High Efficiency Solutions.

CAREL

BLDC waterloop systems in commercial refrigeration: the new frontier for natural refrigerants

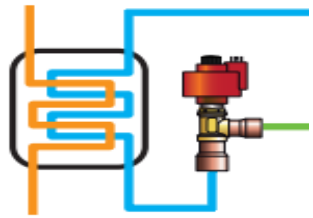
ATMOsphere EUROPE solutions for europe natural refrigerants

16-17 March 2015 in Brussels

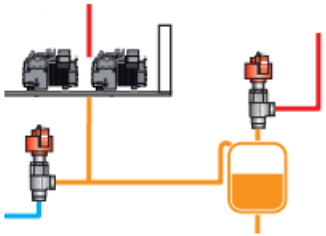
Diego Malimpensa

17th March 2015

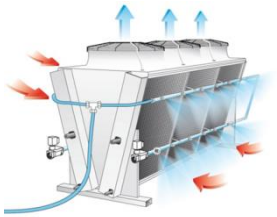
Energy efficiency in CO_2 systems



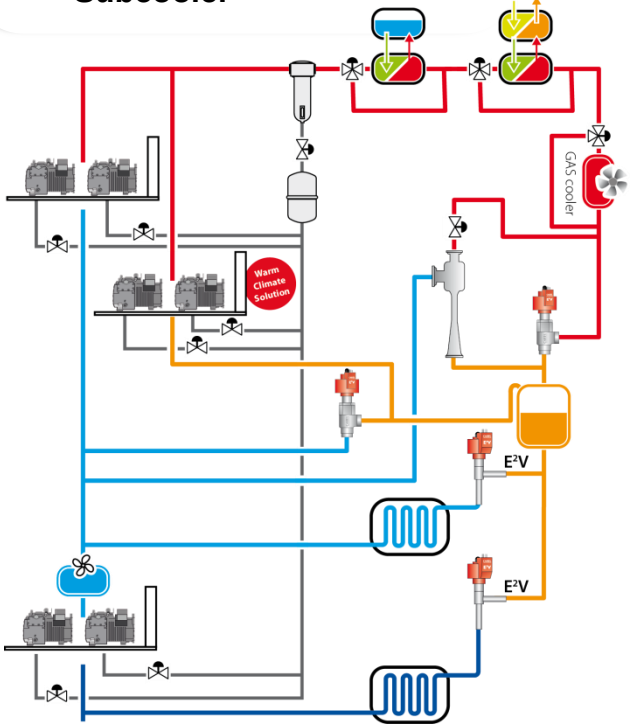
Subcooler



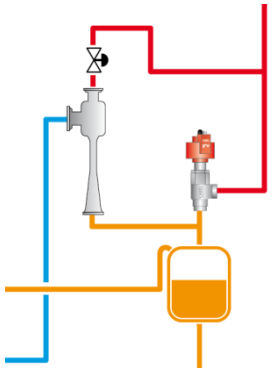
Parallel compression



Evaporative cooling

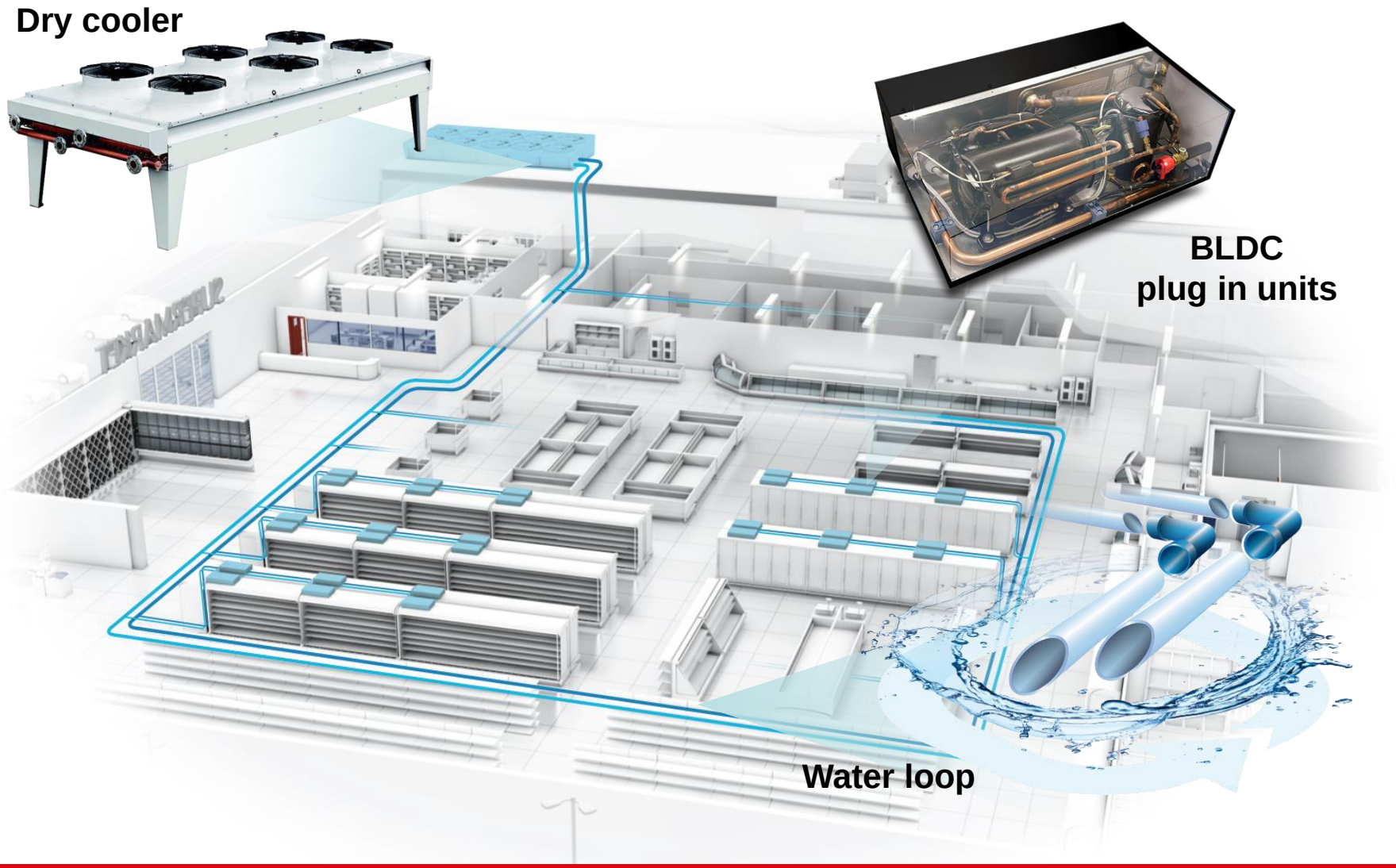


Heat Reclaim & AC integration



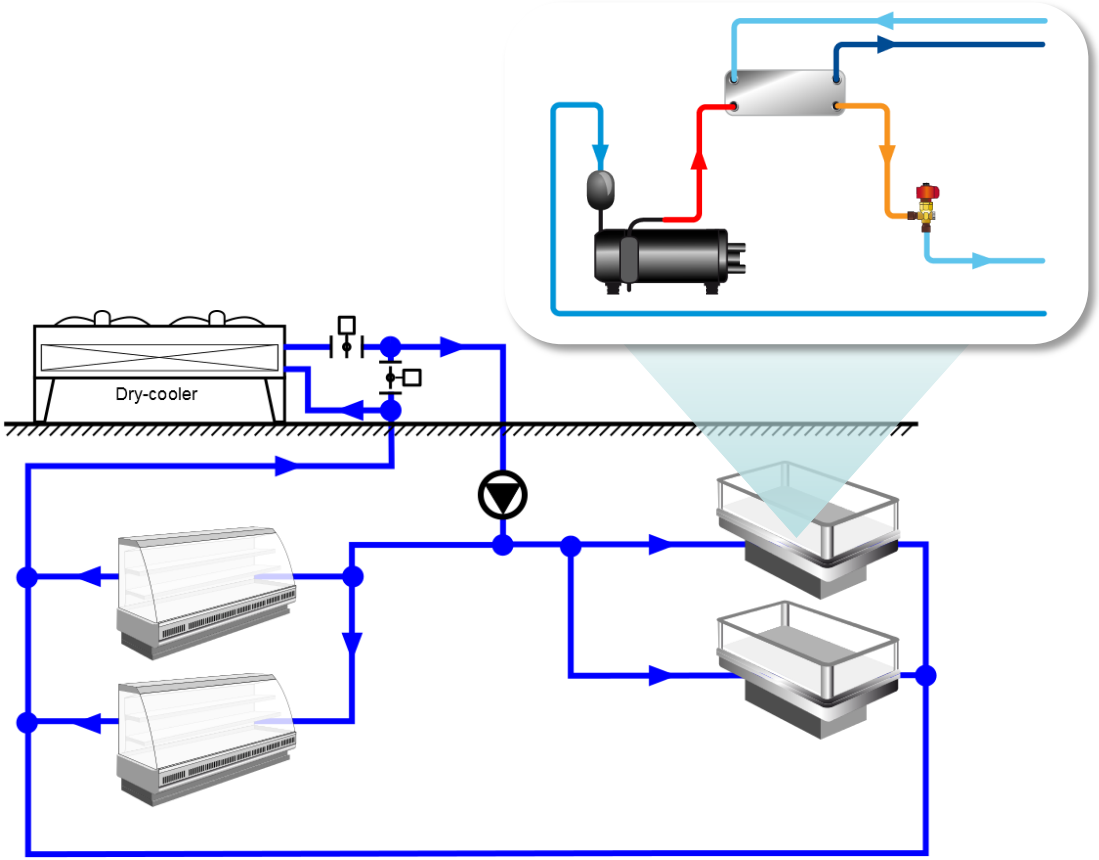
Ejectors

BLDC waterloop systems



BLDC waterloop systems

Plug-in units with BLDC inverter compressor and water condenser on-board connected with a water loop system for condenser heat management



- No long copper pipes
- No comp rack and receivers
- 1-2kg refrigerant charge for cabinets

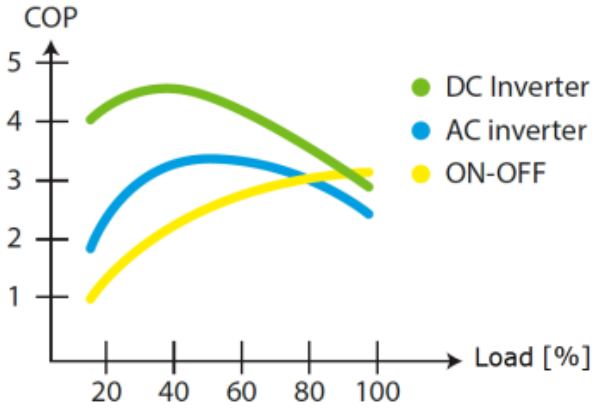
- From «multiplexed systems» 10-15% to «integral cabinets» 1-2%
- No welding on the field
- Factory tested units

- High efficiency BLDC compressors
- Individual evap. temperature
- Fully controlled performances

BLDC waterloop systems

ENERGY EFFICIENCY

- All units always at their best working condition
- Wide modulation range and energy efficiency at part load
- Optimum food temperature control
- Full control of units: preventive diagnostic and maintenance

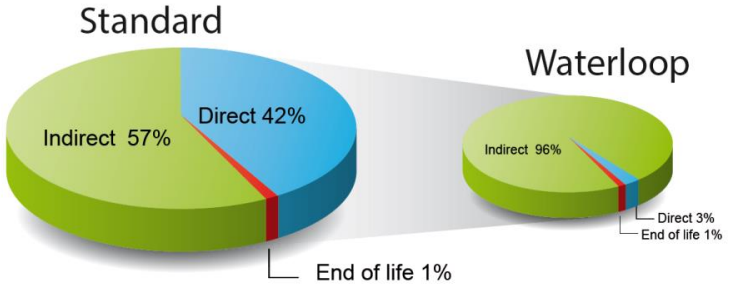


FLEXIBILITY

- Easy layout change and showcases repositioning,
- Wider sales area, less space needed for machine room
- High investment recovery in store relocation
- Low installation and maintenance cost

ENVIRONMENT RESPECT

- Charge reduction **80%**
- Leaks reduction **96%**
- 96% Direct effect reduction
- Almost 50% TEWI reduction (HFC)

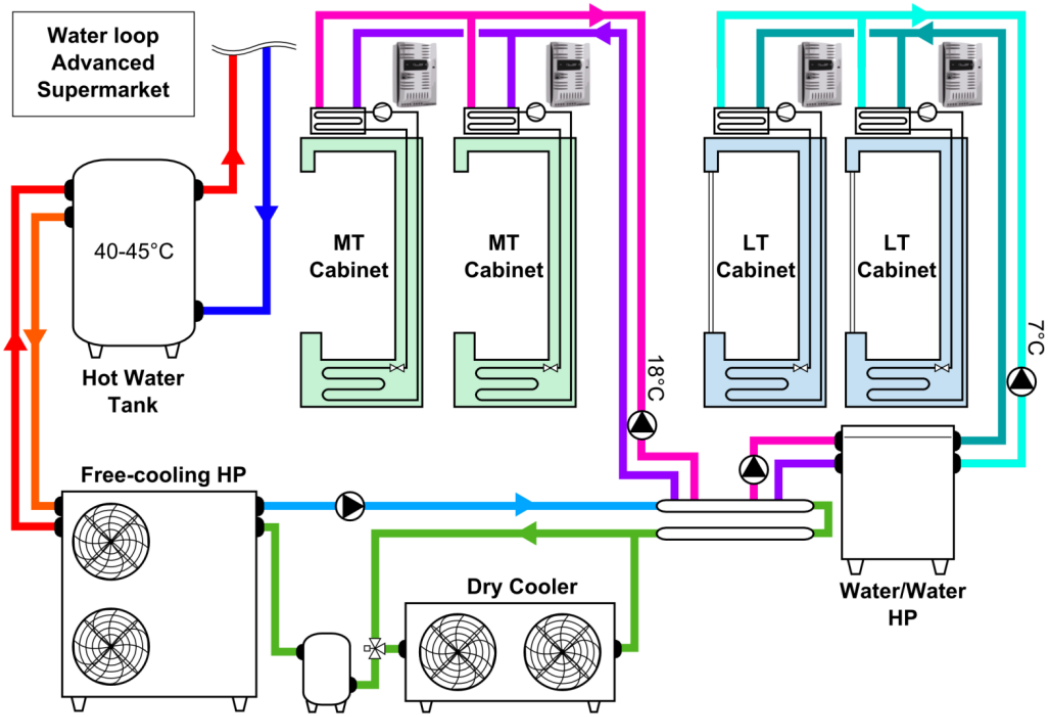


Field experiences

First trail done in 2012 – Bologna (IT)

- 10 LT cabinets (29 kW);
- 28 MT cabinets (63 kW);
- Sales area: 900 m^2;

R404A horizontal scroll compressors
Dry cooler, air chiller,
heat pump for heat reclaim



Results presented on

- Refrigerazione a basso effetto serra. Tendenze verso la sostenibilitò (AiCARR, November 2012) - **Vicenza (IT)**
- Coolenergy.dk exhibition 2013 - **Odense (DK)**
- XV European conferenc on technological innovations in refrigeration (CS Galileo, June 2013) –**Milano (IT)**
  3rd International conference on sustainability and cold chain (IIR, June 2014) - **London (UK)**
- Recenti sviluppi nella tecnologia dei compressori frigoriferi e loro impatto sulla efficienza stagionale delle macchine frigorifere (AiCARR, february 2015) **Vicenza (IT)**

Field experiences

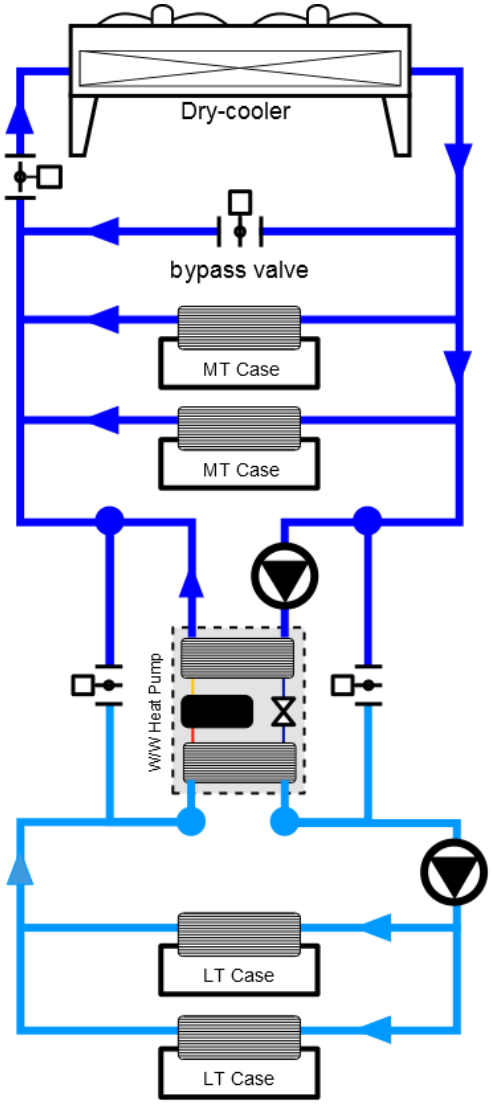
Supermarket Bologna Italy

Field experiences

2014 roll out with best in class configuration

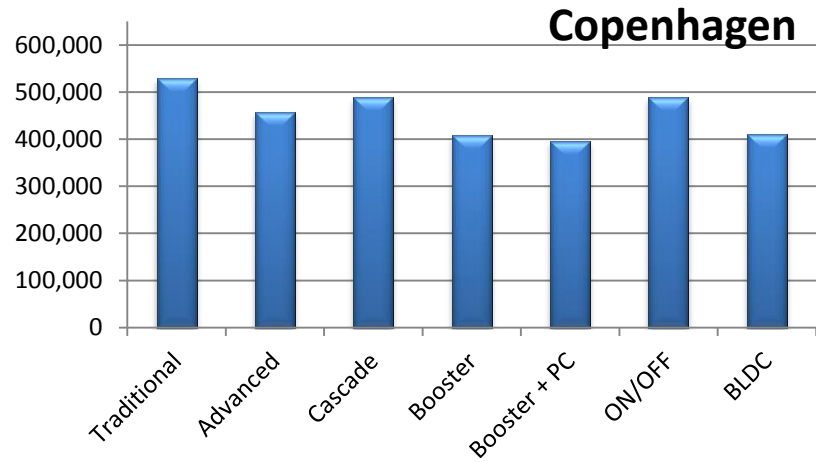
- R410A refrigerant (GWP: 2088)
- Freecooling on MT units
- LT units
  - Freecooling with liquid injection (high discharge temperature)
  - LT loop chiller (W/W or A/W chiller)

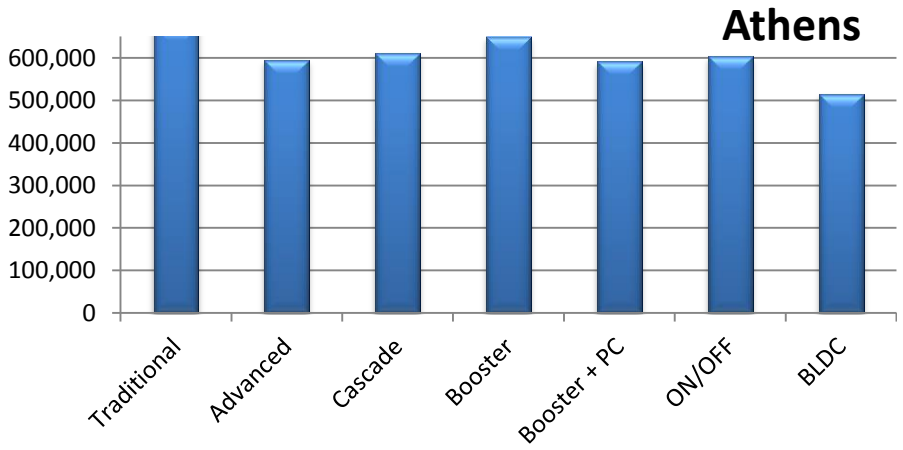
Deployment on going in Europe, USA, Australia.



Energy consumption analysis

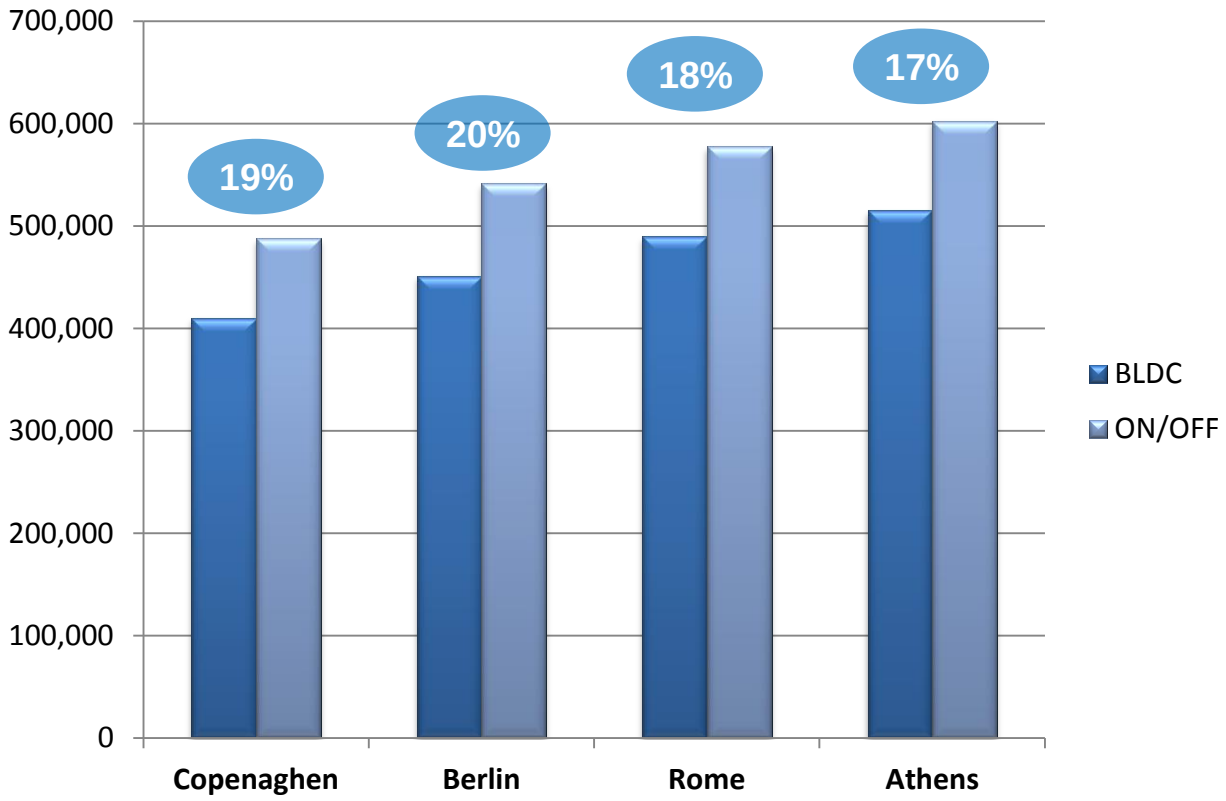
Technology	Refrigerant	Copenhagen		Berlin		Rome		Athens	
		Energy [kWh/yr]	BLDC WL saving	Energy [kWh/yr]	BLDC WL saving	Energy [kWh/yr]	BLDC WL saving	Energy [kWh/yr]	BLDC WL saving
Traditional	R404A	529,604	**29%**	563,657	**25%**	635,056	**30%**	673,193	**31%**
Advanced	R404A	457,006	**11%**	491,037	**9%**	574,779	**17%**	594,958	**15%**
Cascade	R134a/CO2	489,591	**19%**	524,681	**16%**	599,450	**22%**	611,486	**19%**
Booster	CO2	408,603	**0%**	463,802	**3%**	612,575	**25%**	650,412	**26%**
Booster + PC	CO2	396,345	**-3%**	440,612	**-2%**	557,443	**14%**	591,875	**15%**
ON/OFF waterloop	R410A	488,173	**19%**	541,698	**20%**	577,739	**18%**	602,756	**17%**
BLDC waterloop	R410A	410,230		451,415		489,609		515,176	





All data are related to 180kW MT, 50kW LT supermarket in different weather conditions

Energy consumption analysis



	Copenaghen	Berlin	Rome	Athens
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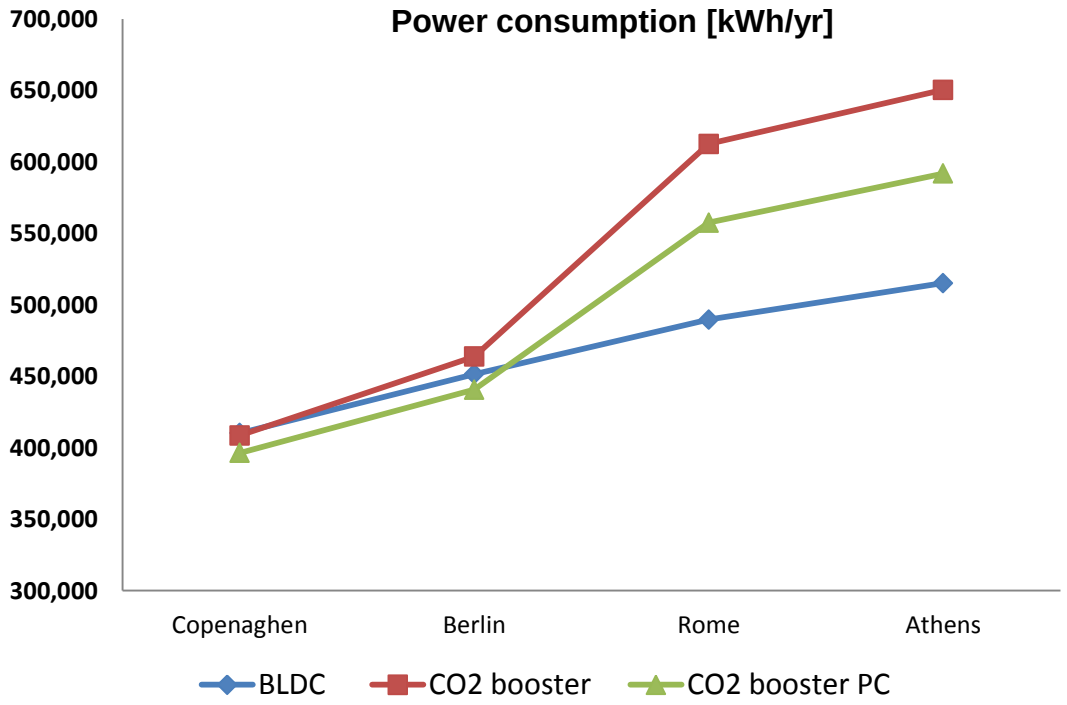


Type	Refrigerant	Copenaghen	Berlin	Rome	Athens
BLDC waterloop	R410A	410,230	451,415	489,609	515,176
Booster	R744	408,603	463,802	612,575	650,412
Booster PC	R744	396,345	440,612	557,443	591,875

Natural refrigerants in BLDC waterloop systems

PROPANE

PRO

- High efficiency refrigerant
- Standard working pressures
- Ideal for small units

CONS

- Flammability
- Missing legislative uniformity at EU and local level
- EN378, EN60079, ATEX EU Dir.
- 150g now enough for supermaket showcases
- High investement for units production/testing

CO_2

PRO

- Well accepted from the market
- Overcomed worries on pressures and usability
- Innovation trends ongoing

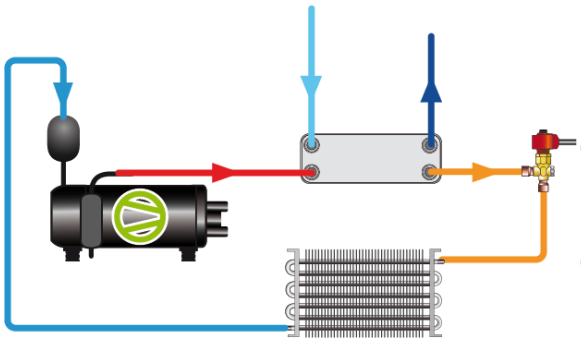
CONS

- Low efficiency in warm climates
- Expensive low capacity high pressure components
- Missing wide compressors range

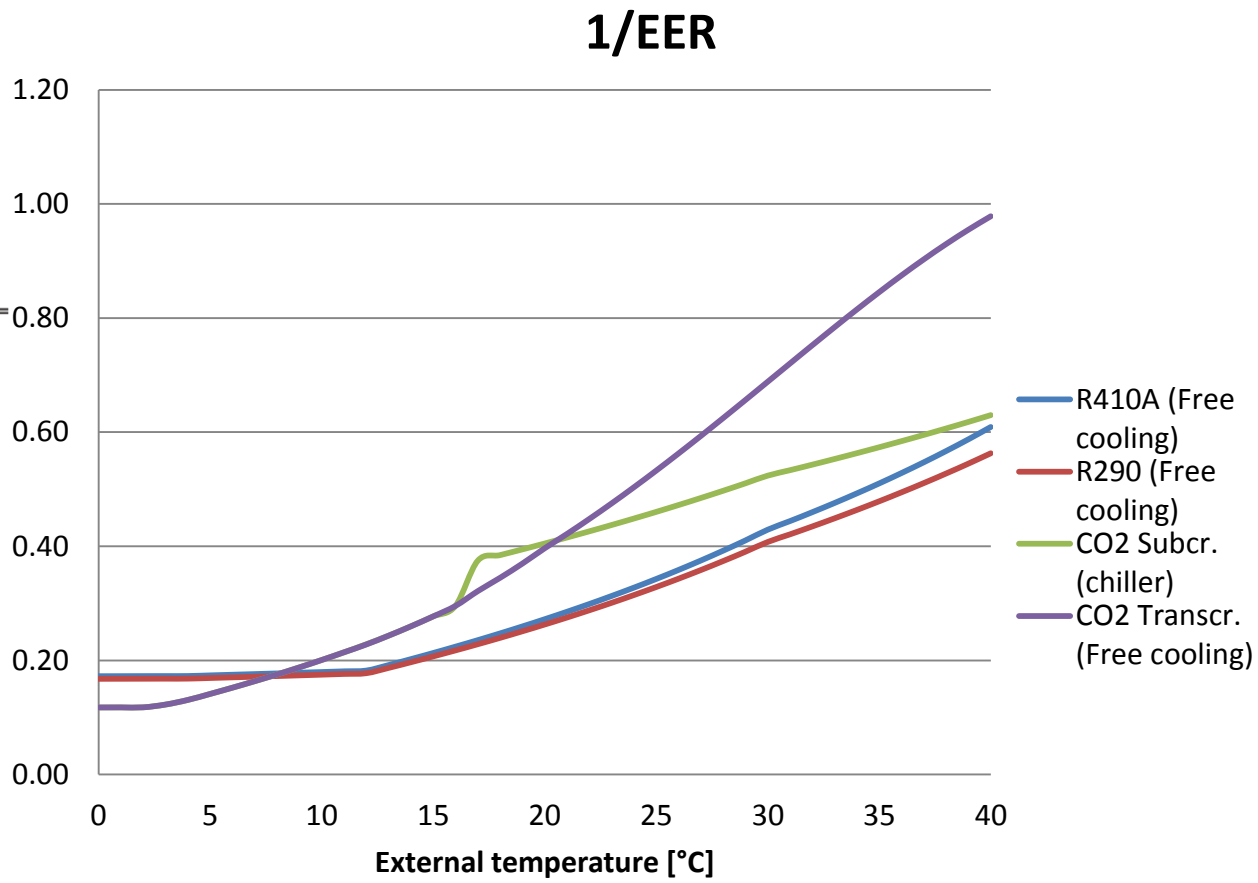
Natural refrigerants in BLDC waterloop systems

Test conditions

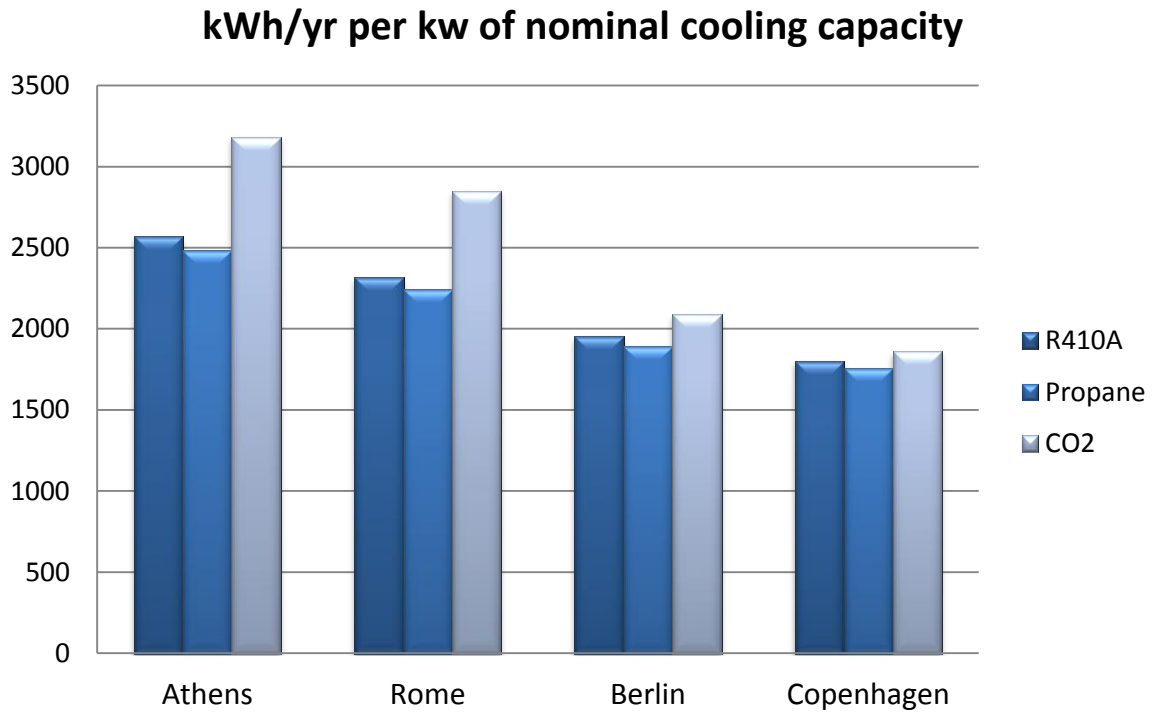
Refrigerant scheme



- MT only
- BLDC comps
- R410A freecooling
- R290 freecooling
- CO_2 sub, chiller activation Twater = 20° C
- CO_2 transcritical, optimum GCpressure control



Natural refrigerants in BLDC waterloop systems



Refr	Tech	Athens	Rome	Berlin	Copenhagen
R410A	Free cooling	2571	2316	1953	1802
Propane	Free cooling	2482	2242	1896	1755
CO2	Chiller 20° C	3184	2850	2087	1861

Conclusions

- BLDC waterloop system is a real and efficient solution in industry portfolio
- Factory tested units to improve ease of installation, flexibility and energy efficiency
- Installation and maintenance cost reduction
- Suitable use with natural refrigerant: Propane and CO_2
- Propane
  - Best in class efficiency
  - Less accepted by industry for high flammability
  - Legislations under revision (EN378)...
- CO_2
  - Well accepted by the market due to intensive job already done by the industry
  - Missing complete range of compressors
  - Issue on efficiency in warm climates in small application… let's work on it!!

https://www.youtube.com/watch?v=eholSWxFzL0

High
Efficiency
Solutions.

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