

Dispensa del corso di “SISTEMI ENERGETICI”

Argomento: Sistemi Energetici (parte 3.3)

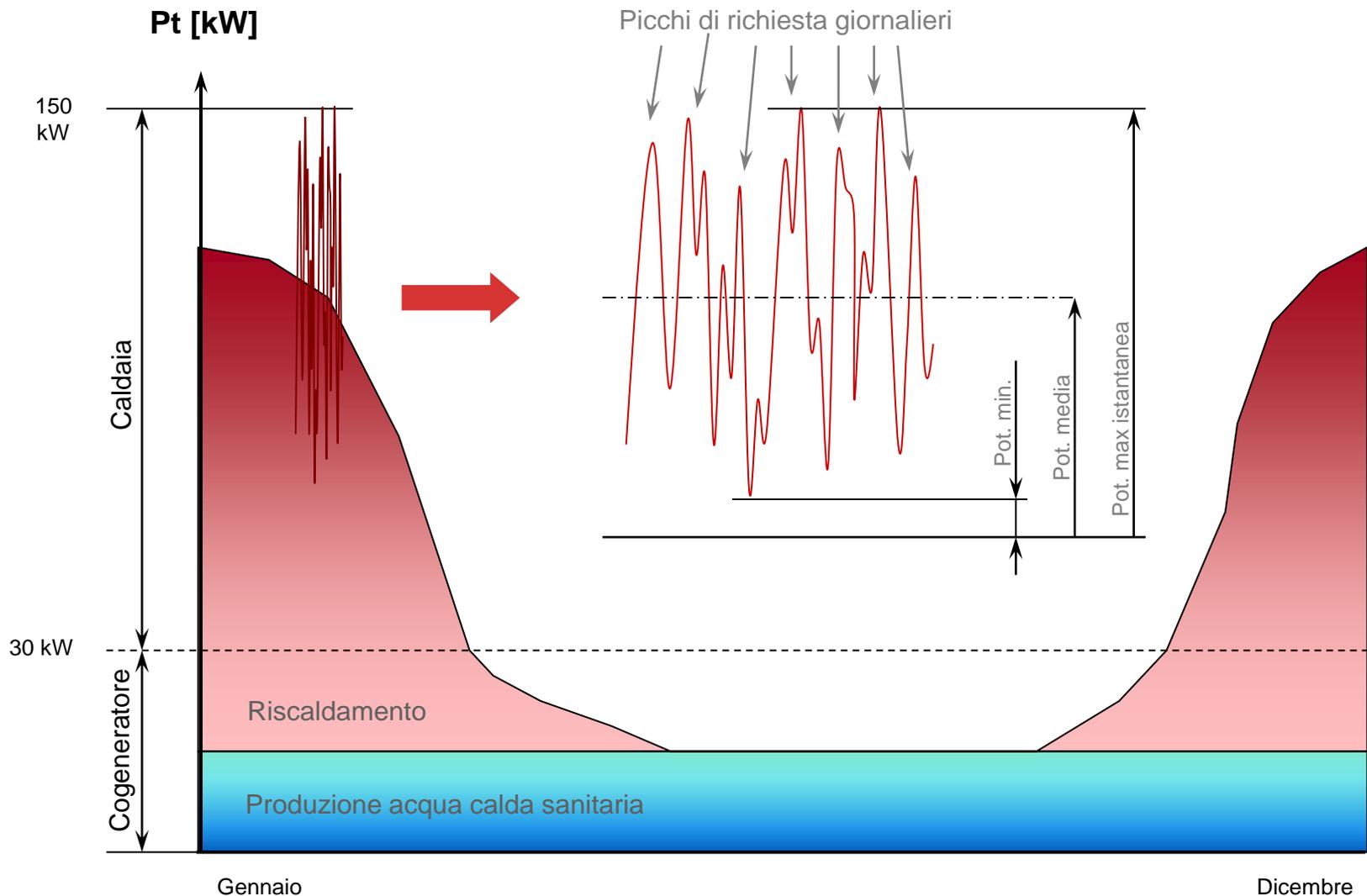
Prof. Pier Ruggero Spina
Dipartimento di Ingegneria



università di ferrara
DA SEICENTO ANNI GUARDIAMO AVANTI.

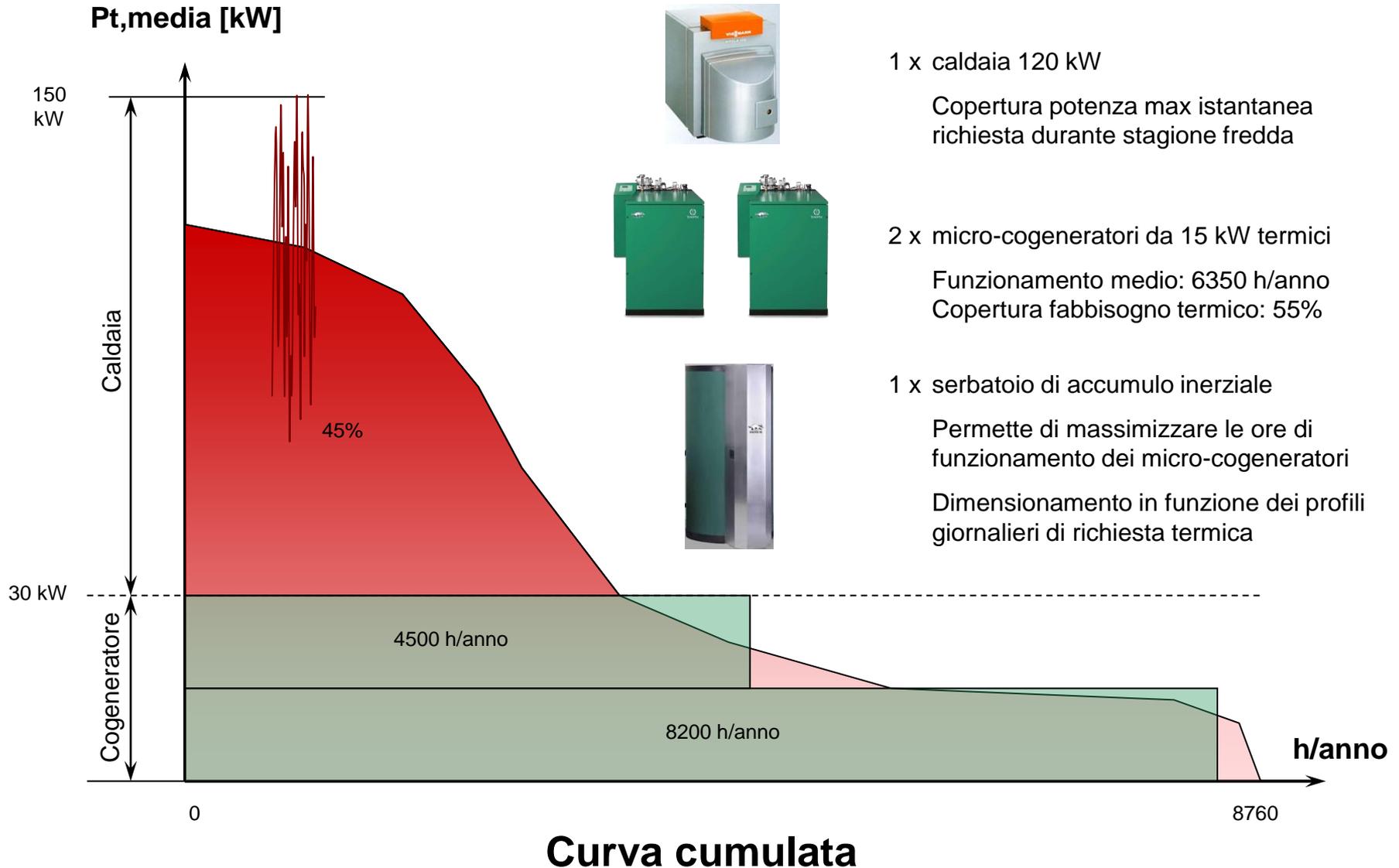
La trigenerazione: motivazioni e tecnologie

Il fabbisogno termico

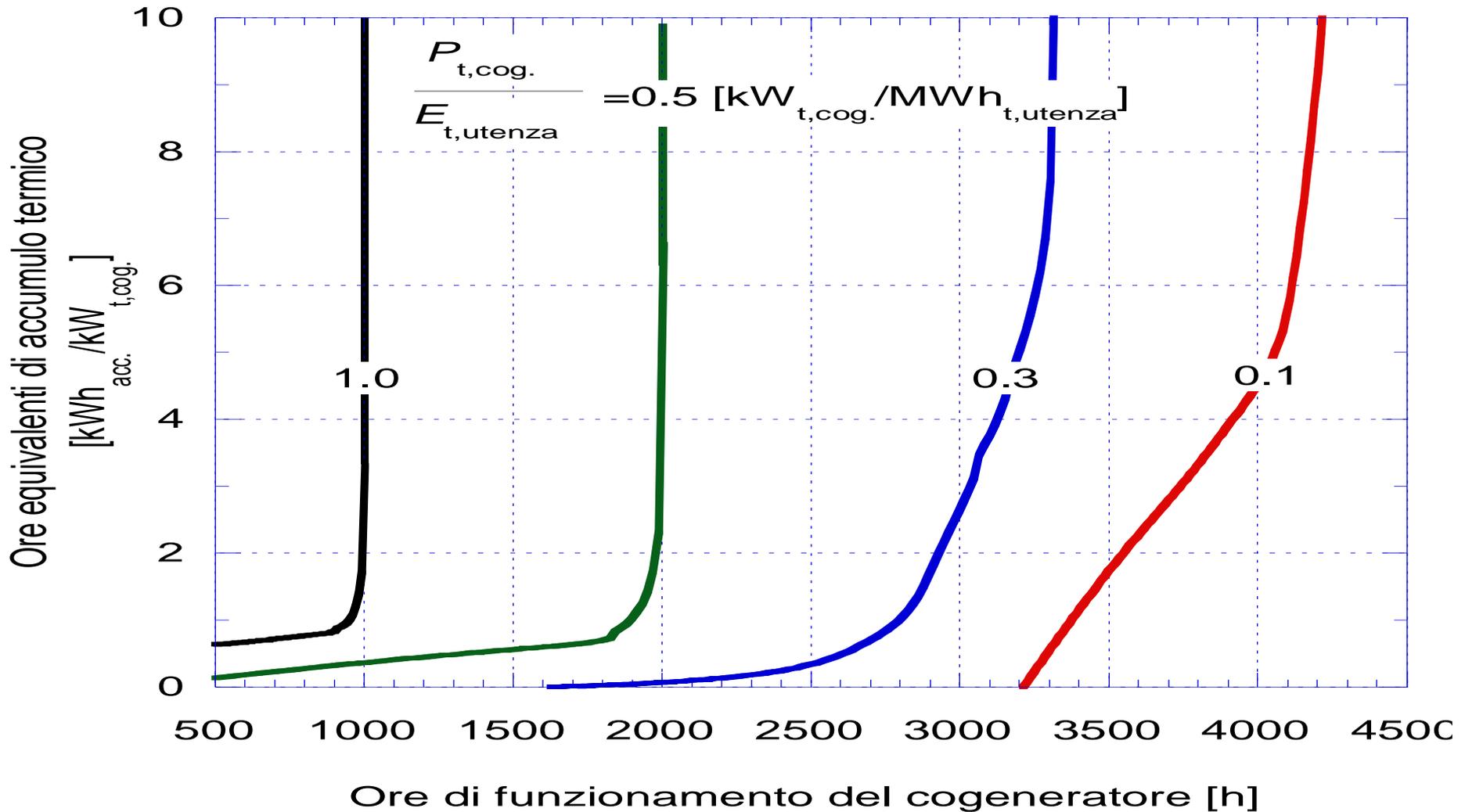


Potenza termica richiesta

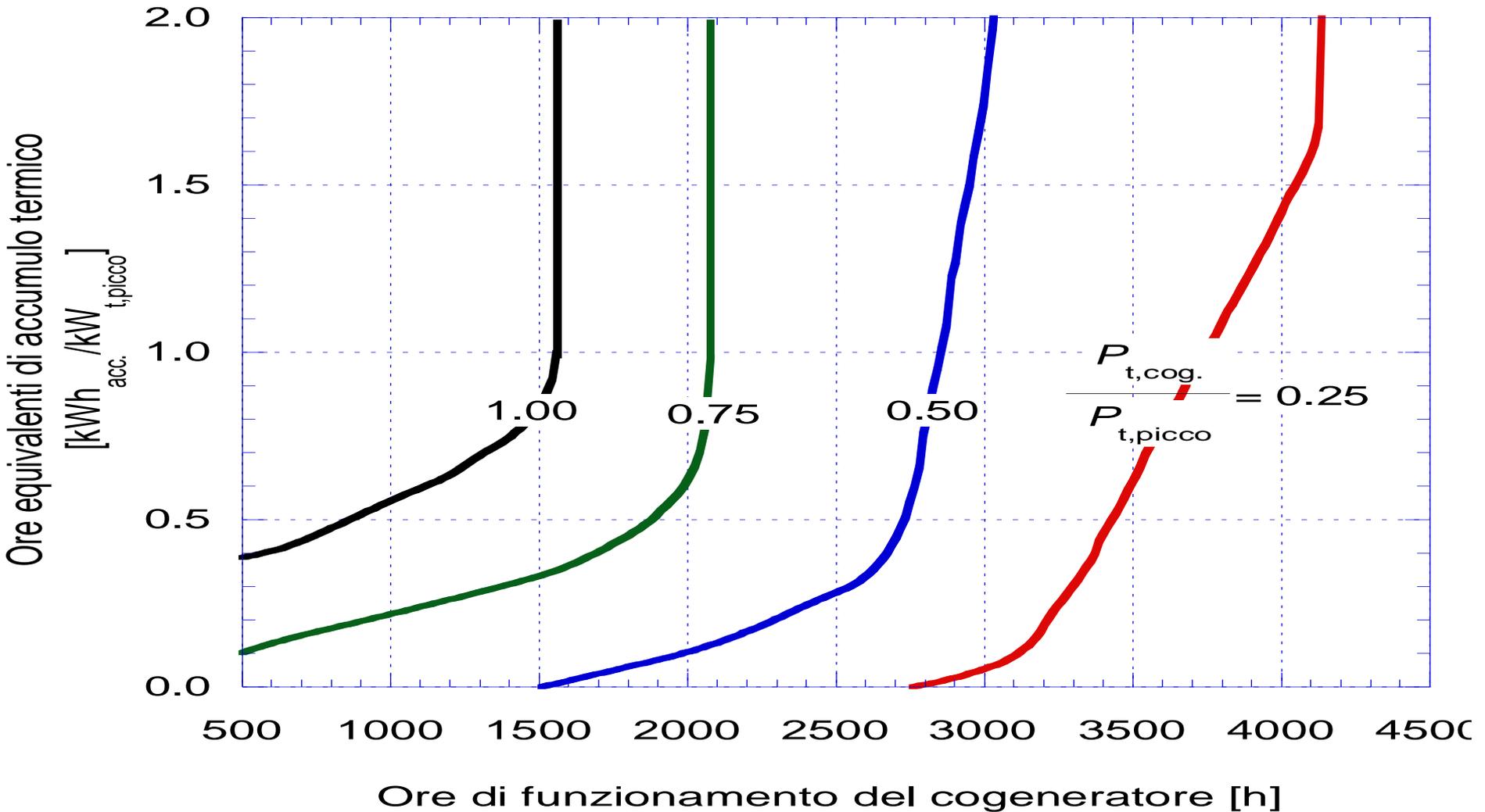
Copertura del fabbisogno termico



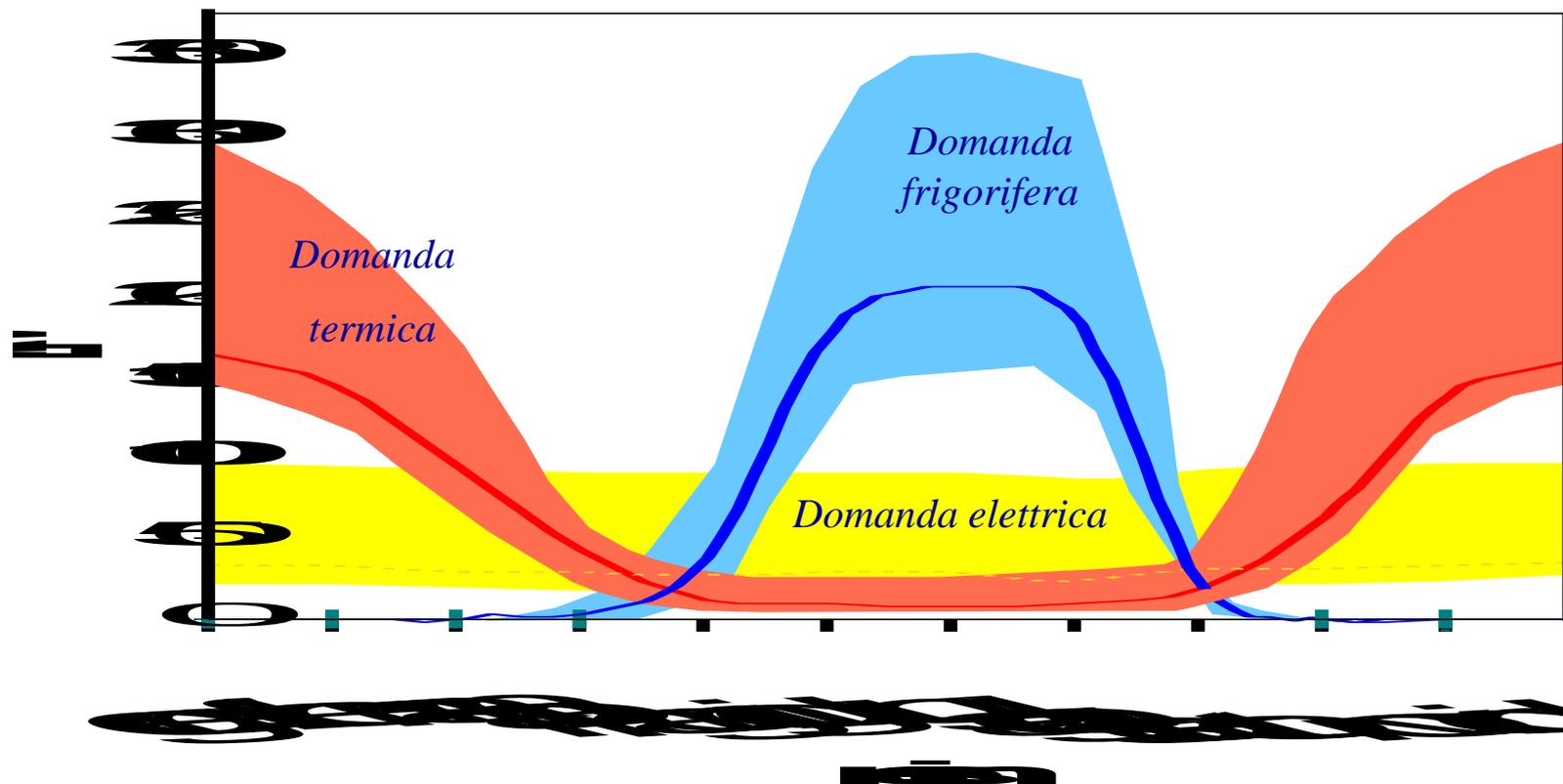
Ruolo dell'accumulo termico



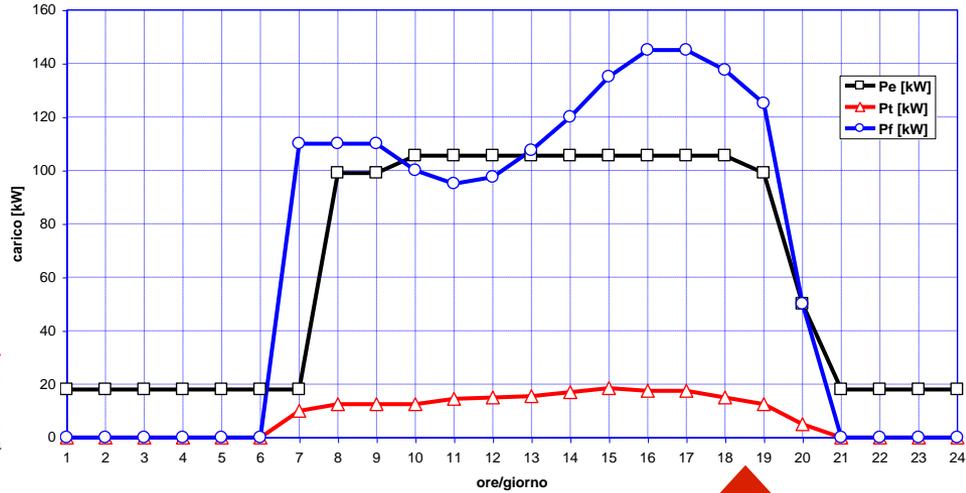
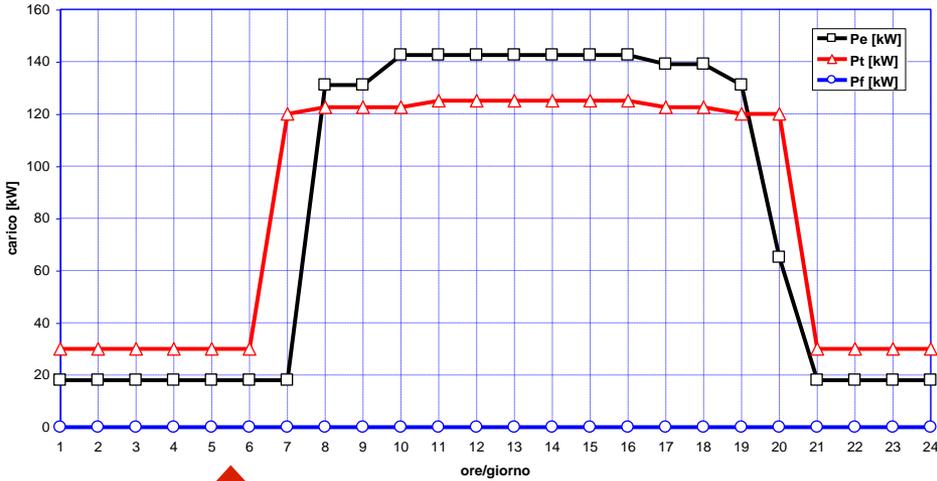
Ruolo dell'accumulo termico



Trigenerazione: la necessità

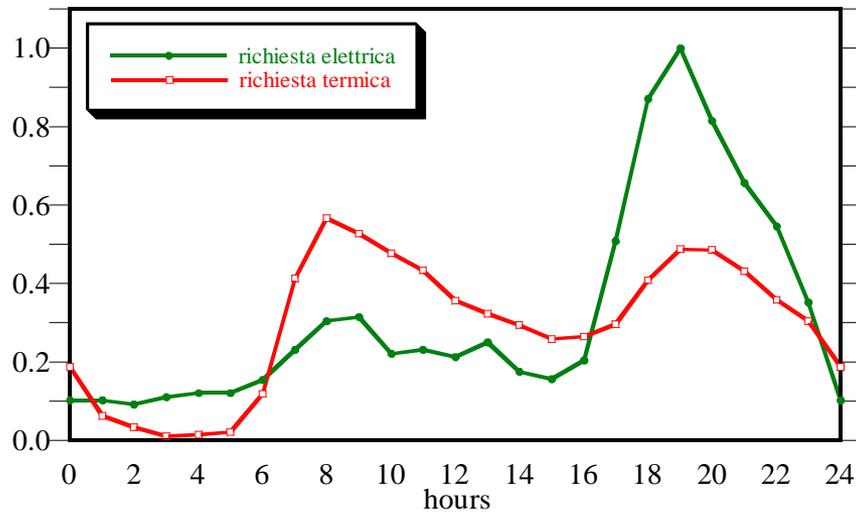


Trigenerazione: la variabilità del carico



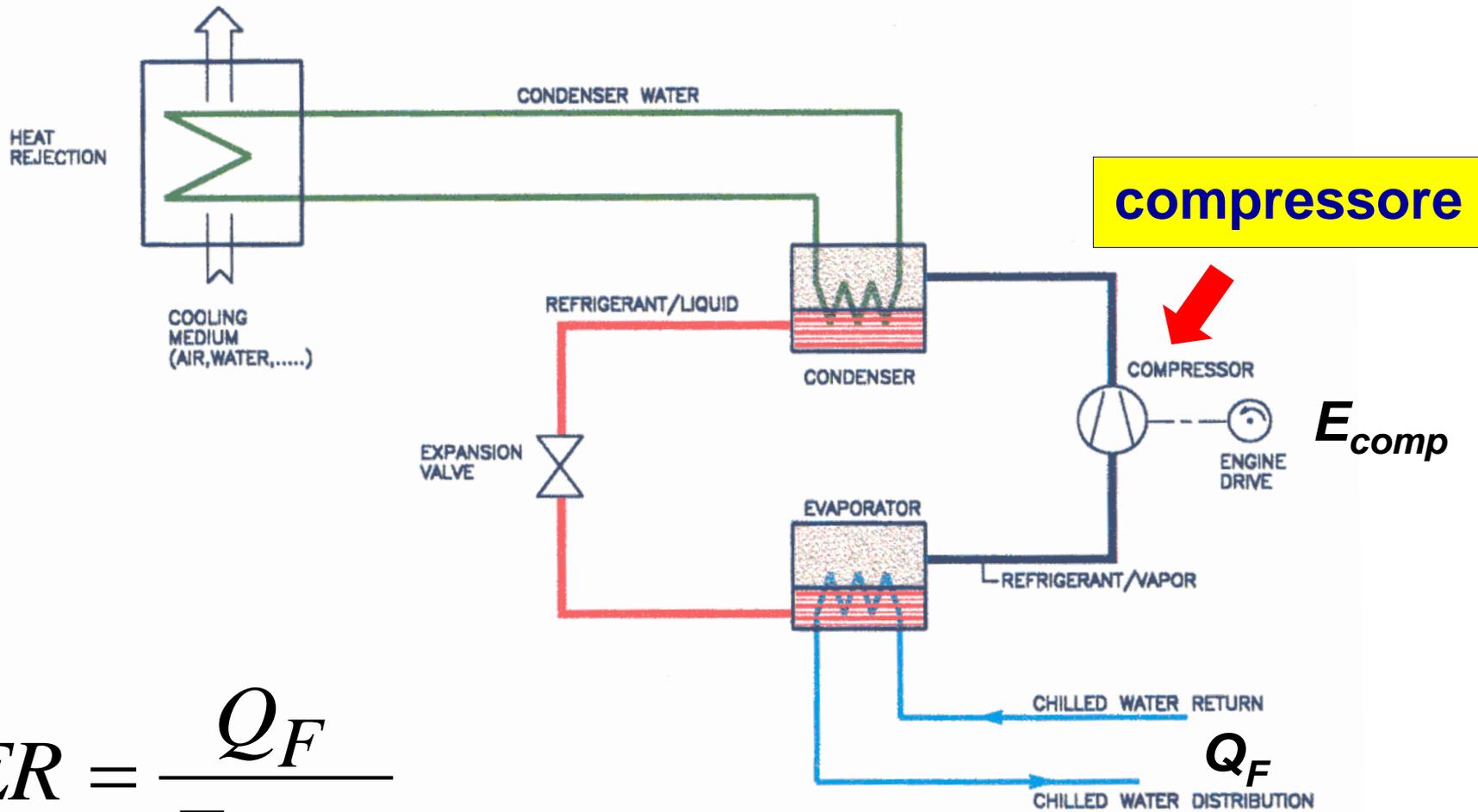
**utenza nel
terziario
(inverno)**

**utenza nel
civile
(inverno)**



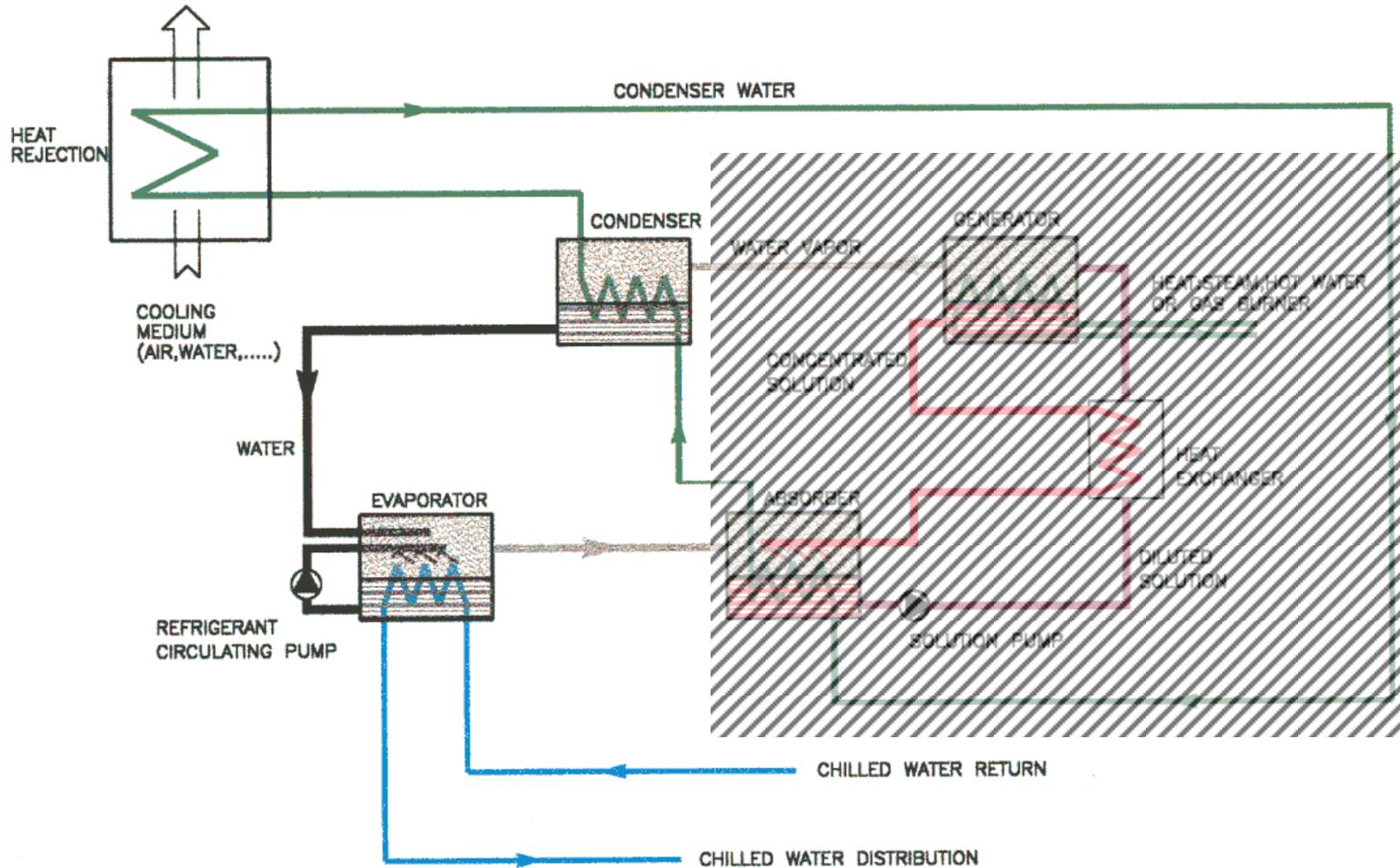
**utenza nel
terziario
(estate)**

Trigenerazione: gli impianti Frigorifero a compressione

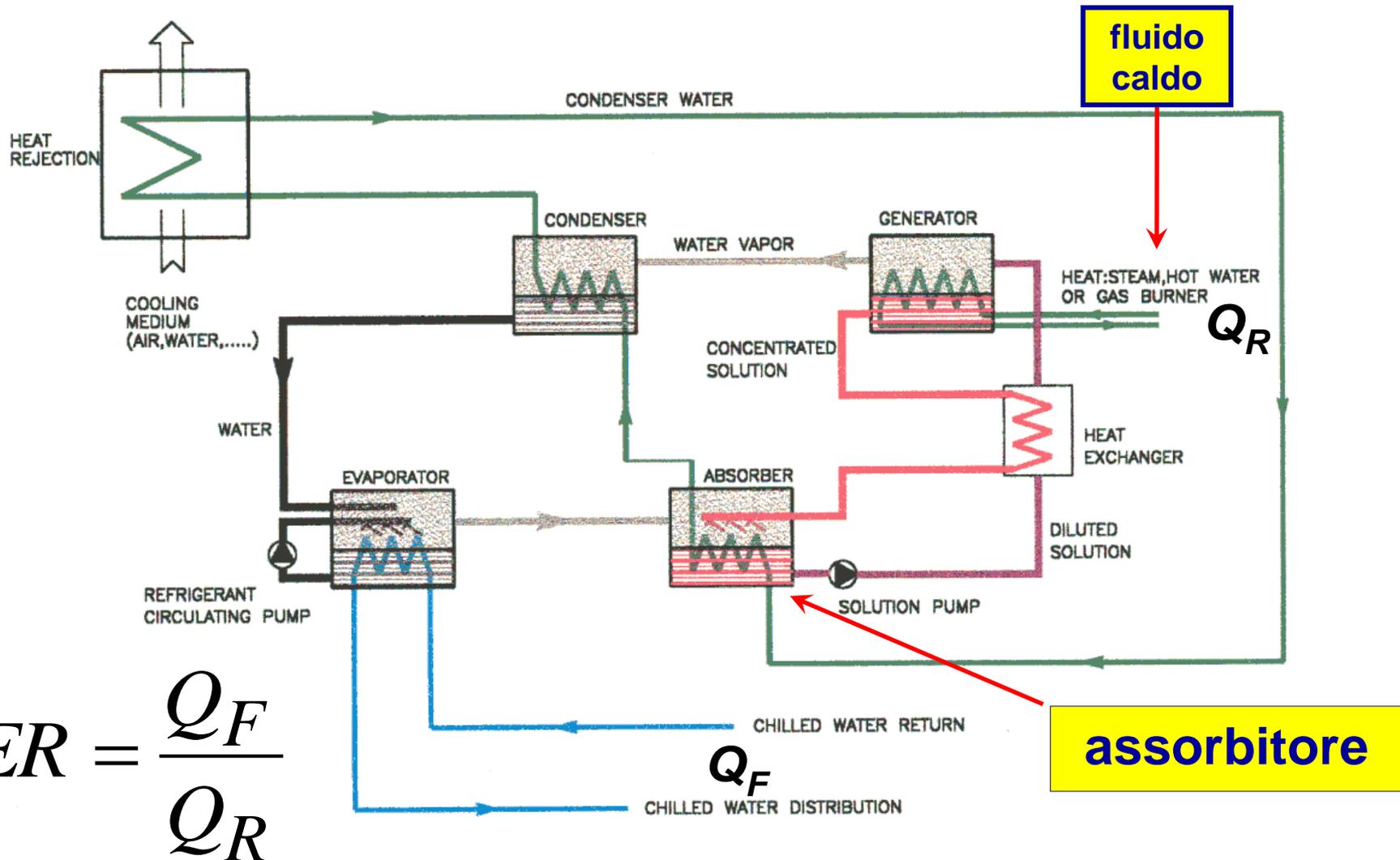


$$EER = \frac{Q_F}{E_{comp}}$$

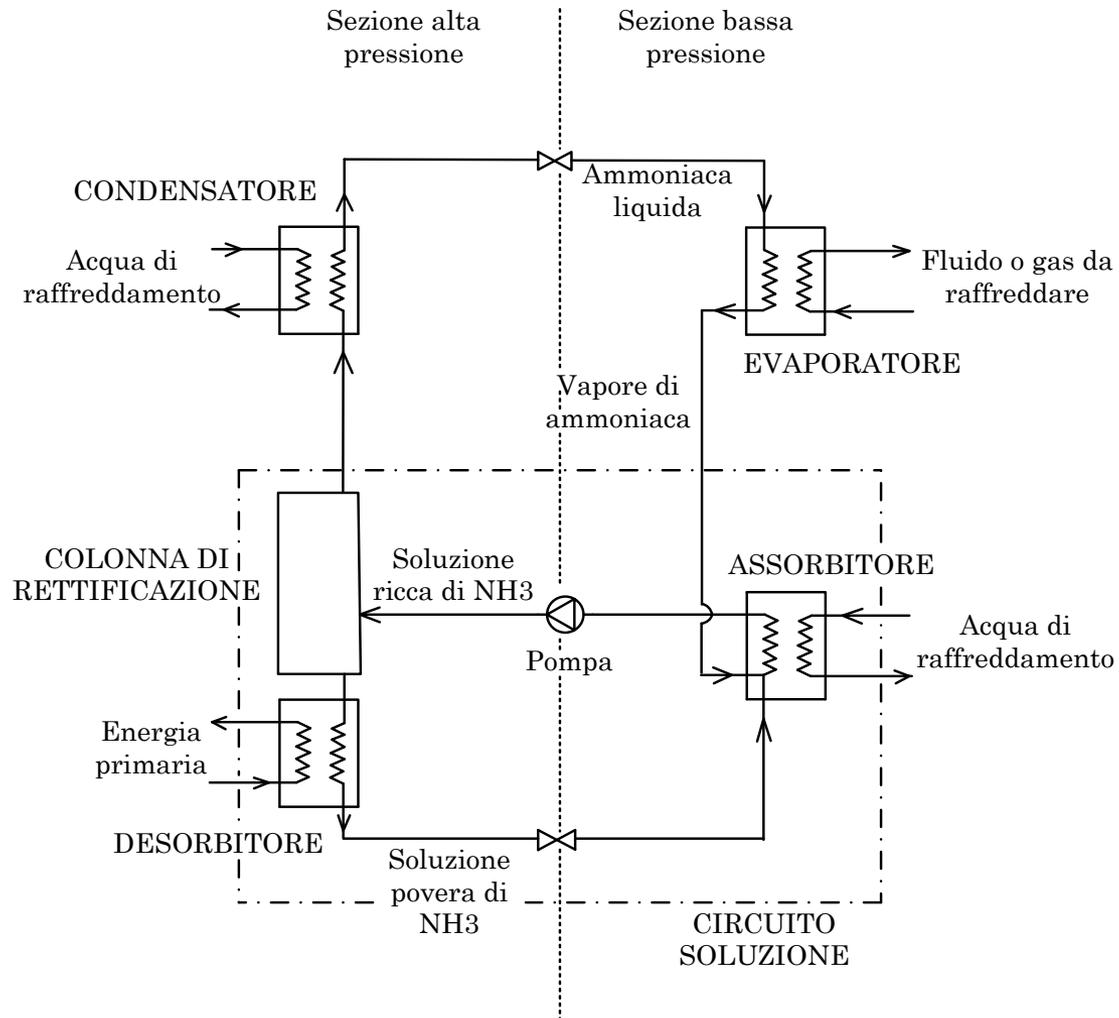
Trigenerazione: gli impianti Frigorifero ad assorbimento



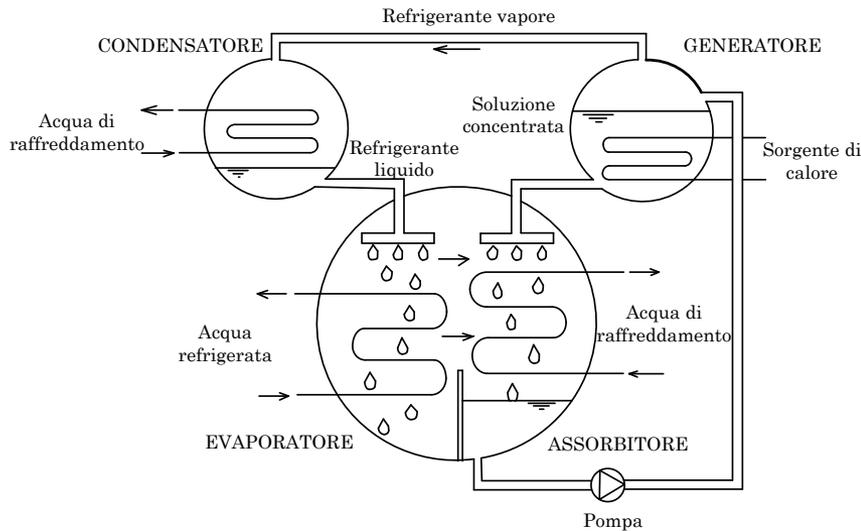
Trigenerazione: gli impianti Frigorifero ad assorbimento



Frigoriferi ad assorbimento ammoniaca-acqua ($\text{NH}_3\text{-H}_2\text{O}$) (temp. refrigerante fino a $-40 \div -60 \text{ }^\circ\text{C}$)



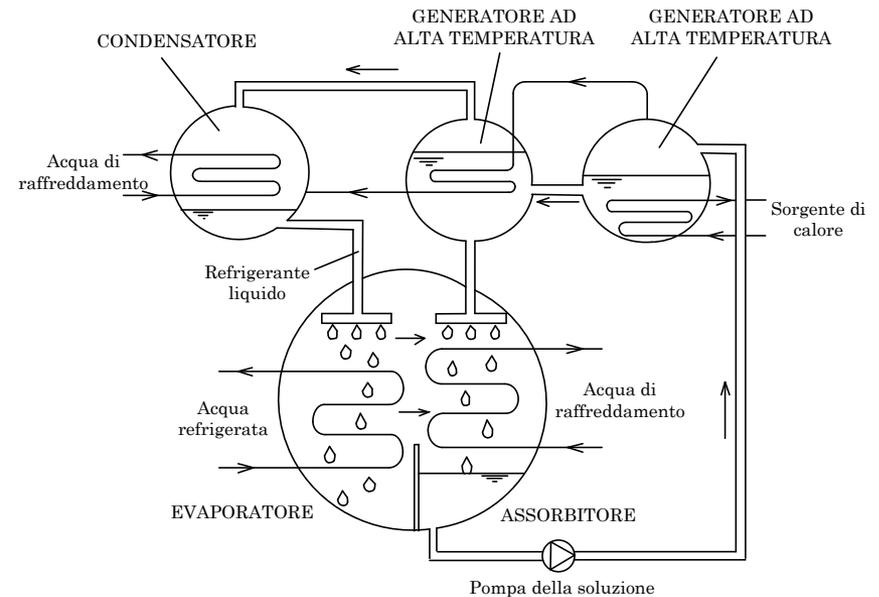
Frigoriferi ad assorbimento acqua-bromuro di litio ($H_2O-BrLi$) (temperatura refrigerante $> 0\text{ }^\circ\text{C}$)



Semplice effetto

$$T_{\text{sorgente calore}} \approx 60 \div 130\text{ }^\circ\text{C}$$

$$\text{EER} \approx 0.60 \div 0.75$$

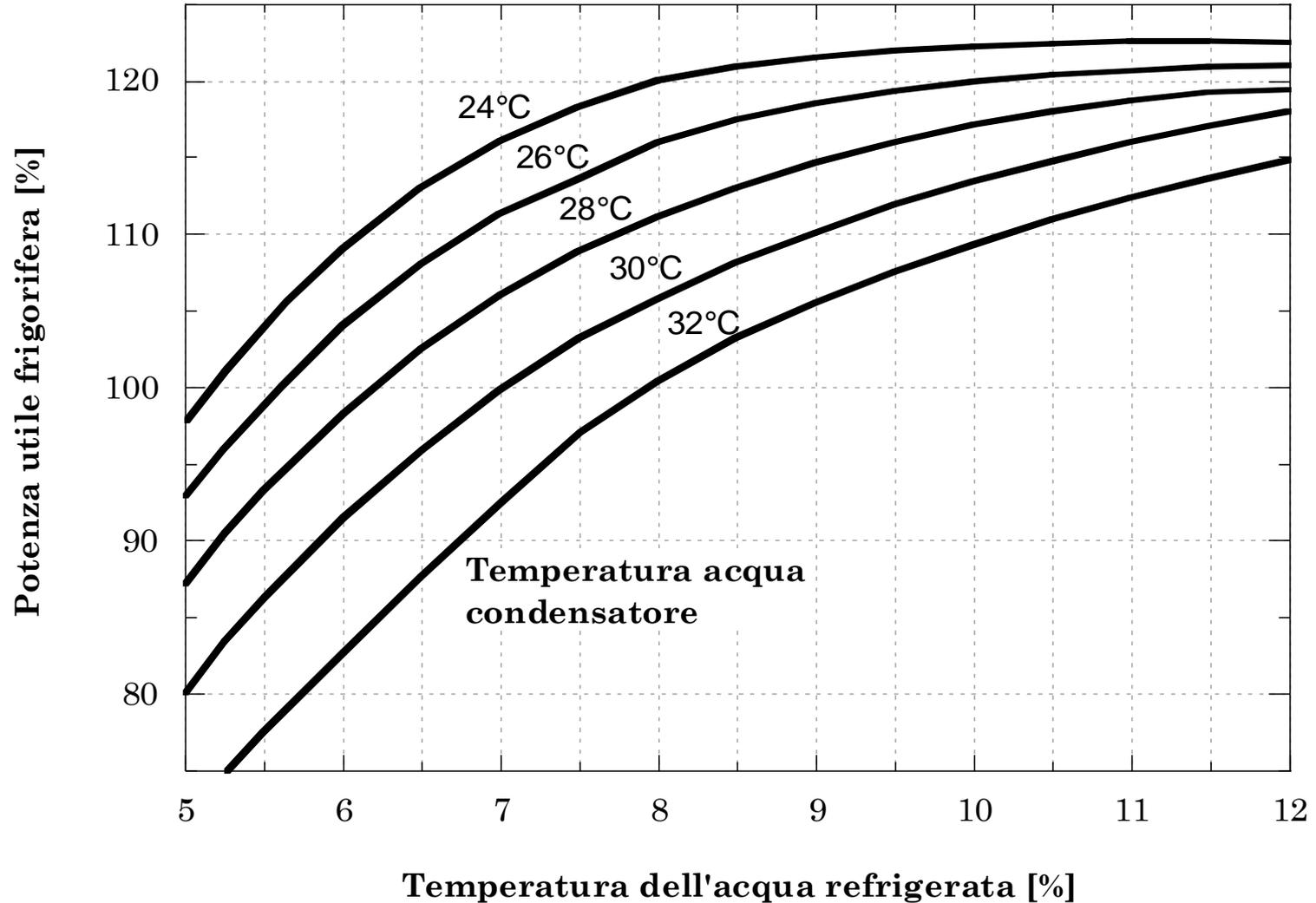


Doppio effetto

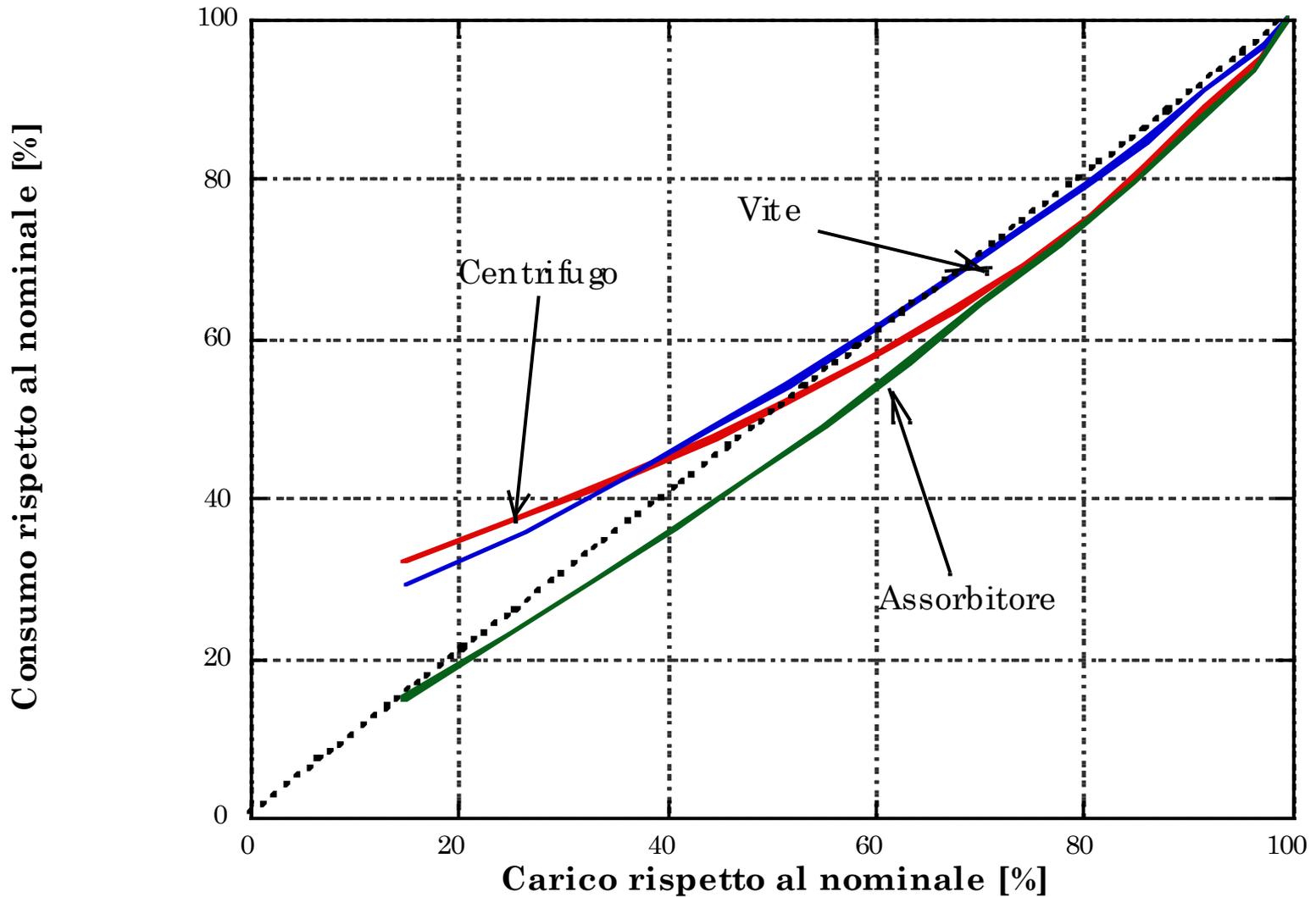
$$T_{\text{sorgente calore}} \approx 150 \div 200\text{ }^\circ\text{C}$$

$$\text{EER} \approx 1.1 \div 1.3$$

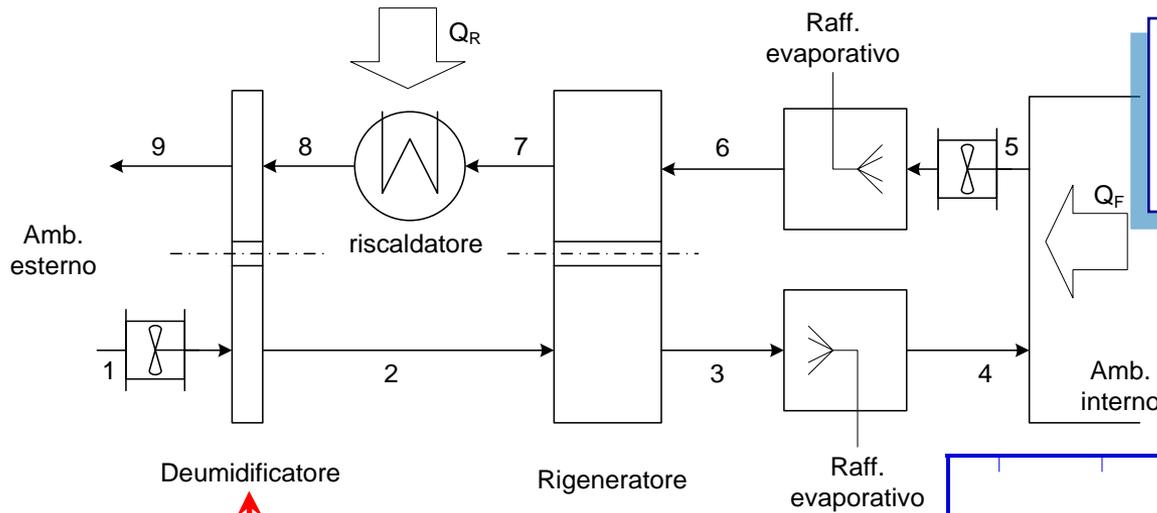
Frigoriferi ad assorbimento: prestazioni



Frigoriferi ad assorbimento: Funzionamento ai carichi parziali



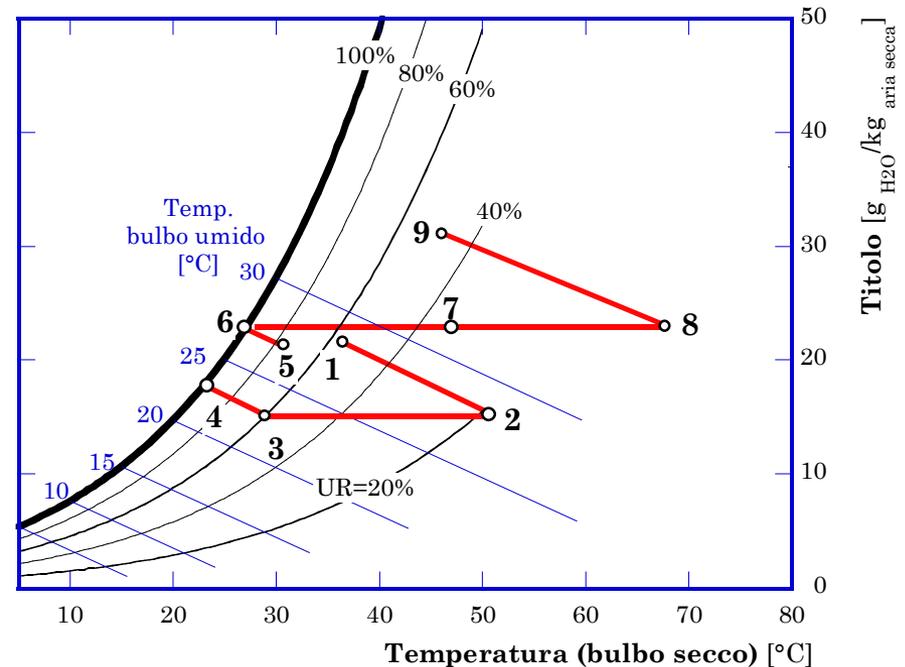
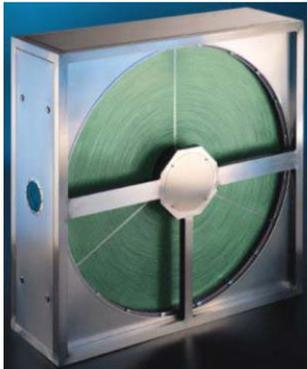
Trigenerazione: gli impianti Desiccant cooling



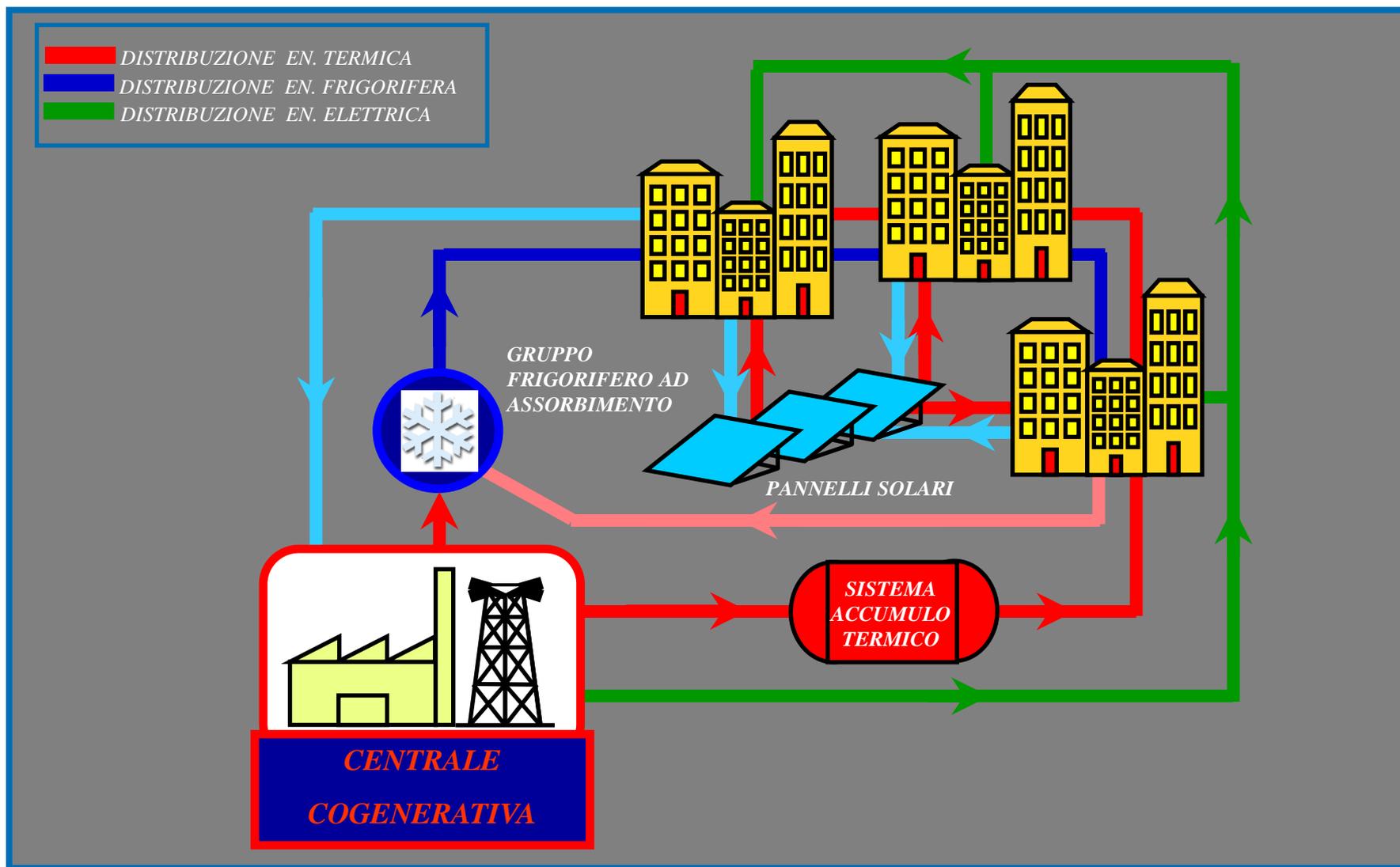
- ✓ $EER \approx 0.5 \div 0.6$
- ✓ $Q_F/E_{el} \approx 5 \div 6$
- ✓ Assenza di fluidi pericolosi

$$EER = \frac{Q_F}{Q_R}$$

**deumidificatore igroscopico
(con sostanze chimiche "silica gel")**



Trigenerazione: le applicazioni



Trigenerazione: le applicazioni

