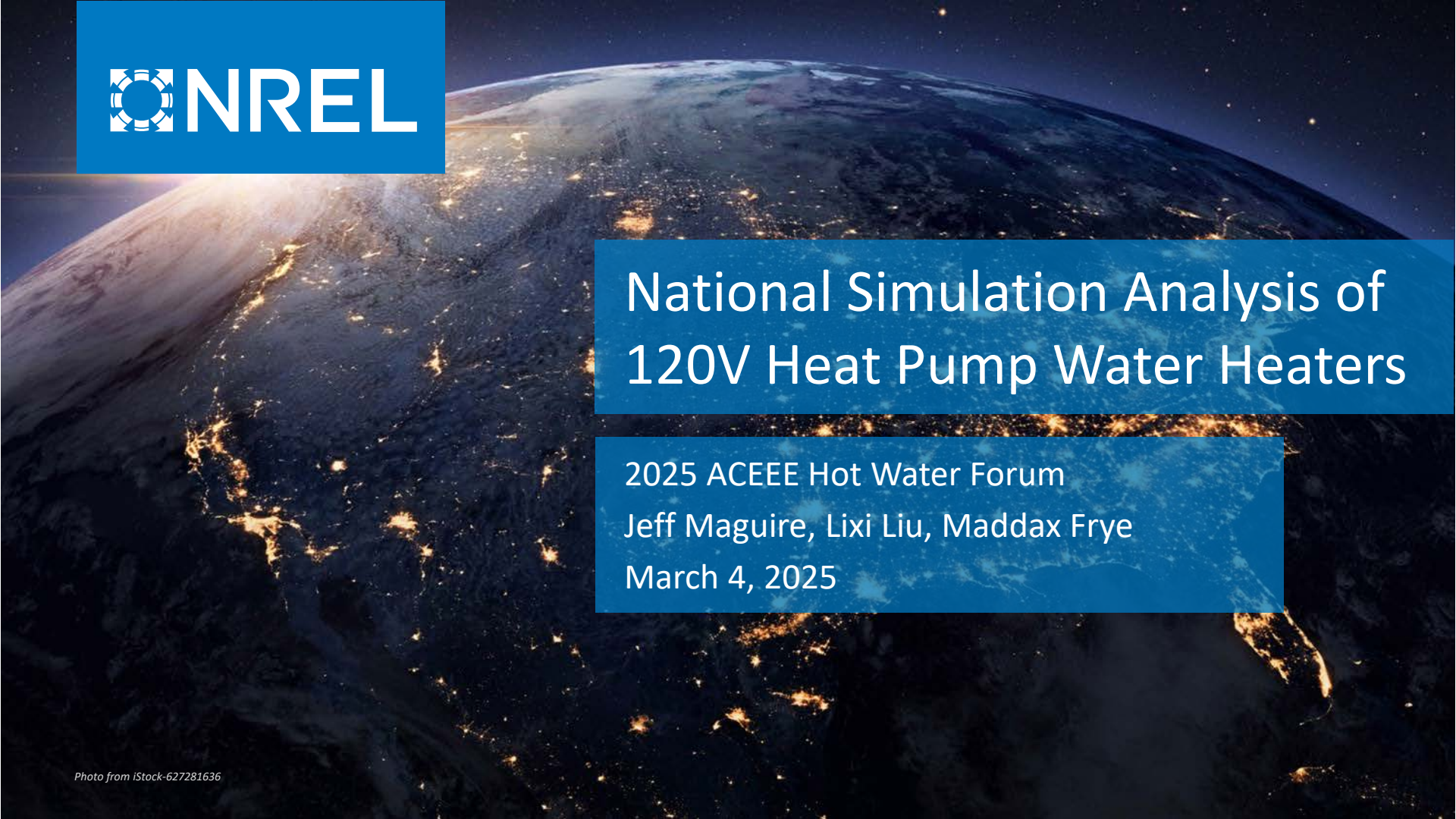


National Simulation Analysis of 120V Heat Pump Water Heaters

2025 ACEEE Hot Water Forum

Jeff Maguire, Lixi Liu, Maddax Frye

March 4, 2025

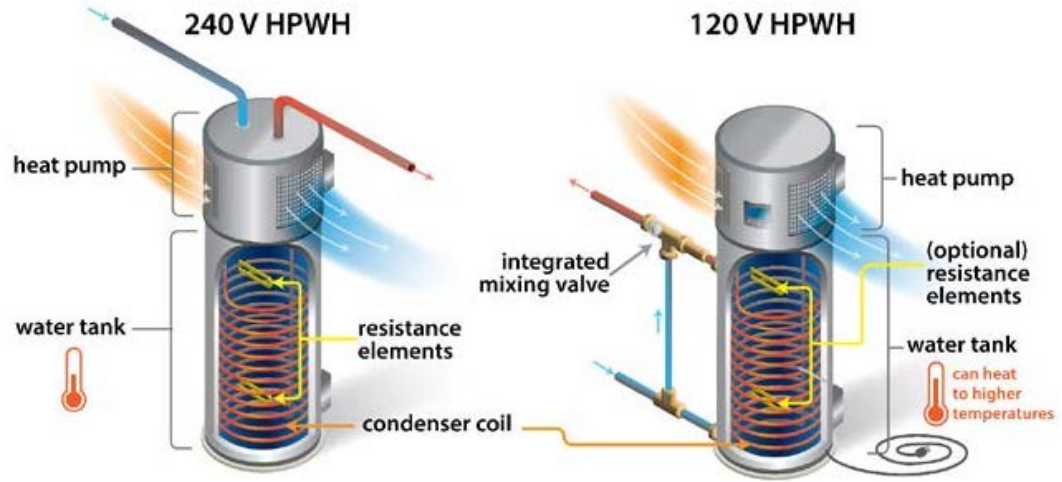
Photo from iStock-627281636

Agenda

1. Overview
2. ResStock
3. 120V HPWH Modeling
4. Preliminary National Results
5. Conclusions and Next Steps

120V HPWHs

- 120V HPWHs can be a lower power option for retrofitting existing homes.
  - Lower power means they may not be suitable for all levels of hot water usage, installation locations, etc.
  - Can avoid panel upgrades in existing buildings

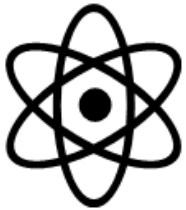


ResStock datasets

ComStock ResStock

Building stock characteristics database

- Variation in building type; size; location; vintage; HVAC system, etc.
- **Over 100** probability distributions of various attributes



Physics-based computer modeling

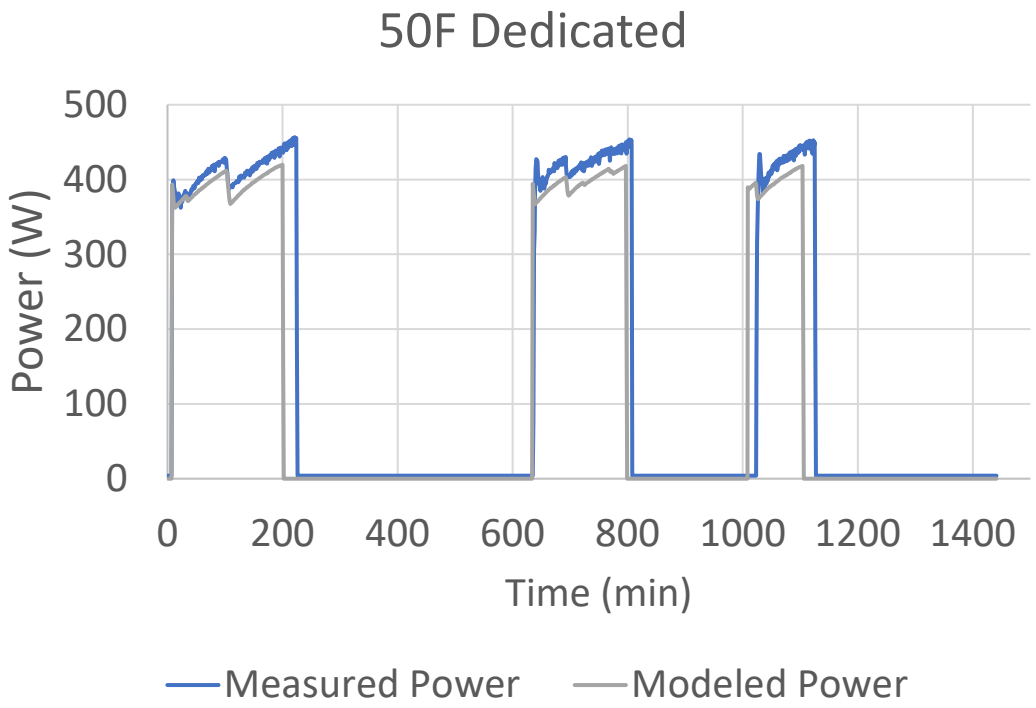
- Representative set of **900,000+ OpenStudio energy models**

High-performance computing

- Simulate models
- Process raw data
- Apply scaling factors
- Publish data

ResStock: 120V HPWH Models

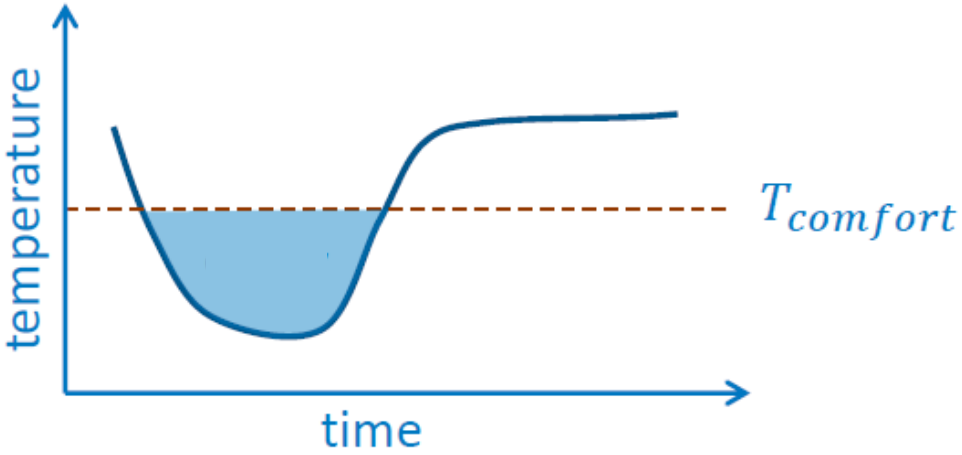
- 120V HPWH Model:
  - 120V shared circuit, 140 F setpoint + tempering valve
  - Sized based on # of occupants
  - Model validated against multiple lab tests



ResStock: Unmet Hot Water Loads

- Simulated hot water use can't always account for real occupant behavior
- Need to ensure savings isn't coming at the expense of comfort!
- Quantify energy and time when the outlet temp drops below **105°F** for **showers**

Water Heater Outlet Temperature

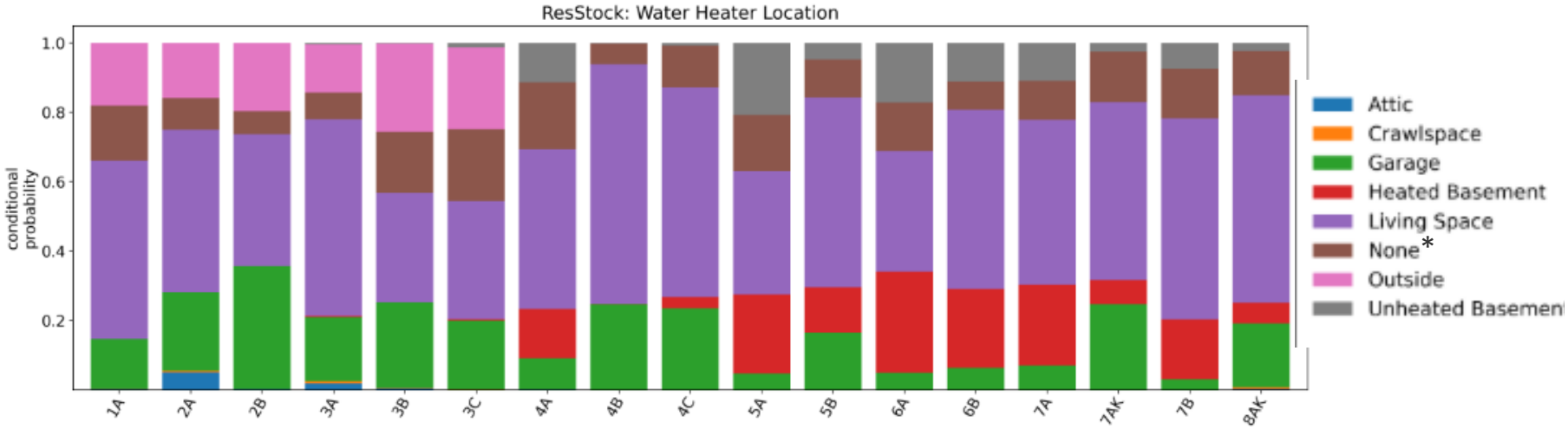


$$When\ T_{out} > T_{comfort}$$

$$E_{unmet} = \dot{m} \times c_p \times \left(T_{comfort} - T_{out}\right)$$

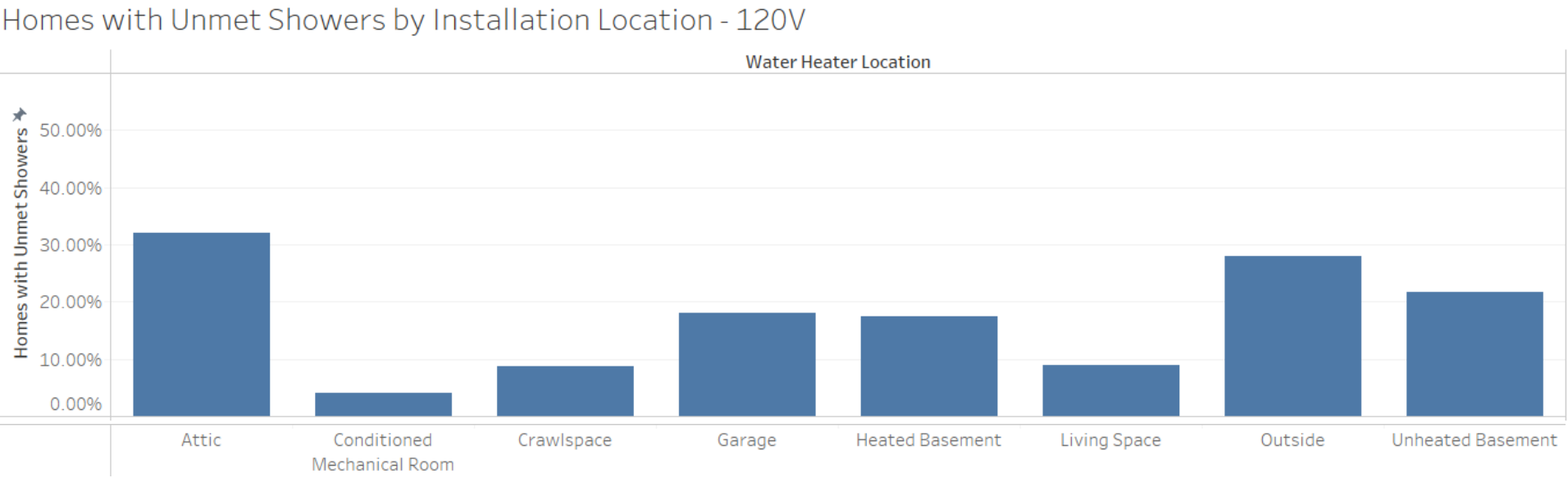
ResStock: Water Heater Location

- Integrated RECS data on water heater installation location
- Depends on IECC Climate zone and building type



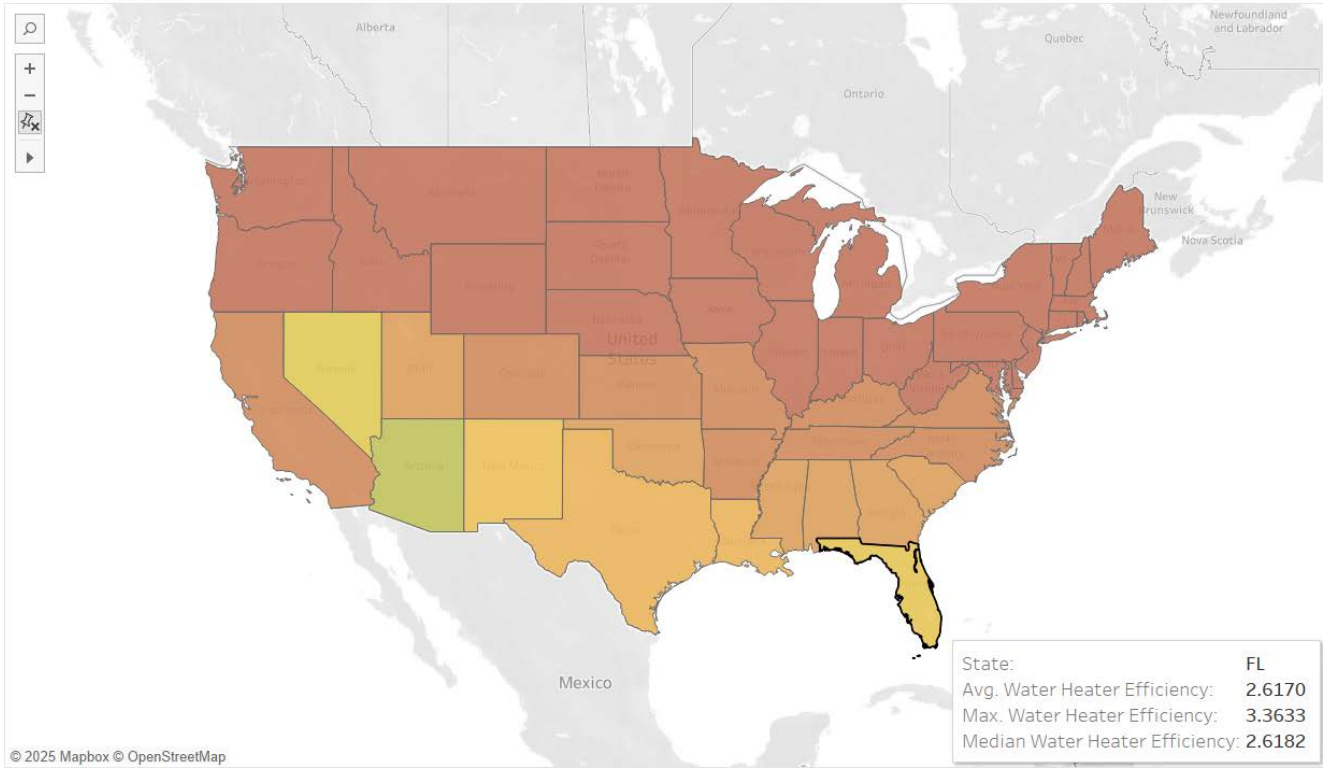
*"None" includes central water heaters in multifamily buildings

Preliminary ResStock Results: Unmet Loads



Preliminary ResStock Results: 120V HPWH Efficiency

Efficiency Map, Conditioned Spaces and Finished Basements (By Occupancy) - 120V State Level

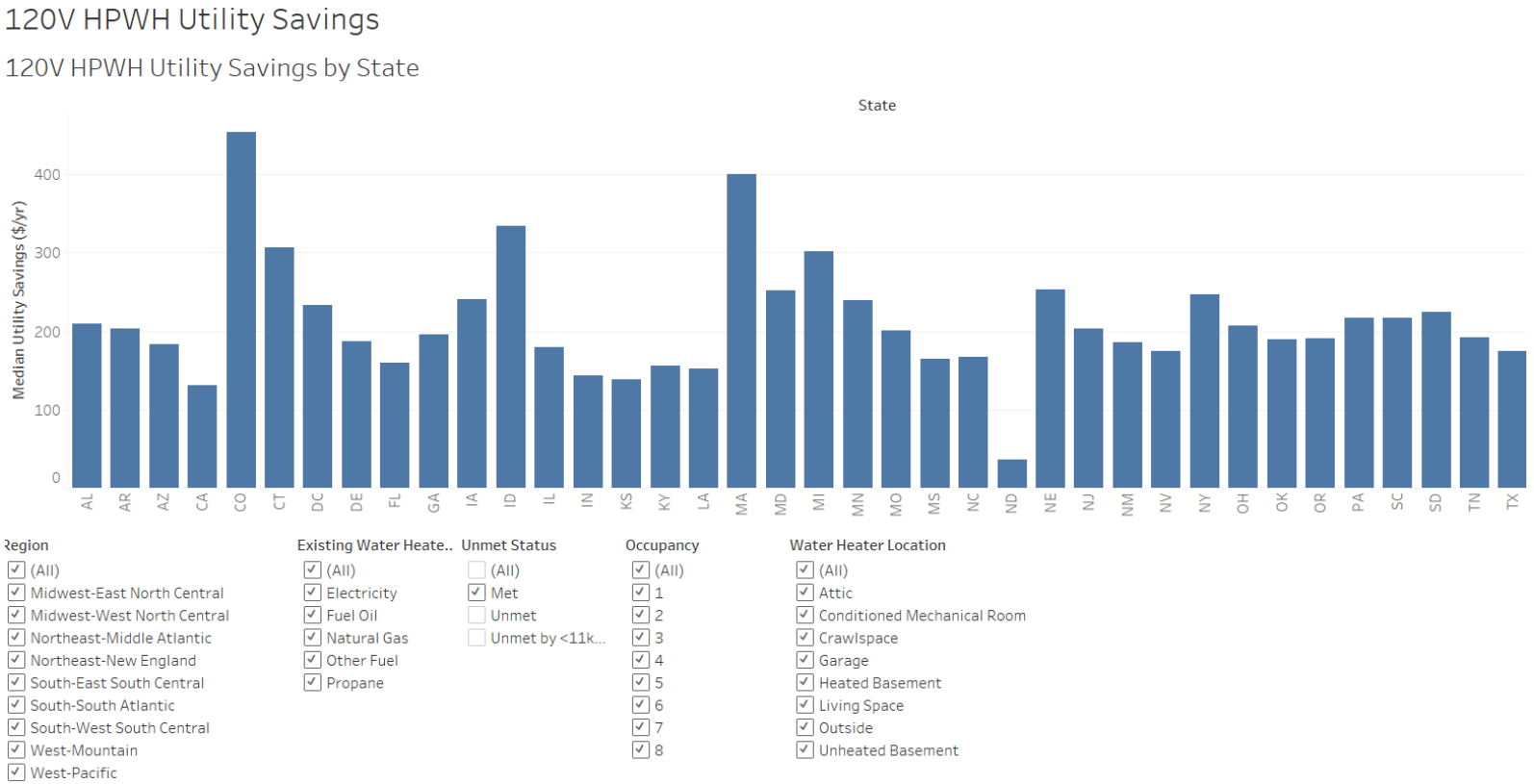


2 occupants

Average Water Heater Efficiency

2.000 3.000

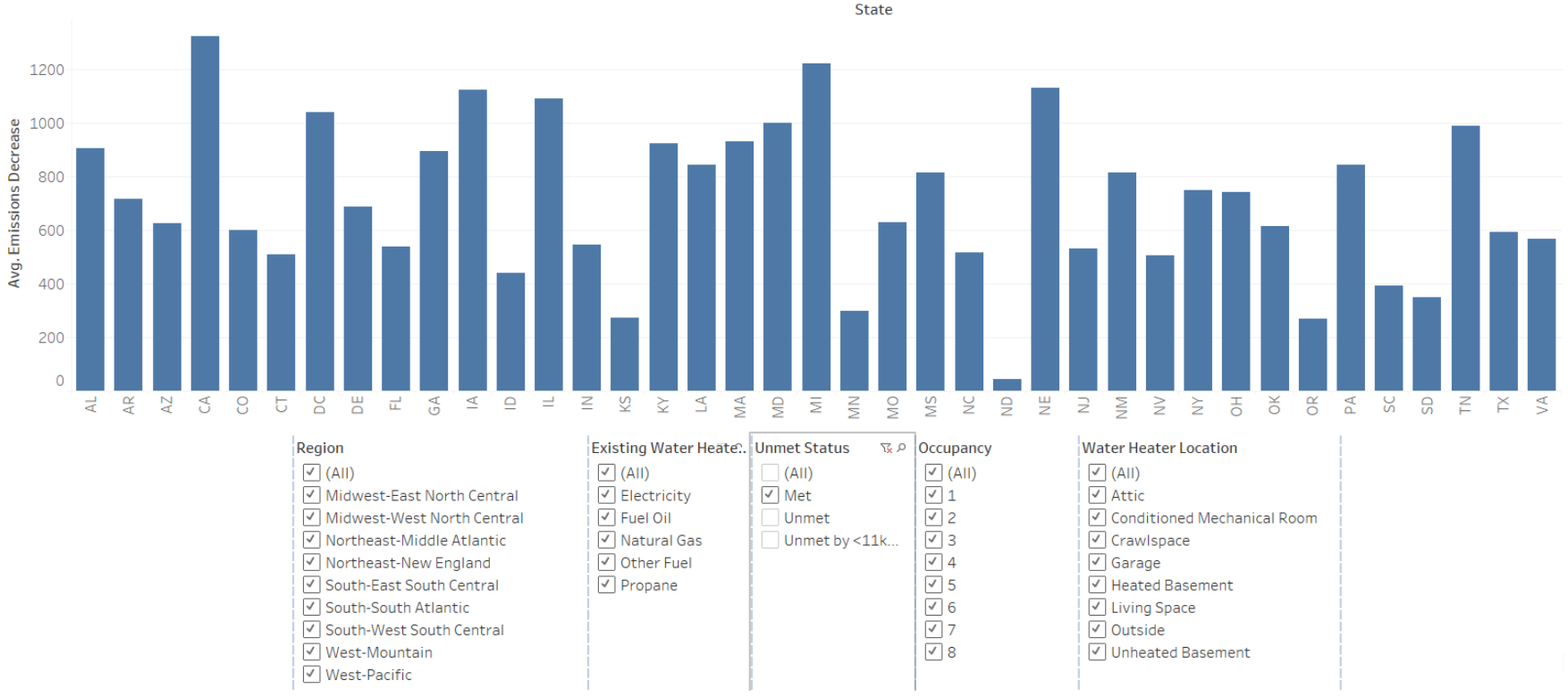
Preliminary ResStock Results: Utility Bill Savings



Preliminary ResStock Results: Emissions

120V HPWH Emissions Decrease

120V HPWH Emissions Decrease by State



Conclusions & Next Steps

- These are preliminary results from an early run of 120V HPWHs
  - Working on integrating into next ResStock release
- Results will include 120V HPWHs as an upgrade across the whole housing stock, so they can be sorted and sliced by climate zone, installation location, number of occupants, and other key drivers
- Need to finalize:
  - Sizing algorithm
  - Best way to quantify unmet load
  - Is any amount of unmet loads acceptable?

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Questions?

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