

Industrial Heat Pump Technology and Market Assessment in the Chicago Area

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ABSTRACT

Industrial heat pumps (IHPs) that recover waste heat and utilize heat pump technology to generate hot water or steam are a powerful decarbonization strategy but have not been widely deployed in the United States due to economic factors, process integration challenges and lack of technology awareness. The current study addresses these issues by focusing on technical, economic, and application feasibility of IHPs for industrial and large commercial users in and around Chicago, Illinois.

A technology review was performed, identifying the equipment with highest potential for integration into large applications in the territory, focusing on industrial and large commercial applications. The primary focus was on IHP's offering near-term, installation-ready to efficiently recover and utilize waste heat for the key applications in the territory. Seven IHP suppliers in the U.S. were highlighted, offering solutions most applicable to the users. Likely solutions are hybrid configurations: electric-driven IHPs in combination with current gas-fired technologies. The equipment offerings are evaluated in terms of temperature capability (maximum supply temperature, maximum inlet temperature, and temperature lift), capacity, as well as equipment maturity and reliability.

A market assessment for the Peoples Gas (PGL) and North Shore Gas (NSG) service territories was performed to determine where IHPs are a likely fit, identifying industries and large commercial applications with the highest potential. The installed customer base was evaluated and users best positioned to adopt IHP technology were identified based on industry classification, processes, economics, and demonstrated commitment to energy efficiency and decarbonization goals. Barriers to implementation of IHPs were identified, including technical, market economics, and others.

Recommendations for pilot programs to incentivize development were presented, focusing on priority markets and applications with the highest benefits and shortest payback periods. Strategies to overcome the most significant barriers were presented, along with outlining potential demonstration sites to address barriers.

1. INTRODUCTION

IHPs are emerging as efficient, versatile and impactful technologies for decarbonizing process heat—the single largest use of energy in U.S. manufacturing—by recovering and upgrading waste heat and electrifying heat supply with much

higher site efficiencies than combustion systems. Multiple recent assessments converge on the same signal: IHPs have the potential to deliver substantial energy and emissions reductions across food and beverage, chemicals, pulp and paper, and other moderate temperature processes, particularly as the electric grid decarbonizes. The focus of the present project is Illinois' industrial sector, which comprises 18% of the states total emissions (IL EPA, 2024). Given Illinois' legislated mandated trend to decarbonize by targeting a 100% carbon-free power sector by 2045 and using 100% renewable energy by 2050, IHP's could play a vital part.

Technology benefits include energy reduction and potential cost savings. Well-matched IHP applications can reduce site energy¹ use substantially. For example, an IHP with a COP of 3 means that 3 units of heat will be delivered for a given unit of electricity. System modeling also shows source energy savings potential in the targeted sectors; field and prototype results document gains under realistic duty cycles. These energy performance improvements translate directly into operating cost considerations, where both efficiency and relative fuel prices influence overall economics. The spark ratio—the ratio of electricity to gas price per unit energy, is a key determinant of operating cost economics, but even where electricity is more expensive per unit energy, the effect of COP can offset that disadvantage. Local emissions and air quality improvements are possible as IHPs recover waste heat and shift loads to electricity—transferring emissions from the site to the grid. While current grid carbon intensities are often high, as grid carbon intensity declines, emissions will drop over time. In general, energy efficiency approaches offer the highest immediate emissions reduction, while electrification of heat may drive decarbonization over a longer period. Beyond energy and emissions reductions, industrial users may realize other process benefits such as reduced cycling of boilers at low firing rates and productive reuse of waste heat.

Key market barriers to broader market adoption include the following:

- **Energy Costs:** Current gas vs electricity costs are such that electricity is relatively expensive vs gas on a per-unit energy value. Even with the high energy efficiency and reduced energy use, the operating costs of IHPs are often equal or even higher than gas technologies. Approaches to this barrier include targeting the highest COP applications, using incentives, and rate designs that reward off-peak operation or thermal storage.
- **Electric demand charges:** Also referred to as capacity charges, these are fixed fees per kW of electric demand from the regional grid operator to ensure sufficient electricity is available to meet peak demands on the grid. Since IHPs can significantly increase a facility's peak electric demand, the resulting increase in monthly capacity charges can also be significant.
- **Capital Costs:** Installation costs of IHPs are much higher than traditional gas technologies. With limited penetration of IHPs in the U.S. markets, the equipment costs are relatively high. If the existing equipment has useful remaining life, it is very difficult to justify replacing it.
- **Applications and installation:** Many of the existing plants do not have readily available space for a retrofit given that the footprint of IHPs is generally larger than current boilers. In addition, integrating the heat pump source and sink can be challenging if they are physically distant in the plant and if the heat source and sink are not concurrent in time.
- **Electrical readiness:** In many cases, the plant electrical equipment, possibly the main plant transformer, along with electrical feed and switchgear, needs to be upgraded. For the electric grid, the utility may need to upgrade feed to the plant or that area of the distribution network.
- **Skills and Training:** Compared with combustion systems, IHPs typically require different skills more aligned with refrigeration systems and controls, and less combustion maintenance. Maintenance of industrial heat pumps is different than combustion system and costs may be somewhat higher.
- **Lack of Awareness and Uncertainty:** Plant personnel and design firms often lack IHP experience, and installation complexity can add to uncertainty and increased costs. Given the above factors, even with emissions reduction benefits and Illinois' legislated direction, users are hesitant to invest in long-term assets that don't show clear payback. Demonstration pilots with thorough Measurement and Verification (M&V), design guides, and training help bridge capability gaps.

The current assessment is being carried out for Peoples Gas and North Shore Gas service territories. For industrial customers in these areas, IHPs represent potential pathways to reduce gas consumption and emissions. The region's

¹ In this context, site energy is the energy consumed at the facility by the equipment, as recorded by the gas and electric utility meters. Source energy is the sum of all energy inputs required to power the equipment: the energy used on-site (site energy) plus the energy required to produce, transmit and distribute that energy to the site.

sector includes industries identified as favorable for IHP applications: food & beverage plants, chemical production, institutional campuses with thermal networks and hospitals with simultaneous heating and cooling loads. As the U.S. grid continues to decarbonize and as equipment suppliers gain experience, the application envelope will expand. It is believed that targeted demonstrations in key industries with near-term focus could provide repeatable prototypes for systems designers and end users. For utilities, this is an opportunity to evaluate incentives, offer design assistance and education so that early adopters become reference sites that accelerate broader market uptake.

2. TECHNOLOGY REVIEW

2.1 U.S. vendor landscape

The vendor landscape in the U.S. includes global suppliers but domestically the number of installations, manufacturing, service support and expertise lag the international market. The focus of the present study is to identify current proven solutions, with high Technology Readiness Levels (TRL), domestic service capabilities and expertise. With this context, the temperature capability, capacity ranges, TRL, installed equipment base and notable differentiators of potential suppliers were identified.

2.2 Temperature capability and TRL

Definitions of high temperature and very high temperature vary in the heat pump literature. For this study, temperature capability is defined in three useful bands aligned to current product landscapes and process needs:

- Conventional heat pumps: up to 85°C (185°F). The upper range of the conventional category is being expanded by some suppliers to approximately 95°C (203°F). Commercial readiness is strongest for hot water up to 80–95°C with conventional IHPs. The operating envelope of existing supplier's equipment is being extended through incremental improvements in their capabilities. In some cases, low pressure steam could be generated for use in the process or further heated as required.
- High temperature heat pumps (HTHP): up to 120°C (248°F). This allows production of pressurized hot water and low-pressure steam. In select cases, equipment is being offered, growing U.S. capabilities and gaining operational experience. TRL is increasing with the capability for pressurized hot water and low pressure steam.
- Very high temperature heat pumps (VHTHP): >120°C (>248°F). This is generally used for higher pressure steam, which is common in many industries. Capabilities are advancing via multi stage compression, novel refrigerants, and steam generating HPs, but offerings are early TRLs. In addition, the economics are often more challenging due to the higher temperature lifts. Pilot demonstrations (both domestically and internationally) are informing cost/performance for broader industry acceptance.

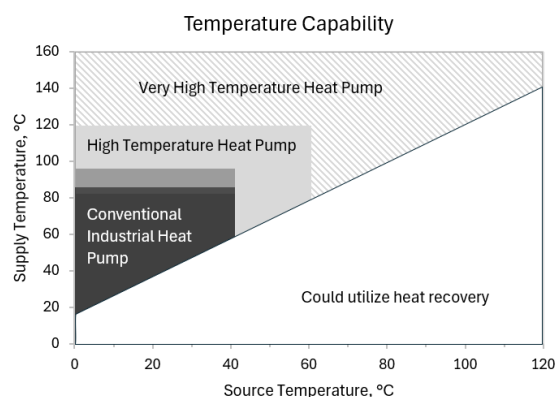


Figure 1: Temperature Capability of IHPs

Conventional and High Temperature Heat Pump capability maps well to the requirements found in food & beverage sanitation and cooking, clean-in-place and hot water systems, low-pressure steam, and some chemical/paper processes.

2.3 Vendor Evaluation

The project focused on suppliers with domestic service support and domestic production was preferred. It should be noted that this review significantly limits the total number of potential vendors, as IHPs are more commonly applied in Europe and Asia. In addition, the listing focused on suppliers with experience beyond demonstration or pilot sites. This criterion was included so that proven and mature technologies were highlighted. One exception was a domestic start-up focused on air-to-steam, given the unique functionality.

For high temperature IHPs (>85°C), the most likely applications are in the 0.5 to 10 MWth range (1.7 – 34 MMBtu/h). This is the most likely needed equipment capacity range for food and beverage installations, for the chemical sector and for hospitals. For moderate temperatures (up to 85°C), IHPs of all size ranges were considered. Larger units are potential solutions for district heating or thermal networks.

Vendors identified as likely candidates are shown in Table 1 below. Suppliers without domestic service support were excluded. Capacity ranges of the equipment is identified. In some cases, the equipment is modular and multiple modules can be supplied as a combined unit. Refrigerant types were classified into synthetics and ammonia, primarily to distinguish for safety/compliance reasons as well as the natural refrigerant offering. The number of U.S. installations is identified, along with the company's level of application expertise.

Table 1: Vendors identified as likely suppliers

Supplier ID	U.S. Manufacturing?	Temperature Capability (°C)	Capacity (MWth)	Refrigerants Used	U.S. Installations	Application Expertise				
						Food & Beverage	Chemical	Paper	Hospitals	Large Institutions
1	Yes	120	50 - 2000	Synthetics	None at present -- numerous international installs	X	X	X	X	
2	Partial	95	Standard to 2500 Custom to 10,000	Ammonia	Multiple	X	X	X	X	X
3	Yes	100 (current), 120 (planned) Large Units to 82	900 (high temperature) 10,000 (large units)	Synthetics	Multiple				X	X
4	Yes	82	50-422 per unit	Synthetics	Multiple	X			X	
5	Yes	Large Units to 95 High Temp to 165	1000-5000 per unit 400-1000 per unit	Ammonia Synthetics	Limited	X	X	X		X
6	Yes	150	650	Synthetics	Demonstration only	X				
7	Yes	82	to 10,000	Synthetics	Multiple				X	X

2.4 Application considerations

- Where ammonia is acceptable, two key suppliers are identified. These providers are likely candidates for plants with ammonia familiarity (generally food and beverage or chemical). These suppliers would be considered where hot water up to 90 °C and steam adjacent strategies are appropriate.
- For large scale solutions such as district heating and thermal networks, three key suppliers are identified. These have very large units and are experienced in dealing with large building and district heating applications to offer practical solutions for these applications.
- For potential steam generation, four suppliers currently promote equipment reaching steam temperatures. Two are suitable for low pressure steam (120 °C), while two achieve higher temperatures (150 and 165 °C). Steam-generating capability is a newer heat pump technology, and will generally result in lower COPs due to the temperature lift. Nevertheless, steam is an ubiquitous heat transfer fluid, so should be considered. One supplier is promoting a drop-in, air-to-steam offering where waste heat is limited, but COPs are even lower.
- Heat recovery chillers are offered by several OEMs in various sizes. These are best for simultaneous heating/cooling in institutions and industrial sites with substantial comfort or process cooling plus hot water demand. This application will often lead to the highest combined COP (heating + cooling), but engineering evaluation is needed to identify concurrence of the heating and cooling loads.
- Custom Engineered high temperature applications are offered by three of the vendors. These have capability to identify and develop specific process solutions, working within plant integration constraints. Custom designs, testing, and performance validation will likely be required.

3. MARKET ASSESSMENT

3.1 Territory Overview and Customer Base Analysis

The primary focus of the Industrial Heat Pump Technology and Market Assessment is to determine whether heat pumps could be more widely applied for industrial and large commercial settings within the Peoples Gas and North Shore Gas service territories. Other studies have evaluated the potential for IHPs at the national level (DOE, 2022), in specific countries (IEA, 2023), or at state levels (California, Lee 2023, Minnesota, CARD 2025). Another study evaluates benefits for a specific sector (EPRI, 2024). The present study is believed to be the only publicly available one assessing technology and market at the utility service territory level. The primary focus is a sector assessment, but guidelines are provided for screening potential customer sites, and a limited number of in-person site screenings are planned.

For background regarding PGL and NSG, they are gas utilities that serve Chicago and its northern suburbs. Publicly available data sources include documents presented to the Illinois Energy Efficiency Stakeholder Advisory Group (IL EE SAG 2024) and the Long Term Gas Infrastructure Plan (Illinois, 2021). For these reports, the service territories were analyzed using a combination of utility data, baseline studies, and nationally recognized energy use datasets. These utilities serve mixed customer bases, though the mix of residential, commercial, and industrial users differs between the two systems.



Figure 2: Service Territory for Peoples Gas and North Shore Gas

Analysis of the gas consumption shows:

- High reliance on natural gas for space and water heating across all customer bases.
- Process loads dominate gas consumption in industrial facilities.
- Weather driven seasonal variability, especially in residential and commercial heating.

Residential customers represent the largest share of total customers in both PGL and NSG service territories. While industrial and commercial users consume more energy per account, the residential sector provides the scale that drives many energy efficiency measures. The number of customers and related energy usage is shown in Table 2.

Table 2: Customers and Energy Usage (2023)

	Number of Customers		
	Peoples Gas	North Shore Gas	Total
Residential	807,340	150,639	957,979
Commercial	77,425	13,858	91,283
Industrial	148	22	170
Total Count	884,913	164,519	1,049,432
	Gas Volume (% , Therms, GJ)		
	Peoples Gas	North Shore Gas	Total
Residential	42.8%	54.0%	
Commercial	42.6%	31.5%	
Industrial	14.6%	14.5%	
Therms	1,498,889,347	324,804,383	1,823,693,730
(GJ)	158,132,826	34,266,862	192,399,689

Commercial and Industrial (C&I) customers represent relatively smaller portion of total accounts but a much larger share of total energy usage. This is consistent with typical utility system load profiles. Examples of C&I categories include office buildings, retail establishments, schools and municipal buildings, warehouses and distribution centers. Information regarding energy fuel use was drawn from Commercial Buildings Energy Consumption Survey (CBECS) and Manufacturing Energy Consumption Survey (MECS) datasets.

Industrial and Process load customers in the PGL and NSG territories include manufacturing sectors that appear in the Chicago region: food manufacturing, metals and machinery, plastics and chemicals, transportation equipment and medical device fabrication. Compared with residential and commercial customers, industrial customers have larger, more concentrated process loads, typically associated with boilers, space heating, water heating, and occasionally industrial process heat systems.

3.2 Utility Detailed Large Customer Analysis

For this analysis, the Peoples Gas and North Shore Gas Energy Efficiency Programs compiled a database of large users—those with usage of >400,000 therms/year (>42,200 GJ/year). The database includes key customer data, including company name, address, company contacts, rate category, annual usage, NAICS classification and other relevant information. The customer data was extensively reviewed, updated and screened by PGL and NSG staff. It was shared with GTI Energy for further analysis under confidentiality agreement that no customer-identifiable data can be shared.

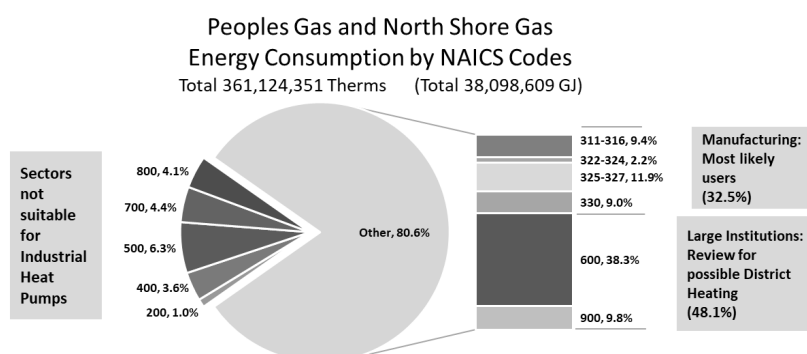
The analysis focused on NAICS classifications, which identify the industry sector. The number of customers and usage based on the classification is shown in Table 3. The data shows that the total number of customers and the majority of usage (over 80%) is concentrated in three general NAICS classifications: 300, 600 and 900. The primary study objective was to assess IHPs for industrial applications. However, since a significant portion of large users are large institutional campuses, the scope of the analysis was expanded to include large commercial institutions (universities and hospitals) with thermal networks of either steam or hot water.

The sectors analyzed are shown graphically in Figure 3, with the following groups:

- NAICS 200, 400, 500, 700 and 800: These sectors comprised 20% of the large customers' consumption. These sectors include construction, transportation, offices and administration. IHPs are generally not suitable for these industries.
- NAICS 300: The manufacturing sector is the most likely to incorporate IHPs into their process heating applications. A more detailed breakdown of the potential within this sector will be described in the following section.
- NAICS 600 and 900: Large institutions could potentially use an IHP if they have a thermal network or large simultaneous loads, for example in hospitals or university campuses with a central heating/cooling plant.

Table 3: Customers and Energy Usage

NAICS	Number of Customers			Energy Used (Therms, 2023)			Total Energy
	Peoples Gas	North Shore Gas	Total	Peoples Gas	North Shore Gas	Total (Therms)	Total (GJ)
200	2	2	4	1,746,070	1,953,158	3,699,228	390,269
300	79	12	91	93,679,702	23,666,398	117,346,100	12,380,014
400	15	2	17	11,956,952	1,048,664	13,005,617	1,372,093
500	21	4	25	13,811,133	9,039,852	22,850,985	2,410,779
600	56	25	81	118,897,885	19,494,138	138,392,023	14,600,358
700	24	2	26	15,620,265	344,532	15,964,797	1,684,286
800	14	1	15	13,811,234	818,427	14,629,661	1,543,429
900	17	5	22	32,708,621	2,527,319	35,235,940	3,717,392
Total	228	53	281	302,231,862	58,892,489	361,124,351	38,098,619

**Figure 3:** PGL and NSG Large Users' Energy Consumption by NAICS Codes

3.2 Energy Prices and Spark Gap

A determining factor in the operating cost benefit of IHPs is the relative cost of the electric energy used for the heat pump compared to the fuel (natural gas) that it is displacing. While heat pumps operate at COPs that range from 1.5 to 6.0, typical COPs are in the 2.5-4.0 range. Thus, for every unit of electrical energy input, the heating output is multiples of the electric energy used. The gas efficiency of the current process needs to be accounted for as well. For example, for a gas-fired water heating system with an efficiency of 90%, a heat pump with a COP of 3.0 would output 3.3 times the energy of the gas input.

To determine the energy cost savings (or increase), the relative gas and electric prices are compared. This is generally done using the spark ratio (often referred to as spark gap or spark spread): the cost ratio of electric to gas on an equal energy basis. The electric cost (\$/MWh) and gas cost (generally in \$/MMBtu) are converted to common energy units. The spark ratio varies significantly throughout the U.S., as both gas and electric costs are variable. Determining actual costs can be quite complex: accounting for electrical demand charges and time-of-use pricing and industrial contracts for gas. To improve heat pump economics, operating during off-peak hours would be beneficial from a cost perspective, but most industrial processes are continuous.

Average industrial spark ratios (EIA, 2024) are shown in Figure 4 below. Illinois ranks 18th in the U.S., with average industrial electric price of \$0.0883/kwh and average industrial price of gas as \$6.37/MMBtu. The PGL and

NSG territories are served electrically by Commonwealth Edison (ComEd) which has an average industrial rate of \$0.0736/kwh. The Illinois average industrial spark ratio is 4.07 and within the ComEd territory is 3.39 (17% lower). Thus, when evaluating potential applications, the breakeven COP needed for equal energy cost can be compared to existing combustion solutions. The line of equal energy cost is shown below in Figure 4 for gas-fired equipment that is 80% or 90% efficient. These graphs are illustrative and are intended to show the relationship between heat pump COP and relative electric vs gas costs.

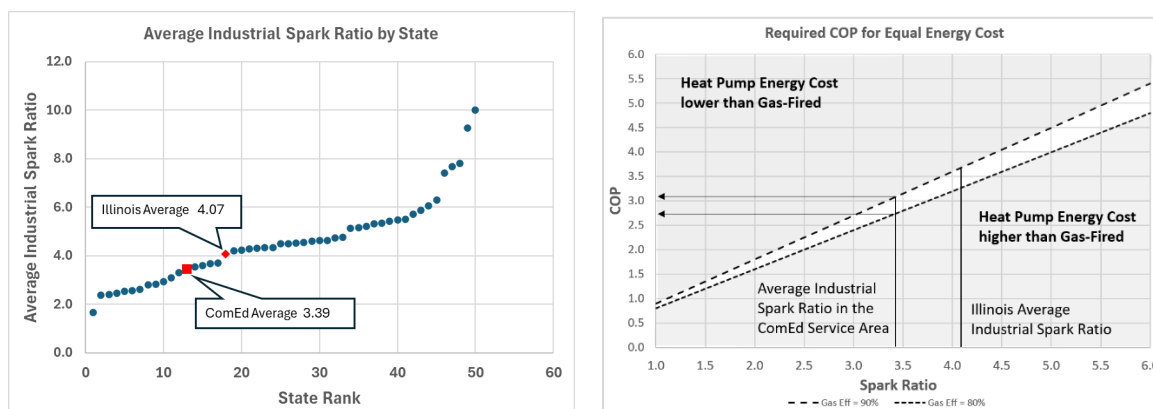


Figure 4: Average Industrial Spark Ratio and COP for Equal Energy Cost (without Demand Charges)

It is important to note that the spark ratio analysis above is based on average energy costs and does not include demand charges, which can significantly affect the economic benefits. For example, demand charges in Chicago (June 2026-2027) will be \$10.01/kW-month. Thus, a plant running a continuous process that adds a 500 kWth IHP, operating at a COP of 3.0, would see an annual demand charge of \$20,010, significantly increasing the overall energy cost.

3.3 Typical IHP Equipment Costs

Capital equipment costs for IHPs are often cited as 2 to 4x those of natural gas boilers. If the existing equipment has remaining service life, the replacement costs are particularly challenging.

Commercially available industrial heat pump equipment costs generally fall within the following ranges:

- Low temperature supply (60-90 °C) and low-lift (<60 °C): 400-1,000 \$/kWth
- High temperature supply (90-120 °C) and medium lift (60-80 °C): 600-1,500\$/KWth.
- Very High temperature supply (>130 °C): prices less defined but estimate 1,000-2,000 \$/kWth.

These values typically include the compressor(s) and motor(s), packaged heat exchangers, system frame and basic controls. Other site specific components and integration costs are separate.

Several other factors contribute to the equipment pricing:

- Temperature lift and supply temperature: Higher temperature lifts reduce COP as described previously. Higher supply temperatures, especially above 120 °C, require equipment that is often still in development stages and which requires more robust compressor designs, specialized refrigerants and higher grade materials, all of which increase cost.
- Capacity and modularity: Small systems (<500 kWth) are often very expensive given fixed installation costs. Larger systems (>2 MWth and larger) benefit from economies of scale, but requirement for custom engineering can offset these savings compared to standardized modular offerings.
- Heat Source: Systems designed to recover waste heat (for example from cooling tower water or process exhaust streams) provide higher source temperatures and reduced lift requirements leading to increased COPs, but the required heat exchangers add complexity and increase integration costs.
- Refrigerant selection: For plants that are not currently using ammonia, an IHP using ammonia can pose safety and regulatory issues that could increase costs. Low GWP refrigerants capable of very high temperatures are often more expensive and less standardized, increasing vendor cost.

One OEM provided historical equipment costs demonstrating the impacts of temperature lift and unit capacity. As can be seen in Figure 5, the cost of the smaller units (300-500 kWth) is quite high, while large units (>1200 kWth) are significantly less expensive. Also, the impact of temperature lift can be seen, as higher lift temperatures lead to increased equipment cost. It should be noted that costs shown are helpful as trends, but to accurately estimate equipment costs, the application needs to be defined and suppliers approached for quotations.

3.4 Territory Wide Potential

Calculating the territory-wide potential of IHPs in the PGL and NSG service area is imprecise, but to provide an order of magnitude estimate, the following approach was used: The potential was computed for two levels: technical potential and economic feasibility. The technical potential—the percentage of thermal process heat that could be provided by IHPs, was estimated based on published information for the sectors and refined by review of the companies large users database. For example, in NAICS 311-316 (largely food and beverage), a value for technical potential of 47% was used because many of the heating processes are within capabilities of current IHPs. In NAICS 325-327 (chemical, pharma and others), the technical potential is moderate (30%) due to the process temperatures and the processes themselves. For NAICS 322-324 (paper, asphalts and paving) as well as NAICS 331-339 (metals), a value of 15% was used for the technical potential. In NAICS 600 and 900, the technical potential was estimated to be only 5%, as the only application for IHPs would be for district heating or thermal networks. With these estimations, the technical potential for the sectors shown is 43,648,000 therms.

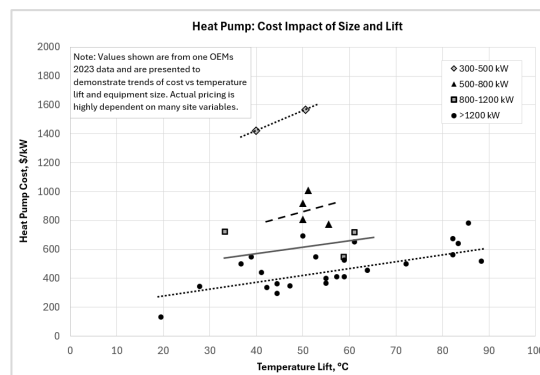


Figure 5: Impact of Heat Pump Size and Lift
(Source GEA)

For economic feasibility, an estimated factor was applied based on the current economic conditions: industrial gas and electric rates, policy drivers, and other factors. Because of the current spark ratio, the economic feasibility is estimated to be quite low—between 5-15%. Using this approach, the total economic feasibility for the large users is estimated to be 3,747,000 therms, approximately 1.3% of these customers' gas usage.

Table 4: Estimated Territory Potential

NAICS	Summary Description	Energy Therms (2023)	Technical Potential		Economic Feasibility	
			Estimated	Therms	Estimated	Therms
311-316	Bakery, Food Manufacturing, Chocolate, Brewery, Leather and Tanning	34,084,509	47%	16,019,719	10%	1,601,972
322-324	Paper, Corrugated, Asphalts, Paving	7,826,902	15%	1,174,035	15%	176,105
325-327	Chemical, Pharma, Paint, Plastics, Cement and Gypsum	43,053,724	30%	12,916,117	10%	1,291,612
331-339	Metals, Machinery, Electrical, Furniture and Medical Devices	32,380,965	15%	4,857,145	5%	242,857
600	Colleges, Hospitals and Healthcare	138,392,023	5%	6,919,601	5%	345,980
900	Government	35,235,940		1,761,797	5%	88,090
Total (Therms)		290,974,000		43,648,000		3,747,000
Total (%)		100%		15%		1.3%

3.5 Case Studies

While the primary project objective is to assess IHP potential at the territory level, an important aspect was identifying companies and sites with high potential to utilize IHPs in their plants with the intent of performing initial, high-level site screening. To identify businesses with potential and likely interest, the Energy Advisors (EAs) from the Peoples Gas and North Shore Gas Energy Efficiency Programs were engaged. EAs are in contact with customers at the plant level and work with them to evaluate energy usage and find energy efficiency solutions.

The review process was performed in several steps: First, the large user database was reviewed to eliminate customers whose processes were generally unsuitable for IHPs as described previously. The reduced list (approximately 135 customers) was distributed to the EAs for review and they responded by addressing questions in several areas:

- Database accuracy: Is the energy use realistic and is the business classified correctly?
- Application: Does the plant have waste heat and hot water needs? Is there simultaneous heating and cooling?
- Customer Interest: Does the customer have sustainability goals?

Based on the EAs review, they recommended whether to contact the customer for a more detailed evaluation. This reduced the potential list to 31 sites. From these, a more detailed evaluation was held, with the plan of performing 5 site visits to the following sectors: Two in the food & beverage sector, 1 in chemical, 1 hospital and 1 large educational institution with thermal network.

At time of submitting the manuscript, one site visit is being scheduled and others are still pending. Several aspects of the process were noteworthy: the general lack of awareness of IHPs for process heating and that most plant personnel, while open to energy savings options that reduce costs, are very busy and hesitant to invest effort in evaluating new technologies when operational cost savings are not a guarantee unless the company has clearly defined sustainability goals.

4. Conclusions and recommendations

The findings of this Industrial Heat Pump Technology and Market Assessment indicate that IHPs offer technical value and credible near term potential within the PGL and NSG service territories, but meaningful adoption will require targeted market development, economic support, education and sustained stakeholder engagement.

Across U.S. and international markets, industrial heat pumps have advanced rapidly in temperature capability, capacity range, and commercial readiness. Multiple OEMs now offer demonstration ready systems capable of providing hot water up to 95°C and 120 °C and, in several cases, low pressure and medium pressure steam. This represents a notable shift from only a few years ago when high temperature steam capable products were limited to pilots. The technology review confirms that major vendors have U.S. presence and product lines suitable for multiple applications within the Peoples Gas and North Shore Gas territories. These offerings span hot water systems, heat recovery chillers, and increasingly steam generating configurations.

The market assessment shows that, on a percentage of total consumption basis, Peoples Gas and North Shore Gas have smaller industrial bases relative to many U.S. gas utilities. However, the territory includes a meaningful number of large institutions with thermal networks, including hospitals and universities, which closely match the highest potential applications for IHPs. Within the industrial sector, the analysis of the large user database highlights customers in the food & beverage and chemical sectors as the most promising near-term candidates. These sectors align well with current IHP capabilities, which are strongest for moderate temperature process heat and combined heating/cooling applications.

Despite the technical potential, the study finds that barriers remain predominantly economic and logistical. Industrial electricity prices relative to gas—expressed as the spark ratio—often require heat pump COPs above 3.0 to achieve operating cost parity with gas-fired systems. When electric demand charges are considered, the breakeven COP increases. While many applications can achieve these performance levels, many sites face challenges due to:

- Unfavorable spark gaps
- Rising electric capacity charges
- High capital and installation costs
- Space constraints and integration complexity
- Electrical infrastructure limitations
- Low familiarity among plant personnel and engineering design firms

These barriers are amplified by the limited number of U.S. reference installations, particularly in industrial high temperature or steam applications. In PGL and NSG territories specifically, several customer interactions indicate that low awareness and concerns about applicability remain significant hurdles, even among facilities with strong sustainability goals or clear simultaneous heating/cooling opportunities.

Overall, the assessment concludes that IHPs present meaningful decarbonization and efficiency opportunities for PGL and NSG industrial and large institution customers, but adoption is likely to remain modest without targeted interventions, demonstrations, and market building activities. Technical potential is substantial—estimated at more than 43 million therms—yet economically feasible potential is closer to 1–2% of large user gas consumption under current conditions. To shift this trajectory, strategic action is required.

Recommendations and Next Steps

To capture the most promising opportunities and overcome current deployment barriers, the following actions are recommended:

- **Grow Stakeholder Interest and Awareness:** Develop broader understanding of IHP technology and its application among industrial decision-makers, plant engineers and sustainability managers by developing outreach programs providing guidance on “best fit” applications, training into how IHPs integrate into industrial processes, sharing case studies and benchmark data. Early awareness-building will help address misconceptions surfaced during this project, particularly among plants that dismissed IHP applicability despite having favorable loads.
- **Technology Transfer and Design Firm Engagement:** Support training for engineering design firms, contractors who play a critical role for industrial customers. Many lack experience with industrial heat pumps, particularly steam-capable systems. Steps include convening technical workshops, developing design aids, and partnering with OEMs for site walk-throughs and demonstrations. This activity reduces perceived technical risk and increases the likelihood that IHPs will be identified early in project scoping.
- **Pilot Demonstrations:** demonstration projects are a key action to accelerate adoption. Strategically selected pilots across the identified high potential sectors would demonstrate viability. Aspects include OEM supported engineering; third-party measurement and verification (M&V) to document performance and economics; financial incentives for the pilots; and public presentations to serve as reference sites. Successful pilots will reduce uncertainty around economics, integration complexity, and operational performance.

Industrial heat pumps represent a viable and emerging decarbonization pathway for segments of the PGL and NSG customer bases—particularly food & beverage, chemicals, and large institutions. While technical potential is significant, economic and awareness barriers currently suppress adoption. Focused action on education, design support, demonstrations, and incentives will be essential to realizing the near-term opportunities and preparing the market for broader uptake as technology prices fall and electric grid carbon intensity continues to decline.

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REFERENCES

- Electric Power Research Institute (EPRI), 2024, *Opportunities for Demonstrating Industrial Heat Pumps in the United States: Prototype Examples in the Food and Beverage Sectors*, Report 3002031135, <https://www.epri.com/research/products/000000003002031135>
- Illinois Energy Efficiency SAG, 2024, Peoples Gas & North Shore Gas Market Potential Study, <https://www.ilsag.info/wp-content/uploads/Peoples-Gas-and-North-Shore-Gas-SAG-Presentation-Deck-Sept-03-2024-Draft-Results.pdf>
- Illinois Environmental Protection Agency, 2024, Priority Climate Action Plan. <https://www.epa.gov/system/files/documents/2024-03/illinois-priority-climate-action-plan.pdf>
- Illinois Public Act 102-0662, 2021, Article 5, *Energy Transition Act*, <https://www.ilga.gov/Documents/Legislation/PublicActs/102/PDF/102-0662.pdf>
- International Energy Agency (IEA), 2023, *Annex 58, High-Temperature Heat Pumps*, Report HPT-AN58-2, <https://heatpumpingtechnologies.org/content/uploads/sites/70/2023/09/annex-58-task-1-technologies-task-report.pdf>
- Lee, C., Baroi, D., Karasawa, A., CalNEXT, 2023, *Industrial Heat Pump Market Study*, ET23SWE0036, <https://www.etcc-ca.com/reports/industrial-heat-pump-market-study>
- Minnesota Commerce Department, Conservation Applied Research and Development (CARD), 2025, *Industrial Electrification Through Heat Pump Adoption for Process Loads*, Contract 240935, https://mn.gov/commerce-stat/energy/data-reports/240935_ee_industrial_electrification_through_heat_pump_adoption_for_process_loads_final_ada.pdf
- United States Department of Energy (DOE), DOE/EE-2635, 2022, *Industrial Decarbonization Roadmap*, <https://doi.org/10.2172/1961393>