

Cost & Savings Estimates

ENERGY STAR
Certified
Manufactured
Homes, Version 2

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ENERGY STAR Certified Manufactured Homes, Version 2 Cost & Savings Estimates

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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 home under Version 2 of the program requirements in each of the three Thermal Zones established by the U.S. Department of Housing and Urban Development Code (HUD Code).

Methodology

To complete this analysis, EPA evaluated twelve multi-section manufactured homes across the three HUD Thermal Zones.¹

The architectural characteristics for each home were determined using the Technical Support Document for the U.S. Department of Energy's Notice of Proposed Rulemaking Establishing Energy Conservation Standards for Manufactured Housing (TSD).² Exhibit 1 shows the house parameters that were modeled consistently across all HUD Thermal Zones.

Exhibit 1: House Parameters Consistent Across Thermal Zones

Parameter	Value
Number of Stories	One
Conditioned Floor Area (ft ²)	1,568
Foundation Type	Vented Crawlspace
Perimeter (ft)	55 x 29
Ceiling Height (ft)	7.5
Bedrooms	3
Window Area (% of Floor Area) & Distribution	12%, Even
Exterior Door Quantity & Total Area	2, 36 ft ²

Exhibit 2 shows the representative location used for each Thermal Zone. Locations were selected to be representative of results of the entire HUD Thermal Zone based on all locations that were modeled in the TSD.

Exhibit 2: Representative Location Used for Each Thermal Zone

Thermal Zone	TZ 1	TZ 2	TZ 3
Location	Miami, FL	Albuquerque, NM	Chicago, IL

Exhibit 3 shows the HVAC equipment configurations that were modeled for the baseline home and the ENERGY STAR home for each of the three efficiency packages that can be used to demonstrate compliance with the program requirements: Electric Heat Pump Package, High-Efficiency Furnace Package, and Envelope-Only Package.

Exhibit 3: HVAC Equipment Configurations

Package	#	Home Configuration	
		Baseline Home	ENERGY STAR Home
Electric Heat Pump	1	Electric Resistance Furnace + AC	Air-Source Heat Pump
	2	Air-Source Heat Pump	Air-Source Heat Pump
High-Efficiency Furnace	3	Gas Furnace + AC	Gas Furnace + AC
Envelope-Only	4	Electric Resistance Furnace + AC	Electric Resistance Furnace + AC
	5	Gas Furnace + AC	Gas Furnace + AC

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

² See Docket ID: EERE-2009-BT-BC-0021



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Note that for the Electric 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 for the Envelope-Only Package, the baseline home and ENERGY STAR home were modeled with two different HVAC configurations – the first was an electric resistance furnace plus air conditioner in both homes, and the second was a gas furnace plus air conditioner in both homes. Both configurations could be present in a home using the Envelope-Only Package. This package was not modeled with a heat pump configuration because it was assumed that if a heat pump was present in the baseline, the Electric Heat Pump Package would be selected rather than the Envelope-Only Package. While the costs for the two configurations that were modeled are the same because there are no equipment measures in the Envelope-Only Package, the savings will vary. Therefore, for this package, the costs and savings for each of the configurations modeled are presented separately.

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.

The energy efficiency features of the ENERGY STAR certified manufactured homes were aligned with the features for each of the three ENERGY STAR Reference Design Homes specified in Exhibit 1 of the ENERGY STAR Certified Manufactured Homes Version 2 program requirements.

These energy efficiency features of the baseline homes and ENERGY STAR certified manufactured homes are summarized in Exhibits 5 through 16.

To estimate energy savings, first, the baseline and ENERGY STAR home configurations were modeled using ICF's Beacon Residential energy modeling tool to determine energy consumption.

Next, energy consumption for the baseline homes and ENERGY STAR certified manufactured homes was converted to purchased energy costs using a national average rate of \$0.121 / kWh and \$1.116 / therm, as referenced from the Energy Information Administration's 2014 Annual Energy Outlook. Finally, the purchased energy costs for the ENERGY STAR certified manufactured homes were subtracted from those of the baseline homes to determine savings.

The incremental costs for each ENERGY STAR certified manufactured home were estimated next. For example, where the ENERGY STAR Certified Manufactured Homes program requires a higher R-value of insulation (e.g., R-38 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 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 requirements of one of the ENERGY STAR Reference Design Homes and the Mandatory Requirements for All Certified Manufactured Homes. 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 – 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 4 summarizes the annual purchased energy costs for each baseline and ENERGY STAR certified manufactured home. In addition, it summarizes the annual purchased energy savings and the total upgrade cost for each ENERGY STAR certified manufactured 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 4: ENERGY STAR v2 Certified Manufactured Home vs HUD Code Home, Illustrative Cost & Savings Summary

HUD TZ	Location	ES Package Name	Heating Fuel	HUD Code	ENERGY STAR Manufactured Homes Version 2						
				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	Miami, FL	Electric Heat Pump	Electric	\$1,682	\$1,395	\$287	17%	\$3,968	\$24	\$21	\$3
2	Albuquerque, NM	Electric Heat Pump	Electric	\$2,525	\$1,697	\$828	33%	\$2,676	\$69	\$14	\$55
3	Chicago, IL	Electric Heat Pump	Electric	\$3,930	\$2,287	\$1,643	42%	\$1,037	\$137	\$6	\$131
1	Miami, FL	High-Efficiency Furnace	Natural Gas	\$1,615	\$1,339	\$276	17%	\$3,570	\$23	\$19	\$4
2	Albuquerque, NM	High-Efficiency Furnace	Natural Gas	\$1,548	\$1,363	\$185	12%	\$2,218	\$15	\$12	\$3
3	Chicago, IL	High-Efficiency Furnace	Natural Gas	\$1,816	\$1,620	\$196	11%	\$1,513	\$16	\$8	\$8
1	Miami, FL	Envelope-Only	Electric	\$1,686	\$1,389	\$297	18%	\$3,739	\$25	\$20	\$5
2	Albuquerque, NM	Envelope-Only	Electric	\$2,774	\$2,308	\$466	17%	\$2,858	\$39	\$15	\$24
3	Chicago, IL	Envelope-Only	Electric	\$4,534	\$3,863	\$672	15%	\$2,318	\$56	\$12	\$44
1	Miami, FL	Envelope-Only	Natural Gas	\$1,615	\$1,323	\$292	18%	\$3,739	\$24	\$20	\$4
2	Albuquerque, NM	Envelope-Only	Natural Gas	\$1,548	\$1,346	\$202	13%	\$2,858	\$17	\$15	\$1
3	Chicago, IL	Envelope-Only	Natural Gas	\$1,816	\$1,633	\$183	10%	\$2,318	\$15	\$12	\$3

Section 2 contains Exhibits 5 through 16, which contain a more detailed breakout of the incremental upgrade costs presented for each home in Exhibit 4.

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 Homes 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 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 5 through 16 contain a more detailed explanation of the incremental upgrade costs presented for each home in Exhibit 4. For each measure, the exhibit lists the HUD Code baseline requirement, the ENERGY STAR Certified Manufactured Homes, Version 2 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.



ENERGY STAR Certified Manufactured Homes, Version 2 Cost & Savings Estimates

Exhibit 5: ENERGY STAR Manufactured Homes v2 vs HUD Code - Thermal Zone 1 - Electric Heat Pump Package

Measure	HUD Baseline	ENERGY STAR	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost	
Heating & Cooling Equipment Measures							
Space Heating	Elec. Furnace+AC Baseline	100 AFUE	8.2 HSPF	\$1,050.00	1	System	-
	Heatpump Baseline	8.2 HSPF	8.2 HSPF	\$0.00	1	System	-
	Weighted Average ¹			\$766.50	1	System	\$767
Space Cooling	Elec. Furnace+AC Baseline	14 SEER	14 SEER	-	-	-	-
	Heatpump Baseline	14 SEER	14 SEER	-	-	-	-
	Weighted Average ¹			-	-	-	-
Envelope & Glazing Measures							
Wall Insulation	R-11	R-11	-	-	-	-	
Floor Insulation	R-22	R-22	-	-	-	-	
Ceiling Insulation	R-22	R-33	\$0.55	1,568	CFA (ft ²)	\$862	
Windows	U-value: 1.08 / SHGC: 0.70	U-value: 0.35 / SHGC: 0.34	\$1.48	1,568	CFA (ft ²)	\$2,323	
Infiltration (ACH50)	8	8	-	-	-	-	
Door (U-factor)	0.4	0.4	-	-	-	-	
Thermostat & Ductwork Measures							
Thermostat	Manual	Programmable	\$16.54	1	Thermostat	\$17	
Duct Location	Crawlspace	Crawlspace	-	-	-	-	
Duct Insulation	R-22	R-22	-	-	-	-	
Duct Leakage (CFA)	12	12	-	-	-	-	
Other Measures							
Electric Water Heater (EF / Gal.)	0.95 EF / 40 Gal.	0.95 EF / 40 Gal.	-	-	-	-	
Appliances	Federal Min.	Federal Min.	-	-	-	-	
High-Efficacy Lighting	34%	34%	-	-	-	-	
Total Incremental Cost for the Home						\$3,968	

Notes:

1. Costs for this measure represent a weighted value assuming that 73% of HUD Code homes will have an electric resistance furnace and 27% will have an air-source heat pump.



ENERGY STAR Certified Manufactured Homes, Version 2 Cost & Savings Estimates

Exhibit 6: ENERGY STAR Manufactured Homes v2 vs HUD Code - Thermal Zone 2 - Electric Heat Pump Package

Measure	HUD Baseline	ENERGY STAR	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost	
Heating & Cooling Equipment Measures							
Space Heating	Elec. Furnace+AC Baseline	100 AFUE	8.2 HSPF	\$1,050.00	1	System	-
	Heatpump Baseline	8.2 HSPF	8.2 HSPF	-	-	-	-
	Weighted Average ¹			\$766.50	1	System	\$767
Space Cooling	Elec. Furnace+AC Baseline ²	13 SEER	14 SEER	\$75.45	2.6	Tons	-
	Heatpump Baseline	14 SEER	14 SEER	-	-	-	-
	Weighted Average ¹			\$55.08	2.6	Tons	\$143
Envelope & Glazing Measures							
Wall Insulation	R-11	R-11	-	-	-	-	
Floor Insulation	R-19	R-22	\$0.14	1,568	CFA (ft ²)	\$215	
Ceiling Insulation	R-22	R-33	\$0.55	1,568	CFA (ft ²)	\$862	
Windows	U-value: 0.50 / SHGC: 0.60	U-value: 0.35 / SHGC: 0.34	\$0.43	1,568	CFA (ft ²)	\$673	
Infiltration (ACH50)	8	8	-	-	-	-	
Door (U-factor)	0.4	0.4	-	-	-	-	
Thermostat & Ductwork Measures							
Thermostat	Manual	Programmable	\$16.54	1	Thermostat	\$17	
Duct Location	Crawlspace	Crawlspace	-	-	-	-	
Duct Insulation	R-19	R-22	(Cost included in Floor Insulation)		-	-	
Duct Leakage (CFA)	12	12	-	-	-	-	
Other Measures							
Electric Water Heater (EF / Gal.)	0.95 EF / 40 Gal.	0.95 EF / 40 Gal.	-	-	-	-	
Appliances	Federal Min.	Federal Min.	-	-	-	-	
High-Efficacy Lighting	34%	34%	-	-	-	-	
Total Incremental Cost for the Home						\$2,676	

Notes:

- Costs for this measure represent a weighted value assuming that 73% of HUD Code homes will have an electric resistance furnace and 27% will have an air-source heat pump.
- Costs for this measure use a baseline of 13 SEER, even though the minimum appliance standard for some states in this Thermal Zone is 14 SEER. This conservatively represents a maximum cost.



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Exhibit 7: ENERGY STAR Manufactured Homes v2 vs HUD Code - Thermal Zone 3 - Electric Heat Pump Package

Measure	HUD Baseline	ENERGY STAR	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost	
Heating & Cooling Equipment Measures							
Space Heating	Elec. Furnace+AC Baseline	100 AFUE	8.2 HSPF	\$1,050.00	1	System	-
	Heatpump Baseline	8.2 HSPF	8.2 HSPF	-	-	-	-
	Weighted Average ¹			\$766.50	1	System	\$767
Space Cooling	Elec. Furnace+AC Baseline ²	13 SEER	14 SEER	\$75.45	2.7	Tons	-
	Heatpump Baseline	14 SEER	14 SEER	-	-	-	-
	Weighted Average ¹			\$55.08	2.7	Tons	\$149
Envelope & Glazing Measures							
Wall Insulation	R-13	R-11		-\$0.04	1,568	CFA (ft ²)	-\$62
Floor Insulation	R-22	R-22		-	-	-	-
Ceiling Insulation	R-30	R-33		\$0.13	1,568	CFA (ft ²)	\$199
Windows	U-value: 0.35 / SHGC: 0.33	U-value: 0.35 / SHGC: 0.34		-\$0.02	1,568	CFA (ft ²)	-\$32
Infiltration (ACH50)	8	8		-	-	-	-
Door (U-factor)	0.4	0.4		-	-	-	-
Thermostat & Ductwork Measures							
Thermostat	Manual	Programmable		\$16.54	1	Thermostat	\$17
Duct Location	Crawlspace	Crawlspace		-	-	-	-
Duct Insulation	R-22	R-22		-	-	-	-
Duct Leakage (CFA)	12	12		-	-	-	-
Other Measures							
Electric Water Heater (EF / Gal.)	0.95 EF / 40 Gal.	0.95 EF / 40 Gal.		-	-	-	-
Appliances	Federal Min.	Federal Min.		-	-	-	-
High-Efficacy Lighting	34%	34%		-	-	-	-
Total Incremental Cost for the Home							\$1,037

Notes:

- Costs for this measure represent a weighted value assuming that 73% of HUD Code homes will have an electric resistance furnace and 27% will have an air-source heat pump.
- Costs for this measure use a baseline of 13 SEER, even though the minimum appliance standard for some states in this Thermal Zone is 14 SEER. This conservatively represents a maximum cost.



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Exhibit 8: ENERGY STAR Manufactured Homes v2 vs HUD Code - Thermal Zone 1 - High-Efficiency Furnace Package

Measure	HUD Baseline	ENERGY STAR	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Heating & Cooling Equipment Measures						
Space Heating	80 AFUE Gas Furnace	90 AFUE Gas Furnace	\$6.92	53	kBtuh	\$369
Space Cooling	14 SEER AC	14 SEER AC	-	-	-	-
Envelope & Glazing Measures						
Wall Insulation	R-11	R-11	-	-	-	-
Floor Insulation	R-22	R-22	-	-	-	-
Ceiling Insulation	R-22	R-33	\$0.55	1,568	CFA (ft ²)	\$862
Windows	U-value: 1.08 / SHGC: 0.70	U-value: 0.35 / SHGC: 0.34	\$1.48	1,568	CFA (ft ²)	\$2,323
Infiltration (ACH50)	8	8	-	-	-	-
Door (U-factor)	0.4	0.4	-	-	-	-
Thermostat & Ductwork Measures						
Thermostat	Manual	Programmable	\$16.54	1	Thermostat	\$17
Duct Location	Crawlspace	Crawlspace	-	-	-	-
Duct Insulation	R-22	R-22	-	-	-	-
Duct Leakage (CFA)	12	12	-	-	-	-
Other Measures						
Gas Water Heater (EF / Gal.)	0.62 EF / 40 Gal.	0.62 EF / 40 Gal.	-	-	-	-
Appliances	Federal Min.	Federal Min.	-	-	-	-
High-Efficacy Lighting	34%	34%	-	-	-	-
Total Incremental Cost for the Home						\$3,570



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Exhibit 9: ENERGY STAR Manufactured Homes v2 vs HUD Code - Thermal Zone 2 - High-Efficiency Furnace Package

Measure	HUD Baseline	ENERGY STAR	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Heating & Cooling Equipment Measures						
Space Heating	80 AFUE Gas Furnace	95 AFUE Gas Furnace	\$8.23	55	kBtuh	\$452
Space Cooling	13 / 14 SEER AC	13 / 14 SEER AC	-	-	-	-
Envelope & Glazing Measures						
Wall Insulation	R-11	R-11	-	-	-	-
Floor Insulation	R-19	R-22	\$0.14	1,568	CFA (ft ²)	\$215
Ceiling Insulation	R-22	R-33	\$0.55	1,568	CFA (ft ²)	\$862
Windows	U-value: 0.50 / SHGC: 0.60	U-value: 0.35 / SHGC: 0.34	\$0.43	1,568	CFA (ft ²)	\$673
Infiltration (ACH50)	8	8	-	-	-	-
Door (U-factor)	0.4	0.4	-	-	-	-
Thermostat & Ductwork Measures						
Thermostat	Manual	Programmable	\$16.54	1	Thermostat	\$17
Duct Location	Crawlspace	Crawlspace	-	-	-	-
Duct Insulation	R-19	R-22	(Cost included in Floor Insulation)			-
Duct Leakage (CFA)	12	12	-	-	-	-
Other Measures						
Gas Water Heater (EF / Gal.)	0.62 EF / 40 Gal.	0.62 EF / 40 Gal.	-	-	-	-
Appliances	Federal Min.	Federal Min.	-	-	-	-
High-Efficacy Lighting	34%	34%	-	-	-	-
Total Incremental Cost for the Home						\$2,218



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Exhibit 10: ENERGY STAR Manufactured Homes v2 vs HUD Code - Thermal Zone 3 - High-Efficiency Furnace Package

Measure	HUD Baseline	ENERGY STAR	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Heating & Cooling Equipment Measures						
Space Heating	80 AFUE Gas Furnace	95 AFUE Gas Furnace	\$8.23	47	kBtuh	\$384
Space Cooling	13 / 14 SEER AC	13 / 14 SEER AC	-	-	-	-
Envelope & Glazing Measures						
Wall Insulation	R-13	R-13	-	-	-	-
Floor Insulation	R-22	R-30	\$0.39	1,568	CFA (ft ²)	\$614
Ceiling Insulation	R-30	R-38	\$0.34	1,568	CFA (ft ²)	\$530
Windows	U-value: 0.35 / SHGC: 0.33	U-value: 0.35 / SHGC: 0.34	-\$0.02	1,568	CFA (ft ²)	-\$32
Infiltration (ACH50)	8	8	-	-	-	-
Door (U-factor)	0.4	0.4	-	-	-	-
Thermostat & Ductwork Measures						
Thermostat	Manual	Programmable	\$16.54	1	Thermostat	\$17
Duct Location	Crawlspace	Crawlspace	-	-	-	-
Duct Insulation	R-22	R-30	(Cost included in Floor Insulation)			-
Duct Leakage (CFA)	12	12	-	-	-	-
Other Measures						
Gas Water Heater (EF / Gal.)	0.62 EF / 40 Gal.	0.62 EF / 40 Gal.	-	-	-	-
Appliances	Federal Min.	Federal Min.	-	-	-	-
High-Efficacy Lighting	34%	34%	-	-	-	-
Total Incremental Cost for the Home						\$1,513



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Exhibit 11: ENERGY STAR Manufactured Homes v2 vs HUD Code - Thermal Zone 1 - Envelope-Only Package – Electric Heating

Measure	HUD Baseline	ENERGY STAR	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Heating & Cooling Equipment Measures						
Space Heating	100 AFUE Elec. Furnace	100 AFUE Elec. Furnace	-	-	-	-
Space Cooling	14 SEER AC	14 SEER AC	-	-	-	-
Envelope & Glazing Measures						
Wall Insulation	R-11	R-13	\$0.04	1,568	CFA (ft ²)	\$62
Floor Insulation	R-22	R-22	-	-	-	-
Ceiling Insulation	R-22	R-38	\$0.76	1,568	CFA (ft ²)	\$1,193
Windows	U-value: 1.08 / SHGC: 0.70	U-value: 0.34 / SHGC: 0.34	\$1.57	1,568	CFA (ft ²)	\$2,467
Infiltration (ACH50)	8	8	-	-	-	-
Door (U-factor)	0.4	0.4	-	-	-	-
Thermostat & Ductwork Measures						
Thermostat	Manual	Programmable	\$16.54	1	Thermostat	\$17
Duct Location	Crawlspace	Crawlspace	-	-	-	-
Duct Insulation	R-22	R-22	-	-	-	-
Duct Leakage (CFA)	12	12	-	-	-	-
Other Measures						
Electric Water Heater (EF / Gal.)	0.95 EF / 40 Gal.	0.95 EF / 40 Gal.	-	-	-	-
Appliances	Federal Min.	Federal Min.	-	-	-	-
High-Efficacy Lighting	34%	34%	-	-	-	-
Total Incremental Cost for the Home						\$3,739

Notes:

1. Costs for this measure represent a weighted value assuming that 73% of HUD Code homes will have an electric resistance furnace and 27% will have an air-source heat pump.



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Exhibit 12: ENERGY STAR Manufactured Homes v2 vs HUD Code - Thermal Zone 2 - Envelope-Only Package – Electric Heating

Measure	HUD Baseline	ENERGY STAR	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Heating & Cooling Equipment Measures						
Space Heating	100 AFUE Elec. Furnace	100 AFUE Elec. Furnace	-	-	-	-
Space Cooling	13 / 14 SEER AC	13 / 14 SEER AC	-	-	-	-
Envelope & Glazing Measures						
Wall Insulation	R-11	R-19	\$0.39	1,568	CFA (ft ²)	\$616
Floor Insulation	R-19	R-22	\$0.14	1,568	CFA (ft ²)	\$215
Ceiling Insulation	R-22	R-38	\$0.76	1,568	CFA (ft ²)	\$1,193
Windows	U-value: 0.50 / SHGC: 0.60	U-value: 0.34 / SHGC: 0.34	\$0.52	1,568	CFA (ft ²)	\$817
Infiltration (ACH50)	8	8	-	-	-	-
Door (U-factor)	0.4	0.4	-	-	-	-
Thermostat & Ductwork Measures						
Thermostat	Manual	Programmable	\$16.54	1	Thermostat	\$17
Duct Location	Crawlspace	Crawlspace	-	-	-	-
Duct Insulation	R-19	R-22	(Cost included in Floor Insulation)			-
Duct Leakage (CFA)	12	12	-	-	-	-
Other Measures						
Electric Water Heater (EF / Gal.)	0.95 EF / 40 Gal.	0.95 EF / 40 Gal.	-	-	-	-
Appliances	Federal Min.	Federal Min.	-	-	-	-
High-Efficacy Lighting	34%	34%	-	-	-	-
Total Incremental Cost for the Home						\$2,858

Notes:

1. Costs for this measure represent a weighted value assuming that 73% of HUD Code homes will have an electric resistance furnace and 27% will have an air-source heat pump.



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Exhibit 13: ENERGY STAR Manufactured Homes v2 vs HUD Code - Thermal Zone 3 - Envelope-Only Package – Electric Heating

Measure	HUD Baseline	ENERGY STAR	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Heating & Cooling Equipment Measures						
Space Heating	100 AFUE Elec. Furnace	100 AFUE Elec. Furnace	-	-	-	-
Space Cooling	13 / 14 SEER AC	13 / 14 SEER AC	-	-	-	-
Envelope & Glazing Measures						
Wall Insulation	R-13	R-21	\$0.44	1,568	CFA (ft ²)	\$682
Floor Insulation	R-22	R-33	\$0.54	1,568	CFA (ft ²)	\$844
Ceiling Insulation	R-30	R-40	\$0.42	1,568	CFA (ft ²)	\$663
Windows	U-value: 0.35 / SHGC: 0.33	U-value: 0.34 / SHGC: 0.34	\$0.07	1,568	CFA (ft ²)	\$112
Infiltration (ACH50)	8	8	-	-	-	-
Door (U-factor)	0.4	0.4	-	-	-	-
Thermostat & Ductwork Measures						
Thermostat	Manual	Programmable	\$16.54	1	Thermostat	\$17
Duct Location	Crawlspace	Crawlspace	-	-	-	-
Duct Insulation	R-22	R-33	(Cost included in Floor Insulation)			-
Duct Leakage (CFA)	12	12	-	-	-	-
Other Measures						
Electric Water Heater (EF / Gal.)	0.95 EF / 40 Gal.	0.95 EF / 40 Gal.	-	-	-	-
Appliances	Federal Min.	Federal Min.	-	-	-	-
High-Efficacy Lighting	34%	34%	-	-	-	-
Total Incremental Cost for the Home						\$2,318

Notes:

1. Costs for this measure represent a weighted value assuming that 73% of HUD Code homes will have an electric resistance furnace and 27% will have an air-source heat pump.



ENERGY STAR Certified Manufactured Homes, Version 2 Cost & Savings Estimates

Exhibit 14: ENERGY STAR Manufactured Homes v2 vs HUD Code - Thermal Zone 1 - Envelope-Only Package – Gas Heating

Measure	HUD Baseline	ENERGY STAR	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Heating & Cooling Equipment Measures						
Space Heating	80 AFUE Gas Furnace	80 AFUE Gas Furnace	-	-	-	-
Space Cooling	14 SEER AC	14 SEER AC	-	-	-	-
Envelope & Glazing Measures						
Wall Insulation	R-11	R-13	\$0.04	1,568	CFA (ft ²)	\$62
Floor Insulation	R-22	R-22	-	-	-	-
Ceiling Insulation	R-22	R-38	\$0.76	1,568	CFA (ft ²)	\$1,193
Windows	U-value: 1.08 / SHGC: 0.70	U-value: 0.34 / SHGC: 0.34	\$1.57	1,568	CFA (ft ²)	\$2,467
Infiltration (ACH50)	8	8	-	-	-	-
Door (U-factor)	0.4	0.4	-	-	-	-
Thermostat & Ductwork Measures						
Thermostat	Manual	Programmable	\$16.54	1	Thermostat	\$17
Duct Location	Crawlspace	Crawlspace	-	-	-	-
Duct Insulation	R-22	R-22	-	-	-	-
Duct Leakage (CFA)	12	12	-	-	-	-
Other Measures						
Gas Water Heater (EF / Gal.)	0.62 EF / 40 Gal.	0.62 EF / 40 Gal.	-	-	-	-
Appliances	Federal Min.	Federal Min.	-	-	-	-
High-Efficacy Lighting	34%	34%	-	-	-	-
Total Incremental Cost for the Home						\$3,739



ENERGY STAR Certified Manufactured Homes, Version 2 Cost & Savings Estimates

Exhibit 15: ENERGY STAR Manufactured Homes v2 vs HUD Code - Thermal Zone 2 - Envelope-Only Package – Gas Heating

Measure	HUD Baseline	ENERGY STAR	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Heating & Cooling Equipment Measures						
Space Heating	80 AFUE Gas Furnace	80 AFUE Gas Furnace	-	-	-	-
Space Cooling	14 SEER AC	14 SEER AC	-	-	-	-
Envelope & Glazing Measures						
Wall Insulation	R-11	R-19	\$0.39	1,568	CFA (ft ²)	\$616
Floor Insulation	R-19	R-22	\$0.14	1,568	CFA (ft ²)	\$215
Ceiling Insulation	R-22	R-38	\$0.76	1,568	CFA (ft ²)	\$1,193
Windows	U-value: 0.50 / SHGC: 0.60	U-value: 0.34 / SHGC: 0.34	\$0.52	1,568	CFA (ft ²)	\$817
Infiltration (ACH50)	8	8	-	-	-	-
Door (U-factor)	0.4	0.4	-	-	-	-
Thermostat & Ductwork Measures						
Thermostat	Manual	Programmable	\$16.54	1	Thermostat	\$17
Duct Location	Crawlspace	Crawlspace	-	-	-	-
Duct Insulation	R-19	R-22	(Cost included in Floor Insulation)			-
Duct Leakage (CFA)	12	12	-	-	-	-
Other Measures						
Gas Water Heater (EF / Gal.)	0.62 EF / 40 Gal.	0.62 EF / 40 Gal.	-	-	-	-
Appliances	Federal Min.	Federal Min.	-	-	-	-
High-Efficacy Lighting	34%	34%	-	-	-	-
Total Incremental Cost for the Home						\$2,858



ENERGY STAR Certified Manufactured Homes, Version 2 Cost & Savings Estimates

Exhibit 16: ENERGY STAR Manufactured Homes v2 vs HUD Code - Thermal Zone 3 - Envelope-Only Package – Gas Heating

Measure	HUD Baseline	ENERGY STAR	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Heating & Cooling Equipment Measures						
Space Heating	80 AFUE Gas Furnace	80 AFUE Gas Furnace	-	-	-	-
Space Cooling	14 SEER AC	14 SEER AC	-	-	-	-
Envelope & Glazing Measures						
Wall Insulation	R-13	R-21	\$0.44	1,568	CFA (ft ²)	\$682
Floor Insulation	R-22	R-33	\$0.54	1,568	CFA (ft ²)	\$844
Ceiling Insulation	R-30	R-40	\$0.42	1,568	CFA (ft ²)	\$663
Windows	U-value: 0.35 / SHGC: 0.33	U-value: 0.34 / SHGC: 0.34	\$0.07	1,568	CFA (ft ²)	\$112
Infiltration (ACH50)	8	8	-	-	-	-
Door (U-factor)	0.4	0.4	-	-	-	-
Thermostat & Ductwork Measures						
Thermostat	Manual	Programmable	\$16.54	1	Thermostat	\$17
Duct Location	Crawlspace	Crawlspace	-	-	-	-
Duct Insulation	R-22	R-33	(Cost included in Floor Insulation)			-
Duct Leakage (CFA)	12	12	-	-	-	-
Other Measures						
Gas Water Heater (EF / Gal.)	0.62 EF / 40 Gal.	0.62 EF / 40 Gal.	-	-	-	-
Appliances	Federal Min.	Federal Min.	-	-	-	-
High-Efficacy Lighting	34%	34%	-	-	-	-
Total Incremental Cost for the Home						\$2,318



ENERGY STAR Certified Manufactured Homes, Version 2 Cost & Savings Estimates

Section 3: Incremental Cost References

A. Heating & Cooling Equipment Measures

Air-source Heat Pump

Reference	Systems Building Research Alliance
Accessed	July 2019
Notes	<ul style="list-style-type: none"> 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.

Central Air Conditioner

Reference	National Renewable Energy Laboratory (NREL) National Residential Energy Efficiency Measures Database v3.0.0 http://www.nrel.gov/ap/retrofits/
Accessed	June 2016
Notes	<ul style="list-style-type: none"> Because the database represents retrofit costs, the low-end of the cost range was used to approximate the costs for new construction. Costs were linearly interpolated by SEER.

Gas Furnace

Reference	NREL National Residential Energy Efficiency Measures Database v3.0.0 http://www.nrel.gov/ap/retrofits/
Accessed	June 2016
Notes	<ul style="list-style-type: none"> Because the database represents retrofit costs, the low-end of the cost range was used to approximate the costs for new construction. Costs were linearly interpolated by AFUE.

B. Envelope & Glazing Measures

Wall Insulation

Reference	Table 5.3 - Technical Support Document for the U.S. Department of Energy's Notice of Proposed Rulemaking Establishing Energy Conservation Standards for Manufactured Housing
Accessed	July 2019
Notes	<ul style="list-style-type: none"> N/A.

Floor Insulation

Reference	Table 5.4 - Technical Support Document for the U.S. Department of Energy's Notice of Proposed Rulemaking Establishing Energy Conservation Standards for Manufactured Housing
Accessed	July 2019
Notes	<ul style="list-style-type: none"> N/A.

Ceiling Insulation

Reference	Table 5.2 - Technical Support Document for the U.S. Department of Energy's Notice of Proposed Rulemaking Establishing Energy Conservation Standards for Manufactured Housing
Accessed	July 2019
Notes	<ul style="list-style-type: none"> N/A.



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Glazing U-Factor & SHGC

Reference	Table 5.5 - Technical Support Document for the U.S. Department of Energy's Notice of Proposed Rulemaking Establishing Energy Conservation Standards for Manufactured Housing
Accessed	July 2019
Notes	<ul style="list-style-type: none"> Costs were interpolated by U-factor and SHGC.

C. Thermostat & Ductwork Measures

Programmable Thermostat

Reference	Honeywell Digital Non-Programmable Thermostat http://www.Homedepot.com , Gulfgate Mall Store #6509 (Houston)
	Economy Heat/Cool Manual Thermostat http://www.Homedepot.com , Gulfgate Mall Store #6509 (Houston)
	Honeywell Round Heat/Cool Thermostat http://www.Homedepot.com , Gulfgate Mall Store #6509 (Houston)
	Honeywell Deluxe Digital Non-Programmable Thermostat http://www.Homedepot.com , Gulfgate Mall Store #6509 (Houston)
	Fahrenheit Non-Programmable Wall-Mount Thermostat http://www.Homedepot.com , Gulfgate Mall Store #6509 (Houston)
	Honeywell 5-2 Day Programmable Thermostat with Backlight http://www.Homedepot.com , Gulfgate Mall Store #6509 (Houston)
	Honeywell 7-Day Universal Touchscreen Programmable Thermostat http://www.Homedepot.com , Gulfgate Mall Store #6509 (Houston)
	Honeywell 5-2 Day Programmable 2H/2C Thermostat with Backlight http://www.Homedepot.com , Gulfgate Mall Store #6509 (Houston)
	Honeywell 7-Day Programmable Touchscreen Thermostat http://www.Homedepot.com , Gulfgate Mall Store #6509 (Houston)
	Honeywell 5-1-1 Day Programmable Thermostat with Backlight http://www.Homedepot.com , Gulfgate Mall Store #6509 (Houston)
	Emerson 5-1-1 Day Programmable Thermostat http://www.Homedepot.com , Gulfgate Mall Store #6509 (Houston)
	Emerson 80 Series 5-1-1 Day Programmable Single Stage Digital Thermostat http://www.Homedepot.com , Gulfgate Mall Store #6509 (Houston)
	Lux 7-Day Touchscreen Universal Application Programmable Thermostat http://www.Homedepot.com , Gulfgate Mall Store #6509 (Houston)
	Lux 5-2 Day Universal Application Programmable Thermostat http://www.Homedepot.com , Gulfgate Mall Store #6509 (Houston)
Accessed	February 2018
Notes	<ul style="list-style-type: none"> Average incremental cost from manual to programmable thermostat from 5 manufacturers.