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Whole Life Carbon Assessment and
Embodied Carbon in Domestic New
Buildings

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1. Introduction

This Approved Document provides statutory guidance under the Wales Building Regulations for integrating Whole Life Carbon (WLC) assessment into building design and construction. It underpins Wales' legally binding commitment to achieve Net Zero by 2050, as outlined in the Net Zero Wales Carbon Budget 2, and aligns with the Well-being of Future Generations (Wales) Act 2015, which requires public bodies to act in ways that safeguard environmental, social, and economic well-being for future generations.

The guidance applies to new buildings, major refurbishments, and projects requiring compliance with Approved Documents L (Conservation of Fuel and Power), F (Ventilation), and O (Overheating), supplemented by WLC requirements to address emissions beyond operational energy. Its purpose is to ensure that all stakeholders—architects, engineers, contractors, developers, and clients—understand the critical role of reducing carbon emissions across the entire life cycle of a building, from material extraction and construction through to operation, maintenance, and eventual deconstruction.

By embedding WLC principles into regulatory frameworks, Wales can lead the UK in sustainable construction practices, delivering measurable benefits such as reduced greenhouse gas emissions, improved resource efficiency, and enhanced resilience to climate change. These measures support economic opportunities through innovation in low-carbon materials and technologies, while promoting social well-being by creating healthier and more energy-efficient environments.

What is Net zero and what it means for newly constructed buildings.

Net Zero in the built environment is about making sure the amount of greenhouse gases a building produces is balanced by the amount removed or offset. In simple terms, buildings should have as little impact on the climate as possible. This goal alters how we design, procure materials, and construct, shifting away from traditional methods toward more sustainable ones.

To get there, we need to tackle two big sources of emissions:

- Operational carbon – the energy used when the building is occupied, like heating, cooling, and lighting.
- Embodied carbon – the emissions created before the building is even used, from making and transporting materials to the actual construction work.

Together, these make up most of a building's carbon footprint. In the past, we focused on operational carbon, but as buildings become more energy-efficient, embodied carbon is now just as important—sometimes even more so. Reaching Net Zero isn't about one quick fix.

It takes a whole-system approach, which means:

- Utilising Passive design – designing buildings to use less energy by making the most of natural light, ventilation, and insulation.
- Using Renewable energy – adding things like solar panels or heat pumps to supply clean energy.
- Implementing Circular economy approaches – reusing materials, reducing waste, and planning for recycling when the building reaches the end of its life.

This also influences how we select suppliers and materials, promoting low-carbon options and more transparent supply chains. Construction methods also need to be reviewed and redesigned, utilising digital tools to track carbon and minimising waste wherever possible.

Net Zero isn't just a technical challenge in the industry; it's a cultural shift that needs to happen before it is too late to address. It means everyone involved, from designers to contractors to clients, needs to work together. Done right, it creates buildings that are futureproof and help meet global climate goals.

2. Scope and Definitions

The scope of this document encompasses all new buildings and major refurbishments within Wales, ensuring that sustainability principles are embedded across the entire built environment. It applies to domestic properties, reflecting the Welsh Government's ambition to decarbonise all sectors of construction. This broad application recognises that both residential and commercial developments contribute significantly to Wales' carbon footprint and therefore require consistent, robust measures to reduce emissions.

Whole Life Carbon assessment considers emissions across every stage of a building's life cycle, from material extraction and manufacturing, through transportation and construction, to operation, maintenance, and eventual end-of-life processes such as demolition and recycling. This integrated approach ensures that decisions made during design and procurement account for long-term environmental impacts, not just short-term operational performance.

Clear definitions are essential for consistency and transparency:

- Whole Life Carbon refers to the total greenhouse gas emissions across all life cycle stages, as defined by BS EN 15978.
- Embodied Carbon relates specifically to emissions from materials and construction processes, often representing a significant proportion of a building's total carbon impact.
- PAS 2080 sets out principles for carbon management in infrastructure and building projects, emphasising leadership, collaboration, and measurable reduction targets.
- The RICS Whole Life Carbon methodology provides a structured framework for quantifying emissions across its stages, product, use, end-of-life, and benefits beyond the system boundary.

- Circular Economy principles, embedded in Welsh Government policy, advocate for resource efficiency, material reuse, and recovery strategies to minimise waste and carbon intensity.

This section also explains how these definitions interact with Welsh Government policies such as Planning Policy Wales and the Well-being of Future Generations Act, as well as international standards like ISO 14040 for life cycle assessment. By aligning terminology and methodology with recognised frameworks, the document ensures that reporting is consistent, comparable, and credible across projects. This clarity supports effective compliance, facilitates benchmarking, and enables Wales to demonstrate leadership in sustainable construction at both the UK and global levels.

3. Regulatory Context

Welsh Building Regulations currently address energy efficiency through Approved Document L (Conservation of Fuel and Power), ventilation via Document F, and overheating risk through Document O. These Approved Documents are issued under the Building Act 1984 as applied in Wales and set minimum standards for health, safety, and sustainability. However, they do not explicitly mandate Net Zero or Whole Life Carbon (WLC) assessment, leaving a critical gap in addressing embodied emissions. The Future Homes and Buildings Standard, scheduled for implementation in 2025, represents a significant regulatory uplift. It will require all new homes to be zero-carbon ready, achieving a 75–80% reduction in operational emissions compared to current standards, and prohibiting fossil fuel heating systems. Compliance will be enforced through updated Approved Documents and calculation methodologies such as the Home Energy Model, replacing SAP for dwellings.

Complementary frameworks such as UKGBC's Net Zero Carbon Buildings Standard and LETI's Climate Emergency Design Guide provide voluntary pathways that anticipate future statutory requirements. UKGBC's standard introduces science-based limits for operational and embodied carbon, supported by third-party verification protocols, while LETI sets clear performance benchmarks for energy use intensity and embodied carbon, which Welsh authorities may adopt as best practice guidance.

Embedding WLC assessment within Welsh Building Regulations would ensure consistency with broader UK decarbonisation strategies and international obligations under the Climate Change Act 2008 and the Paris Agreement, while addressing local priorities under the Well-being of Future Generations (Wales) Act 2015, the Environment (Wales) Act 2016, and Planning Policy Wales (Edition 12). These statutes collectively impose duties on public bodies to act sustainably and reduce greenhouse gas emissions, creating a strong legislative basis for integrating WLC into building control processes.

- Planning authorities can operationalise these requirements through development control mechanisms, including:
- Mandating WLC assessments at the outline and full planning stages for major developments.

- Conditioning planning consent on submission of verified carbon reduction strategies.
- Aligning Local Development Plans with national carbon budgets and circular economy principles.

This approach ensures that sustainability is considered from the earliest design stages, making WLC reporting a statutory obligation rather than a voluntary exercise. It also provides legal clarity for developers and building control bodies, reducing ambiguity and supporting enforcement through established compliance routes.

4. Whole Life Carbon Assessment Framework

The RICS Whole Life Carbon Assessment (WLCA) methodology provides a structured approach for evaluating carbon emissions across all life cycle stages of a building or infrastructure asset. This aligns with BS EN 15978, which defines Modules A–D: Stage A covers product and construction processes, where embodied carbon is most significant; Stage B addresses operational energy, maintenance, and repair; Stage C considers demolition and disposal impacts; and Stage D accounts for potential benefits from material reuse and recycling beyond the system boundary. Complementing this, PAS 2080: Carbon Management in Infrastructure mandates the establishment of carbon baselines, measurable reduction targets, and transparent reporting throughout procurement and delivery, fostering accountability across the supply chain.

Underpinning these frameworks is the Life Cycle Assessment (LCA) methodology, as set out in ISO 14040 and ISO 14044, which provides a systematic process for assessing environmental impacts across a product's life cycle. LCA involves four key phases: goal and scope definition, inventory analysis (data collection on material quantities, energy use, and emissions), impact assessment (evaluating environmental consequences such as global warming potential), and interpretation (drawing conclusions and identifying improvement opportunities). Standards such as BS EN 15804 ensure consistency in Environmental Product Declarations (EPDs), which feed into building-level assessments under EN 15978.

Additional methodologies strengthen this approach. BREEAM, a leading sustainability assessment method, encourages projects to reduce carbon and improve environmental performance through credits linked to life cycle impacts. Similarly, CIBSE TM65 addresses embodied carbon in building services such as heating, ventilation, and electrical systems, areas often overlooked in whole-life assessments but critical for accurate carbon reporting.

Industry frameworks like the UKGBC Net Zero Carbon Buildings Framework and Welsh Government decarbonisation policies reinforce the need for early-stage WLCA to influence design decisions and procurement strategies. Digital tools, including BIM-integrated LCA software, enable accurate data capture and scenario modelling, supporting informed choices on material selection, structural systems, and retrofit options. Practical applications include using BIM to compare embodied carbon impacts

of alternative materials and embedding carbon performance criteria into tender evaluations, aligning with net-zero objectives and whole-life value principles.

5. Embodied Carbon and Its Role in Whole Life Carbon Assessment

Embodied carbon is the greenhouse gas emissions from extracting, processing, transporting, and assembling construction materials. It's a key part of Whole Life Carbon (WLC) assessment, which covers all stages of a building's life—product, construction, use, and end-of-life—under the RICS WLC methodology. In highly efficient buildings, embodied carbon can account for up to 70% of total emissions, making its reduction critical for Net Zero. Strategies include using low-carbon materials like timber and recycled steel, applying circular economy principles for reuse and recycling, and requiring Environmental Product Declarations in procurement. Early design decisions, supported by BIM-integrated LCA tools, help identify high-impact materials and optimise structures. Embedding these practices in Welsh Building Regulations will cut embodied emissions and support Net Zero Wales goals.

Whole Life Carbon Metrics

Whole Life Carbon (WLC) is measured in kilograms of CO₂ equivalent per square metre (kgCO₂e/m²) of a building's floor area, which is the standard metric for benchmarking. It covers four stages: A – materials and construction, B – use and maintenance, C – end-of-life, and D – recycling benefits. The calculation is $WLC = A + B + C - D$, with Stage A usually having the largest upfront impact. Reporting by life cycle stage ensures transparency and accuracy, and using the RICS Whole Life Carbon Assessment method provides consistent and credible results.

To compare carbon intensity across projects, results are normalised using Gross Internal Area (GIA). The industry standard for measuring GIA is set out in RICS Property Measurement (IPMS) guidance. GIA includes all enclosed floor space within the internal face of external walls and excludes areas such as external balconies, terraces, and open voids. To calculate GIA, measure the length and width of each enclosed space, multiply to get square metres, and sum all areas for the total building GIA.

Embodied Carbon Targets

New residential buildings must meet a 2025 upfront embodied carbon limit of 450kgCO₂e/m² under the UK Net Zero Carbon Buildings Standard, based on actual carbon measurements rather than estimates. This target applies to Stage A (materials and construction), which often accounts for the largest share of Whole Life Carbon emissions. Prioritising early design decisions and low-carbon material choices is essential to meet this benchmark for domestic buildings.

6. Design and Construction Standards

Reducing embodied carbon requires prioritising low-carbon materials such as timber, recycled steel, and low-carbon concrete alternatives. Circular economy principles encourage designing for disassembly and material recovery, reducing waste and lifecycle emissions. Procurement strategies/routes should incorporate carbon performance criteria, rewarding suppliers who demonstrate compliance with PAS 2080 and provide Environmental Product Declarations.

Operational energy targets should align with LETI benchmarks and UKGBC guidance, promoting passive design, high-performance fabric, and renewable energy integration. Resilience measures, including flood adaptation and overheating mitigation, ensure buildings remain functional under future climate scenarios, supporting long-term sustainability. Case studies from Welsh projects demonstrate how early adoption of these principles can lead to significant carbon reductions and cost savings over the building's life cycle.

7. Integration of Leading Standards in Wales

Achieving Net Zero in Wales requires combining regulations with proven best-practice standards. These frameworks guide carbon reduction across the building life cycle, from design and construction to operation and end-of-life.

One Planet Development (OPD)

OPD goes beyond energy efficiency by requiring zero-carbon buildings and strict ecological footprint limits. It promotes biodiversity, water recycling, and sustainable land use, making it ideal for rural Welsh projects focused on resilience and self-sufficiency.

Passive House

Passive House delivers ultra-low energy buildings through airtightness, insulation, and thermal efficiency. It cuts heating and cooling demand dramatically and works for both new builds and retrofits, improving comfort and indoor air quality.

LETI

LETI sets clear energy and embodied carbon targets, encouraging early-stage modelling to influence design before construction. Its guidance helps teams set carbon budgets and integrate renewables from the start.

UK Green Building Council (UKGBC)

UKGBC provides science-based limits for operational and embodied carbon, with practical steps for Net Zero pathways. It promotes transparency and industry collaboration for consistent best practice.

AECB Carbon Lite Standards

AECB offers tiered performance levels to cut CO₂ emissions by up to 95%, making it suitable for projects of all sizes and budgets. It focuses on practical, achievable solutions for incremental progress.

By aligning these standards with Welsh priorities—biodiversity, community resilience, and circular economy principles—projects can deliver high-performance, low-carbon buildings that meet regulations and set a benchmark for sustainable construction.

8. Compliance and Verification

Meeting the proposed Net Zero Building Regulations in Wales will require clear and enforceable steps. One of the most important measures is mandatory Whole Life Carbon reporting at both the planning stage and after construction is complete. These reports should be verified by accredited assessors to ensure accuracy and accountability. To maintain consistency across the UK, Welsh regulations should align with the UK Net Zero Carbon Buildings Standard, which provides common definitions and performance benchmarks.

Compliance shouldn't stop when the building is finished. Post-occupancy evaluations are essential measures in place to check whether the building performs as expected in terms of energy use. Digital tools can also play a big role in this process. Online platforms can make reporting easier and more transparent, allowing data to be shared with the Welsh Government for benchmarking and sector-wide learning.

Examples of practical compliance pathways include:

- Using approved templates for Whole Life Carbon reporting to ensure consistency.
- Engaging independent verification bodies for third-party checks.
- Integrating monitoring systems into building management platforms so that performance data is automatically tracked and reported.

By embedding these processes into regulations, Wales can create a clear, reliable framework for achieving Net Zero, while encouraging innovation and accountability across the construction sector.

9. Achieving Net Zero in Wales' Built Environment

Reaching Net Zero in Wales isn't about cutting emissions during a building's use; it means looking at the whole life cycle of a building, from the materials we choose to how we build, operate, and eventually deconstruct. To make this happen, Whole Life Carbon assessment needs to be built into Welsh building regulations, so that carbon impacts are measured, managed and reported at every stage.

This Approved Document sets clear principles for cutting both embodied carbon (materials and construction) and operational carbon (energy use during occupancy). It promotes circular economy practices such as designing for reuse, recycling, and waste reduction, ensuring resources stay in use longer. Compliance should include transparent verification so carbon targets are proven, not just promised. Wales should align with UK-wide standards for consistency while addressing local priorities like community resilience, biodiversity, and rural and coastal challenges. Policies must reduce carbon while supporting healthy communities and protecting natural ecosystems.

By adopting these measures, Wales can position itself as a leader in low-carbon construction. The benefits go beyond the environment—they include lower energy costs, better health and wellbeing, and stronger local economies through green jobs and innovation. In short, Net Zero isn't just a climate goal, it's an opportunity to build a more sustainable and resilient Wales.

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