

Insights from IEA HPT Project 68 - Task 2: Fostering market uptake of High-Temperature Heat Pumps through Sector Collaboration and Stakeholder Integration

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Introduction

High-temperature heat pumps (HTHPs) are a key technology for industrial decarbonization, enabling the substitution of fossil-based process heat with efficient, electricity-driven systems. Despite their technical maturity, the market penetration of HTHPs with 40 documented demonstration cases in Project 68 Task 1 remains limited [1]. Key barriers include the lack of demonstration cases, process-specific challenges such as high safety requirements and restricted heat exchanger areas leading to high supply temperatures, and unfavourable energy price relations. In addition, there are knowledge gaps concerning suitable system integration points, as well as missing standardization and modularization on both manufacturer and end user sides leading to high capital costs for planning and integration. Successful market implementation requires understanding of the corresponding sector-specific value chain as well as the active involvement of all relevant stakeholders such as system integrators, process equipment and technology suppliers, and industrial end users.

IEA HPT Project 68 - Task 2: Sector collaboration

Task 2 of the Technology Collaboration Programme Heat Pumping Technologies Project 68 of International Energy Agency addresses these challenges by establishing a structured framework for sector-specific collaboration and stakeholder engagement. Overarching objective is to facilitate communication and understanding between relevant stakeholders and their specific perspectives. Concretely, the goal is to identify sectoral requirements and challenges, derive opportunities, and outline pathways for broader market uptake of HTHPs. Focus sectors include pulp and paper, dairy, brewery, textiles, pharmaceutical, chemical, recycle and petrochemical industries as well as district heating.

The methodological approach relies on a series of collaborative workshops (*Sector Collaborations*), where participants jointly explore application potentials, process characteristics, integration strategies, and implementation strategies. The outcome will be Barrier-Opportunity-Matrix and a Roadmap of Actions for each sector, defining specific steps and commitments from stakeholder to foster HTHP deployment. Furthermore, tailored communication strategies and targeted dissemination channels will ensure that relevant stakeholders and multipliers are effectively engaged.

Kick-off workshops at High-Temperature Heat Pump Symposium

The workshops began with an introductory keynote talk from end user perspective to highlight the characteristics and decarbonisation activities in the respective sector including major challenges, emission hotspots, key drivers, and opportunities for carbon reduction along the supply chain. The next impulse came from technology suppliers, who focus on technological possibilities outlining performance potentials, integration concepts, illustrative reference cases, and retrofit requirements. Based on this, a panel discussion and interactive part of the workshop supported by poll and voting systems aimed to identify technical, economic, and organisational challenges and encourages to co-create of potential solutions and map relevant stakeholders to define collaborative next steps. The workshop concluded with a wrap-up that synthesizes workshop outcomes, concrete action items, and defines follow-up activities to ensure effective deployment.

In the following, the key challenges were mapped with the potential opportunities for the relevant stakeholders in the textile, pulp and paper and chemicals sectors as identified in the workshops.

Chemical Sector

Table 1 shows sector-specific barriers and possible opportunities for stakeholders to overcome them. While the chemical sector is already familiar with the components of HTHPs, it requires retrofit and process-integrated solutions that can accommodate limited spatial availability, specific process requirements of a heterogeneous process landscape (e.g. thermal separation, thermal treatment, drying) and high cost expectations. Furthermore, the feasibility of potential implementations is significantly influenced by country-specific regulatory boundary conditions, such as grid access and energy pricing. Additionally, economies of scale of HTHP technologies remain limited, even for larger capacities.

Table 1: Barrier-Opportunity-Matrix of chemical sector

Barrier	Opportunity	Stakeholder
Negative feedback effects between efficiency measures; technology lock-in effects	Holistic transformation starts at process level: energy efficiency first (e.g. temperature reduction, heat recovery), heat pumps → pinch analysis	Consultants & planner
High CAPEX regarding technologies	Technology costs reduction: Economy of scales through standardization and modularization	HTHP supplier & system integrator
	CAPEX reduction: Heat as a service; usage of funding programs	Energy supplier; Consultants & planner
High CAPEX regarding integration and planning costs	Greenfield: process-integrated solutions Brownfield: retrofit solutions (e.g. container solutions)	HTHP supplier & system integrator
	Application of pinch analysis	Consultants & planner



Confidentiality obligations	Access to operational experiences and process data	End user
Only a few HTHP suppliers met tender's requirements and obligations	Collaboration as partnership: learning from each other; demonstration cases	HTHP supplier, End user
Lack of standards and guidelines	Education material, European and national engineering guidelines/standards	Education
Flexibility requirements	Adaptability to production needs and energy markets	HTHP supplier, regulatory

Pulp and Paper

The paper machine as core process of this sector is a very energy-intensive drying process and therefore offer enormous potential for decarbonising process heat using heat pumps. European paper industry is organised in joint approaches like the Modellfabrik Paper showing their willingness to collaborate, but on other side heat pump solutions cannot be scaled well due to small number of similar paper machines. Collaboration between technology suppliers, equipment manufacturers, and end users promotes understanding and reduces deployment risks. Large-scale demonstrator projects are needed to validate technical performance and economic feasibility, thereby enhancing market readiness. Dynamic simulation serves as a key tool to analyze transient behaviour, reduce uncertainty, identify integration points, and support informed decision-making. Economic uncertainty, particularly regarding electricity prices and existing CHP assets, remains a major barrier.

Table 2: Barrier-Opportunity-Matrix of Pulp and Paper sector

Barrier	Opportunity	Stakeholder
High OPEX	Deep process integration (e.g. cylinder group-specific HP integration)	Process equipment manufacturer, HTHP supplier, system integrator
	Process modifications are possible to improve process conditions for HTHP integration (e.g. lower temperatures, higher dew points)	R&D, end user
Complex and transient process conditions along paper machines (e.g. temperature requirement, humidity of air)	Dynamic paper machine simulations for virtual evaluation of HTHP integration and their influence on system behavior and conditions	R&D
Conservative industry mindset, fear of production issues, reliability of large-scale HTHP concepts	Partnership, real-world demonstration cases	End user, HTHP supplier, process equipment manufacturer, system integrator
Long investment cycles, high investment, lock-in effects such as steam from CHP	Planning certainty over a long period through stable regulatory framework conditions, funding	Regulatory

Textiles

While the chemical and pulp and paper sectors are already significantly further ahead in terms of heat pump adaption, the textile industry is still in the early stages of its activities. This industry ranks among the most energy-intensive manufacturing sectors, with substantial thermal energy demand arising primarily from wet-processing operations including dyeing, washing, bleaching, and finishing. Achieving deep decarbonization in the textile sector requires coordinated actions and collaboration across the entire value chain among brands, retailers, manufacturers, technology suppliers, financial institutions, and policymakers.

Table 3: Barrier-Opportunity-Matrix of textile sector

Barrier	Opportunity	Stakeholder
Lack of full-scale demonstrators	Transfer of knowledge about European demonstrators	End-user, brands
Lack of sector-specific technical expertise in producing regions (e.g. far eastern countries)	Process integration studies Knowledge transfer regarding technology status and engineering/planning guidelines	Consultants, R&D
Carbon-intensive grids	On-site solar, or power purchase agreements on renewable electricity	End user, regulatory
Uncertainty in investment decisions due to grid reliability and capacity limits, peak demand charges and energy prices	Co-investment across the value chain shares risk and guarantees long-term commitments	Financing

Outlook and Conclusions

The workshops demonstrated that there is substantial potential for decarbonizing process heat through the application of HTHP across the chemical, pulp and paper as well as textile sector. Exploiting this potential, however, requires overcoming several sector-specific barriers. In the chemical industry, the highly heterogeneous process landscape and the absence of mature large-scale HTHP technologies pose major challenges. In the paper industry, complex and transient process conditions along paper machines requires dynamic simulation for the identification of integration points and virtual evaluation of the reliability. Large-scale implementation of HTHP in textile sector is limited by carbon-intensive electricity grids and limited technical awareness.

In addition to these sector-specific barriers, cross-sectoral challenges were identified. These include limited space availability, restricted grid connection capacities, and unfavourable electricity-to-reference energy carrier price ratios. Moreover, higher efficiency gains will depend on deeper process integration and process modifications, while the reduction of capital expenditures can be facilitated through increased standardization and modularization and shared risk investment strategies. A lack of large-scale demonstration cases remains a critical barrier to broader market uptake. The sector collaborations within the framework of IEA Project 68 Task 2 addresses these challenges through coordinated communication, specific actions and stakeholder integration and thereby supports the market uptake of HTHP technologies.

References

- [1] Zühlsdorf, B., Andersen, M. P., Tammone, C. et.al. Industrial High-Temperature Heat Pumps. Task 1 – Technologies: Yearly Report 2025 2025. <https://doi.org/10.23697/9b7b-sz34>.