

# Cost & Savings Estimates

ENERGY STAR  
Certified  
Manufactured New  
Homes, Version 3

January 17, 2025

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# ENERGY STAR Certified Manufactured New Homes, Version 3 Cost & Savings Estimates

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# ENERGY STAR Certified Manufactured New Homes, Version 3 Cost & Savings Estimates

## Section 1: Executive Summary

### Overview

This document is intended to provide partners, utility sponsors, and program designers with an estimate of the incremental costs to build, and associated savings from, an ENERGY STAR certified manufactured new home under Version 3 of the program requirements in each of the three Climate Zones established by the U.S. Department of Housing and Urban Development Code (HUD Code).

### Methodology

To complete this analysis, the EPA evaluated six single-section and eleven multi-section manufactured homes across the three HUD Climate Zones (CZ).<sup>1</sup>

The architectural characteristics for each home were determined using the Technical Support Document for the U.S. Department of Energy's Final Rule Establishing Energy Conservation Standards for Manufactured Housing (TSD).<sup>2</sup> Exhibit 1 shows the house parameters that were modeled consistently across all HUD Climate Zones.

**Exhibit 1: House Parameters Consistent Across Climate Zones**

Parameter	Single Section	Multi Section
Number of Stories	One	One
Conditioned Floor Area (ft <sup>2</sup> )	924	1,568
Foundation Type	Vented Crawlspace	Vented Crawlspace
Perimeter (ft)	66 x 14	56 x 28
Ceiling Height (ft)	7.5	7.5
Bedrooms	3	3
Window Area (% of Floor Area) & Distribution	12%, Even	12%, Even
Exterior Door Quantity & Total Area	2 Doors, 36 ft <sup>2</sup>	2 Doors, 36 ft <sup>2</sup>

Exhibit 2 shows the representative location used for each Climate Zone. Locations were selected by analyzing results from the TSD to select the city with the average energy consumption closest to the weighted average consumption for each Climate Zone, using the weighting factors from the TSD. Note that though El Paso is located in Texas (Climate Zone 1), it is used in the TSD analysis as a representative weather location for Climate Zone 2. While Albuquerque's energy consumption is the closest to the weighted average for Climate Zone 2, it has one of the lowest shipment weights. In contrast, El Paso's energy consumption is the second closest to the weighted average but has the highest shipment weight, making it the preferred selection for Climate Zone 2. Therefore, consistent with the TSD, this analysis used El Paso for Climate Zone 2.

**Exhibit 2: Representative Location Used for Each Climate Zone**

Climate Zone	CZ 1	CZ 2	CZ 3
Location	Houston, TX	El Paso, TX	Helena, MT

The energy efficiency features of the baseline homes were aligned with the federal Manufactured Home Construction and Safety Standards (commonly referred to as the HUD Code) contained in 24 CFR 3280, and as modeled in the TSD analysis.

To explain how the energy efficiency features of the ENERGY STAR certified manufactured new homes were selected, note that Version 3 of the ENERGY STAR Certified Manufactured New Home program includes mandatory requirements that all homes must meet, as defined in Exhibit 1 of that document. These mandatory requirements encompass mandatory energy efficiency features (e.g., related to the envelope, windows, doors, thermostat, and ductwork) as well as mandatory setup requirements. In this analysis, these are referred to as the Mandatory Requirements. Multi-section homes, in addition to meeting the Mandatory Requirements, must select one or more additional energy efficiency measures from Exhibit 2 of the program requirements to achieve a total of at least 10 (ten) points, with the Mandatory Requirements contributing to the 10-point total.

<sup>1</sup> Climate Zone 1 consists of Alabama, Florida, Georgia, Hawaii, Louisiana, Mississippi, South Carolina, and Texas. Climate Zone 2 consists of Arizona, Arkansas, California, Kansas, Kentucky, Missouri, New Mexico, North Carolina, Oklahoma, and Tennessee. Climate Zone 3 consists of all other states.

<sup>2</sup> See Docket ID: EERE-2009-BT-BC-0021-1999



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Exhibit 3 shows the HVAC Equipment Configurations that were modeled for the baseline and ENERGY STAR home for each of the 17 manufactured home scenarios. The exhibit also shows the efficiency measures used to demonstrate compliance with the program requirements for the purpose of this analysis. For single-section homes, this constitutes the Mandatory Requirements alone. For multi-section homes, this constitutes the sample packages that include the Mandatory Requirements plus efficiency measures that meet the 10-point requirement.

Exhibits 4-8 show the selected energy efficiency measures and corresponding point value from Exhibit 2 of Version 3 of the National Program Requirements for different Multi-Section Packages. The EPA selected the measures believed to be likely for home manufacturers to incorporate, though partners have flexibility to choose different measures to meet the program requirements. These energy efficiency features of the baseline homes and ENERGY STAR certified manufactured new homes are also summarized in Exhibits 10 through 26.

Note that for the Heat Pump Package, the baseline home was modeled with two different HVAC configurations – the first was an electric resistance furnace plus air conditioner, and the second was an air-source heat pump. Both configurations represent a possible baseline to which the Electric Heat Pump Package could be applied. Therefore, the costs and savings presented for this package represent a weighted value using the TSD assumption that 73% of HUD Code homes will have an electric resistance furnace, and 27% of HUD Code homes will have an air-source heat pump.

Also note that the Envelope-Only Package applies to Climate Zone 1 and 2 only. In Climate Zone 3, the Envelope-Only option could not achieve the required 10 points, so was paired with other measures as shown in the HPWH & Envelope Package.

**Exhibit 3: HVAC Equipment Configuration and Sample Packages to Meet the Program Requirements**

HUD Climate Zone	Sections	Baseline HVAC Equipment Configuration	ENERGY STAR HVAC Equipment Configuration	Sample ENERGY STAR Packages
1	Single	Electric Res. Furnace + AC	Electric Res. Furnace + AC	Mandatory Requirements
		Gas Furnace + AC	Gas Furnace + AC	Mandatory Requirements
	Multi	A: Electric Res. Furnace + AC B: Air-Source Heat Pump	Air-Source Heat Pump	Heat Pump Package
		Electric Res. Furnace + AC	Electric Res. Furnace + AC	HPWH Package
		Electric Res. Furnace + AC	Electric Res. Furnace + AC	Envelope-Only Package
		Gas Furnace + AC	Gas Furnace + AC	Gas Package
2	Single	Electric Res. Furnace + AC	Electric Res. Furnace + AC	Mandatory Requirements
		Gas Furnace + AC	Gas Furnace + AC	Mandatory Requirements
	Multi	A: Electric Res. Furnace + AC B: Air-Source Heat Pump	Air-Source Heat Pump	Heat Pump Package
		Electric Res. Furnace + AC	Electric Res. Furnace + AC	HPWH Package
		Electric Res. Furnace + AC	Electric Res. Furnace + AC	Envelope-Only Package
		Gas Furnace + AC	Gas Furnace + AC	Gas Package
3	Single	Electric Res. Furnace + AC	Electric Res. Furnace + AC	Mandatory Requirements



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		Gas Furnace + AC	Gas Furnace + AC	Mandatory Requirements
Multi		A: Electric Res. Furnace + AC B: Air-Source Heat Pump	Air-Source Heat Pump	Heat Pump Package
		Electric Res. Furnace + AC	Electric Res. Furnace + AC	HPWH & Envelope Package
		Gas Furnace + AC	Gas Furnace + AC	Gas Package

**Exhibit 4: Sample Heat Pump Package**

Selected Energy Efficiency Measures	Point Value		
	CZ 1	CZ 2	CZ 3
Mandatory Requirements	7.5	2.5	2.0
7.5 HSPF2 / 14.3 SEER2 Heat Pump	9.0	13.5	17

**Exhibit 5: Sample Heat Pump Water Heater (HPWH) Package**

Selected Energy Efficiency Measures	Point Value	
	CZ 1	CZ 2
Mandatory Requirements	7.5	2.5
2.20 UEF Heat Pump Water Heater	6	n/a
3.30 UEF Heat Pump Water Heater	n/a	7
LED Lighting installed in all permanent fixtures	n/a	0.5

**Exhibit 6: Sample Envelope-Only Package**

Selected Energy Efficiency Measures	Point Value	
	CZ 1	CZ 2
Mandatory Requirements	7.5	2.5
Coefficient of heat transmission ( $U_o$ ) $\leq$ 0.049 [Achieved using R-44 Ceiling, R-21 Walls, R-33 Floor, U-0.25 Windows, U-0.19 Doors]	12.0	9.5

**Exhibit 7: Sample HPWH & Envelope Package**

Selected Energy Efficiency Measures	Point Value
	CZ 3
Mandatory Requirements	2.0
3.30 UEF Heat Pump Water Heater	1.5
Coefficient of heat transmission ( $U_o$ ) $\leq$ 0.049 [Achieved using R-44 Ceiling, R-21 Walls, R-33 Floor, U-0.25 Windows, U-0.19 Doors]	4.5
LED Lighting installed in all permanent fixtures	0.5
Bathroom faucets $\leq$ 1.5 gallons per minute (gpm) and showerheads $\leq$ 2.0 gpm	0.5
ENERGY STAR certified refrigerator and dishwasher	0.5
ENERGY STAR certified clothes washer	0.5



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**Exhibit 8: Sample Gas Package**

Selected Energy Efficiency Measures	Point Value		
	CZ 1	CZ 2	CZ 3
Mandatory Requirements	7.5	2.5	2.0
95 AFUE Gas Furnace	n/a	3.5	7.5
0.93 UEF Gas Water Heater	4.5	3.5	n/a
LED Lighting installed in all permanently fixtures	n/a	0.5	0.5

To estimate energy savings, first, the baseline and ENERGY STAR home configurations were modeled in Ekotrope to determine the annual energy consumption.

Next, energy consumption for the baseline homes and ENERGY STAR certified manufactured new homes was converted to purchased energy costs using a national average rate of \$0.150 / kWh and \$1.422 / therm, as referenced from the Energy Information Administration’s 2022 Annual Energy Outlook. Finally, the purchased energy costs for the ENERGY STAR certified manufactured new homes were subtracted from those of the baseline homes to determine savings. Complete savings results for each of the homes modeled are presented in Appendix A.

The incremental costs for each ENERGY STAR certified manufactured new home were estimated next. For example, where the ENERGY STAR Certified Manufactured New Homes program requires a higher R-value of insulation (e.g., R-33 ceiling insulation instead of R-30), the additional cost for the insulation was included in the incremental costs for the program, because it is above and beyond the requirements of the HUD Code.

It is worth noting that the infiltration and duct leakage levels are not assumed to be improved relative to the HUD Code. Typical sealing practices are likely to result in lower levels than the minimum requirements of the HUD Code. However, because independent verification of these measures is not required, neither energy savings nor incremental costs have been accounted for.

ENERGY STAR certified manufactured new homes must be produced in a plant certified by an EPA-recognized Quality Assurance Provider (QAP) that ensures the plant’s home design packages intended for ENERGY STAR certification meet the program requirements. The plant and the QAP will follow procedures developed during the plant certification process, but those procedures are specific to the QAP, and they are expected to require minimal incremental effort relative to the processes already established by the HUD Code. Therefore, neither energy savings nor incremental costs for QAP processes have been accounted for.

For multi-section homes, the program includes two mandatory requirements, in addition to the energy efficiency measures selected from Exhibit 2 of the ENERGY STAR Certified Manufactured New Homes Version 3 program requirements – the inclusion of a marriage line seal during production at the plant and sealing of crossover ducts in the field. Neither energy savings nor incremental costs for the mandatory requirements have been accounted for because they are also required by the HUD Code.



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### Results & Discussion

Exhibit 9 summarizes the annual purchased energy costs for each baseline and ENERGY STAR certified manufactured new home. In addition, it summarizes the annual purchased energy savings and the total upgrade cost for each ENERGY STAR certified manufactured new home, and the resulting monthly purchased energy savings, monthly mortgage upgrade cost, and net cash flow. The monthly mortgage upgrade cost was calculated assuming a 30-year fixed-rate mortgage with a 5.0% interest rate.

**Exhibit 9: ENERGY STAR v3 Certified Manufactured New Home vs HUD Code Home, Illustrative Cost & Savings Summary**

CZ	Home Size	Package	Heating Fuel	HUD Code	ENERGY STAR Manufactured Home Version 3						
				Annual Purchased Energy Costs	Annual Purchased Energy Costs	Annual Purchased Energy Savings	Total Upgrade Cost	Monthly Purchased Energy Savings	Monthly Mortgage Upgrade Cost	Net Cash Flow	
1	Single	Mandatory Reqs	Electric	\$2,099	\$1,702	\$397	19%	\$2,865	\$33	\$15	\$18
1	Single	Mandatory Reqs	Natural Gas	\$1,492	\$1,236	\$256	17%	\$2,865	\$21	\$15	\$6
1	Multi	Heat Pump	Electric	\$2,139	\$1,744	\$396	18%	\$2,372	\$33	\$13	\$20
1	Multi	HPWH	Electric	\$2,245	\$1,957	\$288	13%	\$2,354	\$24	\$13	\$11
1	Multi	Envelope-Only	Electric	\$2,245	\$1,784	\$461	21%	\$4,786	\$38	\$26	\$13
1	Multi	Gas	Natural Gas	\$1,628	\$1,453	\$175	11%	\$2,363	\$15	\$13	\$2
2	Single	Mandatory Reqs	Electric	\$2,040	\$1,695	\$345	17%	\$2,692	\$29	\$14	\$14
2	Single	Mandatory Reqs	Natural Gas	\$1,345	\$1,135	\$210	16%	\$2,692	\$18	\$14	\$3
2	Multi	Heat Pump	Electric	\$2,052	\$1,679	\$372	18%	\$1,230	\$31	\$7	\$24
2	Multi	HPWH	Electric	\$2,175	\$1,962	\$213	10%	\$1,767	\$18	\$9	\$8
2	Multi	Envelope-Only	Electric	\$2,175	\$1,877	\$298	14%	\$2,880	\$25	\$15	\$9
2	Multi	Gas	Natural Gas	\$1,458	\$1,311	\$148	10%	\$1,954	\$12	\$10	\$2
3	Single	Mandatory Reqs	Electric	\$3,569	\$2,887	\$682	19%	\$2,133	\$57	\$11	\$45
3	Single	Mandatory Reqs	Natural Gas	\$1,784	\$1,487	\$297	17%	\$2,133	\$25	\$11	\$13
3	Multi	Heat Pump	Electric	\$3,528	\$2,773	\$755	21%	\$1,069	\$63	\$6	\$57
3	Multi	HPWH & Envelope	Electric	\$3,783	\$3,393	\$390	10%	\$2,740	\$32	\$15	\$18
3	Multi	Gas	Natural Gas	\$1,953	\$1,761	\$192	10%	\$1,036	\$16	\$6	\$10

Section 2 contains Exhibits 10 through 26, which contain a more detailed breakout of the incremental upgrade costs presented for each home in Exhibit 9.

This analysis only accounted for above-code requirements; an approach that was pursued for two reasons. The first reason is that code is a well-defined baseline from which costs and savings can be consistently evaluated. In contrast, standard practice often varies from code-minimum requirements (both below-code and above-code) and is therefore difficult to consistently benchmark against. The second reason for this approach is that most utility-sponsored programs are not able to claim savings for improvements from below-code to code-minimum practices. Therefore, estimating the incremental costs and savings only for the above-code measures of the ENERGY STAR Certified Manufactured New Homes program makes the analysis more relevant to utility sponsors and partners that wish to improve practices above code.

While this analysis provides illustrative incremental costs and savings, these values will vary for any specific certified home, dependent on variables such as baseline



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construction practices, geographic location, house design, and vendor relationships. For example, plants are likely to experience lower incremental costs than stated in this document if they are able to procure equipment or materials at lower rates or if they already build above code-minimum requirements. In addition, many partners achieve decreasing costs over time as they gain experience and develop more cost-effective strategies to meet the program requirements. Therefore, these estimates are only illustrative and are likely to represent the higher end of the cost spectrum.

Section 3 provides references and additional details of the incremental costs associated with each of the features required by the program.

### **Section 2: Detailed Incremental Cost Estimates**

Exhibits 10 through 26 contain a more detailed explanation of the incremental upgrade costs presented for each home in Exhibit 9. For each measure, the exhibit lists the HUD Code baseline requirement, the ENERGY STAR Certified Manufactured New Homes, Version 3 requirement, the incremental unit cost, the quantity of units per home, the cost units (e.g., square feet of conditioned floor area), and the total incremental measure cost.

**Exhibit 10: ENERGY STAR Manufactured Home v3 vs HUD code - Zone 1 - Single Section – Electric Home**

Measure	HUD Baseline	ENERGY STAR v3	Incremental Unit Cost	Cost Qty	Cost Unit	Inc. Cost
<b>Heating, Cooling, Water Heating Equipment Measures</b>						
Space Heating	Elec. Resistance Heater	100% AFUE	100% AFUE	-	-	-
Space Cooling	AC	14.3 SEER2	14.3 SEER2	-	-	-
Water Heating	Electric	0.93 UEF / 40 gal, Storage	0.93 UEF / 40 gal, Storage	-	-	-
Sub-Total of Heating and Cooling Equipment Measures						-
<b>Envelope &amp; Glazing Measures</b>						
Wall Insulation	R-13	R-13	-	-	-	-
Ceiling Insulation	R-22	R-33	\$0.68	924	Insul. Surf. Area (ft <sup>2</sup> )	\$630
Floor Insulation	R-22	R-22	-	-	-	-
Infiltration (ACH50)	5	5	-	-	-	-
Windows	U-value: 1.08 / SHGC: 0.70	U-value: 0.30 / SHGC: 0.25	\$20.15	111	Surf. Area (ft <sup>2</sup> )	\$2,235
Doors U-Factor	0.40	0.40	-	-	-	-
Sub-Total of Envelope & Glazing Measures						<b>\$2,865</b>
<b>Thermostat &amp; Ductwork Measures</b>						
Thermostat	Programmable	Programmable	-	-	-	-
Duct Location	Crawlspace	Crawlspace	-	-	-	-
Duct Insulation	R-22	R-22	(Cost included in Floor Insulation)			-
Duct Leakage	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	-	-	-	-
Sub-Total of Thermostat & Ductwork Measures						-
<b>Other Measures</b>						
Kitchen Appliances	Federal Min.	Federal Min.	-	-	-	-
Water Fixtures	Standard	Standard	-	-	-	-
High-Efficiency Lighting	50% LED 50% CFL	50% LED 50% CFL	-	-	-	-
Sub-Total of Other Measures						-
<b>Total Incremental Cost for the Home</b>						<b>\$2,865</b>



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Exhibit 11: ENERGY STAR Manufactured Home v3 vs HUD code – Climate Zone 2 - Single Section – Electric Home

Measure	HUD Baseline	ENERGY STAR v3	Incremental Unit Cost	Cost Qty	Cost Unit	Inc. Cost
<b>Heating, Cooling, Water Heating Equipment Measures</b>						
Space Heating	Elec. Resistance Heater	100% AFUE	100% AFUE	-	-	-
Space Cooling	AC	14.3 SEER2	14.3 SEER2	-	-	-
Water Heating	Electric	0.93 UEF / 40 gal, Storage	0.93 UEF / 40 gal, Storage	-	-	-
Sub-Total of Heating and Cooling Equipment Measures						-
<b>Envelope &amp; Glazing Measures</b>						
Wall Insulation	R-13	R-21	\$0.65	1,200	Insul. Surf. Area (ft <sup>2</sup> )	\$776
Ceiling Insulation	R-22	R-33	\$0.68	924	Insul. Surf. Area (ft <sup>2</sup> )	\$630
Floor Insulation	R-19	R-22	\$0.15	924	Insul. Surf. Area (ft <sup>2</sup> )	\$142
Infiltration (ACH50)	5	5	-	-	-	-
Windows	U-value: 0.50 / SHGC: 0.60	U-value: 0.30 / SHGC: 0.25	\$10.32	111	Surf. Area (ft <sup>2</sup> )	\$1,144
Doors U-Factor	0.40	0.40	-	-	-	-
Sub-Total of Envelope & Glazing Measures						\$2,692
<b>Thermostat &amp; Ductwork Measures</b>						
Thermostat	Programmable	Programmable	-	-	-	-
Duct Location	Crawlspace	Crawlspace	-	-	-	-
Duct Insulation	R-19	R-22	(Cost included in Floor Insulation)			-
Duct Leakage	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	-	-	-	-
Sub-Total of Thermostat & Ductwork Measures						-
<b>Other Measures</b>						
Kitchen Appliances	Federal Min.	Federal Min.	-	-	-	-
Water Fixtures	Standard	Standard	-	-	-	-
High-Efficiency Lighting	50% LED 50% CFL	50% LED 50% CFL	-	-	-	-
Sub-Total of Other Measures						-
<b>Total Incremental Cost for the Home</b>						<b>\$2,692</b>



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Exhibit 12: ENERGY STAR Manufactured Homes v3 vs HUD Code - Climate Zone 3 - Single Section – Electric Home

Measure	HUD Baseline	ENERGY STAR v3	Incremental Unit Cost	Cost Qty	Cost Unit	Inc. Cost
<b>Heating, Cooling, Water Heating Equipment Measures</b>						
Space Heating	Elec. Resistance Heater	100% AFUE	100% AFUE	-	-	-
Space Cooling	AC	13.4 SEER2	13.4 SEER2	-	-	-
Water Heating	Electric	0.93 UEF / 40 gal, Storage	0.93 UEF / 40 gal, Storage	-	-	-
Sub-Total of Heating and Cooling Equipment Measures						-
<b>Envelope &amp; Glazing Measures</b>						
Wall Insulation	R-19	R-21	\$0.12	1,200	Insul. Surf. Area (ft <sup>2</sup> )	\$146
Ceiling Insulation	R-22	R-38	\$0.97	924	Insul. Surf. Area (ft <sup>2</sup> )	\$897
Floor Insulation	R-22	R-33	\$0.63	924	Insul. Surf. Area (ft <sup>2</sup> )	\$582
Infiltration (ACH50)	5	5	-	-	-	-
Windows	U-value: 0.35 / SHGC: 0.33	U-value: 0.30 / SHGC: 0.33	\$4.18	111	Surf. Area (ft <sup>2</sup> )	\$464
Doors U-Factor	0.40	0.30	\$1.25	36	Surf. Area (ft <sup>2</sup> )	\$45
Sub-Total of Envelope & Glazing Measures						\$2,133
<b>Thermostat &amp; Ductwork Measures</b>						
Thermostat	Programmable	Programmable	-	-	-	-
Duct Location	Crawlspace	Crawlspace	-	-	-	-
Duct Insulation	R-22	R-33	(Cost included in Floor Insulation)			-
Duct Leakage	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	-	-	-	-
Sub-Total of Thermostat & Ductwork Measures						-
<b>Other Measures</b>						
Kitchen Appliances	Federal Min.	Federal Min.	-	-	-	-
Water Fixtures	Standard	Standard	-	-	-	-
High-Efficiency Lighting	50% LED 50% CFL	50% LED 50% CFL	-	-	-	-
Sub-Total of Other Measures						-
<b>Total Incremental Cost for the Home</b>						<b>\$2,133</b>



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Exhibit 13: ENERGY STAR Manufactured Homes v3 vs HUD Code - Climate Zone 1 – Single Section - Gas Home

Measure	HUD Baseline	ENERGY STAR v3	Incremental Unit Cost	Cost Qty	Cost Unit	Inc. Cost
<b>Heating, Cooling, Water Heating Equipment Measures</b>						
Space Heating	Gas Furnace	80% AFUE	80% AFUE	-	-	-
Space Cooling	AC	14.3 SEER2	14.3 SEER2	-	-	-
Water Heating	Gas	0.60 UEF / 40 gal, Storage	0.60 UEF / 40 gal, Storage	-	-	-
Sub-Total of Heating and Cooling Equipment Measures						-
<b>Envelope &amp; Glazing Measures</b>						
Wall Insulation	R-13	R-13	-	-	-	-
Ceiling Insulation	R-22	R-33	\$0.68	924	Insul. Surf. Area (ft <sup>2</sup> )	\$630
Floor Insulation	R-22	R-22	-	-	-	-
Infiltration (ACH50)	5	5	-	-	-	-
Windows	U-value: 1.08 / SHGC: 0.70	U-value: 0.30 / SHGC: 0.25	\$20.15	111	Surf. Area (ft <sup>2</sup> )	\$2,235
Doors U-Factor	0.40	0.40	-	-	-	-
Sub-Total of Envelope & Glazing Measures						\$2,865
<b>Thermostat &amp; Ductwork Measures</b>						
Thermostat	Programmable	Programmable	-	-	-	-
Duct Location	Crawlspace	Crawlspace	-	-	-	-
Duct Insulation	R-22	R-22	(Cost included in Floor Insulation)			-
Duct Leakage	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	-	-	-	-
Sub-Total of Thermostat & Ductwork Measures						-
<b>Other Measures</b>						
Kitchen Appliances	Federal Min.	Federal Min.	-	-	-	-
Water Fixtures	Standard	Standard	-	-	-	-
High-Efficiency Lighting	50% LED 50% CFL	50% LED 50% CFL	-	-	-	-
Sub-Total of Other Measures						-
<b>Total Incremental Cost for the Home</b>						<b>\$2,865</b>



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Exhibit 14: ENERGY STAR Manufactured Homes v3 vs HUD Code - Climate Zone 2 – Single Section - Gas Home

Measure	HUD Baseline	ENERGY STAR v3	Incremental Unit Cost	Cost Qty	Cost Unit	Inc. Cost
<b>Heating, Cooling, Water Heating Equipment Measures</b>						
Space Heating	Gas Furnace	80% AFUE	80% AFUE	-	-	-
Space Cooling	AC	14.3 SEER2	14.3 SEER2	-	-	-
Water Heating	Gas	0.60 UEF / 40 gal, Storage	0.60 UEF / 40 gal, Storage	-	-	-
Sub-Total of Heating and Cooling Equipment Measures						-
<b>Envelope &amp; Glazing Measures</b>						
Wall Insulation	R-13	R-21	\$0.65	1,200	Insul. Surf. Area (ft <sup>2</sup> )	\$776
Ceiling Insulation	R-22	R-33	\$0.68	924	Insul. Surf. Area (ft <sup>2</sup> )	\$630
Floor Insulation	R-19	R-22	\$0.15	924	Insul. Surf. Area (ft <sup>2</sup> )	\$142
Infiltration (ACH50)	5	5	-	-	-	-
Windows	U-value: 0.50 / SHGC: 0.60	U-value: 0.30 / SHGC: 0.25	\$10.32	111	Surf. Area (ft <sup>2</sup> )	\$1,144
Doors U-Factor	0.40	0.40	-	-	-	-
Sub-Total of Envelope & Glazing Measures						\$2,692
<b>Thermostat &amp; Ductwork Measures</b>						
Thermostat	Programmable	Programmable	-	1	System	-
Duct Location	Crawlspace	Crawlspace	-	-	-	-
Duct Insulation	R-19	R-22	(Cost included in Floor Insulation)			-
Duct Leakage	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	-	-	-	-
Sub-Total of Thermostat & Ductwork Measures						-
<b>Other Measures</b>						
Kitchen Appliances	Federal Min.	Federal Min.	-	-	-	-
Water Fixtures	Standard	Standard	-	-	-	-
High-Efficiency Lighting	50% LED 50% CFL	50% LED 50% CFL	-	-	-	-
Sub-Total of Other Measures						-
<b>Total Incremental Cost for the Home</b>						<b>\$2,692</b>



# ENERGY STAR Certified Manufactured New Homes, Version 3

## Cost & Savings Estimates

**Exhibit 15: ENERGY STAR Manufactured Homes v3 vs HUD Code - Climate Zone 3 – Single Section – Gas Home**

Measure	HUD Baseline	ENERGY STAR v3	Incremental Unit Cost	Cost Qty	Cost Unit	Inc. Cost
<b>Heating, Cooling, Water Heating Equipment Measures</b>						
Space Heating	Gas Furnace	80% AFUE	80% AFUE	-	-	-
Space Cooling	AC	13.4 SEER2	13.4 SEER2	-	-	-
Water Heating	Gas	0.60 UEF / 40 gal, Storage	0.60 UEF / 40 gal, Storage	-	-	-
Sub-Total of Heating and Cooling Equipment Measures						-
<b>Envelope &amp; Glazing Measures</b>						
Wall Insulation	R-19	R-21	\$0.12	1,200	Insul. Surf. Area (ft <sup>2</sup> )	\$146
Ceiling Insulation	R-22	R-38	\$0.97	924	Insul. Surf. Area (ft <sup>2</sup> )	\$897
Floor Insulation	R-22	R-33	\$0.63	924	Insul. Surf. Area (ft <sup>2</sup> )	\$582
Infiltration (ACH50)	5	5	-	-	-	-
Windows	U-value: 0.35 / SHGC: 0.33	U-value: 0.30 / SHGC: 0.33	\$4.18	111	Surf. Area (ft <sup>2</sup> )	\$464
Doors U-Factor	0.40	0.30	\$1.25	36	Surf. Area (ft <sup>2</sup> )	\$45
Sub-Total of Envelope & Glazing Measures						\$2,133
<b>Thermostat &amp; Ductwork Measures</b>						
Thermostat	Programmable	Programmable	-	-	-	-
Duct Location	Crawlspace	Crawlspace	-	-	-	-
Duct Insulation	R-22	R-33	(Cost included in Floor Insulation)			-
Duct Leakage	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	-	-	-	-
Sub-Total of Thermostat & Ductwork Measures						-
<b>Other Measures</b>						
Kitchen Appliances	Federal Min.	Federal Min.	-	-	-	-
Water Fixtures	Standard	Standard	-	-	-	-
High-Efficiency Lighting	50% LED 50% CFL	50% LED 50% CFL	-	-	-	-
Sub-Total of Other Measures						-
<b>Total Incremental Cost for the Home</b>						<b>\$2,133</b>



# ENERGY STAR Certified Manufactured New Homes, Version 3

## Cost & Savings Estimates

Exhibit 16: ENERGY STAR Manufactured Homes v3 vs HUD Code - Climate Zone 1 - Multi Section – Heat Pump Package

Measure	HUD Baseline	ENERGY STAR v3	Incremental Unit Cost	Cost Qty	Cost Unit	Inc. Cost	
<b>Heating, Cooling, Water Heating Equipment Measures</b>							
Space Heating	Elec. Resistance Heater	100% AFUE	7.5 HSPF2	\$1,050.00	1	System	-
	Heat Pump	7.5 HSPF2	7.5 HSPF2	-	-	-	-
	Weighted Average			\$766.50	1	System	\$767
Space Cooling	AC	14.3 SEER2	14.3 SEER2	-	-	-	-
	Heat Pump	14.3 SEER2	14.3 SEER2	-	-	-	-
	Weighted Average			-	-	-	-
Water Heating	Electric	0.93 UEF / 40 gal, Storage	0.93 UEF / 40 gal, Storage	-	-	-	-
Sub-Total of Heating and Cooling Equipment Measures							<b>\$767</b>
<b>Envelope &amp; Glazing Measures</b>							
Wall Insulation	R-13	R-13	-	-	-	-	
Ceiling Insulation	R-30	R-33	\$0.14	1,568	Insul. Surf. Area (ft <sup>2</sup> )	\$223	
Floor Insulation	R-13	R-22	\$0.25	1,568	Insul. Surf. Area (ft <sup>2</sup> )	\$386	
Infiltration (ACH50)	5	5	-	-	-	-	
Windows	U-value: 0.32 / SHGC: 0.33	U-value: 0.30 / SHGC: 0.25	\$5.30	188	Surf. Area (ft <sup>2</sup> )	\$997	
Doors U-Factor	0.40	0.40	-	-	-	-	
Sub-Total of Envelope & Glazing Measures							<b>\$1,605</b>
<b>Thermostat &amp; Ductwork Measures</b>							
Thermostat	Programmable	Programmable	-	-	-	-	
Duct Location	Crawlspace	Crawlspace	-	-	-	-	
Duct Insulation	R-13	R-22	(Cost included in Floor Insulation)			-	
Duct Leakage	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	-	-	-	-	
Sub-Total of Thermostat & Ductwork Measures							-
<b>Other Measures</b>							
Kitchen Appliances	Federal Min.	Federal Min.	-	-	-	-	
Water Fixtures	Standard	Standard	-	-	-	-	
High-Efficiency Lighting	50% LED 50% CFL	50% LED 50% CFL	-	-	-	-	
Sub-Total of Other Measures							-
<b>Total Incremental Cost for the Home</b>							<b>\$2,372</b>



# ENERGY STAR Certified Manufactured New Homes, Version 3

## Cost & Savings Estimates

Exhibit 17: ENERGY STAR Manufactured Homes v3 vs HUD Code - Climate Zone 2 - Multi Section – Heat Pump Package

Measure	HUD Baseline	ENERGY STAR v3	Incremental Unit Cost	Cost Qty	Cost Unit	Inc. Cost	
<b>Heating, Cooling, Water Heating Equipment Measures</b>							
Space Heating	Elec. Resistance Heater	100% AFUE	7.5 HSPF2	\$1,050.00	1	System	-
	Heat Pump	7.5 HSPF2	7.5 HSPF2	-	-	-	-
	Weighted Average			\$766.50	1	System	\$767
Space Cooling	AC	14.3 SEER2	14.3 SEER2	-	-	-	-
	Heat Pump	14.3 SEER2	14.3 SEER2	-	-	-	-
	Weighted Average			-	-	-	-
Water Heating	Electric	0.93 UEF / 40 gal, Storage	0.93 UEF / 40 gal, Storage	-	-	-	-
Sub-Total of Heating and Cooling Equipment Measures							\$767
<b>Envelope &amp; Glazing Measures</b>							
Wall Insulation	R-21	R-21	-	-	-	-	
Ceiling Insulation	R-30	R-33	\$0.14	1,568	Insul. Surf. Area (ft²)	\$223	
Floor Insulation	R-19	R-22	\$0.15	1,568	Insul. Surf. Area (ft²)	\$241	
Infiltration (ACH50)	5	5	-	-	-	-	
Windows	U-value: 0.30 / SHGC: 0.25	U-value: 0.30 / SHGC: 0.25	-	-	-	-	
Doors U-Factor	0.40	0.40	-	-	-	-	
Sub-Total of Envelope & Glazing Measures							\$463
<b>Thermostat &amp; Ductwork Measures</b>							
Thermostat	Programmable	Programmable	-	-	-	-	
Duct Location	Crawlspace	Crawlspace	-	-	-	-	
Duct Insulation	R-19	R-22	(Cost included in Floor Insulation)			-	
Duct Leakage	4 CFM per 100 ft² of CFA @ Rough-In	4 CFM per 100 ft² of CFA @ Rough-In	-	-	-	-	
Sub-Total of Thermostat & Ductwork Measures							-
<b>Other Measures</b>							
Kitchen Appliances	Federal Min.	Federal Min.	-	-	-	-	
Water Fixtures	Standard	Standard	-	-	-	-	
High-Efficiency Lighting	50% LED 50% CFL	50% LED 50% CFL	-	-	-	-	
Sub-Total of Other Measures							-
<b>Total Incremental Cost for the Home</b>							<b>\$1,230</b>



# ENERGY STAR Certified Manufactured New Homes, Version 3

## Cost & Savings Estimates

Exhibit 18: ENERGY STAR Manufactured Homes v3 vs HUD Code - Climate Zone 3 - Multi Section – Heat Pump Package

Measure	HUD Baseline	ENERGY STAR v3	Incremental Unit Cost	Cost Qty	Cost Unit	Inc. Cost	
<b>Heating, Cooling, Water Heating Equipment Measures</b>							
Space Heating	Elec. Resistance Heater	100% AFUE	7.5 HSPF2	\$1,050.00	1	System	-
	Heat Pump	7.5 HSPF2	7.5 HSPF2	-	-	-	-
	Weighted Average			\$766.50	1	System	\$767
Space Cooling	AC	13.4 SEER2	14.3 SEER2	(Cost included in Space Heating)			-
	Heat Pump	14.3 SEER2	14.3 SEER2	-	-	-	-
	Weighted Average			-	-	-	-
Water Heating	Electric	0.93 UEF / 40 gal, Storage	0.93 UEF / 40 gal, Storage	-	-	-	-
Sub-Total of Heating and Cooling Equipment Measures							\$767
<b>Envelope &amp; Glazing Measures</b>							
Wall Insulation	R-21	R-21	-	-	-	-	
Ceiling Insulation	R-38	R-38	-	-	-	-	
Floor Insulation	R-30	R-33	\$0.16	1,568	Insul. Surf. Area (ft²)	\$258	
Infiltration (ACH50)	5	5	-	-	-	-	
Windows	U-value: 0.30 / SHGC: 0.25	U-value: 0.30 / SHGC: 0.25	-	-	-	-	
Doors U-Factor	0.40	0.30	\$1.25	36	Surf. Area (ft²)	\$45	
Sub-Total of Envelope & Glazing Measures							\$303
<b>Thermostat &amp; Ductwork Measures</b>							
Thermostat	Programmable	Programmable	-	-	-	-	
Duct Location	Crawlspace	Crawlspace	-	-	-	-	
Duct Insulation	R-30	R-33	(Cost included in Floor Insulation)			-	
Duct Leakage	4 CFM per 100 ft² of CFA @ Rough-In	4 CFM per 100 ft² of CFA @ Rough-In	-	-	-	-	
Sub-Total of Thermostat & Ductwork Measures							-
<b>Other Measures</b>							
Kitchen Appliances	Federal Min.	Federal Min.	-	-	-	-	
Water Fixtures	Standard	Standard	-	-	-	-	
High-Efficiency Lighting	50% LED 50% CFL	50% LED 50% CFL	-	-	-	-	
Sub-Total of Other Measures							-
<b>Total Incremental Cost for the Home</b>							<b>\$1,069</b>



# ENERGY STAR Certified Manufactured New Homes, Version 3

## Cost & Savings Estimates

Exhibit 19: ENERGY STAR Manufactured Homes v3 vs HUD Code - Climate Zone 1 - Multi Section – Heat Pump Water Heater Package

Measure	HUD Baseline	ENERGY STAR v3	Incremental Unit Cost	Cost Qty	Cost Unit	Inc. Cost	
<b>Heating, Cooling, Water Heating Equipment Measures</b>							
Space Heating	Elec. Resistance Heater	100% AFUE	100% AFUE	-	-	-	
Space Cooling	AC	14.3 SEER2	14.3 SEER2	-	-	-	
Water Heating	Electric	0.93 UEF / 40 gal, Storage	2.20 UEF HPWH, Storage	\$748.44	1	System	\$748
Sub-Total of Heating and Cooling Equipment Measures						\$748	
<b>Envelope &amp; Glazing Measures</b>							
Wall Insulation	R-13	R-13	-	-	-	-	
Ceiling Insulation	R-30	R-33	\$0.14	1,568	Insul. Surf. Area (ft <sup>2</sup> )	\$223	
Floor Insulation	R-13	R-22	\$0.25	1,568	Insul. Surf. Area (ft <sup>2</sup> )	\$386	
Infiltration (ACH50)	5	5	-	-	-	-	
Windows	U-value: 0.32 / SHGC: 0.33	U-value: 0.30 / SHGC: 0.25	\$5.30	188	Surf. Area (ft <sup>2</sup> )	\$997	
Doors U-Factor	0.40	0.40	-	-	-	-	
Sub-Total of Envelope & Glazing Measures						\$1,605	
<b>Thermostat &amp; Ductwork Measures</b>							
Thermostat	Programmable	Programmable	-	-	-	-	
Duct Location	Crawlspace	Crawlspace	-	-	-	-	
Duct Insulation	R-13	R-22	(Cost included in Floor Insulation)			-	
Duct Leakage	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	-	-	-	-	
Sub-Total of Thermostat & Ductwork Measures						-	
<b>Other Measures</b>							
Kitchen Appliances	Federal Min.	Federal Min.	-	-	-	-	
Water Fixtures	Standard	Standard	-	-	-	-	
High-Efficiency Lighting	50% LED 50% CFL	50% LED 50% CFL	-	-	-	-	
Sub-Total of Other Measures						-	
<b>Total Incremental Cost for the Home</b>						<b>\$2,354</b>	



# ENERGY STAR Certified Manufactured New Homes, Version 3

## Cost & Savings Estimates

Exhibit 20: ENERGY STAR Manufactured Homes v3 vs HUD Code - Climate Zone 2 - Multi Section – Heat Pump Water Heater Package

Measure	HUD Baseline	ENERGY STAR v3	Incremental Unit Cost	Cost Qty	Cost Unit	Inc. Cost	
<b>Heating, Cooling, Water Heating Equipment Measures</b>							
Space Heating	Elec. Resistance Heater	100% AFUE	100% AFUE	-	-	-	
Space Cooling	AC	14.3 SEER2	14.3 SEER2	-	-	-	
Water Heating	Electric	0.93 UEF / 40 gal, Storage	3.30 UEF HPWH, Storage	\$1,271.76	1	System	\$1,272
Sub-Total of Heating and Cooling Equipment Measures						\$1,272	
<b>Envelope &amp; Glazing Measures</b>							
Wall Insulation	R-21	R-21	-	-	-	-	
Ceiling Insulation	R-30	R-33	\$0.14	1,568	Insul. Surf. Area (ft <sup>2</sup> )	\$223	
Floor Insulation	R-19	R-22	\$0.15	1,568	Insul. Surf. Area (ft <sup>2</sup> )	\$241	
Infiltration (ACH50)	5	5	-	-	-	-	
Windows	U-value: 0.30 / SHGC: 0.25	U-value: 0.30 / SHGC: 0.25	-	-	-	-	
Doors U-Factor	0.40	0.40	-	-	-	-	
Sub-Total of Envelope & Glazing Measures						\$463	
<b>Thermostat &amp; Ductwork Measures</b>							
Thermostat	Programmable	Programmable	-	-	-	-	
Duct Location	Crawlspace	Crawlspace	-	-	-	-	
Duct Insulation	R-19	R-22	(Cost included in Floor Insulation)			-	
Duct Leakage	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	-	-	-	-	
Sub-Total of Thermostat & Ductwork Measures						-	
<b>Other Measures</b>							
Kitchen Appliances	Federal Min.	Federal Min.	-	-	-	-	
Water Fixtures	Standard	Standard	-	-	-	-	
High-Efficiency Lighting	50% LED 50% CFL	100% LED	\$0.02	1,568	CFA (ft <sup>2</sup> )	\$32	
Sub-Total of Other Measures						\$32	
<b>Total Incremental Cost for the Home</b>						<b>\$1,767</b>	



# ENERGY STAR Certified Manufactured New Homes, Version 3

## Cost & Savings Estimates

**Exhibit 21: ENERGY STAR Manufactured Homes v3 vs HUD Code - Climate Zone 3 - Multi Section – HPWH & Envelope Package**

Measure	HUD Baseline	ENERGY STAR v3	Incremental Unit Cost	Cost Qty	Cost Unit	Inc. Cost	
<b>Heating, Cooling, Water Heating Equipment Measures</b>							
Space Heating	Elec. Resistance Heater	100% AFUE	100% AFUE	-	-	-	
Space Cooling	AC	13.4 SEER2	13.4 SEER2	-	-	-	
Water Heating	Electric	0.93 UEF / 40 gal. Storage	3.30 UEF HPWH, Storage	\$1,271.76	1	System	\$1,272
Sub-Total of Heating and Cooling Equipment Measures						<b>\$1,272</b>	
<b>Envelope &amp; Glazing Measures</b>							
Wall Insulation	R-21	R-21	-	-	-	-	
Ceiling Insulation	R-38	R-44	\$0.28	1,568	Insul. Surf. Area (ft <sup>2</sup> )	\$445	
Floor Insulation	R-30	R-33	\$0.16	1,568	Insul. Surf. Area (ft <sup>2</sup> )	\$258	
Infiltration (ACH50)	5	5	-	-	-	-	
Windows	U-value: 0.30 / SHGC: 0.25	U-value: 0.25 / SHGC: 0.25	\$2.98	188	Surf. Area (ft <sup>2</sup> )	\$561	
Doors U-Factor	0.40	0.19	\$2.63	36	Surf. Area (ft <sup>2</sup> )	\$95	
Sub-Total of Envelope & Glazing Measures						<b>\$1,358</b>	
<b>Thermostat &amp; Ductwork Measures</b>							
Thermostat	Programmable	Programmable	-	-	-	-	
Duct Location	Crawlspace	Crawlspace	-	-	-	-	
Duct Insulation	R-30	R-33	(Cost included in Floor Insulation)			-	
Duct Leakage	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	-	-	-	-	
Sub-Total of Thermostat & Ductwork Measures						-	
<b>Other Measures</b>							
Kitchen Appliances	Federal Min.	ES Certified Refrigerator, Dishwasher, and Clothes Washer	\$71.88	1	System	\$72	
Water Fixtures	Standard	Low-Flow Fixtures	\$2.80	2	System	\$6	
High-Efficiency Lighting	50% LED 50% CFL	100% LED	\$0.02	1,568	CFA (ft <sup>2</sup> )	\$32	
Sub-Total of Other Measures						<b>\$109</b>	
<b>Total Incremental Cost for the Home</b>						<b>\$2,740</b>	



# ENERGY STAR Certified Manufactured New Homes, Version 3

## Cost & Savings Estimates

Exhibit 22: ENERGY STAR Manufactured Homes v3 vs HUD Code - Climate Zone 1 - Multi Section – Envelope Package

Measure	HUD Baseline	ENERGY STAR v3	Incremental Unit Cost	Cost Qty	Cost Unit	Inc. Cost
<b>Heating, Cooling, Water Heating Equipment Measures</b>						
Space Heating	Elec. Resistance Heater	100% AFUE	100% AFUE	-	-	-
Space Cooling	AC	14.3 SEER2	14.3 SEER2	-	-	-
Water Heating	Electric	0.93 UEF / 40 gal, Storage	0.93 UEF / 40 gal, Storage	-	-	-
Sub-Total of Heating and Cooling Equipment Measures						-
<b>Envelope &amp; Glazing Measures</b>						
Wall Insulation	R-13	R-21	\$0.61	1,260	Insul. Surf. Area (ft <sup>2</sup> )	\$764
Ceiling Insulation	R-30	R-44	\$0.66	1,568	Insul. Surf. Area (ft <sup>2</sup> )	\$1,039
Floor Insulation	R-13	R-33	\$0.85	1,568	Insul. Surf. Area (ft <sup>2</sup> )	\$1,330
Infiltration (ACH50)	5	5	-	-	-	-
Windows	U-value: 0.32 / SHGC: 0.33	U-value: 0.25 / SHGC: 0.25	\$8.29	188	Surf. Area (ft <sup>2</sup> )	\$1,558
Doors U-Factor	0.40	0.19	\$2.63	36	Surf. Area (ft <sup>2</sup> )	\$95
Sub-Total of Envelope & Glazing Measures						\$4,786
<b>Thermostat &amp; Ductwork Measures</b>						
Thermostat	Programmable	Programmable	-	-	-	-
Duct Location	Crawlspace	Crawlspace	-	-	-	-
Duct Insulation	R-13	R-33	(Cost included in Floor Insulation)			-
Duct Leakage	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	-	-	-	-
Sub-Total of Thermostat & Ductwork Measures						-
<b>Other Measures</b>						
Kitchen Appliances	Federal Min.	Federal Min.	-	-	-	-
Water Fixtures	Standard	Standard	-	-	-	-
High-Efficiency Lighting	50% LED 50% CFL	50% LED 50% CFL	-	-	-	-
Sub-Total of Other Measures						-
<b>Total Incremental Cost for the Home</b>						<b>\$4,786</b>



# ENERGY STAR Certified Manufactured New Homes, Version 3

## Cost & Savings Estimates

Exhibit 23: ENERGY STAR Manufactured Homes v3 vs HUD Code - Climate Zone 2 - Multi Section – Envelope Package

Measure	HUD Baseline	ENERGY STAR v3	Incremental Unit Cost	Cost Qty	Cost Unit	Inc. Cost
<b>Heating, Cooling, Water Heating Equipment Measures</b>						
Space Heating	Elec. Resistance Heater	100% AFUE	100% AFUE	-	-	-
Space Cooling	AC	14.3 SEER2	14.3 SEER2	-	-	-
Water Heating	Electric	0.93 UEF / 40 gal, Storage	0.93 UEF / 40 gal, Storage	-	-	-
Sub-Total of Heating and Cooling Equipment Measures						-
<b>Envelope &amp; Glazing Measures</b>						
Wall Insulation	R-21	R-21	-	-	-	-
Ceiling Insulation	R-30	R-44	\$0.66	1,568	Insul. Surf. Area (ft <sup>2</sup> )	\$1,039
Floor Insulation	R-19	R-33	\$0.76	1,568	Insul. Surf. Area (ft <sup>2</sup> )	\$1,186
Infiltration (ACH50)	5	5	-	-	-	-
Windows	U-value: 0.30 / SHGC: 0.25	U-value: 0.25 / SHGC: 0.25	\$2.98	188	Surf. Area (ft <sup>2</sup> )	\$561
Doors U-Factor	0.40	0.19	\$2.63	36	Surf. Area (ft <sup>2</sup> )	\$95
Sub-Total of Envelope & Glazing Measures						\$2,880
<b>Thermostat &amp; Ductwork Measures</b>						
Thermostat	Programmable	Programmable	-	-	-	-
Duct Location	Crawlspace	Crawlspace	-	-	-	-
Duct Insulation	R-19	R-33	(Cost included in Floor Insulation)			-
Duct Leakage	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	-	-	-	-
Sub-Total of Thermostat & Ductwork Measures						-
<b>Other Measures</b>						
Kitchen Appliances	Federal Min.	Federal Min.	-	-	-	-
Water Fixtures	Standard	Standard	-	-	-	-
High-Efficiency Lighting	50% LED 50% CFL	50% LED 50% CFL	-	-	-	-
Sub-Total of Other Measures						\$0
<b>Total Incremental Cost for the Home</b>						<b>\$2,880</b>



# ENERGY STAR Certified Manufactured New Homes, Version 3

## Cost & Savings Estimates

**Exhibit 24: ENERGY STAR Manufactured Homes v3 vs HUD Code - Climate Zone 1 – Multi Section – High Efficiency Gas Water Heater Package**

Measure	HUD Baseline	ENERGY STAR v3	Incremental Unit Cost	Cost Qty	Cost Unit	Inc. Cost
<b>Heating, Cooling, Water Heating Equipment Measures</b>						
Space Heating	Gas Furnace	80% AFUE	80% AFUE	-	-	-
Space Cooling	AC	14.3 SEER2	14.3 SEER2	-	-	-
Water Heating	Gas	0.60 UEF / 40 gal, Storage	0.93 UEF, Tankless	\$757.20	1	System
Sub-Total of Heating and Cooling Equipment Measures						<b>\$757</b>
<b>Envelope &amp; Glazing Measures</b>						
Wall Insulation	R-13	R-13	-	-	-	-
Ceiling Insulation	R-30	R-33	\$0.14	1,568	Insul. Surf. Area (ft <sup>2</sup> )	\$223
Floor Insulation	R-13	R-22	\$0.25	1,568	Insul. Surf. Area (ft <sup>2</sup> )	\$386
Infiltration (ACH50)	5	5	-	-	-	-
Windows	U-value: 0.32 / SHGC: 0.33	U-value: 0.30 / SHGC: 0.25	\$5.30	188	Surf. Area (ft <sup>2</sup> )	\$997
Doors U-Factor	0.40	0.40	-	-	-	-
Sub-Total of Envelope & Glazing Measures						<b>\$1,605</b>
<b>Thermostat &amp; Ductwork Measures</b>						
Thermostat	Programmable	Programmable	-	-	-	-
Duct Location	Crawlspace	Crawlspace	-	-	-	-
Duct Insulation	R-13	R-22	(Cost included in Floor Insulation)			-
Duct Leakage	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	-	-	-	-
Sub-Total of Thermostat & Ductwork Measures						-
<b>Other Measures</b>						
Kitchen Appliances	Federal Min.	Federal Min.	-	-	-	-
Water Fixtures	Standard	Standard	-	-	-	-
High-Efficiency Lighting	50% LED 50% CFL	50% LED 50% CFL	-	-	-	-
Sub-Total of Other Measures						-
<b>Total Incremental Cost for the Home</b>						<b>\$2,363</b>



# ENERGY STAR Certified Manufactured New Homes, Version 3

## Cost & Savings Estimates

**Exhibit 25: ENERGY STAR Manufactured Homes v3 vs HUD Code - Climate Zone 2 - Multi Section – High Efficiency Gas Water Heater Package**

Measure	HUD Baseline	ENERGY STAR v3	Incremental Unit Cost	Cost Qty	Cost Unit	Inc. Cost	
<b>Heating, Cooling, Water Heating Equipment Measures</b>							
Space Heating	Gas Furnace	80% AFUE	95% AFUE	\$701.68	1	System	\$702
Space Cooling	AC	14.3 SEER2	14.3 SEER2	-	-	-	-
Water Heating	Gas	0.60 UEF / 40 gal, Storage	0.93 UEF, Tankless	\$757.20	1	System	\$757
Sub-Total of Heating and Cooling Equipment Measures					1	System	\$1,459
<b>Envelope &amp; Glazing Measures</b>							
Wall Insulation	R-21	R-21	-	-	-	-	
Ceiling Insulation	R-30	R-33	\$0.14	1,568	Insul. Surf. Area (ft <sup>2</sup> )	\$223	
Floor Insulation	R-19	R-22	\$0.15	1,568	Insul. Surf. Area (ft <sup>2</sup> )	\$241	
Infiltration (ACH50)	5	5	-	-	-	-	
Windows	U-value: 0.30 / SHGC: 0.25	U-value: 0.30 / SHGC: 0.25	-	-	-	-	
Doors U-Factor	0.40	0.40	-	-	-	-	
Sub-Total of Envelope & Glazing Measures							\$463
<b>Thermostat &amp; Ductwork Measures</b>							
Thermostat	Programmable	Programmable	-	-	-	-	
Duct Location	Crawlspace	Crawlspace	-	-	-	-	
Duct Insulation	R-19	R-22	(Cost included in Floor Insulation)			-	
Duct Leakage	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	-	-	-	-	
Sub-Total of Thermostat & Ductwork Measures							-
<b>Other Measures</b>							
Kitchen Appliances	Federal Min.	Federal Min.	-	-	-	-	
Water Fixtures	Standard	Standard	-	-	-	-	
High-Efficiency Lighting	50% LED 50% CFL	100% LED	\$0.02	1,568	CFA (ft <sup>2</sup> )	\$32	
Sub-Total of Other Measures							\$32
<b>Total Incremental Cost for the Home</b>							<b>\$1,954</b>



# ENERGY STAR Certified Manufactured New Homes, Version 3

## Cost & Savings Estimates

**Exhibit 26: ENERGY STAR Manufactured Homes v3 vs HUD Code - Climate Zone 3 - Multi Section – High Efficiency Gas Water Heater Package**

Measure	HUD Baseline	ENERGY STAR v3	Incremental Unit Cost	Cost Qty	Cost Unit	Inc. Cost	
<b>Heating, Cooling, Water Heating Equipment Measures</b>							
Space Heating	Gas Furnace	80% AFUE	95% AFUE	\$701.68	1	System	\$702
Space Cooling	AC	13.4 SEER2	13.4 SEER2	-	-	-	-
Water Heating	Gas	0.60 UEF / 40 gal, Storage	0.60 UEF / 40 gal, Storage	-	-	-	-
Sub-Total of Heating and Cooling Equipment Measures						<b>\$702</b>	
<b>Envelope &amp; Glazing Measures</b>							
Wall Insulation	R-21	R-21	-	-	-	-	
Ceiling Insulation	R-38	R-38	-	-	-	-	
Floor Insulation	R-30	R-33	\$0.16	1,568	Insul. Surf. Area (ft <sup>2</sup> )	\$258	
Infiltration (ACH50)	5	5	-	-	-	-	
Windows	U-value: 0.30 / SHGC: 0.25	U-value: 0.30 / SHGC: 0.25	-	-	-	-	
Doors U-Factor	0.40	0.30	\$1.25	36	Surf. Area (ft <sup>2</sup> )	\$45	
Sub-Total of Envelope & Glazing Measures						<b>\$303</b>	
<b>Thermostat &amp; Ductwork Measures</b>							
Thermostat	Programmable	Programmable	-	-	-	-	
Duct Location	Crawlspace	Crawlspace	-	-	-	-	
Duct Insulation	R-30	R-33	(Cost included in Floor Insulation)			-	
Duct Leakage	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	4 CFM per 100 ft <sup>2</sup> of CFA @ Rough-In	-	-	-	-	
Sub-Total of Thermostat & Ductwork Measures						-	
<b>Other Measures</b>							
Kitchen Appliances	Federal Min.	Federal Min.	-	-	-	-	
Water Fixtures	Standard	Standard	-	-	-	-	
High-Efficiency Lighting	50% LED 50% CFL	100% LED	\$0.02	1,568	CFA (ft <sup>2</sup> )	\$32	
Sub-Total of Other Measures						<b>\$32</b>	
<b>Total Incremental Cost for the Home</b>						<b>\$1,036</b>	



# ENERGY STAR Certified Manufactured New Homes, Version 3 Cost & Savings Estimates

## Section 3: Incremental Cost References

### A. Heating, Cooling, & Water Heating Equipment Measures

#### Air-Source Heat Pump

Reference	<ul style="list-style-type: none"> <li>Systems Building Research Alliance</li> </ul>
Accessed	<ul style="list-style-type: none"> <li>April 2024</li> </ul>
Notes	<ul style="list-style-type: none"> <li>Industry experts estimated the incremental cost to upgrade from an electric resistance furnace to an air-source heat pump to be \$900-\$1,200. The mid-point value of \$1,050 was used as the incremental cost.</li> </ul>

#### Gas Furnace

Reference	<ul style="list-style-type: none"> <li>NREL National Residential Energy Efficiency Measures Database v3.1.0, accessed via BEopt v2.8.0.0. <a href="https://remdb.nrel.gov/">https://remdb.nrel.gov/</a>.</li> </ul>
Accessed	<ul style="list-style-type: none"> <li>April 2024</li> </ul>
Notes	<ul style="list-style-type: none"> <li>Material costs and new construction installation labor costs were taken from this database for 80 AFUE and 95 AFUE equipment.</li> </ul>

#### Heat Pump Water Heater

Reference	<ul style="list-style-type: none"> <li>NREL National Residential Energy Efficiency Measures Database v3.1.0, accessed via BEopt v2.8.0.0. <a href="https://remdb.nrel.gov/">https://remdb.nrel.gov/</a>.</li> <li><a href="https://www.homedepot.com/">https://www.homedepot.com/</a></li> <li><a href="https://www.menards.com/">https://www.menards.com/</a></li> </ul>
Accessed	<ul style="list-style-type: none"> <li>April 2024</li> </ul>
Notes	<ul style="list-style-type: none"> <li>Material costs and new construction installation labor costs were taken from the NREL database for a heat pump water heater with an efficiency of 2.30 EF (equivalent to 2.40 UEF using RESNET's Energy Factor Conversion Equations) and 2.35 EF (equivalent to 2.44 UEF). Because there were limited other efficiencies available in the database, retail costs were taken from Menards for equipment with an efficiency of 3.75 UEF and from Home Depot for equipment with an efficiency of 3.85 UEF. These costs were then linearly interpolated by UEF to calculate the incremental cost of the equipment used in the baseline and ENERGY STAR certified manufactured new homes.</li> </ul>

### B. Envelope & Glazing Measures

#### Wall Insulation

Reference	<ul style="list-style-type: none"> <li>Technical Support Document (TSD): Final Rule Energy Conservation Standards for Manufactured Housing, May 2022.</li> </ul>
Accessed	<ul style="list-style-type: none"> <li>April 2024</li> </ul>
Notes	<ul style="list-style-type: none"> <li>Table 5.3 of the TSD provided incremental upgrade costs from R-11 walls to a variety of higher R-values. The incremental cost between various pairs of insulation levels (e.g., R-13 to R-21 walls) were determined by calculating the difference in incremental cost, as reported by the TSD.</li> </ul>

#### Floor Insulation

Reference	<ul style="list-style-type: none"> <li>Technical Support Document: Final Rule Energy Conservation Standards for Manufactured Housing, May 2022</li> </ul>
Accessed	<ul style="list-style-type: none"> <li>April 2024</li> </ul>
Notes	<ul style="list-style-type: none"> <li>Table 5.4 of the TSD provided incremental upgrade costs from R-11 floors to a variety of higher R-values. The incremental cost between various pairs of insulation levels (e.g., R-19 to R-22 floors) were determined by calculating the difference in incremental cost, as reported by the TSD. The incremental upgrade cost from R-11 to R-33 floors was not provided by the TSD and instead was estimated using linear interpolation by R-value.</li> </ul>

#### Ceiling Insulation



# ENERGY STAR Certified Manufactured New Homes, Version 3 Cost & Savings Estimates

<b>Reference</b>	<ul style="list-style-type: none"> <li>• Technical Support Document: Final Rule Energy Conservation Standards for Manufactured Housing, May 2022</li> </ul>
<b>Accessed</b>	<ul style="list-style-type: none"> <li>• April 2024</li> </ul>
<b>Notes</b>	<ul style="list-style-type: none"> <li>• Table 5.2 of the TSD provided incremental upgrade costs from R-22 ceilings to a variety of higher R-values. The incremental cost between various pairs of insulation levels (e.g., R-30 to R-33 ceilings) were determined by calculating the difference in incremental cost, as reported by the TSD. The incremental upgrade cost from R-11 to R-33 and from R-11 to R-44 ceilings was not provided by the TSD and instead was estimated using linear interpolation by R-value.</li> </ul>

## Glazing U-Factor & SHGC

<b>Reference</b>	<ul style="list-style-type: none"> <li>• Technical Support Document: Final Rule Energy Conservation Standards for Manufactured Housing, May 2022</li> </ul>
<b>Accessed</b>	<ul style="list-style-type: none"> <li>• April 2024</li> </ul>
<b>Notes</b>	<ul style="list-style-type: none"> <li>• Table 5.5. of the TSD provided upgrade costs for several types of glazing (e.g., clear single or dual single) and frame material (i.e., aluminum or vinyl framing), which also account for adding a storm window, or argon gas fill, or enhanced glass spacers, relative to the reference point of an aluminum framed window with clear single glazing. The incremental cost between various pairs of windows (e.g., U-factor: 1.08 / SHGC: 0.70 to U-factor: 0.30 / SHGC: 0.25) were determined by calculating the difference in incremental cost, as reported by the TSD. The incremental upgrade cost to a window with a U-factor: 0.30 / SHGC: 0.33 and U-factor: 0.25 / SHGC: 0.25 was not provided by the TSD and instead was estimated user linear interpolation by U-factor and SHGC.</li> </ul>

## C. Other Measures

### Dishwasher

<b>Reference</b>	<ul style="list-style-type: none"> <li>• NREL National Residential Energy Efficiency Measures Database v3.1.0, accessed via BEopt v2.8.0.0. <a href="https://remdb.nrel.gov/">https://remdb.nrel.gov/</a>.</li> </ul>
<b>Accessed</b>	<ul style="list-style-type: none"> <li>• April 2024</li> </ul>
<b>Notes</b>	<ul style="list-style-type: none"> <li>• Material costs were taken from this database for a dishwasher with consumption of 259, 307, and 318 kWh/yr. Because the database represents retrofit costs, the low-end of the cost range was used to approximate the costs of new construction.</li> <li>• Linear interpolation by annual electricity consumption (kWh/yr) was then used to estimate the material cost of the ENERGY STAR Certified dishwasher (270 kWh/yr).</li> <li>• Finally, the material cost of a standard dishwasher (307 kWh/yr) was subtracted from that of the ENERGY STAR certified dishwasher to determine the incremental cost.</li> </ul>

### Refrigerator

<b>Reference</b>	<ul style="list-style-type: none"> <li>• NREL National Residential Energy Efficiency Measures Database v3.1.0, accessed via BEopt v2.8.0.0. <a href="https://remdb.nrel.gov/">https://remdb.nrel.gov/</a>.</li> </ul>
<b>Accessed</b>	<ul style="list-style-type: none"> <li>• April 2024</li> </ul>
<b>Notes</b>	<ul style="list-style-type: none"> <li>• Material costs and new construction installation labor costs were taken from this database for a refrigerator with consumption of 434 and 480 kWh/yr.</li> <li>• Linear interpolation by annual electricity consumption (kWh/yr) was then used to estimate the material and labor cost of a standard (491 kWh/yr) and ENERGY STAR certified (450 kWh/yr) refrigerator.</li> <li>• Finally, the material and labor cost of a standard refrigerator was subtracted from that of the ENERGY STAR certified refrigerator to determine the incremental cost.</li> </ul>

### Clothes Washer

<b>Reference</b>	<ul style="list-style-type: none"> <li>• NREL National Residential Energy Efficiency Measures Database v3.1.0, accessed via BEopt v2.8.0.0. <a href="https://remdb.nrel.gov/">https://remdb.nrel.gov/</a>.</li> </ul>
<b>Accessed</b>	<ul style="list-style-type: none"> <li>• April 2024</li> </ul>



# ENERGY STAR Certified Manufactured New Homes, Version 3 Cost & Savings Estimates

<b>Notes</b>	<ul style="list-style-type: none"> <li>• Material costs and new construction installation labor costs were taken from this database for a clothes washer with the follow characteristics:               <ul style="list-style-type: none"> <li>○ IMEF = 1.41, Rated Annual Consumption (kWh) = 387</li> <li>○ IMEF = 2.47, Rated Annual Consumption (kWh) = 123</li> </ul> </li> <li>• Linear interpolation by IMEF and then by Rated Annual Consumption (kWh) was used to estimate the material and labor cost of a standard and ENERGY STAR product with the following characteristics:               <ul style="list-style-type: none"> <li>○ Standard: IMEF = 1.57, Rated Annual Consumption (kWh) = 284</li> <li>○ ENERGY STAR certified: IMEF = 2.06, Rated Annual Consumption (kWh) = 152</li> </ul> </li> <li>• Finally, the material and labor cost of a standard clothes washer was subtracted from that of the ENERGY STAR certified clothes washer to determine the incremental cost.</li> </ul>
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## Low-Flow Bathroom Faucets

<b>Reference</b>	<ul style="list-style-type: none"> <li>• California Public Utilities Commission DEER 2016 Database.</li> </ul>
<b>Accessed</b>	<ul style="list-style-type: none"> <li>• August 2021</li> </ul>
<b>Notes</b>	<ul style="list-style-type: none"> <li>• Costs for the following measures, representing a standard faucet aerator and low-flow aerator respectively, were taken from this database:               <ul style="list-style-type: none"> <li>○ “DHW-FaucetAerator-Std”</li> <li>○ “DHW-FaucetAerLowFlow-Res.”</li> </ul> </li> <li>• The material cost of a standard aerator was subtracted from that of the low-flow aerator to determine the incremental cost.</li> </ul>

## Low-Flow Bathroom Showerheads

<b>Reference</b>	<ul style="list-style-type: none"> <li>• Staff Analysis of Water Efficiency Standards for Showerheads by California Energy Commission. <a href="https://efiling.energy.ca.gov/getdocument.aspx?tn=205654">https://efiling.energy.ca.gov/getdocument.aspx?tn=205654</a></li> <li>• <a href="https://www.build.com/">https://www.build.com/</a></li> </ul>
<b>Accessed</b>	<ul style="list-style-type: none"> <li>• April 2024</li> </ul>
<b>Notes</b>	<ul style="list-style-type: none"> <li>• Table 2 of the analysis estimates that the incremental cost for a 1.8 gallon per minute showerhead relative to a 2.0 gallon per minute showerhead is zero “because there is no cost premium for a compliant product (meaning that an efficient product and an inefficient product cost the same, all other variables constant)”.</li> <li>• Retail prices of a low-flow shower head and a standard shower head were the same on Build.com at the time this analysis was conducted.</li> </ul>

## Lighting

<b>Reference</b>	<ul style="list-style-type: none"> <li>• NREL National Residential Energy Efficiency Measures Database v3.1.0, accessed via BEopt v2.8.0.0. <a href="https://remdb.nrel.gov/">https://remdb.nrel.gov/</a>.</li> <li>• Residential Lighting End-Use Consumption Study: Estimation Framework and Initial Estimates. <a href="https://www1.eere.energy.gov/buildings/publications/pdfs/ssl/2012_residential-lighting-study.pdf">https://www1.eere.energy.gov/buildings/publications/pdfs/ssl/2012_residential-lighting-study.pdf</a></li> </ul>
<b>Accessed</b>	<ul style="list-style-type: none"> <li>• April 2024</li> </ul>
<b>Notes</b>	<ul style="list-style-type: none"> <li>• Material costs and new construction installation labor costs for 100% CFL lighting and 100% LED lighting were taken from this database and the difference was used to calculate the incremental cost. These costs are defined per square foot of living area and garage area. Because only hard-wired fixtures will be upgraded at the time of certification, these costs were reduced based on an estimate that 56% of lighting is hard-wired ceiling fixtures from Table 4.5 of the Residential Lighting End-Use Consumption Study.</li> </ul>



# ENERGY STAR Certified Manufactured New Homes, Version 3 Cost & Savings Estimates

## Appendix A: Complete Savings Results for All Modeled Homes

CZ	Home Size	Package	Heating Fuel	HUD Code			ENERGY STAR Manufactured Home Version 3		
				Site Annual Electric Consumption (kWh)	Site Annual Gas Consumption (Therms)	Annual Purchased Energy Costs	Site Annual Electric Consumption (kWh)	Site Annual Gas Consumption (Therms)	Annual Purchased Energy Costs
1	Single	N/A	Electric	13,955	0	\$2,099	11,316	0	\$1,702
1	Single	N/A	Natural Gas	6,535	358	\$1,492	5,482	289	\$1,236
1	Multi	Heat Pump (Elec. Resistance Heater Baseline)	Electric	14,926	0	\$2,245	11,593	0	\$1,744
1	Multi	Heat Pump (Heat Pump Baseline)	Electric	12,327	0	\$1,854	11,593	0	\$1,744
1	Multi	HPWH	Electric	14,926	0	\$2,245	13,010	0	\$1,957
1	Multi	Envelope-Only	Electric	14,926	0	\$2,245	11,863	0	\$1,784
1	Multi	Gas	Natural Gas	7,369	365	\$1,628	6,780	305	\$1,453
2	Single	N/A	Electric	13,564	0	\$2,040	11,268	0	\$1,695
2	Single	N/A	Natural Gas	5,288	386	\$1,345	4,535	318	\$1,135
2	Multi	Heat Pump (Elec. Resistance Heater Baseline)	Electric	14,464	0	\$2,175	11,165	0	\$1,679
2	Multi	Heat Pump (Heat Pump Baseline)	Electric	11,414	0	\$1,717	11,165	0	\$1,679
2	Multi	HPWH	Electric	14,464	0	\$2,175	13,047	0	\$1,962
2	Multi	Envelope-Only	Electric	14,464	0	\$2,175	12,482	0	\$1,877
2	Multi	Gas	Natural Gas	5,945	397	\$1,458	5,666	322	\$1,311
3	Single	N/A	Electric	23,731	0	\$3,569	19,195	0	\$2,887
3	Single	N/A	Natural Gas	3,735	859	\$1,784	3,506	675	\$1,487
3	Multi	Heat Pump (Elec. Resistance Heater Baseline)	Electric	25,151	0	\$3,783	18,437	0	\$2,773
3	Multi	Heat Pump (Heat Pump Baseline)	Electric	18,886	0	\$2,840	18,437	0	\$2,773
3	Multi	HPWH & Envelope	Electric	25,151	0	\$3,783	22,560	0	\$3,393
3	Multi	Gas	Natural Gas	4,556	891	\$1,953	4,454	767	\$1,761