MAGNUS
Low GWP Solutions

Temperzone Talks - October 2019

temperzone
climate innovations

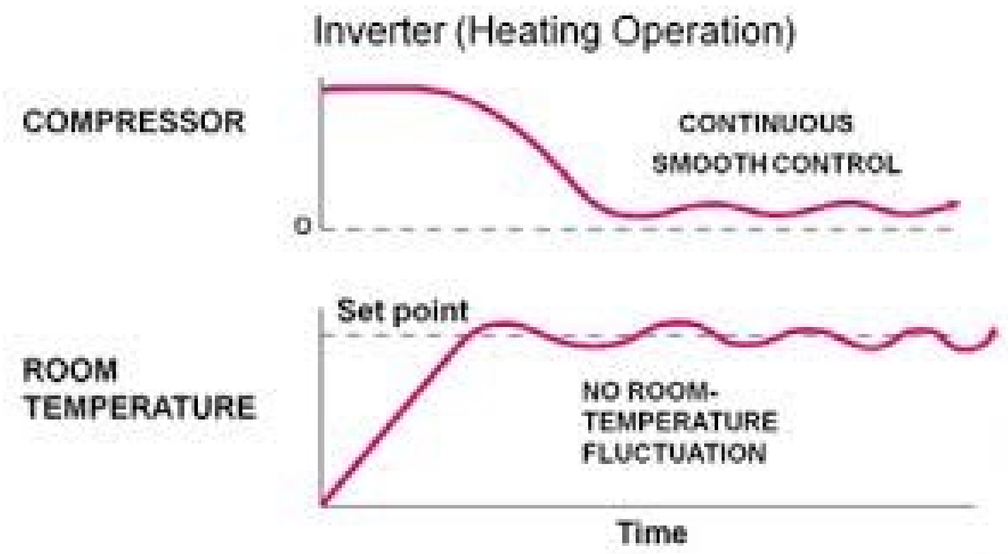
Energy Use in Buildings

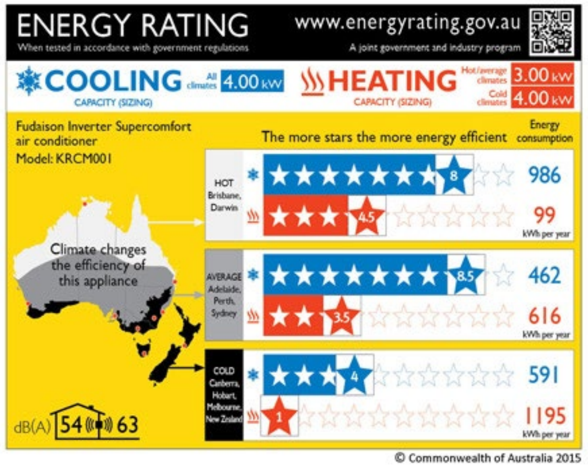
- 16% of NZ electricity usage in non-residential buildings
- 33% used for lighting
- 33% used for HVAC - $1billion / yr
- 7% of national gas consumption $650 million / yr
- 10% of NZ electricity use to heat water
- Water sourced air-conditioners replaced by VRF based systems
- Commercial building use 200 kWh/m^2/yr versus 53 kWh/m^2/yr for residential

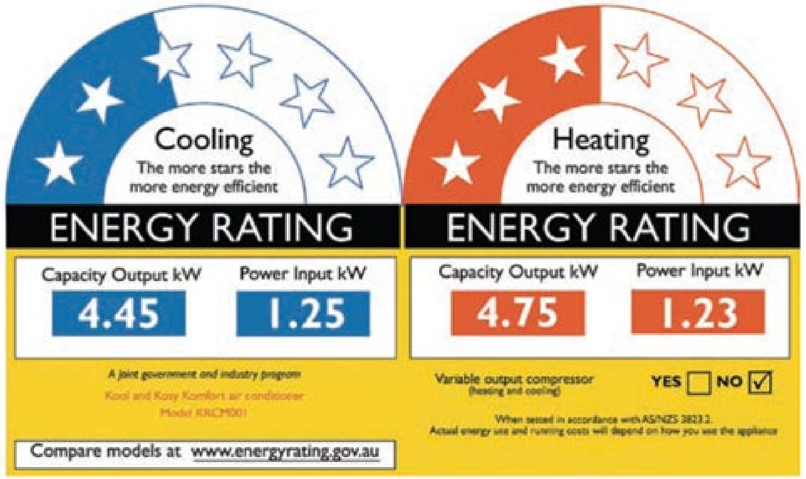
Seasonal Energy Efficiency Rating (SEER)

Requires testing of air-conditioning units at "part load", as well as the traditional T1 and H1 conditions

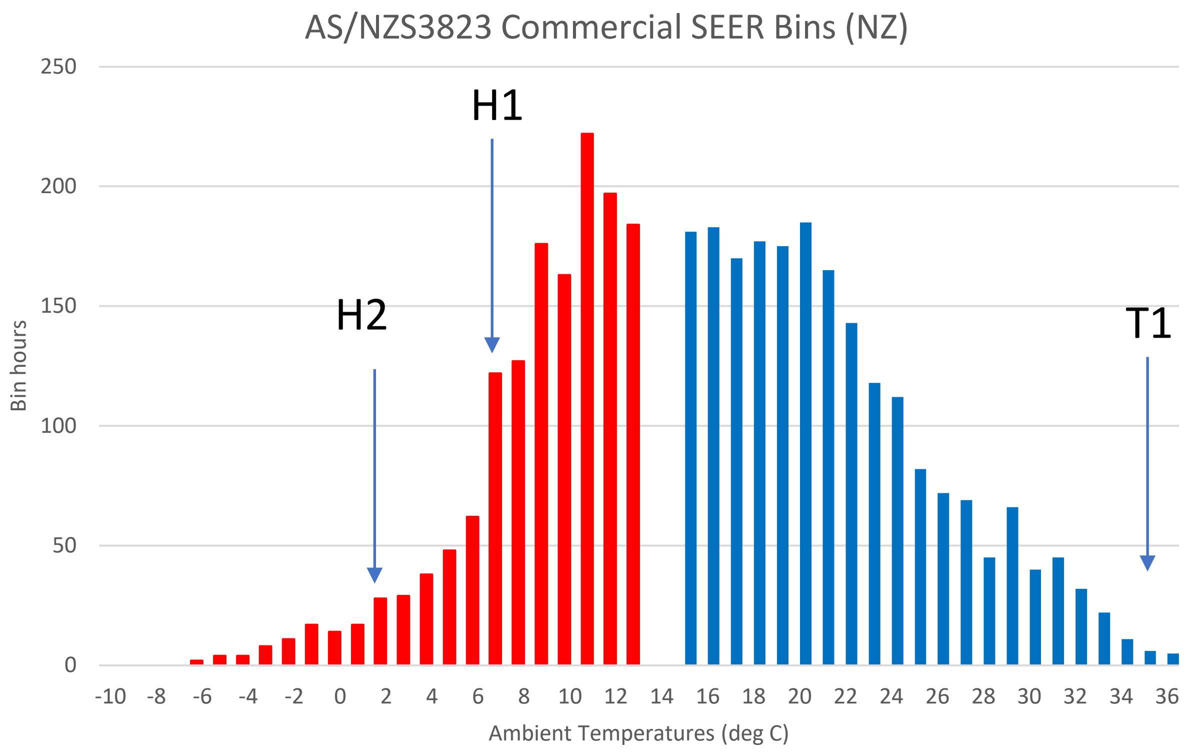
- Unit operates the majority of the time at part load
- Suits inverter based systems
- Variable speed fans
- More complicated technology
- Increased efficiency
- Requires H2 testing for <30 kW units

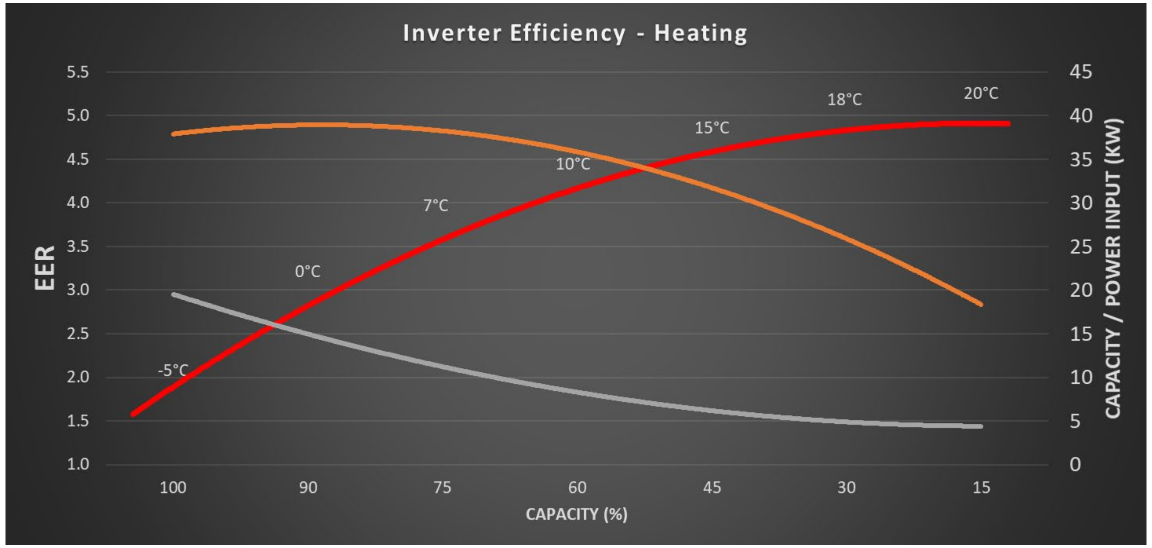


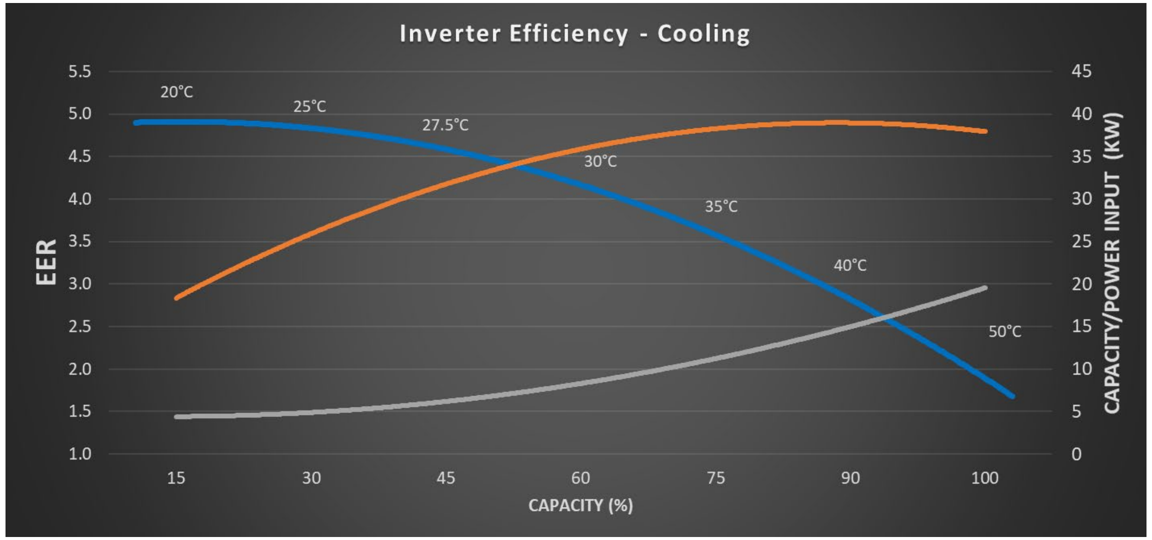




Seasonal Energy Efficiency Rating (SEER)



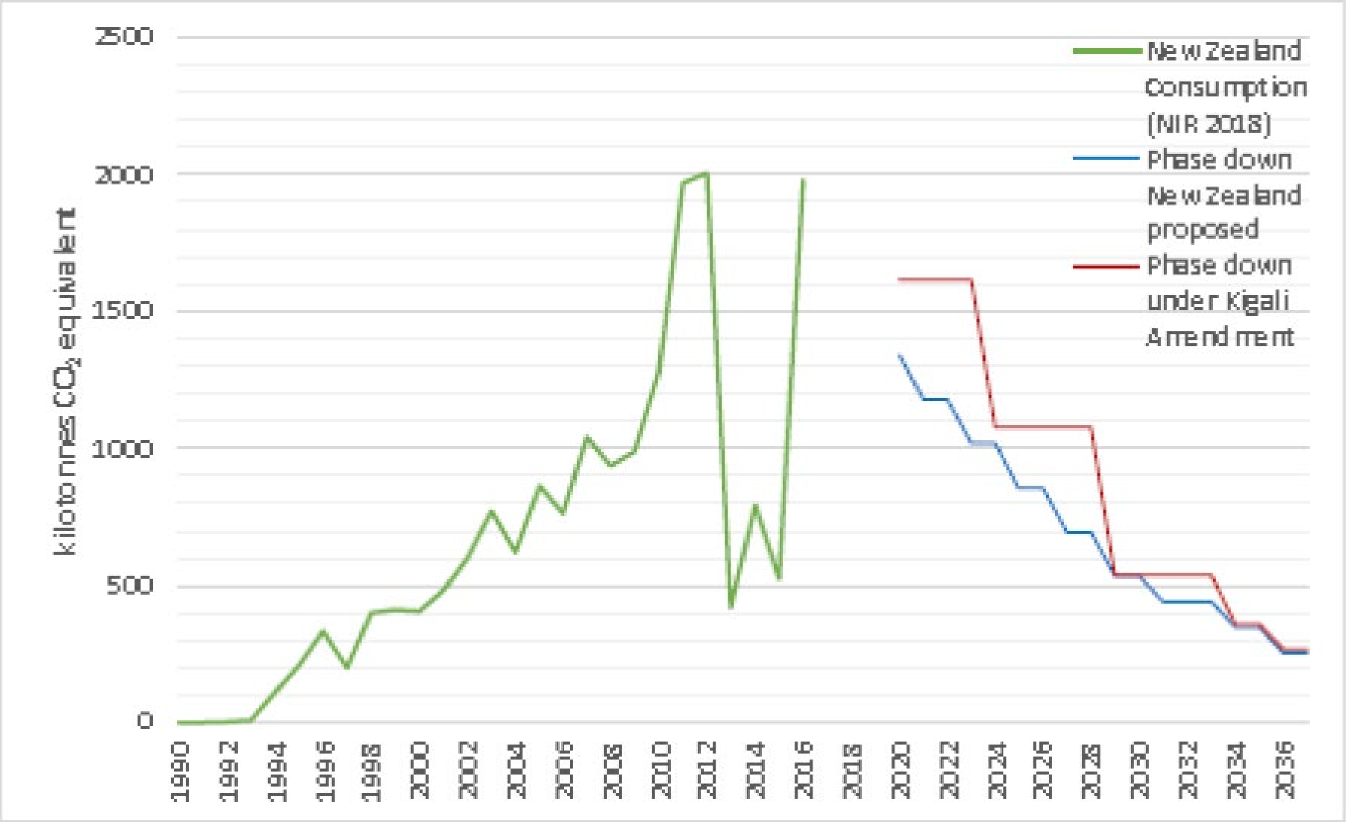




Kilgali Amendment

HFC Phasedown

- Aims to prevent 0.5°C of global warming by 2100
- Ratified Oct 3, 2019. Begins Jan 1, 2020
- 486 tonnes HFC lost to the air each year in NZ,
- 1.1 million tonnes of $CO_{2(eq)}$
- Equivalent to 540,000 cars.
- Or 1 kg released = annual emissions of 1 car



Main refrigerants in play

GWP		A/C & ref	Ref	A/C	
> 4,000			R404A		
< 2,500			R452A R22 R407A/R407F	Flammability line R410A	
< 1,500		R134a	R449A R448A		
< 700		R450A R513A R515	R454A R444B	R32 R454B R452B	
< 150	R1233zd R514A R12336mzzz	R1270 R600a R1234ze	R454C R455A R290	No LGWP option. Must move to low density	R744/CO_2 R717/NH_3
	R123 like	R134a like	R404A | R22 like	R410A alike	Others

Density →

Legend

- A1 - Non-flammable
- A2L - Mildly flammable
- A3 - Highly flammable
- B2L - Toxic less flammable
- Old reference refrigerant
- New and on the market
- Not yet on the market

Kilgali Amendment

HFC Phasedown

- R410a (GWP 2000) being replaced by R32 (GWP 675) is most practical option
- A2L – mildly flammable
- Many residential products now converted
- Transition for commercial products underway
- Charge restrictions in occupied spaces
- More efficient, 30% reduction in charge volumes
- Vapour injection technology often required for heating

“ 75–80% reduction in GWP per kW cooling capacity

Higher COP, and more capacity in heating cycle ”

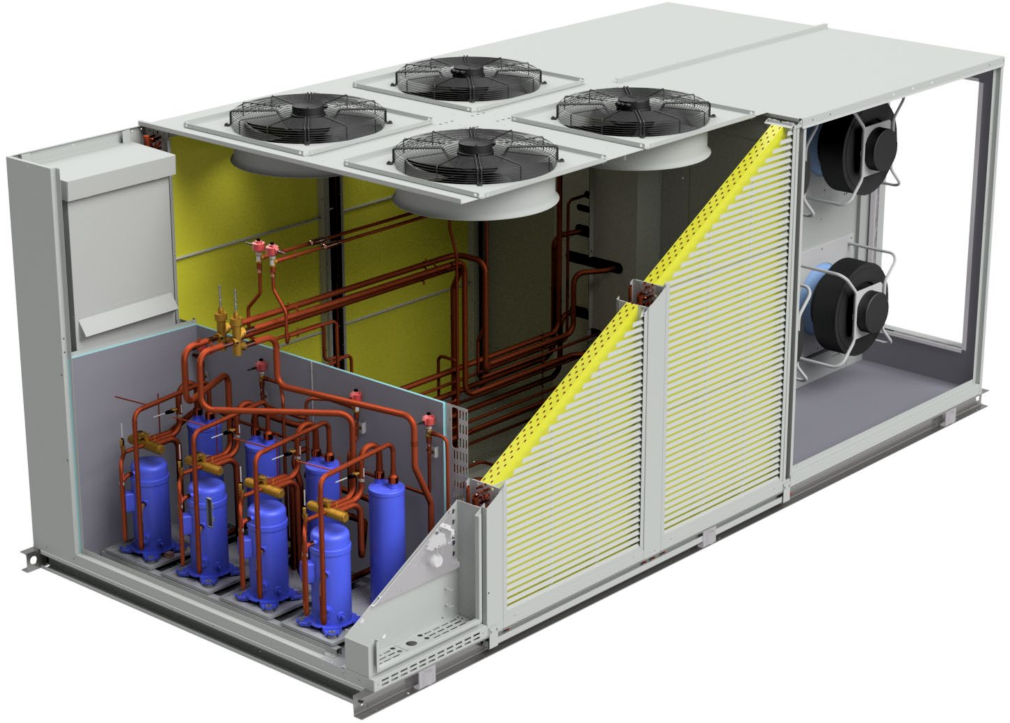
Kilgali Amendment

R32

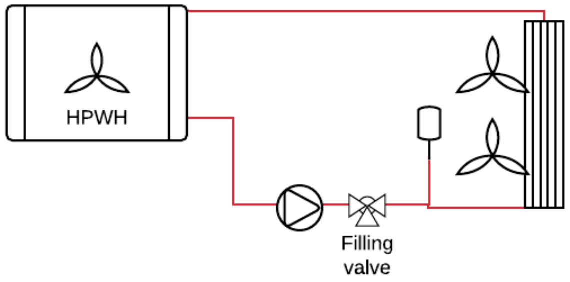
- Era of high refrigerant volumes in buildings is ending
- Affects VRF systems – exceeds charge restrictions
- Increased role of hydronic based HVAC systems
- Allows low charge, and water to be piped through building
- Water likely to be increasingly used as energy carrier around buildings.

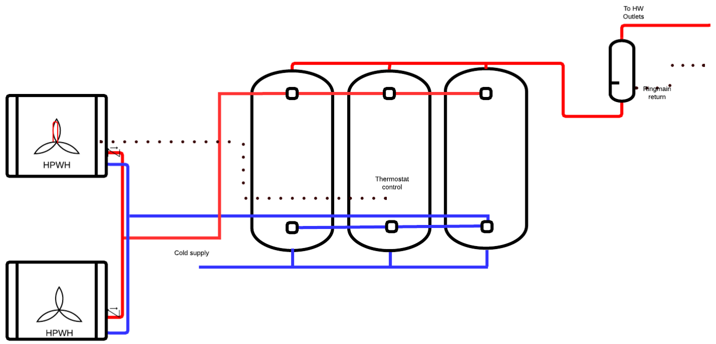
Next Generation Development

- Further development of our commercial inverter and EC fan technologies
- Began work with Honeywell 2014 on post R410a refrigerants
- Adopted hydronic based strategy 2015
- Supported by new class of refrigerant to water heat-exchanger - ThermoShell
- Released in the water source air-conditioners from 2017
- IoT Development platform to support product development from 2017
- To be released in the broad range of HPWH 2019
- Adopted R32 as development platform early 2018
- Field trials of R32 products began Q3 2018
- New range of R32 packaged rooftop and ducted split units for 2020
- Reduction of GWP by 75 - 80% per kW of cooling



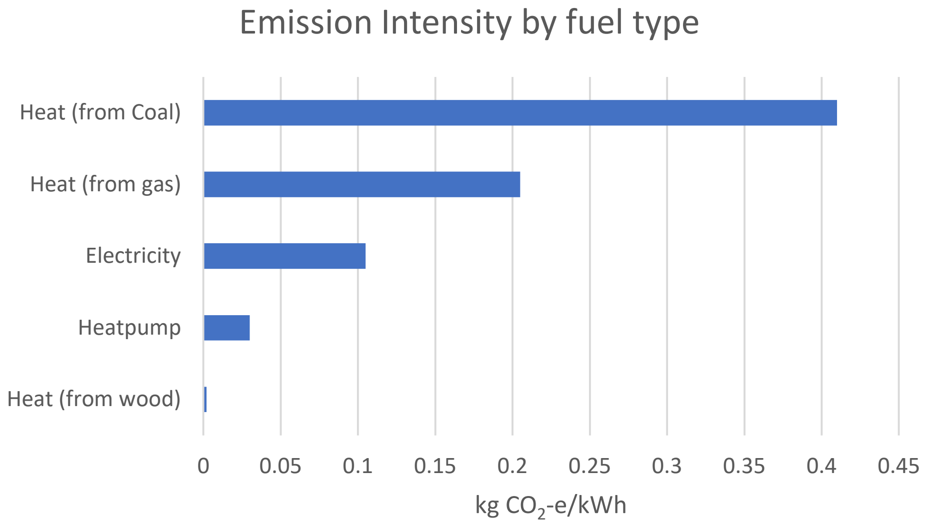
Heating Systems





Increase Electrification. Remove fossil fueled heating options.

- Replace central boiler systems with distributed heat-pump systems
- Separate potable hot water from space heating
- Replace reconditioning boilers with heat-pumps
- Replace electric heater banks with heat-pumps
- Design to lower supply water temperatures
- Separate heating loads into preheat / high temperature components where >65°C is required
- Consider thermal storage, using low cost off-peak electricity



MAGNUS key principle

MAGNUS™
powerhouse water heaters

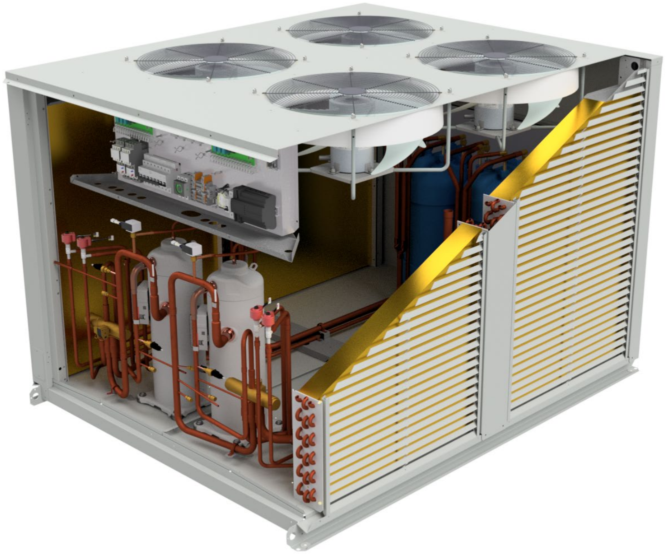
- For a given supply water temperature, the cooler (or warmer in chiller mode) the return, the more efficient the system is.
- Based on a design leaving water temperature (LWT) supported by inverter compressors
- Variable flow to control the capacity
- Simplified controls / highly effective in application
- Supports the part load efficiency of operation
- Next Generation Hydronics platform developed on this basis

Low carbon water heating

- 10% of national electricity consumption to heat water
- Electric, solar and heat-pump water heaters are main options
- >65% electricity savings compared to electric
- Fraction of GHG emissions compared to gas
- Comply with G12/AS2 Legionella control.
- Reduce use of ring-main systems
- Maintain thermal stratification of storage tanks
- Use “biosafe” controls to reduce temperatures required

Low carbon water heating

- Heat-pump water heaters are not “replacement boilers”
- Need to operate within specific conditions for reliability
- Need to be durable to achieve payback
- Care needed when designing ‘combination’ systems
- Selection based on application and climate
- Effective solar / HPWH integration possible



Application specific heat pump water heaters

MAGNUS™
powerhouse water heaters

Space heating

Pool heating

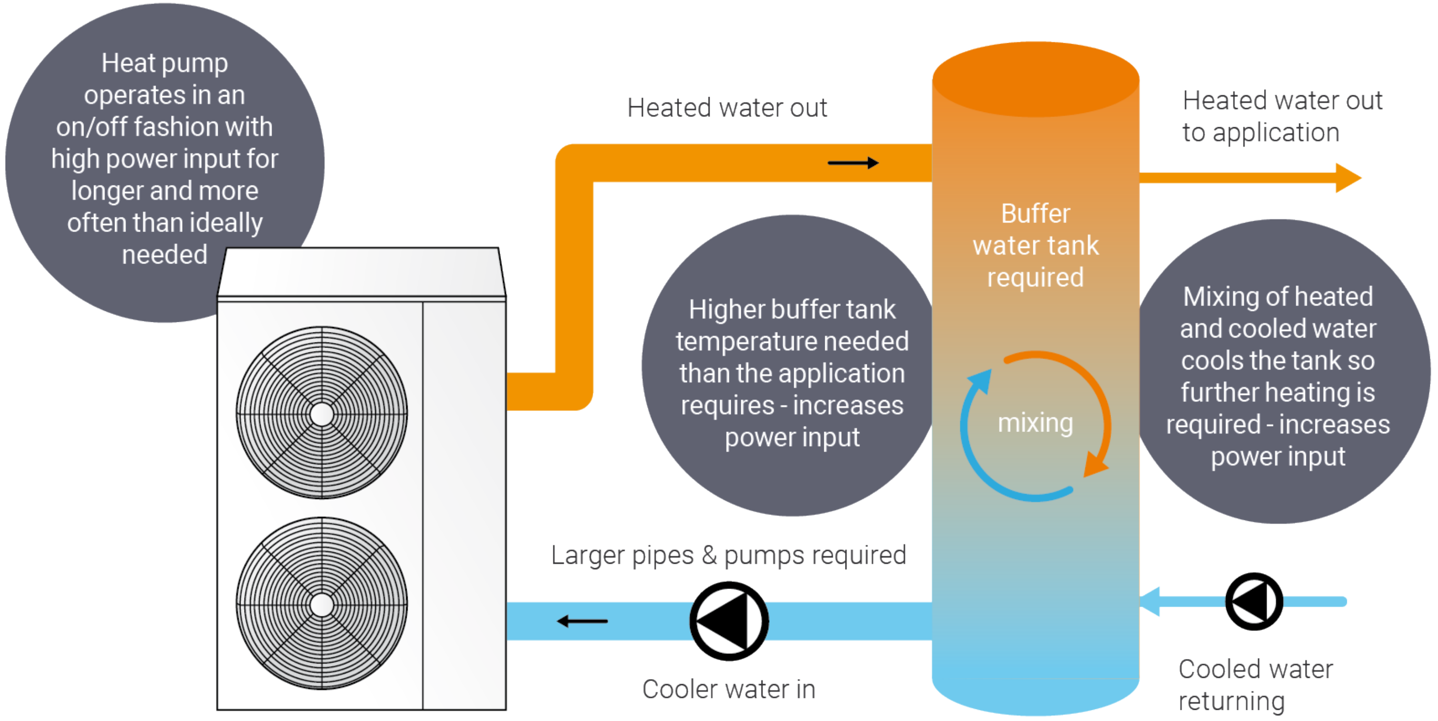
Potable water

Underfloor heating

Traditional Systems

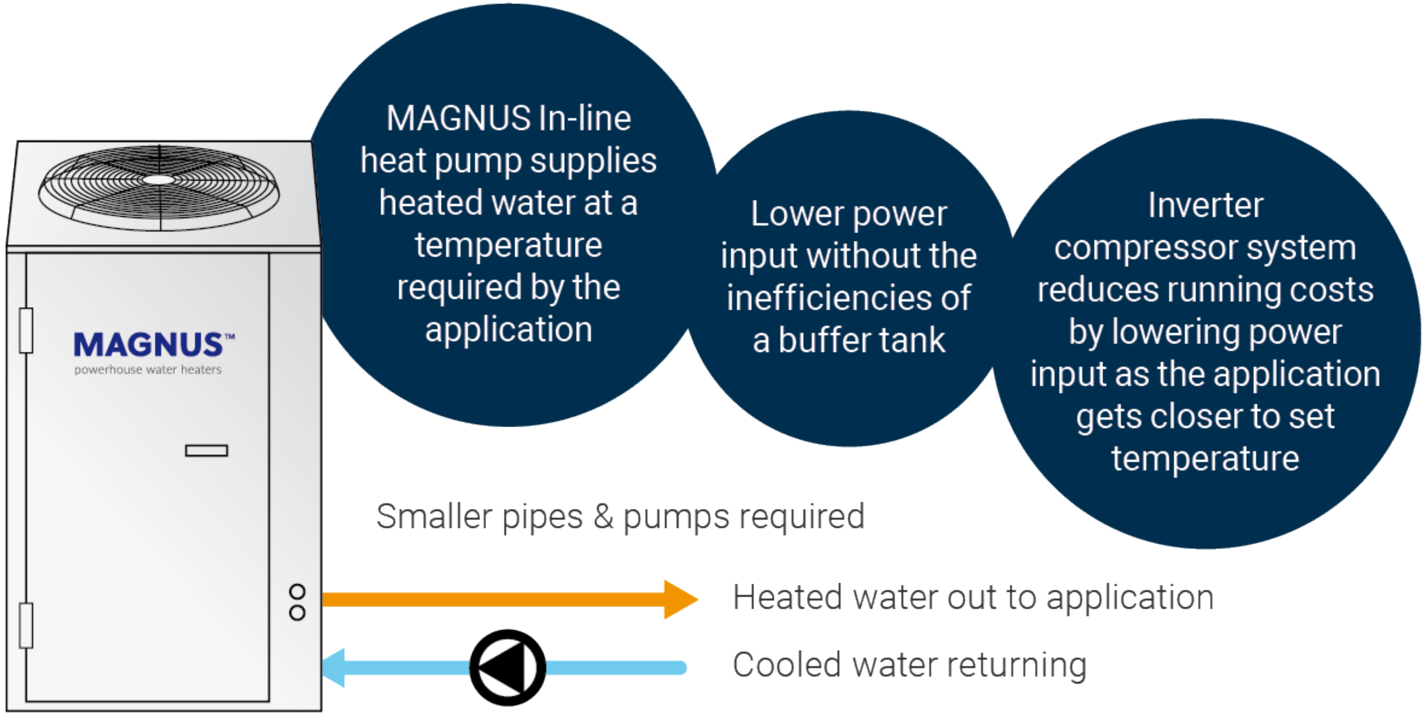
One size fits all approach

- One size fits all approach
- Inefficiencies with buffer tank due to mixing
- Higher buffer tank temperature than needed
- Large pump power required
- Large piping for high water flow rates
- High capital and installation costs
- Larger system footprint



MAGNUS In-line Design
Variable delivery systems

- Application specific design
- Lower capital costs
- No buffer storage tanks required
- Smaller pump size required
- Reduced piping due to lower water flow
- Reliable long-life systems
- Lower servicing requirements
- Compact design



MAGNUS Potable Water

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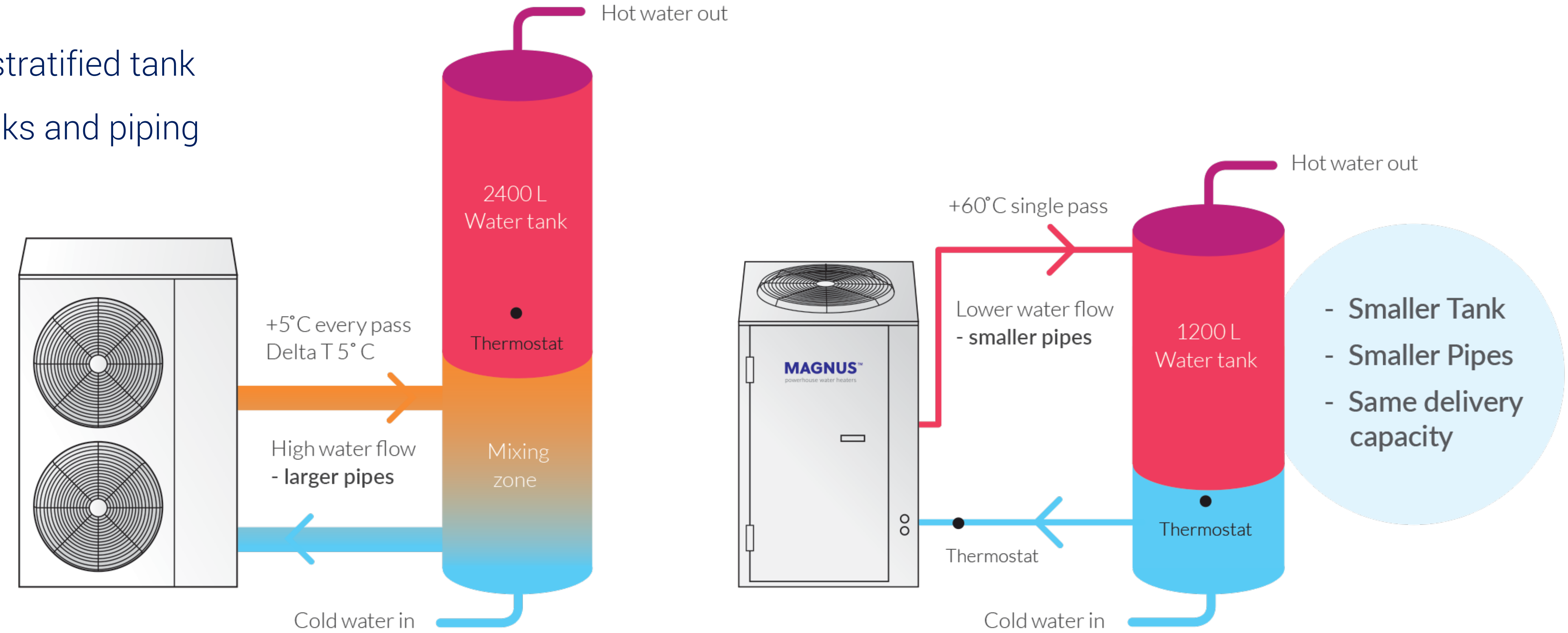
- Thermally stratified tank
- Smaller tanks and piping



Integrated Solutions

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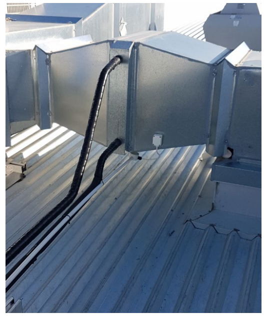
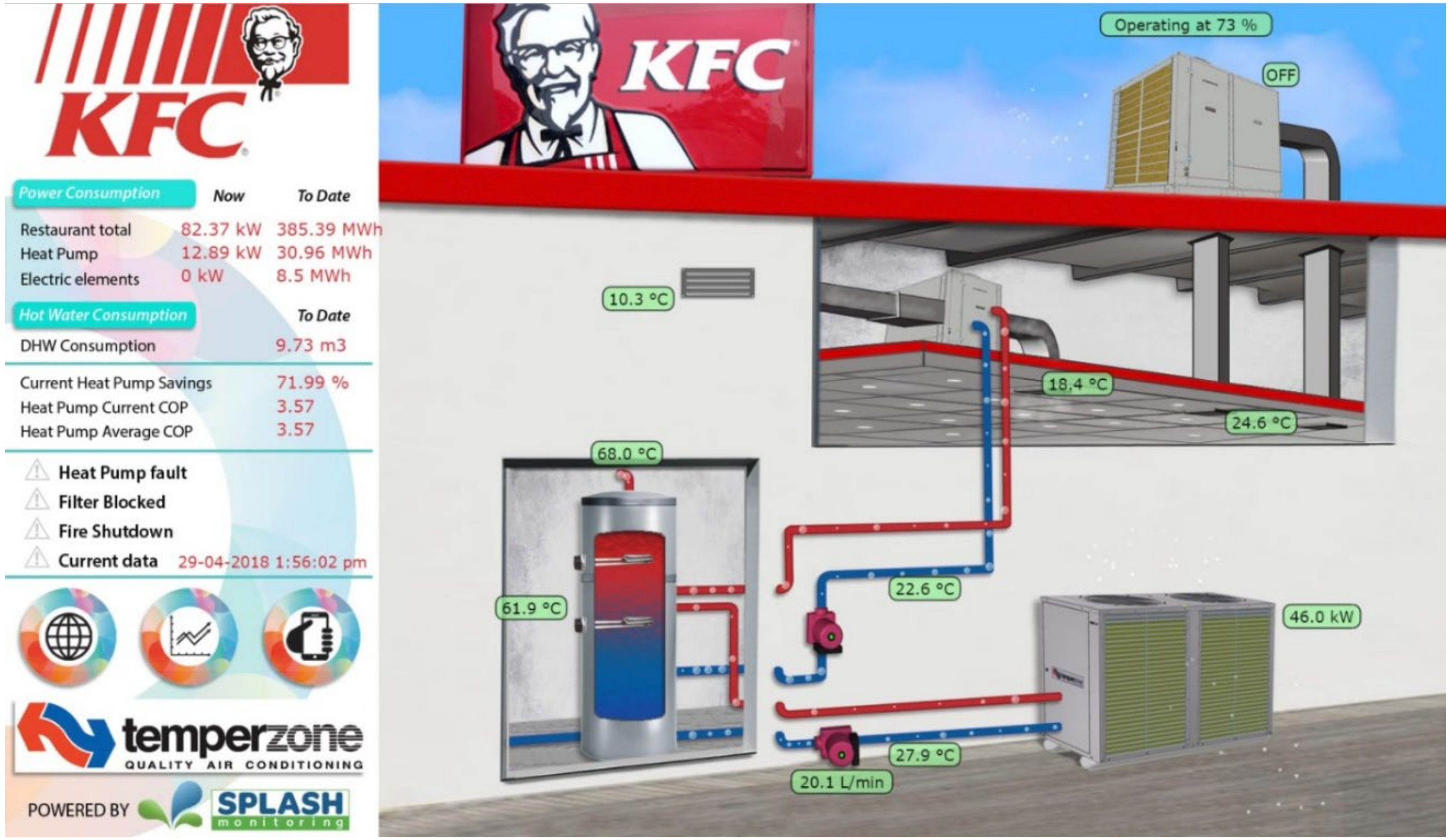
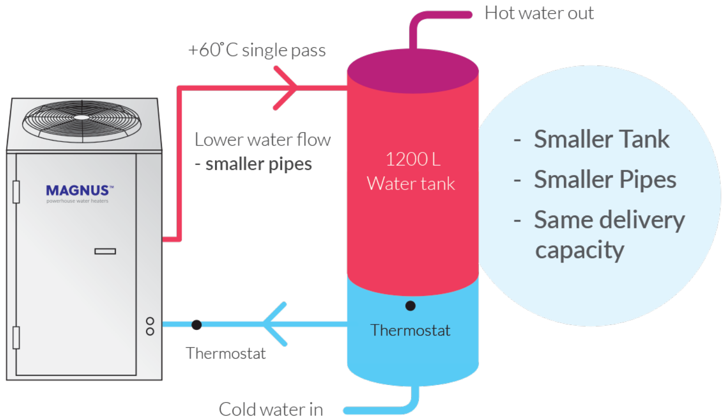
Restaurant Integrated System

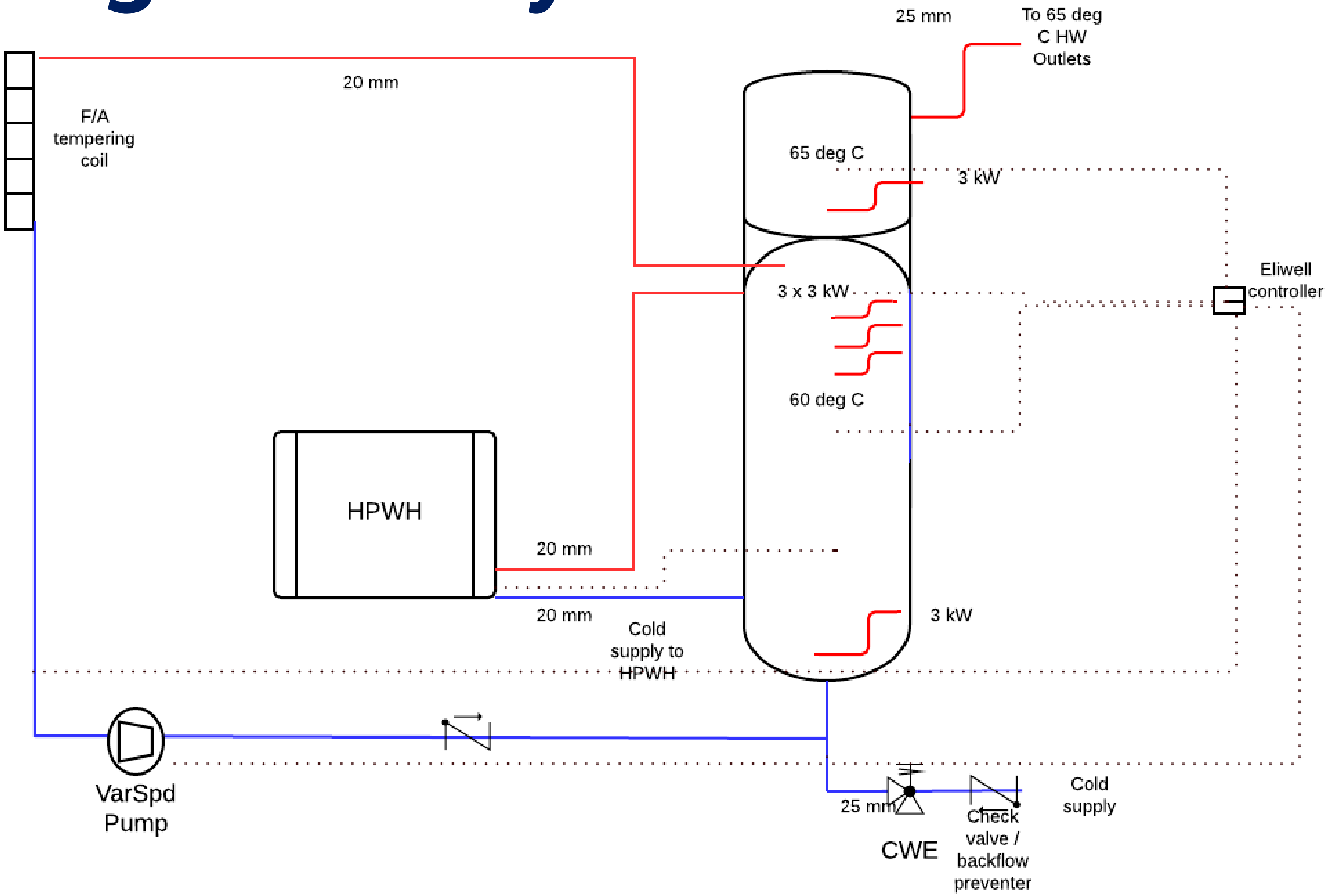
Hot Water / Fresh Air Tempering / Heat Pump Water Heater





Restaurant Integrated System





Zoned Hot Water Storage Tank

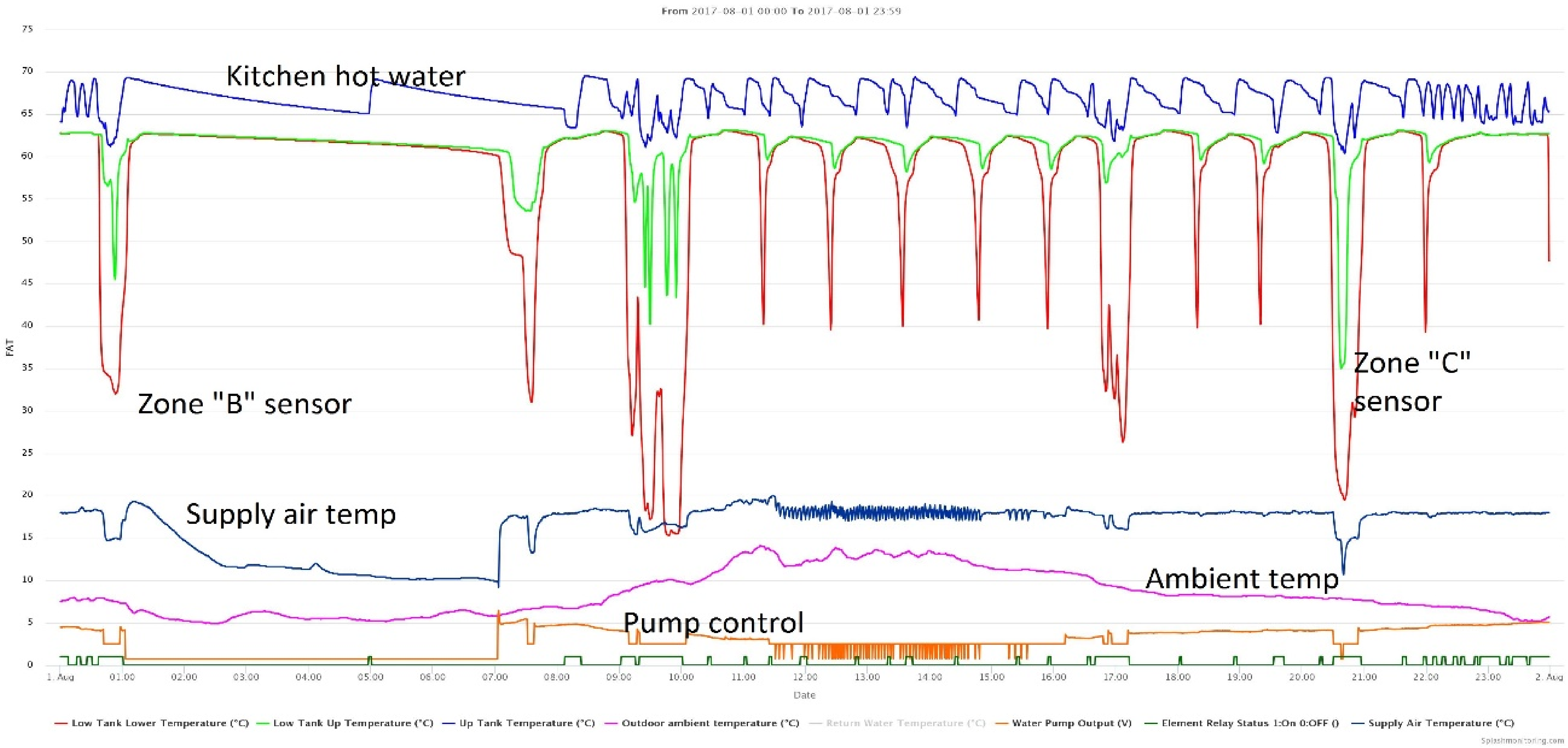
- To meet the simultaneous hot water demand and FAT demand under design conditions (1˚C) ambient temperatures would have required either a substantially larger storage tank, or a doubling in the capacity of the HPWH.
- Both of these options would have significantly increased the capital cost of the system.
- An alternative approach has been trialed instead, using a zoned hot water storage tank in conjunction with a single pass HPWH.

System Performance Splash Monitoring

- The energy performance of the system has been determined for the period from 01/03/2017 to 28/02/2018 through the Splash Monitoring system.

  Monitoring system installed included:
- Flow meter on the total hot water usage
- Flow meter on the HPWH (total HW generated)
- Temperature sensors on HPWH flow / return, and at each zone in the tank
- Current transducers on the HPWH, and each electric element in the tank.

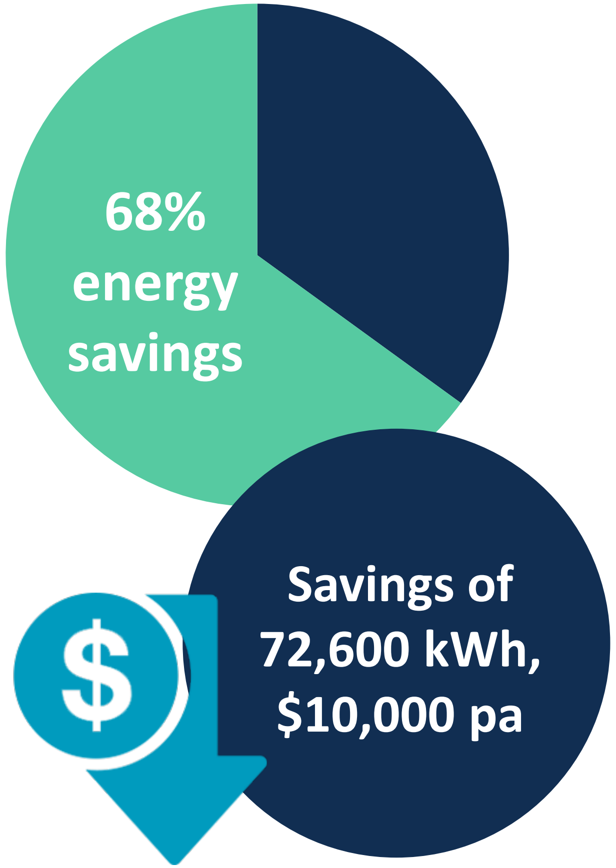
System Design Assessment: FAT / Tank Zoning Monitored Data



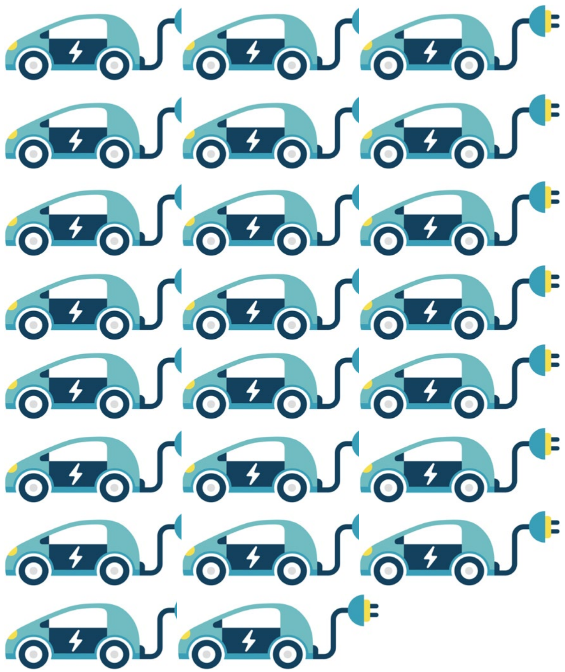
Integrated System Performance

- Average daily hot water consumption of the store was 2200 L and heating this water required 49.4 MWh of energy.
- The FAT system consumed 57.9 MWh of heated water, resulting in a total water heating energy requirement of 107 MWh. This water was heated using 31 MWh of electricity through the HPWH, and a further 2.33 MWh of electric resistance heating.
- The HPWH achieved an annual COP of 3.4, and a **68% reduction in electricity consumption compared to an all electric system**. This corresponds to a 72.6 MWh reduction in electricity usage, at a value of $10,900 (at 0.15c/kWh).
- As proportion of total electricity usage, an all electric water heating and FAT system would be expected to account for 23% of the total electricity usage of the store. **The integrated HPWH based system has reduced that to 8%.**

Annual Energy Savings



23 Electric Cars



traveling 50km every day

365 days a year

Dargaville Hospital Boiler Replacement
Domestic HW & Radiator panels

MAGNUS™
powerhouse water heaters

HPWH Models: MWA250, MWA350, MWF900

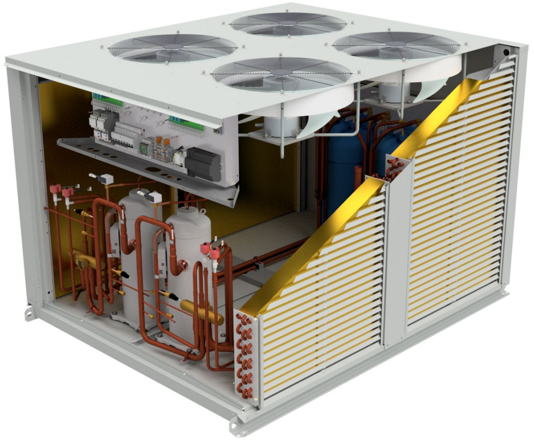
Crown loan program

EECA BUSINESS™
PUTTING ENERGY TO WORK

MAGNUS™
powerhouse water heaters

Dargaville Hospital Boiler Replacement Domestic HW & Radiator panels

- Centralised primary circuits are typically designed to operate to the highest required temperature. Often, the annual load at this temperature is a minor contributor to the total heating load eg space versus potable water heating.
- Distributed, application based heat pump systems increase overall system efficiency by matching the required temperature to the supplied temperature.
- Approach avoids the distribution losses of the primary circuit, particularly outside of the heating season.
- Enables management of buildings based on occupancy levels.
- Allows DHB to operate units based on seasonality.
- Considerable application to remove fossil fuel from older buildings



Dargaville Hospital Boiler Replacement
Domestic HW & Radiator panels

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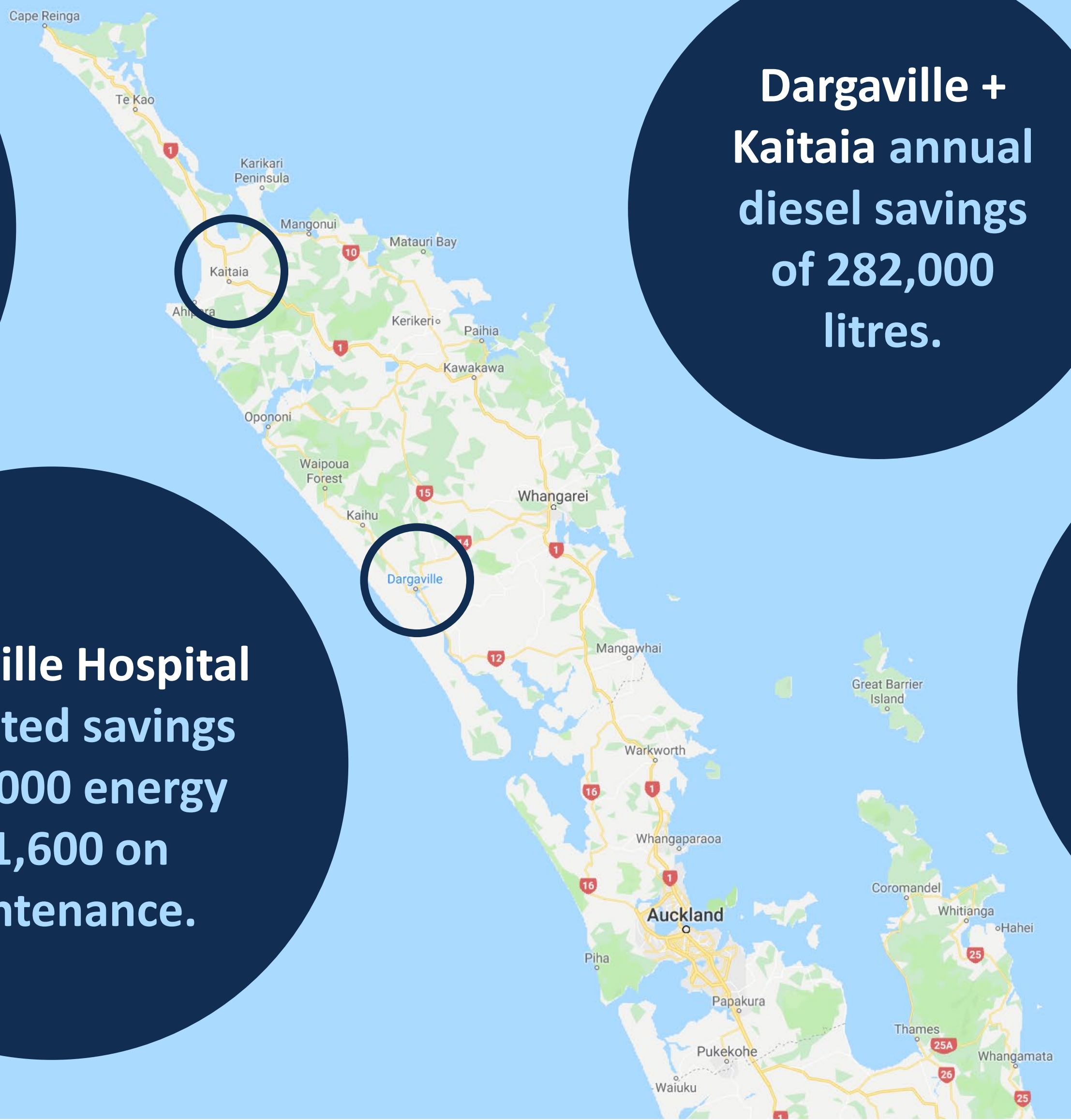
powerhouse water heaters

Kaitaia Hospital predicted savings $89,000 energy $53,900 on maintenance.



Dargaville + Kaitaia annual diesel savings of 282,000 litres.

Dargaville Hospital predicted savings $111,000 energy $41,600 on maintenance.

Dargaville + Kaitaia projected reduction in carbon emissions 794 tonnes annually.

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Coles Maquarie Fields: Electric heater bank replacement. Supplementary store heating

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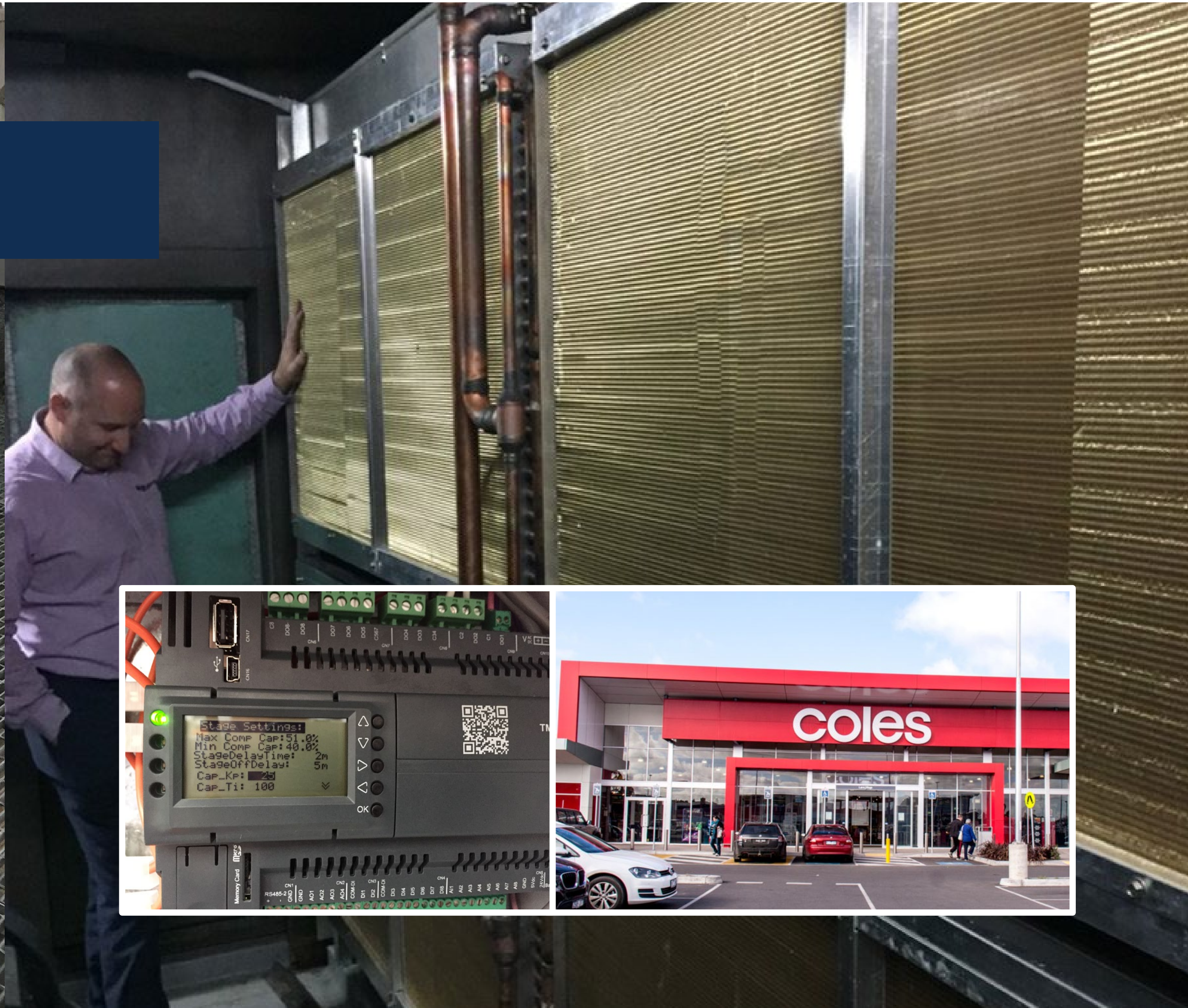
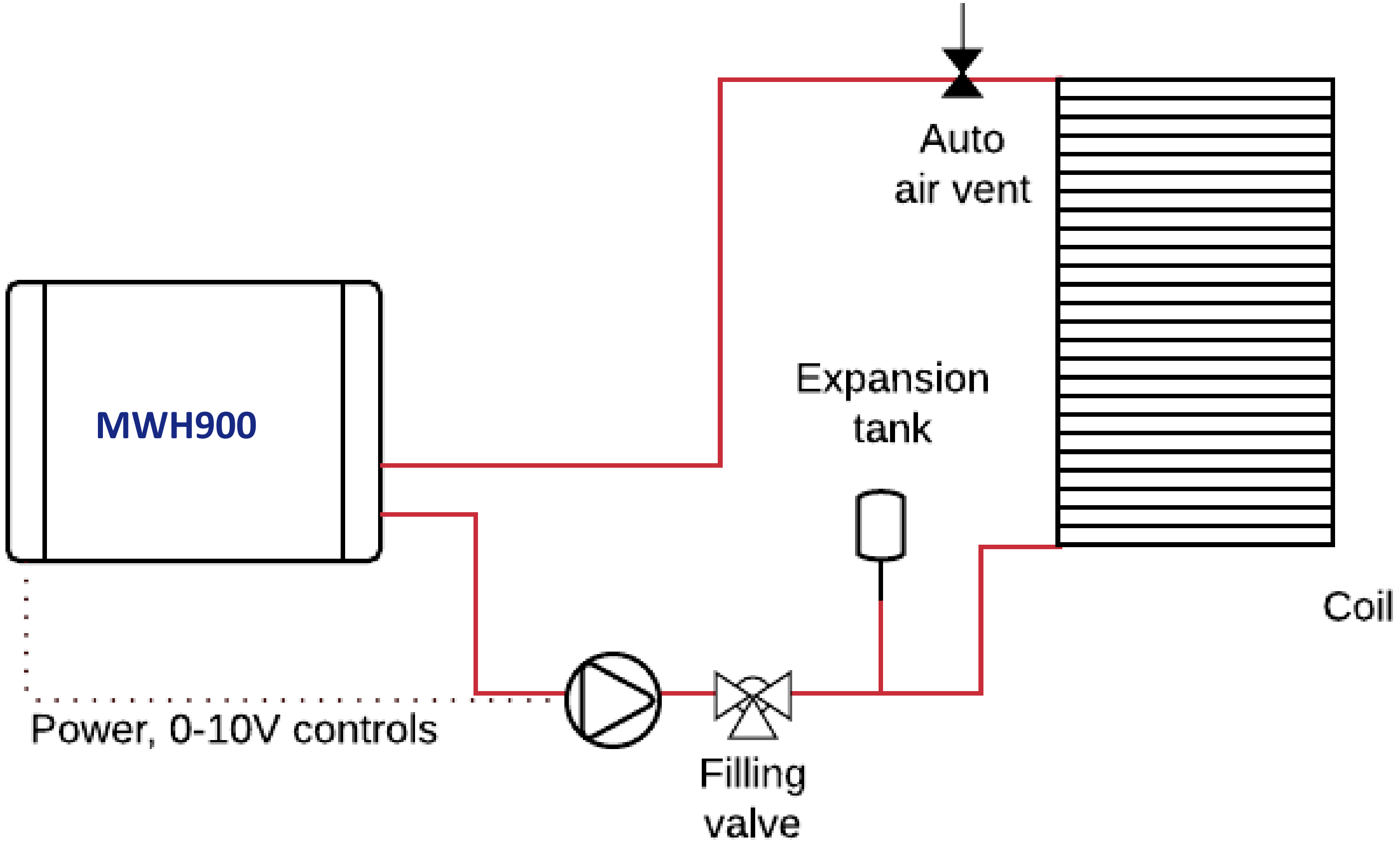
HPWH Models: MWH900 + Temperzone Coil



Coles Maquarie Fields: Electric heater bank replacement. Supplementary store heating



Coles Maquarie Fields: Electric heater bank replacement. Supplementary store heating

> "All up we achieved an actual reduction of 65% energy usage on the HVAC submeter, in raw numbers this is 364,206 kwh of which we estimate 65% was attributed to the heat pump installation (242,998 kwh)."

Coles Macquarie Fields

242,998 kW hours saved, $36,500 pa

Mt Cook YHA – 80 Bed Hostel
Integrated HPWH / Solar thermal

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HPWH Models: MWA250 vapour injection

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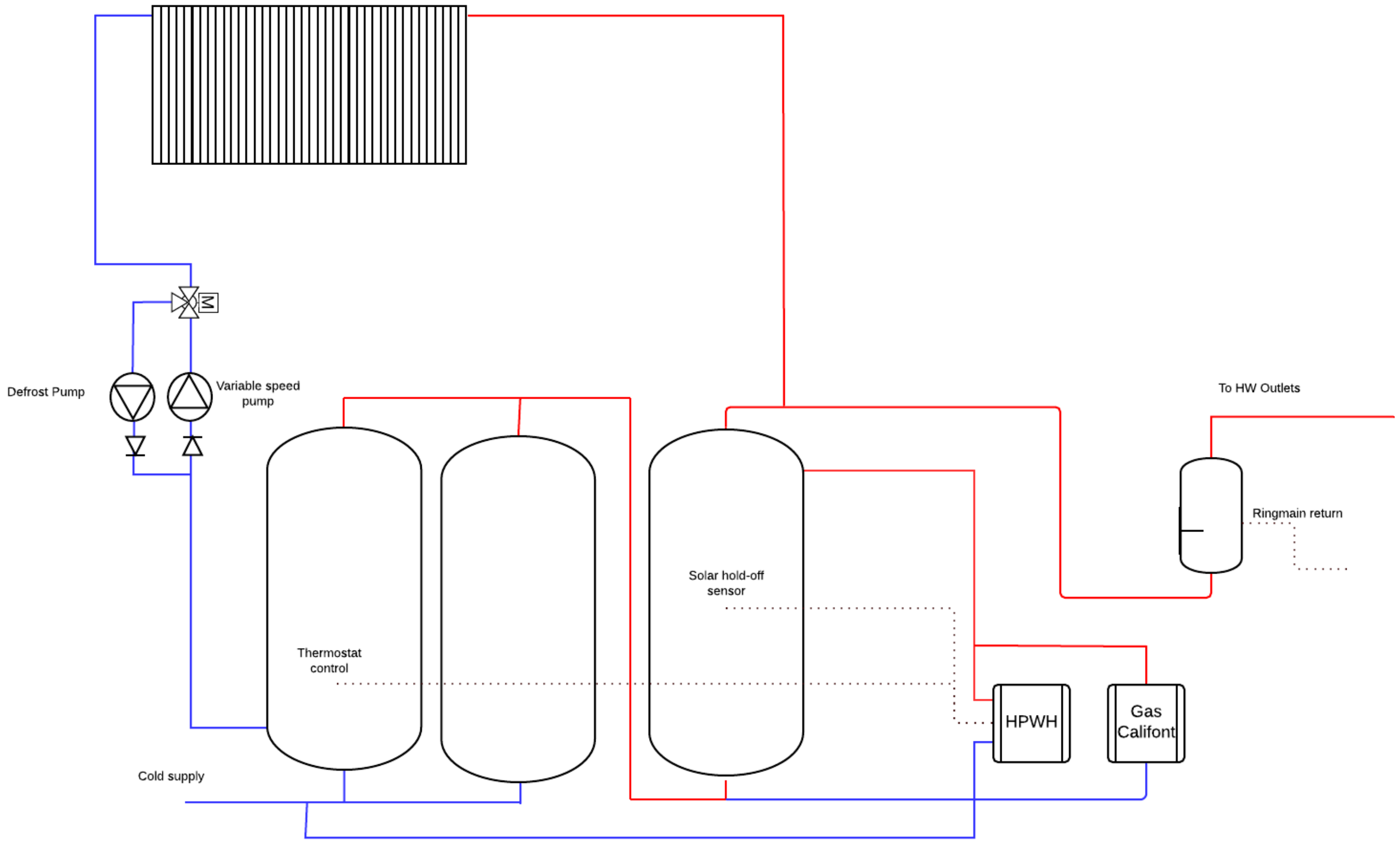
Mt Cook YHA – 80 Bed Hostel Integrated HPWH / Solar thermal



Mt Cook YHA – 80 Bed Hostel
Integrated HPWH / Solar thermal

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Deloitte.
ENERGY EXCELLENCE AWARDS

2019 Finalist - Low Carbon Future

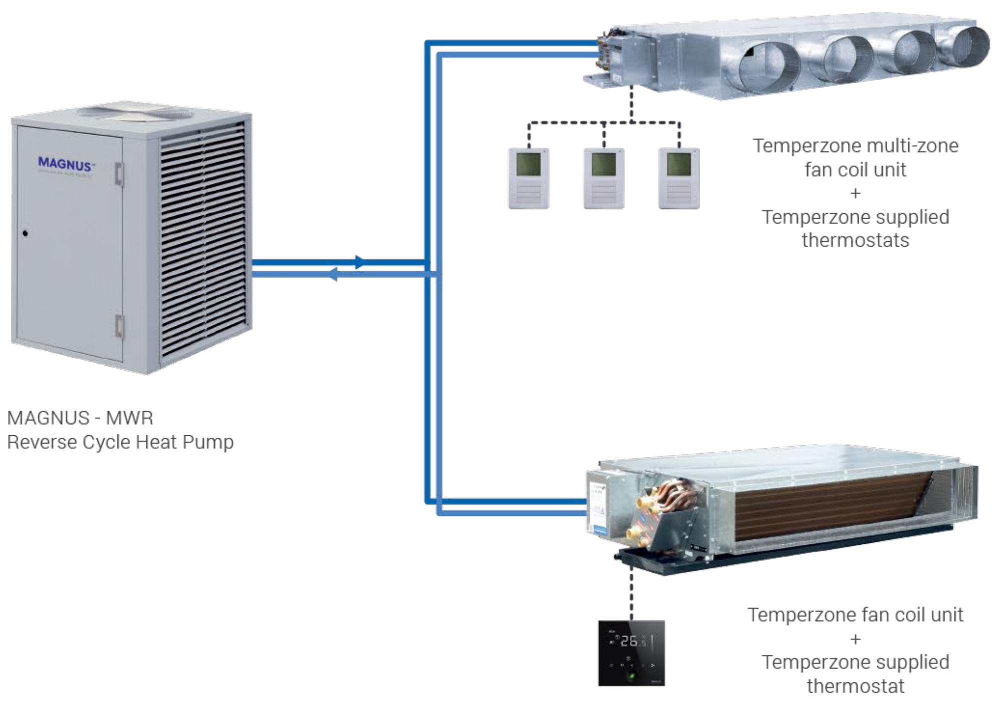
- 1st synergistic heat pump / solar thermal integration
- Only achievable with unique MAGNUS single pass technology
- Provides all water heating without supplementary heating

Energy Savings of $28,700 pa over gas boiler system

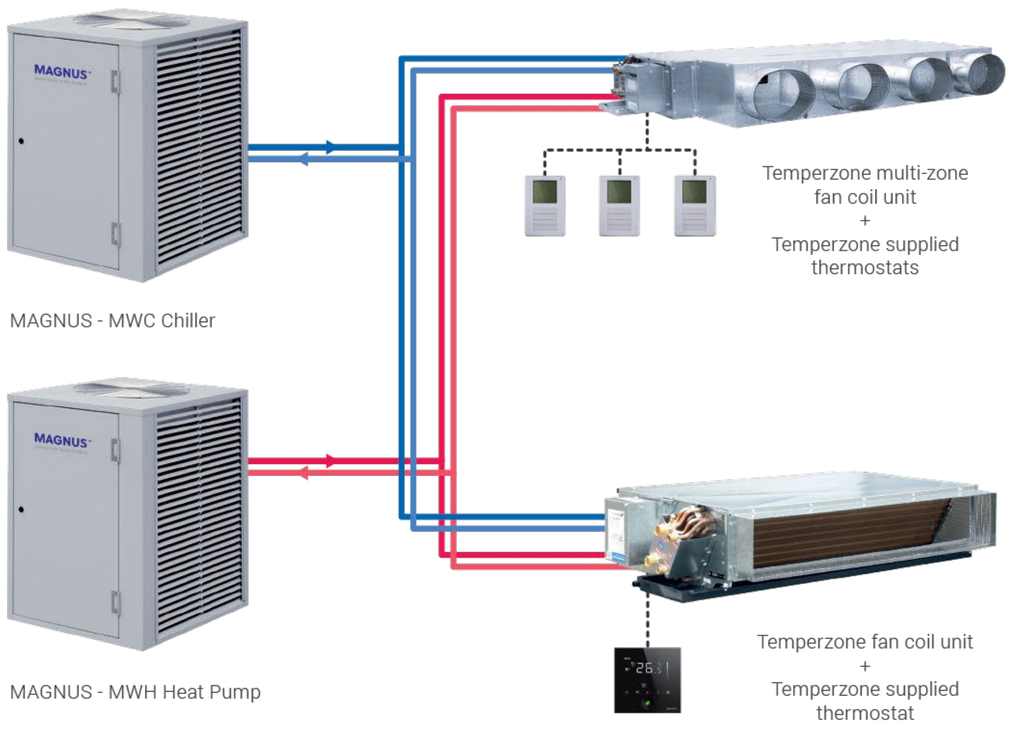
LOW CARBON FUTURE WITH HVAC

temperzone climate innovations

Two Pipe System



Four Pipe System



Two Pipe - System Design

- 12.5 - 90kW system
- Heating or cooling 2 pipe system
- Only heats or cools at any one time
- Thermostat controller / MODBUS
- Connect any Temperzone fan coils
- Fan coil unit controllers
- MAGNUS Inverter Hybrid (MWR) for heated or chilled water loop

Four Pipe - System Design

- 12.5 - 90kW system
- Heating & cooling 4 pipe system
- Simultaneous heating & cooling
- Use any Temperzone fan coils
- Fan coil unit controllers
- Thermostat controller / MODBUS
- MAGNUS Inverter Hybrid (MWH) for heating
- MAGNUS Chiller (MWC) for chilled water loop

Low Carbon Solutions

- Boiler to Heat Pump replacement for lower total emissions
- High part load energy efficiency with Inverter systems
- Efficient without the requirement of water buffer tanks


MUJI