

US Heat Pump Market – 2021 Update

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US Response to International Policies

Paris Climate Accord

(Requires nationally determined contributions (NDCs) for GHG emissions reduction; signed 04/2016, effective 11/2016)

- US withdrew on November 4, 2020; rejoined on January 19, 2021.

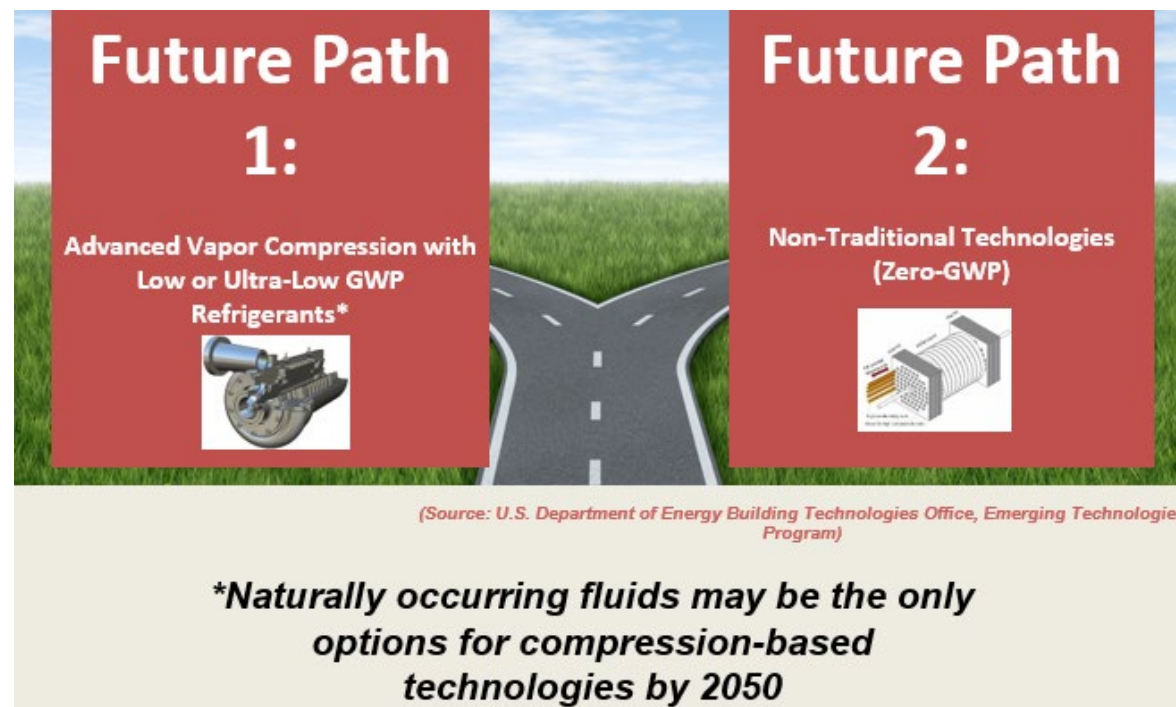
Kigali Amendment to the Montreal Protocol

- US has not ratified the amendment yet, but in April 2021 it pledged to do so.
- US has enacted American Innovation and Manufacturing (AIM) Act of 2020 that requires EPA to implement HFC phasedown plans to reach 15% of 2011-2013 levels by 2036.
 - EPA is proposing its first rule under the AIM Act of 2020 by issuing HFC allowances by October 2021

US Response to International Trends

IEA projects space cooling energy demand to grow by over 4 times in non-OECD countries and 1.5 times for OECD countries by 2050

- R&D on more efficient cooling and refrigeration technologies.
 - Proposed new IEA HPT Annex on “Comfort & Climate Box” for cooling-dominated climates,
 - Annex 53 on advanced cooling/refrigeration technology development.



Annex 53

Two possible paths

US Refrigerant Policies

EPA's Significant New Alternatives Policy (SNAP)

- EPA is not currently pursuing further delisting of HFCs through SNAP
- Some states are considering legislating to reduce the use of HFCs in new HVAC equipment
 - California, Delaware, Maryland, and New York are the only states, so far, with laws in-place
 - New Jersey and DC are working on legislation

US Goals and Objectives

Decarbonize the US power sector by 2035¹

Establish a 2030 net-zero emissions standard for new commercial buildings. The ultimate goal is to reduce the carbon footprint of the nation's buildings by 50% by 2035 and reaching net-zero emissions economy-wide by 2050.

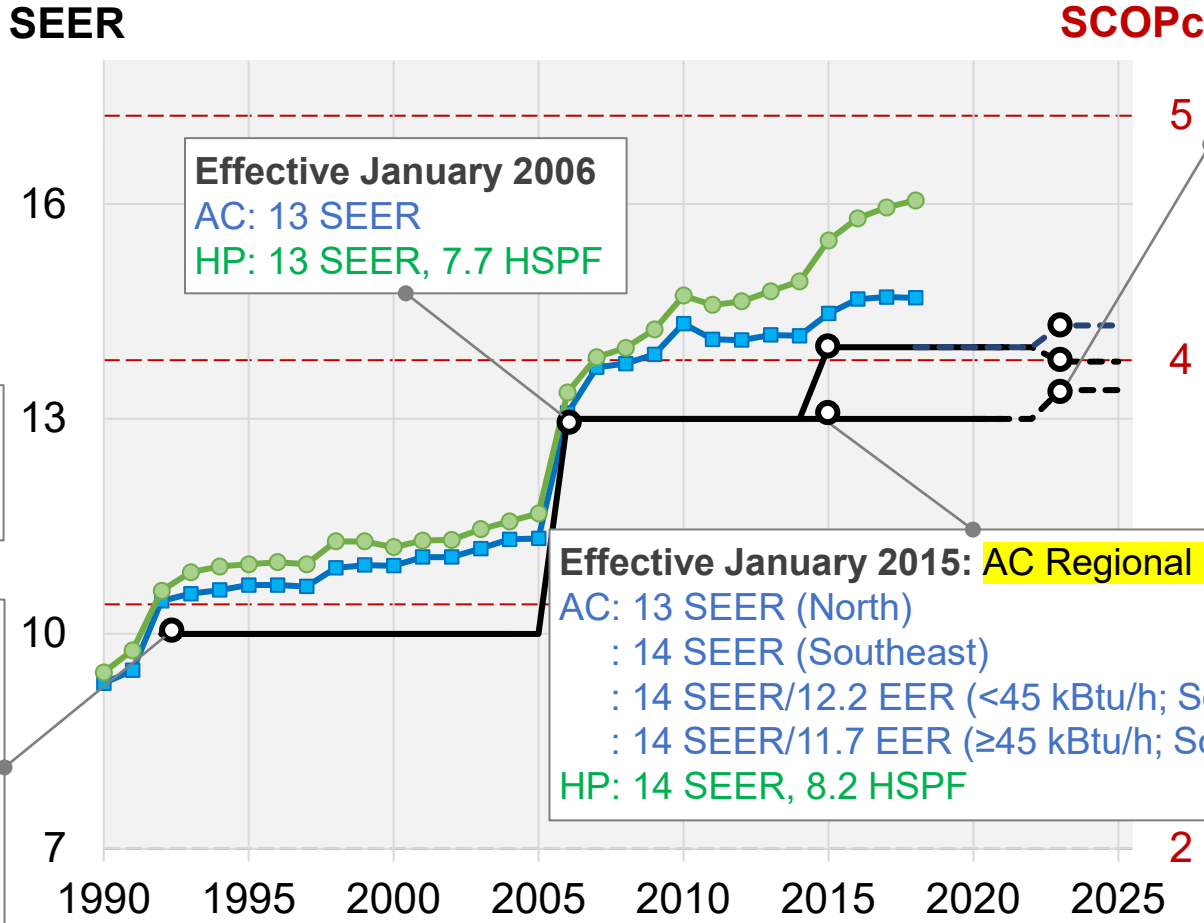
- Modernize and upgrade buildings to be affordable, resilient, accessible, energy efficient, and electrified.

DOE, GSA, and EPA Announce New Programs to Electrify Buildings, Invest \$30M in America's Workforce and Save Consumers Money²

- DOE has launched the [Initiative for Better Energy, Emissions, and Equity \(E3 Initiative\)](#), focused on advancing the research, development, and national deployment of innovating clean and efficient building heating and cooling systems, putting \$10M toward accelerating the research and adoption of heat pump technologies through:
 - Nationwide **Advanced Water Heating Deployment Initiative** to increase market adoption of **high-efficiency, grid-connected Heat Pump Water Heaters** in residential and commercial buildings,
 - **Cold Climate Heat Pump Technology Challenge** to accelerate performance of **cold climate heat pump technologies**,
 - New **collaborative research, development and deployment (RD&D)** efforts partnering National Laboratories and manufacturers to accelerate the development of **low to no-GWP refrigerants**.
- **New ENERGY STAR standards** have been finalized for central AC/HP and residential water heater to advance heat pump technology.³



Minimum Efficiency Requirements & Shipment Weighted SEER for Split-System ACs and HPs



1979
First appearance of SEER for AC

1992:
Min. efficiency requirements established for AC, HP and many other consumer product classes

Effective January 1992
AC: 10 SEER
HP: 10 SEER, 6.8 HSPF

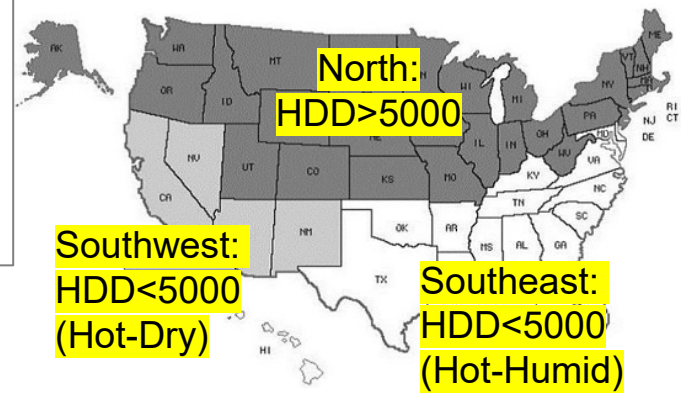
Effective January 2006
AC: 13 SEER
HP: 13 SEER, 7.7 HSPF

Effective January 2015: AC Regional minimums
AC: 13 SEER (North)
: 14 SEER (Southeast)
: 14 SEER/12.2 EER (<45 kBtu/h; Southwest)
: 14 SEER/11.7 EER (≥45 kBtu/h; Southwest)
HP: 14 SEER, 8.2 HSPF

Effective January 2023¹: New rating methods²
AC: 13.4 SEER2 (North)
: 14.3 SEER2 (<45 kBtu/h; Southeast, Southwest)
: 13.8 SEER2 (≥45 kBtu/h; Southeast, Southwest)
HP: 14.3 SEER2, 7.5 HSPF2

¹This transition is still under discussion, and it is possible the transition could extend beyond 2025.

²In 2017, as part of efficiency standards proceeding, DOE announced changes to the rating methods and associated efficiency descriptors for central AC. (Source: [85 CFR 20218](#))

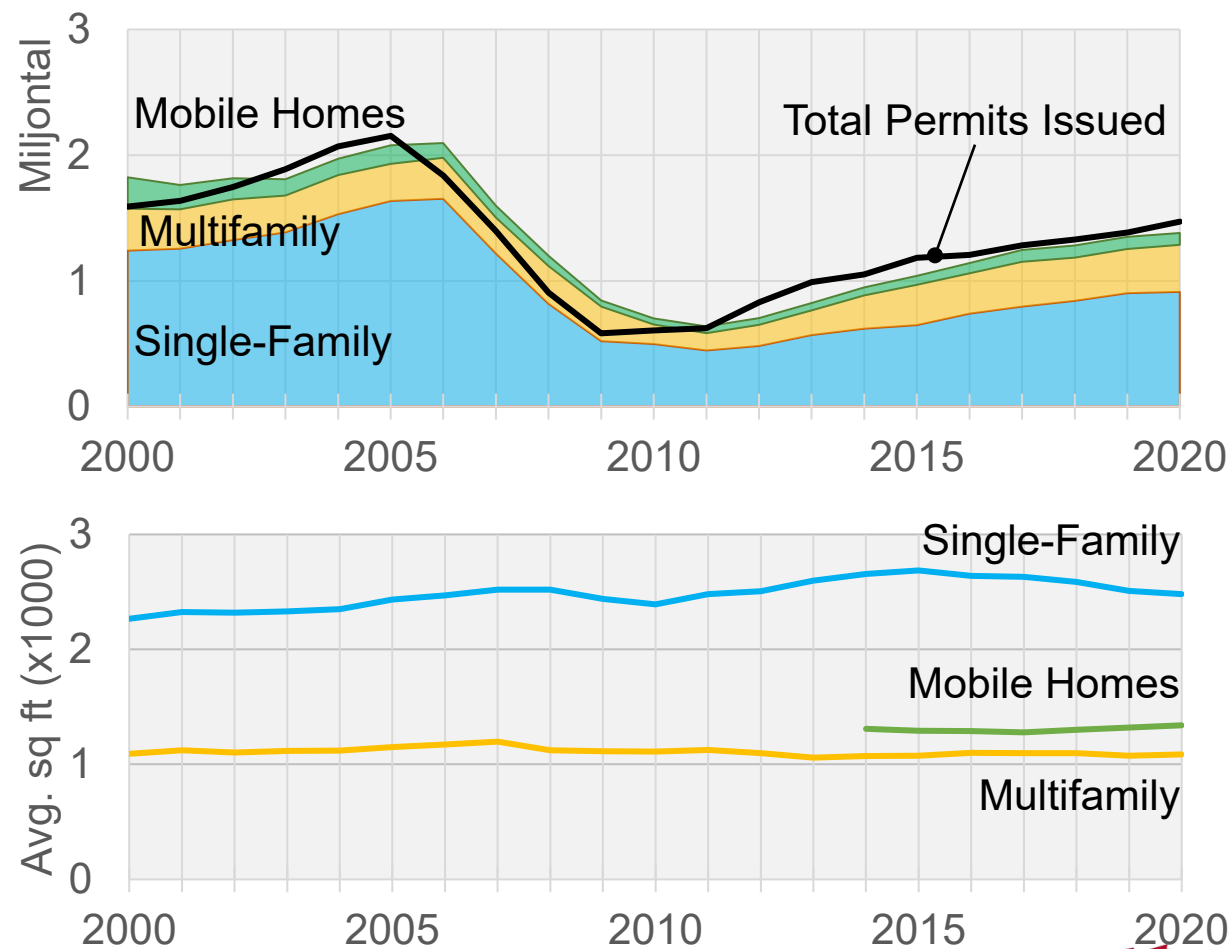


Sources: [10 CFR 430.32 \(Current\)](#), [10 CFR 430.32 \(2013\)](#), AHRI



Annual New Home Construction

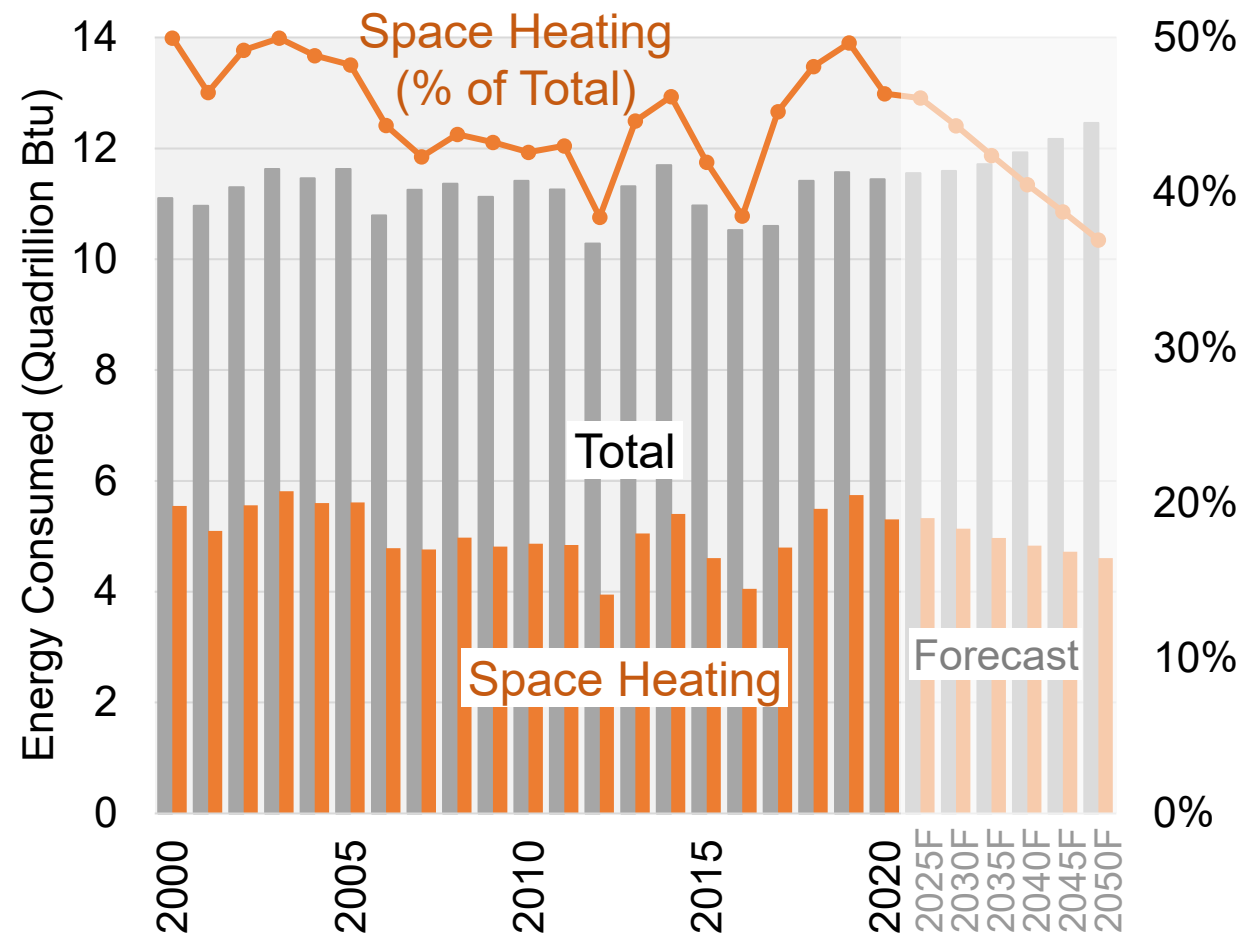
- New SF and MF housing permits steadily increasing since 2011
- New Mobile home and MF home sizes relatively constant since 2014
- New SF home sizes trending down slightly since 2015



Source: [census.gov](https://www.census.gov)

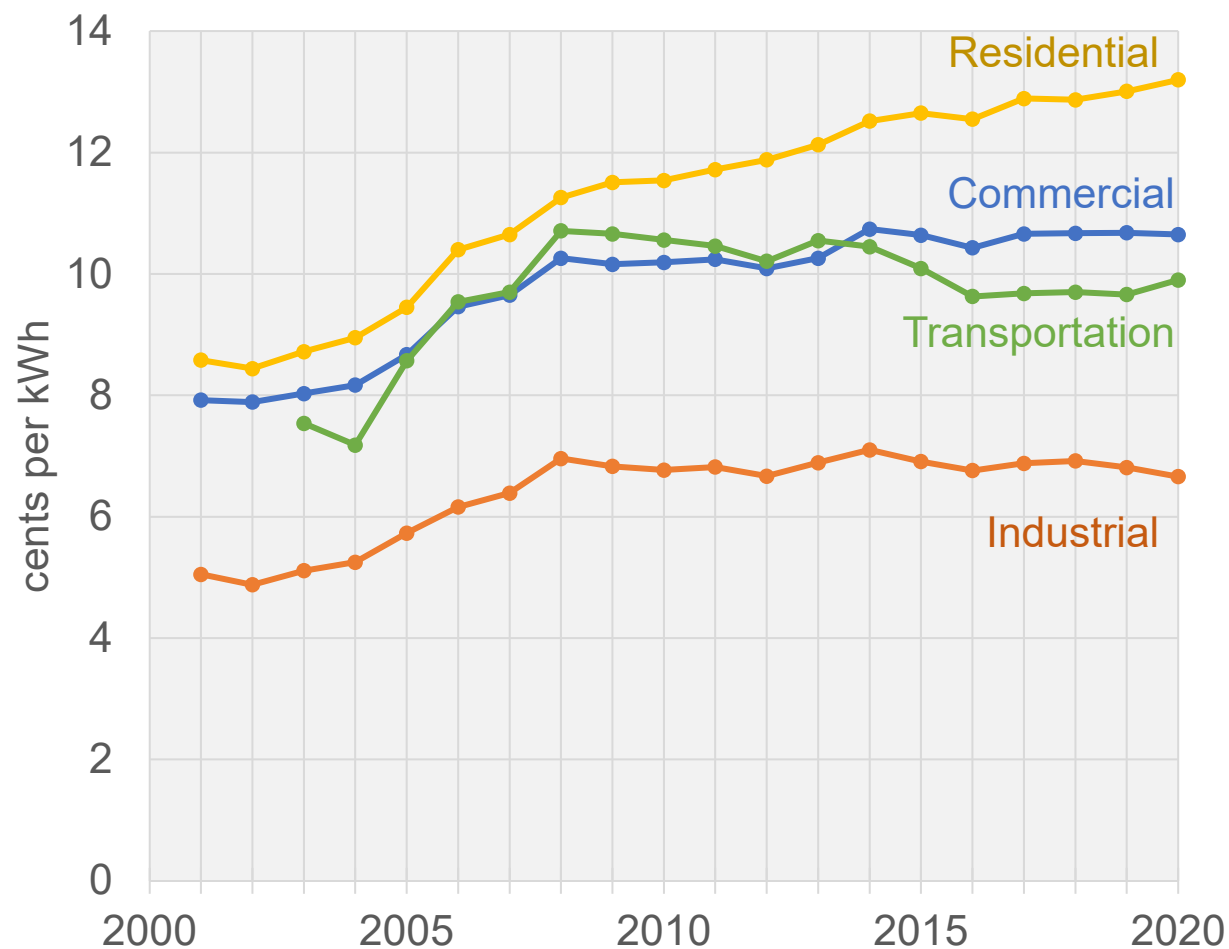
Residential Sector Space Heating Energy Use

- Total residential sector site energy consumption relatively constant from 2000-2020
 - ~10.5 to 11.5 Quads (~11.1 to 12.1 EJ)
 - Forecast to increase by ~10% by 2050
- SH fraction accounted for between 40-50% of total 2000-2020
 - Forecast to drop to ~37% by 2050



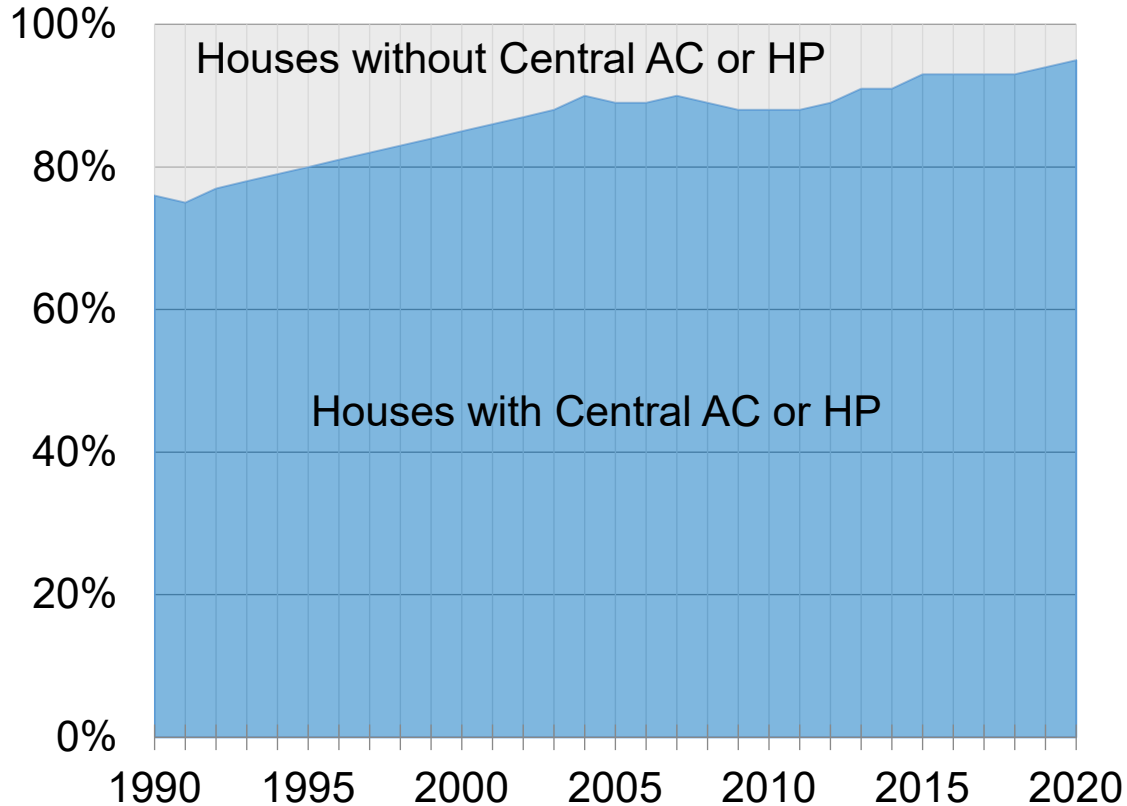
Electricity Price

- Rising electricity price for residential building customers compared to other sectors
 - A barrier for the penetration of HP in residential sector
 - Drives R&D to improve the performance and efficiency

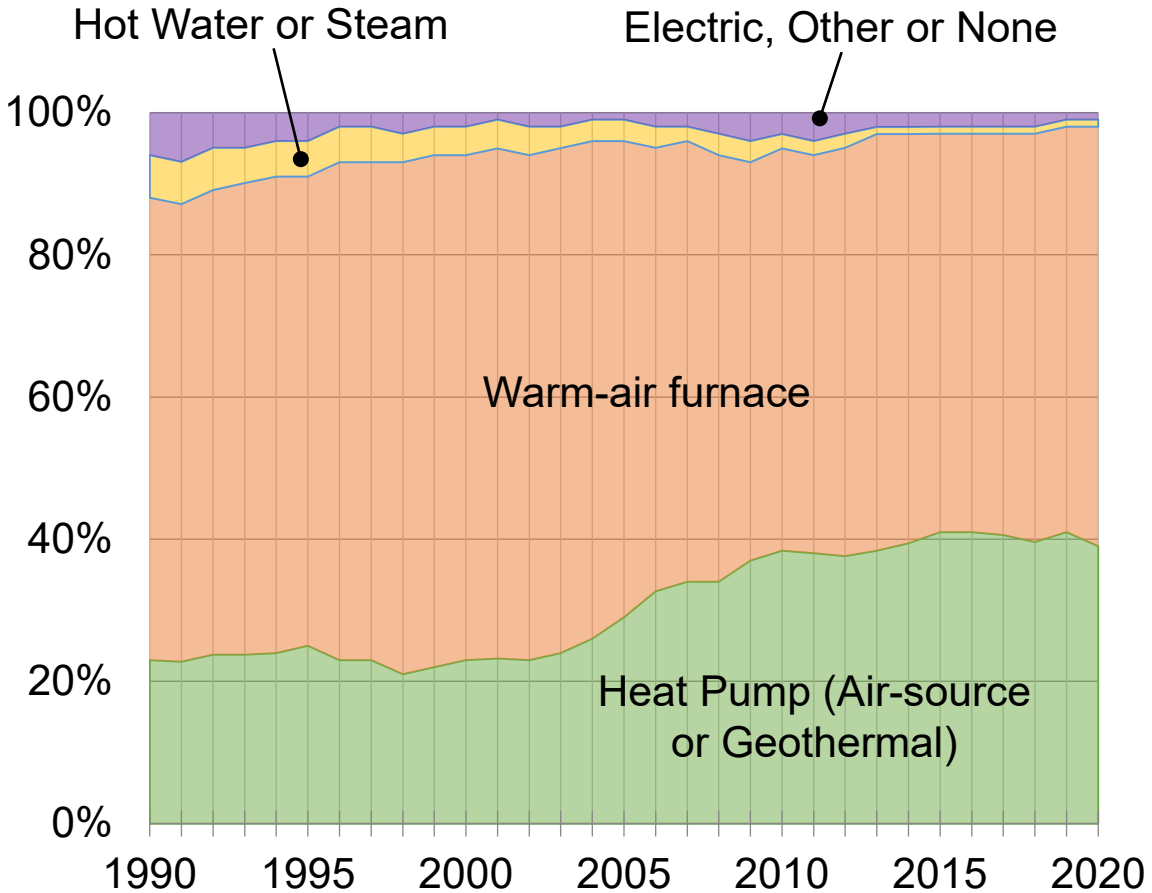


Source: eia.gov

HVAC Systems in Homes



Single-Family Homes With and Without Central AC or HP

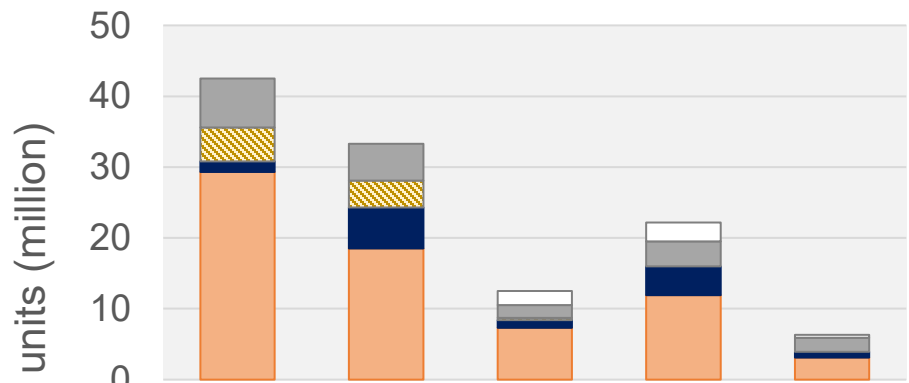


Type of Heating System Used in New Single-Family Houses Completed

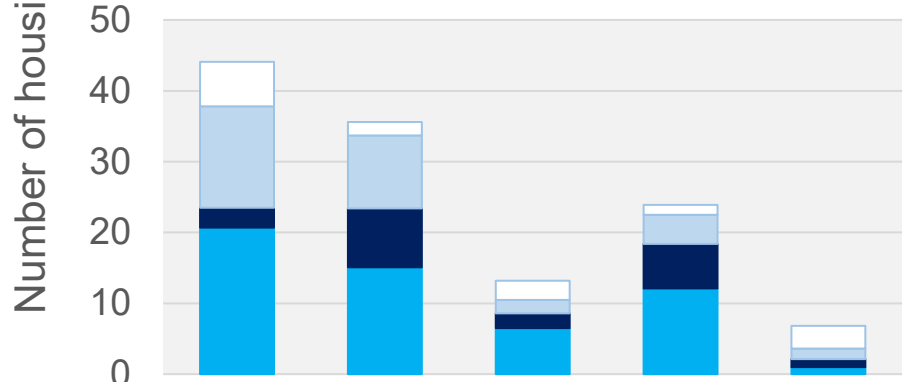
Source: [census.gov](https://www.census.gov)



HVAC Systems by Climate Region

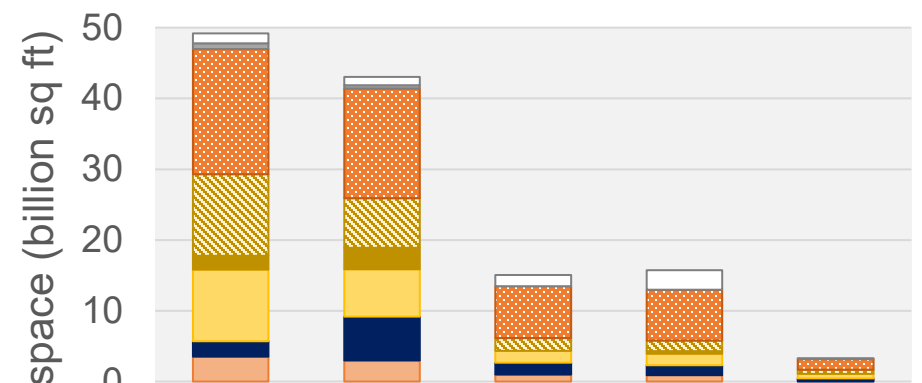


- No heating
- Other
- ▨ Steam/HW
- HP
- Furnace

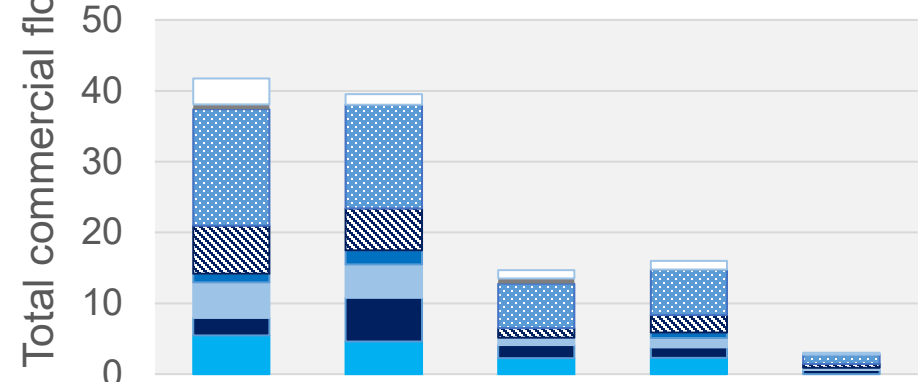


- No Cooling
- Individ AC
- Central HP
- Central AC

Residential Buildings

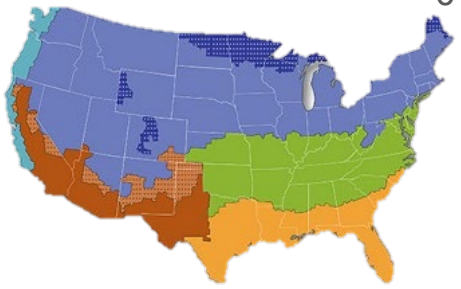


- No Heating
- Other
- Pkg Htg
- ▨ Boilers
- District Heat
- Individ Space Ht
- HP
- Furnaces



- No Cooling
- Other
- ▨ Pkg AC
- ▨ Central Chillers
- District CHW
- Individ AC
- HP
- Central AC

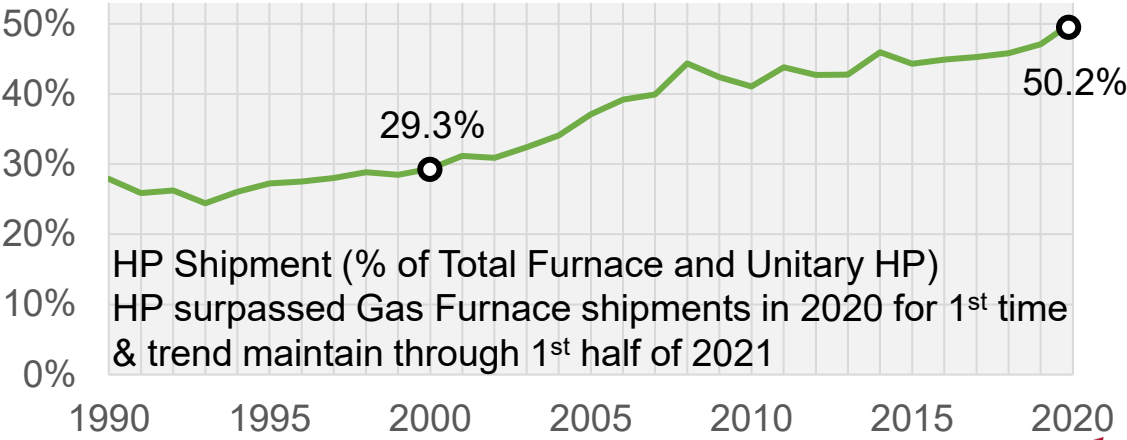
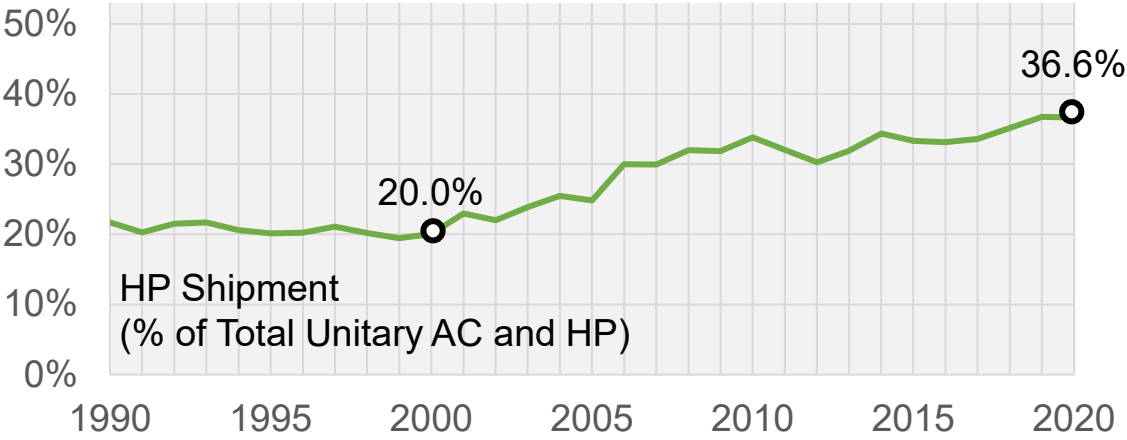
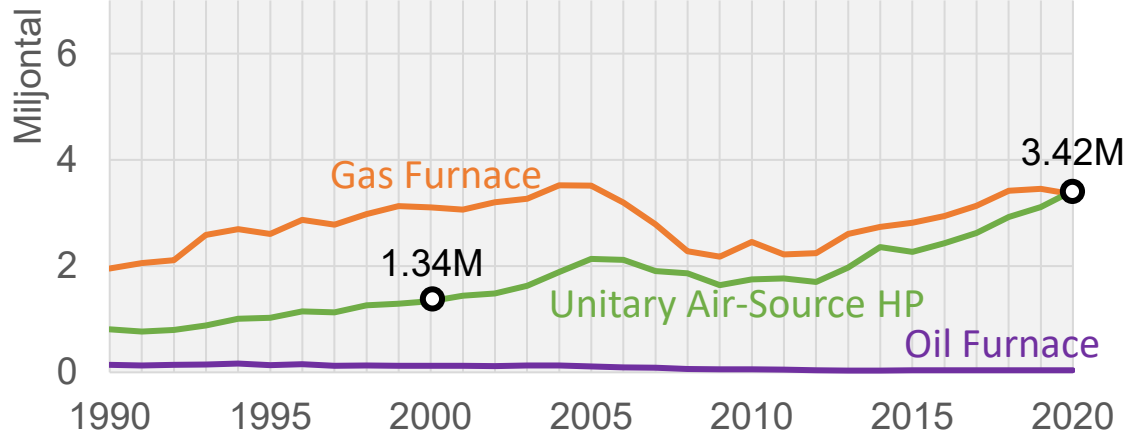
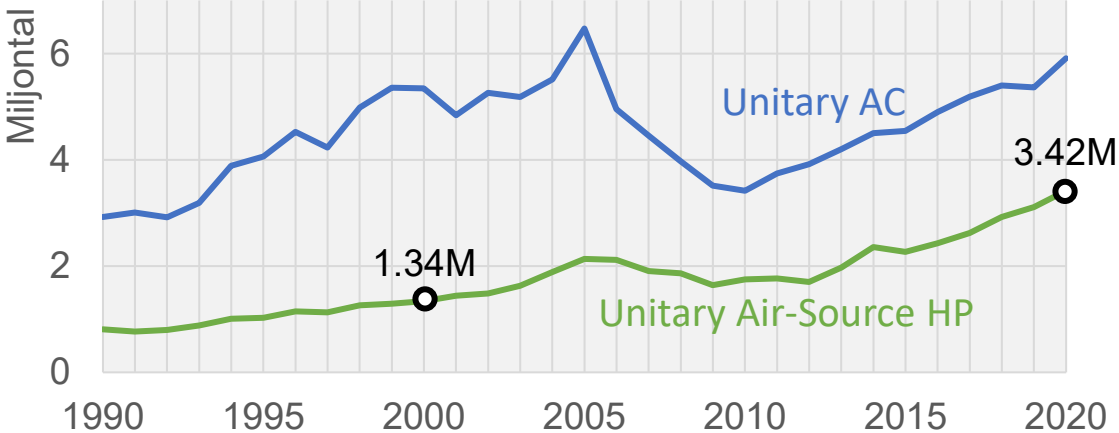
Commercial Buildings



Sources: [2015 RECS](#), [2012 CBECS](#)



Annual Shipments (Unitary AC, HP, and Furnaces)

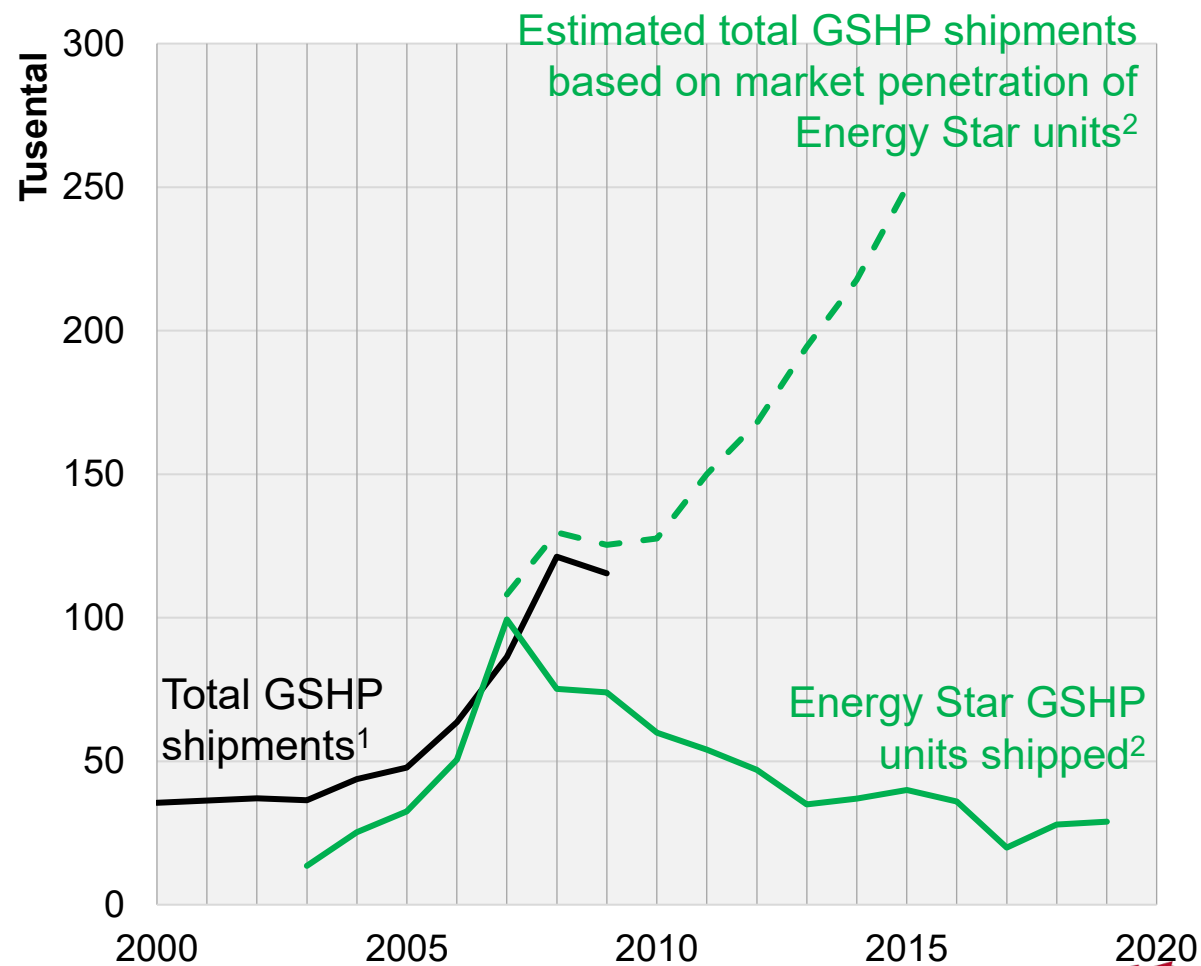


Source: AHRI



Shipments (GSHP)

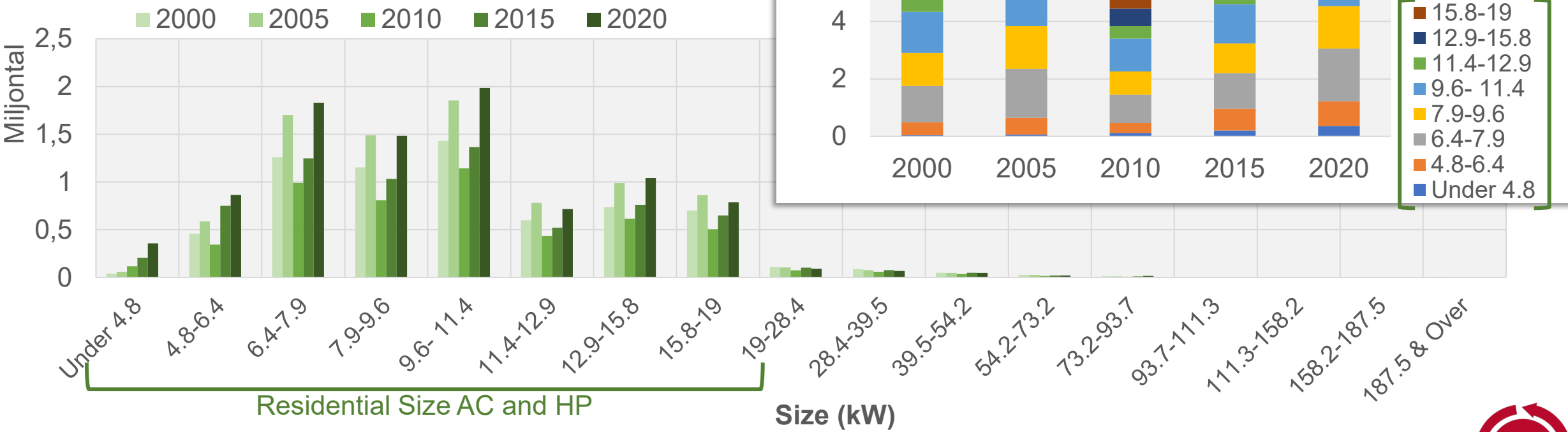
- Steady increase since 2003, partly due to a 30% federal tax credit for units placed in service after 2008 through 2016
 - Tax credit were reinstated in 2019 and will be available until 2023.³



Sources: ¹eia.gov, ²[energystar](http://energystar.gov), ³energystar.gov

Shipments by Equipment Size (Central AC and HP)

- Residential size AC and HP (19 kW or less) accounted for 95-97% of total shipment in the past 20 years



Source: [AHRF](http://www.ahrifoundation.org)



Key Research Challenges

Need for improving:

- efficiency and capacity of heat pumps for cold climates
- efficiency of HPs and ACs for cooling-load-dominated climates

Need for reducing GWP of refrigerants used in heat pump equipment (space conditioning and water heating)

Decarbonization of the US power grid by 2035

Electrification of building sector

High installed cost and lack of sustained performance/reliability of high-efficiency systems

Solutions for problematic heat pump installations such as space and electrical panel constraints (particularly for retrofit & renovation applications)

Current R&D Focus

New Heat Pumping Technologies	Heat Exchanger Technologies	Non-vapor Compression Technologies (long term focus)
<p>Regional solutions for improving HP performance, cold-climate and hot climates</p> <p>Integrated HP technologies for optimizing whole-building energy use</p> <p>Electric HPWH with low-GWP</p> <p>Cold climate RTUs with low-GWP</p>	<p>Advanced heat exchanger manufacturing techniques</p> <p>Next-generation membrane technologies for cost-effective integration with conventional technologies to reduce energy for dehumidification</p>	<p>Nontraditional cooling/refrigeration cycles</p> <p>Non-vapor compression HPWH</p> <p>Non-vapor compression supplemental heat for low temperature operation</p>

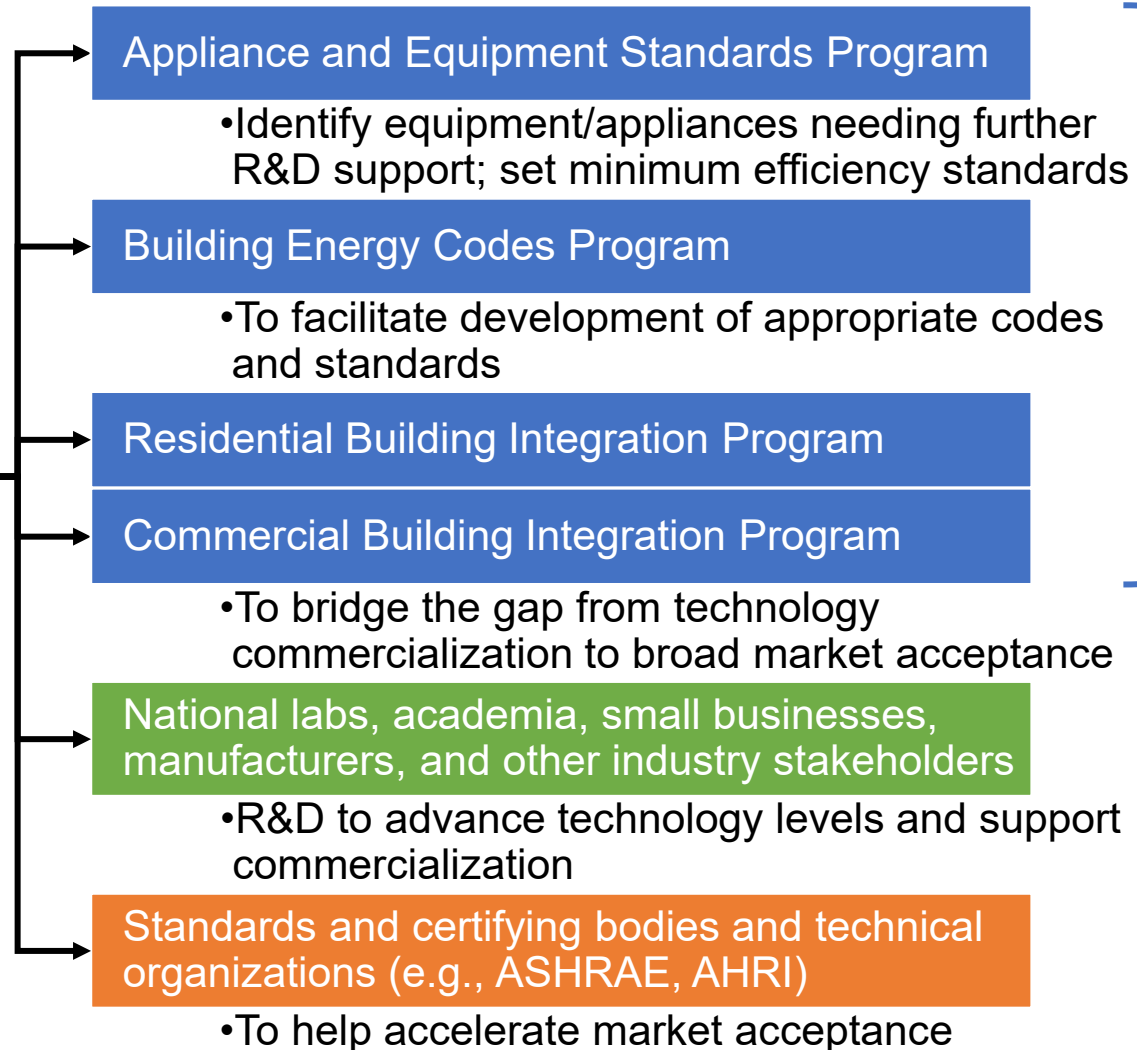
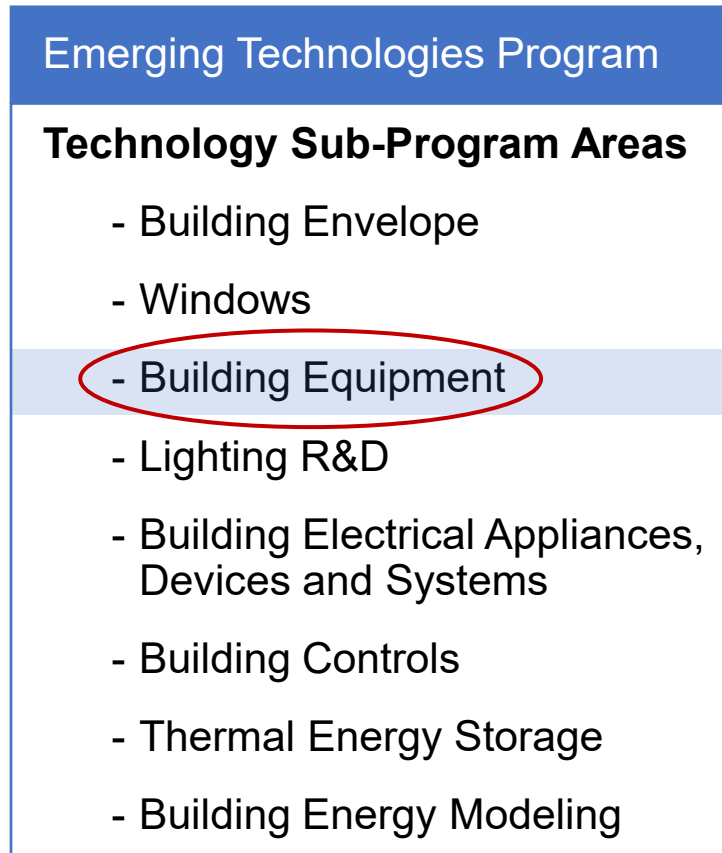
Reducing the cost of premium efficiency technologies

Technology Type	R&D Target	
	COP	Installed Cost Premium per unit (2020\$/ (kBtu/h))
Non-vapor compression Air Conditioning Systems	COP _{cooling} ≥ 12.3	Residential: ≤ 16.8, Commercial ≤ 15.4

Source: energy.gov



R&D Partners



Partnering Programs within US Department of Energy Building Technology Office

Summary and Outlook

- The US HP market has shown steady growth since 2010.
 - Growing at faster pace relative to competing space heating technologies.
- The use of ASHPs in cold climates is becoming more feasible through promising R&D and market developments.
- To cope with environmental concerns and rapid increase of cooling/refrigeration demand, current R&D emphases are primarily on advancing development of:
 - More efficient cooling/refrigeration systems including nontraditional cycles,
 - Alternative or advanced compression cycle technologies,
 - Lower GWP refrigerant alternatives.
- Governmental actions, along with public and private-sector incentive programs, promote deploying more efficient HP systems.
- The future of HP technologies will be highly influenced by the stringent minimum standards, R&D, tax credits and incentive programs.

Questions

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