Case Study 2 – Bruce Rock Supermarket Embodied Carbon (A1–A5)

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Summary

The Bruce Rock Supermarket and Hardware, completed in 2023, carries an upfront embodied carbon (modules A1–A5) of about **785 tCO2e, or 630 kgCO2e/m²** of gross floor area. That figure covers the building only, including a standard allowance for building services. Store fitout adds about 51 kgCO2e/m², and the asphalt yard and plant slabs about 5 kgCO2e/m².

This is ORA's second embodied carbon case study, and its first of a completed new building. The project was designed and built before ORA adopted its Sustainability Action Plan (SAP), so no carbon targets shaped its design. That makes it an honest baseline: it shows what a typical ORA regional commercial building emits when carbon is not considered, and it tells us where to act next time.

Three findings stand out:

- **Structure and concrete dominate.** Steel, concrete and reinforcement are about 60% of the building total. Structural steel alone is 252 tCO2e.
- **Aluminium is a hidden hotspot.** The roof plant deck, roof walkways, window frames and skirting add up to about 64 tCO2e (8%), more than the whole roof.
- **Data quality changes the answer.** Our first estimate, built from the cost plan, was 821 kgCO2e/m². Fabricator shop drawings brought it to 630. Early, element-based quantities are the single biggest improvement ORA can make to its carbon work.

The project

The Shire of Bruce Rock built a new Shire-owned supermarket and hardware store at 52 & 52A Johnson Street, Bruce Rock, in the eastern Wheatbelt. ORA designed it and administered the construction contract (ORA job 2020-0011).

Item	Detail
Client	Shire of Bruce Rock
Builder	Devlyn Australia Pty Ltd

Item	Detail
Gross floor area	About 1,245 m² enclosed (41.7 × 29.9 m), plus a 232 m² rear yard
Pre-tender estimate	$4,292,000 construction cost, $3,459/m² (Rawlinsons, April 2022)
Construction	Issued for construction August 2022; built 2022–23
Structure	18 tilt-up concrete panels (150 mm, 40 MPa) on strip footings; steel trusses and rafters; 125 mm slab on ground
Envelope	Lysaght Spandek roof; Cemintel Barestone and Express Panel façade on a steel frame; Capral aluminium shopfront glazing
Inside	Trading floor, hardware, back of house, three coolrooms (one freezer), office, staff room, amenities
Key consultants and suppliers	Fulcrum Structural Engineering; AES (steel and precast shop drawings); AJ Baker (refrigeration); LGA-WA (windows); Lane Industries (store fitout)

The building is a typical regional retail shed: large spans, a high roof to the trading floor and a deep awning to the street. Those features drive most of its carbon.



The entry and checkouts: high-level windows over the trading floor, polished concrete slab, MDF groove-board bulkhead. Photo: Natalie Davy Photography.

Method

We followed the same method as the Narembeen case study, updated to the NABERS Embodied Carbon framework, so the two studies and future ORA projects can be compared.

- **Scope.** Upfront carbon to EN 15978: materials (A1–A3), transport to site (A4) and construction (A5). Use, maintenance and end of life are excluded.
- **Quantities.** Taken from the as-built record wherever it existed: AES steel material lists and precast panel shop drawings, LGA-WA window shop drawings, the Safemaster plant deck drawing, the Moddex handrail drawing and the AJ Baker refrigeration layout (Rev C.03). The rest came from ORA's IFC drawings, the Fulcrum structural drawings and the IFC Materials and Finishes Schedule and Specification.
- **Emission factors.** NABERS National Emission Factors database v1.0, using its default (uncertainty-adjusted) values where the exact product is unknown. The BlueScope Colorbond EPD was used for roof and wall sheeting, as in Narembeen. EPiC 2024 filled two gaps (the slab membrane and the foil roof insulation).

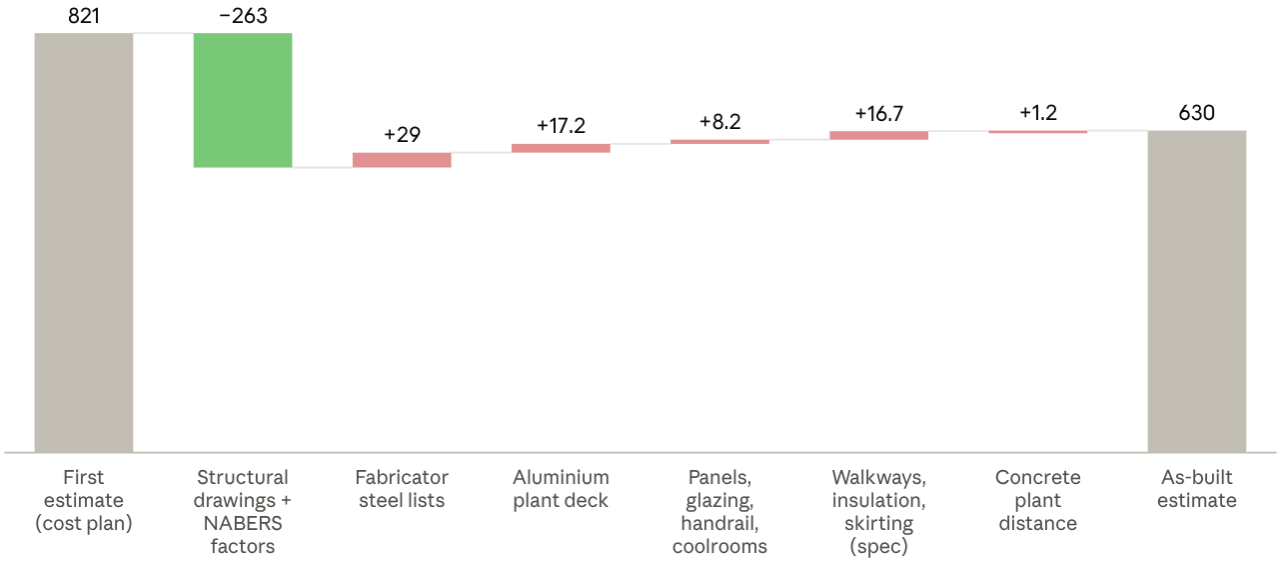
- **Transport (A4).** 16 t truck from WCS Concrete's Kellerberrin plant (about 60 km) for concrete; Perth to site (about 245 km) for local products; rail or truck from the eastern states and shipping for imported steel, glass and aluminium.
- **Construction (A5).** GBCA/thinkstep-anz non-residential ratios interpolated to 2023: site activity 17.2% and waste 1.5% of A1–A3.
- **Building services.** The NABERS rate for low-rise offices and commercial buildings (67 kgCO2e/m²). NABERS requires a rate, not an item take-off, and has no retail rate.
- **Reported separately.** Store fitout (shelving, counters, desks, kitchen) and external works (yard asphalt, plant slabs). Refrigeration equipment, rooftop PV (installed by the Shire outside the contract) and loose items are excluded.
- **Timber storage.** Carbon stored in timber products is not netted off, in line with NABERS.

How the estimate changed as better data arrived

The estimate fell by almost a quarter once real quantities replaced cost-plan assumptions, and the steel tonnage did most of the work.

Better data took the estimate from 821 to 630 kgCO2e/m²

Building A1–A5, kgCO2e/m² GFA. Green = lower, red = higher; totals in grey.



ORA Bruce Rock embodied carbon workbook, successive versions, October 2026

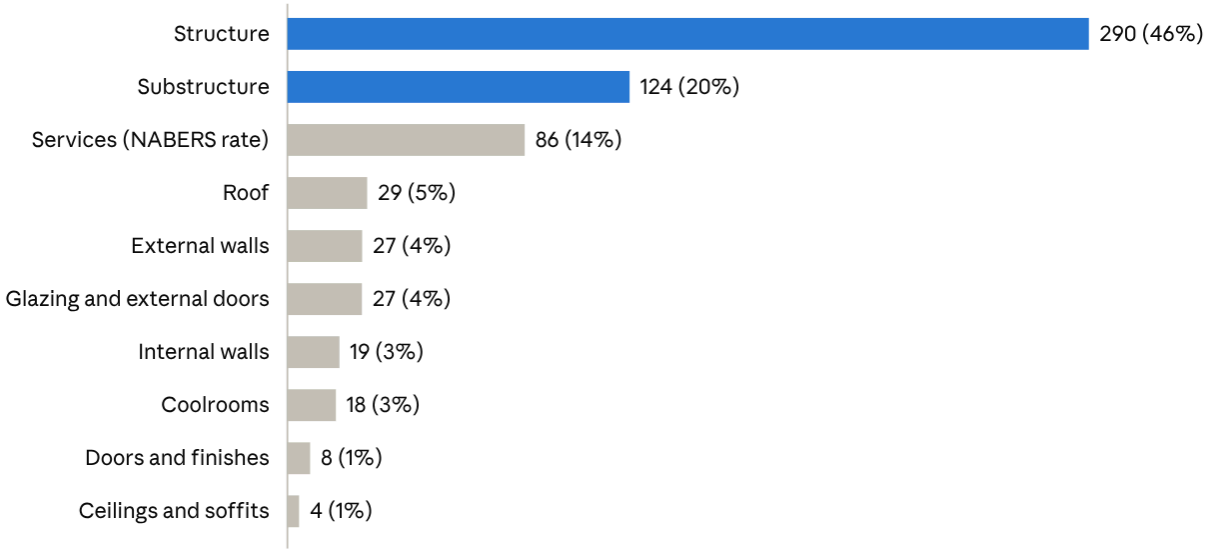
The first pass converted the QS's $807,000 structural steel line into tonnes at an assumed $8,000 per tonne, giving 101 t. Taking the steel off the structural drawings gave 43 t; the fabricator's lists gave 48.9 t, about 39 kg/m². Later documents mostly added items the drawings did not show, such as the aluminium plant deck, roof walkways and skirting. The lesson: a cost plan is not a quantity survey, and the order in which information arrives shapes the answer.

Results and hotspots

The building's upfront carbon is 785 tCO2e (630 kgCO2e/m²): materials 628 t, transport 39 t and construction 118 t.

Structure and substructure are two-thirds of the building's carbon

A1–A5 by element, kgCO2e/m² GFA. Total 630; structure + substructure 66%.



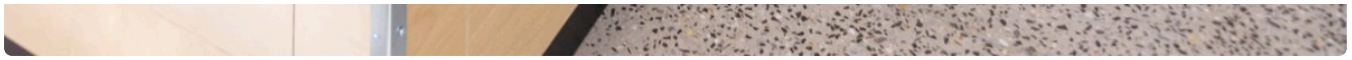
ORA Bruce Rock embodied carbon workbook, Summary sheet, October 2026

The largest single items, in tCO2e (A1–A5):

Item	tCO2e	Share of building
Hot-rolled structural steel incl. plates (35.6 t)	181	23%
Building services (NABERS rate)	107	14%
Ground slab, 125 mm, 32 MPa	91	12%
Cold-formed purlins, girts, bridging (13.3 t)	71	9%
Tilt-up panels, 82 m³, 40 MPa	57	7%
Slab mesh SL92	31	4%
Roof sheeting (Spandek)	25	3%
Aluminium plant deck (650 kg)	23	3%

Steel stands out because its factor is high (about 4.1 kgCO2e/kg) and a long-span supermarket roof needs a lot of it: about 39 kg per m² of floor.


OLYMPIC



Produce area: the exposed steel rafters and purlins, the largest source of the building's carbon, above birch plywood produce bins. Photo: Natalie Davy Photography.

Fitout and external works

Fitout adds about 63 tCO2e (51 kgCO2e/m²) on top of the building. Almost all of it is the steel in the store shelving. NABERS excludes fixtures and fittings, so we report fitout separately; with it, Bruce Rock comes to about 681 kgCO2e/m², the closer comparison with Narembeen, which counted its furniture.

Item	tCO2e (A1–A5)	Basis
Qshelf shelving: 1,235 flat metal and wire shelves	35.1	Counted from the Lane Industries quote; 5 kg per shelf assumed
Qshelf uprights, perforated back panels, bases	26.1	230 bay faces; 20 kg per face assumed from site photos
Checkouts, help desk, office desks, staff kitchen	1.8	Particleboard and plywood; areas from the quote and drawing A6.20
Birch ply trims to shelving ends	0.4	Assumed area
Yard asphalt and plant slabs (external works)	6.3	211 m² asphalt; concrete only under the generator, switchboard, condensers and baler

The shelving weights are assumptions. Each kilogram per shelf moves the fitout by about 5 kgCO2e/m², so supplier weights would firm this up quickly. The footpath reused the existing brick pavers, which carry close to zero upfront carbon.



Hardware help desk (particleboard) with Qshelf steel shelving beyond. Photo: Natalie Davy Photography.

How Bruce Rock compares

Bruce Rock sits about where a typical new commercial building designed around 2020 would. There is no published Australian benchmark for supermarkets yet: supermarkets can be star-rated under NABERS Embodied Carbon, but the star thresholds sit inside its calculator and are not published.

Benchmark	kgCO2e/m²	Scope
Bruce Rock, NABERS default factors	630	A1–A5, building incl. services
Bruce Rock, NABERS average factors (rough re-run)	about 430	Same quantities
LETI commercial, 2020 target (UK)	600	A1–A5, incl. services and fitout
LETI commercial, 2030 target (UK)	350	A1–A5, incl. services and fitout

Benchmark	kgCO2e/m²	Scope
INDICATE, mean of 46 new buildings (Ireland)	546	A1–A5; services often missing
INDICATE, warehouses (3 buildings)	437	A1–A5

The method matters as much as the building. NABERS default factors include an uncertainty margin: the default for 32 MPa concrete is 468 kgCO2e/m³ against an average of 249. Re-running the same quantities with average factors gives about 430 kgCO2e/m². Most published studies use average or product-specific data, so the fair comparison sits between 430 and 630.

The RIBA 2030 Climate Challenge targets (under 650 by 2025, under 500 by 2030) cover the whole life cycle, A to C, so they are not directly comparable.

Narembeen (209 kgCO2e/m²) is not a fair comparison either: it was a refurbishment that kept its existing structure.

What we would do differently

The biggest realistic saving for a building like this is low-carbon concrete, not a change of structural system. We tested three options against the as-built result.

Option	Change in tCO2e	Change in kgCO2e/m²	Practicality in the Wheatbelt
Low-carbon concrete in slab, footings and panels (30% below the NABERS default)	about −51	about −41	Same design and trades; depends on what the batching plant can supply
Shorter roof spans: internal columns halving the ~19 m lower-roof span	Not yet quantified	Not yet quantified	Needs structural engineer input; columns must suit the trading floor layout
Lightweight timber-framed external walls instead of tilt-up	about −22 to −30	about −17 to −24	Needs extra steel for wind and bracing, cladding, and a fire-rated system on the boundary wall
Smaller building	about −63 per 100 m² removed	Little change	A brief and client decision, tested early

Option	Change in tCO2e	Change in kgCO2e/m²	Practicality in the Wheatbelt
Mass timber roof structure instead of steel	Not costed	Not costed	Mass timber is expensive in WA and hard to substitute for steel trusses

Low-carbon concrete. Concrete is about 172 tCO2e (138 kgCO2e/m²) across the slab, footings and panels. Mixes with high cement replacement (fly ash or slag), backed by a supplier EPD, could plausibly cut that by around 30%, without changing the design or the builder's methods. The concrete came from WCS Concrete's Kellerberrin plant. We found no published EPD for its mixes, so the first step on the next Wheatbelt project is to ask the plant what it can batch and document.

Lightweight walls. Replacing the 548 m² of tilt-up with a timber-framed wall removes about 77 tCO2e of panels and their lining. Most of that comes back as about 3 t of extra steel columns and bracing, fibre cement cladding on top hats, and fire-rated plasterboard on the north wall, which sits against the neighbouring shop. The net saving is about 22 tCO2e, or about 30 tCO2e if no fire layers are needed. The LVL would also store about 10 tCO2e, reported separately. The gain is real but modest, and it needs an NCC check of the fire-rated wall system first.

Mass timber and the slab. Mass timber framing is costly in WA and rarely a straight swap for steel trusses. A slab on ground has no practical alternative to concrete, so the lever there is the concrete mix, not the material.

Shorter spans. The lower roof spans about 19 m between grids A and B on five steel trusses (250 PFC chords). In our drawing take-off those trusses are about 8 t of steel, roughly 40 tCO2e. Halving the span, with internal columns in the supermarket floor and within the bulk goods hardware wall, would let the trusses be much lighter: bending moment rises with the square of the span, so at the same 750 mm depth, half the span means roughly a quarter of the chord force. Minimum practical sections and connections limit how much of that shows up as saved steel. A 2025 comparative study by Perrucci and Trabucco is a useful caution: long-span timber frames came out about 29% worse per m² than short-span ones, but its long-span steel joist roof was about 30% better per m², with fewer columns for the floor area covered. Some of the saving goes back into new columns and pad footings, and the columns must work with the shelving layout, so a structural engineer needs to size it before we can put a number on it.

A smaller building. The least carbon is in the floor area not built. At Bruce Rock's average, every 100 m² removed saves about 63 tCO2e. This barely moves the kgCO2e/m² figure, which is why ORA should track total tCO2e as well as intensity: a tighter brief is a real

saving even when the rate per m² stays the same. Intensity alone can mislead: a 120 m² house for four people at 630 kgCO2e/m² is about 19 tCO2e per person, while a 500 m² house for two at an efficient 400 kgCO2e/m² is about 100 tCO2e per person (illustrative figures). The building that does the job with less floor area is the more sustainable one. Building to the minimum area the community needs also saves operational energy and capital cost, which regional councils rarely have to spare: at the pre-tender rate of $3,459/m², every 100 m² not built was about $346,000 in 2022 prices. A practical way to set that minimum is to compare similar supermarkets in surrounding towns, their floor areas and the catchment populations they serve.

Design to the population trend, not the peak. Many Wheatbelt towns have shrunk as farming became more productive while employing fewer people; nine of Australia's ten largest percentage population declines in one comparison were in rural WA, mostly the Wheatbelt (.id). A building sized for growth that does not come stays partly empty but is heated, cooled and maintained in full. Bruce Rock itself has held steady recently: the Shire had 930 residents in 2016 and 979 in 2021, with a median age of 48 (ABS 2016, ABS 2021). Forecasts for the region expect most smaller Wheatbelt areas to grow very little or decline, and to age (.id forecast). Briefs for community buildings should be tested against the Shire's and the surrounding Shires' population trend and age profile, not only today's demand.

Using both of the first two options would bring a building like this from about 630 to about 570 kgCO2e/m² under the conservative NABERS method. Product EPDs in place of defaults would take it below 500.

Other observations

- **Aluminium adds up quietly.** Aluminium carries about 30 kgCO2e per kg, roughly seven times steel. The 650 kg plant deck (23 tCO2e), about 60 m of roof walkway (15 tCO2e), the window and door frames (about 22 tCO2e) and 300 m of aluminium skirting (3.5 tCO2e) total about 64 tCO2e. A steel walkway, a lighter deck or a powder-coated steel skirting are easy wins at design stage.
- **Refrigerants matter more than the cases.** The Bonnet Névé quote lists R404a for the remote freezer cases and R134a for the dairy cases; the plug-in cases use R290. R404a has a global warming potential of about 3,900 times CO2. Leakage is an operational (B1) emission, outside this study, but a modest annual leak could exceed several tonnes of CO2e a year. A natural refrigerant requirement belongs in the brief.
- **Changes during construction change the carbon.** The composite timber battens in the schedule became MDF groove boards; the coolroom panels are 100 mm in the schedule but 75 mm in the refrigeration drawings. As-built records, not design documents, are what count.

- **Not everything was in the contract.** The rooftop PV was installed by the Shire outside the building contract, so it is not counted here, although the walkway that serves it is.
- **Reuse works.** The footpath relaid the existing brick pavers, a simple reuse with almost no upfront carbon.
- **Services are a blunt instrument.** At 86 kgCO2e/m² (14%), services are the third-largest item, but NABERS only allows a standard rate per m². A supermarket's refrigeration pipework and larger switchboards probably push the real figure higher.



Frozen food: refrigerated cases and plant are equipment, outside this study, but their refrigerants are a significant operational emission. Photo: Natalie Davy Photography.

Lessons for ORA's Sustainability Action Plan

Bruce Rock sets ORA's new-build baseline for goal G3 (project embodied carbon) at 630 kgCO2e/m², calculated by the NABERS method. SAP 2.0 sets the 2030 target at 40% below baseline, in line with WorldGBC (about 380 kgCO2e/m² for a building like this), with interim steps of −15% and −25%, and net zero embodied carbon by 2050 through reduction first and certified offsets for the residual. These are the changes it points to:

1. **Right-size the brief first.** Live within our means: establish the minimum floor area the community actually needs, benchmarked against comparable buildings, the catchment they serve and the population trend of the Shire and its neighbours, and design to that.

It is the one decision that cuts embodied carbon, operational energy and cost at the same time.

2. **Ask for element quantities early.** Request an elemental bill of quantities from the QS at design development (concrete m^3 by grade, steel tonnes, cladding m^2), not only a trade cost plan. A cost line cannot be turned reliably into tonnes.
3. **Run a first carbon estimate at schematic design,** when the structural system and envelope can still change, and update it at tender. Test structural spans and floor area with the engineer and client at this stage, while internal columns and a tighter brief are still options.
4. **Specify low-carbon concrete** with a supplier EPD, and check what the nearest regional batching plant can supply before documenting it.
5. **Watch aluminium.** Challenge aluminium roof platforms, walkways and trims; use steel or timber where they do the same job.
6. **Ask for product data with shop drawings.** Add a clause requiring weights and EPDs (or product data sheets) with steel, precast, window, roof access and fitout submittals.
7. **Brief natural refrigerants** for supermarket and coolroom projects, and record what is charged at handover.
8. **Keep the as-built record.** Concrete dockets, fabricator lists and approved RFAs are the data a final calculation needs; collect them at practical completion.
9. **Report two figures:** the building (NABERS scope) and building plus fitout, so ORA projects stay comparable with each other and with NABERS ratings. Track total tCO2e and carbon per unit of use (per occupant, bed, student or user served) as well as $kgCO2e/m^2$, so that a smaller, well-used building counts as the saving it is.

Limitations and next steps

The building figure is now mostly based on shop drawings, but several inputs are still estimates:

- **Concrete:** slab and footing volumes are taken from the structural drawings, not delivery dockets. The slab grade is ambiguous (25 MPa in the drawing legend, 32 MPa in the notes; 32 MPa used).
- **Services:** a standard NABERS rate, not a take-off.
- **Assumed weights:** Spandek sheet thickness, window frame weights (2 kg/m), roof walkway (7 kg/m), skirting length, and the shelving.
- **Transport distances:** approximate road distances.
- **Steel:** within about ±10% of the fabricator lists, which moves the result between 610 and 650 $kgCO2e/m^2$.

Next steps:

- [ ] Enter the quantities in the NABERS Embodied Carbon calculator for an indicative star rating against market-average supermarkets
- [ ] Ask Lane Industries for shelf and bay weights, and Saferight for the walkway weight
- [ ] Ask WCS Concrete what low-carbon mixes and documentation it can provide
- [ ] Repeat the study for the Kondinin pavilion using the same workbook
- [ ] Add the 630 kgCO2e/m² baseline to SAP goal G3 (done in SAP 2.0, October 2026)

References and data sources

Project records

- ORA, Bruce Rock Supermarket IFC architectural drawings, Materials and Finishes Schedule and Specification (job 2020-0011, 2022–23)
- Fulcrum Structural Engineering, structural drawings 21214 S1.01–S5.04 (August 2022)
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Methods and factors

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- ORA, Case Study 1 – Narembeen Administration Office Refurbishment, Version 2 (October 2026)