



# ENERGY STAR Qualified Homes, Version 3 Savings & Cost Estimate Summary

The savings and incremental costs of implementing the ENERGY STAR Qualified Homes guidelines, Version 3, will vary for each individual home, dependent on variables such as baseline construction practices, geographic location, house design, and vendor relationships. For example, builders may experience much lower incremental costs where they are already using above-code windows or equipment efficiencies, complying with code-required high-quality insulation installation not currently enforced, or do not install appliances or ceiling fans within their homes.

As a means of developing *illustrative* savings and costs, EPA evaluated fourteen typical homes across hot, mixed, and cold climates. Each home was a single-story detached home with 2,200 square feet of conditioned floor area, an even width and length, 8 foot ceiling height, and three bedrooms. Window area to floor area ratio was 15% with windows evenly distributed on all four sides of the home. Slab on grade homes were modeled in climate zones 1 through 3, while unconditioned basements were modeled for homes in climate zones 4-8. Two homes were modeled in each climate zone; one was configured with a gas furnace, gas water heater, and electric air conditioner while the other was configured with an electric heatpump and electric water heater.

The energy efficiency features of the baseline homes were aligned with the 2009 IECC prescriptive path, though Grade III insulation installation was assumed for walls and Grade II insulation installation was assumed for ceilings and floors. The assumption of degraded insulation installation reflects EPA's experience with typical homes built to code. The rated homes were aligned with the requirements of the prescriptive path of the Version 3 guidelines, referred to as the ENERGY STAR Reference Design.

Because not all of the features proposed for the ENERGY STAR guidelines, Version 3, are currently recognized or credited within RESNET's current implementation of the HERS guidelines, the energy savings were estimated for each rated home using a two-step process.

First, each of the homes was modeled in REM/Rate v12.85 software with all of the features recognized by RESNET's HERS guidelines and able to be entered into the software program.

Second, improvement factors were developed to account for the impacts of the quality-control checklists that are not currently credited in the RESNET standards (i.e., Fully-Aligned Air Barrier and Air Sealing Sections of the Thermal Enclosure System Rater checklist and HVAC System Quality Installation Contractor and Rater checklists). One of these factors was accounted for using modifications to the REM/Rate inputs (i.e., 15% improvement in duct leakage, from 4.0 to 3.4 CFM per 100 sq. ft. of conditioned floor area, to account for the HVAC System Quality Installation Rater checklist). The others were accounted for by modifying the consumption outputs from REM/Rate. First, the heating and cooling energy consumption was reduced by 15% to account for the Fully-Aligned Air Barrier and Air Sealing Sections of the Thermal Enclosure System Rater checklist. Second, to reflect the HVAC System Quality Installation Contractor checklist, the heating consumption was reduced by 2.5% for combustion heating equipment or by 5% for electric heatpumps and the cooling consumption was reduced by 5% in all homes. More details about each of these improvement factors is included in the supporting savings and cost summary for each of the checklists, at the end of this document.

Incremental costs were estimated for each of the features required by the ENERGY STAR Reference Design as applied to each of the fourteen homes and then summed across all features.

Exhibit 1 on the following page contains a summary of the incremental costs and purchased energy savings for each home, along with the resulting cashflow. Exhibits 2 through 15 contain a breakout of the cost estimate for each of the fourteen homes. This is followed by the supporting savings and cost summary for each of the checklists.



# ENERGY STAR Qualified Homes, Version 3 Savings & Cost Estimate Summary

**Exhibit 1: ENERGY STAR Qualified Homes, Version 3 Illustrative Cost & Savings Summary**

Home	CZ	Location	Stories	Foundation	HVAC Equipment Type	Heating Fuel	Annual Utility Bills			ENERGY STAR Version 3 Upgrade Cost	ENERGY STAR Version 3 Cash Flow Impact			
							Costs		Savings		Monthly Mortgage Cost	Monthly Utility Savings	Monthly Mortgage Cost	Monthly Net Cash Flow
							2009 IECC	ENERGY STAR Version 3	ENERGY STAR Version 3	Total Cost				
1	1	Miami, FL	One-story	Slab	Air-Source Heatpump	Electricity	\$1,706	\$1,402	\$304	\$4,243	\$23	\$25	\$23	\$3
2	1	Miami, FL	One-story	Slab	Gas Furnace / AC	Gas	\$1,603	\$1,303	\$299	\$3,952	\$21	\$25	\$21	\$4
3	2	Daytona Beach, FL	One-story	Slab	Air-Source Heatpump	Electricity	\$1,674	\$1,404	\$271	\$4,011	\$22	\$23	\$22	\$1
4	2	Daytona Beach, FL	One-story	Slab	Gas Furnace / AC	Gas	\$1,589	\$1,317	\$273	\$3,720	\$20	\$23	\$20	\$3
5	3	Fort Worth, TX	One-story	Slab	Air-Source Heatpump	Electricity	\$1,950	\$1,580	\$370	\$4,451	\$24	\$31	\$24	\$7
6	3	Fort Worth, TX	One-story	Slab	Gas Furnace / AC	Gas	\$1,858	\$1,499	\$360	\$4,159	\$22	\$30	\$22	\$8
7	4	St. Louis, MO	One-story	Basement	Air-Source Heatpump	Electricity	\$2,228	\$1,812	\$416	\$4,074	\$22	\$35	\$22	\$13
8	4	St. Louis, MO	One-story	Basement	Gas Furnace / AC	Gas	\$1,977	\$1,608	\$368	\$3,555	\$19	\$31	\$19	\$12
9	5	Indianapolis, IN	One-story	Basement	Air-Source Heatpump	Electricity	\$2,276	\$1,783	\$493	\$4,893	\$26	\$41	\$26	\$15
10	5	Indianapolis, IN	One-story	Basement	Gas Furnace / AC	Gas	\$1,972	\$1,571	\$401	\$3,488	\$19	\$33	\$19	\$15
11	6	Burlington, VT	One-story	Basement	Air-Source Heatpump	Electricity	\$2,763	\$2,058	\$705	\$5,190	\$28	\$59	\$28	\$31
12	6	Burlington, VT	One-story	Basement	Gas Furnace / AC	Gas	\$2,261	\$1,727	\$534	\$3,627	\$19	\$44	\$19	\$25
13	7	Duluth, MN	One-story	Basement	Gnd-Source Heatpump	Electricity	\$3,365	\$1,749	\$1,616	\$9,154	\$49	\$135	\$49	\$86
14	7	Duluth, MN	One-story	Basement	Gas Furnace / AC	Gas	\$2,547	\$1,881	\$666	\$3,627	\$19	\$56	\$19	\$36

**Notes:**

- Purchased energy costs were calculated assuming a national average cost of \$0.11 / kWh and \$1.33 / therm. The electricity rate was determined by averaging the data for 2008 from the Energy Information Administration's Average Retail Price of Electricity to Ultimate Customers, Residential Sector. The natural gas rate was determined by averaging the data for 2008 from the Energy Information Administration's U.S. Price of Natural Gas Delivered to Residential Consumers.
- Monthly mortgage cost was calculated assuming a 30-year fixed mortgage with a 5.0% interest rate.



# ENERGY STAR Qualified Homes, Version 3 Savings & Cost Estimate Summary

**Exhibit 2: Sample Home 1 - Incremental Costs for ENERGY STAR Version 3 Qualified Homes vs 2009 IECC**

## Major Housing Characteristics

<b>Stories</b>	One	<b>City</b>	Miami, FL
<b>Total Conditioned Floor Area (ft²)</b>	2,200	<b>Climate Zone</b>	CZ 1
<b>Conditioned Floor Area per Floor (ft²)</b>	2,200	<b>Space Heating Fuel</b>	Electricity
<b>Foundation Type</b>	Slab	<b>Water Heating Fuel</b>	Electricity

## Incremental Costs

Measure	Baseline Level (2009 IECC)	Efficient Level (ENERGY STAR Version 3)	Unit Cost	Cost Qty	Cost Unit	ES v3 Cost
<b>ENERGY STAR Reference Design</b>						
Cooling Equipment	(See Heating Equipment)	(See Heating Equipment)	-	-	-	-
Heating Equipment	7.7 HSPF / 13 SEER / 11 EER ASHP; Electric Backup	8.2 HSPF / 14.5 SEER / 12 EER ASHP; Electric Backup	\$175.00	4	Tons	\$700
Radiant Barrier	No Radiant Barrier	Radiant Barrier	\$390.00	1	Radiant Barrier	\$390
Ceiling Insulation	R-30	R-30	-	-	-	-
Ceiling Insulation Installation	Grade II Installation	Grade I Installation	\$0.03	2,200	Ins. Surface Area (ft²)	\$56
Above-Grade Wall Insulation	R-13	R-13	-	-	-	-
A-G Wall Insulation Installation	Grade III Installation	Grade I Installation	\$0.10	1,501	Ins. Surface Area (ft²)	\$146
Foundation Insulation	No Slab Insulation	No Slab Insulation	-	-	-	-
Foundation Insulation Installation	Grade I Installation	Grade I Installation	-	-	-	-
Infiltration	7.0 ACH50	6.0 ACH50	\$0.25	2,200	CFA (ft²)	\$550
Windows	U-value: 0.75 / SHGC: 0.30	U-value: 0.60 / SHGC: 0.27	\$1.31	330	Window Area (ft²)	\$434
Doors	R-0.8 Door Insulation	R-4.8 Door Insulation	\$25.00	2	Door	\$50
Water Heater	0.90 EF Electric DHW, 52 Gallons	0.92 EF Electric DHW, 52 Gallons	\$55.00	1	Water Heater	\$55
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Duct Sealing	8 CFM per 100 ft² of CFA	4 CFM per 100 ft² of CFA	\$100.00	2.2	1,000 CFA (ft²)	\$220
Duct Insulation	R-8 Attic, R-6 Other Uncond. Spaces	R-8 Attic, R-6 Other Uncond. Spaces	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	\$0.00	1	Dishwasher	\$0
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	\$30.00	1	Refrigerator	\$30
Lighting	50% Fluorescent Lighting	80% ENERGY STAR CFLs	\$2.80	13	Lamps	\$37
Bathroom Exhaust Fans	Standard Efficiency Exhaust Fans	ENERGY STAR Exhaust Fans	\$25.00	2	Exhaust Fans	\$50
<b>ENERGY STAR Checklists</b>						
Thermal Enclosure System - Rater						\$350
HVAC Sys. Quality Install. - Contractor						\$875
HVAC Sys. Quality Install. - Rater						\$200
Water Management System - Builder						\$100
<b>Total Incremental Cost for Home</b>						<b>\$4,243</b>



# ENERGY STAR Qualified Homes, Version 3 Savings & Cost Estimate Summary

Exhibit 3: Sample Home 2 - Incremental Costs for ENERGY STAR Version 3 Qualified Homes vs 2009 IECC

## Major Housing Characteristics

Stories	One	City	Miami, FL
Total Conditioned Floor Area (ft <sup>2</sup> )	2,200	Climate Zone	CZ 1
Conditioned Floor Area per Floor (ft <sup>2</sup> )	2,200	Space Heating Fuel	Gas
Foundation Type	Slab	Water Heating Fuel	Gas

## Incremental Costs

Measure	Baseline Level (2009 IECC)	Efficient Level (ENERGY STAR Version 3)	Unit Cost	Cost Qty	Cost Unit	ES v3 Cost
<b>ENERGY STAR Reference Design</b>						
Cooling Equipment	13 SEER Central AC	14.5 SEER Central AC	\$107.14	4	Tons	\$429
Heating Equipment	80 AFUE gas furnace	80 AFUE gas furnace	-	-	-	-
Radiant Barrier	No Radiant Barrier	Radiant Barrier	\$390.00	1	Radiant Barrier	\$390
Ceiling Insulation	R-30	R-30	-	-	-	-
Ceiling Insulation Installation	Grade II Installation	Grade I Installation	\$0.03	2,200	Ins. Surface Area (ft <sup>2</sup> )	\$56
Above-Grade Wall Insulation	R-13	R-13	-	-	-	-
A-G Wall Insulation Installation	Grade III Installation	Grade I Installation	\$0.10	1,501	Ins. Surface Area (ft <sup>2</sup> )	\$146
Foundation Insulation	No Slab Insulation	No Slab Insulation	-	-	-	-
Foundation Insulation Installation	Grade I Installation	Grade I Installation	-	-	-	-
Infiltration	7.0 ACH50	6.0 ACH50	\$0.25	2,200	CFA (ft <sup>2</sup> )	\$550
Windows	U-value: 0.75 / SHGC: 0.30	U-value: 0.60 / SHGC: 0.27	\$1.31	330	Window Area (ft <sup>2</sup> )	\$434
Doors	R-0.8 Door Insulation	R-4.8 Door Insulation	\$25.00	2	Door	\$50
Water Heater	0.59 EF Gas DHW, 40 gallons	0.61 EF Gas DHW, 40 gallons	\$35.00	1	Water Heater	\$35
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Duct Sealing	8 CFM per 100 ft <sup>2</sup> of CFA	4 CFM per 100 ft <sup>2</sup> of CFA	\$100.00	2.2	1,000 CFA (ft <sup>2</sup> )	\$220
Duct Insulation	R-8 Attic, R-6 Other Uncond. Spaces	R-8 Attic, R-6 Other Uncond. Spaces	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	\$0.00	1	Dishwasher	\$0
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	\$30.00	1	Refrigerator	\$30
Lighting	50% Fluorescent Lighting	80% ENERGY STAR CFLs	\$2.80	13	Lamps	\$37
Bathroom Exhaust Fans	Standard Efficiency Exhaust Fans	ENERGY STAR Exhaust Fans	\$25.00	2	Exhaust Fans	\$50
<b>ENERGY STAR Checklists</b>						
Thermal Enclosure System - Rater						\$350
HVAC Sys. Quality Install. - Contractor						\$875
HVAC Sys. Quality Install. - Rater						\$200
Water Management System - Builder						\$100
Total Incremental Cost for Home						<b>\$3,952</b>



# ENERGY STAR Qualified Homes, Version 3 Savings & Cost Estimate Summary

Exhibit 4: Sample Home 3 - Incremental Costs for ENERGY STAR Version 3 Qualified Homes vs 2009 IECC

## Major Housing Characteristics

<b>Stories</b>	One	<b>City</b>	Daytona Beach, FL
<b>Total Conditioned Floor Area (ft²)</b>	2,200	<b>Climate Zone</b>	CZ 2
<b>Conditioned Floor Area per Floor (ft²)</b>	2,200	<b>Space Heating Fuel</b>	Electricity
<b>Foundation Type</b>	Slab	<b>Water Heating Fuel</b>	Electricity

## Incremental Costs

Measure	Baseline Level (2009 IECC)	Efficient Level (ENERGY STAR Version 3)	Unit Cost	Cost Qty	Cost Unit	ES v3 Cost
<b>ENERGY STAR Reference Design</b>						
Cooling Equipment	(See Heating Equipment)	(See Heating Equipment)	-	-	-	-
Heating Equipment	7.7 HSPF / 13 SEER / 11 EER ASHP; Electric Backup	8.2 HSPF / 14.5 SEER / 12 EER ASHP; Electric Backup	\$175.00	4	Tons	\$700
Radiant Barrier	No Radiant Barrier	Radiant Barrier	\$390.00	1	Radiant Barrier	\$390
Ceiling Insulation	R-30	R-30	-	-	-	-
Ceiling Insulation Installation	Grade II Installation	Grade I Installation	\$0.03	2,200	Ins. Surface Area (ft²)	\$56
Above-Grade Wall Insulation	R-13	R-13	-	-	-	-
A-G Wall Insulation Installation	Grade III Installation	Grade I Installation	\$0.10	1,501	Ins. Surface Area (ft²)	\$146
Foundation Insulation	No Slab Insulation	No Slab Insulation	-	-	-	-
Foundation Insulation Installation	Grade I Installation	Grade I Installation	-	-	-	-
Infiltration	7.0 ACH50	6.0 ACH50	\$0.25	2,200	CFA (ft²)	\$550
Windows	U-value: 0.65 / SHGC: 0.30	U-value: 0.60 / SHGC: 0.27	\$0.61	330	Window Area (ft²)	\$201
Doors	R-1.5 Door Insulation	R-4.8 Door Insulation	\$25.00	2	Door	\$50
Water Heater	0.90 EF Electric DHW, 52 Gallons	0.92 EF Electric DHW, 52 Gallons	\$55.00	1	Water Heater	\$55
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Duct Sealing	8 CFM per 100 ft² of CFA	4 CFM per 100 ft² of CFA	\$100.00	2.2	1,000 CFA (ft²)	\$220
Duct Insulation	R-8 Attic, R-6 Other Uncond. Spaces	R-8 Attic, R-6 Other Uncond. Spaces	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	\$0.00	1	Dishwasher	\$0
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	\$30.00	1	Refrigerator	\$30
Lighting	50% Fluorescent Lighting	80% ENERGY STAR CFLs	\$2.80	13	Lamps	\$37
Bathroom Exhaust Fans	Standard Efficiency Exhaust Fans	ENERGY STAR Exhaust Fans	\$25.00	2	Exhaust Fans	\$50
<b>ENERGY STAR Checklists</b>						
Thermal Enclosure System - Rater						\$350
HVAC Sys. Quality Install. - Contractor						\$875
HVAC Sys. Quality Install. - Rater						\$200
Water Management System - Builder						\$100
<b>Total Incremental Cost for Home</b>						<b>\$4,011</b>



# ENERGY STAR Qualified Homes, Version 3 Savings & Cost Estimate Summary

Exhibit 5: Sample Home 4 - Incremental Costs for ENERGY STAR Version 3 Qualified Homes vs 2009 IECC

## Major Housing Characteristics

<b>Stories</b>	One	<b>City</b>	Daytona Beach, FL
<b>Total Conditioned Floor Area (ft²)</b>	2,200	<b>Climate Zone</b>	CZ 2
<b>Conditioned Floor Area per Floor (ft²)</b>	2,200	<b>Space Heating Fuel</b>	Gas
<b>Foundation Type</b>	Slab	<b>Water Heating Fuel</b>	Gas

## Incremental Costs

Measure	Baseline Level (2009 IECC)	Efficient Level (ENERGY STAR Version 3)	Unit Cost	Cost Qty	Cost Unit	ES v3 Cost
<b>ENERGY STAR Reference Design</b>						
Cooling Equipment	13 SEER Central AC	14.5 SEER Central AC	\$107.14	4	Tons	\$429
Heating Equipment	80 AFUE gas furnace	80 AFUE gas furnace	-	-	-	-
Radiant Barrier	No Radiant Barrier	Radiant Barrier	\$390.00	1	Radiant Barrier	\$390
Ceiling Insulation	R-30	R-30	-	-	-	-
Ceiling Insulation Installation	Grade II Installation	Grade I Installation	\$0.03	2,200	Ins. Surface Area (ft²)	\$56
Above-Grade Wall Insulation	R-13	R-13	-	-	-	-
A-G Wall Insulation Installation	Grade III Installation	Grade I Installation	\$0.10	1,501	Ins. Surface Area (ft²)	\$146
Foundation Insulation	No Slab Insulation	No Slab Insulation	-	-	-	-
Foundation Insulation Installation	Grade I Installation	Grade I Installation	-	-	-	-
Infiltration	7.0 ACH50	6.0 ACH50	\$0.25	2,200	CFA (ft²)	\$550
Windows	U-value: 0.65 / SHGC: 0.30	U-value: 0.60 / SHGC: 0.27	\$0.61	330	Window Area (ft²)	\$201
Doors	R-1.5 Door Insulation	R-4.8 Door Insulation	\$25.00	2	Door	\$50
Water Heater	0.59 EF Gas DHW, 40 gallons	0.61 EF Gas DHW, 40 gallons	\$35.00	1	Water Heater	\$35
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Duct Sealing	8 CFM per 100 ft² of CFA	4 CFM per 100 ft² of CFA	\$100.00	2.2	1,000 CFA (ft²)	\$220
Duct Insulation	R-8 Attic, R-6 Other Uncond. Spaces	R-8 Attic, R-6 Other Uncond. Spaces	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	\$0.00	1	Dishwasher	\$0
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	\$30.00	1	Refrigerator	\$30
Lighting	50% Fluorescent Lighting	80% ENERGY STAR CFLs	\$2.80	13	Lamps	\$37
Bathroom Exhaust Fans	Standard Efficiency Exhaust Fans	ENERGY STAR Exhaust Fans	\$25.00	2	Exhaust Fans	\$50
<b>ENERGY STAR Checklists</b>						
Thermal Enclosure System - Rater						\$350
HVAC Sys. Quality Install. - Contractor						\$875
HVAC Sys. Quality Install. - Rater						\$200
Water Management System - Builder						\$100
<b>Total Incremental Cost for Home</b>						<b>\$3,720</b>



# ENERGY STAR Qualified Homes, Version 3 Savings & Cost Estimate Summary

Exhibit 6: Sample Home 5 - Incremental Costs for ENERGY STAR Version 3 Qualified Homes vs 2009 IECC

## Major Housing Characteristics

<b>Stories</b>	One	<b>City</b>	Fort Worth, TX
<b>Total Conditioned Floor Area (ft²)</b>	2,200	<b>Climate Zone</b>	CZ 3
<b>Conditioned Floor Area per Floor (ft²)</b>	2,200	<b>Space Heating Fuel</b>	Electricity
<b>Foundation Type</b>	Slab	<b>Water Heating Fuel</b>	Electricity

## Incremental Costs

Measure	Baseline Level (2009 IECC)	Efficient Level (ENERGY STAR Version 3)	Unit Cost	Cost Qty	Cost Unit	ES v3 Cost
<b>ENERGY STAR Reference Design</b>						
Cooling Equipment	(See Heating Equipment)	(See Heating Equipment)	-	-	-	-
Heating Equipment	7.7 HSPF / 13 SEER / 11 EER ASHP; Electric Backup	8.2 HSPF / 14.5 SEER / 12 EER ASHP; Electric Backup	\$175.00	4	Tons	\$700
Radiant Barrier	No Radiant Barrier	Radiant Barrier	\$390.00	1	Radiant Barrier	\$390
Ceiling Insulation	R-30	R-30	-	-	-	-
Ceiling Insulation Installation	Grade II Installation	Grade I Installation	\$0.03	2,200	Ins. Surface Area (ft²)	\$56
Above-Grade Wall Insulation	R-13	R-13	-	-	-	-
A-G Wall Insulation Installation	Grade III Installation	Grade I Installation	\$0.10	1,501	Ins. Surface Area (ft²)	\$146
Foundation Insulation	No Slab Insulation	No Slab Insulation	-	-	-	-
Foundation Insulation Installation	Grade I Installation	Grade I Installation	-	-	-	-
Infiltration	7.0 ACH50	5.0 ACH50	\$0.25	2,200	CFA (ft²)	\$550
Windows	U-value: 0.50 / SHGC: 0.30	U-value: 0.35 / SHGC: 0.30	\$1.94	330	Window Area (ft²)	\$641
Doors	R-2.0 Door Insulation	R-4.8 Door Insulation	\$25.00	2	Door	\$50
Water Heater	0.90 EF Electric DHW, 52 Gallons	0.92 EF Electric DHW, 52 Gallons	\$55.00	1	Water Heater	\$55
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Duct Sealing	8 CFM per 100 ft² of CFA	4 CFM per 100 ft² of CFA	\$100.00	2.2	1,000 CFA (ft²)	\$220
Duct Insulation	R-8 Attic, R-6 Other Uncond. Spaces	R-8 Attic, R-6 Other Uncond. Spaces	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	\$0.00	1	Dishwasher	\$0
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	\$30.00	1	Refrigerator	\$30
Lighting	50% Fluorescent Lighting	80% ENERGY STAR CFLs	\$2.80	13	Lamps	\$37
Bathroom Exhaust Fans	Standard Efficiency Exhaust Fans	ENERGY STAR Exhaust Fans	\$25.00	2	Exhaust Fans	\$50
<b>ENERGY STAR Checklists</b>						
Thermal Enclosure System - Rater						\$350
HVAC Sys. Quality Install. - Contractor						\$875
HVAC Sys. Quality Install. - Rater						\$200
Water Management System - Builder						\$100
<b>Total Incremental Cost for Home</b>						<b>\$4,451</b>



# ENERGY STAR Qualified Homes, Version 3 Savings & Cost Estimate Summary

Exhibit 7: Sample Home 6 - Incremental Costs for ENERGY STAR Version 3 Qualified Homes vs 2009 IECC

## Major Housing Characteristics

<b>Stories</b>	One	<b>City</b>	Fort Worth, TX
<b>Total Conditioned Floor Area (ft²)</b>	2,200	<b>Climate Zone</b>	CZ 3
<b>Conditioned Floor Area per Floor (ft²)</b>	2,200	<b>Space Heating Fuel</b>	Gas
<b>Foundation Type</b>	Slab	<b>Water Heating Fuel</b>	Gas

## Incremental Costs

Measure	Baseline Level (2009 IECC)	Efficient Level (ENERGY STAR Version 3)	Unit Cost	Cost Qty	Cost Unit	ES v3 Cost
<b>ENERGY STAR Reference Design</b>						
Cooling Equipment	13 SEER Central AC	14.5 SEER Central AC	\$107.14	4	Tons	\$429
Heating Equipment	80 AFUE gas furnace	80 AFUE gas furnace	-	-	-	-
Radiant Barrier	No Radiant Barrier	Radiant Barrier	\$390.00	1	Radiant Barrier	\$390
Ceiling Insulation	R-30	R-30	-	-	-	-
Ceiling Insulation Installation	Grade II Installation	Grade I Installation	\$0.03	2,200	Ins. Surface Area (ft²)	\$56
Above-Grade Wall Insulation	R-13	R-13	-	-	-	-
A-G Wall Insulation Installation	Grade III Installation	Grade I Installation	\$0.10	1,501	Ins. Surface Area (ft²)	\$146
Foundation Insulation	No Slab Insulation	No Slab Insulation	-	-	-	-
Foundation Insulation Installation	Grade I Installation	Grade I Installation	-	-	-	-
Infiltration	7.0 ACH50	5.0 ACH50	\$0.25	2,200	CFA (ft²)	\$550
Windows	U-value: 0.50 / SHGC: 0.30	U-value: 0.35 / SHGC: 0.30	\$1.94	330	Window Area (ft²)	\$641
Doors	R-2.0 Door Insulation	R-4.8 Door Insulation	\$25.00	2	Door	\$50
Water Heater	0.59 EF Gas DHW, 40 gallons	0.61 EF Gas DHW, 40 gallons	\$35.00	1	Water Heater	\$35
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Duct Sealing	8 CFM per 100 ft² of CFA	4 CFM per 100 ft² of CFA	\$100.00	2.2	1,000 CFA (ft²)	\$220
Duct Insulation	R-8 Attic, R-6 Other Uncond. Spaces	R-8 Attic, R-6 Other Uncond. Spaces	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	\$0.00	1	Dishwasher	\$0
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	\$30.00	1	Refrigerator	\$30
Lighting	50% Fluorescent Lighting	80% ENERGY STAR CFLs	\$2.80	13	Lamps	\$37
Bathroom Exhaust Fans	Standard Efficiency Exhaust Fans	ENERGY STAR Exhaust Fans	\$25.00	2	Exhaust Fans	\$50
<b>ENERGY STAR Checklists</b>						
Thermal Enclosure System - Rater						\$350
HVAC Sys. Quality Install. - Contractor						\$875
HVAC Sys. Quality Install. - Rater						\$200
Water Management System - Builder						\$100
<b>Total Incremental Cost for Home</b>						<b>\$4,159</b>





# ENERGY STAR Qualified Homes, Version 3 Savings & Cost Estimate Summary

Exhibit 8: Sample Home 7 - Incremental Costs for ENERGY STAR Version 3 Qualified Homes vs 2009 IECC

## Major Housing Characteristics

Stories	One	City	St. Louis, MO
Total Conditioned Floor Area (ft <sup>2</sup> )	2,200	Climate Zone	CZ 4
Conditioned Floor Area per Floor (ft <sup>2</sup> )	2,200	Space Heating Fuel	Electricity
Foundation Type	Unconditioned Basement	Water Heating Fuel	Electricity

## Incremental Costs

Measure	Baseline Level (2009 IECC)	Efficient Level (ENERGY STAR Version 3)	Unit Cost	Cost Qty	Cost Unit	ES v3 Cost
<b>ENERGY STAR Reference Design</b>						
Cooling Equipment	(See Heating Equipment)	(See Heating Equipment)	-	-	-	-
Heating Equipment	7.7 HSPF / 13 SEER / 11 EER ASHP; Electric Backup	8.5 HSPF / 14.5 SEER / 12 EER ASHP; Electric Backup	\$263.54	4	Tons	\$1,054
Radiant Barrier	No Radiant Barrier	No Radiant Barrier	-	-	-	-
Ceiling Insulation	R-38	R-38	-	-	-	-
Ceiling Insulation Installation	Grade II Installation	Grade I Installation	\$0.03	2,200	Ins. Surface Area (ft <sup>2</sup> )	\$56
Above-Grade Wall Insulation	R-13	R-13	-	-	-	-
A-G Wall Insulation Installation	Grade III Installation	Grade I Installation	\$0.10	1,501	Ins. Surface Area (ft <sup>2</sup> )	\$146
Foundation Insulation	R-19 Floor Insulation	R-19 Floor Insulation	-	-	-	-
Foundation Insulation Installation	Grade II Installation	Grade I Installation	\$0.08	2,200	Ins. Surface Area (ft <sup>2</sup> )	\$182
Infiltration	7.0 ACH50	5.0 ACH50	\$0.25	2,200	CFA (ft <sup>2</sup> )	\$550
Windows	U-value: 0.35 / SHGC: 0.45	U-value: 0.32 / SHGC: 0.40	\$0.36	330	Window Area (ft <sup>2</sup> )	\$119
Doors	R-2.9 Door Insulation	R-4.8 Door Insulation	\$25.00	2	Door	\$50
Water Heater	0.90 EF Electric DHW, 52 Gallons	0.92 EF Electric DHW, 52 Gallons	\$55.00	1	Water Heater	\$55
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Duct Sealing	8 CFM per 100 ft <sup>2</sup> of CFA	4 CFM per 100 ft <sup>2</sup> of CFA	\$100.00	2.2	1,000 CFA (ft <sup>2</sup> )	\$220
Duct Insulation	R-8 Attic, R-6 Other Uncond. Spaces	R-8 Attic, R-6 Other Uncond. Spaces	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	\$0.00	1	Dishwasher	\$0
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	\$30.00	1	Refrigerator	\$30
Lighting	50% Fluorescent Lighting	80% ENERGY STAR CFLs	\$2.80	13	Lamps	\$37
Bathroom Exhaust Fans	Standard Efficiency Exhaust Fans	ENERGY STAR Exhaust Fans	\$25.00	2	Exhaust Fans	\$50
<b>ENERGY STAR Checklists</b>						
Thermal Enclosure System - Rater						\$350
HVAC Sys. Quality Install. - Contractor						\$875
HVAC Sys. Quality Install. - Rater						\$200
Water Management System - Builder						\$100
<b>Total Incremental Cost for Home</b>						<b>\$4,074</b>



# ENERGY STAR Qualified Homes, Version 3 Savings & Cost Estimate Summary

Exhibit 9: Sample Home 8 - Incremental Costs for ENERGY STAR Version 3 Qualified Homes vs 2009 IECC

## Major Housing Characteristics

<b>Stories</b>	One	<b>City</b>	St. Louis, MO
<b>Total Conditioned Floor Area (ft²)</b>	2,200	<b>Climate Zone</b>	CZ 4
<b>Conditioned Floor Area per Floor (ft²)</b>	2,200	<b>Space Heating Fuel</b>	Gas
<b>Foundation Type</b>	Unconditioned Basement	<b>Water Heating Fuel</b>	Gas

## Incremental Costs

Measure	Baseline Level (2009 IECC)	Efficient Level (ENERGY STAR Version 3)	Unit Cost	Cost Qty	Cost Unit	ES v3 Cost
<b>ENERGY STAR Reference Design</b>						
Cooling Equipment	13 SEER Central AC	13 SEER Central AC	-	-	-	-
Heating Equipment	80 AFUE gas furnace	90 AFUE gas furnace	\$8.67	64	kBtu/h	\$555
Radiant Barrier	No Radiant Barrier	No Radiant Barrier	-	-	-	-
Ceiling Insulation	R-38	R-38	-	-	-	-
Ceiling Insulation Installation	Grade II Installation	Grade I Installation	\$0.03	2,200	Ins. Surface Area (ft²)	\$56
Above-Grade Wall Insulation	R-13	R-13	-	-	-	-
A-G Wall Insulation Installation	Grade III Installation	Grade I Installation	\$0.10	1,501	Ins. Surface Area (ft²)	\$146
Foundation Insulation	R-19 Floor Insulation	R-19 Floor Insulation	-	-	-	-
Foundation Insulation Installation	Grade II Installation	Grade I Installation	\$0.08	2,200	Ins. Surface Area (ft²)	\$182
Infiltration	7.0 ACH50	5.0 ACH50	\$0.25	2,200	CFA (ft²)	\$550
Windows	U-value: 0.35 / SHGC: 0.45	U-value: 0.32 / SHGC: 0.40	\$0.36	330	Window Area (ft²)	\$119
Doors	R-2.9 Door Insulation	R-4.8 Door Insulation	\$25.00	2	Door	\$50
Water Heater	0.59 EF Gas DHW, 40 gallons	0.61 EF Gas DHW, 40 gallons	\$35.00	1	Water Heater	\$35
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Duct Sealing	8 CFM per 100 ft² of CFA	4 CFM per 100 ft² of CFA	\$100.00	2.2	1,000 CFA (ft²)	\$220
Duct Insulation	R-8 Attic, R-6 Other Uncond. Spaces	R-8 Attic, R-6 Other Uncond. Spaces	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	\$0.00	1	Dishwasher	\$0
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	\$30.00	1	Refrigerator	\$30
Lighting	50% Fluorescent Lighting	80% ENERGY STAR CFLs	\$2.80	13	Lamps	\$37
Bathroom Exhaust Fans	Standard Efficiency Exhaust Fans	ENERGY STAR Exhaust Fans	\$25.00	2	Exhaust Fans	\$50
<b>ENERGY STAR Checklists</b>						
Thermal Enclosure System - Rater						\$350
HVAC Sys. Quality Install. - Contractor						\$875
HVAC Sys. Quality Install. - Rater						\$200
Water Management System - Builder						\$100
<b>Total Incremental Cost for Home</b>						<b>\$3,555</b>



# ENERGY STAR Qualified Homes, Version 3 Savings & Cost Estimate Summary

Exhibit 10: Sample Home 9 - Incremental Costs for ENERGY STAR Version 3 Qualified Homes vs 2009 IECC

## Major Housing Characteristics

<b>Stories</b>	One	<b>City</b>	Indianapolis, IN
<b>Total Conditioned Floor Area (ft²)</b>	2,200	<b>Climate Zone</b>	CZ 5
<b>Conditioned Floor Area per Floor (ft²)</b>	2,200	<b>Space Heating Fuel</b>	Electricity
<b>Foundation Type</b>	Unconditioned Basement	<b>Water Heating Fuel</b>	Electricity

## Incremental Costs

Measure	Baseline Level (2009 IECC)	Efficient Level (ENERGY STAR Version 3)	Unit Cost	Cost Qty	Cost Unit	ES v3 Cost
<b>ENERGY STAR Reference Design</b>						
Cooling Equipment	(See Heating Equipment)	(See Heating Equipment)	-	-	-	-
Heating Equipment	7.7 HSPF / 13 SEER / 11 EER ASHP; Electric Backu	9.25 HSPF / 14.5 SEER / 12 EER ASHP; Electric Backu	\$484.90	4	Tons	\$1,940
Radiant Barrier	No Radiant Barrier	No Radiant Barrier	-	-	-	-
Ceiling Insulation	R-38	R-38	-	-	-	-
Ceiling Insulation Installation	Grade II Installation	Grade I Installation	\$0.03	2,200	Ins. Surface Area (ft²)	\$56
Above-Grade Wall Insulation	R-20	R-20	-	-	-	-
A-G Wall Insulation Installation	Grade III Installation	Grade I Installation	\$0.05	1,501	Ins. Surface Area (ft²)	\$75
Foundation Insulation	R-30 Floor Insulation	R-30 Floor Insulation	-	-	-	-
Foundation Insulation Installation	Grade II Installation	Grade I Installation	\$0.08	2,200	Ins. Surface Area (ft²)	\$182
Infiltration	7.0 ACH50	4.0 ACH50	\$0.25	2,200	CFA (ft²)	\$550
Windows	U-value: 0.35 / SHGC: 0.45	U-value: 0.30 / SHGC: 0.45	\$0.38	330	Window Area (ft²)	\$124
Doors	R-2.9 Door Insulation	R-4.8 Door Insulation	\$25.00	2	Door	\$50
Water Heater	0.90 EF Electric DHW, 52 Gallons	0.92 EF Electric DHW, 52 Gallons	\$55.00	1	Water Heater	\$55
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Duct Sealing	8 CFM per 100 ft² of CFA	4 CFM per 100 ft² of CFA	\$100.00	2.2	1,000 CFA (ft²)	\$220
Duct Insulation	R-8 Attic, R-6 Other Uncond. Spaces	R-8 Attic, R-6 Other Uncond. Spaces	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	\$0.00	1	Dishwasher	\$0
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	\$30.00	1	Refrigerator	\$30
Lighting	50% Fluorescent Lighting	80% ENERGY STAR CFLs	\$2.80	13	Lamps	\$37
Bathroom Exhaust Fans	Standard Efficiency Exhaust Fans	ENERGY STAR Exhaust Fans	\$25.00	2	Exhaust Fans	\$50
<b>ENERGY STAR Checklists</b>						
Thermal Enclosure System - Rater						\$350
HVAC Sys. Quality Install. - Contractor						\$875
HVAC Sys. Quality Install. - Rater						\$200
Water Management System - Builder						\$100
<b>Total Incremental Cost for Home</b>						<b>\$4,893</b>



# ENERGY STAR Qualified Homes, Version 3 Savings & Cost Estimate Summary

Exhibit 11: Sample Home 10 - Incremental Costs for ENERGY STAR Version 3 Qualified Homes vs 2009 IECC

## Major Housing Characteristics

<b>Stories</b>	One	<b>City</b>	Indianapolis, IN
<b>Total Conditioned Floor Area (ft<sup>2</sup>)</b>	2,200	<b>Climate Zone</b>	CZ 5
<b>Conditioned Floor Area per Floor (ft<sup>2</sup>)</b>	2,200	<b>Space Heating Fuel</b>	Gas
<b>Foundation Type</b>	Unconditioned Basement	<b>Water Heating Fuel</b>	Gas

## Incremental Costs

Measure	Baseline Level (2009 IECC)	Efficient Level (ENERGY STAR Version 3)	Cost		Cost Unit	ES v3 Cost
			Unit Cost	Qty		
<b>ENERGY STAR Reference Design</b>						
Cooling Equipment	13 SEER Central AC	13 SEER Central AC	-	-	-	-
Heating Equipment	80 AFUE gas furnace	90 AFUE gas furnace	\$8.67	64	kBtu/h	\$555
Radiant Barrier	No Radiant Barrier	No Radiant Barrier	-	-	-	-
Ceiling Insulation	R-38	R-38	-	-	-	-
Ceiling Insulation Installation	Grade II Installation	Grade I Installation	\$0.03	2,200	Ins. Surface Area (ft <sup>2</sup> )	\$56
Above-Grade Wall Insulation	R-20	R-20	-	-	-	-
A-G Wall Insulation Installation	Grade III Installation	Grade I Installation	\$0.05	1,501	Ins. Surface Area (ft <sup>2</sup> )	\$75
Foundation Insulation	R-30 Floor Insulation	R-30 Floor Insulation	-	-	-	-
Foundation Insulation Installation	Grade II Installation	Grade I Installation	\$0.08	2,200	Ins. Surface Area (ft <sup>2</sup> )	\$182
Infiltration	7.0 ACH50	4.0 ACH50	\$0.25	2,200	CFA (ft <sup>2</sup> )	\$550
Windows	U-value: 0.35 / SHGC: 0.45	U-value: 0.30 / SHGC: 0.45	\$0.38	330	Window Area (ft <sup>2</sup> )	\$124
Doors	R-2.9 Door Insulation	R-4.8 Door Insulation	\$25.00	2	Door	\$50
Water Heater	0.59 EF Gas DHW, 40 gallons	0.61 EF Gas DHW, 40 gallons	\$35.00	1	Water Heater	\$35
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Duct Sealing	8 CFM per 100 ft <sup>2</sup> of CFA	4 CFM per 100 ft <sup>2</sup> of CFA	\$100.00	2.2	1,000 CFA (ft <sup>2</sup> )	\$220
Duct Insulation	R-8 Attic, R-6 Other Uncond. Spaces	R-8 Attic, R-6 Other Uncond. Spaces	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	\$0.00	1	Dishwasher	\$0
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	\$30.00	1	Refrigerator	\$30
Lighting	50% Fluorescent Lighting	80% ENERGY STAR CFLs	\$2.80	13	Lamps	\$37
Bathroom Exhaust Fans	Standard Efficiency Exhaust Fans	ENERGY STAR Exhaust Fans	\$25.00	2	Exhaust Fans	\$50
<b>ENERGY STAR Checklists</b>						
Thermal Enclosure System - Rater						\$350
HVAC Sys. Quality Install. - Contractor						\$875
HVAC Sys. Quality Install. - Rater						\$200
Water Management System - Builder						\$100
<b>Total Incremental Cost for Home</b>						<b>\$3,488</b>



# ENERGY STAR Qualified Homes, Version 3 Savings & Cost Estimate Summary

Exhibit 12: Sample Home 11 - Incremental Costs for ENERGY STAR Version 3 Qualified Homes vs 2009 IECC

## Major Housing Characteristics

<b>Stories</b>	One	<b>City</b>	Burlington, VT
<b>Total Conditioned Floor Area (ft<sup>2</sup>)</b>	2,200	<b>Climate Zone</b>	CZ 6
<b>Conditioned Floor Area per Floor (ft<sup>2</sup>)</b>	2,200	<b>Space Heating Fuel</b>	Electricity
<b>Foundation Type</b>	Unconditioned Basement	<b>Water Heating Fuel</b>	Electricity

## Incremental Costs

Measure	Baseline Level (2009 IECC)	Efficient Level (ENERGY STAR Version 3)	Unit Cost	Qty	Cost Unit	ES v3 Cost
<b>ENERGY STAR Reference Design</b>						
Cooling Equipment	(See Heating Equipment)	(See Heating Equipment)	-	-	-	-
Heating Equipment	7.7 HSPF / 13 SEER / 11 EER ASHP; Electric Backu	9.50 HSPF / 14.5 SEER / 12 EER ASHP; Electric Back	\$559.00	4	Tons	\$2,236
Radiant Barrier	No Radiant Barrier	No Radiant Barrier	-	-	-	-
Ceiling Insulation	R-49	R-49	-	-	-	-
Ceiling Insulation Installation	Grade II Installation	Grade I Installation	\$0.03	2,200	Ins. Surface Area (ft <sup>2</sup> )	\$56
Above-Grade Wall Insulation	R-20	R-20	-	-	-	-
A-G Wall Insulation Installation	Grade III Installation	Grade I Installation	\$0.05	1,501	Ins. Surface Area (ft <sup>2</sup> )	\$75
Foundation Insulation	R-30 Floor Insulation	R-30 Floor Insulation	-	-	-	-
Foundation Insulation Installation	Grade II Installation	Grade I Installation	\$0.08	2,200	Ins. Surface Area (ft <sup>2</sup> )	\$182
Infiltration	7.0 ACH50	4.0 ACH50	\$0.25	2,200	CFA (ft <sup>2</sup> )	\$550
Windows	U-value: 0.35 / SHGC: 0.45	U-value: 0.30 / SHGC: 0.45	\$0.38	330	Window Area (ft <sup>2</sup> )	\$124
Doors	R-2.9 Door Insulation	R-4.8 Door Insulation	\$25.00	2	Door	\$50
Water Heater	0.90 EF Electric DHW, 52 Gallons	0.92 EF Electric DHW, 52 Gallons	\$55.00	1	Water Heater	\$55
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Duct Sealing	8 CFM per 100 ft <sup>2</sup> of CFA	4 CFM per 100 ft <sup>2</sup> of CFA	\$100.00	2.2	1,000 CFA (ft <sup>2</sup> )	\$220
Duct Insulation	R-8 Attic, R-6 Other Uncond. Spaces	R-8 Attic, R-6 Other Uncond. Spaces	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	\$0.00	1	Dishwasher	\$0
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	\$30.00	1	Refrigerator	\$30
Lighting	50% Fluorescent Lighting	80% ENERGY STAR CFLs	\$2.80	13	Lamps	\$37
Bathroom Exhaust Fans	Standard Efficiency Exhaust Fans	ENERGY STAR Exhaust Fans	\$25.00	2	Exhaust Fans	\$50
<b>ENERGY STAR Checklists</b>						
Thermal Enclosure System - Rater						\$350
HVAC Sys. Quality Install. - Contractor						\$875
HVAC Sys. Quality Install. - Rater						\$200
Water Management System - Builder						\$100
<b>Total Incremental Cost for Home</b>						<b>\$5,190</b>



# ENERGY STAR Qualified Homes, Version 3 Savings & Cost Estimate Summary

Exhibit 13: Sample Home 12 - Incremental Costs for ENERGY STAR Version 3 Qualified Homes vs 2009 IECC

## Major Housing Characteristics

<b>Stories</b>	One	<b>City</b>	Burlington, VT
<b>Total Conditioned Floor Area (ft<sup>2</sup>)</b>	2,200	<b>Climate Zone</b>	CZ 6
<b>Conditioned Floor Area per Floor (ft<sup>2</sup>)</b>	2,200	<b>Space Heating Fuel</b>	Gas
<b>Foundation Type</b>	Unconditioned Basement	<b>Water Heating Fuel</b>	Gas

## Incremental Costs

Measure	Baseline Level (2009 IECC)	Efficient Level (ENERGY STAR Version 3)	Cost		Cost Unit	ES v3 Cost
			Unit Cost	Qty		
<b>ENERGY STAR Reference Design</b>						
Cooling Equipment	13 SEER Central AC	13 SEER Central AC	-	-	-	-
Heating Equipment	80 AFUE gas furnace	90 AFUE gas furnace	\$8.67	80	kBtu/h	\$693
Radiant Barrier	No Radiant Barrier	No Radiant Barrier	-	-	-	-
Ceiling Insulation	R-49	R-49	-	-	-	-
Ceiling Insulation Installation	Grade II Installation	Grade I Installation	\$0.03	2,200	Ins. Surface Area (ft <sup>2</sup> )	\$56
Above-Grade Wall Insulation	R-20	R-20	-	-	-	-
A-G Wall Insulation Installation	Grade III Installation	Grade I Installation	\$0.05	1,501	Ins. Surface Area (ft <sup>2</sup> )	\$75
Foundation Insulation	R-30 Floor Insulation	R-30 Floor Insulation	-	-	-	-
Foundation Insulation Installation	Grade II Installation	Grade I Installation	\$0.08	2,200	Ins. Surface Area (ft <sup>2</sup> )	\$182
Infiltration	7.0 ACH50	4.0 ACH50	\$0.25	2,200	CFA (ft <sup>2</sup> )	\$550
Windows	U-value: 0.35 / SHGC: 0.45	U-value: 0.30 / SHGC: 0.45	\$0.38	330	Window Area (ft <sup>2</sup> )	\$124
Doors	R-2.9 Door Insulation	R-4.8 Door Insulation	\$25.00	2	Door	\$50
Water Heater	0.59 EF Gas DHW, 40 gallons	0.61 EF Gas DHW, 40 gallons	\$35.00	1	Water Heater	\$35
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Duct Sealing	8 CFM per 100 ft <sup>2</sup> of CFA	4 CFM per 100 ft <sup>2</sup> of CFA	\$100.00	2.2	1,000 CFA (ft <sup>2</sup> )	\$220
Duct Insulation	R-8 Attic, R-6 Other Uncond. Spaces	R-8 Attic, R-6 Other Uncond. Spaces	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	\$0.00	1	Dishwasher	\$0
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	\$30.00	1	Refrigerator	\$30
Lighting	50% Fluorescent Lighting	80% ENERGY STAR CFLs	\$2.80	13	Lamps	\$37
Bathroom Exhaust Fans	Standard Efficiency Exhaust Fans	ENERGY STAR Exhaust Fans	\$25.00	2	Exhaust Fans	\$50
<b>ENERGY STAR Checklists</b>						
Thermal Enclosure System - Rater						\$350
HVAC Sys. Quality Install. - Contractor						\$875
HVAC Sys. Quality Install. - Rater						\$200
Water Management System - Builder						\$100
<b>Total Incremental Cost for Home</b>						<b>\$3,627</b>



# ENERGY STAR Qualified Homes, Version 3 Savings & Cost Estimate Summary

Exhibit 14: Sample Home 13 - Incremental Costs for ENERGY STAR Version 3 Qualified Homes vs 2009 IECC

## Major Housing Characteristics

Stories	One	City	Duluth, MN
Total Conditioned Floor Area (ft <sup>2</sup> )	2,200	Climate Zone	CZ 7
Conditioned Floor Area per Floor (ft <sup>2</sup> )	2,200	Space Heating Fuel	Electricity
Foundation Type	Unconditioned Basement	Water Heating Fuel	Electricity

## Incremental Costs

Measure	Baseline Level (2009 IECC)	Efficient Level (ENERGY STAR Version 3)	Unit Cost	Qty	Cost Unit	ES v3 Cost
<b>ENERGY STAR Reference Design</b>						
Cooling Equipment	(See Heating Equipment)	(See Heating Equipment)	-	-	-	-
Heating Equipment	7.7 HSPF / 13 SEER / 11 EER ASHP; Electric Backup	3.3 COP / 14.1 EER Ground-Source Heatpump	\$1,550.00	4	Tons	\$6,200
Radiant Barrier	No Radiant Barrier	No Radiant Barrier	-	-	-	-
Ceiling Insulation	R-49	R-49	-	-	-	-
Ceiling Insulation Installation	Grade II Installation	Grade I Installation	\$0.03	2,200	Ins. Surface Area (ft <sup>2</sup> )	\$56
Above-Grade Wall Insulation	R-21	R-21	-	-	-	-
A-G Wall Insulation Installation	Grade III Installation	Grade I Installation	\$0.05	1,501	Ins. Surface Area (ft <sup>2</sup> )	\$75
Foundation Insulation	R-38 Floor Insulation	R-38 Floor Insulation	-	-	-	-
Foundation Insulation Installation	Grade II Installation	Grade I Installation	\$0.08	2,200	Ins. Surface Area (ft <sup>2</sup> )	\$182
Infiltration	7.0 ACH50	4.0 ACH50	\$0.25	2,200	CFA (ft <sup>2</sup> )	\$550
Windows	U-value: 0.35 / SHGC: 0.45	U-value: 0.30 / SHGC: 0.45	\$0.38	330	Window Area (ft <sup>2</sup> )	\$124
Doors	R-2.9 Door Insulation	R-4.8 Door Insulation	\$25.00	2	Door	\$50
Water Heater	0.90 EF Electric DHW, 52 Gallons	0.92 EF Electric DHW, 52 Gallons	\$55.00	1	Water Heater	\$55
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Duct Sealing	8 CFM per 100 ft <sup>2</sup> of CFA	4 CFM per 100 ft <sup>2</sup> of CFA	\$100.00	2.2	1,000 CFA (ft <sup>2</sup> )	\$220
Duct Insulation	R-8 Attic, R-6 Other Uncond. Spaces	R-8 Attic, R-6 Other Uncond. Spaces	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	\$0.00	1	Dishwasher	\$0
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	\$30.00	1	Refrigerator	\$30
Lighting	50% Fluorescent Lighting	80% ENERGY STAR CFLs	\$2.80	13	Lamps	\$37
Bathroom Exhaust Fans	Standard Efficiency Exhaust Fans	ENERGY STAR Exhaust Fans	\$25.00	2	Exhaust Fans	\$50
<b>ENERGY STAR Checklists</b>						
Thermal Enclosure System - Rater						\$350
HVAC Sys. Quality Install. - Contractor						\$875
HVAC Sys. Quality Install. - Rater						\$200
Water Management System - Builder						\$100
Total Incremental Cost for Home						<b>\$9,154</b>



# ENERGY STAR Qualified Homes, Version 3 Savings & Cost Estimate Summary

Exhibit 15: Sample Home 14 - Incremental Costs for ENERGY STAR Version 3 Qualified Homes vs 2009 IECC

## Major Housing Characteristics

Stories	One	City	Duluth, MN
Total Conditioned Floor Area (ft <sup>2</sup> )	2,200	Climate Zone	CZ 7
Conditioned Floor Area per Floor (ft <sup>2</sup> )	2,200	Space Heating Fuel	Gas
Foundation Type	Unconditioned Basement	Water Heating Fuel	Gas

## Incremental Costs

Measure	Baseline Level (2009 IECC)	Efficient Level (ENERGY STAR Version 3)	Unit Cost	Qty	Cost Unit	ES v3 Cost
<b>ENERGY STAR Reference Design</b>						
Cooling Equipment	13 SEER Central AC	13 SEER Central AC	-	-	-	-
Heating Equipment	80 AFUE gas furnace	90 AFUE gas furnace	\$8.67	80	kBtu/h	\$693
Radiant Barrier	No Radiant Barrier	No Radiant Barrier	-	-	-	-
Ceiling Insulation	R-49	R-49	-	-	-	-
Ceiling Insulation Installation	Grade II Installation	Grade I Installation	\$0.03	2,200	Ins. Surface Area (ft <sup>2</sup> )	\$56
Above-Grade Wall Insulation	R-21	R-21	-	-	-	-
A-G Wall Insulation Installation	Grade III Installation	Grade I Installation	\$0.05	1,501	Ins. Surface Area (ft <sup>2</sup> )	\$75
Foundation Insulation	R-38 Floor Insulation	R-38 Floor Insulation	-	-	-	-
Foundation Insulation Installation	Grade II Installation	Grade I Installation	\$0.08	2,200	Ins. Surface Area (ft <sup>2</sup> )	\$182
Infiltration	7.0 ACH50	4.0 ACH50	\$0.25	2,200	CFA (ft <sup>2</sup> )	\$550
Windows	U-value: 0.35 / SHGC: 0.45	U-value: 0.30 / SHGC: 0.45	\$0.38	330	Window Area (ft <sup>2</sup> )	\$124
Doors	R-2.9 Door Insulation	R-4.8 Door Insulation	\$25.00	2	Door	\$50
Water Heater	0.59 EF Gas DHW, 40 gallons	0.61 EF Gas DHW, 40 gallons	\$35.00	1	Water Heater	\$35
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Duct Sealing	8 CFM per 100 ft <sup>2</sup> of CFA	4 CFM per 100 ft <sup>2</sup> of CFA	\$100.00	2.2	1,000 CFA (ft <sup>2</sup> )	\$220
Duct Insulation	R-8 Attic, R-6 Other Uncond. Spaces	R-8 Attic, R-6 Other Uncond. Spaces	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	\$0.00	1	Dishwasher	\$0
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	\$30.00	1	Refrigerator	\$30
Lighting	50% Fluorescent Lighting	80% ENERGY STAR CFLs	\$2.80	13	Lamps	\$37
Bathroom Exhaust Fans	Standard Efficiency Exhaust Fans	ENERGY STAR Exhaust Fans	\$25.00	2	Exhaust Fans	\$50
<b>ENERGY STAR Checklists</b>						
Thermal Enclosure System - Rater						\$350
HVAC Sys. Quality Install. - Contractor						\$875
HVAC Sys. Quality Install. - Rater						\$200
Water Management System - Builder						\$100
Total Incremental Cost for Home						<b>\$3,627</b>





# ENERGY STAR Qualified Homes, Version 3 Savings & Cost Estimate Summary

Measure	Cost Reference
<b>ENERGY STAR Reference Design</b>	
Cooling Equipment	Navigant Consulting. <u>EIA - Technology Forecast Updates - Residential and Commercial Building Technologies - Reference Case Second Edition (Revised)</u> . Reference number 20070831.1. 2007. Average costs were used. Costs were linearly extrapolated for 14.5 SEER central air conditioner.
Heating Equipment	Navigant Consulting. <u>EIA - Technology Forecast Updates - Residential and Commercial Building Technologies - Reference Case Second Edition (Revised)</u> . Reference number 20070831.1. 2007. Average costs were used. Costs were linearly extrapolated for 14.5 SEER/ 8.2 HSPF heat pump and linearly interpolated for 14.5 SEER/ 8.5 HSPF, 14.5 SEER/ 9.25 HSPF, and 14.5 SEER/9.5 HSPF systems.
Radiant Barrier	Nadel, Sachs, et al. <u>Emerging Energy-Saving Technologies &amp; Practices for the Buildings Sector as of 2004</u> . Report Number A042. ACEEE, 2004.
Above-Grade Wall Insulation	Reed Construction Data, Inc.. <u>RSMMeans Residential Cost Data</u> . 25th Annual Edition, 2006. Baseline cost for R-19 batt insulation estimated from Section 7210, Sub-Section 950, Measure 141. Upgrade cost for R-20 blown-in cellulose insulation interpolated from Section 7210, Sub-Section 150, measures 0030 and 0050. As a result of predicted negative incremental cost, a conservative estimate of zero incremental cost was assumed.
Foundation Insulation	Reed Construction Data, Inc.. <u>RSMMeans Residential Cost Data</u> . 25th Annual Edition, 2006. Baseline cost for R-13 batt insulation interpolated from Section 7210, Sub-Section 950, measures 0821 and 0861. Upgrade cost for R-19 batt insulation estimated from Section 7210, Sub-Section 950, Measure 0861.
Insulation Installation	Reed Construction Data, Inc.. <u>RSMMeans Residential Cost Data</u> . 25th Annual Edition, 2006. Incremental costs for higher-quality insulation installation reflected by using higher labor costs. Assumption of 15% ceiling insulation labor increase from Grade II to Grade I, 25% floor insulation labor increase from Grade III to Grade I, 75% fiberglass frame wall insulation labor increase from Grade III to Grade I, and 25% blown-in frame wall insulation labor increase from Grade III to Grade I where baseline labor costs were derived from RS Means. Baseline wall costs for cold climates from Section 7210, Sub-Section 150, measures 0030 & 0050 and from Sub-Section 950, Measures 0821 and 0861 for mixed and hot climates. Baseline ceiling costs from Section 7210, Sub-Section 950, Measures 0901 and 0941. Baseline floor costs from Section 7210, Sub-Section 350, Measures 2100, 2150, & 2200. Linear interpolation used as needed to estimate costs for unlisted insulation levels.
Infiltration	Estimated market costs based on anecdotal evidence.
Windows	Estimated from DEER 2008 costs, using regressions to predict change in cost per unit change in U-value and SHGC.
Doors	Estimated market costs based on anecdotal evidence.
Water Heater	Navigant Consulting. <u>EIA - Technology Forecast Updates - Residential and Commercial Building Technologies - Reference Case Second Edition (Revised)</u> . Reference number 20070831.1. 2007. Average costs were used. Cost was linearly interpolated for 0.92 EF gas DHW unit.
Duct Sealing	Connecticut Light & Power and The United Illuminating Company. <u>CL&amp;P and UI Program Savings Documentation for 2008 Program Year</u> . 9/25/2007.
Dishwasher	United States EPA. <u>Life Cycle Cost Estimate for 1 ENERGY STAR Qualified Dishwasher(s)</u> . Accessed at <a href="http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerDishwasher.xls">http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerDishwasher.xls</a> on April 6, 2009.
Refrigerator	United States EPA. <u>Life Cycle Cost Estimate for 1 ENERGY STAR Qualified Residential Refrigerator(s)</u> . Accessed at <a href="http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Consumer_Residential_Refrig_Sav_Calc.xls">http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Consumer_Residential_Refrig_Sav_Calc.xls</a> on April 6, 2009.
Ceiling Fans	United States EPA. <u>Life Cycle Cost Estimate for 1 ENERGY STAR Qualified Ceiling Fan(s) with Lighting</u> . Accessed at <a href="http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Ceiling_Fan_Savings_Calculator_Consumer.xls">http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Ceiling_Fan_Savings_Calculator_Consumer.xls</a> on April 6, 2009.
Lighting	United States EPA. <u>Life Cycle Cost Estimate for 1 ENERGY STAR Qualified Compact Fluorescent Lamp(s)</u> . Accessed at <a href="http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorCFLs.xls">http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorCFLs.xls</a> on April 6, 2009.
Bathroom Exhaust Fans	Cost estimates obtained for one ENERGY STAR qualified and one non-qualified bathroom fan from the Lowe's website. Accessed on September 23, 2009. Non-qualified exhaust fan: <a href="http://www.lowes.com/lowes/lkn?action=productDetail&amp;productId=207236-14-676&amp;lpage=none">http://www.lowes.com/lowes/lkn?action=productDetail&amp;productId=207236-14-676&amp;lpage=none</a> Qualified exhaust fan: <a href="http://www.lowes.com/lowes/lkn?action=productDetail&amp;productId=89247-14-HD80&amp;lpage=none">http://www.lowes.com/lowes/lkn?action=productDetail&amp;productId=89247-14-HD80&amp;lpage=none</a>
<b>ENERGY STAR Checklists</b>	
Thermal Enclosure System	United States EPA. <u>ENERGY STAR Qualified Homes, Version 3.0 Thermal Enclosure System Checklist Savings &amp; Cost Estimate</u> . 2010.
HVAC Sys. Quality Install. - Contractor	United States EPA. <u>ENERGY STAR Qualified Homes, Version 3.0 HVAC System Quality Installation Contractor Checklist Savings &amp; Cost Estimate</u> . 2010.
HVAC Sys. Quality Install. - Rater	United States EPA. <u>ENERGY STAR Qualified Homes, Version 3.0 HVAC System Quality Installation Rater Checklist Savings &amp; Cost Estimate</u> . 2010.
Water Management System	United States EPA. <u>ENERGY STAR Qualified Homes, Version 3.0 Water Management System Checklist Savings &amp; Cost Estimate</u> . 2010.



# ENERGY STAR Qualified Homes, Version 3 Thermal Enclosure System Rater Checklist Savings & Cost Estimate

## Average Estimated Incremental Cost:

The net cost for the checklist is estimated to be \$350.

## Average Estimated Incremental Savings:

Energy savings of approximately 15% in heating and cooling load and consumption are estimated as a result of the fully-aligned air barriers and air sealing measures that are required in this checklist. These measures will save energy by reducing convective loops and conduction losses.

For the reduced thermal bridging section of the checklist, it is assumed that a reduced framing fraction of 17% will be achieved for exterior walls and 7% will be achieved for ceilings. Average combined annual heating and cooling energy savings from advanced framing techniques have been shown to vary between roughly 3% and 5%.

## Rationale:

Incremental costs for the Fully-Aligned Air Barrier section and Air-Sealing section of the checklist are comprised of added material and labor costs associated with implementing the checklist. Compliance costs will vary widely depending on the percentage of requirements applicable to a particular home, the number of requirements not already being met through standard practice, the complexity of the home, and the strategies used for compliance. Over the past few years of implementing the Thermal Bypass Checklist, which is similar to these two sections, EPA has received anecdotal evidence that average incremental costs for labor and material are approximately \$175. EPA has included an additional \$50 for the new requirement to seal sheetrock to the top plate in wall assemblies.

The purpose of the Reduced Thermal Bridging section of the checklist is to reduce the impacts of thermal bridging over standard construction methods by decreasing the level of unnecessary framing and allowing more space for insulation to be installed. This is accomplished by requiring the builder to either adopt advanced framing techniques based upon optimum value engineered (OVE) principles or by using an advanced wall system such as SIP panels, Insulated Concrete Forms, or double-walls. The increased design, training, and inspection costs for the reduced thermal bridging section of the checklist will be offset by material savings, based upon an ACEEE study and EERE fact sheet cited in the following section. Therefore, the incremental costs were conservatively estimated at zero for this section of the checklist.

Incremental costs for meeting the High-Performance Windows and Quality-Installed Insulation sections of the checklist were accounted for separate from this estimate.

In addition, there will be an incremental cost for third-party verification of this checklist. Third-party inspection costs are estimated at an additional \$125 per home.

The overall incremental cost for the Fully-Aligned Air Barrier section, Air-Sealing section, and Reduced Thermal Bridging section of the checklist is therefore estimated to be \$350.

Energy savings for the Fully-Aligned Air Barrier section and Air-Sealing section are also variable and difficult to assess. For example, the presence and impacts from convective loops, which may significantly degrade the performance of an insulated component, are not recognized nor the impacts quantified in typical energy simulation software. One study compared the real-world energy intensity of homes in Phoenix qualified under the original (i.e., 1995-2006) ENERGY STAR guidelines with those qualified under the Environments for Living (EFL) program. Some of the key differences in program requirements at that time were that EFL contained additional requirements similar to the current Thermal Bypass Checklist, such as an air-barrier and insulation



# ENERGY STAR Qualified Homes, Version 3 Thermal Enclosure System Rater Checklist Savings & Cost Estimate

field inspection. EFL homes were shown to have approximately 15% less summer energy consumption than the ENERGY STAR qualified homes and is used as the basis for the above estimate.

A conservative estimate of savings for the Reduced Thermal Bridging section was determined by estimating the reduced framing fraction associated with the least aggressive measure (i.e., the key design techniques for OVE walls) and then modeling this reduced framing fraction in typical housing configurations. The estimation of representative framing fractions of walls and ceilings before and after the application of these techniques is illustrated in the Supporting Documentation section. The savings estimate was also compared with the results from an ACEEE study and EERE fact sheet. The proposed ENERGY STAR reduced framing fraction does not include all of the typical aspects of more-aggressive OVE practices (e.g. in-line framing, single top plate) and so cannot reach framing levels as low as OVE. On the other hand, some partners will utilize other options available on the checklist, such as SIPs, which will result in even lower framing fractions.

## Supporting Documentation:

The reference for the study comparing EFL and ENERGY STAR qualified homes in Phoenix, mentioned above, is as follows:

Swanson, Colby. "Measuring Public Benefit from Energy Efficient Homes." Advanced Energy, Raleigh, NC. 2005.

According to the 2004 ACEEE *Emerging Technologies & Practices* study, homes with optimum value engineering (OVE) framing can experience ~1% cooling electricity savings and ~2% heating gas savings annually. The aggressive techniques outlined by ACEEE include 24" OC stud spacing, in-line framing, single top plate, two-stud corners, and ladder T-walls. According to the study, material cost savings would be neutrally offset by increased design and training costs. Savings were estimated relative to a standard 2x4 16" OC wall with 26.1% framing fraction.

The August 2000 *Advanced Wall Framing Technology* fact sheet released by EERE claims combined annual heating and cooling savings of up to 5% with the same construction techniques suggested by ACEEE. The fact sheet also estimated labor cost savings between 3% and 5% and material cost savings of \$500 and \$1,000 for 1,200 and 2,400 sqft homes, respectively. This equates to roughly \$0.42 material savings per sqft of floor space.



# ENERGY STAR Qualified Homes, Version 3 Thermal Enclosure System Rater Checklist Savings & Cost Estimate

The following RESNET table shows framing fraction values for both standard and advanced construction.

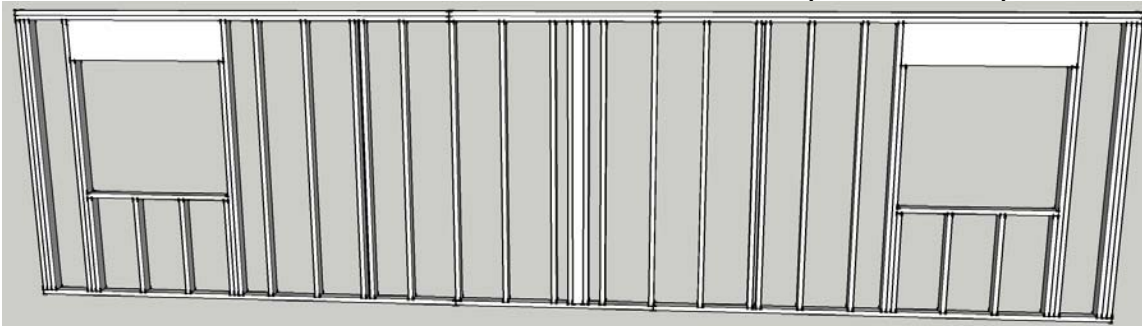
**Table 303.4.1.3. Default Framing Fractions for Enclosure Elements**

Enclosure Element	Frame Spacing (in. OC)	Default Frame Fraction (area)
<i>Walls (standard):</i>		
@16" OC	16	23%
@24" OC	24	20%
<i>Walls (advanced):</i>		
@16" OC	16	19%
@24" OC	24	16%
Structural Insulated Panels (SIPs)	48	10%
<i>Ceilings (standard trusses):</i>		
@16" OC	16	14%
@24" OC	24	11%
<i>Ceilings (conventional framing):</i>		
@16" OC	16	13%
@24" OC	24	9%
<i>Ceilings (advanced trusses – raised heel):</i>		
@16" OC	16	10%
@24" OC	24	7%

Source: 2006 Mortgage Industry National Home Energy Rating Systems Standards

The wall below has the same framing fraction as RESNET's default value for a standard wall with 16" OC framing.

**30' 2x4 16" OC Standard Wall with Two Windows (4'-1" x 3'-8.5")<sup>i,ii</sup>**



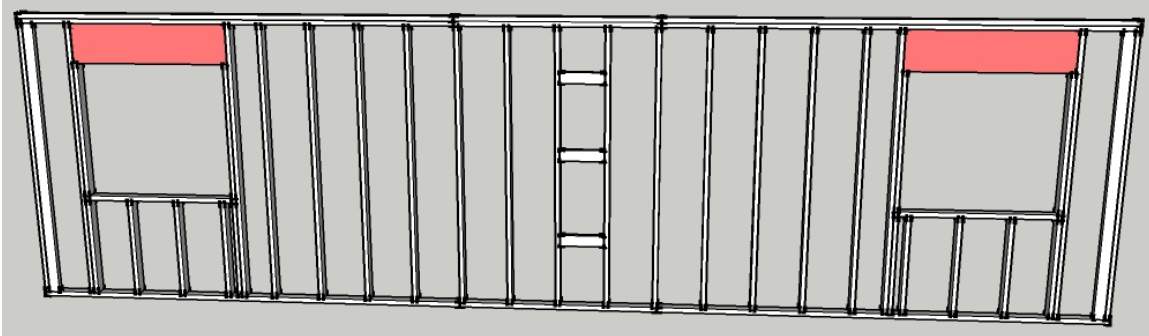
Top & Bottom Plates:	3 * 30' * 1.5"	= 11.3 sqft
King Studs:	23 * 7'-7.5" * 1.5"	= 21.9 sqft
T-Wall Intersection:	7'-7.5" * 3.5"	= 2.2 sqft
4-Stud Corner:	4 * 7'-7.5" * 1.5"	= 3.8 sqft
Cripples & Jacks:	8 * 2'-8.5" * 1.5" + 4 * 6'-6.5" * 1.5"	= 6.0 sqft
Sills:	2 * 4'-1" * 1.5"	= 1.0 sqft
Header:	2 * 4'-4" * 11.5"	= 8.3 sqft
Total Wood Area		= 54.5 sqft
Framing Fraction	= 54.5 / (30 * 8)	= 23%



# ENERGY STAR Qualified Homes, Version 3 Thermal Enclosure System Rater Checklist Savings & Cost Estimate

Below is a wall configuration that reflects a best-case application of the OVE techniques required by the framing checklist, which results in a framing fraction of 15%. The addition of complicated architectural characteristics would add to total framing fraction. Also, effective insulations levels will likely be reduced due to compression behind ladder t-wall framing and corner framing. It is therefore assumed that a higher framing fraction of approximately 17% will be achieved on average, which is equivalent to a 25% reduction from the RESNET standard of 23% framing fraction.

**30' 2x6 16" OC ENERGY STAR Wall with Two Windows (4'-1" x 3'-8.5")<sup>i,ii</sup>**



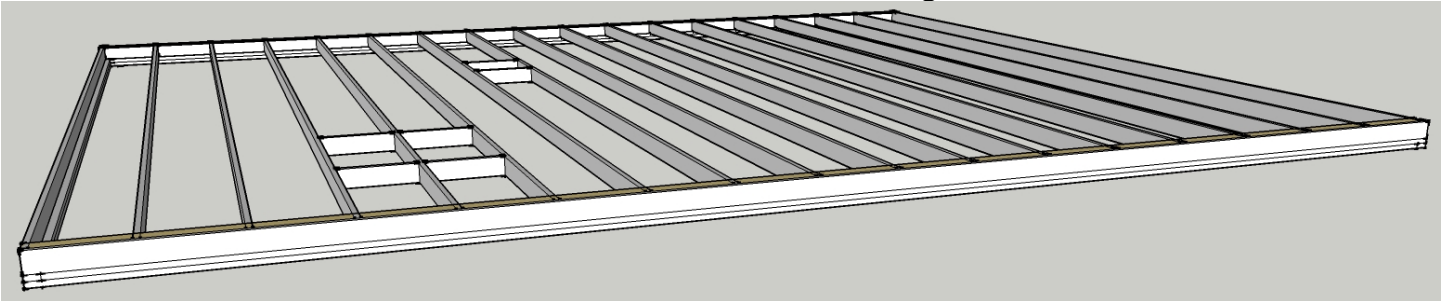
Top & Bottom Plates:	3 * 30' * 1.5"	= 11.3 sqft
King Studs:	19 * 7'-7.5" * 1.5"	= 18.1 sqft
Ladder T-Wall Intersection:	3 * 16" * 3.5"	= Insulated
3-Stud Corner:	2 * 7'-7.5" * 3.5"	= Insulated
Cripples & Split Trimmers:	10 * 2'-8.5" * 1.5" + 4 * 3'-8.5" * 1.5"	= 5.2 sqft
Sills:	2 * 4'-4" * 1.5"	= 1.1 sqft
Header:	2 * 4'-4" * 11.5"	= Insulated
Total Wood Area		= 35.7 sqft
Framing Fraction	= 35.7 / (30 * 8)	= 15%



# ENERGY STAR Qualified Homes, Version 3 Thermal Enclosure System Rater Checklist Savings & Cost Estimate

The ceiling below has the same framing fraction as RESNET's default value for a standard ceiling with 24" OC framing.

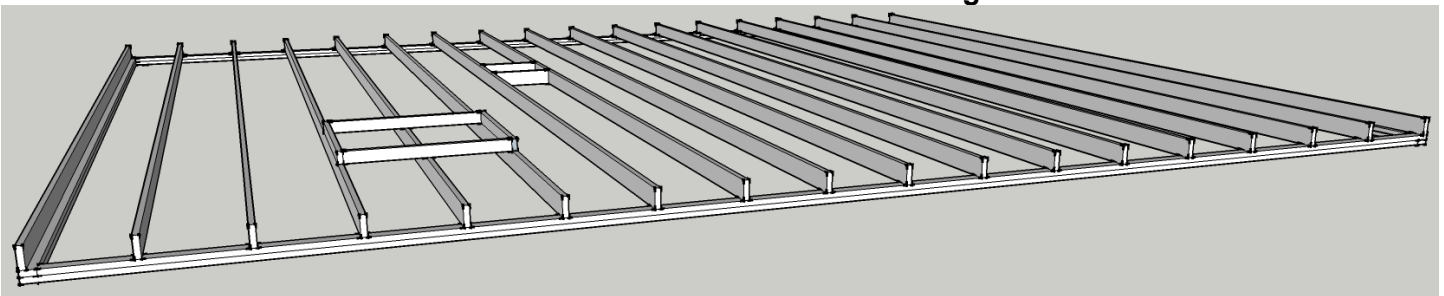
**30' x 34' 24" OC Standard Ceiling<sup>i,ii</sup>**



Rim Joists:	2 * 34' * 1.5"	= 8.5 sqft
Insulation Compression <sup>iii</sup> :	2 * 34' * 6"	= 34.0 sqft
Truss Components:	18 * 29'-9" * 1.5"	= 66.9 sqft
Attic Hatch:	2 * 1'-10.6" * 1.5"	= 0.5 sqft
HVAC Platform:	4 * 1'-10.6" * 1.5"	= 0.9 sqft
Total Wood Area		= 110.8 sqft
Framing Fraction	= 110.8 / (30 * 34)	= 11%

Below is a ceiling configuration that reflects the application of the OVE techniques required by the framing checklist, including raised-heel trusses and a raised HVAC platform, which results in a framing fraction of 7%. This reduced framing fraction matches RESNET's default value for an advanced raised-heel truss ceiling with 24" OC framing.

**30' x 34' 24" OC ENERGY STAR Ceiling<sup>i,ii</sup>**



Truss Components:	18 * 30' * 1.5"	= 67.5 sqft
Attic Hatch:	2 * 1'-10.6" * 1.5"	= 0.5 sqft
HVAC Platform:	2 * 3'-10.5" * 1.5"	= Insulated
Total Wood Area		= 68.0 sqft
Framing Fraction	= 68.0 / (30 * 34)	= 7%

<sup>i</sup> Framing components designed in Google SketchUp

<sup>ii</sup> Framing components are based on a two-story home with 2,000 sqft of conditioned floor area, approximately 1,000 sqft of attic floor space, and roughly 2,000 sqft of above-grade wall area.

<sup>iii</sup> It is assumed that insulation compression against roof sheathing near eaves results in effective increase in framing fraction.



# ENERGY STAR Qualified Homes, Version 3 HVAC System Quality Installation Contractor Checklist Savings & Cost Estimate

## Average Estimated Incremental Cost:

The net cost for the checklist is estimated to be \$875.

## Average Estimated Incremental Savings:

Combined energy savings for complying with the requirements for proper heating and cooling system design, equipment selection, refrigerant tests, electrical measurements, air flow tests, air balancing, and system controls are estimated to be 2.5% of heating consumption for combustion appliances, 5% of heating consumption for air-source heatpumps, and 5% of cooling consumption for heatpumps and air conditioners. In addition, savings from proper duct design and installation are estimated using a reduction in duct leakage from 4.0 to 3.4 CFM per 100 square feet of conditioned floor area (representing a 15% improvement).

Energy savings are not anticipated as a result of implementing the ventilation and filtration requirements related to ASHRAE 62.2-2010. Additional energy used to provide the required ventilation is recognized by RESNET-accredited Home Energy Rating software programs and reflected in the resulting HERS index value.

## Rationale:

It is estimated that increased design efforts, required for compliance with ACCA Manual J, S, & D, and for the ventilation design, will cost approximately \$0.35 per square foot or approximately \$750 for an average sized home. However, the increased cost for proper design is assumed to be partially offset with \$500 in savings from a one ton reduction in equipment size. The cost for equipment commissioning is approximately \$125. An additional \$25 cost for jump ducts or transfer grilles is also assumed.

Ventilation strategies and associated costs will vary between homes. For this estimate, the cost of an air-cycler with motorized damper was included at a cost of \$125 with an additional \$100 for installation. Exhaust-only strategies may be less expensive and systems with integrated energy management will be more expensive.

EPA does not anticipate an increase in cost to meet the requirement for mechanically drafted or direct-vented space heating combustion equipment. A review of furnaces certified by the Gas Appliance Manufacturers Association indicates that over 90% of products with an efficiency of 78-80% AFUE meet this requirement. In the case of high-efficiency direct-vented equipment, the costs may actually decrease due to reduced installation costs that result from the elimination of the B-vent. An incremental cost of \$125 is estimated for the requirement for mechanically drafted or direct-vented water heating equipment, which is typically higher in efficiency than atmospherically vented equipment.

Miscellaneous costs for items such as garage door gasketing, sealing of ducts boots to drywall, and a compliant HVAC filter are estimated at \$50.

The cost of an ECM evaporator motor has been incorporated as a partial cost, as it is not a requirement, but is prevalent in high efficiency air conditioning equipment. The partial cost for the ECM evaporator motor is estimated to be \$75.

Energy savings are based upon an ACEEE paper, Ecotope paper, and Energy Center of Wisconsin paper, cited below, that estimated the typical energy savings for proper sizing and commissioning of HVAC installations in new construction.

## Supporting Documentation:



# ENERGY STAR Qualified Homes, Version 3 HVAC System Quality Installation Contractor Checklist Savings & Cost Estimate

“CL&P and UI Program Savings Documentation for 2008 Program Year” states that the average minimum cost for the diagnostics step of heat pump or central AC commissioning is \$125, though additional labor costs may apply depending on location, contractor, or any issues that may arise with refrigerant charge adjustment. Design costs of \$0.35 per square foot of floor area are based upon an email exchange with Dennis Stroer, CalcsPlus, who provides a similar service. The cost savings for a one ton reduction in AC size is estimated using an average equipment cost per ton of approximately \$500 based upon a Navigant Consulting document prepared for the Energy Information Administration entitled, “Technology Forecast Updates - Residential and Commercial Building Technologies - Reference Case Second Edition (Revised)”.

According to the 1999 ACEEE study “Energy Savings Potential from Addressing Residential Air Conditioner and Heat Pump Installation Problems,” the following are major contributors to potential HVAC and distribution system energy savings:

Characteristic	Energy Savings Potential
Equipment Sizing	2-10%
Airflow over Indoor Coil	7%
Refrigerant Charge	13%
Duct Leakage	10-15%

Due to interactive effects between equipment sizing, airflow, refrigerant charge, and duct leakage, however, individual energy savings are not directly additive. The ACEEE study suggests that typical energy savings for proper sizing, commissioning, and duct installation can result in average energy savings of about 35% for new construction installations. By subtracting the full duct leakage component from this estimate, a final savings value of about 19-20% is achieved.

In contrast to ACEEE, a 2008 paper authored by Scott Pigg of the Energy Center of Wisconsin, entitled “Central Air Conditioning in Wisconsin: A compilation of recent field research”, found more conservative savings on the order of 5%. The paper notes that the more conservative estimate blends many systems that have little or no potential for efficiency improvement from tune-up with a few systems where large savings can be achieved by correcting undercharged systems and reducing airflow.

For its analysis, EPA assumed a conservative national average estimate of 5% cooling energy savings for all homes and 5% heating energy savings for homes with heatpumps. It assumed a more conservative national average estimate of 2.5% heating energy savings for homes with gas heating. In addition, savings for proper duct design, installation, and pressure-balancing were accounted for by assuming a 15% reduction in effective duct leakage from 4.0 to 3.4 CFM per 100 square foot of conditioned floor area.

Regarding ventilation requirements, the cost of an air-cycler system with motorized damper was referenced from Eco-Smart’s online store: <http://www.ecosmartinc.com/catac9special.php>

The estimate of a \$125 incremental cost for non-atmospherically vented water heaters was estimated as follows. First, an estimate of \$250 was derived using the approximate average installed differential cost between equipment with 0.61 EF and 0.64 EF (presumed to be non-atmospherically vented), as reported by Navigant Consulting. EIA - Technology Forecast Updates - Residential and Commercial Building Technologies - Reference Case Second Edition (Revised). Reference number 20070831.1. 2007. Second, this number was reduced by 50% as a gross estimate of the percentage of homes that will not need to comply with this requirement, including those with electric water heaters or with gas water heaters installed outside the pressure boundary.

2006 RS Means was used to estimate an hourly labor rate. An hourly rate of \$46 for a skilled worker foreman, including overhead and profit, was assumed.





# ENERGY STAR Qualified Homes, Version 3 HVAC System Quality Installation Rater Checklist Savings & Cost Estimate

## Average Estimated Incremental Cost:

The net cost for the checklist is estimated to be \$200.

## Average Estimated Incremental Savings:

Savings associated with this checklist are captured within the savings estimate for the HVAC System Quality Installation Contractor checklist.

## Rationale:

The main components of this checklist are the collection and simplified review of the completed HVAC System Quality Installation Contractor checklist; measurement of the duct system for leakage; visual inspection of the duct system for pressure-balancing features and major defects in duct design and installation; and measurement and visual inspection of the ventilation and exhaust systems. It is expected that this can be completed within two and a half hours of onsite inspection and an additional hour and a half of off-site coordination with the HVAC contractor.

## Supporting Documentation:

2006 RS Means was used to estimate an hourly labor rate. An hourly rate of \$46 for a skilled worker foreman, including overhead and profit, was assumed.



# ENERGY STAR Qualified Homes, Version 3 Water Management System Builder Checklist Savings & Cost Estimate

## Average Estimated Incremental Cost:

The net cost for the Water Management System Builder checklist is estimated to be \$100.

## Average Estimated Incremental Savings:

Energy savings are not anticipated as a result of implementing the Water Managed checklist.

## Rationale:

The requirements contained within the Water Management System Builder checklist are largely required by code. Therefore, the significant costs result from additional training, improved practices, and third-party inspection. Additional training and improved practices, which may require additional time, are expected to add approximately \$100 per home.