Challenges and Opportunities for Residential Electrification

Iain Walker

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ENERGY TECHNOLOGIES AREA
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Need to get to scale

- Find major barriers and suggest solutions
- What are the challenges?
- What are the opportunities?

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Challenges and Opportunities for Home Decarbonization

Iain S. Walker
Núria Casquero-Modrego
Brennan D. Less

BERKELEY LAB

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Three Types of Challenge

1. Technical: Are the right products available?

2. Financial: How can we reduce costs?

3. Valuation: What are the home value and non-energy benefits?

Three DOE Priorities

1. Develop solutions for all households: housing types, occupancy, ownership, access to capital

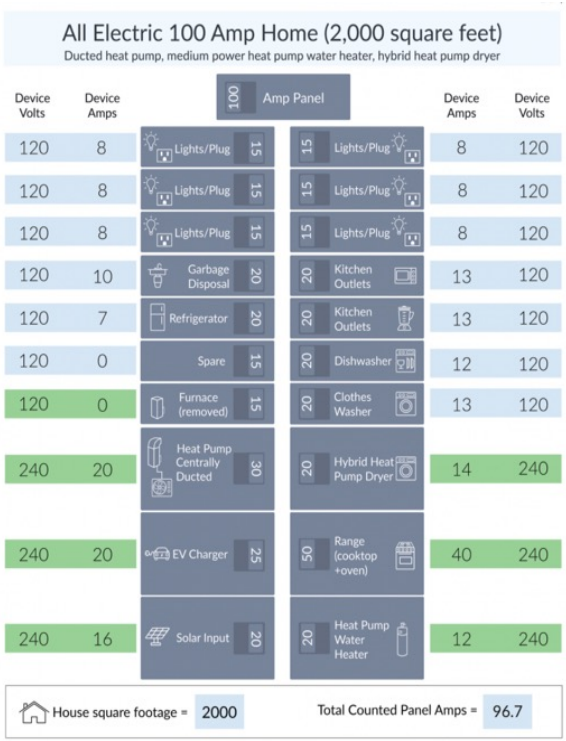
2. Make decarbonization easy and affordable: Current cost ~ $50,000, no workforce, incompatible regulations

3. Support the US transition to a clean energy economy: how can business/industry be engaged? How do we keep the current grid?

Low Power Electrification

Understanding the National Electrical Code (NEC): Watt Diet Calculator

- What are actual coincident loads?
- How close are most homes to panel capacity and ability to add loads?
- Power Efficient Appliances
- Circuit Sharing
- Energy storage
- Focus on large loads: Heating/Cooling, DHW, Clothes Drying, Cooking, PV & EV
- “Watt Diet” calculators



https://www.redwoodenergy.net/watt-diet-calculator

Low Power Electrification

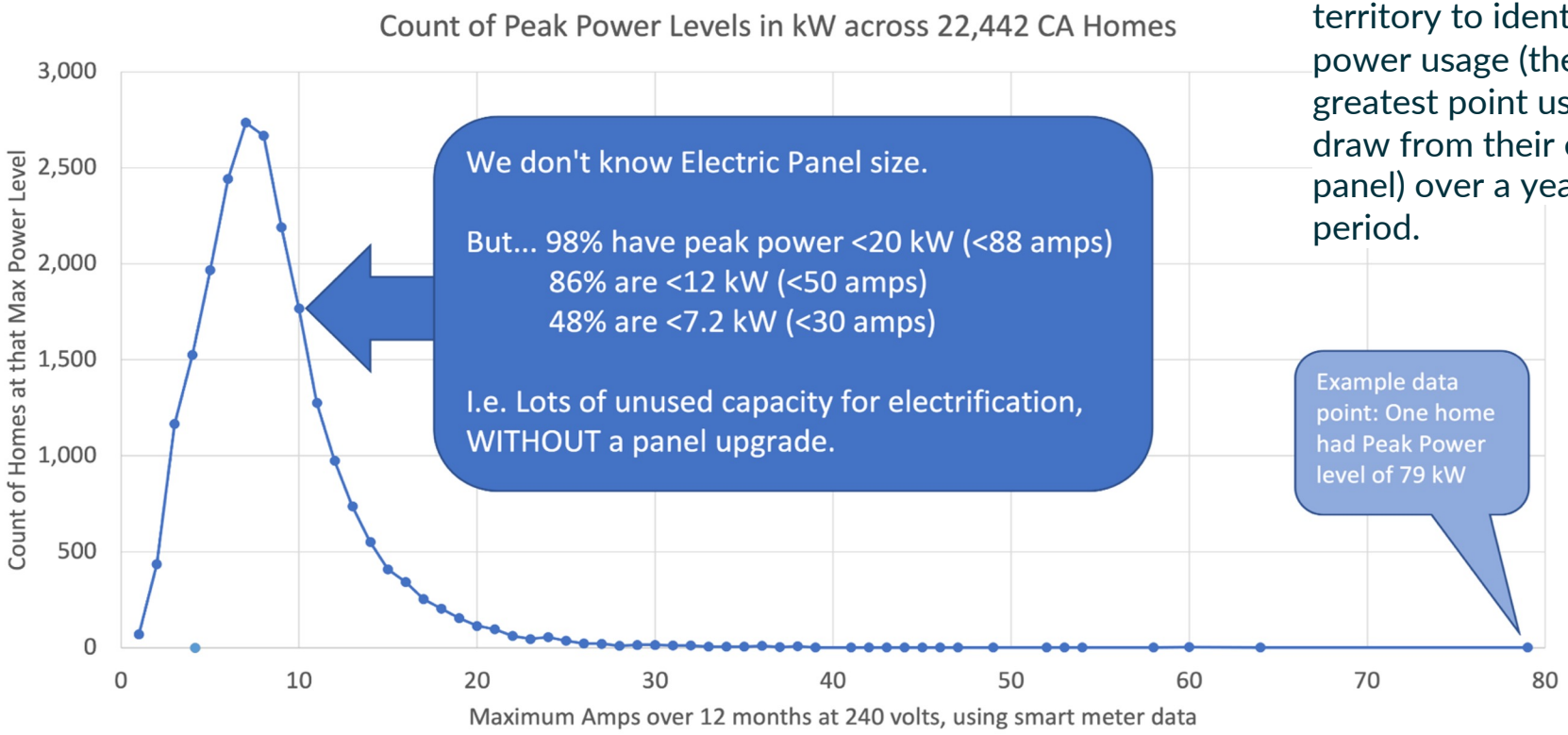
Develop DIY and direct plug and play solutions – good for renters and lack of workforce issues

	LG WM3998HBA 4.5 ft³ Condensing Washer/Dryer Combo	**GE GeoSpring** Heat Pump Water Heater	**Innova HPAC 2.0** Low-Amp Window Heat Pump	**LG LS-120HXV** 120V Mini-Split Heat Pump
Maximum Rating (Amps, Watts)	10A, **1200W**	8.3A, **1000W**	6.3-15A, **~1400W**	10.4A, **1090W**

Figure source: Sean Armstrong/Redwood Energy

Available Capacity to Electrify

An analysis from HEA of smart meter data across 22,000 homes in PG&E territory to identify peak power usage (the single greatest point use power draw from their electrical panel) over a year-long period.



Source: HEA, HomeIntel

Are heat pumps a problem?

~10,000 homes in Vermont

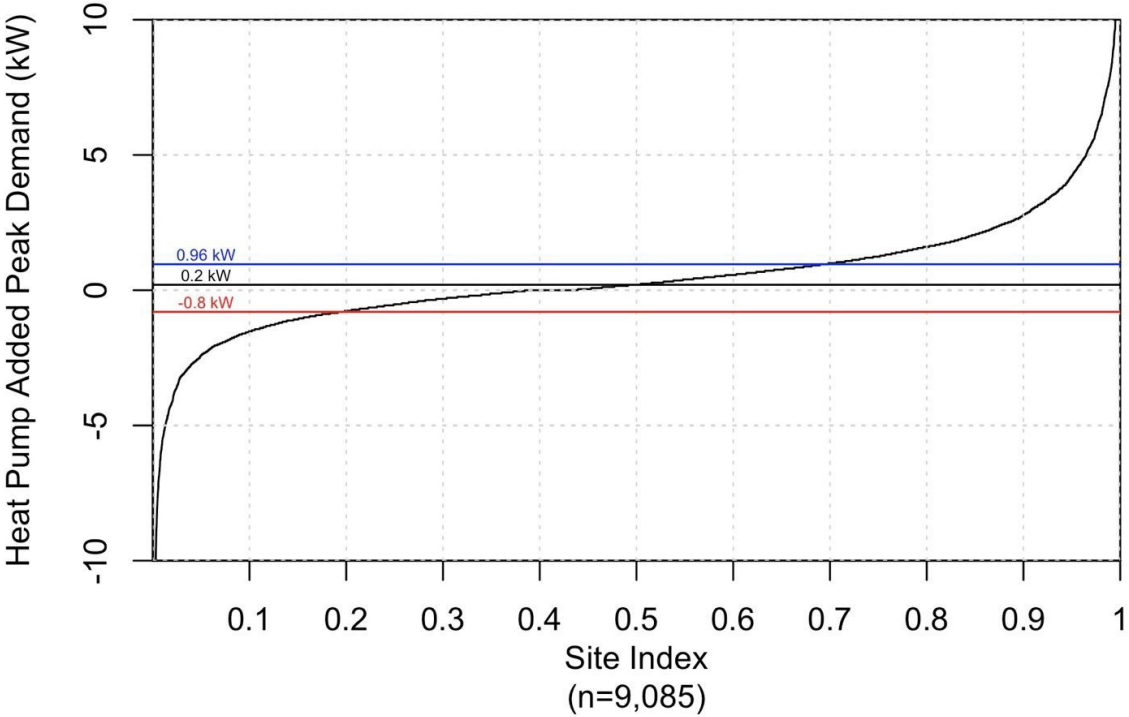
15 minute electric power before and after adding heat pumps

Mean nameplate rating 3.6 kW
Average addition 200 W

TECH Clean California

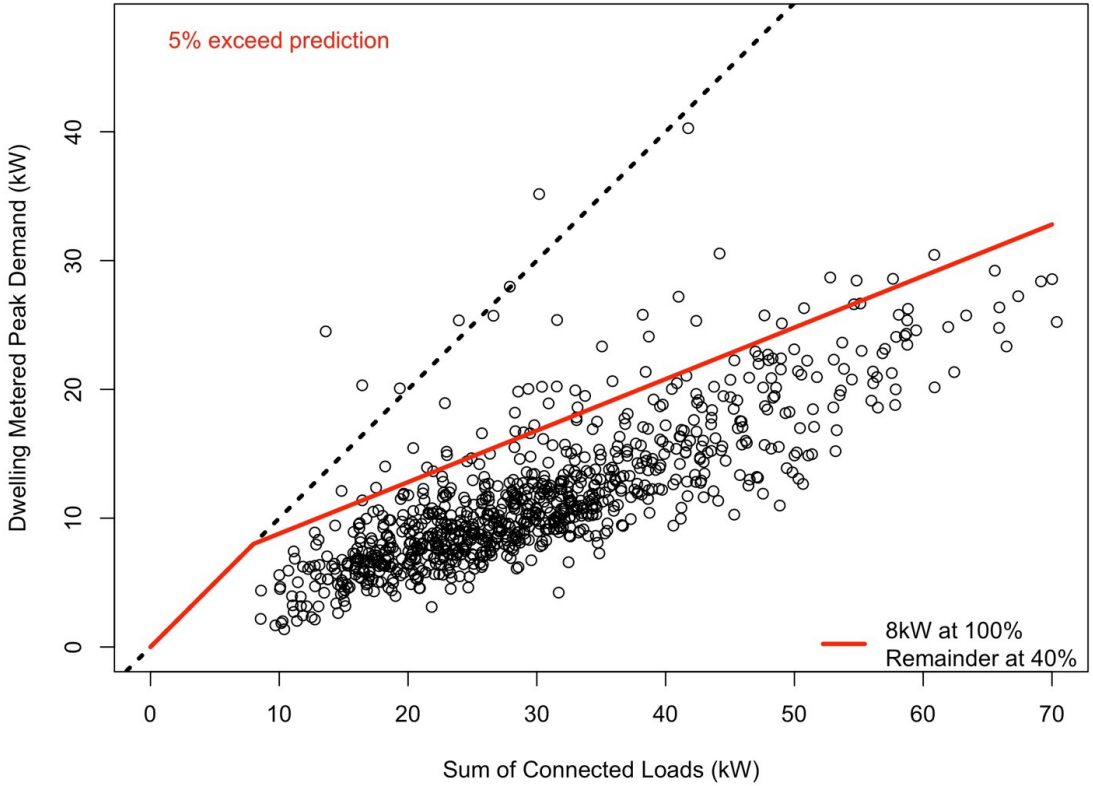
480 panel replacements out of 10,446 heat pump upgrades (**4.6%**)

- **Most panel replacements were from 200A to 300A**
- Smaller set from 100A to 200A



Code and regulation updates

- NEC unclear and not developed with home electrification in mind
- New proposals for NEC calculations
- Local code authorities unprepared
  - Some will not allow circuit sharing or smart panel controls
- Improve allowance for load management, circuit sharing, storage technologies, etc.



Rethinking Electric System Replacement Rebates

Currently $2500 for a panel upsize (IRA up to $4000 + $2500 for additional wiring)

- Allows high power devices and higher peak load from home to utility
- New distribution and transformer upsizing - these costs passed on to ratepayers
- Allowing oversized panels locks out future electrification – City of Palo Alto

Future rebates should be for avoiding panel replacement or only allowed if shown to be necessary using NEC 220.87 or 220.83

- Low power, high performance heat pumps
- 120 V: HPWH, induction cooking, condensing and heat pump clothes dryers
- Circuit sharing and pausing
- Limit EV's to level 2 and use controllers
- Meter collars for Solar PV and EVs

Non-energy benefits

Functionality:

- Comfort – steady temperatures with heat pumps + air sealing + insulation

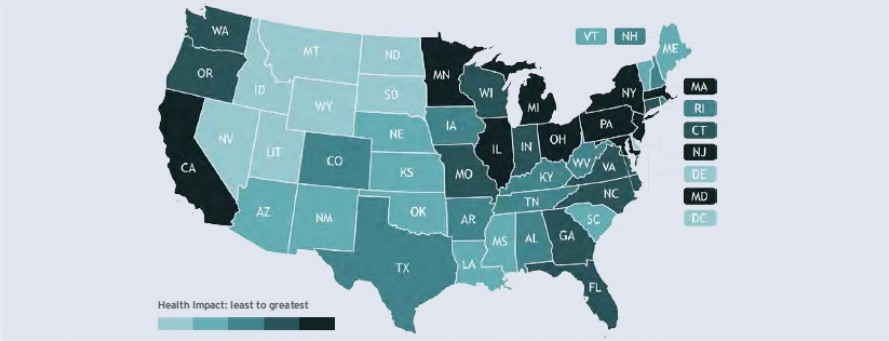
Health & safety:

- No combustion in the house: an IAQ issue indoors AND outdoors
- Cooler surfaces with induction cooking
- Heat stress: Provision of cooling + more affordable heating/cooling

Emphasize value over cost

- Increased home value unknown
- Affordable comfort <> ROI

Exhibit 5 Outdoor Air Pollution Health Impacts from Burning Fuels in Buildings



Source: Brady Seals, Leah Louis-Prescott, "What is the Health Impact of Buildings in Your State?" RMI, May 5, 2021, https://rmi.org/health-air-quality-impacts-of-buildings-emissions

Cost Compression

- Avoid panel and utility service changes (also saves a lot of time!): low power/120 V equipment, Watt Diets
- Programs with bulk purchases, customer referrals for contractors, simplified permitting
- Up front rebates – and rebate the right things!
- Don't remove legacy systems?
- What to do about costly "pre-existing conditions"?
  - non-code dangerous wiring
  - Asbestos/lead abatement
  - Missing/no insulation
  - Broken windows and appliances
  - Structural problems
  - Knob & tube wiring

Solutions for Avoiding Panel and Service Upgrades

Smart Electrical Panels

$3-5k + install

Most complicated and flexible

Circuit Sharing

$300-600 + install when hard-wired

Least complicated, sometimes DIY

Others

NEC Load Calculations

Low Power Appliances

Meter collar solutions

Smart circuit breakers

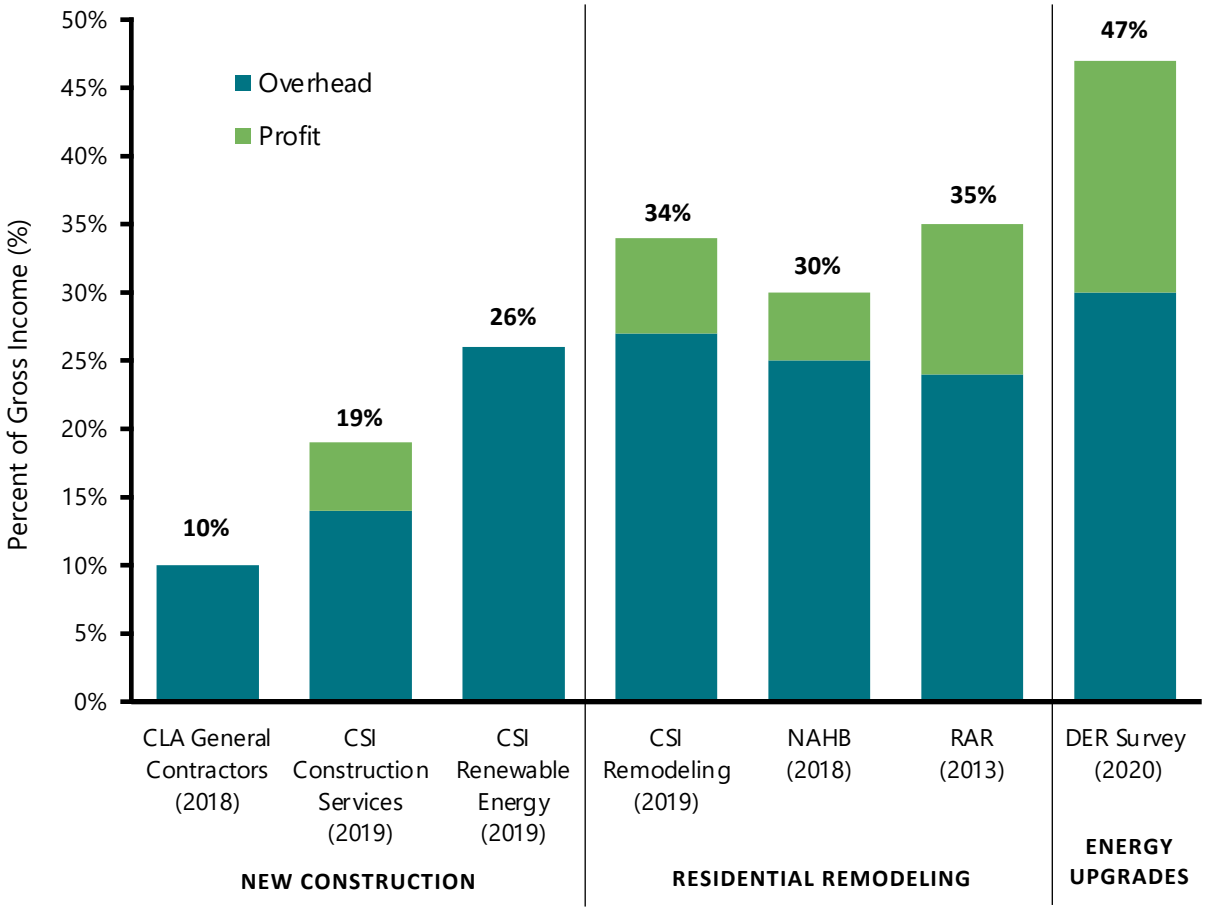
Circuit Pausing

$400-900 + install

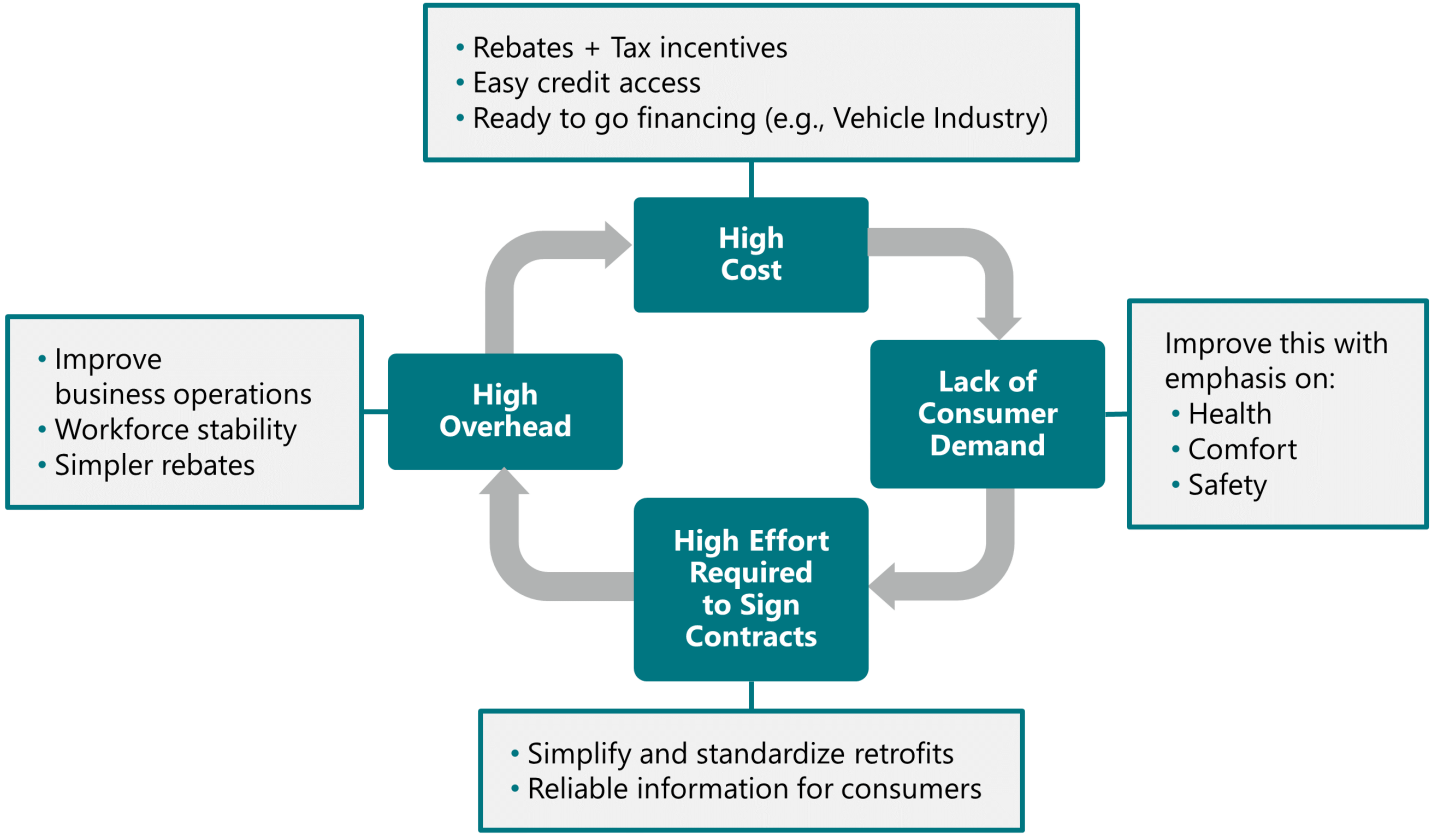
Medium complicated, requires CTs

Helping Business

Energy/Decarb upgrades have very high overhead



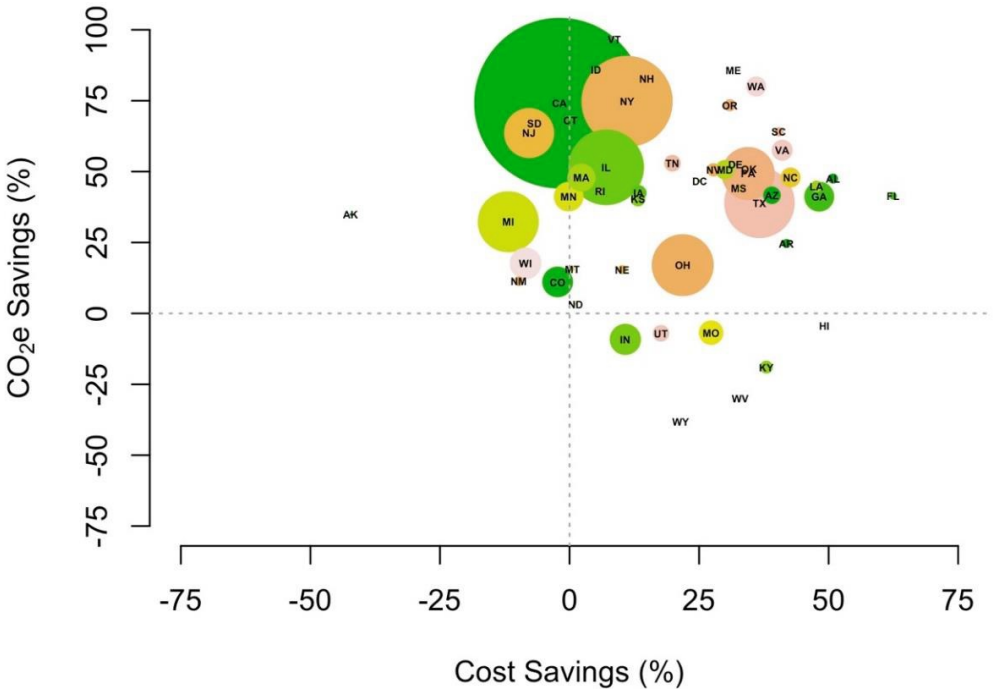
Helping Business



Equity

- Rental regulation & non-vacating solutions
- Rebates not tax credits
- Utility regulation (what to do about net-metering)
- Don’t leave communities behind – who pays for legacy infrastructure?
- Packages of low-cost appliances for apartments
- Minimize bill impacts: include load reductions in programs, consider fuel poverty

PERCENT SAVINGS FOR CO_2E AND ENERGY COST IN EACH US STATE, WHEN REPLACING AN 80% AFUE FURNACE WITH A COP 3 HEAT PUMP USING 2019 EGRID AVERAGE EMISSION FACTORS AND STATE AVERAGE RETAIL ENERGY COSTS FROM EIA



Points are scaled according to the count of natural gas space heating appliances in each state. Color coding is for visual separation only.

Solutions for hard to electrify homes

Simplification and affordability

- Cold climates
- All-gas homes
- Multifamily homes
- Manufactured homes
- Old/historic homes

Questions?