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Residential heat pump water heater installation

Good practice guide

TE TARI TIAKI PŪNGAO
ENERGY EFFICIENCY & CONSERVATION AUTHORITY

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Each heat pump water heater installation is unique in its nature, and installers will need to assess a number of factors when selecting and installing a suitable unit. The information in this guide provides general assistance to help the installer, but should not be regarded as definitive or comprehensive, as constituting legal advice of any sort, or as providing an interpretation of legislative requirements on the part of the installer.

Foreword

New Zealanders have always been quick to embrace smart, practical solutions that make life better and use energy wisely. As we work to build a more affordable and secure energy future, efficient technologies will play an important role in how we heat, cool, and power our homes.

Hot water heating makes up around a third of the energy used in the average home, so improving how we heat our water can make a real difference to comfort, reliability, and household energy costs.

Heat pump water heaters are a proven and efficient option. When installed and maintained well, they can halve a home's water heating energy use, offering dependable performance and long-term savings.

This heat pump water heater: good practice installation guide builds on EECA's continuing heat pump water heater product research, which explores how these systems perform in New Zealand conditions. That research provides a strong foundation for understanding their benefits. This guide takes the next step, turning those insights into clear, practical advice for installers, designers, and specifiers.

Developed with industry experts, it combines best practice and real-world experience to help ensure every installation delivers consistent, high-quality results.

EECA's vision is for New Zealanders to be world leaders in clean and clever energy use. By supporting professionals to deliver reliable, affordable energy solutions for households, we strengthen energy security and make smart energy use the easy choice for all New Zealanders.

Murray Bell

Group Manager, Policy and Regulation, EECA

Section 1: Introduction

1.1 About this guide

This guide is designed for professional installers of residential heat pump water heaters (HPWHs) used for potable water applications, and outlines the processes to follow for selecting and installing HPWH systems, in both new and existing homes.

Some manufacturers and installers may refer to these types of systems as ‘hot water heat pumps’. For the purposes of this document both terms are considered to be equivalent and interchangeable, but for consistency are referred to here as ‘heat pump water heaters’ or HPWHs.

The installation of HPWHs includes prescribed electrical and plumbing work, which should only be carried out by registered electricians and plumbers.

Installers play a critical role in the water heater replacement market, especially in emergency scenarios. They are often the first point of contact for homeowners and can significantly influence their decision-making. Installers are encouraged to recommend HPWHs as an alternative to traditional water heaters (where appropriate), highlighting the energy savings, cost benefits and environmental advantages of these systems.

1.1.1 What the guide covers

This guide provides information on a wide range of topics related to HPWHs and their installation, including toolkits, pipework and refrigerants. Much of this content will already be known to qualified installers, but is provided here for the sake of completeness and as a potential resource to support training new installers.

This guide provides good-practice guidelines for specifying and installing the most common types of ‘packaged’ residential air-to-water HPWH systems, including:

- all-in-one systems
- split systems that connect to a hot water cylinder via a refrigerant loop (split refrigerant-loop systems)
- split systems that connect to a hot water cylinder via a hot water loop (split water-loop systems)
- split systems that connect to a hot water cylinder via a refrigerant and hot water loop (split refrigerant-and-water loop systems).

However, the guide does not cover:

- multi-purpose HPWH systems – such as those also used to heat non-potable water, or air (space or central heating), or other applications
- HPWH for commercial and industrial applications
- custom-designed or bespoke HPWH systems – which are taken as systems where one or more of the components are specifically designed and manufactured for a particular application (this guide focuses on ‘packaged’ commercially available systems)
- HPWH systems powered by energy sources other than electricity – for example, heat-driven heat pumps, such as absorption heat transformers or absorption heat pumps
- ground-sourced (ground-to-water) or water-sourced (water-to-water) HPWH systems
- solar-boosted HPWH systems
- systems designed for multi-unit dwellings – where a HPWH system supplies hot water to more than one domestic dwelling, such as in a block of apartments or flats
- impacts on the weathertightness and airtightness of the building envelope, or the structural integrity of the building (although this must be maintained at all times).

1.2 Background and context

Hot water accounts for around a third of the average New Zealand household's energy use.[1]

HPWHs are an energy efficient and low-carbon-emission technology that can reduce hot water energy consumption by 50% or more, equating to household energy savings of 15% or more.

HPWHs use heat pump technology to heat water within a hot water system. Heat pump technology uses a relatively small amount of electricity to extract much larger quantities of heat energy from the outside air in order to heat air (through heat pumps or air conditioners) or water (through HPWH). Heat pumps have been a popular choice for heating New Zealand homes for over two decades, and are considered energy efficient, clean and convenient.[2]

While HPWHs may have a higher up-front purchase cost, a well-installed and maintained HPWH should ideally operate reliably and efficiently for at least 10 to 15 years, and the savings over the life of the system should outperform traditional electric storage, instantaneous gas and gas storage water heaters.

A comparison of typical household water heating costs for the different types of systems is shown in Figure 1 and Figure 2.[3]

Figure 1: Comparison of household water heating costs

	Unit and installation cost	Running cost p/y	kg CO2 emissions
Hot water heat pump	$7,500	$333	149
Electric hot water cylinder	$3,000	$1,176	527
Gas continuous flow	$3,000	$1,071 / $706*	969

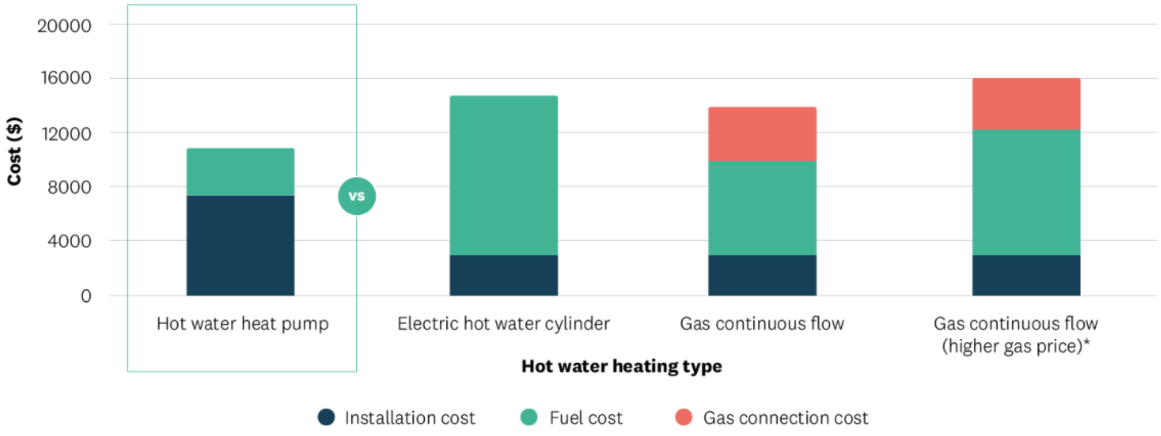
*Excludes annual gas connection cost

Very low — High

Note: Based on a four-person household with average hot water usage.

[1] See: https://www.eeca.govt.nz/insights/eeca-insights/heat-pump-water-heater-product-research/ and Energy End Use Database | EECA
[2] See: 2023 Census population, dwelling, and housing highlights | Stats NZ
[3] Reference for both figures: https://www.eeca.govt.nz/insights/eeca-insights/hot-water-heat-pumps-in-the-home/

Figure 2: Total estimated cost of water heating types over 10 years



*Note: As residential gas prices can vary significantly and future pricing is uncertain, a higher gas price is included here for comparison. Calculations are based on a four-person household with average hot water usage.

While a HPWH offers energy savings when compared with traditional forms of water heating, there are many factors to consider when determining if a HPWH is the right solution for a particular household.

Some situations are relatively straightforward. For example, new builds or where an existing hot water system is being replaced because it no longer meeting a homeowner's needs (either because it is nearing the end of its practical life, its operation is becoming problematic, or the homeowner wants to switch from a low-pressure to a mains-pressure system).

However, the performance of HPWH systems can vary considerably, depending on the type of system selected, the quality of the installation and the local climate; and in all situations, installers should consider the homeowner's requirements before recommending a HPWH.

HPWHs are still a relatively new technology in New Zealand. It is estimated there are around 18,000 HPWH systems installed in New Zealand homes, compared to almost 1.5 million electric storage water heaters and half a million gas water heaters.[4] However, HPWH technology is well-established globally and HPWHs are a popular water heating choice in much of Australia. In total, between 850,000 and 1,000,000 hot water systems are sold every year in Australia (with an annual growth rate of 1.8%), and it is estimated that HPWHs could achieve around 40% of this market by 2036.[5]

Domestic HPWHs should have an operating life of well over 10 years, but this can depend on how well they are installed and how well and regularly they are serviced.

To encourage the uptake of HPWH technology, during 2025, EECA ran a project to install over 75 HPWHs in homes around the motu. The intention was to monitor and demonstrate how well these systems meet homeowners' needs, and to understand any limitations of the technology in different climate zones and household types. This guide has, in part, been informed by the lessons learnt from that project.

More information on HPWHs is available at: https://www.genless.govt.nz/for-everyone/at-home/energy-saving-appliances/choose-good-appliances/hot-water-heat-pumps/

[4] Residential Baseline Study of Energy Use in Residential Sectors of Australia and New Zealand.
[5] See: Heat pumps - Emerging trends in the Australian market

1.3 Outline of the sections in this guide

The following summary provides a brief overview of what is covered in each section of this guide.

Section 1 – introduces HPWHs in general, including how they work and factors to consider when selecting and installing a system.

Section 2 – provides an overview of the four most common types of residential HPWH systems, their various benefits and limitations, and some factors to consider when choosing between them.

Section 3 – looks at how climate conditions and hot water temperature settings can affect the energy efficiency and performance of HPWHs, and how this can vary between day and night, throughout the year and across New Zealand.

Section 4 – discusses key elements to consider when selecting a HPWH such as size, hot water demand, demand flexibility and safe water temperatures. It explains how to determine whether a HPWH is the right type of water heating appliance for a household and how to select the most appropriate system.

Section 5 – lists the toolkits and materials needed for an installation.

Section 6 – concerns refrigerant pipework, and provides a comprehensive explanation of the types of pipework and joints, how to make bends and ensure pipework is supported, and 'first-fit' (or pre-installation) work vs. commissioning.

Section 7 – explains the main elements of work involved in installing a HPWH system, broken down by the four main system types, so installers need only consult the section relating to the type of system they are installing.

Section 8 – covers the different types of refrigerants typically used in HPWHs, with guidance on handling them safely and in an environmentally responsible way.

Section 9 – covers the electrical requirements for HPWH installations, including inverter requirements, multi-phasing, essential load redistribution and basic design considerations.

Section 10 - explains the necessary steps for final testing and commissioning of the system.

Section 11 – sets out instructions for the homeowner, including a checklist for using a HPWH efficiently.

Section 12 – covers servicing and maintenance (both for the homeowner and service engineer) to ensure a long and efficient life for the system.

Section 13 – explains how to decommission a HPWH at the end of its life.

Section 14 – provides a glossary of terms used in the guide.

Section 15 – sets out the various regulations pertaining to HPWHs, along with useful reference documents.

Section 16 – covers the relevant Standards for HPWHs and their installation.

Section 17 – lists other relevant organisations.

1.4 Advantages of heat pump water heaters

HPWHs have a number of advantages over other forms of water heating, including that they:

- are much more energy efficient than electric storage or gas water heaters
- run on electricity, which has a lower carbon footprint than fossil fuels, such as gas
- do not require space to store fuels, such as LPG bottles, and do not produce combustion gases
- have a lower whole-of-life energy footprint and net-cost than traditional hot water systems
- use a water storage cylinder, so don't necessarily have to consume power at the same time that the hot water is being drawn. This enables HPWHs to make use of cheaper, off-peak electricity and be integrated into smart home management systems. Time-of-use electricity pricing is becoming increasingly common in New Zealand, as demand flexibility becomes more available. A correctly sized and installed HPWH should provide adequate hot water when needed, while making use of lower electricity prices.

1.5 Limitations of heat pump water heaters

Potential limitations and disadvantages of HPWHs compared with other forms of water heating, include:

- They are more expensive to purchase and install than an equivalent traditional hot water system – however, in most cases, the whole-of-life costs (which take into account the system running costs) will work out less expensive than an equivalent electric storage or gas water heater
- Their heating capacity and performance reduces at lower ambient temperatures
- in some cases, can be grossly oversized (and correspondingly more expensive) where concerns about performance and delivery are over-compensated for
- they may have increased heat losses if the storage cylinder is installed outside
- there are environmental and safety risks associated with the use of refrigerants within the system – see section 8 for more information
- they may increase demand for peak electricity if they are replacing a gas system, or an electric storage heater that was operating on a night rate or using ripple-controlled electricity (which can also reduce the system's energy cost savings) – see section 4.5.2 for more information.

1.6 Myths about heat pump water heaters

There are several myths and misunderstandings about HPWHs that may impact on their future uptake. The main ones are outlined here to enable installers to discuss them with householders, should they arise.

Myth	Reality of the situation
HPWHs don't work in low temperature climates	Modern HPWHs should be designed to work efficiently even in colder climates. While performance can drop slightly in very low temperatures, most New Zealand models are rated to operate efficiently down to -5°C or even lower. Some units have built-in backup elements to help heat water when it's freezing.
HPWHs heat water too slowly	HPWHs are usually designed to run gradually and efficiently, often during off-peak hours. Households with a correctly sized unit won't notice a difference in hot water availability. Larger families may need a bigger cylinder or a system with a faster recovery rate.
HPWHs are too expensive to install and not worth it	The upfront costs of HPWHs are higher than for standard electric storage water heaters, but their operating costs can be significantly lower, often using 60–70% less electricity. Over time, this can add up to major savings.

	However, it should be noted that replacing a perfectly good, operating water heater with a HPWH system is unlikely to be financially viable.
HPWHs are noisy	While HPWHs do make some noise (like any fridge or air conditioner), this is generally around 40–55dB,[6] and most are relatively quiet. Proper installation (away from bedrooms or quiet areas) helps to eliminate this as an issue.
HPWHs don't work when it's raining or cloudy	This myth is due to HPWHs being confused with solar water heaters. HPWHs extract heat from the ambient air, not the sun, so they can work well when it's cloudy or raining, and in the middle of winter.

1.7 Before you start work

Good design, selection and installation are fundamental for ensuring a HPWH's effectiveness and efficiency. This requires installers to understand the importance of properly sizing the unit, selecting the right unit for the local environment and household needs, and correctly installing the unit.

Make sure you are properly qualified and prepared before beginning an installation.

In most cases, two tradespeople (a plumber and an electrician) are required to undertake all the necessary installation work for a HPWH. The installation should be carried out by a suitably qualified person or people who:

- are licensed to carry out the electrical work
- are licensed to carry out the plumbing work
- hold an Approved Filler Compliance Certificate[7] for handling refrigerants, where required (i.e., for split systems where the cylinder and heat pump are connected by a refrigerant pipe)
- are licensed to carry out any necessary gas work, where relevant
- have the correct toolkit to allow them to carry out the work (refer to section 5).

Know your regulations and standards

Numerous acts, regulations and standards must be complied with when installing a HPWH. These include:

- Acts and regulations:
  - Building Act 2004 – in particular in relation to building consent requirements and building code compliance
  - New Zealand Building Code – clauses B1 Structure, E2 External moisture, G9 Electricity and G12 Water supply
  - Electricity (Safety) Regulations 2010 – including the cited edition of *AS/NZS 3000:2007 Electrical installations* (known as the Australian/New Zealand wiring rules)
  - Plumbers, Gasfitters, and Drainlayers Act 2006
  - Hazardous Substances and New Organisms Act 1996
  - Health and Safety at Work Act 2015
  - Health and Safety at Work (Hazardous Substances) Regulations 2017
  - Consumer Guarantees Act 1993 – which places a legal obligation on the installer to install a system that is suitable for the situation it is installed in.

[6] This is comparable to the typical noise level in a library (40dB) and for moderate rainfall (55dB).
[7] See: https://www.worksafe.govt.nz/topic-and-industry/hazardous-substances/certification-authorisation-approvals-and-licensing/certification-of-people/approved-fillers/

- Standards:
    - AS/NZS 60335.2.40:2023 Household and similar electrical appliances – Safety – Part 2.40: Particular requirements for heat pumps, air-conditioners and dehumidifiers
    - AS/NZS 3500.4:2021 Plumbing and drainage, Part 4: Heated water services – for the installation of potable water heating systems
    - AS/NZS 4020:2018 Testing of products for use in contact with drinking water – for systems heating potable water
    - NZS 4219:2009 Seismic performance of engineering systems in buildings
    - AS/NZS 3000:2018 Electrical installations.

Installers should also adhere to the processes outlined in the Australia and New Zealand Refrigerant Handling Code of Practice 2025.

Understand the warranty

Installers must ensure they make homeowners aware of the warranties provided for each component of the system, including the periods and terms.

Section 2: Heat pump water heater systems

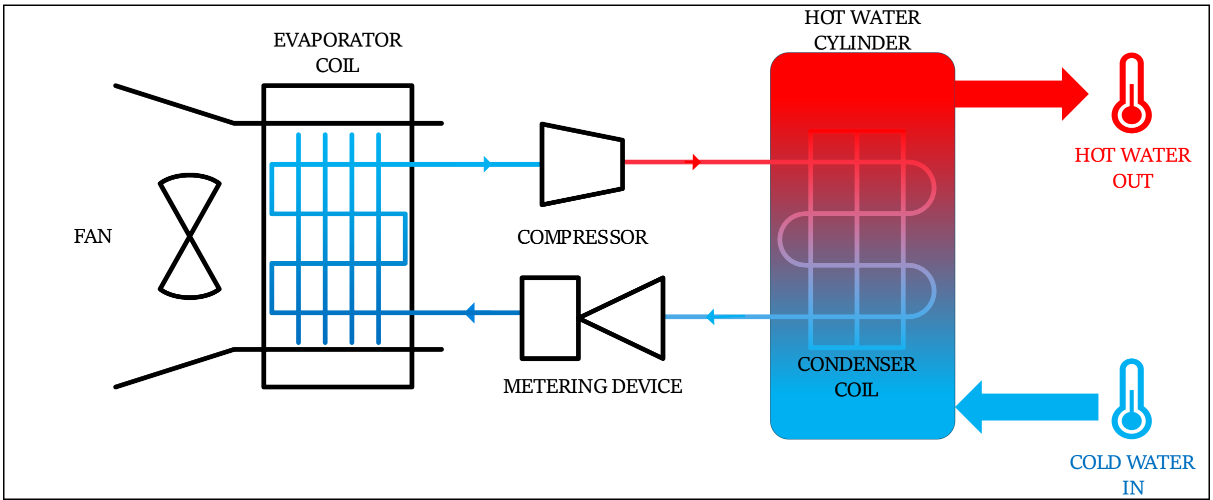
2.1 How does a heat pump water heater work?

HPWHs work on the same principle as a refrigerator, but instead of pumping heat out of the fridge to keep it cool, they pump heat from the outside air into the water to warm it up.

In essence, a **fan** draws air, which contains heat energy, across the **evaporator coil**. This turns the liquid refrigerant in the coil into a gas, which the **compressor** then pressurises to become a hot gas. The hot gas passes through a **condenser coil**, where it transforms from a gas back to a liquid, giving its heat to the water in the **storage cylinder**. The liquid refrigerant then flows back to the evaporator coil to repeat the cycle until the desired water temperature is reached.
A simplified illustration of the process can be seen in Figure 3.

HPWHs are powered by electricity. Yet, because they only use a relatively small amount of electrical energy to generate a larger amount of heat energy and transfer it to the water in the storage cylinder, they are roughly three times as efficient as a conventional electric resistive water heater. However, efficiency will vary depending on the climate and ambient air temperature.

Figure 3: Air-to-water heat pump



2.2 Types of heat pump water heaters

There are different types of HPWHs available, and different systems may be more suited to certain homes and circumstances.

Most systems fall into one of four types.

- **All-in-one HPWH**: where the entire HPWH is contained in one housing. Within the housing, the condenser may either be integral to the cylinder (no circulation of water is required) or stand-alone (requiring a circulating pump to move water from inside the cylinder to the condenser and back). These systems are also referred to as 'integrated' or 'monoblock' systems.
- **Split refrigerant-loop HPWH**: where the refrigerant is circulated between the outdoor unit (containing the compressor and evaporator) and the condenser which is integrated with the cylinder.
- **Split water-loop HPWH**: where water is circulated between the outdoor unit (containing the compressor and evaporator) and the cylinder.
- **Split refrigerant-and-water loop HPWH**: where the refrigerant is circulated between the outdoor unit (containing the compressor and evaporator) and the condenser (which is separate to the cylinder). Heat energy is then transferred from the condenser to the cylinder using a water loop.

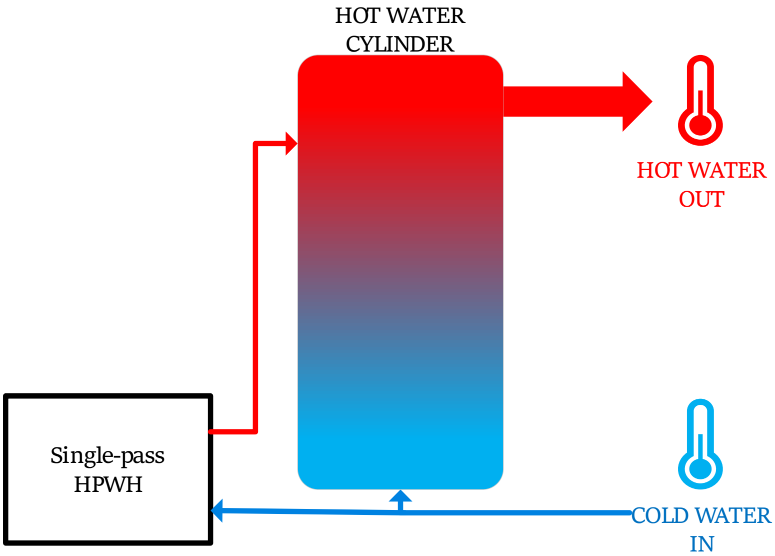
These main types of HPWH systems are discussed further in sections 2.3 to 2.5.

2.2.1 Single-pass and multi-pass systems

Some HPWH systems can then be further sub-divided as either single-pass or multi-pass systems.

Single-pass systems heat the water in 'one shot', as shown in Figure 4. They may be particularly suited to instances where the demand exceeds the capabilities of all-in-one units.

Figure 4: Single-pass heat pump water heater



Single-pass systems have the advantage that they:

- can rapidly recover hot water once the hot water cylinder is depleted
- can produce usable hot water in real time
- require less volume for water storage
- take advantage of the natural thermal stratification[8] that occurs in a hot water storage cylinder; which increases the sub-cooling[9] and therefore the overall efficiency of the system

[8] The natural layering of water temperatures, with hotter water at the top of the cylinder and cooler water at the bottom.

[9] Cooling a liquid refrigerant below its saturation temperature (or condensing point) to ensure it enters the expansion valve in a fully liquid state, preventing flash gas formation and improving system efficiency.

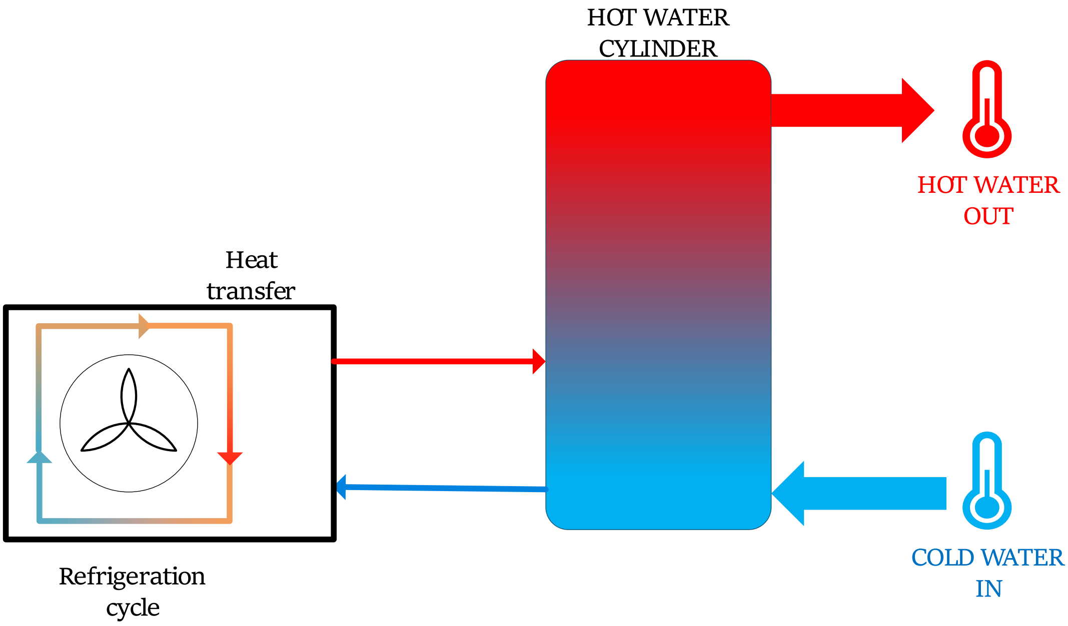
- can spend more time running at lower refrigerant pressures for a given target water temperature, which can increase the overall efficiency and durability of the compressor.

Single-pass systems may be particularly suited to replacing instantaneous gas systems.

Note: When a single-pass heat pump unit is connected to a reticulated-return system (a ring main),[10] additional care must be taken to maintain the thermal stratification within the storage cylinder. While a few systems may be integrated with a reticulated hot-water ring main, unless the manufacturer specifically supports this function, using any HPWH for a ring-main system is not recommended.

Multi-pass systems raise the temperature of the water over several, successive passes, in order to reach the desired temperature (setpoint). However, this can lead to energy losses and higher operational costs, as the water is circulated many times between the heat exchanger and the cylinder, with only a small temperature rise each time.

Figure 5: Multi-pass HPWH



Points to note about multi-pass systems include:

- hot water is not available until the entire cylinder reaches a usable temperature
- a multi-pass system storage cylinder must contain sufficient volume to meet the entire peak usage period
- they are a good choice for supplementary water heating when the heat pump is not expected to handle the entire load alone
- they require higher flow rates between the heat pump and the storage cylinder, which can lead to larger pipe sizes and higher installation costs in some cases
- they may start with a higher coefficient of performance (COP) rating, but as the cylinder approaches the setpoint temperature, the COP drops significantly.

[10] Using a closed-loop or ring of piping to circulate hot water, ensuring it's readily available at outlets, especially in situations with long distances between the water heater and fixture. However, ring mains lose heat via convection losses, and reduce the efficiency of the HPWH by having to reheat the warm returned water. Ring-main systems can result in coefficients of performance (COP) that are worse than supplying hot water locally with a small indoor electric resistance water heater.

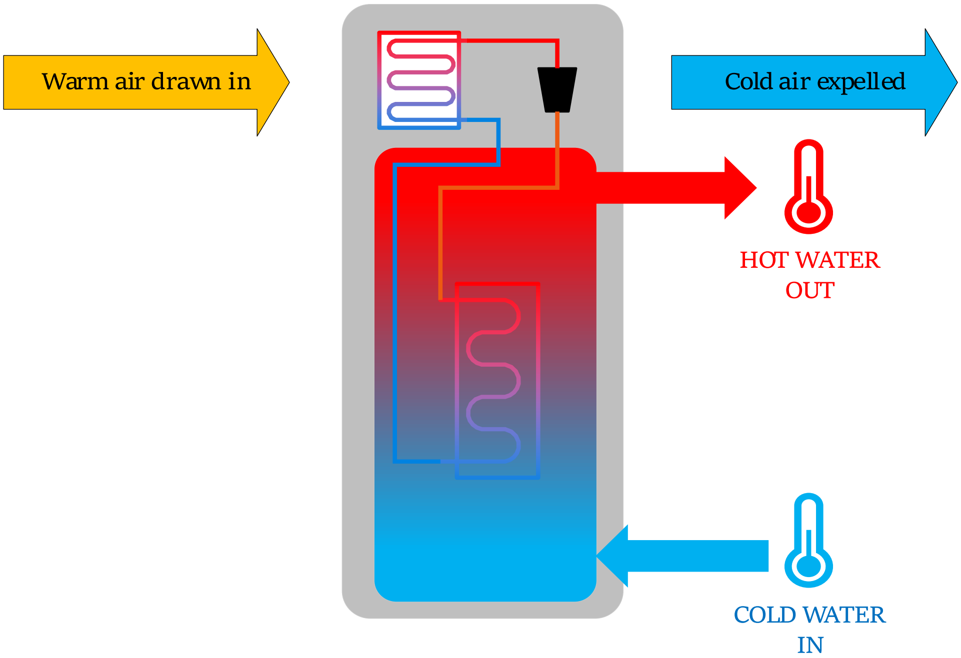
2.3 All-in-one heat pump water heaters

An all-in-one HPWH system is contained within one housing. Within the housing, the condenser may be integral to the cylinder (no circulation of water required), or stand-alone (requiring a circulating pump to move water from inside the cylinder to the condenser and back).

All-in-one systems take up less space than split systems and can be simpler and cheaper to install.

However, they are generally heavier than split systems, and must be installed outside.

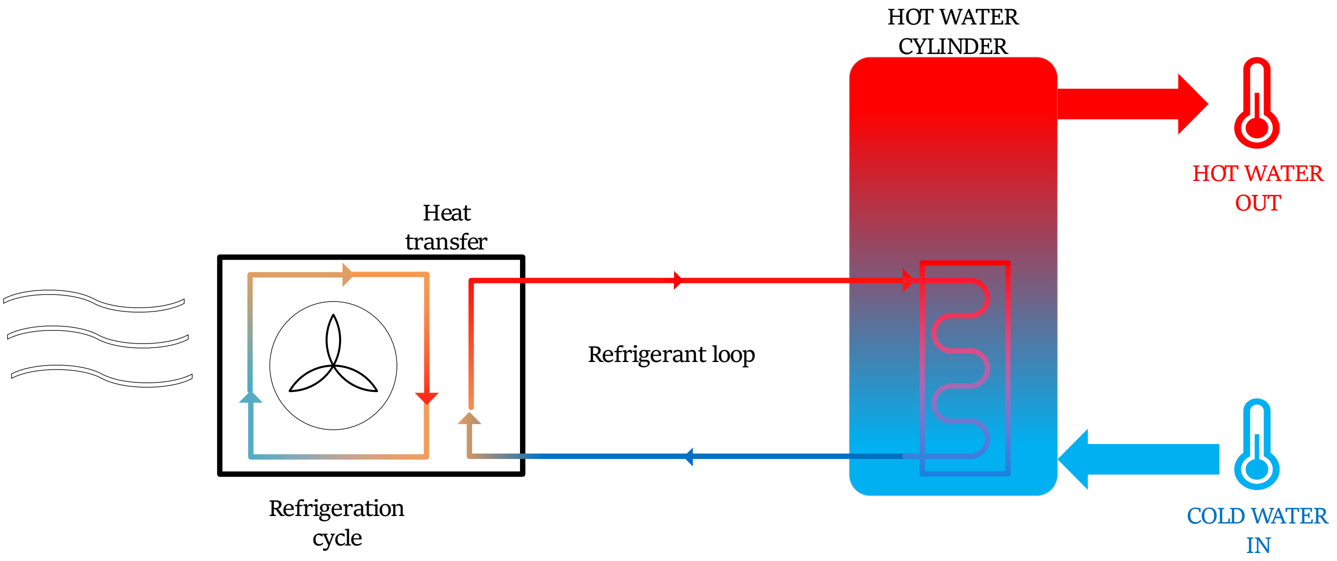
Figure 6: All-in-one HPWH



2.4 Split refrigerant-loop heat pump water heaters

A split refrigerant-loop HPWH system is where the refrigerant is circulated between the outdoor unit (containing the compressor and evaporator) and the condenser integrated in the cylinder.

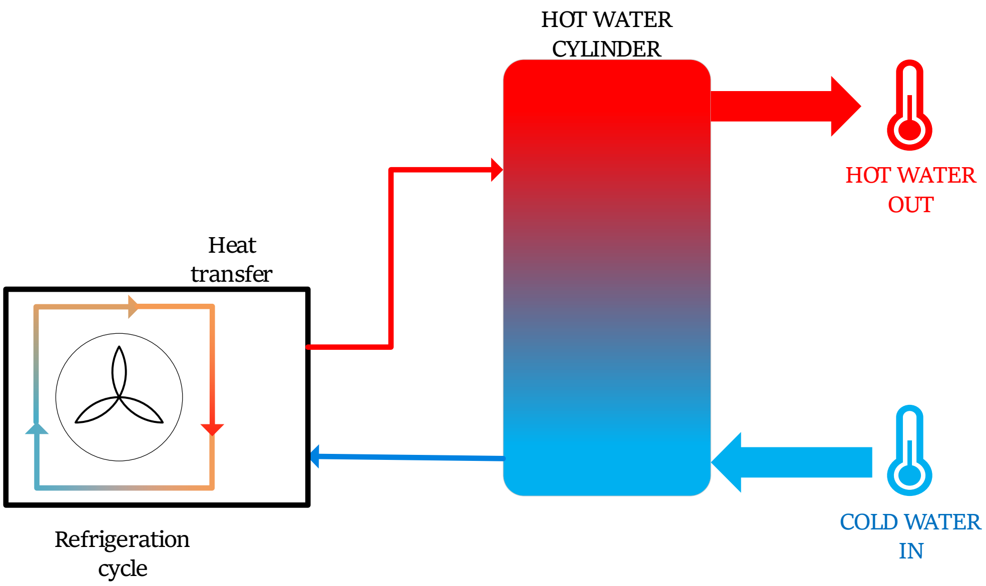
Figure 7: Split refrigerant-loop HPWH



2.5 Split water-loop HPWHs

Typically, split water-loop units offer greater heating capacity than all-in-one units, as they separate the refrigeration system from the storage cylinder. Split water-loop units heat the water outside of the cylinder and pipe it to the cylinder. Some suppliers call the refrigerant in a spilt water-loop system the ‘primary fluid’ and the hot water loop the ‘secondary fluid’.

Figure 8: Split water-loop HPWH

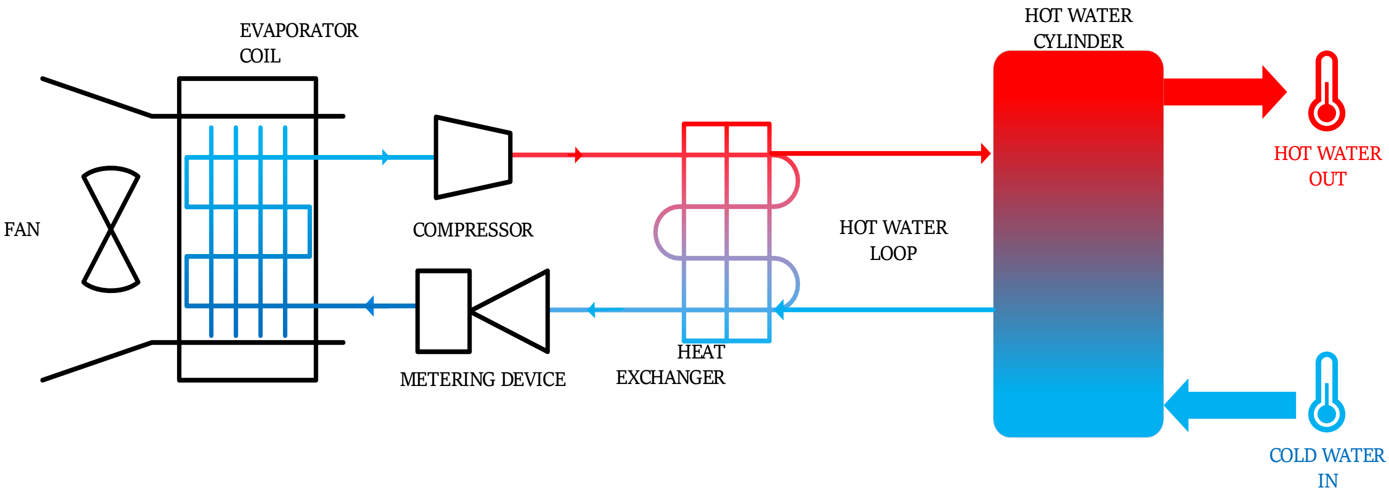


Split-water systems have the advantage of decoupling the outdoor and indoor units, and not requiring a refrigerant loop to be run between the units, which can be beneficial where the system is being retrofitted to an existing hot water cylinder. However, the systems may use extra electricity to pump water around the loop.

In units with an external heat exchanger, the heated water can be delivered to the top of the cylinder at the required temperature and thermally layered from the top of the cylinder down (a single pass heat pump unit). Alternatively, the heated water can be supplied near the bottom of the cylinder, which heats the water in the cylinder from the bottom up (a multi-pass heat pump unit).

Note that if a hot water closed-loop system is used, the pressure equipment used to contain the heat-transfer medium (in this case the hot water) must meet the requirements in AS/NZS 3000:2018 and AS/NZS 4020:2018, as well as the Approved Code of Practice for Pressure Equipment (Excluding Boilers), if required by the Health and Safety in Employment (Pressure Equipment, Cranes, and Passenger Ropeways) Regulations.

Figure 9: Split water-loop HPWH



2.6 Components of a heat pump water heater

The main components of a HPWH, and how they operate, are summarised in Table 1.

Table 1: Heat pump water heater components and their operation

Component	Description
Fan	A fan draws ambient outside air across the evaporator coil and expels the cooler air away from the coil.
Evaporator coil	The evaporator coil is a heat exchanger, which can absorb heat from the outside air and transfer it to the refrigerant. The coil has thin metal fins attached to increase its surface area. The liquid refrigerant, at a low-temperature and low-pressure, passes through the coil where it absorbs heat energy from the surrounding warmer air and evaporates, becoming a gas.
Refrigerant	A refrigerant is a working fluid that circulates around the HPWH system. It can change from being a liquid to a gas and back again, alternately absorbing and releasing heat. See section 8 for more details about refrigerants.
Compressor	The warm refrigerant gas enters the compressor, which increases its pressure and temperature.

	The hot gas is then pumped around the system. Most modern compressors operate on a variable-speed system using variable-speed (inverter) compressors. This means they can ramp-up and run at full-load, or dial-back to operate at part-loads.
Inverter	The inverter allows the compressor and fan to operate at variable speeds, enhancing efficiency, reducing energy consumption, and enabling more consistent temperature control compared to traditional on/off systems.
Refrigerant pipework	The refrigerant flows around a continuous, closed-circuit or sealed pipework system. Insulation should be fitted to the pipework to reduce heat losses. See section 6.1 for more information about refrigerant pipework.
Condenser	The condenser is another type of heat exchanger, which transfers heat from the refrigerant to the hot water in the cylinder or to a separate hot water loop. As the hot refrigerant gas passes through the condenser, it releases heat into the surrounding cooler water, and the refrigerant condenses back to its liquid state.
Hot water cylinder	The hot water cylinder stores hot water for use throughout the day. The cylinder should be large enough to store sufficient hot water for the householder's daily needs. The water in the cylinder may be heated up at various times throughout the day by the HPWH. The system may also have an electric element as a backup or booster. Depending on the system configuration: • cold water may be fed into the bottom of the hot water cylinder, where it is heated by the condenser; the warmer water is less dense than the cold water, so it rises up (thermal convection) • water may be heated in 'one-shot' or several times by the condenser unit until the water reaches the desired temperature (setpoint) • The warmer water will eventually settle at the top of the cylinder (stratification). The cylinder should have baffle-plates installed to minimise the mixing of cold and hot water. When the homeowner opens a tap, hot water is drawn from the top of the cylinder, causing fresh cold water to be drawn into the bottom of the cylinder.
Expansion valve[11]	After passing through the condenser, the cooled liquid refrigerant then passes though the expansion valve, where the rapid expansion of the refrigerant results in a pressure drop, causing the refrigerant to expand and become a cold liquid/vapour mix. The cold refrigerant then flows back to the evaporator coil, where the whole process is repeated.

[11] Refer to section 2.5.5 of SNZ PAS 5210:2024.

2.7 Compressor types

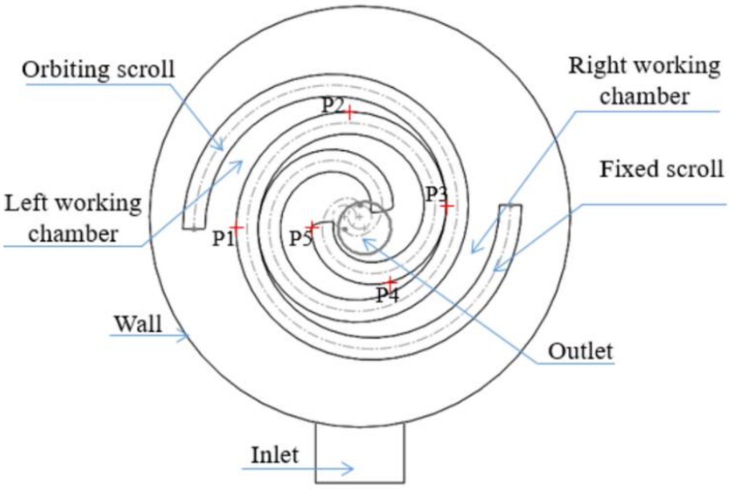
Most domestic HPWHs sold in New Zealand use scroll or rotary compressors, known for their efficiency and reliability.

Most new HPWHs do not use a fixed-speed compressor. However some systems may use a cascade or series of multi fixed-speed compressors.

Scroll compressors

Scroll compressors are a popular choice for HPWHs due to their high efficiency and reliability. Scroll compressors contain two interleaving scroll plates, resembling spirals, one being stationary and the other orbiting eccentrically, as shown in Figure 10.

Figure 10: Scroll compressor

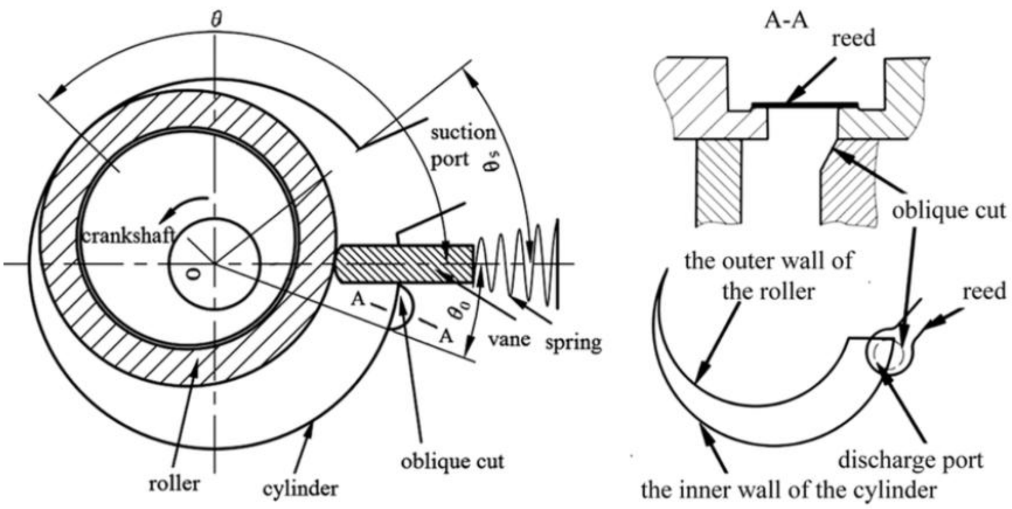


Source: https://www.researchgate.net/figure/Two-dimensional-schematic-diagram-of-the-scroll-pump_fig2_354817249

Rotary compressors

Rotary compressors are another common type of compressor used in New Zealand, and are known for their compact design and ability to handle a wide range of operating conditions. Rotary compressors contain a large cylinder with a smaller vane that rotates eccentrically within a casing, as shown in Figure 11.

Figure 11: Rotary compressor



2.8 Mains-pressure vs low-pressure hot water systems

While traditional low-pressure hot water systems have been common throughout New Zealand for decades, in more recent years many people are seeing the benefits of mains-pressure systems.

In particular, mains-pressure hot water systems are becoming increasingly common in new builds.

Retrofitting a mains-pressure system to replace a low-pressure system in an existing home can come with added complications and costs. It can also result in greater water use, unless suitable fittings, such as efficient shower heads, are installed at the same time.

More information on the suitability and limitations of HPWHs for mains-pressure and low-pressure systems can be found in Table 4.

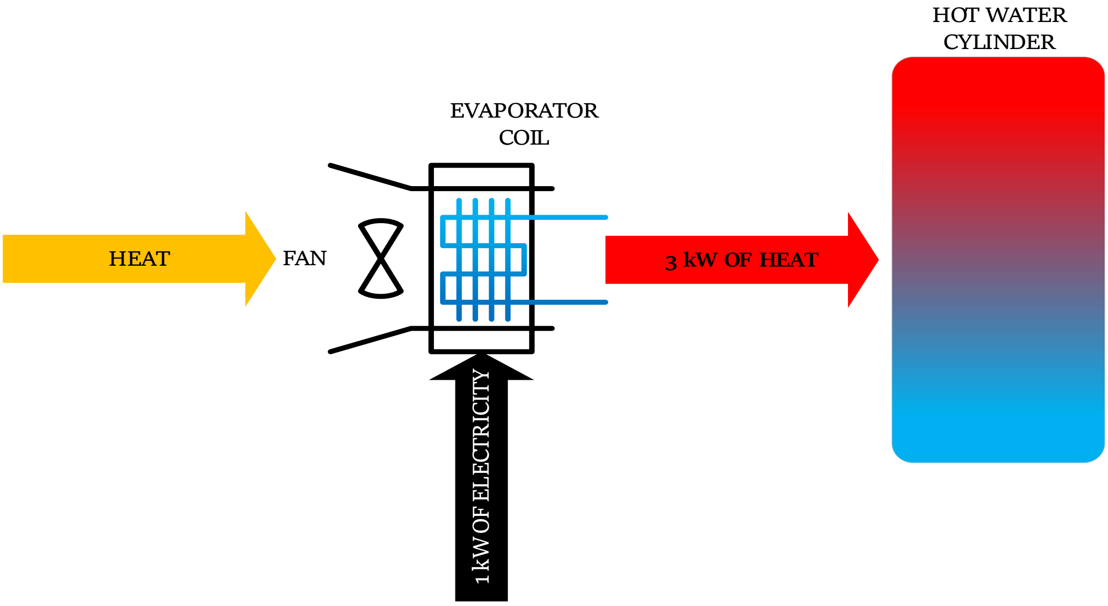
Section 3: Heat pump water heater performance

This section addresses the different factors that influence the efficiency and performance of HPWHs.

Understanding the performance of HPWHs is essential for selecting the right system for a householder's requirements. Selecting a HPWH is covered in more detail in section 0 of this guide.

Figure 12 shows a simplified illustration of how energy is extracted from the ambient air to heat the water in a cylinder.

Figure 12: Energy exchange in a heat pump water heater



However, in practice, there are many factors that influence the actual efficiency of a HPWH, such as:

- installation placement and quality
- climate – the temperature and humidity of the outside air, which can vary considerably throughout the day, night and year (see section 3.3)
- temperature of the incoming cold water
- operating characteristics, such as daily usage and draw-off patterns
- ambient temperature of the house (for split systems, if the cylinder is installed inside) or outside (for all-in-one systems)
- insulation of the hot water cylinder (and wind-chill factor for outside cylinders)
- auxiliary energy consumption (such as booster element, pumps, fans etc)
- how well the system's size is matched to meet to the household's water heating demands (see section 4.4.1)
- type of refrigerant used (see section 8)
- timers and/or demand flexibility capability
- settings, such as the setpoint.[12]

[12] The desired temperature of the water stored in the hot water cylinder, ready for use by the homeowner.

3.1 Heat pump water heater efficiency

The efficiency of a HPWH can be expressed as the ratio of how much heat energy is delivered to the hot water cylinder, compared to the amount of electrical energy input used to operate the system. This is called the COP (short for coefficient of performance), as defined below:

COP = heating delivered (kWh)/electrical energy required to operate the system (kWh).

In monetary terms, a system with a COP of 3 will provide $3 worth of hot water for every $1 of electricity paid for – the higher the COP, the greater the efficiency of the heating system.

Manufacturers generally provide COP values for their systems in information or specification sheets. An acceptable COP should be at least 3, and better products will have a COP of 4 or more.

It's important to note that COP is normally stated in relation to a specific ambient temperature (and starting and end water temperatures). Popular points include 19^{0}C ambient temperature and a 45^{0}C water temperature rise. However, a product may not achieve this COP in practice, due to real-world climate conditions being different to the conditions at which the COP was measured.

HPWH efficiency is sometimes presented a seasonal COP (also known as SCOP), in accordance with AS/NZS 4234:2021. Seasonal COP is a more representative annualised figure, as it includes standby power and takes into account how the COP may change throughout the year under varying climatic conditions.

3.2 Energy performance testing

EECA does not currently regulate HPWH for energy efficiency (unlike space-heating heat pumps, which are regulated). Therefore, there is no mandatory energy efficiency testing, labelling or minimum performance that HPWHs must meet.

However, there are local (AS/NZS) and international standardised testing methods to help determine the energy performance of HPWHs, along with aspects of their design and construction, plus tools to calculate how much energy a HPWH is likely to use over a year.

The most widely used standards to determine performance of HPWH in New Zealand are:

- *AS/NZS 5125.1:2014 Heat pump water heaters - Performance assessment - Part 1*
- *AS/NZS 4234:2021 Heated water systems - Calculation of energy consumption*

Other Standards include:

- *AS/NZS 2712: 2007 Solar and heat pump water heaters – Design and construction*
- *AS/NZS 4692.1:2005 Electric water heaters – Energy consumption, performance and general requirements*
- *SA/SNZ MP 104:2021 Modelling of heated water systems in accordance with AS/NZS 4234:2021, using TRNSYS*
- *BS ISO 19967.1:2019 Heat pump water heaters – Testing and rating for performance, Heat pump water heater for hot water supply*
- *EN 16147:2017 Heat pumps with electrically driven compressors – Testing, performance rating and requirements for marking of domestic hot water units*

More details on these standards which are available from Standards New Zealand.

3.3 Effects of climate on efficiency and water-heating capacity

As noted in section 3.1, the energy efficiency and heating capacity of a HPWH system are not constant, unlike traditional electric storage and gas water heaters.

When selecting a system, it is important to understand how the system will perform in the climatic conditions where it is being installed.

The efficiency and capacity of a HPWH system depend on a number of factors, particularly the:

- temperature and humidity of the outdoor air
- temperature of the water coming into the system
- desired end water temperature (setpoint).

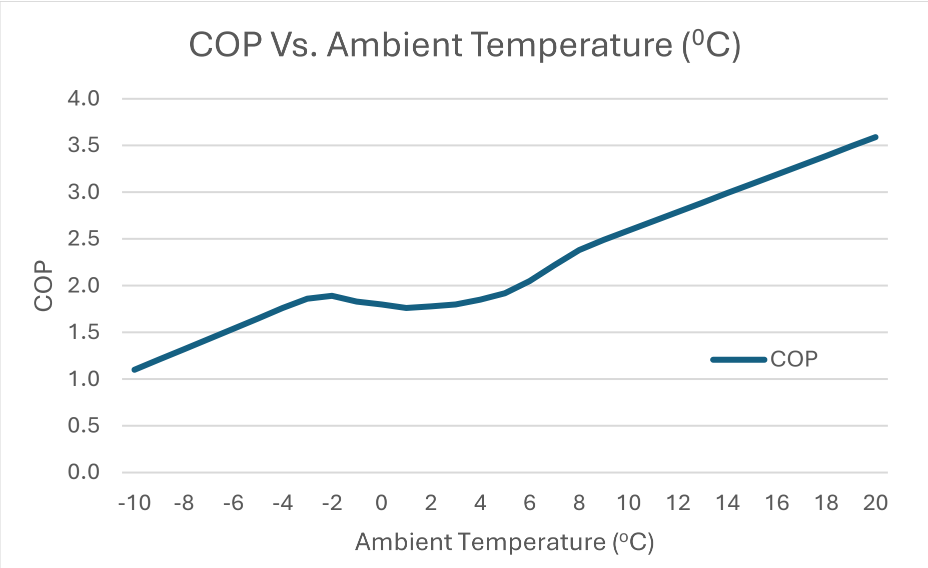
As the outdoor temperature varies, so too does the efficiency of the HPWH. Figure 13 shows a typical trend of HPWH efficiency over a range of temperatures that might be experienced in some parts of New Zealand.

The incoming water temperature has an impact on a HPWH's COP, as colder water will require more energy to get it up to temperature (or temperature lift).

Different HPWHs will perform very differently at sub-zero temperatures. Some systems may keep performing down to as low as -20˚C, while others will struggle to work at temperatures between 0˚C and 7˚C, as illustrated in Figure 13.

Humidity and wind may also adversely affect the performance of the unit.

Figure 13: Heat pump water heater efficiency in relation to temperature



Another key temperature-related factor that affects heating efficiency is the extra energy required for defrosting parts of the system at low temperatures.

At temperatures of around 0˚C to 7˚C, any water vapour in the air may start to condense and freeze onto the outside evaporator coils. This reduces the ability for heat to be absorbed from the surrounding air, and the coils must be de-iced before the system can operate properly again – see sections 3.4 and 4.2.3.

The setpoint of the hot water will also have an impact, as heating water to a higher temperature will require more energy to achieve the required temperature lift.

The energy efficiency and output capacity of HPWHs are usually tested under laboratory conditions at several different ambient temperatures, to reflect the fact that temperatures in some parts of New Zealand, particularly in the central plateau of the North Island and much of the South Island in mid-winter, will significantly impact their performance. These test results may be useful when choosing a suitable HPWH for an area, particularly in colder regions.

3.4 Impact of defrost cycle on efficiency and hot water output

Systems must be sized correctly to minimise the energy losses and disruptions to heating delivery that can occur during their defrost cycle.

A defrost cycle may be necessary to remove the build-up of ice on evaporator coils. Ice build-up can occur when temperatures drop below 7˚C (especially in high humidity), and any water vapour in the air will start to condense and freeze onto the evaporator (outdoor heat exchanger) coils.
This disrupts the heat flow, and the coils must be de-iced before the unit is able to continue heating the water in the cylinder.

No heat is supplied to the hot water cylinder during the defrost phase.

HPWHs generally use one of two methods to remove ice build-up from the coils.

- **Reverse-cycle operation** – where the system temporarily reverses or switches into cooling mode and uses some of the heat generated to defrost the coils. This method is generally more efficient than the hot-gas bypass method, but requires the volume of refrigerant in the evaporator and condenser to be approximately equal.
- **Hot-gas bypass systems** – where a closed-loop cycle or short-circuit is created, which captures heat from the compressor motor that is then used to defrost the coils.

The defrost-cycle control might be either:

- time-temperature defrost – starting and stopping at preset times (e.g. 30, 60 or 90-minute intervals), or
- on-demand defrost –which is generally more efficient because it operates only when it detects a build-up of frost on the outdoor coil. Frost is detected by monitoring air and coil temperature, outdoor airflow, pressure differential across the coil, and refrigerant pressure.

Systems that include a dry-coil defrost cycle[13] may run the outdoor fan at its maximum speed for a short-period before the system starts to heat again. This is to remove any water that may still be on the coil fins and would otherwise immediately refreeze, and is sometimes visible as water vapour being blown from the evaporator unit before the heating cycle resumes.

HPWHs that are undersized or not suited to the local climate will need to defrost more frequently in low ambient temperatures, greatly reducing efficiency and ability to provide sufficient hot water.

[13] This runs the outdoor fan briefly at maximum speed for a short period, to remove moisture from the coil fins before the system resumes heating, preventing ice buildup and ensuring efficient operation.

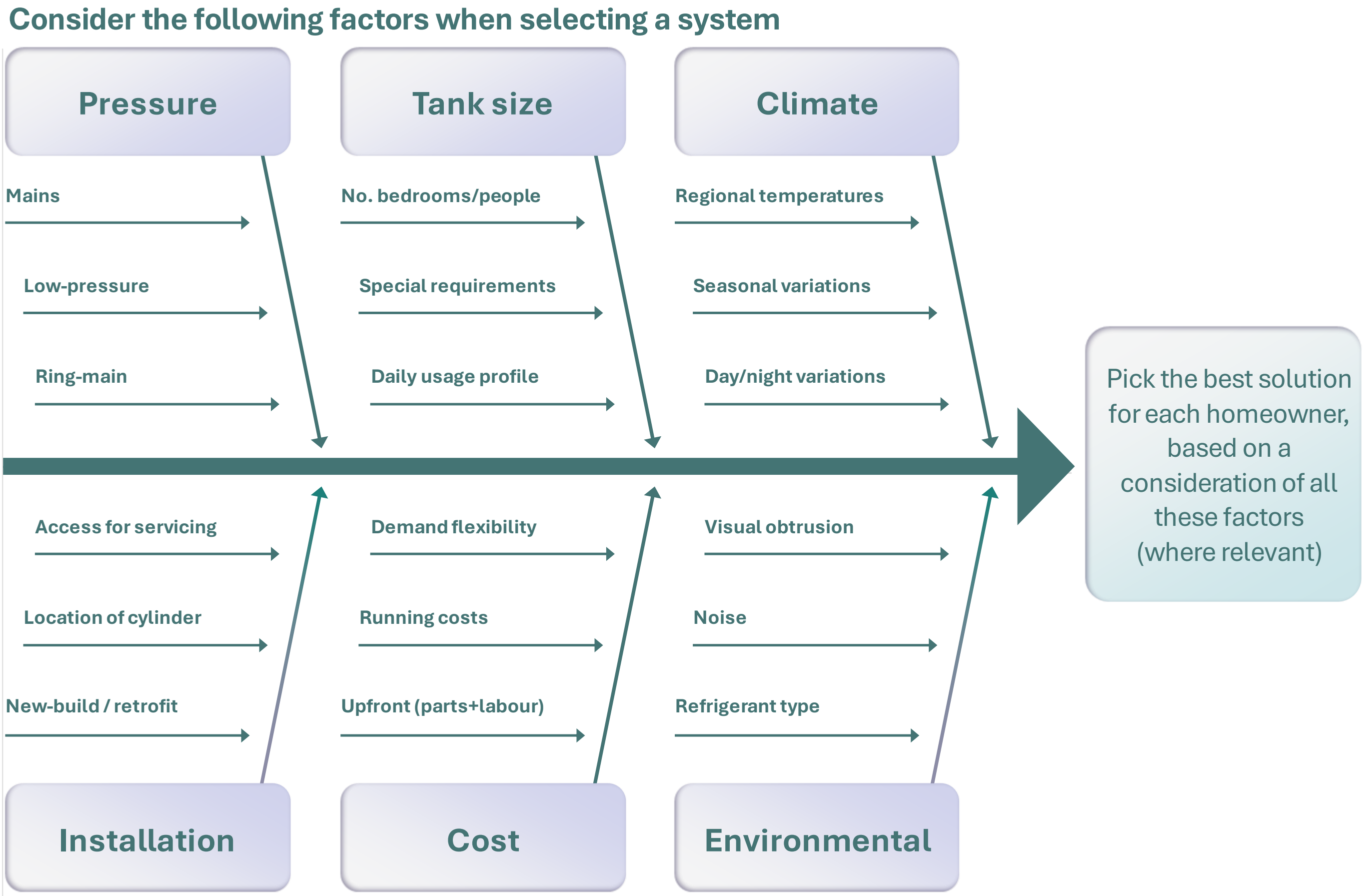
Section 4: Selecting a heat pump water heater system

This section describes the steps for selecting and siting a HPWH system that will perform as efficiently as possible to meet the customer's needs.

4.1 Factors to consider

Figure 14 shows the main factors installers and homeowners should consider when choosing a HPWH system.

Figure 14: Factors for selecting a heat pump water heater system



Before trying to select a suitable unit, it is advisable to discuss the homeowner's needs and visit the home to assess the climate, orientation and space(s) available both inside and outside the home, plus any other relevant factors that may affect whether a particular HPWH is a good option, as detailed in Table 2.

Table 2: Factors impacting on whether a heat pump water heater is a good option

Factor	Comment
Climate	HPWHs are more efficient in warmer climates. In colder regions, the unit may rely more on an electric element backup (if it has one), reducing efficiency – a model with good low-temperature performance would be more suitable in a cooler climate.
Hot water demand	HPWHs are best suited for medium to large households with consistent hot water use. Households with one or two occupants, or that use very little hot water, are unlikely to make sufficient energy savings to justify the purchase cost.
Household wiring	A HPWH will typically draw around 0.9kW of power, and a booster element, where fitted, will typically draw another 1.5kW to 3.5kW. A registered electrical worker should ensure that the current wiring in their household is capable of handling this load.
Installation location	HPWHs need good airflow and sufficient space around the outdoor unit. The cylinder should be relatively close to the bathroom, kitchen and laundry to avoid long pipe runs, which waste heat.
Noise	HPWHs use a compressor and a fan, which will make some noise. Try to select a location that is not adjacent to a bedroom or window, including those of a neighbour.
Local environment	Some environments, such as coastal or geothermal and sulphurous conditions, can impact on the longevity of HPWHs. While mitigation treatments exist, consideration should be given as to whether the environment is suitable for a HPWH.
Current hot water energy source	A well installed HPWH should be considerably cheaper to operate than an equivalent electric storage water heater or gas water heater. In particular, LPG instantaneous gas water heaters are relatively expensive to run, so moving to a HPWH from an LPG instantaneous water heater would result in significant annual energy cost savings.
Current hot water system	Some HPWH systems may be better suited as a retrofit option to replace certain types of hot water systems. See Table 5 for more details of these systems.
Access to solar photovoltaic (PV)	Households with solar photovoltaic systems may be able to use the 'free' power generated during the day to run a HPWH system.
Access to demand flexible pricing	Households with access to demand flexible pricing may be able to use their HPWH at times of the day when electricity pricing is cheap, or even free, to produce cost-effective hot water with a HPWH.
Having a ring-main hot water system	Having a closed-loop or ring of pipework to circulate hot water (known as a ring-main) may result in heat losses through convection and may also reduce the efficiency of a HPWH system. Ring-main systems can result in COPs that are worse than supplying hot water locally with a small indoor electric resistance water heater. HPWHs are generally not recommended as being compatible with a ring-main system.

There are also factors to consider that may make certain types of HPWH systems more suitable to a homeowner's situation and requirements. A comparison of the advantages and disadvantages of different types of HPWH is provided in Table 3.

Table 3: Comparison of advantages and disadvantages of heat pump water heater system types

System type	Advantages and suitable applications	Disadvantages or limitations
Split systems, with a refrigerant loop	May be installed in new houses or as a replacement in homes with an existing hot water cylinder cupboard, where the existing system is no longer meeting the homeowner's needs.	Requires additional refrigerant pipework, which may be more problematic for retrofit installations. Requires internal space (hot water cylinder cupboard).
Split systems, with a hot water loop	May be installed in new houses or retrofitted in homes with an existing hot water cylinder cupboard. May potentially be retrofitted to an existing electric storage water heater cylinder if the heat pump has a built-in heat exchanger.	Requires additional hot water pipework, which may be more problematic for retrofits. Requires internal space (hot water cylinder cupboard), if the cylinder is being installed inside.
All-in-one systems	May be installed in new houses or retrofitted in homes without an existing hot water cylinder cupboard. Saves space inside the home.	No airing cupboard. Increased standing heat losses, as hot water cylinder is located outside.

Whether a home has mains-pressure or a low-pressure water supply can also affect the selection of a HPWH system, as outlined in Table 4.

Table 4: Comparison between low- and mains-pressure heat pump water heater systems

System type	Advantages and suitable applications	Disadvantages or limitations
Low pressure	Better suited for retrofitting in existing low-pressure homes.	May result in a poor flowrate for hot water fixtures. Refer to the manufacturer's instructions regarding any minimum pressure or flow-rate requirements. You might consider installing a booster-pump if this is an issue, but again check the manufacturer's guidelines regarding this. However, installing a booster-pump will increase the running costs and maintenance, and may be a point of failure.
Mains pressure	Better hot water pressure and flowrate.	May use more hot water, unless an efficient showerhead is also fitted. May not be suited if retrofitting into a low-pressure home, unless a suitable pressure-reducing valve is installed, or pipework and fittings are upgraded.

Table 5 notes some points to consider when selecting a new HPWH system based on the type of system currently in place in the home.

Table 5: Considerations based on the type of system being replaced

Type of system being replaced	Advantages	Limitations and disadvantages
Instantaneous gas	May be better suited to all-in-one systems, as there is no hot water cylinder required inside the home.	Cost benefits and payback may depend on whether the home still has other uses for gas, such as cooking hobs or space heaters, as these will still incur a daily standing-charge for the gas supply.
Gas storage water heater	May be suited to all types of systems. May free up internal storage space if there is no longer a need for the cylinder to be inside the home.	Cost benefits and payback may depend on whether the home still has other uses for gas, such as cooking hobs or space heaters, as these will still incur a daily standing-charge for the gas supply.
Electric storage water heater	May be better suited to split systems, as it retains the hot water cylinder cupboard. Alternatively, an all-in-one system may free up internal storage space as there is no longer a need for the cylinder to be inside the home.	Consider if the HPWH is to be operated on cheap-rate ‘controlled’ electricity – if not, this will reduce the cost benefits and payback if the current electric storage system is on a low-rate plan.

4.2 Other factors affecting durability and lifetime

The durability and economic lifetime of HPWHs are influenced by several factors, including climate, water quality, maintenance, installation quality and usage patterns. Some of these factors are discussed elsewhere in this guide. Others are described below.

Electrical requirements

- Electrical requirements will depend on the situation in a particular home.
- It is generally not advised to use a 3-pin plug for a HPWH, unless this specifically meets the manufacturer’s recommendations for the model and comes with a plug fitted, and also meets the wiring regulations.
- Some installations may require new wiring and a circuit breaker, while others may not. Some may require an upgrade to heavier duty wiring, for example from 1.5mm core to 2.5mm core.
- Homeowners should consider whether they will need to make any wiring upgrades as part of a HPWH installation and the likely cost of this.

Technology and build quality

- Compressor durability – the compressor is the most critical and expensive part of the HPWH. Compressors on cheaper models may fail sooner (around 5 to 7 years), while high-end units should last 10 to 15 years or more.
- Cylinder material – stainless steel cylinders resist corrosion better than standard steel with a liner, potentially increasing lifespan.

4.3 Importance of correctly sizing a heat pump water heater

Size matters when selecting a HPWH.

HPWHs work best when they operate at a moderate load for moderate periods, with periodic breaks in between.

Operating an under-sized or over-sized HPWH can degrade the system's components, causing them to wear, and shortening the water heater's life or making it less efficient.

Correct HPWH sizing is critical for efficiency and performance. It is important to select a unit that can provide the required hot water capacity at the external design temperature relevant for the location of the home.

Optimum system sizing involves selecting both a suitably sized compressor unit and a suitably sized hot water storage cylinder for a split system, or a suitably sized all-in-one system, to suit the day-to-day demands of the occupants, keeping in mind that these demands may vary throughout the year.

Unlike heat pump space heaters, which deliver heat to the home when it is needed, a HPWH needs to produce and store enough hot water to meet the various demands throughout the day.

HPWHs (in common with most electric storage water heaters) may be set to take advantage of off-peak low-cost electricity, meaning they may not be able to run at full capacity, if at all, during certain times of the day. This needs to be considered when factoring in when hot water needs to be supplied vs when it can be heated. For more information on demand flexibility and demand response, see section 4.5.2.

If a heat pump's capacity is too low, the system will use more energy than necessary (resulting in increasing running costs, and wear and tear), is likely to need to defrost more frequently during heating operation, and may not be able to provide sufficient heating to deliver enough hot water for the occupant's needs (refer Table 6).

The extra running costs of an undersized HPWH generally outweigh the additional cost of installing a slightly larger unit.

Also, an undersized unit may require its booster element (if it's fitted with one) to switch on too often, which is just as inefficient as having a cheaper 'simple' electric storage water heater.

Selecting a slightly oversized heat pump may provide a safety margin to ensure that water heating requirements will be met. It may also result in improved energy efficiency. However, significant oversizing should be avoided.

A summary of potential issues arising from incorrectly sized systems is shown in Table 6.

Table 6: Effects of incorrectly sized systems

If unit is	Performance	Effects
Undersized	System may struggle to provide sufficient hot water for the homeowner's needs.	• Not enough hot water, causing cold showers etc.
	System may be operating at full capacity too often.	• Increased running costs. • Reduced energy efficiency. • Undue wear and tear, causing premature failure of the equipment.
	System may operate in defrost mode too often. See section 3.4 for impacts of defrost cycle on efficiency and heat output).	• Not enough hot water, causing cold showers etc. • Increased running costs. • Reduced energy efficiency.
Significantly oversized	Increased start-up power use.	• Increased purchase cost. • Increased running costs. • Reduced energy efficiency.
	Short cycling because the output exceeds the demand.	• Reduced energy efficiency. • Increased noise. • Undue wear and tear.
	Runs at low load too often.	• Reduced energy efficiency.

Factors to consider when sizing

Factors to take into account when sizing a HPWH system include:

- the number of adults and children, and the number of bedrooms, in a home
- mains-pressure vs low-pressure hot water systems – when replacing low pressure with mains pressure you get a better 'output' (although consider installing efficient or low-flow shower-heads), but you might also need to replace some fixtures and fittings and secure pipes to avoid knocking[14] etc)
- new vs replacement system – there is a cost to remove an existing system, and some types of HPWH systems may be better suited to either new or replacement scenarios, as shown in Table 5
- backup element (size, type, controls etc)
- control of backup element (simple or smart control; for booster or sanitisation or undersized element)
- size and type of heat exchanger (in-cylinder vs wraparound)
- pipework – refrigerant loop vs hot water loop
- airing cupboard – available inside space, available outdoor space
- single dwellings vs multi-unit dwellings – this Guide only covers single dwellings, and a larger or different type of system may be required for multi-unit dwellings.

Guidance on determining the required capacity of a HPWH system is provided in Table 7.

[14] Where water pressure is too strong causing the pipe to shake despite being secured in place on the walls.

Cylinder size

There are also consequences arising from having a hot water storage cylinder that is too small or significantly oversized.

The hot water storage cylinder must be big enough to suit the demands of the householders. This needs to factor in the quantities and times of use (when hot water is drawn off), as well as the time taken to reheat the cylinder before hot water is needed again.

However, greatly oversized cylinders may require more energy to heat them and have greater standing-losses.[15]

Storage and delivery temperatures

The storage and delivery temperatures (particularly where a thermostatic mixing valve, sometimes referred to as a TMV, is installed) also need to be factored into the sizing calculation, as they will affect the sizing of the necessary cylinder.

Likewise, while a higher storage temperature will increase the total amount of heat energy available in the hot water, it will require significantly more energy to heat the water to higher levels and will result in greater standing losses.

4.4 Steps for selecting a heat pump water heater system

4.4.1 Step 1: Determine the hot water load requirement

The following questions should be considered when determining the hot water requirements of a household.

- The number of occupants in the household.
- The number of bedrooms in the home.
- How much and when is hot water required throughout the day? For example, is hot water mainly used during one or two peak times during the day?
- What is the region and location of the home?
- Are there specific local conditions, such as microclimates within the climatic zones, which may influence system selection?
- What are the seasonal ambient temperatures? (See Table 9 for design temperatures.)
- What type of home is the system for? For example, old, new, with insulated pipework, mains- or low-pressure hot water?
- Is it for a typical single dwelling? Or does it also supply a separate unit, such as a sleep-out? (If the latter, more than one HPWH may be required.)
- What controllability does the owner want? For example, setpoint, different modes, timers?
- Does the owner want to future proof and get a demand-flex-ready unit? See section 4.5.2 for more information.

The number of bedrooms in a home is generally a useful guide to the daily hot water demand. This is because the number of bedrooms can be a proxy for the number of occupants (and therefore the daily hot water use) and also helps to ensure that the system is future-proofed for any future owners of the home. This should be

[15] Standing losses are the heat energy lost through the cylinder's walls and pipes, even when no hot water is being drawn, leading to wasted energy and higher costs.

used as a starting point, then adjusted based on the homeowner's specific needs, for example whether they have baths, washing machines that draw hot water etc.

Table 7 shows the likely daily hot water demand based on the number of bedrooms in a home. This should be used as a starting point, then adjusted based on the homeowner's specific needs, for example whether they have baths, washing machines that draw hot water etc.

Table 7: Determining hot water demand and capacity of heat pump water heater systems[16]

Number of bedrooms	Daily hot water demand from the cylinder
2	100L
3	150L
4	200L
5	250L
6	300L

A HPWH system would generally not be recommended for a household with a very low daily hot water requirement.

Using the information from step 1, you can now determine the required heating capacity for the heat pump and a suitably sized cylinder.

Note that demand is not the same as capacity. For example, a 250L cylinder (capacity) might be sufficient to deliver 300L of hot water per day with some additional cold water being heated (demand) or could be considered a safe size for 200L demand a day with a safety-buffer. Also note that demand is based on the quantity of hot water produced by the HPWH system, rather than the quantity of mixed-water delivered to the outlets.

4.4.2 Step 2: Consider the outside design temperature

Because the capacity of a HPWH reduces with outdoor temperature, a unit must be selected that can meet the hot water needs of a household located in that climate. It is important to note that the HPWH's actual capacity at that temperature is likely to be different to its rated capacity.

It is less critical to consider the possibility of extreme low temperatures when designing a HPWH system, compared with the criticality for a space heating system, where heat is required whenever the occupants want heating. HPWHs can be limited to operating at the warmer hours of the day, so a typical, yet not extreme, daily low temperature could be used for HPWH system design. A temperature of 1°C is commonly used as a 'low temperature' test point and may be a useful design temperature for sizing HPWHs in cooler parts of New Zealand. Furthermore, some products have boosters to help ensure that sufficient hot water is available when ambient temperatures are very low.

Table 8 lists the assumed external design temperatures for a range of climatic zones across New Zealand. Zones are approximately grouped by territorial authority districts (local councils). This is also illustrated in Figure 15.

Note that there may be some variation within each zone, hence a range of minimum design temperatures is given, depending on the specific location of the home (for example, at the bottom of a valley vs a flat open area). If the location where the HPWH is being installed has a particularly severe climate or

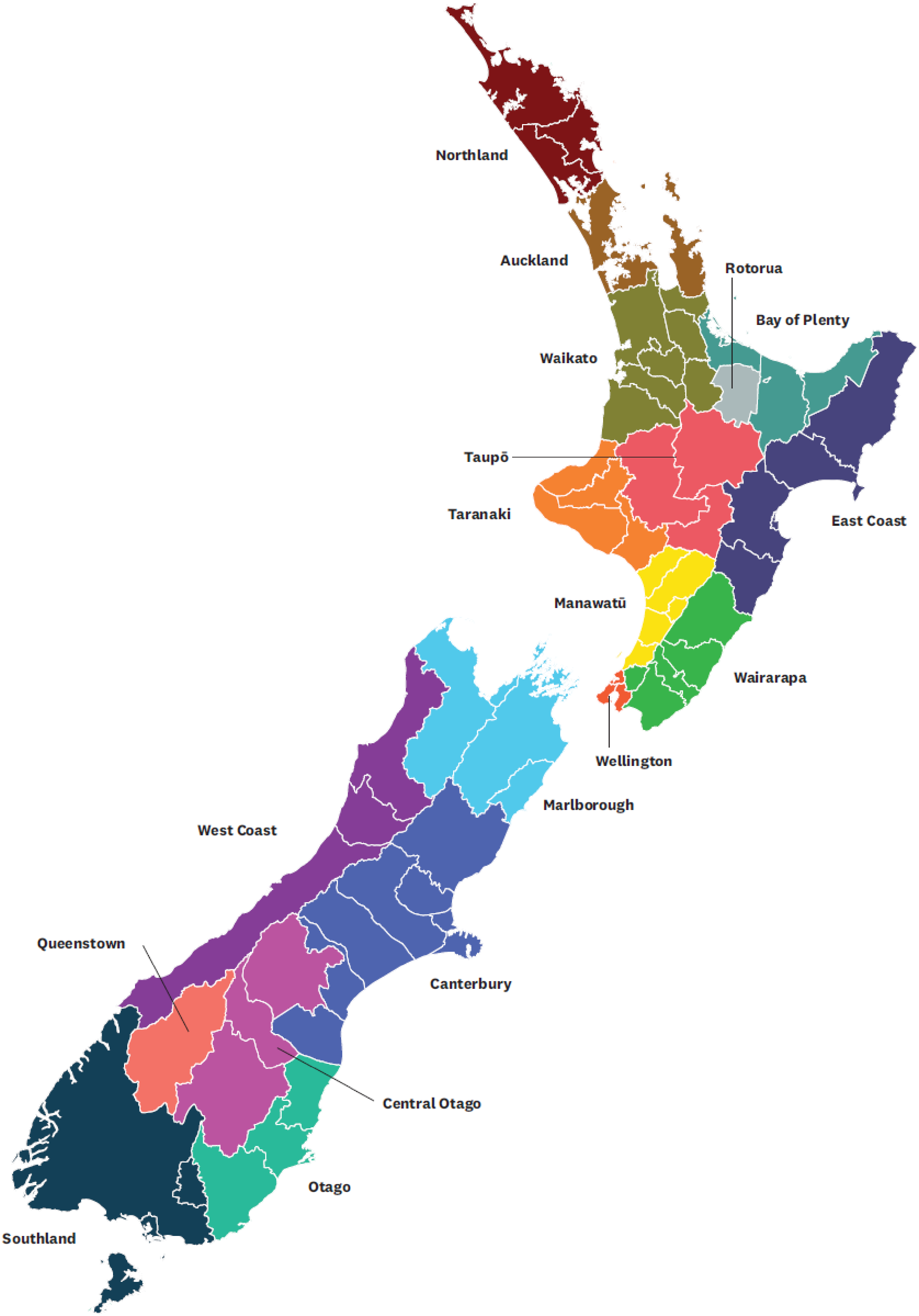
[16] Use AS/NZS 4234:2021 for daily heating-demand and water-draw profiles (time of day, climatic conditions, etc).

microclimate (for example, a sunless or damp valley), this needs to be taken into consideration, and the design temperature may be 1 or 2 degrees lower.

Table 8: External design temperatures for heat pump water heaters based on location by climate zone

Climate zone	Territorial authority areas (approximately)	Minimum design temperature (˚C)
Northland	Far North, Whangarei, Kaipara	7 to 8
Auckland	Auckland, Thames-Coromandel	5 to 7
Bay of Plenty	Western Bay of Plenty, Tauranga, Whakatāne, Kawerau, Ōpōtiki	4 to 6
East Coast	Gisborne, Wairoa, Hastings, Napier, Central Hawke's Bay	2 to 4
Rotorua	Rotorua	1 to 3
Waikato	Hamilton, Hauraki, Waikato, Matamata-Piako, Ōtorohanga, South Waikato, Waipā, Waitomo	2 to 4
Taupō	Taupō, Ruapehu, Northern Rangitīkei	-1 to 1
Taranaki	New Plymouth, Stratford, South Taranaki, Wanganui	3 to 5
Manawatu	Southern Rangitīkei, Manawatu, Horowhenua, Kāpiti Coast	3 to 5
Wairarapa	Upper Hutt, Masterton, Carterton, South Wairarapa, Tararua	0 to 2
Wellington	Porirua, Lower Hutt, Wellington	6 to 7
Marlborough	Tasman, Nelson, Marlborough, Kaikōura	2 to 3
Canterbury	Christchurch, Hurunui, Waimakariri, Selwyn, Ashburton, Timaru, Waimate	-1 to 1
West Coast	Buller, Grey, Westland	2 to 3
Central Otago	Mackenzie, Western Waitaki, Central Otago	-5 to -4
Queenstown	Queenstown-Lakes	-4 to -2
Otago	Dunedin, Eastern Waitaki, Clutha	1 to 2
Southland	Southland, Gore, Invercargill	0 to 2

Figure 15: Climate zones for heat pump water heaters



4.4.3 Step 3: Select a system to meet requirements

Select a system that is suitable for the home that it is being installed in (for example, an all-in-one or a split system) and that can meet the household's hot water demand.

Consider also the plumbing layout of the home, including pipe runs required to the storage cylinder and fixtures and fittings.

Preferred location

It is important to determine the owner's preference for the location of the storage cylinder. For example, an indoor cylinder may be suitable where there was previously a hot water cupboard already located in the house, whereas an all-in-one unit installed outside may save space.

Note that the hot water cupboard may constrain the size of cylinder able to be installed. The recovery rate of the HPWH also needs to be considered in relation to the size of cylinder that can be installed.

Recovery time

Recovery time is a fundamental consideration to help ensure that households have sufficient quantities of hot water.

Recovery times for a HPWH system can vary. However, in general, HPWHs take longer to recover than a traditional electric or gas water heater. This is due to their slightly lower reheating capacity – the reheat capacity of an electric storage water heater is typically 2–3kW, while HPWHs are often lower than this at 1.5–2kW. As a result, a HPWH may require a slightly larger cylinder than an electric storage water heater.

Recovery time can be up to several hours after the cylinder is depleted. A system with a faster recovery rate will be beneficial for households with high hot water demand, such as families with young children or those who take multiple showers. Alternatively, a larger capacity cylinder could be installed.

It can be useful to consider how long a system will take to heat a specified quantity of water.

Other factors to consider

Consider any special requirements of the environment in the area where the HPWH is being installed. Geothermal regions may require the outdoor unit and pipework to be protected against atmospheric sulphurous gases that can cause corrosion. Similarly, coastal regions may require the outdoor unit and pipework to be protected from sea-spray. A suitable proprietary coil protectant should be used in these areas.

Ideally, a HPWH should be selected that uses a refrigerant with the lowest global-warming potential (GWP) practicable – ideally, of less than 675. See section 8.1 for more about refrigerants and their GWP.

Where capacity data is not available for the precise external design temperature relevant to the installation site, use the capacity information for the nearest outdoor temperature available that is below the external design temperature.

4.5 Other considerations

4.5.1 Booster elements

There may be some instances where the HPWH struggles to heat the water in the cylinder to the desired temperature or within the desired time. This could be due to a number of factors, including:

- exceptionally cold conditions, or periods when the HPWH is defrosting for extended periods
- unusually high demand for hot water, for example after a holiday, or when additional people are visiting.

In some situations, a booster or backup element can be used to help address these issues. However, as an electric element only has a COP of 1, this is less than ideal from an energy efficiency perspective and will lower the overall efficiency of the system. The impact of a booster element on annual energy efficiency and energy savings will depend on how often it needs to be used.

4.5.2 Demand flexibility and demand response

It is important to future-proof when selecting a suitable HPWH. One key consideration is the ability for a HPWH to participate in a demand flexible system. New Zealand's electricity system is changing, and with the uptake of intermittent renewable energy (solar and wind) the need for demand flexible end-use products is becoming more important for maintaining energy security and reducing energy costs.[17]

Hot water systems that use a storage cylinder represent a good opportunity for improving demand flexibility, as they do not need to be consuming power at the same time that hot water is being drawn.

Traditionally, electric storage water heaters have been controlled in response to peak demand using ripple control. Ripple control is a signal passed down the electricity line to a relay, which turns the electric storage water heater on or off. In the past, this been used by electricity distribution businesses to manage peak demand (where demand for power is greater than the generation of power, or there are line constraints). In return, the distribution businesses allow the hot water system to run on a lower electricity tariff – known as demand response.

Demand flexibility is more sophisticated than this, as it involves two-way communication between the HPWH (as an end-device) and the system.[18] Demand flexibility helps deliver the benefits of a smart integrated system, where both homeowners and the power system can benefit from controlling when and how power is used. This includes:

- reducing a proportion of the product's peak load by shifting some demand
- running products when there is more renewable generation available – that is, energy generated by solar and wind
- enabling home energy optimisation.

Using products in this way can help reduce running costs, by using them during off-peak periods or on renewable energy, both of which are typically cheaper.

[17] See: Demand flexibility — a smarter grid | EECA

[18] The system could be the wider electricity system, or a local in-home system (e.g. a home energy management system). See: Guidance for smart homes | EECA

The market and products are still developing, but a good, demand-flexible HPWH will:

- use standardised communication protocols (for example, OpenADR or IEEE 2030.5)
- offer a range of product responses (for example turn up, turn down, turn off, turn on, enter mode x)
- send back detailed operation information to ensure the control of the product does not impact on its end use and result in a negative experience for the homeowner.

The sizing of the HPWH may change under a demand flexible approach, as the system may not be able to heat any hot water at certain times of the day, for example during periods of peak demand. This needs to be factored into the sizing of the system, as poor implementation of demand flexibility may potentially result in insufficient hot water being available at certain times of the day, when the householder needs it. The homeowner should also have an override option that will initiate the immediate heating of water.

Demand flexibility may be factored in when homeowners are considering the whole-of-life cost (purchase and running) of their HPWH. Some systems may not be connected or controlled by a demand flexible controller or a home energy management system when they are installed, but could have this capability and be demand-flex ready for a future use, connection or upgrade.

It is important to note that installers should not connect a HPWH to a ripple-controlled circuit unless this is specifically accommodated in the manufacturer's instructions (regarding the potential de-powering of the HPWH).

4.5.3 Water quality requirements

Consider the following aspects of water quality before installing a HPWH system.

- Hard water (with high levels of calcium or magnesium) may lead to scale buildup on HPWH components, reducing their efficiency and lifespan.
- Water with very low (acidic) or very high (alkaline) pH levels, which may lead to or accelerate corrosion issues or scaling.
- Chlorine and chloride levels that can degrade seals and plastic components or corrode cylinders.
- Sediment and particulates that can clog up components, leading to reduced performance.

Manufacturers will generally specify water quality requirements for their systems. Installers should check that the local water quality meets these requirements. Failure to do so may impact on the performance of the system and potentially void the manufacturer's warranty.

4.5.4 Legionella prevention

The thermostat setpoint of the cylinder must be at a sufficient temperature to satisfy the requirements outlined in the Building Code G12.3.9/AS1 to prevent the growth of Legionella bacteria. Typically, this is at least 60°C.

Installers should check both the Building Code requirements and the manufacturer's recommendations.

4.5.5 Maximum temperatures

The temperature of the hot water delivered at any tap or sanitary fixture used for personal hygiene shall not exceed the maximum temperature limits set in Building Code clause G12.3.6. This reduces the risk of scalding, and is typically in the range of 45–50°C, depending on the circumstances.

A suitable thermostatic mixing valve (TMV) or tempering valve (TV) must be correctly installed in the delivery pipework to ensure that sufficient cold water is mixed with the hot water feed.

Section 5: Toolkit, safety equipment and materials

Before you start work, it is important to have the correct tools, safety equipment and materials available; as itemised in the following checklist.

Safety equipment

- ❑ Ear protection
- ❑ Gloves
- ❑ Hard hats
- ❑ Safety glasses
- ❑ Safety boots
- ❑ Other personal protective equipment (PPE)

Equipment

- ❑ Auto-ignition gas torch
- ❑ Brazing equipment
- ❑ Charge hose and connector
- ❑ Charge valve
- ❑ Compression or locked-ring jointing tool
- ❑ De-burring tool
- ❑ Digital thermometer
- ❑ Digital vacuum gauge
- ❑ Electronic leak tester
- ❑ Electronic scales
- ❑ Flaring tools
- ❑ Hose adaptors
- ❑ Leak-testing equipment
- ❑ Manifold set
- ❑ Manometer
- ❑ Oxygen-free nitrogen gas cylinder, with a pressure gauge, manifold valve and flexible clear hose
- ❑ Pipe benders
- ❑ Pipe cutters
- ❑ Recovery cylinder
- ❑ Refrigerant-specific valve core removal tool
- ❑ Set of standard hand tools
- ❑ Stud finder
- ❑ Swaging set
- ❑ Tape measure
- ❑ Torque wrenches
- ❑ Vacuum pump with backflow prevention device
- ❑ Wrenches

Materials

- ❑ Condensate drainage pipe; either smooth, hard PVC pipe (best practice option) or flexible ribbed pipe
- ❑ Copper pipe (hard/soft drawn, twin-insulated, dehydrated)
- ❑ Electrical cable
- ❑ Electrical conduit
- ❑ Galvanised mild steel straps 120 x 25 x 0.5mm
- ❑ Galvanised nails (30mm)
- ❑ Galvanised pipe brackets (65mm diameter)
- ❑ Gas cylinder with a refrigerant that is compatible with the HPWH
- ❑ Oil for flared joints (refrigerant compatible)
- ❑ Pipe insulation
- ❑ Pipe protection
- ❑ Vinyl tape

Section 6: Refrigerant pipework

This section addresses the pipework for refrigerant required for HPWH installations that incorporate a refrigerant loop.

Details of water pipework are provided in the relevant parts of Section 7.

Good pipework gives a safe, efficient and reliable installation, which is necessary for the HPWH system to perform properly. Too many joints, bends and long pipe-runs can increase the risk of leaks and reduce efficiency, as it will require more energy for the compressor to pump the refrigerant around the system.

Many system failures occur due to poor workmanship in the pipework installation. To reduce the likelihood of problems:

- ensure pipes are clean and moisture free
- use pipe sizes recommended by the manufacturer
- design pipelines for the shortest runs and minimum number of bends possible, to limit internal friction
- insulate and protect all pipework with a rated UV capping
- slope pipes towards the compressor to allow any oil that gets into the pipes to drain back to the compressor sump (some compressor oil will likely get into the pipeline in any system, but if it remains there, it will de-rate the system's pressure and hence its efficiency)
- install pipelines to allow for seismic, wind and thermal movement
- ensure pipes are rated for the refrigerant pressure being used in the system.

6.1 Refrigerant pipework installation

Good-quality pipework involves the following tasks.

1. Selecting suitable pipework and jointing (see sections 6.1.1 and 6.1.2).
2. Ensuring pipework is clean (see section 6.1.3).
3. Making bends properly (see section 6.1.4).
4. Creating flared joints correctly (see section 6.1.5).
5. Ensuring pipework is well-supported (see section 6.1.6).
6. Insulating refrigerant pipework (see section 6.1.7).
7. Positioning and connecting the condensate drainage pipe properly (see section 6.1.8).

6.1.1 Types of refrigerant pipework

Copper pipework forms the closed-coil system through which refrigerant flows. Copper may be hard-drawn or soft-drawn.[19]

Hard-drawn pipework is generally recommended as best practice for pipe diameters of 20mm and more,

[19] Hard-drawn, in this instance, refers to copper tubing that has been through a process of being repeatedly pulled through a die, without being heat-treated afterwards. This is sometimes called work hardening, as it makes the copper stronger and stiffer, and is ideal for applications where rigidity is needed.
Soft-drawn refers to a process where the pipe has been formed and heat-heated. Soft-drawn pipework is less rigid than hard-drawn.

but soft-drawn is commonly used because it is easier to work with.

Use UV-rated twin-insulated and dehydrated pipe, which is easier to install in trunking and in ceiling spaces (see Figure 16).

Figure 16: Twin-insulated and dehydrated pipe

6.1.2 Types of jointing

Generally, pipes can be jointed by either brazing or compression (lock-ring) jointing.

Brazed connections

Brazed joints provide the best resistance to pressure, temperature and stress vibrations, and using this type of jointing is recommended as good practice. Pipe joints behind the cylinder and in wall spaces must be brazed, as brazed pipe connections reduce the likelihood of leaks and take up less space. Carry out all brazing with oxygen-free nitrogen circulating through the pipework – this will avoid a build-up of carbon in the pipe, which can cause oil sludging, filter blockage and eventual system failure.

Compression connections

Compression connections are an alternative to brazed connections and are far more reliable than flare joint connections. Compression connections, as shown below, have become more popular in recent years for the following reasons:

- 100% leak free, unlike flare connections (provided the correct assembly procedure is followed)
- clean, efficient and reliable
- no need for heavy brazing gear and associated flame, especially where there is a special fire hazard
- able to be installed indoors while building occupants are around
- suitable for hydrocarbon (HC), hydrofluorocarbon (HFC), Hydrofluoroolefin (HFO), and CO_2 refrigerants
- UL, TUV, and EN/ISO approved
- maximum 75-bar operating pressure, so suitable for high-pressure refrigerants
- no requirement for nitrogen for brazing or purging
- ability to connect differing pipe materials together
- available from 6mm (1/4”) to 42mm (1 5/8”).

Figure 17 to Figure 25 show the procedure for assembling a compression connection.

Figure 17: Step 1 – cleaning the tube end

Figure 18: Step 2 – roughing the end surface

Figure 19: Step 3 – fitting insert when required to support pipe

Figure 20: Step 4 – adding ring

Figure 21: Step 5 – fitting connector marking stop-line

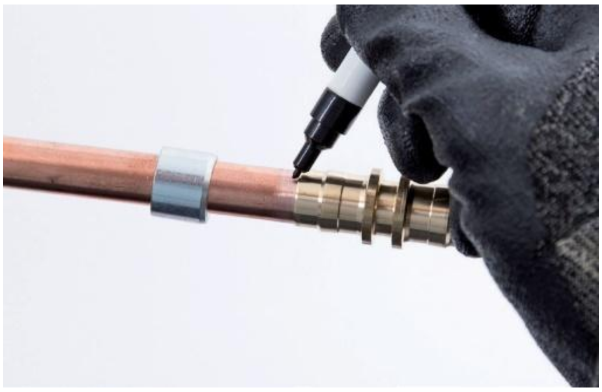
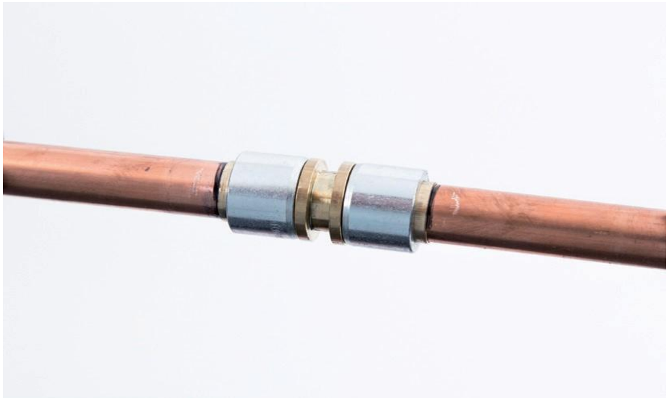


Figure 22: Step 6 – applying sealant solution

Figure 23: Step 7 – fitting connector

Figure 24: Step 8 – compressing one connection end

Figure 25: Step 9 – completing compression connection



Flared joints

Flared joints may be required where connecting the pipework to the outdoor unit.

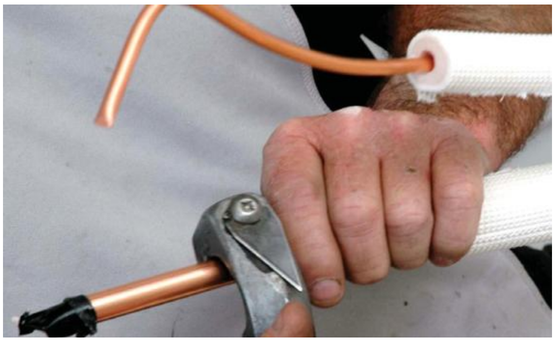
If poorly installed, flared joints have a high risk of the refrigerant leaking. They can also be easily modified by unqualified persons. However, flared joints may be suitable if installed correctly and in accordance with the manufacturer's installation instructions.

See section 6.1.5 for further information on creating flared joints.

6.1.3 Maintaining cleanliness of pipework

Ensure that all pipework is clean and suitable for the system using the following the process.

Figure 26: Pipe opening facing down when cutting



- Holding the pipe opening facing down when cutting.
- Removing metal filings from inside pipework after cutting.

Figure 27: Cover pipe ends

- Always keeping pipe ends covered with caps, by brazing or taping.
- Covering pipe ends prevents moisture, dirt or foreign matter getting into the pipes, particularly when pushing or pulling through wall cavities

Note: DO NOT let any uncapped pipe ends touch the ground.

6.1.4 Making bends

Bend all copper pipes over 9.5mm (or 3/8") diameter with the correct-sized pipe bender (see Figure 28). Handmade bends may kink or have a reduced internal pipe dimension, which reduces refrigerant flow and performance.

Figure 28: Pipe bender

When pre-insulated pipe is used:

- split the insulation and cut away from around the pipe
- bend the pipe using the correct-sized bender
- replace the insulation and tape together using vinyl tape or insert a copper bend using brazed connections, then insulate.

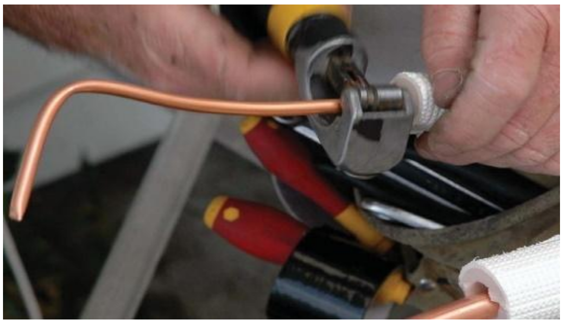
6.1.5 Creating flared joints

Flared joints must be formed by an experienced installer, as the joints have a high risk of the refrigerant leaking.

Flaring of joints is not a simple task and requires the correct tool for the refrigerant gas being used and the pipe wall thickness. This is particularly true for units using R410A, R32 or other high-pressure refrigerants.

Follow the correct steps to create a sound flared joint, as set out and illustrated in Figure 29 to Figure 40.

Figure 29: Cut pipe with tube cutters



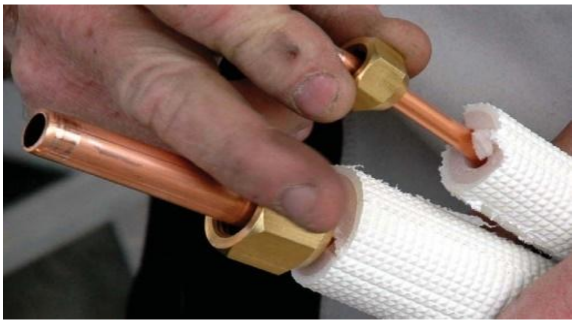
Cut pipe with tube cutters to give a cut that is straight across and clean – use a sharp blade and cut slightly longer than measured length.

Figure 30: Remove all burrs

- Remove all burrs with a de-burr tool.
- Remove any metal filings that may have fallen into the pipe.

DO NOT use a saw blade to cut the pipe.

Figure 31: Place the flare nut over the pipe end



- Remember to remove the flare nut from the unit and put it over the pipe end (Figure 31) – it is not possible to put it on after flaring the pipe.
- Insufficient tube protrusion could lead to a joint that will come apart with vibration and is more likely to leak.

Figure 32: Flare the end of the tube (A)

- Flare the end of the tube using the correctly-sized flare tool and ensure that the correct amount of pipe protrudes (Figure 32 – Figure 36).
- Excess tube protrusion could stop the flare connection sealing properly when the nut is tightened.

Figure 33: Flare the end of the tube (B)

Figure 34: Flare the end of the tube (C)

Figure 35: Flare the end of the tube (D)

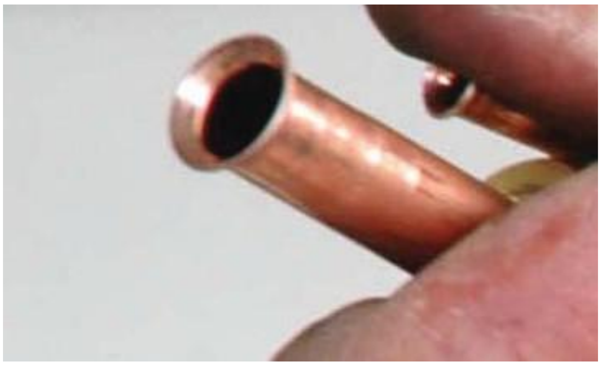


Figure 36: Apply oil to the back of the flared pipe and the flare joint

- Apply oil to the back of the flared pipe and the flare joint. Use oil compatible with the refrigerant before connecting pipes, i.e. use polyolester oil (POE) with R-410A or R32 refrigerant. Oil reduces the possibility of tearing the flare when the nut is tightened.
- Oil must not be allowed to contaminate the refrigerant.

Figure 37: Connect the pipes (A)

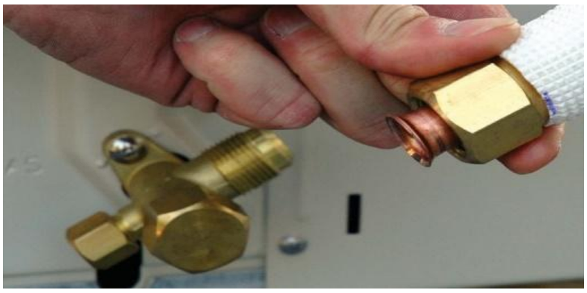
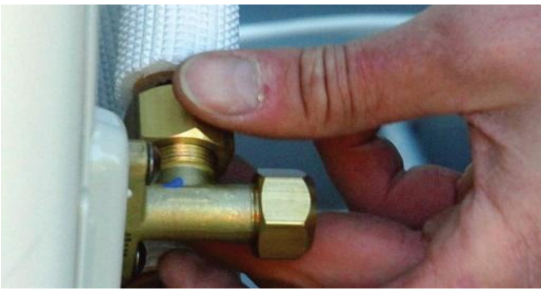


Figure 38: Connect the pipes (B)



Hand-fasten the flare nut to connect the pipes (Figure 37 and Figure 38).

Figure 39: Tighten connection (A)

Figure 40: Tighten connection (B)

Tighten the connection using two spanners to the torque recommended by the manufacturer (Figure 39 and Figure 40). Use a torque spanner to achieve the correct torque. Torque against the second spanner to secure the load while tightening - never tighten the connection just against the joint.

- **DO NOT** mix polyolester oil and mineral-based oil.
- **DO NOT** use leak lock or polytetrafluoroethylene (PTFE) tape – these are not plumbing joints.
- **DO NOT** cross-thread the fittings, as you may damage them.

6.1.6 Ensuring pipework is well supported

Well-supported pipes help ensure the durability and performance of the system by:

- reducing the possibility of cracking or oil traps due to sagging
- eliminating vibration
- eliminating a liquid-hammer effect or damage from fluid movement
- resulting in better fluid-handling characteristics.

As good practice, fix copper tubing at the spacings given in Table 9.

Table 9: Fixing spacings for copper tubing

Tubing diameter (mm)	Maximum fixing spacing (m)
15–22	2.0
22–54	3.0
54–67	4.0

Source: *Australia and New Zealand Refrigerant Handling Code of Practice 2025: Part 2*, clause 4.6.11.

6.1.7 Insulating refrigerant pipework

Insulate all refrigerant pipework to improve the efficiency of the HPWH system.

Ideally use insulation with an R-value as detailed in MBIE's *H1 Energy Efficiency – Verification Method H1/VM3: Energy Efficiency of HVAC Systems in Commercial Buildings*.

Table 7.2.1.2A of the verification method provides minimum R-values for piping in heating, ventilation and air conditioning systems for commercial buildings which can be used as a recommendation basis.

Use a proprietary insulated pair coil, which is UV-stable and heat resistant up to 100ºC.

6.1.8 Positioning and connecting the condensate drainage pipe

Condensate drains must not discharge onto a concrete path or other location where wetness and mould would be undesirable.

Condensate should be discharged:

- into a suitable drain connection, or
- into a stormwater drain (where permitted by local council regulations), or
- onto a grassed or planted area, ideally away from the building.

A condensate drain can be seen in Figure 41.

Figure 41: Condensate drain

6.2 Pipework pre-installation in new buildings

In a new building, install pipework before wall linings and claddings are put on.

Procedure

- Unroll and lay out pipe and connection cable to connect the cylinder and outdoor unit.
- Tape pipe and connection cable together with vinyl tape at 1–1.5m spacings.
- Establish the location and centre of the cylinder.
- Establish the location of the outdoor unit.

Run taped pipe and cable across the top of the bottom truss chord or ceiling joist between the unit locations (see

Figure 42: Run pipe and cable across truss chord or ceiling joist

- Fix with galvanised mild steel pipe brackets.

Notch the plate or studs

- Notch the top plate and studs to a maximum depth of 25mm (for 90 x 45mm timber) or 19mm (for 70 x 45mm timber) to insert the pipe and cable (see Figure 43 and Figure 44).

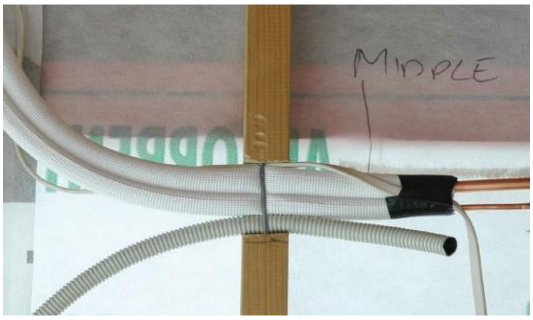
Figure 43: Notch top plate and studs (A)

Figure 44: Notch top plate and studs (B)

- *Insert pipe and cable into notch, and fix galvanised mild steel strap over them to hold them securely in position (see Figure 45).*Figure 45Notching and drilling must not exceed the limits given in *NZS 3604: 2011 Timber framed buildings*. Do not cut more timber than is strictly necessary.

Figure 45: Fix galvanised mild steel strap to hold pipe and cable

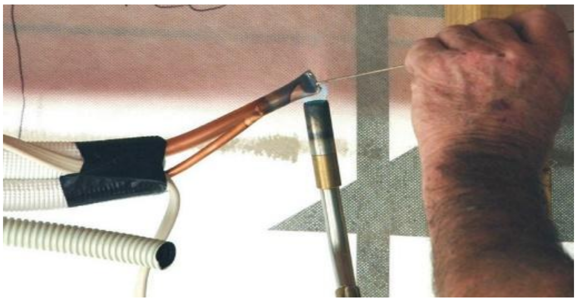
Figure 46: Wedge pipe and cable ends into the stud



Protect pipe against damage caused by other trades

- Wedge the pipe cable end into the stud in readiness for connection to the cylinder (see Figure 46). Use a lightly-fixed and wedged nail that can easily be removed to hold the pipe and cable flat during the interior lining fixing.
- Braze pipe ends closed to keep moisture and debris out (see Figure 47).
- Once brazed, pressurise the pipework with dry nitrogen. If the pipes get damaged and the gas escapes, alert other tradespeople to the fact that they have damaged the pipe. If you return and find the gas is gone, then you know pipes have been damaged.

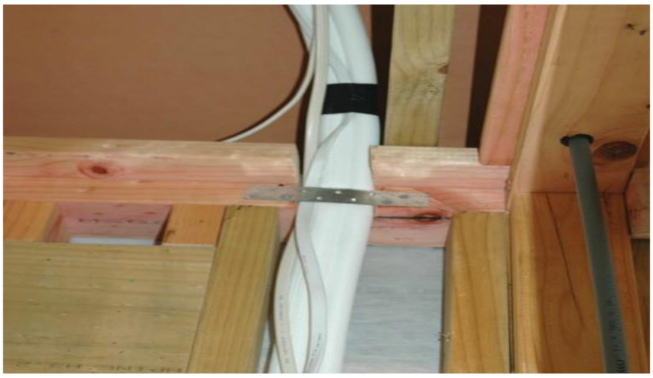
Figure 47: Braze pipe ends closed



Outdoor unit location

- Notch the top plate and studs sufficiently to insert the pipe and cable. Notching and drilling must not exceed the limits given in *NZS 3604: 2011 Timber framed buildings*. Do not cut more timber than is strictly necessary.
- Insert the pipe, connection cable and power cable (run from the meter board) into the notches, and fix a galvanised mild steel strap over them to hold them securely in position (see Figure 48).

Figure 48: Fix galvanised mild steel strap to hold pipe and connection cable



Feed pipe and cable for connection to the outdoor unit through a hole cut in the building wrap (see

Figure 49: Feed pipe and cable through building wrap

Seal pipes or sleeve with flexible flashing tape to weatherproof around pipework and cables (see Figure 50).

Figure 50: Seal pipes or sleeve

- Braze pipe ends closed to keep moisture and debris out.
- Leave pipe and cable neatly coiled and taped. Note that the taping off has not been completed in Figure 50.

Section 7: Heat pump water heater installation

7.1 General requirements for all heat pump water heaters

This section is structured to first show general information that is relevant to all types of HPWH installations (see section 7.1).

This is then followed by sections for all-in-one systems (section 7.2), split water-loop systems (section 7.4) and split refrigerant-loop systems (section 7.5).

For both types of split systems, section 7.3 provides information on installing the outdoor unit. Section 7.4 and section 7.5 then provide specific information on installing split water-loop systems and split refrigerant-loop systems, respectively.

For systems that use both a water loop and a refrigerant loop, installers should refer to the relevant parts of sections 7.4 and 7.5 for the respective system connections.

General rules for installing heat pump water heaters

Some general rules for installing HPWH are:

- when transporting a HPWH to site for installation, do not lie it down for transportation – for systems that are too tall to fit into a van or a ute with a canopy, either use a trailer or an open-tray ute for transportation to ensure that the HPWH unit remains upright
- follow the manufacturer's instructions supplied with the system
- use tools and equipment appropriate for the task and in a well-maintained condition (see section 5)
- ensure components are compatible
- avoid drilling into the heat pump unit of any type of system to avoid puncturing refrigerant or water pipes
- keep the entire system clean and dry.

7.1.1 Building consent requirements for heat pump water heaters

Schedule 1 of the Building Act 2004 provides a list of exemptions to the general requirement that a building consent must be obtained when installing water heaters.

In all cases, even where a building consent is not required, it is mandatory that an authorised person[20] completes the work and that the installation complies with the Building Code.

In general, where an existing water heater of any type is replaced or repositioned, a building consent is not required provided all of the heat sources are controlled. A controlled heat source is one that ensures the water storage cylinder cannot be heated to greater than 90°C.

Typical installations of HPWHs that would be exempt under this provision are:

- replacing a water storage heater with a HPWH
- replacing and repositioning an internal water storage heater with an external HPWH
- replacing an external water storage heater with an external HPWH
- replacing an external gas instantaneous heater with an external HPWH.

[20] An 'authorised person' is typically a person authorised under the Plumbers, Gasfitters, and Drainlayers Act 2006 to perform specific plumbing, gasfitting or drainlaying work. This authorisation excludes individuals authorised under specific sections (sections 15, 16, 19, or 25) of the act.

Note: Connecting a single-pass water heater to an existing storage cylinder may require a building consent, since the existing water heater is neither being replaced nor repositioned. Check with the local council first, as it may be able to issue a discretionary exemption for this work.

7.1.2 Pre-installation checklist

Before installing the HPWH system, check the following.

System components

❑ Check that the system is what was specified and that model numbers match.

❑ Remove the system from the packaging and check that all components are supplied.

❑ Check for any damaged components.

❑ Ensure that installation and owner's manuals are supplied.

Trade coordination

❑ Confirm on-site trade co-ordination between the installer, builder (for new construction) and electrician (only a registered electrician can hardwire the system).

Health and safety

❑ Ensure appropriate health and safety procedures are in place and implemented to comply with the Health and Safety at Work Act 2015 and any other applicable legislation or standards (e.g., electrical safety requirements, flammable refrigerant handling requirements).

❑ Appropriately plan the installation including considering the health and safety risks relevant to the installation works, and what steps are required to control those risks before work commences.

Install location

❑ Check and measure indoor and outdoor locations for available space, access and required clearances for installation and servicing (see sections 7.2.1 or 7.3.1 as relevant for the particular system type). Consider if there is a suitable pathway to get the outdoor unit in position, as this may be heavy and require either a sack-barrow or two-person lift.

❑ Identify the location of a suitable power source (see section 9 for electrical requirements).

7.1.3 Installations into new homes under construction

For the installation of any type of HPWH into a new home, the installation is typically carried out in two key stages: the first fit (or pre-pipe or pre-wire stage) and final fit-out (or commissioning stage).

These activities will usually be coordinated between the heat pump installation team including a plumber, electrician and a refrigeration technician where relevant.

First fit stage

This stage happens before the internal linings (e.g., plasterboard) are installed, and often during the main plumbing and electrical rough-in.

Plumbing tasks:

- decide and prepare the location for the HPWH
- run copper pipework (hot and cold water) to and from the planned cylinder or all-in-one system location
- install cold water supply to the cylinder location, including pressure-limiting and non-return valves as needed

- complete pipework for the tempering valve, if required (to ensure delivery of safe hot water to taps)
- plumb the condensate drainage (for units that produce condensate)
- plumb the temperature and pressure relief (TPR) valve (also known as a pressure and temperature relief or PTR valve), including a drain to a compliant termination point.

Electrical tasks:
- recommend running a dedicated electrical cable to the outdoor unit (typically from a switchboard, with RCD or MCB protection)
- install conduit and junction boxes, as needed, near to the cylinder and compressor locations
- prepare for any controls, sensors or Wi-Fi units (if a smart system is being used).

Final fit-out stage
This happens once the interior is completed, and the house is ready for final services (after painting, flooring, etc).

Plumbing tasks:
- install hot water cylinder or all-in-one system
- connect hot and cold pipework to the cylinder
- install tempering valve and final fittings
- connect condensate drain
- flush and pressure test pipework
- ensure TPR valve is operational and terminated correctly.

Electrical tasks:
- connect HPWH unit(s) to power (both cylinder and outdoor unit, if separate)
- wire and test sensors or control interfaces (thermostats, timers, etc)
- test earthing and residual-current devices (RCDs).

Heat pump installer tasks:
- install outdoor compressor unit (for split systems)
- connect refrigerant lines (for split refrigerant-loop systems) and pressure test
- evacuate and charge refrigerant loop (if not pre-charged)
- commission the system, including:
    - setting the hot water temperature
    - running diagnostics
    - checking noise levels and insulation
    - educating homeowner on operation and maintenance.

7.1.4 Decommissioning existing hot water systems

If you are replacing an existing hot water system, you will need to:

- disconnect and temporarily cap any water pipes, gas pipes and electrical supplies
- drain the cylinder, if there is one
- remove the existing system, including the hot water cylinder and any pipework, as necessary
- make good and permanently seal any water and gas pipes as necessary.

The latter (gas pipe sealing) will need to be undertaken by a certified or qualified gasfitter. Likewise, any electrical cables and connections will need to be made suitably safe by a registered electrician with a current practicing licence.

When removing an existing hot water cylinder prior to installing a new HPWH, the old cylinder should be taken to a reputable scrap metal recycler so that the materials can be re-used.

7.1.5 Electrical requirements

Details of the electrical requirements are provided in section 9.

It is important to refer to the manufacturer's wiring diagrams for the system, which are supplied with the system.

7.2 All-in-one systems

All-in-one systems have the heat pump and the cylinder physically connected to each other as part of one unit (for example, with the heat pump unit sitting on top of the cylinder within one casing).

These systems will be relatively straightforward to install, and will require only electrical connection and connection to the home's plumbing.

7.2.1 Locating the unit

In general, the all-in-one HPWH unit should be installed outside.

However, in some cases, it may be appropriate to install an all-in-one unit in a garage, carport etc, provided that sufficient airflow is available around the unit. Note that a HPWH installed in a garage or other enclosed space will lower the temperature in that space.

Key considerations when choosing a location for the unit include:

- there must be sufficient access space for installation and subsequent maintenance
- the unit should be as close as possible to the internal hot water outlets
- the location must comply with the requirements of AS/NZS 5601, as it pertains to heat pumps containing a flammable refrigerant
- ideally, the unit should not be installed within 2m of a bedroom or 3m of a neighbour's window
- the inlet and outlet fans must be clear of any obstacles that may block them
- the manufacturer's specified clearances from walls must be capable of being adhered to
- the control interface should be accessible to users and there must be clear access to the electrical panel at the back of the system
- the TPR valve, and cold-water expansion valve (which is a safety device for controlling cold water pressure entering a cylinder), and any access covers, must all have sufficient clearances and remain accessible for service and removal.

Avoid installing the unit in areas where falling debris, such as leaves, may be excessive.

Also try and find a location with a suitable access or pathway leading to it, as the unit may be heavy.

The unit should not be dropped, and if using a sack-barrow, it should ideally not be tipped more than the manufacturer's recommendations.

7.2.2 Base requirements

The unit must be installed in an upright position on a level, stable and water-impervious base that allows air to flow in and out freely.

The base must be capable of withstanding the weight of a full system, and allow the condensate water and TPR valves to be drained into an area that will not cause damage to the surrounding area.

7.2.3 Plumbing requirements

In many parts of New Zealand, when the outside air drops below 0ºC, water in external pipes may be at risk of freezing and expanding, which can cause pipes to burst. This includes pipes for hot water supply, hot water return, and any hydronic loops.

All water pipework and water fittings should be insulated with UV-stable insulation of a suitable R-value for the climate where the system is installed in order to optimise its performance and energy efficiency.

The installer is responsible for adequately sizing the distribution pipework in a home to ensure that all outlet fittings perform sufficiently. Pipe sizing and valve selection must allow for the home's water supply pressure.

All water connections should be made good, tested and be sufficient to last the expected life of the home.

Note that for any soldered joints, installers should refer to the latest provisions relating to lead in plumbing products within Acceptable Solution G12/AS1, which will be effective from 1 May 2026. Following this date, any products that contain a copper alloy and that will be in contact with potable water intended for human consumption must be lead free.

7.2.4 Inlet water pressure and temperature

Different manufacturers recommend different minimum pressures and temperatures for their systems. Minimum water pressure is typically between 50kPa and 200kPa, and maximum water pressure is typically 500kPa.

Installers should refer to the manufacturer’s specifications and confirm that the inlet water pressure and temperatures comply with these.

7.2.5 Outlet water pressure and temperature

The storage temperature needs to be high enough for the water to be safe from Legionella bacteria.

However, the outlet temperature should not be so hot as to cause scalding. See section 4.5.4 of the New Zealand Building Code G12.3.6 for more details.

A TPR valve must be installed to ensure safe operation of the system. Failure to do so can potentially cause injury and damage the unit.

The TPR valve should be connected to a vertical discharge pipe that enables water to always flow downwards. The TPR discharge pipe outlet should be positioned such that the hot water leaving the pipe cannot cause injury to people or damage to the building. The valve should be insulated to reduce heat loss.

The TPR valve and vertical discharge pipe can be seen in Figure 51..

Figure 51: Temperature and pressure relief valve and discharge pipe

7.2.6 Installing the unit

The unit must be securely fixed, otherwise noise and vibration may result.

Install the unit in such a way that the manufacturer's specified minimum clearance to walls and other structures are adhered to. Follow the installation instructions as provided by the product supplier.

It is mandatory to install a pressure reducing valve in accordance with AS/NZS 3500. This must be rated 500 kPa on the cold inlet to the cylinder.

It is mandatory to install a tempering valve in accordance with AS/NZS 3500. The typical set point is 45-50 °C depending on the application.

The TPR valve and drain-line should be insulated and installed as described in the manufacturer's instructions. The valve must also be installed so that the drain-line is facing downwards at all times, with the discharge point remaining open to the air.

Once all the pipework is complete and all connections are tight, begin filling the unit with cold water. Open the cold-water inlet isolating valve or the TPR valve to begin the process. As the water begins to fill up inside the cylinder, the buildup of pressure can be released by slowly opening the safety relief valve. Repeat this process until the cylinder is full and water begins to flow out of the safety relief valve.

Next, open the non-return valve on the cold-water inlet to begin filling the system with water. At the same time, ensure at least one hot water tap is open inside the house. While the system begins filling with water you will hear air being expelled from the open hot water tap. This is called "bleeding the system" and it ensures that no air pockets remain. Once water begins running out of the hot water tap, the system is completely bled, and you can then turn the tap off.

Always ensure that the cylinder is completely full before connecting and turning on the electricity supply.

7.2.7 Seismic restraint

An all-in-one unit requires adequate structural support against earthquake forces and must meet the requirements laid out in the New Zealand Building Code's acceptable solution G12/AS1 6.11.4 or section 203 of NZS 4603:1985.

Refer to the manufacturer's installation instructions or follow the requirements of the Building Code, namely:

- for cylinders between 200 litres and 360 litres, restrain the unit with three 25mm x 1mm galvanised steel straps, tensioned when fixed in place. For cylinders less than 200 litres, only two straps are required,
- straps are to be fixed to timber framing using an 8mm coach screw with either one 30 x 2mm thick washer, or two 20 x 2.5mm thick washers,
- coach screws must penetrate the timber framing by a minimum of 50mm.

It is also recommended to install either two (or more) scalloped back-restraints, or two 50mm x 50mm vertical blocks that extend the full height of the cylinder, and ensure they are suitably fixed to the timber framing.

When securing the unit to masonry or concrete walls, standard timber-framed restraint methods are not directly applicable. Instead, use masonry expansion anchors to attach the straps to the wall. It is critical to anchor the restraints into a structural masonry or concrete wall, not merely into brick veneer, as the latter lacks the necessary strength.

Figure 58 and 59 show a seismic restraint of a water cylinder to a masonry structure.

7.3 Split systems

This section applies to all split systems, regardless of the type of connection(s) to the hot water cylinder.

7.3.1 Locating and installing the outdoor unit

The heat pump unit used for spilt systems should be installed outside.

The distance between the cylinder and the outdoor heat pump unit should be minimised and insulated so as to improve system efficiency. Check the system's pipe run does not exceed the maximum length or the maximum differential height recommended by the manufacturer.

Usually, the outdoor unit can be retrofitted to any electric storage cylinder where the condenser is separate from the cylinder, provided there is sufficient polyurethane or expanded polystyrene foam insulation on all the pipework.

Install the outdoor unit so that:

- the manufacturer's specified clearances from walls are adhered to
- there is sufficient access for installation and subsequent maintenance – see Figure 52
- there is a suitable clearance to allow for good air flow – see Figure 52
- the inlet and outlet fan are clear of any obstacles that may block them
- it is not subject to excess falling debris, such as leaves
- it is not within 2m of a bedroom or 3m of a neighbour's window
- there is 1.5m clearance from any LPG bottles (gas cylinders that get swapped and refilled offsite) or 3.5m clearance from any in-situ LPG tanks (fixed gas cylinders that get refilled onsite by tanker)
- there is an unobstructed gap of about 100mm underneath the unit to allow for clearing away leaves and dirt – see Figure 53

- the control interface is accessible to users and there is clear access to the electrical panel at the back of the unit
- it sits level
- its weight is fully supported to prevent sagging and it cannot fall over
- it creates no vibration
- the location complies with the requirements of AS/NZS 5601 that concern heat pumps containing a flammable refrigerant
- the fixings used are corrosion-resistant – typically, stainless steel.

Figure 52: General clearance around outdoor unit

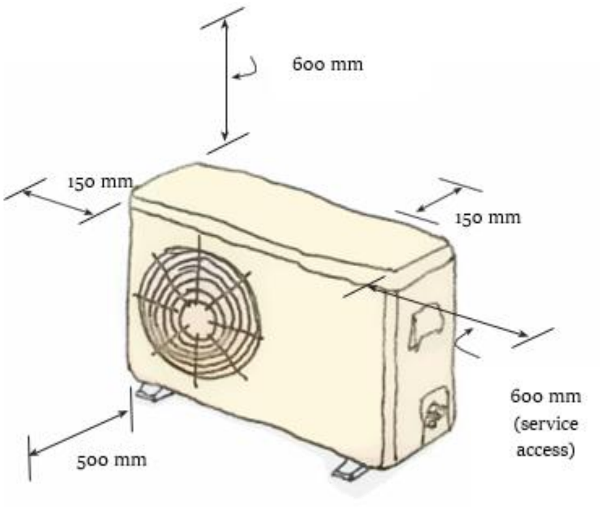


Figure 53: Unobstructed gap under outdoor unit fixed on concrete pad cast in place

7.3.2 Different means of fixing the outdoor unit

The outdoor unit can be fixed on:

- a concrete pad cast in place or a single piece of pre-cast slab at least 40mm thick (see Figure 54)
- a concrete patio or balcony
- a timber slatted deck with anti-vibration mounts (see Figure 56)

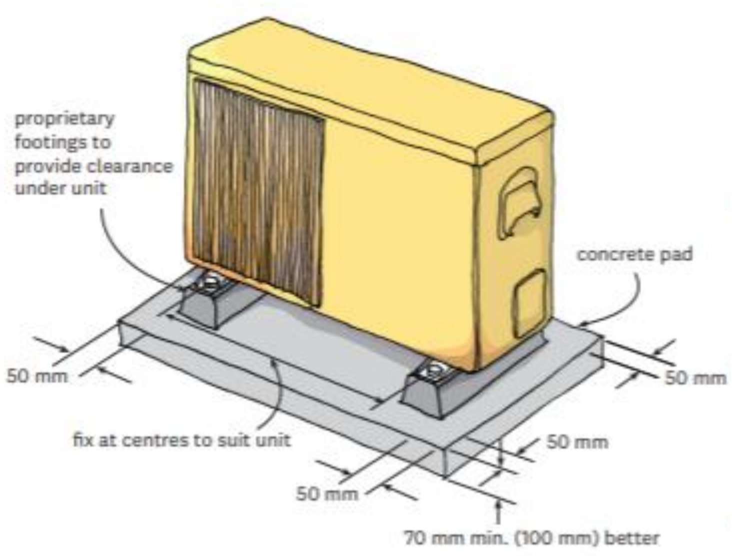
- brackets fixed to a foundation or wall (see Figure 57)
- the roof where the installation has been specifically designed (engineered) to accommodate live loads and wind forces acting on the roof, and the installation incorporates anti-vibration mounts
- a specified base in accordance with manufacturer's instructions.

Proprietary mounting systems for roofs and walls are available and should be installed in accordance with the supplier's instructions.

Note: Do not fix the unit directly onto a waterproof deck or a membrane roofing system as the fixings will penetrate and compromise the waterproofing.

Installing an outdoor unit on a concrete pad

Figure 54: Concrete pad construction



- Construct the pad as shown in Figure 54 (check construction if done by others) or place and level a single unit 950 x 450 x 50 mm thick pre-cast concrete slab.
- Fix proprietary mounting rails, where supplied, or hot-dip, galvanised mounting rails at centres to suit the unit.
- Securely fix the mounting rails to the concrete with Grade 316 stainless steel masonry anchors or screw bolts, using two fixings per rail.
- Check that rails are level before tightening – pack with plastic shims as necessary to level.
- Fix the unit to the rails and tighten fixing bolts/anchors.

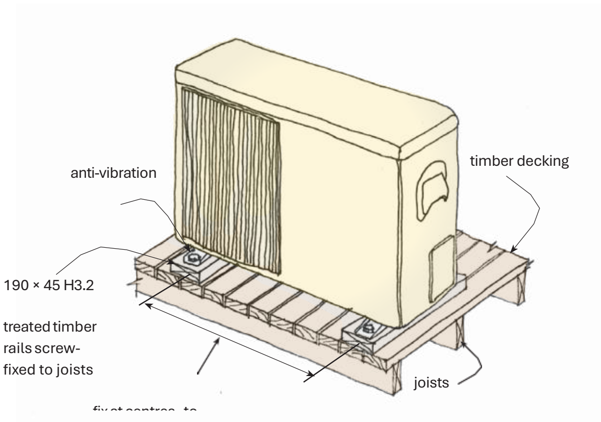
Installing an outdoor unit on a concrete balcony or patio

- Fix proprietary mounting rails (where supplied) or hot-dip galvanised mounting rails over anti-vibration mounts, at centres to suit the unit.
- Securely fix the mounting rails to the concrete with 316 grade stainless steel masonry anchors or screw bolts, with two fixings per rail.
- Check that rails are level before tightening – pack with plastic shims as necessary to level.
- Fix the unit to the rails and tighten fixing bolts.

Note: Do not fix units to waterproof concrete or timber-framed decks.

Installing an outdoor unit on a timber deck

Figure 55: Fixing unit to a timber deck



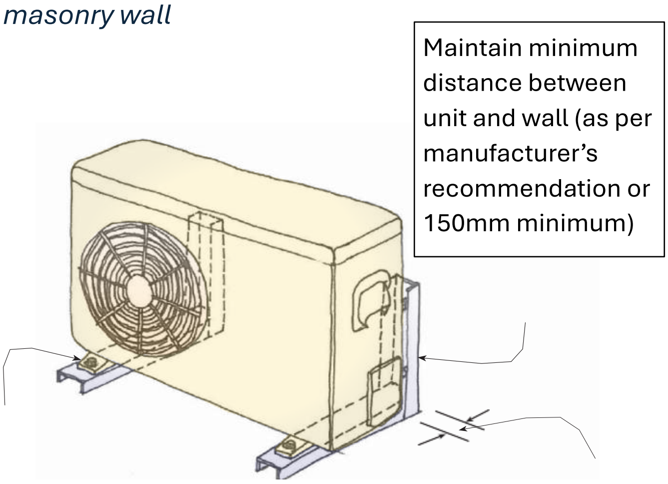
- Fix hot-dip galvanised mounting rails into the joists with 75 mm long stainless steel screws. Alternatively, fix the mounting rails to 190 x 45 H3.2 treated timber rails laid on flat that are screw- fixed to the decking joists with 115 mm long stainless steel screws.
- Provide anti-vibration mounts or pads.
- Fix hot-dip galvanised mounting rails through the rails and joists with 75 mm long stainless steel screws.

Figure 56: Pack with plastic shims to level

- Check that rails are level before tightening – pack with plastic shims as necessary to level.
- Fix the unit to the rails and tighten fixing bolts.

Installing an outdoor unit on a foundation or wall (concrete/concrete masonry only)

Figure 57: Wall-mounted unit on brackets – masonry wall



- Check the structural integrity of the wall
- Bolt-fix hot-dip, galvanised brackets or proprietary brackets to the wall or foundation using stainless steel masonry anchors or screw bolts (Figure 57).
- Check that the brackets are level before tightening.
- Waterproof around fixings according to the material.

- Fix the unit to the brackets.
- Anti-vibration pads may be used.
- Ensure the ground underneath is stable, compact and level
- Ensure clearance to ground is sufficient and as per manufacturer's instructions.
- maintain a minimum distance between the unit and wall e.g.150mm or as per manufacturer's recommendation.

Note: Outdoor units may be able to be wall-mounted to some lightweight claddings, but the connections and weatherproofing details must be specifically designed to maintain the integrity of the weatherproofing.

Installing an outdoor unit onto a roof

It is preferable not to install a heat pump outdoor unit onto a roof, due to noise vibration transfer, service accessibility, exposure to elements and moisture ingress.

However, if you do install an outdoor unit into a roof, note that roof installations must be specifically designed, and adhere to the following:

- Always check and follow the instructions of the roofing system manufacturer.
- Screw-fix hot-dip galvanised brackets or a proprietary mounting system into the roof framing. If mounting on a timber base, use painted H3.2-treated timber.
- Use anti-vibration mounts.
- Insert ethylene propylene diene M-class (EPDM) rubber washers between the bracket and the roofing.
- Check that the brackets are level before tightening.
- Seal all fixings as for the rest of the roof fixings, for example, using EPDM or neoprene.
- Fix the unit to the base.

Note: Do not:

- mount units on concrete or clay tile roofs (these types of tiles are not strong enough to allow mounting or bear the weight of the installers working on the roof)
- mount units directly onto metal roofing, as roofing can act as a sound amplifier and direct fixing may cause corrosion of the roofing
- allow copper-chromium-arsenate treated (tanalised) timber to come into direct contact with galvanized steel roofing, as it is not compatible.

7.4 Split water-loop systems

Split water-loop systems have a separate cylinder and heat pump box that are connected by a water pipe loop. The water pipe loop will need to be installed by a plumber.

Split water-loop systems may be installed as retrofits to an existing hot water cylinder.

Details for the installation of the heat pump unit are provided in section 7.3.

7.4.1 Connecting to an existing cylinder

A split water-loop system can be installed to an existing cylinder that has an eco or solar port (which will be converted to a sensor pocket) and a built-in heat exchanger. An existing cylinder must also have polyurethane or expanded polystyrene foam insulation.

Before connecting a HPWH outdoor unit to an existing cylinder, consideration should be given to the age and condition of the existing cylinder. If there is any doubt about the condition of the existing cylinder, it may be best to opt for a new cylinder as part of the system.

Contact the supplier of the HPWH if there is any doubt about connection to an existing cylinder.

The installer is responsible for adequately sizing the distribution pipework in a home to ensure that all outlet fittings perform sufficiently. Pipe sizing and valve selection must allow for the home's water supply pressure.

All water connections should be made good, tested and be sufficient to last the expected life of the home.

In many parts of New Zealand, when the outside air drops below 0ºC, water in external pipes may be at risk of freezing and expanding, which can cause pipes to burst. This includes pipes for hot water supply, hot water return and any hydronic loops. All pipework should be fitted with UV-stable insulation of a suitable R-value for the climate where the system is installed.

Cylinder valves, pipework and drains are to be installed according to current versions of AS/NZS 3000:2018, AS/NZS 3500 and G12/AS1.

7.4.2 Locating and installing a new cylinder

This section relates to situations where a new cylinder is fitted as part of the installation.

A HPWH typically requires a well-insulated hot water cylinder to function correctly. The cylinder must be sized for the maximum anticipated draw off in an 8-hour period, so that the homeowner does not run out of hot water. A new cylinder can be installed inside or outside the home.

When installing a new cylinder, the distance between the cylinder and the outdoor unit should be minimised and any pipework insulated, so as to improve system efficiency. Ensure the new cylinder is placed in a suitable location, preferably with a drain tray for safe water management.

The cylinder must be installed in an upright position on a level, stable base that must be capable of withstanding the weight of a full cylinder.

The process for installing a new cylinder is as follows.

- Connect the inlet and outlet pipes to the new cylinder, using appropriate fittings and in accordance with New Zealand Building Code section G12 and AS/NZS 3500.4. Check the system pipe run does not exceed the maximum length and differential height recommended by the manufacturer.
- Connect the electrical supply to the new cylinder following the wiring diagram and ensuring all connections are secure. This must be done by a qualified electrician in accordance with New Zealand electrical regulations.

- Check all connections for leaks after the pipes are connected.
- Turn the water supply back on and fill the cylinder with water.
- Once full, perform an earth continuity test as outlined in Annex A of AS/NZS 60335.1.
- Restore the power supply to the new cylinder after all checks are complete.

7.4.3 Seismic restraints for the cylinder

If installing a cylinder as part of the HPWH installation, the cylinder requires adequate structural support against earthquake forces and must meet the requirements laid out in the New Zealand Building Code's acceptable solution G12/AS1 6.11.4 or section 203 of NZS 4603:1985.

Refer to the manufacturer's installation instructions or follow the requirements of the Building Code, namely:

- for cylinders between 200 litres and 360 litres, restrain the unit with three 25mm x 1mm galvanised steel straps, tensioned when fixed in place. For cylinders less than 200 litres, only two straps are required,
- straps are to be fixed to timber framing using an 8mm coach screw with either one 30 x 2mm thick washer, or two 20 x 2.5mm thick washers,
- coach screws must penetrate the timber framing by a minimum of 50mm.

It is also recommended to install either two (or more) scalloped back-restraints, or two 50mm x 50mm vertical blocks that extend the full height of the cylinder, and ensure they are suitably fixed to the timber framing.

When securing the cylinder to masonry or concrete walls, use masonry expansion anchors to attach the straps and restraints to the wall. It is critical to anchor restraints into the structural masonry or concrete wall and not merely into brick veneer, which lacks the necessary strength.

Figure 58 and 59 show a seismic restraint of a water cylinder to a masonry structure.

Figure 58: Seismic restraint for a hot water cylinder

Figure 59: Seismic restraint for a hot water cylinder

7.4.4 Inlet water pressure and temperature

Different manufacturers recommend different minimum pressures and temperatures for their systems. Minimum water pressure is typically between 50 and 200kPa and maximum water pressure is typically 500kPa.

Installers should refer to the manufacturer's specifications and confirm that the inlet water pressure and temperature complies.

7.4.5 Outlet water pressure and temperature

The outlet temperature needs to be high enough for the water to be safe from Legionella bacteria, but not so hot as to cause scalding (New Zealand Building Code clause G12.3.6). See section 4.5.4 for more details.

A TPR valve must be installed to ensure safe operation of the system. Failure to do so can potentially cause injury and damage the unit.

The TPR valve should be connected to a vertical discharge pipe that enables water to always flow downwards, and that is positioned to ensure the outlet hot water cannot injure people or damage the building. The pipe should be insulated to reduce heat loss.

7.5 Split refrigerant-loop systems

Split refrigerant-loop systems have a physically separate outdoor unit connected to a cylinder via a refrigerant line. Installation of these systems requires a refrigeration technician to run refrigerant lines between the two components.

Details for the installation of the heat pump unit are provided in section 7.3.

Details for the installation of a new water cylinder are provided in section 7.4.2.

7.5.1 Plumbing requirements

All water pipework and water fittings should be insulated with UV-stable insulation with a suitable R-value for the climate at the installation location, in order to optimise the HPWH system's performance and energy efficiency.

The installer is responsible for adequately sizing the distribution pipework in a home to ensure that all outlet fittings perform sufficiently. Pipe sizing and valve selection must allow for the home's water supply pressure.

All water connections should be made good, tested, and be sufficient to last the expected life of the home.

In many parts of New Zealand, when the outside air drops below 0ºC, water in external pipes may be at risk of freezing and expanding, which can cause pipes to burst. This includes pipes for hot water supply, hot water return and any hydronic loops.

7.5.2 Connecting refrigerant piping between cylinder and outdoor unit

Full details of refrigerant pipework including jointing, making bends etc are provided in section 6.1.4.

Connecting the piping to the cylinder and outdoor unit must be done in the following order.

1. Connect the piping to the cylinder.
2. Fix the trunking.
3. Connect the piping to the outdoor unit:

- Locate the pre-installed pipework.
- Add any necessary dwangs.

Procedure for connecting the piping to the cylinder

Figure 60: Bind insulation with vinyl tape

- Use twin-insulated and dehydrated copper piping.
- Cut and flare the copper pipes for connection to the cylinder (see **6.1.5 Creating flared joints**).
- Apply oil to both the flare and the cylinder, ensuring that the oil is compatible with the refrigerant.
- Align and connect the pipes and tighten the flare nut by hand.
- Tighten the flare nut connections using two spanners to the correct torque.
- Overlap the connection pipe and indoor pipe insulation. Bind the insulation with foam insulation tape, then follow with vinyl tape (Figure 60).Figure 60

Figure 61: Tape drainage hose to drainage outlet

- Connect and tape the drainage hose to the drainage outlet (Figure 61).

Procedure for fixing the trunking

Figure 62: Install trunking neatly

- Screw-fix proprietary trunking to the exterior wall from the outlet to the outdoor unit.
- Use stainless steel screws.
- Install trunking neatly in straight runs with 90º angles, tight weather seals and waterproof flashings (Figure 62).
- Run horizontal trunking with a slight downhill slope if it contains the condensate drainage pipe.

Figure 63: Fit refrigerant piping, drainage pipe and connecting cable into trunking

- Fit refrigerant piping, drainage pipe and connecting cable into trunking (Figure 63).
- Attach trunking cover.

Figure 64: Fill hole around piping with sealant

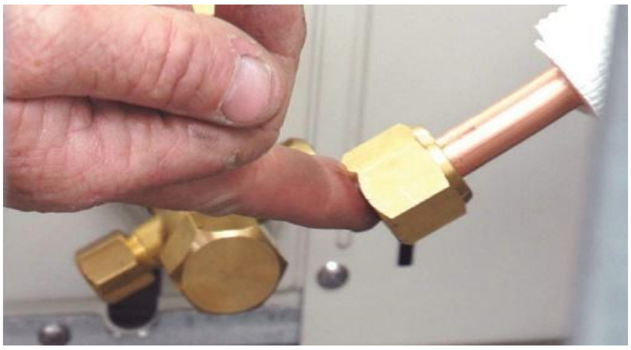
- Fill hole around piping with sealant compatible with the trunking and the cladding system (Figure 64).

Figure 65: Seal around cover

Figure 66: Fit cover over opening

Procedure for connecting the piping to the outdoor unit

Figure 67: Apply oil to the back of the flare and the outdoor unit



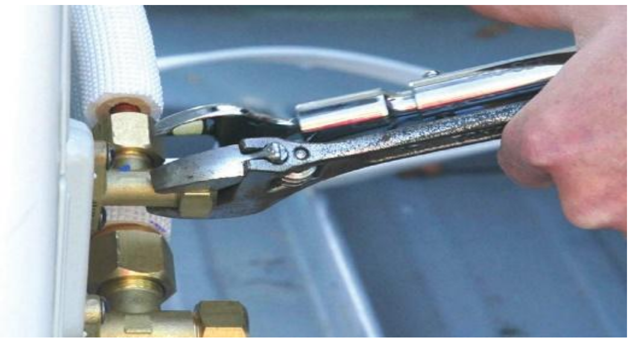
- Cut both pipes to the correct length.
- Flare the pipe ends for connection to the outdoor unit (see **6.1.5 Creating flared joints)**.
- Purge the system by blowing oxygen- free nitrogen (OFN) into the pipes before making final flare connection. Note: Hard-drawn copper pipe must be annealed before bending and therefore also requires purging with nitrogen.
- Apply oil to the front and back face of the flare and the outdoor unit, ensuring that the oil is compatible with the refrigerant (Figure 67).

NOTE: Do not use adhesive threadlocker or thread sealant.

Figure 68: Connect pipes and tighten flare nut

Align and connect the pipes and tighten the flare nut by hand.

Figure 69: Tighten flare nut connections



- Tighten the flare nut connections using two spanners and to the correct torque.
- Figure 69Check all mechanical joints for tightness on completion.
- Remove all rubbish from the installation.
- Clean any marks from the area around the units.

7.5.3 Testing for leaks and pressure

It is good practice to pressure test the system for leaks after the pipework installation is complete, using the following procedure.

- Remove the service port valve cap from the gas valve on the outdoor unit (the isolation valve must be kept closed).
- Use oxygen-free dry nitrogen (OFN). Any oxygen introduced into a system during pressure testing is extremely dangerous and can cause a large explosion.
- Connect the nitrogen gas cylinder to the service port valve.
- Pressurise the system to a maximum 500 psi/3.45MPa and allow to hold for 5 minutes.
- Watch the pressure gauge for any drop-off in pressure.
- Test joints by using a bubble test solution. If using electronic testing, a trace gas must be added to the nitrogen. Be aware that electronic testing can be unreliable in windy conditions – if a leak is found with an electronic tester, it must be verified using a bubble test solution.
- Release the nitrogen pressure to discharge.
- Disconnect the cylinder when the pressure has returned to normal.
- Wipe the bubble test solution off the joints after testing.

7.5.4 Evacuating the system

It essential to evacuate the system to remove air, moisture and any nitrogen remaining from the pressure testing. Any air, moisture or foreign matter remaining in the system may cause:

- the pressure in the system to rise, resulting in compressor malfunction
- the operating current to rise, resulting in performance loss
- moisture to freeze and block the pipework and valves
- oil sludge build-up
- corrosion of parts of the system.

Always use an electronic digital vacuum gauge to monitor the evacuation.

Ensure, as a minimum, that the vacuum pump is in good working order, is serviced regularly and has clean oil. Vacuum pump oil should be replaced after 25 uses or every 6 weeks. Ensure the vacuum pump is equipped with a backflow prevention device to prevent the oil in the pump flowing backwards into the refrigerant pipes (should power fail during the test), as this could cause major damage to the system.

Procedure for evacuating the system

Carry out the evacuation according to:

- the manufacturer's instructions, or
- the methods specified in the *Australia and New Zealand Refrigerant Handling Code of Practice 2025: Part 1*, section 3.4.

Figure 70: Remove vacuum pump and gauges (A)

- Connect the vacuum pump hose to the service port valve on the gas valve.
- Start the pump.
- Moisture removal will take place when the pressure is 500 microns or less.
- Continue evacuating down to 200 microns and measure this with an electronic vacuum gauge.
- The evacuation time will depend on the pump's capacity and the length of the tubing, so do not time but instead read the pressure gauge to check that evacuation is complete.

Figure 71: Remove vacuum pump and gauges (B)

- When the required level of evacuation has been reached, close the manifold valve and stop the pump.
- Allow to hold for minimum 10 minutes – refer back to Section **7.5.3 Leak/pressure test** if pressure not held.
- Remove the vacuum pump and gauges.

Figure 72: Remove vacuum pump and gauges (C)

Figure 73: Progressively release the vacuum

- Progressively release the vacuum by opening both the liquid and gas side isolation valves. Use the valve core removal tool and turn it counter-clockwise a ¼ turn so that air is not introduced into the system.

Figure 74: Tighten valve caps

- Replace both liquid and gas valve caps and gas service port valve caps and tighten using an adjustable wrench (Figure 73). If a valve cap cannot be finger-tightened first, do not force-tighten it, as this may strip the thread. Instead, remove and refit the cap. Securely fasten the caps to prevent refrigerant leakage from the system.
- Leak test with bubble solution to confirm.

Section 8: Refrigerants

8.1 Types of refrigerants

Refrigerants are the working fluids in HPWHs, enabling the heat transfer to occur by absorbing and releasing thermal energy.

Common refrigerants include R32, R134a, R410A and R744 (CO_2); they each have their own thermodynamic properties and environmental impacts.

With growing concerns over global warming, many newer HPWH systems are transitioning to low-GWP refrigerants such as R290 (propane) and CO_2, which also offer efficiency and sustainability benefits.

However, all refrigerants will have some impact on the environment, and GWP also needs to be considered in the context of the quantity of the refrigerant, and its performance (COP), ozone-depletion potential and leakage-rates (pressure).

Typical early refrigerants used were chlorofluorocarbons (CFCs). Their ozone-depleting nature led to them being phased out and replaced with hydrochlorofluorocarbons (HCFCs), such as R-22. These have in turn now have largely been phased out and replaced with blended hydrofluorocarbon (HFC) compounds.

The commonly used refrigerants in HPWHs can be summarised as follows.

- **R134a** is a HFC refrigerant widely used in air conditioning and heat pump systems. It has a high GWP, contributing to climate change, and for that reason is being phased out in New Zealand.
- **R32** is also a HFC refrigerant, which has gained popularity as a lower-GWP alternative to R134a. R32 is used in many newer air conditioning and heat pump systems in New Zealand.
- **R744** (CO_2, or carbon dioxide) is a natural refrigerant that has zero ozone-depletion potential and much lower GWP. CO_2 refrigeration systems are commonly used in larger commercial applications, such as supermarkets and refrigerated warehouses.
- **R290** (propane) has been used in industrial refrigeration for many years and is emerging as an increasingly viable alternative for homes, which will be available soon. With a very low GWP and zero ozone-depletion potential, R290 is seen as an environmentally friendly option.

Common HPWH refrigerants, and their GWP and flammability are shown in Table 10.

Table 10: Common refrigerants and their global warming potential and flammability

Refrigerant	GWP	Flammability[21]
R744 (CO_2)	1	Non-flammable
R290 (Propane)	3	Highly flammable
R32	675	Lower flammability
R134a	1,430	Non-flammable
R410A	2,088	Non-flammable
R404A	3,922	Non-flammable

[21] See: https://hvacrcentre.nz/wp-content/uploads/2024/08/Flammable-Refrigerants-Fact-Sheet-1_updated-2_2019.pdf

8.1.1 Safety and environmental factors

All refrigerants have risks and hazards associated with them, such as toxicity, flammability, global-warming potential (GWP) and ozone-depletion potential. It is essential that the handling of any refrigerants during installation and decommissioning is undertaken with appropriate caution and care, and to ensure all pipework is leak-free to ensure that no harm is caused by any refrigerant leakages.

When selecting a HPWH, ensure you understand which refrigerant is suitable for the system. The installation and technical guide supplied by the manufacturer will provide this information and must be observed at all times.

Installers should not the following points.

- The switch from HFCs to more environmentally acceptable alternatives will help combat climate change, but may also present increased risks to health and safety in some circumstances because of higher toxicity, flammability or pressure.
- While R32 has a lower GWP compared to R134a, its still requires proper handling and adherence to safety regulations to ensure a HPWH’s safe and efficient operation.
- CO_2 systems also require strict adherence to safety regulations, due to the high pressures in these units.
- Improper maintenance, servicing and end-of-life disposal of HPWHs can contribute to climate change. Some older refrigerants used in HPWHs have high GWPs when released into the atmosphere.
- Some refrigerants are also hazardous owing to their toxicity or flammability. The refrigerant installed in a HPWH should be appropriately labelled, with correct safety measures applied for the specific hazard level.
- AS/NZS ISO 817:2016 has definitions of safety levels, and AS/NZS 5149, Parts 1 to 4 includes refrigerant classifications on the basis of flammability and toxicity. HPWHs must comply with the safety requirements of the relevant classification.
- HFCs, such as R410A and R32, are currently widely used in refrigeration and air conditioning systems. However, HFCs are greenhouse gases with high GWP, and a worldwide phase down of them is being implemented.

8.2 Refrigerant handling code of practice

Compliance with the *Australia and New Zealand Refrigerant Handling Code of Practice 2025* is mandatory for the handling of fluorocarbon refrigerants by anyone holding a refrigerant handling licence or refrigerant trading authorisation.

The code of practice is in two parts.

- Part 1 covers self-contained low-charge systems that do not require any work on the refrigeration circuit to install and contain less than 2kg of fluorocarbon refrigerant.
- Part 2 covers all other stationary and transport refrigeration and air conditioning systems.

Essential requirements of the code are that:

- heat pump units must be able to be installed, operated, serviced and decommissioned without loss of refrigerant,
- heat pump systems must be installed by an appropriately qualified person who holds an Approved Filler Compliance Certificate for refrigerant handling,
- refrigerant must not be intentionally released into the atmosphere – releasing refrigerants into the atmosphere can incur hefty fines.

8.3 Refrigerant charging

The outdoor unit may be factory-charged with sufficient refrigerant to allow for a specific pipe run to and from the water cylinder. Refer to the manufacturer's installation instructions for the pre-charge pipe length. Extra refrigerant will need to be added where pipe runs exceed the manufacturer's parameters for the factory-charged amount of refrigerant.

It is generally not advised to charge a HPWH system with a refrigerant that differs from the one that it was designed to use. Refrigerants of different safety classification require different engineering controls, so charging a HPWH with a refrigerant that has a different safety class could be hazardous to people or property.

The procedure for recharging refrigerant is as follows.

- Only use the refrigerant specified by the manufacturer for charging.
- Measure the additional pipe run length.
- Accurately calculate the amount of refrigerant required according to the manufacturer's instructions.
- Measure the required amount of refrigerant (where additional charge is required) by mass, using electronic scales.
- Keep the charge lines as short as possible.
- Leak-test the pipework before charging, by partially opening, then closing the cylinder valve to pressurise the connecting pipework.
- Charge using liquid refrigerant from the cylinder – using the least possible amount of refrigerant.
- Check for leaks using the bubble test solution.
- Ensure that the cylinder and unit are at the same height to prevent gravity transfer of the refrigerant.

Important points to note

It is important to minimise refrigerant leaks because they can damage the ozone layer, increase greenhouse gases, or present health and safety risks.

- Always check with the manufacturer for the correct refrigerant to be used.
- Do not use the incorrect refrigerant in a heat pump, as this could void the warranty and can create the risk of an accident.
- Do not release refrigerant into the atmosphere.

- Do not use ultraviolet dye.
- Do not use reclaimed refrigerant to add additional charge.

8.4 Labelling as a record of service

Any system that is charged with refrigerant or lubricant must be labelled. Label all compressors, systems and liquid refrigerant pumps in accordance with AS/NZS 5149.2: 2016 clause 4.5 *Marking and Documentation*.

A permanent label should be placed on the outer side of unit identifying:

- refrigerant type
- date of service
- lubricant type
- refrigerant charge (total including any additional charge).

Section 9: Electrical

9.1 General requirements

All electrical work must be electrically safe and carried out by a suitably licenced and registered electrical worker. An electrical certificate of compliance (also known as a CoC) and/or an electrical safety certificate (also known as an ESC) must be issued on completion, as required.

Electrical work must be carried out in accordance with the Electricity Act 1992, Electricity (Safety) Regulations 2010, and AS/NZS 3000: 2018 Electrical installations (also known as the Australian/New Zealand wiring rules).

Any product supplied in New Zealand should be accompanied by a Supplier's Declaration of Conformity (also known as a SDoC) and/or be registered in the Electrical Equipment Safety Scheme (also known as the EESS) administered by the Australian government.

Important points to note

- The power supply to the heat pump module or element must not be energised until the system is filled with water. Failure to follow this requirement may result in damage to the wiring in the element due to overheating.
- Household wiring to the system must be capable of withstanding the appliance load.
- It is not recommended to install a HPWH system using a plug and socket arrangement.
- All work must be tested in accordance with AS/NZS 3000: 2018to ensure compliance and safety.

9.2 Installing electrical wiring

The maximum demand of the installation should be calculated to determine if the installation can accommodate any additional load that may be imposed on all or part of it.

Before starting work, check to see if the intended supply has sufficient capacity for the HPWH.

Depending on the HPWH's power input rating (including for the booster element, where fitted), and the building's existing electrical installation, the HPWH may either be connected to an existing sub-circuit with sufficient spare capacity (e.g., looped off an existing power socket), or preferably, to a separate dedicated sub-circuit.

It is not recommended that a HPWH is connected to an existing circuit with the following attributes:

- a protective device with a rating of less than 15 amps
- a circuit clearly intended for use for lighting or other dedicated purposes.

Initial assessment of the installation should include consideration of controlled supplies. A controlled supply is a circuit that can be switched remotely by the network operator, often using ripple control signals or a separate pilot supply. These supplies are typically used for appliances such as electric storage water heaters, where power can be interrupted at certain times.

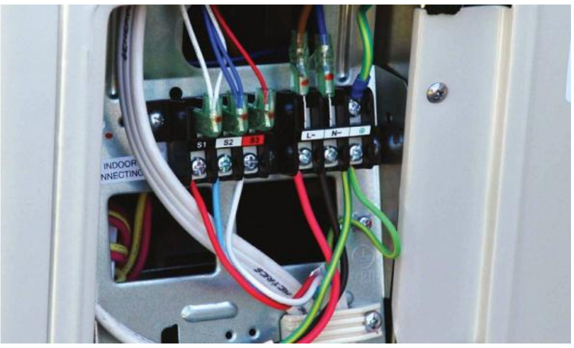
Factors to consider include:

- some retailers offer reduced rates for controlled supply (see Ripple control)
- some devices may not be suitable for the regular switching of a controlled supply (check the manufacturer's instructions for suitability)
- local network operators may require, or prefer, hot water systems to be connected to controlled supplies.

9.3 Heat pump outdoor unit connections

Use the following procedure when connecting the outdoor unit to the power supply.

Figure 75: Connect power supply cable to terminal block



Remove service cover from outdoor unit.

- Fix outdoor connecting cable correctly to the terminal block in the outdoor unit.
- Tighten terminal screws to ensure that wires are firmly secured.
- Connect power supply cable to terminal block in outdoor unit.

Figure 76: Install lockable isolating switch (A)

- Install a lockable isolating switch adjacent to the outdoor unit.
- Install the switch so that it can be reached for servicing.
- Attach the isolating switch to the house or other suitable location – the isolating switch should not be attached directly to the outdoor unit.

Figure 77: Install lockable isolating switch (B)

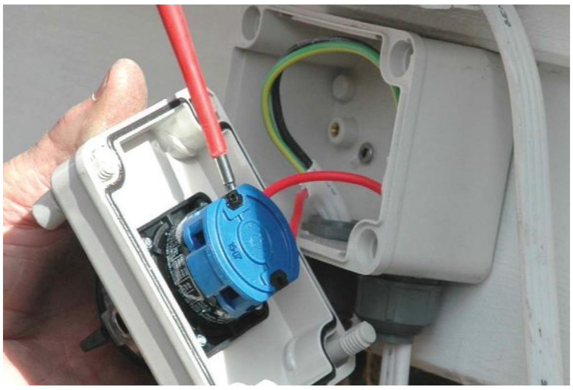


Figure 78: Install lockable isolating switch (C)

Figure 79: Replace service cover to outdoor unit

- Provide appropriate mechanical and ingress protection to the connection as required, such as:
  - cable gland
  - flexible conduit.
- Replace service cover to outdoor unit when all connections are complete.

Important notes

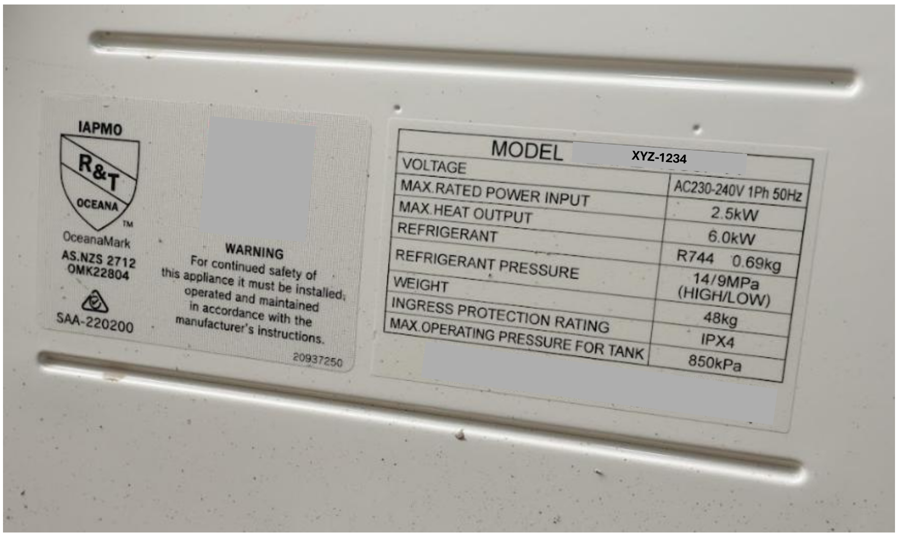
- Do not connect the isolating switch to the outdoor unit. Otherwise, the unit cannot be isolated from the power.
- Do not allow contact between the wiring and refrigerant pipework.
- Do not allow electrical work to be carried out by a person who is not authorised to undertake electrical work or without the appropriate certification being issued. Otherwise, the owner's house insurance may be voided.

9.4 Nameplate

Ensure the nameplate on the outdoor unit (see Figure 80) is visible in an accessible location and displays the:

- manufacturer's name and/or trademark
- type or model designation and serial number
- rated voltage
- rated frequency
- cooling capacity
- heating capacity
- refrigerant type (designation) and charge.

Figure 80: Example of nameplate on an outdoor unit



9.5 All-in-one system connections

Electric terminals must be connected to a 230/400 V AC 50 Hz power supply.

A lockable isolating switch must be installed in accordance with AS/NZS 3000:2018.

The power supply to the heat pump module or element must not be energised until the system is filled with water. Failure to follow this requirement may result in damage to the wiring in the element due to overheating.

Installation wiring must be capable of withstanding the appliance load.

Fixed wiring must be protected from contact with the internal surfaces of the system.

Connect all active, neutral and earth wires in accordance with the wiring diagrams.

Inspect and ensure all connections are secure prior to fixing the access cover and turning the power on.

Once the cylinder is full of water perform an earth continuity test, as outlined in Annex A of AS/NZS 60335.1.

Typical wiring connections for an all-in-one system are illustrated in Figure 81.

Note that:

- red = active
- black = neutral
  green or yellow = earth.

Figure 81: Typical wiring connections

9.6 Wi-Fi connection

Many modern HPWHs have Wi-Fi capability. This allows remote monitoring of the HPWH, and control of its operation.

Installers should refer to the manufacturer's installation manual or website for more details of available apps and connection methods.

Section 10: Testing and commissioning

This section covers what needs to be done once a HPWH system is installed. It includes what to check before it is commissioned, and how to test the system, brief the homeowner about it and carry out a quality assurance check once everything is completed.

For testing and commissioning, follow the manufacturer's instructions where provided. Otherwise, follow the *Australia and New Zealand Refrigerant Handling Code of Practice 2025, Part 1*.

10.1 Pre-commissioning quality assurance checklists

Before commissioning the new system, carry out a quality assurance check of the heat pump water heater, addressing the following areas.

Cylinder and all-in-one systems

- ❑ Is the cylinder or all-in-one unit secure?
- ❑ Are the valves fully opened and have the valve caps been replaced and securely tightened?
- ❑ Has the test run been carried out?
- ❑ Is the unit neatly installed with no pipework or ducting visible?
- ❑ Have the installer's checklists been sighted?

Outdoor unit

- ❑ Is the outdoor unit secure with no likelihood of falling over?
- ❑ Is there any vibration or noise disturbance to the homeowners or adjacent properties?
- ❑ Is the area around the unit clear, so there is no likelihood that the air supply routes will become blocked?
- ❑ Has the unit been installed to provide future servicing access?
- ❑ Is all the exterior ducting neat and tidy, with all flashing and waterproofing completed?
- ❑ Have all service covers been replaced?
- ❑ Is the unit clearly labelled?
- ❑ Have the installer's checklists been sighted?

Pipework and plumbing

- ❑ Is the pipework appropriate for the refrigerant used in the system?
- ❑ Has a leak test been carried out?
- ❑ Was the system evacuated?
- ❑ Is the system charged to a level appropriate for the pipe length?
- ❑ Are the stop valves fully open?
- ❑ Have the installer's checklists been sighted?

Drainage

- ❑ Has the outdoor drainage pipe been directed away appropriately?
- ❑ If a condensate pump has been used, has it been tested to ensure it is working correctly, that it is not siphoning, and that the float switch is working correctly?

Electrical

- ❑ Have the tests required under the Electricity (Safety) Regulations, including the cited edition of *AS/NZS 3000:2007 Electrical installations* (known as the Australian/ New Zealand wiring rules) been carried out?
- ❑ Does the electrical work have an electrical certificate of compliance?
- ❑ Has a copy of the electrical certificate of compliance been given to the owner?
- ❑ Is the unit connected to a separate circuit, hard-wired back to the mains distribution board; or if its is connected to an existing circuit, does the circuit have sufficient spare capacity?
- ❑ Is there a circuit breaker in the system and has the circuit been properly labelled on the distribution board?

Labelling:

- ❑ Has the switchboard fuse been labelled appropriately?

Instructions to the owner

- ❑ Has the operation of the system been explained to the owner?
- ❑ Does the owner have the operating manual?
- ❑ Has the owner been advised of maintenance and servicing requirements?
- ❑ Has the owner been given a copy of the warranty?
- ❑ Does the owner understand the operating modes and settings to be used to optimise performance?

10.2 Commissioning the new system

Filling the system

- Open a hot-water tap at the sink.
- Open the cold-water isolation valve to the system.
- Allow the system to fill and the air to bleed through the tap.
- Turn off the hot tap at the sink when water flows freely without any air bubbles or air bursts.
- Check for leaks and rectify if detected.
- Bleed any remaining air from the TPR valve.
- Turn on the power to the heat pump unit and wait 30 seconds for the circulation pump to turn on. Any remaining air will be bled from the automatic air vent. The heat pump will start after approximately five minutes.

Turning the system off

Turn the system off again, if required, such as when the installation is in a new home that is still being completed, or the home will be vacant for some time.

- Switch off the electricity supply at the isolating switch to the system.
- Close the water isolation valve at the inlet to the water heater.
- Drain the system if there is a risk of freezing.

Draining the system, if required

- Turn off the system as above.
- Open all the hot water taps.
- Gently open the TPR valve; this will relieve pressure in the system.
- Open the drain valve. Make sure no damage or injury will occur from the discharged water.
- Open the TPR valve again. This allows air into the system and will result in the cylinder draining.

Section 11: Customer training and instructions

Customer training and handover are an essential part of the installation and commissioning phase and must be completed before the work is finished.

11.1 Instructions for the owner

Checklist of instructions for the owner on using the system

- ❑ Demonstrate how to set the controls and different modes correctly.
- ❑ Advise of service requirements.
- ❑ Recommend reading the operating instructions manual.
- ❑ Provide a service checklist.
- ❑ Provide the warranty and explain key aspects of the warranty to the homeowner.

Before the installer leaves

- ❑ Ensure the electrician has provided an electrical certificate of compliance.
- ❑ Provide a record of the system commissioning data.
- ❑ Provide contact names and numbers for after-sales support.

11.2 Instructions for using a heat pump water heater efficiently

Understanding how to use a HPWH efficiently is important and should be discussed with the homeowner, including the following points.

Smart water use and scheduling

- ❑ Use a timing function to heat water when demand is lowest, when electricity prices are lower or to use solar photovoltaic power where available.
- ❑ Stagger water use (for example, take showers and do the laundry and dishwashing at different times) to reduce strain on the system.
- ❑ Avoid excessive water use. Low-flow showerheads and efficient appliances help reduce demand.

Regular maintenance for longevity and efficiency

- ❑ Check and clean the air intake every 6 months to ensure it is clear of litter, leaves, weeds etc, and to maintain airflow efficiency.
- ❑ See section 12 for more information.

Section 12: Servicing and maintenance

Regular servicing is important for a HPWH for several reasons, especially when it comes to optimising the system's performance and extending its lifespan.

Key benefits of regular servicing include the following:

Optimising performance and efficiency

- HPWHs rely on airflow and refrigerant systems to extract heat from the air. Over time, dust and grime can clog filters, fans, and coils, reducing efficiency.
- A serviced unit uses less electricity to heat the same amount of water, lowering power bills.
- Servicing helps ensure consistent hot water supply, particularly in colder parts of New Zealand or during winter.
- Regular maintenance helps prevent salt corrosion, mould build-up, and weather-related wear and tear, particularly in harsh or coastal environments.

Extending life of the system

- Regular checks help identify minor issues before they become major failures, such as corrosion, leaks or pump faults.
- Cleaning and maintaining the compressor and fan components can add years to the life of the unit.
- Servicing helps avoid expensive emergency repairs or premature replacement.

Maintaining warranty coverage

- Most manufacturers require proof of regular servicing to honour warranties.
- Skipping maintenance can void coverage, leaving the homeowner to pay for any breakdowns.

Some servicing can be undertaken by the owner, whereas other service tasks are more suited to being undertaken by a qualified technician or service engineer.

12.1 Owner maintenance

Follow the manufacturer's instructions. Most manufacturers provide copies of their manuals on their website. A checklist of typical key tasks for homeowners is provided below.

Outdoor unit

- ❑ Keep the area around the outdoor unit clear of garden waste and dirt.
- ❑ Remove any growth around or into the unit.
- ❑ Make sure the unit is off when cleaning. Follow manufacturer's instructions when turning off the power.
- ❑ Check and clean the outdoor coils as per manufacturer's instructions when they are dirty. In a corrosive environment, cleaning may be required as regularly as every 3 months.
- ❑ Contact a service person if there are any unusual sounds or signs of operational issues.
- ❑ It is recommended to have an annual servicing agreement with your installer. Failure to maintain your HPWH to the manufacturer's instruction may void the warranty.

Note: Do not spray the fan, motor or wires with water (e.g. from a garden hose).

Hot water cylinder

- ❑ Inspect and operate the TPR valve and cold-water expansion valve every 6 months – this can be done by the owner if they feel confident to do so.

12.2 Service personnel maintenance

The system should be serviced by a qualified tradesperson every 12 months, depending on use. Before servicing, establish the type of refrigerant used in the system.

While there is no specific New Zealand regulation that mandates a fixed 12-month service interval for potable HPWHs, most manufacturers selling systems in New Zealand specify in their installation and user manuals that a unit should be serviced annually by a qualified person.

Anyone servicing a HPWH needs to have an Approved Filler Compliance Certificate, as it is generally not known in advance of servicing whether there will be a requirement to handle refrigerants.

If a HPWH repeatedly goes into defrost over a short time-period, for example every 1 or 2 hours, the unit may need to be serviced or re-gassed, or there may be a problem with its installation or commissioning.

A checklist of key tasks for service personnel is given below.

Outdoor unit

- ❑ Clean the condenser coils as follows.
  - ✓ Clear the outside of the coil of debris.
  - ✓ Vacuum the coil fins using a soft bristle brush attachment – take care to avoid bending the fins.
  - ✓ Spray water from the inside to the outside of the coils to remove stuck debris using a hose and spray gun.
  - ✓ Do not spray the fan motor or wires with water.
  - ✓ Vacuum or remove by hand any debris remaining in the unit.
- ❑ Check coil fins for damage – if coil fins are bent, straighten using a proprietary tool.
- ❑ Lubricate fan bearings if required – sealed bearing units do not require lubricating.
- ❑ Inspect fan for damage and repair as required.
- ❑ Replace grille covers.
- ❑ Check that the condenser unit is secure and level in both directions. If necessary, adjust the levelling feet, or make the unit level with timber or plastic shims. If the unit is seriously out of level, repair or replace the base the unit sits on.
- ❑ Check for any unusual noise or vibration.
- ❑ Check for sediment build-up in the cylinder and flush it annually if necessary.
- ❑ Inspect anode rods (for non-stainless steel cylinders) every few years and replace them if corroded.
- ❑ Ensure refrigerant levels are checked every few years to maintain performance.

Refrigerant

- ❑ Check pipe joints for refrigerant leakage with bubble solution.
- ❑ Check refrigerant levels and pressure.

Hot water cylinder

- ❑ Inspect and operate the TPR and cold-water expansion valves.
- ❑ Check the temperature of the hot water with a digital thermometer for normal operation. Hot water should be maintained at 60°C or higher.
- ❑ Check the anode rod in the cylinder. Replace it if it is significantly corroded, or due for replacement, as specified by the manufacturer's guidelines.

Electrical

- ❑ Check terminals and connections – clean and tighten if necessary.
- ❑ Check fan motors for lubrication.
- ❑ Check that all controls are operating correctly.
- ❑ Check that the thermostat is operating correctly.
- ❑ Check the voltage.

Service checklist

- ❑ Update service records and provide the owner with a service checklist after each service.

Section 13: Decommissioning heat pump water heater systems

Proper disposal of a HPWH at the end of its life is essential because of the potential environmental impact from the refrigerants they contain. These refrigerants can contribute to climate change if not handled correctly.

Recommended disposal steps and options are as follows.

1. **Engage a licensed technician.** Before disposal, it's important to have a licensed technician remove the refrigerant from the unit. This ensures that harmful substances are handled in compliance with environmental regulations. There is normally a fee for this service.
2. **Contact a local recycling centre.** After the refrigerant has been safely extracted, the unit can be taken to a local recycling facility that accepts large appliances. These centres can process the materials responsibly, ensuring that components are recycled or disposed of properly.
3. **Consult the manufacturer or supplier.** Some manufacturers or suppliers offer take-back or recycling programmes for their products. Refer to the website of the manufacturer of the relevant HPWH or contact with them to obtain guidance on disposal.
4. **Consult a reputable refrigerant recovery organisation.** Services are provided by various companies and include options such as collection sites where you can swap a bottle, drop off refrigerants, use onsite services or courier services, and recycle used refrigerants. These initiatives ensure that refrigerants are handled in a way that minimises their environmental impact, maintains safety and environmental standards, and helps to prevent the release of harmful refrigerants into the atmosphere. A list of refrigerant recovery organisations is provided here: https://hvacrcentre.nz/refrigerant-recovery/

If you do not know whether an appliance contains an ozone-depleting refrigerant or a synthetic greenhouse gas, you should take a cautious approach and assume that it contains some form or quantity of refrigerant. Arrange to have a suitable company de-gas and dispose of the unit in an appropriate and environmentally responsible way.

Section 14: Glossary

Term, acronym or abbreviation	Description
Coefficient of performance (COP)	The ratio of the useful amount of heat energy provided (kW), divided by the amount of electrical energy input (kW) required to operate the system. See also seasonal coefficient of performance (SCOP).
Cold water expansion valve (CWE valve)	A safety device for controlling cold water pressure entering a cylinder.
Demand flexibility (DF)	The ability of consumers to shift their electricity consumption patterns or reduce their overall demand in response to signals from the grid or fluctuating electricity prices. Demand flexibility contributes to a more stable and efficient energy system through reducing peak demand.
Demand response (DR)	The ability of network operators to manage network loads by switching power on or off to particular circuits, such as domestic water heating.
Electrical Equipment Safety Scheme (EESS)	A regulatory framework aimed at increasing consumer safety in household electrical equipment throughout participating jurisdictions in Australia and New Zealand. The framework is administered by the Australian government.
Global-warming potential (GWP)	A measure of how much heat a greenhouse gas traps in the atmosphere relative to carbon dioxide (CO_2). GWP is used to compare the relative potency of different greenhouse gases.
Hydrochlorofluorocarbons (HCFC)	Chemicals that contain chlorine, hydrogen, fluorine and carbon. They are used in air conditioning and refrigeration.
Hydrofluorocarbons (HFC)	Synthetic gases used as refrigerants and in air conditioning.
Hydronic loop	A closed-loop system, where heated water is circulated through a network of pipes, typically under the floor, to heat a space.
Multi-pass	Multi-pass systems raise the temperature of the water over several, successive passes, in order to reach the desired temperature setpoint.
Ozone-depletion potential (ODP)	A relative measurement of how much a chemical can damage the ozone layer over time.
Refrigerant	The working fluid in a HPWH that conveys heat from the heat source to the heat sink. It can be in a liquid, gas or vapour state, as it passes through various stages of a fully reversible **vapour-compression refrigeration cycle.**
Seasonal coefficient of performance (SCOP)	Seasonal COP accounts for the fact that COP will vary throughout the year as climatic conditions and demands vary, which in turn affects the system's net efficiency. It is the ratio of **the sum of heat energy provided** (kWh) over the year, divided by the **sum of the total power consumption** (kWh) over the year.
Setpoint	The desired temperature of the water stored in the hot water cylinder, ready for use by the homeowner. This may not be the same as the temperature that the water is heated to at the compressor's heat

Term, acronym or abbreviation	Description
	exchanger, as some mixing and cooling will always occur. Some HPWH systems may struggle to achieve certain setpoint temperatures, and may require a backup or booster element under certain conditions.
Single-pass	Single-pass systems heat the water in 'one-shot'.
Solar photovoltaic (PV)	A solar photovoltaic system is mounted on a home's roof and converts sunlight directly into electricity using the photovoltaic effect. These systems are commonly used for residential electricity generation and typically sized from 3kW to 10kW.
Temperature and pressure relief valve **(sometimes known as a TPRV, TPR or PTR valve)**	A safety device that releases water from a water heater (or mixes the water with cold water) if the water becomes either too hot or too pressurised. It is a vital part of all hot water systems.
Temperature lift	Temperature lift is the difference between the incoming cold water temperature and the desired setpoint temperature for the hot water in the cylinder. Generally, a bigger temperature lift will require more energy. This does not include the amount of energy required to maintain the temperature of the hot water in the cylinder.
Thermal stratification	The natural layering of water temperatures, with hotter water at the top of the cylinder and cooler water at the bottom.
Thermostatic mixing valve (TMV) or tempering valve (TV)	This valve is crucial for safety and is a vital part of hot water systems, as it regulates the temperature of hot water supplied to fixtures, preventing scalding by mixing hot and cold water to a safe temperature.
Time of use (ToU)	Time-of-use electricity pricing uses different rates for electricity depending on the time of day, with peak hours (typically evenings and mornings) costing more than off-peak hours (typically nights and weekends).
Transient system simulation tool (TRNSYS)	A software tool used to evaluate the annual energy performance of thermal systems, including water heaters.
Vapour-compression refrigeration cycle	A closed system, where a refrigerant is continuously circulated, absorbing heat at a low pressure in the evaporator, then being compressed to a high pressure, releasing that heat in the condenser, and finally expanding through an expansion valve to return to a low-pressure state, allowing the cycle to be repeated. Essentially the cycle works by using the phase-changes of a refrigerant to transfer heat from one place to another through compression and expansion processes.
Variable-speed drive (VSD)	A device that controls the speed of an AC motor. Variable speed drives are also known as adjustable speed drives (ASDs) or frequency inverters. They sit between the electrical supply and the motor and convert the fixed frequency and voltage input to a variable frequency and voltage output, thus regulating the power that is fed to the motor.

Section 15: References and regulations

There are various references and regulations relevant to the installation of HPWHs, and referred to in various places in this guide. These are summarised in Table 11.

It should be noted that:

- An Act (primary legislation) is a law passed by the New Zealand Parliament. It is the highest level of legislation and sets out broad legal principles, duties and powers. An Act is enforceable by law and mandatory to follow.
- A Regulation (secondary or subordinate legislation) is a legally binding rule made under the authority of an Act. It is used to fill in the details and provide for practical implementation of the Act. A Regulation is enforceable by law and mandatory to follow.
- A Rule (sub-delegated legislation) is typically a technical or operational requirement made by a government agency or regulator under the authority of an Act or Regulation. Rules are binding and mandatory to follow.

Table 11: Relevant references and regulations

Document	Description
Building Act 2004	Provides for the regulation of building work, establishes a licensing regime for building practitioners, and sets performance standards for buildings. The act also aims to promote the accountability of owners, designers, builders and building consent authorities who have responsibilities for ensuring that building work complies with the Building Code.
Building Regulations 1992 (the Building Code)	Schedule 1 of the regulations (the Building Code) outlines how a building should perform in its intended use and addresses aspects such as structural stability, fire safety, access, moisture control, durability, services and facilities, and energy efficiency.
Electricity (Safety) Regulations 2010	Regulations that define and set-out requirements for certain electrical works, installations, fittings, and appliances or associated equipment, which are deemed as being either electrically safe or unsafe. Schedule 1 (prescribed electrical work) stipulates certain requirements for the installation, connection and disconnection, or maintenance of conductors and fittings, along with testing, inspection and certification of such works.
Electricity Act 1992	Primary legislation that aims to: a) provide for the regulation, supply, and use of electricity in New Zealand; and b) protect the health and safety of members of the public in connection with the supply and use of electricity in New Zealand; and c) promote the prevention of damage to property in connection with the supply and use of electricity in New Zealand; and d) provide for the regulation of fittings and electrical appliances that are, or may be, exported pursuant to an international trade instrument; and

Document	Description
	e) provide for the regulation of electrical workers.
Good Practice Guide – Heat Pump Installation	EECA's good practice guidelines for designing and installing the most common type of residential heat pump system (namely air-to-air single-split heat pump system; also known as reverse-cycle air conditioner), which is used primarily for heating. This is a comparable 'sister' document to this guide.
Hazardous Substances (Compressed Gases) Regulations 2004	The approved filler course (required by the Hazardous Substances (Compressed Gas) Regulations 2004) is the minimum legal obligation for anyone working with refrigerants.
Hazardous Substances and New Organisms Act 1996 (HSNO)	Legislation that aims to protect the environment, and the health and safety of people and communities, by preventing or managing the adverse effects of hazardous substances and new organisms
Health and Safety at Work (Hazardous Substances) Regulations 2017	Legislation that aims to protect people against harm to their health, safety and welfare caused by risks arising from work. The rules around managing hazardous substances that affect human health and safety in the workplace, and for mitigating the risks associated with such substances, transferred to these regulations from the Hazardous Substances and New Organisms Act 1996.
Residential Tenancies (Healthy Homes Standards) Regulations 2019	For reference purposes, schedule 2, section 5 of the regulations lists the assumed external temperature for each territorial authority district.

Section 16: Relevant standards

Various standards are relevant to HPWHs and referred to in various places in this guide. These are summarised in Table 12.

It is important to note the following points about standards.

- Standards are not laws by themselves. They are technical documents that specify methods, performance criteria, safety practices or design principles for products, systems or services. However, they become legally enforceable in New Zealand when they are cited or referenced in an act, regulation or rule. For example:
    - The Electricity (Safety) Regulations 2010 cite specific parts of AS/NZS 60335.2.40 for appliance safety. If an appliance doesn't comply with that standard, it may not be legally sold or connected in New Zealand.
    - The Health and Safety at Work (Hazardous Substances) Regulations 2017 cite standards like AS/NZS 60079 (for explosive atmospheres) and AS/NZS 5149 (for refrigerant safety).
- Standards not cited in an act, regulation or rule still serve as authoritative guidance or best practice, particularly in compliance audits, insurance and professional practice.
- Standards are, however, the floor and not the ceiling – that is, they are a minimum starting point.

Table 12: Relevant standards

AS/NZS 2712: 2007 Solar and heat pump water heaters – design and construction	Provides designers, manufacturers, installers and interested parties with performance-based design and construction requirements for solar and heat pump hot water supply systems.
AS/NZ 3000:2018 Electrical installations (known as the Australian/New Zealand wiring rules)	Sets out requirements for the design, construction and verification of electrical installations, including the selection and installation of electrical equipment forming part of such electrical installations. Note: The 2018 standard supersedes AS/NZS 3000:2007. However, the earlier 2007 edition remains applicable as it is cited in the Electricity (Safety) Regulations 2010. Users of this standard should consult with Energy Safety (part of WorkSafe New Zealand) for clarity and to confirm requirements as appropriate.
AS/NZS 3500.4:2021 Plumbing and drainage, Part 4: Heated water services	Sets out the requirements for the design, installation and commissioning of heated water services using drinking water. Includes aspects of the installation from the valve(s) on the cold water inlet, to the hot water storage cylinder or water heater, and the downstream fixtures and fittings. It applies to new installations, as well as alterations, additions and repairs to existing installations.
AS/NZS 4020:2018 Testing of products for use in contact with drinking water	Specifies requirements for the suitability of products for use in contact with drinking water, with regard to their effect on the quality of water. Particular consideration has been given to the suitability of non-metallic products for use in contact with water intended for human consumption, with regard to their effect on the quality of the water.
AS/NZS 4234:2021 Heated water systems – Calculation of energy consumption	Sets out a method for evaluating the annual energy performance of water heaters, using a combination of test results for component performance and mathematical models to

	determine the standardised annual supplementary energy use.
AS/NZS 4692.1:2005 Electric water heaters - Energy consumption, performance and general requirements	Includes performance test procedures, minimum performance requirements and a range of other requirements for water heaters. It also includes the revised test method for the determination of standing heat loss for electric storage water heaters, and the method for the determination of hot water delivery and mixed hot water delivery.
AS/NZS 5125.1:2014 Heat pump water heaters – Performance assessment – Part 1	Performance assessment methods for air-sourced heat pump water heaters.
AS/NZS 5149.1:2016 Refrigerating systems and heat pumps – Safety and environmental requirements – Definitions, classification and selection criteria	Requirements for the safety of persons and property in relation to refrigerating systems and heat pumps. Provides guidance for the protection of the environment, and establishes procedures for the operation, maintenance and repair of refrigerating systems and the recovery of refrigerants. Also specifies the classification and selection criteria applicable to refrigerating systems and heat pumps.
AS/NZS 5149.2:2016 Refrigerating systems and heat pumps - Safety and environmental requirements - Design, construction, testing, marking and documentation	Design, construction, testing, marking and documentation of refrigerating systems and heat pumps, including piping, components, materials and ancillary equipment directly associated with such systems. Includes specific requirements for testing, commissioning, marking and documentation.
AS/NZS 5149.3:2016 Refrigerating systems and heat pumps – Safety and environmental requirements – Installation site	Applies to the installation site (plant space and services), setting out requirements for the site for safety, regarding the refrigerating system and its ancillary components. Applicable to new refrigerating systems, extensions or modifications of existing systems, and for used systems being transferred to and operated on another site. Also applies to the conversion of a system to the use of another refrigerant.
AS/NZS 5149.4:2016 Refrigerating systems and heat pumps - Safety and environmental requirements - Part 4	Requirements for safety and environmental aspects regarding the operation, maintenance and repair of refrigerating systems; plus the recovery, reuse and disposal of all types of refrigerants, refrigerant oil, heat transfer fluid and refrigerating systems.
AS/NZS 60335.2.40:2019 or AS/NZS 60335.2.40:2023	Deals with the safety of electric sanitary HPWHs with a maximum rated voltage of not more than 300V for single phase appliances and 600V for multi-phase appliances. Appliances not intended for normal household use, but which nevertheless can be a source of danger to the public, such as appliances intended to be used in shops, light industry and on farms, are within the scope of this standard. Note: AS/NZS 60335.2.40:2023 will supersede AS/NZS

	60335.2.40:2019 from 30 June 2026.
Australia and New Zealand Refrigerant Handling Code of Practice 2025, Part 1	Code of practice for handling refrigerants in self-contained low-charge systems.
Australia and New Zealand Refrigerant Handling Code of Practice 2025, Part 2	Code of practice for handling refrigerants in systems other than self-contained low-charge systems.
EN 16147:2017 Heat pumps with electrically driven compressors – Testing, performance rating and requirements for marking of domestic hot water unit	A European standard which specifies methods for testing, rating the performance and calculating the water heating energy efficiency of certain heat pumps.
ISO 19967.1:2019 Heat pump water heaters	Sets out methods for testing and rating the performance of HPWHs for hot water supply.
NZS 4219:2009 Seismic performance of engineering systems in buildings	Sets out the criteria for the seismic performance of engineering systems that are related to a building's function. Covers the design, construction and installation of seismic restraints for engineering systems such as air-handling units, cylinders, cabinets, pipework and ductwork. To demonstrate compliance with the New Zealand Building Code's earthquake resistance requirements, it must be read along with verification method B1/VM1.
SA/SNZ MP 104:2021 Modelling of heated water systems in accordance with AS/NZS 4234:2021, using TRNSYS	Provides software tools to support the calculation of energy consumption, for use in evaluating the annual energy performance of water heaters and determining the standardised annual purchased energy use.
SNZ PAS 5210:2024 High-temperature heat pumps	Publicly available specification for high-temperature heat pumps – includes a lot of information that overlaps with this guide.
H1 Energy Efficiency verification method H1/VM3: Energy efficiency of HVAC systems in commercial buildings	Verification method for clause H1 of the Building Code. Table 7.2.1.2A provides minimum R-values for piping in HVAC systems for commercial buildings, which can be used as a recommended basis for installations of HPWH in homes, as appropriate.

Section 17: Relevant organisations

Table 13 sets out the websites of some relevant organisations.

Table 13: Relevant organisations

Acronym	Organisation	Website
ARI	Air-Conditioning and Refrigeration Institute (United States)	www.ari.org
ANSI	American National Standards Institute	www.ansi.org
ANZWHA	Australian and New Zealand Water Heating Association	https://www.anzwha.org.au/
AIRAH	Australian Institute of Refrigeration Air Conditioning and Heating	www.airah.org.au
ARC	Australian Refrigeration Council	www.arctick.org
CCC	Climate Change Commission	https://www.climatecommission.govt.nz/
DCCEEW	Department of Climate Change, Energy, the Environment and Water (Australia)	www.dcceew.gov.au
EECA	Energy Efficiency and Conservation Authority	https://www.eeca.govt.nz/
IRHACE	Institute of Refrigeration, Heating and Air Conditioning Engineers New Zealand	www.irhace.org.nz
	Master Electricians	https://www.masterelectricians.org.nz/
	Master Plumbers	https://www.masterplumbers.org.nz/
MPA	Master Plumbers Australia and New Zealand	https://masterplumbersanz.com/
NZS	New Zealand Standards (Standards New Zealand)	www.standards.govt.nz
RLNZ	Refrigerant License New Zealand	https://hvacrcentre.nz/rlnz/
RRA	Refrigerant Reclaim Australia	www.refrigerantreclaim.com.au
SAE	Society of Automotive Engineers (United States)	www.sae.org
SA	Standards Australia	www.standards.org.au