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100% CO₂ cooling solutions for electrical enclosures

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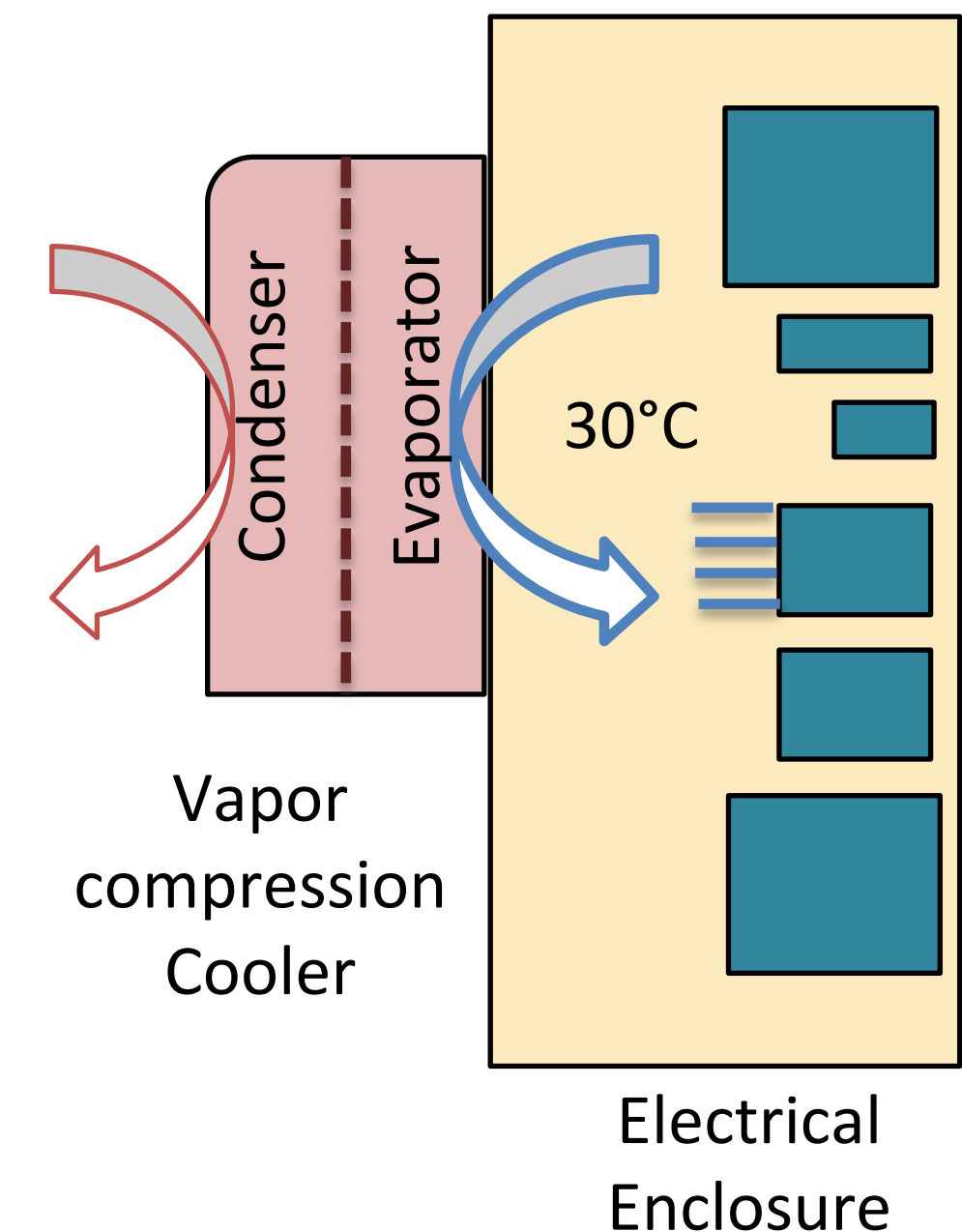


Function and advantages of electrical enclosure air cooler

- Enclosure air cooling to avoid electric components overheat and the process failure
- Increase the lifetime thanks to cooling (drive controller, batteries, electrical and electronical components, controllers, etc)
- Protect the components from the environment (dust, oil, humidity, graphite, etc.) by preventing the mix between inside and outside air (compared to ventilation)

Constraints of standard air coolers (R134a)

- Maintenance
 - Refrigeration technician (HFC) required
 - Changing filters, cleaning, fans exchanges
- Energy consumption
- Carbon footprint

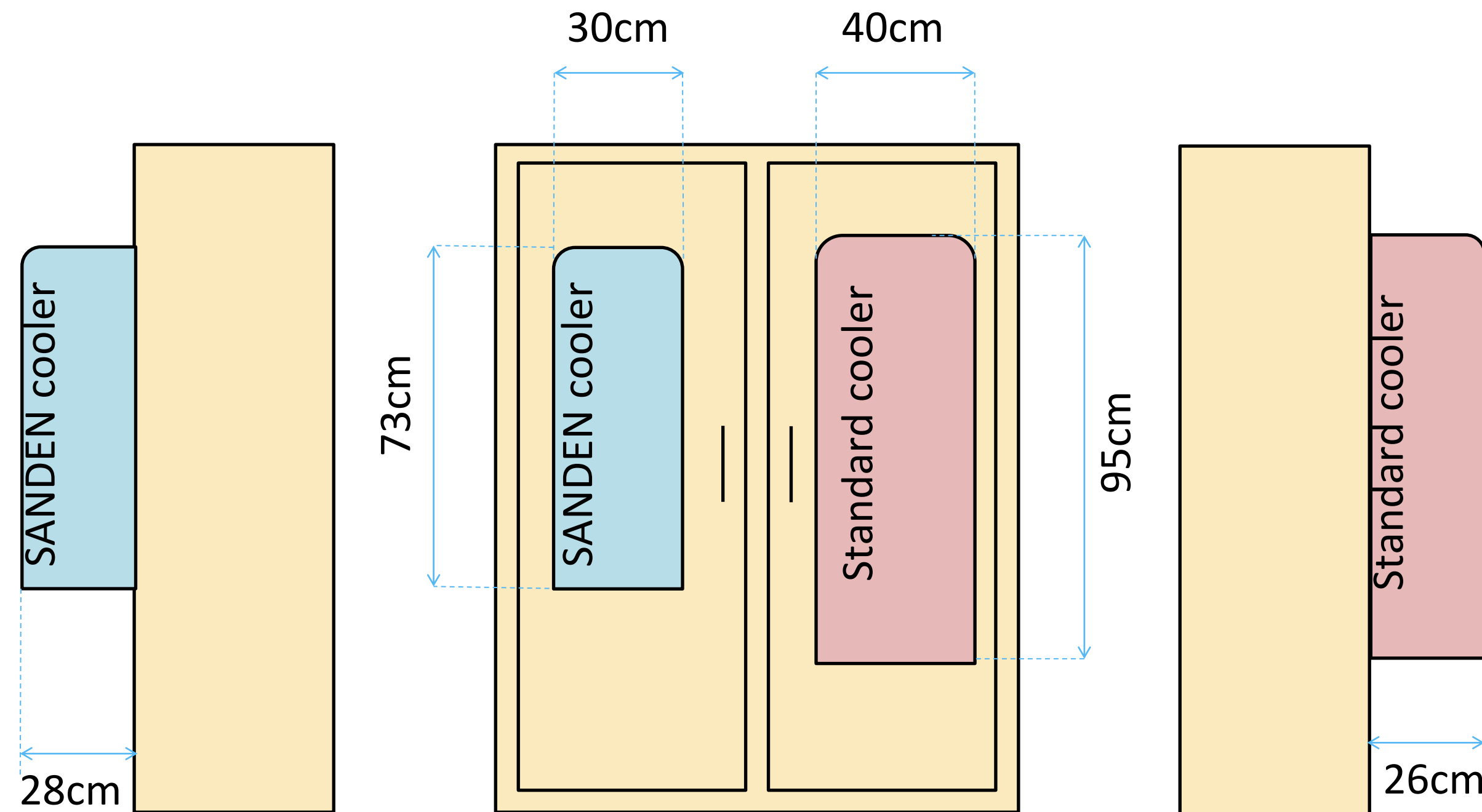


➤ INCREASED DURABILITY

- Low pressure ratio
- Reduced friction surfaces
- Adapted cooling capacity to avoid short cycles
- No degradation of the condenser (fin corrosion, disassembly/reassembly of the equipment)

➤ COMPACTNESS

- Compact thermodynamic loop
- No oversizing (Stable Cooling Capacity)
- 40% Volume reduction



Size comparison for a same cooling capacity

CO₂ technology benefits

➤ WITHOUT FILTER, WITHOUT MAINTENANCE

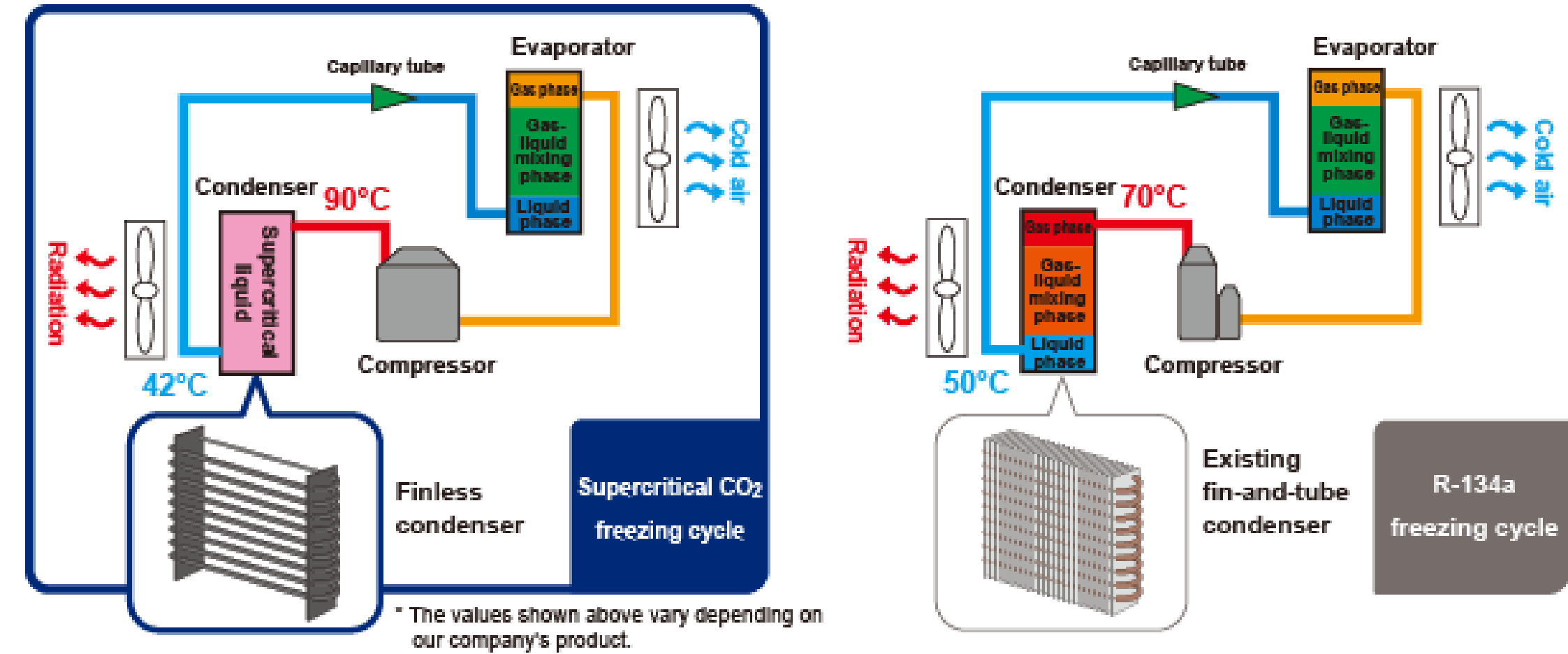
The cooling capacity is directly function of the exchange surface « A » and of the difference of temperature between the gas and the air.

$$P = U * A * (T_{Ref} - T_{air})$$

(U is the heat transfer coefficient of the used materials)

For a same heat load, the exchange surface necessary is divided by 2.5 when the ΔT ($T_{Ref} - T_{air}$) is double.

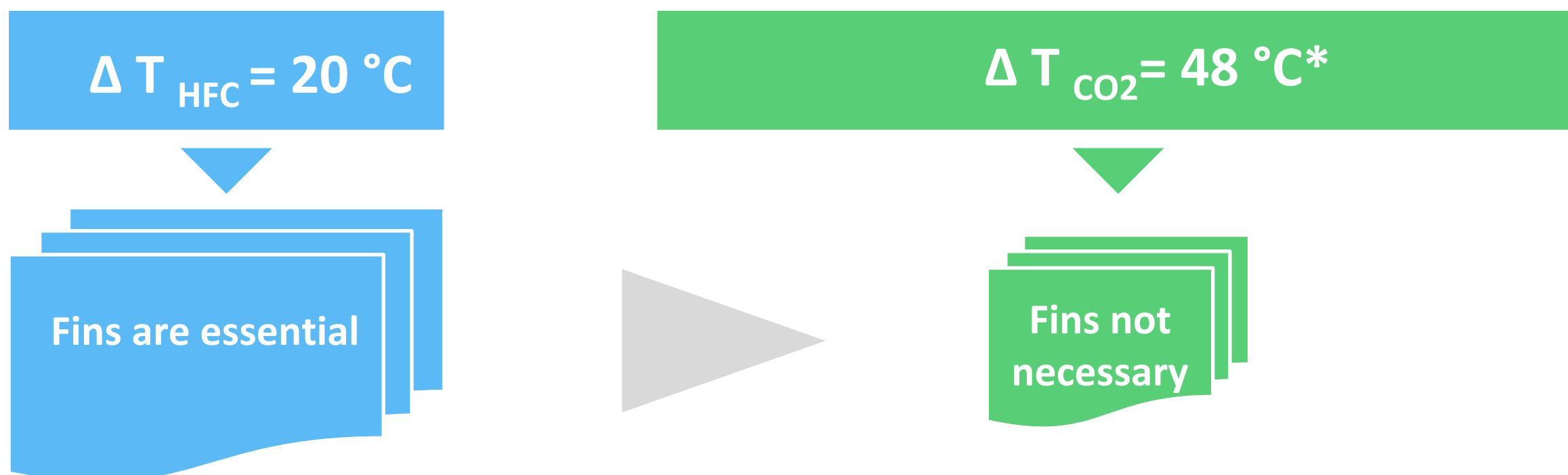
Higher ΔT than HFC (48K versus 20K)



Advantages of CO₂ (R744) as Refrigerant

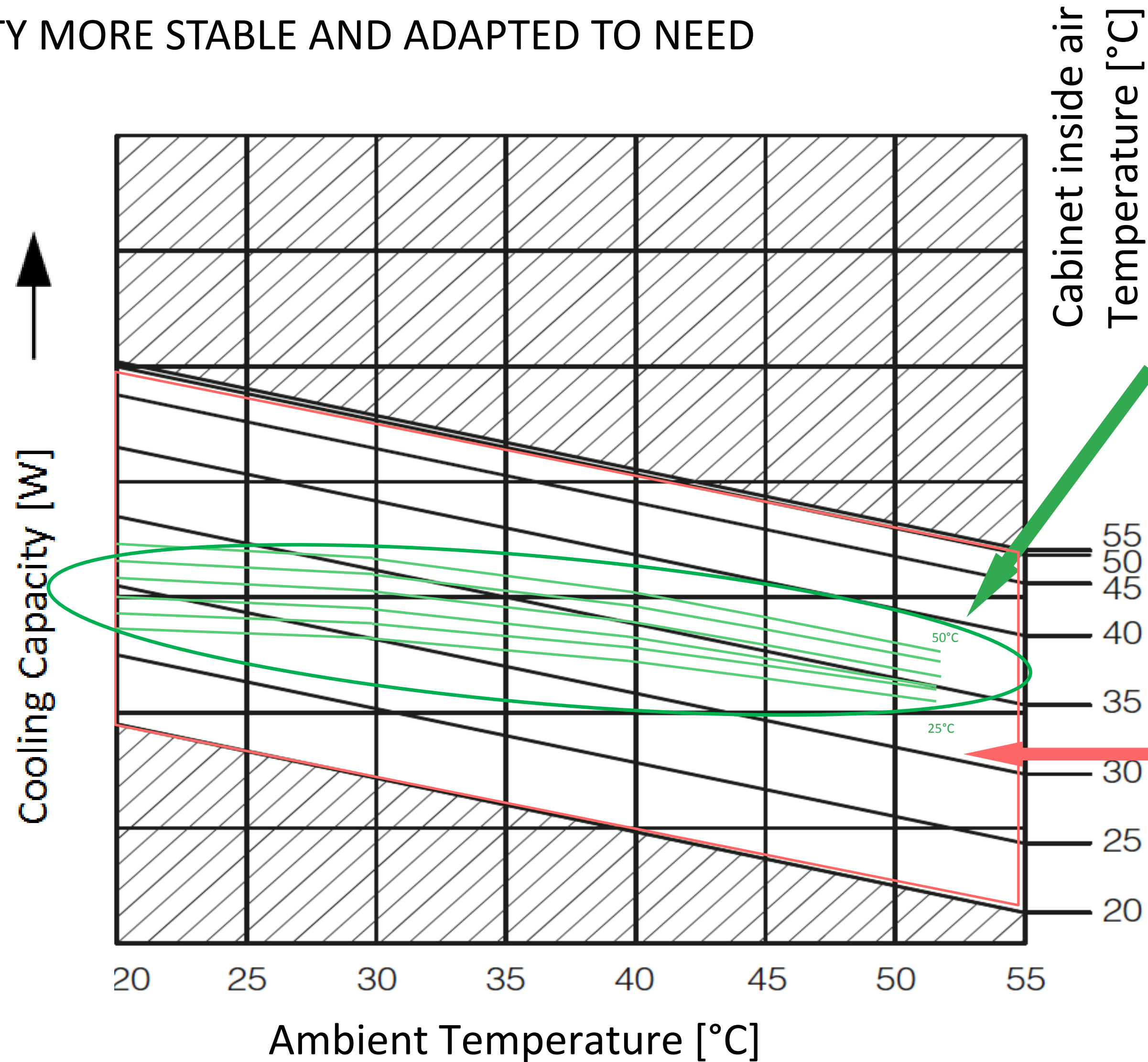


- Non toxic
- Non flammable
- ODP = 0
- GWP = 1
- ➔ No need for Refrigerant recovery





➤ COOLING CAPACITY MORE STABLE AND ADAPTED TO NEED



Cooling Capacity is more stable with SANDEN CO₂ technology

Cooling capacity falls down with R134a products

➤ WITHOUT FILTER, WITHOUT MAINTENANCE

The CO₂ Thermodynamic loop allows to avoid fins and thus avoid to protect these by a filter.

SANDEN CO₂ air cooler



Standard air cooler



- Maintenance cost reduction (change time and filter).
- No risk of increasing consumption or decreasing performances.
- No risk of fins corrosion.
- No risk on health by reducing the ambient air quality (due to dirty filters).
- No risk of condenser fans failure due to filter soiling.

Product range & cooling capacity

➤ Lateral enclosure air coolers



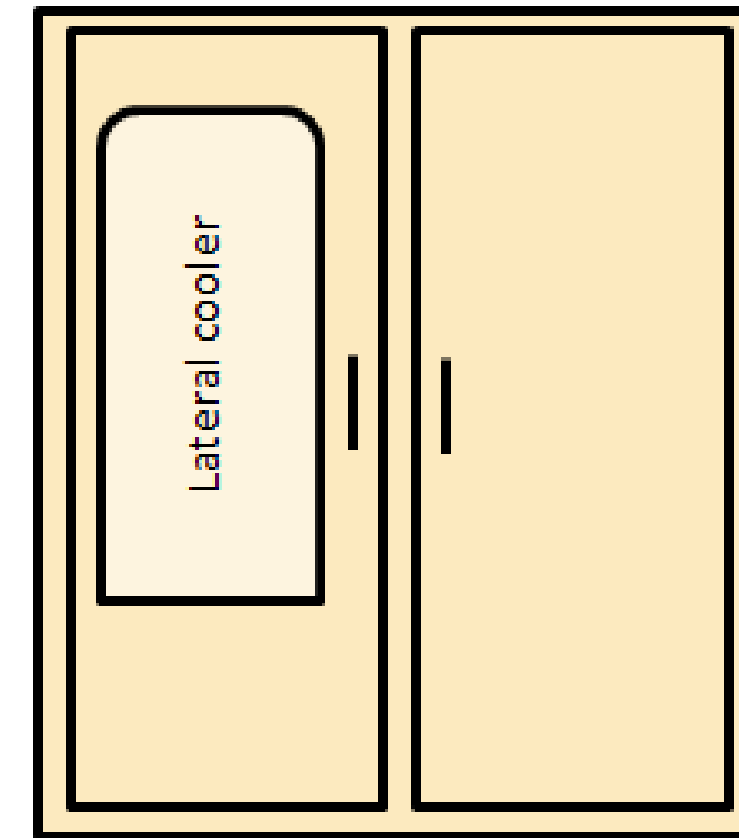
500W



1000W



1350W



➤ Top mounted enclosure air coolers



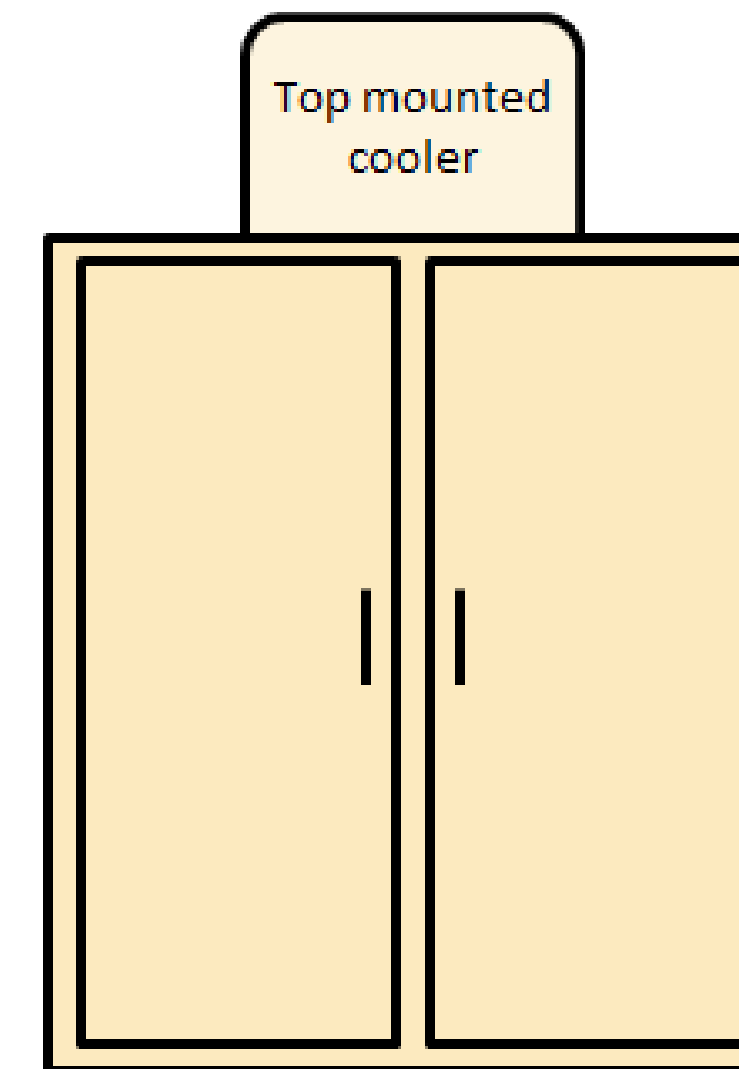
450W



900W



1350W



➤ Power Consumption comparison between :

- 1- Our lateral CO₂ enclosure cooler (1000W)
- 2- A standard lateral R134a enclosure cooler (1000W)

Laboratory tests:

- Controlled conditions
- COP results table

	COP @ 25°C/25°C	COP @ 35°C/35°C
CO ₂ cabinet cooler	2,7	2,4
R134a cabinet cooler	2,5	1,76

The CO₂ cooler has a **gain of 24%** on the consumption in real conditions

Field Tests in Factory:

Cooling down electrical enclosure for Machining process



CO₂ cooler field test

➤ Consumption results table

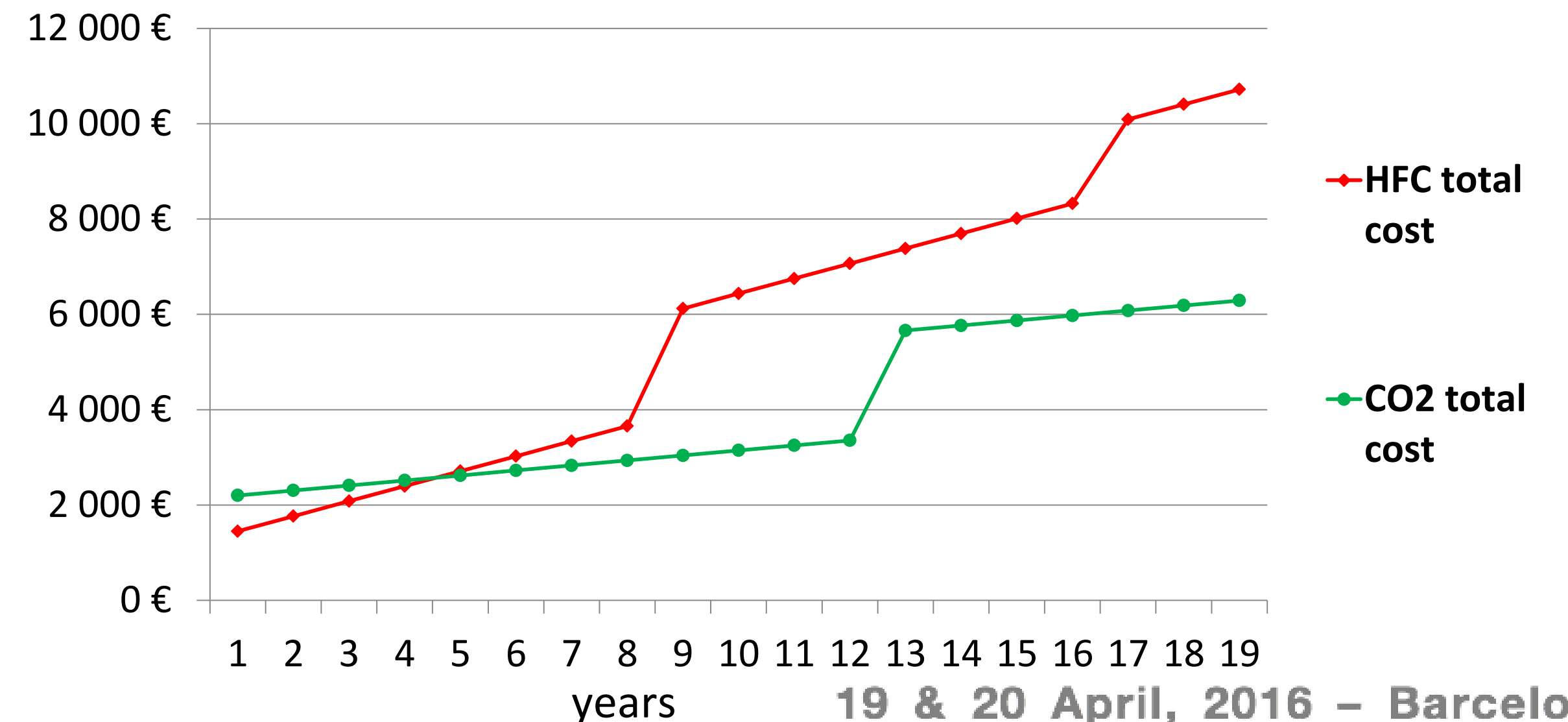
Cooler	Consumption [kWh]	Mean power supply [W]	Mean inside temperature [°C]	Mean outside temperature [°C]
CO ₂ cooler	83,7	108,4	33,93	25,01
Standard enclosure cooler	111,1	142,8	36,56	25,19
Energy savings with CO₂ [%]	24,7 %			

- **Investment return period** calculation (comparison with a standard R134a cooler)
- The following assumptions are based on data from the market

	Standard R134a cooler	SANDEN CO2 cooler	
Lifetime	8	12	years
Initial cost	1450	2200	€
Electrical Energy Consumption	1000	750	kWh/year
	140	105	€/year
Maintenance	175	0	€/year
Cost at end of life	700	0	€

- Return on investment period less than **4 years** for the CO₂ cooler.
- Total cost for CO₂ cooler of **6290 EUR** (after eighteen years).
- Total cost for R134a cooler of **10720 EUR**.

Total cost for the cooling of an electric enclosure



- ✓ Green and Safe technology for air coolers
- ✓ Heavy Duty Product and long lifetime
- ✓ Compactness gain ~40%
- ✓ Energy savings ~24%
- ✓ No over-sizing of cooling capacity
- ✓ Acceptable ROI and low running cost



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THANK YOU!
GRACIAS!

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Thank you very much!