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# Mitsubishi Electric Guide to Heat Recovery Chillers

**Information** Guide 67

Cooling | Heating | Ventilation | Controls

# Mitsubishi Electric Guide to Heat Recovery Chillers

This is an independent guide produced by Mitsubishi Electric to enhance the knowledge of its customers and provide a view of the key issues facing our industry today.

This guide accompanies a series of seminars, all of which are CPD certified.

## Contents

# Introduction

Heat is required in buildings across the year. Whether it is used for space heating or domestic hot water services, heat is vital for occupant comfort and health. However, production of heat in buildings not only represents a cost in terms of energy, but is also increasingly under pressure from legislation due to the carbon and other emissions associated with heating systems.

The drive to cut carbon produced when heating buildings is now well and truly on, and optimising efficient production and use of heat is rapidly rising up the agenda.

The Committee on Climate Change (CCC) recently announced that it regards decarbonising the UK's heat production as a key objective in the next five to ten years. While the early focus is likely to be on the domestic sector, commercial buildings will have to be included in the programme in the near future if UK carbon reduction targets are to be met.

What's more, commercial building owners and managers already face a number of regulations and laws which are driving building heating systems up the environmental and business agenda.

## Key legislation to consider:

### Grid emission factors and the Climate Change Levy (CCL)
The UK has been very successful in decarbonising its electricity production. As a result, electricity is regarded as a ‘cleaner’ energy source than gas. The government’s emission factors reflect this shift away from fossil-fuels, and they are intended to encourage businesses to move to electricity as the source of heating.

### Climate Change Act revision
The UK government has agreed to ‘net zero’ greenhouse gases by 2050, a target that has increased from the previous ‘80% reduction’.

### Part L revision
Part L of the Building Regulations is due to be updated. Government has made it clear that it will be following the advice of the CCC, and leaning towards further phasing out of fossil fuels.

### London Plan and clean air policies
Local government is also creating change by making legislation to mitigate air pollution, with London leading the way in this area. Having already been taken to task by the EU for missing its targets on air quality, the Greater London Council (GLC) is setting tougher targets on NOx and other emissions. The result is that gas heating options are harder to use; and even CHP (combined heat and power) is proving less popular as an option for commercial buildings.

### MEES and EPC improvements
At the same time, Minimum Energy Efficiency Standards are in force for commercial buildings. These require a minimum EPC rating of D before a building can be leased. This has already seen major property owners begin to divest poorly-performing buildings, putting a monetary value on energy performance as never before. Heating and cooling systems are large energy users, so their performance plays an important role in achieving a good EPC rating.

**NOTE:** Mitsubishi Electric Guides to MEES, Part L and the London Plan are available from our document library website.

# Save energy - recover your heat

The message is that whatever the source of energy used to produce heat in your building, the more that can be done to save it, the better. Fortunately, there are increasingly sophisticated approaches to capturing heat that would otherwise be wasted or dissipated into the atmosphere - and harnessing this to save energy and money.

One area that is seeing increasing interest is the application of heat recovery systems. Simply put, by re-using heat that has been generated in the building (for example, when rejected from the cooling system), it is possible to save significant amounts of energy - reducing operational costs in the long-term. The captured heat can be applied to various areas of building services which are discussed later in this Guide.

Heat recovery offers a number of other benefits which are proving very useful for today's built environment. While low-carbon heating options for buildings are certainly available, they generally occupy a larger footprint than traditional systems. This may not be a problem for all projects, but for many urban new-builds and refurbishments it is a serious consideration. Inner city applications are using much more compact HVAC solutions, so large CHP plant may be impractical simply for reasons of space availability.

However, heat recovery systems can be included in the HVAC plan with little to no impact on space requirements. Even a small heat recovery system supplementing larger plant can have a dramatic impact, reducing energy consumption and carbon emissions - both factors becoming more important for gaining planning permission. For mixed use projects or large offices, where heat profiles are diverse, heat recovery works particularly well. Heat can be captured from the cooling process and used to reduce the heating requirements in other areas of the building.

# Methods of heat recovery

Simple heat recovery is already at work in the popular VRF systems that have been applied in many projects over the past few years. VRF systems use direct expansion as the heat recovery method. However, for chilled water applications, there are a number of solutions and approaches that are available, depending on the particular project requirements.

## Partial heat recovery (desuperheater)

This method is great for smaller applications and is an excellent solution for providing domestic hot water (DHW) in a building. Each refrigerant circuit is fitted with a desuperheater in series with the condenser coils. This harnesses the 'waste' energy in the form of heat and is ideal for providing hot water at around 60ºC.

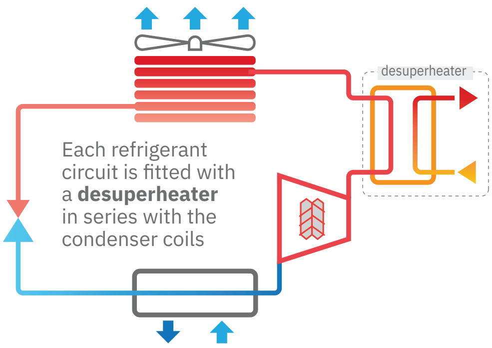
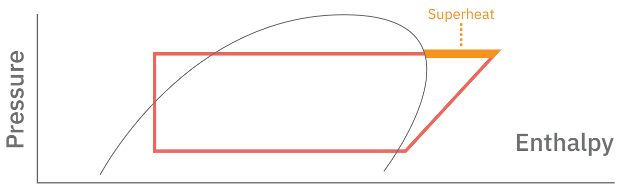



Illustration 1

Approximately **20%** of the chiller's capacity

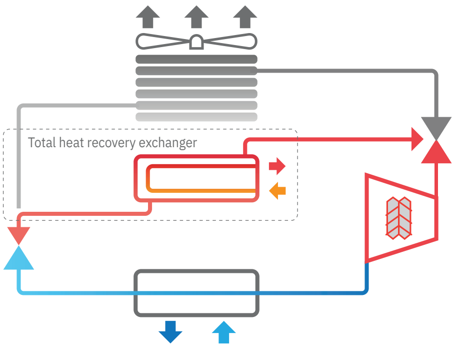
Up to **60ºC** of outlet water temperature




# Methods of heat recovery

## Total heat recovery

This is an excellent solution where there is a very large cooling requirement such as in manufacturing processes and IT cooling. The greater the cooling load, the more heat energy there is to collect. As the diagram below shows, each refrigerant circuit is fitted with a total heat recovery exchanger in parallel with the condenser coils.




Each refrigerant circuit is fitted with a **total heat recovery exchanger** in parallel with the condenser coils

Always **100%** of the chiller's capacity | Up to **60°C** of outlet water temperature

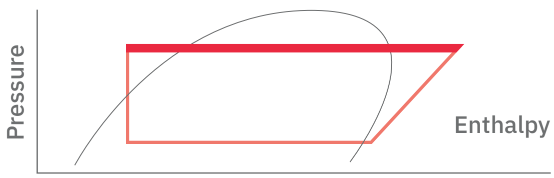



Illustration 2

## Simultaneous heating and cooling chillers

This is an approach that works very well in mixed-use applications, large office buildings and data centres where there are coincidental heating and cooling loads.

Even in modern offices, it is not unusual to find that one area of a building requires cooling while another needs heating, depending on the orientation of the building, shading and other factors. And in mixed-use developments, with offices, residential and perhaps retail and hotel facilities nearby, the requirements for heating and hot water will vary - as will occupancy and times of peak demand.

This is an ideal environment in which to cool and recover heat from an office, for example and use it to provide heating for residential areas, or perhaps to supplement hot water, thereby reducing the load on boilers. The traditional approach to the challenge of providing heating and cooling simultaneously has been to use a gas boiler and a chiller. The diagram to the right illustrates how the boiler operates largely in winter months, and the chiller in summer.

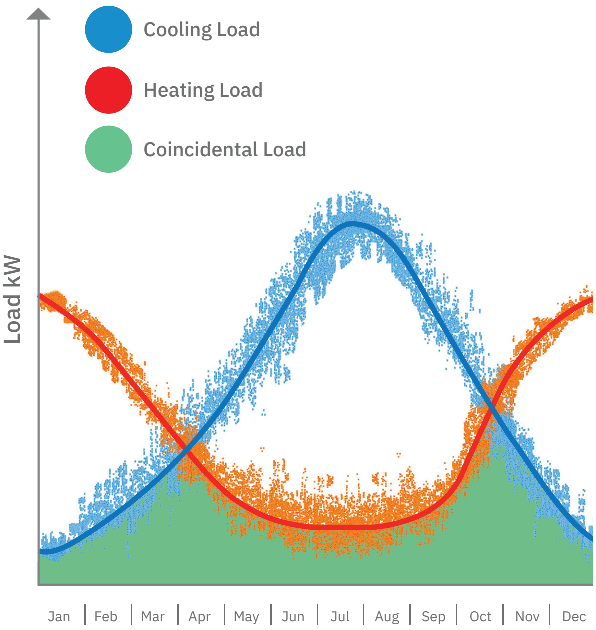



Illustration 3

However, an alternative approach, particularly for those looking to move away from the use of gas as a heat source towards cleaner electricity, is to use a chiller with simultaneous heating. The first benefit is reduced capital cost, as there is no boiler to install and no gas connection required. And long-term operating costs have also been shown to be significantly lower than the chiller-boiler combination, with up to 40% energy savings as shown in the below diagram.

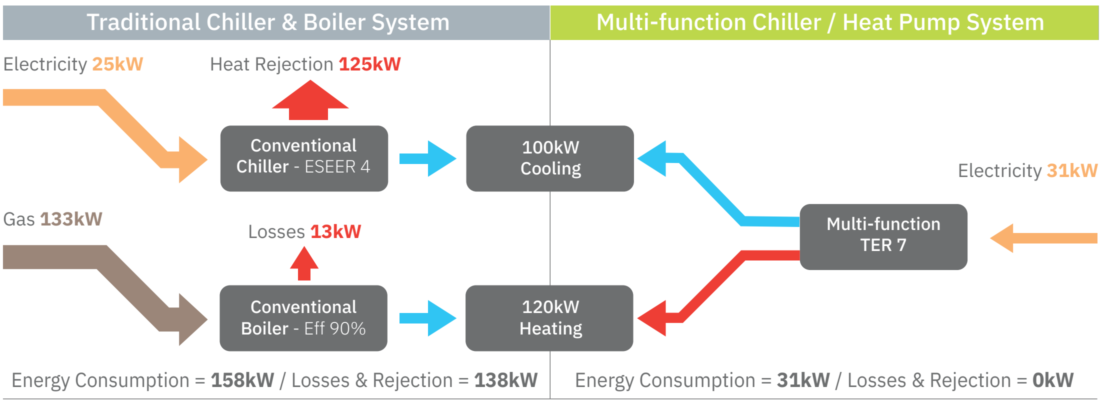



Illustration 4

Simultaneous heating and cooling equipment sometimes referred to as 4 pipe chillers, has the usual compressor, condenser and evaporator components. However, it also contains additional auxiliary exchangers, enabling the chiller to take the 'waste' heating or cooling energy and to transfer it where it's needed in the building. The diagram below shows how the 4-Pipe Integra chiller operates:

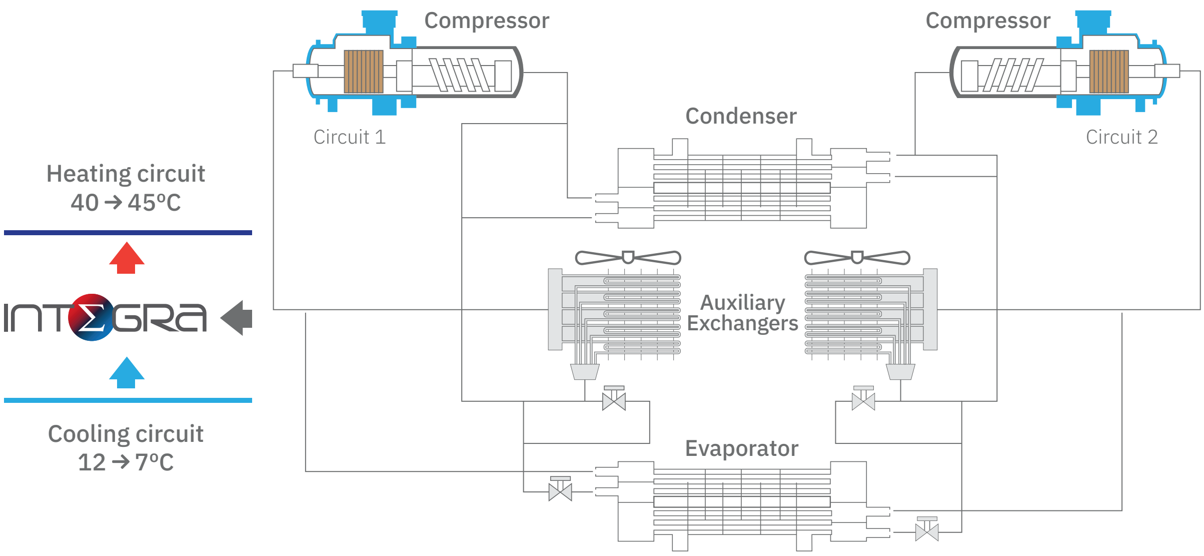



Illustration 5

# Methods of heat recovery

## Simultaneous heating and cooling chillers with primary reversible heat pump chiller

This is a continuation of the strategy to utilise multifunction chillers to overcome the heating and cooling base load, with reversible heating or cooling chillers being used to meet peak heating or cooling demand.

This method creates an adaptable heating and cooling system which optimises use of roof plant, while reducing energy use and carbon emissions.

The additional cooling required in the summer is overcome by a heat pump chiller, however in the winter the additional heating required is overcome by the same plant now working, in reverse.

The use of modular chillers is additionally executable so that the system can remain robust to the needs of the building throughout the year.

By calculating the combined output of the cooling and heating process, divided by the power input, the system achieves a much higher overall efficiency rate. As we see in illustration 5, this compares very favourably with the traditional chiller/boiler system both in terms of energy use and carbon emissions.

## Dedicated heat recovery heat pump

This approach applies a water source heat pump, which uses the condenser water or return chiller water as its energy source. This has proved a very useful approach for large water-cooled chiller applications. It improves the performance of large capacity chillers and dedicated plant - enhancing the ROI of the capital expenditure and improving long-term performance.

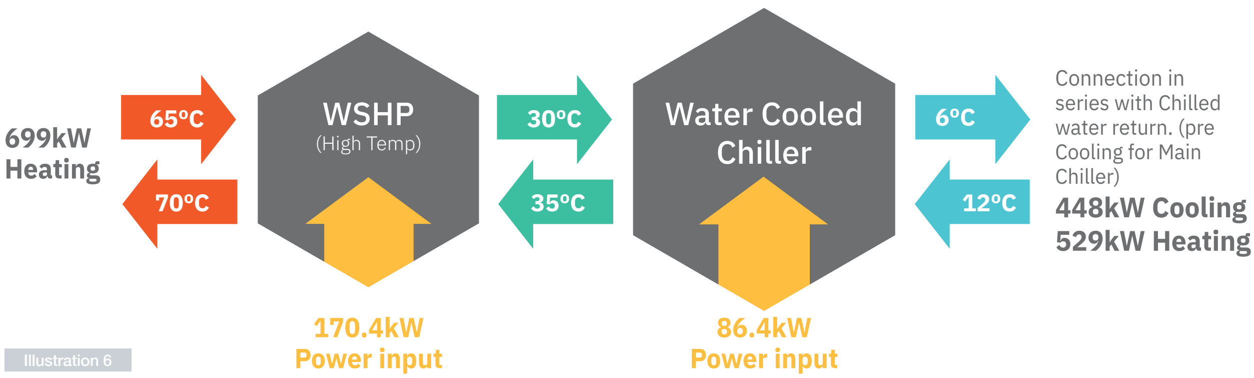



Illustration 6

Total Efficiency ratio = Cooling [448kW] + Heating [699kW] ÷ Power Input [86.4 + 170.4KW] = **4.46**

Again, we see here how the application of heat recovery through a water-source heat pump greatly increases the system's overall efficiency, reduces overall energy use and cuts carbon emissions as a result.

# Conclusion

For the past decade, government policy has enabled the UK to move to much lower-carbon production of electricity.

However, the national carbon reduction targets continue to set new challenges - heating is the next big win for cutting emissions. At the same time, we need to reduce our energy use overall, creating an enormous challenge for building designers and managers.

Heat is an often-wasted by-product of cooling in our commercial buildings. Given these growing policy pressures and rising costs, it is simply throwing money away to leave that heat unused. Heat recovery is not only a commercially savvy option, it provides a genuine route to reducing a building's impact on the environment.

To receive a CPD seminar on Heat Recovery Chillers, you can call your Mitsubishi Electric Regional Sales Office to arrange an in-house presentation of this information.

If you would like to receive invitations to future CPD events, please email **livingenvironmentalsystems@meuk.mee.com**

## Further information

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