
Energy
in Buildings - Cyprus
ASHRAE Hellenic Chapter
ASHRAE Cyprus Chapter
ΤΕΕ
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Limassol, Cyprus
@ Atlantica Miramare

Key Study

High Temperature Energy Storage for DHW production in Hotels

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AHI Carrier S.E. Europe Air-Conditioning S.A.

HOT WATER APPLICATIONS

Residential, Commercial & Industrial Applications

Buildings and processes that need cooling

Byproducts of processes & waste treatment..

HEAT IS BEING WASTED ALL AROUND US

Heating for space & sanitary heating & processes

Traditional heating (oil, gas, boilers) efficiency COP<1

EXCESS ENERGY USE & EMMISSIONS

+35°C	+35°C	+40°C	+60°C	+80°C	+100°C
					
OFFICES & HOSPITALITY	DATA CENTRES	INDUSTRIAL & PROCESSES	SINGLE/MULTI RESIDENTIAL	OFFICES & HOSPITALITY	INDUSTRIAL & PROCESSES
COOLING	COOLING	COOLING	HEATING	HEATING	HEATING

WASTED LOW GRADE HEAT

NEED HIGH QUALITY TEMPERATURES

HEAT SOURCES

High Temperature WSHP

Industrial Excess Heat

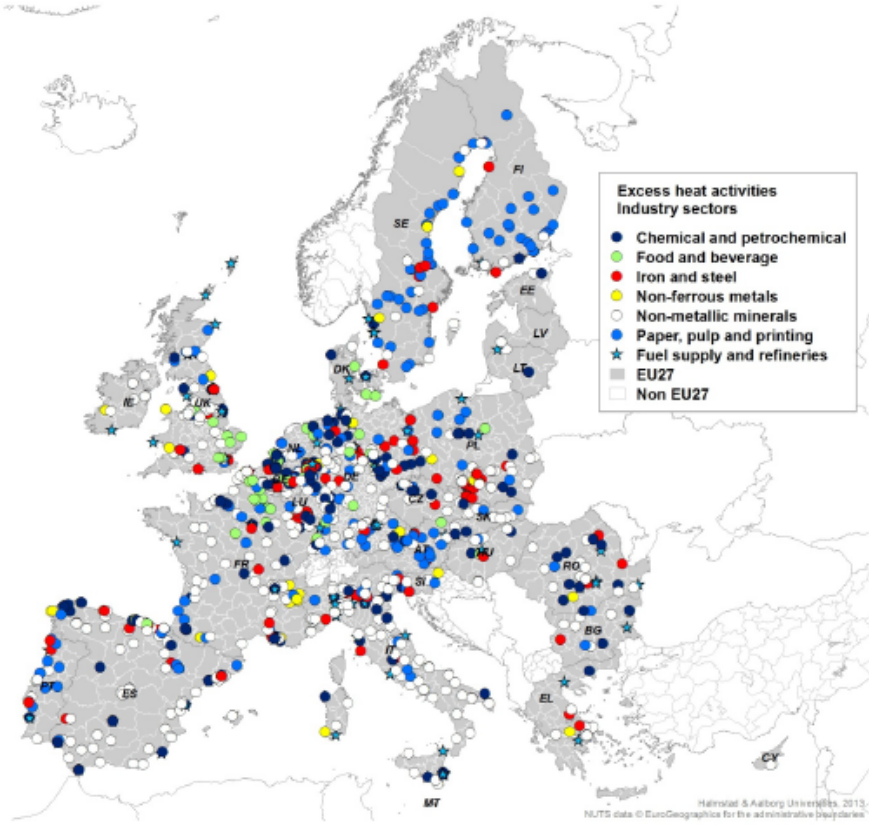


Figure 83: Locations of major energy intensive industries with considerable volumes of excess heat. Source The E-PRTR database at EEA in Copenhagen.

Geothermal Heat

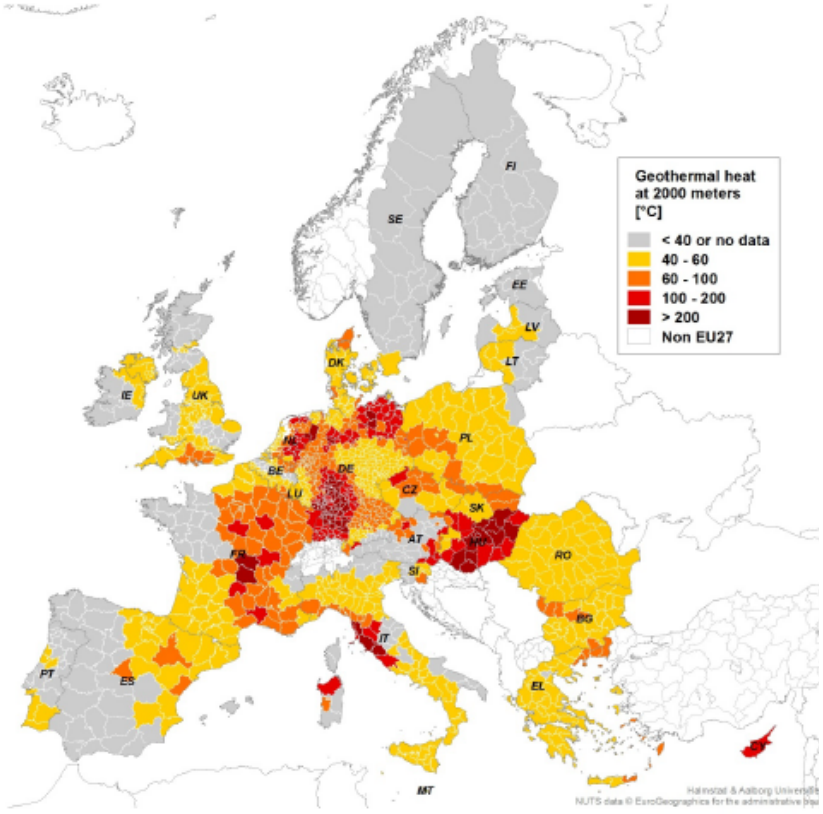


Figure 84: Identified geothermal heat resources by temperature at 2000 m depth by NUTS3 region. So
European Commission, Atlas of Geothermal Resources in Europe. Publication EUR 17811, Luxembourg

PRODUCTS

Water to Water Heat Pump Range

up to 85°C

up to 65°C

SINGLE & MULTI RESIDENTIAL

COMMERCIAL APPLICATIONS

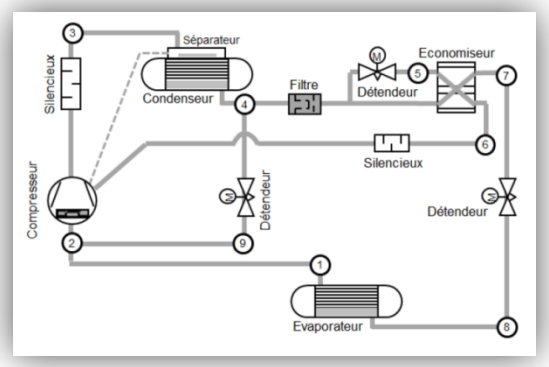
INDUSTRIAL PROCESSES & WASTE TREATMENT

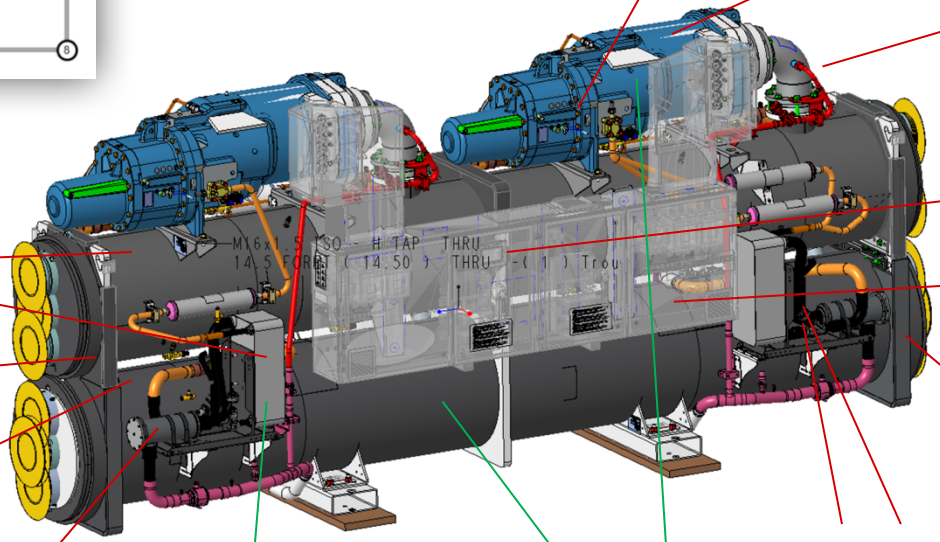
DATA CENTRES

RANGES TO MEET ALL SIZE & APPLICATION TYPES

OVERVIEW

Product Details





Specific compressor (min cap 50%)

New High pressure switches

New injection line at compressor suction

New software

Specific Electrical cabinet (New Amps & compatible HFO)

One, two & three passes evaporator & condenser

New EXV resistant to high temperature

Condenser and Compressor thermal insulation in standard

Default Economized cycle

High pressure components PS= 30 bar (Oil sep, Muffler, HXs, etc)

New relief valves for evaporator & condenser

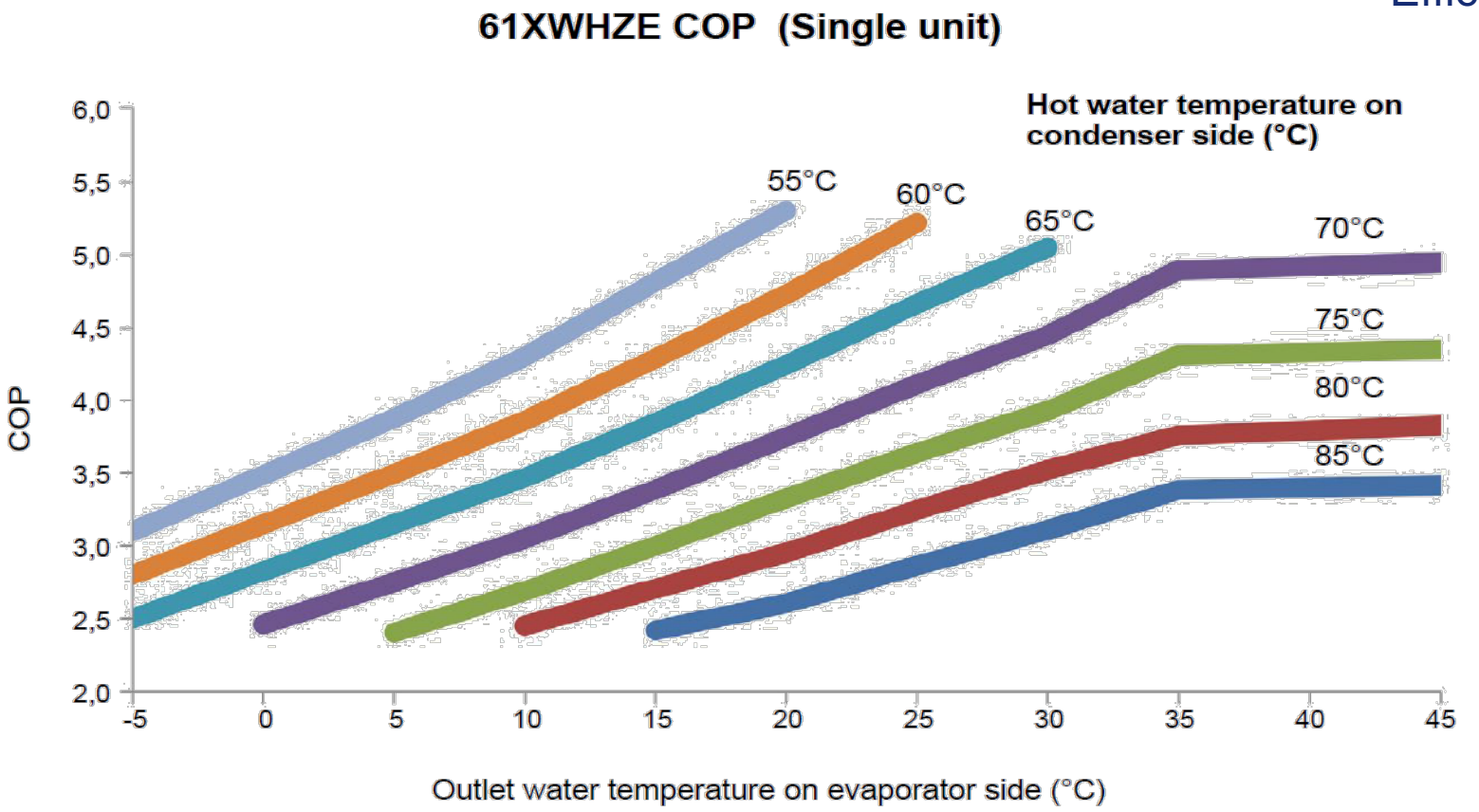
Low pressure components PS= 23 bar

New High pressure transducer

Specific documentation for installation, maintenance & safety instructions

OVERVIEW

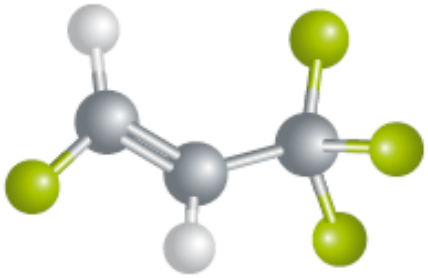
Efficiencies



ΔT on the condenser side	One unit	Two units	Three units	Four units
ΔT 10 K	0%	4-7%	5-9%	6-10%
ΔT 20 K	0%	9-15%	11-19%	14-23%
ΔT 30 K	0%	15-24%	19-31%	23-40%

HFO

Using HFO R1234ZE(E)



HFO-R1234ze(E)

PURETEC HFO-R1234ze(E)	
Molecular Formula	$CF_3CH{=}CHF$
Appearance	Colourless
Ozone Depletion Potential (ODP R_{11} = 1)	0
Global Warming Potential (GWP CO_2 = 1)	< 1
Atmospheric lifetime	18 days
ASHRAE Std. 34 Safety Classification	A2L
Flammability Limits – ASTM E681-04 @ 21°C	Non Flammable
Flammability Limits – ASHRAE 34 @ 100°C	7% - 12% (by volume)
Vapour pressure at 25°C	5 bars

4th Generation Refrigerants for the 21st Century

*HFO stands for HydroFluoroOlefin

REFRIGERANTS

R1234ZE(E)

Refrigerants:

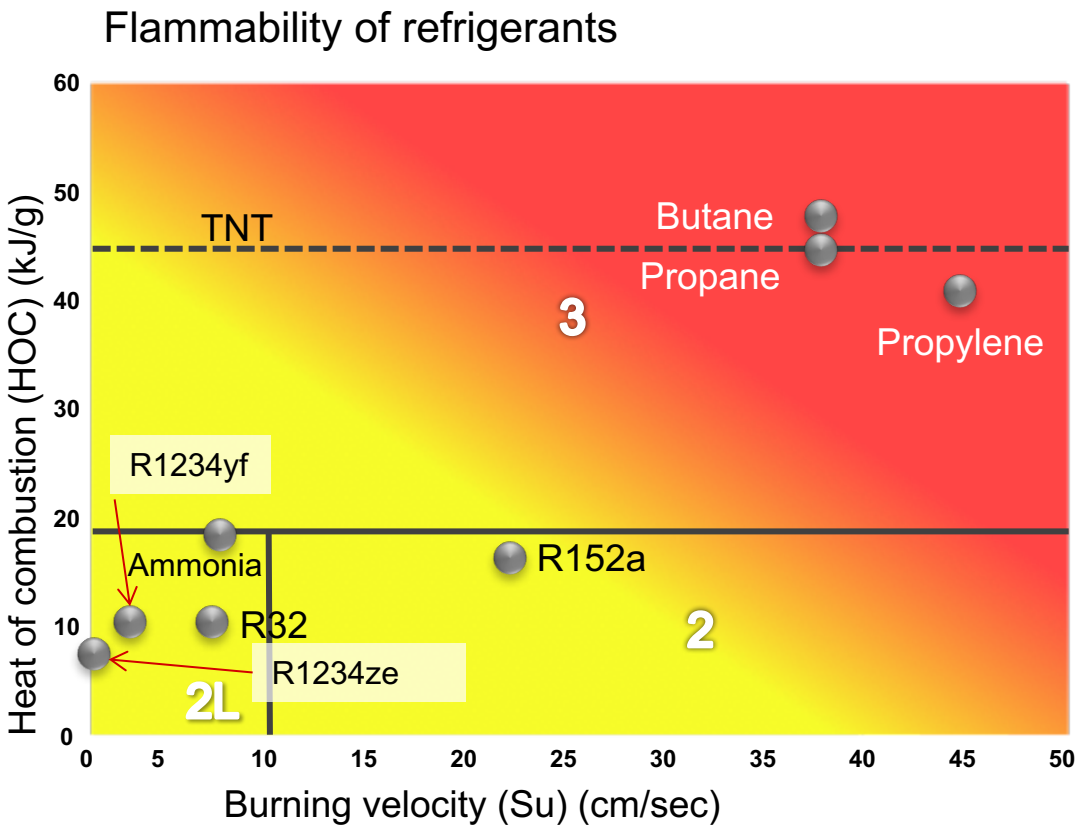
Name	Flammability	Class	ODP	GWP
R134A	Non-flammable	A1		1300
R407C	Non-flammable	A1		1774
R410A	Non-flammable	A1		1924
HC-600a	High	A3		~5
R1234ze	Moderate	A2L		1
R32	Moderate	A2L		677

Note 1: A: low toxicity. B: high toxicity
Note 2: GWP following new version UNEP 15

REFRIGERANTS

R1234ZE(E)

Classes of refrigerants:



	Safety group	
High flammability	A3	B3
Low flammability	A2 A2L	B2 B2L
No propagation		
	Low toxicity	High toxicity

R1234ZE(E)

A2L Equipment Revisions for Safety

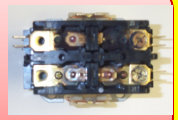
New flammability labels

Strength and proof test with new refrigerant 

Update pressure vessel calculations and approval

Controls to interface with refrigerant sensors and ventilation 

Leak Reduction and Protection of high risk tubing 

Flame arrestors on ignition sources or qualification testing 

New installation and service literature and training 

Limit hot surface temperatures to <700 C (requires testing annex JJ) 

Shipping and vibration tests 

New factory charging facilities and procedures as well as field charging procedures 

Resize relief valves and insure they are vented outdoors, no fusible plugs 

★ Additional Requirements

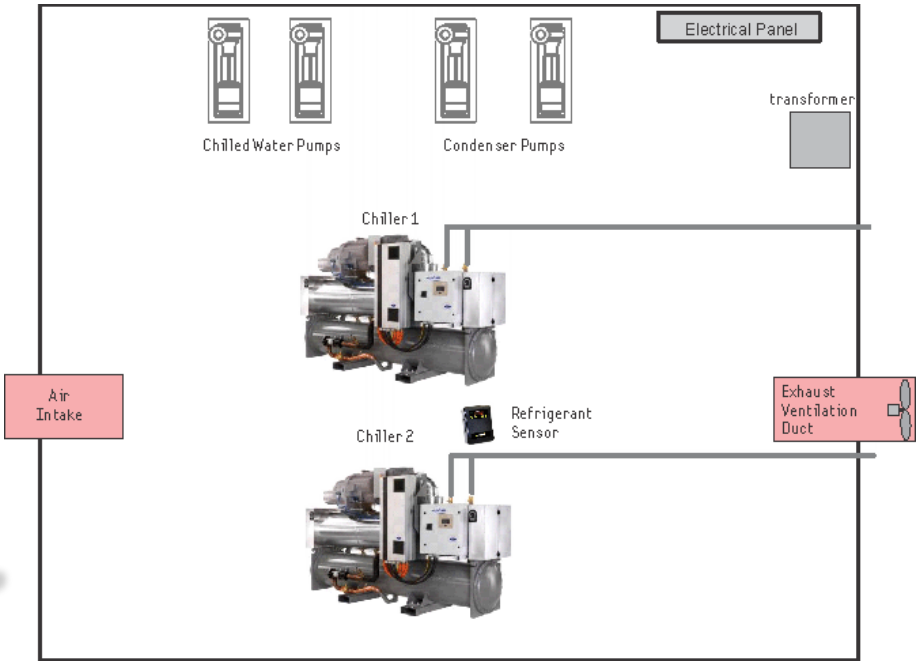
R1234ZE(E)

A2L Mechanical Room Safety Modifications

Room Design

- No open flames, ignition source control
- No combustion equipment
- Emergency exits and signal
- No flammable material storage
- Relief valves vented outdoors
- Relief valves added to waterside sized for vapor ★

Typical Machine Room (controlled access only – Category C)



Ventilation/Alarm

- Revised alarm ventilation per UTRC study
- Fault tolerant Refrigerant Sensors
- Visual and audible alarms with diagnostics
- Alarm starts ventilation & stops chiller and ignition source
- Control of ignition sources in machine room when alarm

Commissioning/Operation/Service

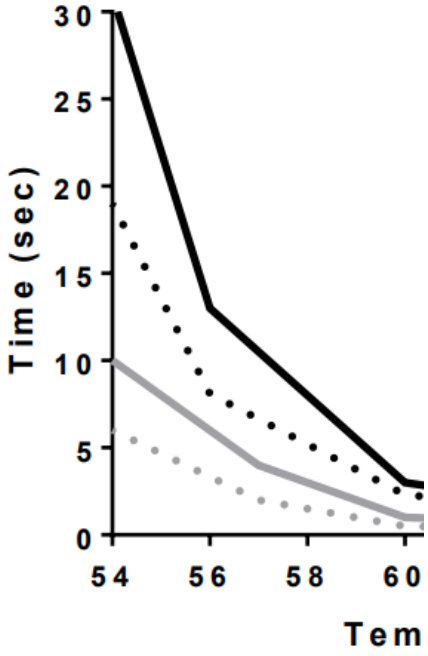
- Commission punch list ★
- New service procedures ★
- Routine inspection and testing ★
- Required logbook

★ Additional Requirements

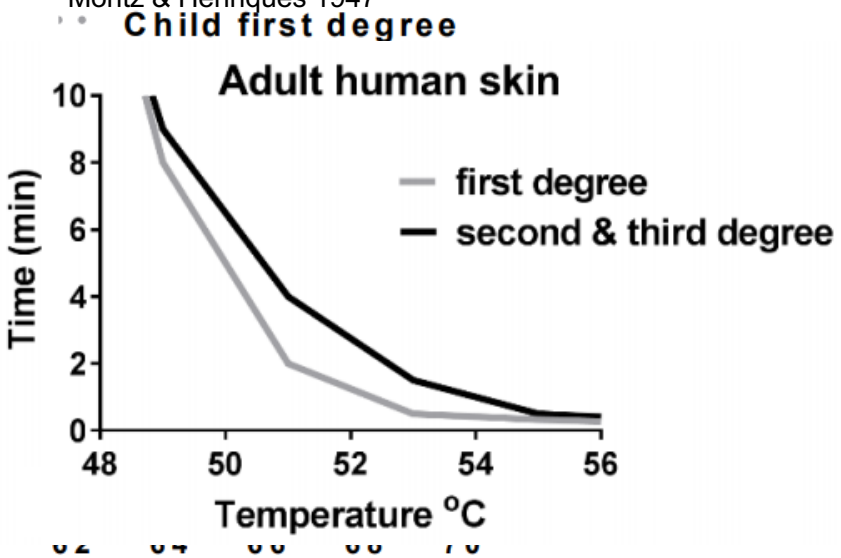
LEGIONELLA CONTROL

Hot water temperature – Burn – Duration of exposure

Feldman 1983(96)



Moritz & Henriques 1947



LEGIONELLA CONTROL

Thermal Method

Control of *Legionella* growth can occur through chemical or thermal methods. Temperature affects the survival of *Legionella* as follows:

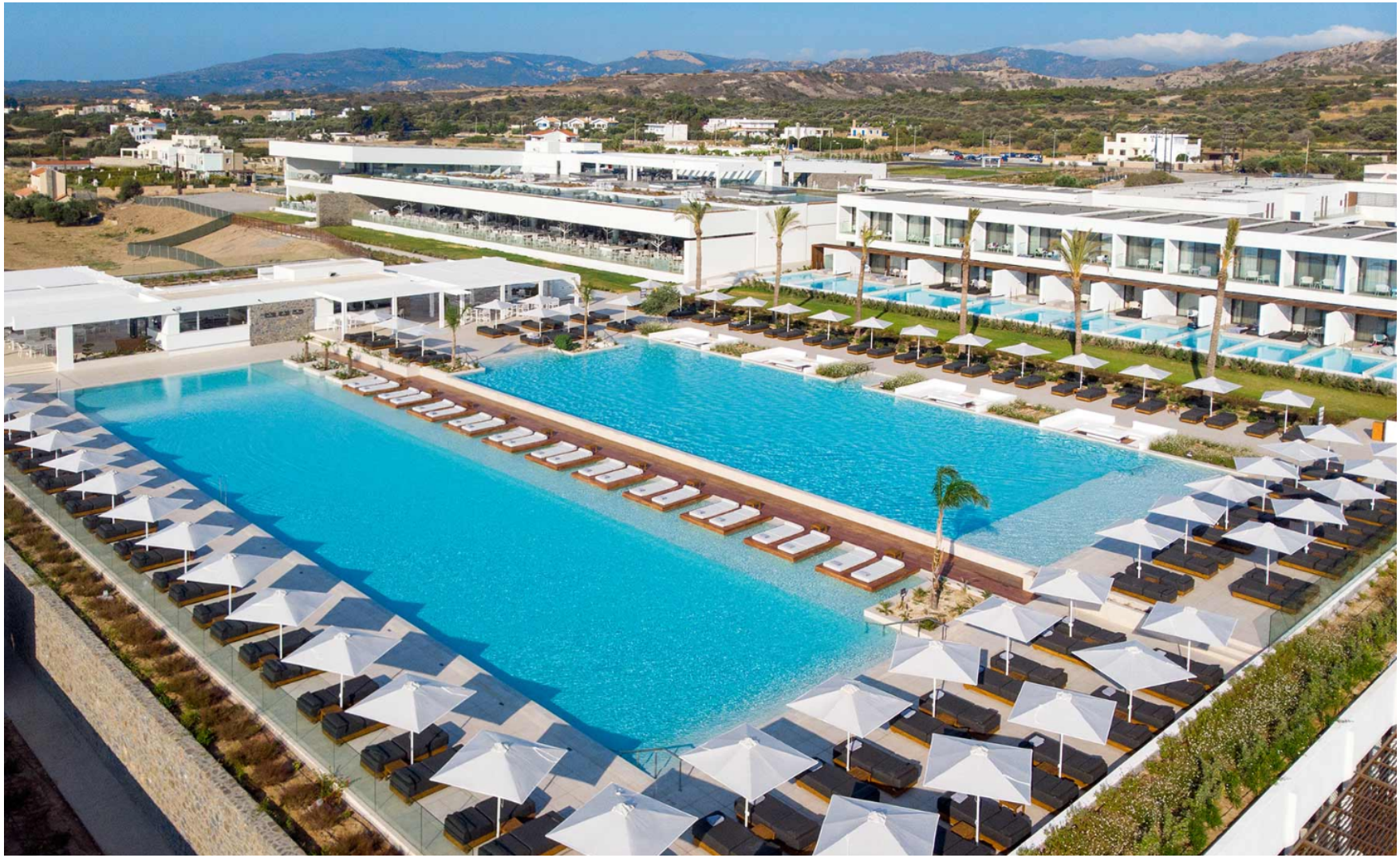
Above 70 °C – *Legionella* dies almost instantly
At 60 °C – 90% die in 2 minutes
At 50 °C – 90% die in 80–124 minutes
48 to 50 °C – can survive but do not multiply
32 to 42 °C – ideal growth range
25 to 45 °C – growth range
Below 20 °C – can survive, even below freezing, but are dormant

World Health Organization

Other temperature sensitivity
60 to 70 °C to 80 °C – Disinfection range
66 °C – *Legionella* dies within 2 minutes
60 °C – *Legionella* dies within 32 minutes
55 °C – *Legionella* dies within 5 to 6 hours

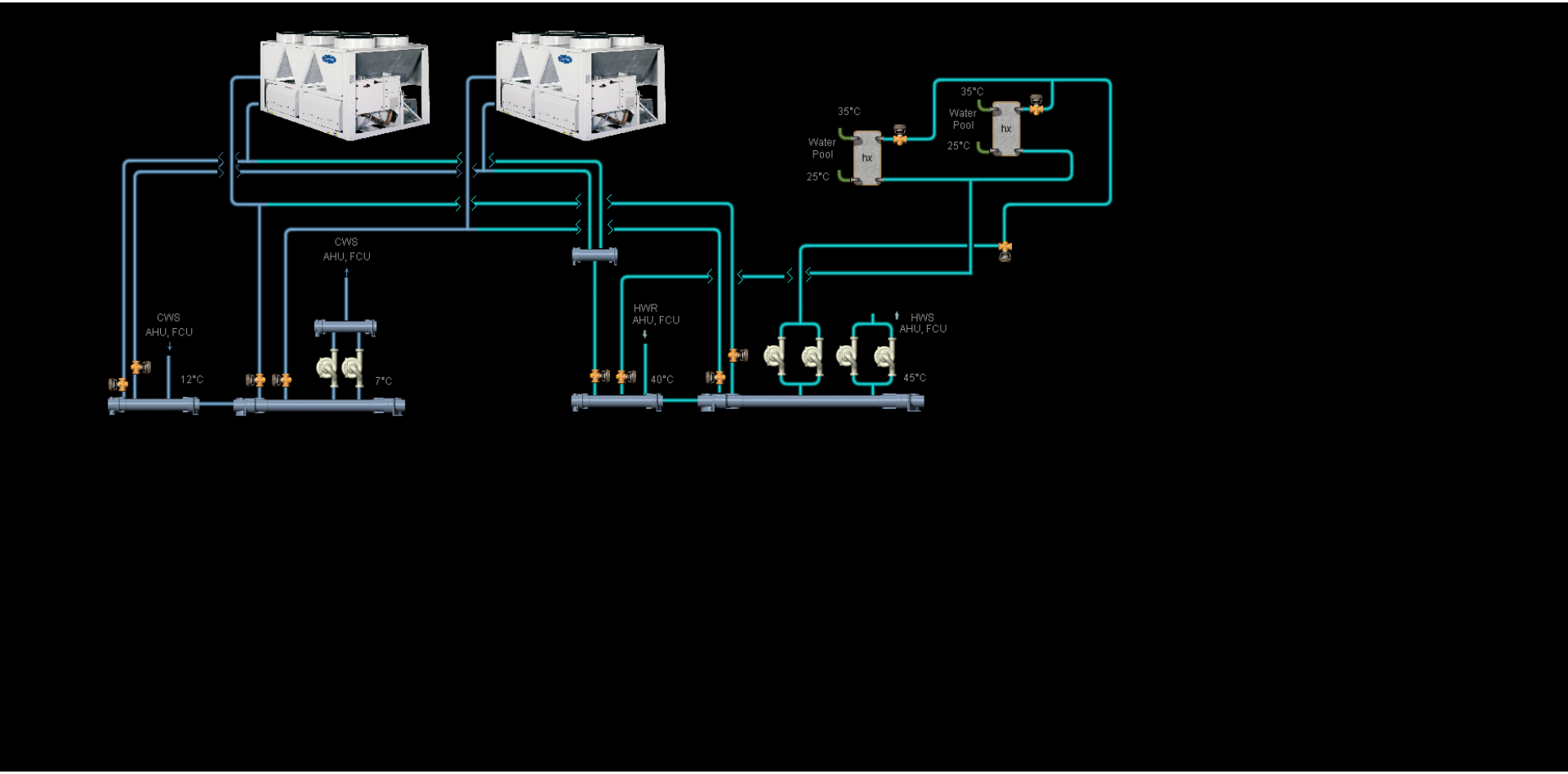
Chartered Institute of Plumbing & Heating Engineering, Health and Safety Executive


GENNADI GRAND RESORT
★★★★★



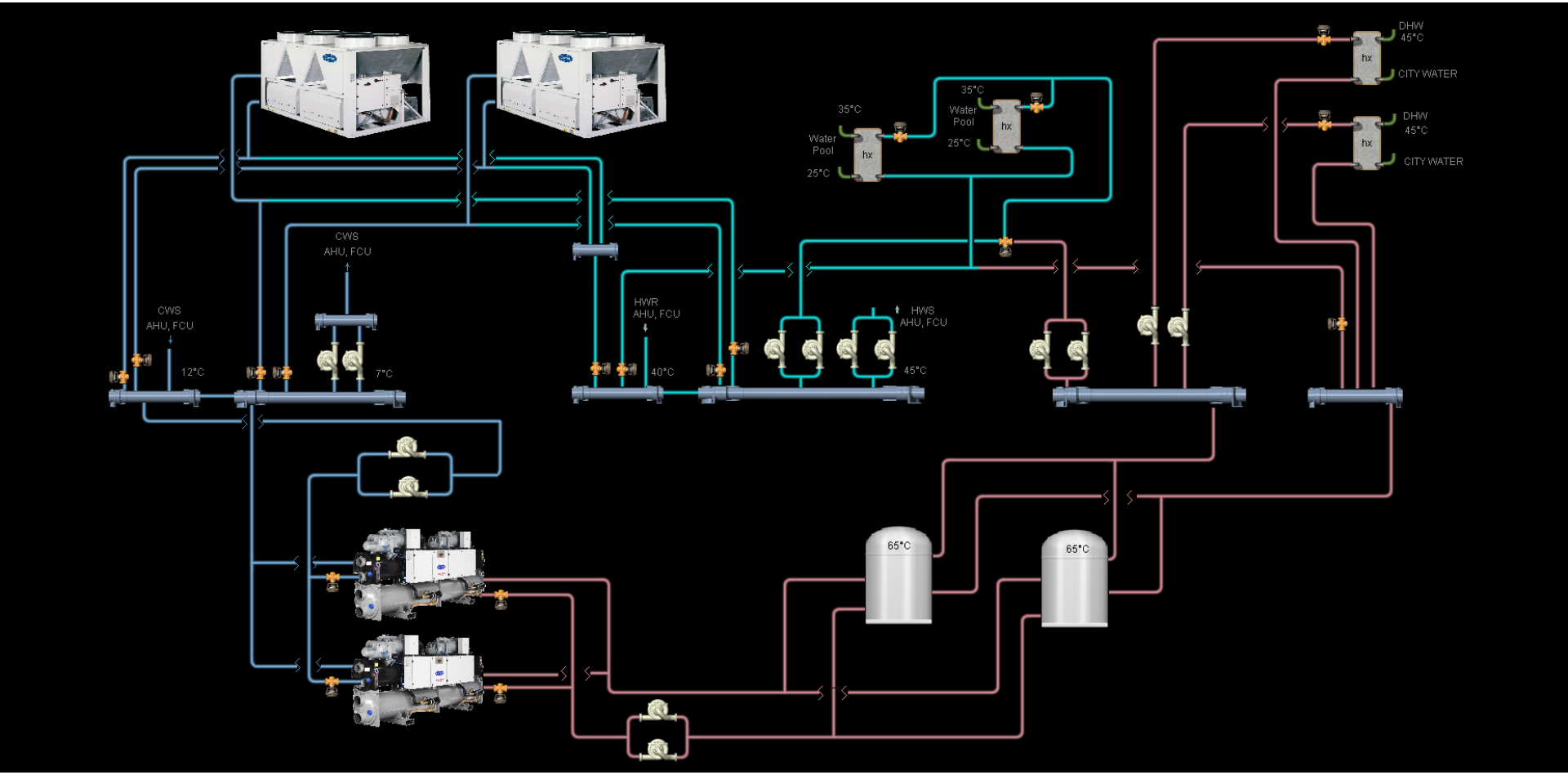
SYSTEM DIAGRAM

STD Heat Pump piping diagram, w/o DHW



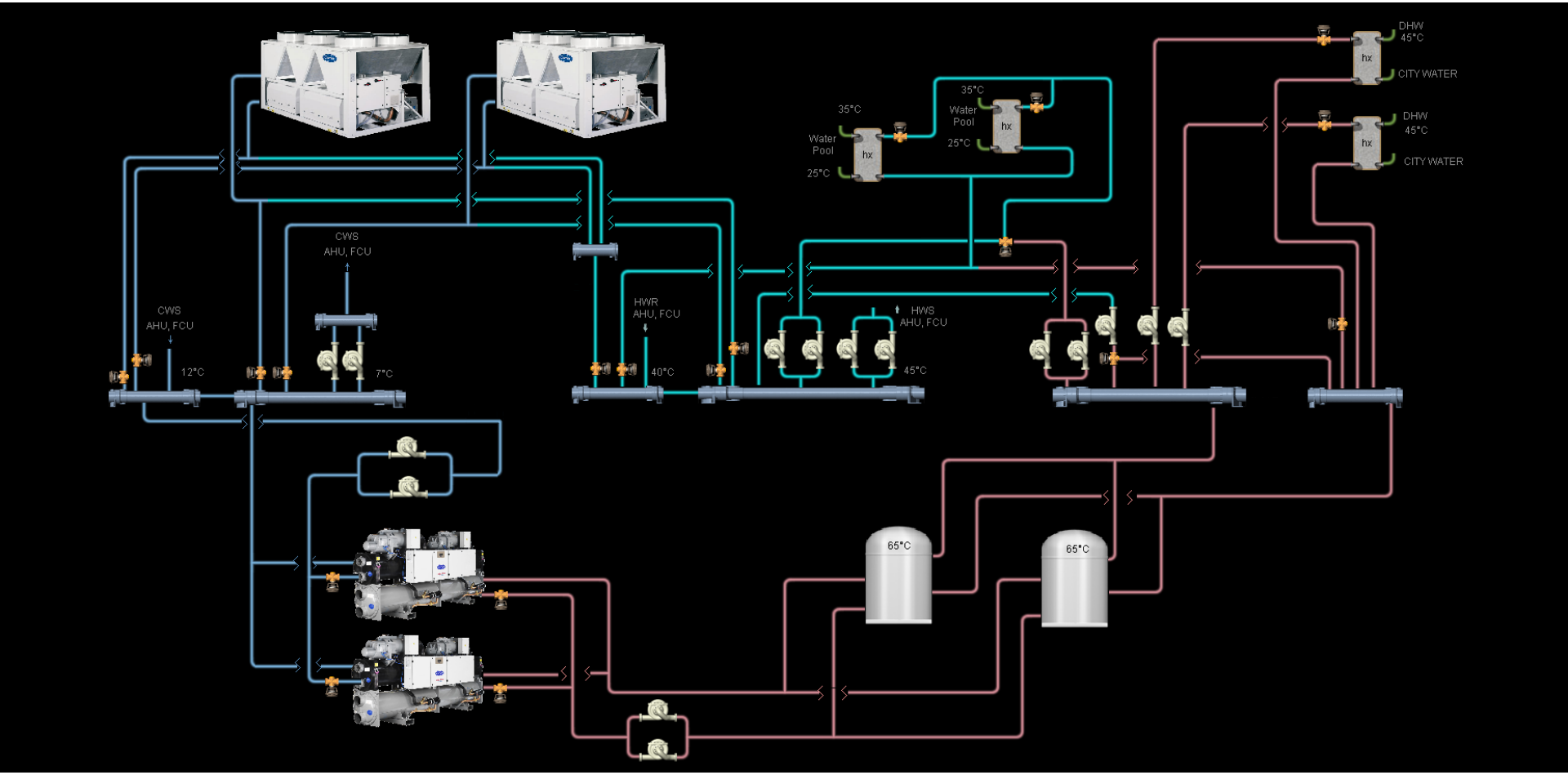
SYSTEM DIAGRAM

Water to Water Heat Pump addition and DHW



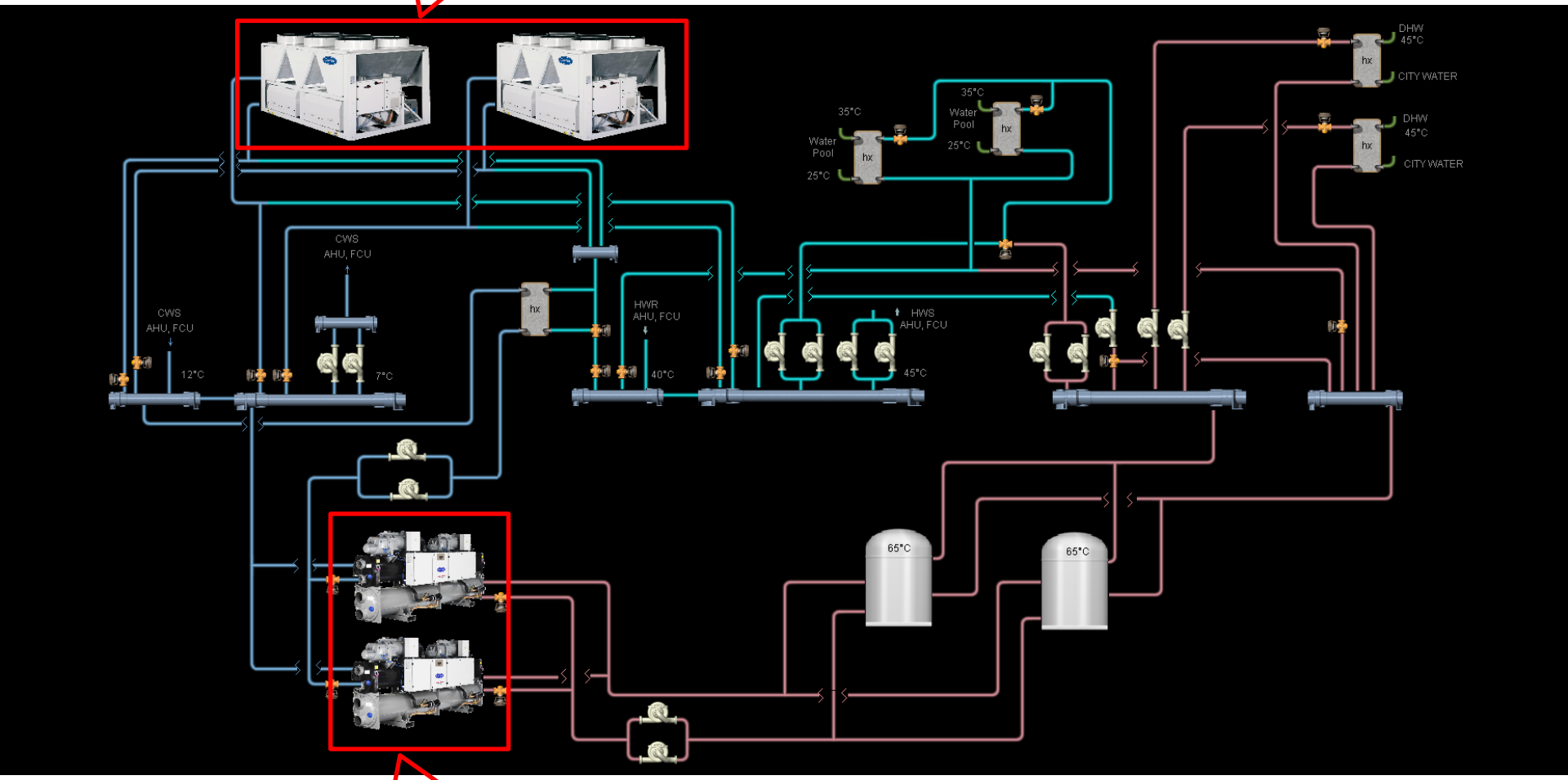
SYSTEM DIAGRAM

Backup



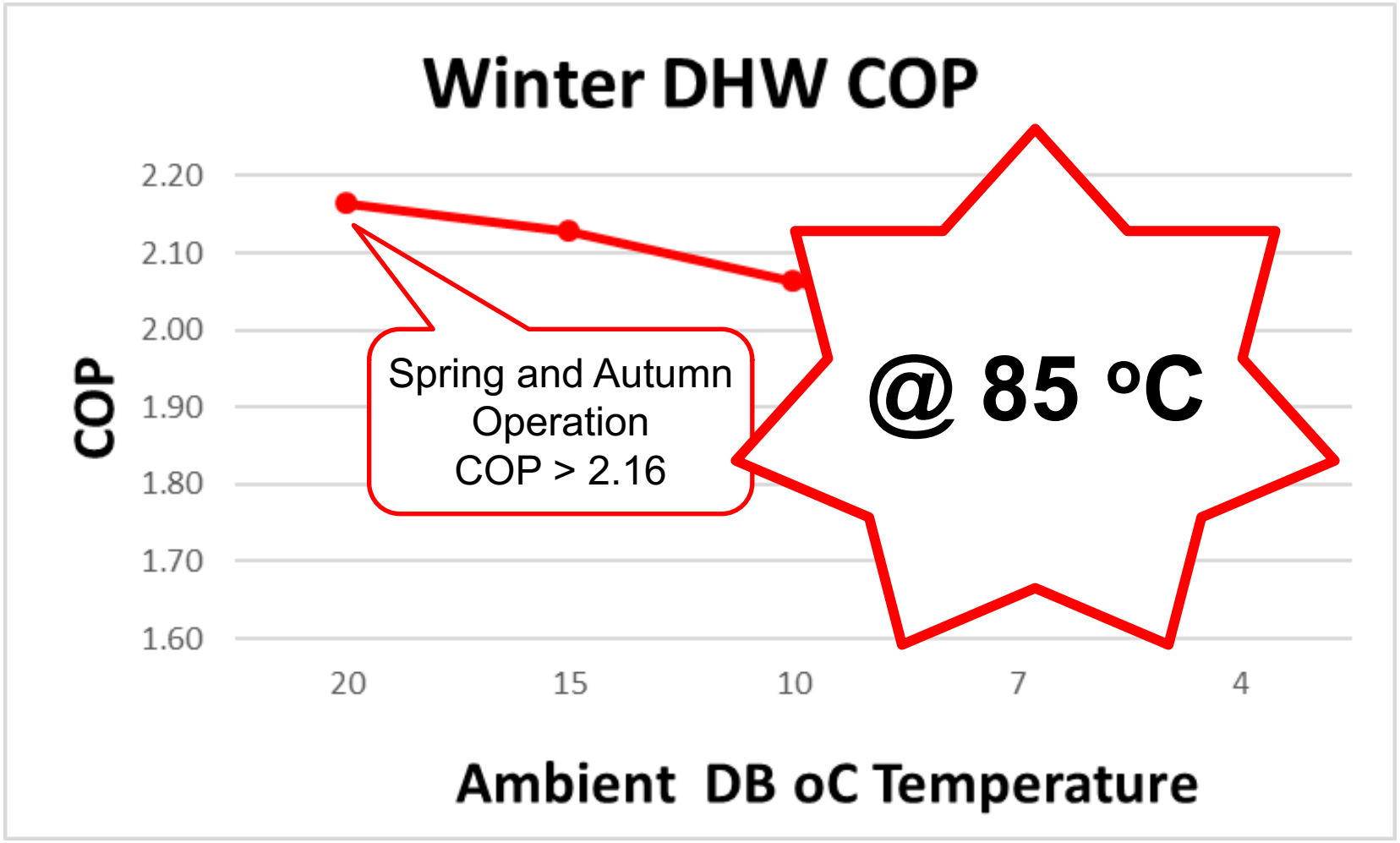
SYSTEM DIAGRAM

Spring and Autumn operation



WATER TO WATER H/P @ NO COOLING LOADS

Air Cooled and Water to Water H/P both in Heating Operation



PROJECT

Mechanical Room

PROJECT

Mechanical Room

PROJECT

AHU

PROJECT

AHU

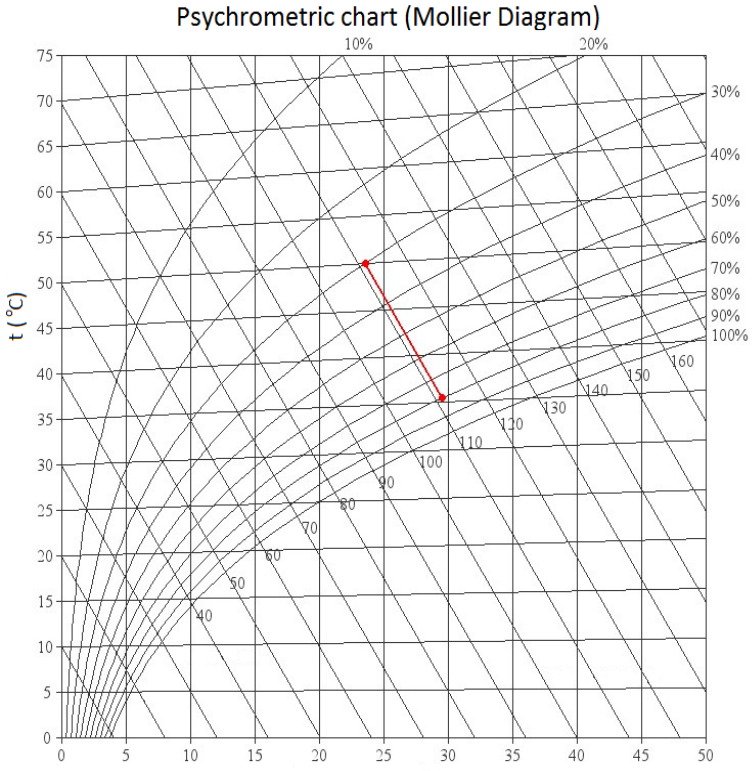
PROJECT

Air Cooled Heat Pumps

ADIABATIC COOLING

ADIABATIC COOLING

Energy Savings and Increased Cooling Capacity



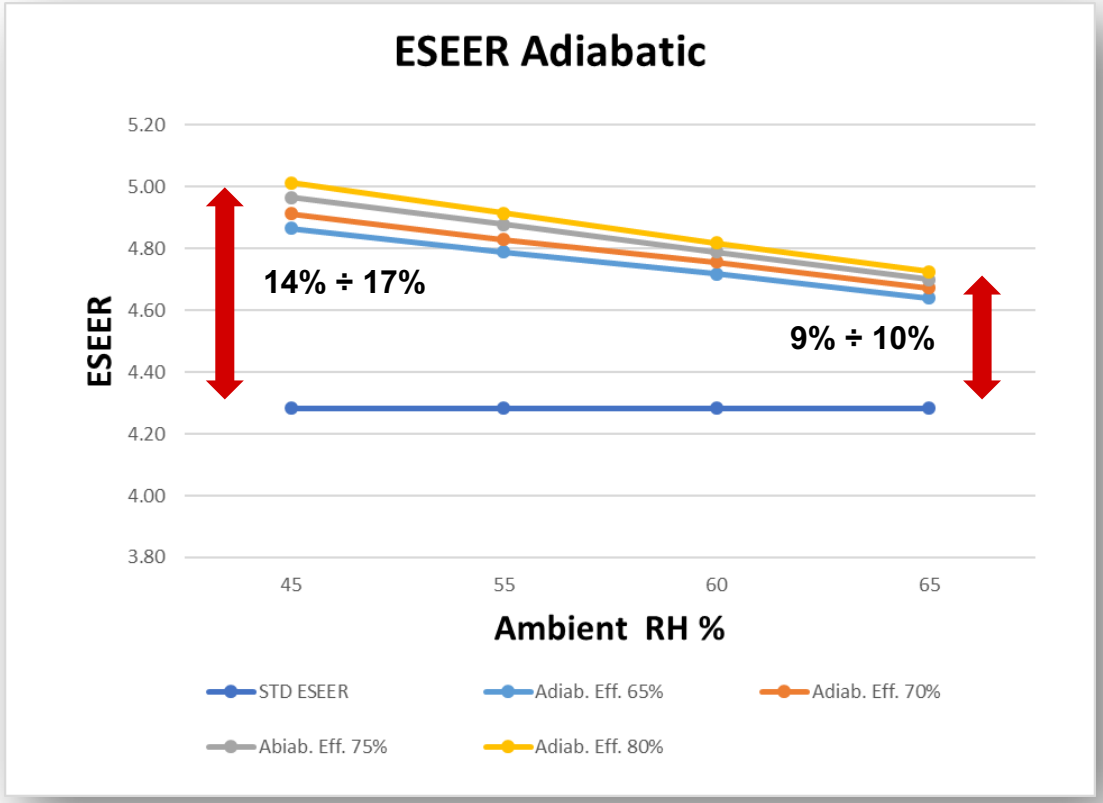
			1	2
			Before spray	After Spray
Temperature	t	C	50	32.9
Rel. Humidity		%	30%	95%
Wet Bulb Temp.	t	C	32.1	32.1
Act. Air flow	Vs	M3/h	18 785	17 982
Nom. Air Flow	Vn	M3/h	16 250	16 250
Evap.Water	**qw**	**Kg/h**		**137.6**

ADIABATIC COOLING

ESEER Improvement

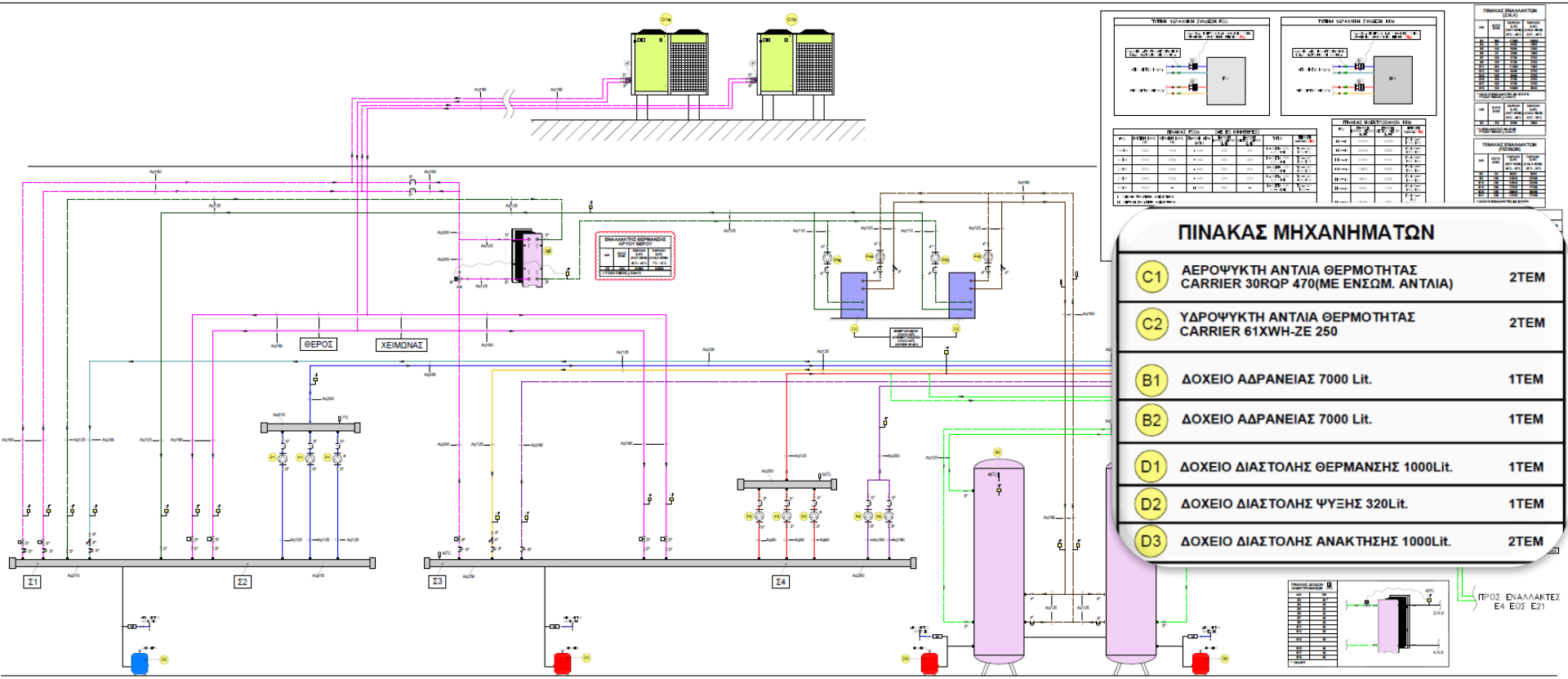
Adiabatic Efficiency %		80					
Partial Load Ratio	Outdoor Air	Water Temp	Weighting coefficients	STD Eurovent Conditions			
				CC	PI	EER	ESEER
	DB oC	oC		kW	kW	kW/kW	kW/kW
100	35	30	0.03	423.7	145.9	2.90	4.28
75	30	26	0.33	317.5	89.0	3.57	
50	25	22	0.41	211.3	48.2	4.38	
25	20	18	0.23	105.1	19.8	5.31	

Adiabatic Efficiency %		80							
Partial Load Ratio	Outdoor Air	Water Temp	Weighting coefficients	Outdoor Air					
				%RH	Adiab out	CC	PI	EER	ESEER
	DB oC	oC			DB oC	kW	kW	kW/kW	kW/kW
100	35	30	0.03	~ 60	29.4	452.1	132.6	3.41	4.82
75	30	26	0.33		24.4	338.8	81.5	4.16	
50	25	22	0.41		20.2	225.4	45.7	4.93	
25	20	18	0.23		16	112.1	19.5	5.75	



SYSTEM DIAGRAM

As Build Drawing



NEW INSTALLATION

QUESTIONS