

SMART COOLING CONTROL CUTS CONSUMPTION OF ENERGY

By leveraging a digital twin and the AI-powered, fully automated software solution from Factor4Solutions, Stadtwerke Karlsruhe were able to reduce the annual energy consumption of the existing refrigeration system at the GartenCarée complex by 20 percent within just the first six months of operation – significantly increasing its efficiency. And the full potential is far from reached: for an entire year of operation, the utility expects energy savings of up to 40 percent.

ENERGY EFFICIENCY, INDUSTRIAL EQUIPMENT & SUPPLIES



As a municipal utility with around 1,100 employees, Stadtwerke Karlsruhe supplies more than 400,000 people with electricity, natural gas, district heating, and drinking water – including the GartenCarée site in Karlsruhe, whose cooling system is operated by the utility. **In addition to residential units and office spaces, the building complex also houses a data center, medical practices, retail shops and restaurants.** The GartenCarée cooling system consists of three absorption chillers powered by environmentally friendly district heating such as process waste heat from a nearby refinery, as well as a mechanical compression chiller with two compressors and a cooling tower. **"When it came to the energy consumption of our system, we were more or less flying blind,"** recalls Jürgen Weiß, Head of Construction Management and Technology at Stadtwerke Karlsruhe, describing the situation before the solution was implemented. "At the end of the year, all we could see was how many megawatt-hours of cooling we had produced and how much electricity and district heating we had used to achieve it – nothing more, nothing less."

Project Goal: Greater Transparency and Efficiency in Refrigeration

That was about to change. **Stadtwerke Karlsruhe set out to identify and realize potential energy savings.** "To that end, we implemented an automated energy system management solution together with the provider, which enables better control of the individual components and provides detailed monitoring and analysis," explains Weiß. "As a result, all energy flows are now visible in detail, and optimizations can be implemented and analyzed directly. **The transparency we've gained is a major advantage.**" The system measures and analyzes parameters such as the flow rate of chilled and cooling water, orchestrates them to maximize system efficiency and determines whether it is more economical to operate the chillers or use free cooling depending on the outdoor temperature. One example: pumps running constantly at 100 percent flow, even when 60 percent – or less – would be sufficient depending on conditions, present significant potential for improved efficiency and energy savings.

A common challenge in refrigeration systems is that pumps and cooling towers often consume as much electricity as the chillers themselves—without this being detected. Moreover, energy optimization typically occurs only at the component level and is often

based on a single operating condition defined during system planning. However, this condition accounts for less than three percent of total operating hours. The result is unnecessary electricity consumption during a large portion of system runtime. Achieving efficiency gains through improved interaction between components is the specialty of Factor4Solutions.

After Six Months: 20 Percent Less annual Electricity Consumption and Five-Figure Cost Savings

The intelligent software from Factor4Solutions analyzes the operation of all components relevant to the cooling system as a whole – including all components' energy consumption. To do this, the solution uses digital twins of both the individual components and the entire cooling system, allowing it to calculate in real time, or on demand, how each component must behave to support the assembly of components and to maximize overall system efficiency.

As a result, chillers and auxiliary equipment are no longer controlled in a fixed sequence based on base and peak load logic. Instead, they are operated dynamically and efficiency-based, depending on weather conditions and required cooling output, via standardized system management protocols. This ensures the system runs at maximum efficiency under all load conditions.

The Stadtwerke Karlsruhe team was able to confirm the system's effectiveness right after the test phase ended. "In just those six months alone, we reduced annual electricity consumption for cooling by more than 20 percent, which translates to financial savings in the five-digit range," says Weiß with satisfaction. And that's likely just the beginning. Over the course of a full year, there is still significant optimization potential – especially since the efficiency of the cooling system's various components interact differently depending on seasonal temperature changes and cooling demand.

Weiß is confident: "The other six months, the system was still running under our conventional control logic. That means we can save significantly more energy. According to calculations from Factor4Solutions, we're looking at savings of over 40 percent. And that's exactly what we're aiming for."

100 Percent Operational Reliability

Another major benefit for Stadtwerke Karlsruhe is the fact that the system – both hardware and software – continues to be monitored, maintained, and optimized by the provider after installation. Weiß comments: "Of course,

we monitor the system ourselves, but having the expert team at Factor4Solutions operate it via AI-supported remote access is a huge advantage for us. Their in-depth expertise in refrigeration technology ensures that we're immediately informed if anything isn't working as it should."

Thanks to the use of digital twins and real-time data comparison, Factor4Solutions can even notify its customers in advance of anomalies and potential failures, allowing these to be prevented proactively through predictive maintenance.

"Guaranteed operational reliability at all times is absolutely critical for us because we're obligated to supply cooling," explains Weiß. "At GartenCarée, we're not just providing cooling for offices and apartments—but also for a data center, among others."

When asked about the implementation phase, Weiß notes: "Everything went smoothly. In collaboration with the service provider responsible for our measurement and control systems, we provided the necessary data points that the vendor required to set up the solution. Factor4Solutions, who manage the system remotely from Berlin, had already told us in advance which data points were needed – such as flow rates, temperatures, and energy meters for heating and cooling." Once that was done, things moved quickly: the software was configured within a single day, and the first analysis was available within four to six weeks. Based on that initial data, it became clear which additional data points would be helpful, and the system was fine-tuned accordingly. **This simple, streamlined installation process makes the solution attractive across industries – anywhere cooling systems are used.**

Rapid Payback Supports Expansion of the Partnership

It became clear right after the test phase: "All I had to do was compare the annual energy consumption and cooling output to the previous year to see the significant increase in efficiency and the energy savings," says Weiß. The team leader is also very satisfied with the system's return on investment: "The annual cost of working with the refrigeration specialists is already offset by the energy savings within the first five months of each year."

It's no surprise, then, that Stadtwerke Karlsruhe is considering expanding the partnership. "We're already having a second system managed by Factor4Solutions," says Weiß. "And we operate several other cooling systems that could also be suitable candidates."

Since the solution can be integrated into almost any system, there's a strong likelihood that the AI-based approach will also deliver valuable insights and savings in those cases.