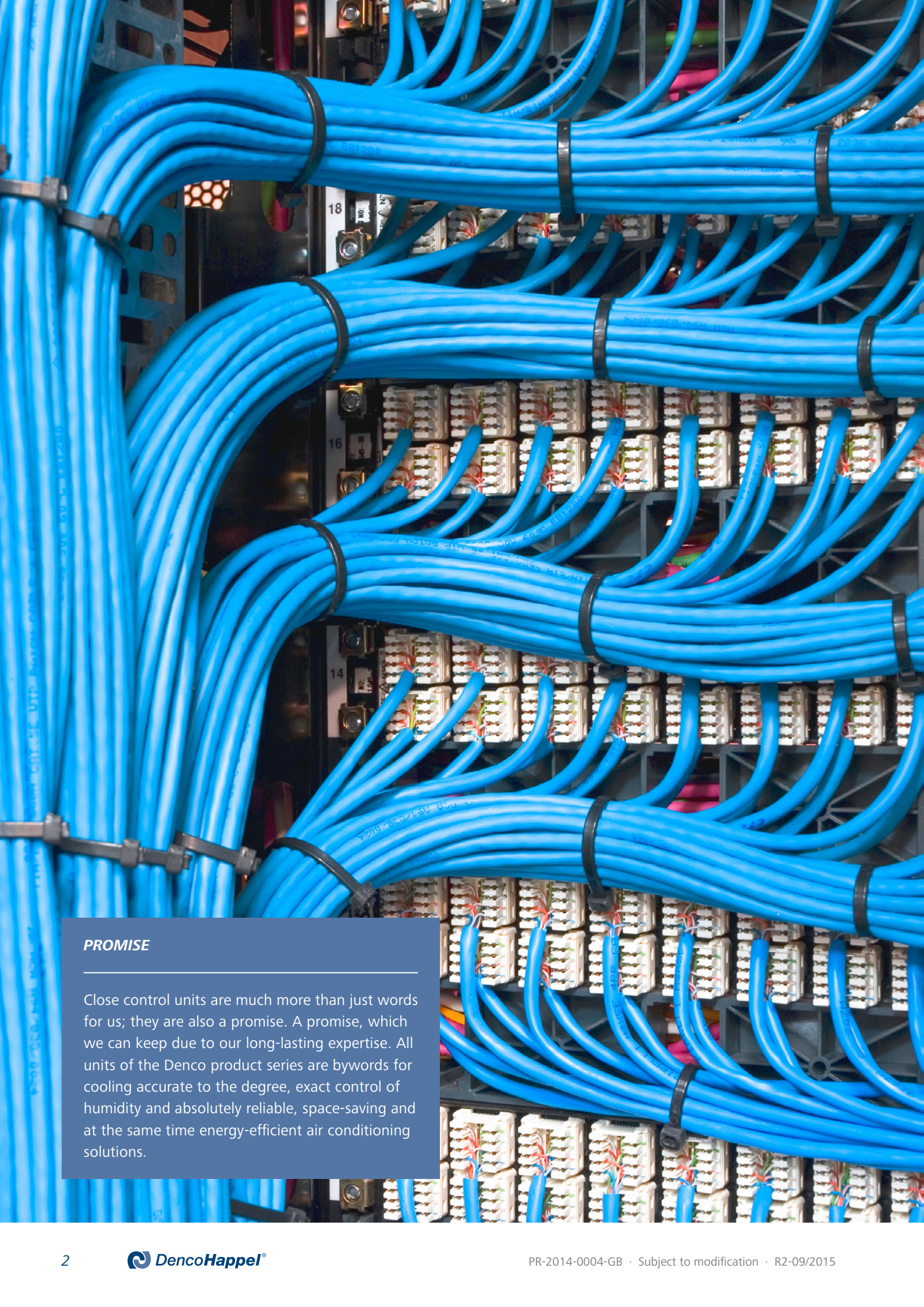


APPLICATION BROCHURE

Reliable and Highly Efficient Cooling
DENCO®-Products

***Precision Climate Control
for Critical Environments***





PROMISE

Close control units are much more than just words for us; they are also a promise. A promise, which we can keep due to our long-lasting expertise. All units of the Denco product series are bywords for cooling accurate to the degree, exact control of humidity and absolutely reliable, space-saving and at the same time energy-efficient air conditioning solutions.

Efficient solutions for sensitive environments

We are involved and experienced in a wide variety of industries: from cooling towers and large volume handlers to office-based comfort cooling. We use this vast pool of knowledge to supplement our extensive history within the industry to continually design, innovate, redesign and improve our products so we can enable your operations to thrive.

When it comes to close control environments such as data centres, communications rooms, laboratories and more, we have the DENCO product portfolio. Our solutions include:

Adia-DENCO®

An air handling unit that utilises the principles of adiabatic cooling to deliver exceptional power to cooling ratio.

Multi-DENCO®

An adaptable and reliable solution for efficient cooling that can be applied to multiple situations and designs.

Ultra-DENCO®

A chilled water underfloor solution with superb cooling and energy performance.

Row-DENCO®

A high density, small footprint unit, which is located amongst or next to servers.

Picco-DENCO®

A smaller, flexible unit, specifically designed for small rooms requiring cooling.

Our products are based and driven on efficiency. They are design efficient, service efficient, control efficient and most importantly energy efficient. With reports suggesting that energy consumption within data centres accounts for approximately 2 % of global energy use, which is equivalent to the aviation sector, never before has energy efficiency been so fundamental to the future of the industry.

We do not only supply you with efficient components, but can supply efficient systems as well. With a wide range of industry knowledge, we provide ideal solutions to work in harmony with new or existing subsystems, maximising the potential saving returns. Our products are designed and built with the highest quality standards to provide an ecological and economical durability to your application. We can provide maintenance and service capabilities, further extending that durability.

We have an established support network and a global presence. With international locations of factories, sales offices, service and support, we can be wherever you need us to.

- Decades of experience
- Comprehensive product portfolio
- Efficiency focused design
- System based solutions
- High quality designs and manufacture
- In-house maintenance and service capabilities
- Established support network
- Global presence
- Trusted and experienced suppliers



We recommend

- *Adia*-DENCO
- *Ultra*-DENCO
- *Multi*-DENCO
- *Row*-DENCO

We recommend

- *Adia*-DENCO
- *Picco*-DENCO
- *Row*-DENCO

Data Centres

We consider a large data centre to be greater than 5000m² foot print, a medium data centre to be up to 5000m² and a small data centre to be up to 500m². For all sizes of data centres, higher levels of investment are available to ensure high energy saving for a quicker payback period. Data centre customers will be looking for the best technology available to give maximum efficiency along with a consistent cooling solution. They will want good redundancy features whilst maintaining the ability to adapt to a fast paced and everchanging industry. They will ultimately be looking for a “24 by forever” solution and will not want their mechanical services to limit their IT potential.

Server Rooms

Enterprises or end-user clients who must keep control of their servers and data may maintain smaller scale data centres or rooms up to a scale of 100m² with lower density equipment. They may not have space or resources to operate a comprehensive redundancy, but they will want consistency of design, simplicity and reliability. Ultimately they will want a system that is efficient, easily configurable and allows them to have a good level of uptime to meet their business needs.



Laboratories, Archive Stores and Museums

Cooling capacity requirements of these types of rooms may not be as high or as dense as data centres, but the requirements for close control will be equal or higher. For these customers, energy efficiency is a desired metric, but it comes second to the accuracy and control with the customer needs over that climate. The precision required is enabled by the DENCO product range by use of both variable cooling and variable heating to enable a precise and continuous environmental control. This coupled with humidifier options and dehumidification using heater control allows for ideal climate management.

Telecom and Switching Rooms

The crossroads for most communications within a building, the telecom rooms, can be a critical point for the network management of an enterprise. Whilst not requiring large amount of space or particularly large cooling capacities, users will still need the control and protection of a good environment for the equipment to work in.

We recommend

- *Multi-DENCO*
- *Picco-DENCO*

We recommend

- *Multi-DENCO*
- *Picco-DENCO*

Optimise conditions and maximise your savings

The Uptime Institute

- Unbiased, third-party data centre research organisation
- Founded in 1993
- www.uptimeinstitute.com

ASHRAE

- American Society of Heating, Refrigerating and Air-Conditioning Engineers
- Mission statement: To advance the arts and sciences of heating, ventilation, air-conditioning and refrigeration to serve humanity and promote a sustainable world.
- Founded as ASHAE in 1894
- Modern format due to merger of ASHAE and ASRE in 1959
- www.ashrae.org

With energy costs increasing pressure on data centres and more than two-thirds describing that reducing energy consumption is “very important”¹, control of room temperature is no longer our industry’s only priority. Buying more efficient equipment can be a good start, but you can maximise savings by evaluating your operating conditions, enabling cost reduction to be made year-on-year.

ASHRAE Thermal Guidelines ²			
Class	Dry-Bulb Temperature (°C)	Humidity Range (Non Condensing)	Maximum Rate of Change (°C/hr)
A1	15 – 32	20% to 80% RH	5/20
A2	10 – 35		
A3	5 – 40	-12 °C DP & 8% to 85% RH	
A4	5 – 45	-12 °C DP & 8% to 90% RH	

Class B and C do not apply to data centres.

For the classes above, the guidelines have a recommended dry bulb temperature range of 18 °C to 27 °C. DENCO products recognise the developments in IT equipment and are designed to capitalise on these capabilities. The higher temperatures allow for better efficiency throughout our range. Alongside this opportunity, we also have knowledge and experience of other methods to save energy:

- A sensible heat ratio (SHR) of 1 is best for performance. All the energy used is going directly into cooling the dry-bulb temperature of the air. Any other value than 1 shows that energy is being wasted.
- EC fans or inverter compressors enable great energy savings. These technologies combined and networking strategies, such as running redundancy, enable greater savings than the sum of the individual parts.
- Use hot and/or cold aisle configuration: higher air inlet temperatures increase freecooling potential.
- Humidifiers can be a source of energy waste: a sealed room can reduce or remove humidification needs or only require installation of humidifiers on some units.
- Air tightness expresses how well sealed the room is. It helps the stability and control of an environment.

¹ Uptime Institute 2013 Data Centre Industry Survey – Matt Stansberry & Julian Kudritzki

² Allowable boundaries are expansive values based on assessment of specification and adhering to ASHRAE assessment methodology. Values: “2011 Thermal Guidelines for Data Processing Environments – Expanded Data Center Classes and Usage Guidance”

Increase your profits on the bottom line

SHR: Sensible Heat Ratio

An SHR of 1 is ideal. It demonstrates that all the energy is being used to cool the air, whereas a lower value shows that the moisture content in the air is being changed during the cooling process, i.e. condensation is being made. Other methods of calculating SHR include looking at inlet or outlet temperatures and moisture.

$$\text{Sensible Heat Ratio} = \frac{\text{Gross Sensible Capacity}}{\text{Gross Total Capacity}}$$

SEER: Seasonal Energy Efficiency Ratio

As EER values would vary when comparing the same system in different locations with different climates, the SEER is a useful annualised comparison. The use of total is to signify a time period relating to interest.

$$\text{Seasonal Energy Efficiency Ratio} = \frac{\text{Total Effective Cooling}}{\text{Total Power Input}}$$

EER: Energy Efficiency Ratio

The EER expresses a comparison of the how much useful cooling has been made relative to the amount of power that has been used by the unit. It is a sample of a specific condition at a particular moment and would be affected by conditions indoors as well as outside of the building.

$$\text{Energy Efficiency Ratio} = \frac{\text{Effective Cooling}}{\text{Power Input}}$$

PUE: Power Usage Effectiveness

This metric has received rapid adoption by the industry as a simple method to give a ratio as to the power requirements to maintain operation of your IT equipment. This is discussed in greater depth on the next page.

$$\text{Power Usage Effectiveness} = \frac{\text{Total Power Consumption}}{\text{Power Consumption by IT Equipment}}$$

Minimising use, minimising costs

Four categories classify the accuracy of a PUE measurement:

PUE Category 0

- IT load measured at UPS output(s)
- Total data centre power measured at the utility meters
- Peak utilisation/demand in a single snapshot measurement

PUE Category 1

- IT load measured at UPS output(s)
- Total data centre power measured at the utility meters
- 12 month cumulative readings

PUE Category 2

- IT load measured at PDUs supporting IT loads
- Total data centre power measured at the utility meters
- Peak utilisation/demand in a single snapshot measurement

PUE Category 3

- IT load measured at the point of connection of IT devices to electrical system
- Total data centre power measured at utility meters
- 12 month cumulative readings

Power usage effectiveness (PUE) is a ratio to assess how much energy has been used to service or cool the IT equipment in the data centre relative to the amount of energy used by the IT equipment. It has a simple equation:

$$\text{Power Usage Effectiveness} = \frac{\text{Total Power Consumption}}{\text{Power Consumption by IT Equipment}}$$

The ideal value is 1, where all energy used within the data centre has only been used on the IT equipment and therefore no cooling, lighting, uninterrupted power supply (UPS) losses or mechanical services have been required to keep the IT equipment running.

The Uptime Institute survey estimates that an average PUE amongst data centres is 1.65¹, but also advises that with companies investing in better energy efficient equipment and adopting industry best practice, this number could be reduced considerably. Some companies have been noted to perform exceptionally, achieving PUE scores of 1.10 or less, the implication that for every 1 kW of energy they use on IT equipment, it only requires 0.1 kW of energy to cool, light and maintain the data centre.

When using PUE, caution is required: the figure can easily be manipulated. As the IT equipment's energy is the denominator of the equation, then if you had two quotes, both with the same mechanical equipment, but one has less efficient IT equipment, the less efficient quote would have a better PUE value, even though, in the real world, it would be the wrong option.

We would recommend, where possible, using the highest category as the measurement technique for sampling your PUE. The lower the category the less accurate your sample of PUE will be. It could be affected by hot or cold days as well as by under-utilised IT equipment. Using a lower category will also mean it is difficult to know if you are making effective improvements to your energy saving..

¹ Based on self-reported figures in the Uptime Institute 2013 Data Centre Industry Survey
– Matt Stansberry & Julian Kudritzki

Little affect, little effect

Green IT

Green IT can mean different things to different individuals or organisations. For instance: “Green IT is a collection of strategic and tactical initiatives that directly reduces the carbon footprint of an organisation’s computing operation” is a part of how BCS, The Chartered Institute for IT, outline the subject.

Alternatively, Greenpeace equate ‘Green IT = Energy Efficiency + Renewable Energy’ with an emphasis and focus on the source of the energy, rather than just the efficiency of the consuming device.

Others may combine these ideologies, but the objective is the same: reduce and minimise our industry’s impact of the environment that we inhabit. All our products have efficiency as a central focus, reducing our consumption, and some products can utilise their environment conditions to provide freecooling for your systems.

We believe by having a green approach and technical expertise, combined with our customers desires and applications, we can together make our environment a better place for all.

Tier Classification

The Uptime Institute devised a set of tier classifications to be able to consistently describe and compare data centres and their infrastructure in terms of projected reliability and uptime availability.

The standard is designed in a manner so that any site is limited to its weakest subsystem. It helps individuals to understand and assess complex infrastructure when comparing across sites and can allow for a common comparable aspect on what might be vastly differing designs.

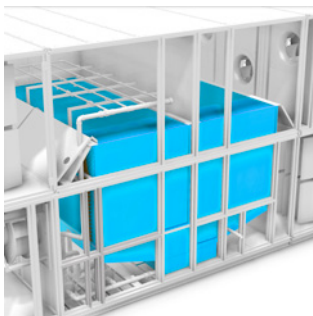
DENCO products are designed in awareness of this standard and its growing popularity and use within the industry and therefore have several options to help align with your tier requirements. Whether that is N+1 networking capabilities for seamless maintenance or dual power supply inputs.



Large volume meets efficient design

THE AMBIENT ENHANCER

Adia-DENCO utilises your local climate for energy efficient operation. Adiabatic cooling, coupled with a large plate heat exchanger empowers long term, energy efficient customers to achieve exceptional EER values. Up to 300+ kW in several casing sizes using two airflow configurations, means that any site location can capitalise on the potential of their ambient climate.



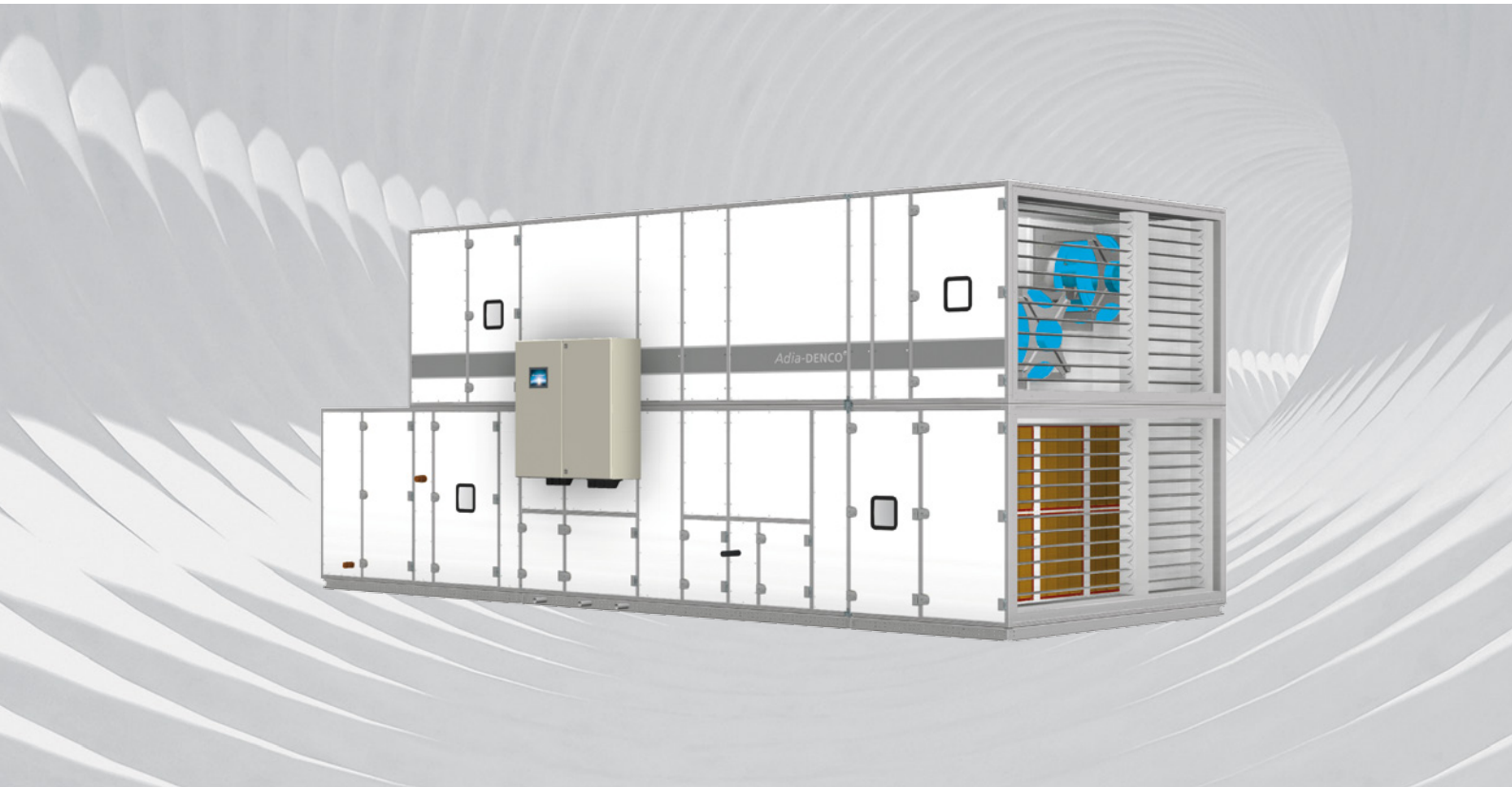
Double Plate Heat Exchanger inside

- Large surface area
- Low air pressure drop
- Epoxy-coated
- Sealed aluminium plates

Adia-DENCO has evolved from the well-established CAIR range of air handling units, incorporating adiabatic cooling and being tailored to data centres. The adiabatic process is not used constantly. Below approximately 30 kJ/kg (e.g. 15 °C, 55 % room humidity) it can operate on indirect freecooling. Adiabatic cooling (without using refrigeration technology) can extend cooling up to an enthalpy of approximately 60 kJ/kg (e.g. 28 °C, 50 % room humidity).

Adia-DENCO stands for indirect freecooling. It does not expose the room to contaminants in ambient air, ensuring a high quality of cleanliness. It can use Eurovent certified bag filters, which ensures that air entering the plate heat exchanger (PHE) is clean and of high quality.

These are only a few features available with a Adia-DENCO unit and when coupled with an advanced, multi-lingual control interface, makes it a fantastic investment.



Peak protection

For climates with wide variability in their temperatures, *Adia-DENCO* units can be installed with a redundant cooler coil as an option. These coils can cover either peak load or redundancy to ensure smooth operation.

Casing configured

Adia-DENCO has a variety of casing features available including indoor and outdoor versions and can be installed with dampers, weather guards and a weather roof. The casing material can also be tailored to individual needs.

Finest filtration

Using Eurovent certified bag filters, your unit will ensure durability and effectiveness between maintenances. Filters meet EN779:2012 and filter classes G4, M5 and F7 are selectable along with special requests for hygienic, explosion-proof and fire-proof filters.

Water saving

Adia-DENCO units use reverse osmosis water which allows for the water to be reused in adiabatic cooling several times. This dramatically reduces flush cycles from every hour to typically once a day. This, combined with intelligent control software, allows for water use to be minimised.



Adiabatic cooling

- Optimised nozzle configuration
- Inbuilt redundancy options
- No degradation using demineralised water
- Water saving controls
- Stainless steel low pressure nozzles

CASE STUDY

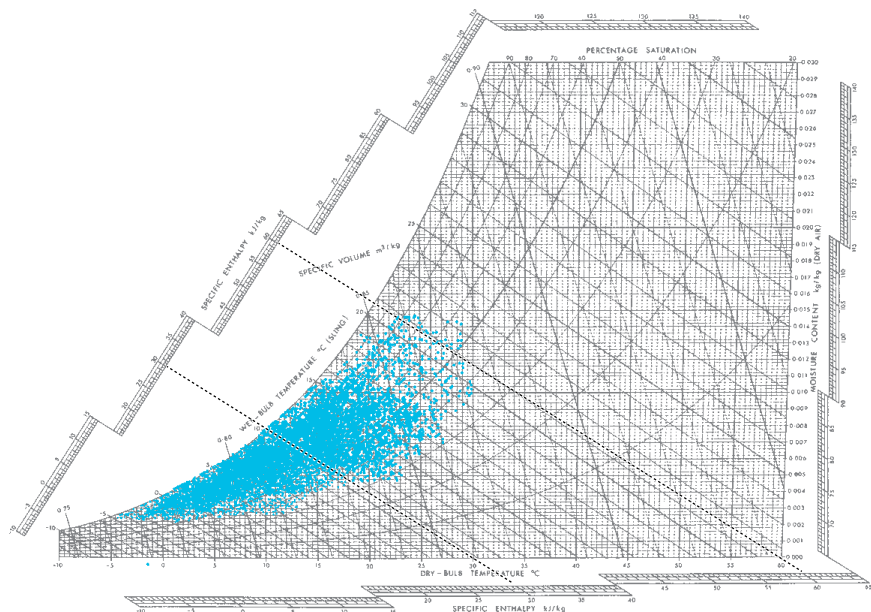
Reduce costs for capital, installation and consumption

- Exploits the principles of both freecooling and adiabatic cooling
- Can reduce or eliminate need for mechanical cooling within central Europe
- Meets all requirements relating to Green IT
- Global compatibility

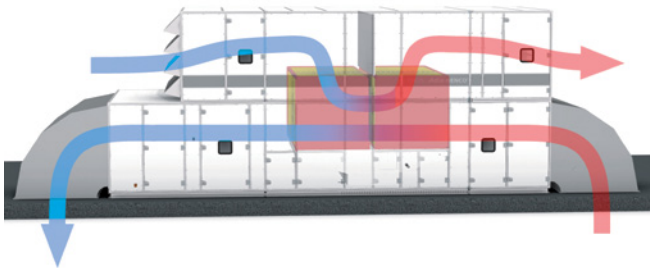
The graph below shows the temperature and humidity profile of London, UK over a year on a psychrometrics chart. The two diagonal lines represent approximate points where *Adia-DENCO* unit operation changes. The lower line shows a change from freecooling to adiabatic cooling with the higher line showing a transition from adiabatic to mechanical cooling.

Those boundaries are representative and we have calculated that you can achieve all those samples using adiabatic and freecooling only, with a supply air temperature of 25°C. We have compared this temperature profile with the rest of central Europe and it has shown that mechanical cooling is not required with an *Adia-DENCO* within central Europe. This design means you can have lower capital costs, lower install costs and, most importantly, lower consumption costs for both energy and water.

London, UK

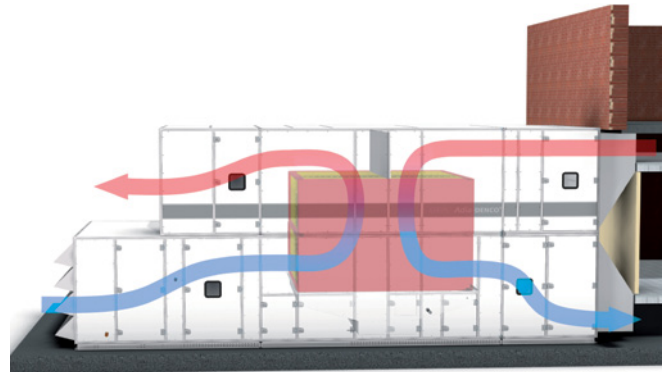


Airflow configurations



Roof configuration

In this configuration, cold ambient air, entering in the top left of this image, passes through the plate heat exchanger and exits the unit on the top level out of the right hand side. The air returning from the room enters from the bottom right of the unit and travels in a straight line through the plate heat exchanger to be returned back to the room out of the bottom left of the unit.



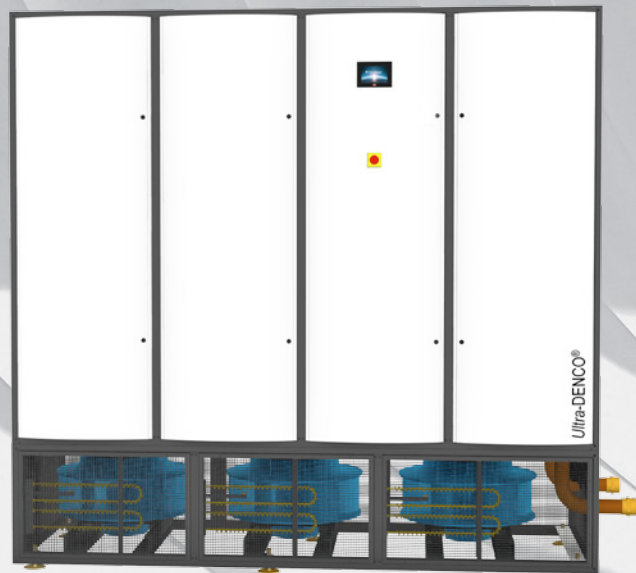
Wall configuration

In this configuration, any air that enters the unit is returned to the same side, therefore allowing the unit to be installed alongside your room. Cold ambient air enters in the bottom left of the unit and flows upwards through the plate heat exchanger. An advantage of this arrangement is that adiabatic cooling is possible against the flow of air, improving efficiencies. Air returning from the room enters in the top right of the unit and is drawn downwards through the plate heat exchanger, allowing for cross flow against the ambient air.

For high efficiency and consistent temperatures

THE POWERFUL PERFORMER

Ultra-DENCO is driven on cooling performance. Designed specifically for data centres, it can deliver up to 200kW of chilled water cooling by utilising down flow air path with large EC fans mounted directly in the floor void. This reduces pressure drops and delivers exceptional performance for the best economies of scale.



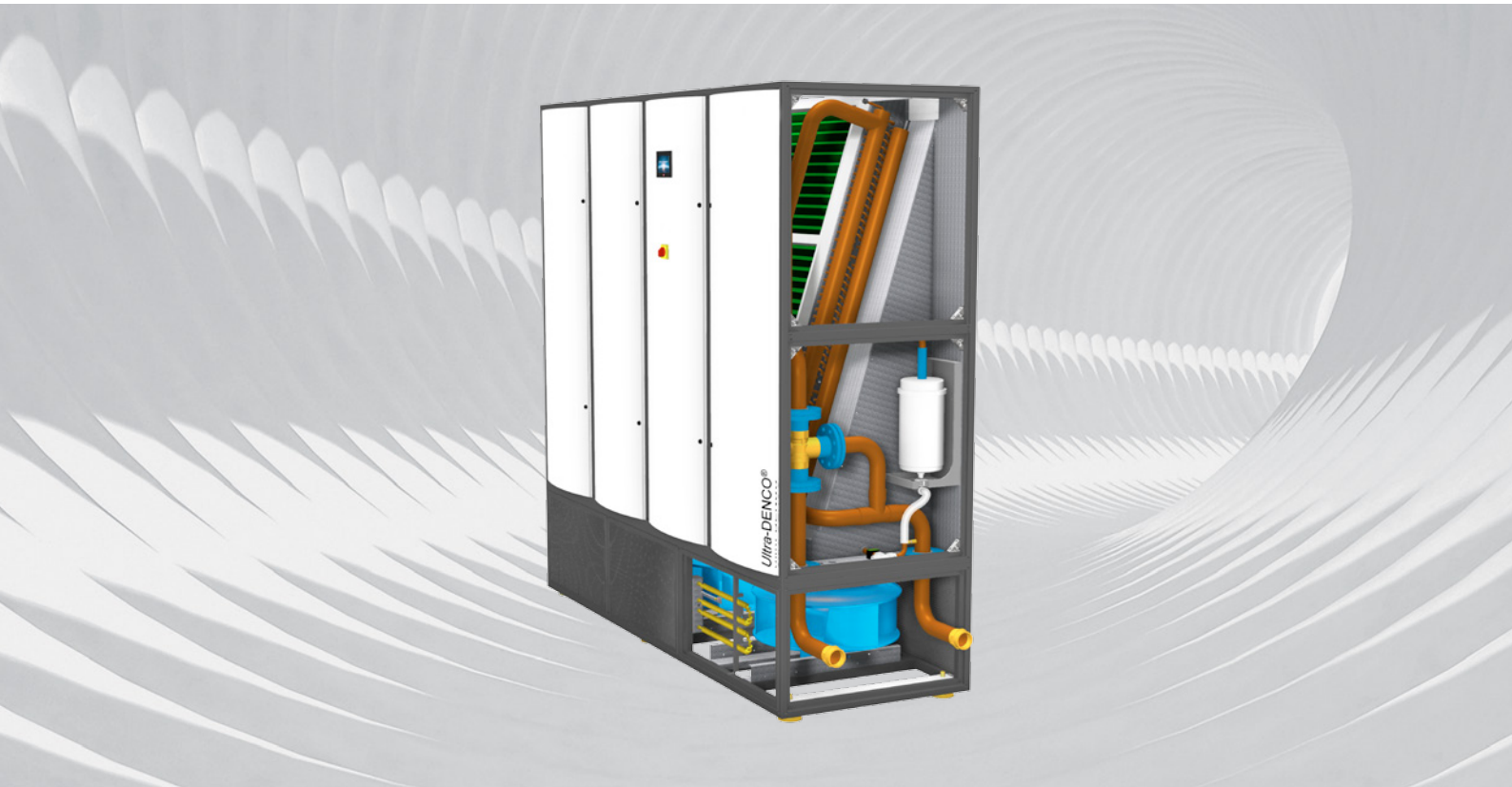
EC fans

- Large diameter EC fans
- Reduced static regain losses
- Easy maintenance access
- Variable for efficient partial loads and APS compatibility

Ultra-DENCO is all about performance. It is specifically designed for high efficiency and consistent temperatures so that your servers can give a peak performance. The units are available from 50kW to 200kW and utilise underfloor voids for the fans to improve the airflow and cooling performance. They are only available in down flow air configuration.

Ultra-DENCO units benefit from the positioning of the fan in the raised floor. It reduces the static regain losses, which allows for a large coil increasing the surface area and reducing the pressure drops across the coil. It allows for exclusive maintenance from the front of the unit. For performance, it has a large six row coil and each component within the chilled water circuit has been specifically designed for minimum pressure drop.

The design allows for very high duties at standard water temperatures with the possibility of greater efficiencies at higher temperatures. They are ideally suited towards data centres with a floor void of 500mm or larger, orientated in a down flow configuration and can function with such features as automatic pressurised system (APS) to be used in the floor void.



Large EC plug fans

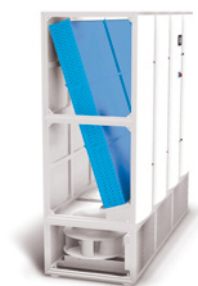
By utilising the floor void as location for the EC fans in an *Ultra-DENCO*, it reduces static regain losses allowing for a reduction in power consumption. The use of EC fans also allows for efficient operation at partial load conditions.

Six rows deep coil

The large coil increases capacity whilst reducing pressure drop. Refined using computational fluid dynamics (CFD) simulations to ensure return air is carefully guided over the coil vanes to give even distribution and maximum heat exchange.

Network capability

With a range of compatible interfaces, networking capabilities and running redundancy capabilities, the scale of *Ultra-DENCO* units is not limited to our largest size. It is also compatible with most common industry building management systems, enabling remote operation and monitoring.



Larger coil

- Increased capacity
- Reduced air pressure drops
- Reduced water pressure drops
- Coil angle optimised for efficiency

Less energy consumption, more savings

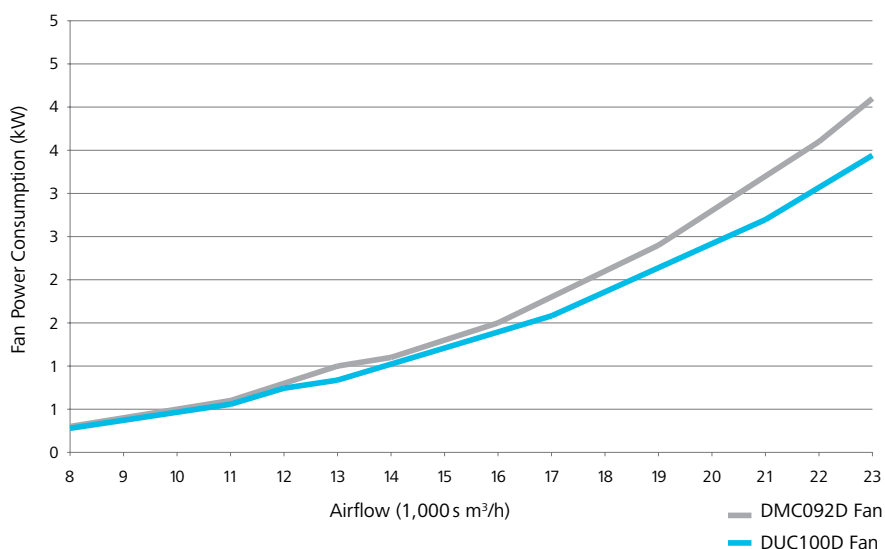
- Reduced fan power consumption
- Savings increase with airflow
- Easy fan access

The graph below shows a comparison between a *Multi-DENCO* DMC092D unit and a *Ultra-DENCO* DUC100D. Both units cool air by chilled water, use the same number and type of fans and have approximately the same footprint (2.20m² vs 2.26m²). The main difference between them is that the DUC100D unit has fans that are installed in the floor void and therefore it has a larger coil.

The result is that across the range of comparable airflows, *Ultra-DENCO* fans use less power consumption. These savings increase along with an increase in the airflow. There are significant savings available from this configuration at 23,000 m³/h, the DUC100D unit uses 0.7 kW less power. When this saving is scaled up to annual consumption, you could save €920 per annum*.

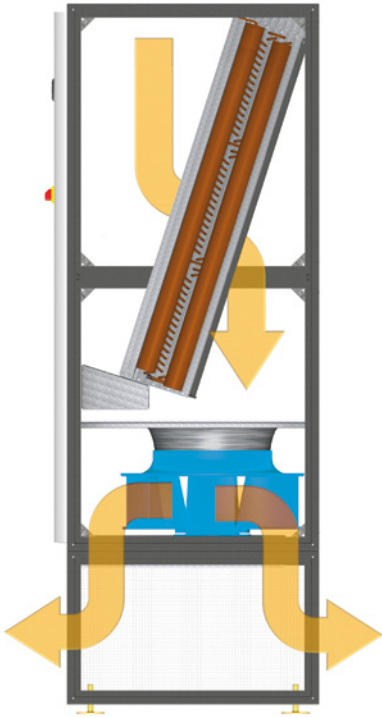
Ultra-DENCO can exploit further savings as it can provide more cooling (higher delta temperatures) at certain airflows.

Fan Power Comparison



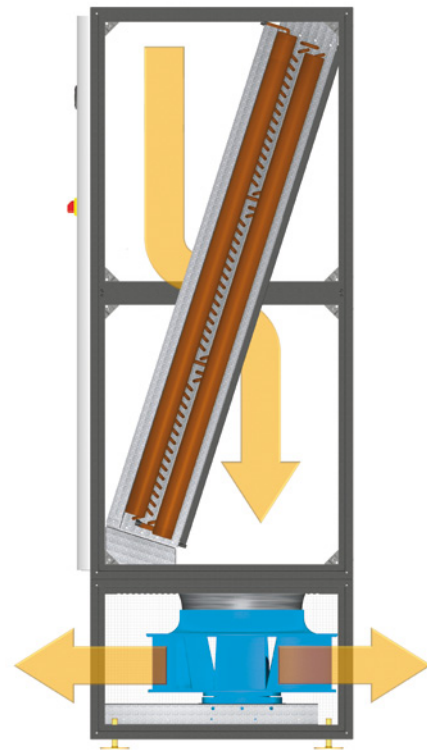
* Calculated using 1 kWh = €0,15

Airflow advantages



Traditional

With previous designs including the fan within the unit, rather than within the floor void, the unit's airflow was less efficient. Air was typically directed against solid objects and had larger static regain losses due to the air needing to change direction several times. Another effect was a limitation of the coil size as free space for the fan was required.



Ultra-DENCO®

With *Ultra-DENCO* fans being in the floor void, it allows for a larger coil. Secondly, it reduces those static losses as the air is sent directly into the free space where it is required.

Three versions, top performance

THE FLEXIBLE ALL-ROUNDER

Multi-DENCO is a flexible and adaptable product. Up to 130 kW in seven casing sizes, there are three cooling versions and two airflow directions. It can work with room cooling or aisle containment and can humidify, dehumidify and even heat your room. With such a large variety of options, features and designs, it can be the mould to your needs.



Inverter compressors

- Energy efficient
- Enables closer, proportional control
- Lower start-up currents
- Fewer damaging ON/OFF routines
- Oil self-regulation

There are three versions of the *Multi-DENCO* design available:

A-Version

Using R410A with inverter compressors in the indoor unit, it can deliver the best EER values.

C-Version

Chilled water cooling utilising either four row or six row coils for high performance along with a variety of valve and actuator combinations.

X-Version

To reduce sound or refrigerant within a room, the X-Version is similar to the A-Version except the compressors are in the outdoor unit.

All the above versions can be made as CombiCool units: an additional chilled water circuit added to the unit for primary cooling with the possibility of utilising a freecooling source with the other circuit as a redundancy backup.



Inverter compressors

For direct expansion versions, inverter compressors allow the unit to match your load. This enables closer, proportional control. The inverter looks at several variables and then adjusts its speed to match the demand exactly.

EC plug fans

By using the largest EC plug fans possible for the space inside a *Multi-DENCO* unit allows for slower speeds resulting in quieter, more efficient fan operation.

Advance controls

The latest control technology is integrated into a *Multi-DENCO* unit along with a 4.3" touch screen display. This combines with networking capabilities and system recording to give high quality feedback and control.

Inbuilt redundancy

All *Multi-DENCO* units can be customised into a CombiCool configuration: Three rows of the coil being for one circuit, the other three being for a separate circuit. This allows for 100 % cooling redundancy within the unit with the controls system being easily able to switch between each circuit.



CombiCool

- Inbuilt redundancy
- Freecooling possibilities
- Automatic change-over
- Cooling diversity
- Established technology

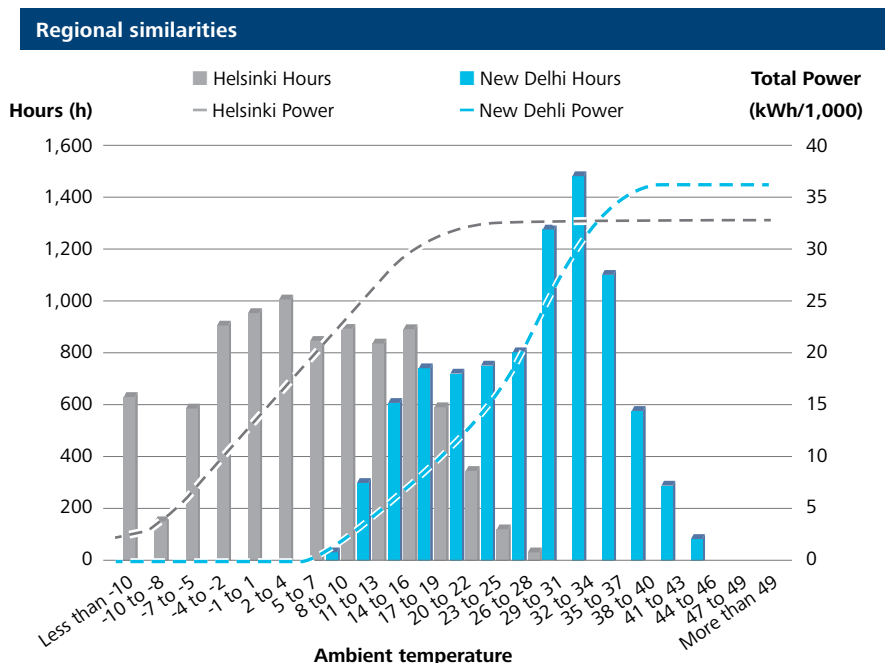
Energy efficiency around the globe

- Predictable energy consumption
- Mechanical reliability
- Climate irrelevant output
- Global installation opportunities

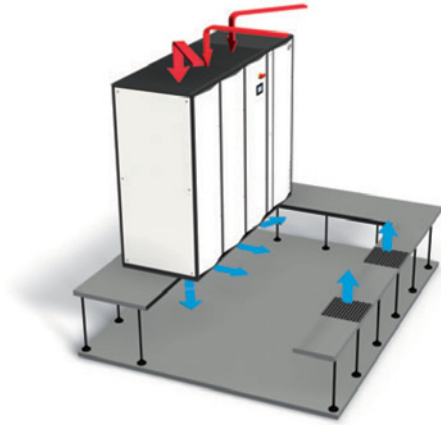
The graph below shows a comparison of two *Multi-DENCO* units both operating with the same indoor conditions, using R410A refrigerant, but one unit is operating in Helsinki – Finland (grey) and the other is in New Delhi – India (orange).

The bar graph shows the number of hours per year that each location is at that temperature and as you already know, Helsinki is considerably colder than New Delhi. The line graph shows the cumulative power consumption as the temperatures rise per annum. The unit is very efficient in both locations, but what you may not know is there is only a difference of 3,860 kWh total energy used between these two extreme locations.

The reason is that our direct expansion system has constant, but low, power consumption for all ambient temperatures below 21 °C in this example. This allows for you to have predictability and flexibility; no longer are cold climates the only ideal location for data centres. This means that *Multi-DENCO* units can address your local needs whilst providing great energy savings.



Airflow configurations



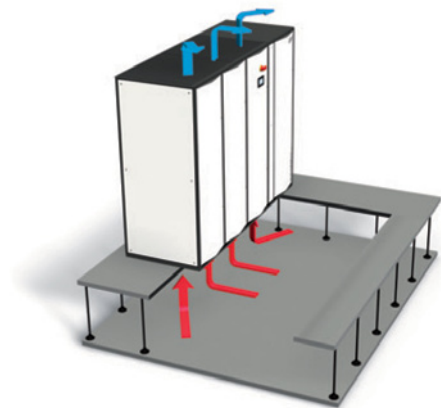
Downflow – Underfloor

Warm air is taken from within the room or from a suspended ceiling and then cold air is delivered into a raised floor.



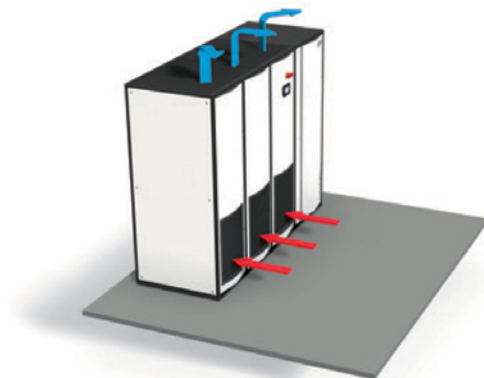
Downflow – In-room

Warm air is taken from within the room or from a suspended ceiling but cold air is delivered directly into the room through the grilles that are mounted into the front doors.



Upflow – Underfloor

Warm air is taken from the raised floor, cooled and then delivered either directly into the room or into a suspended ceiling or ductwork.



Upflow – In-room

Warm air is taken directly from the room using grilles in the front doors and then cold air is delivered either directly into the room or into a suspended ceiling or ductwork.

Getting closer to the action

THE NEXT-DOOR NEIGHBOUR

Row-DENCO positions alongside your servers. Designed specifically for data centres, units are only 300 mm wide available as direct expansion and chilled water cooling. Four airflow configurations are available allowing the unit to be positioned amongst a server row. It is an adaptable and scalable design in a compact configuration.



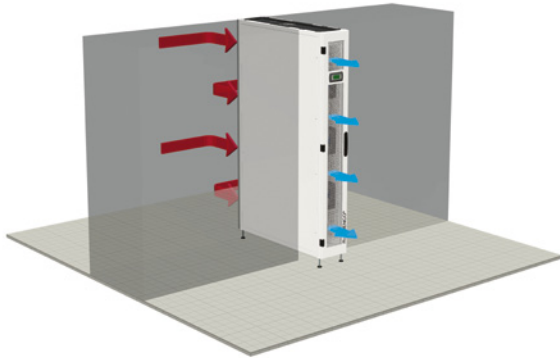
Row-DENCO is our most direct product, reducing airflow path lengths by placing the unit side-by-side with the heat source of the room between your servers. This has distinct advantages; it can improve airflow around the servers, eliminating potentially dangerous hot spots, it can allow the unit to be associated directly with high density servers rather than whole room-cooling and it can work with an improved temperature differential between the hot and cold aisles.

Row-DENCO is built with speed, simplicity and compatibility in mind. There are four airflow paths available, connections for all units can be made at either the top or the bottom of the unit. The unit has integrated wheels for easy moving and positioning on site and it requires no raised floor or suspended ceiling. All these features and more make Row-DENCO ideal for an expanding, high density data centre.

Features

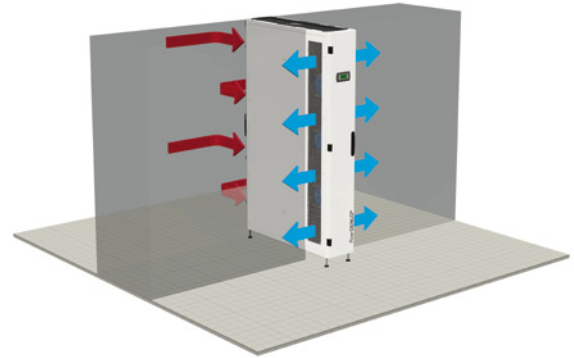
- Hot swappable EC fans
- Standard U42 rack height
- Energy monitoring

Airflow configurations



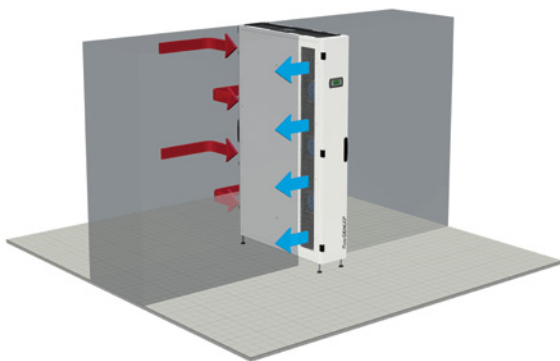
Front discharge

Front discharge is possible using either a 1,000 mm casing or 1,200 mm casing (shown above). Warm air is drawn from the hot aisle and then cold air is delivered directly out of the front of the unit, allowing for the air to diffuse back to the servers.



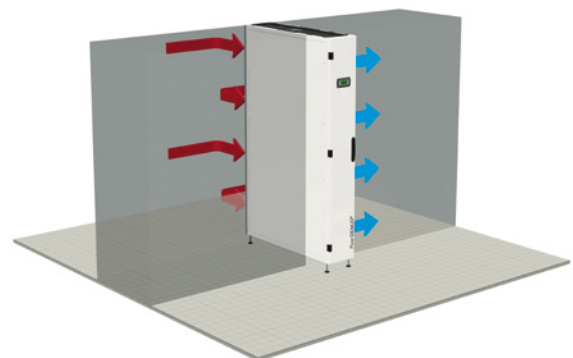
Left and right discharge

Left and right discharge uses a 1,200 mm deep case. As the Row-DENCO unit extrudes into the cold aisle, the air is delivered across the face of the servers through grilles on the side panels. The front door has no grille, therefore the air is forced horizontally.



Right discharge

Right discharge uses a 1,200 mm deep case. It is similar to the left and right discharge design except with one grille is blocked. Typically these designs would be used for the end of a server rack.



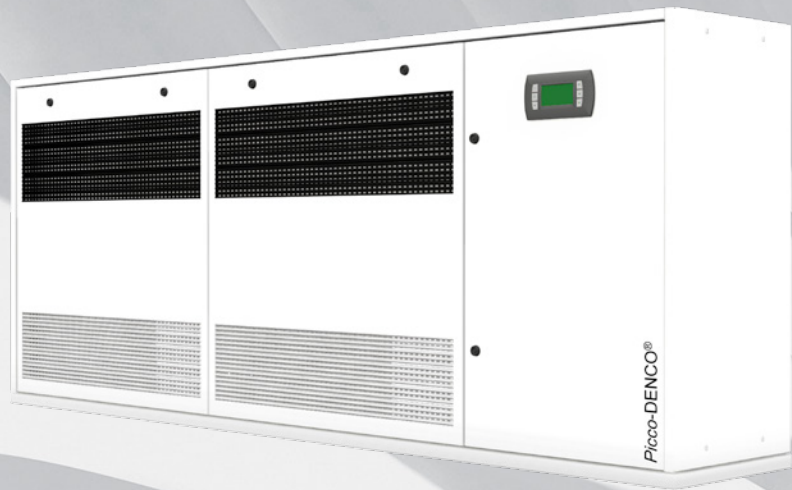
Left discharge

Left discharge uses a 1,200 mm deep case. It is similar to the left and right discharge design except with one grille is blocked. Typically these designs would be used for the end of a server rack.

Small, yet significant

THE COMPACT CLASS

Picco-DENCO is our solution for lower capacities in a diverse range of applications. With cooling capacities up to 11 kW, it is available as a direct expansion or chilled water version over two model sizes. With EC fans as standard and features such as humidification and electric heating or low pressure hot water heating available, it is a small unit, containing a large potential.



Features

- Heating options
- EC Fans
- Humidification
- Remote temperature and humidity sensors
- BMS interfaces options

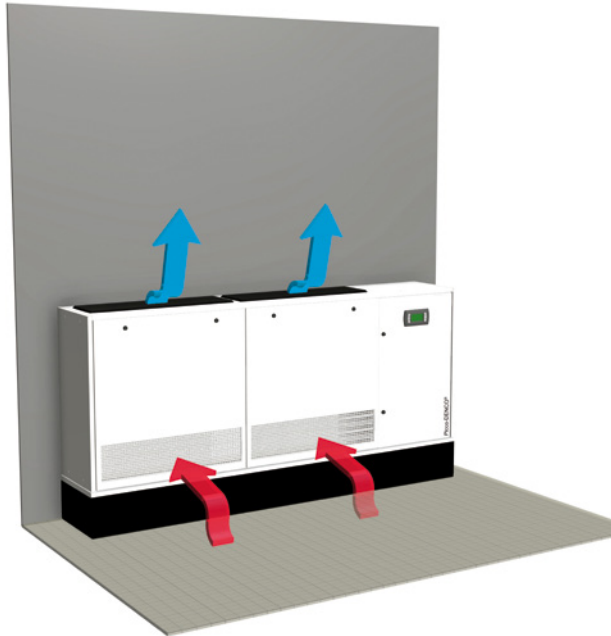
Picco-DENCO is our compact solution, providing full function capabilities in a unit suited for a variety of locations and applications. The design is suited to applications where capacities and air volumes are lower, but demand for close control air conditioning is no less.

Available with an upflow air configuration, the *Picco-DENCO* units can be floor or wall mounted and can operate as a chilled water version (CW) or as a direct expansion version (DX) with the latter having the compressor installed in an outdoor condensing unit.

The controls feature of the unit allows the unit to operate with duty standby conditions or as running redundancy and furthermore the ability to integrate with common BMS protocols such as Modbus, pCOWeb & BACNet.

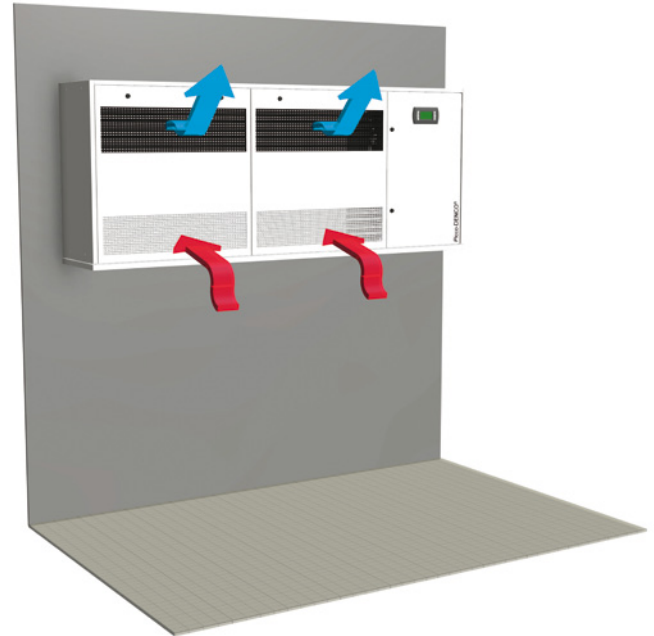
The features are able to deliver up to 11+ kW cooling duty with possibility of no floor space being required.

Airflow configurations



Floor configuration

With a floor configuration, air is taken in through grilles on the front doors of the unit and cold air is released into the room out of the top of the unit. Typically this configuration is used with a plinth to allow for mechanical and electrical services to enter through the bottom of the unit.



Wall configuration

For wall configuration, both supply and return air pass through the grilles on the front panels of the unit. Mechanical services are also supplied through the bottom panel of this configuration.

Technical Data

Adia-Denco®								
Unit Sizes		55	120	170	190	220	250	251
Cooling Duty (Gross Total)	kW	58.4	122.3	182.9	199.8	238.1	264.1	264.1
Airflow (Ambient)	m³/h	9,000	18,500	30,500	29,250	36,500	44,500	44,500
Airflow (Room)	m³/h	1,000	23,200	34,100	37,900	44,300	49,500	49,500
Power Input	kW	5.22	7.39	17.41	12.02	18.38	20.98	23.78
Configuration		Roof	Roof	Wall	Roof	Wall	Roof	Wall
Length	mm	5,280	5,800	4,960	6,480	5,160	5,160	6,480
Width	mm	1,720	2,640	2,640	2,920	2,920	3,240	3,240
Height	mm	2,240	2,880	4,080	4,080	4,720	4,720	4,720
Weight	kg	Available on request						

Return air conditions: 38 °C/23 % R,H, Supply air with a Delta T 15 K, Ambient: 32 °C/32 % R,H,, 0 Pa external pressure drop,
Weights and dimensions are approximate representations and will vary depending on features installed and version selected,
For more information see specific unit drawings,

Ultra-Denco®					
Unit Sizes		50	100	150	200
Cooling Duty (Gross Total)	kW	44.6	90.9	142.8	184
Airflow	m³/h	10,080	20,520	30,600	44,000
Power Input	kW	1.2	2.7	4.6	6.8
Width	mm	1,335	1,995	2,650	3,310
Depth	mm	900	900	900	900
Height (incl. fan section)	mm	1,960 (2,510)	1,960 (2,510)	1,960 (2,510)	1,988 (2,538)
Weight (incl. fan section)	kg	380 (490)	520 (700)	700 (935)	930 (1.200)

Return air conditions: 24 °C/45 % R.H.

100 % water, delta T = 6 K (7 / 13 °C)

Weights and dimensions are approximate representations and will vary depending on features installed and version selected.

For more information see specific unit drawings.

Multi-Denco®								
Unit Sizes		010	018	030	045	065	092	130
Airflow	m³/h	2,993	5,148	8,640	12,338	18,338	25,920	37,260
A-Version Cooling Duty	kW	10.1	18.6	30.6	45.2	67.5	93.1	131.4
A-Version Power Input	kW	3.0	6.3	8.9	13.7	21.1	30.3	43.8
C-Version Cooling Duty	kW	10.7	18.4	31.1	46.0	67.8	98.9	135.6
C-Version Power Input	kW	0.6	1.6	1.5	2.5	4.1	7.2	10.8
X-Version Cooling Duty	kW	10.1	19.0	30.3	45.1	-	-	-
X-Version Power Input	kW	3.2	6.7	9.2	11.8	-	-	-
Width	mm	600	800	1,180	1,670	1,992	2,500	3,380
Depth	mm	600	600	780	780	880	880	880
Height	mm	1,940	1,940	1,940	1,940	1,972	1,972	1,972
Weight	kg	220	240	330	480	610	770	1,050

Return air conditions: 24 °C/50 % R.H. for all versions.

A- & X-Versions: Condensing Temperature: 45 °C.

C-Version: 100 % water. Delta T = 5 K (7 °C/12 °C)

Weights and dimensions are approximate representations and will vary depending on features installed and version selected.

For more information see specific unit drawings.

Row-Denco®

Unit Sizes		051	071	121	020	025	035	036
Cooling Type		DV	DV	DV	KW	KW	KW	KW
Cooling Duty (Gross Total)	kW	10.63	16.59	28.62	16.14	20.52	24.6	20.95
Airflow	m³/h	1,500	2,700	4,200	2,520	3,360	4,200	4,200
Power Input	kW	3.1	5.3	9.3	0.5	0.7	0.9	0.9
Length x Width x Height	mm	1,000 x 300 x 2,100			1,000 x 300 x 2,100			
Weight	kg	175	190	193	190	193	195	205

Return air conditions: 35 °C / 27 % R.H.

Direct Expansion (DX): ambient: 35 °C

Chilled Water (CW): 100 % water, Delta T = 5 K (10 °C / 15 °C)

Weights and dimensions are approximate representations and will vary depending on features installed and version selected.

For more information see specific unit drawings.

Picco-Denco®

Unit Sizes		007	011	007	011
Cooling Type		DV	DV	KW	KW
Cooling Duty (Gross Total)	kW	7.6	11	6.2	15.2
Airflow	m³/h	1,260	2,880	1,260	2,880
Power Input	kW	2.3	3.4	0.1	0.5
Width	mm	1,400	1,900	1,400	1,900
Depth	mm	300	360	300	360
Height	mm	800	800	800	800
Weight	kg	85	120	85	120

Return air conditions: 24 °C / 50 % R.H.

X-Version (DX): ambient: 32 °C. Power input includes typical outdoor condensing unit.

C-Version (CW): 100 % water, Delta T = 5 K (7 / 12 °C)

Weights and dimensions are approximate representations and will vary depending on features installed and version selected.

For more information see specific unit drawings.

Using our resources effectively



COMPUTATION FOR THE NEXT GENERATION OF COOLING

Our calculations are not limited to within our units. With our software and expertise we also perform calculations on room environments and systems to understand real life applications. It can highlight issues that might be difficult to understand or foresee, but allows for early assessment and modifications as required. Modifications at the design stage have significant cost savings versus later in the project lifecycle.

For DENCO products we are able to work accurately and effectively from development of first concepts, through to validation of final designs. Computational Fluid Dynamics (CFD) software has been used across the range of DENCO products. It allows for the improvement and validation of designs and products that can then be further refined. And with this information, we have been able to achieve improvements such as best angles for a coil within a unit, improved fan positions and removed turbulences at the entry and exit of units. This combined with our use of 3D and 2D CAD packages allows for accurate design, accurate calculations and accurate production.

Validation of our designs is equally important not only for production, but also to give confidence to our customers. We are able to offer customer witness tests and test reports for their final product at conditions they require, with a test engineer to explain their products, operations and possibilities.



Testing facilities in Hereford, UK



Testing facilities in Liberec, Czech Republic



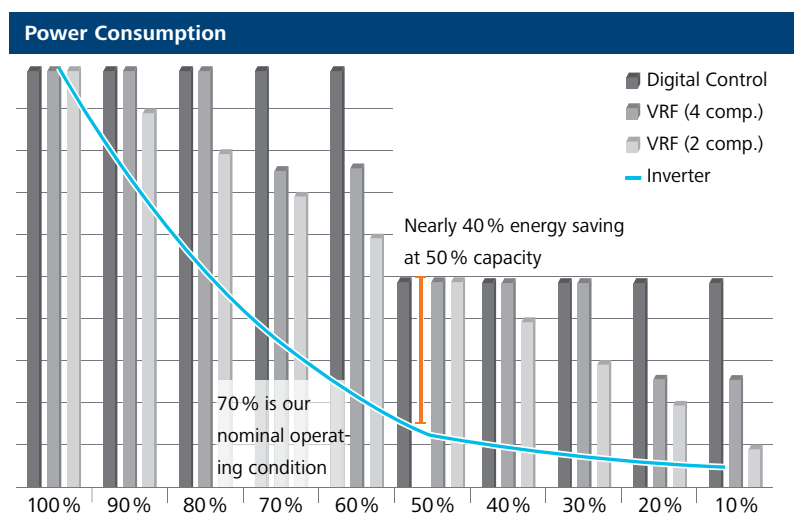
QUALITY

Our DENCO range uses a variety of high-end components. Only the finest parts and materials are used to ensure that your cooling solution is built to last. We undertake strict processes to ensure our suppliers deliver the highest of standards that we require, because our customers deserve nothing less.

Staying on the front edge of development

Inverter compressors

Inverter compressors are widely available across our range of DENCO products. They are truly distinguished in providing the best efficiency for compressor power consumption, especially at partial loads. Very few close control applications operate at nominal or maximum conditions all of the time, therefore the potential energy savings, even compared with a 10 stage digital control, are significant. The inverter compressor not only brings energy savings but also greater control. *Multi-DENCO* units have been shown to be able to control room or return temperatures to an accuracy of $\pm 0.3^{\circ}\text{C}$. Along with no regular ON/OFF, this means that the service length of the compressor can be extended beyond the average.



EC fans

Electronically commutated (EC) fans also observe the 'cube root law' and combine both alternating current (AC) and direct current (DC) voltages. This enables the fans to be infinitely variable and with no frequency dependencies. EC fans are standard across our range of DENCO products. Their high ability for control means that they have enabled advance features within our designs such as automatic pressurised system (APS), sensors averaging to allow for even distribution across several units and the possibility for multiple units to suitably increase their speed when a unit is offline for maintenance. With the energy related products (ErP) directive affecting designs and usage of fans, firstly in 2013 and a further tightening of regulation in 2015, EC technology in fans has been a natural and efficient direction for our designs to meet your requirements.





Pressure independent control valves

Pressure independent control valves (PICV) can save you money by eliminating start-up, routine balancing and install costs. A PICV combines the balancing technology within itself so that it can automatically maintain a stable flow, and therefore a constant cooling duty to negate any pressure instabilities that may be within your system.

As the valve and the balancing aspect are combined into a single component, enabling it to balance both the pressure needs of the system and respond to the flow control requirements. As a result, this combination leads to low basic pressure drop (typically 30 kPa), excellent controllability and head pressure independent control, along with an easier and more convenient install.

Energy monitoring

PUE is an industry recognised metric and it can only be calculated by measurements of power consumption. By installing energy monitoring onto your close control unit, you can see directly the input required on that element in the system.

Performance reporting is important for managerial decisions and with the information transferable via a building management system (BMS), this enables readily available feedback to prove that your unit is as efficient as initially estimated.

Airflow monitoring

Airflow monitoring enables accurate readings of the state and condition of the unit's airflow, which in turn can help reduce time required for commissioning and most importantly give you confidence that your airflow requirements are being met. The inclusion of the sensor can also allow for airflow volumetric control to be implemented.

Power redundancy

Data centres are designed for minimum downtime and that means that your supporting services need to stay online also. DENCO products have several options available to ensure continuous availability and fast recovery:

- Fast restart times – even when continuously availability may not be operationally justifiable, DENCO products have a quick start time to ensure minimal impact on your operations.
- Dual power supply options – for sites with two sources of power, DENCO products can automatically switch between the two sources to use any power available.
- UPS for controllers – Capacitor power supply is available on some DENCO products to enable the controller to be in a standby state, removing start up times completely and being ready to enable cooling as fast as possible.

Panel colours

DENCO product colours are not only a fashion statement, but a considered addition to your data centre. Lighting is an additional cost for any data centre and room illumination cost can be reduced by using our white panels over traditional black panels since they improve the lighting conditions.



With our advance control system

C5-12 controls

Available with *Multi-DENCO*, *Ultra-DENCO* and *Picco-DENCO*, our C5-12 controls software has been designed to capitalise on our hardware's potential, giving you a complete solution, as standard.

The software can help safeguard the unit. Advance compressor protection allows the software to detect the compressors' operating envelope and remain in this protective range. All this information can be displayed on a 4.3" touch screen, installed directly onto the unit as standard. The displays are also available as remote terminals or duplicate terminals, enabling you to control a host of applications from a single location. Our application software ensures you are the operations manager you need to be.



Features include:

- Sensor averaging
- Automatic pressurised system (APS)
- Smart cooling mode
- Running redundancy
- Events and alarm history for 28 days
- BMS interfaces available
- Graphical output of operating conditions

MATRIX controls

MATRIX software is available with our *Adia-DENCO* range and is in-house software that has been produced, tested and certified. MATRIX software utilises fast processor technology to calculate adiabatic optimisation during operation using current conditions and pre-configured water and energy costs to ensure that the unit is operating as economically as possible. Energy monitoring and local area network (LAN) integration allow you to prove and share those savings.

MATRIX software allows for true accessibility. With a web server application, you can access and control your units even from your smartphone or tablet, enabling true portability. All these features are combined with a full override capability for individual aspects of the unit, allowing for greater accuracy in testing and commissioning to give you a high level of assurance that it is a quality system.



- Graphic analysis of operational modes and all information
- Web server application (tablet/smart phone compatible)
- Active monitoring of humidification system and performance
- Optional energy and water consumption monitoring
- BMS interfaces available

Conserve, reuse and reduce



Fresh air

The resource of fresh air is a requirement for any area that people operate within and data centres are not exempt. The volumes of air required may be small, due to the number of hours and people that are present in the data room itself, but it can sometimes be an overlooked aspect with implications. Ideally, the air should be conditioned before it enters the room, a process a CAIR unit can competently and accurately achieve. Otherwise the fresh air supply should be integrated into the air returning to the close control units. This ensures that all air being supplied to the IT equipment has been conditioned, otherwise fresh air being directly supplied to IT equipment could be at the wrong temperature or humidity; loosening your control.

We can offer CAIR as an ideal solution for this requirement. With the 100 % supply model, you can have options such as air intake control, humidification, a frost coil, high filtration, cooling and heating and a supply fan to ensure a one way flow.

Heat recovery

Naturally you will want to utilise as many of the elements within your site as possible and heat is a valuable source that is best not wasted. Reusing the heat produced by your servers is not as complicated as commonly thought. DENCO products are able to accommodate these requirements, for example:

- Using a *Multi-DENCO A-Version* unit and connecting it to a plate heat exchanger (PHE) rather than to a condenser to recover the heat into a different water circuit.
- We can offer chilled water solutions that are connected to water cooled chillers which have a heat pump circuit to recover heat into other services within your site.



Running redundancy

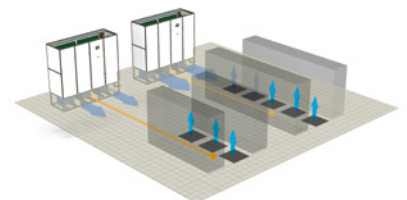
Reduce your energy use by utilising your standby unit, otherwise it will put extra stress on active units and will cost you money. DENCO products work well under partial load conditions, by utilising EC fans and inverter compressors, to give durability and make your products last longer at no extra cost. Below is an example of *Multi-DENCO* units delivering 90 kW cooling capacity, all data shown is only for the on-duty unit where applicable:

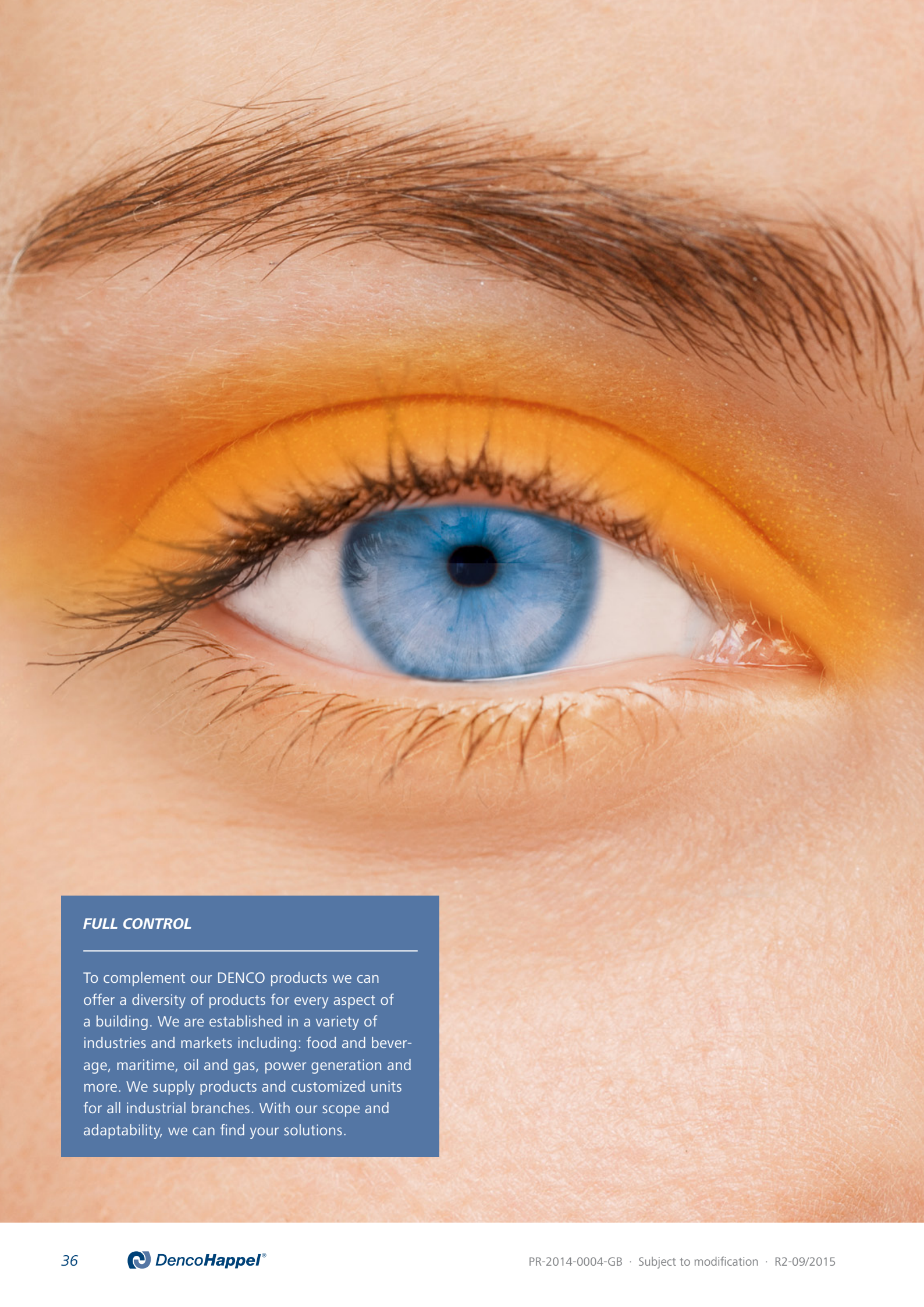
Operation comparison				
		DMA092 + 2 x DMOUCD050E	DMA045 + 1 x DMOUCD050E	DMA045 + 1 x DMOUCD050E
Operation		Duty/ Standby	Duty/ Standby	Running Redundancy
Number of Units (+standby)		1 (+1)	2 (+1)	3 (+0)
Gross Capacity (each)	kW	90.9	45.8	31.3
Gross Capacity (total)	kW	90.9	91.6	93.9
Power Consumption (each)	kW	31.5	15.3	8.5
Power Consumption (total)	kW	31.5	30.6	25.5
Annual Power Consumption	kW/h	275,940	268,056	223,380
Potential Saving per year	€	0	1,183	7,884

Calculation based on a 24 °C/45 % relative humidity air inlet conditions. Ambient temperature = 32 °C. Annual power consumption based on 8760 hours per year at consistent conditions and excludes outdoor unit consumption. Energy costs = €0.15 per kWh.

Automatic pressurisation system (APS)

APS is a system to ensure a constant air pressure within the floor void. This can give great advantages: it helps to prevent any hot spots and allows for very fast reaction to any changes in the airflow, such as room expansion or server rows being offline. The latter offers significant energy saving potential: the air volume supplied to the floor only needs to be the same as the airflow being drawn by the servers, therefore matching supply and demand. By reducing fan speeds and saving energy, this solution works well with cold-aisle containment and is available for the *Adia-DENCO*, *Multi-DENCO* and *Ultra-DENCO* units.





FULL CONTROL

To complement our DENCO products we can offer a diversity of products for every aspect of a building. We are established in a variety of industries and markets including: food and beverage, maritime, oil and gas, power generation and more. We supply products and customized units for all industrial branches. With our scope and adaptability, we can find your solutions.

Energy reductions in cooling production

Irrespective of whether your requirement is for indoor or outdoor installation, air or watercooled, with or without heat pumps, there is a vast variety of equipment and an extensive spectrum of accessories available to you within our capacity range of 5–2,750 kW.

Our chillers are characterized by their efficiency and their high potential for energy conservation, additionally emphasised by the use of high-quality components and environmentally considerate refrigerants (R-410A and R-134a). With our chillers and heat pumps (with reversible circuit), you can provide cooling or cooling and heating. If you require a compressor, condensing unit or want a system with external condenser, our range includes these for you. The choice is yours.

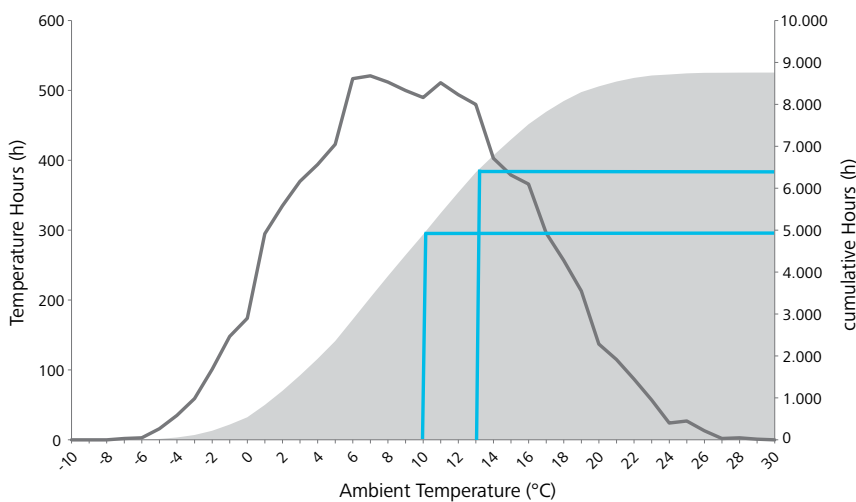
A Chiller with a free-cooling is ideal for any, all year cooling requirements. By using your local climate you can reduce your energy costs whilst maintaining a high accuracy of supply. If you consider these possibilities at the design stage, then by increasing your water inlet temperature to 15 °C, rather than the traditional 12 °C, you not only increase the efficiency of your indoor units, but in a typical London, UK climate you also increase the time available for free-cooling by 1,485 hours. That is a massive 17 % of the year, which is almost 62 days. Our chillers have the potential to operate at even higher temperatures, meaning even more savings are possible.



GLFC range of free-cooling chillers

- Free-cooling with only 1 or 2 °C temperature difference
- Large energy savings possible below 10 °C ambient.
- Further savings possible if water inlet is 15 °C or above
- R134a and R410A refrigerants available
- Super low-noise configuration available
- Indoor installation

Energy saving potential with free-cooling chillers



A graph for a Chiller in a typical London climate over 1 year. The grey line chart shows the number of hours at a particular temperature and the grey area shows the cumulative hours as the temperature increases. The blue line shows the benefits from the example above.

Air tailored to you

Features can include:

- Large variety of fans
- Variety of high quality filters
- Different heat exchangers for individual use
- Humidification of air
- Casing variety – including hygienic and explosion protection
- Dampers and sound attenuators
- Multiple cooling options including chilled water coil and integrated cooling
- Mixing chamber for the heat recovery
- Advanced control system

Having created the backbone for our highly efficient *Adia-DENCO*, the *CAIRplus* (CAIR = Customized AIR) range supports you in meeting your buildings other requirements in the best way possible. The new generation offers a large number of model sizes. Interior or exterior unit, vertical or horizontal installation, stacked, alongside or even inline – almost every type of installation is available.

You may require air conditioning for other rooms or locations, you could use a *CAIRplus* unit to perform direct free-cooling or even control humidification of your room. As fresh air supply will still be a requirement for data centres, you can combine this requirement with a great opportunity for energy saving and improved performance.

CAIRplus is a modular air handling unit that is designed to handle air volume flows from 500 m³/h up to 100,000 m³/h. With the modular design allowing for multiple configuration, there is also an expansive range of options for a variety of functions that can be performed.

The motto of the Eurovent Certification Program is “Measuring is knowing” and our systems have undergone stringent, periodic testing by independent institutions, which means we know our systems are efficient and we can predict their performance accurately. *CAIRplus* products receive Eurovent energy labels rating their efficiency from A to <E. Alongside this, *CAIRplus* units are awarded efficiency classes in line with RLT – German Association of HVAC Manufacturers. These classes can be A+, A and B and are only awarded if all conditions are met for classification.



AND EVEN MORE ...

We can find your solutions



Plate Heat Exchangers

We use state-of-the-art processes combined with our project knowledge from the whole scope of heat exchangers technology. This allows us to make high quality products in our worldwide network of modern manufacturing plants. As a world-leading manufacturer of plate heat exchangers, we can offer one of the widest ranges. This includes gasket, brazed and fully welded versions alongside process-optimised model ranges, delivering specialist functions.

Plate heat exchangers are particularly useful for direct expansion systems, where there is a large distance between your temperature controlled space and your heat rejection location. This is particularly useful in high rise buildings.

With a high and continual investment in research and development, PHE Systems will remain on the leading edge of high quality products and developments giving you better improved solutions for the future.



Searle Condensers

Searle are able to offer 1,000s of models of air-cooled condensers. With a modular design and variety of fan sizes, we can offer a choice to match your requirements. EC technology is standard across the range giving speed control and high efficiency. Backed by one of the most comprehensive research and development facilities in the European refrigeration industry, we continually ingrain excellence within each of our products.

Performance can be improved further by the use of Searle adiabatic cooling system to enhance the thermal performance of air-cooled condensers and dry air coolers by reducing the effective incoming air temperature. Adiabatic features gives benefits including; fluid temperatures lower than the ambient dry bulb (in certain conditions), reduction in physical size of equipment and an increase in the capacity of the existing systems – adiabatic systems can be retrofitted to already installed equipment.



Cooling Towers

Cooling Towers are able to offer the whole portfolio: from smaller, ready-to-install towers to large, natural-draft cooling systems. We have combined activities for modular and large cooling towers enabling the sharing of knowledge and expertise to deliver an all-encompassing solution. Our solutions include natural and fan assisted draft, field-erected mechanical draft, modular cell - CMDIF, CMDI, CMDR, CMC.

If you have a data centre with a large scale operation, a cooling tower can provide the magnitude of heat rejection that you require to enable an effective and efficient performance.

Our expertise for all stages of a project lifecycle are complimented by the comprehensive after-sales support, which can include; maintenance, overhaul and upgrading, periodic inspections, fan balancing, parts and hire, capacity measurement and noise reduction.



SERVICE

Rely on the best possible service with competent planning. Thanks to our know-how as one of the leading designers and manufacturers of air conditioning systems and our network of regional depots, we can provide you with scheduled maintenance, certification and record logs for your complete inventory of equipment and installations.

A natural choice for continued support

Count on our know-how and our global presence

We are able to offer regional, national and international support to customers that join our service plans available. With an established network in several countries, 4Service can provide planned and emergency support to ensure that your equipment maximises its potential and any downtime is kept to an absolute minimum.

With our established position as a supplier of high quality climate control equipment, our service engineers have the industry expertise to be able to address any issues your equipment may unfortunately encounter.

Not only will our engineers repair your issues on site, but they can give comprehensive support to your equipment's requirements. Whether that is advising on maintenance schedules or providing certifications and maintaining record logs for your full inventory.*

Our engineers appreciate our customers' considerations for the environment and climate. They are knowledgeable and conform to the latest fluorinated greenhouse gases regulations and stay up-to-date with any developments or amendments to such legislation. With the development of our own products, our engineers also appreciate how to get the best efficiency out of your products and can advise our customers how.

With four levels of maintenance support (bronze, silver, gold and platinum*), an established network and with knowledgeable and resourceful engineers, 4Service will be the natural choice for your support.

* Certain locations only

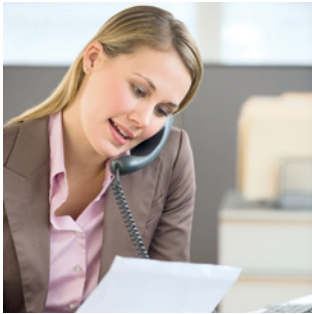


Our service at a glance

- International locations with regional contacts
- Maintenance contracts available
- Emergency service support
- 24/7 emergency call facilities for 365 days in several locations
- Full system commissioning service
- Energy efficiency advice
- Spare parts supplier
- Documentation and certification



Always at your side



Our services at a glance

- Own heat exchanger production
- Use of certified products and components
- Use of components from well-known component manufacturers
- Short delivery times for spare parts
- Commissioning of new facilities
- Periodic servicing
- Maintenance
- Factory trial run
- Upgrading and optimisation of old facilities
- Maintenance agreements

Economical from the beginning

The technical developments of DencoHappel represent state-of-the-art swimming pool climate control. Our systems support diverse applications that optimally conform to current criteria of cost effectiveness, safety and sustainability. Our products and services go far beyond pure technology. They are integrated into a comprehensive and in every respect customised service package. This programme includes not only conventional services such as spare part delivery, maintenance, and repair. It unites the consulting and engineering of a technology leader with customised after-sales service and rapid response times. And this not only for installing new equipment. This service also applies for upgrading and optimising old equipment and provides you with perfect support in all project phases. The functionality of the system is secured over its entire service life.

International service und support in experienced hands

Wherever you need us, we will be there for you in the shortest time. All over Europe, our own customer service ensures that you are able to make optimal use of our units' advantages at all times. Many technicians are ready on-call in Germany alone for rapid deployment. All services are designed for absolute safety and reliability. For example, an on-site function check is a part of our delivery service, conducted by an experienced DencoHappel technician together with the installer. This way we directly and personally pass on our functional know-how built up over many years. In this context we should also mention the training we offer in the technology of our climate control systems. Such training is a beneficial instrument for ensuring the lasting functionality and availability of the systems.

A decision for quality

A high quality standard is the basis and principle for all our services. All our service specialists are highly experienced and devote themselves to their work with great diligence. Technically and personally convincing: this is what you can expect from us.



- Initial installation
- Maintenance and servicing
- Assembly services
- Spare parts
- Customer service
- Consulting
- Refurbishing
- Training

DencoHappel is a globally operating company with great expertise in air treatment, air conditioning and filtration technology.

Our nearest consulting and service teams will be glad to discuss ideas and develop creative and effective solutions with you.

