BUILDINGENERGY BOSTON

Proof over Promises:
Cold Climate Multifamily Retrofit Results

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Northeast Sustainable Energy Association (NESEA) | March 23, 2026

slipstream

Climate Solutions for everyone.

The knowledge, people, and resources to solve our biggest energy challenges.

Four Studies

Air to Water Heat Pump Conversions

- It’s just a simple swap out, right?

Ductless Heat Pump Controls

- Who’s really in control here?

Full Electrification Retrofit

- A sum better than its parts?

120V Heat Pump Water Heater Replacements

- Are these still running on fumes?

Air to Water Heat Pumps

On-going objectives:

- What are the **installation barriers**
- What are the **performance impacts?**
- Do **systems provide both sufficient heat and hot water**?
- What are the **comfort impacts?**
- What is the **load shifting potential**?

4-unit MF Retrofit

- 2x Enertech Advantage monoblocs
- In-floor radiant heat + DWH
- Gas backup

SF Retrofit #1

- Enertech Advantage monobloc
- In-floor radiant heat + DWH
- Electric backup

SF Retrofit #2

- LG Therma V monobloc
- In-floor radiant heat + DHW
- Cooling through air handler
- Gas backup

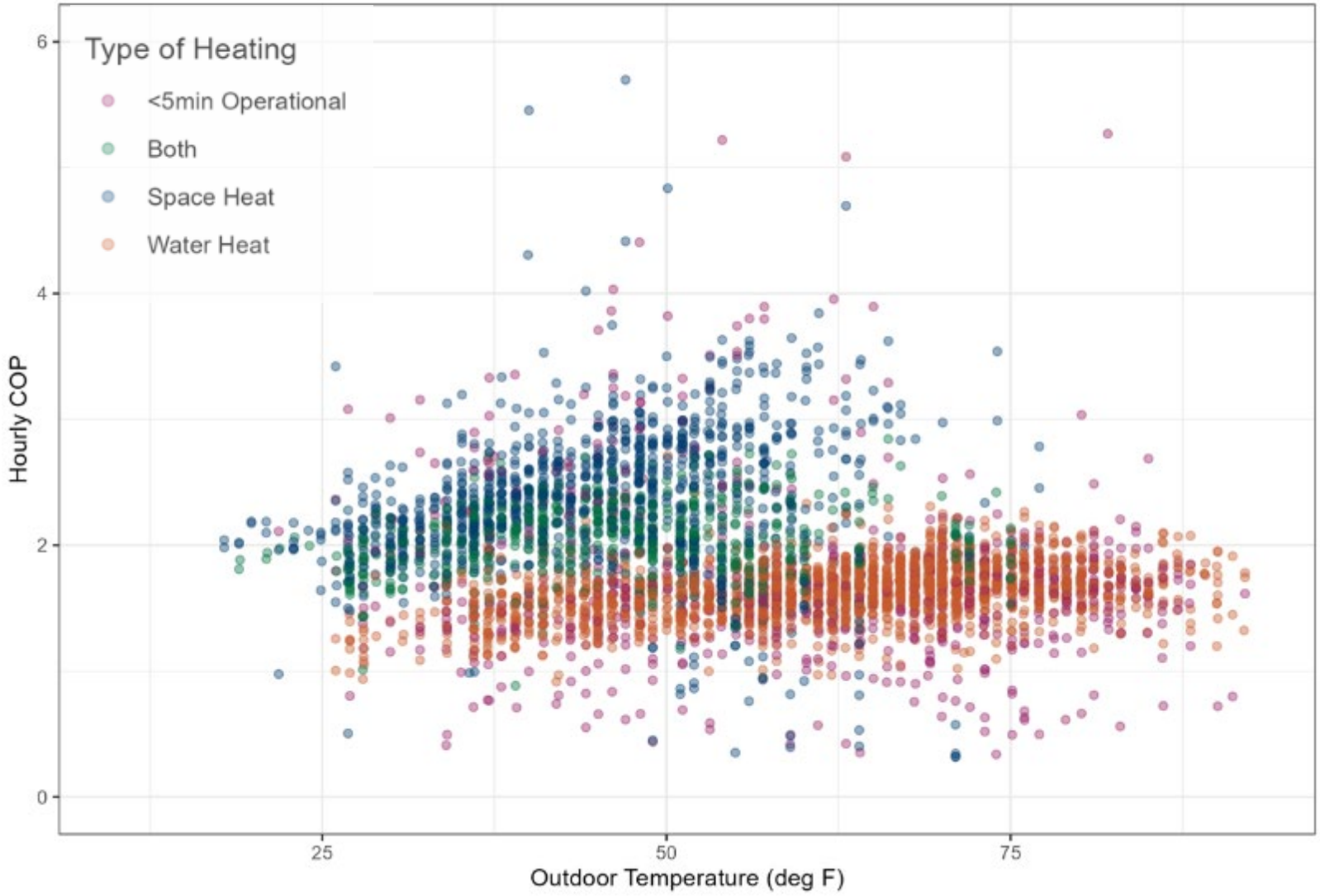
Multifamily Retrofit

Installation

- Required electrical panel upgrades
- Install went well with geothermal contractor leading

Performance

- Space heating performed well
- Water heating COPs significantly lower than space heating driven by lift to maintain 125F



Multifamily Retrofit

Utility impacts

- Operational costs estimated to go up with the AWHP driven by the relatively low cost of natural gas

Installation costs

- The installation cost for each of the 4-units was approximately $25,000

	Electricity	Natural Gas	Net Energy	Estimated Annual Costs
Unit costs	$0.1357/kWh (marginal rate)	$0.84/therm (marginal rate)		
Pre-retrofit Use (Actual)	1,604 kWh	1,952 therms	201 MMBTU	$2,748
Post-retrofit Use (Modeled)	16,886 kWh	26 therms	61 MMBTU	$3,194
Net change	-15,282 kWh	1,926 therms	140 MMBTU	-$446

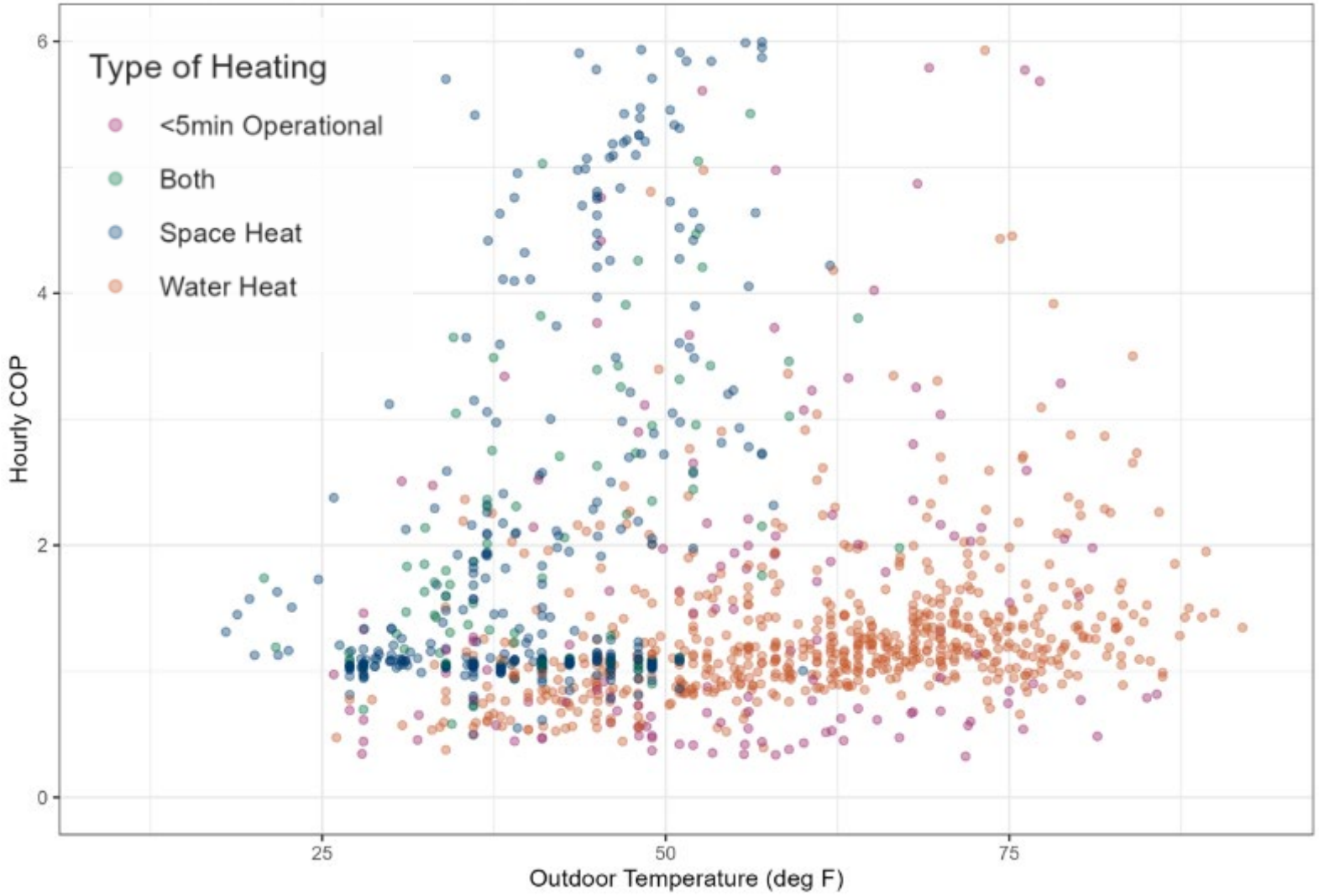
Single Family Retrofit 1

Installation

- Initial installation went well with experience AWHP contractor
- Firmware issues on AWHP controls disrupted early operation
- Subsequent compressor issue with HP

Performance

- TBD awaiting replacement compressor, current system is relying on electric backup



Single Family Retrofit 1

Utility impacts

- Modelled savings indicate potential for positive bill impacts due to the electric resistance heating baseline

Installation costs

- Total install was $43,000

	Electricity	Natural Gas	Net Energy	Estimated Utility Costs
Unit costs	Boiler and water heating are on variable rate meter: Summer rate $0.0901/kWh; Winter rate $0.0685/kWh	N/A		
Pre-retrofit use (Actual)	20,151 kWh	N/A	69 MMBTU	$2,344
Post-retrofit use (Modeled)	7,968 kWh	N/A	27 MMBTU	$1,504
Net change	12,021 kWh	N/A	42 MMBTU	$840

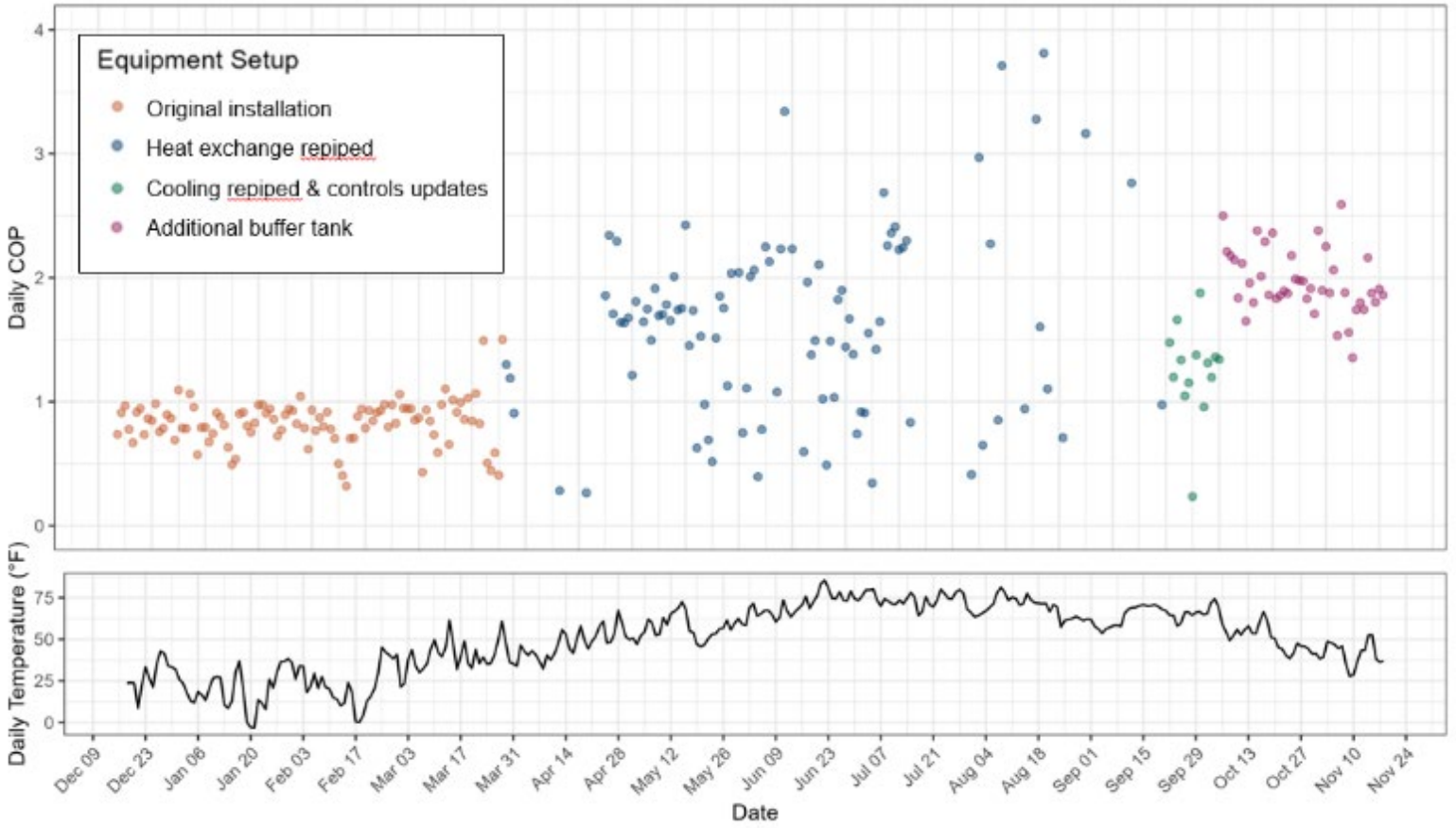
SF Single Family Retrofit 2

Installation

- On-going challenges with limited contractor A2WHP experience. Complex system serving HHW, DHW, furnace cooling

Performance

- Space heating performed okay after design and installation was reconciled



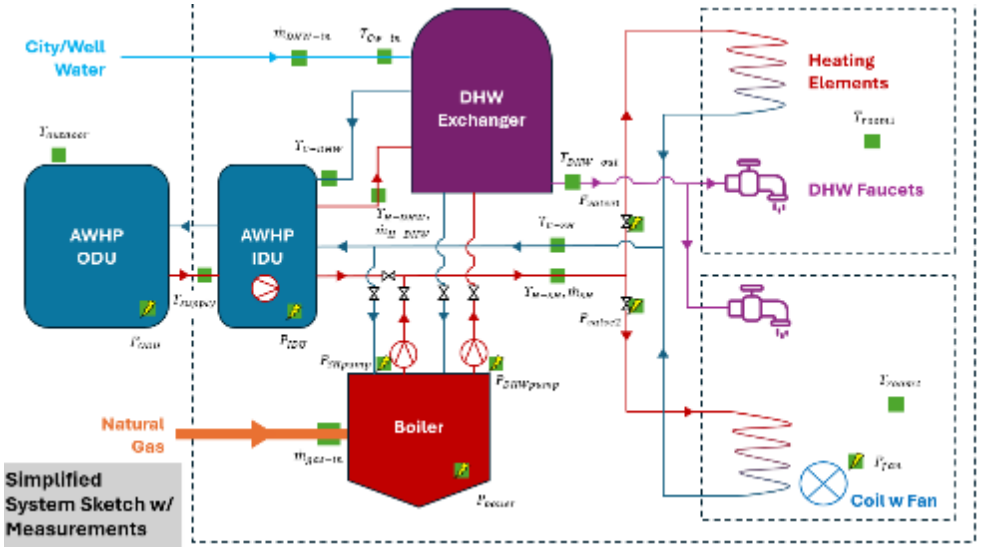
Single Family Retrofit 2

Utility impacts

- TBD

Installation costs

- Total install was $41,000



Ductless Heat Pump Integrated Controls

Objective:

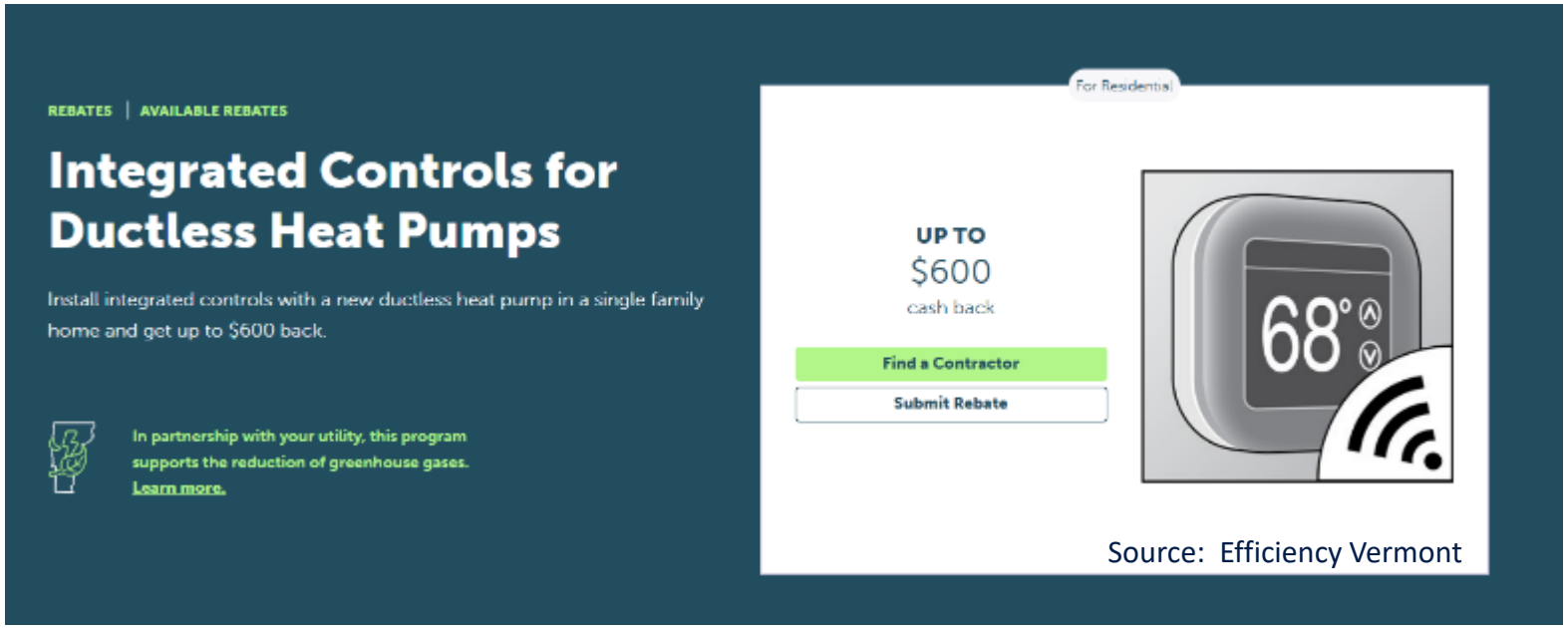
What can we learn about mini splits with integrated controls among households with existing electric heat?

- Installation ease?
- Energy savings?
- Comfort?
- Satisfaction?

Integrated Controls for Ductless Heat Pumps

An Emerging Product Class

- Incentivized (or required) by utility programs in New England and the Pacific Northwest
- Not much on the radar yet in the Midwest



Source: Efficiency Vermont

Integration Controls

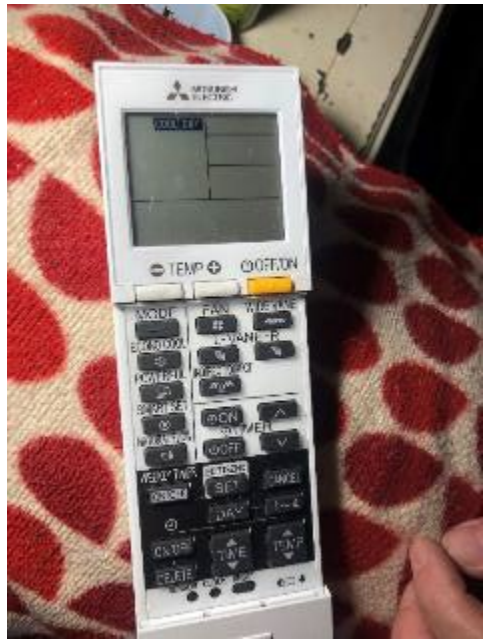
Site 1

- 3rd party t-stat + other components
- 3 trips to install (missing/incorrect parts)
- Cost: $2,457

Site 2

- LG wall-mount t-stats + other components
- 2 trips to install (missing part)
- Cost: $1,390

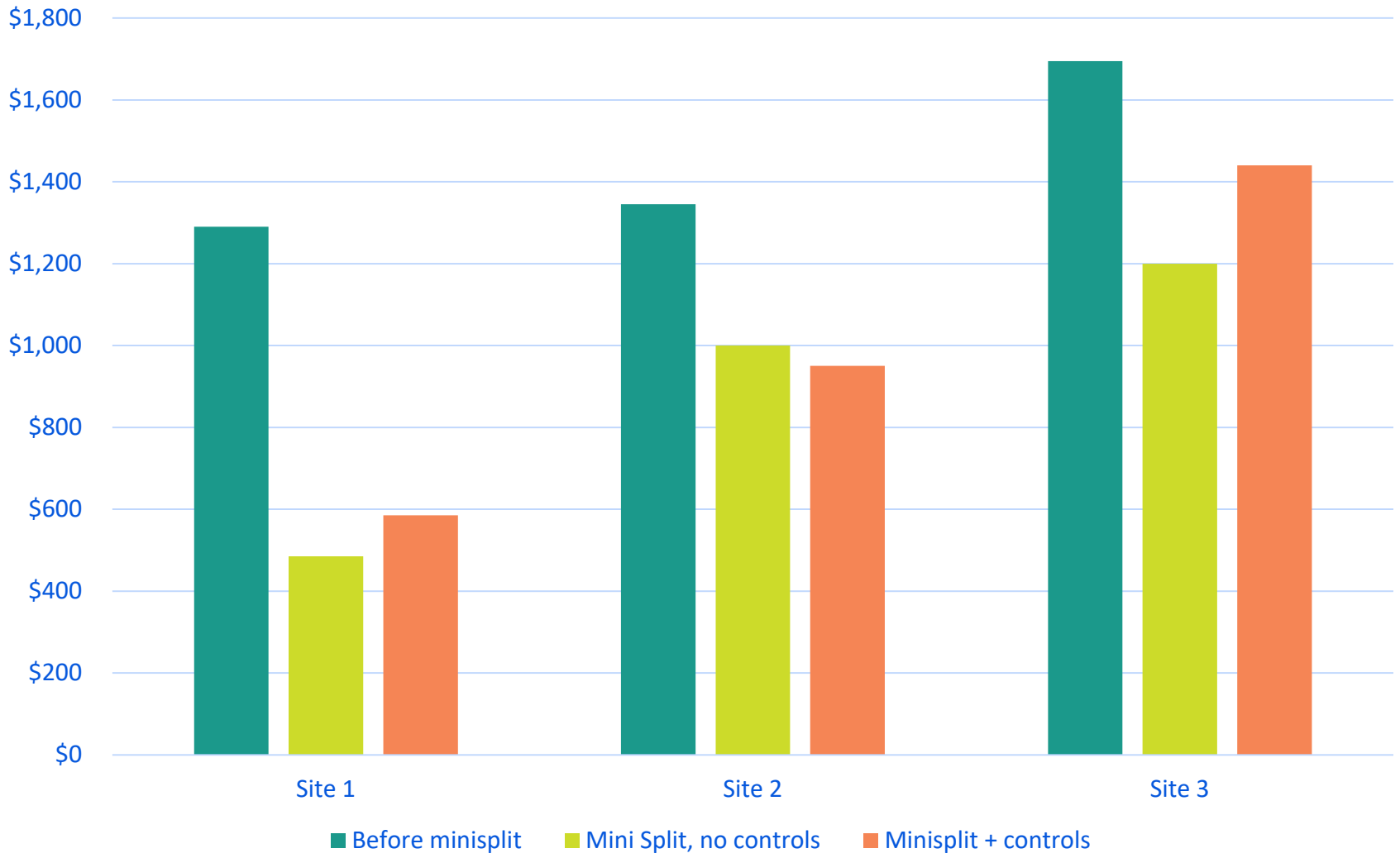
Site 3



- Mitsubishi relay kit + other components
- 1 trip to install
- Cost: unknown

Baseboard heat triggered if actual temperature 3F or more below setpoint (temperature droop)

Annual Heating and Cooling Costs (weather adjusted)



Interviews

All LOVED the mini splits

- Energy cost savings
- Improved comfort / better cooling
- Predictable indoor conditions

All were MEH about the controls

- Didn’t care
- Not needed
- Prefer the remote

Full Electrification

Objectives:

- What are the annual energy impacts of electrification in multifamily residential buildings?
- What are the indoor air quality (IAQ) implications of the electrification retrofits?

La Paz Apartments: Holistic Electrification

- La Paz Place is in Chicago, consists of three 4-story walkup buildings, and 44 units total
- The building was converted to all-electric space heating, water heating, clothes dryers, and cooking ranges

Equipment	Number of Units	Installations Begin	Installations Finished
Electric Cooktops	17	February 2022	February 2022
Electric Dryers	2	July 2022	July 2022
Ducted Heat Pumps	18	September 2022	Nov 2022
Heat Pump Water Heaters	5	March 2024	March 2024 + rework 2025

Heating Results

Time Period and Group	Average weather-normalized heating use	Heating Cost, 2022 rates	Heating Cost, 2023/24 rates
Pre-retrofit: furnace therms	276	$312	$241
Pre-retrofit: furnace converted kWh	8087	-	-
Post-retrofit: HP kWh	2460	$290	$290
Calculated Savings	5627	$22	-$49

Calculated using billing data

- Bill impact was rate dependent with savings flipping from positive to negative between ‘22 and ‘23/24
- 70% energy savings
- Indoor vs outdoor temperature deltas suggested equivalent comfort produced by the heat pump
- Heat stratification was observed, with lower floors heating more and higher floors heating less

Cooling Results

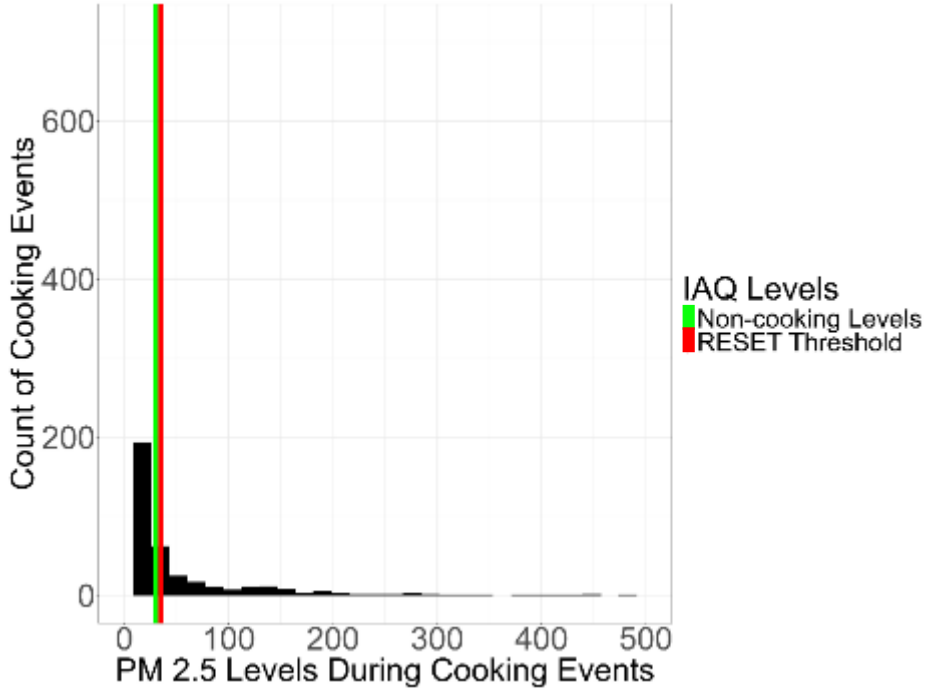
Group	Average weather-normalized cooling use (kWh)	Average Total Cooling Cost*
Pre-retrofit: Cooling use (window AC)	442	$57.90
Post-retrofit: Cooling use (window AC + HP)	85	$10.03
Calculated Savings	357	$47.87

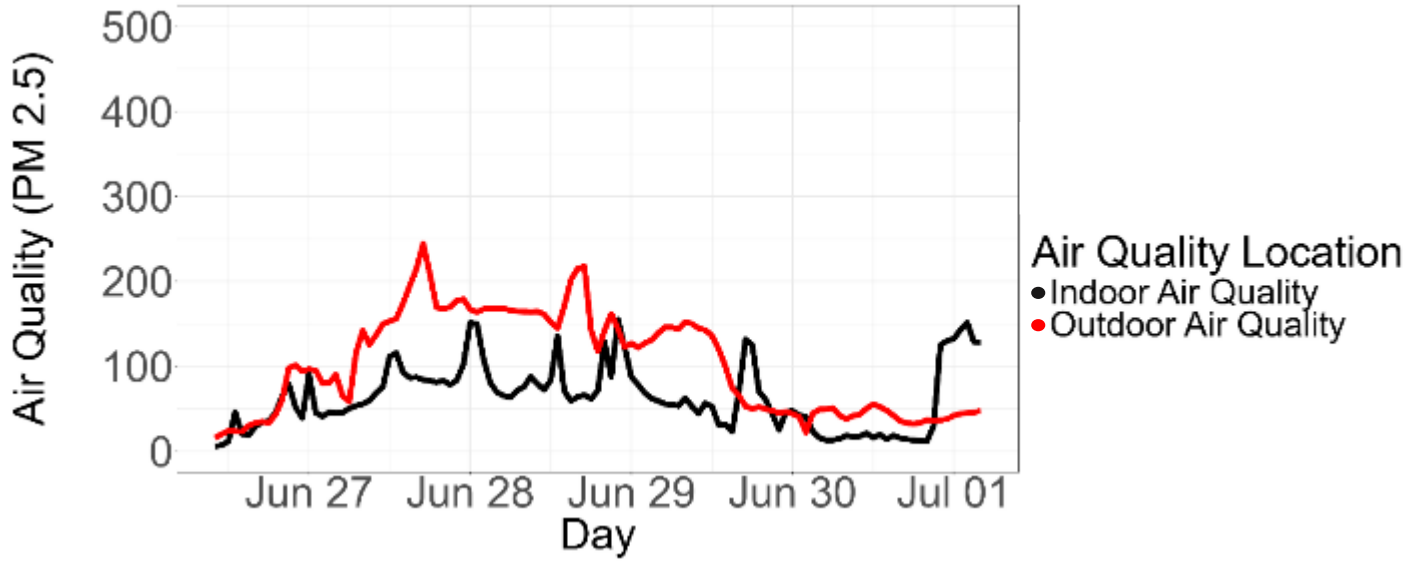
- Significant utility bill savings
- Billing data indicated a 80% energy reduction
- Only some units used the heat pump frequently to cool
- Indoor vs outdoor temperature deltas were notable, with post install performing much better (1F cooler) vs pre-install was (3F warmer) than outdoor air
- One unit kept their window AC and used it frequently

Indoor Air Quality Impacts

	CO2 (ppm)	VOC (ppb)	PM2.5 (ug/m3)
RESET Thresholds	1000	279	35
Pre-Retrofit	817	803	42
Post-Retrofit	710	416	25
Net Improvement	**117**	**387**	**17**

- Notable improvements to IAQ across all measures
- IAQ was not tied to outdoor air conditions, only in-unit activity unless extreme conditions
- Cooking events still decreased IAQ but still stayed in acceptable levels in a lot of cases





Pre/Post-Retrofit

Domestic Hot Water System

- Many challenges and lessons learned with the HPHW conversion
- Hot water needs were adequately met
- HPWH system used only 9% less energy than the pre-retrofit DHW system which was much lower than expected,
  - Likely due to faults in the recirculation pump and controls among some early design flaws
- Costs of DHW heating increased by more than 250%
- On going work to troubleshoot issues

Overall Results and Key Takeaways

- Fixed gas fees created cost savings
- Energy reduced by 55% + for in-unit electrification measures
- Gas to electric ranges had a minimal impact on utility bills
- Overall project costs are higher than lifetime savings of measures with several piloted features

	Pre-period	Post-period	Savings
Total kWh	3,083	6,982	-3,899
Variable kWh cost	$403	$823	-$420
Total therms	298	0	298
Volumetric therm cost	$336	$0.00	$336
Fixed gas service fees	$370	$0.00	$370
Total Cost	**$1,110**	**$823**	**$286**
Claimable kWh	11,814	6,982	4,832

*$1.13/therm and $30.84/month fixed cost per resident in the pre-period for natural gas. Electricity was $0.131/kWh in the pre-period and $0.118/kWh in the post-period which accounts for electric space heating adjustments and multi-family building adjustments.

120V Heat Pump Water Heaters

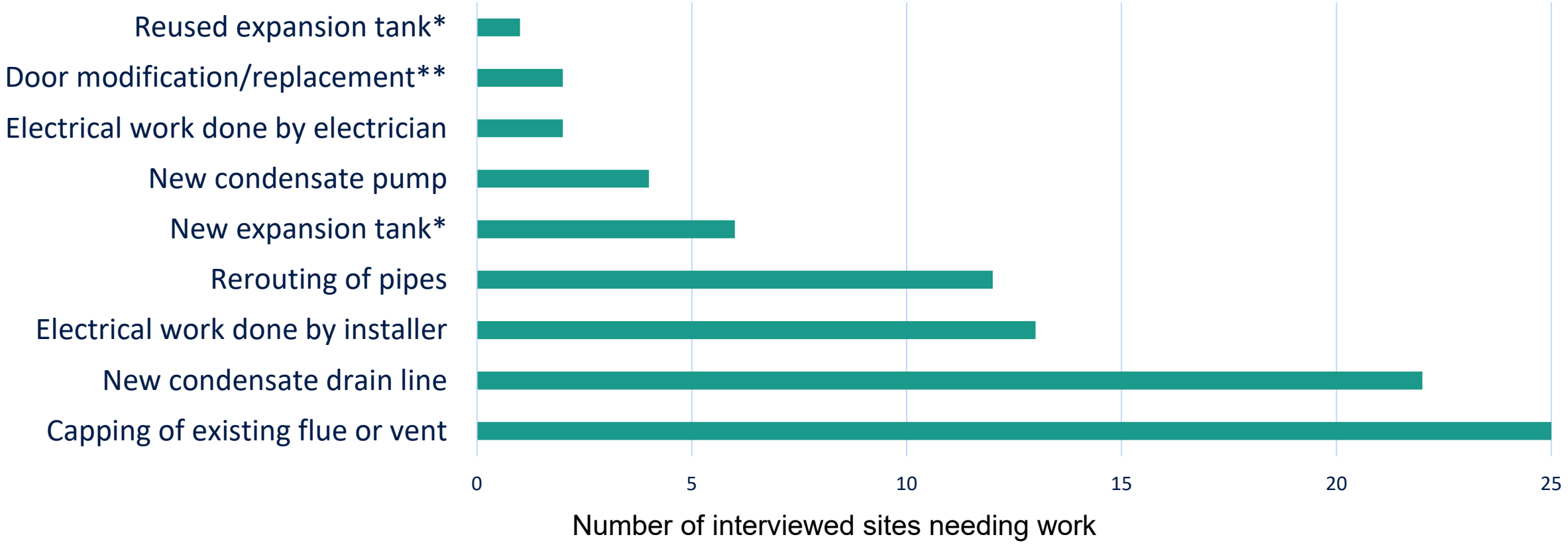
Objectives:

- What were the installation barriers?
- Was adequate hot water able to be maintained?
- What was the performance difference between shared (7A) and dedicated (15A) circuit options?

Unit Sizing and Selection

- **19 shared circuit**
  - 8 Rheem, 10 A.O. Smith, 1 Nyle
    - Upsized by two sizes
  - Installed mixing valve
- **8 dedicated circuit**
  - All Rheem
  - Did not upsize
  - No mixing valve
  - Faster runtime and larger power draws
  - Required more electrical work

Installation Work

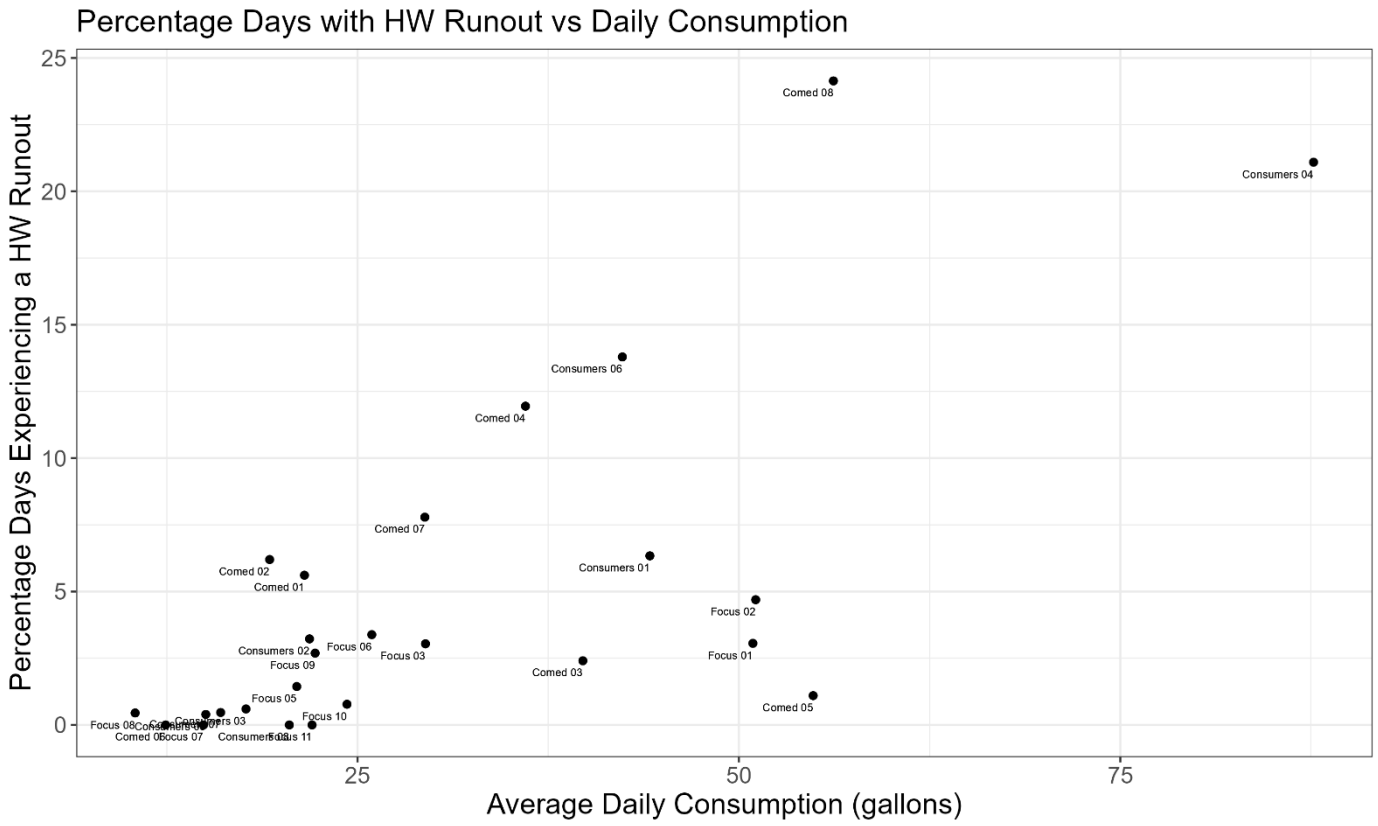


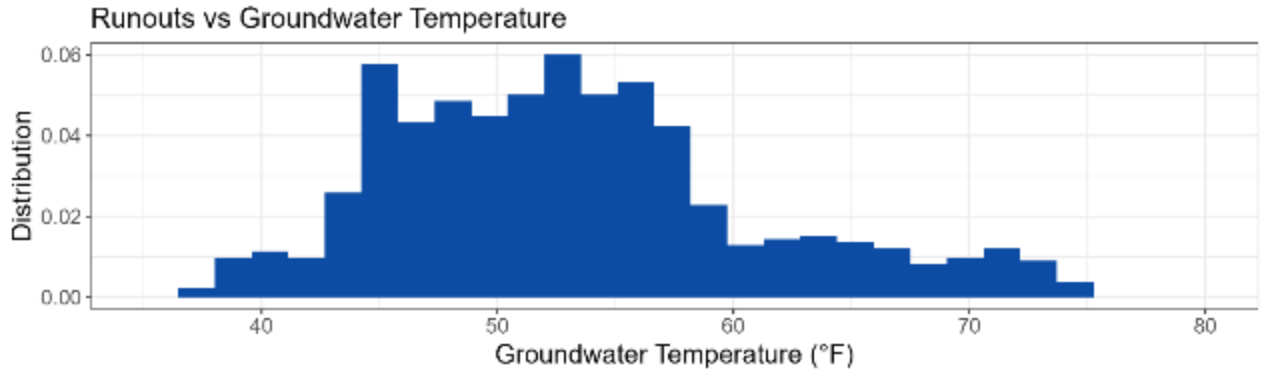
* Sites without a reused or new expansion tank did not need one at all.

** One room door was replaced with a louvered door, and one was modified to fit the HPWH through.

Hot Water Runouts

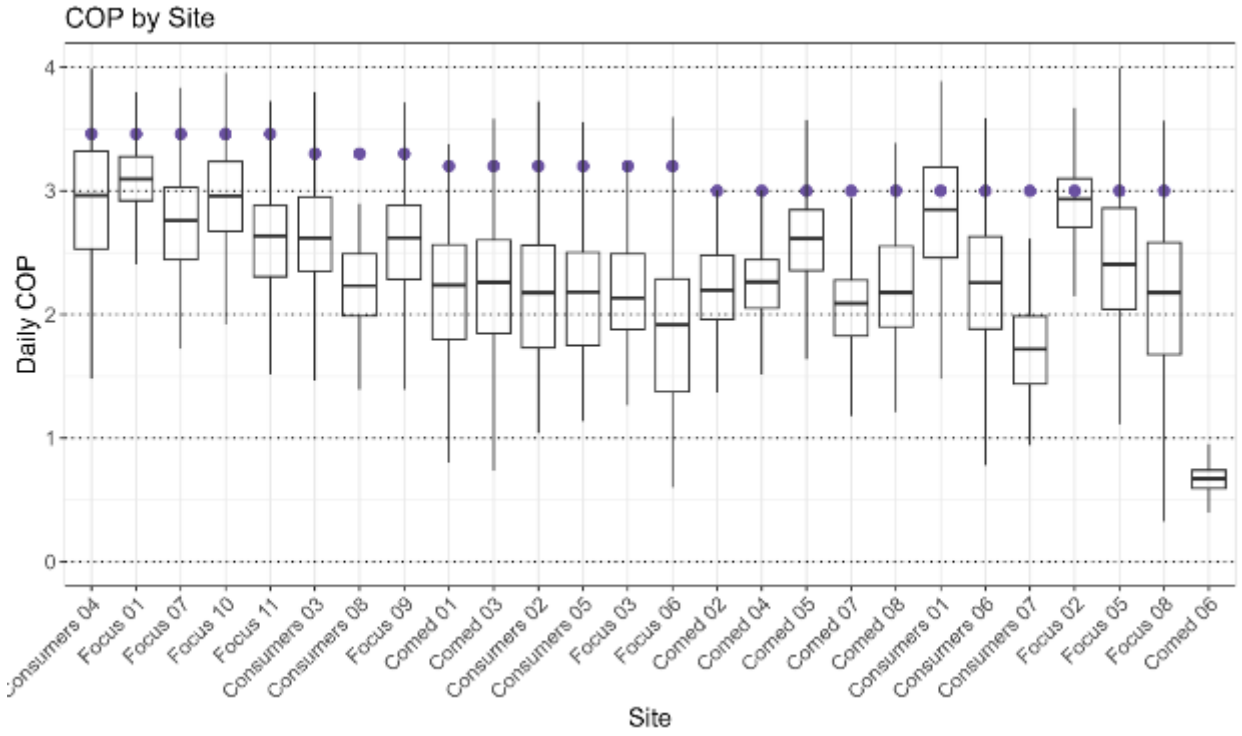
- **Sites experienced a runout on 5% of days, on average**
- **Sites with higher consumption had more runouts**
  - The site with the most runouts:
    - Dedicated circuit
    - 56 gallons/day consumption
    - Changed consumption schedule but was very satisfied with the unit
  - The site with the second-most runouts:
    - Shared circuit
    - 87 gallons/day consumption
    - Replaced their unit at the end of the study due to runouts, worst in the winter
- **More runouts occurred when groundwater temperatures were lower**

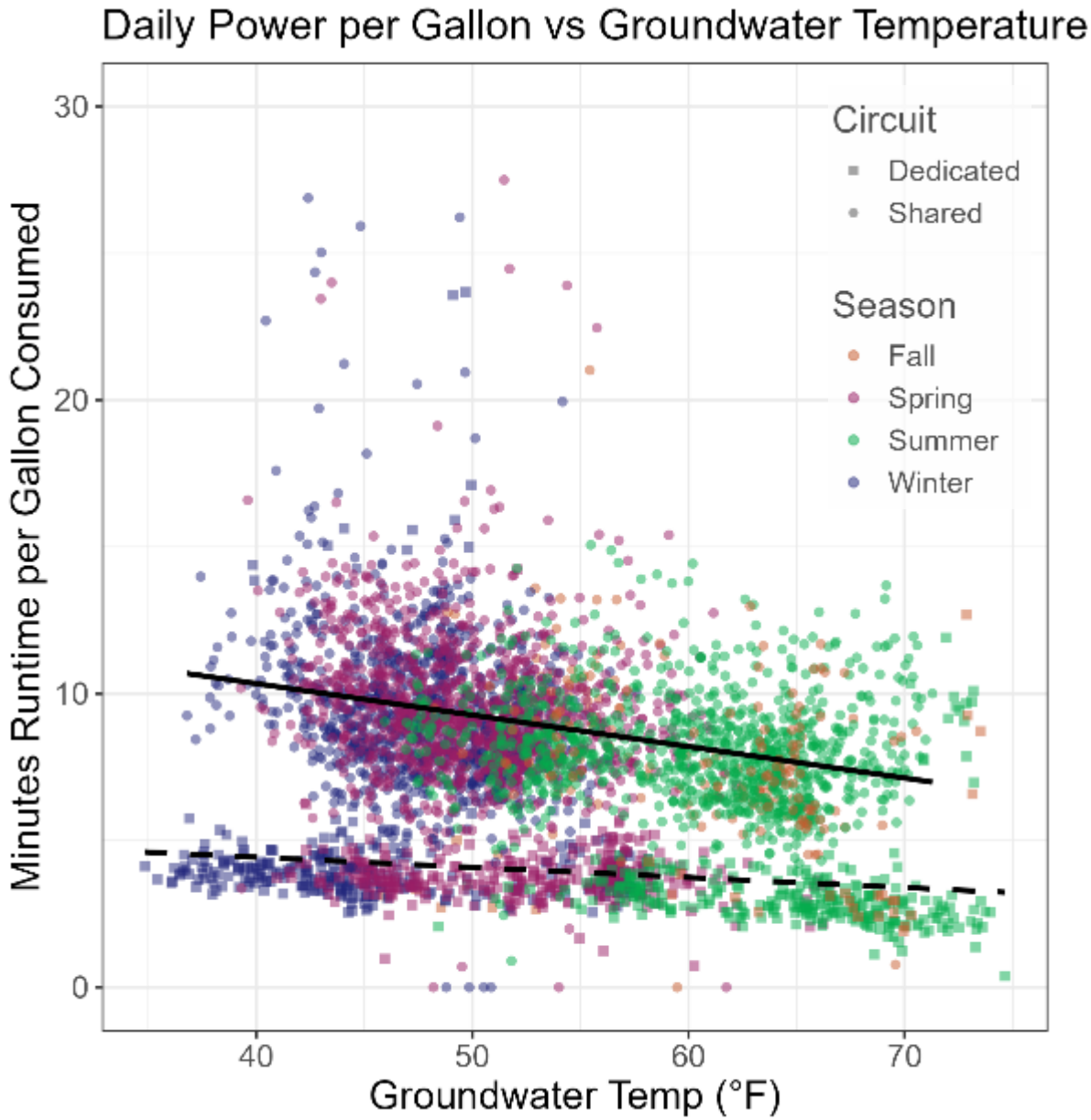




Performance

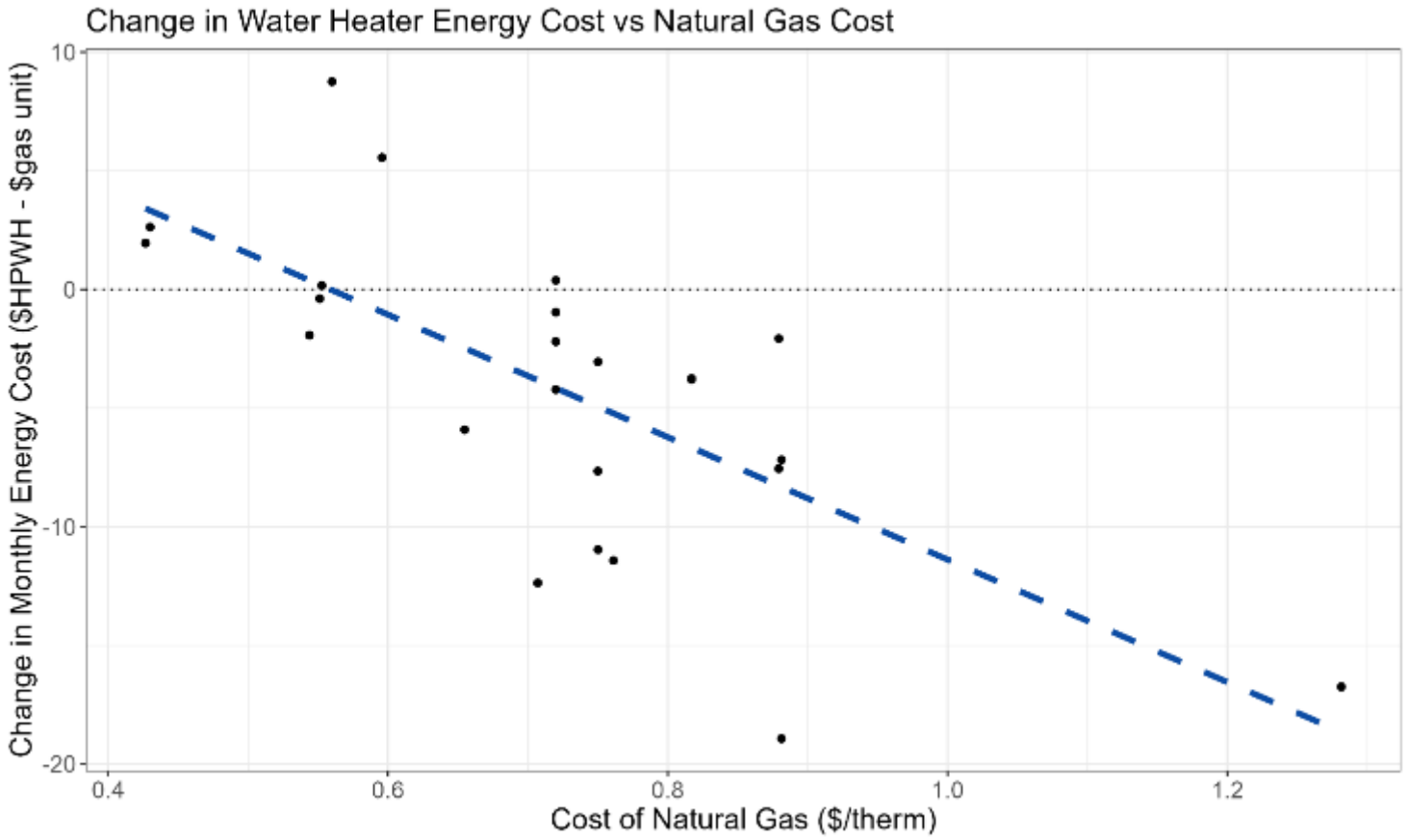
- Daily COP average of 2.4
- Correlated negatively with groundwater and positively with inlet air temperature
  - These combined effects led to very little seasonal variation in COP
- Longer runtime per gallon at lower groundwater temperatures
- Shorter runtime per gallon in dedicated circuit units



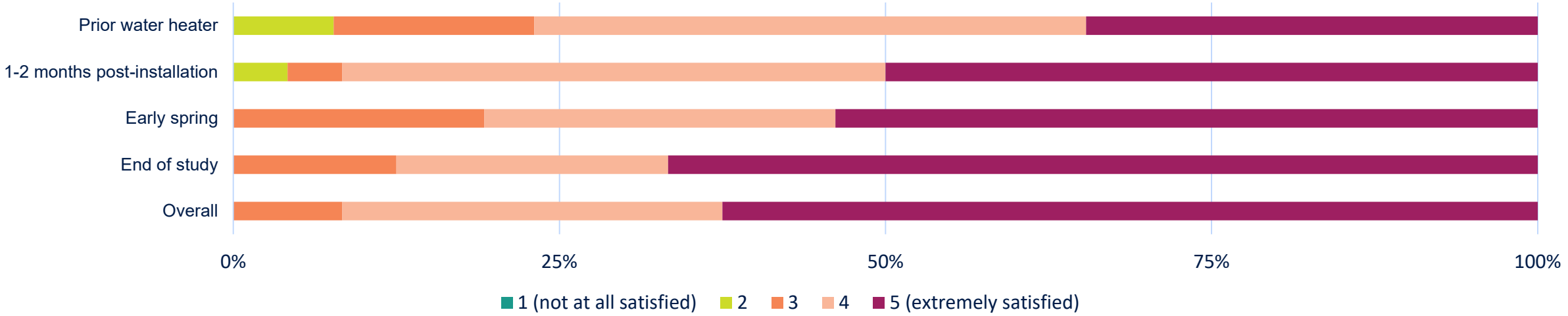


Energy and Cost Savings

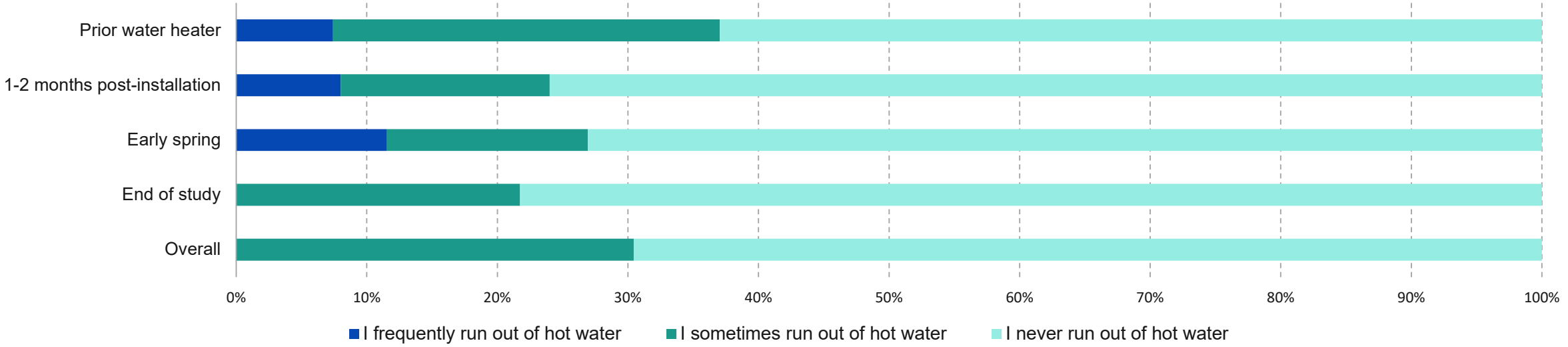
- Sites saved 87% of the energy use of their prior heater
- Sites saved $7/month on average
  - For an average 120V cost of $14/month
- Propane site saved $22/month
- Electric resistance site saved $40/month
- Retrofits cost $5,500 in the study, and are estimated to cost $4,200 at program scale



Overall Satisfaction



Hot Water Availability



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Proof over Promises:
Cold Climate Multifamily Retrofit Results

Part 2

Multifamily Retrofit Case studies

Electrification Case Studies

What worked, what didn't, and what surprised us?

- Property 1: Mixed Use Mid-Rise
- Property 2: Garden Style Complex
- Property 3: Midrise Public Housing
- Property 4: 8-Unit Co-op
- Property 5: Dorm Decarb

Property 1: Mixed Use Mid-Rise

More than energy cost savings

Building Information (Low Rise Tower)

56 Apartments

Affordable + market rate rental

90,000 Residential square feet

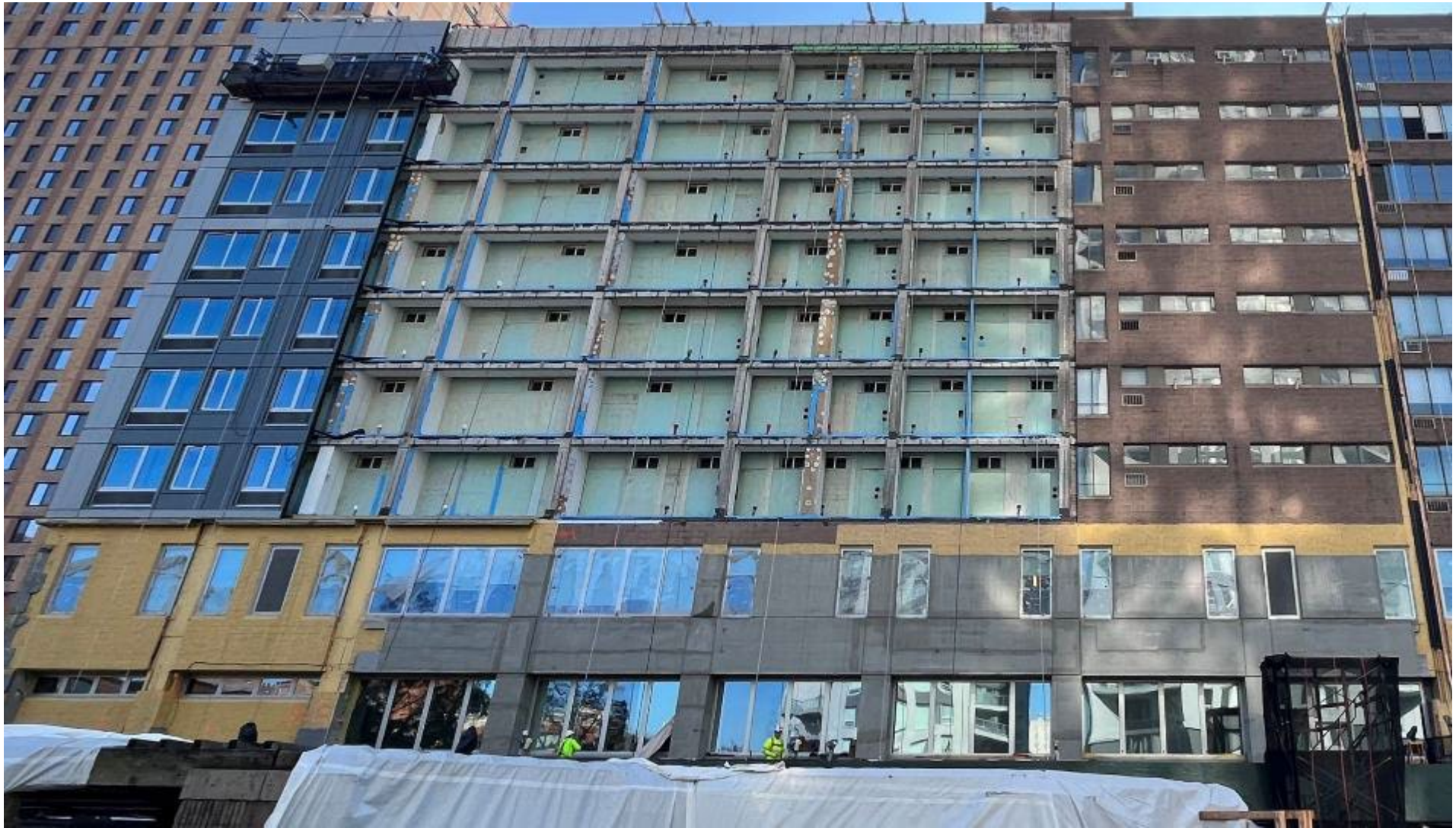
Electric resistance baseboard heat

Sleeve air conditioners

Master Metered

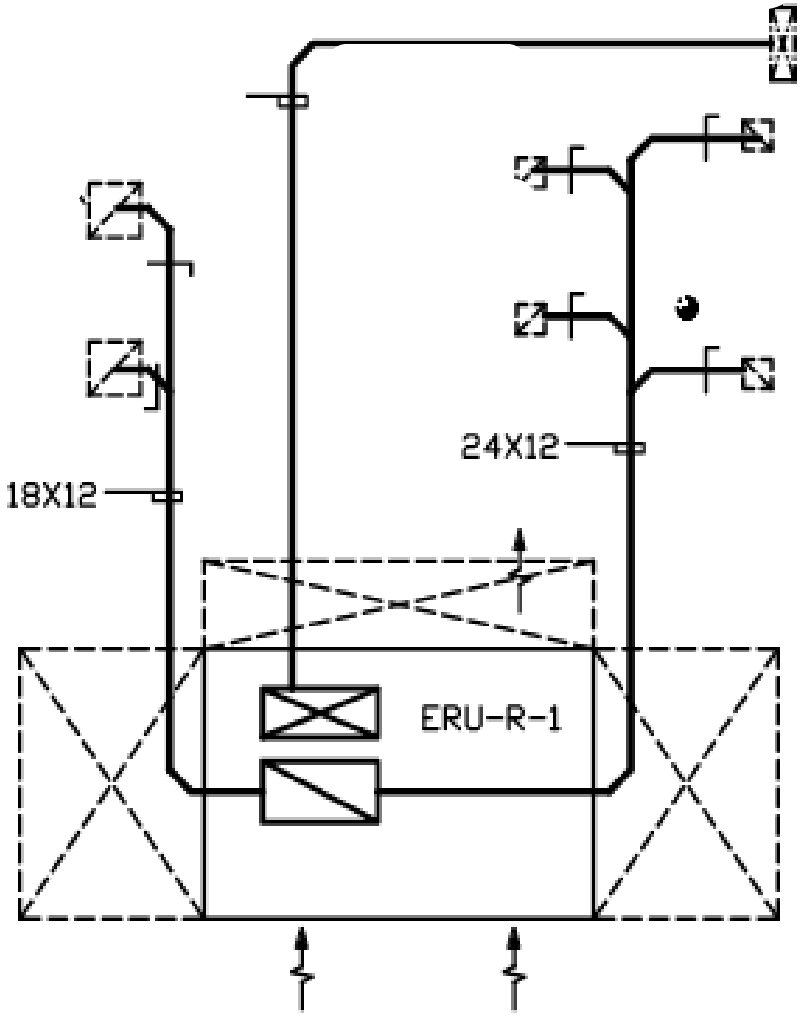
The Upgrades

New Facade



Ice Air Cold Climate Packaged Terminal Heat Pump

Corridor ERV & Apartment Exhaust Fans



Costs

Item	$/Unit
Total Project (Excluding ventilation)	**$130 K**
Heat Pumps	$34 K
Central Controls & Thermostats	$12 K
Facade + Roof Replacement	$83 K

Space Heating Energy Use

Weather-normalized

Pre-retrofit:	23 kbtu/sf/yr
Post-retrofit:	11 kbtu/sf/yr

52% Reduction

Other Fun Results

- Eliminated $6 M in façade repair costs (LL11)

AWHP for DHW

CO_2!

Cx in progress!

Property 2: Garden Style Complex

High Pre-retrofit consumption = High savings!

Building Information

200 Apartments

Naturally occurring affordable rental

168,900 Square Feet

Oil & Gas Hydronic Baseboard

Window ACs

Direct Metered

The Upgrades

Ducted split heat pump systems

Additional Measures

- Attic & Crawl Space Spray Foam
- New gas DHW boilers
- Low flow fixtures
- Lighting

Capital Costs

Item	$/Unit
Total Project	**$10,500**
Heat Pumps	$7,500
Insulation	$1,400

Capital Costs

Item	$/Unit
Total Project	**$10,500**
Heat Pumps	$7,500
Insulation	$1,400

Space Heating Energy Use

Weather-normalized

Pre-retrofit:	80 kbtu/sf/yr
Post-retrofit:	8.6 kbtu/sf/yr

89% Reduction

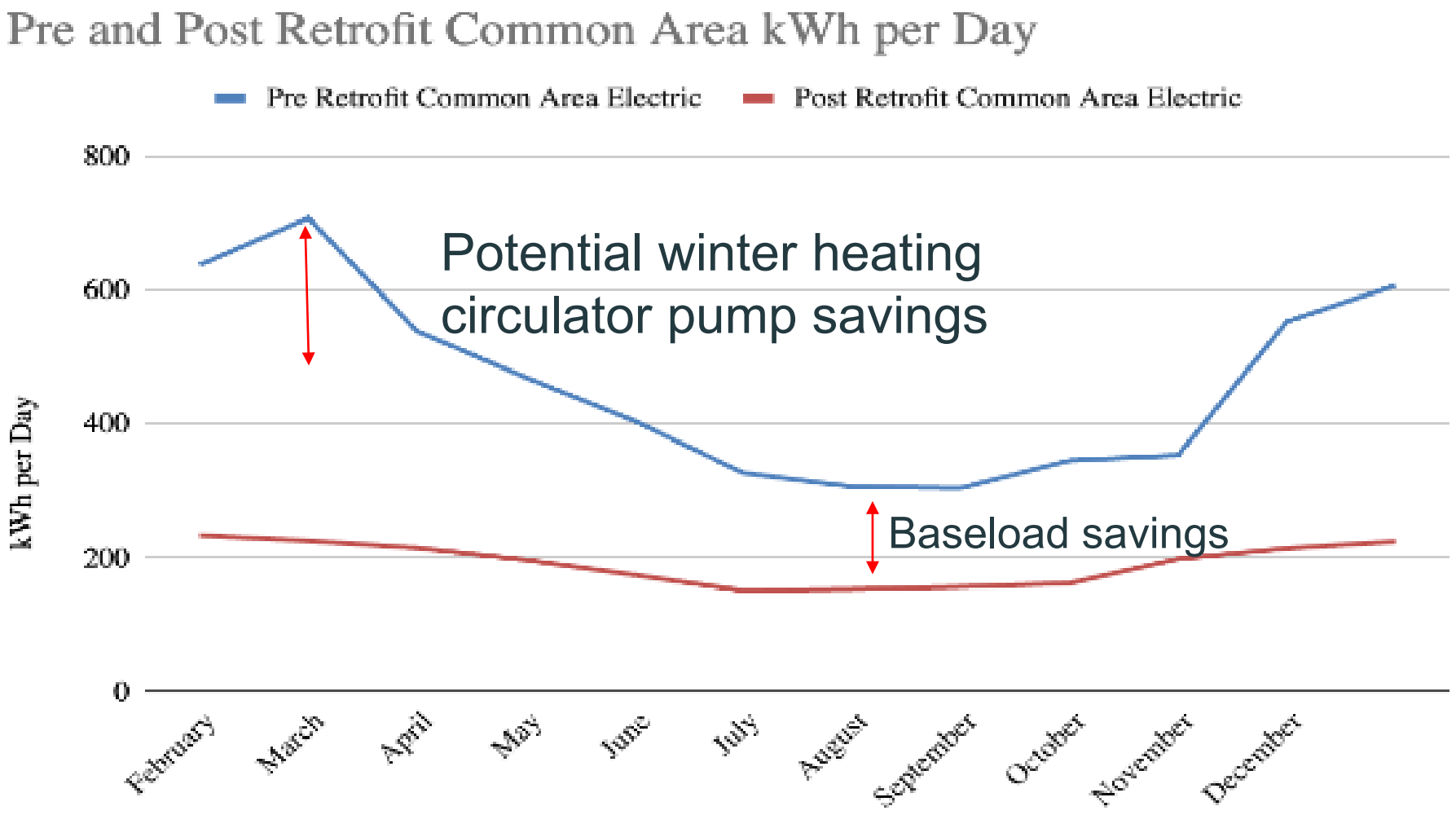
There's a catch…

Watch out for the COST SHIFT!

Energy savings is on the owner meter
Energy INCREASE on the tenant

*Note: Modeled increase for rent control board

A note on heating pumps…



Property 3: 6-Story Public Housing

Simpler(ish) retrofit = High Performance
Bonus: Grid Lessons!

Building Information

65 Apartments

Public Housing

63,000 Square Feet

Gas-fired Boilers

2-Pipe Steam

Window/Sleeve Acs

Master Metered

The Upgrades

ccPTHP

- Epocha → wall sleeves
- Sleeve Air Sealing
- 65 electric heaters in kitchens

Additional Upgrades

New Windows (U-0.27)

Central Air to Water Heat Pumps for DHW

Costs

Item	$/Unit
PTHPs + Sleave Air Sealing	$18,700
Windows	$6,900

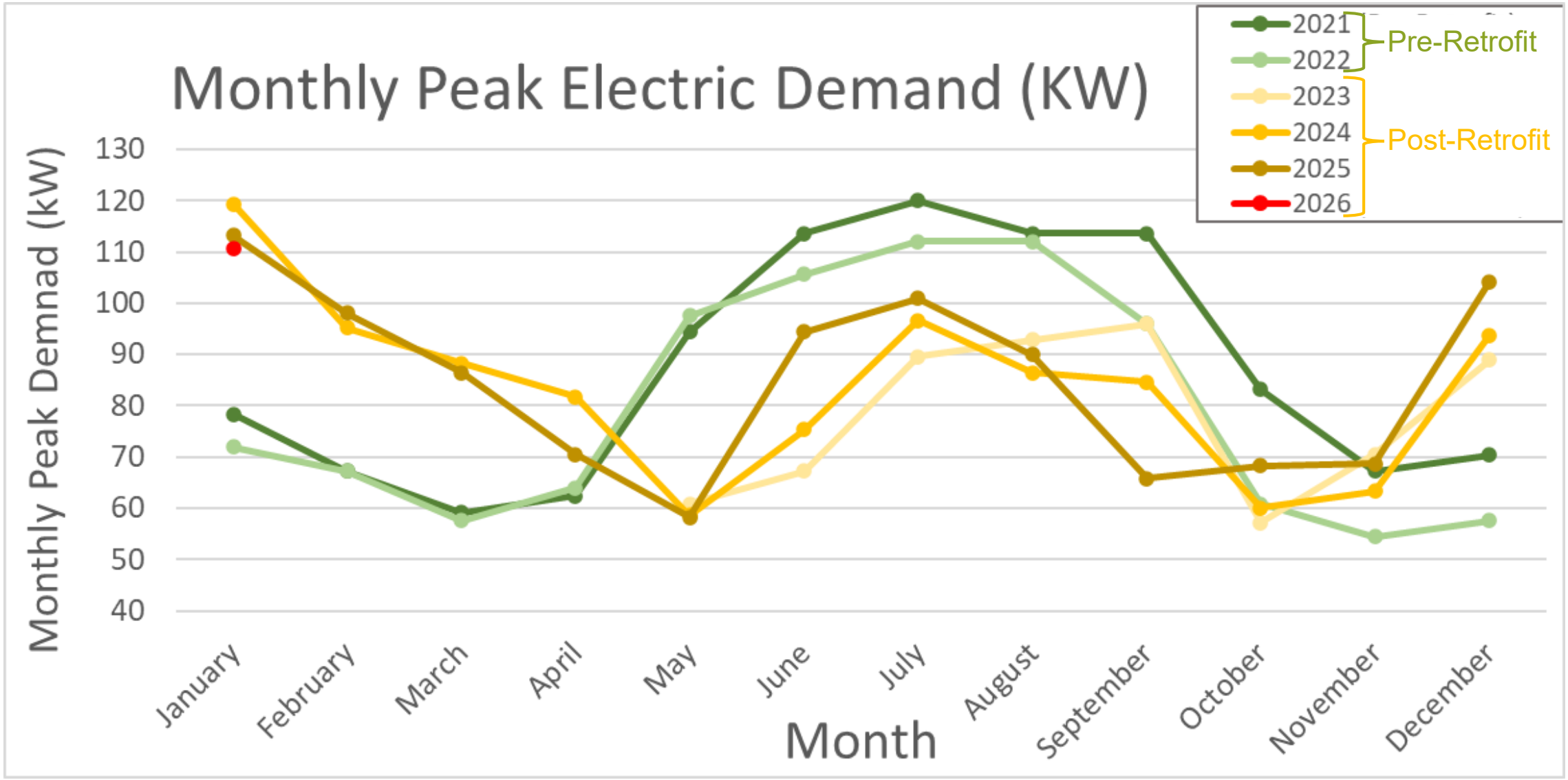
Space Heating Energy Use

Weather-normalized

Pre-retrofit:	75 kbtu/sf/yr
Post-retrofit:	5.4 kbtu/sf/yr

93% Reduction

Demand more data?


Monthly Peak Electric Demand (KW)
Monthly Peak Demnad (kW)
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120
110
100
90
80
70
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50
40
January
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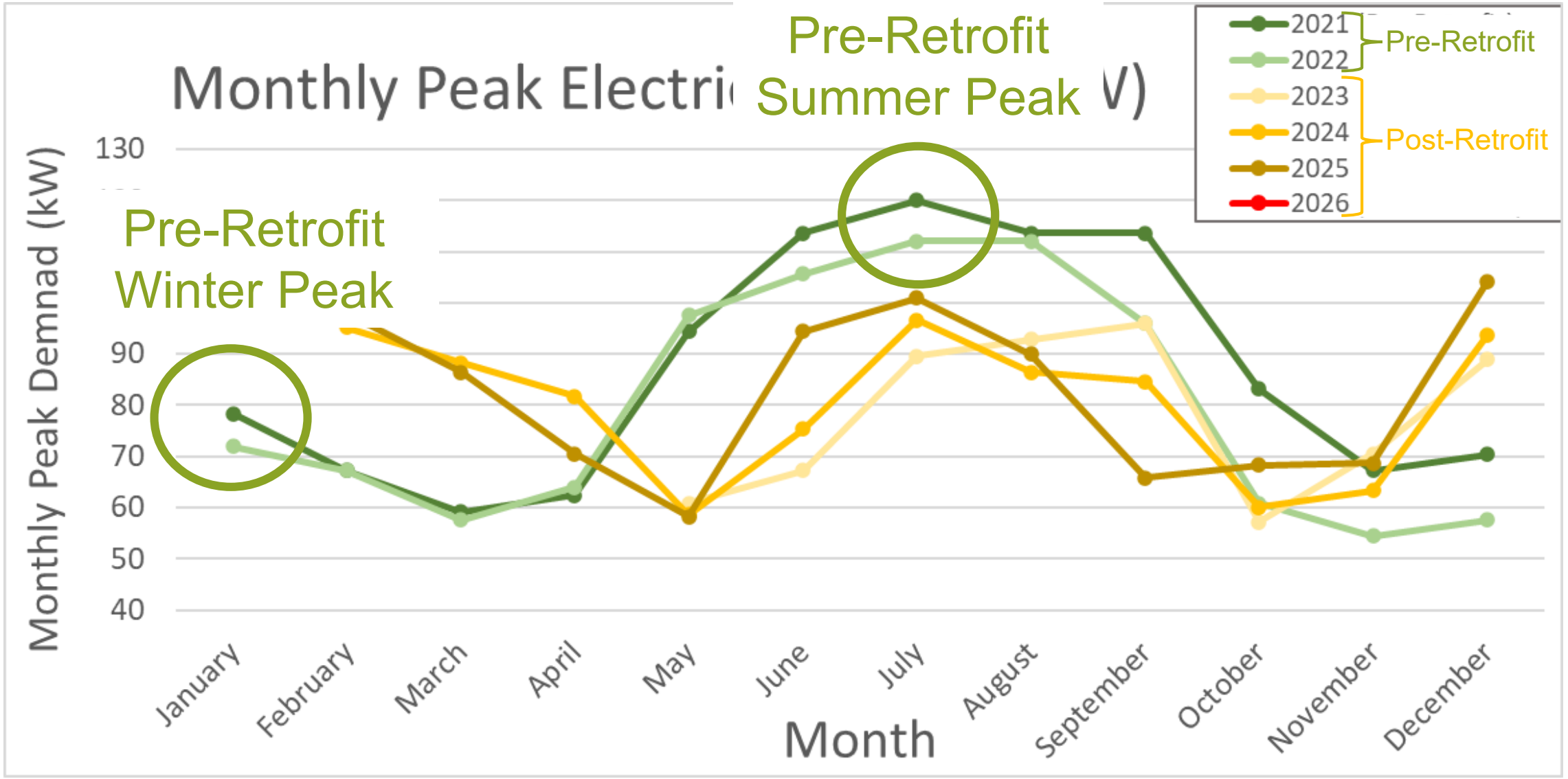
Month
2021
2022
2023
2024
2025
2026
Pre-Retrofit
Post-Retrofit


Monthly Peak Electri V)
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Pre-Retrofit
Post-Retrofit
Monthly Peak Demnad (kW)
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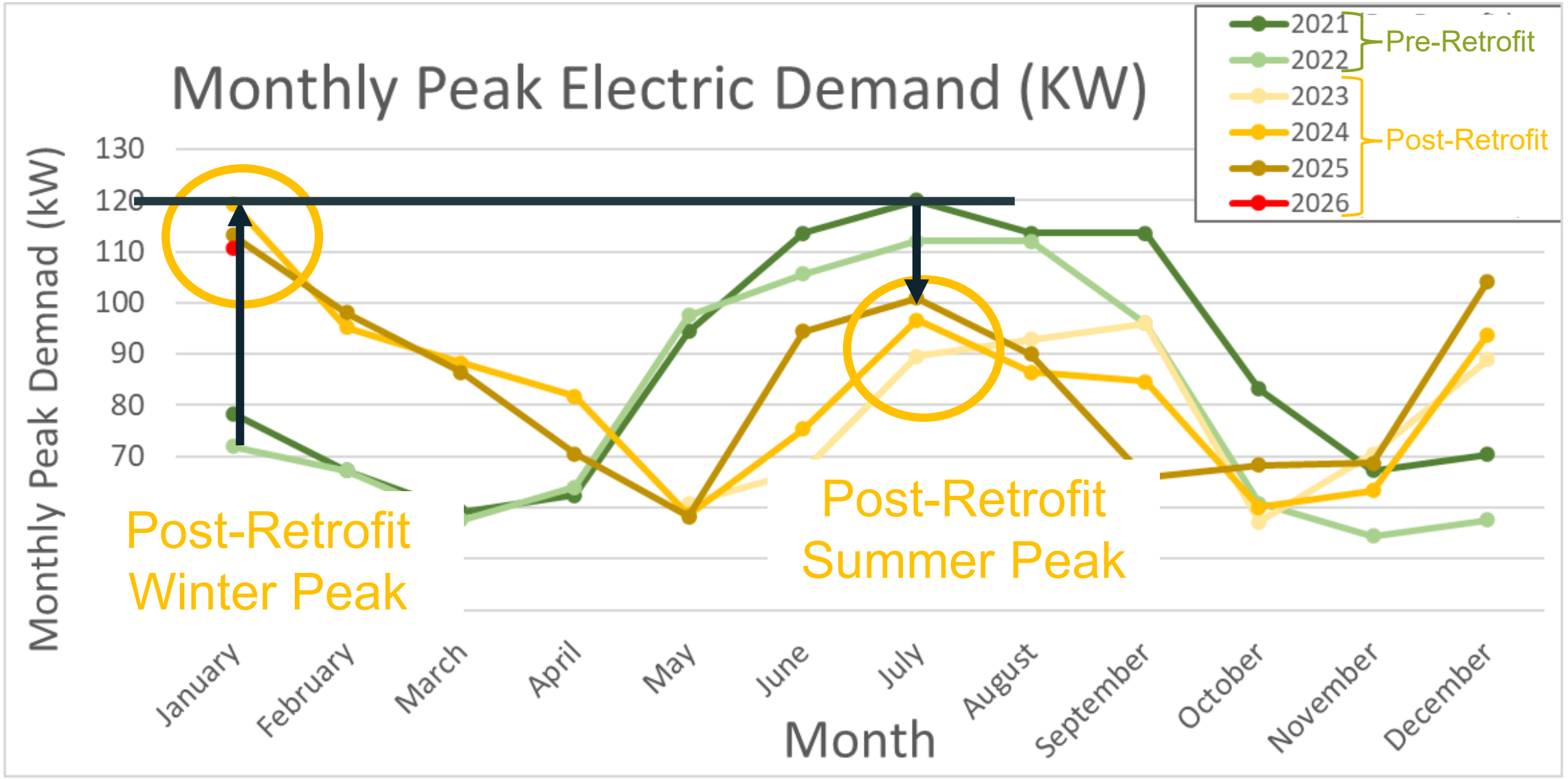
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2021
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2026
Pre-Retrofit
Post-Retrofit
Post-Retrofit
Winter Peak
Post-Retrofit
Summer Peak
January
February
March
April
May
June
July
August
September
October
November
December
Month

Property 4: 8 Unit Orphan

Under-resourced buildings can get stuck between good intentions and bad performance

Building Information

8 Apartments

Naturally occurring affordable

2,500 Square Feet

Oil #2 boilers with one-pipe steam

Window air conditioners

The Upgrades

Mitsubishi Air Source Split Heat Pumps

AO Smith Heat Pump Water Heater

Costs

Item	$/Unit
Heating Heat Pumps	$43 K
DHW Heat Pumps	$1.4 K

Space Heating Energy Use

Weather-normalized

Pre-retrofit:	unknown kbtu/sf/yr
Post-retrofit:	~25+ kbtu/sf/yr

Space Heating Energy Use

Weather-normalized

Pre-retrofit:	unknown kbtu/sf/yr
Post-retrofit:	~25+ kbtu/sf/yr
	TOO HIGH!

Property 5: The Dorm

Deepest Renovation, Strong results.

Building Information

258 Dorms

Private University

156,000 Square feet

Oil-fired Boilers & Steam distribution

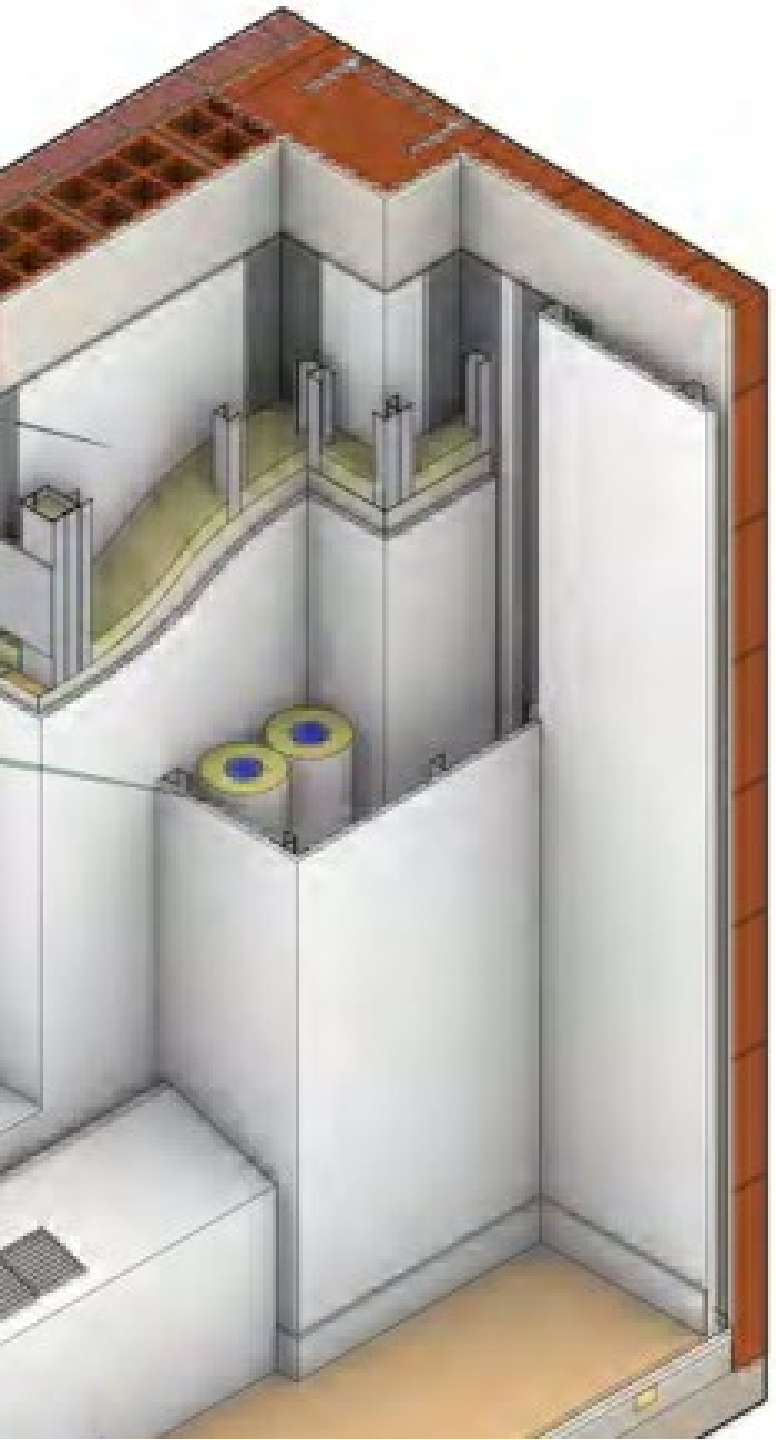
Minimal AC

Windows for Ventilation

Uninsulated walls

The Upgrade

Air-to-Water HPs with 2-pipe Fan Coils



Additional Measures

Insulation from the inside

Rooftop DOAS with heat recovery

Custom, triple-pane windows

Lighting, heating, and cooling occupancy sensors

Central Air-to-Water Heat Pumps for DHW

Costs

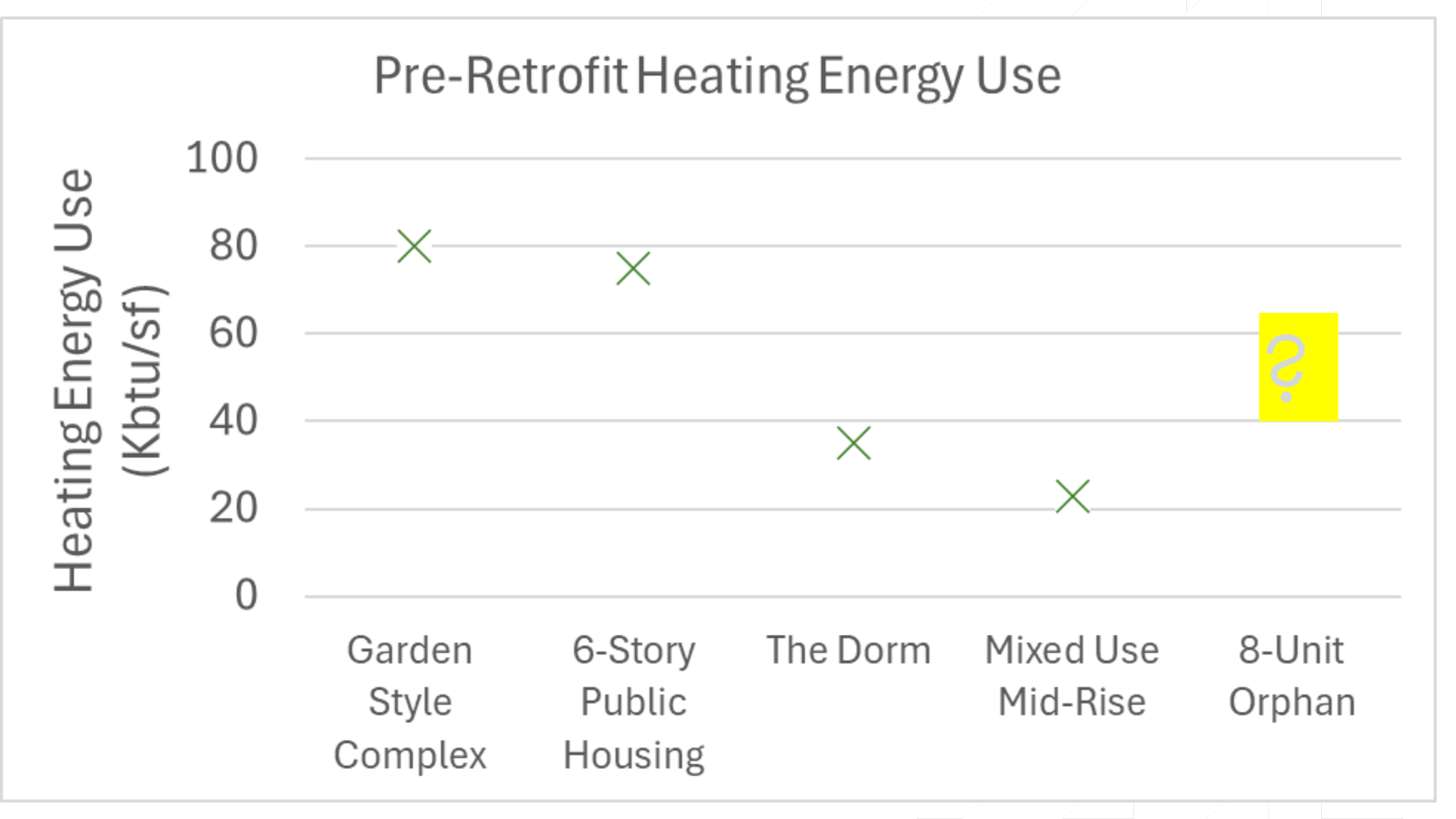
Item	$/Unit
Whole Construction Project	$298,000
Energy Upgrades	$20,000

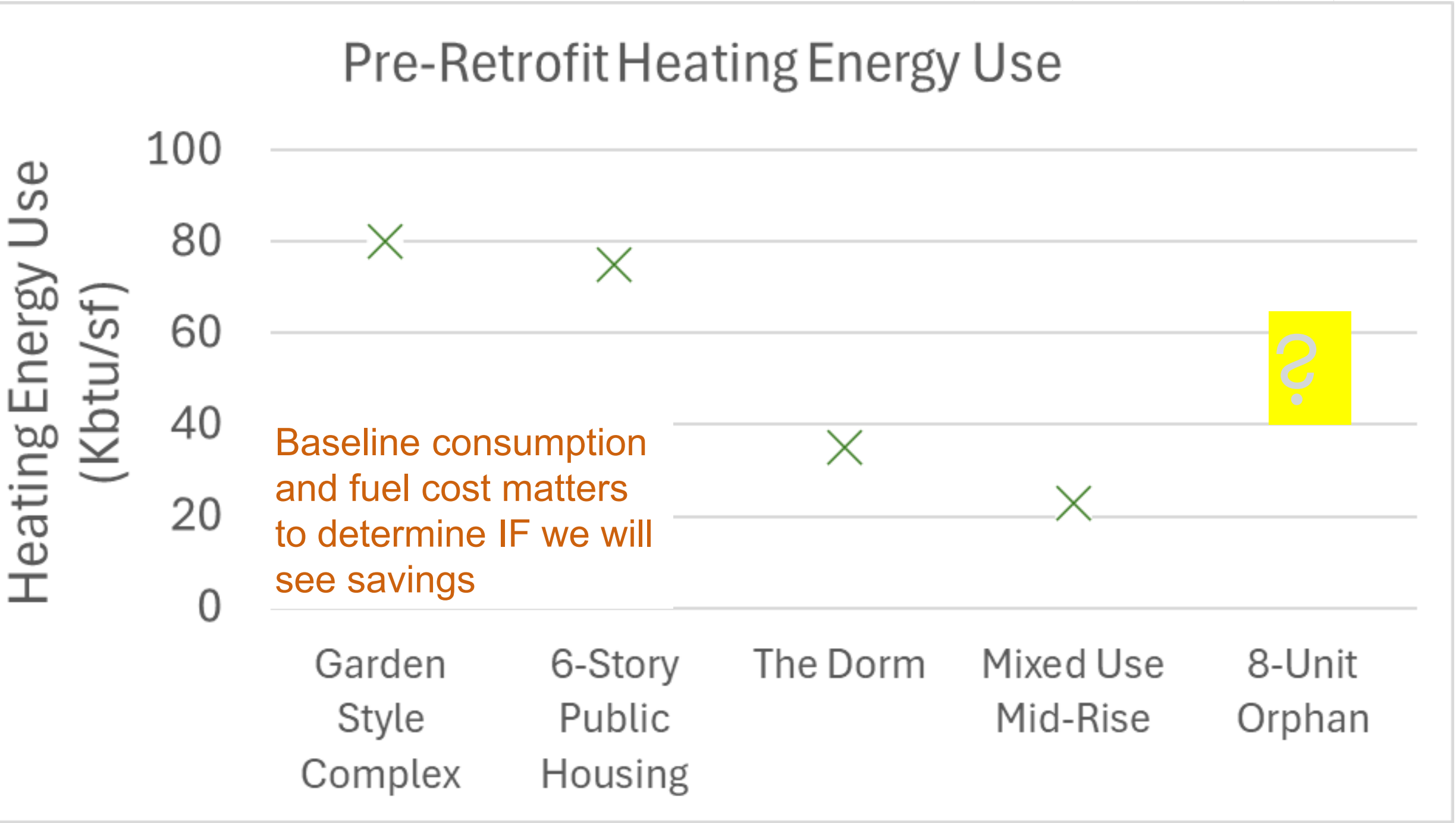
Space Heating Energy Use

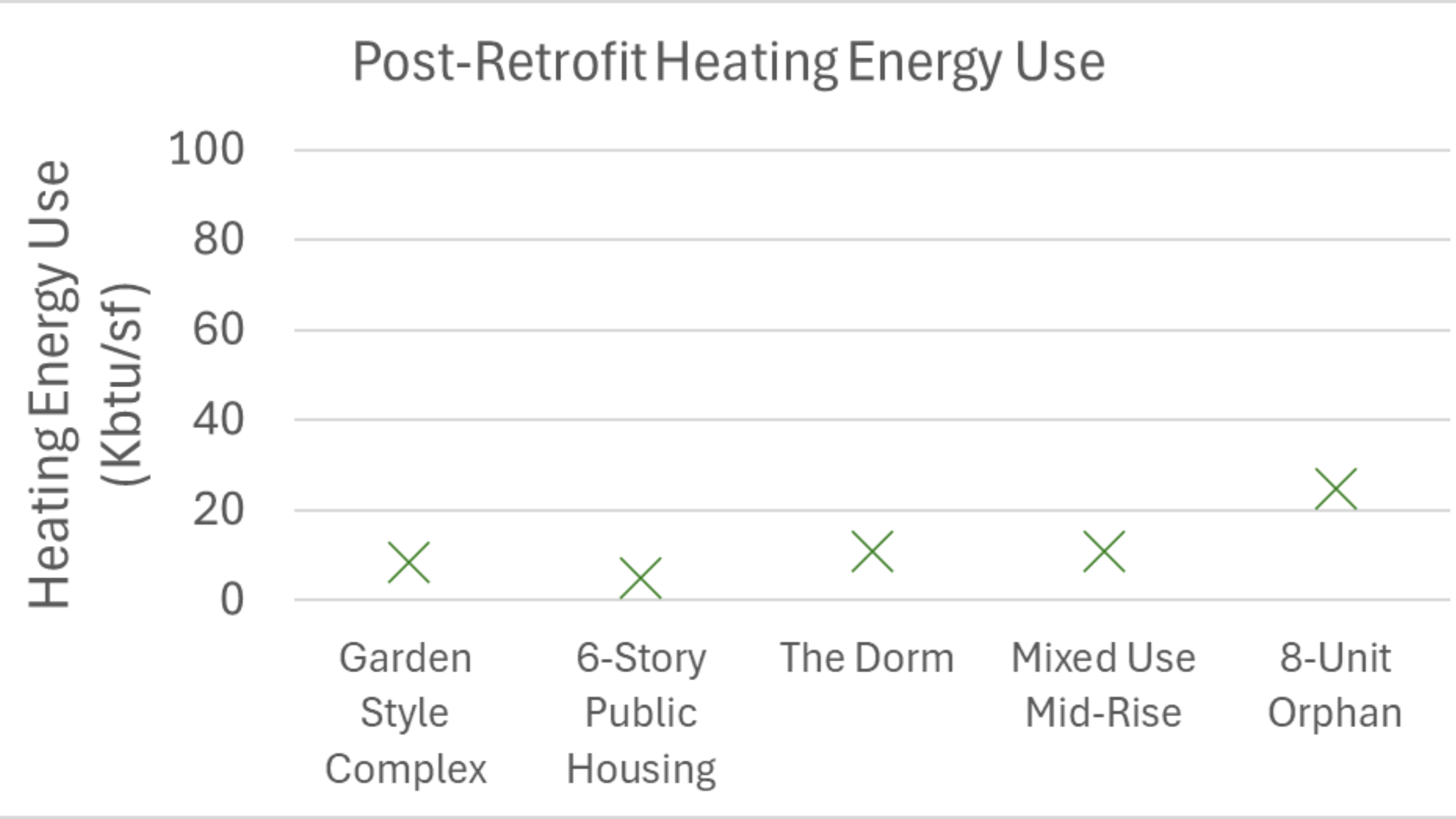
Weather-normalized

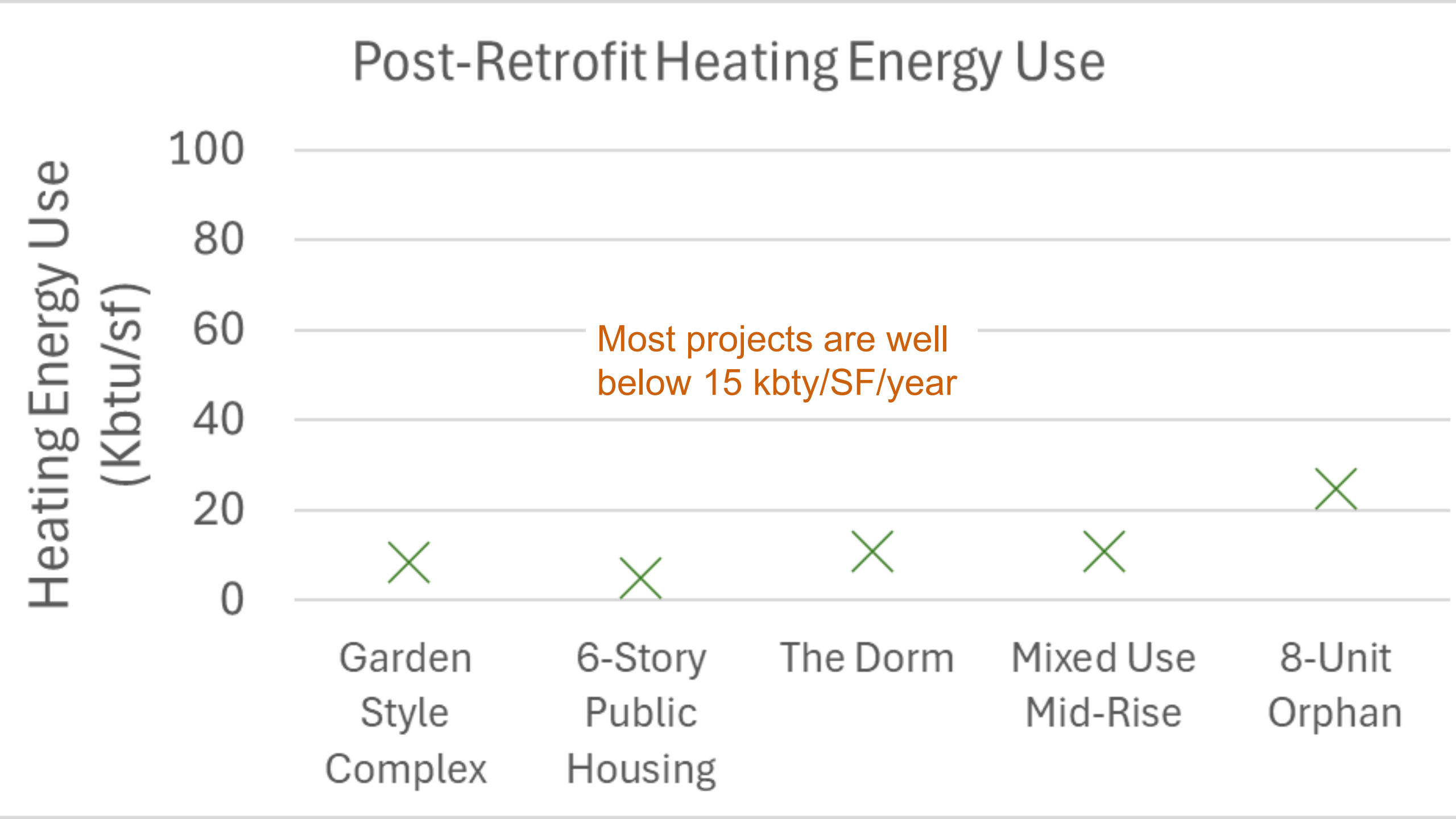
Pre-retrofit:	35 kbtu/sf/yr
Post-retrofit:	~11 kbtu/sf/yr
	~70% Reduction

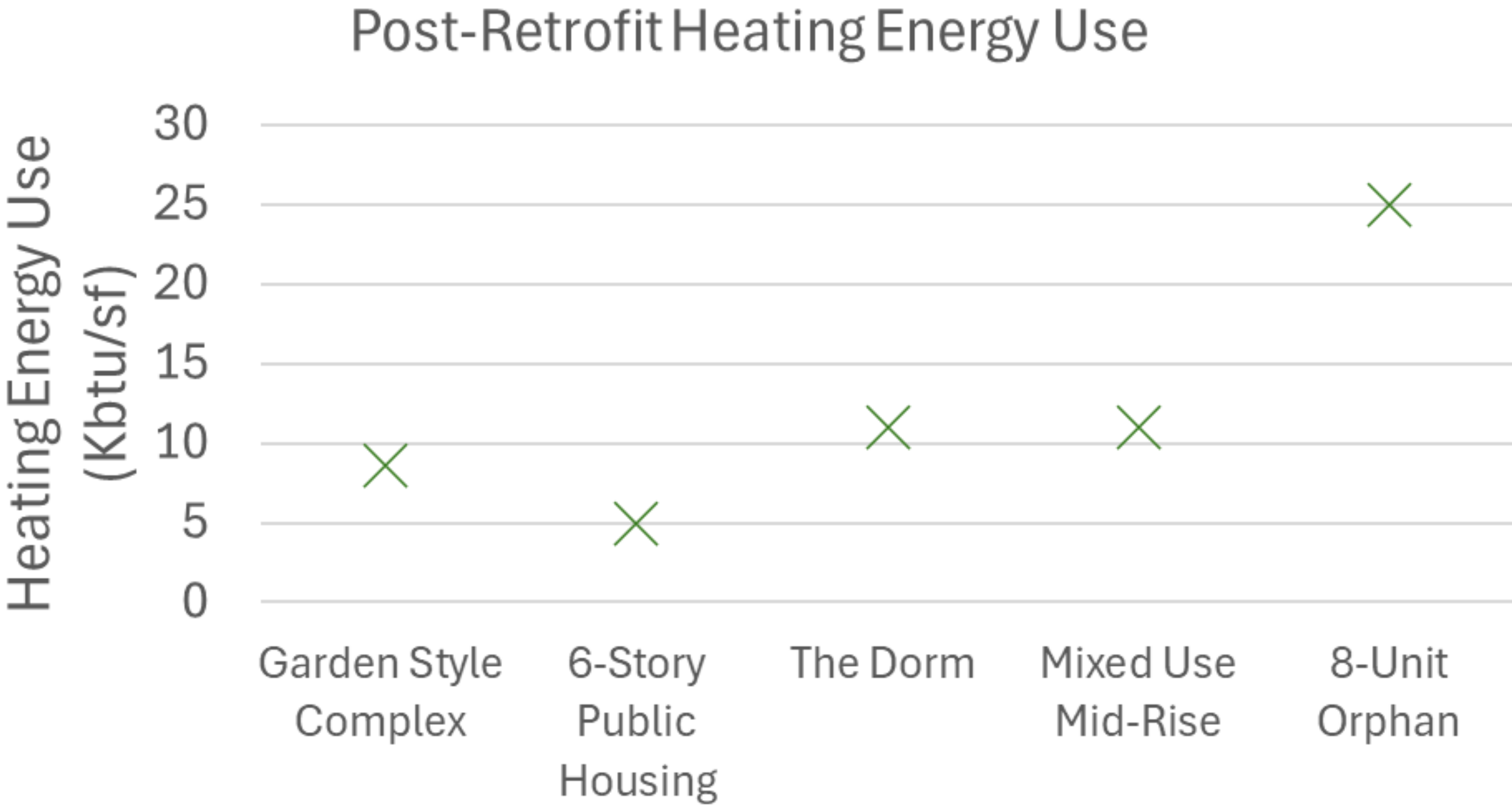
What we're learning across projects

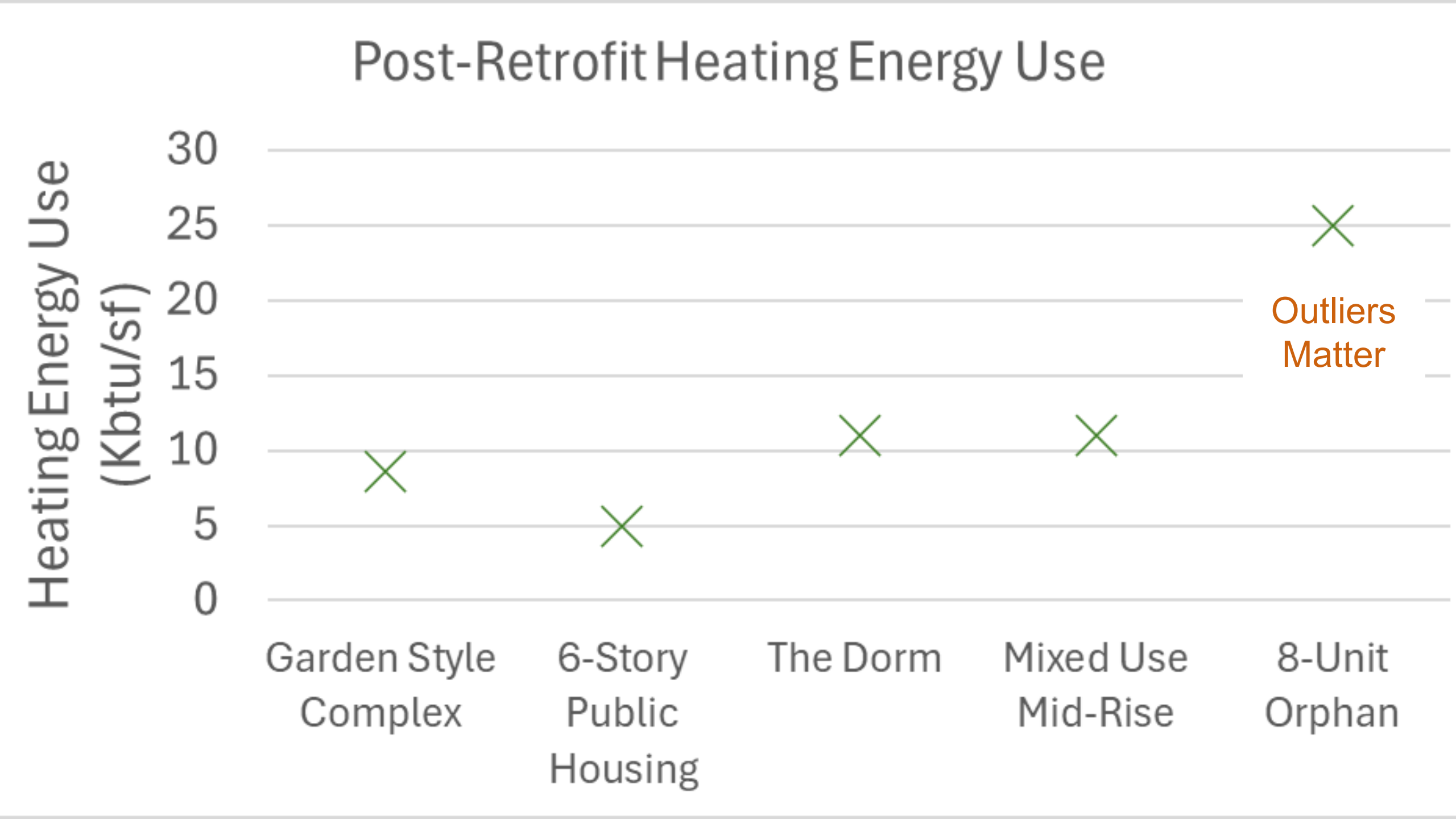

Pre-Retrofit Heating Energy Use
Heating Energy Use (Kbtu/sf)
100
80
60
40
20
0
?
Garden Style Complex
6-Story Public Housing
The Dorm
Mixed Use Mid-Rise
8-Unit Orphan

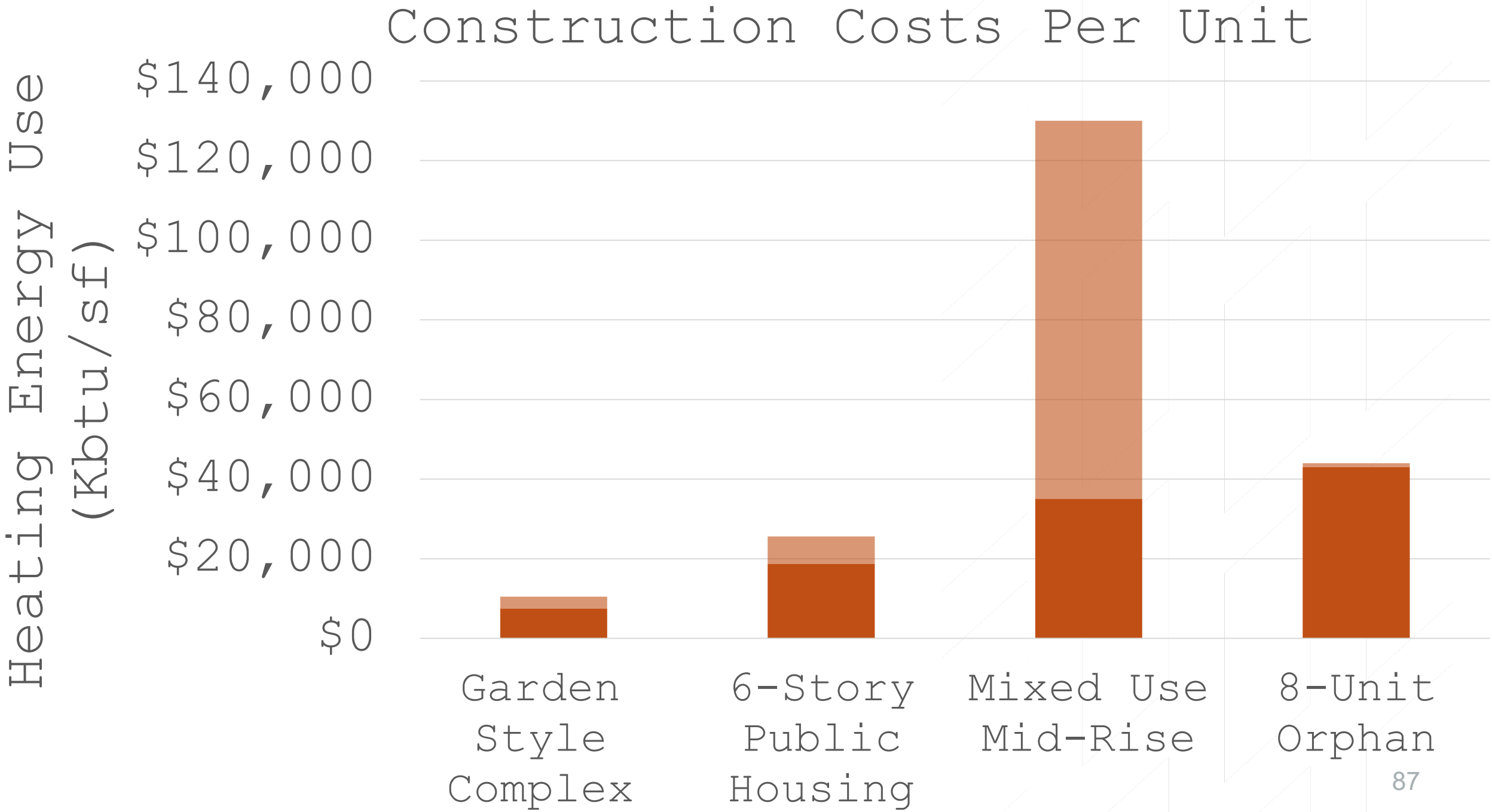

Pre-Retrofit Heating Energy Use
Heating Energy Use (Kbtu/sf)
100
80
60
40
20
0
Baseline consumption and fuel cost matters to determine IF we will see savings
?
Garden Style Complex
6-Story Public Housing
The Dorm
Mixed Use Mid-Rise
8-Unit Orphan


Post-Retrofit Heating Energy Use
Heating Energy Use (Kbtu/sf)
100
80
60
40
20
0
Garden Style Complex
6-Story Public Housing
The Dorm
Mixed Use Mid-Rise
8-Unit Orphan

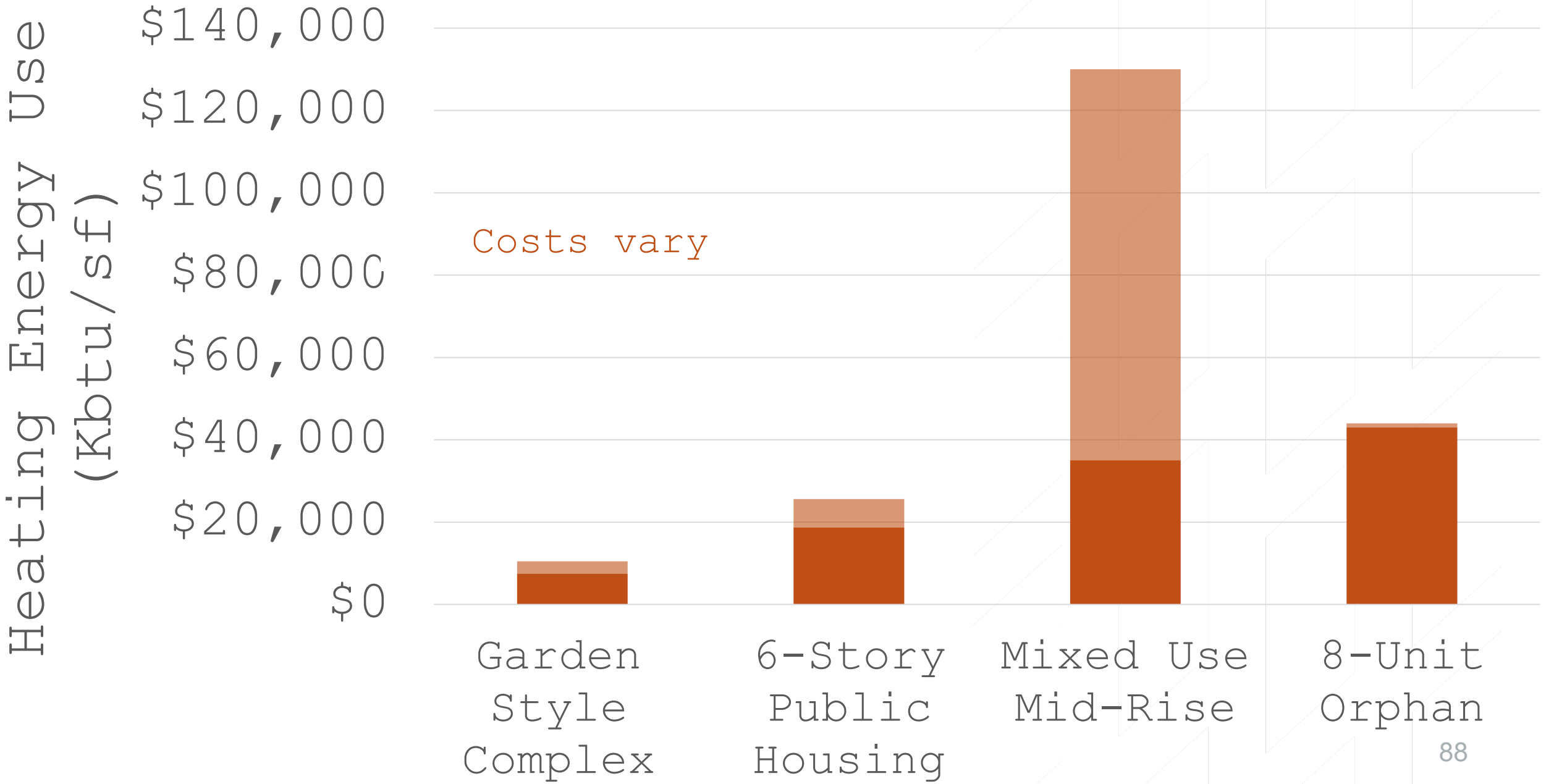

Post-Retrofit Heating Energy Use
Heating Energy Use (Kbtu/sf)
100
80
60
40
20
0
Most projects are well below 15 kbty/SF/year
Garden Style Complex
6-Story Public Housing
The Dorm
Mixed Use Mid-Rise
8-Unit Orphan


Post-Retrofit Heating Energy Use
Heating Energy Use (Kbtu/sf)
30
25
20
15
10
5
0
Garden Style Complex
6-Story Public Housing
The Dorm
Mixed Use Mid-Rise
8-Unit Orphan

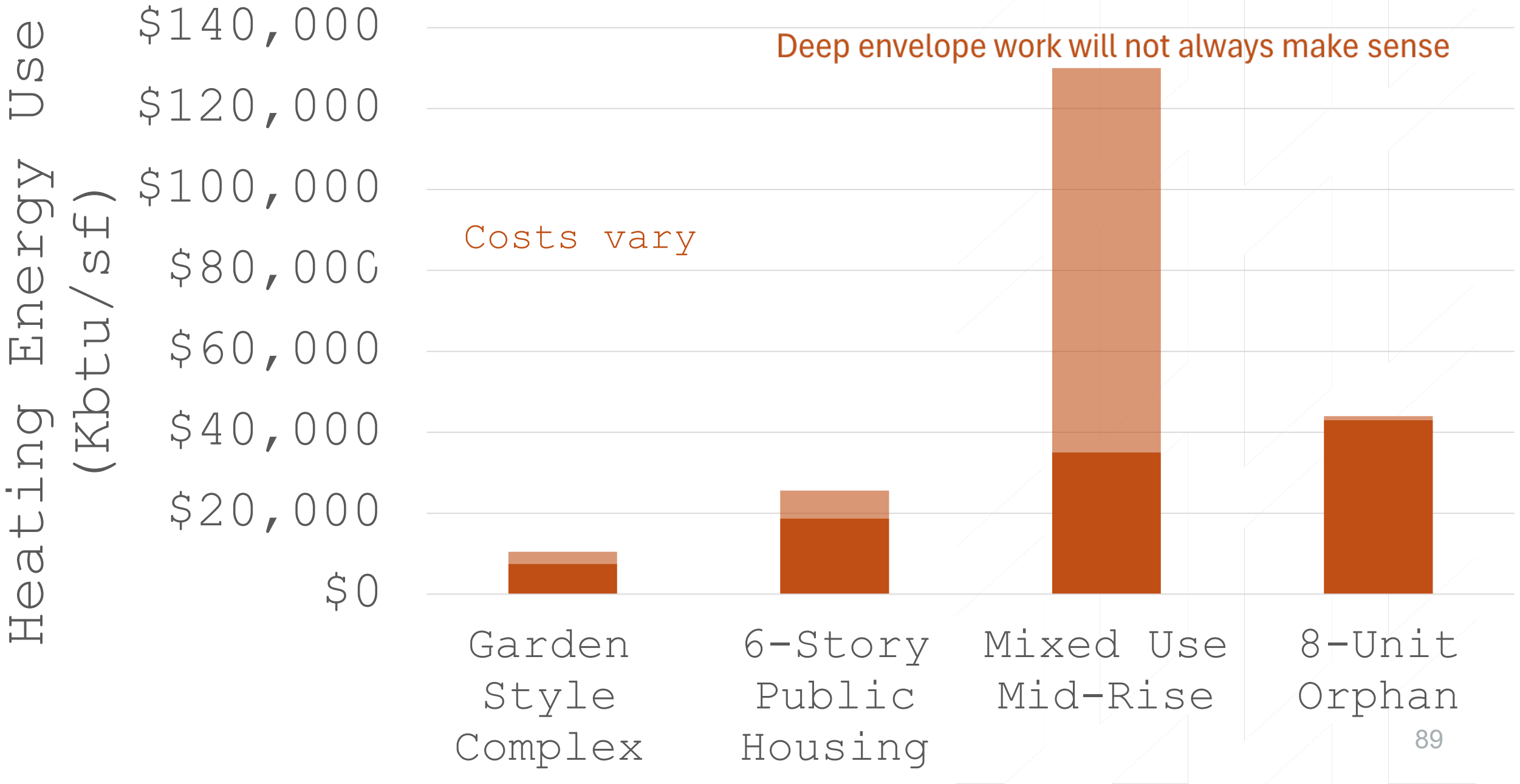

Post-Retrofit Heating Energy Use
Heating Energy Use (Kbtu/sf)
30
25
20
15
10
5
0
Outliers Matter
Garden Style Complex
6-Story Public Housing
The Dorm
Mixed Use Mid-Rise
8-Unit Orphan


Construction Costs Per Unit
Heating Energy Use (Kbtu/sf)
$140,000
$120,000
$100,000
$80,000
$60,000
$40,000
$20,000
$0
Garden Style Complex
6-Story Public Housing
Mixed Use Mid-Rise
8-Unit Orphan

Construction Costs Per Unit



Construction Costs Per Unit



What do you think?

Which of these results would make you hesitate to electrify your next project?

What surprised you?

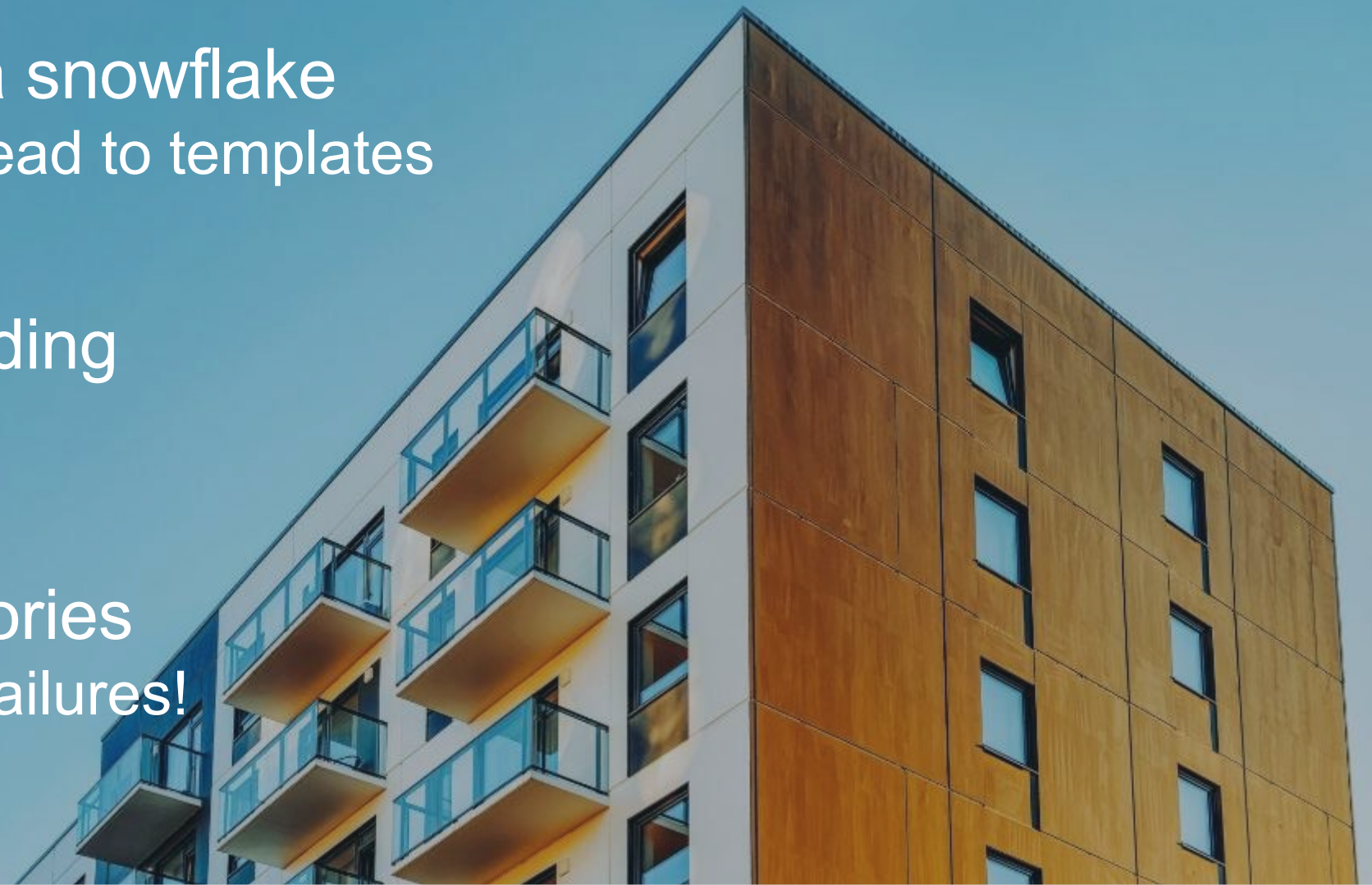
What matched your expectations?

What's one thing you changed your mind on?

what data would you need to feel confident moving forward?

What's Next

- Every building is a snowflake
  - But lessons can lead to templates
- Momentum is building
  - but slowly
- We must share stories
  - Successes AND failures!



Stay in Touch

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BUILDINGENERGY BOSTON

Please fill out an evaluation for this session

or: *nesea.org/eval*

Northeast Sustainable Energy Association (NESEA)