EuroSun2026

ACTIVATING FLEXIBILITY OF THE HEAT SUPPLY SYSTEMS AT THE LAGARDE-CAMPUS IN BAMBERG: EVALUATION OF THE CONTROL SYSTEM

Summary

Within the last years, the Lagarde Campus in Bamberg has been transformed into an energy efficient campus for living and commercial use. To implement flexible operations of installed heat pumps (HP) and combined heat and power (CHP) units, an information and communication system (ICT) for the complete interaction of sensors, components, forecasting systems, and interfaces to the grid operator, energy supplier, and a trading platform has been included. A monitoring system enables the evaluation of the energy supply system regarding key performance indicators, like energy efficiency, prices and CO_2. Energy-market oriented flexible operation of HP and CHP units has been implemented and evaluated for the winter period 2025/2026. Due to system constraints, the flexibility potential of HPs for domestic hot water provision is limited whereas for space heating, a significant shift potential is applicable showing cost savings of up to 30%. The flexible operation of the CHP units can easily be carried out leading to cost savings of up to 10% for the whole campus system.

Keywords: Heat Pumps, District Heat, Flexibility, Geothermal Heat, ICT

Field of application for the findings: Sustainable Heating and Cooling Systems

Addressed audience: Energy Suppliers, Aggregators, Researchers

1. Study Site Lagarde Campus

Over the last years, the district Lagarde-Campus in Bamberg (Germany) has been converted from a former military site to an energy efficient campus for living and commercial use (Fig. 1). With an area of around 20 hectares, the Lagarde Campus is one of the largest infrastructure projects in Germany, comprising housing for around 1,200 families as well as areas for business, services, culture, and social facilities.

Fig. 1: Photo of the south-western part of the Lagarde-Campus (Source: Stadtwerke Bamberg)

With the energy supply concept operated by Stadtwerke Bamberg, thermal energy for new buildings is provided by heat pumps (HP) connected to a cold district heating grid that utilizes geothermal sources (soil collectors and boreholes) as well as waste-water heat (Meyer et al.). For existing buildings, a combined heat and power (CHP) plant is supporting the district heat coming from a waste combustion power plant. In addition to the electric power from the CHP unit, a large proportion of the electricity for operating the HPs is generated by photovoltaic systems on the roofs of the campus buildings. Besides the warm and cold heating grids, an additional electricity grid has been integrated to utilize the electricity for the energy supply systems on campus level (Fig. 2).

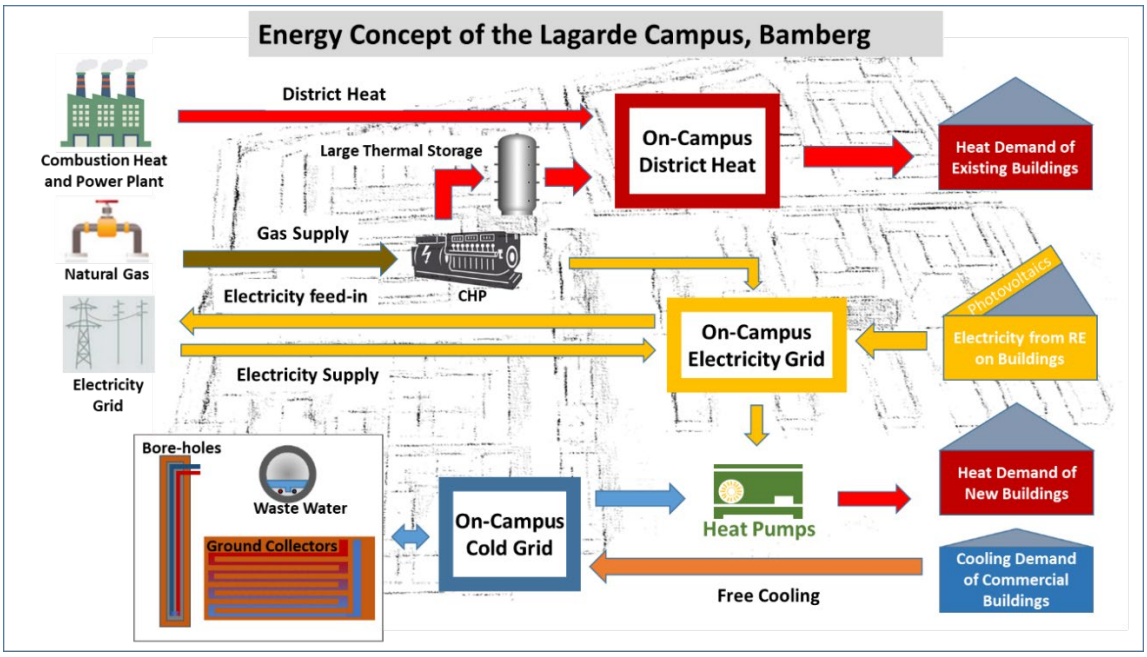

Fig. 2: Elements of the energy supply concept of the Lagarde-Campus

Within the research project Enable funded by the German Ministry for Economics and Energy (BMWE), an optimization of the cross-sector control of the district systems has been implemented. The optimization especially focuses on the utilization of the system flexibility including marketing of electricity demand and consumption (Langemeyer et al). For this, an information and communication (ICT) system for the complete interaction of sensors, components, forecasting systems, and interfaces to the grid operator, energy supplier, and a trading platform operated by SEtrade has been included. The aim of the project is to demonstrate this complete ICT chain in the field at the Lagarde-Campus and to evaluate energy efficiency as well as CO_2 and cost benefits of the flexible operation. For this, an automated energy management system has been implemented by Siemens Building Services in interaction with the conventional building management system and external services like weather, spot market prices and AI-based forecasting techniques.

2. Monitoring Results

Within the research project, the performance of the different HP systems being installed in the different multi-family houses at the Lagarde Campus has been evaluated. Until the end of 2025, the heat pump systems of 15 buildings have started their operation. Each HP system consists of one to three single brine-to-water heat pumps connected to the cold grid for the provision of space heating (SH) and/or domestic hot water (DHW). The temperatures in the buffer tank for SH are controlled depending on the ambient temperature and differ between 35°C and 45°C. For DHW, even if building central fresh-water stations have been installed, minimum temperatures of 60°C for withdrawal have to be ensured at all times.

As can be seen in Fig. 3, for all buildings the coefficients of performance (COP) are in the range of 2.8 in summer (for DHW) and up to 4 (for combined DHW and SH provision) in winter, proving the good overall performance of the energy concept of the Lagarde Campus. Within two buildings (LKS6, LKS10), DHW is provided with fresh water stations being installed in the building apartments, leading to reduced supply temperatures und thus to COP of the HP system of up to 5.

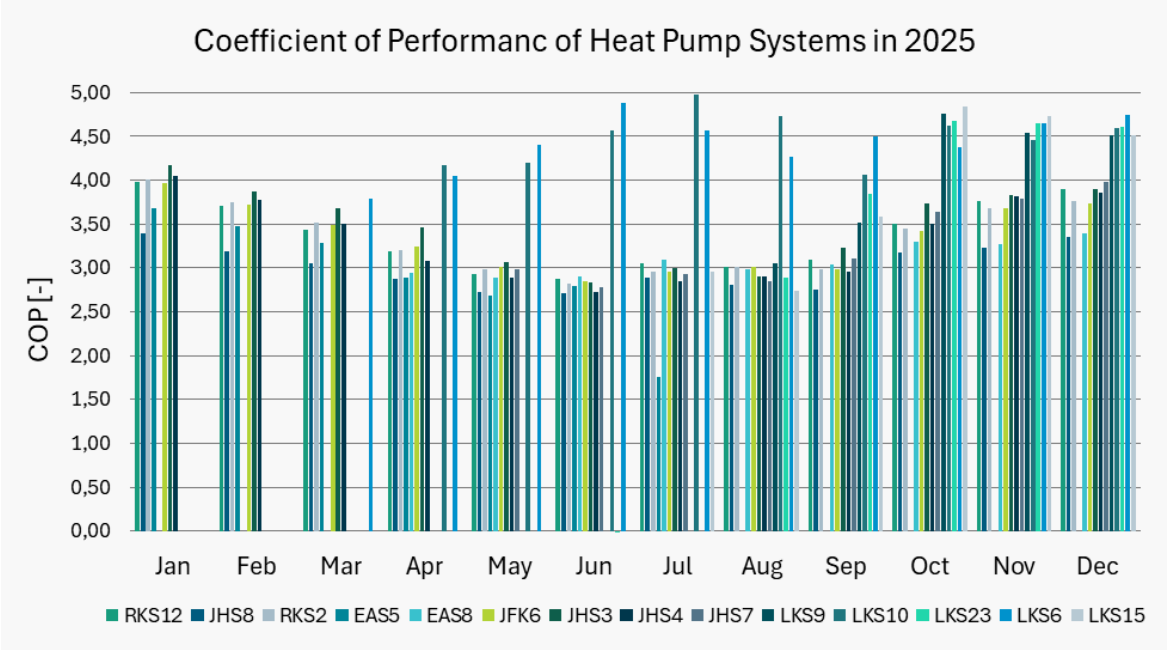

Fig. 3: Coefficient of Performance (COP) of the monitored heat pump systems in 14 buildings at the Lagarde Campus within the year 2025. In each of the buildings, 1-3 heat pumps have been installed for the provision of space heating and domestic hot water.

Building up on the evaluation of the demand-oriented operation of the heat pumps, the impact of the energy-market-oriented flexible operation of the entire system - including both heat pumps and CHP units - has been assessed. Regarding the operation of the heat pumps, temperature set values for heat pumps and the respective storage tanks have been shifted depending on the price signals. In case of DHW, the potential of increasing and decreasing set points is limited to the temperature range 60-65°C due to the legionella requirements as well as the maximum possible provision temperature of the DHW heat pump. Following this, the shift potential of the operation is quite limited as well. In terms of space heating, the shift potential is significantly higher. In winter months, a temperature range from 45-60°C can be assessed whereas in spring and autumn, a spread from 35-60°C is possible. However, since the total heat demand in the transition periods is significantly lower compared to the winter times (especially for new residential buildings), the shiftable thermal and electrical energy is much lower as well. In the current case of non-modulating heat pumps being installed in the buildings, the part-load behavior leads to additional constraints in the flexible operation. Overall, first results on subsystem level show cost savings of up to 30%.

Compared to the heat pumps, the flexibility potential of the CHP units is much higher within the Lagarde Campus. Since the CHP units are an add-on to the district heat serving the existing buildings, the operation can easily been shifted or even limited to times of high electricity market prices. For the complete campus – including the uncontrollable loads – a saving potential of up to 10%, depending on price and weather conditions is expected. For activating the operational flexibility, limitations exist only with regard to number of starts of the units and minimum operation times for each day. However, high operation times of the CHP are still required to ensure good overall economic performance considering the investment cost of the CHP units.

3. References

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