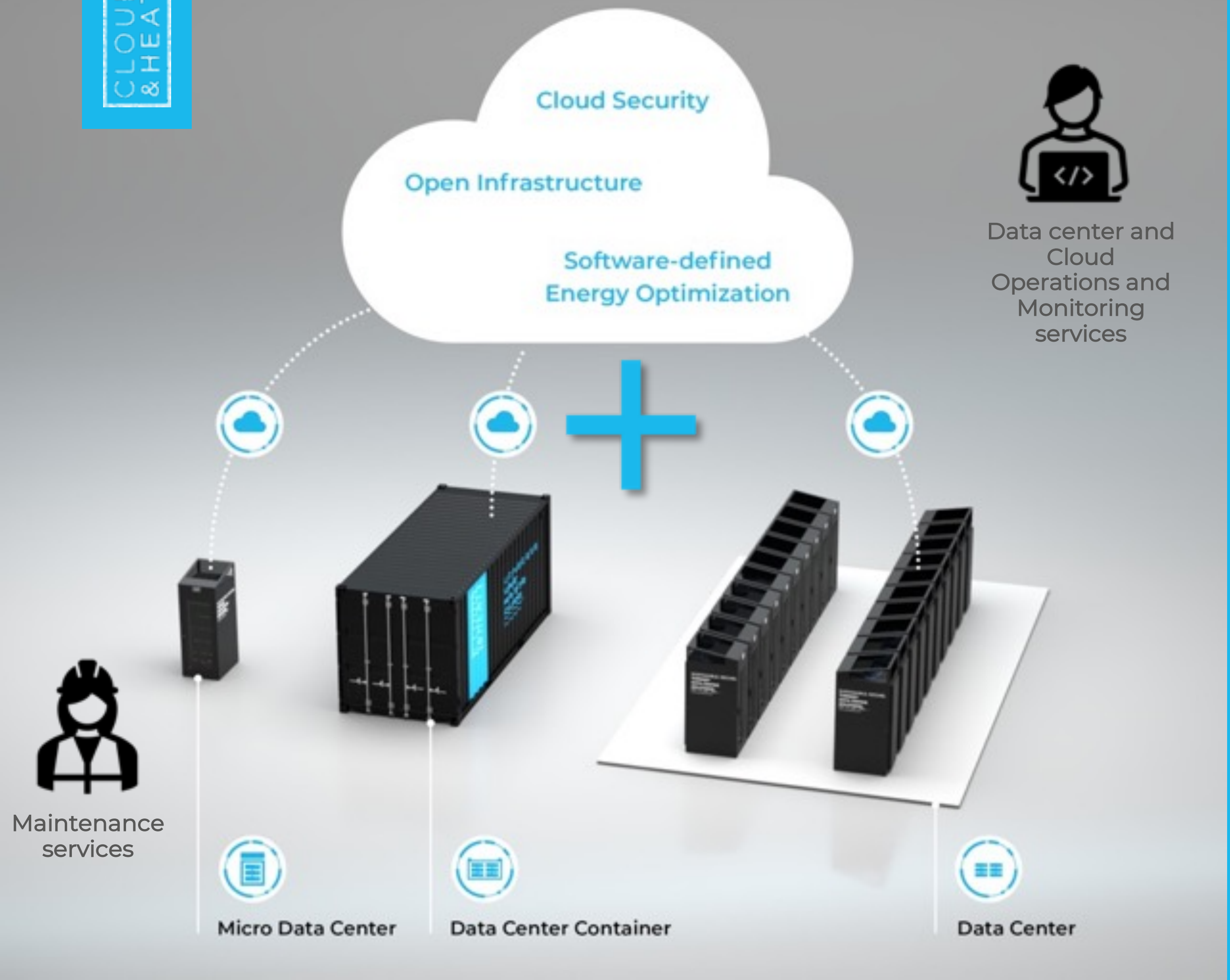
ADVANCED COOLING FACILITY

Open for All.

OCP GLOBAL SUMMIT

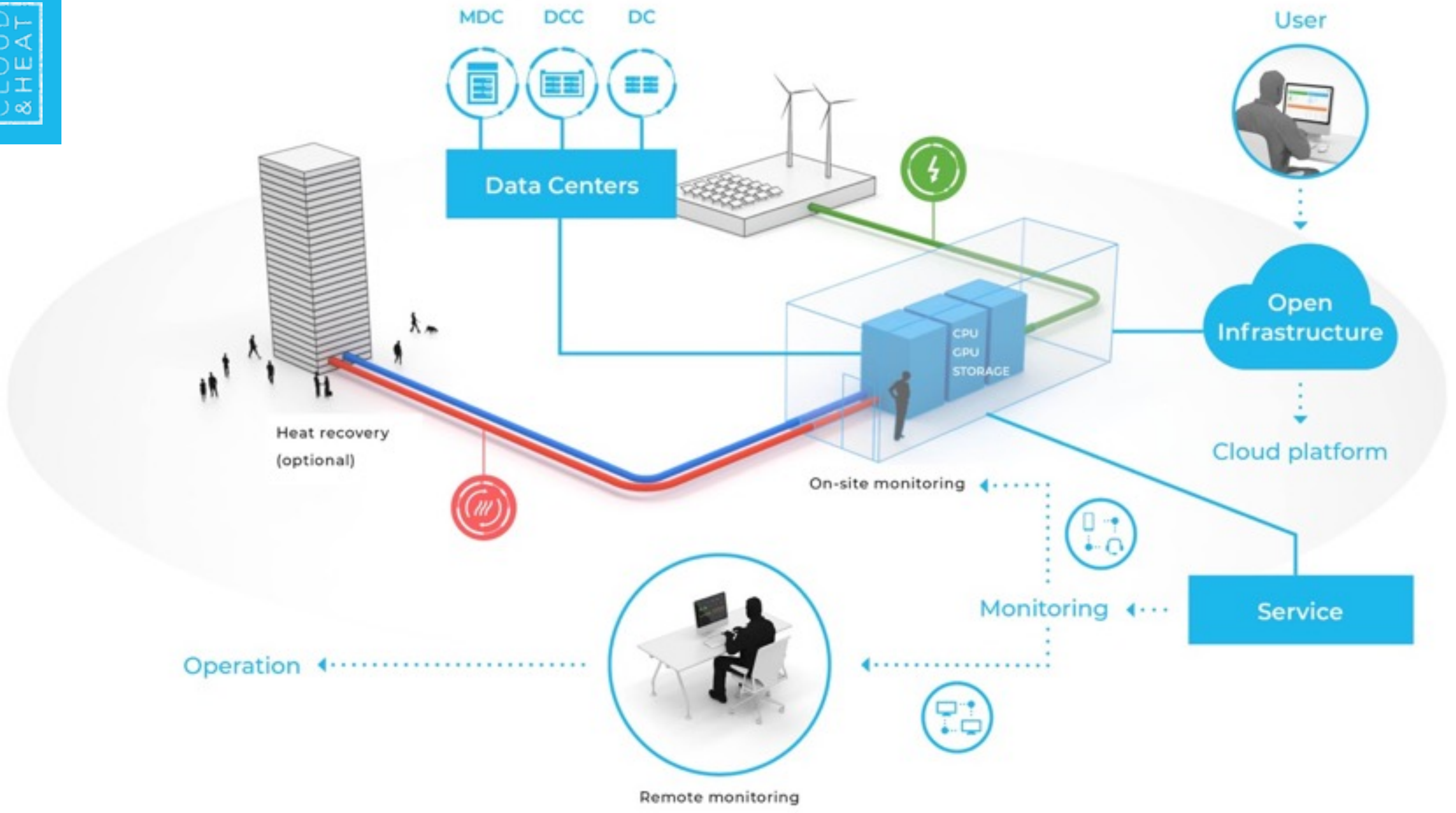
POWER TO DATA - DATA TO HEAT



ONE-STOP SHOP

OUR SOLUTIONS

By combining sophisticated physical and virtual infrastructures, our solutions not only save energy and costs but also significantly reduce the carbon footprint of data centers.



A HOLISTIC APPROACH TO DIGITALISATION

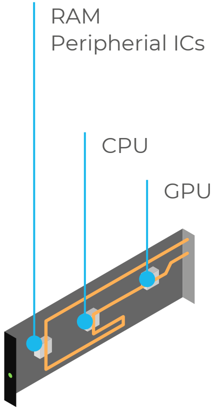
CLOUD & HEAT

WATER-COOLED SOLUTIONS

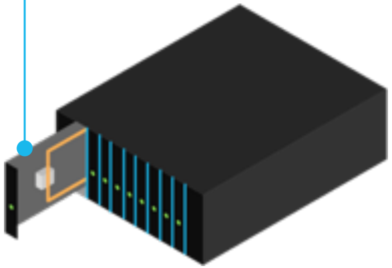
OVERVIEW

HARDWARE

CHOICE BETWEEN WATER-COOLED EXISTING OEM SOLUTIONS OR CUSTOMER-SPECIFIC RETROFITTING TO DIRECT HOT WATER COOLING (CUSTOMIZED COOLING KIT)



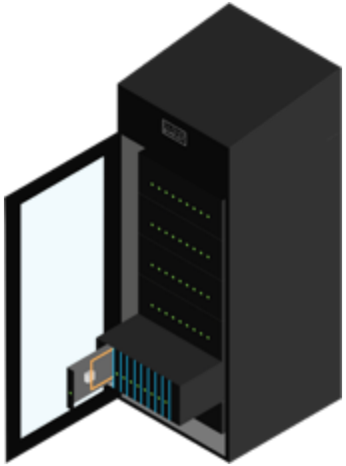
Blade



Server

MICRO DATA CENTER

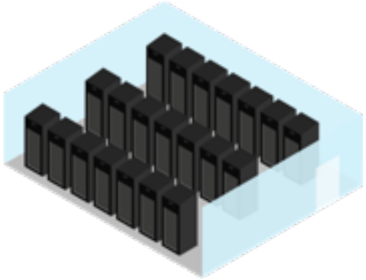
INDOOR SOLUTION



Rack

DATA CENTER

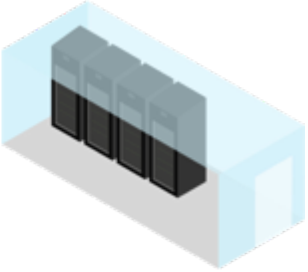
INSIDE A BUILDING



Integration into new as well as existing buildings

DATA CENTER CONTAINER

OUTDOOR SOLUTION



Integration into a 20 ft/40 ft container

HARDWARE

WATER-COOLED OEM SOLUTIONS

- Availability of water-cooled hardware from different manufacturers
- Compatibility with different rack water cooling systems

COMPATIBILITY LIST (EXAMPLES):

MEGWARE SLIDESX CHASSIS

DELL EMC POWEREDGE C6420

LENOVO THINKSYSTEM SD650

CUSTOMERS:

innogy | ai4bd | nyris | VATTENFALL

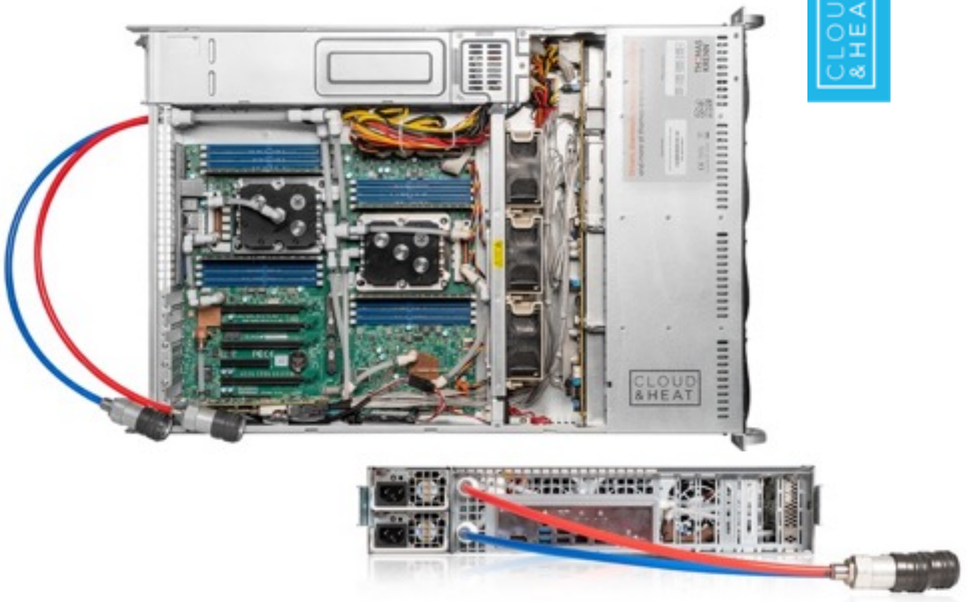
HARDWARE

WATER-COOLED CUSTOMIZED COOLING KIT

- Implementation of individualized hardware in an existing water cooling infrastructure
- Retrofitting of air-cooled hardware into efficient direct hot water cooling
- Development of original solutions for OEM

REFERENCES OF OEM SOLUTIONS:

- Thomas Krenn RI 2208-LCS
- Supermicro 9029
- Nvidia RTX Server
- TradeDX R5211



PROCESS:

1 | Evaluation & conception

2 | Prototype development

3 | Serial product development

4 | Certification

CUSTOMERS:

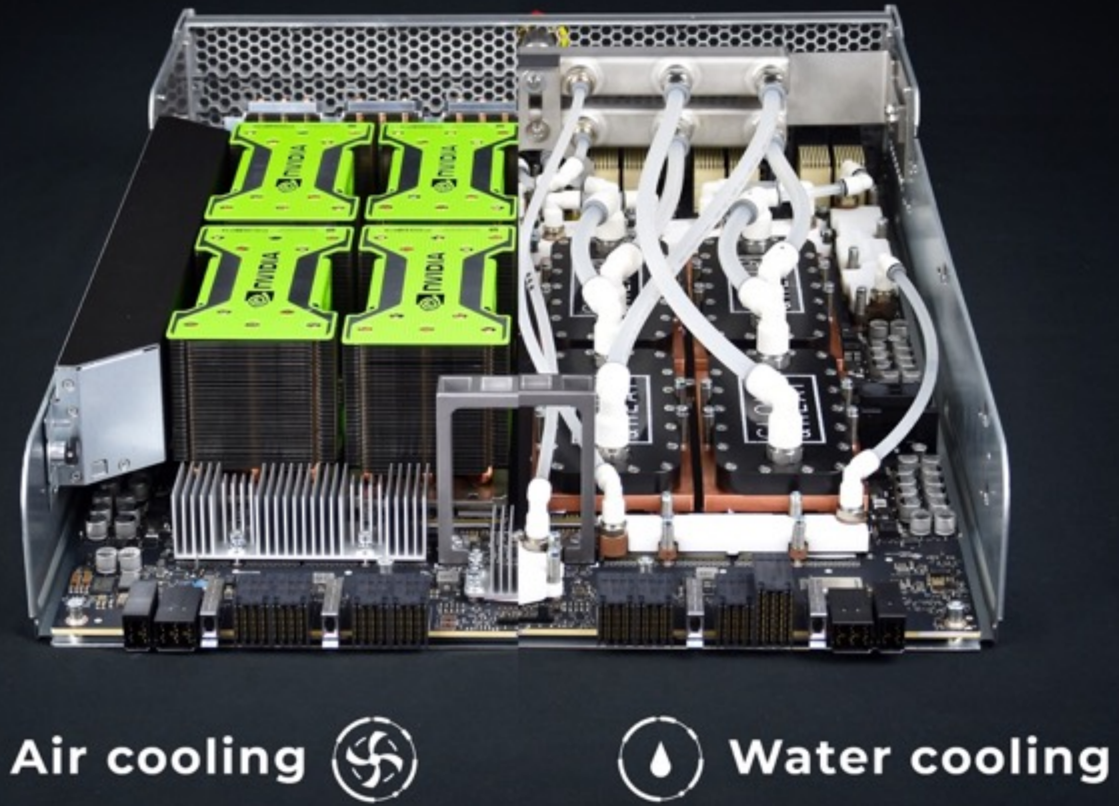
THOMAS KRENN

VATTENFALL

BENEFITS:

- Cooling **CPUs, GPUs, peripherial ICs, converters, network chips and cards, PCIe expansion cards**
- Increase in **power density** per rack
- Reduction in **operative costs**
- Reduction in **fan power** & **noise level**
- **Quick connectors** for easy and safe installation

CUSTOMIZED COOLING KIT



MICRO DATA CENTER

THE WATER-COOLED STANDARD

TECHNICAL DATA:

19“ / 21“ Rack standards	**80 kW** Max. power supply
48 U Max. rack height	**60 °C** Max. water return temperature

OPTIONAL MODULES:

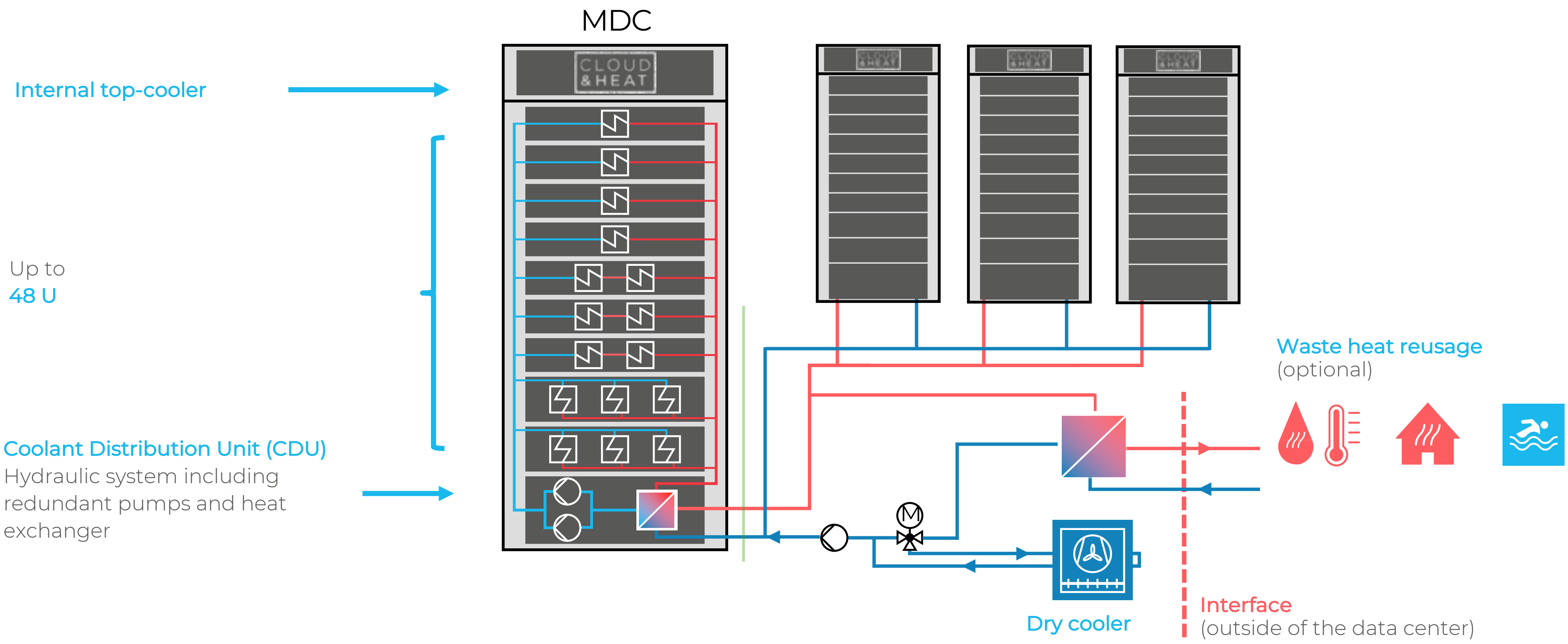
- Sidecooler
- Top cooler
- Heat pump
- Recooling device
- Customer branding
- Redundant PDU
- UPS
- IT servers
- Network hardware
- Fire detection and firefighting
- Monitoring
- Data visualization incl.. Grafana Dashboard
- SecuStack

CUSTOMERS:

T · · innogy VATTENFALL

MICRO DATA CENTER

TECHNICAL ASPECTS OF THE WATER-COOLING SOLUTION

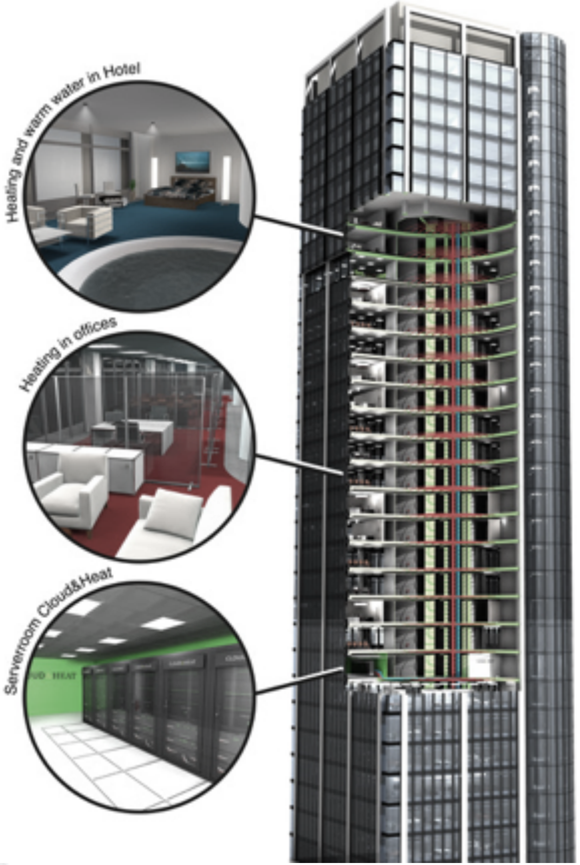


INDOOR DATA CENTER

EUROTHEUM DATA CENTER IN FRANKFURT

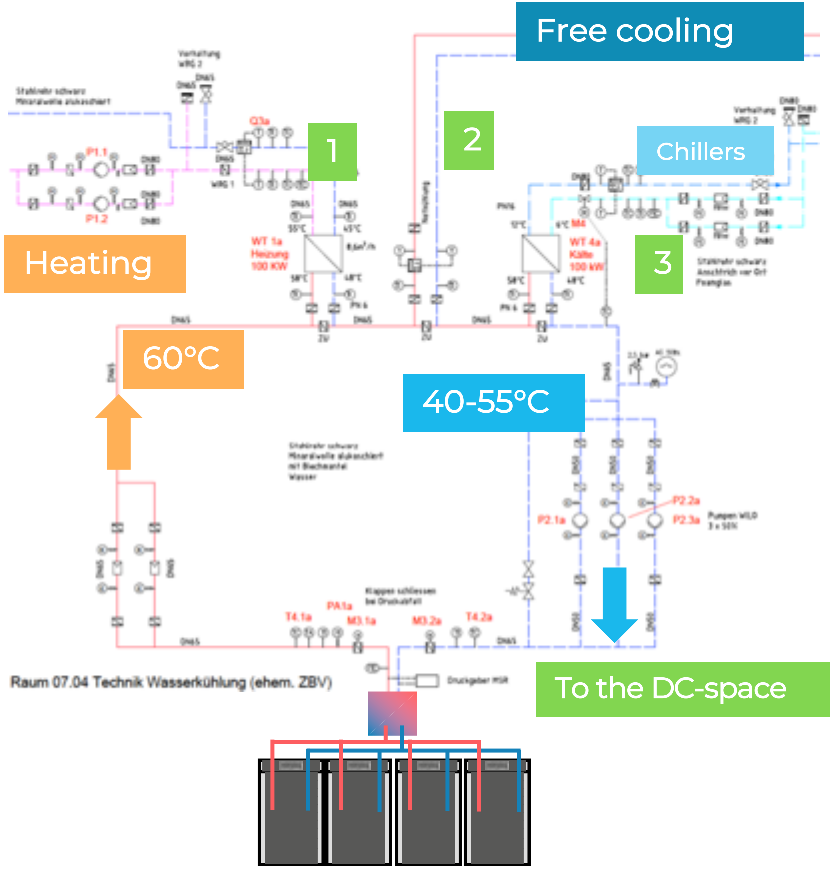
KEY FACTS:

- Original built in 1999
- C&H refurbishment: 2017/18
- Direct water-cooling and waste heat utilization in the same building
- DC-rooms at 7th floor
- TIER 3+ class
- 500 kW capacity
- C&H OpenStack public Cloud infrastructure



INDOOR DATA CENTER

EUROTHEUM DATA CENTER IN FRANKFURT



Data center cooling process:
1)Heating system ⇢ 2)Free-cooling ⇢ 3)A/C

1) Waste heat transferred to the heating system via a heat exchanger (for heating return temperatures<55°C)

2) 100% free-cooling possible using the ventilation system and the north façade flaps for high server temperatures (50-60°C)

3) If needed A/C supply by using standard chillers (n+1)

INDOOR DATA CENTER

ADDED VALUE OF THE IMPLEMENTATION

1. ADAPTATION OF THE DATA CENTER:

- Located in the Eurotheum building in Frankfurt (Main)
- Adaptation of an existing data center to efficient direct hot water cooling

500 kW

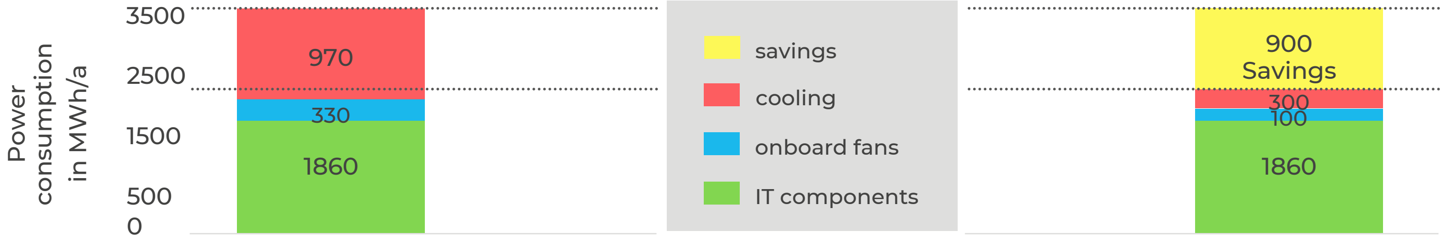
Data center power


Data center


Cooling distribution

2. SAVINGS CALCULATION:

AIR COOLING: DIRECT HOT WATER COOLING:



= 645 T€/a

Classical cooling costs per year

= 391 T€/a

Cooling costs with Cloud&Heat technology

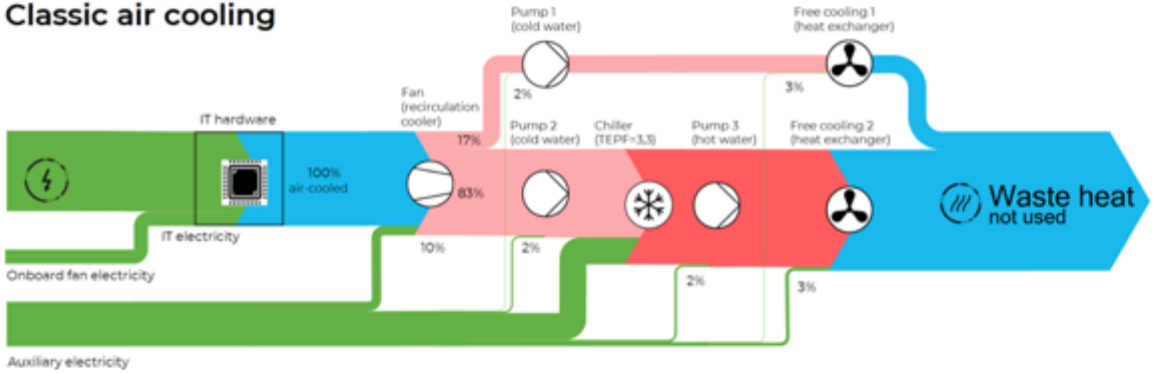
Savings: -255 T€/a

INDOOR DATA CENTER

ENERGY FLOW DIAGRAM

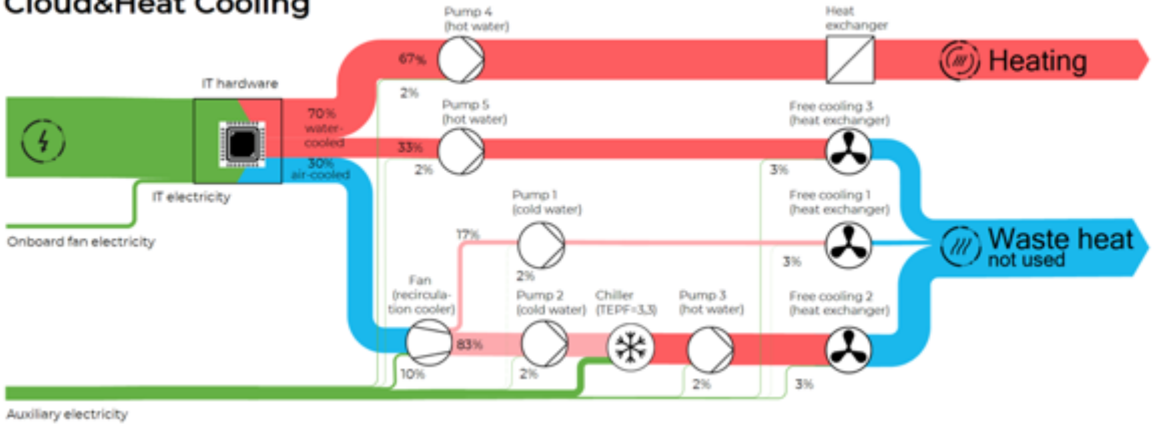
1. Air cooling 500 kW

Classic air cooling



2. Adaptation to direct hot water cooling

Cloud&Heat Cooling



- Electricity
- Heat flow – water (60 °C / 12 °C)
- Heat flow – air

[Source: White Paper Cloud&Heat Technolgoies GmbH]

DATA CENTER CONTAINER

THE WATER-COOLED STANDARD

TECHNICAL DATA:

19“ / 21“ Rack standards	**275 kW** Max. power supply
48 U Max. rack height	**20 ft / 40 ft** Container length

OPTIONAL MODULES:

- Sidecooler
- Heat pump
- Reecoler device
- Increased access security
- Redundant PDUs
- UPS
- 21” Rack OCP ORV2
- IT servers
- Network hardware
- Customer branding
- Monitoring
- Fire detection and firefighting
- Data visualization incl. dashboard
- SecuStack
- Flexible power supply and power density values

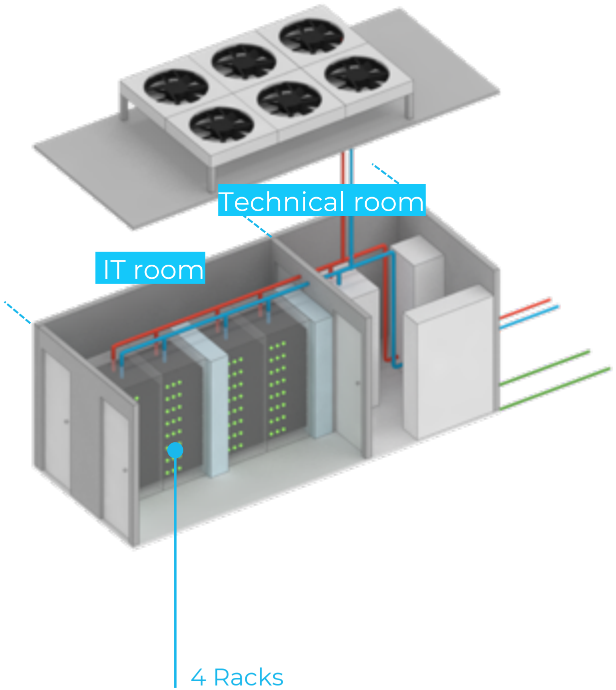
CUSTOMERS:

INABATA | VATTENFALL

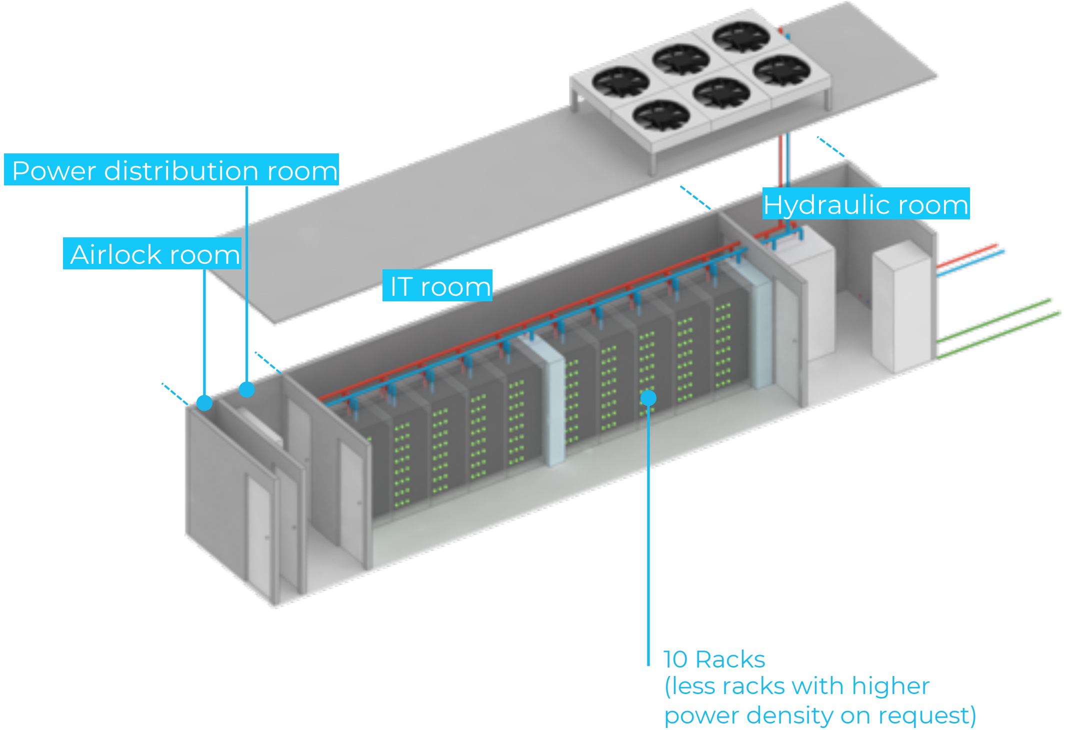
DATA CENTER CONTAINER

VARIANTS

20 FT CONTAINER:



40 FT CONTAINER:



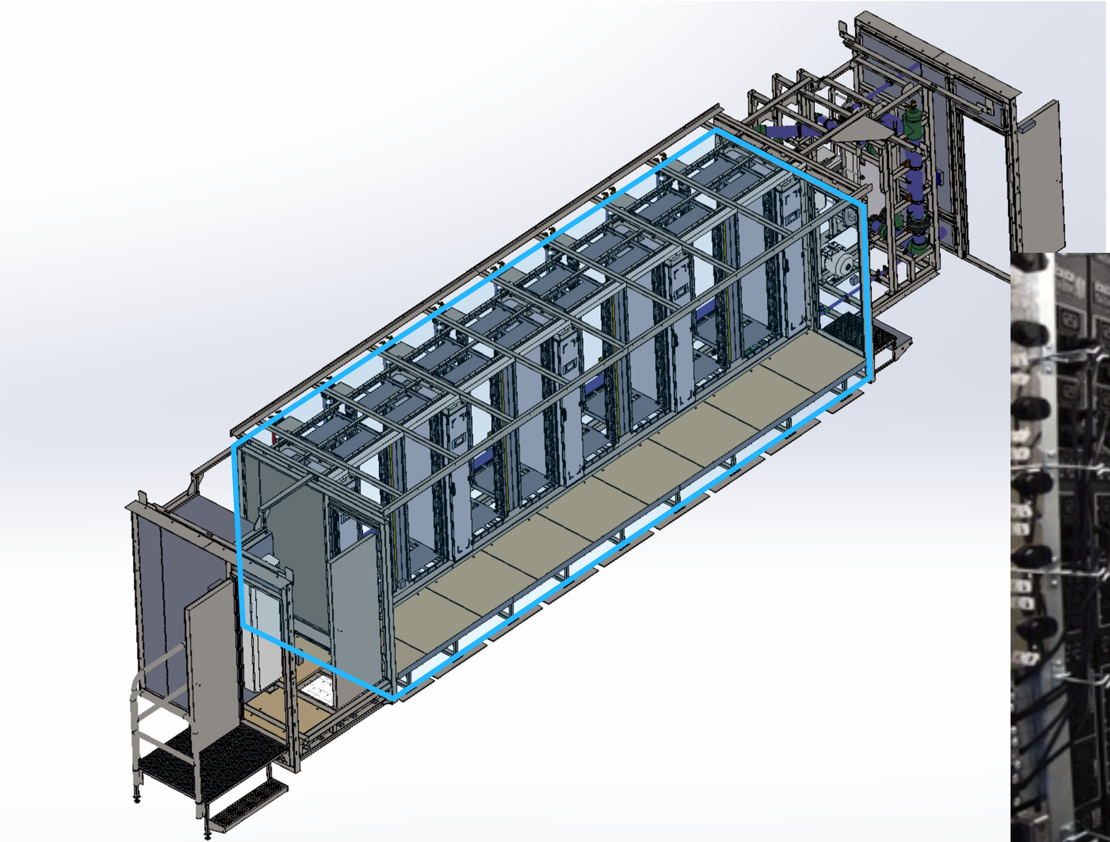
DATA CENTER CONTAINER

USE CASE

- 40 ft standard container for rendering purposes
- Weight with load: 17,000 kg/37,500 lb

DATA CENTER CONTAINER

SERVER ROOM

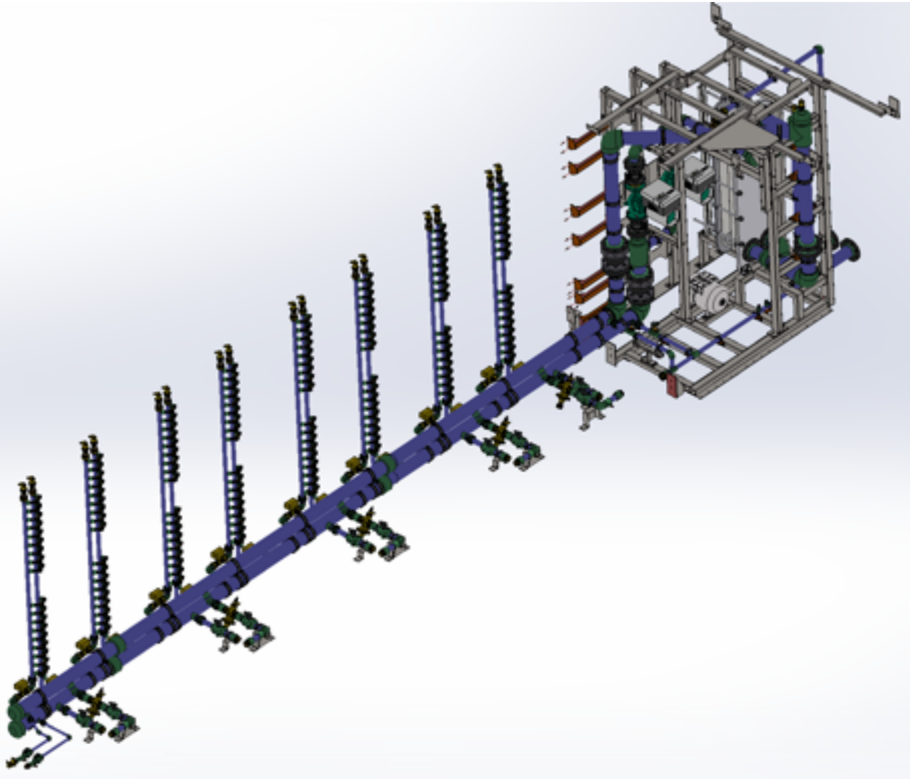


DATA CENTER CONTAINER

HYDRAULIC ROOM

- One hydraulic system for direct and indirect water-cooling
- Connecting pipes and manifolds made of plastic
- Heat output up to 350 kW/119 kbtu/hr
- Cooling liquid: purified water with up to 34% glycol

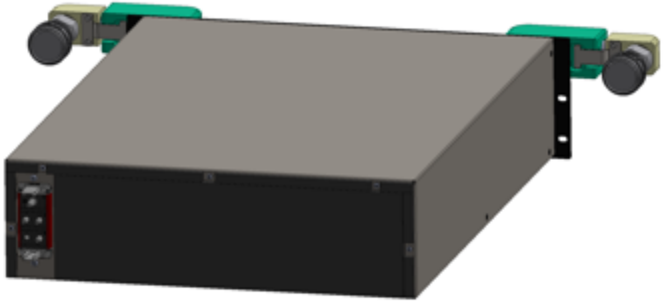
  (failsafe until -20°C/-4°F)

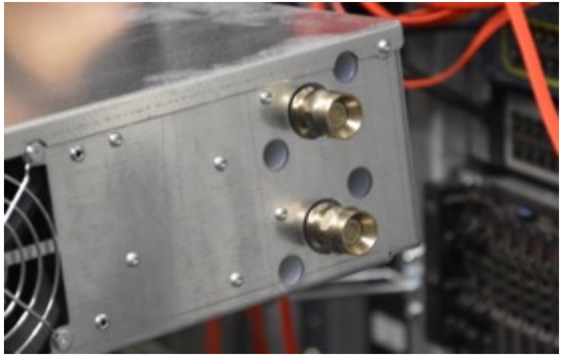


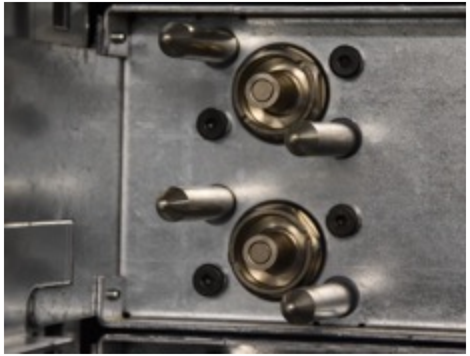
DATA CENTER CONTAINER

BACKPLANE AND INTERFACES

- Dripless couplings for connection of water-cooling
- Blind mate system - connection via pin guidance
- Ready to use system for eletrical quick connectors



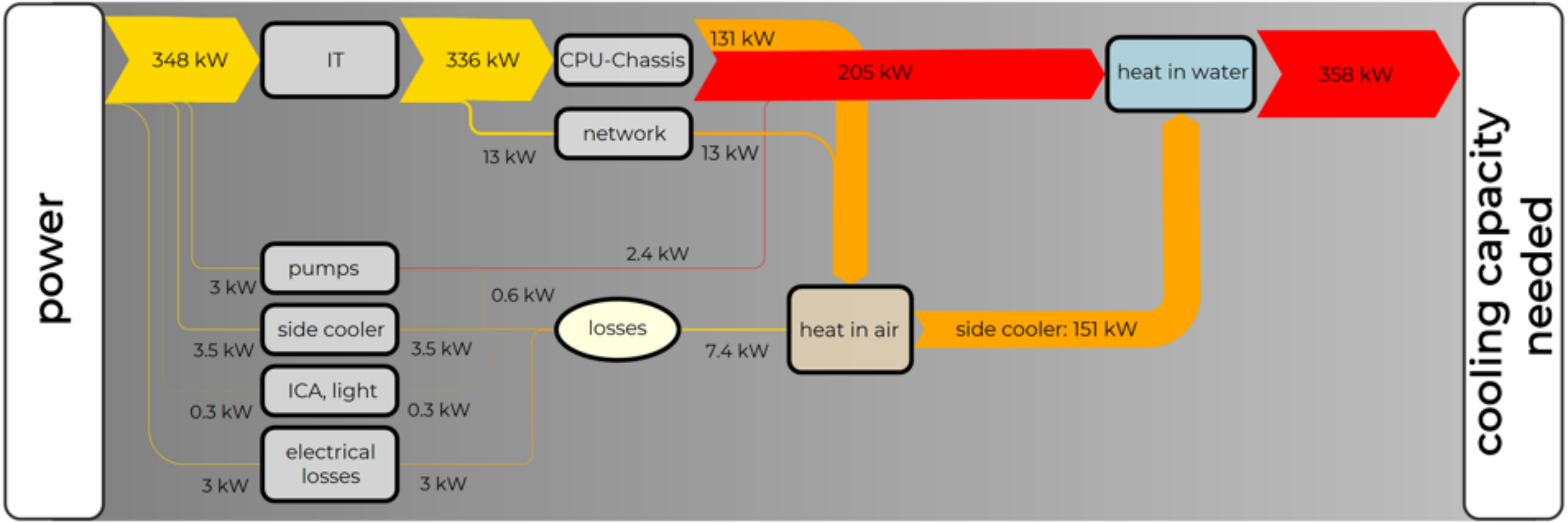




DATA CENTER CONTAINER

ENERGY EFFICIENCY

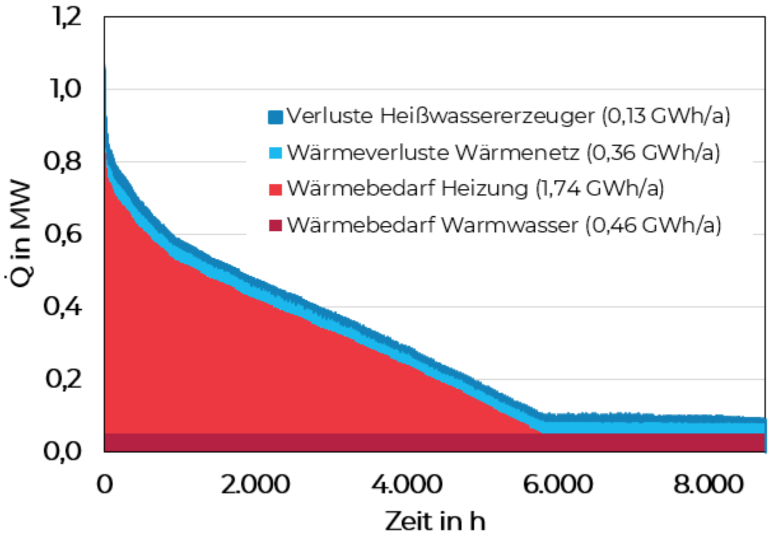
dPUE=1,03



WASTE HEAT REUSE

INTERFACES

- Our interface is always the heat exchanger. Stainless steel V4A.
- The maximum temperature delivered can reach 63°C DC-side. Heat-client side it drops to 60°C. If the waste heat is meant to heat a heating network reaching 70 to 100°C, the DC waste heat input is done to the return.
- Pressure in DC no more than 3 bar. To the outside depends on what is connected. Usually between 16 and 25 bar for heating networks.
- Liquid has to be suited to the heat exchanger. Demineralized water with glycol –if needed- and other additives is the liquid for DC.



Yearly 1MW-peak district heating power

DIRECT HOT WATER COOLING

ADDED VALUE OF ALTERNATIVE COOLING CONCEPTS

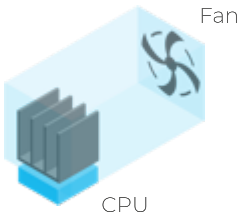
HEAT TRANSFER FLUID

Air volume

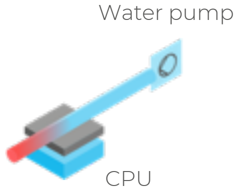
Water volume

Water has a higher density and specific heat capacity than air and is therefore 3,500 times more efficient than air as a heat transfer fluid

SPACE NEEDED FOR AIR COOLING VS. WATER COOLING



Air-cooled CPU processor



Water-cooled CPU processor

POTENTIAL OF WATER COOLING

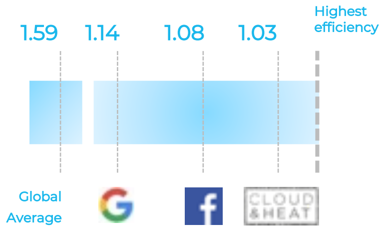
Lower energy consumption for cooling

Higher power density

High temperatures 60°C

Waste heat utilization

PUE*= Energy consumption DC / Energy consumption IT servers



Comparison of DC energy efficiencies

Source: Uptime Institute

*PUE (Power Usage Effectiveness)

SPACE SAVINGS

4 kW 1990

40 kW 2020

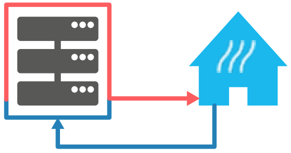
Twice the power in the same rackspace

Lower investment costs for rackspace

Higher power density per IT area

Source: Intel, AMD

WASTE HEAT UTILIZATION



Closed water circuit at a high temperature can be used for waste heat utilization (e.g. building heating)

SAVINGS POTENTIAL*

26%

Lower cooling costs

Lower heating costs

480 t/a

Reduction CO_2-emissions

≙ 250 cars

For an IT power of

400 kW

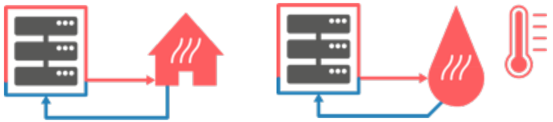
*) Reference: Slide 12 (Source: Cloud&Heat Whitepaper Data Center Eurotheum)

WASTE HEAT UTILIZATION POTENTIALS

HEAT REUSAGE SCENARIOS (EXAMPLES)

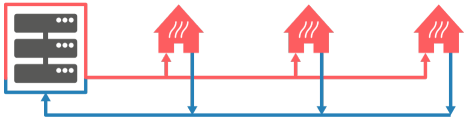
RESIDENTIAL HEATING + DHW

23-60 °C



DISTRICT HEATING

30-60 °C

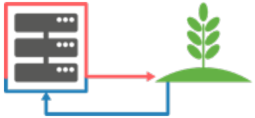


SWIMMING POOL

40-60 °C

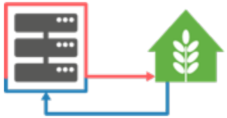
FIELD HEATING

25-45 °C



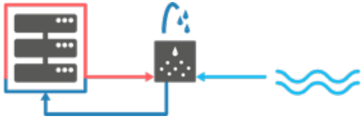
GREENHOUSE HEATING

3-60 °C



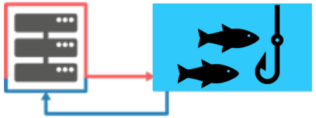
SEAWATER DESALINATION

33-60 °C



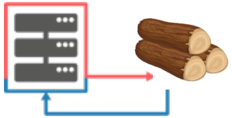
FISH FARMING

15-25 °C



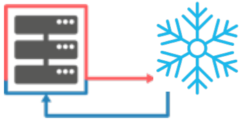
WOOD DRYING

30-60 °C



COOLING ENERGY

50-60 °C



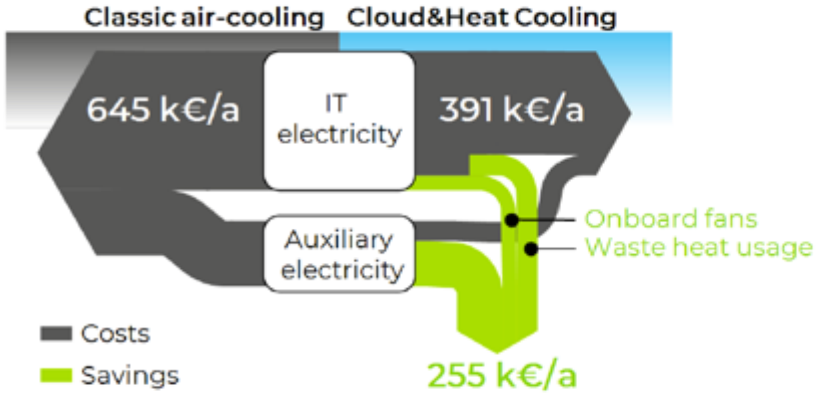
CLOUD&HEAT DESIGNS ARE ADAPTED TO COOL DOWN THE DATA CENTER BY REUSING THE HEAT FOR OTHER PURPOSES, WITHOUT COMPROMISING THE OPERATION OF THE IT COMPONENTS.

PUE VALUES CAN BE PUSHED UNDER 1.0 IF WASTE HEAT UTILIZATION IS CONSIDERED IN THE TOTAL ENERGY BALANCE.

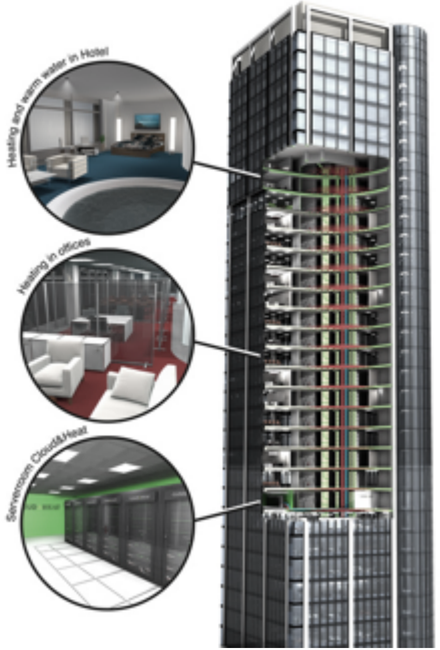
WASTE HEAT UTILIZATION POTENTIALS

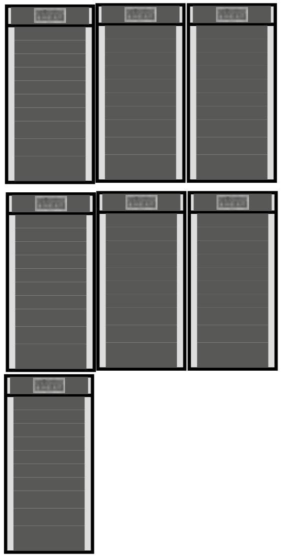
HEAT REUSAGE SCENARIO: WASTE HEAT FOR RESIDENTIAL HEATING

- 500 kW Tier 3 C&H data center with water-cooled servers, 70% water-cooled HW, 67% reusable.
- Waste heat recovery: supplied to hotel, customers and offices in same building
- Heating potential of around 8000 m^2



Cost flow diagram - standard air-cooling vs. Cloud & Heat Cooling





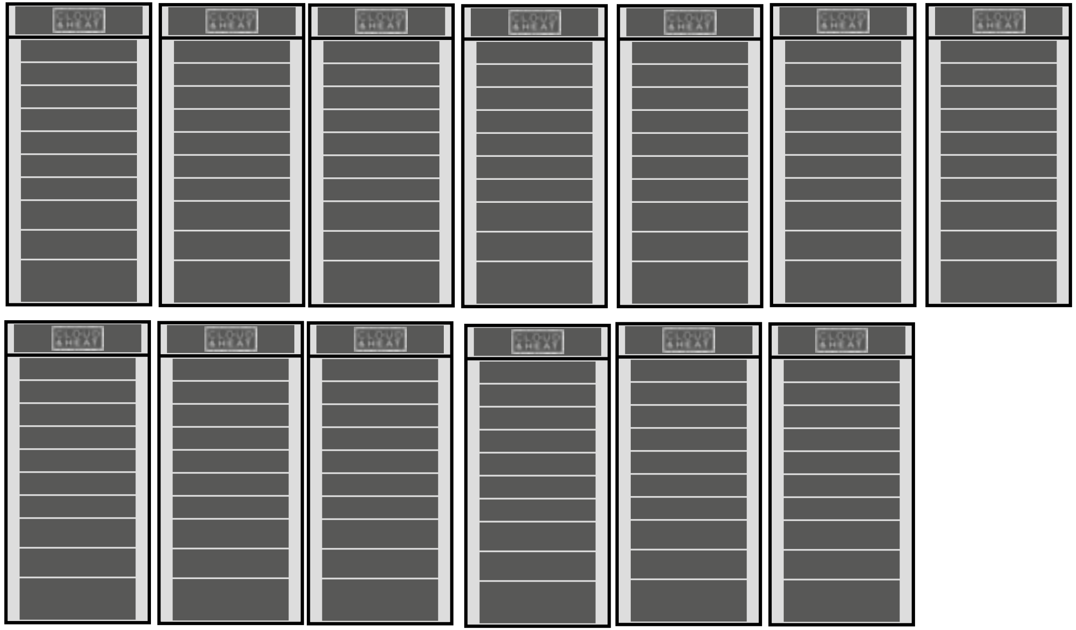
Outcomes for one year

- Saved cooling costs: 190.000 €/a
- Saved heating costs: 65.000 €/a
- CO_2 reduction: 710 tons/a (90 football fields of forest)

WASTE HEAT UTILIZATION POTENTIALS

HEAT REUSAGE SCENARIO: WASTE HEAT FOR SWIMMING POOL HEATING

- 800 kW for an olympic swimming-pool heating*
- 40°C hot water supply
- 14 MDCs at full capacity (75% water-cooled)

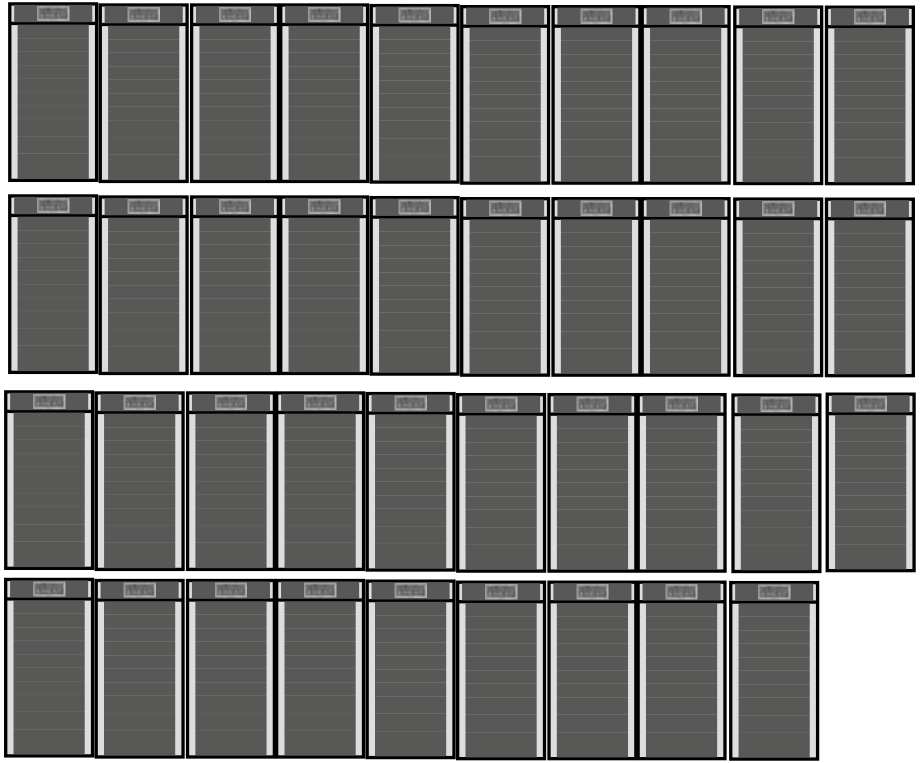


*https://www.secespol.com/en/realized-projects-7/olympic-pool-heating-1301.html

WASTE HEAT UTILIZATION POTENTIALS

HEAT REUSAGE SCENARIO: WASTE HEAT FOR GREENHOUSE HEATING

- 2300 kW for heating 1 ha. greenhouse to 25°C with -5°C outside*
- 39 MDCs at full capacity (75% water-cooled)

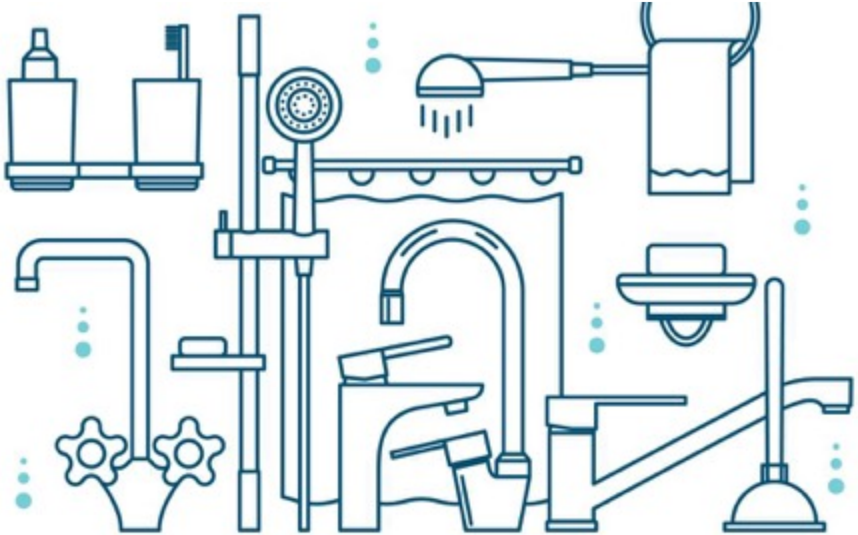


*http://www.littlegreenhouse.com/heat-calc.shtml

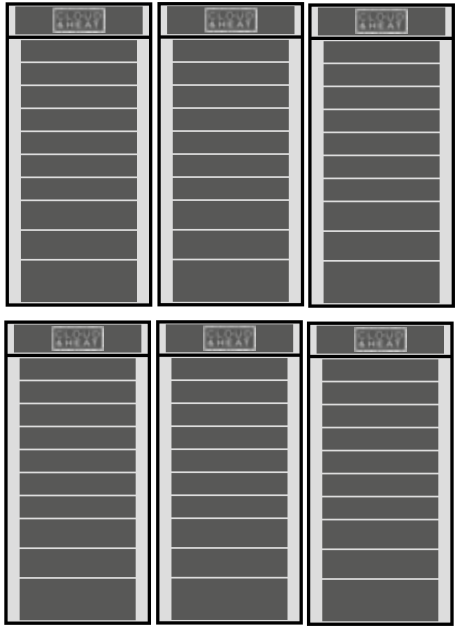
WASTE HEAT UTILIZATION POTENTIALS

HEAT REUSAGE SCENARIO: WASTE HEAT FOR DESALINATION

- UK average 3 people family uses 367 L of water per day*. Assuming 16 households per building: 5872 L/day
- 17 L of distillated water with 1 kWh of heat at 60°C + 0,036 kWh electrical power needed (using MED desalination)
- 345 kWh heat + 12 kWh electrical power are needed
- 6 MDCs at full capacity (75% water-cooled)



https://www.neefusa.org/nature/water/household-water-use

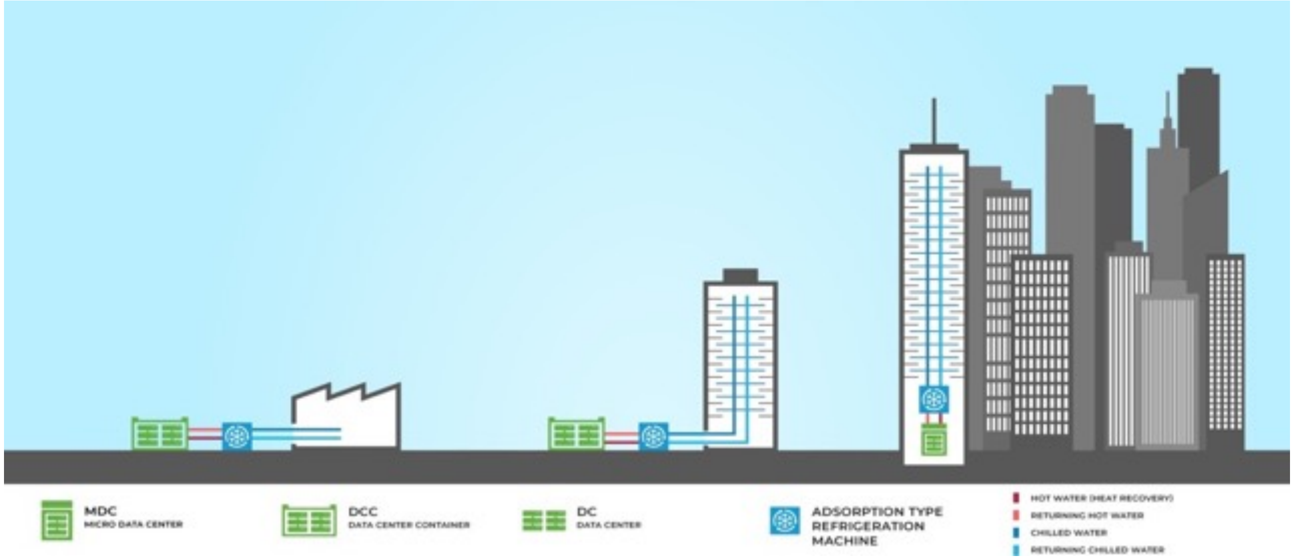


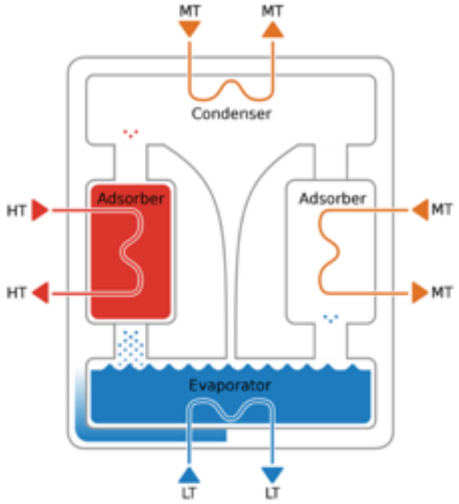
*https://www.statista.com/statistics/827278/liters-per-day-household-water-usage-united-kingdom-uk/

WASTE HEAT UTILIZATION POTENTIALS

HEAT REUSAGE SCENARIO: WASTE HEAT INTO COOLING ENERGY

- Heat drives a thermodynamic process to produce cooling energy
- No compressor required
- Minimal electrical auxiliary energy demand for pumps, measurement, control and actors
- Waste heat conversion into cooling energy for other buildings, greenhouses, industries or
- For the cooling of the data center itself



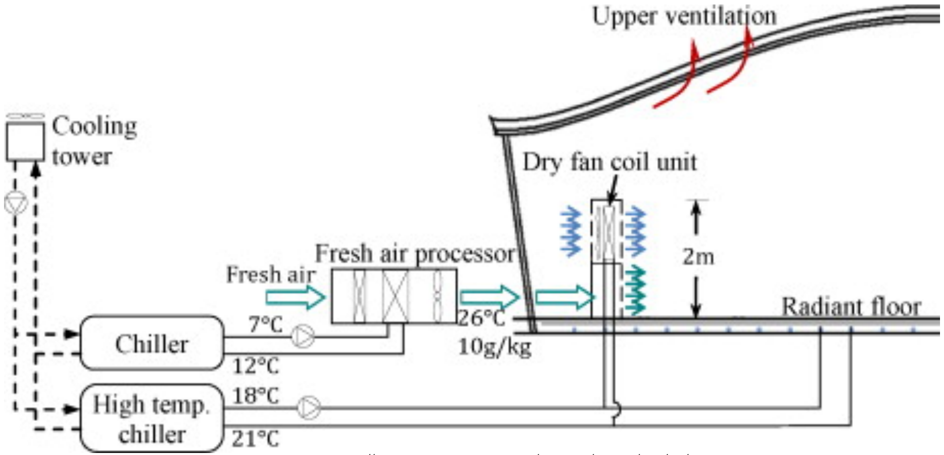


WASTE HEAT UTILIZATION POTENTIALS

HEAT REUSAGE SCENARIO: WASTE HEAT INTO COOLING ENERGY

- 2000 m2 building needs ca. 100 kW cooling power for cooling down from 40 to 25 °C*.
- Adsorption coolers have an efficiency of 40% and work at “high” cold temperatures (around 15°C)
- 2 MDCs at full capacity (75% water-cooled)


https://www.greenbuildingadvisor.com/article/does-radiant-floor-cooling-make-sense

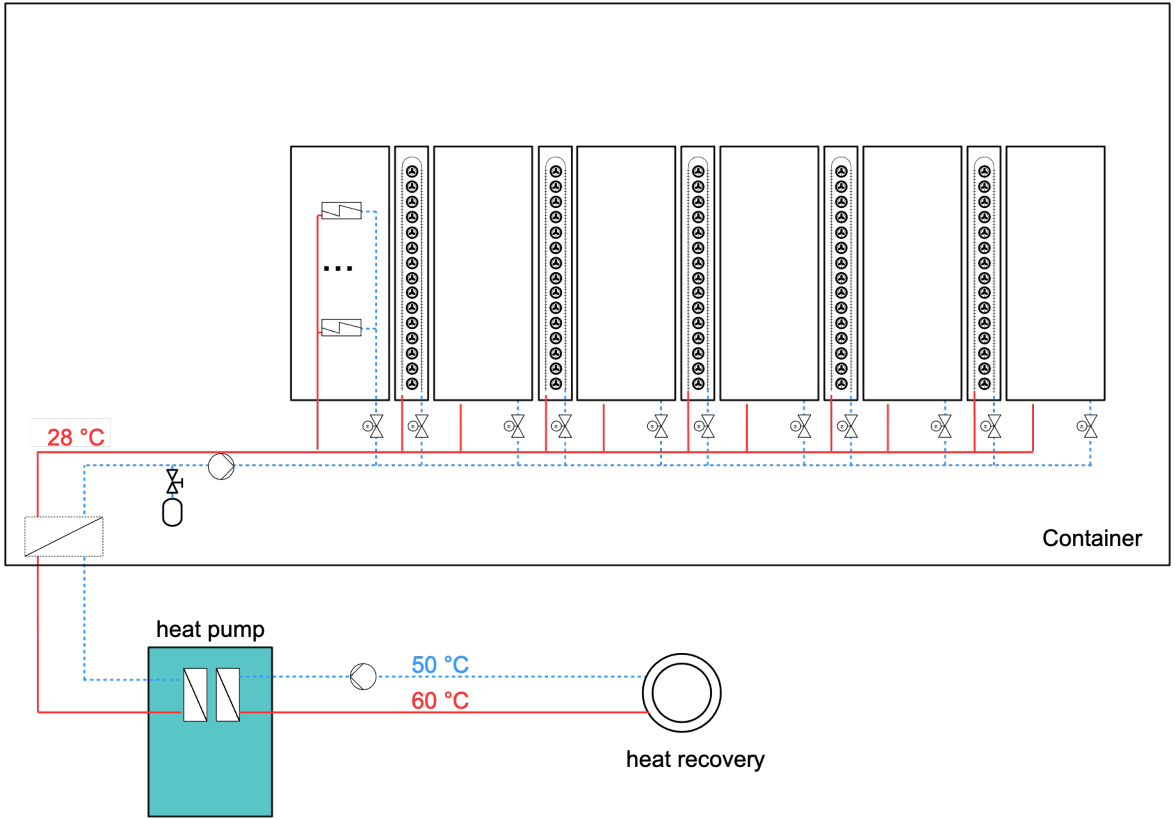


https://www.sciencedirect.com/science/article/abs/pii/S0378778813004027

*https://www.calculator.net/btu-calculator.html

CONFIGURATIONS FOR WASTE HEAT UTILIZATION

FOR DIFFERENT HEAT REUSAGE SCENARIOS



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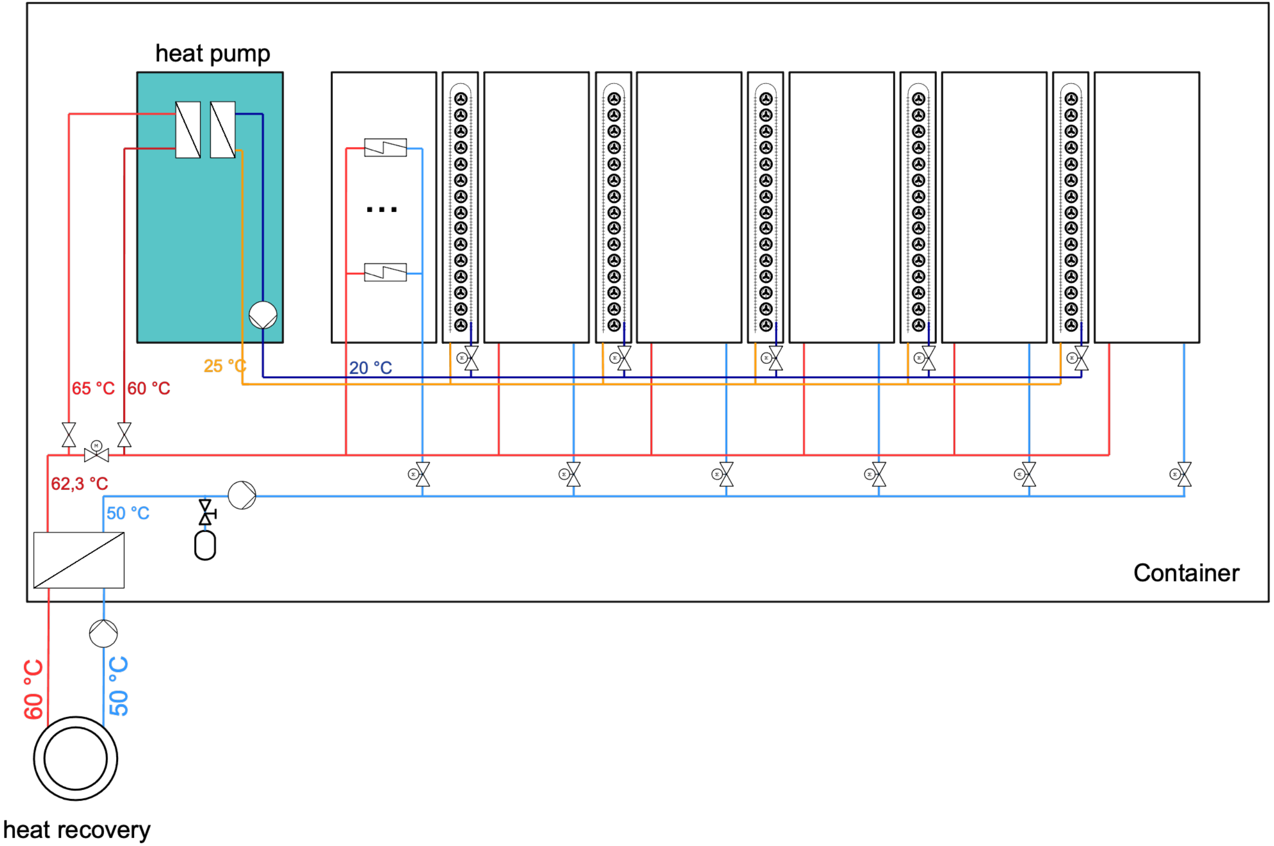

SUMMARY: DATA CENTERS HEAT REUSE

CHALLENGES AND OPPORTUNITIES

CHALLENGES

- Complexity at the business model
- Connections with different standards according to countries and usage of heat
- Alliance with local partners involved in the energy sector (make them your clients)
- Data center‘s and servers‘ cooling design according to the reusage kind
- Balance the generation of heat (=usage of servers) and heat demand

OPPORTUNITIES

- Reduce cooling costs
- Reduce heating costs
- Reduce greenhouse gases emissions
- Monetize a waste
- Create synergies between industries