BUILDINGENERGY NYC

Will Heat Pumps Break the Grid? Here's Real Data!

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Northeast Sustainable Energy Association (NESEA)
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Learning Objectives

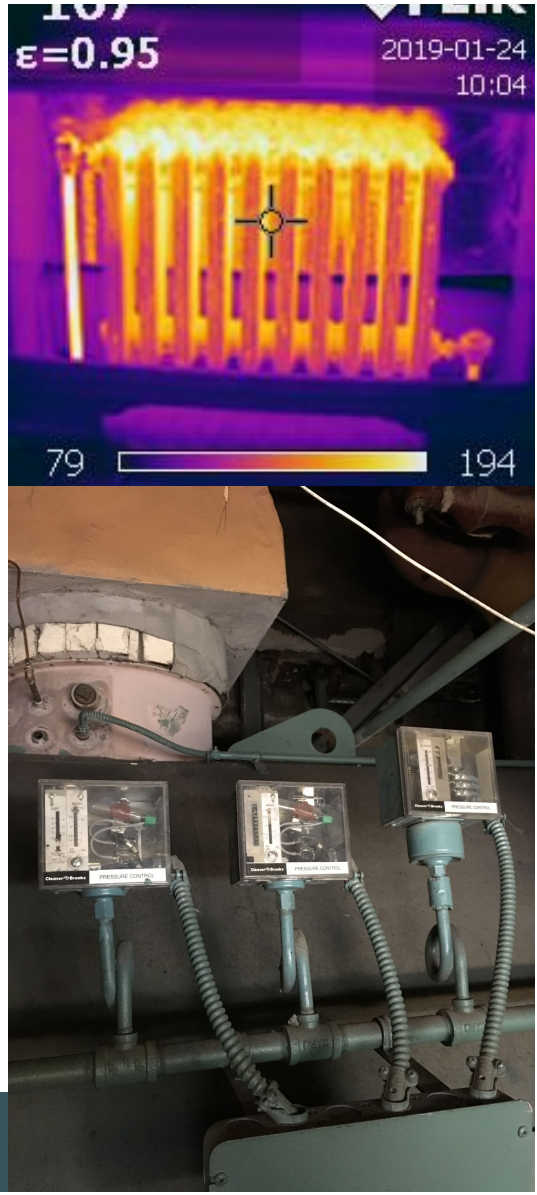
1. Describe how the studied electric heating peak demands compare to fuel heating peak demands.
2. Understand how electricity baseload changes seasonally.
3. Understand why analytical approaches to electricity demand estimation are not enough without some measured ground truth.
4. Predict future grid impact using today's electric usage and equipment efficiencies.

Setting the Stage

- How can we anticipate **electricity demand profiles** of electrified heating systems in multifamily buildings?
- Financing, project development, and other criteria depend on the actual loads.

The Knowledge Gap

- Current performance of large, centralized heating systems is not a good indicator for a more controllable, efficient heating system.
- Distribution losses, imbalance, poor control of large centralized systems are hard to capture in a model
  - Energy modeling reflects a standardized condition to compare design alternatives against each other.



What is Fossil Fuel Heat?

- Powered by natural gas or oil
- Central plant that burns the fuel, pipes throughout the building
- Pipes may be filled with steam or hot water

What is an electrically heated building?

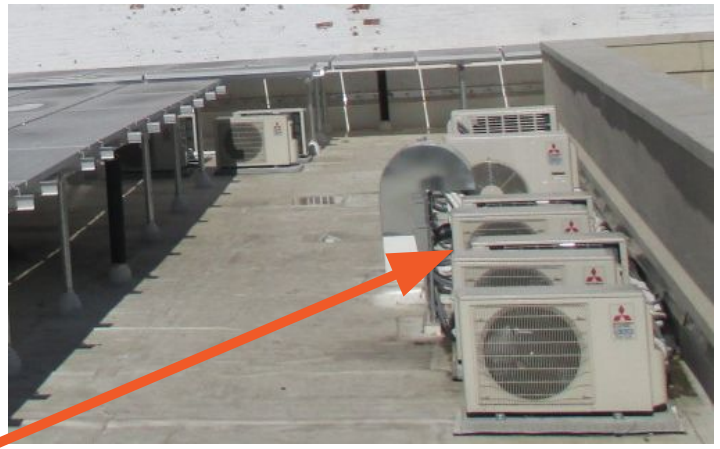
Older Buildings / Electric Resistance

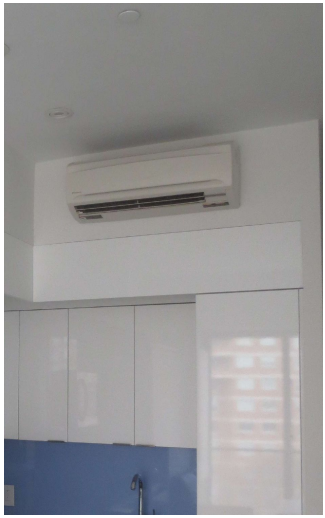
- Uses electric resistance for space heating of the apartments
- Could be:
  - Electric baseboards
  - Electric Packaged Terminal Air Conditioners (PTACs)
  - Non-cold climate PTHP with electric resistance supplemental heating

What is an electrically heated building?

Cold Climate Heat Pumps

- Could be:
  - mini-split per apartment
  - ground source HP
  - commercial scale central plants





What Did We Study?

- Purpose:
  - Present the anticipated demand of electrically-heated buildings to **inform the effects of electrification of existing multifamily buildings**
- Intended Outcome:
  - Supply information about electric demands to help plan:
    - Future grid infrastructure
    - Demand Energy Response (DER) requirements

Thank you to:

NYSERDA for funding and reviewing this research

NYC building owners who participated

What we studied: electrically-heated MF buildings

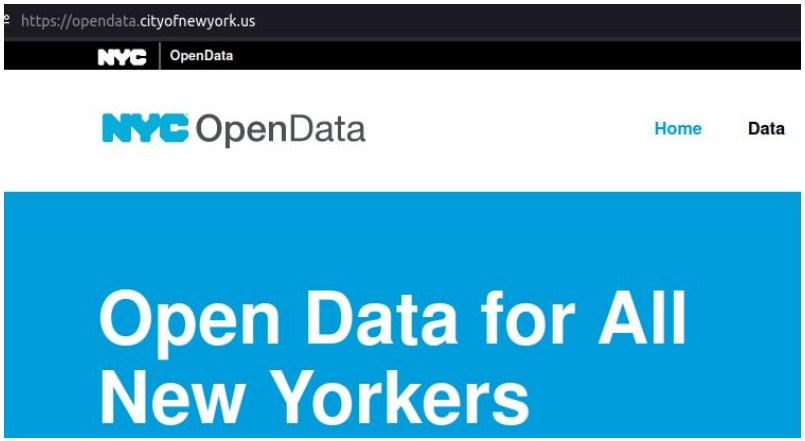
Old electric MF: similar to old fuel MF

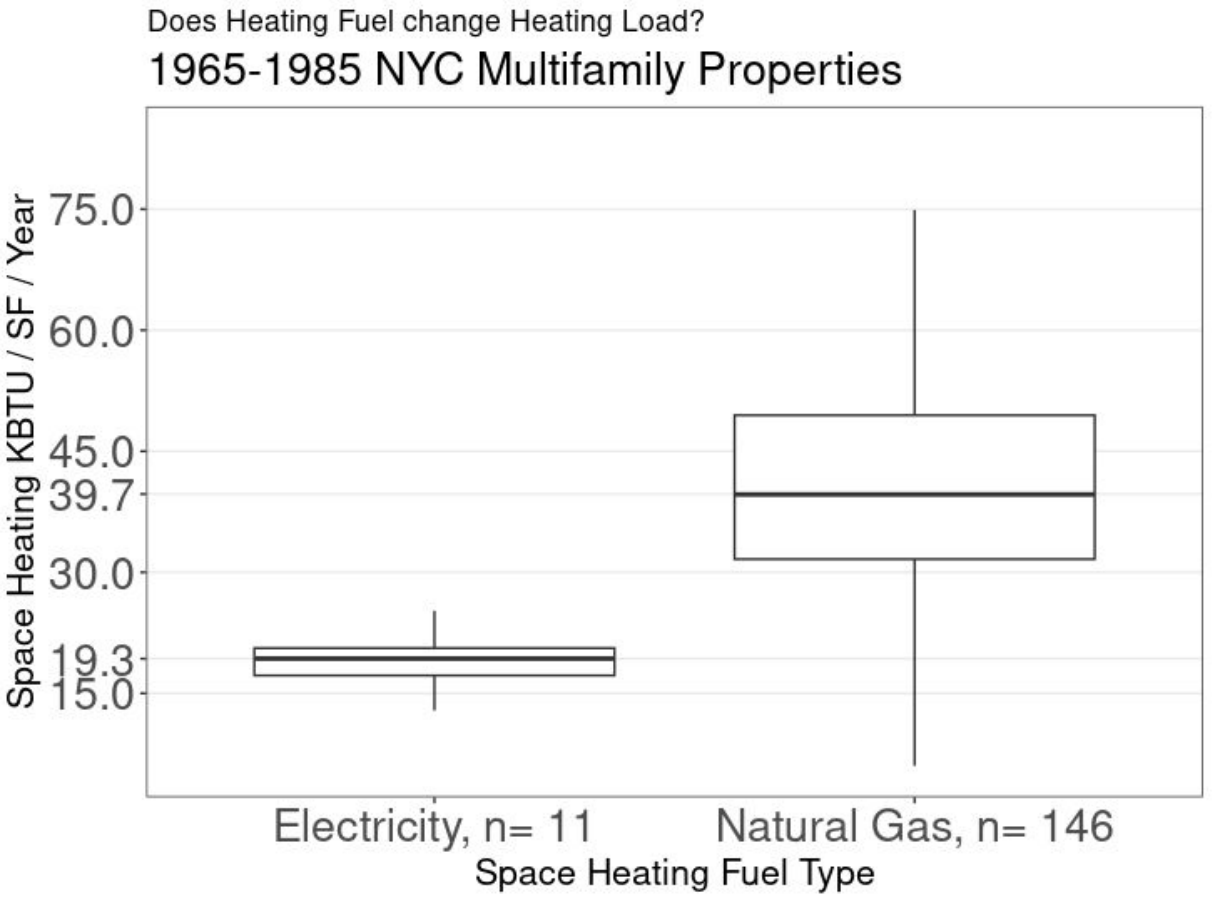
Electric Heat

Natural Gas Heat

Electric Heat

The initial question: why are they so different?

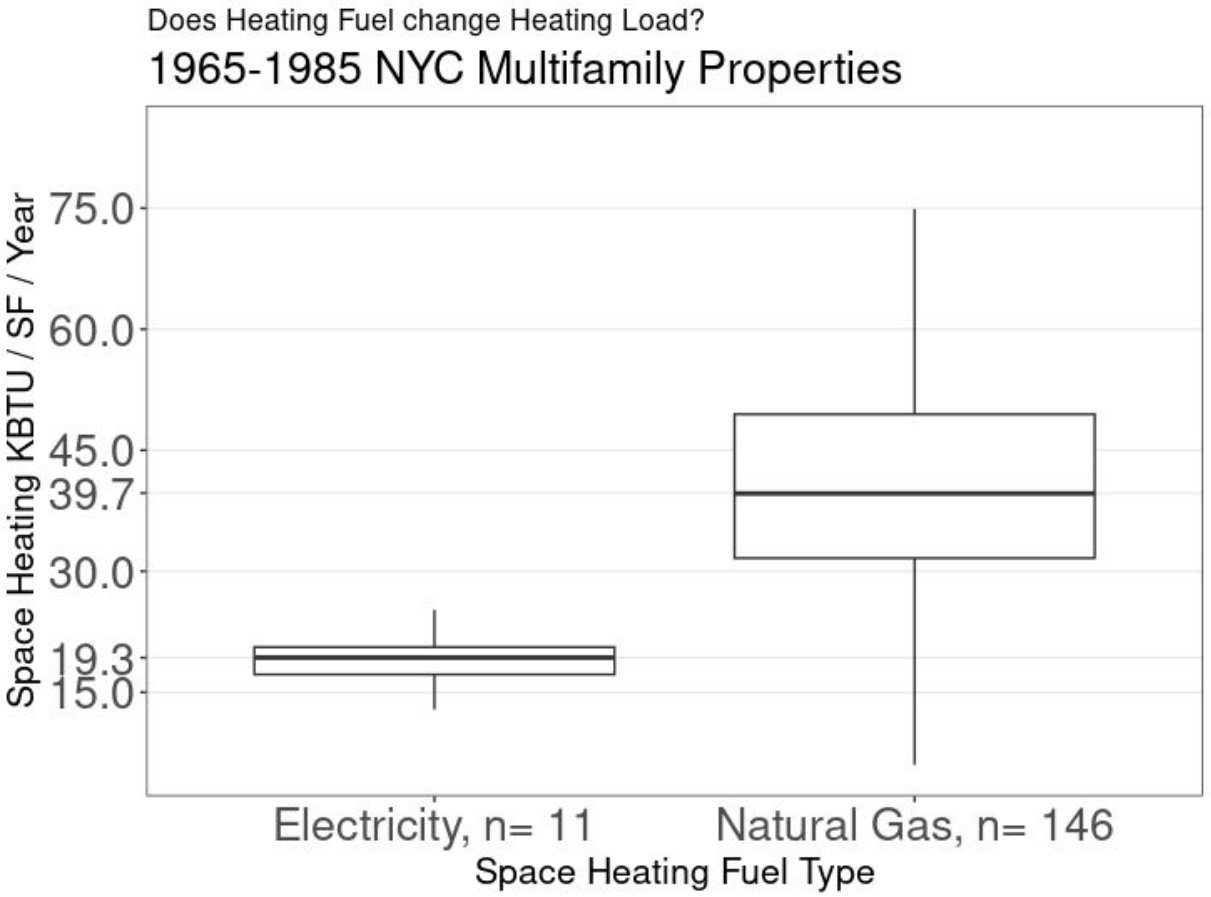




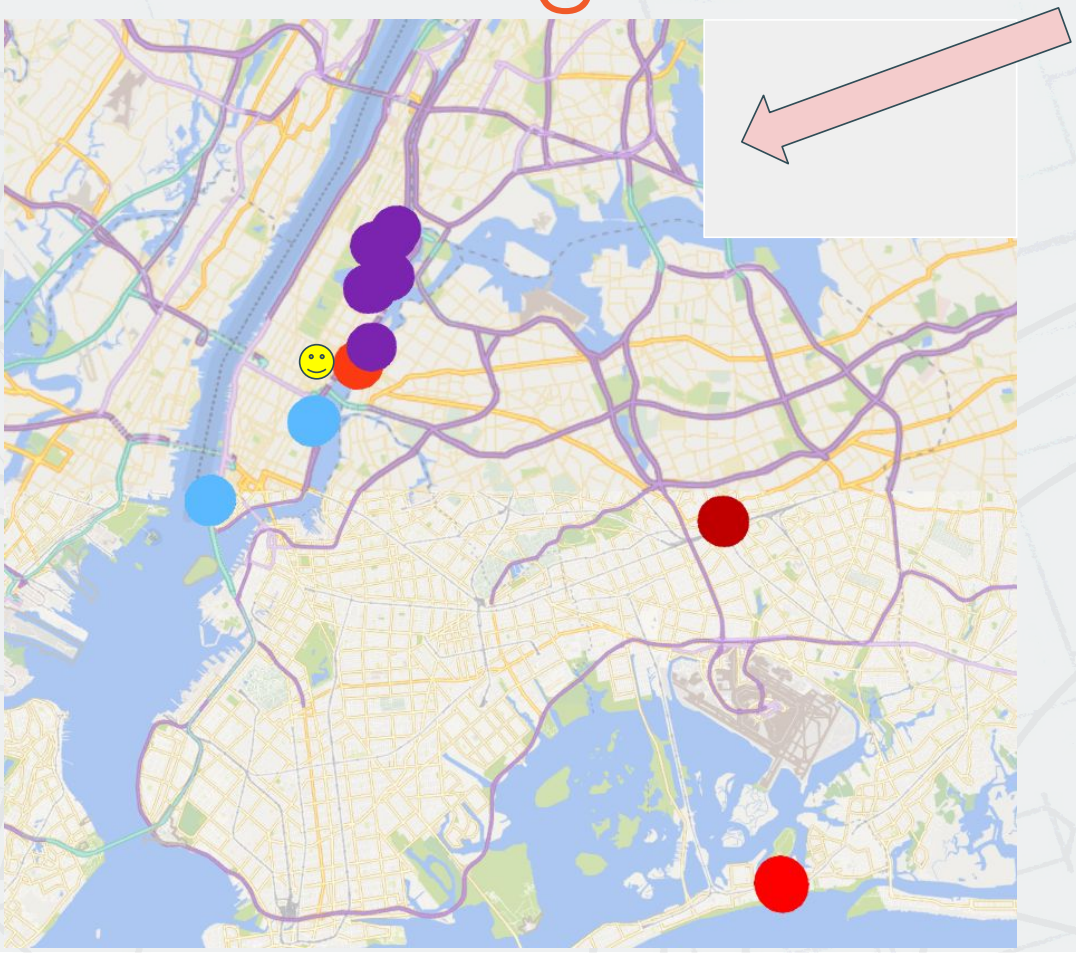
The initial question: why are they so different?

Compared to electricity-heated peers, these fuel-heated properties have:

- 2x heating usage (median)
- 3x relative range of heating usage



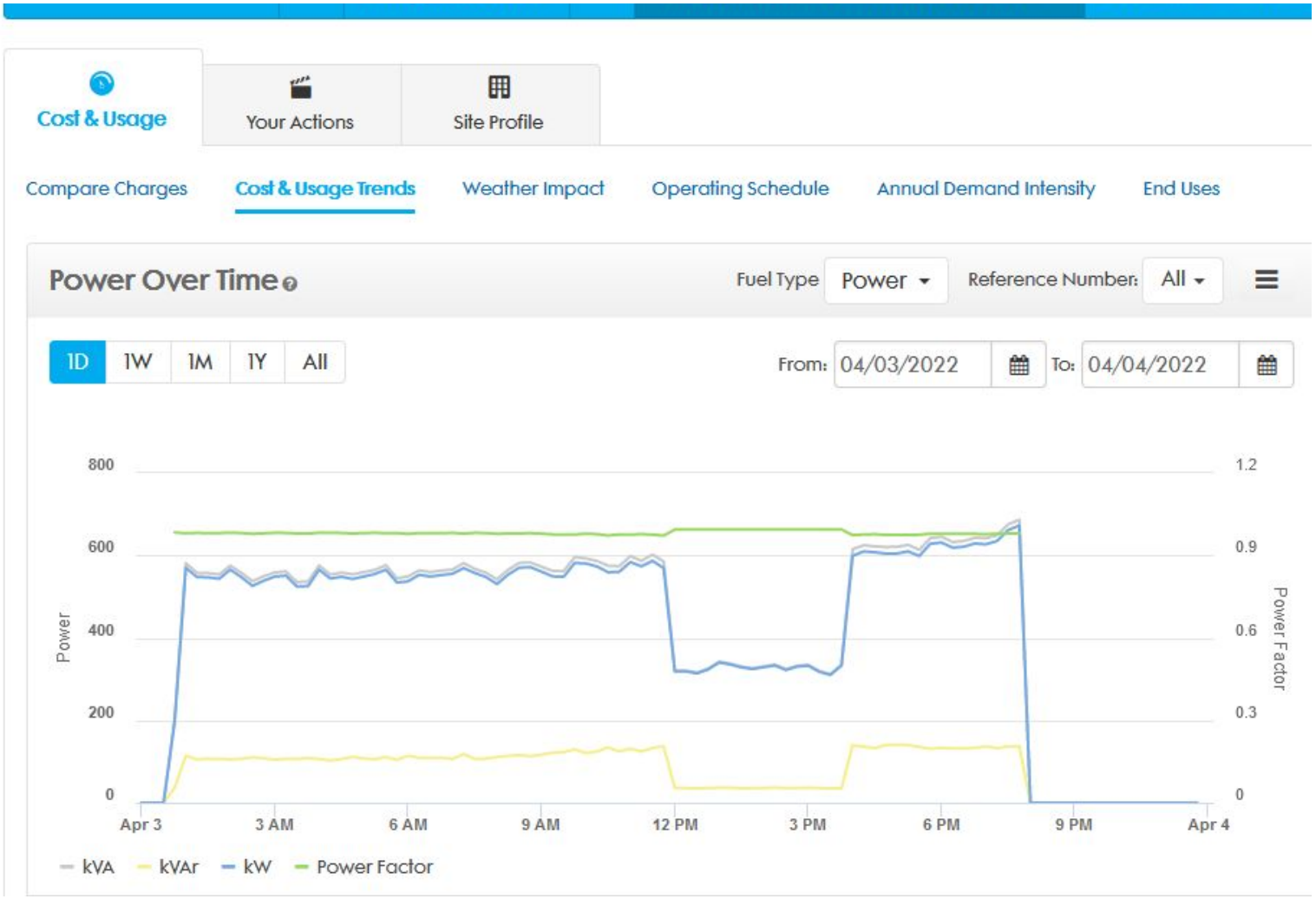
The Buildings



Year Built	Heating	Gross Floor Area [ft2]	Floors
1975	ER baseboard	666k	38
1975	ER baseboard	795k	42
1975	ER baseboard	693k	40
1972	ER baseboard	360k	13
1974	ER baseboard	680k	34
1974	ER baseboard	343k	32
1974	ER baseboard	43k	9
1969	ER baseboard	804k	16
1975	PTHP	447k	40
1975	PTHP	447k	40
1973	PTHP	341k	37
1983	PTHP	1,800k	34
2014	ASHP	89k	11
2017	VRF	266k	26
2019	GSHP	121k	9

Process

- Owner approval
- All remote data access via utility or prior monitoring
- 15-minute data
- Master or sub-metered
- Add weather
- Add building information



Heating Demand Intensity Findings

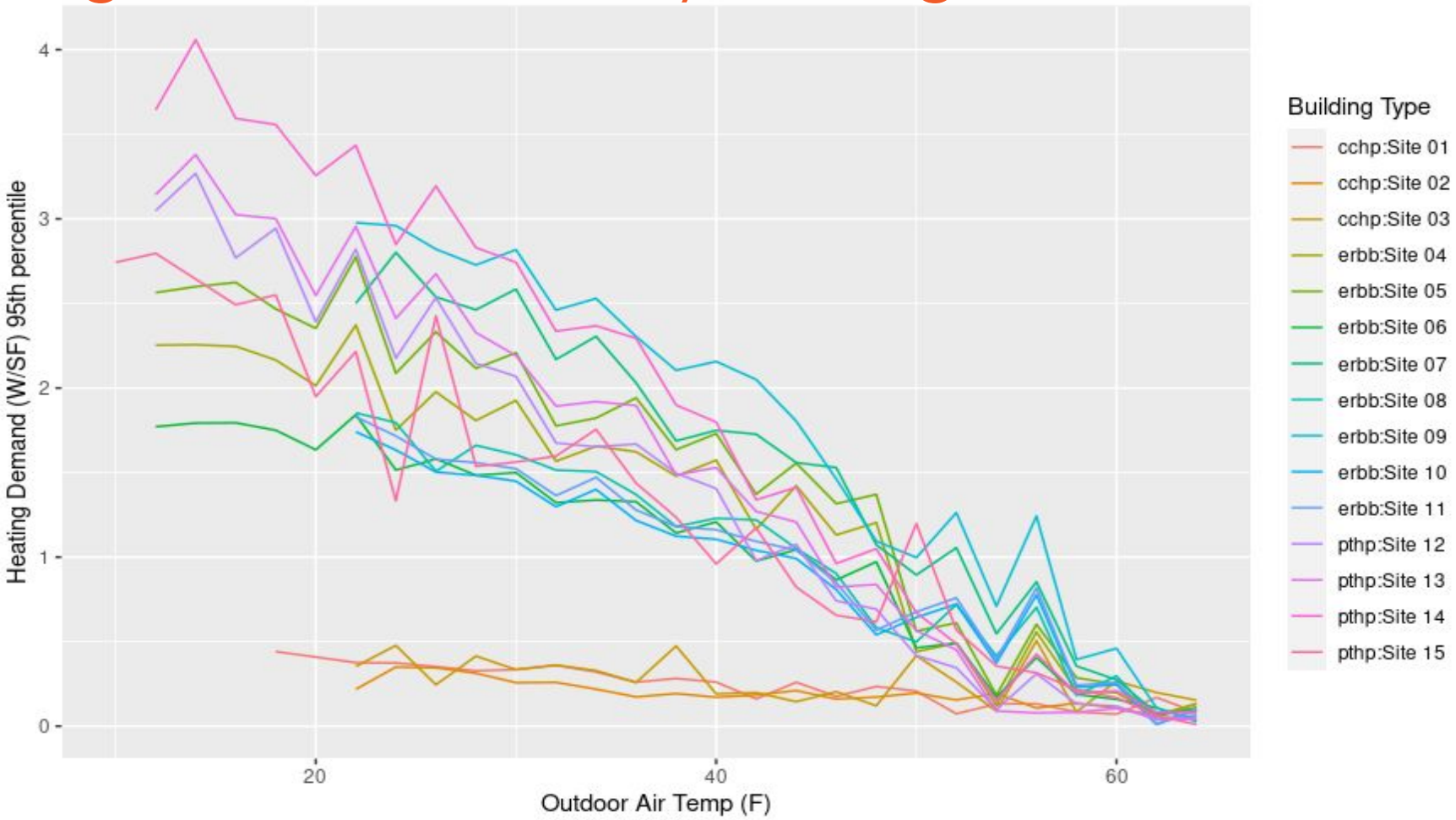
Electric Resistance Heating Demand Has a Strong Linear Relationship with Outdoor Temperature

New cold climate heat pump buildings are harder to predict

Next chart shows:

- Heating demand peak in Watts/SF vs outdoor temperatures
- Baseload electricity use is removed (this is just heating)

Heating Demand Intensity Findings



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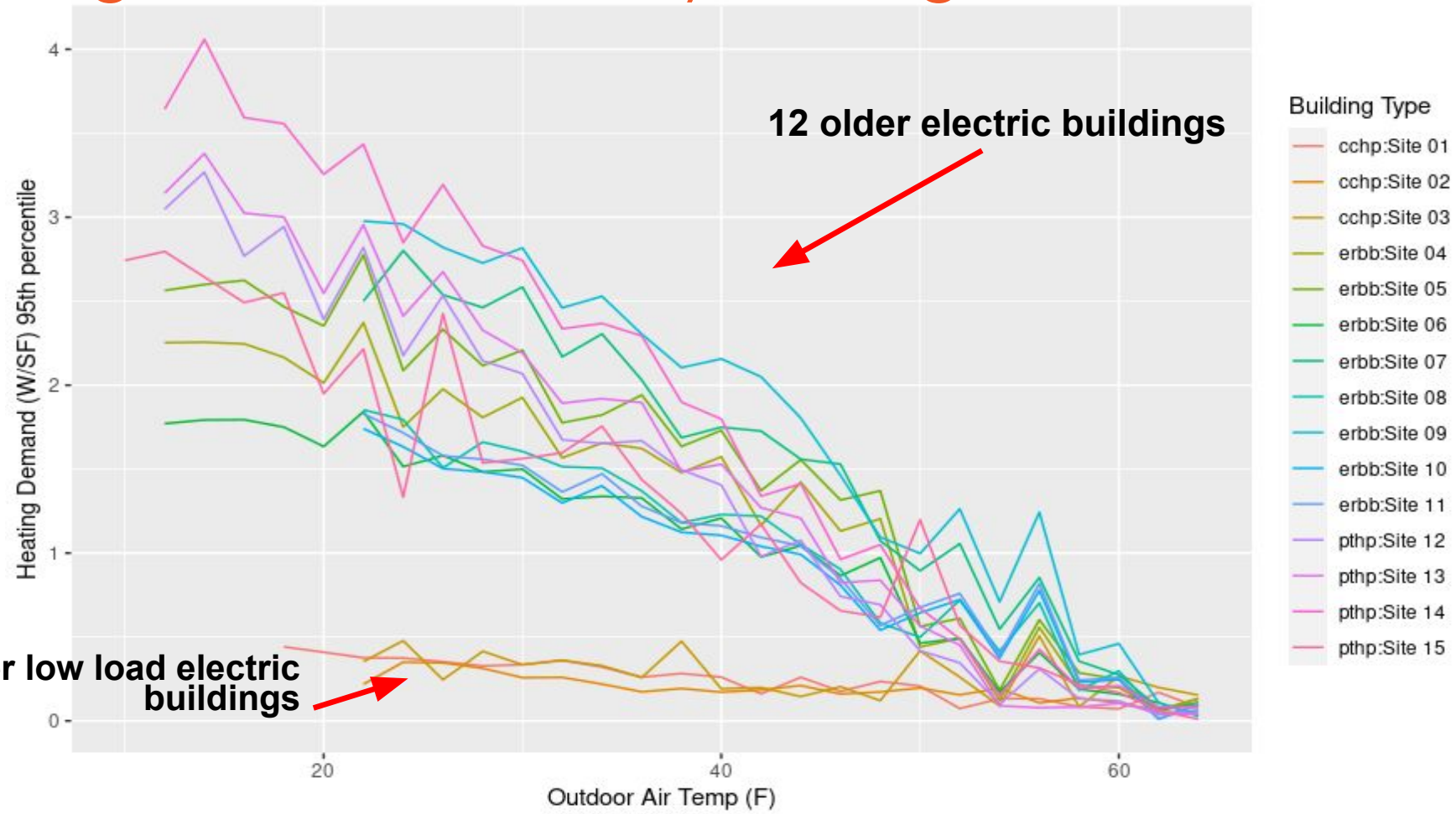


Building Baseload Demand Findings

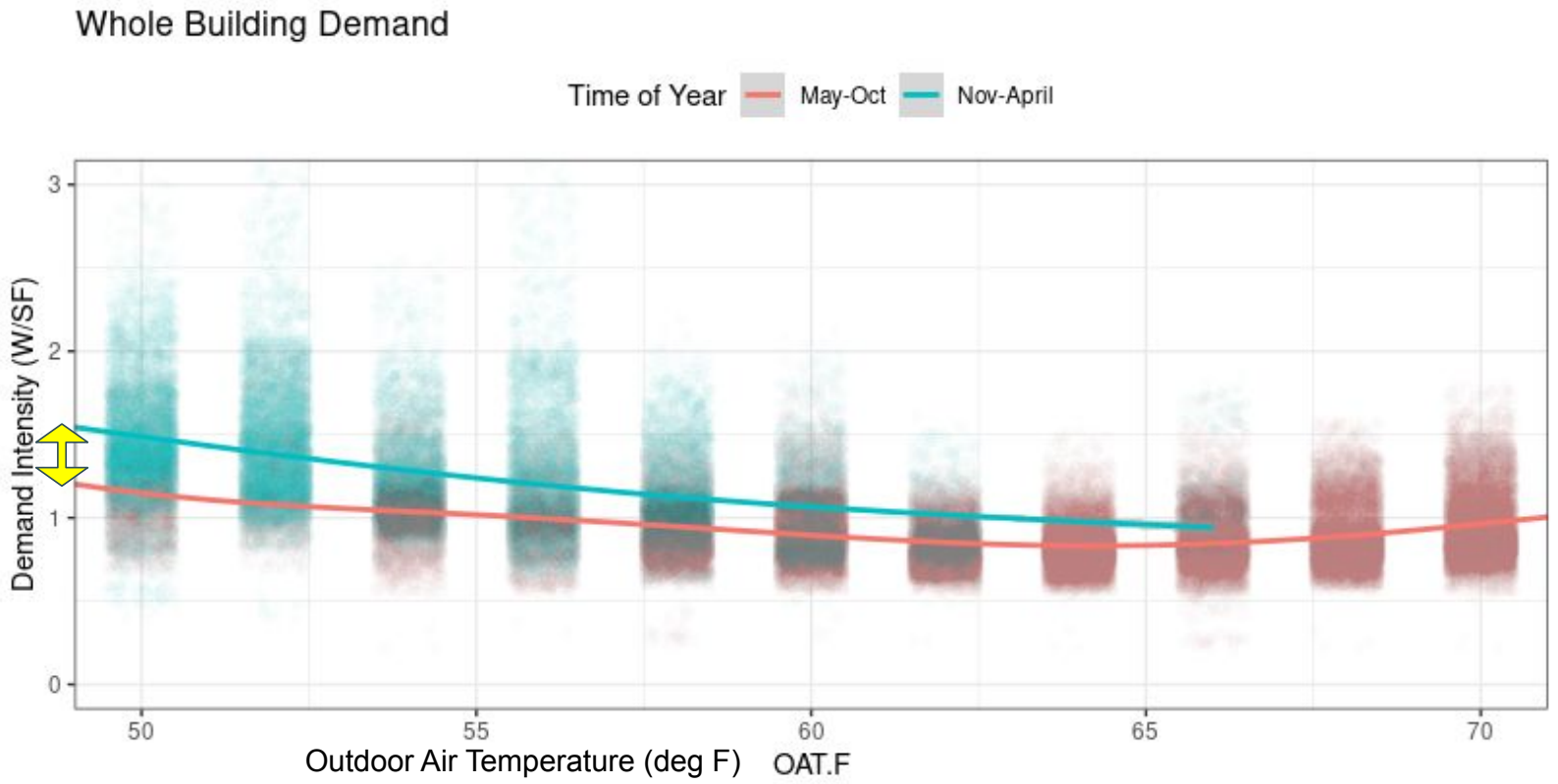
Baseload: not heating or cooling

- Common practice: use summer load (minus cooling) as winter baseload
- What we miss if we estimate heating use by comparing to summer use:
  - Vacations and split residence
  - More time outside in the summer
  - Longer days in the summer = less lighting

- With 15-minute data, we can look specifically at **warm winter days versus cold winter days** and see the differences

- Winter electricity baseload may be 0.25 to 0.4 W/SF higher in winter than non-winter.

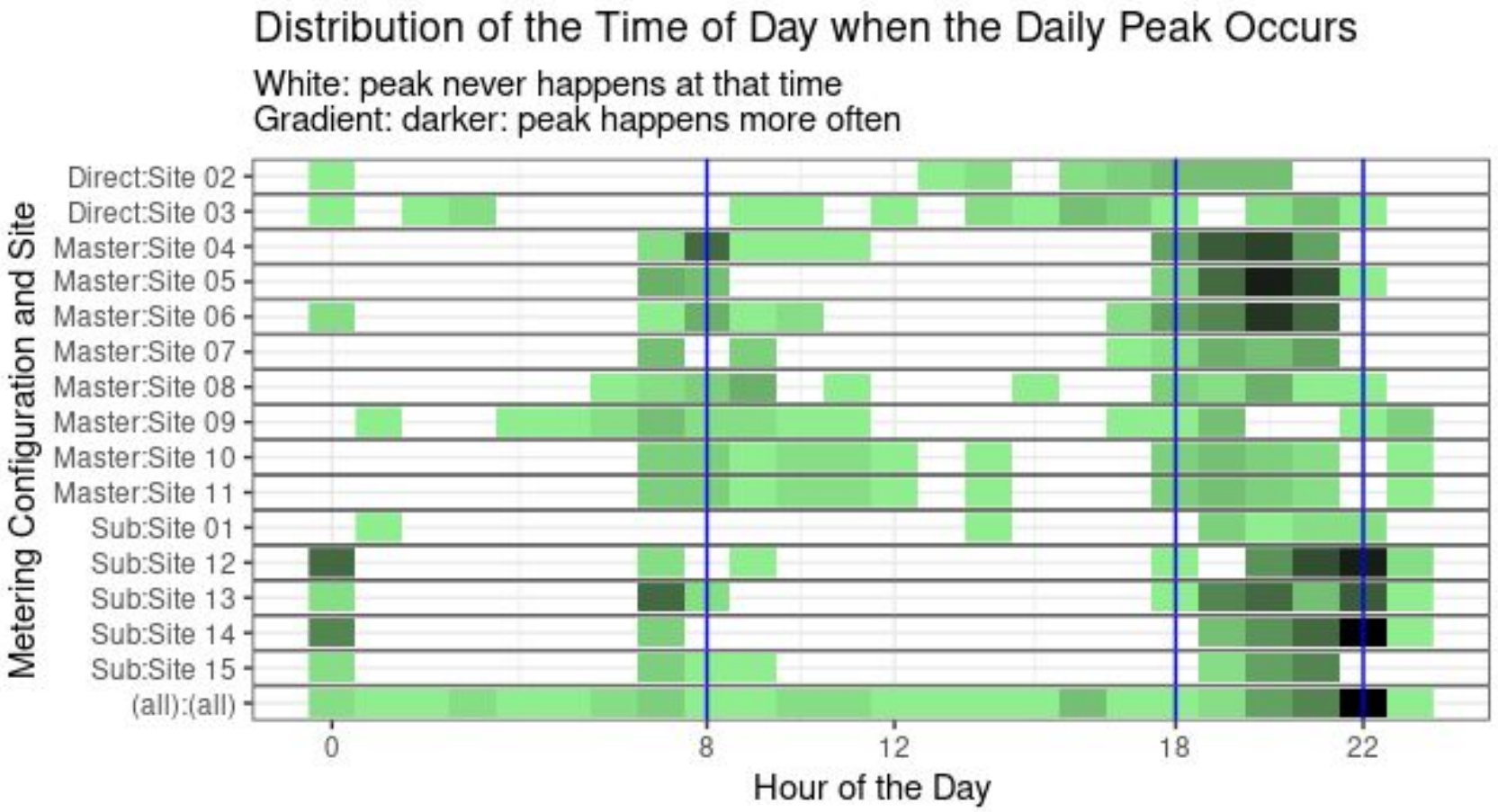
Building Baseload Demand Findings
Blue Winter versus Red Not Winter



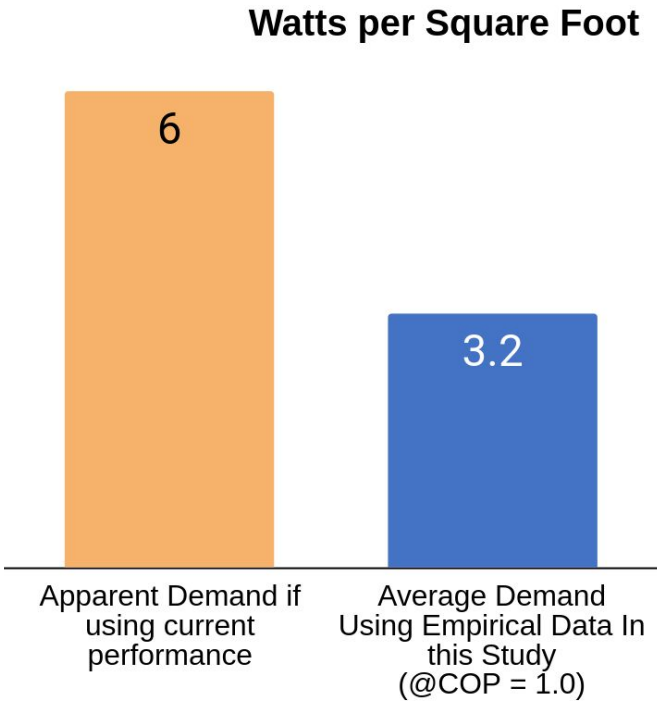
Building Demand Peak Time of Day Findings

- Other use in the building is also important when trying to predict **whole building** peak
- Peak typically happens in the afternoon/evening
- This is usually the **warmest** time of day, not the coldest

Building Demand Peak Time of Day Findings



Summary - Heating Demand at 5°F Older Electric Resistance Buildings



*Watts/SF of apparent heating demand = Typical Fossil Fuel Heat slope * boiler efficiency * 60 HDD / 24 Hours / 3.412Btu/W

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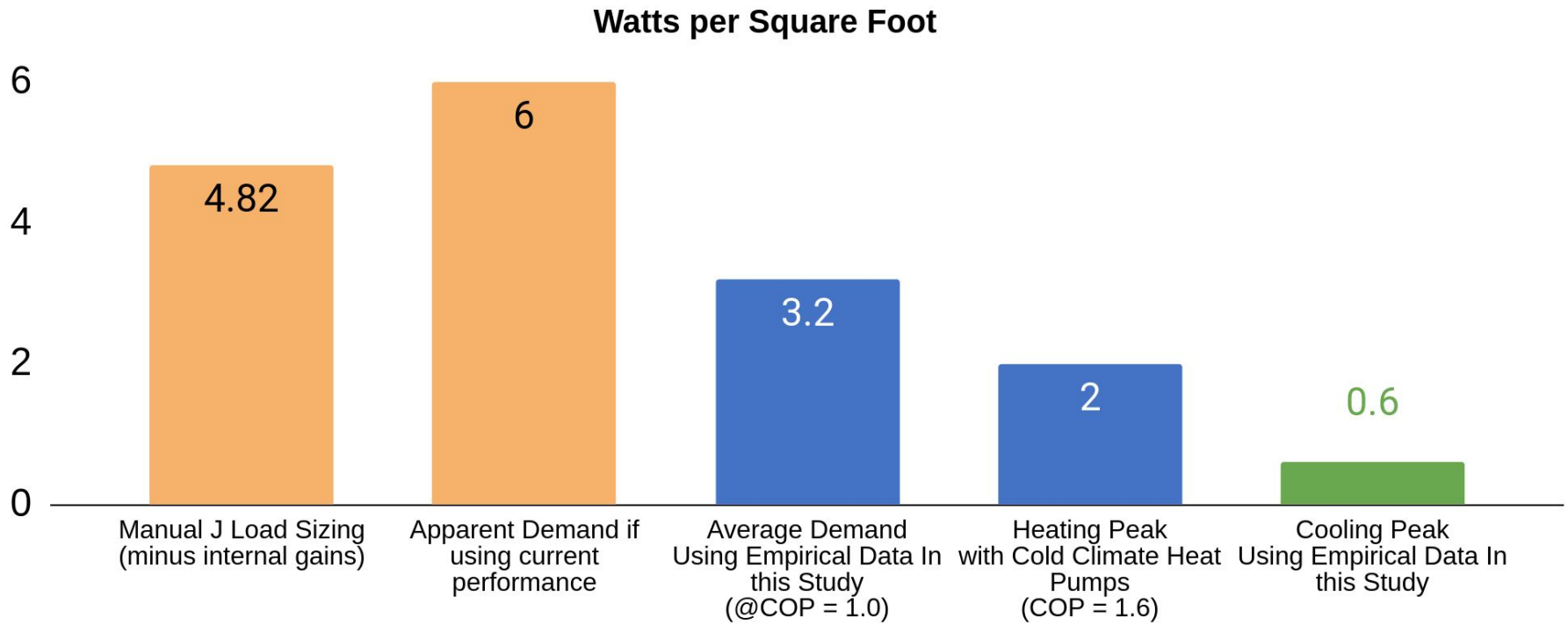

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Will heat pumps break the grid?

This is not the answer, but it teaches us:

- Some existing buildings can teach us a lot about future scenarios
- To look for ground truth to test modeling assumptions
- Strain on the grid may be less than we thought

Questions / Suggestions?

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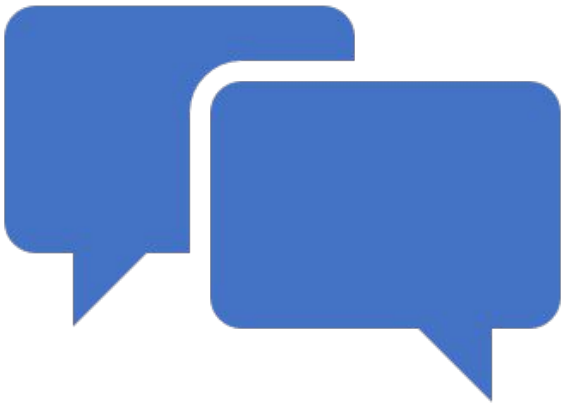

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