ORA Office of Regional Architecture

CASE STUDY 3

Kondinin Pavilion: Embodied Carbon of Keeping What We Have

Embodied carbon calculation, modules A1–A5

Tuan Ngo, Director · November 2026



The new roof frame going up over the retained red brick pavilion during construction. Image: ACorp Construction.

Summary

The Kondinin Pavilion refurbishment put about **252 tCO2e** into new materials (modules A1–A5), or **363 kgCO2e/m² of covered area**. The covered area is everything under the new roof: the 358 m² pavilion plus the 338 m² verandah around it, 696 m² in all. That is the carbon of what we added: a new curved steel roof over the whole building, the concrete verandah floor under it, new change rooms, kitchen, toilets and club room fit-out. The red brick walls, slab and footings we kept carry no new carbon.

This is ORA's third embodied carbon case study, after the Narembeen Administration Office refurbishment and the Bruce Rock Supermarket new build. It is the first one calculated after construction from as-built records, and the first where the main design decision was what to keep.

Three findings stand out:

- **Keeping the building saved an indicative 73 tCO2e** compared with demolishing and rebuilding the same design (about 326 tCO2e): about a fifth less carbon.
- **The new roof structure is the hotspot.** Steel trusses, columns and purlins (18.6 t) account for 94 tCO2e, 37% of the total.
- **The covered area is the fair measure for a pavilion like this.** The roof shelters almost twice the enclosed floor. Per m² of enclosed floor alone the figure would be 705 kgCO2e/m², which hides that half of the useful space is outside the walls.

The project

The Kondinin Pavilion at 44 Gordon Street serves the town's football, hockey, netball and community clubs. The Shire of Kondinin asked ORA to bring the old red brick pavilion up to current standards: accessible toilets, separate home, away, hockey and umpire change rooms, a new kitchen and a better club room.

Instead of demolishing it, we kept the brick building and put a new curved steel roof over the whole of it. The roof extends past the walls to form a new verandah on a concrete floor, so players and spectators have shade and rain cover on the oval side.

Client	Shire of Kondinin
ORA project	2022-0017
Head contractor	ACorp Construction
Structural engineer	Fulcrum Structural Engineering
Construction	Footings July 2025; roof installed June 2026; O&M manual September 2026
Gross floor area	358 m² (39 m² new, 319 m² refurbished)
New roof	696 m², curved ZINCALUME on steel trusses and 21 CHS columns
Kept	External and most internal red brick walls, ground slab, footings, bench seats and coat hooks
Removed	Old roof and tiled mansard eaves (451 m²), clerestory, footy tower, kitchen and toilet fit-outs
Pre-tender estimate	$1.95 million excl. GST (RWQS, February 2025)

Why we kept the building

The first reason was cost. Regional councils have limited budgets, and keeping the walls, slab and footings removes whole trades from the job. Depending on how you count it, a completely new pavilion might have

cost about the same. Demolition, disposal and working around an old building all add cost back. We still believed keeping as much as possible was the better choice.

The second reason is our ethos as heritage and sustainable architects. The red brick is part of the site. It belongs to the place, and to the clubs that have used the pavilion for years. A new roof over the old walls lets the building change without losing that.



The steel frame stands on its own columns, clear of the old brick walls, which stay in place under the new roof. Image: ACorp Construction.

The third reason is carbon, and this study puts a number on it. The materials already in place were made when the pavilion was first built; their carbon has already been spent. Every wall and slab we keep is one we do not have to make again. It is the first principle of ORA's design philosophy, retain and reuse, and Kondinin shows what it is worth.

Working with what we have came with design work of its own:

- **Fitting new rooms into old walls.** We bricked up 10 openings, cut new ones, and laid out the change rooms and toilets inside the existing shell.
- **A firewall through the cavity.** The 90/90/90 firewall reuses an existing 110 mm brick wall and continues it through the cavity and up to the new roof.
- **Plumbing through the old slab.** The builder cut out the existing slab in the wet areas, laid the new drainage, and poured new concrete back with the falls formed in it.
- **Joining new and old.** New stud walls clad in Custom Orb close the gap between the top of the old brickwork and the new curved roof.

The design choices beyond carbon

Keeping the walls was one part of the sustainability thinking. The new roof, the verandah and the materials were chosen for how the building will be used and looked after for decades.

Replacing the roof was deliberate. The old roof had box gutters that leaked, and they had become a maintenance problem for the Shire, where staff and trades are scarce. The new arched roof has no gutters at all: it sheds rain straight to the ground on both sides. There is nothing to block, overflow or leak into the building.

The verandah is a room without walls. It extends the club room and the change rooms outdoors, and it is where players and the community meet before and after games. With the verandah, the pavilion holds far more people than the club room could on its own, without enclosing, lining and air-conditioning that extra space.

Shade first, then air-conditioning. The roof overhangs the walls on every side, keeping the harsh Wheatbelt sun off the brickwork and windows. This passive response reduces the heat entering the building and the energy needed to cool it.

Materials that suit the site and take the knocks.

- **ZINCALUME roof and cladding:** robust, unpainted, low maintenance, and a material people in the Wheatbelt know from sheds, homesteads and farm buildings.
- **Fibre cement at ground level:** where boots, balls and bags hit the walls, a hard, easily repaired surface.
- **Face brick kept and repaired:** the original red brick carries on as the base of the building.

The familiar corrugated roof also makes the building feel like home, even though much of it is new. That matters more than it might seem.

A building people love is a building people keep. The most sustainable building is one its users cherish, protect and maintain far into the future. A pavilion the community is proud of will be cared for, adapted and kept, rather than run down and replaced. Every year it stays in use spreads its embodied carbon over a longer life.

Method

We used the same method and workbook as the two earlier case studies, so the three results can be compared.

- **Scope:** upfront embodied carbon, EN 15978 modules A1–A3 (materials), A4 (transport to site) and A5 (construction), for the new work only. Retained materials count as zero. Demolition of the old roof and fit-out belongs to the old building's end of life (module C) and is not included.
- **Emission factors:** NABERS National Emission Factors database v1.0 defaults, plus the BlueScope Colorbond EPD and EPiC 2024 where the earlier studies used them. Carbon stored in timber is not netted off.
- **Transport (A4):** Perth to Kondinin by truck (about 280 km), overseas legs for imported steel and glass. Concrete was batched locally by Kondinin Building Services.
- **Construction (A5):** the GBCA/thinkstep-anz split for non-residential buildings, 2025.
- **Services:** the NABERS rate per m² of floor area, as for Bruce Rock.

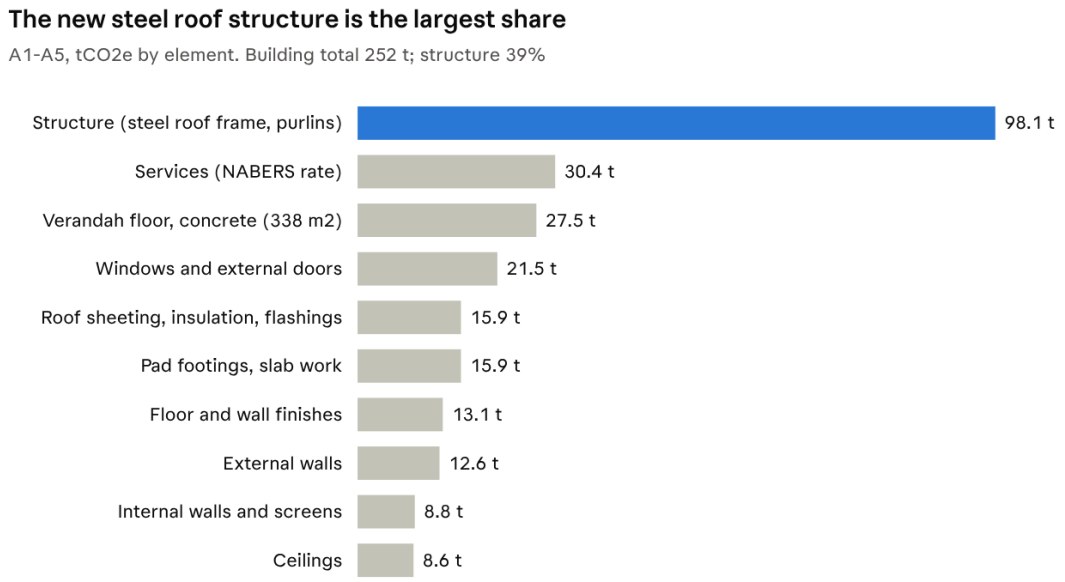
Quantities came from, in order of reliability:

1. **Fabricator records:** the Ascent Structural steel traceability report in the O&M manual, listing all 620 pieces with section and weight (13.9 t).
2. **The quantity surveyor's pre-tender estimate** (RW Quantity Surveyors, February 2025): floor area, roof, wall, finish and paving quantities.
3. **The drawings and schedules:** ORA's architectural set, Fulcrum's structural drawings, the finishes schedule and specification.
4. **Allowances** where nothing better exists, marked yellow in the workbook.

Where the as-built record and the estimate differ, we used the as-built record. The QS counted 13.1 t of steel against the fabricator's 13.9 t, which gives some confidence in both.

Results and hotspots

The new work came to about 252 tCO2e: 206 t from materials (A1–A3), 11 t from transport (A4) and 36 t from construction (A5), each rounded. Over the 696 m² covered area that is 363 kgCO2e/m².



ORA Kondinin embodied carbon workbook, Summary sheet, 11 November 2026

The steel roof frame dominates because it is a whole new structure standing on its own 14 pad footings. It carries the roof clear of the existing walls. The largest single items are:

Item	Quantity	tCO2e (A1–A5)
Structural steel: CHS columns, trusses, struts, beams	13.9 t	69.8
Building services (NABERS rate, enclosed floor only)	358 m²	30.4
Verandah floor: 100 mm concrete paving, thickenings, mesh	338 m²	27.5
Cold-formed purlins	4.5 t	23.8
Aluminium window frames	~200 m	15.2
Roof sheeting, ZINCALUME	696 m²	12.1
Pad footings, 25 MPa	17 m³	8.0

Aluminium appears again as a hotspot, as it did at Bruce Rock: about 0.4 t of window frames account for 15 t. The wet-area slab work, by contrast, is small: about 2 t for cutting out and re-pouring the slab around the new drainage.

What keeping the building saved

Demolishing the old pavilion and building the same design new would have come to roughly **326 tCO2e**, against 252 tCO2e for the refurbishment as built (both including the verandah). Keeping the walls, slab and footings saved about 73 tCO2e, a fifth of the new-build figure. Per m² of covered area, that is 468 against 363 kgCO2e/m².

Scenario	What it includes	A1–A5 tCO2e (approx.)	kgCO2e/m² of covered area
As built: refurbish and re-roof	The new work in this study, including the verandah	252	363
Demolish and rebuild the same design	As built, plus new walls, slab and footings, plus demolition, less the work only a refurbishment needs	~326	~468
Difference		~73 (22%)	~105

The new-build figure is an indicative estimate, not a design. We built it up from the as-built result:

Change from the as-built result	Basis (approximate)	tCO2e
New external double brick walls	~245 m² net of openings, 2 × 90 mm leaves	+34
New ground slab and mesh	~300 m² at 100 mm (the part we kept)	+19
New internal brick walls	~150 m² at 90 mm (allowance)	+11
New strip footings and reinforcement	~86 m under the external walls	+8
Demolition and removal of the old building	~200 t of brick and concrete trucked ~60 km, plus machinery	+4
Work only a refurbishment needs	Bricking up 10 openings, cutting and re-pouring the wet-area slab	−3
Net		**~+73**

The first four rows use the same factors as the new work, with transport and construction added (about 21%). Demolition is counted as site preparation for the new building (A5); the waste mass and distance are assumptions. Demolition would also send about 200 t of sound brick and concrete to landfill or crushing.

The old roof is the same in both cases. We chose to replace it to end the leaking box gutters (see The design choices beyond carbon), so the new roof structure is in both figures and is the largest part of each. That is where the next gain lies (see What we would do differently).

How Kondinin compares

Measured over the covered area, Kondinin's new work (363 kgCO2e/m²) sits between the Narembeen refurbishment and the Bruce Rock new build. The rebuild scenario would be closer to a new build.

Project	Type	Area basis	A1–A5 kgCO2e/m²	Note
Narembeen Administration Office	Refurbishment	540 m² floor	209	Design stage; existing roof largely kept (27 m² new sheet)
Kondinin Pavilion, as built	Refurbishment + new roof	696 m² covered (358 enclosed + 338 verandah)	363	705 per m² of enclosed floor only
Kondinin Pavilion, rebuild scenario	New build, same design	696 m² covered	~468	Indicative
Bruce Rock Supermarket	New build	1,245 m² floor	630	Covered area roughly equal to floor
SAP 2.0 G3 target, 2030	New non-residential	Floor	~380	40% below the Bruce Rock baseline

Three things explain the pattern:

- **Narembeen kept its roof; Kondinin replaced it.** The roof structure is the largest item in both new-build and re-roof projects, so a refurbishment that keeps the roof does much better.

- **The verandah is half the useful space.** Players and spectators use the 338 m² under the roof outside the walls. Counting it in the area, and its concrete in the total, gives a fairer picture than enclosed floor alone, which would show 705 kgCO2e/m².
- **Bruce Rock and the rebuild scenario include new walls and slab.** Kondinin's as-built figure does not, which is the saving from keeping the building.

The comparison is approximate. The bases differ: Narembeen and Bruce Rock are measured per m² of floor, and the SAP target is set on floor area, so Kondinin's 363 should not be read as meeting it. Narembeen also used some product EPDs and netted timber carbon storage.

What we would do differently

The budget shaped every choice. The project was scraped back item by item to meet it, and some items were removed from the scope altogether. Most lower-carbon alternatives below were known to us and set aside on cost. The biggest opportunity is the roof structure, and it starts with a question for the engineer at concept stage: could the old walls help carry the new roof?

Smaller columns: our view, not tested. The roof was designed to stand completely independent of the existing brick walls, on 21 CHS 273 × 6.4 columns and 14 pad footings. That is a cautious choice: it avoids relying on old masonry of unknown condition. We believe the columns could have been smaller, but the budget did not allow a second engineer to review the structure, so we have not tested it and do not claim the saving. As an indication only: the 273 CHS columns alone weigh 3.0 t and account for about 15 tCO2e with their share of transport and construction. If lighter columns, or some load shared with the walls, cut that steel by a third, the saving would be about 5 tCO2e, plus smaller pad footings.

Test the roof structure at concept stage. On the next re-roof, compare two or three structural options for carbon and cost before the design is fixed: independent frame, frame sharing load with the walls, and lighter trusses at closer spacing.

Treated pine studs instead of steel: a small but real saving. The new stud walls (132 m²) used about 0.3 t of light steel framing, roughly 1.6 tCO2e. MGP10 treated pine studs would save about 0.7–1.3 tCO2e, under 1% of the total. The roof framing stays steel: the sheeting spans between widely spaced, lapped Z purlins, which timber battens could not do without a different roof design. The walls are different. The 415 m of steel top hats behind the Custom Orb wall cladding could be treated pine battens where they are fixed to studs at normal spacing, saving about another 1.7 tCO2e. Together, timber studs and wall battens would save about 2.4–3 tCO2e, around 1% of the total. Termites do not change the answer here: treated pine resists termites, and the pavilion already has a HomeGuard termite management system that needs an annual inspection under AS 3660 to keep its warranty, whatever the frame is made of. Large timber structure was not an option: the Shire could not afford its cost.

Timber windows instead of aluminium. About 0.4 t of powder-coated aluminium window frames account for 15 tCO2e, 6% of the total, from only about 200 m of frame. Timber frames would cut most of that: roughly 1.4 m³ of hardwood frames at about 1–2 tCO2e, a saving of around 13–14 tCO2e. That is the largest single saving open to us, larger than timber studs, wall battens or fly ash concrete. Timber windows were considered but not used: beyond their cost, they bring a termite risk to watch and regular repainting at an exposed sports ground, the same maintenance burden for the Shire that the new roof was designed to remove. Two other frame options would save almost as much:

- **uPVC frames** (with steel reinforcement): roughly 2–3 tCO2e, a saving of about 12–13 tCO2e.
- **Lower-carbon ("green") aluminium,** made with renewable power or high recycled content: roughly 2–4 tCO2e, a saving of about 11–13 tCO2e.

These are rough estimates. They use typical published values for PVC and low-carbon aluminium, not the NABERS factors used elsewhere in this study; the supplier's product EPD would confirm them. Like green steel and fly ash concrete, both were cost-prohibitive. Fewer, smaller openings would also reduce this item.

Lower-carbon steel and concrete: considered, but beyond the budget. We looked at lower-emission ("green") steel and fly ash concrete. Both were cost-prohibitive for this project. They target the two largest items: the steel frame and purlins (about 94 tCO2e) and the concrete in the footings, slab work and verandah floor (about 40 tCO2e). As a guide, every 10% cut in the carbon of the steel would save about 9 tCO2e, and every 10% cut in the concrete about 4 tCO2e. The concrete came from Kondinin Building Services, a small local plant; any lower-carbon mix would also depend on what it can supply. As prices fall, these become the next step after designing less material in.

Keep the as-built record as we go. The fabricator's steel traceability report made this study reliable. We had no concrete dockets on this job, so the concrete comes from the QS and drawing take-offs. Asking for dockets, roof sheet orders and window shop drawings at handover would firm up the remaining items.

Lessons for ORA's Sustainability Action Plan

Kondinin is ORA's first measured result for a refurbishment with a new roof. It supports goal G3 (project embodied carbon) and the first principle of our design philosophy, retain and reuse.

1. **Start every brief by asking what can be kept.** Walls, slab, footings, fittings: each one kept is carbon not spent, and here it saved about a fifth of a new build.
2. **Give retention a fair cost comparison.** A new building can look similar in cost once demolition and the risks of working with old fabric are priced. Put the carbon difference beside the cost difference so the client sees both.
3. **Ask the engineer to test load sharing with existing walls.** Where the old structure is sound, using it can shrink the new frame. Raise it at concept stage, when it costs least to explore: on this project the budget did not stretch to a second review later.
4. **Report three figures for refurbishments:** total tCO2e, kgCO2e per m² of covered area (enclosed floor plus verandah, with the verandah floor counted), and kgCO2e per m² of enclosed floor. Floor area alone penalises verandahs.
5. **Report the avoided carbon as well as the spent carbon.** An indicative demolish-and-rebuild comparison makes the benefit of retention visible.
6. **Collect fabricator records at handover.** The steel traceability report in the O&M manual is the best single data source for a calculation like this.

Limitations

The steel figure is measured; most other quantities come from the pre-tender estimate, the IFC drawings or allowances. The column and footing sizes were not reviewed by a second engineer, so the smaller-column saving above is our estimate only. The main uncertainties:

- **Changeroom wall change (VAR13/14, August–September 2025):** came after the QS estimate. The existing changeroom brick was cut back to the window line and replaced with a steel stud wall on the slab edge, about 28 m² net (SD.06, VAR13 option 2, A_302). We counted stud, Custom Orb cladding, sarking, insulation, plasterboard and paint; SD.06 notes Exotec instead, to confirm as built.
- **Footings and concrete:** the schedule shows 14 pads, the QS counted 16. Pad reinforcement is assumed (about 40 kg per pad). No concrete dockets were available, so all concrete volumes are take-offs from the QS and drawings.

- **Wet-area slab:** only the IFC hydraulic drawings were issued (no as-constructed set), so we assumed about 60 m of trench cut out and re-poured. Full room floors would add about 2 tCO2e.
- **Roof sheet:** the warranty says ZINCALUME, the QS says Colorbond. The Colorbond EPD is used as a conservative proxy.
- **Services:** the NABERS new-build rate (30 tCO2e) may overstate a refurbishment.
- **Rebuild scenario:** indicative only, sized from the drawings; not a design.

Acknowledgements

The Kondinin Pavilion was a team effort. ORA thanks the Shire of Kondinin, the Kondinin Community Recreation Council, and the clubs who use the pavilion, and the consultants who worked with us:

Consultant	Role
Fulcrum Structural Engineering	Structural engineering
EMP Consulting	Electrical and hydraulic services design
Tim Franklin Engineering	Mechanical services design
E-LAB Consulting	Fire engineering
Access Right	Accessibility consulting and performance solution
Russell Building Approvals	Building surveying, BCA assessment, energy efficiency report and occupancy permit
RW Quantity Surveyors	Quantity surveying and pre-tender estimate
Perth Geotechnics	Geotechnical investigation
F.M. Surveys	Feature survey
Hilti (Aus.)	Firestop engineering judgement

We also thank ACorp Construction and its subcontractors and suppliers, including Ascent Structural & Architectural Steel, Teksteel Roofing, KM Fabrications and Kondinin Building Services, for building it and for the as-built records that made this study possible.

References and data sources

Project records

- ORA, Kondinin Pavilion Refurbishment architectural drawings A_100–A_801, issued for construction April 2025, revised to October 2025 (VAR 14 wall type update).
- ORA, Architectural Specification Rev 01 and Fixtures, Finishes and Equipment Schedule Rev 3 (August 2025).
- Fulcrum Structural Engineering, drawings S1.01–S5.03, project 24119 (April–May 2025).
- RW Quantity Surveyors, Pre-Tender Estimate v2.0, job 24023 (11 February 2025).
- ACorp Construction, O&M Manual, contract 04/2024-2025 (September 2026), including the Ascent Structural & Architectural Steel material traceability report (contract 1738, 21 July 2026), MTC concrete test reports and the BlueScope warranty advice (20 May 2026).
- Ascent shop drawings 1738-2MP01 to 2MP33 Rev A; Laminex partition and bench shop drawings; Moddex handrail drawings.
- ORA, Case_Study3-Kondinin_Pavilion_Embodied_Carbon-111126.xlsx (embodied carbon workbook, 11 November 2026).

Methods and factors

- NABERS Embodied Carbon: National Emission Factors database v1.0 and Rules.

- GBCA and thinkstep-anz, Embodied Carbon & Embodied Energy in Australia's Buildings (2021): A5 split.
- EPiC Database 2024 (University of Melbourne).
- BlueScope Colorbond steel EPD.
- EN 15978: life cycle stages A1–A5.

Earlier ORA case studies

- Case Study 1: Narembeen Administration Office refurbishment (revised 2026).
- Case Study 2: Bruce Rock Supermarket (2026).

Kondinin Pavilion Refurbishment: embodied carbon of the new works (A1-A5) - ORA Case Study 3

ORA job 2022-0017, Shire of Kondinin. Refurbishment of the existing brick pavilion with a new curved steel roof over the whole building, new change rooms, kitchen, ablutions and club room fit-out. Head contractor ACorp Construction; built 2025-26. Method and factors as the Narembeen and Bruce Rock case studies (NABERS NEF v1.0 defaults, GBCA/thinkstep-anz A5 split, non-residential). Only new materials are counted: the retained walls, slab and footings carry zero A1-A5.

Quantities: RWQS pre-tender estimate v2.0 (11/02/2025) for most elements; structural steel from the Ascent fabricator traceability report (13.9 t); IFC drawings A_100-A_801, S1.01-S5.03 and the O&M manual (Sep 2026). The QS predates VAR13/14 (Aug-Sep 2025): the changeroom wall is taken from SD.06, VAR13 and A_302. Yellow cells on the A1-A5 sheet are assumed values.

Element group	A1-A3 kgCO2e	A4 kgCO2e	A5 kgCO2e	A1-A5 kgCO2e	% of total	kgCO2e/m2 GFA
Substructure	13,272	271	2,320	15,863	6.3%	23
Verandah	23,080	420	4,034	27,535	10.9%	40
Structure	79,447	4,748	13,887	98,083	38.9%	141
Roof	13,081	578	2,286	15,945	6.3%	23
External walls	10,241	588	1,790	12,619	5.0%	18
Glazing	18,049	342	3,155	21,546	8.5%	31
Internal walls	6,924	631	1,210	8,765	3.5%	13
Ceilings	7,079	299	1,237	8,616	3.4%	12
Finishes	10,526	687	1,840	13,052	5.2%	19
Services	23,986	2,254	4,193	30,433	12.1%	44
TOTAL BUILDING	**205,684**	**10,818**	**35,953**	**252,456**	**100.0%**	**363**
External works (concrete paving, ramps, steps, bin store), separate	3,440	89	601	4,130		6
Fitout: stainless benches, joinery, new bench seats, separate	3,528	62	617	4,208		6
Building + fitout				**256,664**		**369**
Check: equals A1-A5 sheet total	0					
Covered area (m2): GFA 358 + verandah 338 (= new roof)	696.00					
Upfront carbon A1-A5, new works (kgCO2e/m2 of covered area)	**363**					
Total, building (tCO2e)	252.5					
Structural steel incl. purlins (tonnes)	18.6					
kgCO2e per m2 GFA (enclosed 358 m2 only)	705	358.00				

Sensitivity: steel +/-10%

Steel factor	A1-A5 kgCO2e/m2
90%	349
100%	363
110%	376

Not counted: the retained brick walls, slab and footings (reused in place, zero A1-A5); demolition of the old roof and fit-out (module C of the old building); relocated benches and fittings; sanitaryware and appliances as products (in the services rate). Carbon storage in timber is not netted.

Assumptions and uncertainties (largest effect first)

1. VAR13/14 changeroom feature wall: Custom Orb per VAR13 option 2 (SD.06 notes Exotec); ~28 m2 from A_302
2. Pad footing reinforcement (S5.02) assumed; no concrete dockets available, so concrete volumes stay as QS/drawing take-off; QS counted 16 pads, schedule shows 14
3. Roof sheet: ZINCALUME (warranty) vs Colorbond (QS); BMT and mass
4. Timekeepers stair (QS PSum, no details) and stainless bench masses
5. Purlin lengths from the roofer order (QS lengths used)
6. Services: NABERS new-build rate applied to a refurbishment

Comparison (A1-A5, kgCO2e/m2, NABERS method; Kondinin per m2 of covered area)

Narembeen Administration Office refurbishment (2026 revision)	209
Bruce Rock Supermarket, new build (Case Study 2)	630
Kondinin Pavilion refurbishment + new roof (this study)	363
SAP 2.0 G3 2030 target for new non-residential (about 40% below the Br	378

Indicative comparison: demolish and rebuild the same design (ORA estimate, not a design)

New external double brick walls (~245 m2 net, 2 x 90 mm leaves)	28,315
New ground slab and mesh (~300 m2 at 100 mm)	16,168
New internal brick walls (~150 m2 at 90 mm, allowance)	8,668
New strip footings and reinforcement (~86 m)	6,423
Subtotal A1-A3, plus A4 and A5 (~21%)	72,084
Demolition and removal of the old building (~200 t, ~60 km; assumed, A5	4,000
Less work only a refurbishment needs (brick-ups, wet-area slab cut-outs)	-3,000
Rebuild scenario total (kgCO2e)	325,540
Saving from keeping the building (kgCO2e)	73,084
Saving as % of the rebuild scenario	22%
Rebuild scenario, kgCO2e per m2 of covered area (696 m2)	468
As built, kgCO2e per m2 of covered area	363

Kondinin Pavilion Refurbishment (Shire of Kondinin): upfront embodied carbon A1-A5 of the NEW WORKS (refurbishment and new roof over the retained building). ORA job 2022-0017. Prepared November 2026. Quantities from IFC drawings (Apr-Oct 2025), structural S1.01-S5.03 (Fulcrum 24119) and the O&M manual (Sep 2026); see Status column.

Element / material	Number	Linear m	Area (m2)	Volume (m3)	Weight (kg)	A1-A3 ECF kgCO2e/unit	A1-A3 kgCO2e	A1-A3 kgCO2e per unit qty	A4 ECF kgCO2e/kg	A4 kgCO2e	A5a (2025) 15.94% of A1-A3	A5w (2025) 1.54% of A1-A3	Total A1-A5 kgCO2e	Status	Source / assumption	Element group	Emission factor source
SUBSTRUCTURE (new work only; existing slab and footings retained)																	
Pad footings PF1-PF14 to new roof columns, 25 MPa				16.99	40,764.00	0.17	6,726.06		0.00	44.03	1,071.91	103.80	7,945.80	Measured	S1.01 footing schedule (14 pads: 9 x 1500, 3 x 1800, 1 x 1600, 1 x 1200, all 500 deep). The QS counted 16 (items 37-40). N25 confirmed by MTC test report CON:MC25-00996 (pavilion footings, 4/07/2025); batched locally by Kondinin Building Services.	Substructure	NABERS NEF v1.0 default
Pad footing reinforcement and cast-in hold-down bolts					600.00	3.65	2,190.00		0.22	131.05	349.01	33.80	2,703.86	Assumed	Pad reinforcement is referred to detail on S5.02 but is not readable as text; ~40 kg per pad plus HD bolts assumed.	Substructure	NABERS NEF v1.0 default
New internal ground slab 100mm, 25 MPa (100A) with ET1 edge thickening			32.00	5.00	12,000.00	0.17	1,980.00	61.88	0.00	12.96	315.54	30.56	2,339.06	Measured	RWQS PTE v2.0 (11/02/2025) items 41-42: 32 m2 slab, 30 m ET1. S1.01 legend 100A. MTC report CON:MC25-01088 "floor slab" N25, 15/07/2025.	Substructure	NABERS NEF v1.0 default
Mesh SL82 to new slab (3.56 kg/m2 + 10% laps) and dowels to existing slab			32.00		163.67	3.65	597.41	18.67	0.22	35.75	95.21	9.22	737.58	Estimated	S1.01 legend 100A; S5.02 N12 x 360 dowels @ 250 along ~30 m of joint.	Substructure	NABERS NEF v1.0 default
Waterproof membrane 0.2mm polyethylene under new slab			32.00		6.08	1.20	38.40	1.20	0.06	0.37	6.12	0.59	45.48	Measured	S1.01 legend. 1.2 kgCO2e/m2 for 200 micron film (EPiC 2024), as Bruce Rock.	Substructure	EPiC Database 2024
Slab modifications for new plumbing (change rooms, toilets, UAT, kitchen): saw cut, trench and reinstate 100mm slab, 25 MPa		60.00	27.00	2.70	6,480.00	0.17	1,069.20	39.60	0.00	7.00	170.39	16.50	1,263.09	Assumed	Tuan, Nov 2026: existing slab cut out in the change room and toilet areas, drainage pre-laid, then refilled with new concrete (falls formed in the new pour; no screed). Not itemised in the QS (within hydraulic builder's work). ASSUMED ~60 m of trench x 450 wide (11 floor wastes, 7 WCs, urinal, 5 showers, 8 basins, sinks). IFC hydraulic drawings only; no as-constructed set issued.	Substructure	NABERS NEF v1.0 default
Slab reinstatement: N12 dowels both sides @ 400, SL72 mesh strips and membrane patches		60.00			183.78	3.65	670.80	11.18	0.22	40.14	106.90	10.35	828.19	Assumed	Typical trench reinstatement detail assumed (not on S5.02). Membrane patches negligible.	Substructure	NABERS NEF v1.0 default
STRUCTURE (new roof structure over the retained building, and timekeepers box)																	
Structural steel: CHS columns, RHS/SHS trusses TR1-TR7, CHS struts, PFC/UB beams, angles and plates					13,898.80	4.09	56,846.09		0.22	3,035.69	9,059.34	877.32	69,818.44	Measured	Ascent Structural & Architectural Steel Material Traceability Report, contract 1738 (21/07/2026, O&M pp. 1077-1133): 620 pieces with section and weight. Painted (Duremax GPE) and hot-dip galvanised; galvanised factor used for all. Mills mostly overseas. Cross-check: RWQS PTE v2.0 (11/02/2025) items 43-55 total 13.1 t.	Structure	NABERS NEF v1.0 default
Bolts, anchors and site fixings (2% allowance)					277.98	4.09	1,136.92		0.22	60.71	181.19	17.55	1,396.37	Assumed	Not in the traceability report.	Structure	NABERS NEF v1.0 default
Cold-formed galvanised purlins Z/C150, Z/C200, Z/C250 @ 900, incl. bridging (+5%)					4,471.23	4.24	18,958.00		0.33	1,497.32	3,021.26	292.58	23,769.16	Measured	RWQS PTE v2.0 (11/02/2025) items 58-61: Z/C15012 28 m, Z/C20015 336 m, Z/C20019 279 m, Z/C25024 159 m. Not in the fabricator list (roofer supply). kg/m as Bruce Rock.	Structure	NABERS NEF v1.0 default
Roof strap bracing RBR2 50x1.0 (139 m) and RBR1 30x1.0 (15 m) PGI; wall bracing 90x6 EA (14 m)		154.00			172.89	4.24	733.05	4.76	0.33	57.90	116.82	11.31	919.09	Measured	RWQS PTE v2.0 (11/02/2025) items 56, 57, 72.	Structure	NABERS NEF v1.0 default
Timekeepers box: floor joists J1 190x35 MGP10		48.00		0.32	175.56	442.00	141.09	2.94	0.06	10.62	22.48	2.18	176.37	Measured	RWQS PTE v2.0 (11/02/2025) item 49 (48 m). LVL factor used as a proxy for sawn MGP10; carbon storage not netted (as Bruce Rock).	Structure	NABERS NEF v1.0 LVL (proxy for sawn softwood)
Timekeepers box: Structaflor particleboard flooring 19mm			12.00	0.23	162.11	880.00	200.64	16.72	0.06	9.80	31.98	3.10	245.52	Measured	RWQS PTE v2.0 (11/02/2025) item 50 (12 m2).	Structure	NABERS NEF v1.0 default
Timekeepers access stair: steel stringers, treads and handrails (allowance)					350.00	4.09	1,431.50		0.22	76.44	228.13	22.09	1,758.17	Assumed	RWQS PTE v2.0 (11/02/2025) item 51 PSum $16,000, no details. 350 kg steel assumed; confirm from the stair shop drawing.	Structure	NABERS NEF v1.0 default
ROOF																	
Roof sheeting: ZINCALUME corrugated (Custom Orb), curved to long radius, 0.48 BMT			696.00		3,062.40	3.24	9,919.11	14.25	0.16	479.20	1,580.77	153.08	12,132.17	Measured	RWQS PTE v2.0 (11/02/2025) item 62: 696 m2 (QS described Colorbond). BlueScope warranty advice 20/05/2026 (O&M p. 1209): ZINCALUME, unpainted, curved roof, traditional profile. Colorbond EPD used as a conservative proxy (no ZINCALUME EPD on file). ~4.4 kg/m2 assumed.	Roof	BlueScope Colorbond EPD (proxy for ZINCALUME)
Roof insulation R1.5 Anticon blanket (glass wool + foil)			696.00		626.40	2.67	1,856.93	2.67	0.06	37.88	295.93	28.66	2,219.40	Measured	FF&E 01.01.01; included with QS item 62. Foil 1.9 kgCO2e/m2 + ~0.8 kg/m2 glass wool at 0.96 kgCO2e/kg.	Roof	EPiC 2024 foil + glass wool (as Narembeen)
Flashings: head wall, curved side wall, under/over (144 m at ~0.6 m girth)			86.40		387.07	15.10	1,304.64	15.10	0.16	60.57	207.92	20.13	1,593.26	Estimated	RWQS PTE v2.0 (11/02/2025) items 63-65 (144 m). Girth assumed.	Roof	BlueScope Colorbond EPD (as Narembeen)
EXTERNAL WALLS (existing face brick walls retained)																	
New 90mm brick external walls, rendered both sides (WT1)			32.00	2.88	4,118.40	0.45	1,849.16	57.79	0.06	249.08	294.69	28.54	2,421.47	Measured	RWQS PTE v2.0 (11/02/2025) item 66. Brick density 1430 kg/m3 of wall as Narembeen.	External walls	As Narembeen (clay brick)
VAR13/14 changeroom feature wall: 92 steel stud on slab edge		84.00	28.00		66.14	4.24	280.44	10.02	0.06	4.00	44.69	4.33	333.46	Measured	SD.06 (changeroom wall update) and VAR13 feature wall option 2 Rev2: existing changeroom brick (W10) demolished back to the window line, cavities closed with brick, new steel stud wall on the slab edge. A_302 VAR14: ~12.1 m x 2.74 m, ~28 m2 net of openings. 3 lm/m2 and 1.27 lm/kg as Bruce Rock.	External walls	NABERS NEF v1.0 default
VAR13/14 changeroom feature wall: Custom Orb ZINCALUME 0.48 BMT cladding			28.00		123.20	3.24	399.04	14.25	0.16	19.28	63.59	6.16	488.08	Measured	SD.06 (changeroom wall update) and VAR13 feature wall option 2 Rev2: existing changeroom brick (W10) demolished back to the window line, cavities closed with brick, new steel stud wall on the slab edge. A_302 VAR14: ~12.1 m x 2.74 m, ~28 m2 net of openings. Cladding per VAR13 option 2 quote (SD.06 notes Exotec FC).	External walls	BlueScope Colorbond EPD (proxy for ZINCALUME)
VAR13/14 changeroom feature wall: top hats, sarking, R2.5 insulation		67.20	28.00		428.22	1.00	428.22	15.29	0.06	25.90	68.24	6.61	528.97	Estimated	SD.06 (changeroom wall update) and VAR13 feature wall option 2 Rev2: existing changeroom brick (W10) demolished back to the window line, cavities closed with brick, new steel stud wall on the slab edge. A_302 VAR14: ~12.1 m x 2.74 m, ~28 m2 net of openings. F column is kgCO2e (factor 1). Insulation assumed as WT2.	External walls	As rows above (steel 4.24/kg; EPiC foil 1.9/m2; glass wool 0.96/kg)
VAR13/14 changeroom feature wall: 10mm plasterboard and paint inside			28.00		238.00	0.48	115.37	4.12	0.06	14.39	18.39	1.78	149.94	Measured	SD.06 (changeroom wall update) and VAR13 feature wall option 2 Rev2: existing changeroom brick (W10) demolished back to the window line, cavities closed with brick, new steel stud wall on the slab edge. A_302 VAR14: ~12.1 m x 2.74 m, ~28 m2 net of openings. Plasterboard 8.5 kg/m2; paint as other rows.	External walls	NABERS NEF v1.0 default
VAR13/14: brick to close cavities at the cut-back walls			2.00	0.18	257.40	0.45	115.57	57.79	0.06	15.57	18.42	1.78	151.34	Assumed	SD.06 (changeroom wall update) and VAR13 feature wall option 2 Rev2: existing changeroom brick (W10) demolished back to the window line, cavities closed with brick, new steel stud wall on the slab edge. A_302 VAR14: ~12.1 m x 2.74 m, ~28 m2 net of openings. 2 m2 allowance.	External walls	As Narembeen (clay brick)
280 brick in closing up external openings			2.00	0.50	715.00	0.45	321.04	160.52	0.06	43.24	51.16	4.95	420.39	Measured	RWQS PTE v2.0 (11/02/2025) item 67.	External walls	As Narembeen (clay brick)
Steel stud walls WT2/WT4 (92 stud)		360.00	120.00		283.46	4.24	1,201.89	10.02	0.06	17.14	191.54	18.55	1,429.12	Measured	RWQS PTE v2.0 (11/02/2025) items 69-71: 39 + 71 + 10 m2. 3 lm/m2 and 1.27 lm/kg as Bruce Rock.	External walls	NABERS NEF v1.0 default
Custom Orb ZINCALUME cladding: WT2 (110 m2), WT4 both sides (20 m2), lining to existing brick ZC2 (43 m2)			173.00		761.20	3.24	2,465.53	14.25	0.16	119.11	392.92	38.05	3,015.61	Measured	RWQS PTE v2.0 (11/02/2025) items 68-71.	External walls	BlueScope Colorbond EPD (proxy for ZINCALUME)
Top hat battens / furring channels to Custom Orb		415.20			451.30	4.24	1,913.53	4.61	0.06	27.29	304.95	29.53	2,275.31	Estimated	2.4 lm/m2, 0.92 lm/kg as Bruce Rock.	External walls	NABERS NEF v1.0 default
Fibre cement lining (Exotec / CFC) to WT2 other face			39.00		581.10	1.39	807.73	20.71	0.06	35.14	128.72	12.47	984.06	Measured	RWQS PTE v2.0 (11/02/2025) item 69 (39 m2); VAR 14 specified James Hardie Exotec (WT5). FC panel mass as Bruce Rock.	External walls	NABERS NEF v1.0 default
R2.5 glass wool insulation to WT2 stud walls			110.00		267.30	0.96	256.61	2.33	0.06	16.17	40.89	3.96	317.63	Measured	RWQS PTE v2.0 (11/02/2025) items 69-70; FF&E 01.01.03.	External walls	As Narembeen (product EPD/earlier factor)
Paint to external cladding and FC			173.00		34.60	0.50	86.50	0.50	0.06	2.09	13.79	1.33	103.71	Estimated	RWQS PTE v2.0 (11/02/2025) items 68-71 include paint.	External walls	As Narembeen (product EPD/earlier factor)
WINDOWS AND EXTERNAL DOORS																	
Glazing 6mm toughened: windows (56 m2, 20 no.) and glazed aluminium doors (~11 m2)			67.00		1,005.00	2.38	2,391.90	35.70	0.22	219.51	381.19	36.91	3,029.51	Measured	RWQS PTE v2.0 (11/02/2025) items 74-75, 79-80. Door glass area assumed (~1 single + 2 double doors).	Glazing	NABERS NEF v1.0 default
Aluminium frames, powder coated Colorbond Monument (Alspec / Viewmax / Swan Evo)		201.00			402.00	32.00	12,864.00	64.00	0.22	87.80	2,050.08	198.53	15,200.42	Estimated	KM Fabrications (Boulder) shop drawings, O&M pp. 1215-1222. ~3 lm of frame per m2 of glazing, 2 kg/m (as Bruce Rock).	Glazing	NABERS NEF v1.0 default
Insect and security screens (aluminium / stainless)			9.00		27.00	32.00	864.00	96.00	0.22	5.90	137.69	13.33	1,020.92	Assumed	RWQS PTE v2.0 (11/02/2025) items 76-78 (9 m2). ~3 kg/m2 assumed, aluminium factor.	Glazing	NABERS NEF v1.0 default

Roller shutter RD01 1.92 x 2.49 m			4.78		123.70	132.00	630.45	132.00	0.06	7.48	100.47	9.73	748.14	Measured	Arco O&M p. 1230 (36mm extruded shutter); QS item 82. NABERS roller door default per m2.	Glazing	NABERS NEF v1.0 default
Solid core external doors (6), timber	6		11.70		351.00	111.00	1,298.70	111.00	0.06	21.23	206.97	20.04	1,546.94	Measured	RWQS PTE v2.0 (11/02/2025) item 81. NABERS timber door per m2.	Glazing	NABERS NEF v1.0 default
INTERNAL WALLS AND SCREENS																	
New 90mm internal brick walls faced both sides (WT1)			28.00	2.52	3,603.60	0.45	1,618.02	57.79	0.06	217.95	257.86	24.97	2,118.79	Measured	RWQS PTE v2.0 (11/02/2025) item 87.	Internal walls	As Narembeen (clay brick)
110 brick firewall 90/90/90 (extension to underside of roof) and 110 brick-up			19.00	2.09	2,988.70	0.45	1,341.93	70.63	0.06	180.76	213.86	20.71	1,757.25	Measured	RWQS PTE v2.0 (11/02/2025) items 88-89; spec 0335; S4.03.	Internal walls	As Narembeen (clay brick)
280 brick in closing up internal openings (6 no.)			5.00	1.25	1,787.50	0.45	802.59	160.52	0.06	108.11	127.91	12.39	1,050.99	Measured	RWQS PTE v2.0 (11/02/2025) item 90.	Internal walls	As Narembeen (clay brick)
Stud walls: 76 stud lined both sides (6 m2), 92 stud lined one side (6 m2)		36.00	12.00		28.35	4.24	120.19	10.02	0.06	1.71	19.15	1.85	142.91	Measured	RWQS PTE v2.0 (11/02/2025) items 85-86.	Internal walls	NABERS NEF v1.0 default
Plasterboard to stud walls (18 m2) and Fyrchek lining to existing brick for 90/90/90 (27 m2)			45.00		498.60	0.47	235.84	5.24	0.06	30.16	37.58	3.64	307.22	Measured	RWQS PTE v2.0 (11/02/2025) items 85, 86, 91. Fyrchek 16mm ~12.8 kg/m2.	Internal walls	NABERS NEF v1.0 default
Toilet and shower partitions and doors, 13mm compact laminate (Aqualoo)			40.00	0.75	1,055.60	1,320.00	995.28	24.88	0.06	63.84	158.61	15.36	1,233.10	Measured	RWQS PTE v2.0 (11/02/2025) items 92-93: 40 m2 partitions + 10 doors. FF&E 04.08.01. No compact laminate factor on file; MDF per m3 used as a proxy.	Internal walls	NABERS NEF v1.0 MDF (proxy for compact laminate)
Internal doors: 4 solid core + 1 hollow core sliding, timber	5		9.75		292.50	111.00	1,082.25	111.00	0.06	17.69	172.47	16.70	1,289.12	Measured	RWQS PTE v2.0 (11/02/2025) items 95-96; A_801.	Internal walls	NABERS NEF v1.0 default
Steel door frames: JDS 1.2mm zincanneal (11 external + internal)		57.20			171.60	4.24	727.58	12.72	0.06	10.38	115.95	11.23	865.14	Estimated	FF&E 02.04.01. ~5.2 m per frame, ~3 kg/m assumed.	Internal walls	NABERS NEF v1.0 default
WALL FINISHES																	
Plaster to new and existing internal brick walls (12mm)			459.00		11,016.00	0.17	1,817.64	3.96	0.00	11.90	289.67	28.05	2,147.26	Measured	RWQS PTE v2.0 (11/02/2025) items 98-99: 60 + 399 m2. ~24 kg/m2 at 12mm.	Finishes	NABERS 25 MPa concrete (proxy for cement plaster)
Internal paint, 2 coats			604.90		105.86	0.39	237.12	0.39	0.06	6.40	37.79	3.66	284.97	Measured	RWQS PTE v2.0 (11/02/2025) items 98-101 plus door faces.	Finishes	As Narembeen (product EPD/earlier factor)
Ceramic wall tiles and splashbacks			69.00		1,242.00	0.98	1,222.13	17.71	0.22	271.27	194.77	18.86	1,707.03	Measured	RWQS PTE v2.0 (11/02/2025) items 102-103.	Finishes	As Narembeen (product EPD/earlier factor)
Waterproofing to shower walls and floors			41.00		20.50	0.46	9.43	0.23			1.50	0.15	11.08	Measured	RWQS PTE v2.0 (11/02/2025) items 104, 110.	Finishes	As Narembeen (product EPD/earlier factor)
CEILINGS																	
Plasterboard ceilings 13mm: standard 130, moisture resistant 120, raking 11, acoustic 80, bulkhead 2 (m2)			343.00		2,915.50	0.47	1,379.03	4.02	0.06	176.33	219.77	21.28	1,796.41	Measured	RWQS PTE v2.0 (11/02/2025) items 114-118 (343 m2). FF&E 02.03.	Ceilings	NABERS NEF v1.0 default
Ceiling suspension (Rondo)		1,029.00			1,118.48	4.24	4,742.35	4.61	0.06	67.65	755.77	73.19	5,638.95	Estimated	FF&E 02.03.05. 3 lm/m2.	Ceilings	NABERS NEF v1.0 default
R4 bulk insulation to ceilings			343.00		857.50	0.96	823.20	2.40	0.06	51.86	131.19	12.70	1,018.96	Measured	FF&E 01.01.02; included in QS items 114-118. ~2.5 kg/m2 glass wool.	Ceilings	As Narembeen (product EPD/earlier factor)
Ceiling paint			343.00		60.03	0.39	134.46	0.39	0.06	3.63	21.43	2.08	161.59	Measured		Ceilings	As Narembeen (product EPD/earlier factor)
FLOOR FINISHES																	
Vinyl: heavy duty non-slip (118 m2) and acoustic (28 m2), with coved skirting			146.00		438.00	37.80	5,518.80	37.80	0.22	95.67	879.51	85.17	6,579.15	Measured	RWQS PTE v2.0 (11/02/2025) items 107-108, 113. FF&E 02.01.01-02 (Tarkett Safetred, Tapiflex).	Finishes	NABERS NEF v1.0 default
Carpet tiles (GH Commercial, club room)			80.00		62.40	5.30	424.00	5.30	0.22	13.63	67.57	6.54	511.74	Measured	RWQS PTE v2.0 (11/02/2025) item 109.	Finishes	As Narembeen (GH Commercial EPD)
Ceramic floor tiles to falls and tile skirting			73.20		1,317.60	0.98	1,296.52	17.71	0.22	287.78	206.62	20.01	1,810.93	Measured	RWQS PTE v2.0 (11/02/2025) items 106, 112.	Finishes	As Narembeen (product EPD/earlier factor)
BUILDING SERVICES																	
Building services MEP: NABERS rate per m2 GFA (enclosed 358 m2 only)			358.00		6,730.40	67.00	23,986.00	67.00	0.33	2,253.88	3,822.55	370.18	30,432.61	Assumed	NABERS Rules s.9.6: services by rate per m2 (office/commercial low rise), as Bruce Rock. QS 1.18-1.20: new sanitary fixtures, electrical to all 358 m2, split systems and cassette, mechanical ventilation. A rate for new-build services may overstate a refurbishment.	Services	NABERS NEF v1.0 default
VERANDAH UNDER THE NEW ROOF (338 m2 floor, part of the covered area)																	
Verandah: in-situ concrete paving 100mm 25 MPa			338.00	33.80	81,120.00	0.17	13,384.80	39.60	0.00	87.61	2,133.08	206.57	15,812.06	Measured	RWQS PTE v2.0 (11/02/2025) items 180-182, 190 (376 m2 in total). Verandah = new roof area 696 m2 less GFA 358 m2 = 338 m2; the rest lies outside the roofline.	Verandah	NABERS NEF v1.0 default
Verandah: edge thickenings ET1 250x250				10.79	25,889.36	0.17	4,271.74		0.00	27.96	680.77	65.93	5,046.40	Measured	RWQS PTE v2.0 (11/02/2025) items 183-185, 191 (extra depth below the slab only), pro rata by area.	Verandah	NABERS NEF v1.0 default
Verandah: mesh SL72 (2.6 kg/m2 + 10%) and trench mesh			338.00		1,374.89	3.65	5,018.34	14.85	0.22	300.29	799.75	77.45	6,195.83	Estimated	S1.01 legend 100; 3-L8TM assumed in thickenings.	Verandah	NABERS NEF v1.0 default
Verandah: waterproof membrane			338.00		64.22	1.20	405.60	1.20	0.06	3.88	64.64	6.26	480.38	Measured	S1.01 legend 100.	Verandah	EPiC Database 2024
EXTERNAL WORKS (reported separately, not in the building total)																	
Paving outside the roofline: in-situ concrete paving 100mm 25 MPa			38.00	3.80	9,120.00	0.17	1,504.80	39.60	0.00	9.85	239.81	23.22	1,777.69	Measured	RWQS PTE v2.0 (11/02/2025) items 180-182, 190 (376 m2 in total). Verandah = new roof area 696 m2 less GFA 358 m2 = 338 m2; the rest lies outside the roofline.	External works	NABERS NEF v1.0 default
Paving outside the roofline: edge thickenings ET1 300x300 and ET2 250x250				1.21	2,910.64	0.17	480.26		0.00	3.14	76.54	7.41	567.35	Measured	RWQS PTE v2.0 (11/02/2025) items 183-185, 191 (extra depth below the slab only), pro rata by area.	External works	NABERS NEF v1.0 default
Paving outside the roofline: mesh SL72 (2.6 kg/m2 + 10%) and trench mesh			38.00		154.57	3.65	564.19	14.85	0.22	33.76	89.91	8.71	696.57	Estimated	S1.01 legend 100; 3-L8TM assumed in thickenings.	External works	NABERS NEF v1.0 default
Paving outside the roofline: waterproof membrane			38.00		7.22	1.20	45.60	1.20	0.06	0.44	7.27	0.70	54.01	Measured	S1.01 legend 100.	External works	EPiC Database 2024
Colorbond fencing 1.8 m (23 m) and double gate, bin store			45.00		220.50	3.24	714.20	15.87	0.16	34.50	113.82	11.02	873.54	Measured	RWQS PTE v2.0 (11/02/2025) items 192-193.	External works	BlueScope Colorbond EPD (as Narembeen)
Handrails to external steps, steel	4.00				32.00	4.09	130.88	32.72	0.22	6.99	20.86	2.02	160.75	Estimated	RWQS PTE v2.0 (11/02/2025) item 186.	External works	NABERS NEF v1.0 default
FITOUT: KITCHEN, BENCHES AND FITMENTS (reported separately, not in the building total)																	
Stainless steel bench units (15 m), overhead shelf (1 m)	16.00				480.00	5.99	2,875.20	179.70	0.06	29.03	458.21	44.37	3,406.81	Assumed	RWQS PTE v2.0 (11/02/2025) items 120-121, 123; CCR Commercial. ~30 kg/m assumed.	Fitout	NABERS NEF v1.0 default
Laminate cupboards and benches: melamine particleboard (MHG Group, Bruce Rock)		35.00	0.63		447.93	880.00	554.40	15.84	0.06	27.09	88.35	8.56	678.40	Assumed	RWQS PTE v2.0 (11/02/2025) items 121, 124-125 (~8 m of joinery); ~35 m2 of board assumed.	Fitout	NABERS NEF v1.0 default
New bench seats (hockey, umpire), compact laminate			5.76	0.07	104.83	1,320.00	98.84	17.16	0.06	6.34	15.75	1.53	122.46	Measured	Acorp/Laminex shop drawing 54514-ST2 (umpire 1.2 m, hockey 2.2 m) and QS item 127. Home and away benches are the relocated existing seats (reused).	Fitout	NABERS NEF v1.0 MDF (proxy for compact laminate)
NOT COUNTED																	
Existing double brick walls, slab, footings and internal walls retained														Excluded	Zero A1-A5: reused in place. The main carbon saving compared with a new pavilion.	Not counted	
Demolition: old roof (451 m2), clerestory, footy tower, kitchen, toilets, paving (130 m2)														Excluded	End-of-life (module C) of the old building, not A1-A5 of the new work. QS 1.2 and 2.2.	Not counted	
Relocated bench seats (28 m), coat hooks, stainless island bench, HWS and gas bottles														Excluded	Reused (A_200; QS items 11-12, 122, 128).	Not counted	
Septic system, tanks, leach drains, in-ground services														Excluded	External services (QS 2.6); materials not specified.	Not counted	
Sanitaryware, tapware, appliances, AC units as products														Excluded	Covered by the NABERS services rate; no item take-off.	Not counted	
Recycled plastic bollards (16), trees														Excluded	Recycled content / landscaping; not counted.	Not counted	
TOTAL kgCO2e (building new works, excl. external works and fitout)							**205,684.35**			**10,818.11**	**32,779.10**	**3,174.38**	**252,455.94**				
kgCO2e per m2 of covered area (under the new roof)							**295.52**			**15.54**	**47.10**	**4.56**	**362.72**				
Covered area (m2) = new roof area: enclosed GFA 358 + verandah 338			696.00														
Total tCO2e													252.46				
GFA enclosed (m2), RWQS PTE v2.0 (39 new + 319 refurbished)			358.00														
kgCO2e per m2 GFA (enclosed only)													705.18				

Ref: Table 7 (page 33), 'Embodied Carbon & Embodied Energy in Australia's Buildings', GBCA and thinkstep-anz for DISER (2021). Linear interpolation between 2019 and 2050 values, kgCO2e/m2 shares.

							Construction year (input)	
		2019	Proportion to A1-3	2050	Proportion to A1-3	Slope (m)	2025	Proportion to A1-3
Non-residential	A1-A3	7.35	1	9.44	1	0.067419355	7.754516129	100.00%
	A4	0.13	0.01768707482993	0.21	0.02224576271186	0.002580645	0.145483871	1.88%
	A5a	1.47	0.2	0.26	0.02754237288136	-0.03903226	1.2358064516	15.94%
	A5w	0.11	0.01496598639456	0.16	0.01694915254237	0.001612903	0.1196774194	1.54%
	C2	0.03	0.00408163265306	0.05	0.00529661016949	0.000645161	0.0338709677	0.44%
	C3-C4	0.04	0.00544217687075	0.06	0.00635593220339	0.000645161	0.0438709677	0.57%

Kondinin construction 2025-26 (footings July 2025, practical completion mid 2026). 2025 used; change H3 to test.

A4 Default Transport Emission

Project location:	Kondinin	
Distance from Perth (km)	280	ASSUMED: approx. road distance Perth to Kondinin (~280 km); confirm. Steel (High Wycombe), roofing (Wangara) and most trades from Perth.
Concrete plant distance (km)	5	Concrete batched locally by Kondinin Building Services (O&M directory; MTC test reports). 5 km assumed.

	Distance 1 km	Emission 1 kgCO2e/tkm	Distance 2 km	Emission 2 kgCO2e/tkm	A4 EF kgCO2e/kg
Local supply 16t truck (concrete)	5	0.216			0.001080
Perth supply 16t truck	280	0.216			0.060480
Eastern States product (truck) + Perth leg	4000	0.0686			0.334880
Eastern States product (rail) + Perth leg	4000	0.024			0.156480
Overseas product (Shanghai) + Perth leg	190	0.0686	9000	0.0161	0.218414

Same transport assumptions and emission factors as the Narembeen and Bruce Rock case studies, with Kondinin distances.

Structural steel. Part 1: Ascent Structural & Architectural Steel, Material Traceability Report, contract 1738, 21/07/2026 (O&M manual pp. 1077-1133). One line per piece; weights as printed. Part 2: cold-formed purlins taken off S1.01/S3.02 (not in the fabricator list).

Section	Pieces	Mass (kg)	Type
200X100X6.0RHS-C350LO	14	3,366	Section
273X6.4CHS-C350LO	21	3,018	Section
100X6.0SHS-C350LO	14	1,717	Section
10PL-250	737	1,304	Plate
114X4.5CHS-C350LO	23	1,296	Section
50X3.0SHS-C350LO	92	467	Section
50X5EA-300+	83	435	Section
125X4.0SHS-C350LO	5	327	Section
180X75PFC-300+	8	319	Section
5PL-250	28	312	Plate
150X75PFC-300+	7	274	Section
12PL-250	15	228	Plate
200X75PFC-300+	1	182	Section
150UB14-300+	2	121	Section
90X6EA-300+	5	119	Section
89X3.5SHS-C350LO	3	91	Section
75X3.0SHS-C350LO	4	77	Section
75X5.0SHS-C350LO	2	64	Section
75X8EA-300+	58	56	Section
100X3.0SHS-C350LO	2	50	Section
42X3.2CHS-C350LO	2	27	Section
34X3.2CHS-C350LO	2	22	Section
8PL-G350	21	17	Plate
3PL-250	4	7	Plate
2PL-300+	4	4	Plate
TOTAL fabricated steel (kg)		13,899	
Check: 273 CHS columns, 21 no. (7 single C5 + 7 double C2		3,183	

PURLINS: RWQS PTE v2.0 items 58-61 (lengths); S1.01 member schedule P1-P9 @ 900 c/c. kg/m as Bruce Rock workbook.

Section	Marks	kg/m	Length (m)	Mass (kg)
Z/C15012	P1	2.72	28	76
Z/C20015	P3, P6, P7, P8	4.24	336	1,425
Z/C20019	P4, P5	5.37	279	1,498
Z/C25024	P2, P9	7.92	159	1,259
Purlins subtotal (kg)				4,258
Bridging, cleats, laps +5%				213
TOTAL cold-formed purlins (kg)				4,471

Z/C20019 mass scaled from Z/C20015 by thickness (approx.). Cross-check: QS steel (items 43-55) 13.1 t vs fabricator 13.9 t.

Copied to column C for the A1-A5 link: 4,471