

An aerial photograph of a coastal road. The road is a two-lane asphalt highway with white lane markings, running diagonally from the top right towards the bottom left. A single white car is visible on the road. To the left of the road is a rocky coastline with waves crashing against the shore. The water is a deep teal color. To the right of the road is a rugged, rocky hillside with sparse green vegetation. The overall scene is a dramatic coastal landscape.

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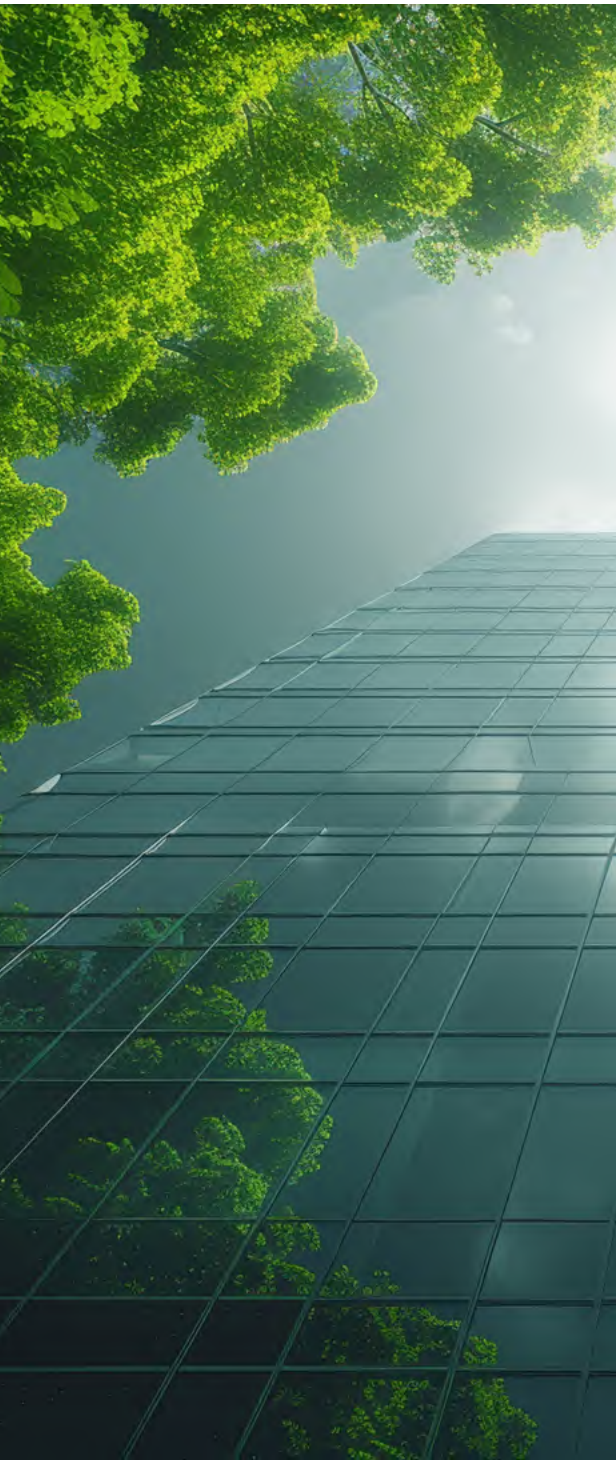
Slattery benchmarking report:

Let's be upfront about upfront embodied carbon

August 2024

Let's be upfront about carbon

Australia has an ambitious target to reach net zero carbon emissions by 2050. We can't meet this target without addressing embodied emissions in the built environment. Slattery, with Australia's first carbon planning service, is releasing our data and knowledge so the industry can move further and faster together.



Introduction

A building's upfront embodied carbon emissions are locked in before a light switch is flicked, an airconditioner is turned on or a single occupant walks through the front door.

Until very recently, the built environment sector was focused on driving down operational emissions, which make up 28% of the world's greenhouse gas emissions footprint, according to the [World Green Building Council](#).

But the built environment's embodied emissions are responsible for another 11% of the world's carbon footprint. Most of these emissions are generated 'upfront', during the design and construction phases of buildings. This means the opportunity to reduce these emissions can only happen upfront.

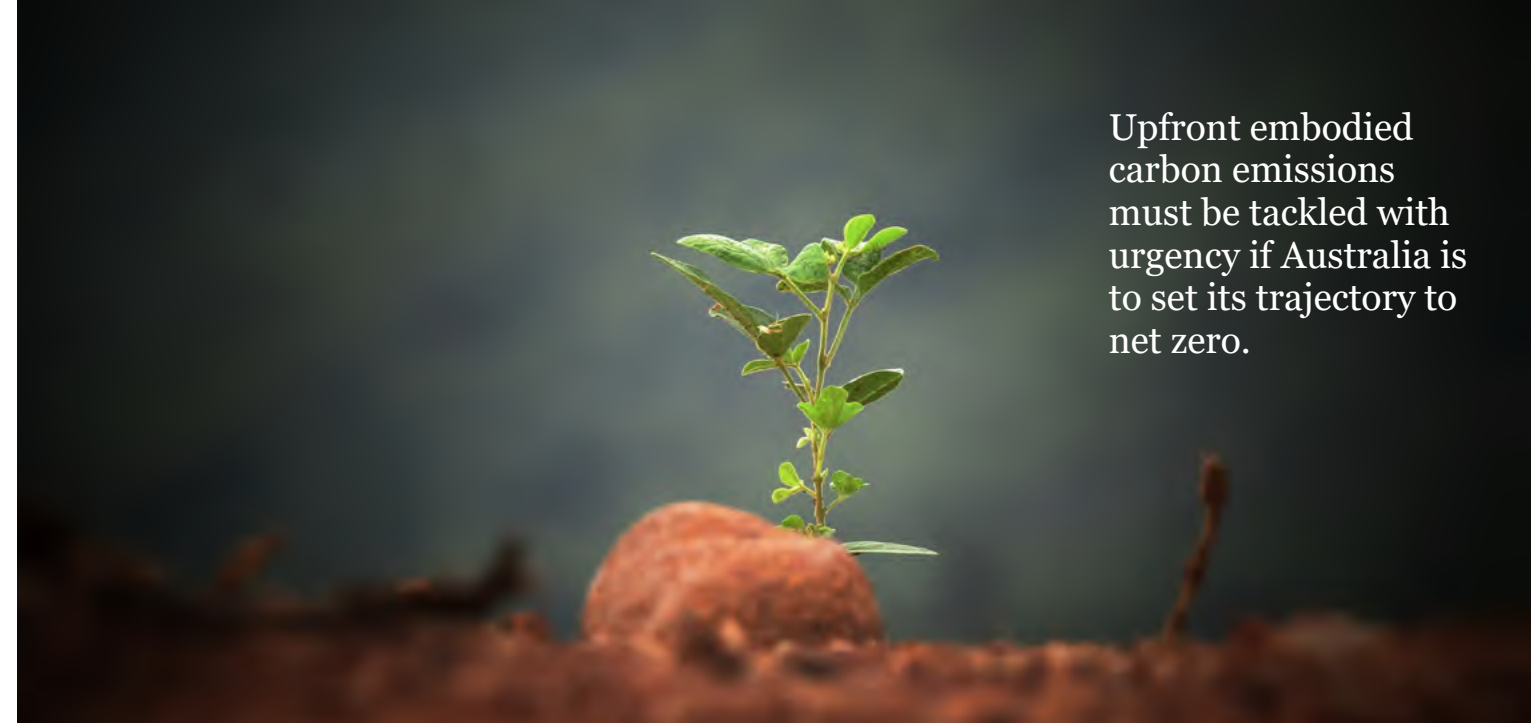
Slattery released our first upfront embodied carbon benchmarking paper in May 2022. Since then, we have expanded the breadth and depth of our upfront embodied carbon benchmarking database and have data on a wide range of sectors, including commercial office, industrial, tertiary, healthcare, aged care, arts and cultural and justice.

In this report, we share breakdowns of upfront embodied carbon for four new sectors. We also offer an overview of the most recent developments influencing the direction of the property industry.

Upfront embodied carbon emissions must be tackled with urgency if Australia is to set its trajectory to net zero. In this report, we provide some new analysis which compares current upfront embodied carbon data, based on our benchmarks, against Australia's targets. By breaking the task down by building typology, we reveal the enormity of the task ahead and the need for accelerated action.

In section three of this report, we examine a case study of Hines' office development, 600 Collins, in Melbourne. This project demonstrates how smart design decisions can deliver significant embodied carbon savings.

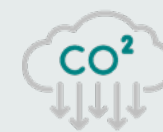
The upfront embodied carbon conversation, we believe, is so vital to the future of Australia's property and construction industry, that we've put this information 'up front'.



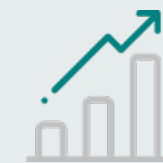
Upfront embodied carbon emissions must be tackled with urgency if Australia is to set its trajectory to net zero.

Key insights from Slattery's benchmarks

Our latest benchmarking data reconfirms the findings from our July 2023 report and provides some additional insights. The headline findings are:



Australia's construction industry must reduce upfront embodied carbon emissions by **31-36%** by 2030 to adhere to the Science Based Target initiative (SBTi) and limit global temperature increase to 1.5°C above pre-industrial levels.



We now have upfront embodied carbon benchmarks for four new sectors including industrial, justice, arts & culture and commercial base building refurbishments.



On average, new commercial office buildings generate **4.5 times** more upfront embodied carbon emissions than commercial office refurbishments, emphasising the importance of refurbishment over rebuilding.



82-91% of the upfront embodied carbon in typical new builds come from the cold shell scope.

We find that upfront embodied carbon savings of around 20% savings are achievable through design decisions that do not carry a significant cost impost. Our data reconfirms that extending the life of existing buildings through retrofitting and reuse is the most effective strategy to minimise upfront embodied carbon emissions and meet sustainability targets.

Section one: Upfront embodied carbon and Paris Agreement targets

Australia, as a signatory to the [Paris Agreement](#), has agreed to “hold the increase in the global average temperature to well below 2°C above pre-industrial levels” and to “pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels”.

New Slattery analysis suggests that the required reduction in upfront embodied carbon (GWP/m² or kgCO₂eq/m²) to maintain the 1.5°C trajectory is very ambitious.

We assessed the average upfront embodied carbon (kgCO₂eq/m²) across the Slattery benchmarking dataset against the Science-Based Targets initiative (SBTi) required to maintain a 1.5°C pathway. The reductions in upfront embodied carbon required are shown in Exhibit 1, measured in units of kgCO₂eq/m².

For example, for the Commercial office sector, the average new-build upfront embodied carbon intensity (kgCO₂eq/m²) in 2024/2025 is 740 kgCO₂eq/m². To align with Paris Agreement targets, the industry will need to be achieving 18 kgCO₂eq/m² in 2050.

Typology	2024/2025	2030	2035	2040	2045	2050
Residential	639	415	242	132	77	18
Commercial office	740	507	305	161	87	18
Health	796	554	364	196	110	24
Aged care	535	372	244	132	74	16
Industrial	549	382	251	135	76	16
Schools	697	485	318	171	96	21
Arts and cultural	730	508	333	179	100	22
Tertiary	955	665	437	235	132	28

Exhibit 1

Australian upfront embodied greenhouse gas emission intensity (kgCO₂eq/m² of Gross Floor Area) targets to limit global temperature increase to 1.5°C above pre-industrial levels.

Key findings

To achieve SBTi-aligned targets and limit global temperature increase to 1.5°C above pre-industrial levels, Australia’s construction industry must reduce the upfront embodied carbon emissions by:

- **31-36%** by 2030
- **55-63%** by 2035
- **76-80%** by 2040
- **87-89%** by 2045
- **98%** by 2050.



These targets can appear overwhelming and unachievable when we consider that upfront embodied carbon must be almost entirely eliminated by 2050.

But applying a shorter-focus lens reveals the immense challenge for Australia’s construction industry right now.

Building projects in the early design phase today will be in construction in 2030 and must, therefore, be designed to reduce upfront embodied carbon by a third on today’s business-as-usual.

The 31-36% reduction by 2030 is the average across all buildings. Given embodied carbon is not yet measured on most projects, the industry’s leaders must step up quickly to make up for the laggards.

Methodology

To determine these figures, we expanded on the work of [2050-Materials](#) co-founder and CEO, Phanos Hadjikyriakou, who broke down upfront embodied carbon targets of residential buildings in the United Kingdom into their key components. To do this, he combined two datasets:

- [Embodied carbon data from LETI](#) (London Energy Transformation Initiative) and
- Data from the Science Based Targets initiative (SBTi) report [a 1.5°C pathway for the global buildings sector’s embodied emissions](#).

From this work, Phanos has questioned whether the current Science-Based Targets are achievable for the UK’s residential sector.

Slattery completed a similar exercise by combining our benchmarking data averages for new builds with the SBTi upfront embodied carbon reduction targets and percentage reductions required to align with the 1.5°C climate change trajectory.

The 31-36% reduction by 2030 is the average across all buildings. Given embodied carbon is not yet measured on most projects, the industry’s leaders must step up quickly to make up for the laggards.



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Slattery's modelling suggests Australia must encourage more than just market leaders to meet Green Star upfront embodied carbon targets. We need every project to be thinking about embodied carbon upfront.

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Measurement: A long road starts with a simple step

We know, in some cases and depending on the building type, we can make upfront embodied carbon savings of up to 20% without imposing a cost premium.

Any project team seeking a [Green Star Buildings rating](#) from the Green Building Council of Australia must reduce upfront carbon by at least 10%. Higher ratings require a 20% reduction as a minimum expectation, and the GBCA has indicated this will increase to 40% over time to encourage market leading practices.

In section three of this report, we examine a case study of Hines' office development, 600 Collins, in Melbourne. Hines' work with Slattery illustrates how a 44% reduction in upfront embodied carbon could be achieved with a relatively small cost impost.

However, this case study also demonstrates the challenge for Australia's construction industry. This outcome was driven by a motivated team with ambitions for a world-leading building.

Slattery's modelling suggests Australia must encourage more than just market leaders to meet Green Star upfront embodied carbon targets. We need every project to be thinking about embodied carbon upfront.

To meet Australia's 2030 targets and maintain 1.5°C trajectory will require a step change in design, procurement and construction.

How can we proceed? Addressing upfront embodied carbon in the built environment will require collaboration across the entire supply chain. We have explored some of the opportunities in [Retrofitting reimagined](#), the previous issue of our embodied carbon series.

Ultimately, Australia will not meet its targets if we don't measure the upfront embodied carbon component of every building. Only then can we make informed and cost-effective decisions about design, make choices that incentivise innovation in product manufacturing, and expand the market for low-carbon materials.



Read our latest embodied carbon report into commercial retrofits.

Section two: Upfront embodied carbon benchmarks

Slattery continues to expand the breadth and depth of our upfront embodied carbon benchmarking database. We now have benchmarks for the following sectors:

- Commercial office new build
- Commercial base building refurbishment
- Fitout
- Industrial
- Education (both tertiary and schools)
- Healthcare
- Aged care
- Residential
- Justice
- Arts and cultural.

We have not recorded significant shifts in the range of results across most sectors since publishing our embodied carbon benchmarking report in July 2023. However, the number of benchmarked projects within these ranges has significantly increased, which enhances the quality of our data.

The major changes since July 2023 include:

- Commercial fitout and tertiary fitout have now been combined into one sector within the dataset
- Schools sector data range has widened from 700–860 kgCO₂eq/m² to 466–910 kgCO₂eq/m²
- Aged care upper range has increased to 730 kgCO₂eq/m² from 580 kgCO₂eq/m².

Detailed information on the percentage breakdown of upfront embodied carbon for commercial new builds is available in our July 2023 report. And we provide a detailed comparison of commercial new builds and retrofits in our March 2024 paper, *Retrofitting reimagined*.

In this report, we share fresh insights into four new sectors. Our main takeaway from our detailed analysis to date is that “a building is not just ‘a building’”. The quantum of carbon in each building type can vary significantly, which means a bespoke project-by-project and sector-by-sector approach will be the key to unlocking carbon savings in design, procurement and construction.

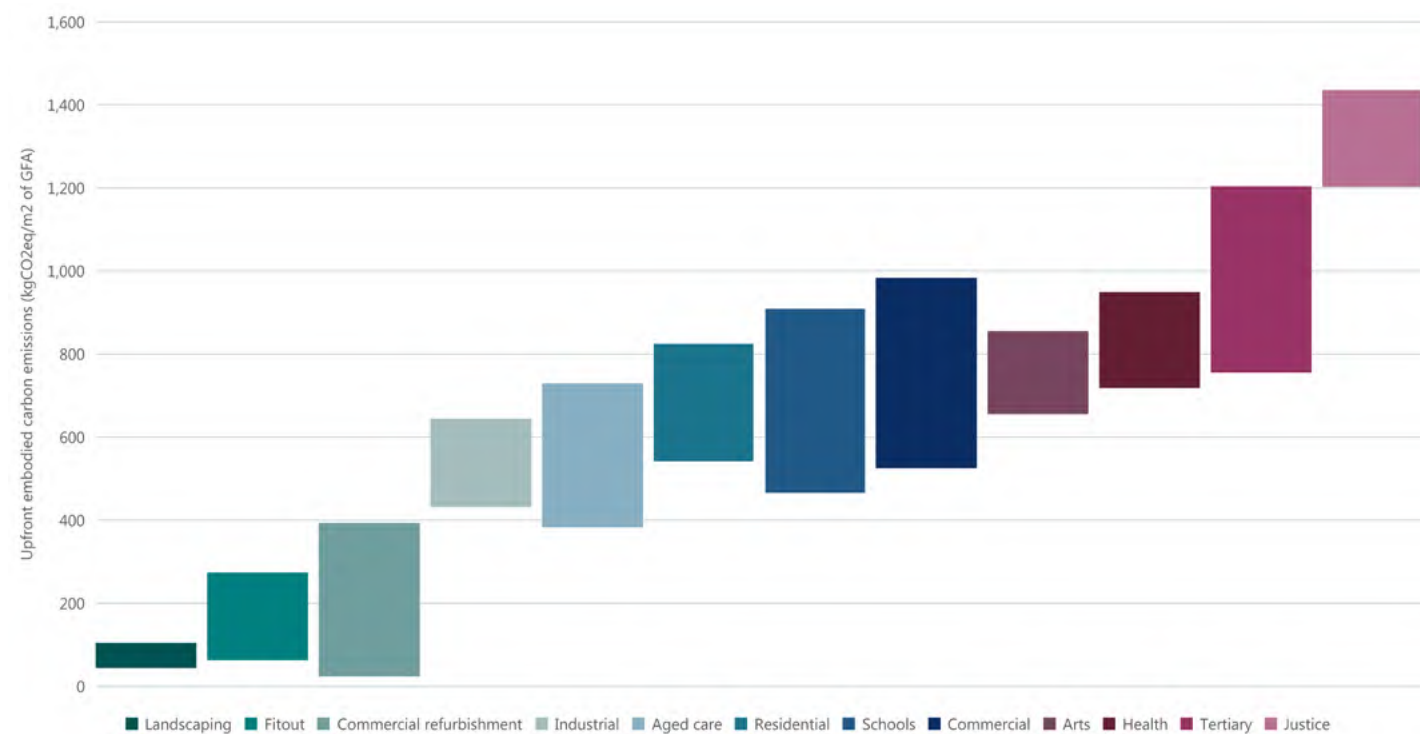


Exhibit 2
Ranges of upfront embodied carbon (kgCO₂eq/m²) per sector

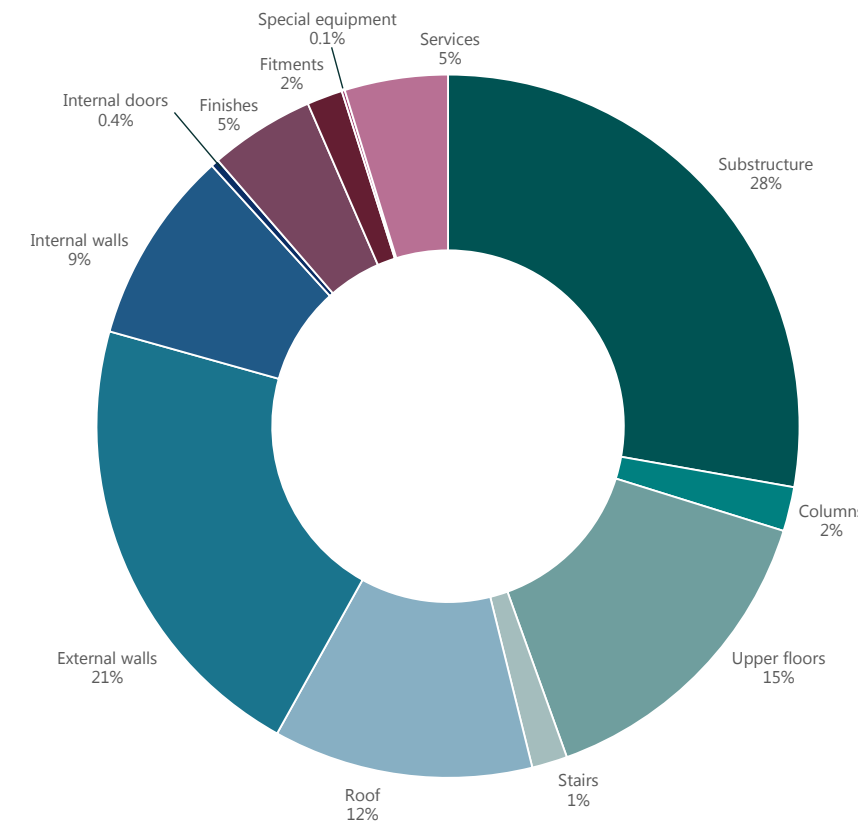


Exhibit 3
Average building elemental percentage breakdown of upfront embodied carbon in Slattery arts and cultural buildings

New data: Arts and culture

This new sector includes museums, art galleries, cultural and community centres, and visitor centres.

Arts and cultural buildings tend to prioritise bespoke designs, visual appeal and open, expansive space. The specific architectural features, with large load and span requirements, can make arts and cultural buildings carbon-intensive structures.

The key carbon indicators are the substructure, external walls, upper floors and roof. The substructure and superstructure (columns, upper floors, stairs, roof, external walls, internal walls and doors) contribute, on average, 88% of the typical building's upfront embodied carbon. This means reuse and repurposing existing buildings are a smart strategy. When constructing new arts and cultural assets, the key will be to think about longevity over centuries, rather than decades.

The range of results for arts and culture benchmarks is 655-856 kgCO₂eq/m².



Image credit
Berninait Cultural and Community Centre, Jackson Clements Burrows Architects, Victor Vieaux

Comparable, consistent and replicable benchmark data is at the heart of informed decision-making. Slattery has developed a methodology in alignment with international best practice frameworks and the NABERS Embodied Emissions Initiative. [Read more about our methodology.](#)

New data: Commercial refurbishment

We have isolated commercial refurbishment because it is an important sub-sector of Australia's commercial property market. Our data includes projects with base-building cold shell refurbishment work. The work completed on these projects is mostly internal; therefore, the key carbon-intensive elements are finishes, services, internal walls, upper floors, and fitments.

The project type and scope will dictate which building elements are addressed and the focus areas. More information about the opportunities to save upfront embodied carbon savings on commercial refurbishment can be found in our [Retrofitting.reimagined](#) thought leadership paper, published in March 2024.

The range of results for commercial refurbishment benchmarks is 24-394 kgCO₂eq/m².

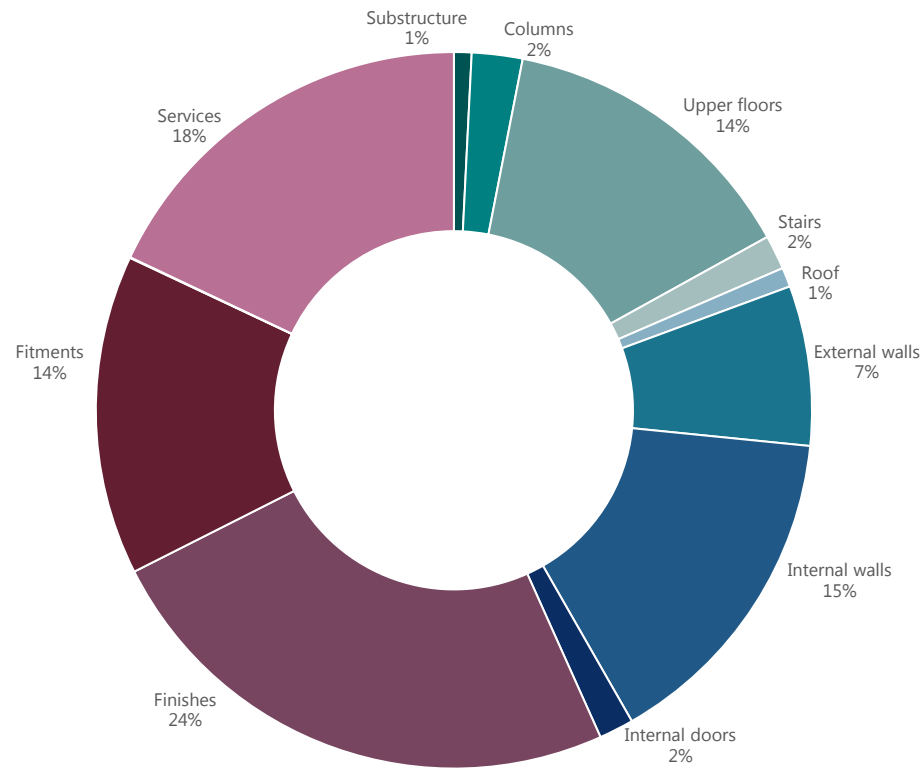


Exhibit 4
Average building elemental percentage breakdown of upfront embodied carbon in Slattery commercial refurbishment projects

New data: Industrial

This new sector's benchmarks are predominantly storage facility projects. These projects generally have high loading requirements and therefore require a heavy structure and substructure. As a result, the substructure (32%) and upper floors (22%) are the largest contributors to upfront embodied carbon emissions.

As this sector expands to larger single-storey sheds, as well as multi-storey warehouses, the building elemental percentages for upper floors are likely to change.

Our work with industrial developers reveals a significant barrier in the current delivery method. In most cases, a builder designs and constructs based on the developer's brief. This is a cost-effective delivery method, but means the developer has little control during the design process or in the selection of materials. Unravelling the upfront embodied carbon challenge in the industrial sector may need innovation in delivery models.

The range of results for industrial benchmarks is 432-645 kgCO₂eq/m².

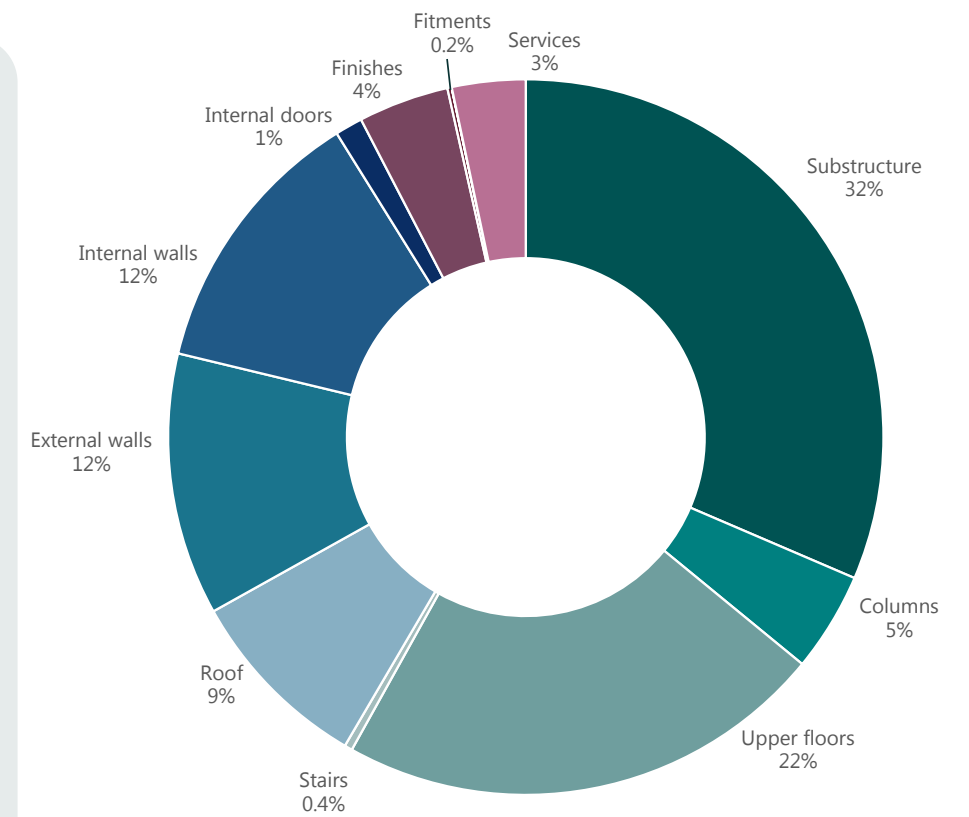


Exhibit 6
Average building elemental percentage breakdown of upfront embodied carbon in Slattery industrial projects

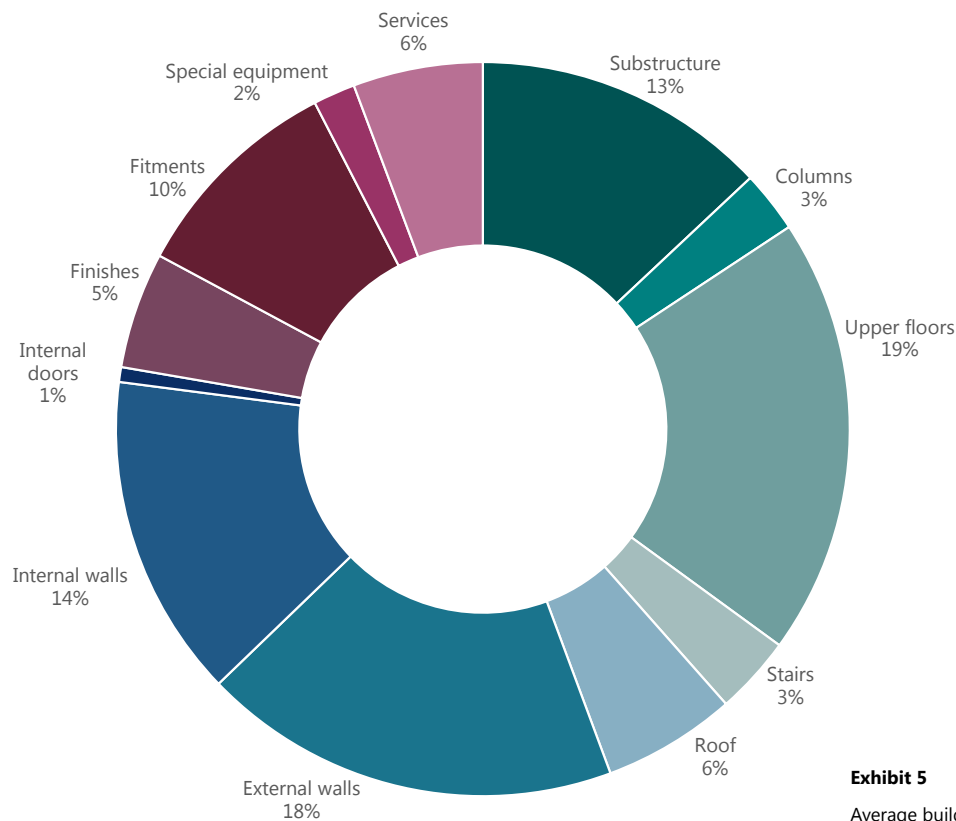


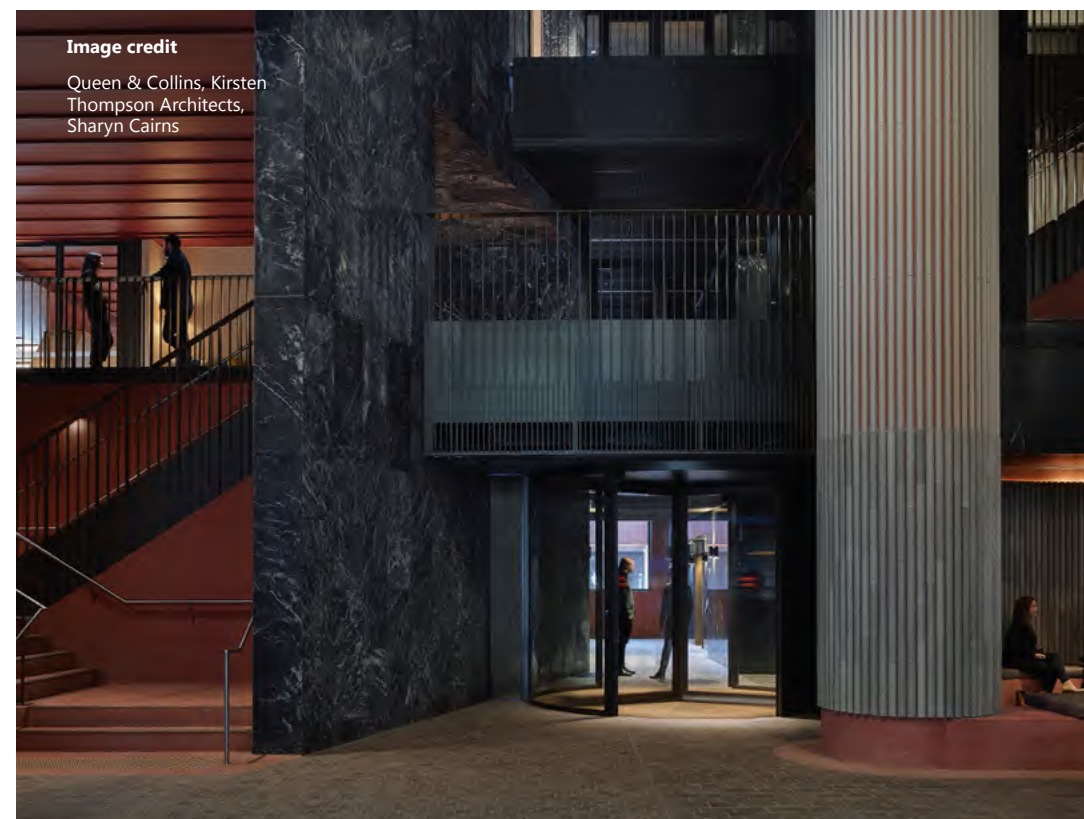
Exhibit 5
Average building elemental percentage breakdown of upfront embodied carbon in Slattery justice projects

New data: Justice

This sector includes law courts, prisons and correction centres. Justice buildings have significant security requirements which can mean in-situ or precast concrete walls, additional corridors for access or privacy, and additional steel for security.

Therefore, the upfront embodied carbon emission intensity for the justice sector is high. The key carbon indicator elements of this sector include internal walls, external walls and upper floors.

The range of results for justice benchmarks is 1203-1436 kgCO₂eq/m².





“ Addressing embodied carbon in construction is a crucial step towards a sustainable future for Australia’s built environment. At Hines, we’ve been actively reducing embodied carbon across the assets we own, manage, and develop. Through innovative materials, design choices, and construction practices, we’re helping to advance Australia’s low-carbon future. ”

David Warneford, Senior Managing Director, Hines

Image: 600 Collins Street

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Section three: Case study

600 Collins, Melbourne

Smart design decisions can deliver significant embodied carbon savings.

Hines acquired 600 Collins Street in 2020 with plans to develop a Premium grade office tower with a strong focus on sustainability, amenity, wellness and tenant experience.

Standing 180 metres tall with an articulated curved façade, 600 Collins is targeting a 6 Star Green Star and 6 star NABERS Energy rating, as well as a Platinum WELL Certification for shell and core.

Hines’ team was determined to design a low-carbon asset and engaged Slattery to undertake cost and carbon planning.

Our initial measure of the upfront embodied carbon of the schematic design resulted in an upfront embodied carbon of 757 kgCO₂eq/ m² of GFA.

Slattery compared this measure to other similar commercial office benchmarks. We highlighted specific design efficiencies that could reduce upfront carbon. Following a collaborative process with Hines’ project team, the design of the structure was altered to reduce the amount of concrete required without impacting the net lettable area. Consequently, upfront carbon at the 70% design development phase was lowered to 680 kgCO₂eq/m².

Slattery also provided a pathway for further upfront embodied carbon reductions with multiple lower carbon material specification options. These could be specified with a cost uplift of less than 1% on the total build cost.

Taking this pathway would achieve an upfront embodied carbon measure of 424 kgCO₂eq/m², equivalent to a 44% reduction when compared to the schematic design measure.

Carefully controlling the cost and carbon budgets throughout design, measuring multiple iterations of the design and providing robust data to guide informed design decision-making, have delivered an achievable pathway to deliver a high-quality, lower upfront embodied carbon building.

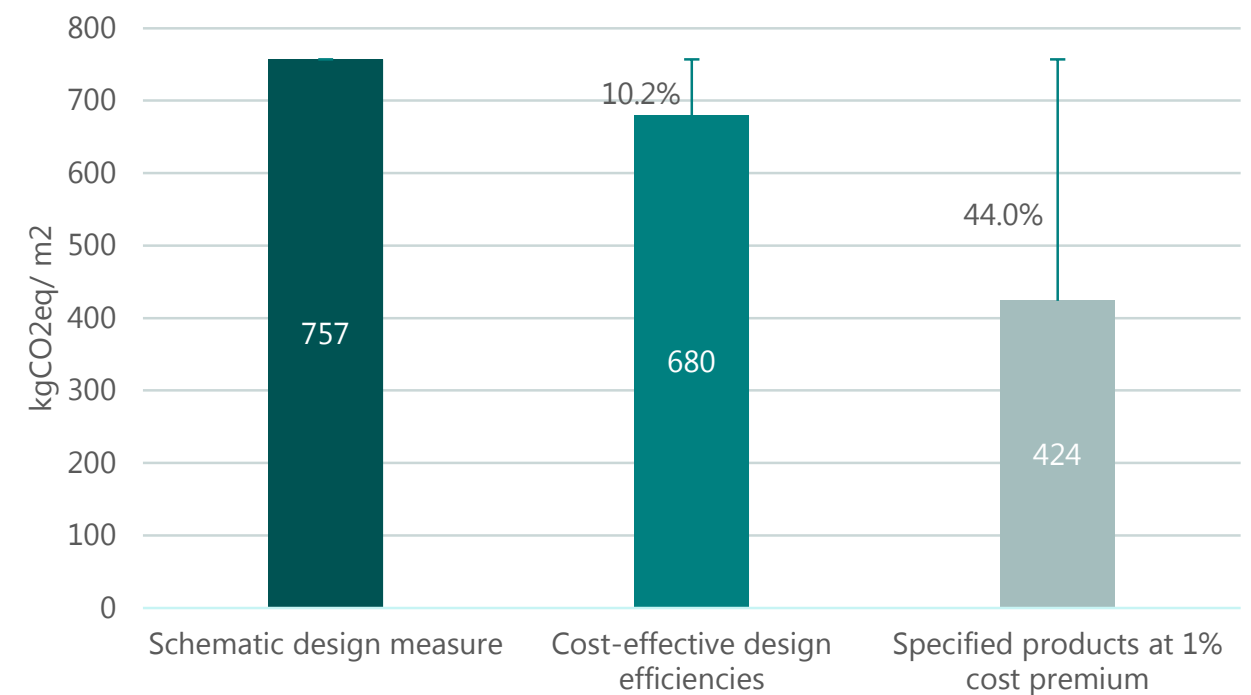


Exhibit 7
Upfront embodied carbon reduction on 600 Collins Street

Section four: Looking ahead

Slattery's team is finding efficiencies in designs that drive cost and carbon outcomes on projects around Australia.

We are working with many of the market leaders, including Hines, and with engaged and innovative project teams who understand the imperative, value and opportunity of lower upfront embodied carbon buildings.

With upfront embodied carbon a hot conversation topic across Australia's construction industry, the library of research reports, policy papers and thought leadership positions continues to grow. Since reporting on this in July 2023, the five biggest shifts we've observed for Australia's built environment are:

1. NSW mandates to measure embodied carbon: The [NSW Sustainable Buildings State Environmental Planning Policy \(SEPP\)](#) came into force on 1 October 2023, mandating that certain large and state-significant projects must measure upfront embodied carbon emissions at the Development Application phase and then again at the construction certificate stage. This policy is a clear signal to the market, and similar policies from other state governments can be expected.

2. Federal government guidelines for low-carbon procurement: Introduced in April 2024, the [Australian Government's Environmentally Sustainable Procurement \(ESP\) policy](#) guides federal government departments and agencies across three areas: climate, the environment and circularity. Businesses bidding for government construction projects above \$7.5 million must meet certain sustainability outcomes from 1 July 2024. While the policy doesn't specifically mention upfront embodied carbon, it signals that the Australian Government will use its significant purchasing power to accelerate the market for low-carbon materials.

3. Growth of EPDs: As more project teams specify low-carbon products, suppliers and manufacturers are scrutinising their Scope 1, 2 and 3 emissions to remain competitive. A record 108 Environment Product Declarations were published in 2023, according to [EPD Australasia](#). In total, 274 EPDs have been independently verified and registered with EPD Australasia, building valuable and comparable data about the lifecycle environmental impact of products. EPDs are currently competitive differentiators for product manufacturers, but as more EPDs become available over time, we expect the competitive advantage to be in the carbon impact delivered.

4. New reporting standards cover Scope 3 emissions: In October 2023, the Australian Accounting Standards Board released an exposure draft for disclosure of climate-related financial information, aligned with the [International Sustainability Standards Board's new standards](#). This proposal, applying to annual reporting from 1 January 2025, would require companies to prepare a 'sustainability report' that includes Scope 3 disclosures. This is expected to bring an uplift in data expectations around embodied carbon reporting, as even smaller companies not required to report will be approached by their clients and customers for Scope 3 emissions data.

5. NABERS embodied carbon tool: NABERS undertook [public consultation](#) of 10 proposals in 2023. After assessing feedback, NABERS has settled on a development pathway for a framework to measure, benchmark and certify embodied carbon of building materials and construction. Currently slated for release in late 2024, the framework should align and fast-track benchmarking efforts so the industry can set robust upfront embodied carbon reduction targets. The NSW Government has noted the [NSW Sustainable Buildings SEPP](#) will use the NABERS embodied carbon framework, upon its release. The GBCA has also flagged its intention to align Green Star's upfront carbon calculation methodology with the NABERS framework. NABERS is currently testing the draft framework on pilot projects.



Conclusion

As Slattery's database of real-world project upfront embodied carbon benchmarks expands, we will continue to publish our data. As leading carbon planners, we are committed to sharing information and educating industry participants about how they can begin to address upfront embodied carbon now.

There are choices we can make on building projects today that can enhance their value while uplifting industry capability, incentivising innovation and helping us to meet net zero targets tomorrow.

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Image: Slattery Naarm / Melbourne office Jack Lovel

About Slattery and Kaizen

Slattery is a property and construction advisory firm specialising in quantity surveying, cost management, early phase project advisory and carbon accounting.

With an outstanding history spanning four decades, and a commitment to excellence, innovation and collaboration, Slattery has earned the trust and respect of clients and project teams around Australia.

We work hand-in-hand with public and private sector clients, as well as with planners, architects and design teams on ambitious projects. We are committed to knowledge leadership, reconciliation, sustainability and achieving great outcomes for the community through the built environment.

Our Kaizen papers share knowledge, ideas and cost information to move our industry further and faster together. Kaizen is the Japanese word for improvement, reflecting a business philosophy focused on change for the better.

Explore our knowledge base of Kaizens at www.slattery.com.au/thought-leadership.

Slattery Carbon Planning

In 2021, Slattery was the first quantity surveying firm in Australia to launch a carbon planning service. We help our clients to address upfront embodied carbon on current and future developments, and to achieve their net zero and sustainability targets.

Read more about Slattery's carbon planning offering at www.slattery.com.au/carbon-planning

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