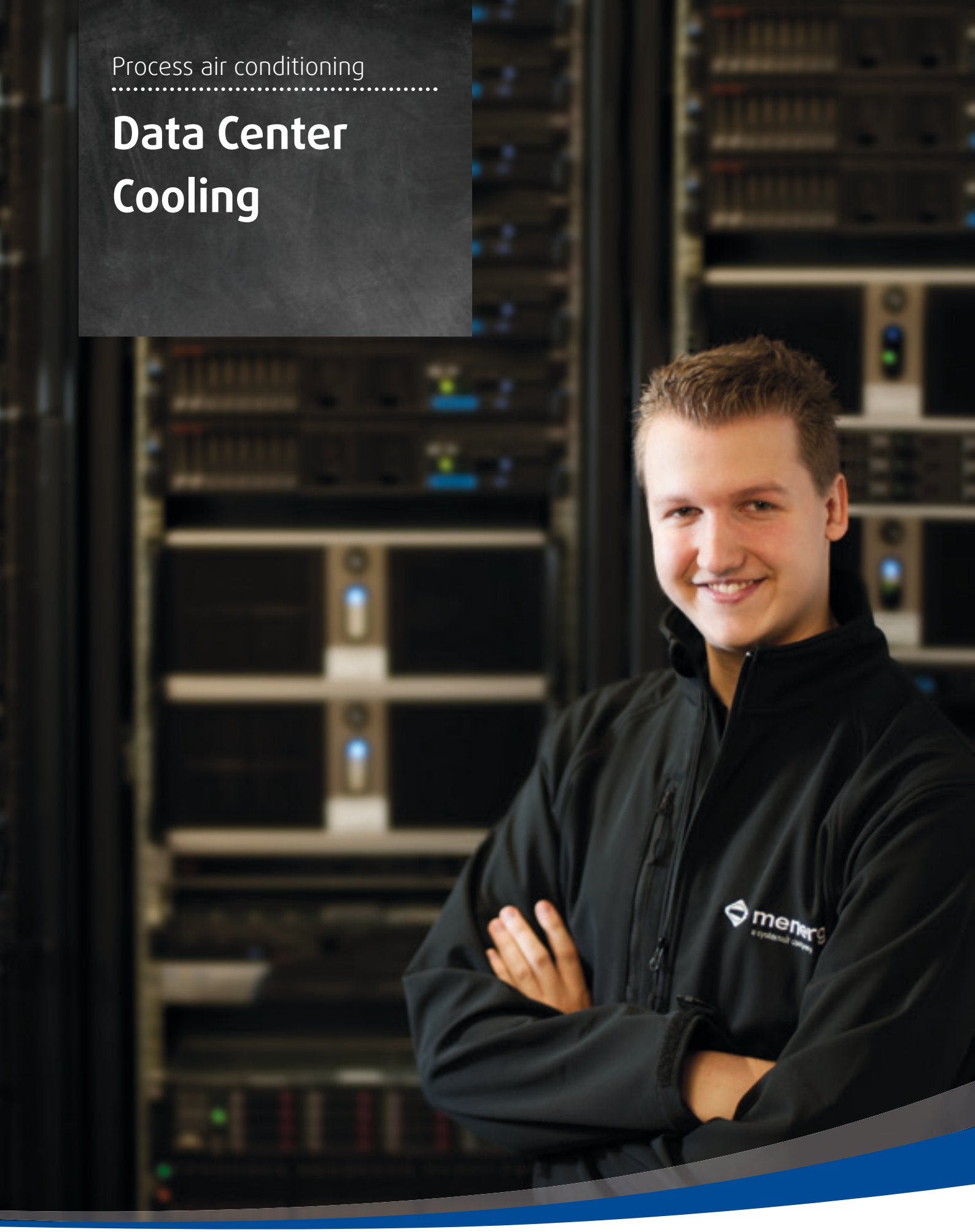
Process air conditioning

Data Center Cooling



menerga
a systemair company

Introduction

DATA CENTER COOLING

Content

Information and communications technology (ICT) enjoys a high priority in your daily life. Technological developments such as cloud computing or big data, as well as the distribution of mobile devices, lead to a very high demand for computing capacity. To meet these requirements, data center capacities continue to expand, and thereby the energy demand and the CO_2 emissions as well.

Energy efficiency measures enable energy demand and in turn the CO_2 emissions to be reduced. One of the most important measures is the selection of an efficient cooling system.

Technical service

EXPERTS AT YOUR SERVICE

Experts at your service, at any time and place. With an extensive offer and an area-wide network. Menerga's technical service ensures equipment efficiency from the day of commissioning throughout the entire life cycle of your system.

More than 120 service technicians at our various service centers and 40 service professionals at Menerga locations provide full-time service, with the aim of high unit availability and maximum efficiency.

The business activities of Menerga's technical service extends from the factory run and on-site commissioning, periodic maintenance, repair, remote maintenance and remote diagnostics, and direct dial-in options through restructuring and optimization of the units.

We offer you a tailor-made customer- and user-specific service concept. In the event of a breakdown, you can reach us at any time at:
+49 208 9981-199

Tasks

ROUND-THE-CLOCK COOLING MODE

Electronic components and in particular processors generate heat during operation. The servers run non-stop 24 hours a day. The amount of heat that is released from the servers depends on the computing capacity. This heat needs to be removed from the data center to avoid performance failures due to excessive temperatures. Cooling down during a resting phase is not possible due to the required round-the-clock operation.
To avoid overloading components such as the CPU, drives, and UPS batteries and to enable smooth operation, constant and reliable cooling of the server rooms is indispensable. If people are in the room, the cooling maintains a comfortable temperature level.
ASHRAE has developed guidelines on the interaction between reliability and energy efficient operation of data centers. The ambient temperature of the servers should be between 18 and 27 °C. Failures caused by excessive temperatures are not expected within this temperature range. It should be noted, however, that as the temperature rises, the servers' demand for electricity increases. A thorough check must be made to determine whether a higher temperature pays off with respect to energy.

Specific requirements

- Year-round cooling mode with 24/7 operation of the unit
- Development of redundancy scenarios
- Heat transport with air
- Low air-side pressure drop in the device for low energy demand
- Indirect heat output for outdoor air, lowest possible outdoor air volume flow for smaller air ducts of the outdoor and inlet air in order to reduce the energy demand of the fans
- Indoor installation of air handling units for protection against external influences
- Low space requirement of the air handling units
- Compliance according to the temperature and humidity limits determined by ASHRAE (server intake temperature 18-27 °C / 20-80 % relative humidity)
- Airtight separation of the recirculating airflow from the cooling airflow through a recuperator
- Filtering of extract and outside air
- Low outside airflow requirement for cooling
- Increased internal operational safety by independent cooling systems (adiabatic evaporative cooling, mechanical compression cooling)
- No components within the server area at risk of condensation

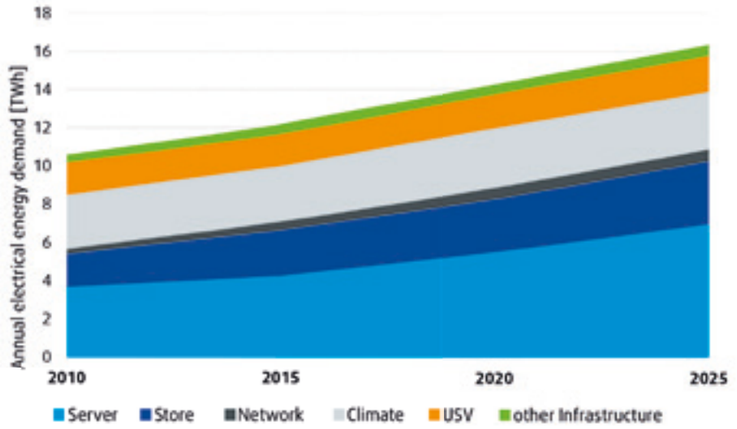
Development of electricity demand

BENEFICIAL COOLING = BENEFICIAL COMPUTING POWER

Electrical energy requirements for operation of data centers in Germany was approximately 12.0 TWh in 2015 and will rise to approximately 16.4 TWh by 2025.

Depending on the cooling system selected, the amount needed for cooling ranges between 20 % and 60 %; this plays an important role in the infrastructure of data centers.

The selection of an efficient cooling system is one of the most important measures to reduce the cost of UPS systems, emergency power, energy costs, as well as CO_2 emissions.



Source: Fraunhofer Institute/Borderstep

Energy efficiency in data centers

CHARACTERISTIC VALUES OF DATA CENTERS

According to the Green Grid trade association, two characteristic values are used to assess the energy efficiency of data centers: **Power Usage Effectiveness (PUE) and Data Center Infrastructure Efficiency (DCiE).**

The PUE value is used to calculate the efficiency of the energy input. It relates the data center's total energy use to the energy consumption of the computers.

When assessing a theoretically optimal PUE value 1, the whole performance flows into the server. Values of up to 1.2 are evaluated as very efficient. In this case, 20 % of the input energy will be used inefficiently. The current average PUE in Germany is approximately 1.8. For 2025, a PUE of 1.54 is predicted.

The DCiE value is the reciprocal of the PUE and thus shows the efficiency of the energy used in the data center.

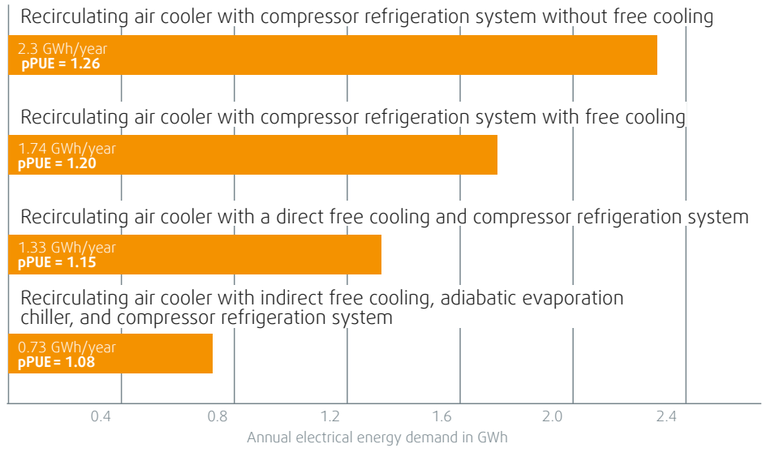
Which data center cooling system is most suitable for use can be identified by means of the **Partial Power Usage Effectiveness (pPUE)**. The pPUE value shows the ratio of the energy demand for cooling the IT equipment to the power demand of the IT equipment and is thus an indicator of the cooling system. The lower the value, the less electrical energy is required for cooling purposes.

PUE	DCiE efficiency level	Level of efficiency
3.0	33 %	Very inefficient
2.5	40 %	Inefficient
2.0	50 %	Average
1.5	67 %	Efficient
<1.2	<83 %	Very efficient

Source: GreenGrid

System comparison

CHOOSING THE OPTIMAL COOLING SYSTEM!



Assumption: The internal heat load of the high thermal load room is fixed at 1 MW and is not influenced by external factors. Extract/supply air temperature = 34 °C / 20 °C. Extract air humidity between 20 % and 80 % r.h.. The use of cold water is flow/return = 10 °C / 15 °C.

The proportion of direct free cooling depends on the data center's approved temperature and humidity range. These factors have to be considered when choosing a cooling system.

As illustrated in the adjoining calculation, the electrical energy demand of all consumers including compressors, fans, cold-water and adiabatic pumps have been considered. It also takes into account that the performance of the consumer increases the thermal load in the room.

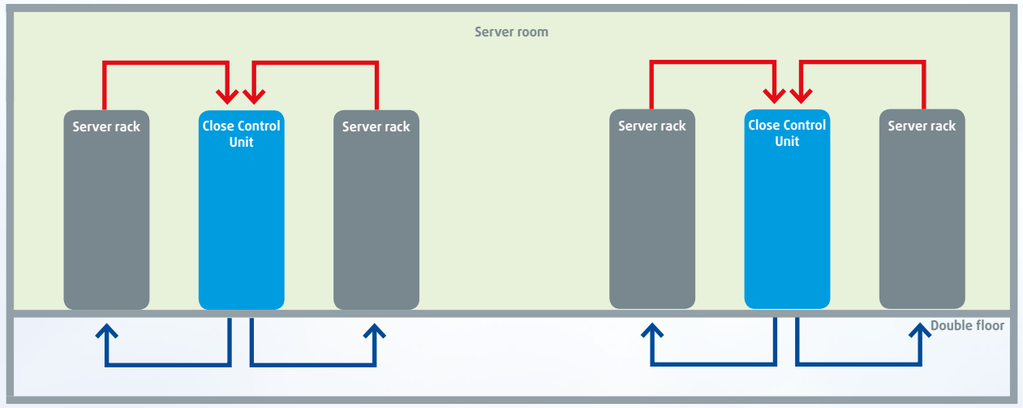


Fig. 1: Schematic drawing of conventional cooling with a close control unit

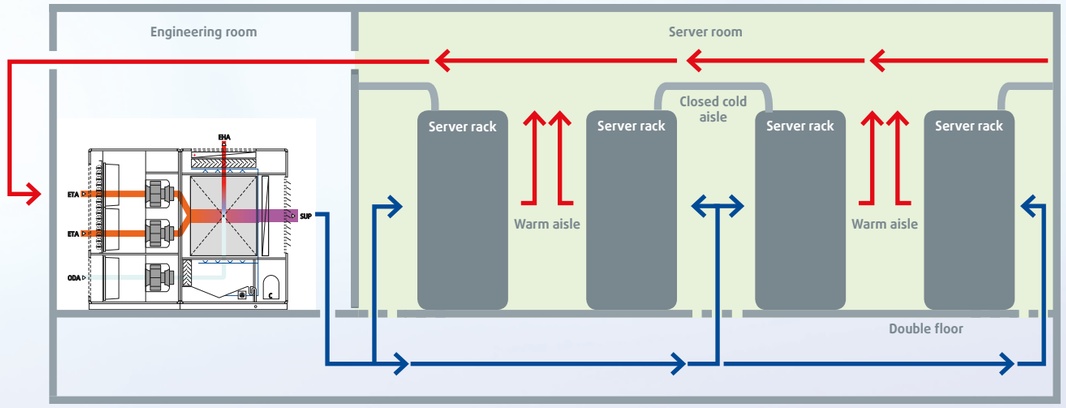


Fig. 2: Schematic drawing of the ideal installation of an Adcoolair: consistent separation of warm and cold aisle in the air duct

Standard solution

COOLING WITH CLOSE CONTROL UNITS

Conventional cold air management in the double floor: the air is cooled in the close control unit via a compressor refrigeration system and is conducted over the false floor through the supply air grid in front of the server racks into the cold aisle. The cooled air is suctioned from the process fans and released as warmed air over the rear of the rack. The units are installed between the server racks and therefore inside the server room.

Operating costs
Up to 100 % of refrigeration takes place via a mechanical refrigeration system. There are the highest costs in the system comparison.

Resilience
Depending on the equipment, failure of a single unit can be compensated by others; under certain circumstances, the cooling capacity may be reduced.

Investment
The large number of individual components leads to high investment costs.

Maintenance
Very high maintenance due to the large number of individual components. Stringent requirements because of the F-Gas regulation. Maintenance or service work in the safety area.

Space requirement
Concept requires plenty of space for installation of the units in the server room. Minimum flexibility for the design of the server rooms. Valuable capacities for IT components are lost.

Installation effort
Very high installation effort, as a wide variety of components have to be installed and put into operation. Vapor density insulation of the cold water installation.

Menerga solution

INDIRECT COOLING USING COLD/HOT AISLE SEPARATION

Indirect recirculating air cooling with three cooling levels (indirect free cooling, evaporative cooling, compressor refrigeration). The air is evenly directed through cold/hot aisles across the racks. Only one device is needed to reach the required refrigeration capacity. In practice, in order to create redundancies we work with at least n+1 devices to increase the resilience. The air conditioning units are placed in an engineering room separately from the servers. This ensures the highest safety of the components within the server room. Maintenance and service can be carried out in the engineering room.

Operating costs
Depending on the region and operating conditions, up to 85 % free cooling and adiabatic evaporative cooling. Lowest energy expenditure in the system comparison.

Resilience
Failure of one refrigeration system can be intercepted by another one. In case of an emergency, quick start of the cooling system in 15 seconds. Units as multiple axle increases reliability of operation.

Investment
Higher investment, amortization due to energy efficiency of the system in a short period of time.

Maintenance
Easy maintenance, thanks to a low number of required devices. All components are installed inside the device. Ideal access to the equipment because it is centrally placed outside the server area.

Space requirement
Higher server capacities because equipment can be placed in a separate engineering room.

Installation effort
Low installation costs, as the technology is already assembled and factory-tested in a test run.

Automatically selects the most economical operating mode

Free cooling + adiabatic evaporation cooling + compressor refrigeration system

The adiabatic evaporation cooling provides approximately 50 % of the required cooling capacity, and consequently the continuously variable compressor refrigeration system is dimensioned at approximately only half of the total cooling capacity.*

Extremely compact

Compact, solid construction for placement in the engineering room; no water-conducting elements in the storage.

Indirect free cooling

Physically separated process stream, therefore no transfer of moisture, dust and other harmful substances.

Low ODA/EHA-cooled airflow

Smaller duct and silencer measurements, lower performance of the fan motor.

Highest electrical efficiency

All the components are designed for lowest pressure losses.

Durable

Non-corrosive cross-flow heat exchanger made of polypropylene.

Intelligent engineering

Detachable oil sump heater, use of electronic expansion valves.

Security

Unproblematic use of CO_2 extinguishing systems.

COOLING PERFORMANCE:

11.1 - 226.6 KW

Adcoolair

FREE COOLING + ADIABATIC + COMPRESSOR COOLING = TOP EFFICIENCY!

The higher operating temperature in data centers from up to 27 °C opens up room for new cooling concepts that ensure operating safety and substantial savings on energy costs.

An ideal solution is air-managed cooling, in which the heat from storage is released indirectly into the outdoor air. In the process, the recirculation and cooling airflow are physically separated. Further treatment of the ambient air to meet IT requirements is not required – for example, by using fine filters or dehumidifiers. Because of the large temperature discrepancies between the supply and exhaust air (ΔT ≥ 10 K), indirect free cooling in conjunction with the heat exchanger is needed in order to meet a major part of the annual cooling energy demand.

If the outdoor air temperature approaches the required supply air temperature, the adiabatic evaporative cooling key is switched on to reach the required temperature level. A integrated compressor refrigeraton system is switched on as the third step if the temperature can no longer be achieved. As only the proportion of refrigeration energy must be provided, which goes beyond the performance of the evaporative cooling, the chiller is correspondingly small.*

Simultaneously, use of compressor cooling is reduced to a minimum due to the combination of various cooling methods. Typically, it is less than 574 hours per year, which corresponds to only 6.5 % of the total operating time.

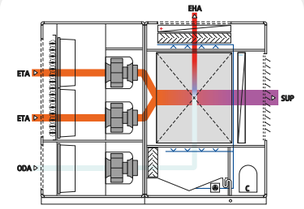
Due to the significantly reduced demand for electricity, the electric connection load is decreased; a back-up power supply can be smaller as well.

* Upon request, we can configure the system at 100 % redundancy (the adjustable compressor refrigeration system can provide 100 % of the cooling capacity).

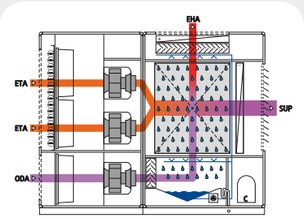
At a glance!

- Compact dimensions
- No additional cooling tower
- Complete integration of the refrigeration equipment into the building
- Low ODA/EHA rate for heat discharge
- Three independent cooling systems
- Free cooling without limitation from ETA humidity
- Constant humidity within the room*
- No supply of dust and harmful corrosive substances from the outdoor air
- Quick start of the compressor refrigeration system in max. 15 seconds
- Very good pPUE values possible
- Low energy demand
- Efficient refrigeration through use of natural resources
- Low-maintenance systems
- Low installation cost
- Redundancy possible
- Hardware and data are protected
- Reliable, well-known technology
- Quick service in an emergency
- Built-in control and regulation that is compatible with all conventional Building Management Systems

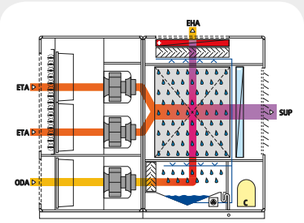
*Depending on the ambient conditions, periodic supply air dehumidification may be necessary.



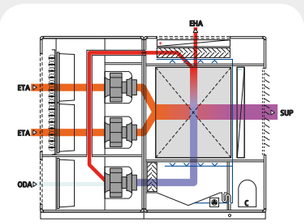
Indirect free cooling at low outdoor air temperatures
The warm process air of the highly thermally loaded room is cooled indirectly via the asymmetric cross-flow recuperator with the aid of low outdoor air temperatures. With the decreased temperature, the flow rate and thus the power input of the fans are reduced.



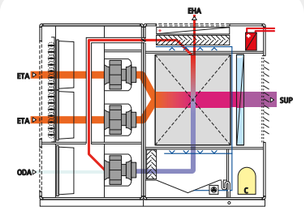
Adiabatic operation at medium and low outdoor air temperatures
The process air is cooled by indirect, adiabatic evaporative cooling. As a result, the heat-dissipating outdoor/exhaust airflow can be minimized and the absorbed power from the fan motor unit is reduced to a minimum.



Operation at high outdoor temperatures
At high outdoor air temperatures, the compressor refrigeration system with power-controlled scroll compressors is connected to the adiabatic evaporative cooling.



Optionally:
Exhaust/outdoor air bypass
To prevent dehumidification of the process air at low outdoor temperatures, the outdoor air can be preheated with a built-in exhaust air/outdoor air bypass. This avoids condensation of the outgoing air humidity in the recuperator.



Optionally:
Hot water condenser
The heat extracted by the process air on the evaporator can be used as a heater or for hot process water by means of a hot water condenser. In this mode, the integrated compressor cooling unit works as a heat pump.

All signs point to safety

BENEFITS OF THE ADCOOLAIR SYSTEM

Our system solutions are designed for operation in a data center. Thereby great value is set on a high level of resilience.

The three matching cooling systems are synchronized with to each other, so that the failure of one unit does not cause the entire unit to fail. The mechanical compressor refrigeration system is able to do a quick start within a maximum of 15 seconds.

In most major data centers, the cooling systems are configured as a redundancy network. The units typically run at partial-load. If a system fails, the others can maintain the required total cooling of the entire system. Full cooling capacity can be thus provided during maintenance.

All Menerga systems are “vicomo-ready,” making them ready for quick intrusion by vicomo monitoring and control software. And the best part? Access to the cooling system is completely independent of the local area network via a secure 256-bit encrypted peer-to-peer connection. You can use this service to monitor the function and efficiency of the systems. Possible defects, such as very dirty filters, are already visible online in advance so you can take quick action. There is also an alarm option in case of malfunctions via prioritized text messages on your cell phone or via e-mail.

The installation engineering of our system solutions are designed for the ultimate in resilience. Together we can find truly intelligent concepts for your individual solution.

Menerga in Data Centers

Cooling capacity: 105 kW

BADEN-WÜRTTEMBERG STATE BANK,
Airflow: 15,500 m³/h

Cooling capacity: 59.1 kW

FREIBURG DISTRICT OFFICE
Airflow: 5,300 m³/h

Cooling capacity: 89 - 201 kW

UNIVERSITY OF PASSAU
Airflow: 5,300 - 16,000 m³/h

Creating redundancies

STANDARD FOR RESILIENCE

By creating overcapacity (redundancies) the availability of all components in the data center infrastructure can be increased.

The American Uptime Institute has therefore defined a standard for data centers in the TIA 942 (Telecommunications Industry Association). This standard includes statements about resilience and redundancies.

The Tier classification described in this standard refers to the entire infrastructure of data centers, including UPS, wiring, fire protection, cooling, etc. Depending on the chosen redundancy, the estimated maximum downtime per year is between 28.8 h (Tier I) and 54 minutes (Tier IV). These values correspond to an availability of 99.671 % or 99.995 %.

Renewable energy

FULFILLMENT OF THE RENEWABLE ENERGIES HEAT ACT

In addition to the economic benefits, normative requirements can be achieved more easily using air-managed cooling from the Adcoolair system. Thus, the Renewable Energies Heat Act (EEWärmeG) in Germany stipulates the mandatory use of a specific proportion of renewable energy in new buildings. This requirement is fulfilled if 50 % of the refrigeration or heating energy demand is covered through environmental heat. As they require both free cooling as well as evaporative cooling and these procedures provide up to 100 % of the required cooling capacity, EEWärmeG requirements for air-managed cooling are automatically met.

communicode AG, Essen | Germany
COOLING CAPACITY: 20 kW; AIRFLOW: 3,500 m³/h

communicode balance
01/2013 - 12/2014 = 24 months

The reduction of the electricity demand compared to the previously installed circulating air cooling units without free cooling (pPUE = 1.26) is 24,222 kWh.

This correlates to a CO2 reduction of 13.78 t.
The following figures result on a basis of electricity costs of 0.20 €/kWh and water costs of 3.00 €/m³:

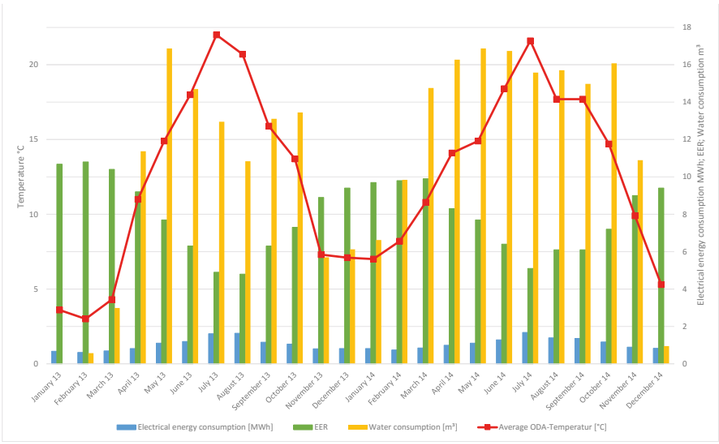
Reduced electricity costs:	4,844,- €
Water costs:	-791,- €
Savings of operating costs:	4,053,- €
Savings after 12 months*:	**2,026,- €**

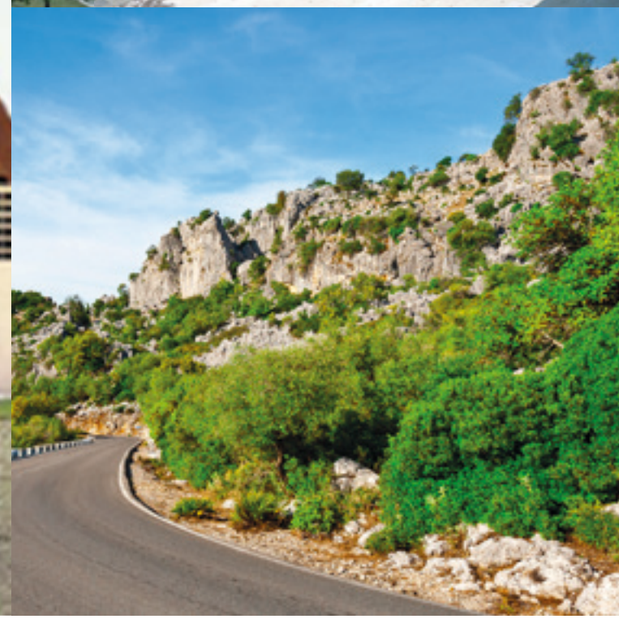
*Projection based on calculated data.

communicode Essen

SMALL TO MEDIUM-SIZED DATA CENTERS

Communicode is a specialist in product information and CMS systems. There are 50 employees at the Essen location, which also houses the company's server room. Communicode hosts projects for Osram Opto Semiconductor, Deichmann, Zander, and others on servers with a total capacity of approximately 20 terabytes.
Large heat loads from 5 to 16 kW occur in the 25 m² server room. In the past, this room was exclusively cooled by a mechanical refrigeration system. This solution is very expensive and in addition, a system failure will nearly always lead to a breakdown of the entire server system.
One of the first Adcoolair units was started up in June 2010. The system operates with a sequential combination of indirect free cooling, adiabatic evaporative cooling, and adjustable capacity of the compressor refrigeration system. The process airflow and the indirect cooling necessary for the outdoor airflow have been separated completely from each other. This prevents contamination of the server room with moisture, dust and corrosive pollutants. One of the major advantages of the system is that it can be installed indoors with minimal space requirements and a small required outdoor air connection. The data center uses a plug-in, highly efficient solution that is usually used for large data centers with multiple MW capacity.
The device has been evaluated for several years using long-term monitoring by the vicomo system. The prior calculated data projected a medium pPUE of 1.08 for the entire system, including fans, compressors and pumps. This was based on the climatic conditions in Essen with supply and extract air temperatures in the server room from 20 to 34 °C. The year-round relative humidity is between 20 % and 80 %. The evaluation of the system with a flow rate of 2,500 m³/h and a cooling capacity of 20 kW has confirmed these very good estimates. As there were still capacities for further development of the data center, the maximum cooling load was 15.75 kW over the given period. From January 2013 to December 2014, the circulation air cooling unit's heat dissipation was at 188 MWh with an electricity power demand of 25 MWh. Compared to the previously installed air circulation cooling unit without free cooling, the unit has reduced the electricity power demand to 24,222 kWh in this period and reduced CO_2 emissions to 13.78 t. Water consumption for the adiabatic cooling system was at 1.4 m³ per MWh for the cooling capacity. In spite of the very low cooling load, the reduction of the operating costs were calculated with 1,500 to EUR 2,000 per year. The investments have already paid for themselves after five years.





Banco Santander

BIG DATA CENTERS

Banco Santander is the largest bank in Spain and one of the largest in the world. The company had exacting requirements during the design of the new data center for the headquarters in Spain: 150 million euros have been invested in sustainable technologies, both for use within IT as well as for the building equipment, resulting in a definitely presentable green IT data center with a very high total energy efficiency.

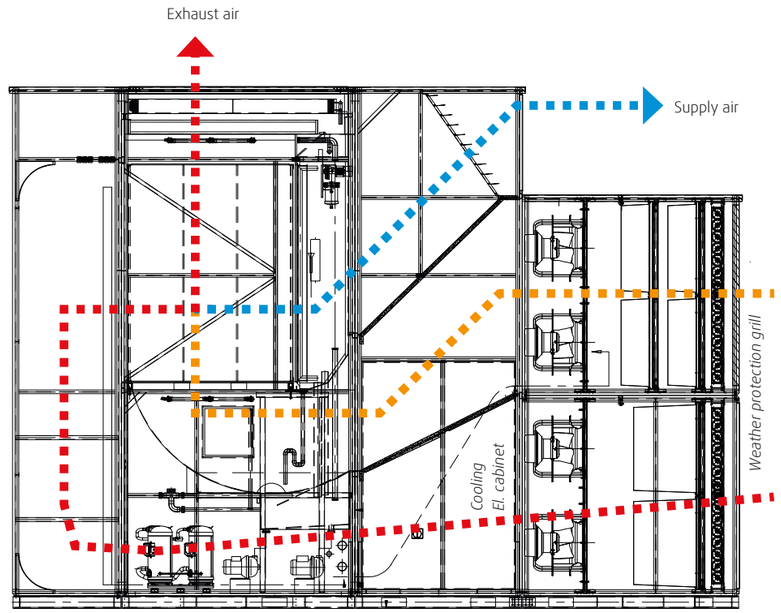
Commissioned in 2011, the complex in Solares, in the Cantabria region, consists of two nearly identical buildings, each with a base area composed of 5,500 m². Each building is designed like a silo: there are six separate server rooms in the first two underground levels, while the ground floor above is fully air conditioned. The futuristic-looking and decorative, rusty-looking elements in the photo are parts of the ventilation ducts and were designed by a leading architect.

In particular, the low electrical connection performance from the air conditioning units was decisive in terms of meeting the requirements for high energy efficiency. 18 Adcoolair units with a total cooling capacity of 8.1 MW have been installed. Each system has a capacity of 450 kW at a maximum airflow of 78,000 m³/h.

Three Adcoolair units per server room cool the air with adiabatic evaporation cooling. Should one unit fail, the other two can immediately replace the missing cooling capacity. Each unit has two adiabatic systems and four types of cooling circuits. The facilities are designed so that a complete failure is extremely unlikely, for example through the use of fan connections instead of a single fan per airway.

For Banco Santander, the units have been additionally adapted for redundancy reasons, so that the systems run at full capacity even without water for the adiabatic cooling.

An important factor in the selection of the Menerga units was the fulfillment of Santander's high performance standard with both maximized unit efficiency and maximum resilience. The most important criterion in the contract award was the technical solution, with a percentage of 55 %. This part was met with 53.3 % by Menerga and, with a degree of fulfillment of just under 97 %, meant that Menerga led the competition.



Creating a good indoor climate since 1980. Worldwide.

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