Air@Work

most efficient air cooling

Introduction

Next Generation Sustainable Datacenter

Cost effective • Sustainable • Reliable

statiqcooling inside

Marius Klerk

Commercial Director

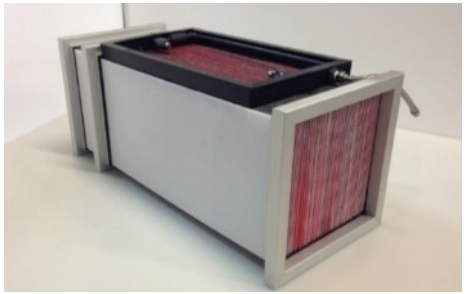
- **B Eng** (Bachelor of Enginering)
- **CDCEP** (*Certified Data Centre Energy Professional*)

- Member of The Netherlands Standardization Institute (NEN)
  - **EN 50600** Information technology data centre facilities and infrastructures
- Partner of **Green IT Amsterdam** region

About Air@Work

Air@Work
most efficient air cooling

- Manufacturer of Energy efficient Air Handling Units.
- 20 year of experience.
- Delivering AHU with counter-flow exchanger, sorption wheel and indirect evaporative counter-flow exchanger
- Using “Statiqcooling Technology” indirect evaporative cooling
    - The Counterflow Heat Exchanger is made of polypropylene.
    - Most efficient evaporative cooler by evaporation direct on the plates.
- Building modular and hybrid systems
- Including dynamic control system
- Quality components, StatiqCooler, EBM-papst fans, Regin control.
- 100 % plug & play.
- Certified by the Dutch TNO for legionella free and the German VDI 6022.
- Complying to European standards.



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Next Generation Sustainable Datacenter

- Reliable. Critical 24/7
- Modular. Selecting the right components
- Energy Efficient. SMART operation is key
- Sustainable. Think about the future! CO_2 footprint!
- Cost effective. Its all about the money!

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Latvia's most sustainable high capacity datacenter

- Design and installation by Moduls Riga:
  - Reliable by N+1 Redundancy
  - High capacity 10 kW per rack
  - Energy Efficient design below PUE 1,2
  - High energy efficient "compressorless" cooling system!
  - High efficient UPS system
  - Modular approach
  - Reuse of existing Building by Modusec Data centre concept!
  - Reuse of heat from the data center for surrounding buildings!

MODULS RĪGA
INŽENIERTEHNISKIE RISINĀJUMI

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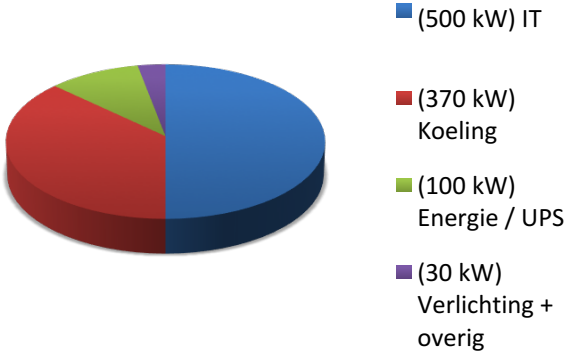
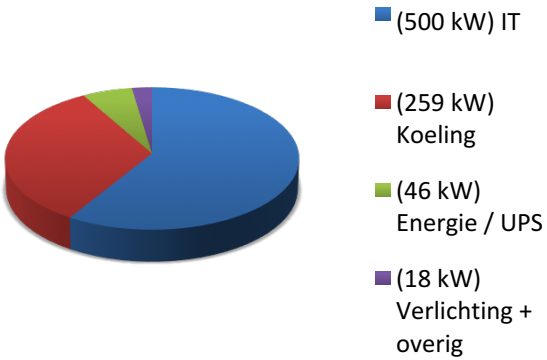
Optimizing a data centre makes sense

Traditional datacenter



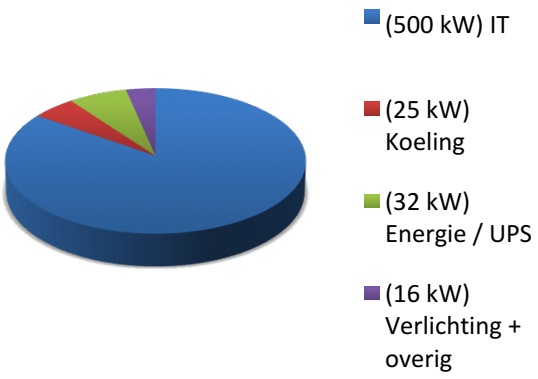
PUE datacenter = 2
PUE koeling = 1,7

Optimized datacenter



PUE datacenter = 1,6
PUE koeling = 1,5

Replacing cooling



PUE datacenter = 1,15
PUE koeling = 1,05

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About Ashrae TC 9.9

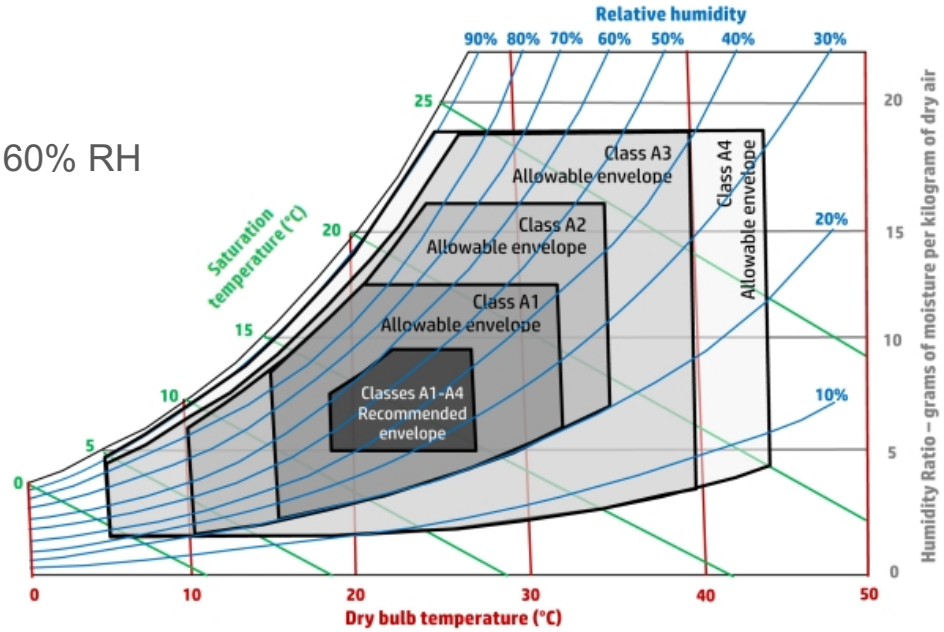
- TC 9.9 is concerned with all aspects of mission critical facilities, technology spaces, and electronic equipment/systems.
- To be recognized by ALL areas of the datacom industry as the UNBIASED engineering leader in HVAC and an effective provider of technical datacom information.
- IT Equipment (ITE) is the Foundation of TC 9.9's work.
- 2004 >> 2008 >> 2011 >> 2015 Version
- 2004 to 2008 a major change!

	2004 Version	2008 Version
Low End Temperature	20° C (68 ° F)	18° C (64.4 ° F)
High End Temperature	25° C (77 ° F)	27° C (80.6 ° F)
Low End Moisture	40% RH	5.5° C DP (41.9 ° F)
High End Moisture	55% RH	60% RH & 15° C DP (59 ° F DP)

Complying with ASHRAE TC 9.9 2011 requirements

- Recommended envelop Ashrae TC 9.9
  - Supply temp. 18˚C to 27˚C
  - Humidity 5.5˚C DP to 15˚C DP and 60% RH

- Allowable envelope Ashrae TC 9.9
  - Supply temp. 15˚C to 32˚C
  - Humidity 20% to 80%



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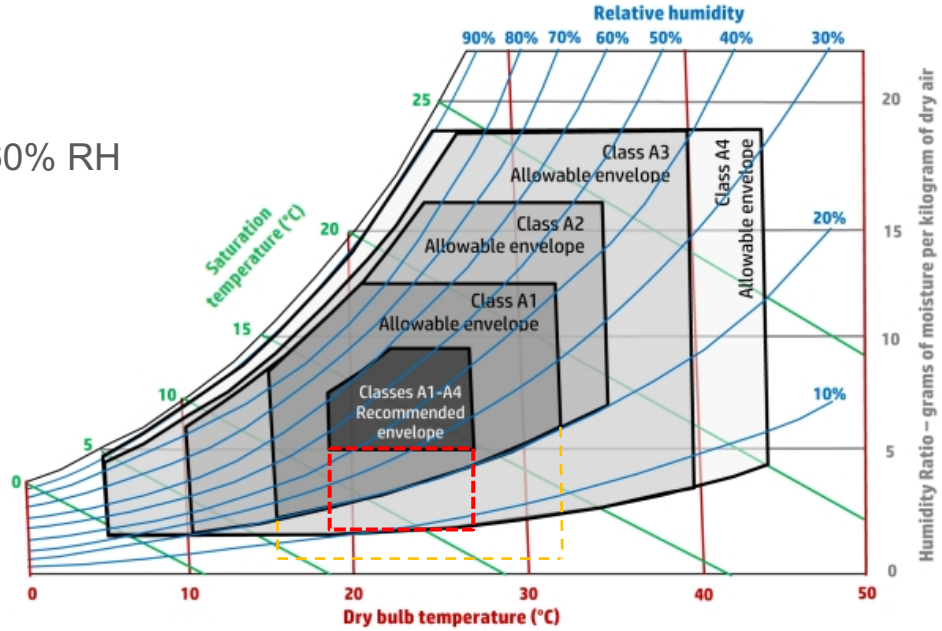
Complying with ASHRAE TC 9.9 2015 requirements

- Recommended envelop Ashrae TC 9.9
  - Supply temp. 18˚C to 27˚C
  - Humidity -9˚C DP to 15˚C DP and 60% RH

- Allowable envelope Ashrae TC 9.9
  - Supply temp. 15˚C to 32˚C
  - Humidity -12˚C DP and 8% RH

    to 17˚C DP and 80% RH



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Ashrae 2011 Recommended envelop
Humidity control based on Riga climate

	Hours	Temperature DryBulb	RelativeHumididty	Temperature Dew Point	Abs Hum
Humidification is required complying Ashrae TC 9.9 2011	2	-21	86	-22,5	0,5
	1	-20	88	-20,2	0,6
	4	-19	87	-20,4	0,6
	4	-18	84	-19,8	0,6
	14	-17	83	-19	0,7
	13	-16	76	-18,9	0,7
	24	-15	78	-17,7	0,8
	35	-14	77	-16,8	0,9
	36	-13	76	-16	0,9
	27	-12	78	-14,7	1
	30	-11	81	-13,3	1,2
	33	-10	83	-12,1	1,3
	23	-9	84	-11	1,5
	52	-8	82	-10,2	1,6
	48	-7	81	-9,4	1,7
	68	-6	81	-8,4	1,8
	140	-5	82	-7,3	2
	189	-4	79	-6,7	2,1
	228	-3	81	-5,5	2,38
	210	-2	81	-4,5	2,6
	298	-1	83	-3,2	2,88
	402	0	83	-2,6	3,1
	461	1	85	-1,3	3,5
	483	2	87	0	3,7
	496	3	85	0,7	4
	426	4	85	1,7	4,3
	312	5	79	1,7	4,3
	245	6	83	3,3	4,8
	235	7	81	4	5
	248	8	79	4,6	5,3
	4787				

	Hours	Temperature DryBulb	RelativeHumididty	Temperature Dew Point	Abs Hum
Operation complying Ashrae TC 9.9 2011	256	9	81	5,9	5,8
	266	10	79	6,6	6
	298	11	79	7,5	6,4
	299	12	80	8,7	7
	308	13	79	9,5	7,4
	381	14	77	10,1	7,7
	361	15	78	11,2	8,3
	337	16	73	11,2	8,3
	277	17	71	11,7	8,6
	272	18	69	12,3	8,8
	244	19	67	12,8	9,2
	198	20	64	13	9,3
	154	21	58	12,5	9
	99	22	55	12,6	9,1
	65	23	56	13,8	9,8
	47	24	52	13,6	9,7
	37	25	51	14,2	10,1
	21	26	50	14,8	10,5
	34	27	45	14,1	10
	18	28	43	14,3	10,1
	1	29	47	16,6	11,8
	3973				

Ashrae 2015 Recommended envelop
Humidity control based on Riga climate

	Hours	Temperature DryBulb	RelativeHumididty	TemperatureDew Point	Abs Hum
Humidification is required complying Ashrae TC 9.9 2015	2	-21	86	-22,5	0,5
	1	-20	88	-20,2	0,6
	4	-19	87	-20,4	0,6
	4	-18	84	-19,8	0,6
	14	-17	83	-19	0,7
	13	-16	76	-18,9	0,7
	24	-15	78	-17,7	0,8
	35	-14	77	-16,8	0,9
	36	-13	76	-16	0,9
	27	-12	78	-14,7	1
	30	-11	81	-13,3	1,2
	33	-10	83	-12,1	1,3
	23	-9	84	-11	1,5
	52	-8	82	-10,2	1,6
	48	-7	81	-9,4	1,7
	346				

	Hours	Temperature DryBulb	RelativeHumididty	Temperature Dew Point	Abs Hum
Operation complying Ashrae TC 9.9 2015	68	-6	81	-8,4	1,8
	140	-5	82	-7,3	2
	189	-4	79	-6,7	2,1
	228	-3	81	-5,5	2,38
	210	-2	81	-4,5	2,6
	298	-1	83	-3,2	2,88
	402	0	83	-2,6	3,1
	461	1	85	-1,3	3,5
	483	2	87	0	3,7
	496	3	85	0,7	4
	426	4	85	1,7	4,3
	312	5	79	1,7	4,3
	245	6	83	3,3	4,8
	235	7	81	4	5
	248	8	79	4,6	5,3
	256	9	81	5,9	5,8
	266	10	79	6,6	6
	298	11	79	7,5	6,4
	299	12	80	8,7	7
	308	13	79	9,5	7,4
	381	14	77	10,1	7,7
	361	15	78	11,2	8,3
	337	16	73	11,2	8,3
	277	17	71	11,7	8,6
	272	18	69	12,3	8,8
	244	19	67	12,8	9,2
	198	20	64	13	9,3
	154	21	58	12,5	9
	99	22	55	12,6	9,1
	65	23	56	13,8	9,8
	47	24	52	13,6	9,7
	37	25	51	14,2	10,1
	21	26	50	14,8	10,5
	34	27	45	14,1	10
	18	28	43	14,3	10,1
	1	29	47	16,6	11,8
	8414				

Climate conditions Riga, Latvia

RIGA, LATVIA (WMO: 264225)

Lat:**56.92N** Long:**23.97E** Elev:**10** StdP: **101.2** Time zone:**2.00** Period:**94-10**

Annual Heating and Humidification Design Conditions

Coldest Month	Heating DB		Humidification DP/MCDB and HR						Coldest month WS/MCDB				MCWS/PCWD to 99.6% DB	
	99.6%	99%	99.6%			99%			0.4%		1%			
			DP	HR	MCDB	DP	HR	MCDB	WS	MCDB	WS	MCDB	MCWS	PCWD
1	**-18.9**	**-14.2**	**-21.1**	**0.6**	**-18.7**	**-17.2**	**0.8**	**-13.9**	**11.9**	**0.8**	**9.9**	**0.0**	**1.5**	**180**

Annual Cooling, Dehumidification, and Enthalpy Design Conditions

Hottest Month	Hottest Month DB Range	Cooling DB/MCWB						Evaporation WB/MCDB						MCWS/PCWD to 0.4% DB	
		0.4%		1%		2%		0.4%		1%		2%			
		DB	MCWB	DB	MCWB	DB	MCWB	WB	MCDB	WB	MCDB	WB	MCDB	MCWS	PCWD
7	**10.1**	**28.9**	**20.3**	**27.0**	**19.7**	**25.1**	**18.3**	**21.8**	**26.8**	**20.5**	**25.1**	**19.4**	**23.8**	**4.0**	**350**

Dehumidification DP/MCDB and HR									Enthalpy/MCDB						Hours 8 to 4 and 12.8/20.6
0.4%			1%			2%			0.4%		1%		2%		
DP	HR	MCDB	DP	HR	MCDB	DP	HR	MCDB	Enth	MCDB	Enth	MCDB	Enth	MCDB	
20.0	**14.7**	**24.4**	**18.9**	**13.7**	**23.1**	**17.9**	**12.8**	**21.7**	**63.2**	**26.5**	**58.8**	**24.9**	**55.0**	**23.5**	**852**

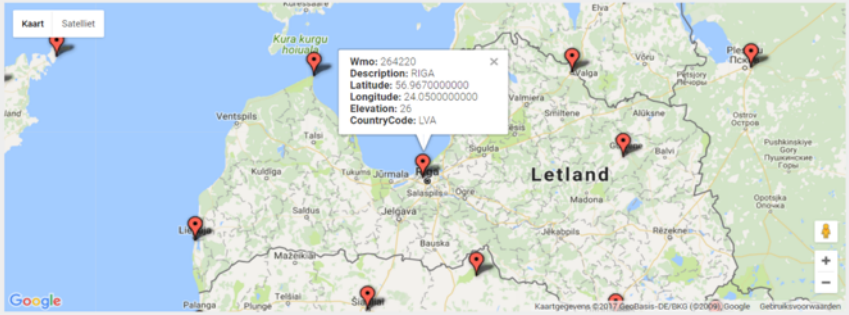
Extreme Annual Design Conditions

Extreme Annual WS			Extreme Max WB	Extreme Annual DB				n-Year Return Period Values of Extreme DB							
				Mean		Standard deviation		n=5 years		n=10 years		n=20 years		n=50 years	
1%	2.5%	5%		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
9.1	**8.1**	**7.3**	**26.1**	**-22.7**	**31.3**	**4.4**	**2.1**	**-25.8**	**32.8**	**-28.4**	**34.0**	**-30.9**	**35.2**	**-34.0**	**36.7**

http://ashrae-meteo.info/

Online Simulation tool (Beta)

Choose design conditions



Location

Riga

Conditions

Cooling Capacity [kW] — 260 kW — 25 kW — 1000 kW

ΔT [°C] — 12 °C — 8 °C — 14 °C

Airflow Primary [m³/h] — 65000 m³/h — 5400 m³/h — 375000 m³/h

Goal [°C] — 24 °C — 10 °C — 40 °C

PrimarySide Temperature DryBulb [°C] — 36 °C — 18 °C — 54 °C

CutOff [°C] — 12 °C — 6 °C — 30 °C

Results

3(+1)x DC 21000

Redundancy: N + 1

Cooling Capacity: 260 kW
ΔT: 12 °C
Airflow Primary: 65000 m³/h
Nominal: 77%

Clear values | Select

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Simulation Riga 100% ICT load Input

Output Calculator **Riga**

Version 2.0

Air@Work most efficient air cooling

Datacenter Characteristics

Country	LV	
Location	Riga	
WMO	264.220	
Total required cooling capacity (kW)	260	kW
Redundancy (N+…)	1	
Air@Work IAC DC 21000	4	
ICT load DC (%)	100	%

Condition Characteristics

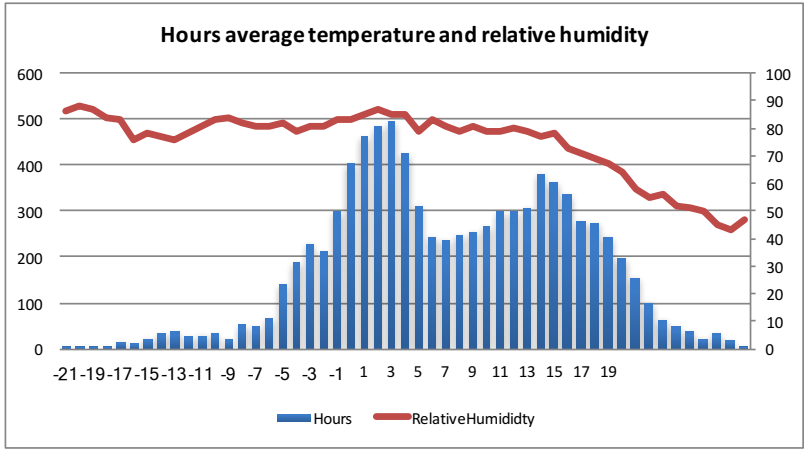
Preferred ingoing temperature Cold Corridor (°C)	24	˚C
Delta T over server (°C)	12	˚C
Outgoing temperature Hot Coridor (°C)	36	˚C
Airflow Primary (m3/h)	65.000	m3/h
Wet/dry set point (˚C)	12	˚C

Datacenter cooling requirments

Ashrae recomended envelop max. supply temp (˚C)	✔	27	˚C
Ashrae allowable envelop max. supply temp (˚C)	✔	32	˚C

Weather conditions analysis

Ashrae location: Riga LV WMO 264220



Outside Relative Humidity

Average RH year	75%		
Average RH when >24°C	48%	Ashrae recomended envelop RH	✔

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Simulation Riga 100% ICT load Technical Analysis

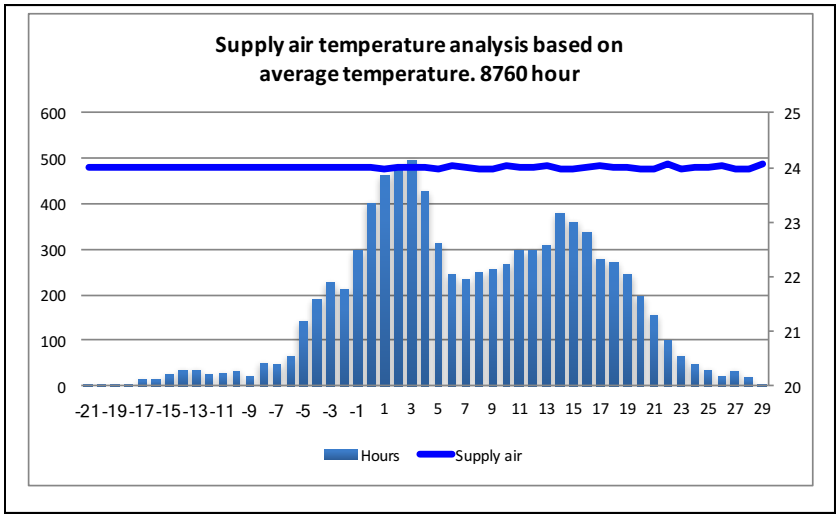
Output Calculator **Riga**

Version 2.0

Air@Work most efficient air cooling

Technical Analysis

Cooling time		
Calculated hours indirect free cooling/per year	5.607	
Calculated hours indirect adiabatic cooling per year	3.153	
Calculated hours trim cooling per year		
Airflow and temperature		
Assumed difference of outgoing (36°C) and ingoing temperature (24°C) (°C)	12	˚C
Calculated required supply air (m3/hour)	65.000	m3/h
Energy consumption		
Energy consumption IT equipment (kWh/year)	2.277.600	kWh/year
Required annual cooling capacity (kWh/year)	2.277.600	kWh/year
Energy consumption for cooling (kWh/year)	87.924	kWh/year
Water consumption		
Water consumption for cooling (m3/year)	930	m3/year
Efficency calculation		
Average Water Usage Effectiveness (WUE)	0,41	
Average calculated Seasonal EER of cooling system	26	
Average PUEcooling of cooling system	**1,04**	



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Simulation Riga 100% ICT load Financial Analysis

Output Calculator Riga
Version 2.0

Air@Work most efficient air cooling

Financial and investment analysis	Alternative system		Air@Work DC	
Investment in cooling equipment	185.000	EUR	200.000	EUR
Cost of 1 kWh	0,1	EUR	0,1	EUR
Average calculated Seasonal EER of cooling system	2,5		26	
Required annual cooling capacity (kWh/year)	2.277.600		2.277.600	
Energy consumption for cooling (kWh/year)	911.040		87.924	
Annual energy costs for cooling (EUR/year)	**91.104**	**EUR**	**8.792**	**EUR**
Annual maintenance costs (EUR/year)	**P.M.**		**P.M.**	
Costs of m3 water			1,5	EUR
Water consumption for cooling (m3/year)			930	
Annual water costs (EUR/year)			**1.395**	**EUR**
Energy consumption IT equipment (kWh/year)	2.277.600		2.277.600	
Annual energy costs for IT equipment (EUR/year)	**227.760**	**EUR**	**227.760**	**EUR**
Sum of costs (EUR/year)	**318.864**	**EUR**	**237.948**	**EUR**

Summary of Environmental savings with Air@Work	
Average PUEcooling	1,04
Average Water Usage Effectiveness (WUE)	0,41
Annual CO_2 savings on energy use (kg)	493.870
Annual energy savings (kWh)	823.116

Summary of Financial savings with Air@Work		
Annual cost savings	80.916	EUR
Annual return on extra investment (%)	539%	
Payback time on extra investment (years)	0,19	

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Simulation Riga 75% ICT load Input

Output Calculator **Riga**

Version 2.0

Air@Work most efficient air cooling

Datacenter Characteristics

Country	LV	
Location	Riga	
WMO	264.220	
Total required cooling capacity (kW)	196	kW
Redundancy (N+…)	1	
Air@Work IAC DC 21000	4	
ICT load DC (%)	75	%

Condition Characteristics

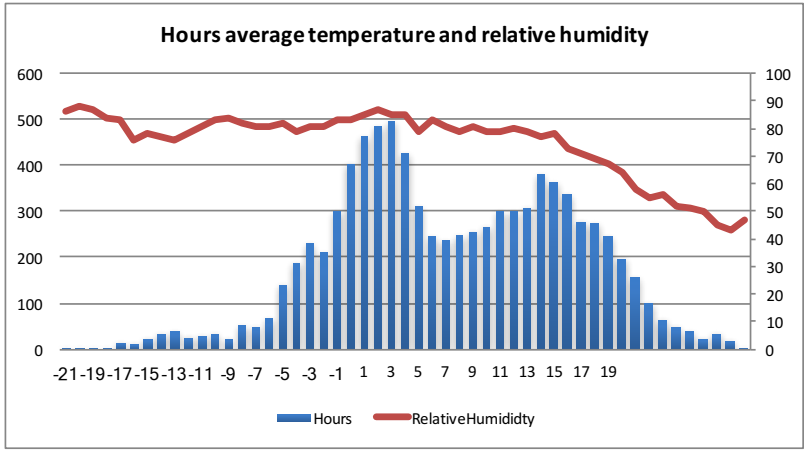
Preferred ingoing temperature Cold Corridor (°C)	24	˚C
Delta T over server (°C)	12	˚C
Outgoing temperature Hot Coridor (°C)	36	˚C
Airflow Primary (m3/h)	51.000	m3/h
Wet/dry set point (˚C)	12	˚C

Datacenter cooling requirments

Ashrae recomended envelop max. supply temp (˚C)	✔	27	˚C
Ashrae allowable envelop max. supply temp (˚C)	✔	32	˚C

Weather conditions analysis

Ashrae location: Riga LV WMO 264220



Outside Relative Humidity

Average RH year	75%		
Average RH when >24°C	48%	Ashrae recomended envelop RH	✔

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Simulation Riga 75% ICT load Technical Analysis

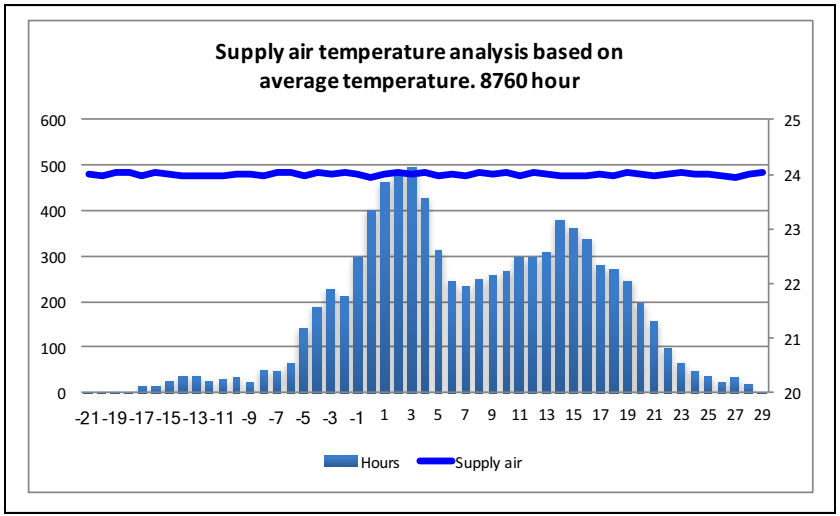
Output Calculator **Riga**

Version 2.0

Air@Work most efficient air cooling

Technical Analysis

Cooling time		
Calculated hours indirect free cooling/per year	5.607	
Calculated hours indirect adiabatic cooling per year	3.153	
Calculated hours trim cooling per year		
Airflow and temperature		
Assumed difference of outgoing (36°C) and ingoing temperature (24°C) (°C)	12	˚C
Calculated required supply air (m3/hour)	51.000	m3/h
Energy consumption		
Energy consumption IT equipment (kWh/year)	1.716.960	kWh/year
Required annual cooling capacity (kWh/year)	1.716.960	kWh/year
Energy consumption for cooling (kWh/year)	46.646	kWh/year
Water consumption		
Water consumption for cooling (m3/year)	699	m3/year
Efficency calculation		
Average Water Usage Effectiveness (WUE)	0,41	
Average calculated Seasonal EER of cooling system	37	
Average PUEcooling of cooling system	**1,03**	



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Simulation Riga 75% ICT load Financial Analysis

Output Calculator Riga
Version 2.0

Air@Work most efficient air cooling

Financial and investment analysis	Alternative system		Air@Work DC	
Investment in cooling equipment	185.000	EUR	200.000	EUR
Cost of 1 kWh	0,1	EUR	0,1	EUR
Average calculated Seasonal EER of cooling system	3,5		37	
Required annual cooling capacity (kWh/year)	1.716.960		1.716.960	
Energy consumption for cooling (kWh/year)	490.560		46.646	
Annual energy costs for cooling (EUR/year)	**49.056**	**EUR**	**4.665**	**EUR**
Annual maintenance costs (EUR/year)	**P.M.**		**P.M.**	
Costs of m3 water			1,5	EUR
Water consumption for cooling (m3/year)			699	
Annual water costs (EUR/year)			**1.048**	**EUR**
Energy consumption IT equipment (kWh/year)	1.716.960		1.716.960	
Annual energy costs for IT equipment (EUR/year)	**171.696**	**EUR**	**171.696**	**EUR**
Sum of costs (EUR/year)	**220.752**	**EUR**	**177.409**	**EUR**

Summary of Environmental savings with Air@Work	
Average PUEcooling	1,03
Average Water Usage Effectiveness (WUE)	0,41
Annual CO_2 savings on energy use (kg)	266.348
Annual energy savings (kWh)	443.914

Summary of Financial savings with Air@Work		
Annual cost savings	43.343	EUR
Annual return on extra investment (%)	289%	
Payback time on extra investment (years)	0,35	

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Cooling cost for 1 MW @ € 0,1 kWh/h

EER	PUE Cooling	Required electrical power (kW)	Energy cost per year
2,5 (DX)	1,4	400	€ 350.400,-
3,5 (CW)	1,3	285	€ 249.660,-
8 (CW + Dry)	1,15	150	€ 131.400,-
15 (Free air+ DX)	1,1	55	€ 48.180,-
25 (IAC)	1,04	40	€ 35.040,-

Indirect Adiabatic Cooling

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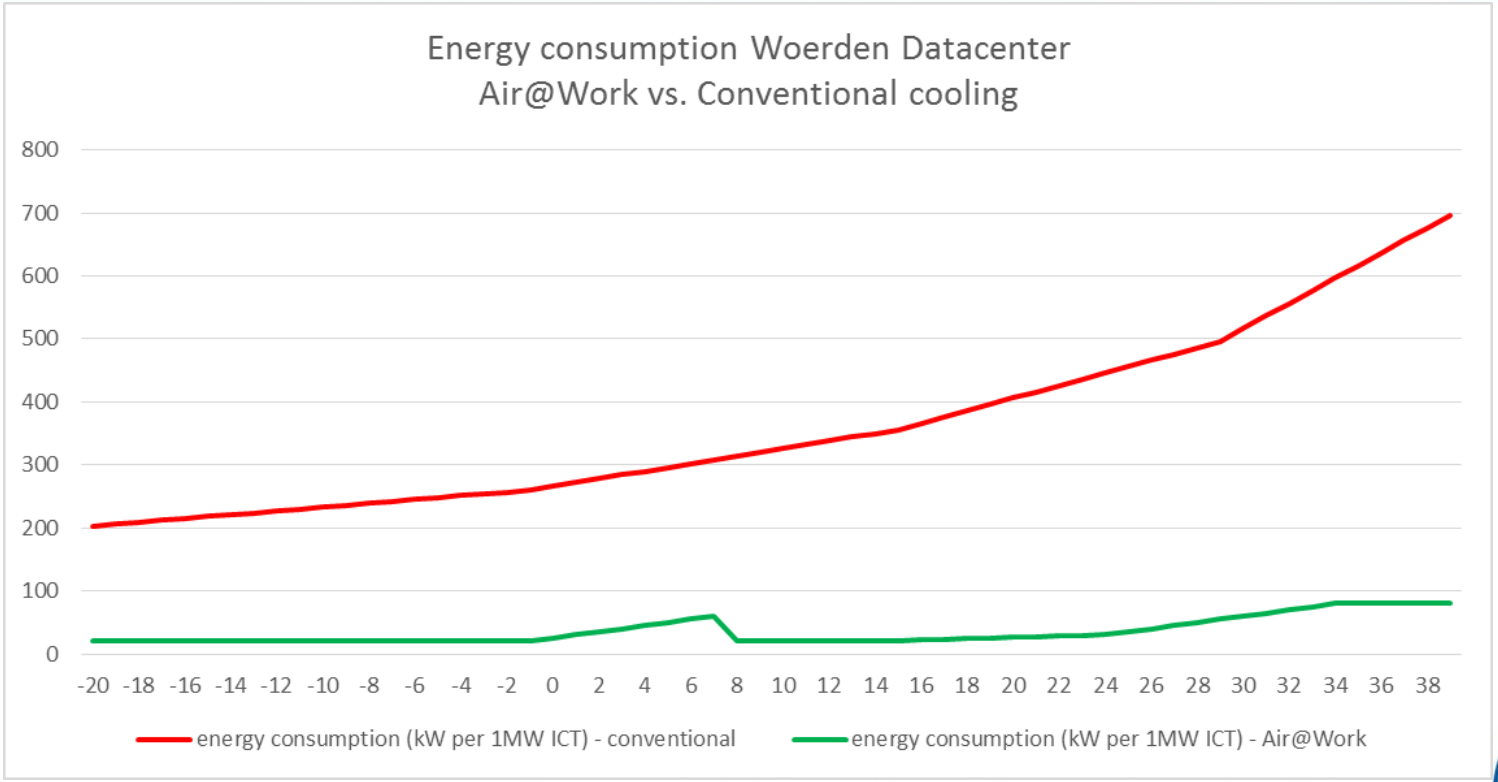
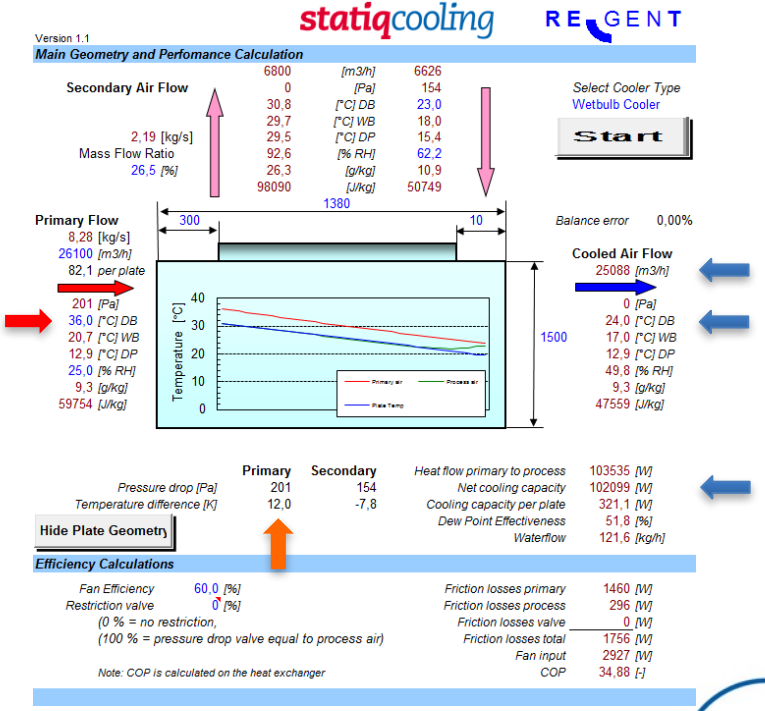
Air@Work data center cooling has a low energy consumption and has no peak at hot periods



statiqcooling inside

Mixing IT load situation “Next Generation DC Cooling”

- IT equipment Delta T 10˚C <> 25 ˚C
- Same amount of supply air.
- Pressure control
- Supply air set point 24˚C



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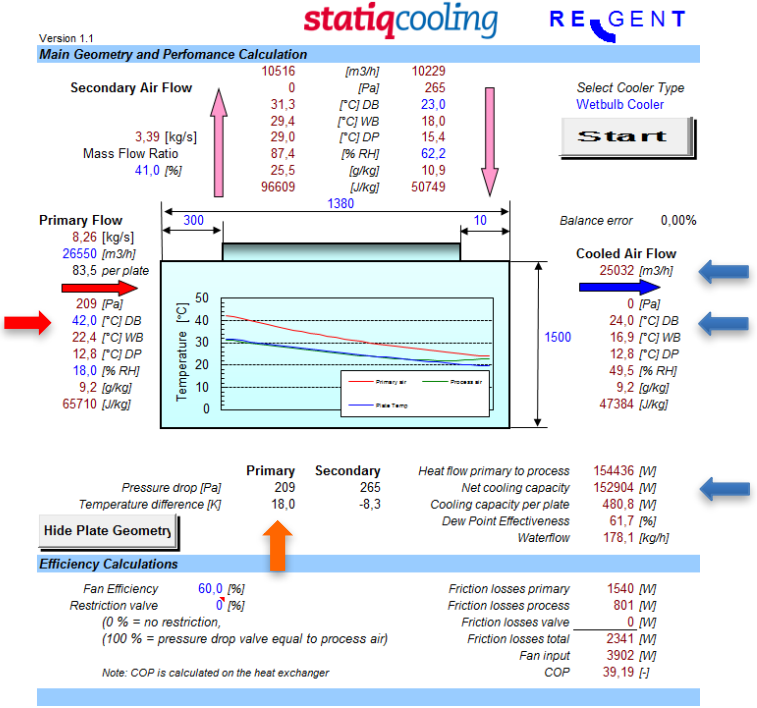
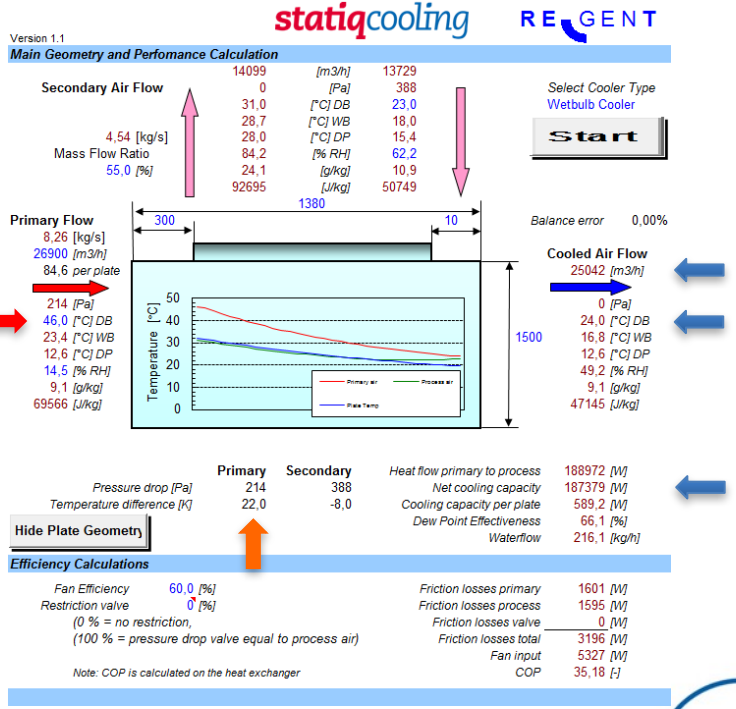
Delta T 18˚C and 22˚C





statiqcooling inside

Air@Work datacenter cooling

"The Next Generation Evaporative Cooling"

- Using a polypropylene counter flow heat exchanger!
  - 100% corrosion free
  - Offering a better heat transfer then any other IEC heat exchangers
- The evaporating of water through a hygroscopic layer on the data center air!
  - Using less water for evaporative cooling
- Using only 50% of ambiant / outside air to cool 100% data center air!
  - Saving on fan power
- Only fans and a water valve
  - Minimising moving parts

Sustainable and more efficient

Saves water

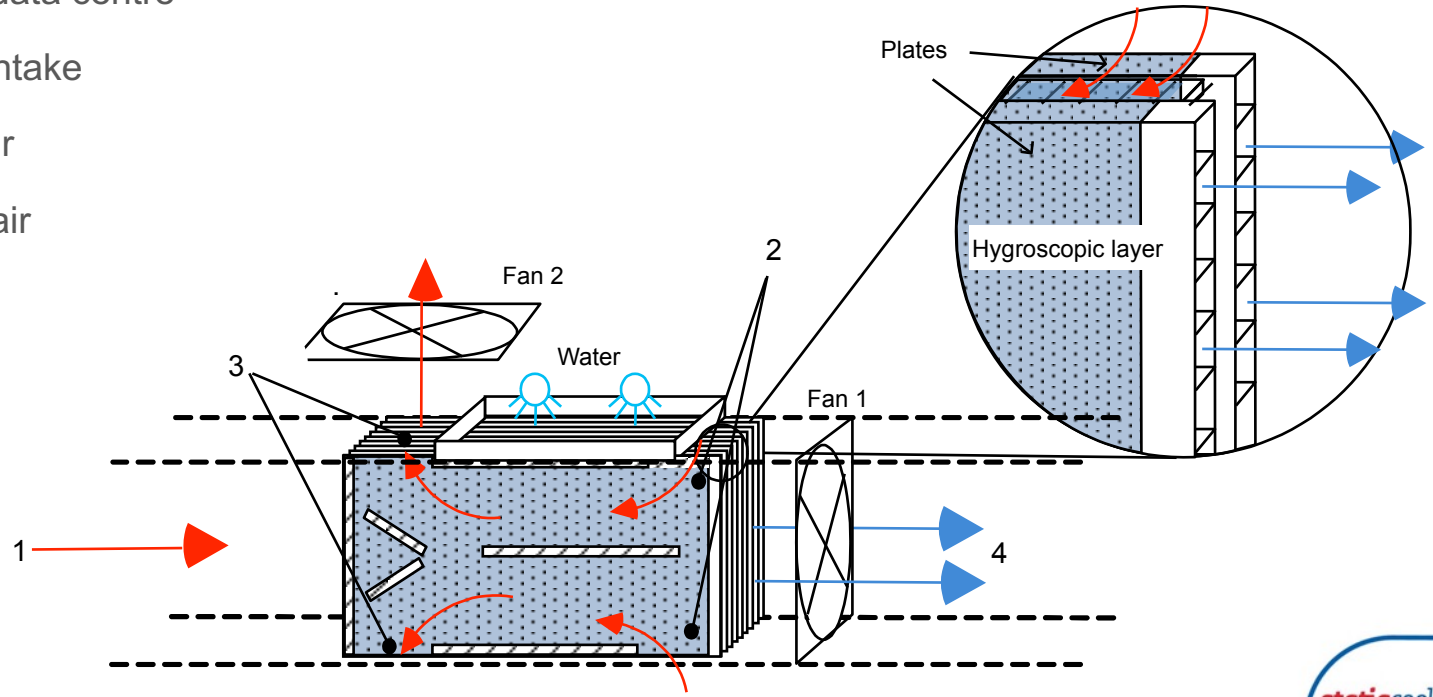
Less energy

Reliable

statiqcooling inside

The counter flow heat exchanger; How does it Work?

1. Hot air from data centre
2. Ambient air intake
3. Scavenger air
4. Cool supply air



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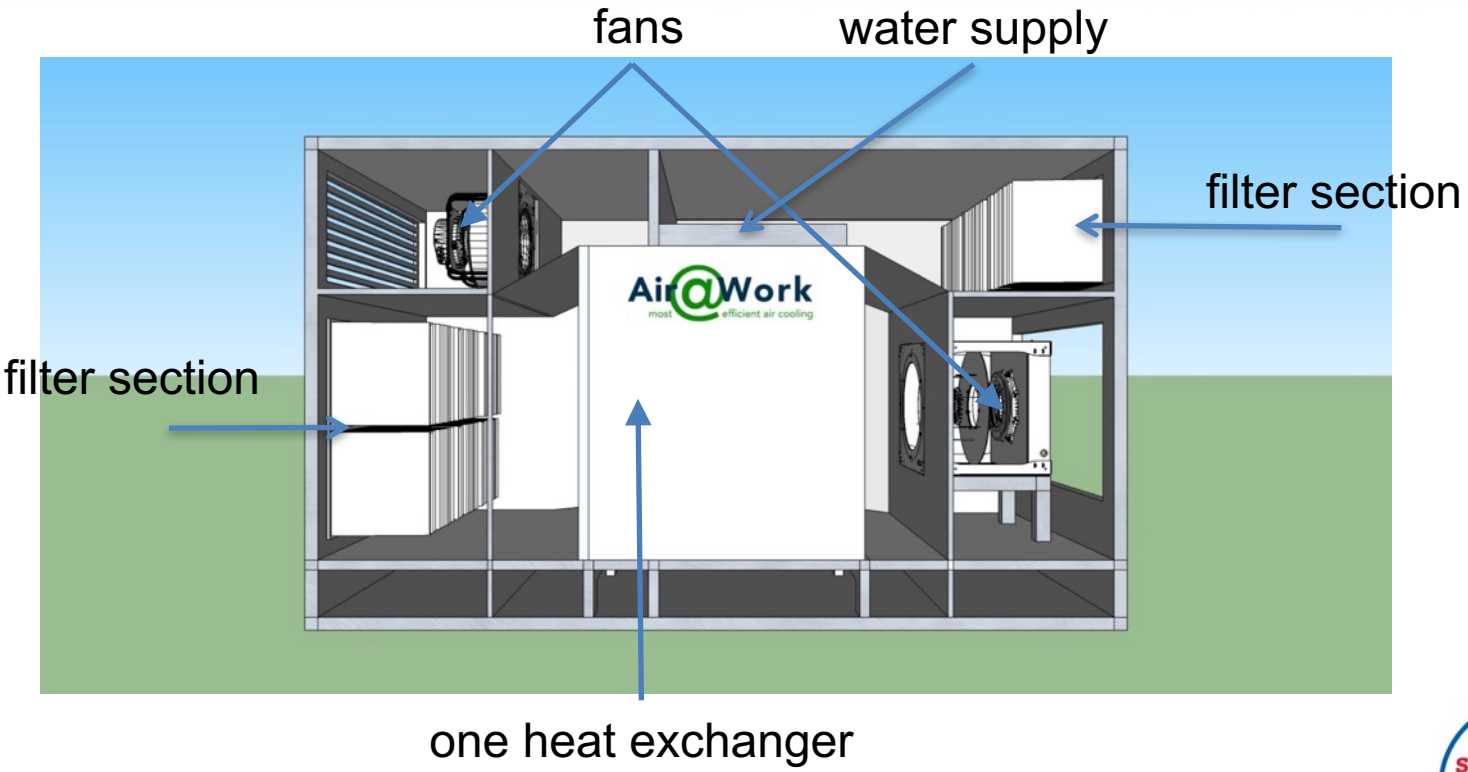
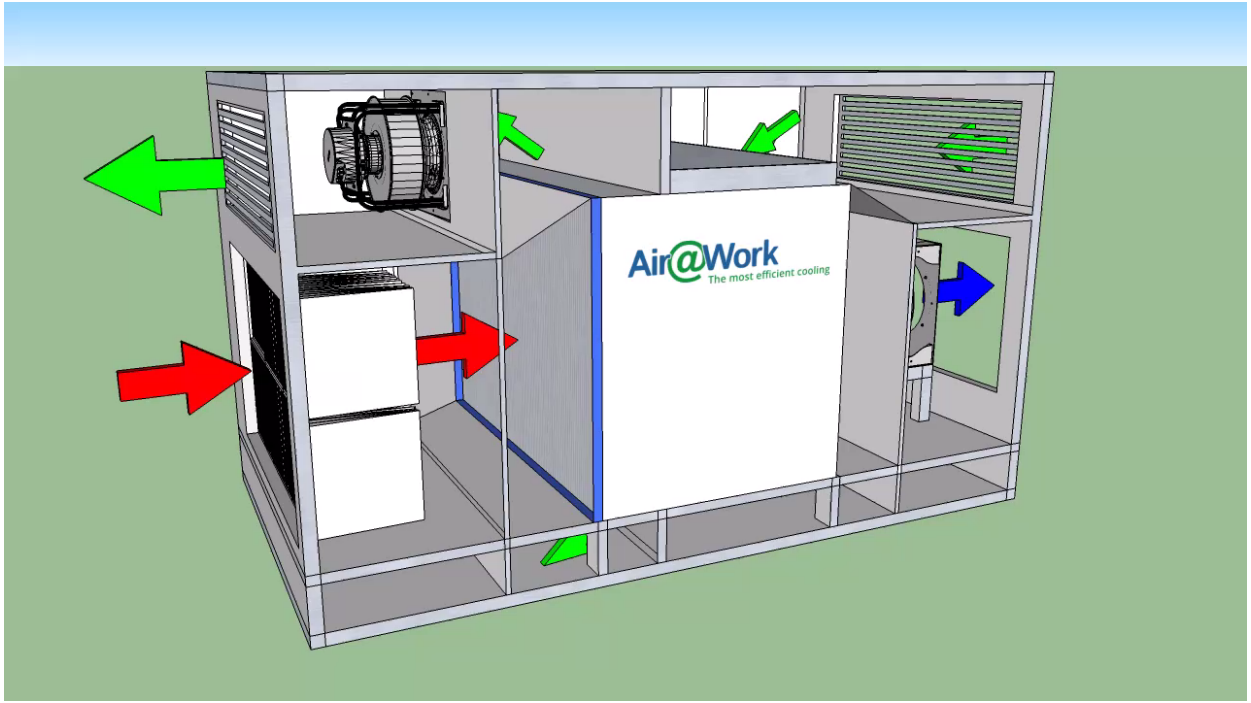
The heat exchanger forms the basis of each Air@Work air handler with simple easy to understand design and use



The air is doing the work



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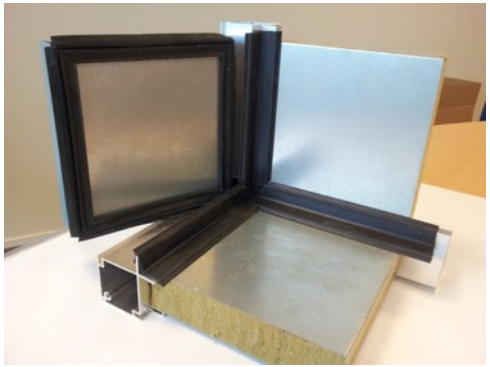
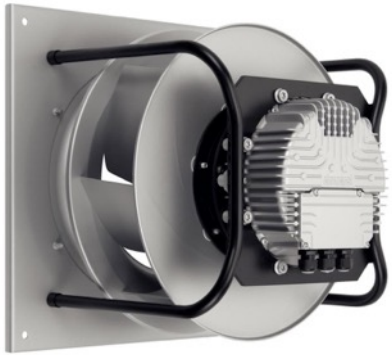
Robust and Quality Fabrication



Double wall panels /
Thermal bridge free



High efficient EC fans

Dynamic control system

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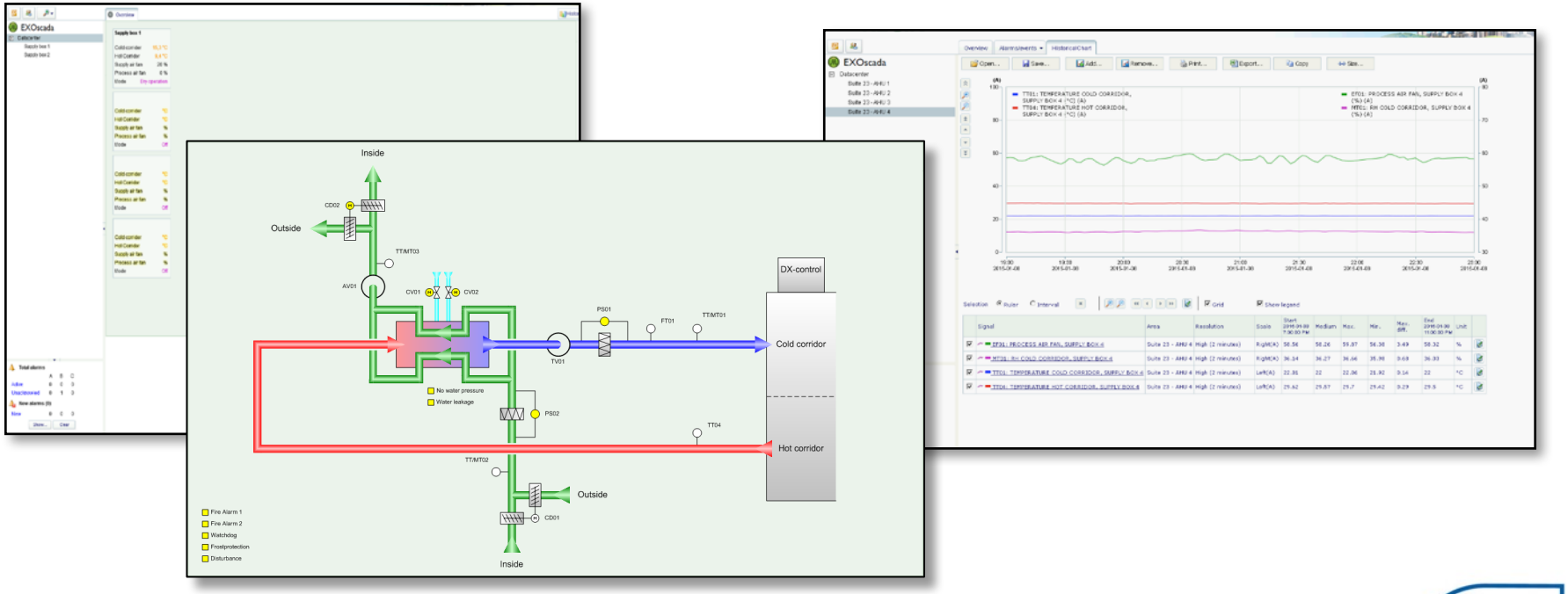
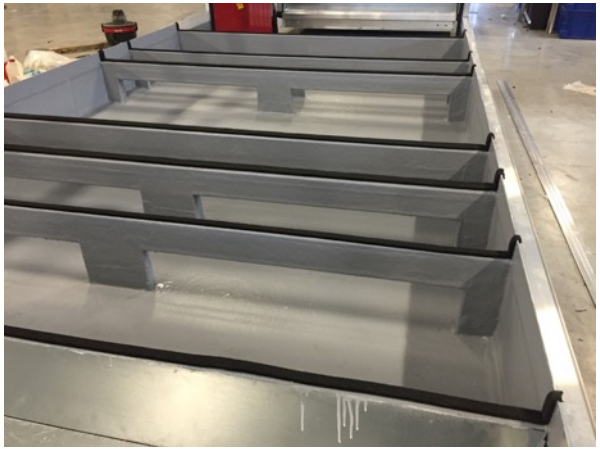
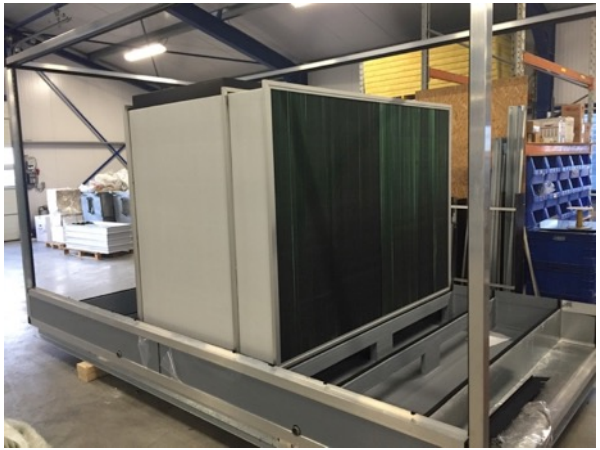
Air@Work controls are designed well, easy to use and able to communicate with all building management systems



Production AHU



Epoxy coted drip tray



Counter flow heat exchanger

Galvanised metal sheeds

Production AHU

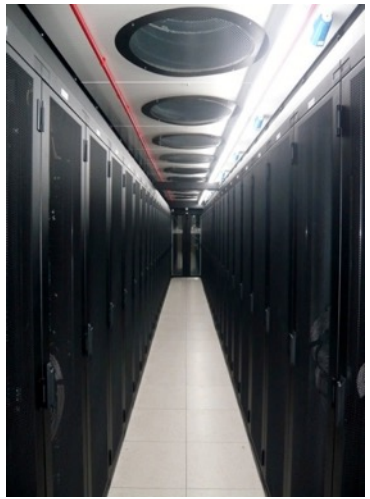
CE primary fan

Water supply section

Filter Section

Reference application: Air recirculation in a datacenter

Reference project modulair suite concept

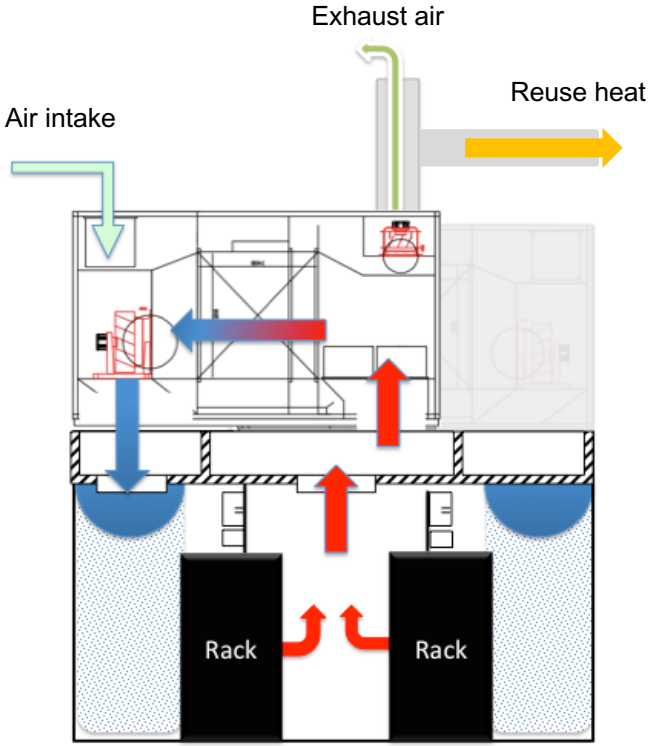


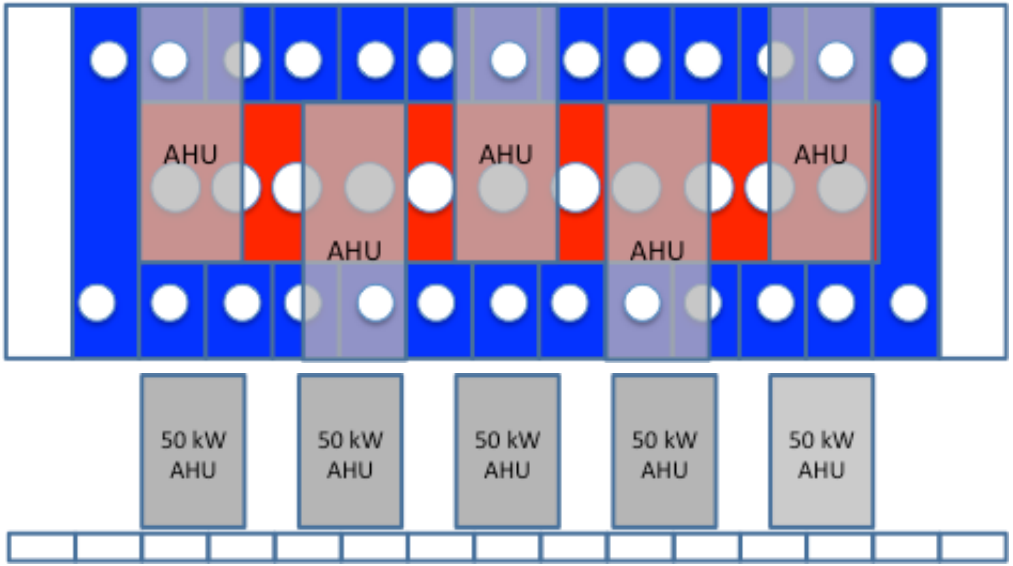
1 suite:
- 50 racks 200 kW

3 x private suite:
- 16 racks 66 kW

Reference project modular cooling concept

SmartDC
MODULAR DATACENTERS





- A central hot corridor.
- A cold ring around the corridor
- Modular grow 1 – 5 AHU 50 kW
- Supply air by industrial socks

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Air@Work reference project

SmartDC
MODULAR DATACENTERS

Project:

- Customer – Smart DC
- Start Date – Operational in real datacenter environment from April 2014
- Cooling technology – 100% compressorless indirect free cooling with StatiqCooling technology
- AHU – Air@Work
- Air distribution – Overhead AirSocks
- Controls – Dynamic Control Regent
- Modulair – Up to 250 kW

Results:

- PUE COOLING – Calculated PUECOOLING <1,04, Peak PUECOOLING <1,10
- Temperatures – Calculated supply air < 24°C at any time
- Temperature control – Supply air change < 1°C per hour at any time
- Air distribution – No hot spots

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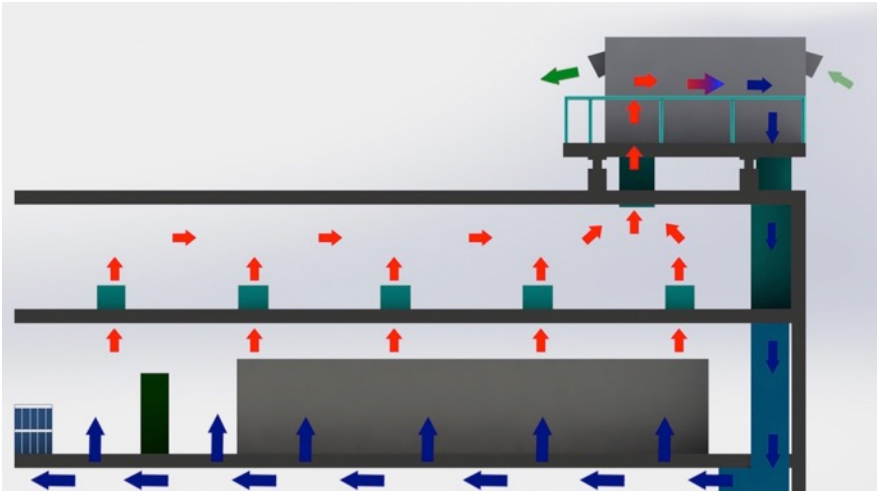
Reference retrofit project Step 1

Optimizing Air flow
- Placing racks in rows
- Closing racks

Optimizing by cold aisle cube

Reference retrofit project step 2



Replacing:

- 100 kW for 200 kW

Benefit:

- More cooling less energy consumption

Case study retrofit 1 MW 1972 Datacenter

switch datacenters

Existing situation:

- 30 – 80% of ICT power consumption
- High maintenance cost
- Single point of possible failure
- Components:
  - 60 fans
  - 60 valves
  - 22 dampers
  - 20 big pumps
  - 2 cooling towers
  - 2 chillers

New situation:

- 3 – 10% of ICT power consumption
- Low maintenance cost
- 2N design and build
- Components:
  - 12 fans
  - 16 valves
  - 6 dampers
  - 2 small pumps
  - -
  - -
  - 2 water softeners

statiqcooling inside

Case study retrofit 1 MW 1972 Datacenter

switch datacenters

Other benefits:

- Safer system!
- 30% of power capacity freed up for ICT equipment use
- More cooling capacity
  - 2 kW to 6 kW per rack
- Less complexity, ease of maintenance

Result:

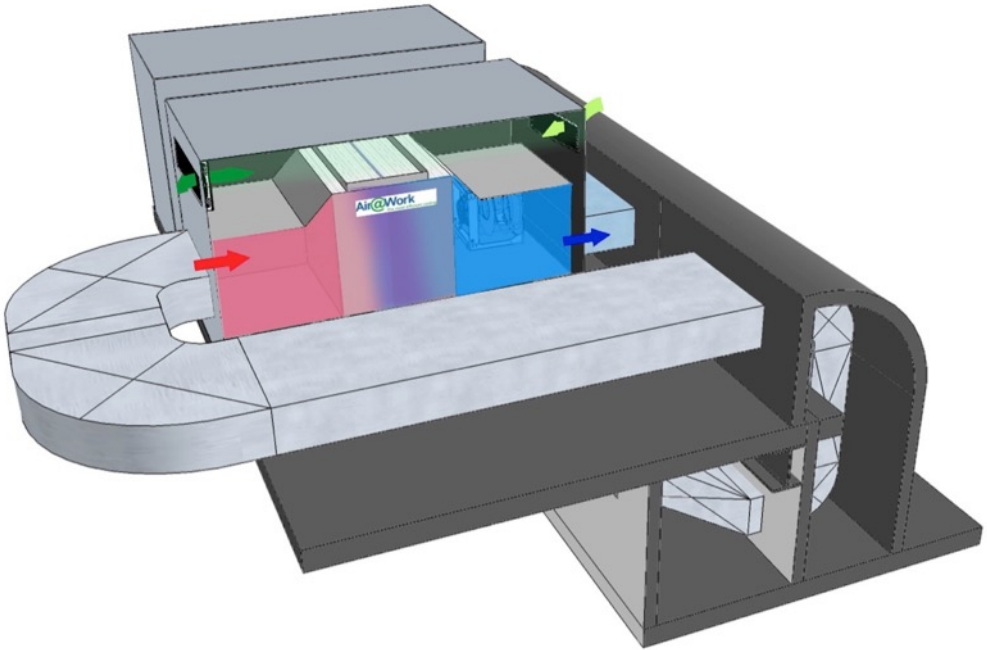
- 90% lower energy cost
- 60% savings on maintenance
- More turnover
- Higher profits
- < 4 year pay back on investment

Air@Work air coolers on top of renovated 1972 datacenter besides dry coolers of the conventional cooling system

switch datacenters

statiqcooling inside

Creative ducting on the roof of a retrofit datacenter



Creative ducting inside a retrofit datacenter, air socks supply cool air from above

switch datacenters

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Air@Work presents a series of air coolers for datacentres

- Wide range of indirect adiabatic cooling modules
- Capacities from 25kW to 400kW
- Reliable heat exchanger. 100% corrosion free
- The oldest heat exchanger is running for 15 year
- Most efficient heat exchanger on the market
- Water evaporation through hygroscopic layer, low water consumption
- DX or cold water coil optional for humid climates

Low consumption of energy and water

$PUE_{cooling}$ 1,03 and lower possible

statiqcooling inside

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