

DHW supply for multiple family dwellings, Switzerland

Investigation of the efficiency of domestic hot water generation, storage and supply systems for multiple family dwellings using heat pumps

Key facts

Building

Location	Switzerland
Construction	2010
Type	2 multiple dwellings (2 x 24 apartments)
Ground plot	2 x 48.5 m x 14 m
Heat distribution	underfloor heating
Level of insulation	very good (Minergie-P)

Heat pump and source

Number of heat pumps	2(1 heating,1 DHW)
Installed power	80 kW + 40 kW
Operation mode	monoenergetic
Heat source	groundwater

Heating system

Heat demand	<30kWh/m ²
Heating temperature	35°C

Domestic hot water

Type of system	centralized
Temperature	60°C (return 50°C)
Circulation system	conventional, 264 m
Storage tank	6'000 liters
Average consumption	4'285 liters per day (44 l/d per person)
Thermal energy	66 kWh/m ³
Electric energy	19 kWh/m ³

Lessons learned

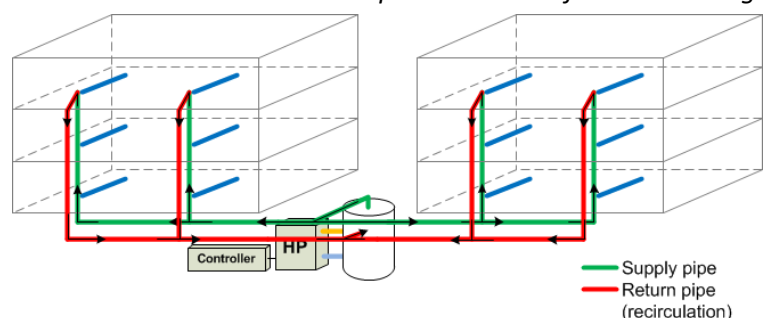
- Highest efficiency is achieved for recirculation systems including a recirculation heat pump.
- Conventional recirculation systems are prone to installation and setup errors, which lead to mixing of the DHW tank and reducing the efficiency.
- Systems with a heating cable have only a slightly lower overall efficiency.
- Systems using heat pumps for space heating to load decentralized DHW tanks show a very high energy consumption.



In multiple family houses, the water is often heated in a centralized or decentralized installation with a large distribution network. This leads to the combination of heat pumps with various trace heating systems to ensure both comfort and protection from legionella disease. The COP of the heat pump can be greatly affected by the choice of the heat tracing system, which influences the overall efficiency of the domestic hot water supply system significantly.

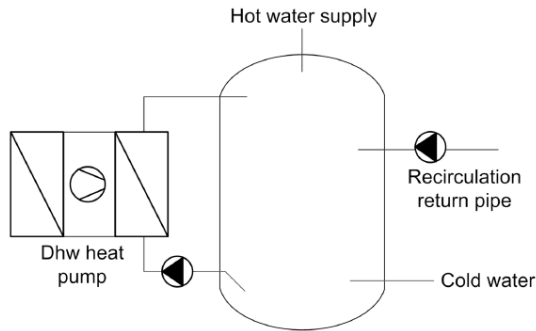
In this study, several heat storage and heat tracing methods were coupled with heat pumps as the main heat source. The investigated installations feature either a recirculation loop or some kind of electrical trace heating. Focused on multiple family dwellings the energy consumption of the overall system including hot water supply and water heating is analyzed. A physical model for four different systems was built and applied to several virtual building complexes sized from 8 to 192 apartments. The model was validated using data from the building mentioned on the left and two other buildings. Different domestic hot water supply technologies were then simulated and compared.

Conventional recirculation implemented in reference building

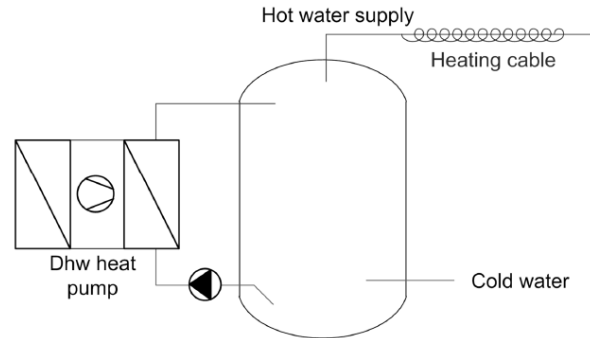


Technical details of the investigated DHW systems

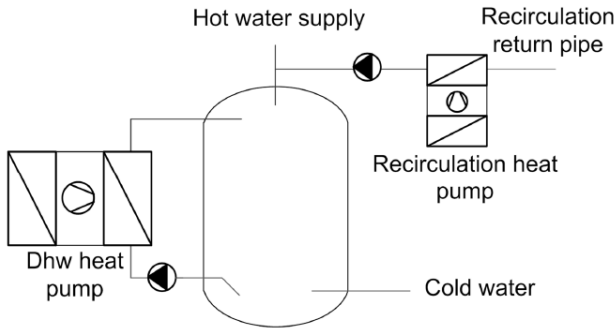
Conventional recirculation



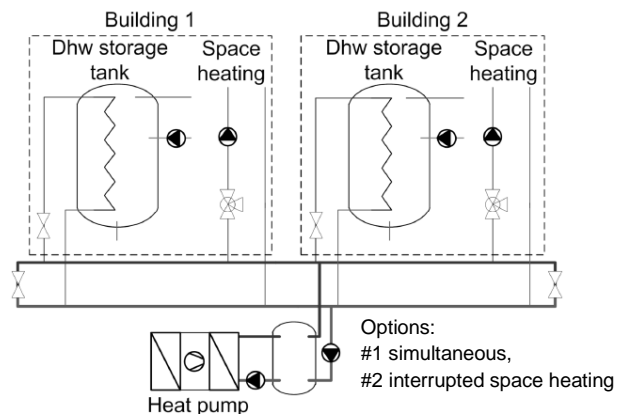
Heating cable



Recirculation heat pump



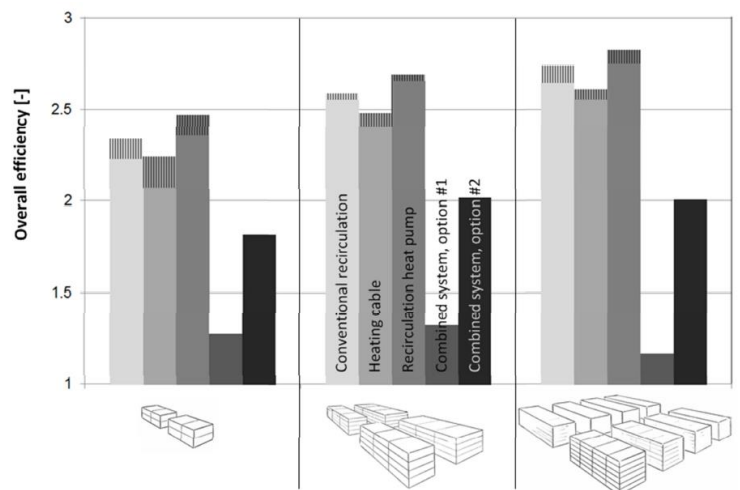
Combined system



Description of the technical concept – Modelling results

The modelling allowed making a comprehensive comparison of the investigated systems using the same boundary conditions. The recirculation systems including a separate recirculation heat pump showed best overall efficiency. The most common system in Switzerland, a conventional recirculation loop showed second best performance, about 5% lower in the best case. The major disadvantage of this system is its high sensitivity to installation and setup errors, which leads to mixing of the DHW tank. The DHW storage tank has a significant influence on the overall efficiency depending on its mixing behavior due to the flow turbulence induced by recirculation. It is a key element to reach a good efficiency. A good estimate to adjust the recirculation flow rate is to set the return temperature to about 10°C below the supply temperature (not 2°C as the factory setting).

Systems with a heating cable have an approximately 10% lower overall efficiency compared to the most efficient system. Heating cable systems are easier to handle and cheaper in installation and less prone to installation error.



Overall efficiency of the DHW supply systems:
(striped: decentralized option, solid: centralized)

Combined systems using heat pumps for space heating to load decentralized DHW tanks over the heat distribution system show energy consumptions that are 50% to 100% higher than the others. This shows that the two temperature levels for space heating and DHW supply have to be provided by independent supply systems.