while preserving as much of the structure and skin is hence considerable, and requires innovative solutions and leadership at building management level.

The motivation from a landlord/owner to transition a building (previously in the 15% worst performing office buildings in Ireland - before the refurbishment 2016) to net zero is as a consequence of demand from both the occupier and investor/lender community. A transition driven by the global Environmental, Social and Governance (ESG) movement (SBTi, sustainable finance, ESG indices/ benchmarks etc.) and changes in the regulatory environment (EPBD recast, CSRD, SFDR, EU Taxonomy, SEC etc.).

This transition is examined within the context of the global and national net zero carbon trajectory.

Net Zero: What Do We Mean and Who Defines it?

While the term Net Zero, has gained recent popularity and resulted in national- and entity- level net zero targets, typically to 2030, 2050, or beyond, its success is likely linked to its simple two-word nature rather than its clarity.

These two words alone are incomplete, and while there is general understanding and agreement on what net zero means from a global perspective[1], a specific sectoral definition is, to-date, still largely non-harmonized.

This report does not aim to add another definition to an already-expanding list of net zero building definitions but instead compares a selection of the key definitions with this particular case study.

This report primarily aims to present a comparison of the net zero pathways and position 1 Cumberland Place relative to these.

Net Zero – What?

Energy vs. Emissions

The headline metric to evaluate building performance has steadily been moving away from *energy use* to *carbon emissions*. If the Energy Performance of Buildings Directive (EPBD) – the EU's key legislative tool to promote the low-energy performance of buildings – is anything to go by, its latest recast document[15] mentions "*emission/emissions*" 131 times, compared to the previous tally of 2 mentions, in the recast from 2018.[16] The discussion in the EU has now moved from Nearly Zero Energy Buildings (nZEB) to net zero carbon emissions buildings, or to use the EPBD's current choice of language – Zero-emission buildings.

[1] Net zero carbon dioxide (CO2) emissions are achieved when anthropogenic CO2 emissions are balanced globally by anthropogenic CO2 removals over a specified period.

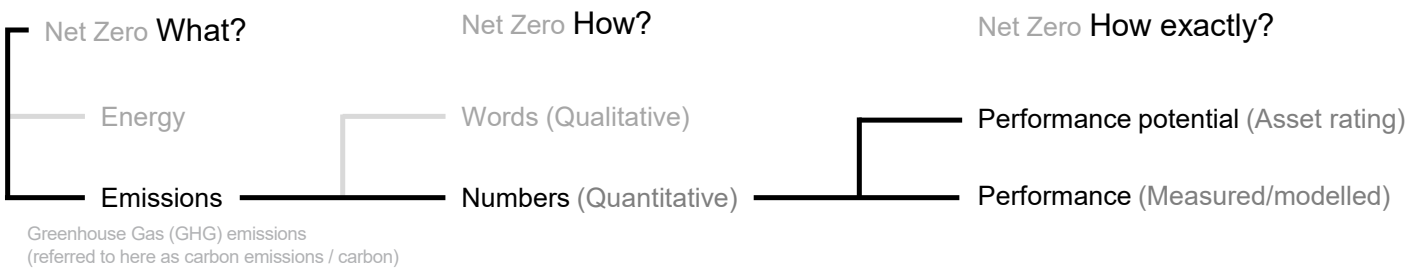


Figure 5. Mapping the meaning of Net Zero

Net Zero – How?
Words vs. numbers

Throughout the current literature and technical reports on net zero buildings, both descriptive (words) and prescriptive (target numbers) definitions exist.

One recently agreed upon descriptive definition by CIBSE, ICE, IStructE, LETI, RIBA, RICS, UKGBC[17] is that "*A 'Net Zero (whole life) Carbon' Asset is one where the sum total of all asset related GHG emissions, both operational and embodied, over an asset's life cycle (Modules A0-A5, B1- B8, C1-C4) are minimized, which meets local carbon, energy and water targets or limits, and with residual 'offsets', equals zero*" while the Irish Green Building Council (IGBC) recently (as of 13.08.23) published a draft report which includes their own definition[18]: "*A 'Net Zero Whole Life Carbon' building does not exceed local targets for operational energy use or embodied carbon, where renewable energy sources are utilised for all building energy use and, as a last resort, residual carbon is compensated for; such that the sum total Global Warming Potential for all cradle to grave life cycle stages are less than or equal to zero.*" While these descriptive definitions help us imagine what a "net zero" building might be, there is also a growing list of numeric net zero targets which help guide designers and building managers i.e. how far do they need to go before compensation becomes an acceptable option for dealing with the residual emissions.

Net Zero – How Exactly?
Performance vs. performance potential

Several different target metrics exist and are discussed later but it is important to group the metrics into those which measure a building's performance and those that rate its performance potential – both of which are assessed within this report. The latter is used to assess the building's rated performance in the form of an Energy Performance Certificate (EPC), or Ireland's equivalent rating system - the Building Energy Rating (BER).

Net Zero – Says who?

Comparing net zero targets

While the Irish Government has set sectoral targets, including a 45% reduction in GHG emissions for the commercial building sector by 2030, more detailed sector-specific targets are required to achieve global/national net zero targets. These targets set out in the Climate Action Plan (CAP) only count Scope 1 emissions (i.e. on-site fossil fuel combustion). This is inadequate and risks blinkering focus on simply switching energy source from fuel to electricity - rather than reducing demand in the first place and/or focusing on embodied carbon. This report goes a step further and reviews the meaning of net zero beyond the scope defined in Ireland's CAP.

Net zero carbon emissions, in its most literal sense, means the sum of all carbon emissions and carbon abatement considered equate to zero. An equation which can be manipulated in many ways to achieve its end goal of zero emissions. This has consequently resulted in a range of targets which vary both by metric and magnitude. Some commonality exists such as a requirement to completely remove on-site combustion of fossil fuels or the use of Energy Use Intensity (EUI) net zero pathways (e.g. Carbon Risk Real Estate Monitor (CRREM)[19] or targets (e.g. Low Energy Transformation Initiative (LETI)[20]). The Science Based Targets initiative (SBTi), for example, are preparing guidance for the setting of building specific SBTis. Two sector-relevant guidance documents are currently in draft format, one for buildings generally[21] and one specifically looking at a 1.5°C aligned embodied carbon pathway[22], full publishing is expected towards the end of 2023. There is considerable cross-over between the SBTi publications and the work of the CRREM[19,23]. These are therefore grouped together in Table 1 which summarises the different targets.

A common general philosophy includes:
i) removing on-site fossil-fuel technologies;
ii) reducing energy use intensity;
iii) offsetting remaining emissions through, e.g., surplus on-site renewable energy technologies.
While some common themes exist, there are also considerable differences. Most of which are related to the scope of emissions – with many targets neglecting embodied carbon emissions for example. Part of this negligence is due to the lack of data available currently – a gap which can only be filled with more data.

Table 1. Summary of some key net zero targets for offices

		OPERATIONAL				EMBODIED	
Source(s)	**Publication Date(s)**	**"Net Zero" definition**	**Energy Target (kWh/(m²·yr)) Gross Internal Area (GIA)**	**Energy Use Intensity (EUI) / Primary Energy**	**On-Site Renewable Incorporated into Target**	**Interim Targets for Upfront Emissions ($kgCO_2/m^2$)**	**Description**
LETI[20,24]	2023, 2021	"Net Zero Targets"	55	EUI	no	350	This is Band A from LETI's 2030 Carbon Alignment target for offices[24]
UKNZCB [25]	2023 (Draft)	"Future Exemplar"	30	EUI	yes	481	This is the 25th percentile of 61 current case studies
CRREM / SBTi [19,21–23]	2023 (Some drafts)	"1.5°C pathway"	85*	EUI	yes	410	This is the 2030 target for offices[22], the 2050 "target" is 14.3.
UKGBC[26]	2020	"Paris proof"	55	EUI	yes	-82%	The UKGBCs roadmap targets an 82% reduction for non-domestic buildings[27].
EPBD[15]	2023 (Draft)	"Zero emission building"	85	Primary Energy	no*	x	This references Level(s); no explicit targets yet.

Net Zero Targets: Operational

In terms of operational targets, the key metric used is the EUI. This is an all-inclusive measure of how much energy the building consumes. It appears to be particularly popular in the UK, where most of the documents presented in Table 1 derive from. The UK Green Buidling Council (UKGBC) uses "Paris Proof Target" to describe their whole building EUI target of 55 kWh/(m²·yr) and also includes a separate target for both occupier and landlord spaces individually. These targets have since been cited in other documents e.g. the Better Buildings Partnership (BBP)[28] and The British Council for Offices (BCO)[29].

The most stringent EUI appears to be the 30 kWh/(m²/yr) cited in the UK's Net Zero Carbon Building Standard's technical update and consultation report (UKNZCB)[25]. This target, like the UKGBC's one, accounts for the energy supplied by on-site renewable energy systems (e.g. Photovoltaic (PV)) and hence might actually be less stringent than the LETI target of 55 kWh/(m²·yr) which does not include the contribution of PV. The LETI target needs to be achieved before renewables (likely PV) are even considered. Of the sources presented in Table 1 the UKNZCB standard is also one of the few which explicitly cites this target for new buildings. The other sources generally do not disclose whether the target is set for new or existing buildings. The LETI operational modelling guide[20] does, however, note that "*Net zero targets can be more challenging to achieve in existing buildings.*"

The least stringent EUI target of those listed in Table 1 is the target found in the CRREM model of 85 kWh/(m²·yr) where the assumption is that by 2038 the Irish grid will have fully decarbonised. The latest recast of the Energy Preperformance of Buildings Directive (EPBD), which is entering the final stage of the EU legislative process[30], takes a slightly different approach in that it specifies primary energy targets rather than EUI. The EUI target for zero emission buildings in Ireland (an oceanic region) would be 46.3 kWh/(m²/yr). This conversion is calculated using the SEAI's most recent primary energy conversion factors for 2022[31].

Net Zero Targets: Embodied

While operational carbon targets have their differences, there is enough commonality to make high level decisions towards net zero. A similar level of agreement for embodied carbon is yet to be concluded.

The 2050 net zero targets are so low that they are difficult to comprehend currently. For example the SBTi specify an embodied carbon target of 14.3 $kgCO_2e/m^2$ by 2050. Arriving at a figure of such minuteness (relative to today's benchmarks) would likely mean leaning on the reliance of currently under developed technologies such as Carbon Capture Utilisation and Storage (CCUS) as well as a considerable move toward an almost completely circular construction economy.

The examples presented in Table 1, are therefore a selection of interim upfront targets (i.e. within modules A1-A5 of the much cited standard EN 15978[32]) which are more achievable with current technology. One of the major challenges when it comes to embodied carbon is the lack of a reliable benchmark from which to set reduction targets[33], with considerable variability existing between the academic literature[34,35] and industry reports[24].

In the interim several targets have been set by the likes of the Royal Institute of the Architects of Ireland (RIAI)[36] and the Royal Institute of British Architects (RIBA)[37], both of whom use LETI's carbon alignment table[24] from which to set their targets.

The 2030 target for offices set by LETI is <350 kgCO2e/m² which is more stringent then the SBTi's 2030 target of 410 kgCO2e/m² (Table 6.1 of Reference [22]). To put this into context, the UKNZCB[25] reference a database of 61 office buildings with the best 25th percentile to be less than <481 kgCO2e/m².

The fact that this means 75% are higher than this value, highlights the scale of the challenge to reach either the LETI or even the SBTi 2030 targets.

→ NOTES ON DATA

*This is the value for Ireland. Other values exist for other countries.

Commonality: Most of these do not explicitly refer to a new/renovated building and are targets set for all building. The UKNZCB[25] explicitly cite new buildings, while the EPBD's presented target is for existing buildings[15]. All targets presented at left refer to the whole building i.e. both occupier and landlord. For further detail on specific occupier vs. landlord targets, see [26]. All are presented for GIA except for the EPBD which cites "usable floor area".

Case Study **Results**

1

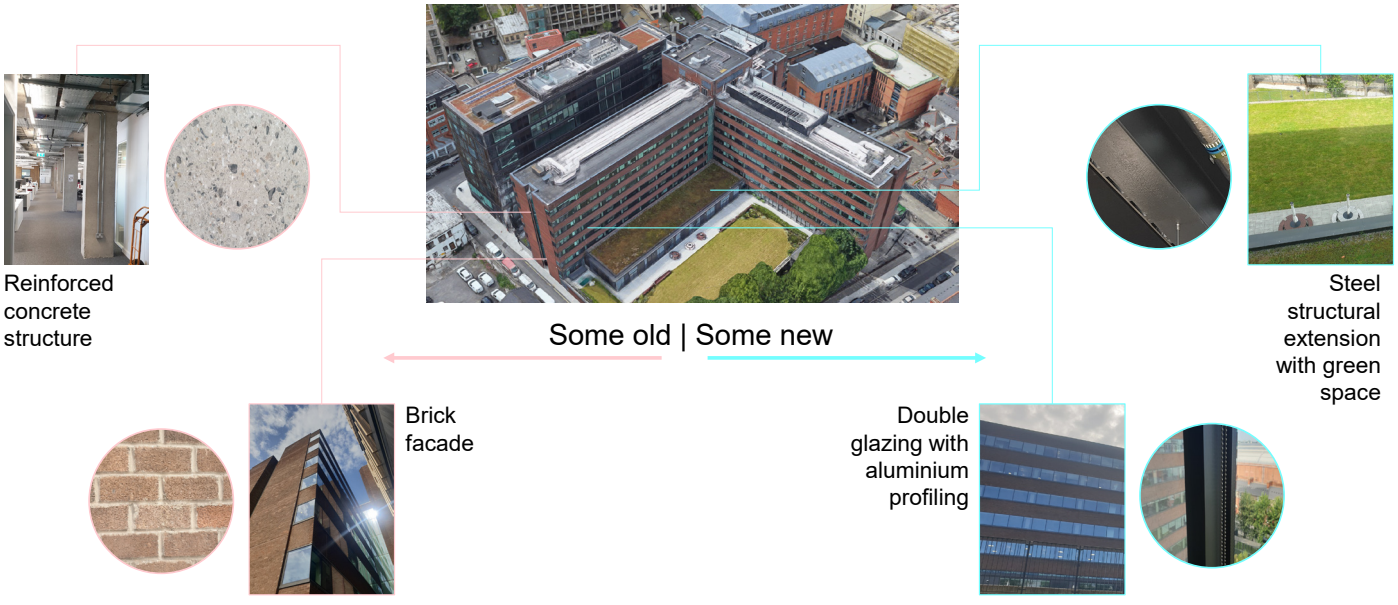
The renovation in 2016 upgraded the **operational performance potential** from an E2 to a B2 BER - a 63% reduction in rated primary energy demand.

2

The measured **operational performance** is currently outperforming the rated BER performance. The **measured** primary energy demand for the whole building in 2022 was 26% lower than the **rated** primary energy demand.

3

All this was achieved while retaining the majority of the building's structure and much of its skin. The **embodied carbon** cost of revitalising this building was one third the embodied carbon cost of building new.



1 Operational Performance Potential

Although measured and modelled building performance is on the ascendency, the most abundant data available on the Irish and European building stock is related to the performance potential, through EPC, or BER, as used in Ireland.

These asset rating systems are used at an EU-wide level with the newest version of the EPBD likely to introduce a set of criteria which would see the worst performing buildings targeted first, where the measure of worst is through the EPC/BER.

In the case of 1 Cumberland Place, the building advanced from an E2 to a B2 rating, as illustrated in Figure 6 which also shows its position relative to a sample set of Ireland's office building stock. This energy upgrade was primarily achieved through fabric upgrades to the glazing, walls, roof and floors. These upgrades resulted in a reduction in the building's heat loss coefficient from 2.1 to 0.35 W/(m²K) – a sixfold reduction. The heating, ventilation and cooling system was also upgraded prior to the post-retrofit BER score and has since been improved upon.

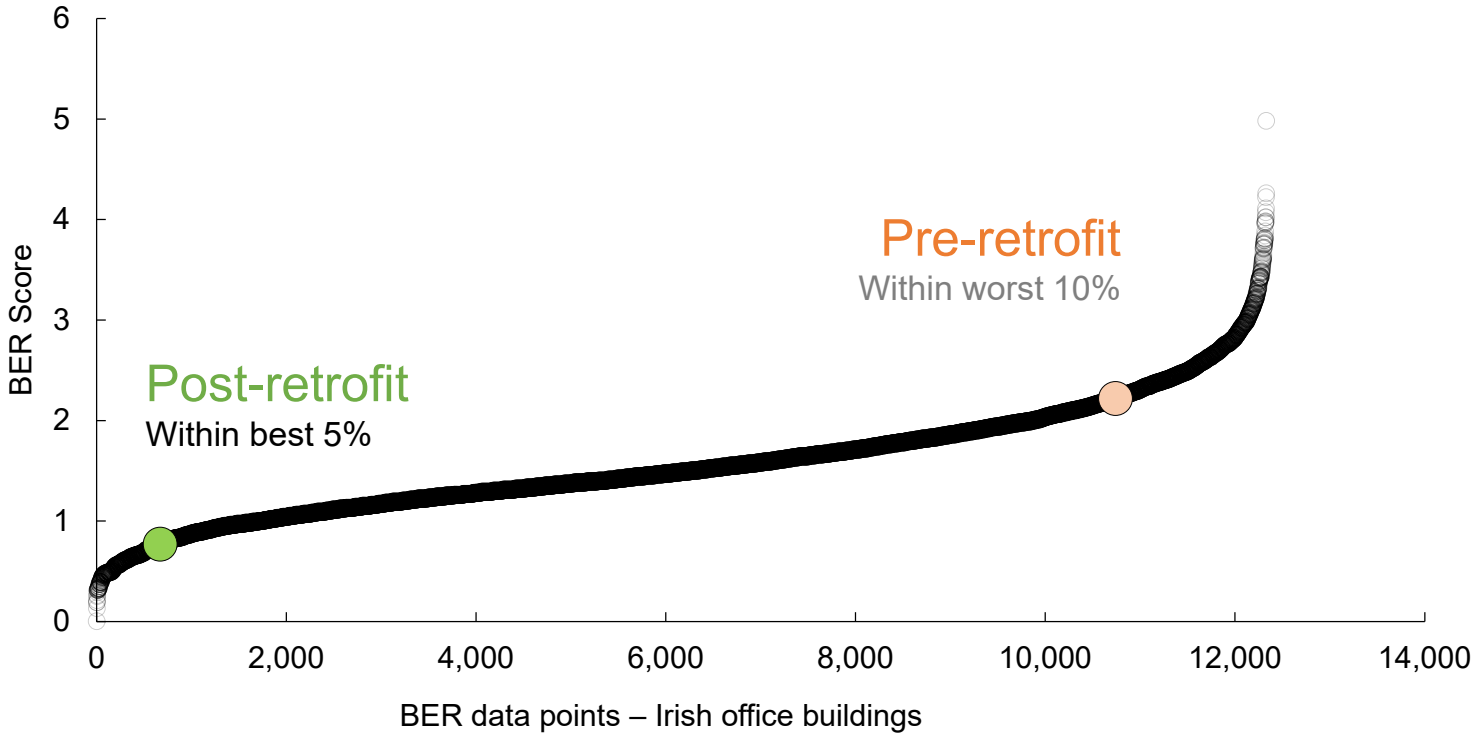


Figure 6. BER score for Irish office buildings which have received a rating ordered from best to worst and highlighting the location of 1 Cumberland Place pre- and post-retrofit.

EU Taxonomy Relevance

The EPBD is not the only instrument which uses EPCs/BERs as the KPI to determine sustainable building performance.

The EU taxonomy, which is a classification system used in the EU to determine if an activity qualifies as sustainable[38], also references EPCs within the Construction and Real Estate sector. Under the "Acquisition and ownership of buildings" activity the criteria for a building to be taxonomy aligned are summarised in Table 2 under the climate mitigation criteria. The key result being that 1 Cumberland Place's rated primary energy demand is within the top 15% of office buildings in Ireland, as shown in Figure 7.

EU Taxonomy – Substantial contribution criteria	1 Cumberland place
1. For buildings built before 31 December 2020, the building has at least an Energy Performance Certificate (EPC) class A. As an alternative, the building is within the top 15% of the national or regional building stock expressed as operational Primary Energy Demand (PED) and demonstrated by adequate evidence, which at least compares the performance of the relevant asset to the performance of the national or regional stock built before 31 December 2020 and at least distinguishes between residential and non-residential buildings.	The retrofit of 1 Cumberland resulted in a B2 rating (BER from 2017) and hence would not qualify under the "has at least an Energy Performance Certificate (EPC) class A." criteria. The alternative is provided for which 1 Cumberland place does meet the criteria as shown in Figure 6. 
2. For buildings built after 31 December 2020, the building meets the criteria specified in Section 7.1 of this Annex that are relevant at the time of the acquisition.	NA
3. Where the building is a large non-residential building (with an effective rated output for heating systems, systems for combined space heating and ventilation, air-conditioning systems or systems for combined air-conditioning and ventilation of over 290 kW) it is efficiently operated through energy performance monitoring and assessment(314).	1 Cumberland Place is also compliant under this criteria. It was equipped with a modern BMS upon renovation and more recently has been equipped with Symphony's system which monitors, optimises and automates the building's performance. 

Table 2. EU taxonomy substantial contribution criteria and comment relative to 1 Cumberland place

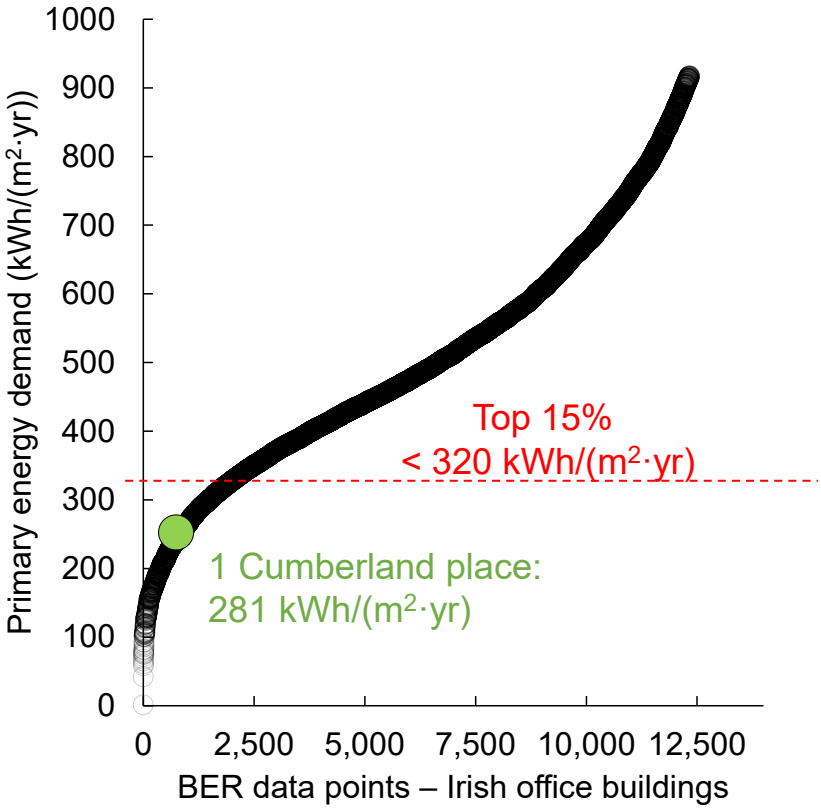


Figure 7. Primary energy demand for Irish office buildings which have received a rating - ordered from worst to best and highlighting the location of 1 Cumberland Place post-retrofit and the criteria for alignment based on this data set.

Notes on the data set

The sample set presented in this figure is filtered to include data for building floor areas >50m² with some line entries displaying non-sensical floor areas removed. The dataset also only includes BERs issued pre-2020. The final data set used in this presentation includes 12,333 buildings.

With the SEAI's heat study estimating that there are a total of 39,000 office buildings in Ireland[39], the dataset used here equates to approximately 1/3 of the Irish office building stock and is assumed approximately representative. It is more likely that it is an overestimate of the stock's performance, with very poor performing older buildings unlikely to have, or want, a BER and hence the minimum compliance criteria shown here of < 307 kWh/(m²/yr) is likely a conservative estimate, and in reality might be higher.

2 Operational Performance

The measured performance is presented here using two key metrics:

→ The Primary Energy Demand (PED)

...to enable comparison with the BER / EPCs.

→ The Energy Use Intensity (EUI)

...to enable comparison with the majority of the net zero targets from Table 1.

Data Sources and Assumptions

Data is sourced from several sources and has been processed by several third parties. This level of detail enables robust conclusions to be drawn. Nevertheless, as with all measured data some assumptions and calculations have been made which are listed here in detail:

Whole building first

In line with the data presented in Table 1, this exercise is concerned with the whole building i.e. both landlord and occupier space. Unless specified, performance values are therefore presented for the whole building. A breakdown of the split between landlord and occupier is provided.

Floor area

The floor area used to measure the building's performance is the IPMS2 metric, which was measured post retrofit in 2016 by Malcolm Hills surveyors. The IPMS2 for this building is 13,587m² which is similar (<1% difference) to the GIA of 13,497m². The net lettable area is smaller, and equates to 11,999m².

Data sources

Data from utility providers is used primarily although data from additional sensors is used to verify results and fill in some gaps. This data is acquired from the *CoolPlanet*, *Symphony Cycle* and *ZiggyTec* systems.

Data gaps/assumptions

Occupier electricity data was not available for 2018. For visual completeness, the data used in the graphs for this portion are assumed equivalent to the 2019 value.

Construction of a neighbouring building used energy from 1CP during 2019 and 2020, this is measured and corrected for 2019. For 2020 it is assumed that a similar amount of energy was used.

The measured gas data for 2020 and 2021 is taken from the Ziggytec meters rather than the GPRN data due to unreliable GPRN data during this period.

Conversion factors

Conversion factors are taken from the SEAI's database for primary energy and emission conversion[31]. Emission conversion factors which exclude Transmission and Distribution (T&D) losses are used in the presentation of emission data following the latest CRREM guidelines.

Measured Primary Energy Demand

The Primary Energy Demand (PED) (kWh/(m²·yr)) accounts for generation, transformation and distribution losses, and is the key metric used in BERs / EPCs.

The PED for 1 Cumberland place is shown in Figure 8 for a 5 year period highlighting a general downward trend in landlord electricity and gas consumption and a dip in 2020 due to reduced occupancy during the height of the COVID-19 pandemic. Over the past three years the actual PED has been less than the rated performance. In 2022, the latest full year of measurement, the PED was 26% less than the BER rated performance and 35% lower than the benchmark derived in Figure 7 for EU taxonomy compliance.

Although the whole building (both occupier and landlord consumption) falls short of the EPBD's zero emission building definition for existing office buildings, the landlord's proportion alone is on par with that stringent target.

It should also be noted that these measured values include all unregulated loads which are not accounted for in BER ratings, meaning that despite the greater scope, it is still performing better than the predicted performance.

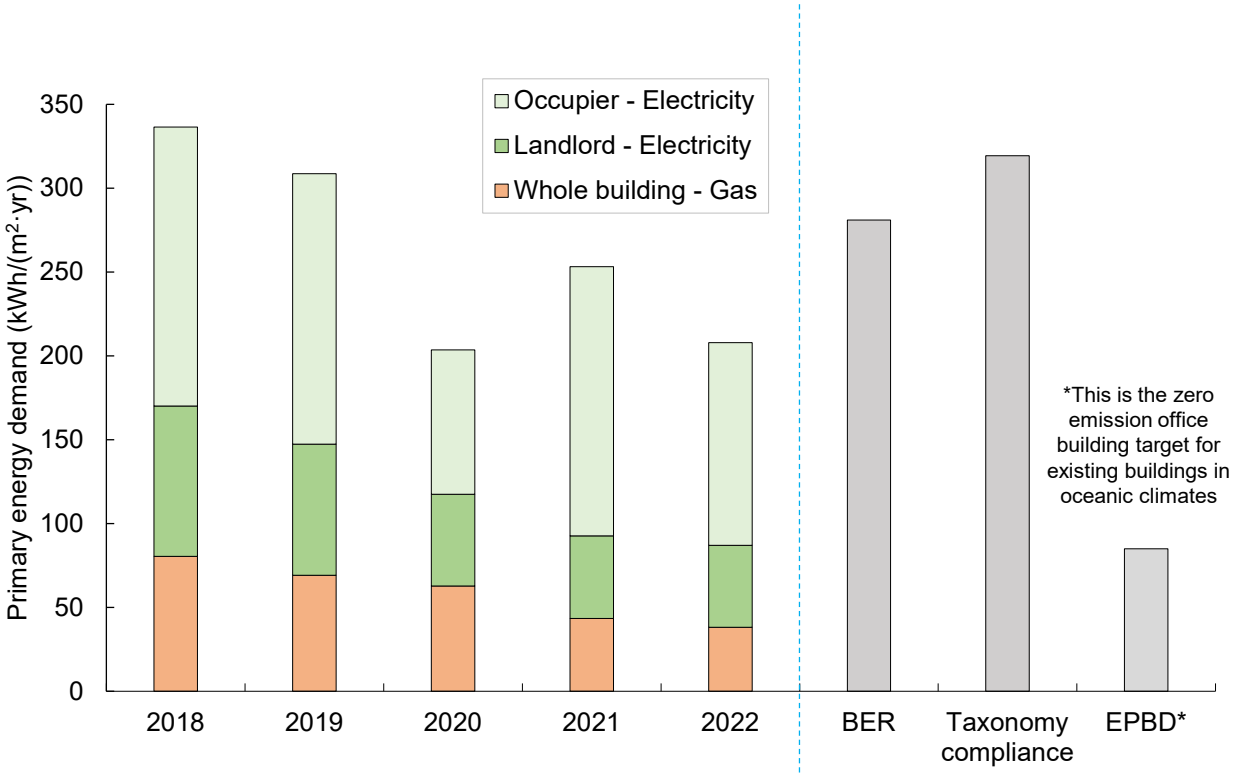


Figure 8. Primary energy demand for 1 Cumberland place between 2018 and 2022, compared with 1) its rated BER, 2) the requirement for EU taxonomy compliance as derived in Figure 7 and 3) the Zero Emission building target as per the latest EPBD.

Measured Energy Use Intensity

While the primary energy demand is used in asset ratings (EPC/BER), which are cited in the EU taxonomy and EPBD, it is the EUI which is gaining traction among the “net zero” definitions, as described in Table 1.

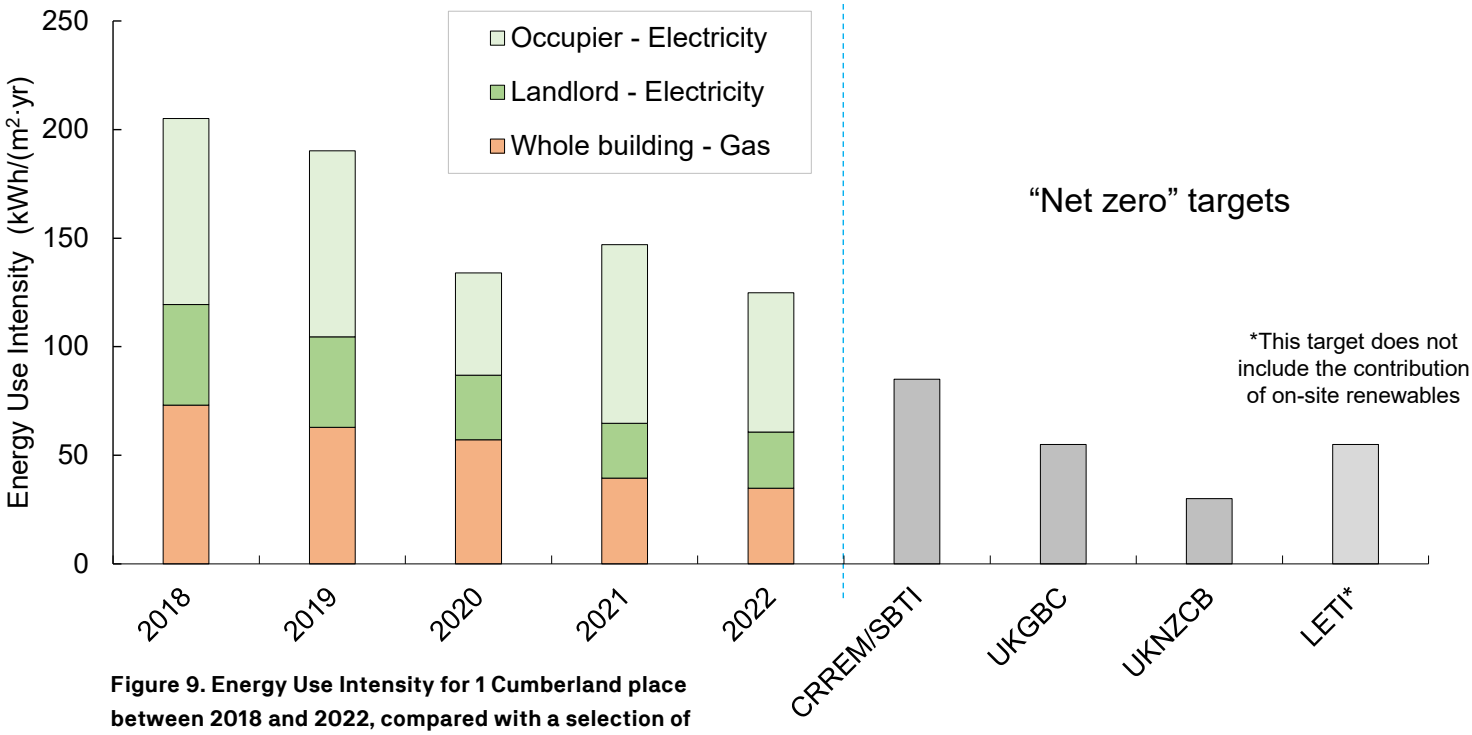


Figure 9. Energy Use Intensity for 1 Cumberland place between 2018 and 2022, compared with a selection of “net zero” targets described in detail in Table 1.

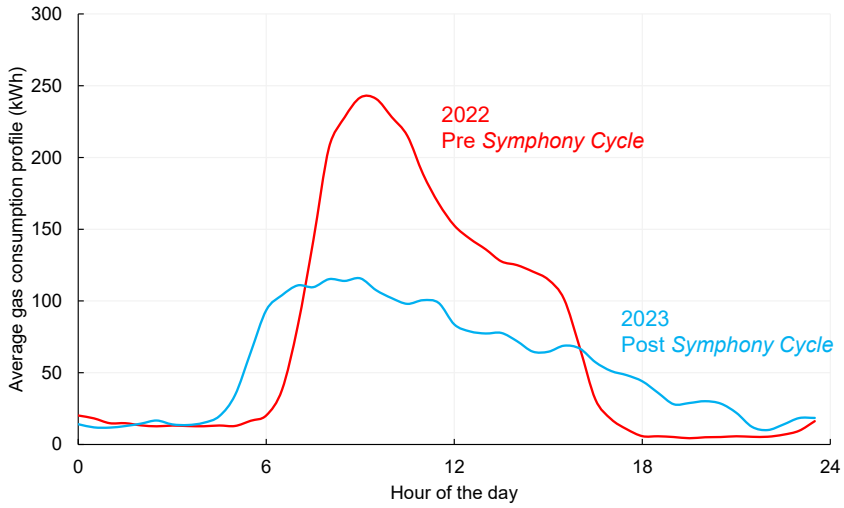


Figure 10. Average daily gas consumption profiles over a two month period (Jan-Feb) pre- and post-installation of the Symphony cycle.

The EUI of 1 Cumberland Place, as shown in Figure 9, follows a similar trajectory to that of the PED. One major difference between the two graphs is the proportional change between natural gas and electricity. This is due to the primary energy factors for electricity being greater than that of natural gas - as defined by the SEAI[31].

While the most recent full year for the whole building’s EUI falls short of the defined net zero targets, the trajectory is a positive one and it is likely to continue on this downward trajectory following the recent install of a patented heat recycling process that generates cooling and heat – the Symphony Cycle. Early indication of the system’s full potential is presented in Figure 10, which clearly illustrates a reduction in peak load and daily total gas consumption. The reduction is approximately 23% during this period.

3 Embodied Carbon

The positive operational performance is particularly impressive considering this is a renovation case study, and not a new build. An intervention which resulted in embodied carbon and material savings

There is a paucity of research comparing the embodied carbon of new vs. renovated buildings with most studies estimating that a renovation is in the order of one third that of a new build[40-42].

The embodied carbon savings achieved by prioritising maintenance and renovation over the status quo build-demolish-build cycle is conceptualised in Figure 11, where every cycle of demolition and rebuild consumes considerable embodied carbon from our carbon budget. Preserving the building stock saves carbon, but requires careful management.

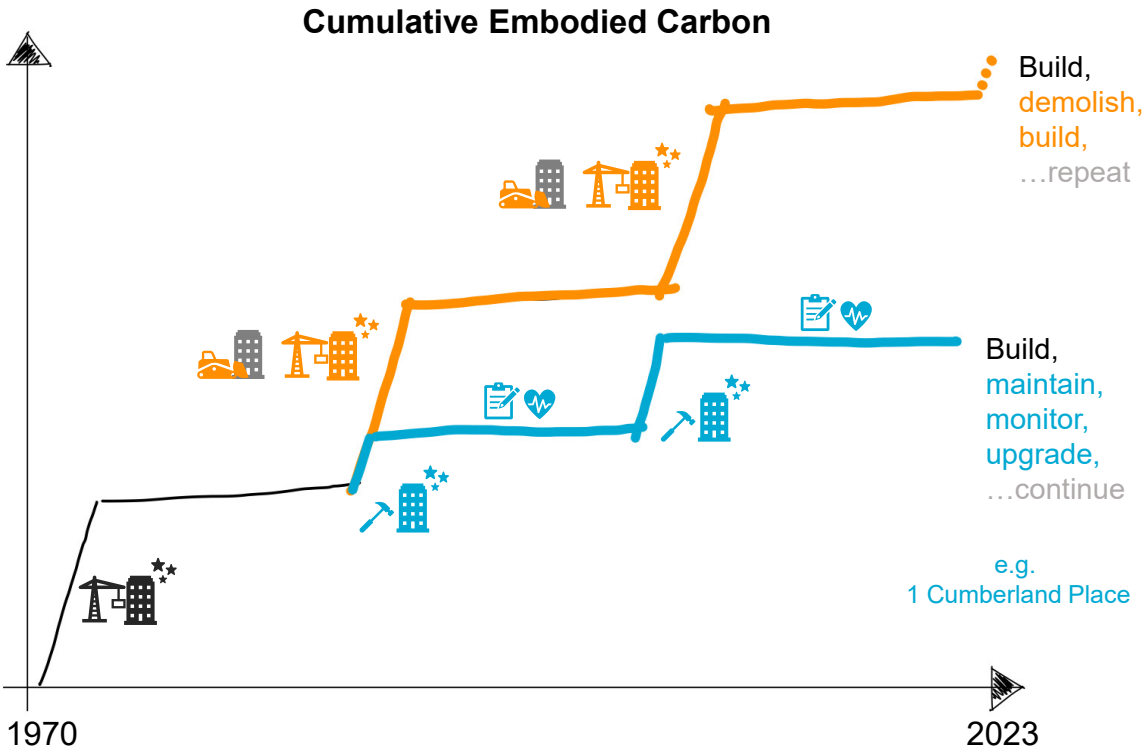


Figure 11. Conceptualising two approaches to managing our building stock.

Preliminary Life Cycle Analysis

To take the study a step further, a preliminary upfront life cycle analysis was conducted to estimate the embodied carbon cost of the renovation works on the existing structure, extension and facade.

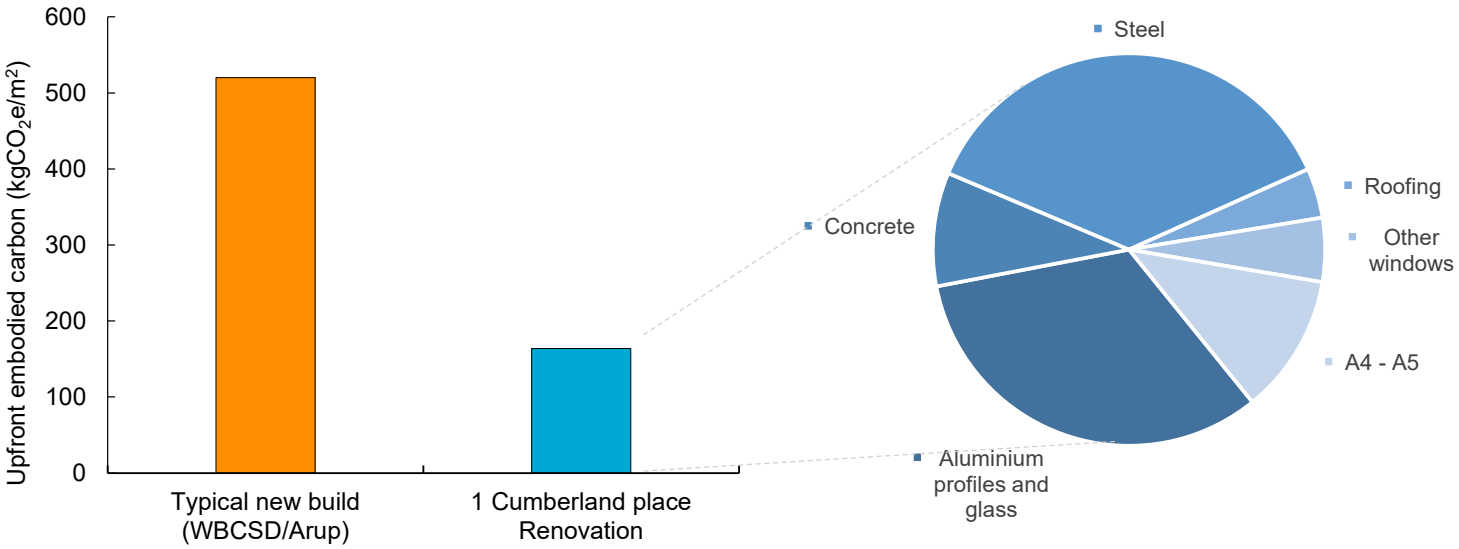


Figure 12. Upfront embodied carbon of the renovation works for 1 Cumberland Place compared with the equivalent embodied carbon cost of a new office (data for which is taken from [44]).

The results are based primarily on data used in an earlier LEED evaluation as well as some preliminary bill of quantities, which are presented in monetary units primarily.Many of these values have then been subsequently converted into planar (m^2), volumetric (m^3) and or mass-based (tonne) units where relevant. The carbon conversions were taken primarily from the IGBC's Upfront tool and the A4 and A5 boundaries were estimated to be 13% of that of the A1 to A3 boundaries, in line with the mean upfront values presented in other research[43].

A more detailed LCA is subject to further future investigation but the results are in line with what might be expected for this scope of works.

1 Cumberland Place presents a positive exemplar for how Ireland's built environment can carve out a pathway to net zero.

Its net zero journey to date already aligns with many of the recommendations of the Irish Green Building Council's whole life carbon roadmap[45].

The case study outperforms the Irish office stock on several metrics. Its building energy rating improved from an E2 to a B2 rating while its actual measured operational performance is outperforming its rated performance.

In most cases the performance gap exists in reverse where the measured performance is greater than the rated performance. Both rated and measured performance are within the best 15% of Ireland's office building stock and hence validates 1 Cumberland Place as EU taxonomy aligned. All of which has been achieved through a renovation rather than a new build, resulting in embodied carbon savings of approximately 66% of an equiavalent new build.

Even after fabric upgrade, careful and considered building management and post occupancy evaluation through Coolplanet's monitoring system has enabled understanding of the building's performance, which had in turn enabled the identification of further improvement through the Symphony Cycle system, the results of which are looking like they will reduce gas consumption by a further 23% and bring 1 Cumberland Place closer to the net zero targets summarised in this report.

To ultimately achieve the target of net zero, Hibernia have a short-, medium- and long-term strategy in place, which includes further occupier engagement, full electrification of the heating system and on-site renewable installation.

While there is still uncertainty over the volume of vacant and reusable floor space in Ireland[46,47], and hence the measurable impact that scaling up a solution like this will have on the built environment, it is nevertheless a positive story which can encourage similar action nationally.

If 1 Cumberland Place is to be used as an exemplar it should be noted that achieving these results requires a hands-on approach to building monitoring, management and improvement.

> a positive story which can encourage similar action nationally.

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