EUROVENT MIDDLE EAST

HVACR Leadership Workshops

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Agenda

1. Benefits of VRF Technology
2. VRF Specifications: Misperceptions and Solutions
3. VRF: The Installer's Role in Adding Value
4. VRF Regulatory Requirements in the GCC
5. VRF in Residential Applications
6. VRF as a Retrofit Solution
7. Moderated Discussion
8. Networking Dinner

Benefits of VRF Technologies

Omar Dawood

Technical Sales Manager - System Air Conditioners

Samsung Gulf Electronics

1. HVAC system requirements

- Central / Zone Control
- Reasonable HVAC Usage Charge to tenant

- Mandatory
  User Friendly
  Individual Control
- Simple & Easy Control

- Energy efficiency
- Partial area operation according to occupants

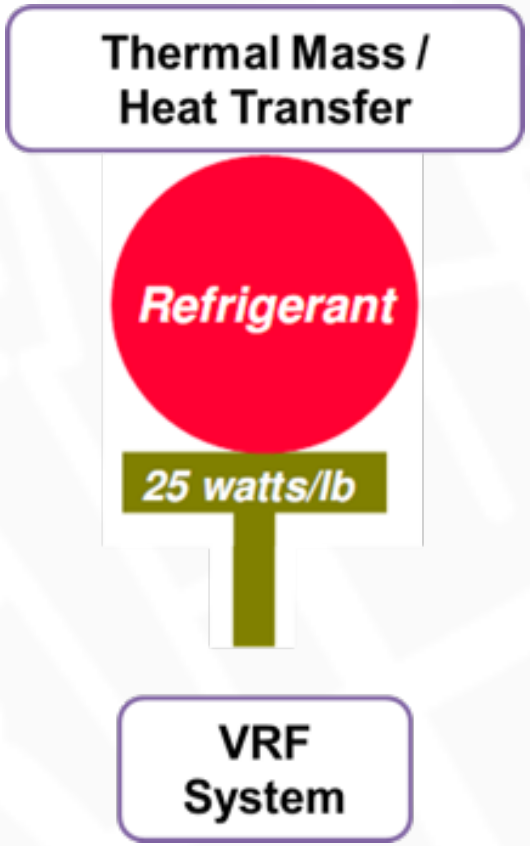
- Temperature
- Humidity
- Air Flow
- Air Quality Control

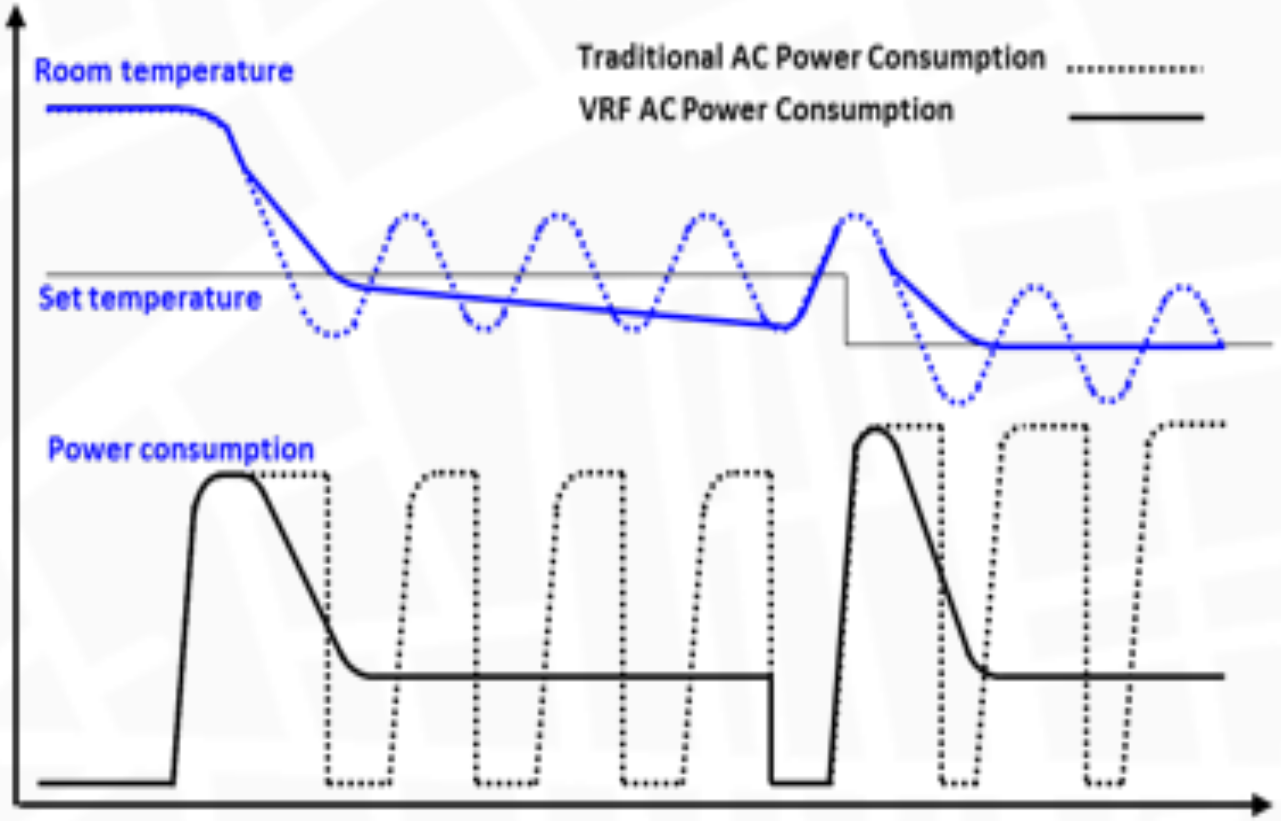
- Easy Maintenance
- Service supporting

2. Major Benefits of VRF

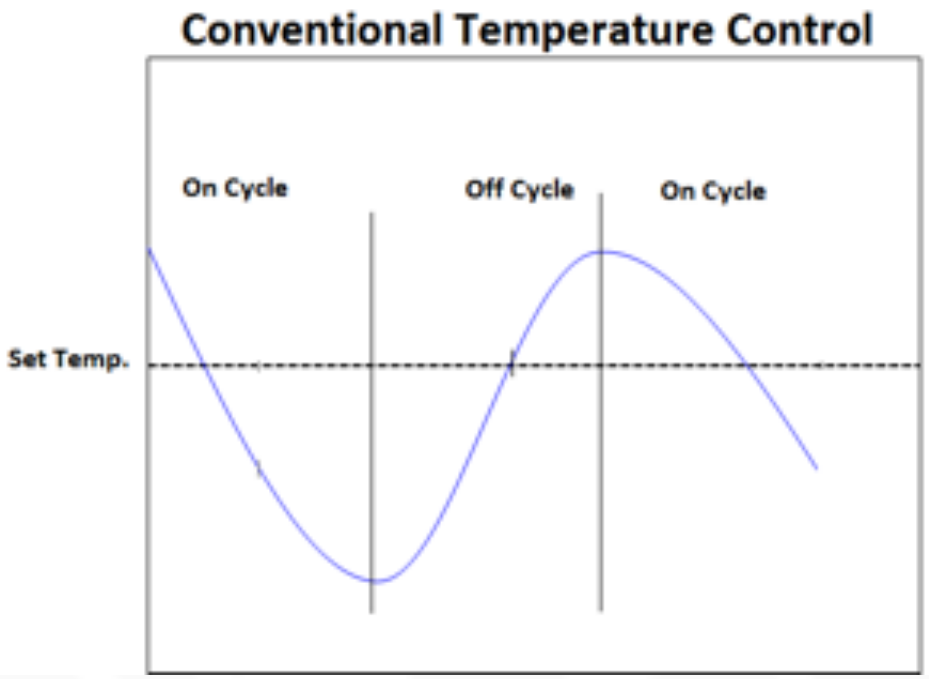
- Higher efficiency at standard and high ambient temperatures
- Precise temperature control
- Architectural benefits
- Flexibility in design
- Sophisticated control options

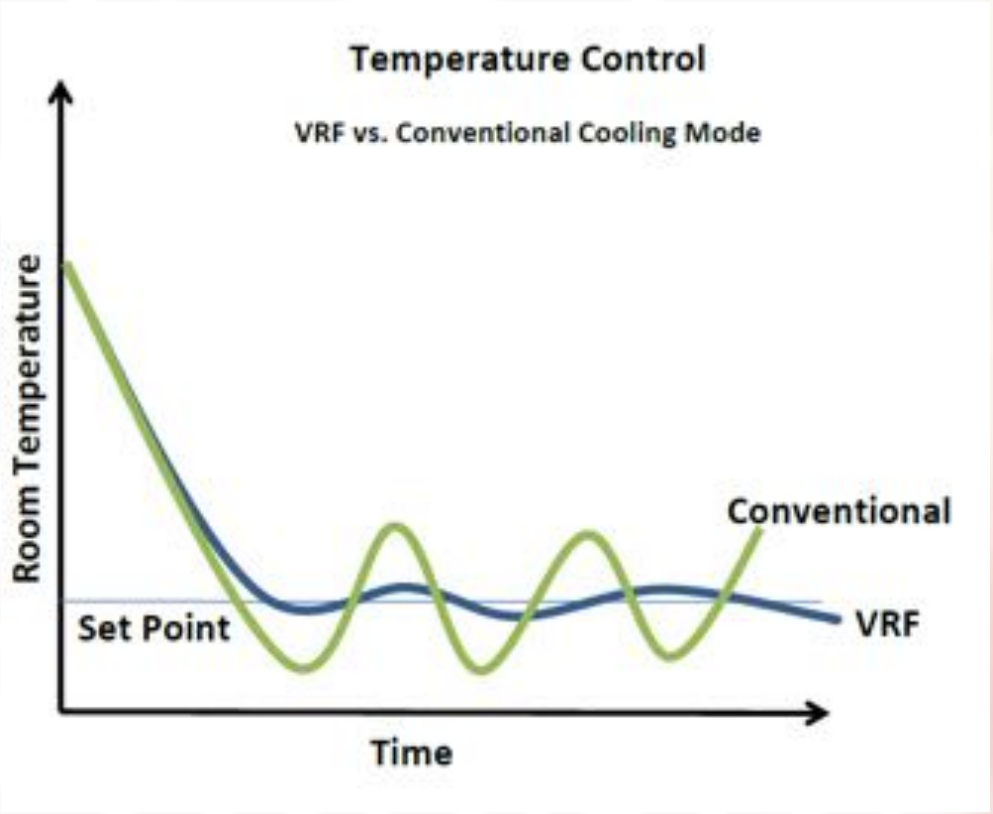
2.1. High Energy Efficiency





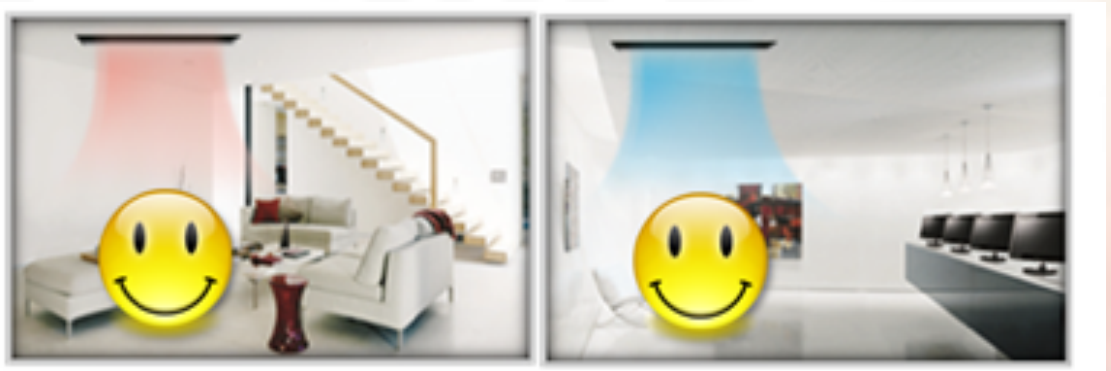
2.2. Precise Temperature Control





2.2. Precise Temperature Control

(Quick Start)



2.3. Architectural benefits

No machine room requirement

VRF System

Only need ODU Space

Have a roof garden

Get more parking lots

2.3. Architectural benefits

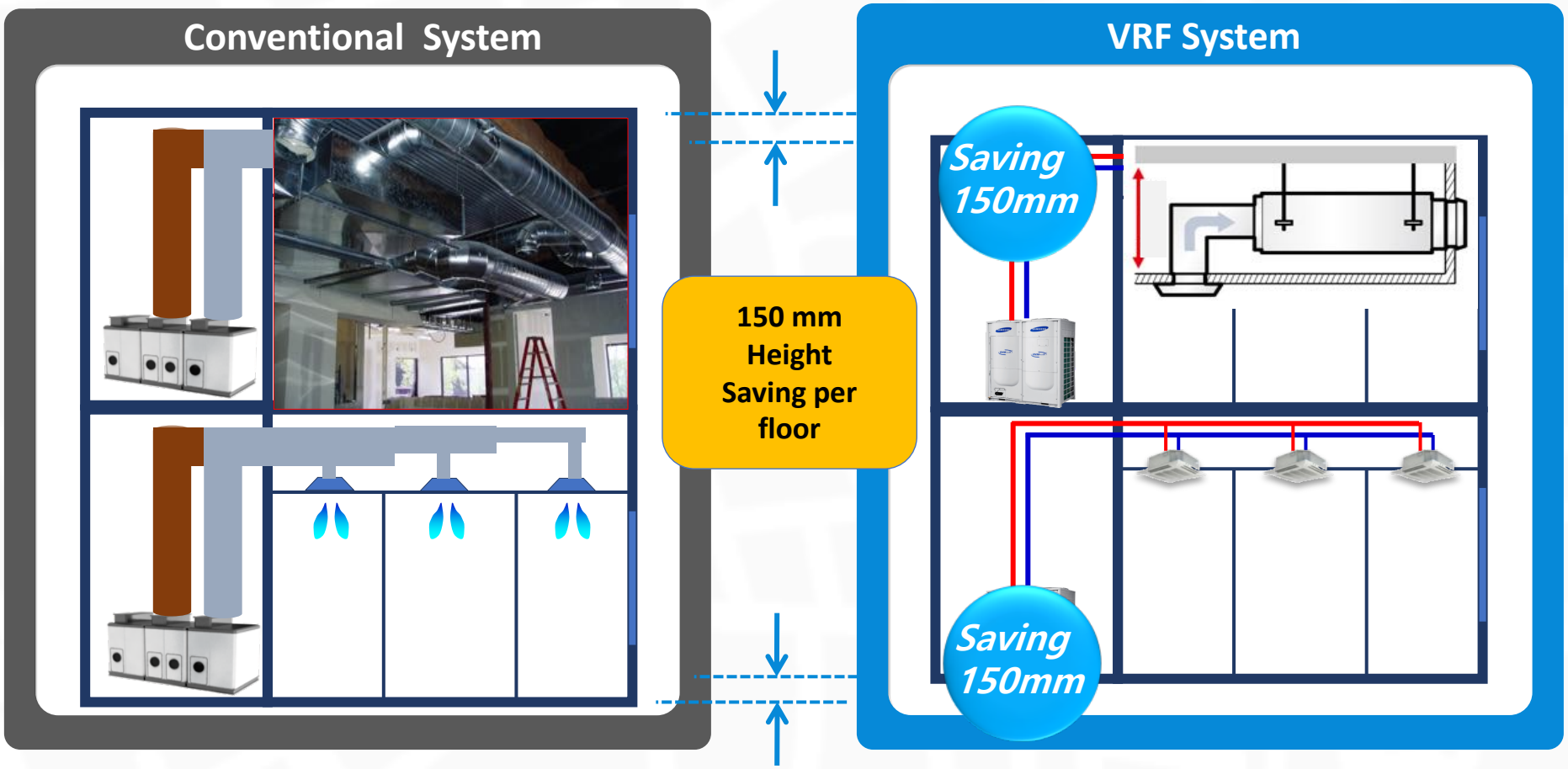
Interior flexibility

- **Various types/capacity/design**
- Cassette, Duct, Stand, Wall-mounted, Ceiling suspended, AHU
- Well matched to interior design, it's purpose
- and room capacity.

VRF System

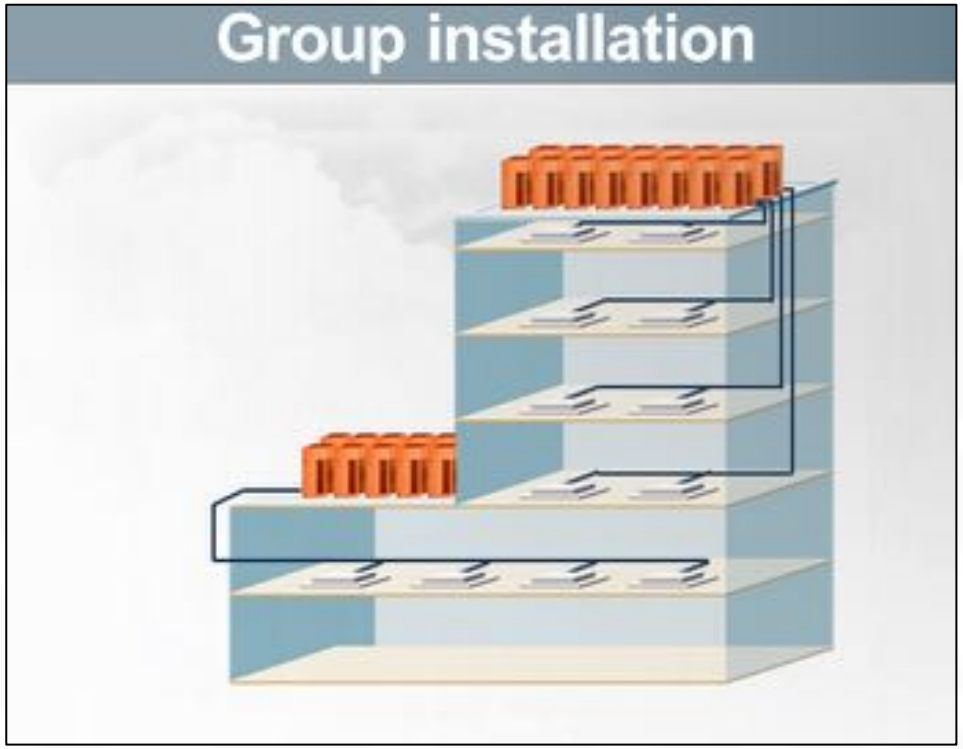
2.3. Architectural benefits

VRF can *save construction cost of 150mm height for each floor.*



2.3. Architectural benefits

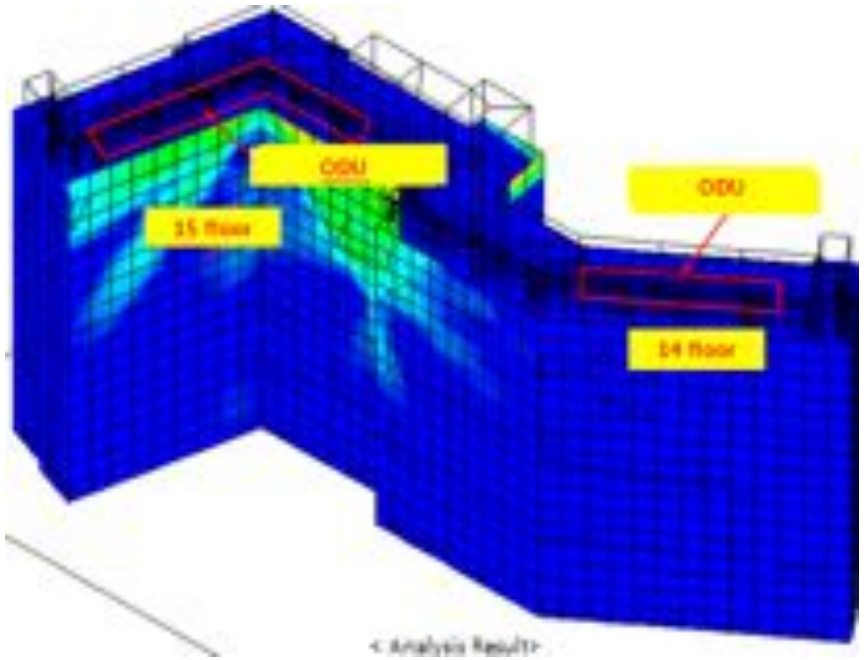
Flexible & Modular Design, Simple to Install



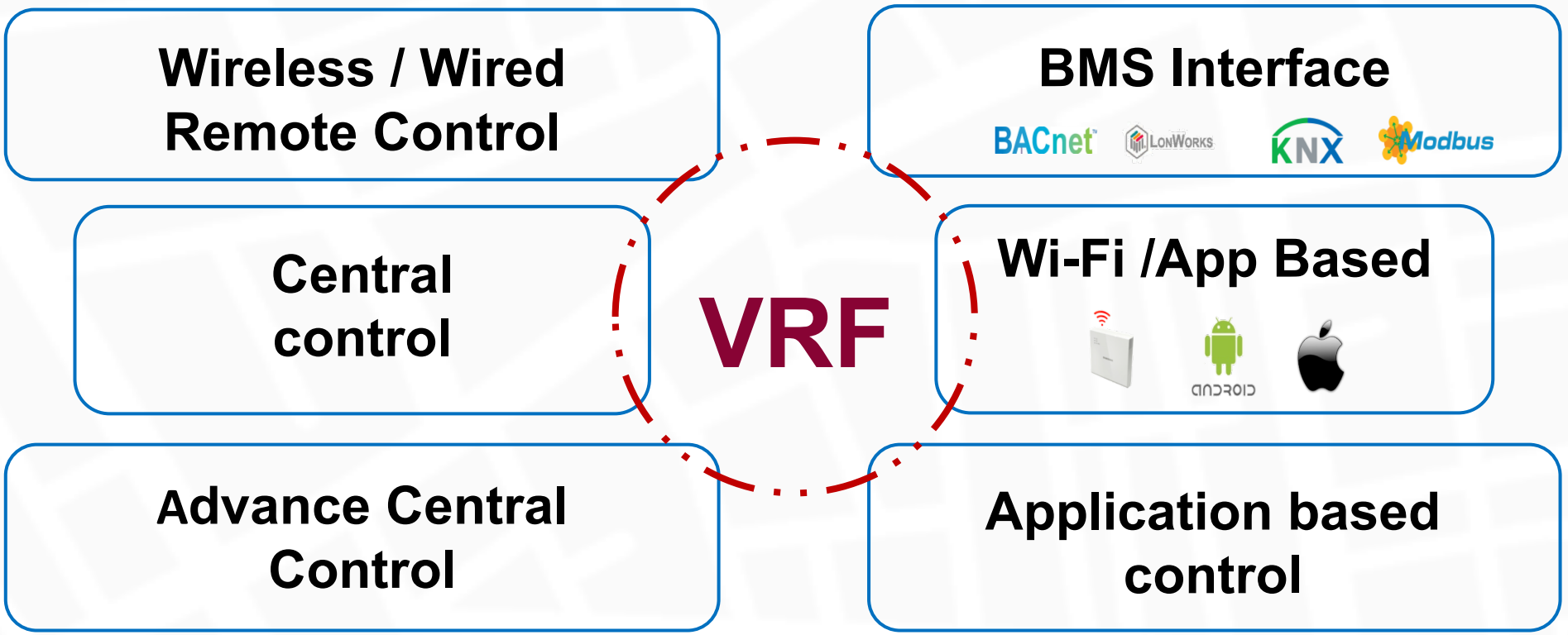
2.4. Noise and Vibration reduction

Sound level is less than 45dBA at the top floors.

VRF System



2.5. Sophisticated Control System



3. Conclusion

- The increasing awareness about Global Warming and Environment Protection by reducing power consumption calls for serious rethinking about most used equipment in various industries.
- The HVAC industry works inline with the global trend, by introducing new eco friendly technologies that minimize the damaging effects to Mother Nature.
- Thanks to the invention and continuous improvement of VRF technology for the contribution in creating a healthier environment for today and for future generations.

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VRF Specifications: Misperceptions and Solutions

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1. Abstract

As VRF systems are relatively new in the central air-conditioning field, there are many misperceptions to interpret Specifications such as:

- Performance
- Key components, etc.

In this presentation the main criteria for selecting VRF systems will be discussed.

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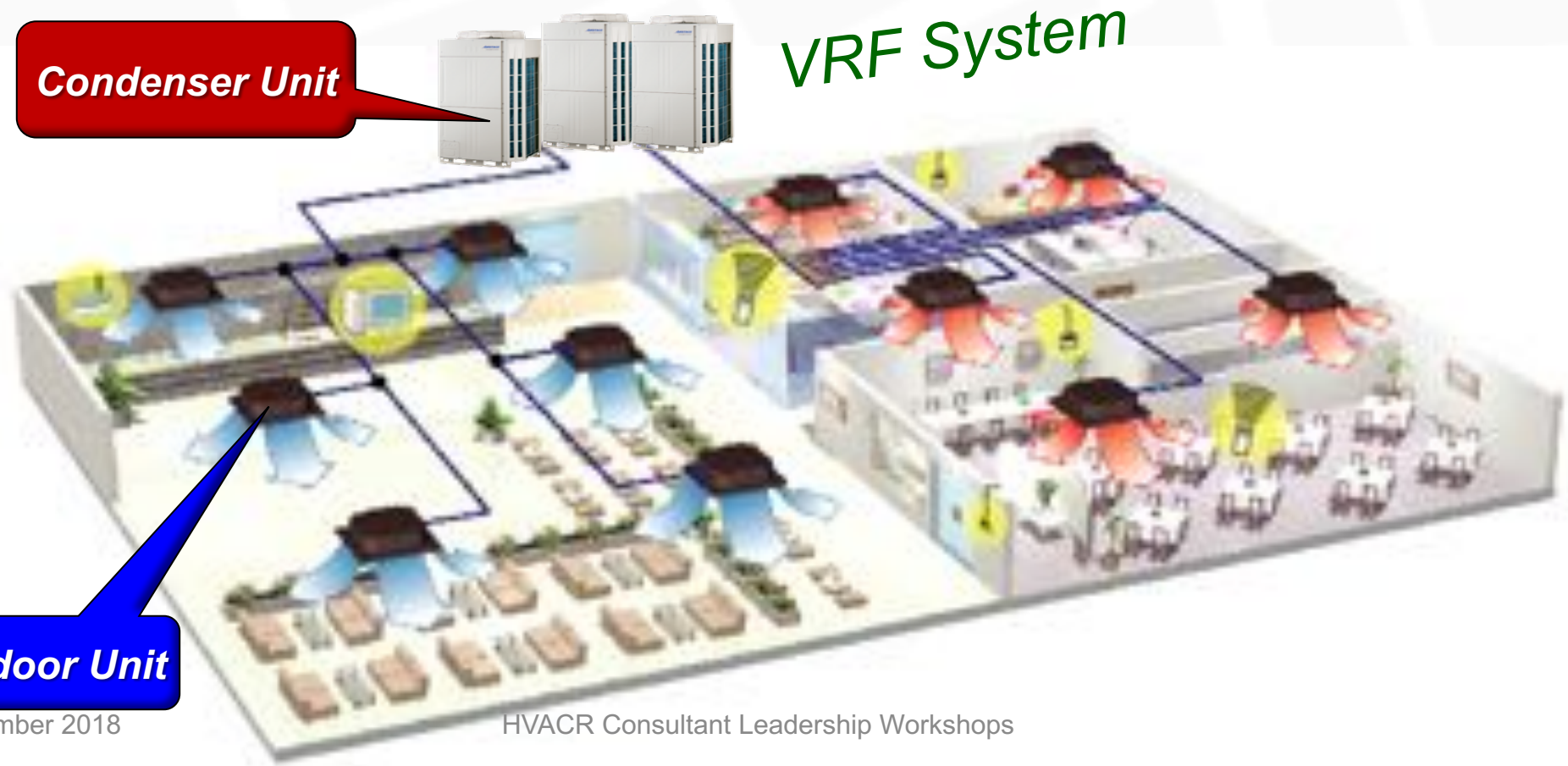
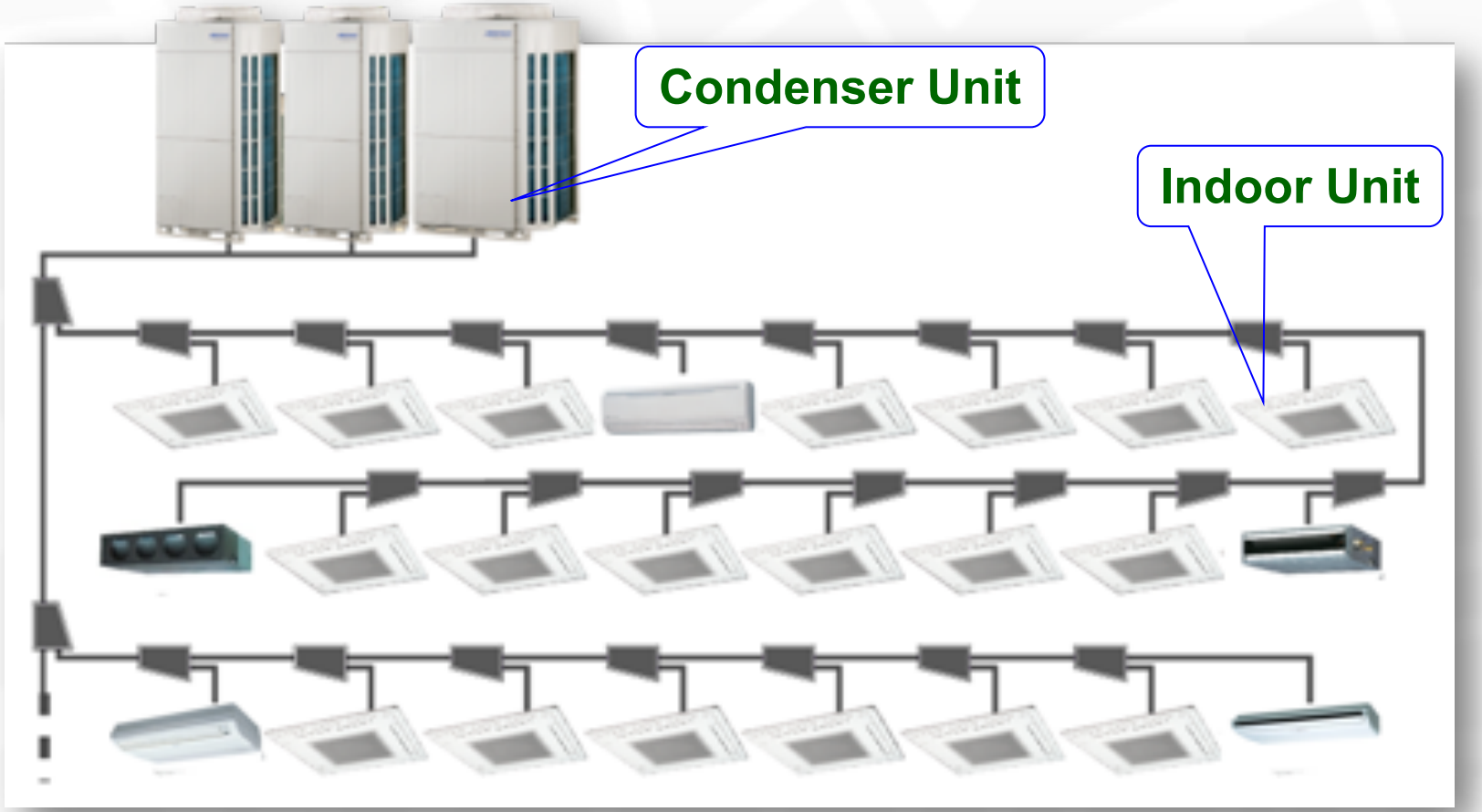
2. Basics of VRF Systems

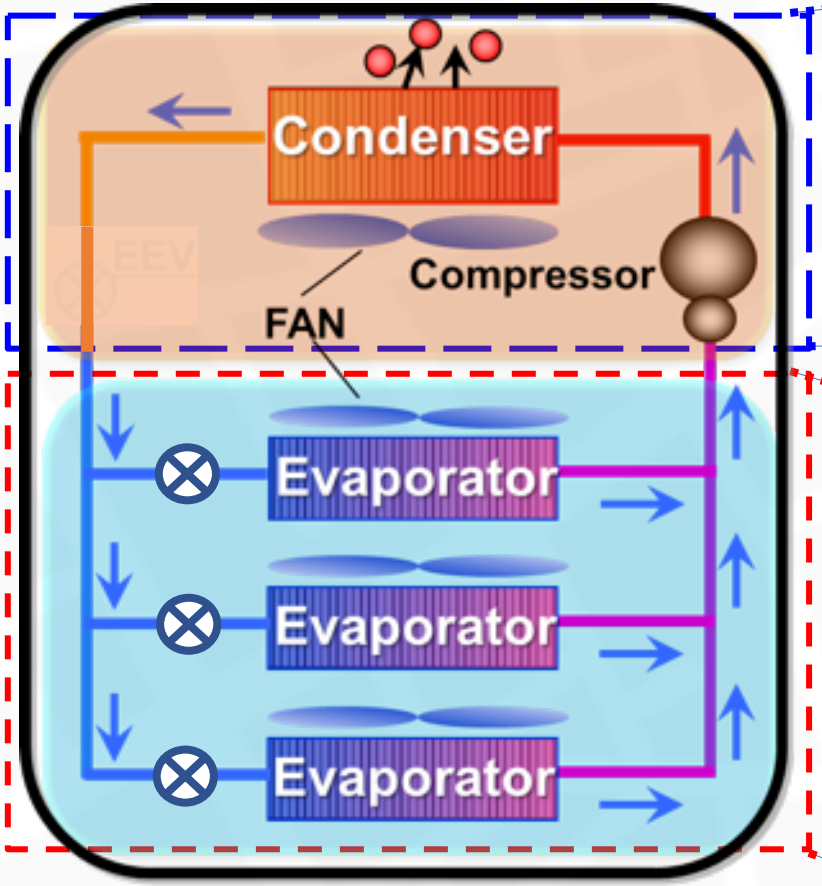
2.1. What is a VRF system?



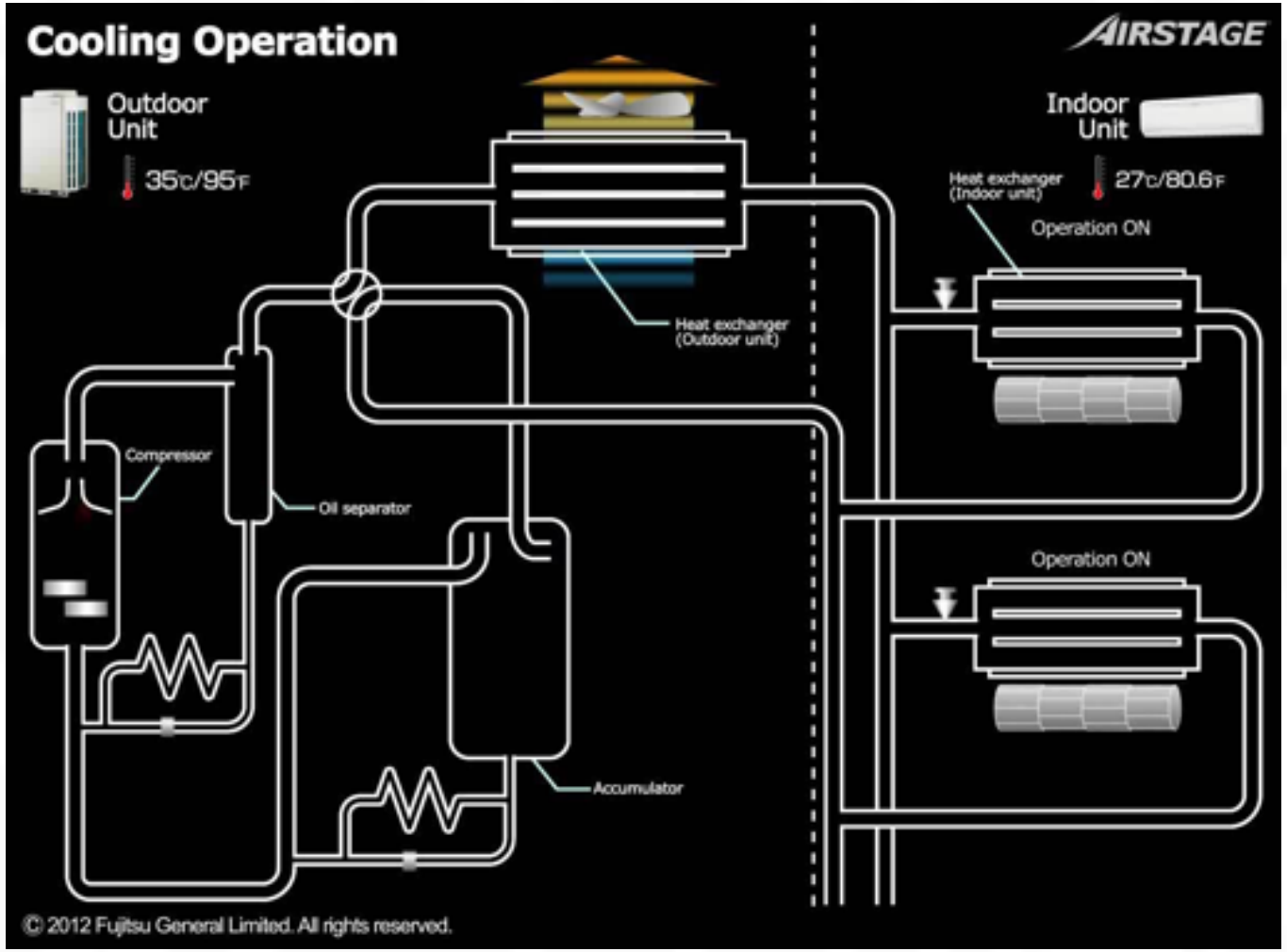
2.2. Connection Method



2.3. Operational Mechanism



2.3. Operational Mechanism



2.4. Benefits of VRF

- Improved energy savings
- Individual operation
- Smart control
- Modular design

3. Misperceptions in Performance

3.1. Parameters to determine VRF performance

- **Cooling Capacity (Q)**
- **Power Consumption (P)**

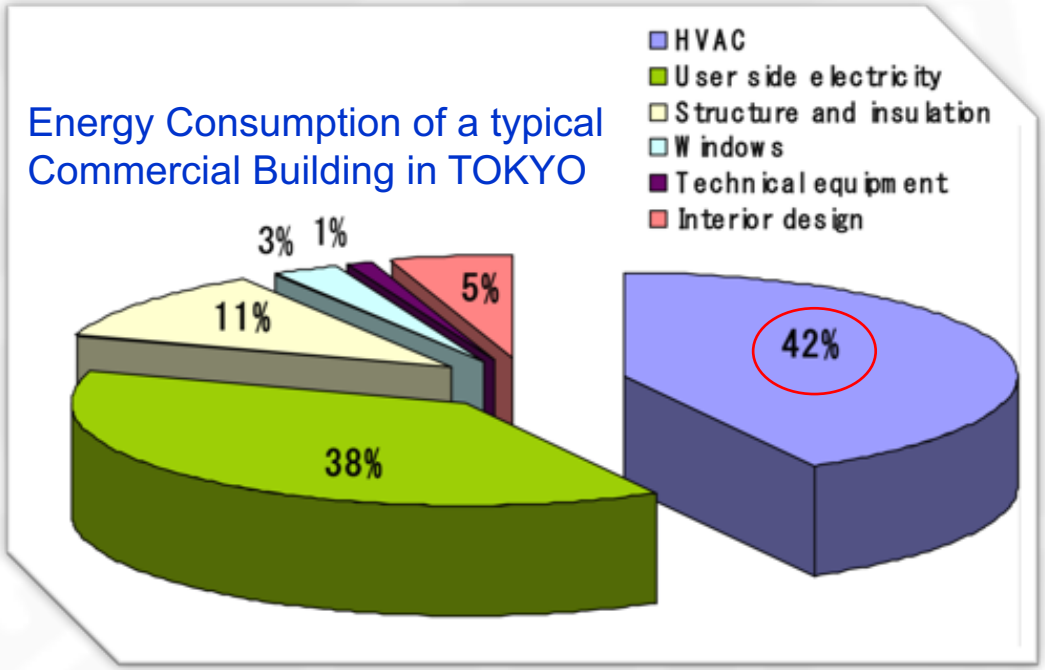
Energy Efficiency Ratio (EER)

EER = Q / P

Country wise there is a Minimum Energy Performance Standard (MEPS) that is determined by circumstance of each country like, Outdoor Air Temperature, Electricity Supply Condition, etc.

3.2. Why MEPS for VRF

Air-conditioner shows more than 40% of a total Power Consumption. To avoid the extra burden to the POWER PLANT, every country has own MEPS Regulation for Air-conditioner.



3.3. Overview of MEPS test methods

- **AHRI** (Air-Conditioning, Heating and Refrigeration Institute) – USA
  Considers IEER for seasonal performance (heating & cooling)
- **ISO** (International Organization for Standardization) – Internationally adopted by member countries
  Considers CSPF/HSPF for seasonal performance (heating and cooling)
- **EN** (European Norm) – Europe
  Considers SEER for seasonal performance (heating and cooling)

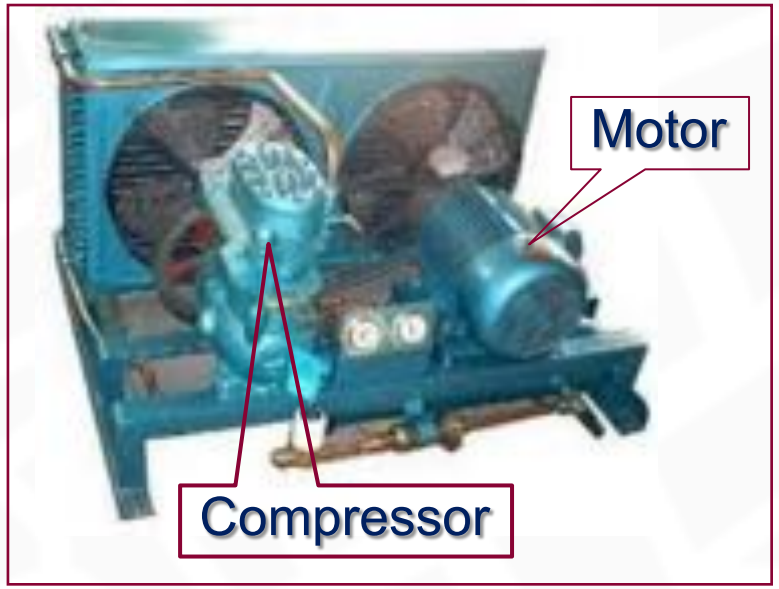
Specified VRF under UAE Standard

****ESMA** (Emirates Authority for Standardization and Metrology) – UAE
Considers EER for cooling performance at 46ºC outdoor ambient temp. based on

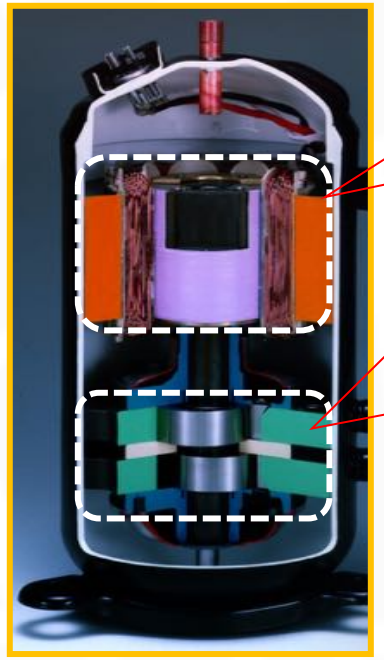
4. Misperceptions of VRF Key Components

4.1. Compressor – Technology

- Beginning of 20th century
  - Semi Hermetic Type



- End of 20th century
  - Hermetic Type



MOTOR

AC Motor → DC INV Motor

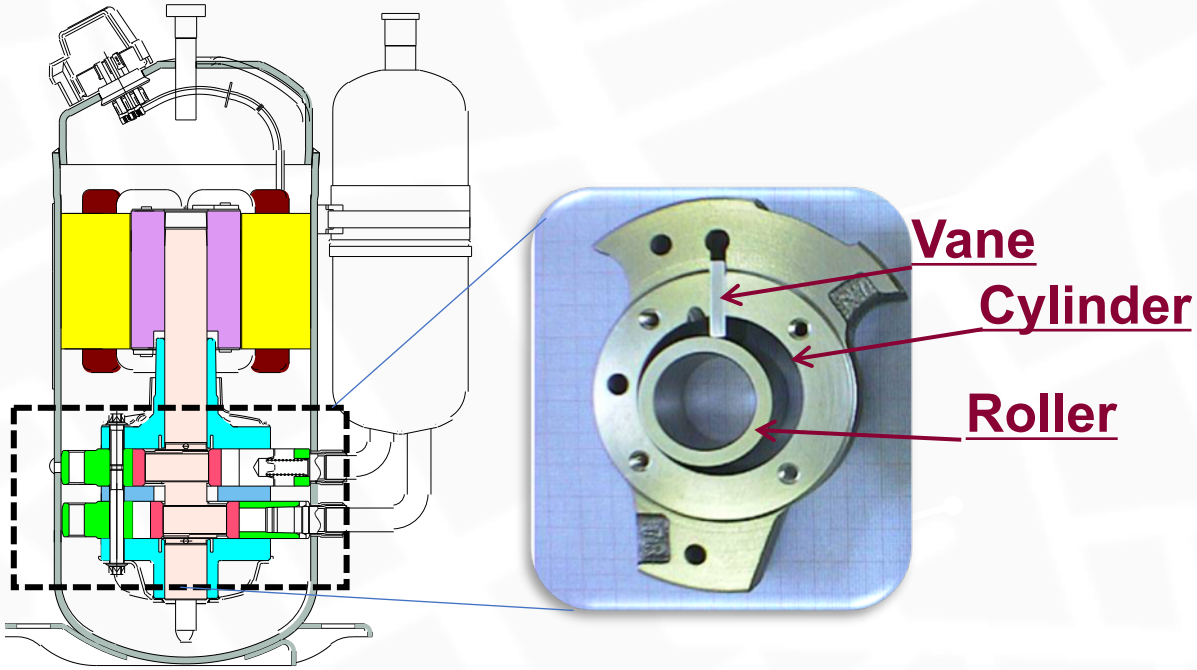
COMPRESSOR

- Piston Type
- Rotary Type:

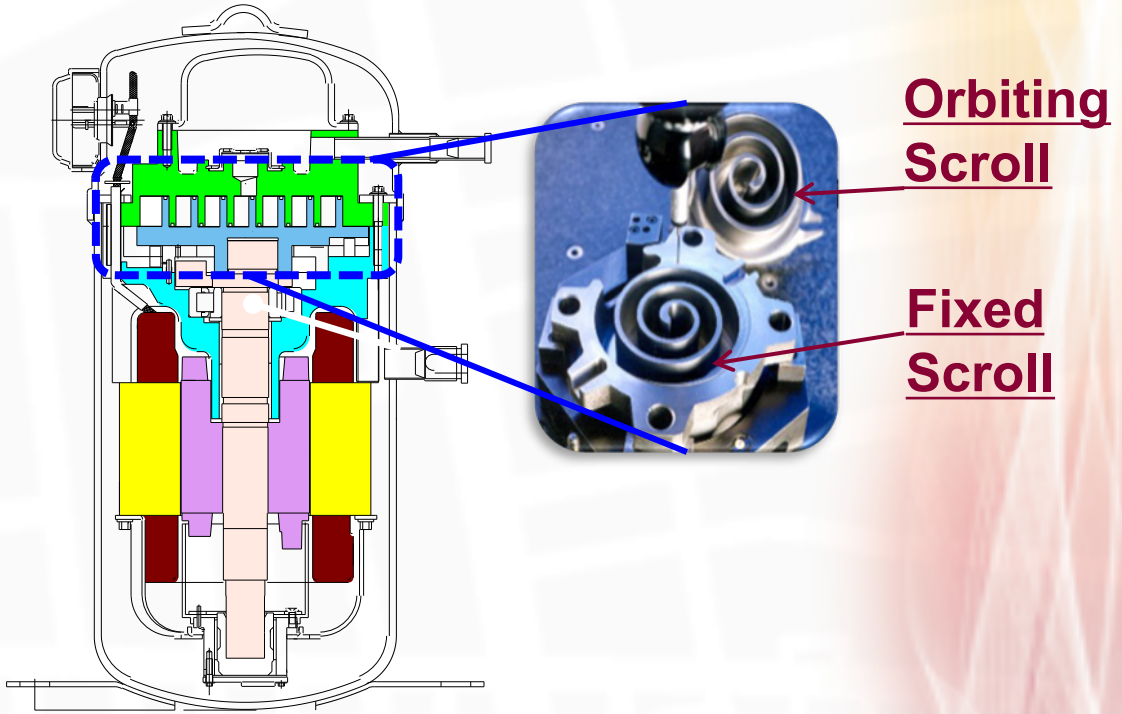
Twin Vane / Scroll / Screw

4.1. Compressor – Mechanical structure

Twin Vane Compressor

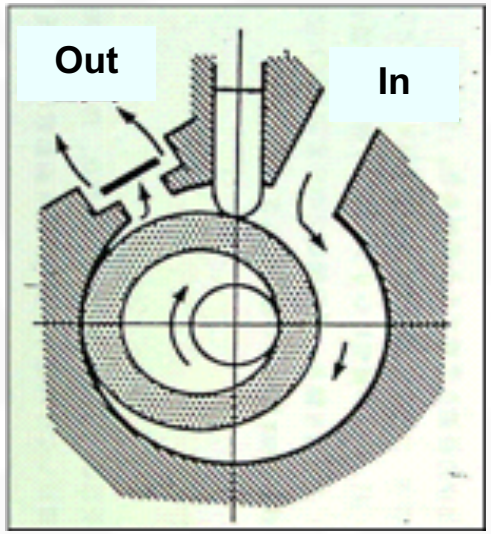


Scroll Compressor

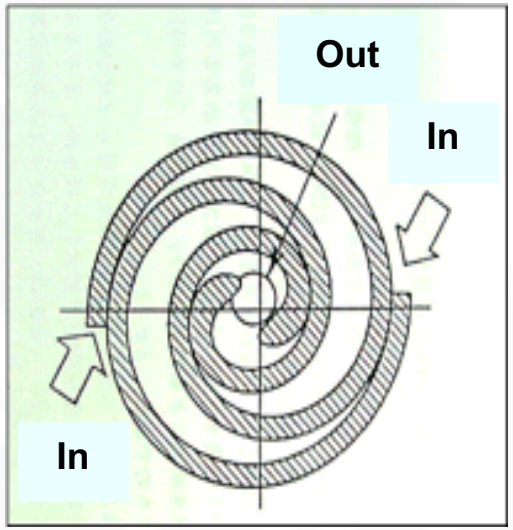


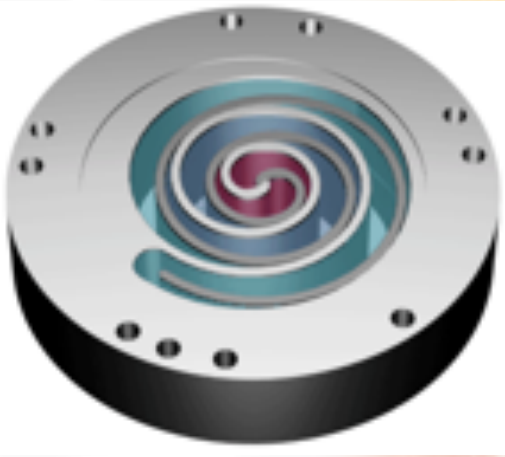
4.1. Compressor – Mechanism

Twin Vane



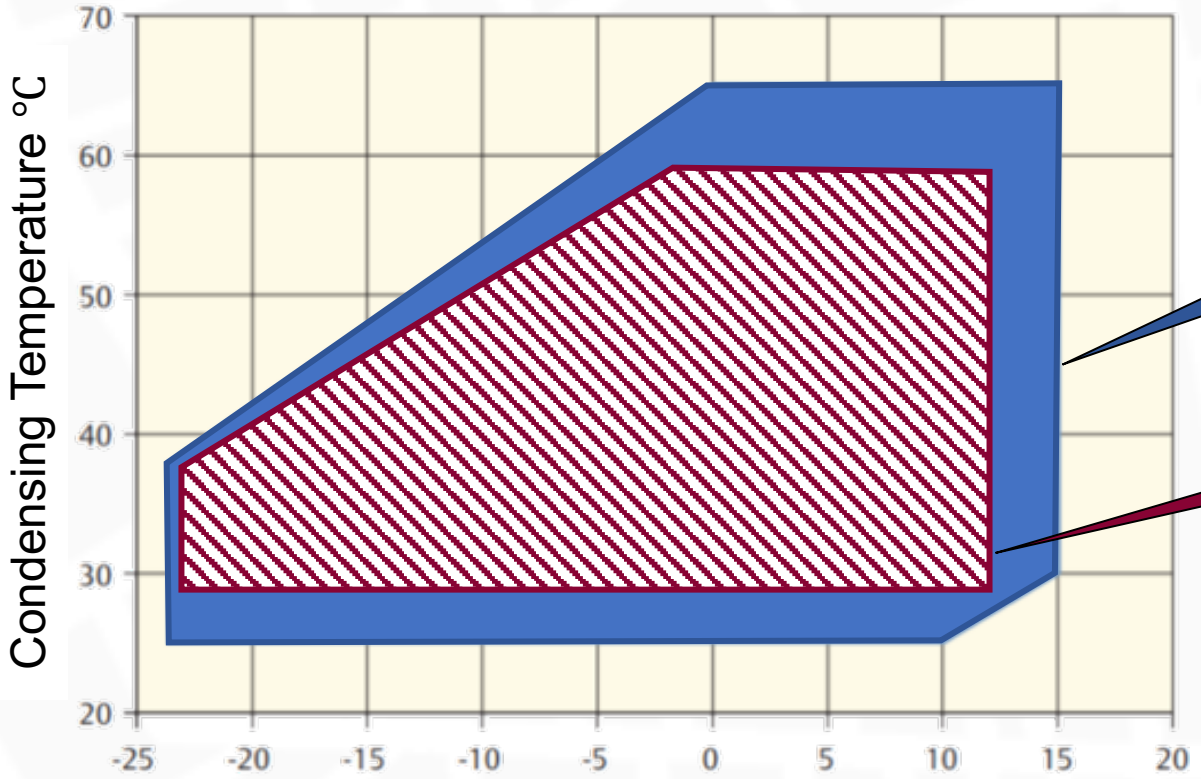
Scroll





4.1. Compressor – Selection parameters

Operation Envelope



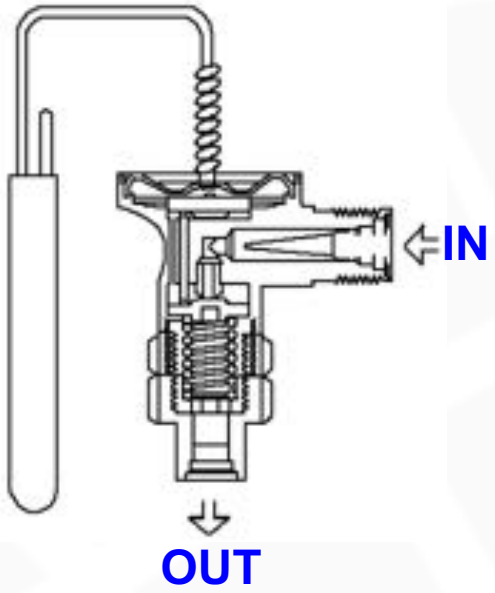
Compressor

Air-conditioner

@11K Super Heat

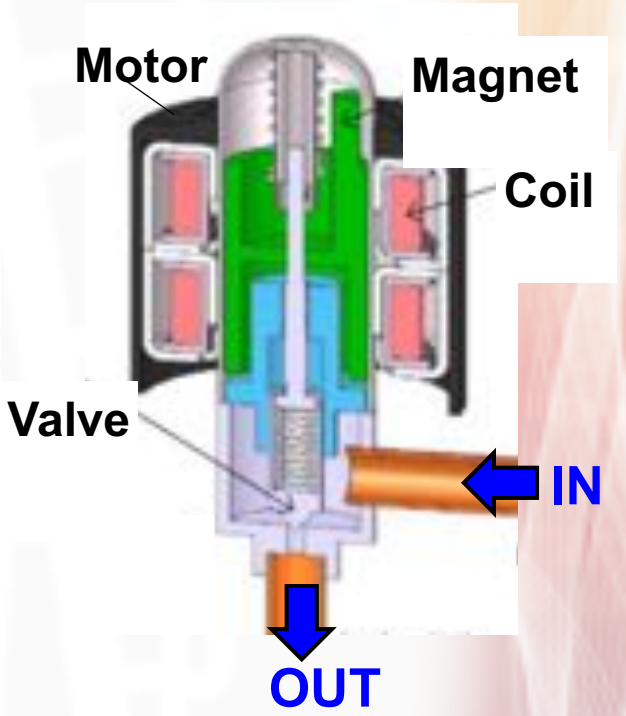
4.2. Expansion valve – Type and Mechanism

Thermostatic Expansion Valve

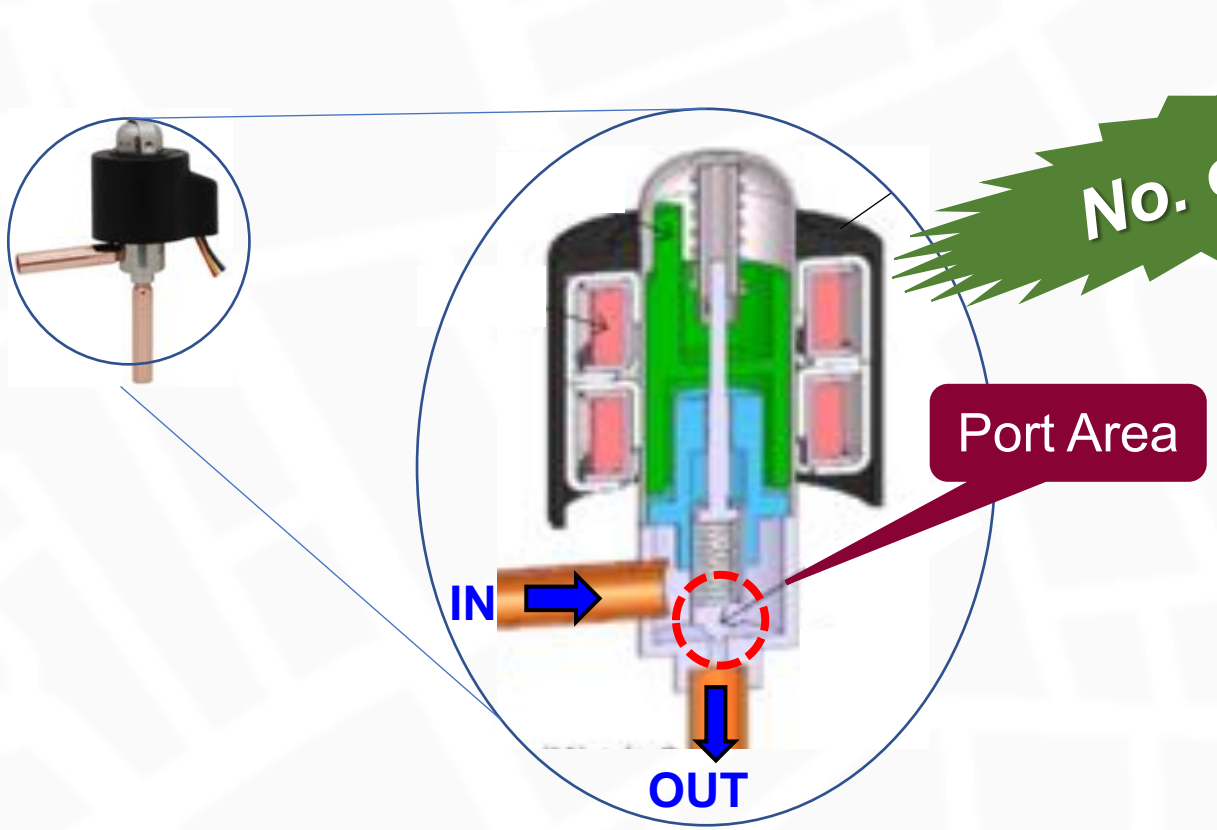


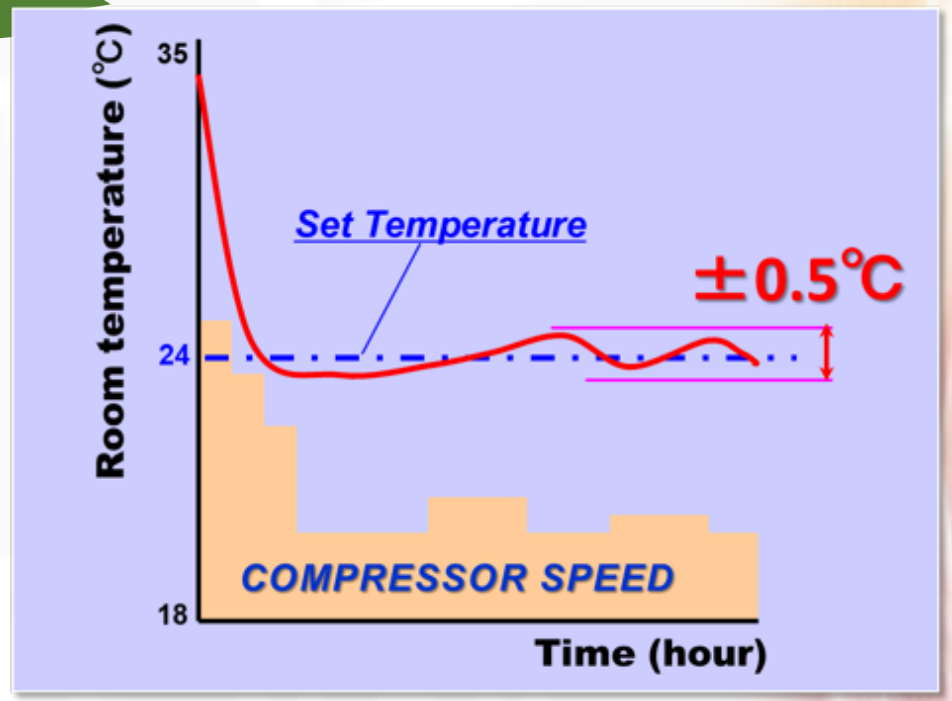
Electronic Expansion valve

VRF USE



4.2. Expansion valve – Selection parameters





4.3. PCB (printed circuit board)

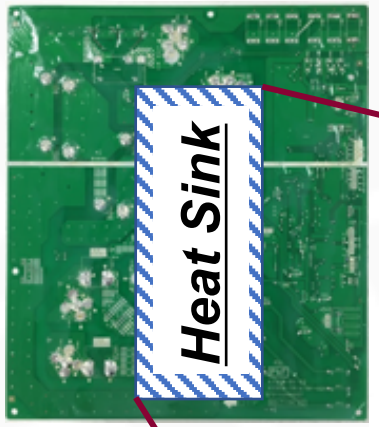
What is the PCB?

The PCB contents all electrical components for regulating refrigerant flow by adjusting the Compressor, Fan Motor, Expansion valve, etc...

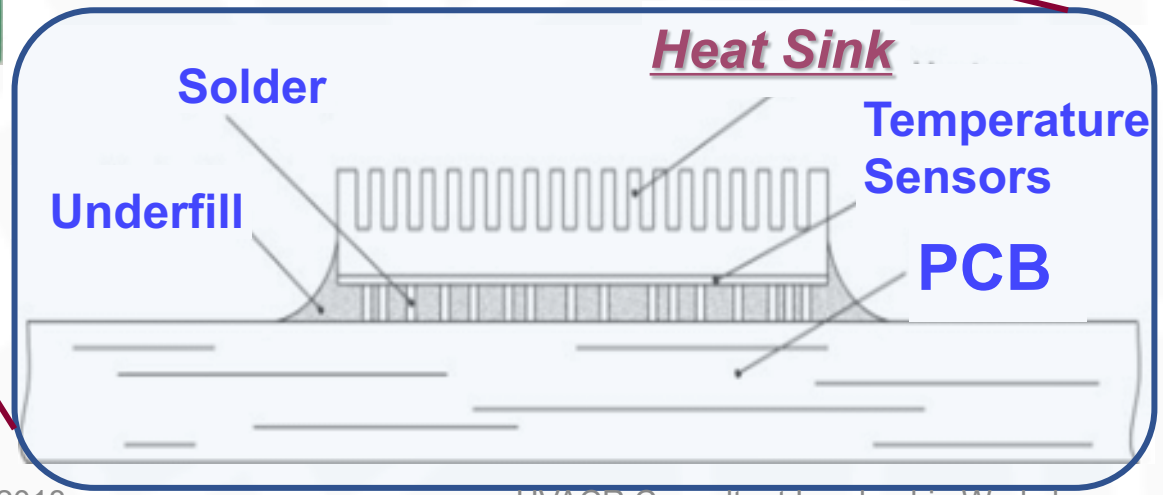
PCB dissipates Heat and therefore needs to be cooled.

4.3. PCB (printed circuit board)

Cooling methods of the PCB



- ***Heat Sink*** *(heat rejection device) is connected to PCB for cooling*



Suitable for VRF

Cooling Media

- ***Air***
- ***Refrigerant***
- ***Water***

Over cooling and undercooling can have detrimental effects on the PCB. Overcooling can lead to condensation while under cooling can cause malfunction.

4.4. Fan Motor – Types

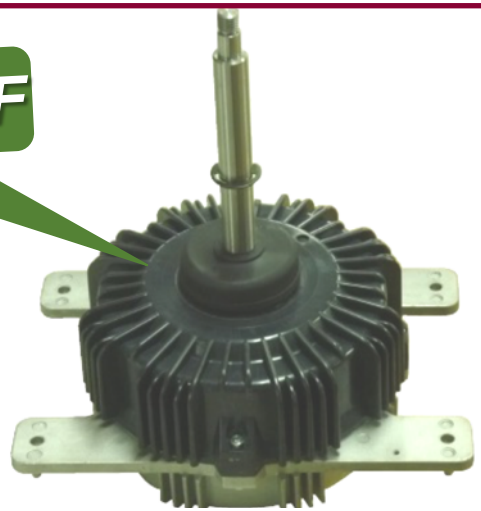
AC MOTOR

Efficiency:

45% to 55%

DC INV MOTOR

Suitable for VRF



Efficiency:

More than 80%

4.4. Fan Motor – Selection parameters

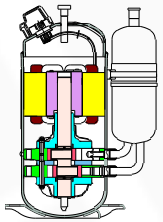
- **Brushless DC MOTOR**
- **Multiple Rotational Speed**

  (More than 10 steps for smooth control of VRF Operation)

4.5. The role of the VRF Development Engineer

A trade-off needs to be found between those components to optimize the performance of the system.

COMPRESSOR / FAN MOTOR / EXPANSION VALVE / PCB / COILS





In order to achieve:

- The best performance
- Optimal comfort
- Best serviceability

5. Main criteria for VRF system selection

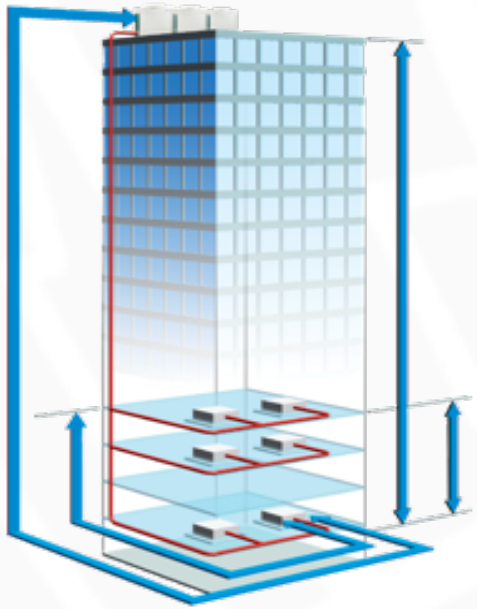
5.1. Energy efficiency

Each country has a MEPS regulation. That regulation should be the base for choosing Efficiency

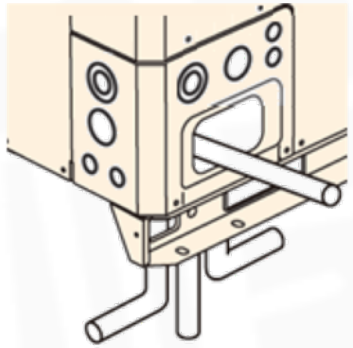
MEPS Regulation (ESMA in UAE)

Rated Cooling	Minimum Energy Efficiency @ 46℃
≦ 90,000 Btu/h	EER **8.3** Btu/Wh
90,000 to 130,000 Btu/h	EER **7.8** Btu/Wh
135,000 Btu/h ≦	EER **7.5** Btu/Wh

5.2. Installation freedom – Piping



- **Height Difference**
- **Total Pipe Length**
- **Actual Pipe Length**



- **Easy Piping Connection**

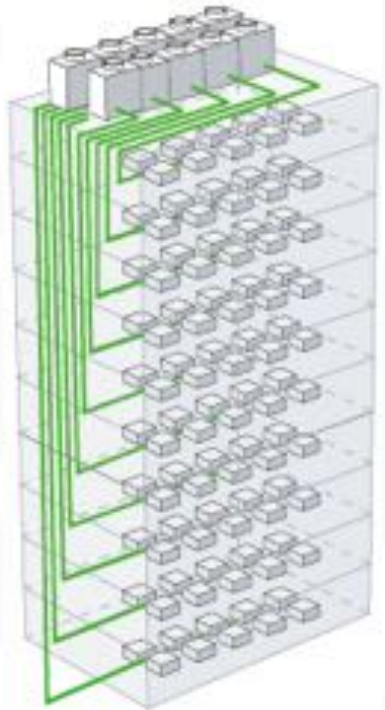
5.2. Installation freedom – Easy transportation

- **By Crane**

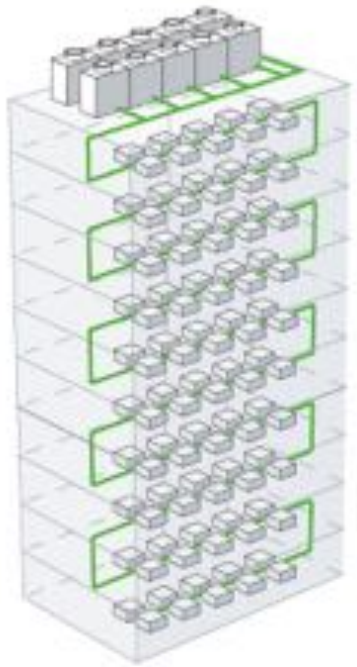
- **By Forklift**

- **By Elevator**

5.2. Installation freedom – Transmission wiring



- ***Parallel Wiring***



- ***Serial Wiring***

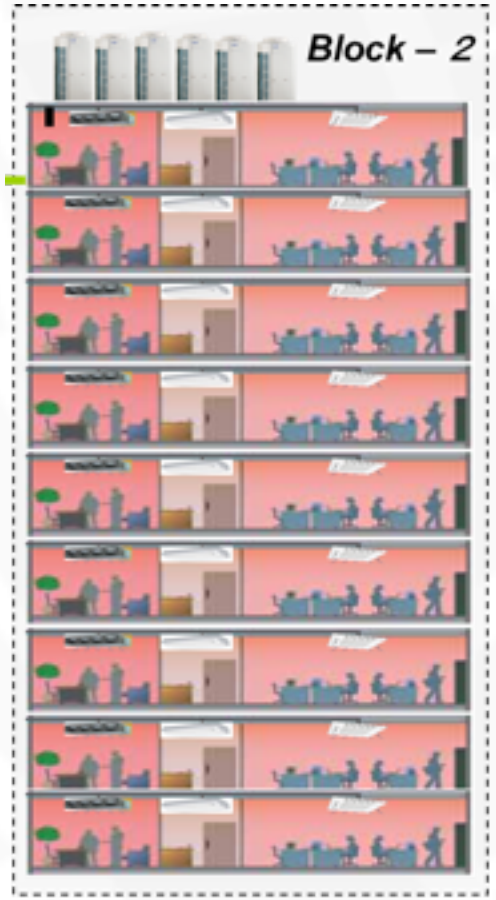
- **Type of Wiring (Parallel or Serial or both)**
- **Wiring Length**
- **Wiring Size**

5.3. Easy to design

Availability of Design Software for,

- Unit Selection
- Piping Design
- Wiring Design
- Preparing Report

5.4. User Friendly Controllers



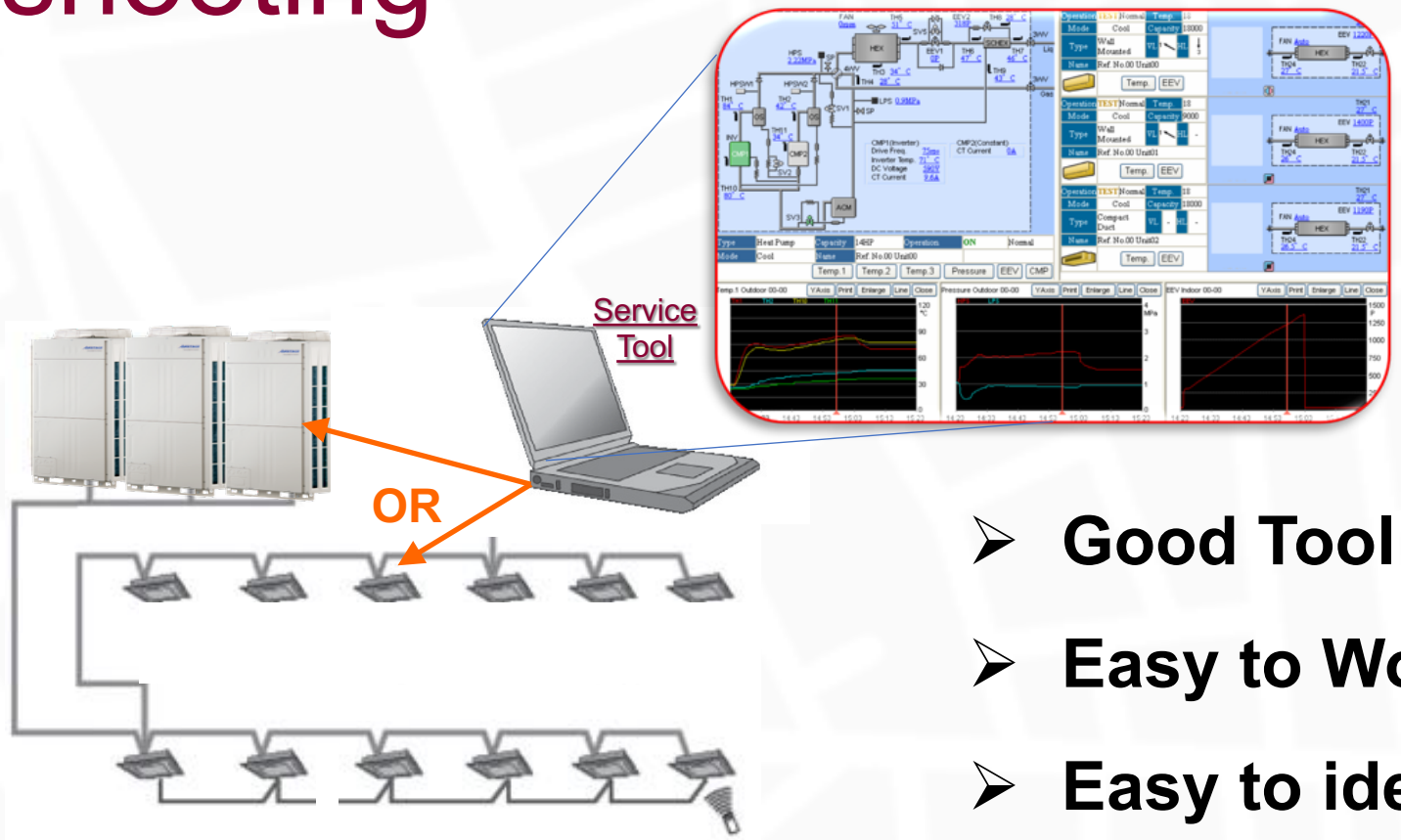
- **Individual Controller**

- **Central Controller**

- **Wi-Fi Controller**

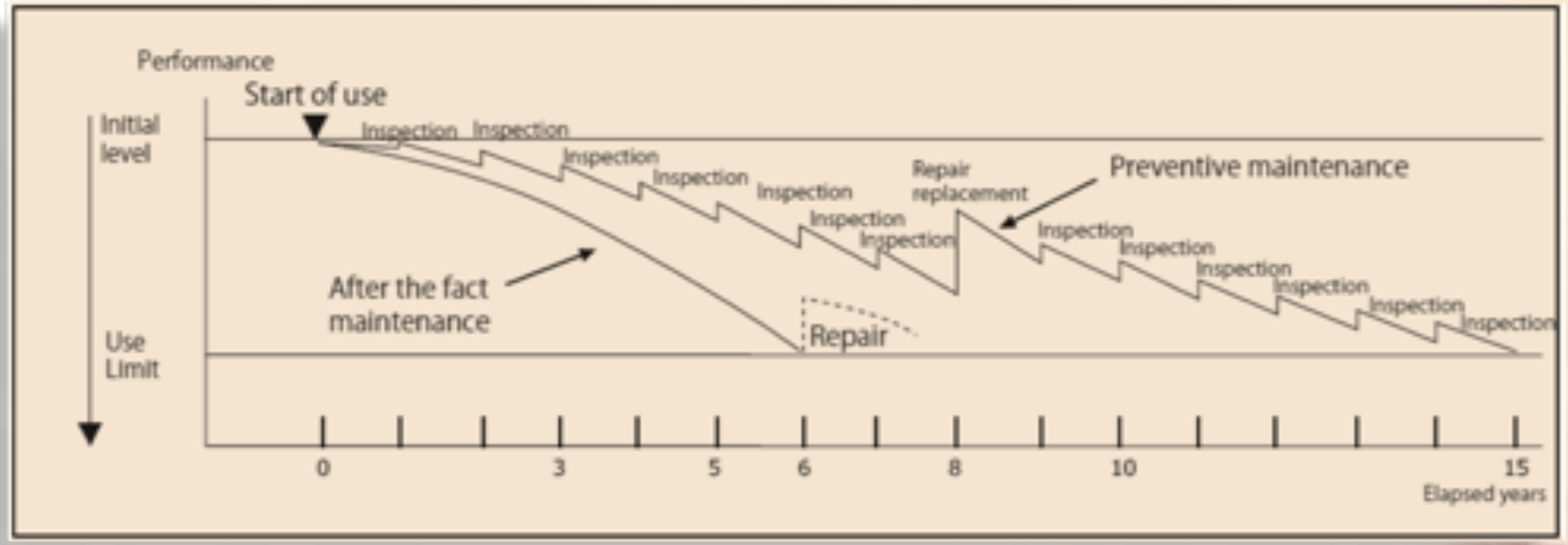
- **BMS Controller**

5.5. Easy commissioning and trouble-shooting



- **Good Tool (Software) availability**
- **Easy to Work** (from Room or from Outside)
- **Easy to identify the Trouble**

5.6. Preventive maintenance – Necessity



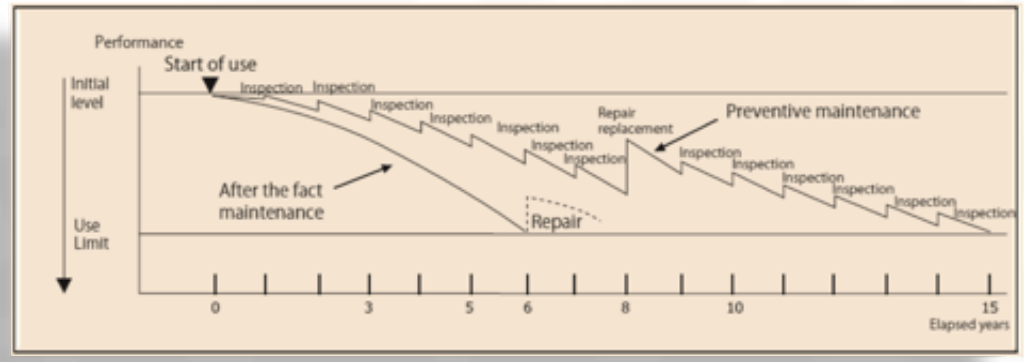
Source : Japan Refrigeration and Air Conditioning Industry Association

5.6. Preventive maintenance – Guideline

Source : Japan Refrigeration and Air Conditioning Industry Association

Parts	Periodic inspections			Conservation		
	Points to inspect	Inspection method	Criteria	Conservation method	Inspection Period	Renewing period (Change or Repair)
Cabinet(Panel), Guard	・Paint peeling ・Crack or break of plastic parts	・Visual inspection	・Severe rust ・Crack or break	・Touch-up (Paint peeling) ・Change (Crack, Break)	Once a year Before hot season	8 years
Vibration rubber	・Deterioration, Calcification	・Visual inspection	・Presence of normal vibration-proof function	・Cleaning (Deterioration, Calcification)		10 years
Fan, Fan guard	・Revolution unbalance ・Dust, Appearance	・Visual, sound inspection	・Absence of severe unbalance ・Absence of distortion	・Parts change (Unbalance) ・Cleaning (Dust)		10 years
Fan motor	・Abnormal noise ・Insulated resistance	・Visual inspection	・Absence of abnormal noise ・Insulated resistance, more than 1MΩ	・Bearing change (Disturbing sound) ・Motor change (Insulated resistance lowering)		20,000 hours
Compressor	・Abnormal noise or vibration when starting, running and stopping ・Insulated resistance	・Sound inspection ・Insulated resistance tester	・Absence of noise or abnormal vibration ・Insulated resistance, more than 1MΩ ・Absence of terminal loose or lines	・Change (Abnormal noise, Vibration, Insulated resistance lowering) ・Tightening (Terminal loose)		20,000 hours
Crank case heater	・Conduction ・Insulated resistance of wire coat ・Deterioration of wire coat	・Tester ・Insulated resistance tester	・Absence of noise or abnormal vibration ・Insulated resistance, more than 1MΩ ・Absence of abnormality	・Parts change		8 years
Heat exchanger	・Dust grime ・Clog ・Refrigerant leak	・Visual inspection ・Refrigerant detector	・Absence of clog ・Absence of refrigerant leak	・Cleaning (Grime) ・Parts change (Refrigerant leak)		5 years
Pipe	・Noise from pipe resonating ・Refrigerant leak from corrosion ・Resonating, touch of capillary	・Visual inspection	・Absence of abnormal resonating (sound), corrosion or erosion	・Adjusting or changing pipes		20,000 hours
Electric expansion valve	・Behavior ・Running sound	・Touch inspection ・Sound inspection	・Refrigerant is circulating ・Vibration sound, temperature shift	・Parts change		20,000 hours
Electriv valve, 4-way valve	・Behavior of magnetic valve and 4-way valve ・Insulation ・Corrosion, Noise	・Insulated resistance tester ・Visual, sound inspection	・Insulated resistance, more than 1MΩ ・Absence of noise or corrosion	・Parts change		20,000 hours

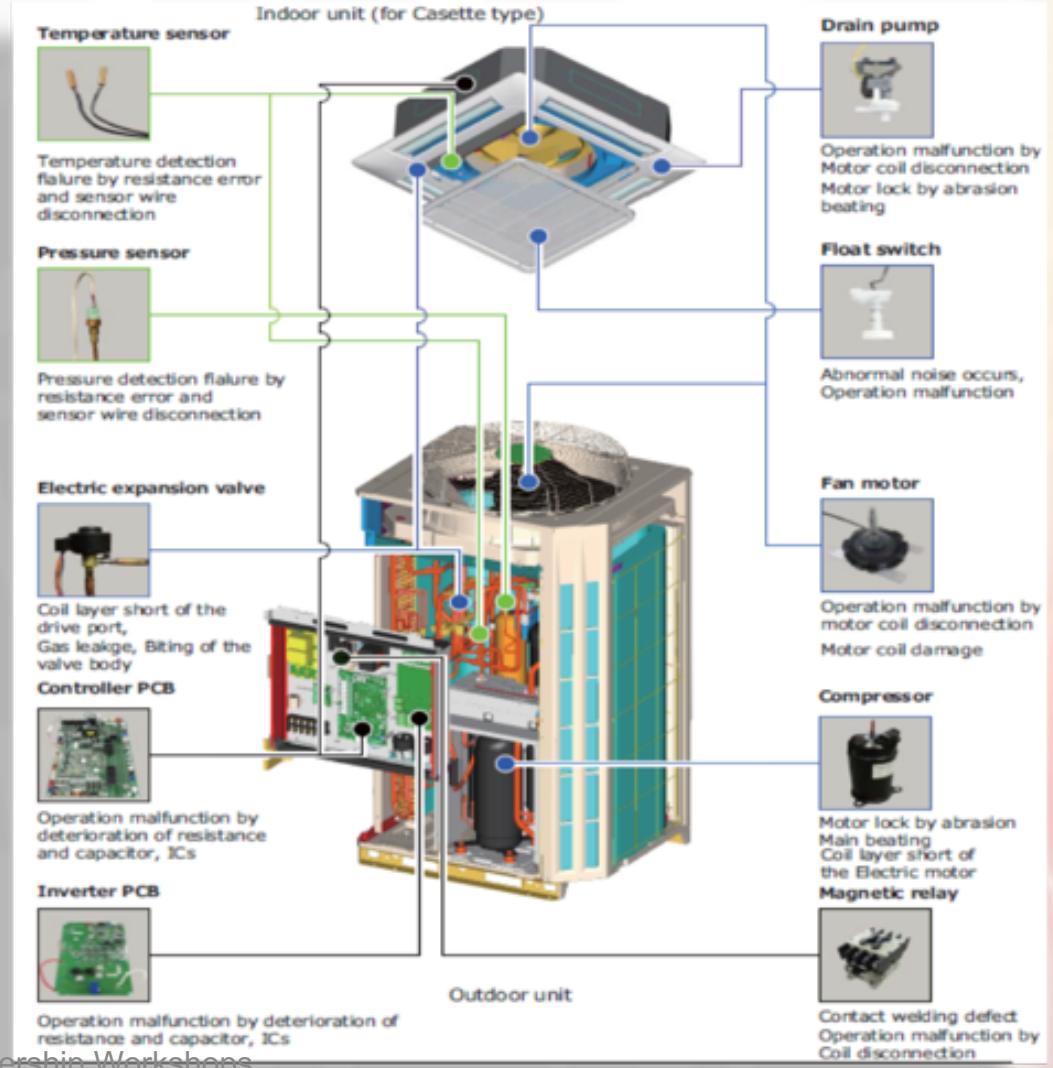
5.6. Preventive maintenance – Components



Check wearing of parts, after 25.000 hours since started operation

Check wearing of parts, after 20.000 hours since started operation

Check wearing of parts, after 5 years since started operation



6. Conclusion

6. Conclusion

- Calibration of the system components results in VRF System Efficiency; the efficiency of the system is not just affected by the components.
- Effective selection of the VRF system results in the following benefits for stakeholders:

End Users:

✓ Energy savings, Lower noise, Cooling comfort & Efficient service.

Consultants:

✓ Easy to design & Availability of supporting documents.

Contractors:

✓ Installation flexibility and Support from manufacturer.

Service Personnel:

✓ Spare parts availability, Quick response time and Reduced downtime.

VRF- The Installer's Role in Adding Value

Bibin Thomas

Business Development Manager

Adel Electronics Trading LLC

Introduction

- A good **dish** is a combination of the right **ingredients** in the right proportion, prepared to meet the **essence** of the dish by a **professional**, which should be pleasing to the eyes and **fulfill your appetite**.

Relation to the context

- **Dish** – VRF/VRV equipment
- **Ingredients** – Tools and fittings
- **Professional**- Competent Installer
- **Essence** – With the full knowledge
- **Fulfill your appetite** - Problem-free installation

1. Types of DX units

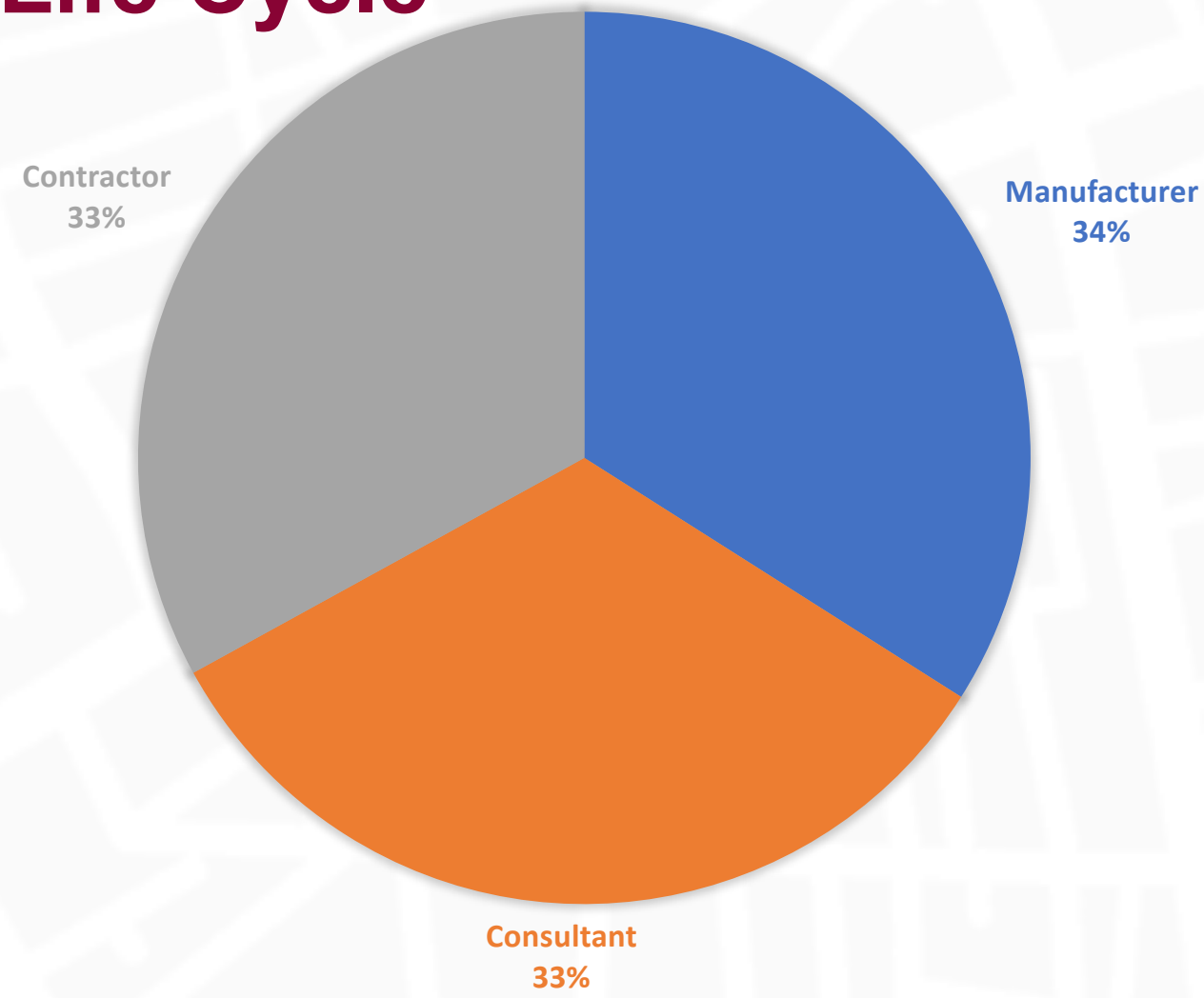
Standard One to One DX units

- Single outdoor, single piping, single communication cabling
- Large outdoor space required to install multiple indoor units
- Higher power consumption in comparison to multiple VRF units
- Simple installation practices
- Low to medium brazing skills required

VRF/VRV Units

- Single system, interconnected piping and loop series cabling
- Reduced footprint when connected to Multiple indoor units (For: eg 20 nos)
- Lower power consumption when connected to multiple units
- Complex installation practices
- Medium and high brazing skills required

2. The VRF Life Cycle

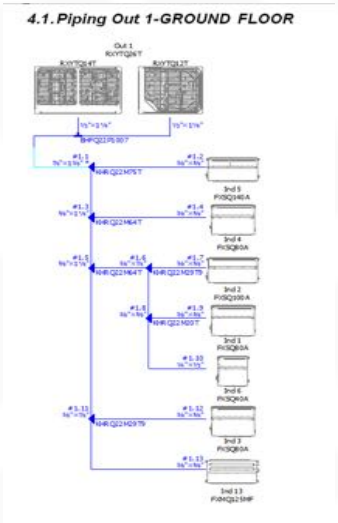


3. Installation basics

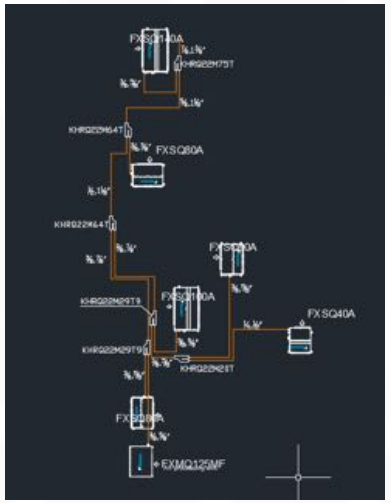
Where should the installer start?

STEP 1

- Understand the selection piping schematics, wiring chart



- Compare the selection with the calculated load and drawing



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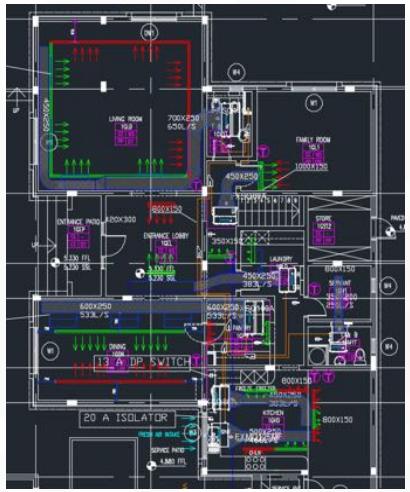
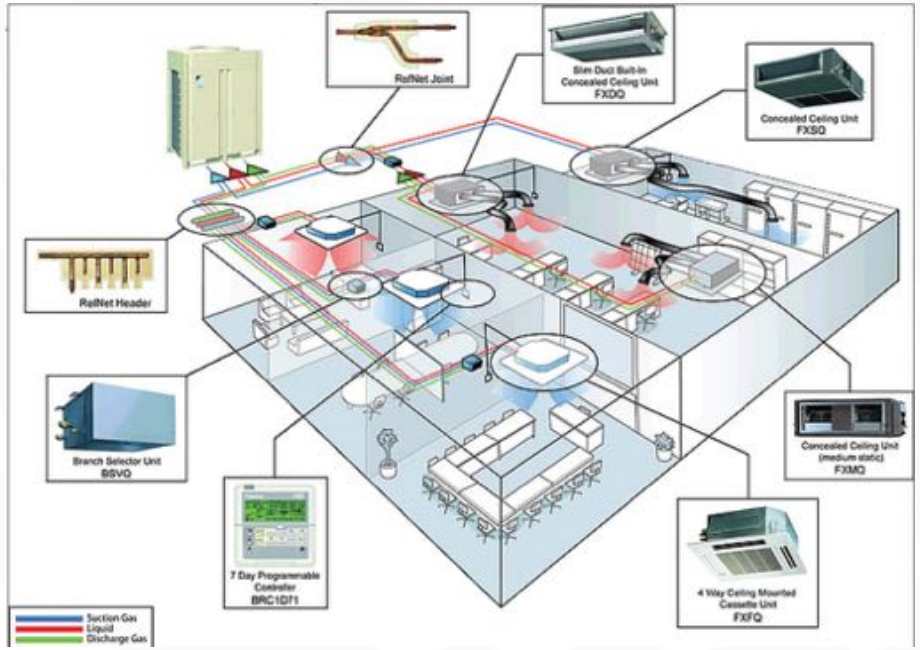


3. Installation basics

Where should the installer start?

STEP 2: Plan and organize the work plan for the project

- Evaluate the prepared drawings with site conditions

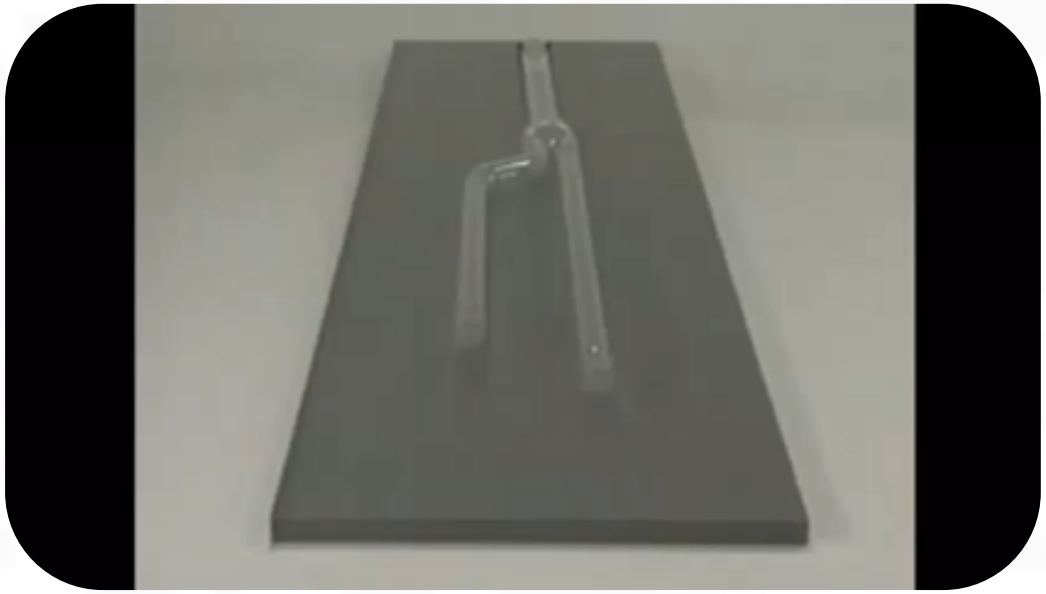


- Plan and mark the locations for the indoor unit, pipe supports and drain supports

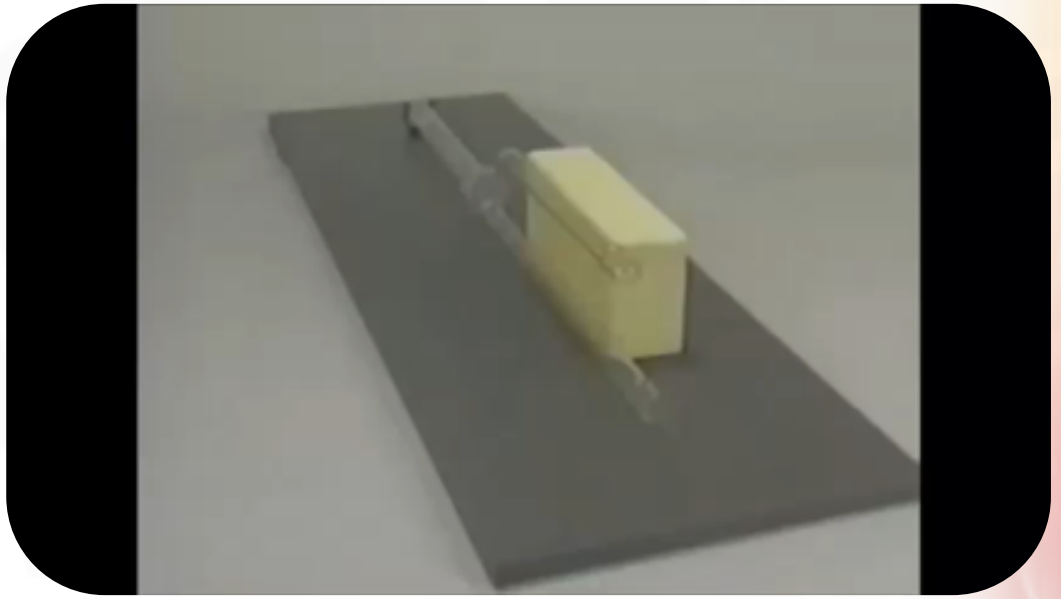
3. Installation basics

How to position Refrigerant piping

Correct position for REFNET piping

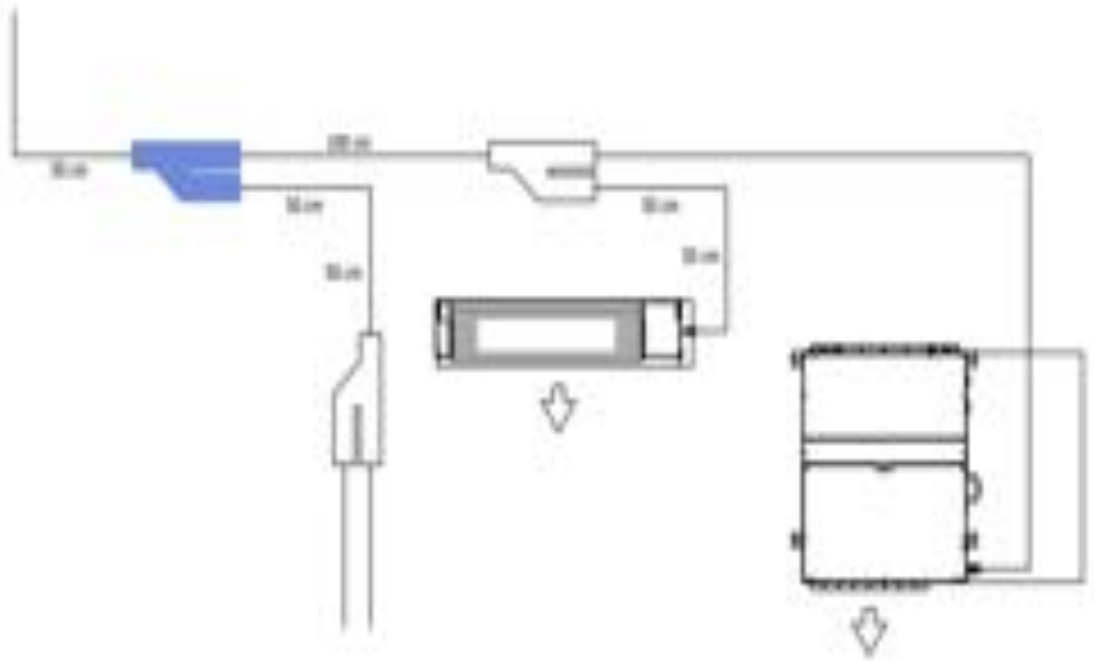


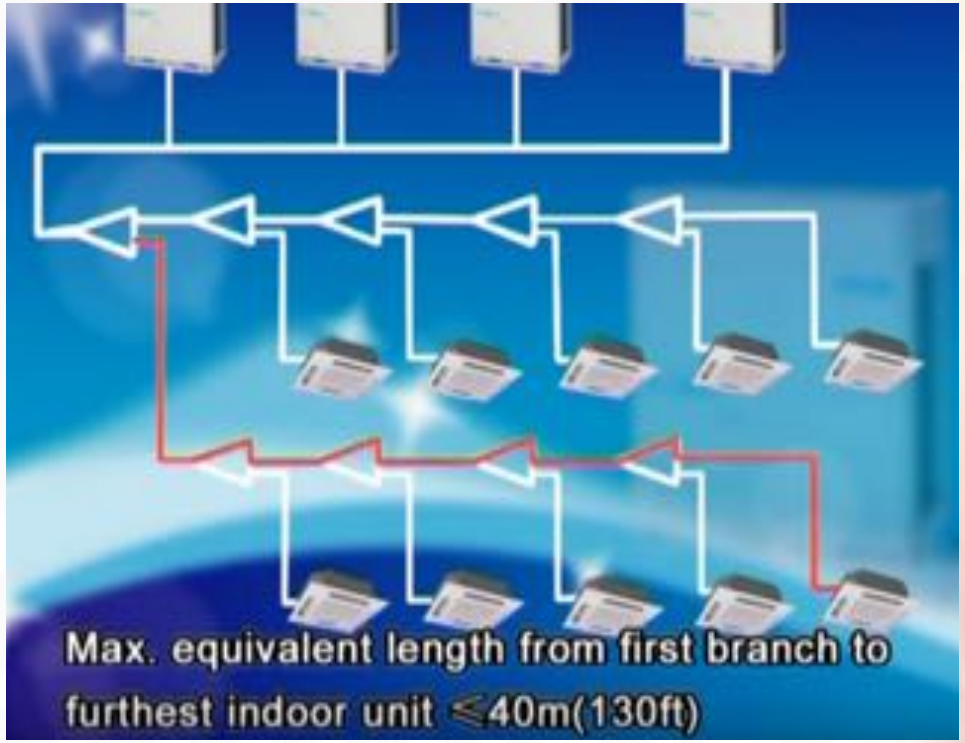
Incorrect position for REFNET piping



3. Installation basics

Maintaining the correct distances





3. Installation basics

Where should the installer start?

STEP 3: Precautions and preparation for brazing and REFNET

- To be addressed by a licensed brazing technician
- Know the correct quantity for nitrogen purging
- Prepare the site in accordance with the required safety precautions

3. Installation basics

Where should the installer start?

STEP 4: Flushing of the system with Nitrogen

- Maintain a pressure of 80 PSI
- Separate all pipelines from the indoor units
- Install individual access valves or shut-off valves for each unit

3. Installation basics

Where should the installer start?

STEP 5: Pressure Testing

Day 1 maintained at 580 PSI

Day 2 maintained at 200 PSI

3. Installation basics

Where should the installer start?

STEP 6: Vacuuming the system and refrigerant gas charging

- A micron vacuum gauge
- Vacuum up to 500 microns
- Charging scale

3. Installation basics

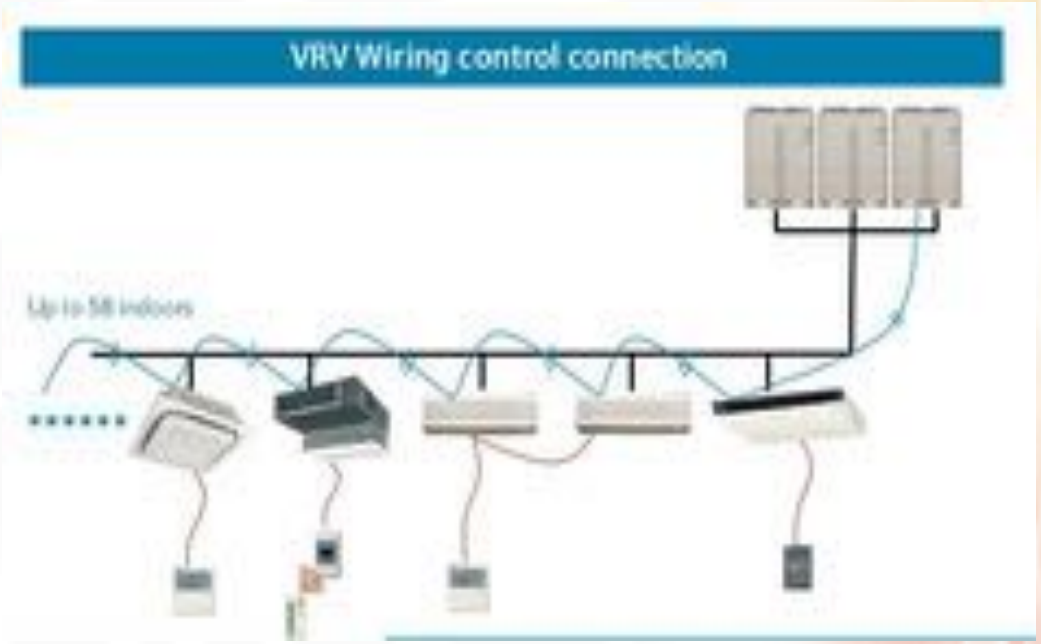
Where should the installer start?

STEP 7: Power, communication and thermostat cabling

Power(Indoor) :- 3 core 2.5 mm Flexible cables

Power(Outdoor) :- 4core + earth 10 mm armored cables

Communication :- 2 core 0.7mm shielded/unshielded cables



4. Installation recommendations

Vibration absorption pads

4. Installation recommendations

Content of Testing and Commissioning reports

- Date and time of pressure testing
- Photos before and after pressure testing
- Photos before and after the vacuum
- Refrigerant charge and specifications
- Photos of electrical observations during the commissioning and post-commissioning
- Recommended spare parts list for future maintenance

4. Installation recommendations

Alternative piping, crimp solutions

- A 360 degree lock solution
- Quick and easy to install
- Neat & clean piping result
- Max. pressure of 3000 PSI
- Performance test pressure up to 700 PSI
- Does not require nitrogen brazing
- No hot work perm

4. Installation recommendations

Insulation materials

- Colour-coded insulation addresses the labeling factor on the project site
- Maintains a neat appearance
- Increased fire protection and safety
- Easy handling on site and quick identification
- High durability factor

Yellow	Flammable Fluids & Gasses
Red	Fire-Quenching Fluids
Orange	Toxic or Corrosive Fluids & Gasses
Green	All Water (Potable, Boiler, etc.)
Blue	All Air (Compressed, Lab, etc.)
Brown	Combustible Fluids & Gasses
Purple	Definable by user
Black	Definable by user
White	Definable by user
Gray	Definable by user

The ANSI/ASME standard recommends using label colors in the above ways.

Refrigerant Pipe

Water Pipe

4. Installation recommendations

Cable trays and containments

- Protects the piping from any external damages
- Creates a quality, visually appealing finish to the piping network

5. Conclusion

- Increase in VRF jobs by 17% between 2015 to 2017 (BSRIA Reports 2017)
- Therefore the need for qualified installation professionals has increased
- Qualified personnel ensures the best installation, resulting in the best performance of the product and satisfied customers.

VRF Regulatory Requirements in the GCC

Michel Farah

Vice-Chairman

Eurovent Middle East

1. Air conditioning

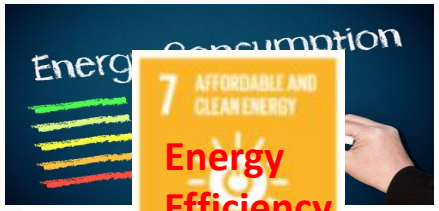
Contribution to the 17 UN SDGs

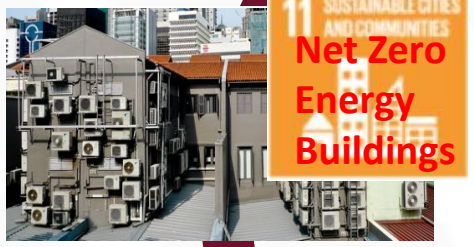
1. Air conditioning

The Global Warming Cycle

Population Growth

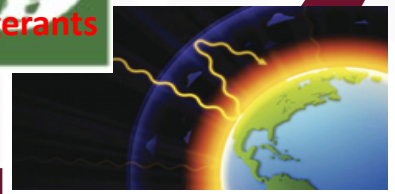
Income Growth
in Emerging countries





CO2 Emissions

Global Warming

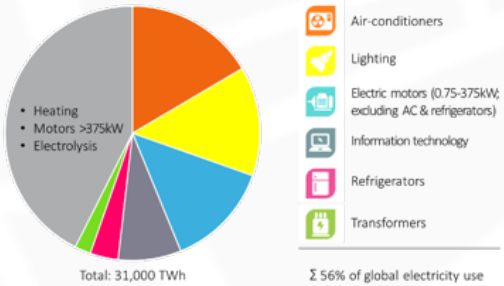


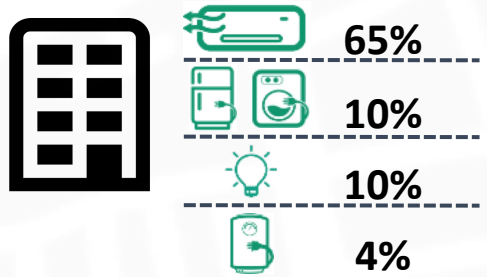
Green House Effect

1. Air conditioning

Actions to reduce energy consumption

Global Electrical Consumption in Buildings





Electrical Consumption in Buildings in the GCC

Increase Air Conditioner demand

Increase electricity demand

Increase CO2 emission by newly-built power plants

Accelerate global warming

Increase energy efficiency Policy (MEPS and CSPF)

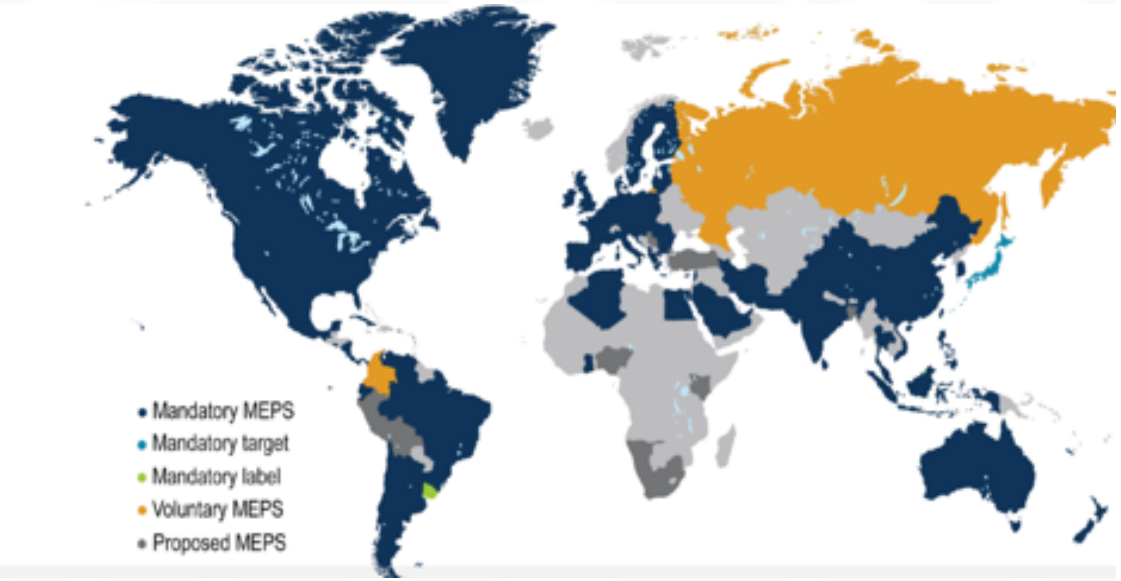
Disseminate energy efficient air conditioning

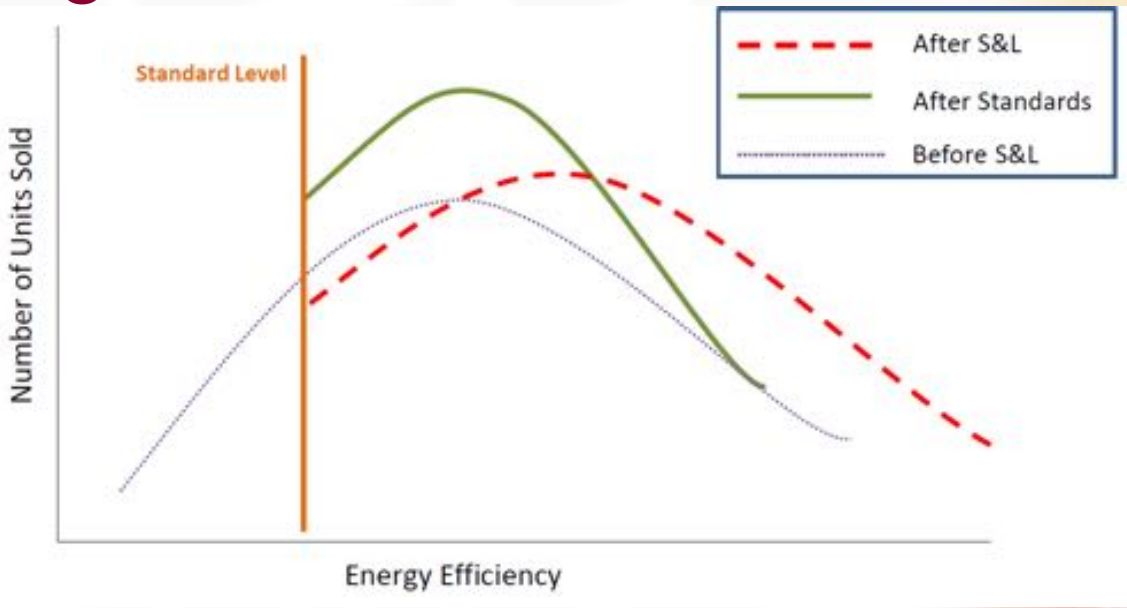
Minimize CO2 emission and newly-built power plants

2. Regulations

2. Regulations

Facts on standards and labeling schemes





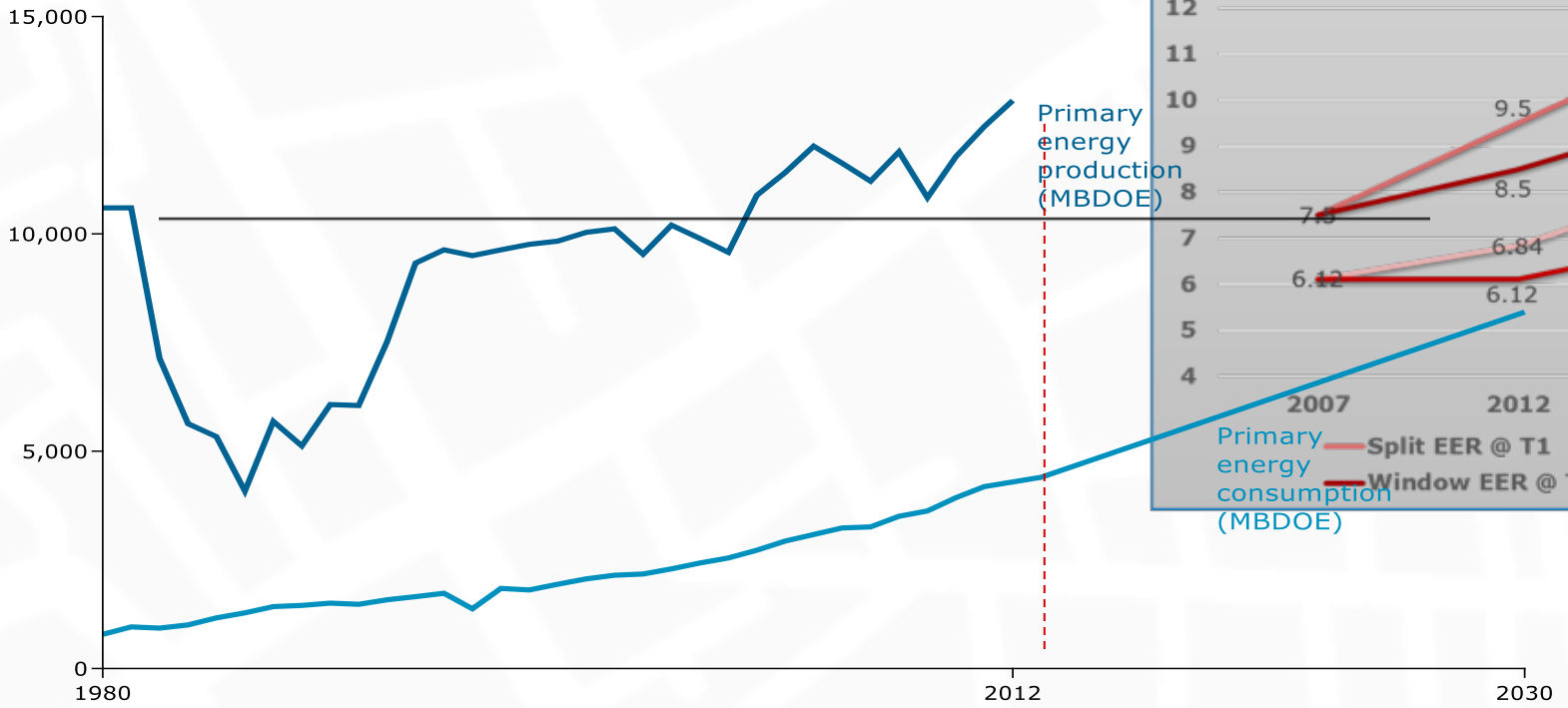
In most regulated markets

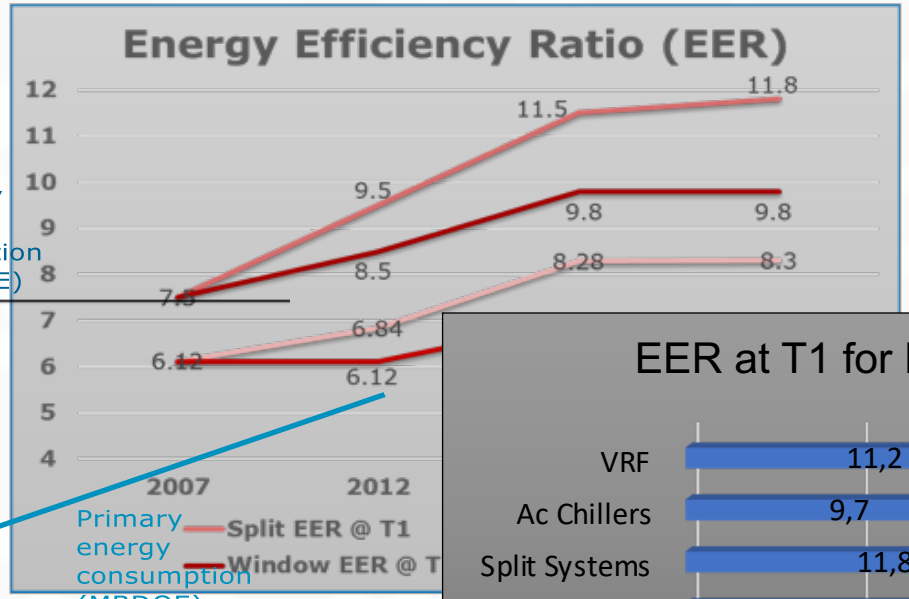
- 20% of the regulated population will automatically comply with any regulation
- 5% will attempt to evade the regulation
- The remaining 75% will comply as long as they think that the 5% will be caught and punished

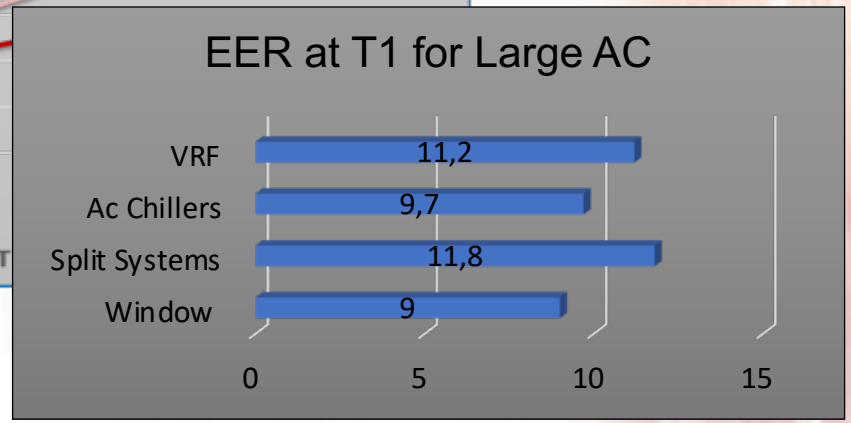
2. Regulations

Saudi Energy Efficiency Programme

Kingdom has seen a steep increase in energy efficiency requirements





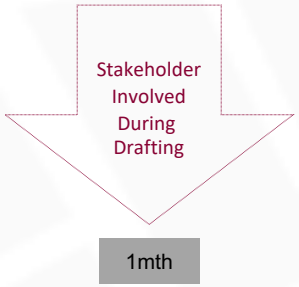


Energy Efficiency and Safety regulations in the UAE

Entity	Product	Regulation	Certificate	Mark/Label
ESMA	Residential Non-Ducted and Commercial HVAC	Minimum Energy Efficiency at T3 for DX and T1 for Chillers Requires (3rd party test or Factory Audit)		 
ESMA	Residential Non-Ducted	Safety compliance with IEC 60335-2-40 requires (3rd party test and RoHS)		 
GSO	Residential Non Ducted	Electro Magnetic Compatibility and Safety as per IEC 60335-2-40 requires (3rd party test)		

2. Regulations

Stakeholder collaboration for smooth implementation



- Define Product: Identify types of model involved based on new technology
- Product Development: Develop new product & design modification
- Conformity Assessment: Include tests according to regulation & certify products
- Set-up Production: Production line preparation/ install new facility

→ **Lead time ranging from 6 – 30 months**

Implementation Lead Time

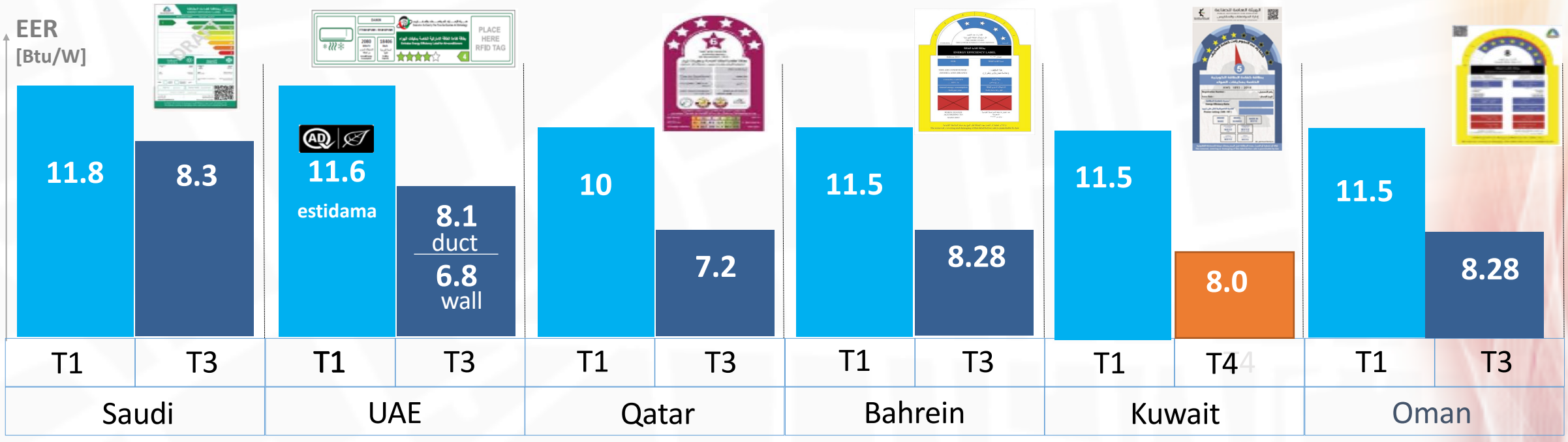
- Essential processes to introduce new product (includes minor changes) to comply with the regulation

GCC Energy Efficiency Requirements for Split AC

The path to unified regulations is a long one

- Different countries, different EER regulations…
- Different EER requirements, at different Temperature conditions
- Different scope of products
- Different energy labels and nameplate requirements

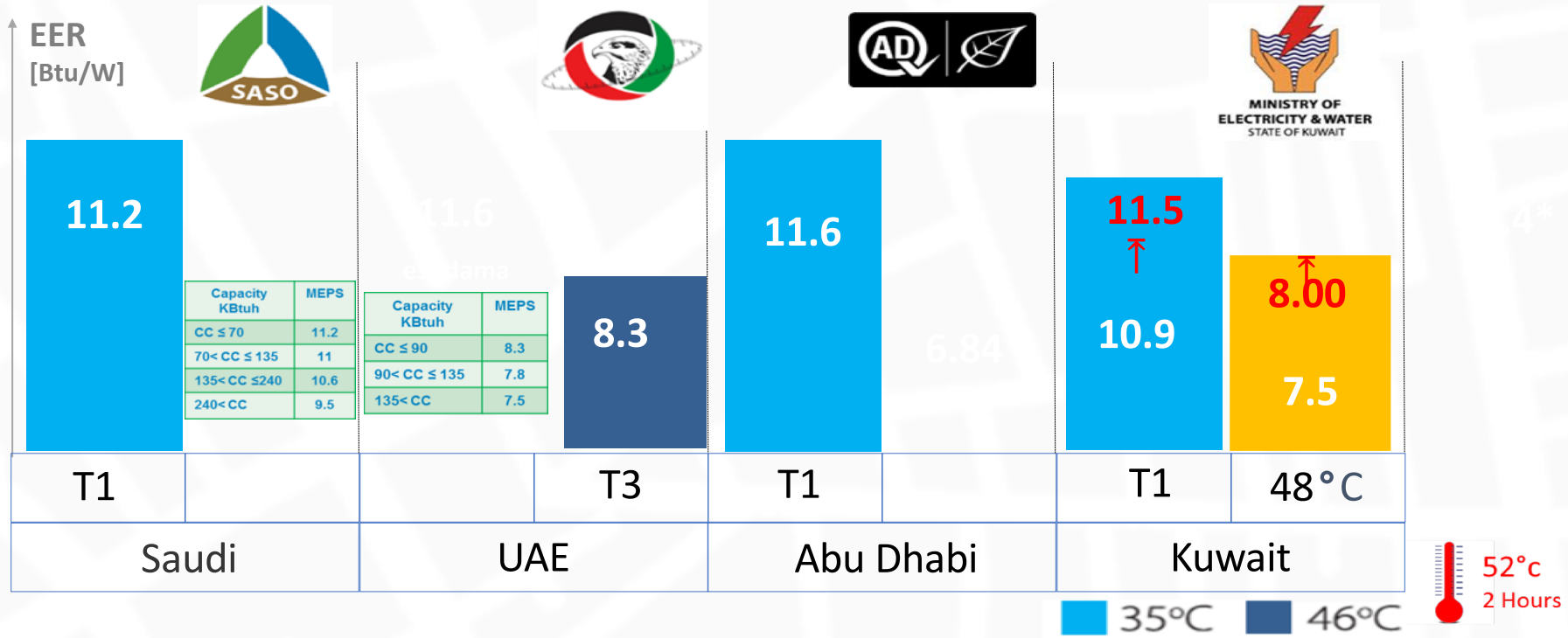
T1 = 35° C
T3 = 46 °C
T4 = 48 °C



GCC Energy Efficiency Requirements for VRF

VRF recognition by the GCC countries

- Different countries, different EER regulations…
- Different EER requirements, but all defined at different Conditions
- Different scope of products
- Different energy labels and nameplate requirements



2. Regulations

VRF testing and certification criteria of acceptance

- Current regulations lacks harmony towards testing standards and certification programs
- VRF multiple combinations requires equal comparison with other category products such as Chillers
- Call for a specific GCC certification program in line with European and US programs but adapted to the local weather conditions
- Current regulations have only one thing in common, they specify Full load EER while the world trend is to use SEER to show part load and seasonal year round performance

VRF Criteria of acceptance by GCC regulation authorities

		Tetsing			Certification	
		AHRI 1230	ISO 15042	EN14511	AHRI	Eurovent
KSA	SASO	x	x		x	
UAE	ESMA		x			
UAE	ADQCC	x	x	x	x	x
KWT	MEW	x	x			

3. From EER to SEER

To measure real, year round efficiency

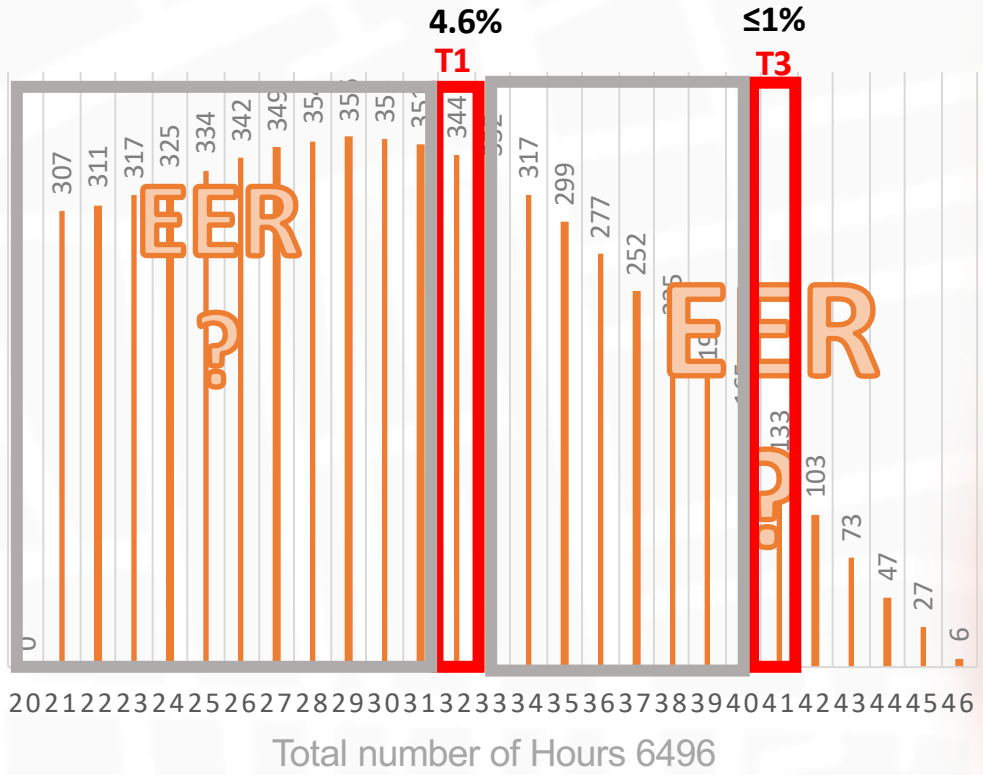
- Current EER measure efficiency at Full load only at 35°C or 46°C
- Full load EER does not consider energy efficiency at lower ambient temperatures with more than 80% of the operation time
- Air conditioning technology trending towards variable speed such as inverters for superior year round part load efficiency i.e. SEER, CSPF
- Regulations tend to increase full load MEPS which does not reflect higher year round total efficiency
- The same issue led to adapt international ISO standards to local weather conditions i.e. India

Country	Weighted EER	Seasonal Performance Factor	
Japan		✓	ISO 16358 base
European Union		✓	EN14825
Turkey		✓	EN14825
GCC		✓	AHRI210/240 or ISO 16358 base
China		✓	ISO 16358 base
Taiwan		✓	ISO 16358 base
India		✓	ISO 16358 base
Vietnam		✓	ISO 16358 base
Thailand		✓	ISO 16358 base
Malaysia		✓ (2019)	ISO 16358 base
Singapore	✓		
Indonesia	✓		
Australia		✓ (2017)	ISO 16358 base
United Stats		✓	AHRI210/240
Mexico		✓	AHRI210/240
Brazil	✓		

3. From EER to SEER

SEER for year round Energy Efficiency Evaluation

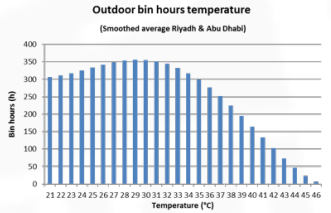
- EER at T1 or T3 does not provide information on the Majority Climatic Zone where the unit is operating most of the time
- We need to evaluate SEER for both Fixed and Variable speed air conditioners at all the weather conditions where cooling is required
- Calculation needs to consider High Ambient Hot Climate T3 Climatic Zone
- ISO 16358 is the reference method for T1 has been adapted to T3 climate conditions. Standard to be released.



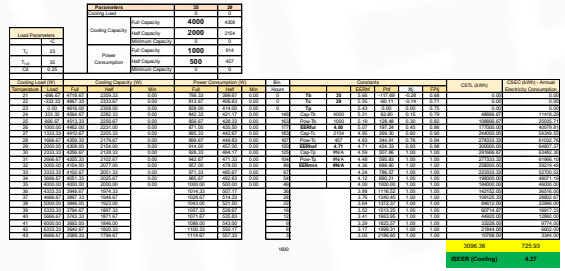
3. From EER to SEER

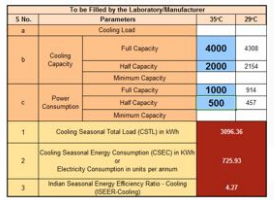
Using ISO 16358 for the T3 condition

- ISO16358-1(CSPF*) is a calculation method which can evaluate the performance in actual use for Fixed, Multi Stage and Variable speed air conditioners
- Testing conditions as per ISO 5151, ISO 13253 and ISO 15042 at T1 and T3 conditions
- Testing points at T1 and T3 Full Capacity and T1 Half Capacity
- Calculation method using hot climate weather bin based on an average between Riyadh and Abu Dhabi climates and could be customized for a specific city weather bin



T3 Weather bin for CSPF calculation





India ISEER Calculation tool

19 September 2018

EUROVENT MIDDLE EAST

HVACR Leadership Workshops

Conclusion

- AC energy efficiency is an important contributor to the UN 17 Sustainable Development Goals
- Energy efficiency improvements help mitigate climate change and global warming
- MEPS regulations and labeling programs help shift the market towards higher efficiencies
- GCC regulations revisions need to involve the Stakeholders to be fairly applicable and efficient
- Air conditioning variable speed trends can play an important role in achieving energy efficiency and carbon reduction targets
- We call for a gradual move from EER to SEER for the T3 condition demonstrate the real year round energy efficiency and savings

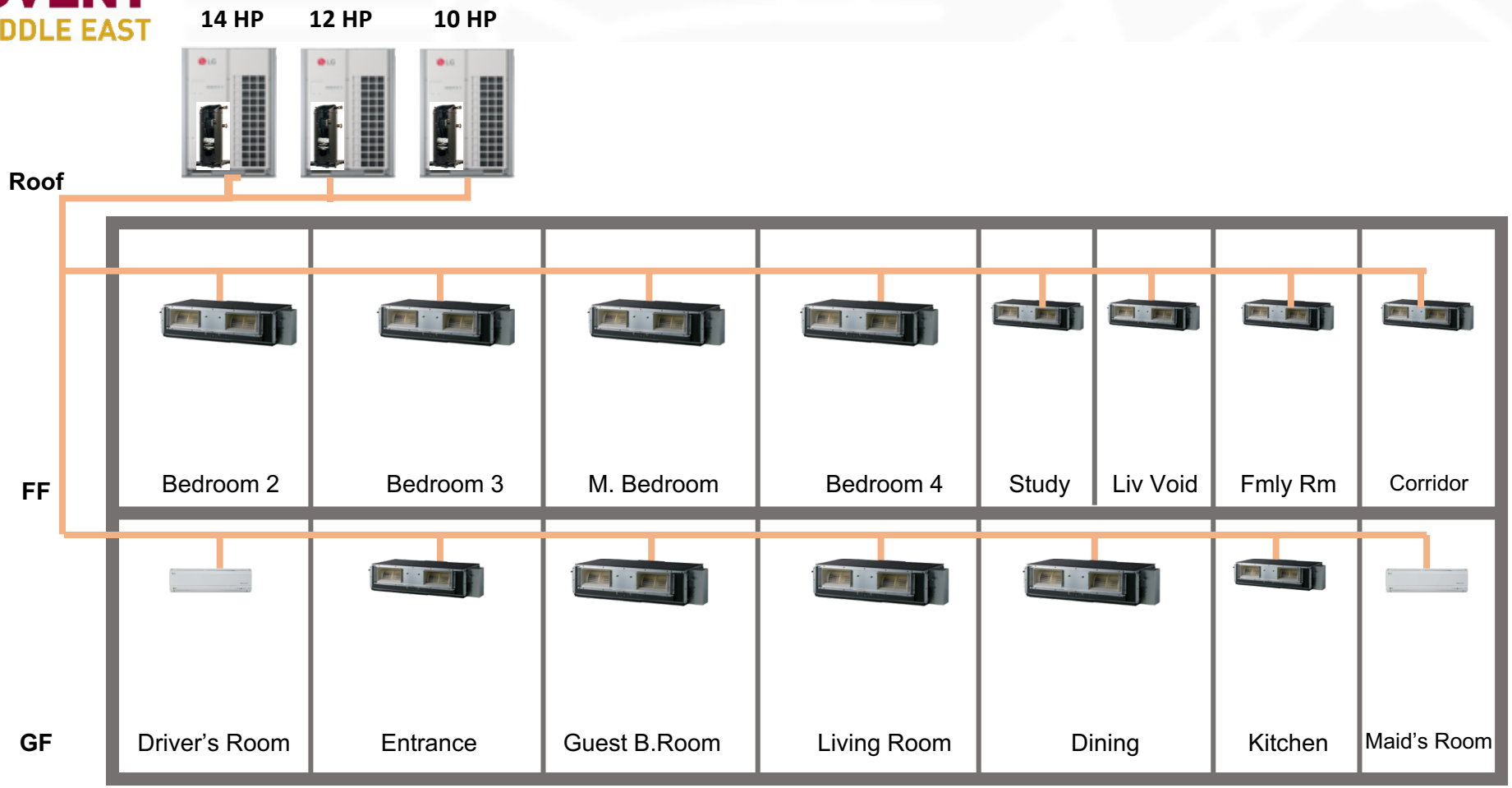
VRF in Residential Applications

Dharmesh Sawant

Senior Manager

LG Electronics

VRF Schematic Layout
Villa Type 2A



- Majority of the high-end luxury projects use VRF system in order to comply with DM Green Building Guidelines.
- Independent control of AC units.

- Illustrative purpose only.
- The actual layout varies with this layout

Key concerns and solutions for tenants

Key factors in AC selection

1) AC system inline with the image of the Project

Innovative and sustainable AC system

2) Tenant Asset – Longevity of AC

Tropical weather (Dust clogging) leads to higher operating cost and reduced life

3) Comfort condition

Precise control of latent load
Non stop cooling even at 55 deg C.

Key factors in AC selection

4) Close proximity to sea

Corrosion leading to higher replacement cost

5) Lower operating cost

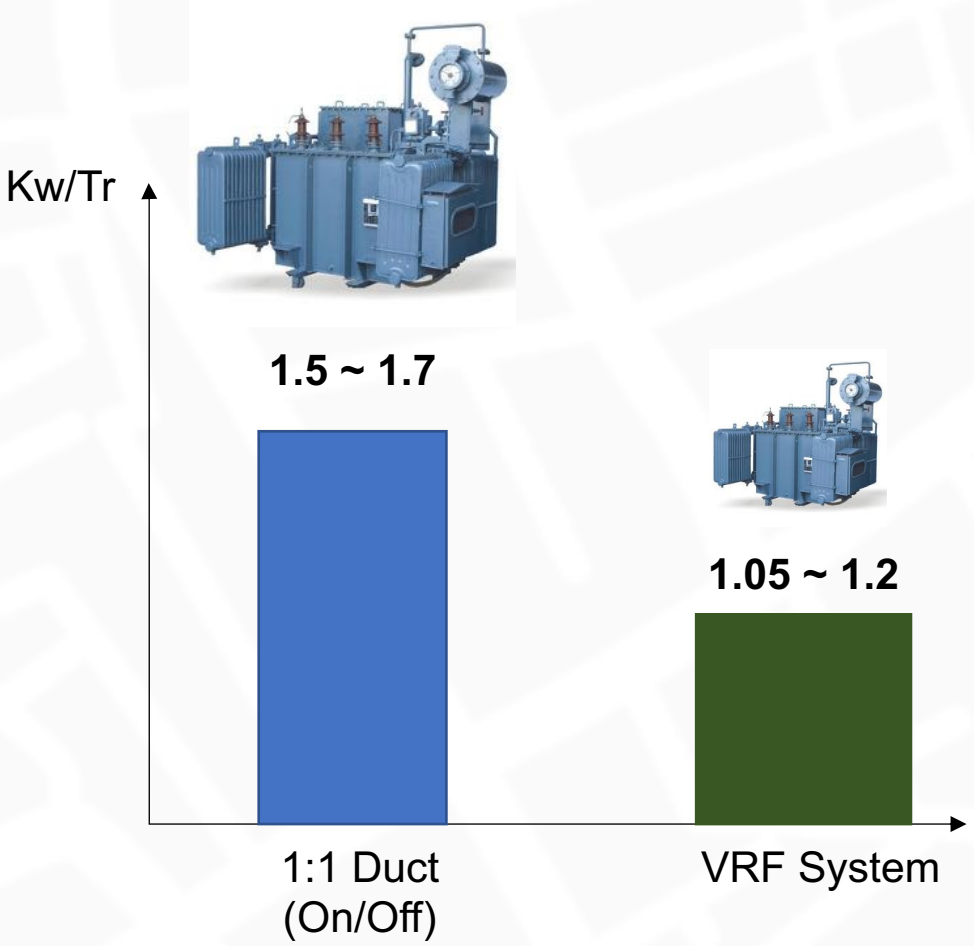
Sustainable future and peace of mind for tenants

6) Peace of mind during operation

Redundancy or continuous cooling

VRF systems stand out as a BETTER CHOICE.

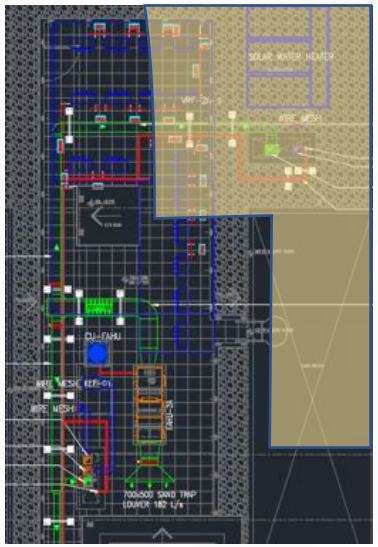
VRF offers lower connected load



- All inverter compressor
- Control of superheat, suction & discharge pressure, sub-cooling
- Reduction in transformation leading to lower connection fees
- Complies with Trakhees, Estidama, ESMA and SASO Regulations

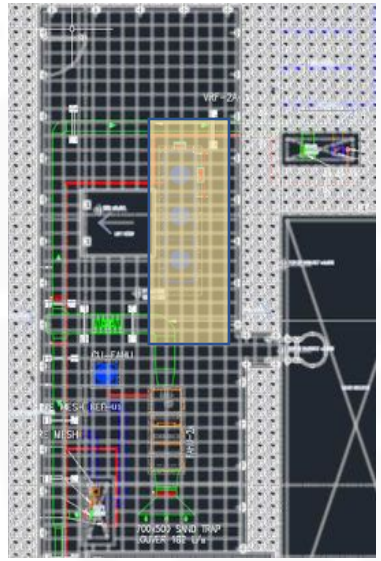
VRF saves valuable roof space

DX Split System



- Roof congested with AC ODUs
- Roof space occupied by AC – 260 Sq ft
- Total No. of ODU – 16 Nos.
- Difficult and expensive to maintain

VRF System

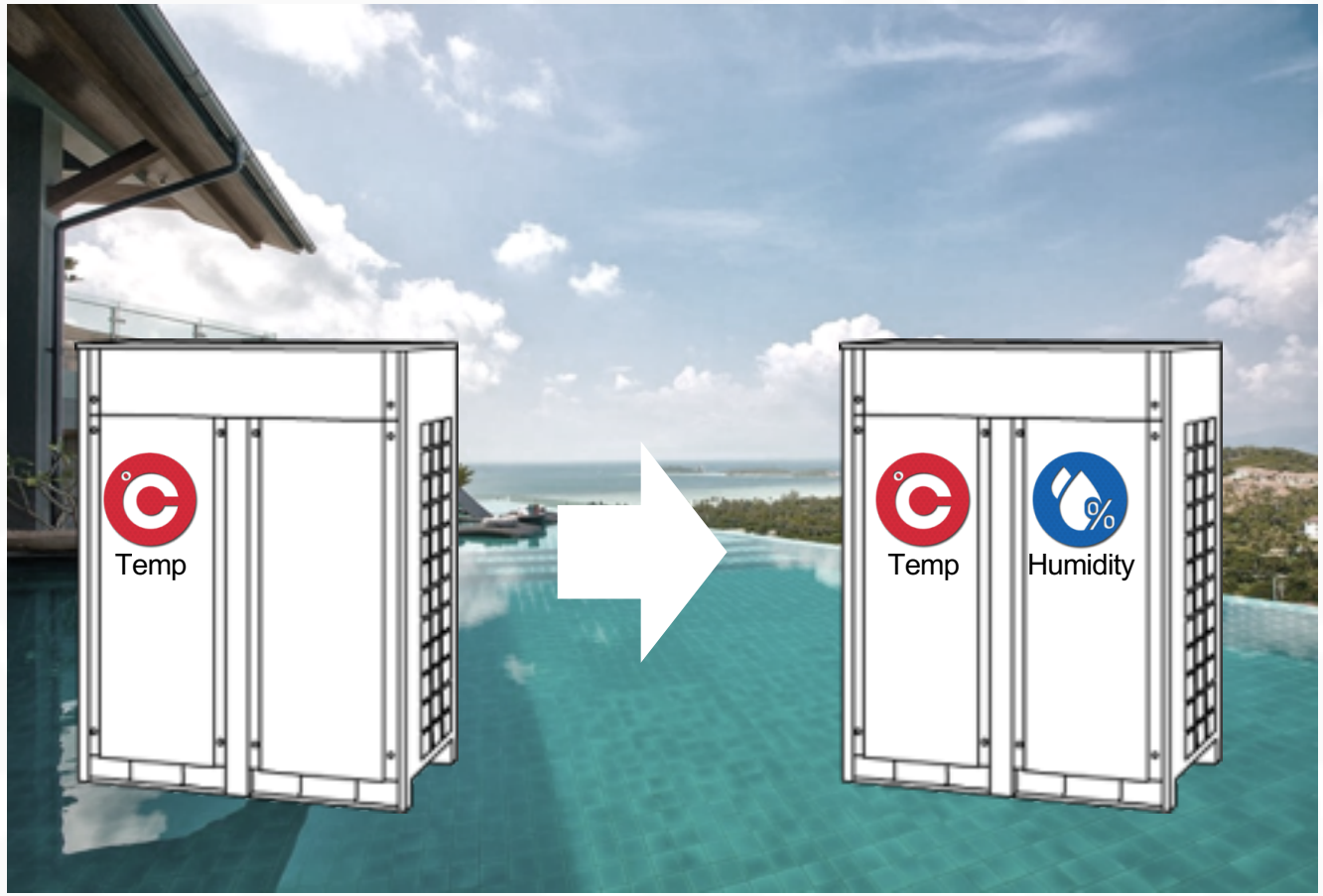


- Neat roof layout, leaves space for other utilities through reduced footprint
- Roof space occupied by AC – 80 Sq ft
- Total No. of ODU – only 3 Nos.

VRF enhances life of the condenser

- Maintains the condenser coil relatively cleaner for better heat transfer.
- Lower operating cost due to cleaner coil.
- Lower capacity deration in harsh climatic condition (Dust storm)

VRF offers faster latent load control



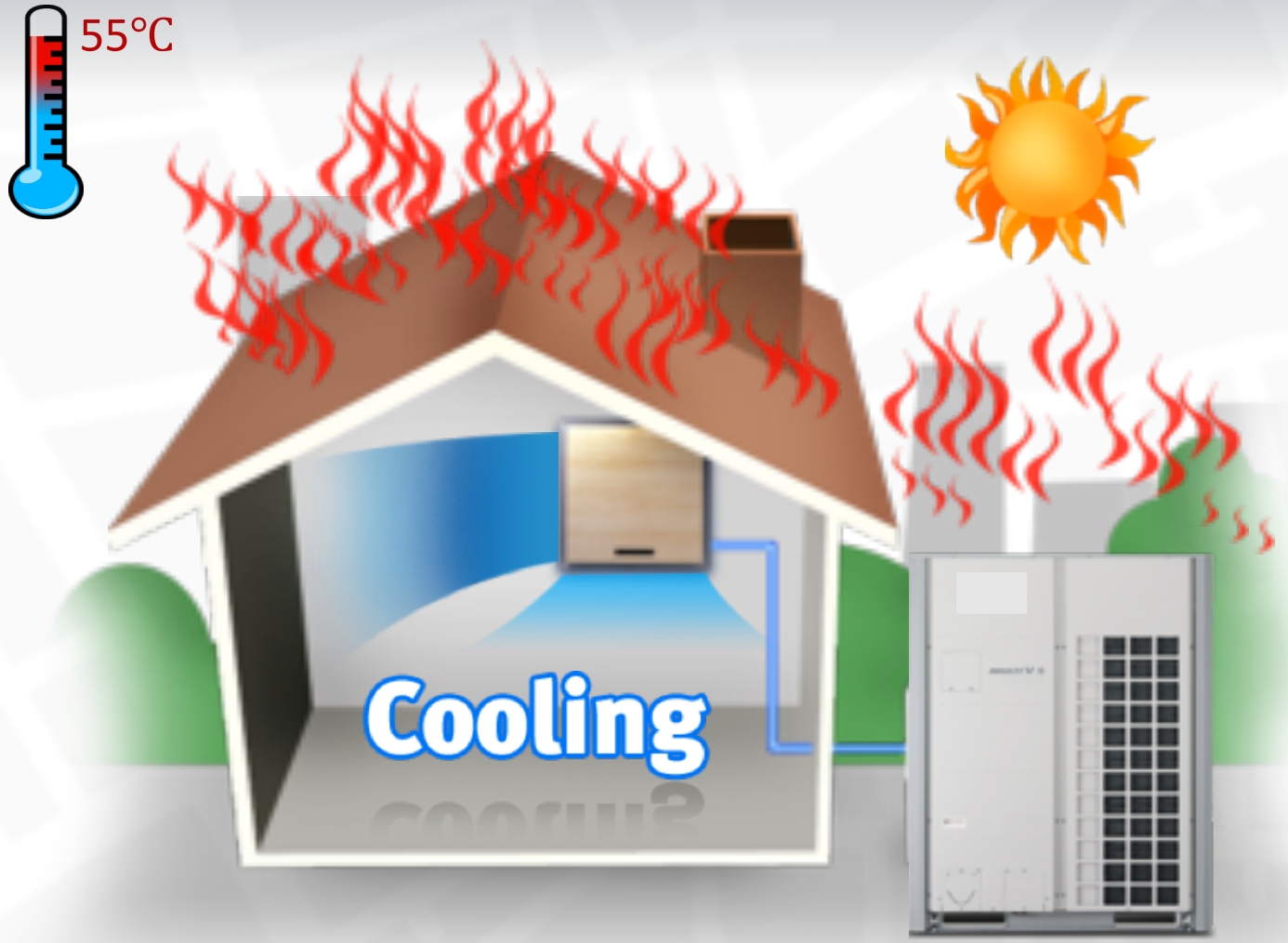
- Latent load a major concern in coastal area.
- Conventional 1:1 has only temperature sensor
- Some VRF system has dual sensing of Temp and Humidity
- Setting of evaporation based on temp / humidity.

VRF offers faster latent load control

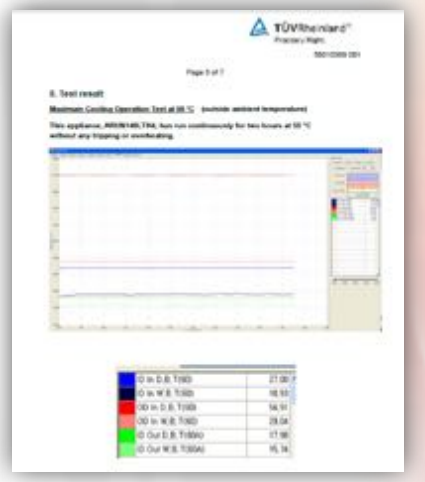
- Uncomfortable Environment
  - sets evaporation temp based on temperature sensor only.
  - slower in meeting latent load

- Comfortable Environment
  - sets lower evaporation temp based on humidity sensor also.
  - Faster latent load.

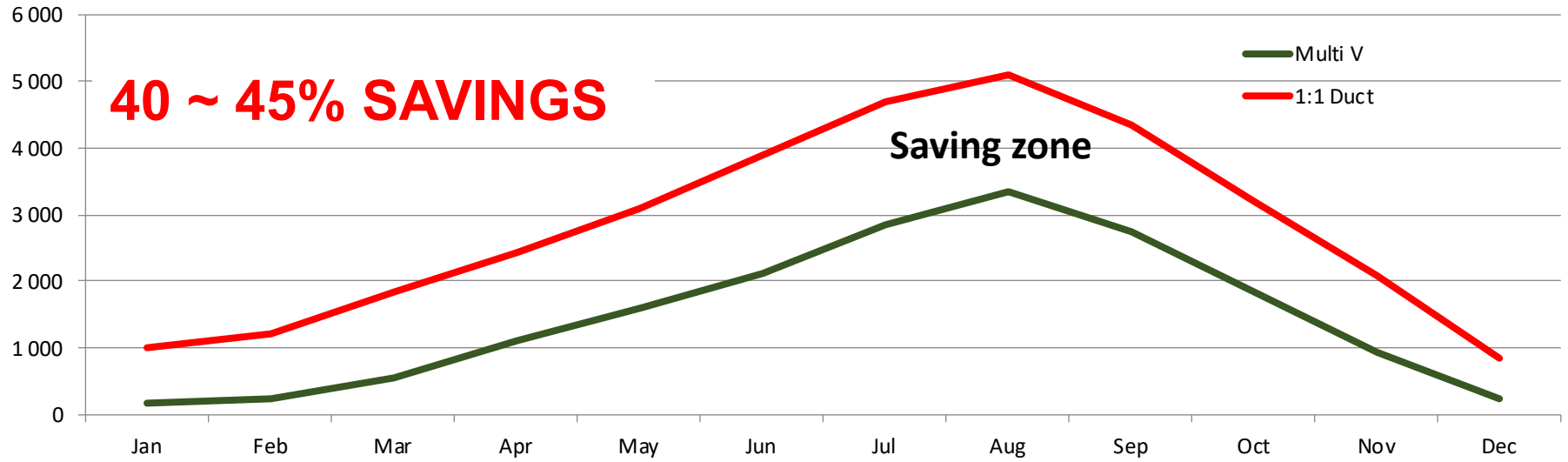
Wide range of operation / cooling at 52℃ or higher



3rd Party Test certificate verifying performance at high ambient temperatures



VRF offers higher saving in OPEX

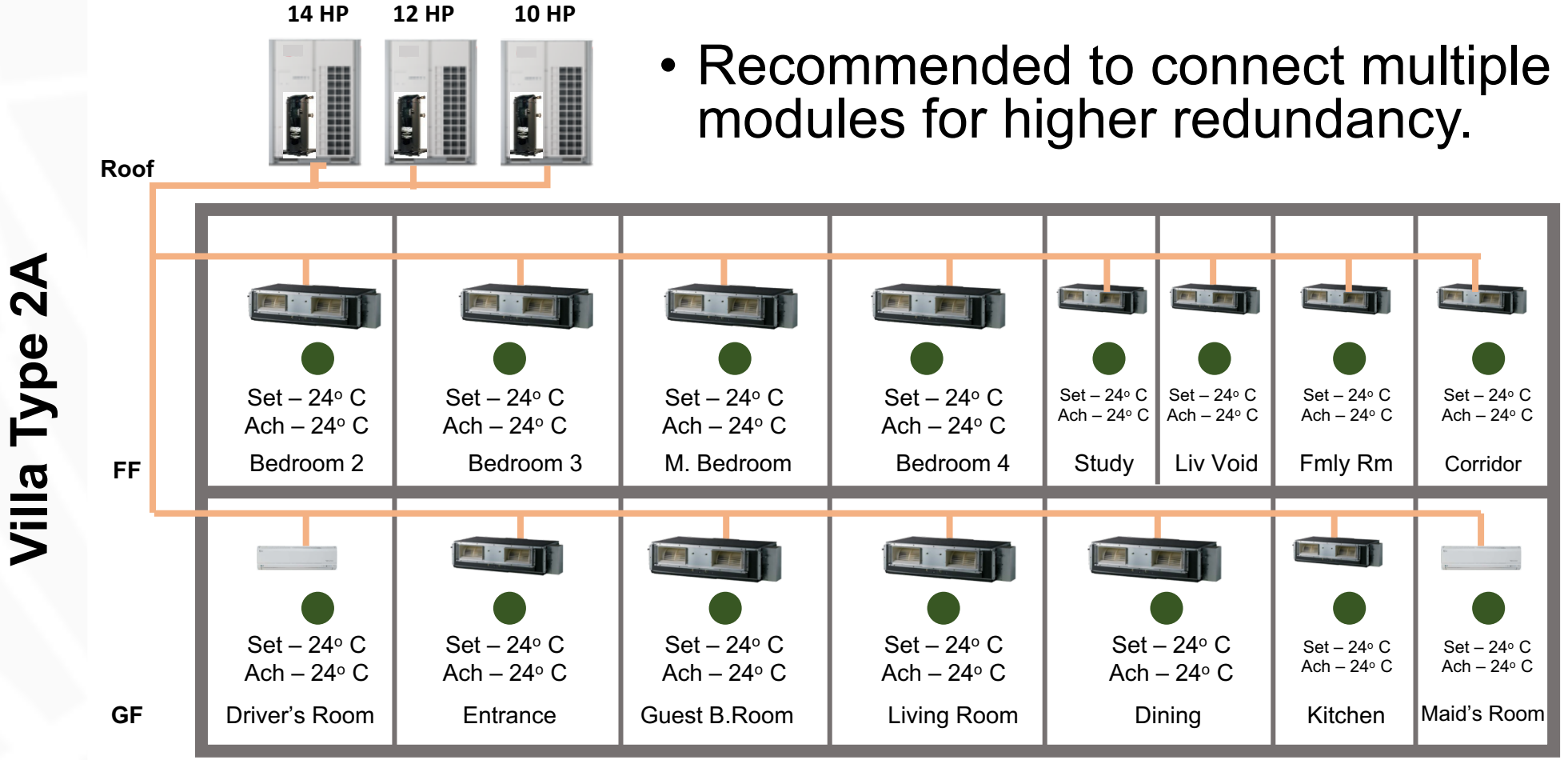


AC System	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly
VRF	176	232	569	1,125	1,599	2,124	2,840	3,348	2,762	1,850	950	236	17,811
Ducted Split	1,000	1,200	1,850	2,447	3,105	3,903	4,690	5,100	4,350	3,200	2,100	850	33,794

All values in AED

Comparison of Electricity bill

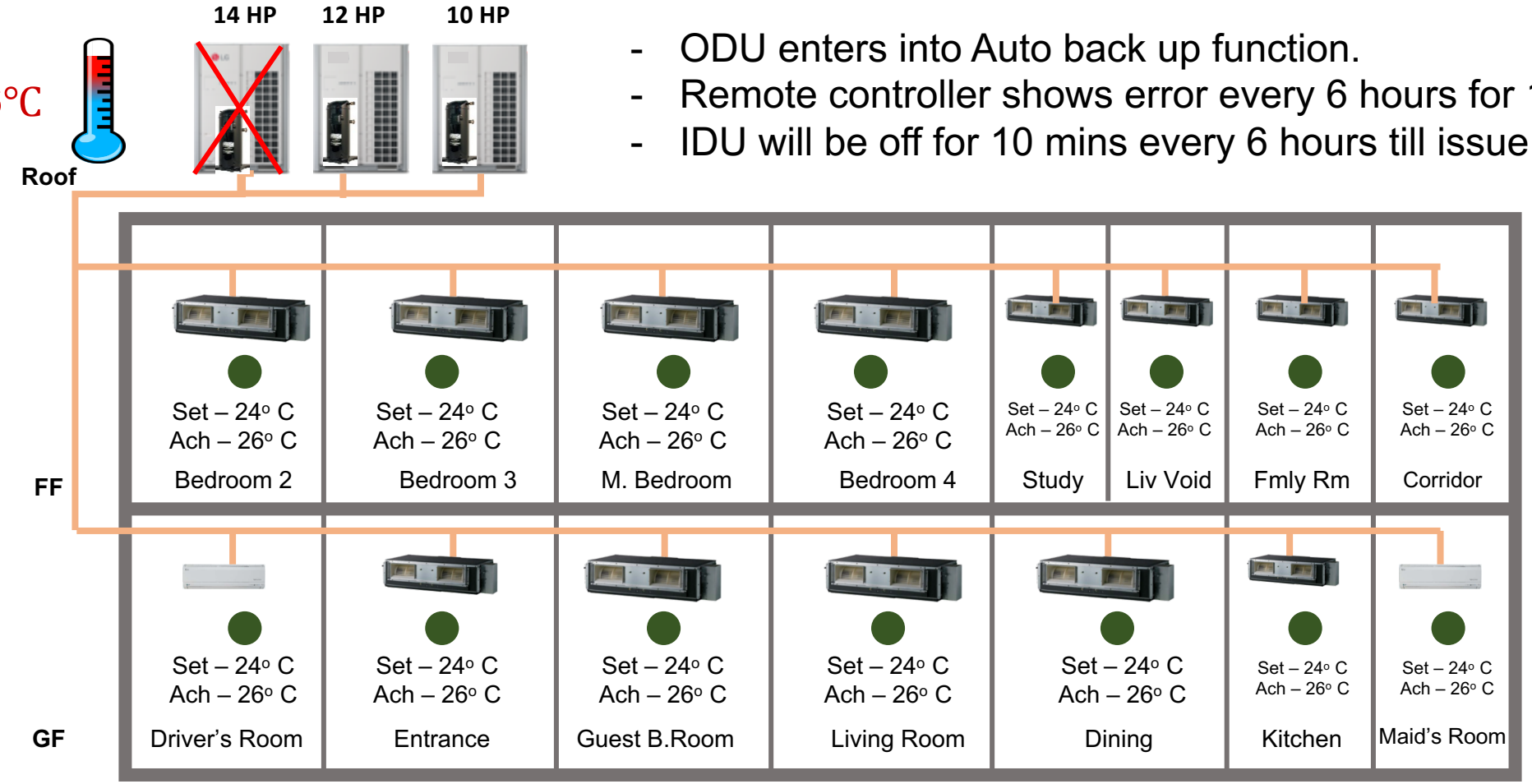
VRF offers higher redundancy



- Recommended to connect multiple modules for higher redundancy.

- Illustrative purpose only.

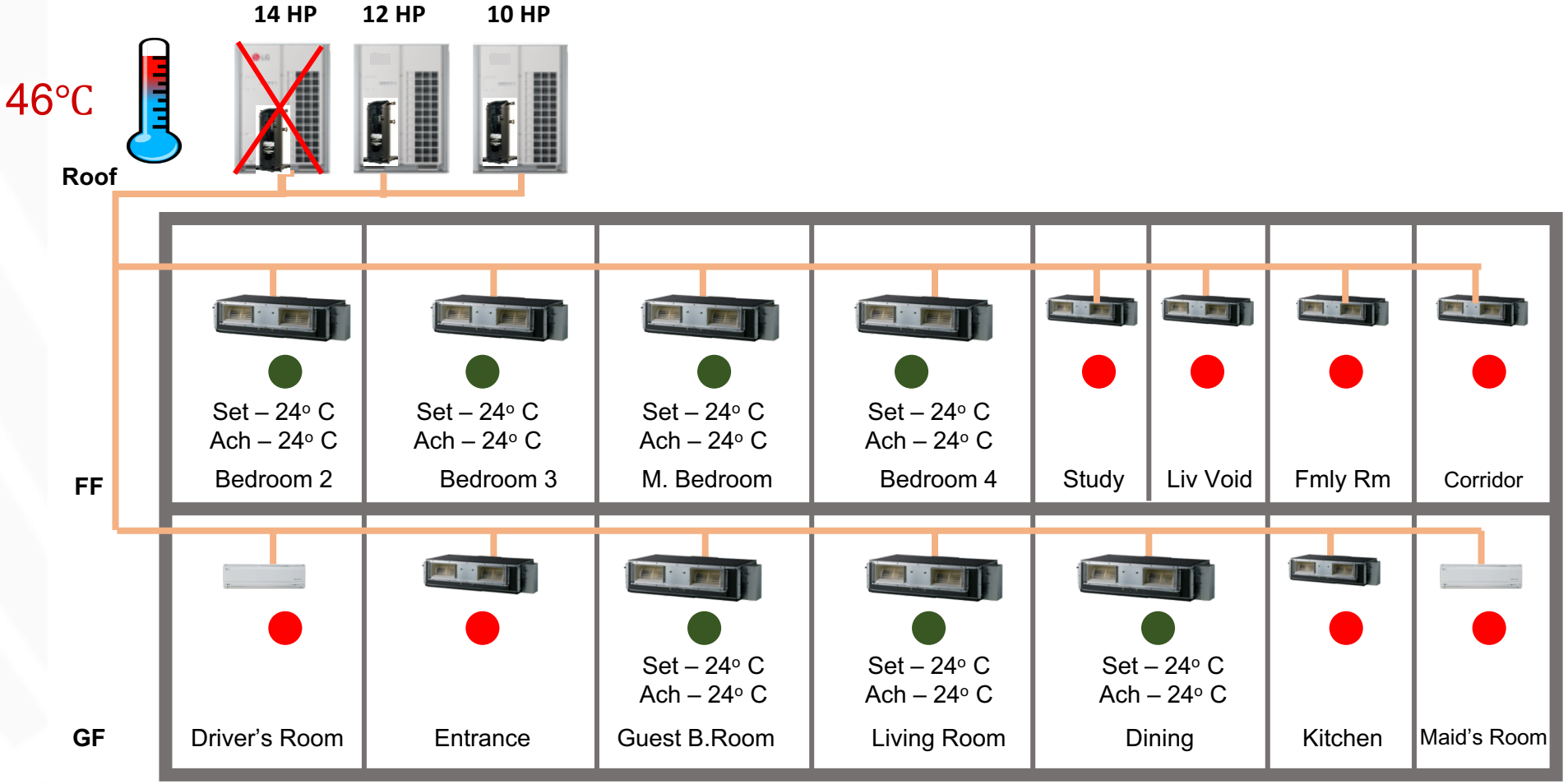
• Scenario 1 – Failure of one module, but all IDU in operation.



- ODU enters into Auto back up function.
- Remote controller shows error every 6 hours for 10 minutes.
- IDU will be off for 10 mins every 6 hours till issue resolved.

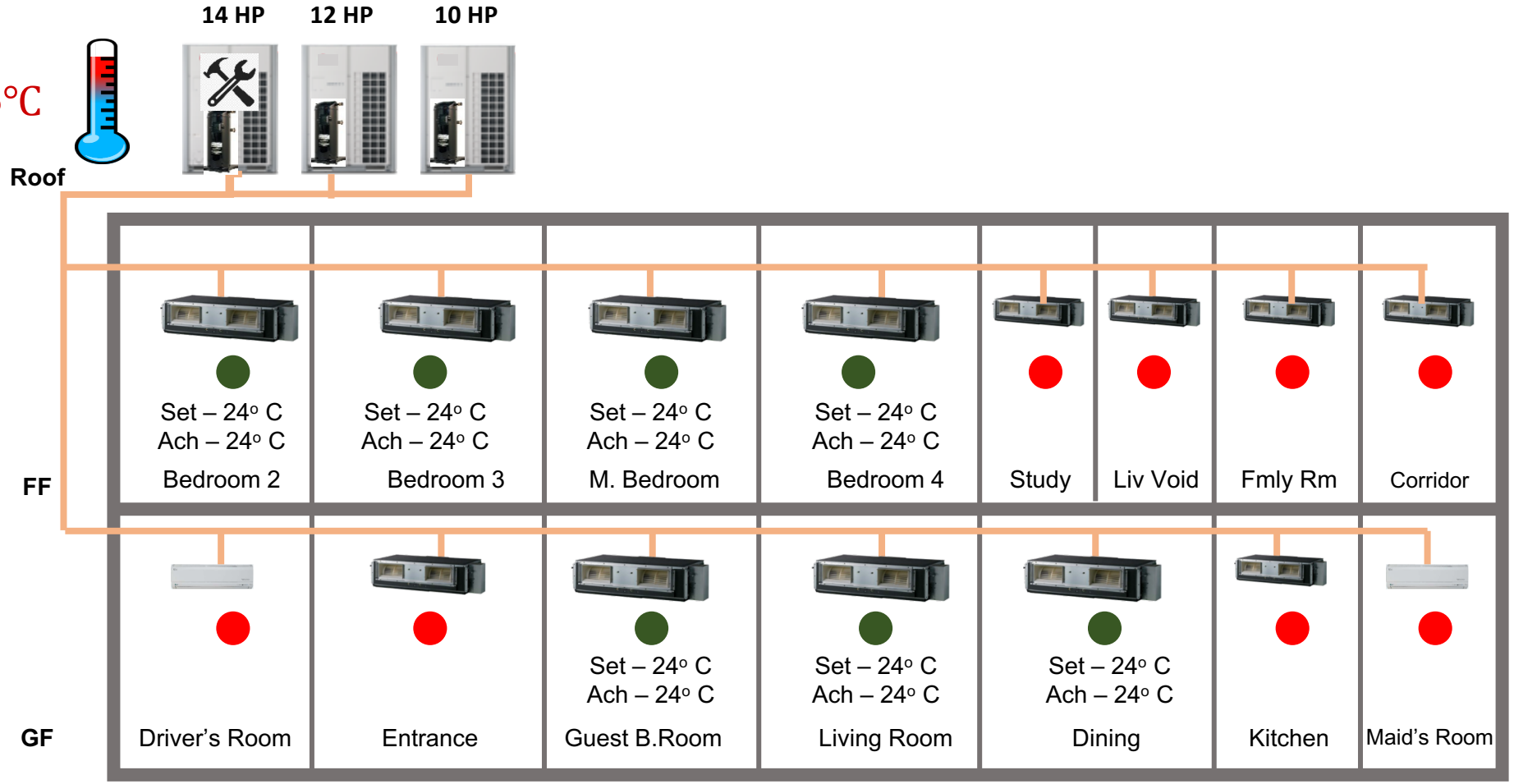
- Illustrative purpose only.

- **Scenario 2 – Failure of one module, but needs full load in critical area.**



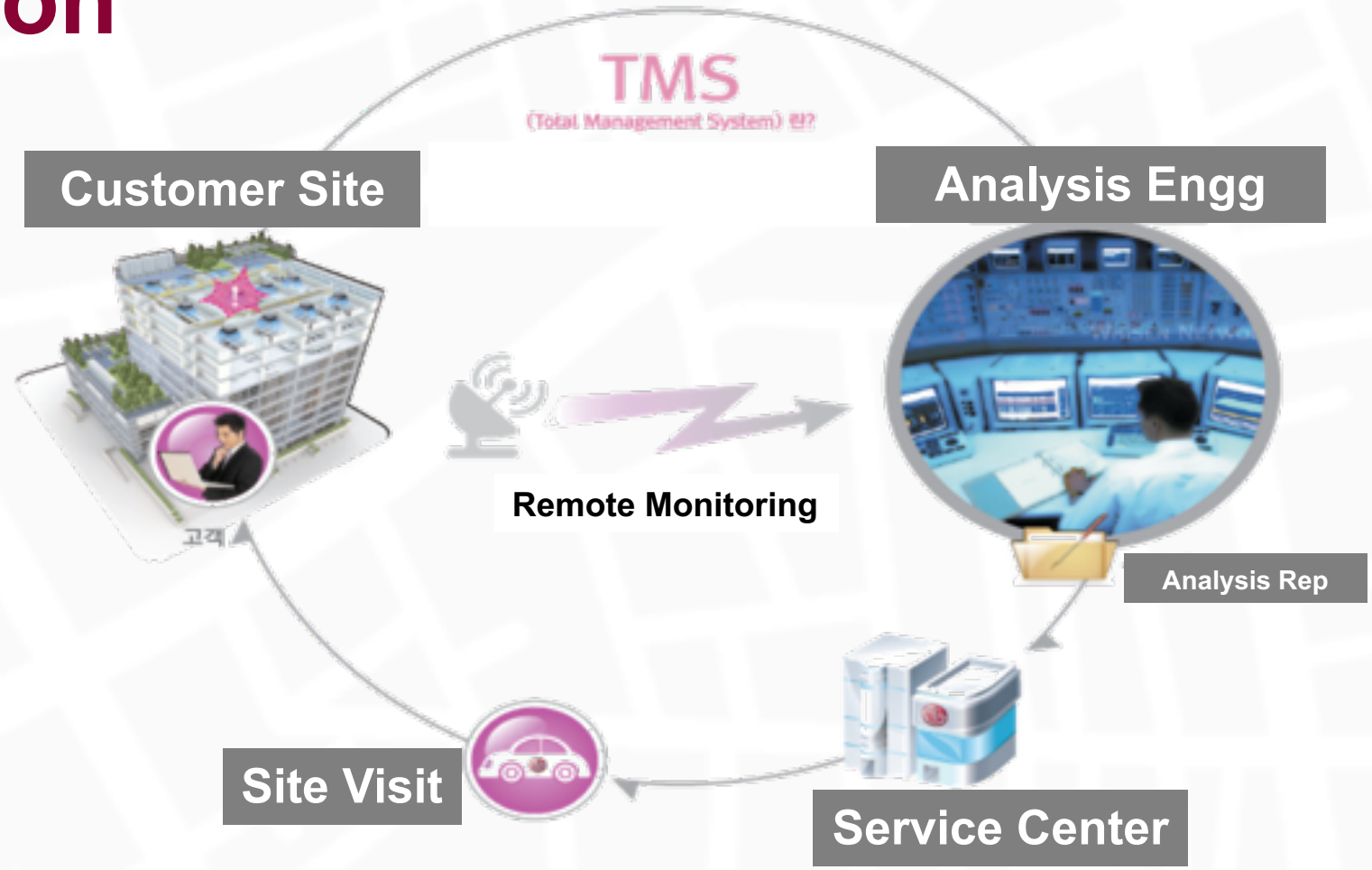
- Illustrative purpose only.

- **Scenario 3 – During repair of one module needs full load in critical area.**

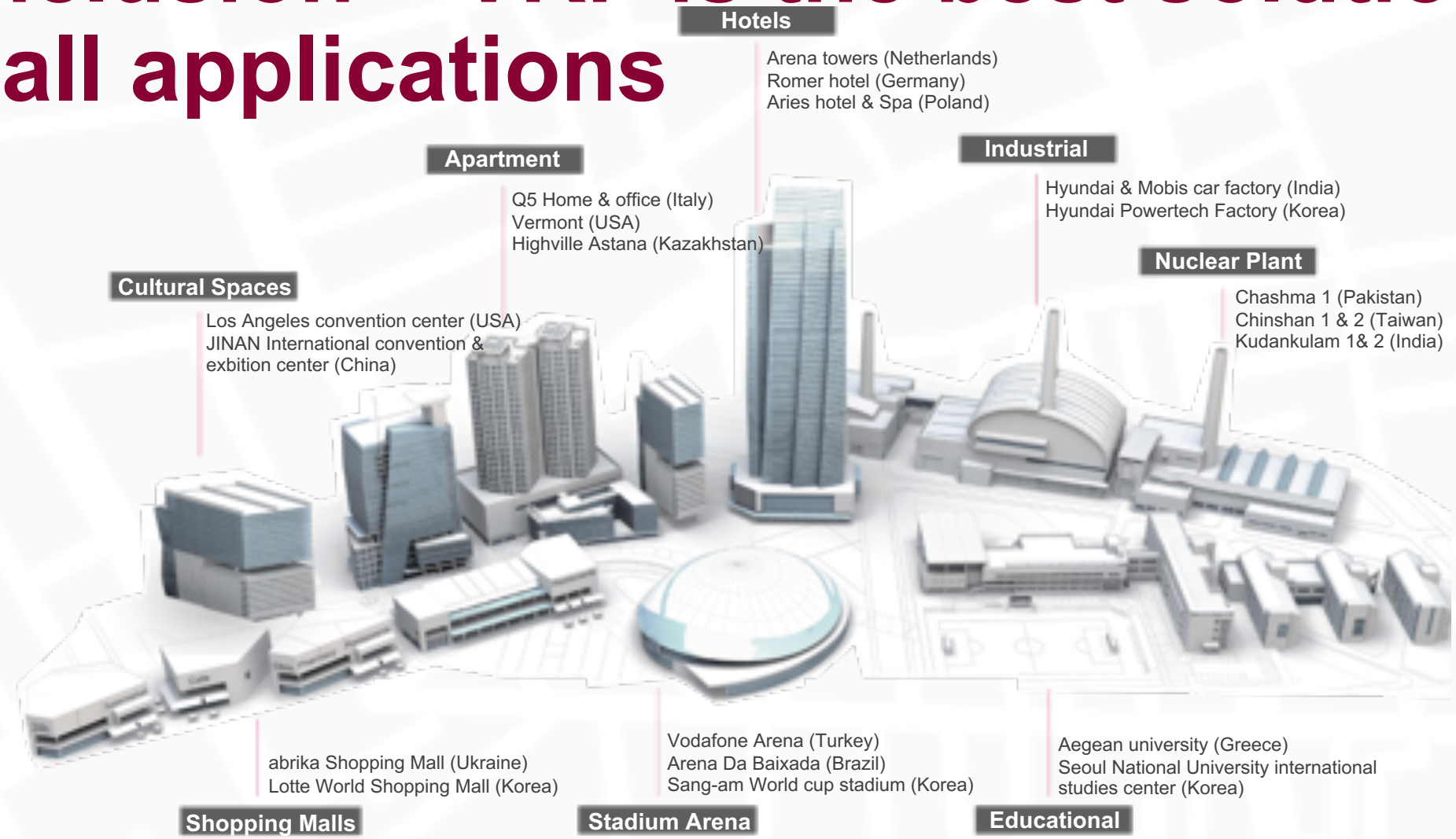


- Illustrative purpose only.

Ease of service through cloud based solution



Conclusion – VRF is the best solution for all applications



VRF for Retrofit Applications

Peck Zhao

Overseas Marketing Manager

Midea Commercial Aircon

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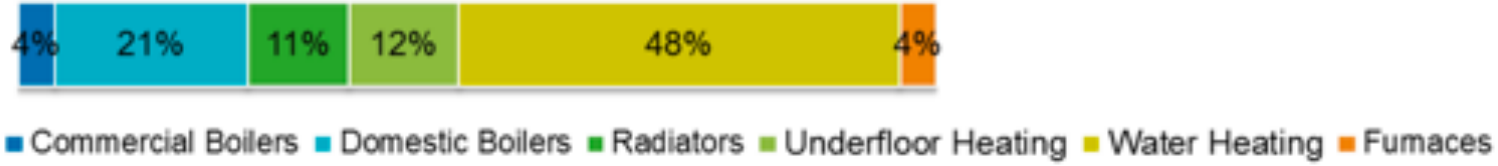
HVACR Market Overview

The World Air Conditioning market by type of product in 2017(e)

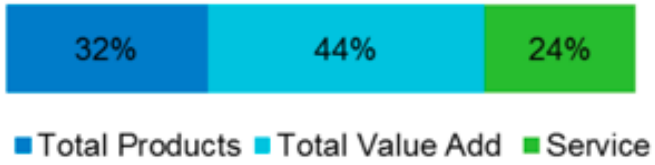
100+ bln USD

The World Heating market by type of product in 2017 (e)



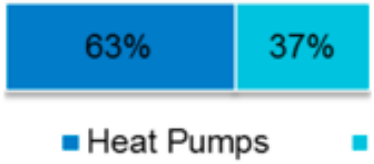
60+ bln USD

The World BACS market in 2017 (e)



30+ bln USD

The World Renewables market by type of product in 2017 (e)



20+ bln USD

HVAC market overview

World AC market by value in 2017 (USD 103 Billion/5% growth

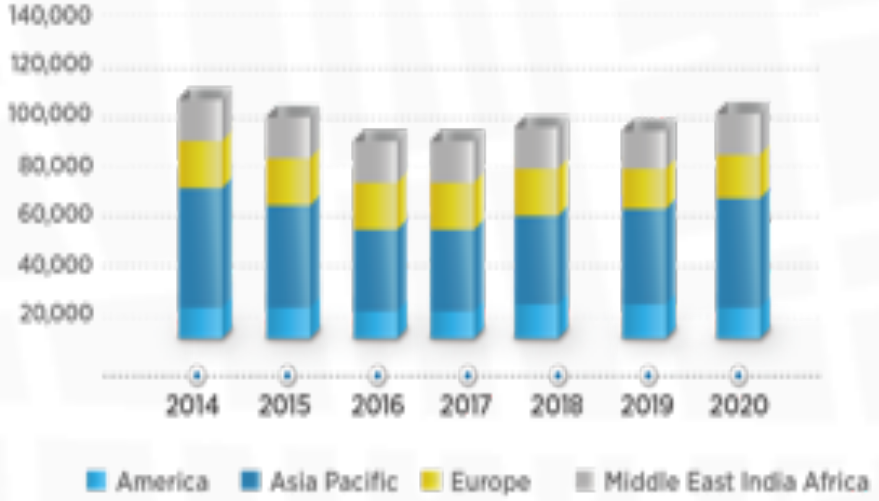
World Air Conditioning Market from 2014 to 2020

Total Units in 2017

128 million

Total Value in 2017

USD 103 billion



Source: The Building Services Research and Information Association (BSRIA)

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HVAC market overview

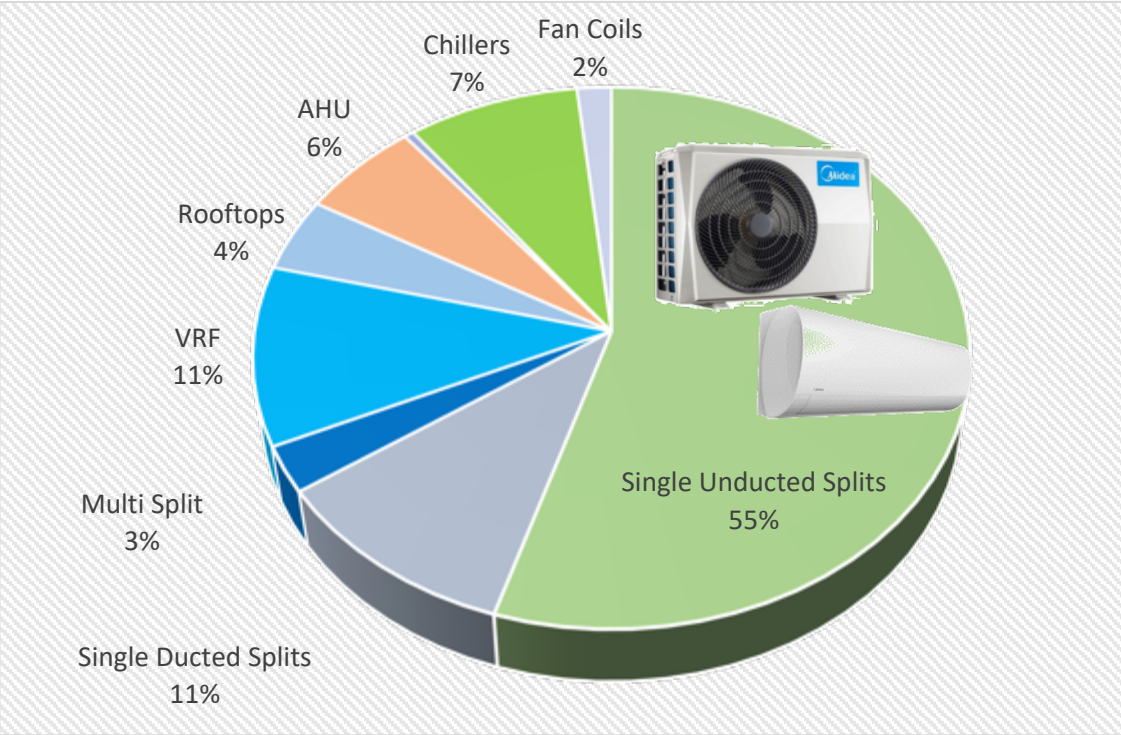
Key countries

Ranking	Country	Trend	Market Value USD m	Market growth % 16-17
1	China	↑	34,000	+ 21%
2	USA	↗	16,650	+ 7%
3	Japan	↗	13,904	+ 4%
4	S. Korea	↑	3,875	+ 44%
5	India	↗	2,600	+ 7%
6	Australia	↑	1,600	+ 28%
7	Italy	↓	1,395	- 7%
8	Saudi Arabia	↓	1,270	- 3%
9	Germany	↗	1,162	+ 3%
10	Turkey	↑	1,055	+ 17%
11	France	↗	1,015	+ 6%
12	Spain	↑	990	+ 10%

Source: BSRIA

HVAC market overview

Global AC sales breakdown by product (2017)



Product Category	Market Share
VRF	11% (11 $bn)
Chiller	7% (7.5$bn)
AHU & FCU	8% (8 $ bn)
Ducted Splits (Including US ducted))	11% (10 $bn)
Rooftops	4% (4 $bn)
Total CAC	30% - 40%, 40 US$ billion

Source: The Building Services Research and Information Association (BSRIA)

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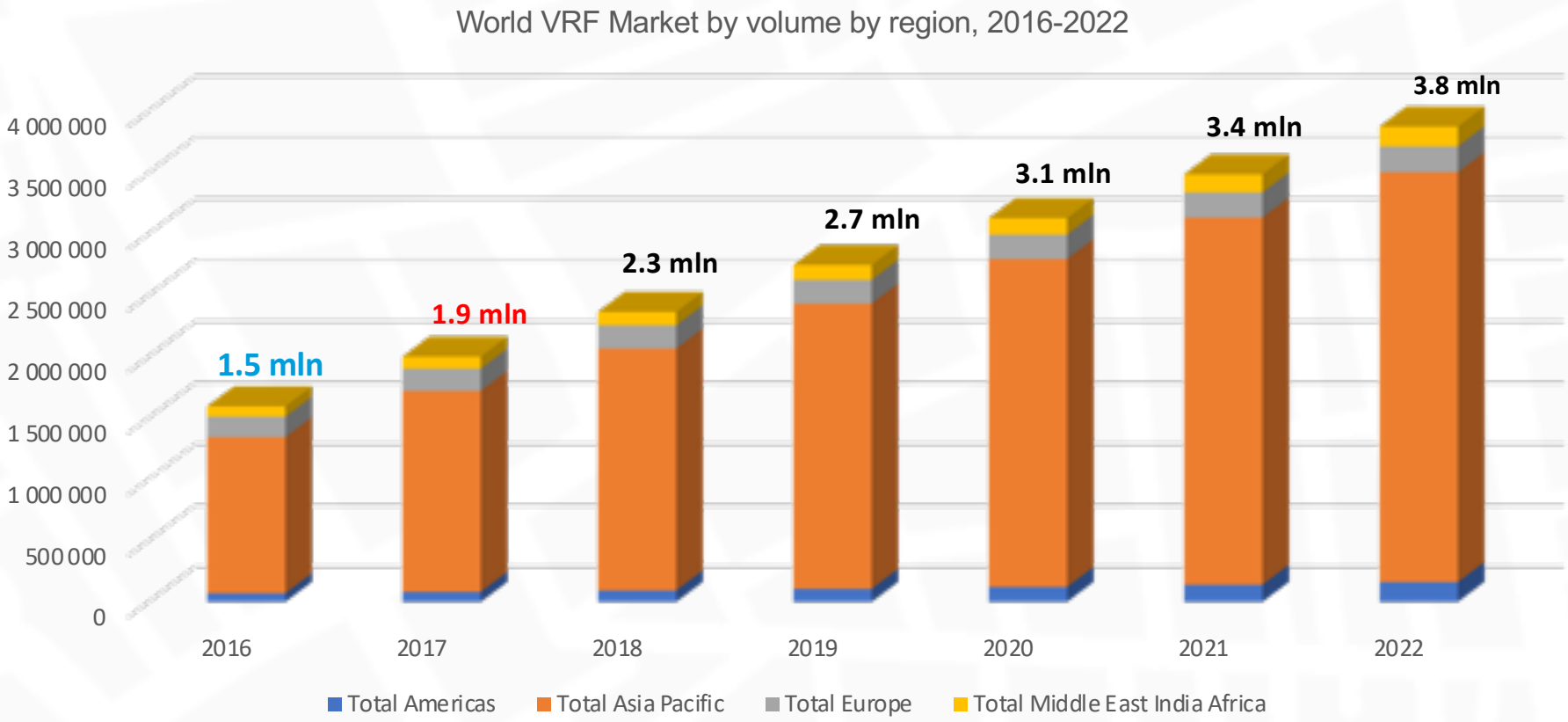
HVAC market overview

World VRF 1.9 VRF ODUs, 11+ bln USD



by 2022

+ 11.4%

20 US$ billion VRF market

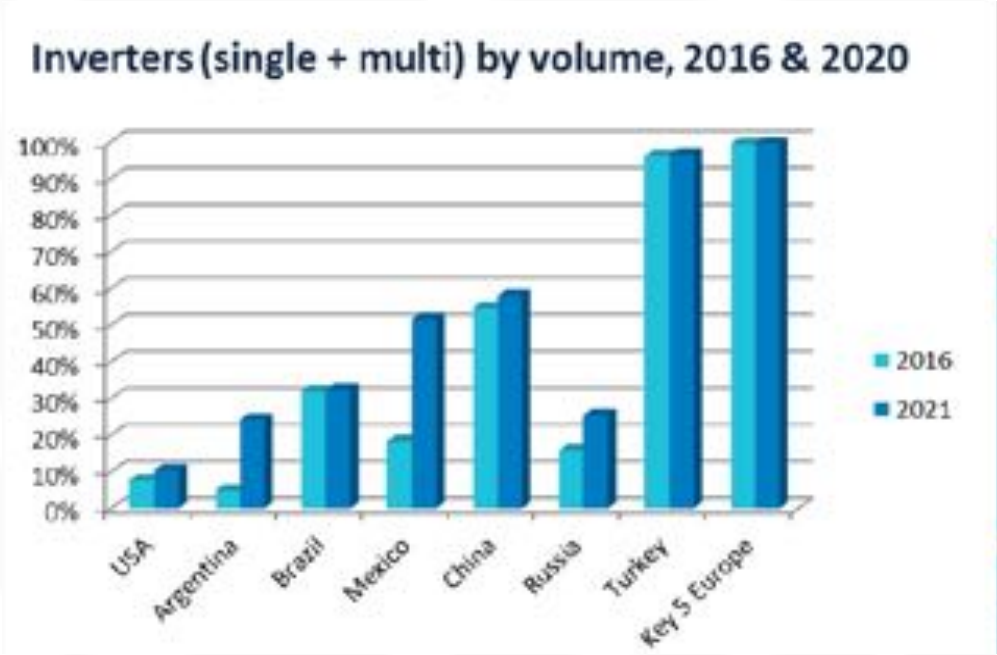
Vs.

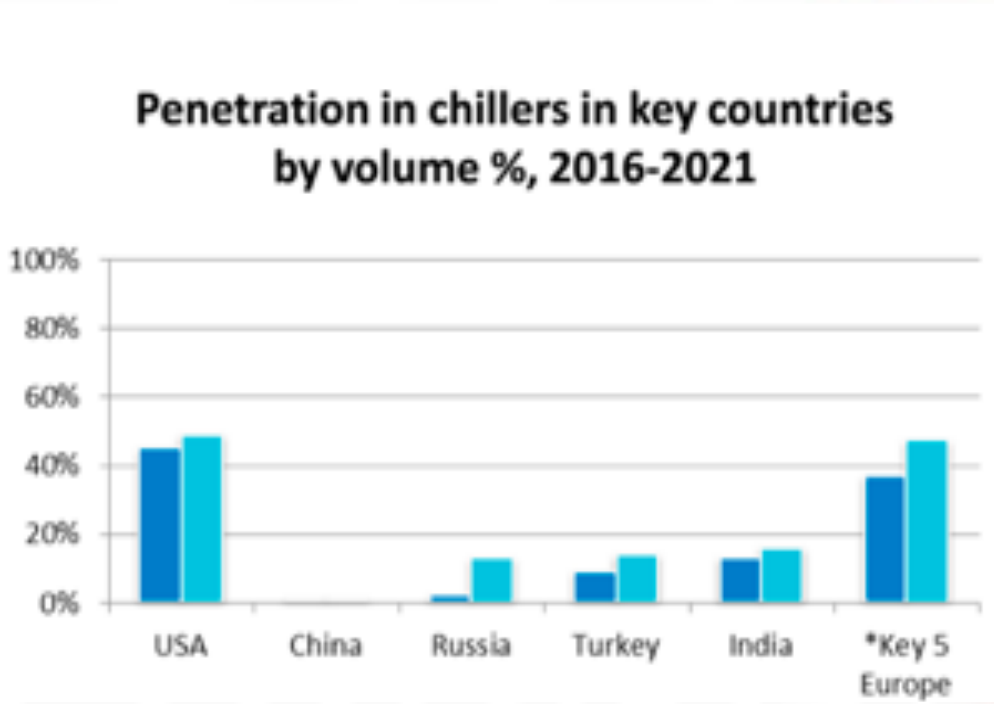
+ 3%

Global GDP

Inverter popularity in the market is increasing

Inverter DX split and chillers





50% + of Air Conditioners are inverter driven

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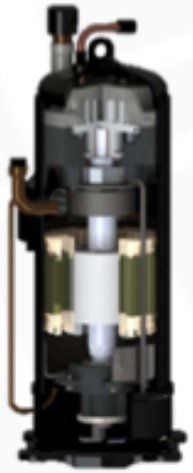
Inverter & VRF

Before

6HP
36KG
502mm

Now



18HP
39KG
539mm

Before

32HP

Now

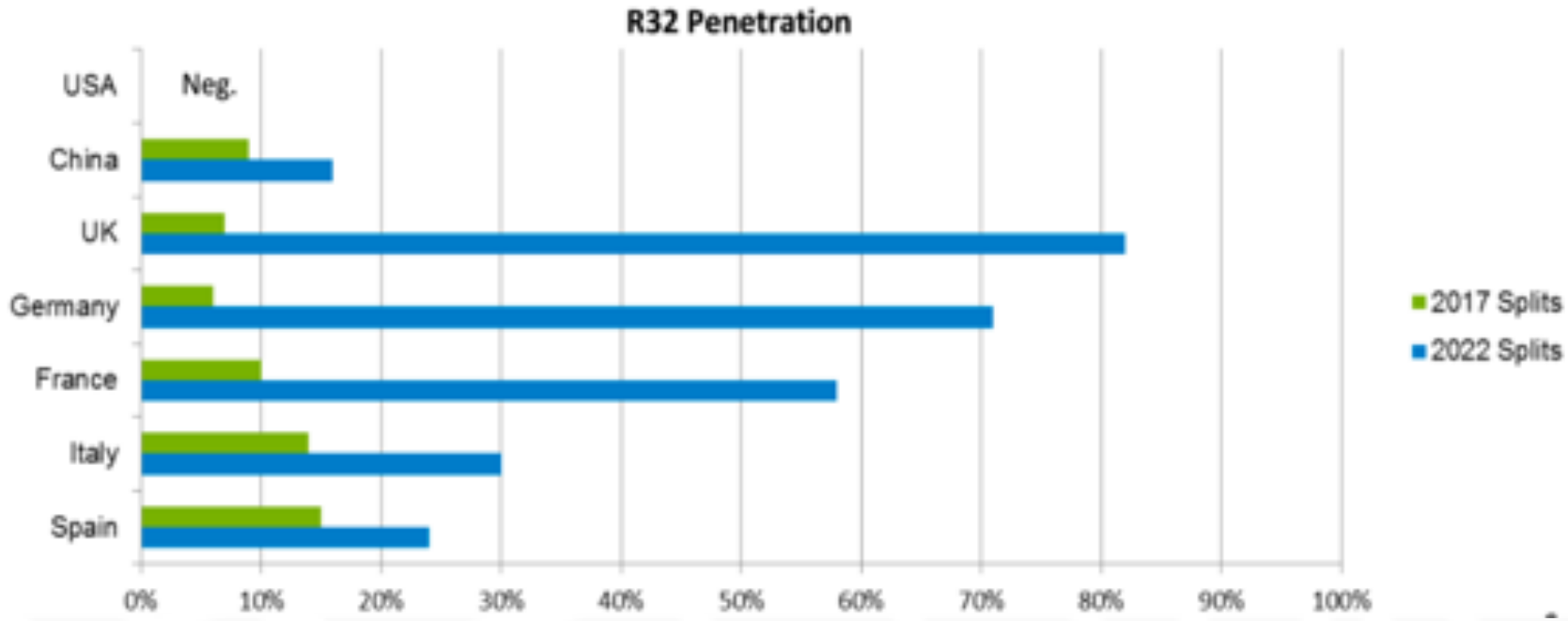
32HP

Inverter makes the VRF more powerful with smaller size

AC Global Trends

Market drivers and restraints

AC Global Trends



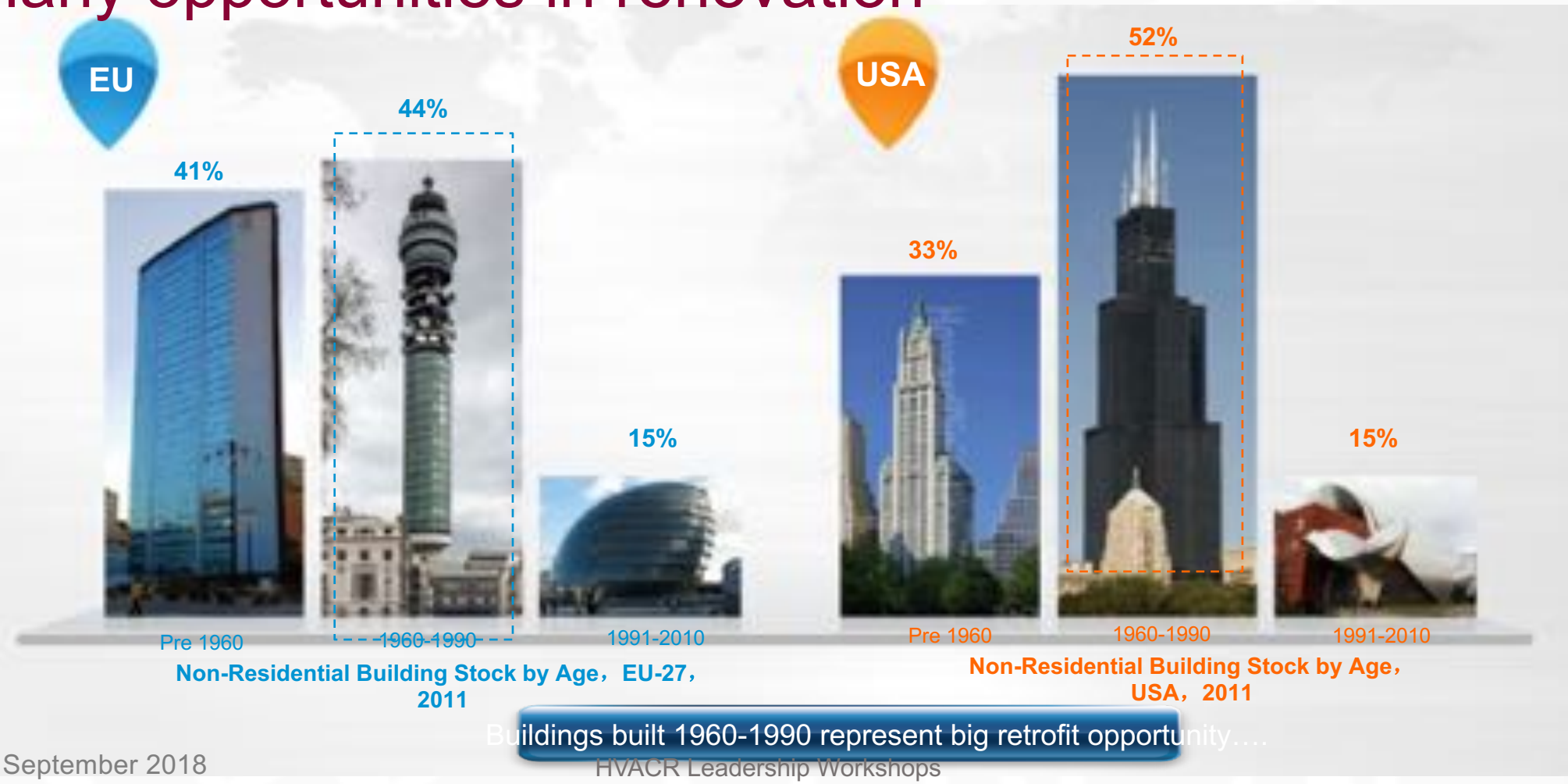
Splits: Shift from R410A ——> R32
Or R290

VRF: Shift from R410A ——> ?

Flammability is a concern!

Global AC Trends

Many opportunities in renovation



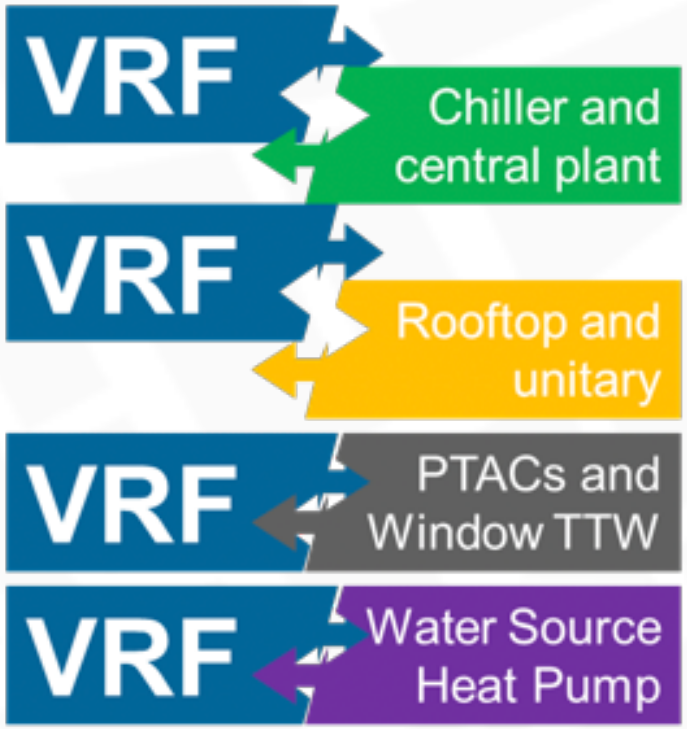
Buildings built 1960-1990 represent big retrofit opportunity….

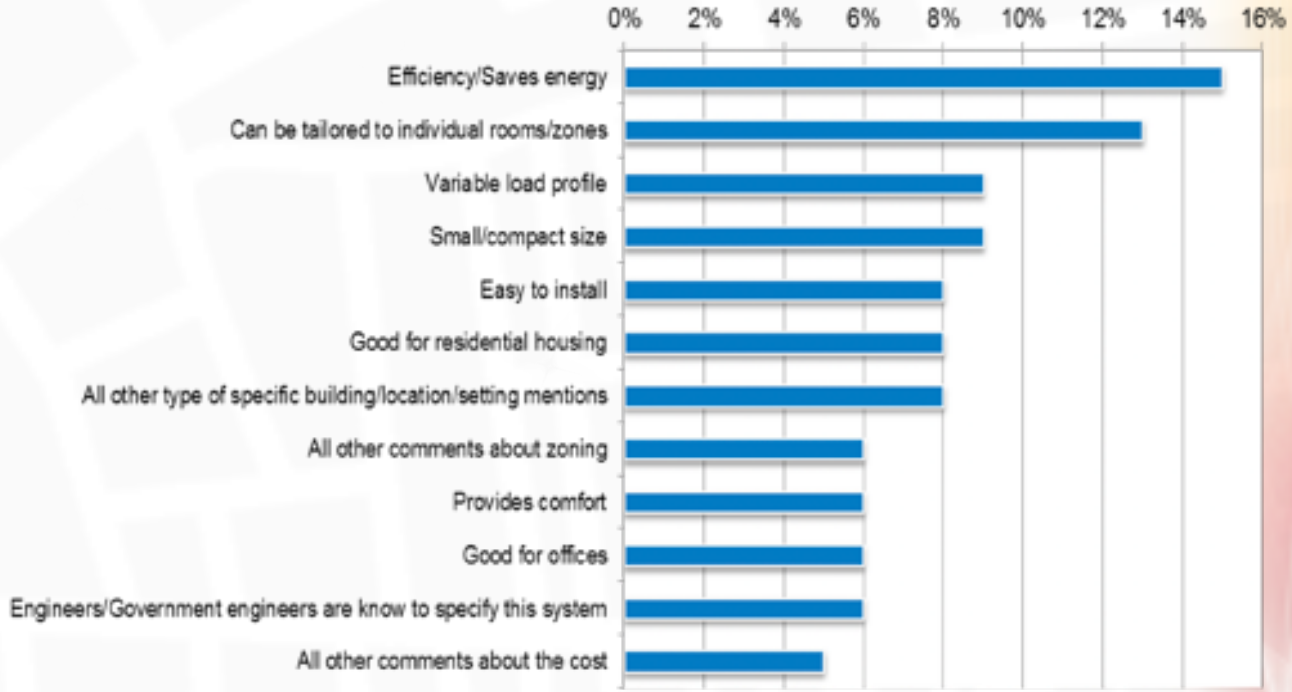
Global AC Trends

Sustainability

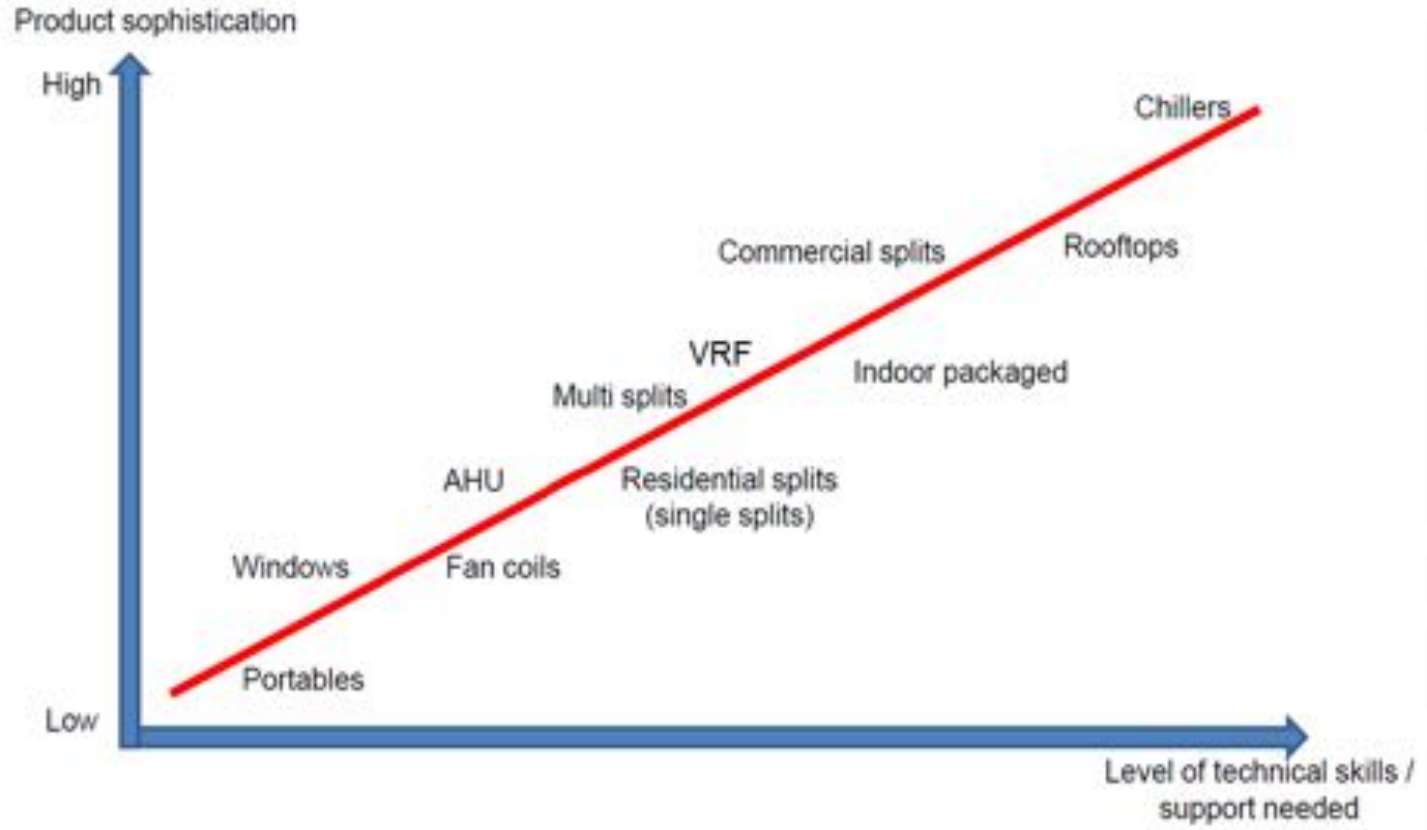
VRF considered a suitable alternative to most AC systems – DX & Water Based

For capacity 3HP up to 5,000 HP





Product sophistication vs level of technical skills



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What are the benefits of VRF?

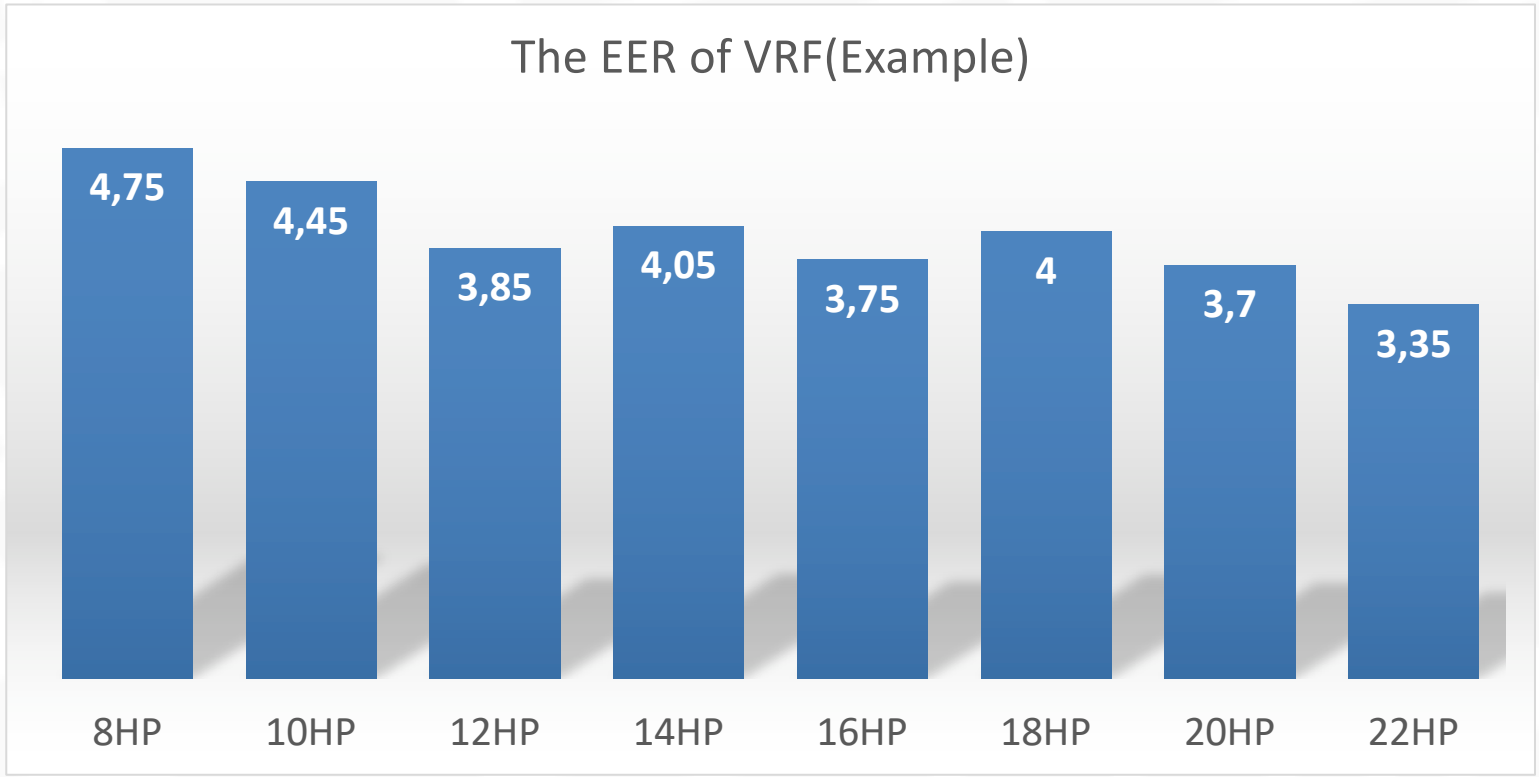
1	**Energy Saving**. The volume or flow rate of refrigerant is accurately matched to the required heating or cooling loads. It is estimated that the power consumption can be reduced up to 30%.VRF system has High Efficiency in part load.
2	**Energy Saving**. Heat recovery VRF technology allows individual indoor units to heat or cool as required, while the compressor load benefits from the internal heat recovery.
3	**Modular design**. The modular design offers comfort on demand allowing the choice to use the system only in the zones where it is needed. Provides dehumidification and temperature control by rapidly adapting to changing loads.

Energy Efficiency

- System Automatically Matches the Zone Load
- Adjusts the Flow of Refrigerant and Energy
- Adjusts the Compressor Speed and Fan Speed
- Improves Temperature Control
- VRF's have multiple indoor evaporator units connected to one outdoor SYSTEM
- The condensers work only as needed, providing energy savings from partial load conditions.
- VRFs are predicted to provide 50% energy savings on average over the lifetime of the system.

Energy Efficiency

EER (Energy Efficiency Ratio)



High Efficiency – EER & COP
30%+ @full load, 50%+@part load more efficient than split

Energy Efficiency

Utilizing VRF with LEED

The VRF (variable refrigerant flow) air conditioning system is engineered for sustainable green buildings and provides opportunities for designers to claim numerous LEED® prerequisites and points.

- Energy and Atmosphere: VRF Can achieve up to 21 points
- Environmental Quality: VRF can achieve up to 7 points

LEED NC 3.0

- Certified: 40-49 points
- Silver: 50-59 points
- Gold: 60-79 points
- Platinum: 80 + points

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What are the benefits of VRF?

4	**Quiet operation.** Sleep without noise. Indoor units may operate at 25dB(A) sound levels and outdoor units can operate at 50dB(A) and lower with night quiet operation.
5	**Ease of Design, installation & transportation.** Selection software enables a fast method of laying out a VRF system. VRF is developed based on Split system, piping and wiring work are similar. Small size and light weight make it easy to transport.
6	**Centralized monitoring**. Feature that gives users control over the entire system from a single location or via the Web.

What are the benefits of VRF?

VRF presents better aesthetic value compared to split

Advantages of VRF over Split AC

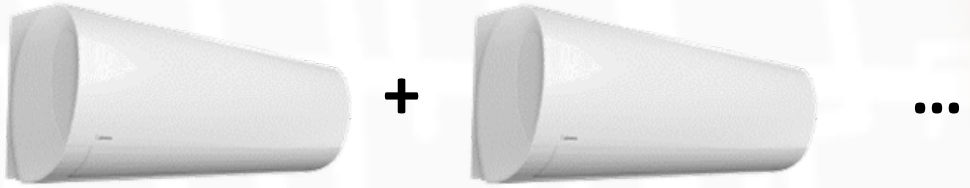
Possibility to connect more indoor units

Split A/C

1-3HP
1 indoor unit

VRF

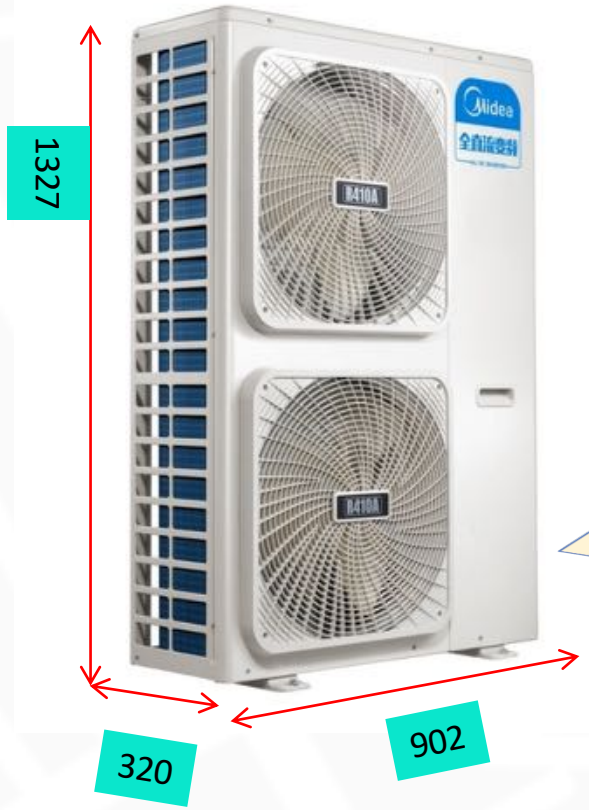
3- 32HP
3-53 indoor units



Advantages of VRF over Split AC

VRF: 20- 32HP

1.43 m^2 in footprint



0.28m^2

1.43m^2

DX: 3- 6HP

0.28 m^2 in footprint

VRF advantages over chillers

- **VRF offers efficiency without requiring the space**
- **Chiller system require space for pumps, boilers, chillers, ducts, piping, heat exchangers**

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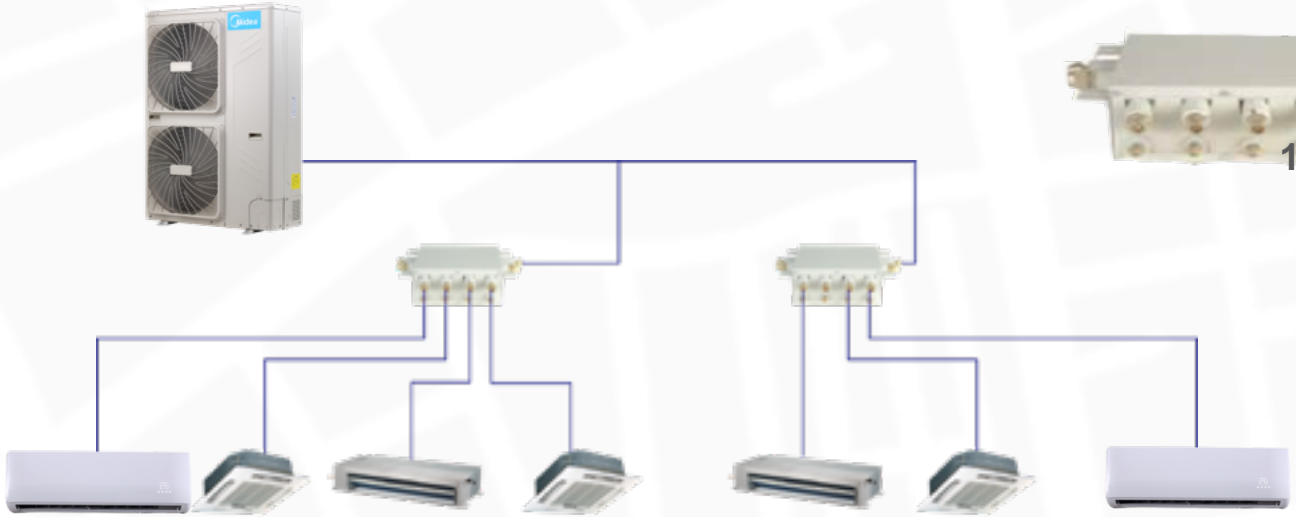
Mini VRF

Optimised design for residential buildings and small offices

- Slim & Flexible design
- Easier and safer installation thanks to a branch box



1 to 4 branch box

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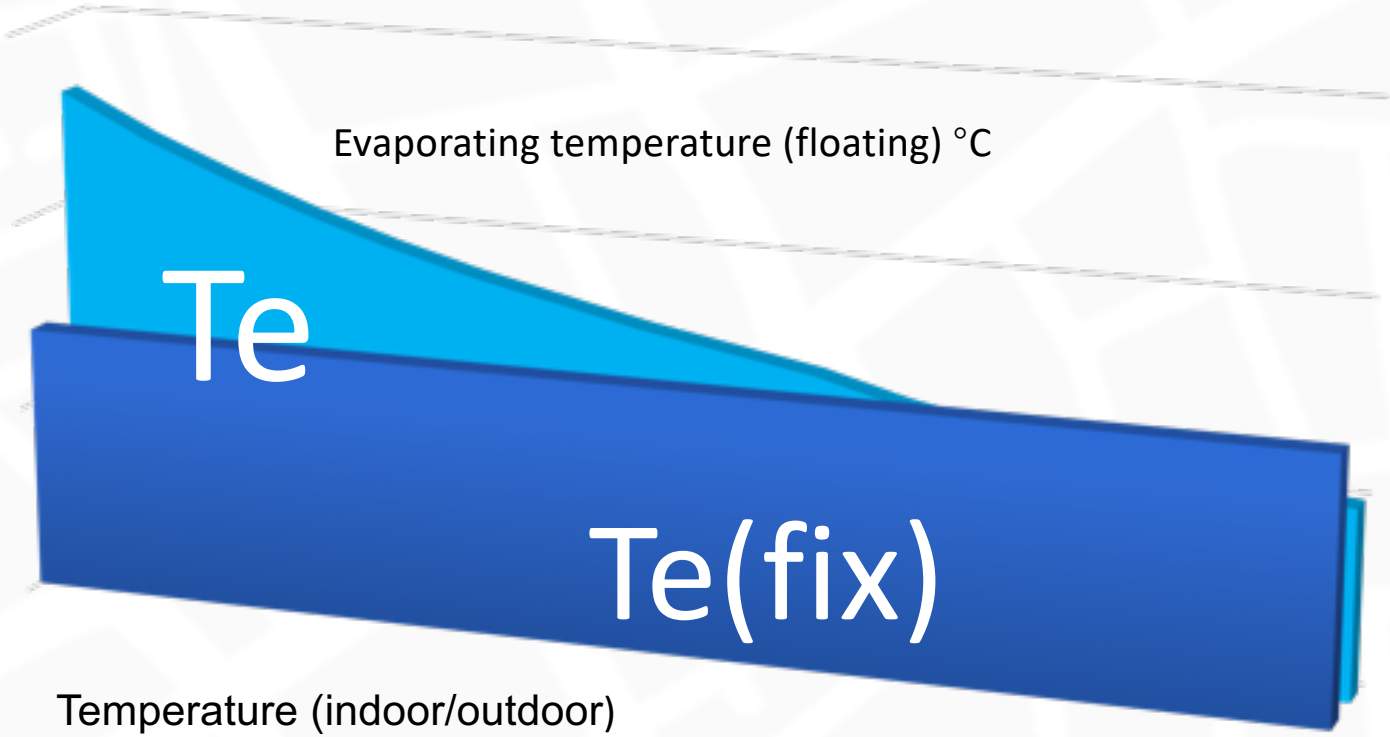
Energy Management Systems

Floating Refrigerant Temperature for balancing comfort and efficiency



- With the integration of EMS (Energy Management System), VRF would be able to adjust evaporating temperature (in cooling) and condensing temperature (in heating) to maximize the comfort and energy efficiency automatically.
- Background knowledge:
  - For low ambient temperature, lower load and capacity are required
  - Lower load and capacity need, higher evaporating temperature can be
  - Higher evaporating temperature results in higher efficiency, especially for transition seasons
    - Automatically adjust temperature
    - Save Energy
    - Comfortable cooling/heating

Ease of installation: Automatic charge function

- VRF system can be charged with the necessary amount of refrigerant automatically via a push button on the PCB.
- Automatic charging will stop once the appropriate amount of refrigerant has been transferred.
- Need to be customized.

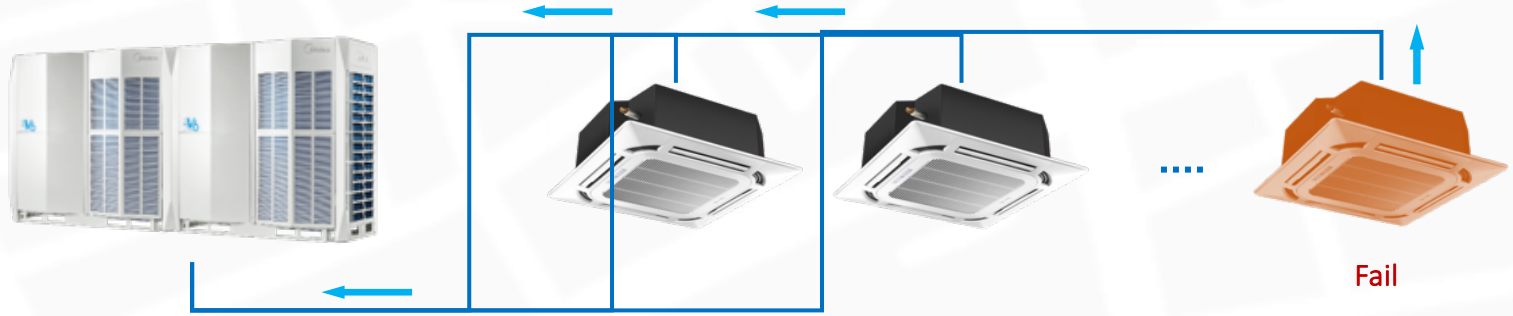
Conventional manual charge:

1. Calculation of additional refrigerant charging volume
2. Measuring the weight of the cylinder
3. Charging the unit with additional refrigerant

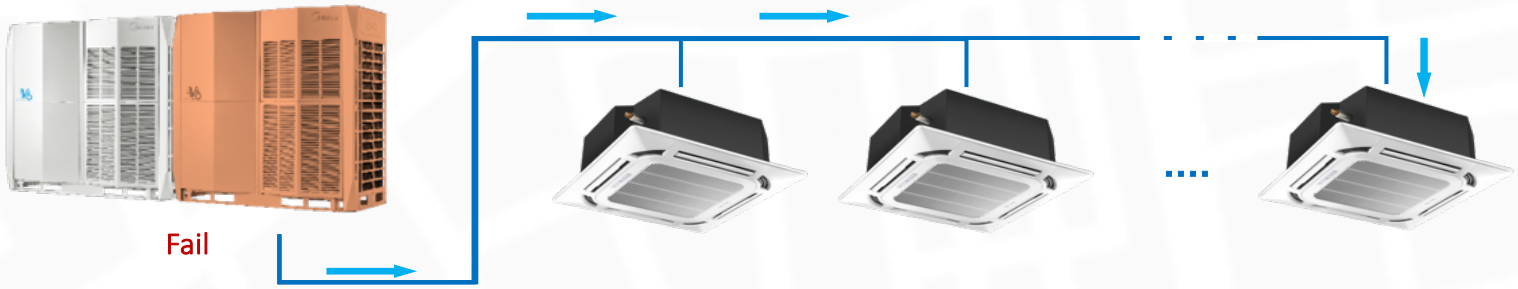
Automatic Charge Function (optional)

Ease of service - Refrigerant recycling function

Case One : Refrigerant collect to outdoor units



Case Two : Refrigerant collect to indoor units



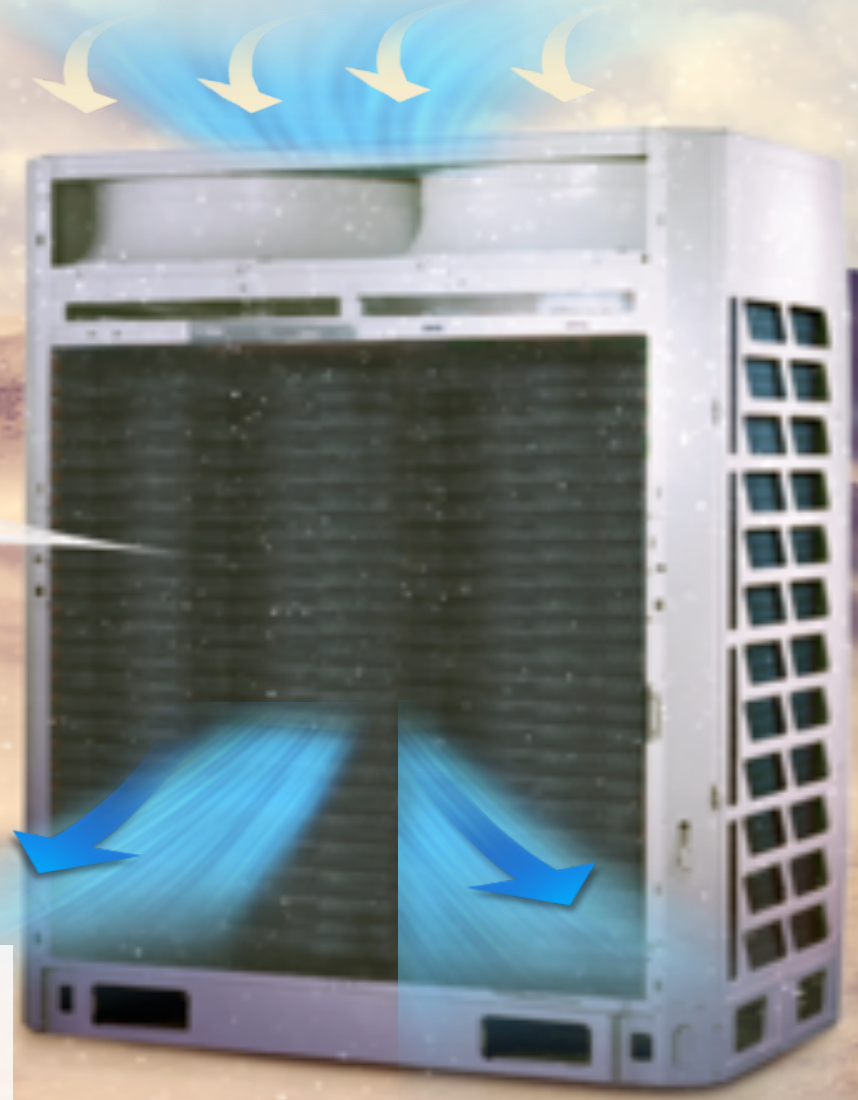
Case Three : Recycle to a tank

Ease of service - Continuous running when indoor unit requires repair

- In case of one particular IDU needs to be repaired, it can be power off without any interruption to the system's operation.
- In case of indoor unit disconnected (Error display on ODU PCB), the system will keep running.

The system can be repaired without interruption to normal operation.

Auto Dust Cleaning



Self-clean

- The innovatively designed dust-clean function enables the outdoor unit to prevent the dust by itself.
- To improve the reliability and maintain system operate efficiently

Complete control solutions

Various controllers and software

Individual | Group | PC/ Network | BMS

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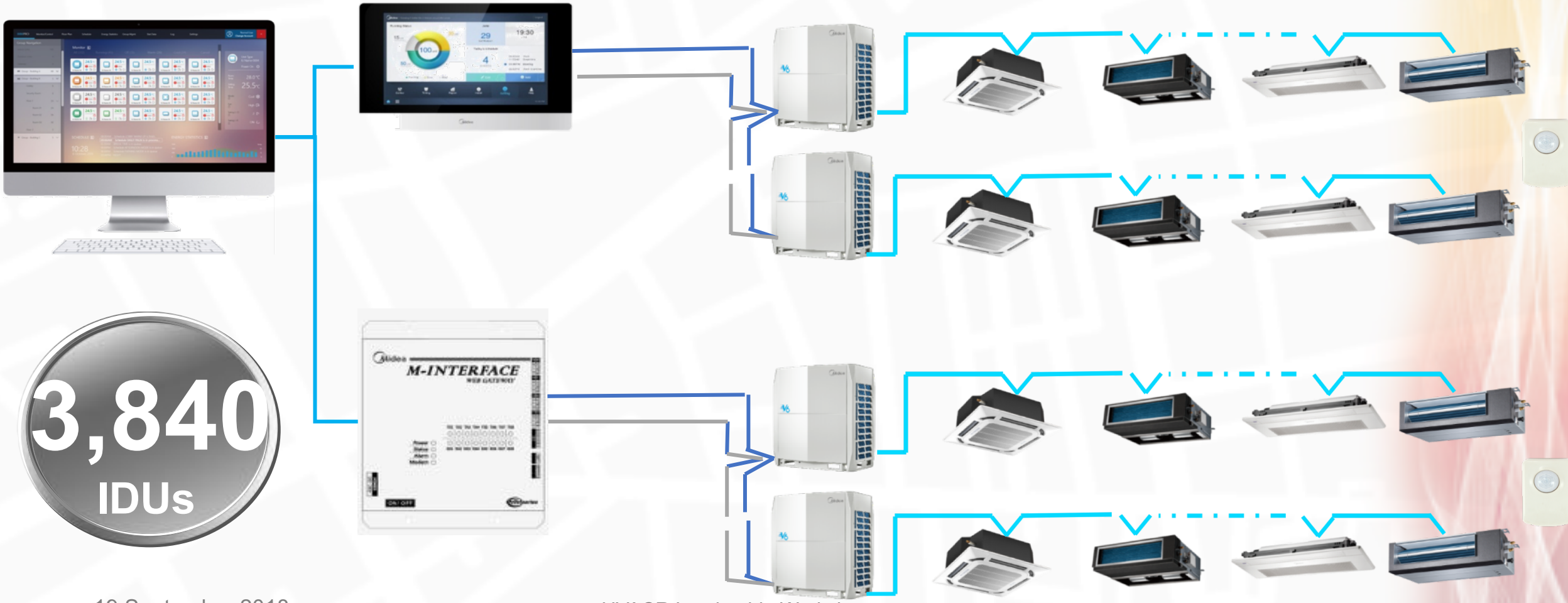
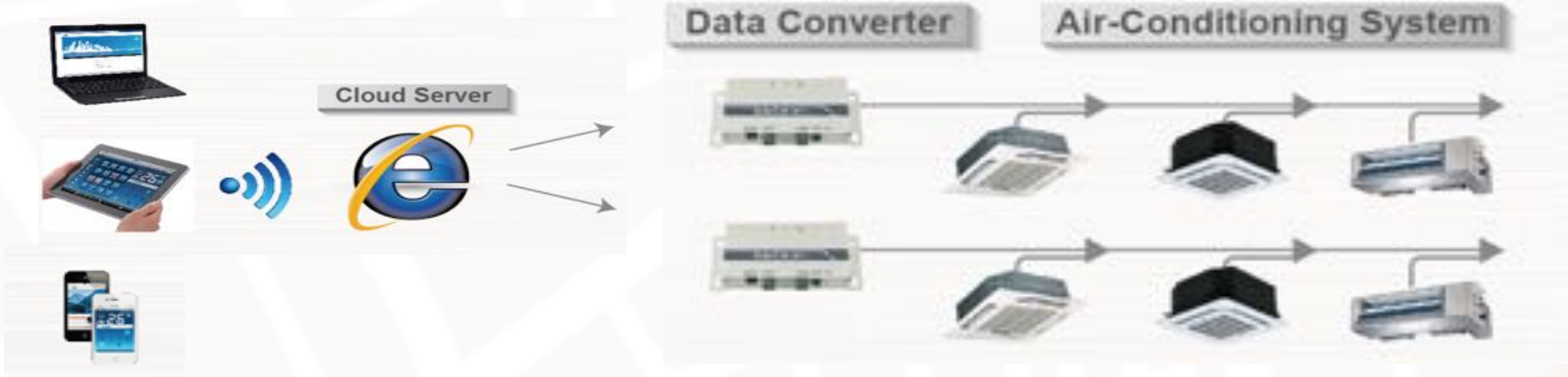
Complete control solutions

Updated PC control



Complete control solutions

Cloud based smart app/web control



- To enable the long-distance control for VRF system through internet.
- As well the smart phone, tablet PC, laptop or desktop PC can be as a web controller.
- More user-friendly with updated APP and convenient cloud server access.

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Complete control solutions

BMS Gateways

MD-CCM08/E

LonGW64/E

CCM-18A

MD-KNX-01

- BMS Gateways are compatible to multiple communication protocol of **BACnet, LonWorks, RS485, Profibus, Modbus, KNX**, etc.
- Connectible to BMS or Smart Home systems

Conclusion

- Many opportunities for retrofit as the demand is increasing in the HVAC market
- Benefits of VRF systems:
  - ✓Mostly ductless, saving space
  - ✓Uses a condenser unit that works with multiple units
  - ✓No need for water piping, requiring only refrigerant piping
  - ✓Lower utility costs
  - ✓Less space used
  - ✓Better individual temperature control
  - VRF Systems are changing the way we Heat and Cool buildings