



jump into STEM

It's Electric: Electrifying U.S. Buildings

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Motivation

jump into
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Source: www.bu.edu/sph/files/2022/07/power-grid-3.png

Motivation



Source: [www.thespruce.com/thmb/dPX8LR8wM_6UJidSPxrcSmwqP08=/3869x2574/filters:fill\(auto,1\)/hot-water-heater-and-furnace-in-basement-86517326-580e190f5f9b58564c5b36bf.jpg](http://www.thespruce.com/thmb/dPX8LR8wM_6UJidSPxrcSmwqP08=/3869x2574/filters:fill(auto,1)/hot-water-heater-and-furnace-in-basement-86517326-580e190f5f9b58564c5b36bf.jpg)

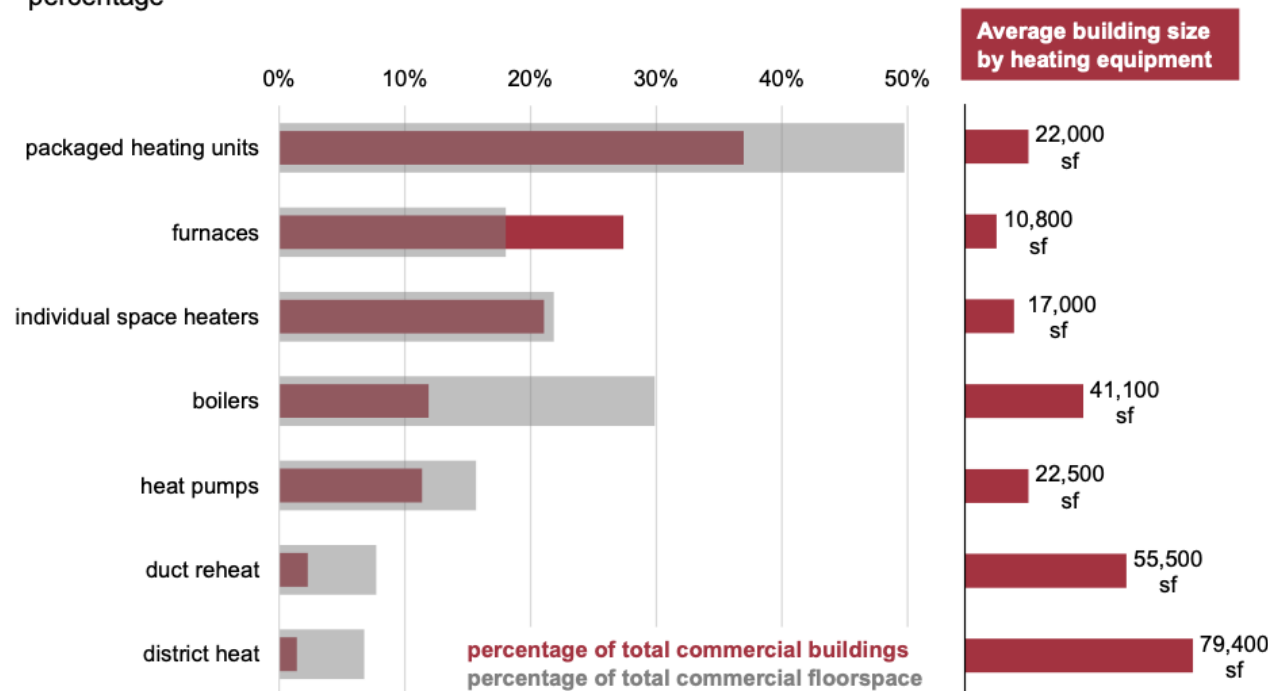


- Buildings directly burn fossil fuels on-site most commonly to provide:
 - Space heating
 - Water heating
 - Other appliances

Source: [www.thespruce.com/thmb/dPX8LR8wM_6UJidSPxrcSmwqP08=/3869x2574/filters:fill\(auto,1\)/hot-water-heater-and-furnace-in-basement-86517326-580e190f5f9b58564c5b36bf.jpg](http://www.thespruce.com/thmb/dPX8LR8wM_6UJidSPxrcSmwqP08=/3869x2574/filters:fill(auto,1)/hot-water-heater-and-furnace-in-basement-86517326-580e190f5f9b58564c5b36bf.jpg)

Motivation

Total commercial buildings and floorspace by heating equipment, 2018
percentage



Note: More than one type of heating equipment may apply.

- Over 50% of commercial buildings use natural gas, propane, or fuel oil as primary space heating source
- Just over 10% currently use heat pumps

Source:
www.eia.gov/consumption/commercial/data/2018/pdf/CBECS_2018_Building_Characteristics_Flipbook.pdf

Motivation

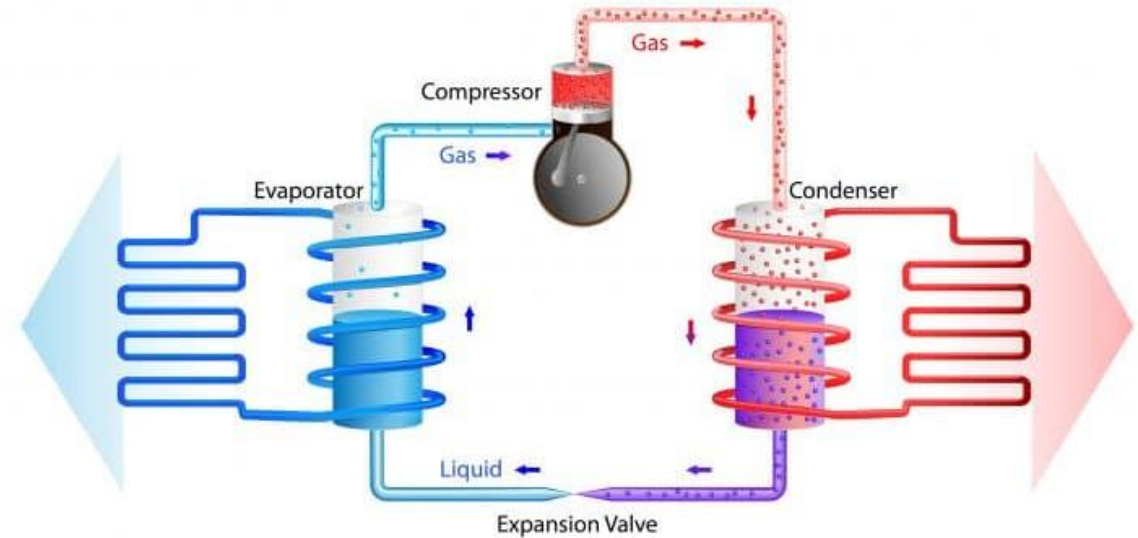
Buildings will play an integral role in achieving decarbonization objectives, and eliminating the burning of fossil fuels, also known as electrification, will be a crucial step.

What Can We Do?

Such a substantial transformation across the residential and commercial building sectors will require innovative solutions, as well as widespread adoption of both new and existing technologies.

Heat Pumps

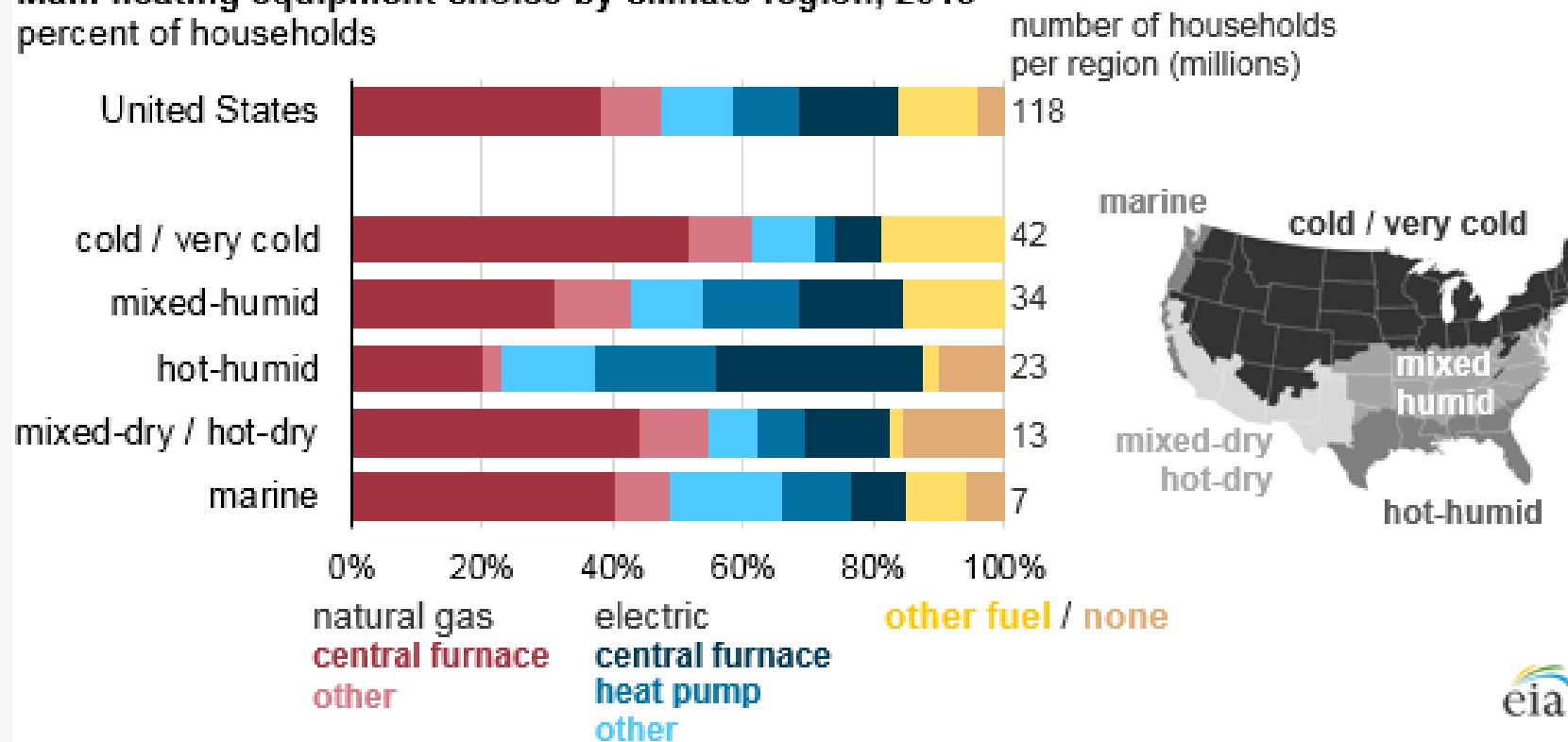
- Many types
 - Air-source
 - Water-source
 - Ground-source
- Can provide
 - Space heating
 - Water heating



Source: <https://www.ghginsight.com/wp-content/uploads/2020/09/teplonasos2-768x529.jpg>

Heat Pumps: Space Heating

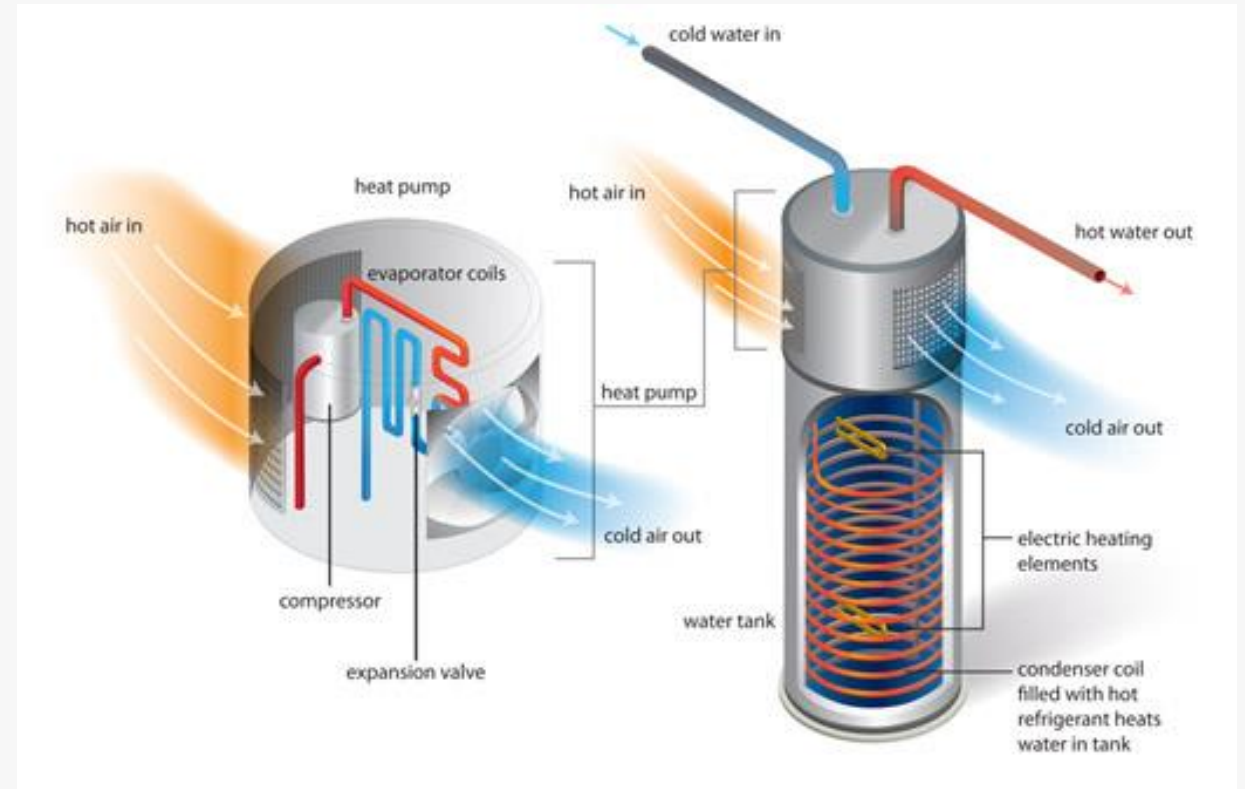
Main heating equipment choice by climate region, 2015
percent of households



Source:
www.eia.gov/todayinenergy/images/2017.04.06/main.png

Heat Pumps: Water Heating

- Cooling benefits as an operational byproduct
- Residential offerings more prevalent than commercial
- First costs are still a market adoption barrier



Source: www.energystar.gov/sites/default/files/assets/images/HeatPump_Works.jpg

Infrastructure Implications



- Estimated that nearly half of homes in the U.S. have 100-amp electrical service
- Upgrading to 200-amp to support electrification averages \$1,300-\$2,500
 - Other constraints could easier increase costs
 - PV, batteries, and EVs also add complexity and cost

Source: integraelectrical.co/wp-content/uploads/2020/04/f228d216-018b-44a8-ba70-34fad1869e62_cdv_photo_001-cjlw41bkegg.jpg

The Challenge

This topic challenges student teams to develop an innovative solution that will address electrification in buildings. Students can focus on any aspect related to this transition away from directly burning fossil fuels on-site. Solutions can be considered at the individual building and multi-building scale.

Additional Resources



Electrification Resources

- <https://www.nrel.gov/analysis/electrification-futures.html>

Policy Resources

- <https://www.whitehouse.gov/briefing-room/statements-releases/2021/12/08/fact-sheet-president-biden-signs-executive-order-catalyzing-americas-clean-energy-economy-through-federal-sustainability/>

Heat Pump Resources

- <https://www.energy.gov/energysaver/heat-pump-systems>
- <https://www.energy.gov/energysaver/air-source-heat-pumps>

Additional Resources



Energy Resources

- <https://www.eia.gov>

Energy Justice Resources

- <https://iejusa.org>
- <https://www.energy.gov/promoting-energy-justice>

Market Transformation Resources

- <https://www.energy.gov/eere/fuelcells/market-transformation>
- <https://guidehouse.com/insights/energy/2019/what-makes-market-transformation-successful>
- <https://www.aceee.org/research-report/u1715>

Thank You

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