High-Performance Measure Details

Measure Name
Component-Level High-Frequency Power Metering for Nonresidential Packaged Heat Pump HVAC Units

Use Category
HVAC

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January 20, 2024

End Date
Pending New Version Release in June, 2026

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1.2

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Technology Summary

Packaged heat pump HVAC unit component-level metering refers to the installation of independent electrical and runtime sensors on major subsystems of commercial packaged HVAC units—most notably the compressor(s), supply fan, and condenser fan—to capture granular operational data. These systems are self-contained packaged HVAC units commonly used in nonresidential buildings to provide heating, cooling, and ventilation from a single factory-assembled cabinet, whether mounted on rooftops, at grade, or on structural platforms. Within the CEDA context, component metering is applied to larger electric packaged heat pump units (typically at or above 65,000 Btu/hr) to support electrification and decarbonization efforts by enabling designers, owners, and operators to verify that electrified HVAC systems are performing as intended in new construction projects aimed at reducing fossil energy use and boosting grid resilience.

For California's electrification and decarbonization goals, detailed metering matters because it exposes how these large HVAC assets draw power and respond to controls in real-world conditions. As buildings move away from gas-fired HVAC toward all-electric systems, understanding part-load behavior, cycling frequency, fan energy, and overall

load profiles becomes essential for validating design assumptions, optimizing control strategies, and minimizing unintended demand peaks. Without this visibility, inefficiencies can persist unnoticed, degrading site energy performance and hindering accurate demand forecasting for the grid.

Common performance gaps this HPM is designed to gain insights on: (1) persistent compressor short-cycling due to improper control staging; (2) supply fans running at high speed outside occupied hours or without modulation; (3) condenser fans failing to modulate with load, resulting in excess electrical draw; (4) discrepancies between modeled and actual equipment energy use that go undetected at system level; and (5) lack of insight into resistance heat or supplemental heating operation that elevates energy use. These gaps often arise from a combination of minimal metering, poorly tuned controls, and insufficient commissioning.

Relevant industry performance and rating standards/certifications include AHRI Standard 340/360 (commercial unitary equipment), AHRI certification programs for Unitary Large Equipment (ULE), ANSI/ASHRAE/IES Standard 90.1 (energy efficiency), and ASHRAE Guideline 36 (high-performance sequences of operation).

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 component-level high-frequency power metering on nonresidential packaged heat pump HVAC units, this helps to increase the availability and market familiarity of advanced metering architectures that support performance verification, operational optimization, and future code development, 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 the *Component-Level High-Frequency Power Metering for Nonresidential Packaged Heat Pump HVAC Units* HPM are intended to address persistent gaps in the planning, commissioning, and verification of electrified packaged HVAC systems in nonresidential buildings. While packaged heat pump HVAC units are increasingly used to displace fossil-fuel systems and support all-electric design, many projects lack the metering infrastructure needed to verify efficient operation, confirm design assumptions, or quantify grid and carbon benefits. Without targeted inducement, designers and owners may forgo high-resolution power and runtime metering on key components, limiting the ability to diagnose performance issues, validate modeled outcomes, and integrate HVAC loads into demand-side management and broader decarbonization strategies.

This measure encourages adoption of component-level, high-frequency electrical metering on qualifying nonresidential packaged heat pump HVAC units that comply with applicable Title 24 system requirements. By establishing clear expectations for measured operational performance and enabling granular visibility into compressor, supply fan, and condenser fan behavior, the inducement supports improved performance verification in new construction and major alterations. This reduces risks associated with under-metered installations, including undetected control inefficiencies, unverified part-load performance, and limited insight into runtime behavior.

Eligibility for inducement under this HPM is determined by compliance with the System Design Requirements and confirmation that qualifying systems are equipped with component-level high-frequency power metering capable of ongoing data collection and analysis. Review includes verification of the conditioned floor area served, confirmation of data accessibility and quality sufficient for performance evaluation, and compliance with required documentation and data-sharing commitments. Inducement levels are calculated based on conditioned floor area served, consistent with CEDA program parameters. Final eligibility and inducement amounts are confirmed through the CEDA review process to ensure alignment with documented installation scope and measurable data-readiness objectives.

System Design Requirements

1. **Nonresidential Packaged Heat Pump HVAC Unit with High-Frequency Power Metering:** The system shall be a factory-assembled packaged heat pump HVAC unit serving a nonresidential building and equipped with high-frequency power and runtime metering on key components (compressor(s), supply fan(s), condenser fan(s)) capable of supporting ongoing data collection and analysis.
2. **Nominal Capacity Threshold:** The packaged heat pump HVAC unit must have a nominal cooling capacity equal to or greater than 65,000 Btu/hr to align with typical nonresidential commercial heat pump applications eligible for this measure.
3. **Metering & Data Integration:** The system must be configured to support component-level electrical metering and ongoing data collection. Metering must allow for high-resolution tracking of energy use and operational patterns and be accessible for analysis.
4. **Commitment to Data Sharing:** The project owner shall commit to sharing component-level, circuit metering data with PG&E/Advanced Codes & Standards teams or designated CEDA reviewers for performance evaluation and post-occupancy review.
5. **Appropriate System Type for Application:** The installed packaged heat pump HVAC unit shall be suitable for the intended conditioned space and climate zone. System type selection (e.g., heat pump, dual-fuel) should align with standard practice for the building use, climate, and load, consistent with California Title 24 system definitions.
6. **Support for Monitoring & Controls:** The system shall interface with a monitoring platform capable of collecting, storing, and exporting data to track space usage, energy use, trends, and packaged heat pump HVAC unit component behavior to support performance verification and optimization.

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 of high-frequency, component-level metering infrastructure on qualifying nonresidential packaged heat pump HVAC units relative to a code-compliant packaged heat pump HVAC unit without such metering in new construction under typical California market conditions.

Values are expressed in dollars per ton ($/ton) of nominal cooling capacity and reflect the incremental cost associated with installing dedicated electrical metering on major packaged heat pump HVAC unit components (e.g., compressor, supply fan, condenser fan), along with required data acquisition infrastructure and commissioning to enable performance tracking and data accessibility.

Actual project costs may vary based on unit capacity, electrical panel configuration, metering architecture and data integration scope, site conditions, and contractor pricing. The IMC values below are intended as program-level normalization inputs and are not to be used for project-specific cost estimating or reconciliation.

Base Case

The Base Case is a code-minimum nonresidential packaged heat pump HVAC unit with nominal cooling capacity $\geq$ 65,000 Btu/hr (i.e., typically $\geq$ ~5.4 tons of cooling), installed without dedicated component-level electrical power metering on the compressor, supply fan, and condenser fan. Monitoring, if present, is limited to standard factory or field controls/BMS points typical of conventional packaged unit installations (e.g., basic operational states), without independent high-resolution electrical measurement of major end uses.

Measure Case

The Measure Case is the same packaged heat pump HVAC unit as the Base Case, plus component-level electrical power metering for key unit components (compressor, supply fan, condenser fan), using current transformers (CTs) and a meter/data acquisition approach capable of producing high-resolution interval data suitable for performance evaluation and analytics. The Measure Case also includes incremental scope for a gateway or data concentrator (as needed) and data acquisition infrastructure sufficient to collect, store, and export interval data in a usable format, plus functional checkout/commissioning activities to confirm operational and accessible data streams. Circuit-level metering platforms evaluated by GSA/NREL illustrate this general architecture (meter + gateway + CTs + data platform).

IMC Values and Normalization

The normalized IMC rate below applies to the nominal cooling capacity (tons) of qualifying nonresidential packaged heat pump HVAC units equipped with high-frequency, component-level power metering. Use the nominal cooling capacity of each qualifying unit to determine the applicable IMC.

- **$450/ton IMC** — applies to nonresidential packaged HP HVAC units $\geq$ 65,000 Btu/hr (≈5.4 tons) of nominal cooling capacity.

This value reflects the incremental installed cost associated with component-level electrical metering of primary unit loads (e.g., compressor, supply fan, condenser fan), including metering hardware (submeters and current transformers), electrical installation, controls integration, gateway or protocol hardware where required, data acquisition scope, and commissioning necessary to enable high-resolution performance data and operational verification. The normalized value is a program-calibration midpoint across typical nonresidential unit size classes (approximately 6 to 20 tons) in California new construction.

Because metering and integration include fixed-cost elements (e.g., gateway hardware, configuration, and commissioning), smaller-capacity packaged units may exhibit higher effective $/ton costs, while larger-capacity units may benefit from scale efficiencies. If a project includes multiple qualifying packaged HP HVAC units serving the same building, apply the normalized IMC to each unit individually based on its nominal cooling 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:

- GSA, Low-Cost Submetering Guidance for GSA (Jan 15, 2025) — provides context on historical $/point costs and low-cost submetering architectures (CTs, meters, gateways).
- GSA CEBT / NREL field evaluation summary, Submeters and Analytics: Single-Circuit Meter – Findings (Jan 2021) — provides installed cost per measured load ($470 equipment + $431 installation) and describes gateway + CT + meter system architecture and integration considerations.
- LBNL, Data Center Metering and Resource Guide (2017) — provides rough-order metering cost per point ranges illustrating variability by wired/wireless point types and scope.
- DOE/PNNL metering best-practice materials highlighting that advanced metering costs vary widely due to equipment specs and site/local factors.
- Heschong Mahone Group / CALMAC, Incremental Measure Costs in New Construction Programs (IMC white paper) — establishes IMC definition and role in incentives/cost-effectiveness context.
- Market pricing anchors (public listings; used as calibration cross-checks, not bid proxies)
    - DENT PowerScout pricing examples (meters and multi-circuit submeters).
    - Veris split-core CT pricing examples.
    - Protocol gateway pricing examples: FieldServer gateway (Jackson Control listing) and Contemporary Controls gateway listing.

Code Readiness Objectives

This measure supports CEDA's Code Readiness efforts by collecting high-resolution operational and market data for nonresidential packaged heat pump HVAC units equipped with component-level power metering. The data will help determine how packaged heat pump HVAC performance, controls behavior, and integration practices vary across real projects and climate zones and inform where future Title 24 requirements may be needed to ensure consistent energy performance and control quality. The objectives include the following:

- **Quantify real-world part-load performance.** Metering compressors, supply fans, and condenser fans will reveal how units perform in real conditions relative to modeled predictions across typical nonresidential applications.
- **Evaluate control strategies and operational behavior.** High-frequency runtime and power data will identify how existing control sequences (e.g., fan modulation, staging) behave in the field and where future code language can strengthen control requirements.
- **Assess resistance heat and backup usage patterns.** Data on supplemental heating activation will help gauge how often and under what conditions resistance or auxiliary heat operates, supporting targeted limitations or sequencing requirements in future codes.
- **Characterize climate-zone variation in performance.** Comparing data across California climate zones will help identify climate-specific performance trends and determine whether code provisions should vary by climate or operating context.
- **Assess market readiness and implementation capability.** Tracking installation practices, data accessibility, metering completeness, and integration challenges will illuminate barriers to widespread adoption of advanced metering and data platforms.
- **Identify distribution of cost drivers for advanced metering.** Analysis of incremental cost components (hardware, installation, data infrastructure, commissioning) will support cost-effectiveness evaluation for future code requirements.
- **Correlate high-resolution data with energy modeling assumptions.** Comparing field data to design model outputs will help refine modeling inputs and support more accurate code compliance pathways.
- **Support verification pathways for future performance compliance.** Establish whether high-frequency component-level metering provides reliable, actionable data that could underpin future performance-based compliance or verification mechanisms in Title 24.

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:

- Provide high-resolution operational data on compressor, supply fan, and condenser fan performance to quantify real-world energy use and part-load behavior.
- Measure actual system coefficient of performance (COP), cycling frequency, and staging under varying climate and occupancy conditions.
- Identify excessive fan energy, unintended resistance heat operation, short-cycling, or improper control sequencing.
- Characterize peak demand (kW) and load profiles to evaluate electrification impacts and grid-interactive potential.
- Validate modeled Title 24 performance assumptions with measured interval data and support refinement of compliance modeling inputs.
- Assess effectiveness of advanced control strategies (e.g., economizer operation, demand control ventilation, temperature reset).
- Enable development of future prescriptive or performance-based code pathways for electrified packaged heat pump HVAC units in small- and medium-sized nonresidential buildings.
- Inform lifecycle cost assumptions, incremental measure cost updates, and long-term market transformation strategy.

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
Compressor(s) Power Draw	Amps or kW	Maximum and minimum values; measured via CT on compressor circuit(s)
Supply Fan(s) Power Draw	Amps or kW	Maximum and minimum values; measured via CT on supply fan circuit(s)
Condenser Fan(s) Power Draw	Amps or kW	Maximum and minimum values; measured via CT on condenser fan circuit(s)
System Supply Air Flow	CFM	Maximum and minimum values; measured via air flow monitoring station, or supplemental sensors
Ambient Dry-bulb Temperature	Degree-F	Maximum and minimum values; measured via supplemental sensors, or BMS
Ambient Wet-bulb Temperature or RH	Degree-F/%RH	Maximum and minimum values; measured via supplemental sensors, or BMS
System Return Air Temperature	Degree-F	Maximum and minimum values; measured via supplemental sensors, or BMS
System Supply Air Temperature	Degree-F	Maximum and minimum values; measured via supplemental sensors, or BMS
System Mixed Air Temperature	Degree-F	Maximum and minimum values; measured via supplemental sensors, or BMS
Indoor Zone Air Temperature	Degree-F	Maximum and minimum values; measured via supplemental sensors, or BMS

Code Reference

SECTION 140.4 – PRESCRIPTIVE REQUIREMENTS FOR SPACE CONDITIONING SYSTEMS

(a) Sizing, Equipment Selection, and Type.

2. ***Single Zone Space Conditioning System Type****. Single zone space conditioning systems with direct expansion cooling with rated cooling capacity 240,000 Btu/hr or less serving the following spaces shall meet the applicable requirements in A-H, or shall meet the performance compliance requirements of Section 140.1. All other system types, including systems with rated cooling capacity greater than 240,000 Btu/hr, multi-zone systems, and systems using central boilers or chillers, shall comply with the applicable requirements of Section 140.*

- *A. Retail and Grocery Building Spaces in climate zones 2 through 15. The space conditioning system shall be a heat pump.*
- *B. Retail and Grocery Building Spaces in climate zones 1 and 16 with cooling capacity less than 65,000 Btu/hr. The space conditioning system shall be an air conditioner with furnace.*
- *C. Retail and Grocery Building Spaces in climate zones 1 and 16 with cooling capacity 65,000 Btu/hr or greater. The space conditioning system shall be a dual-fuel heat pump.*
- *D. School Building Spaces. For climate zones 2 through 15, the space conditioning system shall be a heat pump. For climate zones 1 and 16, the space conditioning system shall be a dual-fuel heat pump.*
- *E. Office, Financial Institution, and Library Building Spaces in climate zones 1 through 15. The space conditioning system shall be a heat pump.*
- *F. Office, Financial Institution, and Library Building Spaces in climate zones 16 with cooling capacity less than 65,000 Btu/hr. The space conditioning system shall be an air conditioner with furnace.*
- *G. Office, Financial Institution, and Library Building Spaces in climate zones 16 with cooling capacity 65,000 Btu/hr or greater. The space conditioning system shall be a dual-fuel heat pump.*
- *H. Office Spaces in Warehouses. The space conditioning system shall be a heat pump in all climate zones.*

EXCEPTION to Section 140.4(a)2: *Systems utilizing recovered heat for space heating.*

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 systems, applications, and conditions do not qualify for inducement under this *Component-Level High-Frequency Power Metering for Nonresidential Packaged Heat Pump HVAC Units* high-performance measure. Projects that meet any of the criteria below are excluded from claiming inducements for this measure:

Out-of-Scope System Types and Applications

- Comfort-only HVAC systems that are not configured as packaged heat pump HVAC units (e.g., split systems, mini-splits, VRF systems, fan coil units) and lack centralized duct distribution or a standalone packaged air-handling configuration.
- HVAC equipment used in primarily residential systems that do not meet the nonresidential packaged heat pump HVAC configuration and data integration requirements of this measure, including systems serving individual dwelling units rather than common nonresidential building loads.
- Process cooling, refrigeration equipment, or systems that serve loads outside the defined space conditioning intent of this HPM.
- Packaged units with nominal cooling capacity < 65,000 Btu/hr, which fall below the eligible size threshold for this measure, are not eligible.
- Systems that do not include permanent dedicated component-level metering of the defined primary loads (compressor(s), supply fan(s), condenser fan(s)) at the circuit level.
- Retrofit metering added to existing packaged heat pump HVAC units without installation of metering infrastructure meeting this HPM's System Design Requirements is out of scope.

Efficiency / Certification Exclusions

- Systems that do not meet basic Title 24, Part 6 system type requirements applicable to nonresidential packaged heat pump HVAC configurations are excluded.
- Packaged heat pump HVAC units that are installed with component-level metering hardware but are non-operational at the time of installation or not commissioned for active high-resolution data collection do not qualify.
- Metering installations that only capture aggregate electrical demand (e.g., building main meter, utility meter data) or that lack separate metering for each of the defined packaged unit subcomponents (compressor, supply fan, condenser fan) are out of scope.

Anti-Double-Dip / Incentive Overlap

To prevent overlapping incentives, the following restrictions apply:

- A system cannot claim inducements under this *Component-Level High-Frequency Power Metering for Nonresidential Packaged Heat Pump HVAC Units* HPM and the BMS HPM for the same metering equipment, controls hardware, or integration scope. Any metering or controls upgrades that are eligible under the BMS HPM shall not be claimed again under this measure.
- Data and Integration Conditions
    - Projects that do not commit to data sharing with PG&E/Advanced Codes & Standards teams or designated CEDA reviewers, as required by this measure, are excluded.
    - Systems that install metering but do not provide a means of collecting, storing, and exporting high-frequency component-level data in an accessible format are not eligible.
    - (Export may occur through a BMS, EMS, dedicated monitoring platform, or equivalent data acquisition system.)

These exclusions ensure that this HPM remains focused on nonresidential packaged heat pump HVAC units equipped with high-frequency component-level power metering and associated integration sufficient to support data-driven performance insights and future code readiness.

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

- ☐ Packaged heat pump HVAC unit serving a nonresidential building (mechanical schedule, equipment submittal, or project narrative confirms nonresidential application)
- ☐ Nominal cooling capacity ≥ 65,000 Btu/hr (manufacturer cut sheet, nameplate, or equipment schedule)
- ☐ System type suitable for the intended conditioned space and climate zone, consistent with California Title 24 system definitions (mechanical plans or compliance documentation)

Component-Level High-Frequency Metering

- ☐ High-frequency power and runtime metering installed on:
  - ☐ Compressor(s)
  - ☐ Supply fan(s)
  - ☐ Condenser fan(s)

  (documented in electrical one-line, metering schematic, or panel schedule)
- ☐ System configured to support component-level electrical metering and ongoing data collection
- ☐ Metering allows high-resolution tracking of energy use and operational patterns and is accessible for analysis (sample trend log, screenshot, or export file format)

Monitoring & Data Access

- ☐ System interfaces with a monitoring platform capable of collecting, storing, and exporting data to track conditioned space usage, energy use, trends, and packaged heat pump HVAC unit component behavior
- ☐ Documentation confirms ability to export high-frequency interval data in an accessible format (e.g., CSV, API, BACnet, Modbus, or equivalent)

High-Performance Measure Requirements	Comments

Data Sharing Commitment

- ☐ Project owner commitment to share circuit-level metering data with PG&E/Advanced Codes & Standards teams or designated CEDA reviewers for performance evaluation and post-occupancy review (signed statement or participation agreement)

Documentation Completeness

- ☐ Mechanical schedules clearly identify nonresidential packaged heat pump HVAC equipment and rated capacity
- ☐ Electrical documentation identifies metered circuits corresponding to compressor(s), supply fan(s), and condenser fan(s)
- ☐ Reviewer confirms no overlapping inducement claimed for the same metering or controls scope under the BMS HPM

Version History Log

Version	Effective Date	End Date	Change Description
1	February 23, 2023	February 19, 2026	N/A
1.2	February 20, 2026	Pending New Version Release in June, 2026	Updated measure to the current CEDA HPM format, IMC, all eligible packaged HP HVAC units, and added reviewer checklist