

Heat Pump Awards 2026

Application submission

Implementation of sustainable heat upgrade technologies for industry (“SPIRIT”).

Demonstration case 2 in the SPIRIT project (GEA Refrigeration Germany GmbH, Danish Technological Institute, Tiense Suikerraffinaderij) | Large Heat Pump Award

1. Application overview

Award category	Large Heat Pump
Title of the project	Implementation of sustainable heat upgrade technologies for industry ("SPIRIT").
Organisation Name	Demonstration case 2 in the SPIRIT project (GEA Refrigeration Germany GmbH, Danish Technological Institute, Tiense Suikerraffinaderij)
Exact address of the project	Aandorenstraat 1, 3300 Tienen, Belgium
Funding	Private; EU funds
Organisations involved in the project	a. GEA Refrigeration Germany GmbH, Heating & Refrigeration Technologies, Berlin, Germany b. Tiense Suikerraffinaderij N.V., Tienen, Belgium c. Danish Technological Institute, Refrigeration and Heat Pump Technology, Aarhus, Denmark
Project ending date	28/02/2027
Project website	https://spirit-heat.eu/
Sector of application	Industrial

2. Applicant & EHPA contact details

Full name	Jonas Lundsted Poulsen
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EHPA member involved	Danish Technological Institute
Role of EHPA member	Knowledge provider (Research and Technology Organisation)

3. Project description and benefits

Project description (goal, problem addressed, and solution provided by the heat pump)

In the energy-intensive sugar refining industry, juice concentration relies on multi-effect falling film evaporators traditionally driven by fossil fuel-fired steam boilers. Under the EU Horizon Europe project SPIRIT, a first-of-a-kind 4 MW high-temperature heat pump (HTHP) was developed by GEA and integrated into Tiense Suikerraffinaderij in Tienen, Belgium. The heat pump uses the natural refrigerant n-Pentane (R-601), which is a hydrocarbon with a GWP < 1, and recovers low-grade vacuum vapor at around 75 °C from the final evaporation effects and upgrades it into process steam at 115 °C - 140 °C (verified up to 150 °C) directly for the primary evaporation effect. Through demonstration in a real industrial environment the novel heat pump has proven the

potential for enhancing energy efficiency and accelerating industrial decarbonization by using advanced heat pump solutions.

Expected or achieved benefits

Direct fossil fuel replacement and CO₂ savings as it replaces natural gas combustion with an estimated greenhouse gas savings of 3,000-3,500 tonnes of CO₂/year. In addition, significant thermal capacity has been added to the steam system. The heat pump delivers up to 4 MW, covering 6 % of the sugar factory's total steam demand. This development supports the expansion and development of GEA's product portfolio for high-temperatures heat pumps, with a verified stable operating heat pump design, which in full-load operation have been delivering saturated process steam up to 150 °C (4.8 bar(a)).

Obstacles/barriers encountered during development

The project has high focus on ATEX safety compliance in the food sector, hence safely integrating a MW size heat pump with a charge of flammable R-601 required constructing of a dedicated two-story machine-room building conforming to all standards, featuring anti-static flooring, gas detection, and emergency mechanical ventilation. In addition, the amount of non-condensables in the heat source vacuum steam were higher than anticipated, hence dedicated drain lines and equipment were installed to maintain full functionality.

Why should this project win an award?

To our knowledge, this demonstrator represents the world's largest demonstrated high-temperature heat pump running on pentane (R-601), which is lighthouse project in the heat pump community. Operating in a real-world food processing environment, the system delivers up to 4 MW of direct process steam at temperatures up to 150 °C. Generating multi-megawatt steam at these temperatures using this hydrocarbon has often been considered too complex or hazardous for industrial scale. This installation demonstrates that natural refrigerants can be deployed safely to replace fossil-fired boilers in the industry, and its paves the way for many future systems.

4. Technical specifications

Capacity of unit(s)	3600 kW
Energy sources used	The heat source is vacuum steam and the compressor is electrically driven
Coefficient of Performance (COP)	Two main operating modes: a. COP = 3.6, heat source = 75 °C and heat sink (steam) = 115 °C b. COP = 2.7, heat source = 72 °C and heat sink (steam) = 135 °C
Service provided	The heat pump is integrated into the energy supply of steam for process heating in an energy-intensive sugar refining process at Tiense Suikerraffinaderij, which is a sugar factory operated by Tiense Suiker and located in Tienen, Belgium. In this diffusion process, sugar is extracted from the beets by cutting them into cossettes and bringing them into contact with warm water. The resulting sugar-rich solution is then concentrated through several falling film evaporation steps, in the end resulting in the production of sugar as the final product. The newly developed heat pump generates steam at temperatures around 140 °C for the first evaporator, utilizing a heat source consisting of around 75 °C vacuum steam from one of the last evaporators
Refrigerant type	R-601, n-Pentane.

Heat pump details (compressor technology, heat exchanger, system configuration)

The heat pump is a single stage heat pump with a screw compressor with a double shaft seal. The type of heat exchangers are shell-and-tube and made of stainless steel. The condenser is 9 m wide and evaporator 7 m wide. The system has an internal heat exchangers, and the oil colling loop is connected to a water based heat recovery system.

5. Renewable energy integration and grid response

Integration of renewable energy sources

Tiense Suiker's long-term ambition goal is to extensively electrify its sugar refinery process, where green electricity is key. The first step to achieve this goal was to join the SPIRIT project and integrate and demonstrate a high-temperature heat pump in their production process.

Response to energy demand / smart grid integration

The VFD-driven screw compressor can modulate its electric load up to 1.4 MW to vary the steam production as need. This enables the heat pump to ramp the power consumption up or down in response to volatile electricity market prices.

6. Innovation, monitoring and replicability

General (all awards)

Why the project is innovative *(all awards)*

GEA have performed an assessment and optimization of their compressor for operation at these elevated temperatures and this working fluid. Among other things this included a focus on the sealings, bearings, and electrical components.

Monitoring approach (performance, cost, and carbon targets) *(all awards)*

Data is collected in the SCADA system and also in the GEA OMNI control for performance analysis.

For Large Heat Pump or Building Solutions Award

Why the project serves as a model for others *(Large Heat Pump or Building Solutions Award)*

This installation provides a reference case for the decarbonisation of core industrial processes. Many manufacturing sites operate multi-effect evaporators, distillation columns, or drying processes with identical thermal profiles (waste heat at 60 °C – 80 °C and steam demand at 120 °C –150 °C). It shows a brownfield integration of a heat pump into a live steam header and demonstrates that large-scale steam heat pumps are not experimental concepts, but commercially viable alternatives to fossil boilers.

Potential for expansion to other locations/industries *(Large Heat Pump or Building Solutions Award)*

The concept can be adapted to other process industries with similar thermal profiles - such as dairy, brewing, chemical distillation, and starch processing, where 60 °C – 80 °C waste streams can be upgraded to 120 °C –150 °C process steam.

Barriers to replication elsewhere *(Large Heat Pump or Building Solutions Award)*

Key barriers could include an unfavorable electricity-to-gas price ratio some places and industry hesitation regarding ATEX compliance with flammable refrigerants. These can be overcome by careful integration of the heat pump and efficient and safe design with ventilation and gas sensors, and with the possible inclusion of a thermal storage for de-risking and also creating a flexible process heat solution.

Business opportunities for expansion, licensing, or commercial production *(Large Heat Pump or Building Solutions Award)*

Yes. For GEA, the project directly supports the qualification and validation of their high-temperature screw compressor for steam generation up to 150 °C, opening substantial commercial market possibilities across the European process industry.

For Innovation Award

Technology/technique developed solely for this project *(Innovation Award only)*

Especially the compressor has been assed and modified for higher temperatures, but also the large two story machine room building has been built.

Differentiation from state-of-the-art solutions & market maturity *(Innovation Award only)*

This project differentiates itself by delivering 4 MW of direct process steam at up to 150 °C using a natural hydrocarbon (R-601), bridging a significant temperature lift from 75 °C vacuum steam in a robust, closed-loop cycle partly located outdoors. The project is in early commercial deployment, and the technology has been proven in an authentic industrial manufacturing environment and it can be used as a basis for commercial scale-up.

Regional benefits (energy savings, emissions, jobs, infrastructure) *(Innovation Award only)*

It is indirectly future-proofing Tiense Suikerraffinaderij against escalating fossil fuel and carbon costs, hence protecting the long-term competitiveness of a vital regional agro-industrial hub, supporting local beet growers and regional supply-chain jobs.

Commercial potential *(Innovation Award only)*

Yes. For GEA, the project directly supports the qualification and validation of their high-temperature screw compressor for steam generation up to 150 °C, opening substantial commercial market possibilities across the European process industry.

Consent and submission notes

People's Choice Award opt-out: No answer provided (not opted out).

Consent to publish project information: Yes.

Consent to publish exact project location: Yes.

Consent to future Awards contact: Yes.

Consent to publish project pictures: Yes.

Supporting materials: No answer provided.