

# Dispensa del corso di “SISTEMI ENERGETICI”

Argomento: Sistemi Energetici (parte 3.3)

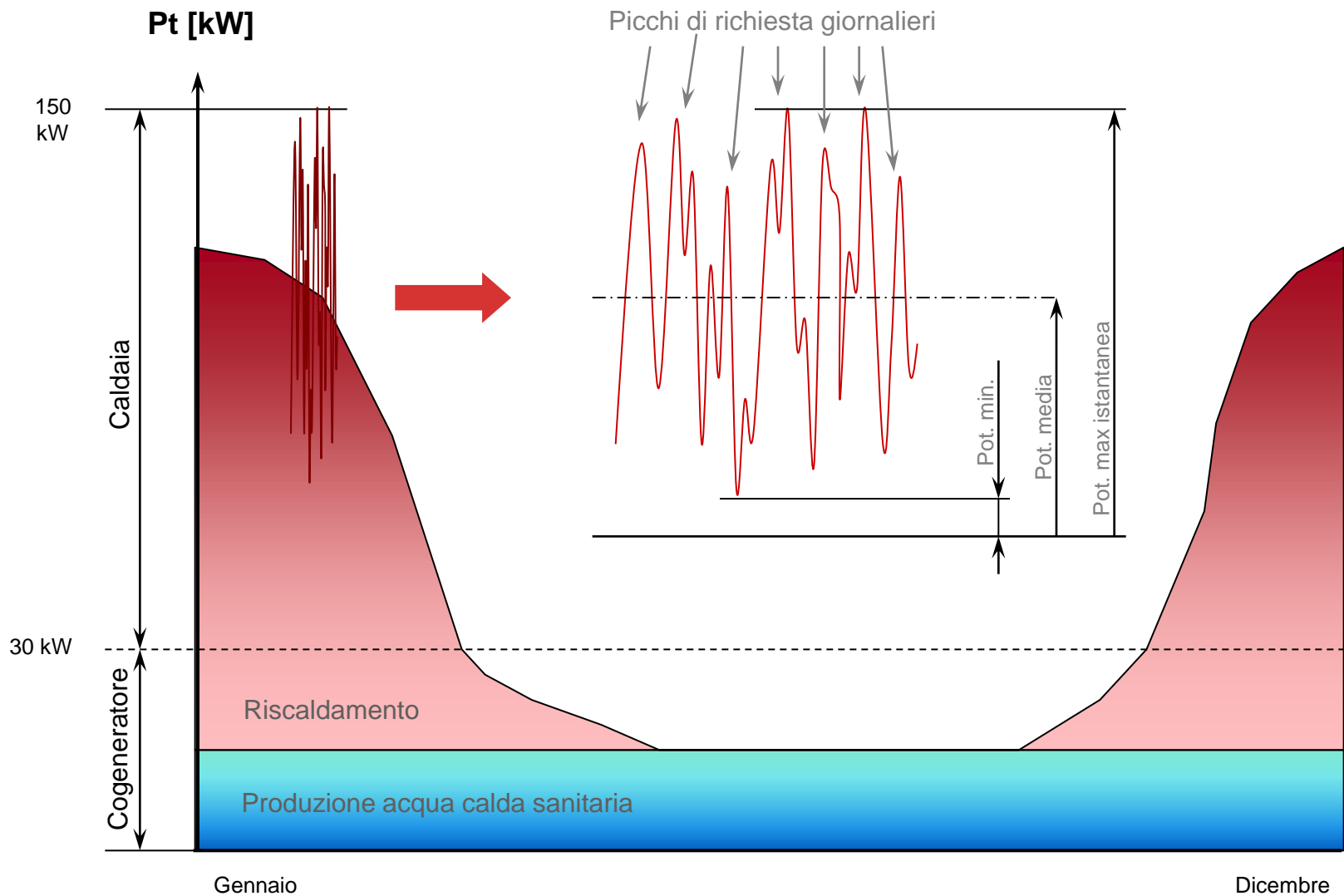
**Prof. Pier Ruggero Spina**  
Dipartimento di Ingegneria



università di ferrara  
DA SEICENTO ANNI GUARDIAMO AVANTI.

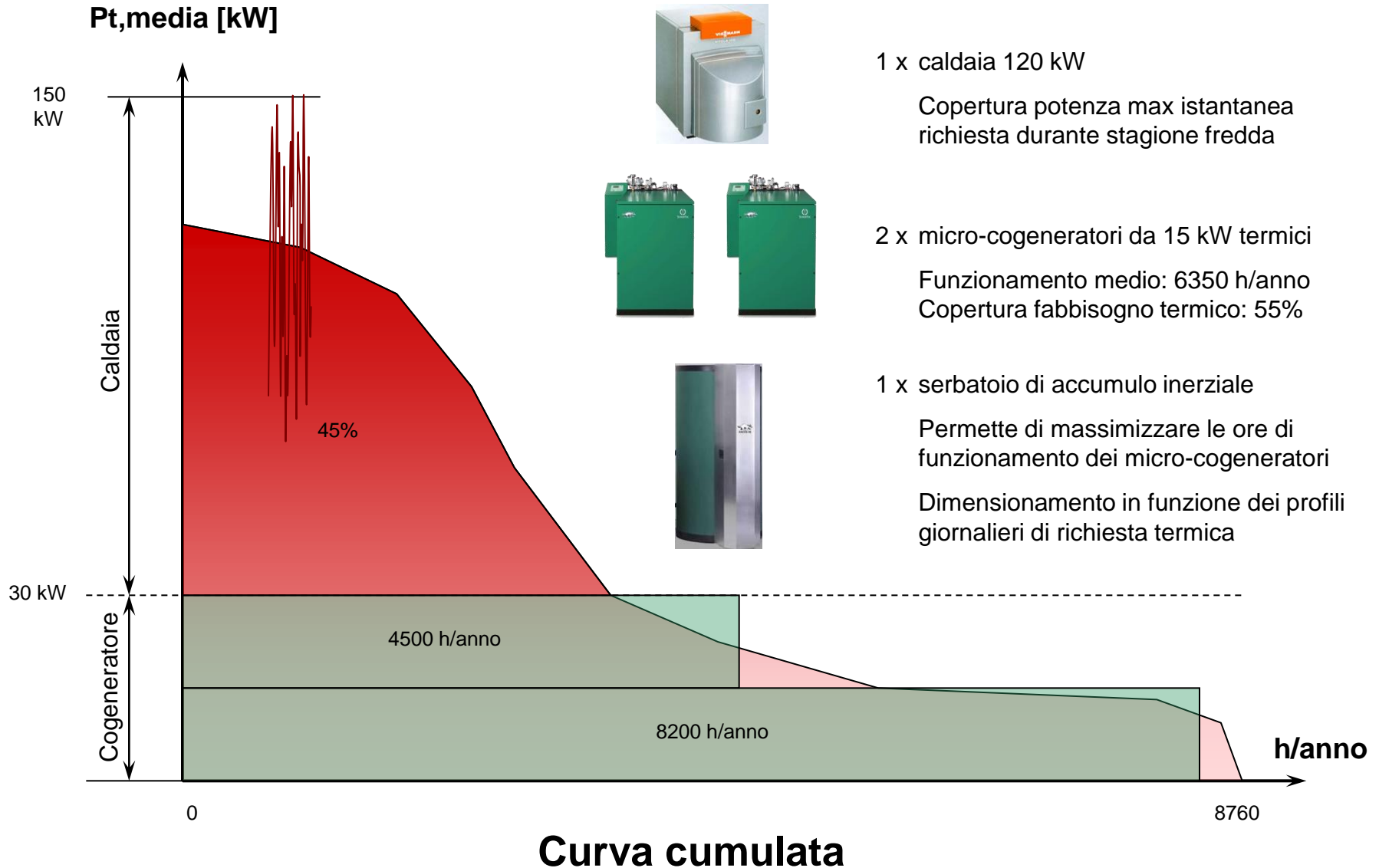
# **La trigenerazione: motivazioni e tecnologie**

# Il fabbisogno termico

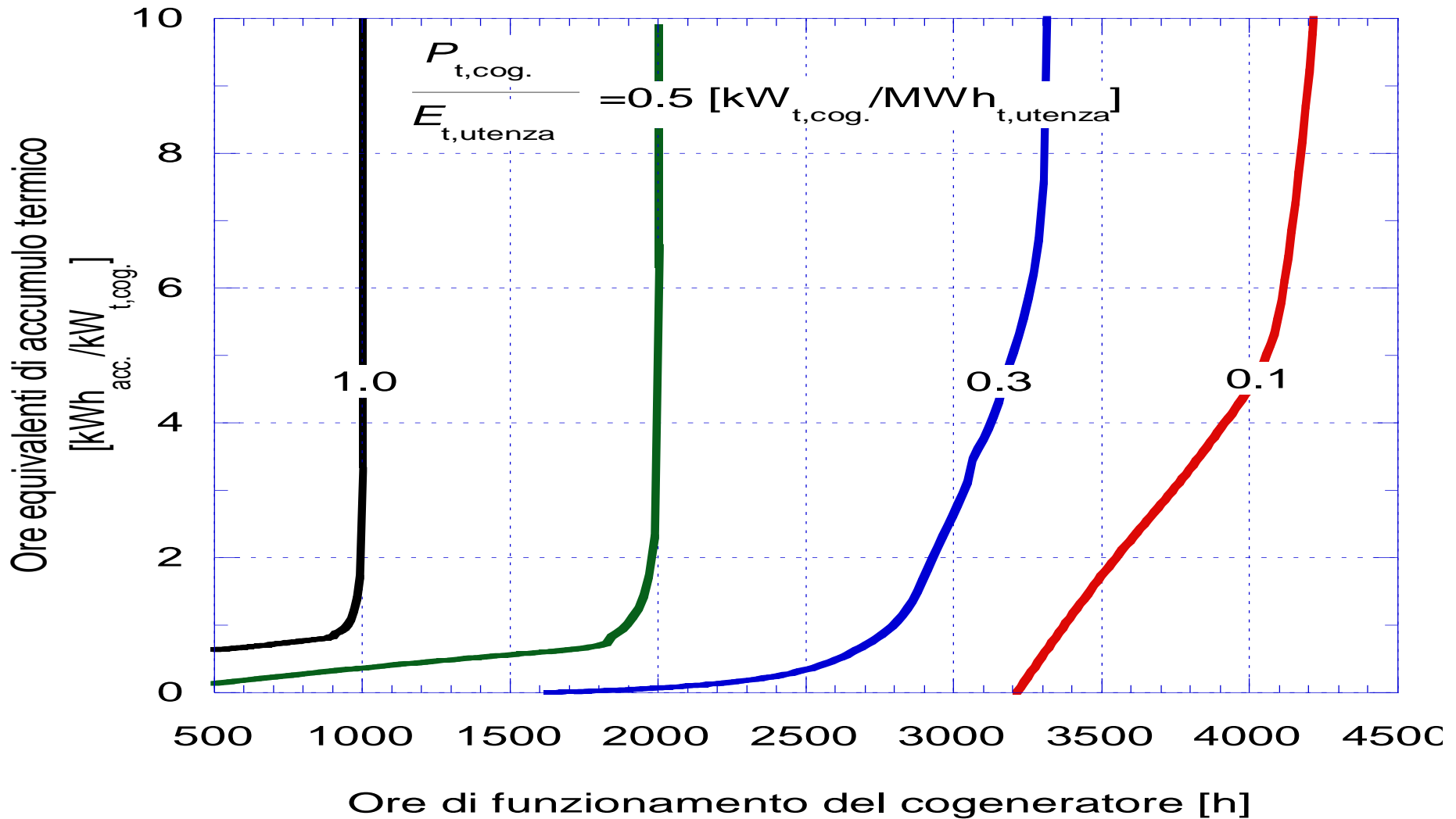


**Potenza termica richiesta**

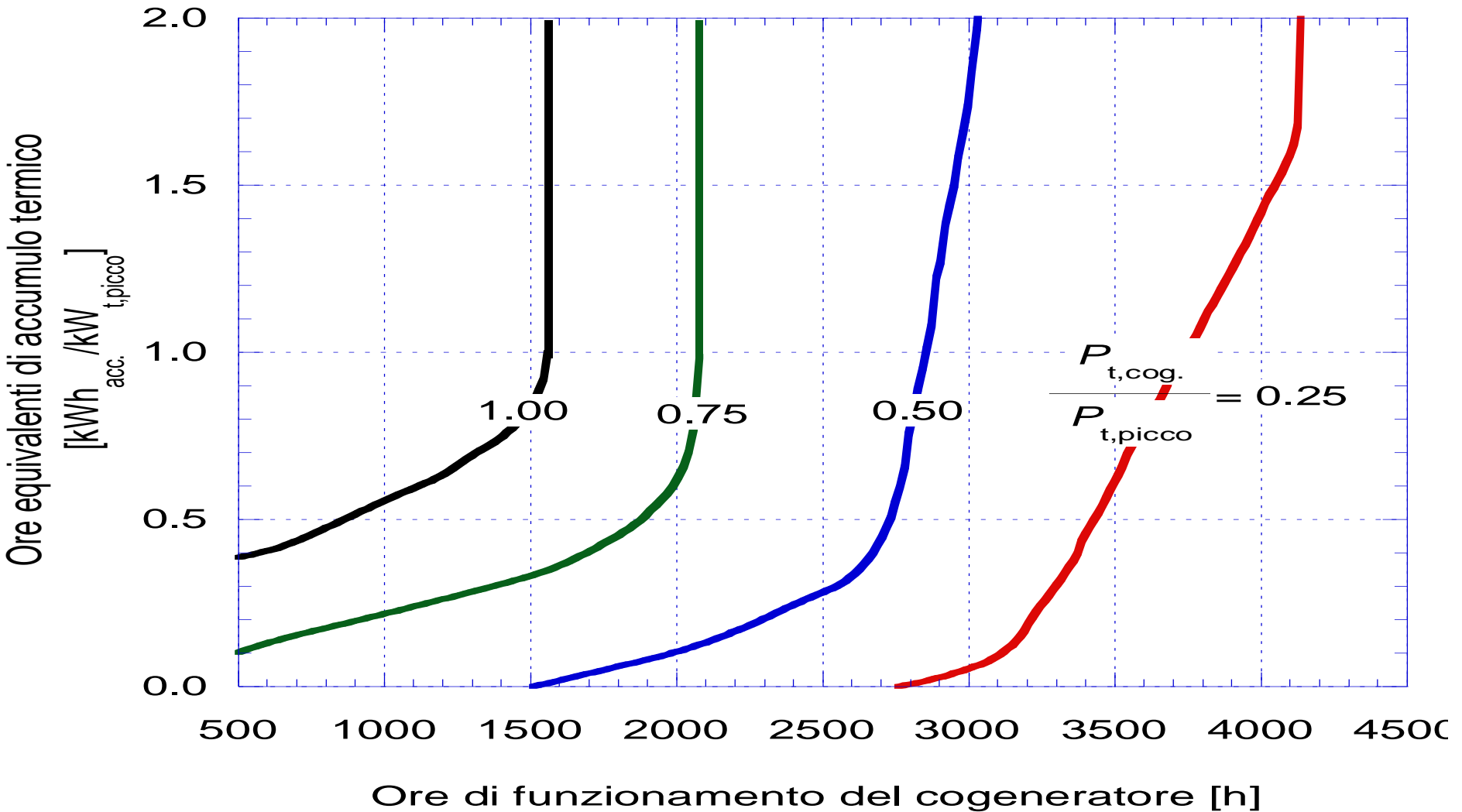
# Copertura del fabbisogno termico



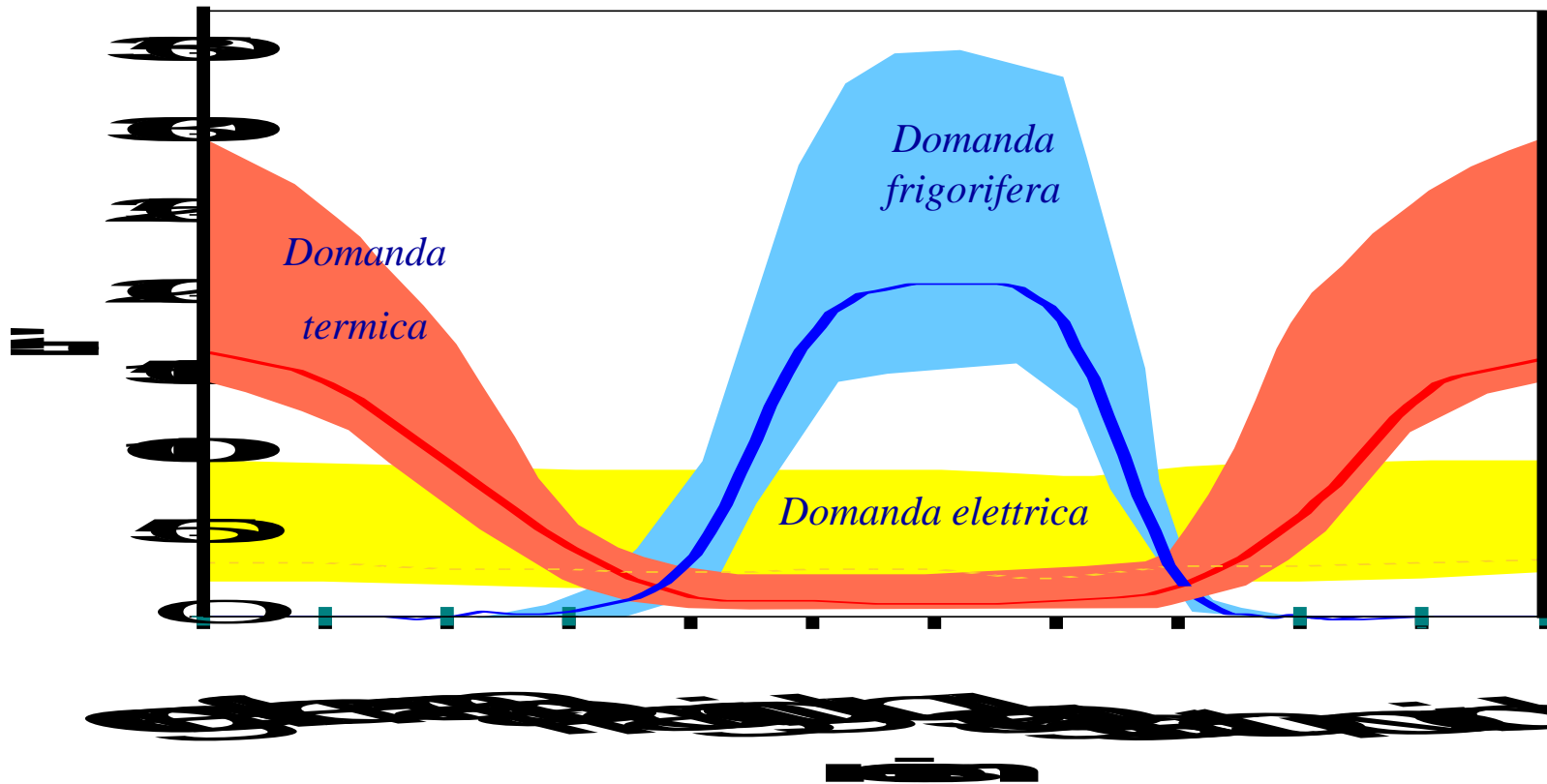
# Ruolo dell'accumulo termico



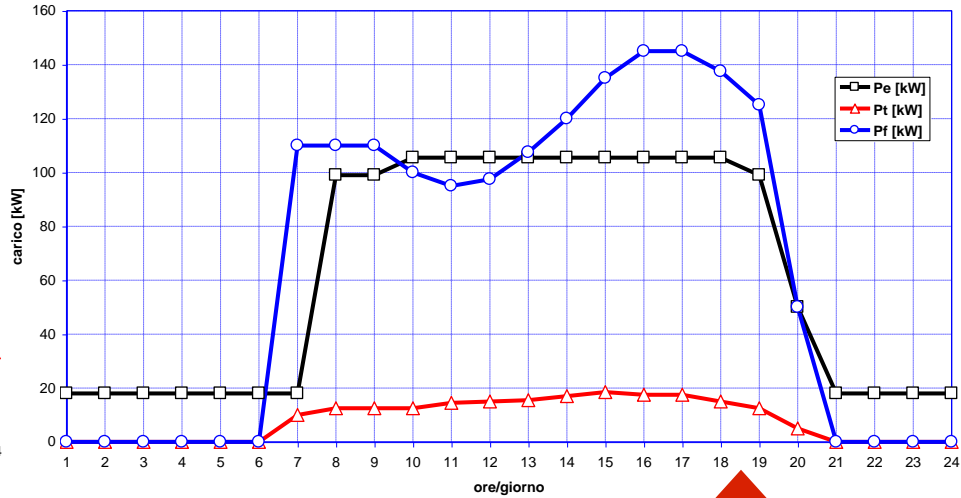
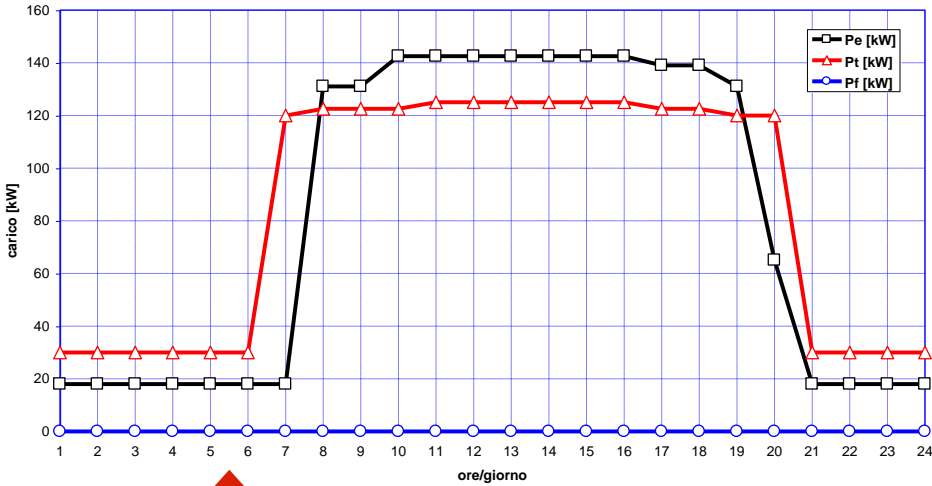
# Ruolo dell'accumulo termico



# Trigenerazione: la necessità

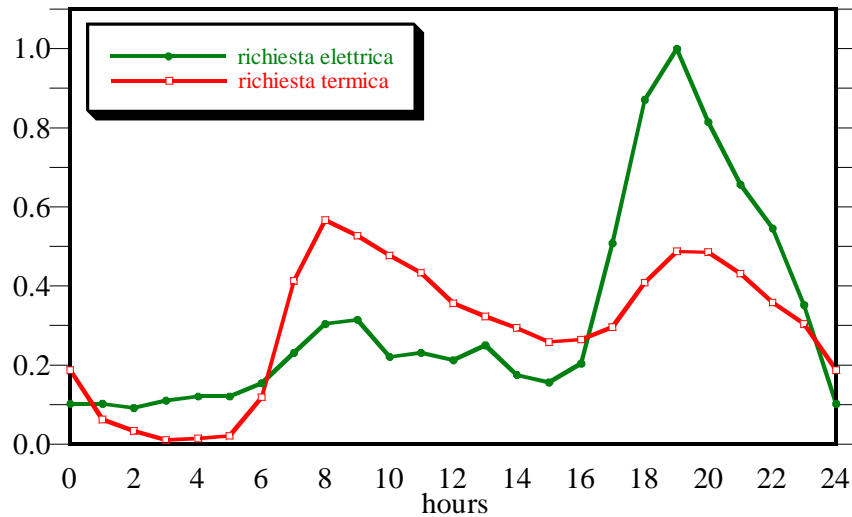


# Trigenerazione: la variabilità del carico



**utenza nel  
terziario  
(inverno)**

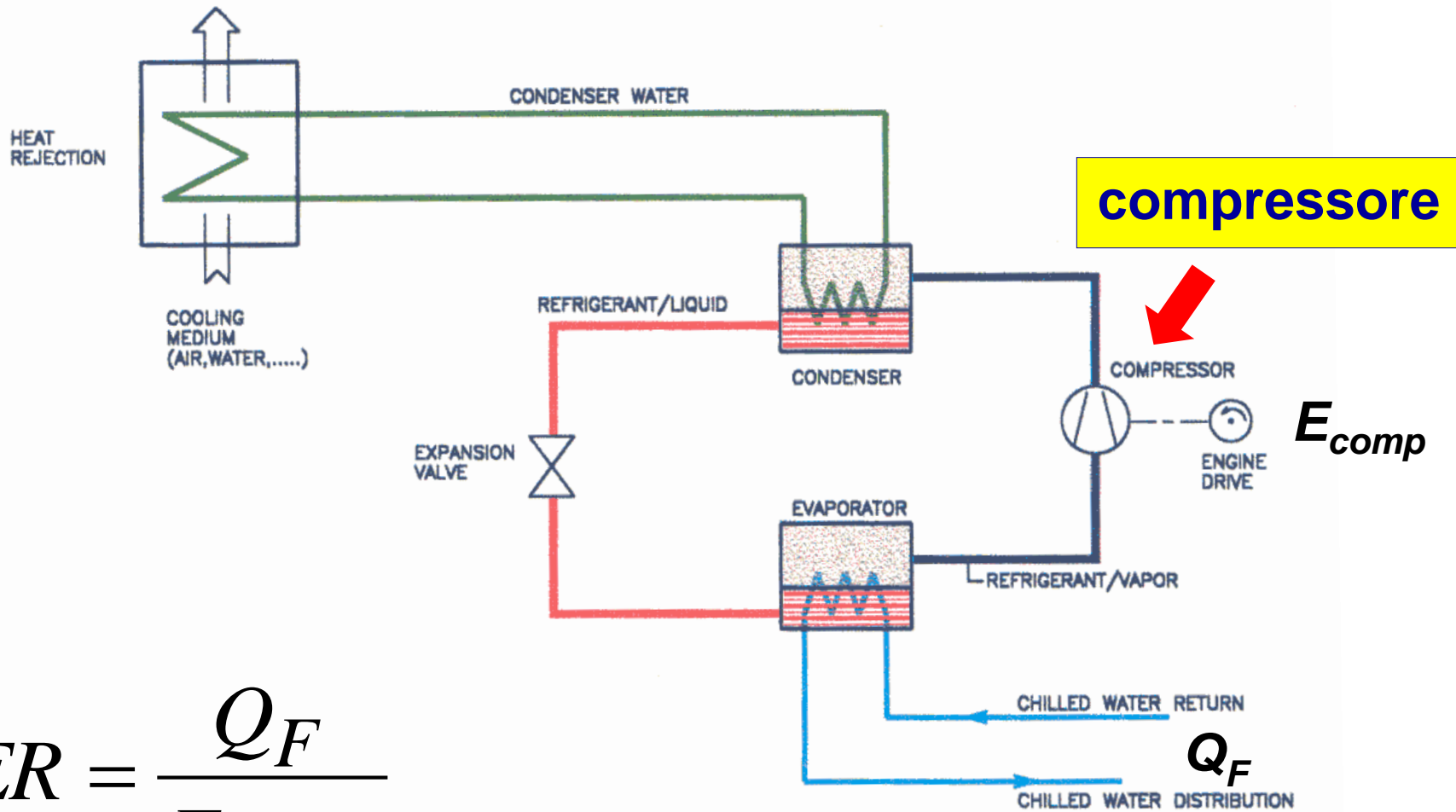
**utenza nel  
civile  
(inverno)**



**utenza nel  
terziario  
(estate)**

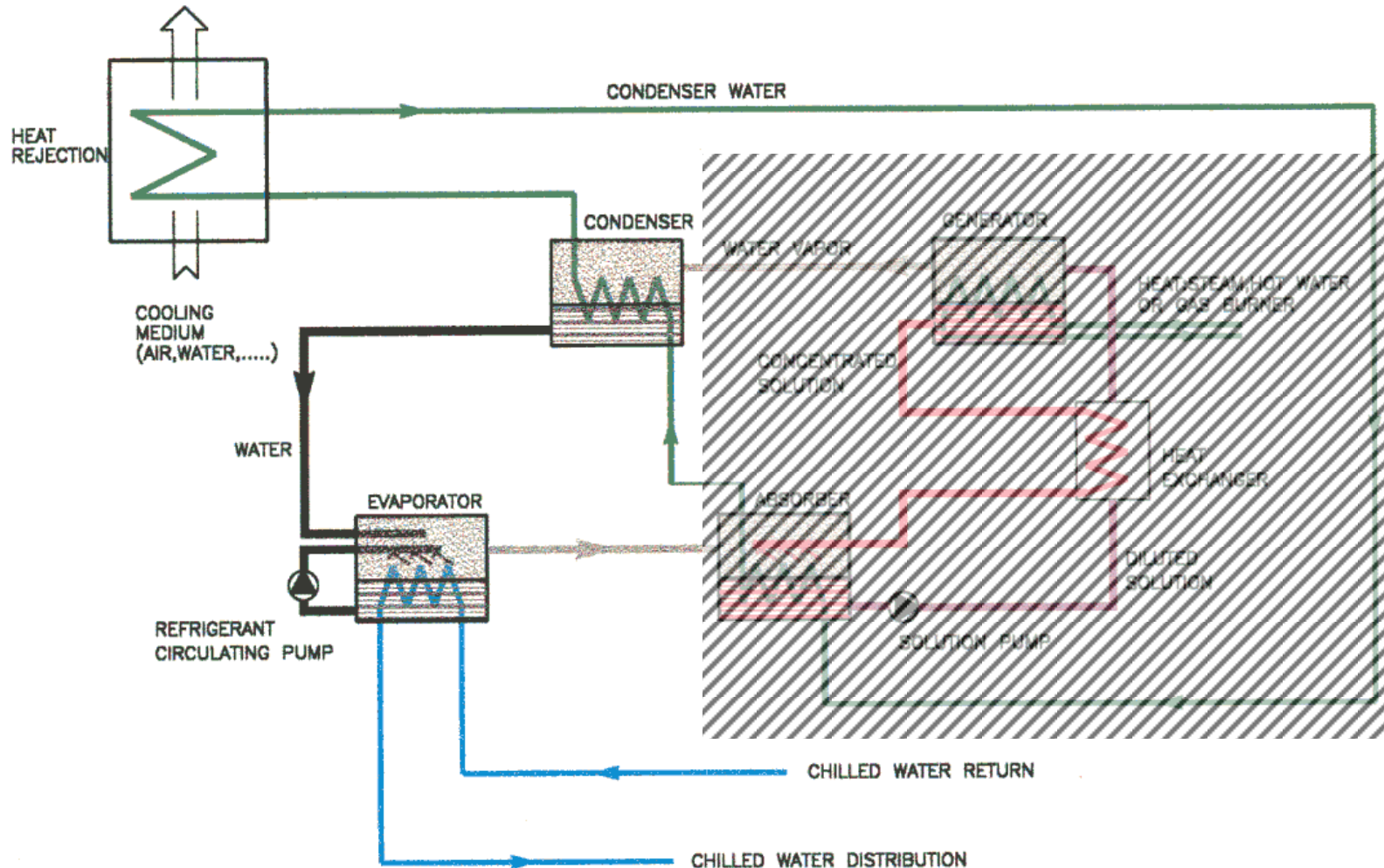


# Trigenerazione: gli impianti Frigorifero a compressione

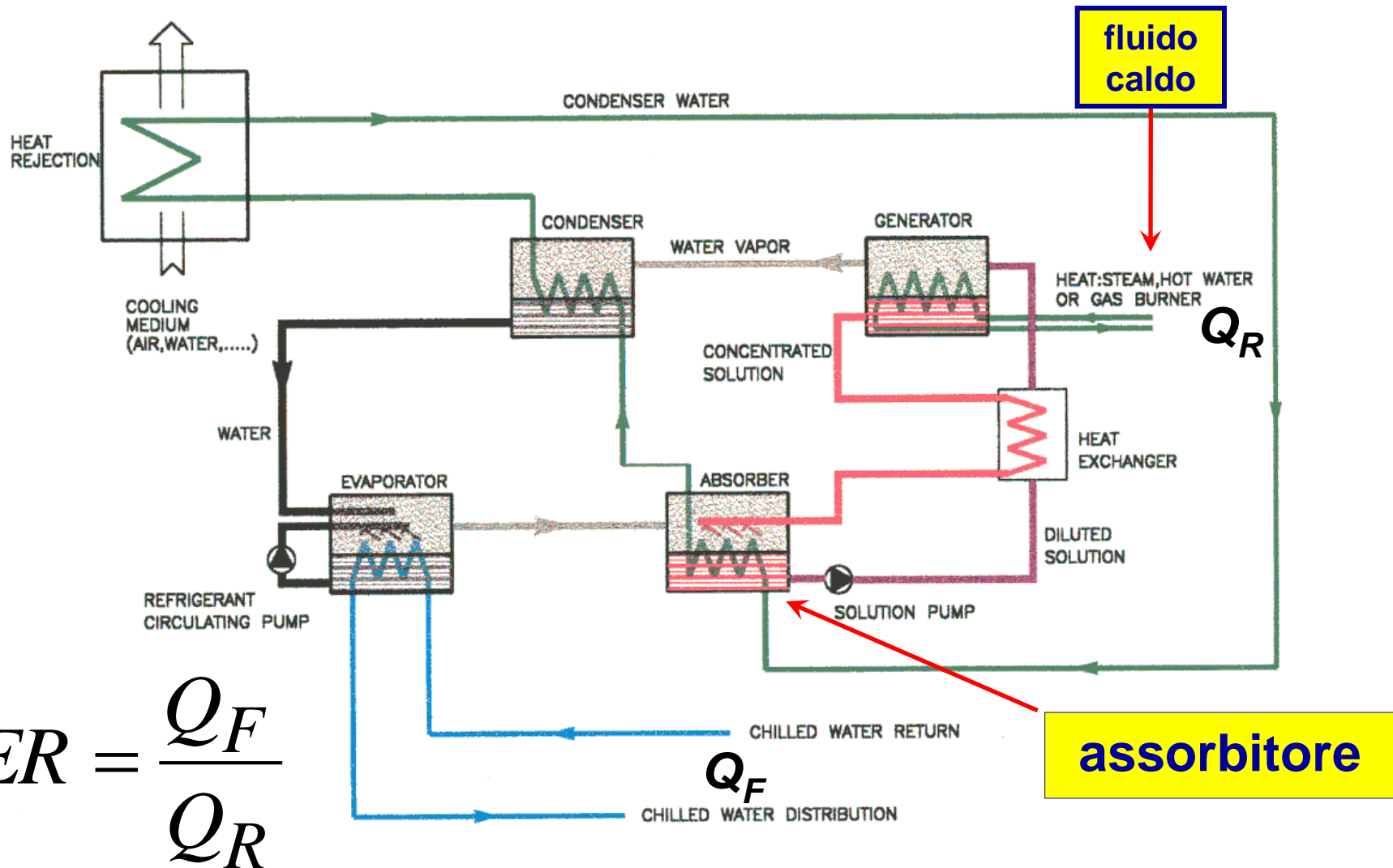


$$EER = \frac{Q_F}{E_{comp}}$$

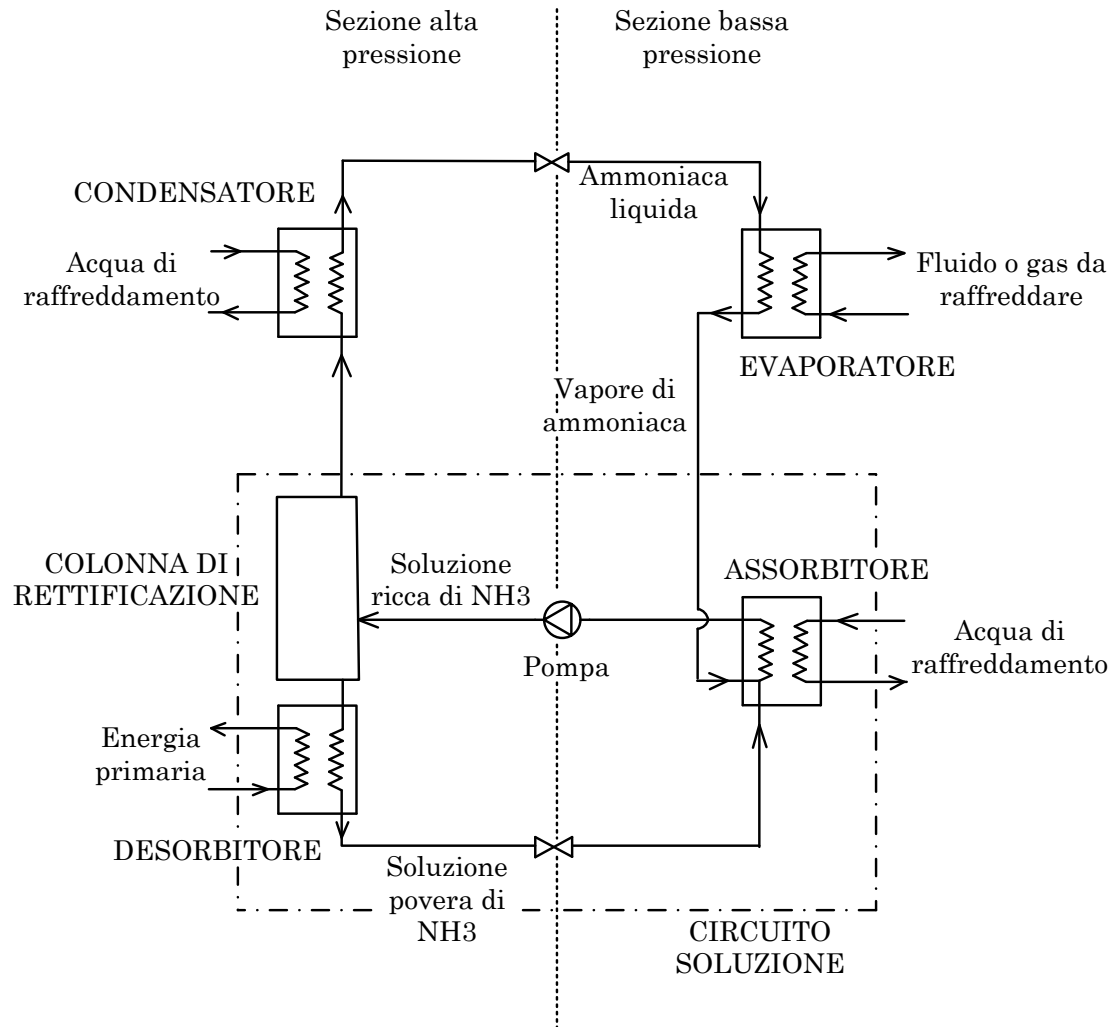
# Trigenerazione: gli impianti Frigorifero ad assorbimento



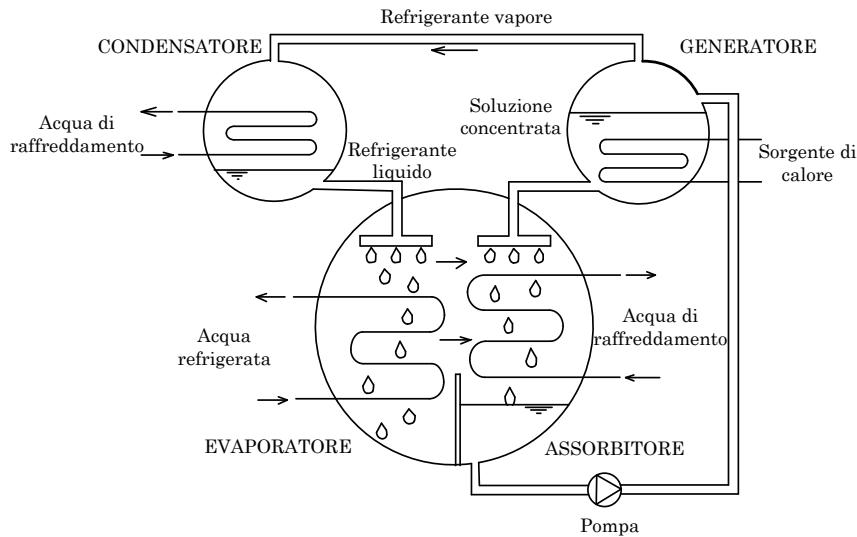
# Trigenerazione: gli impianti Frigorifero ad assorbimento



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



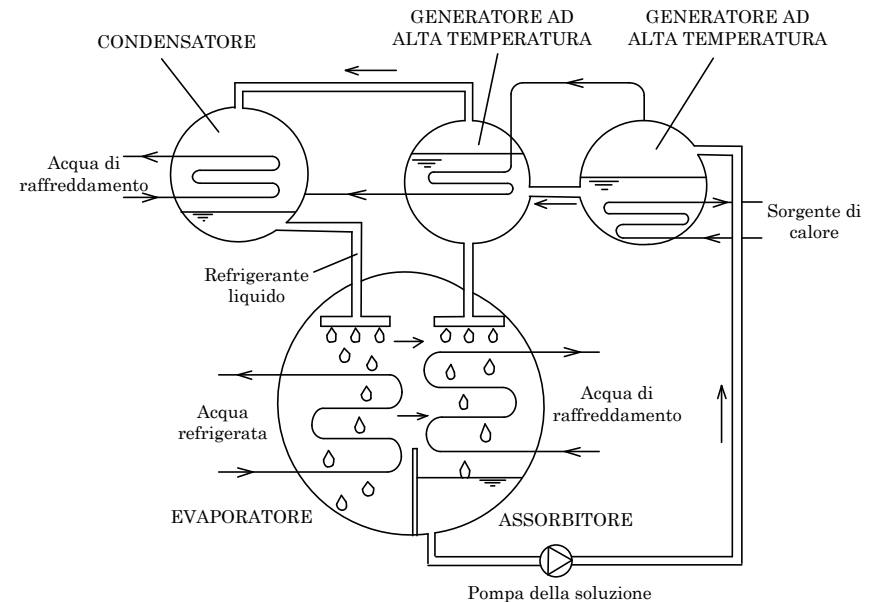
# **Frigoriferi ad assorbimento** **acqua-bromuro di litio ( $H_2O-BrLi$ )** **(temperatura refrigerante $> 0\text{ }^\circ\text{C}$ )**



## **Semplice effetto**

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

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

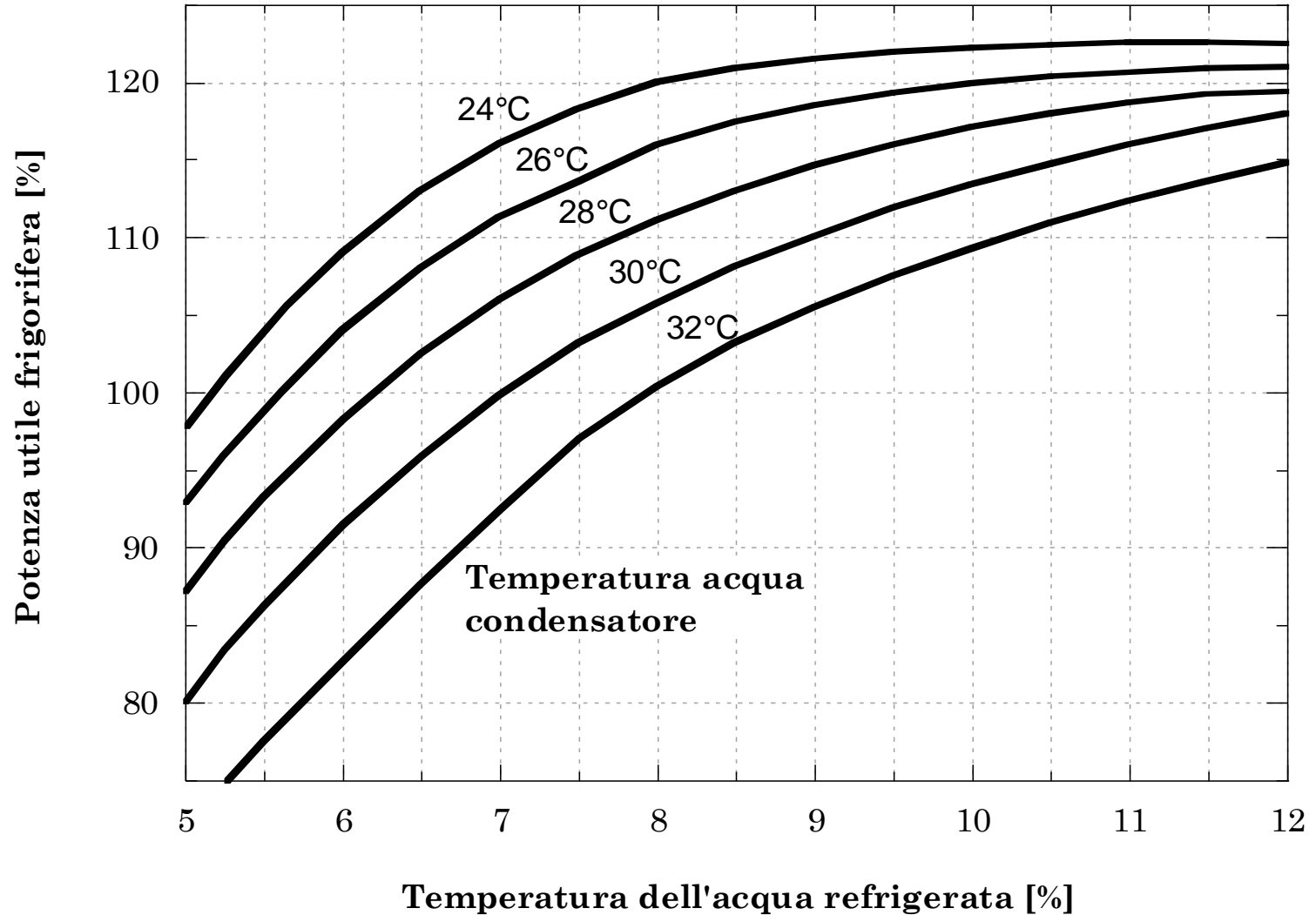


## **Doppio effetto**

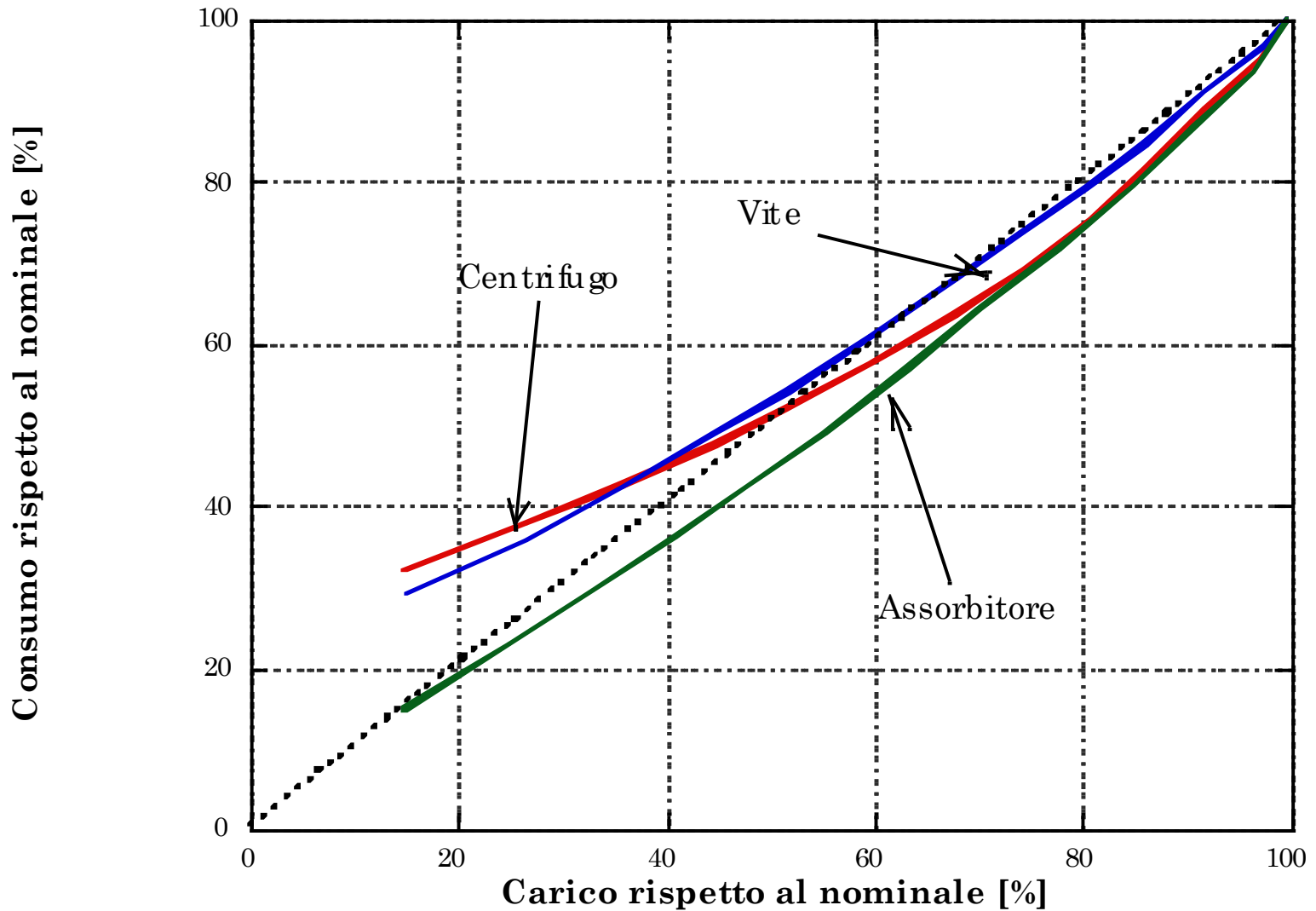
$$T_{\text{sorgente calore}} \approx 150 \div 200\text{ }^\circ\text{C}$$

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

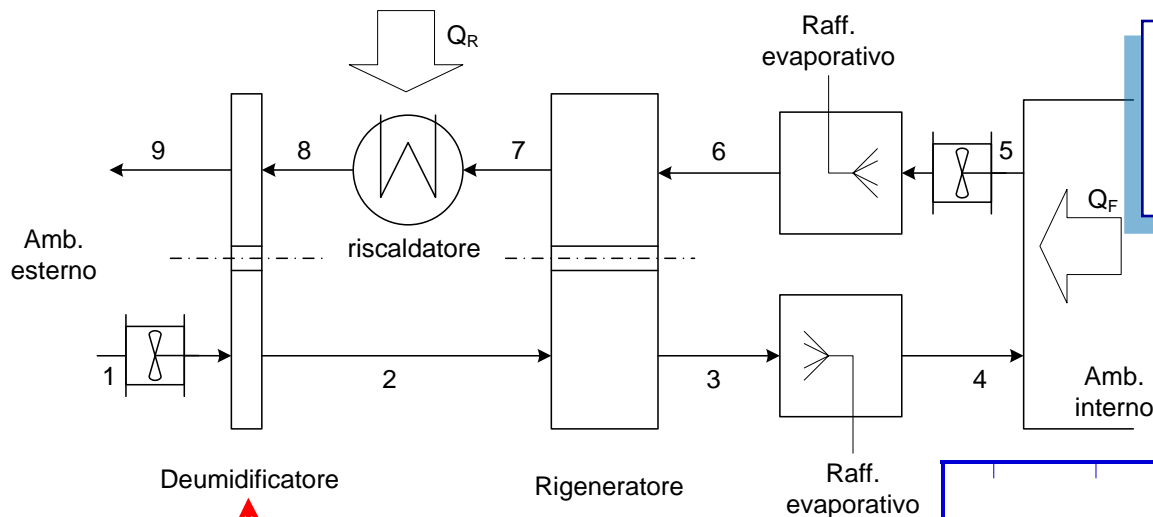
# *Frigoriferi ad assorbimento: prestazioni*



# Frigoriferi ad assorbimento: Funzionamento ai carichi parziali



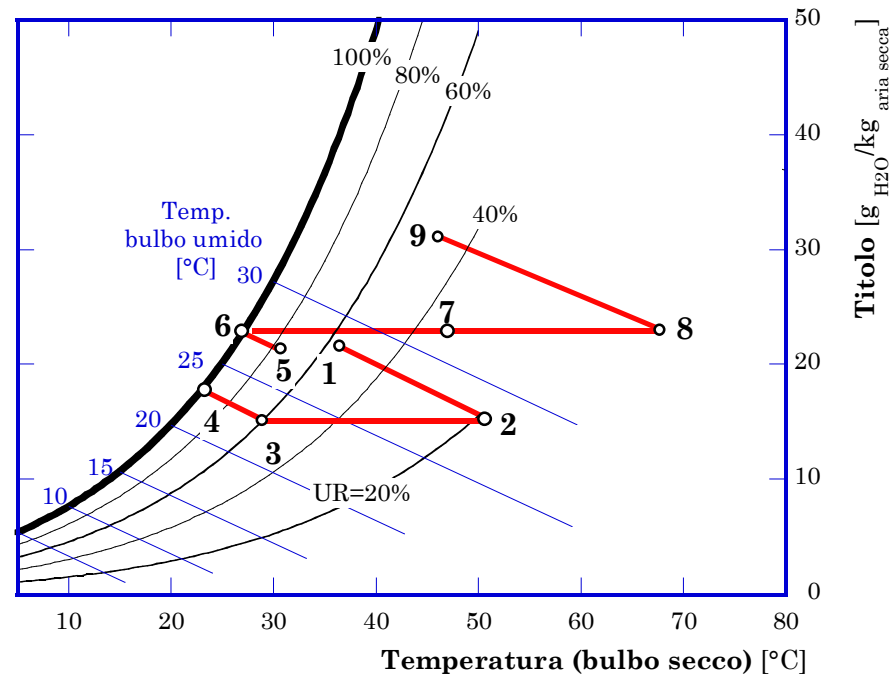
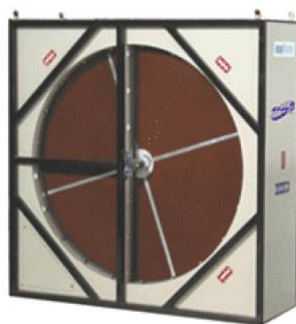
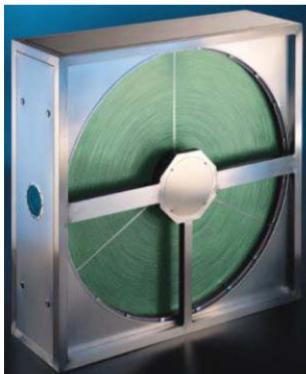
# Trigenerazione: gli impianti Desiccant cooling



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

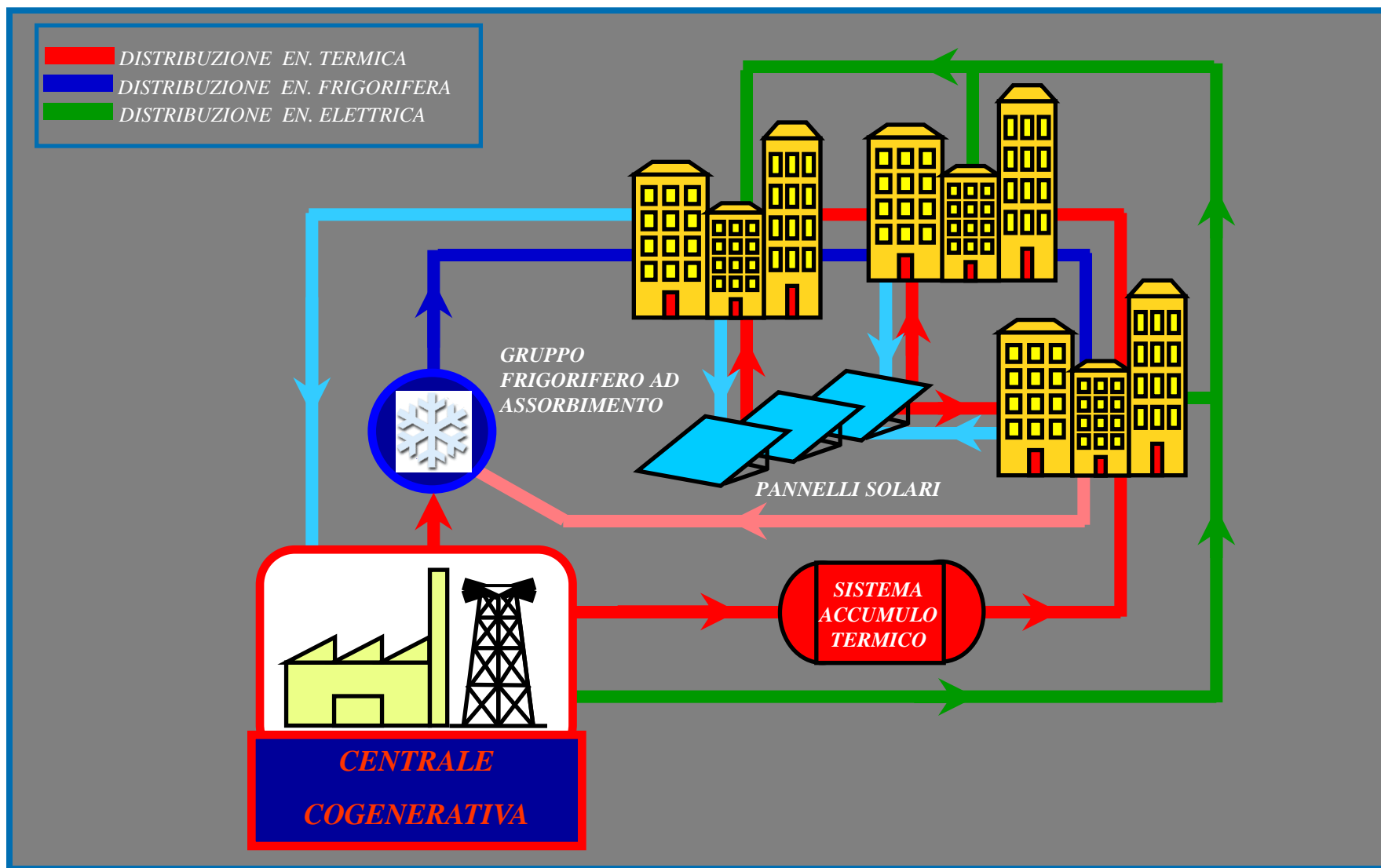
$$EER = \frac{Q_F}{Q_R}$$

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

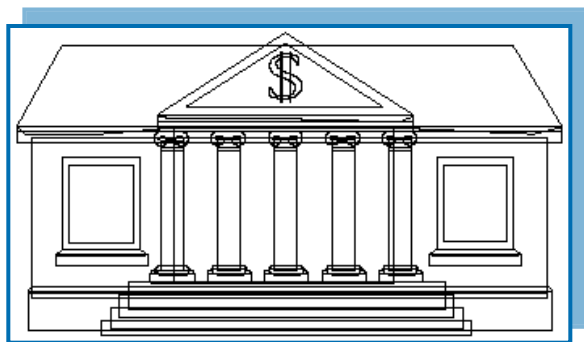




# Trigenerazione: le applicazioni



# Trigenerazione: le applicazioni



Windows