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HUD Manufactured Housing Comparison

Peter Schneider
Senior Consultant

Leslie Badger
Lead Energy Analyst



Base Efficiency - Minimum Requirements

Assembly	HUD 2023		ENERGY STAR MH v3		ZERH MH v1	EVT 3.0
	Single-wide	Double-wide	Single-wide	Double-Wide		
Walls	R-19	R-21	R-21			R-32 (min R-12ci)
Floor	R-22	R-30	R-33			R-38 or R30+5ci
Ceiling	R-22	R-38	R-38			R-60 (R-49 slope)
Windows	U-0.35	U-0.30	U-0.30			U-0.21
Doors	U-0.40	U-0.40	U-0.30			NR
Air leakage	Visual inspection					1 ACH50
Heating & Cooling	NR (Federal minimum standard)					ENERGY STAR
Water heating	NR (Federal minimum standard)					ENERGY STAR
Ventilation	Any, with min cfm/w					Balanced (QPL)
Thermostat	Manual		Programmable			
Duct Leakage	*4 CFM25/100sf (not tested)		*10% tested			*Tested, and in fully conditioned space
Duct Insulation	NR		Floor cavity: enclosed by insulation All other spaces: R-8			NR in conditioned space
Lighting	NR (Federal minimum standard)					ENERGY STAR
Appliances	NR (Federal minimum standard)					ENERGY STAR
Additional EE points	0		0	10	18	n/a

VT Residential Building Energy Standards 2020

Table 5-1. Requirements by component for base packages

REQUIREMENTS BY COMPONENT FOR BASE PACKAGES					
Component ^a	Package 1 Standard	Package 2 SIPS	Package 3 Thick Wall	Package 4 Cavity Only	Package 5 Log Homes
Ceiling	R-49 ^f	R-28 cont.	R-49 ^f	R-60g attic / R-49 ^f slope	Construct log home to ICC 400-2017 "Standard on the Design and Construction of Log Structures" OR Table R402.1.6 in RBES code language
Wood Frame Walls	R-20+5 ^e OR 13+10 ^e	R-21 cont.	R-20+12 ^e	R-20 cavity	
Common Wall Insulation	R-10	R-10	R-10	R-10	
Floor	R-30	R-30	R-30	R-38	
Basement/Crawl Space Wall ^c	R-15 (continuous) OR 20 (cavity) OR R-13+5	R-15 (continuous) OR 20 (cavity) OR R-13+5	R-20 (continuous) OR R-13+10 ^e	R-20 (continuous) OR R-13+10 ^e	
Slab Edge ^d	R-15, 4ft OR R-10 perimeter + R-7.5 under entire rest of slab	R-15, 4ft OR R-10 perimeter + R-7.5 under entire rest of slab	R-10, 4 ft	R-15, 4 ft OR R-10 perimeter + R-7.5 under entire rest of slab	
Heated Slab ^d	R-15 (edge and under)	R-15 (edge and under)	R-15 (edge and under)	R-15 (edge and under)	
Fenestration ^b (Window and Door)	U-0.30 max.	U-0.30 max.	U-0.30 max.	U-0.28 max.	
Skylight ^b	U-0.55 max.	U-0.55 max.	U-0.55 max.	U-0.55 max.	
Air Leakage ⁱ	≤3.0 ACH50 ^h tested	≤3.0 ACH50 ^h tested	≤3.0 ACH50 ^h tested	≤3.0 ACH50 ^h tested	
Duct Leakage	Inside thermal boundary	Inside thermal boundary	4 CFM25 per 100 sq. ft. of CFA ⁱ	Inside thermal boundary	
Percent High Efficacy Lamps ⁱ	90%	90%	90%	100%	

Additional Efficiency Requirements

	Points	ENERGY STAR MH v3		ZERH MH v1		Target
		Double-wide		All		All
Mandatory Requirements	CZ 3	Fuel heat	All-electric	Fuel heat	All-electric	All-electric
All requirements in Exhibit 1.	2.0	X	X	X	X	X
Optional Envelope Improvements						
Coefficient of heat transmission (Uo) ≤ 0.049.	4.5	X	X	X		X
Optional Heating and Cooling Equipment						
Heat pump ≥ 7.5 HSPF2 / 14.3 SEER2	17.0				X	X
Gas / propane Furnace ≥ 90 AFUE	5.5	X		X		
Gas / propane Furnace ≥ 95 AFUE	7.5					
Gas / Propane Furnace ≥ 96 AFUE	8.5					
Optional Water Heater Equipment						
Gas / Propane WH ≥ 0.93 UEF.	0.5					
HPWH ≥ 2.20 UEF	1.5					
HPWH ≥ 3.30 UEF	1.5		X			
HPWH ≥ 2.20 UEF	7.5			X		
HPWH ≥ 3.30 UEF	9.0					X
Optional Lighting, Appliances, & Water Fixtures						
LED lighting in all permanent fixtures	0.5		X			X
Bathroom faucets ≤1.5 gpm, showerheads ≤2.0 gpm	0.5		X			X
ENERGY STAR certified refrigerator and dishwasher.	0.5		X			X
ENERGY STAR certified clothes washer.	0.5		X			X
Points Total		12	10	19.5	19	34.5
Points Required		10		18		

Modeling Assumptions w Points (fuel heat baseline)

Assembly	HUD 2023		ENERGY STAR v3		ZERHv1	ZERHv1 (Target)	EVT 3.0 (ZEM)
	Single	Double	Single	Double	All	All	All
Walls	R-19	R-21		R-21+R-3 ci			R-20+R-12 ci
Floor	R-22	R-30	R-33				R-38
Ceiling	R-22	R-38		R-44			R-60
Windows	U-0.35	U-0.30		U-0.25			U-0.21
Doors	U-0.40 (R-2.5)		U-0.30 (R-3)				
Air leakage	8 ACH50				4 ACH50	3 ACH50	1 ACH50
Heating	Propane furnace (80%)		Propane furnace (90%)			ASHP (8.8 HSPF2)	
Cooling	Central Air (13.4 SEER2)					ASHP (16.2 SEER2)	
Ventilation	Exhaust (2.8 cfm/w)					HRV (87% SRE)	
Hot Water	Propane Tank (0.56 UEF)				HPWH (2.2 UEF)	HPWH (3.3 UEF)	
Thermostat	Manual		Programmable				
Duct Leakage	4 CFM25/100sf						Conditioned space
Duct Insulation	Surrounded by floor insulation, R-8 cross-over duct						
Lighting	100% CFL					100% LED	
Appliances	Federal Minimum					ENERGY STAR	

Modeling Assumptions w Points (electric heat baseline)

Assembly	HUD 2023		ENERGY STAR v3		ZERHv1	ZERHv1-(Target)	EVT 3.0 (ZEM)
	Single	Double	Single	Double	All	All	All
Walls	R-19	R-21	R-21+R-3 ci	R-21	R-21+R-3 ci	R-20+R-12 ci	
Floor	R-22	R-30	R-33				R-38
Ceiling	R-22	R-38	R-44	R-38	R-44	R-60	
Windows	U-0.35	U-0.30	U-0.25	U-0.30	U-0.25	U-0.21	
Doors	U-0.40 (R-2.5)		U-0.30 (R-3.3)				
Air leakage	8 ACH50			4 ACH50	3 ACH50	1 ACH50	
Heating	Electric furnace (100%)			ASHP (7.5 HSPF2)	ASHP (8.8 HSPF2)		
Cooling	Central Air (13.4 SEER2)			ASHP (14.3 SEER2)	ASHP (16.2 SEER2)		
Ventilation	Exhaust (2.8 cfm/w)				HRV (87% SRE)		
Hot Water	Tank (0.92 UEF)		HPWH (2.2 UEF)	Tank (0.92 UEF)	HPWH (3.3 UEF)		
Thermostat	Manual		Programmable				
Duct Leakage	4 CFM25/100sf					Conditioned space	
Duct Insulation	Surrounded by floor insulation, R-8 cross-over duct						
Lighting	100% CFL		100% LED	100% CFL	100% LED		
Appliances	Federal Minimum		ENERGY STAR	Federal Minimum	ENERGY STAR		

ZEM – ZERH Comparison (All Electric)

Assembly	ZERHv1-(Target)	EVT 3.0 (ZEM)
	All	All
Walls	R-21+R-3 ci	R-20+R-12 ci
Floor	R-33	R-38
Ceiling	R-44	R-60
Windows	U-0.25	U-0.21
Doors	U-0.30 (R-3.3)	
Air leakage	3 ACH50	1 ACH50
Heating	ASHP (8.8 HSPF2)	
Cooling	ASHP (16.2 SEER2)	
Ventilation	HRV (87% SRE)	
Hot Water	HPWH (3.3 UEF)	
Thermostat	Programmable	
Duct Leakage	4 CFM25/100sf	Inside conditioned space
Duct Insulation	Surrounded by floor insulation, R-8 cross-over duct	
Lighting	100% LED	
Appliances	ENERGY STAR	

Example of DOE
ZERH Technical
Requirements



U.S. DOE Zero Energy Ready Home Manufactured Homes
National Program Requirements, Version 1

Exhibit 3: Mandatory Technical Requirements

In addition to meeting the requirements in Exhibits 1 and 2, all requirements in Exhibit 3 must be met, including Factory Installed M and Field Installed Measures.

FACTORY INSTALLED MEASURES				
THERMAL ENVELOPE				
Measure	Technical Requirement	Documentation	Verification	Frequency
1 Reduced Thermal Bridging				
1.1 Roof truss heel height	For insulated ceilings with attic space above (i.e., non-cathedralized), the minimum roof truss heel height is 5.5 in. ✓	Design Approval Primary Inspection Agency (DAPIA) / Quality Control Manual (QCM)	In-Plant Primary Inspection Agency (IPIA)	IPIA inspection
1.2 Insulation beneath attic platforms	Insulation beneath attic platforms (e.g., HVAC platforms, walkways) must be $\geq R-21$.	DAPIA/QCM	IPIA	IPIA inspection
1.3 Reduced wall thermal bridging	At above-grade walls separating conditioned from unconditioned space, one of the following options used (rim / band joists exempted): Option 1: Advanced framing ¹² ✓ Option 2: Extended plate and beam wall system. Option 3: Continuous rigid insulation, insulated siding, or combination of the two is: $\geq R-3$ in HUD climate zone 1 and 2; $\geq R-5$ in HUD climate zone 3.	DAPIA/QCM	IPIA	IPIA inspection

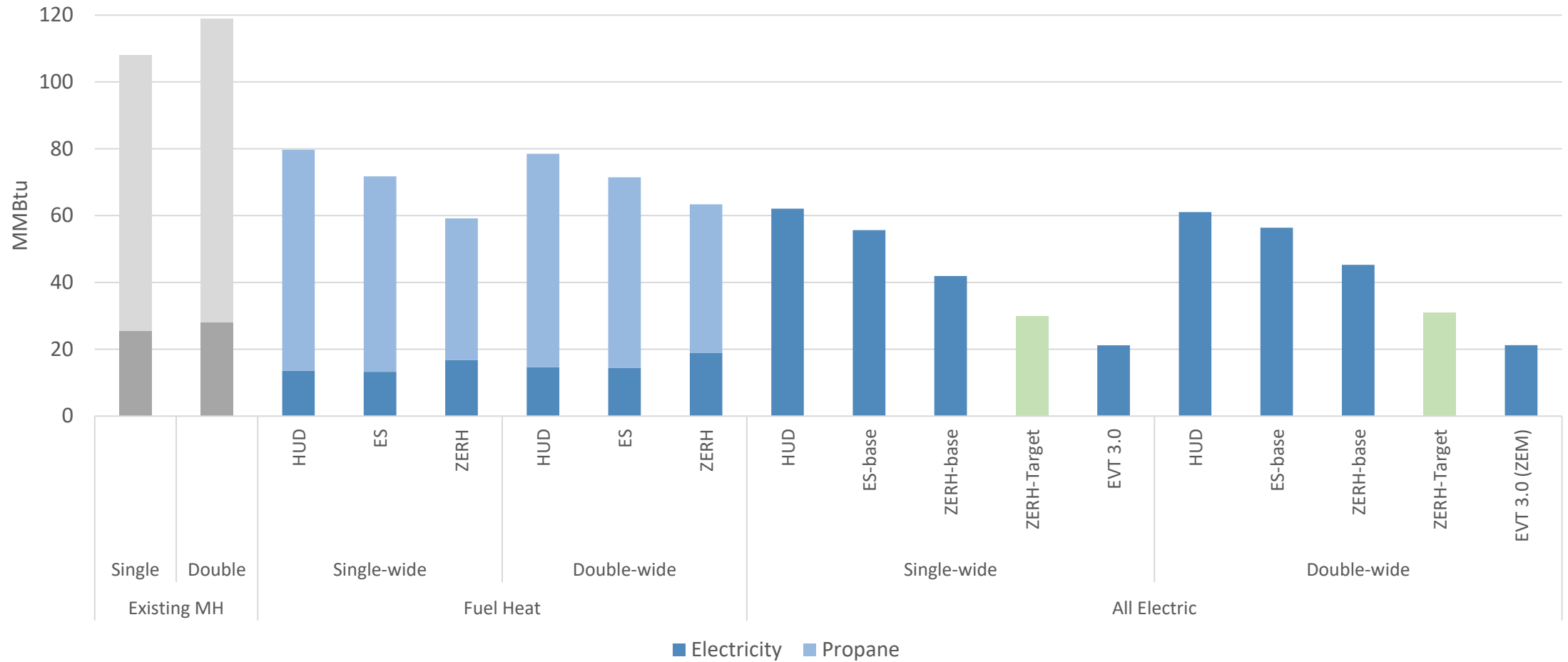
Example of DOE
ZERH Technical
Requirements

2 Air Sealing					
2.1 Sealing recessed lighting	Recessed lighting fixtures adjacent to unconditioned space must be ICAT (Insulation Contact Airtight) labeled and gasketed. ✓	DAPIA/QCM	IPIA	IPIA inspection	
2.2 Sealing exterior doors	Doors adjacent to unconditioned space (e.g., attics, garages, basements) or ambient conditions must be made substantially air-tight with weatherstripping or equivalent gasket. ✓	DAPIA/QCM	IPIA	IPIA inspection	
2.3 Sealing floor penetrations	All plumbing, electrical, and HVAC penetrations through the floor must be sealed at the floor, even where the floor is not serving as the air barrier. ✓	DAPIA/QCM	IPIA	IPIA inspection	
2.4 Sealing bottom board or belly board	In any installation where the bottom board or belly board is used as part of the air barrier, the perimeter and any seams in the bottom board or belly board must be sealed with caulk, foam, tape, gasket, or equivalent air sealing material. ✓	DAPIA/QCM	IPIA	IPIA inspection	

Example of DOE
ZERH Technical
Requirements

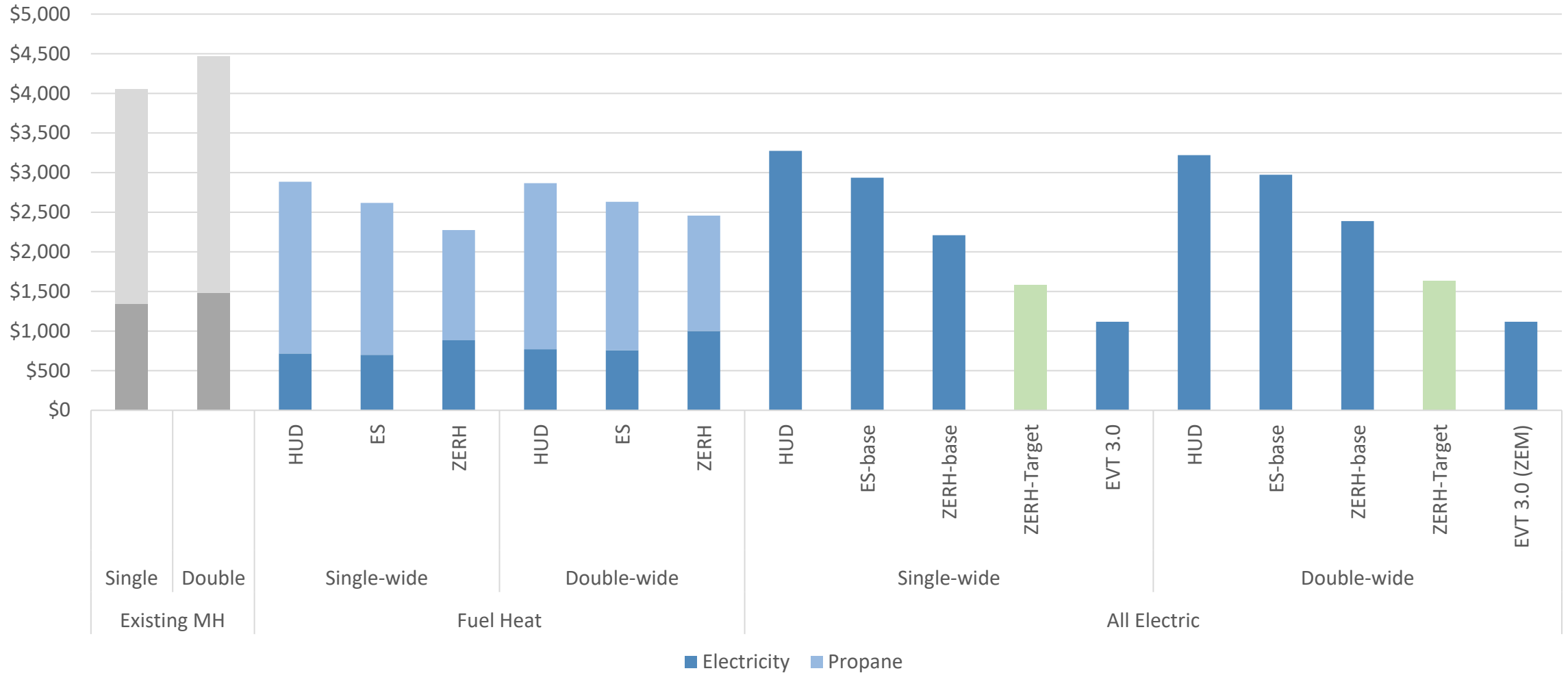
Renewable-Ready Features				
Measure	Technical Requirement	Documentation	Verification	Frequency
16 PV-Ready				
16.1 Documentation	Include in the installation manual information about the location of PV breaker space and conduit for PV panels. ✓	MIM	DAPIA	Every Home
16.2 Conduit to Inverter	Install a 1 in. electrical conduit, material as approved under the HUD Code, for wire run from the designated PV array location to the designated inverter location (cap and label both ends). ✓	DAPIA/QCM	DAPIA	As per standard plant inspection protocol
16.3 Conduit to service panel	Install a 1 in. electrical conduit, material as approved under the HUD Code, from designated inverter location to electrical service panel (Cap and label both ends). ✓	DAPIA/QCM	IPIA	As per standard plant inspection protocol
16.4 Circuit breaker slot requirement	Provide a labeled slot for a dual circuit pole breaker in the electrical service panel. Service panel must be sized and have space for a dual pole circuit breaker. ✓	DAPIA/QCM	IPA	As per standard plant inspection protocol

Modeled Annual Energy Consumption

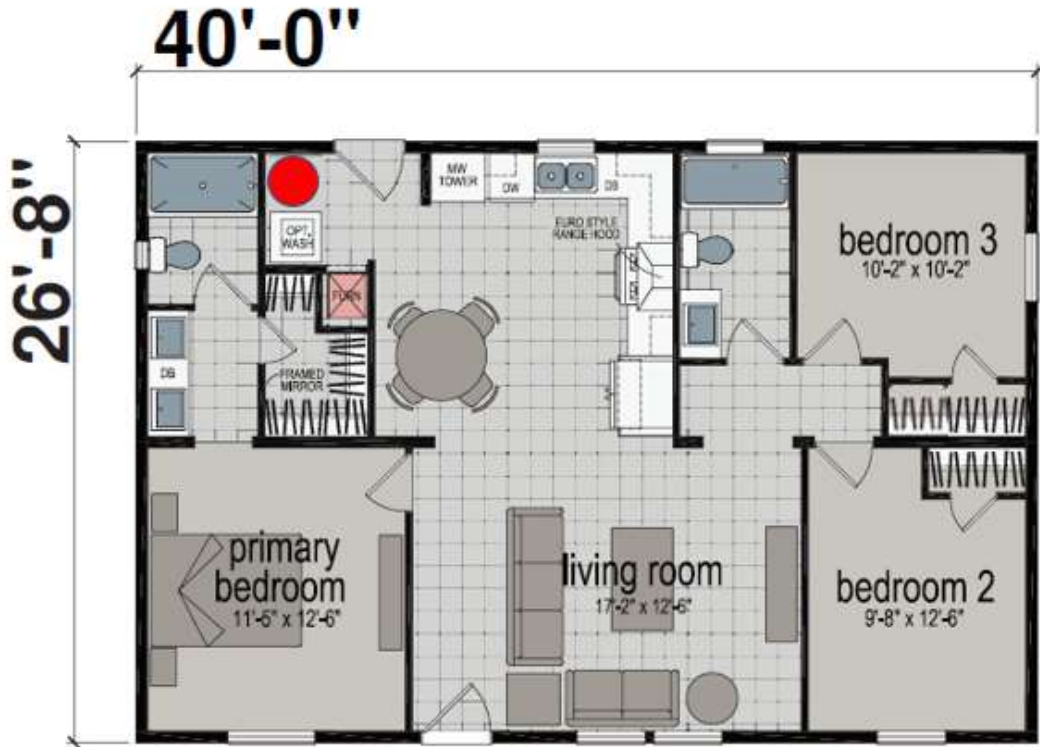


*Assumptions: 3,412 Btu/kWh (electricity); 91,452 Btu/gal (propane)

Modeled Annual Energy Costs



*Assumptions: \$0.18/kWh (electricity); \$3.00/gal (propane)



Costs	
\$ 65,850	Ascend Ideal 40 x 26'-8" 3BED 2BATH (948)
\$ 7,303	Options
\$ 4,983	Misc Charges
\$ 12,000	Foundation
\$ 4,000	Freight
\$ 10,000	Installation
\$ 5,000	Skirting
\$ 21,000	Solar PV (7kW)
\$ 6,000	Fridge, Dishwasher, Induction oven/range, range hood, Washer/Dryer
\$ 15,000	EE upgrades (heat pump, ERV, HPWH)
\$ 151,136	