nezo

Operational Energy Model

Modelling Guide & Methodology

Northcote N12 Apartment Building — OpenStudio / EnergyPlus

Project	N12 Development — 135–137 Lake Road, Northcote, Auckland
Client	Simplicity Living
Architect	Brewer Davison
Mechanical / H1	Thurston Consulting Ltd (project 224474)
Building	Building A — 96 apartments, 9 occupied levels
Climate	NZ Building Code H1 — Climate Zone 1 (Auckland)
Energy model	SketchUp geometry → OpenStudio → EnergyPlus, with the Nezo measures
Document	Internal methodology guide — v1, 2026-06-21

How to use this guide

This document captures every modelling decision taken on the Northcote energy model so the work can be (a) explained to others, (b) finished from where it currently sits, and (c) **replicated as a repeatable standard** on the next Simplicity Living building. Where a decision differs from the formal H1/VM1 compliance run, that is called out — this is the broader Nezo operational-energy model, not a compliance submission.

Contents

1. Project & purpose

The N12 development is a new multi-unit residential building (MURB) in Northcote, Auckland. **Building A** contains **96 apartments** over nine occupied levels above two carpark / service levels, with an approximate conditioned floor area of **7,200 m²**. The apartment mix is a small number of repeating typologies (below), which is exactly what makes the building a good candidate for a standardised, preloaded modelling approach.

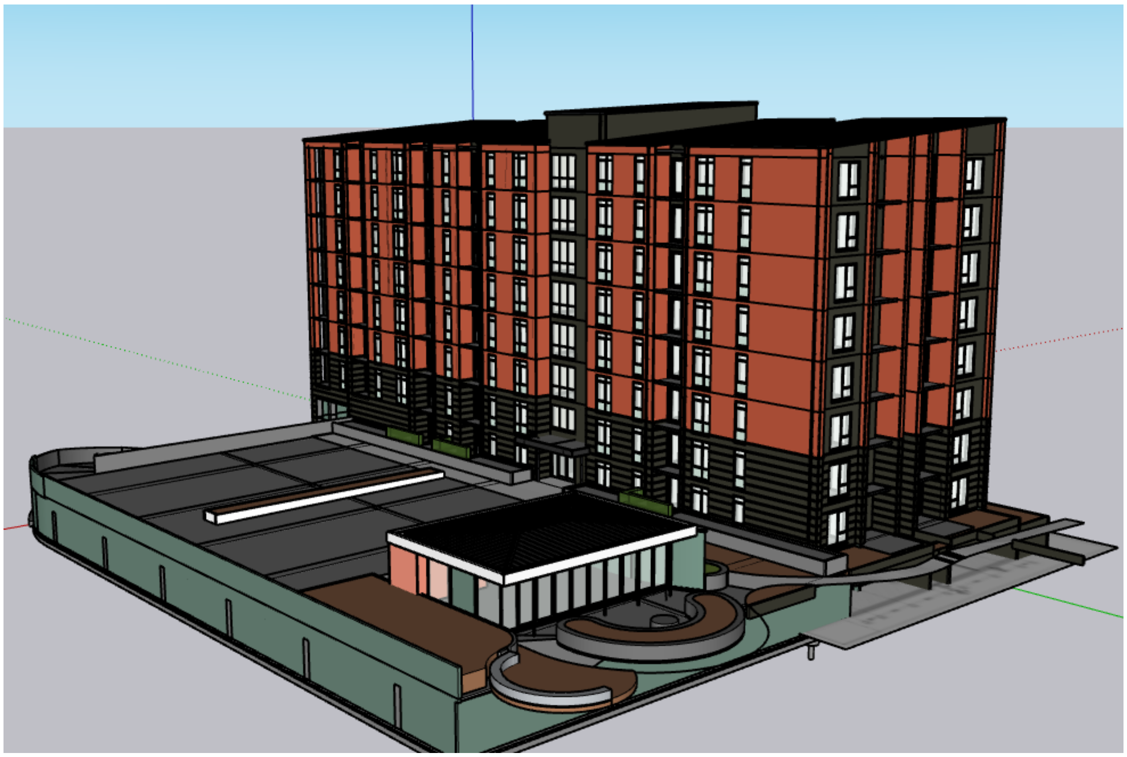
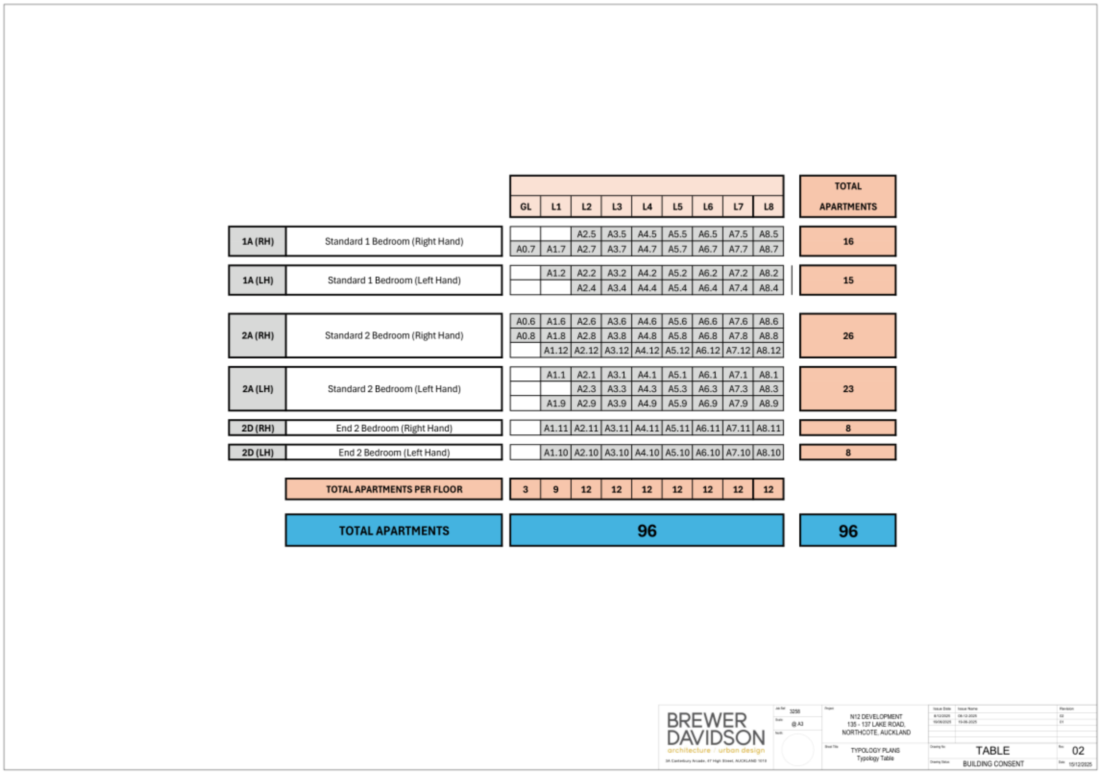


Figure. *Architectural massing — Building A (apartment tower) over the podium / carpark and pavilion. The brick-veneer / concrete tower is the conditioned envelope being modelled.*

1.1 Apartment typologies

The building repeats six unit types (right- and left-hand variants of three plans). Because every level above the ground is thermally near-identical, these repeating plans drive the whole simplification strategy.

Type	Description	Count	Bedrooms
1A (RH / LH)	Standard 1 bedroom	31	1
2A (RH / LH)	Standard 2 bedroom	49	2
2D (RH / LH)	End 2 bedroom	16	2
Total	Per floor: 3 (basement) · 9 (ground) · 12 (L1–L7)	**96**	—



Type	Description	GL	L1	L2	L3	L4	L5	L6	L7	L8	TOTAL APARTMENTS
1A (RH)	Standard 1 Bedroom (Right Hand)			A2.5	A3.5	A4.5	A5.5	A6.5	A7.5	A8.5	16
		A0.7	A1.7	A2.7	A3.7	A4.7	A5.7	A6.7	A7.7	A8.7	
1A (LH)	Standard 1 Bedroom (Left Hand)		A1.2	A2.2	A3.2	A4.2	A5.2	A6.2	A7.2	A8.2	15
				A2.4	A3.4	A4.4	A5.4	A6.4	A7.4	A8.4	
2A (RH)	Standard 2 Bedroom (Right Hand)	A0.6	A1.6	A2.6	A3.6	A4.6	A5.6	A6.6	A7.6	A8.6	26
		A0.8	A1.8	A2.8	A3.8	A4.8	A5.8	A6.8	A7.8	A8.8	
			A1.12	A2.12	A3.12	A4.12	A5.12	A6.12	A7.12	A8.12	
2A (LH)	Standard 2 Bedroom (Left Hand)		A1.1	A2.1	A3.1	A4.1	A5.1	A6.1	A7.1	A8.1	23
				A2.3	A3.3	A4.3	A5.3	A6.3	A7.3	A8.3	
			A1.9	A2.9	A3.9	A4.9	A5.9	A6.9	A7.9	A8.9	
2D (RH)	End 2 Bedroom (Right Hand)		A1.11	A2.11	A3.11	A4.11	A5.11	A6.11	A7.11	A8.11	8
2D (LH)	End 2 Bedroom (Left Hand)		A1.10	A2.10	A3.10	A4.10	A5.10	A6.10	A7.10	A8.10	8
	TOTAL APARTMENTS PER FLOOR	3	9	12	12	12	12	12	12	12	
	TOTAL APARTMENTS	96									96

Figure. *Apartment stacking table (Brewer Davison typology set): 3 units at basement, 9 at ground, then 12 identical units on each of Levels 1–7 = 96 apartments total.*

1.2 What this model is for

The formal **H1/VM1 compliance** for this building has already been completed by Thurston Consulting in IES Virtual Environment and **passes** (see §9). H1/VM1 only compares heating + cooling load against a reference building — it deliberately excludes hot water and ventilation fans. This Nezo model goes further: it is a **whole-building operational-energy model** used to:

- Estimate total operational energy (heating, cooling, hot water, ventilation, lighting, plug loads) so the design can be reported beyond bare compliance.
- Run a **parametric "mass concrete" study** — swapping the exterior wall construction to test whether the client's preferred heavy concrete delivers a real energy benefit in Auckland's mild maritime climate.
- Establish a repeatable workflow and a preloaded Nezo tool option so the next Simplicity Living building can be modelled the same way.

2. Modelling philosophy

A 10-storey MURB modelled exactly as drawn — every partition, sliver and reveal — is a simulation that crashes. The guiding principle here is **thermal honesty with geometric ruthlessness**: keep everything that changes the heat balance, delete everything that only adds polygons. Three rules follow from that.

- **Repeat, don't redraw.** Identical mid-floors are drawn once and repeated with a zone multiplier (§3).

- **One box per apartment.** No internal partitions; thermal mass of internal walls is added back as an Internal Mass object (§4).
- **Model the buffers, don't condition them.** Corridors, lift/stair cores, loading bay and stores are drawn but left unconditioned, so the envelope stays closed and inter-zone heat flow is correct (§5).

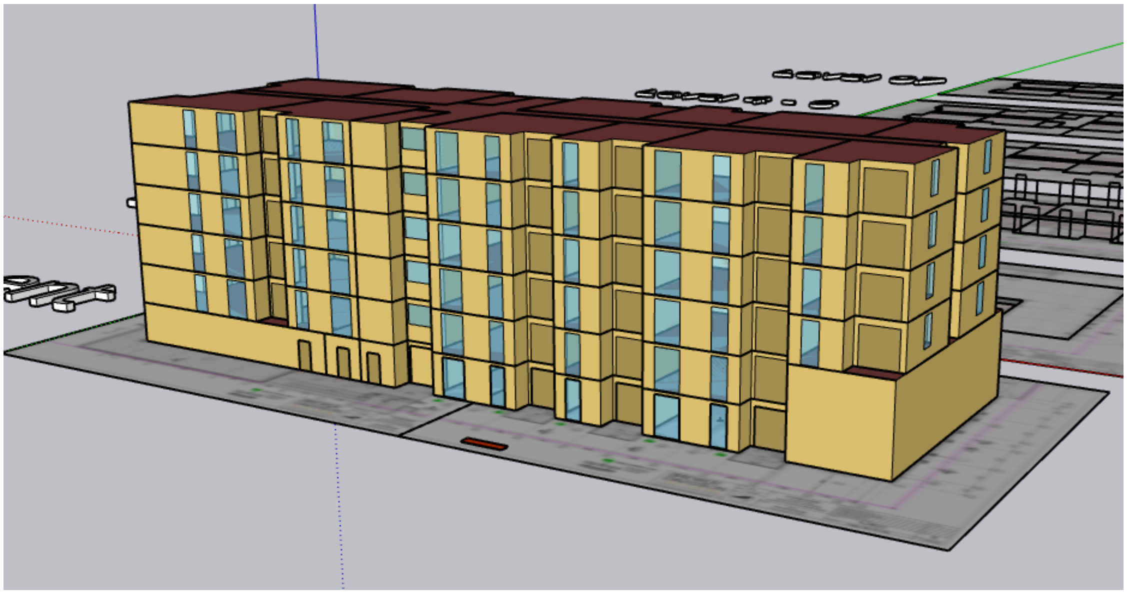


Figure. *The OpenStudio energy model — the same building reduced to clean apartment boxes (yellow walls, brown roof, blue glazing). Note the "stubby" height: multiplied mid-floors are drawn once, so the model is shorter than the real tower (§3.3).*

3. Vertical stacking & zone multipliers

The building is captured with six physically-drawn floor plates. Five would be ideal, but the concrete wall thickness steps down partway up the building, so the typical floors split into two groups.

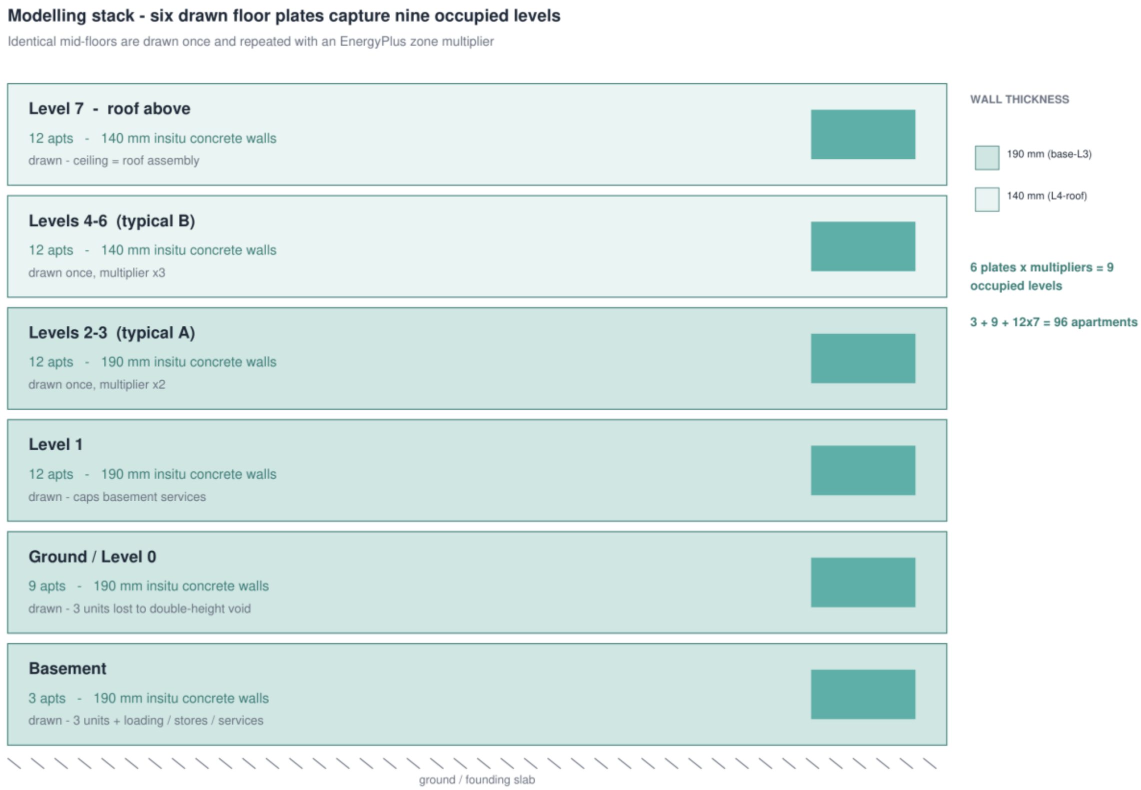


Figure. *The six-plate modelling stack. Each plate is drawn once; the two "typical" plates carry a zone multiplier (×2 and ×3) so EnergyPlus scales their loads, areas and volumes automatically.*

3.1 The wall-thickness step (why six plates, not five)

External and inter-tenancy walls are **190 mm insitu concrete from basement up to Level 3**, then reduce to **140 mm insitu concrete from Level 4 to the roof**. Because the two typical floor groups now have a different construction (and a different thermal mass), they cannot share one multiplied plate — hence two typical plates:

Plate (drawn once)	Represents	Wall	Multiplier
Basement	Basement	190 mm	×1
Ground / Level 0	Ground	190 mm	×1
Level 1	Level 1	190 mm	×1
Typical A	Levels 2–3	190 mm	×2
Typical B	Levels 4–6	140 mm	×3
Level 7	Level 7 (roof above)	140 mm	×1

Apply the 140 mm wall to the upper plates

The 190 mm wall is the building-default. The Exterior Walls card now also carries the **140 mm concrete** as a **secondary construction**, so the measure **builds it into the model as a named construction** — no hand build-up in OpenStudio. To honour the 190→140 step you simply select the Typical-B and Level-7 surfaces and set their construction to **"Brick + 140 mm**

Plate (drawn once)	Represents	Wall	Multiplier

> **concrete — R1.4 (SPL, L4–roof)"**. A 155 mm CLT wall ships as a third construction for the mass-timber comparison (§10).

3.2 What the multiplier does

A zone multiplier tells EnergyPlus "this zone occurs N times." It multiplies the zone's internal gains, exposed wall and window areas, volume and HVAC loads — so a single drawn Typical-B plate with a ×3 multiplier reports the heating, cooling and energy of three identical floors without any extra geometry. This is the single biggest stability win in the model.

3.3 Does the "stubby" model break solar or wind?

No for solar. The sun is effectively at infinity, so a north window on the drawn Typical-B plate receives the same direct radiation as the real Levels 4, 5 and 6. EnergyPlus computes solar from each surface's orientation and tilt, not its absolute height.

Watch two things. (1) *Shading* — the multiplied plate applies whatever shading hits the one drawn floor to all of its copies, so self-shading balconies must be modelled as shading surfaces, and a tall neighbour that only shades low floors would be misapplied to all. (2) *Wind / exposure* — set the multiplied zones' relative ceiling height so the engine applies the correct wind-speed profile at elevation.

4. Inside the apartment — one open-plan zone

Every apartment is modelled as **a single open-plan thermal zone** — one hollow box from structural floor to underside of the slab above. Bedroom, bathroom and kitchen partitions are **not drawn**.

4.1 Why internal partitions are left out

- **No envelope value.** Under the comfort regime every room chases the same 18–25 °C, so a partition between two equally-conditioned rooms transfers no net heat. Splitting the apartment into rooms adds zero to the load calculation.
- **Geometry risk.** Internal partitions are the main source of sliver spaces, intersecting surfaces and the degenerate-surface crashes that have killed past runs. Removing them cuts surface-matching errors by roughly 80%.
- **Air mixing is realistic.** A single zone lets air mix across the unit — a fair approximation of an open-plan apartment served by one high-wall heat pump.

4.2 Putting the mass back: Internal Mass

Omitting the partitions geometrically does *not* mean ignoring their weight. Internal plasterboard, battens and the inter-tenancy concrete absorb and release heat and slow the apartment's temperature swing. That thermal storage is added back with an OpenStudio **Internal Mass** object per apartment zone (an exposed area of plasterboard-on-frame), so EnergyPlus still sees the damping without a single extra drawn wall.

4.3 Pelmets and ceiling plenums — also out

- **Pelmets** are negligible thermally and pure geometry risk — omitted.
- **Ceiling plenums / service voids** are not drawn as separate boxes. Between two apartments the cavity sits between two equal temperatures (no net flow), so the void is folded into the mid-floor construction (slab + cavity + ceiling batt + plasterboard). At the roof, the void is folded into the roof assembly. Drawing plenums would double the surface count for no thermal gain — they are only modelled explicitly where a ceiling is a return-air plenum, which this building does not have.

5. Buffer & non-apartment spaces

These spaces are drawn (so the envelope stays closed and the slabs above them have a correct boundary) but carry no heating or cooling. Getting their boundary condition right is what makes the apartments above and beside them behave correctly.

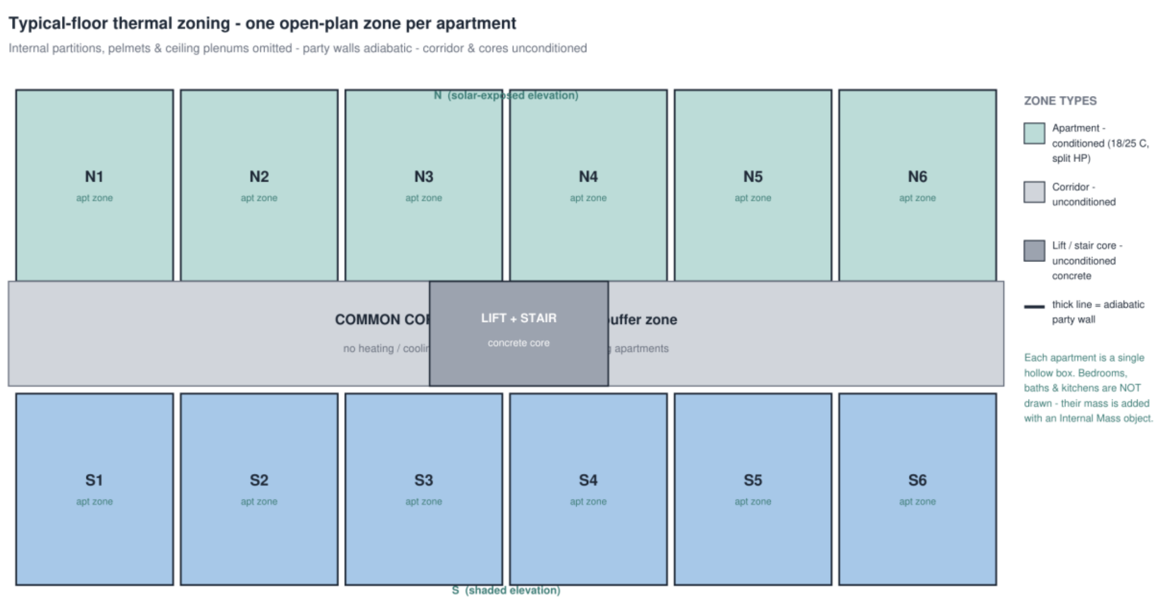


Figure. *Typical-floor zoning: twelve apartment zones (grouped by orientation) around an unconditioned central corridor and concrete lift/stair core. Party walls between units are modelled adiabatic.*

Space	Treatment	Why
Apartments	Conditioned 18/25 °C	The occupied envelope; one zone each, grouped by orientation.
Common corridors	Unconditioned buffer	Rarely heated/cooled in NZ MURBs; a central thermal buffer that absorbs leakage from surrounding units.
Lift & stair cores	Unconditioned, sealed	A continuous concrete spine; a thermal flywheel and a stack-effect path. Drawn floor-by-floor and matched into one vertical zone.
Loading bay	Ambient / highly ventilated	Open to outside via the vehicle gate — air tracks outdoor temperature (see §5.1).

Space	Treatment	Why
Stores / services	Unconditioned	Buffer below/around apartments; keeps the slab boundary correct.

5.1 The loading bay — an “ambient” zone

A large part of the basement is a drive-in loading bay (~15 × 6.5 m) open to the weather through a roller gate, with conditioned Level 1 apartments two storeys above it (double height). It is **not deleted** — that would leave a hole under Level 1. Instead it is drawn and configured to behave like the outdoors: unconditioned, with a very high air-change rate (≈20–30 ACH) so its air tracks the Auckland weather file. After surface matching, the floor of Level 1 above it is correctly flagged as an **exposed floor** — which matters, because a 190 mm concrete slab over a cold, wind-swept bay will pull heat out of the apartments above unless it is insulated (this building uses the R1.44 suspended floor for exactly that reason).

5.2 Party (inter-tenancy) walls — adiabatic

Walls shared between two apartments (10 mm plasterboard / UPVC batten / R1.2 masonry batt / 140–190 mm concrete, STC 60–62) are modelled **adiabatic**: the wall and its mass exist, but no heat flows through it because the neighbour is at the same temperature. After stacking, OpenStudio’s Intersect + Match Surfaces converts these shared walls (and the mid-floors between stacked units) into interior/adiabatic boundaries automatically.

6. Constructions & R-values

Assembly R-values are taken from the Northcote H1 report (Thurston Consulting, Rev B), calculated to NZS 4214 with the framing/thermal-bridging already included. In the model each is built as **real layered material** (mass) with the insulation layer back-solved to hit the target R — never a single no-mass layer, which H1/VM1 prohibits and which would strip the concrete’s thermal mass.

Element	Build-up (outside → inside)	Overall R
Roof	TRIMRIB metal / purlin cavity / EPS R2.63 (100 mm) / concrete / cavity / R1.0 ceiling batt / plasterboard	**4.13**
Wall (base–L3)	Brick veneer / cavity / 190 mm concrete / 45 mm strapping + R1.2 batt / plasterboard	**1.40**
Wall (L4–roof)	Brick veneer / cavity / 140 mm concrete / 45 mm strapping + R1.2 batt / plasterboard	**1.40**
Floor 1	Concrete slab on grade (H1/AS1 App. F)	**0.75**
Floor 2	Suspended concrete over loading dock / stores, R1.30 insulation	**1.44**
Door	Solid-core door	**0.37**
Glazing	Double glazed, argon, low-E, aluminium frame, SC 0.60 (whole-window incl. frame)	**0.30 (U≈3.3)**
Party wall	Plasterboard / batten / R1.2 batt / concrete — modelled adiabatic	n/a (adiabatic)

The hybrid construction trick

Element	Build-up (outside → inside)	Overall R

> You have already done the proper NZS 4214 bridged R-value in the external calculator. So in the model, keep every real layer (brick, cavity, concrete, plasterboard) at its true density and thickness, and let the measure **back-solve only the insulation layer's conductivity** to land exactly on the target R. EnergyPlus then gets realistic thermal lag and mass, while you only ever type one R-value per element. This is built into the Nezo measure.

7. Internal loads, occupancy & schedules

Two sets of numbers matter. The first column below is the H1/VM1 prescribed set (used for the compliance run); the second is the realistic operational set used for the full Nezo energy model. Keeping both documented prevents confusion when the two runs disagree.

Input	H1/VM1 (compliance)	Nezo operational
Heating setpoint	18 °C	18 °C
Cooling setpoint	25 °C	25 °C
Occupancy	H1 residential schedule, 150 W/person	Same; per-unit design occupancy
Lighting	5 W/m^2	5 W/m^2 (LED)
Plug loads	24.5 W/m^2 (H1 default)	~4–8 W/m^2 (realistic diversified)
Ventilation	0.5 ACH constant	Mechanical extract (see §8)
Infiltration	0.20 ACH (perimeter)	0.2–0.3 ACH

The big one to watch is **plug load**: H1 mandates 24.5 W/m^2, which is far above what an apartment actually draws. For the operational model use a realistic diversified figure (≈4–8 W/m^2) or the energy total will be dominated by fictitious appliance heat. This single input explains most of the gap between an H1 run and a real-energy run.

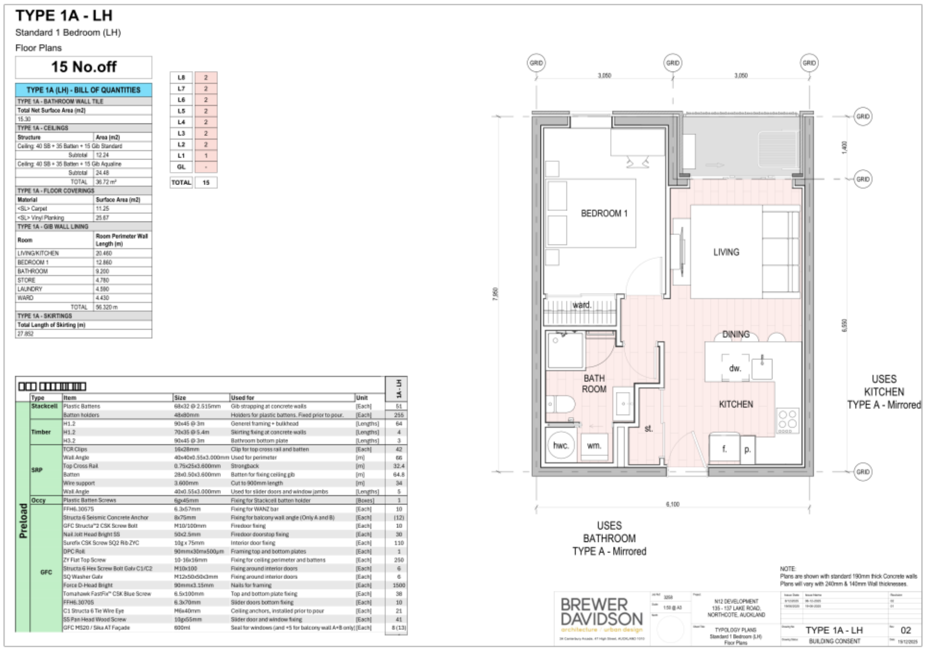


Figure. *Representative unit (Type 1A, 1-bed). In the energy model the whole apartment — including the bathroom and kitchen shown here — becomes one open-plan zone; the internal walls are replaced by an Internal Mass object.*

8. HVAC, hot water & ventilation

8.1 Space conditioning — per-apartment heat pumps

Each apartment has its own **Daikin single-split high-wall heat pump** (FTXV35 / RXV35, R32) — 3.5 kW cooling, 3.7 kW heating, rated **ACOP ≈ 4.68 (heating)** and AEER ≈ 3.95 (cooling). Because the system is fully decentralised, the model adds a generic per-zone Packaged Terminal Heat Pump (PTHP) to every apartment zone via the measure, with COP ≈ 4.5 — no central plant loop to wire up. Corridors and cores get no equipment.

8.2 Domestic hot water

Each apartment has a **Rheem 180 L electric mains-pressure cylinder**. DHW is excluded from H1 but is a major end use in the operational model, so it is added as a stand-alone WaterHeater:Mixed per unit (electricity, efficiency ≈ 1.0, 180 L tank, ~45 L/person/day at 60 °C, standing loss included).

8.3 Mechanical ventilation

Ventilation is continuous mechanical extract from each apartment (Fantech EF-01, ~80 L/s, 0.04 kW) plus rangehoods, with make-up air via leakage. Common systems — corridor supply (SF-01), basement carpark exhaust (EAF-04), lift-shaft cowl, bike and rubbish extract — serve the unconditioned spaces. In the model these are represented as zone-level ventilation + fan energy (full scope only).

System	Equipment	Duty
Apartment heat pump	Daikin FTXV35 single split	3.5 kW C / 3.7 kW H
Apartment extract	Fantech TD-500/150SIL	80 L/s · 0.04 kW

System	Equipment	Duty
Corridor supply	Fantech CD EC56S	930 L/s · 1.5 kW
Carpark exhaust	Fantech RDLE0806 (CO-controlled)	4,100 L/s · 2.42 kW
Hot water (per unit)	Rheem 180 L electric cylinder	Electric, mains pressure

9. H1/VM1 compliance result (reference point)

The independent IES VE compliance run is the anchor the Nezo model is sanity-checked against. It compares only heating + cooling load:

Annual load (kWh/m²·yr)	Reference	Proposed	Δ
Heating	0.1	1.6	—
Cooling	44.0	~30.7	−27%
Total	**44.1**	**32.3**	**−23%**

Result: **PASS** — proposed heating + cooling load is 23% below the reference building. Note this is *thermal load*, not delivered energy: divide by the heat-pump COP (~4.5) to get electricity. Auckland's mild climate means cooling, not heating, dominates — a useful cross-check on the Nezo run.

10. The mass-concrete study

The reason for a full energy model rather than a compliance tick is to answer the client's question: *does heavy concrete pay off?* EnergyPlus's transient heat-balance engine is built for exactly this. The method:

1. Run the as-designed concrete envelope (190/140 mm) as the baseline.
2. Swap only the exterior wall construction to a lightweight framed alternative of the same R-value, keeping geometry, loads and schedules identical.
3. Compare annual heating, cooling and (especially) summer overheating hours.

Expect a trade-off, not a free win: concrete's mass dampens daily swings and can cut winter peak, but unshaded north/west glazing turns it into a heat battery that radiates back at night and raises summer cooling unless night-purge ventilation is available. Report the result as "concrete changes cooling by X% and heating by Y%," and note whether the concrete is left exposed internally or lined — lining with battens + plasterboard largely buries the mass and changes the answer.

> **Mass timber comparison is preloaded**
> The eventual default for a mass-timber version of this building is a **155 mm CLT wall**, which already ships as a third wall construction in the apartment Quick Start. Because the measure builds it into the model, running mass-timber vs mass-concrete is a single construction swap on the exterior walls — same geometry, loads and schedules — so the energy delta is isolated cleanly. For an equal-R comparison (mass effect only) set the CLT target R down to 1.4 to match the concrete; leave it at the realistic R3.0 to compare the walls as each would actually be built.

11. Build workflow (repeatable)

This is the standard sequence to reproduce on the next building.

4. **Trace & stack.** Import each floor PDF into SketchUp, trace OpenStudio spaces over it, and stack the six plates on a single “golden origin” (a structural point common to every plan) locked to the Z axis — never by eye.
5. **Make unique.** After copy-pasting a floor up, run the OpenStudio “make spaces/shading unique” user script so duplicated spaces get their own handles (otherwise the run crashes on duplicate IDs).
6. **Intersect & match.** Run Intersect Surfaces then Match Interzone Surfaces to fuse ceilings/floors and convert party walls to adiabatic boundaries.
7. **Set multipliers.** Apply ×2 to the Typical-A zones and ×3 to Typical-B; set their relative ceiling heights.
8. **Clean geometry.** Purge degenerate / duplicate surfaces (e.g. two surfaces sharing identical vertices) via the Inspector or by deleting the stray OS:Surface block in the .osm text — a recurring cause of failed runs.
9. **Apply the Nezo measure.** Load the apartment Quick Start, export the measure, Apply Measure Now, attach the Auckland EPW, then assign the 140 mm wall to the upper plates.
10. **Run & report.** Simulate, then run the Nezo reporting measure for the H1/VM1 tables and the energy summary.

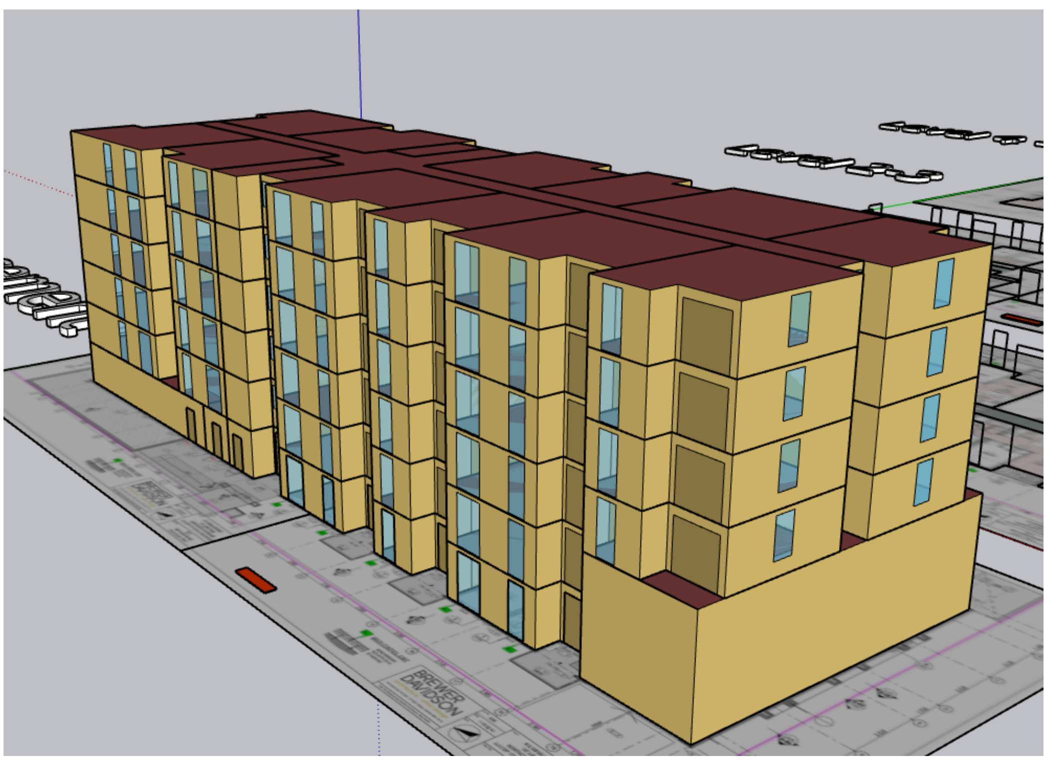


Figure. *The completed OpenStudio model — stacked, matched and zoned, ready to simulate.*

12. The preloaded Nezo apartment option

The Nezo Energy Model Setup tool (helper) now ships a one-click **"Simplicity Living — Apartment Building"** Quick Start in its catalogue. It preloads the as-designed envelope so the constructions never have to be rebuilt by hand:

- Building use: Apartment Building (multi-unit), Auckland Zone 1, ~7,200 m², 9 storeys.
- Roof R4.13, Wall R1.4 (190 mm and 140 mm presets), Slab R0.75, suspended-floor R1.44, glazing U3.3 / SC0.6 — all from the H1 report.
- **Multi-construction Exterior Walls card.** The 190 mm concrete is the building default; the 140 mm concrete (secondary) and a 155 mm CLT (tertiary) are toggled on the same card and built into the measure as named constructions — ready to assign to the upper floors or swap in for the mass-timber study. Add further wall constructions with "+ Add wall."
- Per-apartment PTHP heat pump (COP 4.5), 18/25 °C, full operational scope (DHW + extract ventilation).

The catalogue also reserves "coming soon" cards (townhouse block, school, aged care, AU/NCC apartment) so the same standardisation can extend to the next building types.

13. What is left to finish

The model is built and zoned; the remaining work is calibration and the parametric study. Checklist:

- **Confirm the 140 mm wall construction is assigned to all Level 4–7 plates** (not left on the 190 mm default).
- Add the Internal Mass object to each apartment zone (internal partition area per unit).
- Verify the loading-bay ACH and confirm the Level-1 floor reads as an exposed/insulated floor after matching.
- Set realistic plug-load density for the operational run (replace the H1 24.5 W/m²).
- Add self-shading balconies as shading surfaces on the typical plate.
- Sanity-check the simulated electricity against the assumed-benchmark report (companion document) — end use by end use.
- Run the mass-concrete variant and record the heating/cooling deltas.

> **Cross-reference**
> The companion document, ***"Northcote N12 — Assumed Energy Benchmark,"*** gives an independent bottom-up estimate of expected annual energy by end use for a building of this size and unit count. Use it to judge whether the Nezo simulation output is within a sensible few-percent band or off by an order of magnitude (indicating a modelling error).