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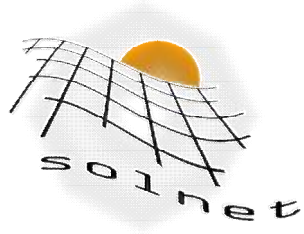

PhD project:
Advanced solar combisystems

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PhD project

Advanced solar combisystem

Project period: October 16, 2006-October 15, 2009

Supervisor: Associate professor Simon Furbo

Background

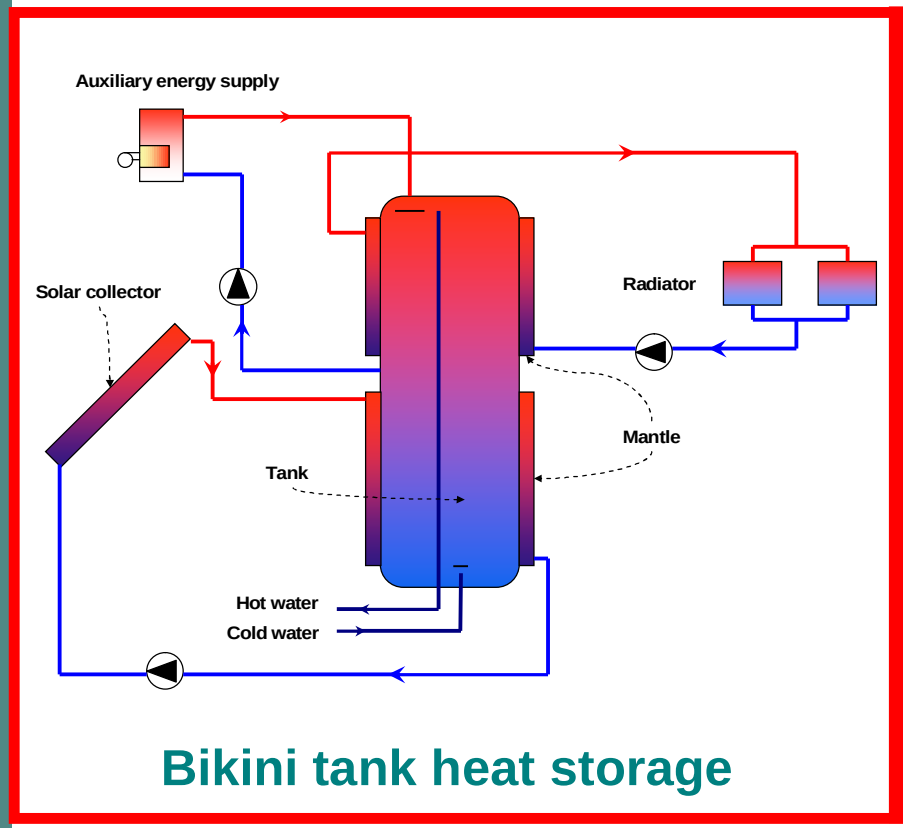
- Mantle tanks for SDHW systems are very attractive
- Smart solar tanks for SDHW system: Performance increased: 5-35%
- Tank in tank heat storage is attractive for solar combisystems
- New houses have low heat demand

Aim

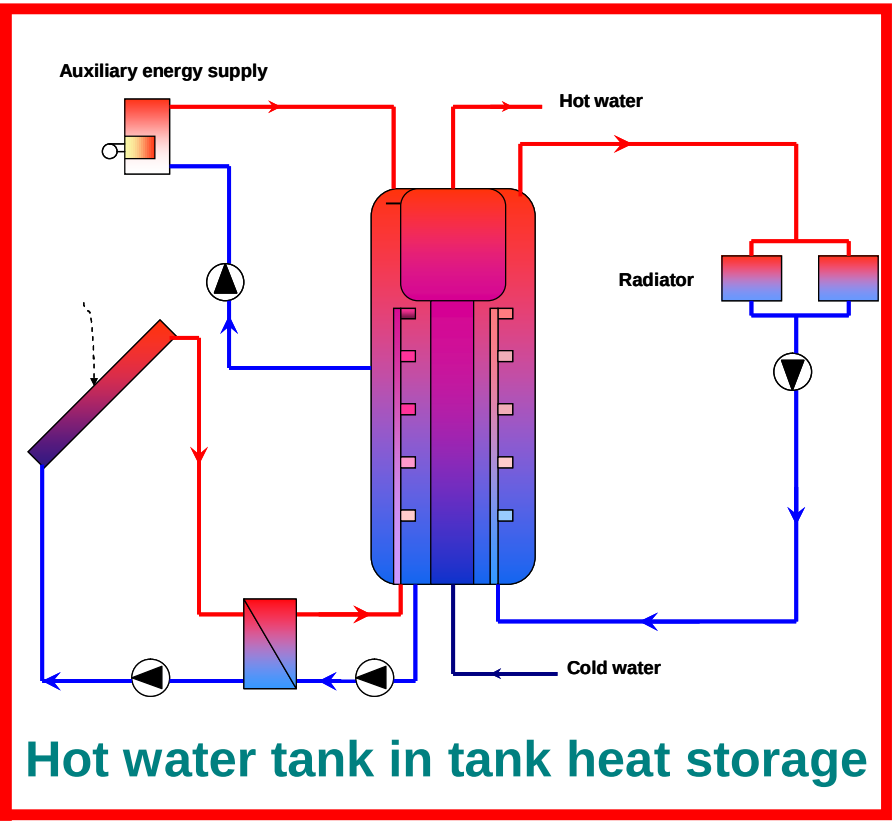
To carry out the basic research needed to establish the basis for development of an advanced smart heat storage and control system for solar combisystems with an oil fired boiler or a natural gas burner used as the auxiliary energy supply system.

PhD project
Advanced solar combisystem

Two heat storage types:



Bikini tank heat storage

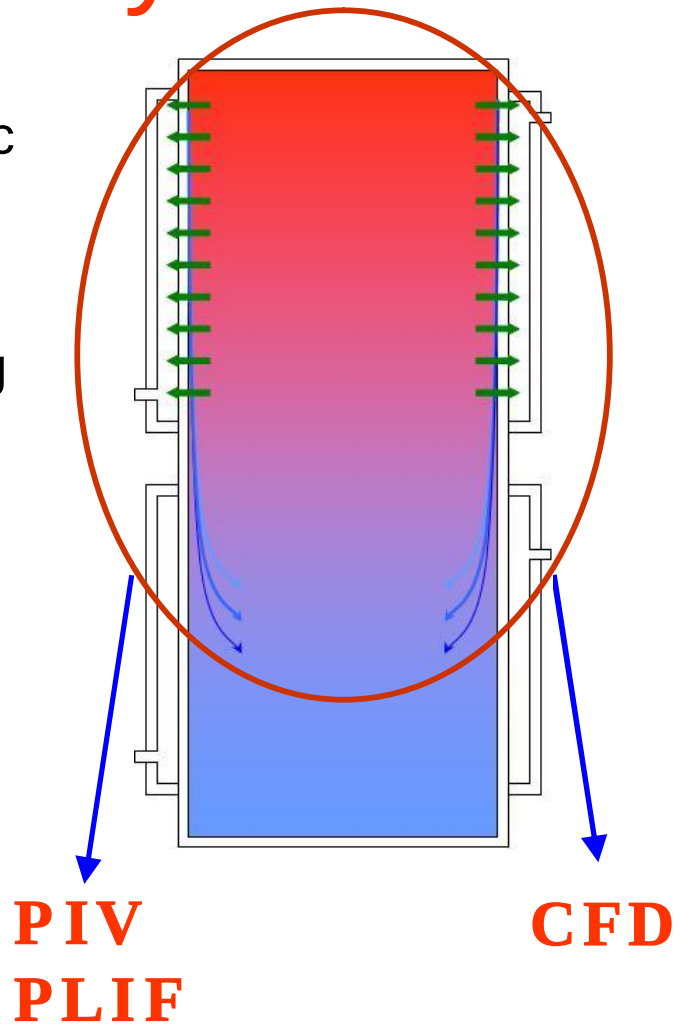


Hot water tank in tank heat storage

PhD project

Advanced solar combisystem

- Analyses on which heat storage principle is most attractive from a production, economic and thermal performance point of view.
- Investigations on controlling the operation of the boiler/burner.
- CFD (Computational Fluid Dynamics) using Fluent
- PIV (Particle Image Velocimetry) and PLIF (Planar Laser Induced Fluorescence) measurements
- Development and validation of simulation models for the thermal behavior of the heat storage and of a solar heating system based on the heat storage.
- Calculations with the developed simulation models



Last months activities

- Participation in the course entitled ‘MEETING DENMARK- intercultural encounters in a Danish context’.
- Supervision of one Master Thesis project student.
- TRNSYS simulations have been carried out in order to calculate the thermal performance of a solar combisystem based on a bikini tank.
- TRNSYS calculations for a tank-in-tank solar combisystem have been started.
- The paper ‘Solar combi system based on mantle tank’ was presented at the ISES Solar World Congress 2007, Beijing, China.
- Detailed laboratory experiments on a bikini tank have been carried out in order to determine how thermal stratification is built up in periods where the tank is discharged by means of the upper mantle.
- Participation in weekly meetings on the progress of the study.

TRNSYS calculations

Assumptions

Solar collector loop:

Solar collector area: 3-8 m²

Collector tilt: 45°

Mass flow rate: 0.15 kg/m²min

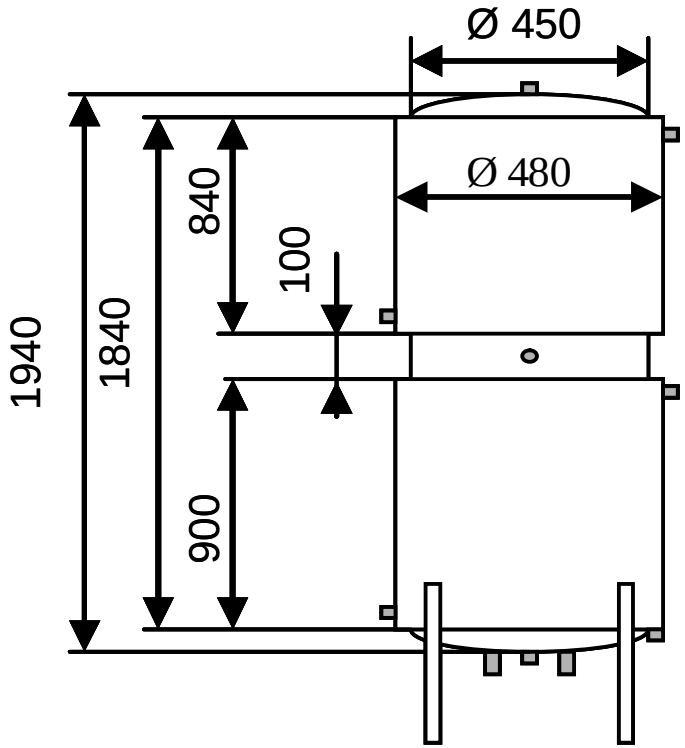
Control system:

Start temperature difference: 10 K
Stop temperature difference: 0.1 K

Weather data: Copenhagen, Denmark

Tank:

Tank volume: 300 L
Auxiliary volume: 150 L
Tank heat loss coefficient: 2.4 W/K
Heat transfer coefficients of upper and lower mantle: 200 W/m²K
Heat transfer area of the upper mantle: 1.19 m²
Heat transfer area of the lower mantle: 1.27 m²



TRNSYS calculations

Assumptions for the DHW and space heating system

Cold and hot water temperatures:

10°C and 50°C

Hot water consumption:

100 l/day, corresponding to 1700 kWh/year

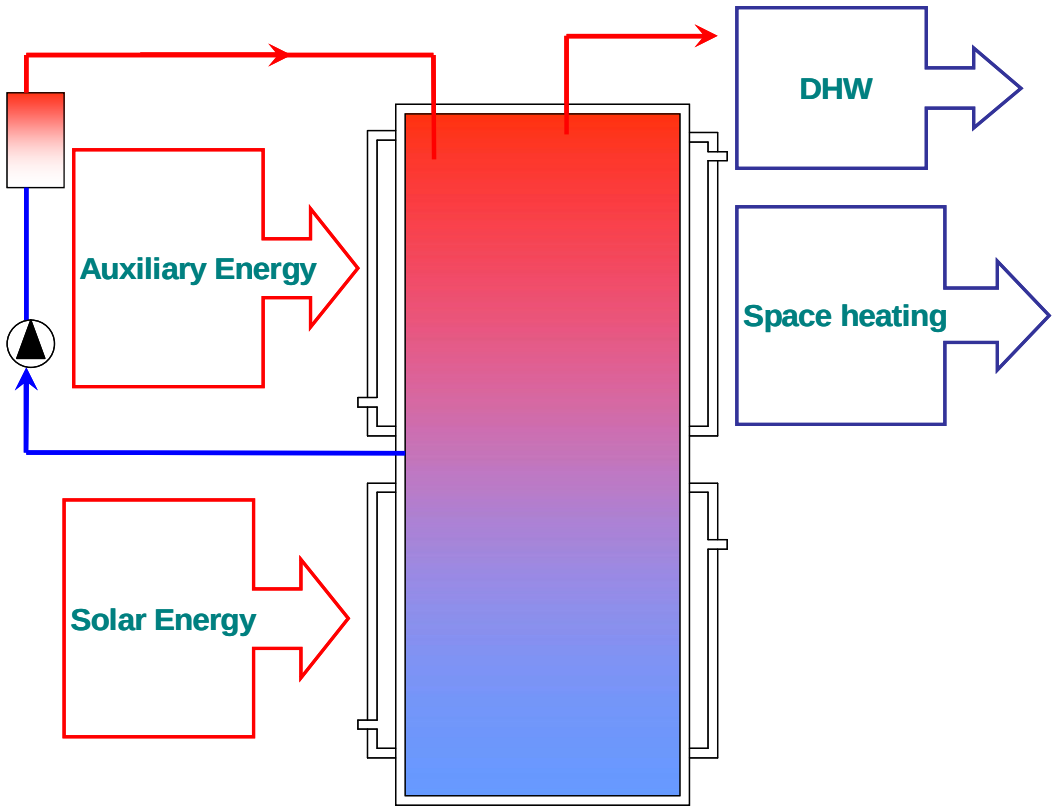
Three auxiliary set point temperatures:

50.5°C, 55°C and 60°C

Space heating demand: 5000 kWh/year

House area: 150 m²

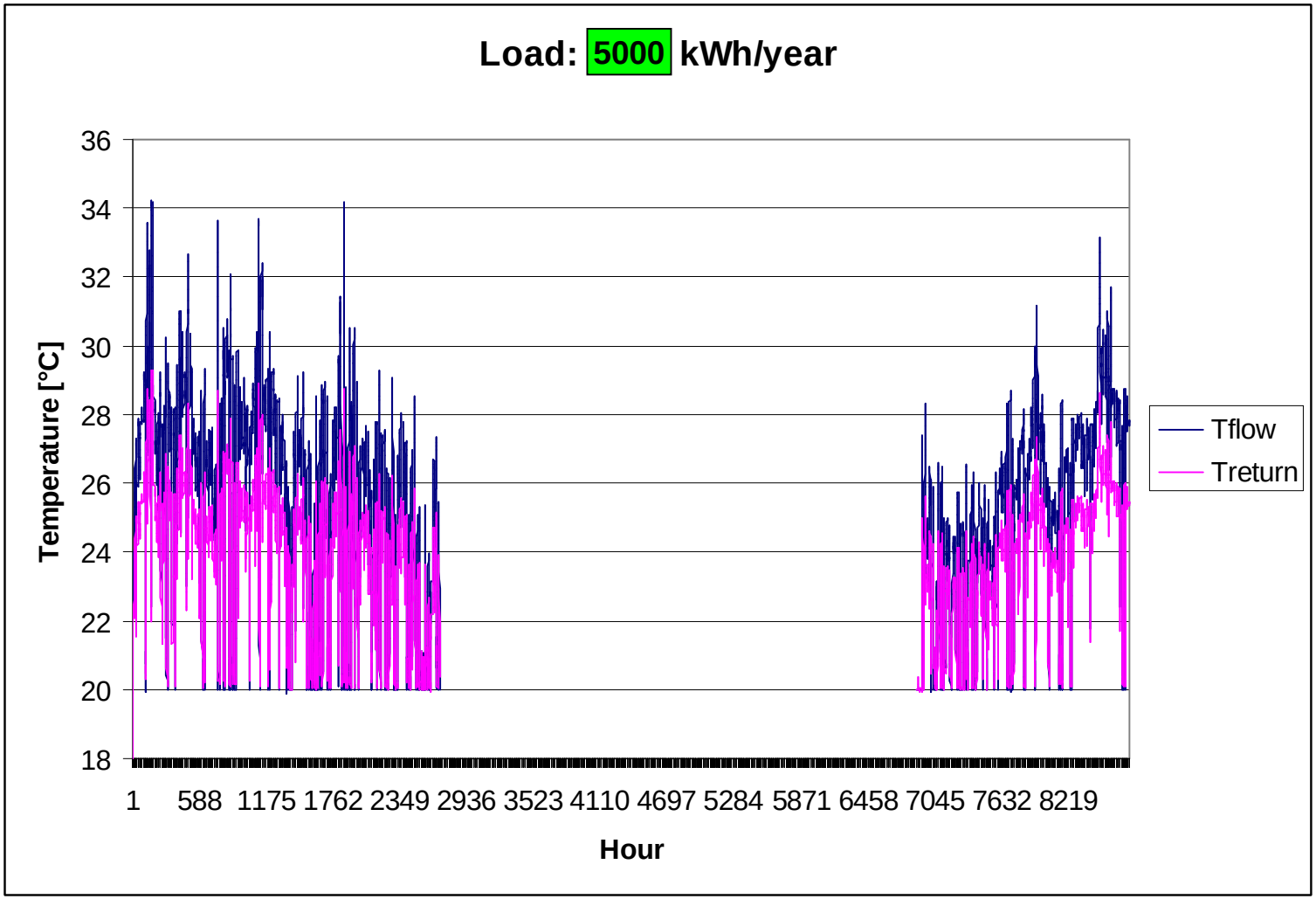
Definition of NUSE



Net Utilized Solar Energy = Space heating demand + DHW consumption - Auxiliary Energy

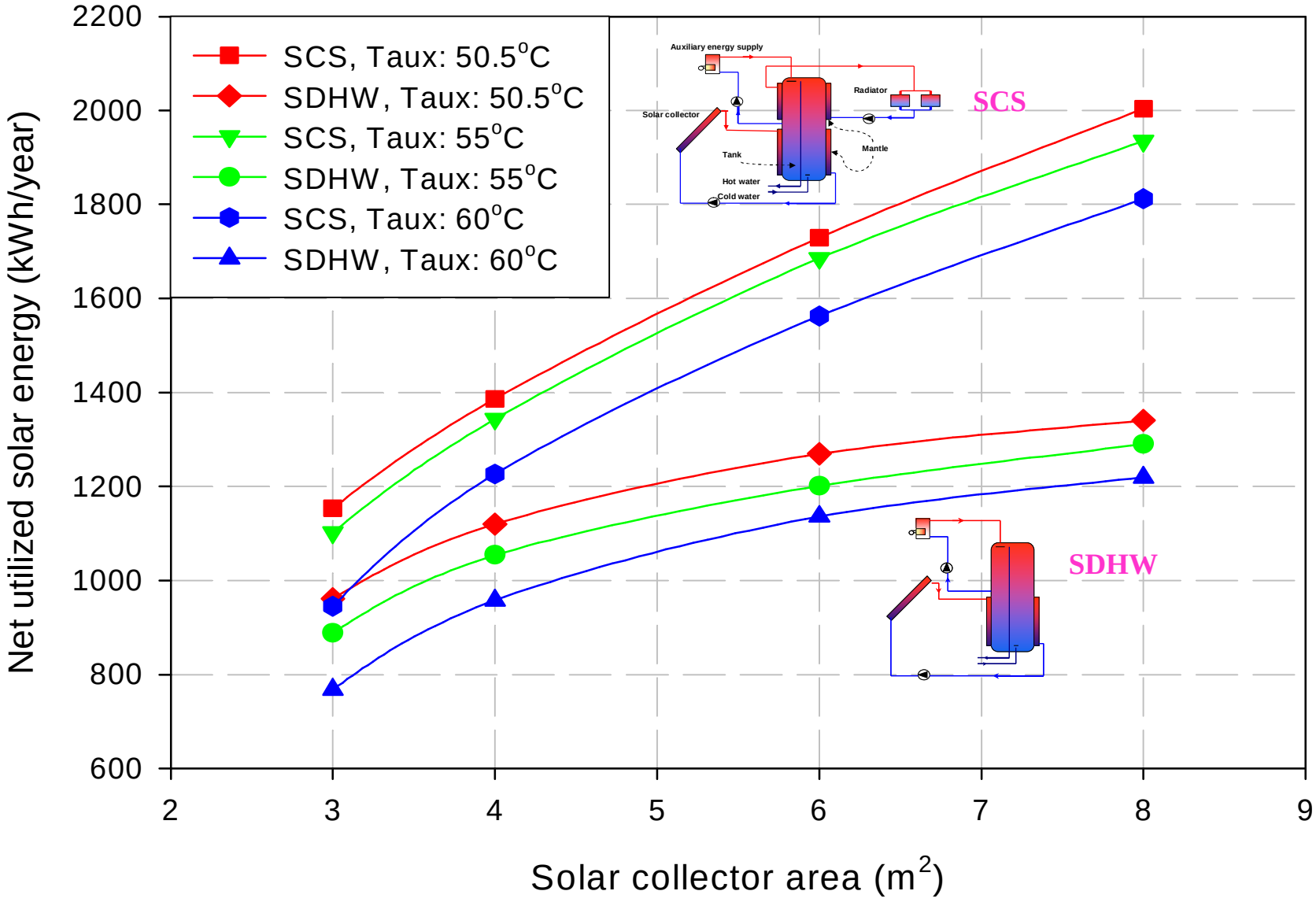
TRNSYS results

Space heating system with variable flow rate



TRNSYS results

Solar combi systems versus SDHW systems



Conclusion

The larger the radiator:

- the lower the required temperature for the auxiliary heater
- the higher the thermal performance of the system

The lower the space heating demand of the house:

- the lower the required temperature for the auxiliary heater
- the higher the thermal performance of the system

J Solar combi systems with bikini tanks perform better than SDHW systems with mantle tanks

J Solar combi systems based on bikini tanks are promising for low energy houses

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MARIE CURIE ACTIONS

SolNet

Thank you for your attention!