Paper & Pulp

High-Temperature
Heat Pump Symposium

High-Temperature Heat Pumps in the Pulp & Paper Industry: Challenges, Opportunities and Priorities from a Stakeholder Panel

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Abstract

At the *High Temperature Heat Pumps Symposium* in Copenhagen, a dedicated workshop addressed the role of **high-temperature heat pumps (HTHPs) in the pulp and paper industry**. The session brought together six experts from heat pump manufacturing, paper production, process engineering, and research. The aim was to capture the current status of HTHP integration, identify the main challenges, and discuss opportunities to accelerate implementation. The workshop combined a moderated panel discussion with interactive audience feedback using Mentimeter surveys.

Current Integration Concepts and Industrial Context: The pulp and paper industry is among the most promising sectors for large-scale HTHP deployment due to its high and continuous heat demand, especially in drying processes. A commonly discussed integration concept involves using a heat pump to generate medium-pressure steam, which is then further upgraded using mechanical vapor recompression (MVR). Typical heat sources include dryer hood exhaust air or warm process water loops.

An industrial reference case presented during the workshop illustrated the scale of current developments: a steam-generating heat pump with a capacity of up to 12 MWth, delivering steam at 3.4 bara and 150–180 °C using waste heat from a paper mill water loop and Iso-Butane (R600a) as a refrigerant. This example demonstrates both the technical feasibility and the unprecedented capacity requirements in this sector.

Main Challenges

In the first Mentimeter survey, participants were asked about the biggest obstacles to HTHP adoption in the pulp and paper industry. Eighteen responses were collected, and the results, together with the panel discussion, highlighted three major challenge clusters.

- **Economic and business-case uncertainty:** Many responses explicitly mentioned investment costs, uncertain return on investment, electricity price levels, and the electricity-to-gas price ratio. Paper mills often operate large combined heat and power (CHP) plants that historically

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provided low-cost steam while also generating electricity revenues. Replacing or supplementing these assets with electric heat pumps fundamentally changes the plant's economic structure and introduces new risks. Panelists noted that the transition from fuel-based to electricity-based heat supply increases dependency on electricity price volatility and grid availability. The long lead times for large heat pumps—reported to be up to four years—further increase planning and financial risks.

- **Integration complexity and process dynamics:** Participants highlighted the need for detailed process knowledge, including temperature levels, load profiles, and available heat sources. Comments referred to system complexity, lack of detailed simulations, and challenges in retrofitting existing mills. Panelists emphasized that heat pumps cannot be treated as simple add-on utilities. Paper machines are highly dynamic systems with multiple temperature levels in the drying process. Effective integration requires system-level design, close interaction with the process, and often modifications to existing heat and steam networks.
- **Scale, technology readiness, and operational risks:** Several survey responses pointed to the very large required capacities, unclear technology readiness at scale, and concerns about potential impacts on production. Panelists noted that many mills operate CHP units in the range of 40–60 MW. Replacing these with heat pumps requires similarly large systems and significant upgrades to the electrical infrastructure. The dynamic nature of paper production also demands flexible and robust heat pump operation. Concerns were raised about reliability, maintenance, and the consequences of unexpected downtime in such critical process steps.

Key Opportunities to Overcome Barriers

In the second Mentimeter question and the subsequent discussion, participants identified several opportunities to address the identified challenges. Although only seven responses were collected in the survey, the panel discussion provided additional context.

- **System simulation and model-based design:** Dynamic system simulation was highlighted as a key enabler for understanding integration effects, reducing uncertainty, and supporting investment decisions. Panelists reported increasing use of simulation tools to evaluate concepts and convince customers. Simulation allows the interaction between the heat pump, the drying process, and the energy system to be assessed under realistic, time-dependent conditions. This is particularly important in paper mills, where loads fluctuate and multiple temperature levels are involved.
- **Real-world demonstration projects:** Participants stressed the importance of demonstration projects and industrial reference cases to prove reliability and economic viability. Real-world examples help build confidence among mill operators and reduce perceived technological risks. However, panelists also pointed out that demonstration projects at the required scale—often above 40 MW—are difficult to implement without public funding or joint industry initiatives.
- **Process optimization and improved drying concepts:** Several participants emphasized that improvements in drying technologies and process conditions can significantly enhance the viability of heat pump integration. Optimizing temperature levels, heat recovery, and process design can reduce the required temperature lift and improve overall system efficiency. Such measures not only facilitate heat pump integration but also contribute directly to energy savings and lower production costs.
- **Partnerships across the value chain:** Strong collaboration between paper producers, heat pump manufacturers, equipment suppliers, and research institutions was identified as a key enabler. Joint projects can reduce risks, share costs, and accelerate learning across the sector. Panelists emphasized that the European pulp and paper industry has a unique structure, making

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coordinated approaches particularly valuable. Improved communication between manufacturers and end users was also highlighted as a practical and effective measure.

Prioritization of Opportunities

In the final Mentimeter question, 21 participants ranked the four opportunity areas. The results show a balanced but informative picture:

1. Partnerships with companies
2. Real demonstrators
3. Dynamic simulation
4. Optimize process conditions

The results indicate that **partnerships and real demonstrators** received the most first-place votes, highlighting the importance of practical collaboration and real-world experience. **Process optimization** was most frequently ranked second, suggesting broad agreement on its supporting role. **Dynamic simulation** showed a more polarized perception, with both many first-place and many fourth-place rankings, reflecting differing views on its immediate relevance.

Outlook and Conclusions

The workshop revealed a clear consensus among panelists and participants: high-temperature heat pumps are technically feasible for the pulp and paper sector, but their successful deployment depends on **system-level integration, economic confidence, and large-scale collaboration**.

Several key conclusions emerged:

- Heat pumps must be integrated at the process level rather than treated as standalone utilities.
- Economic uncertainty, especially related to electricity prices and existing CHP assets, remains a major barrier.
- Dynamic simulation can play a crucial role in reducing uncertainty and supporting decision-making.
- Large-scale demonstration projects are essential to build confidence in the technology.
- Partnerships across the value chain are critical for accelerating implementation.

With tightening climate regulations and increasing pressure to decarbonize industrial heat supply, the panel agreed that companies delaying the adoption of heat pump technology may face competitive disadvantages in the coming years.

Overall, the discussion highlighted that the transition to electrified process heat in the pulp and paper industry is not only a technological challenge but also a systemic and organizational one—requiring coordinated efforts across industry, research, and policy.

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Paper and Pulp Sector Workshop

Copenhagen, 21st–22nd January 2026 | HTHP symposium 2026

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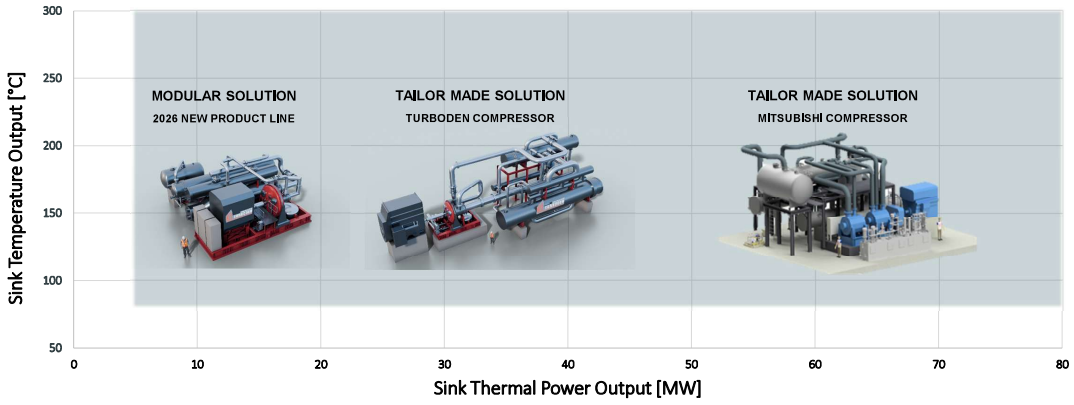
TURBODEN PRODUCT PORTFOLIO



HEAT PUMPS

Custom made units designed for complex projects with power from 10 to 80 MW

Modular units scalable design with sizes from 5 to 15 MW and pre-assembled skids

Temperatures up to 130°C for district heating, up to 300°C for industrial applications

STEAM COMPRESSOR

Large Scale Customized MVR (3-60 ton/h)

Mini-scale MVR (1-3 ton/h)

Steam Temperatures up to 300°C, pressure up to 30 barg

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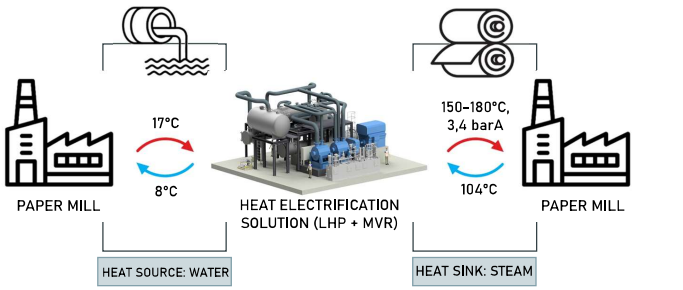
CASE HISTORY:
DELFORT GROUP AG PAPER MILL - OVERVIEW

delfort



WATCH THE VIDEO

World's Largest Steam-Producing Heat Pump is now in operation!

The customer valorized the low-temperature waste heat from the paper mill by installing an innovative heat-upgrade solution, a LHP together with an MVR, to **produce valuable steam** for the paper mill itself.

Delfort Group required a solution capable of supplying its production with **fully decarbonized steam**, while guaranteeing the same standards provided by fossil-fuel boilers. Turboden addressed this need by developing a **customized heat electrification solution** that produces steam from renewable electricity.

The result is a robust, efficient, and future-proof system that avoids more than **19,000 tons of CO_2** emissions per year (calculated), significantly reducing the environmental footprint of the production site.

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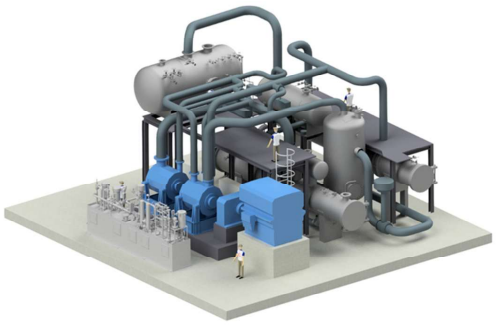
CASE HISTORY:
DELFORT GROUP AG PAPER MILL - LAYOUT



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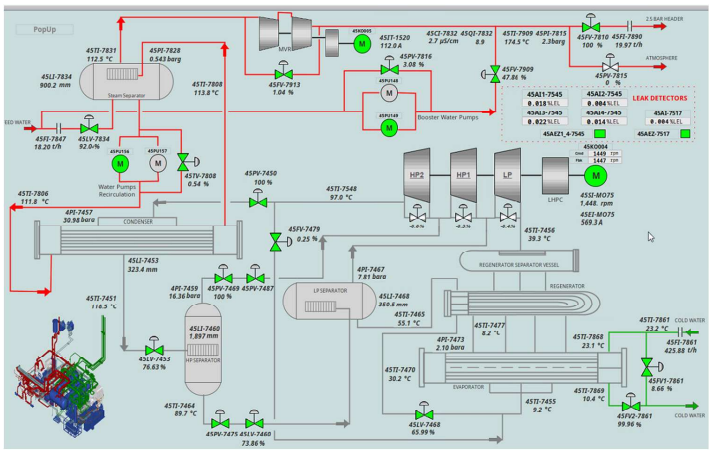
CASE HISTORY:
DELFORT GROUP AG PAPER MILL - SCADA



PROJECT FEATURES

- Integration of LHP with MVR to provide high-temperature steam at high efficiency (COP 2)
- Thermal power: 12 MWt, 20 ton/hr steam
- Electrical power: 6 MWe
- LHP working fluid: Iso-Butane (R600a)

HEAT SOURCE

- Type: Exploitation of paper mill waste heat through an intermediate water circuit
- Inlet: 25°C – 15°C
- Outlet: 15°C – 5°C

HEAT SINK

- Type: Superheated steam delivered to the paper mill for the drying process
- Inlet: Condensate 104°C
- Outlet: Superheated steam at 170°C, 3,4 barA

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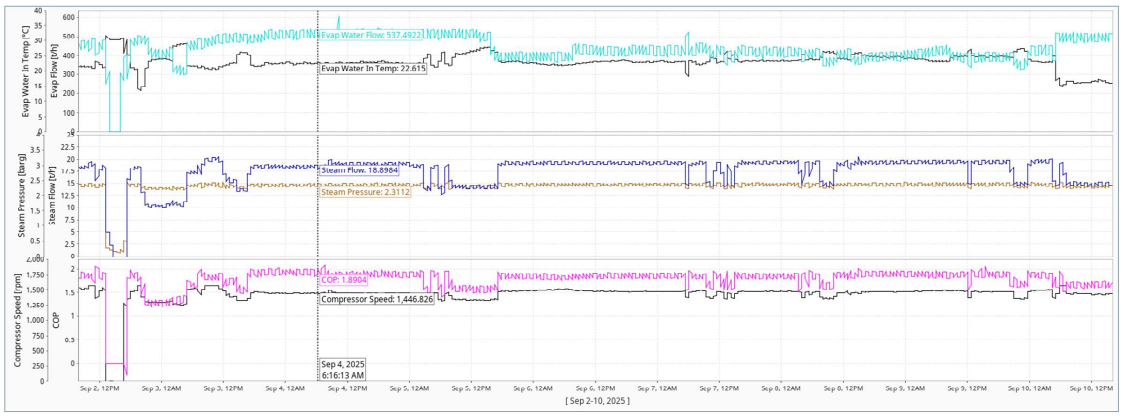
CASE HISTORY:
DELFORT GROUP AG PAPER MILL - DATALOG



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CASE HISTORY:
DELFORT GROUP AG PAPER MILL - ERECTION



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CASE HISTORY:
DELFORT GROUP AG PAPER MILL - ERECTION MCO COMPRESSOR


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CASE HISTORY:
DELFORT GROUP AG PAPER MILL - FIRST STEAM PRODUCTION

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MEET OUR SPEAKER

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Thank you!

Decarbonization is not a cost:
It is the most safe investment for the future

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