INDUSTRIAL HEAT PUMPS

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Industrial Innovation Initiative

a partnership between Great Plains Institute and World Resources Institute

THE BIG PICTURE

Industrial heat pumps (IHPs) are a critical strategy for electrifying manufacturing in sectors like food and beverage, glass, pulp and paper, and chemical production. These industries rely primarily on low- and medium-temperature heat, which IHPs can produce more efficiently than any other technology. See our industrial electrification guide for a broader discussion of the potential benefits of electrifying manufacturing facilities with IHPs.

WHAT ARE INDUSTRIAL HEAT PUMPS (IHPS)?

IHPs are a high-efficiency technology that upgrade ambient or waste heat to useful temperatures by using relatively small amounts of electricity.

PHOTO OF AN INDUSTRIAL HEAT PUMP

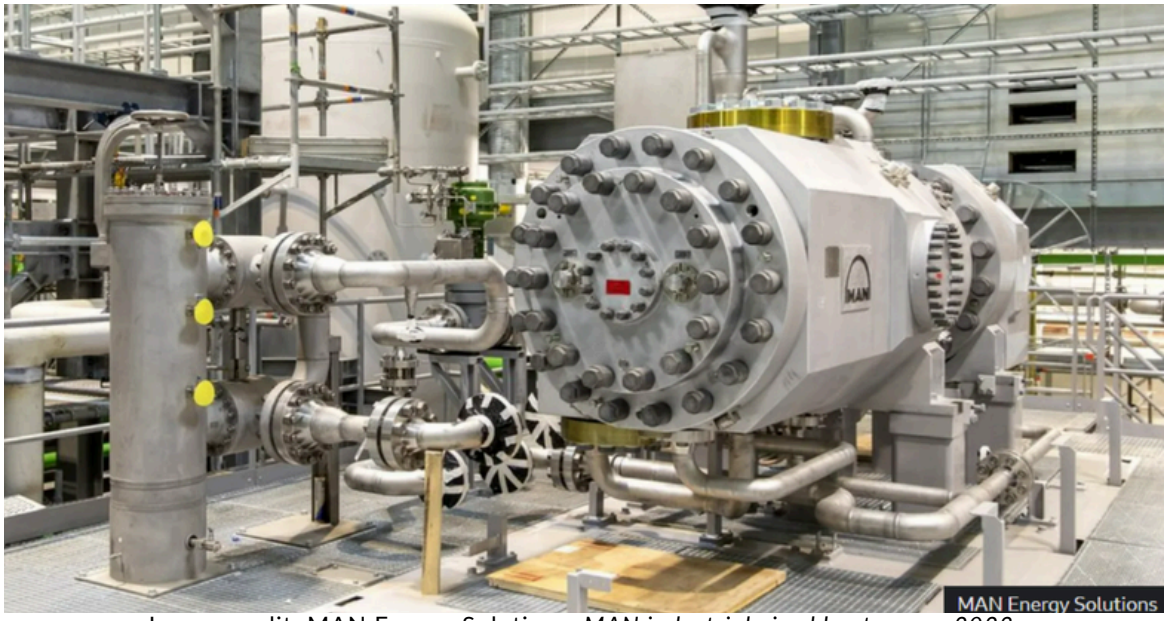

Image credit: MAN Energy Solutions. *MAN industrial-sized heat pump. 2023. https://www.bbc.com/news/business-65321487.*

HOW DO INDUSTRIAL HEAT PUMPS WORK?

Industrial heat pumps (IHPs) operate on basic refrigeration principles. Instead of generating heat like conventional boilers, they compress it and transfer it from one place to another. They convert lower-temperature ambient or waste heat into useful, higher-temperature heat by compressing a refrigerant working fluid. The energy consumed by a heat pump depends on how much the IHP increases the temperature of the waste heat.

Heat pumps perform 3 basic functions:

1. They receive heat from the waste or ambient heat source.
2. They increase the temperature of the heat.
3. They deliver the useful heat at the elevated temperature to the heat sink.

WHAT MAKES INDUSTRIAL HEAT PUMPS MORE EFFICIENT?

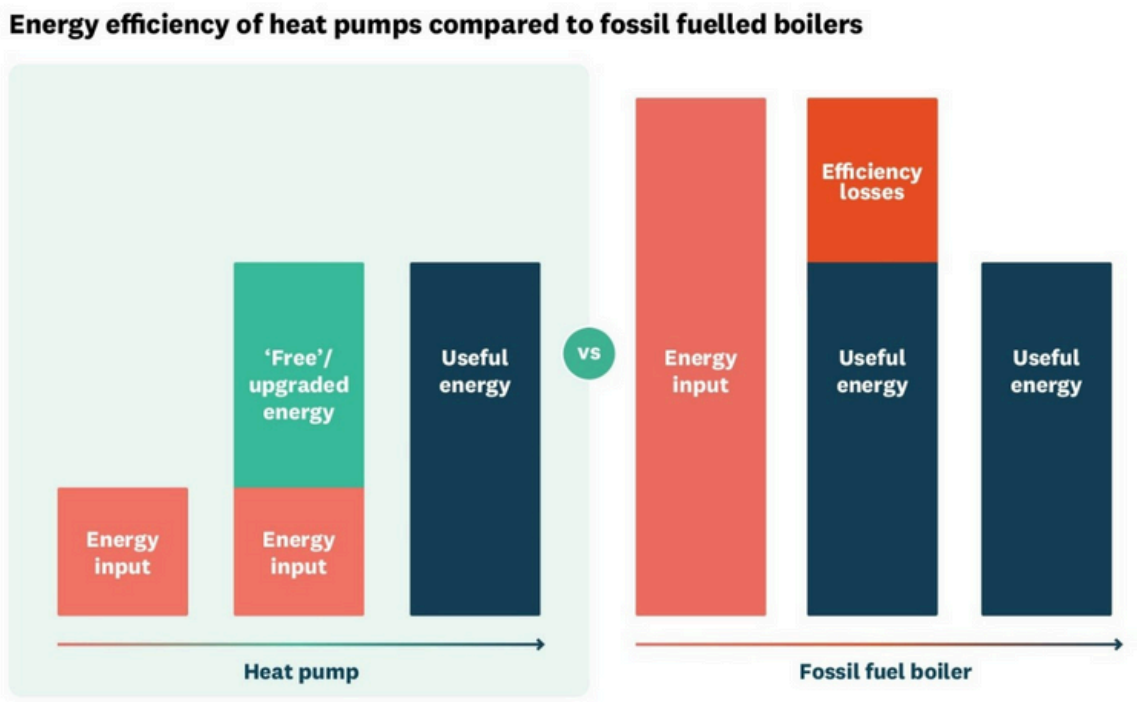

Image credit: EECA of New Zealand. Energy efficiency of heat pumps compared to fossil fuelled boilers. 2023. https://www.eeca.govt.nz/insights/eeca-insights/industrial-heat-pumps-for-process-heat/

As shown above on the left, industrial heat pumps (IHPs) make use of 'free' energy from waste heat or ambient air and upgrade it to deliver significantly more useful energy than is originally supplied. Conventional heating systems have efficiency losses, and as shown above on the right, deliver significantly less useful energy than was originally supplied. The inherent energy efficiency advantage of IHPs is also an inherent cost savings advantage.

WHAT ARE OTHER ADVANTAGES OF INDUSTRIAL HEAT PUMPS?

- **Save space:** IHPs are compact. Multiple heat pumps can be distributed around a site (if the site is suitable) close to the heat sink, reducing distribution network heat losses and improving heating system efficiency.
- **Cleaner:** IHPs have no direct emissions (e.g., no products of combustion to dispose of such as ash or flue gases including NOx and SOx, and no coal dust) and are cleaner to operate than a fossil-fuel-fired boiler-based heating system.
- **Better response time:** Staged compressors and variable speed drives offer rapid load response and good turndown control.
- **Reduced maintenance needs:** Component degradation rates are lower for heat pumps due to lower component temperatures, meaning that less maintenance is required.
- **Future proof:** Future power grids will likely require more rapid responses to changes in demand. Heat pumps can offer cost-effective demand response capabilities.

FINANCIAL INCENTIVES AND TECHNICAL ASSISTANCE FOR INDUSTRIAL HEAT PUMPS

48C tax credit: The 48C tax credit (TC) included in the Inflation Reduction Act provides a 30 percent investment TC for investments in facilities to manufacture clean energy technologies. It is a competitive program with $10 billion available in TC allocations. The IRS awarded the first $4 billion in credits in March of 2024. Applications for the remaining $6 billion are due in October 2024.

Section 179d of the Commercial Buildings Energy Efficiency Tax Deduction: This tax deduction is available for installation of heating, cooling, ventilation, or hot water systems that meet certain standards for reducing energy and power costs. Industrial heat pumps could qualify for support under this program.

Industrial Training & Assessment Center (ITAC) Implementation Grants: ITAC implementation grants from DOE's Manufacturing and Energy Supply Chain (MESC) office provide federal cost share for energy efficiency projects at small- and medium-sized manufacturers. Manufacturers must receive an energy assessment from an ITAC to be eligible. ITACs can also provide technical assistance.

Onsite Technical Assistance Partnerships (TAPs): Large manufacturers should consult the Onsite Technical Assistance Partnership (TAP) in their region for advice on achieving site-specific energy objectives, including installation of IHPs.

Utility Energy Efficiency Programs: Many utilities also offer industrial energy efficiency programs that could provide technical assistance and incentives for IHP systems.

State Energy Efficiency Programs: Some states have enacted programs that offer financial incentives for installation of IHPs and other technologies that promote energy efficiency.

Examples:

- California's Industrial Decarbonization and Improvement of Grid Operations (INDIGO) program provides supports for projects that electrify processes currently powered by fossil fuels.
- New York State's Energy Research and Development Authority (NYSERDA) Commercial and Industrial Carbon Challenge and Flexible Technical Assistance Program provides funding for project implementation and energy studies.

A list of industrial heat pump manufacturers includes:	
Airthium	Nyle Thermal
Armstrong International	Skyven Technologies
Carrier Corporation	Siemens
Copeland	Trane
GEA	Turboden
Hydrotemp Corporation	York International
Johnson Control	

HOW CAN STATES FACILITATE DEPLOYMENT OF INDUSTRIAL HEAT PUMPS?

Raise the profile of industrial heat pumps (IHPs):

IHPs remain a novelty in the United States. As a result, industrial decision-makers, engineers, and installers are largely unfamiliar with them. State environmental agencies and energy offices should publicize the potential benefits of IHPs in their outreach to trade associations and individual facilities.

Connect manufacturers and technical assistance providers:

States can work with industrial stakeholders to identify facilities where IHPs may be suitable for generating process heat. They can encourage these facilities to reach out to Industrial Training & Assessment Centers (ITAC) and Onsite Energy Technical Assistance Partnerships (TAPs). ITACs and TAPs can help manufacturers evaluate the feasibility of switching to heat pumps. The Technical Assistance Page can be used as a starting point to obtain more targeted information and guidance.

Design rate structures that make IHPs a viable financial option:

Some utilities have designed rate structures intended to incentivize electric vehicles. State utility commissions should encourage utilities to establish rate structures that make IHPs more competitive with fossil-fueled heat sources. These structures would buffer the costs of demand charges, reducing the effective cost of operating IHPs.

Allow utilities to operate fuel switching programs:

Some states have been reluctant to permit utility-sponsored energy efficiency programs from being used to implement fuel switching because they do not wish to incentivize actions with a predominantly load building or load retention character. Fuel switching with heat pumps leads to more efficient use of energy and can significantly reduce emissions if powered by renewable energy. States should permit the use of utility energy efficiency funds for fuel switching.

Update building codes to permit IHP refrigerants

Some state or local building codes may prohibit the use of refrigerants used in IHPs. Many states have begun to modify their building codes to permit R32, a potentially flammable refrigerant used in some residential heat pumps. Consistent with public safety, states will need to periodically revise building codes to ensure that manufacturers have access to a range of IHP models.