EuroSun2026

FAÇADE AS HEAT SOURCE IN HEAT PUMP SYSTEMS FOR MULTIFAMILY HOUSES: POTENTIAL ANALYSIS AND IMPLEMENTATION OF TWO DEMONSTRATION BUILDINGS

Summary

Heat pumps are expected to almost completely replace fossil-fired boilers in the European building sector in the next two decades. The targeted transformation represents a huge challenge, especially for densely populated urban areas with space, geological or other kind of constrains (noise, regulations, general acceptance issues). The energetic use of the building envelope offers a promising alternative to conventional heat sources with untapped potential. The work discusses the use of thermally activated, rear ventilated façades as additional heat source in heat pump systems for multifamily houses. Our simulation study with the software TRNSYS based on validated models shows, that these new facades can reduce the size of borehole fields up to 35% in small buildings. After this first theoretical analysis we present heat supply concepts, practical experiences and monitoring results of two demonstration buildings with different active façades, which were implemented in 2023 und 2025 respectively.

Keywords: solar façade, ground-coupled heat pumps, multi-family houses, solar regeneration

Field of application for the findings: energy-efficient building design and renovation

Addressed audience: façade and heat pumps manufacturers, housing companies, architects, building system engineers, energy consultants, researchers

Heat pumps are expected to progressively replace fossil-fuel-fired boilers as the primary heat generator in the European building sector. Energy scenarios for achieving Germany’s climate goals project an increase in the number of heat pumps from 2 million today to as many as 15 million by 2045. The targeted market growth represents an enormous challenge, particularly in urban areas. A key issue here is accessing the heat source of heat pump systems, as installation conditions are often unfavorable (lack of space, noise emissions, distance regulations as well as general acceptance issues).

Solar thermal collectors can mitigate this challenge by both serving as a direct heat source or regenerating other heat sources like geothermal systems or ice storage. While traditional rooftop installations have long been established for this purpose, the use of the building envelope remains an unconventional alternative that has been tested exclusively in research works or rare pilot projects. A key benefit here is the synergy resulting from the combined renovation of the building envelope and building system engineering, which can lead to cost savings.

In an ongoing research project, a team of facade manufacturers, housing companies, and research institutes is investigating the potential of solar-thermally activated, rear ventilated façades as heat pump sources in apartment buildings. What makes the project approach particularly remarkable is, on the one hand, the use of standard facade claddings as solar absorbers and, on the other hand, the invisible integration of heat exchangers into the ventilation gap, ensuring that the resulting appearance is not distinguishable from that of conventional facades. Following the successful development of various facade and heat supply concepts, the project has moved into the implementation and demonstration phase, aiming at the construction and scientific monitoring of two pilot buildings.

The first pilot project is a new multi-family house, consisting of 19 residential units, which was completed in 2023 (see Figure 1). Heat is supplied by two brine-water heat pumps with a total thermal power of 38 kWh operating in monovalent mode. As heat source for the heat pump system a combination of four 150 m deep boreholes and 128 m² thermally activated facades is being investigated. The experimental setup was designed so that one geothermal probe could be shut off, allowing the system behavior to be examined and compared with both 4 and 3 probes over two consecutive years of operation. The activation of the rear-ventilated concrete façade is achieved by embedding plastic capillary tube mats as heat-exchanger into the cladding during the manufacturing process and can reduce to size of the borehole field by 30%. Monitoring began in the summer of 2024.

Fig. 1: Demonstration building with thermally active concrete façade. View of the west (left) and east (center) façades as well as design sketch and manufacturing process (right)

The second pilot plant is located in a residential neighborhood with over 100 residential units, which is currently undergoing a step-by-step energy-efficiency retrofit (see Figure 2). Heat is supplied here by a three-component system consisting of a combined heat and power unit (33 – 51 kW), a brine-water heat pump (38 kW), and a gas-fired peak-load boiler, with heat distributed via a local heating network. Since there was insufficient space in the courtyard for the planned borehole field, the housing company decided to test the use of a thermally activated metal façade (65 m²) and a solar air absorber field (43 m²) as complementary solutions. In this case as well, these serve as an additional heat source for the heat pump and as a regeneration source for the borehole field. This allows the size of the field to be reduced by 35% (from 24 to 16 probes) and ensures a long-term sustainable operation of the system. Monitoring began in the winter 2025/2026.

Fig. 2: Demonstration building with thermally active metal façade. General view of the building complex under renovation (center), installed solar air absorber field (left) and active metal façade (right).

After a theoretical analysis of the potential of the facades for this specific application based on simulations with the software TRNSYS, the paper presents and discusses the heat supply concepts for both buildings, focusing on the practical aspects of the implementation, as well as monitoring results.