System performance parameters

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Outline

- **Performance parameters**
  - Utilization
  - Solar system efficiency
  - Solar energy yield
  - Solar fraction
  - Fractional energy savings
  - Exergy efficiency

Outline

- **Heat exchangers**
  - Types
  - Sizing and performance assessment methods

- **Performance parameters**
  - Utilization
  - Solar system efficiency
  - Solar energy yield
  - Solar fraction
  - Fractional energy savings
  - Exergy efficiency

Performance parameters

Utilisation: solar field size as compared to demand, sizing parameter

$$Ut_{sol} = \frac{Q_{demand}}{A_{coll}}$$ [kWhm^{-2}a^{-1}]

Solar system efficiency: limited to the solar loop

[- , %]

$$\eta_{sol} = \frac{Q_{sol}}{G \cdot A_{coll}}$$

Solar fraction: share of demand covered by solar loop

$$SF_{sol} = \frac{Q_{sol}}{Q_{demand}}$$ [- , %]

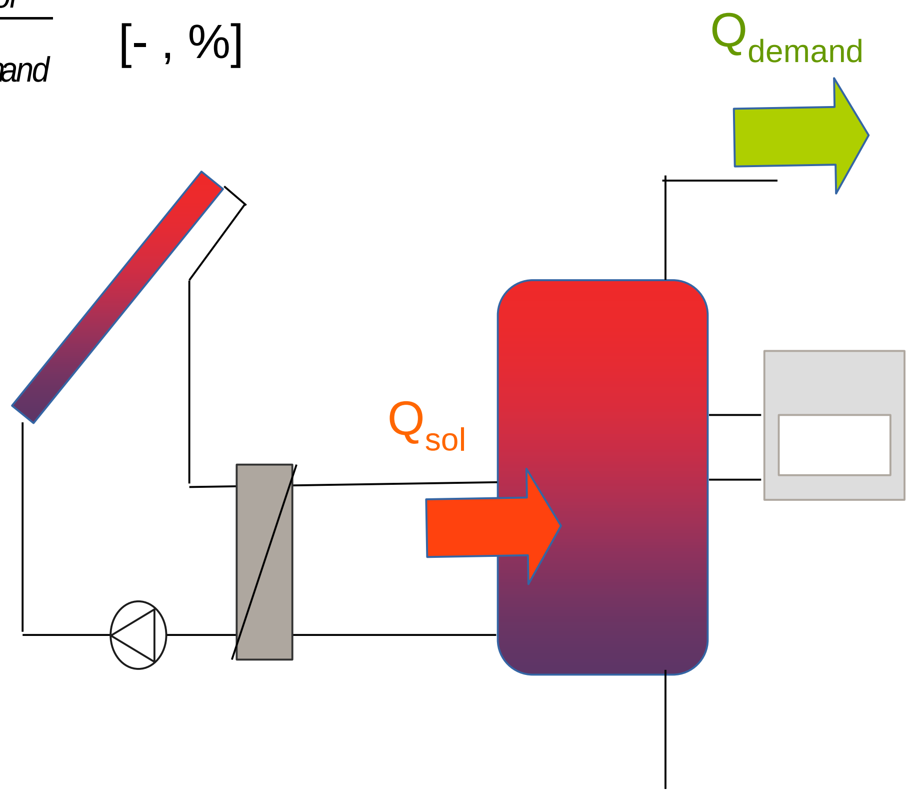
where $\mathbf{Q_{sol}}$ is the heat input in the storage from the solar loop

Performance parameters

Utilisation: $Ut_{sol} = \frac{Q_{demand}}{A_{coll}}$ [kWhm^{-2}a^{-1}]

Solar system efficiency: $\eta_{sol} = \frac{Q_{sol}}{G\ A_{coll}}$ [- , %]

Solar fraction: $SF_{sol} = \frac{Q_{sol}}{Q_{demand}}$ [- , %]

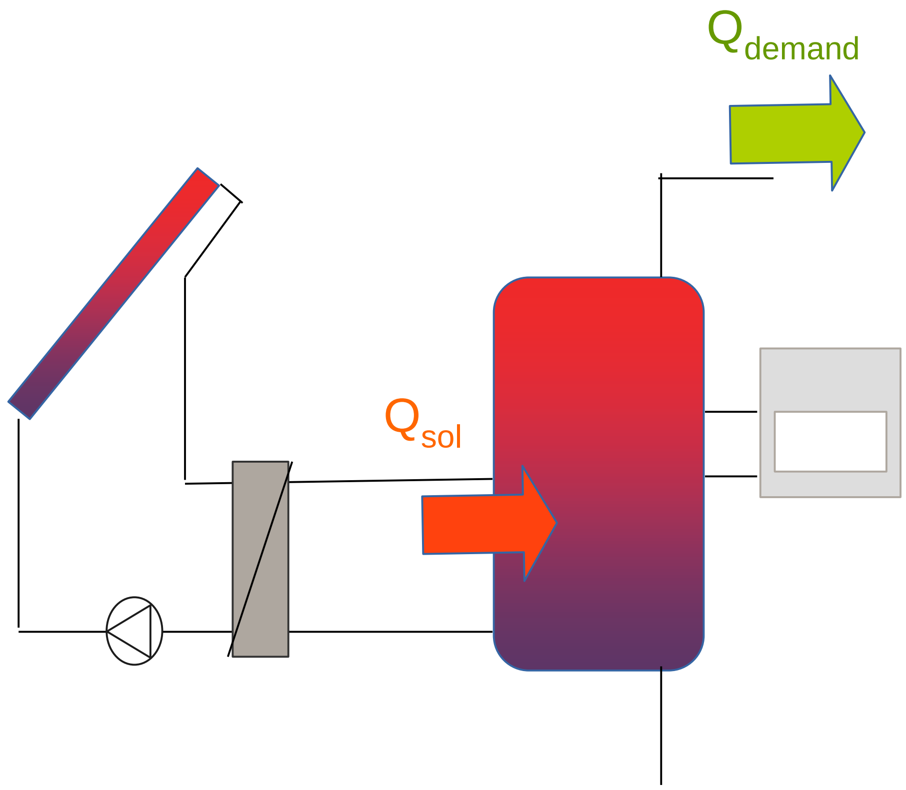


Performance parameters

Solar fraction: share of demand covered by solar loop

$$SF_{sol} = \frac{Q_{sol}}{Q_{demand}} \qquad [- , \%]$$

Is the solar system being "blamed" for thermal storage losses??



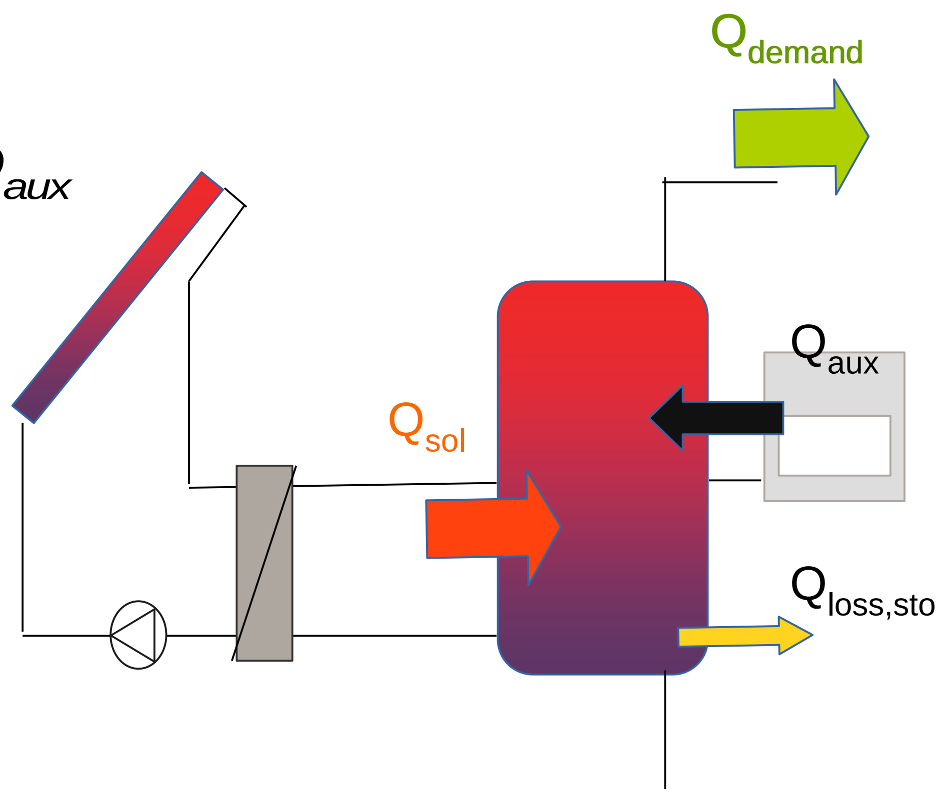
Performance parameters

Solar fraction: share of demand covered by solar loop

$$SF_{sol} = \frac{Q_{sol}}{Q_{demand}} \qquad [-, \%]$$

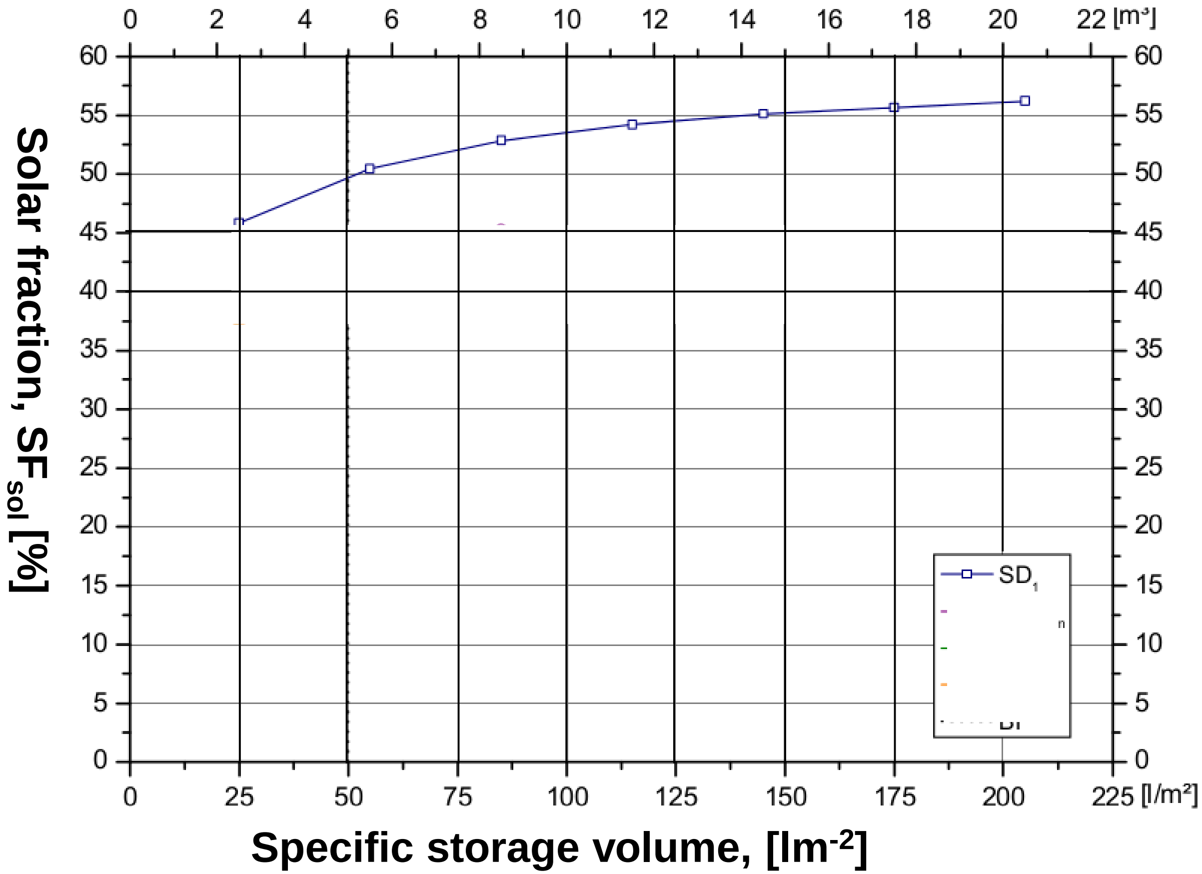
Is the solar system being "blamed" for thermal storage losses??

$$Q_{sol} = Q_{dem} + Q_{loss,sto} - Q_{aux}$$



YES! Auxiliray is considered as solely supplying the load

Performance parameters



Source: Heimrath, 2004

Performance parameters

Thermal fractional energy savings:

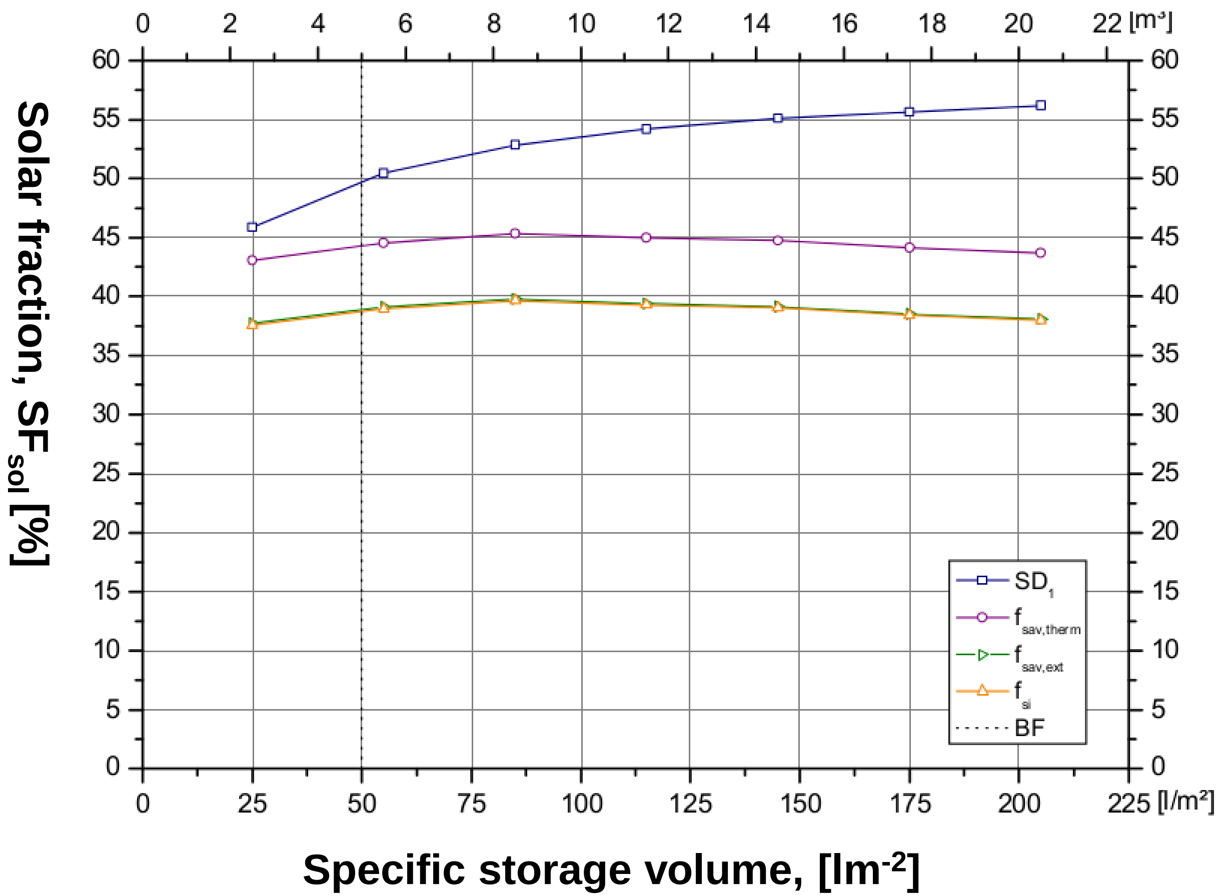
$$f_{sav,\,therm} = 1 - \frac{\dfrac{Q_{boiler}}{\eta_{boiler}} + \dfrac{Q_{el.heater}}{\eta_{el.heater}}}{\dfrac{Q_{boiler,\ ref}}{\eta_{boiler,\ ref}}} = 1 - \frac{E_{aux}}{E_{ref}}$$

Extended fractional energy savings:

$$f_{sav,\,ext} = 1 - \frac{\dfrac{Q_{boiler}}{\eta_{boiler}} + \dfrac{Q_{el.hetaer}}{\eta_{el.heater}} + \dfrac{W_{par}}{\eta_{el}}}{\dfrac{Q_{boiler,\ ref}}{\eta_{boiler,\ ref}} + \dfrac{W_{par,\ ref}}{\eta_{el}}} = 1 - \frac{E_{total}}{E_{total,\ ref}}$$

Source: Streicher, 2003

Performance parameters



Source: Heimrath, 2004

Performance parameters

- Utilisation, Ut_{sol}
- Solar system efficiency, η_{sol}
- Solar fraction, Sf_{sol}

- Thermal fractional energy savings, $f_{sav,therm}$
- Extended fractional energy savings, $f_{sav,ext}$

- **Specific collector yield** (yearly), q_{sol}: gives an idea of the thermal output of the solar field

$$q_{sol} = \frac{Q_{sol}}{A_{coll}} \qquad [kWhm^{-2}a^{-1}]$$

Performance parameters

Typical figures for different system setups

	Units	DHW small
Ut_{sol}	[$kWhm^{-2}a^{-1}$]	300-400
η_{sol}	-	0.35
SF_{sol}	-	0.60
q_{sol}	[$kWhm^{-2}a^{-1}$]	350-400
Costs	€m^{-2}	800-1000

Performance parameters

Typical figures for different system setups

	Units	DHW small	DHW big
Ut_{sol}	$[kWhm^{-2}a^{-1}]$	300-400	1000-1500
η_{sol}	-	0.35	0.50
SF_{sol}	-	0.60	0.35
q_{sol}	$[kWhm^{-2}a^{-1}]$	350-400	500
Costs	€m^{-2}	800-1000	800

Performance parameters

Typical figures for different system setups

	Units	DHW small	DHW big	DHW + SH
Ut_{sol}	[$kWhm^{-2}a^{-1}$]	300-400	1000-1500	**1500-2500**
η_{sol}	-	0.35	0.50	**0.20-0.30**
SF_{sol}	-	0.60	0.35	**0.25-0.30**
q_{sol}	[$kWhm^{-2}a^{-1}$]	350-400	500	200-300
Costs	€m^{-2}	800-1000	800	600-900

References

- Weselak, Schabbach. 2009. *Regenerative Energietechnik.* Springer Ed.

- Streicher, 2003. R*eport on Solar Combisystems Modelled in Task 26 (System Description, Modelling, Sensitivity, Optimisation).* IEA SHC Task 26.

- Incropera et al., 2007. Fundamentals of Heat and Mass Transfer. John Wiley and Sons, 2007