



EVENT PARTICIPATION

15th IEA Heat Pump Conference



CFD-based ejector design to extend the operating range of ammonia/water absorption heat transformers

Federico Mazzelli*, Vu-Hai La*, Mathilde Wirtz*, Hai-Trieu Phan*

*Université Grenoble Alpes, CEA, LITEN, DTCH, L2TS, F-38000, Grenoble, France

Abstract

The early onset of cut-off conditions, referred to as operational limits, is one of the key factors hindering the adoption of ammonia/water absorption heat transformers (AHTs) in hot climates, particularly during peak summer periods. The relatively low cut-off temperature (30-35°C) arises from the coupling between the generator pressure and the pressure established at the condenser. At high ambient temperatures, condenser pressure increases, which limits the amount of ammonia that can be desorbed in the generator. One strategy to address this issue is to decouple the condenser and generator pressures, creating a system with three distinct pressure levels. A gas compressor could be used for this purpose; however, this solution is costly and may not be justified, as its operation would be limited to periods of high ambient temperatures. As a simpler alternative, gas ejectors can be employed. To operate the ejector, a portion of the evaporated ammonia is diverted from the evaporator outlet and used to entrain and compress the low-pressure vapor from the desorber, raising it to condenser pressure. This paper presents the methodology used to design and simulate an ejector integrated into an ammonia/water AHT system. A CFD-based optimization loop was developed to refine the geometry of the mixing chamber. This optimization framework is coupled with high-fidelity 2D CFD simulations that allow for a more reliable design process.

© HPC2026.

Selection and/or peer-review under the responsibility of the organizers of the 15th IEA Heat Pump Conference 2026.

Keywords: Absorption Heat Transformer; Ammonia/Water; Ejector; CFD simulations

1. Introduction

In recent years, increasingly complex absorption-cycle architectures –including those incorporating vapor ejectors– have been investigated to enhance cycle performance [1]. Vapor ejectors demonstrates the ability to expand the heat-source operating range of absorption cycles, enabling a COP close to 1 for the H₂O/LiBr single-effect cycle [2] at a heat-source temperature of 200 °C (approximately 80 °C above the conventional range). Similar improvements have been reported for the H₂O/LiBr double-effect cycle [3], achieving a COP around 0.9 at heat-source temperatures between 120 °C and 140 °C (around 20 °C below the typical range). These advancements for H₂O/LiBr systems have subsequently motivated studies on NH₃/H₂O machines [4], which indicate the potential for performance enhancement at higher heat-source temperatures, although further experimental validation is still needed.

Over the past few decades, the rise of CFD-based numerical modeling has undoubtedly extended into the study of ejectors. Previous work [5,6] has demonstrated not only good accuracy in predicting the ejector entrainment ratio (ER) but also strong agreement with local-scale characteristics, such as pressure profiles.

In the framework of the ZIMBA project, an innovative ammonia/water AHT system aiming to produce 15 kWh at 110°C will be developed. It is improved by the integration of a two-phase ejector, designed to stabilize its performance and widen the operating conditions range – in particular under hot conditions.

*Corresponding author. E-mail address: hai Trieu.phan@cea.fr

26-29 May 2026 | Hofburg, Vienna

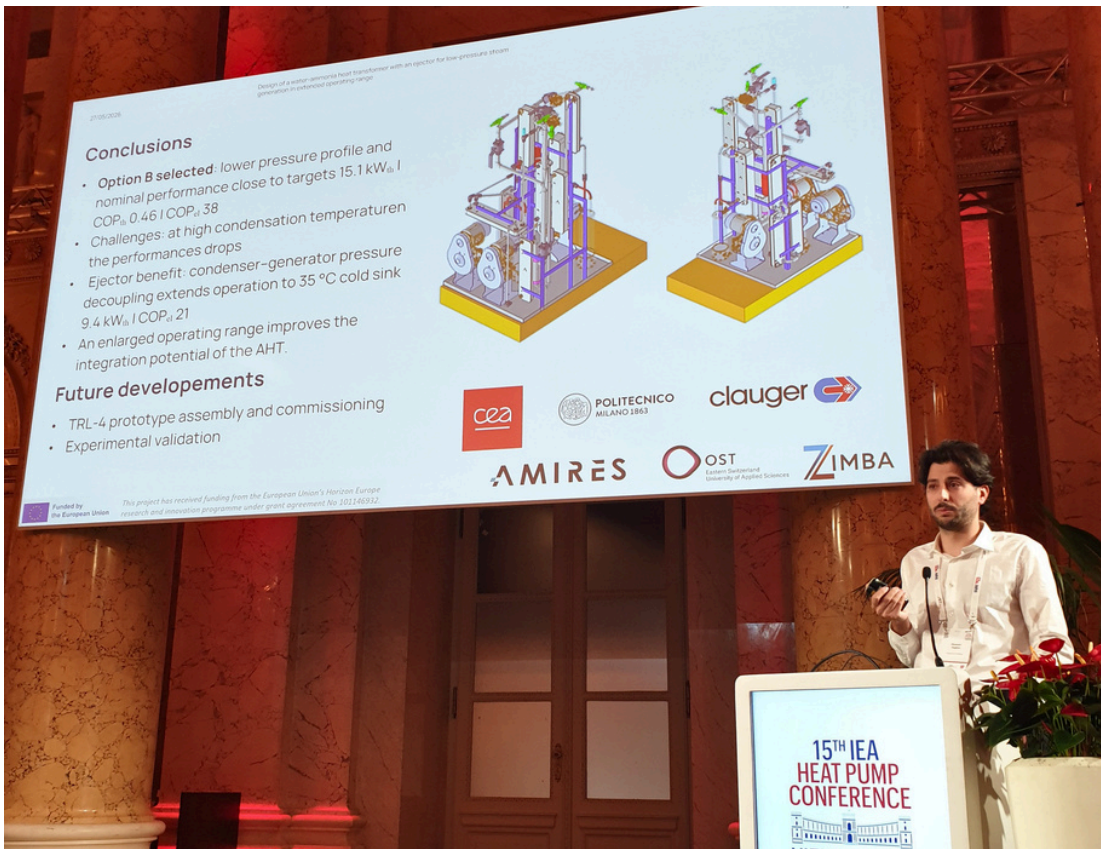
Read the paper here





EVENT PARTICIPATION

15th IEA Heat Pump Conference



Design of a water-ammonia heat transformer with an ejector for low-pressure steam generation in extended operating range

Giovanni Vaghini^{1*}, Lorenzo Pistocchini², Tommaso Toppi³

¹Energy Department, Politecnico di Milano, Milano 20156, Italy

Abstract

Absorption heat transformers (AHTs) can contribute to the decarbonization of the industrial sector thanks to their capacity to upgrade intermediate-temperature waste heat to higher temperatures, suitable for industrial processes, while rejecting part of it to a lower temperature sink. Additionally, AHTs use much less electricity than heat pumps of the same heating capacity. The European project ZIMBA aims to develop a single-stage water-ammonia AHT for steam production driven by waste heat. The system is designed to deliver 15 kW_{th} of steam at 1.3 bar(a) while working with a heat source at 80 °C and a heat sink at 20 °C. To extend the operability range, the integration of an ejector to decouple generator and condenser pressures is also introduced. In this work, two cycle configurations are evaluated through numerical simulations under varying cold sink temperatures to assess system performance. The most promising configuration showed that at a sink temperature of 10 °C, the system achieves an electrical COP of 43.6, thermal COP of 0.47, and 15.1 kW_{th} of thermal output. At 35 °C, the identified cut-off condition, performance decreases significantly, with an electrical COP of 18.5, thermal COP of 0.38, and thermal output of 9.64 kW_{th}. This decline is mostly dependent on the increase in condensation pressure, which limits ammonia desorption in the generator. These performances result from optimal concentration operation for each sink temperature; however, near cut-off, optimal concentration shifts significantly towards higher ammonia concentration, and without separate water and ammonia storage, hardly implementable in a heat transformer cycle, cut-off performance deteriorates further. But thanks to the ejector, at 35 °C, the most promising configuration achieves an electrical COP of 21.08, a thermal COP of 0.30, and 9.37 kW_{th} at a limited rise of ammonia concentration.

© HPC2026.

Selection and/or peer-review under the responsibility of the organizers of the 15th IEA Heat Pump Conference 2026.

Keywords: Heat transformer; Absorption; Water-ammonia; Waste heat;

1. Introduction

The coming years call for a drastic transformation of the energy sector to achieve carbon neutrality by 2050 and limit global warming to below 1.5 °C by the end of the century. Industry plays a pivotal role in this transition, accounting in 2022 for around 25% of final energy consumption and 20% of total emissions in the European Union [1]. Most of this demand arises from process heating, which represents about 66% of industrial energy use, with 37% of it being required at temperatures below 200 °C. At the same time, the EU generates an estimated 2700 PJ/year of waste heat, corresponding to roughly 4% of its gross available energy [2], [3]. This context highlights the strong potential of heat pump technologies, which can upgrade waste heat to process-relevant temperature using either heat or electricity as the driving input, thereby enabling its reuse and reducing both energy consumption and CO₂ emissions. Nevertheless, in planning the transition toward a carbon-neutral society, careful consideration must be given to the pace and scale of industrial electrification, due to its significant impact on the electric grid.

Absorption heat transformers (AHTs) offer a suitable alternative for specific applications. Unlike vapor compression heat pumps, AHTs are thermally activated by the low-exergy waste heat available at intermediate

26-29 May 2026 | Hofburg, Vienna

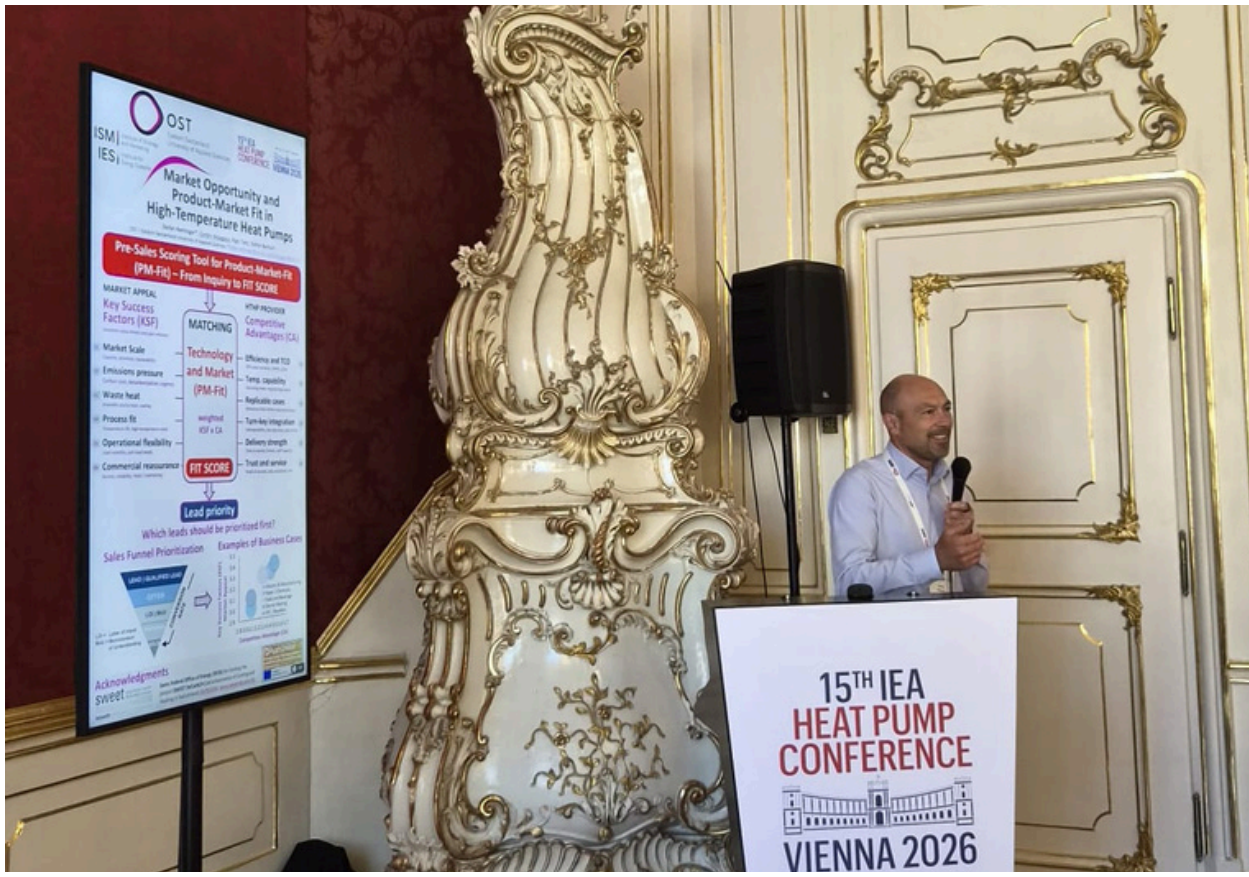
Read the paper here





EVENT PARTICIPATION

15th IEA Heat Pump Conference



Accelerating Industrial Heat Electrification in Europe: Barriers and Policy Recommendations to Heat Pump Adoption

Cordin Arpagaus^a, Jan Rosenow^b, Sem Oxenaar^b, Elian Pusceddu^c

^aOST - Eastern Switzerland University of Applied Sciences, Institute for Energy Systems (IES), Buchs, Switzerland
^bRegulatory Assistance Project (RAP), Brussels, Belgium
^cCleanTech Energy Consulting, Berlin, Germany

*Corresponding author: cordin.arpagaus@ost.ch, Tel. +41 (0)58 257 34 94

Abstract

Accelerating the electrification of industrial energy use is essential for achieving net-zero climate goals, given its significant potential to decarbonize energy consumption and enhance efficiency, particularly in process heating. Mature electrification solutions, such as industrial heat pumps and resistive heating systems, are already available. Advanced solutions for very high temperatures have existed for decades, with innovations emerging regularly. Despite these technological advancements, the industrial sector remains hesitant to adopt electrification. It is hindered by several persistent barriers, including economic constraints, technical limitations, knowledge gaps, and insufficient infrastructure. This paper examines the current landscape of industrial electrification policies in Europe, with a focus on industrial heat pumps. It categorizes policy instruments and assesses their implementation at the EU level and in 10 selected countries: Austria, Belgium, the Czech Republic, Denmark, Finland, Germany, Italy, the Netherlands, Switzerland, and the UK. To supplement the policy review, a survey was conducted with national experts from each country to evaluate the effectiveness of existing policy instruments supporting industrial electrification. Findings reveal that regulatory frameworks are often inadequate, and electrification continues to receive low priority among policymakers. While a few countries have emerged as leaders with comprehensive and innovative policy approaches, most still lack the robust policy frameworks necessary to drive meaningful change. Addressing these policy gaps is vital for accelerating industrial decarbonization. A well-coordinated and ambitious policy approach is essential at both the EU and national levels. Only an integrated set of policies – including strong carbon pricing, clearly defined electrification targets, and fossil fuel phase-out timelines – can achieve the scale and speed of transformation needed to meet Europe’s climate and energy goals.

© HPC2026. Selection and/or peer-review under the responsibility of the organizers of the 15th IEA Heat Pump Conference 2026.

Keywords: industrial electrification; heat pumps; decarbonization; policy instruments; energy transition

1. Introduction and Method

The recent surge in energy prices and the risk of natural gas shortages pose an existential threat to many industrial companies, particularly SMEs. Industrial heat pumps (IHPs) can be a viable option for low and medium-temperature heat needed in many industries [1]. They significantly reduce energy demand and dependence on natural gas. According to the IEA, commercially available IHPs could meet nearly 30% of the heat demand in the chemical, paper, and food industries, with an installation potential of 15 GW across 3,000 European facilities [2]. Rising gas prices have made IHPs the most cost-effective option for process heat, even in countries with high electricity-to-gas price ratios (e.g., Germany, Italy, the UK) [3]. Consequently, a wide range of industrial high-temperature heat pumps (HTHPs) is now available, and industry interest is high. Promising business models are purchasing an HTHP [3]. Yet, actual deployment remains limited [4]. Why?

26-29 May 2026 | Hofburg, Vienna

Read the paper here

