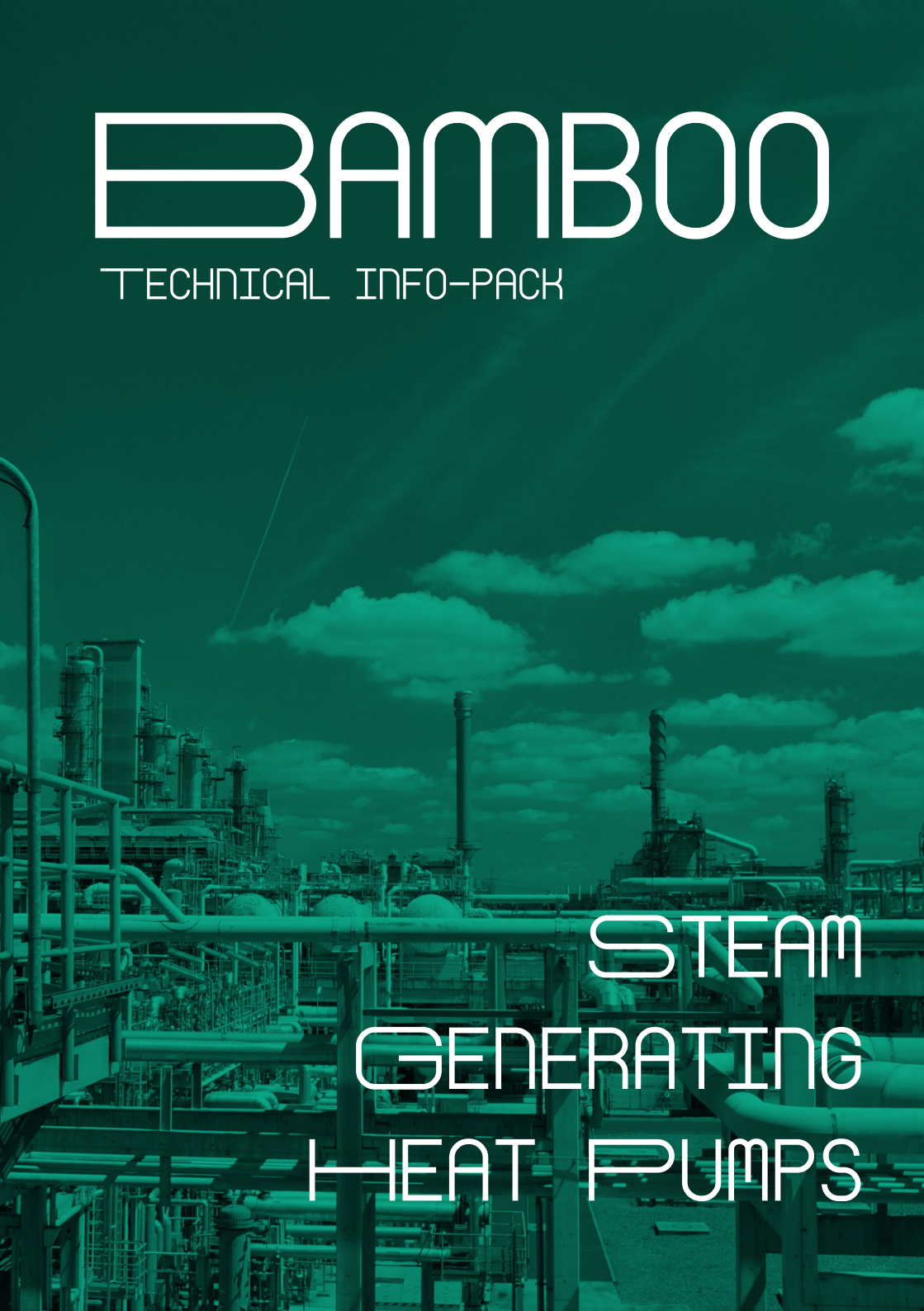
BAMBOO

TECHNICAL INFO-PACK



STEAM GENERATING HEAT PUMPS

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Lower energy costs in industrial processes thanks to greater energy efficiency and to upgrading of waste heat

DESCRIPTION

Heat pumps have great market potential to reduce emissions and energy costs by upgrading waste heat to a higher temperature. This can be achieved while still providing flexibility in industrial processes, if the use case and possible partial load scenarios are carefully planned.

Specifically, industrial heat pumps can be applied whenever low-grade waste heat is used to generate process heat. **Steam-generating heat pumps**, in particular, play a special role since in industrial processes the required heat is predominantly provided by steam, and the same is also used as reactant. The use of industrial heat pumps increases the energy supply efficiency and advances decarbonizing of the industry sector through electrification. Upgrading waste heat from low to higher temperatures makes these improvements possible by utilizing electrical energy.

BAMBOO demonstrates that certain state-of-the-art heat pumping technologies are suitable for producing saturated steam with **output pressures of up to 5 bar (152°C)**. This relatively novel market segment enlarges the potential applicability across energy-intensive industries, due to the number of relevant processes that work at higher temperatures. The applications for steam in these processes are wide-ranging. It is used for heat transfer, especially in the food & beverage, chemical, pulp and paper sectors and in low-temperature processes in the steel industry. It is also relevant as a process reactant in the chemical and pharmaceutical industry.

POTENTIAL MARKETS AND END-USERS

The most relevant target for heat pumps are energy-intensive sectors that make use of heat lower than 200°C in their production processes. These sectors are:

- **Pulp & Paper**
  The sector's overall heat demand is composed of heat needed for drying the paper and mechanical energy used for pumps, compressors, fans, and machine drives. It has also potential opportunities due to the demand for sustainable packaging and sanitary grades. The technology is attractive for its capacity to increase energy efficiency, reduce energy costs and curb emissions.

- **Food, Beverage & Tobacco**
  The application of heat pumps in this sector mainly focuses on products and processes which employ large-scale drying

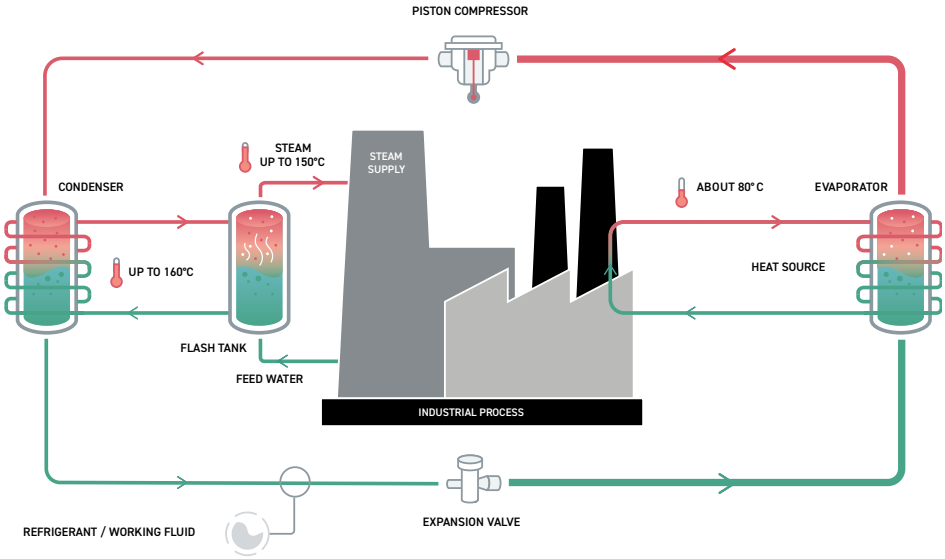

Figure 1. Diagram of the steam-generating heat pump realized in the BAMBOO project.

and dewatering but it can also concern the concentration of waste liquids, heating of cleaning water, sterilisation, beer brewing, and distillation.

- **Chemicals & refining**
  Distillation is the most common and the most energy-intensive process where heat pumps reduce primary energy consumption.

- **Steel & iron**
  Steelmaking factories are big consumers of steam, which is typically used to heat streams such as mixtures, water, air or oil. recognise, and understand combustion conditions to ensure low NOx emissions and to understand energy conversion and pollutant formation.

RESULTS

Within BAMBOO project, a steam-generating heat pump has been developed, designed and manufactured.

- **Manufacturing and commissioning**
  The steam-generating heat pump system consists of two individual components: a high-temperature water-to-water heat pump and a flash tank unit for steam generation. Both subunits were produced by independent manufacturers. These subunits were brought together and connected to the test rig of the EDF labs.

- **First test runs**
  The basic functionality of the steam-generating heat pump has already been tested. The controls work together smoothly and the system is stable. In these first tests, the goal of producing steam with a pressure of 5 bar (152°C) has already been reached.

Figure 2. Demonstrator of the steam-generating heat pump employing a flash tank realized within the BAMBOO project.

- **Performance evaluation according to test matrix**
  The relevant operating states of interest were determined and are currently being tested. The measurement results are constantly being evaluated and, if needed, additional operating states are added to the test matrix. This ensures a faithful representation of the equipment over the entire spectrum of operating conditions.

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