

COMMERCIAL OWNERS GUIDE TO VRF

VARIABLE **R**EFRIGERANT **F**LOW

IMPROVE PROJECT PERFORMANCE WHILE MAXIMIZING TENANT COMFORT

It all starts with knowing your options. Today's market demands highly efficient equipment with low first costs and low operating costs. Building owners around the globe are now relying on Variable Refrigerant Flow (VRF) HVAC systems to meet their performance goals.

VRF systems are inherently simple and inexpensive to design, install, operate, and maintain while providing tenants with the most comfortable HVAC system available on the market.

The following guide will walk you through VRF technology and what commercial building owners need to know.

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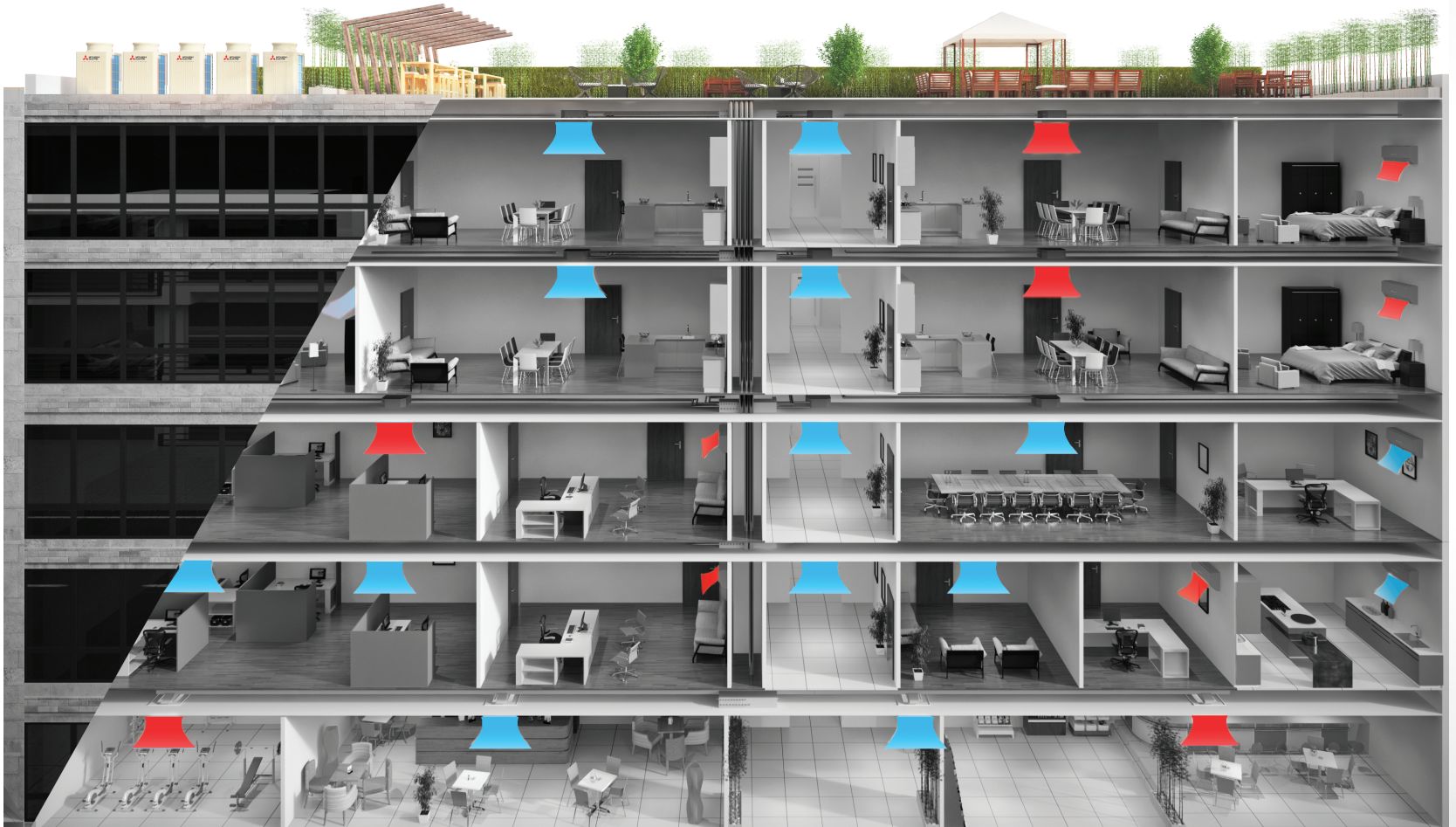
intro to Variable Refrigerant Flow Technology

Variable Refrigerant Flow (VRF) technology utilizes refrigerant piping to deliver conditioned refrigerant directly to the space requiring cooling or heating. This not only saves ceiling space within a building, which helps solve design and architectural challenges, but also provides a more efficient way to condition a zone or entire building. VRF systems incorporate innovative features such as simultaneous cooling and heating and whole building control, which help VRF systems deliver personalized comfort to building occupants.



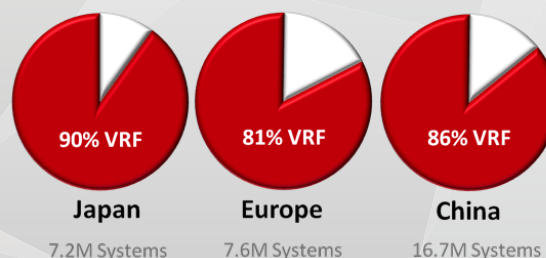
Intro to Variable Refrigerant Flow Technology

VRF provides a unique advantage when it comes to zone-by-zone occupant comfort. Through the use of individual indoor units located within spaces requiring conditioning, VRF systems provide the ability to modify the temperature of one, or more, zones from within that space. Thermostats are located within each zone, empowering a building's occupants to make comfort personal. The addition of simultaneous cooling and heating capabilities can even allow certain zones to be in cooling mode while others are in heating mode, all while maximizing efficiency.



This is not new technology. VRF has been used throughout the world since the 1980's. In many countries, it is the most-used HVAC technology: for example in Japan VRF represents 90 percent of installed systems within Commercial buildings, Europe 81 percent and China 86 percent. Building owners have favored VRF systems for many reasons, among them longer line lengths for more flexible design and more affordable cold-climate heating.

VRF EMBRACED GLOBALLY

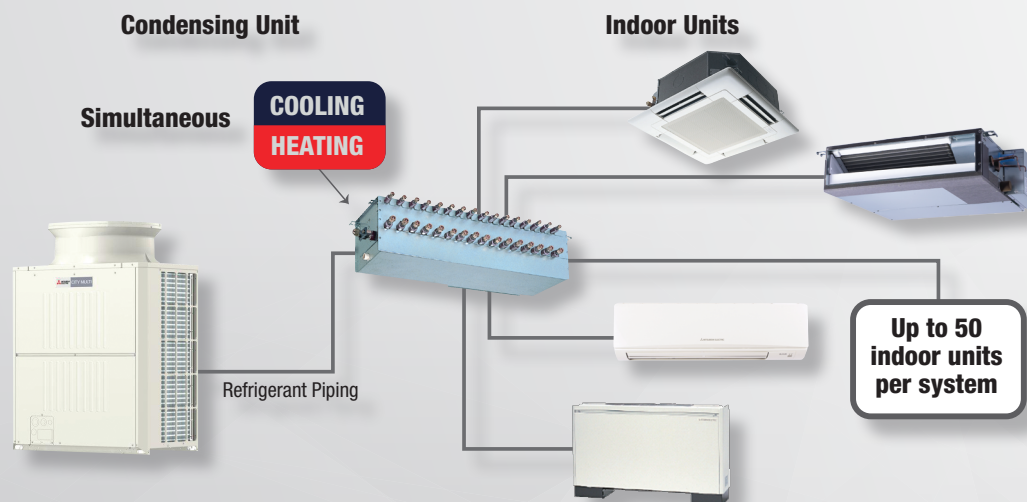


The Technology

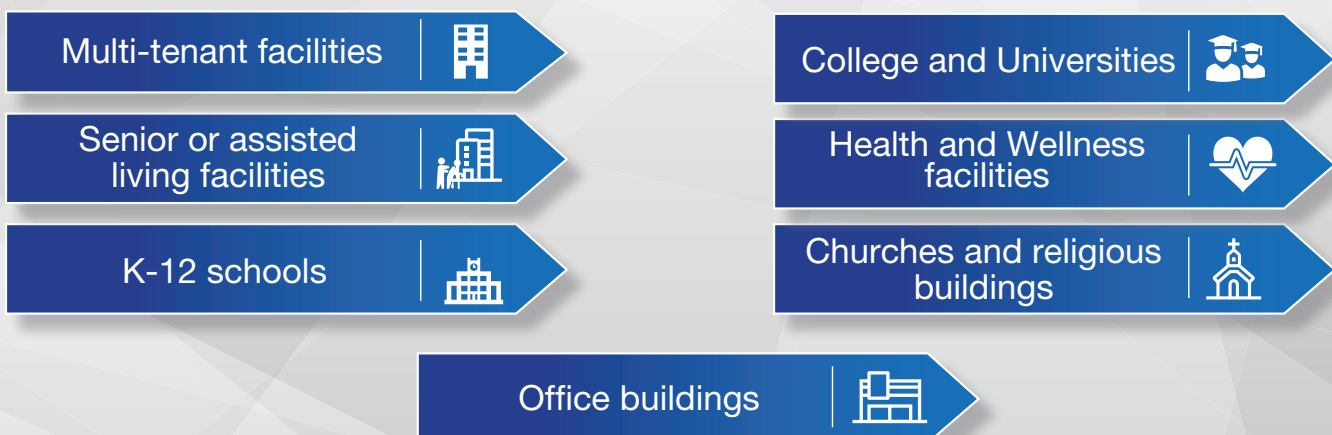
A building's interior is broken into zones, each of which can be operated separately including cooling one room while simultaneously heating another. This is possible because of the outdoor unit's INVERTER-driven compressor that varies the motor rotation speed, allowing it to precisely meet each zone's conditioning requirement while reducing overall power consumption. The system's total capacity is distributed to each indoor unit via the branch circuit controller. The result is a facility where each zone can be customized.

Features and Benefits of VRF

- ▶ Wide variety of indoor air handling units
- ▶ Smaller refrigerant piping reduces space requirements
- ▶ Eliminates long, bulky ductwork
- ▶ Mechanical chases and rooms can be smaller
- ▶ Easy to reconfigure as tenants change
- ▶ Manage multiple indoor air handling units through the use of intuitive building controllers

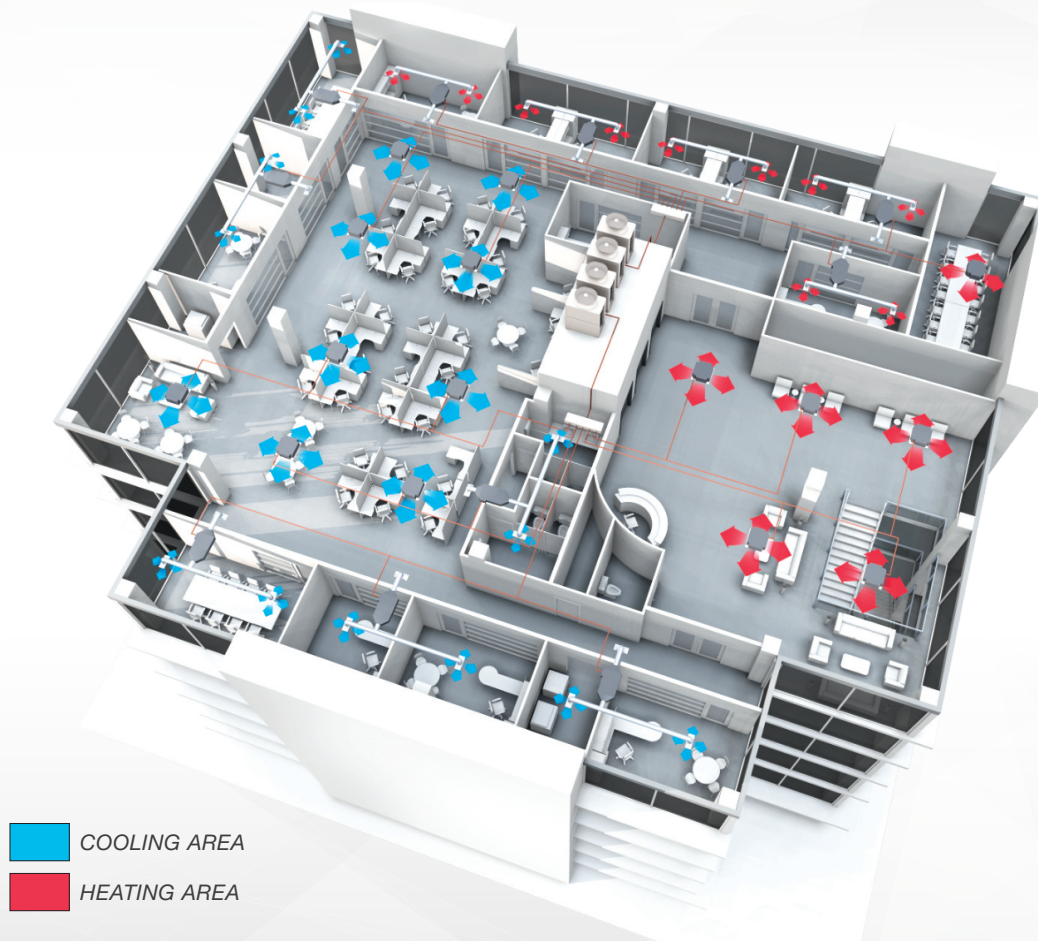


Target Applications for VRF Technology

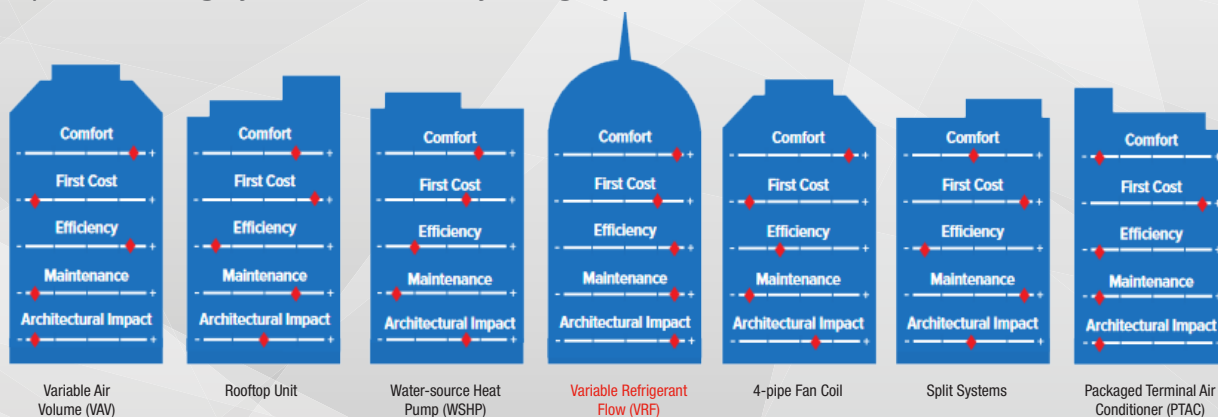


The Technology

A building's interior is broken into zones, each of which can be operated separately. One room can be cooled while another is simultaneously heated. This is possible because of the outdoor unit's INVERTER-driven compressor that varies the motor rotation speed, allowing it to precisely meet each zone's conditioning requirement while reducing overall power consumption. The system's total capacity is distributed to each indoor unit via the branch circuit controller. The result is a facility where each zone can be customized.



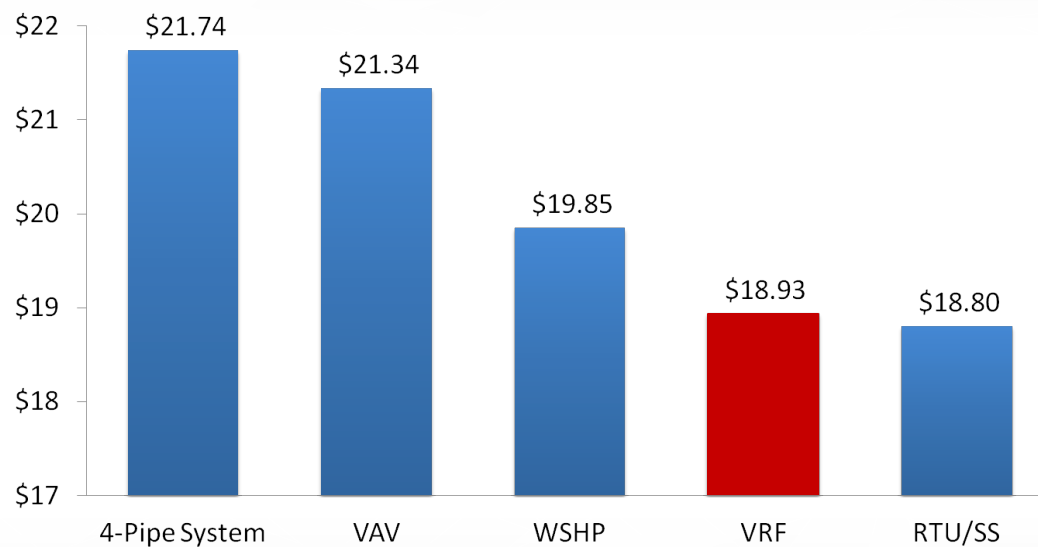
Compared to other systems- such as Variable Air Volume, Rooftop Units, and Water-Source Heat Pumps- VRF is highly favorable in every category:



First Cost

First cost is important when it comes to selecting mechanical systems, and HVAC is no different. But first cost goes beyond just the equipment itself. Construction costs are also impacted by the HVAC system, and the selection of VRF will have positive impacts. With many features resulting in efficient installation, including the use of refrigerant piping instead of bulky ductwork and fewer building penetrations, VRF is the smart choice for keeping costs down.

Construction Cost (\$/SF)



In addition to reducing initial construction costs, the use of VRF systems contributes to the reduction in costs for other trades involved in the building process. Those reductions include:

No need for natural gas services within the building



Fewer wall and roof penetrations



Fewer duct shafts within the building



Smaller electrical service required



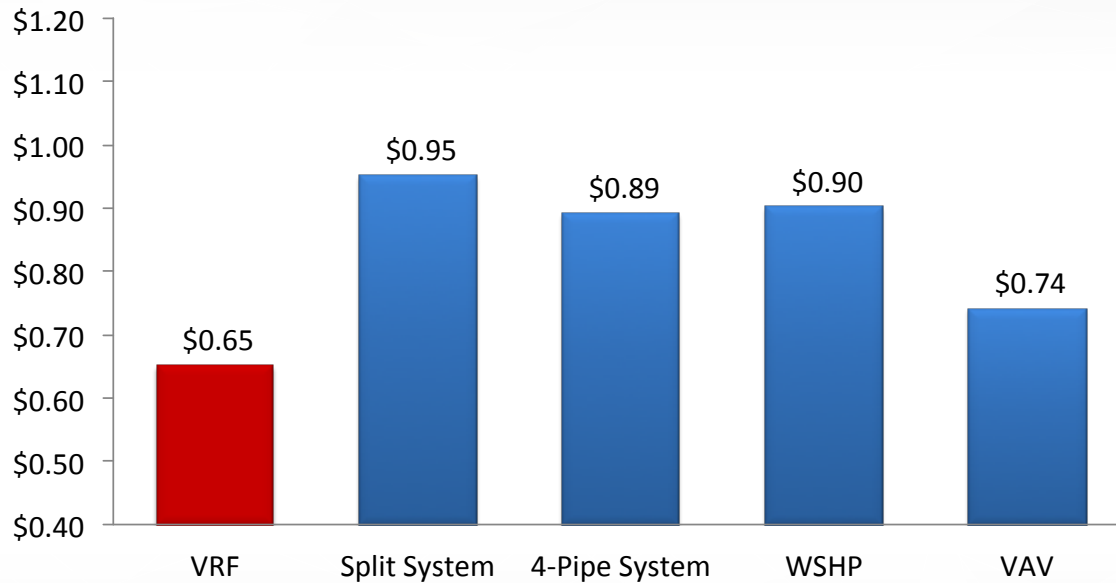
Reduced structural steel and reinforcements due to an up to 30% decrease in weight vs. traditional HVAC system



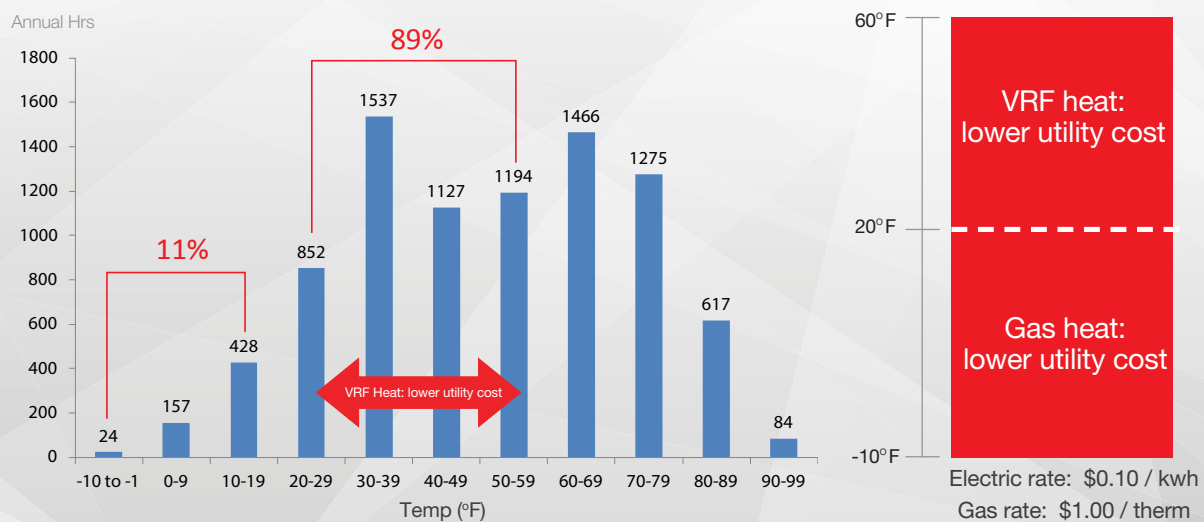
Operating Cost

As much as 40 percent of a building's operating costs are tied to HVAC and other mechanical systems. It's important to minimize operating costs while achieving other goals like reliable performance, a modern aesthetic and personalized comfort. VRF systems consistently perform at 30% higher efficiency, based on local market utility rates, than conventional HVAC systems. VRF technology uses the absolute minimum energy necessary to maintain comfort levels while adjusting to partial-load conditions, which occur most of the time.

Annual Energy Cost (\$/SF)



Heating Economics



These charts provide an example, demonstrating Chicago's heating economics. For 89 percent of Chicago's heating season, it is cheaper to heat with VRF than any other kind of HVAC system.

Customized Financial Analysis

The design and application of each building is unique, which requires customized analysis to determine the energy efficiency of chosen mechanical systems. The CITY MULTI® Efficiency Evaluator is a tool developed to provide customized financial analysis on a specific building. This cloud-based application compares Mitsubishi Electric's VRF solutions to existing and proposed HVAC systems. It calculates expected energy usages, life cycle costs and LEED® points for each system based on multiple building factors.

This allows owners to not easily see how different systems stack up. The program uses a sophisticated building simulation program called WeidtSim. It evaluates a variety of HVAC technologies, including Variable Air Volume (VAV) systems, water-source heat pumps, fan coils, and chillers. It is also compatible for multiple devices for added convenience.



Maintenance Requirements

Maintaining an HVAC system can be a complicated challenge for even the best facility management team. The multitude of preventative maintenance tasks can create a scheduling nightmare for a team tasked with maintaining all mechanical systems within a building. With VRF, those scheduling nightmares turn into dreams. With two simple preventative maintenance items required on a regular basis, the facility management team can turn their attention to more pressing matters. And best of all, the building owner saves on man hours and service parts.

MAINTENANCE ITEM	TRADITIONAL SYSTEM	VRF SYSTEM
Water Treatment	X	
Cooling Tower	X	
Pump Seals	X	
10 Year Overhaul	X	
Boiler Analysis	X	
Chiller Maintenance	X	
Tube Brushing	X	
Belt Changes	X	
Strainer Cleaning	X	
Filter Changes	X	✓
Condenser Cleaning	X	✓

Eliminate Hot and Cold Calls

Hot and cold calls are a consistent source of frustration for facility management staff. Tenants often complain about their thermal comfort and can never agree on the optimal temperature for their office space, hotel room, or classroom. With VRF, those frustrations are eliminated. VRF is surprisingly simple to control and includes a thermostat in each zone requiring conditioning. Tenants are now in control of their own personal comfort and are free to make changes as they see fit. Eliminating this frequent tenant complaint enables a facility staff to turn their attention to other, more pressing matters.

#1 Tenant Complaint



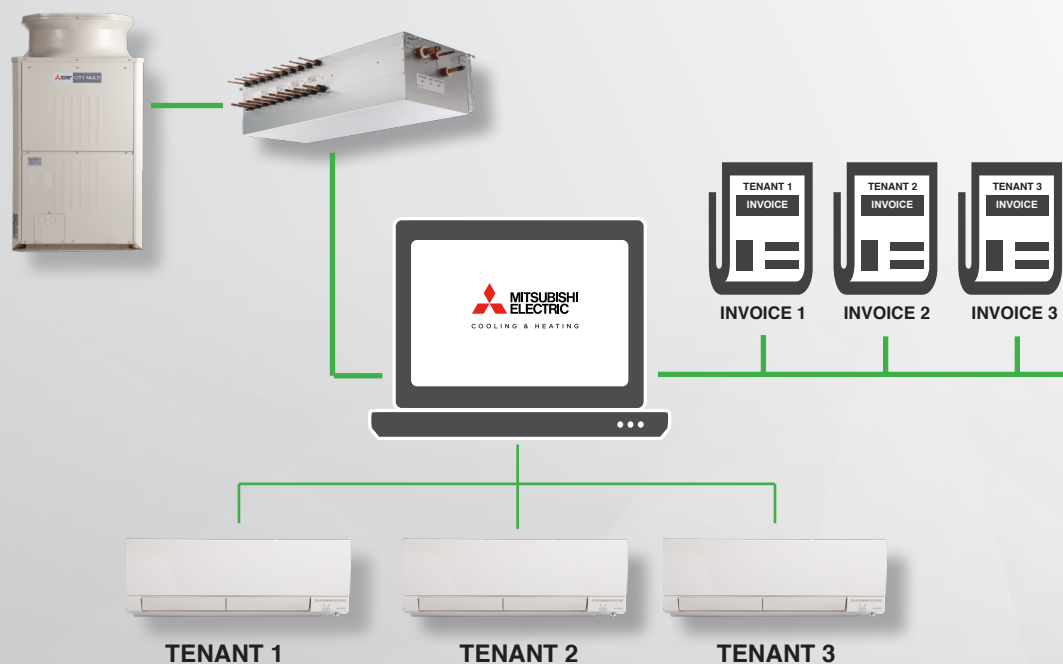
Tie your mechanical systems together in one easy building automation controls solution with Diamond Controls™. The system provides convenient monitoring and control of virtually any mechanical system within your building, leading to a seamless operating experience.



Appropriately allocating energy usage for billing purposes is a challenge in buildings with multiple tenants. VRF systems can utilize software which enables a building owner to properly allocated usage based on refrigerant flow and power consumption.

Invoice Individual Tenants

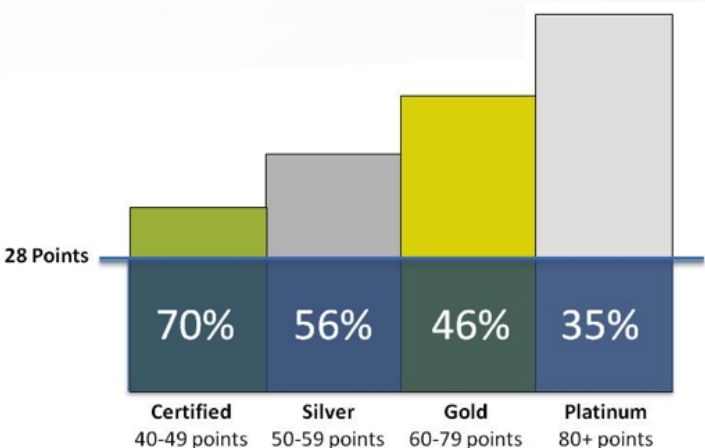
- ▶ Each tenant is responsible for their cooling and heating usage.
- ▶ Allocation of HVAC cooling and heating consumption per tenant.
- ▶ Indoor units configurable per apartment, condominium, or business.
- ▶ Automated consumption spreadsheet generated for each tenant.
- ▶ System software can monitor up to 2,000 indoor units from one networked PC



Facility managers can access and operate their systems from any place, at any time of day or night. Current controller options empower owners and managers to make the most of their systems- from adjusting set points to enjoying the convenience of energy allocation and after-hours settings. From simple controls to whole building controllers that tie in multiple automated systems, VRF works on management platforms that are user friendly and highly effective.

LEED® and More Usable Square Footage

The application of VRF within a commercial building can assist an owner in obtaining LEED certification. VRF is a core contributor to the indoor air quality categories, specifically in the Energy and Atmosphere and the Indoor Environment sections. There are many benefits of pursuing LEED Certification within a building, and VRF can help an owner run a more efficient operation while providing a healthier environment for building occupants.



Points	Category
21	Energy and Atmosphere (Eac)
7	Indoor Environment (Eqc)
28	TOTAL

Reclaim Usable Square Footage

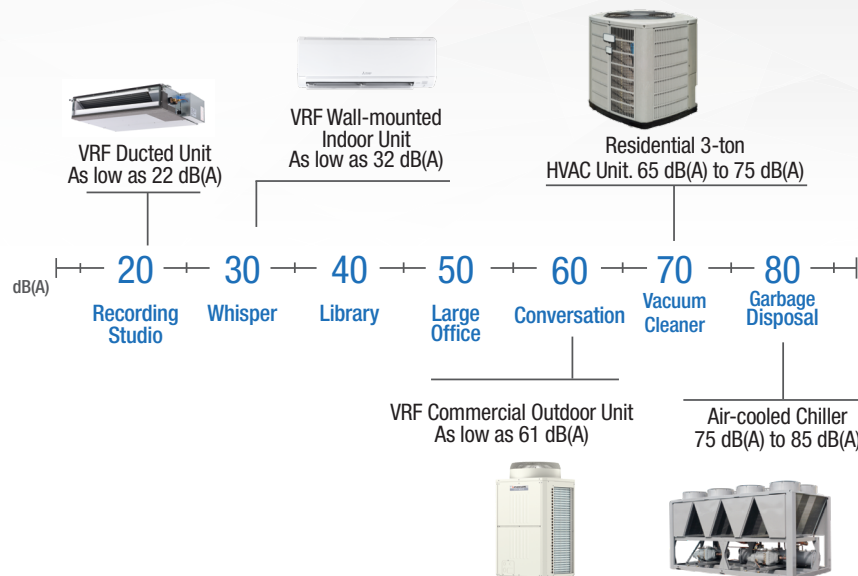
VRF's smaller system footprint also means a lighter overall weight. For example, VRF is 31 percent lighter than chilled water systems. The implications are profound: ultimately lower construction costs. This is possible because installations of lighter systems require less structural support, reducing the amount of physical materials and labor required. Finally, the smaller footprint also takes the form of minimized wall penetrations. Two small pipes connect the outdoor units to the interior system, reducing installation costs and impact. On the inside of the building, VRF is all about re-capturing usable square footage.



Noise Considerations and Elimination of Ductwork

Noise Considerations

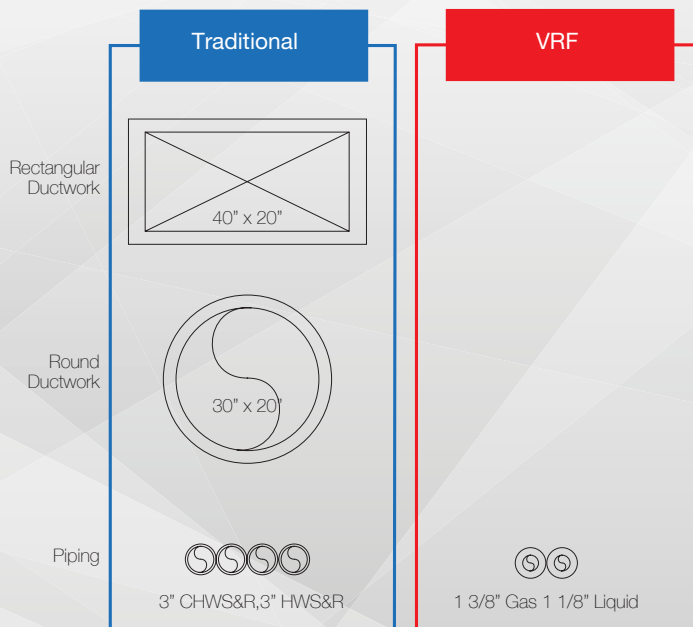
VRF systems operate at whisper-quiet levels. This is no exaggeration. Whispers come in at 35 decibels; VRF indoor units have a lower decibel rating- for some brands between 19-34 decibels.



Eliminate Ductwork

By reducing the plenum size, building owners can realize the benefits of raised ceiling heights. The benefits are threefold:

- ▶ A more spacious, modern feel.
- ▶ Lower construction costs due to the possibility of designing shorter ceilings.
- ▶ The option to add an additional floor for more leasable space.



Designers turn to VRF for a multitude of reasons. From a building's exterior to interior, from an architect's clients to the end user, VRF has the features and benefits that let architects' design shine. The exterior of a commercial building is still a space of usable square footage. VRF's modular and compact design eliminates the bulky condensing units of traditional HVAC systems. This enables flexible design; outdoor units can be spread around a property or located together, placed inside or outside, placed in a mechanical room or in an alleyway.



About This Building

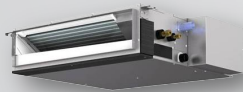
The David Whitney Building, a class A skyscraper in Detroit, used VRF's flexibility to split outdoor units across three areas: on the roof, in an alley and in the basement.



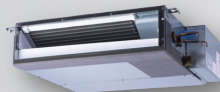
Indoor Unit Styles

Mitsubishi Electric VRF system indoor units come in many styles, all designed to ensure flexibility when applied to any commercial building application. The various styles include:

Ducted Units



Medium Static
Ducted Unit



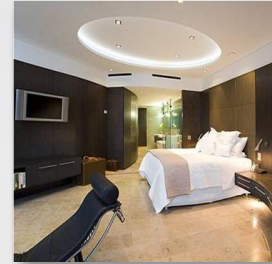
Low Profile
Ducted Unit



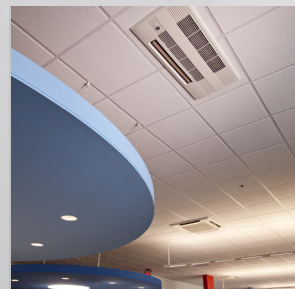
High Static
Ducted Unit



Multi-position
Air Handler



Ductless Units



Sacramento Drill Tower

Sacramento, California

Scope: 9,476 ft² concrete facility – two-thirds of which is a water tower, one-third of which is offices.

Challenge, Results: The facility's old, failing mechanical systems cost too much money to operate and required substantial maintenance. VRF drastically cut maintenance calls and led to a total energy savings (kBtu usage) of 50 percent and a total cost savings of 19 percent – in the range of \$5,000 a year.



Change in Energy Usage and Energy Bill Between pre-installation and post-installation years

Month	kBtu Usage	Energy Bill
January	-48%	-6%
February	-47%	-1%
March	-33%	-4%
April	-53%	-9%
May	-57%	-28%
June	-47%	-26%
July	-55%	-33%
August	-57%	-38%
September	-29%	-10%
October	-61%	-31%
November	-44%	-8%
December	-58%	-24%

Towson City Center

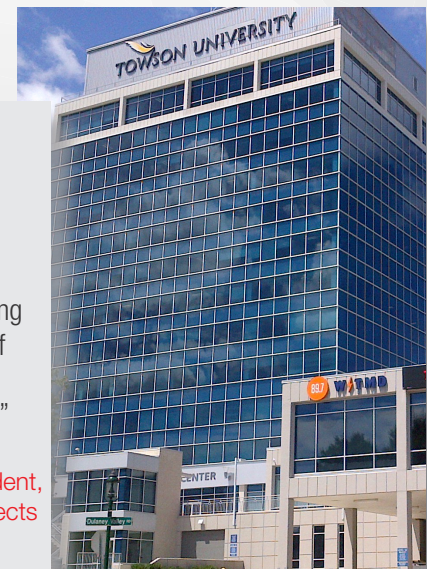
Towson, Maryland

Scope: 170,000 ft², 15-story high-rise building

Challenge, Results: Renovating a 1960s high-rise with low deck height meant any HVAC system with ductwork was off the table. VRF offered a solution that was not just possible, but that won a \$421,999 utility rebate and helped earn LEED® Silver certification.

"In many ways, that has been the most satisfying [project of my career] because, as a team, we made [the project] work. We turned a long-standing eye-sore in the middle of town into a LEED Silver landmark of great value."

– D. Ronald Brasher, AIA, president,
Brasher Architects



Screven Elementary

Screven, Georgia

Scope: 143,000 ft² educational facility.

Challenge, Results: Replacing a dated and inefficient HVAC system with VRF offered a quick installation that didn't disrupt operations, cost-saving centralized controls and a 25 percent average annual energy savings.

Average Energy Savings: 25%

Average Yearly Savings: \$16,226

	Average Monthly Cost	Energy Use
Pre-Renovation	\$12,375	115,833 kWh
Post-Renovation	\$11,023	87,313 kWh



Grand Lake Mental Health Center

Nowata, Oklahoma

Scope: 20,000 ft² health and wellness facility.

Challenge, Results: The sensitive nature of patient-doctor conversations required an HVAC system that could maintain privacy while also guaranteeing physical comfort. VRF created a safe, functional environment, and was flexible enough to serve the facility's many spaces – patient rooms, gym, pharmacy, and more.



That risk of voices carrying is not happening with the [VRF] system. The design of the system allows for privacy.”

– Larry Smith, chief operations officer, Grand Lake Mental Health Center



MAKE COMFORT *Personal*[®]

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