INDUSTRIAL HEAT RECOVERY

Harnessing heat decarbonization with
GEA heat pump technology

GEA Engineering for a better world.

GEA.com

World-class, integrated cooling and heating solutions
GEA is a global specialist in high-efficiency refrigeration and heat pump technologies for food, beverage and dairy processes.

THINK DIFFERENTLY ABOUT HEAT GENERATION

Your route to a more energy-efficient and climate-friendly production process.

Everyone's talking about the environment. Of course we are. It's the biggest global issue this century and one that will affectall our lives for generations to come. But for those of us who are serious about reducing emissions and protecting valuable resources, it's time to take a radically different approach to processing plant design. It's time to talk to GEA and say goodbye to the boiler.

Cooling and heating demand for processing plants
Every processing plant – dairy, food, beverage – uses heat for cooking, pasteurization, cleaning and refrigeration to cool products down again and keep them fresh. Roughly 60% of the energy cost of processing is for heat production and subsequent chilling.

So, what if the heat removed during refrigeration at the end of the process could be recovered and fed back for cooking, pasteurization, and all operations that require hot water? It sounds upside down, but we have been doing it for years. It reduces energy consumption, virtually eliminates CO_2 and NOx emissions, and can even do away with the need for a boiler completely.

It's a revolution in heat generation. Zero carbon production is now one step closer. It's the plant of the future.

HEAT PUMP – A MODERN TECHNOLOGY FOR HEAT RECOVERY

Recover, re-boost and reuse

There is nothing new about heat recovery. Rather than recover heat at the same temperature level, why not boost the temperature of the waste heat from the refrigeration plant, so that it can be used back in the process at the temperature level that is most needed? That's the job a heat pump can do. Traditionally, a small amount of high temperature heat has been recovered from de-superheating or oil cooling of the refrigeration plant. However, rather than meeting only a fraction of the demand, heat pumps supply all of the heat needed at medium to high temperatures.

Every food processing factory is designed to be like an enormous refrigerator. Everything within that space, such as storage of raw materials, processing (heating and cooling) of raw materials, lighting, machinery, and people, is cooled by the factory's refrigeration plant to the optimum working temperature. Using a heat pump, the heat removed at the low temperature can be boosted, through the addition of a little electrical power, up to 95°C or above. In practice, the heat generated by the factory itself is harvested and used for processing, closing the loop, and wasting virtually no heat at all.

No need for a boiler

Utilizing heat pumps can result in up to 70% increase in heating performance, 90% reduction in CO_2 and NOx emissions, huge costs savings from reduced energy usage and a significant reduction in water consumption. All applications can reduce the size of boiler and condensing equipment. In some cases, the boiler can be turned off completely or omitted from a new build.

Benefits

It lowers your energy consumption
Heat pump solutions, either combined with energy-efficient refrigeration systems, or stand alone can improve your heating performance significantly.

It reduces your carbon footprint
By reducing or eliminating the use of fossil fuel, a heat pump can help you pave the way towards your zero-emission target.

It decreases your operating costs
By replacing the fossil fuel based-heating system with a highly efficient heat pump, you will lower your operating costs.

It meets your sustainability goals
A heat pump solution is a future-proof investment, especially in the face of ever-stricter guidelines on carbon emissions and environmental compatibility.

HOW A HEAT PUMP WORKS

A heat pump works in exactly the same way as a refrigerator: using a refrigerant to remove heat from one environment, lifting it and transferring the heat elsewhere.

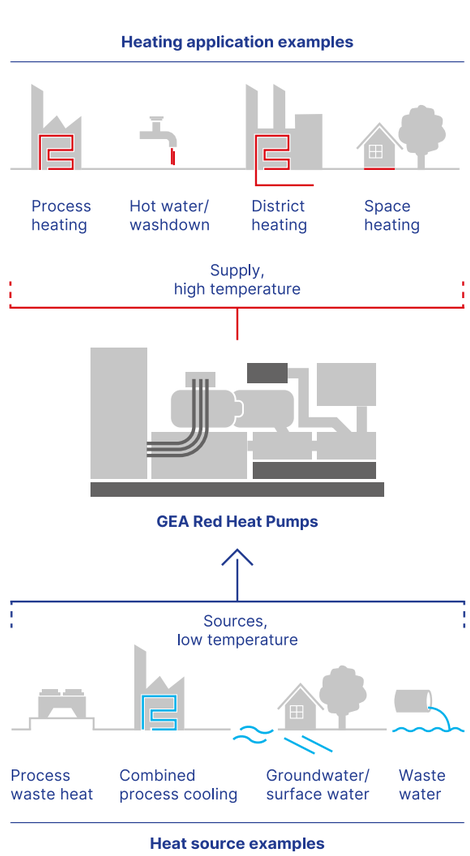
A heat pump in a processing factory simply removes heat from the process at a low temperature and lifts it to an elevated temperature to heat the process and/or water.

Rather than burning gas, a fossil fuel with a fixed carbon content, the heat pump uses a relatively small amount of electrical energy from the national grid – increasingly generated from renewable sources – to power the heat pump compression process. This reduces primary energy consumption and can, in many cases, eliminate the need for a boiler. It also greatly reduces the load on the refrigeration system's condenser that rejects the waste heat to the environment. With a heat pump, the plant also uses less water and chemicals for water treatment.

Thermal buffering is used to balance the load between the cooling and heating sides of the system, which in turn again raises the overall system performance. If the heat demand is time shifted from the moment it can be generated from the refrigeration plant, buffer tanks can be used to store it until it is required.

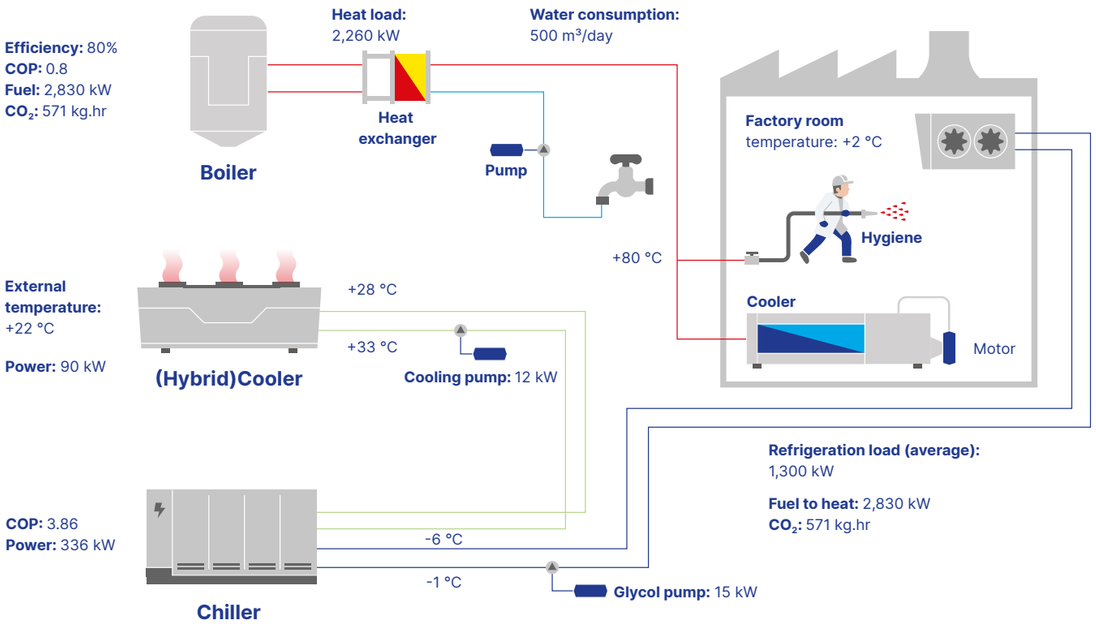
Designed efficiency at an early stage
Heat pumps can be fitted to any food processing plant and will significantly reduce its carbon footprint, water usage and effluent disposal costs, which results in significantly lower operational costs. However, by considering the use of heat pumps at the design stage of the processing part of the plant, GEA can radically change the flow of heat around the factory for maximum efficiency. If considered in the early design phase, the factory can often save the capital cost of the boiler and condensing equipment thereby achieving an even faster return on investment.

Selling your additional heat
Most applications can generate more heat with heat pumps than is required for the process. In these cases, the excess heat can often be sold to your neighbor or a local district heating network, further increasing the return on investment.



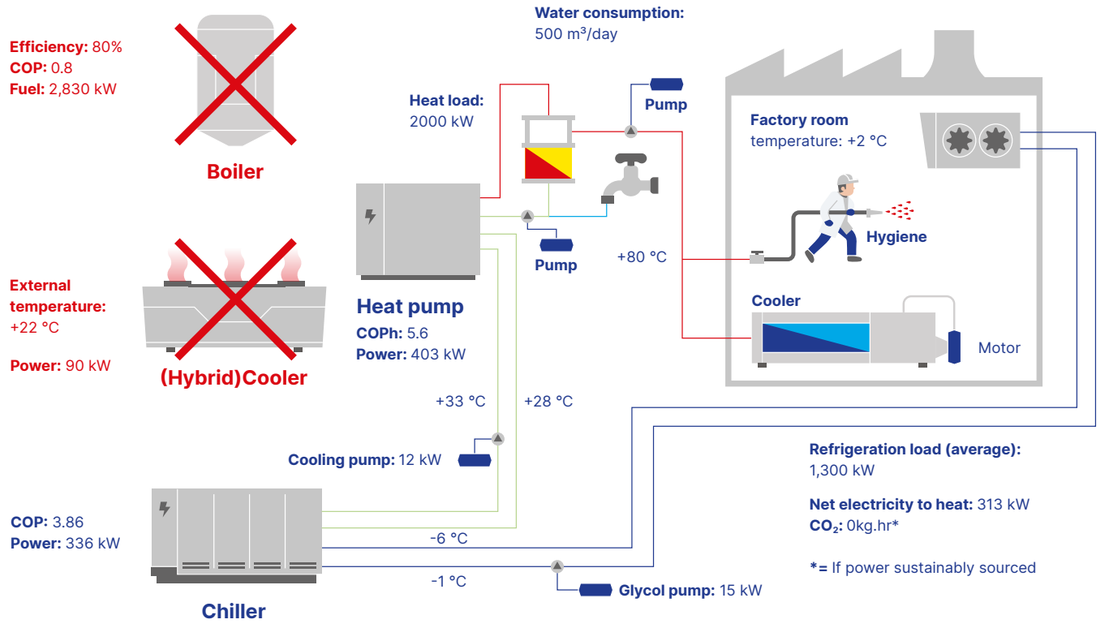
HOT WATER PRODUCTION EXAMPLE

Assuming the cost and CO_2 emissions of fuel are € 0.027/kWh | e.g. 0.203[1)] kg/kW, and those for electricity are € 0.070/kWh | 0.229[1)] kg/kW, and that the factory runs 316 days per year. Discover how much you can save in energy costs and CO_2 by replacing a fuel-fired boiler with a heat pump.



Hot water production by boiler

- Heating capacity = (2,260 kW/0.8) x 20 hr x 316 d = 17,854K kWhr
- Refrigeration power consumption = (332 + 12 + 90 kW) x 20 hr x 316 d = 2,742K kWhr
- **Total annual energy cost = (17,854K kWhr x €0.027) + (2,742K kWhr x €0.07) = €674K/year**
- **Total annual CO_2 emissions = (17,854K x 0.203) + (2,742 x 0.229) = 4,252 tons/year**



Hot water production by heat pump

- Heating capacity = 418 kW x 20 hr x 316 d = 2,641K kWhr
- Refrigeration power = (332 + 12 kWh) x 20 hr x 316 d = 2,174 K kWhr
- **Total annual energy cost = (2,641K + 2,174K) kWhr x €0.070 = €337,000**
- **Total annual CO_2 emissions = (2,641K + 2,174K) kWhr x 0.229 kg/kW = 1,102 tons, zero if green electricity is used**

[1)] Figures used are based on UK 2022 average. (carbonindependent.org)
[2)] Thermal Heat of Rejection

Savings with heat pump solutions
Total annual energy costs = €240K
Total annual CO_2 savings = approx. 3,150 tons
(CO_2 savings will reach 100% if green electricity is used)

HEAT PUMP SOLUTIONS FROM GEA

Proven technology – efficient and reliable

GEA is unique in its ability to deliver a complete plant, including cooling and heating, ready to run, with its heat requirement analyzed, balanced, proven and with heat pumps integrated for maximum efficiency.

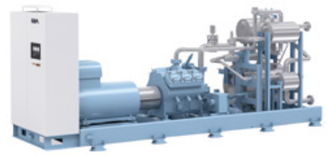
Our heat pump solution and expertise are matched to your specific requirements based on our engineers' vast process experience, covering various applications such as food, beverage and dairy, in a unique, cohesive approach. You can find more product information in our heat pump product brochure: GEA Red Heat Pumps.

GEA has a wide range of heat pumps designed for specific applications from 300 to 10,000 kW. All feature the highly efficient screw or reciprocating (also known as piston) compressors from GEA.

	Temperature (°C)	Heating capacity (kW)
GEA RedGenium 5 HP, V HP or V XHP reciprocating compressor based	Up to +95	300 - 3,000
GEA customized heat pumps 5 HP, V HP or V XHP reciprocating compressor based	Up to +95	300 - 3,500
Blu-Red Fusion heat pumps Screw or reciprocating compressor based	Up to +95	500 - 2,500
GEA RedAstrum Screw compressor based	Up to +85	600 - 3,000
GEA customized heat pumps Screw compressor based	Up to +95	600 - 10,000

If you are switching your refrigeration plant from F-Gas to natural refrigerant, now is the time to employ a heat pump and reduce your energy costs and CO_2 emissions in one stroke.

GEA RedAstrum



GEA RedGenium

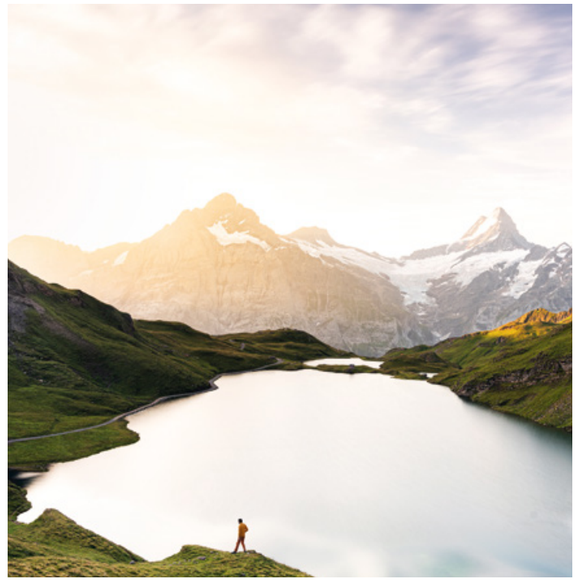
GEA Customized Heat Pump

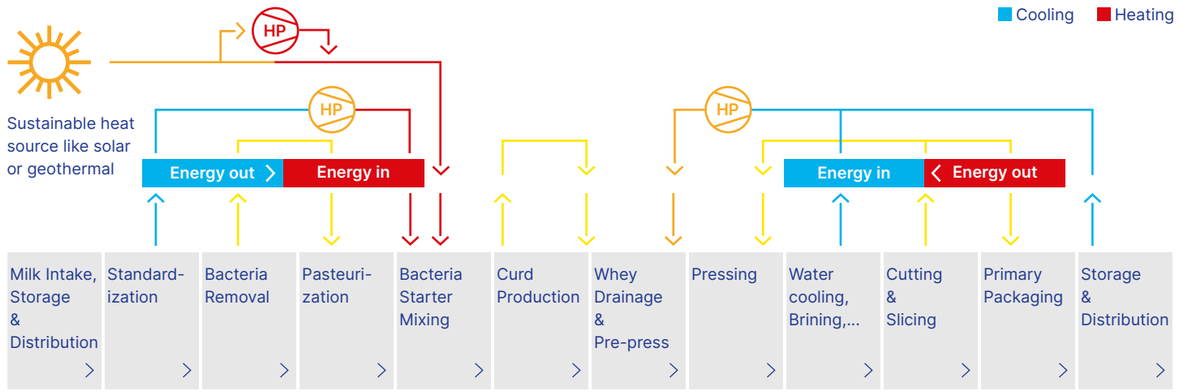
ENVIRONMENTAL FRIENDLINESS WITH GREATER EFFICIENCY

GEA takes environmental protection and sustainability seriously, that's why we use natural refrigerants (e.g. NH3) in our heat pumps.

More sustainable production process
The use of natural refrigerants makes heat pumps even more efficient and environmentally compatible. Heat pumps lead to a reduction in primary energy use and avoid direct CO_2 emissions because they supplement or replace existing, inefficient, conventional components that supply heat. The favorable environmental balance sheet can be improved even more when the electrical power for driving the heat pumps comes from renewable energy sources. (See the dairy processing example below).

F-Gas regulation
Global Warming Potential (GWP) is the internationally accepted environmental benchmark for the use of refrigerants. As a key part of the European regulation adopted in 2014, the GWP rates refrigerants based on their CO_2 equivalent. The use of high GWP refrigerants will be severely restricted worldwide in the future. Natural refrigerants such as a NH3 , CO_2 , HC, do not deplete the ozone layer and have no (NH3) or only a low (CO_2 , HC) GWP, which comply to the EU F-Gas regulation.





This dairy processing example illustrates the levels at which sustainable heat may be managed in order to achieve a zero-carbon-emission solution.

Level 1: Reusing energy that flows directly via heat exchangers.
Level 2: Applying a heat pump to elevate the temperature level to a higher value.
Level 3: Harvesting solar heat (directly from solar collectors or indirectly from geothermal heat) and applying it directly in the process after a temperature lift with a heat pump.

HEAT PUMP CUSTOMER STORIES

The heat from heat pumps can be used throughout the factory. This can include wash-down water in food processing factories and cooking operations as well as pasteurization of dairy and beverage products. Here are some customer references of how heat pumps from GEA have transformed customers' processes to help them save money and protect the environment.

At GEA, sustainability and value creation are intertwined.

CUSTOMER STORY

Aurivo milk processing plant in Killygordon, Ireland

Aurivo, Ireland's second-largest liquid milk processor, has cut CO_2 emissions at its Killygordon site by 80% thanks to a multimillion-euro upgrade of their new liquid processing systems with integrated refrigeration and heat pump solutions from GEA. The successful project has also been awarded the Excellence in Energy Efficiency Design (EXEED) Certification from the Sustainable Energy Authority of Ireland.

The challenge
Aurivo was looking to increase efficiency and capacity, as well as reduce carbon footprint, at its milk processing facility in Killygordon. It already used a green electricity supplier, so Aurivo focused on reducing overall energy use, especially that consumed by fossil-fuel fired water boilers.

The GEA Solution
GEA designed and installed a new refrigeration plant that would replace the existing inefficient refrigeration system and a customized heat pump system was installed to boost the waste heat from the new refrigeration plant to heat water for the milk pasteurization process. As a single-source supplier of both liquid processing (pasteurization, separation, homogenization and milk standardization equipment) and refrigeration & heating systems, GEA integrated the refrigeration, heat pump and pasteurization systems. "We didn't just provide a heat pump, we optimized the pasteurizer to suit the heat pump application for the Aurivo site," stated Kenneth Hoffmann, heat pump product manager at GEA. "All the way through the project we were focused on offering a complete solution, not just individual parts, so that our technologies could help to reduce energy consumption and use of fossil fuels, making the Aurivo facility one of the most sustainable dairy plants in Ireland."

The result
The overall upgrade has reduced Aurivo's energy consumption for processing, heating and chilling by about 12%. Operational savings amount to more than €347,000 annually, and CO_2 emissions have dropped by more than 780 tons per year. "The upgraded Killygordon plant has operated faultlessly since the new system was installed, with no disruption to milk processing capacity or quality during commissioning." said Stephen Carlin, Aurivo's engineering manager.

GEA scope of supply:
GEA solution: Customized heat pump system
Heating capacity: 1200 kW
Supplied temperature: 80°C
COP: 6.7 (yearly average)
Compressor type: GEA Grasso reciprocating compressors
Natural refrigerant: Ammonia

CUSTOMER STORY

Mars chocolate factory in Veghel, The Netherlands

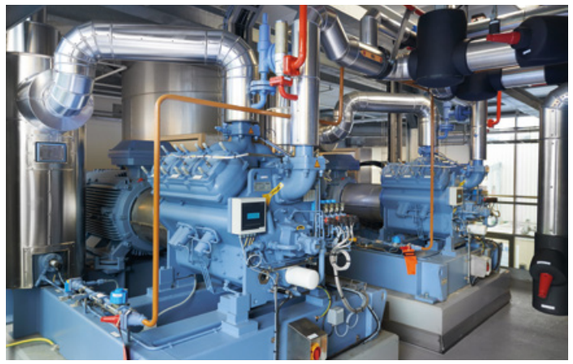
Mars Wrigley Confectionery, the world's leading manufacturer of chocolate, chewing gum, mints and fruity confections, has achieved energy and CO2 reduction with GEA's heat pump solution at its facility in Veghel, the Netherlands — one of the largest chocolate factories in the world.

The customer challenge
As a step along the way toward a sustainable future, Mars has been seeking to reduce its carbon footprint and its use of natural resources at its production facilities. One of the key focuses is to make its production process more energy efficient.

The GEA solution
The customized GEA heat pump solution makes it possible to extract and boost what is otherwise unusable low-temperature heat from the refrigeration units, which is then used to heat water. This water is then channeled through the factory's specially installed rooftop warm water piping network, from where it is sent to various processes and uses within the plant, for example, chocolate and syrup storage, and air-handling units.

The result
"We engaged in fruitful discussions with the GEA team on how to achieve further energy efficiency and CO_2 reduction at our facility – and the approach of installing heat pumps systems to reach this goal has proven successful."– Paul Simons, global technology leader of utility/civil at Mars. At Mars' Veghel site, GEA innovative heat pump solution has contributed to a reduction of 1,000,000 m3 of natural gas per year, equivalent to a reduction of more than 1,000 t CO_2 per year, or more than 1,800 t CO_2 per year if green electricity is applied.

GEA scope of supply:
GEA solution: Customized heat pump system
Heating capacity: 1400 kW
Supplied temperature: 63°C
COP: 5.9 (yearly average)
Compressor type: GEA Grasso reciprocating compressors
Natural refrigerant: Ammonia



(Photo source: RCC K&L)

CUSTOMER STORY

Intermalt malting plant in Ba Ria Vung Tau province, Vietnam

Interflour is one of Southeast Asia's largest grain processors. The company's Intermalt facility in Vietnam is meeting the growing demand for high-quality, locally produced malt for Vietnam and the Southeast Asia market.

A cool demand and challenge
Germinating barley generates heat, so cool humidified air is needed to blow through the bed of grain in the germination vessels to maintain the required temperature levels. Working closely with Intermalt at a very early stage in the project, GEA designed, configured and subsequently installed an efficient, cost-effective cooling solution that has given Intermalt highly controllable and consistent conditions for germination.

From cold to hot
Interflour's close partnership with GEA was originally focused on supplying cooling technology. However, GEA's in-depth analysis of the process revealed that it could help Intermalt to reduce fuel consumption, significantly increase energy efficiency and improve their environmental footprint through the installation of energy-saving GEA heat pump technology. The heat pump upgrades the waste heat from the cooling plant and channels it to heat the air required for the kilning process, which is the stage during which the geminated malt is dried.

Sustainable energy solution
"The GEA heat pump solution fits quite well with our aim for a sustainable and energy efficient production process," stated Matthias Benz, operations manager at Intermalt, "Partnering with GEA at an early stage gave us the opportunity to interact closely with the design, project, engineering and installation teams who were all completely dedicated to the project. This enabled us to tailor the highest quality heating and cooling solutions that would interface with our equipment to optimize our processes."
Robert Wicks, general manager at Intermalt, adds, "The heat pump technology has significantly reduced our energy consumption. We are saving approximately 2,000 tons of CO_2 per year from the heat pumps. It has enabled us to operate in an environmentally responsible manner, while providing customers with high-quality malt at competitive price points."

GEA scope of supply:
GEA solution: Customized refrigeration and heat pump
Heating capacity: 12 MW
Supplied temperature: 60°C
COP: 5.22 (yearly average)
Compressor type: GEA Grasso screw compressors
Natural refrigerant: Ammonia

KEEPING IT COOL, WITH GEA SERVICE.

Reduce the life cycle cost of your plant and equipment.

We work alongside our customers in close partnership, supporting them throughout the full life cycle of their plant and equipment to ensure lasting business success.

Getting you started
As a supportive and committed partner for life, we plan and build around individual needs, sharing process knowledge, training employees and supporting operators to get our customers up and running and ensure a smooth, seamless on-going service.

Keeping it running
To ensure our customers benefit from continuous production processes for minimal unexpected downtime, we provide fast support, efficient maintenance and top-quality spare parts, whenever and wherever needed.

Constantly improving
We safeguard our customers' investments by constantly looking ahead through modernizing or upgrading of equipment and optimizing of processes to meet changing needs and new market demands. We are always working to increase production efficiency and ensure peak performance.

Together with you
Commitment to our customers and their business means investing in their objectives, their risks and their future success. We work in ever-closer collaboration, providing on-going systems audits and on-site support through innovative new service models in order to generate improved performance.

Our four stages of continued success

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