BUILDING A ZERO CARBON IRELAND

A Roadmap to decarbonise Ireland's
Built Environment across its Whole Life Cycle

#BUILDINGLIFE

IGBC
IRISH GREEN BUILDING COUNCIL

Acknowledgement

We would like to thank all the participants who attended and contributed to our workshops, as well as the draft reviewers. In particular, we would like to thank our #BuildingLife Campaign Ambassadors, as well as the members of the National Leadership Forum and National Technical Committee.

These are listed on pages 68 & 69 of the document.

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INTRODUCTION

The sustained drought experienced across the globe this summer, with hot and dry conditions fuelling wildfires, reducing crop yields, and impacting electricity generation, highlights once again the urgency to reduce greenhouse gas emissions across all sectors. In Ireland, the Climate Action & Low Carbon Development (Amendment) Act (2021) recently set a legally binding target of a 51% reduction in national CO_2eq emissions by 2030 and an overall target of a climate neutral economy by 2050[1].

For the first time ever, this roadmap looks at the impact of the construction and built environment in Ireland across its whole life cycle. It shows that the **construction and built environment sectors account for 37% of Ireland's carbon emissions**, equalling agriculture. Just under two-thirds (23%) of these emissions come from operating buildings but more than a third (14%) comes from the manufacture, transport and installation of building materials themselves – usually referred to as 'Embodied Carbon'. Policies and regulation to date have mainly focused on reducing operational emissions, however, **without urgently addressing these embodied carbon emissions, the construction and built environment sector will exceed its carbon budget**.

While the transformation to a Net Zero built environment will be challenging, decarbonising our built environment across its whole life cycle is critical in reaching our climate targets. It also offers many opportunities to innovate and improve people's quality of life – See Benefits of Going to Zero.

This roadmap was developed by the Irish Green Building Council (IGBC) in close cooperation with key stakeholders to address embodied emissions and decarbonise Ireland's built environment across its whole life cycle by 2050.

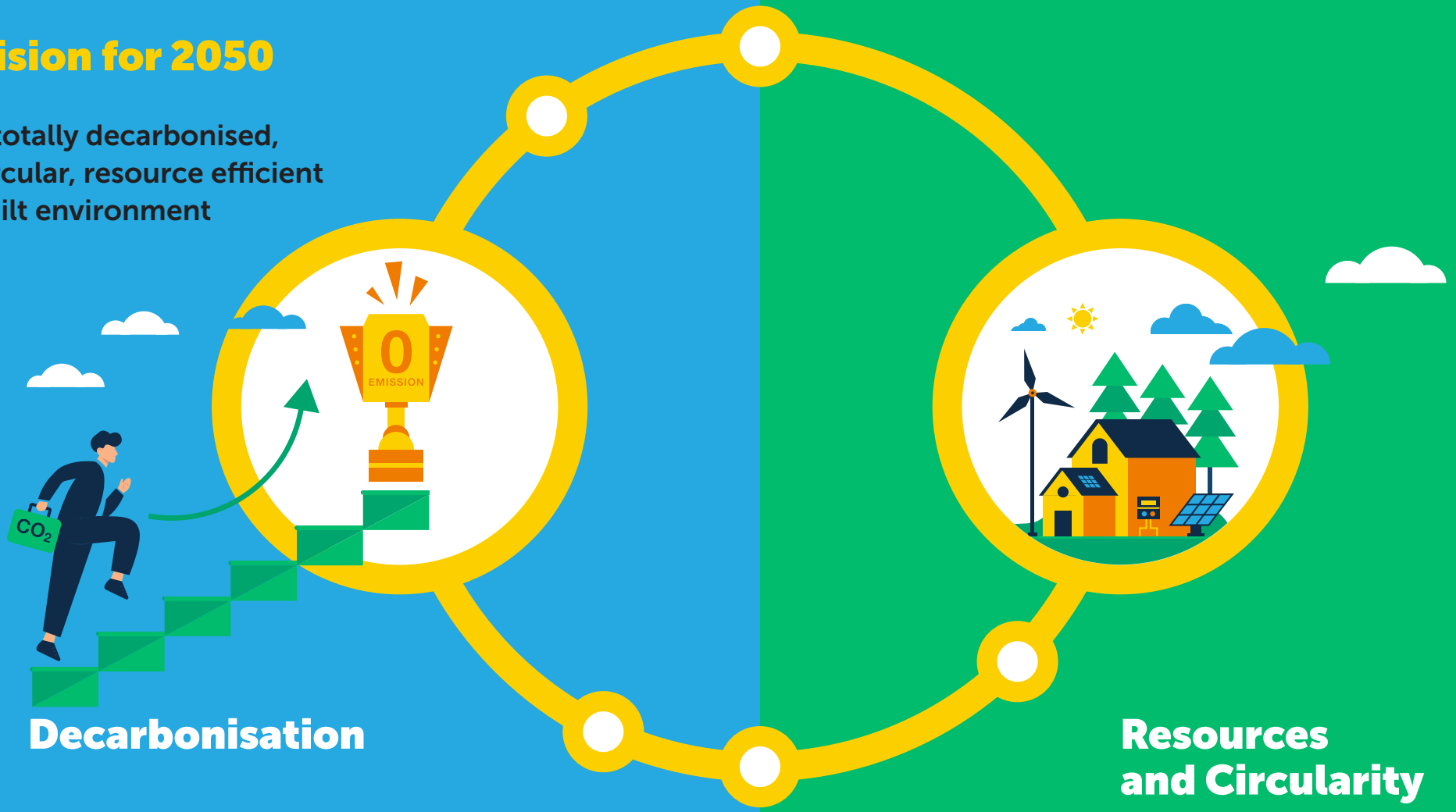
Similar roadmaps were developed in Croatia, Finland, France, Germany, Italy, the Netherlands, Poland, Spain, and the UK, as well as at European level. These will support the work of officials at local, national and EU levels.

The "Building a Zero Carbon Ireland" roadmap **outlines the steps we must take to decarbonise our built environment across its whole life cycle by 2050**. It details a series of near-term actions to put us on a clear path towards this goal, as well as a range of further, longer-term actions to accelerate the transformation of our built environment. It covers topics such as planning, regulation, public procurement, finance, education, and innovation. To make it easier for readers and to facilitate the implementation of this roadmap, recommendations are subsequently broken down by sector.

1. SUMMARY

Vision for 2050

A totally decarbonised, circular, resource efficient built environment



Decarbonisation

New developments, infrastructure, and renovations will have Net Zero embodied carbon, and all buildings, including existing buildings, must be Net Zero operational carbon

Resources and Circularity

A built environment that supports restoration of resources and natural systems within a thriving circular economy

The Scale of the challenge

To understand the scale of the challenge for this roadmap and develop solutions, IGBC commissioned the Building in a Climate Emergency (BIACE) Research Lab at the UCD School of Architecture, to baseline emissions associated with the whole lifecycle of the building stock and infrastructure in Ireland and worked with them to model a variety of scenarios based on existing government policies and potential policies to bring emissions in line with science-based targets by 2030.

The 37% for the baseline year of 2018 is made up of **23% operational emissions** (14MtCO_2e) associated with the energy we use to heat, cool, and light our buildings and a further **14% embodied carbon emissions** (9 MtCO_2e) from the production of construction materials, transport of materials, construction process, maintenance, repair and disposal of buildings and infrastructure.

From the baseline study a number of scenarios were developed to model at high level what would be needed to achieve a 51% cut by 2030 using available data and Government projections and policies for construction and renovation.

The model shows that the **current actions in the Climate Action Plan[2] will not be sufficient to deliver a science-based cut of 51% by 2030 from the built environment** and if left unchecked emissions could actually grow as the proposed increase in construction and renovation over the next ten years is not currently factored in.

Implementing the actions for renovation under the Government Climate Action Plan, should result in a fall in operational carbon emissions from buildings but **it is the embodied carbon from the greatly expanded construction programme in the National Development Plan (NDP) which will likely blow our carbon budget without immediate action**.

For further information on carbon emissions associated with construction and the built environment in Ireland, and the carbon modelling work, please see “Understanding the Scale of the Challenge” section.

How to get to zero?

Delivering the required cuts in emissions involves **accelerating Ireland's retrofit programme** and **developing a whole new set of policies and actions to tackle embodied carbon of construction**. These must support **greater optimisation of the existing building stock and stringent cuts in carbon intensity of construction**.

Benefits of Going to Zero

Beyond climate targets, transitioning to zero carbon construction with extreme urgency offers many **environmental, social, and economic benefits**.

- Evaluating carefully and prioritizing what needs to be built, ensures more effective use of scarce financial, manpower and material resources and guarantees that real social needs such as housing, and a climate and energy resilient renovation plan can be met.
- Maximising use of the existing stock eliminates dereliction and creates vibrant towns and villages where people want to live across the country.
- By building up new low carbon industries from our agricultural and circular economy we can provide employment across the country and support dynamic local economies.
- By acting now, we avoid becoming solution takers, instead developing innovative new forms of low carbon construction products, processes, and services for export, whilst creating the space to build more of what our citizens need under ever tighter carbon budgets.

Reduction strategies for operational carbon

To halve our sector emissions by 2030, **the delivery of Ireland's national retrofit programme must be significantly accelerated.** This will require further support for homeowners, small business owners and landlords, in their renovation journey, from accessing independent professional advice to making energy renovation more affordable, through lower taxation on energy efficient products, lower cost finance, or free upgrade for those without the means. In addition, to enable high quality, phased renovations, the development of Building Renovation Passports (BRPs) should be sped up.

The performance gap needs to be addressed urgently. CSO figures currently show little correlation between a Building Energy Rating (BER) and gas/electricity usage which is more influenced by home size and type. In the non-residential sector, actual energy use must be disclosed, and investors and developers must ask for energy intensity performance and per capita targets to be met rather than asset ratings such as the BER.

The introduction of Minimum Energy Performance standards (MEPS), which should be tightened up over time, is also key in ensuring that all residential and non-residential properties are fully decarbonised by 2050.

Decarbonisation of the grid means that electrification of homes and buildings will deliver reductions in carbon but the roll out of district heating based on waste heat and fossil free fuel will need to be a significant part of the solution. More specifically, the roll out of district heating in areas where already promised and where there are available sources of waste or fossil free heat must be sped up if developers are expected to credibly sign up for connection.

Finally, the successful implementation of these actions will require significant upskilling of building professionals and construction workers.

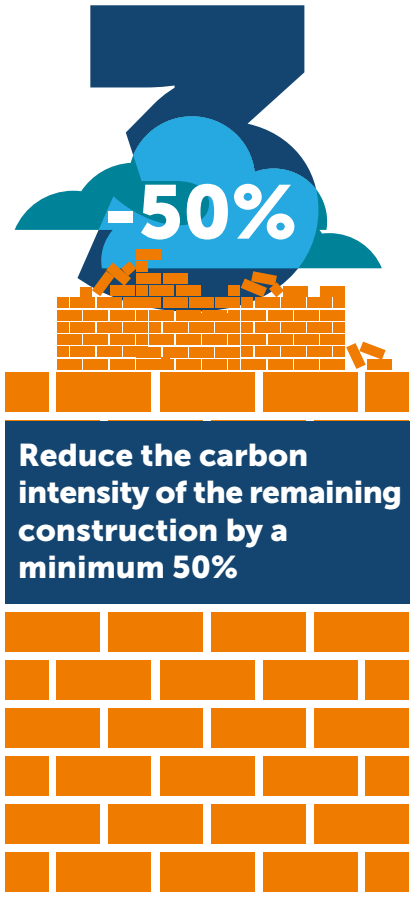
Reduction strategies for embodied carbon

Tackling embodied carbon of construction will require a three-prong approach, firstly **prioritising projects within the National Development Plan (NDP) based on environmental and social needs to 2030**, secondly **maximizing existing buildings stock**, by bringing Ireland's very high levels of vacant, derelict, and suboptimal use of space[3] back into more intensive use across the country and finally a **radical strategy of reducing the carbon intensity of the remaining construction by a minimum of 50%.**

Reductions in carbon intensity is needed not only per square meter but also per capita, through a reduction of unnecessary floor areas. This will be achieved initially by leaner design driven by clear signalling of intent by government on regulations and disclosure of whole life carbon. It must be accompanied by a review of building regulations to support innovation, and by substantial investment to accelerate a decade of innovation to deliver new processes, systems, products, and services to decarbonise construction.

All these strategies must be supported by a significant increase in skills and awareness, and a financial system which supports rapid transition.

As the combined strategies are likely to be politically sensitive, it is suggested getting agreement on a set of policies focusing on "climate and housing" using the successful citizens' assembly model.



The roadmap

Based on the strategies developed through the modelling a series of actions and a timeline for implementation are set out for policy makers at different levels. Individual roadmaps are also provided for each stakeholder in the built environment value chain tasked with delivering these actions on the ground, including educators, finance, investment, developers, manufacturers and all professionals operating in the construction industry. See Your Journey to Net Zero section.

BUILDING A ZERO CARBON IRELAND

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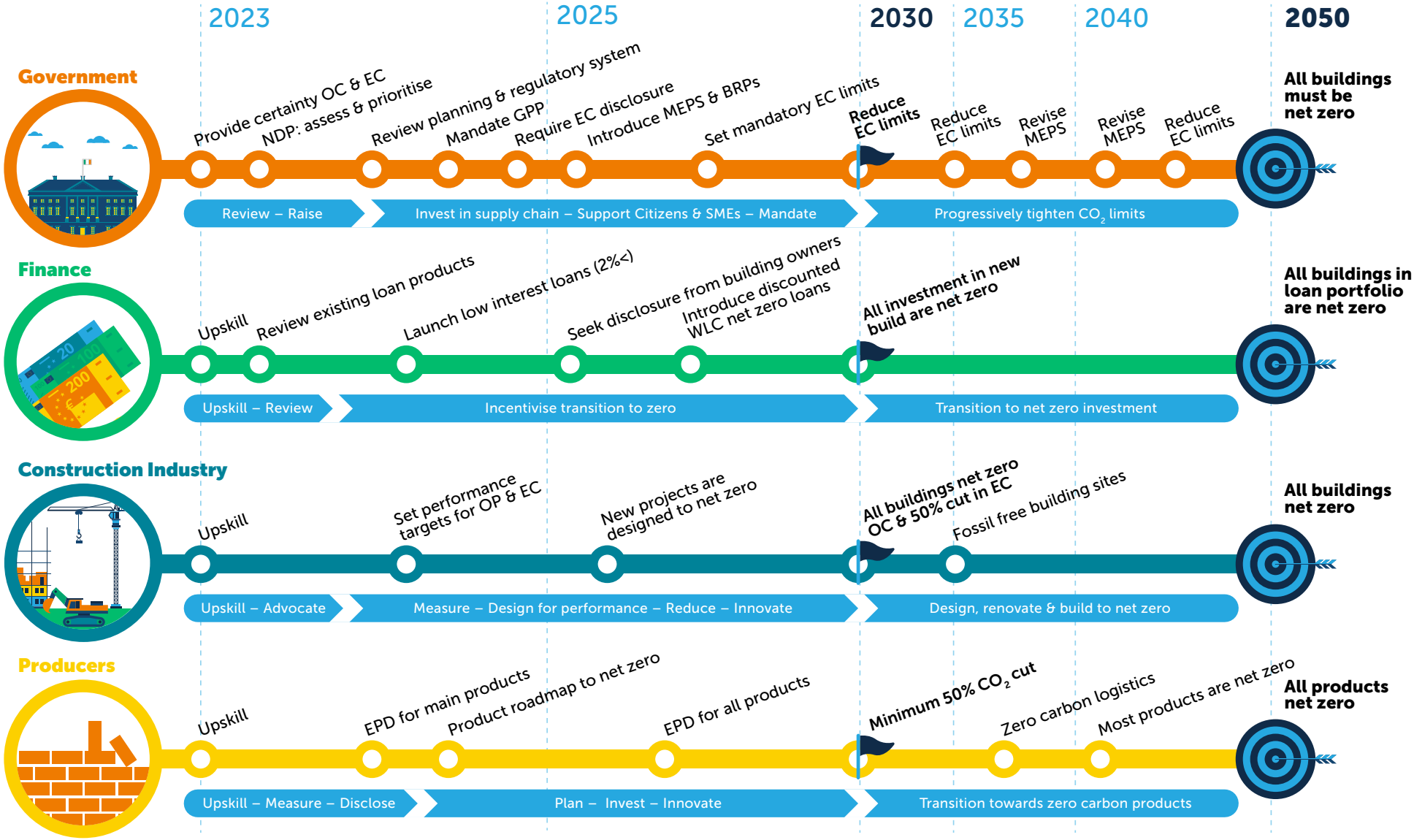


BRPs: Building Renovation Passports
EC: Embodied Carbon
EPD: Environmental Product Declaration
GPP: Green Public Procurement
MEPS: Minimum Energy Performance Standards
NDP: National Development Plan
OC: Operational Carbon
WLC: Whole Life Carbon

2. ENDORSE THE ROADMAP NOW

Over the next few months, the IGBC will keep working closely with all the stakeholders involved in the development of this roadmap and #BuildingLife ambassadors to ensure Ireland's built environment is fully decarbonised across its whole life cycle by 2050 at the latest.

To support the IGBC with this work we **encourage all of you to endorse this roadmap and to communicate extensively with clients, suppliers, and policymakers about the importance of addressing whole life carbon in the built environment.**

How to endorse the roadmap?

To make it easier for you to endorse the part of the roadmap which relates to your sector, sector specific endorsement letters have been developed for all sectors listed under the "Your Journey to Net Zero" section.

We are now asking you to endorse the three key recommendations at the top of the section which relates to your sector. So, if you are an architect, this means committing to:

- **Upskilling in whole life carbon and circularity**
- **Designing for performance and signing up to the RIAI climate challenge**
- **Advocating for renovation and adaptive reuse.**

Simply download the letter of support relevant to your sector on www.igbc.ie, sign it, and return it to irene@igbc.ie with permission to use your logo as part of the campaign.

Want to go further and take one more concrete step to decarbonise your activities? Why not join one of the following campaigns run by the IGBC?

EPD Campaign

Do you specify construction products? Help us drive the demand for better environmental data from manufacturers by joining our EPD campaign. Ask Environmental Product Declarations and prefer products with EPD where possible within procurement restrictions.

Learn more at www.igbc.ie/epd-campaign/.

EPD IRELAND
THE ENVIRONMENTAL PRODUCT DECLARATION PROJECT

Level(s) Procurement commitment

Commit today to use some key indicators of the European Framework for sustainable buildings, Level(s) and get assistance from the IGBC to support your pledge.

As a first step, we encourage you to focus on one (or more) of the following indicators:

- Life Cycle Assessment (LCA),
- Life Cycle Cost (LCC),
- Indoor Air Quality (IAQ) and
- Circularity.

Learn more at https://www.igbc.ie/certification/levels-eu-sustainable-buildings-framework/life-levels-commitment/.

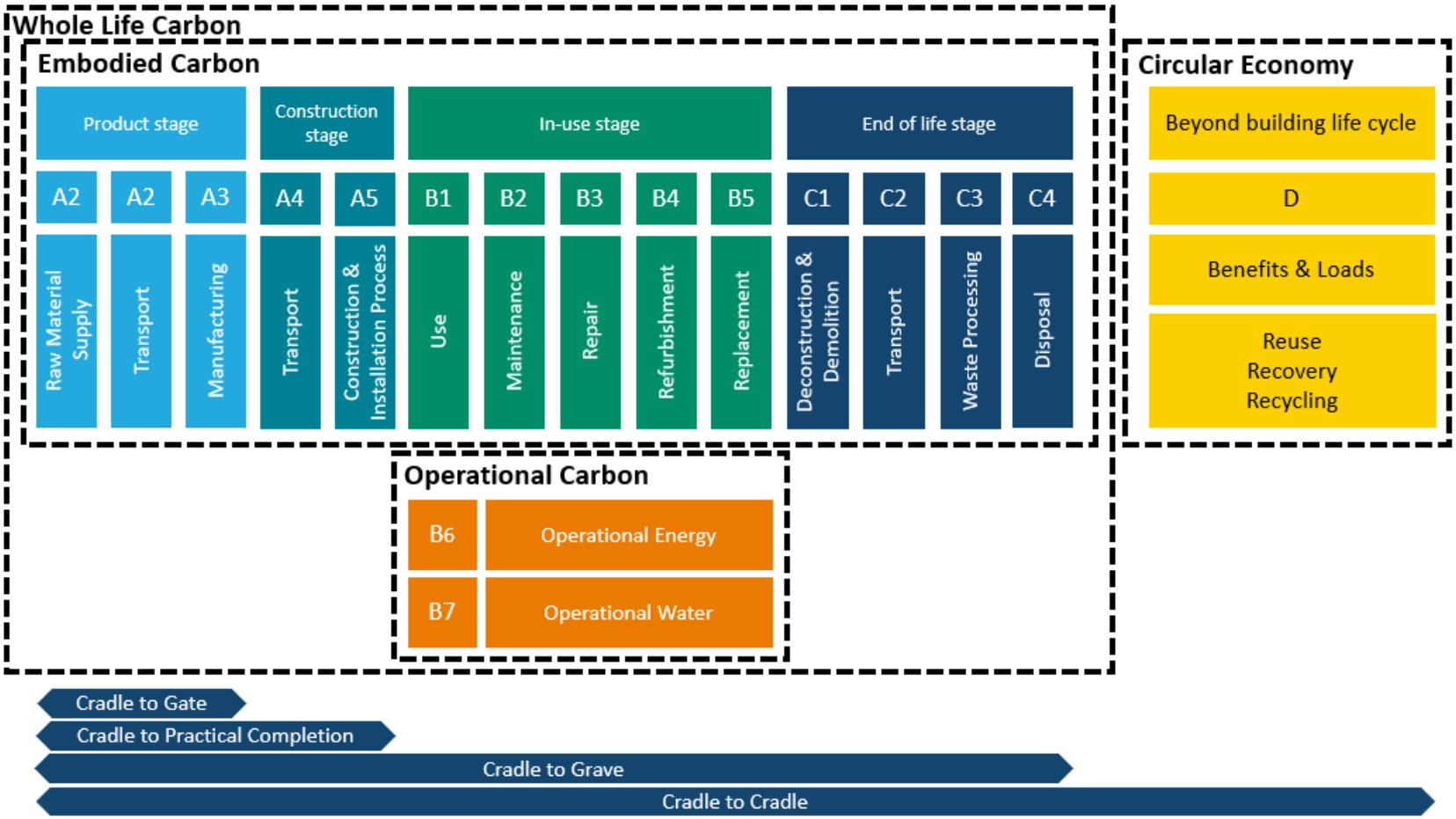
LIFE Level(s)

3. KEY CONCEPTS

The IGBC adopted the following definitions when developing this roadmap.

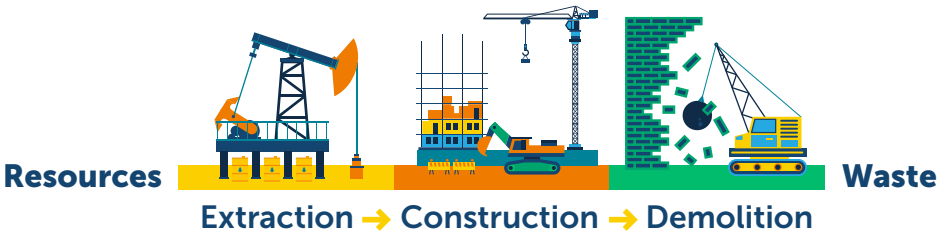
Building life cycle stages are defined by EN15978:2011

- Modules A1 – A3 (PRODUCT stage) [Cradle]
- Modules A4 – A5 (CONSTRUCTION PROCESSES stage)
- Modules B1 – B7 (USE stage)
- Modules C1 – C4 (END OF LIFE stage) [Grave]
- Module D (Benefits and loads beyond the system boundary)



A circular economy is one that is **restorative and regenerative by design**, and which aims to keep products, components and materials at their **highest utility and value at all times**, distinguishing between technical and biological cycles. The construction sector is currently in a linear model of take, make and dispose.

LINEAR ECONOMY



A **Net Zero Building** is a highly energy and resource efficient building where renewable energy sources and offsetting are utilised, such that the total Global Warming Potential (GWP) for the whole building life cycle is less than or equal to zero. 'Net Zero' is often referred to as 'Net Zero Carbon' or 'Carbon Neutral'.

A "**Net Zero Operational Carbon Building**" is a highly energy efficient building where renewable energy sources are utilised for all energy use, such that the annual Global Warming Potential for operational energy use is less than or equal to zero.

The **Global Warming Potential (GWP)** of a greenhouse gas (GHG) is a characterisation factor to represent the climate change impact of that GHG relative to that of carbon dioxide.

- The overall GWP of a building should be calculated as per Indicator 1.2 of the EU framework for sustainable buildings, Level(s).
- GWP is quantified in kg $CO_2e/m^2/yr$ for a reference study period of 50 years.

Offsetting is when GHG emission reductions or removals achieved elsewhere are used to compensate, or "offset", the residual carbon of a building.

- Residual carbon is the remaining GHG emissions once both operational and embodied carbon have been reduced as far as possible.
- Offsetting should only be used after all efforts to reduce emissions have been exhausted and should be done following the Oxford Principles for Net Zero Aligned Carbon Offsetting[4]

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All buildings must be highly energy and resource efficient. The built environment must be considered holistically to achieve a Net Zero carbon energy system and economy, and to minimise the use of offsetting which should not be viewed as a long-term solution. To achieve this, local targets have been developed to establish the energy and resource efficiency required by all buildings.

- The RIAI 2030 Climate Challenge[5] has established voluntary local targets for operational energy use, water use, and embodied carbon in Ireland.
- Annex III of the proposed Energy Performance of Buildings Directive (EPBD)[6] revision defines the 'very high energy performance' of a 'zero-emission building' in terms of local Energy Use Intensity (EUI) targets.

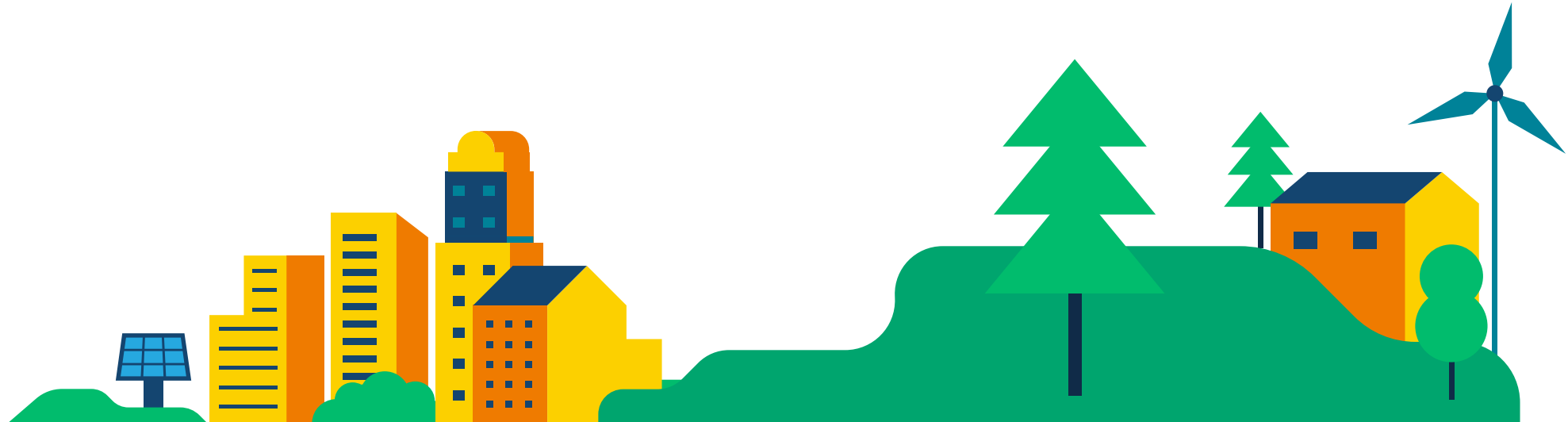
Note: Local targets may change over time as Net Zero carbon knowledge and strategies evolve.

Renewable energy sources are those that are defined as such at national level. These may be any combination of on-site renewable generation. Off-site renewable energy generation is also acceptable if it demonstrates additionality. In this context, additionality is the procurement of renewable energy for the building's use which results in new installed renewable energy capacity that would not have occurred otherwise. Direct emissions and any upstream emissions from renewable energy sources must be included as part of a WLC assessment.

Note: The requirement for all operational energy use to be met via renewable energy sources implies that a Net Zero carbon building does not utilise fossil fuels in any way.

'**Whole Life Carbon**' (WLC) is the total GWP associated with all life cycle stages of a building including both operational and embodied carbon.

- 'Operational Carbon' is the GWP associated with operational energy and water use (modules B6 and B7) during the use stage of a building's life cycle.
- 'Embodied Carbon' is the GWP associated with all construction materials and products over a building's whole life cycle; cradle to grave (modules A1-A5, B1-B5 and C1- C4).
- 'Upfront Embodied Carbon' is the GWP associated with all construction materials and products up to building handover following construction; cradle to practical completion (modules A1-A5). Upfront Carbon excludes biogenic sequestration.



4. UNDERSTANDING THE SCALE OF THE CHALLENGE

The modelling developed by the Building in a Climate Emergency (BIACE) Research Lab at the UCD School of Architecture, Planning and Environmental Policy **underpins the assumptions made in the roadmap**. This **quantifies for the first-time carbon emissions associated with the whole lifecycle of the building and infrastructure stock in Ireland**.

The research also **modelled emissions for a variety of scenarios based on the proposed level of construction and renovation outlined in the National Development Plan, Climate Action Plan and Housing for All policy**. The scenarios were further informed by a technical committee established by IGBC to advise the research team.

The full carbon modelling report is available at www.igbc.ie.

Consumption based emissions versus production emissions.

The EPA sectoral emissions inventory[7] divides the nation's total greenhouse gas (GHG) emissions into ten sectors. It does not provide a single sectoral category for the Built Environment (BE). Emissions attributable to the BE are found under a range of headings, across electricity generation, residential, commercial, and public buildings, with a significant proportion of emissions from manufacturing combustion, industrial processes, landfill waste and transport. Furthermore, the EPA sectoral emissions inventory takes a production-based approach, as opposed to a consumption-based approach. This means that emissions associated with imported products used in construction in Ireland are not measured, whereas emissions associated with the production of products manufactured in Ireland, such as cement for export are included*. This is different to the way that embodied carbon emissions are reported in the construction sector which are on a consumption basis and is irrespective of where the products are produced either nationally or globally and therefore this is the approach in this report.

Consumption based Emissions by Materials

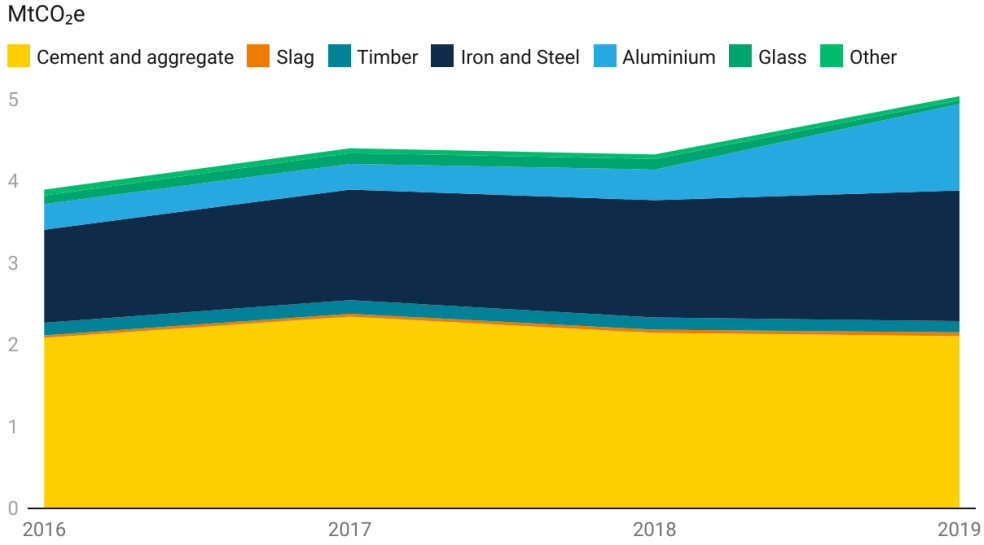
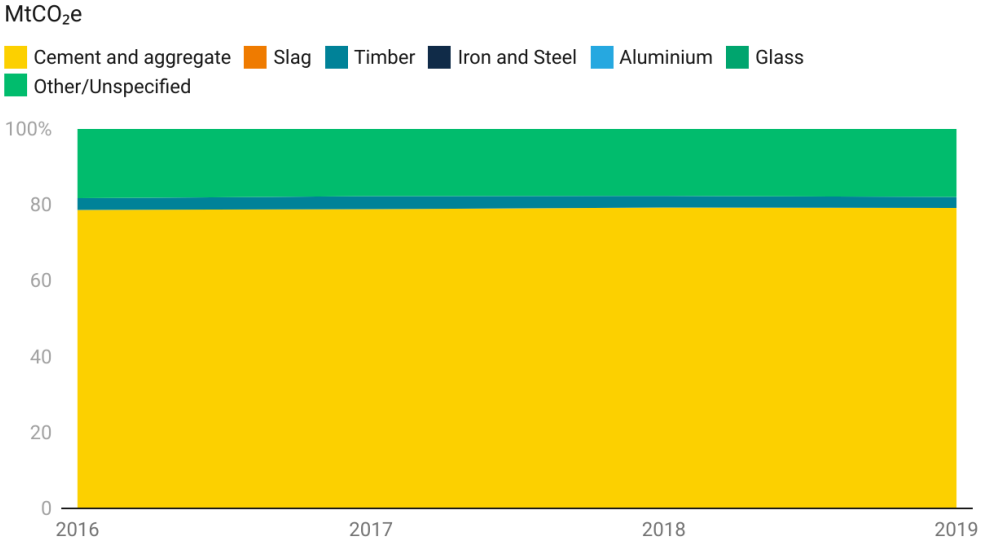


Chart: Irish Green Building Council • Source: BIACE UCD • Created with Datawrapper

Production based Emissions by Materials



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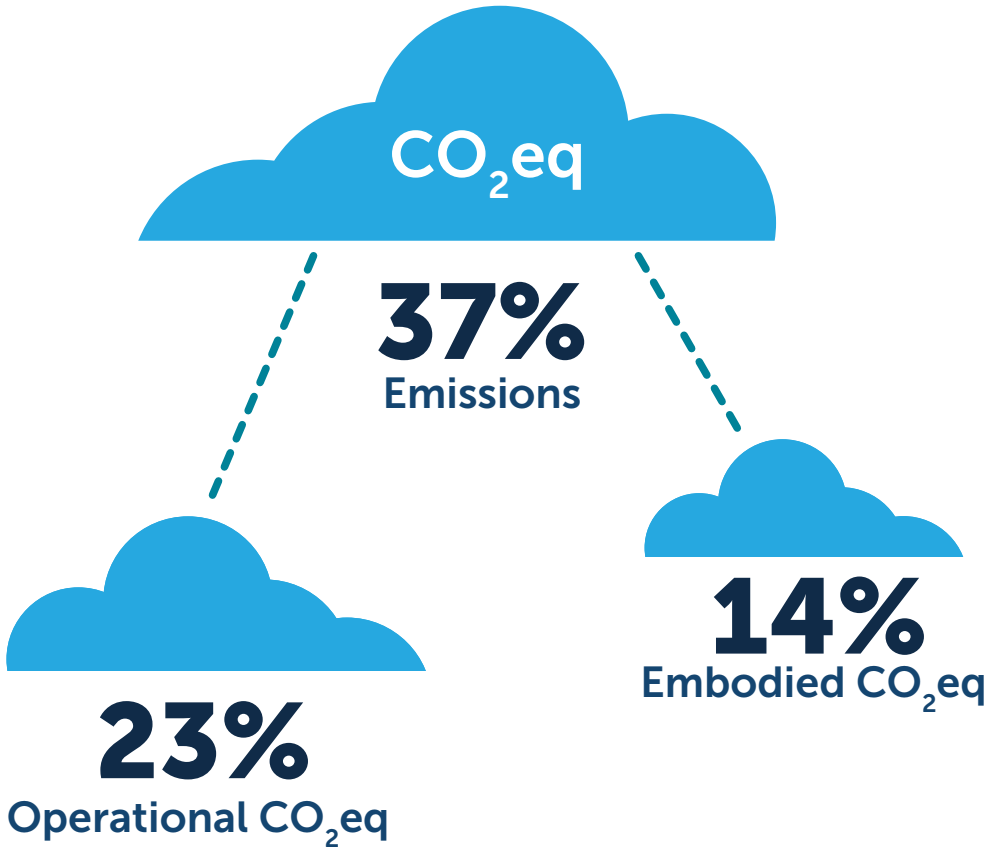
**Note: The figures above show that consumption-based emissions and production-based emissions are roughly in balance in Ireland though consumption based emissions slightly higher. While Ireland imports many high emissions products such as steel, aluminium and glass for use in the construction sector these are offset by the export of high emissions concrete based products.*

Current levels of emissions

For this study, the baseline year is 2018.

The report indicates that in Ireland 23MtCO_2e per year are linked to the construction and operation of our built environment (BE). This equates **to 37% of all national emissions**, the same as agriculture.



The challenge to decarbonise key materials

The most carbon intensive and commonly used materials in Irish construction, i.e., cement from portland clinker and steel, cannot be easily decarbonised. Their production involves the chemical release of CO_2 which is not related to the fuels or energy used in the industrial process. For example, when converting limestone to cement clinker, CO_2 is released in the chemical process. Calcium Carbonate (CaCO3) converts to Calcium Oxide releasing Carbon dioxide ($C0_2$). Substitution with zero carbon fuels can only reduce up to 40% of these emissions with potentially 90% of fuel replacement, with the only option being carbon capture for the remaining 60%. This is unlikely before the late 2030's or early 2040's given the need to build infrastructure to transport the CO2 to geological formations. The alternative is substituting chemically different clinkers[8] or alternative binders in concrete.

This 37% is made up of **23% operational emissions** associated with the energy we use to heat, cool, and light our buildings and a further **14% embodied carbon emissions** from the production of construction materials, transport of materials, construction process, maintenance, repair and disposal of buildings and infrastructure. The **single largest contributor to BE emissions was found to be the operation of residential buildings**, which account for 45% of the total emissions of the sector (23MtCO_2e).

Impact of electricity decarbonisation on built environment emissions.

The carbon intensity of the electrical grid has fallen from 635gCO_2/kWh in 2005 to 375gCO_2/kWh in 2018. This has a pronounced effect on decarbonising operational emissions, especially in the non-residential sector where the electrification rate is 67%. It has much less impact on residential where it currently only accounts for 25% of energy demand – hence the drive for electrification of homes, and even less on the decarbonisation of construction itself.

Average CO_2e emissions projected by BER Rating per m²

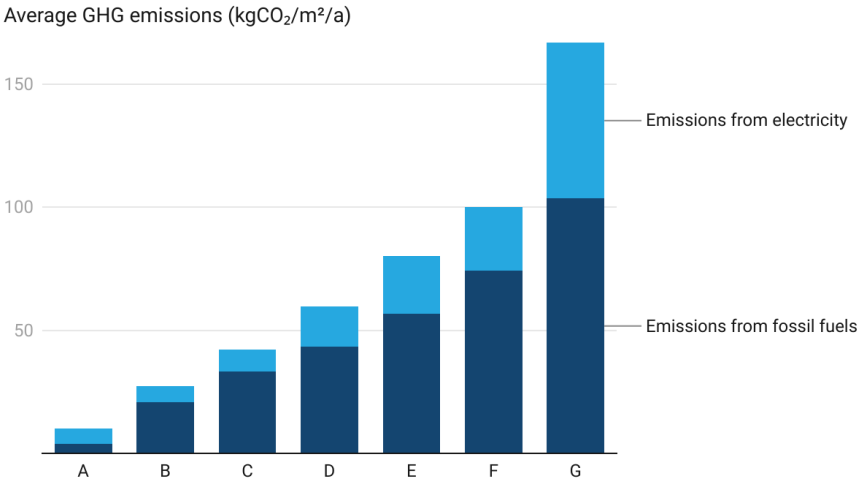
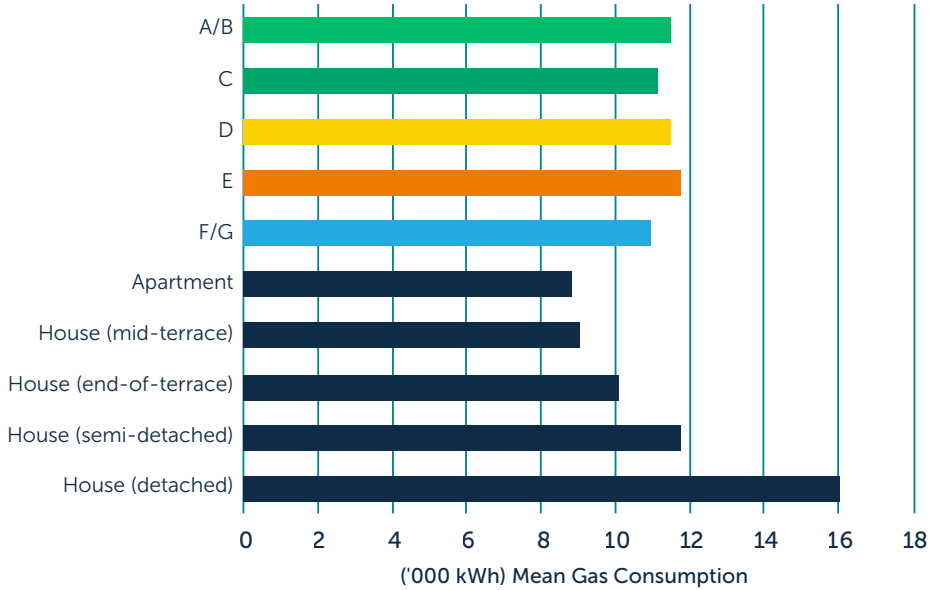


Chart: Irish Green Building Council • Source: BIACE UCD • Created with Datawrapper

CSO figures from August 2022[9] show little correlation between the BER rating of a home and overall gas and electricity usage which is more influenced by size of home and type of home[10]. As it currently stands, the more energy efficient homes tend to have a larger floor area, which tends to offset their overall efficiency i.e., average size of G rated homes is 83m² with average of A rated homes 133m². **Apartments and mid terrace homes are inherently considerably more energy efficient, down not just to smaller size but because of a much smaller form factor which reduces the heat loss from exposed wall, floor, and roof areas versus detached homes. This also means they are much more cost effective to upgrade.**

Mean Gas Consumption by Type of Dwelling and by Energy Rating 2020



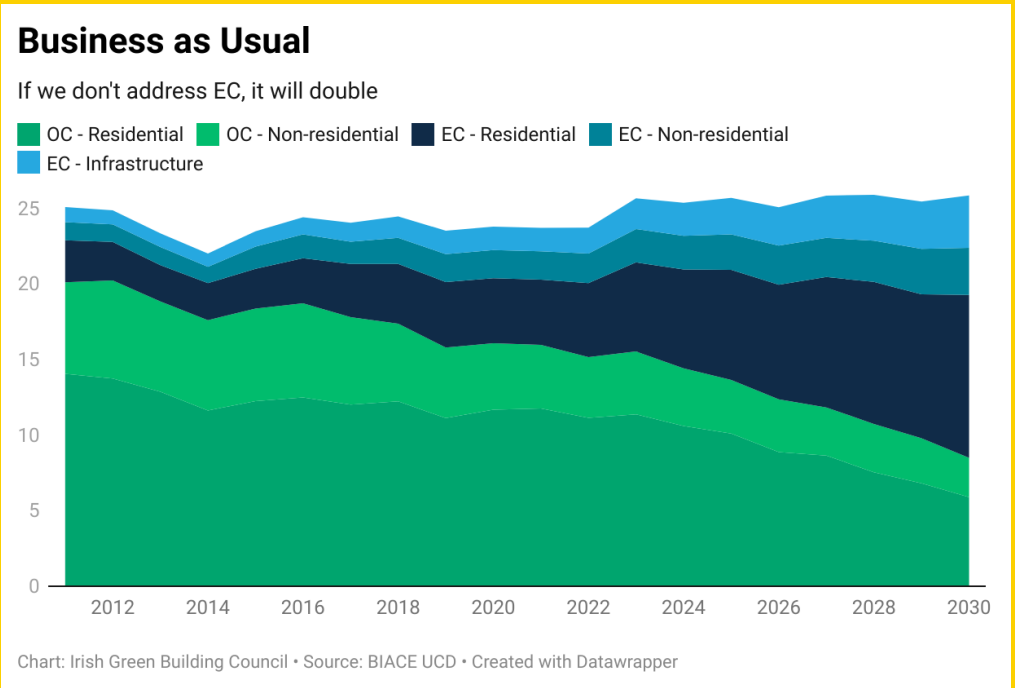
Source: CSO Irela

Scenario modelling to 2030

The report includes projections to 2030 for a range of scenarios. The national retrofit scheme and energy efficiency improvements in new build (NZEB standard), alongside a decarbonising grid, will **drive operational emissions down in the next decade, however, new construction outlined in the National Development Plan (NDP), the Housing for All policy, and the Climate Action Plan proposal for renovation of 500,000 homes will lead to a significant increase in embodied carbon, effectively negating the savings in operational emissions**.

At this early stage, three WLC scenarios were tested to scope their future impact on overall emissions from the built environment. All three assume all new housing energy will be supplied by electricity and that the carbon intensity of the grid will continue its downward trajectory, reaching around 150gmCO_2e/kWh by 2030 with the actions in the climate action plan fully implemented.

Scenario 1 – The first considers a 'business as usual' scenario where the rate of construction and retrofit increases as planned but no efforts are made to address embodied carbon (EC). The increase in the volume of building and renovation leads to an increase in EC, which negates any carbon savings from the decarbonising grid and actions in Government's existing policies. This leads to an overall built environment emissions increase to 2030.



Scenario 2 - The second scenario makes the same assumptions as above but considers the impact on emissions if embodied carbon intensity reduces as per the RIAI Climate Challenge, i.e., a 50% reduction per square metre. In this scenario, operational and embodied carbon emissions decline but not sufficiently to reach the target.

Scenario 3 – The final scenario can only achieve a 51% reduction by greater ambition on renovation, greater reuse of vacant and unused space instead of new build in addition to further cutting carbon intensity of construction or further decarbonisation of the grid. This final scenario is explored in greater detail below.

EC reduces in line with RIAI targets

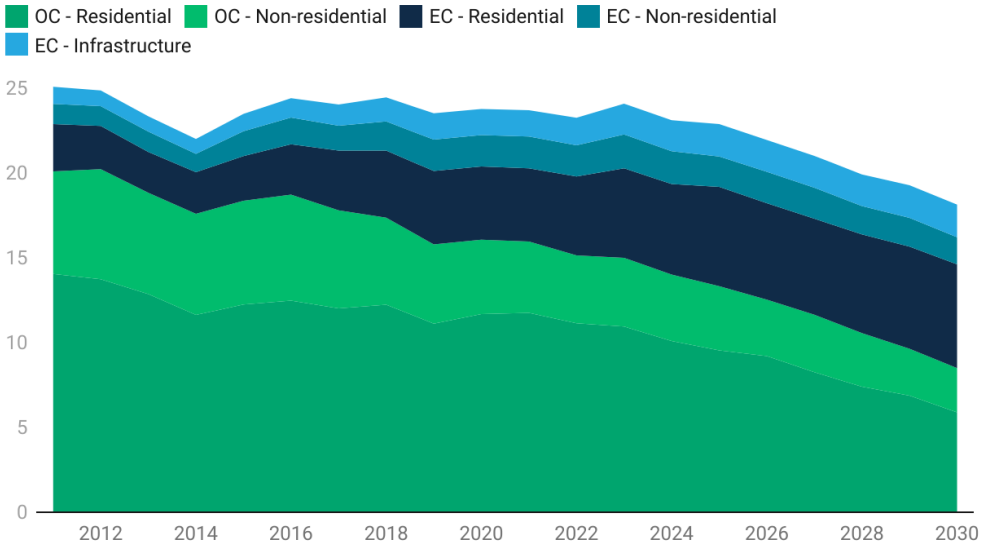


Chart: Irish Green Building Council • Source: BIACE UCD • Created with Datawrapper

EC Reduces by 80% + We Make Use of 100,000 Vacant Buildings

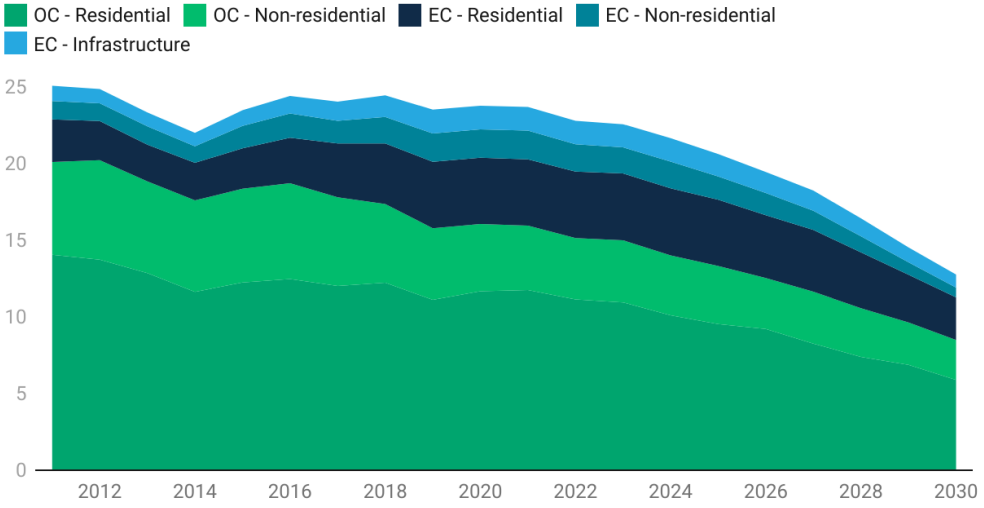
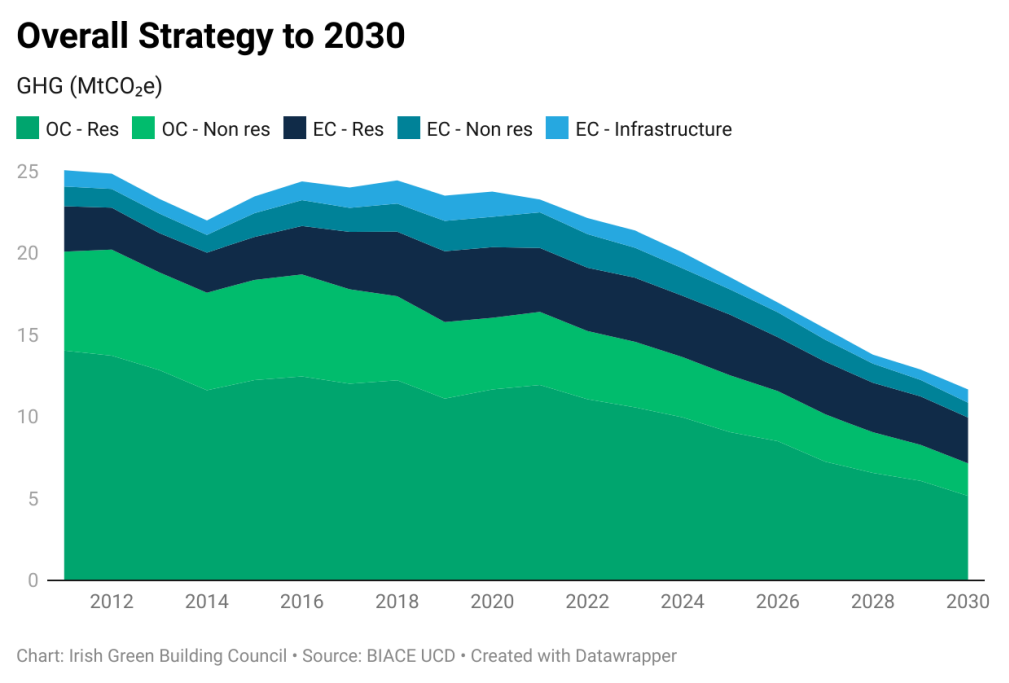


Chart: Irish Green Building Council • Source: UCD BIACE • Created with Datawrapper

5. PATHWAY TO ZERO

Overall strategy to 2030

The final modelling scenario **optimises the most realistic combinations of solutions to reduce carbon emissions from construction and the built environment by 51%.**



In this final modelling scenario, IGBC made the following assumptions:

OPERATIONAL EMISSIONS

The scenario requires **increasing the ambition on renovation** and ensuring that 500,000 homes are brought up to an A3 BER standard rather than a B2, and where homes are still using gas and oil by 2030 that the carbon intensity of fuels is reduced by 10%. An alternative could be to increase the target for an additional 200,000 renovations to a B2 standard.

It is also assumed that **all new buildings and retrofits are performing in line with their BER rating**. To achieve this and eliminate the performance gap requires upskilling of building professionals and construction workers, performance disclosure - particularly in the non-residential sector, and improving users' understanding of energy efficiency in buildings.

EMBODIED CARBON

The following three strategies were implemented in the model to achieve reductions in embodied carbon from construction.

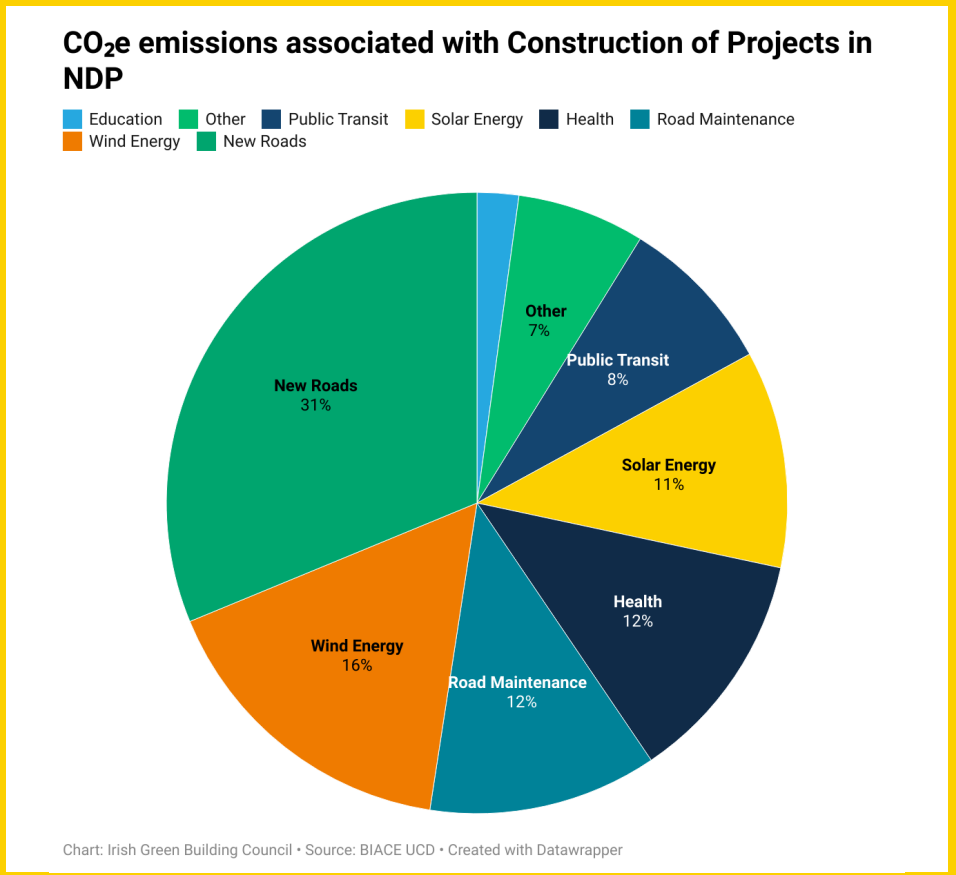
1. Prioritise

Prioritise what needs to be built under the National Development Plan (NDP) to meet citizens' necessary housing, health, sustainable transport, economic and educational needs. Poorly optimised buildings (including dwellings) or infrastructure which induce demand for resources, and directly or indirectly increase emissions without significant societal or environmental benefits should be reconsidered. Certain road enhancement schemes will induce private car use, increasing disperse settlement patterns also associated with larger home size and carbon emissions from transport. While reducing non-residential and infrastructure projects such as new roads was not modelled, this could be an alternative to reducing the carbon budget for homes.

Reducing the average new home size area by 28% to the European median[11] leads to a very substantial impact on embodied carbon emissions within the model.

The trend of smaller households is likely to continue and to get closer to the EU average over the next few years. The fertility rate in Ireland has already dropped from 2.05 in 2010 to 1.6 in 2020[12]. Therefore, the mix of home sizes needs to be re-evaluated with a sufficiency of 3- and 4-bedroom homes likely already within the existing stock. Integration of 1- and 2-bedroom homes into neighbourhoods could enable downsizing, freeing up family homes for those who need them. Policy could **accelerate a reduction** in the construction of the number of detached sub-optimally sized homes and support a transition to more compact forms of development such as apartments and terraced homes. This will also reduce operational energy use from these new homes. The advantage for housing policy is that this would allow **more homes to be built for less cost in manpower, materials, and carbon emissions**.

Impact of projects in National Development Plan (NDP)

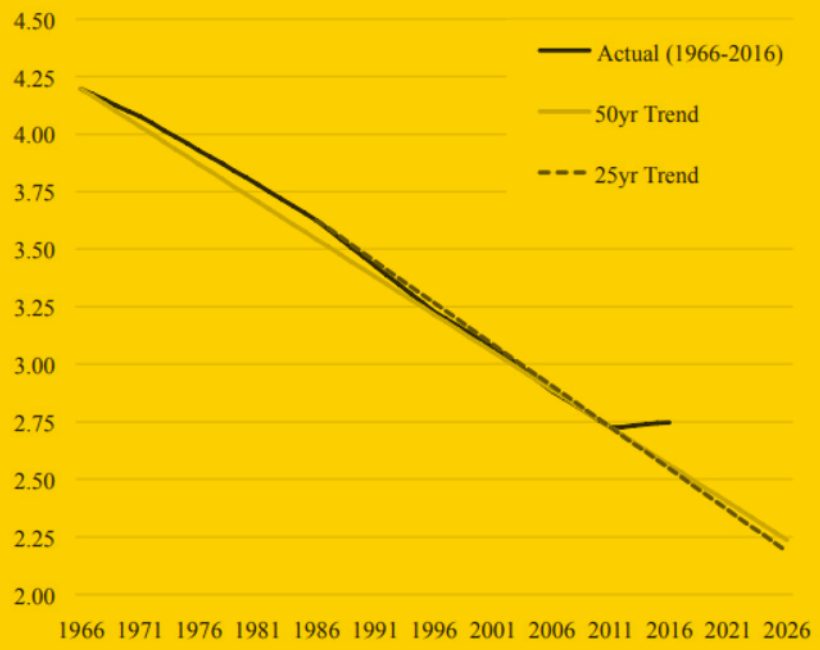


The embodied carbon of projects in the NDP were estimated using a bottom-up approach by applying carbon factors to the different projects identified therein. The figure above shows an estimation of the relative contribution of the different types of projects to embodied carbon emissions.

Other includes the following categories: Energy Storage, Water & Flood, as well as Air & Sea.

Optimisation of areas of new built non-residential buildings by better scheduling of space and taking into account hybrid working could reduce areas needed for non-residential use.

Average household size, by year and trend.



Source: Ronan Lyons.

Why per capita benchmarks are also needed.

In the *Towards embodied carbon benchmarks for buildings in Europe report*[13], published by Ramboll with funding from the Laudes foundation, LCAs for 50 buildings across Europe were measured looking at both CO_2e emissions per m^2 and per capita based on occupancy density.

Per m^2 emissions for residential developments showed apartments had the highest values with terraced houses the lowest. However per capita values for residential buildings based on the number of bedspaces per residential unit, showed a mean value for full life cycle embodied carbon of around 32t CO_2e /cap, with values lowest for apartments and terrace homes (26t CO_2e/cap and 24t CO_2e/cap respectively), and highest for single homes 33t CO_2/cap.

The report recommended that in addition to reporting per CO_2kg/m^2, per capita emissions measured in CO_2kg should also be reported. This is to ensure that the rebound effect where greater energy efficiency per m^2 (as noted in Irish CSO figures[14]) is offset by an increase in floor area, is not also repeated for embodied carbon.

2. Re-use

The model also assumed that **over 33% of homes or 124,000 units would be sourced from the 166,000 permanently vacant properties** identified in the 2022 census, the 29,317 vacant commercial properties identified in the Geo Directory Commercial vacancy rate 2021[15], and the very extensive vacant space above retail premises or other commercial properties in our town centres[16]. This ties in with existing government objectives to regenerate towns and settlements across Ireland to reduce need for new construction. This reduces the number of new homes that need to be built from 363,000 to 239,000, i.e., to 21,000 annually. Embodied carbon of renovation is estimated to have approximately 25% the carbon intensity of new build.

3. Reduce

Even with above measures, **carbon intensity of new construction and renovation per m^2 would need to be reduced by 60% to achieve the target.** This will be achieved initially by **leaner design** i.e., using commonly available

materials, but **using less by optimising building form factor, efficient structural design, and material use**. This requires upskilling of design professionals and development of more efficient construction systems such as offsite construction or Modern Methods of Construction (MMC) cutting waste.

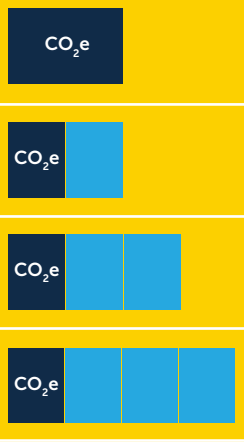
However, use of MMC using carbon intensive materials has its limits and will be unlikely to be sufficient to deliver the 60% target, therefore the next step is rapid decarbonisation of the materials themselves or development of alternative low carbon materials. Reductions of this order of magnitude are a very difficult challenge in the time frame to 2030, so the key steps to achieve it are set out below.

Alternatively, if a 90% decarbonisation of electricity could be achieved, with decarbonisation of fuels by 20% or less if combined with further reductions in built area this may allow the carbon intensity of construction to be reduced **by a more achievable 50%.**

Construction Outputs vs. Carbon intensity reductions

The greater the increase in construction output, the greater the reduction in the carbon intensity per unit is needed to meet a science-based target for the built environment.

Ireland's total embodied carbon emissions from construction = Total volume of construction x carbon intensity per unit of construction.



Construction output 2018 baseline emissions for embodied carbon

Same construction output as 2018 requires 50% cut in carbon intensity by 2030

50% increase in construction output, requires 66% cut in carbon intensity by 2030

100% increase in construction output, requires 75% cut in carbon intensity of 75% by 2030

Steps to rapid reduction of construction carbon intensity

A 50–60% reduction in carbon intensity per m^2 is extremely challenging. It goes beyond the 40% proposed by the World Green Building Council and the 50% proposed by RIAI climate challenge, but is the best way to open up more space within a carbon budget for new homes and buildings and achieve the science-based target.

Three steps have been identified to reduce carbon intensity and all need to start immediately as each has a different timeline to impact, with step 3 likely to be the slowest, due to time delay to bring to market and scale innovation. Step 2 needs immediate action as Step 3 is dependent on it.

Step 1: Introduce measurement through mandatory disclosure.

This would educate the industry and is the first step in creating a baseline for current CO_2 emissions per square meter enabling creation of benchmarks and limit values.

The infrastructure to do this must be accelerated including the development of data, a national methodology, a database of building LCA leading to benchmarks and free tools to enable calculation.

A planned schedule of stricter limits would give the industry long term visibility on what it needs to do to decarbonise construction. This in turn would support the drive for innovation which is needed to rapidly cut emissions.

Whole Life Carbon (WLC) Regulation in Europe

At EU level, a detailed reporting framework to improve the sustainability of buildings from the life cycle perspective was launched in 2020. The key idea with the Level(s) framework is that all member states focus on the same indicators, so that we can use them to learn, set benchmarks and develop standards. The EU Taxonomy for sustainable activities, and the proposed revisions of the Energy Efficiency and Energy Performance of Buildings Directives all require or encourage measurement of Whole Life Carbon using the methodology set in the Level(s) framework, and more specifically indicator 1.2.

A number of European countries and cities have already regulated or are about to regulate WLC, these include Denmark, Finland, France, the Netherlands and the city of London. In the United Kingdom, industry has proposed an amendment to the Building Regulations to address WLC. The proposed "Part Z" outlines requirements on the assessment of whole life carbon emissions, and limiting of embodied carbon emissions, for all major building projects.

Step 2: Develop a supportive regulatory environment

Review the full building regulatory and building control system to ensure it is taking into account climate action and is responsive to changing building practices through greater engagement with industry.

This starts with reviewing and removing all current barriers identified in the roadmap, including regulatory, planning, and fiscal barriers, currently inhibiting, or slowing down adoption of innovative development typologies, construction methods, products and processes.

More specifically, all TGDs must be reviewed to accelerate conversion of existing vacant space including parts K and M. TGD B must also be reviewed to address the limits placed on timber construction above 3 stories. The application and interpretation of TGD D and requirement for certification (Irish Agrément) must be clarified to support innovation and reduce delays and costs in this certification system.

Guidelines must be published under section 28 of the planning act to ensure that all planning are assessed for low carbon compact growth ensuring consistency across all local authorities.

To secure a future supply of low carbon materials, the licencing of planting and felling of timber[i], as well as of industrial hemp production, should be reviewed.

Finally, the application of articles 27 & 28 of the EU Waste Framework Directive in Ireland must be urgently reviewed to enable reuse of materials or speed up the licencing process.

Cross Laminated Timber (CLT)

CLT is a highly engineered product made up of planks of between 20 and 60mm glued at right angles to each other to create massive timber structural elements. The technology was developed in Europe in the early 1990's, with the first medium rise structures completed in the first decade of the 21st century. The 19 story Sara Kulturhus in Sweden was completed in 2021 with a 37 tower due for completion in Rotterdam[17] in 2025 with medium rise and high rise structures built or planned in Canada and Australia. The UK has had one of the most rapid expansions in the use of CLT in Europe with about 40,000 cubic metres used per year, in part due to the non-prescriptive nature of UK part B regulations which set the requirements that should be met and did not require a change in the regulations to allow use in higher structures[17]. Estimated production in 2021 was in excess of 1.4 million cubic metres produced in 2021[18]. The production is currently concentrated in central Europe (Germany, Austria and the Czech Republic) and the Nordic countries (Finland and Sweden)[19].

Sara Kulturhus in Skellefteå Sweden – photograph creative commons.

i This is currently being addressed by DAFM's 'Project Woodland'.

Step 3: Invest in a low carbon supply chain.

As a final step, government should **proactively enable the industry to adopt low carbon forms of construction**, by investing in the measures that will accelerate these, including research and support for businesses to develop, test, certify and bring innovative materials to market.

This requires initially **supporting a greater use of offsite construction and MMC** where greater efficiencies and lighter construction can lead to a fall in carbon intensities. This may mean public private partnerships for innovation enabling pilot projects to be delivered quickly.

However, leaner design has its limits. The roadmap is material neutral, and developments in technology may deliver alternative ways of capturing carbon from the atmosphere but biomaterials already do this through their growth cycle. **Ireland with a large agricultural sector has a strategic interest to identify, encourage, and develop local low carbon biobased solutions from agriculture and forestry and to encourage solutions from the circular economy** – reusing resources that are already available locally.

This could be done through **strategic government investment in production or risk sharing aiming to create large export orientated industries** building on success of industries such as Coillte's MediteSmartply. This could start with a feasibility studies such as one developed in 2022 by DAFM for wool production, extending to other potential construction materials such as CLT, industrial hemp, straw and other agricultural fibres, as well as exploring potential of newer bio-based materials such as mycelium. These industries will only likely gain traction with significant state involvement through investment and engagement with the agriculture sector.

Biomaterials and Biogenic carbon

Published EPDs[20] show that bio-based materials generally have lower embodied carbon to produce than alternatives such as steel and concrete. In addition, fast growing bio-based materials used for building and renovation fix biogenic carbon taken up during plant growth for the duration of the building's life. At the end of the building's life, this carbon can be released depending on how the building is disposed of, either through incineration or in landfill, emitting gases such as methane that should be reported in Whole Life Carbon assessments – End-of-life scenario module (C3). Where buildings are designed with circularity in mind, through adaptability to extend their life, or for disassembly allowing the product to be easily removed and reused in another building or use, this biogenic carbon can remain fixed for a longer period.

Scenario modelling to 2050

Beyond 2030, the following assumptions were made. There will be ongoing decarbonisation of the electrical grid, and certain milestones (including reaching 100% renewable electricity by 2040) will be achieved.

As mentioned in Ireland's long-term renovation strategy[21], there will be an ongoing renovation programme to upgrade homes beyond 2030. By 2045 all homes should be heated by either decarbonised electricity, zero carbon district heating using waste heat networks or fossil free fuel sources such as biogas or green hydrogen with all fossil fuel boilers decommissioned.

By 2050 embodied carbon is reduced to zero with most products achieving carbon neutrality by 2045. More difficult to decarbonise sectors such as steel and cement will have been fully decarbonised either by a combination of alternative clinker replacement or with carbon capture storage by 2050.

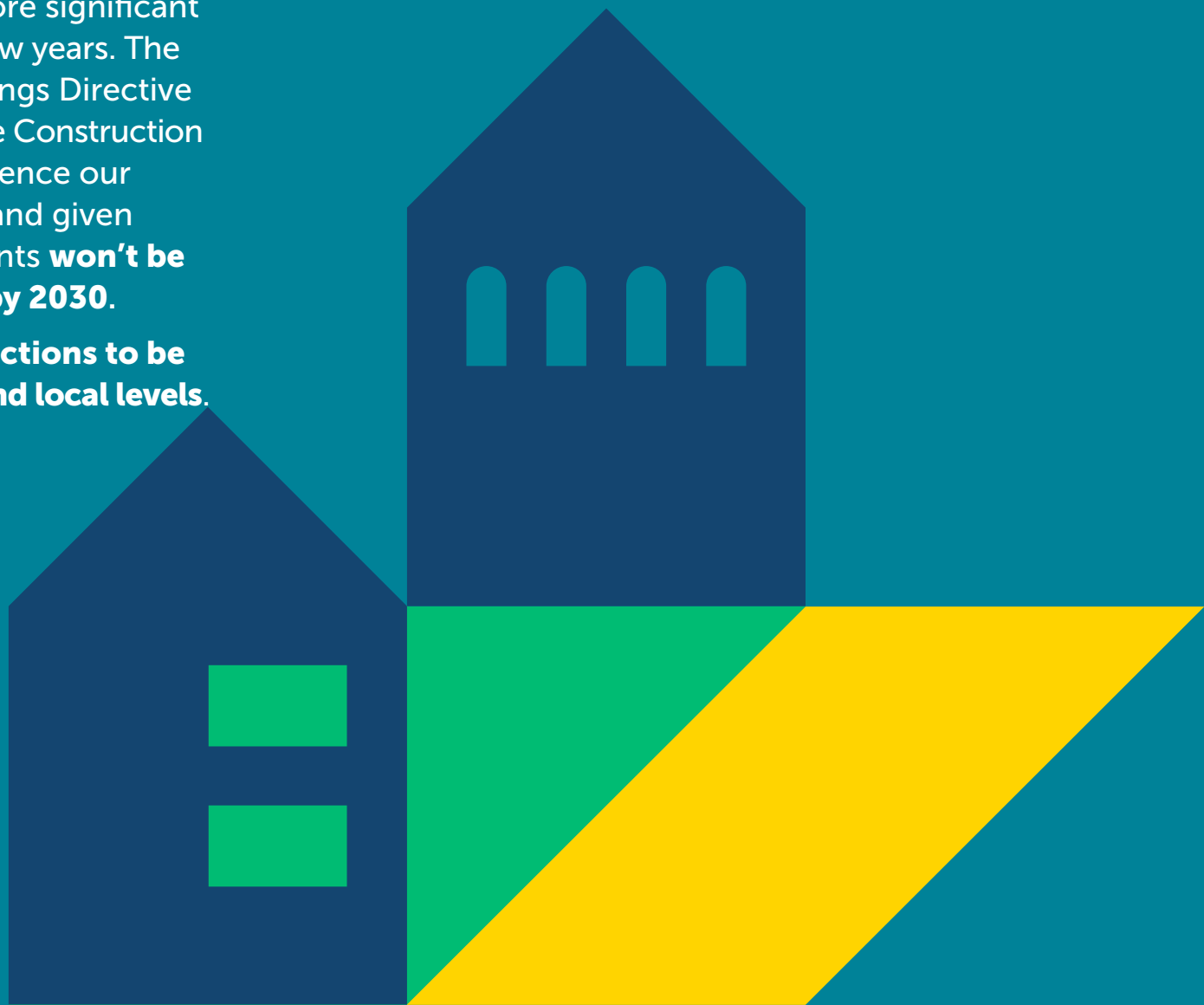
6. YOUR JOURNEY TO NET ZERO

To facilitate implementation of this roadmap and our transition to a zero-carbon built environment, this section presents a set of specific recommendations for policy makers, educators, investors and the property and construction industry.

6.1 POLICY MAKERS

While the EU Taxonomy for sustainable activities is already having a significant impact on how sustainability is assessed in some parts of the market in Ireland, even more significant changes will happen at EU level in the next few years. The revision of the Energy Performance of Buildings Directive (EPBD), the Energy Efficiency Directive and the Construction Products Regulation to name a few will influence our policies and regulations. Although positive, and given the scale of the challenge, these developments **won't be sufficient to halve our sector's emissions by 2030**.

This section presents **a set of coordinated actions to be implemented by policymakers at national and local levels**.



6.1.1 NATIONAL LEVEL

This section summarises actions required at national level to fully decarbonise Ireland's built environment by 2050. These recommendations were developed to **optimise the use of our building stock, reduce operational emissions, as well as embodied emissions** associated with new built and renovation. Having a just transition is critical to the success of Ireland's climate ambitions and to improve people's health and wellbeing. A social justice approach was hence taken when creating this roadmap, for example when developing recommendations on the national retrofit programme and ensuring all housing needs are met within the carbon budget.

As per national policies, it is anticipated that the grid will continue its downward trajectory and that it will be upgraded to support demand response in buildings. The roadmap does not include any recommendations on this topic.

KEY RECOMMENDATIONS

- **Introduce mandatory Whole Life Carbon measurement and signal future direction of CO_2e limits per m^2 and per capita.**
- **Create a supportive regulatory environment for rapid decarbonisation.**
- **Invest now in a low carbon construction supply chain.**

1. ENSURE SUPPORTING POLICIES ARE IN PLACE

1.1 Framework & General Policies

2023

1.1.1 Give **responsibility of overseeing and coordinating climate action to one Department** (e.g., the Department of An Taoiseach) to ensure a holistic and efficient approach to carbon emission reductions.

1.1.2. **Set up a Citizens' Assembly on housing and climate action**, to raise awareness about these issues and build a consensus around more contentious policies to address them such as optimisation and re-use.

1.1.3. Ensure **production and consumption based GHG emissions accounts are published** on a regular basis to improve baseline. Keep tracking progress towards 2050 targets on a regular basis and make this data widely available.

1.1.4. Set up a working group to **ensure policies, regulations and financial incentives are fully aligned to make adaptation and reuse of existing buildings easier**. These would need to be reviewed on a regular basis through the 2020s to ensure they fully support Ireland's carbon emissions reduction objectives.

1.1.5. Publish **guidelines under section 28 of the planning act** to support low carbon planning. These should at least cover compact growth, WLC measurement, re-use and demolition, home per capita limits, as well as solar access for renewables, and highlight the importance of enforcement and consistency across local authorities to avoid unintended consequences – e.g., developments happening in counties with the lowest requirements.

1.1.6. Develop **guidance on the practice of offsetting for construction**, ensuring it happens at the most local level to any development and provides additionality.

1.1.7 Complete a full review of the existing stock to evaluate what is available for use and where, and to assess what additional space and building types may be needed.

The review should also help in gaining a better understanding of financial and technical measures required. This process could be supported by expanding the Collaborative Town Centre Health Check Programme (CTCHC) programme to all towns and cities and launching a national housing condition survey.

2024

1.1.8 Require **better reporting on impact of renovation for all publicly funded projects**, using reporting frameworks such as Build Upon – Energy Renovation Framework to track progress and measure impacts and benefits of renovation.

2025

1.1.9 Integrate WLC as a key consideration within the next National Building Renovation Plan[22].

1.1.10 Develop a comprehensive national circularity strategy for the reuse of material streams coming out of the retrofit programme, including glass, insulation, and timber.

1.1.11 Develop a **national carbon offsetting scheme and rules of offsetting for construction**, ensuring it happens at the most local level to any development and provides additionality (i.e., carbon mitigation would not otherwise have occurred).

2030 - 2040

1.1.12 Review and adjust planning, reuse, retrofit and decarbonisation of the construction industry policies on a regular basis to ensure they fully support Ireland's carbon emissions reduction objectives.

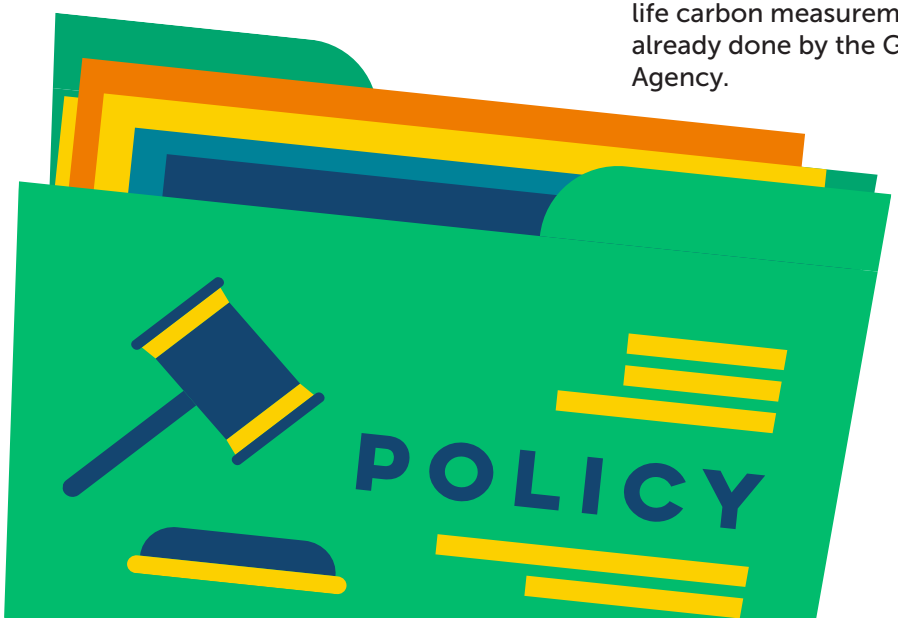
1.2 Publicly funded projects

2023

1.1.13 Require a **full assessment of the carbon impact of all projects included in the National Development Plan** and start prioritising them where necessary.

1.1.14 **Review the public spending code**, including increasing the shadow price of carbon, eliminating differentiation between ETS and non-ETS, and replacing it with a bill of carbon, requiring a full lifecycle pricing of energy and carbon.

1.1.15 Review the Capital Works Management Framework (CWMF) so that environmental and decarbonisation objectives are included in the project appraisal parameters. Incorporate the evaluation of carbon within Pillar 3 of the CWMF.



1.1.16 Develop **a strong Green Public Procurement (GPP)** policy to support innovation and build capacity within industry to decarbonise Ireland's built environment.

1.1.17 Develop **high quality guidance documents for GPP** to lower the perceived risks associated with GPP. These should include guidance to underpin the application of WLC within public procurement for all building types and a knowledge bank with case studies and examples of tools that can be used or piloted.

1.1.18 Update Office of Government Procurement template and contract documents to ensure all procurers are clear on the requirements.

1.1.19 Encourage public bodies to require whole life carbon measurement and indicative targets, as already done by the Grangegorman Development Agency.

2024

1.1.20 **Mandate the use of GPP for all public notices** published for procuring buildings and renovations – including social housing, as well as infrastructures, and more specifically, the Level(s) indicators 1.2 - WLC, 2.3 - Design for adaptability and renovation, 2.4 - Design for deconstruction, reuse and recycling and 6.1 - Life Cycle Costing.

2025

1.1.21 Introduce the **first per square metre and per capita carbon targets for different building types** in public notices for procuring new buildings and large renovation and tighten them progressively so that all new public buildings are procured to Net Zero carbon standard by 2028, and all major renovation by 2030.

1.3 Addressing operational emissions

2023

1.1.22 Ensure funding for social housing renovation allows for best practice implementation of Government policy on ventilation, electrification of heat and achieving at minimum a BER of B2.

1.1.23 Develop **quality assurance scheme for one-stop-shops** to ensure independent advice and customer protection are provided, hence supporting high quality retrofit works. Two key steps are the expansion of the SEAI Technical Advisor scheme to all projects, and the **introduction of a warranty scheme for all SEAI's retrofit schemes** to better protect building owners and increase trust in the process.

1.1.24 SEAI & Met Eireann to develop free open-source Test Reference Year (TRY) and Design Summer Year (DSY) weather data sets, as well as free open-source climate change scenario weather data sets for multiple locations in Ireland.

This will enable the application of more appropriate weather data for NEAP and DEAP calculations outside of Dublin; and will be important for any NABERS style "Design for Performance" rating which would help address the performance gap. Climate change scenario weather data will help design teams ensure passive design strategies, such as natural ventilation, can adequately handle warmer climate conditions.

1.1.25 Eirgrid to develop carbon metering protocols and tariffs that adjust carbon tax applied accordingly, to enable Building Management Systems (BMS) control for load shifting linked to grid CO_2 intensity rather than time of day, and optimisation of local energy storage for lowest carbon intensity.

2024

1.1.26 Expend the role and competency of **SEAI's technical advisors for all funded projects** – as per recommendations of the BUNRS project[23], so that they provide fully independent energy renovation advise and enable the uptake of Building Renovation Passports.

1.1.27 Complement the existing BERs with the disclosure of verified operational energy use data; this could be achieved via the introduction of a **digital logbook** for residential properties and a **NABERS-like rating scheme** for non-residential buildings.

1.1.28 Review DEAP & NEAP methodologies to improve BERs accuracy and data quality (e.g., by limiting the use of default value to a very limited number of cases).

2025

1.1.29 Introduce **building renovation passports (BRPs)** to create a long-term renovation strategy for each building and support phased renovation. Ensure these digital BRPs are held within a central property database to support projects aggregation.

Actions to be implemented through the 2020s

1.1.30 Support the deployment of hydrogen within industry to aid decarbonisation where high temperature processes are required, and work with industry to identify feasible options for Carbon Capture and Storage (CCS) and support its development to deal with hard to-abate emissions for which there are no alternative mitigation options.

1.4 Addressing embodied carbon emissions

2023

1.1.31 **Review NSAI certification process (agréments)**, including time and costs, to make it easier and faster for new innovative, low embodied carbon materials, to be placed on the Irish market without lowering standards.

1.1.32 To lead by example in optimising building use, an office scheduling protocol and portal should be developed to optimise public sector office space use.

1.1.33 **Develop and maintain a central database for embodied carbon**, covering both asset and product level, to gather data across the industry, standardise inputs, and help set benchmarks and targets per sector. The construction product database should include product specific EPDs, generic EPDs and defaults for construction products. The building level database should focus on LCA data for new buildings.

2024

1.1.34 Make WLC measurement a requirement for local authorities to secure funding for social housing from the Department of Housing, Local Government and Heritage.

1.1.35 Support the development of **recertification and remanufacturing schemes for reuse**.

2026

1.1.36 Develop **building material passports** to retain information on performance and ingredients to enable building products and materials to be reused in future[24].

1.1.37 Government to support the development of physical and virtual marketplaces (e.g., Materials exchange).

1.1.38 Government to support the development of a database of Buildings As Material Banks (BAMB), including demolitions and refurbishments, creating a (geographical) map of resources suitable for reuse. Examples of these include CMEx and Madaster.com.

2030

1.1.39 BER certificate and Building Renovation Passports to be updated to include information on WLC.

NABERS

From asset to performance rating: NABERS – An Australian success story.

The National Australian Built Environment Rating System[25] (NABERS) was launched by the Australian government twenty-five years ago to better understand the energy intensity use of office buildings. Initially operated on a voluntary basis, it became mandatory in 2010. Disclosure is based on actual energy use with up to six stars awarded based on readily understandable benchmarks. Over the past 14 years Australian offices rated using NABERS have achieved savings of 42% and reduced their greenhouse gas emissions by 53%, one of the fastest transformations of buildings globally. The introduction of NABERS has led to a design for performance approach with a very high correlation between the simulated design and post-occupancy performance. The annual disclosure has a normative effect on driving improvement with 5-star ratings required by many portfolio holders. The system is now being extended across a range of building typologies.

2. DEVELOP THE RIGHT REGULATORY FRAMEWORK

2.1 Overarching actions

2023

1.1.40 Set up a government task group to **review all buildings regulations TGDs** and how they can better support the decarbonisation of the built environment across its lifecycle and reflect Ireland's climate objectives. Specific areas and topics to consider include:

a. **TGD B to reflect international research and developments in mass timber construction** and best practice[26].

b. **TGD D, and more specifically the definition of "proper materials"** -section D3 subsection (c), to clarify on alternative technical specification that 'provides in use an equivalent level of safety and suitability' to make it easier and faster for new innovative, low embodied carbon materials, to be placed on the Irish market without lowering standards.

c. **TGD G to integrate water efficiency requirement** for sanitary ware to reduce energy use associated with hot water consumption[27].

d. TGD L in line with 5-year review.

e. **TGD K and M to better support** reuse of existing properties.

1.1.41 Set up a government task group to **review planning regulations** and how they can better support the decarbonisation of the built environment across its lifecycle and reflect Ireland's climate objectives. Specific areas to consider include the list of **"Reasons for the Refusal of Permission which Exclude Compensation"** and **section 10** (Content of development plans) of the Planning and Development Act, 2000.

2024

1.1.42 Update Building Regulations based on the findings of the government task group to ensure they better support Ireland's climate objectives.

1.1.43 Establish a legal framework for a D**igital Building Logbook** and capture this information centrally to gather better quality data on buildings, support aggregation of retrofit projects and reuse of construction materials. These should be introduced alongside **Building Materials Passports** to facilitate reuse and the transition to a circular economy.

2.2 Addressing Operational and Embodied emissions

2023

1.1.44 Publish a **clear implementation pathway** with key dates for regulation of **MEPS** and **Building Renovation Passports** to provide certainty to the industry.

1.1.45 Update the landlord and tenant (amendment) act 1980 to incorporate green clauses as a basic provision to raise energy efficiency and environmental awareness in the industry.

1.1.46 Cut-off date for sales of gas and oil boilers for new homes

1.1.47 Publish a **clear implementation pathway** with key dates for **regulation of EC** to provide certainty to the industry.

1.1.48 Review the implementation of **articles 27 and 28 of the Waste Framework Directive** in Ireland to better support re-use (e.g., review international best practice, explore the opportunity of regulating a new type of waste or demolition contractor role[28]).

In the interim, ensure the **EPA have sufficient resources to process article 27 or 28 applications** quickly and smoothly and the fee for doing so is not prohibitive.

1.1.49 Review existing **licensing process for industrial hemp** production to scale up production and use in construction.

2024

1.1.50 Mandate WLC measurements for all larger buildings (over 2,000m^2)

2026

1.1.51 Mandate WLC measurements for all new buildings and large renovation.

1.1.52 Introduce the **first WLC budgets per m^2 and per capita** for larger buildings (over 2,000m^2).

2027

1.1.53 First level of **MEPS** come into effect

2030

1.1.54 Cut-off date for sales of new gas and oil boilers for all properties

1.1.55 Tighten up WLC budgets per m^2 and per capita

2035

1.1.56 Second MEPS comes into force, integrating WLC

2040

1.1.57 Review WLC budgets per m^2 and per capita

2042

1.1.58 Third MEPS coming into force

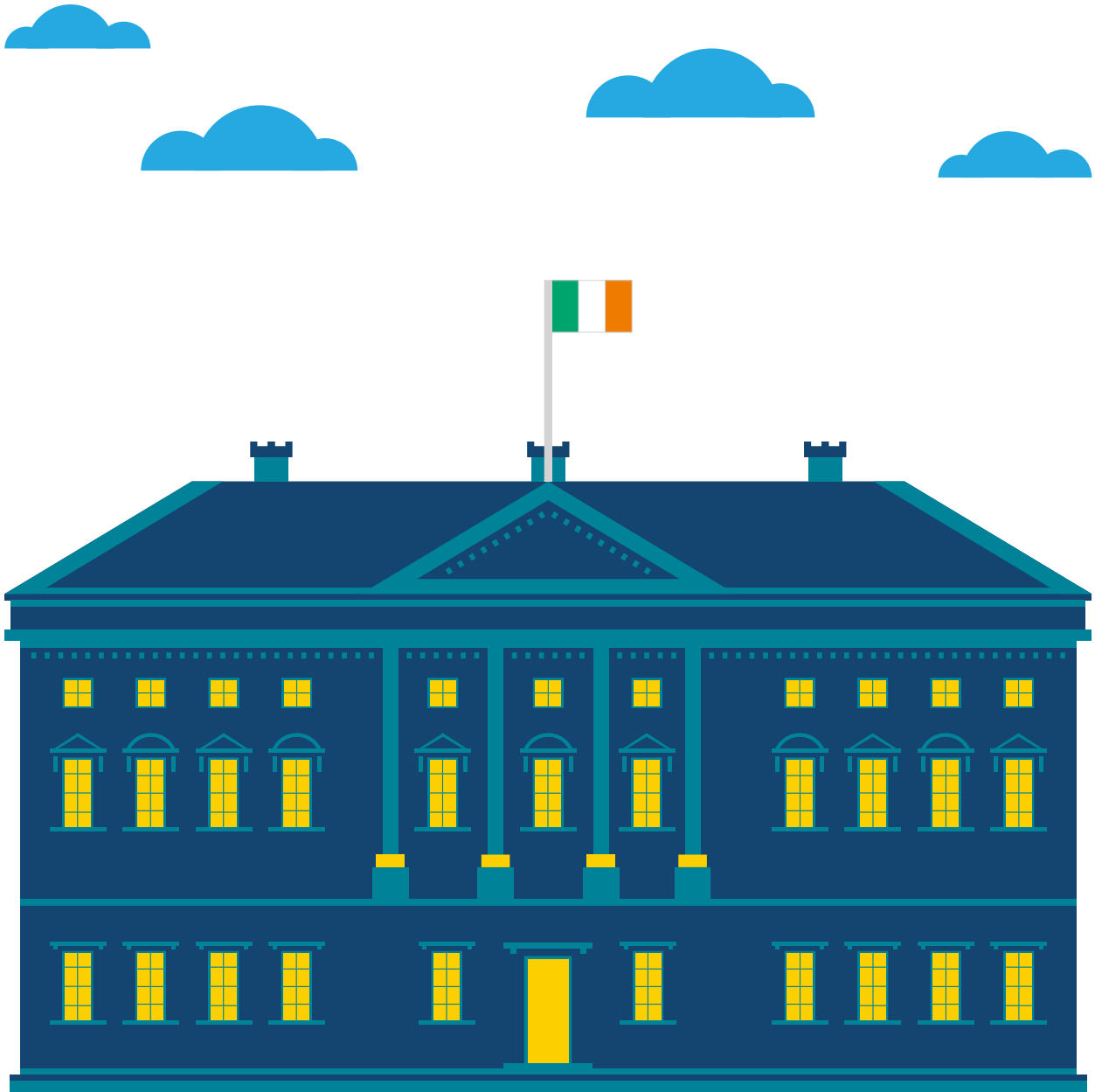
2045

1.1.59 Review WLC budgets per m^2 and per capita to reach Net Zero by 2050

1.1.60 The **national carbon offsetting scheme is phased out**. All projects must reach net zero without offsetting.

3. INVEST IN BUILDING A ZERO CARBON IRELAND

Public money can go a long way toward supporting a decarbonisation of our built environment, but the money must be spent wisely and leverage private financing. As the recommendations presented here are for policymakers, this section primarily focuses on public funding, including tax and grants. For further information on actions required on private finance, please see Banks and financial institution section.



3.1 General principles

1.1.60 Ensure all **government's expenditure and fiscal policies are fully aligned with Ireland's 2030 and 2050 Climate targets**.

1.1.61 Ensure sufficient resources are allocated to enforce policies and regulation to fully decarbonised Ireland's built environment.

1.1.62 Review financial support for energy efficiency on a regular basis to ensure it provides additionality and supports a just transition.

1.1.63 Where government invests in buildings, including housing through grant aid or procurement ensure that these **developments adhere to higher sustainability requirements** – e.g., through green building certifications. More specifically, from 2023, public sector should demonstrate alignment with the Taxonomy for all investment in new build and major renovations.

3.2 Grants & tax incentives

2023

1.1.64 **Review existing retrofit grants and tax incentives to ensure they are fully aligned with overall carbon reduction goals, including regeneration objectives**. This would involve taking into account operational emissions, embodied carbon and location-based indicators that impact transport emissions.

1.1.65 **Reform the Free Energy Upgrades scheme to ensure low-income households (e.g., based on P60) living in low BER homes are eligible** – regardless of home ownership status and/or welfare payment eligibility.

1.1.66 **Reduce VAT to 9% on professional services for retrofits**. Too often, homeowners do not all know what to do and where to start in relation to energy renovation. Independent high-quality advice is key, especially to support phased renovation and retrofit of traditionally built buildings.

1.1.67 Introduce reduced or zero VAT rate for all construction products which contribute to the decarbonisation of the building stock in its operational phase, signalling that by 2025, the reduced rate would only apply to products with low embodied carbon as demonstrated by EPDs.

1.1.68 Review grants currently available for renewables and ensure funding is available for a wider range of renewable. E.g., connections to district heating.

1.1.69 Use grants and the Accelerated Capital Allowance (ACA) scheme to encourage the use of the best performing heat pumps in the market (e.g., working with natural refrigerants with global warming potential below 5) to deliver higher climate benefits.

1.1.70 Introduce a capital allowance scheme for small landlords and developers to convert empty/ underused space above the shop to apartments.

1.1.71 Introduce a tax relief for money spent on refurbishing or converting commercial and residential properties in all Irish towns and cities centre.

1.1.72 Provide **financial incentives or directly fund research and production facilities for biobased construction materials** (e.g., CLT, sheep's wool, hemp, mycelium, and straw). E.g., through an accelerator scheme.

1.1.73 **Review SEAI grants criteria for insulation materials** to accept alternative methodologies as per TDG D to encourage best practice and a greater use of biobased construction materials.

1.1.74 Introduce a design and capital grants scheme (similar to SEAI's EXEED programme) for project developers engaged in innovative, measurable low carbon construction.

1.1.75 Increase **financial support for small manufacturers to develop EPDs**, reduce the carbon impact of their products, and to facilitate safety testing and certification of low carbon construction products.

1.1.76 Create a Green Skills Fund to channel low cost, long-term loans to SMEs specifically for investment in formal, sustainability focussed R&D. A similar fund exists in Holland, where the MKB+ (Innovation Fund for SMEs) gives construction firms access to finance to embed innovative new products, services, and processes in their business.

2024

1.1.77 Replace the property tax by a **site value tax** charged on the value of the land to disincentivise under use of properties and sites.

2025

1.1.78 Introduce **reduced or zero VAT rate for low embodied carbon construction products** as demonstrated by EPDs, including biobased and recertified products.

1.1.79 Extend the Accelerated Capital Allowance scheme to renovation products that have at least 50% lower than average GWP in their product category as demonstrated in their EPDs.

2026

1.1.80 All public grants and tax incentives to be fully aligned with the EU Taxonomy.

2030

1.1.81 Ensure financial and technical support is available for the "unable to pay" who have to change their fossil fuel boilers.

3.3 Funding for support actions

2023

1.1.82 Support the development of a **generic database of products and a national WLC assessment methodology**, aligned with the Level(s) framework.

1.1.83 Allocate funding to the development of a **warranty scheme for all SEAI's retrofit programmes** to better protect building owners and increase trust in the process.

1.1.84 Allocate funding for **research initiatives to support Ireland's transition to a fully decarbonise built environment**. More specifically,

a. Increase support for **innovative methods of construction and materials**. E.g., increase funding for Enterprise Ireland's Built to Innovate programme to further support MMC.

b. Research on the **WLC impact of deep and shallow retrofits** on different building typologies in an Irish context. This should then inform research into opportunities to standardise retrofit of Ireland's existing building stock, including the potential for off-site manufacturing of certain elements, the potential to standardise heat pumps, and the potential to use economy of scale to make retrofit cheaper.

c. Research suitability, affordability and efficiency of heat pumps, district heating and solar PVs for different building typologies in Ireland, taking a WLC approach. This would support the development of Guidance on when heat pumps are most appropriate.

d. LCA of traditional vs off-site manufacturing in the built environment in an Irish context to create baseline database.

e. Fund a comprehensive study on the impact on WLC emissions caused by different zoning decisions (e.g., considering ground conditions, carbon sequestration, infrastructure, and parking requirements).

f. Fund pilot projects showcasing alternatives to current methods of construction/retrofit and their benefits (e.g., through the Construction Technology Centre).

2024

1.1.85 Invest in a large-scale **training programme in carbon accounting and WLC assessment for public procurers**.

2025

1.1.86 Allocate funding to develop an independent, accredited Building Level WLC assessor and auditor scheme modelled on the ECO Platform EPD verification process to ensure the quality and repeatability of WLC assessments.

4. RAISE AWARENESS AND MAKE SURE WE HAVE THE RIGHT SKILLS

2023

1.1.87 Run a **large-scale awareness raising campaign** to ensure all citizens understand the benefits and importance of tackling WLC emissions and reusing buildings. The campaign should also address the perception that reused materials and timber frame buildings are of lower quality and may compromise safety.

1.1.88 The Broadcasting Authority of Ireland should extend the Sound and vision scheme – Climate Action Climate action round, and ring fence funding for programmes on the built environment and climate change.

1.1.89 Develop comprehensive policies to facilitate and incentivise energy renovation upskilling of building professionals and construction workers, and to attract more people to the industry. More specifically, run targeted communication campaigns to inspire, recruit and upskill in energy renovation school leavers, those working in declining sectors and construction workers.

1.1.90 Incentivise and support construction companies to take on new apprentices.

1.1.91 Ensure primary, secondary and third level curriculum is infused with environmental education to increase carbon literacy. More specifically, WLC could be covered at secondary school level as part of STEM subjects, construction studies, geography, or home economics.

1.1.92 Explore potential mechanisms to incentivise upskilling in the industry. E.g., Launch a "sustainability pass" similar to "Safe Pass", make "energy efficiency training clauses" the norm in all public contracts and/or place the Construction Industry Register of Ireland (CIRI) on a statutory footing and integrate minimum upskilling requirements in WLC and circularity.

1.1.93 Upskill public bodies in WLC and low carbon materials. More specifically, develop and deliver carbon literacy training programmes for local authorities and regional authorities' staff. These should cover WLC requirement, LCA, low carbon construction and renovation, as well as policy tools and procurement of low carbon products, and circular use of buildings and materials.

1.1.94 Run awareness level training on climate policies, WLC, low carbon solutions and the circular economy for local Councillors.

1.1.95 Develop guidance documents for the industry, including:

a. Guidance for planners and local authorities on the optimal relationship between design, density, building height, land use and infrastructure to minimise WLC emissions.

b. Guidance on the reusability potential for different building typologies, including adaptive reuse of different existing building typologies (e.g., office to residential) and future reuse of new built and building elements. – An interactive construction material pyramid such as the Danish Materiale Pyramiden[29] to allow designers and all key stakeholders to quickly identify construction materials with lower embodied carbon.

6.1.2 LOCAL LEVEL

As highlighted in the Climate Act, the Climate Action Plan and other policies, **local authorities have a key role to play in Ireland's transition to a decarbonised economy**. This role is **not limited to the buildings they own and manage**. Through planning and awareness raising activities (among others), local authorities can **influence county wide emissions**. For these actions to be effective, they must be part of a multi-scale strategy and fully connected with national initiatives. Measures relating to planning and requiring central government action are presented in section 6.1.1. Recommendations presented in this section complement these actions and aim at optimising the use of the existing building stock, and at reducing operational and embodied emissions.

KEY RECOMMENDATIONS

- **Ensure Development Plans and planning policies are fully aligned with national carbon targets.**
- **Where local authorities invest in buildings, ensure that these developments adhere to higher sustainability standards.**
- **Upskill local authorities' staff in carbon literacy.**

1. ENSURE SUPPORTING POLICIES ARE IN PLACE

1.1 Framework & General Policies

1.2.1 **Ensure all local authorities' policies are fully aligned with Ireland's 2030 and 2050 carbon reduction targets**. i.e.,

- Development plans to support a transition to more compact development by encouraging a reduction in form factor leading to lower heat loss and greater material efficiency.
- Development plans to promote higher building density to support more cost-effective and sustainable development of infrastructure (e.g., heat networks and transport infrastructure).

1.2.2 **Track progress towards 2030 and 2050 targets on a regular basis** and make this data widely available to contribute to awareness raising. e.g., using a live dashboard.

– Gather and share comprehensive data on the impact of local authorities' energy renovation programme. E.g., using the Build Upon Energy Renovation Framework.

1.2.3 Liaise with adjacent local authorities to ensure consistency in planning policies, including embodied carbon emissions to avoid buildings being constructed in local authorities with the least strict planning standards.

1.2.4 **Review and adjust planning policies and financial incentives on a regular basis** to ensure they fully support Ireland's carbon emissions reduction objectives.

Low carbon planning typologies – The missing middle

Goldsmith St, the winner of the UK's Stirling award (the UK's most prestigious award for architecture) is an example of what is known as the missing middle, low rise 2-3 stories higher density development with **82 units to the hectare**. The houses are certified to the Passive house standard, facilitated by reduced form factor of the row house typology and orientation.

It maximises solar access and lends itself to cost effective minimisation of heat loss and embodied carbon by minimising external walls. The timber frame was supplied by Irish manufacturer Cgynum and insulated with low carbon cellulose insulation from recycled newspaper. The density is facilitated by reduced parking, carriageway widths and opposing distances. The scheme would generally not be possible in most local authorities in Ireland due to development planning standards resulting in densities as low as 35 units per hectare.

1.2 Publicly funded projects

2023

1.2.5 Require a full assessment of the carbon impact of all projects included in local Development Plans across their life cycle and start prioritising where necessary.

2024

1.2.6 **Mandate the use of GPP for all public notices published for procuring buildings and renovations** – including social housing, and more specifically, the Level(s) indicators 1.2 – WLC, 2.3 – Design for adaptability and renovation, 2.4 – Design for deconstruction, reuse and recycling and 6.1 – Life Cycle Costing.

1.3 Addressing operational emissions

2023

1.2.7 Develop and implement local-level energy plans with clear pathways and long-term commitments to a low-carbon future.

1.2.8 Liaise with building users from the very beginning of any renovation works and ensure the handover process forms an integral part of all retrofits, with users receiving clear and reliable information about the building, particularly for new, less familiar technologies.

2024

1.2.9 Implement evidence-based zoning for district heating based on (1.1.84e) and requirements for buildings in these areas

1.4 Addressing embodied carbon emissions

2023

1.2.10 Request pre-demolition assessments, presenting the environmental and economic case for repair or replacement. In cases where demolition is an appropriate course of action, request waste audits conducted by external auditors ahead of demolition to further support the mitigation of Construction & Development Waste (CDW).

1.2.11 To lead by example in optimising building use, an office scheduling protocol and portal should be developed to optimise local authorities' office space use.

2025

1.2.12 Support the development of **physical and virtual marketplaces** (e.g., Materials exchange).

2. INVEST IN BUILDING ZERO CARBON IRELAND

2.1 General principles

1.2.13 Ensure all local authorities' expenditure and fiscal policies are fully aligned with Ireland's 2030 and 2050 Climate targets. A first step is to review existing policies and financing mechanisms to ensure they are aligned with overall carbon reduction goals, including regeneration objectives. This would involve taking into account actual operational emissions, embodied carbon and location-based indicators that impact transport emissions.

1.2.14 **Ensure sufficient funding is allocated to enforce climate policies and building control**.

1.2.15 **Where local authorities invest in buildings, ensure that these developments adhere to higher sustainability requirements** – e.g., through green building certifications.

1.2.16 More specifically, from 2023, local authorities should demonstrate **alignment with the Taxonomy for all investment in new build and major renovations**.

2.2 Green Public Procurement

1.2.17 Use GPP to support innovation and build capacity within industry to decarbonise Ireland's built environment. More specifically, use the Level(s) macro-objectives, including WLC (Level(s) indicator 1.2), Design for adaptability and renovation (Level(s) 2.3), Design for deconstruction, reuse and recycling (Level(s) 2.4), and Life Cycle Costing (Level(s) 6.1) for all procured buildings and renovations – including social housing.

2.3 Fiscal policies

1.2.18 Introduce **financial incentives to support reuse and low carbon developments**. This may include increasing levies on vacant properties, applying an additional planning levy (or increased rates) to new construction where major demolition is involved, or reducing planning levies for buildings of low carbon intensity (i.e., with 3rd party validated low carbon intensity as defined by benchmarks in RIAI climate challenge).

3. SUPPORTING ACTIONS

2023

1.2.19 Get involved in pilot projects to support the decarbonisation of the built environment, e.g., CTCHC programme or housing condition surveys.

1.2.20 **Use the Decarbonising Zones to support innovation and capacity building, through low WLC innovative projects**.

1.2.21 Review the impact on WLC emissions caused by different zoning decisions (e.g., considering ground conditions, carbon sequestration, infrastructure, and parking requirements), so that it can be considered as part of zoning and planning permission decisions.

2025

1.2.22 Develop Urban Metabolism (Buildings As Material Banks) mapping for all non-protected buildings as already implemented in several Dutch cities. Urban metabolism (describing and analysing material flows using digital technologies such as GIS, BIM and databases of digital logbooks, materials passports and EPDs) is an important pillar in working towards a decarbonised built environment.

2026

1.2.23 Support the development of a database of Buildings As Material Banks (BAMB), including demolitions and refurbishments, creating a (geographical) map of resources suitable for reuse. Examples of these include CMEx and Madaster.com.

4. RAISE AWARENESS AND ENSURE WE HAVE THE RIGHT SKILLS

2023

1.2.24 **Run awareness raising campaigns to ensure all citizens understand the benefits and importance of tackling WLC emissions and reusing buildings**. The work could involve organising "open house" type events to showcase low carbon buildings, working in close cooperation with libraries, etc.

1.2.25 **Use "energy efficiency training clauses" as part of all publicly funded projects to incentivise upskilling**[30].

1.2.26 **Increase inhouse expertise through training in carbon literacy**, circularity and green public procurement to support implementation of the roadmap. Training programmes should cover WLC requirement, LCA, low carbon construction and renovation, as well as policy tools and procurement of low carbon products and circular use of buildings and materials.

1.2.27 Run awareness level training on climate policies, WLC, low carbon solutions and the circular economy for local Councillors

6.2 EDUCATORS AND AWARENESS RAISERS

Behaviour change and public acceptance will be critical to reaching our climate targets. While the benefits of energy efficiency are now largely understood and accepted, delivering this roadmap will be challenging as it requires re-evaluating expectations of constant growth in new construction and how we build. Besides extensive communication activities to raise awareness among the general public, the lack of skills at all levels of the supply chain also needs to be addressed. Tackling WLC challenges the industry to do much more with less and to start on a decade of innovation and change. The media, our education system and construction bodies all have a role to play in supporting this transition.

6.2.1 Media, influencers and NGOs

Actions presented in this section should be supported by construction bodies – see 6.2.3.

2023

2.1.1 Run **large-scale awareness raising campaigns to ensure all citizens understand the benefits and importance of tackling WLC emissions and reusing buildings**. The campaign should address the perceptions around reused materials and materials such as timber frame buildings being of lower quality as per the proposed actions in the DAFM forestry strategy. To reach a wider audience, the campaign should be run in cooperation with banks, professional bodies, hardware stores and homeowner associations.

2.1.2 The Broadcasting Authority of Ireland's Sound and Vision funding should continue as per call 44 of 2022, to support programme makers focusing on climate action, with additional emphasis on the climate whole life impact of the broader built environment and not only homes and operational energy.

2.1.3 Run an awareness programme for local Councillors on the WLC impact of buildings and the need to integrate it within Development Plans.

6.2.2 Primary, secondary, and tertiary education

This section should be read in conjunction with the recommendations for construction bodies below 6.2.3.

2023

2.2.1 **Ensure primary, secondary and third level curriculum is infused with environmental education** to increase carbon literacy and understanding of resource constraints. More specifically, WLC could be covered at secondary school level as part of STEM subjects, construction studies, geography, or home economics.

2.2.2 Third level institutions to engage with construction bodies to **ensure key WLC skills are covered in their programmes**.

2.2.3 To facilitate upskilling of those already working in industry, all education providers must ensure their **training programmes are flexible, affordable, and widely available. In particular, they should be available online, in blended format or onsite**.

2024

2.2.4 Complete a full review of construction and built environment degrees, as well as apprenticeship to ensure key WLC skills are fully covered.

2.2.5 ETBs to develop and run training courses covering key WLC skills identified and support upskilling of construction workers.

2.2.6 Higher education providers to develop training courses to cover key WLC skills identified.

2030's – 2040s'

2.2.7 Construction and built environment degrees, as well as apprenticeships will need to be reviewed on a regular basis to 2050 to ensure curricula and mode of delivery keep pace with technology development and market needs.

6.2.3 Construction bodies

Construction bodies have a powerful role to play in raising awareness among their members and upskilling them. These actions should be read in conjunction with action plans for relevant professional discipline and with actions for education bodies – 6.2.2.

Key Actions

- **Run an awareness campaign to their own members on WLC setting out the urgency of acting and imminence of legislation for disclosure.**
- **Engage with third level institutions to ensure that third level curriculum for their future member is aligning with decarbonisation objectives.**
- **Develop, deliver, and encourage uptake of WLC training courses.**

2023

2.3.1 Support public awareness campaigns (6.2.1) around the need for decarbonisation across the full life cycle of buildings.

2.3.2 Run an awareness campaign to their own members on WLC, Level(s) Indicator 1.2 and EN15978 setting out urgency of acting and imminence of legislation for disclosure.

2.3.3 Identify key skills their members need to decarbonise Ireland's built environment across its life cycle. Although many are profession specific, these will include energy efficiency, use of renewable energy for heat and power production, site suitability assessment, carbon budgeting, LCC, application of measurable circularity to construction, digital solutions for modern buildings, timber techniques, MMC and POE, as well as soft skills (e.g., communication for retrofit advisors) and cross-sectoral cooperation. The construction and property development industry (including property valuers and estate agents) must also be aware of the needs and expectations of the financial sector in relation to WLC, including sustainable financial policy and financial regulatory developments that will drive financial institutions in coming years. This work should be supported by the National Centre of Excellence, the Construction Technology Centre, education providers and professional bodies.

2.3.4 Engage with third level institutions to ensure that third level curriculum for their future member is aligning with environmental education to increase carbon literacy. More specifically, WLC and circularity should be covered.

2.3.5 Encourage members to engage in with existing initiatives such as the Build Up Skills Advisor App and DASBE which are being developed to make it easier for building professionals and construction workers to identify training courses that suit their needs and offer short courses in a flexible and affordable way.

2.3.6 All institutes with annual CPD requirements introduce mandatory minimum requirement for members to engage in upskilling in carbon literacy.

2025

2.3.7 Have reviewed accreditation of relevant degrees and training courses and made future accreditation conditional upon alignment to key sustainability skills identified.

2.3.8 Those with professional practice entry exams ensure that competence on integrating low carbon strategies in practice is included as part of the professional exam criteria.

2030

2.3.9 All construction bodies have ensured that their members have the right level of carbon expertise for their role and continue to review the curricula of 3rd level institutes and apprenticeships.

6.3 BANKS AND FINANCIAL INSTITUTIONS

As we transition to a low carbon, circular economy, financial institutions are increasingly focussed on financial risks associated with the decarbonisation of the built environment. Key drivers of this agenda include pressure from shareholders, increasing evidence of the financial materiality of climate risk, market demand for green buildings and opportunity in the real estate sector, as well as the push from policymakers, in particular the EU, to steer capital towards greener economic activities, and the increasing focus of financial regulators on climate-related financial risk[31].

Key actions

- **Train staff in carbon literacy and the key issues within the built environment impacting carbon emissions.**
- **Ensure that lending supports homeowners to decarbonise their homes and home buyers to purchase the most sustainable homes.**
- **Set a timeline to only fund net zero carbon development and buildings.**

2023

3.1.1 **Train staff in key indicators of the built environment that impact carbon emissions**, including operational carbon, whole life carbon, transport emissions and resource use to be able to advise customers.

3.1.2 Develop incentives and supports for homeowners and small landlords to encourage retrofits. E.g., **low interest rates < 2% on green loans and mortgage top-ups**.

3.1.3 Make residential mortgages and retrofit top up more accessible to applicants who wish to purchase commercial properties for conversion to residential as part of bringing vacant space back into use.

3.1.4 Encourage landlords to develop a Building Renovation Passport for each asset to achieve Net Zero operational emissions.

3.1.5 Engage with public finance providers (national and EU) on risk-sharing and credit guarantee mechanisms to reduce the financing cost for property owners on buildings that have low or Net Zero WLC.

3.1.6 Financial institutions should commence measuring and disclosing the operational carbon emissions and embodied carbon of all properties (owned and financed) through annual reporting.

3.1.7 As building owners, financial institutions should set a science-based decarbonisation trajectory for each asset and require this to be done for buildings they have lent against. This could be done through using the Carbon Risk Real Estate Monitor tool (CRREM), an EU-funded building-level tool to manage stranding risk and renovation strategy.

3.1.8 Financial institutions should begin to report in line with the Task Force on Climate-related Financial Disclosures (TCFD) recommendations, in preparation for mandatory TCFD reporting requirements, and should consider how the analysis and approach influences future real estate portfolio strategies.

3.1.9 The Central Bank of Ireland (CBI) should introduce supervisory expectations with regards to climate risk management of real estate assets. It should state that it expects financial institutions to measure and disclose operational and embodied carbon emissions of all properties, reported in line with the TCFD. The CBI should also set a science-based decarbonisation trajectory for each asset.

2025

3.1.10 Have introduced new discounted green finance products that incentivise the purchase and renovation of existing vacant buildings to support regeneration within existing towns, cities and villages.

3.1.11 Have introduced preferential incremental discounted green mortgages for new homes based on additional criteria such as WLC, transport accessibility and land use. These should be aligned with the EU taxonomy, and with higher discounts for Net Zero carbon.

3.1.12 Include net zero operational energy performance and embodied carbon targets in financing/project development criteria and verify them through due diligence and should be aligned with national and EU climate targets.

3.1.13 As part of non-residential retrofit project funding, lenders should require and verify that all property owners evaluate and minimise embodied carbon in retrofit and renovation works through WLC assessment.

3.1.14 Have developed criteria and thresholds to quantify carbon emissions of residential and commercial development based on operational, embodied emissions, and location impact.

3.1.15 Always require valuers to integrate sustainability aspects into market appraisal and risk rating including issues such as adaptability, design for disassembly, and life cycle costs. This will require valuers to upskill in WLC and costs appraisal – see 6.2.3.

2030

3.1.16 Have ceased lending to the most carbon intensive new development based on maximum thresholds of total combined carbon footprint of operational, embodied emissions, and transport emissions.

3.1.17 Review their lending policies to ensure:

a) they are successful in driving ambition of developers and homebuyers towards Net Zero Carbon development and driving innovation in the circular economy and low carbon construction.

b) they have been successful in supporting Government policy on regenerating village, town and city centres by bringing back vacant space and creating additional homes.

2035

3.1.18 Lending policy reviewed again based on revised carbon intensity thresholds and ensure that it continues to drive the circular economy.

6.4 PROPERTY AND CONSTRUCTION INDUSTRY

Multiple stakeholders are involved across the full lifecycle of the built environment from planning, design, construction, to occupation/use, maintenance, repair and ultimately demolition. Each group has a distinct role to play. Roadmaps are set out for each sector.

6.4.1 Building owners and investors

Key actions

- **Disclose operational energy and carbon on all assets.**
- **Develop a decarbonisation strategy for all held assets.**
- **Develop Building Renovation Passports for each asset.**

2023

4.1.1 **Provide training to staff on carbon literacy**, ESG reporting and disclosure.

4.1.2 All larger building portfolios begin to disclose the operational energy and carbon performance of all held properties (at asset level) across their portfolios (funds) in annual reporting.

4.1.3 **Start to request Building Renovation Passports** (BRPs) for all their assets setting out a roadmap to decarbonise each asset.

4.1.4 Large building owners with rental properties use green leases to reduce operational and embodied carbon emissions.

4.1.5 **All institutional investors set WLC targets within project funding criteria for developers in line with the EU taxonomy**.

4.1.6 Irish property owners who have signed up to the Net-Zero Asset Owner Alliance[32] to use their leadership position to advocate for all other institutional property owners nationally to do so too.

2025

4.1.7 **Disclose the operational energy and carbon performance of all held properties** (at asset level) across their portfolios (funds) in annual reporting.

4.1.8 Have BRPs for each asset and have started to implement these. All works are recorded in digital logbooks.

2030

4.1.9 **Have made significant progress in reducing emissions across their portfolio by at least 50%**.

2050

4.1.10 **Have achieved Net Zero Carbon for all their assets**.

6.4.2 Developers

Developers can drive the transition to zero carbon buildings by the targets they set for the design team.

Key actions

- **Require a design for performance approach for all projects and set targets for Whole life Carbon.**
- **Invest in innovation ensuring that at least a percentage of new buildings integrate innovative construction products and processes.**
- **All new projects are fossil free and start to target Net Zero carbon.**

2023

4.2.1 **Provide carbon literacy training to all their staff**.

4.2.2 **Request a Design for Performance approach** from design teams and contractors and seek to include contractual targets where possible.

4.2.3 Integrate training clauses for contractors and sub-contractors to upskill their onsite personnel including sub-contractors in low energy construction skills.

4.2.4 Start to **plan the first Net Zero Carbon projects** and ensure that all their developments are fossil fuel free.

4.2.5 **Include targets for embodied carbon and material reuse alongside operational energy intensity targets** in project briefs using benchmarks such as RIAI climate challenge.

4.2.6 Require the design team to **develop an overall circularity concept for projects**; design for adaptability, disassembly and re-use and set a target for a percentage of reused and recycled products in designs.

4.2.7 Drive demand for EPDs by **requiring that increasing percentages of products used in new and renovation projects have EPDs**.

4.2.8 Start to develop a strategy on innovation to reach net zero to ensure this is integrated in future projects.

4.2.9 Allow for **post occupancy evaluation of completed developments** to ensure lessons learnt are passed back to design team.

4.2.10 Ensure that fees are adequate to cover any increased scope of works for design team.

2025

4.2.11 **All new buildings are being designed to meet Net Zero Carbon**, meeting strict operational and embodied carbon limits such as the RIAI climate challenge.

4.2.12 Ensure that a minimum percentage of projects are trialling new innovative construction techniques, products, and processes.

2030

4.2.13 **All new buildings on completion are achieving Net Zero Whole life Carbon** with at minimum a 50% cut in upfront embodied carbon.

4.2.14 All new buildings are incorporating high levels of reused and recycled products.

6.4.3 Product manufacturers and suppliers

Product manufacturers and suppliers are critical to the decarbonisation of construction as materials and products can represent more than 80% of the embodied carbon of construction.

Key Actions

- **Develop EPD for products.**
- **Develop a roadmap to zero carbon products.**
- **Should consider developments at EU level, including the Eco-design for sustainable products regulation and plan for circular business models.**

2023

4.3.1 All Irish producers:

a. **Access support from Enterprise Ireland to develop LCA for their main construction product lines and publish EPD**.

b. Analyse the LCA to **produce carbon reduction action plans** for their products and operations. This should involve immediate goals for optimising the production process (reducing materials and energy use) and using renewable energy wherever possible, as well as investing in research into alternative solutions with aim of achieving net zero carbon production.

c. Action plan considers the EU Eco-design for sustainable products regulation, and **integrate principles of the circular economy**, i.e., adopting new circular business models, supporting repair, reuse, take back schemes and recyclability of products

d. Complies at minimum with EU taxonomy regulations on Pollution Prevention and control 'Do no significant harm' and provide clear 3rd party verified disclosure documentation to confirm to specifiers and investors.

4.3.2 Suppliers of imported construction products have requested EPD from the international producers or suppliers.

4.3.3 Main material suppliers to develop a strategy with producers to progressively reduce carbon emissions from the transport of goods to sites (A4 module) to **achieve zero carbon logistics by 2035**.

2025

4.3.4 Irish producers have published **EPDs for all construction products** apart from minor lines or bespoke products.

4.3.5 Producers have made significant progress in implementing the carbon action plan for the main product lines, targeting initial reductions of between 20–25%; and are **engaging in significant research to achieve more radical reductions**, including through alternative new low carbon production processes.

4.3.6 Where appropriate producers should **explore the potential of the local bio economy** to develop new product lines or new circular business models such as product as a service.

4.3.7 Suppliers aim to ensure that at least 50% of their imported products have EPD.

2030

4.3.8 All Irish producers of construction products have updated EPD reflecting deep cuts in carbon, with a minimum 50% reduction in GWP for their product. All have initiated the final phase of their strategy to achieve zero emissions products and accelerated work on achieving circularity.

4.3.9 Irish producers have brought innovative low carbon construction techniques and solutions to market.

4.3.10 Suppliers have EPDs for all imported products.

2035

4.3.11 Producers and suppliers have achieved significant progress towards goal of net zero carbon and fully circular products.

4.3.12 Suppliers have achieved net zero carbon emissions for transport of products from their manufacturing location (EN 15978 A4 module).

2045

4.3.13 All products are net zero carbon and designed to enter fully closed circular technical or biological loops.

6.4.4 Planners

Planners advise at a larger scale on zoning and development and must be aware of the climate impact implications of different typologies, densities, orientation and approaches to development.

Key Actions

- **Integrate climate impact as a key consideration of all development.**
- **Upskill in WLC and understand the relationship between density, infrastructure, layout, orientation, on operational and embodied carbon emissions.**

2023

4.4.1 Start to develop skills and carbon literacy, to understand how development typologies and required infrastructure impacts operational and embodied carbon. This can include issues such as form factor, orientation, solar access for renewables, density, height, layout, awareness of impact of ground conditions on carbon emissions, as well as awareness of the relationship between EC of infrastructure and density.

4.4.2 Have **awareness of whole life carbon**, and more specifically of Level(s) indicator 1.2 and EN15978. Are able to interpret LCA reports.

4.4.3 Start to understand the principles of circularity in design including:

- Optimisation of adaptability and repurposing in future,
- Ease of maintenance, upgrade, and access,
- Ease of disassembly and reuse of elements,
- Resource minimisation.

2025

4.4.4 Have developed competency and understanding on all the impacts of development typologies and carbon emissions.

2030

4.4.5 Detailed carbon literacy of how to plan best practice low carbon development backed by evidence accounting for whole life carbon of buildings and infrastructure.

6.4.5 Design Professionals

A collaborative, integrated design process involving the building owner, occupant (where possible), various disciplines of the design team, architect, structural engineer, mechanical and electrical engineer, contractor and facilities management team is needed to optimise design and actual performance outcomes.

Each member of the design team brings specific skills which are essential to decarbonisation of buildings across their life cycle.

6.4.5.1 Architects

Architects make the key initial concept design decisions where shape, form, grid design and orientation have greatest potential to influence operational and embodied carbon emissions. They influence the specification of all the materials used in the building and can hence drive the market towards lower carbon materials.

Key actions

- **Upskill now in whole life carbon and circularity.**
- **Design for performance and sign up to RIAI climate challenge.**
- **Be an advocate for renovation and adaptive reuse.**

2023

Upskill

4.5.1.1 Start to **develop skills and awareness of whole life carbon**, and more specifically of Level(s) indicators 1.2 and EN15978.

4.5.1.2 **Understand the impact of design decisions on embodied carbon** including form factor and simplify designs to reduce structural requirements, e.g., by reducing spans, use of regular grids and eliminating large cantilevers working in close collaboration with the structural engineer.

4.5.1.3 **Start to understand the principles of circularity in design** and take a structured approach in line with Level(s) indicators 2.1, 2.2, 2.3 and 2.4.

- optimise adaptability and repurposing in future,
- ease of maintenance, upgrade, and access,
- ease of disassembly and reuse of elements.

Design

4.5.1.4 **Design to demanding energy intensity targets such as 2030 RIAI climate challenge** and understand impact of design decisions on operational carbon including form factor and orientation.

4.5.1.5 Use tools such as the Soft Landings Framework to reduce the performance gap.

4.5.1.6 **Adopt the use of early design tools such as** Carbon Designer for Ireland at early design stages to optioneer and explore potential embodied carbon savings and carbon sequestration opportunities, and be able to quantify embodied carbon to clients.

4.5.1.7 Adopt Building Information Modelling (BIM) to support greater efficiency and reduction in material usage and waste.

4.5.1.8 **Adopt design approaches suitable for Modern Methods of Construction (MMC)**.

4.5.1.9 **Specify construction materials with EPD** to EN15804 and with low embodied carbon to drive demand.

Advocate

4.5.1.10 **Advocate for reuse of existing structures and adaptive re-purposing instead of demolition**.

4.5.1.11 Advise domestic clients of the total carbon impact of larger homes and advocate for much greater overall embodied carbon reduction in line with RIAI climate challenge for homes in excess of 133m^2.

2025

4.5.1.12 **Have developed high levels of competence in carbon measurement to Level(s) indicators 1.2 and EN15978**.

4.5.1.13 **Commit to meeting the RIAI climate challenge by 2030 with all projects at design stage**.

4.5.1.14 Are integrating the principles of circularity into design and advise client, providing circularity statements as standard for larger projects and advocate for reused materials.

2030

4.5.1.15 **All completed building meeting RIAI Climate Challenge target as proven by Post Occupancy Evaluation (POE)**.

4.5.1.16 Have very high levels of carbon literacy, directly informing design from concept through to completion with calculated evidence.

4.5.1.17 Are integrating reused structures, components and materials as standard in their designs.

6.4.5.2 Structural Engineers

Structural Engineers design the elements of the building with the greatest embodied carbon impact so high levels of competence in understanding where reductions can be made are vital to address whole life carbon.

Key actions

- **Be able to calculate the carbon impact of different structural options.**
- **Optimise structure and material use and always propose low carbon options.**

2023

4.5.2.1 **Start to develop skills and awareness of whole life carbon, and more specifically of Level(s) indicators 1.2 and EN15978**.

4.5.2.2 **Can advise based on site ground bearing conditions** and the potential to optimise foundations to reduce embodied carbon.

4.5.2.3 **Understand the impact of structure on embodied carbon and work in close collaboration with the architect** at early design stage to advise on strategy to reduce embodied carbon from structure and foundations, e.g., reducing mass, reducing design loads, simplifying designs, optimisation of spans and grids.

4.5.2.4 **Reduce cement in concrete** by specifying the minimum needed for sufficiency and substituting wherever feasible.

4.5.2.5 S**tart to understand and integrate principles of circularity** in structures considering potential for disassembly and reuse of structural elements.

4.5.2.6 Advise on reuse of existing building structures where possible.

2025

4.5.2.7 Have developed high levels of competency in embodied carbon to EN 15978.

4.5.2.8 **Always propose innovative low carbon structural solutions and integrate structural optimisations as standard**.

4.5.2.9 **Are able to calculate the comparative embodied carbon impact of different low carbon structural options and present these at the early design stages onwards**.

4.5.2.10 Are competent to work on innovative MMC, e.g., CLT structures.

2030

4.5.2.11 Integrate design for disassembly into structural elements and consider use of reused structural elements into new buildings, including structural steel or recertified reused hollow core slabs.

4.5.2.12 Are able to work on innovative low carbon structures such as MMC as standard.

6.4.5.3 Mechanical and Electrical Engineers

Mechanical and Electrical Engineers bring key science and engineering skills to advise on optimisation of early design and for designing systems to reduce operational emissions.

Key actions

- **Design for performance - not just compliance.**
- **Always work in integrated way with design team from concept.**
- **Work to improve and share energy intensity limits of different building types.**

2023

4.5.3.1 **Adopt a design for performance approach** rather than just for compliance, including use of simulation software and detailed methodologies for accurately simulating operational energy use.

4.5.3.2 **Develop, improve and share data on energy intensity limits such as the RIAI climate challenge**. Work with their institutes (ACEI, ASHRAE, CIBSE and Engineers Ireland) to improve the benchmarks for different sectors.

4.5.3.3 Work at earliest possible stage in close collaboration with the architect and other design team professionals to ensure opportunities to reduce energy intensity are not missed.

4.5.3.4 Consult owners and where possible, facility managers and users during the design stages to ascertain their requirements and provide them with appropriate information on how to use the building in the way it was designed to be used after handover.

4.5.3.5 **Use tools such as the Soft Landings Framework as part of the design process to reduce the performance gap**.

4.5.3.6 Start to develop skills and awareness of whole life carbon, and more specifically of Level(s) indicators 1.2 and EN15978 and impact of mechanical and electrical equipment.

2025

4.5.3.7 **Are working to energy intensity limits on all renovation and new build projects**.

2030

4.5.3.8 **Have eliminated the performance gap through POE and design for performance**.

6.4.5.4 Quantity Surveyors

Quantity Surveyors have the skills to extend cost accounting to carbon accounting and ensuring that full life cycle costs are taken into account.

Key actions

- **Upskill in Whole Life Carbon and carry out Bills of Quantity measurement and carbon accounting to ICMS 3**
- **Upskill in and carry out life cycle costing on projects.**
- **Always advise on impact of value engineering on operational and embodied carbon.**

2023

4.5.4.1 **Develop skills and awareness of Whole Life Carbon**, including Level(s) indicators 1.2 and EN15978.

4.5.4.2 Start to develop Bills of Quantity to ICMS 3 to facilitate comparability and ease of measurement to EN15978.

4.5.4.3 **Are aware of how to carry out Life Cycle Costing** to Level(s) indicator 6.1 and can advise clients on life cycle costs.

2025

4.5.4.4 **Have highly developed skills in carbon accounting to ICMS 3**

4.5.4.5 **Can carry out Life Cycle Costing on all projects**

4.5.4.6 Ensure Carbon reduction is always prioritised as part of value engineering when advising clients.

2030

4.5.5.7 **Carbon accounting is on an equal footing with costing when advising clients**.

6.4.5.5 Valuers

Valuers must play a role in ensuring that the value of low carbon construction is accounted for and not just the costs.

Key actions – Valuers

- **Upskill in impact of Life Cycle Costs on valuation.**
- **Always assess climate risk as part of valuation.**

2023

4.5.5.1 **Develop carbon literacy and awareness of how climate change and associated legislation will impact the valuation of properties**.

4.5.5.2 **Are aware of the Level(s) framework** and indicator 6.2.

4.5.5.3 **Start to integrate sustainability aspects into market value appraisal and risk rating processes**.

2025

4.5.5.4 **As standard, integrate sustainability aspects into market appraisal and risk rating into valuations including issues such as design for adaptability, design for disassembly and life cycle costs**.

2030

4.5.5.5 By this stage climate risk should be central to valuation and valuers continue to upskill to integrate additional climate risks and legislation into valuation.

6.4.6 Contractors

Contractors play a key role in the transition to zero carbon buildings, with the expertise to advise at design stage on new low carbon forms of construction and processes.

Key actions

- **Upskill all site personnel in low energy construction.**
- **Invest in innovation and low carbon methods of construction, including MMC.**
- **Improve carbon reporting from site activities and develop a strategy for zero carbon sites.**

2023

4.6.1 Have a strategy in place to ensure a**ll site personnel including subcontractors are upskilled in low energy construction**.

4.6.2 **Are aware of whole life carbon, EN 15978 standard and targets set by client and agree to meet or exceed**.

4.6.3 **Engage proactively with the design team and sub-contractors to propose optimisations of construction and lower carbon options**.

4.6.4 **Engage with subcontractors and design teams to drive the adoption of low carbon MMC**.

4.6.5 **Drive demand for EPDs** by requiring that increasing percentages of products used in new projects have them.

4.6.6 **Start to measure the carbon footprint of the construction process and share this with Irish industry bodies** to develop more accurate benchmarks for A5 module.

4.6.7 **Develop a roadmap for transition to fossil free zero carbon construction sites by 2035**.

4.6.8 **Tier 1 & 2 contractors start to engage on innovation and Construction Technology Centre**.

2025

4.6.9 **All site personnel have upskilled in low energy construction** and training is a condition for employment of subcontractors.

4.6.10 **All contractors are measuring the carbon footprint of the construction process and have started to implement strategies for decarbonisation**.

4.6.11 Have ensured minimisation of waste on site collaborating with suppliers on take back schemes and circular business models.

4.6.12 All tier 1 and tier 2 contractors are implementing innovative low carbon construction and developing their capabilities to deliver MMC.

2030

4.6.13 **All contractors are delivering low carbon MMC at scale**.

4.6.14 All contractors are achieving 95% waste diversion from landfill and incineration.

2035

4.6.15 **All construction sites are fossil fuel free**

6.4.7 Facility Managers

Facility managers play one of the most important roles in the decarbonisation of buildings. They can optimise performance, ensure that information on actual performance feeds back into the design and renovation of buildings, and inform investment strategies for decarbonisation of assets.

Key actions

- **Establish systems for energy use reporting and disclosure**
- **Engage with the users and tenants to understand and optimise the systems within the building.**
- **Engage with owner on developing Building Renovation Passports**
- **Understand the full life cycle impacts of maintenance.**

2023

4.7.1 **Have set up systems for reporting energy use** including data on variables such as occupancy rates and hours of use and are disclosing it to the building owner.

4.7.2 Engage with the designers and contractor at all stages, including handover stage of new or renovated buildings to ensure that measured operational energy emissions are in line with target set at the design stage, and optimise building management processes as necessary.

4.7.3 **Have made themselves aware of the full lifecycle impact of repair and replacement elements**. Consider quality, longevity, re-use and recycle potential when selecting components.

4.7.4 **Consider 'product as a service' for high energy or frequently replaced elements such as lighting, carpets, and furniture**. This shifts the onus of efficiency from the customer to the provider and enables the repair and service economy.

2025

4.7.5 **Are reporting energy use data each year in a consistent way to the building owner for disclosure and allowing benchmarking against other buildings**.

4.7.6 Develop with the building owner and design professionals a Building Renovation Passport to enable staged improvements of services and fabric to achieve Net Zero carbon operation.

4.7.7 Have implemented a strategy to reduce the embodied impacts of repair and maintenance.

2030

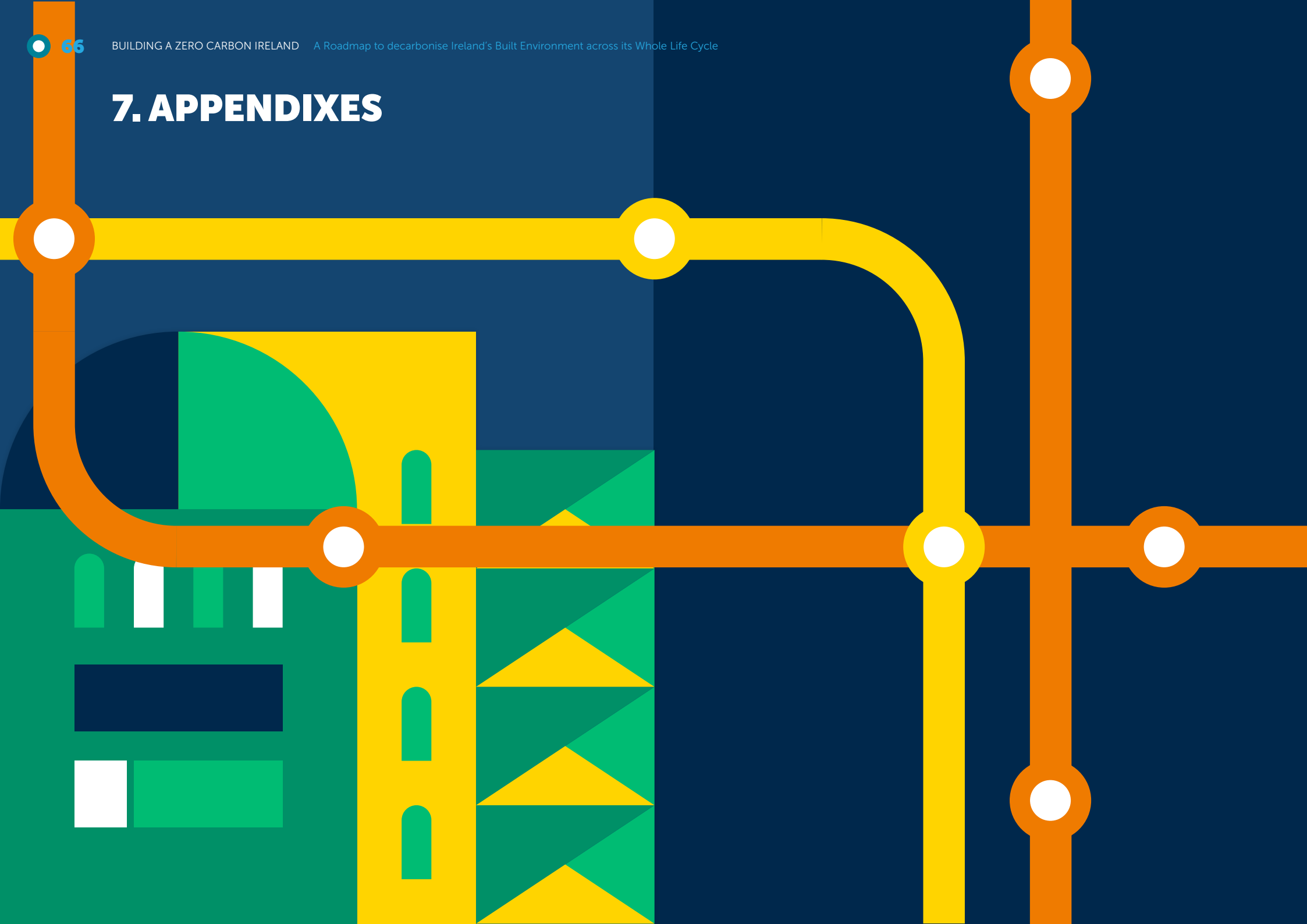
4.7.8 **Have made considerable progress in implementing building renovation passport and are recording all reduction measure in a digital logbook**. A 50% cut in operational carbon emissions from existing buildings is achieved at minimum.

4.7.9 Are recording, reporting, and reducing ongoing embodied impact of repair and maintenance.

2040

4.7.10 **Are operating all their buildings at net zero carbon**.

7. APPENDIXES



ABOUT THE PROCESS

Overview of the engagement process

Kick-off

Desk research – Briefing Papers

March

2021

Stakeholders Engagement
9 Thematic Workshops
Baseline Modelling Report V1

October

2022

6th May – Launch Draft
Recommendations & Scenario Modelling

Public Consultation
Workshops & Online Survey

May

7th October
Roadmap launch

October

#BUILDINGLIFE AMBASSADORS

Thank you to our #BuildingLife Ambassadors

National Leadership Forum

Thank you to the members of the National Leadership Forum.

- ACEI – Sarah Ingle
- BDP – Juan Morillas
- CIF – Sean Downey
- Coillte – Des O'Toole
- Department of agriculture, food and the marine – Fergus Moore
- Department of Environment Climate and Communications – Bernie Kiely
- Department of Housing, Planning and Local Government – Simon McGuinness
- Department of Public Expenditure and Reform - Ken Cleary
- Dublin City Council – Ali Grehan
- Enterprise Ireland – Ross O'Colman
- EPA – Shane Colgan
- GMIT – Mark Kelly
- IBEC – David Duffy
- LDA – Michael Goan
- OGP – Charles Mitchell
- OPW – Gosia Kubia
- OSC – Patrice McVeigh
- ReDiscovery Centre – Sarah Miller
- RIAI – Kathryn Meghan
- SEAI – Orla Coyle

National Technical Committee

Thank you to the members of the National Technical Committee

- ARUP – Conor Hayes
- CBRE – Rachael McGinley
- Cement Manufacturers Ireland - Brian Gilmore
- Ecocem – Andrew McGrane
- Ecological Building Solutions - Niall Crosson
- Ecoreview – Peter Seymour
- Gottstein Architects -Catriona Duggan
- Hibernia Reit – Neil Menzies
- HJ lyons – Pat Kirwan
- IPUT – Paul Cleary
- KRA – Krystyna Rawicz
- KSN – Mick Slevin
- LDA – Michael Goan
- OPW – Gosia Kubia
- RKD – Karolina Backmann
- Xtratherm – Marc Walsh

Workshop Participants

Thank you to all our workshop participants

- ACEI
- Architects Declare
- Ardstone Capital
- ARUP
- Ballymore
- Barry and Partners
- BDP
- BAM
- BER Certs
- BRE Global
- Cairn Homes
- CAR
- CBRE
- Caelan Bristow
- Chadwicks Group
- CIF
- CIOB
- CMI
- COADY ARCHITECTS
- CODEMA
- Coffey Group
- Coilte
- Colliers
- Cork City Council
- Courts Services
- CSO
- Cundall
- Department of Agriculture, Food and the Marine
- Department of Environment, Climate and Communications
- Department of Enterprise, Trade and Employment
- Department of Further and Higher Education, Research, Innovation and Science
- Department of Housing, Local Government and Heritage
- Department of Public Expenditure and Reform
- Dublin City Council
- Ecocem
- Ecocon
- Ecological Building Solutions
- Ecoview
- EDC Engineers
- Engineers Ireland
- Enterprise Ireland
- EPA
- GMIT
- Gaia Ecotecture
- G-Frame
- Gottstein Architects
- Greenville Procurement Partners
- Gyproc - Saint-Gobain
- Hemp Cooperative Ireland
- Heritage Council
- Hibernia REIT
- Higher Education Authority
- Hines
- HJ Lyons
- IBEC
- IBSO
- IDDEA
- Integrated Materials Solutions
- IPUT
- JB CONSULTING
- JW Engineering
- KRA
- KSN
- Lake and Land Civil Engineering
- LDA
- Limerick City Council
- Lioncor
- Marlet
- Medite Smartply
- MTU
- NUIG
- NSAI
- OGP
- OMP
- OPR
- OPW
- OCSC
- Partel
- Passive House +
- Philip Lee Solicitors
- Public Procurement Analysis
- Reddy Charlton Solicitors
- Rediscovery Centre
- RIAI
- Richard McCarthy QSI
- RKD
- Robert Bourke Architects
- Robert Whiteside Architecture & Furniture
- Savills
- Scott Tallon Walker
- SCSI
- SEAI
- Simon Beale + Associates
- Sisk
- Solas
- Technological University of the Shannon
- Technological University Dublin
- Tempo Housing
- Turner and Townsend
- UCD
- Urban Land Institute
- Varming
- Walls
- WWETB
- Wicklow County Council
- XTRATHERM

GLOSSARY

Additionality: Additionality is the procurement of renewable energy for a building's use which results in new installed renewable energy capacity that would not have occurred otherwise. The principles of additionality apply when an organisation / consumer self-generates renewable energy from their own facilities or closes an electricity purchasing contract that contributes to the construction of new renewable energy facilities. Projects that comply with the principle of additionality result in real and verifiable emission reduction or emission avoidance for the organisation / consumer, as their direct effect is to increase renewable energy generation[33].

Building Life Cycle: A building's lifecycle can be broken down into sixteen modules across three stages as defined in EN15978. A further stage, stage D, includes the potential reuse and recycling benefits of the building's components after the useful life of the building. The definition of the specific life cycle stages of a building is defined in EN 15978. The life cycle stages include A1-3 production, A4-5 transport and construction, B1-7 use, and C1-4 end of life[34].

Built Environment: ranges from the scale of the individual building to neighbourhoods, communities, and cities with their associated infrastructure[35].

Building Renovation Passports are masterplans for retrofit and include a record of works. They ensure that any renovation works are planned and implemented in a holistic and technically sound manner, hence preventing "lock-ins" and facilitating a step-by-step approach to deep renovation.

Carbon offsets: Emission reductions or removals achieved by one entity can be used to compensate (offset) emissions from another entity[36].

A **circular economy** is one that is restorative and regenerative by design, and which aims to keep products, components and materials at their highest utility and value at all times, distinguishing between technical and biological cycles.

Decarbonisation: is the means of reducing carbon dioxide (and other greenhouse gas) emissions into the atmosphere. Climate neutrality is the goal of the decarbonisation process, i.e., to achieve zero net greenhouse gas emissions (Net Zero carbon footprint) by the target date[37].

Embodied carbon: covers the entire carbon emissions associated with materials and construction processes throughout the whole lifecycle of a building or infrastructure. Embodied carbon therefore include the following modules (or lifecycle stages of a building) under EN 15978: material extraction (module A1), transport to manufacturer (module A2), manufacturing (module A3), transport to site (module A4), construction (module A5), use phase emissions (module B1, e.g. refrigerant leakage but excluding operational carbon), maintenance (module B2), repair (module B3), replacement (module B4), refurbishment (module B5), deconstruction (module C1), transport to end of life facilities (module C2), processing (module C3), disposal (module C4). Benefits beyond the system boundary (modules D1 – D4) should also be reported separately to modules A-C[38].

EN 15978: This European Standard specifies the calculation method, based on Life Cycle Assessment (LCA) and other quantified environmental information, to assess the environmental performance of a building, and gives the means for the reporting and communication of the outcome of the assessment. The standard is applicable to new and existing buildings and refurbishment projects[39].

Greenhouse Gases (GHG): In the context of the scope of the built environment only the following GHGs with Global Warming Potentials (GWP) are considered: carbon dioxide (CO_2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6)[40]. Their GWP is quantified in units of carbon dioxide equivalent. A kilogram of carbon dioxide therefore has a GWP of 1 kg CO_2eq[41].

Level(s): Launched in October 2020, Level(s) is a framework of sustainability indicators that are common to all buildings. The key idea is that if all member states focus on these same indicators, we can use them to learn, set benchmarks and develop standards. The framework offers comprehensive manuals for the understanding and reporting of each indicator. Level(s) was developed as a detailed reporting framework to improve the sustainability of buildings from the life cycle perspective, including the transition towards a circular economy. It encourages life cycle thinking and supports users all the way from design stage through to operation and occupation of a building.

Life Cycle Assessment (LCA) is defined as a systematic set of procedures for compiling and examining the inputs of materials and energy into a process, and the outputs in terms of the associated environmental impacts directly attributable to the process. It defines the scope or system boundary of the process and assigns environmental impact factors to all energy and materials within that scope, which in turn becomes the inventory for measurement. ISO 14040-44 provides a general overview of the principles, framework, and requirements; The detailed procedure for applying LCA methodology in the built environment is described in EN 15978 (ISO 14040: 2006)[42].

Life Cycle Costing (LCC) takes into account cost or cash flows, i.e., relevant costs (and income and externalities if included in the agreed scope) arising from acquisition through operation to disposal of buildings and constructed assets (ISO 15686-5:2017(en))[43].

Major renovation: is renovation of a building where more than 25% of the surface of the building envelope undergoes renovation[44].

NABERS is a sustainability rating for the built environment. Like the efficiency star ratings that you get on your fridge or washing machine, NABERS provides a rating from one to six stars for buildings efficiency across: Energy, Water, Waste, and Indoor environment. This helps building owners to understand their building's performance versus other similar buildings, providing a benchmark for progress.

Net Zero embodied carbon building (new or renovated) or infrastructure asset is highly resource efficient with upfront carbon minimised to the greatest extent possible and all remaining embodied carbon reduced or, as a last resort, offset in order to achieve net zero across the lifecycle[45].

Net Zero in-use carbon: A 'Net Zero In-Use Carbon Asset' is one where on an annual basis the sum total of all asset related GHG emissions, both operational and embodied, (Modules B1-B7 (plus B8 and B9 for Infrastructure only)) are minimized, meets local carbon, energy and water targets, and with residual 'offsets', equals zero[46].

A **Net Zero carbon – operational energy** asset is one where no fossil fuels are used, all energy use (Module B6) has been minimised, meets the local energy use target (e.g., kWh/m2 /a) and all energy use is generated on- or off- site using renewables that demonstrate additionality. Any residual direct or indirect emissions from energy generation and distribution are 'offset'[47].

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 A1-A5, B1-B7 (plus B8 and B9 for Infrastructure only), C1-C4) are minimized, meet local carbon, energy and water targets, and with residual 'offsets', equals zero[48].

Nearly Zero Energy Building (NZEB) is not a separate standard; it is a definition for the energy performance required, i.e., to comply with TGD L a building must achieve or exceed NZEB performance.

Offset: Where a certain quantity of carbon emissions is deemed too difficult or even impossible to mitigate directly within the building life cycle, the equivalent amount of emissions may be mitigated elsewhere, either by purchasing certified carbon credits or by investing in carbon sequestration projects (e.g., reforestation)[49].

Operational carbon: 'Operational Carbon – Energy' (Module B6) are the GHG emissions arising from all energy consumed by an asset in-use, during the operational stage of its life cycle[50].

Shadow pricing: is a means of placing a value on a non-market good. Carbon emissions are monetised according to the 'shadow price of carbon' differentiated between domestic and large industry emissions. In Ireland the shadow price for industrial emissions captured within the Emissions Trading Scheme (EU-ETS) is based on market projections for the price of carbon traded within the EU-ETS up to 2025 and based on the EU Reference Values thereafter. For domestic emissions outside the ETS emissions (non-ETS) the shadow price is based on the estimated cost to Ireland of removing emissions from the atmosphere [18, p. 5] Details of the differentiated price are presented in the Public Spending Code[51].

Training clauses allow public procurers to require companies winning NZEB projects to train their staff in energy efficiency. This type of clause is currently in-use in the Hauts-de-France region (France), where the companies winning these projects must train staff working on a project (construction workers and site supervisors) in energy efficiency. The clause is currently being piloted in Ireland[52].

The **EU Taxonomy** outlines the key criteria to be met for an economic activity to be regarded as "green" or "social", with a view to tackling greenwashing. In simple terms, the more environmentally friendly a project is, the easier it should be to obtain funding at a lower interest rate.

Whole Life Carbon (WLC) is simply the sum of the embodied and operational carbon. It includes all the major and immediate sources of a building's carbon footprint. It is based on lifecycle stages as defined in EN 15978, (i.e., modules A1 to C4, with module D reported separately).[53]

List of acronyms

ACA	Accelerated Capital Allowance
ACEI	Association of Consulting Engineers of Ireland
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BAMB	Buildings As Material Banks
BE	Built Environment
BER	Building Energy Rating
BIACE	Building in a Climate Emergency
BMS	Building Management Systems
BRPs	Building Renovation Passports
CBI	Central Bank of Ireland
CCS	Carbon Capture Storage CCS
CDW	Construction & Development Waste
CIBSE	Chartered Institution of Building Services Engineers
CIF	Construction Industry Federation
CIOB	Chartered Institute of Building
CIRI	Construction Industry Register of Ireland
CLT	Cross-Laminated Timber
CPD	Continuous Professional Development
CRREM	Carbon Risk Real Estate Monitor
CSO	Central Statistics Office
CTCHCP	Collaborative Town Centre Health Check Programme
CWMF	Capital Works Management Framework
DAFM	Department of Agriculture, Forestry and Marine
DEAP	Domestic Energy Assessment Procedure
DSY	Design Summer Year
EC	Embodied Carbon
EPA	Environmental Protection Agency
EPBD	Energy Performance of Buildings Directive
EPD	Environmental Product Declaration
ETB	Enterprise and Training Board
EUI	Energy Use Intensity
GHG	Greenhouse Gas
GPP	Green Public Procurement
GWP	Global Warming Potential
ICMS	International Cost Management Standards
IGBC	Irish Green Building Council
LCA	Life Cycle Assessment
LCC	Life Cycle Cost
IAQ	Indoor Air Quality
IPAV	Institute of Professional Auctioneers and Valuers
MEPS	Minimum Energy Performance Standard (MEPS)
MMC	Modern Methods of Construction
NABERS	National Australian Built Environment Rating System
NDP	National Development Plan
NEAP	Non-Domestic Energy Assessment Procedure
NZEB	Nearly Zero Energy Building
OC	Operational Carbon
OGP	Office of Government Procurement
POE	Post Occupancy Evaluation
RIAI	Royal Institute of the Architects in Ireland.
SCSI	Society of Chartered Surveyors of Ireland
SEAI	Sustainable Energy Authority of Ireland
STEM	Science, Technology, Engineering, Mathematics
TCFD	Task Force on Climate-related Financial Disclosures
TGD	Building regulations Technical Guidance D ocuments
TRY	Test Reference Year
UCD	University College Dublin
WLC	Whole Life Carbon
WGBC	World Green Building Council

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27 Hot water use is one the highest energy loads for certain building typologies including apartments and hotels.

28 I.e., A contractor that is authorised to collect, segregate, transport, and temporarily store by-products and end-of-waste products without affecting the non-waste status of those products even if they are collected alongside waste materials for recycling, landfill, or incineration.

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