

A large, industrial-grade compressor unit, likely a scroll compressor, shown in a faded, light blue color. It has a complex structure with various ports, valves, and a cylindrical motor housing. A label with the "DORIN" brand name is visible on the front panel.

OFFICINE MARIO DORIN S.P.A.

CO₂ AGAINST NH₃

CONTENTS

1. INTRODUCTION

2. CO₂ VS AMMONIA: SAFETY AND TECHNICAL DIFFERENCES

3. CO₂ VS AMMONIA: PERFORMANCE COMPARISONS

4. CONCLUSIONS

- **F-gas REGULATION:**
 - **STRONG INFLUENCE IN THE EUROPEAN REFRIGERATION INDUSTRY**
- **NATURAL REFRIGERANTS:**
 - **THE BEST ALTERNATIVE FOR ALMOST ALL THE APPLICATIONS**
- **INDUSTRIAL APPLICATIONS**
 - **CO₂ IS APPROACHING THIS FIELD AGAINST AMMONIA**

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2. CO₂ VS AMMONIA: SAFETY AND TECHNICAL DIFFERENCES

3. CO₂ VS AMMONIA: PERFORMANCE COMPARISONS

4. CONCLUSIONS

- **AMMONIA IS A NICE REFRIGERANT BUT HAS SOME DRAWBACKS:**
- **TECHNICAL DRAWBACKS**
 - **CALLS FOR SPECIAL AND MORE EXPENSIVE COMPONENTS**
 - **CALLS FOR OPEN TYPE COMPRESSORS: LEAKAGES**
 - **NON MISCIBLE LUBRICANT - OIL MANAGEMENT IS AN ISSUE**
 - **CANNOT FLOW IN HEAT RECOVERY COILS: POOR EFFICIENCY**
 - **DAMAGE TO CONTROLS IN CASE OF LEAKAGE (PLANT SHUT DOWN !!)**
- **SAFETY DRAWBACKS**
 - **TOXIC AND FLAMMABLE (T1 DOORS FOR MACHINERY ROOMS)**
 - **COMPLEX AUTHORIZATION FOR COMMISSIONING AND MAINTENANCE**

COOLING POST

\$154,000 fine for ammonia leaks



USA: A fruit juice processor that experienced three ammonia refrigeration leaks in the past year faces fines of \$154,000 by Washington State's Department of Labor & Industries (L&I).

The Johanna Beverage Company of Spokane has been accused of putting employees at risk through a lack of emergency planning.

In each of the incidents – one in December 2015 and two in August 2016 – employees were unsure what to do, which way to run to escape the corrosive vapours and how to call for emergency help. In one of the August incidents, panicked employees ran downwind of the leak into the vapour cloud. Eight employees were exposed; one was sickened and taken to the hospital. One incident also resulted in the temporary shutdown of Interstate 90 as fire crews responded to the leak thought to have involved between 600lb and 800lb of ammonia.

<http://www.coolingpost.com/world-news/154000-fine-for-ammonia-leaks/>

CONTENTS

1. INTRODUCTION

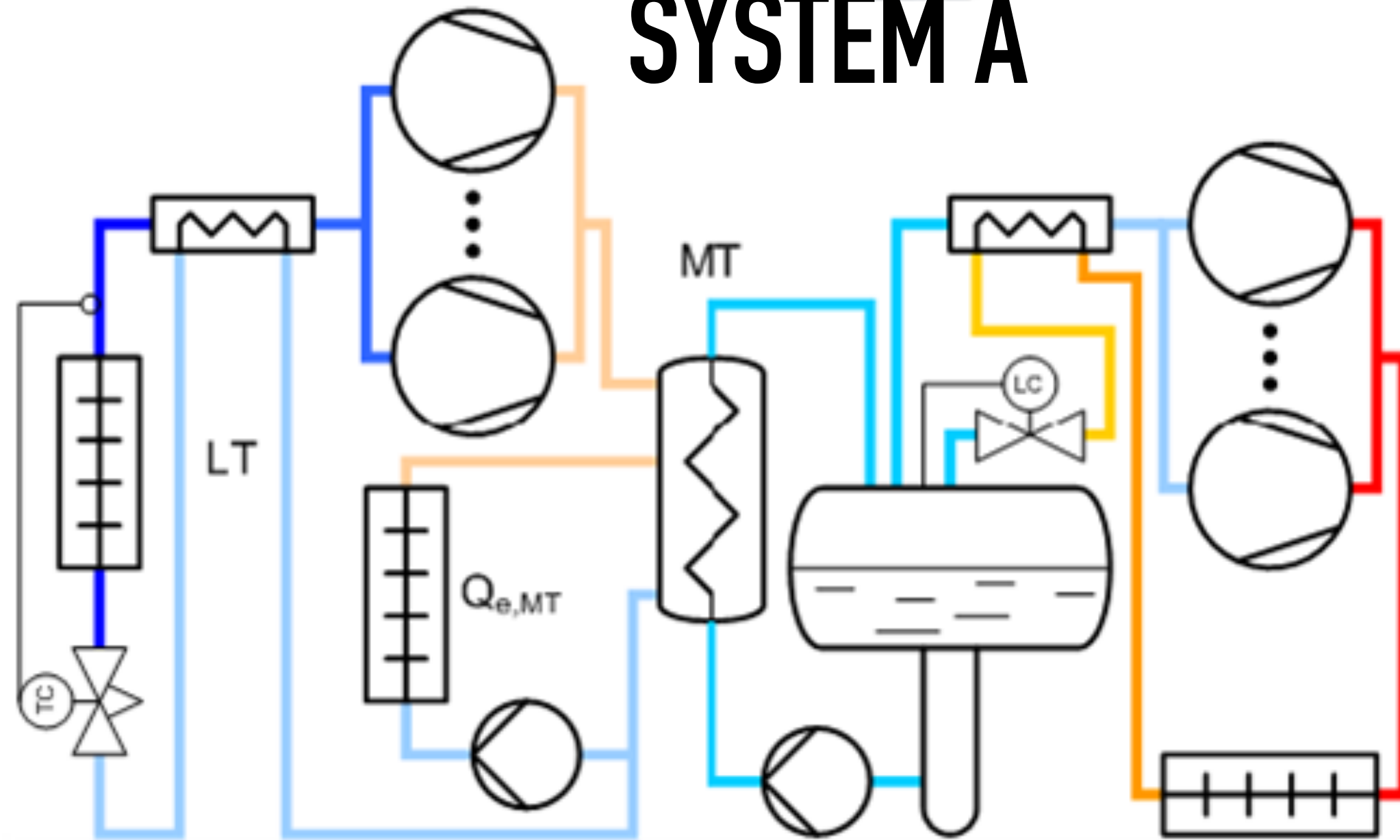
2. CO₂ VS AMMONIA: SAFETY AND TECHNICAL DIFFERENCES

3. CO₂ VS AMMONIA: PERFORMANCE COMPARISONS

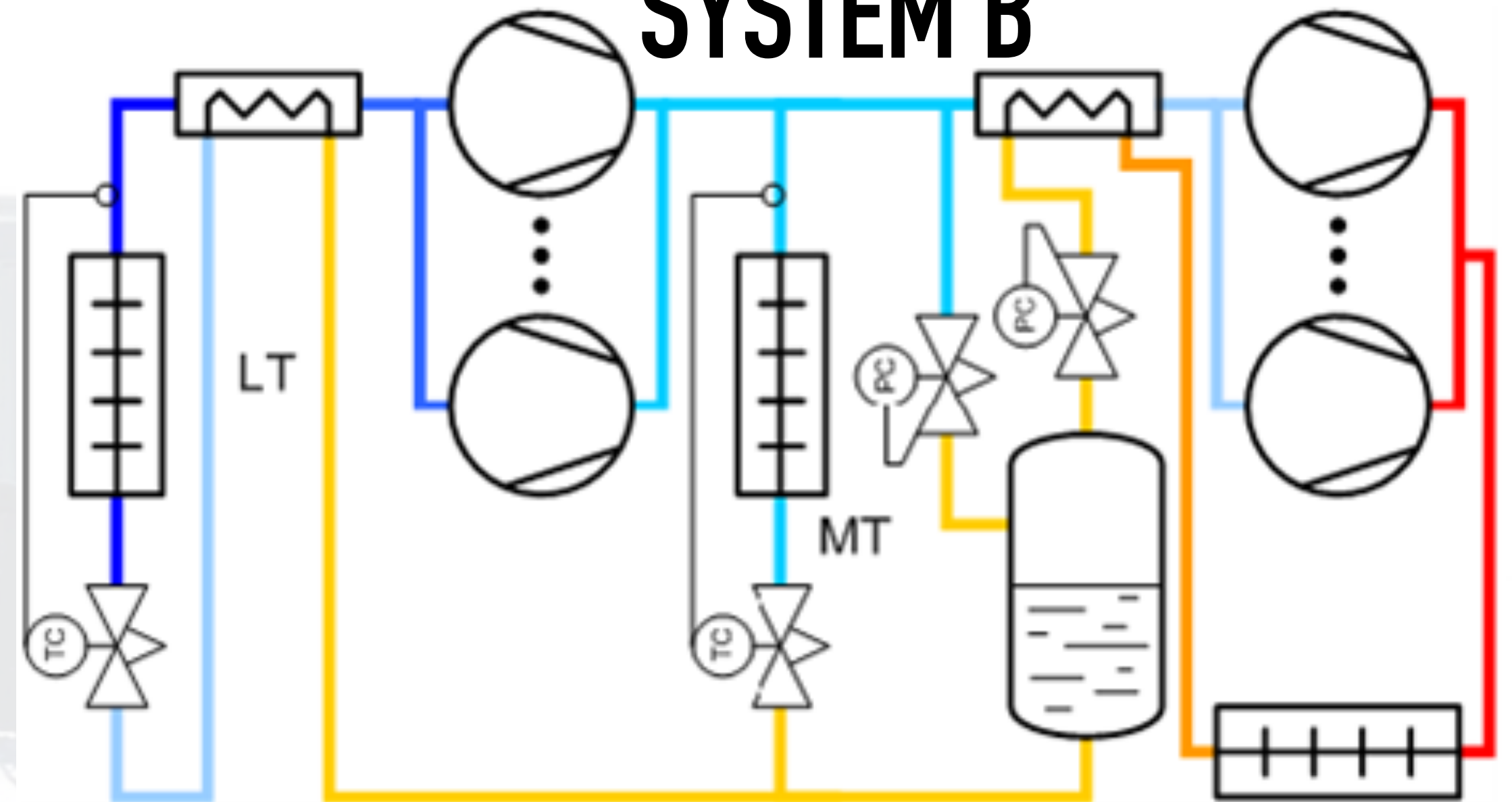
4. CONCLUSIONS

- **ENERGY CONSUMPTION COMPARISON – NH₃ vs CO₂ – SYSTEM FEATURES:**
 - **250 kW LT CAPACITY**
 - **500 kW NET MT CAPACITY**
 - **NO HEAT RECLAIM (TO BE CONSERVATIVE)**
- **SYSTEM A: CO₂ CASCADED WITH NH₃**
- **SYSTEM B: FULL CO₂ BOOSTER – FLASH GAS BYPASS (FGB)**
- **SYSTEM C: FULL CO₂ BOOSTER – PARALLEL COMPRESSION (PC)**
- **NH₃: MINIMUM T_{COND} ACCORDING TO BITZER OSKA RANGE ENVELOPE**
- **CO₂: MINIMUM T_{COND} ACCORDING TO DORIN CD RANGE ENVELOPE**

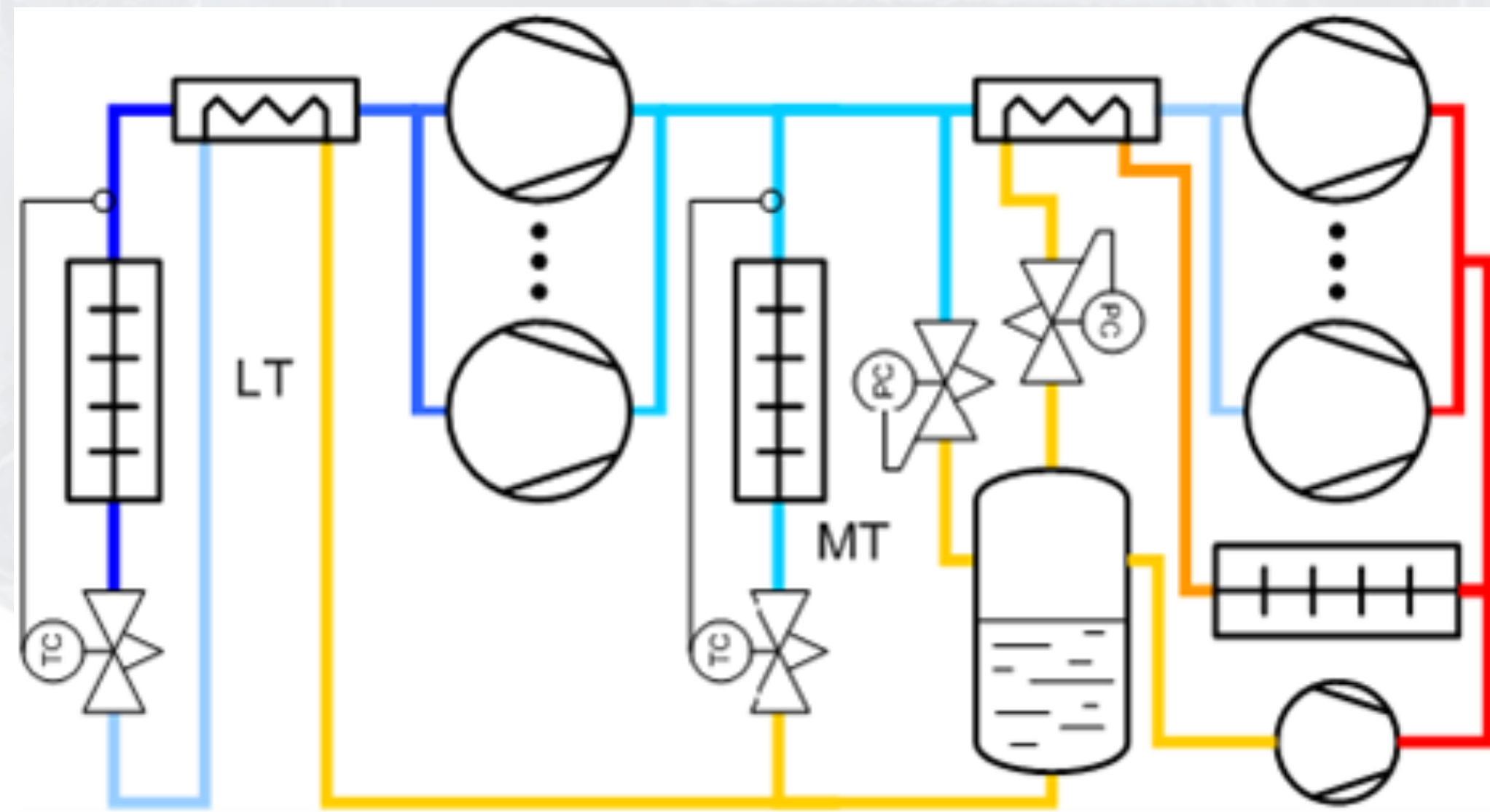
SYSTEM A



SYSTEM B



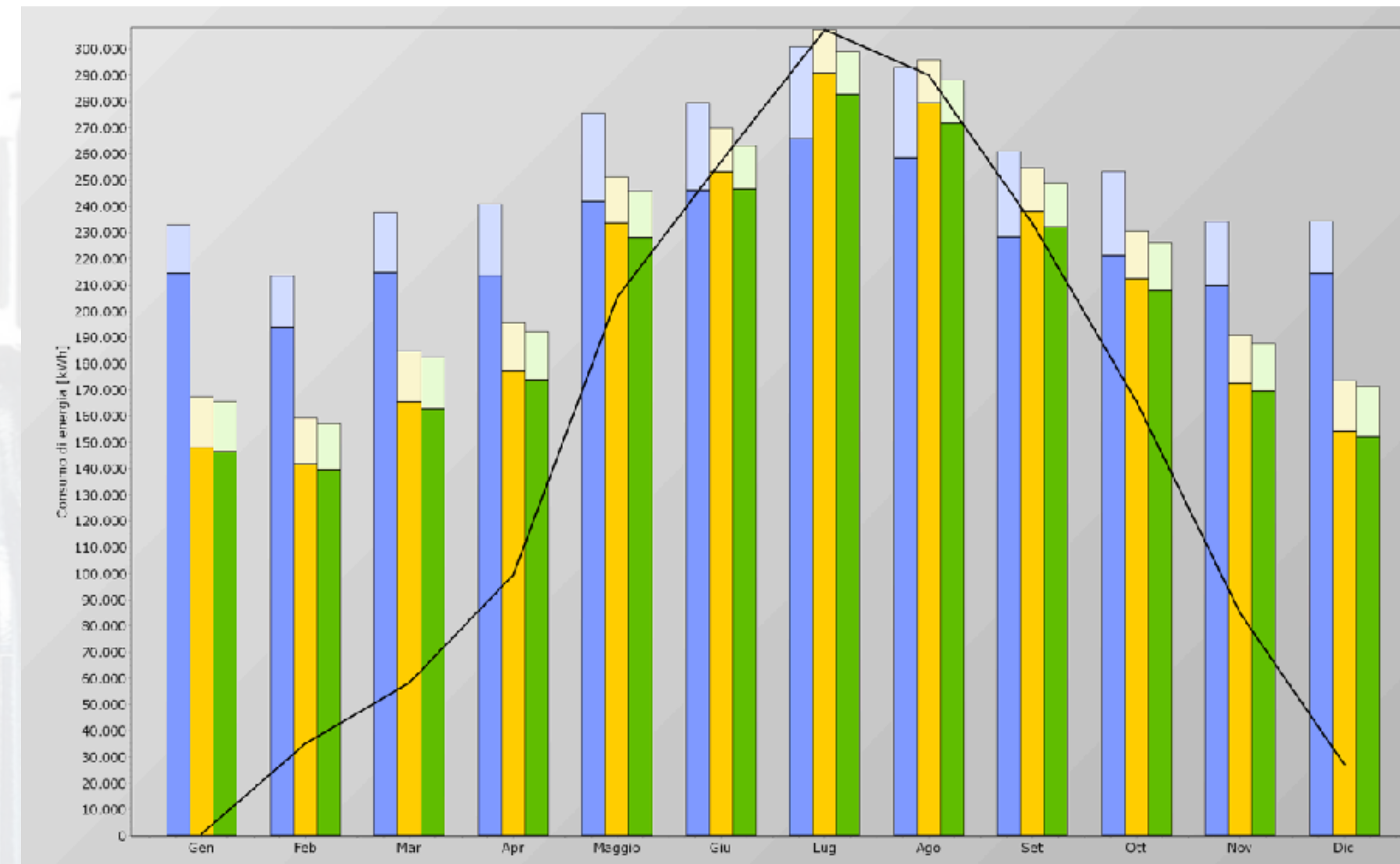
SYSTEM C



- **A: CO₂ CASCADED WITH NH₃**
- **B: CO₂ - FLASH GAS BYPASS (FGB)**
- **C: CO₂ - PARALLEL COMPRESSION (PC)**

YEARLY ENERGY & COST COMPARISON: STOCKHOLM

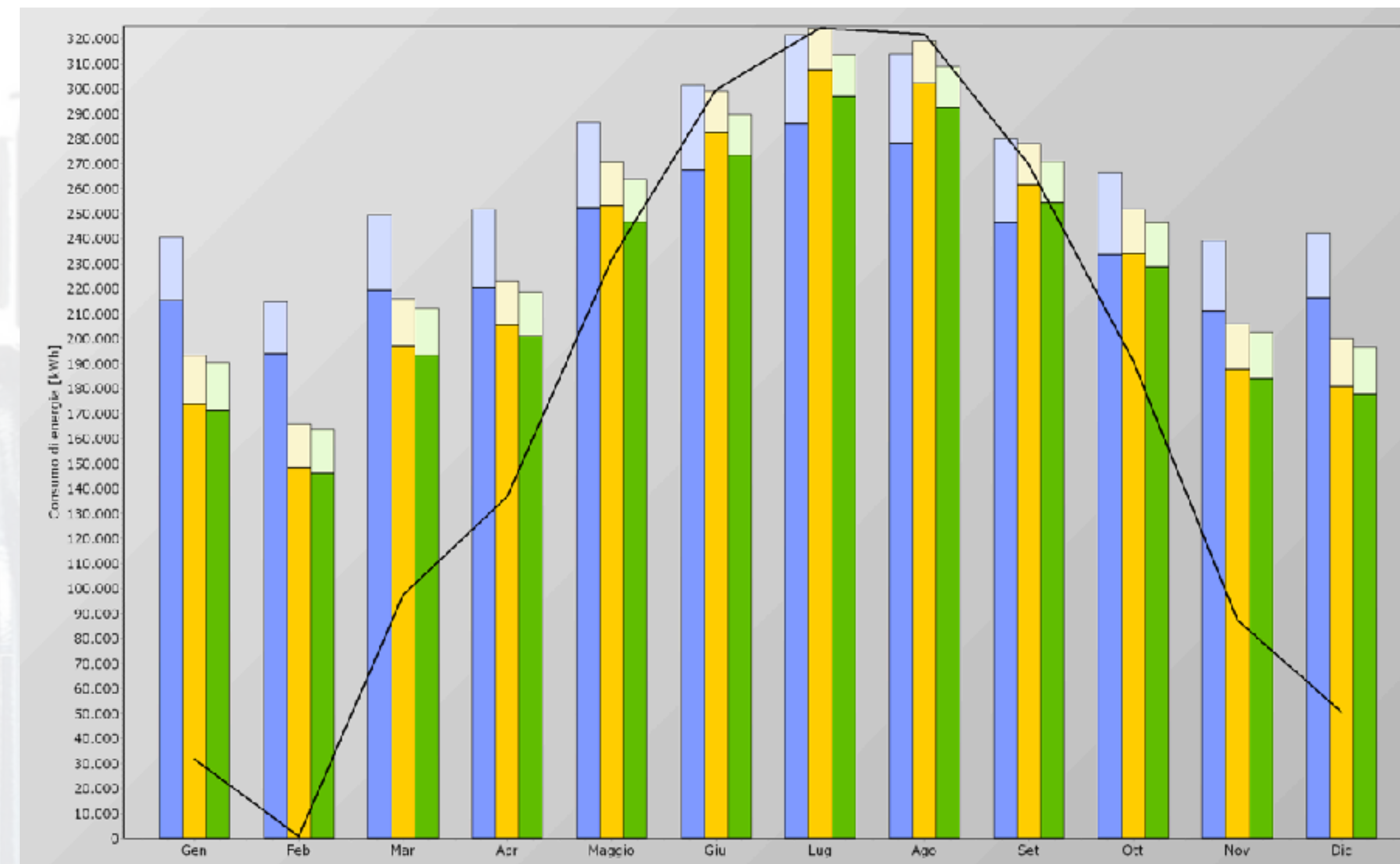
	NH3	CO2 FGP	CO2 PC
Soddisfacimento del carico in % del tempo			
LT:	100,0	100,0	100,0
MT:	100,0	100,0	100,0
Totale:	100,0	100,0	100,0
Soddisfacimento del carico in % di energia			
LT:	100,0	100,0	100,0
MT:	100,0	100,0	100,0
Totale:	100,0	100,0	100,0
COP medio			
LT [-]:	4,50	4,99	4,99
MT [-]:	4,46	5,10	5,25
Totale [-]:	2,73	3,12	3,18
Consumo di energia di pompe e ventilatori			
LT [kWh]:	0	0	0
MT [kWh]:	335.190	215.938	215.206
Totale [kWh]:	335.190	215.938	215.206
Consumo di energia del compressore			
LT [kWh]:	943.423	849.868	849.868
MT [kWh]:	1.778.087	1.614.632	1.331.260
Parallel [kWh]:	0	0	230.656
Totale [kWh]:	2.721.510	2.464.500	2.411.783
Consumo totale di energia			
LT [kWh]:	943.423	849.868	849.868
MT [kWh]:	2.113.278	1.830.570	1.777.121
Totale [kWh]:	3.056.700	2.680.438	2.626.989
Risparmi			
Risparmi di energia annui [kWh]:	-	376.262	429.712
Risparmi di energia annui [%]:	-	12,3	14,1



- **SYSTEM A: NH₃**
- **SYSTEM B: CO₂ FGB**
- **SYSTEM C: CO₂ PC**

● YEARLY ENERGY & COST COMPARISON: BERLIN

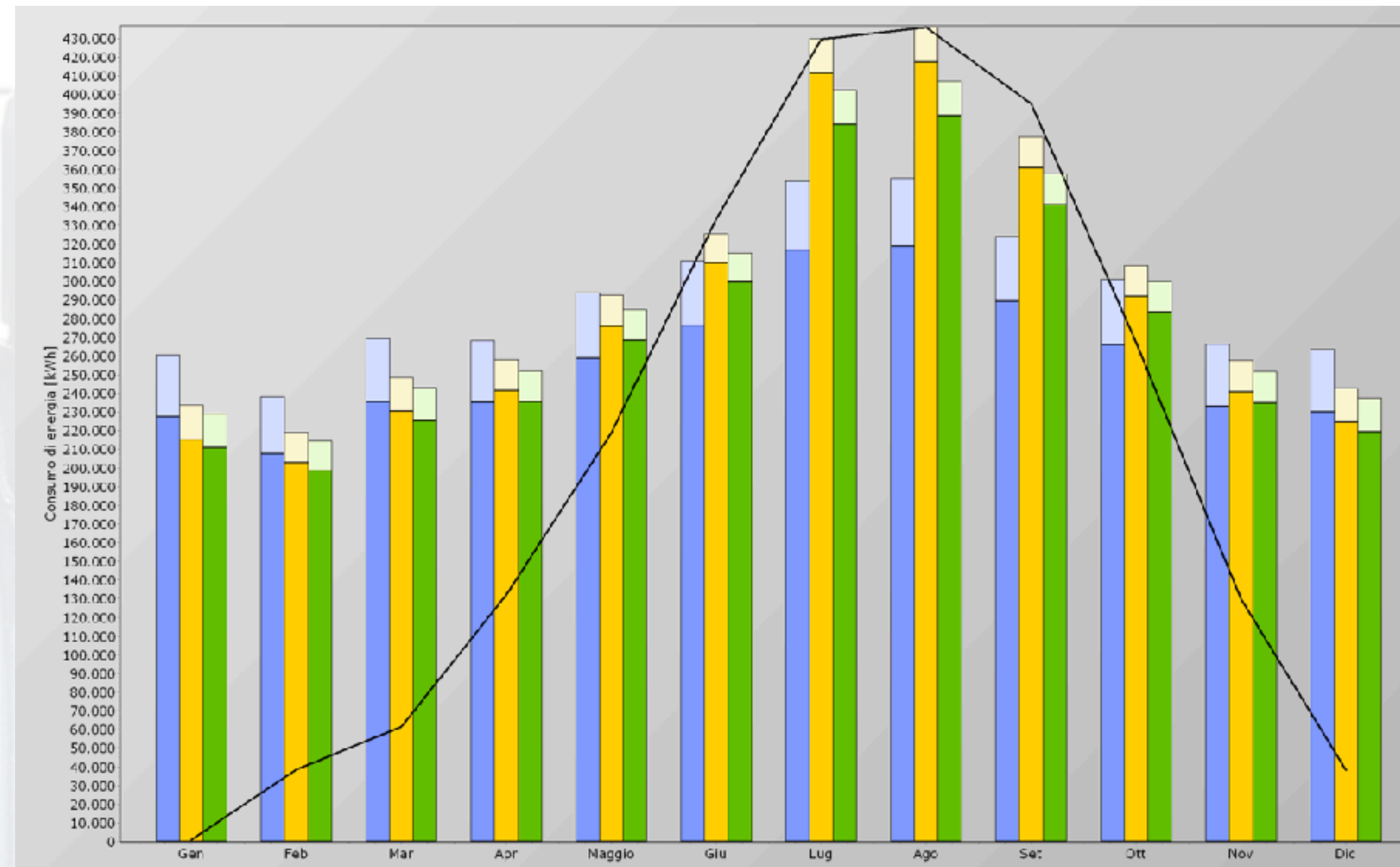
	NH3	CO2 FGP	CO2 PC
Soddisfacimento del carico in % del tempo			
LT:	100,0	100,0	100,0
MT:	100,0	100,0	100,0
Totale:	100,0	100,0	100,0
Soddisfacimento del carico in % di energia			
LT:	100,0	100,0	100,0
MT:	100,0	100,0	100,0
Totale:	100,0	100,0	100,0
COP medio			
LT [-]:	4,50	4,99	4,99
MT [-]:	4,18	4,48	4,63
Totale [-]:	2,61	2,85	2,92
Consumo di energia di pompe e ventilatori			
LT [kWh]:	0	0	0
MT [kWh]:	369.249	212.635	211.791
Totale [kWh]:	369.249	212.635	211.791
Consumo di energia del compressore			
LT [kWh]:	946.283	852.445	852.445
MT [kWh]:	1.891.374	1.879.374	1.504.059
Parallel [kWh]:	0	0	306.643
Totale [kWh]:	2.837.658	2.731.819	2.663.147
Consumo totale di energia			
LT [kWh]:	946.283	852.445	852.445
MT [kWh]:	2.260.623	2.092.009	2.022.493
Totale [kWh]:	3.206.907	2.944.454	2.874.938
Risparmi			
Risparmi di energia annui [kWh]:	-	262.453	331.968
Risparmi di energia annui [%]:	-	8,2	10,4



- **SYSTEM A: NH₃**
- **SYSTEM B: CO₂ FGB**
- **SYSTEM C: CO₂ PC**

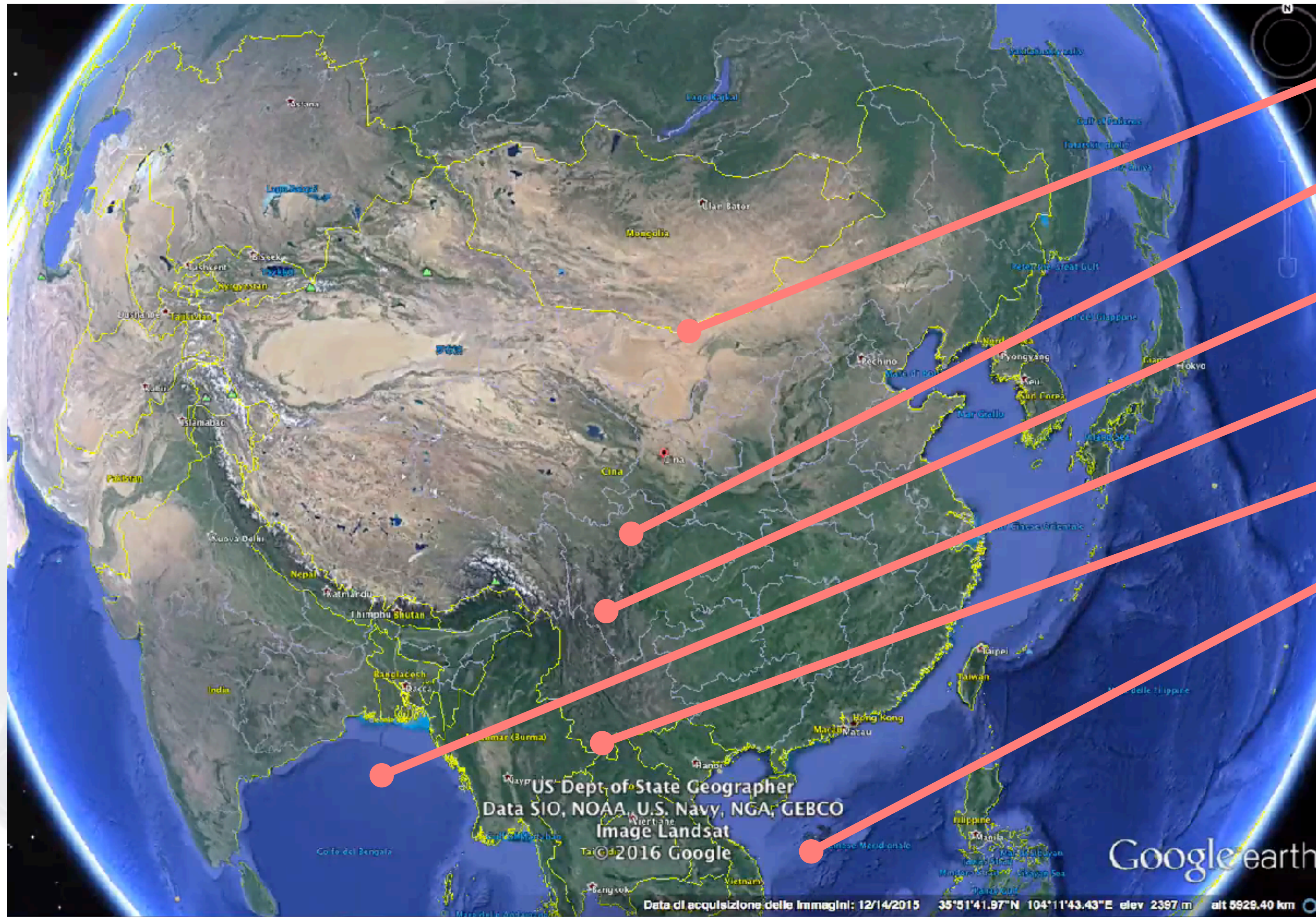
YEARLY ENERGY & COST COMPARISON: BARCELONA

	NH3	CO2 FGP	CO2 PC
Soddisfacimento del carico in % del tempo			
LT:	100,0	100,0	100,0
MT:	100,0	100,0	100,0
Totale:	100,0	100,0	100,0
Soddisfacimento del carico in % di energia			
LT:	100,0	100,0	100,0
MT:	100,0	100,0	100,0
Totale:	100,0	100,0	100,0
COP medio			
LT [-]:	4,50	4,99	4,99
MT [-]:	3,72	3,40	3,57
Totale [-]:	2,41	2,32	2,41
Consumo di energia di pompe e ventilatori			
LT [kWh]:	0	0	0
MT [kWh]:	410.792	206.663	205.713
Totale [kWh]:	410.792	206.663	205.713
Consumo di energia del compressore			
LT [kWh]:	951.563	857.201	857.201
MT [kWh]:	2.142.516	2.564.423	1.887.384
Parallel [kWh]:	0	0	544.167
Totale [kWh]:	3.094.079	3.421.623	3.288.752
Consumo totale di energia			
LT [kWh]:	951.563	857.201	857.201
MT [kWh]:	2.553.309	2.771.086	2.637.265
Totale [kWh]:	3.504.872	3.628.286	3.494.466
Risparmi			
Risparmi di energia annui [kWh]:	-	-123.415	10.406
Risparmi di energia annui [%]:	-	-3,5	0,3



- **SYSTEM A: NH₃**
- **SYSTEM B: CO₂ FGB**
- **SYSTEM C: CO₂ PC**

● YEARLY ENERGY & COST COMPARISON: EUROPE



● CO₂ (FGP: -22575 €)

● CO₂ (FGP: -15547 €)

● CO₂ (FGP: -15502 €)

● CO₂ (PC: -625 €)

● CO₂ (PC: -598 €)

● CO₂ (PC: -307 €)

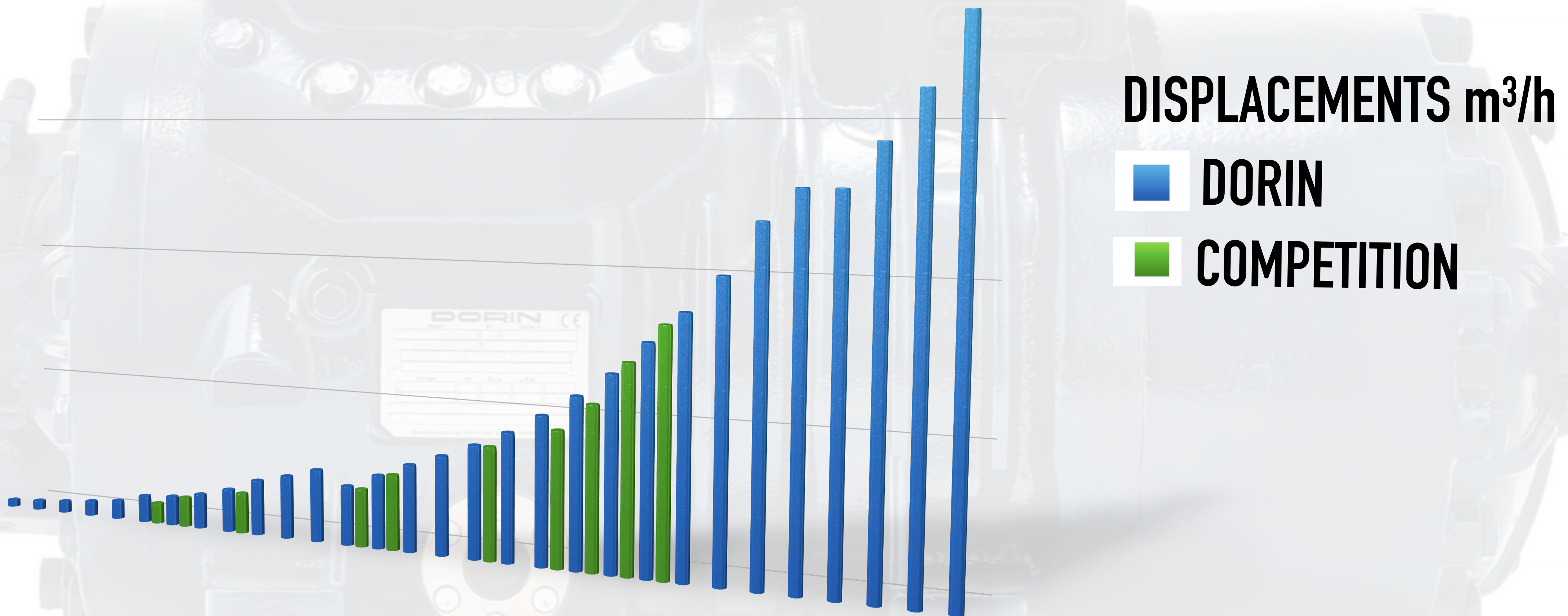
● YEARLY ENERGY & COST COMPARISON: EUROPE

	NH ₃	CO ₂ FGP	CO ₂ PC
STOCKHOLM - SWEDEN	REF	- 22575 €	- 25782 €
BERLIN - GERMANY	REF	- 15547 €	- 19918 €
MUNICH - GERMANY	REF	- 15502 €	- 19681 €
BARCELONA - SPAIN	REF	+ 4815 €	- 625 €
FLORENCE - ITALY	REF	+ 5108 €	- 598 €
ATHENS - GREECE	REF	+ 7819 €	- 307 €
- 0,06 € per kWh -			

- **TOTAL MT CAPACITY: 850 kW**

- **COMPETITION CO₂ COMPRESSORS**
- **(30–38) m³/h: 10–15 PIECES NEEDED**
- **N.2 RACKS – EXPENSIVE SOLUTION**

- **DORIN 6 CYL CO₂ RANGE – 60 m³/h**
- **6 PIECES ONLY ARE NEEDED**
- **N.1 RACK ONLY – SIMPLER SOLUTION**





RACK WITH DORIN 6 CYL. TRANSCRITICAL COMPRESSORS 60 m³/h EACH
courtesy PROFROID - GREEN & COOL

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 - **THE BEST ALTERNATIVE FOR ALMOST ALL THE APPLICATIONS**
- **INDUSTRIAL APPLICATIONS**
 - **CO₂ IS APPROACHING THIS FIELD AGAINST AMMONIA**
 - **CO₂ PROVIDES SOME TECHNICAL & SAFETY ADVANTAGES**
 - **CO₂ CAN ALSO PROVIDE COST SAVINGS**
 - **DORIN 6 CYLINDERS TRANSCRITICAL COMPRESSORS UP TO 60 m³/h ALLOW CO₂ TO APPROACH THE INDUSTRIAL MARKET IN AN EFFECTIVE WAY**



THANK YOU !!