DRAFT FOR CONSULTATION

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Residential heat pump water heater installation - 2025

Good practice guide

EECA
TE TARI TIAKI PŪNGAO
ENERGY EFFICIENCY & CONSERVATION AUTHORITY

Contents

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This Guide draws some inspiration from, and makes some reference to, the 'High-temperature heat pumps' Publicly Available Specification (PAS), which EECA sponsored and is published by Standards New Zealand as SNZ PAS 5210:2024. The PAS is freely available for anyone to download and use but remains the copywritten property of Standards New Zealand.

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Each 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 provided in this Guide is intended to give general assistance to help the installer and should not be regarded as definitive and comprehensive, nor should it be deemed as legal advice of any sort, or an interpretation of legislative requirements on the part of the installer.

Foreword from EECA Chief Executive

(TBC)

EECA's vision is to help mobilise New Zealanders to be world leaders in clean and clever energy use, through the use of energy efficiency, empowering energy users, and accelerating renewable energy.

Heat pump water heaters, also known as hot water heat pumps, are just one tool which can support our strategy for residential hot water efficiency.

This work programme, and HPWHs as a wider application of this technology, contributes towards EECA's Horizon Plan as well as focusing on areas of efficient Hot Water and a well-functioning 'Smart Energy system'.

Kiwis are innovative and smart, and quick to adopt clean, green and energy efficient appliances for a better tomorrow.

1 Introduction

1.1 Purpose of this Guide

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

Some manufacturers and/or 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's sake are referred to here as 'heat pump water heaters' or HPWHs.

EECA recommends that HPWH systems are only installed by experienced installers and not attempted as DIY projects by homeowners.

Plumbers and 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 significantly influence decision-making. Tradespeople should be motivated to recommend HPWHs as an alternative to traditional water heaters (where appropriate), highlighting the energy savings, cost benefits, and environmental advantages.

This Guide provides good-practice Guidelines for the specifying and installing the most common types of 'packaged' residential air-to-water HPWH systems – these being:

- all-in-one systems,
- split systems connecting to the cylinder with a refrigerant loop,
- split systems that connect to a hot water cylinder via a hot water loop, and
- split systems that connect to a hot water cylinder via a refrigerant and hot water loop.

However, the Guide does not cover the installation of:

- Multi-purpose HPWH systems – such as those also used to heat non-potable water, air (space/central heating), or other applications.
- HPWH for commercial and industrial applications.
- Custom designed or bespoke HPWH systems which are considered to be systems where one or more of the components are specially designed and manufactured for that specific application. This Guide is focused on 'packaged' commercially available HPWH systems.
- HPWH systems powered by energy sources other than electricity e.g. heat-driven heat pumps, such as absorption heat transformers or absorption heat pumps.
- Ground-sourced (ground-to-water) or water-sourced (water-to-water) heat pump systems.
- Solar boosted systems.
- Multi-user dwellings – where a HPWH system supplies hot water (HW) to more than one domestic dwelling e.g. apartments, flats etc.
- Weathertightness and airtightness of the building envelope, and structural integrity (although this must be maintained at all times).

1.2 Background and Context

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

Heat pump water heaters (HPWHs) are an energy efficient and low carbon emissions technology which can reduce hot water energy consumption by 50% or more, which equates to household energy savings of 15% or more.

While they 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 water heaters, instantaneous gas, and gas storage water heaters.

A comparison of typical household water heating costs is shown in Figure 1 and Figure 2.

Figure 1: Comparison of household water heating costs

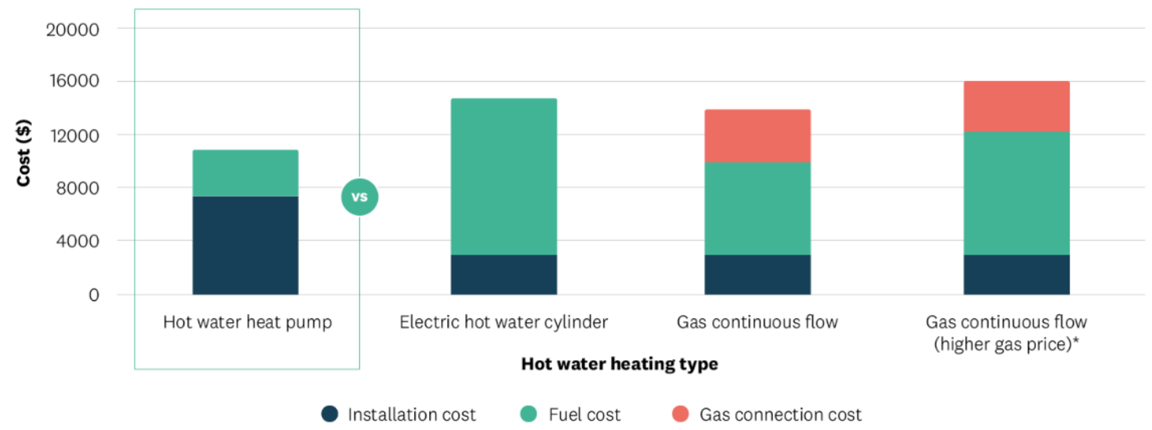
	Unit and installation cost	Running cost p/y	kg CO2 emissions
Hot water heat pump	$7,500	$333	149
Electric hot water cylinder	$3,000	$1,176	527
Gas continuous flow	$3,000	$1,071 / $706*	969

*Excludes annual gas connection cost

Very low — High

* Based on a four-person household with average hot water usage. A full list of assumptions and can be found in the reference list at the end of this page.

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



*As residential gas prices can vary significantly and future pricing is uncertain, a higher gas price case is included here for comparison. Calculations are based on a four-person household with average hot water usage. A full list of assumptions and can be found in the reference list at the end of this page.

Ref for both figures: https://www.eeca.govt.nz/insights/eeca-insights/hot-water-heat-pumps-in-the-home/

[1] https://www.eeca.govt.nz/insights/eeca-insights/heat-pump-water-heater-product-research/ and Energy End Use Database | EECA

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. Some situations are more straightforward e.g. new-builds or as a replacement for an existing hot water system that is no longer meeting a homeowner's needs i.e. where the existing system 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. Installers should consider the homeowner's requirements before recommending a HPWH.

For over two decades now, heat pumps have been a popular choice for heating our homes across New Zealand, as they are energy efficient, clean and convenient[2].

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 our homes or our domestic hot water. Typically, space heating and water heating appliances each account for around one-third of our home energy use, so the savings they deliver through their high energy efficiencies can help us save energy, save money and reduce greenhouse gas emissions.

The performance of HPWH systems can vary considerably, depending on the type of heat pump selected, the quality of the installation, and what climate they are installed in.

HPWHs are still a relatively new technology in New Zealand - it is estimated that there are around 18,000 HPWH systems installed in New Zealand homes, compared to almost 1.5 million electric storage water heaters and 0.5 million gas water heaters[3]. 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%). It is estimated that heat pump water heaters could achieve around 40% of this market by 2036[4].

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 installed over 50 HPWHs in homes around the motu, to monitor and demonstrate how these products meet the needs of homeowners, 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 this 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/

[2] 2023 Census population, dwelling, and housing highlights | Stats NZ

[3] Residential Baseline Study of energy use in residential sectors of Australia and New Zealand

[4] Heat pumps - Emerging trends in the Australian market

1.3 Inclusions

The following is a summary of the sections in this Guide and a brief overview of what is covered in each section.

Section 1 - is an introduction to HPWHs in general, in terms of how they work, and factors to consider when selecting and installing a system.

Section 2 - gives an overview of the four most common types of residential HPWH systems, their various benefits or limitations, and 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 other key elements to consider when selecting and sizing a HPWH such as sizing, hot water demand, demand flexibility, 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 you will need to have before starting an installation.

Section 6 - is dedicated to refrigerant pipework. It provides a comprehensive explanation on types of pipework and joints, how to make bends and ensure pipework is supported, and 'first-fit' or pre-installation work Vs commissioning in new-build houses.

Section 7 - explains the main work elements when installing the HPWH system. This is broken down by the four main system types so that installers need only consult the section relevant to the HPWH type being installed.

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

Section 9 - covers electrical requirements, including inverter requirements, multi-phasing, essential load redistribution, installation guidance, and basic design considerations.

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

Section 11 - explains customer instructions for the owner and a checklist for using the HPWH efficiently.

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

Section 13 - covers decommissioning of the HPWH at the end of its life.

Section 14 - is a glossary of terminology used throughout the document.

Section 15 - covers the various regulations, and useful reference documents that might help you.

Section 16 - covers relevant Standards.

Section 17 - covers relevant organisations.

1.4 Advantages of HPWHs

There are a number of advantages of HPWHs over other forms of water heating, and these include:

- HPWHs are much more energy efficient than their ESWH or gas counterparts.
- HPWHs run on electricity, which has a lower carbon footprint than fossil fuels, such as gas.
- HPWHs use a water storage cylinder so don't necessarily have to consume power at the same time that the hot water is drawn, meaning they can make use of cheap, off-peak electricity and can 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.
- HPWHs do not require space to store fuels such as LPG bottles and do not produce combustion gases.
- HPWHs have a lower whole-of-life energy footprint and net-cost than traditional hot water(HW) systems.

1.5 Limitations of HPWHs

Limitations and potential disadvantages of HPWHs compared with other forms of water heating include:

- HPWHs are more expensive to purchase and install than an equivalent traditional HW system. However, in most cases the 'whole of life' costs (by taking into account the running costs of the hot water system) will work out less expensive than an equivalent electric/ESWH or gas water heater.
- A perfectly good, operating water heater should generally not be replaced with a HPWH system, as this may not be financially viable.
- Their heating capacity and performance reduces at lower ambient temperatures.
- In some cases, HPWHs can be grossly oversized (and are correspondingly more expensive) where concerns about performance and delivery are over-compensated for.
- HPWHs may have greater heat losses if the storage cylinder is installed outside.
- HPWHs may increase demand for peak electricity if they are replacing a gas system or replacing an ESWH that was operated on night rate or ripple-controlled electricity. In the case of night rate or ripple-controlled electricity, this can also reduce the HPWH's energy cost savings. For more information on this, see section 4.3.2.
- All refrigerants have various risks and hazards associated with them such as toxicity, flammability, global warming potential (GWP), and ozone depletion potential (ODP). Therefore, it is essential that the handling of any refrigerants during installation and decommissioning is undertaken with appropriate caution and care, ensuring pipework is leak-free to ensure that no harm is caused by any refrigerant leakages.

1.6 HPWH Myths

There are numerous myths, misunderstandings and incorrect information in relation to HPWHs that may impact on the current and future uptake of HPWHs and should be discredited. These include:

Myth	Truth
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 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 just need a bigger cylinder or a system with a faster recovery rate.
HPWHs are too expensive to install and not worth it	Upfront costs are higher than a standard ESWH, but operating costs can be significantly lower - often using 60–70% less electricity. Over time, this can add up to major savings.
HPWHs are noisy	While HPWHs do make some noise (like any fridge or air conditioner) it's generally around 40–55 decibels[5], and most are relatively quiet. Proper installation (away from bedrooms or quiet areas) helps to eliminate this as a real issue.
HPWHs don't work when it's raining or cloudy	This myth often gets mixed up with solar water heaters. HPWHs extract heat from the ambient air, not the sun, so they work fine when it's cloudy, raining, or even in the middle of winter.

1.7 Before you start work

Good design, selection and installation of a HPWH is fundamental to their effectiveness and efficiency. This involves understanding the importance of correctly 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 works as part of an installation. The installation of any HPWH system should be carried out by a suitably qualified installer or installers who is/are:

- licensed to carry out the electrical work,
- qualified to carry out the plumbing work,
- hold an Approved Filler Compliance Certificate[6] for the handling of refrigerants, where required, i.e. for split systems where the cylinder and heat pump are connected by a refrigerant pipe,
- licensed to carry out any necessary gas work, where relevant,
- has the correct toolkit to allow them to carry out the work (Refer to section 5).

Know your Regulations and Standards

Mandatory Regulations and Standards which apply to installing a HPWH include the following:

Regulations:

- Building Code Clauses B1 Structure, E2 External moisture and G9 Electricity.
- Plumbing Code – as described in New Zealand Building Code section G12: Water Supplies

[5] 40 dB is typical in a library; 55 dB is typical of moderate rainfall.
[6] https://www.worksafe.govt.nz/topic-and-industry/hazardous-substances/certification-authorisation-approvals-and-licensing/certification-of-people/approved-fillers/

- Building Consent requirements
- Electricity (Safety) Regulations, including the cited edition of AS/NZS 3000 Electrical installations (known as the Australian/New Zealand Wiring Rules)
- New Zealand electrical codes of practice https://www.worksafe.govt.nz/laws-and-regulations/electrical-and-gas-codes-of-practice/electricity-codes-of-practice/
- Health and Safety at Work Act (HSWA) 2015
- Hazardous Substances and New Organisms Act 1996 (HSNO)
- 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

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
- Potable water - heated water systems shall be installed in accordance with AS/NZS 3500.4 Potable water heaters water system shall comply with AS/NZS 4020
- Seismic performance of systems in buildings including restraints in accordance with NZS4219:2009

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

Warranty
Ensure that the homeowner is made aware of the warranty provided for each component of the system, including period and terms.

2 Heat pump water heater systems

2.1 How does a heat pump water heater work?

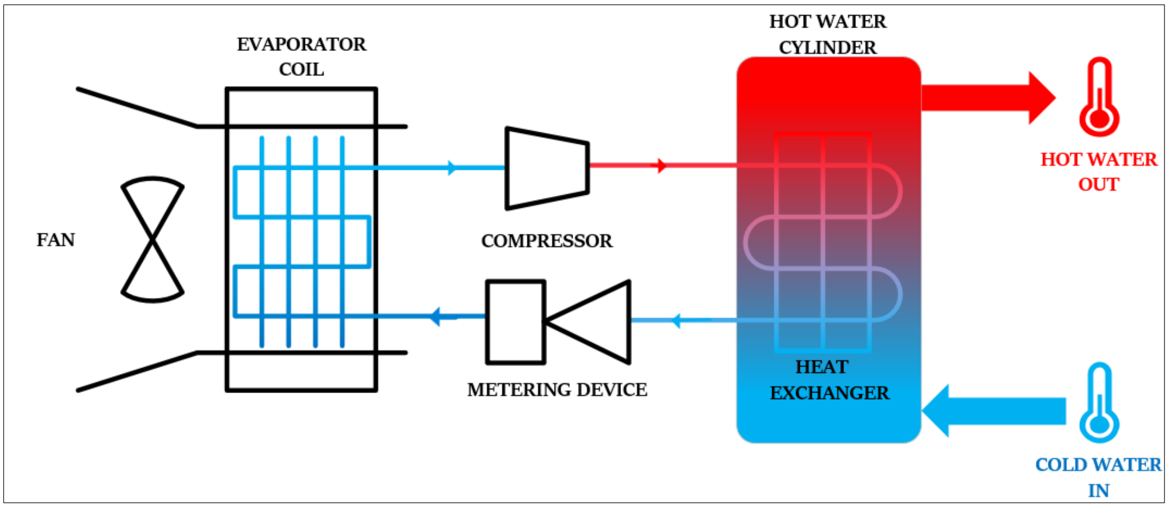
HPWHs work on the same principle as a refrigerator, but instead of pumping heat out of the fridge to keep it cool, they pump heat from the outside air into the water.

A fan draws in air, containing heat energy, across the evaporator coil. This turns the liquid refrigerant into a gas and the compressor pressurises the refrigerant into a hot gas. The hot gas passes through a condenser coil, where it transforms from a gas to a liquid, giving its heat to the water. The liquid refrigerant then flows back to the evaporator coil to repeat the cycle until the desired temperature is reached.

HPWHs are powered by electricity, but 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 a storage cylinder, they are roughly three times as efficient as a conventional electric resistive water heater.

A simplified illustration of the process can be seen in Figure 3.

Figure 3: Schematic diagram of an air-to-water heat pump



Note, in colder climates it is important to choose a HPWH that has been specifically designed for the cold i.e. it will still work and provides a reasonable level of energy efficiency.

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, as follows:

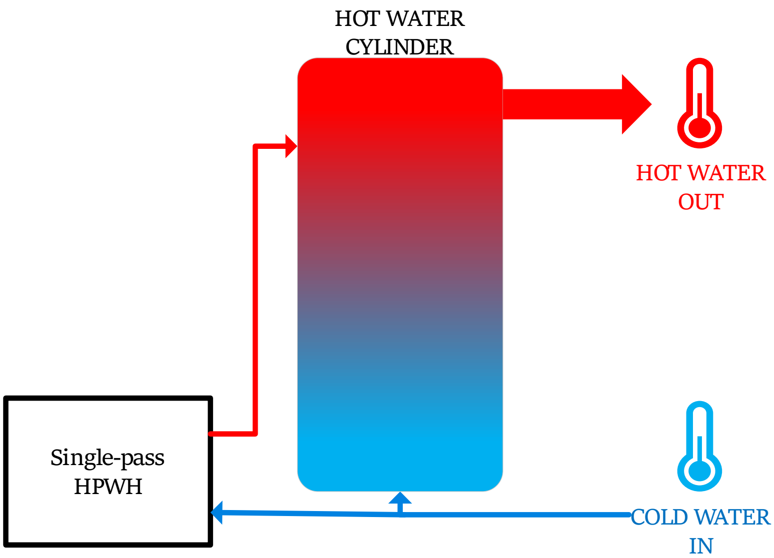
- **All-in-one HPWH**: where the entire HPWH is contained in one housing. Within the housing the condenser may be **integral** to the cylinder (i.e. no circulation of water is required), or **stand-alone** (requiring a circulating pump to move water from inside the cylinder to the condenser (heat-exchanger) and back). These systems may also be 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 to 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 separated to the cylinder). Heat energy is then transfer from the condenser to the cylinder using a water loop.

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

Single-pass systems heat the water in 'one-shot'. They may be particularly suited to instances where the demand exceeds the capabilities of integral units.

Figure 4: Schematic diagram of a multi-pass heat pump water heater



Single-pass systems have the following main advantages:

- They can rapidly recover hot water once the cylinder is depleted
- They can produce usable hot water in real time
- Reduced volume of water storage is required
- They take advantage of the natural thermal stratification[7] that occurs in a "push through" hot water storage cylinder. This increases the sub-cooling[8] and therefore the overall efficiency of the HPWH system,
- They may 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 better suited to replacing instantaneous gas or electric HW systems (i.e. those without a hot water storage cylinder).

However, when a single-pass heat pump unit is connected to reticulated-return system (a ring-main[9]), additional care is required to maintain the thermal stratification within the storage cylinder. Note that 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.

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

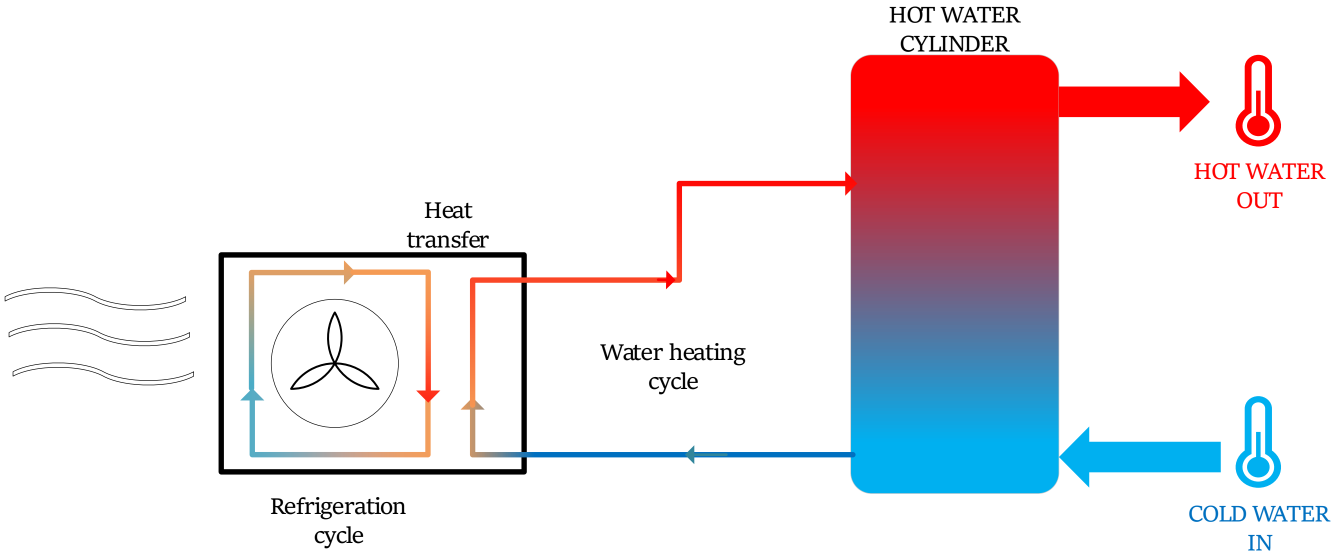
[8] Cooling a liquid refrigerant below its saturation temperature (or condensing point) to ensure it enters the expansion valve in a fully liquid state, preventing flash gas formation and improving system efficiency.

[9] 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 COPs that are worse than supplying hot water locally with a small indoor electric resistance water heater.

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 they circulate water many times between the heat exchanger and the cylinder, with only a small temperature rise each time.

An illustration of a multi-pass heat pump water heater is shown in Figure 5.

Figure 5: Schematic diagram of a multi-pass heat pump water heater



The characteristics of 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 heat pump 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 COP rating, but as the cylinder approaches the setpoint temperature, the COP drops significantly.

The main types of HPWH systems are addressed in the following sections:

2.3 All-in-one HPWHs

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 (heat-exchanger) and back).

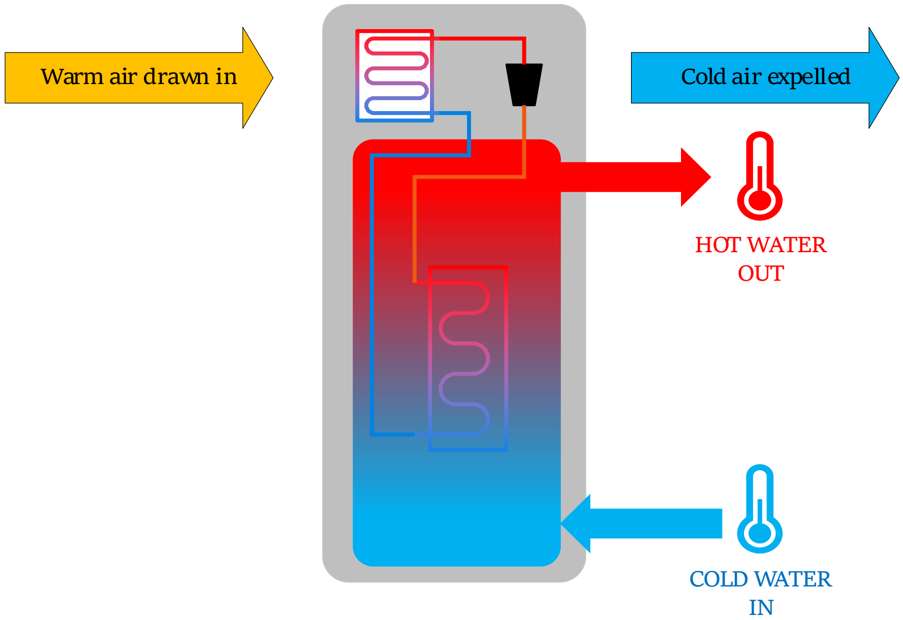
All-in-one systems take up less space than a split system and can be simpler and cheaper to install.

However, they are generally heavier than split systems and must be installed outside as they would draw heat from the surrounding living space and have insufficient air flow and capacity to support the unit's operation.

An illustration of an all-in-one HPWH is shown in

Figure 6.

Figure 6: Illustration of an all-in-one HPWH

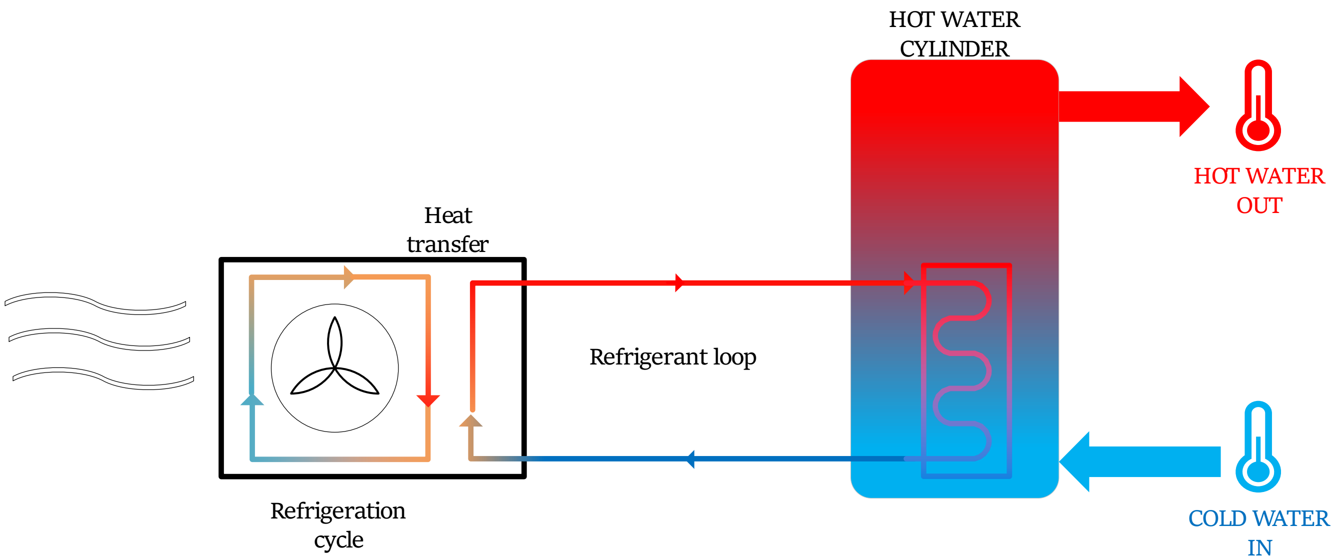


2.4 Split-refrigerant loop HPWHs

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

A diagram of a split–refrigerant loop HPWH is shown in Figure 7.

Figure 7: Split – refrigerant loop HPWH

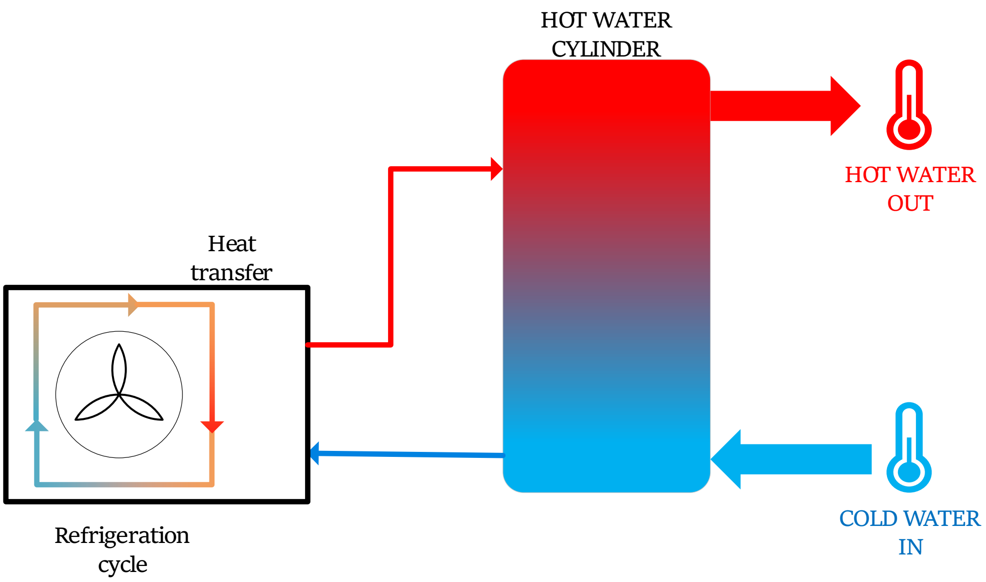


2.5 Split-water loop HPWHs

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.

A diagram of a split-water-loop HPWH is shown in Figure 8.

Figure 8: Split-water loop HPWH



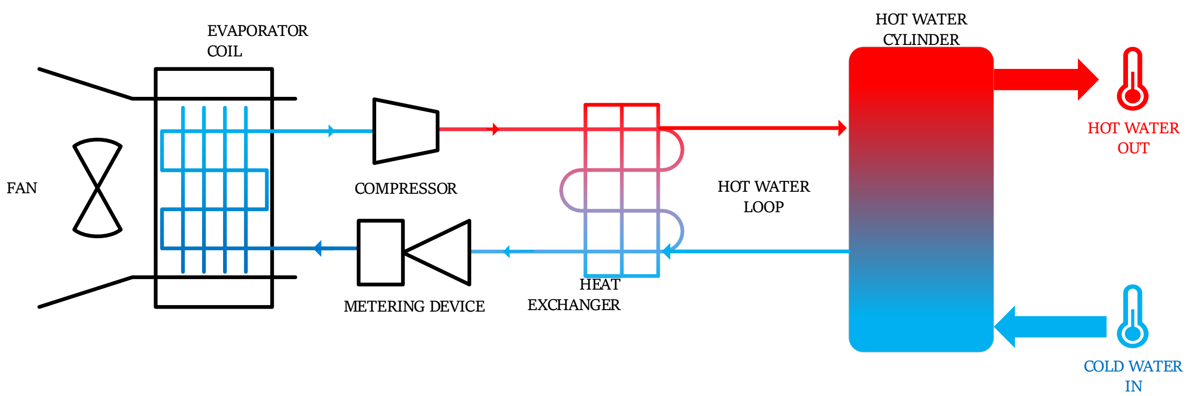
Some suppliers call the refrigerant the 'primary fluid' and the hot water loop the 'secondary fluid'. They have the advantage of decoupling the outdoor and indoor units and not requiring a refrigerant loop to be run between the outdoor and indoor units, which may be advantageous where the system is being retrofitted to an existing HW cylinder. However, they 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: 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 outlined in AS/NZS 3000:2018 and AS/NZS 4020, 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.

A diagram of a split-water-loop HPWH is shown in Figure 9.

Figure 9: Schematic diagram of a 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
1 Fan	A fan draws ambient outside air across the evaporator coil and expels the cooler air away from the coil.
2 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 the 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.
3 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).
4 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.
5 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.
6 Refrigerant Pipework	The refrigerant flows around a continuous, closed-circuit/sealed pipework system. Insulation should be fitted to the pipework to reduce heat losses. (see Section 6.1 Refrigerant pipework installation).
7 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.
8 Hot Water (HW) 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)*. • The 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.
9 Expansion valve[10]	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 which causes 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.

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

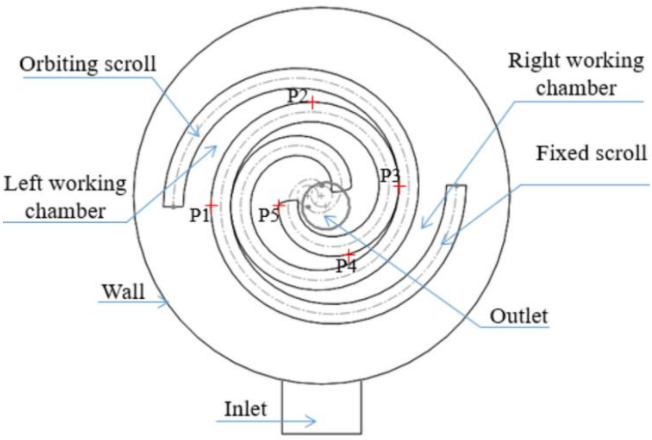
2.7 Compressor types

Domestic HPWHs commonly sold in New Zealand utilise scroll or rotary compressors, known for their efficiency and reliability.

- **Scroll Compressors:**

These are a popular choice for HPWHs due to their ability to provide high efficiency and reliability. Scroll compressors contain two interleaving scroll plates, resembling spirals, one being stationary and the other orbiting eccentrically.

Figure 10: Diagram of scroll compressor



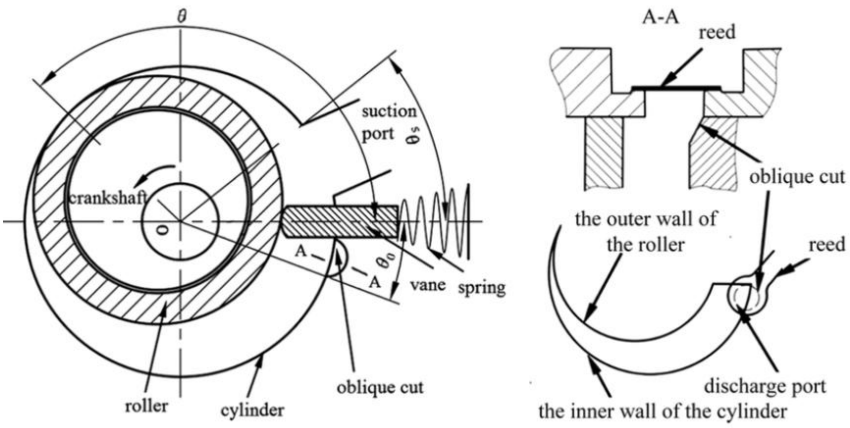
https://www.researchgate.net/figure/Two-dimensional-schematic-diagram-of-the-scroll-pump_fig2_354817249

[10] Refer to Section 2.5.5 of SNZ PAS 5210:2024

- **Rotary Compressors:**

Another common type, rotary compressors 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.

Figure 11: Diagram of rotary compressor



https://www.researchgate.net/figure/A-schematic-diagram-of-a-rotary-compressor_fig1_325574415

2.8 Mains Vs. low-pressure systems

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

In particular, mains-pressure systems are becoming increasingly common in new builds, whereas retrofitting a mains-pressure system to replace a low-pressure system 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 of mains pressure vs low pressure systems can be found in Table 4.

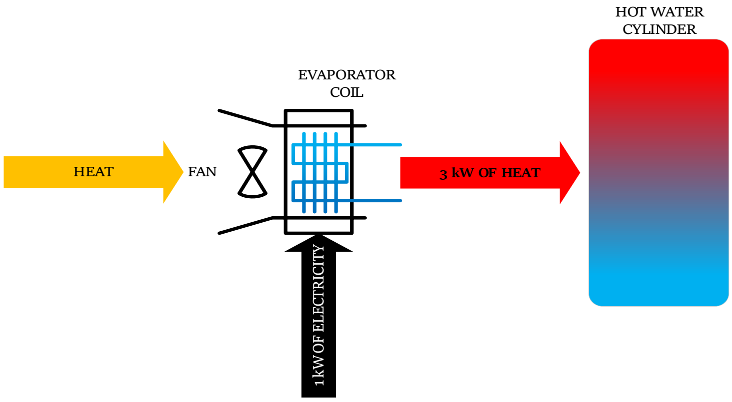
3 Heat pump water heater performance

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

Understanding the performance of HPWHs is essential when it comes to selecting the right system for a householder's requirements. This is covered in more detail in section 4 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: Schematic of heat pump water heater performance



However, in practice, there are many factors which can 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 HPWH size is matched to meet to the water heating demands (see section 4.2.1),
- Type of refrigerant used (see section 8),
- Timers and/or demand flexibility capability,
- Settings, such as setpoint[11].

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 electrical energy input used to operate the system. This is called the coefficient of performance (COP), as defined below.

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

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 systems on their 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 with a specific ambient temperature and starting and end water temperature. 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 stated.

HPWH efficiency is sometimes presented as annual energy use and/or seasonal COP (SCOP), in accordance with AS/NZS 4234, which is a more representative annualised figure as it includes standby power and factors in how the COP may change throughout the year under varying climatic conditions.

3.2 Energy performance testing

Unlike space-heating heat pumps, EECA does not currently regulate HPWH for energy efficiency and therefore there is no mandatory energy efficiency testing, labelling, or minimum performance that must be met.

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

The most widely used Standards to determine performance 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 Energy consumption, performance and general requirements for Electric water heaters**
- **SA/SNZ MP 104:2021 Modelling of heated water systems in accordance with AS/NZS 4234:2021, using TRNSYS**
- **ISO 19967.1:2019 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 can be found in the Standards which are all 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 the heating capacity of a HPWH system are not constant, unlike traditional electric storage water heaters, or gas water heaters. They are dependent on a number of factors, but particularly the:

- Outdoor air temperature (and humidity),

- Incoming temperature of water to the system, and
- The desired end water temperature.

A HPWH's efficiency and capacity may be 'rated' for a particular outdoor temperature and humidity, but when selecting a system, it is important to understand how the system will perform for the climatic conditions it is being installed in.

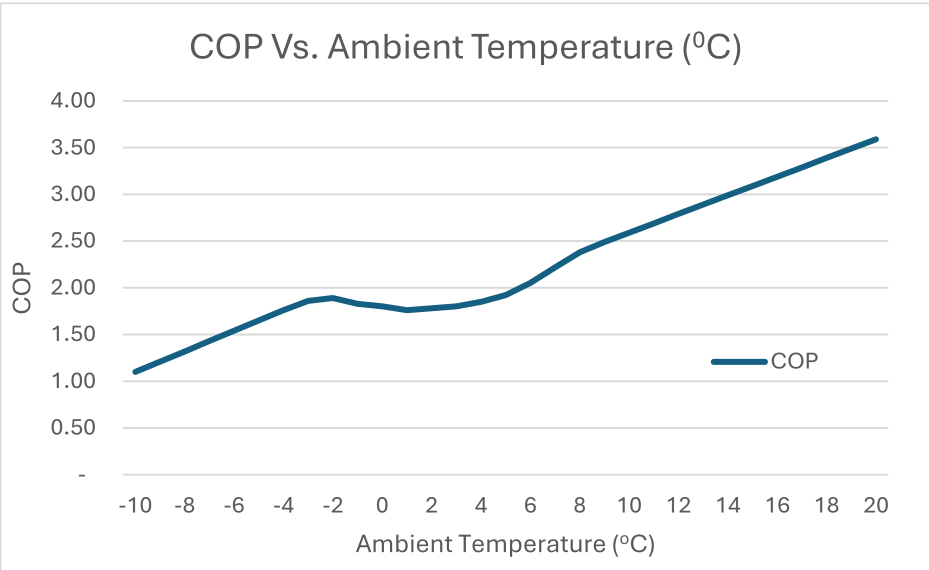
As the outdoor temperature varies, so too does the efficiency of the HPWH. This is illustrated in Figure 13, which shows a typical trend of HPWH efficiency over a range of temperatures that might be experienced in some parts of New Zealand.

The incoming cold water temperature has an impact on COP as colder water will require more energy to get it up to temperature (temperature lift). 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.

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 below.

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

Figure 13: Graphical representation of heat pump efficiency



Another key temperature-related factor that affects heating efficiency is the extra energy required for defrosting at low temperatures. At temperatures of around 0 – 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 Section 0

Impacts of defrost cycle on efficiency and hot water output and section 4.2.3 Step 3:

Heat pumps are usually tested for efficiency and output capacity 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 give significantly different levels of performance.

Test results for the different temperatures may help in choosing a suitable HPWH for an area where it is being installed, particularly in colder regions.

3.4 Impacts 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 the defrost cycle.

A defrost cycle may be necessary to remove the build-up of ice on evaporator coils. Ice build-up occurs 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 will disrupt the heat flow, and the coils must be de-iced before the unit is able to continue heating the water in the cylinder.

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

- **Reverse-cycle operation -** where the system temporarily reverse/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/short-circuit is created, which captures heat from the compressor motor, which it uses 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 frost build-up on the outdoor coil, by monitoring air and coil temperature, outdoor airflow, pressure differential across the coil and refrigerant pressure.

Systems that include a dry-coil defrost cycle[12] may run the outdoor fan at its maximum speed for a short-period before the system starts to heat again, in order to remove any water that may still be on the coil fins and would otherwise immediately refreeze. This operation can sometimes be seen as water vapour being blown from the evaporator unit before the heating cycle resumes.

During the defrost phase no heat is supplied to water in the HW storage cylinder.

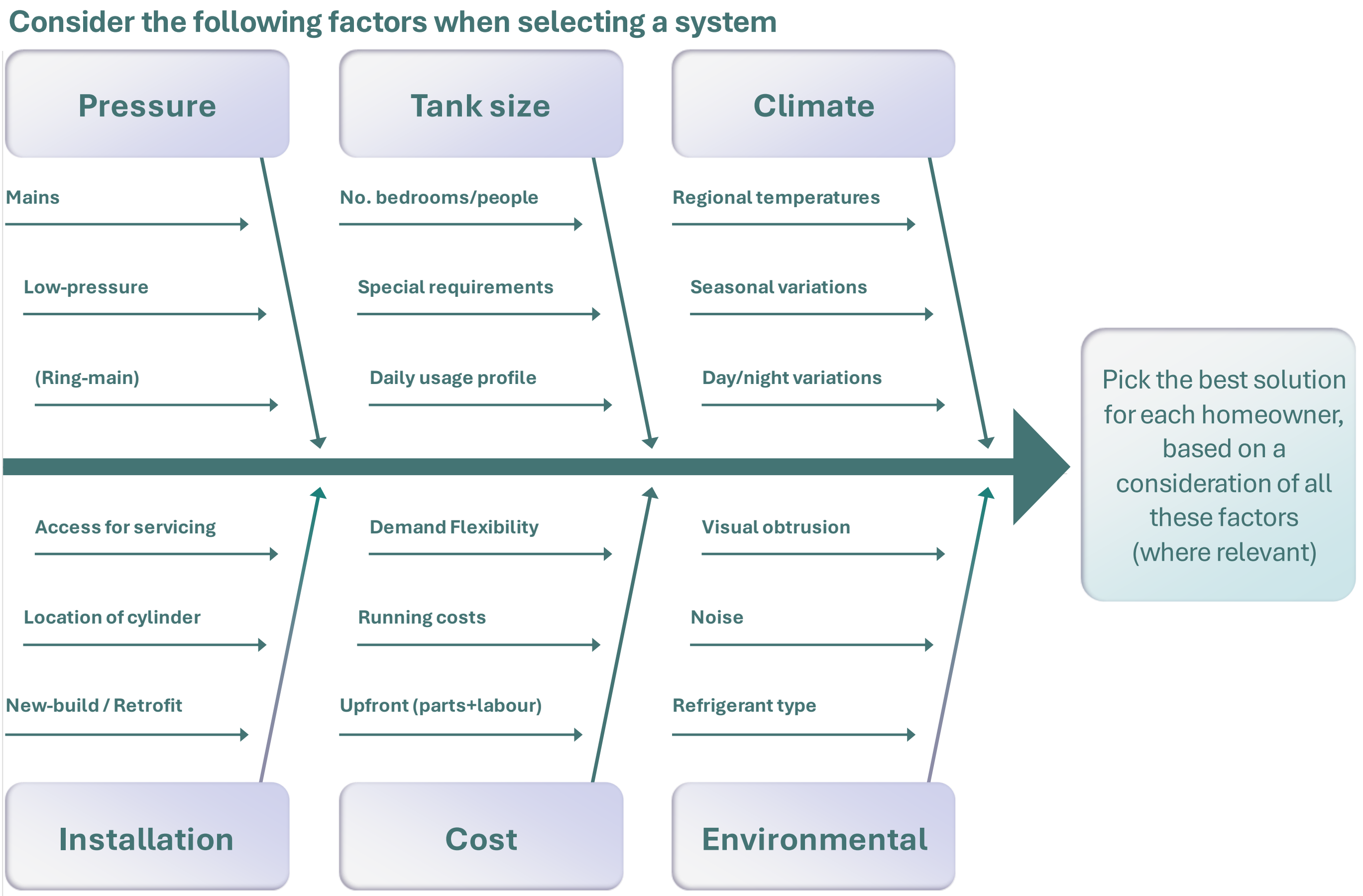
HPWHs which are undersized or not suited to the local climate will need to defrost more frequently in low ambient temperatures, which greatly reduces the system's efficiency and their ability to provide sufficient hot water.

[12] This uses the outdoor fan briefly at maximum speed to remove moisture from the coil fins before the system resumes heating, preventing ice buildup and ensuring efficient operation.

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.

Figure 14: Factors to consider when selecting a HPWH system



Before selecting a suitable unit, it is advisable to discuss the homeowner's needs and also to 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 a HPWH being a good, or not so good, option for a homeowner, as detailed in Table 2.

Table 2: Factors impacting on whether a HPWH 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, so 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 0.9 kW of power, and a booster element, where fitted, will typically draw another 1.5 to 3.5 kW. Householders 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/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/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 certain types of hot water system being replaced – see Table 5 for more details.
Access to solar photovoltaic (PV)	Households with solar PV 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 piping to circulate hot water 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 and 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 different types of HPWH is provided in Table 3.

Table 3: Comparisons between HPWH 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 HW cylinder cupboard and 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 (HW cylinder cupboard).
Split systems, with a hot water loop	May be installed in new houses or retrofitted in homes with an existing HW cylinder cupboard. May potentially be retrofitted to an existing ESWH cylinder if the heat pump has a built-in heat exchanger.	Requires additional HW pipework, which may be more problematic for retrofits. Requires internal space (HW 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 HW cylinder cupboard. Saves space inside the home.	No airing cupboard. Increased standing heat losses, as HW 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: Comparisons between low and mains pressure HPWH 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 HW 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 manufacturers 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 HW 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 considerations 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 (GWH)	May be better suited to integral 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 (GSWH)	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/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 (ESWH)	May be better suited to split systems, as it retains the HW 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/payback if the current ESWH is on a low rate plan.

Other considerations

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 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 circuit breaker whereas others may not. Some may require an upgrade to heavier duty wiring e.g. 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. Cheaper models may fail sooner (~5-7 years), while high-end units should last 10-15+ years.
- Cylinder material: Stainless steel cylinders resist corrosion better than standard steel with a liner, potentially increasing lifespan.
- Refrigerant.
- Noise.
- Warranty.

4.1 The importance of correctly sizing a HPWH: performance and durability

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 and cause them to wear and shorten the product's life and make them less efficient.

Therefore, 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 which 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, like the majority of ESWHs, may take advantage of off-peak low-cost electricity so 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 4.3.2.

If the heat pump capacity is too low, the system will use more energy than necessary (resulting in increasing running costs, and wear and tear), will likely 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 a booster element, if fitted, to switch on too often, which is just as inefficient as a cheaper 'simple' ESWH.

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

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

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

However, greatly oversized cylinders may require more energy to heat them and have greater standing losses.[13]

[13] 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.

Factors to be taken into consideration when sizing a HPWH system include:

- The number of adults and children in a home and the number of bedrooms.
- Mains pressure Vs low pressure hot water systems i.e. when replacing low pressure with mains pressure you get a better ‘output’ (although consider installing efficient/low-flow shower-heads), but you might also need to replace some fixtures/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 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 Vs ‘smart’ control? Booster Vs. sanitisation Vs. 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-user dwellings. This Guide only covers single dwellings, and a larger or different type of system may be required for multi-user dwellings.

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 – e.g. cold showers.
	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 0 for impacts of defrost cycle on efficiency and heat output).	· Not enough hot water – e.g. cold showers. · 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.

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.

Storage and delivery temperatures

The storage and delivery temperatures (particularly where a TMV15 is installed) also need to be factored into the sizing calculation, as they will affect the sizing of the necessary cylinder.

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

4.2 Steps for selecting a heat pump water heater system

4.2.1 Step 1: Determine the hot water load requirement

Items to consider when determining the hot water requirements of a household include:

- Number of occupants in the household.
- Number of bedrooms in the home.
- What hot water is required and when is it required? 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 8 on design temperatures)?
- What type of home is the system for? For example, old, new, 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 so, more than one HPWH may be required).
- What controllability does the owner want e.g. set point, different modes, timers?
- Does the owner want to future proof and get a 'demand flex ready' unit? See section 4.3.2 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 used as a starting point, and adjusted based on the homeowner's needs e.g. 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, and adjusted based on the homeowner's needs e.g. baths, washing machines that draw hot water etc.

Table 7: Determining hot water demand and capacity of HPWH systems[16]

Number of bedrooms	Daily hot water demand from the cylinder
2	100L

[15] Thermostatic Mixing Valve
[16] Use AS/NZS 4234 for daily heating-demand and water-draw profiles (time of day, climatic conditions, etc)

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 calculate the required heating capacity for the heat pump and a suitably sized cylinder. Note that demand is not the same as capacity i.e. a 250l cylinder might be sufficient to deliver 300l of hot water per day with some cold water being heated/reheated or could just be considered to be a safe/sufficient size for 200l demand a day with a safety-buffer.

4.2.2 Step 2: 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 the owner in that climate. The HPWH's capacity at that temperature will likely be different to the rated capacity.

It is less critical to consider likely extreme low temperatures when designing a HPWH system compared with a space heating system where heat is required whenever the occupants want heating. HPWHs could be limited to operating at warmer hours of the day so a typical, yet not extreme, daily low temperature could be used for HPWH system design. 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 NZ. Furthermore, some products have boosters to help ensure that sufficient hot water is available in low ambient temperature situations.

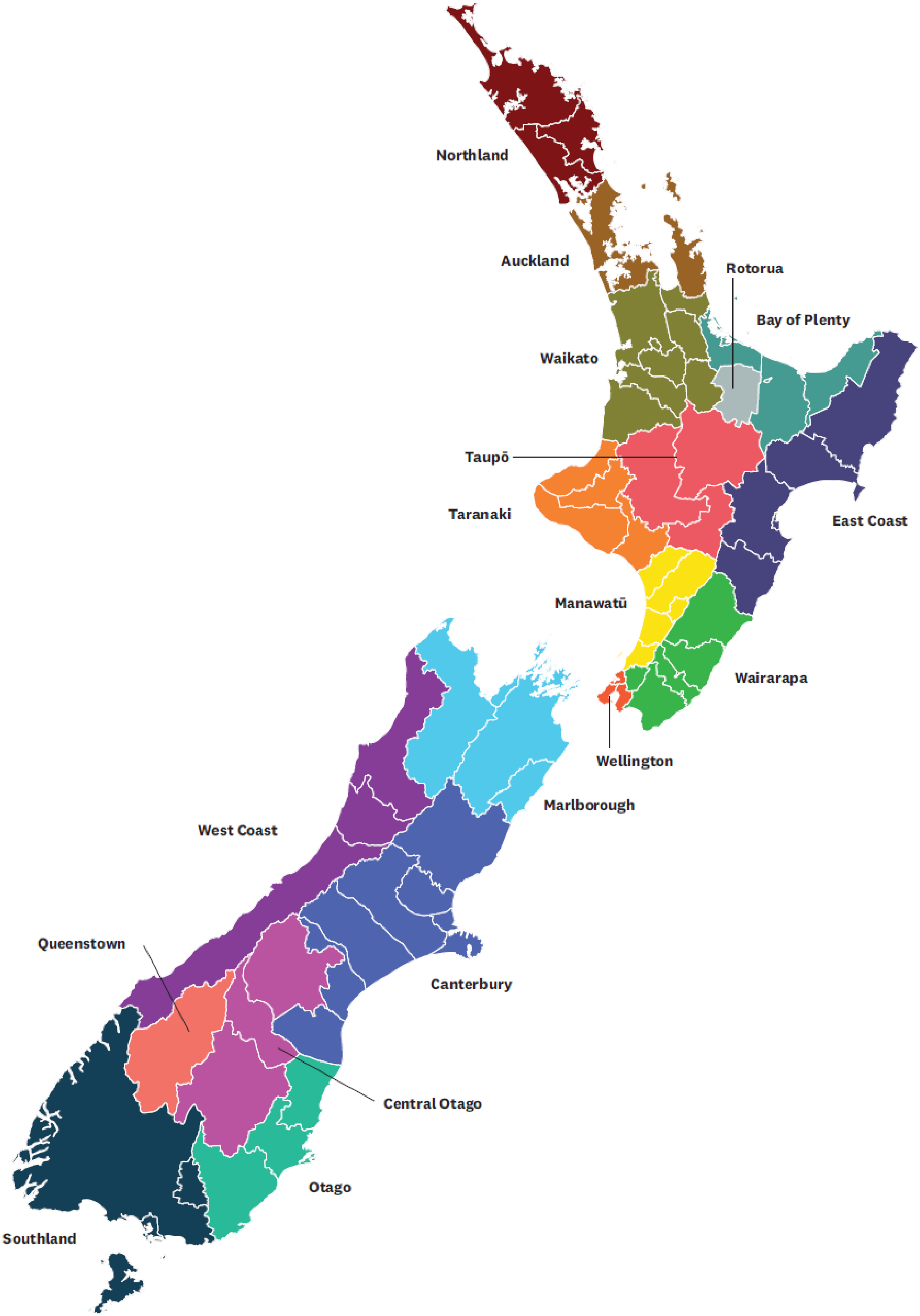
Table 8 lists the assumed external design temperatures for a range of climatic zones across New Zealand, approximately grouped by territorial authority districts (local councils). This is also illustrated in Figure 15.

Note that there may be some variation within each area, hence a range is given, depending on the specific location i.e. bottom of a valley Vs flat, open areas. If the location where the HPWH is being installed has a particularly severe climate or microclimate (for example, a sunless or damp valley), this needs to be taken into consideration, and the design temperature may be one or two degrees lower.

Table 8 Determining the external design temperature for a HPWH based on the location by climate zones

Climate Zone	Territorial Authorities (approx.)	Minimum design temperature (Deg 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: Illustration of the climate zones, when considering the external design temperatures for a HPWH



4.2.3 Step 3: Select a system to meet requirements

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

Consider also the plumbing layout of the home such as pipe runs to the storage cylinder and fixtures and fittings.

What is 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, and also, the recovery rate of the HPWH needs to be considered in the context of the size of cylinder that can be installed.

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

The recovery time for a HPWH system can vary, but generally, it takes longer than a traditional electric or gas water heater (due to slightly lower heating capacity). The reheat capacity of an ESWH is typically 2-3kW. HPWHs are often lower than this (1.5-2kW). As a result, a HPWH may require a slightly larger cylinder than an ESWH.

Recovery time can be up to several hours after depleting the cylinder with multiple showers. A faster recovery rate is 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.
Consider how long a system will take to heat a specified quantity of water.

Consider any special requirements of the **environment** that the HPWH is being installed in.
Geothermal regions may require the outdoor unit and pipework to be protected against atmospheric sulphurous gases that can cause corrosion.

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, along with considering other factors such as cost and efficiency, select a HPWH that uses a refrigerant with the lowest global warming potential (GWP) practicable – ideally, a GWP 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 below the external design temperature.

4.3 Other considerations

4.3.1 Booster elements

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

- Exceptionally cold conditions, and/or periods when the HPWH is defrosting for extended periods,
- An unusually high demand for hot water – e.g. after a holiday, or when additional people are visiting.

In some of these cases, a booster or backup element may be used to help address these issues.

However, as an electric element only has a COP of approximately 1, this is less than ideal from an energy efficiency perspective and will lower the overall efficiency of the system. The impact on annual energy efficiency and energy savings will depend on how often the electrical element is used.

4.3.2 Demand flexibility (DF) and demand response (DR)

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 cost[17].

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

Traditionally, ESWHs 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 line constraints), and in return the hot water system can run on a lower electricity tariff - this is known as demand response (DR).

Demand flexibility (DF) is more sophisticated than this, as it involves two-way communication between the HPWH (as an end-device) and the system. DF 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, and/or
- running products when there is more renewable generation available e.g. solar and wind.

Using products in this way can reduce running costs, by run during off-peak periods and/or on renewable energy, which are typically cheaper.

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

- use standardised communication protocols (e.g. 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, resulting in a negative experience for the homeowner.

The sizing of the HPWH may change as the system may not be able to heat any hot water at certain times of the day e.g. 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 may also have an override option that will initiate the 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-flex controller or a Home Energy Management System (HEMS) when installed, but could be demand-flex 'ready' for future use/connectivity/upgrade.

DO NOT connect the HPWH to a ripple-controlled circuit unless this specifically meets the manufacturer's instructions regarding the potential de-powering of the HPWH.

[17] Demand flexibility — a smarter grid | EECA

4.3.3 Water quality requirements

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

- **Hard water** (high levels of calcium or magnesium) that may lead to scale buildup on HPWH components, reducing efficiency and lifespan.
- **Very low (acidic) or very high water (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 provide 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.

4.3.4 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 may be around 60° C.

Check to ensure compliance with the Building Code and the Manufacturer's recommendations.

4.3.5 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 the Building Code G12.3.6. This is to reduce the risk of scalding. Typically, this may be around 50° C.

Therefore, 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.

5 Toolkit, safety equipment and materials

Before starting it is important to have the correct tools, safety equipment and materials available. These are listed in the checklist below.

Safety equipment

- ❑ Ear protection
- ❑ Gloves
- ❑ Hard hats
- ❑ Safety glasses
- ❑ Safety boots
- ❑ Other 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 refrigerant that is compatible with HPWH
- ❑ Oil for flared joints (refrigerant compatible)
- ❑ Pipe insulation
- ❑ Pipe protection
- ❑ Vinyl tape

6 Refrigerant pipework

Note this section addresses pipework for refrigerant for HPWH installations that incorporate a refrigerant loop.

Details of water pipework are provided in the relevant parts of Section 7, i.e. Sections 7.2.3, 7.4.1 or 7.5.1.

Good pipework gives a safe, efficient and reliable installation 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 requires more energy for the compressor to pump the refrigerant around the system.

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

- pipes must be clean and moisture-free
- use pipe sizes recommended by the manufacturer
- design pipelines for the shortest runs and minimum number of bends 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, and 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
- pipes must be rated for the refrigerant pressure being used in the system.

6.1 Refrigerant pipework installation

Good-quality pipework involves the following steps:

1. Selecting suitable pipework and jointing (see Sections 6.1.1 and 6.1.2)
2. Ensuring pipework is clean (see Section 0).
3. Making bends properly (see Section 6.1.4).
4. Creating flared joints properly (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[18].

[18] 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 and is less rigid than hard-drawn.

Hard-drawn is generally recommended as best practice for pipe diameters of 20 mm and more, 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 (OFN) circulating through the pipework – this will avoid a build-up of carbon in the pipe, which will 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 a variety of 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 HC, HFC, 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 an example of 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 stopline

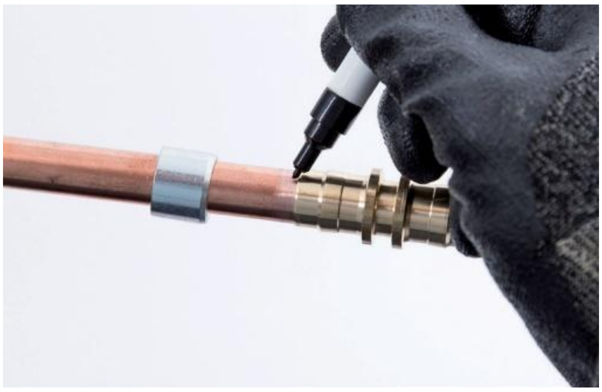
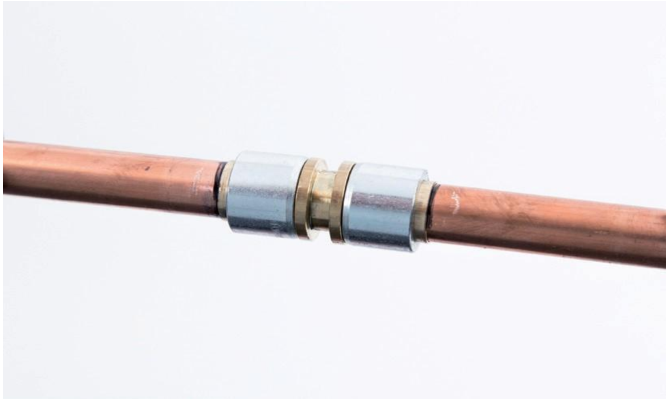


Figure 22: Step 6: Applying sealant solution

Figure 23: Step 7: Fitting connector

Figure 24: Step 8: Compressing one connection end

Figure 25: Step 9: Completed compression connection



Flared joints

Flared joints have a higher risk of the refrigerant leaking but may be required where connecting the pipe to the outdoor unit.

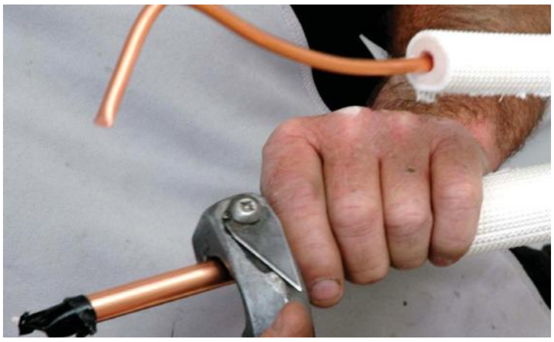
If poorly installed, flared joints have a high risk of the refrigerant leaking. They can also be easily modified by unqualified persons. Flared joints may be suitable if installed correctly and in accordance with the manufacturer's installation instructions.

See **6.1.5 Creating flared joints** for further information.

6.1.3 Maintaining cleanliness of pipework

Ensure that all pipework is clean and suitable for the system by:

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 ends of pipe touch the ground.

6.1.4 Making bends

Bend all copper pipes over 9.5 mm or 3/8" diameter with the correct-sized pipe bender (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

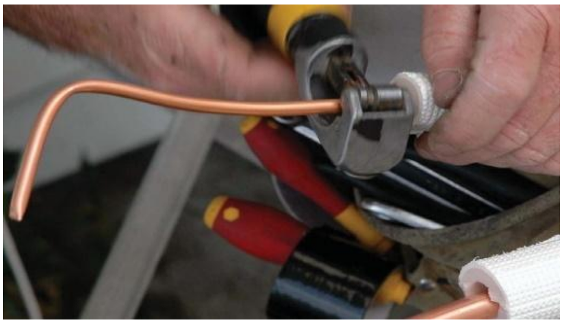
Flared joints must be formed by an experienced installer, as the joints have a high risk of the refrigerant leaking.

Flaring of joints is not a simple task and requires the correct tool for the refrigerant gas being used and the pipe wall thickness.

Units using R410A, R32 or other high-pressure refrigerants require a specific flaring tool to cope with the refrigerant pressure and the pipe thickness.

Follow the correct steps to create a sound flared joint.

Figure 29: Cut pipe with tube cutters



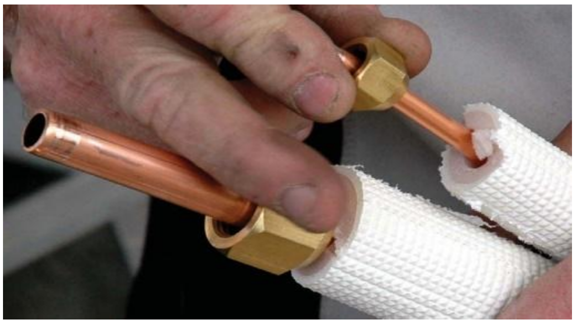
- Cut pipe with tube cutters to give a cut that is straight across and clean (Figure 29) – use a sharp blade and cut slightly longer than measured length.

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)

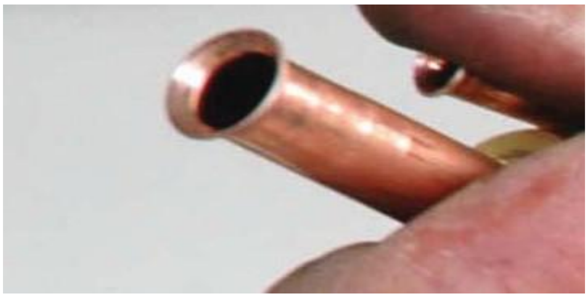


Figure 36: Apply oil to the back of the flared pipe and the flare joint

- 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.

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

Figure 37: Connect the pipes (A)

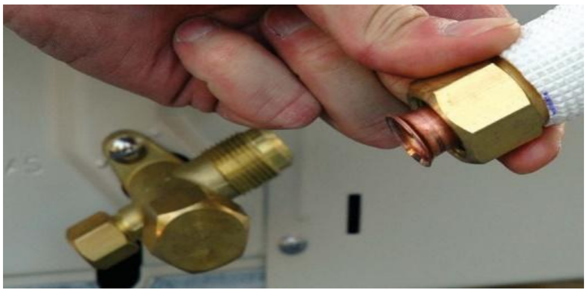
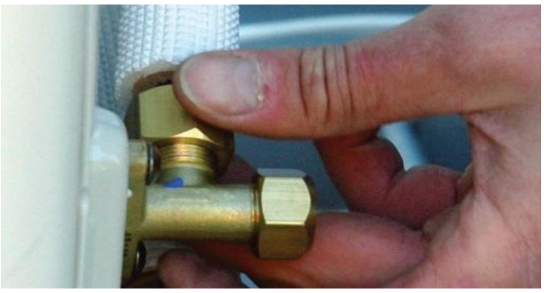


Figure 38: Connect the pipes (B)



- 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.

Figure 39:Tighten connection (A)

Figure 40: Tighten connection (B)

NOTE:

- **DO NOT mix polyolester oil and mineral-based oil**
- **DO NOT use leak lock or PTFE (polytetrafluoroethylene) 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 8.

Table 8: 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.
Use a proprietary insulated pair coil, which is heat resistant up to 100 ºC.

6.1.8 Positioning and connecting the condensate drainage pipe

Condensate drains must be run where the unit would otherwise discharge condensate onto a concrete path or other location where wetness and mould would be undesirable.

Condensate should be discharged:

- into a suitable drain connection
- onto a grassed or planted area
- into a stormwater drain (where permitted by local council regulations).

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 1-1.5 m spacings.
- Establish the location and centre of the cylinder.
- Establish the location of the outdoor unit.
- Run taped pipe/cable across the top of the bottom truss chord/ceiling joist between the unit locations (Figure 42).
- Fix with galvanised mild steel pipe brackets.

Figure 42: Run pipe/cable across truss chord/ceiling joist

Notching plate or studs

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

Figure 43: Notch the top plate and studs (A)

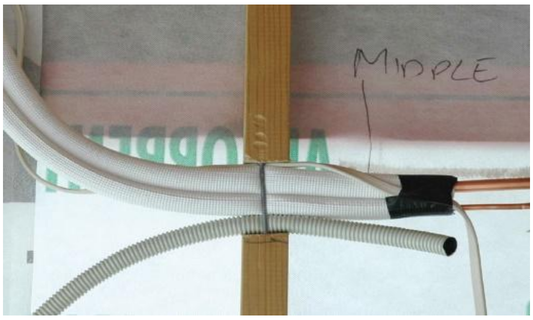
Figure 44: Notch the top plate and studs (B)

- Insert pipe/cable into notch and fix galvanised mild steel strap over to hold securely in position (Figure 45). Notching and drilling must not exceed the limits given in NZS 3604: 2011 – Timber framed buildings.

Protect pipe against damage caused by other trades.

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

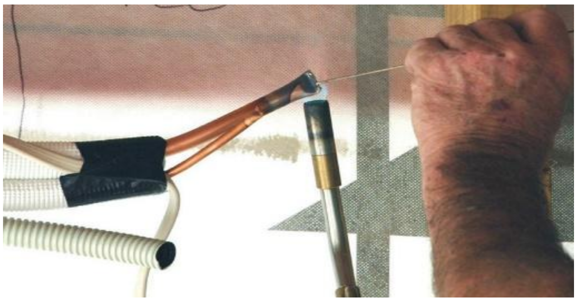
Figure 46: Wedge the pipe cable end into the stud



- Wedge the pipe cable end into the stud in readiness for connection to the cylinder (Figure 46) – use a lightly-fixed and wedged nail that can easily be removed to hold the pipe/cable flat for interior lining fixing.
- Braze pipe ends closed to keep moisture and debris out (Figure 47).

Once brazed, pressurise pipework with dry nitrogen. If the pipes get damaged, the gas escapes, alerting 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



- For floor-mounted units on internal walls:
  - fix pipe/cable in notched dwangs
  - drill holes and feed the pipes through
- Feed pipes through a hole in the building wrap to outside and seal to weatherproof around pipe.

NOTE: DO NOT CUT OUT MORE TIMBER THAN NECESSARY.

Outdoor unit location

- Notch the top plate and studs sufficiently to insert pipe/cable. Notching and drilling must not exceed the limits given in NZS 3604: 2011 – Timber framed buildings.
- Insert pipe/connection cable and power cable (run from meter board) into notches and fix galvanised mild steel strap over to hold securely in position (Figure 48).

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

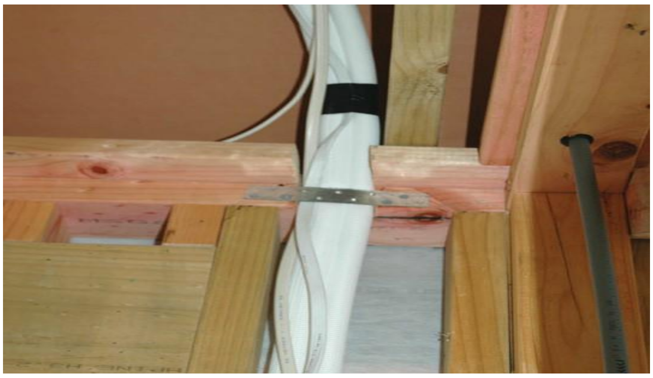


Figure 49: Feed pipe/cables through building wrap

Figure 50: Seal pipes or sleeve

- Feed pipe/cables for connection to outdoor unit through a hole cut in building wrap (Figure 49).
- Seal pipes or sleeve with flexible flashing tape to weatherproof around pipework and cables (Figure 50).
- Braze pipe ends closed to keep moisture and debris out.
- Leave pipe/cable neatly coiled and taped. Note that the taping off has not been completed in Figure 50.

7 Heat pump water heater installation

7.1 General requirements

This section is structured firstly showing general information that is relevant to all types of HPWH installations followed by sections for all-in-one systems, split-water loop systems and split-refrigerant loop systems.

For split systems, Section 7.3 provides information on installing the outdoor unit. Sections 0 and 7.5 provide specific information on installing split-water loop systems and split-refrigerant loop systems respectively.

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

Some general rules for installing heat pump water heaters are:

- Follow the manufacturer's instructions supplied with the system
- Use tools and equipment appropriate for the task and in a well-maintained condition – refer 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 HPWHs

Schedule 1 of the Building Act 2004 provides a list of exemptions to the requirements for a Building Consent for a range of water heaters. In all cases, even where a Building Consents is not required, it is mandatory that an Authorised Person[19] completes the work.

In general, where an existing water heater of any type is replaced or repositioned, a Building Consent is not required provided all the heat sources are controlled. A controlled heat source is one which ensures the cylinder cannot be heated to greater than 90ºC.

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.

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 they may be able to issue a discretionary exemption.

[19] An "authorised person" under the New Zealand Building Act 2004 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 (15, 16, 19, or 25) of the Plumbers, Gasfitters, and Drainlayers Act 2006.

7.1.2 Pre-installation checklist

Before installing the heat pump units, 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 manuals are supplied.

Trade co-ordination

- ❑ Confirm on-site trade co-ordination between the installer, builder (for new construction) and the electrician (only a registered electrician can hard wire the heat pump units).

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 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 9.0 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: **first fit** (or pre-pipe/pre-wire) and **final fit-out** (or commissioning). 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 internal linings (e.g. plasterboard) are installed and often during the main plumbing and electrical rough-in.

Plumbing Tasks

- Decide and prepare location for the heat pump water heater
- Run copper pipework (hot and cold water) to and from the planned cylinder/all-in-one system location
- Install cold water supply to the cylinder location, including pressure-limiting and non-return valves as needed
- Pipework for tempering valve if required (to ensure delivery of safe hot water to taps)
- Provision for condensate drainage (for units that produce condensate)
- Plumb for the PTR (pressure and temperature relief) valve including drain to compliant termination point.

Electrical Tasks

- Run dedicated electrical cable to heat pump outdoor unit (typically from switchboard, with RCD or MCB protection).
- Install conduit and junction boxes as needed near 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 PTR valve is operational and terminated correctly.

Electrical Tasks

- Connect heat pump unit to power (both cylinder and outdoor unit, if separate)
- Wire and test sensors or control interfaces (thermostats, timers, etc.)
- Test earthing and 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 of 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 HW cylinder and any pipework as necessary.

- Make good and permanently seal any water and gas pipes as necessary. The latter will need to be undertaken by a certified/qualified gasfitter. Likewise, any electrical cables and connections will need to be made suitably safe by a certified electrician.
- 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 unit and the cylinder physically connected to each other as part of one box, e.g. with the HP unit sitting on top of the cylinder. These systems will be relatively straightforward installations requiring only electrical connection and connection to the home's plumbing.

7.2.1 Locating the unit

The all-in-one HPWH unit should generally be installed outside. 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:

- The location must allow sufficient access space for installation and subsequent maintenance.
- The inlet and outlet fan must be clear of any obstacles that may block them.
- The installation location must be as close as possible to the internal hot water outlets.
- Ensure that the installation location complies with the requirements of AS/NZS 5601 as it pertains to heat pumps containing a flammable refrigerant.
- It is recommended that the unit is not installed with two metres of any bedrooms or three metres from a neighbour's window.
- Ensure that the manufacturer's specified clearances from walls are adhered to.
- The unit should be installed so that the control interface is accessible to users and that there is clear access to the electrical panel at the back of the system.
- Ensure the temperature and pressure relief (TPR) valve, also known as a pressure and temperature relief valve (PTR), and any access covers have sufficient clearances and are accessible for service and removal.
- Avoid installation in areas where falling debris such as leaves is excessive.

NOTE: Try to find a suitable access/pathway, 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 and 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.

A TPR drain can be seen in Figure 51.

Figure 51: TPR drain

7.2.3 Plumbing requirements

All water pipework and water fittings should be insulated with polyethene foam or equivalent insulation to optimise performance and energy efficiency.

It is the installer's responsibility to adequately size the distribution pipe work in a property to ensure sufficient performance from all outlet fittings.

Pipe sizing and valve selection must be performed to 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 0 ºC, water in any 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.

7.2.4 Inlet water pressure and temperature

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

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

7.2.5 Outlet water pressure and temperature

The outlet temperature needs to be high enough for the water to be safe from Legionella and not so hot as to cause scalding (NZBC G12.3.6). Refer to section 4.3.4 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. The TPR discharge pipe outlet should be positioned such that the outlet hot water cannot cause injury to persons 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 52.

Figure 52: TPR valve and vertical 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.

Once all the pipework is complete and all connections are tight, the installer can begin filling the unit with cold water. Open the cold-water inlet isolating valve or the TPR to begin the process. As the water begins to fill up inside the cylinder, you can release the buildup of pressure 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.

The TPR valve must be insulated and installed as described in the manufacturer's instructions.

The relief valve must be installed so that the drain line is facing downwards at all times with the discharge point remaining open to the air.

It is mandatory to install a pressure reducing valve in accordance with AS 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 3500. The typical set point is 50 °C.

After all plumbing and valves are installed, the cylinder can be filled and pressurised, as follows:

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, G12 6.11.4 or Section 203, NZS4603.

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 3 x 25mm x 1mm galvanised steel straps, tensioned when fixed in place. For cylinders less than 200 litres, only 2 straps are required.
- Straps are to be fixed to timber framing with either 1 No. 8mm coach screw with 30x2mm thick washer, or 2 No. 20x2.5 mm thick washers.
- Coach screws must penetrate the timber framing by a minimum of 50 mm.

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 a masonry or concrete wall. It is critical to anchor restraints into the structural masonry or concrete wall, not merely into brick veneer as this lacks the necessary strength.

See Figure 59 for an illustration of a seismic restraint of a water cylinder to a concrete structure, which will be the same as used for an all-in-one system.

7.3 Split systems – locating and installing the outdoor unit

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

The heat pump unit associated with these systems is to be installed outside.

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

The water heater unit can generally be retrofitted to any electric storage cylinder where the condenser is separate from the cylinder and as long as it has polyurethane or expanded polystyrene foam insulation.

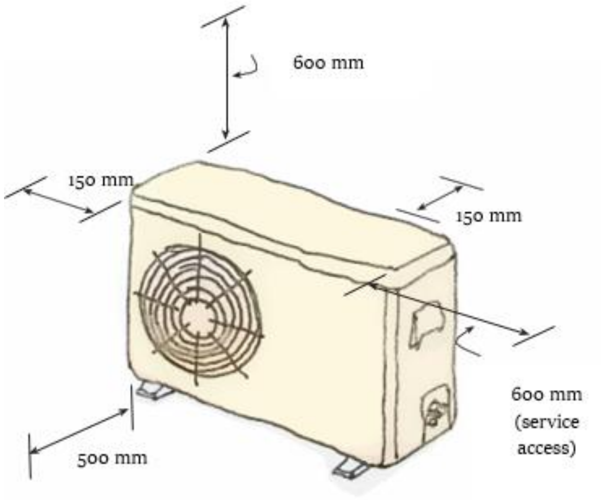
Install the outdoor unit so that:

- The manufacturer's specified clearances from walls are adhered to.
- The location allows for sufficient access space for installation and subsequent maintenance.
- The inlet and outlet fan must be clear of any obstacles that may block them.
- Avoid installation in areas where falling debris such as leaves is excessive.
- The unit is not installed with two metres of any bedrooms, or three metres from a neighbour's window.

- There is a suitable clearance abound the unit to allow for good air flow and access for maintenance – see Fig 7.15 below for details
- There is a 1.5m clearance from any LPG bottles (i.e. 45 kg gas cylinders that get swapped and refilled offsite) or 3.5m clearance from any in-situ LPG tanks (i.e. fixed gas cylinders that get refilled onsite by tanker)
- The unit has an unobstructed gap underneath it (about 100mm) to allow for hosing and clearing of leaves and dirt (Figure 53)
- The control interface is accessible to users and that there is clear access to the electrical panel at the back of the system.
- The unit sits level
- The weight of the unit is fully supported to prevent sagging, and it cannot fall over
- It creates no vibration
- The installation location complies with the requirements of AS/NZS 5601 as it pertains to heat pumps containing a flammable refrigerant.
- Fixings used are corrosion-resistant – typically requiring stainless steel.

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

Figure 54: General clearance around outdoor unit



Different means of fixing the outdoor unit

The outdoor unit can be fixed on:

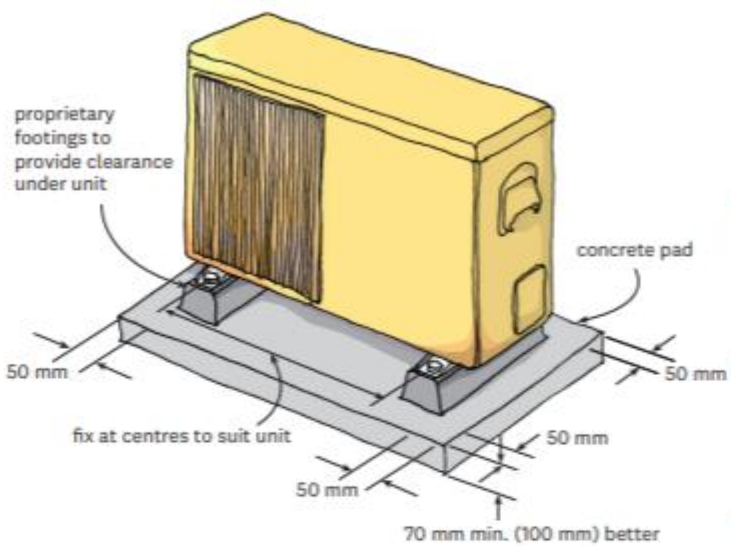
- a concrete pad cast in place or a single piece pre-cast slab at least 40 mm thick (see Figure 55)
- a concrete patio or balcony
- a timber slatted deck with anti-vibration mounts (see Figure 56)
- brackets fixed to a foundation or wall (see Figure 58)
- the roof where the installation has been specifically designed (engineered) to accommodate live loads and wind forces acting on the roof, and it 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 55: Concrete pad construction



- Construct the pad as shown in Figure 55 (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.

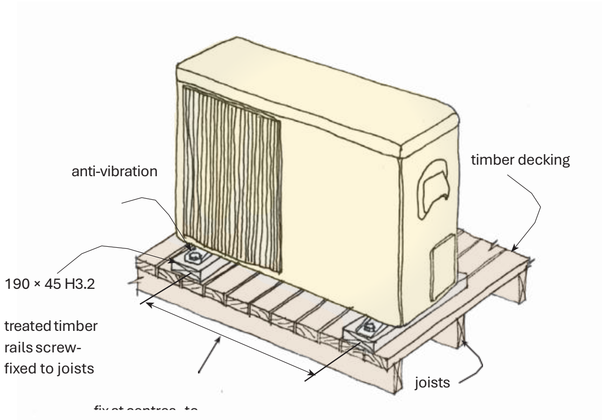
Installing an outdoor unit on a concrete balcony or patio

- 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 Grade 316 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 56: Fixing unit to a timber deck



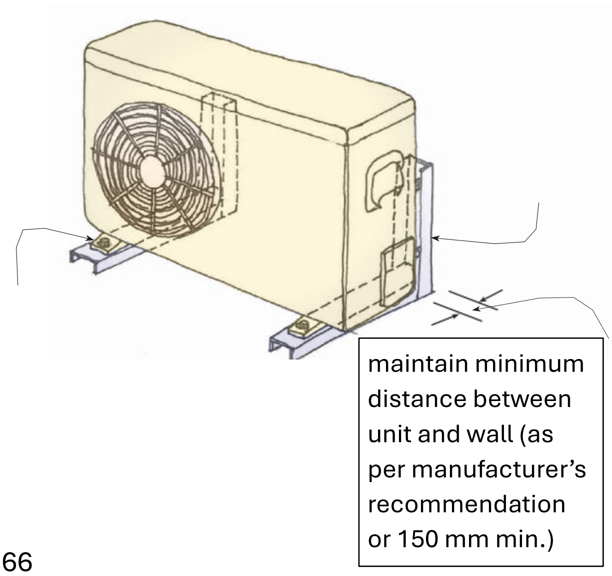
- Fix hot-dip galvanised mounting rails into the joists with 75 mm long stainless steel screws. Alternatively, fix the mounting rails to 190 x 45 H3.2 treated timber rails laid on flat that are screw- fixed to the decking joists with 115 mm long stainless steel screws.
- Provide anti-vibration mounts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

Figure 57: 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 58: 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 58).
- 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. 150 mm 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, adhere to the following:

- Roof installations must be specifically designed.
- 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 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 fixing; for example, use 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 and the weight of the installers working on the roof)

DO NOT mount directly onto metal roofing, as roofing can act as a sound amplifier and direct fixing may cause corrosion of the roofing

DO NOT let Copper-Chromium-Arsenate treated (tanalised) timber 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 which will need to be installed by a plumber. These may be installed as retrofits to an existing HW 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/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 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.

It is the installer's responsibility to adequately size the distribution pipe work in a property to ensure sufficient performance from all outlet fittings.

Pipe sizing and valve selection must be performed to 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 0 ^{o}C, water in any 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.

Cylinder valves, pipework and drains are to be installed according to current versions of AS/NZS 3000, AS/NZS 3500, 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 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 NZ 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 restraint 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, G12 6.11.4 or Section 203, NZS4603, namely:

- For cylinders between 200 litres and 360 litres, restrain the cylinder with 3 x 25mm x 1mm galvanised steel straps, tensioned when fixed in place. For cylinders less than 200 litres, only 2 straps are required.
- Straps are to be fixed to timber framing with either 1 No. 8mm coach screw with 30x2mm thick washer, or 2 No. 20x2.5 mm thick washers.
- Coach screws must penetrate the timber framing by a minimum of 50mm.

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

Figure 59 shows a seismic restraint of a water cylinder to a masonry structure.

Figure 59: Seismic restraint for a hot water cylinder

7.4.4 Inlet water pressure and temperature

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

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

7.4.5 Outlet water pressure and temperature

The outlet temperature needs to be high enough for the water to be safe from Legionella and not so hot as to cause scalding (NZBC G12.3.6). Refer to section 4.3.4 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. The TPR discharge pipe outlet should be positioned such that the outlet hot water cannot cause injury to persons or damage to the building. It 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 will require 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 polyethene foam or equivalent insulation to optimise performance and energy efficiency.

It is the installer's responsibility to adequately size the distribution pipe work in a property to ensure sufficient performance from all outlet fittings.

Pipe sizing and valve selection must be performed to 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 0 ºC, water in any 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.

Connection of piping to the cylinder and the outdoor unit must be done in the following order:

1. Connect the piping to the cylinder
2. Fix trunking

3. Connect the piping to the outdoor unit

- Locate the pre-installed pipework.
- Have any required dwanging added.
- Add any necessary seismic straps/restraints 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 61: Tape drainage hose to drainage outlet

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

Fix 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 90° 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

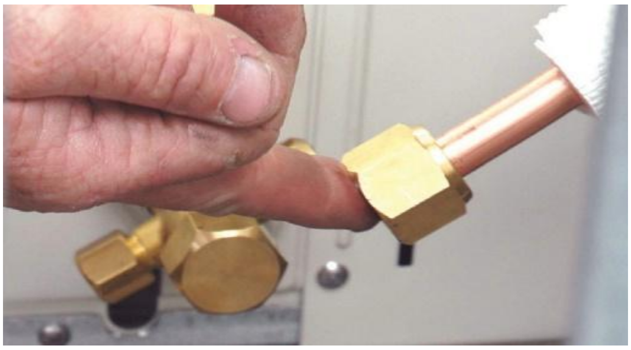
- Fill hole around piping with sealant compatible with the trunking and the cladding system (Figure 64).

Figure 65: Seal around cover

Figure 66: Fit cover over opening

Connect the piping to the outdoor unit

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



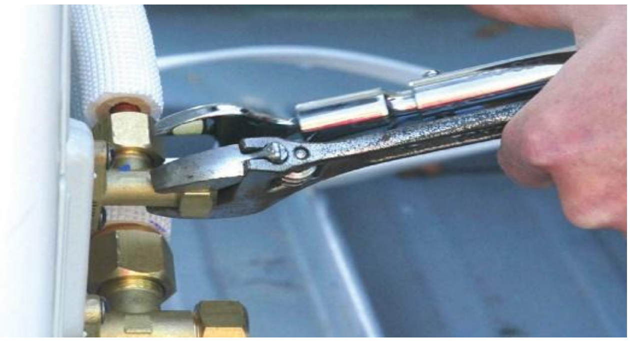
- Cut both pipes to the correct length.
- Flare the pipe ends for connection to the outdoor unit (see **6.1.5 Creating flared joints)**.
- Purge the system by blowing oxygen- free nitrogen (OFN) into the pipes before making final flare connection. Note: Hard-drawn copper pipe must be annealed before 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 69).
- Check 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 Leaks and pressure test

It is good practice to pressure test the system for leaks after completion of pipework installation, as per 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 can be extremely dangerous and can cause a large explosion.
- Connect the nitrogen gas cylinder to the service port valve.
- Pressurise the system to maximum 500 psi/3.45 MPa 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. 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 Evacuation of 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 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

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)

- 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 (Figure 72) so that air is not introduced into the system.

Figure 73: Progressively release the vacuum

- 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.

Figure 74: Tighten valve caps

8 Refrigerants

8.1 Introduction to refrigerants

Refrigerants are the working fluids in HPWHs, which enable heat transfer by absorbing and releasing thermal energy.

Common refrigerants include **R32, R-134a, R-410A,** and **R-744 (CO_2)**, each with their own thermodynamic properties and environmental impacts.

With growing concerns over global warming potential (GWP) many newer systems are transitioning to low-GWP refrigerants such as **R-290 (propane)** and **CO_2**, which offer efficiency and sustainability benefits.

A number of different refrigerants have been used over the years, and all have some degree of impact on the environment.

GWP also needs to be considered in the context of the quantity of the refrigerant, performance (COP), ozone depletion potential (ODP) and leakage-rates (pressure).

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

A brief overview of the commonly used refrigerants in HPWHs is as follows:

- **R134a** is a hydrofluorocarbon (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 ODP 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 that will be available soon. With a very low GWP and zero ODP, R290 is seen as an environmentally friendly option.

Common HPWH refrigerants and their GWPs and flammability are shown in Table 9.

Table 9: Common HPWH refrigerants and their GWP and flammability

Refrigerant	GWP	Flammability[20]
R-744 (CO_2)	1	Non-flammable
R-290 (Propane)	3	Highly flammable
R-32	675	Lower flammability
R-134A	1,430	Non-flammable
R-410A	2,088	Non-flammable
R-404A	3,922	Non-flammable

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

It is important to note that while R32 has a lower GWP compared to R134a, its use still requires proper handling and adherence to safety regulations to ensure 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 due to the refrigerants they use. Some older refrigerants have high global warming potentials (GWPs) when released into the atmosphere.

Some refrigerants are also hazardous owing to their toxicity or flammability. The refrigerant installed in a HPWH shall 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.

Hydrofluorocarbons (HFCs) such as R410A and R32 are currently widely used in refrigeration and air conditioning systems. However, HFCs are greenhouse gases with high global warming potential and a worldwide phase down of HFCs is being implemented.

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 the higher toxicity, flammability or pressure.

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.

8.2 Australia and New Zealand 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 license 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 2 kilograms 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 with 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 is 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 different 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 notes

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 record of service

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

A permanent label is to be placed on the outer side of unit that identifies:

- Refrigerant type
- Date of service
- Lubricant type
- Refrigerant charge (total including any additional charge).

9 Electrical

9.1 Introduction

All electrical work shall be electrically safe and must be carried out by a suitably licenced, and registered electrical worker. An Electrical Certificate of Compliance[16] (CoC), and Electrical Safety Certificate (ESC) must be issued on completion.

Electrical work must be carried out in accordance with the Electricity Act, Electricity (Safety) Regulations, and AS/NZS 3000 Electrical installations (known as the Australian/New Zealand Wiring Rules).

Any product supplied in New Zealand should have a Suppliers Declaration of Conformity (SDoC) and/or be registered in the Electrical Equipment Safety System (EESS) administered by the Australian Government.

The power supply to the heat pump module 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 to ensure compliance and safety

9.2 Installing electrical wiring

Maximum demand of the installation shall be calculated to determine if the installation can accommodate any additional load imposed on all, or part of the installation.

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

Depending on the heat pump's power input rating (including a 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 any one or more of the following attributes:

- A protective device with a rating of less than 15 amps,
- A circuit using wire with cross-sectional area of less than 1.5 mm^2 or 3/.036 inch[21]
- A circuit clearly intended for use with 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.

Things to consider include:

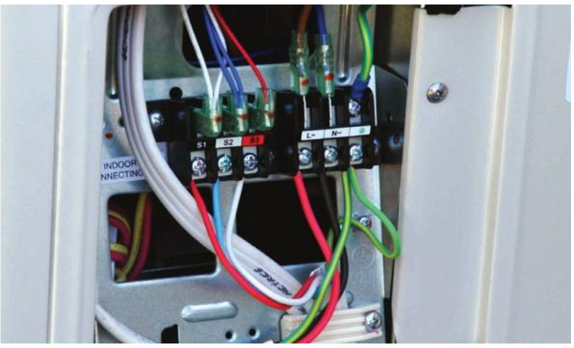
- Available supply capacity.

[21] 3/.036 inch designation refers to the wire's dimensions in terms of the number of strands (3) and the diameter of each strand (.036 inch)

- Some retailers offer reduced rates for controlled load consumption.
- Some devices may not be suitable for regular switching of the supply (manufacturer's instructions may specify whether a device is suitable for this application).
- Local network operators may require, or prefer, hot water systems to be connected to controlled supplies.

9.3 Heat pump outdoor unit connections

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 (Figure 76, Figure 77 and Figure 78).
- 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)

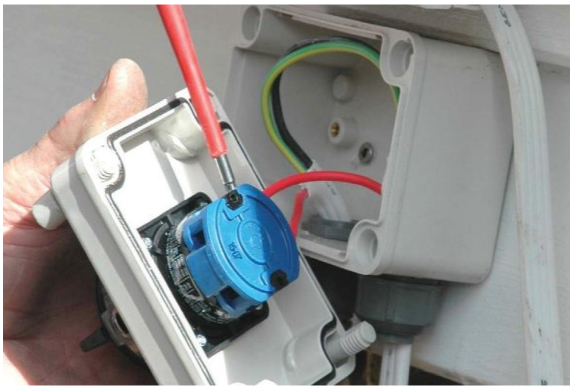


Figure 78: Install lockable isolating switch (C)

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 power

Do not allow contact between wiring and refrigerant pipework

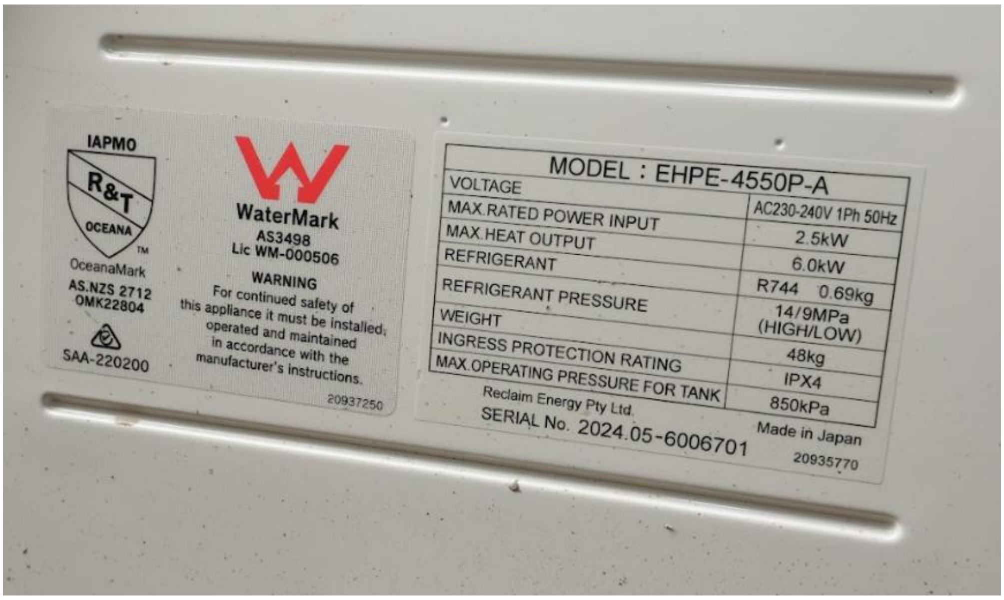
Do not allow electrical work to be carried out by a person not authorised to undertake electrical work or without issuance of appropriate certification. Otherwise, the owner's house insurance may be voided.

9.4 Nameplate

Ensure nameplate (Figure 80) is visible in an accessible location displaying:

- 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 a 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.

The power supply to the heat pump module 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 are illustrated in

Figure 81.

Figure 81: Typical wiring connections for an all-in-one system

- Red: active
- Black: neutral
- Green/yellow: earth

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.

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, testing the system, briefing the homeowner on the new system and carrying 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

Prior to commissioning the new system, carry out a quality assurance check on completion of the heat pump water heater, addressing the following areas:

Cylinder and all-in-one systems

- ❑ Is the cylinder/all-in-one unit secure?
- ❑ Ensure the valves are fully opened and valve caps have 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 owners and/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, test this 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 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 connected to existing circuit, does it have sufficient spare capacity)?
- ❑ Is there a circuit breaker in the system and has the circuit been properly labelled on the distribution board?

Labelling:

- ❑ Ensure Switchboard fuse has 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

Fill the system

- Open 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.

- Turn on 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.

Turn the system off – if required, such as if it is a new home 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 if there is a risk of freezing.

Drain 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/injury will occur from discharged water.
- Open the TPR valve again. This allows air into the system and will result in the cylinder draining.

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 to the owner

Checklist of instructions to the owner on the use of the system:

❑ Demonstrate how to set the controls/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:

❑ Electrician to provide an electrical Certificate of Compliance (CoC).

❑ Provide a record of the system commissioning data.

❑ Provide contact names and numbers for after sales support.

11.2 Checklist for using a heat pump water heater efficiently

Understanding how to use a HPWH efficiently is important and should include consideration of the following points:

Smart water use and scheduling

- Use a timing function to heat water when demand is lowest, electricity prices are lower, or to utilise solar PV where available.
- Stagger water use (e.g., showers, 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 – refer to Section 12 for more information

- Check and clean the air intake every 6 months to ensure it is clear from litter, leaves, weeds etc, to maintain airflow efficiency.

12 Servicing and maintenance

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

Key benefits of regular servicing include:

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.
- Ensures 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.
- Helps avoid expensive emergency repairs or premature replacement.

Maintain 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.

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 at any sign of unusual sounds or operation.
- ❑ It is recommended to have an annual servicing agreement with your installer. Failure to maintain your heat pump water heater 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

12.2 Service personnel maintenance

The system should be serviced by a qualified person 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 into NZ specify in their installation and user manuals that a unit must be serviced annually by a qualified person.

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

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

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 level with timber/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 test pressure relief valve.
- ❏ Check the temperature of the hot water with a digital thermometer for normal operation, hot water should be held/maintained at 60°C or higher.
- ❏ Anode – check the anode rod in the cylinder and replace it if it is significantly corroded, or due for replacement as specified by the manufacturer's guidelines for replacement.

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.

13 Decommissioning heat pump water heater systems

13.1 End-of-life removal and disposal of a heat pump water heater

Proper disposal of a heat pump water heater 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:

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 programs for their products. Refer to the website of the manufacturer of the relevant HPWH or make 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, courier services and recycle used refrigerants. These initiatives ensure that refrigerants are handled in a way that minimises 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.

14 Glossary of Terms

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) to operate the system - See SCOP below.
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 electricity prices, contributing 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 System (EESS)	A regulatory framework aimed at increasing consumer safety in household electrical equipment throughout participating jurisdictions in Australia and New Zealand, which 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 (CO2). 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 either be a liquid or gas/vapour state, as it passes through various stages of a fully reversible **vapour-compression refrigeration cycle.**
Seasonal coefficient of performance (SCOP)	SCOP accounts for the fact that COP will vary throughout the year as climatic conditions and demands vary, which in turn affect the systems 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 (sometimes referred to as set point or set-point)	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 heat/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 3 to 8 kW.
Temperature and Pressure Relief Valve (TPRV) (sometimes known as a 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 set-point 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, as it regulates the temperature of hot water supplied to fixtures, preventing scalding by mixing hot and cold water to a safe temperature and is a vital part of hot water systems.
Time of use (ToU)	ToU 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 it 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. VSDs 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.

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 10.

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/subordinate legislation) is a legally binding rule made under the authority of an Act. It is used to fill in the details and provide 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 10: 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. It 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 (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.
Electrical codes of practice	Electrical codes of practice (ECPs) are issued by WorkSafe under Section 36 of the Electricity Act 1992. Their purpose includes the setting of standards and requirements for those involved in working with electricity and any electrical installations or appliances. These standards and requirements include training and qualifications, design and construction, operation and supply, and safety around people and property.
Electricity (Safety) Regulations 2010	Regulations which 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/disconnection or maintenance of conductors and/or fittings, along with testing, inspection and certification of such works.
Electricity Act 1992	Primary legislation which 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 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 – air-to-air single-split heat pump systems (also known as reverse-cycle air conditioners), 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 HSNO 2004 Compressed Gas Regulations) is the minimum legal obligation for anyone working with refrigerants.
Hazardous Substances and New Organisms Act 1996 (HSNO)	Legislation which 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 which 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 transferred from HSNO to the Hazardous Substances Regulations under HSWA. The rules and duties to mitigate risks posed by hazardous substances sit under HSWA (including the Hazardous Substances Regulations) for work risks.
Residential Tenancies (Healthy Homes Standards) Regulations 2019.	For reference purposes - Schedule 2, section 5 lists the assumed external temperature for each territorial authority district the home is located in.

16 Relevant Standards

There are various Standards relevant to HPWHs and referred to in various places in this Guide. These are summarised in Table 11.

It should be noted that:

- 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 e.g.,
  - 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 NZ.
  - The HSWA (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 i.e. minimum starting point.

Table 11: 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/NZS 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 WorkSafe - Energy Safety 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. It includes aspects of the installation from, and including, the valve(s) on the cold water inlet to any cold 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 -	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

Calculation of energy consumption	determine the standardized annual supplementary energy use.
AS/NZS 4692.1:2005 Energy consumption, performance and general requirements for Electric water heaters	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, 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. It specifies the classification and selection criteria applicable to the 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) - 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 and 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	Standard which deals with the safety of electric sanitary hot water heat pumps with a maximum rated voltage of not more than 300 V for single phase appliances and 600 V 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 by laymen in shops, in 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	This European Standard specifies methods for testing, rating of performance and calculation of water heating energy efficiency.
ISO 19967.1:2019 Heat pump water heaters	Testing and rating for performance - Heat pump water heater 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 related to a building's function. It 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 evaluating the annual energy performance of water heaters, to determine the standardized annual purchased energy use.
SNZ PAS 5210:2024	Publicly Available Specification for high-temperature heat pumps – this includes a lot of information that overlaps with this Guide.

17 Relevant Organisations

Acronym	Organisation Name	Website
ARI	Air-Conditioning and Refrigeration Institute (American)	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	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 (American)	www.sae.org
SA	Standards Australia	www.standards.org.au