



ENGINEERING OPTIONS REPORT

47339_EOR_01 - 47359 461 Chapel Rd,
Sustainable Development Group Ltd

POWERED BY
neuron

Date 30/04/2025 - Revision 04

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Revisions

Revision No.	Issue name	Issue date	Engineer
1	Preliminary for comment	20/02/2024	SYC
2	Revision issue	14/10/2024	SYC
3	Preliminary for comment	06/01/2025	SYC
4	Final DA issue	30/04/2025	SYC

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Steven Cassells NER, RPEQ, CEng, MSc, BEng, MCIBSE, MIEAust.
Engineering Lead

EXECUTIVE SUMMARY

Key:

Not viable

Recommended

System	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Chosen System	Comment
Substation type	Indoor Subterranean substation	Indoor Surface/Elevated substation	External (Padmount Substation)	Low Voltage Connection					
Domestic hot water	Centralised Electric Heat Pumps	Instantaneous electric heaters per apartment (single phase)	Instantaneous electric heaters per apartment (three phase)	Centralised Gas System	Instantaneous gas heat per apartment	Hot water storage per apartment			
Air Conditioning	1:1 DX Split Systems with condensers located on balconies	Roof mounted 1-1 DX Splits	1-1 DX Splits in an on-floor AC farm	Roof mounted centralised air-cooled VRV	Centralised VRV in an on-floor plant room	Water cooled VRV with cooling towers			
Apartment cooktops	Electric hobs	Single phase induction cooktops	Three phase induction cooktops						
Solar PV panels	Yes, included, common property loads only	Yes, included, maximise PV via ENO solution	Yes, included, maximise PV via Solshare system						
Solar hot water panels	Not included	Included							
Recycled water	Not included	Rainwater reuse	Greywater treatment	Blackwater treatment	Other				
Commercial kitchen exhaust	Discharge at roof level	Discharge locally with filtration	Not applicable						
Distributed Antenna System (DAS)	Not included	Full DAS included	Repeater or booster system included only						
Car park ventilation system	DtS fully ducted	DtS with plenums	CFD solution with ductwork	CFD solution with plenums	Other				
EV Chargers	NCC 2022 minimum provisions only	NCC 2022 provisions with additional chargers							
Apartment ventilation	Naturally ventilated	Mechanically ventilated locally from facade	Mechanically ventilated with per apartment HRV locally from facade	Mechanically ventilated via per room HRV locally from facade	Mechanically ventilated via centralised HRV				Assume operable Windows with makeup air from the common corridor
Lifts	Minimum lift requirements only	Mid-range solution preferred	High-end lift solution preferred	Other					

1. The above table shows a column called 'chosen system type'. The intent is this will be filled in and agreed by the project team after the engineering options workshop. This list intends to become the agreed MEP services strategy and forms the basis of the concept design and subsequent design guide that will be carried forward into the design.
2. Note greyed out options indicate options that are not viable for the project.



- > MECHANICAL
- > ELECTRICAL
- > HYDRAULIC
- > FIRE PROTECTION
- > LIFTS
- > OTHER

SITE OVERVIEW

This report has been developed for Sustainable Development Group Ltd for the proposed residential development at 461 Chapel Rd, Bankstown NSW 2200, Australia.

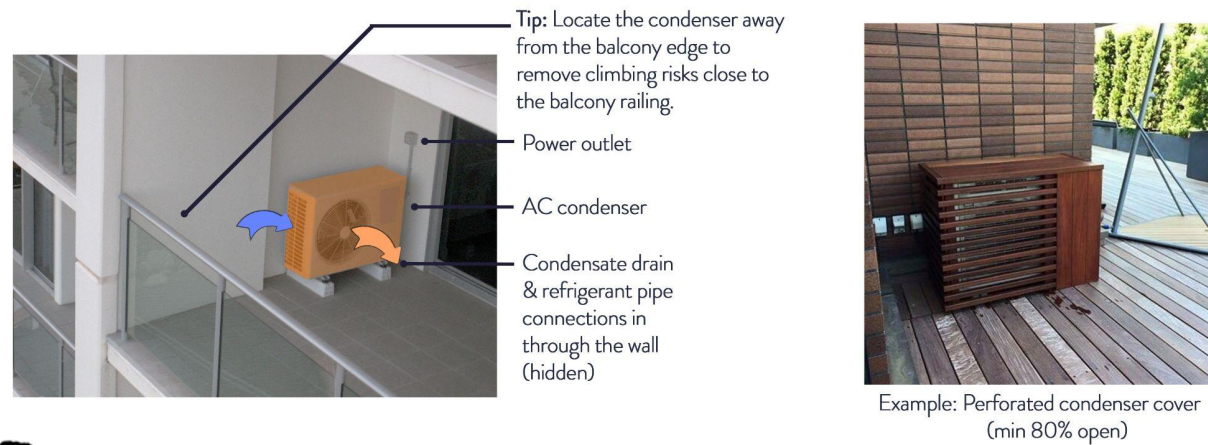
This report intends to outline the major engineering options associated with the building to support initial decision-making and spatial planning.

This report is based on the documents received prior to 06/01/2025. These drawings and area schedules were used as the basis of this preliminary analysis.

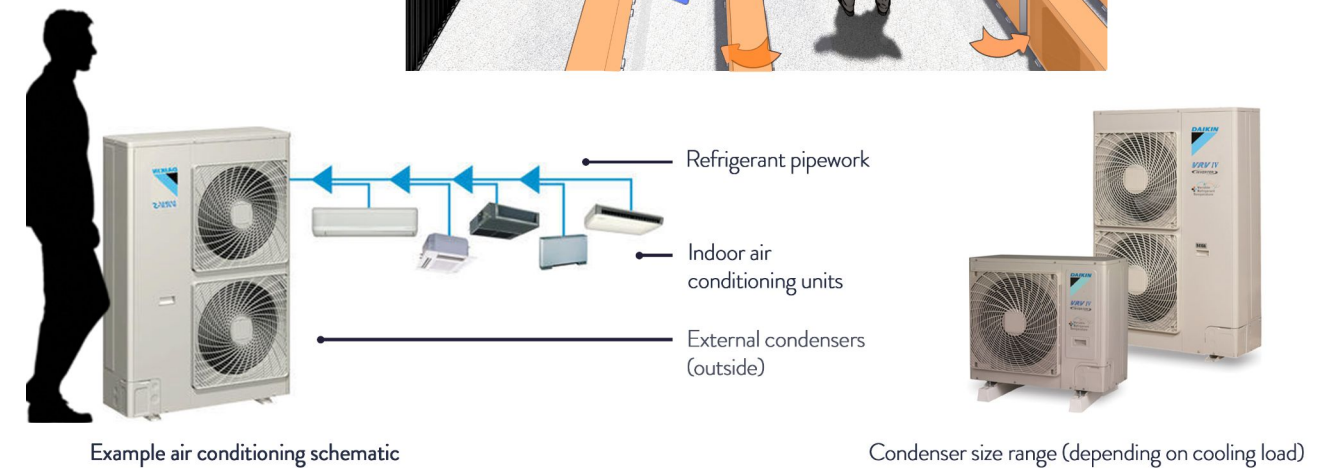
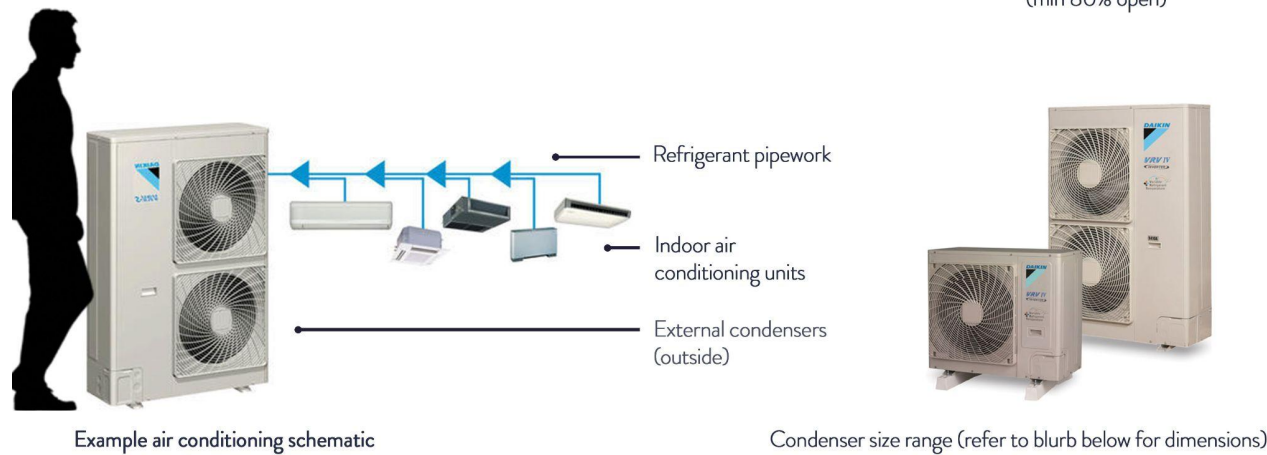
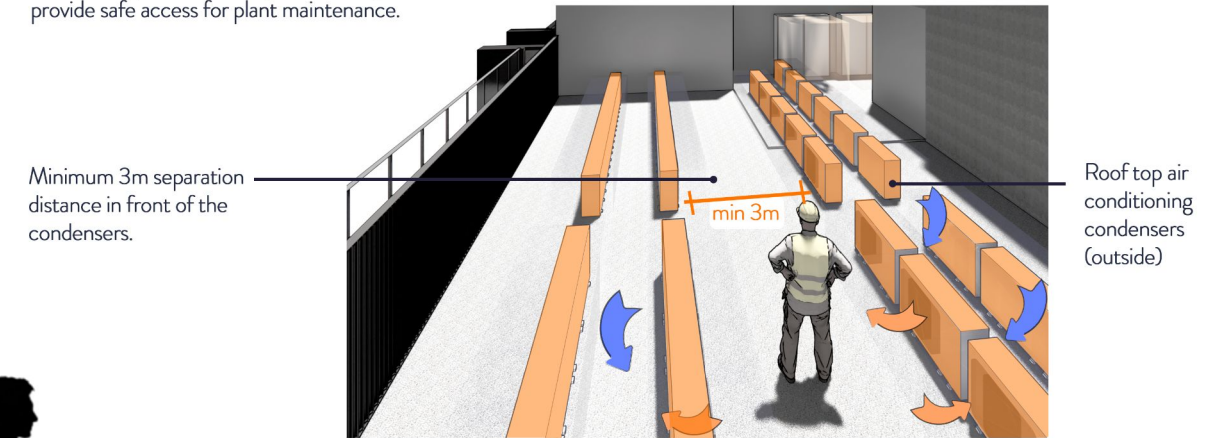
MECHANICAL SERVICES

AIR CONDITIONING OPTIONS

The development has several options available regarding air conditioning for the apartments. This section gives an overview of each option, what it entails, and the costs and design considerations associated with each option.



Tip: locate condensers outside in a safe location away from roof edges. Ensure you provide safe access for plant maintenance.



AC Option 1: DX Split Systems with condensers located on balconies

This is the cheapest option available for the project. Individually powered from apartment distribution boards, metering is simplified with billing data being gathered from the power meters located within the on-floor electrical cupboards.

This option also is the most space-efficient as no additional mechanical shafts or roof plant space is required. In addition, this option uses the least amount of materials, minimising the use of copper and insulation products on the project. Refer to the cost analysis section for detailed costs.

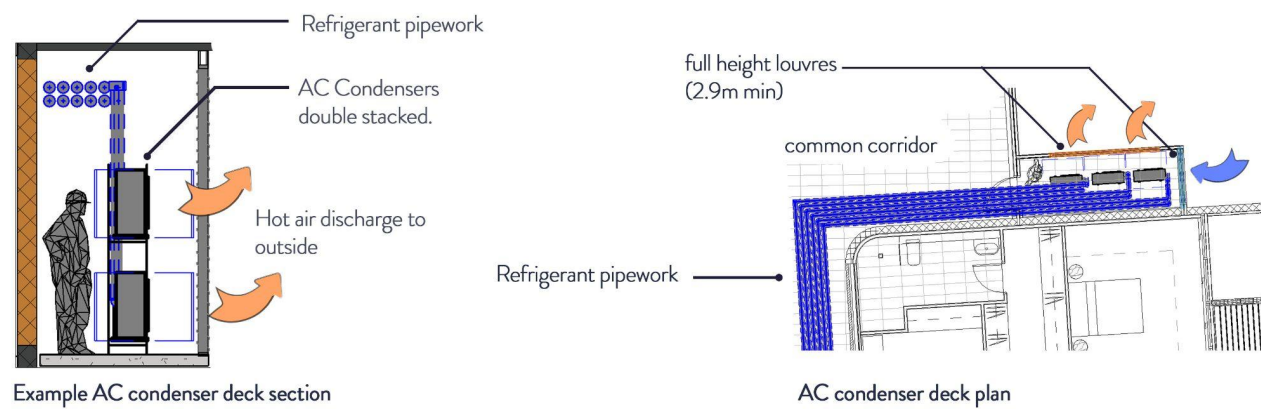
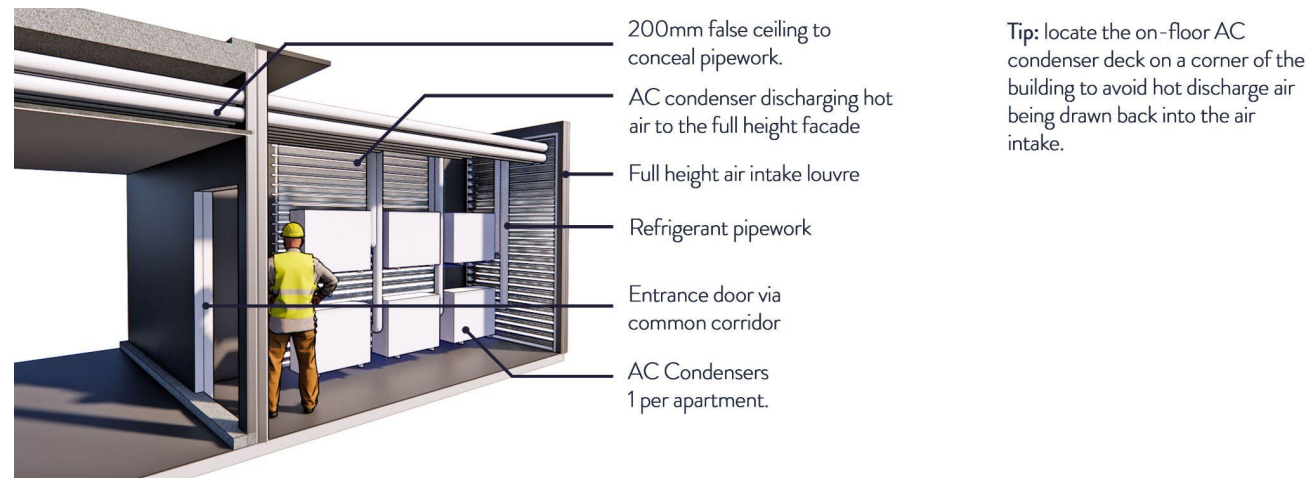
AC Option 2: DX Split Systems with condensers located on the roof

This option will not be available to the project. Beyond 8 levels, the distances are too great for this option to work. It is a limit of the technology (70m max. distance between condenser and apartment FCU).

Individually powered from apartment distribution boards, metering is simplified with billing data being gathered from the power meters located within the on floor electrical cupboards.

This option will require a mechanical shaft to connect each apartment to the associated roof-mounted condenser. Roof plant space will also be required to contain the condensers, as illustrated below. Refer to the cost analysis section for details on specific space required and cost.

MECHANICAL SERVICES



AC Option 3: DX Split Systems with condensers located in an on-floor plant room

This option will be available to the project. Individually powered from apartment distribution boards, metering is simplified with billing data being gathered from the power meters located within the on floor electrical cupboards.

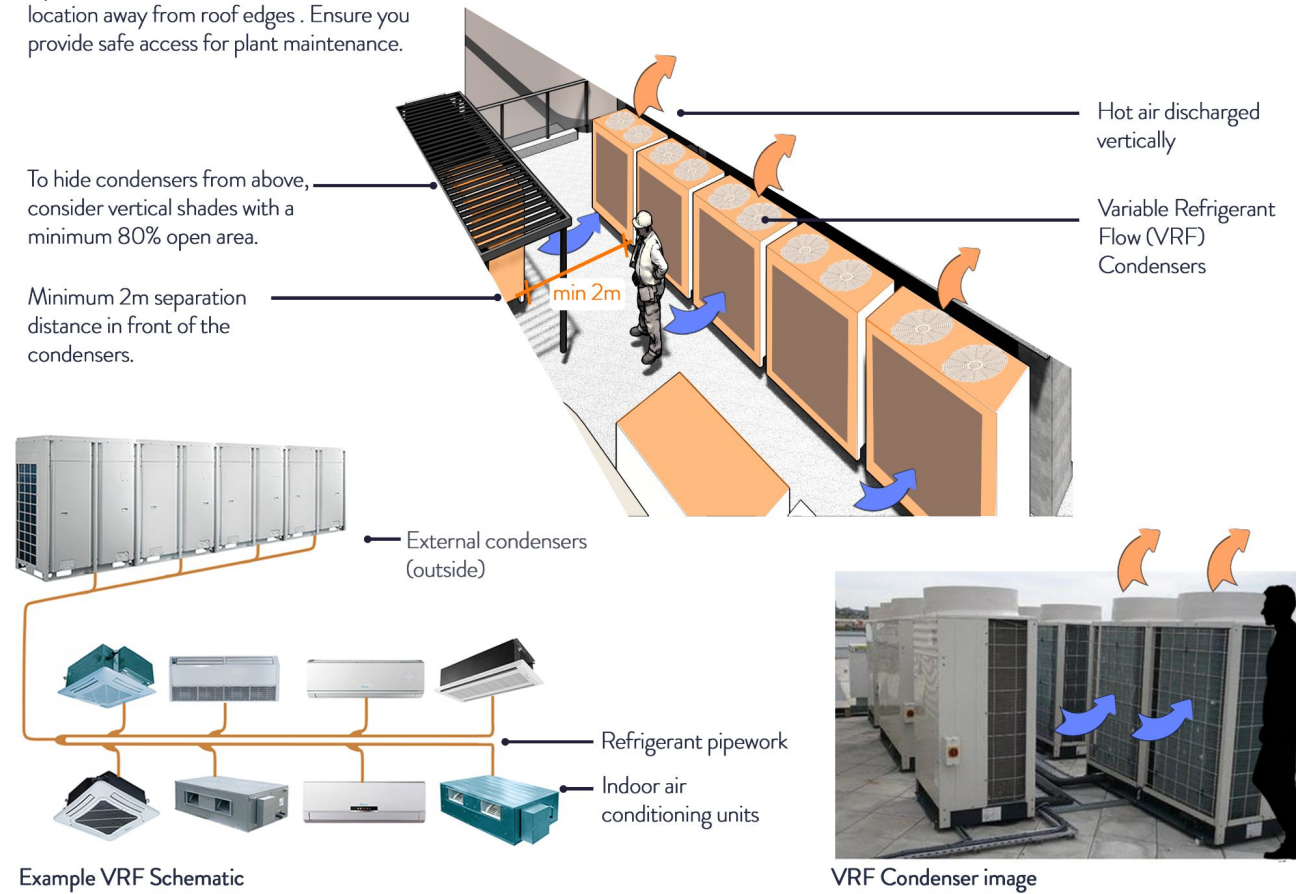
This option will require an on-floor mechanical plant room on each level located off the common corridor, as illustrated below.

A false ceiling is required in the corridor to conceal the refrigerant pipework from each condenser out to its associated apartments. Refer to the cost analysis section for details on specific plant room sizing, area and costs.

Tip: locate condensers outside in a safe location away from roof edges. Ensure you provide safe access for plant maintenance.

To hide condensers from above, consider vertical shades with a minimum 80% open area.

Minimum 2m separation distance in front of the condensers.



AC Option 4: Roof Mounted Centralised Variable Refrigerant Volume (VRF) System

This option will not be available to the project. This system type utilises centralised, larger condensers to serve multiple apartments.

This system has great operating efficiency and offers a spatially efficient solution for larger buildings to serve all apartments. This centralised system is powered by a dedicated MSSB (switchboard). For this reason, a proprietary billing system is required to calculate individual energy consumption to enable accurate billing. There are several proprietary billing systems in the market.

This option will require a roof mechanical plant compound and refrigerant shafts running down through each level located off the common corridor.

A false ceiling is required in the corridor to conceal the refrigerant pipework from the riser out to each apartment. Refer to the cost analysis section for details on specific plant and shaft areas and costs.

MECHANICAL SERVICES

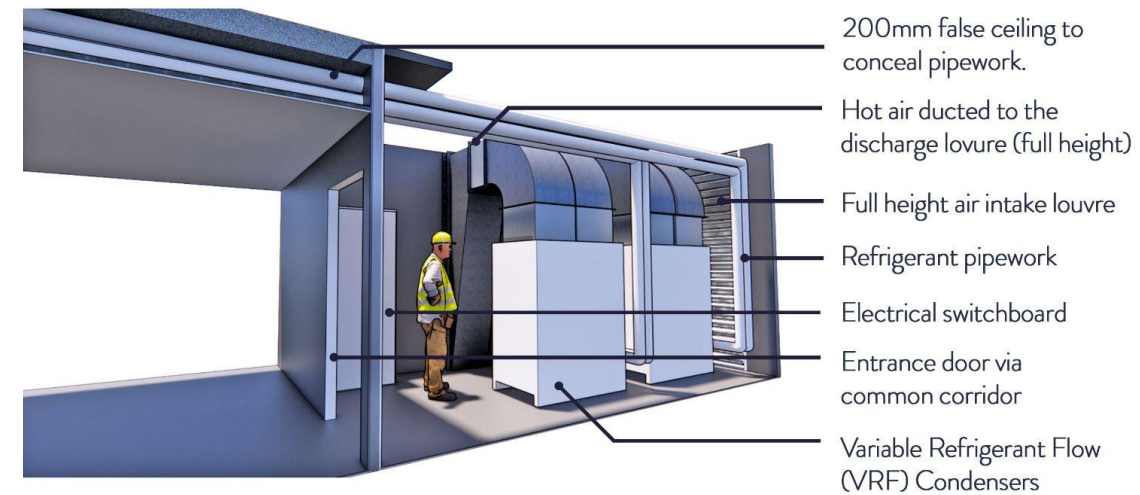
AC Option 5: Centralised Variable Refrigerant Volume (VRV) System with on-floor condensers

This option will be available to the project. This system type utilises centralised, larger condensers to serve multiple apartments. This system has great operating efficiency and offers a spatially efficient solution on larger buildings to serve all apartments.

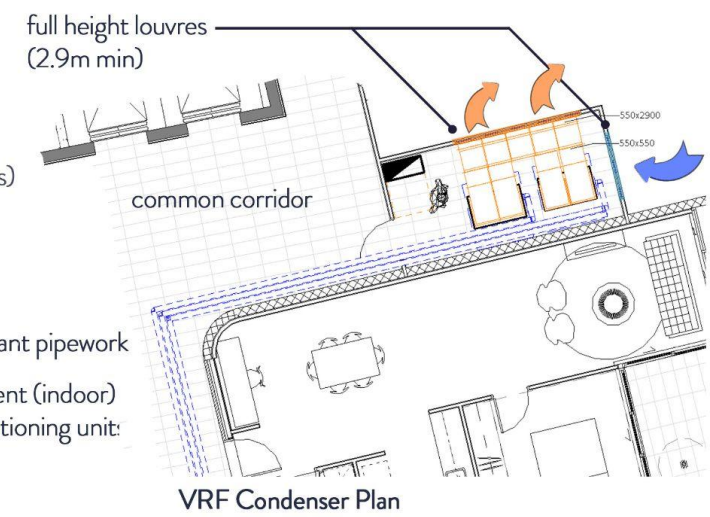
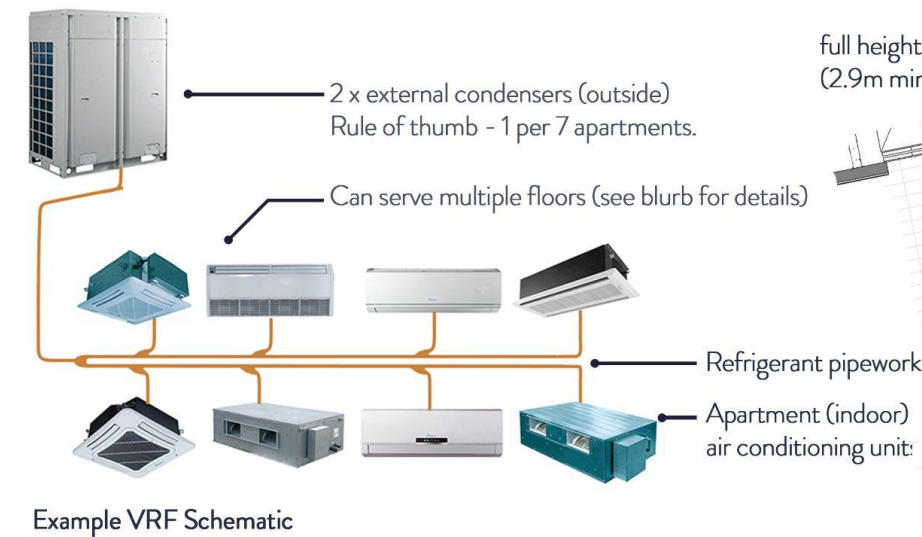
This centralised system is powered by a dedicated MSSB (switchboard). For this reason, a proprietary billing system is required to calculate individual energy consumption to enable accurate billing.

There are several proprietary billing systems in the market. This option will require a mechanical plant room on each level, located off the common corridor, as illustrated below.

A false ceiling is required in the corridor to conceal the refrigerant pipework from the plant room out to each apartment. Refer to the cost analysis section for details on specific plant and shaft areas and costs.



Tip: locate the on-floor condenser deck on a corner of the building to avoid hot discharge air being drawn back into the air intake.



MECHANICAL SERVICES

- > **MECHANICAL**
- > ELECTRICAL
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AC Option 6: Water-Cooled Variable Refrigerant Volume (VRV) System

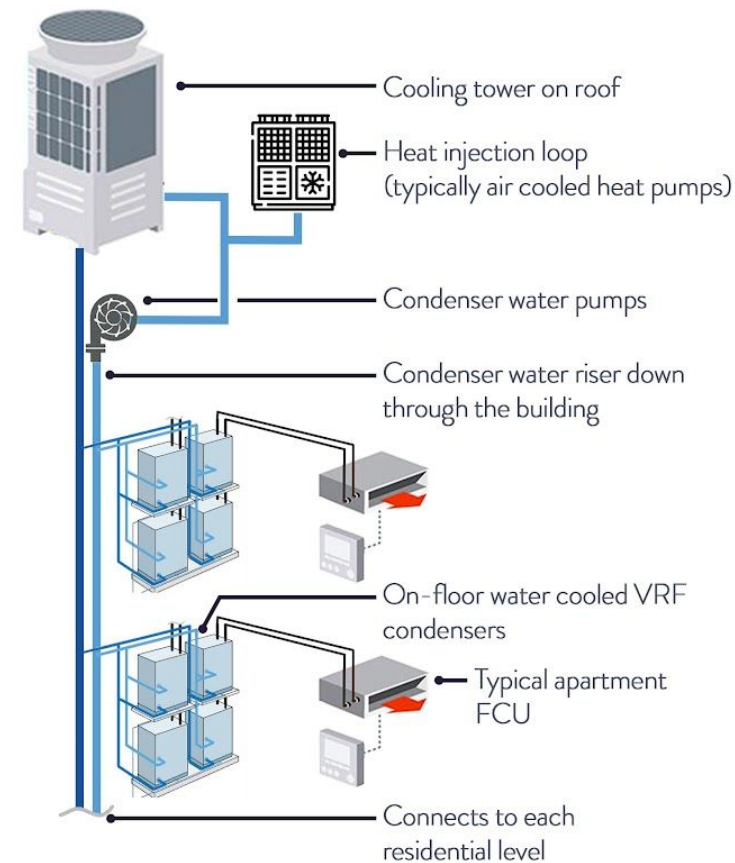
This option will be available to the project, but is typically only used on very tall buildings due to the higher capital and ongoing maintenance costs. It consists of a cooling tower, associated pumps and ancillary equipment located on the roof. The cooling tower circulates condenser water down through the building within two large condenser water pipes.

On each level, vertically stacked, is a small room located off a common corridor that connects from those two condenser water pipes to several water-cooled VRF condensers. These condensers operate similar to normal AC condensers; however, instead of rejecting their heat to the outside air, they reject their heat into the condenser water loop.

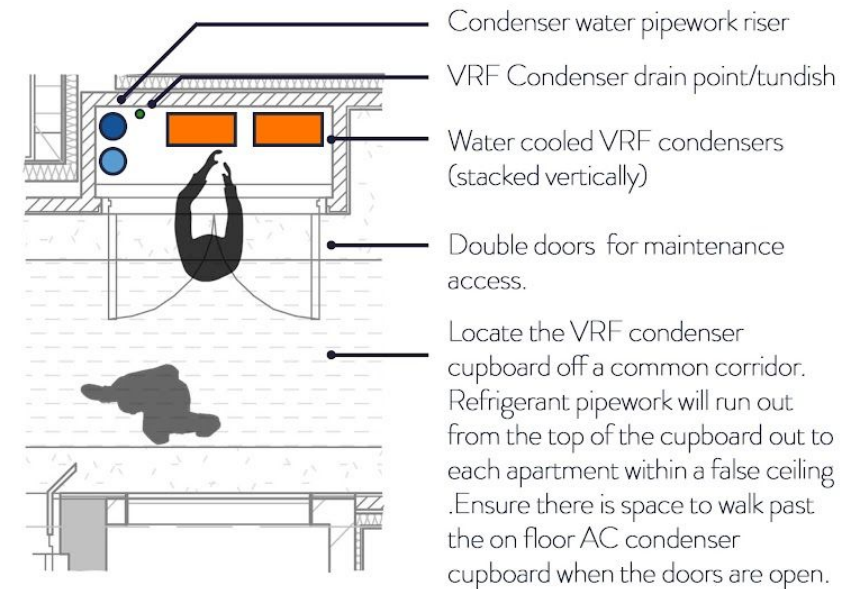
The rooftop cooling tower then rejects the heat from that water loop to the air. The on-floor water-cooled VRF condenser plant room does not need to be ventilated and can be located within the building form.

This system requires a billing system. Typically, a bill for this system has two parts, a base cost that covers cooling tower energy and maintenance costs and a proprietary billing system that calculates energy usage out to each apartment from the on-floor condensers.

Tip: Locate the cooling tower away from the edge of the building with safe access for testing and maintenance. See the blurb for details, including the height of the cooling tower.



Example Water Cooled VRF Schematic



Water Cooled VRF Condenser image

MECHANICAL SERVICES

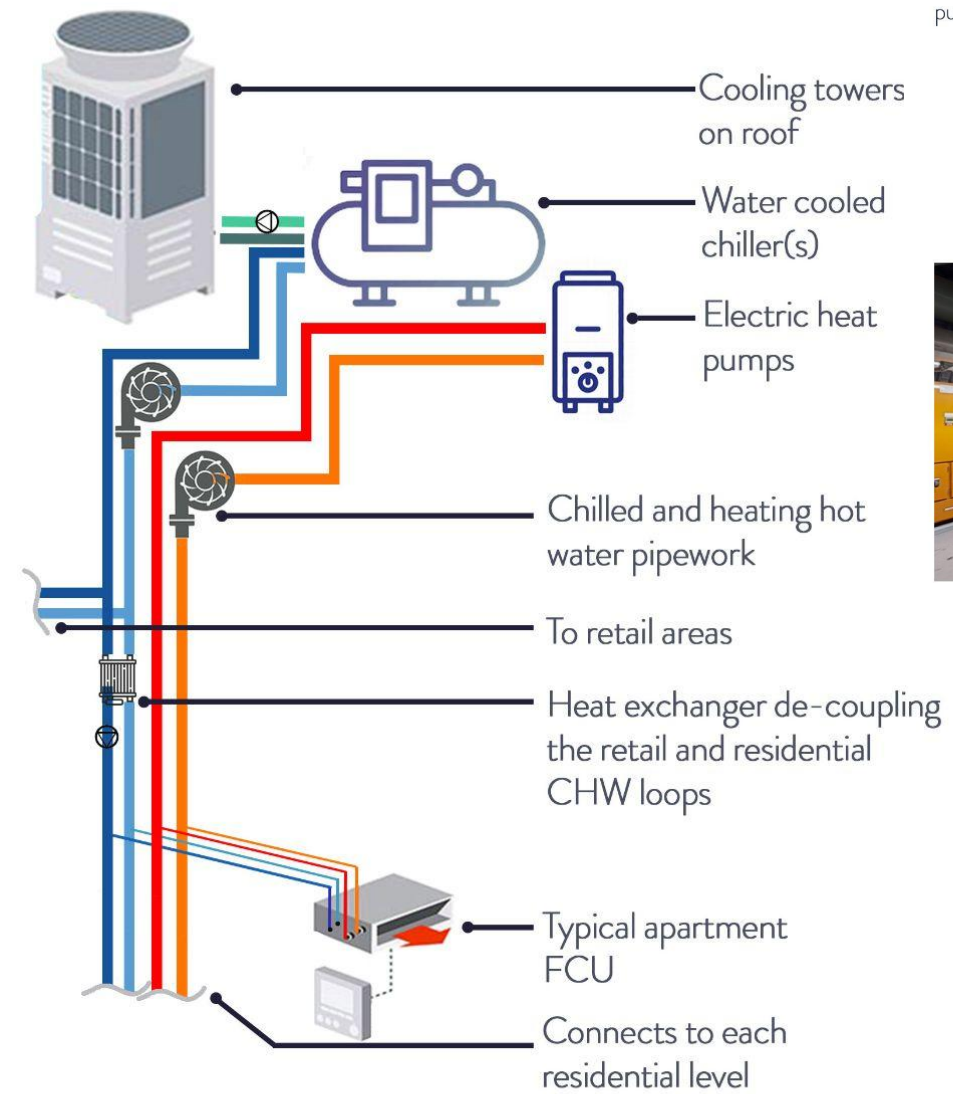
AC Option 7: CHW and HHW FCU System

This option will not be available to the project, given the size and cooling load of this building. It consists of chilled water type Fan Coil Units (FCU's) being used in each apartment instead of refrigerant-based FCU's. Each FCU has two coils, a heating and cooling coil that conditions the air within the apartments.

Chilled and heating hot water pipework runs through the building connecting the FCU's back to the source of heating and cooling.

A new centralised cooling system would be required. This system would require 2 x NMI type meters per apartment for heating/cooling billing.

Tip: Locate the cooling tower away from the edge of the building with safe access for testing and maintenance. See the blurb for details, including the height of the cooling tower.



Example image of electric heat pump for space heating



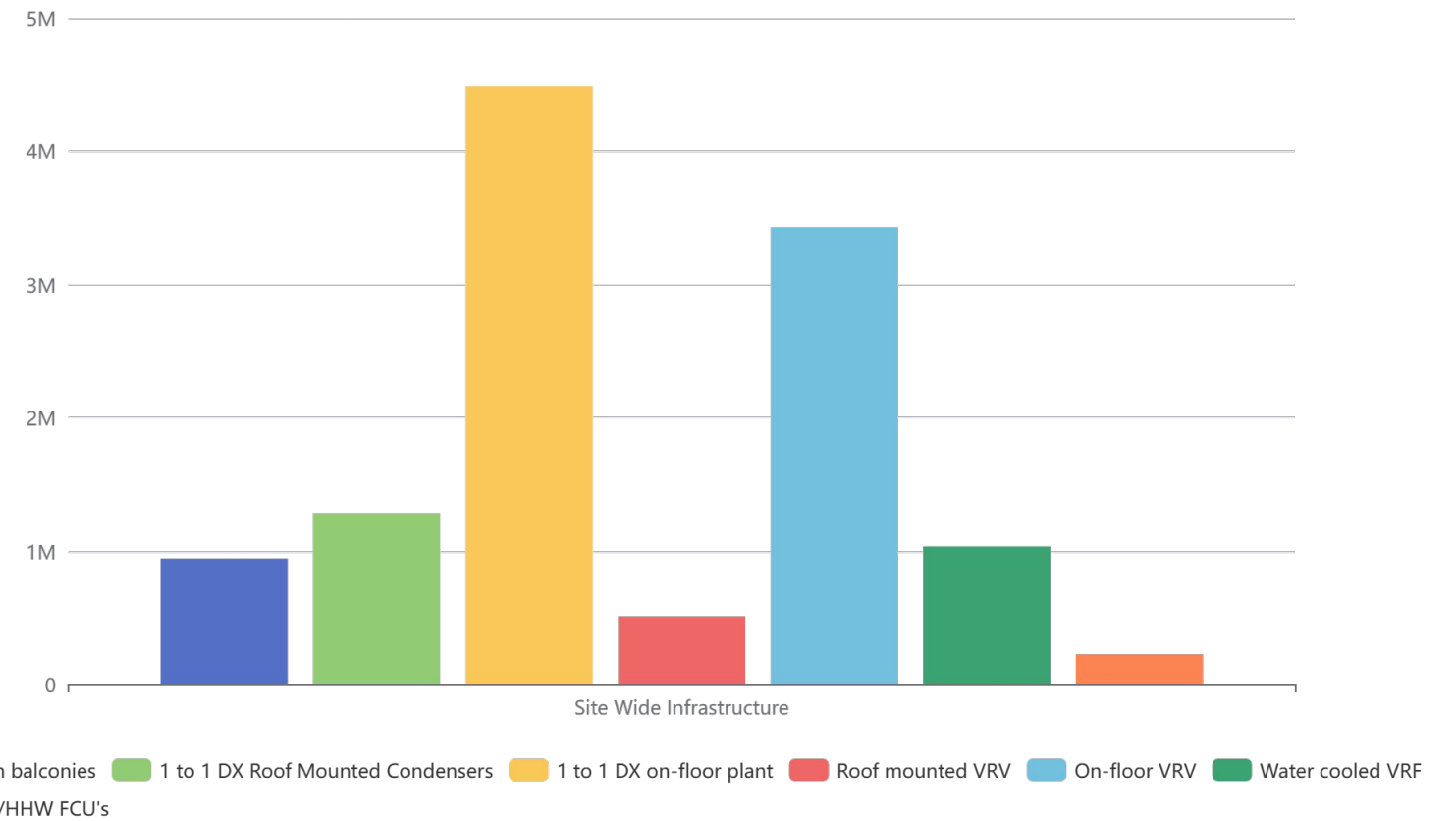
MECHANICAL SERVICES

AC Options Cost of Space Comparison

The graph next to this text shows the comparative cost of space for each AC option, with detailed data on the following page. We suggest evaluating not just the capital cost of each system, but also the space needed on each typical level for each option.

We've considered the value of each square meter of space to assess the development impact of the lost space, assuming it could otherwise be sold.

If the space is not sellable, a build cost rate can be applied to determine the best solution, considering both the capital cost and the value of the space needed for each option.



Air-Conditioning Area Comparisons (on-floor areas only)

Building reference	Component	\$/sqm used for comparison	AC on balconies	1 to 1 DX Roof Mounted Condensers	1 to 1 DX on-floor plant	Roof mounted VRV	On-floor VRV	Water cooled VRF	CHW/HHW FCU's
Site Wide Infrastructure	AC Condenser Area Options (On floor)	\$15,000	\$943,500	\$1,287,000	\$4,483,500	\$510,000	\$3,430,500	\$1,035,000	\$225,000
Total		\$15,000	\$943,500	\$1,287,000	\$4,483,500	\$510,000	\$3,430,500	\$1,035,000	\$225,000

MECHANICAL SERVICES

Air-Conditioning Cost Comparisons

Building reference	Component	AC on balconies	1 to 1 DX Roof Mounted Condensers	1 to 1 DX on-floor plant	Roof mounted VRV	On-floor VRV	Water cooled VRF	CHW/HHW FCU's
Site Wide Infrastructure	AC Condenser Cost Options	\$555,000	\$2,155,892	\$743,232	\$1,050,600	\$1,034,500	\$1,314,748	\$552,524
Site Wide Infrastructure	Central Plant Commissioning	\$0	\$0	\$0	\$0	\$0	\$0	\$145,411
Site Wide Infrastructure	Central Plant Costs							\$807,840
Site Wide Infrastructure	Fan Coil Units	\$882,552	\$882,552	\$882,552	\$882,552	\$882,552	\$882,552	\$1,248,852
Site Wide Infrastructure	Commissioning				\$92,500	\$92,500	\$307,225	\$216,165
Site Wide Infrastructure	Metering	\$0	\$0	\$0	\$60,000	\$60,000	\$128,000	\$222,000
Total		\$1,437,552	\$3,038,444	\$1,625,784	\$2,085,652	\$2,069,552	\$2,632,525	\$3,192,792

Air-Conditioning Area Comparisons (m²)

Building reference	Component	AC on balconies	1 to 1 DX Roof Mounted Condensers	1 to 1 DX on-floor plant	Roof mounted VRV	On-floor VRV	Water cooled VRF	CHW/HHW FCU's
Site Wide Infrastructure	AC Condenser Area Options (On floor)	62.9	85.8	298.9	34.0	228.7	69.0	15.0
Site Wide Infrastructure	AC Condenser Area Options (Roof)	0.0	315.0	0.0	169.0	0.0	220.0	0.0
Site Wide Infrastructure	Site wide infrastructure							253.4
Total		62.9	400.8	298.9	203	228.7	289	268.4

Note: The area shown for Air-Conditioning (AC) condenser on balconies is shown for the scenario where balconies need to be increased in area to not be affected by the condenser on the balcony only. That space is within the apartment and not elsewhere in the building like the other options.

MECHANICAL SERVICES

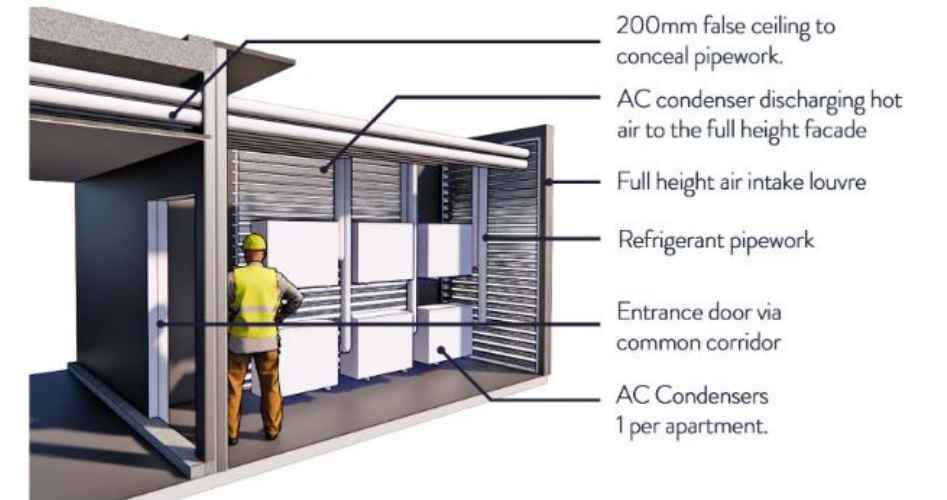
AC Options Comparison

Where build costs for on-floor plant rooms are unknown, a high level cost estimate has been generated to help. It contemplates a basic concrete slab and two louvres as illustrated in the below image where the condensers will be housed on each level for the two on-floor AC options namely;

- On-floor 1 to 1 DX System
- On-floor air-cooled VRV System.

Plant room cost estimates

Building reference	Plantroom costs for an on-floor 1 to 1 DX System	Plantroom costs for an on-floor VRV System
Site Wide Infrastructure	\$327,618.90	\$279,275.20



MECHANICAL SERVICES

Global Warming Potential (GWP) Refrigerants

Many of the DX-split AC options and electric heat pump systems mentioned in this report are electric-based systems. This means that the development will not be using gas. If you couple this with a renewable energy tariff, purchasing power from renewable energy sources, the building will significantly reduce its carbon footprint.

Another sustainability aspect of this development will be its use of potentially harmful refrigerant gases used in these all-electric systems. It is important to choose systems that use gases with a low Global Warming Potential (GWP). As a reference, the below list of refrigeration gases are considered to have a high GWP and ideally should be avoided:

- R410A - GWP of 2,088 (the lower this number the better)
- R407C - GWP of 1,610
- R134A - GWP 1,430

Alternative refrigerant gases which are recommended include:

- R32 - GWP of 675
- R513A - GWP of 631
- R450A - GWP of 605
- R454b - GWP of 466
- CO2 - GWP of 1

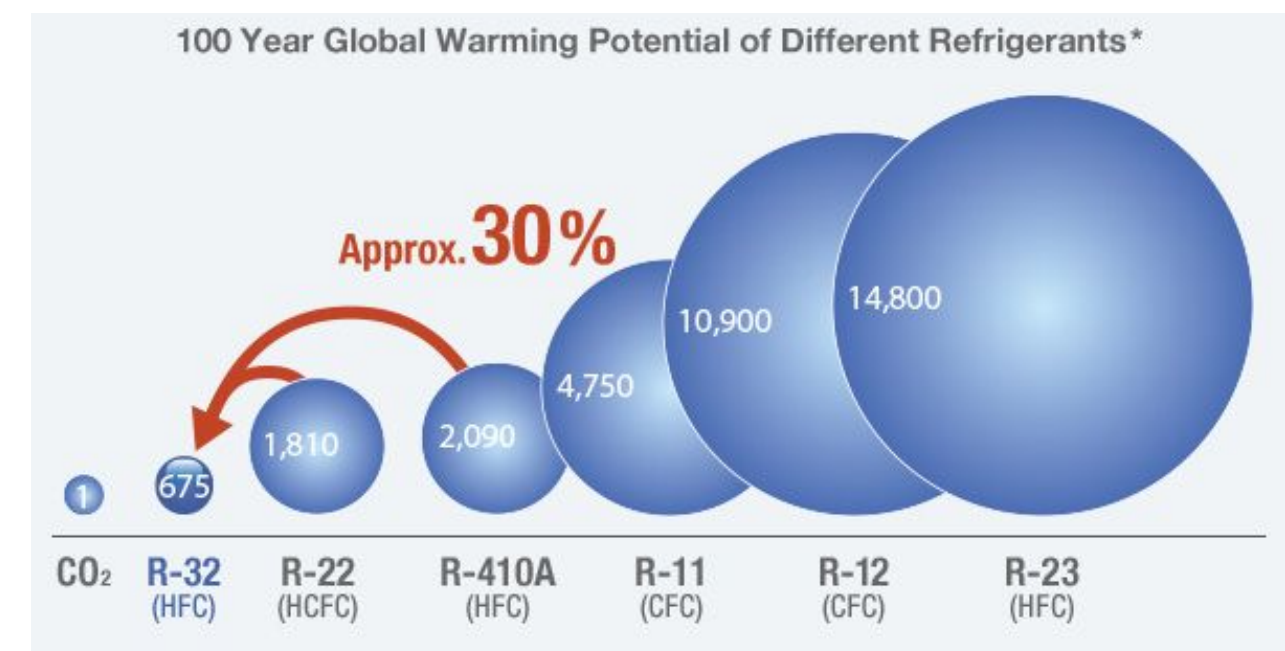
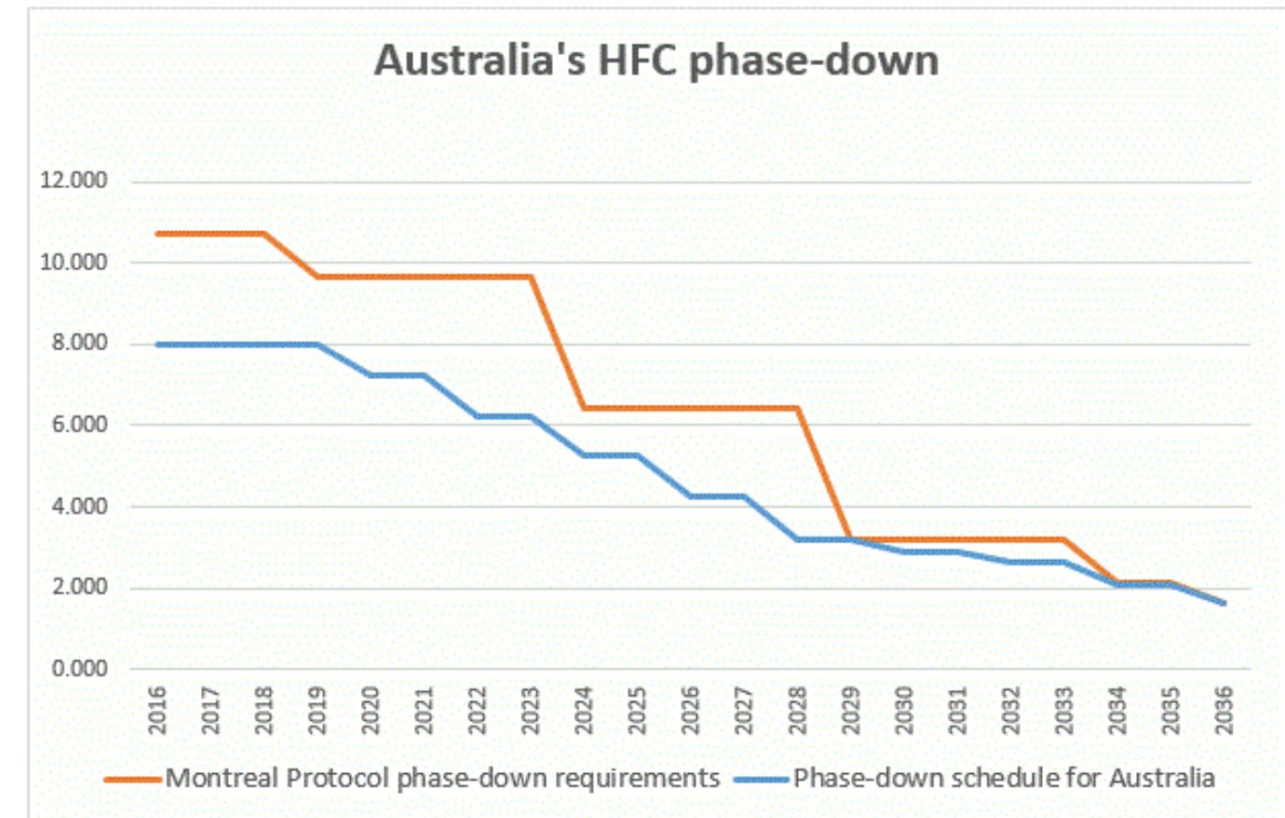
Ideally, all refrigerant systems should be using refrigerant gases from the second group with as low GWP as possible.

CO2 Heat Pumps: Some heat pump products are entering the market which use CO2. The largest product that could be sourced at the time of this report was a 40kW system, which may be suitable for this development. From a cost perspective, the CO2 version of the heat pumps investigated in this report is approx. 1.8 times the cost. If CO2 heat pumps are not preferred, the heat pumps selected for this feasibility study use R513A and R454b. Both of these gases have a significantly reduced GWP when compared to conventional refrigerant gases. The cost of these units has already been factored into the cost analysis section of this report.

Note Australia has a roadmap shown adjacent to phase down the use of high GWP refrigerants in buildings. The exact rollout of this from a policy perspective is still unknown however as shown it is likely coming in the near future.

Link for further details:

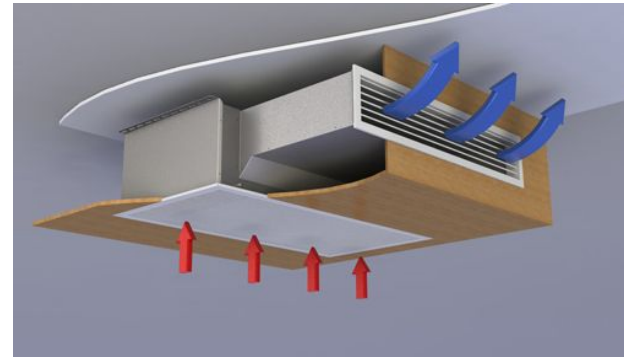
<https://www.dcceew.gov.au/sites/default/files/documents/hfc-phase-down-factsheet.pdf>



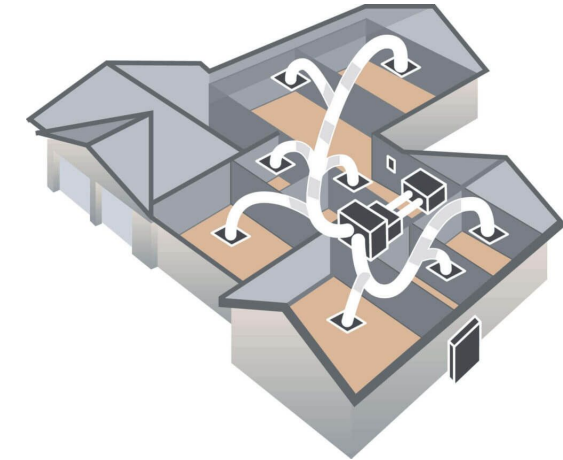
MECHANICAL SERVICES



Wall Mounted Split System (Indoor Unit)



Concealed Fan Coil Units



Fully Ducted Fan Coil Unit System (Refrigerant or Chilled Water)

Typical Apartment Air-conditioning Costs based on Fan Coil Unit Type and Extent of Air Conditioning

Building reference	Component	AC to the living area only	AC to the bedrooms only	AC to the living area and bedrooms	AC to living and one bedroom only
Site Wide Infrastructure	AC Costs - Wall mounted splits	\$462,500	\$467,500	\$707,700	\$703,000
Site Wide Infrastructure	AC Costs - Concealed FCU's	\$732,600	\$740,520	\$1,347,984	\$1,343,100
Site Wide Infrastructure	AC Costs - Fully ducted	\$732,600	\$735,372	\$882,552	\$734,976
Site Wide Infrastructure	AC Costs - Fully ducted CHW/HHW	\$1,098,900	\$1,101,672	\$1,248,852	\$1,101,276
Total		\$3,026,600	\$3,045,064	\$4,187,088	\$3,882,352

MECHANICAL SERVICES

- > **MECHANICAL**
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Occupied Spaces: Ventilation Options

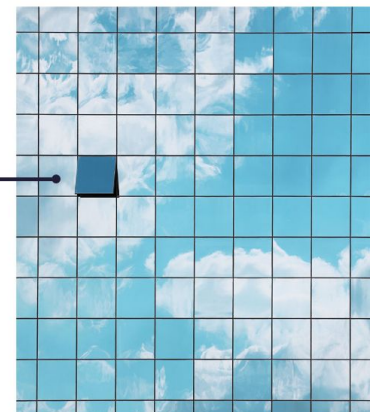
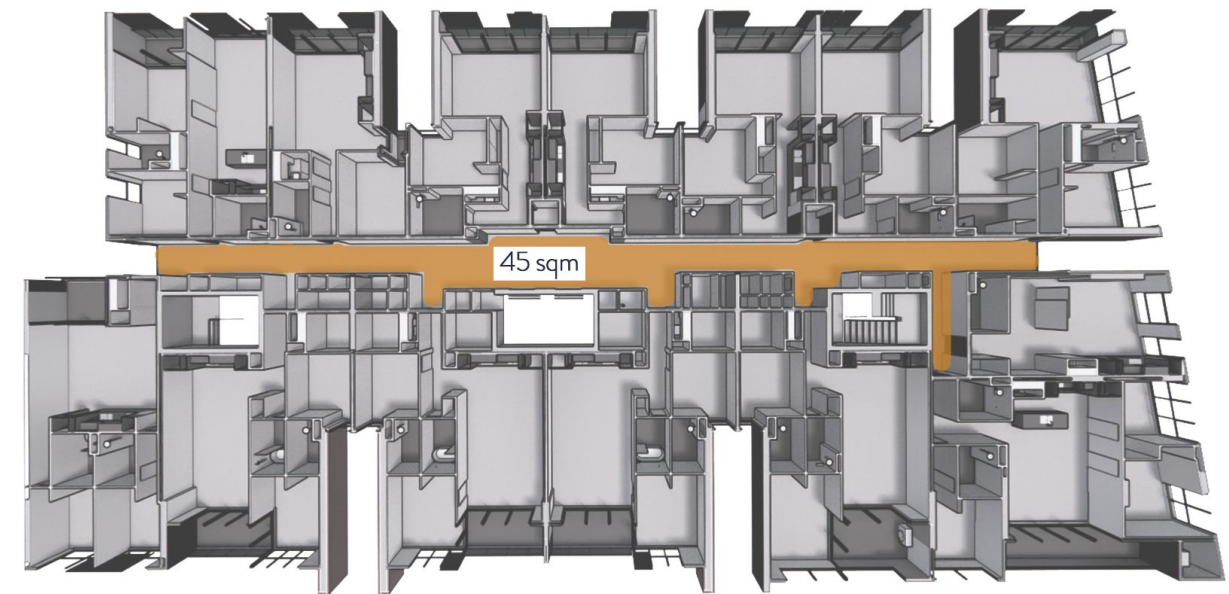
Occupied spaces can be either naturally or mechanically ventilated. Many corridors and apartments are naturally ventilated via operable windows or elements that equate to 5% of the area served (to comply with AS/NZ 1668.4). See image adjacent for details.

Where that is not possible or appropriate i.e. near sources of excessive noise, then a mechanical ventilation option is often employed.

How to mechanically ventilate an occupied space: If mechanically ventilated, those spaces must have outside air mechanically blown into each livable space designed to comply with AS/NZ 1668.2.

The most cost-effective way to achieve this is a dedicated outside air fan per apartment that connects to a single fully ducted Fan Coil Unit (FCU) that serves both the living areas and bedrooms.

This means the air conditioning unit supplies both outside air and conditioned air to all spaces. Because the air conditioning unit is not required all of the time, a bypass damper would be required to ensure outside air is sent to all spaces even if the FCU is not operating. This is required to comply with AS/NZ 1668.2 and will need to be verified on-site during the commission process.



Tip: In this example, the corridor is 45sqm therefore there must be a minimum of 2.25sqm of openable windows .

5% of the corridor served must be "openable windows" to enable a corridor to be naturally ventilated

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Ventilation Options: Heat Recovery Ventilators (HRV's)

Heat recovery ventilators: HRVs use a heat exchanger to transfer heat from the outgoing stale air to the incoming fresh air. This process not only helps to maintain a comfortable temperature indoors during cold or hot periods, but also provides fresh air to the living space, removes excess humidity, and reduces indoor air pollutants.

Specifically, these two air streams flow in opposite directions and are separated by a heat-conductive material. As the stale air is exhausted from the building, the heat in that air is transferred to the heat-conductive material.

The incoming fresh air is then heated by this material as it flows in so that the fresh air is pre-heated before it enters the living space. In the summer, the opposite occurs, with the HRV transferring heat from the incoming air to the cooler outgoing air, helping to keep the indoor environment cool.

Effectiveness of HRV's: HRVs are not active heating or cooling devices. They transfer heat purely on the temperature difference between the inside and outside air temperatures. During cold winter mornings i.e. 12 degrees outside, if the indoor air temperature was 21 then the HRV would likely preheat that outside air up to circa 16 degrees. In this way, it provides some heating of that outside air but it cannot heat it beyond that.

Similarly, on a 20-degree day, if it was 21 degrees inside, the HRV would provide negligible impact as there is no temperature difference to drive the heat transfer. For this reason, purely from an energy efficiency perspective, they are best suited to climates with large ranges in outside temperatures, typically climates that have cold winters and/or very hot summers.

Air quality for apartments: For buildings located close to pollution sources, mechanical ventilation devices like HRVs can aid ventilation and act as a barrier against outdoor noise. HRVs, when used with additional filtration equipment, can enhance internal air quality by providing filtered fresh air while windows remain shut.

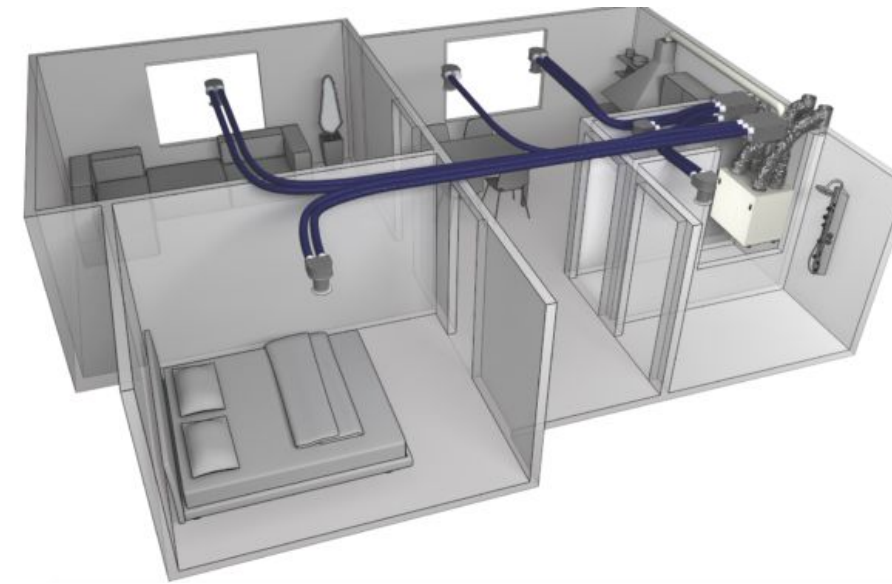


Image of a centralised per apartment HRV system

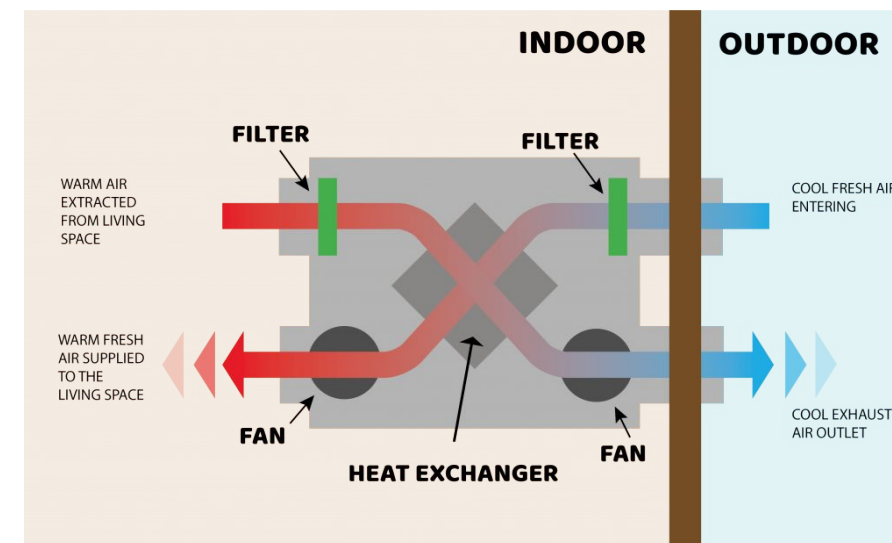


Image of a perroom mini HRV unit

MECHANICAL SERVICES

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Ventilation Options: Bushfire consideration and filtration

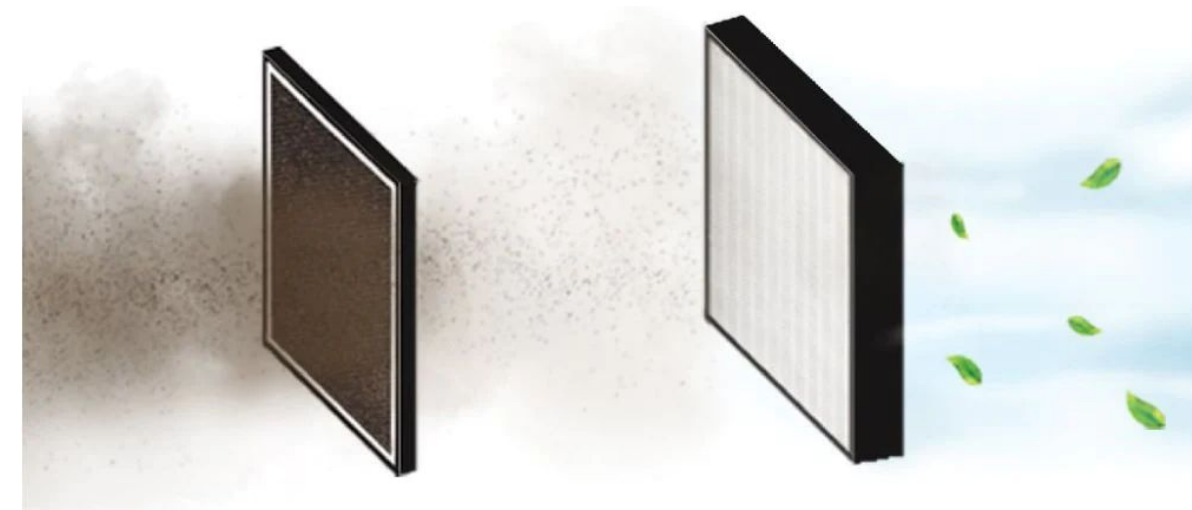
Many parts of Australia will continue to be subject to bushfires in the coming years during dry seasons. As seen in recent years, cities and towns can be covered in blankets of the byproducts of fires filling our buildings with smoke and odours that have adverse health effects on occupants.

Filtration can help manage these risks for occupants during such events to maintain healthier safer environments during these often dangerous and extended periods (weeks or months at a time). During these bushfire conditions, one strategy that can be employed is to 'close up' the building to minimise outside air into the building during these periods and centrally control make-up air to exhaust systems with pre-filtered make-up air.

One cost-effective way to achieve this is to use the lobby relief shaft in reverse in normal mode, add a carbon filter to that supply (manually done by maintenance personnel) and install fire/smoke dampers above apartment doors so the make-up air comes via the corridor into each apartment.



Example air quality during typical bushfire scenarios. Source: <https://www.theguardian.com/>



An example of Carbon filters (left) and HEPA filters (right) which can improve air quality. Source: <https://www.smarterhepa.com/>

MECHANICAL SERVICES

- > **MECHANICAL**
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Ventilation Options: Cost comparison

If heat recovery is desired, an additional heat recovery ventilator system will be required.

There are three options outlined below:

1. A central heat recovery ventilator that connects to the apartment FCU: This unit would take relief air from the apartment and pass it by an outdoor air intake supply which would then connect to the outside air connection on the FCU. A bypass damper would be required to ensure outside air is sent to all spaces even if the FCU is not needed. This would need to operate 24/7 to remain compliant with AS 1668.2.
2. A centralised heat recovery ventilator system that is not tied to the FCU: It would be an individual standalone system that again operates 24/7 if used as the only outside air system for the apartments.
3. A per-room heat recovery ventilation system: These are installed in the external walls of each room and again operate 24/7 if used as part of the outside air supply to each space. The flow rates on these units are quite small therefore for living rooms, multiple units may be required.

Apartment Ventilation Options

Building reference	Item Name	Centralised Standalone HRV per unit	Centralised HRV connected to single FCU	Wall mounted HRV per room	OA fan per apartment to single FCU	Centralised HRV per unit used in conjunction with toilet exhaust system
Site Wide Infrastructure	Apartment ventilation options	\$925,800	\$777,600	\$281,800	\$592,000	\$394,629

Note: Where apartments can have windows and natural ventilation openings equating to 5% of the area served, no additional systems are required.

Should apartment make up air be drawn from the corridor rather than via the facade (either through a HRV or separately) then the sizing of the corridor make up air system is dependent upon the assumed diversity of exhaust systems running simultaneously. The table to the right outlines the impact diversity has on ventilation volumes which will have a corresponding impact on duct sizes and spatial implications.

Apartment make-up air (l/s)

Building reference	Make up air @ 80% diversity	Make up air @ 60% diversity	Make up air @ 50% diversity	Make up air @ 40% diversity	Make up air @ 30% diversity	Make up air @ 20% diversity
Site Wide Infrastructure	22,248	16,686	13,905	11,124	8,343	5,562

Note: The above flowrates contemplate the toilet exhaust system only. The rangehood exhaust is assumed not operational for the purposes of make-up air due to relatively short periods of operation.

MECHANICAL SERVICES

Ventilation Options: Commercial Kitchen

Commercial kitchens require several ventilation systems to operate. Some of these systems will be dictated by the operator. A few typical systems that should be considered include:

- Commercial kitchen exhaust - 5,000 l/s
- Commercial kitchen exhaust make-up air - 4,500 l/s ducted directly to the hood
- Wood-fired pizza oven exhaust - 5,000 l/s dedicated exhaust with ember guard
- Dishwasher exhaust - 3,000 l/s dedicated exhaust
- Dishwasher make-up air system - 2,700 l/s

Exact provisions should be discussed as a team and compared against the brand standards to which the design should align.

Ventilation Options: Commercial Laundries

Commercial laundries require exhaust systems, ventilation and often lint control measures to maintain a healthy environment during use. Commercial washers and dryers also are large power users. Some operators choose to have laundry serviced off-site for this reason. Should an on-site laundry be desired a few typical systems that should be considered include:

- Laundry exhaust - dependent on the size of the laundry
- Heat recovery AHU with 100% outside air
- Spot cooling in occupied areas of the laundry

KITCHEN EXHAUST COST COMPARISON

BUILDING REFERENCE	ITEM NAME	DISCHARGE AT ROOF LEVEL	DISCHARGE LOCALLY WITH FILTRATION	DIFFERENCE
Site Wide Infrastructure	Retail Kitchen Exhaust Costs	\$62,000	\$100,000	-\$38,000
Total		\$62,000	\$100,000	-\$38,000

KITCHEN EXHAUST AREA COMPARISON

BUILDING REFERENCE	ITEM NAME	DISCHARGE AT ROOF LEVEL	DISCHARGE LOCALLY WITH FILTRATION	DIFFERENCE
Site Wide Infrastructure	Retail Kitchen Exhaust Areas	51.75	0.00	51.75
Total		51.75	0	51.75

MECHANICAL SERVICES

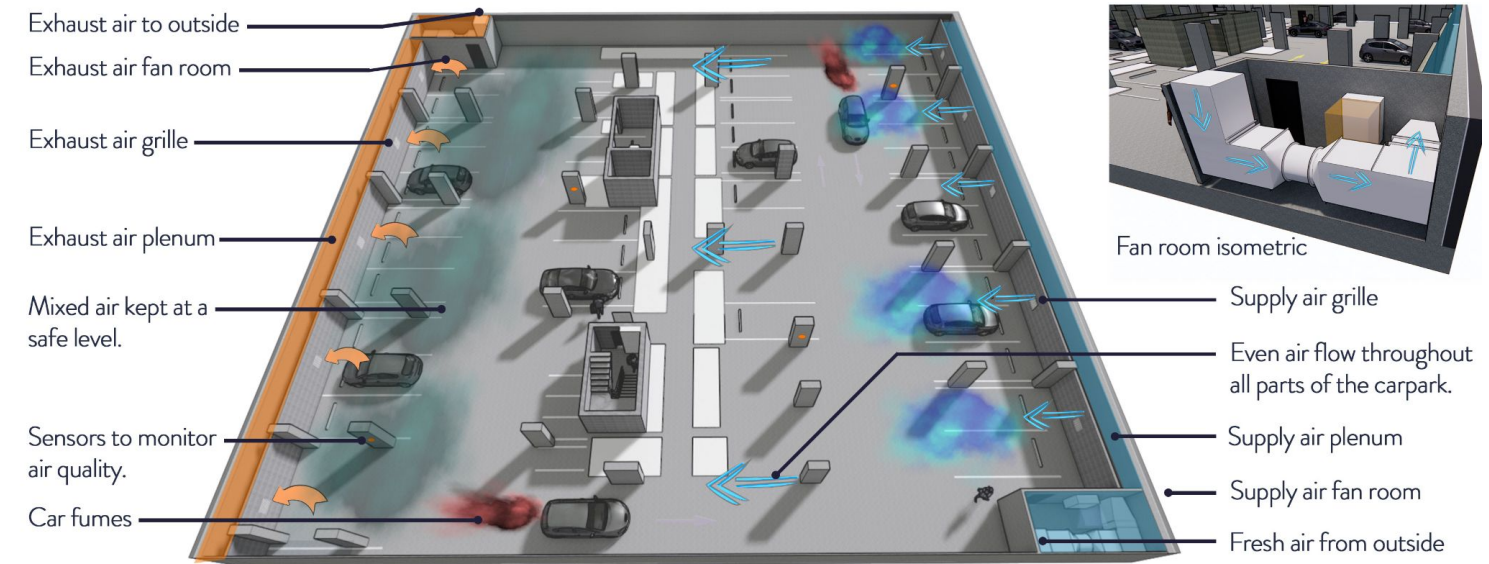
Ventilation Options: Car park ventilation options

A car park ventilation system is required to meet the performance requirements set out in AS 1668.2. This code provides two pathways for compliance. The first is called “deemed to satisfy” where you follow a specific list of requirements set out in the code, then it is automatically deemed to comply.

The second is a performance-based approach, where we come up with a custom design and prove that it meets the performance requirements set out in the code. This process involves CO modelling. It requires a specialist CFD consultant to complete the modelling (we can recommend one if you do not currently have a company you typically use).

For this development, we believe applying CO modelling will enable us to remove the need for plenums/ductwork on each of the levels of the underground car park while also reducing the size of the fan rooms, shafts, and external louvres.

Given the size of this project, it will likely not result in significant savings for the project which is why it is not our recommended approach. Refer to the analysis section for estimated savings. This can be further assessed once basement drawings have been circulated.



Car park ventilation system savings

Building reference	Item Name	DtS Cost	CFD Cost	Difference
Site Wide Infrastructure	Car park ventilation	\$140,595	\$129,630	\$10,965
Total		\$140,595	\$129,630	\$10,965

Car park Excavation Cost

Building reference	Excavation savings estimate (soil/sand)	Excavation savings estimate (rock)	Estimated Plenum Blockwork wall savings
Site Wide Infrastructure	\$8,554	\$47,520	\$22,810
Note: consultants design costs (typically \$15,000-\$30,000)			

Car park ventilation system area savings

Building reference	Item Name	DtS Cost	CFD Cost	Difference
Site Wide Infrastructure	Car park ventilation	117.6	40.87	76.73
Total		117.6	40.87	76.73

Airflow comparison

Building reference	DtS Exhaust (L/s)	CFD Exhaust (L/s)	DtS Supply (L/s)	CFD Supply (L/s)
Site Wide Infrastructure	6,789	4,618	6,110	4,139

ELECTRICAL SERVICES

Substation Options

There are two types of substations available for developments; namely an external (padmount) Substation and an internal substation. Padmount substations are generally cheaper than indoor substations electrically as shown. In addition as shown the indoor substation will require a fire rated room that will need to be constructed to house the substation equipment. This room will require an additional cost on top of the electrical cost difference. In addition, this area associated with the internal substation may result in a loss of saleable area. When you multiply the value of that area by that area and add on the electrical cost difference you will get the true value difference between the options.

Note the cost and space difference between these options only form part of the assessment. Locating either options within the development need to be considered architecturally. Planning, site constraints or developer visions for the site must be assessed in addition to the below data to help land on the appropriate solution for the project.

Typically, a workshop is required to analyse this data and the specific planning requirements of both substation options against the actual plans to find the optimum solution for the project.

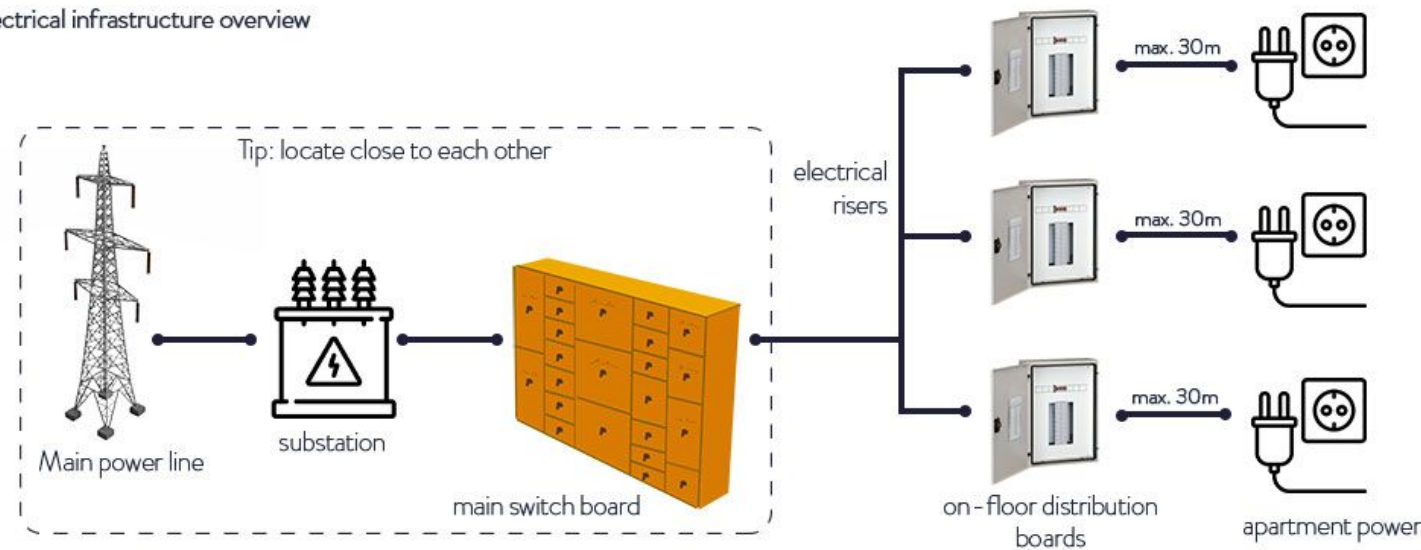
Substation Cost Comparison

Building reference	Item Name	Outdoor (Padmount) Substation	Indoor Substation	Difference
Site Wide Infrastructure	Substation Cost Options	\$240,000	\$520,000	\$280,000
Total		\$240,000	\$520,000	\$280,000

Substation Area Comparison

Building reference	Item Name	Outdoor (Padmount) Substation	Indoor Substation	Difference
Site Wide Infrastructure	Substation Area Options		38.6	38.6
Total		0	38.6	38.6

Electrical infrastructure overview



EV Charger Options

The main project factors that affect maximum demand are all-electric kitchens, electric vehicle charging, gas-fired or all-electric domestic hot water, and the efficiency of the air-conditioning and heating plant. Refer to the analysis section for an overview of power supply options, which consider these key items.

The NCC 2022 outlines specific requirements for EV chargers in residential buildings. It stipulates that electrical infrastructure must be provided to cater for the future installation of EV chargers to serve 100% of the car parking spaces. It does not, however, require that the chargers are installed. It states the minimum quantities of dedicated EV charger distribution boards required within the car parks, along with the need for a power management system. The NCC requires a future provision for each EV charger of 12kWh over an 8-hour period overnight, equating to an average of 1.5kW per (future) charger. Since this load occurs overnight it does not necessarily add the entirety of that load to the maximum demand, because the peak load typically occurs in the daytime on hot days when the air conditioning demand is at its peak outside of this nighttime charging period. Ultimately, the amount of EV charging capacity we include within the maximum demand calculation will be a design team decision after we have discussed the real usage and need for chargers within the site.

Power management system: Through the use of a power management system it is possible to physically install significantly more EV chargers within the car park than what is designed to simultaneously operate at the same time electrically. The power management system manages the load ensuring that the power used by the EV chargers stays within a prescribed or adjusted limit. These set points are flexible and can be dynamic. This means when spare power is available in the building for example, more power can be sent to EV chargers, but during a maximum demand scenario (1-2% of the year) power usage by the EV chargers is throttled back to ensure the overall power usage remains within the set supply to the development.

We recommend that the quantity of EV chargers designed to operate simultaneously is chosen based on working within the constraint of an optimum substation allocation unless the client has a desire to enable significant simultaneous charging as part of the desired vision for the product.

Some local councils are starting to classify different types of EV chargers in 'Levels' in the adjacent table.

	Power	Range added per hour	Charging time	Typical application
Level 1 - single phase (domestic)	2.4-3.7kW	10-20km range / hour	5-16 hours	Home
Level 2 slow - single phase (domestic or public)	7 kW	30-45km range / hour	2-5 hours	Home, work, shopping centres, car parks
Level 2 fast - three-phase (public)	11-22kW	50-130km range / hour	30mins - 2 hours	Urban roadside
Level 3 - fast charge (public)	50kW	250-300km range / hour	20-60 mins	Regional near highways, motorways and key routes
Level 4 - super-fast charge (public)	120kW	400-500km range / hour	20-40 mins	Regional near highways, motorways and key routes
Ultra-fast charge (public)	350kW	1000+ km range / hour	10-15 mins	Highways and motorways

Neuron has tested scenarios with various power allowances per charger, rather than assuming that each charger runs at 100% capacity. This is in line with the methodology set out in NCC 2022 which requires an average 1.5kW from a 7kW (level 2) chargers.

EV Charger Scenarios - maximum demand (AS/NZS 3000 demand in amps)

Building reference	No EV chargers	10 EV chargers	20 EV chargers	30 EV chargers	40 EV chargers	50 EV chargers
Site Wide Infrastructure	1,846	1,921	1,996	2,071	2,146	2,221
Site Wide Infrastructure	0	75	150	225	300	375

ELECTRICAL SERVICES

Distributed Antenna System (DAS) Options

The majority of residential buildings have NBN and a reasonable communications backbone. In some areas, mobile base station coverage and capacity are poor. Developments that strive for improved robust connectivity to support high-performance solutions for occupants and smart building infrastructure, may consider incorporating a 5G Distributed Antenna Systems (DAS).

When to consider a DAS: When you rely on outdoor macro networks to provide connectivity such as local mobile base stations, they are sharing cell capacity with other buildings around them and the public. As network demand increases, the total available capacity decreases. A DAS is used to essentially create a dedicated capacity zone for your building and therefore avoids congestion resulting in a better performance.

Another benefit of using a DAS is that occupants will experience longer battery life and lower EME emitted from their mobile devices. This is because occupant mobiles now connect to local DAS receivers instead of larger Base Stations physically located much further away, which uses much less “energy”. The cost and spatial impacts of incorporating a DAS system into the building are included in the analysis section, including costs, areas and specific dimensions. Note a DAS room is typically centrally located in the most upper basement level, to minimise fibre backbone lengths from the DAS room out to the risers that connect up to on-floor communication cupboards.

Alternative systems: Where possible we recommend a DAS system as the optimum signal management system for a building however should DAS be cost or space-prohibitive, there are alternative options to boost signal quality that are not as effective as a full DAS but better than having no system in place. Signal booster systems like Nextivity Quatra can boost mobile signal strength within the building. They work by taking the signal available outside the building and boosting it through the building via roof-mounted antennas and repeaters distributed throughout the building. It is less effective than a full active or passive DAS as it does not increase the carrier capacity, but it can help in those situations where a DAS is not viable. The system cost is also lower than a DAS. This system requires space in a riser or a single rack in the Main Communications Room, rather than needing a dedicated DAS room, and therefore has significantly lower spatial requirements.

If you are unsure, mobile coverage and performance tests can be undertaken to further understand this risk. This work is typically carried out by a specialist contractor. We recommend engaging with specialist suppliers and contractors to further explore these options.

DAS System Details

Building reference	DAS Room dimensions	DAS Room area (sqm)	DAS System Cost
Site Wide Infrastructure	6m (l) x 5.5m (d) x 2.7m (h)	33	\$1,253,662

Note: DAS carrier lead-in cabling cost component of the above overall DAS System Cost are a high level estimate only.



Distributed Antenna System (DAS)

- Ensure occupants have robust wireless connections throughout your building
- Reduce your dependency on overcapacity mobile towers for signal strength

image source: ponprojects.com.au

ELECTRICAL SERVICES

Solar Photovoltaics (PV)

Solar Photovoltaics (PV) can often be used in multi-residential developments to offset electrical demand. In Strata buildings, this is typically limited to common property electrical demand. For this development, the residential common property loads would include:

- Lifts
- Corridor lighting and power
- Roof/external space lighting power
- Residential related irrigation systems (if applicable)
- Domestic hot water system (if an electric system is utilised)

Solar panel capacity is often limited by available roof space. Review the architectural layouts to understand the available space which could dictate the maximum solar capacity. Once this is known, review against the three scenarios below. Based on that kW size one of the below scenarios can be picked as the electric solution to use this power.

1. Common property loads only. If the solar array is less than the common property loads then a simple solar system can be connected up to the main switch board
2. If the solar array is more than the common property loads, and an Embedded Network Operator (ENO) is envisaged for the project, then again this arrangement is quite straightforward and it will just need to be agreed with the ENO that they will allow solar to be connected to apartment electrical loads
3. Where the solar array is more than the common property loads, and there is no ENO, then a *Solshare System* will be required to electrically enable solar power to connect to apartments. See overleaf for details.



Explanation of options: As shown below where theoretically a very large solar PV is possible we need a system to enable that to connect to apartments, the largest power used of buildings. In reality, unless an ENO is in place, this is very challenging electrically as it creates significant billing challenges. There one of the three options below is required to connect power to the building. Generally we find batteries do not have a viable ROI and have therefore been excluded from this assessment. You will note using solar PV in conjunction with EV charging stations can significantly increase the solar PV load.

Basic Solar PV Common property loads only

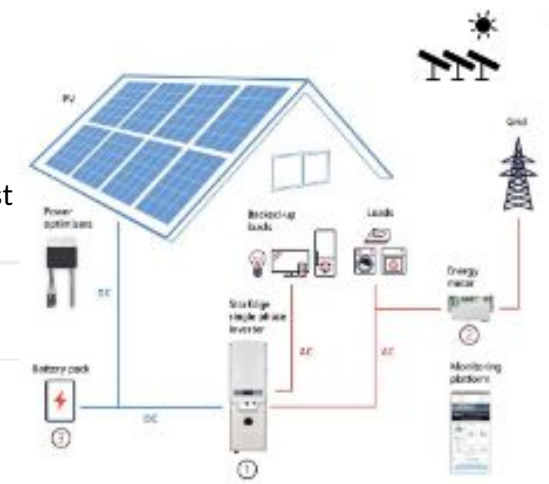
Building reference	Common Property Load (kW)	Number of panels	Cost	Area (sqm)
Site Wide Infrastructure	30	91	\$60,000	210

Solar PV with ENO

Building reference	Item Name	Cost	Area (sqm)	No. of panels
Site Wide Infrastructure	Solar PV	\$90,000	315	137

Solar for apartments (Solshare system)

Building reference	kW Array	Solar panel costs	Solshare system	No. of Solshare units	Battery costs	Total system cost
Site Wide Infrastructure	45	\$90,000	\$166,667	14	\$480,000	\$736,667



ELECTRICAL SERVICES

Solarshare

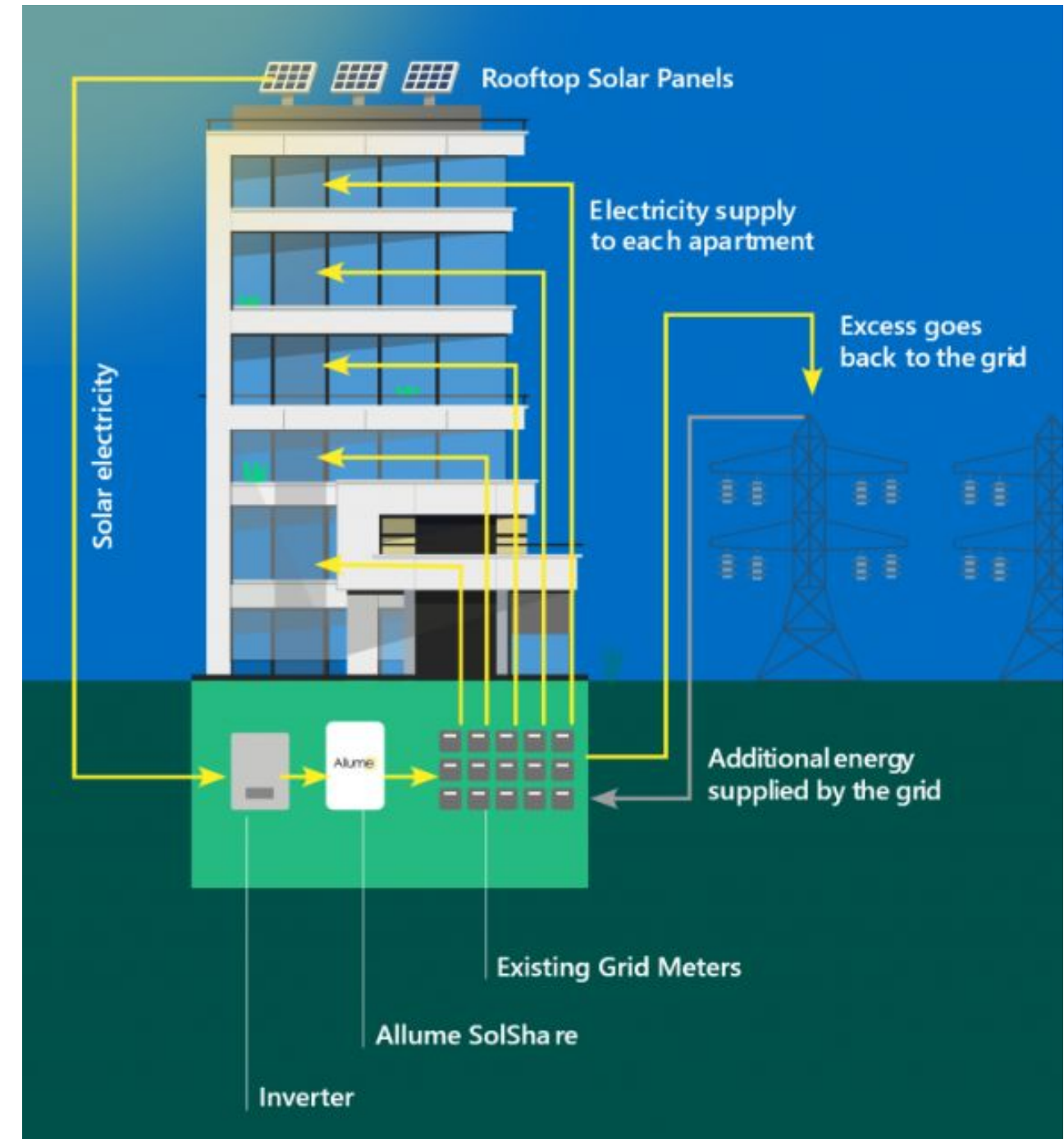
Due to the scale of this development, we have assumed that an embedded network provider would be viable for this project.

Where an embedded network is not utilised on a project, there is one relatively new technology that may investigate to enable Solar PV power to be delivered to each apartment. The SolShare solution is essentially a smart diverter that enables solar energy from a single rooftop solar system to be shared between multiple apartments within the same building.

To make the system as efficient as possible but also fair, the SolShare delivers the same amount of solar energy to each apartment over the course of a month but supplies it when it's needed by each unit.

Electrically, the solar power connection is downstream of the electrical meter which monitors each unit's power drawn from the electrical grid to inform the dynamic distribution of AC energy among the connected units.

Link to further details: <https://allumeenergy.com/au/case-studies/>



HYDRAULIC SERVICES

Domestic Hot Water Systems

There are several domestic hot water options available for this development depending on the desired quality, energy efficiency and budget constraints. The common options which have been assessed include:

1. Centralised Refrigerant Electric Heat Pump System
2. Centralised CO2 Electric Heat Pump System
3. Local individual electric water heaters (three phase instantaneous)
4. Local individual electric water heaters (single phase storage)
5. Local individual instantaneous gas water heaters
6. Roof-mounted centralised gas domestic hot water heaters
7. A large centralised gas hot water system within an internal plant room, typically below the residential levels

An overview of each options has been included on subsequent pages. A growing number of councils and states have already banned gas for residential uses and we strongly recommend not contemplating any gas options in this development. In saying this, for the sake of completeness they have been included in the assessment for information.

In addition, electric heat pumps work using refrigerant (typically 134a). Different types of refrigerant have varying Global Warming Potential (GWP). The higher the number the worse it is for the environment. The lowest GWP heat pump is called a CO2 heat pump. This uses CO2 in lieu of traditional refrigerants to aid with this problem. These have all been included to aid with the assessment depending on you sustainability aspirations, budget and available space.



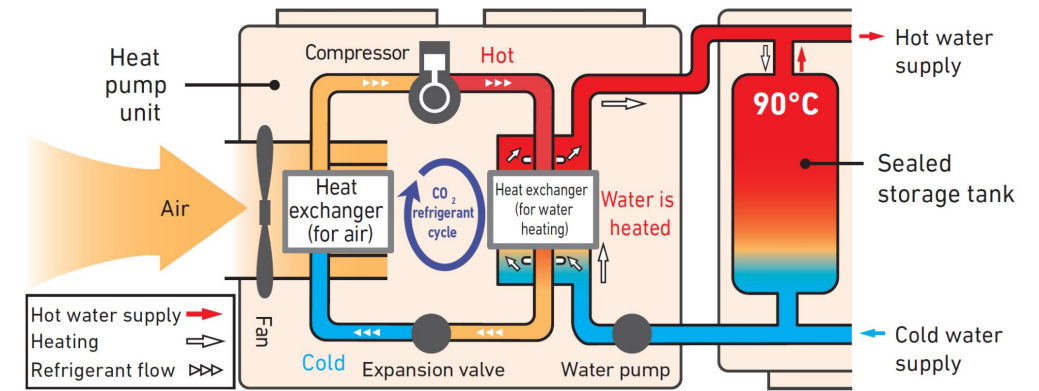
HYDRAULIC SERVICES

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- > ELECTRICAL
- > **HYDRAULIC**
- > FIRE PROTECTION
- > LIFTS
- > OTHER



Centralised Refrigerant Electric Heat Pump System

The electric heat pump system is quite similar in operation to the gas domestic hot water heaters, however, it utilises a refrigerant cycle to heat the water instead of burning gas. Therefore, it is a purely electric system. With heating water through electricity, the heating rate is much slower, meaning the equipment needed is much larger than a gas equivalent. In addition, as the rate of heating is much slower, larger holding tanks are required to ensure hot water is available when needed. A detailed comparison of both of these options is outlined in the cost analysis section. This option would also require pumps to circulate DHW out to each on-floor water meter cupboard. We would recommend using one of the low Global Warming Potential (GWP) refrigerant gases outlined later in this report.



Centralised CO2 Electric Heat Pump System

The CO2 electric heat pump system is a type of refrigerant electric heat pump system that uses CO2 as the refrigerant. This provides benefits such as a global warming potential of 1 compared to 1,300 for common refrigerants (R134a), meaning that the R134a refrigerant is 1,300 more likely to warm the earth. The refrigerant heats water more efficiently, raising temperatures from 5°C to 90°C in a single pass, unlike traditional systems which heat gradually. This efficiency can lead to smaller holding tank sizes and a reduced overall plant footprint.

A detailed comparison of both of these options is outlined in the cost analysis section. This option would also require pumps to circulate DHW out to each on-floor water meter cupboard.

HYDRAULIC SERVICES

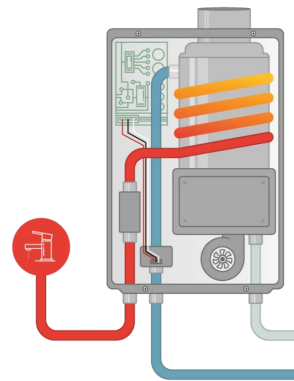
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Electric storage unit



Electric 3ph instantaneous water heater

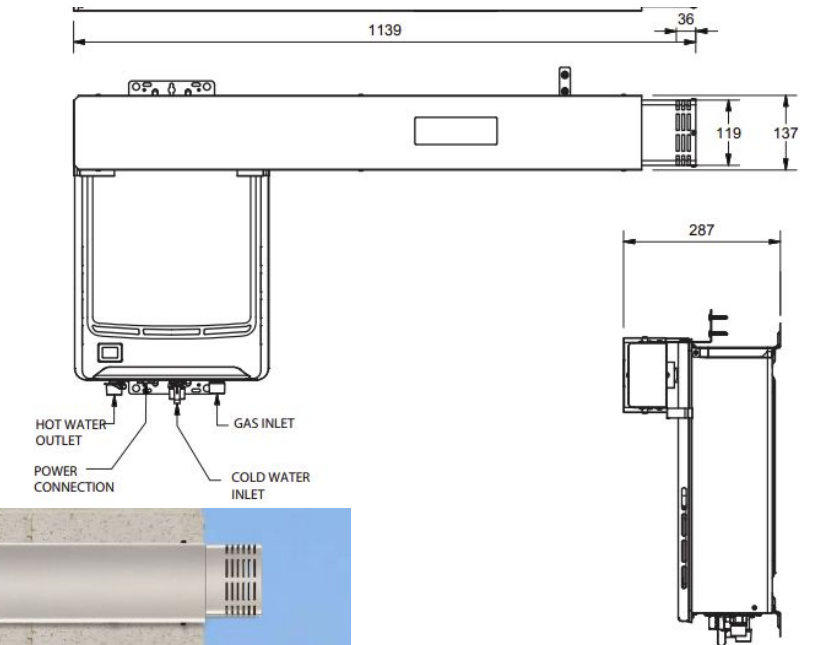


Local individual electric water heaters

Local individual water heaters come in four types: single-phase, three-phase, single-phase instantaneous with storage, and heat pumps with storage. All these systems use local electric heaters in each room or suite.

Instantaneous water heaters consume 3 to 4 times more power than heat pumps, making them less efficient. They should be assessed against sustainability goals, with guidance from your sustainability consultant. Instantaneous options include single-phase and three-phase units. Three-phase systems heat water faster and perform better, while single-phase units struggle to provide high temperatures.

Electric storage systems can heat water during off-peak periods, lowering ongoing energy costs. They require additional space for tanks and may incur higher standby losses.



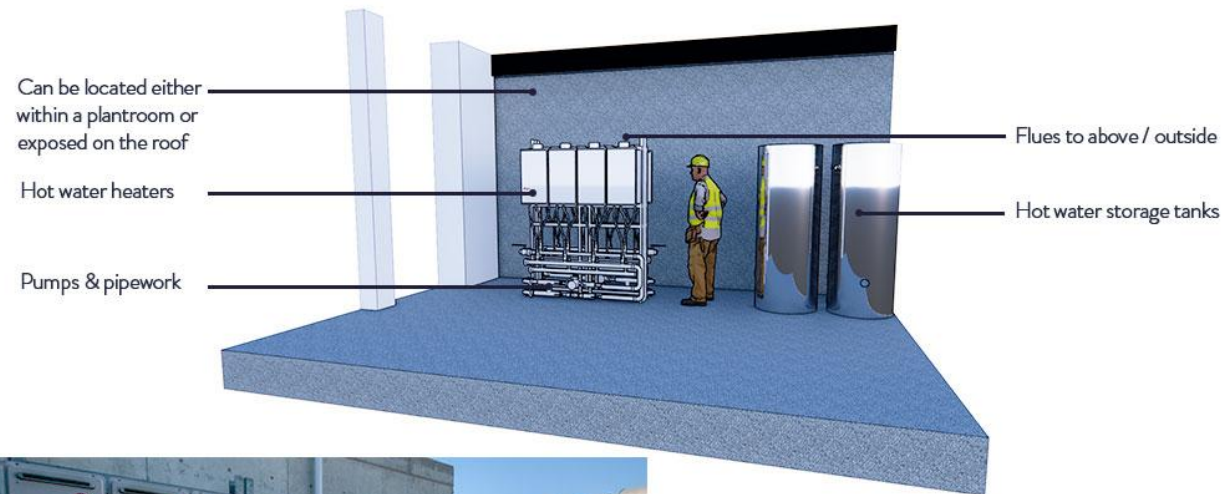
Model Number	Rheem 12	Rheem Metro 16	Rheem Metro Max 26
Pre-set Temperature 50°C	876812NF	876T16NF	876T26NF
Pre-set Temperature 60°C	874812NF	874T16NF	874T26NF
Number of People	1 – 5		
Gas Type	Natural Gas only		
Gas Energy Rating	Stars 6.0		
Flow Rate @ 25°C Rise	L/min	12/16/26	
Min. Operating Flow Rate	L/min 2.0		
Nominal Gas Consumption	MJ/hr 94/126/199		
Dimensions			
Height A	mm	520	
Width B	mm	355	
Depth C	mm	187	
Depth – from wall to Hot Water Outlet	mm	87	
Depth – from wall to Cold Water Inlet	mm	68	
Depth – from wall to Gas Inlet	mm	77	

Local individual instantaneous gas water heaters

This option utilises local instantaneous gas heaters which are typically located on each room/suite balcony. Contact your sustainability consultant regarding the impact of this option as gas is generally not preferred or in some cases not allowed. Standard mounting details are shown in the image above.

Note: The flue detail for this unit can be troublesome and difficult to coordinate. Should this option be preferred carefully coordination of this element with the architect will be required to ensure it complies with AS/NZS 5601.

HYDRAULIC SERVICES



An Image of hot water heaters located outside on a roof

Centralised Gas Domestic Hot Water System (roof mounted)

Roof-mounted gas domestic hot water heaters: Typically arranged exposed on the roof, heaters fire on when domestic hot water is drawn from the system and is replenished with a cold water supply that requires heating. The insulated storage tanks hold a body of water to ensure hot water is available at all times. Pumps circulate hot water to each on-floor water meter cupboard.



Centralised Gas Domestic Hot Water System (internal)

The internal version of this system is shown below. It operates in a very similar manner; however, it utilises a single or multiple larger hot water heaters to achieve the same intent. Because the gas heaters are located within an enclosed plant room (typically in the basement), a flue is required to discharge fumes to the outside. Typically this plant gets located centrally to minimise pipe runs out to each building/room.

HYDRAULIC SERVICES

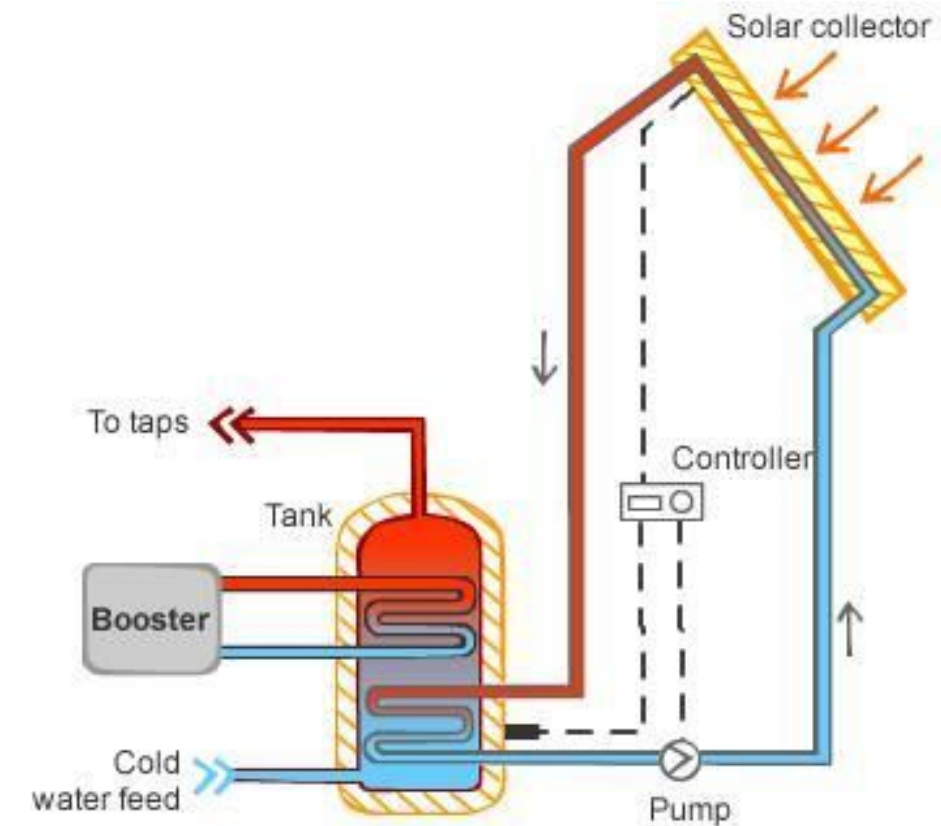
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- > FIRE PROTECTION
- > LIFTS
- > OTHER

Solar hot water pre-heat

The solar hot water panels could be utilities to offset the electrical usage of the electric domestic hot water system. A schematic of the arrangement is illustrated in the adjacent image. In short, the panels collect heat from the sun through the solar collectors and this heat is transferred to the storage tanks to heat the Domestic Hot Water (DHW). The gap between the water temperature in the tank and the required domestic water supply temperature is made up by the electric heat pumps noted as the “booster” in the illustration.

The array size would be selected to meet the base domestic hot water load. ASHRAE recommends 95 litres/unit of hot water usage. Should the development proceed with centralised heat pump systems serving the apartments, then associated solar collectors arrays could be considered to offset the electrical usage.

The array can be sized to align with the available roof space in these locations and the base heating load of those systems. Further detailed analysis is required to establish an accurate array size, cost and output capacity for this option. Seek input from your sustainability consultant.



HYDRAULIC SERVICES

Domestic Hot Water Systems

The main domestic hot water options are outlined below including capital cost comparisons and spatial comparisons for each. Refer to the notes below for inclusions and exclusions for each option.

Domestic Hot Water Options Cost Comparison

Building reference	Item Name	Central Gas DHW	Centralised DHW heat pumps	Local on balcony units (Gas)	Single-phase Instantaneous electric heaters	3-phase Instantaneous electric heaters	Centralised DHW heat pump (CO2)
Site Wide Infrastructure	DHW System Cost Options	\$382,760	\$701,760	\$222,000	\$279,000	\$741,500	\$1,052,640
Total		\$382,760	\$701,760	\$222,000	\$279,000	\$741,500	\$1,052,640

Domestic Hot Water Options Area Comparison (m²)

Building reference	Item Name	Gas Centralised DHW	Electric Centralised DHW	Difference
Site Wide Infrastructure	DHW System Area Options	19.50	78.00	58.50
Total		19.5	78	58.5

Note: Centralised heat pump costs include pipework reticulation, tempering valves and metering cost estimates.

HYDRAULIC SERVICES

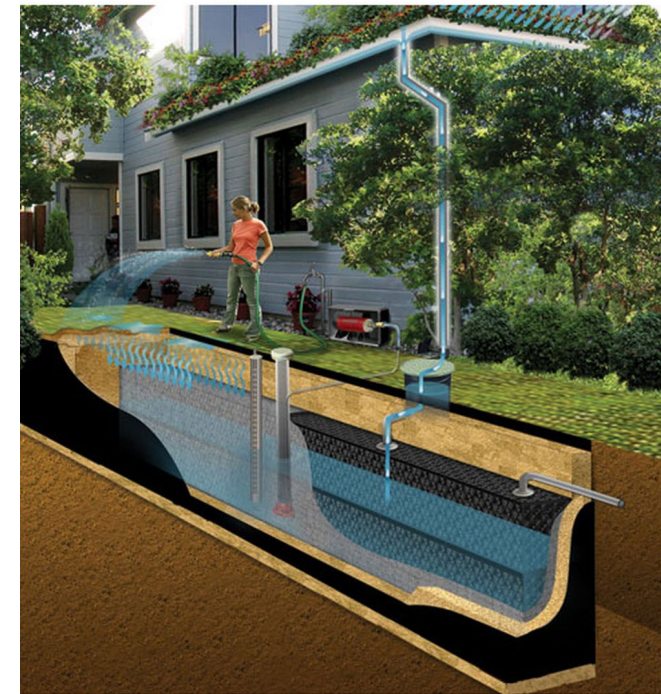
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Recycled water options

There are several recycled water options available for the project for consideration. Each is explored in this section of the report.

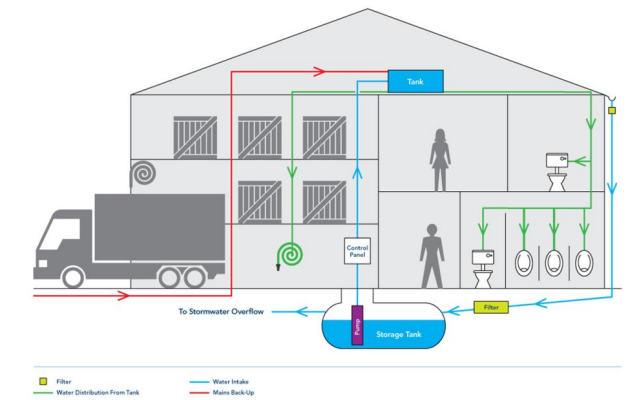
Rainwater re-use

Refer to the Services Infrastructure Report to see if a municipal recycled water network runs close to the site and if it is potentially available for connection. For most developments incorporating a rainwater tank into the development to store roof and surrounding pavement rainwater and incorporate filtration systems and pumps to re-circulate this rainwater to serve the building is required by the sustainability consultant. As a minimum, this could feed the development's irrigation system. From a review of the building plans, there appears to be a reasonable amount of landscaped areas that would justify a small to medium-sized rainwater reuse system. The sustainability consultant should be able to provide sizing data however given the limited catchment area, a medium-sized rainwater tank should suffice. As an aspirational target, a dual water system could be installed to serve all apartment toilets for flushing. If this is desired, the second set of water metres will be required, lengthening the water meter cupboards by typically 500mm. The area and cost of both the rainwater tank and the dual water system are outlined in the previous tables.



Example layout of an inground rainwater tank

Tip: Placing the tank lower than the external stormwater in the street is not recommended due to the size of the pumps required to pump out this water and the potential flooding risk should those pumps ever fail.



Rainwater harvesting system arrangement

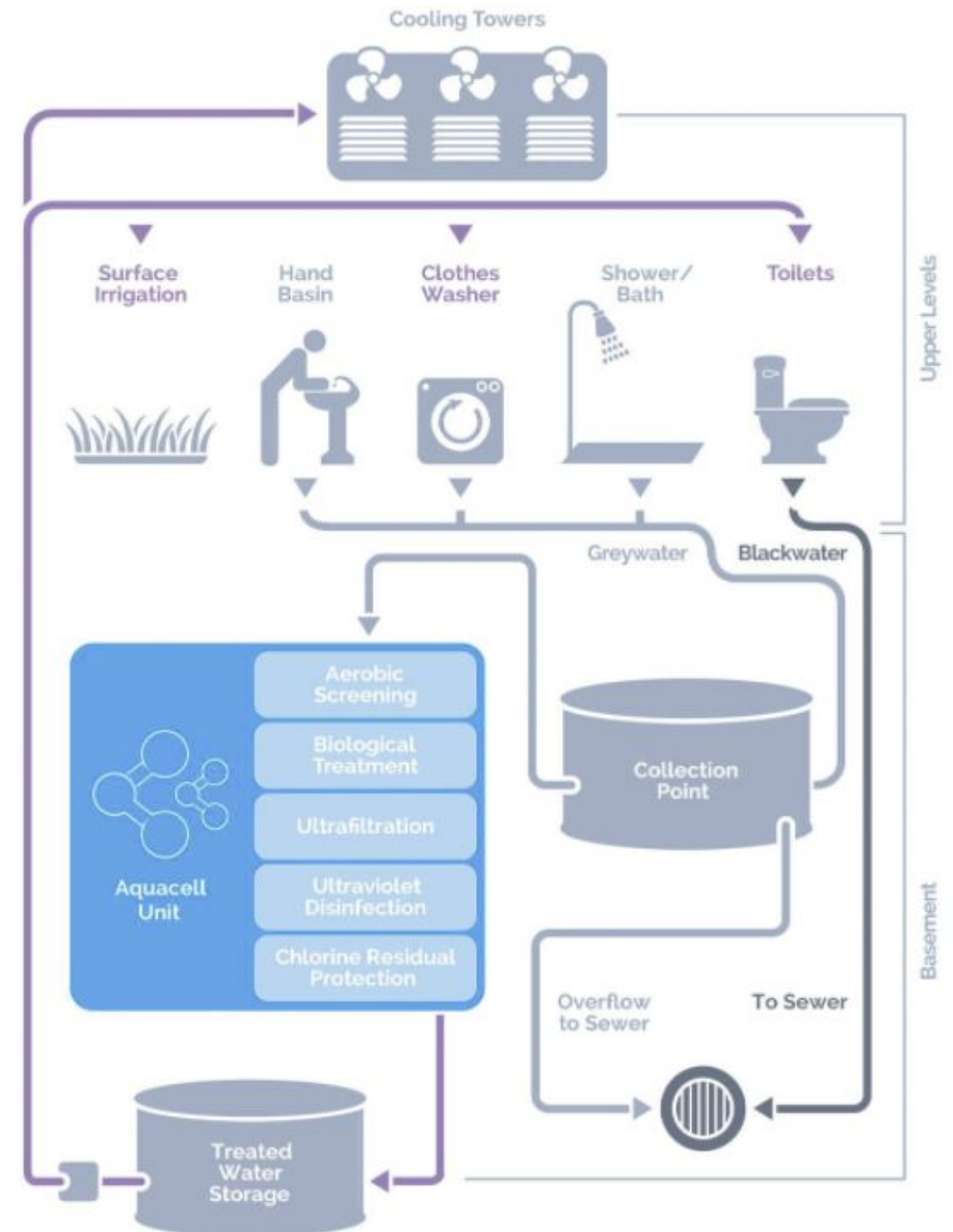
HYDRAULIC SERVICES

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- > FIRE PROTECTION
- > LIFTS
- > OTHER

Greywater reuse

As an additional measure, greywater reuse could be utilised to further reduce the water usage on the site. As illustrated in the adjacent image from 'Aquacell', the system works by collecting wastewater from basins, washing machines and showers (not toilets), sending that water to a collection tank where it then passes through a treatment process and ends up in a storage tank ready for re-use for non-potable items such as toilets, irrigation systems, and washing machines. Note for irrigation systems, careful selection of maintenance of plants will be required to ensure appropriate water quality is maintained for the plants to survive and thrive.

Like the rainwater reuse system, a dual water system would be required to serve greywater back to the apartments. If this is desired, the further set of water metres will be required, lengthening the water meter cupboards by typically 500mm. The area and cost of both the grey water treatment system and the dual water system are outlined in the previous tables. Note a Water Industry Competition (WICA) licence will be required should this system be installed as it has over 30 dwellings.

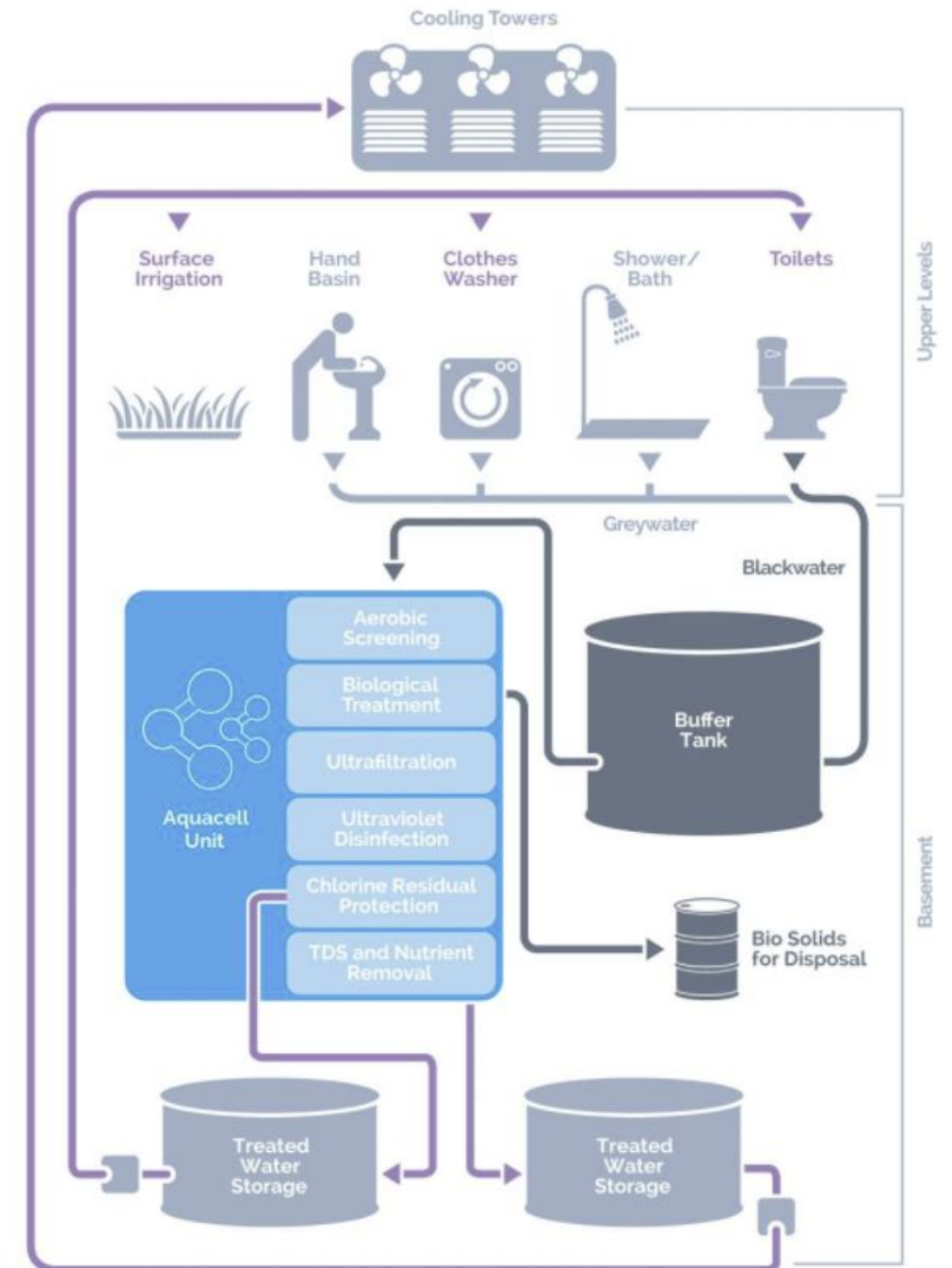


HYDRAULIC SERVICES

Blackwater systems

As an additional measure, a blackwater system could be utilised to further reduce the site's generated wastewater. As illustrated in the adjacent image from 'Aquacell', the system works by collecting wastewater from the toilets and, sending that water to a collection tank where it then passes through a treatment process (aerobic screening, biological treatment, ultrafiltration, ultraviolet disinfection, TDS and nutrient removal, & chlorination) and ends up in a storage tank ready for re-use to non-potable items such as toilets, irrigation systems, and washing machines. Note for irrigation systems, careful selection of maintenance of plants will be required to ensure appropriate water quality is maintained for the plants to survive and thrive.

Like the rainwater reuse system, a dual water system would be required to serve greywater back to the apartments. If this is desired, a further set of water metres will be required, lengthening the water meter cupboards by typically 500mm. The area and cost of both the grey water treatment system and the dual water system are outlined in the previous tables. Refer to the analysis section for budget costs and required areas for this system.



HYDRAULIC SERVICES

Recycled water options

There are several recycled water options available for the project for consideration.

Cost associated with each system is outlined below. Note for the grey water system you must include the costs for the dual water system and dual sewer system to connect it up for apartment toilet flushing. For the blackwater treatment system you must include the cost of the dual water supply system also. Note for any options that contemplates recycled water used for toilet flushing will require the dual water supply system costs.

Recycled water options

Building reference	Item Name	Cost	Area (m ²)
Site Wide Infrastructure	Rain water tank	\$70,000	25
Site Wide Infrastructure	Dual water supply system	\$92,750	0.25
Site Wide Infrastructure	Grey-water treatment	\$785,000	156.00
Site Wide Infrastructure	Black water treatment	\$820,000	144.00
Site Wide Infrastructure	Dual sewer mains	\$491,544	
Total		\$2,259,294	325.25

Note: Where a recycled water authority main is used, the dual water system additional costs noted comprise of additional pipework, water meters and connections to toilets within each apartment. Note this arrangement would result in the water meter cupboards lengthening by 500mm to accommodate the extra water meters. Where a private network is used, additional metering is optional.

LIFT SERVICES

Cost comparison

There are several lift options available for this development, depending on the desired lift quality and budget constraints. Each lift option has different shaft sizes, headroom and pit requirements.

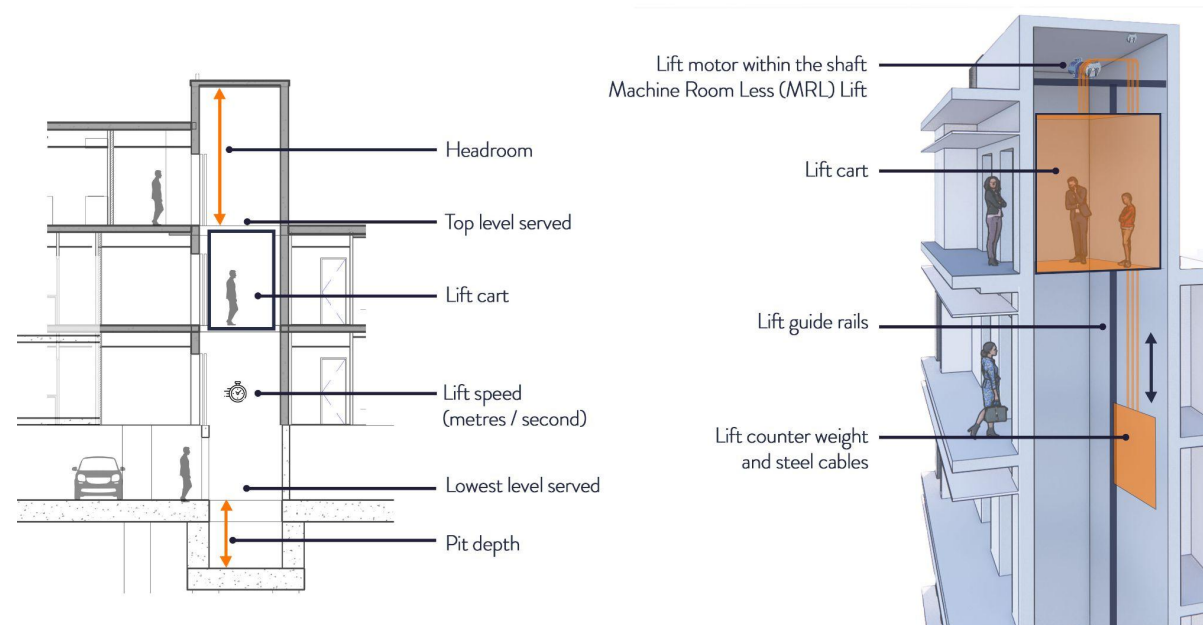
The cost analysis section has contemplated two scenarios for each building. The minimum required by code and the Apartment Design Guidelines (ADG) and a “mid-range” selection allowing for slightly larger and faster lifts to aid with activities such as occupant furniture removal. The space and costs for each of these scenarios are outlined in the comparison.

Occupants will likely use the lifts to move in and out of apartments. Therefore consideration should be given to typical furniture sizes that may need to be transported in the lifts.

Larger furniture includes:

- King size bed (1.85m (l) x 2m (h)).
- Kitchen tables (i.e. a 7ft table at 1.1m(l) x 2.2m (h)).
- A three-seat couch (2.1m (l) x 1m (h)).
- A treadmill (2m (l) x 1m (h)).
- A large fridge (1.5m (l) x 1.8m (h)).

We recommend, at a minimum, one of the lifts serving each core be sized for such equipment; however, ultimately, this is a client decision.



Passenger Lifts Cost Comparison

Building reference	Item Name	Cost Effective	Mid-Range	Difference
Site Wide Infrastructure	Lift Cost Options	\$1,011,000	\$1,275,000	\$264,000
Total		\$1,011,000	\$1,275,000	\$264,000

Passenger Lifts Area Comparison

Building reference	Cost Effective	No. of lifts	Mid-Range	No. of lifts	Difference
Site Wide Infrastructure	18.75	3	18.75	3	0.00
Total	18.75	3	18.75	3	0

Base lift selection details

Building reference	Shaft Dimensions (mm)	No. of lifts	Lift pit (mm)	Lift Headroom (mm)	Door Opening Width	Lift Speed (m/s)
Site Wide Infrastructure	2500mm (w) x 2500mm (d)	3	3200	5300	1100mm (w) x 2100mm (h)	3.0

EMBEDDED NETWORK OPERATORS (ENO's)

- > MECHANICAL
- > ELECTRICAL
- > HYDRAULIC
- > FIRE PROTECTION
- > LIFTS
- > **OTHER**

ENO Considerations

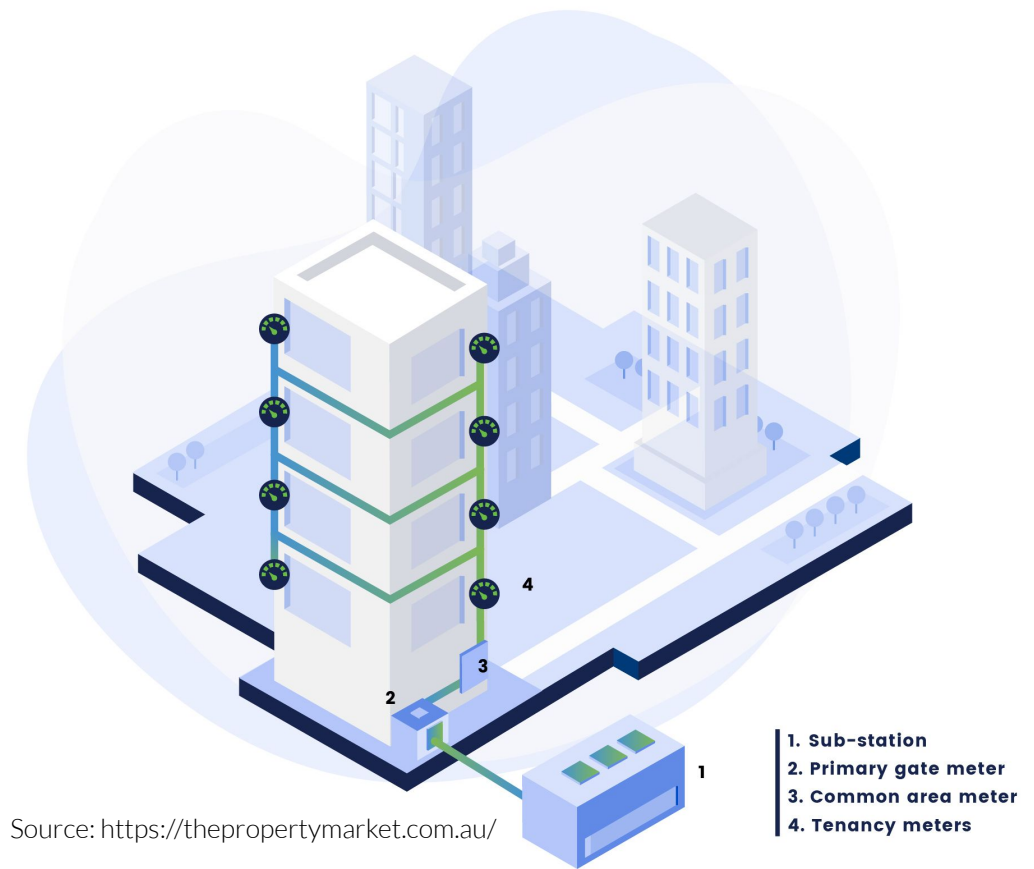
Embedded network operators manage the supply and billing of utilities within a building or complex. They purchase utilities in bulk and distribute them to individual units, often at a lower rate than retail providers. Residents are billed by the operator based on their usage, typically through a contract or agreement.

Example: In a residential apartment building, an embedded network operator installs meters to track each unit's electricity usage. They purchase electricity in bulk from a supplier and distribute it to residents. The operator bills each resident based on their individual usage, often at a discounted rate compared to retail providers. Residents sign a contract with the operator for the supply of electricity and are billed accordingly.

Reputation: The ENO industry came under fire following investigations that revealed limited regulation and varying quality and fairness of some ENO contracts where they signed occupants up to unfair long term contracts. Since then regulation has tightened and some of the poor ENO's have been driven out of the market. Still when tendering for an ENO it is critical to have a balanced review of the ENO offer and the contracts which they will sign up the building occupants.

From experience, ENO's will often offer capital contributions to get on the project. This varies considerably but often includes paying for the solar panels, hot water plant, meters and some EV chargers. Ensure that the contracts associated with such an offer do not put occupants in contractual situations as outlined above. Generally speaking ENO's need to make money so whatever they offer up front often has something in the contracts for rates etc. that make that money back down the track.

Balancing this is crucial as occupants signed up to a bad ENO that are left disadvantaged, will likely associate the developers reputation with that arrangement so a balanced informed approach is recommended. Ideally a tendering process as early as possible to understand each offer is a prudent approach.



Source: <https://thepropertymarket.com.au/>

Embedded Network Operator

Building reference	Item Name	Hot Water System	Solar Panels	Hot Water Meters
Site Wide Infrastructure	Embedded Network Operator	\$279,000	\$60,000	\$88,985
Total		\$279,000	\$60,000	\$88,985

Potential items an ENO could contribute towards.

SUSTAINABILITY

General sustainability considerations

If the building was to explore further sustainability initiatives, further consideration could be given to:

- High-efficiency lighting fixtures
- 100% electric helps with fuel switching
- High efficiency lifts with regenerative drives
- Naturally ventilated common areas/corridors
- Natural light into common areas/corridors
- Insect screens on windows, including in common areas/corridors
- Highly reflective blinds to reflect solar radiation back out of the window and reduce cooling load
- Drip irrigation
- Fire test water recycling
- EV charging stations
- Rainwater reuse for cooling tower water supply
- Dual water systems for toilet flushing
- Smart metering to enable occupant level demand side power management
- Low energy comfort devices such as ceiling fans within all living areas and bedrooms
- eWater systems in lieu of standard cleaning products and processes www.ewater.com/
- Induction cooktops in lieu of gas. Safety note: Induction cooktops generate an electromagnetic field which may interfere with the operation of pacemakers. Further investigation required.
- High performing facade and optimised glazing ratios
- Apartment design for zero waste (insinkerator and organic waste facilities such as worm farms or composting systems)
- Smart controllers for dimmable lighting of common areas, car parks and the like
- Efficient water fixtures (high WELL rating)
- Additional hot water storage facilities and controllers to take advantage of free solar power or off peak electrical rates at different times of the day to optimise energy costs to produce and store hot water for apartments

MIXED-USE MATRIX

Mixed-Use Engineering Matrix

Retail tenant name	Area (sqm)	Cooling load (kW)	AC Condenser sizes	Outside air (l/s)	Kitchen exhaust (l/s)	Kitchen Exhaust Shaft Size (sqm)	Air intake louvre size (sqm)	Electrical power infrastructure (kVA)	Grease waste (litres)	Gas usage (MJ/hr)
GF Flex Cafe	94	24	0.95m (l) x 0.8m (d) x 1.7m (h)	470				14	1000	500
GF Flex Retail	140	35	0.95m (l) x 0.8m (d) x 1.7m (h)	210				21	0	0
GF Foyer	49	5	1m (l) x 0.4m (d) x 0.8m (h)	75				4	0	0
GF Pre Function	161	16	0.95m (l) x 0.8m (d) x 1.7m (h)	240				14	0	0
GF Admin/Staff	34	4	1m (l) x 0.4m (d) x 0.8m (h)	35				5	0	0
GF Kitchen	23	6	1m (l) x 0.4m (d) x 0.8m (h)	115	3000	0.8	2.3	14	1500	1000
GF Hall	205	51	0.95m (l) x 0.8m (d) x 1.7m (h)	770				31	0	0
GF Parents/Cry	13	1	1m (l) x 0.4m (d) x 0.8m (h)	20				1	0	0
GF Green Room	16	2	1m (l) x 0.4m (d) x 0.8m (h)	25				1	0	0
L1 Comm 1	154	18	0.95m (l) x 0.8m (d) x 1.7m (h)	115				23	0	0
L1 Comm 2	109	13	1m (l) x 0.4m (d) x 1.6m (h)	80				16	0	0
L1 Comm 3	117	14	1m (l) x 0.4m (d) x 1.6m (h)	90				18	0	0
L1 Childcare	278	56	1.9m (l) x 0.8m (d) x 1.7m (h)	595				42	0	200
L1 Childcare Kitchen	16	4	1m (l) x 0.4m (d) x 0.8m (h)	80	3000	0.8	2.3	10	1500	1000
L1 Childcare Office	17	2	1m (l) x 0.4m (d) x 0.8m (h)	20				3	0	0
L1 Post Function	200	20	0.95m (l) x 0.8m (d) x 1.7m (h)	300				17	0	0
L1 Admin/Staff	28	3	1m (l) x 0.4m (d) x 0.8m (h)	30				4	0	0
L1 Kitchen	13	3	1m (l) x 0.4m (d) x 0.8m (h)	65	3000	0.8	2.3	8	1500	1000
L1 Hall	270	68	1.9m (l) x 0.8m (d) x 1.7m (h)	1015				41	0	0
L1 Creche/Cry	40	4	1m (l) x 0.4m (d) x 0.8m (h)	60				3	0	0
L1 Green Room	20	2	1m (l) x 0.4m (d) x 0.8m (h)	30				2	0	0
L2 Communal	110	11	1m (l) x 0.4m (d) x 1.6m (h)	165				9	0	0
L10 Communal	61	6	1m (l) x 0.4m (d) x 0.8m (h)	90				5	0	0
	2168	368		4695	9000	2.4	6.9	306	5500	3700

Note: In addition, each retail tenancy receives a distribution board, network termination device, fire detection and sprinkler coverage, hose reel, water, gas, and sewer/floor waste connections.

DESIGN INPUTS

- > MECHANICAL
- > ELECTRICAL
- > HYDRAULIC
- > FIRE PROTECTION
- > LIFTS
- > OTHER

Question	Answer
Number of rooms	185
Total building area	16287
Number of levels (above ground)	23
Total number of levels in the building (incl. any underground levels)	24
What is the buildings total effective height? (m)	74.2
Maximum number of rooms per level	11
Number of stairwells above ground?	2
Type of development?	Mid-range
Is an external kiosk substation acceptable (recommended if possible)	Yes
Are 1.9m high rooftop plant acceptable on this development?	No
Is centralised domestic hot water plant acceptable? (recommended)	No
Do you want natural gas in your development	No
Are air-conditioning condensers acceptable on balconies?	Yes
Air conditioning to both bedrooms and living areas?	Both bedrooms and living areas
Preferred air-conditioning indoor unit type?	Fully ducted AC
How many electric car charging points are preferred	5
Does your building have an underground carpark?	Yes
Number of levels of underground car parking	2

Question	Answer
Total area of underground parking spaces	2163
Total number of underground car parking?	60
Number of basement stairwells	2
Does your carpark have a loading dock that is more than 10m deep / from an external opening?	Yes
Are there mixed-use tenancies in your development?	Yes
Overall area of all mixed-use	2168

DESIGN INPUTS

Refer to the design guide for the full list of standards and codes used to establish the preliminary loads for this development.

- > MECHANICAL
- > ELECTRICAL
- > HYDRAULIC
- > FIRE PROTECTION
- > LIFTS
- > OTHER