# Industrial Heat Pumps for Electrification and Energy Efficiency

- Understand product options for energy efficient electrification of industrial process heating.
- Service territory-specific market potential analysis for industrial heat pump from energy-efficiency and electrification perspectives.
- Controlled technical evaluation of industrial heat pump in a laboratory setting.
- Customer site demonstrations and technology transfer to enable transformation of industrial process heat generation.

## Objectives

This project seeks to evaluate market transforming heat pump technology for industrial process heating, which mostly relies on fossil fuel or low-grade electric heating today. This will be accomplished by characterizing the state-of-the-art for "industrial heat pumps" through a technical and application product review, as well as a thorough analysis of energy savings, cost benefits, and electrification and GHG reduction potential. Additionally, the project seeks to demonstrate, measure, and verify energy savings impacts for an industrial heat pump through equipment testing in the laboratory, and though a future phase, at industrial customer sites.

## Background and New Learning

The industrial sector consumes approximately one-third of the final energy globally and accounts for 25% of energy-related $CO_2$ emissions. Chemicals, Cement, Food Manufacturing and other industries are large consumers of energy and producers of $CO_2$ emissions. Currently, industrial heat is provided by fossil energy or low-grade electric heating in most cases. Heat pumps are an attractive solution for heat delivery because of their energy efficiency combined with the use of electricity as the input energy source, which together offer a clear route to deep decarbonization. Recent technology developments have introduced several high temperature heat pumps with heat output at 100–200°C (temperatures typical of industrial process at a Coefficient of Performance > 3). This has been made possible through (a) Optimization and development of heat pump components and systems, (b) Increasing cycle efficiency through multi-stage circuits and oil-free turbo compressors, (c) Scale-up of functional models to industrial scale, (d) Development of environmentally friendly synthetic refrigerants with low global warming potential and (e) Use of natural refrigerants, such as hydrocarbons or water.

Deployment of industrial heat pumps in the U.S. chemical, food and paper industries can reduce natural gas use by 293–400 TBtu/year (42–57% of the 704 TBtu/year of process heat energy) and reduce $CO_2$ emissions by 10–12 million tons/year[1]. The market potential for energy efficiency, electrification and decarbonization would be far greater with the expansion of industrial heat pumps across the entire manufacturing sector.

## Benefits

This project seeks to investigate this potential to help equip utility representatives and program designers/ implementers with data, tools and knowledge needed for this transformation. The study results may also allow them to develop electrification and/or energy efficiency incentive programs, meaning more program choices for industrial

[1] Rightor, E., Scheihing, P., Hoffmeister, A., Papar, R. "Industrial Heat Pumps: Electrifying Industry's Process Heat Supply". March 2022, ACEEE Report.

customers. The project may also help in establishing relationships with potential industrial heat pump manufacturers to foster continued technology innovation. Given the energy and greenhouse gas savings potential associated with industrial heat pumps, this project may also ultimately contribute towards broader economic and environmental benefits as well.

## Summary and Approach

The project is comprised of two phases:

*Phase I: Market Research and Technology Evaluation*

- Characterization of the state-of-the-art industrial heat pump technology through a technical and application product review.
- Lifecycle cost analysis of industrial heat pumps from the perspectives of electrification and energy efficiency.
- Market potential evaluation for adoption in individual members' service territories for each manufacturing industry by NAICS codes, including energy savings and GHG reduction potential.
- Evaluation specification and selection of an industrial heat pump for technical assessment at EPRI's Knoxville lab facility or at a technology center of a member utility.
- Detailed equipment performance results from lab testing.

*Phase II: Customer Site Demonstrations*

- Installation of an industrial heat pump at a customer facility of the participating utility.
- Evaluation of technology specific to the customer site through demonstration planning, equipment. specification, test plan development, and metering.
- Analysis of results from the industrial heat pump demonstration.
- Technology transfer by identifying manufacturers, research and development institutions and demonstration projects in Europe, Japan, and U.S.

## Deliverables

*Phase I Deliverables*

- Technology evaluation report that details the technical description and applications of industrial heat pump.
- Market evaluation report containing member-specific market assessments and cost-benefit analysis data.
- Laboratory test report for industrial heat pump prototype.
- Infographic marketing material on industrial heat pumps.
- Periodic update webcasts.

*Phase II Deliverables*

- Customer site demonstration test plan
- Specification and related support for equipment procurement
- Final project report summarizing all findings
- Periodic update webcasts with other Phase II participants

For both phases, findings will be shared periodically through webcasts or workshops with all collaborative members.

## Price

Members may join the entire project (Phase I and II) or join Phase I only. Project costs for Phase I only are listed below. Phase II pricing is custom dependent on each member's application and scope. Payment for Phase I can be split over four calendar years. This project qualifies for Tailored Collaboration (TC) or Self-Directed Funds (SDF).

| Annual Distribution (GWh) | Phase I Cost Total | Phase I Cost per Year |
|---|---|---|
| Less than 15,000 | $ 120,000 | $ 30,000 |
| 15,000 – 50,000 | $ 180,000 | $ 45,000 |
| Greater than 50,000 | $ 240,000 | $ 60,000 |

## Schedule

Phase I will begin when 4 participants have joined. Phases I and II are expected to take approximately 30 and 18 months, respectively.

## Who Should Join

Utilities and their staff interested in understanding the capabilities and application details of industrial heat pumps. Utility staff in both energy efficiency and electrification groups will find value in this project, as well as personnel involved in incentivizing industrial process heating technologies, designing and managing industrial programs, or advising customers.

## Contact Information

For more information, contact the EPRI Customer Assistance Center at 800.313.3774 (askepri@epri.com).

## Technical Contacts

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