Bader Ventura
Passive House Development

Thank you to our project partners

Overview

Development Overview

Bader Ventura replaces three older state homes that were no longer fit-for-purpose with 19 new warm, dry homes.

1x4

1x 4-bedroom standalone home (not Passive House)

18x

18 x Passive House apartments in three story walk-ups (6 x 2-bedroom and 12 x 3-bedroom homes)

6

All 6 ground floor units are built to full universal design standard enabling customers to live well and age in place.

Building Performance

Bader Ventura is the highest quality, best performing design Kāinga Ora has built to date – achieving both Passive House standard and Homestar ratings.

- Targeting both an 8 Homestar v4.1 and 7 Homestar v5 built rating
- Low carbon concrete
- Considerably higher floor, wall and roof insulation, combined with smarter design and construction detailing to practically eliminate thermal bridges
- Heating and cooling these homes will be around 50% cheaper for customers*
- Reduced operational energy carbon around 32%
- Reduced space heating electricity by around 62%*
- The first Kāinga Ora homes built to Passive House standard
- Will achieve MBIE's draft Building for Climate Change 2035 'final' thermal performance cap 12 years ahead of expectation

*compared to a 6 Homestar v4.1 baseline

How Passive House and Homestar **work together**

Bader Ventura is designed to achieve both the Passive House Standard and 8 Homestar v4.1 requirements. These certified systems evaluate and rate the energy efficiency, indoor environmental quality and sustainability of buildings.

The Passive House Standard focuses primarily on reducing a building's energy consumption and indoor environmental quality through rigorous design and construction standards. The Homestar rating system evaluates the building through a broader range of categories including density and resource efficiency, energy health and comfort, water, waste and materials.

Passive House has strict energy efficiency standards that must be met in order to receive certification. The Homestar rating system has levels of certification that are awarded based on the overall performance.

Passive House features

HIGH PERFORMING
- Double glazed windows with argon gas fill and lowE film
- Thermally broken uPVC frames

AIRTIGHT CONSTRUCTION
- Airtight thermal envelope
- Minimal penetrations
- Seals around joins/junctions

INSULATION
- Very low thermal bridging
- Specialised insulated pre-cast panel construction
- Insulated plasterboard as internal lining
- PIR insulation creating a 'warm roof'

MECHANICALLY VENTILATED
- Very quiet continuous mechanical ventilation system with heat recovery
- Fresh filtered air to all rooms

Original source: Peddlethorp

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HOMESTAR FEATURES

- Healthy indoor environment, with eco-certified and low-emitting materials
- Energy efficient lighting and good daylight levels
- Low flow tapware, showers and toilets
- Construction waste management and minimisation
- Walking distance to local amenities and access to public transport

Monitoring and Evaluation

Building Performance **Evaluation**

Bader Ventura is unique to Kāinga Ora in terms of its designed high performance, resource efficiency and environmentally low impacting characteristics.

To establish benchmarks, better understand the process and improve future projects, an array of targeted metrics are being collected during construction and post occupancy.

The bulk of the monitoring will be carried out over the first year of occupation: July 2023 – June 2024 and Kāinga Ora intends to publish its findings.

Assessing the **features, cost and benefits**

Post occupancy surveys

Using the 'Beacon Pathway Medium Density Housing Survey' we will be assessing the following key areas to find out how people feel about living in these homes.

LIVEABILITY
Providing quality facilities that meet our residents' needs.

COMMUNITY
Encouraging positive interactions between residents through design and facilitation.

CONNECTIVITY
How customers travel around and what might make it easier.

CLIMATE CONSCIOUS DESIGN
To understand customers' views on environmentally friendly approaches to building and actions to reduce climate change.

Design features

- Interviewing our project partners as subject matter experts, to ensure knowledge can be applied to future builds with the potential to normalise higher performance construction.
- Interview topics will cover the design areas of structure, fire, architecture, ventilation, heating and cooling, and maintenance.

Lifecycle cost

- Calculating the lifecycle cost of the building from construction through to end of life as per international best practices standards and guidelines.
- This will explore the construction cost increase associated with the high performance design and construction of Passive House. Kāinga Ora aims to examine the cost and benefits of individual design solutions as well as a holistic system compared to industry benchmarks.

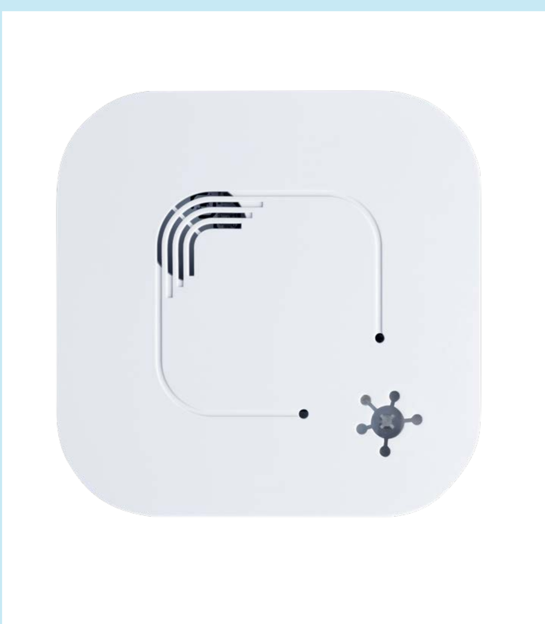
Whole building lifecycle carbon assessment

- Calculating the lifecycle carbon impact of the building by examining the carbon impact of construction materials, build process, electricity and water usage.

Sensor and meter installation

Multiple sensors and a hot water meter are installed in each home to gather data, which will help us understand as-built performance in the following areas:

- Temperature, moisture and indoor air quality - to determine measurable health-related indicators of the internal living environment.
- Resource use - to better understand the resource needs of our customers (such as electricity and hot water) for more accurate thermal and energy modelling.



TEMPERATURE/HUMIDITY/CO2 SENSOR
Temperature/humidity/CO2 sensors are bundled together into one unit and will be attached to the wall in the living room and bedrooms.

ELECTRICITY SENSOR
To collect information on electricity use for more accurate energy and carbon modelling.

DUST SENSOR
Attached to the wall in the living area to measure ultra fine dust levels in the home.

WATER METER
To collect information on hot water usage to aid future energy and carbon modelling.

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Carbon and Sustainability

Carbon **Contributions**

Buildings and infrastructure are responsible for approximately 20% of our nation's carbon impact, and the impact of buildings alone is around 9%. To help achieve net zero emissions by 2050, the construction sector must play its part.

At Kāinga Ora, our Carbon Neutral Housing programme aims to design homes that achieve a 42% lifecycle carbon intensity reduction by 2030.

TO HELP ACHIEVE THIS, THE PROGRAMME IS FOCUSING ON THREE KEY AREAS:

- Reducing the embodied energy and lifecycle carbon in building materials, their maintenance and waste.
- Reducing operational energy use with a focus on customer health, wellbeing and energy hardship.
- Leading and supporting industry transformation and change towards a low carbon sector.

KEY STEPS TO REDUCE CARBON EMISSIONS IN BADER VENTURA INCLUDE:

Operational carbon reduction (from running the buildings):

- A very high performing thermal envelope
- Airtight construction
- High performance window glass and joinery
- A whole house mechanical ventilation system with heat recovery
- Many amenities within walking distance, to reduce private car usage
- All habitable rooms receiving good amounts of daylight, to reduce need for artificial lighting

Carbon reduction (from constructing and maintaining the buildings)

9t

Using a low carbon concrete that emitted around 9 tonnes less CO_2 than a standard mix design and required around 13.8 tonnes less cement.

22.8kg

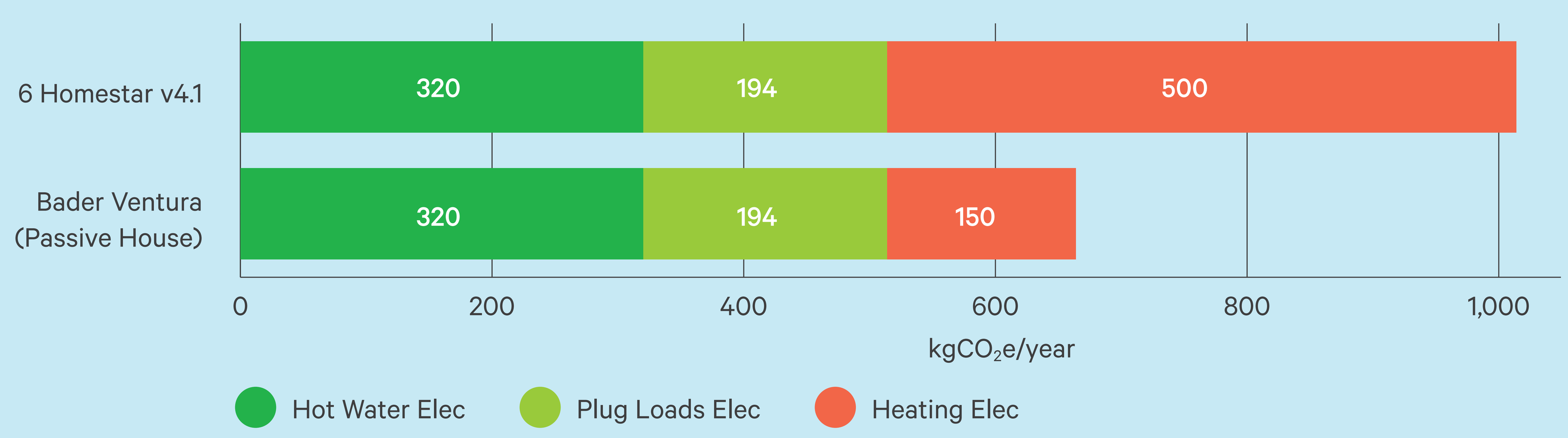
Minimising construction waste during the build to produce less than 22.8kg of waste per square metre of building.

35t

Over the entire project, around 48 tonnes of waste was produced, with over 35 tonnes diverted from landfill.

Estimated Annual Grid Carbon Emissions per Apartment at Bader Ventura

assuming 0.160kgCO_2e/KWh (BRANZ 2023)



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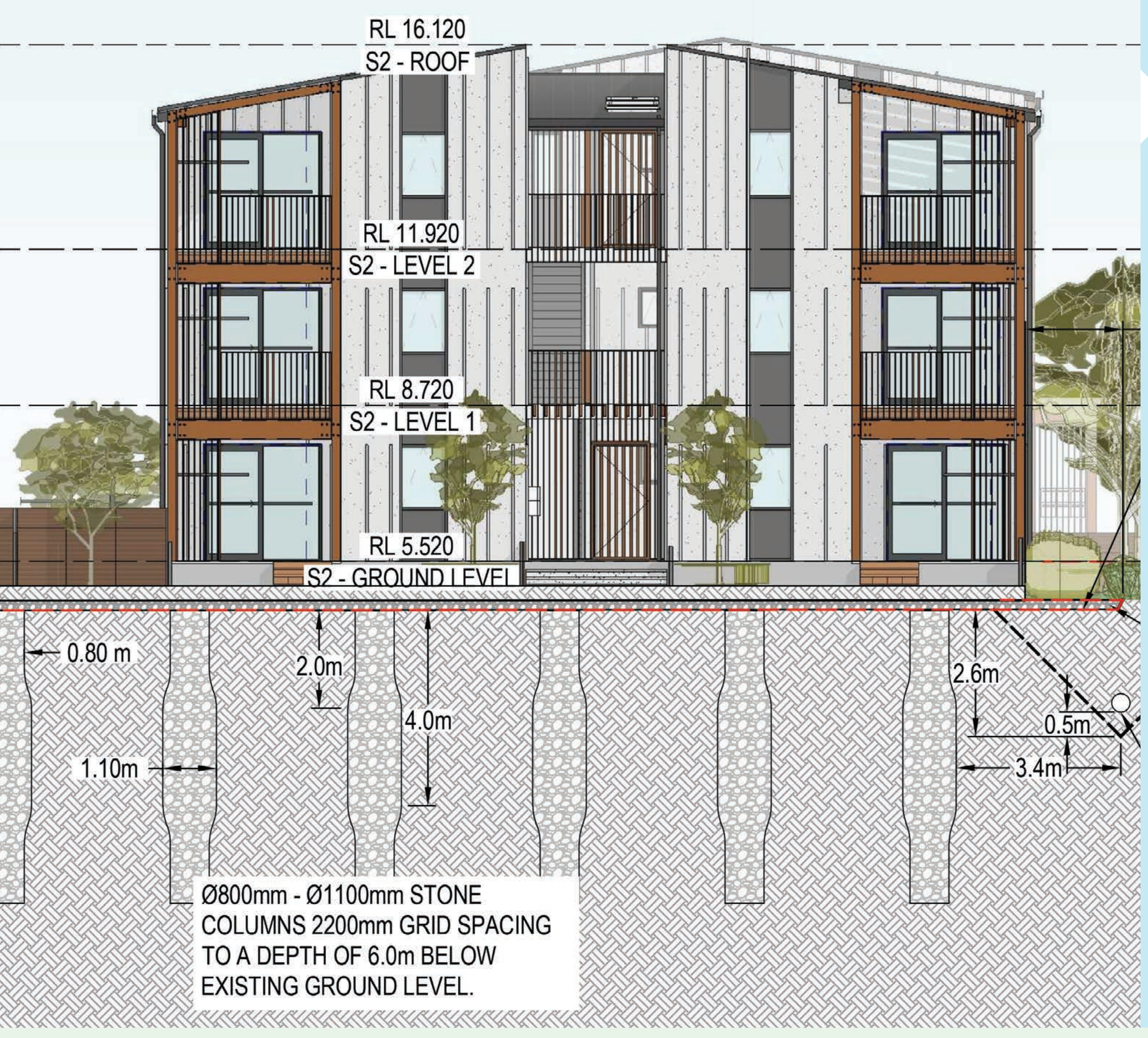
Building Platform

Building **Site**

Kāinga Ora was aware of the need to improve the existing ground conditions before a building platform could be created for Bader Ventura. Geotechnical investigations assessed the ground conditions and found that site hazards included differential ground settlement, lateral ground movement and a high groundwater table.

To moderate the effects of these hazards, Kirk Roberts (engineers) considered that bottom fed, displacement stone columns would be an effective method for controlling hazards and improving ground conditions.

BADER VENTURA



NON VIBRATION STONE COLUMNS (NVSC)

NVSC are an innovative technology developed in New Zealand by McMillan Civil as part of the Cantebury earthquakes rebuild.

Stone columns are installed by drilling bore holes into the ground and filling them with crushed stone. The columns are constructed in a grid pattern across the site in areas where the foundations sit and the columns go down to a depth of around 6 metres below ground.

Original source: Kirk Roberts

Key benefits of the stone columns include:

- **Stabilising the ground** - by moderating the effects of minor global lateral spread and lateral stretch, and minimise ground deformation.
- **Improving load bearing capacity** – we started with 56 kPa ultimate bearing capacity and the stone columns provided a 300 kPa geotechnical ultimate bearing capacity from which a level building platform could be constructed using a gravel raft.
- **Improved efficiency** – column installation can begin within three hours of the equipment arriving on site depending on which base machine is used, so the process is extremely time efficient.
- **Reduced disruption** – the process of installing the columns minimises impact to neighbouring properties by reducing noise, vibrations and dust often created through traditional methods such as driven/rammed piles.

Precast **foundations**

Precast foundations were constructed offsite and delivered as ready to install units. This simplified the onsite construction process by reducing the need for excavation and formwork and minimising disturbance to the surrounding enviroment.

While the precast foundations were under construction, the stone columns were being finalised and drainage was being installed on site.

This is the first time that both Kāinga Ora and Kirk Roberts had used this precast foundation system.

Original source: Kirk Roberts

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ARCHITECTURAL DESIGN

Detail Design and Performance

Architectural detail **performance**

Design details were developed to minimise thermal bridging and negate interstitial moisture (condensation within the building element).

Strategies to achieve this were:

- Use of thermally broken components
- Continual insulation across the thermal envelope
- Use of effective air seals and material choice in architectural detailing in order to reduce heat transfer

Reducing thermal bridges

Thermal bridging refers to a phenomenon in building where an area or component of a building acts as a pathway for heat to flow more freely than the surrounding materials.

A thermal break is insulation material that is used in the region of a thermal bridge to increase the thermal resistance and so reduce heat flow.

Heat transfer leads to heat loss or heat gain. It can lead to higher energy consumption, reduced thermal comfort.

Thermal bridging can contribute to condensation issues within a building. When warm air comes into contact with a cold surface due to a thermal bridge, condensation may occur leading to moisture related problems such as mould growth and the degradation of building materials.

Surface temperature factor

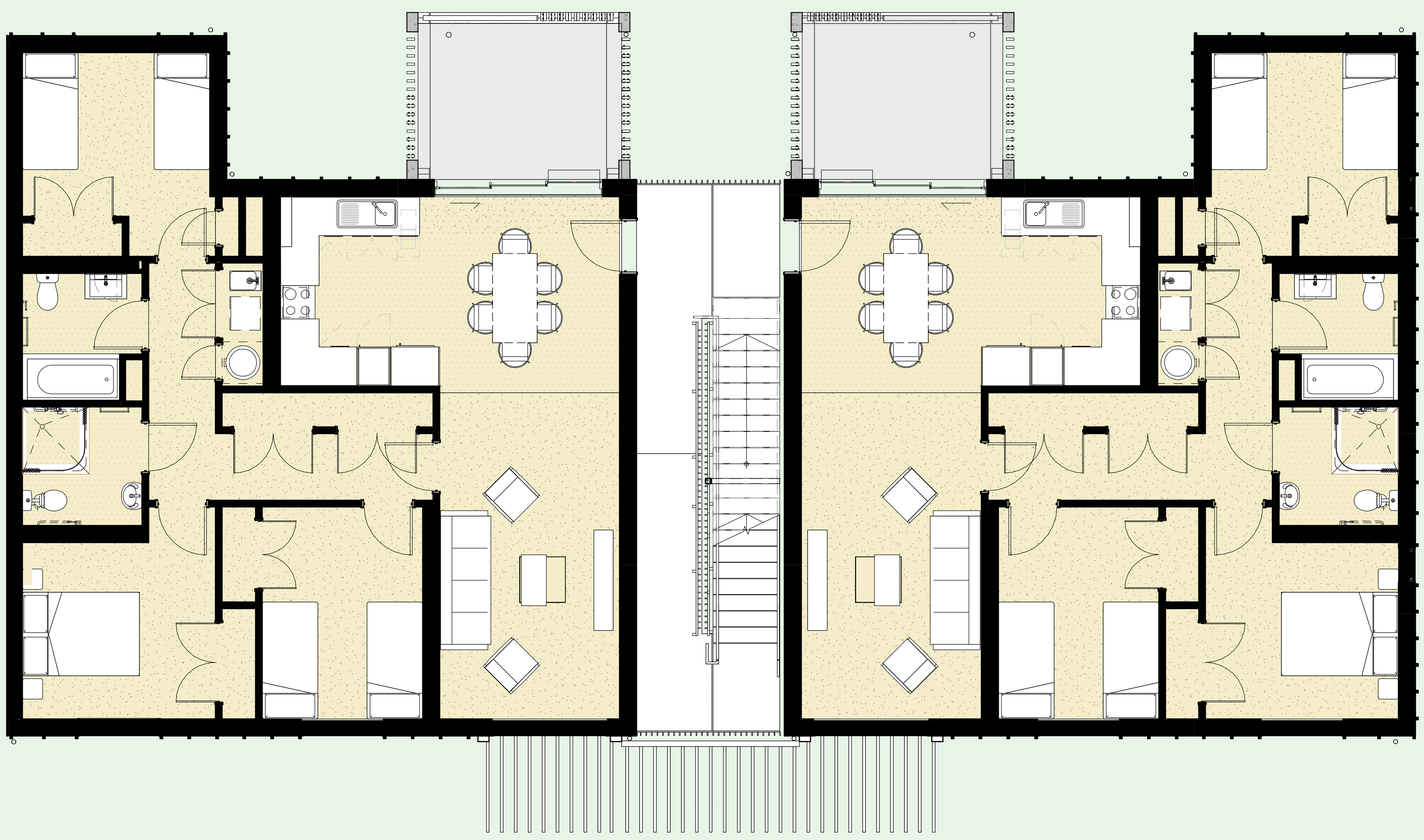
A simplified way to calculate, assess and lower the risk of mould-growth is by looking at the surface temperature factor (fRSI) value.

This is a dimensionless, construction-specific value, which is compared to the current fRSI limits for the particular climate zone (fRSI is not a Building Code requirement but it is a recognised requirement in Homestar v5).

For Bader Ventura, the fRSI value has been calculated for each junction detail and compared to the Passive House Planning Package requirement for Auckland (>0.55), to ensure that the mould growth risk is low.

TYPICAL APARTMENT PLANS

TYPICAL BLOCK 2 APARTMENTS



TYPICAL BLOCK 3 APARTMENTS

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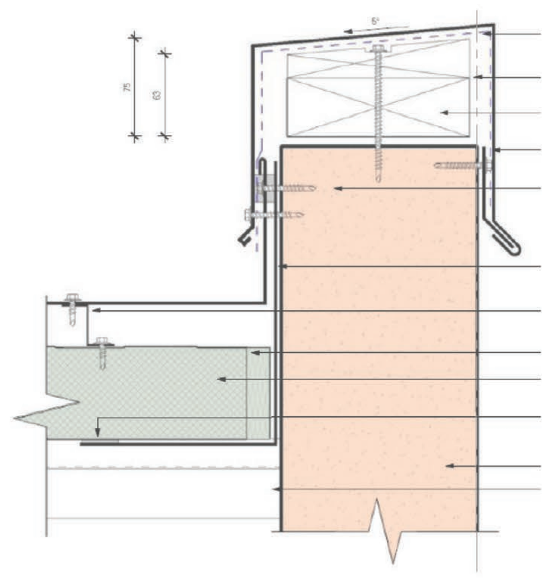
Junction Roof and Wall Construction

Roof-Wall Junction

Warm roof construction is where rigid board insulation is placed over the roof deck and the waterproof membrane is laid over the insulation This means that the insulation is on the outside of the building envelope and the roof structure and ceiling space are at a similar temperature to the building interior.

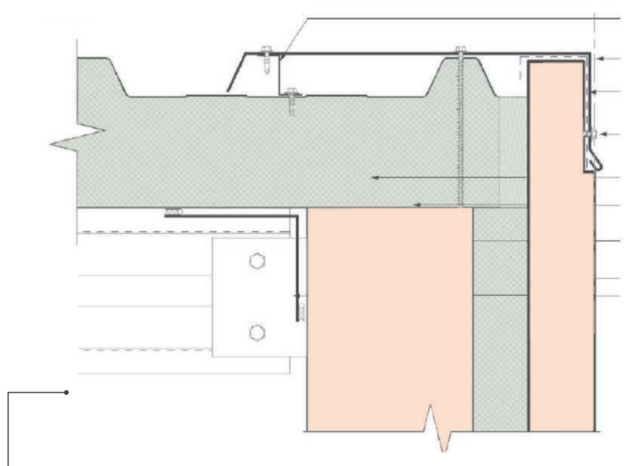
Warm roofs have significant benefits including improved energy efficiency and reduced heating and ventilation costs.



STANDARD DETAILING

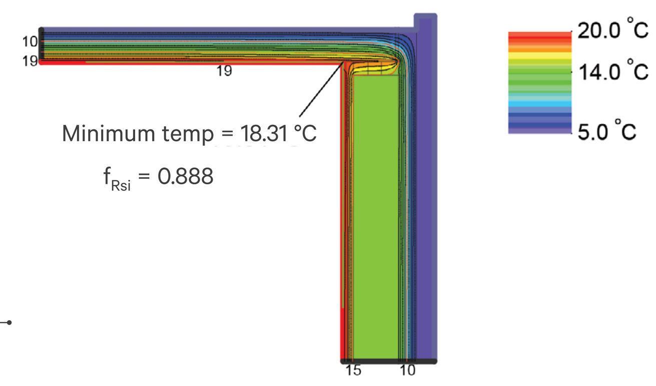
- Warm roof detailing achieves NZ Building Code and 6 Homestar.
- This provides an improved indoor thermal quality and moisture control. However, heat loss can still occur through the roof and walls as the envelope is not airtight.

Original source: Peddlethorp



IMPROVED DETAILING

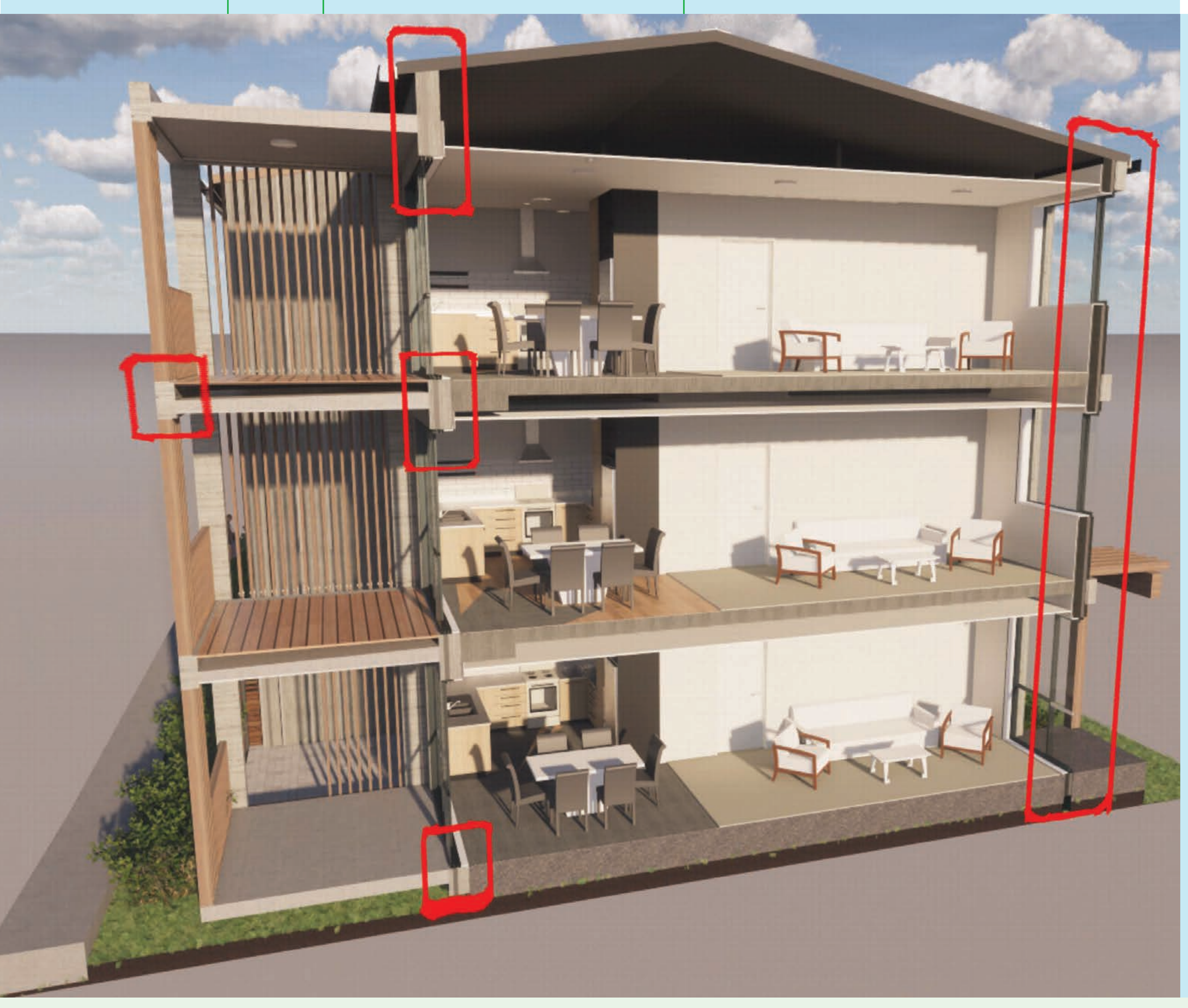
Using a 100mm Kingspan roof panel and insulated precast panel combination provides a considerably higher performing thermal and air sealing solution, compared to a typical construction.



ROOF-WALL JUNCTION

- The figure above shows the iso-therm lines (linking equal temperatures). The large difference between the internal and external temperatures show the high level of thermal resistance provided by the wall elements insulation and lack of thermal bridging.
- The minimum internal surface temperature (of 18.3°C) and the mould growth risk factors (of 0.875) show that even the weakest spot has a low risk of mould growth because it is above the pass/fail threshold of fRSI 0.55 for Auckland.

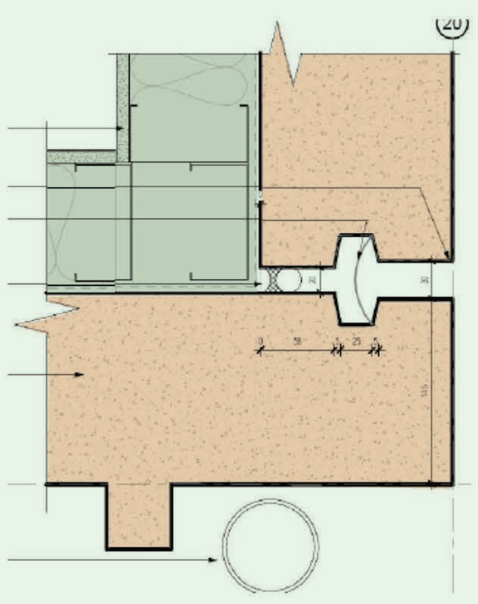
Original source: Oculus



Wall Construction

Bader Ventura has been constructed using high mass, insulated precast panels. It consists of 150mm thick structural panel, 60mm insulation and 60mm non-structural concrete panel. The insulations layer is required to achieve the PH requirements.

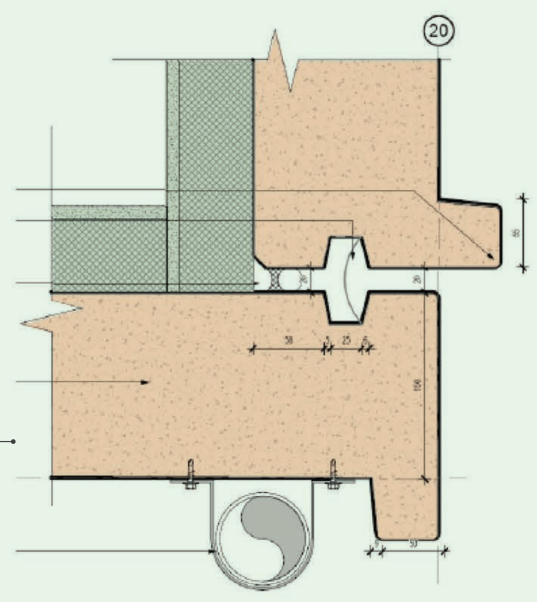
Original source: Oculus



STANDARD DETAILING

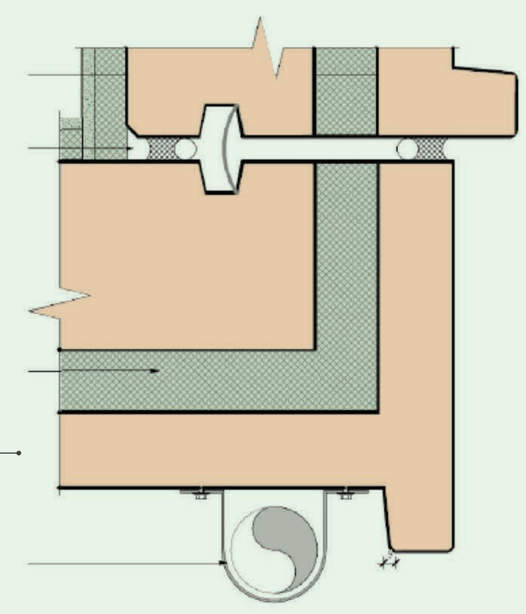
- Standard 150mm precast wall construction with steel frame strapping and lining, 90mm R2.8 insulation on the inside face.
- This detailing complies with NZ Building Code, Healthy Homes Act and Kāinga Ora M255 v4 requirements.
- Adequate indoor thermal quality.

Original source: Peddlethorp



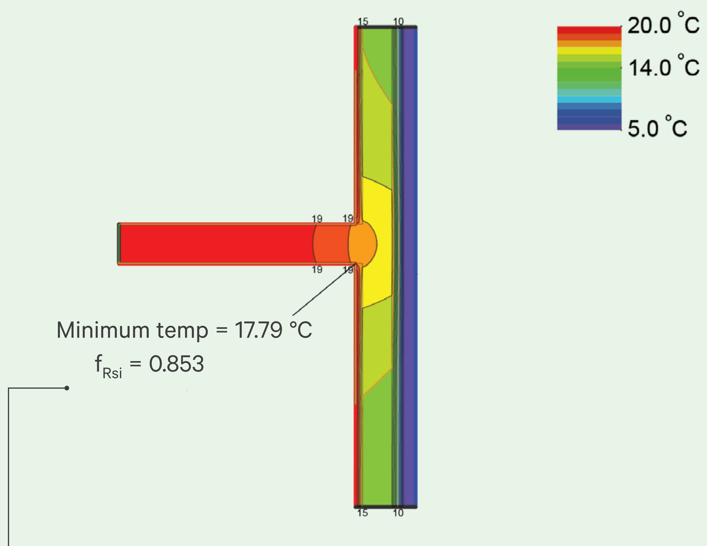
IMPROVED DETAILING

- Standard 150mm precast wall construction with 70mm Kingspan K17 R3.1.
- This detailing improves on the NZ Building Code standards.
- Provides an improved indoor thermal quality.



PASSIVE HOUSE DETAILING

- Insulated precast wall construction with 60mm concrete cladding, 60mm rigid insulation (Kooltherm R3.0, Goldfoam R2.14), 150mm precast concrete, 35mm R1.3 internal lining.
- This detailing increases the thermal performance for the building envelope as well as reducing heat transfer, and increasing air tightness aligning with Passive House principles.



MID-FLOOR JUNCTION

- The figure above shows the iso-therm lines (linking equal temperatures). The large difference between the internal and external temperatures show the high level of thermal resistance provided by the wall elements insulation and lack of thermal bridging. The minimum internal temperature (of 17.79OC) and the mould growth risk factors (of 0.853) show that even the weakest spot has a low risk of mould growth.

Original source: Oculus

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Thermally Broken uPVC Windows

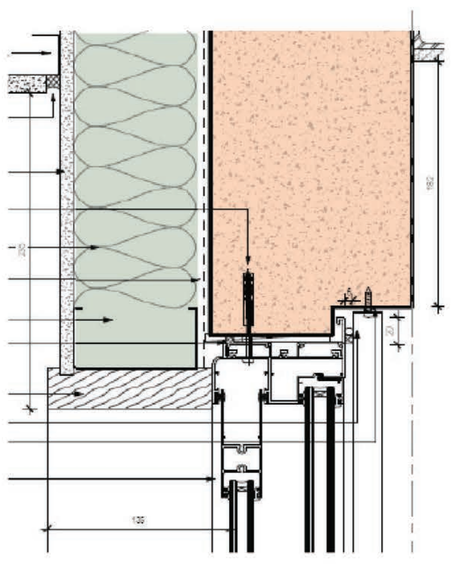
Thermally broken uPVC windows

High performance, argon filled, double glazed uPVC windows were selected for their high thermal insulation properties, minimising heat transfer between the interior and exterior of the building.

The main benefits provided by argon filled, double glazed uPVC windows include:

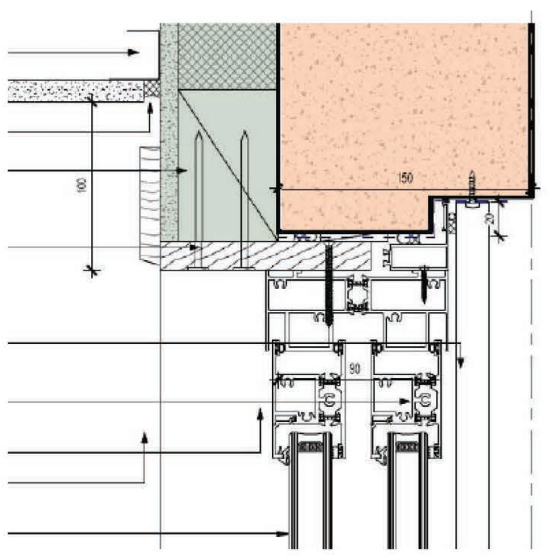
- The reduction in heat transfer eliminates condensation from forming on the inside.
- Reduced transmission of external noise, creating a quieter indoor environment.
- They have a high UV stability, which means they are durable and don't warp or get brittle in the sun.
- uPVC windows are relatively maintenance free.

JOINERY DEVELOPMENT



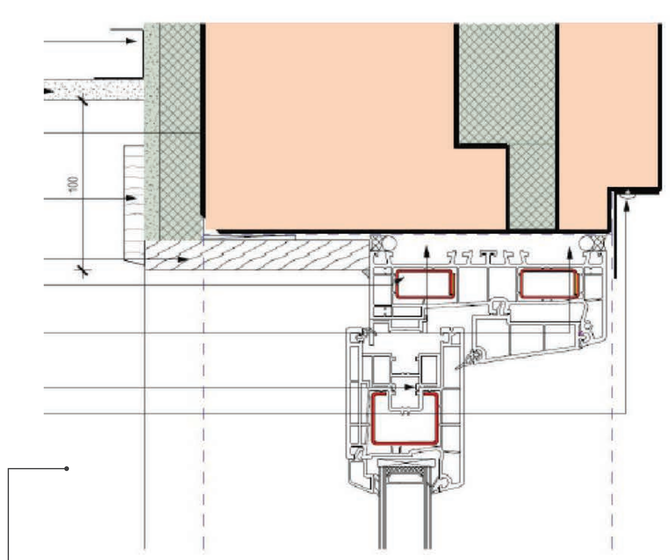
STANDARD DETAILING

- Standard aluminium joinery with 90mm R2.8 insulation, steel stud and plasterboard lining.
- This detailing complies with NZ Building Code and helps achieve 6 Homestar.
- Lower thermal performance and complex construction.



THERMALLY BROKEN DETAILING

- Thermally broken aluminium joinery with 70mm R3.1 Phenolic insulation internal lining.
- Performing higher than NZ Building Code and helps achieve 7 Homestar.
- Introduction of Kingspan K17 internal lining providing better thermal performance and simpler construction.

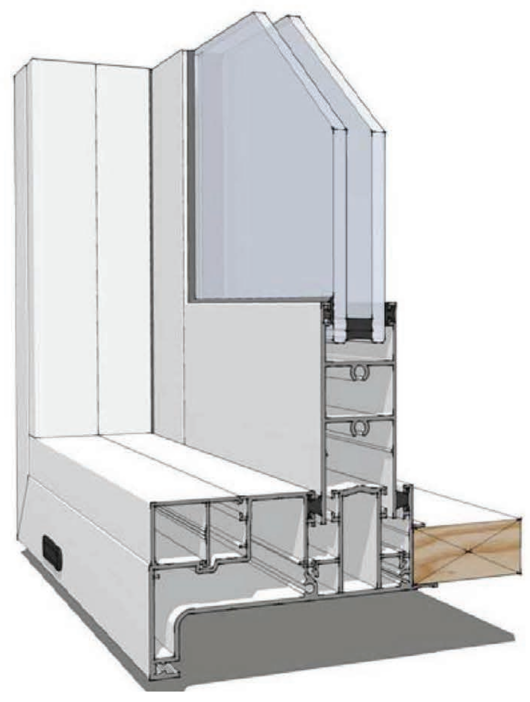


PASSIVE HOUSE DETAILING

- Thermally broken uPVC joinery, provides the highest performance, exceeding NZ Building Code and will help towards 8 Homestar.
- Insulated precast sandwich panels with Kingspan internal lining providing the best thermal performance.
- This detailing will contribute to achieving Passive House certification.

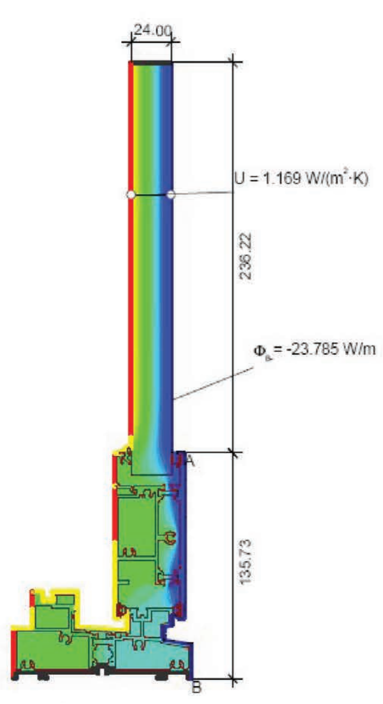
Original source: Peddlethorp

JOINERY SECTION



STANDARD ALUMINIUM JOINERY

- Standard aluminium joinery will comply with the NZ Building Code and provide an adequate indoor thermal environment. However, with no thermal separation within the joinery, internal surface temperatures can reach levels that can produce condensation and potentially mould.



- Thermal analysis undertaken to identify Passive House suitability (thermally broken aluminium joinery)

THERMALLY BROKEN uPVC JOINERY

- Thermally broken uPVC joinery provides a higher performance standard to the joinery unit. Multiple thermal breaks within the joinery itself minimises cold bridging. Building with uPVC provides added benefits over standard aluminium due to the lower thermal conductivity of the material, such as less condensation. This provides lower internal surface temperatures and a better quality indoor environment.

Original source: Fairview window specifiers

Original source: Aluplast.net

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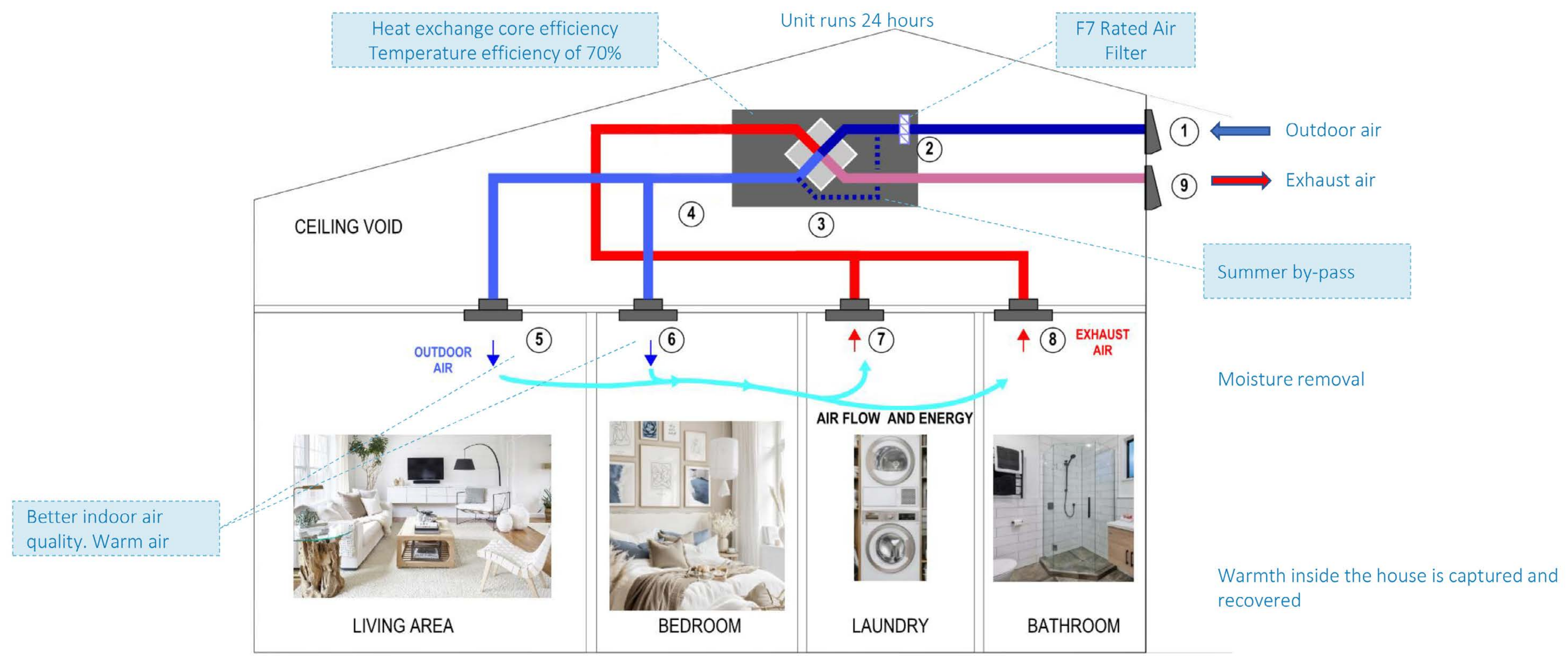
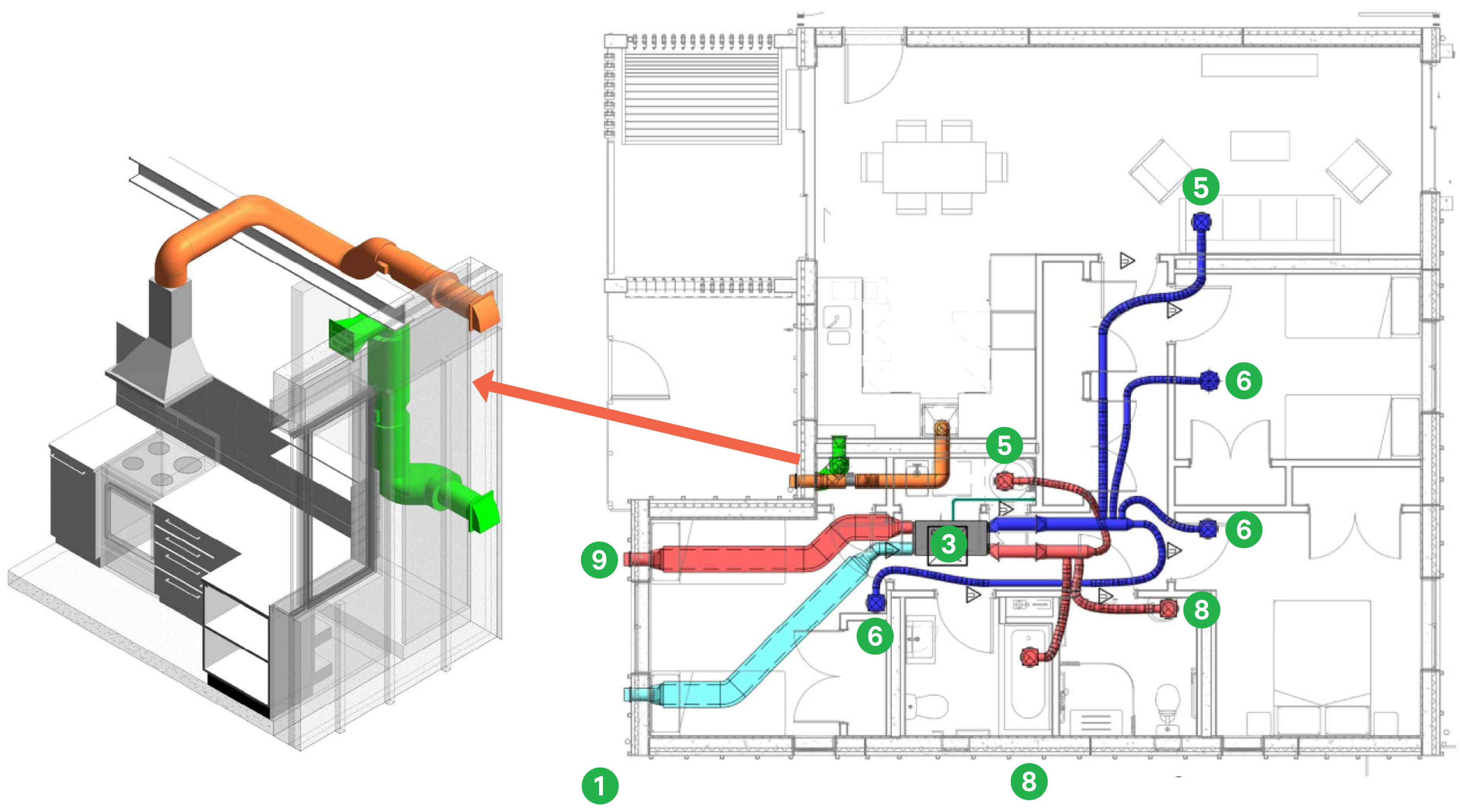
Mechanical Ventilation System

A mechanical ventilation with heat recovery system (MVHR), is a type of ventilation system that not only provides fresh air but also recovers and transfers heat between the outgoing and incoming air streams. This allows for greater energy efficiency and helps maintain a comfortable indoor environment.



KITCHEN MAKE-UP AIR

Independent of the MVHR system, the project also includes kitchen rangehoods that are ducted directly to the outside air. The challenge with introducing a rangehood into such an airtight building is the lack of air leaks required to provide the necessary replacement 'make-up' air. To solve this, the design includes direct ducted make-up air, with motorized dampers that open when the kitchen extract is in use.



Original source: 2PiR Consulting

How does **heat recovery work?**

Fresh air intake:
The system simultaneously pulls in fresh outdoor air ❶ while extracting stale indoor air. Both air streams pass each other through a heat exchanger ❸ where heat from the warm extract air is transferred to the cold fresh outside air. The heat exchanger allows for the transfer of heat between the two air streams without mixing them.

Air filters: ❷
Air filters are an essential part of mechanical ventilation systems. They remove airborne particles, such as fine dust, pollen, and some pollutants from the incoming air resulting in improved indoor air quality. These filters need to be changed periodically, to ensure effectiveness.

Ducting:
The now preconditioned fresh air is distributed to different areas of the building through ductwork, while the extracted stale air is vented to the outside. Ducting used in Bader Ventura had smooth interior linings to minimise turbulence, maximising the air transfer effectiveness. Ducting also included insulation on the fresh air and extract air ducts to minimise heat loss from the interior space to the cold air.

Fire safety:
The airtight construction of a passive house means that the building envelope is highly sealed, with minimal air leakage. This means it is theoretically possible to cause an overpressure in the unit on fire, to such a level that the apartment egress door may not be able to be opened for a period of time. A unique safety feature of this system is that in the event of a fire automatic window openers (window actuators) and the motorised dampers will be activated to open. This will reduce the pressure in the apartment to a level that the egress door can be opened in the event of fire.

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