Building Owner's Guide to VRF

Variable Refrigerant Flow

MITSUBISHI ELECTRIC
HEATING & AIR CONDITIONING

MITSUBISHI ELECTRIC
HEATING & AIR CONDITIONING

VRF is the Future of HVAC

Mitsubishi Electric Trane HVAC US (METUS) is a leading provider of ductless and VRF (variable refrigerant flow) systems in the United States and Latin America. With unmatched energy efficiency, performance and control, it's never been easier to make any building, anywhere more comfortable and energy efficient. Plus our all-electric systems help mitigate climate change by lowering your carbon footprint.

When it comes to providing personalized comfort in every room of every building, Mitsubishi Electric Trane HVAC US is here to help. No other company is as committed to creating environmentally friendly and affordable technology that's ideal for today's home and work environments, no matter the size or shape.

A better way to heat and cool any space, anywhere.

Contents

What is Variable Refrigerant Flow?

Welcome to VRF Technology 4

The Technology 6

Why Commercial Owners Choose VRF

Reduced Building Cost 8

Customized Financial Analysis 10

Maintenance Requirements 10

Eliminate Tenant Complaints 12

Effective Facility Management 13

LEED® and More Usable Square Footage 14

Design Benefits

Noise Considerations and Elimination of Ductwork 15

Comfort Zones 16

Indoor Unit Styles 17

Success Stories 18-19

Target Applications for VRF Technology

Multi-tenant Facilities

Religious Buildings

K-12 Schools

What is Variable Refrigerant Flow?

Welcome to VRF 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.

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.

Every tenant has their own definition of comfort. Our VRF zoning systems are the perfect solution because they can be customized to provide the desired comfort level to each tenant's unique area. Systems can be operated by staff or tenants within their own space, with independent control of zones. Some systems are so efficient, they can provide heating and cooling to multiple zones at the same time. 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.

Colleges and Universities

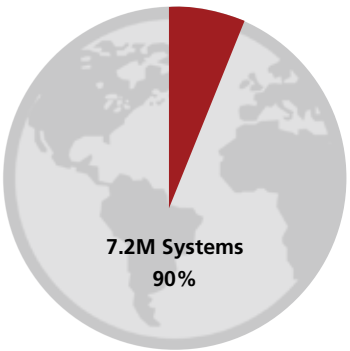
Senior Living Facilities

Hotels and Hospitality

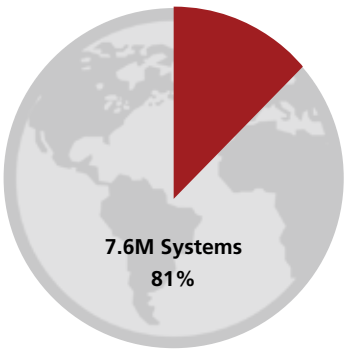
Office Buildings

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. In addition, sustainability and strategic electrification are becoming increasingly important in today's world.

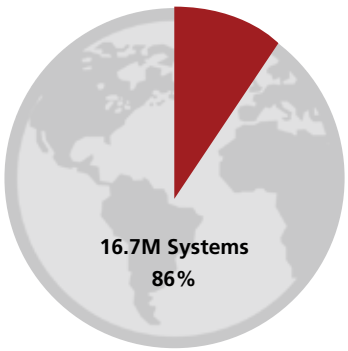
VRF Embraced Globally



Japan



Europe



China

"I never want to work with any other system ever again. Each guest has individual comfort controls in their room, which makes them happy, and for me, a snap to work this VRF system is awesome!"

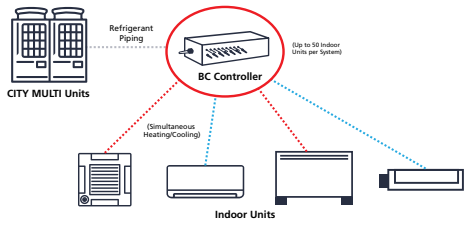
— Sean McClellan, Chief Engineer, Allison Inn & Spa

The Technology

Advanced 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 (BC) controller. The result is a facility where each zone can be customized.

System Example



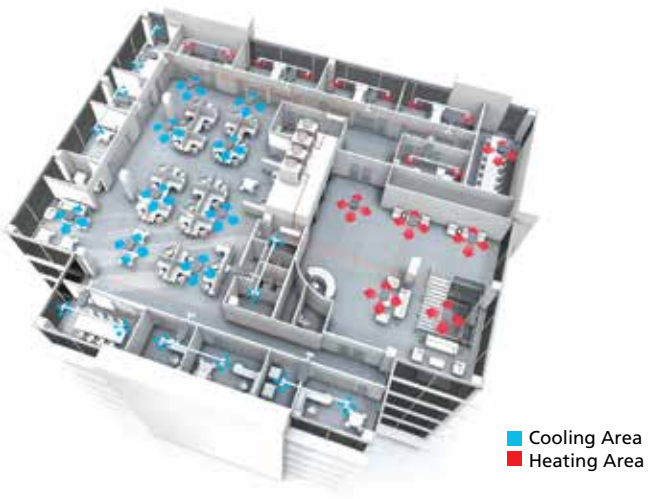
Features and Benefits of VRF

- 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

Additional Benefits

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:

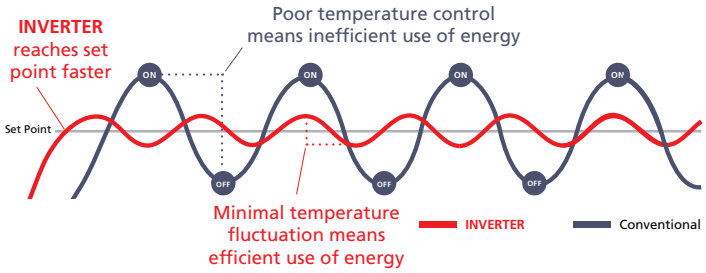
- No need for natural gas services within the building
- Smaller electrical service required
- Fewer wall and roof penetrations
- Fewer duct shafts within the building
- Reduced structural steel and reinforcements due to a decrease in weight



INVERTER-driven Compressor Technology

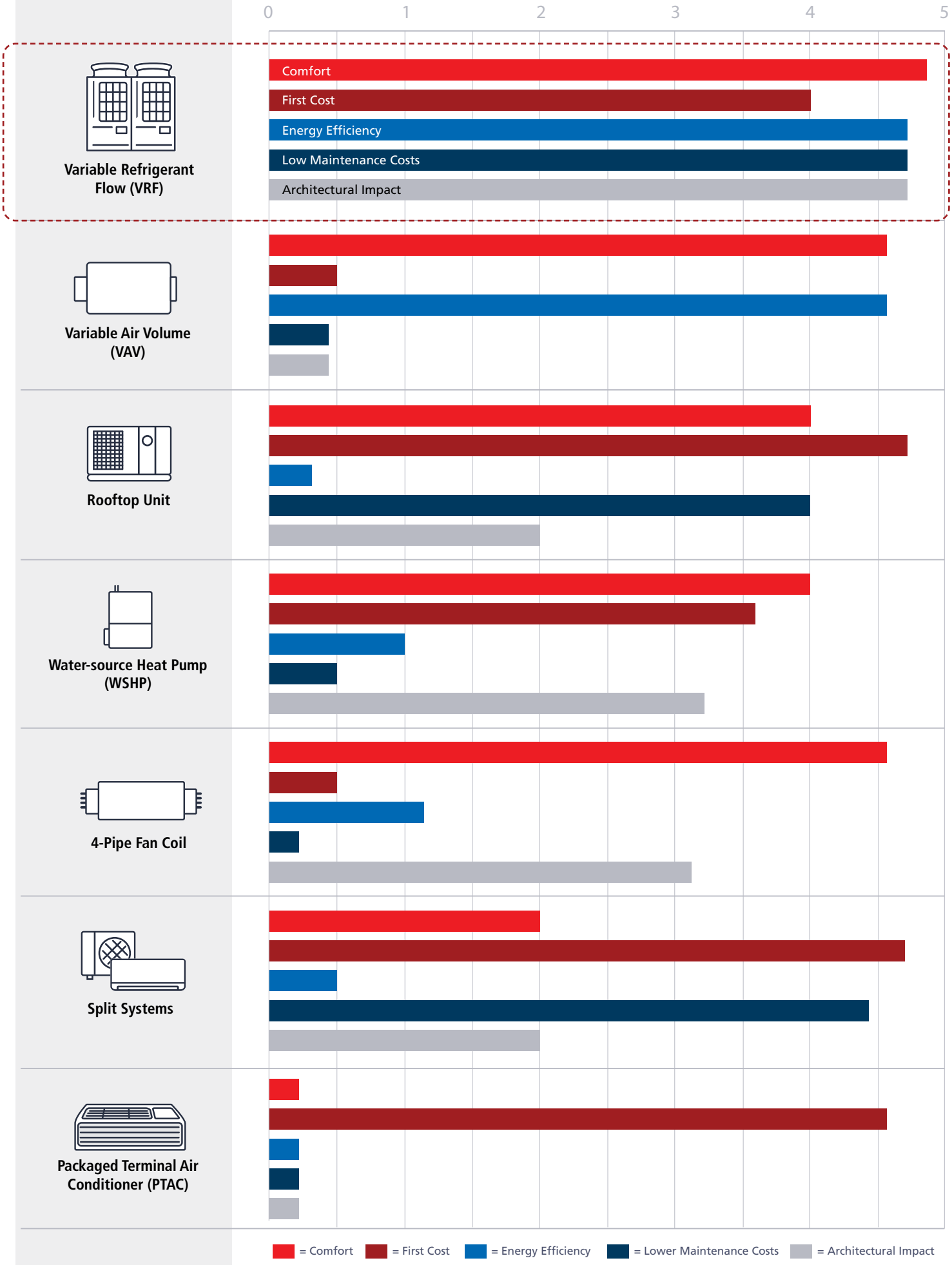
All CITY MULTI® compressors are inverter-driven to precisely match the cooling and heating demands of each building. The compressor varies its speed to match the indoor cooling or heating demand and therefore consumes only the energy that is required. When an inverter-driven system operates at partial load, the energy efficiency of the system is significantly higher than that of a standard fixed speed, non-inverter system. The fixed speed system can only operate at 100%, but partial load conditions prevail for the majority of the time. Therefore, it cannot match the annual efficiency of an inverter-driven system.

INVERTER vs. Conventional System Operation



Industry Leading VRF Solutions

As a global leader in VRF zoning solutions, you can trust that you're receiving the most advanced technology and dedicated support in the industry. Compared to other systems- such as Variable Air Volume, Rooftop Units, and Water-Source Heat Pumps- VRF is highly favorable in every category:

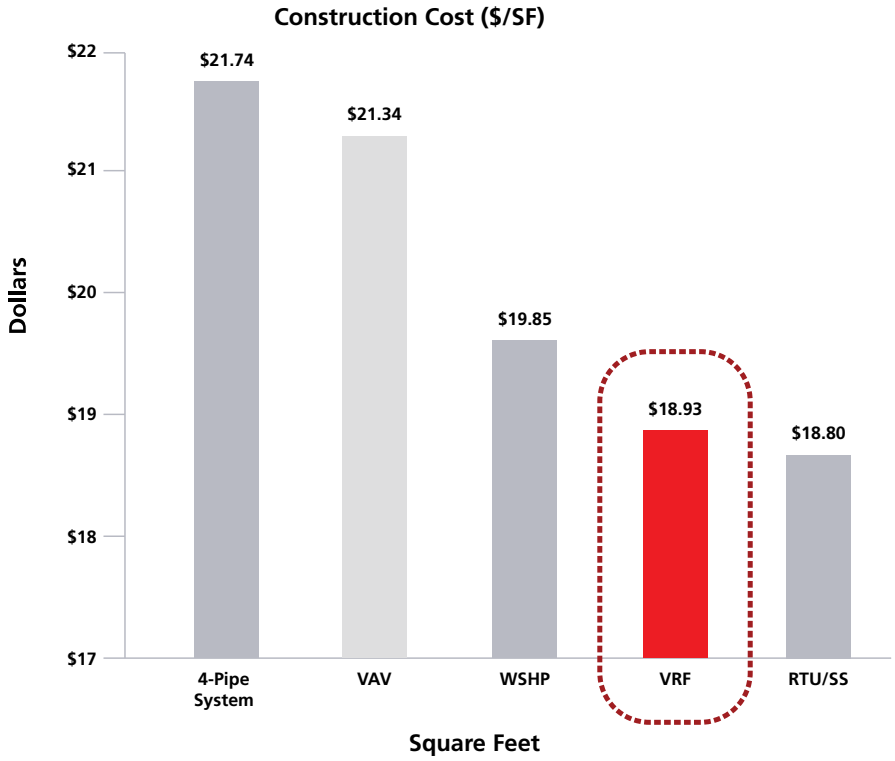

0
1
2
3
4
5
Variable Refrigerant Flow (VRF)
Comfort
First Cost
Energy Efficiency
Low Maintenance Costs
Architectural Impact
Variable Air Volume (VAV)
Rooftop Unit
Water-source Heat Pump (WSHP)
4-Pipe Fan Coil
Split Systems
Packaged Terminal Air Conditioner (PTAC)
= Comfort
= First Cost
= Energy Efficiency
= Lower Maintenance Costs
= Architectural Impact

Why Commercial Owners Choose VRF

Reduced Building Costs

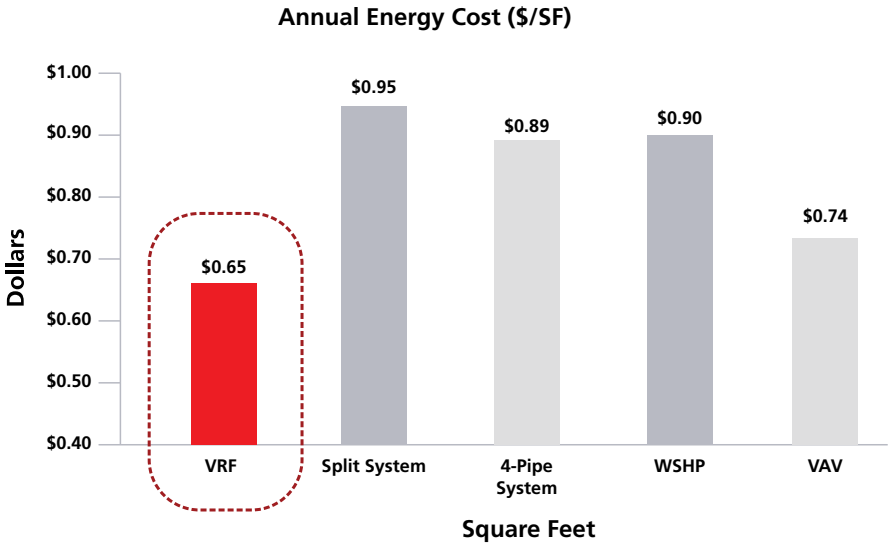
Initial Cost

Initial 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.



Operating Cost

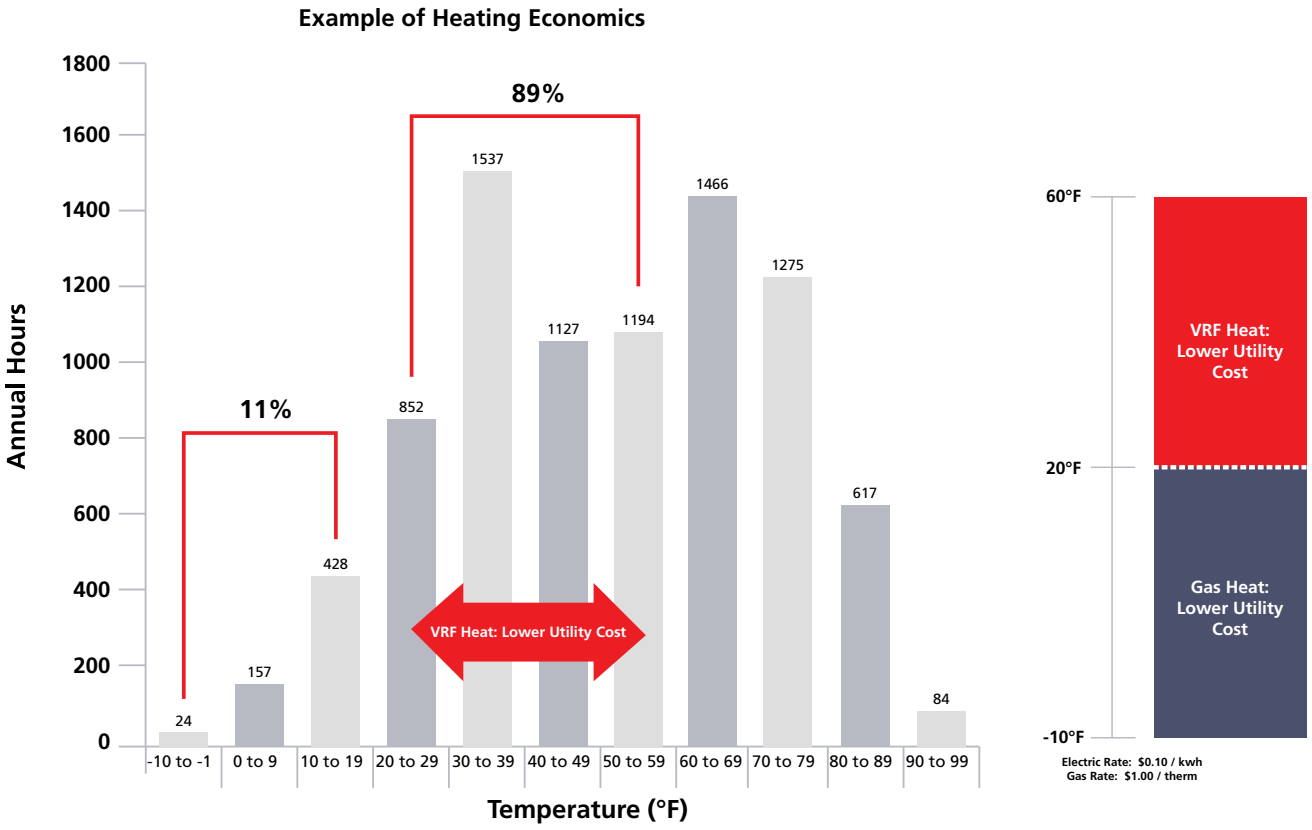
It's important to minimize operating costs while achieving other goals like reliable performance, a modern aesthetic and personalized comfort. VRF systems consistently perform at 30% higher efficiency, based on local market utility rates, than conventional HVAC systems. VRF technology uses the absolute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



As much as **40% of a building's operating costs are tied to HVAC** and other mechanical systems.

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 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 duties 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 staff 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	√

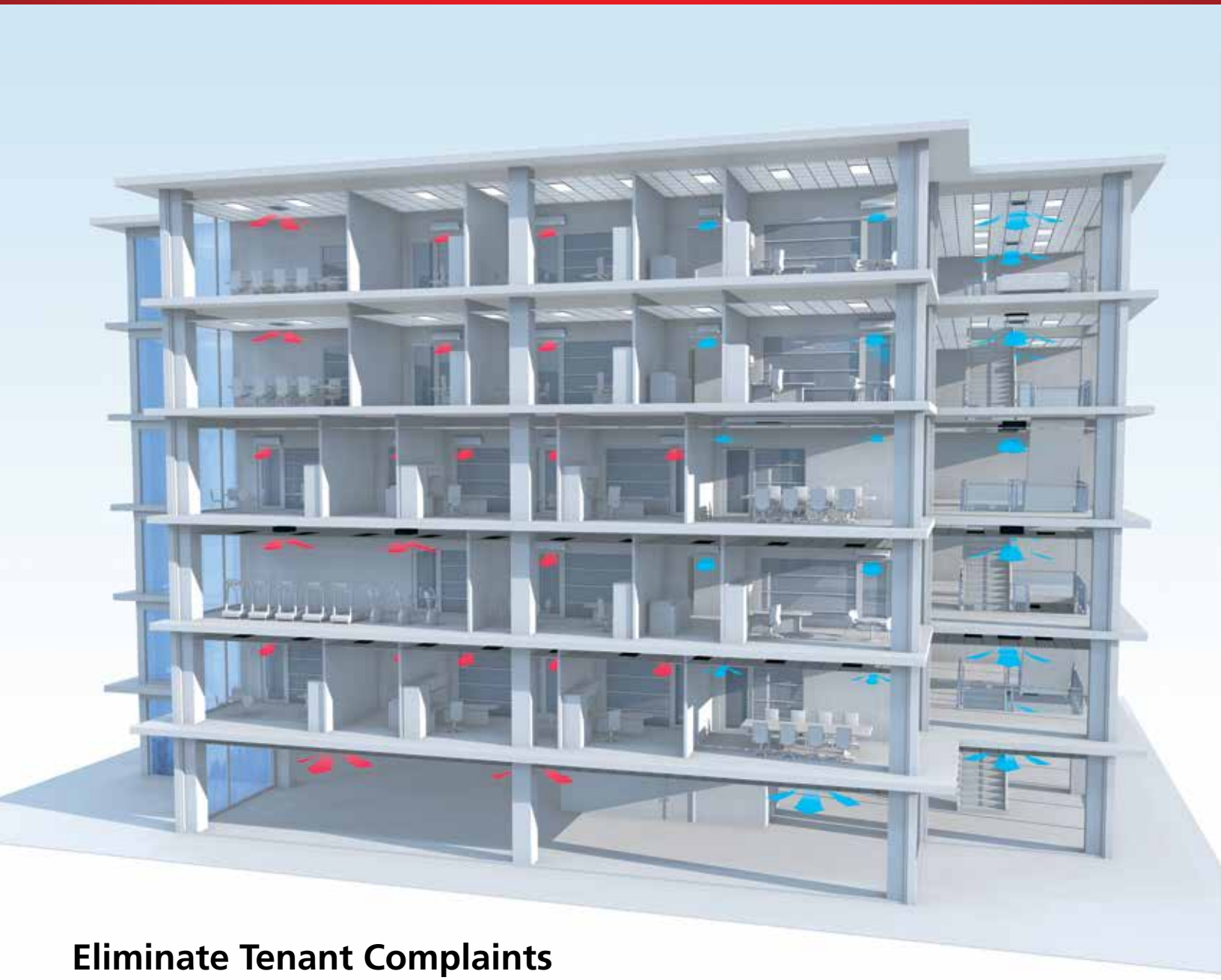
More Space for You, Less Space Needed for HVAC

Space is a big consideration for multi-tenant living. With Mitsubishi Electric, it's much smaller. That's because our modular system design eliminates the need for mechanical rooms and bulky equipment on your rooftop. Our compact indoor and outdoor units are also perfect for smaller spaces. Compared to large trunks of ductwork, our refrigerant lines save a lot of valuable space. Plus, our wall-mounted and floor-mounted units require no ceiling space at all, giving you more living space for your tenants.

"With the nature of our building being all glass, energy efficiency is so important in our operations. We haven't had any issues with the system and at the end of the day, our guests are happy."— Orcun Turkay, General Manager, Shaner Hotel Group

VRF provides the efficiency, comfort and flexibility modern buildings and facilities demand.

"The truth is, Mitsubishi Electric is a far superior product than its industry competitors. And to that point, we have not heard one single complaint from engineering or hotel management about the system."— Joseph G. Cervantes, R.D. Olson Construction, Inc.



Eliminate Tenant Complaints

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.

DIAMOND CONTROLS™

Control Your Building with a Finger

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. The system can integrate into Trane Controls or integrate with third party controls using BACnet.

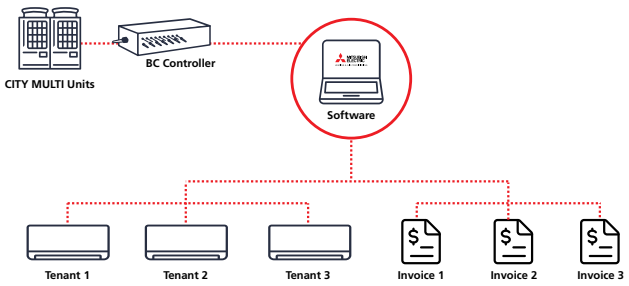
Diamond Controls Solutions allows building managers to control multiple tenant spaces within the same building, multiple buildings on a site and multiple sites. For example, a school with several campuses spread across a state can use Diamond Controls Solutions to manage every campus. The controlled systems can come from any manufacturer; an HVAC system from one company can be managed alongside an outdoor lighting system from another company.

Effective Facility Management

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 or 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



Management from A to Z

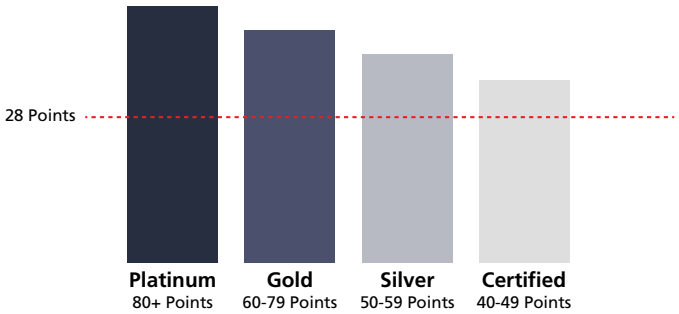
Facility managers can access and operate their systems from any place, at any time of day or night. Current controller options empower owners and managers to make the most of their systems- from adjusting set points to enjoying the convenience of energy allocation and after-hours settings. From simple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

Effective controls make an immense difference in multifamily building management, saving money, time and effort. A manager using Diamond Controls can pull up historical trends, operating reports and analyses in real time, revealing how the building's systems are reacting to user behavior, building conditions and outdoor ambient conditions. Diamond Controls can be applied to facilities ranging from a four level condo building to a 10-building apartment complex to a collection of properties across a city. It can integrate any number of systems from Mitsubishi Electric or any other mechanical equipment manufacturer.

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.

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



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.

"A VRF zoning system was ideal for the adaptive reuse of the Doan School because the units are non-intrusive, reliable, simple to install and extremely quiet. We have not had a single complaint."

— Doan School Apartments, Cleveland, OH

Design Benefits

Unobtrusive Design and Operation

Being small and quiet makes tenants happier. Our quiet system operation means fewer potential occupant complaints. In addition, VRF zoning systems offer a variety of compact indoor and outdoor units, making them a perfect fit for any space requirement. By reducing the plenum size, building owners can realize the benefits of raised ceiling heights.

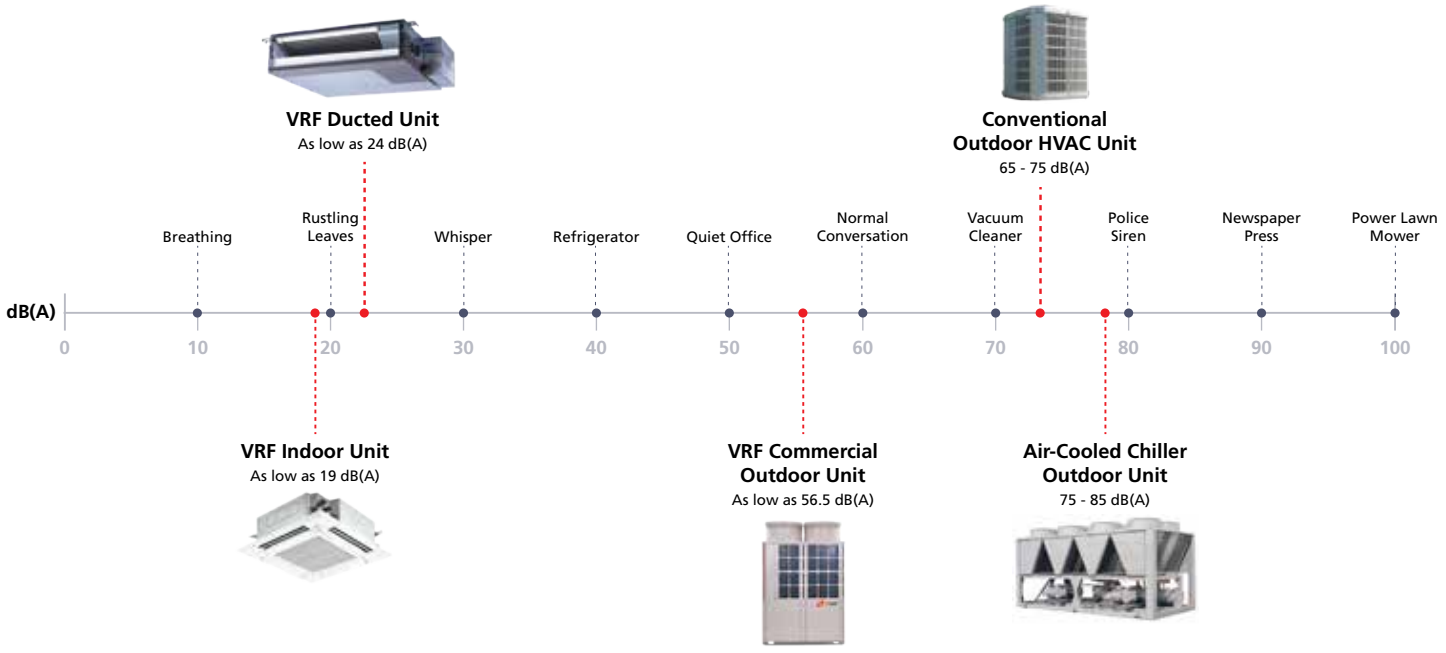
The Benefits Include:

- 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

So Quiet, They Might Not Notice it's On

VRF systems operate a 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. Our systems are designed to provide comfort without getting in the way. They operate quietly to avoid potential tenant complaints. And our VRF zoning systems are available in a variety of highly compact indoor and outdoor units. It's perfect for fitting into whatever your space requires.

Sound Chart Comparison



Comfort Zones

Eliminate Ductwork

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

The Benefits Include:

- 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

Architecture

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.

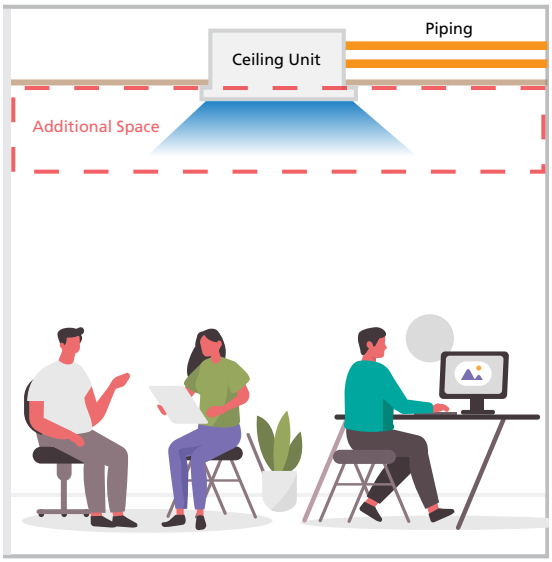
Simultaneous Operation

VRF systems can provide simultaneous cooling and heating any time of year. This innovation transfers heat from one zone, normally ejected outside the building, to be used in another zone within the building.

Personal Comfort Control

With independent control of conditions within each zone, building occupants control their own comfort and building owners minimize their energy consumption.

Conventional



VRF Systems

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

One-way Ceiling Cassette

Four-way Ceiling Cassette

Ceiling-suspended

Floor-standing

Wall-mounted

Success Stories

800 North High Street Building

Columbus, OH | October 2019

Challenge:

Specifying a versatile, cost-effective and energy-efficient HVAC system for a mixed-use building.

Results:

An energy-efficient building that maximizes leasable space and keeps occupants comfortable while minimizing operational costs.

UBER Advanced Technologies

Pittsburgh, PA | June 2018

Challenge:

Selecting a streamlined HVAC system and controls platform for a multi-functional office space.

Results:

An energy-efficient, comfortable office building with ventilation and HVAC tied in to one controls interface.

MITSUBISHI ELECTRIC
HEATING & AIR CONDITIONING

mitsubishicomfort.com

MITSUBISHI ELECTRIC
TRANE HVAC US

Printed in the USA

ME_CM_1614_8-21