

ZERO CODE™ for CALIFORNIA

A California building energy standard for
new nonresidential, high-rise residential and
hotel/motel buildings.



ZERO CODE™

ZERO Code for California

Based on the California Title 24, Part 6, Building Energy Efficiency Standards, 2019

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The ZERO Code for California standard is presented solely as a guide, which may be modified and consequently adopted as such by appropriate legal jurisdictions. In utilizing the standard or Energy Calculator, practitioners must research and ensure compliance with ordinances and codes applicable in their jurisdictions.

INTRODUCTION

The ZERO Code for California (ZERO Code_{ca}) is a building energy standard developed by Architecture 2030 that applies to new commercial, institutional, high-rise residential, and hotel/motel buildings, the prevalent building types being constructed in cities today. The ZERO Code_{ca}, which can be adopted immediately, integrates cost-effective energy efficiency standards with on-site and/or off-site renewable energy resulting in Zero-Net-Carbon (ZNC) buildings. The ZERO Code_{ca} can either be incentivized or required by implementing jurisdictions. Adoption of the ZERO Code_{ca} is an important component of addressing climate change and reducing CO₂ emissions in these building types.

The ZERO Code_{ca} includes prescriptive and performance paths to compliance based on the California Building Energy Efficiency Standards (BEES) and is supported by the compliance tool and simulation software CBECC-Com. The ZERO Code_{ca} is also supported by a web-enabled Energy Calculator that eases the implementation process and reduces errors when using the prescriptive path.

The ZERO Code_{ca} offers code adaptable language and a flexible approach for incorporating renewable energy, both through on-site generation and/or off-site procurement. By establishing a flexible approach, the ZERO Code_{ca} is applicable to all new commercial, institutional, high-rise residential, and hotel/motel buildings, including those buildings with limited on-site renewable energy generating capacity (e.g. buildings in dense urban environments).

Technical support documents are available that explain the concepts of the ZERO Code_{ca} and describe potential options for off-site procurement of renewable energy. The feasibility/desirability of each option will vary with each authority having jurisdiction that adopts the ZERO Code_{ca}.

THE ZERO CODE FOR CALIFORNIA

1. PURPOSE

New nonresidential, high-rise residential and hotel/motel buildings shall be energy efficient and install on-site renewable energy systems and/or procure off-site renewable energy of adequate capacity to achieve zero net energy (ZNE).

2. SCOPE

This standard applies to new commercial, institutional, high-rise residential, and hotel/motel buildings that are addressed by the California Building Energy Efficiency Standards (BEES). See Section 100.0–Scope of the BEES.

3. DEFINITIONS AND TERMS

The definitions from the California BEES shall apply to this standard and are supplemented by the definitions below.

authority having jurisdiction (AHJ): the agency or agent responsible for enforcing this standard.

building source energy (BSE): the source energy consumption of the building calculated on an hourly basis, kBtu/y.

eligible hydro: hydroelectric plants less than 30 MW that qualify for the California renewable portfolio standards.

procurement factor (PF): a factor related to the method used to procure off-site renewable energy, unitless.

source energy credit (SEC): the annual source energy credit from renewable energy, either generated on-site or procured off-site, kBtu/y.

source energy factor (SEF): the source energy that results from the generation or procurement of renewable energy, kBtu/KWh.

source energy intensity (SEI): the source energy intensity for a particular building type and climate zone, kBtu/ft²-y.

time dependent source (TDS) energy: an 8,760 time-series of the hourly source energy factors for electricity and natural gas, which vary by climate zone, kBtu/kWh for electricity and kBtu/therm for gas.

4. ADMINISTRATION AND ENFORCEMENT

4.1 Compliance

New buildings shall comply with Section 5 (minimum energy efficiency) and Section 6 (renewable energy).

4.2 Compliance Software

The California Building Energy Code Compliance (CBECC-Com) software may be used to demonstrate compliance with the ZERO Code for California through the performance approach. The Architecture 2030 ZERO Code website has tools to assist compliance when the prescriptive approach is used.

5. MINIMUM ENERGY EFFICIENCY

Buildings shall comply with the 2019 California BEES using either the performance requirements Section 140.1 or the prescriptive requirements of Section 140.2

6. RENEWABLE ENERGY

6.1 Zero Net Energy

The *source energy credits* from on-site renewable energy systems or procured off-site renewable energy shall be greater than or equal to the *building source energy* on an annual basis. *Building source energy* and *source energy credits* from renewable energy systems shall be evaluated for each hour of the year and summed.

Equation 1

$$\begin{array}{ccc}
 \textit{Building Source Energy} & & \textit{Source Energy} \\
 & & \textit{Credit}_{\text{On-Site RE}} \\
 & & \textit{Source Energy} \\
 & & \textit{Credit}_{\text{Off-Site RE}} \\
 \text{(kBtu)} & \leq & \text{(kBtu)} \quad + \quad \text{(kBtu)} \\
 \text{(from Equations 2 or 3)} & & \text{(from Equation 6)}
 \end{array}$$

6.2 Building Source Energy

When the proposed building complies with the California BEES using the prescriptive requirements of Section 140.2, the *building source energy* shall be calculated by multiplying the conditioned floor area times the *source energy intensity* from Table 6.1.

Equation 2

$$\begin{array}{rcl}
 \text{Building Source Energy} & & \text{Conditioned Floor Area} \\
 \text{(kBtu/y)} & = & \text{(ft}^2\text{)} \\
 & & \times \\
 & & \text{Source Energy Intensity} \\
 & & \text{(kBtu/ft}^2\text{/y)} \\
 & & \text{(from Table 6.1)}
 \end{array}$$

When the proposed building complies with the California BEES using the performance requirements of Section 140.1, the building source energy shall be determined by multiplying the hourly building energy for each fuel times the time dependent source (TDS) energy rate for that hour and fuel.

Equation 3

$$\text{Building Source Energy} = \sum_{h=1}^{8760} BE_h \cdot TDS_{e,h} + \sum_{h=1}^{8760} BG_h \cdot TDS_{g,h}$$

where

BE_h = Building electricity use for the hth hour of the year

TDS_{e,h} = Time-dependent source energy rate for electricity use in the hth hour of the year

BG_h = Building gas use for the hth hour of the year

TDS_{g,h} = Time-dependent source energy rate for gas use for the hth hour of the year

Table 6.1 Source Energy Intensities (SEI) by Building Type and Climate (kBtu/ft²-y)

Climate Zone	Office	Retail	School	Restaurant	Hotel	Warehouse	Residential
1	38	35	39	186	31	26	29
2	41	37	36	177	29	20	30
3	38	33	33	177	26	19	27
4	40	35	34	175	27	18	29
5	39	32	33	179	26	18	27
6	39	33	31	174	25	14	28
7	38	32	30	168	24	13	27
8	40	35	32	174	26	14	28
9	41	37	33	171	27	15	29
10	42	38	34	175	28	15	30
11	44	42	39	183	32	22	33
12	42	39	38	175	30	21	31
13	44	41	39	182	32	20	32
14	45	42	39	184	32	21	32
15	46	44	38	192	32	14	34
16	46	45	45	187	36	31	35

6.3 Source Energy Credit from On-Site Renewable Energy

When the proposed building complies with the California BEES using the prescriptive requirements of Section 140.2, the source energy credit from on-site renewable energy shall be calculated by multiplying the estimated annual renewable energy production times the source energy factor from Table 6.2. The annual energy production from on-site renewable energy systems shall be determined using the PVWatts software or other software approved by the *authority having jurisdiction*.

Equation 4

$$\begin{array}{l}
 \text{Source Energy Credit}_{\text{OnSite RE}} \\
 \text{(kBtu)}
 \end{array}
 =
 \begin{array}{l}
 \text{Annual On-Site PV} \\
 \text{Production} \\
 \text{(kWh)}
 \end{array}
 \times
 \begin{array}{l}
 \text{Source Energy Factor} \\
 \text{(kBtu/kWh)} \\
 \text{(from Table 6.2)}
 \end{array}$$

When the building complies with the California BEES using the performance requirements of Section 140.1, the *source energy credit* from on-site renewable energy systems shall be determined by multiplying the renewable energy production for each hour times the time dependent source (TDS) energy rate for that hour.

Equation 5

$$Source\ Energy\ Credit_{OnSite\ RE} = \sum_{h=1}^{8760} OnSiteRE_h \cdot TDS_{e,h}$$

where

OnSiteRE_h = On-site renewable energy production for the hth hour of the year

TDS_{e,h} = Time-dependent source energy rate for electricity use in the hth hour of the year

Table 6.2 Source Energy Factor (SEF) for On-Site Photovoltaic Production (Btu/kWh)

Climate Zone	Source Energy Factor	Climate Zone	Source Energy Factor
1	2,501	9	2,551
2	2,526	10	2,525
3	2,527	11	2,530
4	2,537	12	2,486
5	2,512	13	2,472
6	2,491	14	2,526
7	2,509	15	2,542
8	2,537	16	2,588

6.4 Source Energy Credit from Off-Site Renewable Energy

The source energy credit for off-site renewable energy shall be determined with the following equation.

Equation 6

$$Source\ Energy\ Credit_{OffSite\ RE} = \sum_{p=1}^n PF_p \cdot \left[\sum_{r=1}^q OffSiteRE_{r,p} \cdot SEF_r \right]$$

where

OffSiteRE_{r,p} = Off-site renewable energy procurement for the rth generation source and for the pth procurement method (MWh)

PF_p = Renewable energy procurement factor for the pth method from Table 6.3 (unitless)

- SEF_r = Source energy factor for the rth generation source from Table 6.4 (kBtu/MWh)
- p = Index for the procurement method
- r = Index for the renewable energy generation source
- n = Number of procurement methods
- q = Number of renewable energy generation sources for the pth procurement method

Table 6.3 Renewable Energy Procurement Factors

Source: ZERO Code Off-Site Procurement of Renewable Energy, Technical Support Document, Architecture 2030, April 2018

Class	Procurement Factor (PF)	Procurement Method	Additional Requirements
1	0.75	Community Renewables	
		REIFs	Entity must be managed to prevent fraud or misuse of funds.
		Virtual PPA	
		Self-Owned Off-Site	Provisions shall prevent the generation asset from being sold separately from the building.
2	0.55	Green Retail Tariffs	The offering shall not include the purchase of unbundled RECs.
		Direct Access	The offering shall not include the purchase of unbundled RECs.
3	0.20	Unbundled RECs	The vintage of the RECs shall align with building energy use.

The following requirements apply to all off-site renewable energy procurement methods.

1. The building owner shall sign a legally binding contract to procure qualifying off-site renewable energy.
2. The procurement contract shall have duration of not less than 15 years and shall be structured to survive a partial or full transfer of ownership of the property.
3. RECs and other environmental attributes associated with the procured off-site renewable energy shall be assigned to the building project for the duration of the contract.
4. The renewable energy generating source shall be photovoltaic systems, solar thermal power plants, geothermal power plants, wind turbines, and *eligible hydro*.
5. The generation source shall be located where the energy can be delivered to the building site by the same utility or distribution entity; the same ISO or RTO; or within integrated ISO's (electric coordination council).
6. The off-site renewable energy producer shall maintain transparent accounting that clearly assigns production to the ZNC building. Records on power sent to or purchased by the building shall be retained by the building owner and made available for inspection by the Authority Having Jurisdiction (AHJ) upon request.

Table 6.4 Source Energy Factor (SEF) for Off-Site Renewable Energy Procurement

<i>Off-Site Renewable Energy Generation Source</i>	<i>Source Energy Factor (Btu/kWh)</i>
Wind	4,840
Solar	2,769
Geothermal	4,636
Eligible Hydro	4,636

7. REFERENCES

California Building Energy Efficiency Standards, 2019

National Renewable Energy Laboratory, PVWatts Version 5 Manual, Technical Report NREL/TP-6A20-62641, September 2014. See also <https://developer.nrel.gov/docs/solar/pvwatts-v5/>.