POLITECNICO DI MILANO

Solar cooling systems utilizing concentrating solar collectors - An overview

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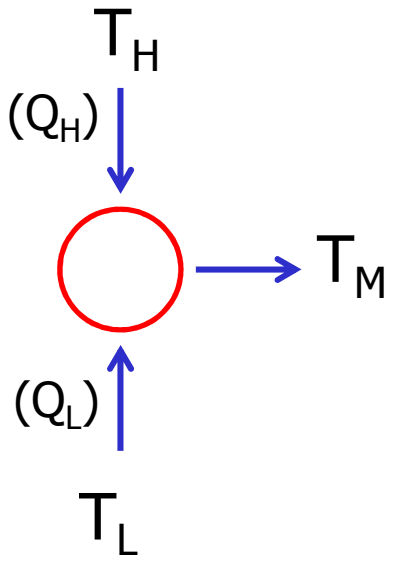
Structure

- Concept
- Practical benefits
- Common design issues
- Recent installations:
  - Examples
  - Classification
- Electrical SEER
- Conclusion

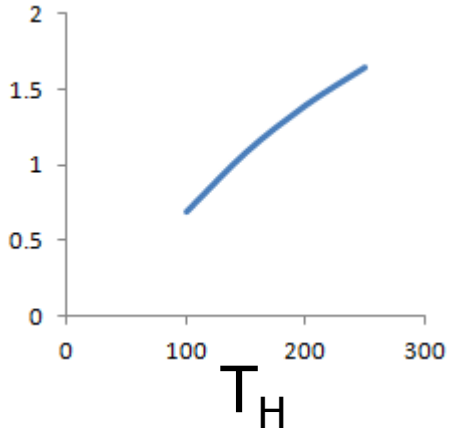
Concept

- Increasing driving temperatures (T_H) can lead to
  - Higher thermal COPs (Q_L/Q_H)
  - Higher temperature lifts (refrigeration)
  - Higher irreversibilities

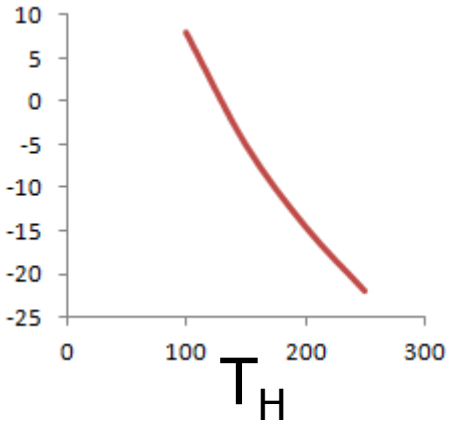


$$COP = f_{Carnot} \frac{T_L}{T_H} \frac{T_H - T_M}{T_M - T_L}$$

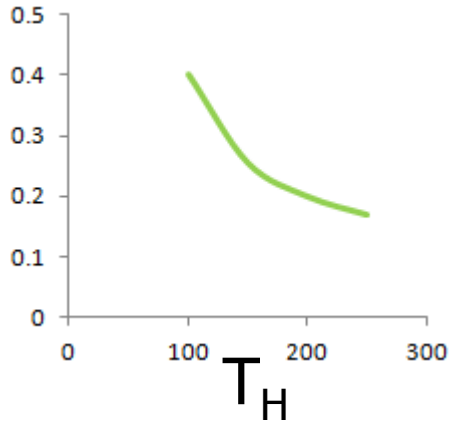
COP



T_L



f_{Carnot}

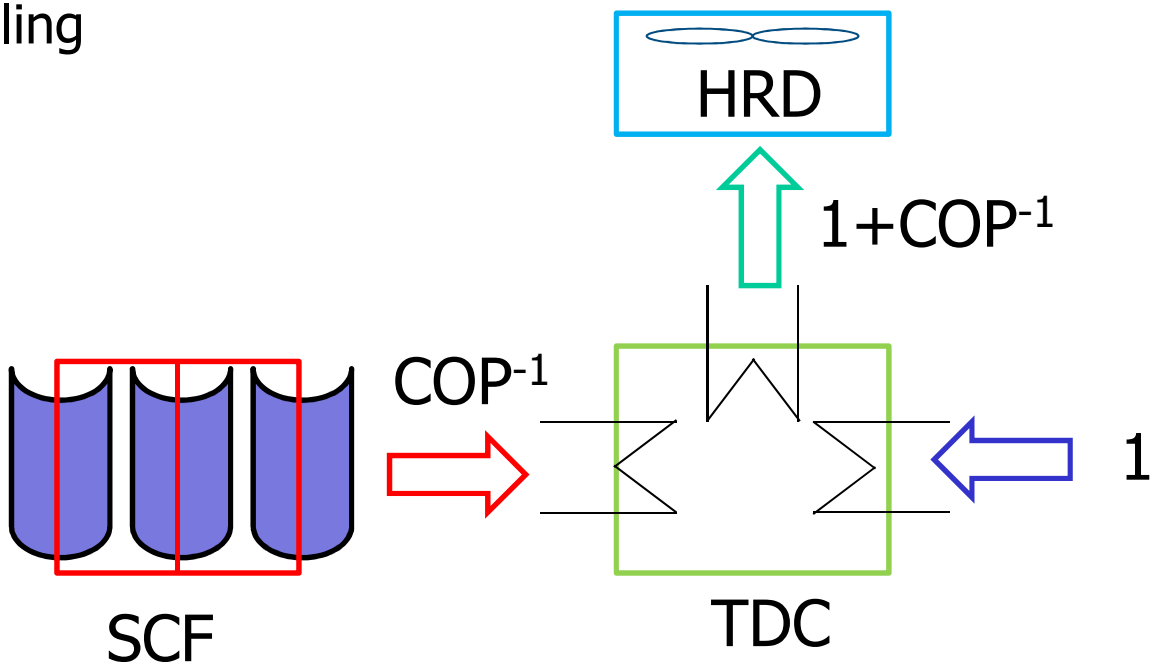


Practical benefits

- Higher COP ➔ Less heat input at generator
  - Less collector area per unit of cooling (kW)
  - Smaller HRD, less parasitic energy
- Decrease in T_L ➔ refrigeration with high temperature lifts
- Decrease in f_{Carnot} ➔ lower parasitic energy in heat rejection, dry cooling

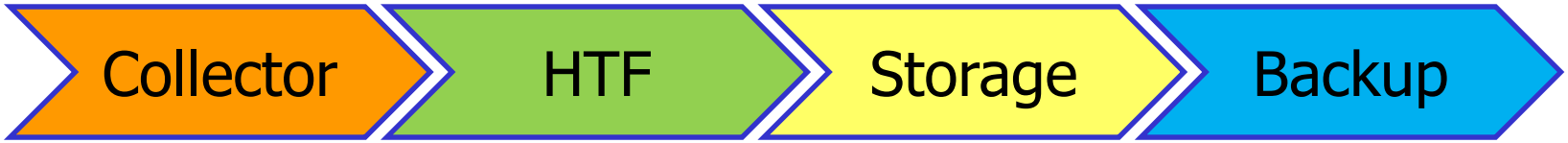
DE
LiBr H20
wet cooled

SE GAX
H20 NH3
dry cooled



Common design issues

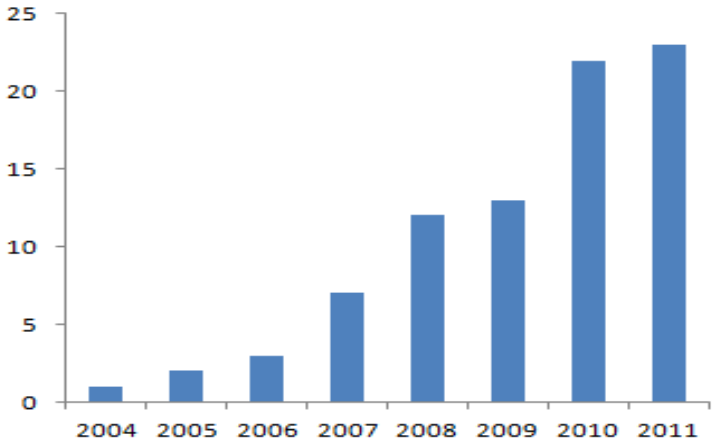
- Common design issues (besides the selection of a suitable chiller type)
  - Concentrating collectors
  - Heat transfer fluid (HTF)
  - Heat storage Vs direct coupling
  - Hot Vs Cold backup



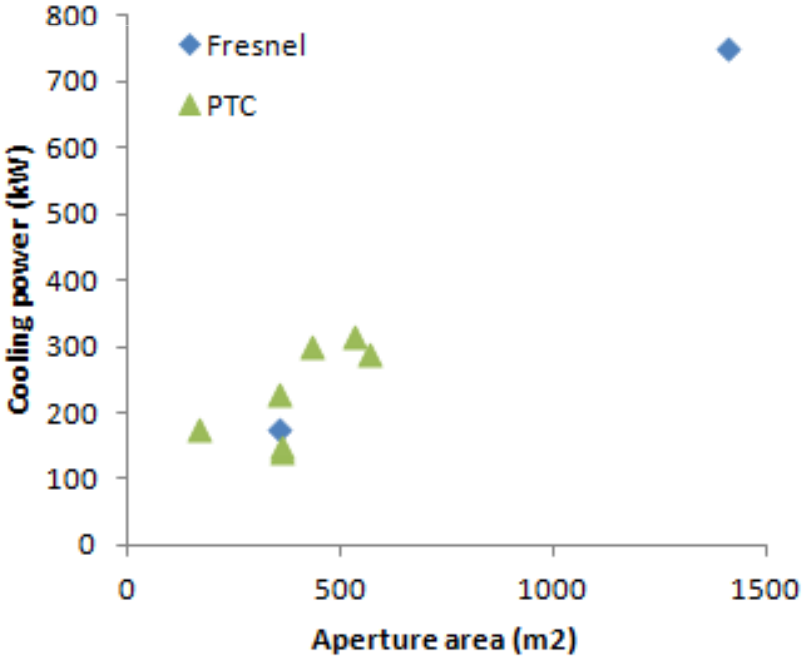
Collector	HTF	Storage	Backup
stationary or sun tracking reflectors (PTC, Fresnel)	water steam oil	pressurized or atmospheric tank or direct coupling cold storage	Hot or cold backup

Recent installations

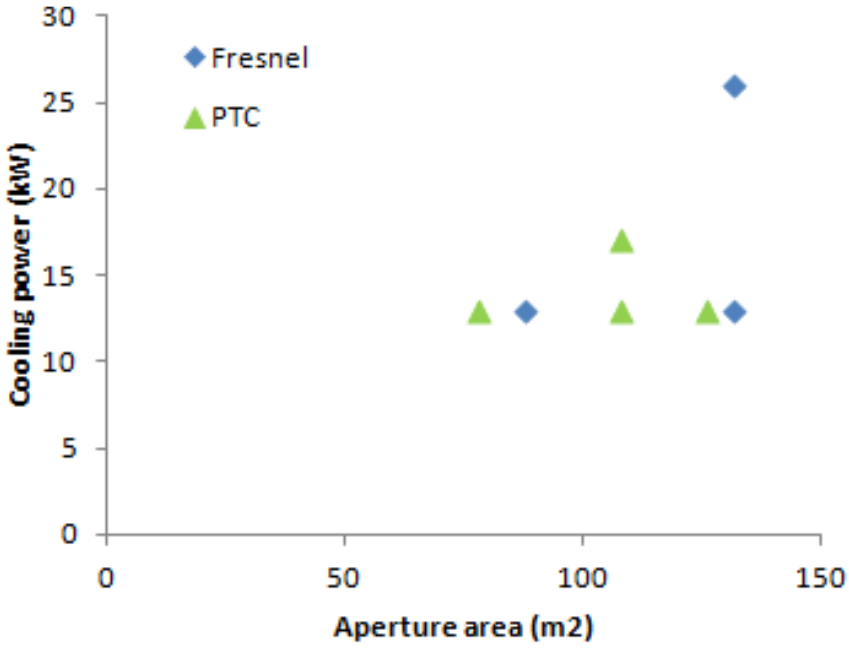
- First demonstration in 1878
- Prototypes: 1950 ÷ 1990
- New growth starting with 2004…



DE LiBr water

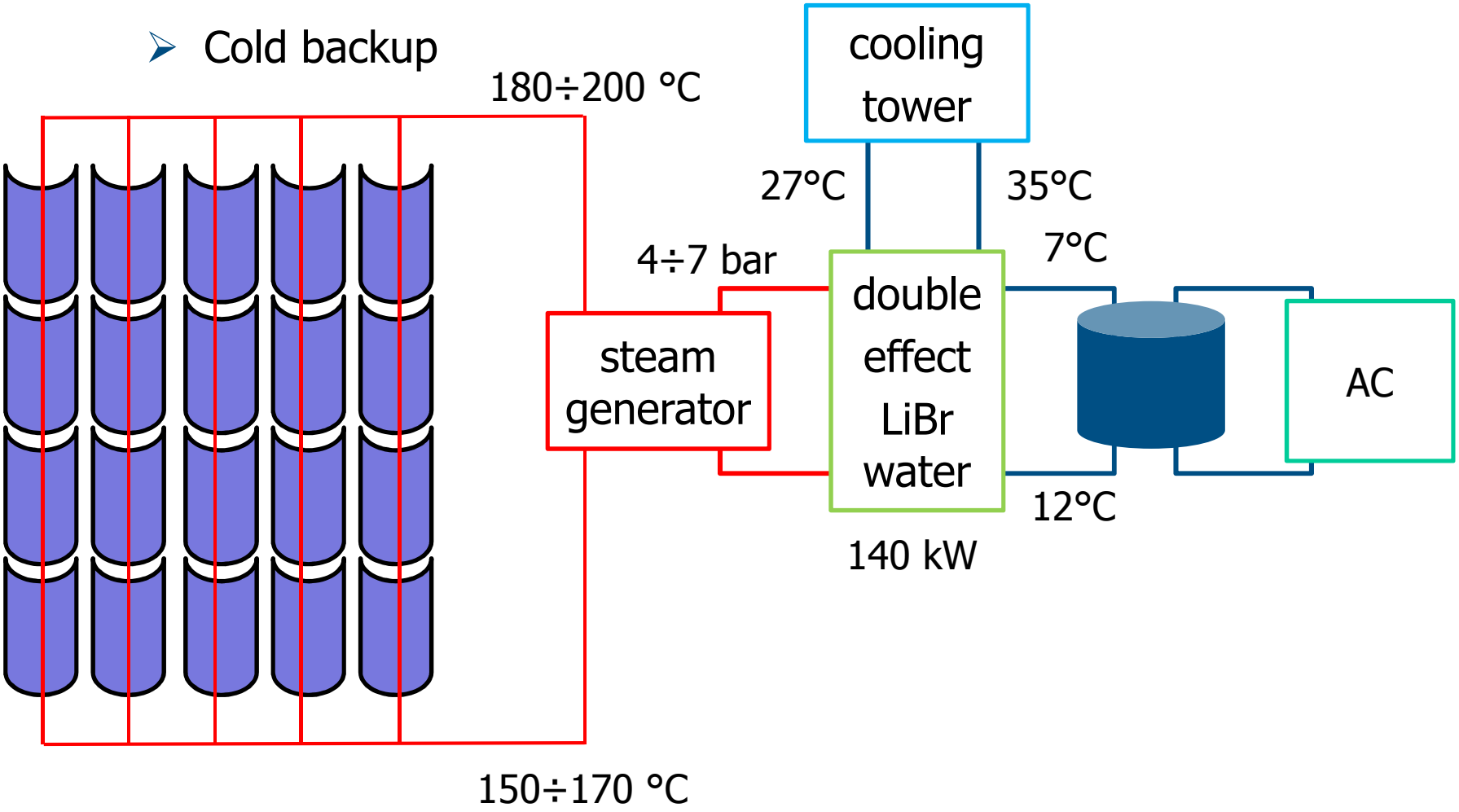


SE water ammonia



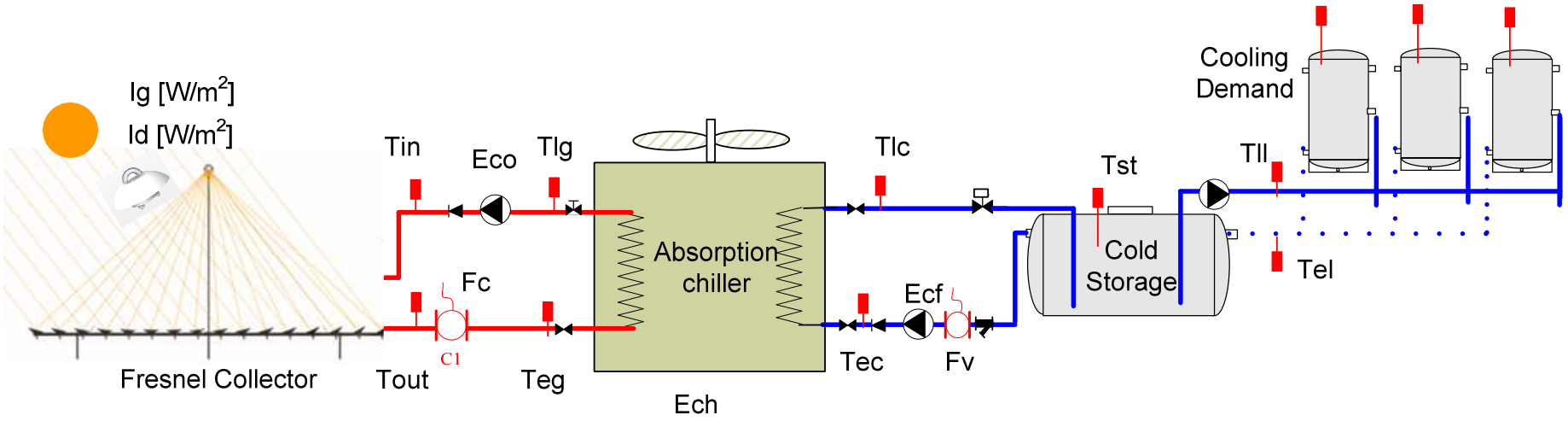
Recent installations

- Solar air conditioning (Dalman / Turkey - Hotel)
  - PTC collectors 360 m2
  - Cold backup



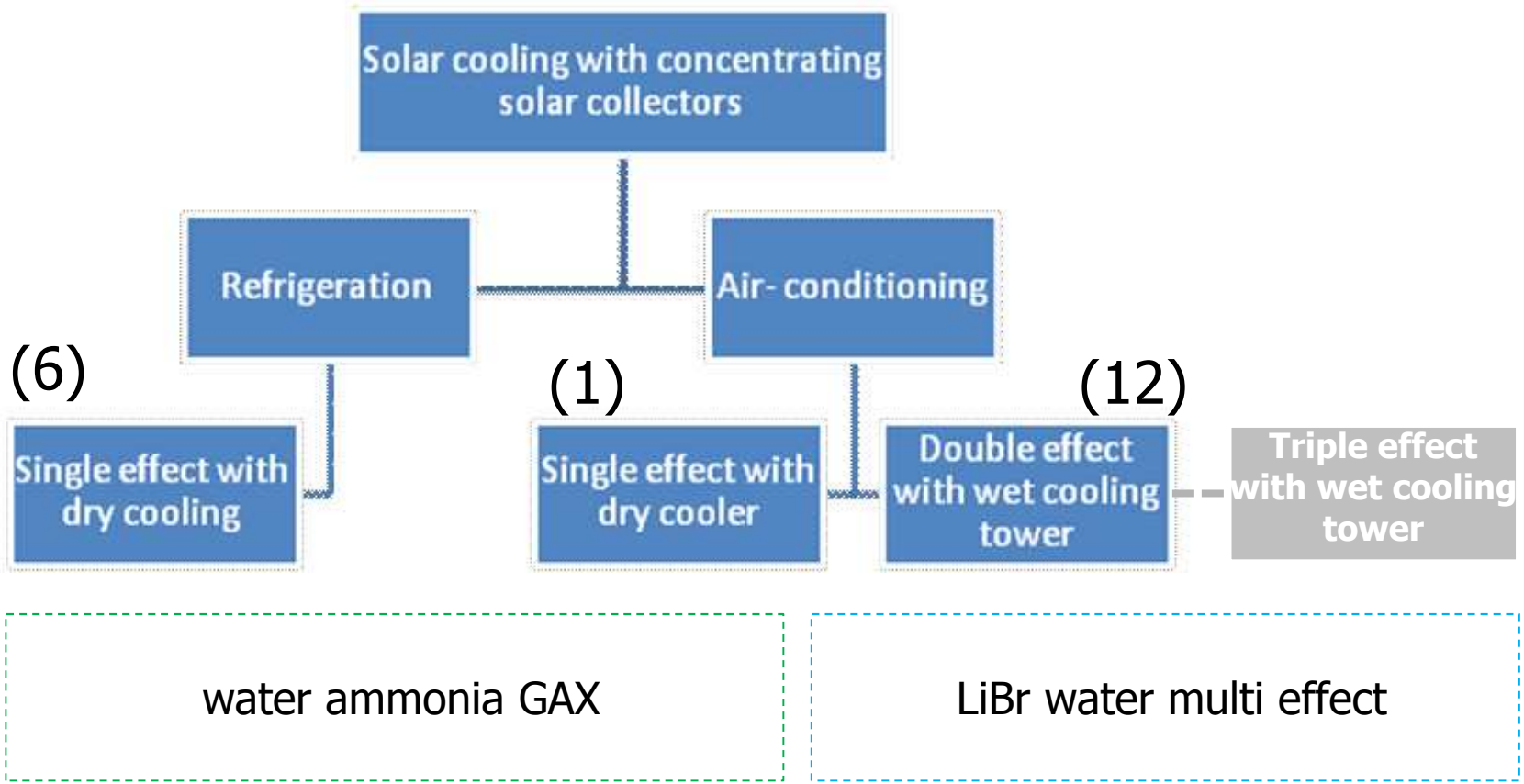
Recent installations

- Solar industrial refrigeration (Grombalia / Tunisia - Winery)
  - Fresnel collector 88 m2
  - Driving temperature range: 180 ÷ 160 °C (press. water)
  - Brine temperature range: -10 ÷ -5 °C
  - Air cooled water ammonia GAX chiller (12 kW) + Cold backup



Recent installations

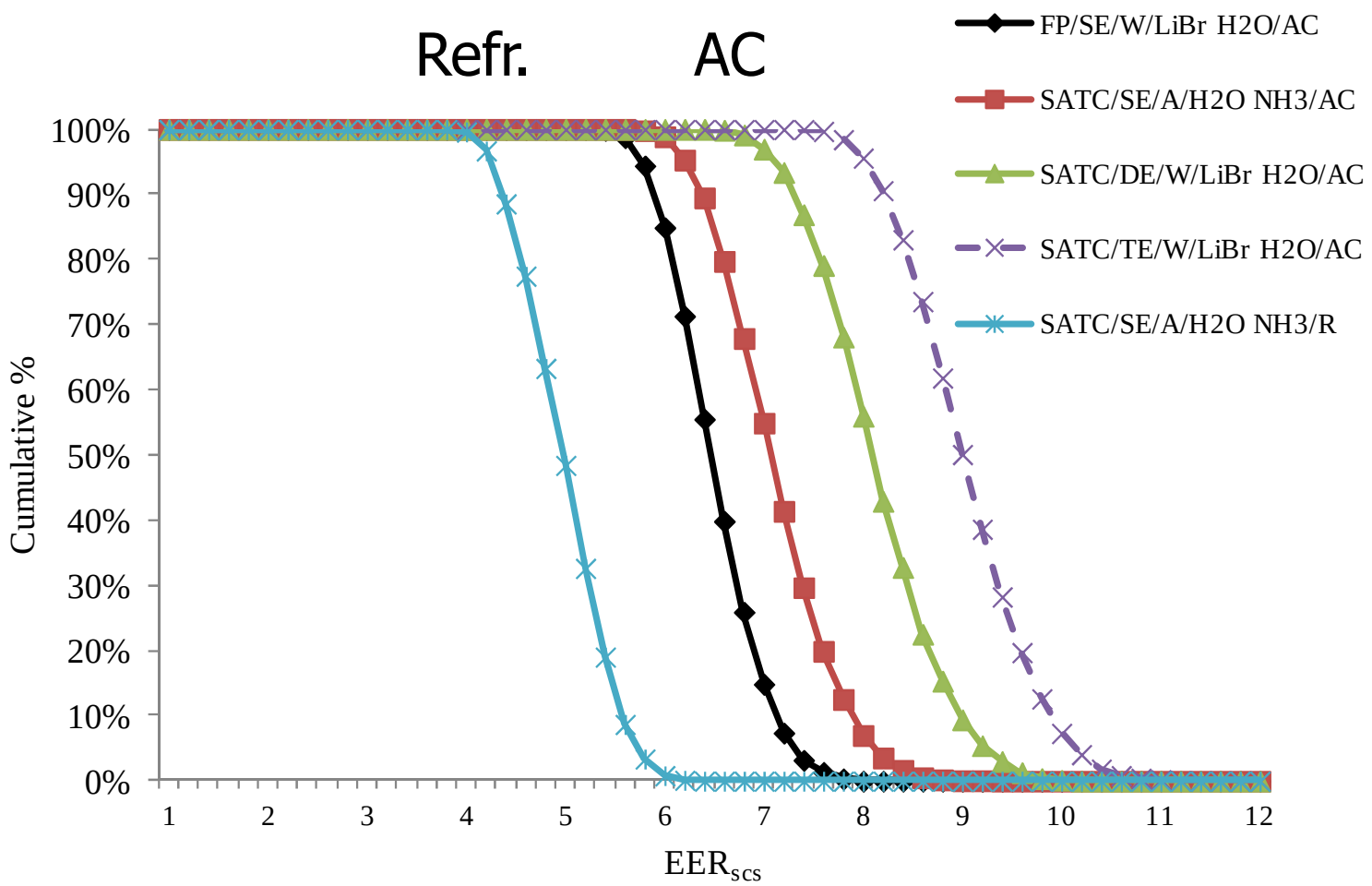
- Classification (based on existing installations)



- Heat transfer fluid: pressurized water in nearly all plants

Electrical SEER

- Expected SEER (theoretical, assuming correct design and control)



Conclusion

- Practical benefits deriving from higher driving temperatures in TDC applications: lower collector area, lower parasitic consumption, refrigeration with high temperature lift, dry instead of wet cooling
- Increasing number of installations using medium temperature collectors, both PTC and Fresnel, growing since 2004
- The concept has been effectively applied: SE dry cooled for AC or R, DE wet cooled for AC only
- Limited choice of market available chillers suitable for the considered applications
- Potentially attractive SEER in all applications, assuming correct design and control

Thank you for your attention !