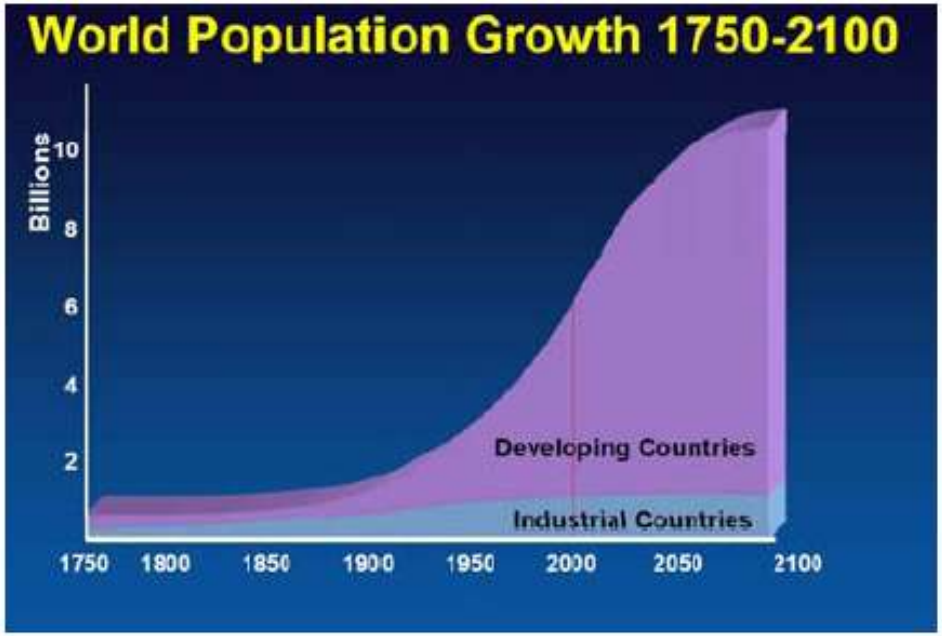
Energy savings in Air-conditioning equipment

Importance

Top Ten Issues for Next 50 Years

1. ENERGY
2. WATER
3. FOOD
4. ENVIRONMENT
5. POVERTY
6. WAR
7. DISEASE
8. EDUCATION
9. DEMOCRACY
10. POPULATION



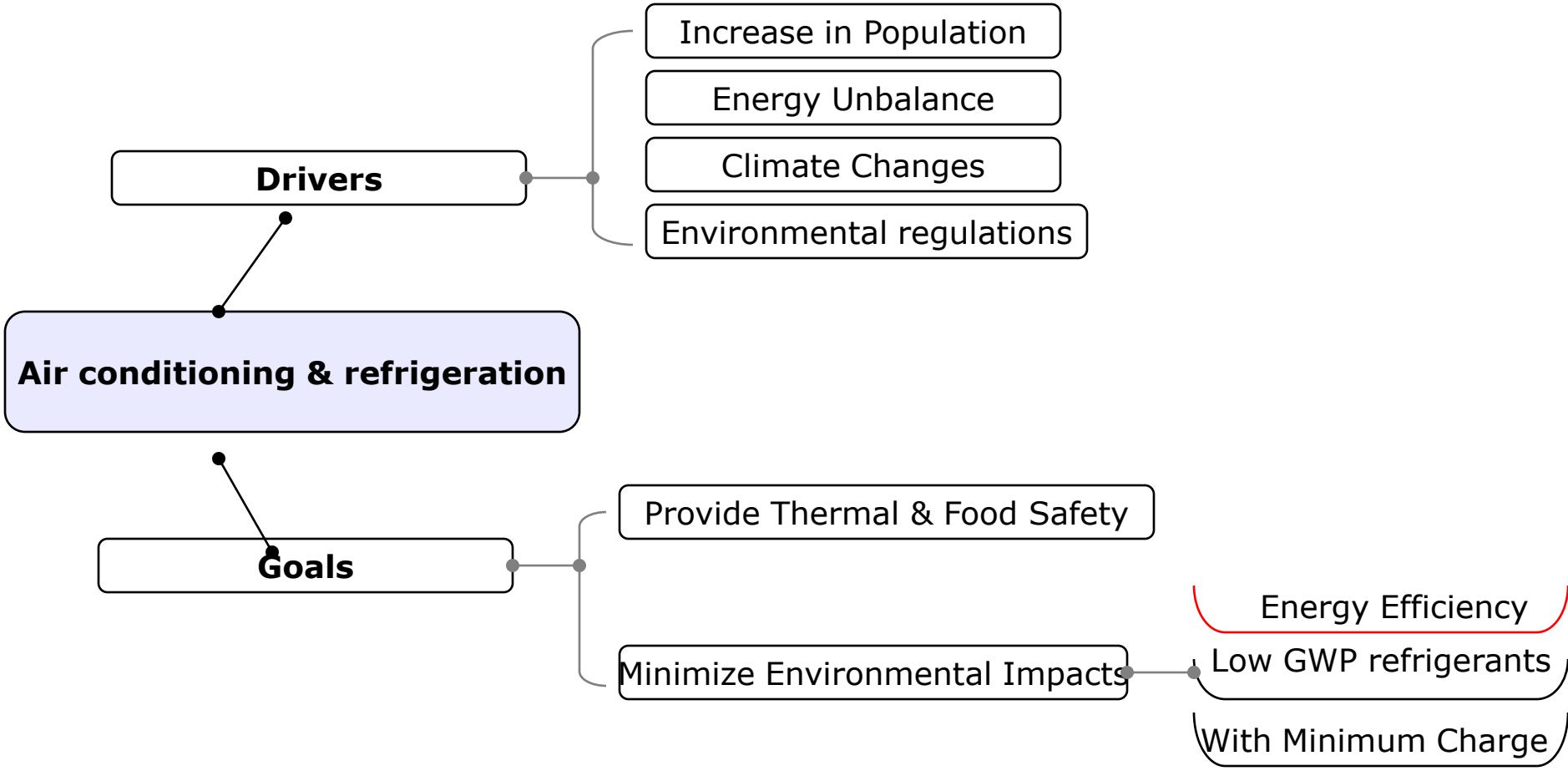
2003 6.5 Billion People
2050 8-10 Billion People

Source: UNEP

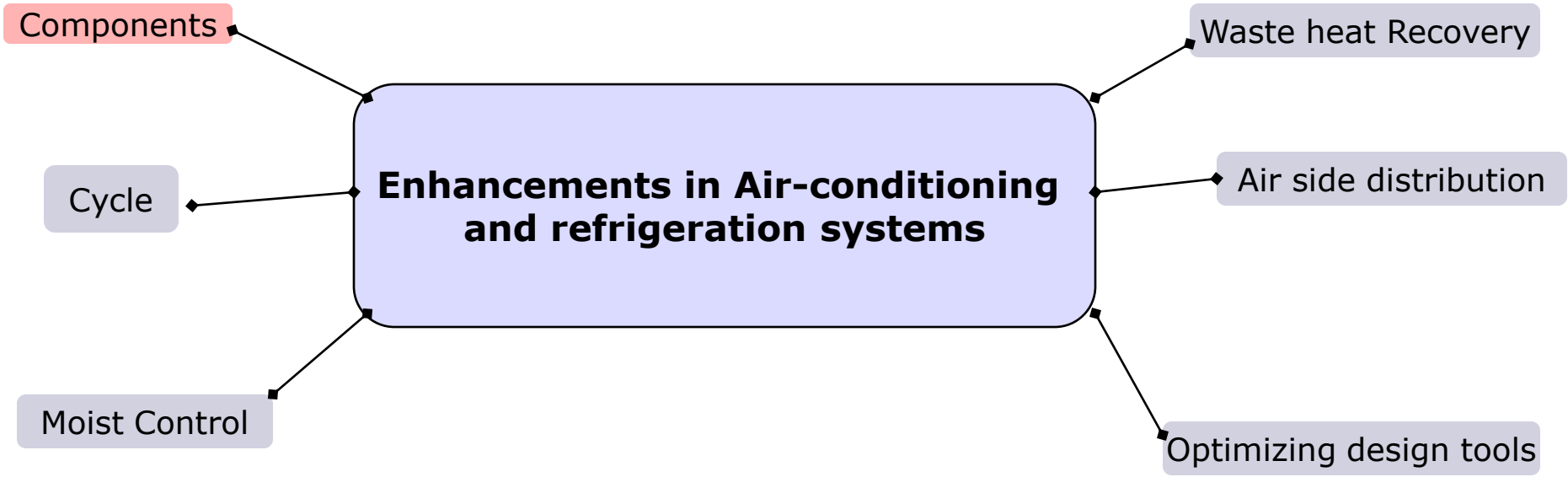
Introduction:

"An air conditioner is an appliance, system, or machine designed to stabilise the air temperature and humidity within an area (used for cooling as well as heating depending on the air properties at a given time), typically using a refrigeration cycle but sometimes using evaporation, commonly for comfort cooling in buildings and motor vehicles. "

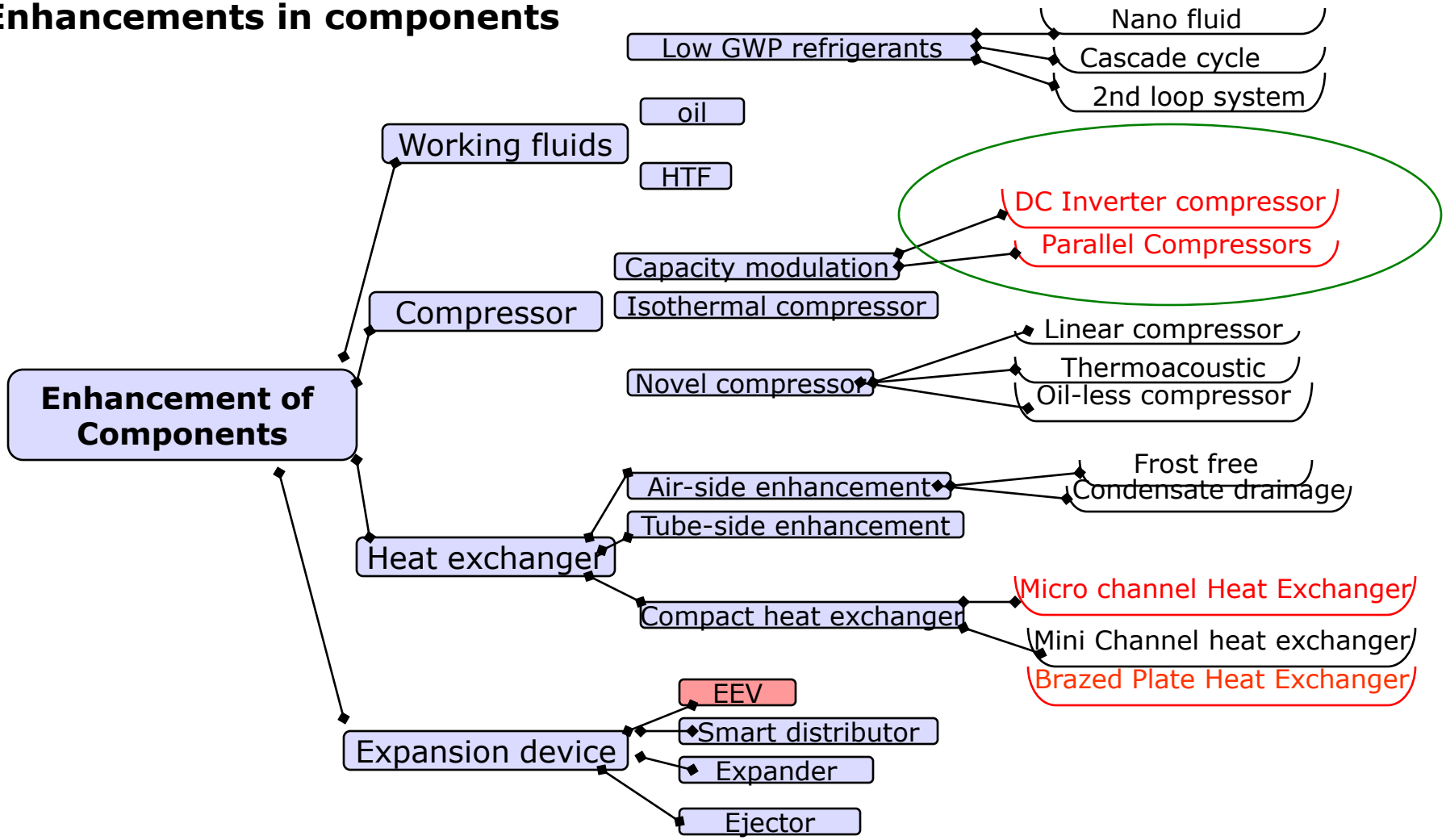
Drivers and goals of AC & R Industry



Enhancing Air conditioning systems



Enhancements in components



Scroll Compressor Technologies- Saving opportunities

- **Individual Circuit Fixed Speed**

- Selection of low power crank case heater which is often neglected

- **Parallel Fixed speed (Tandem/trio/quadro)**

-Optimising compressor ON/OFF system - By increasing the number of compressors in parallel.

- **Intermittent gas compression**

-External hot gas by pass

-Internal hot gas by pass

-Modulation of capacity by intermittent compression

- **Variable speed permanent magnet**

-Matching the capacity by variable speed of compressor

Case Study: Comparison of Scroll Technologies

Water chillers with R410A and by air condensation. They are equipped with scroll technology compressors

Compressor	Capacity En12900 / HBP	Main Architecture Capacity Variation
15 TON	39.1 kW	1 circuit / 1 FS (ON/OFF)
2 X 7.5 TON	39.7 kW	2 circuits / 1 FS per circuit (ON/OFF)
DUO 7.5 TON	39.7 kW	1 circuit / 2 FS in parallel (ON/OFF)
VSH 10 TON	48.6 kW	1 circuit / 1 VS (Variable speed)
15 TON intermittent	39.1 kW	1 circuit / 1 IC (Intermittent compression)
VSH 10 TON PM Reduced built-in pressure ratio	49.2 kW	1 circuit / 1 VS PM motor and reduced compression rate (Variable Speed)

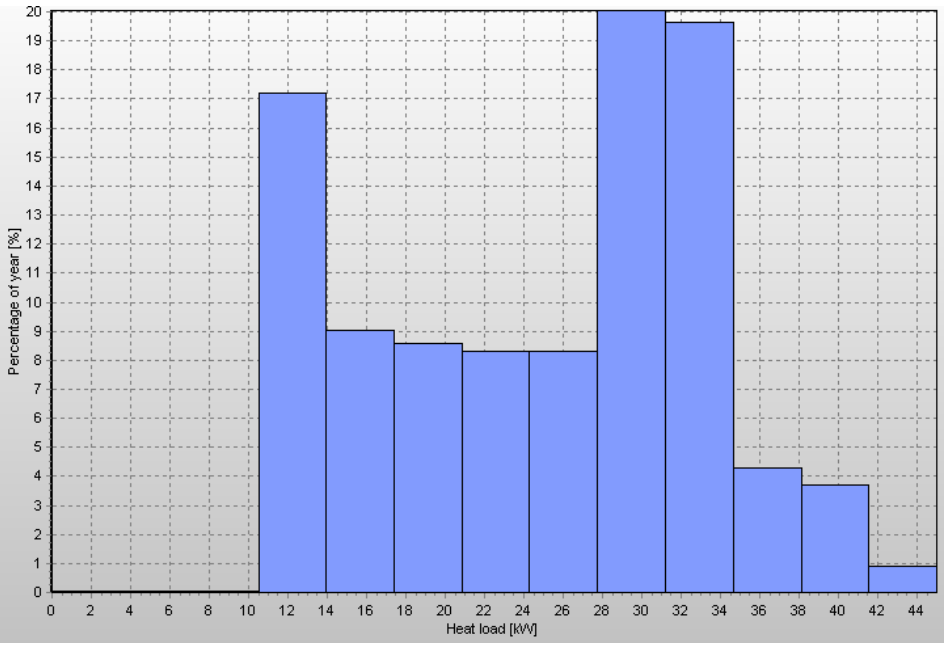
FS: fixed speed compressor

VS: variable speed compressor
PM: permanent magnet motor

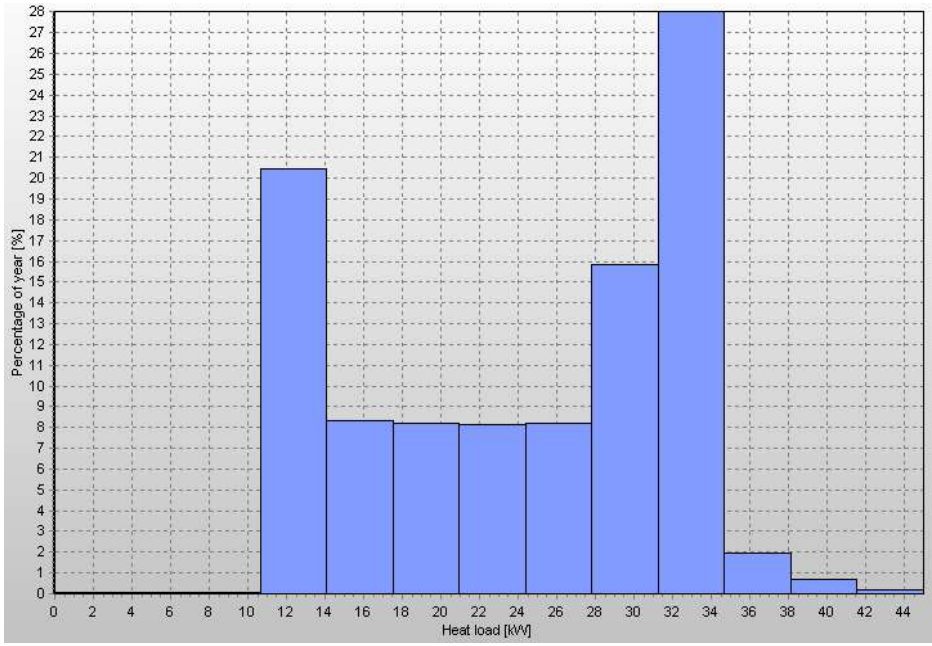
IC: intermittent compression

Case Study: Climate conditions

The 6 configurations of water chillers are compared in the context of their use under two very different French climates which seek to demonstrate the impact of the local climate on the choice of compression technology when it comes to optimising seasonal performance.



Thermal load in Marseilles



Thermal load in Nancy

The hottest climate chosen is that of Marseilles and the coldest is that of Nancy.

Case Study: Results

	15 TON (Reference)		2 X 7.5 TON		DUO 7.5 TON		10 TON VSH		15 TON Intermittent		10TON VSH PM, PR ↓	
	Mars	Nanc	Mars	Nanc	Mars	Nanc	Mars	Nanc	Mars	Nanc	Mars	Nanc
Annual energy savings [kWh]	0	0	839	761	-1379	-1505	-75	-370	2254	2437	-10751	-10310
Annual gains [%]	0,0	0,0	-1.7	-1.7	2.8	3.4	0.2	0.8	-4.6	-5.5	22.1	23.2
Annual COP	4.48	4.78	4.41	4.70	4.61	4.95	4.49	4.82	4.28	4.53	5.75	6.22

- Influence of the climate: The system in Nancy have on average electricity consumption level 10% lower than Marseilles. This difference arises irrespective of the compressor technology used. This effect is mainly linked to the lower average condensing temperature in a cold climate.
- The intermittent compression technology does not reach the seasonal performances of the ON/OFF capacity variation. The main reason is that the performance level of the compressor falls when internal leakages occur.
- A 5% difference in performance between a 2 circuit machine (each one equipped with a 7.5 TON compressor) compared with a single-circuit system integrating the same 2 compressors in parallel.
- The case of the variable speed compressor with a reduced built-in pressure ratio and PM motor is significant of the gain contributed by the adaptation of the design of the compressor to the need.

Conclusion

In the future, thermodynamic systems must be designed to ensure that the production of heat or warmth is adapted to fluctuating requirements throughout the year.

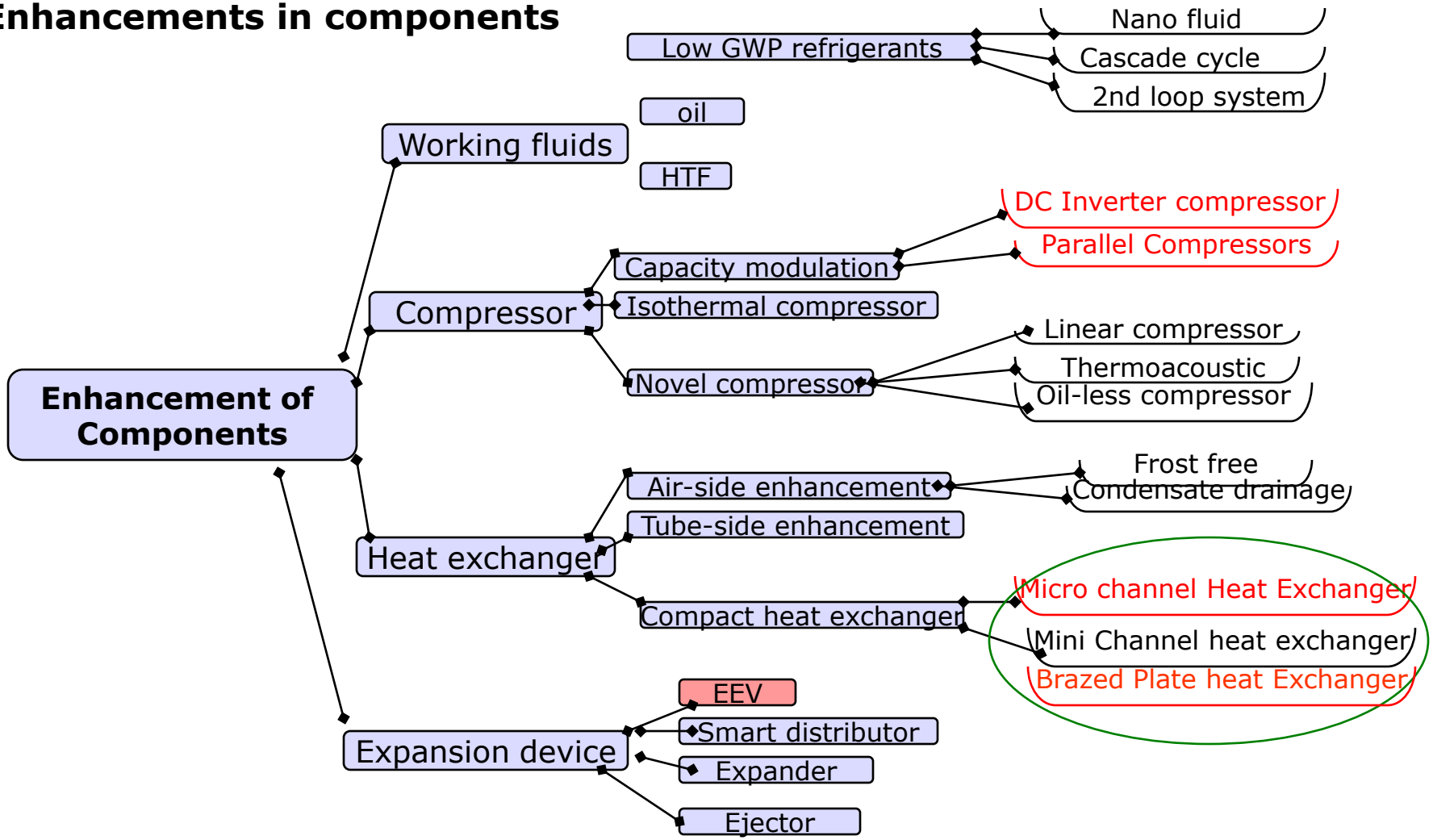
The example dealt with in this article clearly shows that the choice of compression technology is of capital importance and that its influence on the annual COP can reach more than 50%.

ECBC Guidelines:

Air cooled chiller - Minimum COP- 2.9

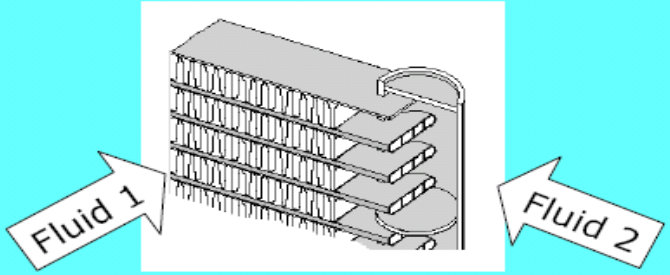
With Variable speed PM technology Annual COP -6.22

Enhancements in components



Microchannel heat exchangers

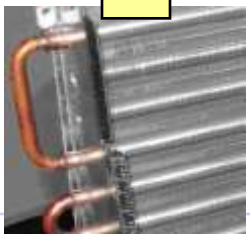
Micro channel as technology is not new this is a proven technology since 1980 in automotive air conditioning. The same technology is modified to residential and commercial air conditioning systems.

Compact	Heat Transfer Surface Area Density Greater than **700 m^2 / m^3**
Cross-Flow	
Micro-Channel	 Dh < 2 mm

Case study results

Here is snapshot of Advantages of using micro channel heat exchanger over Fin & Tube, which was the outcome of case study we conducted on 5TR ductable split unit's condenser with an OEM in India

Performance Advantages	• Contributes to higher EER (8%) • Less maintenance
Manufacturing Advantages	• Space saving coil depth (66%) •Reduced coil weight / easier handling (60%)
System Advantages	•Reduced refrigerant charge(30%) •Smaller packaging(8.7%) •Better corrosion resistance
Environmental Advantages	• Reduce transport cost •100% recyclable • Less refrigerant in system



Brazed Plate heat Exchangers

Features

- Compact size
- Superior efficiency
- High LMTD
- Less amount of refrigerant and water
- Cost effective
- Maximum heat transfer

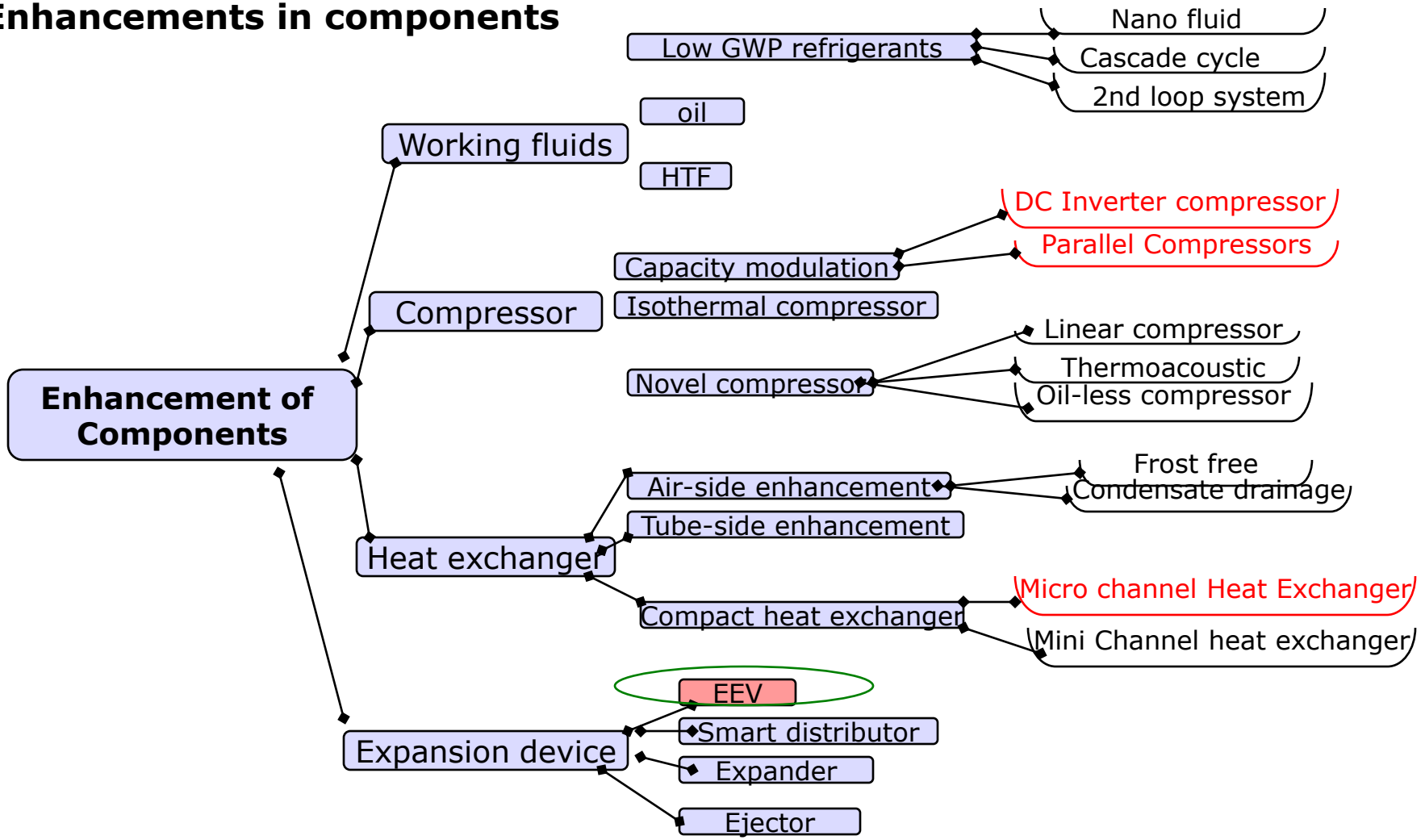
Applications

- Evaporator
- Condenser
- Heat recovery
- Economizer
- De super heater

Case study – Using PHE in heat recovery from AC unit (Restaurant application

Refrigeration capacity of the unit installed= Ductable split unit with R22 Scroll compressor	8.3TR(29.2KW)
Temperature In/out of refrigerant = Temperature In/out of water =	115/60C 30/63 C
Total capital cost of retrofit installation =Rs. 80,000 (Include SS tank, Insulation, piping,installation etc)	
Hot water usage Fuel saving LPG Savings in LPG cost @42perKg	1000 lpd 4.69Kg/day Rs 200/day
Savings in Electric cost (condenser fan load reduction, Improved efficiency in refrigeration cycle)	Rs. 200/day
Savings in operating cost Annual Savings (360day) Payback period (Simple analysis)	Rs. 400/day Rs.1.44L ~6months

Enhancements in components



Electronic expansion valve

"As many things move from Mechanical to electronic way, Expansion device is no exception"

- Ensures better control of refrigerant based on load requirement
- **Improves efficiency of system upto 10%**

Suggestions on current standards:

5.2.2 Minimum equipment efficiency:

Terms used for ratings like COP and IPLV are more constant. In real situations outside temperature and loads are changing. Hence we need an approach which takes of actual variations in the lines of SEER approach.

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