Cooling without refrigerants – How sustainable hall conditioning is overtaking traditional cooling technology

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Cooling reimagined: without refrigerants, without compromises

Industrial halls and production facilities are currently facing a paradigm shift: Overheating in production areas is becoming increasingly common during the warm season. The consequences are not only reduced comfort for employees, but also serious impairments to machines and processes – from rising reject rates to unplanned downtime.

At the same time, the use of traditional refrigeration systems is becoming increasingly questionable from an economic and ecological point of view. Energy prices are rising, maintenance is becoming more complex and expensive, and the legal requirements for the operation of refrigeration systems – especially in connection with fluorinated greenhouse gases (F-gases) – are constantly increasing.

The end of traditional refrigeration technology has been heralded. The amended EU F-Gas Regulation (EU 2024/573) makes it clear that the use of refrigerants with high global warming potential will be gradually phased out. Many plant operators already have to bear high costs for refrigerant refills, leak tests, and compliance with legal requirements. At the same time, energy efficiency and CO_2 reduction requirements are becoming more stringent – both from a regulatory perspective and in terms of ESG criteria and eligibility for subsidies.

But there is an alternative. *Sustainable Hall Conditioning (SHC)* is a new generation of industrial hall cooling that not only does without synthetic refrigerants, but also sets new standards in terms of efficiency, cost-effectiveness, and sustainability. SHC combines state-of-the-art air technology, intelligent control systems, two-stage adiabatic cooling, and heat recovery in a modular overall system – designed to meet the specific requirements of industrial manufacturing environments.

Why this white paper? The aim of this white paper is to show decision-makers in industry – especially planners, operators, and project developers – why traditional refrigeration technology no longer has to be the first choice. And how SHC can be used to achieve stable production conditions, legally compliant systems, and low operating costs even without refrigeration machines.

Why refrigerants are becoming obsolete

Legal, economic, and ecological reasons for the switch

For a long time, compression refrigeration systems were considered to be without alternative. Their mode of operation is well known and their technology widely used. However, what was considered state of the art for decades has now become a burden – for the environment, companies, and planners alike. The use of synthetic refrigerants is increasingly at odds with regulatory requirements, economic rationality and corporate responsibility.

1. **Regulatory pressure: The F-Gas Regulation (EU 2024/573)**

The revised EU F-Gas Regulation is part of the "Fit for 55" package and has a clear goal: to drastically reduce emissions of fluorinated greenhouse gases (F-gases), which are particularly harmful to the climate. The focus is on so-called HFCs (hydrofluorocarbons), which are used in many conventional refrigeration systems.

Timetable for bans on use in commercial refrigeration

The regulation provides for specific stages, starting immediately and continuing in the coming years, during which certain applications with certain refrigerants may no longer be placed on the market or installed:

Year	Prohibited applications	Refrigerants affected	GWP limit
2025	Hermetically sealed commercial refrigeration systems	R-134a, R-404A, etc.	>150
2026	Commercial central refrigeration systems ≥40 kW	R-410A, R-407C, R-404A	>150
2027	Stationary split refrigeration systems (monosplit and multisplit)	R-32, R-410A, R-407C	>150
2029	All stationary refrigeration systems	All HFCs	>150
2032	Mobile refrigeration systems (e.g., transport refrigeration)	Various	>150
2040	General ban on the placing on the market of HFCs	All	---

What does this mean for existing systems?

- Protection of existing systems: Systems that are already installed may continue to be operated, but only if strict testing, maintenance, and documentation requirements are met.
- Economic pressure: Replacement refrigerants are becoming increasingly expensive and are in some cases being withdrawn from the market.
- Investment risk: New systems with HFCs lose a significant amount of value as soon as they are commissioned.

Mandatory measures for operators:

- Leak tests from 5 t CO_2 equivalent annually or semi-annually
- Entry in a refrigerant operating log
- Retrofitting obligation with leak detection systems
- Mandatory recovery during dismantling

2. Economic disadvantage: Cost factor refrigerant & operation

In addition to regulatory risks, operators of conventional refrigeration technology are increasingly facing **tangible economic disadvantages** – throughout the entire life cycle. Both **direct operating costs** and **indirect follow-up costs** have an impact here. The most important cost drivers are detailed below:

2.1. Skyrocketing refrigerant prices

Due to EU-wide quantity restrictions (HFC quotas) and growing demand, prices for conventional refrigerants are rising massively:

- **Example R-404A**: From approx. €20/kg (2015) to up to €200/kg (2023–2024)
- **Example R-134a**: Price increases of over 500% since the introduction of F-gas quotas

This price trend affects not only new purchases, but also **regular refills in the event of leaks** – which is regularly necessary in older systems with a higher risk of leaks.

2.2. High electricity consumption & peak load costs

Compression refrigeration systems consume electrical energy with comparatively low efficiency:

- **EER (Energy Efficiency Ratio)** is often only 2–3, and in some cases even lower
- At high outside temperatures, efficiency decreases further – precisely when the cooling load is at its highest
- This results in **high peak loads**, which have a direct impact on grid fees and electricity bills

SHC, on the other hand, reduces the power consumption for cooling by up to **90%**.

2.3. Maintenance, inspection requirements, and operating costs

Operating a refrigeration system with fluorinated refrigerants is complex and costly:

- **Leak tests**: 1–2 times per year by a certified specialist company, depending on CO_2 equivalent
- **Leak detection systems** for systems >500 t CO_2eq
- **Recurring inspection** in accordance with §22 of the Refrigeration Systems Ordinance
- **Maintenance contracts & standby costs**

All these measures incur **ongoing fixed costs** – often several thousand euros per year per system.

2.4. Rising investment risks

Traditional refrigeration systems are increasingly considered to be **unsustainable**:

- **Resale value** drops dramatically with each ban imposed by the F-Gas Regulation
- Funding agencies give preference to **non-fossil, refrigerant-free systems** when awarding grants
- In ESG assessments or tenders (e.g., green building certifications), synthetic refrigerants can even be **a knockout criterion**

2.5. Supply & maintenance

The industry is adapting to the new regulation:

- **Decline in spare parts and service technicians** for older refrigeration machines
- Shortages of **specialized skilled workers** as many companies switch to future-proof systems
- Increasing delivery times for complex repairs

Environmental responsibility: climate risk refrigerants

Refrigerants are considered "invisible climate killers." Although they are enclosed in technical systems, they regularly escape into the atmosphere – whether through leaks, maintenance work, or the dismantling of equipment. The environmental impact is enormous, as many of these substances are among the most climate-damaging substances of all.

1. Global warming potential (GWP): The invisible burden

The **GWP** (global warming potential) describes how much a substance contributes to global warming compared to CO_2. Many widely used refrigerants have GWP values that are **thousands of times higher** than CO_2:

Refrigerant	Type	GWP	Comparison to CO_2
R-404A	HFC	3,922	1 kg = 3.9 Tones of CO_2
R-410A	HFC	2,088	1 kg = 2.1 tons of CO_2
R-134a	HFC	1,430	1 kg = 1.4 tons of CO_2
CO_2	natural	1	Reference

Just **one kilogram of escaped R-404A** causes a climate impact **equivalent to** the **annual CO_2 emissions of a mid-range car** – without any benefit whatsoever.

2. Leaks: The systemic problem

Even in state-of-the-art systems, leaks are not the exception but the rule:

- Studies show average leakage rates of **10–20% per year**
- Even with regular maintenance, **several kilograms** of refrigerant can escape each year
- Many leaks go **unnoticed for a long time**, which makes them particularly dangerous

Over the life cycle of a typical industrial refrigeration system, **tens of tons of CO_2 equivalent** can be released – without anyone being aware of it or compensating for it.

3. Disposal: A ticking time bomb
Synthetic refrigerants are difficult to recover and often can only be destroyed thermally:

- Improper disposal leads to direct release
- Processing is complex, expensive, and not available for all substances
- The effort increases with each additional regulatory level

Many operators underestimate the **ecological (and legal)** consequences of improper decommissioning - especially in older systems.

4. Image and sustainability impact
At a time when ESG reporting, CO_2 balances, and sustainability certificates are becoming increasingly important, climate-damaging refrigerants pose a **reputational risk**:

- Sustainability goals (e.g., CO_2 neutrality, green building, DGNB, LEED) sometimes **explicitly exclude** HFCs
- Supply chain requirements based on CSR or EU taxonomy criteria demand **sustainable technologies**
- Customers, investors, and employees are increasingly paying attention to **visible** climate protection **measures**

Those who rely on climate-friendly systems such as *Sustainable Hall Conditioning* demonstrate **concrete responsibility rather than mere compensation**.

5. SHC: Cooling without climate risk
Unlike traditional refrigeration systems, SHC is based on **adiabatic cooling with water**:

- **Zero GWP**: Water is climate-neutral, non-toxic, and available everywhere
- **No risk of leakage**: There are **no closed refrigerant circuits**
- **No disposal costs or environmental regulations**
- **Highest energy efficiency with maximum environmental compatibility**

SHC compared to conventional refrigeration technology

A new benchmark for industrial cooling

Traditional compression refrigeration systems are widely used in industry – often out of habit, not because they are the best solution. *Sustainable Hall Conditioning (SHC)* is an alternative system that outperforms conventional technology in almost all relevant disciplines: efficiency, operating costs, environmental compatibility, flexibility, and indoor air quality.

- **1. Operating principle: Compression vs. evaporation & heat exchangers**

Conventional refrigeration technology

The basic principle is based on the thermodynamic cycle of a refrigeration machine (compression refrigeration):

- A chemical refrigerant is compressed using a large amount of energy (compressor),
- then condensed in the condenser,
- expanded via an expansion valve
- and evaporated in the evaporator, whereby it extracts heat from the environment.

This process requires electrical energy – not only for the cooling itself, but also for pumps, recoolers, leakage monitoring, and, if necessary, water treatment. It generates high load peaks in the power grid and is costly to maintain and control.

SHC – Sustainable Hall Conditioning

SHC uses a two-stage adiabatic cooling process based on the natural evaporation of water – without the use of refrigerants:

- In the first stage, the outside air is pre-cooled by cooled return water via an air-water heat exchanger (sensible cooling).
- In the second stage, this air flows over an evaporation medium, where latent heat is extracted through the evaporation of water. → Result: a noticeable reduction in air temperature of up to 17 K.

SHC does not use a closed refrigeration circuit and only requires pumps and fans – the energy requirement is drastically lower in comparison.

2. Cooling capacity: Effectiveness at high outside temperatures

Conventional refrigeration systems

The efficiency (EER) decreases as the outside temperature rises because the condensing pressure in the system increases. This means:

- The electrical power consumption increases,
- the cooling capacity decreases,
- the system runs at full load – often inefficiently.

Many systems reach their performance limits, especially in extreme summer temperatures. In industrial halls with high internal heat loads, the risk of overheating is real.

SHC

The adiabatic cooling process has the opposite effect:

- The warmer and drier the outside air, the better the evaporative cooling works.
- For example, at 37 °C outside air, the systems achieve a supply air temperature of 19 °C – this corresponds to up to 100 kW of cooling capacity per unit (depending on the air volume flow).

Another advantage is that the air temperature generated is constant and predictable, as SHC systems are designed on the basis of simulations. There are no temperature delays as with slow-acting cooling systems – a decisive factor for processes with tight tolerance specifications.

3. Energy consumption & CO_2 emissions: Climate advantage without compromise

Conventional refrigeration technology

Refrigeration systems are electrical "energy guzzlers." Typical values:

- EER of 2.5 (i.e., 1 kW of electricity generates 2.5 kW of cooling capacity)
- Peak power consumption in midsummer overloads the power grid and leads to high energy prices
- Waste heat must be dissipated via recoolers – additional energy requirement

In addition:

- Refrigerant emissions cause high indirect CO_2 emissions (see previous chapter)
- Emissions from electricity consumption: Depending on the grid supply, CO_2 values of several tons per year can quickly accumulate – for a single cooling process.

SHC

- SHC requires no compression, no recooling, no refrigerants – only water and fan power
- Typical electrical power consumption per device: approx. 1–2 kW (vs. 10–50 kW for conventional systems)
- Up to 90% less power consumption
- No CO_2 emissions from refrigerants
- Simulations show: A typical SHC system saves up to 24 tons of CO_2 and over €12,000 in energy costs annually, depending on building size, location, and use

4. Indoor air quality & thermal comfort: Fresh air instead of recirculated air

Conventional refrigeration systems

- Mainly operate in recirculation mode: The room air is extracted, cooled, and returned.
- The proportion of fresh air is often low, as any supply of external air worsens the energy balance.
- Air quality suffers: aerosols and emissions from manufacturing processes (e.g., oil mist, fine dust, VOCs) are not completely removed.
- The result: an unhealthy indoor climate, inadequate odor neutralization, and reduced comfort.

From a thermal perspective, drafts or excessively dry air often occur, especially at low outlet temperatures without adequate control.

SHC – Sustainable Hall Conditioning

- 100% fresh air principle: The entire air volume is replaced by outside air – filtered and conditioned.
- Two-stage cooling keeps the temperature and humidity in the optimum range (e.g., min. 25 °C room temperature, max. 65% relative humidity).
- Textile air outlets ensure draft-free air intake over large surfaces.
- Integrated air purification modules (e.g., oil mist and fine dust filters) further improve air quality.

5. Investment & integration: Flexible and future-proof
Conventional refrigeration systems

- High planning and investment costs: Separate components (refrigeration machine, evaporator, recooler, pump station, etc.) must be coordinated with each other.
- Integration into existing buildings is often difficult, expensive, or even impossible.
- Decommissioning costs and subsequent retrofitting are considerable.
- Long delivery times and high complexity increase the project risk.

SHC

- Modular system design: SHC is delivered as a fully assembled functional unit.
- Can be used both as a pre-stage module for existing ventilation systems and as a stand-alone complete solution.
- Can be adapted to existing buildings without major modifications (e.g., no water pipes inside the building, no refrigeration piping).
- Simulation tools support precise planning in advance – including temperature forecasts, air volume flow, energy consumption, and CO_2 balance.

6. Regulations & future-proofing: Free of obligations and risks
Conventional refrigeration technology

- Subject to numerous legal requirements:
  - F-Gas Regulation (EU 2024/573)
  - Refrigeration Systems Ordinance (§22, §29)
  - Inspection obligations according to ChemKlimaschutzV
- Operator obligations:
  - Leakage monitoring,
  - Recycling,
  - Training obligations,
  - Keeping logbooks
- Risk: Changes in legislation can devalue systems overnight (see for example the ban on use from 2027)

SHC

- No refrigerant – no risk:
    - No entry in refrigerant register
    - No inspection requirements
    - No documentation required
    - No transport of hazardous goods
- Hygienically certified (VDI 6022), food-safe, and suitable for sensitive applications
- Future-proof in terms of ESG criteria, eligibility for subsidies, and sustainability assessments (taxonomy-compliant)

Cooling capacity vs. energy consumption

Why SHC establishes a new efficiency class

In an industrial environment, the pure cooling capacity of a system is only part of the story. The decisive factor is how much energy is required to achieve this – especially in halls with high internal loads, long operating times, and rising electricity costs. *Sustainable Hall Conditioning (SHC)* achieves outstanding results in this area because it relies on intelligent evaporation instead of energy-intensive compression – using water as the medium.

1. Energy efficiency comparison: SHC beats conventional refrigeration technology

In conventional compression systems, the typical **EER (Energy Efficiency Ratio)** – i.e., the ratio of cooling capacity generated to electrical power consumed – is approximately:

- **2.5 to 3.5** under ideal conditions
- significantly **below 2.0** at high outside temperatures or poor partial load conditions

With SHC, the energy requirement is dramatically lower, as the cooling effect is achieved through physical evaporation (adiabatic cooling). Electrical consumption is limited to:

- a **fan** for air transport
- a **circulation pump** for the water
- the **intelligent control unit**

This results in a total **energy consumption of only approx. 1–2 kW per unit**, while providing **up to 100 kW of cooling capacity** in real operation.

2. Cooling capacity when it is needed most

Conventional systems lose performance at high outside temperatures because condensing pressure and compressor work increase – they then deliver less cooling but consume more electricity.

SHC uses this heat to its advantage:

- **The hotter and drier the outside air**, the more effective the evaporative cooling
- The technology achieves stable supply air temperatures **below 20 °C** even on the hottest days
- There are no technical limitations such as overheating, partial load losses, or compressor damage

This performance stability is a huge advantage, especially in production environments with tight tolerances, shift operation, or heat-sensitive processes.

3. Avoid peak loads and grid congestion

In many businesses, **peak electricity consumption** is a decisive cost factor – whether in the form of grid fees, reactive power costs, or internal load management systems.

Refrigeration machines cause problems in precisely this area:

- High starting currents of the compressors
- Simultaneous operation of multiple components (pumps, valves, recoolers)
- Significant fluctuations in consumption due to changing outside temperatures

SHC significantly reduces these load peaks:

- Low base load (typically 1–2 kW per module)
- No sudden load changes
- Ideal for combination with PV, battery storage, or self-generated electricity solutions

The system is grid-friendly, **predictable, and** stable—an important contribution to energy efficiency strategy and grid compatibility.

4. Year-round benefits through combination with heat recovery

SHC is not just a summer cooling system. Thanks to the intelligent combination of waste heat utilization, mixed air boxes, and demand-based control, operators can also benefit in winter:

- **Preheated supply air** from internal loads reduces heating requirements
- **Reduction of ventilation heat losses** through optimized fresh air supply
- Stable room air temperature all year round for people and machines

Instead of operating separate heating and cooling systems, SHC creates an **integrated hall climate system**.

Maintenance and safety aspects

Less technology – less risk – less effort

In industry, every component that needs to be maintained, tested, or monitored incurs costs, risks, and downtime. Refrigeration systems with compression technology and fluorinated refrigerants in particular entail a multitude of technical, organizational, and legal requirements. *Sustainable Hall Conditioning (SHC)* reduces these burdens to a minimum – thanks to its low-maintenance, safe, and refrigerant-free concept.

1. Maintenance of conventional refrigeration systems: an intensive list of requirements

Conventional refrigeration technology is maintenance-intensive and strictly regulated by law:

- **Mandatory annual leak testing** for systems with more than 5 tons of CO_2 equivalent
- **Leak detection systems mandatory** for 500 tons of CO_2-eq or more
- **Keeping a refrigerant logbook** (required by law)
- **Safety risks** due to pressure vessels, flammable or toxic refrigerants
- **Certification requirement for service personnel**
- **System inspection in accordance with §22 of the Refrigeration Systems Ordinance**
- Regular **replacement of seals, valves, and pressure sensors**
- **Downtime** in the event of maintenance, leaks, or compressor failure

All of this causes planning effort, external dependencies, and, last but not least, considerable **operating** costs—often several thousand euros per year.

2. SHC: Low maintenance with concept

Sustainable Hall Conditioning is designed from the ground up as **a maintenance-friendly system**:

- **No refrigerant** → no leak testing, no logbook, no chemical storage
- **No moving parts in the cooling process** (apart from the fan and pump)
- **Self-cleaning evaporation media** with a service life of 3–5 years
- **Maintenance-free heat exchanger** made of corrosion-protected aluminum
- **Filter replacement, visual inspection, and cleaning once a year** is sufficient

In practice, this means **maintenance costs of less than 10%** of a conventional refrigeration system – and **no unplanned downtime** due to system failure or inspection requirements.

- **3. Safety through simplicity**

Safety aspects are low with SHC due to the nature of the system:

- **No pressure components** → no risk from pressure relief, no explosion protection necessary
- **No toxic or flammable refrigerant circuit**
- **Use of drinking water without water treatment** – with hygiene protection (VDI 6022-compliant)

This is also an advantage for operators: **no training requirements, no certificates of competence**, no complex safety concepts.

- **4. Digital control without technician visits**

SHC systems can be equipped with digital status monitoring on request:

- **Live monitoring of temperatures, humidity, water consumption**
- **Alarm messages in the event of undershoots or failures**
- Fully **integrable into building management systems**

This makes maintenance work plannable and remotely controllable – a modern feature that classic refrigeration systems often only offer at considerable additional expense.

Simulation & planning: What is really necessary

Precisely designed instead of oversized – why SHC creates planning reliability

One of the major differences between conventional refrigeration technology and *Sustainable Hall Conditioning (SHC)* lies in the planning approach. While conventional systems are often designed for estimated peak loads – with corresponding oversizing, high investment costs, and inefficient partial load operation – SHC is based on **realistic, data-supported simulation.** This allows energy requirements, temperature profiles, and air flow to be calculated precisely in advance – and the system is as large as necessary, but no larger than reasonable.

1. Data-driven from the outset: the basis of every SHC design

The design of an SHC system does not begin with assumptions, but with **real, reliable building data**. This makes SHC planning fundamentally different from classic refrigeration technology, which is often planned based on empirical values or oversized standard tables.

The following input variables are included in the design:

- **Climate data for the location**:
  → Average and maximum outside temperatures, humidity, summer days per year (from meteorological climate databases, e.g., TRY or Meteonorm data)

- **Building physics and geometry of the hall**:
  → Room volume, hall height, degree of insulation, window areas, roof structures, door areas, etc.

- **Internal heat loads**:
  → Waste heat from machines, process heat, lighting, employees, IT components – measured or estimated based on energy data or empirical values

- **Usage profiles**:
  → Daily and weekly operating hours, night cooling possible or not, rest periods

- **Ventilation infrastructure**:
  → Existing ventilation systems, heating systems, hall air flow (e.g., displacement ventilation, mixed ventilation)

This data is transferred to a **thermal simulation** that accurately models:

- Temperature profiles in the hall
- Air stratification and air velocity
- Energy requirements depending on operating times
- Potential savings

2. What really needs to be planned – and what doesn't

While traditional refrigeration projects involve a large number of technical interfaces and system components (refrigeration machine, recooler, piping, control system, hydraulics, etc.), SHC planning focuses on just a few key parameters:

a) Air volume flow per zone

The decisive factor in SHC is the correct dimensioning of the fresh air flow:

- How many m³/h are needed to reliably remove the internal heat load?
- How is this air flow distributed in the hall?
- What supply air temperature can be achieved by SHC under the local conditions?

The calculation is based on thermal simulation, supplemented by empirical values from over 100 industrial projects.

b) Supply air distribution & introduction

SHC works with low supply air velocity and large-area distribution:

- As a rule, the air is introduced via **textile air outlets** that operate without causing drafts.
- The planner determines how the air is distributed in the room – ideally taking into account the machine layout and occupied areas.

c) Device arrangement & connections

- Where will the equipment be positioned? (Inside, outside, on the roof, on the facade)
- How is the **water connection** made? (Drinking water connection, wastewater pipe if necessary)
- How is the **electrical connection** implemented?

Since SHC has a modular design, systems can be **integrated piece by piece** or retrofitted in stages.

3. Simulation replaces oversizing

A key planning principle at SHC is: *design according to actual requirements – not according to a safety margin*. Because:

In classic refrigeration technology, oversizing is standard practice:

- To "play it safe," systems are often designed with a 20–30% power reserve.
- Unclear usage data leads to generous design
- The result: higher investments, poorer partial load operation, higher energy costs

SHC uses precise predictions instead of reserve buffers:

- The **actual climatic conditions at the location** are incorporated into the design
- Internal heat loads are **simulated realistically** (not estimated on a flat-rate basis)
- The **supply air temperature at full load** is calculated taking into account the local humidity
- The difference gives the **actual amount of air required** – no more and no less

This results in:

- **Precisely tailored system sizes**
- **Better energy efficiency** through partial load optimization
- **lower investment costs** without performance risk

And: If requirements change (e.g., due to additional machines or expansion), **further modules** can **simply be added** – without having to replace the entire system.

Temperature targets

Not just cooling – understanding what is really needed

One of the key strengths of *Sustainable Hall Conditioning (SHC)* is not only the cooling technology itself, but **also the way it is planned**: individually, data-driven, and tailored to actual needs. After all, not every temperature requirement is technically or economically feasible. That's why every SHC planning process begins with a simple but crucial question:

Why is cooling required?

1. Temperature target = operating target: first understand, then plan

When planning a project, INFRANORM® does not simply provide thermometers and measuring devices, but works with the customer to analyze:

- **Is this a process-critical temperature target?**
  - Do machines, materials, or products need to be reliably maintained within narrow temperature limits?
  - Are there any quality-related specifications (e.g., for plastics, electronics, food)?
  - Are there risk analyses for temperature exceedances?
- **Or is it primarily a matter of employee comfort and ergonomic working conditions?**
  - Are there complaints about overheating, circulatory problems, or declining concentration?
  - Are there operational goals such as reducing error rates, reducing sick leave, or improving working conditions?

This differentiation is crucial—because it directly influences:

- the **necessary supply air temperature**,
- the **required air volume flow**,
- and ultimately **the size and number of SHC modules**.

2. Process reliability means control – not low temperatures

In industrial practice, the goal is usually not to create rooms that are as cool as possible, but rather a stable thermal environment that prevents failures, rejects, or malfunctions.
INFRANORM® therefore analyzes in detail:

- **Which processes or machines are temperature-dependent?**
- **Are there product-specific tolerance ranges or test limits?**
- **Which areas of the room are particularly sensitive?**

SHC is not dimensioned according to the maximum outdoor temperature, but according to the target indoor temperature. And that is precisely what reduces the investment costs – without compromising process reliability.

3. Comfort is more than just a number on the thermometer

Many project inquiries specify a fixed target temperature: "We want to achieve 21 °C."
But what is often missing is the question of "why" – because thermal comfort does not depend solely on air temperature, but on the interaction of several factors:

a) Air temperature – depending on clothing and season
In industrial applications, employees are usually active and wear work clothes or protective suits. In such cases, an air temperature between 24 and 27 °C is considered perfectly acceptable – especially in summer, when light clothing and physical activity coincide.

b) Humidity – between fresh and muggy
A range between 30% and 65% relative humidity is perceived as pleasant and harmless to health. Due to the adiabatic process, SHC is usually in the upper range of the comfort zone (50–60%), which contributes to a fresh and lively indoor climate – in contrast to the often dry recirculated air of conventional air conditioning systems.

c) Air movement – noticeable but not disruptive
Draft-free, even air movement is an essential factor in comfort. SHC uses large-area textile air outlets that enable low air velocities with high volume flow. The result: high air renewal without unpleasant drafts, even in occupied areas.

d) Radiation temperature – the environment must play along
A room is not only perceived by the air temperature, but also by the temperature of the surrounding surfaces: walls, ceilings, windows. SHC ensures that heat islands or heat build-up are avoided through continuous fresh air supply and targeted air flow – which significantly improves the perceived room temperature, even if the measured temperature remains the same.

e) Activity and clothing – realistically taken into account

An assembly worker perceives 27 °C very differently from someone in a quiet office. That is why it is important not to plan according to office standards across the board, but to take into account the actual activities and clothing habits in the room.
SHC allows for adaptive planning here: the temperature target and air flow are adjusted to actual usage behavior – not to rigid specifications.

4. Lower temperature target = smaller system

Every degree Celsius that does **not** need to be cooled down additionally reduces:

- the required air volume flow
- the required device power
- the electricity and water consumption
- and investment costs

By clearly defining objectives in the planning phase, SHC can be designed not only to be more efficient, but also more cost-effective – without compromising on comfort or process reliability.

Conclusion

Sustainable Hall Conditioning – sustainable cooling without refrigerants

The requirements for industrial cooling are changing fundamentally: Refrigerants are becoming more expensive and subject to legal regulations, energy prices are rising, and at the same time, the need for thermal stability in production halls and warehouses is increasing. Against this backdrop, it is time to reevaluate classic refrigeration technology – and in many cases, to leave it behind.

Sustainable Hall Conditioning (SHC) offers an innovative and practical way to actively address this change:

- **Without synthetic refrigerants**
- **With drastically reduced energy consumption**
- **With high technical availability and minimal maintenance requirements**
- **With flexible integration into existing and new systems**

The system uses physical principles—water, air, evaporation—combined with intelligent control and precise planning. This creates a **sustainable alternative to traditional compression refrigeration technology** that is both economically and ecologically convincing.

SHC is particularly strong in areas where compromises often had to be made in the past:

- **Temperature stability without cold spots**
- **Comfortable climate without overcooling**
- **Cooling capacity where it is needed – with as little energy consumption as possible**

And best of all: planning does not start with equipment, but with the question: *What do you really need – for your processes, your employees, and your building?*

INFRANORM® supports you in answering this question – with simulation, design, subsidy advice, and a modular system that grows with your requirements.

Sustainable Hall Conditioning is more than just a technology. It is a new standard for industrial climate control concepts. Without refrigerants. Without detours.

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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