



Additional Information for OIRA Staff DOE Furnace SNO PR

June 30, 2016



A 70 kBtuH threshold appears to provide a balance between total national energy savings and good outcomes for vulnerable consumers.

- ***A 70 kbtuH size threshold is targeted to help the consumers most likely to otherwise be harmed by the rule.*** Residents of attached housing (row houses, townhomes) are most likely to be unable to install a condensing furnace because of limited access to external walls.
- ***This analysis indicates that in most of the country, a 70 kBtuH furnace is adequate to supply dependable heat to a moderately sized townhome.***
- ***A 70 kBtuh threshold would not undermine market movement towards condensing technologies.*** Limiting non-condensing furnace options to this size and below would be adequate to protect the most vulnerable consumers without weakening the rule overall.
- ***DOE analysis indicates that a threshold of 70 kBtuH provides nearly identical national energy savings to a threshold of 65 kBtuH.***

AGA Manual J Analysis for Select U.S. Cities

- AGA engaged H.T.R. Engineering to conduct a Manual J analysis for home designs typical of select U.S. cities. Below are the results for four housing types, at two building efficiency levels, in five cities.
- **Housing Types:**
 - Two-story townhome with basement;
 - Two-story townhome without basement;
 - Three-story townhome without basement; and
 - Small single family detached home.
- **Cities:** Atlanta, Chicago, Minneapolis, Salt Lake City, and Oklahoma City.
- **Furnace Efficiencies (AFUE):** The analysis assumes an AFUE of 80 for purposes of sizing a non-condensing furnace.
- **Building Efficiencies:** The E.T.R. Engineering analysis considered two categories that provide reasonable “brackets” for the majority of housing stock:
 - Highly efficient homes built to 2015 code; and
 - Highly inefficient homes built to 1950s era practices and standards.

Why is an analysis based on Manual J assessments important for the furnace rulemaking?

- **Manual J assessments are the “gold standard” for residential HVAC sizing.** Manual J assessments consider:
 - All surfaces of the building envelope, including total area, and insulation level;
 - Presence of – and materials used in – all windows and doors;
 - Location and tightness of the duct system;
 - Infiltration rate of the house;
 - Internal loads (appliances and people); and
 - Home location and placement (e.g. above/below grade).
- ***Unlike actual market data which can include oversizing, Manual J assessments indicate appropriate furnace sizes*** for the fictional but representative home types considered in this analysis.
- Manual J is the most rigorous approach available to industry professionals. However, results may vary slightly because some inputs may need to be approximated on a case-by-case basis, and may reflect subjective comfort levels and preferences.

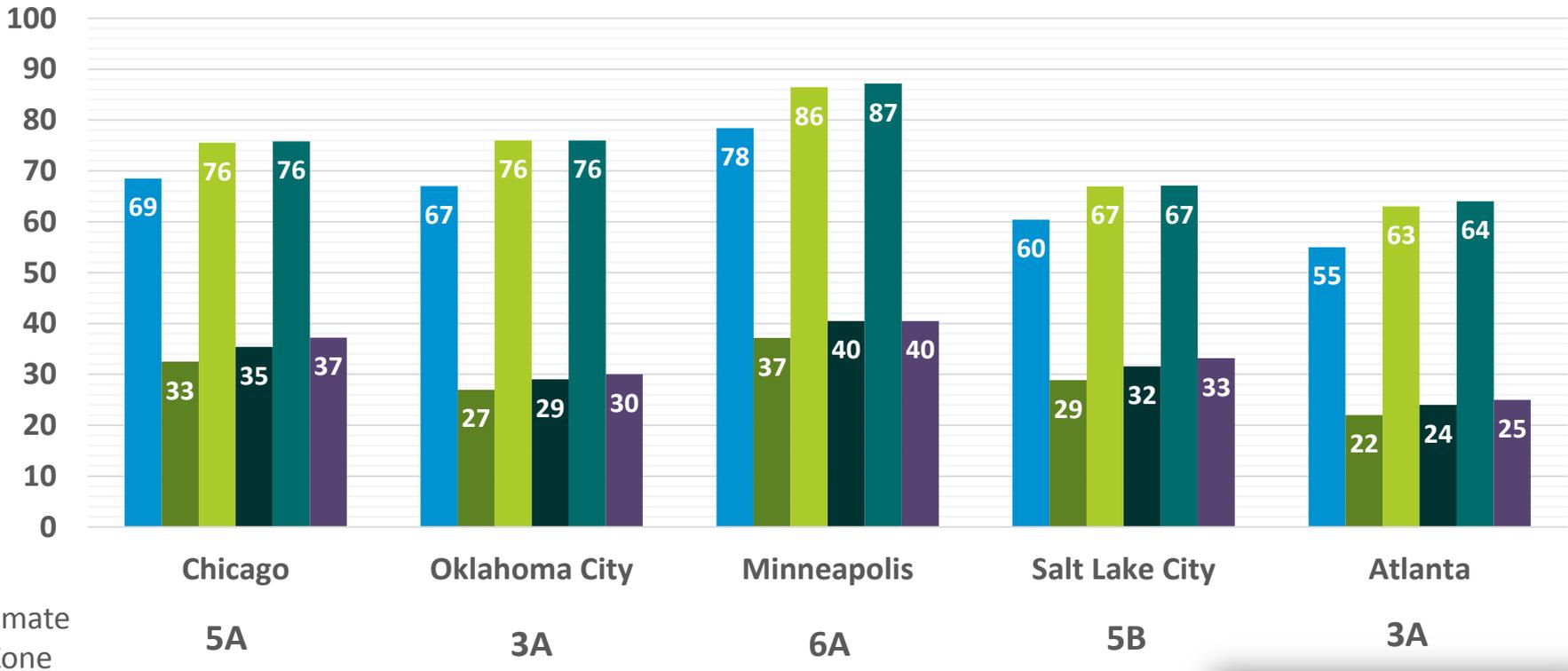
Support for Use of ACCA Manual J for Proper Furnace Sizing

- “Right-sizing of an HVAC system involves the selection of equipment and the design of the air distribution system to meet the accurate predicted heating and cooling loads of the house. ***Right-sizing the HVAC system begins with an accurate understanding of the heating and cooling loads on a space.***”¹
- “The procedures of residential HVAC design are covered in detail by a series of publications produced by the Air Conditioning Contractors of America (ACCA), which in turn references information provided by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).”²
- “The heat loss and gain values are estimated using the procedures from the ***ACCA Manual J—Residential Load Calculation (Manual J).***”³

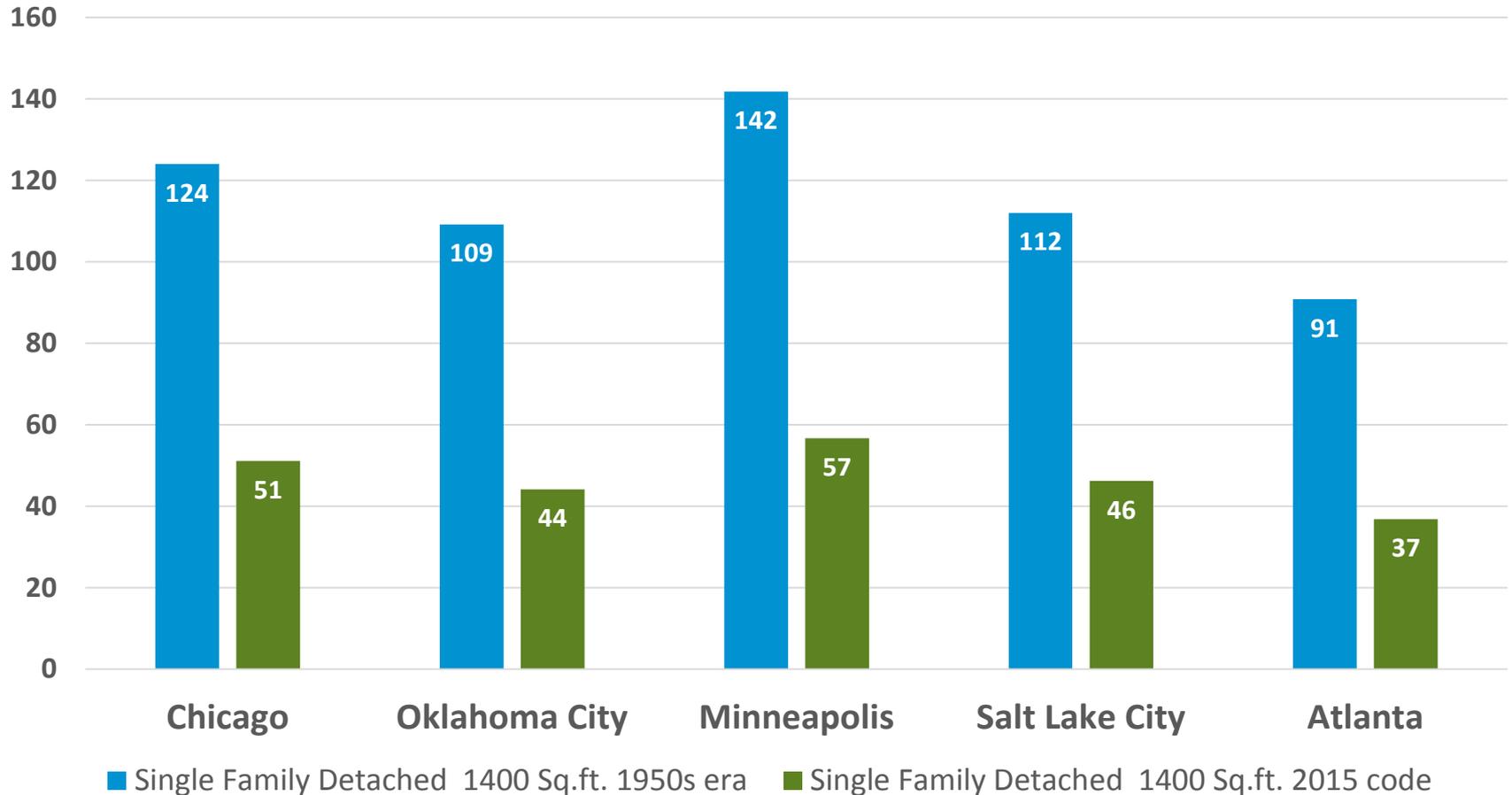
^{1,2,3} *Strategy Guideline: HVAC Equipment Sizing*, prepared by Alan Burdick for DOE Building Technologies Program, NREL, 2012, <http://www.nrel.gov/docs/fy12osti/52991.pdf>, accessed June 26, 2016. Emphasis added.

Appropriate Furnace Size for Highly Efficient and Inefficient Townhouses, based on Manual J and Manual S Assessments

- Two Story Townhome unheated basement 1950s era 1100 sq.ft
- Two Story Townhome unheated basement 2015 code 1100 sq.ft
- Two Story Townhome heated basement 1950s era 1500 sq. ft
- Two Story Townhome heated basement 2015 code 1500 sq. ft
- Three Story Townhome unheated basement 1950s era 1500 sq.ft
- Three Story Townhome unheated basement 2015 code 1500 sq. ft



Appropriate Furnace Size for Highly Efficient and Inefficient Small (1400 sqft) Single Family Detached Homes, based on Manual J and Manual S Assessments

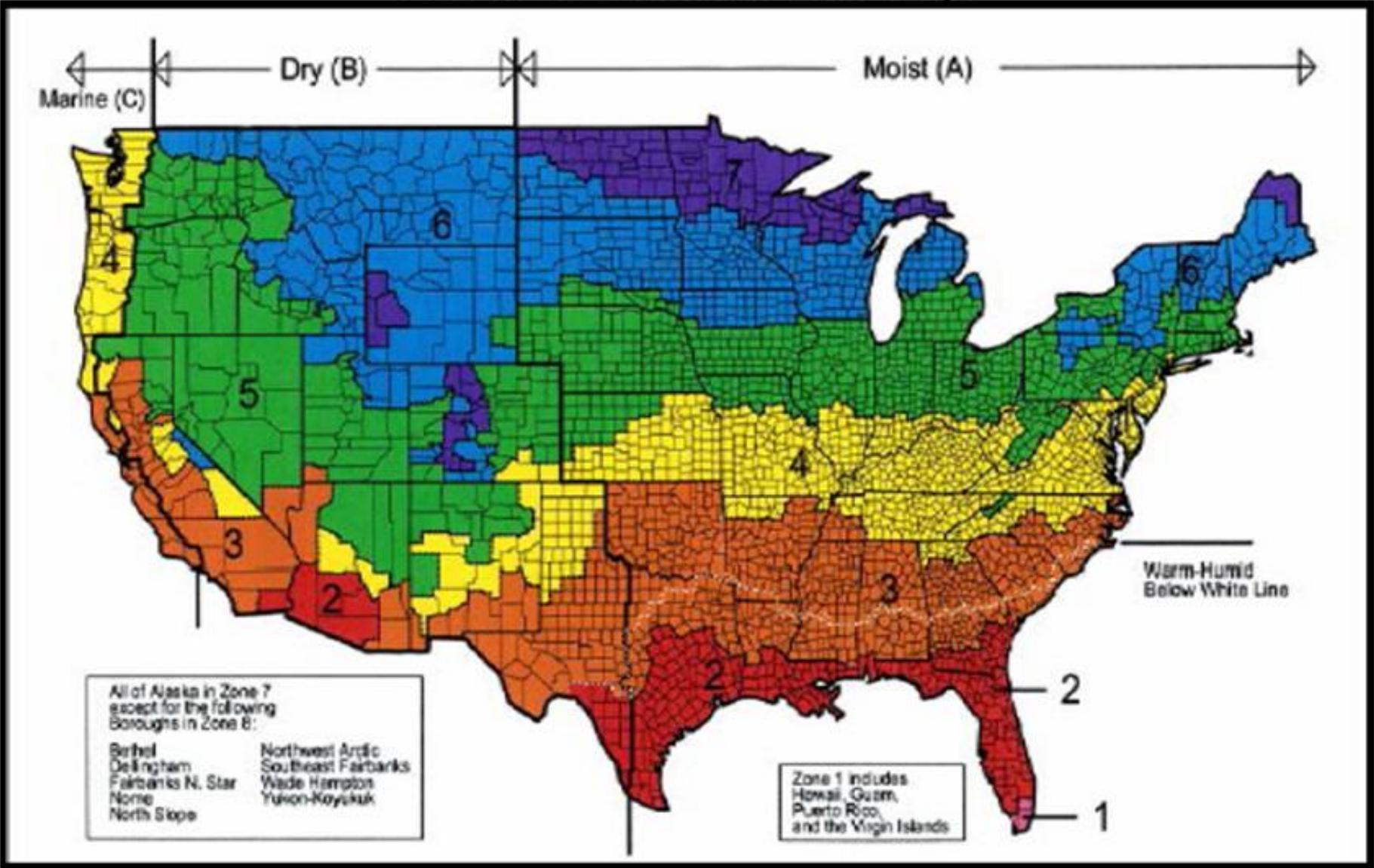


This graph indicates that in regions with the highest winter season heating needs, a 70 kBtuH furnace would not be adequate for most single family detached structures.

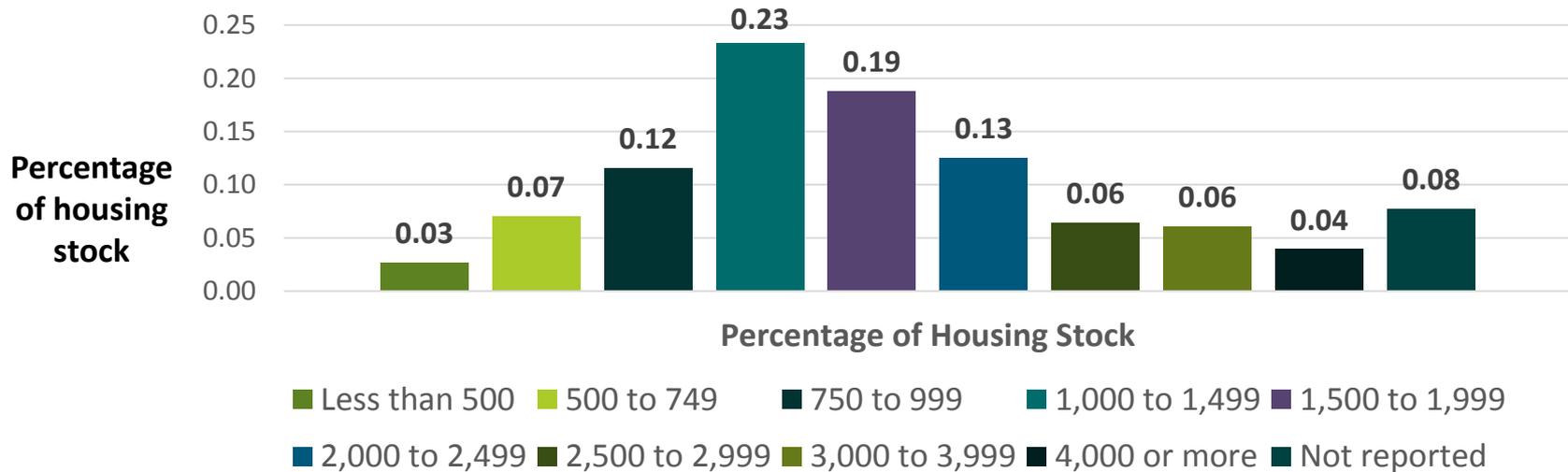
What explains the variation in results?

- **Regional Climate.**
- **Age of Housing Stock.**
 - *Older homes are less “tight” than newer homes and present a significantly higher heating load than comparably-sized homes of newer construction.*
- **Past Housing Codes.**
 - *Differences in state and local building codes over many decades influence the heat losses typical for buildings in each city.*
- **Attached v. Detached Structures.**
 - *Attached structures are insulated by adjacent units and tend to have lower heating loads than detached structures.*
 - *Note, for example, in these results, that furnace sizes for a 1400 sqft detached home are significantly higher than a 1500 sqft attached home (townhouse).*

2012 IECC Climate Zone Map



Nationwide Housing Stock by Square Footage



- *Based on the above graph, homes with square footage of 1100 square feet or less represent approximately 25 percent of total housing stock – but it would be wrong to conclude that 25 percent of the market would continue to use non-condensing furnaces.*
- *Maintaining **the option** of small non-condensing furnaces does not mean that all homeowners buying small furnaces will choose non-condensing models. In fact, in 2014, fifty percent of furnaces sold in sizes 70 kBtuH or below were condensing furnaces, continuing a long-term market trend toward condensing options.*

A 70 kBtuH threshold appears to provide a balance between total national energy savings and good outcomes for vulnerable consumers.

- *Maintaining market availability of gas furnaces of size 70 kbtuH and below is a solution that would be targeted to help the consumers who may be otherwise harmed by the rule.*
- *Residents of attached housing (row houses, townhomes) are likely at the highest risk of being unable to install a condensing furnace because of limited access to external walls.*
- ***This analysis indicates that, in most parts of the country, a 70 kBtuH furnace would be adequate to supply dependable heat to a moderately sized townhome.***
- *While approximately 25 percent of U.S. homes are sized at or below 1100 square feet, the percentage of residents in this category who would continue to purchase non-condensing furnaces can be expected to be much lower.*
- *Maintaining **the option** of small non-condensing furnaces does not mean that all homeowners buying small furnaces will choose non-condensing models. In fact, in 2014, fifty percent of furnaces sold in sizes 70 kBtuH or below were condensing furnaces, continuing a long-term market trend toward condensing options.*

Residential Space Heating Systems – Cost Comparison

Type of Heating System for Mid-sized Homes	Average Retail Cost of Equipment	Average Installation Cost	Average Total Installed Cost	Cost Premium/ (Discount) to 95% AFUE Condensing Furnace *
Non-Condensing Gas Furnace (80kBtu/h, 80% AFUE)	\$939 (a)	\$2,150 (b)	\$3,089	(\$1,476)
Condensing Gas Furnace (80kBtu/h, 92% AFUE)	\$1,319 (a)	\$2,700 (b)	\$4,019	(\$546)
Condensing Gas Furnace (80kBtu/h 95% AFUE)	\$1,865 (a)	\$2,700 (b)	\$4,565	—
Electric Furnace (For 1,500 s.f. home in SE US)	\$665 (c)	\$1,950 (c)	\$2,645	(\$1,920)
Electric Heat Pump (3 Tons)	—	—	\$6,305 (d)	N/A (e)

(a) [Furnace Compare - 2013 Furnace Price Guide](#)

(b) [ACCA, PHCC, AHRI Survey of Furnace Installation Contractors](#)

(c) [Home Advisor - How Much Does it Cost to Install a Furnace? – Average costs for Electric Furnaces](#)

(d) [Home Advisor - Home Much Do Heat Pumps Cost to Install or Replace](#) – Total System and Installation Estimate for Lennox Model

(e) Since Heat Pumps provide both heating and cooling it is not fair to compare the cost to a gas furnace that only provides heating.

* Cost differentials would be similar for comparisons of smaller sized heating systems.