MAKING THE ULTIMATE DECISION: CHILLER vs VRF

Comparing the two different system types, chiller and VRF systems, is essential when selecting the right fit for a project. This white paper provides a side-by-side comparison of the chiller and VRF systems.

Ahead of the Expected

CHILLER VRF

White Paper Contents

01

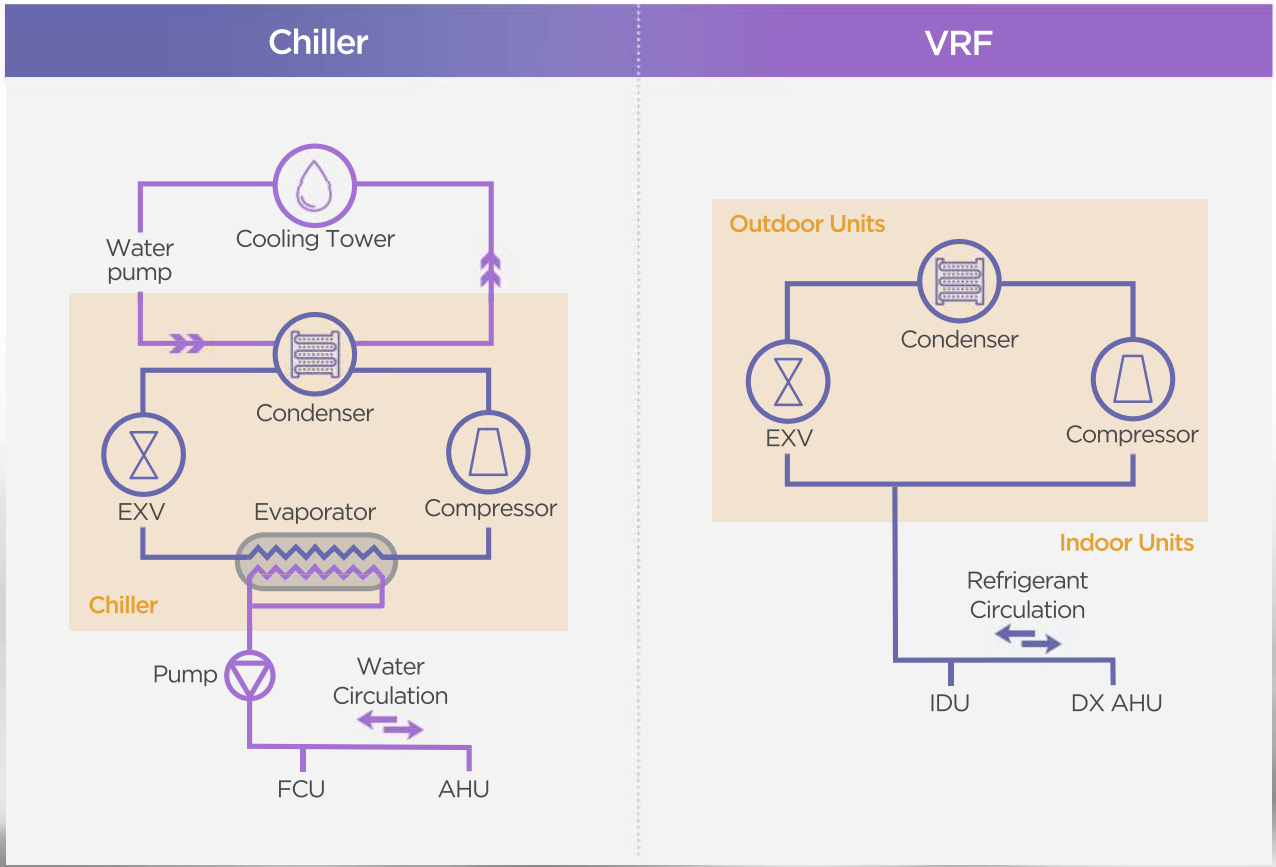
Making the Ultimate Decision:
LG HVAC Chiller and VRF Comparison

Introduction

From building owners and administrators to designers, engineers, and even tenants, most stakeholders are interested in the efficiency, performance, and costs of HVAC systems as far as it directly affects them. This is because HVAC systems are extensive systems that consume large amounts of energy, making it expensive to install and costly to operate. For this reason, **it is imperative to make informed decisions when selecting an HVAC system** type to ensure that all parties are sufficiently satisfied.

A wide range of factors must be considered for each project, including efficiency, convenience, installation conditions, system control, and maintenance. In this decision-making process, **it is essential to undertake a cost-benefit analysis of both the VRF and chiller systems to determine which system type will be most suitable for a given project.**

Our goal with this white paper is to address the benefits of each type of system and help people with their decisions-making process when planning for, and designing an apt HVAC system.



02

Making the Ultimate Decision:
LG HVAC Chiller and VRF Comparison

Cost and Energy Efficiency

Efficiency

Depending on their size and capacity, chillers can provide approximately 20RT-5,000RT. The large cooling capacity makes chillers an adequate solution for large commercial buildings. **Chillers are particularly well-suited to large, open-floor facilities where they will be operated for extended periods of time.** These systems commonly condition the entire building at predetermined times regardless of user demand or specific time of days. Chiller products typically have a high Coefficient of Performance (COP) but when you take into consideration the energy consumption of additional components such as pumps and cooling towers, the power consumption of the entire system can increase.

VRF systems are systems that distribute refrigerant to different zones through interconnected refrigerant piping. **VRFs can control the amount of refrigerant flowing to each segment at will to ensure total comfort while being mindful of energy efficiency.** Owing to their unique system architecture, VRF systems make it possible to cool individual spaces in a building efficiently and only operate in areas where needed according to user demand.

In general, VRF systems are thought to be better for effective targeted zone control, however chillers are also able to manage flow rate control. The main difference here is that EEV control in a VRF system does not incur additional costs as each indoor unit has the required valves already installed while chillers require additional FCU valves and control systems.

A VRF system will also allow for cooling in one space and heating in another space at the same time. Simultaneous heating and cooling are made possible by adding boilers to the chiller system, but this makes the system more complicated and increases the costs.

Ultimately, you should not only consider the size of your facility but also consider factors such as facility usage and usage patterns.

02

Cost and Energy Efficiency

Initial Investment

In general, **VRF systems tend to be less expensive in terms of initial investment for small to medium-sized facilities.** A VRF system consists of outdoor units and indoor units, and it does not require additional investment for equipment such as cooling towers and pumps.

Chiller units are large pieces of equipment that require a dedicated mechanical room and additional equipment for operation. However, **the initial investment for a chiller is more favorable for larger facilities over the long-term.**

If we simply compare the system configurations, VRF is simpler but what precisely makes VRF more favorable for small to medium-size facilities and chillers more favorable for larger facilities? With the example below, let's explore why the size of a system matters.

	200RT Facility	2,000RT Facility
VRF	Outdoor units - 20RT*10 Indoor units - 2RT*100	Outdoor units - 20RT*100 Indoor units - 2RT*1,000
Chiller	Chiller units - 100RT*2 Pump - 2 Cooling tower - 2 FCU - 2RT*100	Chiller units - 1,000RT*2 Pump - 2 Cooling tower - 2 FCU - 2RT*1,000

The initial investment for a VRF system can be lower in small to medium-scale facilities because VRFs don't need a cooling tower or pumps that are issued separately from the core system framework. But how does this work out in a facility that is 10 times larger?

If the capacity of a system is increased by 10, the size of a VRF system must also increase 10 times and this directly applies to the initial investment as well. The reason for this increase in costs is due to the smaller capacity of VRF outdoor units and its ability to scale. Increasing the capacity of VRF systems require the addition of more VRF units, causing a greater increase in required investment.

Conversely, when installing a chiller system, the number of chiller units does not need to be increased even if the capacity of the system is increased ten-fold, meaning, the initial investment cost also does not proportionately increase with expansion. This difference in investment also applies to additional components such as pumps and cooling towers.

With this simple comparison, we can see that from a design and cost perspective, chillers are more favorable for larger facilities, while VRF systems are more favorable for small to medium sized-scale systems.

02

Making the Ultimate Decision:
LG HVAC Chiller and VRF Comparison

Cost and Energy Efficiency

Efficiency of Operation Load Design

Due to the different characteristics of VRF and chiller systems, operation load designs can be made more efficient depending on the size of the facility. For VRF systems, outdoor units are installed with a capacity appropriate for the peak operation load of each zone. For a chiller system that covers multiple zones with a single unit, systems are designed to match the peak operation loads across an entire facility and can be installed with a smaller capacity than a VRF system. For larger buildings, this difference is more significant. This is one of the reasons that chillers are more often installed in larger facilities.

Required Total VRF Capacity

740

By Peak Operation
Load **Across All Zones**

Required Total Chiller Capacity

700

By Peak Operation
Load **for Entire Building**

North-West Morning – 80 Day – 80 Evening - 90	**North** Morning - 80 Day – 80 Evening - 80	**North-East** Morning - 90 Day – 80 Evening - 80
West Morning - 80 Day – 90 Evening - 100	**Core**	**East** Morning - 100 Day – 90 Evening - 80
South-West Morning - 80 Day – 90 Evening - 90	**South** Morning - 90 Day – 100 Evening - 90	**South-East** Morning - 90 Day – 90 Evening - 80

Sample of Peak Load for Each Zone

* Sample data to help in the understanding of operation load capacity. Actual figures will vary for each installation site.

03

Making the Ultimate Decision:
LG HVAC Chiller and VRF Comparison

Design

As can be seen from the figure below, a VRF system is more straightforward in design than its chiller counterpart. The system configuration and structure of a chiller are more complicated than a VRF system and require additional equipment such as a water pump and cooling tower. **VRF systems consist of an outdoor unit, an indoor unit, and refrigerant piping and installation of these components is an easier process than water piping installation.** However, this does not mean that VRF systems are superior to chillers – everything is purpose-driven.

	Chiller System	VRF
System Composition	Chiller (water cooled type) Cooling tower Water pumps Fan Coil Unit Air Handling Unit	Outdoor unit (air-cooled type) Indoor unit Air Handling Unit

Conversely, **one of the significant advantages of chillers is that they come in a wide range of configurations and can be customized.** In terms of design convenience, chillers are "tailor-made" solutions that offer as many options and accessories as might be needed to meet the desired specifications of many different installation environments.

Furthermore, their design flexibility allows for chilled water systems to be combined with various units such as fan coils, floor cooling/heating, AHUs, ice storage systems, and other chiller cascade systems. Of course, with additional options, the initial investment may increase depending on the required specs.

Chillers use water piping that requires more component accessories than a VRF system. Some of these accessories include elbow joints, tee joints, reducers, unions, couplings, crosses, caps, swage nipples, plugs, bushings, adapters, outlets, valves, and flanges. Since each installation is customizable to the needs of the facility, there are many different components and factors to be checked.

Most chiller systems also use electricity, but chillers are able to utilize waste heat to operate. Absorption chiller systems can take advantage of a wide range of heat sources for energy, making a chiller an environmentally-conscious system.

Installation and System Expansion

When it comes to installation, we can approach VRF systems and chillers from two different viewpoints. HVAC systems can be installed in both new developments and in the renovations of existing facilities.

The lifespan of the piping in an HVAC system can last relatively longer than the HVAC equipment itself. In a facility with an existing HVAC system, it is common to upgrade to the same type of system when the time comes. When a chiller system needs to be upgraded, typically only the chiller units need to be replaced due to the long lifespan of chiller water piping. But if the piping is in poor condition, it's worth considering both chiller and VRF options. VRF piping can also be reused when a system is upgraded, but if the new system uses a different type of refrigerant, the piping will also need to be replaced.

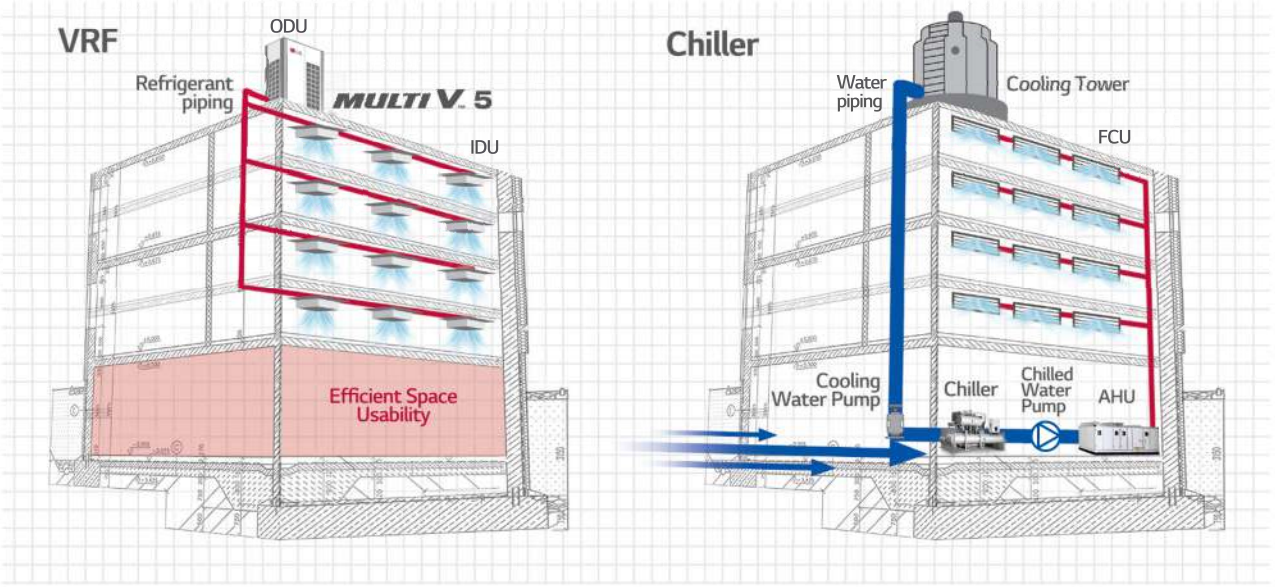
For a new installation, ease of phasing is another point to be considered. With VRF, a building can be zoned so that each group of rooms is entirely independent of the others. Just like a VRF system, a chiller can be constructed in phases so the chiller units can be installed and then the piping can be added as the construction of the building is being completed.

Unlike chiller units, **VRF units can be easily installed on the rooftop of a building without additional equipment or a separate mechanical room.** The straightforward design of VRF systems provides advantages in terms of efficient utilization of space and ease of installation.

Also, unlike VRF systems, **chiller system piping can extend longer distances, allowing for more diverse custom configurations like high-rise buildings.**

In general, all HVAC systems are designed with a spare load capacity along with the base-minimum required load capacity. For larger buildings, chillers tend to have a larger range for spare load capacity. Therefore, when adding just one room or area, **a chiller system can be expanded by adding an FCU and the additional piping that is required.** But if an additional unit is required for a larger expansion of a chiller system, the costs and complexity of the expansion can make things significantly more difficult.

On the other hand, **VRF systems have the advantage of being easier to expand when it comes to adding additional units.** However, when expanding the system, outdoor units need to be installed to match the required system capacity.



Control

An advantage of VRF systems is that both individual control and central control are possible. Remote control and centralized control functionalities are easily achieved by merely connecting communication lines with the VRF system.

Additional control functionality beyond what the system manufacturer provides is not possible, but an array of system control mechanisms are possible without excessive costs, making VRF systems a more appealing option for small to medium-sized facilities.

For a chiller system, additional control systems must be implemented for pumps, cooling towers, FCUs, AHUs, and other required equipment, which naturally increase costs. Of course, chiller system control can be further customized, making chiller solutions more appropriate for the needs of certain bespoke facilities. For example, when connected with a 3rd-party control system, a chiller system can be turned on when the lighting system is in operation or temperature settings can be changed when occupants are detected. Such customized system control can be configured through logic modification of the BMS.

Maintenance

When it comes to maintaining an HVAC system, things can get complicated. But depending on your facility and its specific requirements, the decision to install a VRF or chiller system can make your maintenance strategy more convenient and less costly over the long-run.

VRF systems require many outdoor units to be installed to deliver effective climate control. **Because the area covered by each VRF outdoor unit is relatively small, the areas impacted by an interruption in operation when the system breaks down are also minimized.** The simple structure of VRF systems also makes them easier to access and service regularly with a dedicated scheduled maintenance plan. However, keep in mind that service may be required more frequently with a larger number of outdoor units. Service and maintenance can be more complicated for larger sites with a VRF system.

Conversely, chiller systems typically consist of fewer units covering larger loads for cooling a facility. Therefore, **the management of chiller systems can be more convenient due to the fewer units and less frequent maintenance.** When a chiller unit breaks down, even though the total capacity of the system declines, the remaining areas can be covered by the other chiller units depending on the zoning configuration of the system. Chiller systems require more components, such as cooling towers and pumps. These additional components make it more likely to require maintenance and service.

The water pipes in chillers also need cleaning to ensure proper water flow, whereas, VRF refrigerant piping does not require cleaning. The water stored in a chiller cooling tower requires frequent monitoring and treatment to prevent issues with the water supply. For these reasons, administrators at facilities with chiller systems can expect to schedule more regular inspections and service visits. Depending on the region, a dedicated administrator may be required in facilities with chiller systems.

Summary

Of course, for those of you that have been contemplating the installation of a VRF or chiller system, parts of this white paper may be too broad and general. Nonetheless, we hope to have given you an objective look at the merits of both system types. Therefore, the information included in this white paper will help you in the decision-making process to find the right HVAC system ideal for your circumstances.

Each system type has its definite advantages and depending on the building type and size, these advantages will be amplified in delivering efficiency, comfort, quick and easy installation, and convenient maintenance given that the most apt choice is made. There's no one right answer to the dilemma of deciding between a VRF or chiller system but armed with a wealth of knowledge, you'll be able to make the right decision for your own needs.

Implementation of VRF systems have been expanding in small to medium-sized buildings such as retail shops, residential buildings, offices, and shopping centers as well as commercial facilities. However, chillers still have a larger market share in buildings that require high-capacity or have limited installation space such as high–rise office buildings, hospitals, factories, logistics centers, storage facilities, and special locations like data centers.

In order to compensate for the shortcomings of each system type, water-cooled VRF and air-cooled chiller systems were developed. Water-cooled VRF systems use the VRF refrigerant method that makes it easier to manage control for individual spaces, which is typically difficult for chiller systems. An air-cooled chiller can also be constructed for a large-capacity system using an air heat exchange method. It is relatively easy to configure and operate an air conditioning system with this method than with a water-cooled chiller system.

A hybrid system with both a VRF and chiller system can also be recommended for multi-use buildings. Buildings such as hospitals, hotels, and factories, can utilize the chiller system for large areas that require a large operation load and use the VRF system for more intimate areas like offices or individual rooms that require a smaller operation load.

Choosing an optimum air conditioning system is one of the most important decisions in terms of building management system. Speaking from an economical point of view, choosing the right air conditioning system means saving energy and reduced costs. This can be a step towards the success of your business. If you are not sure which HVAC system to go for, visit LG.com for more information. Also, if you need more detailed advice, contact an LG HVAC expert.

Making the Ultimate Decision:
LG HVAC Chiller and VRF Comparison

Product Line-up : Chiller

[us RT]

Centrifugal Chiller

* The above range is based on the nominal tonnage.

- **Conventional Chiller**

1 Comp. **200-3,000**
2 Comp. **1,000-5,000**

- **Oil-free Magnetic Chiller**

1 Comp. **200-1,100**
2 Comp. **400-2,200**

- **Ice-storage Chiller**

300-1,900
Slurry **350-600**

- **Centrifugal Heat pump**

Heating Capacity
2,462kW-14,067kW

* Chilled water : 12/7℃, Cooling Water : 32/37℃

[us RT]

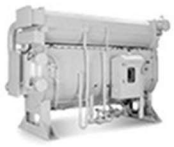
Absorption Chiller

* The above range is based on the nominal tonnage.

- **Direct Fired Absorption Chiller & Heater**

100- 1,500

- **Steam Fired Absorption Chiller**



100-1,500

- **Hot Water Driven Absorption Chiller**

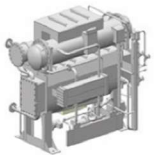
80-1,490

- **Hot Water Driven Absorption Chiller**

90-1,450

- **Absorption Heat pump**

349kW-30,218kW



[us RT]

Screw Chiller

* The above range is based on the nominal tonnage.

- **Water-Cooled Screw Chiller**

50Hz **75-347**
60Hz **80-413**

- **Ice-storage Water-Cooled Screw Chiller**

50Hz **50-230**
60Hz **75-290**

- **Air-Cooled Screw Chiller**

50Hz **83-498**
60Hz **77-508**

* @T1 Condition

Inverter Scroll Chiller

- **Inverter Scroll Chiller**

Cooling Only
220V **18-55**
380V **18-63**
460V **18-63**

Heat Pump
380-415V
Cooling Capacity **18-42**
Heating Capacity **70kW-162kW**

* Up to 5 units per 1 HMI can be controlled.
* @T1 Condition

Making the Ultimate Decision:
LG HVAC Chiller and VRF Comparison

Product Line-up : VRF

MULTI V 5

- 8-12 HP
  380V, 3Ø

- 14-20 HP
  380V, 3Ø

- 22-40 HP
  380V, 3Ø

- 42-60 HP
  380V, 3Ø

- 62-80 HP
  380V, 3Ø

MULTI V S

- 4 HP
  220V, 1Ø

- 5-6 HP
  220V, 1Ø
- 4-8 HP
  380V, 3Ø

- 10-12 HP
  380V, 3Ø

- 6 HP
  220V, 1Ø
  Heat Recovery

- 8-12 HP
  380V, 3Ø

MULTI V M

- 5 HP
  220V, 1Ø
  380V, 3Ø

MULTI V WATER 5

- 8-20 HP
  380V, 3Ø

- 22-40 HP
  380V, 3Ø

- 42-60 HP
  380V, 3Ø

09

References

- **Can VRF overcome the chiller mentality in the Middle East?**

  https://eurovent.me/?q=articles/can-vrf-overcome-chiller-mentality-middle-east

- **Hybrid VRF System Delivers the Best of VRF and Chiller Technologies**

  https://les.mitsubishielectric.co.uk/latest-news/hybrid-vrf-system-delivers-the-best-of-vrf-and-chiller-technologies

- **Devil is in the Details: The VRF Opportunity**

  https://srsworx.com/2021/04/23/devil-is-in-the-details-the-vrf-opportunity/

- **Advantages of VRF system over mini chiller**

  https://sarmasazan.co/en/advantages-of-vrf-system-over-mini-chiller/

- **Choice Between VRF System and Chillers in HVAC Design**

  https://www.qprodesignconsultants.com/knowledge-centre/hhasc3654a44fj4kmath26axhlj39n

- **ADVANTAGES AND DISADVANTAGES OF WATER-COOLED CHILLERS**

  https://www.jcyounger.com/advantages-disadvantages-watercooled-chillers/

- **4 Reasons VRF Could be the HVAC Solution For Your Building**

  https://www.trane.com/commercial/north-america/us/en/about-us/newsroom/blogs/four-reasons-vrf-is-the-hvac-solution-for-your-building.html

- **HIAC commercial members Energy Efficient**

  https://www.iapmo.org/hiac/energy_efficient

www.lg.com/global/business/air-solution

facebook.com/lghvacglobal

linkedin.com/company/lghvacglobal