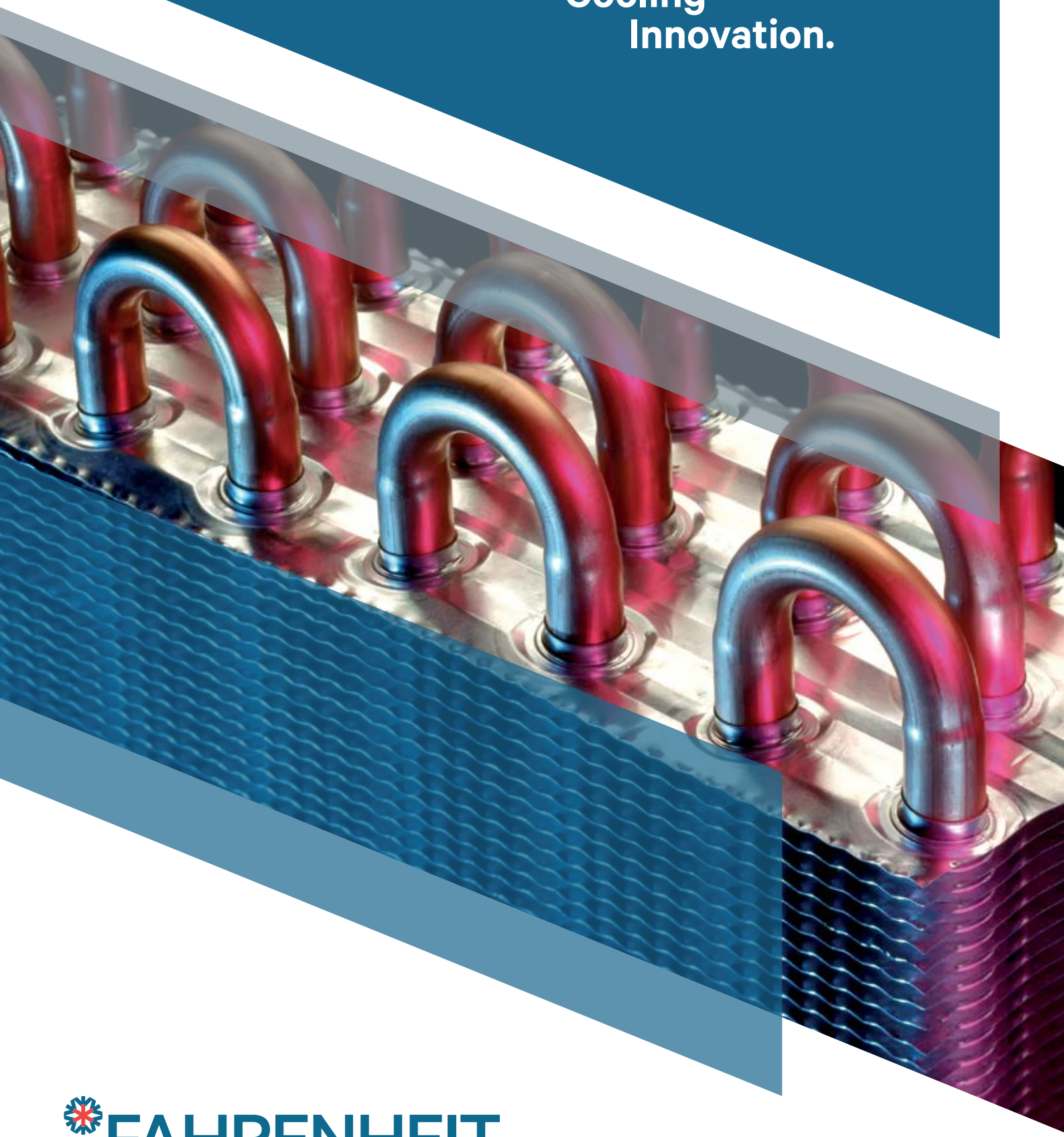
Cooling
Innovation.



FAHRENHEIT

FAHRENHEIT is a pioneer in adsorption technology. Based in Germany, we design and manufacture the most advanced adsorption cooling devices on the market.

We apply innovative research to delivering energy efficient cooling solutions.

Our products have made their way into hundreds of installations worldwide across a diverse range of industries and applications.

WALTER MITTELBACH
CTO

Innovation is our Capital.

Climate change, a worldwide scarcity of resources, and constantly rising energy prices create a mounting urgency for us to rethink how we generate and utilize energy. In the building sector - one of the largest energy users - the deployment of new innovative technologies is key to energy savings and environmental protection.

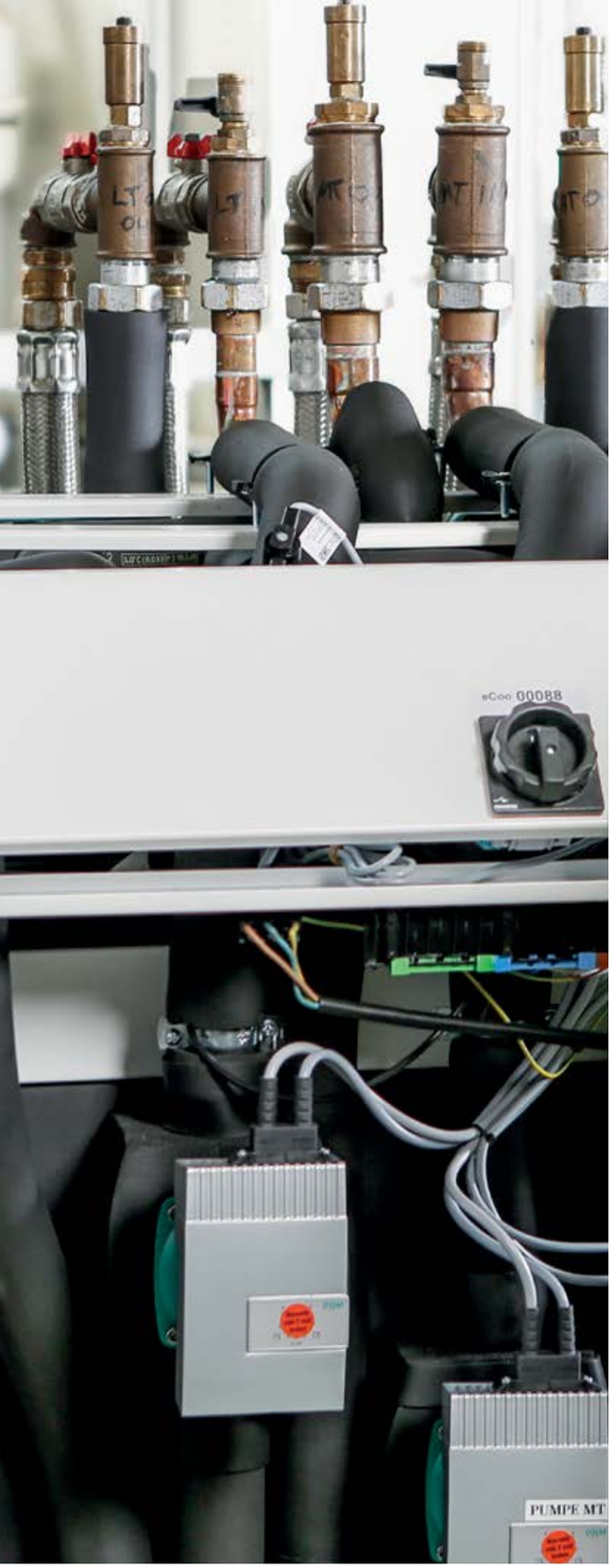
Early on – long before the topic of energy efficiency had achieved mainstream awareness – we at FAHRENHEIT had recognized a substantial energy and cost savings potential that existed within the waste and process heat generated by industry and trade. We were equally certain that the adsorption chiller technology would be able to offer brand new and previously unimagined possibilities.

Since the company's formation in 2002 we have conducted intense research and – in true pioneer fashion – continuously optimized and advanced that technology. Today, satisfied customers across industries and regions benefit from our products and expertise. Wherever FAHRENHEIT is deployed, the goals are always the same: Optimally utilize waste heat to generate cold, resulting in a reduction of operating costs and better protection of the environment. Together with our current staff – all specialists in their respective fields – we are proud to tackle the challenges of the future. We encourage you to explore and benefit from the combined knowledge of all members of FAHRENHEIT – from our engineers to our service technicians – along with our ambition to repeatedly break new ground with creative solutions.

Innovative systems are not just comprised of great components, but most and foremost a result of great ideas. Something we live by every day. The Drive for Innovation is our Capital.

Sincerely,

Walter Mittelbach
CTO



MATTHIAS HOENE
CEO

FAHRENHEIT: Raising adsorption to the next level.

After several years of research and development and early commercial successes, our company is entering a new phase from March 2017: The founding of FAHRENHEIT marks a technological step change and underscores our commitment to growth in a global market.

The experience gained from hundreds of installations translates into highly reliable and maintenance-friendly machines. Our unique zeolite coating process is now ready for rollout and enables us to design more powerful modules with a smaller footprint than ever before. By combining our innovations, the fruits of sustained investments and years of intellectual effort, we are taking adsorption to unprecedented levels of performance. By providing more thermal power in a smaller shape, and at lower cost, adsorption technology becomes a viable alternative for many applications.

Wherever waste heat is available, zeolite-based adsorption can provide cooling while saving electricity and avoiding CO_2 emissions: From industrial manufacturing to data centers, from office buildings to shipping containers, from agriculture to automobiles. Furthermore, adsorption modules can add new functionality to existing products, for example turning combined heat and power plants into tri-generation modules, flexibly delivering electricity, heat and cold depending on demand.

With the establishment of FAHRENHEIT, we look forward to spearheading the broad breakthrough of adsorption technology and to contributing to a more energy-efficient and sustainable world.

Sincerely,

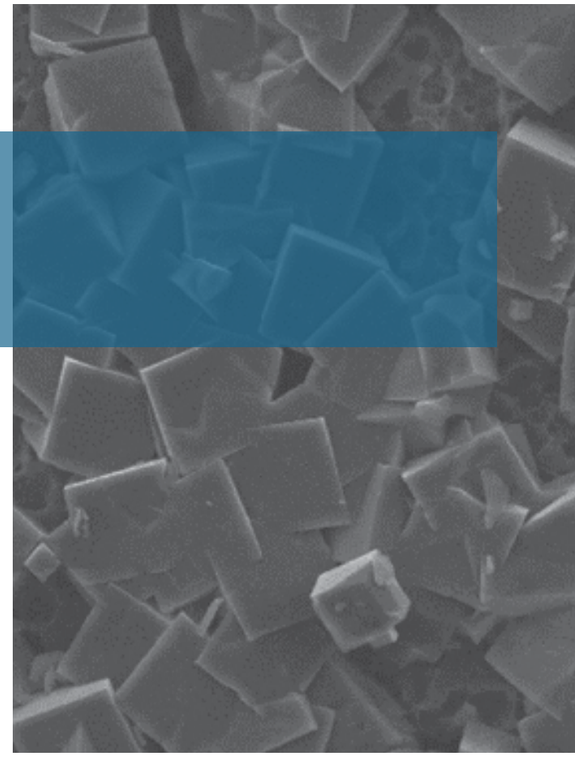
Matthias Hoene
CEO

Pioneering adsorption cooling since 2002.

Research and development has played a central role in FAHRENHEIT from the very start since the company's founding in 2002. Our original research coupled with a keen awareness of our customers' requirements resulted in ground breaking patents in energy solutions. We develop and manufacture innovative and efficient solutions to generate and store cold anywhere cold is needed and waste heat is available.

The power of FAHRENHEIT: Innovative coating technique.

FAHRENHEIT chillers operate on the principle of adsorption. Adsorption occurs when molecules of a liquid (in our case water) adhere to the surface of a solid (in our case zeolite crystals). This causes the liquid to evaporate, generating cold. Once the solid material is saturated, heating it will cause it to release the adsorbed liquid, allowing the process to start anew.



Environmental friendliness begins with our choice of materials.

FAHRENHEIT uses zeolite crystals not only because it is a powerful adsorber, but also because it is efficient, non-toxic and environmentally-friendly. The other main input is water, pure and simple.

FAHRENHEIT: A history of innovation.

2002 Founding of SorTech AG in Freiburg as a spinoff of Fraunhofer Institute for Solar Energy (ISE). Released prototype chiller ACS 05 for field testing

2008 Launched first commercial chillers ACS 08/ACS 15 in the German market

2009 First international deliveries

2011 Developed first zeolite heat pump

2013 Launched advanced silica gel based eCoo line of products

2015 Launched eZea, the first zeolite based chiller

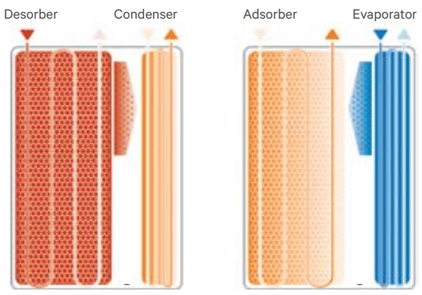
2016 Expanded into high-power applications with introduction of eCoo industry

2017 Company relaunched as FAHRENHEIT to mark a dedicated expansion into international markets and the commercial readiness of ground breaking zeolite technology

FAHRENHEIT holds over 20 patents – three examples.

VACUUM THIN STEEL ENCLOSURE: THE COFFEE BAG PRINCIPLE

The two heat exchangers which make up an adsorption module are encased and vacuum sealed by a thin steel or aluminum enclosure. The design principle is as simple as it is ingenuous: The enclosure forms a thin envelope which rests on the heat exchangers themselves and does not require any additional support structure. The outside air pressure holds everything tightly together. In essence, this design resembles a coffee bag. It is simple to manufacture, and the material savings result in less weight and, moreover, less thermal mass and therefore higher efficiency.



DUAL-CHAMBER TECHNOLOGY: DURABLE DESIGN WITHOUT MOVING PARTS

Our dual-chamber technology is a major step towards even more reliable and maintenance free cooling and heating solutions. Our chillers contain two (or more) identical adsorption modules. Each one contains a pair of heat exchangers, one acting as adsorber/desorber, and the other as evaporator/condenser. The process chambers are interconnected through computer controlled 3-way-valves which ensure that heat and cold is always guided where it is needed in each process phase. This setup does not require moving parts or valves within the adsorption modules and therefore ensures optimal reliability and an almost maintenance free system.

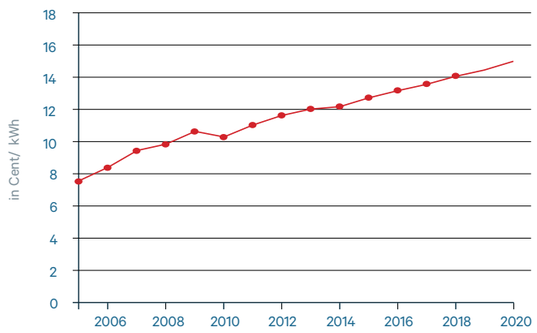
ZEOLITE COATING PROCESS: A REVOLUTION FOR THE COOLING INDUSTRY

Zeolites are a class of non-toxic crystals which are ideally suited for adsorption. In order to optimally apply zeolite to our heat exchangers, we developed a process called PST – Partial Support Transformation. This process, via sophisticated chemistry, makes zeolite crystals grow directly out of the surface of the heat exchangers. This alleviates the need for any kind of coating or glue and optimizes heat conductivity. Because zeolite can reach even the smallest cavities of porous or fibrous material, the surface-to-volume ratio and therefore power density can be maximized.

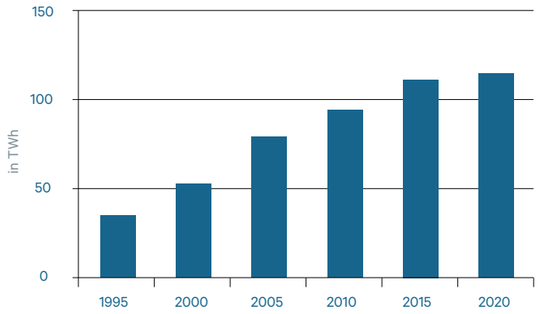
FAHRENHEIT solves current cooling challenges in a new way.

Current conventional cooling technologies are as much a burden as they are a boon. Excessive energy consumption and harmful refrigerants add to our environmental challenges. Electricity prices keep on increasing, making conventional cooling ever more expensive. At the same time, tightening CO_2 regulations require companies to limit their overall energy consumption. Energy efficient and environmentally friendly cooling systems are increasingly needed.

FAHRENHEIT provides an innovative and effective answer to this global challenge. Adsorption cooling is fueled by waste heat, not electricity. It is CO_2-neutral. It is also non-toxic, free of hydrofluorocarbons (HFC), and uses only water as coolant. It functions without moving parts and requires only minimal maintenance. These advantages make adsorption technology the cornerstone of our future cooling infrastructure.



INCREASINGLY EXPENSIVE ELECTRICITY
Prices for electric power in the EU continue to rise – even for industry and trade. It is estimated that by 2020 the kWh will cost around 15 Cents.



ANNUAL AIR-CONDITIONING DEMAND OF 15 MOST IMPORTANT EU STATES GROWING
Not just the price for electricity, but also the need for cooling within the EU countries is on the rise.

Applicable wherever there is heat.

PROCESS HEAT

Many industrial and manufacturing processes generate waste heat – for example, air compressors, printing presses, or extrusion machines. This waste heat is either dissipated or it requires re-cooling. At the same time, there is usually a need to supply cold air or water for industrial processes, and often offices also require cooling.

Adsorption utilizes the excess heat which is otherwise wasted to provide energy efficient and environmentally friendly cooling. It leads to direct electricity cost savings and, depending on the amount of cooling required, often very short payback of the investment.

SOLAR THERMAL SYSTEM

There is more to solar thermal units than hot water generation and heating. When combined with adsorption chiller systems, the excess heat serves as an energy source to generate environmentally friendly and efficient cold for the solar cooling of buildings and processes. The pay-off is especially attractive during the summer, when the demand for air-conditioning is high and the sun generates heat in abundance. Adsorption refrigeration technology allows for better utilization of a solar unit, and at the same time protects it from overheating and overloading. In turn, this extends the lifespan of the system and increases its economic efficiency.

Last but not least: this intelligent technology can function as a heat pump during the winter. With this additional option, even low solar collector temperatures can generate usable thermal heat.

COMBINED HEAT & POWER (CHP) SYSTEM

A CHP unit provides heating and electric power independent of the electric grid. When combined with an adsorption chiller system, it can be turned into a tri-generation unit which flexibly provides electricity, heat, and cold, depending on demand. This ensures solid utilization year-round and makes the economic case for a CHP unit even more compelling. In addition, besides direct cost savings, it ensures reliability even in case of an electric power outage.

LOCAL AND DISTRICT HEATING

During the summer, supplying heat and warm water via an extensive piping system is not an attractive proposition, when low utilization translates into poor grid productivity. When district heating is combined with adsorption chiller technology for cooling purposes, however, this effect can be countered, and district-heating providers can optimize their asset utilization.

For utilities, this strategy pays off economically and ecologically. For one, extending the operational cycle of the heat and power generating infrastructure allows for higher electric power production and sale. At the same time, the deployment of adsorption refrigeration technology reduces the CO_2 footprint for cooling, and it alleviates the need for environmentally questionable cooling agents.

More than 500 installations.

COOLING SERVERS WITH THEIR OWN WASTE HEAT

The Leibniz Computing Center (LRZ) north of Munich is the central IT infrastructure provider to all universities in Munich and operates one of the fastest computers in the world, SuperMUC. It has been conducting research on energy-efficient cooling solutions for high performance computers. The objective is to optimally re-use the waste heat generated by the servers. Using FAHRENHEIT adsorption chillers, the waste heat generated by SuperMUC is used to cool its own components. This cooling solution unlocks an enormous savings potential, saving hundreds of thousands of Euros worth of electricity each year. At the same time, it reinforces LRZ's standing as a progressive and environmentally conscious computing center.

Leibniz-Rechenzentrum
der Bayerischen Akademie der Wissenschaften

ECONOMIC BENEFITS

Payback Period
4.9 Years
Net Annual Saving
8,300 €
CO_2 Emissions
76.8 t p.a.

Power Source	Server Heat
Heating Temperature	55 °C
Refrigeration Capacity	49 kW
Cooling Temperature	21 °C
Re-cooling	Existing Dry Cooler
Initial Start-up	2015
Annual Operating Time	8,760 h

COOLING OF FERMENTATION GASES WITH ADSORPTION

Mannheim's Wastewater Management (EBS) had previously cooled their sewage gas with well water in order to dry the gas and to protect the filters of their combined heat and power plants. This approach, however, caused sediments to form in the hydraulic system and the gas coolers, requiring regular extensive cleaning work. A better solution turned out to be a closed cooling circuit which uses the excess heat from the combined heat and power plants and other processes for cooling. The FAHRENHEIT adsorption chiller system exactly met these requirements. After the stainless steel tube heat exchanger was cleaned mechanically and chemically one last time, it has been supplied with 11°C cold water from the new adsorption chiller system. The system has been running continuously and reliably ever since, ensuring longevity of the vital water management equipment and at the same time saving energy.

EBS MANNHEIM 2
Stadtentwässerung

ECONOMIC BENEFITS

Payback Period
1.8 Years (including subsidies)
Net Annual Saving
7,700 €
CO_2 Emissions
30.2 t p.a.

Power Source	CHP System
Heating Temperature	70 - 80 °C
Refrigeration Capacity	30 kW
Cooling Temperature	11 °C
Re-cooling	Dry Cooler
Initial Start-up	2014
Annual Operating Time	8,760 h

More than 500 installations.

PROCESS COOLING WITH COMPRESSOR WASTE HEAT

More than three quarters of the heat produced by air compressors can be recovered for warm water systems. However, the warm water is only useful in the winter. ERKO CNC installed five FAHRENHEIT adsorption chillers to utilize the thermal energy which previously went to waste. The cooling capacity is used to cool an emulsion which in turn serves to cool machine tools. Especially in a multi-shift operation and with high machine uptimes, this makes a lot of economical and ecological sense

ERKO GmbH
CNC-Präzisionstechnik im DREHEN & FRÄSEN

ECONOMIC BENEFITS

Payback Period
4.1 Years (including subsidies)
Net Annual Saving
9,700 €
CO_2 Emissions
51.9 t p.a.

Power Source	Compressor Heat
Heating Temperature	75 °C
Refrigeration Capacity	63 kW
Cooling Temperature	20 °C
Re-cooling	Dry Cooler
Initial Start-up	2016
Annual Operating Time	6,000 h

SOLAR DRIVEN COOLING FOR FRAUNHOFER INSTITUTE

The Fraunhofer Institute for Solar Energy Systems (ISE) has 1,300 employees who research energy generation, efficiency, supply, and storage. As early as 2005, Fraunhofer installed an adsorption cooling system for cooling its cafeteria in the summer and heating it in the winter. Ever since then, the system has proven its reliability, ease of maintenance, and economical and environmental benefits. At the same time, it underscores Fraunhofer's progressiveness when it comes to innovative and sustainable energy solutions.

Fraunhofer ISE

ECONOMIC BENEFITS

Payback Period
0.9 Years (including subsidies)
Net Annual Saving
1,000 €
CO_2 Emissions
2.5 t p.a.

Power Source	Solar Thermal (Backup CHP)
Heating Temperature	70 – 80 °C (Backup 65 °C)
Refrigeration Capacity	6 – 8 kW
Cooling Temperature	11 °C
Re-cooling	Geothermal
Initial Start-up	2005
Annual Operating Time	up to 2,300 h

Benefitting your bottom line – and the environment.

REDUCTION OF ENERGY COSTS - AND RELIABLE PLANNING

Saving electricity and other forms of energy used for cooling – your savings grow as energy prices keep increasing. In addition, you are able to plan your energy budgets in the long term, without the price volatility of electricity or fossil fuels.

SCALABILITY AND DURABILITY

Adsorption chillers can provide cooling capacity up to several hundred kW, accommodating and even growing with your specific cooling needs. Compared to conventional cooling compressors, adsorption chillers achieve a significantly longer operational life span at much lower maintenance cost.

OPTIMIZING OVERALL ENERGY EFFICIENCY AND THE ENVIRONMENT

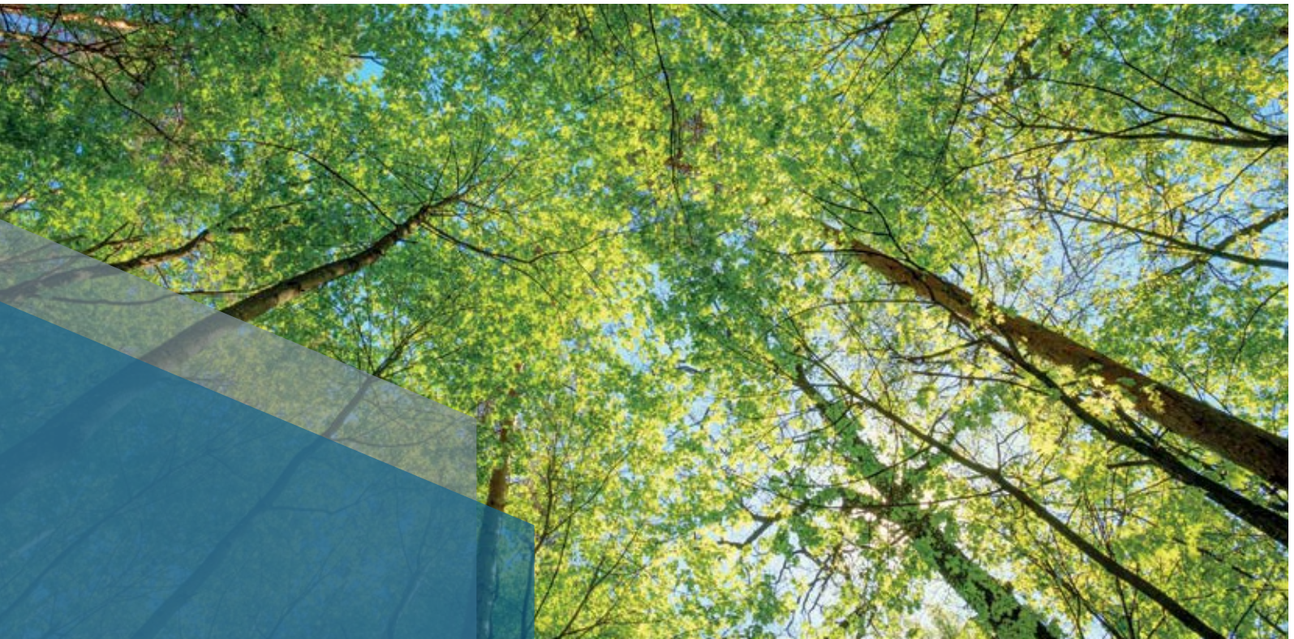
By re-using existing heat via adsorption technology, your company's overall energy efficiency increases, and your CO_2 footprint is reduced accordingly. You will actively contribute to a cleaner, more sustainable environment.

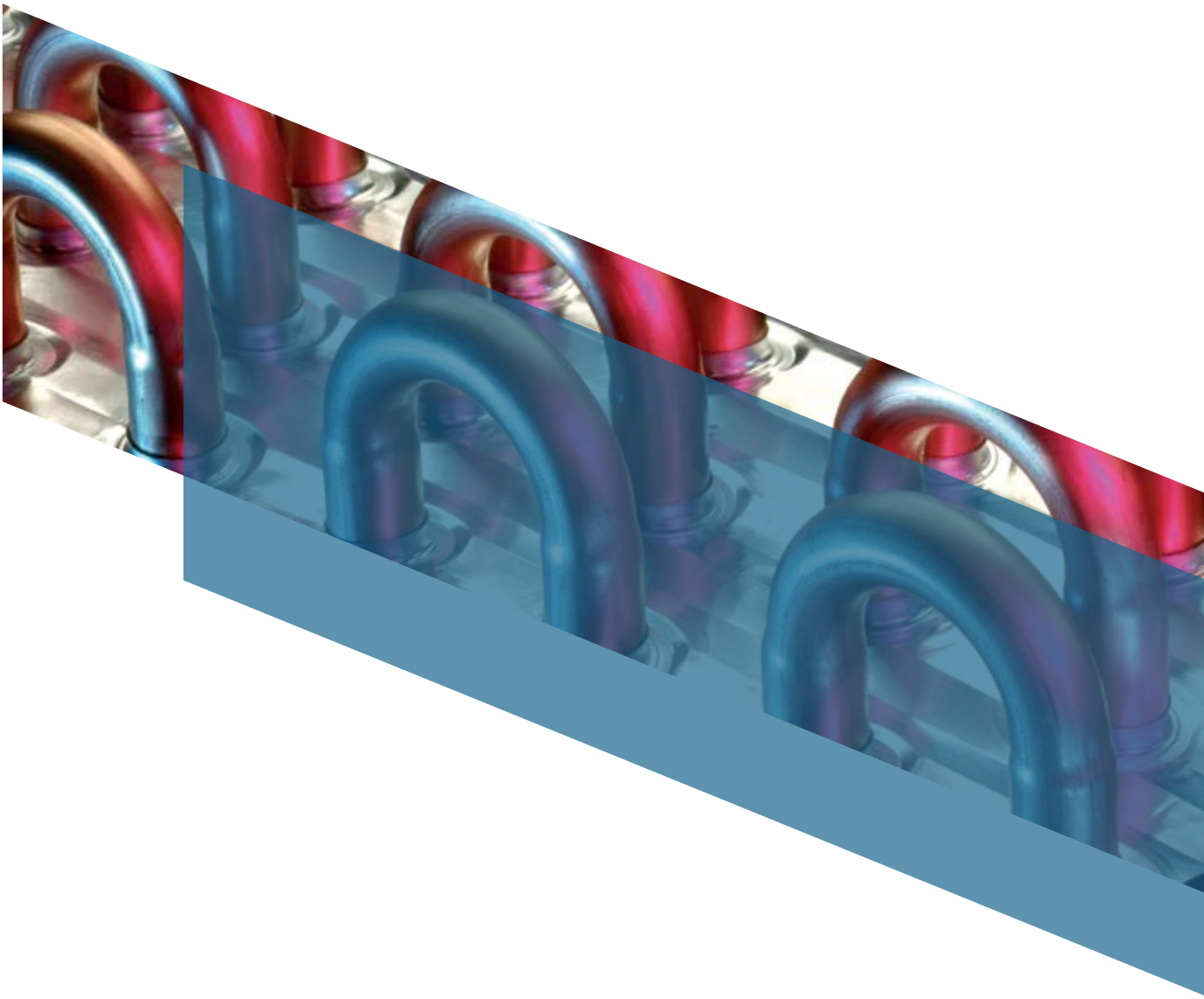
QUICK PAYBACK

The investment in modern cooling technology saves costs from day one, because it lowers energy consumption by up to 90%. Since a cooling concept can integrate a variety of energy sources, amortization is accelerated for both the adsorption chiller and the heat source investment. In many cases, the overall investment pays back in three years or less.

FUTURE-PROOF INVESTMENT

Adsorption chillers are environmentally friendly and use water as cooling agent. Your investment is shielded against the unpredictability of legislation concerning more harmful energy sources and cooling technologies.





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