# High-Performance Measure Details

| Measure Name | Use Category |
|---|---|
| High-Performance Dehumidification with Recovered Reheat | WHR – HVAC Heat Recovery |
| **Effective Date** | **Version** |
| October 28, 2026 | 1.1 |
| **Measure Code** | **Measure Stage** |
| LM646 | Early Adoption & High Priority Data Collection |

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# Technology Summary

**High-Performance Dehumidification with Recovered Reheat** is a technology-neutral HVAC approach that removes moisture to maintain project-specific environmental conditions while using recovered thermal energy that would otherwise be rejected or wasted to provide reheat that would otherwise require a separate heating source. Applicable configurations may include hydronic heat recovery, wraparound heat pipes or runaround coils, heat-recovery chiller arrangements, refrigerant heat recovery, and other integrated dehumidification systems capable of recovering useful heat from the dehumidification process. Typical applications include controlled environment horticulture (CEH), indoor swimming pools, museums and archives, healthcare and laboratory spaces, industrial or manufacturing environments, and other facilities with high latent loads or close humidity, dew point, or process-control requirements. This performance-based approach aligns with CEDA's role in advancing high-performance technologies beyond minimum code while building market experience and information that can inform future California Codes and Standards (C&S).

The technology is particularly relevant to California because conventional dehumidification can require simultaneous cooling and reheating: air is cooled below its dew point to remove moisture and may then require reheating before it is supplied to the space. Recovering heat already available within the HVAC or dehumidification process can reduce reliance on separately generated reheat from boilers, electric resistance, heat pumps, or other

heating sources while still maintaining required environmental conditions. This is especially important for high-load applications such as CEH, where the Statewide CASE Team has previously examined HVAC/dehumidification strategies using site-recovered heat, capacity modulation, and integrated temperature and humidity controls, but identified gaps in industry test procedures, sizing guidance, commissioning practices, and performance validation that limited advancement into the 2025 Energy Code.

**Common real-world performance gaps include**: improper equipment sizing based on rules of thumb or sensible-load assumptions rather than the actual sensible and latent load profile; oversizing or insufficient capacity modulation that can cause short cycling and unstable temperature or humidity control; inadequate coordination between cooling, dehumidification, recovered reheat, and supplemental heating; controls or sensors that are poorly located, calibrated, or sequenced; and incomplete functional commissioning or ongoing verification that allows installed operation to diverge from the design intent. The CEH CASE research specifically identified variable latent loads, oversizing, short cycling, inconsistent load-calculation practices, and limited commissioning guidance as barriers to reliable HVAC/dehumidification performance. ASHRAE guidance likewise emphasizes accurate humidity sensing, energy-conserving dehumidification sequencing, and functional verification of HVAC controls.

# Alignment with CEDA Program Goals

The **California Energy Design Assistance (CEDA)** program is a Market Support program that advances decarbonization, accelerates adoption of emerging and high-performance technologies, informs future C&S, and helps nonresidential and high-rise multifamily new construction and major-alteration projects achieve deeper energy and operational performance. **High-Performance Measures (HPMs)** let projects implement, evaluate, and build market experience with technologies and design practices that exceed conventional practice.

Projects seeking a CEDA HPM inducement must meet the requirements in the following section. Where aligned with Code Readiness priorities, selected projects may also provide market, design, cost, and operational or metered performance data to inform future California Codes and Standards. This measure supports CEDA's Market Support objectives by:

- **Increasing market demand** by introducing project teams and owners to high-performance dehumidification strategies that maintain required moisture-control conditions while reducing reliance on separately generated reheat, increasing familiarity with recovered-energy approaches across humidity-intensive applications.
- **Increasing market supply and delivery capability** by encouraging greater specification and implementation of technology-neutral dehumidification and recovered-reheat solutions, expanding experience among designers, contractors, manufacturers, controls providers, commissioning providers, and operators, and creating opportunities for multiple technical configurations to compete on performance.
- **Building market partnerships and knowledge** by connecting project teams with technical expertise, manufacturers, industry resources, and best practices while collecting feedback on design, installation, commissioning, cost, and operational challenges that may otherwise limit adoption.
- **Advancing innovation and accessibility** by supporting emerging or underutilized technologies and design approaches that can improve energy efficiency, reduce emissions, lower implementation barriers, and encourage continued product and system innovation as market experience increases.
- **Supporting Code Readiness and future market transformation** by identifying projects that can provide information on product availability, technology costs, design and construction practices, commissioning, controls, and measured performance. Where applicable, these projects can provide field data that supports evaluation of future California energy-code, appliance-standard, deemed-measure, or other market-transformation pathways.

# CEDA Inducement Requirements

High-performance dehumidification can reduce the energy penalty associated with mechanically removing moisture and then reheating the conditioned air, but performance depends on appropriate system sizing, heat-recovery integration, controls, and commissioning. Market practice varies considerably across applications, and the presence of a heat-recovery component does not by itself ensure that recovered energy is prioritized or that the system will maintain the intended temperature and moisture conditions. The CEDA inducement is intended to help overcome the incremental design, equipment, controls, integration, and commissioning effort associated with achieving and verifying higher-performance dehumidification.

Inducement eligibility is based on compliance with the applicable **Measure Eligibility (ME), System Design Level Requirements (SDLR), and Supporting Documentation Requirements (SDR)**. The primary performance quantity is the qualifying system's design moisture-removal capacity, expressed in lb of water per hour, at the documented **HPM Design Dehumidification Condition**. Where this value is not provided directly by the equipment manufacturer, it may be established through engineering calculations. For IMC and inducement normalization, the measure quantity is the design airflow, expressed in CFM, through the qualifying dehumidification and recovered-reheat system, as defined in the Incremental Measure Cost section. Additional project and performance data may be collected for program and Code Readiness purposes.

This HPM is intended to achieve performance beyond applicable **2025 Title 24, Part 6** requirements and common industry practice by establishing a higher recovered-reheat performance outcome together with coordinated controls and functional verification. The measure is **technology-neutral** and does not prescribe a specific manufacturer, refrigerant cycle, coil arrangement, or heat-transfer medium. Any technical configuration may qualify if it achieves the applicable performance requirements.

The HPM may apply to **new construction and qualifying major alterations, including eligible additions**, where a meaningful mechanical dehumidification and reheat load exists. In addition to supporting individual projects, participating systems can provide Code Readiness information on moisture removal, recovered-heat utilization, supplemental reheat, controls, commissioning, costs, and operational performance that may help inform future California Codes and Standards activities.

## Measure Eligibility (ME) – All Projects

### 1. Qualifying Measure Scope

1.1. The project shall include a mechanical dehumidification or HVAC/dehumidification system that removes moisture to maintain documented project-specific environmental conditions and requires reheat, regeneration heat, or an equivalent post-dehumidification heating function.

1.2. The qualifying system shall use recovered or transferred thermal energy associated with the HVAC/dehumidification process to reduce separately generated reheat energy.

1.3. Eligibility is based on the **function and performance achieved**, not on the use of a particular heat-recovery device, manufacturer, or system configuration.

1.4. A heat-recovery or hot-gas-reheat feature does not qualify by itself. The complete system shall meet the applicable HPM performance, controls, and verification requirements.

### 2. Design Dehumidification Condition

2.1. The project shall establish a documented **HPM Design Dehumidification Condition**, defined as the project-specific operating condition used to size or select the qualifying dehumidification and reheat system for the applicable design latent load under normal operation.

2.2. The **HPM Design Dehumidification Condition** shall be based on the project's normal mechanical design calculations, equipment selection, or manufacturer performance data and shall identify, as applicable:

2.2.1. Entering-air temperature and moisture condition;

2.2.2. Design airflow or process moisture load;
2.2.3. Required leaving-air dew point, humidity ratio, or other moisture-control condition;
2.2.4. Required supply-air temperature after reheat; and
2.2.5. Design moisture-removal capacity.

2.3. Use the operating condition that drives the dehumidification and reheat design, even if it is not the project's outdoor cooling design condition.

2.4. If more than one normal operating condition could drive dehumidification performance, the project shall identify the condition that is most challenging for the recovered-reheat system and use that condition to demonstrate HPM compliance.

## 3. Recovered Heat Capacity Ratio

3.1. Recovered-reheat performance shall be evaluated using the **Recovered Heat Capacity Ratio (RHCR):**

$$RHCR = \frac{\text{Qrecovered reheat}}{\text{Qtotal reheat}}$$

where:

$Q_{recovered\ reheat}$ = recovered thermal capacity (Btu/h) available to provide dehumidification reheat or equivalent regeneration heat at the **HPM Design Dehumidification Condition**; and
$Q_{total\ reheat}$ = total reheat capacity (Btu/h) required at the **HPM Design Dehumidification Condition**, including recovered and separately generated supplemental reheat.

3.2. Recovered-reheat capacity used in the RHCR calculation shall be limited to the useful recovered thermal capacity that can be applied to the required reheat load at the **HPM Design Dehumidification Condition**. RHCR shall not exceed **1.00**.

3.3. RHCR may be demonstrated using manufacturer performance data, equipment-selection information, or an engineering heat balance. Where the same airstream passes through the dehumidification and recovered-reheat components, airside temperature-rise calculations may be used where applicable.

3.4. Only heating used to satisfy the reheat or regeneration requirement associated with the qualifying dehumidification process at the **HPM Design Dehumidification Condition** shall be included in total reheat capacity. Heating used solely for upstream preheat, independent space heating, terminal-zone heating, frost protection, or other functions not required by the dehumidification process shall be excluded. Where terminal or downstream heating is intentionally used as part of the dehumidification-reheat sequence, that heating shall be included as supplemental reheat.

## 4. Environmental Performance and Monitoring

4.1. The qualifying system shall be designed to maintain the documented project-specific temperature and moisture-control requirements.

4.2. System sizing shall account for the applicable sensible and latent loads of the qualifying project scope.

4.3. Where a building automation or management system (BAS/BMS/EMS) is installed, the points used to confirm environmental conditions and recovered/supplemental reheat operation shall be available for trending where practical.

## 5. Eligible Projects

5.1. Eligible projects include **new construction and qualifying major alterations, including eligible additions**, consistent with current CEDA program eligibility.

5.2. The HPM may apply statewide in **California Climate Zones 1 through 16** to eligible **commercial**, **public**, **agricultural**, and **industrial** projects with a meaningful mechanical dehumidification and reheat load.

*Note: Detailed building-type and project-scope applicability is provided in the Eligible Climate Zones, Building Types, and Project Scopes section.*

## 6. Code Compliance

6.1. All projects shall comply with applicable **2025 Title 24, Part 6 requirements and all applicable state and local codes**.

6.2. CEDA HPM requirements are intended to be above-code and do not replace or waive code-compliance obligations.

6.3. Where Title 24 already requires dehumidification heat recovery or related controls, the project shall demonstrate that the claimed HPM scope exceeds the applicable minimum requirement.

### 7. Interaction with Other CEDA HPMs

7.1. Heat recovered from a separate refrigeration process—such as supermarket cases, walk-ins, or process refrigeration—is outside the scope of this HPM and may be evaluated under the applicable **Refrigeration Heat Reclaim HPM**.

7.2. The same recovered energy, incremental cost, or performance benefit shall not be claimed under more than one CEDA HPM.

### 8. Design Information

8.1. Projects shall provide standard project design documents sufficient to verify measure eligibility and the selected design tier. Existing project documents may be used; a separate CEDA-specific design package is not required.

## System Design Level Requirements (SDLR) – New Construction

### 1. Essential Level: High-Performance Recovered Reheat

1.1. Recovered-Reheat Performance

1.1.1. The qualifying system shall achieve a **RHCR ≥ 0.90**, at the **HPM Design Dehumidification Condition**.

1.2. Controls

1.2.1. Controls sequence shall prioritize recovered heat and enable separately generated supplemental reheat only when recovered heat is insufficient to maintain the required system or environmental condition.

1.2.2. Dehumidification, recovered reheat, supplemental reheat, and applicable temperature and moisture controls shall operate as a coordinated system.

1.3. Functional Verification

1.3.1. The qualifying system shall be checked during startup, commissioning, or controls checkout to verify dehumidification operation, recovered-reheat priority, supplemental-reheat sequencing, and operation consistent with the final control sequence.

### 2. Premium Level: Full Recovered Reheat

*All Essential Level requirements shall be met.*

2.1. Recovered-Reheat Performance

2.1.1. The qualifying system shall achieve **RHCR = 1.00** at the **HPM Design Dehumidification Condition**.

2.1.2. Supplemental reheat may remain available for backup or operating conditions outside the **HPM Design Dehumidification Condition** but shall not be required at that design condition.

## System Design Level Requirements (SDLR) – Additions and Alterations

### 1. High-Performance Recovered Reheat

1.1. The qualifying addition or major alteration shall install, replace, or substantially modify the dehumidification/reheat system serving the applicable project scope.

### 2. Performance

2.1. The qualifying system shall achieve a **RHCR ≥ 0.90**, at the **HPM Design Dehumidification Condition**.

### 3. Controls and Verification

3.1. Controls sequence shall prioritize recovered reheat before separately generated supplemental reheat.

3.2. The modified system shall be checked during startup, commissioning, or controls checkout to verify recovered-reheat operation and priority, supplemental-reheat sequencing, and operation consistent with the final control sequence.

## Supporting Documentation Requirements (SDR)

Documentation already included in project drawings, schedules, submittals, control sequences, Title 24 compliance documents, commissioning records, or cost estimates **does not need to be duplicated**. The intent of this section is to identify the minimum information needed to verify measure eligibility, the claimed tier or pathway, and the applicable above-code design features. CEDA verification may rely on standard startup, controls-checkout, or commissioning records. Post-occupancy trend logging is not required for HPM eligibility unless separately requested for Code Readiness or measurement and verification purposes.

### 1. All Projects

1.1. Installed System

1.1.1. Provide final project documentation sufficient to identify the qualifying system, such as applicable final drawings, schedules, approved equipment submittals, or manufacturer information. For additions and alterations, the documentation shall identify the components included in the qualifying altered scope.

1.2. Performance

1.2.1. Provide an engineering calculation, equipment-selection output, or equivalent design summary identifying:

1.2.1.1. HPM Design Dehumidification Condition;

1.2.1.2. Qualifying moisture-removal capacity;

1.2.1.3. Recovered-reheat capacity;

1.2.1.4. Total reheat capacity; and

1.2.1.5. Calculated RHCR.

1.2.1.6. Qualifying design airflow (CFM) used for IMC and inducement normalization.

1.3. Controls

1.3.1. Provide the final sequence of operation, controls drawing, or equivalent documentation sufficient to verify:

1.3.1.1. Recovered-reheat priority;

1.3.1.2. Supplemental-reheat sequencing; and

1.3.1.3. Applicable temperature and moisture controls.

1.4. Functional Verification

1.4.1. Provide an available startup, controls-checkout, commissioning, or functional-test record showing that the applicable HPM control sequence was reviewed or tested.

1.4.2. A separate CEDA commissioning report is not required where equivalent verification is already included in normal project commissioning documentation.

1.5. Code and Cost Information

1.5.1. Provide applicable final Title 24 compliance documentation and available project cost information sufficient to support CEDA program verification and incremental-cost tracking.

1.5.2. Acceptable cost documentation may include a contractor/vendor proposal, schedule of values, purchase order, invoice, bid, cost estimate, or equivalent project record.

### 2. New Construction – Essential Level

2.1. No additional documentation beyond the All Projects' requirements is required.

3. New Construction – Premium Level
   3.1. In addition to the All Projects' requirements, provide a representative functional test, controls-checkout record, or short trend demonstrating that supplemental reheat remains off when recovered heat is sufficient to meet the active reheat load.
4. Additions and Alterations
   4.1. No additional documentation beyond the All Projects' requirements is required.

# Incremental Measure Cost

The Incremental Measure Cost (IMC) represents the estimated additional first cost of implementing a qualifying **High-Performance Dehumidification with Recovered Reheat** system compared with an applicable code-minimum or standard-practice system designed to serve the same dehumidification load and environmental conditions. Incremental costs may include enhanced heat-recovery equipment, controls, system integration, engineering, startup, and other features needed to achieve the applicable HPM performance level.

The IMC is used as a **CEDA program-calibration input** to establish an appropriate inducement level and cost cap. It is not intended to serve as a contractor bid, detailed project cost estimate, or project-specific cost-reconciliation value. Actual project costs will vary based on system configuration, airflow, equipment selection, building type, installation conditions, geographic location, labor rates, and market conditions. Consistent with current CEDA policy, HPM cost estimates are intended to be high-level market estimates and should be updated as additional supplier, manufacturer, and participating-project cost information becomes available. Current CEDA policy caps HPM inducements at 70 percent of the applicable IMC.

Because this HPM is intentionally **technology-neutral**, there is not one universal Base Case or Measure Case equipment package. A passive heat-pipe system, hydronic recovery arrangement, heat-recovery chiller system, and integrated HVAC/dehumidification system may have materially different equipment and installation costs while achieving the same HPM outcome. The normalized IMC values below are therefore the primary CEDA cost inputs; the detailed material/labor comparison is provided as a representative planning framework to support future deemed-measure development.

## Base Case

The **Base Case** is an applicable 2025 Title 24-compliant or otherwise code-minimum/standard-practice dehumidification and reheat system designed to meet the same project-specific moisture-control and environmental conditions as the Measure Case.

The Base Case includes equipment, heat recovery, reheat, controls, and other system features already required by applicable code or considered part of the normal system design. Where Title 24 already requires dehumidification heat recovery or related controls, those features are included in the Base Case and are not treated as incremental HPM costs.

The Base Case does not include the additional recovery capacity, system integration, controls, or other design features necessary to achieve the applicable HPM **Recovered Heat Capacity Ratio (RHCR)** and associated System Design Level Requirements.

## Measure Case

The **Measure Case** is a technology-neutral dehumidification system that meets the applicable HPM requirements while serving the same design moisture-control conditions as the Base Case.

Depending on the selected technical pathway, incremental Measure Case costs may include:

- Enhanced recovered-reheat coils, heat pipes, thermosiphons, runaround components, heat exchangers, hydronic recovery equipment, or equivalent recovery components;
- Heat-recovery-chiller or refrigerant-heat-recovery integration;
- Pumps, valves, piping, bypass or modulation devices, and associated controls;
- Additional controls programming and integration needed to prioritize recovered heat before supplemental reheat; and
- Incremental engineering, startup, controls checkout, or commissioning effort associated with the qualifying HPM features.

Where the high-performance design eliminates or reduces equipment that would otherwise be required in the Base Case, such as supplemental reheat capacity, electrical infrastructure, refrigerant piping, or other ancillary components, the IMC is intended to reflect the **net incremental first cost**, not simply the gross cost of added heat-recovery equipment.

## IMC Values & Normalization

The recommended normalized IMC unit is:

**$/CFM of design airflow through the qualifying dehumidification and recovered-reheat system**

Design airflow provides a practical and consistently available basis for scaling costs associated with coils, heat exchangers, heat pipes, air-handling equipment, pressure-drop impacts, controls, and other system-integration requirements. The value is also readily available from normal mechanical schedules and equipment selections.

Although design moisture-removal capacity in lb water/hr is the preferred HPM quantity for characterizing dehumidification performance, it is less suitable for cost normalization because moisture-removal capacity varies substantially with entering-air conditions, required leaving-air dew point, and application. Similarly, $/ton can be misleading for systems with substantially different sensible heat ratios. **$/CFM therefore provides the most practical common cost basis across the technology-neutral HPM scope.**

For projects with multiple qualifying systems, the measure quantity shall be the sum of the applicable design airflow through each qualifying dehumidification/recovered-reheat system.

## Representative Size and Pricing Anchors

Available market and Codes & Standards cost information demonstrate that costs vary significantly depending on the selected system architecture. Published technical literature for factory-integrated wraparound heat pipes provides evidence that passive heat-recovery configurations can represent a comparatively lower-cost technology pathway. Because the available published pricing predates the current cost year, historical pricing is used only as a qualitative reasonableness reference and not as a current-dollar IMC input. This represents a relatively simple passive-recovery configuration and does not capture the full range of controls, hydronic equipment, piping, integration, engineering, or commissioning that may be associated with other qualifying HPM pathways.

The **Controlled Environment Horticulture Final CASE Report** provides a more comprehensive California-specific system cost reference. For its representative indoor flower-room analysis, the Statewide CASE Team estimated baseline and proposed HVAC/dehumidification first costs of approximately **$292.81 and $298.57 per canopy square foot**, respectively, for a net incremental first cost of **$5.76 per canopy square foot**. The analysis also shows

why net incremental cost is important: the integrated system had substantially higher primary equipment cost, but lower electrical, condensate, refrigerant-piping, and other ancillary costs offset most of that premium.

The same CASE analysis cites integrated HVAC/dehumidification equipment pricing generally in the range of approximately **$2,500 to $3,500 per ton**, depending on configuration and low-ambient capability, while noting that correctly sized integrated systems can have higher equipment costs but lower installation costs than comparable decoupled systems. These values are not directly convertible to the HPM $/CFM basis but provide useful market reasonableness checks for the recommended normalized values.

## Recommended HPM IMC Values

The following values are initial program-calibration assumptions rather than statistically derived market averages and should be refined as additional participating-project and market cost data become available.

| HPM Offering | Normalized IMC | Primary Cost Drivers |
|---|---|---|
| NC – Essential Level | $5.00/CFM | Enhanced recovery capacity; controls and integration |
| NC – Premium Level | $7.00/CFM | Full design-condition recovered reheat; additional recovery/modulation capability |
| A&A – Single Tier | $6.00/CFM | Recovery upgrade; field modification and controls integration |

***Note**: The Premium Level value represents the **total incremental cost relative to the Base Case**, not an additional $7.00/CFM above the Essential Level.*

These values are recommended as initial CEDA program-calibration values and should be periodically reviewed as additional participating-project, contractor, manufacturer, and supplier cost information becomes available.

## Representative Base and Measure Cost Comparison

The following table provides a **preliminary cost structure** to support future measure-proposal or deemed-workpaper development. The values separate representative material/equipment and labor/installation costs while maintaining the normalized CEDA IMCs identified above.

Because this HPM can be satisfied by multiple technical configurations, these absolute Base Case and Measure Case cost allocations are **planning assumptions rather than universal market prices**. Future measure development should replace or refine these allocations using technology-specific contractor quotes, manufacturer pricing, and installed-project cost data.

| Measure Offering | Base Case | | Measure Case | | Full Measure Cost ($/CFM) | Incremental Measure Cost ($/CFM) |
|---|---|---|---|---|---|---|
| | Material Cost ($/CFM) | Labor Cost ($/CFM) | Material Cost ($/CFM) | Labor Cost ($/CFM) | | |
| NC – Essential Level | $6.00 | $9.00 | $10.00 | $10.00 | $20.00 | $5.00 |
| NC – Premium Level | $6.00 | $9.00 | $11.50 | $10.50 | $22.00 | $7.00 |
| A&A – Single Tier | $6.00 | $9.00 | $10.00 | $11.00 | $21.00 | $6.00 |

The representative IMC is calculated as:

$$IMC = (Measure\ Material + Measure\ Labor) - (Base\ Material + Base\ Labor)$$

For the purposes of future measure development, **material cost** is intended to represent primary HVAC/dehumidification and recovered-reheat equipment, controls hardware, pumps, valves, heat exchangers, coils, and similar installed components. **Labor cost** is intended to represent installation, piping or duct modifications, electrical work, controls programming and integration, startup, testing, and other installation-related effort.

The A&A labor allocation is modestly higher than the comparable new-construction case to account for the additional coordination, tie-in, field modification, and controls-integration effort commonly associated with alterations.

***Cost Development Note:*** *The material and labor allocations above are preliminary planning assumptions intended to establish a consistent starting framework for future deemed-measure cost development. The normalized CEDA IMC values are the primary HPM cost inputs and should be refined as additional market and participating-project data become available.*

## Sources

IMC values are informed by a combination of publicly available market pricing, California Codes & Standards cost research, manufacturer information, and CEDA/program experience. These sources are intended to reflect representative market conditions and support program calibration rather than establish project-specific pricing.

- ET22SWE0040_High Efficiency Dehumidification System Field Study_Final Report – **CalNEXT – High Efficiency Dehumidification System Field Study (ET22SWE0040), Final Report.** Provides California field-performance evidence from the Timken Museum of Art in San Diego, including measured and modeled impacts of HEDS energy recovery on cooling, reheat, electricity, natural gas use, and greenhouse gas emissions. The study also documents the system configuration, operating sequences, monitoring approach, market barriers, and recommendations for broader utility-program adoption. It is particularly useful as a **technology-specific validation source for one qualifying recovered-reheat pathway**, while the HPM itself remains technologically neutral.
- Controlled Environment Horticulture – **California Statewide CASE Team – 2028 Controlled Environment Horticulture Final CASE Report, June 2026.** Provides detailed California-specific baseline and proposed HVAC/dehumidification equipment and installation costs, including equipment, controls, sensors, electrical, ductwork, piping, design, testing, and other ancillary costs.
- Wrap-Around-Heat-Pipes-For-Humid-Climates – **ASHRAE Technical Feature: Wrap-Around Heat Pipes in Humid Climates, November 2016.** Provides a published equipment-level cost anchor of approximately $1.50/CFM for a representative 10,000 CFM wraparound heat-pipe application, which is useful as a lower-cost technology reference but does not include the full range of controls, piping, integration, or other configurations covered by this HPM. Because the available published pricing predates the current cost year, historical pricing is used only as a qualitative reasonableness reference and not as a current-dollar IMC input.

# Code Readiness Objectives

This HPM is intended to support CEDA's Code Readiness role by increasing field experience with **technology-neutral, high-performance dehumidification and recovered-reheat systems** and by identifying which design, controls, verification, and performance metrics could ultimately support broader market adoption or future California Codes and Standards. CEDA's current program framework specifically uses HPMs to increase market knowledge on available products, technology costs, design and construction practices, and to provide selected projects for deeper metered data collection where useful to future code development.

This measure is particularly relevant to ongoing Code Readiness work because CEH HVAC/dehumidification has been identified as an area where additional field experience, sizing methods, controls verification, and test procedures are needed. Earlier CEH CASE research documented gaps in CEH-specific sizing, performance, and commissioning guidance, while the 2028 Final CASE Report now proposes mandatory sizing, recovered-heat, controls, and acceptance-testing requirements for high-intensity indoor growing facilities. The Code Readiness portfolio has also advanced a **CEH HVAC-Dehumidification Test Procedure Development** concept for further research.

Routine CEDA verification is not intended to become an extended M&V study for every participating project. Standard project information should establish HPM eligibility and installation, while **selected projects may be referred to Code Readiness for deeper monitoring** where the site, system configuration, and available controls provide useful research value. This approach is consistent with the existing CEDA/Code Readiness collaboration, which uses participating new-construction projects to collect real-world performance data and inform future Title 24 requirements, acceptance testing, modeling assumptions, and market-readiness assessments.

The Code Readiness objectives for this HPM are to:

- **Validate recovered-reheat performance in the field.** Compare the design **Recovered Heat Capacity Ratio (RHCR)** with actual recovered and supplemental reheat operation at selected monitored sites to determine whether the design metric is a useful predictor of real-world performance.
- **Quantify dehumidification and energy performance.** Where sufficient monitoring is available, characterize moisture-removal rate, lb of moisture removed per kWh, supplemental reheat energy, system electric demand, fan/pump impacts, and operating hours to better understand the net energy benefit of different recovered-reheat configurations.
- **Evaluate controls behavior and performance persistence.** Determine whether recovered heat is consistently prioritized before supplemental reheat, how often supplemental reheat operates, whether temperature and moisture setpoints are maintained, and which controls, sensor, sequencing, or commissioning issues most commonly prevent intended operation.
- **Assess performance across applications and California conditions.** Compare system behavior across representative climate zones, building types, latent-load profiles, and operating schedules to identify where recovered-reheat strategies provide the greatest benefit and where climate or process loads materially affect performance. CEH should be a priority application, while other humidity-intensive uses can broaden the evidence base.
- **Compare multiple technology pathways.** Collect comparable performance and design information from HEDS-type hydronic systems, heat-pipe or runaround approaches, heat-recovery-chiller systems, desiccant/recovered-heat systems, and other qualifying configurations to determine whether common technology-neutral metrics and requirements can be applied without favoring a single proprietary solution.
- **Identify market and contractor readiness.** Track available manufacturers and system configurations, designer and contractor familiarity, controls and commissioning capabilities, installation complexity, and recurring project-development challenges to determine whether the market can reliably deliver the

measure at broader scale. CEDA policy specifically identifies product availability, design/construction knowledge, and geographic contractor availability as useful market-support and Code Readiness information.

- **Refine incremental cost and cost drivers.** Compare actual project cost information against the preliminary **$/CFM IMC framework**, including the relative contribution of recovery equipment, controls, hydronic/refrigerant integration, labor, engineering, and commissioning, to improve future cost-effectiveness analysis and potential deemed-measure development.
- **Identify a practical future code and verification pathway.** Evaluate which performance criteria can be confirmed through normal construction documents, equipment selections, control sequences, startup records, and standard acceptance activities, and which may require a dedicated test procedure or additional field monitoring. Findings should help inform future requirements that are technically meaningful while remaining practical for designers, contractors, acceptance-test technicians, and enforcement agencies.

## Code Readiness Site Monitoring

If selected for Code Readiness monitoring, dehumidification system energy use and operating performance may be monitored on-site for a period of up to 12 months. To support performance evaluation and data collection, projects shall provide reasonable access for the installation and operation of temporary metering, sensors, data loggers, and communication equipment.

Projects equipped with a Building Automation System (BAS), Building Management System (BMS), Energy Management System (EMS), or equivalent controls platform should enable use or integration of available system points and advanced metering devices where feasible to facilitate data collection and remote access. For projects without an applicable controls platform, or where existing points are insufficient, the Code Readiness team may install temporary stand-alone data loggers, sensors, meters, and communication equipment as needed for the monitoring period.

Instrumentation may be installed or supplemented, where necessary, to measure key system and environmental parameters sufficient to evaluate **moisture-removal performance, recovered-reheat operation, supplemental-reheat use, controls behavior, energy use, and operating conditions**. Depending on the system configuration, monitored parameters may include air temperature and humidity or dew point, airflow, space environmental conditions, recovered- and supplemental-reheat status or capacity, equipment power, chilled- and heating-water temperatures and flow, fan or pump operation, and other relevant system conditions needed to assess performance.

Monitoring will be structured to minimize disruption to normal building operations and may use existing BAS/BMS/EMS trend data where suitable. Data collected through selected projects may be used to evaluate actual recovered-reheat performance relative to design assumptions, identify controls or commissioning issues, compare system configurations and applications, and inform future California Codes and Standards, test procedures, and market-transformation activities.

## Data Benefits

Collected data will help support the following:

- Validation of Recovered Heat Capacity Ratio (RHCR) under actual operating conditions.
- Comparison of design assumptions to measured recovered-reheat performance.
- Quantification of supplemental reheat use and avoided reheat energy.
- Evaluation of moisture-removal performance and environmental control.
- Assessment of system energy use and moisture-removal efficiency.
- Identification of controls, sequencing, sensor, and commissioning issues.
- Comparison of technology pathways, applications, and climate-zone performance.
- Evaluation of performance persistence over seasonal and part-load conditions.
- Refinement of incremental cost, market readiness, and contractor capability assumptions.
- Development of future Code Readiness metrics, test procedures, acceptance criteria, and California Codes & Standards requirements.

## 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 system configuration, available controls infrastructure, and needs of the monitoring effort.

| Data Points to Meter | Unit | Additional Specifications |
|---|---|---|
| **Minimum / Core Data Points** | | |
| Outdoor Air Condition | °F + dew point / humidity ratio | Where outdoor conditions materially affect system operation; supports climate-zone and seasonal performance analysis. |
| Entering Air Condition | °F + dew point / humidity ratio | Temperature and moisture condition at or immediately upstream of the qualifying dehumidification section; RH may be used when paired with corresponding dry-bulb temperature. |
| Air Temperature After Dehumidification / Cooling | °F | Immediately downstream of the primary dehumidification or cooling section, before recovered reheat where accessible. |
| Air Moisture Condition After Dehumidification | %RH / °F dew point | Used with airflow to characterize actual moisture removal. |
| Supply Air Temperature After Reheat | °F | Final leaving-air temperature after recovered and supplemental reheat. |
| Supply Airflow | CFM | Measured, BAS-trended, or otherwise derived from calibrated system data. |
| Representative Space Temperature | °F | Representative controlled space or process zone. |
| Representative Space Moisture Condition | %RH / °F dew point / VPD | Use RH, dew point, or VPD as appropriate to the application. |
| Dehumidification System Operating Mode / Status | Status | On/off plus cooling, dehumidification, standby, or other applicable operating mode. |

| Data Points to Meter | Unit | Additional Specifications |
|---|---|---|
| Recovered-Reheat Enable / Operating Status | Status / % | Enable, valve position, stage, bypass position, or equivalent indication of recovered-reheat operation. |
| Supplemental-Reheat Enable / Operating Status | Status / % | On/off, stage, valve position, or equivalent indication of separately generated reheat. |
| Dehumidification System Electrical Power | kW | Interval average and peak demand where feasible; identify system boundary. |
| **Calculated / Derived Performance Data** | | |
| Moisture Removal Rate | lb water/hr | Calculated from airflow and entering/leaving air moisture conditions where sufficient data are available. |
| Recovered-Reheat Capacity | Btu/h | Calculated from airside or fluid-side measurements or obtained from reliable controls data where available. |
| Supplemental-Reheat Capacity / Energy | Btu/h, kW, or therms | Based on applicable electric, hydronic, steam, or combustion heating source. |
| Operational Recovered-Reheat Fraction | % | Recovered reheat divided by total active reheat; useful for comparison with design RHCR. |
| Moisture-Removal Efficiency | lb water/kWh | Optional derived efficiency metric where system energy and moisture removal can be measured consistently. |
| **Optional / Technology-Specific Data Points** | | |
| Recovery-Loop or Chilled-Water Supply / Return Temperatures | °F | Applicable to hydronic, HEDS-type, runaround-loop, or heat-recovery-chiller configurations. |
| Recovery-Loop or Chilled-Water Flow | gpm | Recommended where recovered thermal capacity will be calculated from measured flow and ΔT. |
| Recovery Pump / Fan / Auxiliary Power | kW | Optional; captures parasitic energy associated with pumps, fans, wheels, or other recovery components. |

# Code Reference

The references below identify the primary **current federal and California regulatory requirements** that may apply to the Base Case or Measure Case for this HPM. Applicability varies by system type, building use, and project scope. Industry standards are listed here only where they are incorporated or required by the applicable regulation; newer technical editions should be tracked separately for future Code Readiness and deemed-measure development.

## Applicable Codes and Standards

| CODE | APPLICABLE CODE REFERENCE | EFFECTIVE DATE | CODE REVIEW DATE |
|---|---|---|---|
| Federal – 10 CFR Part 430, Subpart B | 10 CFR §§430.23(z), 430.32(v), and Appendix X/X1 to Subpart B – Establish federal test procedures and energy conservation standards for covered dehumidifiers and are specifically referenced by 2025 Title 24 §120.6(h) for applicable CEH dehumidification equipment. | Current Federal Requirement | September 2026 |
| Federal – 10 CFR Part 431, Subpart F | 10 CFR §§431.92 and 431.97(h), and Appendix B to Subpart F – Applies to federally covered DX-DOAS equipment and establishes the applicable definition, minimum efficiency standards, and federal test procedure. DOE currently requires Appendix B for efficiency representations. | Current Federal Requirement | September 2026 |
| 2025 Title 24, Part 6 – Space-Conditioning Equipment | §110.2 and applicable Tables 110.2-H through 110.2-K – Establish mandatory efficiency and test-procedure requirements for applicable DX-DOAS, heat-pump, and heat-recovery-chiller equipment. Table 110.2-H uses ISMRE2/ISCOP2 for DX-DOAS; Tables 110.2-I through K address applicable heat-recovery chiller performance. | January 1, 2026 | September 2026 |
| 2025 Title 24, Part 6 – Controlled Environment Horticulture | §120.6(h) – Establishes mandatory HVAC/dehumidification requirements for applicable indoor-growing facilities and is a key Base Case reference for CEH applications. | January 1, 2026 | September 2026 |
| 2025 Title 24, Part 6 – Controls, Acceptance, Commissioning, and Heat Recovery | §120.5, §120.8, and §140.4(r) and (s), as applicable – Covers mechanical-system acceptance, nonresidential commissioning, DDC control logic based on the adopted ASHRAE Guideline 36 requirements, and applicable mechanical heat-recovery requirements. The current code specifically requires qualifying DDC programming libraries under §140.4(r). | January 1, 2026 | September 2026 |
| 2025 Title 24, Part 6 – Additions and Alterations | §141.0 and §141.1, as applicable – Establish requirements for additions and alterations to nonresidential buildings and covered processes, including when mandatory and prescriptive HVAC/covered-process provisions apply to altered or newly installed systems. | January 1, 2026 | September 2026 |

# Eligible Climate Zones, Building Types, and Project Scopes

## Eligible Climate Zones

This high-performance measure applies statewide in **California Climate Zones 1–16**. Projects must identify the applicable Title 24 climate zone and demonstrate a meaningful mechanical dehumidification and reheat application based on the building's environmental requirements, process loads, operating conditions, or other project-specific moisture-control needs.

## Eligible Building Types

This high-performance measure applies to eligible **commercial, public, agricultural, and industrial facilities** with significant or humidity-sensitive dehumidification loads.

Representative applications may include **Controlled Environment Horticulture (CEH), healthcare and laboratories, pharmaceutical and clean-room facilities, museums and archives, indoor pools and natatoriums, conditioned warehouses, manufacturing and industrial facilities, education, hospitality, and other spaces requiring active moisture control**.

Eligibility is based on the presence of a qualifying dehumidification and recovered-reheat opportunity, not solely on building type.

## Eligible Project Scopes

This high-performance measure applies to:

- **New construction** projects incorporating a qualifying high-performance dehumidification and recovered-reheat system.
- **Qualifying major alterations, including eligible additions**, that install, replace, or substantially modify the dehumidification/reheat system serving the qualifying project scope.

This high-performance measure does **not** apply to:

- **Low-rise residential** buildings, including single-family and multifamily buildings with **three (3) or fewer habitable stories above grade**.
- Projects without a meaningful mechanical dehumidification and reheat load.
- Minor maintenance, like-for-like replacement, or controls-only work that does not otherwise meet the applicable HPM Measure Eligibility and System Design Level Requirements.

# Measure Exclusions

The following systems, applications, and project scopes are **not eligible** for this HPM. Exclusion from this measure does not necessarily mean the technology is ineligible for other CEDA offerings.

1. **Systems without a qualifying dehumidification and reheat load.** Projects that do not require active mechanical moisture removal followed by reheat, regeneration heat, or an equivalent post-dehumidification heating function are not eligible.
2. **Code-minimum or standard-practice systems only.** Equipment or system configurations that only meet applicable Title 24 requirements, federal efficiency standards, or standard industry practice without satisfying the applicable HPM RHCR, controls, and system-design requirements do not qualify.
3. **Heat-recovery equipment without demonstrated HPM performance.** The presence of a heat pipe, runaround loop, hot-gas or condenser-reheat feature, heat-recovery chiller, or other recovery component does not by itself establish eligibility. The complete system must meet the applicable RHCR, controls, and verification requirements.
4. **Ventilation energy recovery not serving the qualifying dehumidification process.** ERVs, HRVs, energy wheels, runaround loops, or similar systems used only for outdoor-air/exhaust-air energy recovery are not eligible unless the recovered energy directly supports the qualifying dehumidification/reheat function and the complete system meets the HPM requirements.
5. **Separately generated reheat without sufficient recovered energy.** Systems that rely primarily on boilers, electric resistance, steam, hot water, or another separately generated heat source for routine dehumidification reheat and do not achieve the applicable RHCR are not eligible.
6. **Separate refrigeration heat-reclaim applications.** Heat recovered from supermarket refrigeration, refrigerated cases, walk-ins, freezers, process refrigeration, or another separate refrigeration process is outside the scope of this HPM and may instead be evaluated under the applicable **Refrigeration Heat Reclaim HPM**.
7. **Minor maintenance and like-for-like replacement.** Routine maintenance, component repair, controls-only adjustments, or like-for-like equipment replacement that does not establish a qualifying high-performance dehumidification and recovered-reheat scope is not eligible.
8. **Systems that cannot demonstrate the required design performance.** Projects that cannot establish the **HPM Design Dehumidification Condition**, qualifying moisture-removal capacity, or applicable RHCR are not eligible.
9. **Overlapping CEDA inducements.** The same recovered energy, incremental cost, or performance benefit may not be claimed under more than one CEDA HPM. Where measures interact, CEDA program administrators reserve the right to determine the eligible scope and allocation of costs and benefits to prevent double counting.

# Reviewer Checklist

## HPM Reviewer Checklist: LM646– High-Performance Dehumidification w/ Recovered Reheat – V1.1

**Checklist Description:** This checklist captures the minimum design and post-installation elements used to confirm HPM inducement eligibility and identify projects for optional Code Readiness monitoring.

**Project Name:** _____ **Review Date:** _____

**Assessment:**

☐ Approved

☐ Not approved

**Notes:**

**Reviewer:** _____ **Signature:** _____

## Reviewer Checklist – High-Performance Measure Requirements

*Use this checklist to confirm that the submitted project scope, design documents, and supporting documentation demonstrate compliance with the claimed HPM tier or pathway. Review only the items applicable to the claimed project scope.*

### Project Eligibility (select all)

☐ Project is an eligible **new construction or qualifying major alteration/addition** within the applicable CEDA program scope.

☐ Project is located in **CA CZ 1–16** and includes a mechanical dehumidification and reheat application.

☐ Project includes an eligible commercial, public, agricultural, or industrial application requiring active moisture control.

### Qualifying System Scope (select all)

☐ Qualifying system removes moisture to maintain documented project-specific environmental conditions and uses recovered or transferred thermal energy to reduce separately generated reheat.

☐ **HPM Design Dehumidification Condition** is documented using normal project design calculations, equipment selections, or manufacturer performance data.

☐ Design information identifies the applicable moisture-removal capacity and environmental conditions used to evaluate HPM performance.

### Recovered-Reheat Performance (select one)

☐ **NC Essential Level:** System demonstrates **RHCR ≥ 0.90** at the HPM Design Dehumidification Condition.

☐ **NC Premium Level:** System demonstrates **RHCR = 1.00** at the HPM Design Dehumidification Condition.

☐ **A&A Single Tier:** Modified system demonstrates **RHCR ≥ 0.90** at the HPM Design Dehumidification Condition.

### Controls and Verification (select all, except optional)

☐ Controls prioritize **recovered reheat before separately generated supplemental reheat**.

☐ Dehumidification, recovered reheat, supplemental reheat, and applicable temperature/moisture controls operate as a coordinated system.

**HPM Reviewer Checklist: LM646– High-Performance Dehumidification w/ Recovered Reheat – V1.1**

☐ Available startup, controls-checkout, commissioning, or functional-test records show that the applicable HPM control sequence was reviewed or tested.

☐ *(Optional)* Where a BAS/BMS/EMS is installed, applicable points used to confirm environmental conditions and recovered/supplemental reheat operation are available for trending where practical.

## Code and Scope Coordination (select all)

☐ Project demonstrates compliance with applicable **2025 Title 24, Part 6** and other applicable state/local requirements; HPM scope is above the applicable minimum code requirement.

☐ Heat recovered from a separate refrigeration process is not being claimed under this HPM unless appropriately separated from the **Refrigeration Heat Reclaim HPM** scope.

☐ The same recovered energy, incremental cost, or performance benefit is not being claimed under another CEDA HPM.

## Supporting Documentation (select all)

☐ Final project documentation is sufficient to identify the installed qualifying system and claimed tier/pathway.

☐ Engineering calculation, equipment-selection output, or equivalent documentation supports the qualifying moisture-removal capacity, recovered-reheat capacity, total reheat capacity, and calculated RHCR.

☐ Final control sequence or equivalent documentation supports recovered-reheat priority and supplemental-reheat sequencing.

☐ Applicable Title 24 compliance documentation and available project cost information have been provided.

☐ Qualifying design airflow (CFM) used for IMC and inducement normalization is documented.

***Note:*** *Post-occupancy trend logging or extended monitoring is* ***not required for HPM eligibility*** *unless the project is separately selected for Code Readiness or measurement and verification activities. CEDA verification may rely on standard project drawings, submittals, equipment-selection information, control sequences, startup records, controls-checkout documentation, commissioning records, and other normal construction documentation.*

# Version History Log

| Version | Effective Date | End Date | Change Description |
|---|---|---|---|
| 1.0 | October 12, 2026 | October 27, 2026 | Initial release establishing measure scope, eligibility, design requirements, supporting documentation, IMC, Code Readiness objectives, and reviewer checklist. |
| 1.1 | October 28, 2026 | Active | HPM has been updated with LM code 646 for the HVAC heat recovery application, and general formatting changes have been applied. |

***Note**: The version identified as 'Active' is the current published version and remains in effect until superseded by a subsequent published version. CEDA may update, replace, or retire High-Performance Measures without prior notice. End dates are assigned to prior versions once superseded.*