Demonstrating How to Reduce Natural Gas Consumption in Existing Large Buildings

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Overview

Objective

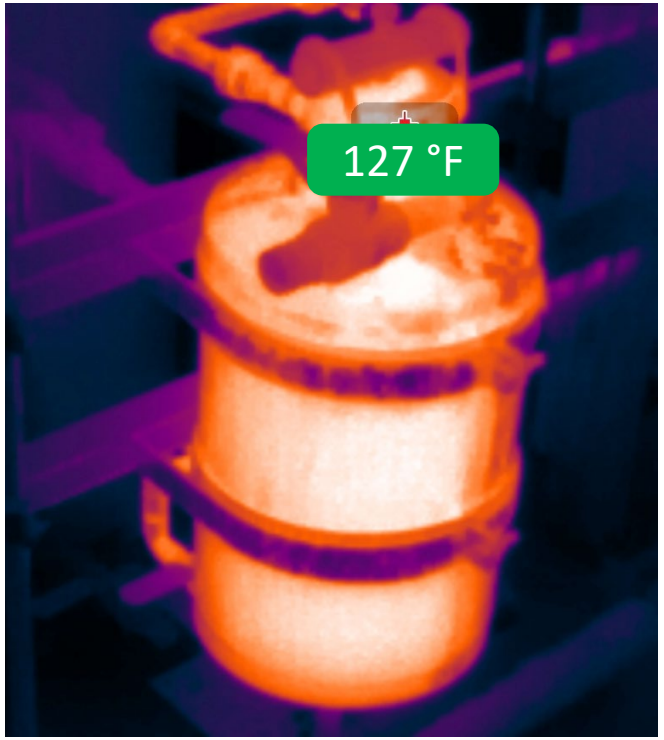
- Reduce heating hot water (HHW) gas consumption in existing large commercial buildings

Scope

- Measure performance in both lab and field
- Gather and analyze data from hundreds of systems
- Demonstrate reductions in existing office buildings

Funding

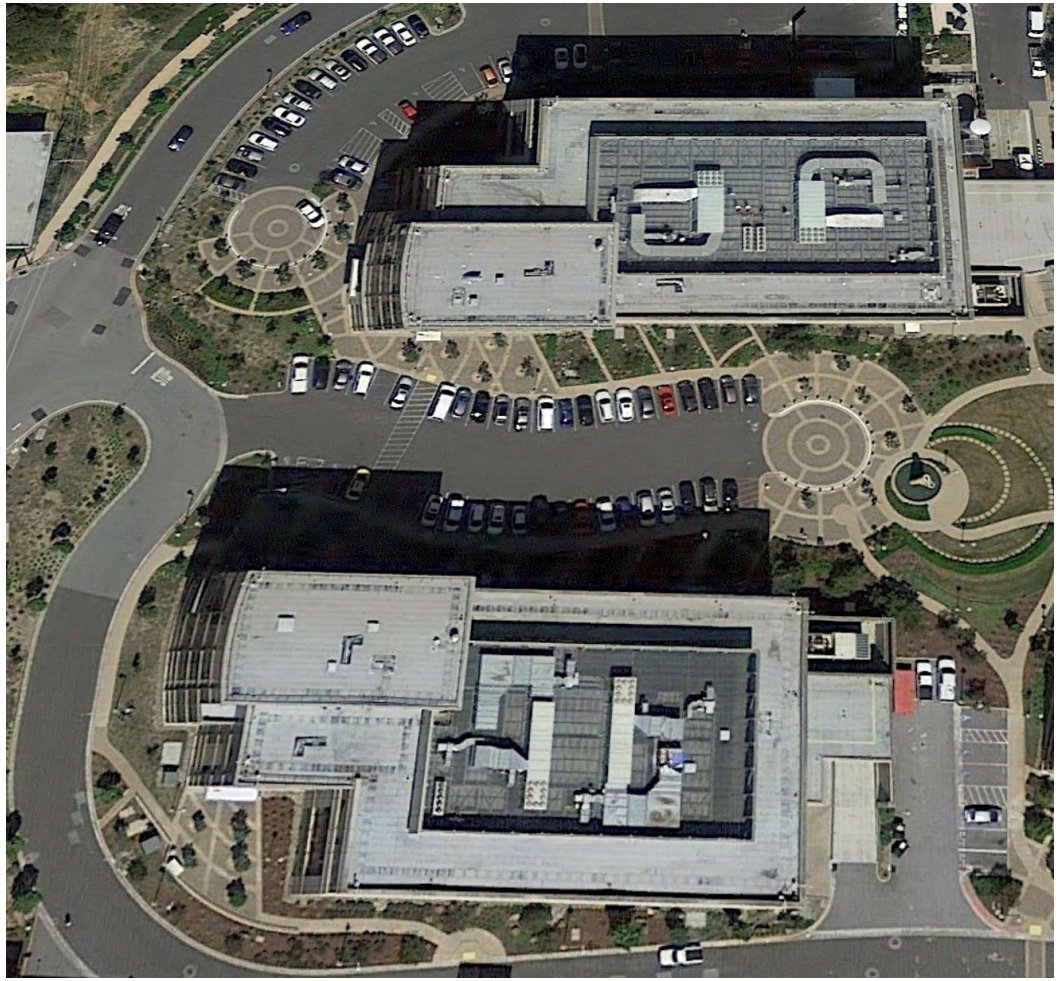
- California Energy Commission ($1.5M, 3.5 years)
- CBE, building owners & Price Industries



Infra-red image of heating system losses

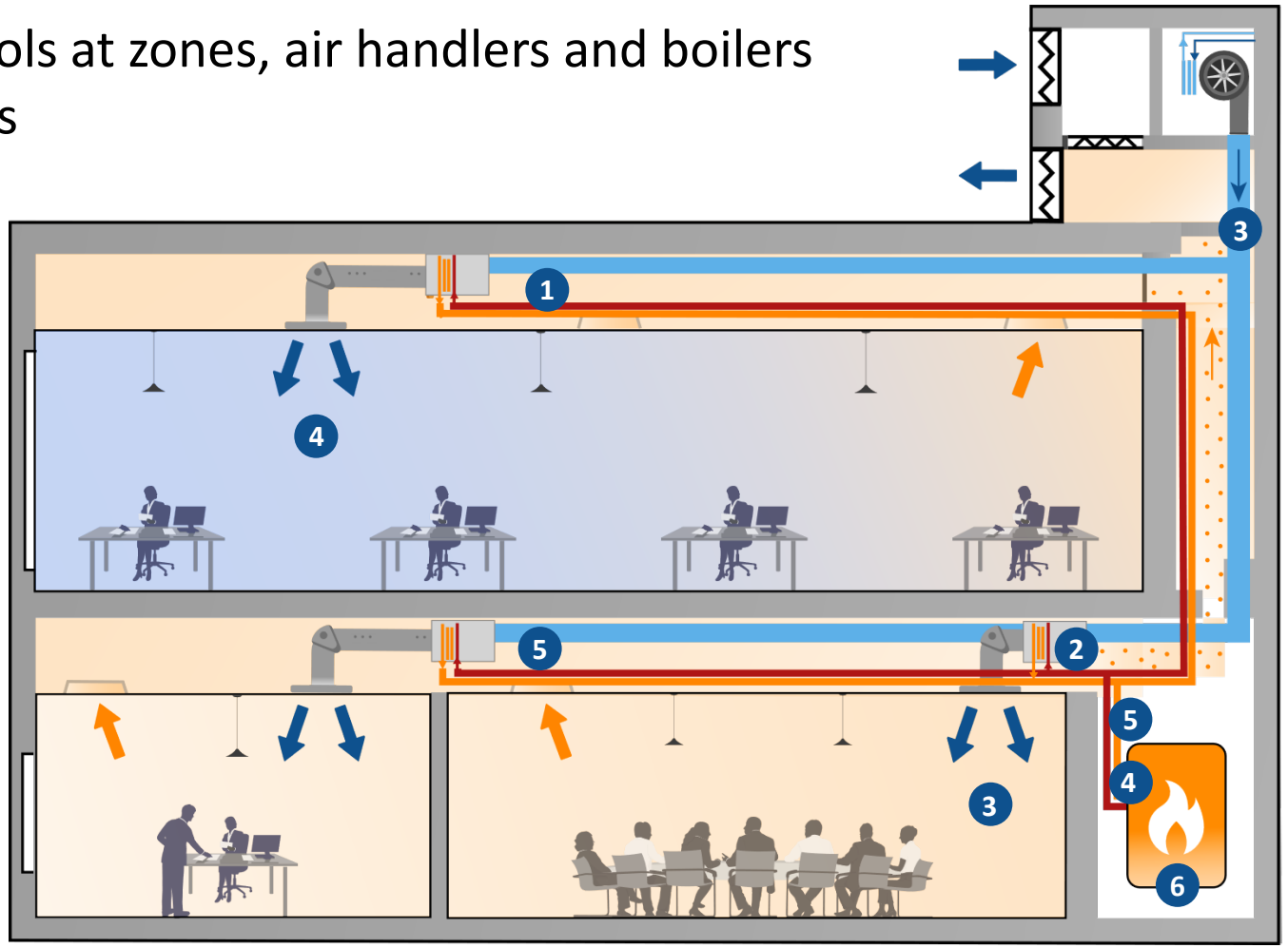
Demonstration sites: Existing conditions

- 120k and 110k ft² office buildings
- Built 2006 and 2007
- Each building had:
  - One non-condensing boiler
  - Distributed chilled water system
  - 2 air handlers and ~200 VAV zones
  - Hot water reheat in perimeter zones

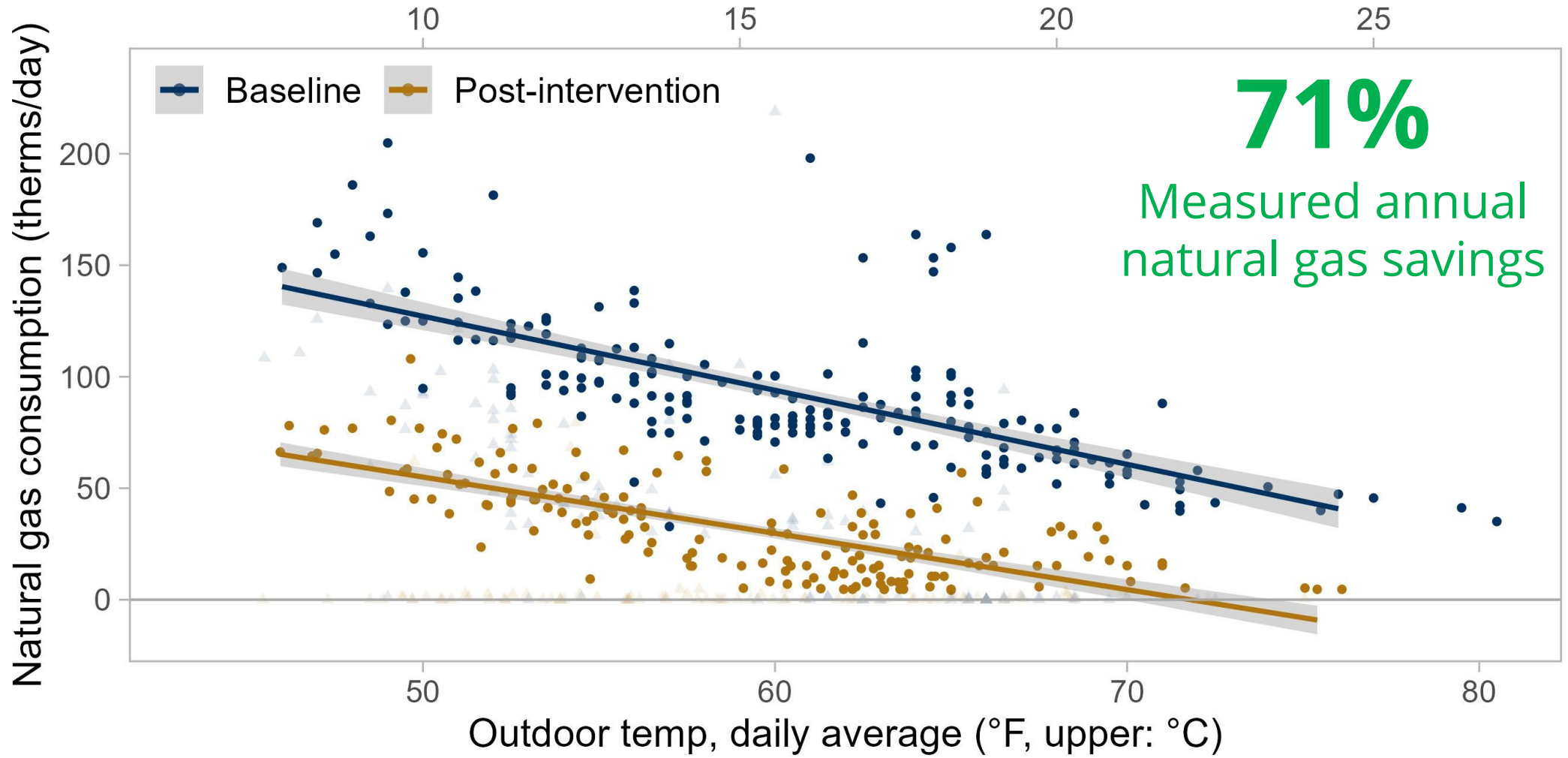


High level efficiency measures

- ASHRAE Guideline 36-2021 controls at zones, air handlers and boilers
- Small, new, high turndown boilers

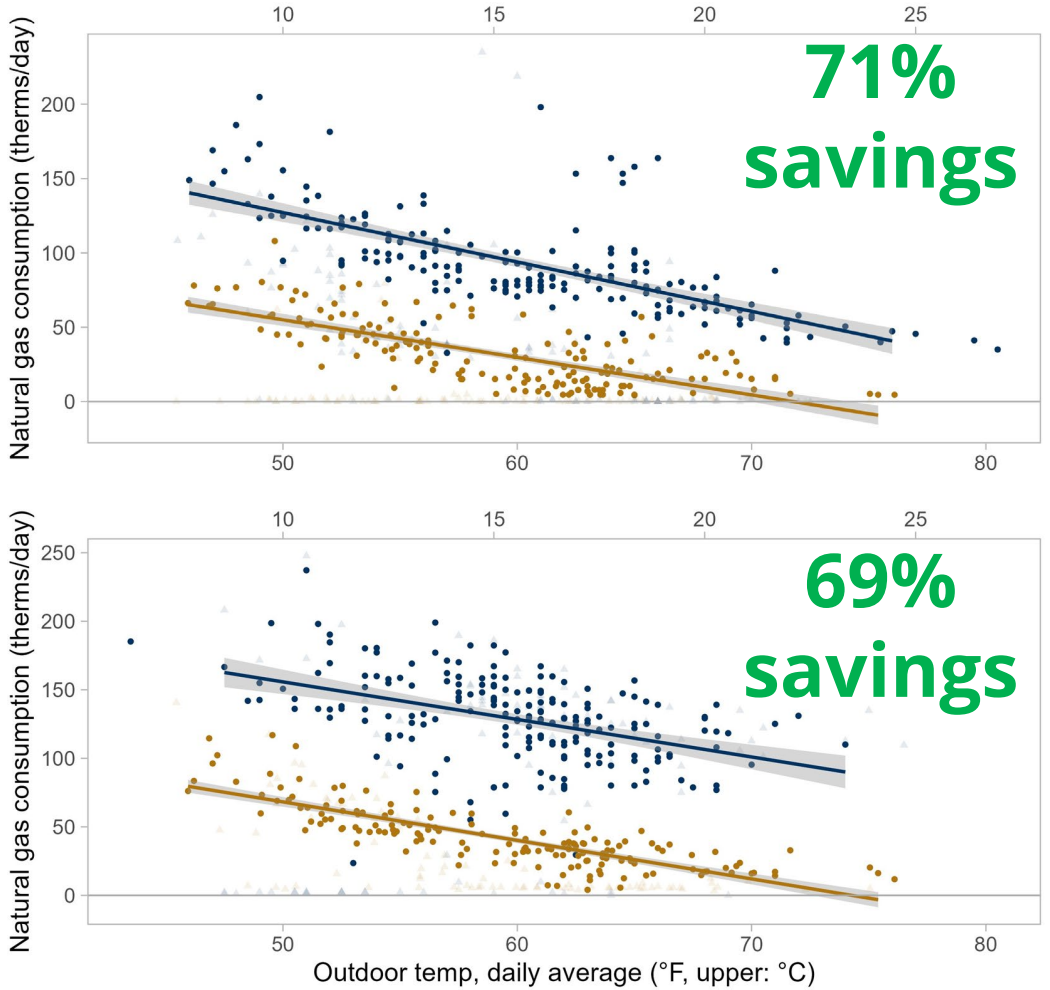


Pre- and post-retrofit comparison



Pre- and post-retrofit comparison: Both buildings

- 70% natural gas savings
- HVAC electricity savings:
  Fan ~20-25%, chilled water ~ 40%
- Total utility savings:
  ~ $110k ($0.5/ft²) per year



How would we further reduce emissions in these buildings?

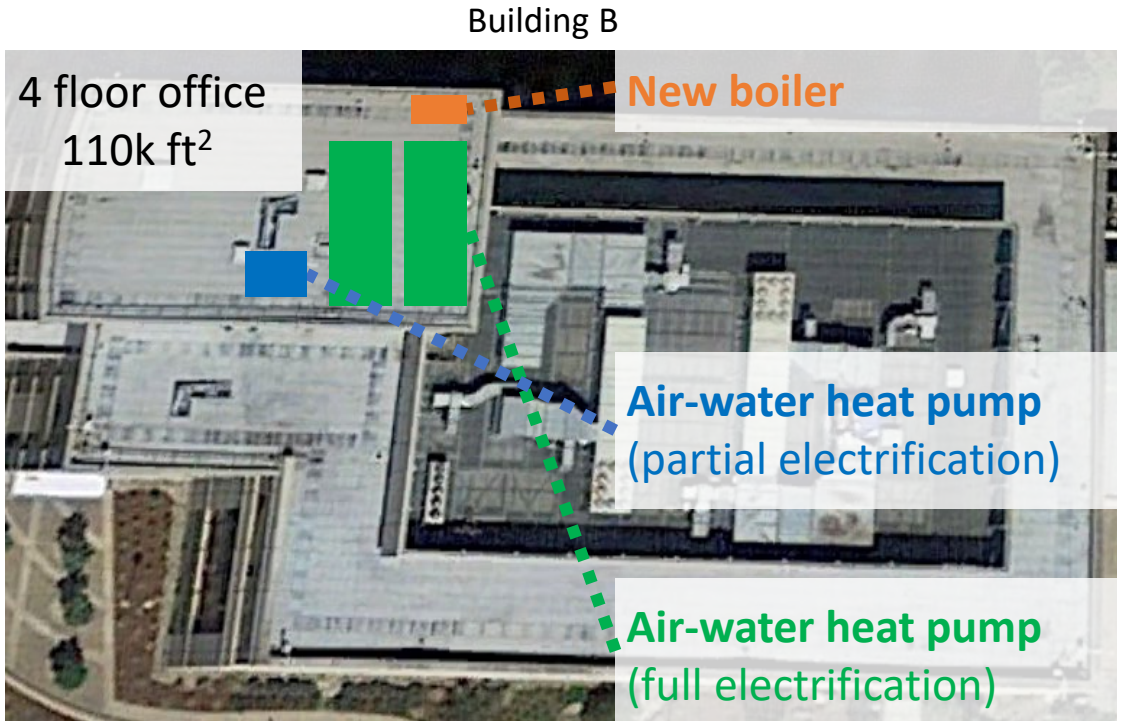
Further decarbonization through electrification

How large should the heat pump be?

- Consider: cost, space, weight, electrical service capacity…

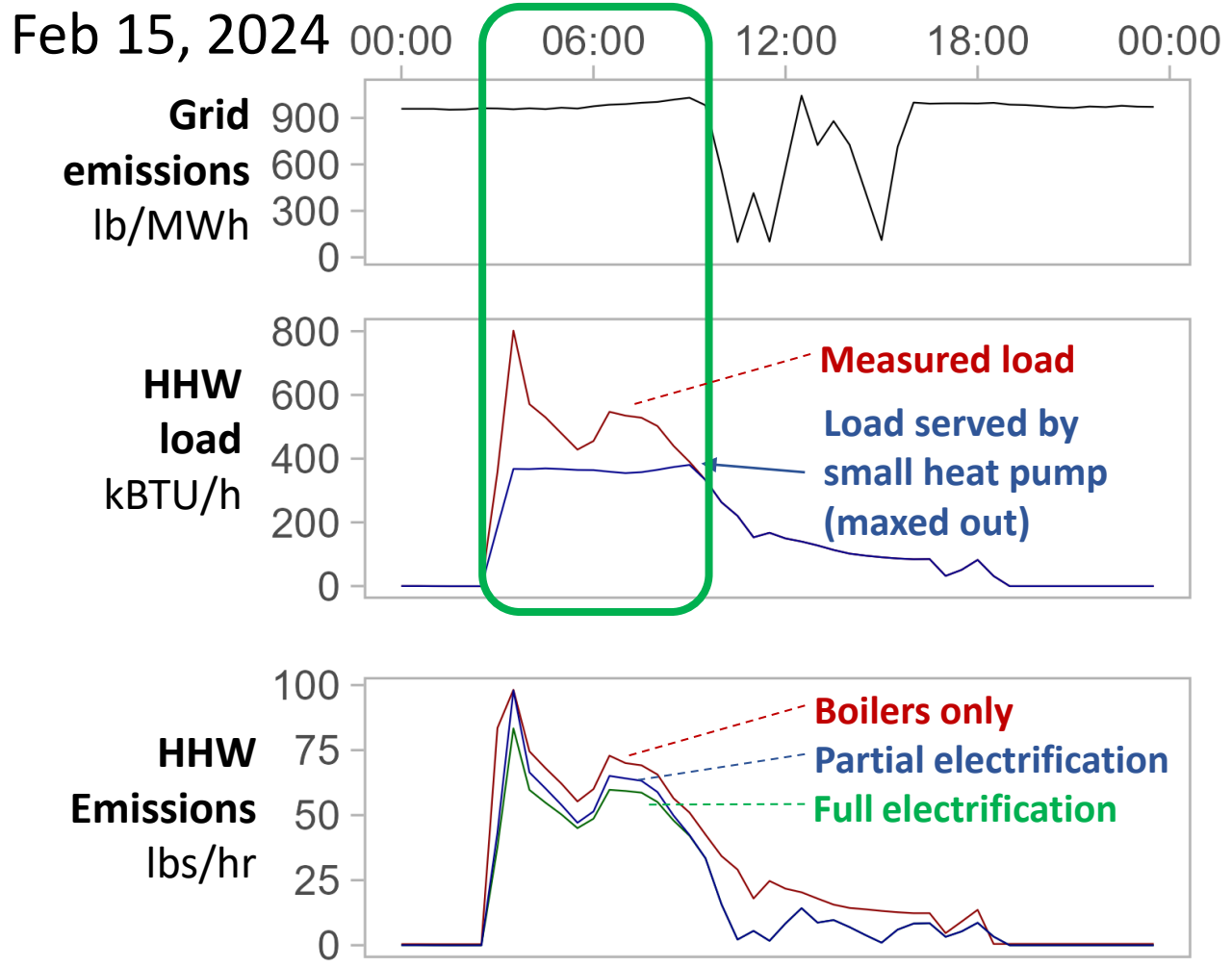
Partial electrification option

- 14% of installed boiler capacity (at heating design day temp)
- 20% of *peak* load
- **77%** of *total annual* load



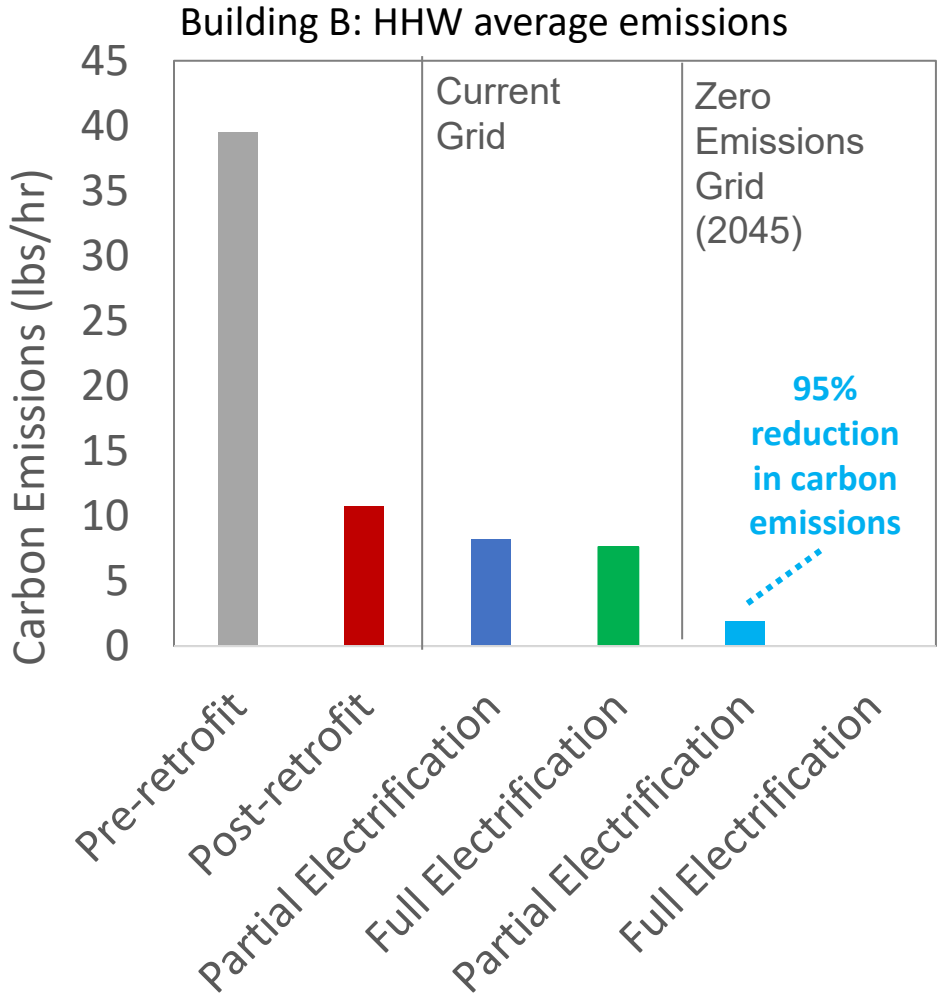
Effect of grid and weather conditions on emissions reduction

- Grid emissions vary with time
- Rare, high heat load hours coincide with:
  - High emissions grid
  - Cold temperatures
  - Less efficient heat pump
  - Less heat pump capacity



Existing building decarbonization thoughts to consider

- Large emissions reduction from thorough efficiency
- Makes electrification easier and puts less stress on grid after electrification
- Partial electrification would reduce emissions by almost the same as full electrification after efficiency measures
  - Fraction of cost and refrigerant
  - More uniform heat pump loads



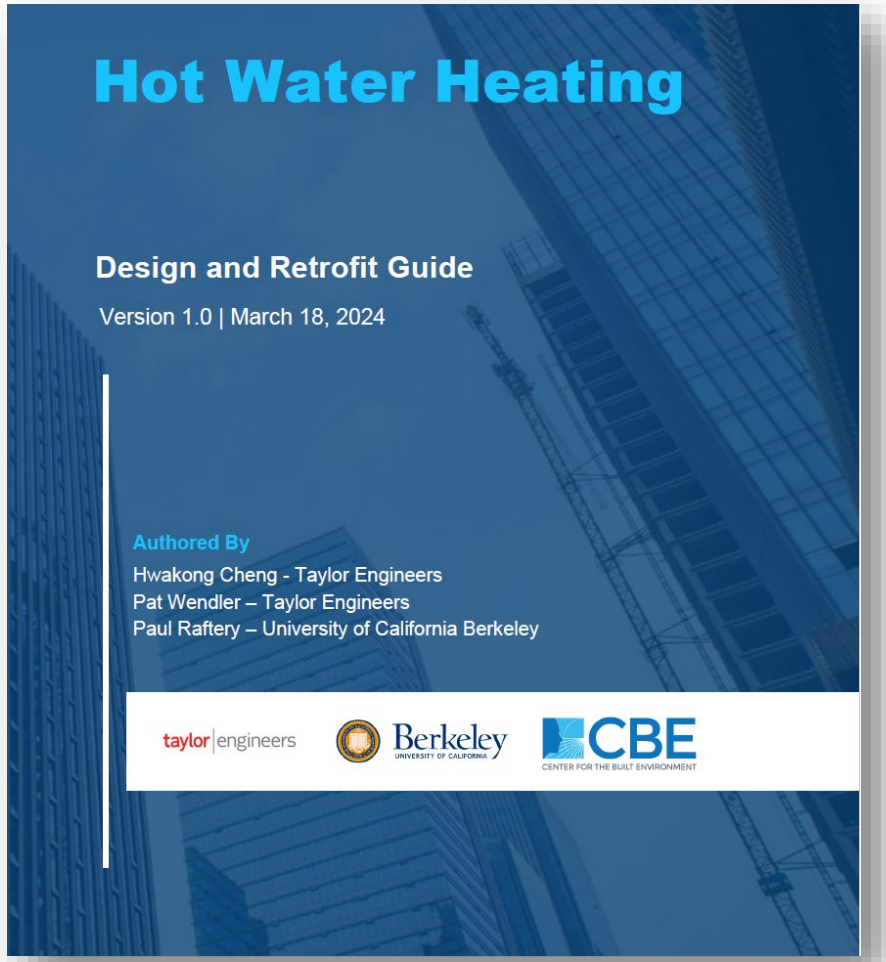
There is more potential to reduce emissions through efficiency than people think.

How to identify buildings to scale these savings?

Look for office buildings with any of these characteristics:

- A *single, old* non-condensing boiler
- Poor boiler turndown (> 3 BTU/hr.ft²)
- Zone minimum air flow rates ≥ 30% of max
- Heating plants that run 24/7 or don't reset to low temperatures in summer
- Summer gas bills > 700 BTU/month.ft² (assuming no other major gas use present)

More info in new design guide



Recommendations for existing buildings

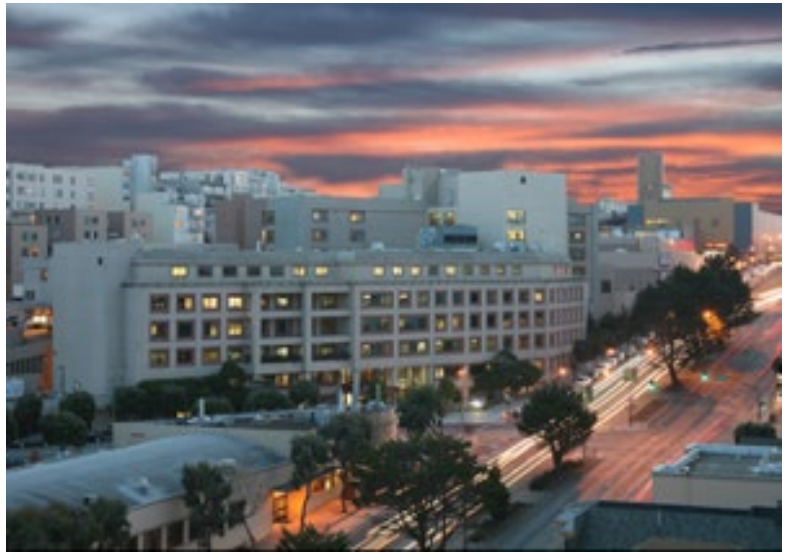
- Make a decarbonization plan for each building
  - 5-10 year timeframe
  - Consider synergies with other planned activities (end-of-life replacement, upgrades, renovations, new construction)
  - Understand constraints (space, structural, electrical…)
- Install building level HVAC metering
- Perform deep controls & efficiency measures
- Winter testing
- Then electrify

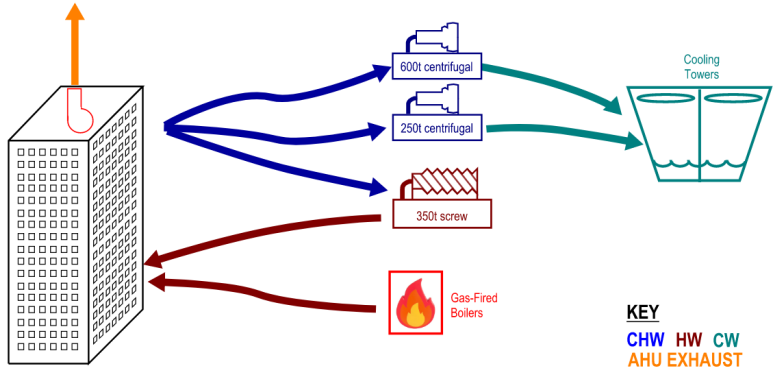
Existing buildings are most of the pie:
Two thirds of buildings globally will still exist by 2040

Next steps

- New CEC project starting this fall (5-year, $6M)
- Focused on decarbonizing existing large buildings through heat recovery, AWHPs, and storage using ultra-low global warming potential refrigerants
- Looking for:
  - Full and partial electrification example projects
  - Case studies to compare energy, emissions or comfort before and after
  - Interviewees for current practices, lessons learned, innovative solutions.

  Technical advisory committee members





Q&A

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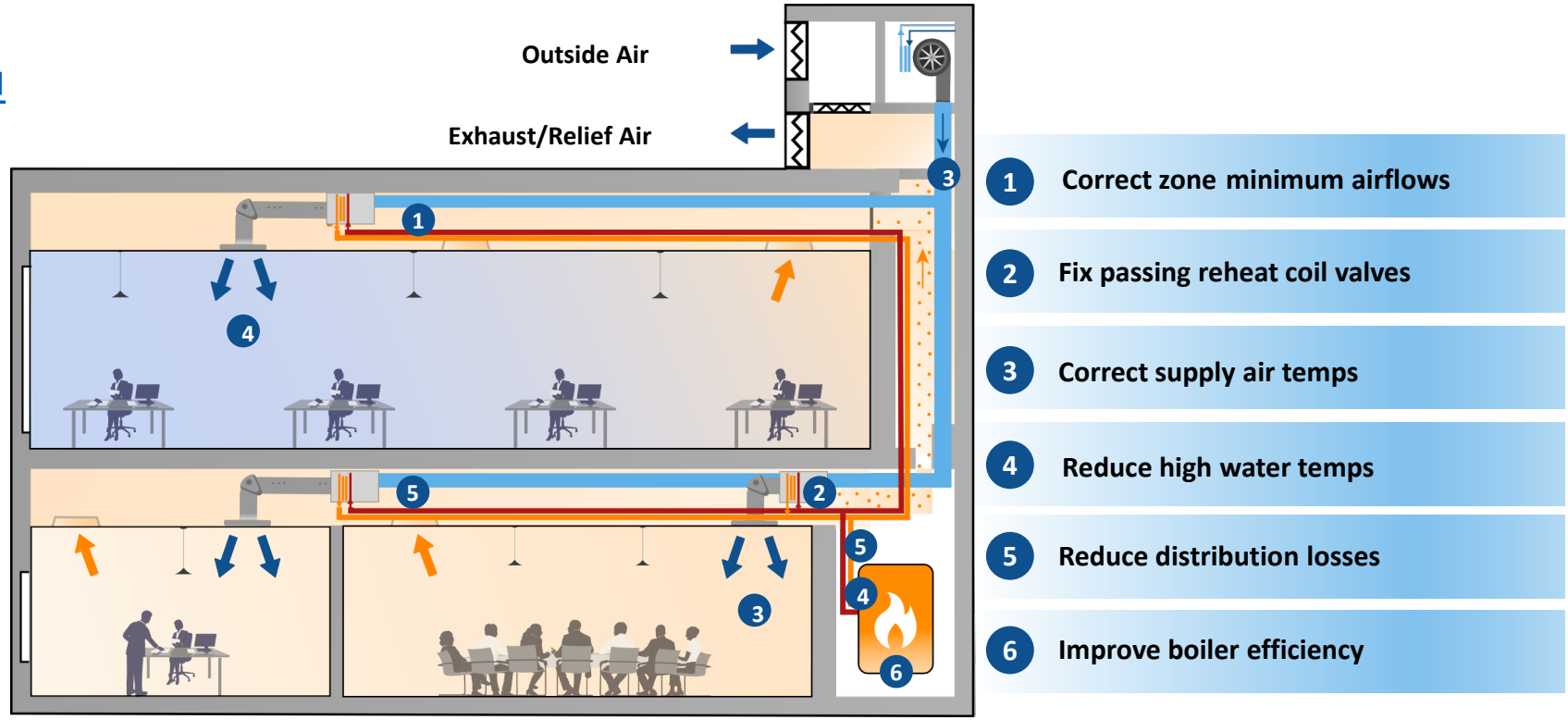

1. Correct zone minimum airflows
2. Fix passing reheat coil valves
3. Correct supply air temps
4. Reduce high water temps
5. Reduce distribution losses
6. Improve boiler efficiency

https://cbe.berkeley.edu/research/reducing-gas-consumption/