General refurbishment of two MFH with PV and heat pumps, Germany

A5

In 2023, a refurbishment was completed and the heat pumps were installed, featuring an added external control system to monitor heating element usage.

Key facts

Buildings

Location	*Bochum, Germany*
Construction	*1955*
Project type	*retrofit*
Heat distribution	*radiators*
Heated space	*820 m² (in two buildings)*
No. of apartments	*2 x 6*
Level of insulation	*good*

Heat pump and source

Number of	*2 (1 per building)*
Operation mode	*bivalent with electrical heating elements*
Heat source	*ambient air*
Electrical heating elements	*2 x 19,4 kW (2 x 3 elements)*

Heating system

Installed power	*2 x 22,1 kW*
Heating demand qH	*39 kW/m2*
Heating load	2 x 22,7 kW
Heating temperature	*55°C*

Domestic hot water

Type of system	*Fresh water stations*
Max. temperature	*55°C*
Circulation system	*Fresh water system*

Other information

Efficiency heat Pump (SPF)	*1,2/1,4*
Refrigerant	R 407c

The general refurbishment was carried out in 2023 in order to keep future heating costs for tenants at a reasonable level and meet the climate protection targets by improving energy efficiency. After evaluating the first heating period with system coefficients of performance of 1.2 - 1.4, an external control system has now been retrofitted in the systems to monitor the use of the heating elements.

Fine-tuning and, if necessary, further measures will be carried out in the second heating period in order to ensure proper operation, prevent overruns in heat-related ancillary costs and, from the tenant's point of view, ensure a reduction in heating costs compared to the situation before the refurbishment.

“Lessons learned”

The SPF measured in the 1st heating period is 1.2 and 1.4, respectively, due to an approx. 60 and 70% share of the heating elements. This is due to high network volume flows with mixed storage tanks and inadequate manufacturer control, which is based on a 24 kW electric boiler that was not allowed to be installed due to high heating costs and the EnEV specifications with a maximum proportion of heating rods of 5%. In the meantime, the complex retrofitting of an external control system has been carried out in the systems in order to be able to control the use of the heating rods. The problem is also typical for other medium-temperature heat pumps if, due to the system, high proportions of heating elements or “electric boilers” are required to operate the target temperature level. This was taken into account in follow-up systems.

Pictures: Stiftung Energieeffizienz

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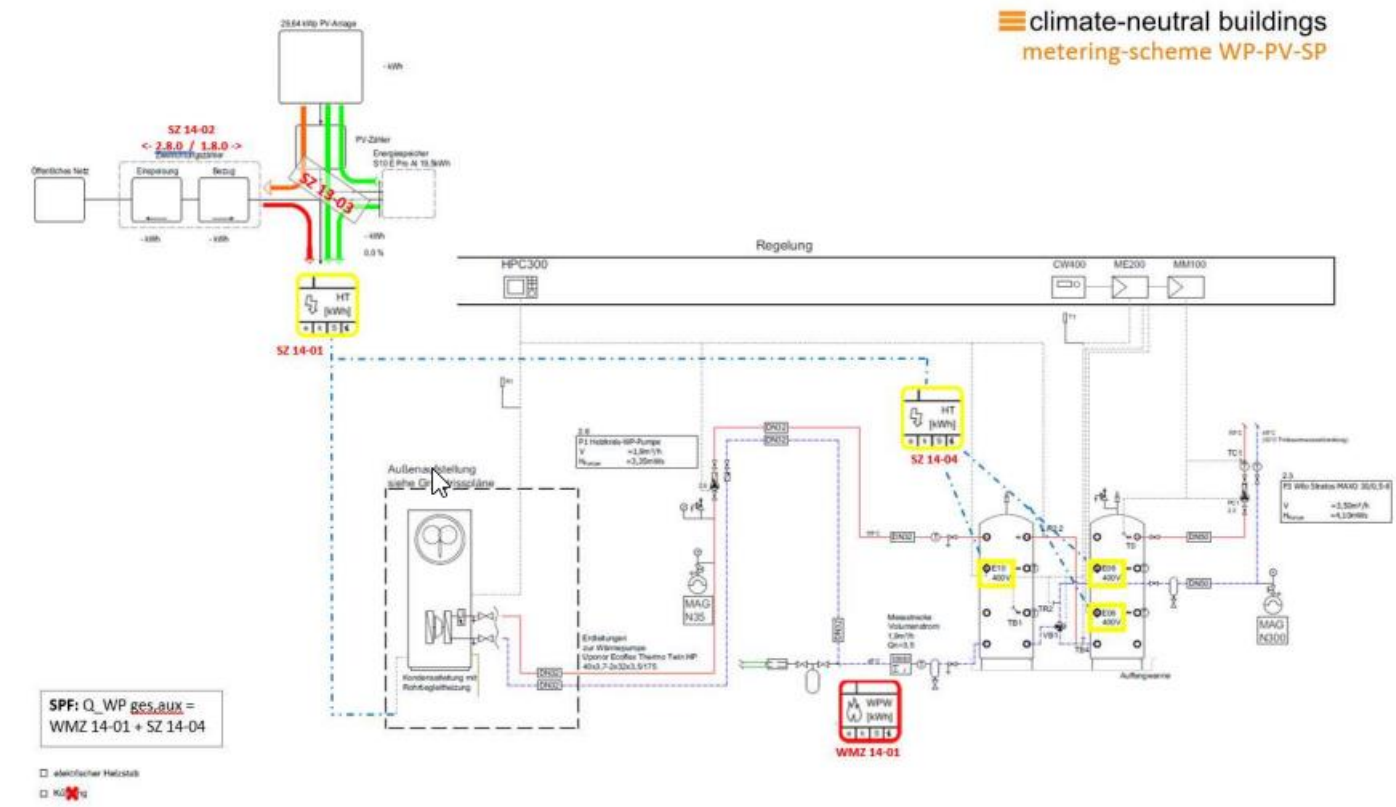
Technical details



Description of the technical concept

The two 22 kW air source heat pumps were each installed in open spaces outside the buildings, taking noise protection into account. Operation at a storage temperature of 55° in the buffer and standby storage tanks was agreed with the manufacturer in order to avoid permanent heating of the water in the standby storage tank, which had only been preheated to 45°C in the buffer tank, and to limit the operation of the heating elements to a maximum of 3 %. Two 6 kW heating elements were installed in the standby storage tanks to release heat below the bivalence point of approx. -2.5°C. The 7.4 kW heating element in the buffer cylinder is used solely for defrosting. The 2-pipe distribution circuit is operated all year round with a flow temperature of 55° C and a maximum return temperature of 45°. The self-regulating stations are intended to limit the return temperature without thermostatic preheating modules in the lowest station. The low overall temperature spread in the system places increased demands on the control system.

Results Monitoring

During the 1st heating period since autumn 2023, findings were collected about the operation in order to optimize the operation. The performance data for the efficiency and CO2-assessment is based on the measured value-based evaluation of the 1st heating period up to July 2024 by the climate-neutral buildings portal (CNB module of the sustainable data platform).

For fault detection, additional analyses of the system behaviour and the user side were carried out using the non-invasive peer4 sensor case for heating optimization. The lack of network spreading, problems with the apartment transfer stations (overflow), the uncontrolled use of the heating elements and incorrect settings during commissioning were identified as the main deficiencies. The evaluation of an internal heat pump controller indicates a coefficient of performance of 1.9, which is reduced by the inclusion of the electricity consumption for the heating elements.