## Decarbonising Infrastructure Delivery

# Delivering on an upfront embodied carbon target – Barangaroo South precinct

**Photo credit** - Infrastructure NSW

## Summary

The Barangaroo South precinct is a significant urban renewal project in Sydney. Barangaroo South is a 7.5-hectare mixed-use area, including commercial, residential, retail and public spaces on which government partnered with Lendlease and Crown.

Barangaroo South exemplifies a proactive approach to reducing carbon by embedding sustainability into every phase of delivery. The project set a clear goal of a 20% reduction in upfront embodied carbon, compared to standard construction practices. In addition, the project committed to carbon neutral operation and enhanced energy efficiency.

- **Delivery agency:** Infrastructure NSW
- **Delivery partner:** Lendlease
- **Project stage:** Under development (to be broadly complete in late-2025)

## Collaboration across the supply chain

The former Barangaroo Delivery Authority, now incorporated into Infrastructure NSW, set ambitious objectives for sustainability performance and carbon reduction from the outset for Barangaroo South. The precinct renewal was one of the first in Australia to commit to carbon neutral operations and a 20% reduction in upfront embodied carbon. This commitment was included in the project development agreements, and in the 99-year ground leases.

As developer and builder, Lendlease worked to deliver carbon reductions through key procurement packages, influencing emissions (e.g. concrete supply and façade design) with carbon included as a tender evaluation criterion. This was informed by detailed upfront carbon assessments, for which some of the key results are detailed in the next section. Lendlease developed decarbonisation roadmaps for each building, which set out the pathway to achieve the targets. Lendlease embedded data reporting requirements on material sourcing and provision of verified carbon data within scopes of work to enable the embodied carbon assessment and tracking against the 20% reduction target.

### What is upfront embodied carbon?

Upfront embodied carbon (or upfront carbon) includes the carbon emissions associated with the production of materials and equipment, their transportation to site, and emissions from construction activities on-site. Note that broader embodied carbon also includes materials-related emissions from asset operations and maintenance, as well as deconstruction and end-of-life waste treatment.

## Upfront carbon assessment to understand source of emissions

Upfront embodied carbon assessment was used to track performance against the reduction target, and to understand the key contributions to upfront carbon for Barangaroo South. Some of the key outputs from analysis are illustrated in Figures 1 and 2.[1] This ensured that carbon reduction efforts were focused where there was the most potential to reduce emissions. **Figure 1** shows that the impacts from product manufacturing are responsible for the greatest share of upfront carbon. **Figure 2** reveals that structural (e.g. steel and concrete) and façade elements contribute most to the upfront carbon. Lessons from this analysis can be taken for other similar precinct and building developments, which are likely to have similar upfront carbon 'hotspots'.

**Figure 1 | Upfront carbon contribution by lifecycle stage (estimated)**

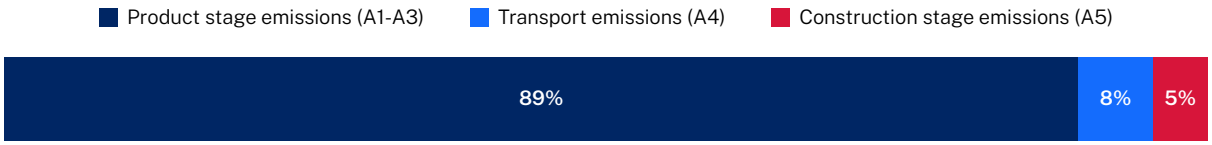
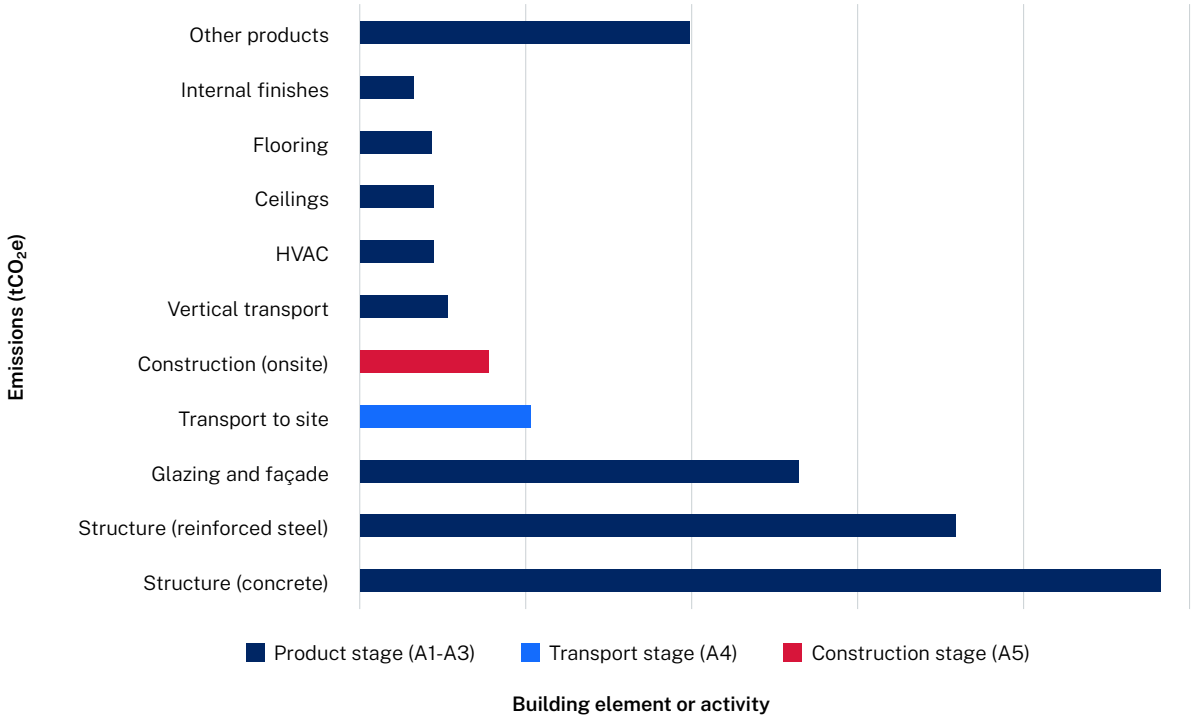



**Figure 2 | Estimated upfront carbon contribution by building element or activity in tonnes of $CO_2$ equivalent ($tCO_2e$)[2]**



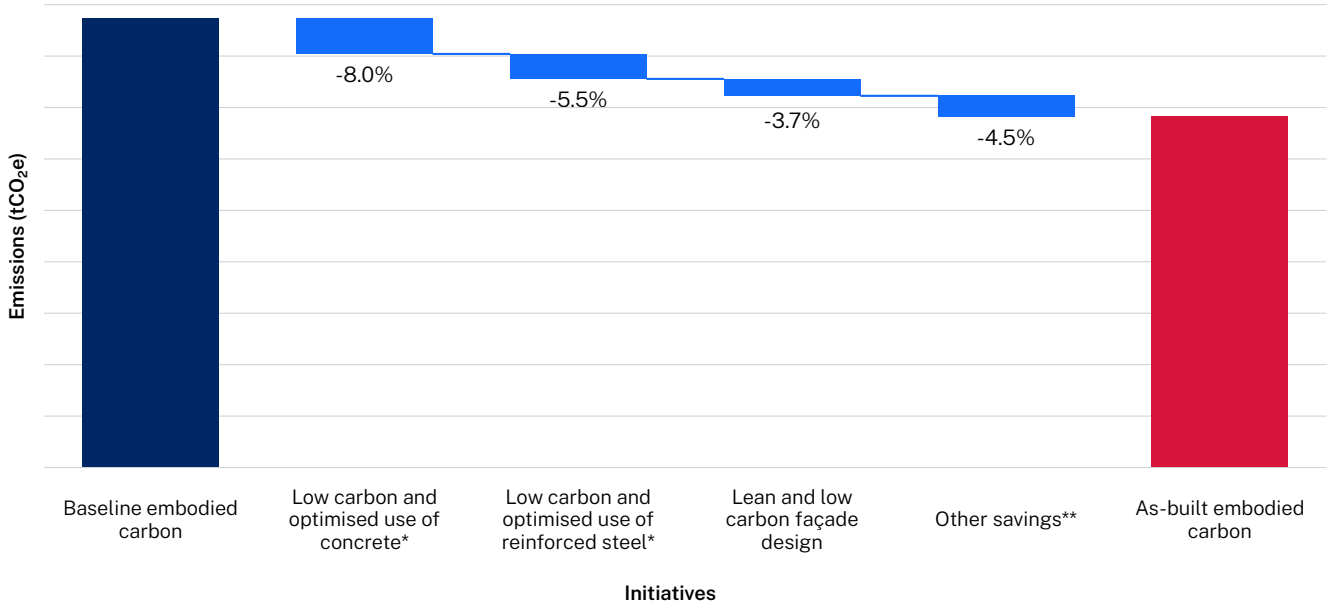

## Implementation of decarbonisation opportunities

Lendlease undertook engagement with its design teams and industry suppliers to investigate opportunities to reduce sources of upfront carbon. These potential savings were assessed against standard construction activities/practices and informed final design and product selection. **Figure 3** shows some of the key initiatives implemented in the final design and construction, with the estimated carbon reductions achieved against the baseline.

1 While initial estimates are used for contribution analysis, these figures show results from the final as-built assessment. The figures are based on available and reviewed information from the embodied carbon reports developed by Lendlease at time of drafting. The figures do not include estimates for the Crown resort and Buildings R4A, R4B, and R5 (cumulatively the One Sydney Harbour Residences). For further information, refer to section 5.8.2 and Case Study 4 (p.26-27) of the Embodied Carbon Measurement for Infrastructure – Technical Guidance.

2 "Other Products" include all other building elements (e.g., electrical services, formwork, metal work, infrastructure plant, carpentry, hydraulics etc.)

Figure 3 | Estimated upfront carbon savings by initiative for Barangaroo South in tonnes of $CO_2$ equivalent ($tCO_2e$)[3]




Key upfront carbon reduction initiatives, including those illustrated above, are further described below:

- **Low carbon and optimised use of concrete:** Lendlease conducted a competitive tender process to source low embodied carbon mix options. New mixes, including 60% cement replacement mixes, were piloted on non-structural and test elements of project sites. Lendlease also used sacrificial formwork for high strength concrete in tower columns, lowering the amount of concrete required.
- **Low carbon and optimised use of reinforcing steel:** Lendlease worked with steel suppliers and contractors across several projects to maximise the use of post-consumer recycled scrap content and waste materials in electric arc furnace steel making, reducing carbon emissions from manufacturing.
- **Lean and low carbon façade design:** A competitive tender led to optimised material use for several buildings' façades, such as optimised aluminium requirements for sun shading brackets, reduced aluminium wall thicknesses relative to sill heights, and reduced glass thicknesses where possible. In addition, Lendlease sourced aluminium products from a supplier that sourced hydroelectricity for aluminium smelting operations.
- **Leveraging a timber structure:** International House Sydney was Australia's first commercial office building constructed from timber, utilising cross-laminated timber (CLT) and glue-laminated timber (GLT).[4] Daramu House was also delivered using a CLT and GLT structure. The use of structural engineered timber avoided significant reinforcing steel, mesh, and post-tensioning requirements associated with a post tensioned reinforced concrete building.
- **Construction transport initiatives:** Key strategies to avoid transport emissions involved installing an on-site concrete batching plant and avoiding concrete agitator truck movements. The on-site plant was also designed to operate using lower emissions.[5] For example, the plant:
  - used electric motors for several conveyors, augers, and concrete mixers
  - was placed into an 'idle' state between each concrete batch production
  - was designed for wet mix processing using electric motors rather than dry mix processing that would require diesel powered concrete agitator trucks.

3 Figure is based on available and reviewed information from the embodied carbon reports developed by Lendlease at time of drafting. The figure does not include estimates for the Crown resort and Buildings R4A, R4B, and R5 (cumulatively the One Sydney Harbour Residences). The included projects covering approximately 350,000 m2 of gross floor area.

* These initiatives form part of the product stage (A1-A3).

**Other Savings cover other initiatives across product, transport, and construction stages (A1-A5) and include initiatives related to construction transport, onsite construction activities (e.g., use of electric luffing cranes), finishes, structural efficiency, timber structures, and other elements.

4 https://www.barangaroo.com/see-do-stay/daramu-house

5 https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=SSD-5967%2120190227T051619.319%20GMT

To achieve the upfront carbon target for each development, the purchase of carbon neutral products was also used as a final resort. Purchase of carbon neutral products or carbon offsets was used after design, procurement and construction initiatives were exhausted.

## Lessons learnt

Barangaroo South's success in achieving upfront carbon savings offers valuable lessons.

**1 Establish a clear and transparent carbon measurement methodology**

At the start of precinct development in 2010, there were no suitable benchmarks or government mandated guidance for upfront carbon measurement and reporting. To ensure the consistency in measurement and credibility of claimed reductions, projects can improve transparency and auditability by defining:

- system boundaries, inclusions/exclusions, and underlying assumptions to be applied
- how project performance is to be assessed against a baseline or available benchmarks
- expectations for tracking, interim reporting, data format (i.e. separate treatment of offsets), and documentation
- how carbon offsets are to be considered in achieving targets (e.g. as a last resort to offset residual emissions that cannot be reduced through design, procurement construction, or planning interventions).

**2 Set clear carbon reduction requirements of all partners in development agreements**

The project development agreements were crucial in establishing clear expectations between government and delivery partners involved in Barangaroo South. Objectives and requirements related to carbon reduction should be clearly defined and tested during market engagement and the tender process.

**3 Establish clear specifications along with early supplier engagement and support**

Managing upfront carbon is relatively new to many in the industry. To effectively manage this, as part of its procurement process for façade subcontractors for One Sydney Harbour Tower 3, Lendlease provided subcontractors and suppliers with simple guidelines. They also asked for material data and initiatives in returnable schedules and proposed various low carbon options. This ensured the tender documentation identified and set ambitious and performance-based requirements, which allowed for a flexible (rather than a prescriptive) procurement approach. Early supplier engagement and collaboration on carbon reduction strategies led to procurement of a viable solution using a supplier that used hydroelectricity for aluminium smelting operations.

**4 Larger scale and longer-term developments offer greater opportunities for continual improvement**

The scale and sequential delivery of Barangaroo South presented a significant opportunity to leverage and drive the market for low carbon solutions. Lendlease was able to work through learning curves with suppliers, drive environmental product declarations, and develop novel solutions. For example, Lendlease's willingness to pilot new concrete mixes has enabled a greater understanding of these mixes, product improvements and wider industry adoption. Lendlease was also able to improve procurement and design practices and standardise these across other projects.

## Achieving carbon neutral operations

In addition to addressing upfront embodied carbon in Barangaroo South, Barangaroo became the **first mixed-use precinct to achieve carbon neutral certification under the Australian Government Climate Active Carbon Neutral Standard for Precincts.** The certification is a voluntary and ambitious goal that goes beyond current NSW Government policy requirements. It involves independent third-party assessment and certification of efforts to measure, reduce, and offset emissions, based on international standards. The precinct has maintained this status since the initial issue in 2019.[6]

Carbon emissions generated by the operations at the precinct are lowered through infrastructure, such as the District Cooling Plant and the on-site rooftop solar panels with sufficient energy to power public areas.[7]

The NSW Government also negotiated a $48 million Green Product Purchase Agreement (GPPA) with CleanPeak Energy to address emissions associated with grid supplied electricity use at Barangaroo.[8] The GPPA supplies Renewable Energy Certificates (REC) to the Barangaroo precinct for 25 years from 1 January 2025. The RECs provide renewable energy attributes to electricity consumption in the precinct without the need for tenants to purchase green power. Other residual emissions from operations that could not be avoided are offset by high-quality Australian Carbon Credit Units.

6 https://www.barangaroo.com/editorials/celebrating-a-half-decade-of-carbon-neutrality

7 https://www.barangaroo.com/past-present-future/a-21st-century-transformation/sustainability

8 https://cleanpeakenergy.com.au/cleanpeak-energy-partners-with-infrastructure-nsw-on-48-million-green-product-purchase-agreement/