BayREN Energy Target Setting and Performance Verification Tool User Guide

What is the purpose of this tool?

This free tool has been developed to assist the building community in the San Francisco Bay Area[1] to set design energy performance targets in the context of California Title 24 Energy Standards and assess performance after construction, using the Zero Energy Performance Index (zEPI). zEPI is a simplified, unitless 0 to 100 scale that allows comparison across building types and energy code vintages. Lower scores represent more efficient building performance, and as the name implies, the zEPI scale encourages reaching a score of 0 (representing a zero-net energy building) or below (net energy producer).

zEPI differs from energy use intensity (EUI); zEPI provides a baseline and a relative scale that can be consistently interpreted across buildings of different uses, and can be adjusted for operational characteristics (e.g., occupancy, hours of operation) and process loads. This is achieved by comparing the proposed/actual building with a reference base building with the same construction, use, and loads.

The tool allows the user to iteratively tailor a zEPI target based on expected building operational characteristics. This tool is best suited to evaluate buildings that are predominantly comprised of the 16 building types that represent most of the nation's floor area – including municipally and privately-owned buildings. It is primarily meant for building designers, developers, and energy modelers to inform building design, construction, and operation:

Before Construction:

- Set an energy consumption target below 2016 Title 24 Energy Standards (and – ideally – consistent with or exceeding the Architecture 2030 Challenge). The target will factor in building type, occupant characteristics, and mix of uses.
- Calculate a rough budget for electricity generation potential via rooftop PV, to assess feasibility of zero net energy annual performance.

After the Project is Completed:

- Compare actual energy consumption to the established pre-construction energy consumption target, Title 24 Energy Standards[2], and the Architecture 2030 Challenge target.

The data requirements of this tool are aligned with the data requirements of EPA Energy Star Portfolio Manager. Where benchmarking is required by state law or local ordinance, this tool is complementary but does not replace benchmarking and reporting with Portfolio Manager. In situations where the use of this tool is mandatory, the local government may additionally require reporting via Portfolio Manager.

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[1] The calculator currently supports CEC Climate Zones 2, 3, 4, and 12 – so it's usable well outside of the SF Bay Area. If you're interested in using the tool in other parts of California, please contact BayREN: https://www.bayrencodes.org/contact/ If your project is outside California, check out the Zero Tool (https://zerotool.org/). The BayREN calculator is unique in providing context of California Title 24 and rough potential for site ZNE, but the Zero Tool can provide zEPI scores to buildings throughout the US and Canada.

[2] Note that the tool allows for comparison with a code-equivalent zEPI score but is not a substitute for code compliance.

How do I use this tool?

A. Identification.

Enter the applicant name, building name, and building street address.

Applicant Name		Street Address	
Building Name		City	

B. Section 1: Building Characteristics.

Select the main functional use for the building from the "Primary Building Area" dropdown menu. Each use category is described in more detail in the "Building Use Categories" appendix. Categories are generally consistent with EPA Energy Star Portfolio Manager definitions.

If the main functional use of the building is not listed, either:

○ Select the most similar category of use (e.g. "retail" for a big box store that includes some grocery function, or "primary school" for a school that includes both primary and pre-school), OR

○ If there is no similar option, select "Other" (e.g. laboratory, manufacturing, parking).

Primary Building Area

① Office

- Office
- Bank
- Medical Office
- Hotel / Motel
- Retail
- Standard Warehouse
- Refrigerated Warehouse
- Primary School
- Secondary School
- Multifamily Housing
- Adult Education Center
- Childcare Center
- Library
- Medical Clinic
- Police & Fire Stations
- Recreation Center
- Other

Enter the characteristics of the Primary Building Area as indicated (e.g. square footage, number of computers, etc). If the building is in design or planning, enter its anticipated characteristics. If the building is in operation, enter actual characteristics.

Primary Building Area

① Office

Building Gross Area (ft2)	10000
Computers (#)	50
Weekly Operating Hours	60
Workers on Main Shift (#)	75

C. **Section 2: Multi-Use Building.**
    If multiple uses exist in the facility, click "Add Building Area", and select additional uses and enter their characteristics as necessary. Up to three building area types may be selected for an individual facility.

If a building contains more than three uses:
  – If a fourth category of use is separately metered and comprises less than 10% of the gross building floor area, that building area type may be excluded from the calculator *provided that* energy consumed by that building area *is excluded* in the building energy use totals entered under Section 3 (e.g. a separately metered tenant).
  – If the fourth category of use is not separately metered and therefore *is included* in building energy use, then combine the floor area and characteristics for this area with the most similar area.

D. **Section 2: Weather Data.**
    Select the applicable climate zone from the dropdown menu. This automatically inserts typical historic Base 65 Heating Degree Day and Cooling Degree Day values for the climate zone selected. If the building is in operation or is not in one of the climate zones listed, enter the HDD_65 and CDD_65 for the operation year directly into the entry boxes.

Climate zones are as defined by the California Energy Commission for building energy code compliance. See http://www.energy.ca.gov/maps/renewable/building_climate_zones.html.

Historic HDD/CDD reference thirty-year (1981-2010) NOAA Climate Normals for the weather stations listed below. These are available at: https://www1.ncdc.noaa.gov/pub/data/normals/1981-2010/products/auxiliary/high-precision-degree-days/daily-high-precision-cdd-normal.txt

2	SANTA ROSA SONOMA CO AP
3	OAKLAND METRO INTERNATIONAL AP
4	SAN JOSE INTERNATIONAL AP
12	SACRAMENTO EXECUTIVE AP

E. Section 3: Design stage modeled energy.
Enter the design stage projected energy usage data for the facility determined by the energy model or other calculation techniques. Note that this energy consumption should be the estimated *actual* energy consumption, based on anticipated operating characteristics, not the energy consumption calculated for Title 24 Part 6 code compliance (which is based on standardized operating characteristics).

The available building roof area should also be entered in order for the user to quickly and very roughly assess rooftop solar PV generation potential. For users not currently planning to implement solar PV, visualizing the generation potential should still be done to assess feasibility and possibly inform future solar PV procurement decisions. The resulting PV potential will be shown in blue on the zEPI Scores graphic (see Section 5 below).

Since PV is generally optional in California and the baseline building stock does not include PV, it is recommended that design stage projected energy use reflect gross expected consumption, excluding any PV that may be planned for installation. By this method, the design zEPI target will reflect energy efficiency of the design.

If part of the building was excluded from the Building Data under Section 1, then the energy consumed by that section should also be excluded from these totals (e.g. for a small separately metered tenant).

3 12 Month Modeled Energy
(design stage)

Electricity Usage w/o PV (kWh)	300,000
Natural Gas Usage (therms)	75,000
Available Roof for PV (ft2)	0

F. Section 4: Operational metered data.
If the building is in operation, enter the actual energy consumption for a recent continuous 12-month period, and enter the billing end date for that period.

Where PV is installed, the user must decide whether to include or exclude onsite generation:

4 12 Month Metered Data
(input data once operational)

Electricity Usage (kWh)	250,000
Natural Gas Usage (therms)	50,000
Billing End Date	3/5/2018

- o **In favor of including onsite generation:** Including onsite generation in metered data is the best approach to reflect progress toward Zero Net Energy. PV is generally net metered, so it may be easier to enter net energy use. In addition, solar thermal is rarely excluded from similar calculations.

- o **In favor of excluding onsite generation:** Excluding onsite generation directly reflects operational energy efficiency. When onsite generation is excluded, operational metered data and the performance target are consistently calculated and more comparable.

If part of the building was excluded from the Building Data under Section 1, then the energy consumed by that section should also be excluded from these totals (e.g. for a small separately metered tenant).

G. Section 5: Calculate Targets and Performance.

Click "Calculate". The tool will calculate two zEPI Scores for your building: one based on the design stage modeled energy ("Design Target"). The other is based on actual metered data ("Metered Outcome"). For buildings in design or construction, where no metered data is available, the outcome will be "No Data Yet".

The tool will compare the Metered Outcome to two zEPI values for evaluation:

- **Energy Code Compliance.** This value represents the zEPI score of a prototype building with the same mix of uses and climate zone, in compliance with Title 24 Part 6 2016. Code compliance thresholds for single-use buildings are listed at the end of this document.
- **Architecture 2030 zEPI Target.** Architecture 2030's "2030 Challenge" calls for new and existing buildings to reduce energy consumption by 70 percent compared to the historical reference performance for that building use and climate. This is by definition a zEPI score of 30. The "2030 Challenge" also calls for an 80% reduction by 2020, 90% by 2025, and carbon neutrality by 2030. This target can be used to compare a building's design target and actual performance against energy efficiency practice best practices.

If any areas have been assigned the "Other" use category and comprise more than 10% of the total building floor area, the tool will calculate a zEPI score but will not compare it to the Energy Code because no prototype or reference value are applicable to the "Other" use category.
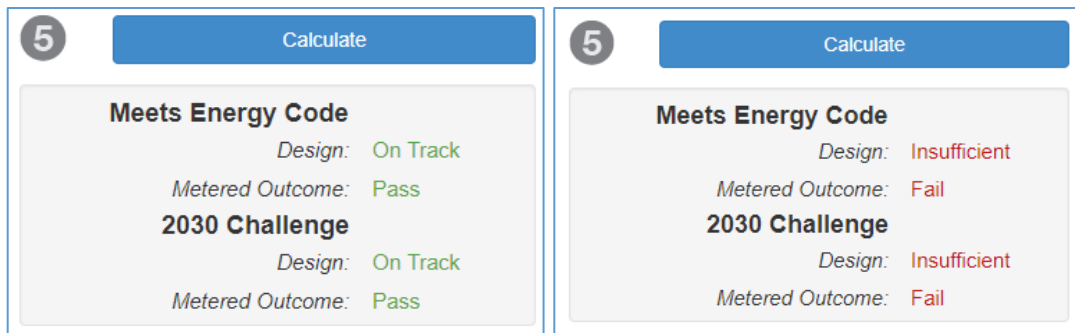
In addition, the visualization compares performance targets & outcomes to reference values:

- MEETS CODE: The zEPI score of a prototypical building with the same mix of uses located in the same climate built to meet Title 24 2016. May be referenced as a threshold for outcome-based code compliance.
- EFFICIENT: The zEPI score of a building which meets the Architecture 2030 Challenge
- DESIGN TARGET: The calculated zEPI score based on the building's expected performance entered in Section 3
- METERED OUTCOME: The calculated zEPI score based on measured energy use entered in Section 4
- DESIGN WITH PV POTENTIAL: A rough approximation of generation potential from rooftop PV given the available roof area entered in Section 3
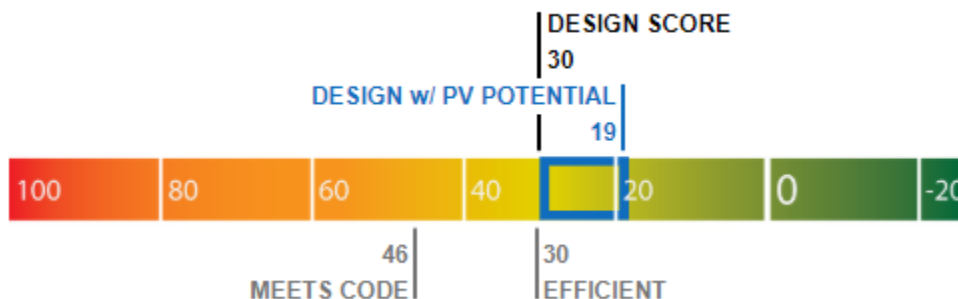
H. Importing Data and Exporting Results

The BayREN calculator does not store or record user data. To retain results from the calculator:

zEPI Analysis Data: For export to a document or spreadsheet, the "zEPI Analysis Data" table contains the same information displayed in the visualization. Simply highlight, copy, and paste the data table into any application that supports your device's clipboard, such as presentations, spreadsheets, or word processors.

zEPI Scores Visualization: A screenshot is the best option to export the visualization

Printing: The inputs, results table, and visualization from a calculation may be printed by clicking on "Print" from your web browser.

Electronic File with all Inputs and Outputs: The BayREN zEPI calculator solely supports input and output using a JavaScript Object Notion ("JSON") file structure. The purpose of this JSON file export option is solely to save data offline so it can be accessed by the BayREN calculator in a future session without re-entering the same information – which may be useful when managing zEPI calculations for multiple buildings. The export function may also be used to submit a record demonstrating compliance, as in San Francisco.

> **How To export:** Once all information is entered and the calculation is run, click "Export". A system browser window will open, prompting the user to choose a location to save the JavaScript Object Notion ("JSON") file. Consider naming the file after the name of the building.
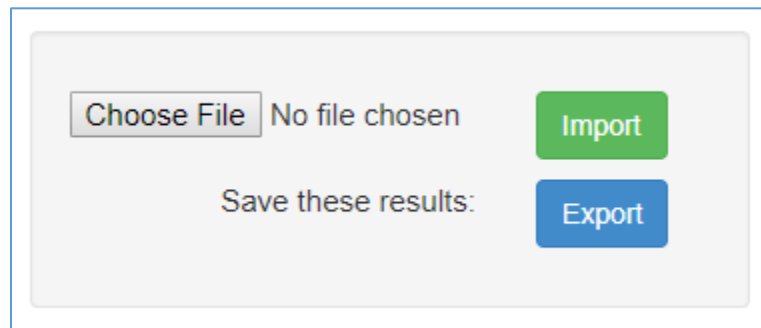
> **How to import:** The calculator can only import JSON files exported by the BayREN calculator in a previous session. To import a file back into the zEPI calculator, click "Import" and select the desired file.

Definitions

Primary Energy: Raw fuel (e.g. oil, natural gas, coal).

Secondary Energy: A product created from raw fuel, such as electricity or steam.

EUI: Energy Use Intensity. The ratio of annual whole-building energy consumption in thousands of British Thermal Units (kBtu), divided by the building gross floor area in square feet (SF).

Site EUI: EUI for which the whole-building energy consumption is defined in terms of energy consumed on-site. Site energy includes both primary and secondary energy consumed directly on site.

Source EUI: EUI for which the whole-building energy consumption is defined in terms of source energy. Source energy includes both site energy plus all delivery and production losses. To determine delivery and production losses, each fuel Is multiplied by a site-to source ratio. In this calculator, site-to-source ratios shall be used consistent with those used for Energy Star Portfolio Manager https://portfoliomanager.energystar.gov/pdf/reference/Source%20Energy.pdf

Outcome EUI: Source EUI for the proposed building. Calculated using actual building metered annual energy consumption. Shall include net contributions of on-site generation if installed.

Reference EUI: Source EUI generated from a regression for the building type. Regression generation represents normalization for a specific set of independent building attributes to a median equivalent value for the U.S. Commercial Building Energy Consumption Survey (CBECS) 2003.

zEPI: Zero Energy Performance Index. The ratio of energy performance of a rated or prototype building, to the reference energy consumption of a similar building at the turn of the millennium that is operated in a similar climate, for similar hours of and similar operating conditions.

Target zEPI Score: The zEPI score which an applicant building must meet in order to demonstrate compliance with this statute. As defined in this statute and by methodology provided by the authority having jurisdiction.

Building zEPI Score: The zEPI score for the applicant building. Calculated as defined in this statute and by methodology provided by the authority having jurisdiction.

HDD: Heating Degree Days. Base 65F. A measure of one day and one degree that the temperature conditions outside the building are less than the defined threshold comfort temperature inside the building.

CDD: Cooling Degree Days. Base 65F. A measure of one day and one degree that the temperature conditions outside the building are greater than the defined threshold comfort temperature inside the building.

Building Types

Buildings are defined generally consistently with the EPA's Energy Star Portfolio Manager and Title 24, Part 6.

Large Office: A building of which a minimum of 90 percent of floor area is characterized as Office (CBC Group B Occupancy), and of which the gross building floor area excluding parking is greater than or equal to 100,000 square feet.

Medium Office: A building of which a minimum of 90 percent of floor area is characterized as Office (CBC Group B Occupancy), and of which the gross building floor area excluding parking is greater than or equal to 25,000 square feet and less than 100,000 square feet.

Small Office: A building of which a minimum of 90 percent of floor area is characterized as Office (CBC Group B Occupancy), and of which the gross building floor area excluding parking is less than 25,000 square feet.

Medical Office: Non-"I" occupancy building used to provide diagnosis and treatment for medical, dental, or psychiatric outpatient care. May include spaces used to provide diagnosis and treatment for rehabilitation and physical therapy. Does not provide overnight patient care.

Medical Clinic: buildings used to treat patients, usually on an unscheduled, walk-in basis, who have an injury or illness that requires immediate care but is not serious enough to warrant a visit to an emergency department.

Large Hotel/Motel: A building of which a minimum of 90 percent of floor area is characterized as Hotel/Motel (with multiple rooms available to be rented overnight on a room/suite and nightly basis), and of which the gross building floor area excluding parking is greater than or equal to 100,000 square feet.

Small Hotel/Motel: A building of which a minimum of 90 percent of floor area is characterized as Hotel/Motel (with multiple rooms available to be rented overnight on a room/suite and nightly basis), and of which the gross building floor area excluding parking is less than 100,000 square feet.

Bank: Building used for financial services, and/or a commercial banking outlet that offers banking services to walk-in customers.

Retail: Building in which the primary activity is the retail sale of non-food consumer merchandise. Retail Store should be a single store that is at least 5,000 square feet and has an exterior entrance to the public (i.e. is not an enclosed mall nor store inside a mall).

Refrigerated Warehouse: Refrigerated building or space that is used to store perishable goods or merchandise using refrigeration at temperatures generally below 55 degrees Fahrenheit.

Standard Warehouse: Unrefrigerated building or space that is used to store goods, manufactured products, merchandise or raw materials.

Primary School: Buildings or campuses used as a school for primarily Kindergarten through Junior High students. At a minimum 90 percent of the building floor area is used for education, but in which less than 90 percent is classrooms.

Secondary School: Buildings or campuses used as a school for primarily High School students. At a minimum 90 percent of the building floor area is used for education, but in which less than 90 percent is classrooms. This does not include college or university classroom facilities/laboratories, or vocational, technical, trade, adult, or continuing education schools.

Adult Education Center: buildings used primarily for providing adult students with continuing education, workforce development, or professional development outside of the college or university setting.

Childcare Center: buildings used for educational programs or daytime supervision/recreation for young children before they attend Kindergarten.

Police and Fire Stations: Buildings used as either a dedicated police stations, dedicated fire station, or combined police and fire station. Police Station applies to buildings used for federal, state, or local police forces and their associated office space. Fire Station refers to buildings used to provide emergency response services associated with fires. Fire stations may be staffed by either volunteer or full-time paid firemen.

Recreation Center: Buildings in which the primary activity is recreation, including fitness center, health club, gymnasium, swimming pool, or other recreation.

Multifamily Housing: A building of which a minimum of 90 percent of floor area is characterized as Multifamily Housing (Occupancy Group R-2 or R-4), which has two or more residential living units, and which has four (4) or more habitable stories.

Library: buildings used to store and manage collections of literary and artistic materials such as books, periodicals, newspapers, films, etc. that can be available for reference or lending.

Mixed-Use: A building that contains a combination of two or more distinct space types, which each individually comprise ten percent or more of the building gross floor area.

Title 24 Part 6 2016 zEPI Code Compliance Thresholds

The following zEPI targets are referenced in the tool to calculate energy code equivalent thresholds in the San Francisco Bay Area. These zEPI targets represent equivalency with the California Building Energy Efficiency Standards, Title 24 Part 6, 2016 which came into effect on January 1, 2017.

Building Type	ZEPI Code Compliance Threshold			
	Climate Zone 2	Climate Zone 3	Climate Zone 4	Climate Zone 12
Large Office	52	49	53	55
Medium Office	49	46	49	52
Small Office	40	38	40	42
Primary School	65	61	65	68
Secondary School	54	51	55	57
Multifamily	50	49	51	52
Retail	37	33	37	39
Medical Office	37	35	37	39
Warehouse	57	53	55	57
Large Hotel/Motel	54	53	55	56
Small Hotel/Motel	69	67	69	71

Additional References

zEPI and Outcome-Based Energy Codes

Charles Eley, et. al. (2011). Rethinking Percent Savings - The Problem with Percent Savings and zEPI: The New Scale for a Net Zero Energy Future. ASHRAE Transactions, 117, 787-800. Retrieved from http://www.eley.com/sites/default/files/pdfs/ASHRAE-D-ML-11-029-20110922.pdf

Architectural Energy Corporation (2009) Rethinking Percent Savings: The Problem with Percent Savings and the New Scale for a Zero Net-Energy Future. Codes and Standards Development, Souther California Edison Design and Engineering Services, CS 08.17. Retrieved from http://newbuildings.org/sites/default/files/Rethinking_Percent_Savings.pdf

New Buildings Institute. zEPI. http://newbuildings.org/code_policy/zepi/

New Buildings Institute. Outcome-Based Energy Codes. http://newbuildings.org/code_policy/outcome-based-energy-codes/

HDD / CDD

NOAA 30-year Climate Normals: https://www1.ncdc.noaa.gov/pub/data/normals/1981-2010/products/auxiliary/high-precision-degree-days/daily-high-precision-cdd-normal.txt

EPA Energy Star Portfolio Manager

Property Types: https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager/identify-your-property-type

Source and Site Energy: https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager/understand-metrics/difference

Source and Site Metrics: https://portfoliomanager.energystar.gov/pdf/reference/Source%20Energy.pdf

Metrics: https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager/understand-metrics/energy-star

Building Codes

California Building Energy Efficiency Standards (Title 24 Part 6): http://www.energy.ca.gov/title24/

California Green Building Standards a.k.a. CALGreen (Title 24 Part 11): http://www.bsc.ca.gov/Home/CALGreen.aspx

San Francisco Green Building Code: http://sfenvironment.org/article/new-construction-and-major-renovations/green-building-ordinance-san-francisco-building-code