

Addressing the barriers to heating electrification in the US

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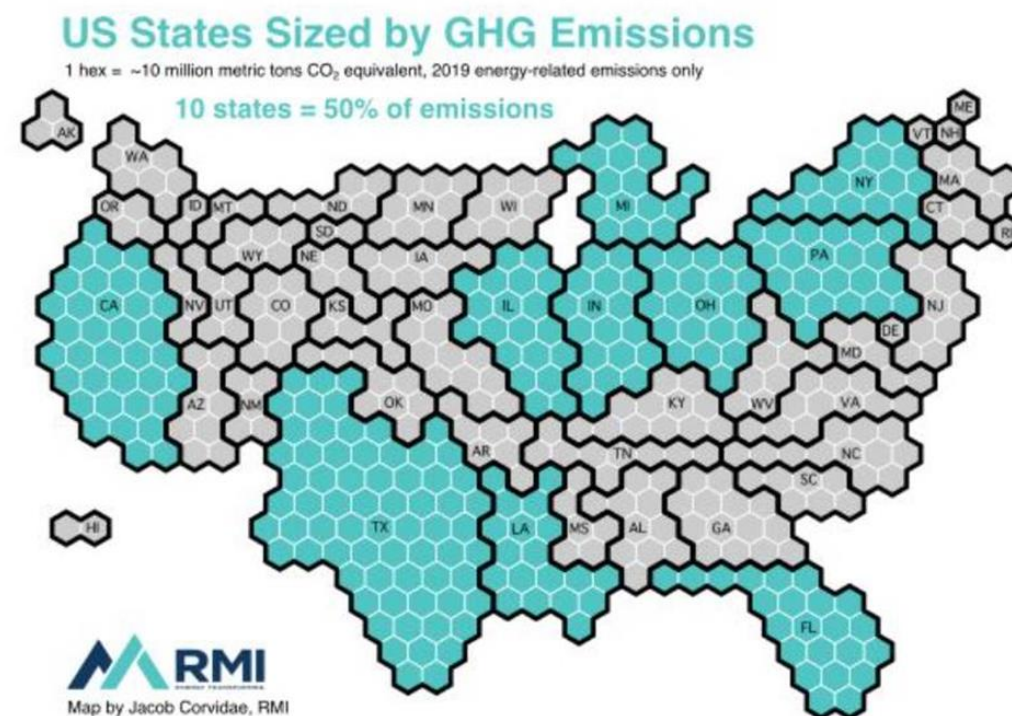
Strata-G, LLC

Objectives

- Assess barriers to heating electrification in areas where the highest greenhouse gas emissions occur
 - seven states with the highest emissions occur in the northeast and west coast
- Meet with organizations in high emission states to determine their most difficult barriers

Organizations

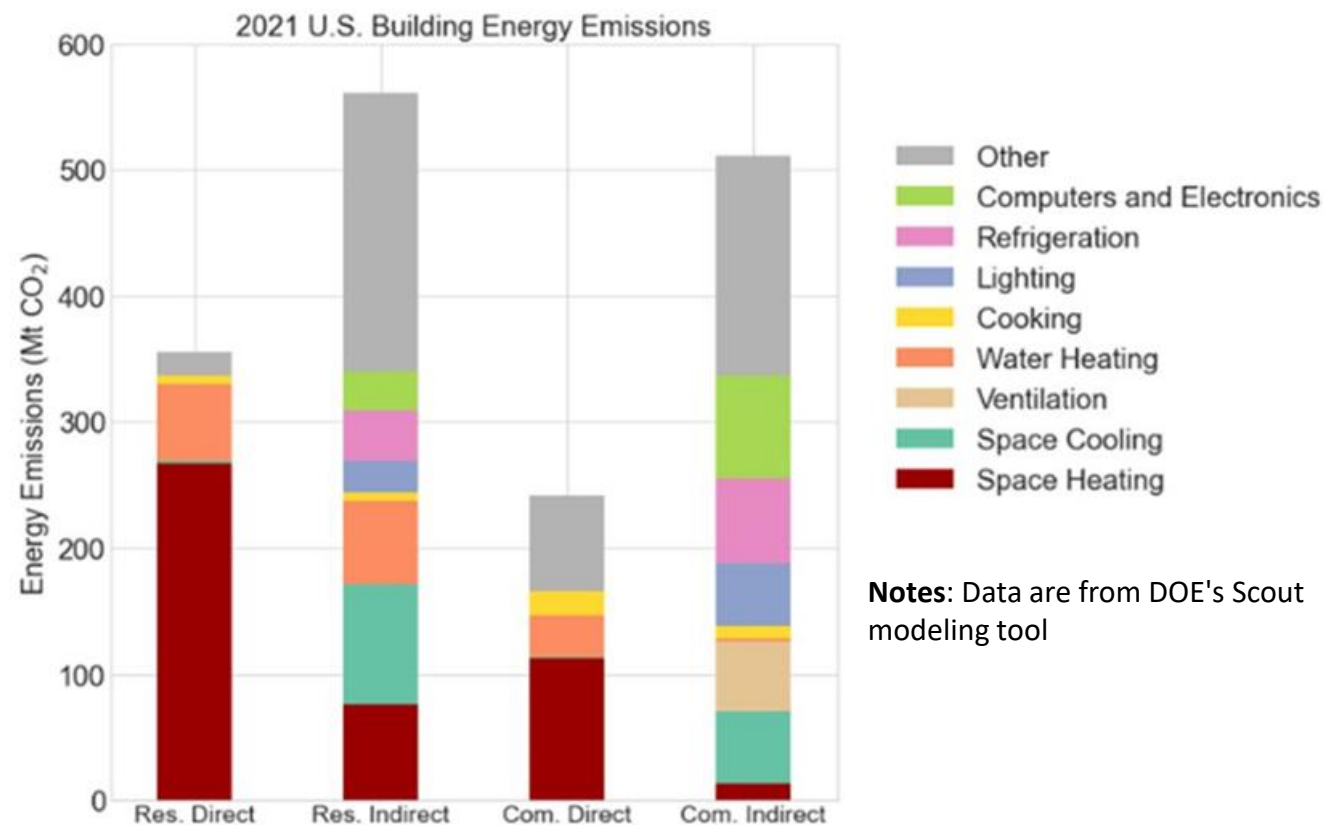
- California Energy Commission (CEC)
- Northwest Energy Efficiency Alliance (NEEA)
- Northeast Energy Efficiency Partnerships (NEEP)
- New York State Energy Research (NYSERDA)
- Electric Power Research Institute (EPRI)
- Air-Conditioning, Heating, and Refrigeration Institute (AHRI)



Credit to Jacob Corvidae Rocky Mountain Institute

Observations:

- Space heating is the largest contributor to *direct* emissions in buildings
 - residential (75%)
 - commercial (45%)
- Water heating is the next largest contributor
 - residential (17%)
 - commercial (12%)
- Natural gas furnaces and water heaters are the main contributors, accounting for 78% of *direct* emissions in buildings
 - furnaces (63%)
 - water heaters (15%)
- Space and water heating electrification is critical to achieve significant emission reductions



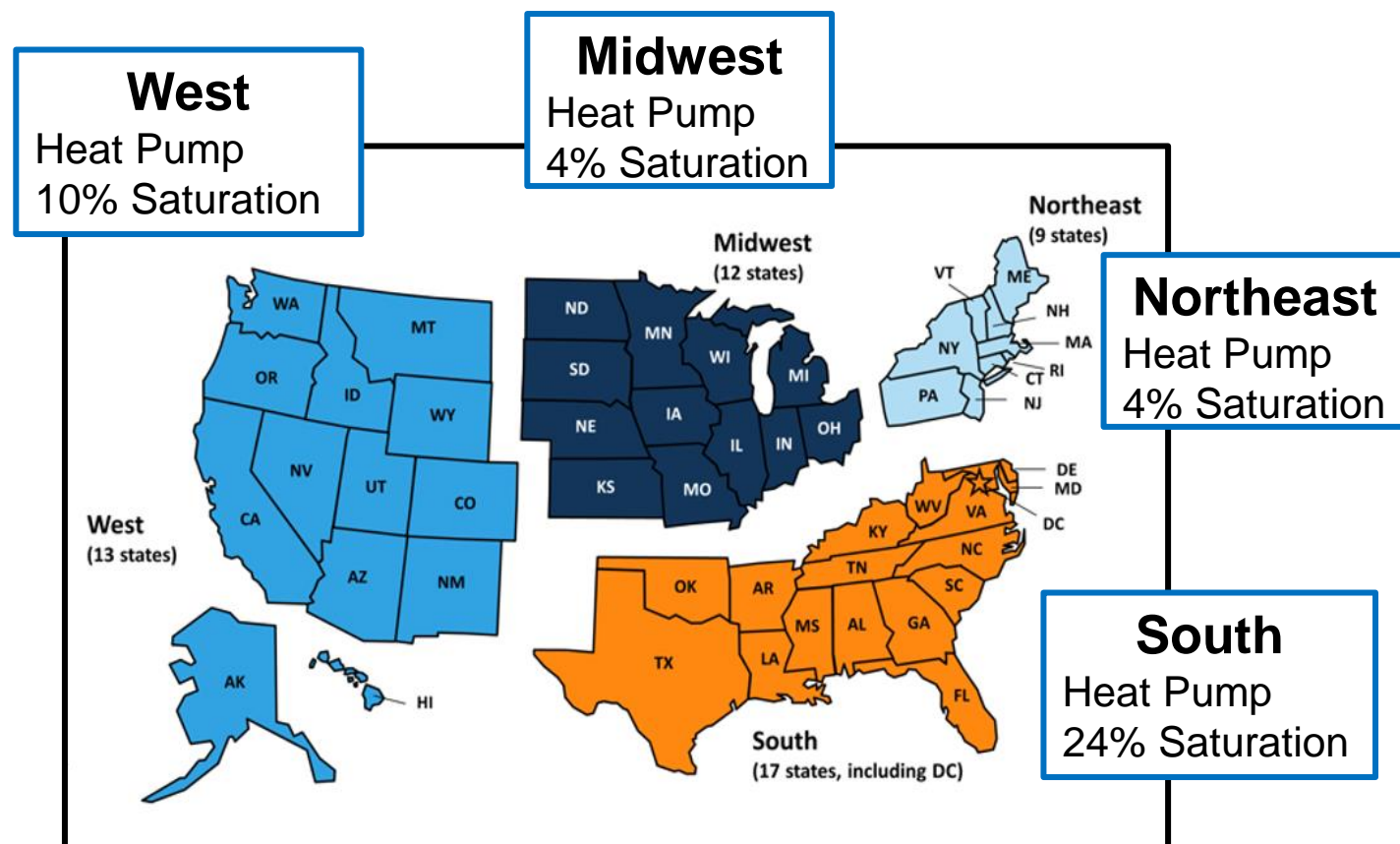


Heat Pump/Heat Pump Water Heater Market



Observations:

- Saturation levels of heat pumps are lowest in the Northeast and Midwest where natural gas is prevalent
 - heat pumps (4%)
 - *high priority is replacement of natural gas furnaces with cold climate heat pumps*
- For West region, heat pumps only comprise 10% of the market
- All these regions also include the most highly populated cities
- Heat pump water heaters presently account for 2% of market share
 - *increased market penetration would significantly reduce emissions*



<https://www.eia.gov/consumption/residential/data/2015/>



Main Barriers – Heat Pumps

Installation cost

- Average installed cost of heat pumps in northeast is \$12,000 vs \$8,250 for gas furnace with electric A/C
 - reduced capacity at low temps requires larger units to maintain temperature and reduce electric resistance
 - variable-speed units are necessary to reduce capacity in the summer to prevent frequent cycling
 - some contractors charge a premium to install a heat pump versus natural gas
 - unfamiliar with HP technology
 - perceived call back issues due to consumer unfamiliarity with cooler register temperatures versus natural gas

Cost Estimate for 3 ton CC-ASHP
(NYSERDA 2019, Table 5-2 [Link](#))

HVAC System Type	Installed Cost
Air-source heat pump	\$12,000
Gas Furnace w/ AC	\$8,250
Incremental Cost	\$3,750
Incremental Cost %	45%



Main Barriers – Heat Pumps

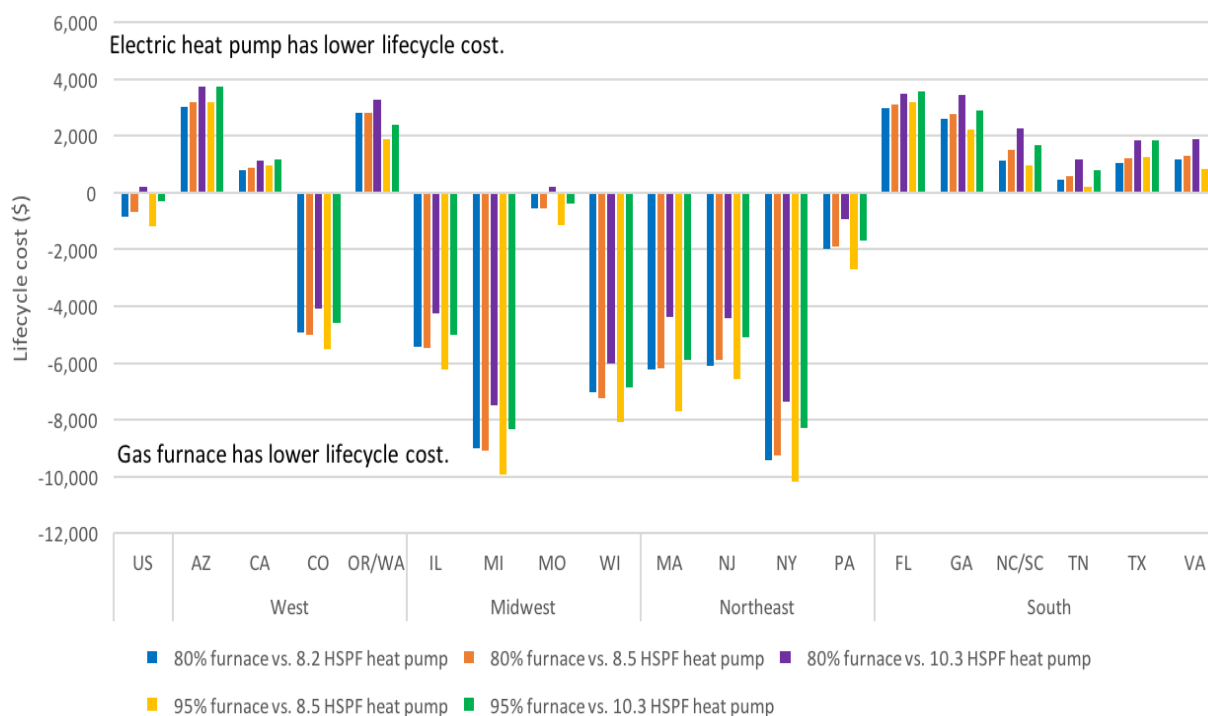


Life-cycle cost

- In the South, life-cycle costs for heat pumps are *lower* due to electricity costs versus natural gas
- In the Northeast and Midwest, life-cycle costs are *higher* for heat pumps due to higher electricity costs versus natural gas
 - higher installation costs are also a contributing factor to higher life-cycle costs

Installation challenges

- Electric panels in approximately 48 million homes will need to be upgraded to install all-electric equipment
 - California is problematic due to the number of homes with a 100 amp breaker box
 - approximately \$100 billion investment to upgrade



2016 ACEEE report on Heat Pumps replacing Gas Heating Equipment ([Link](#))



Main Barriers – Heat Pumps



Consumer issues

- Gravitate toward lowest product cost
 - life-cycle costs may be lower with higher cost product
- Reactive; only replace in emergency situations
- Usually replace like for like

Work force issues

- Inadequate number of trained installers
 - up to 30% turnover every year
- Many trained installers are retiring
- Difficult to attract workers to HVAC field
- Big investment in training, especially for handling new low-GWP refrigerants and more complex VS equipment



Photo credit iStock photos



Main Barriers – Heat Pumps



Commercial applications

- Multifamily is big challenge; accounts for 26% of housing stock nationwide
- Space constraints are one of the major issues, especially for ductwork
- Noise complaints when outdoor units are in common areas or balconies
- Renter-occupied units comprise 86% of multifamily units; no incentive for owners to invest in heat pumps where renters get benefits of lower energy cost
- In New York, 65% of homes are hydronic; require high-temperature heat pumps



Photo credit iStock photos



Main Barriers – Heat Pump Water Heaters



- Many of the barriers for heat pumps also apply to heat pump water heaters
 - installed costs are higher when replacing an existing natural gas or electric resistance unit with a HPWH due to increased product cost and condensate piping
 - panel upgrades may be required
 - space constraint issues especially in closet (require 700 – 800 ft³ of ventilation)
 - consumer acceptance; noise complaints when compared to electric resistance
- Capacity may be an issue, especially when replacing a natural gas water heater or when located in a cold ambient
- Product availability due to low/no stock, especially with plumbers
- Multifamily and large commercial applications; limited number of products, especially for high temperature applications

- Incentives
 - upstream, mid-stream, downstream
 - no consensus on which programs are best – depends on who you talk to
 - in the long term, manufacturers may have to absorb excess inventory resulting from scale-up during periods of higher demand due to incentives
 - some incentive programs aren't adequately funded; incentives run out before consumers and installers are informed
 - for small businesses, investments in inventory and training are a financial burden if incentives are short-lived
 - contractors may have to lay off workers when demand drops
 - need to consider how to sustain higher volume of heat pump installations when incentives go away





Hardware Solutions

- DOE Cold Climate Heat Pump Challenge
 - two segments: 5° F, minimum COP 2.1 to 2.4; -15° F (optional), heat pump operates as measured by compressor cut-in, cut-out temperatures
 - low-GWP refrigerant
 - nine manufacturers have joined the Challenge
- 120V heat pump water heater
 - eliminates the need for panel upgrade
 - field tests in California are evaluating performance
 - several manufacturers have introduced a limited number of units in the market
- Low GWP refrigerants
 - Compressor and HX development, equipment testing



Cold-climate heat pumps (CCHPs) provide both space heating and cooling for homes, and incorporate advanced features that allow for improved heating capacity and efficiency at cold weather conditions compared with traditional heat pumps.

Photo credit stock.adobe.com.



Concluding Remarks



- Concentrating deployment efforts in a handful of states could produce significant reductions in emissions and uptake in HP adoption rates
- Deployment strategies should be tailored to the needs of different parts of the US
 - Northeast, West and South (low hanging fruit)
- Ways of reducing costs to achieve more widespread deployment will help in the short term
 - New federal tax credits and incentives are a start
- Need to look at ways to create a demand for heat pumps without the need for financial assistance in order reach deployment levels needed to significantly reduce emissions; grid reliability and resiliency
- Workforce development has to be addressed, especially with all the issues and as the number of heat pumps continues to increase
- Additional equipment, such as RTUs, high temperature heat pumps, and solutions for multifamily, have to be developed if full electrification is to be achieved
- Consumer education needs to be a main thrust to increase HP adoption