Cost & Savings Estimates

ENERGY STAR Multifamily New Construction, Version 1.2 (Rev. 04)

October 01, 2024

Contents

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 low-rise multifamily building under Version 1.2 (Rev. 04) of the program in regions that have adopted the 2021 ICC codes (e.g., 2021 IECC, 2021 IRC), or an equivalent code. There are a variety of multifamily buildings eligible to participate in the ENERGY STAR Multifamily New Construction program (e.g., low-, mid-, and high-rise buildings). This document only estimates the costs and savings of a typical low-rise multifamily building, which is a common building type participating in the program. For this type of building, the residential portions of the ICC codes are applicable, while the commercial sections of the ICC codes, or other codes and standards (e.g., ASHRAE 90.1), may be applicable to other buildings eligible to participate in the ENERGY STAR Multifamily New Construction program.

Methodology

To complete this analysis, the EPA evaluated fourteen typical buildings across hot, mixed, and cold climates. The architectural characteristics for each building were determined using the U.S. Department of Energy's Methodology for Evaluating Cost-Effectiveness of Residential Energy Code Changes[1]. Exhibit 1 shows the building and unit parameters that were modeled consistently across all Climate Zones.

The analysis was performed using a three-story low-rise multifamily building with six dwelling units per floor, arranged in two rows with an open breezeway in between. Each dwelling unit was modeled to have its own separate heating and cooling equipment. The building was considered to have no common spaces, central systems, or hydronic equipment, so program requirements for these spaces and systems were not evaluated as part of this analysis. One building in each zone was configured with an electric heat pump and electric water heater, named Configuration A. A second building was configured with a gas furnace, electric air conditioner, and gas water heater, named Configuration B

Exhibit 1: Building and Unit Parameters Consistent Across Climate Zones

Parameter		Value
Number of Stories in Unit		One
Conditioned Floor Area Per Unit (sq. ft.)		1,200
Number of Stories in Building		Three
Number of Units in Building		18
Unit Perimeter (ft)		30 x 40
Ceiling Height (ft)		8.5
Bedrooms		2
Window Area (% of Floor Area) & Distribution		23% of exterior wall (not including breezeway)
Exterior Door Quantity & Total Area (sq. ft.)		1 Doors, 21 sq. ft.
Framing		Wood
Foundation Type		Slab
Space Heating, Cooling & Water Heating	Configuration A	Electric Air-Source Heat Pump & Electric Water Heater
	Configuration B	Gas Furnace, Electric AC, & Gas Water Heater

[1] https://www.energycodes.gov/sites/default/files/2021-07/residential_methodology_2015.pdf

Exhibit 2 shows the locations used for modeling across Climate Zones.

Exhibit 2: Modeling Locations per Climate Zone

CZ	Location
1	Miami, FL
2	Tampa, FL
3	Memphis, TN
4	St. Louis, MO
5	Chicago, IL
6	Burlington, VT
7	Duluth, MN

The energy efficiency features of the baseline units were aligned with the 2021 IECC prescriptive path, except for the following. For window and door performance in Climate Zone 1, the 2021 IECC defines a U-factor of 0.50. This level of performance is worse than what is likely to be available in the marketplace, so the improved window and door requirements of Climate Zone 2, a U-factor of 0.40, were modeled instead. For windows in Climate Zone 4 through 7, the 2021 IECC defines a SHGC of 0.40 or no requirement, but it was assumed that a typical window meeting the required U-Factor of 0.30 would have a SHGC of 0.30.

In addition, because no insulation installation grade is defined or required by code, all zones were modeled with Grade II insulation installation in walls and floors, and Grade I insulation installed in ceilings. This was based upon the predominant insulation grade, by assembly type, identified for low-rise buildings not indicated as 'above-code,' using data from the U.S. Department of Energy Residential Energy Code Field Studies[2].

Further, because no HVAC installation quality grade is defined or required by code, all zones were modeled with Grade III blower fan airflow, blower fan watt draw, and refrigerant charge as defined in ANSI / RESNET / ACCA / ICC 310-2020. Finally, the prescriptive path of the 2021 IECC requires builders to select one additional efficiency package from among five options. The EPA selected the measure believed to be the most likely for builders to incorporate, which is the option to have a more efficient duct thermal distribution system. This option requires that 100 percent of ducts and air handlers be located entirely within the building thermal envelope. The EPA believes that this is the most likely compliance option for multifamily because, for architectural reasons, many of the units will already have ducts in conditioned spaces. In addition, the infiltration requirement was converted to a compartmentalization metric, with each code apartment assumed to have 0.3 cfm50 of leakage per sq ft of enclosure area (for Climate Zones 3-7, where 3 ACH50 was required) and 0.5 cfm50 of leakage per sq ft of enclosure area (for Climate Zones 1-2, where 5 ACH50 was required). The enclosure area includes all surfaces surrounding the apartment (exterior and party walls, floors, and ceilings).

These energy efficiency features of the baseline buildings are summarized in Exhibit 3.

[2] https://www.energycodes.gov/residential-energy-code-field-studies

Exhibit 3: Key Efficiency Features of Modeled 2021 IECC Baseline Buildings

Climate Zone	1	2	3	4	4C & 5	6	7	8
Thermal Enclosure								
Ceiling Insulation U-Factor	U-0.035	U-0.026		U-0.024				
Ceiling Insulation	R-30	R-49		R-60				
Ceiling Insulation Grade	I							
Wall U-Factor	U-0.084		U-0.060	U-0.045				
Wall Insulation: Cavity	R-13		R-20					
Wall Insulation: Continuous	None			R-5				
Wall Insulation Grade	II							
Door U-factor	0.40		0.30					
Window U-factor	0.40		0.30					
Window SHGC	0.25			0.30				
Slab Insulation & Depth	Uninsulated		R-10 2ft	R-10 4ft				
Infiltration and Mechanical Ventilation								
Infiltration (Compartmentalization)	0.5 cfm50/ft^2		0.3 cfm50/ft^2					
Mechanical Vent. Type & Efficiency (CFM / W)	Supply Fan & 3.8				Exh. Fan & 2.8		HRV & 1.2	
HVAC								
Furnace & AC Efficiency (AFUE / SEER)	80 & 15				80 & 14			
Heat Pump Efficiency (HSPF / SEER)	8.8 & 15							
HVAC Grade: Airflow Deviation	-25%							
HVAC Grade: Watt Draw Efficiency (W / CFM)	0.58							
HVAC Grade: Refrigerant Grade	III							
Thermostat Type	Programmable							
Duct Leakage to Outside & Insulation	0 CFM / 100 sq. ft. of CFA & Not Present							
Duct Location - Top Floor Units	100% Conditioned Space							
Duct Location - Ground/Middle Floor Units	100% Conditioned Space							
Water Heating								
Gas: Efficiency (UEF) & Capacity (Gal.)	0.61 & 40							
Electric: Efficiency (UEF) & Capacity (Gal.)	0.93 & 40							
Water Heater Insulation	None							
Low Flow Fixtures	None							
Lighting & Appliances								
Lighting	100% Tier 1, Per ANSI / RESNET / ICC 301							
Refrigerator (kWh / yr)	491							
Dishwasher	NAECA Minimum Defaults, Per ANSI / RESNET / ICC 301							

The energy efficiency features of the ENERGY STAR certified multifamily buildings were aligned with the National ERI Target Procedure, Version 1.2 (Rev. 04). Key features include a thermal enclosure system with insulation levels aligned with the 2021 IECC prescriptive compliance option, achieving Grade I insulation installation; windows and doors aligned with the latest ENERGY STAR Windows, Doors, and Skylights specification (Version 6.0); infiltration using a compartmentalization metric of 0.3 cfm50/ft^2 enclosure area; heat pump efficiency in all climates and air conditioner efficiency in warm and mixed climates aligned with the latest ENERGY STAR Central Air Conditioner and Heat Pump specification (Version 6.0); furnaces in mixed and cold climates generally aligned with the latest ENERGY STAR Furnace specification (Version 4.1), with all HVAC systems achieving Grade I for total duct leakage and Grade II installation for blower fan airflow and watt draw, per ANSI / RESNET / ACCA 310; 100% of ducts located in conditioned space; WaterSense fixtures; 0.90 UEF gas-fired instantaneous water heaters, and a 1.49 UEF electric heat pump water heater; a refrigerator meeting the requirements of the latest ENERGY STAR Consumer Refrigeration Products specification (Version 5.1); a dishwasher aligned with the ENERGY STAR defaults defined in ANSI / RESNET / ICC 301; and 100% Tier 2 lighting, as defined by ANSI / RESNET / ICC 301. While electric water heating equipment does not exist at the modeled efficiency of 1.49 UEF, it is used in the Reference Design to allow flexibility when choosing designs to meet the ERI Target. These features are summarized in Exhibit 4 below, with improved features relative to the baseline building shaded green.

Exhibit 4: Key Efficiency Features of Modeled ENERGY STAR MFNC National Version 1.2 Buildings

<table>
<tr><th>Climate Zone</th><th>1</th><th>2</th><th>3</th><th>4</th><th>4C & 5</th><th>6</th><th>7</th><th>8</th></tr>
<tr><td colspan="9">Thermal Enclosure</td></tr>
<tr><td>Ceiling Insulation U-Factor</td><td>U-0.035</td><td colspan="2">U-0.026</td><td colspan="5">U-0.024</td></tr>
<tr><td>Ceiling Insulation</td><td>R-30</td><td colspan="2">R-49</td><td colspan="5">R-60</td></tr>
<tr><td>Ceiling Insulation Grade</td><td colspan="8">I</td></tr>
<tr><td>Wall U-Factor</td><td colspan="2">U-0.084</td><td>U-0.060</td><td colspan="5">U-0.045</td></tr>
<tr><td>Wall Insulation: Cavity</td><td colspan="2">R-13</td><td colspan="6">R-20</td></tr>
<tr><td>Wall Insulation: Continuous</td><td colspan="3">None</td><td colspan="5">R-5</td></tr>
<tr><td>Wall Insulation Grade</td><td colspan="8">I</td></tr>
<tr><td>Door U-factor</td><td colspan="8">0.17</td></tr>
<tr><td>Window U-factor</td><td colspan="2">0.40</td><td colspan="2">0.30</td><td colspan="4">0.27</td></tr>
<tr><td>Window SHGC</td><td colspan="3">0.25</td><td colspan="5">0.30</td></tr>
<tr><td>Slab Insulation & Depth</td><td colspan="2">Uninsulated</td><td>R-10 2ft</td><td colspan="5">R-10 4ft</td></tr>
<tr><td colspan="9">Infiltration and Mechanical Ventilation</td></tr>
<tr><td>Infiltration (Compartmentalization)</td><td colspan="2">0.3 cfm50/ft^2</td><td colspan="6">0.3 cfm50/ft^2</td></tr>
<tr><td>Mechanical Vent. Type & Efficiency (CFM / W)</td><td colspan="4">Supply Fan & 3.8</td><td colspan="2">Exh. Fan & 2.8</td><td colspan="2">HRV & 1.2</td></tr>
<tr><td colspan="9">HVAC</td></tr>
<tr><td>Furnace & AC Efficiency (AFUE / SEER)</td><td colspan="3">80 & 16</td><td>90 & 16</td><td colspan="4">95 & 14</td></tr>
<tr><td>Heat Pump Efficiency (HSPF / SEER)</td><td colspan="8">9.2 & 16</td></tr>
<tr><td>HVAC Grade: Airflow Deviation</td><td colspan="8">-20%</td></tr>
<tr><td>HVAC Grade: Watt Draw Efficiency (W / CFM)</td><td colspan="8">0.52</td></tr>
<tr><td>HVAC Grade: Refrigerant Grade</td><td colspan="8">III</td></tr>
<tr><td>Thermostat Type</td><td colspan="8">Programmable</td></tr>
<tr><td>Duct Leakage to Outside & Insulation</td><td colspan="8">0 CFM / 100 sq. ft. of CFA & Not Present</td></tr>
<tr><td>Duct Location - Top Floor Units</td><td colspan="8">100% Conditioned Space</td></tr>
<tr><td>Duct Location - Ground/Middle Floor Units</td><td colspan="8">100% Conditioned Space</td></tr>
<tr><td colspan="9">Water Heating</td></tr>
<tr><td>Gas: Efficiency (UEF) & Capacity (Gal.)</td><td colspan="8">0.90 & 0 (Instantaneous)</td></tr>
<tr><td>Electric: Efficiency (UEF) & Capacity (Gal.)</td><td colspan="8">1.49 & 60</td></tr>
<tr><td>Water Heater Insulation</td><td colspan="8">None</td></tr>
<tr><td>Low Flow Fixtures</td><td colspan="8">WaterSense</td></tr>
<tr><td colspan="9">Lighting & Appliances</td></tr>
<tr><td>Lighting</td><td colspan="8">100% Tier 2, Per ANSI / RESNET / ICC 301</td></tr>
<tr><td>Refrigerator (kWh / yr)</td><td colspan="8">450</td></tr>
<tr><td>Dishwasher</td><td colspan="8">ENERGY STAR Defaults, Per ANSI / RESNET / ICC 301</td></tr>
</table>

To estimate energy savings, the baseline and ENERGY STAR certified multifamily dwelling units were modeled in Ekotrope v4.2.1. Energy consumption was determined from the resulting Fuel Summary report. For reference, the reported ERI values were also recorded. The resulting energy consumption for the baseline units and ENERGY STAR units was then converted to purchased energy costs using a 2019 national average rate of $0.1301 / kWh and $1.014 / therm, from the Energy Information Administration.[3,4] Finally, the purchased energy costs for the ENERGY STAR units were subtracted from those of the baseline units to determine savings.

For a multifamily building, energy costs and savings for individual units will vary based on the location of the unit (e.g., top floor, middle floor, ground floor, corner unit, interior unit) primarily due to the amount of wall/ceiling/floor area that is exposed to unconditioned space rather than another conditioned unit. To limit the amount of modeling required to estimate program savings, the EPA modeled just four of six unit types in Ekotrope: ground corner, middle interior, top corner, and top interior. Ground interior units were assumed to have the same savings as a middle interior unit, and middle corner units were assumed to have the same savings as a ground corner unit. Using the modeled results for the four unit types and the assumed savings for the two remaining unit types, the EPA was able to assign savings for all 18 units within the building. Finally, the weighted average unit savings across all 18 units was calculated for each climate zone. Complete savings results for each of the units modeled, including reported ERI values from Ekotrope, calculated according to ANSI / RESNET / ICC 301-2019 including Addenda A and B are presented in Appendix A.

The incremental costs of the features for each ENERGY STAR certified multifamily building were estimated next. This included both the mandatory measures required by the program along with the measures that are not mandatory but are used to meet the ENERGY STAR Energy Rating Index (ERI) Target required by the program. Measures applicable to common spaces were not considered in this analysis, as the low-rise building considered does not have any common space.

Results & Discussion

Exhibit 5 summarizes the multifamily unit-weighted average annual purchased energy savings for each ENERGY STAR certified multifamily building. In addition, it summarizes the unit-weighted average total upgrade cost, which is the total building costs in Exhibits 7 through 20 divided by the 18 units in the building. Finally, Exhibit 5 shows the resulting monthly purchased energy savings, monthly mortgage upgrade cost, and net cash flow per unit. The monthly mortgage upgrade cost was calculated assuming a 30-year fixed mortgage with a 5.0% interest rate. Although the majority of multifamily units are rental units, this analysis evaluates the upgrade cost as if it were included into the mortgage of a single unit, as if an individual purchased the unit. This was done to align with the approach outlined in the U.S. Department of Energy's Methodology for Evaluating Cost-Effectiveness of Residential Energy Code Changes.

[3] Average retail price of electricity to ultimate customers; annual retail price, by sector, by state, by provider. https://www.eia.gov/electricity/data.php#sales

[4] Natural gas prices; residential price; annual. https://www.eia.gov/dnav/ng/ng_pri_sum_a_EPG0_PRS_DMcf_a.htm

Exhibit 5: ENERGY STAR National Multifamily New Construction v1.2 vs 2021 IECC, Illustrative Cost & Savings Summary

			ENERGY STAR Version 1.2					
CZ	Location	HVAC Equipment Type	Weighted Average Annual Purchased Energy Savings		Weighted Average Total Upgrade Cost	Monthly Purchased Energy Savings	Monthly Mortgage Upgrade Cost	Net Cash Flow
1	Miami, FL	Elec. Air-Source HP	$103	12%	$967	$9	$5	$3
1	Miami, FL	Gas Furnace / Elec. AC	$131	16%	$1,367	$11	$7	$4
2	Tampa, FL	Elec. Air-Source HP	$104	12%	$967	$9	$5	$3
2	Tampa, FL	Gas Furnace / Elec. AC	$114	15%	$1,367	$10	$7	$2
3	Memphis, TN	Elec. Air-Source HP	$107	11%	$790	$9	$4	$5
3	Memphis, TN	Gas Furnace / Elec. AC	$80	10%	$1,189	$7	$6	$0.3
4	St. Louis, MO	Elec. Air-Source HP	$119	11%	$785	$10	$4	$6
4	St. Louis, MO	Gas Furnace / Elec. AC	$84	10%	$1,306	$7	$7	$0.02
5	Chicago, IL	Elec. Air-Source HP	$142	11%	$878	$12	$5	$7
5	Chicago, IL	Gas Furnace / Elec. AC	$99	11%	$1,494	$8	$8	$0.2
6	Burlington, VT	Elec. Air-Source HP	$152	11%	$878	$13	$5	$8
6	Burlington, VT	Gas Furnace / Elec. AC	$100	11%	$1,494	$8	$8	$0.3
7	Duluth, MN	Elec. Air-Source HP	$171	10%	$878	$14	$5	$10
7	Duluth, MN	Gas Furnace / Elec. AC	$116	11%	$1,494	$10	$8	$2

For reference, the reported ERI values from Ekotrope, calculated according to ANSI / RESNET / ICC 301-2019 including Addenda A and B, are shown in Exhibit 6.

Exhibit 6: ERI Values of 2021 IECC and ENERGY STAR National v1.2 Multifamily New Construction

CZ	Location	HVAC Equipment Type	Weighted Average ERI Values: 2021 IECC	Weighted Average ERI Values: ENERGY STAR v1.2
1	Miami, FL	Elec. Air-Source HP	54	47
1	Miami, FL	Gas Furnace / Elec. AC	55	44
2	Tampa, FL	Elec. Air-Source HP	56	49
2	Tampa, FL	Gas Furnace / Elec. AC	57	46
3	Memphis, TN	Elec. Air-Source HP	50	45
3	Memphis, TN	Gas Furnace / Elec. AC	52	44
4	St. Louis, MO	Elec. Air-Source HP	53	48
4	St. Louis, MO	Gas Furnace / Elec. AC	54	45
5	Chicago, IL	Elec. Air-Source HP	57	51
5	Chicago, IL	Gas Furnace / Elec. AC	59	47
6	Burlington, VT	Elec. Air-Source HP	58	52
6	Burlington, VT	Gas Furnace / Elec. AC	60	48
7	Duluth, MN	Elec. Air-Source HP	54	48
7	Duluth, MN	Gas Furnace / Elec. AC	54	43

Section 2 includes Exhibits 7 through 20, which contain a more detailed breakout of the incremental upgrade costs presented in Exhibit 5. While this analysis provides illustrative incremental costs and savings, these values will vary for any specific building, dependent on variables such as baseline construction practices, geographic location, building and unit design, vendor relationships, and financial incentives. For example, builders or developers are likely to experience lower incremental costs than stated in this document if they are able to procure equipment or materials below retail 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. Finally, state and utility incentives and federal tax credits are often available and were not accounted for. Therefore, these estimates are only illustrative and are likely to represent the higher end of the cost spectrum.

Sections 3 through 9 provide a more detailed discussion of the incremental costs and savings associated with each of the mandatory measures required in the MFNC National Rater Field Checklist, MFNC National HVAC Design Report, MFNC National Rater Design Review Checklist, MFNC National Functional Testing Checklist, and MFNC National Water Management System Requirements.

Within these mandatory measures, the program provides two tracks for satisfying elements related to HVAC design and installation – Track A: HVAC Grading by Rater and Track B: HVAC Testing by FT Agent. Track A leverages ANSI / RESNET / ACCA / ICC 310, which requires the Rater to complete a design review and four field tasks to assess the installation quality of the HVAC equipment. Track B requires the Rater to review ENERGY STAR-specific HVAC design documentation and leverages Functional Testing Agents (e.g., HVAC contractors that have been credentialed by an HVAC Quality Installation Training & Oversight Organization) to complete field commissioning. For this analysis, the use of Track B was assumed. However, Sections 4 through 7 also include a brief discussion of the comparable costs for Track A, had that track been chosen.

With this analysis, the measures used to achieve ENERGY STAR certification were compared to the requirements of the 2021 IECC and 2021 IRC codes, and only requirements above code were accounted for.

For example, code requires that HVAC systems be designed in accordance with Manual J, D, and S, or equivalent methodologies, so no costs or savings were assumed for meeting these design requirements. In contrast, residential code does not require functional testing of HVAC systems, so both incremental costs and savings were estimated for these requirements.

This approach 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 v1.2 program requirements makes the analysis more relevant to utility sponsors and partners that wish to improve practices above code.

Despite the fact that many of the mandatory measures for the program are required by code, the EPA believes that their inclusion provides significant benefits: code often allows these items to be traded-off for other improvements, while the ENERGY STAR program helps ensure that these details are included in every unit to consistently deliver a complete thermal enclosure system, complete HVAC system, and complete water management system; the ENERGY STAR program consolidates critical code-required details in a relatively concise format that improves compliance; the ENERGY STAR program provides a consistent set of building-science details from which to educate and train partners; and many of the ENERGY STAR mandatory measures are required to be third-party verified by a Rater, whereas most jurisdictions do not require such oversight.

Finally, Section 10 provides additional references to support the assumptions used in the analysis.

Section 2: Detailed Incremental Cost Estimates

Exhibits 7 through 20 contain a more detailed explanation of the incremental upgrade costs presented for each building in Exhibit 5. For each building, the costs are divided into eight sections.

The first section in each exhibit contains the energy efficiency measures that are not mandatory for ENERGY STAR certification and were used solely to meet the ENERGY STAR ERI target.

The next seven sections contain the costs required to comply with, respectively, the Thermal Enclosure System section of the National Rater Field Checklist; the HVAC System section of the same checklist, assuming use of Track B – HVAC Testing by FT Agent ; the National Rater Design Review Checklist, assuming the use of Track B; the HVAC design documentation that must be completed for Track B; the National HVAC Functional Testing Checklist; the National Water Management System Builder Requirements; and the energy modeling completed by a Rater; relative to the 2021 ICC codes.

Within these documents, some measures improve the ERI of the unit, some do not, and they have been grouped accordingly. This is an important distinction because partners have expressed an interest in knowing what the cost of the mandatory measures of the program are, yet many of them might also be included as part of a standard energy rating. For example, Grade I insulation installation is mandatory in the National Rater Field Checklist, unless rigid insulation is used, so that cost is grouped with the checklist even though a builder not participating in the ENERGY STAR program might also select that measure to achieve a better ERI. In contrast, verification that HVAC equipment model numbers match the design, is also a mandatory requirement of this checklist but does not impact the ERI of the unit.

For each measure, the exhibit lists the 2021 IECC baseline code requirement, the ENERGY STAR Multifamily New Construction, Version 1.2 (Rev. 04) requirement, the incremental unit cost, the quantity of units per building, the cost units (e.g., tons, sq ft of window area, sq ft of conditioned floor area), and the total incremental measure cost.

Measures applicable to common spaces were not considered in this analysis, as the low-rise building considered does not have any common.

ENERGY STAR Multifamily New Construction, Version 1.2 (Rev. 04)

Cost & Savings Estimates

Exhibit 7: ENERGY STAR Multifamily New Construction v1.2 vs 2021 IECC - CZ 1 - Whole Building - Electric

Measure	2021 IECC Baseline	ENERGY STAR MFNC v1.2	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						
Infiltration	0.50 CFM50 / sq. ft.	0.30 CFM50 / sq. ft.	$0.10	21,600	CFA (sq. ft.)	$2,262
Cooling Equipment	(See Heating Equipment)	(See Heating Equipment)	-	-	-	-
Heating Equipment	8.8 HSPF / 15 SEER	9.2 HSPF / 16 SEER	$178.05	18	System	$3,205
Duct Location	Conditioned Space	Conditioned Space	-	-	-	-
Water Heater	0.93 UEF Electric DHW, 40 Gallons	1.49 UEF HPWH, 60 Gallons	$211.79	18	Water Heater	$3,812
DHW Fixtures	Standard	Low-Flow WaterSense	$2.80	18	Bathroom	$50
Lighting	100% Fluorescent Lighting	100% LED Lighting	$0.04	21,600	CFA (sq. ft.)	$877
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	$30.83	18	Dishwasher	$555
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	$6.41	18	Refrigerator	$115
Sub-Total of Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						**$10,877**
Rater Field Checklist: Thermal Enclosure System						
Ceiling Insulation	R-30, Grade I Installation	R-30, Grade I Installation	-	-	-	-
Above-Grade Wall Insulation	R-13, Grade II Installation	R-13, Grade I Installation	$0.05	15,300	Ins. Surface Area (sq. ft.)	$835
Foundation Insulation	No Slab Insulation	No Slab Insulation	-	-	-	-
Windows	U-value: 0.40 / SHGC: 0.25	U-value: 0.40 / SHGC: 0.25	-	-	-	-
Doors	R-2.5	R-5.9	$2.88	378	Door Surface Area (sq. ft.)	$1,087
Additional Checklist Measures: Rater Verification						$475
Sub-Total of Thermal Enclosure System Checklist						**$2,397**
Rater Field Checklist: HVAC System for Track B - HVAC Testing by FT Agent						
Duct Sealing - Total Leakage	8 CFM per 100 sq. ft. of CFA @ Final	8 CFM per 100 sq. ft. of CFA @ Final	-	-	-	-
Duct Insulation	No Ins.; Ducts in Conditioned Space	No Ins.; Ducts in Conditioned Space	-	-	-	-
Additional Checklist Measures: Rater Verification of Equipment Model Numbers, Static Pressure, Bedroom Pressure Balancing, Ventilation System, and Filter						$800
Sub-Total of HVAC System Checklist						**$800**
Rater Design Review Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of Rater Design Review Checklist: Rater Collection of HVAC Design Report, Rater Review of Design, Partnership, & Credential						**$200**
HVAC Design Report for Track B - HVAC Testing by FT Agent						
Ventilation	ENERGY STAR Supply Fan	ENERGY STAR Supply Fan	-	-	-	-
HVAC Equipment Right-Sizing	1.5 Tons	1.5 Tons	-	-	-	-
Additional Checklist Measures: Checklist Completion by Designer						$35
Sub-Total of HVAC Design Report						**$35**
HVAC Functional Testing Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of HVAC Functional Testing Checklist: Credential Cost, Refrigerant Charge Check, Air Handler Airflow Check, Completion of Checklist						**$1,450**
Water Management System Requirements						
Sub-Total of Water Management System Builder Checklist: Foreman's Completion of Checklist						**$0**
Energy Modeling						
Sub-Total of Cost of Energy Modeling Performed by Rater						**$1,650**
Total Incremental Cost for the Building						**$17,409**

Exhibit 8: ENERGY STAR Multifamily New Construction v1.2 vs 2021 IECC - CZ 1 - Whole Building - Gas

Measure	2021 IECC Baseline	ENERGY STAR MFNC v1.2	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						
Infiltration	0.50 CFM50 / sq. ft.	0.30 CFM50 / sq. ft.	$0.10	21,600	CFA (sq. ft.)	$2,262
Cooling Equipment	15 SEER Central AC	16 SEER Central AC	$124.00	18	System	$2,232
Heating Equipment	80 AFUE Gas Furnace	80 AFUE Gas Furnace	-	-	-	-
Duct Location	Conditioned Space	Conditioned Space	-	-	-	-
Water Heater	0.61 UEF Gas DHW, 40 Gal.	0.90 UEF Gas Tankless	$665.27	18	Water Heater	$11,975
DHW Fixtures	Standard	Low-Flow WaterSense	$2.80	18	Bathroom	$50
Lighting	100% Fluorescent Lighting	100% LED Lighting	$0.04	21,600	CFA (sq. ft.)	$877
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	$30.83	18	Dishwasher	$555
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	$6.41	18	Refrigerator	$115
Sub-Total of Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						**$18,067**
Rater Field Checklist: Thermal Enclosure System						
Ceiling Insulation	R-30, Grade I Installation	R-30, Grade I Installation	-	-	-	-
Above-Grade Wall Insulation	R-13, Grade II Installation	R-13, Grade I Installation	$0.05	15,300	Ins. Surface Area (sq. ft.)	$835
Foundation Insulation	No Slab Insulation	No Slab Insulation	-	-	-	-
Windows	U-value: 0.40 / SHGC: 0.25	U-value: 0.40 / SHGC: 0.25	-	-	-	-
Doors	R-2.5	R-5.9	$2.88	378	Door Surface Area (sq. ft.)	$1,087
Additional Checklist Measures: Rater Verification						$475
Sub-Total of Thermal Enclosure System Checklist						**$2,397**
Rater Field Checklist: HVAC System for Track B - HVAC Testing by FT Agent						
Duct Sealing - Total Leakage	8 CFM per 100 sq. ft. of CFA @ Final	8 CFM per 100 sq. ft. of CFA @ Final	-	-	-	-
Duct Insulation	No Ins.; Ducts in Conditioned Space	No Ins.; Ducts in Conditioned Space	-	-	-	-
Additional Checklist Measures: Rater Verification of Equipment Model Numbers, Static Pressure, Bedroom Pressure Balancing, Ventilation System, and Filter						$800
Sub-Total of HVAC System Checklist						**$800**
Rater Design Review Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of Rater Design Review Checklist: Rater Collection of HVAC Design Report, Rater Review of Design, Partnership, & Credential						**$200**
HVAC Design Report for Track B - HVAC Testing by FT Agent						
Ventilation	ENERGY STAR Supply Fan	ENERGY STAR Supply Fan	-	-	-	-
HVAC Equipment Right-Sizing	1.5 Tons	1.5 Tons	-	-	-	-
Additional Checklist Measures: Checklist Completion by Designer						$35
Sub-Total of HVAC Design Report						**$35**
HVAC Functional Testing Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of HVAC Functional Testing Checklist: Credential Cost, Refrigerant Charge Check, Air Handler Airflow Check, Completion of Checklist						**$1,450**
Water Management System Requirements						
Sub-Total of Water Management System Builder Checklist: Foreman's Completion of Checklist						**$0**
Energy Modeling						
Sub-Total of Cost of Energy Modeling Performed by Rater						**$1,650**
Total Incremental Cost for the Building						**$24,599**

Exhibit 9: ENERGY STAR Multifamily New Construction v1.2 vs 2021 IECC - CZ 2 - Whole Building - Electric

Measure	2021 IECC Baseline	ENERGY STAR MFNC v1.2	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						
Infiltration	0.50 CFM50 / sq. ft.	0.30 CFM50 / sq. ft.	$0.10	21,600	CFA (sq. ft.)	$2,262
Cooling Equipment	(See Heating Equipment)	(See Heating Equipment)	-	-	-	-
Heating Equipment	8.8 HSPF / 15 SEER	9.2 HSPF / 16 SEER	$178.05	18	System	$3,205
Duct Location	Conditioned Space	Conditioned Space	-	-	-	-
Water Heater	0.93 UEF Electric DHW, 40 Gallons	1.49 UEF HPWH, 60 Gallons	$211.79	18	Water Heater	$3,812
DHW Fixtures	Standard	Low-Flow WaterSense	$2.80	18	Bathroom	$50
Lighting	100% Fluorescent Lighting	100% LED Lighting	$0.04	21,600	CFA (sq. ft.)	$877
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	$30.83	18	Dishwasher	$555
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	$6.41	18	Refrigerator	$115
Sub-Total of Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						**$10,877**
Rater Field Checklist: Thermal Enclosure System						
Ceiling Insulation	R-49, Grade I Installation	R-49, Grade I Installation	-	-	-	-
Above-Grade Wall Insulation	R-13, Grade II Installation	R-13, Grade I Installation	$0.05	15,300	Ins. Surface Area (sq. ft.)	$835
Foundation Insulation	No Slab Insulation	No Slab Insulation	-	-	-	-
Windows	U-value: 0.40 / SHGC: 0.25	U-value: 0.40 / SHGC: 0.25	-	-	-	-
Doors	R-2.5	R-5.9	$2.88	378	Door Surface Area (sq. ft.)	$1,087
Additional Checklist Measures: Rater Verification						$475
Sub-Total of Thermal Enclosure System Checklist						**$2,397**
Rater Field Checklist: HVAC System for Track B - HVAC Testing by FT Agent						
Duct Sealing - Total Leakage	8 CFM per 100 sq. ft. of CFA @ Final	8 CFM per 100 sq. ft. of CFA @ Final	-	-	-	-
Duct Insulation	No Ins.; Ducts in Conditioned Space	No Ins.; Ducts in Conditioned Space	-	-	-	-
Additional Checklist Measures: Rater Verification of Equipment Model Numbers, Static Pressure, Bedroom Pressure Balancing, Ventilation System, and Filter						$800
Sub-Total of HVAC System Checklist						**$800**
Rater Design Review Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of Rater Design Review Checklist: Rater Collection of HVAC Design Report, Rater Review of Design, Partnership, & Credential						**$200**
HVAC Design Report for Track B - HVAC Testing by FT Agent						
Ventilation	ENERGY STAR Supply Fan	ENERGY STAR Supply Fan	-	-	-	-
HVAC Equipment Right-Sizing	1.5 Tons	1.5 Tons	-	-	-	-
Additional Checklist Measures: Checklist Completion by Designer						$35
Sub-Total of HVAC Design Report						**$35**
HVAC Functional Testing Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of HVAC Functional Testing Checklist: Credential Cost, Refrigerant Charge Check, Air Handler Airflow Check, Completion of Checklist						**$1,450**
Water Management System Requirements						
Sub-Total of Water Management System Builder Checklist: Foreman's Completion of Checklist						**$0**
Energy Modeling						
Sub-Total of Cost of Energy Modeling Performed by Rater						**$1,650**
Total Incremental Cost for the Building						**$17,409**

Exhibit 10: ENERGY STAR Multifamily New Construction v1.2 vs 2021 IECC - CZ 2 - Whole Building - Gas

Measure	2021 IECC Baseline	ENERGY STAR MFNC v1.2	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						
Infiltration	0.50 CFM50 / sq. ft.	0.30 CFM50 / sq. ft.	$0.10	21,600	CFA (sq. ft.)	$2,262
Cooling Equipment	15 SEER Central AC	16 SEER Central AC	$124.00	18	System	$2,232
Heating Equipment	80 AFUE Gas Furnace	80 AFUE Gas Furnace	-	-	-	-
Duct Location	Conditioned Space	Conditioned Space	-	-	-	-
Water Heater	0.61 UEF Gas DHW, 40 Gal.	0.90 UEF Gas Tankless	$665.27	18	Water Heater	$11,975
DHW Fixtures	Standard	Low-Flow WaterSense	$2.80	18	Bathroom	$50
Lighting	100% Fluorescent Lighting	100% LED Lighting	$0.04	21,600	CFA (sq. ft.)	$877
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	$30.83	18	Dishwasher	$555
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	$6.41	18	Refrigerator	$115
Sub-Total of Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						**$18,067**
Rater Field Checklist: Thermal Enclosure System						
Ceiling Insulation	R-49, Grade I Installation	R-49, Grade I Installation	-	-	-	-
Above-Grade Wall Insulation	R-13, Grade II Installation	R-13, Grade I Installation	$0.05	15,300	Ins. Surface Area (sq. ft.)	$835
Foundation Insulation	No Slab Insulation	No Slab Insulation	-	-	-	-
Windows	U-value: 0.40 / SHGC: 0.25	U-value: 0.40 / SHGC: 0.25	-	-	-	-
Doors	R-2.5	R-5.9	$2.88	378	Door Surface Area (sq. ft.)	$1,087
Additional Checklist Measures: Rater Verification						$475
Sub-Total of Thermal Enclosure System Checklist						**$2,397**
Rater Field Checklist: HVAC System for Track B - HVAC Testing by FT Agent						
Duct Sealing - Total Leakage	8 CFM per 100 sq. ft. of CFA @ Final	8 CFM per 100 sq. ft. of CFA @ Final	-	-	-	-
Duct Insulation	No Ins.; Ducts in Conditioned Space	No Ins.; Ducts in Conditioned Space	-	-	-	-
Additional Checklist Measures: Rater Verification of Equipment Model Numbers, Static Pressure, Bedroom Pressure Balancing, Ventilation System, and Filter						$800
Sub-Total of HVAC System Checklist						**$800**
Rater Design Review Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of Rater Design Review Checklist: Rater Collection of HVAC Design Report, Rater Review of Design, Partnership, & Credential						**$200**
HVAC Design Report for Track B - HVAC Testing by FT Agent						
Ventilation	ENERGY STAR Supply Fan	ENERGY STAR Supply Fan	-	-	-	-
HVAC Equipment Right-Sizing	1.5 Tons	1.5 Tons	-	-	-	-
Additional Checklist Measures: Checklist Completion by Designer						$35
Sub-Total of HVAC Design Report						**$35**
HVAC Functional Testing Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of HVAC Functional Testing Checklist: Credential Cost, Refrigerant Charge Check, Air Handler Airflow Check, Completion of Checklist						**$1,450**
Water Management System Requirements						
Sub-Total of Water Management System Builder Checklist: Foreman's Completion of Checklist						**$0**
Energy Modeling						
Sub-Total of Cost of Energy Modeling Performed by Rater						**$1,650**
Total Incremental Cost for the Building						**$24,599**

Exhibit 11: ENERGY STAR Multifamily New Construction v1.2 vs 2021 IECC - CZ 3 - Whole Building - Electric

Measure	2021 IECC Baseline	ENERGY STAR MFNC v1.2	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						
Infiltration	0.30 CFM50 / sq. ft.	0.30 CFM50 / sq. ft.	-	-	-	-
Cooling Equipment	(See Heating Equipment)	(See Heating Equipment)	-	-	-	-
Heating Equipment	8.8 HSPF / 15 SEER	9.2 HSPF / 16 SEER	$178.05	18	System	$3,205
Duct Location	Conditioned Space	Conditioned Space	-	-	-	-
Water Heater	0.93 UEF Electric DHW, 40 Gallons	1.49 UEF HPWH, 60 Gallons	$211.79	18	Water Heater	$3,812
DHW Fixtures	Standard	Low-Flow WaterSense	$2.80	18	Bathroom	$50
Lighting	100% Fluorescent Lighting	100% LED Lighting	$0.04	21,600	CFA (sq. ft.)	$877
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	$30.83	18	Dishwasher	$555
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	$6.41	18	Refrigerator	$115
Sub-Total of Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						**$8,615**
Rater Field Checklist: Thermal Enclosure System						
Ceiling Insulation	R-49, Grade I Installation	R-49, Grade I Installation	-	-	-	-
Above-Grade Wall Insulation	R-20, Grade II Installation	R-20, Grade I Installation	$0.02	15,300	Ins. Surface Area (sq. ft.)	$382
Foundation Insulation	R-10 Slab Insulation, 2 ft.	R-10 Slab Insulation, 2 ft.	-	-	-	-
Windows	U-value: 0.30 / SHGC: 0.25	U-value: 0.30 / SHGC: 0.25	-	-	-	-
Doors	R-3.3	R-5.9	$1.63	378	Door Surface Area (sq. ft.)	$614
Additional Checklist Measures: Rater Verification						$475
Sub-Total of Thermal Enclosure System Checklist						**$1,471**
Rater Field Checklist: HVAC System for Track B - HVAC Testing by FT Agent						
Duct Sealing - Total Leakage	8 CFM per 100 sq. ft. of CFA @ Final	8 CFM per 100 sq. ft. of CFA @ Final	-	-	-	-
Duct Insulation	No Ins.; Ducts in Conditioned Space	No Ins.; Ducts in Conditioned Space	-	-	-	-
Additional Checklist Measures: Rater Verification of Equipment Model Numbers, Static Pressure, Bedroom Pressure Balancing, Ventilation System, and Filter						$800
Sub-Total of HVAC System Checklist						**$800**
Rater Design Review Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of Rater Design Review Checklist: Rater Collection of HVAC Design Report, Rater Review of Design, Partnership, & Credential						**$200**
HVAC Design Report for Track B - HVAC Testing by FT Agent						
Ventilation	ENERGY STAR Supply Fan	ENERGY STAR Supply Fan	-	-	-	-
HVAC Equipment Right-Sizing	1.5 Tons	1.5 Tons	-	-	-	-
Additional Checklist Measures: Checklist Completion by Designer						$35
Sub-Total of HVAC Design Report						**$35**
HVAC Functional Testing Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of HVAC Functional Testing Checklist: Credential Cost, Refrigerant Charge Check, Air Handler Airflow Check, Completion of Checklist						**$1,450**
Water Management System Requirements						
Sub-Total of Water Management System Builder Checklist: Foreman's Completion of Checklist						**$0**
Energy Modeling						
Sub-Total of Cost of Energy Modeling Performed by Rater						**$1,650**
Total Incremental Cost for the Building						**$14,221**

Exhibit 12: ENERGY STAR Multifamily New Construction v1.2 vs 2021 IECC - CZ 3 - Whole Building - Gas

Measure	2021 IECC Baseline	ENERGY STAR MFNC v1.2	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						
Infiltration	0.30 CFM50 / sq. ft.	0.30 CFM50 / sq. ft.	-	-	-	-
Cooling Equipment	15 SEER Central AC	16 SEER Central AC	$124.00	18	System	$2,232
Heating Equipment	80 AFUE Gas Furnace	80 AFUE Gas Furnace	-	-	-	-
Duct Location	Conditioned Space	Conditioned Space	-	-	-	-
Water Heater	0.61 UEF Gas DHW, 40 Gal.	0.90 UEF Gas Tankless	$665.27	18	Water Heater	$11,975
DHW Fixtures	Standard	Low-Flow WaterSense	$2.80	18	Bathroom	$50
Lighting	100% Fluorescent Lighting	100% LED Lighting	$0.04	21,600	CFA (sq. ft.)	$877
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	$30.83	18	Dishwasher	$555
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	$6.41	18	Refrigerator	$115
Sub-Total of Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						**$15,805**
Rater Field Checklist: Thermal Enclosure System						
Ceiling Insulation	R-49, Grade I Installation	R-49, Grade I Installation	-	-	-	-
Above-Grade Wall Insulation	R-20, Grade II Installation	R-20, Grade I Installation	$0.02	15,300	Ins. Surface Area (sq. ft.)	$382
Foundation Insulation	R-10 Slab Insulation, 2 ft.	R-10 Slab Insulation, 2 ft.	-	-	-	-
Windows	U-value: 0.30 / SHGC: 0.25	U-value: 0.30 / SHGC: 0.25	-	-	-	-
Doors	R-3.3	R-5.9	$1.63	378	Door Surface Area (sq. ft.)	$614
Additional Checklist Measures: Rater Verification						$475
Sub-Total of Thermal Enclosure System Checklist						**$1,471**
Rater Field Checklist: HVAC System for Track B - HVAC Testing by FT Agent						
Duct Sealing - Total Leakage	8 CFM per 100 sq. ft. of CFA @ Final	8 CFM per 100 sq. ft. of CFA @ Final	-	-	-	-
Duct Insulation	No Ins.; Ducts in Conditioned Space	No Ins.; Ducts in Conditioned Space	-	-	-	-
Additional Checklist Measures: Rater Verification of Equipment Model Numbers, Static Pressure, Bedroom Pressure Balancing, Ventilation System, and Filter						$800
Sub-Total of HVAC System Checklist						**$800**
Rater Design Review Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of Rater Design Review Checklist: Rater Collection of HVAC Design Report, Rater Review of Design, Partnership, & Credential						**$200**
HVAC Design Report for Track B - HVAC Testing by FT Agent						
Ventilation	ENERGY STAR Supply Fan	ENERGY STAR Supply Fan	-	-	-	-
HVAC Equipment Right-Sizing	1.5 Tons	1.5 Tons	-	-	-	-
Additional Checklist Measures: Checklist Completion by Designer						$35
Sub-Total of HVAC Design Report						**$35**
HVAC Functional Testing Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of HVAC Functional Testing Checklist: Credential Cost, Refrigerant Charge Check, Air Handler Airflow Check, Completion of Checklist						**$1,450**
Water Management System Requirements						
Sub-Total of Water Management System Builder Checklist: Foreman's Completion of Checklist						**$0**
Energy Modeling						
Sub-Total of Cost of Energy Modeling Performed by Rater						**$1,650**
Total Incremental Cost for the Building						**$21,411**

Exhibit 13: ENERGY STAR Multifamily New Construction v1.2 vs 2021 IECC - CZ 4 - Whole Building - Electric

Measure	2021 IECC Baseline	ENERGY STAR MFNC v1.2	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						
Infiltration	0.30 CFM50 / sq. ft.	0.30 CFM50 / sq. ft.	-	-	-	-
Cooling Equipment	(See Heating Equipment)	(See Heating Equipment)	-	-	-	-
Heating Equipment	8.8 HSPF / 15 SEER	9.2 HSPF / 16 SEER	$178.05	18	System	$3,205
Duct Location	Conditioned Space	Conditioned Space	-	-	-	-
Water Heater	0.93 UEF Electric DHW, 40 Gallons	1.49 UEF HPWH, 60 Gallons	$211.79	18	Water Heater	$3,812
DHW Fixtures	Standard	Low-Flow WaterSense	$2.80	18	Bathroom	$50
Lighting	100% Fluorescent Lighting	100% LED Lighting	$0.04	21,600	CFA (sq. ft.)	$877
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	$30.83	18	Dishwasher	$555
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	$6.41	18	Refrigerator	$115
Sub-Total of Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						**$8,615**
Rater Field Checklist: Thermal Enclosure System						
Ceiling Insulation	R-60, Grade I Installation	R-60, Grade I Installation	-	-	-	-
Above-Grade Wall Insulation	R-20+5, Grade II Installation	R-20+5, Grade I Installation	$0.02	15,300	Ins. Surface Area (sq. ft.)	$382
Foundation Insulation	R-10 Slab Insulation, 4 ft.	R-10 Slab Insulation, 4 ft.	-	-	-	-
Windows	U-value: 0.30 / SHGC: 0.30	U-value: 0.30 / SHGC: 0.30	-	-	-	-
Doors	R-3.3	R-5.9	$1.63	378	Door Surface Area (sq. ft.)	$614
Additional Checklist Measures: Rater Verification						$475
Sub-Total of Thermal Enclosure System Checklist						**$1,471**
Rater Field Checklist: HVAC System for Track B - HVAC Testing by FT Agent						
Duct Sealing - Total Leakage	8 CFM per 100 sq. ft. of CFA @ Final	8 CFM per 100 sq. ft. of CFA @ Final	-	-	-	-
Duct Insulation	No Ins.; Ducts in Conditioned Space	No Ins.; Ducts in Conditioned Space	-	-	-	-
Additional Checklist Measures: Rater Verification of Equipment Model Numbers, Static Pressure, Bedroom Pressure Balancing, Ventilation System, and Filter						$700
Sub-Total of HVAC System Checklist						**$700**
Rater Design Review Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of Rater Design Review Checklist: Rater Collection of HVAC Design Report, Rater Review of Design, Partnership, & Credential						**$200**
HVAC Design Report for Track B - HVAC Testing by FT Agent						
Ventilation	ENERGY STAR Supply Fan	ENERGY STAR Supply Fan	-	-	-	-
HVAC Equipment Right-Sizing	1.5 Tons	1.5 Tons	-	-	-	-
Additional Checklist Measures: Checklist Completion by Designer						$35
Sub-Total of HVAC Design Report						**$35**
HVAC Functional Testing Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of HVAC Functional Testing Checklist: Credential Cost, Refrigerant Charge Check, Air Handler Airflow Check, Completion of Checklist						**$1,450**
Water Management System Requirements						
Sub-Total of Water Management System Builder Checklist: Foreman's Completion of Checklist						**$0**
Energy Modeling						
Sub-Total of Cost of Energy Modeling Performed by Rater						**$1,650**
Total Incremental Cost for the Building						**$14,121**

Exhibit 14: ENERGY STAR Multifamily New Construction v1.2 vs 2021 IECC - CZ 4 - Whole Building - Gas

Measure	2021 IECC Baseline	ENERGY STAR MFNC v1.2	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						
Infiltration	0.30 CFM50 / sq. ft.	0.30 CFM50 / sq. ft.	-	-	-	-
Cooling Equipment	15 SEER Central AC	16 SEER Central AC	$124.00	18	System	$2,232
Heating Equipment	80 AFUE Gas Furnace	90 AFUE Gas Furnace	$216.12	18	System	$3,890
Duct Location	Conditioned Space	Conditioned Space	-	-	-	-
Water Heater	0.61 UEF Gas DHW, 40 Gal.	0.90 UEF Gas Tankless	$665.27	18	Water Heater	$11,975
DHW Fixtures	Standard	Low-Flow WaterSense	$2.80	18	Bathroom	$50
Lighting	100% Fluorescent Lighting	100% LED Lighting	$0.04	21,600	CFA (sq. ft.)	$877
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	$30.83	18	Dishwasher	$555
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	$6.41	18	Refrigerator	$115
Sub-Total of Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						**$19,695**
Rater Field Checklist: Thermal Enclosure System						
Ceiling Insulation	R-60, Grade I Installation	R-60, Grade I Installation	-	-	-	-
Above-Grade Wall Insulation	R-20+5, Grade II Installation	R-20+5, Grade I Installation	$0.02	15,300	Ins. Surface Area (sq. ft.)	$382
Foundation Insulation	R-10 Slab Insulation, 4 ft.	R-10 Slab Insulation, 4 ft.	-	-	-	-
Windows	U-value: 0.30 / SHGC: 0.30	U-value: 0.30 / SHGC: 0.30	-	-	-	-
Doors	R-3.3	R-5.9	$1.63	378	Door Surface Area (sq. ft.)	$614
Additional Checklist Measures: Rater Verification						$475
Sub-Total of Thermal Enclosure System Checklist						**$1,471**
Rater Field Checklist: HVAC System for Track B - HVAC Testing by FT Agent						
Duct Sealing - Total Leakage	8 CFM per 100 sq. ft. of CFA @ Final	8 CFM per 100 sq. ft. of CFA @ Final	-	-	-	-
Duct Insulation	No Ins.; Ducts in Conditioned Space	No Ins.; Ducts in Conditioned Space	-	-	-	-
Additional Checklist Measures: Rater Verification of Equipment Model Numbers, Static Pressure, Bedroom Pressure Balancing, Ventilation System, and Filter						-$1,000
Sub-Total of HVAC System Checklist						**-$1,000**
Rater Design Review Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of Rater Design Review Checklist: Rater Collection of HVAC Design Report, Rater Review of Design, Partnership, & Credential						**$200**
HVAC Design Report for Track B - HVAC Testing by FT Agent						
Ventilation	ENERGY STAR Supply Fan	ENERGY STAR Supply Fan	-	-	-	-
HVAC Equipment Right-Sizing	1.5 Tons	1.5 Tons	-	-	-	-
Additional Checklist Measures: Checklist Completion by Designer						$35
Sub-Total of HVAC Design Report						**$35**
HVAC Functional Testing Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of HVAC Functional Testing Checklist: Credential Cost, Refrigerant Charge Check, Air Handler Airflow Check, Completion of Checklist						**$1,450**
Water Management System Requirements						
Sub-Total of Water Management System Builder Checklist: Foreman's Completion of Checklist						**$0**
Energy Modeling						
Sub-Total of Cost of Energy Modeling Performed by Rater						**$1,650**
Total Incremental Cost for the Building						**$23,501**

Exhibit 15: ENERGY STAR Multifamily New Construction v1.2 vs 2021 IECC - CZ 5 - Whole Building - Electric

Measure	2021 IECC Baseline	ENERGY STAR MFNC v1.2	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						
Infiltration	0.30 CFM50 / sq. ft.	0.30 CFM50 / sq. ft.	-	-	-	-
Cooling Equipment	(See Heating Equipment)	(See Heating Equipment)	-	-	-	-
Heating Equipment	8.8 HSPF / 15 SEER	9.2 HSPF / 16 SEER	$178.05	18	System	$3,205
Duct Location	Conditioned Space	Conditioned Space	-	-	-	-
Water Heater	0.93 UEF Electric DHW, 40 Gallons	1.49 UEF HPWH, 60 Gallons	$211.79	18	Water Heater	$3,812
DHW Fixtures	Standard	Low-Flow WaterSense	$2.80	18	Bathroom	$50
Lighting	100% Fluorescent Lighting	100% LED Lighting	$0.04	21,600	CFA (sq. ft.)	$877
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	$30.83	18	Dishwasher	$555
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	$6.41	18	Refrigerator	$115
Sub-Total of Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						**$8,615**
Rater Field Checklist: Thermal Enclosure System						
Ceiling Insulation	R-60, Grade I Installation	R-60, Grade I Installation	-	-	-	-
Above-Grade Wall Insulation	R-20+5, Grade II Installation	R-20+5, Grade I Installation	$0.02	15,300	Ins. Surface Area (sq. ft.)	$382
Foundation Insulation	R-10 Slab Insulation, 4 ft.	R-10 Slab Insulation, 4 ft.	-	-	-	-
Windows	U-value: 0.30 / SHGC: 0.30	U-value: 0.27 / SHGC: 0.30	$0.80	2,111	Window Area (sq. ft.)	$1,689
Doors	R-3.3	R-5.9	$1.63	378	Door Surface Area (sq. ft.)	$614
Additional Checklist Measures: Rater Verification						$475
Sub-Total of Thermal Enclosure System Checklist						**$3,160**
Rater Field Checklist: HVAC System for Track B - HVAC Testing by FT Agent						
Duct Sealing - Total Leakage	8 CFM per 100 sq. ft. of CFA @ Final	8 CFM per 100 sq. ft. of CFA @ Final	-	-	-	-
Duct Insulation	No Ins.; Ducts in Conditioned Space	No Ins.; Ducts in Conditioned Space	-	-	-	-
Additional Checklist Measures: Rater Verification of Equipment Model Numbers, Static Pressure, Bedroom Pressure Balancing, Ventilation System, and Filter						$700
Sub-Total of HVAC System Checklist						**$700**
Rater Design Review Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of Rater Design Review Checklist: Rater Collection of HVAC Design Report, Rater Review of Design, Partnership, & Credential						**$200**
HVAC Design Report for Track B - HVAC Testing by FT Agent						
Ventilation	Exhaust Vent. System	Exhaust Vent. System	-	-	-	-
HVAC Equipment Right-Sizing	1.5 Tons	1.5 Tons	-	-	-	-
Additional Checklist Measures: Checklist Completion by Designer						$35
Sub-Total of HVAC Design Report						**$35**
HVAC Functional Testing Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of HVAC Functional Testing Checklist: Credential Cost, Refrigerant Charge Check, Air Handler Airflow Check, Completion of Checklist						**$1,450**
Water Management System Requirements						
Sub-Total of Water Management System Builder Checklist: Foreman's Completion of Checklist						**$0**
Energy Modeling						
Sub-Total of Cost of Energy Modeling Performed by Rater						**$1,650**
Total Incremental Cost for the Building						**$15,810**

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Exhibit 16: ENERGY STAR Multifamily New Construction v1.2 vs 2021 IECC - CZ 5 - Whole Building - Gas

Measure	2021 IECC Baseline	ENERGY STAR MFNC v1.2	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						
Infiltration	0.30 CFM50 / sq. ft.	0.30 CFM50 / sq. ft.	-	-	-	-
Cooling Equipment	14 SEER Central AC	14 SEER Central AC	-	-	-	-
Heating Equipment	80 AFUE Gas Furnace	95 AFUE Gas Furnace (Combi)	$1,105.70	18	System	$19,903
Duct Location	Conditioned Space	Conditioned Space	-	-	-	-
Water Heater	0.61 UEF Gas DHW, 40 Gal.	0.90 UEF Gas Tankless (Combi)	(See Heating Equipment)			-
DHW Fixtures	Standard	Low-Flow WaterSense	$2.80	18	Bathroom	$50
Lighting	100% Fluorescent Lighting	100% LED Lighting	$0.04	21,600	CFA (sq. ft.)	$877
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	$30.83	18	Dishwasher	$555
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	$6.41	18	Refrigerator	$115
Sub-Total of Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						**$21,501**
Rater Field Checklist: Thermal Enclosure System						
Ceiling Insulation	R-60, Grade I Installation	R-60, Grade I Installation	-	-	-	-
Above-Grade Wall Insulation	R-20+5, Grade II Installation	R-20+5, Grade I Installation	$0.02	15,300	Ins. Surface Area (sq. ft.)	$382
Foundation Insulation	R-10 Slab Insulation, 4 ft.	R-10 Slab Insulation, 4 ft.	-	-	-	-
Windows	U-value: 0.30 / SHGC: 0.30	U-value: 0.27 / SHGC: 0.30	$0.80	2,111	Window Area (sq. ft.)	$1,689
Doors	R-3.3	R-5.9	$1.63	378	Door Surface Area (sq. ft.)	$614
Additional Checklist Measures: Rater Verification						$475
Sub-Total of Thermal Enclosure System Checklist						**$3,160**
Rater Field Checklist: HVAC System for Track B - HVAC Testing by FT Agent						
Duct Sealing - Total Leakage	8 CFM per 100 sq. ft. of CFA @ Final	8 CFM per 100 sq. ft. of CFA @ Final	-	-	-	-
Duct Insulation	No Ins.; Ducts in Conditioned Space	No Ins.; Ducts in Conditioned Space	-	-	-	-
Additional Checklist Measures: Rater Verification of Equipment Model Numbers, Static Pressure, Bedroom Pressure Balancing, Ventilation System, and Filter						-$1,100
Sub-Total of HVAC System Checklist						**-$1,100**
Rater Design Review Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of Rater Design Review Checklist: Rater Collection of HVAC Design Report, Rater Review of Design, Partnership, & Credential						**$200**
HVAC Design Report for Track B - HVAC Testing by FT Agent						
Ventilation	Exhaust Vent. System	Exhaust Vent. System	-	-	-	-
HVAC Equipment Right-Sizing	1.5 Tons	1.5 Tons	-	-	-	-
Additional Checklist Measures: Checklist Completion by Designer						$35
Sub-Total of HVAC Design Report						**$35**
HVAC Functional Testing Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of HVAC Functional Testing Checklist: Credential Cost, Refrigerant Charge Check, Air Handler Airflow Check, Completion of Checklist						**$1,450**
Water Management System Requirements						
Sub-Total of Water Management System Builder Checklist: Foreman's Completion of Checklist						**$0**
Energy Modeling						
Sub-Total of Cost of Energy Modeling Performed by Rater						**$1,650**
Total Incremental Cost for the Building						**$26,896**

Exhibit 17: ENERGY STAR Multifamily New Construction v1.2 vs 2021 IECC - CZ 6 - Whole Building - Electric

Measure	2021 IECC Baseline	ENERGY STAR MFNC v1.2	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						
Infiltration	0.30 CFM50 / sq. ft.	0.30 CFM50 / sq. ft.	-	-	-	-
Cooling Equipment	(See Heating Equipment)	(See Heating Equipment)	-	-	-	-
Heating Equipment	8.8 HSPF / 15 SEER	9.2 HSPF / 16 SEER	$178.05	18	System	$3,205
Duct Location	Conditioned Space	Conditioned Space	-	-	-	-
Water Heater	0.93 UEF Electric DHW, 40 Gallons	1.49 UEF HPWH, 60 Gallons	$211.79	18	Water Heater	$3,812
DHW Fixtures	Standard	Low-Flow WaterSense	$2.80	18	Bathroom	$50
Lighting	100% Fluorescent Lighting	100% LED Lighting	$0.04	21,600	CFA (sq. ft.)	$877
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	$30.83	18	Dishwasher	$555
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	$6.41	18	Refrigerator	$115
Sub-Total of Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						**$8,615**
Rater Field Checklist: Thermal Enclosure System						
Ceiling Insulation	R-60, Grade I Installation	R-60, Grade I Installation	-	-	-	-
Above-Grade Wall Insulation	R-20+5, Grade II Installation	R-20+5, Grade I Installation	$0.02	15,300	Ins. Surface Area (sq. ft.)	$382
Foundation Insulation	R-10 Slab Insulation, 4 ft.	R-10 Slab Insulation, 4 ft.	-	-	-	-
Windows	U-value: 0.30 / SHGC: 0.30	U-value: 0.27 / SHGC: 0.30	$0.80	2,111	Window Area (sq. ft.)	$1,689
Doors	R-3.3	R-5.9	$1.63	378	Door Surface Area (sq. ft.)	$614
Additional Checklist Measures: Rater Verification						$475
Sub-Total of Thermal Enclosure System Checklist						**$3,160**
Rater Field Checklist: HVAC System for Track B - HVAC Testing by FT Agent						
Duct Sealing - Total Leakage	8 CFM per 100 sq. ft. of CFA @ Final	8 CFM per 100 sq. ft. of CFA @ Final	-	-	-	-
Duct Insulation	No Ins.; Ducts in Conditioned Space	No Ins.; Ducts in Conditioned Space	-	-	-	-
Additional Checklist Measures: Rater Verification of Equipment Model Numbers, Static Pressure, Bedroom Pressure Balancing, Ventilation System, and Filter						$700
Sub-Total of HVAC System Checklist						**$700**
Rater Design Review Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of Rater Design Review Checklist: Rater Collection of HVAC Design Report, Rater Review of Design, Partnership, & Credential						**$200**
HVAC Design Report for Track B - HVAC Testing by FT Agent						
Ventilation	Exhaust Vent. System	Exhaust Vent. System	-	-	-	-
HVAC Equipment Right-Sizing	1.5 Tons	1.5 Tons	-	-	-	-
Additional Checklist Measures: Checklist Completion by Designer						$35
Sub-Total of HVAC Design Report						**$35**
HVAC Functional Testing Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of HVAC Functional Testing Checklist: Credential Cost, Refrigerant Charge Check, Air Handler Airflow Check, Completion of Checklist						**$1,450**
Water Management System Requirements						
Sub-Total of Water Management System Builder Checklist: Foreman's Completion of Checklist						**$0**
Energy Modeling						
Sub-Total of Cost of Energy Modeling Performed by Rater						**$1,650**
Total Incremental Cost for the Building						**$15,810**

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Exhibit 18: ENERGY STAR Multifamily New Construction v1.2 vs 2021 IECC - CZ 6 - Whole Building - Gas

Measure	2021 IECC Baseline	ENERGY STAR MFNC v1.2	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						
Infiltration	0.30 CFM50 / sq. ft.	0.30 CFM50 / sq. ft.	-	-	-	-
Cooling Equipment	14 SEER Central AC	14 SEER Central AC	-	-	-	-
Heating Equipment	80 AFUE Gas Furnace	95 AFUE Gas Furnace (Combi)	$1,105.70	18	System	$19,903
Duct Location	Conditioned Space	Conditioned Space	-	-	-	-
Water Heater	0.61 UEF Gas DHW, 40 Gal.	0.90 UEF Gas Tankless (Combi)	(See Heating Equipment)			-
DHW Fixtures	Standard	Low-Flow WaterSense	$2.80	18	Bathroom	$50
Lighting	100% Fluorescent Lighting	100% LED Lighting	$0.04	21,600	CFA (sq. ft.)	$877
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	$30.83	18	Dishwasher	$555
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	$6.41	18	Refrigerator	$115
Sub-Total of Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						**$21,501**
Rater Field Checklist: Thermal Enclosure System						
Ceiling Insulation	R-60, Grade I Installation	R-60, Grade I Installation	-	-	-	-
Above-Grade Wall Insulation	R-20+5, Grade II Installation	R-20+5, Grade I Installation	$0.02	15,300	Ins. Surface Area (sq. ft.)	$382
Foundation Insulation	R-10 Slab Insulation, 4 ft.	R-10 Slab Insulation, 4 ft.	-	-	-	-
Windows	U-value: 0.30 / SHGC: 0.30	U-value: 0.27 / SHGC: 0.30	$0.80	2,111	Window Area (sq. ft.)	$1,689
Doors	R-3.3	R-5.9	$1.63	378	Door Surface Area (sq. ft.)	$614
Additional Checklist Measures: Rater Verification						$475
Sub-Total of Thermal Enclosure System Checklist						**$3,160**
Rater Field Checklist: HVAC System for Track B - HVAC Testing by FT Agent						
Duct Sealing - Total Leakage	8 CFM per 100 sq. ft. of CFA @ Final	8 CFM per 100 sq. ft. of CFA @ Final	-	-	-	-
Duct Insulation	No Ins.; Ducts in Conditioned Space	No Ins.; Ducts in Conditioned Space	-	-	-	-
Additional Checklist Measures: Rater Verification of Equipment Model Numbers, Static Pressure, Bedroom Pressure Balancing, Ventilation System, and Filter						-$1,100
Sub-Total of HVAC System Checklist						**-$1,100**
Rater Design Review Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of Rater Design Review Checklist: Rater Collection of HVAC Design Report, Rater Review of Design, Partnership, & Credential						**$200**
HVAC Design Report for Track B - HVAC Testing by FT Agent						
Ventilation	Exhaust Vent. System	Exhaust Vent. System	-	-	-	-
HVAC Equipment Right-Sizing	1.5 Tons	1.5 Tons	-	-	-	-
Additional Checklist Measures: Checklist Completion by Designer						$35
Sub-Total of HVAC Design Report						**$35**
HVAC Functional Testing Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of HVAC Functional Testing Checklist: Credential Cost, Refrigerant Charge Check, Air Handler Airflow Check, Completion of Checklist						**$1,450**
Water Management System Requirements						
Sub-Total of Water Management System Builder Checklist: Foreman's Completion of Checklist						**$0**
Energy Modeling						
Sub-Total of Cost of Energy Modeling Performed by Rater						**$1,650**
Total Incremental Cost for the Building						**$26,896**

Exhibit 19: ENERGY STAR Multifamily New Construction v1.2 vs 2021 IECC - CZ 7 - Whole Building - Electric

Measure	2021 IECC Baseline	ENERGY STAR MFNC v1.2	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						
Infiltration	0.30 CFM50 / sq. ft.	0.30 CFM50 / sq. ft.	-	-	-	-
Cooling Equipment	(See Heating Equipment)	(See Heating Equipment)	-	-	-	-
Heating Equipment	8.8 HSPF / 15 SEER	9.2 HSPF / 16 SEER	$178.05	18	System	$3,205
Duct Location	Conditioned Space	Conditioned Space	-	-	-	-
Water Heater	0.93 UEF Electric DHW, 40 Gallons	1.49 UEF HPWH, 60 Gallons	$211.79	18	Water Heater	$3,812
DHW Fixtures	Standard	Low-Flow WaterSense	$2.80	18	Bathroom	$50
Lighting	100% Fluorescent Lighting	100% LED Lighting	$0.04	21,600	CFA (sq. ft.)	$877
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	$30.83	18	Dishwasher	$555
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	$6.41	18	Refrigerator	$115
Sub-Total of Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						**$8,615**
Rater Field Checklist: Thermal Enclosure System						
Ceiling Insulation	R-60,Grade I Installation	R-60, Grade I Installation	-	-	-	-
Above-Grade Wall Insulation	R-20+5, Grade II Installation	R-20+5, Grade I Installation	$0.02	15,300	Ins. Surface Area (sq. ft.)	$382
Foundation Insulation	R-10 Slab Insulation, 4 ft.	R-10 Slab Insulation, 4 ft.	-	-	-	-
Windows	U-value: 0.30 / SHGC: 0.30	U-value: 0.27 / SHGC: 0.30	$0.80	2,111	Window Area (sq. ft.)	$1,689
Doors	R-3.3	R-5.9	$1.63	378	Door Surface Area (sq. ft.)	$614
Additional Checklist Measures: Rater Verification						$475
Sub-Total of Thermal Enclosure System Checklist						**$3,160**
Rater Field Checklist: HVAC System for Track B - HVAC Testing by FT Agent						
Duct Sealing - Total Leakage	8 CFM per 100 sq. ft. of CFA @ Final	8 CFM per 100 sq. ft. of CFA @ Final	-	-	-	-
Duct Insulation	No Ins.; Ducts in Conditioned Space	No Ins.; Ducts in Conditioned Space	-	-	-	-
Additional Checklist Measures: Rater Verification of Equipment Model Numbers, Static Pressure, Bedroom Pressure Balancing, Ventilation System, and Filter						$700
Sub-Total of HVAC System Checklist						**$700**
Rater Design Review Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of Rater Design Review Checklist: Rater Collection of HVAC Design Report, Rater Review of Design, Partnership, & Credential						**$200**
HVAC Design Report for Track B - HVAC Testing by FT Agent						
Ventilation	HRV	HRV	-	-	-	-
HVAC Equipment Right-Sizing	1.5 Tons	1.5 Tons	-	-	-	-
Additional Checklist Measures: Checklist Completion by Designer						$35
Sub-Total of HVAC Design Report						**$35**
HVAC Functional Testing Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of HVAC Functional Testing Checklist: Credential Cost, Refrigerant Charge Check, Air Handler Airflow Check, Completion of Checklist						**$1,450**
Water Management System Requirements						
Sub-Total of Water Management System Builder Checklist: Foreman's Completion of Checklist						**$0**
Energy Modeling						
Sub-Total of Cost of Energy Modeling Performed by Rater						**$1,650**
Total Incremental Cost for the Building						**$15,810**

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Cost & Savings Estimates

Exhibit 20: ENERGY STAR Multifamily New Construction v1.2 vs 2021 IECC - CZ 7 - Whole Building - Gas

Measure	2021 IECC Baseline	ENERGY STAR MFNC v1.2	Inc. Unit Cost	Cost Qty	Cost Unit	Inc. Cost
Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						
Infiltration	0.30 CFM50 / sq. ft.	0.30 CFM50 / sq. ft.	-	-	-	-
Cooling Equipment	14 SEER Central AC	14 SEER Central AC	-	-	-	-
Heating Equipment	80 AFUE Gas Furnace	95 AFUE Gas Furnace (Combi)	$1,105.70	18	System	$19,903
Duct Location	Conditioned Space	Conditioned Space	-	-	-	-
Water Heater	0.61 UEF Gas DHW, 40 Gal.	0.90 UEF Gas Tankless (Combi)	(See Heating Equipment)			-
DHW Fixtures	Standard	Low-Flow WaterSense	$2.80	18	Bathroom	$50
Lighting	100% Fluorescent Lighting	100% LED Lighting	$0.04	21,600	CFA (sq. ft.)	$877
Thermostat	Programmable Thermostat	Programmable Thermostat	-	-	-	-
Dishwasher	Standard Efficiency Dishwasher	ENERGY STAR Dishwasher	$30.83	18	Dishwasher	$555
Refrigerator	Standard Efficiency Refrigerator	ENERGY STAR Refrigerator	$6.41	18	Refrigerator	$115
Sub-Total of Measures Not Required by Checklists & Used to Meet ENERGY STAR ERI Target						**$21,501**
Rater Field Checklist: Thermal Enclosure System						
Ceiling Insulation	R-60, Grade I Installation	R-60, Grade I Installation	-	-	-	-
Above-Grade Wall Insulation	R-20+5, Grade II Installation	R-20+5, Grade I Installation	$0.02	15,300	Ins. Surface Area (sq. ft.)	$382
Foundation Insulation	R-10 Slab Insulation, 4 ft.	R-10 Slab Insulation, 4 ft.	-	-	-	-
Windows	U-value: 0.30 / SHGC: 0.30	U-value: 0.27 / SHGC: 0.30	$0.80	2,111	Window Area (sq. ft.)	$1,689
Doors	R-3.3	R-5.9	$1.63	378	Door Surface Area (sq. ft.)	$614
Additional Checklist Measures: Rater Verification						$475
Sub-Total of Thermal Enclosure System Checklist						**$3,160**
Rater Field Checklist: HVAC System for Track B - HVAC Testing by FT Agent						
Duct Sealing - Total Leakage	8 CFM per 100 sq. ft. of CFA @ Final	8 CFM per 100 sq. ft. of CFA @ Final	-	-	-	-
Duct Insulation	No Ins.; Ducts in Conditioned Space	No Ins.; Ducts in Conditioned Space	-	-	-	-
Additional Checklist Measures: Rater Verification of Equipment Model Numbers, Static Pressure, Bedroom Pressure Balancing, Ventilation System, and Filter						-$1,100
Sub-Total of HVAC System Checklist						**-$1,100**
Rater Design Review Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of Rater Design Review Checklist: Rater Collection of HVAC Design Report, Rater Review of Design, Partnership, & Credential						**$200**
HVAC Design Report for Track B - HVAC Testing by FT Agent						
Ventilation	HRV	HRV	-	-	-	-
HVAC Equipment Right-Sizing	1.5 Tons	1.5 Tons	-	-	-	-
Additional Checklist Measures: Checklist Completion by Designer						$35
Sub-Total of HVAC Design Report						**$35**
HVAC Functional Testing Checklist for Track B - HVAC Testing by FT Agent						
Sub-Total of HVAC Functional Testing Checklist: Credential Cost, Refrigerant Charge Check, Air Handler Airflow Check, Completion of Checklist						**$1,450**
Water Management System Requirements						
Sub-Total of Water Management System Builder Checklist: Foreman's Completion of Checklist						**$0**
Energy Modeling						
Sub-Total of Cost of Energy Modeling Performed by Rater						**$1,650**
Total Incremental Cost for the Building						**$26,896**

Section 3: Incremental Cost & Savings of the National Rater Field Checklist: Thermal Enclosure System

Average Estimated Incremental Cost

As can be seen in Exhibits 7 through 20, the net cost for complying with the Thermal Enclosure System section of the National Rater Field Checklist was estimated to be between $1,471 and $3,160 per building, depending on Climate Zone, and encompasses both requirements that improve the ERI and those that do not.

Excluding the requirements that improve the ERI, the remaining checklist requirements address reduced thermal bridging requirements and Rater verification of the checklist items and result in a net cost of $475 in all Climate Zones.

The Rationale section, below, discusses the costs for all measures in more detail.

Average Estimated Incremental Savings

The savings for all requirements of the Thermal Enclosure System section of the National Rater Field Checklist that impact the ERI were captured within Ekotrope.

The Rationale section, below, discusses the approach to estimating savings for all measures in more detail.

Rationale

Section 1 of the checklist requires high-performance fenestration. The incremental cost for improving fenestration from the requirements of the 2021 IECC to ENERGY STAR certified windows was captured in Exhibits 7 through 20. The energy savings from this measure were captured within Ekotrope.

Section 1 also requires quality-installed insulation that meets 2021 IECC levels and achieves Grade I insulation installation (or Grade II for surfaces that contain a layer of continuous, air impermeable insulation that meets a minimum specified insulation level). However, for this analysis it was assumed that all assemblies in ENERGY STAR certified multifamily buildings achieved Grade I insulation.

The insulation levels were modeled to be consistent with the 2021 IECC requirements and, therefore, no incremental cost or energy savings were estimated. In contrast, an incremental cost was estimated for achieving Grade I insulation installation in walls, relative to the Grade II that was assumed for the baseline buildings. The installation grade of the baseline building was based upon the predominant insulation grade, by assembly type, identified for single-family residential homes not indicated as ‘above-code,’ using data from the U.S. Department of Energy Residential Energy Code Field Studies. The incremental cost for this measure was estimated for each unit configuration and each relevant assembly (i.e., wall, floor) as shown in Exhibits 7 through 20. The energy savings from Grade I insulation installation were estimated within Ekotrope.

Section 2 requires fully-aligned air barriers in walls, floors, and ceilings. These details are generally implicitly or explicitly required by the 2021 IECC. For example, code requires that the exterior thermal envelope insulation for framed walls be installed in substantial contact and continuous alignment with the building envelope air barrier, that insulation be installed to maintain permanent contact with the underside of subfloor decking, that a minimum of a 1-inch space be provided between insulation and the roof sheathing to not block the free flow of air at the location of the vent, and that air barriers in any dropped ceiling or soffit be substantially aligned with insulation. Because these requirements are required by code, no incremental cost or energy savings were estimated. The one detail not required by code that is required by this section of the checklist is that, in Climate Zones 4 through 8, an air barrier must be included on the interior vertical surface of wall insulation. This is anticipated to be accomplished by achieving Grade I insulation installation, per Section 1, which will minimize gaps, voids, and compressions that would prevent alignment with drywall. Therefore, no additional incremental cost or energy savings were estimated for this section.

Section 3 requires the use of details that reduce thermal bridging. Several of these details are required by the 2021 IECC, such as extending full height uncompressed insulation over the wall top plate at the eaves and requiring that access be provided to all equipment in attics that prevents damaging or compressing the insulation beneath.

However, Section 3 also requires that a strategy be selected to reduce thermal bridging in above-grade walls. For this analysis, it was assumed that the ‘advanced framing’ strategy would be used in Climate Zones 1-3 which allows for exceptions for structural framing members. It was assumed that these additional structural framing members would result in a framing fraction similar to a code-built building, and a default value of 23% for 16 inch on-center Standard walls in ANSI / RESNET / ICC 301-2019, December 2018. For Climate Zones 4-8 the 2021 IECC insulation levels modeled include continuous insulation, which meets the requirements of another strategy to reduce thermal bridging in above-grade walls in Section 3. Therefore, no additional incremental cost or energy savings were estimated for this Section.

Section 4 requires air sealing of penetrations, cracks, and other openings in the unit's thermal enclosure system. These details largely overlap with the 2021 IECC, which requires that all joints, seams, and penetrations; other sources of infiltration; and utility penetrations be caulked, gasketed, weather-stripped or otherwise sealed with an air barrier material, suitable film or solid material. Code specifically requires that the junction of the foundation and sill plate be sealed (but does not require a gasket); that the space between window/door jambs and framing be sealed; and that duct shafts, utility penetrations, knee walls and flue shafts opening to exterior or unconditioned space be sealed. For recessed luminaires, code requires that they be IC-rated and labeled as meeting ASTM E283 and be sealed with a gasket or with caulk between the housing and the interior wall or ceiling covering. Finally, code requires that access doors from conditioned spaces to unconditioned spaces be weather-stripped and insulated to a level equivalent to the insulation on the surrounding surfaces.

As a result of these code requirements, no incremental costs were estimated for the air sealing measures in Section 4. Instead, it was assumed that these requirements will largely be met to achieve the code-required infiltration limit of 3 or 5 ACH50. For this analysis, the infiltration requirement was converted to a compartmentalization metric, with each code apartment assumed to have 0.3 cfm50 of leakage per sq ft of enclosure area (for Climate Zones 3-7, where 3 ACH50 was required) and 0.5 cfm50 of leakage per sq ft of enclosure area (for Climate Zones 1-2, where 5 ACH50 was required). Also note that no incremental cost was estimated for the blower door test, as it was assumed that a blower door test will be used to demonstrate compliance with the code-required infiltration limits. However, an incremental cost was estimated in Exhibits 7 through 10 to account for additional air sealing, beyond that required by Section 4, to reduce the infiltration rate in Climate Zones 1 and 2 from 5 ACH50 to the level included in the ENERGY STAR Version 3.2 Reference Design. Included in this cost was the one air sealing detail from the checklist that is not required by code – the inclusion of a gasket between the sill plate and foundation. The energy impact of a 2021 IECC infiltration rate that was more stringent than the ENERGY STAR level was captured within Ekotrope.

Finally, despite the fact that many of the requirements in the checklist are also required by code, the 2021 IECC does not require third-party verification of these details by a Rater. It is estimated that this will require two inspections plus transportation time. Combined, this was estimated to take an average of 8 hours per building. At a labor rate of approximately $60 per hour for a Rater, this was estimated to cost $484.

In summary, the costs for the measures that impact the ERI are itemized in Exhibits 7 through 20. The additional cost for Rater verification of the checklist sum to $484 for all Climate Zones, and was rounded to the nearest $25, for a final estimated cost of $475.

Section 4: Incremental Cost & Savings of the National Rater Field Checklist: HVAC System

Average Estimated Incremental Cost

For this analysis it was assumed that Track B: HVAC Testing by FT Agent had been selected to satisfy the HVAC design and commissioning requirements. As part of this track the Rater is required to verify that the equipment model numbers match the design documentation and to measure static pressure.

As can be seen in Exhibits 7 through 20, the net cost for complying with the HVAC System Section of the National Rater Field Checklist was estimated to be between a cost of -$1,100 and $800, depending on Climate Zone, and encompasses both requirements that improve the ERI and those that do not.

Excluding the requirements that impact the ERI, the remaining checklist requirements address Rater verification and other requirements, which are estimated to cost $800 for gas and electric buildings in Climate Zones 1-3, a savings of $1,000 for gas buildings in Climate Zone 4, a savings of $1,100 in gas buildings in Climate Zones 5-7, and a cost of $700 in electric building in Climate Zones 4-7.

The Rationale section, below, discusses the costs for all measures in more detail.

Had Track A: HVAC Grading by Rater been selected to satisfy the HVAC design and commissioning requirements instead of Track B: HVAC Testing by FT Agent, the Rater would have been required to complete three additional field assessment tasks, per ANSI / RESNET / ACCA / ICC 310. Rounded to the nearest $25, these requirements would have resulted in a cost of $707, rather than $154 for the Rater to complete the tasks associated with Track B. However, the HVAC contractor would not have been required to complete additional tasks as discussed in Section 7.

Average Estimated Incremental Savings

The requirements of the HVAC System section of the National Rater Field Checklist for Track B simply help ensure that the heating, cooling, ventilation, and duct system requirements contained in the National HVAC Design Report have been met. Therefore, no additional energy savings were associated with these requirements.

However, as discussed in Section 7, Track B: HVAC Testing by FT Agent requires proper design and installation, and therefore energy savings are associated with those tasks. Had Track A HVAC Grading by Rater been selected to satisfy the HVAC design and commissioning requirements instead of Track B: HVAC Testing by FT Agent, the savings would have been identical because Track A also requires proper design and installation.

Due to the identical savings between Track A and B, the energy savings associated with proper installation are reflected in the ERI of the units through the grading criteria contained in ANSI / RESNET / ACCA / ICC 310. The baseline units were configured with the default Grade III installation for blower fan airflow, blower fan watt draw, and refrigerant charge because no HVAC installation quality grade is defined or required by code. ENERGY STAR certified buildings are allowed to be certified with Grade I or II airflow and watt draw. The refrigerant charge is generally required to achieve Grade I; however, an exemption is provided under certain circumstances. Therefore, savings were conservatively estimated by configuring the units with Grade II airflow and watt draw and Grade III refrigerant charge. These are the worst-performing grades allowed while still permitting a unit to be ENERGY STAR certified.

Rationale

When Track B: HVAC Testing by FT Agent has been selected, Section 5 of the National Rater Field Checklist requires the Rater to check the manufacturer and model number of the installed equipment against the HVAC Design Report. It is estimated that this review would have taken 7 minutes per unit and would have been performed on 9 units in the building with sampling. At a labor rate of $60 per hour for a Rater, the estimated cost is $63. Raters would also have been required to duplicate the static pressure test conducted by the contractor. It is estimated that the Rater could conduct this test while on-site for their final inspection and complete the test in approximately 10 minutes per unit, performed on 9 units in the building with sampling. Therefore, it is estimated that this would have cost $91 at a labor rate of $60 per hour. In total, these Rater tasks for Track B: HVAC Testing by FT Agent sum to an incremental cost of $154.

Section 5 of the checklist also requires the National HVAC Functional Testing Checklist(s) be collected. However, this is not required where credentialed HVAC contractors complete the National HVAC Functional Testing Checklist. It was assumed that a credentialed HVAC contractor would complete this checklist so no incremental cost was estimated for the Rater to collect the documentation. The estimated time required to verify that the HVAC contractor is credentialed is 1 minute. At a labor rate of $60 per hour for a Rater, this was estimated to cost $1.

Section 5 also contains requirements for stairwell motorized dampers, freeze protection systems, snow- and ice-melting systems, and hydronic distribution. On average, it is not expected that buildings considered in the analysis will have these systems, and therefore no incremental cost was assumed for compliance.

Section 5 and Section 6 also require that a Rater verify thermostatic controls, duct insulation levels be visually verified, and ductwork be inspected for kinks, sharp bends, compressions. It is expected that this visual inspection will take 5 minutes per unit and will be performed on 9 units with sampling. At a labor rate of $60 per hour for a Rater, this was estimated to cost $45.

Had Track A: HVAC Grading has been selected, Section 5 of the National Rater Field Checklist requires Raters to complete three additional field tasks, per ANSI / RESNET / ACCA / ICC 310: an assessment of blower fan airflow, blower fan watt draw, and refrigerant charge.

During a pilot of the standard, Raters reported that these three tasks took, on average, a total of 26 minutes per system. For this analysis, this average time was increased by 50% to 39 minutes per unit to account for the potential for re-testing, and to account for process inefficiencies because the standard is relatively new. At a labor rate of $60 per hour for a Rater, this results in an incremental cost of $707 for completing the tests on all 18 units.

The energy savings associated with proper installation are reflected in the ERI of the units. The baseline units were configured with the default Grade III installation for blower fan airflow, blower fan watt draw, and refrigerant charge because no HVAC installation quality grade is defined or required by code. ENERGY STAR certified buildings are allowed to be certified with Grade I or II airflow and watt draw. The refrigerant charge is generally required to achieve Grade I; however, an exemption is provided under certain circumstances. Therefore, savings were conservatively estimated by configuring the units with Grade II airflow and watt draw and Grade III refrigerant charge. These are the worst-performing grades allowed while still permitting a home to be ENERGY STAR certified.

Section 6 requires that ducts be tested and verified to meet air leakage limits. The 2021 IECC also requires this for the baseline units analyzed. Therefore, no incremental cost was assumed for testing. Additionally, the duct leakage limits in the 2021 IECC are equally stringent to those in the National Rater Field Checklist for testing at final with one or two ducted returns. Therefore, there was no incremental cost for meeting the duct leakage limits in the Rater-F included in Exhibits 7 through 20.

Next, Section 6 requires that the bedrooms in the unit be pressure-balanced for rooms with a design supply airflow ≥ 150 CFM. It was assumed that none of the bedrooms would have a design airflow greater than 150 CFM, and, therefore, no incremental cost was estimated for this task.

Section 6 also requires inspection of common space supply, return, exhaust ductwork, and duct leakage testing of central exhaust systems. It was assumed that for the low-rise multifamily building considered in this analysis there was no incremental cost for meeting the requirements in these sections.

Section 7 requires the dwelling unit mechanical ventilation rate to be measured. Verifying that the Rater-measured ventilation rate is within ±15 CFM or ±15% of the design value on the National HVAC Design Report was estimated to take between 5 and 20 minutes. At a labor rate of $60 per hour, the test will cost between $5 and $20 per unit. By averaging the two values, a cost of $13 was estimated per unit. When performed on 9 units in the building with sampling, the total cost was estimated at $113. Note that the incremental cost of the mechanical ventilation system itself is accounted for with the National HVAC Design Report. Section 7 also defines dwelling unit mechanical ventilation control, fan efficiency, inlet location, and sound requirements, which are not addressed in the 2021 IRC. The requirements were assumed to only apply to units with supply ventilation in Climate Zones 1-4. These quick visual inspections were estimated to take 5 minutes per unit and be performed on 9 units in the building with sampling. At a labor rate of $60 per hour, the cost for verification was $45.

Section 8 primarily defines airflow requirements for kitchen and bath exhaust fans. While the 2021 IRC requires bath and kitchen exhaust fan airflow rates that are consistent with the requirements of the National Rater Field Checklist, it does not require a third-party to verify the airflow rates. Because airflow must be verified by the Rater for ENERGY STAR certification, an incremental cost was estimated to purchase a bath fan with 70 CFM of rated airflow rather than 50 CFM, to help ensure compliance. This incremental cost was estimated to be $15 per fan for each of the 18 units. It was estimated that it takes 10 minutes to measure the bath fan and kitchen fan exhaust requirements, and that this measurement would be performed on 9 units in the building with sampling. At a labor rate of $60 per hour, this equates to $90. It was assumed that verification of sound level requirements for continuously running bath fans used for mechanical ventilation occurs during the airflow test, and the sound level requirement is achieved with the bath fan upgrade so no incremental cost was assumed to achieve these limits.

Section 9 defines filtration requirements. The 2021 IRC does not explicitly require the installation of a filter, that all return air and mechanically supplied outdoor air pass through filter prior to conditioning, or that the filter access panel include a gasket or comparable sealing mechanism and fit snugly against the exposed edge of the filter when closed to prevent bypass. However, a filter is routinely included with new equipment and can be installed to meet these requirements with little to no added effort or cost. Therefore, only an incremental cost of $2 was estimated to upgrade the filter from MERV 2 to MERV 6+ for all 18 units. In addition, visual verification of these requirements by the Rater was estimated to take 5 minutes and be performed on 9 units in the building with sampling. At a labor rate of $60 per hour, this equates to $40.

Section 10 defines combustion safety requirements. Unlike the National Rater Field Checklist, the 2021 IRC does not explicitly require power-vented or direct-vented combustion appliances, nor does it explicitly require combustion safety testing. However, for buildings in Climate Zones 1 through 3, it was assumed that the most common compliance path would be to move the combustion appliances outside the pressure boundary, such as an unconditioned mechanical room on a balcony, or to use electric space and water heating equipment. In Climate Zones 4 through 8, the most common compliance path would be to use power-vented or direct-vented combustion appliances or electric space and water heating equipment. The cost associated with upgrading to a direct-vented furnace and power-vented water heater was accounted for in Exhibits 14 through 20 for the gas fueled buildings in Climate Zones 4 through 8. For these building configurations, it was assumed that a “B-vent” metal combustion vent was replaced with a PVC side-wall combustion inlet and vent system, resulting in savings of $100 per unit, or $1,800 for all 18 units in the building.

The remainder of Section 10 defines requirements for combustion appliances, other than cooking ranges or ovens. On average, it is not expected that units will have combustion appliances of these types and, therefore, no incremental cost was assumed for compliance.

Section 11 defines domestic hot water system requirements. It specified minimum efficiency level for units using the Prescriptive Path, and for equipment serving common spaces. The low-rise building in this analysis was considered to have no common spaces, and it was assumed that the ERI Path would be used, so no incremental cost or savings were associated with Items.

Sections 12, 13, and 14 define requirements for lighting, appliances, and a whole building energy consumption data acquisition strategy respectively. It was assumed that for the low-rise multifamily building considered in this analysis there was no incremental cost for meeting the requirements in these sections.

In summary, the costs for the measures that impact the ERI are itemized in Exhibits 7 through 20. The remaining checklist requirements address Rater verification and sum to $800 for gas and electric buildings in Climate Zones 1-3, -$1,000 for gas buildings in Climate Zone 4, - $1,090 in gas buildings in Climate Zones 5-7, and $710 in electric building in Climate Zones 4-7. These were rounded to the nearest $25, for a final estimated cost of $800, -$1,000, -$1,100, and $700, respectively.

Had Track A: HVAC Grading by Rater been selected the remaining checklist requirements would have addressed by Rater verification of installation quality per ANSI / RESNET / ACCA / ICC 310. All other tasks would have remained the same. These would have summed to $1,353 for gas and electric buildings in Climate Zones 1-3, -$447 for gas buildings in Climate Zone 4, -$537 in gas buildings in Climate Zones 5-7, and $1,263 in electric building in Climate Zones 4-7. These were rounded to the nearest $25, for a final estimated cost of $1,350, -$450, -$525, and $1,275, respectively.

Section 5: Incremental Cost & Savings of the National HVAC Design Report

Average Estimated Incremental Cost

For this analysis, it was assumed that Track B: HVAC Testing by FT Agent had been selected to satisfy the HVAC design and commissioning requirements. As part of this track, the HVAC designer is required to complete the ENERGY STAR National HVAC Design Report (HVAC-D).

As can be seen in Exhibits 7 through 20, the net cost for completing the ENERGY STAR National HVAC Design Report was estimated to be $35.

The Rationale section, below, discusses the costs for all measures in more detail.

Had Track A: HVAC Grading by Rater been selected to satisfy the HVAC design and commissioning requirements instead of Track B: HVAC Testing by FT Agent, the costs would have been identical because Track A requires the completion of design documentation, and underlying design requirements, which are substantially the same as Track B.

Average Estimated Incremental Savings

Because code requires that heating and cooling design loads be properly calculated, that equipment capacity be properly selected, and that ducts be properly designed, no energy savings were associated with these requirements.

In addition, no energy impacts were associated with meeting the filter requirements of ASHRAE 62.2-2010. However, energy use required to meet the ventilation requirements of ASHRAE 62.2-2010 was captured within Ekotrope.

The Rationale section, below, discusses all measures in more detail.

Had Track A: HVAC Grading by Rater been selected to satisfy the HVAC design and commissioning requirements instead of Track B: HVAC Testing by FT Agent, the savings would have been identical because Track A also requires proper load calculation, equipment selection, duct design, and compliance with ASHRAE 62.2-2010.

Rationale

Some Sections and Items within the HVAC-D are intended to ensure that the HVAC Designer accounts for certain program requirements of the HVAC system (e.g., mechanical ventilation, controls, duct quality installation, filtration, and bedroom pressure differential). The costs and savings associated with these features are accounted for in other checklists, so are not included in this section.

Section 1 of the HVAC-D requires the designer to provide a basic overview of their design. While not explicitly required by the 2021 IECC, providing this information does not add any incremental cost other than the time required to complete the paperwork.

Section 2 of the HVAC-D requires the designer to document basic information about dwelling unit mechanical ventilation systems, which is also required to be installed by the 2021 IRC.

In Climate Zones 1 through 4, all units contained a ventilation system comprising an inline supply ventilation fan with an on-board controller for ASHRAE 62.2 compliance, and an integrated motorized fresh air damper. Such a system can be ducted to provide fresh air directly to one or more rooms or provide ventilation air to the return-side of the HVAC system. The on-board controller can optimize run-time to coincide with times when the HVAC fan in heating or cooling mode, and can optionally turn on the HVAC blower fan to run simultaneously with the ventilation system during the remaining run-time. For this analysis, it was assumed that the system is connected to the return-side of the HVAC system, optimizes run-time to coincide with the HVAC system, and does not turn on the HVAC blower fan during the remaining run-time.

For Climate Zones 5 and 6, all units contained a ventilation system comprising an ENERGY STAR certified bathroom exhaust fan and bath fan controller. Units with this system use the bathroom exhaust fan to provide all required ventilation.

For Climate Zones 7 and 8, a ventilation system was modeled comprised of an HRV. The 2021 IECC requires use of an HRV or ERV in these locations.

No incremental costs were estimated for these ventilation systems because the 2021 IRC also requires a whole-house system. However, the energy impact from the ventilation load and the fan power were captured within Ekotrope.

Sections 3 through 5 of the HVAC-D require that designers properly calculate heating and cooling design loads (generally per ACCA Manual J), select right-sized equipment capacities (generally per ACCA Manual S), and design the duct system (generally per ACCA Manual D). No incremental costs or savings were estimated specifically for these design tasks, as they are also required by the 2021 IRC.

The baseline units and the ENERGY STAR units were assumed to be right-sized per code requirements, however the cooling equipment capacity of the ENERGY STAR units were assumed to be the same capacity as the baseline units and still meet sizing limits.

The low-rise building in this analysis was considered to have no common spaces, central systems, or hydronic equipment, so no incremental cost or savings were associated with Items in the HVAC-D for these spaces and systems.

In summary, the costs for the measures that impact the ERI are itemized in Exhibits 7 through 20. The additional cost for the completion of the HVAC-D by the designer is estimated to be $35. The EPA is working to automate this task, such that it will require negligible time or money to complete. In the interim, however, many designers will complete this task manually. Filling out one HVAC design report manually is estimated to take 5 minutes for each unique unit, plus 10 minutes for the whole building with no common spaces. Assuming that for the 18 unit building with no common systems to document, there are 4 separate load calculations representing the 4 unique units, the time to complete for the entire building is 0.5 hours. At a labor rate of $69 per hour for a mechanical engineer, the total labor cost equates to $35, which was rounded to the nearest $5, for a final estimated cost of $35.

Section 6: Incremental Cost & Savings of the National Rater Design Review Checklist

Average Estimated Incremental Cost

For this analysis, it was assumed that Track B: HVAC Testing by FT Agent had been selected to satisfy the HVAC design and commissioning requirements. As a result, the Rater is required to complete the Track B: HVAC Testing by FT Agent portion of the National Rater Design Review Checklist. These requirements do not directly affect the ERI. As can be seen in Exhibits 7 through 20, the net cost for complying with the National Rater Design Review Checklist was estimated to be $200.

The Rationale section, below, discusses the costs for all measures in more detail.

Had Track A: HVAC Grading by Rater been selected to satisfy the HVAC design and commissioning requirements instead of Track B: HVAC Testing by FT Agent, the costs would have been identical because Track A requires a substantially equivalent design review.

Average Estimated Incremental Savings

While the tasks required on the National Rater Design Review Checklist add value, there are no estimated savings directly associated with them.

Rationale

The National Rater Design Review Checklist requires the Rater to verify that the builder or developer is an ENERGY STAR partner, and to verify that the fenestration and insulation specified in the energy rating file complies with the program's requirements. In addition, for Track B: HVAC Testing by FT Agent the Rater is required to collect an ENERGY STAR National HVAC Design Report. The Rater must review the report to ensure that the documented HVAC design falls within the tolerances of the program.

Therefore, the incremental costs of this checklist are all related to the labor of the Rater. The estimated time required to verify that the builder or developer is an ENERGY STAR partner is 1 minute. Verification that the fenestration and insulation meets program requirements is estimated to take 8 minutes for the entire building. It is assumed to take one hour on average to collect the required HVAC Design Report. Lastly, it is assumed that there are 4 unique load calculations for the building and that 30 minutes are required to review each. The estimated time to review is therefore 2 hours for the entire building. Finally, Section 5 of the National Rater Design Review Checklist contains recommended, but not required verification tasks. Therefore, no additional incremental costs were estimated for Section 5 of the National Rater Design Review Checklist.

In summary, the tasks on the National Rater Design Review Checklist require 3 hours and 9 minutes per building. At a labor rate of $60 per hour, the total labor cost equates to $190. This was rounded to the nearest $25, for a final estimated cost of $200.

Section 7: Incremental Cost & Savings of the National HVAC Functional Testing Checklist

Average Estimated Incremental Cost

For this analysis, it was assumed that Track B: HVAC Testing by FT Agent had been selected to satisfy the HVAC design and functional testing requirements. Therefore, completion of the National HVAC Functional Testing Checklist would be required, resulting in an average incremental cost of $1,450.

Had Track A: HVAC Grading by Rater been selected to satisfy the HVAC design and commissioning requirements instead of Track B: HVAC Testing by FT Agent, completion of the National HVAC Functional Testing Checklist would not be required.

The Rationale section, below, discusses the costs for all measures in more detail.

Average Estimated Incremental Savings

The field assessment tasks completed as part of Track B: HVAC Testing by FT Agent help ensure that the HVAC system has been properly designed and installed. The savings that result from this proper installation are reflected in the ERI of the home and were therefore captured within Ekotrope.

Had Track A: HVAC Grading by Rater been selected to satisfy the HVAC design and functional testing requirements instead of Track B: HVAC Testing by FT Agent the savings would have been identical because Track A also requires proper design and installation.

As discussed in Section 4, the energy savings associated with proper installation are reflected in the ERI of the units through the grading criteria contained in ANSI / RESNET / ACCA / ICC 310.

Rationale

There are several entities that may complete the National HVAC Functional Testing Checklist, one of which is a contractor credentialed, prior to installation of HVAC systems, by an HVAC Quality Installation Oversight Organization (H-QUITO). For the purposes of this analysis, it was assumed this is who would complete the checklist because prior to the development of this program, 3-story buildings were eligible for the ENERGY STAR Single-Family New Homes program, where a credentialed HVAC contractor was required to complete this work. Therefore, it is likely that a credentialed HVAC contractor would continue to work on these types of buildings under this program. Two H-QUITO’s are available, each with its own fee structure and an overall cost per home or unit that is dependent on the number of homes and units that the contractor installs systems in annually. The number of ENERGY STAR Single-Family New Homes certified in 2020 divided by the number of credentialed contractors available that year is equal to 83 homes per contractor. Using this average results in credential costs of approximately $7 per home after the first year of being credentialed, assuming no significant quality assurance issues. Though this cost was estimated based on an analysis of single-family homes, it is assumed that the cost per multifamily unit would be the same. For the entire 18-unit building, the total cost would be $130.

Section 1 of the National HVAC Functional Testing Checklist requires the contractor to provide a basic overview of the system they are performing functional testing on. While not explicitly required by the 2021 IECC, providing this information does not add any incremental cost other than the time required to complete the paperwork.

The remainder of the National HVAC Functional Testing Checklist requires several HVAC functional tests to be completed, which are not explicitly required by the 2021 IRC. In Section 2, the contractor is required to verify the refrigerant charge. Using a digital manifold, this is estimated to take 20 minutes for each of the 18 units. In Section 3, the contractor is required to assess the air handler airflow using the measured static pressure and fan-speed setting. This was estimated to take 15 minutes for each of the 18 units. Section 4 recommends, but does not require, that the contractor measure and balance the register airflow. Because this is only a recommendation, no incremental cost was assumed. It is estimated to take 10 minutes per unit to complete the functional testing of the indoor / terminal units in Section 5, and that this would be performed on 9 units in the building with sampling. Lastly, it was estimated to take 5 minutes to fill out the checklist with the information gathered in the field for each of the 18 units. The total time for functional testing (i.e., measuring refrigerant charge, using static pressure and the fan-speed setting to approximate air handler airflow, other functional testing steps, and completing the checklist) was estimated to take 13 hours and 30 minutes for the entire 18-unit building. At a labor rate of $97 per hour for an HVAC Contractor, this translates to $1,314. With the addition of the approximately $7 per unit credential fee, this sums to a total cost of $1,444. This was rounded to the nearest $25, which is $1,450.

Sections 6, 7, 8, and 9 contain requirements for VRF outdoor units, central boilers, cooling towers, and chillers. The low-rise multifamily building considered in this analysis does not contain any equipment applicable to these sections, therefore there was no incremental cost for meeting the requirements in these sections.

Section 8: Incremental Cost & Savings of the National Water Management System Req.'s

Average Estimated Incremental Cost

The requirements of the National Water Management System Requirements do not impact the ERI. Furthermore, because they are also required by the 2021 IRC, there is estimated to be no net cost for meeting these requirements.

The Rationale section, below, discusses the measures in more detail.

Average Estimated Incremental Savings

Energy savings were not anticipated as a result of implementing the National Water Management System Requirements, as the measures implemented are focused on water management details.

Rationale

Section 1 defines water management details applicable to the site and to the building's foundation, Section 2 defines details applicable to the wall assembly, Section 3 defines details applicable to the roof assembly, and Section 4 defines requirements that help manage water in building materials. These requirements are aligned with the requirements of the 2021 IRC. Therefore, no incremental cost was estimated for meeting these code-required checklist items. Furthermore, since the National Water Management System Requirements is simply a list of requirements and not a formal checklist that must be completed, there is no cost associated with documenting compliance with the requirements.

Section 9: Incremental Cost of Modeling ERI Certification Path

Average Estimated Incremental Cost

There are three paths available in the certification process to meet performance requirements. These are the Prescriptive Path, ERI Path, and ASHRAE Path. It was assumed that the ERI Path would most likely be used for a low-rise multifamily building considered in this analysis. For this path, projects must use a software rating tool approved by an EPA-Approved Home Certification Organization (HCO) to determine the ENERGY STAR ERI Target, which is the highest ERI value that each rated unit may achieve to earn the ENERGY STAR. It was assumed that this would be done by creating 4 base units that would be copied and edited in the software for all 18 units in the building. These base units would take no more than 2 hours each to create. It would then take an additional 45 minutes to create software files for each of the other 14 units. Finally, there would be another 30 minutes for each of the 18 units to finalize inputs after the final field inspection and testing. This results in a total of 27.5 hours to determine and evaluate the ERI Target for all 18 units. At a labor rate of $60 per hour for a Rater, this was estimated to cost $1,662. This was rounded to the nearest $25, for a final estimated cost of $1,650.

Section 10: Cost References

A. Thermal Enclosure System

Air Sealing

Reference	NREL National Residential Efficiency Measures Database v3.1.0, access via BEopt 2.8.0.0
Accessed	August 2021
Notes	• Material costs and new construction Installation labor costs for infiltration rates of 3 and 5 ACH50 were taken from this database.

Doors

Reference	NREL National Residential Efficiency Measures Database v3.1.0 accessed via BEopt 2.8.0.0
Accessed	August 2021
Notes	• Material costs and new construction Installation labor costs were taken from this database. • Costs linearly interpolated by U-factor using the following entries: ○ Swinging Entry, Opaque, Wood Frame, U-Value: 0.48 ○ Swinging Entry, Opaque, Fiberglass Frame, U-Value: 0.20

Framing

Reference	RS Means Construction Cost Data 2010
Accessed	August 2021
Notes	• Framing costs for the advanced framing strategy are based upon RS Means Line Number 06 11 10.40 6145, representing 2x4 8.5 ft. high studs where applicable, and RS Means Line Number 06 11 10.40 6165, representing 2x6 8.5 ft. high studs where applicable. • All costs prorated by 22.2% to adjust for inflation between 2010 and 2019 using BLS Producer Price Index Materials for Construction cost data.

Insulation Installation

Reference	RS Means Construction Cost Data 2010
Accessed	August 2021
Notes	• Incremental cost for going from Grade II to Grade I wall insulation: ○ In 2x4 wall assemblies: Assumed to cost 17.5% more than labor rate for RS Means Line Number 07 21 16.20 0080, representing batt insulation. ○ In 2x6 wall assemblies: Assumed to cost 12.5% more than labor rate for RS Means Line Number 07 21 26.10 0020, representing blown insulation. • Incremental cost for going from Grade II to Grade I floor insulation assumed to cost 25% more than labor rate for RS Means Line Number 07 21 16.10 2215, representing blown insulation. • All labor rates prorated by 24.8% to adjust for inflation between 2010 and 2019 using BLS Current Employment Statistics Survey hourly earnings data.

Windows

Reference	ENERGY STAR Windows V7.0 Criteria Analysis Report, July 2021 https://www.energystar.gov/sites/default/files/asset/document/ES_Residential_WDS_Draft%201_ _Criteria%20Analysis%20Report.pdf
Accessed	August 2021
Notes	• Costs were taken from Table 7, which provides the incremental consumer ('retail') cost over the market baseline for a variety of U-factors and SHGC values, assuming a 15 square foot window. • Specifically, the incremental costs in Climate Zones 5 through 8 were determined by subtracting the retail cost of a window with a 0.28-0.31 U- factor and a SHGC > 0.25 from the retail cost of a window with a 0.27 U-factor and a SHGC > 0.25. • Note that the no incremental cost was calculated in Climate Zones 1 through 4, because there was no upgrade in window performance relative to code.

B. Space Conditioning Equipment & Filter

Air-Source Heat Pump

Reference	NREL National Residential Efficiency Measures Database v3.1.0, accessed via BEopt 2.8.0.0
Accessed	August 2021
Notes	• Material costs and new construction installation labor costs were taken from this database for equipment ranging in efficiency from 8.2 HSPF / 14 SEER to 9.5 HSPF / 19 SEER. These costs were then linearly interpolated by SEER and HSPF to calculate the incremental cost of the equipment used in the baseline and ENERGY STAR certified homes and units.

Central Air Conditioner

Reference	NREL National Residential Efficiency Measures Database v3.1.0, accessed via BEopt 2.8.0.0
Accessed	August 2021
Notes	• Material costs and new construction installation labor costs were taken from this database for 15 and 16 SEER equipment and used to calculate the incremental cost of the equipment used in the baseline and ENERGY STAR certified homes.

Filter

Reference	http://www.homedepot.com, Watertown Store #2602
Accessed	August 2021
Notes	• Sample filter used to estimate baseline cost: Pamlico Air 20 in. x 25 in. x 1 in. Fiberglass Air Filter FPR 1, Model # 11004-012025 • Sample filter used to estimate upgrade cost: Honeywell 20 in. x 25 in. x 1in. Allergen Plus Pleated MERV 11 – FPR 7 Air Filter, Model # 90701.012025

Gas Furnace

Reference	NREL National Residential Efficiency Measures Database v3.1.0, accessed via BEopt 2.8.0.0
Accessed	August 2021
Notes	• Material costs and new construction installation labor costs were taken from this database for 80 AFUE, 90 AFUE, and 95 AFUE equipment. These costs were then linearly interpolated by AFUE to calculate the incremental cost of the equipment used in the baseline and ENERGY STAR certified homes and units.

Combi Boiler

Reference	• https://www.homedepot.com/p/Rheem-Prestige-9-9-GPM-Natural-Gas-High-Efficiency-Combi-Boiler-with-199000-BTU-RCBH199DVLN/308997826 • https://www.homedepot.com/p/Rinnai-Hydronic-Air-Handler-30-MBH-with-Circulator-AH083CP/313571118 • NREL National Residential Efficiency Measures Database v3.1.0, accessed via BEopt 2.8.0.0 • https://ma-eeac.org/wp-content/uploads/RES19_Assembled_Report_2018-09-27.pdf
Accessed	August 2021
Notes	• A combi-boiler system was assumed for gas units in Climate Zones 5-7, which provides hot water heating as well as space heating through a hydronic air handler. • Material costs were estimated based on the products above which would serve both space heating and water heating loads. • Construction installation labor costs were taken from the NREL database for 0.96 EF (equivalent to 0.96 UEF) water heating equipment, and 95 AFUE gas furnace equipment. Costs were reduced by 37% based on the "Water Heating, Boiler, and Furnace Cost Study"

C. Domestic Hot Water Equipment

Electric Water Heater

Reference	• NREL National Residential Efficiency Measures Database v3.1.0, accessed via BEopt 2.8.0.0 • www.lowes.com • www.homedepot.com
Accessed	August 2021
Notes	• Material costs and new construction installation labor costs were taken from the NREL database for a heat pump water heater with an efficiency of 2.30 EF (equivalent to 2.40 UEF using RESNET's Energy Factor Conversion Equations) and 2.35 EF (equivalent to 2.44 UEF. Because there were limited other efficiencies available in the database, retail costs were taken from Lowes for equipment with an efficiency of 3.45 UEF and from Home Depot for equipment with an efficiency of 3.85 UEF. These costs were then linearly interpolated by UEF to calculate the incremental cost of the equipment used in the baseline and ENERGY STAR certified homes.

Gas Water Heater

Reference	NREL National Residential Efficiency Measures Database v3.1.0, accessed via BEopt 2.8.0.0
Accessed	August 2021
Notes	• Material costs and new construction installation labor costs were taken from this database for 0.82 EF (equivalent to 0.82 UEF using RESNET's Energy Factor Conversion Equations) and 0.96 EF (equivalent to 0.96 UEF) equipment. These costs were then linearly interpolated by UEF to calculate the incremental cost of the equipment used in the baseline and ENERGY STAR certified homes.

D. Appliances & Lighting

Dishwasher

Reference	NREL National Residential Efficiency Measures Database v.3.1.0, accessed via BEopt 2.8.0.0
Accessed	August 2021
Notes	• Material costs were taken from this database for a dishwasher with consumption of 259 and 307 kWh/yr. Because the database represents retrofit costs, the low-end of the cost range was used to approximate the costs of new construction. These costs were then interpolated to estimate the cost of a baseline and ENERGY STAR certified dishwasher.

Lighting

Reference	NREL National Residential Efficiency Measures Database v3.1.0, accessed via BEopt 2.8.0.0
Accessed	August 2021
Notes	• Material costs and new construction installation labor costs for 100% CFL lighting and 100% LED lighting were taken from this database and the difference was used to calculate the incremental cost. These costs are defined per square foot of living area and garage area. Because only hard-wired fixtures will be upgraded at the time of certification, these costs were reduced based on an estimate that 56% of lighting are hard-wired ceiling fixtures from Table 4.5 of the Residential Lighting End-Use Consumption Study.

Refrigerator

Reference	NREL National Residential Efficiency Measures Database v3.1.0, accessed via BEopt 2.8.0.0
Accessed	August 2021
Notes	• Material costs and new construction installation labor costs were taken from this database for a refrigerator with consumption of 434 and 480 kWh/yr. These costs were then interpolated to estimate the cost of a baseline and ENERGY STAR certified refrigerator.

Low-Flow Bathroom Faucets and Showerheads

Reference	• CPUC DEER 2016 Database • California Energy Commission "Staff Analysis Of Water Efficiency Standards For Showerheads"
Accessed	August 2021
Notes	• Measures used for costs were: "DHW-FaucetAerator-Std", and "DHW-FaucetAerLowFlow-Res." • CEC analysis showed $0 incremental cost for low-flow showerheads.

E. Labor

Reference	RS Means Construction Cost Data 2010
Accessed	August 2021
Notes	• Hourly rate listed by position: (see table below) • All labor rates prorated by 24.8% to adjust for inflation between 2010 and 2019 using BLS Current Employment Statistics Survey hourly earnings data.

Cost & Savings Role	RS Means Trade	Hourly Rate with Overhead and Profit
Rater	'Helpers' Average	$60
HVAC Assistant	'Helpers' Average	$60
HVAC Contractor	Plumber	$97
Foreman	Foreman Average, Outside	$86
HVAC Designer	n/a	$69

Appendix A: Complete Savings Results for All Modeled Building Units

CZ	Location	Unit Type	HVAC Equipment Type	2021 IECC	ENERGY STAR MFNC Version 1.2		
				Annual Purchased Energy Costs	Annual Purchased Energy Costs	Annual Purchased Energy Savings	
1	Miami, FL	Ground Corner	Elec. Air-Source HP	$917	$813	$104	11%
1	Miami, FL	Middle Interior	Elec. Air-Source HP	$852	$749	$103	12%
1	Miami, FL	Top Interior	Elec. Air-Source HP	$869	$769	$99	11%
1	Miami, FL	Top Corner	Elec. Air-Source HP	$908	$805	$104	11%
1	Miami, FL	Ground Corner	Gas Furnace / Elec. AC	$856	$718	$138	16%
1	Miami, FL	Middle Interior	Gas Furnace / Elec. AC	$789	$657	$133	17%
1	Miami, FL	Top Interior	Gas Furnace / Elec. AC	$805	$676	$129	16%
1	Miami, FL	Top Corner	Gas Furnace / Elec. AC	$826	$711	$116	14%
2	Tampa, FL	Ground Corner	Elec. Air-Source HP	$895	$794	$101	11%
2	Tampa, FL	Middle Interior	Elec. Air-Source HP	$845	$741	$104	12%
2	Tampa, FL	Top Interior	Elec. Air-Source HP	$862	$757	$105	12%
2	Tampa, FL	Top Corner	Elec. Air-Source HP	$899	$790	$109	12%
2	Tampa, FL	Ground Corner	Gas Furnace / Elec. AC	$799	$682	$116	15%
2	Tampa, FL	Middle Interior	Gas Furnace / Elec. AC	$750	$633	$117	16%
2	Tampa, FL	Top Interior	Gas Furnace / Elec. AC	$766	$648	$118	15%
2	Tampa, FL	Top Corner	Gas Furnace / Elec. AC	$785	$680	$105	13%
3	Memphis, TN	Ground Corner	Elec. Air-Source HP	$1,024	$916	$108	11%
3	Memphis, TN	Middle Interior	Elec. Air-Source HP	$922	$819	$104	11%
3	Memphis, TN	Top Interior	Elec. Air-Source HP	$961	$856	$105	11%
3	Memphis, TN	Top Corner	Elec. Air-Source HP	$998	$888	$110	11%
3	Memphis, TN	Ground Corner	Gas Furnace / Elec. AC	$812	$733	$79	10%
3	Memphis, TN	Middle Interior	Gas Furnace / Elec. AC	$727	$647	$81	11%
3	Memphis, TN	Top Interior	Gas Furnace / Elec. AC	$757	$678	$79	10%
3	Memphis, TN	Top Corner	Gas Furnace / Elec. AC	$788	$707	$81	10%
4	St Louis, MO	Ground Corner	Elec. Air-Source HP	$1,158	$1,037	$121	10%
4	St Louis, MO	Middle Interior	Elec. Air-Source HP	$1,022	$908	$114	11%
4	St Louis, MO	Top Interior	Elec. Air-Source HP	$1,071	$954	$117	11%
4	St Louis, MO	Top Corner	Elec. Air-Source HP	$1,112	$992	$120	11%
4	St Louis, MO	Ground Corner	Gas Furnace / Elec. AC	$856	$768	$88	10%
4	St Louis, MO	Middle Interior	Gas Furnace / Elec. AC	$748	$669	$79	11%
4	St Louis, MO	Top Interior	Gas Furnace / Elec. AC	$784	$703	$81	10%
4	St Louis, MO	Top Corner	Gas Furnace / Elec. AC	$817	$733	$84	10%
5	Chicago, IL	Ground Corner	Elec. Air-Source HP	$1,321	$1,174	$147	11%
5	Chicago, IL	Middle Interior	Elec. Air-Source HP	$1,135	$1,003	$132	12%
5	Chicago, IL	Top Interior	Elec. Air-Source HP	$1,200	$1,064	$136	11%
5	Chicago, IL	Top Corner	Elec. Air-Source HP	$1,256	$1,111	$145	12%
5	Chicago, IL	Ground Corner	Gas Furnace / Elec. AC	$921	$814	$107	12%
5	Chicago, IL	Middle Interior	Gas Furnace / Elec. AC	$783	$698	$85	11%
5	Chicago, IL	Top Interior	Gas Furnace / Elec. AC	$828	$737	$91	11%
5	Chicago, IL	Top Corner	Gas Furnace / Elec. AC	$868	$769	$98	11%
6	Burlington, VT	Ground Corner	Elec. Air-Source HP	$1,409	$1,253	$155	11%
6	Burlington, VT	Middle Interior	Elec. Air-Source HP	$1,192	$1,054	$138	12%
6	Burlington, VT	Top Interior	Elec. Air-Source HP	$1,263	$1,121	$142	11%
6	Burlington, VT	Top Corner	Elec. Air-Source HP	$1,337	$1,174	$163	12%
6	Burlington, VT	Ground Corner	Gas Furnace / Elec. AC	$947	$837	$110	12%
6	Burlington, VT	Middle Interior	Gas Furnace / Elec. AC	$792	$708	$84	11%
6	Burlington, VT	Top Interior	Gas Furnace / Elec. AC	$841	$750	$91	11%
6	Burlington, VT	Top Corner	Gas Furnace / Elec. AC	$883	$783	$100	11%
7	Duluth, MN	Ground Corner	Elec. Air-Source HP	$1,790	$1,612	$178	10%
7	Duluth, MN	Middle Interior	Elec. Air-Source HP	$1,457	$1,301	$156	11%
7	Duluth, MN	Top Interior	Elec. Air-Source HP	$1,562	$1,402	$160	10%
7	Duluth, MN	Top Corner	Elec. Air-Source HP	$1,659	$1,483	$175	11%
7	Duluth, MN	Ground Corner	Gas Furnace / Elec. AC	$1,096	$967	$129	12%
7	Duluth, MN	Middle Interior	Gas Furnace / Elec. AC	$897	$801	$96	11%
7	Duluth, MN	Top Interior	Gas Furnace / Elec. AC	$960	$856	$104	11%