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| DEER Building Prototype System User Guide |
| Version 1.0 |

**Change Log**

| **Version** | **Date** | **Description** |
| --- | --- | --- |
| 1.0 | 2024-01-26 | Original Document |
| 2.0 | 2024-02-22 | Modified section 3.1.2 and 3.2.3 regarding case naming conventions |
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# Introduction

## Overview

This document presents the Database of Energy Efficiency Resources (DEER) Building Prototype System User Guide prepared by DNV on behalf of the California Public Utilities Commission (CPUC). This user guide provides a step-by-step guide to help modelers use the CPUC’s new DEER Prototype System and includes background information and documentation guidelines.

Efficiency savings are quantified via measure packages (formerly called workpapers), technical engineering documents that prescribe pre-determined values for energy savings, measure costs, and other ex-ante values. Measure packages are generally used for homogenous, high-volume interventions and have historically been developed by the California program administrators (PAs)[[1]](#footnote-2) with the CPUC’s input and approval. Some energy efficiency measures are modeled using a building energy simulation software tool. To facilitate consistency across measures, CPUC has developed a DEER Prototype System that includes tools to run a batch of energy simulations in the EnergyPlus™ modeling tool. The batch process is managed by Big Ladder Software’s Modelkit framework, and simulation post-processing is performed using Python and PostgreSQL scripts. All the files are stored in a CPUC GitHub repository.

Refer to the Statewide Rulebook v5.0 for definitions that will be useful in simulated energy efficiency measure development such as building vintage and how it differs for residential and commercial buildings, or the definition of measure application types which determine which baseline type must be used.

## File locations and further resources

EnergyPlus Commercial and Residential DEER prototype models are available online. To access the repository, please use this link ([sound-data/DEER-Prototypes-EnergyPlus (github.com](https://github.com/sound-data/DEER-Prototypes-EnergyPlus)). This repository contains the EnergyPlus models parametrization framework developed using Modelkit. Therefore, the user will only see the parametrized [prototype models](https://github.com/sound-data/DEER-Prototypes-EnergyPlus/tree/main/prototypes) per building type and the [models’ templates](https://github.com/sound-data/DEER-Prototypes-EnergyPlus/tree/main/templates/energyplus). To create models, EnergyPlus input data files (IDF), and run measures (see [residential examples](https://github.com/sound-data/DEER-Prototypes-EnergyPlus/tree/main/residential%20measures)) the user will have to clone the repository to their local machine and follow the provided instructions in the README.md file. Consult the Modelkit documentation for definitions of files specific to the Modelkit framework such as root files, templates, code files, cohorts files, and cases files.

Educational resources are located here:

1. [Frequently Asked Questions and Answers on CEDARS](https://cedars.sound-data.com/deer-resources/tools/energy-plus/resource/19/history)
2. [EnergyPlus Documentation](https://energyplus.net/documentation)
3. [Modelkit Documentation](https://bigladdersoftware.com/projects/modelkit/)
4. [How to use DEER Prototypes in Modelkit/EnergyPlus training video](https://www.youtube.com/watch?v=39nZlooH7yc)
5. [How to create a pull request in GitHub](https://docs.github.com/en/pull-requests/collaborating-with-pull-requests/proposing-changes-to-your-work-with-pull-requests/creating-a-pull-request)

## Audience

This user guide is intended to provide current and future implementers of California energy efficiency programs with a better understanding of modeling procedures to be followed when proposing and designing new measures. We also anticipate that other stakeholders of energy efficiency programs will benefit from the increased transparency and centralized guidance.

## Versioning

The user guide is intended to be a living document that will be updated for clarity and accuracy over time. Any new prototype-related guidance developed by the CPUC or the Program Administrators (PAs) will be incorporated into future versions. The current version and start date are indicated on the Change Log page.

# DEER prototype models quick guide

This section provides an overview of DEER prototype models usage. Section 2.1 offers an introduction to EnergyPlus, the energy simulation engine modelers will use for DEER prototype building simulation models going forward; Section 2.2 lists required tools and installation steps; Section 2.3 explains how to use this new modeling framework; and Section 2.4 provides ways for modelers to contribute to the project such as installing new measures and fixing bugs. To conclude this section, we’ve provided a list of new features that will be added or improved upon in the future.

This section also echoes the information provided in the README file in the GitHub repository (<https://github.com/sound-data/DEER-Prototypes-EnergyPlus>)

## Introduction

The GitHub repository houses the modeling system developed for transitioning DEER prototype building simulation models from DOE2-eQUEST to EnergyPlus. EnergyPlus is a modern energy simulation engine with strong support from the Department of Energy and NREL. Previously, MASControl3 was used for batch simulations, but the new system employs Modelkit, a free and open-source cross-platform framework for parametric modeling developed by Big Ladder Software (<https://bigladdersoftware.com>). Big Ladder Software specializes in providing support for EnergyPlus.

This repository includes Modelkit files for generating EnergyPlus input files and various types of scripts. In each measure folder, there is a script (called rakefile.rb) for running batch simulations. Python scripts are provided for transforming Modelkit energy consumption results into the DEER database format. Additionally, Python and PostgreSQL scripts calculate permutation-level energy savings from simulation outputs. While the current process reuses most of the scripts developed by the previous DEER Ex Ante team to manipulate MASControl3 outputs, the future optimization of those scripts and the Modelkit-based modeling framework are planned.

## Required Tools and Installation

To install and use the prototype energy models on Windows-based computers (instructions for Mac will be provided in the future), follow these steps:

1. Install EnergyPlus [version 9.5](https://github.com/NREL/EnergyPlus/releases/tag/v9.5.0) (for residential prototypes) and [version 22.2](https://github.com/NREL/EnergyPlus/releases/tag/v22.2.0) (for commercial prototypes).
2. Install [Modelkit](https://share.bigladdersoftware.com/files/modelkit-caboodle-0.9.3+59d2aa1.exe).
3. Install [Python](https://www.python.org/downloads/).
4. Install database management software that supports PostgreSQL, such as pgAdmin4 or DBeaver.
5. Install [Git](https://github.com/git-guides/install-git).
6. (Optional) Install a GUI for Git if preferred over the command line.
7. Clone the repository to your machine using Git or your preferred tool. The clone should be located as “close” to the (C:) drive as possible to avoid path-length issues.

## How to Use This Modeling Framework

To run measure cases:

1. Open a command line in one of the folders (e.g., "\_SWSV001-05 Duct Seal\_DMo") within the "\_residential measures/\_" directory
2. Execute the command ‘modelkit rake’. This command runs all predefined simulations in the specified directory.

To run all measures in all folders within "\_residential measures/\_" or "\_commercial measures/\_", use the provided "automated\_run.py" Python script located in "\_scripts/\_". The predefined measures are grouped by general measure group name, building type, and vintage. Each of these folders contains a set of measure cases (offerings and baselines) defined in the "\_cases/\_" folder, per building type in "\_prototypes/". Modelkit runs all measures and stores simulation outputs (IDFs, hourly output variables, etc.) in multiple folders named after the measure case names in "\_runs/\_" (this folder appears after simulations are complete). A results summary file, mainly containing annual energy consumptions, is stored in "\_summary-results.csv\_". More detailed information about how Modelkit works and its features can be found on the [developer's website](https://bigladdersoftware.com/projects/modelkit/).

Post-processing steps for residential measures include:

1. Open one of the three building-type-specific Python scripts.
2. Specify the specific subdirectories in the analysis folder (containing simulation results) in the script and specify the "measure name" to be processed (a list of measure names can be found in "DEER\_EnergyPlus\_Modelkit\_Measure\_list.xlsx" under the "Measure\_list" sheet, in the "Measure (general name)" column.
3. Run the script to generate three CSV files: 'current\_msr\_mat.csv', 'sim\_annual.csv', and 'sim\_hourly\_wb.csv' (or 'sfm\_annual.csv' and 'sfm\_hourly\_csv' for single-family).
4. Load these three CSV files into the PostgreSQL database management software.
5. Run the post-processing SQL queries R1 to R4 (for residential measures only), then P1 to P8 (for all measures), in order.
6. Export 'meas\_impacts\_2022\_res' as the output.

Post-processing steps for commercial measures include:

1. Open the Python script Com.py (at the time of writing, it is Com\_draft.py) in the “data transformation” directory.
2. In line 26, or the line defining “measure\_name = ..”, specify the corresponding measure folder. In the example code, it is specified as “SWXX111-00 Example\_SEER\_AC”. This should be the same name as the folder name under the directory “commercial measures”. A corresponding measure record with matching cohort/case file names should be present in the workbook “DEER\_EnergyPlus\_Modelkit\_Measure\_list\_working.xlsx” under the same directory.
3. Run the script to generate three CSV files: 'current\_msr\_mat.csv', 'sim\_annual.csv', and 'sim\_hourly\_wb.csv'
4. Load these three CSV files into the PostgreSQL database management software.
5. Run the post-processing SQL queries P1 to P8.
6. Export ‘meas\_impacts\_2023\_com” as the output.

## How to Contribute to the Project

Contributions to the project are welcome. To add new measures or fix bugs, follow the following steps.

### How to Add a New Measure

1. Install the modeling framework as described above.
2. If the proposed measure doesn't fit into any general measure categories (see folder names in "\_residential measures/\_" or "\_commercial measures/\_"), create a new folder with the MeasureVersionID followed by a short version of the measure package name in one of the two directories. Refer to later sections in this document for further folder naming (section 3.2.1), cohort naming (section 3.2.2), and case naming (section 3.2.3) instructions.
3. Within the newly created folder, create a subfolder named "\_cases/\_".
4. Copy the file named "\_query.txt\_" from any existing measure and paste it into the new folder.
5. Create two new files in the newly created folder: "\_climates.csv\_" and "\_cohort.csv\_". Populate "\_cohort.csv\_" with necessary information about weather files and prototype buildings to be used. Additional details on preparing the cohort file are also in the User Guide.
6. If needed, modify the prototype, root.pxt file in "\_prototypes/\_" to define the new measure (e.g., a new HVAC system or equipment).
7. In the "\_cases/\_" folder, create a \*.csv file and provide parameter values corresponding to each measure (offerings and baselines). Each \*.csv file is related to a given building prototype referred to as the root file, whose path should be provided in "\_cohort.csv\_". Case names should coincide with Technology IDs, see the User Guide for more information.
8. Run all the newly added measures and provide the generated "\_results-summary.csv\_" files with your [pull request](https://docs.github.com/en/pull-requests/collaborating-with-pull-requests/proposing-changes-to-your-work-with-pull-requests/about-pull-requests) for review.
9. If the proposed measure fits within an existing measure category, simply add it to the appropriate folder and files.
10. Follow steps 7 and 8.

### How to Fix Bugs

1. Install the modeling framework as described above.
2. Fix the identified bug on your local repository.
3. Run all the existing measures and provide the generated "\_results-summary.csv\_" files with your [pull request](https://docs.github.com/en/pull-requests/collaborating-with-pull-requests/proposing-changes-to-your-work-with-pull-requests/about-pull-requests) for review.

### Features to Be Added in the Future

In the future, the following features will be added or improved:

1. Optimization of residential prototype model files to reduce the number of root files.
2. Streamlining the data transformation process from Modelkit system outputs to the DEER database.
3. Development of a script to produce measure permutation energy savings information in eTRM format.
4. Reduction of the number of residential measure folders by parameterizing code fields in "\_climates.csv\_" that vary by building type, in a separate table.
5. Addition of the Airflow Network model to the Modelkit residential prototypes.

# DEER building prototype system

The CPUC maintains a set of residential and commercial building prototypes that define the building geometry, window area and placement, thermal properties, HVAC type(s), schedules, etc. High-level building descriptions and characteristics are listed in Appendix C.

Measures are defined and modelled by adding to these prototype models. In Section 3.1, we discuss how to add a measure to the prototypes including the CPUC review process for additions or improvements to the models. In Section 3.2, we discuss the structure of the GitHub folders and naming conventions which are important since many stakeholders will be creating new measure files and folders. Section 3.3 discusses the DEER prototype documentation and lists definitions of DEER terms that are particularly relevant to a measure developer.

## Measure development procedures

The following sections contain detailed information for modeling energy efficiency measures in the DEER prototype system. All modeled measures using the DEER prototype system should follow the guidelines in this section.

### Adding a measure to DEER

When adding a measure to a DEER prototype, for consistency and efficiency, it is preferable to incorporate system variants into the same root file. While developers can create or update templates for unusual systems, maintaining the same root file is advantageous, given an unchanged building type. However, it's worth noting that residential prototypes currently lack optimal parameterization compared to commercial ones. Our goal is to upgrade them in the future.

As measure package developers make changes to the models to incorporate energy efficiency measures, the DEER team will review and approve those changes and merge them into the main prototype branch for all users. This should expedite the measure package approval process and allow consistency between measures developed by different stakeholders.

This process will use the pull request feature in GitHub. As depicted in Figure 3‑1, a pull request is initiated when a user requests that changes made within their branch be merged with the main branch. Any stakeholder may submit pull requests. To guard against duplicated effort, consider sending an email to [DEERSupport@dnv.com](mailto:DEERSupport@dnv.com) outlining the anticipated change and the approach that will be taken. We may suggest a different approach or may connect several stakeholders working on the same issue.

Figure ‑. Depiction of pull request in GitHub

A screenshot of a computer

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It is important to stay up to date on all GitHub repository updates during measure development. Look for outstanding pull requests and accept branch updates in your copy as they become available. As you make changes in your branch to add a measure, submit one or more pull requests through GitHub to incorporate all changes to Modelkit and post-processing files. Include the MeasureVersionID in the pull request. Also, attach to the pull request Microsoft Excel® or Word® documentation files supporting measure-specific input parameter values. These files would eventually be included as references in the eTRM measure package.

Pull requests will be reviewed and approved as soon as possible (two weeks maximum), and they will be incorporated into the repository to be used by all measure developers. This will ensure consistency for any attributes shared between measures. Wait for approval and make sure your branch is merged before running the final versions of the measure.

### Modeled measure documentation

To ensure transparency and consistency between measures all Modelkit changes used in DEER measures must be contained in the GitHub repository. If necessary, the DEER team may re-run measures to fix errors or to maintain consistency. A DEER table will be maintained that includes all the rows from the post-processing file, “DEER\_EnergyPlus\_Modelkit\_Measure\_list.xlsx”, that manages the savings calculations from pre- and post-case measure simulations. Measure developers should create a new file in the same format as “DEER\_EnergyPlus\_Modelkit\_Measure\_list.xlsx” with rows specific to the measure (name the measure specific file using naming convention: [measure folder]\_Measure\_list.csv, i.e. “SWBE006-02 Ceiling Insulation\_Measure\_list.csv”). Save this file at the highest level in the measure directory and email it to [DEERSupport@dnv.com](mailto:DEERSupport@dnv.com) for inclusion of the added rows in the master file: DEER\_EnergyPlus\_Modelkit\_Measure\_list table. We will keep this DEER table synched with the post-processing file of the same name on GitHub.

#### Model inputs documentation

It is important to document the model inputs used for each of the measures. In some cases, this will be relatively simple, such as improved efficiency of HVAC systems where the efficiency aligns with the offering description. However, even in these relatively simple cases, there must be clear documentation of the sources and methodology used to determine the input values that are changed from those used in the baseline prototype. This documentation should be included in the eTRM measure documentation. Please also attach this file to a pull request when relevant. The names of these files should include the MeasureVersionID and a short version of the measure name. This file will be updated each time the measure package receives a new version number.

#### eTRM documentation

All deemed measures must be documented in the eTRM. The California eTRM is the *Official Source of California Energy Efficiency Measure Data*.[[2]](#footnote-3) The eTRM was adopted as a Data Source of Record in Resolution E-5082 and is the source of energy efficiency measure information approved for energy efficiency planning and reporting for PY2021 and beyond.

To document modeled measures in the eTRM, fill out *Section 3: Modeled Measures* of the Measure Characterization Template. Fill in the UEC Modeling Tool Summary and include the DEER GitHub path to the measure folder, see the example in Table 3‑1 that follows. Zip the measure folder containing all Modelkit files and include it as a reference in the measure package. Also include “DEER\_EnergyPlus\_Modelkit\_Measure\_list\_*MeasureVersionID*.xlsx” with all rows relevant to the modeled measure. This zip file should include all Modelkit and post-postprocessing files to replicate the simulation.

Table ‑. Example of Unit Energy Consumption (UEC) Modeling Tool Summary table in Statewide Measure Characterization Template, Section 3 for *Modeled Measures*

| **Platform** | **EnergyPlus Example** |
| --- | --- |
| Model Type | DEER |
| Energy Modeling Engine | EnergyPlus version 9.5 |
| Energy Modeling Interface | modelkit-catalyst-0.5.0 |
| Batch Processor | DEER Modelkit |
| Weather files | CEC CZ2022 |
| GitHub path to measure folder | DEER-Prototypes-EnergyPlus/residential measures  /SWHC031-03 Furnace/ |
| Prototype Source | D26v1 |

### HVAC performance curves

All the modeled heat pump systems except VRF are included in this [template](https://na01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fgithub.com%2Fsound-data%2FDEER-Prototypes-EnergyPlus%2Fblob%2Fmain%2Ftemplates%2Fenergyplus%2Ftemplates%2Fsystem%2Funitary.pxt&data=05%7C02%7CJennifer.McWilliams%40dnv.com%7C27b6bca2642a4e3aba6108dc19228996%7Cadf10e2bb6e941d6be2fc12bb566019c%7C0%7C0%7C638412883377081303%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C3000%7C%7C%7C&sdata=vSBY1t3FEBHGsiwFRFJYSw8UHZCpY1QFzm3C%2BP%2BuKLI%3D&reserved=0) which includes performance curves and their sources. The available curves don't specifically model VCHP for residential applications. To incorporate VCHP systems, the user will need to add specific objects ([cooling](https://na01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fbigladdersoftware.com%2Fepx%2Fdocs%2F22-1%2Finput-output-reference%2Fgroup-heating-and-cooling-coils.html%23coilcoolingdxvariablespeed&data=05%7C02%7CJennifer.McWilliams%40dnv.com%7C27b6bca2642a4e3aba6108dc19228996%7Cadf10e2bb6e941d6be2fc12bb566019c%7C0%7C0%7C638412883377090710%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C3000%7C%7C%7C&sdata=iiotc0yR4xks8x4q9bFPIwUmQj7Aat%2Bp%2FXsw2IcyZII%3D&reserved=0), [heating](https://na01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fbigladdersoftware.com%2Fepx%2Fdocs%2F22-1%2Finput-output-reference%2Fgroup-heating-and-cooling-coils.html%23coilheatingdxvariablespeed&data=05%7C02%7CJennifer.McWilliams%40dnv.com%7C27b6bca2642a4e3aba6108dc19228996%7Cadf10e2bb6e941d6be2fc12bb566019c%7C0%7C0%7C638412883377098110%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C3000%7C%7C%7C&sdata=CgeeF2vZfezOVnEmhqPOlCoVQvMfvXlFA6lp%2FqsfbNY%3D&reserved=0)) to the template along with the corresponding curves. Here is an example of a [coil](https://na01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fgithub.com%2Fsound-data%2FDEER-Prototypes-EnergyPlus%2Fblob%2F13c041af2b2ba14efaa86dc351ac35fddc8b4798%2Ftemplates%2Fenergyplus%2Ftemplates%2Fsystem%2Funitary.pxt%23L311&data=05%7C02%7CJennifer.McWilliams%40dnv.com%7C27b6bca2642a4e3aba6108dc19228996%7Cadf10e2bb6e941d6be2fc12bb566019c%7C0%7C0%7C638412883377105009%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C3000%7C%7C%7C&sdata=9tzDoUfmHT3BTSIXfuD%2FxKTdk%2FvedoaaTvm%2BlTiRM1I%3D&reserved=0) and one of its [curve](https://na01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fgithub.com%2Fsound-data%2FDEER-Prototypes-EnergyPlus%2Fblob%2F13c041af2b2ba14efaa86dc351ac35fddc8b4798%2Ftemplates%2Fenergyplus%2Ftemplates%2Fsystem%2Funitary.pxt%23L1982C3-L1982C38&data=05%7C02%7CJennifer.McWilliams%40dnv.com%7C27b6bca2642a4e3aba6108dc19228996%7Cadf10e2bb6e941d6be2fc12bb566019c%7C0%7C0%7C638412883377111919%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C3000%7C%7C%7C&sdata=%2BZ8hUYsYaaBSGeMF47%2F4%2F5kr8bKkltn%2FRVz0jE8y%2F%2FI%3D&reserved=0)s. Create a new parameter (or more) or utilize an existing one (e.g., *dx\_comp\_speed*) to activate the VCHP choice as needed. Please note a valuable [resource](https://na01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fgithub.com%2Fbigladder%2Fresdx%2Fblob%2Fmain%2Fexamples%2Fneep-examples.py&data=05%7C02%7CJennifer.McWilliams%40dnv.com%7C27b6bca2642a4e3aba6108dc19228996%7Cadf10e2bb6e941d6be2fc12bb566019c%7C0%7C0%7C638412883377118367%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C3000%7C%7C%7C&sdata=ZsTXNUdf8sIBXjH38cUQ7qRbKz0Ua6%2BAEjjgl1BZWqg%3D&reserved=0) developed by Big Ladder that converts VCHP NEEP data to EnergyPlus performance curves or tables.

Once a user has added and parameterized the objects, they can define the system using parameters like *cool\_coil\_type*, *heat\_coil\_type*, *dx\_type*, *dx\_comp\_speed*, or any other relevant parameter in the cases folder. This defined system will then be added to a prototype model of their choice. New parameters introduced in a template should be passed to the root file where the template is referenced using the command ‘*insert’*.

## DEER prototype GitHub structure

The GitHub folder structure used to house the DEER prototypes is set up to enable batch simulations in Modelkit. The results of a particular simulation are in a case folder nested within a cohort folder, within a climate zone folder, within a measure\_bldgtype\_vintage folder, within a measure folder. The post-processing scripts subtract the results of two simulation cases (a pre- and a post-) to obtain energy savings that are ultimately stored in the eTRM as a permutation. A cohort may contain multiple pre-cases such as a standard baseline and an existing baseline, and it may contain multiple post-cases such as measure offerings with different SEER ratings. The post-processing file, “DEER\_EnergyPlus\_Modelkit\_Measure\_list.xlsx”, discussed in section 3.1.2 defines the pre-and the post-case for each permutation savings calculation.

### Defining measure folders

Measure folders contain all the Modelkit files necessary to run simulations for that measure. Each measure folder is located within either the “commercial measures” or “residential measures” folder. Name the highest-level measure folder using the eTRM MeasureVersionID followed by a short text version of the measure package title. (Example high-level measure folder name: SWBE006-02 Ceiling Insulation)

Nested within this high-level measure folder, separate folders are needed for each building type and each vintage because they each use a different “codes” file where CA Title-24 parameters are defined. (The codes file is specified within the “climates.csv” file.) These lower-level measure folders should be named using the MeasureVersionID, and the short text measure title should be followed by an underscore, the building type, another underscore, and the vintage. For commercial measures, most building types (all except hotel) use a common “codes” file and are collapsed into a single folder where the “\_bldgtype\_” designation is omitted from the folder name. If multiple building vintages are specified with one “codes” file, then the measure folder can be similarly collapsed (as in some residential measure folders) with the vintage omitted from the folder name. (Example detail level measure folder name: SWBE006-02 Ceiling Insulation\_SFm\_1975)

### Defining simulation cohorts

All simulations in a cohort must use the same root file. The cohort name is defined in the cohorts.csv file where the root file is specified along with certain parameters that are used for all simulations in that cohort. Each cohort has a corresponding *cohortname.csv* file in the cases folder. Each file in the cases folder defines the cases to be simulated within each cohort. These are sometimes referred to as cases files since they are contained in the cases folder; however, each file is named with a cohort name, and it defines the cases within that cohort.

For consistency and clarity, cohorts should be named with a concatenation of the following elements: building type, number of floors, building HVAC, vintage, tech group, and tech type. The elements are shown in Table 3‑2 with two residential examples and one commercial example. The concatenation will use an ampersand between each element except the technology group and technology type which will be joined by two underscores one after another with no space in between. For example, a residential cohort filename would look like this:DMo-Any-rDXGF-Ex-SpaceHtg\_eq\_\_GasFurnace.csv.

Table ‑. Cohort nomenclature using residential and commercial examples

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Building type** | **# of floors** | **Building HVAC** | **Vintage** | **Tech group** | **Tech type** |
| Residential Example | DMo | Any | rDXGF | Ex | SpaceHtg\_eq | GasFurnace |
| Residential Example | SFm | 2 | rDXGF | 1985 | BldgShell | AttBatIns |
| Commercial Example | OfL | Any | cDXGF | 1975 | SpaceHtg\_eq | GasFurnace |

The existing list of technology groups and technology types is held in a DEER support table and is available on the eTRM website under CPUC Support Tables, see Figure 3‑2. TechnologyIDs, which will be used to create simulation case names described in the next section, are available in the same location in a table called Technology. Send an email to [DEERSupport@dnv.com](mailto:DEERSupport@dnv.com) if a new technology group, technology type, or Technology ID is needed.

Figure ‑. Location of technology group and technology type tables in eTRM



### Defining simulation cases

Cases listed in *cohortname.csv* files should be named using a Technology ID (TechID) that describes the technology modeled in the simulation. An example of a case name would look like this: Res-GasFurnace-AFUE92-ECM. A short dash “-“ should be used to separate portions of the TechID.

Refer to Statewide Rulebook v5.0 and “TechID Creation template.xlsx” stored on CEDARS for the recommended naming convention that should be used for TechIDs for all measures. In some cases, historic TechIDs in the Technology table will have more detail than the simulated measure, and that detail should be dropped in the case name. For instance, in the last two examples provided in Table 3‑3 below, the size detail in the TechID is not modeled (because the equipment capacity is auto-sized) and it should be dropped when creating a case name.

Table ‑. Case nomenclature examples

| **Technology ID** | **Example case name** |
| --- | --- |
| Res-GasFurnace-AFUE92-ECM | Res-GasFurnace-AFUE92-ECM |
| dxAC-PTAC-**7to15k-**8.2-RQ | dxAC-PTAC-8.2-RQ |
| dxAC-Com-Pkg-**110to135kBTUh-**EER10.1-1Spd | dxAC-Com-Pkg-EER10.1-1Spd |

The same technology could correspond to one or more of two DEER baseline types: “Pre” indicating a pre-existing condition baseline, “Std” indicating a code-prescribed standard technology baseline, or it could correspond to “Msr” indicating an energy efficiency measure described by a measure offering within an eTRM measure.

## DEER prototype documentation

The DEER prototypes were previously built for eQUEST/DOE-2© using batch file processing controlled by the MASControl3© batch control software package. These prototypes were fully documented in the [DEER 2005 Update documentation](https://cedars.sound-data.com/deer-resources/tools/energy-plus/file/3076/download). The transition to EnergyPlus prototypes began in early 2022 with residential models available in late 2022 and commercial models available in late 2023 for use for the DEER2026 update. These new EnergyPlus prototypes were based on the geometry of the previous models and maintain many other characteristics such as operating schedules, HVAC system types, etc.

### Commercial building prototypes

The commercial building prototypes were transitioned to EnergyPlus as part of the California Building Energy Modeling ([CalBEM](https://calbem.ibpsa.us/about/)) stakeholder group’s Benchmarking Database project. The CalBEM [commercial models documentation](https://calbem-benchmarking.com/docs/building-energy-models/non-residential/) is the best current source of documentation for the DEER commercial prototype models.

### Residential building prototypes

The characteristics of the residential building prototypes are documented in [this spreadsheet](https://cedars.sound-data.com/deer-resources/tools/energy-plus/file/2990/download) on CEDARS. It shows not only the characteristics but also the sources used to update the HVAC fan energy. Heating systems were assumed to be 15 years old (installed in 2007) since that is the HVAC Effective Useful Life (EUL) i.e., half the systems of that age will have failed. Therefore, in existing homes half the systems will be older and half will be younger than 15 years. The residential building prototypes were recalibrated when they were transitioned to the EnergyPlus platform. The [residential prototype calibration memo](https://cedars.sound-data.com/deer-resources/tools/energy-plus/file/2975/download) on CEDARS documents that process. The CalBEM residential models were not used as the basis of the residential DEER prototypes because they don’t use the EnergyPlus simulation engine; instead, they use the California Simulation Engine.

### Building types

Eligible DEER building types can be found in the eTRM and in Table 3‑7. New building types may be proposed to the CPUC staff for consideration.

Table ‑. DEER building types supported by building energy simulation modeling platforms

| Sector | BldgType | Description | MASControl3/ eQUEST-DOE2© | ModelKit/ EnergyPlus© |
| --- | --- | --- | --- | --- |
| Ag | GHs | Greenhouse | Pre-DEER2026 | DEER2026+ |
| Com | Com | Commercial | Weighted average | Weighted average |
| Asm | Assembly | Pre-DEER2026 | DEER2026+ |
| ECC | Education - Community College | Pre-DEER2026 | DEER2026+ |
| EPr | Education - Primary School | Pre-DEER2026 | DEER2026+ |
| ERC | Education - Relocatable Classroom | Pre-DEER2026 | DEER2026+ |
| ESe | Education - Secondary School | Pre-DEER2026 | DEER2026+ |
| EUD | University Dormitory | Pre-DEER2026 | DEER2026+ |
| EUn | Education - University | Pre-DEER2026 | DEER2026+ |
| Fin\*\* | Financial Institution | N/A | DEER2028+ |
| Gro | Grocery | Pre-DEER2026 | DEER2026+ |
| HGR | Hotel Guest Room | Pre-DEER2026 | DEER2026+ |
| Hsp | Health/Medical - Hospital | Pre-DEER2026 | DEER2026+ |
| Htl | Lodging - Hotel | Pre-DEER2026 | DEER2026+ |
| Lib\*\* | Library | N/A | DEER2028+ |
| Mtl | Lodging - Motel | Pre-DEER2026 | DEER2026+ |
| Nrs | Health/Medical - Nursing Home | Pre-DEER2026 | DEER2026+ |
| OfL | Office - Large | Pre-DEER2026 | DEER2026+ |
| OfS | Office - Small | Pre-DEER2026 | DEER2026+ |
| Rel\*\* | Religious | N/A | DEER2028+ |
| RFF | Restaurant - Fast-Food | Pre-DEER2026 | DEER2026+ |
| RSD | Restaurant - Sit-Down | Pre-DEER2026 | DEER2026+ |
| Rt3 | Retail - Multistory Large | Pre-DEER2026 | DEER2026+ |
| RtL | Retail - Single-Story Large | Pre-DEER2026 | DEER2026+ |
| RtS | Retail - Small | Pre-DEER2026 | DEER2026+ |
| SCn | Storage - Conditioned | Pre-DEER2026 | DEER2026+ |
| SUn | Storage - Unconditioned | Pre-DEER2026 | DEER2026+ |
| WRf | Warehouse - Refrigerated | Pre-DEER2026 | DEER2026+ |
| Ind | MBT | Manufacturing Biotech | Pre-DEER2026 | DEER2026+ |
| MLI | Manufacturing Light Industrial | Pre-DEER2026 | DEER2026+ |
| Res | Res | Residential | Weighted average | Weighted average |
| SFm | Residential Single Family | Pre-DEER2024\* | DEER2024+\* |
| MFm | Residential Multi-family | Pre-DEER2024 | DEER2024+ |
| DMo | Residential Mobile Home | Pre-DEER2024 | DEER2024+ |

\* Except for the whole-house fan measure (SWHC030-03) which was updated for PY2023 using ModelKit/EnergyPlus tools.

\*\* New CalBEM proposed building type.

More information regarding the characteristics of each building type is provided in Appendix C .

# Appendices

###### Appendix A – Glossary

| Term | Definition | |
| --- | --- | --- |
| California Public Utilities Commission (CPUC) | Regulates investor-owned electric and natural gas utilities operating in California. Regulates privately owned electric, natural gas,  telecommunications, water, railroad, rail transit, and passenger transportation companies, in addition to authorizing video franchises.[[3]](#footnote-4) |
| Code | In California energy efficiency context, generally refers to Title 20 (appliance energy efficiency) and Title 24 (building energy efficiency) of the California Code of Regulations but can be any codes and regulations enacted by federal and local governments and regulatory agencies that mandate a particular technology to be utilized.[[4]](#footnote-5) |
| Database of Energy Efficiency Resources (DEER) | Database stored on Amazon S3 instance that contains information on energy efficiency technologies and measures, including estimates of energy savings potential for these technologies in residential and non-residential applications. |
| Deemed Measure | A prescriptive energy efficiency measure. Energy efficiency measures with predefined savings calculations, cost, eligibility, and other measure attributes.[[5]](#footnote-6) |
| Energy Efficiency (EE) | Activities or programs that influence customers to reduce energy use by making investments in more efficient equipment or controls, which reduce energy use while maintaining a comparable level of service.[[6]](#footnote-7) |
| Energy Efficiency Measure or Measure | Energy using equipment, control system, or practice whose installation and/or implementation results in a reduction of energy purchased from the distribution utility (while maintaining a comparable or higher level of a specific service or to accomplish a specific amount of work).  For purposes of these Rules, solar-powered, non-generating technologies are eligible energy efficiency measures.  To be included in a program, the CPUC must approve the measure assumptions to be used to report savings. Also referred to simply as “measure.”[[7]](#footnote-8) |
| Energy Efficiency Savings | Energy efficiency measures may result in both energy savings (measured in kilowatt-hours or therms) and demand (measured in kilowatts). The term “energy savings” may be used to refer to both energy and demand reductions. |
| Indirect Energy Savings or Interactive Effects | The secondary energy and demand impacts that result from a measure to a secondary system or equipment not directly involved in the retrofit activity (e.g., cooling or heating energy impacts resulting from the installation of efficient lighting fixtures). Associated with Resource Programs as opposed to Non-Resource Programs.[[8]](#footnote-9) |
| Measure package | Documentation prepared by the program administrators or program implementers that documents the data, methodologies, and rationale used to develop ex ante estimates. Measure packages are available at caetrm.com. |
| Sector | Customer groups sharing common characteristics and barriers that are building blocks to PG&E’s portfolio, including Residential, Commercial, Public, Industrial, Agricultural, and Cross-Cutting. |
| Standard Practice Baseline | A measure or practice used as the baseline for a specific measure that represents what the customer would implement in the absence of program influence or intervention.  A standard practice can be established from an ISP study, from similar and recent typical activity, or from an analysis of the current viable options applicable to the customer and the customer’s typical decision-making process.  Where a standard practice is identified that exceeds the minimum efficiency established by a code or regulation, the standard practice is the appropriate baseline. |
| Title 24 | Title 24 of the California Code of Regulations is known as the California Building Standards Code. Part 6 is the California Energy Code. |
| To Code | Refers to the installation of measures (or the resulting savings) with an efficiency level that complies with (but does not exceed) the current California Title 24 Building Efficiency Standards, Title 20 Appliance Efficiency Regulations, or industry standard practice.[[9]](#footnote-10) |

###### Appendix B – Abbreviations

The following abbreviations are used throughout the document:

| Abbreviation | Term | |
| --- | --- | --- |
| AOE | Add-On Equipment |
| AR | Accelerated Replacement |
| ARC | Accelerated Replacement Cost |
| ASHRAE | American Society of Heating, Refrigerating and Air-Conditioning Engineers |
| BRO | Behavioral, Retro-commissioning, and Operational |
| BRO-Bhv | BRO-Behavioral |
| BRO-RCx | BRO-Retro-commissioning |
| BRO-Op | BRO-Operational |
| BTU | British Thermal Unit |
| BW | Building Weatherization |
| CAL TF | California Technical Forum |
| CCA | Community Choice Aggregators |
| CEC | California Energy Commission |
| CEDARS | California Energy Data and Reporting System |
| COM | Commercial Building Type |
| CPUC | California Public Utilities Commission |
| DI | Direct Install |
| DEER | Database for Energy Efficient Resources |
| EAR | Ex Ante Review |
| EE | Energy Efficiency |
| EI | Energy Insight |
| ESP | Electric Service Provider |
| ET | Emerging Technologies |
| eTRM | Electronic Technical Reference Manual |
| EUL | Effective Useful Life |
| EM&V | Evaluation, Measurement and Verification |
| FMC | Full Measure Cost |
| GSIA | Gross Savings and Installation Adjustment |
| HTR | Hard-to-Reach |
| HVAC | Heating, Ventilation, and Air Conditioning |
| IMC | Incremental Measure Cost |
| IOU | Investor-Owned Utility |
| IPMVP | International Performance Measurement and Verification Protocol |
| ISP | Industry Standard Practice |
| LED | Light Emitting Diode |
| MAT | Measure Application Type |
| M&V | Measurement and Verification |
| MWD | Metropolitan Water District |
| NC | New Construction |
| NMEC | Normalized Metered Energy Consumption |
| NR | Normal Replacement |
| NTG or NTGR | Net-to-Gross Ratio |
| OTR | “Other” Building Type |
| O&M | Operations and Maintenance |
| PA | Program Administrator |
| PAC | Program Administrator Cost Test |
| PC | Project Cost |
| POE | Preponderance of Evidence |
| POS | Point-of-Sale |
| PPP | Public Purpose Program |
| QA/QC | Quality Assurance/Quality Control |
| QPL | Qualified Product List |
| RCT | Randomized Control Trial |
| RCx | Retro-commissioning |
| RUL | Remaining Useful Life |
| TRC | Total Resource Cost |
| TSB | Total System Benefit |
| UEC | Unit Energy Consumption |
| UES | Unit Energy Savings |
| WEA | Weatherization |
| WEN | Water-Energy Nexus |

###### Appendix C – Building type characteristics

| **code [1]** | **Utility Applicable Sectors [2]** | **CEDARS/eTRM Bldg Description  [3]** | **Building Type Definition  [5]** | **Representative Area (sqft.) [6]** | **HVAC Type(s)**  **[7]** |
| --- | --- | --- | --- | --- | --- |
| Asm | Com/Ind | Assembly | Buildings in which people gather for civic, social, religious, or recreational activities, whether in private or non-private meeting halls. Assembly or gathering areas within other building types are not included in this building type.  Sub-categories on assembly buildings may include: social or meeting (e.g., community center, lodge, meeting hall, convention center, senior center), library, funeral home, student activities center, exhibition hall, entertainment or culture (e.g., museum, theater, cinema, casino), and recreation (gymnasium, health club)   **Requirement: A minimum of 60% of the building (conditioned space) is designated for a large open space such as an "auditorium" or "sanctuary"** | 100,000 | Rooftop Gas Pack OR Rooftop HP  (CalBEM: PVAV with Boilers) |
| Com | Com | Commercial | Commercial weighted across all applicable commercial building types  ***Note: E-5221 directs the PAs that "claims shall be based on actual building type rather than using Com or Res for all downstream programs and—where possible—for midstream and upstream programs."*** | N/A | N/A |
| DMo | Res | Residential Mobile Home | Residential structure that is transportable in one or more sections when erected onsite is 400 or more square feet and is built on a permanent chassis and designed to be used as a single-family dwelling with or without a foundation system when connected to the required utilities, and includes the plumbing, heating, air conditioning, and electrical systems contained therein. | 1,240 | PTAC Or PTHP |
| ECC | Com | Education - Community College | Buildings used for academic or technical classroom instruction operating within a community college campus. Buildings on education campuses for which the main use is not classroom are included in the category relating to their use. For example, administration buildings are Office buildings, dormitories are Lodging, and libraries are Public assembly buildings.  Industry in the Educational Services subsector that provides instruction and training in a wide variety of subjects. The instruction and training are provided by specialized establishments, such as schools, colleges, universities, and training centers.  **Requirement: A minimum of 50% of the building (including conditioned space) is designated for "Classroom/Lecture."** | 300,000 | VAV or FC System + Central Plant (Chiller/Boiler)  (CalBEM: VAV plus kitchen MAU, computer room AC, with boilers/chillers) |
| EPr | Com | Education - Primary School | Buildings used for academic or technical classroom instruction operating within a primary school campus.   Buildings on education campuses for which the main use is not classroom are included in the category relating to their use. For example, administration buildings are part of the Office.  Industry in the Educational Services subsector that provides instruction and training in a wide variety of subjects. The instruction and training are provided by specialized establishments, such as schools, colleges, universities, and training centers.  **Requirement: A minimum of 50% of the building (including conditioned space) is designated for "Classroom/Lecture."** | 50,000 | Rooftop Gas Pack OR Rooftop HP  (CalBEM: SZVAV) |
| ERC | Com | Education - Relocatable Classroom | Relocatable buildings used for academic or technical classroom instruction.  Buildings used for academic or technical classroom instruction, such as elementary, middle, or high schools, and classroom buildings on college or university campuses.   Industry in the Educational Services subsector that provides instruction and training in a wide variety of subjects. The instruction and training are provided by specialized establishments, such as schools, colleges, universities, and training centers.  **Requirement: A minimum of 80% of the building (including only conditioned space) is designated for "Classroom/Lecture."** | 1,920 | Rooftop Gas Pack OR Rooftop HP OR Vertical-mount HP OR AC unit (Office OR Single Classroom)  (CalBEM: SZVAV) |
| ESe | Com | Education - Secondary School | Buildings used for academic or technical classroom instruction operating within a secondary school.   Buildings used for academic or technical classroom instruction, such as secondary school. Buildings on education campuses for which the main use is not classroom are included in the category relating to their use. For example, administration buildings are part of the Office.  Industry in the Educational Services subsector that provides instruction and training in a wide variety of subjects. The instruction and training are provided by specialized establishments, such as schools, colleges, universities, and training centers.  **Requirement: A minimum of 50% of the building (including only conditioned space) is designated for "Classroom/Lecture."** | 150,000 | VAV or FC System + Central Plant (Chiller/Boiler) + Rooftop Gas Pack OR Rooftop HP  (CalBEM: PVAV or SZVAV, with boilers) |
| EUD | Com | University Dormitory | University building used to offer accommodations for short-term or long-term students. | 30,000 | VAV or FC System + Central Plant (Chiller/Boiler)  OR  PTAC/PTHP |
| EUn | Com | Education - University | Buildings used for academic or technical classroom instruction operating within a university campus  Buildings used for academic or technical classroom instruction such as college or university campuses. Buildings on education campuses for which the main use is not classroom are included in the category relating to their use. For example, administration buildings are part of the Office, dormitories are Lodging, and libraries are Public assembly.  Industry in the Educational Services subsector that provides instruction and training in a wide variety of subjects. The instruction and training are provided by specialized establishments, such as schools, colleges, universities, and training centers.  **Requirement: A minimum of 40% of the building (including only conditioned space) is designated for "Classroom/Lecture."** | 1,000,000 | VAV or FC System + Central Plant (Chiller/Boiler)  (CalBEM: VAV / SZAC with boilers/chillers) |
| GHs | Ag | Greenhouse | A structure with walls and roof (including electrical service) in which plants requiring regulated climatic conditions are grown and/or controlled atmosphere for growing horticultural products. Building type supports establishments primarily engaged in growing crops, plants, vines, or trees and their seeds.  It supports industries in the Crop Production subsector to grow crops mainly for food and fiber. The subsector includes establishments such as farms, orchards, groves, greenhouses, and nurseries, primarily engaged in growing crops, plants, vines, or trees and their seeds. | 1,500 | **Building's HVAC must include cooling and/or heating and dehumidification systems for environmental control. Indoor agriculture HVAC systems must be designed for loads and operation specific to the growing crop that is different than that for human space conditioning.** |
| Gro | Com | Grocery | Buildings used for the primary retail or wholesale of food.   Includes establishments generally known as supermarkets and grocery stores primarily engaged in retailing a general line of food, such as canned and frozen foods; fresh fruits and vegetables; and fresh and prepared meats, fish, and poultry.   **Requirements:  1. Building must include multi-compressor refrigeration system serving low-temp (freezer) and medium-temp (cooler) refrigerated cases and walk-in zones and storage used for retail or wholesale of food.  2. "Refrigeration" end-use must consume (at a minimum) 60% of the total building's energy.   3. A minimum of 60% of the building's area must be designated for "retail sales grocery"** | **50,000  (Bldg area not to exceed 70,000 sqft.)** | Rooftop Gas Pack OR Rooftop HP OR VAV or FC System + Central Plant (Chiller/Boiler)  **HVAC system(s) serving low-temp and medium-tem zones (are independent from those HVAC systems serving space confort and) must include dedicated air-cooled and/or water-cooled condensers sized to meet refrigeration's temperature requirements.**  (CalBEM: SZVAV) |
| **HGR** | Com | Hotel Guest Room | Guest room within a "Lodging-Hotel" building | 200 | VAV or FC System + Central Plant (Chiller/Boiler)  AND/OR  FPFC systems and/or PTHP/PTAC systems |
| Hsp | Com | Health/Medical - Hospital | Buildings used as diagnostic and treatment facilities for inpatient care including hospital and inpatient rehabilitation. Space within this BT in addition to "medical and clinical care" may include dining, kitchen and food preparation, laboratory medical, and office (general).  Includes establishments known and licensed as general medical and surgical hospitals primarily engaged in providing diagnostic and medical treatment (both surgical and nonsurgical) to inpatients with any of a wide variety of medical conditions. These establishments maintain inpatient beds and provide patients with food services that meet their nutritional requirements.   **Requirement:  A minimum of 30% of the building's gross area (including conditioned space) must be designated for "medical and clinical care."** | 235,500 | VAV or FC System + Central Plant (Chiller/Boiler)  (CalBEM: VAV with boilers/chillers) |
| Htl | Com | Lodging - Hotel | It includes establishments primarily engaged in providing short-term lodging in facilities. In addition to lodging, these establishments may provide a range of other services to their guests.  Building or buildings that have six or more guest rooms or a lobby serving six or more guest rooms, where the guest rooms are intended or designed to be used, or which are used, rented, or hired out to be occupied, or which are occupied for sleeping purposes by guests, and all conditioned spaces within the same building envelope.  **Hotels** may have multi-floor layout. It may include other facilities such as laundry, kitchen and food preparation, and/or restaurants and/or swimming pools.   **Requirement: "A minimum of 60% of the building gross area (including conditioned space) is designated for "guest room""** | 140,000 | Guestrooms are served by  FPFC systems and/or Packaged Terminal Heat Pump systems  (CalBEM: PVAV + SZAC with boilers) |
| MBT | Com/Ind | Manufacturing Biotech | Generally industrial facilities that may potentially have several different industrial activities whose single largest activity is manufacturing (biotech) goods. These industrial building types are defined as being less than 20% office space with loading docks.  Includes establishments primarily engaged in conducting biotechnology (except nanobiotechnology) research and experimental development.   **Requirements: 1. Building MUST support manufacturing activities including the mechanical, physical, or chemical transformation of materials, substances, or components into new products.**  **2. A minimum of 40% of the building's area must be designated for "high tech bio tech lab."** | 200,000 | Rooftop Gas Pack OR Rooftop HP  (CalBEM: VAV + Boilers/Chillers + Kitchen MAU + Computer Room AC) |
| MFm | Res | Residential Multi-family | Multifamily residential (also known as multi-dwelling unit or MDU) is a housing classification where multiple separate housing units for residential inhabitants are contained within one building or several buildings within one complex or residential building that houses more than one family at a time. Apartments, condos, townhouses, duplexes, and quadruplexes are examples of multifamily housing options.  A dwelling unit of occupancy group R, as defined in the CBC, that shares a common wall and/or floor/ceiling with at least one other dwelling Unit. | 33,740 | Rooftop Gas Pack OR Rooftop HP OR VAV or FC System + Central Plant (Chiller/Boiler) |
| MLI | Com/Ind | Manufacturing Light Industrial | Comm/Ind Work (General High Bay). Generally industrial facilities that may potentially have several different industrial activities whose single largest activity is manufacturing. Storage (Unconditioned) included in some cases.  **Requirements: 1. Building MUST support manufacturing activities including the mechanical, physical, or chemical transformation of materials, substances, or components into new products.**   **2. A minimum of 60% of the building's gross area must be designated for "comm/Ind work."** | 100,000 | Rooftop Gas Pack OR Rooftop HP  (CalBEM: PVAV + boilers) |
| Mtl | Com | Lodging - Motel | It includes establishments primarily engaged in providing short-term lodging in facilities. In addition to lodging, these establishments may provide a range of other services to their guests.  Building or buildings that have six or more guest rooms or a lobby serving six or more guest rooms, where the guest rooms are intended or designed to be used, or which are used, rented, or hired out to be occupied, or which are occupied for sleeping purposes by guests, and all conditioned spaces within the same building envelope.   **Motels** may have a one or two-floor layout. Motels offer short-term accommodations, hence fewer services when compared to Hotels.   **Requirement: A minimum of 60% of the building gross area (including conditioned space) is designated for "guest room"** | 30,000 | PTAC Or PTHP  (CalBEM: PVAV, SZAC, +boilerS) |
| Nrs | Com | Health/Medical - Nursing Home | Buildings used as licensed residential care institutions for elderly citizens. Medical offices are included here if they use any type of diagnostic medical equipment (if they do not, they are categorized as an office building).  **Requirement: A minimum of 40% of the building's gross area must be designated for "guest rooms" and/or "patient rooms."** | 60,654 | VAV or FC System + Central Plant (Chiller/Boiler)  (CalBEM: PVAV + Boilers + Kitchen MAU) |
| OfL | Com | Office - Large | Buildings used for general office space, professional office, or administrative offices. Medical offices are included here if they do not use any type of diagnostic medical equipment (if they do, they are categorized as an outpatient health care building). See representative HVAC system for size differentiation.  It includes establishments primarily engaged in providing a range of day-to-day office administrative services, such as financial planning; billing and recordkeeping; personnel; and physical distribution and logistics, for others on a contract or fee basis. **Requirements: 1. 60% of the building's conditioned space or more must be served by a central HVAC plant including chiller and boiler equipment.**  **2. A minimum of 60% of the building gross area must be designated for "executive/private and/or open plan offices."** | 175,000 | VAV or FC System + Central Plant (Chiller/Boiler)  (CalBEM: VAV + Boilers/Chillers) |
| OfS | Com | Office - Small | Buildings used for general office space, professional office, or administrative offices. Medical offices are included here if they do not use any type of diagnostic medical equipment (if they do, they are categorized as an outpatient health care building).  It includes establishments primarily engaged in providing a range of day-to-day office administrative services, such as financial planning; billing and recordkeeping; personnel; and physical distribution and logistics, for others on a contract or fee basis.   **Requirements: 1. 60% of the building's conditioned space or more must be served by rooftop HVAC (unitary) equipment, (e.g., direct expansion (DX) cooling and gas (furnace) heating).**  **2. A minimum of 60% of the building's gross area must be designated for "executive/private and/or open plan offices."** | 10,000 | Rooftop Gas Pack OR Rooftop HP  (CalBEM: SZVAV) |
| Res | Res | Residential | Weighted across all applicable residential building types.  ***Note: E-5221 directs the PAs that "claims shall be based on actual building type rather than using Com or Res for all downstream programs and—where possible—for midstream and upstream programs."*** | N/A |  |
| RFF | Com | Restaurant - Fast-Food | Buildings used for preparation and sale of food and beverages for consumption. A restaurant serving food primarily prepared in advance and sold to its customers at a counter, and/or a restaurant utilizing a drive through facility.  It includes establishments primarily engaged in providing food services to patrons. | 2,500 | Rooftop Gas Pack OR Rooftop HP  (CalBEM: SZCAV with Kitchen MAU) |
| RSD | Com | Restaurant - Sit-Down | Buildings used for preparation and sale of food and beverages for consumption.   It includes establishments primarily engaged in providing food services to patrons who order and are served while seated (i.e., waiter/waitress service) and pay after eating. These establishments may provide this type of food service to patrons in combination with selling alcoholic beverages, providing carryout services, or presenting live nontheatrical entertainment.  **Requirement: A minimum of 50% of the building's gross area must be designated for "dining."** | 5,600 | Rooftop Gas Pack OR Rooftop HP  (CalBEM: SZCAV, PVAV, Kitchen MAU) |
| Rt3 | Com | Retail - Multistory Large | Buildings used for the sale and display of goods other than food. Multistory large building (including two or more stories) used for the sale and display of goods other than food, including enclosed malls and strip shopping centers.  It includes establishments engaged in retailing merchandise, generally without transformation, and rendering services incidental to the sale of merchandise.   **Requirements: 1. A minimum of 60% of the building gross area must be designated for "retail sales" and/or "wholesale Showroom."** **2. Building must consist of 2 or more stories**. | 120,000 | VAV or FC System + Central Plant (Chiller/Boiler)  (CalBEM: PVAV, SZVAV, Boilers) |
| RtL | Com | Retail - Single-Story Large | Buildings used for the sale and display of goods other than food. Large single-story building used for the sale and display of goods other than food, including enclosed malls and strip shopping centers. See representative area for size differentiation.  Retail single story large will include other "activity areas" including auto repair workshop, and/or kitchen and food preparation, and/or general office space, among others.   It includes establishments engaged in retailing merchandise, generally without transformation, and rendering services incidental to the sale of merchandise.  **Requirements:  1. A minimum of 60% of the building gross area is designated for "retail sales" and/or "wholesale Showroom." 2. Building must consist of single story.** | 130,000 | Rooftop Gas Pack OR Rooftop HP  (CalBEM: SZVAV, SZCAV) |
| RtS | Com | Retail - Small | Buildings used for the sale and display of goods other than food. Small building used for the sale and display of goods other than food. See representative area for size differentiation.  It includes establishments engaged in retailing merchandise, generally without transformation, and rendering services incidental to the sale of merchandise.  **Requirements: 1. A minimum of 60% of the building gross area is designated for "retail sales" and/or "wholesale Showroom."** **2. Building must consist of single story.** | 8,000 | Rooftop Gas Pack OR Rooftop HP  (CalBEM: SZVAV, SZCAV) |
| SCn | Com/Ind | Storage - Conditioned | Facilities used to store goods, manufactured products, merchandise, raw materials, or personal belongings such as public self-storage.  Warehousing and Storage primarily engaged in operating (**CONDITIONED**) warehousing and storage facilities for general merchandise, goods, and other warehouse products. These establishments provide facilities to store goods. They do not sell the goods they handle.  **Requirement: A minimum of 90% of the building's gross area must be designated for "Storage-Conditioned."** | 250,000 | Rooftop Gas Pack OR Rooftop HP  (CalBEM: VAV) |
| SFm | Res | Residential Single Family | Single-family homes are designed to be used as a single-dwelling unit, with one owner, no shared walls, and its own land. A single dwelling unit of occupancy group R-3, as defined in the CBC, that stands separate from other dwelling units but may have an attached garage. | 2200 | Central (DX/GAS or HP) HVAC |
| SUn | Com/Ind | Storage - Unconditioned | Facilities used to store goods, manufactured products, merchandise, raw materials, or personal belongings such as public self-storage.  Warehousing and Storage primarily engaged in operating (**UNCONDITIONED**) warehousing and storage facilities for general merchandise, goods, and other warehouse products. These establishments provide facilities to store goods. They do not sell the goods they handle.  **Requirement: A minimum of 90% of the building's gross area must be designated for "Storage-Unconditioned."** | 250,000 | Unit Heater |
| WRf | Com/Ind | Warehouse - Refrigerated | Warehousing facilities for general merchandise, refrigerated goods, and other warehouse products. These establishments provide facilities to store goods. They do not sell the goods they handle. These establishments take responsibility for storing the goods and keeping them secure.   **Requirement A minimum of 50% of the building's gross area must be designated for "Storage-Conditioned" and include refrigerated (cooled storage).** | 100,000 | Rooftop Gas Pack Or Rooftop HP (Office) |

| **Source** | **Description** | **Link** |
| --- | --- | --- |
| **NAICS** | NAICS is unique among industry classifications in that it is constructed within a single conceptual framework. Economic units that have similar production processes are classified in the same industry, and the lines drawn between industries demarcate, to the extent practicable, differences in production processes. This supply-based, or production-oriented, economic concept was adopted for NAICS because an industry classification system is a framework for collecting and publishing information on both inputs and outputs, for statistical uses that require that inputs and outputs be used together and be classified consistently | <https://www.census.gov/naics/reference_files_tools/2022_NAICS_Manual.pdf> |
| **USDA** | U.S. DEPARTMENT OF AGRICULTURE | <https://www.usda.gov/> |
| **NCSU** | College of Agriculture and Life Sciences | <https://cals.ncsu.edu/farms-food-and-you/> |
| **DEER** | Database of Energy Efficiency Resources (DEER) Updates | <https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/energy-efficiency/database-of-energy-efficiency-resources-updates> |
| **CBECS** | CONSUMPTION & EFFICIENCYCOMMERCIAL BUILDINGS ENERGY CONSUMPTION SURVEY (CBECS) | <https://www.eia.gov/consumption/commercial/> |
| **LawInsider** | General definitions on BTs related to contracting | <https://www.lawinsider.com/> |
| **ASHRAE** | ASHRAE - a diverse organization dedicated to advancing the arts and sciences of heating, ventilation, air conditioning and refrigeration to serve humanity and promote a sustainable world. | <https://www.ashrae.org/> |
| **Health and Safety Code** | California Legislative Information | <https://leginfo.legislature.ca.gov/faces/codesTOCSelected.xhtml?tocCode=HSC&tocTitle=+Health+and+Safety+Code+-+HSC> |
| **California CDE** | California Department of Education | <https://www.cde.ca.gov/> |
| **EnergyCodeAce** | An array of downloadable materials providing practical and concise guidance on how and when to comply with California's building and appliance energy efficiency standards. | <https://energycodeace.com/> |
| **Title 24 Energy Standards** | The Building Energy Efficiency Standards serve to reduce wasteful, uneconomical, and unnecessary uses of energy for the state. They include requirements in the Energy Code (Title 24, Part 6) and voluntary energy efficiency provisions in CALGreen (Title 24, Part 11). The Building Energy Efficiency Standards are updated every three years. | <https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards> |
| **California Code of Regulations (CCR), Title 22** | DEPARTMENT OF HEALTH CARE SERVICES | <https://www.dhcs.ca.gov/services/adp/Pages/CA_Code_Regulations.shtml.aspx> |

| **Acronyms** | **Description** |
| --- | --- |
| **Central Plant** | Central plant HVAC system with chiller to provide chilled water for cooling, and a boiler to provide hot water for space heating |
| **CRAC** | Computer room air conditioner |
| **CRAH** | Computer room air handler |
| **DFDD** | Dual-fan dual duct |
| **DX** | Direct Expansion, e.g., as the refrigerant evaporates and expands, it removes energy, lowering the temperature of the supply air stream. |
| **FC System** | Fan coil system which consisting of a heat exchanger (coil) and a fan. |
| **FPFC** | Four-pipe fan coil |
| **HV** | Heating and Ventilation Only |
| **PSZ-AC** | Packaged Single Zone |
| **PSZ-HP** | Packaged Single Zone Heat Pump |
| **PSZVAV** | Single Zone VAV |
| **PSZVAVH** | Single Zone VAV Heat Pump |
| **PTAC** | Packaged Terminal Air Conditioner |
| **PTAC** | Packaged Terminal Air Conditioner |
| **PTHP** | Packaged Terminal Heat Pump |
| **PVAV** | Packaged VAV with Reheat |
| **RADFLR** | Radiant floor heating and cooling |
| **Rooftop DX/Gas Packaged** | An HVAC packaged rooftop unit with a complete AC (DX cooling) + Gas (heating) in which all components are housed in the same heavy duty steel cabinet. |
| **Rooftop HP** | An HP packaged rooftop system in which all components are housed in the same heavy duty steel cabinet. |
| **SPVAC** | Single package vertical air conditioner |
| **SPVHP** | Single package vertical heat pump |
| **Unit Heater** | Single-source heating technology used to warm a given space |
| **VAV** | Variable Air Volume - VAV with Reheat |
| **WSHP** | Water-source heat pump |

1. The California Program Administrators include four investor-owned utilities: Pacific Gas & Electric (PGE), Southern California Edison (SCE), Southern California Gas Company (SCG), and San Diego Gas & Electric (SDGE); and eleven Regional Energy Networks (RENs) and Community Choice Aggregators (CCAs): Bay Area Regional Energy Network (BAY), East Bay Community Energy (EBCE), Inland Regional Network (IREN), Lancaster Choice Energy (LCE), Marin Clean Energy (MCE), Peninsula Clean Energy (PCE), Redwood Coast Energy Authority (RCEA), Sonoma Clean Power (SCP), Southern California Regional Energy Network (SCR), San Jose Clean Energy (SJCE), and Tri-county Regional Energy Network (TCR). [↑](#footnote-ref-2)
2. California Electronic Technical Reference Manual (eTRM). Accessed 1/25/24. <https://www.caetrm.com/> [↑](#footnote-ref-3)
3. http://www.cpuc.ca.gov/aboutus/. [↑](#footnote-ref-4)
4. California Code of Regulations, Title 24 (Building Standards Code) and Title 20, Division 2, Chapter 4, Article 4 (Appliance Energy Efficiency Regulations). [↑](#footnote-ref-5)
5. *Energy Efficiency Policy Manual, v 6.0*, p. 69. [↑](#footnote-ref-6)
6. *Energy Efficiency Policy Manual, v 6.0*, p. 73. [↑](#footnote-ref-7)
7. *Energy Efficiency Policy Manual, v 6.0*, p. 73. [↑](#footnote-ref-8)
8. Generalization of the *EE Policy Manual* definition of HVAC interactive effects. [↑](#footnote-ref-9)
9. California Public Utilities Commission, November 9, 2017, D.17-11-006: *Decision Regarding To-Code Pilots*, p. 3. [↑](#footnote-ref-10)