High-Performance Measure Details

Measure Name
Industrial Heat Pumps / High Temperature Heat Pumps

Use Category
ProcDist – Process Distribution

Effective Date
February 13, 2026

End Date
Pending New Version Release in June, 2026

Version
1.2

Measure Code
LM405

Measure Stage
Early Adoption & High Priority Data Collection

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Technology Summary

High-temperature heat pumps (HTHPs) are electrically powered thermal systems designed to deliver sustained elevated temperatures for process heat in commercial and industrial facilities. Unlike typical heat pumps used for residential space conditioning, HTHPs operate at higher leaving-water or steam temperatures—commonly between roughly 180 °F and 320 °F—by leveraging advanced vapor-compression or cascade cycle designs. Typical applications include food and beverage manufacturing, commercial and industrial laundry, pulp and paper processing, chemical processing, and other facilities with continuous or batch process heat demands. Within the California Energy Design Assistance (CEDA) program, HTHPs are positioned as a decarbonization pathway for new construction and major upgrades that displace fossil combustion with high-efficiency electric process heat, supporting statewide goals for electrification, emissions reduction, and grid resilience.

Process heat loads historically represent a large portion of natural gas consumption in nonresidential buildings and industrial facilities, and electrifying these loads is critical to California's decarbonization strategy. As the state's electricity grid continues to decarbonize, replacing fossil boilers and burners with HTHPs can reduce direct combustion emissions and improve overall site energy performance. Because many HTHPs can recover and upgrade low-grade waste heat from exhaust streams, condensers, or external sources, they have the potential to increase system efficiency beyond that of standalone combustion systems while enabling better integration with demand response strategies, thermal storage, and building energy management systems.

Despite the promise of HTHPs, real-world projects often underperform relative to modeled expectations due to recurrent gaps in design and integration. Common challenges include undersized or poorly characterized heat sources that limit achievable lift and operating efficiency, reliance on oversized fossil backup systems without clear sequencing logic, inadequate integration with existing hydronic or steam distribution networks, control systems that do not modulate effectively at part-load conditions, and limited metering to verify actual seasonal performance. Additionally, mismatches between required process temperature profiles and selected heat pump capabilities can lead to unnecessary energy penalties or increased backup usage. This HPM's inducement approach is intended to encourage more rigorous engineering and verification practices to avoid these pitfalls.

Relevant industry performance and rating standards include AHRI 550/590 (I-P and SI), ASHRAE 90.1, and international benchmarks such as metrics used in ISO 50001 energy management frameworks.

Alignment with CEDA Program Goals

The CEDA program supports the implementation of energy efficiency measures that support Code Readiness' Long Term Tactical Plan (LTTP) to drive the goals of electrification, decarbonization, and load reduction.

Projects must meet the CEDA Inducement Requirements identified in the next section to receive an inducement on the equipment and will be evaluated for level of interest in metering to support Code Readiness Objectives.

This measure meets the CEDA program goals as follows:

- **Building partnerships with market stakeholders** by consulting on innovative technologies and best practices in energy efficiency which can lead to the development of more effective solutions and accelerate the adoption of new technologies. As teams adopt the measure, this increases the volume of engineers able to design the equipment, contractors capable of installing the equipment, and owners able to operate the equipment.
- **Increasing the supply of high-performance measures and all-electric buildings** by combining electrification with energy efficiency that can result in projects implementing measures to achieve greater energy savings, reduced emissions, and overall improved building performance. As more buildings specify and install high temperature heat pumps, this helps to increase the overall supply of high temperature heat pumps in the market for others to use, including beyond new construction.
- **Increasing the demand for high-performance measures and all-electric buildings** by pushing for electrification that drives the need for technological advancements, supporting economic growth opportunities through innovation, and raising awareness of the benefits of electrification to increase consumer adoption. As demand in the market increases for newer technologies, the long-term benefit is increased demand for manufacturers and suppliers to provide additional options available in the market.
- **Advancing new high-performance measure technology** by raising public awareness about new technologies and their benefits, helping build acceptance and demand through market support advocacy efforts that can influence stakeholder decisions that enables technological innovation.
- **Providing Codes & Standards with projects of interest** to collect metered data that will inform future California energy codes.

CEDA Inducement Requirements

The inducement requirements for this High Temperature Heat Pump (HTHP) measure are designed to address persistent market and implementation gaps in the deployment of high-temperature electric process heat systems. Although heat pump technologies capable of serving elevated process temperatures have matured, real-world projects often fail to realize modeled energy savings and carbon reductions due to inconsistent design quality, incomplete characterization of heat sources and loads, and a lack of clear expectations for system performance. Without targeted guidance and incentives, facilities may install systems that do not materially displace fossil-based boilers or achieve reliable high-temperature output, which undermines electrification, decarbonization, and grid resilience goals.

This high-performance measure is structured to encourage intentional, well-documented HTHP system design that supports measurable electrification and emissions reduction outcomes in commercial and industrial buildings. By clarifying system performance expectations and promoting coordinated design practices, the measure helps reduce implementation risk and improve real-world performance consistency.

Inducement eligibility is determined based on the project's compliance with the applicable System Design Requirements and Supporting Documentation Requirements. Inducement amounts for this measure are calculated based on avoided Therms relative to a conventional gas boiler baseline, reflecting the electrification impact of displacing fossil-fuel-based process heat systems. Final eligibility and inducement levels are verified through the CEDA review process.

System Design Requirements

1. Achieve a minimum coefficient of performance (COP) of 1.5.
2. Have a minimum capacity of 100 kW, with a preferred capacity of at least 1 MW.
3. Provide a distribution temperature operating at or above 219 °F (preferred).
4. Have steam pressure at or above 2 psi for the building's distribution system, with typical building applications falling in the range of 2–15 psi where steam is served.
5. It is designed to capture and utilize waste heat streams effectively, enhancing overall energy efficiency, where feasible or available.
6. Industrial HTHP systems using distribution temperatures between 180–219 °F will be considered and do not need to meet the steam pressure requirement for distribution.

Incremental Measure Cost

The Incremental Measure Cost (IMC) presented below is intended for CEDA program planning and inducement calibration purposes only. It represents a normalized estimate of incremental first cost for High Temperature Heat Pumps (HTHPs) relative to a natural gas low-pressure steam boiler baseline in new construction under typical California market conditions. Values are expressed in $/kW-thermal ($/kW-th) of delivered heating capacity and reflect economies of scale, recognizing that actual project costs vary based on temperature lift, heat-source availability, electrical infrastructure requirements, and integration complexity.

Base Case

The Base Case is a natural gas–fired low-pressure steam or high-temperature hot water boiler plant serving industrial or large commercial process loads. The system provides distribution temperatures consistent with typical process heating applications (commonly 180–300°F), including low-pressure steam in the 2–15 psi range where applicable. The baseline plant includes boiler(s), combustion controls, stack/flue, feedwater or hydronic pumping, and associated distribution infrastructure sized to meet the same peak thermal load as the proposed system.

For IMC normalization, the Base Case assumes a conventionally designed new-construction installation using packaged or field-erected gas boilers with standard efficiency performance typical of current market practice.

Measure Case

The Measure Case replaces the fossil-fuel boiler plant with an electrically driven High-Temperature Heat Pump (HTHP) system designed to meet the same process heating load. The system provides supply temperatures between 180°F and ≥219°F (preferred), and where applicable, supports low-pressure steam distribution (≥2 psi).

The Measure Case includes industrial-grade heat pump equipment, compressors, heat exchangers, hydronic or steam interface components, electrical service upgrades as required, and controls necessary to achieve a minimum COP of 1.5. Where feasible, the system is designed to capture and utilize available waste heat streams as the source, reducing required temperature lift and improving overall system efficiency. Balance-of-plant components reflect typical new-construction integration for centralized process heat electrification.

IMC Values and Normalization

The normalized IMC rates below apply to the total installed HTHP plant heating capacity (kW-th of delivered heat at design operating conditions) serving the qualifying process/distribution loop. Use the sum of all heat pump modules included in the HTHP plant to determine the applicable size capacity range.

- **$550/kW-th IMC** — applies to HTHP plants ≥ 100 kW-th and < 1,000 kW-th (1.0 MW-th) of installed heating capacity.
- **$360/kW-th IMC** — applies to HTHP plants ≥ 1,000 kW-th (≥ 1.0 MW-th) of installed heating capacity.

These values reflect the consistent cost trend that smaller systems exhibit higher $/kW installed costs due to fixed integration, controls, and commissioning overhead and reduced economies of scale.

Note: If a project includes multiple HTHP units installed as a single coordinated plant serving the same process/distribution system, apply the size capacity range based on the combined plant capacity.

Sources

IMC values are informed by a combination of publicly available market pricing, industry cost references, and program experience, and are intended to reflect typical market conditions rather than project-specific pricing, including:

- California Joint Utilities IMC guidance for new construction (Heschong Mahone Group / CalMAC IMC white paper).
- Heat pump and baseline boiler CAPEX anchors and scaling curve (E3 "Decarbonizing Industrial Heat" report, including Table A.1 and the heat-pump CAPEX vs capacity function).
- Industrial heat pump capital cost per kW ranges by heat pump type (ACEEE "Industrial Heat Pumps" report, Table B1).
- Regional scoping study reproducing industrial heat pump cost table and noting use of ~$600/kW planning average for an MVC scenario (Bonneville Power Administration industrial heat pump market study appendix).
- Inflation adjustment indices (BLS CPI-U index levels Dec-2021 and Dec-2025).
- Technology availability context (commercially available industrial heat pumps up to ~165°C / 329°F) and definitions of HTHP / steam-generating classes (CalNEXT industrial heat pump market study).
- Practical vendor sizing/temperature examples presented in a CEDA-associated industrial heat pumps roundtable deck (e.g., multi-hundred-kW to multi-MW range and ~248°F hot water/steam capability).
- Typical boiler efficiency planning assumption (EPA CHP efficiency methods page).

Code Readiness Objectives

This measure supports CEDA's Code Readiness efforts by collecting performance and market data for future Title 24 improvements related to HTHPs. The data will help determine the most cost-effective, low-energy configurations of HTHP systems compared to gas boiler systems. The objectives include the following:

- Validate delivered heating performance at ≥219°F supply temperature, including measured COP under design and part-load conditions with documented entering/leaving source and load temperatures.
- Measure seasonal system performance (SPF or annualized COP) across representative operating conditions to assess real-world efficiency relative to modeled assumptions.
- Characterize control sequencing and backup heat interaction, including modulation range, compressor cycling frequency, and runtime fraction of supplemental electric or fossil systems.
- Assess climate-zone sensitivity and temperature-lift impacts, documenting how ambient/source temperatures affect annualized efficiency and peak-load performance.
- Document system sizing relative to actual load profiles, evaluating whether ≥100 kW (minimum) and ≥1 MW (preferred) installations demonstrate scale-based efficiency and cost advantages.
- Track installation and commissioning challenges, including hydronic distribution at ≥219°F, steam interface integration (≥2 psi where applicable), electrical service upgrades, and waste heat integration feasibility.
- Collect normalized installed cost data ($/kW-th) with cost drivers disaggregated (equipment, electrical upgrades, distribution, controls, integration complexity) to support future CASE and code-cycle analysis.

Code Readiness Site Monitoring

If selected for Code Readiness monitoring, equipment energy consumption and mechanical system performance may be monitored on-site for a period of up to 24 months. To support performance evaluation and data collection, projects shall provide reasonable access for the installation and operation of metering, sensors, and communication equipment.

Projects equipped with a Building Automation System (BAS), Energy Management System (EMS), or equivalent platform should enable integration of advanced metering devices through the existing system to facilitate data collection and remote access. For projects without a BAS or EMS, the Code Readiness team may install temporary stand-alone data loggers, sensors, and communication equipment as needed to monitor system performance for the duration of the monitoring period.

Instrumentation may be installed or supplemented, where necessary, to measure key system and equipment parameters sufficient to evaluate system performance and operational characteristics. All monitoring equipment will be temporary and installed in a manner that minimizes disruption to normal building operations.

Data Benefits

Collected data will help support the following:

- Energy Efficiency: Data collected on the performance of HTHPs will demonstrate their ability to enhance industrial energy efficiency by leveraging waste heat and minimizing energy losses.
- Cost Savings: Detailed economic analyses will reveal potential cost savings from reduced fuel consumption and operational efficiency improvements.
- Performance Metrics: Data on the coefficient of performance (COP) and installation and equipment costs will help refine and optimize HTHP applications.

Sample Data Points

A sample set of data points that would ideally be collected is provided below for reference. This list will be re-developed for each project based on the infrastructure and need of the monitoring effort:

Data Points to Meter	Unit	Additional Specifications
HP Power	kW	Maximum and minimum values
Mode of Operation	-	Flag indicating heating or cooling or off
Thermal Load Provided	BTU	Average and peak values
Operational Efficiency	COP	Efficiency measured at each instance

Code Reference

RESERVED

Eligible Climate Zones and Building Types

Eligible Climate Zones

This high-performance measure applies statewide in **California Climate Zones 1-16** (Title 24). Applicants must identify the project's climate zone in the submittal.

Eligible Building Types

This high-performance measure applies to:

- **Nonresidential**: **Commercial, public, agricultural, and industrial** facilities (e.g., offices, retail, lodging, education, healthcare, food service, warehouses, manufacturing, civic buildings).

Eligible Project Scopes

This high-performance measure applies to:

- **New construction**, **additions**, and **major alterations/retrofits** to systems served by the measure.

This high-performance measure does not apply to (not in scope):

- **High-Rise Multifamily**: Buildings with four (4) or more habitable stories above grade.
- **Low-rise residential** (single-family and multifamily ≤3 habitable stories above grade).

Measure Exclusions

The following system types, applications, and configurations are not eligible for inducements under the High Temperature Heat Pump (HTHP) High-Performance Measure. These exclusions are intended to clearly define the boundaries of this measure and prevent overlap with unrelated technologies or partial system upgrades.

Out-of-Scope System Types and Applications

- Heat Recovery Chillers (HRCs) or heat recovery chillers serving primarily cooling-driven loads with secondary heat reclaim. These systems are fundamentally cooling-dominant and do not qualify as high-temperature process heat heat pumps under this measure.
- Low-temperature hydronic heat pumps designed for space heating applications with distribution temperatures below 180°F. These systems fall outside the high-temperature process heat intent of this HPM.
- Service or Domestic Hot Water (DHW/SHW) systems serving potable water heating loads. Systems primarily serving DHW or SHW applications are not eligible under this measure.
- Pool heating systems or spa heating systems.
- Comfort-only HVAC systems (e.g., air-to-air heat pumps, VRF systems, rooftop units) that do not provide high-temperature hydronic or steam process heat.
- Process systems not delivering heat to a building distribution loop, including direct-contact heating systems or equipment without a hydronic or steam distribution interface.
- Systems serving only localized equipment loads (e.g., single appliance or equipment skids) that do not function as a central plant or central distribution system with minimum 100 kW thermal capacity.
- Systems below 100 kW thermal capacity, as this measure is intended for industrial-scale and large commercial applications.

Certification / Efficiency Cases That Do NOT Qualify

- Equipment that does not demonstrate a minimum COP ≥ 1.5 at the intended operating condition.
- Systems that cannot document delivered thermal capacity at the specified distribution temperature.
- Systems operating exclusively below 180°F supply temperature without meeting the qualifying high-temperature criteria.
- Equipment not listed, certified, or compliant with applicable state or federal appliance efficiency regulations (where regulated).
- Installations where fossil-fuel equipment remains the primary heating source and the heat pump functions only as supplemental or secondary trim heat.
- Systems installed solely to comply with a mandatory local electrification ordinance or other regulation where no performance uplift beyond required minimum standards is demonstrated.

Anti-Double-Dip Provision

To prevent overlapping incentives, the following restrictions apply:

- A single HTHP system installation may not claim inducements under any other CEDA High-Performance Measure for the same equipment scope, capacity, or controls integration.
- If a project includes multiple qualifying technologies, each inducement claim must be limited to distinct and non-overlapping equipment scopes.
- The same thermal capacity, electrical infrastructure upgrade, control system, or integration cost may not be counted toward inducement calculations under more than one HPM.
- Projects found to have overlapping inducement claims for the same system scope will be required to select a single applicable measure and adjust claims accordingly.

These exclusions ensure that the High Temperature Heat Pump HPM remains focused on industrial-scale electrified process heat applications delivering ≥180℉ hydronic or low-pressure steam service and demonstrating measurable performance beyond baseline fossil-fuel systems.

Reviewer Checklist

High-Performance Measure Reviewer Checklist

Checklist Description: This checklist captures the elements that must be present in the project design to be eligible for the high-performance measure inducement or consideration for additional site metering.

Project Name: ________________________________

Review Date: ________________________________

Assessment:

- ☐ Approved
- ☐ Not approved

Notes:

Reviewer: ________________________________

Signature: ________________________________

High-Performance Measure Requirements	Comments

System Eligibility

- ☐ Minimum COP ≥ 1.5 demonstrated at the intended operating condition, listed on the manufacturer submittal or stamped performance schedule
- ☐ Installed thermal capacity ≥ 100 kW (equipment schedule, nameplate, or submittal)
- ☐ If applicable, documentation confirms preferred-scale capacity ≥ 1 MW (informational; not mandatory)

Distribution Temperature & Steam Requirements

- ☐ Design documents show distribution temperature operating at or above 219°F (preferred)
- ☐ If serving steam distribution: documentation confirms steam pressure ≥ 2 psi, with typical building application within 2–15 psi range
- ☐ If operating between 180–219°F distribution temperature, reviewer confirms steam pressure requirement is not applicable

Water Heat Integration

- ☐ Design drawings or narrative confirm the system is designed to capture and utilize waste heat streams effectively, where feasible (if available)
- ☐ If waste heat is not utilized, documentation includes engineering explanation of infeasibility or inapplicability (e.g., no viable waste heat source available, waste heat stream not necessary for HTHP operation, etc.)

Baseline & Electrification Confirmation

- ☐ Project documentation confirms system replaces or avoids installation of a natural gas-fired low-pressure steam boiler or comparable fossil baseline (project narrative or mechanical schedule)
- ☐ No fossil-fuel equipment remains as the primary heating source (backup electric heat permitted where applicable)

Documentation Completeness

- ☐ Mechanical schedules include rated capacity (kW-th) and COP values
- ☐ Control sequence documentation confirms intended operating temperature setpoints
- ☐ Reviewer confirms no overlapping inducement claimed for the same system scope

Version History Log

Version	Effective Date	End Date	Change Description
1	September 10, 2024	February 12, 2026	N/A
1.2	February 13, 2026	*Pending New Version Release in June, 2026*	Updated measure to the current CEDA HPM format, IMC, and added reviewer checklist