DAIKIN

VRV 5

Hotel Sector Analysis

Enhancing ROI Through HVAC System Upgrades

Introduction:

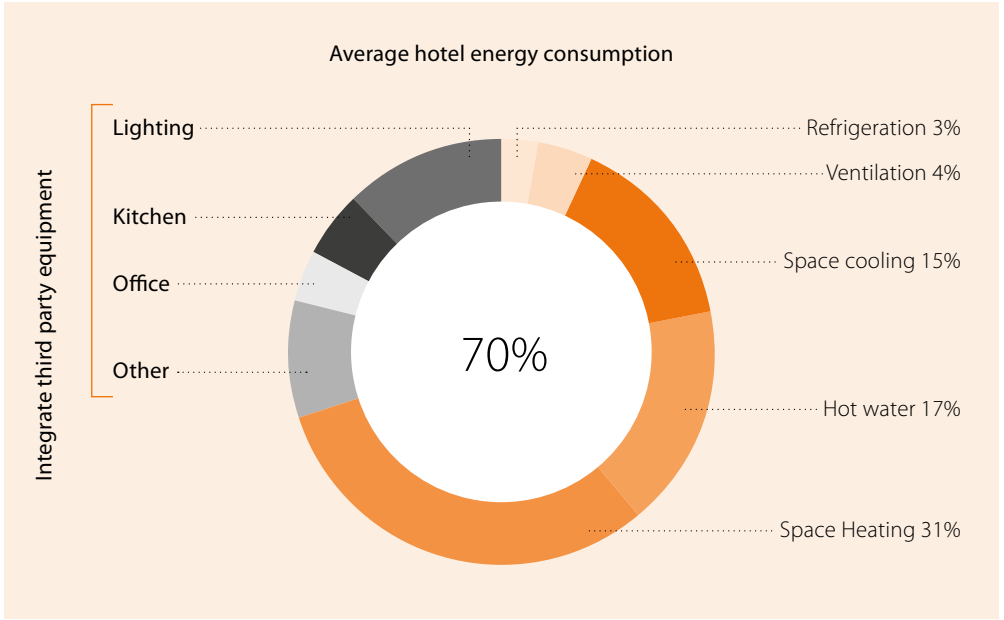
The Role of Modern HVAC Systems in Hotels

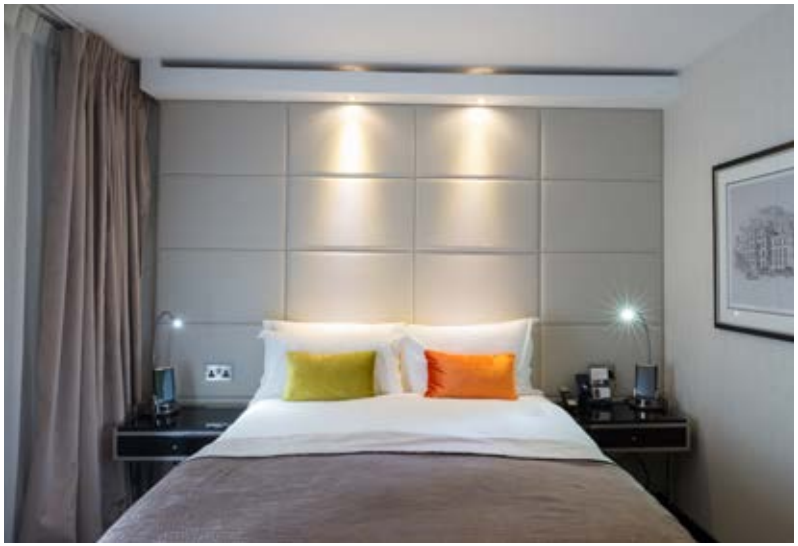
HVAC systems play a vital role in hotel operations, ensuring guest comfort across various areas. Guest rooms are often the main focus. However, shared spaces, restaurants and lobby areas all must be maintained at the right level of comfort.

HVAC systems can provide cooling during the Summer and heating during Winter. Through continuous innovation, systems have improved in reliability and sophistication with heat recovery, increased response times, as well as improved filtration and controls – all can be set to meet the needs of the space.

Legislation has played a significant role in driving higher efficiencies and lower energy usage. Ensuring the adoption of the latest, future-proof technology - equipped with the most environmentally friendly refrigerants - will not only comply with these regulations but also ensure optimal guest comfort.

The latest systems will deliver the right environment at the lowest life cycle cost. When decarbonisation is being considered, heat pump technology can also be used for retrofit in high-temperature high usage hot water applications.





Time for Change:

The Case for System Replacement

VRV-type Systems can have a lifespan in excess of 15 years, where a regular maintenance regime is followed. Generally maintenance costs rise over time and system efficiency declines supporting the need to look at these costs when considering system replacement.

Technological advancements further reduce the return on investment for keeping outdated systems. Maintenance costs can increase not just due to increased failures but also due to the lack of availability of spare parts. Systems can be mothballed with other systems asked to work even harder to make up the shortfall in capacity. Guest comfort is then compromised, energy bills become even higher as well and rooms are out of service for longer periods of time, leading to decreased revenue.

All these factors point towards the need to replace these ageing systems with the latest, highly efficient systems.

Hotel Profile:

Typical HVAC Configuration

Hotels with HVAC systems generally have between 100 to 200 rooms. In a 150-room hotel, for example, there are likely to be around 12 separate VRV systems, with each 10 HP unit providing heating and cooling to approximately 12 rooms.

Typically, a 2.5 kW ducted unit is installed above the bulkhead in each room. The system is managed via a central controller, with individual room controls for precise temperature regulation.

Daikin UK case study, Citadines, Barbican

R32 VRV Systems:

The Latest Future Proof Technology

For DX systems, the latest technology now incorporates R32 refrigerant, offering significant improvements in energy efficiency and environmental sustainability. This section examines the key features and advantages of R32 VRV systems.

VRV 5 S-series | VRV 5 Heat Recovery | VRV 5 Heat Pump

The widest range of R-32 indoor units

NEW

Daikin app

Lower CO_2 equivalents

Industry-leading real life efficiencies

Flexibility to take care of every room

Latest technology vs previous systems'

- These systems contain the latest R32 technology, giving ~14% more efficiency compared with the previous R410a system, leading to the lowest life cycle carbon footprint. This also future-proofs the system against changes in the F-Gas regulations.
- Shirudo technology with built-in leak detection and shut down valves so no additional leak detection is needed catering for the requirements of IEC standard for A2Ls.
- The system has been designed for even easier access for maintenance; saving costs on site. Innovations included also reduce set up and install costs.
- The new systems are connectable to the widest range of indoor units, including AHU connection to a range of ducted, cassette, floor, wall and ceiling units.
- Connectivity to Central controller, room controllers and apps as well as peripherals that could be required in a room such as sensors, door and window contacts.
- The VRV solution is very compact, with the 14 hp having a footprint of ~0.7m2 and height of 1.6m, up to 28 hp as a connected system. It's available in modular form, which means you can add incremental capacity to meet your total capacity needs. The systems could be on the roof with pipework entering down risers, in floor-level machine rooms – assuming the right level of louvring is present - or in the basement.
- During a replacement with VRV 5, the outdoor and indoor units would need to be replaced, along with the internal boxes and wiring. Individual piping requirements would need to be checked and replaced as required.

A comparison between VRV II and VRV 5 reveals several key differences, outlined below:

Feature (10 hp example)	**VRV II**	**VRV 5**
Refrigerant	R407c	R32
GWP	1774	675
Compressor type	Fixed speed	Variable speed
Cooling efficiency SEER	3.04	7.14
Heating efficiency SCoP	2.7	4.34
Equivalent Piping length limit	125	190
Sound pressure (Cooling) dba	58	58
Operating range (Cooling) degC	-5/46	-5/46
Max no. of indoors	13	21
Pipework Size	Base	-23%

	Piping mm		**Piping Inch**	
	RSEYP10	REYA10	RSEYP10	REYA10
	34.9	19.1	1 3/8"	3/4"
	28.6	15.9	1 1/8"	5/8"
	12.7	9.52	1/2"	3/8"
Total Size	76.2	44.52		
Difference		42%		

An Assessment of Previous VRV Generations

Spare Part Availability

Spare parts are a critical part of support for VRV systems throughout their life. DAUK classifies its spare parts into different categories, with A being the most critical and most used. Four of the R407c units have the current spare parts availability status:

Spare parts for R407c systems	RSEYP10K7W1	RSEYP8K7W1	RSXP10L7W1	RSXP8L7W
A- not available	1	0	2	3
A- critically low	4	8	3	4
A- available	22	24	13	15
B/C/D - not available	2	1	0	0
B/C/D- critically low	12	12	5	6
B/C/D- available	18	16	4	4
Total A	27	32	18	22
Total B/C/D	30	29	9	10

Across all four R407C products, 6% of critical parts are out of stock meaning if one of these parts failed there is no replacement and the systems are cannot function. 25% are either critically low or not available. Replacing systems before this happens, with planning, will minimise system changeover costs and guest disruption.

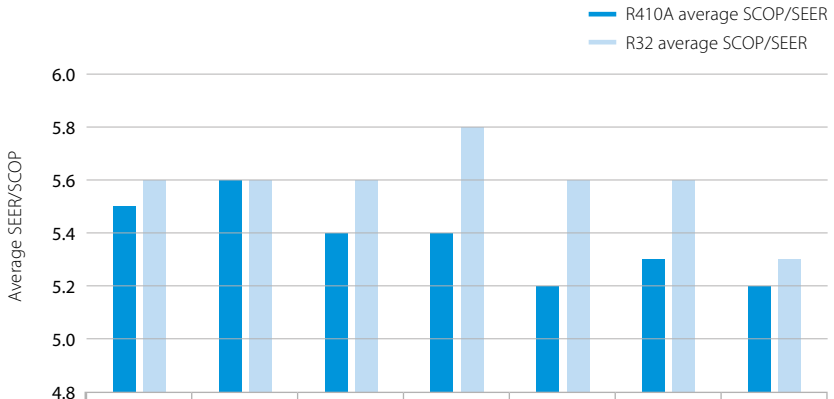
With older systems, there is a real possibility that they become stranded assets where they are seen as a liability with escalating costs associated with them that far outweigh the utility value of the system. Managing the upgrade of a system will prevent these escalating costs and allow a managed transfer from older to new future-proof technology.

Improvements in Efficiency

From one generation of VRV to the next incremental efficiency improvements have been gained through innovation.

The current range is VRV5, which is >50% more efficient relative to the early systems and 13% more efficient than VRV IV in cooling (see chart). Some of the innovations include the following: moving from fixed speed to variable speed compressors, Variable refrigerant temperature, back pressure control on compressors, more efficient refrigerants such as R32 and improved system refrigerant flow and control. By replacing older systems, a customer can take advantage of all these innovations and their benefits.

Average SEER/SCOP comparison



	8HP	10HP	12HP	14HP	16HP	18HP	20HP
R410A average SCOP/SEER	5.5	5.6	5.4	5.4	5.2	5.3	5.2
R32 average SCOP/SEER	5.6	5.6	5.6	5.8	5.6	5.6	5.3

ErP 2021 COMPLIANT

CO_2

Up to +8% average seasonal efficiency (cooling / heating increase!)

Expected Return On Investment

The benefits of changing from an older VRV II or VRV III system are clear. However, assessment of costs is important to be able to build the business case. For the hotel with 150 bedrooms serviced by 12 x 10HP systems with 2.5kw fan coils in each bedroom, the budget system cost is given in chart 1.

Chart 1- Budget new system kit and install

Model	Quantity	Description	List price	Nett price	Total £
REYA10A	12	REYA-A (VRV 5 Heat Recovery)	£8,487	£5,771	£69,254
BS4A14AV1B	30	Branch selector unit	£2,887	£1,963	£58,895
BS6A14AV1B	6	Branch selector unit	£3,951	£2,687	£16,120
FXDA25A	150	FXDA-A - Slim concealed ceiling unit	£907	£617	£92,514
BRC1H52W	150	Remote controller (white)	£119	£81	£12,138
				Equipment total	£248,921
				Installation	£248,921
				Total	£497,842

Chart 2- Annual system running costs

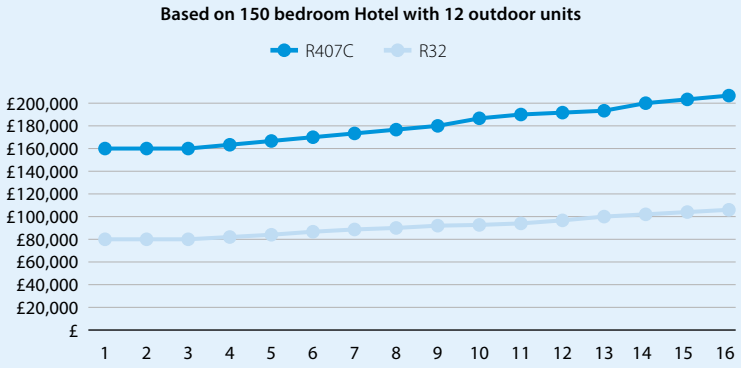
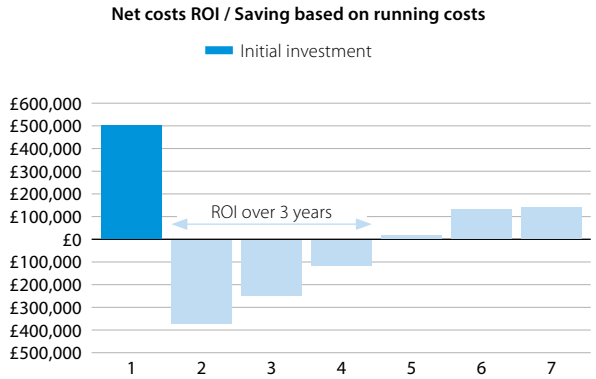


Chart 3- Return on investment in circa 3 years'



Based on 150 bedroom Hotel running current R407c VRV vs new R32 VRV
(removal and decommissioning of exsisting system not included)
33p/ KWhr used, All calculations based on UK conditions

Total costs to consider

- Increase in Reactive maintenance
- Out of warranty repairs
- Revenue loss of systems not operating = rooms not able to sell
- Guest poor comfort refunds
- Energy efficiency difference (considered in analysis)

Importance of R407c Gas Reclaim

The refrigerant that can be recovered from the older system is a valuable resource which can be cleaned and reused for maintenance in other systems.

DAUK, in partnership with A-Gas, provide a recovery service that can extract the gases from all systems quickly and efficiently, at low cost, with all waste certifications provided. Your decommissioning contractor can make use of this service by contacting DAUK.

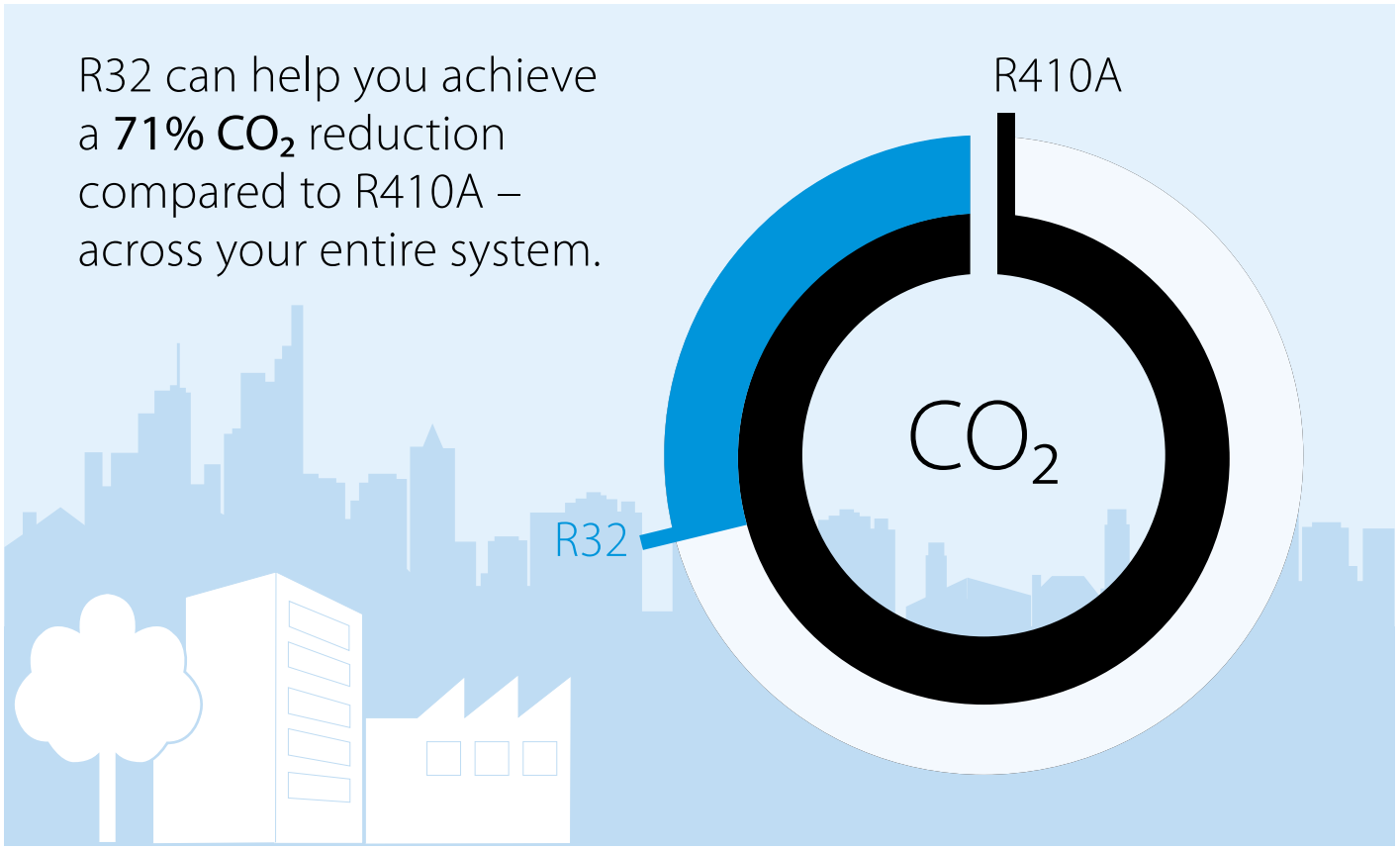
R32:

The Next Generation of Refrigerants

R32 is the latest and most environmentally friendly refrigerant, with a significantly lower GWP (Global Warming Potential) compared to previous alternatives. As a single-component gas, it is easier to handle, reclaim, and recycle.

With a GWP one-third that of R410A, the refrigerant used in VRV IV (the previous generation), R32 offers a much lower environmental impact. Additionally, R32's increased volumetric efficiency allows for around a 10% reduction in charge compared to R410A, further enhancing system performance and sustainability.

R32 can help you achieve a **71% CO_2** reduction compared to R410A – across your entire system.



R32 is the lowest GWP refrigerant on the VRV/VRF market today.

It's also the most cost-efficient.

Advantages of R32 refrigerant

- Lower GWP: only 1/3rd of R410A
- Lower refrigerant charge: 15% less compared to R410A
- Higher energy efficiency – greatly reducing the indirect CO_2 eq. impact
- Reduced system running costs
- Single component refrigerant – easy to recycle
- Low toxicity

R-32

Legislation and Standards

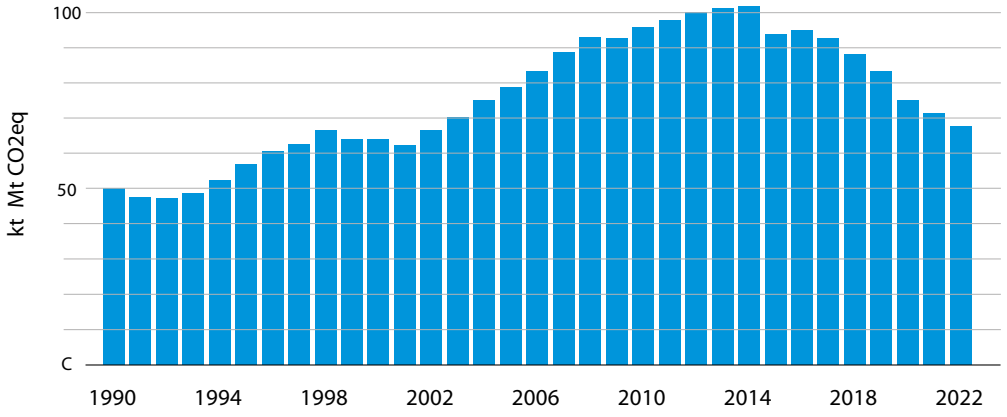
F-Gas 2024 edition II

F-Gas legislation means that older systems that contain gases, such as R22 and R407c, cannot now be sold as new systems. These systems also do not meet the efficiency requirements of Eco Design Directive ERP Lot 21. These systems are old and at the end of their life and do not comply with modern environmental and efficiency standards. R32 VRV 5 is seen as the future-proof refrigerant, continuing as the preferred gas well into the next decade. R410A new systems will gradually be phased out over the coming years.

R410a systems have been the industry standard. However, by upgrading now, you can jump straight to the latest environmentally friendly R32 gas.

Gases such as R407C and R410a for older systems will still be available for Service; however, they will gradually increase in price as supply becomes restricted with the reduction in quota. R22 gas and R22 new systems are now banned.

Emissions in EU-27



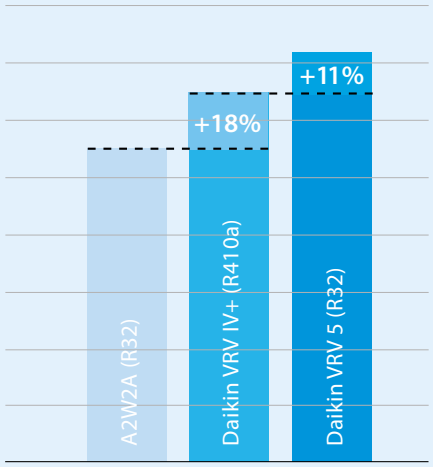
In 2022 F-Gas emissions have decreased by 33% compared with 2014 which was the start of EU 2nd F-Gas regulation

Eco Design Directive (ERP) Lot 21

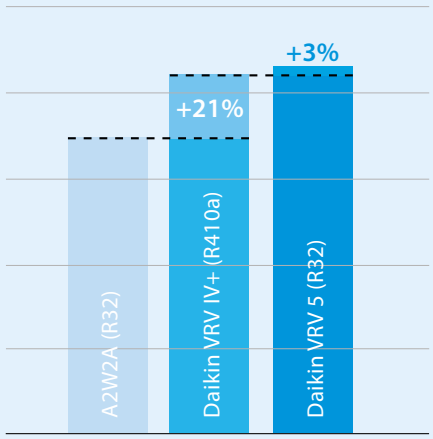
Lot 21 covers the requirements for DX systems with a >12kw capacity and includes VRF /VRV systems as part of the ERP Directive. The Directive covers the Performance thresholds, efficiency metrics, Product categories and the test methodology. The Seasonal efficiency (SEER), which is the efficiency of the system when cooling, and the Seasonal Coefficient of Performance (SCOP), which is the efficiency in heating, are efficiency metrics used.

The test standard EN14825 defines how the systems should be tested so a comparison can be made between different systems. Over the years, the efficiency values that need to be achieved have increased, driving innovation and reducing the system's total life energy consumption. All DX systems used in hotels must comply with ERP Lot 21. Daikin systems are industry-leading for Lot 21.

Seasonal efficiency comparison



Average SEER (Cooling)



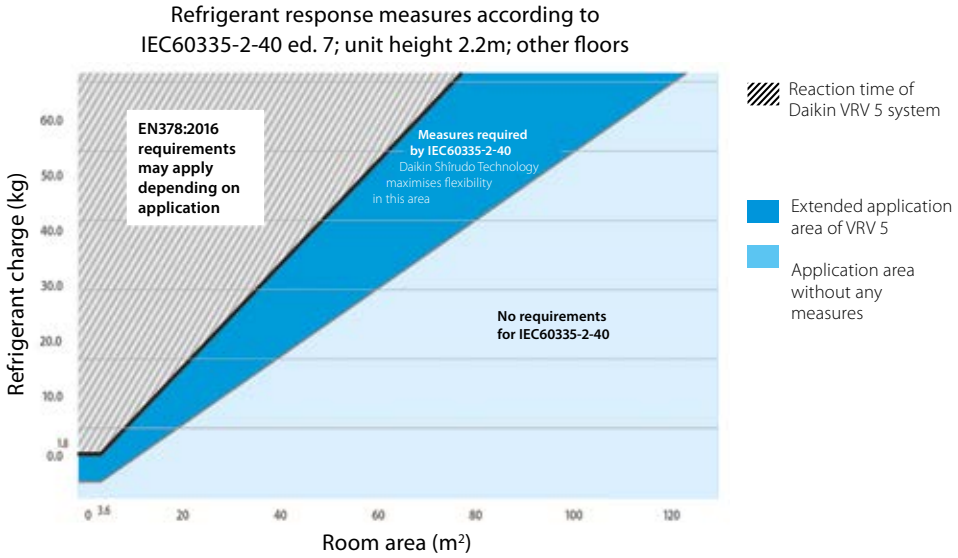
Average SCOP (Heating)

International Product standard updated for R32 systems

IEC 60335-2-40 (ED 7)

The International standard IEC 60335-2-40 was updated to enable the global role out of the new environmentally friendly gas R32. The standard was updated with new rules covering the new category of A2L (mildly flammable) refrigerants, of which R32 was one, to enable the safe use of R32 in larger systems such as those used in Hotels.

Daikin has installed over 42 million R32 systems over the past years with no incidents. This is one of the reasons why the safety requirements have been relaxed in the latest 7th edition. Toxicity levels for R32 did not change from those covered in EN378, which meant that the IEC standard did not cover the toxicity of R32, only flammability.



Area 1: application area without any measures

- Typically Split & Sky Air systems fall in this area thanks to very low refrigerant charges
- A typical mini VRV installation, with 6.5 kg of refrigerant would require a minimum room surface of **39 m²**

Area 2: application area with two measures integrated

- Daikin Shîrudo technology enables you to use the VRV system to its full potential

Environmental Product declaration

EN 15804 & ISO 14025/ ISO 21930

Whole-life carbon analysis is becoming an important area of our built environment. Embodied carbon is the greenhouse gas emissions associated with the manufacture of a product, its installation, maintenance, repair, replacement, and end of life.

The embodied carbon associated with building services design can be significant over a building's lifetime, due to the materials used and high replacement rates. Environmental Product Declaration (EPD) certificates give details of the embodied carbon and can be obtained for a range of Daikin products including VRV 5.

Environmental product declaration available

Leak Detection

Traditionally the UK has looked to EN378 as the safety standard that defines the measures that need to be implemented to guard against the toxicity effects of refrigerants.

What is included in Shîrudo Technology?

- **Complete peace of mind** as all refrigerant control measures are factory-integrated, ensuring compliance to the IEC60335-2-40 product standard, 3rd party certified by a Notified Body

Leak detection sensor in every indoor unit

Shutoff valves in the outdoor unit or SV box

Audible & visual alarm in Madoka controller

Specially developed algorithms

Full **validation** of your project via our Xpress software

AI (R410a) and A2Ls (R32) are covered in the standard, including the measures that need to be followed for room smaller hotel room sizes where the system charge size is above a certain kg. EN378 is only concerned with safety rather than the environment, so it defines the location of sensors (150mm above floor level) and does not include methodology to shut off any leak. This means that the whole content of a system can be emptied into a room before the gas is detected and the alarm sounds.

IEC 60335-2-40 works on a different principle as it focuses on ensuring the absolute minimum amount of gas escapes from the system in the eventuality of a leak. With this in mind, the sensor is in the fan coil for speedy gas detection. As soon as the leak is detected, a signal is sent to shut off valves on the same leg as the fan coil, shutting the valve within a defined time period to minimise the gas loss. An alarm in the room also sounds and flashes.

EN378 is currently being reviewed (2024/2025), and consideration would be to include a more up-to-date method of gas detection and shut-off as defined in the IEC standard. Further updates will be available once the new EN378 version is published.

Full Decarbonisation Solution:

Addressing Hot Water Demand

Daikin's new CZ-HT Commercial high temperature heat pump can deliver hot water up to temperatures of 70 degrees centigrade, making it an ideal solution to accompany VRV 5 when considering full decarbonisation of the hotel's energy needs with the removal of gas.

The new product uses a new gas, R454C, which is ideally suited for this type of application. A combination of systems, such as 2 of the EWYE 070CZ units, will deliver the required capacity.

More detailed design will enable the number of hot water tanks to be established; however, the current tank could be considered. The CZ-HT Commercial high temperature heat pump is modular in design, which allows total design flexibility.

Hot Water Considerations

- 150 beds
- 200 litres /bed @ tset=60°C (EU standard)
- Reheating time, tr=8 hours
- Reheating cycleS, P=2
- Water supply temperature, Ttank=10°C
- ηtank=90%

1. Quantity of water (W):

W = No. beds x water per bed x safety factor = 150 x 200 x 1.10 = 33,000 litres

2. Volume of the storage tank(s) (W'):

$$W' = \frac{W}{P} = \frac{33}{2} = 16{,}500 \text{ litres}$$

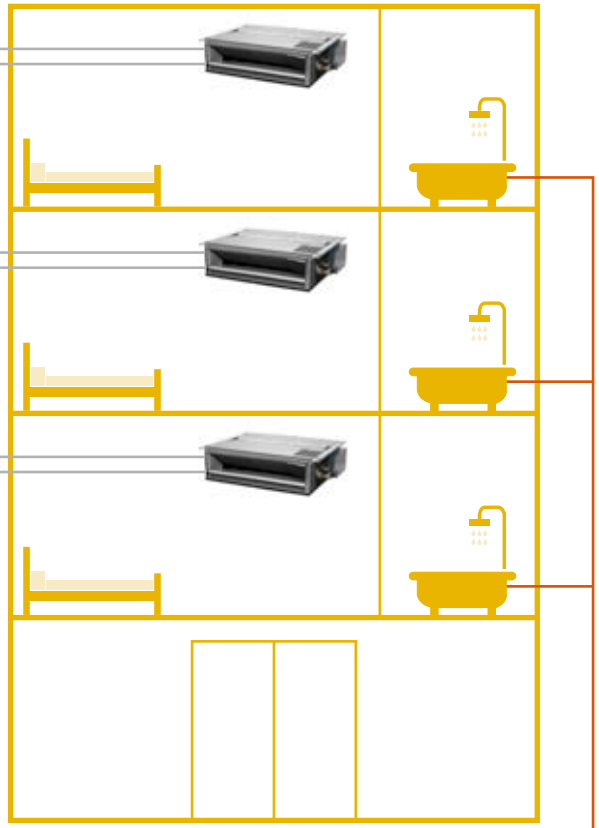
3. Total heating capacity required (C):

$$C = \frac{W' x\ cp\ x\ (Tset - T\ tank)}{tr\ x\ \eta tank} = \frac{16{,}500\ x\ 4.186\ x\ (60 - 10)}{8\ x\ 3.600\ x\ 0{,}9} = 133.23\ \textbf{kW}$$

VRV 5

Centralised DHW production + VRV for space Cooling / Heating
Dedicated accessory for DHW to be added

Ideal solution for Retrofit / upgrade (hotels, offices...)



CZ-HT

Centralised heating and DHW production (dedicated generator for DHW)
Dedicated accessory for DHW to be added

Possible terminals:
- Existing radiators (High temperature)
- Floor heating
- Fan coils

Controls and Cost of Ownership

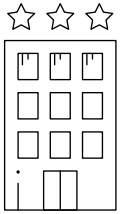
Central Controls

Central controls, such as the iTM, provide a single point of reference for the A/C installed within the whole hotel.

They allow for remote access to the units without having to enter the guest room (such as if a guest complains that their unit is operating). A Browser facility aids in this, as it permits 'reception' to make adjustments from their computer without having to leave the reception to go and access the central controller screen.

They also allow for 'global' automatic functions to be carried out without having to program each room controller individually (setback operation, set point range restrictions, operational mode restrictions, etc).

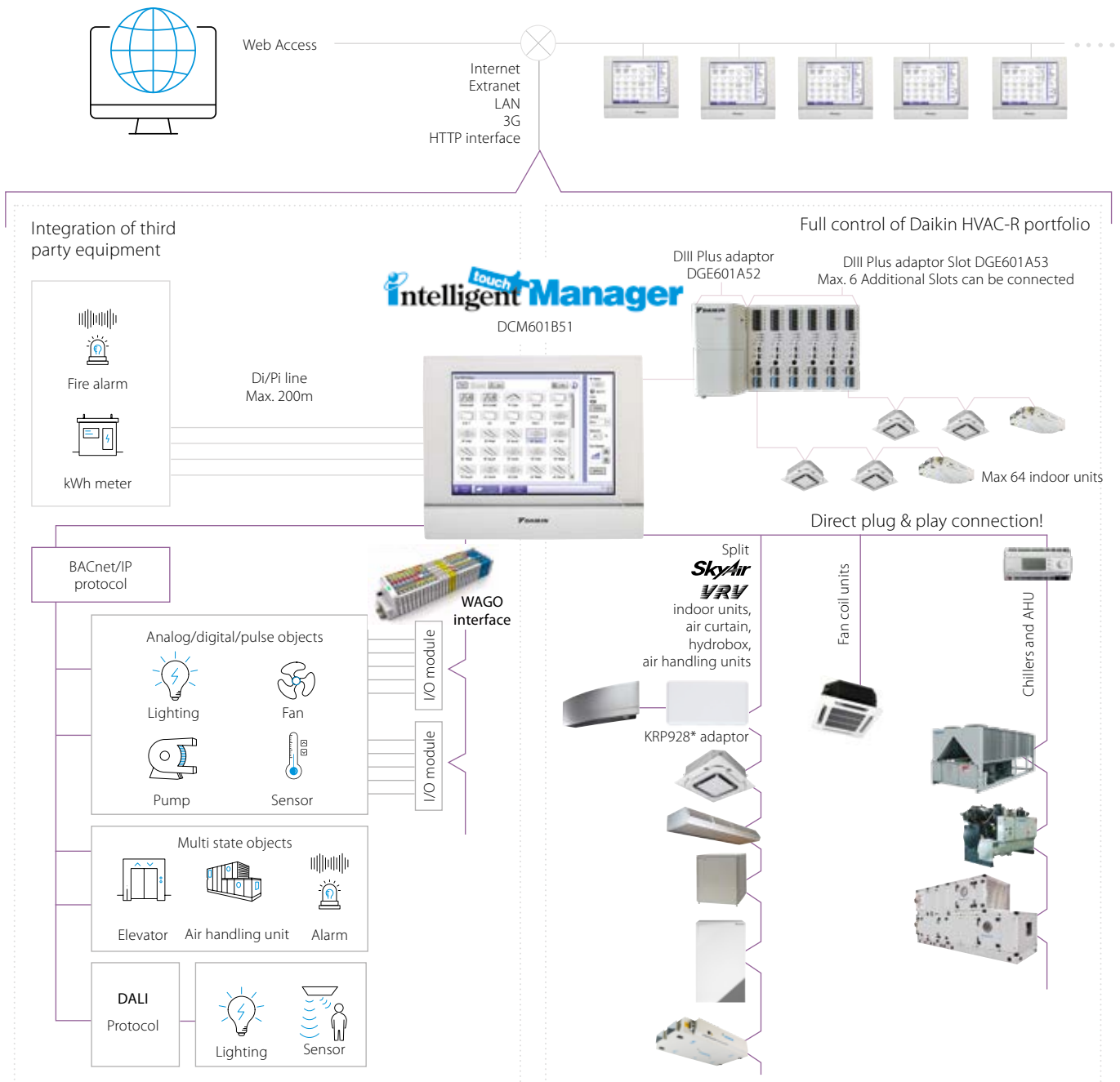
Hotel



	Unit control	Integrating control		Advanced control			
							
	BRC1H52 W7/S7/K7	RTD-20	KLIC DI V2	DCM010A51	DCM601B51	DGE601A51	DGE602A51
	1 remote controller for 1 indoor unit (group)	1 gateway for 1 indoor unit (group)	Two additional probes can be connected	1 interface for up to 2,500 indoor units	1 iTM for 64 indoor unit(s) (groups) (1)	Up to 512 units with extension modules via Daikin Cloud Plus	Max 64 units via Daikin Cloud Plus
Hotel guest can control & monitor basic functionalities from his room	•						
Limit control possibilities for hotel guests	•	•	•	•	•	•	•
Interlock with window contact		•			•	•	•
Interlock with key-card		•			•	•	•
Integrate Daikin units into existing BMS via Modbus		•					
Integrate Daikin units into existing BMS via KNX			•				
Integrate Daikin units into existing BMS via HTTP				•			
Integrate Daikin unit control in hotel booking software				•			
Oracle Opera PMS				•			
Monitor energy consumption					•	•	•
Advanced energy management					•	•	•
Integrate Daikin products cross pillars into Daikin mini- BMS					•	•	
Integrate third party products into Daikin mini-BMS					•	•	•
Online control					•	•	•

(1) 7 iTM plus adapters (DGE601A52 and DGE601A53) can be added to have 512 indoor groups and 80 outdoor (systems)

Controls at the heart of the system



Local Controls

The local room controller is the primary point of control for the guest. As such, they should be attractive and easy to use. Ideally, they should not rely on text but rather on symbols so that they are multi-lingual. The Madoka offers an ideal solution.

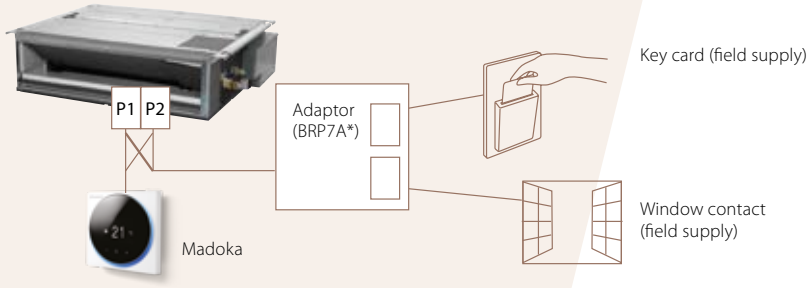
The ability to integrate with a key card interface, door contact, PIR, or window contact is essential (currently via T1/T2 in the fan coil unit) as these all form part of the energy-saving measures.

Ideally, the ability to interface wirelessly with multiple inputs reduces the wiring required and allows for greater flexibility (coming in the next generation of Daikin remote controllers).

Hotel application features

- Energy saving through key card, window contact integration and set point limitation (BRP7A*)
- Flexible setback function ensures room temperature remains within comfortable limits to ensure guest comfort

Key card and window
contact integration



Predictive Maintenance & The Cloud

Cloud monitoring and control (DCS+ c/w Edge controller) offers significant opportunities:

- The ability to remotely access the hotel systems from anywhere in the world (so long as an internet connection is available).
- The ability to group hotels and change settings across multiple hotels with a single click.
- Logging of energy usage/system performance and comparison across different hotels.
- Prediction of potential faults and instant fault notification (via email or cloud site alert) – this can reduce/eliminate downtime on a system, leading to rooms not having to be taken out of action.

Benefits

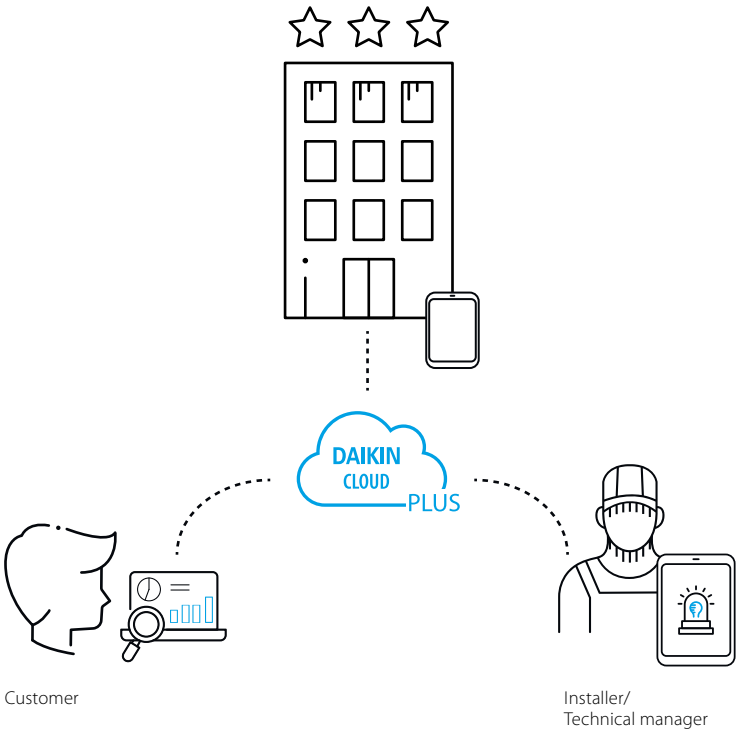
Easy control of multiple sites
- Remote control and manage sites remotely
- Floor plan control per site
- Multi-site access
- Permission based access

Save energy & meet sustainability goals
- Monitor energy consumption trends
- Smart control of systems to save energy
- Insights to improve HVAC system performance
- Reduced costs
- Contribute to carbon neutrality

Connectivity and integration possibilities
- Simple to advanced edge controllers
- Various interfaces
- Advanced security

Manage, monitor and control indoor climate from anywhere
- Limits the necessity for on-site control
- Minimises downtime and engineer call outs
- Optimised maintenance
- Monitoring of indoor air quality

What needs do we solve?



Were you aware that HVAC systems account for as much as 40% of the total energy consumption in buildings?

- Daikin Cloud Plus logs historical data and allows you to monitor, compare HVAC consumption
- Daikin Cloud Plus allows you to integrate with energy meters so you can monitor not only HVAC but also other energy consumers (facility, gas, water, …)
- Daikin Cloud Plus allows you to configure and control the system smarter to save energy with restrictions, "if this than that" rules, schedules, etc.

Are you interested in tracking the progress of sustainability goals or the sustainability policies you put into action?

- Daikin Cloud Plus allows you to monitor, analyse and compare HVAC energy consumption
- Daikin Cloud Plus allows you to remote control and manage new cooling or heating related policies (e.g. heating setpoint of 1° lower)

How do you ensure maximum comfort and minimal interruptions of cooling and heating?

- Daikin Cloud Plus can predict failures to anticipate and prevent unplanned downtime of the heating or cooling
- Daikin Cloud Plus real-time system error notifications to ensure a direct response in case something goes wrong
- Daikin Cloud Plus logs all events in the system and visualised the temperature evolutions
- Daikin Cloud Plus remote system access to indoor and outdoor unit operational data reduces engineering visits on site

How to manage and remote control one or multi-site building estate and apply uniformisation in climate control?

- Daikin Cloud Plus allows you to monitor, manage and control multiple sites from anywhere
- Daikin Cloud Plus allows to compare multiple sites

How give peace of mind about indoor air quality?

- Daikin Cloud Plus integrates with IAQ sensors and can take automated actions or provide warnings where needed
- Daikin Cloud Plus allows to monitor and analyse the indoor air quality in order to take necessary actions

How to control my other systems at the facility?

- Daikin Cloud Plus provides possibilities to integrate with other facility systems as a stand-alone system, such as integration with lighting system
- Daikin Cloud Plus provides possibilities to integrate with other facility management systems like BMS or BEMS

Maintenance Contracts:

Protecting Your Investment

Daikin offers a range of warranty options that can protect your system throughout its lifetime.

The standard 7-year and extended 10-year warranties are available. A lifetime warranty will also be available, covering the units for up to 15 years, following a system assessment each year after the 10-year period.

The important part of a warranty is that the systems are installed according to the manufacturer's installation requirements, and the systems are maintained every year, as well as core components being replaced as part of the service regime at intervals defined in the Service manuals.

Maintaining a system and ensuring that it is set up for the required application will reduce reactive maintenance calls and increase the operating efficiency hence reducing running costs through the systems lifetime. These actions will ensure that your initial investment is protected.

Please talk to your sales engineer for the details of each package.

For further information contact your sales engineer or visit:
www.daikin.co.uk/contact