

DOE Challenge Home HERS Index Target Procedure for National Program Requirements

April 1, 2012

This document provides detailed instructions for determining the DOE Challenge Home HERS Index Target, the highest HERS Index value that a home can achieve and qualify under the Performance Path of the program. The Performance Path provides flexibility to select a custom combination of measures through energy modeling that achieves the required DOE Challenge Home HERS Index Target. Note, however, that regardless of the measures selected, the Mandatory Requirements for All Qualified Homes in Exhibit 1 of the DOE Challenge Home National Program Requirements (Rev 1) shall be met.

Follow these steps using any RESNET-accredited software program to calculate the DOE Challenge Home HERS Index Target:

1. Determine the HERS Index of the DOE Challenge Home Target Home (the "Target Home"). To accomplish this, use Exhibit 2 below, Expanded DOE Challenge Home Target Home Design Definition, to model the Target Home and determine its associated HERS Index value. For Raters configuring the Target Home manually, EPA provides the following guidance:
 - a. The Target Home is virtually identical to the home that would have been built using the minimum requirements of the Prescriptive Path. Therefore, DOE suggests that Raters complete a plan take-off of the home to be built, configure it with the minimum requirements of the Prescriptive Path, and then review Exhibit 2 of this document for any remaining items that need to be changed.
 - b. Any item in Exhibit 2 that states "Same as Rated Home" means that the parameter should be identical to the rated home. Therefore, if the Rater follows the guidance in item a) above, then these parameters do not need to be further adjusted when calculating the DOE Challenge Home HERS Index Target.
 - c. RESNET requires that all accredited software automatically configure certain parameters when calculating a HERS index value (e.g., internal gains, thermostat set points, water heater temp.). Any item in Exhibit 2 that begins with a plus (+) and is shaded gray will be automatically configured by the software, indicating that the Rater need not do anything to comply with these items when calculating the HERS Index Target.
 - d. In Exhibit 2, slab insulation R-values represent nominal insulation levels; U-factors and SHGC coefficients for windows and doors apply to the entire assembly; and assembly U-factors for foundations, floors, walls, and ceilings represent the overall U-value of the assembly, inclusive of exterior sheathing materials, cavity insulation and installation quality, framing, and interior finishes. To create an assembly that meets the required U-factor, Raters may wish to start with the nominal insulation R-values indicated in the Target Home applicable to the Rated Home, and then modify the assembly details until the U-factor aligns.

Note that DOE will provide modified Mandatory Requirements and DOE Challenge Home Target Home specifications for states with energy codes significantly more rigorous than the 2009 IECC. Once published, these modified specifications shall be used after a specified transition period, typically 60 days, to determine the DOE Challenge Home HERS Index Target in these states.

2. For all single-family detached homes, townhomes, row homes, duplexes, triplexes, and quad-plexes, calculate the Size Adjustment Factor (SAF) using the following equation:

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

Where:

$\text{CFA}_{\text{Benchmark Home}}$ = Conditioned Floor Area of the Benchmark Home, using Exhibit 1

$\text{CFA}_{\text{Home to be Built}}$ = Conditioned Floor Area of the Home to be Built

For the purposes of this step, calculate the number of bedrooms and the CFA of the home to be built using RESNET standards with the following exception: floor area in basements with at least half of the gross surface area of the basement's exterior walls below grade shall not be counted.¹ If a home has zero bedrooms with regard to the Benchmark Home Size determination, then the Benchmark Home Size for one bedroom shall be used. If the CFA of the home to be built exceeds the CFA of the Benchmark Home, then the Performance Path

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shall be used. Because the SAF cannot exceed 1.0, it only modifies the HERS Index Target for homes with conditioned floor area greater than the Benchmark Home. For condos and apartments in multi-family buildings the SAF shall always equal 1.0.

NOTE: CONDITIONED BASEMENT EXCLUSION LOGIC USED IN ENERGY STAR V3 SHALL ALSO BE APPLIED TO DOE CHALLENGE HOME.

3. The HERS Index of the DOE Challenge Home Target Home is calculated next²:

$$\text{Challenge Home HERS Target} = \text{HERS Index of Challenge Home Target Home} \times \text{Size Modification Factor}$$

4. Next, proceed with Step 4 of the Performance Path as outlined in the DOE Challenge Home National Program Requirements, (Rev. 01).

Exhibit 1: Benchmark Home Size³

Bedrooms in Home to be Built	1	2	3	4	5	6	7	8
Conditioned Floor Area <small>Benchmark Home</small>	1,000	1,600	2,200	2,800	3,400	4,000	4,600	5,200

Exhibit 2: Expanded DOE Challenge Home Target Home Design Definition

Building Component	Expanded DOE Challenge Home Target Home Design Definition ^{4,5}								
Foundations⁶	Construction Type & Structural Mass: Same as Rated Home, except: <ul style="list-style-type: none"> • For masonry floor slabs, modeled with 80% of floor area covered by carpet and 20% of floor directly exposed to room air 								
	Conditioning Type: Same as Rated Home, except: <ul style="list-style-type: none"> • Crawlspace shall be modeled as vented with net free vent aperture = 1sq. ft. per 150 sq. ft. of crawlspace floor area 								
	Gross Area: Same as Rated Home								
	Insulation ⁷ : Choose appropriate insulation level below; <ul style="list-style-type: none"> • Basement Wall Assembly U-factor only applies to conditioned basements; if applicable, insulation shall be located on interior side of walls • Floor assemblies above crawlspace foundations shall be configured to meet the applicable floor assembly U-factor listed in the building component section for Floors Over Unconditioned Spaces • Slab floors with a floor surface less than 12" below grade shall be insulated to the Slab Insulation R-value. The insulation shall extend downward from the top of the slab on the outside of the foundation wall and then vertically below-grade to the Slab Insulation Depth 								
	Climate Zone	CZ 1	CZ 2	CZ 3	CZ 4	CZ 4C & 5	CZ 6	CZ 7	CZ 8
	Slab Insulation R-Value	0	0	0	10	10	10	10	10
	Slab Insulation Depth (ft)	0	0	0	2	2	4	4	4
	Basement Wall Assembly U-Factor	0.360	0.360	0.091	0.059	0.050	0.050	0.050	0.050
Floors Over	Construction Type: Wood frame								

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Unconditioned Spaces⁶	Gross Area: Same as Rated Home								
	Insulation ⁷ :								
	Climate Zone	CZ 1	CZ 2	CZ 3	CZ 4	CZ 4C & 5	CZ 6	CZ 7	CZ 8
	Floor Assembly U-Factor	0.064	0.064	0.047	0.047	0.033	0.033	0.028	0.028
Above-Grade Walls⁶	Interior & Exterior Construction Type: Wood frame								
	Gross Area: Same as Rated Home								
	Solar Absorptance = 0.75								
	Emittance: 0.90								
	Insulation ⁷ :								
	Climate Zone	CZ 1	CZ 2	CZ 3	CZ 4	CZ 4C & 5	CZ 6	CZ 7	CZ 8
	Wall Assembly U-Factor	0.082	0.082	0.057	0.057	0.057	0.048	0.048	0.048
Thermally Isolated Sunrooms	None								
Doors⁶	Area: same as Rated home								
	Orientation: same as Rated home								
	U-Values and SHGCs, based on ENERGY STAR doors ⁸								
	Door Type	Opaque			≤1/2-Lite			>1/2-Lite	
	U-Value	0.21			0.27			0.32	
	SHGC	N/A			0.30			0.30	
Glazing^{9,10}	Total Area: (except in homes with conditioned basements and attached homes ¹¹)								
	<ul style="list-style-type: none"> • Same as Rated Home, where Rated Home glazing area is less than 15% of conditioned floor area; OR • 15% of the conditioned floor area, where the Rated Home glazing area is 15% or more of the conditioned floor area 								
	Orientation: Equally distributed to North, East, South, and West								
	+ Interior Shade Coefficient: Same as HERS Reference Home, as defined by RESNET's standard ¹²								
	External Shading: none								
	U-Values and SHGCs, as defined below:								
	Climate Zone	CZ 1	CZ 2	CZ 3	CZ 4	CZ 4C & 5	CZ 6	CZ 7	CZ 8
	U-Value	0.4	0.4	0.3	0.3	0.27	0.27	0.27	0.27
SHGC	0.25	0.25	0.27	0.27	0.40	0.40	0.40	0.40	
Skylights	None								
Ceilings⁶	Construction Type: Wood frame								
	Gross Area: Same as Rated Home								
	Insulation ⁷ :								
	Climate Zone	CZ 1	CZ 2	CZ 3	CZ 4	CZ 4C & 5	CZ 6	CZ 7	CZ 8
	Ceiling Assembly U-Factor	0.035	0.030	0.030	0.026	0.026	0.026	0.026	0.026

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Attics	Construction Type: Vented with aperture = 1sq. ft. per 300 sq. ft. ceiling area								
	Radiant Barrier: none								
Roofs	Construction Type: Composition shingle on wood sheathing								
	Gross Area: Same as Rated Home								
	Solar Absorptance = 0.92								
	Emittance = 0.90								
Heating Systems	Heating loads may be calculated and equipment capacity selected according to the latest edition of ACCA Manual J, ASHRAE 2009 Handbook of Fundamentals, or a substantively equivalent procedure; otherwise, same as Rated Home.								
	Fuel Type: Same as Rated Home ¹³								
	System Type: Same as Rated Home, except Target Home shall be configured with air-source heat pump in Climate Zones 1-6 where Rated Home is modeled with ground-source heat pump, electric strip or baseboard heat, and Target Home shall be configured with ground-source heat pump in Climate Zones 7 & 8 where Rated Home is modeled with air-source or ground-source heat pump, electric strip or baseboard heat; applicable efficiency selected from below.								
	Climate Zone	CZ 1	CZ 2	CZ 3	CZ 4	CZ 4C & 5	CZ 6	CZ 7	CZ 8
	Gas Furn, AFUE	80	80	90	90	94	94	94	94
	Oil Furn, AFUE	80	80	90	90	94	94	94	94
	Gas/Oil Boiler, AFUE	80	80	90	90	94	94	94	94
	Air-Source HP, HSPF	8.2	8.2	9.0	9.0	10.0	10.0	N/A	N/A
	Air-Source HP Back-up	electric	electric	electric	electric	electric	electric	N/A	N/A
Ground-Source HP, COP	N/A	N/A	N/A	N/A	N/A	N/A	3.6	3.6	
Cooling Systems	Cooling loads may be calculated and equipment capacity selected according to the latest edition of ACCA Manual J, ASHRAE 2009 Handbook of Fundamentals, or a substantively equivalent procedure; otherwise, same as Rated Home.								
	Fuel Type: Same as Rated Home ¹³								
	System Type: Same as Rated Home, except Target Home shall be configured with air-source heat pump in Climate Zones 1-6 where Rated Home is modeled with ground-source heat pump and Target Home shall be configured with ground-source heat pump in Climate Zones 7 & 8 where Rated Home is modeled with air-source or ground-source heat pump; applicable efficiency selected from below.								
	Climate Zone	CZ 1	CZ 2	CZ 3	CZ 4	CZ 4C & 5	CZ 6	CZ 7	CZ 8
	AC SEER	18	18	15	15	13	13	13	13
	Air-Source HP SEER	18	18	15	15	13	13	13	13
Ground-Source HP EER	N/A	N/A	N/A	N/A	N/A	N/A	17.1	17.1	
Service Water Heating Systems	+ Use (Gallons per Day): Same as HERS Reference Home, as defined by RESNET's standard. ¹²								
	+ Tank Temperature: Same as HERS Reference Home, as defined by RESNET's standard. ¹²								
	Fuel Type: Same as Rated Home ¹³								
	System Type: ENERGY STAR water heater of same fuel type as Rated Home. Select applicable efficiency from below.								
	Gas Water Heaters				EF = 0.67				
	Oil Water Heaters (note ENERGY STAR rated)				EF= 0.60				

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	Electric Water Heaters	EF = 2.0							
Thermal Distribution Systems¹⁴	Duct Leakage to Outside: 4 CFM25 per 100 sq. ft. of conditioned floor area								
	Duct Insulation: Same as Rated Home								
	Duct Surface Area: Same as Rated Home								
	Duct Location: 100% within the thermal and air barriers of the home								
Thermostat	Type: Programmable								
	Temperature Set points: Same as HERS Reference Home, with offsets defined by RESNET's standard ¹²								
Infiltration & Whole-House Mechanical Ventilation	Infiltration Rates, Ventilation Fan Efficacy, Ventilation Heat Recovery, and Ventilation Type ¹⁵ :								
	Climate Zone	CZ 1	CZ 2	CZ 3	CZ 4	CZ 4C & 5	CZ 6	CZ 7	CZ 8
	ACH50	3.0	3.0	2.5	2.5	2.0	2.0	2.0	1.5
	Ventilation Fan Efficacy (cfm/W)	1.4	1.4	1.4	1.4	1.2	1.2	1.2	1.2
	Ventilation Heat Recovery	No	No	No	No	Yes; 60% SRE	Yes; 60% SRE	Yes; 60% SRE	Yes; 60% SRE
	Ventilation Type	supply	supply	supply	supply	balanced	balanced	balanced	balanced
	Rate: CFM = (0.01 * CFA) + (7.5 * (Nbr + 1)), where CFA = Conditioned Floor Area and Nbr = Number of Bedrooms								
	Hours per Day: 24								
Lighting, Appliances, & Internal Gains	Fluorescent Lighting: 80%								
	Refrigerator: 423 kWh per year								
	Dishwasher: 0.66 EF								
	Ceiling Fan: 122 CFM per Watt; Target Home to have same quantity as Rated Home								
	+ Internal Gains: Defined by Section 303.5.1.1 of RESNET's standard ¹² and adjusted for internal gains from the high-efficiency lighting and appliances listed above, as provided by Section 303.4.1.7.								
Internal Mass	+ Same as HERS Reference Home, as defined by RESNET's standard ¹²								
	Additional mass specifically designed as a Thermal Storage Element for the Rated Home shall be excluded.								

Footnotes:

¹ To determine whether at least half of the basement wall area is below grade, use the gross surface area of the walls that are in contact with either the ground or ambient outdoor air, measured from the basement floor to the bottom of the basement ceiling framing (e.g., the bottom of the joists for the floor above). Note that the exception regarding the floor area in basements is only for the purpose of determining a home's Benchmark Home Size, Size Adjustment Factor, and eligibility to use the Prescriptive Path. The full conditioned floor area, per RESNET's standards, should be used when rating the home (e.g., determining compliance with duct leakage requirements).

² On-site power generation may not be used to qualify a home for the DOE Challenge Home Target Home requirements, but can be used to achieve additional HERS Index Score reductions needed for homes larger than the Benchmark Home.

³ The average-size home with a specific number of bedrooms is termed the "Benchmark Home". The conditioned floor area of a Benchmark Home (CFA Benchmark Home) is determined by selecting the appropriate value from Exhibit 3. For

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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.

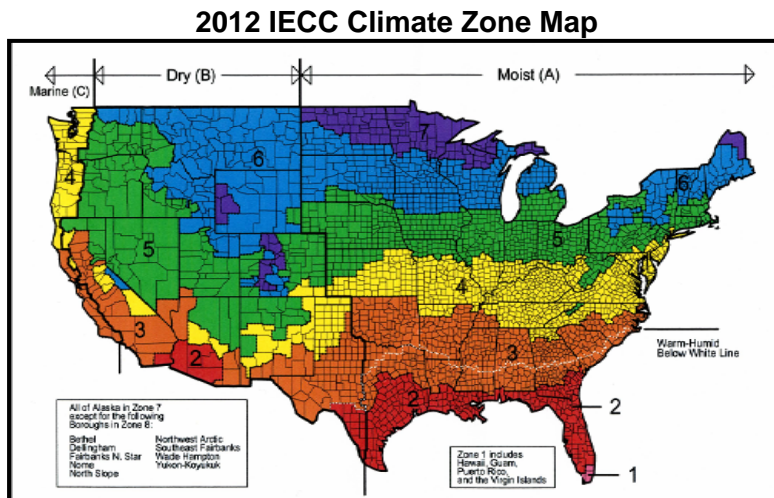
Example: CFA Benchmark Home for a 10 bedroom home = (600 sq. ft. x 10) + 400 sq. ft. = 6,400 sq. ft.

A bedroom is defined by RESNET as a room or space 70 sq. ft. or greater size, with egress window and closet, used or intended to be used for sleeping. A "den", "library", or "home office" with a closet, egress window, and 70 sq. ft. or greater size or other similar rooms shall count as a bedroom, but living rooms and foyers shall not.

An egress window, as defined in 2012 IRC section R310.1.1, shall refer to any operable window that provides for a means of escape and access for rescue in the event of an emergency. The egress window definition has been summarized for convenience. The egress window shall:

- have a sill height of not more than 44 inches above the floor; AND
- have a minimum net clear opening of 5.7 sq. ft.; AND
- have a minimum net clear opening height of 24 in.; AND
- have a minimum net clear opening width of 20 in.; AND
- be operational from the inside of the room without the use of keys, tools or special knowledge.

⁴ The following Map is shown to depict climate zone boundaries. It is for illustrative purposes only and is based on the 2012 IECC.



⁵ Any parameter not specified in this exhibit shall be set to "Same as Rated Home".

⁶ Insulation levels in a home shall meet or exceed the component insulation requirements in the 2012 International Energy Conservation Code (IECC) - Table R402.1.1. The following exceptions apply:

- a. Steel-frame ceilings, walls, and floors shall meet the insulation requirements of the 2012 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;

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- 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 or less than specified in 2012 IECC Table 402.1.3 complies. A total building thermal envelope UA that is less than or equal to the total UA resulting from the U-factors in Table 402.1.3 also complies. The insulation levels of all non-fenestration components (i.e., ceilings, walls, floors, and slabs) can be traded off using the UA approach under both the Prescriptive and the Performance Path. Note that fenestration products (i.e., windows, skylights, doors) shall not be included in this calculation. Also, note that while ceiling and slab insulation can be included in trade-off calculations, Items 4.1 through 4.3 of the ENERGY STAR for Homes V3 Thermal Enclosure System Rater Checklist 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.

⁷ For informative purposes, assembly U-factors are meant to correlate to typical assemblies containing the nominal R-values as listed in 2012 IECC Table 402.1.1.

⁸ All Target Home door U-value and SHGC requirements are based on the ENERGY STAR Program Requirements – Version 5.0 as outlined at www.energystar.gov/windows. Note that the U-factor requirement applies to all fenestration while the SHGC only applies to the glazed portion.

⁹ Windows shall meet the ENERGY STAR Window Product Criteria which are in force at the time of the final rating inspection. See www.energystar.gov/windows for current ENERGY STAR Window Product Criteria.

¹⁰ Fenestration shall meet the applicable ENERGY STAR Window Product Criteria for U and SHGC, with the following exceptions:

- 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 $\geq 50\%$ 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 / ft³°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.

¹¹ When determining the Target Home HERS Index Target for homes with conditioned basements and for attached homes under the Performance Path, the following formula shall be used to determine total window area of the Target Home:

$$AF = 0.15 \times AFL \times FA \times F$$

Where:

- AF = Total fenestration area
- AFL = Total floor area of directly conditioned space

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- $FA = (\text{Above-grade thermal boundary gross wall area}) / (\text{Above-grade boundary wall area} + 0.5 \times \text{Below-grade boundary wall area})$
 - $F = 1 - 0.44 \times (\text{Common wall area}) / (\text{Above-grade thermal boundary wall area} + \text{Common wall area})$

And where:

- Thermal boundary wall is any wall that separates directly or indirectly conditioned space from unconditioned space or ambient conditions;
- Above-grade thermal boundary wall is any portion of a thermal boundary wall not in contact with soil;
- Below-grade boundary wall is any portion of a thermal boundary wall in soil contact; and
- Common wall is the total wall area of walls adjacent to another conditioned living unit, not including foundation walls.

¹² RESNET's 2006 Mortgage Industry National Home Energy Rating Systems Standard.

¹³ In the DOE Challenge Home Target Home, fuel type(s) shall be same as Rated Home, including any dual-fuel equipment where applicable. For a Rated Home with multiple heating, cooling, or water heating systems using different fuel types, the applicable system capacities and fuel types shall be weighted in accordance with the loads distribution (as calculated by accepted engineering practice for that equipment and fuel type) of the multiple systems.

¹⁴ Exceptions 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: minimum R-8 duct insulation with an additional minimum 1.5" of closed-cell spray foam insulation encapsulating the ducts; total duct leakage ≤ 3 CFM25 per 100 ft² of conditioned floor area; and ductwork buried under at least 2" of blown-in insulation
- d. 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.
- e. Ducts are located within an unvented crawl space
- f. Ducts are located in a basement which is within the home's thermal boundary
- g. Ductless HVAC system is used

¹⁵ Ventilation Type is identified here for clarity in programming the Target Home only. Numerous factors such as energy performance, induced sensible and latent loads, IAQ, and moisture management should be considered in selecting an appropriate ventilation system type.