

Sustainable Hall Conditioning: The energy-efficient solution for industrial hall conditioning in the era of climate change

Industrial companies worldwide are increasingly confronted with the challenges of rising energy costs and the urgent need to reduce CO₂ emissions. The question of how large production halls can be air-conditioned efficiently and in an environmentally friendly manner is therefore central to companies that want to increase their environmental responsibility and competitiveness at the same time. Traditional cooling systems do provide cooling capacity, but at the expense of the environment and the economic efficiency of companies due to high operating costs.

This is where Sustainable Hall Conditioning (SHC) comes in – a technological innovation developed by INFRANORM® that enables halls to be efficiently conditioned throughout the year. SHC combines energy efficiency, environmental friendliness, and flexibility in a modular system that improves production conditions while significantly reducing energy costs.

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1. The technology

The **two-stage** adiabatic process enables a significant reduction in the supply air temperature through a combination of indirect adiabatic pre-cooling and direct adiabatic cooling. First, the warm outside air is pre-cooled by an air-water heat exchanger. The cooling water used for this purpose is cooled to a usable temperature by the adiabatic cooling process in the cooler itself and circulated. This step already significantly reduces the temperature before the air enters the second cooling stage. In this second stage, the pre-cooled air comes into contact with the evaporation medium water, where it is further cooled by the natural evaporation process.



Figure 1: Schematic representation of the 2-stage adiabatic cooling process



This two-stage process enables the SHC system to reduce the supply air temperature to up to 7 °C below the values of conventional adiabatic cooling systems. This creates a comfortable room temperature that is ideal for both employees and machines.

A special feature of the SHC system is its sliding setpoint control, which enables precise control of the room humidity. This feature is particularly important for production environments where constant and not too high humidity levels are required. Thanks to its flexible control, SHC ensures an optimal room climate that improves both employee productivity and the quality of the goods produced.

2. Advantages

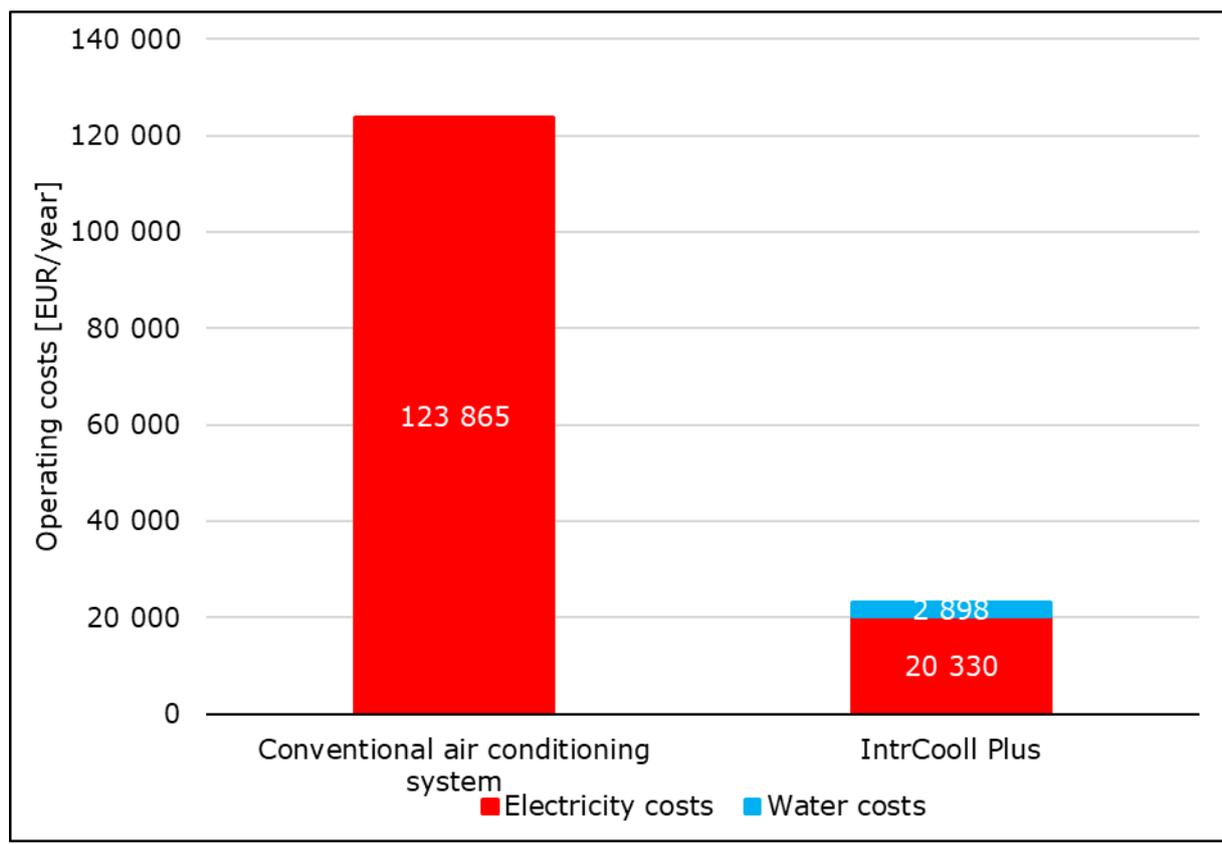


Figure 2 Energy cost comparison during the cooling period

Compared to conventional cooling systems, SHC can reduce electricity consumption by up to 90%. This is achieved through the efficient use of water and air as cooling media, eliminating the need for climate-damaging refrigerants. This drastic reduction in energy costs not only offers companies short-term financial benefits but also helps them comply with strict CO₂ regulations in the long term.



Another advantage of SHC is the reduction of peak electrical loads by up to 90%. During the hot summer months, when cooling systems traditionally run under high loads, SHC significantly reduces the strain on the power grid while also lowering operating costs.

Although SHC uses water for cooling, water consumption is up to 30% lower than other adiabatic systems. This is achieved through optimized evaporation technology, which uses water more efficiently, thereby minimizing operating costs and the ecological footprint.

Compared to conventional solutions with compression refrigeration systems, which are very energy-intensive in operation, effective water consumption can even be reduced by up to 75%. The Central European electricity mix from renewable energy sources and thermal power plants was used for this calculation.

The water that is not evaporated in the cooling process is returned to the natural water cycle. This is possible without complex water treatment and the water is not contaminated.

Energy efficiency is a key success factor in modern industries that want to reduce both operating costs and CO₂ emissions. Sustainable Hall Conditioning addresses this issue and offers a solution that significantly reduces energy consumption while optimizing cooling performance.

An often underestimated but significant advantage of Sustainable Hall Conditioning is its positive impact on employee health and safety. With stable and comfortable room temperatures achieved by the SHC

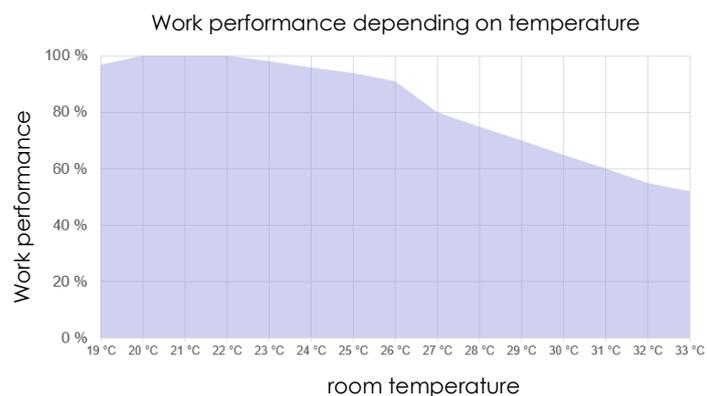


Figure 3 Work performance as a function of temperature

system, employees work more efficiently and feel more comfortable. Studies show that excessive temperatures in working environments can lead to fatigue, loss of concentration, and an increased error rate. The constant, comfortable temperatures provided by SHC not only increase productivity but also improve the general well-being of employees.



Furthermore, the reduction in the risk of accidents is a significant factor. High temperatures increase the risk of accidents, especially in industrial environments where machinery and heavy equipment are used. Fatigue and overheating can impair responsiveness and lead to accidents. The pleasant, cooler temperatures ensured by SHC significantly reduce this risk, which has a positive impact on both employee safety and production efficiency.

Through continuous air exchange and filtration, SHC not only ensures efficient cooling, but also a healthier indoor climate. A key aspect is the innovative use of specially coated cooling wabs, which enable a continuous self-cleaning process. This coating prevents the accumulation of dirt, mold, or limescale, thus ensuring a permanently hygienic environment. These measures not only significantly improve working conditions but also help to reduce sick leave and create a safer working environment.

3. Sustainability aspects

Considering increasing global demands for CO₂ reductions and stricter environmental regulations, Sustainable Hall Conditioning (SHC) offers a groundbreaking opportunity to achieve the industry's environmental goals without sacrificing powerful and efficient cooling technologies. SHC combines innovative cooling technologies with sustainable principles to ensure maximum reduction in emissions and resource consumption. The system's energy-efficient operation enables companies to reduce their CO₂ emissions by up to 95%, which is particularly important for companies that are subject to strict international climate commitments or are consistently pursuing their operational sustainability goals.

While conventional cooling systems rely on climate-damaging refrigerants, SHC uses only water as a cooling medium. This not only has a positive impact on the environment, but also significantly reduces long-term maintenance and operating costs. Since no hazardous refrigerants are used, there is no need for expensive maintenance and regular inspections, as required by law for conventional refrigeration systems. This makes SHC not only more environmentally friendly, but also more cost-efficient and low-maintenance. In addition, SHC also contributes to resource conservation. Through optimized water use and reduced water consumption compared to conventional systems, SHC makes an important contribution to sustainable water use. This



technology proves particularly advantageous and future-proof in regions where water is a scarce commodity.

In addition, the system supports the circular economy with its durable and low-maintenance evaporation media, which have a service life of up to five years and do not require complex water treatment. The modular design of SHC also makes it possible to expand or adapt the system as needed without requiring additional large investments. This not only minimizes resource consumption during production and maintenance but also extends the service life of the system and reduces material waste.

Another important aspect of SHC's sustainability is its heat recovery capability. During operation, the waste heat generated in production can be efficiently used to heat the halls in winter. This enables companies to save up to 40% on heating costs, significantly reducing energy consumption during the cold season while improving the overall energy efficiency of the operation.

4. Adaptability

Modularity is another feature of SHC. The system can be individually adapted to the needs of different industries and hall sizes, offering maximum flexibility. If the requirements in an industrial hall change, it is easy to add further systems to meet the increasing demands in an energy-efficient and climate-friendly manner.

The modular design of SHC allows for tailor-made adaptation to any production hall. The individual modules – whether cooling, heating, or air purification – can be combined and expanded as needed. This ensures a flexible and future-proof solution that can grow with the requirements of the company.

SHC is not only designed for summer operation, but also for efficient use in winter. By integrating heat recovery modules, waste heat can be used to heat the halls while reducing heating costs by up to 40%.

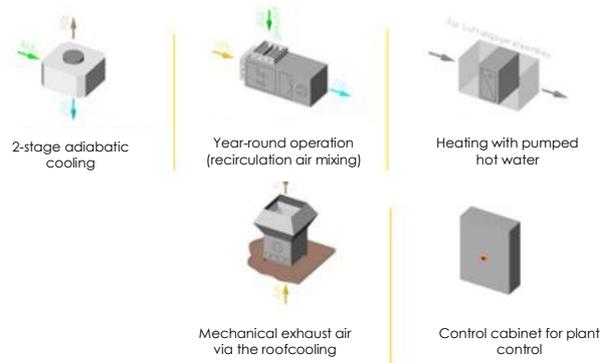


Figure 4 Example modules Sustainable Hall Conditioning



5. Maximum planning accuracy through simulation tools

INFRANORM® offers advanced simulation tools to help you plan the installation of the SHC system optimally. These tools calculate the expected temperatures and energy costs based on weather data, building simulations, and internal loads. This allows companies to accurately estimate in advance the impact SHC will have on the environment and operating costs.

6. Replicability

The modular, complete Sustainable Hall Conditioning system from INFRANORM® can be replicated and individually adapted to the respective conditions using standardized elements. This has a positive impact on quality, time, and costs, making the system economically competitive.

Due to climate change, many commercial buildings increasingly require a conditioning system – not only for the people working in them, but also for the machines. Sustainable Hall Conditioning tackles energy consumption for cooling head-on and reduces it dramatically.

A study by the International Energy Agency (IEA) reports that air conditioning systems consumed approximately 2,000 TWh of energy in 2020. It is assumed that energy consumption through the use of conventional refrigeration machines will rise to 6,200 TWh by 2050 [see technical article "6,200 billion kilowatt hours of air conditioning electricity" in the BTGA Almanac 2019; pp. 94-96; btga.de].

There is enormous potential for savings here. Sustainable Hall Conditioning from INFRANORM® Technologie GmbH makes this potential usable.



About INFRANORM®TECHNOLOGIE GMBH

Founded in Wels in 2004 by Christian Lindner, INFRANORM® is a plant engineering company specializing in infrastructure technology for manufacturing companies. It provides comprehensive solutions in the field of energy and environmental technology for leading production companies and global market leaders. With its comprehensive INFRANOMIC® system, INFRANORM® develops solutions for reducing energy and operating costs and increasing productivity in manufacturing companies.

Further information can be found at www.infranorm.com.

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