DOE Zero Energy Ready Home National Program Requirements (Version 1, Rev. 08)

November 1, 2022

To qualify as a DOE Zero Energy Ready Home, a home shall meet the minimum requirements specified below, be verified and field-tested by a verifier working under an EPA-recognized Home Certification Organization (HCO), and meet all applicable codes[1]. Builders may meet the requirements of either the Performance path or the Prescriptive path to qualify a home for certification.[2]

The following homes and building types are eligible to participate in the DOE Zero Energy Ready Home program using Version 1 program requirements:

- Detached dwelling units[3] (e.g., single-family homes); duplexes; townhomes[4]; multifamily and mixed-use buildings with dwelling or sleeping units no taller than 5 stories above grade[5], where the dwelling units, sleeping units, and common space exceed 50% of the building's square footage. Parking garage square footage is excluded from this calculation.[6]

Dwellings in eligible multifamily buildings as listed above may be served by central heating, cooling, or hot water[7] systems. Partners are also advised that DOE is developing a revised program design for multifamily dwellings of any height, consistent with the ENERGY STAR Multifamily New Construction program.

Partners must determine the required version and revision of DOE Zero Energy Ready Home program requirements based on a project's building type, location, and permit date[8], posted on the DOE ZERH Program Requirements webpage.

Homes may qualify for DOE Zero Energy Ready Home using either the Prescriptive path or Performance path in all locations except California, for which regional program requirements apply. Note that compliance with the ZERH program requirements is not intended to imply compliance with all local code requirements that may be applicable to the home to be built.

DOE Zero Energy Ready Home Prescriptive Path

The Prescriptive path provides a single set of measures that can be used to construct a labeled DOE Zero Energy Ready Home. Modeling is not required, but no tradeoffs are allowed. Follow these steps to use the Prescriptive path:

1. Assess eligibility by using the number of bedrooms in the home to be built to determine the conditioned floor area (CFA) of the Benchmark Home, Exhibit 3. If the CFA of the home to be built exceeds this value, the performance path shall be used.
2. If the Prescriptive path is eligible for use based on the prior step, build the home using the mandatory requirements for all labeled homes, Exhibit 1, and all requirements of the DOE Zero Energy Ready Home Target Home, Exhibit 2. The rigor of the specifications in Exhibit 2 shall be met ***or*** exceeded.
3. Verify that all requirements have been met using an approved verifier.[9]

All homes certified through the Prescriptive path shall be submitted to DOE by email at zerh@doe.gov.

DOE Zero Energy Ready Home Performance Path

While all mandatory requirements for labeled homes in Exhibit 1 shall be met, the Performance path provides flexibility to select a custom combination of measures that meet the performance level of the DOE Zero Energy Ready Home Energy Rating Index (ERI) Target Home (Exhibit 2). Modeling is required, but measures can be optimized for each particular home or builder. Follow the steps below to use the Performance path with software used by an EPA-recognized HCO.

1. The ERI of the DOE Zero Energy Ready Home Target Home is determined. The DOE Zero Energy Ready Home Target Home is identical to the home that will be built, except that it is configured with the energy efficiency features of the DOE Zero Energy Ready Home Target Home as defined in Exhibits 1 and 2. The ERI of the Target Home is automatically calculated in accordance with ANSI/RESNET/ICC Standard 301, using the software EPA has recognized for use by an EPA-recognized HCO.
2. A size modification factor is next calculated using the following equation:

Size Modification Factor = [CFA $_{Benchmark\ Home}$ / CFA $_{Home\ To\ Be\ Built}$] $^{0.25}$, but not to exceed 1.0

Where:

CFA $_{Benchmark\ Home}$ = Conditioned Floor Area of the Benchmark Home, using Exhibit 3
CFA $_{Home\ to\ be\ Built}$ = Conditioned Floor Area of the Home to be Built

Since the Size Modification Factor cannot exceed 1.0, it only modifies the ERI score for homes larger than the CFA of the Benchmark Home.

3. The DOE Zero Energy Ready Home Target Home ERI is calculated next

DOE Zero Energy Ready Home Target Home ERI =
ERI of DOE Zero Energy Ready Home Target Home x Size Modification Factor

4. Complete ERI software calculations for preferred set of energy measures and verify resulting ERI at or below DOE Zero Energy Ready Home Target Home ERI, modified, as required, for house size. [10]:
5. Construct the home using measures that result in an ERI at or below the DOE Zero Energy Ready Home Target Home ERI, calculated above, and the mandatory requirements for all labeled homes, Exhibit 1.
6. Verify that all requirements have been met using an approved verifier.[9]

All homes certified through the Performance path shall be submitted to DOE by submitting them through the EPA-recognized Home Certification Organization's reporting framework or by submitting the compliance verification report to zerh@doe.gov.

Exhibit 1: DOE Zero Energy Ready Home Mandatory Requirements for All Labeled Homes

Area of Improvement	Mandatory Requirements
1. ENERGY STAR for Homes Baseline	☐ Certified under ENERGY STAR Qualified Homes Program Version 3, 3.1, or 3.2 (depending on state), or under ENERGY STAR Multifamily New Construction program Version 1.0, 1.1, or 1.2 (depending on state) [11, 12, 13]
2. Envelope	☐ Fenestration shall meet or exceed ENERGY STAR requirements. See End Note for specific U, SHGC values, and exceptions. [14] ☐ Ceiling, wall, floor, and slab insulation shall meet or exceed 2015 IECC levels[15,16]
3. Duct System	☐ Duct distribution systems located within the home's thermal and air barrier boundary or an optimized location to achieve comparable performance.[17] ☐ HVAC air handler is located within the home's thermal and air barrier boundary.
4. Water Efficiency	☐ Hot water delivery systems (distributed and central) shall meet efficient design requirements[18] ***or*** ☐ Water heaters and fixtures shall meet efficiency criteria[19]
5. Lighting & Appliances	☐ All installed refrigerators, dishwashers, and clothes washers are ENERGY STAR qualified. [20] ☐ 80% of lighting fixtures are LEDs or LED lamps (bulbs) in minimum 80% of sockets ☐ All installed bathroom ventilation and ceiling fans are ENERGY STAR qualified
6. Indoor Air Quality	☐ Certified under EPA Indoor airPLUS Version 1 [13]
7. Renewable Ready	☐ Provisions of the DOE Zero Energy Ready Home PV-Ready Checklist are completed [21]

Exhibit 2: DOE Zero Energy Ready Home Target Home [22]

HVAC Equipment[23]			
	Hot Climates (2015 IECC Zones 1,2) [24]	**Mixed Climates** (2015 IECC Zones 3, 4 except Marine)	**Cold Climates** (2015 IECC Zones 4 Marine 5,6,7,8)

AFUE	80%	90%	94%
SEER	18	15	13
HSPF	8.2	9	10[25]
Geothermal Heat Pump	ENERGY STAR EER and COP Criteria		
ASHRAE 62.2 Whole-House Mechanical Ventilation System	2.8 cfm/W no heat exchange	2.8 cfm/W no heat exchange	1.2 cfm/W; heat exchange with 60% SRE

Insulation and Infiltration

- Insulation levels shall meet the 2015 IECC and achieve Grade 1 installation, per RESNET standards.
- Infiltration – Detached Dwellings[26] (ACH50): 3.0 in CZs 1-2 | 2.5 in CZs 3-4 | 2 in CZs 5-7 | 1.5 in CZ 8
- Infiltration – Attached Dwellings (ACH50): 3.0 (all Climate Zones) [27]

Windows[28, ,29, 30]

	Hot Climates (2015 IECC Zones 1,2)	**Mixed Climates** (2015 IECC Zones 3, 4 except Marine)	**Cold Climates** (2015 IECC Zones 4 Marine, 5,6,7,8)
SHGC	0.25	0.25	any
U-Value	0.4	0.3	0.27

Homes qualifying through the Prescriptive path with a total window-to-floor area greater than 15% shall have adjusted U-values or SHGCs.[31]

Water Heater

ENERGY STAR levels for the system Energy Factor, as follows:
- Gas/propane systems of ≤ 55 gallons, EF = 0.67
- Gas/propane systems of > 55 gallons, EF = 0.77
- Electric systems in detached dwellings, EF = 2.0
- Electric systems in attached dwellings, EF = 1.5

For heating oil water heaters use EF = 0.60

Thermostat[32]

- Programmable thermostat (except for zones with radiant heat)

Lighting & Appliances

- For purposes of calculating the DOE Zero Energy Ready Home Target Home ERI, homes shall be modeled with an ENERGY STAR dishwasher, ENERGY STAR refrigerator, ENERGY STAR ceiling fans, and ENERGY STAR lamps (bulbs) in 80% of sockets or 80% of lighting fixtures are ENERGY STAR Qualified.

Exhibit 3: Benchmark Home Size[33]

Bedrooms in Home to be Built	0	1	2	3	4	5	6	7
Conditioned Floor Area Benchmark Home	1,000	1,000	1,600	2,200	2,800	3,400	4,000	4,600

Endnotes:

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[1] Where requirements of the local codes, covenants, manufacturers' installation instructions, or engineering documents overlap with the requirements of these guidelines, DOE offers the following guidance:

a. In cases where the overlapping requirements exceed the DOE Zero Energy Ready Home guidelines, these overlapping requirements shall be met;
b. In cases where overlapping requirements conflict with a requirement of these DOE Zero Energy Ready Home guidelines, then the home is exempt from conflicting requirement within these guidelines. However, certification shall only be allowed if the Rater has determined that no equivalent option is available that could meet the intent of the conflicting requirement of these DOE Zero Energy Ready Home guidelines. Note that, under the Performance path, a home must still meet the Target Home ERI requirement. Therefore, other efficiency measures may be needed to compensate for the omission of the conflicting requirement.

[2] In the event that a Rater is not able to determine whether an item is consistent with the intent of a provision, (e.g., an alternative method of meeting a checklist requirement has been proposed), then the Rater shall consult their Provider. The term 'Provider' refers to an Approved Rating Provider, as defined by ANSI / RESNET / ICC 301, that is approved by an EPA-recognized HCO. If the Provider also cannot make this determination, then the Rater or Provider shall report the issue to DOE prior to project completion at: zerh@doe.gov and will typically receive an initial response within 10 business days. If DOE believes the current program guidelines are sufficiently clear to determine whether the intent has been met, then this guidance will be provided to the Partner and enforced beginning with the house in question. However, if DOE believes the program guidelines require revisions to make the intent clear, then this guidance will be provided to the Partner but only enforced for homes permitted after a specified transition period after the release of the revised guidelines., This process will allow DOE to make formal policy decisions as Partner questions arise and to disseminate these policy decisions through the periodic release of revised program documents to ensure consistent application of the program guidelines.

[3] A dwelling unit, as defined by the 2021 IECC, is a single unit that provides complete independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking, and sanitation.

[4] A townhome is defined as a single-family dwelling unit constructed in a group of three or more attached units in which each unit extends from the foundation to roof and with open space on at least two sides.

[5] Any above-grade story with 20% or more occupiable space, including commercial space, shall be counted towards the total number of stories for the purpose of determining eligibility to participate in the program. The definition of an 'above-grade story' is one for which more than half of the gross surface area of the exterior walls is above-grade. All below-grade stories, regardless of type, shall not be included when evaluating eligibility. Per ASHRAE 62.2-2010, occupiable space is any enclosed space inside the pressure boundary and intended for human activities or continual human occupancy, including, but not limited to, areas used for living, sleeping, dining, and cooking, toilets, closets, halls, storage and utility areas, and laundry areas.

[6] Buildings that do not contain dwelling or sleeping units are not eligible for certification under DOE ZERH. The term 'building' refers to a structure that encompasses dwelling/sleeping units and (if present) common spaces, sharing one or more of the following attributes: a common street address, a common entrance or exit, central/shared mechanical systems, or structurally interdependent wall or roof systems. A skyway or a breezeway that connects two structures is not considered a common entrance or exit. A 'sleeping unit', as defined by ANSI / RESNET / ICC 301, is a room or space in which people sleep, which can also include permanent provisions for living, eating, and either sanitation or kitchen facilities but not both. A 'dwelling', as defined by ANSI / RESNET / ICC 301, is any building that contains one or two dwelling units used, intended, or designed to be built, used, rented, leased, let or hired out to be occupied, or that are occupied for living purposes. For the purposes of eligibility, hotels, motels, and senior care facilities are not considered multifamily buildings.

Eligible multifamily building types for DOE ZERH are the same as those for the ENERGY STAR Multifamily New Construction program, with the exception that DOE ZERH currently limits participation to such buildings no taller than 5 stories above grade. More information on the eligibility for dormitories, residence halls, and other building types is found here: https://www.energystar.gov/partner_resources/residential_new/program_reqs/mfnc_building_eligibility

[7] Central systems for domestic hot water are allowed in multifamily buildings. Such central systems must include on-demand recirculation which operates based on both a demand indicator and the loop temperature. Central systems in multifamily buildings do not have a stored volume limit at this time (see Advisory under Endnote 15).

[8] The Rater may define the 'permit date' as either the date that the permit was issued or the date of the contract on the home. In cases where permit or contract dates are not available, Providers have discretion to estimate permit dates based on other construction schedule factors. These assumptions should be both defensible and documented.

[9] The term "verifier" refers to the person completing the third-party inspections required for qualification. This party must be a rater that is working under the oversight of an EPA-recognized Home Certification Organization (HCO). EPA-recognized HCOs are listed here:
https://www.energystar.gov/partner_resources/residential_new/working/other_participants/hco .

[10] On-site power generation may not be used to qualify a home for the DOE Zero Energy Ready Home Target Home ERI requirements, but can be used to achieve additional ERI score reductions needed for homes larger than the Benchmark Home.

[11] The version of ENERGY STAR Homes or ESMFNC to be used shall be determined based on ENERGY STAR program requirements and implementation timelines. See the ENERGY STAR Homes program site for information: https://www.energystar.gov/newhomes/homes_prog_reqs/national_page. See the ESMFNC program site for information: https://www.energystar.gov/newhomes/homes_prog_reqs/multifamily_national_page#site-built.

[12] DOE Zero Energy Ready Home requires projects to be certified under the ENERGY STAR Single Family New Homes program or under the ENERGY STAR Multifamily New Construction (ESMFNC) program. Projects certifying under the ESMFNC program are advised that DOE ZERH certification requires that such projects use either the Prescriptive or Performance paths to attain DOE ZERH certification, and that such projects are limited to 5 stories above grade or less to be eligible for DOE ZERH certification. Project certification under the ENERGY STAR Multifamily High-Rise program is not accepted at this time.

Sampling of those requirements for ENERGY STAR Homes qualification is permitted consistent with the ENERGY STAR for Homes V3 allowances for sampling (see ENERGY STAR Homes National Program Requirements). Sampling for Indoor airPLUS qualification is permitted consistent with the Indoor airPLUS program requirements.

With respect to Provision 1.3 within the ENERGY STAR Single-Family New Homes National Rater Field Checklist, Version 3/3.1/3.2 (Rev. 12) requiring RESNET-defined Grade I installation of insulation, where ceiling, wall, or floor assembly insulation is installed "blind" between layers of sheathing and therefore cannot be visually inspected, such assemblies are deemed equivalent to a RESNET-defined Grade I installation if the assembly insulation level is at least 50% greater than the specified value for the DOE Zero Energy Ready Home Target Home, based on nominal R-value.

[13] For homes achieving PHIUS+ certification, DOE will allow compliance with the 2015 IRC kitchen ventilation airflow rates (M 1507.4) as an alternative to those specified within ASHRAE 62.2. This alternative will remain in effect while DOE works to develop an ASHRAE 62.2-compliant solution optimized for very low-load homes.

[14] Windows shall meet the product criteria (based on ENERGY STAR v5.0 and V6.0 Window Specifications) listed in this table.

Window Specs Required for DOE Zero Energy Ready Home Projects	Hot Climates IECC CZ 1-2		Mixed Climates IECC CZ 3-4 except Marine		Cold Climates IECC CZ 5-8 and 4 Marine	
	U-Value	SHGC	U-value	SHGC	U-Value	SHGC
	0.40	0.25	[CZ 3] 0.30 [CZ 4] 0.30	[CZ 3] 0.25 [CZ 4] 0.40	0.30 0.31 0.32	Any ≥0.35 ≥0.40

The following exceptions apply:

a. An area-weighted average of fenestration products shall be permitted to satisfy the U-factor requirements;
b. An area-weighted average of fenestration products ≥ 50% glazed shall be permitted to satisfy the SHGC requirements;
c. 15 square feet of glazed fenestration per dwelling unit shall be exempt from the U-factor and SHGC requirements, and shall be excluded from area-weighted averages calculated using a) and b), above;
d. One side-hinged opaque door assembly up to 24 square feet in area shall be exempt from the U-factor requirements and shall be excluded from area-weighted averages calculated using a) and b), above;
e. Fenestration utilized as part of a passive solar design shall be exempt from the U-factor and SHGC requirements, and shall be excluded from area-weighted averages calculated using a) and b), above. Exempt windows shall be facing within 45 degrees of true South and directly coupled to thermal storage mass that has a heat capacity > 20 btu / ft^3x°F and provided in a ratio of at least 3 sq. ft. per sq. ft. of South facing fenestration. Generally, thermal mass materials will be at least 2 in. thick.
f. For homes achieving PHIUS+ certification where triple glazed window assemblies with thermal breaks/spacers between the panes are used, such windows are deemed to meet this requirement even in the absence of an ENERGY STAR certification.

[15] Building envelope assemblies, including exterior walls and unvented attic assemblies (where used), shall comply with the relevant vapor retarder provisions of the 2015 International Residential Code (IRC).

[16] Insulation levels in a home shall meet or exceed the component insulation requirements in the 2015 International Energy Conservation Code (IECC) – Table R402.1.2. The following exceptions apply:

a. Steel-frame ceilings, walls, and floors shall meet the insulation requirements of the 2015 IECC – Table 402.2.6.
b. For ceilings with attic spaces, R-30 shall satisfy the requirement for R-38 and R-38 shall satisfy the requirement for R-49 wherever the full height of uncompressed insulation at the lower R-value extends over the wall top plate at the eaves. This exemption shall not apply if the alternative calculations in d) are used;
c. For ceilings without attic spaces, R-30 shall satisfy the requirement for any required value above R-30 if the design of the roof / ceiling assembly does not provide sufficient space for the required insulation value. This exemption shall be limited to 500 sq. ft. or 20% of the total insulated ceiling area, whichever is less. This exemption shall not apply if the alternative calculations in d) are used;
d. An alternative equivalent U-factor or total UA calculation may also be used to demonstrate compliance, as follows: An assembly with a U-factor equal to or less than specified in Table 402.1.4 of the 2015 IECC complies. A total building thermal envelope UA that is less than or equal to the total UA resulting from the U-factors in Table 402.1.4 also complies. The insulation levels of fenestration, ceilings, walls, floors, and slabs can be traded off using the UA approach under both the Prescriptive and the Performance path. Also, note that while ceiling and slab insulation can be included in trade-off calculations, Items 3.1 through 3.3 of the ENERGY STAR Single Family New Homes National Rater Field Checklist, Version 3/3.1/3.2 (Rev. 12) shall be met regardless of the UA tradeoffs calculated. The UA calculation shall be done using a method consistent with the ASHRAE Handbook of

Fundamentals and shall include the thermal bridging effects of framing materials. The calculation for a steel-frame envelope assembly shall use the ASHRAE zone method or a method providing equivalent results, and not a series-parallel path calculation method.

[17] Exceptions and alternative compliance paths to locating 100% of forced-air ducts in home's thermal and air barrier boundary are:

a. Up to 10' of total duct length is permitted to be outside of the home's thermal and air barrier boundary.
b. Ducts are located in an unvented attic, regardless of whether this space is conditioned with a supply register
c. Ducts are located in a vented attic with all of the following characteristics:
    i. In Moist climates (Zones 1A, 2A, 3A, 4A, 5A, 6A and 7A per 2015 IECC Figure R301.1) and Marine climates (all "C" Zones per 2015 IECC Figure R301.1), minimum R-8 duct insulation with an additional minimum 1.5" of closed-cell spray foam insulation encapsulating the ducts; duct leakage to outdoors ≤ 3 CFM25 per 100 ft^2 of conditioned floor area (in addition to meeting *total* duct leakage requirements from Section 4.1 of the ENERGY STAR HVAC Rater checklist); and ductwork buried under at least 2" of blown-in insulation.
    ii. In Dry climates (all "B" Zones per 2015 IECC Figure R301.1), minimum R-8 duct insulation; duct leakage to outdoors ≤ 3 CFM25 per 100 ft^2 of conditioned floor area (in addition to meeting *total* duct leakage requirements from Section 4.1 of the ENERGY STAR HVAC Rater checklist); and ductwork buried under at least 3.5" of blown-in insulation.

    Note that in either of these designs the HVAC equipment must still be located within the home's thermal and air barrier boundary.
d. Systems which meet the criteria for "Ducts Located in Conditioned Space" as defined by the 2018 IECC Section R403.3.7 or 2021 IECC Section R403.3.2.
e. Jump ducts which do not directly deliver conditioned air from the HVAC unit may be located in attics if all joints, including boot-to-drywall, are fully air sealed with mastic or foam, and the jump duct is fully buried under the attic insulation.
f. Ducts are located within an unvented crawl space
g. Ducts are located in a basement which is within the home's thermal boundary
h. Ductless HVAC system is used

This provision does not apply to equipment or ductwork that only provides ventilation.

[18] Hot water delivery systems **in single family homes and distributed (individual water heater) systems in multifamily buildings** meet the following efficiency requirements:

To minimize water wasted while waiting for hot water, the hot water distribution system shall store no more than 0.5 gallons (1.9 liters) of water in any piping/manifold between the hot water source and any hot water fixture. In the case of on-demand recirculation systems, the 0.5 gallon (1.9 liter) storage limit shall be measured from the point where the branch feeding the fixture branches off the recirculation loop, to the fixture itself. To verify that the system stores no more than 0.5 gallons (1.9 liters), verifiers shall calculate the stored volume using the piping or tubing inside diameter and the length of the piping/tubing. System options include manifold-fed systems; structured plumbing systems; core plumbing layouts, and on-demand recirculation systems. The following requirements apply to recirculation systems:

a. Recirculation systems must be based on an occupant-controlled switch or an occupancy sensor, installed in each bathroom which is located beyond a 0.5 gallon stored-volume range from the water heater.
b. Recirculation systems which operate based on "adaptive" scheduling, meaning that they "learn" the hot water demand profile in the home and adapt their operation to anticipate this profile, are permitted at this time, and do not require the use of occupant-controlled switches or occupancy sensors.
c. Recirculation systems that are activated based **solely** on a timer and/or temperature sensor are not eligible.

No more than 0.6 gallons (2.3 liters) of water shall be collected from the hot water fixture before hot water is delivered. Only the fixture with the greatest stored volume between the fixture and the hot water source (or recirculation loop) needs to be tested. To field verify that the system meets the 0.6 gallon (2.3 liter) limit, verifiers shall first initiate operation of on-demand recirculation systems, if present, and let such systems run for at least 40 seconds. If an Adaptive Scheduling system cannot be "forced" into recirculation mode, contact DOE for further guidance. Next, a bucket or flow measuring bag (pre-marked for 0.6 gallons) shall be placed under the hot water fixture. The hot water shall be turned on completely and a digital temperature sensor used to record the initial temperature of the water flow. Once the water reaches the pre-marked line at 0.6 gallons (approximately 24 seconds for a lavatory faucet), the water shall be turned off and the ending temperature of the water flow (not the collection bucket) shall be recorded. The temperature of the water flow must increase by ≥ 10 °F. Under the DOE Zero Energy Ready Home program, the approved verifier may confirm compliance with these requirements.

Central hot water delivery systems in multifamily buildings must include on-demand recirculation which operates based on both a demand indicator and the loop water temperature. For qualifying central systems, verifiers must confirm that the pump is installed with flow in the correct direction and that the system's temperature sensors are installed.

Advisories:

- On-demand central systems in multifamily buildings do not currently have a stored volume limit. DOE encourages partners to design central hot water distribution systems in multifamily buildings to limit the stored volume between the recirculation loop and the furthest fixture to 1.0 gallons.
- Piping for central system recirculation loops in multifamily buildings should be insulated per the local code requirements. DOE encourages the use of R-4 pipe insulation on recirculation loop piping.
- DOE encourages that the recirculation pump for central systems be set to operate at a temperature which is at least 5°F less than the water heater set point temperature.

DOE will evaluate the possibility of making these recommendations into requirements in future updates to these specifications.

[19] Water heaters and fixtures in single family homes and in multifamily dwellings with their own independent water heater meet the following efficiency criteria:

a. Gas water heaters, if present, shall have an Energy Factor ≥ 0.90 or a Uniform Energy Factor ≥ 0.87
b. Electric water heaters, if present, shall have an Energy Factor ≥ 2.2 or a Uniform Energy Factor ≥ 2.2
c. All showerheads and bathroom sink faucets shall be WaterSense labeled.
d. The hot water distribution system shall store no more than 1.2 gallons between the hot water source and the furthest fixture. This shall be verified by either 1) a calculation using the piping or tubing interior diameter and the system length based on plans, or 2) by a field verification test, using the protocol described in Endnote 15, which demonstrates a minimum temperature rise of 10 °F by the time 1.4 gallons of water is delivered to the furthest hot water fixture.

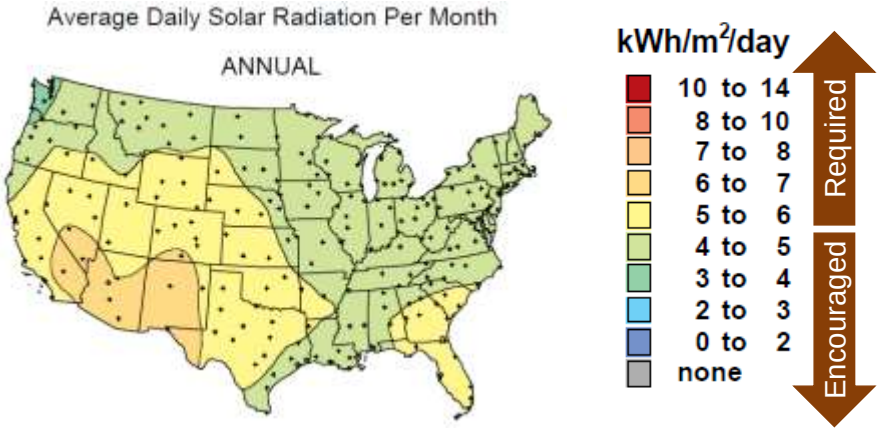
These provisions do not apply to multifamily buildings with central hot water delivery systems. These project types must instead satisfy the Efficient Hot Water Distribution provision instead (see Endnote 15).

[20] For products in categories which are not covered by ENERGY STAR product criteria, such as combination all-in-one clothes washer-dryers, these products are exempt.

[21] DOE Zero Energy Ready Home requires that the provisions of the PV-Ready Checklist are completed based on the requirements and allowances in this end note. For multifamily buildings, the PV-Ready provisions may be applied to the electric service for the building's common space instead of being applied to each dwelling unit. DOE encourages, but does not require, the use of the Solar Water Heating-Ready provisions.

The PV-Ready Checklist only applies when all of the following conditions a through d below are satisfied. Homes for which the PV-Ready Checklist does not apply based on these criteria may still qualify for DOE Zero Energy Ready Home if all other program requirements are satisfied. Homes that utilize renewable energy from utilities or third parties on a contractual basis may also be exempt from the PV-Ready Checklist – contact DOE for further guidance.

a. The home does not already include a PV system. This includes installed community solar systems which contribute some amount of offset to the home's electrical usage.
b. Location, based on zip code, has at least 5 kWh/m^2/day average daily solar radiation based on annual solar insolation using this online tool: https://pvwatts.nrel.gov/ . Users should enter the project location zip code, use the System Info default settings, and then proceed to the "Results" tab on the tool to see the Average Annual Solar Radiation value in kWh/m^2/day.

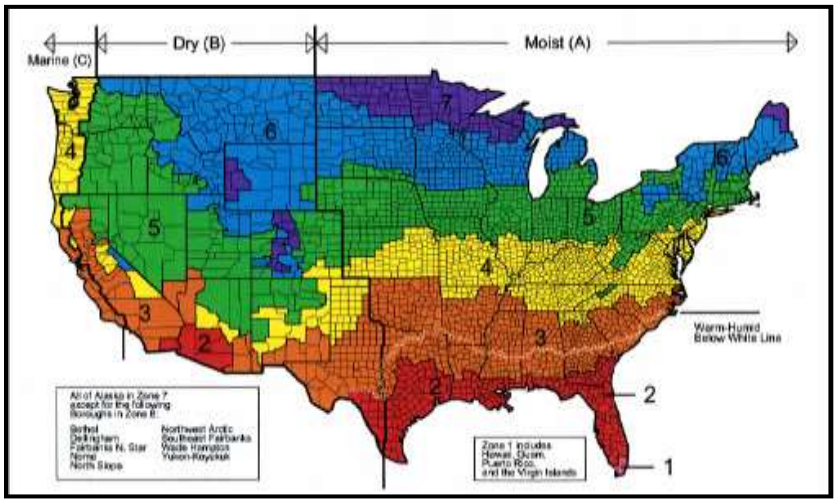


c. Location does not have significant natural shading (e.g., trees, tall buildings on the south-facing roof).
d. Home as designed has the minimum free roof area within +/- 45° of true south as noted in the table below.

Conditioned Floor Area of House (ft^2)	Minimum Roof Area within +/- 45° of True South for PV-Ready Checklist to Apply (ft^2)
≤ 2000	110
≤ 4000	220
≤ 6000	330
>6000	440

[22] The following Map is shown to depict climate zone boundaries. It is for illustrative purposes only and is based on the 2015 IECC.

2015 IECC Climate Zone Map



[23] HVAC System Type for the Target Home shall be the same as the Rated Home, with the following exceptions. The Target Home is configured with an air-source heat pump in Climate Zones 1-6 when the Rated Home is modeled with a ground-source heat pump, electric strip or baseboard heat; and the Target Home is configured with ground-source heat pump in Climate Zones 7 & 8 when the Rated Home is modeled with an air-source or ground-source heat pump, electric strip or baseboard heat. Applicable efficiency levels shall be selected from Exhibit 2.

[24] DOE recommends, but does not require, that cooling systems in hot/humid climates utilize controls for immediate blower shutoff after condenser shutoff, to prevent re-evaporation of moisture off the wet coil.

[25] Air source heat pumps with electric resistance backup cannot be used in homes qualified in Climate Zones 7 & 8 using the Prescriptive path.

[26] Envelope leakage shall be determined by an approved verifier using a RESNET-approved testing protocol.

[27] For Prescriptive compliance path projects that are not single family detached homes, an infiltration rate of ≤ 0.27 CFM50 per square foot of enclosure area may be used as an alternate to the ACH50 requirement. This alternate Prescriptive compliance path requirement applies to all climate zones.

[28] All decorative glass and skylight window areas count toward the total window area to above-grade conditioned floor area (WFA) ratio.

[29] DOE strongly encourages all DOE Zero Energy Ready Home partners to consider using R-5 windows in cold climates in anticipation of them becoming the state-of-the-art window choice in the near future.

[30] For homes using Exhibit 2 for Prescriptive compliance with the DOE Zero Energy Ready Home, the following exceptions to the U-Value and SHGC requirements in Exhibit 2 apply:

a. An area-weighted average of fenestration products shall be permitted to satisfy the U-factor requirements;
b. An area-weighted average of fenestration products ≥ 50% glazed shall be permitted to satisfy the SHGC requirements;
c. 15 square feet of glazed fenestration per dwelling unit shall be exempt from the U-factor and SHGC requirements, and shall be excluded from area-weighted averages calculated using a) and b), above;
d. One side-hinged opaque door assembly up to 24 square feet in area shall be exempt from the U-factor requirements and shall be excluded from area-weighted averages calculated using a) and b), above;

e. Fenestration utilized as part of a passive solar design shall be exempt from the U-factor and SHGC requirements, and shall be excluded from area-weighted averages calculated using a) and b), above. Exempt windows shall be facing within 45 degrees of true South and directly coupled to thermal storage mass that has a heat capacity > 20 btu / ft^3x °F and provided in a ratio of at least 3 sq. ft. per sq. ft. of South facing fenestration. Generally, thermal mass materials will be at least 2 in. thick.

[31] *For Prescriptive path:* All decorative glass and skylight window areas count toward the total window area to above-grade conditioned floor area (WFA) ratio. For homes using the Prescriptive path that have a WFA ratio > 15%, the following additional requirements apply:

a. In Climate Zones 1, 2, and 3, an improved window SHGC is required and is determined by:

Improved SHGC = [0.15 / WFA] x [ENERGY STAR SHGC]

Where the ENERGY STAR SHGC is the maximum allowable SHGC in Exhibit 1, ENERGY STAR Reference Design, for the Climate Zone where the home will be built.

b. In Climate Zones 4, 5, 6, 7, and 8, an improved window U-Value is required and is determined by:

Improved U-Value = [0.15 / WFA] x [ENERGY STAR U-Value]

Where the ENERGY STAR U-Value is the maximum allowable U-Value in Exhibit 1, ENERGY STAR Reference Design, for the Climate Zone where the home will be built.

[32] In homes with heat pumps, programmable thermostats shall have "Adaptive Recovery" technology to prevent the excessive use of electric back-up heating.

[33] The average-size home for a specific number of bedrooms is termed “Benchmark Home”. The conditioned floor area for a Benchmark Home (CFA Benchmark Home) is determined by selecting the appropriate value from Exhibit 3. For homes with more than 8 bedrooms, the CFA Benchmark Home shall be determined by multiplying 600 sq. ft. times the total number of bedrooms and adding 400 sq. ft.

Example 10-Bedroom Home: Benchmark Home = (600 sq. ft. x 10) + 400 sq. ft. = 6,400 sq. ft.