PASSIVE MULTIFAMILY

MN CARD grant research supported by MN Commerce Dept.

phius con
MILWAUKEE 2025

PASSIVE MULTIFAMILY

MN CARD grant

1| DISCOVERY
2| ENERGY
3| COST
4| MARKET STUDY
5| INCENTIVES

learning objectives

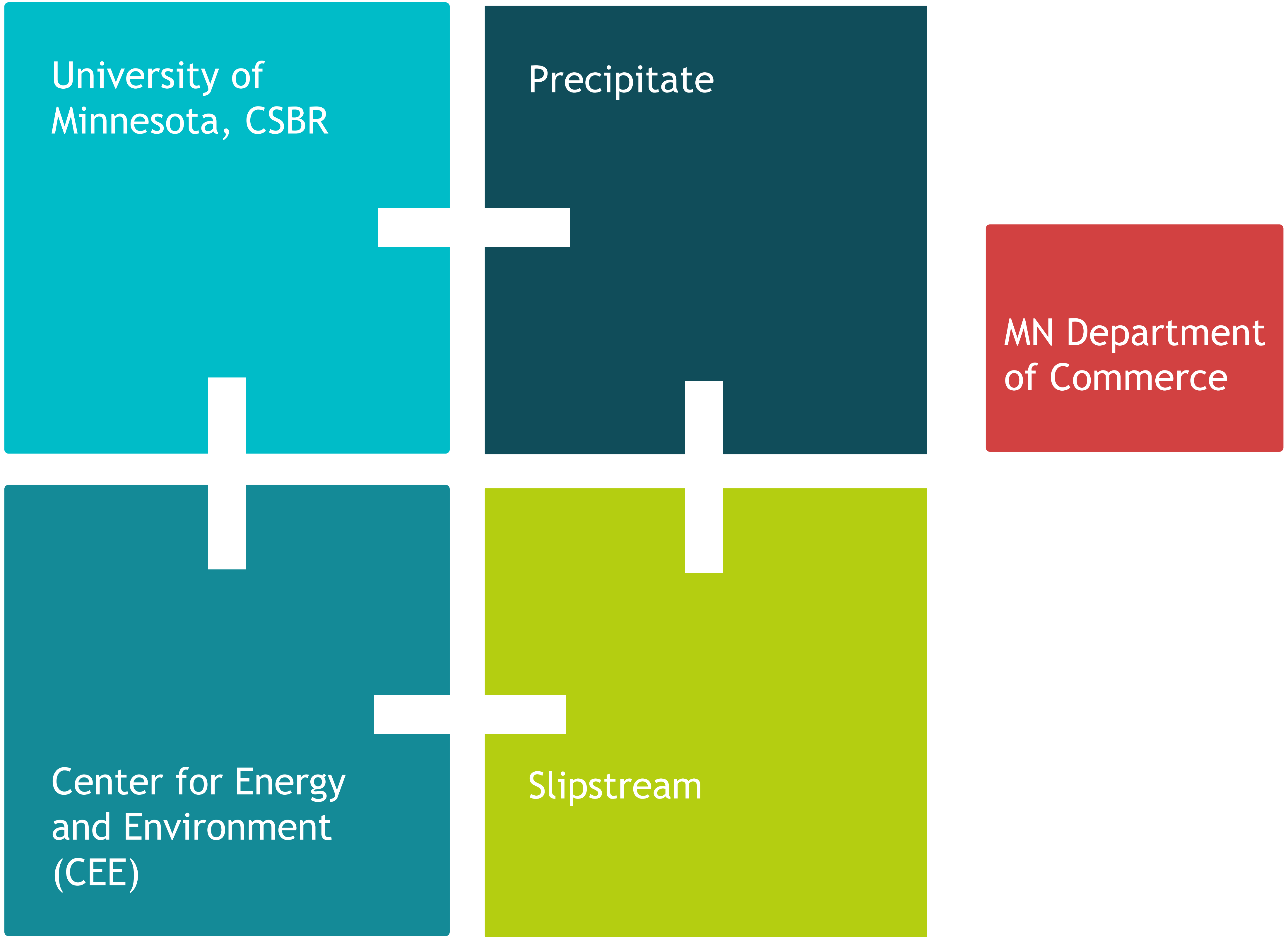
1. Learn how multifamily passive building construction is gaining momentum and what barriers remain in Minnesota, driven by state incentives, ambitious energy codes, and a growing body of completed projects.
2. Understand the impact Phius certified designs have on energy performance compared to code baseline across three climate zones and three multifamily building types in MN
3. Articulate the differences in cost (both initial construction and operations) between code baseline and Phius construction in Minnesota
4. Discover how thoughtful policies, utility program design, and incentives could unlock wider adoption.

what is a CARD grant?

$280,000+ grant awarded & administered by the MN Department of Commerce and funded by pooled investment from MN utilities.

*Conservation Applied Research and Development (CARD) grants are **research-focused** grants designed to improve and expand the reach and energy savings of utility CIP programs (Conservation Improvement Programs)*

CARD grant team



"The Market for Passive House Multifamily Projects in MN"

This CARD grant is designed as a multi-year study of the potential market and energy savings for multifamily Passive House buildings in the state.

- *Determine cost effectiveness and energy savings potential*
- *Develop understanding of the drivers and barriers related to adoption of Passive House-certified multifamily buildings*
- *Provide guidance on how to structure future, improved CIPs (targeted at PH-certified MF buildings) to maximize market uptake and energy savings*

Image credit – Mike Kane - Bloomberg

1

what does phius cost?

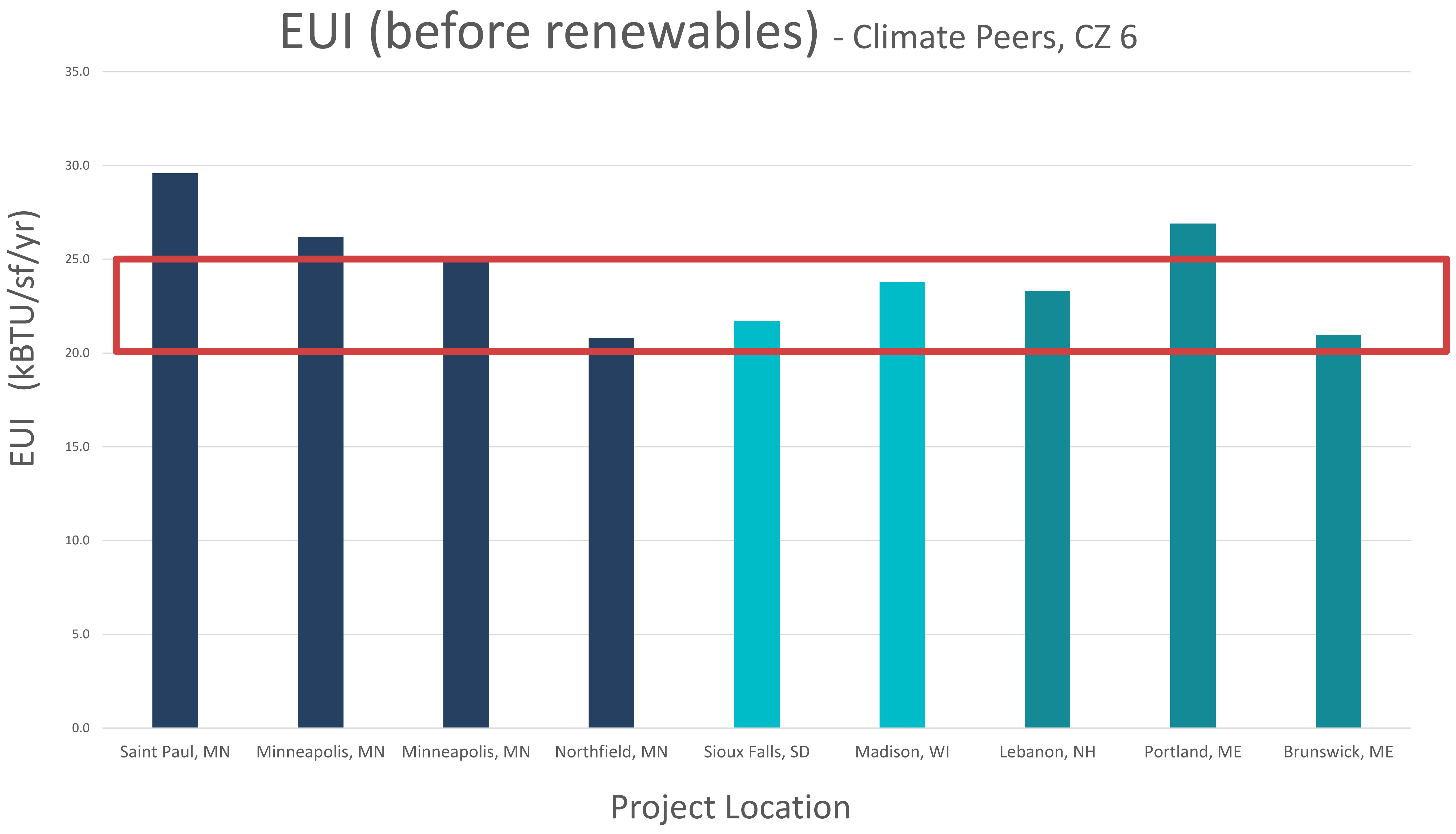
2

what can phius save?

TASK 1 DISCOVERY

understanding the market

multifamily phius in minnesota and peers



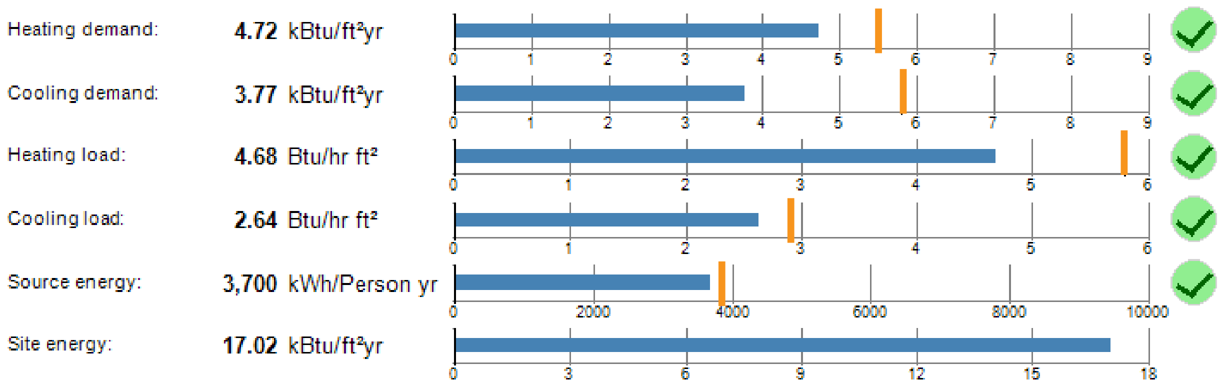
Typical EUI:
20-25 kBTU/sf/yr

Site energy savings:
40 - 60% ***modeled*** *savings compared to typical affordable multifamily construction in MN*

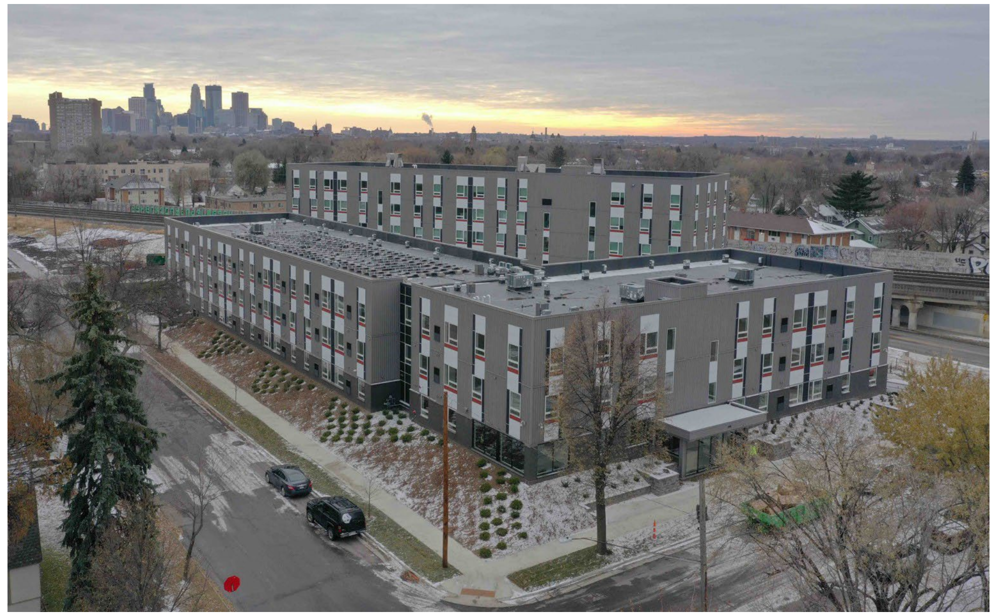
multifamily phius in minnesota in 2022

image courtesy - Kaas Wilson

VERDANT PHIUS+ 2018 CERTIFIED

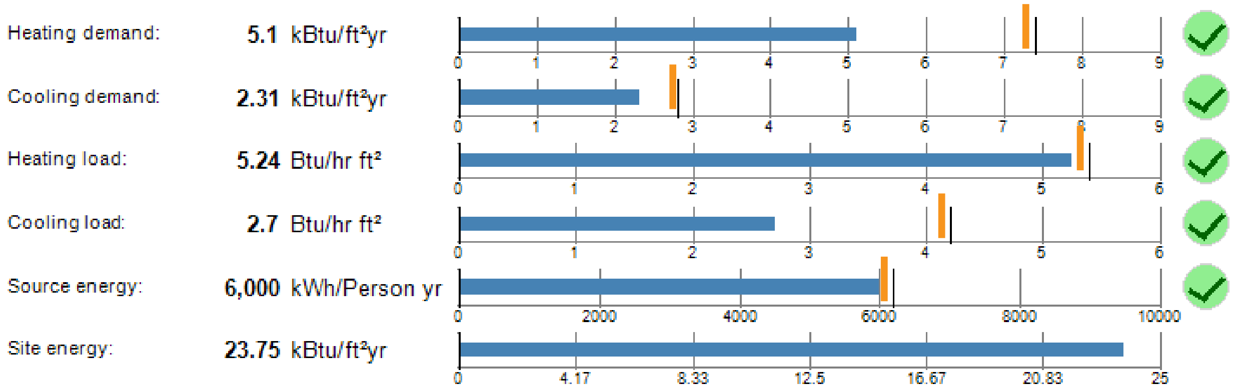


Developer: Sherman Associates
Architect: Kaas Wilson
Contractor: Frana
CPHC: Precipitate



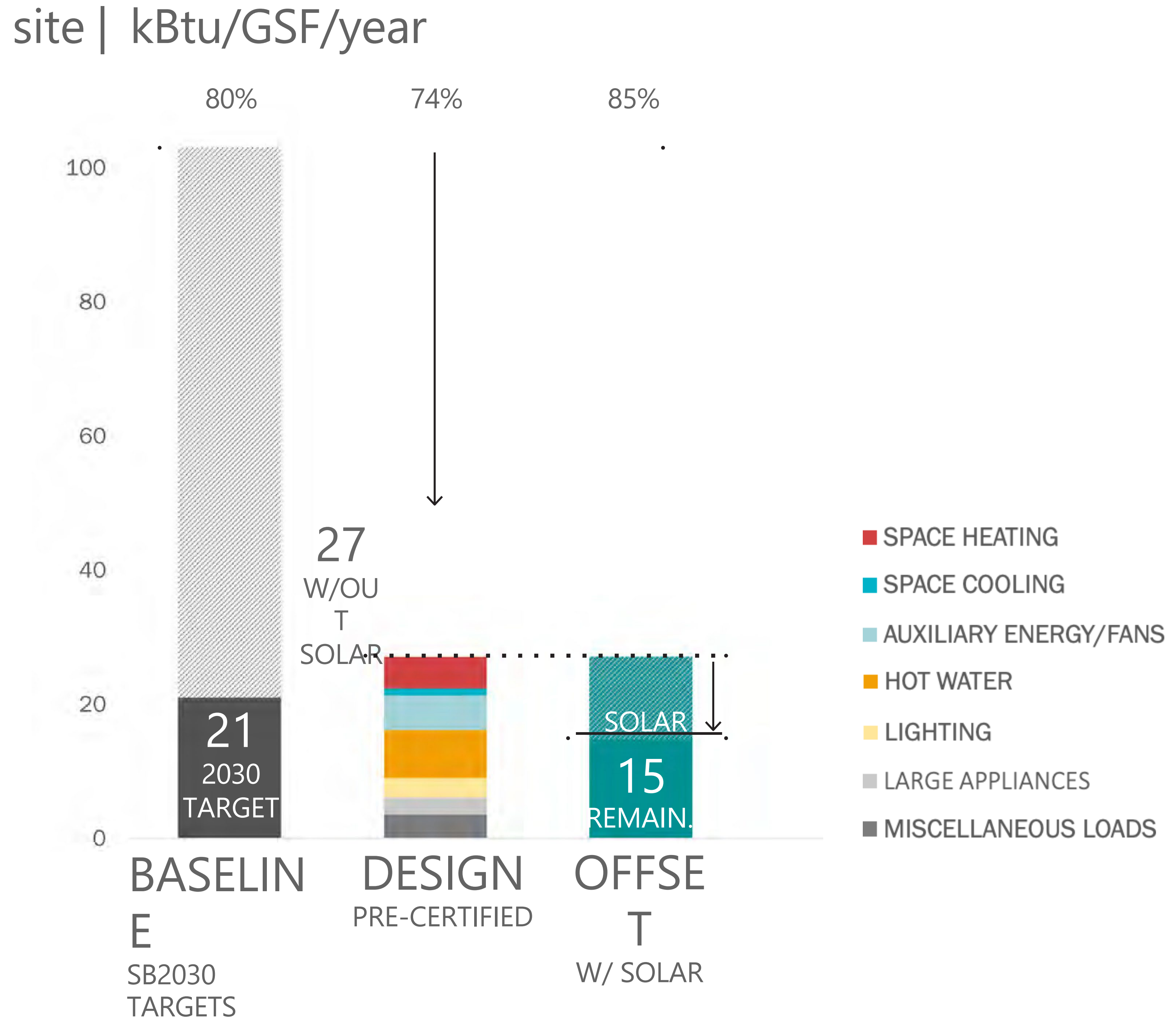
Copyright Newport Midwest

HOOK & LADDER PHIUS+ 2015 CERTIFIED

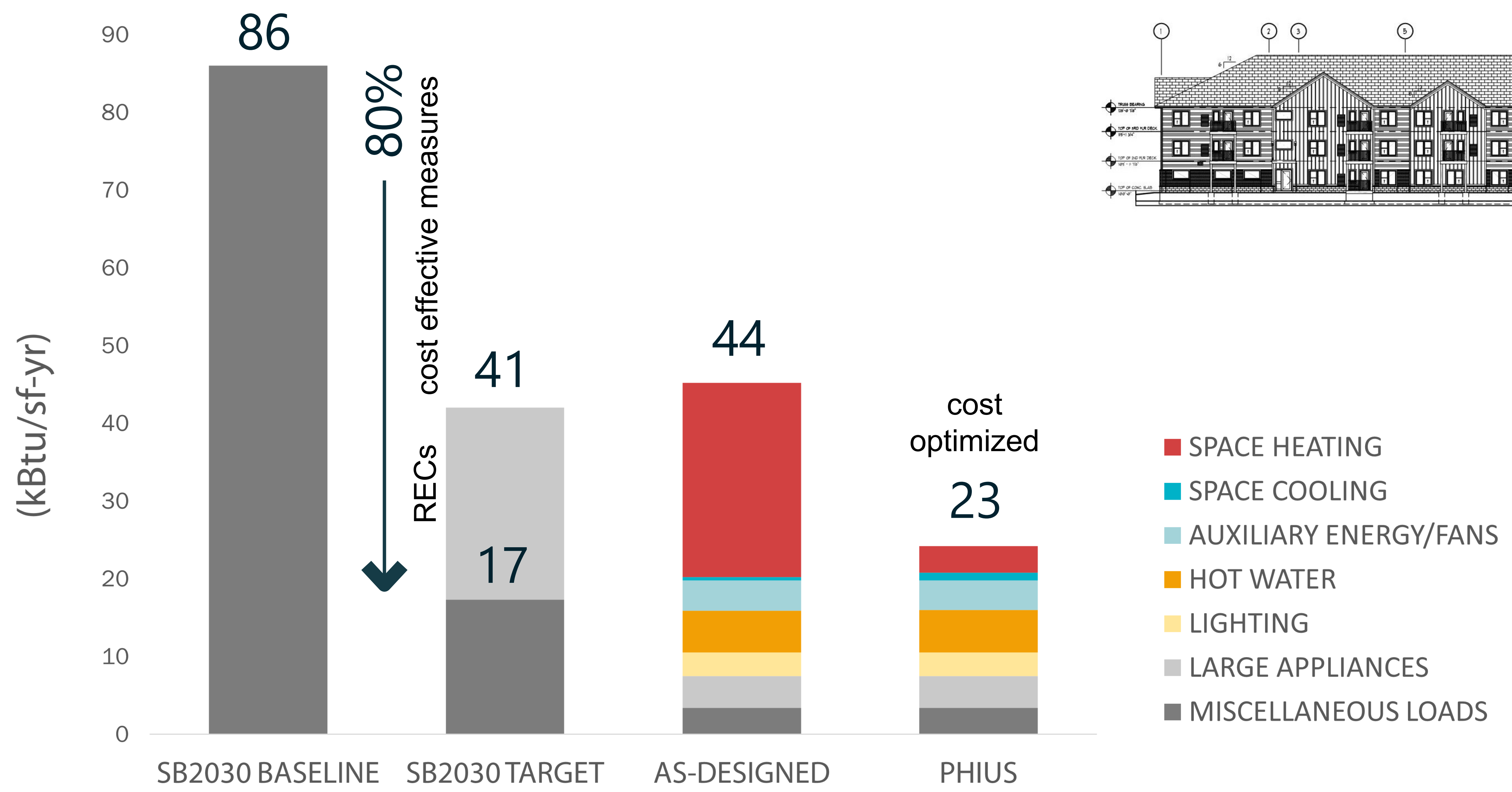


Developer: Newport Midwest
Architect: LHB
Contractor: Frerichs
CPHC: Precipitate

verdant: annual energy use



comparison with sb2030 - edge apartments



Sand Architects, LLC

Upgrades from Energy Star

- Walls 1” → 2” CI
- Windows U 0.27 → 0.16/0.14
- Under slab insulation R15
- Reduced thermal bridging
- Air Sealing 0.13 → 0.06
- Centralized Mechanical
  - WSHP Heating / Cooling
  - ERV

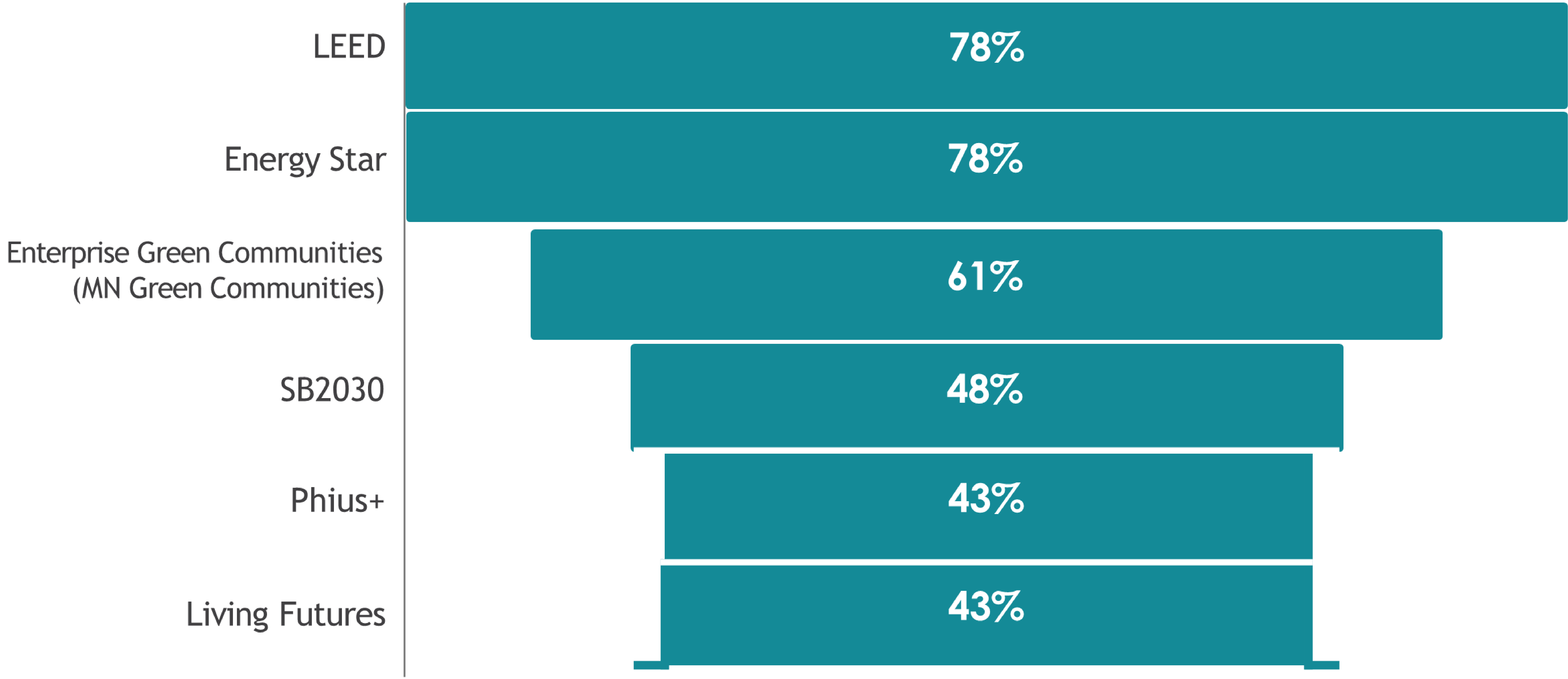
interview synthesis

Distribution of Interviewees

Initial outreach was conducted with 59 unique stakeholders across the building design, development, and construction community as well as local housing authorities and municipal entities.

Out of that original pool of candidates we carried out structured phone interviews with 29 people.

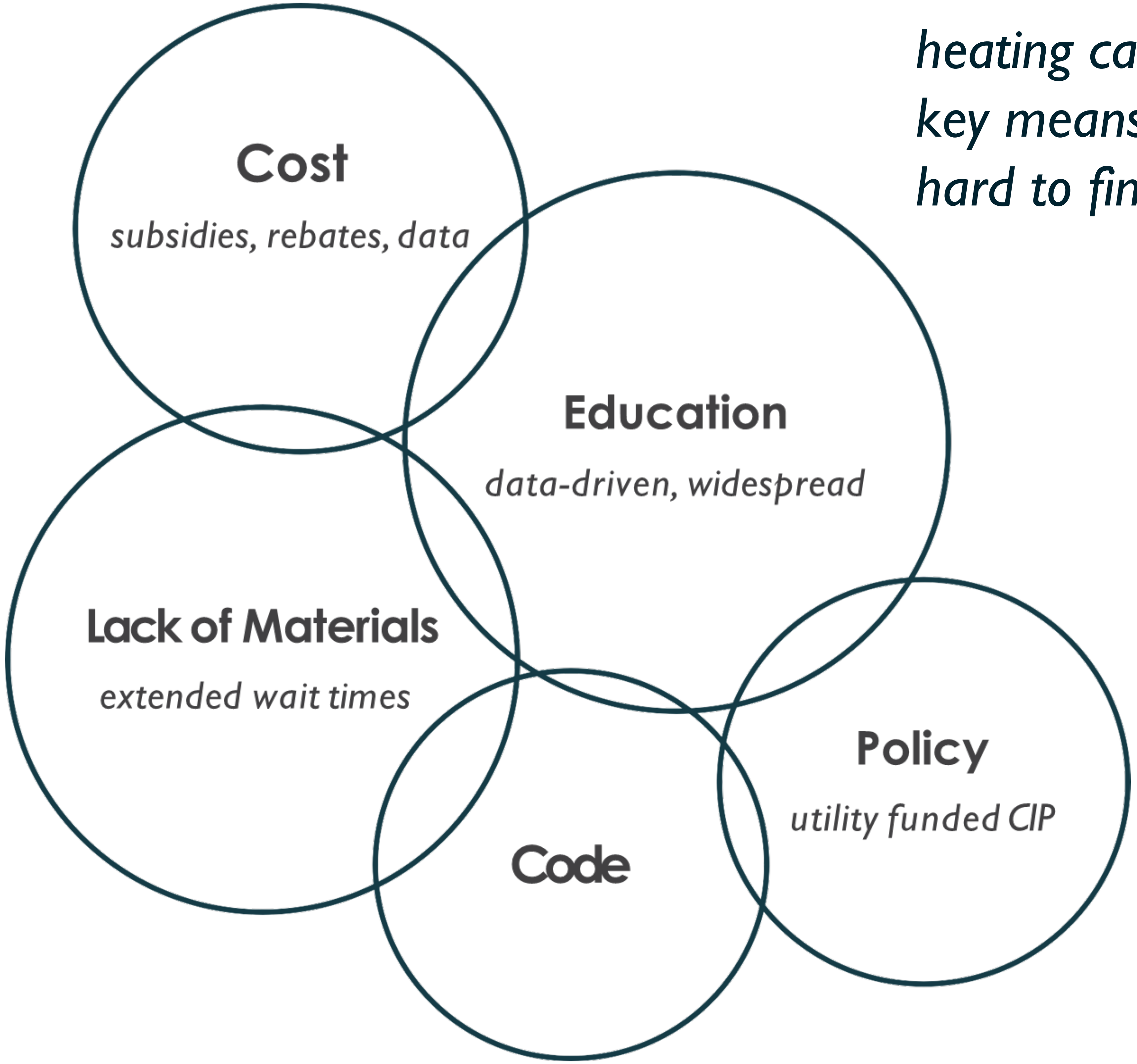
familiarity with green standards



opportunities identified

Complex mechanical and control systems that are unfamiliar in the market can dramatically increase construction and operational costs.

Unfamiliar mechanical systems may necessitate special service contracts that can raise maintenance costs for management companies.



Minimized HVAC design and heating capacity reductions are a key means to reduce costs but hard to find willing engineers

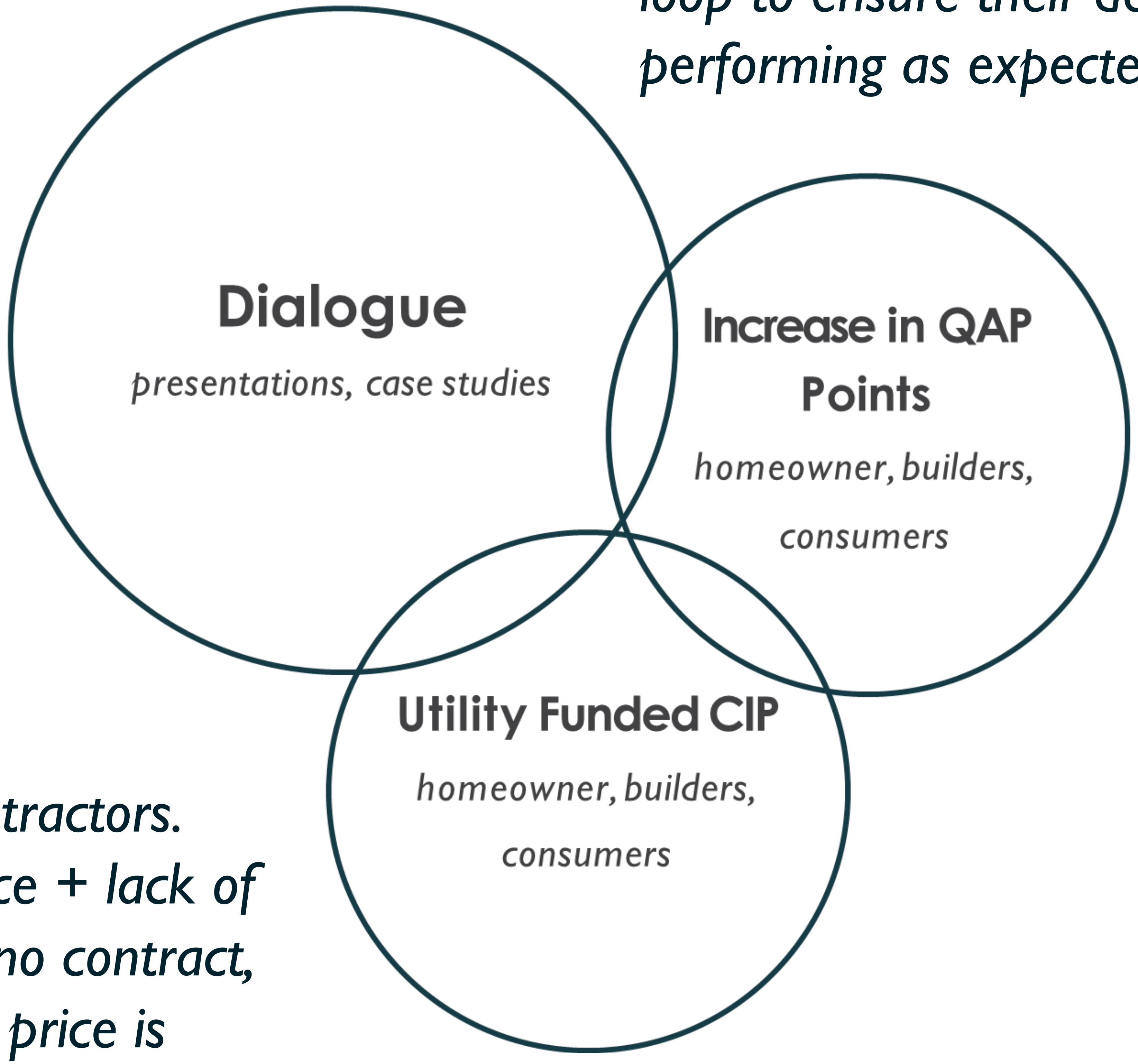
Education and knowledge transfer are essential when building ownership and/or management changes.

Resident education in a PH building is important and is always ongoing.

possible solutions

Specialized products such as gaskets and membranes may be more expensive but are often worth it for the labor savings and performance.

Architects and engineers need a feedback loop to ensure their designs are performing as expected in the field.



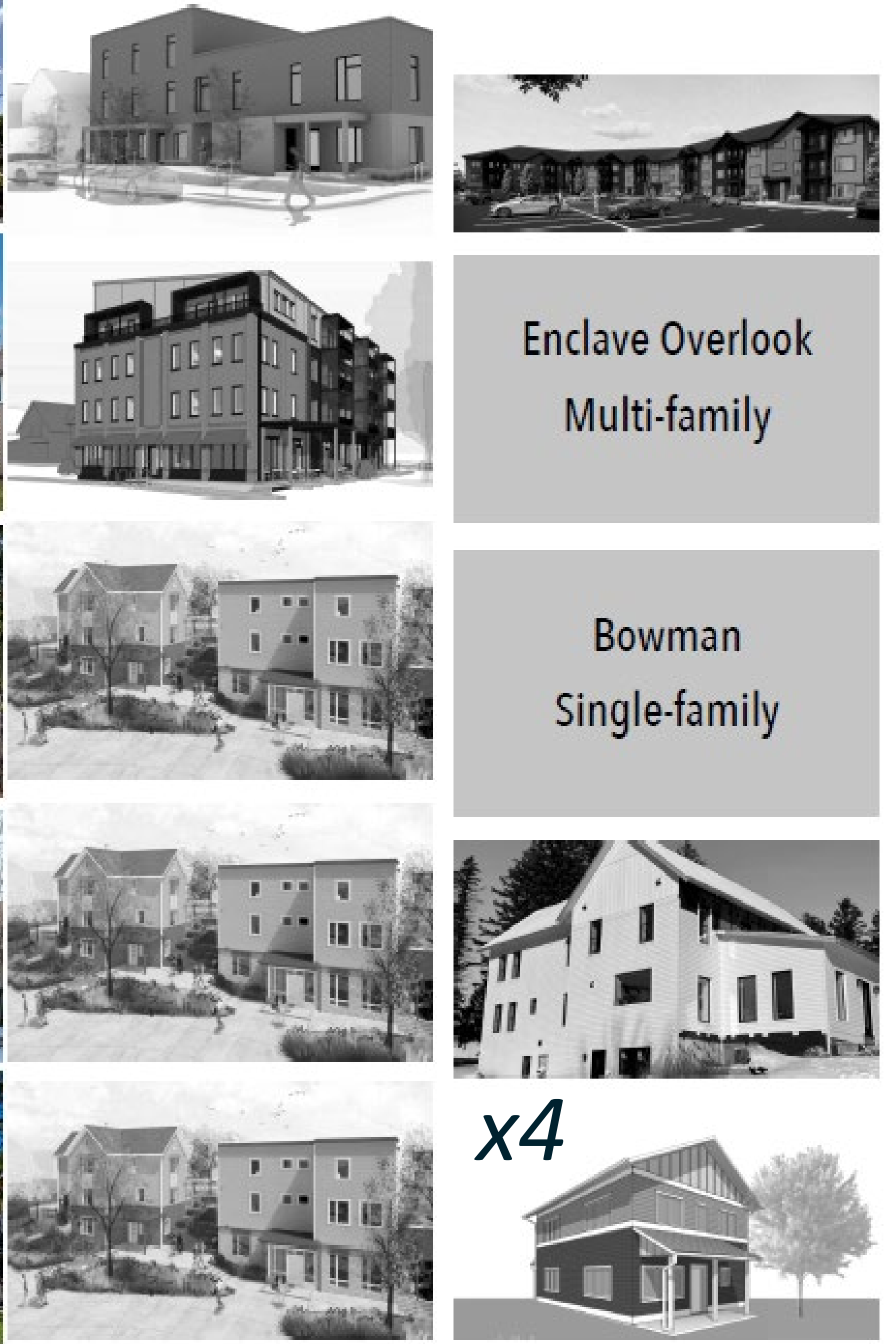
Packaged mechanicals (and controls) reduce the risk of installation issues.

Screen contractors. inexperience + lack of interest = no contract, even if the price is tempting.

how is the market continuing to transform?

phius alliance MINNESOTA

interviews



2020 2021 2022 2023 2024 2025

+ 10 projects registered

tips for success

- Use Phius to access additional funding
- Source energy is hardest to meet for MF
- Consider schedule & team impacts
  - Engage CPHC early & often
  - Engage mechanical engineers in Schematic Design stage
  - Allow appropriate time for energy modeling & Phius reviews
- Location matters: choose site in southern range of climate zone for reduced insulation differences from code
- Optimize massing & orientation when possible
  - Allow for general east-west orientation with plenty of southern light
  - Minimize SF/occupant

TASK 2 ENERGY

modeling and measuring

energy modeling objective

UNDERSTAND THE POTENTIAL **ENERGY SAVINGS**
FOR **MULTIFAMILY BUILDINGS** ACROSS THE STATE

BY COMPARING A **CODE BASELINE BUILDING** TO A
PHIUS CERTIFIABLE BUILDING
FOR **THREE SCALES** OF MULTIFAMILY BUILDINGS
IN **THREE MN CLIMATES**

3 buildings scales

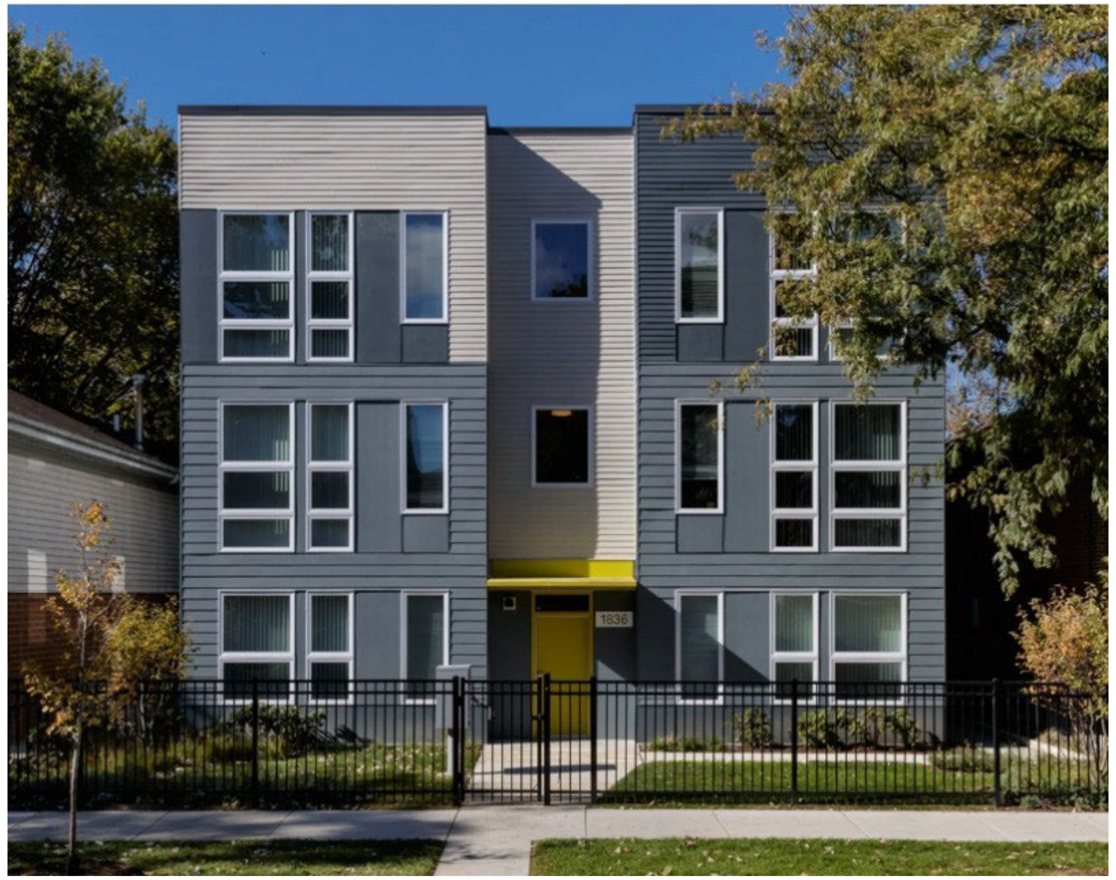


Image courtesy Phius

A. SMALL MULTIFAMILY

Envelope Area	14,107
iCFA	8,596
Dwelling Units	6
Bedrooms	18

Image courtesy Precipitate

B. MEDIUM MULTIFAMILY

Envelope Area	21,103
iCFA	17,880
Dwelling Units	23
Bedrooms	23

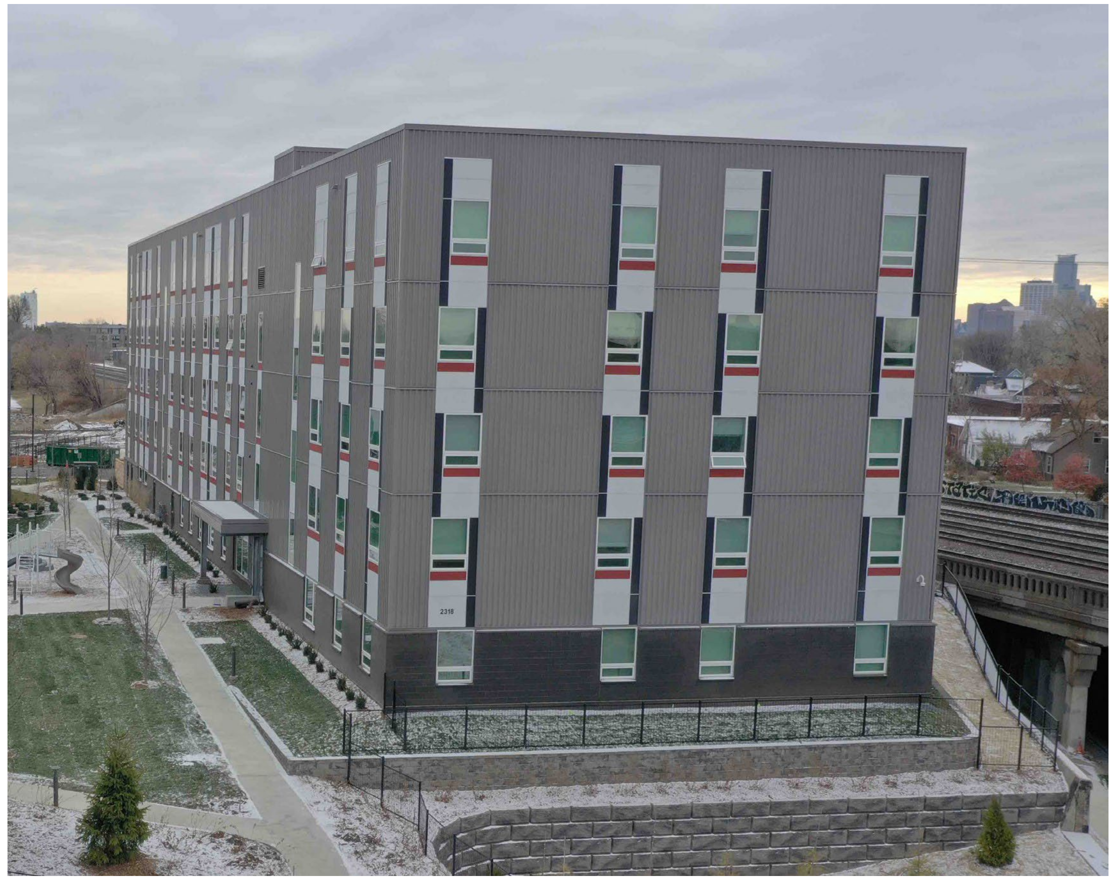


Image courtesy Newport Midwest

C. LARGE MULTIFAMILY

Envelope Area	56,200
iCFA	53,167
Dwelling Units	59
Bedrooms	97

3 climates

7 NORTH
BEMIDJI MUNICIPAL AIRPORT

6A CENTRAL
Minneapolis - St. Paul Intl Airport

6A SOUTH
Albert Lea
(AWOS)

These cities were chosen to study three, different regions that represent a good cross-section of Minnesota.

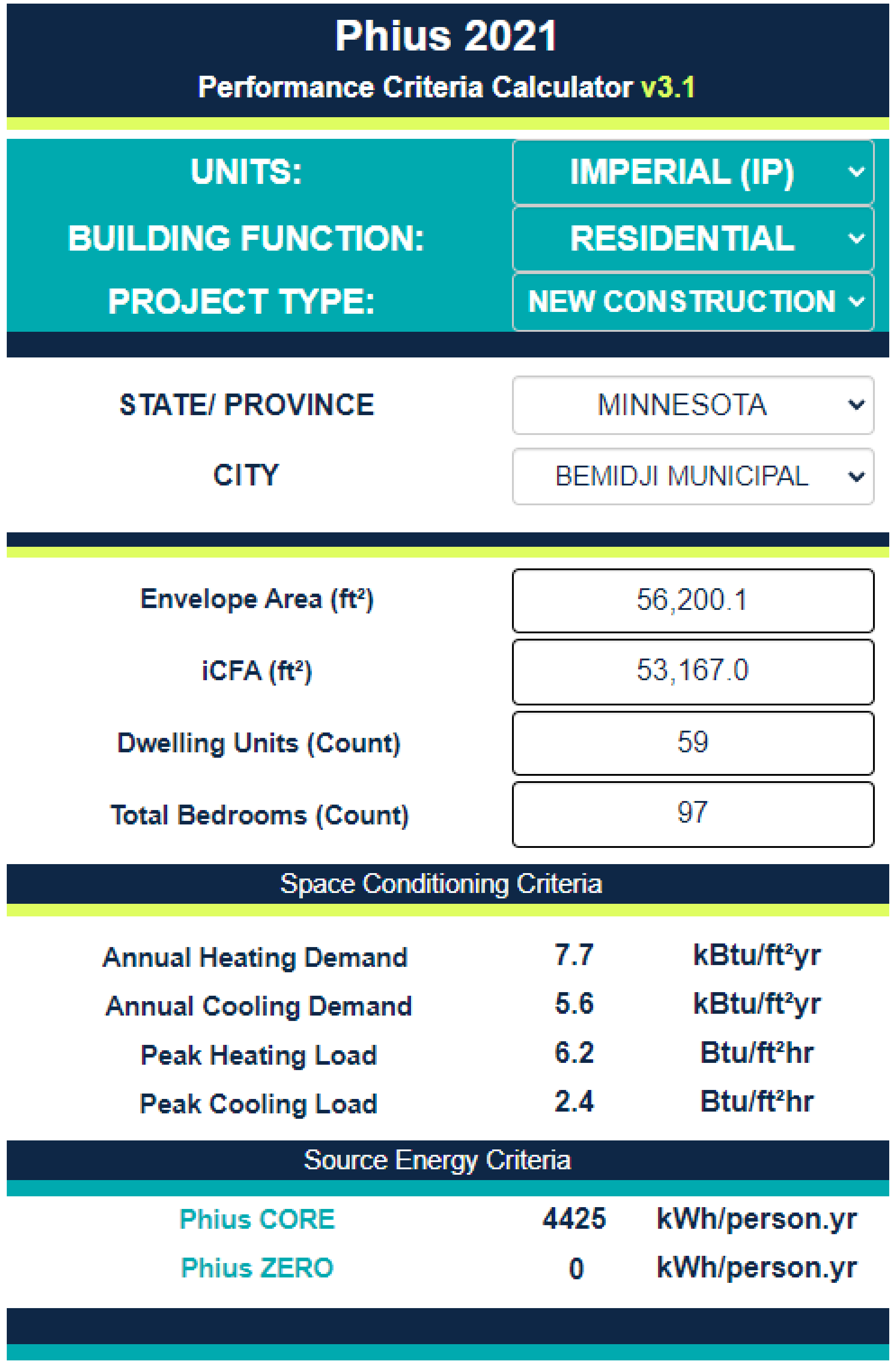
Bemidji in the north, is located in climate zone 7, and the city is surrounded by lakes and forestland.

Minneapolis and St. Paul are located in climate zone 6A along the Mississippi River and network of lakes, and it represents the largest city of the three examples.

Albert Lea in the south, is located in the climate zone 6A, and is located between lakes and farmland.

phius core 2021 targets

	BEMIDJI	MSP	ALBERT LEA
	TARGET	TARGET	TARGET
A. SMALL MULTIFAMILY			
Heating Demand	8.5	7.3	7.6
Cooling Demand	4.3	5.5	5.2
Heating Load	5.9	6.3	5.4
Cooling Load	1.9	2.6	2.5
Source Energy	3850	3850	3850
B. MEDIUM MULTIFAMILY			
Heating Demand	8.1	7.3	7.5
Cooling Demand	5.2	6.5	6.8
Heating Load	6.5	6.9	5.9
Cooling Load	2.4	3	2.9
Source Energy	4350	4350	4350
C. LARGE MULTIFAMILY			
Heating Demand	7.7	6.9	7.2
Cooling Demand	5.6	6.8	7
Heating Load	6.2	6.6	5.7
Cooling Load	2.4	3	2.9
Source Energy	4425	4425	4425



images from PHIUS online calculator

model assumptions for small multifamily

	BASELINE RESIDENTIAL CODE 2012 IECC W/MN AMENDMENTS			PASSIVE
	GAS	ELECTRIC RESISTANCE	ELECTRIC ASHP	PHIUS+ 2021
Roof	R49			PERFORMANCE BASED (VARIES)
(whole wall) Wall	R20 (R16 Effective)			
Slab	R10			
Windows	Uw-0.32, SHGC 0.4, 0.75 site & summer shading, no interior blinds			
Doors	Uw-0.32 (R3.125)			
Air Sealing	0.31 cfm/SF @50 Pa (3 ACH50)			.06 cfm/SF @50 Pa
Heating	80 AFUE Gas Furnace	All-in-One Elec Heating & AC	Air Source Heat Pump COP 3.4 @ 47f / 2.2 @ 17F	Air to Air Heat Pump 20,000 BTU/h Heating COP 4 @ 47F / 2.33 @ 17F
Cooling	Electric AC 13 SEER / 11.38 EER		Air Source Heat Pump 13 SEER / 11.38 EER	Air to Air Heat Pump 20 SEER
Ventilation	Balanced, No Recovery 1 W/cfm Fan Efficiency			Energy Recovery Ventilator SRE 0.84 / LRE 0.64 / 0.49 W/cfm
DHW	Standard Natural Gas 0.80 EF / 50 ga. tank R3.3 Pipe Insulation	Electric 0.92 UEF / 50 ga. tank R3.3 Pipe Insulation		Electric Heat Pump 3.75 UEF / 50 ga. tank R3.3 Pipe Insulation
Lighting & Power	75% LED, Utility Baseline Appliances			100% LED, Median Energy Star Apps.
Thermal Bridging	Not Included in Baseline Models			

space conditioning baselines

Natural Gas
Furnace
Electric AC

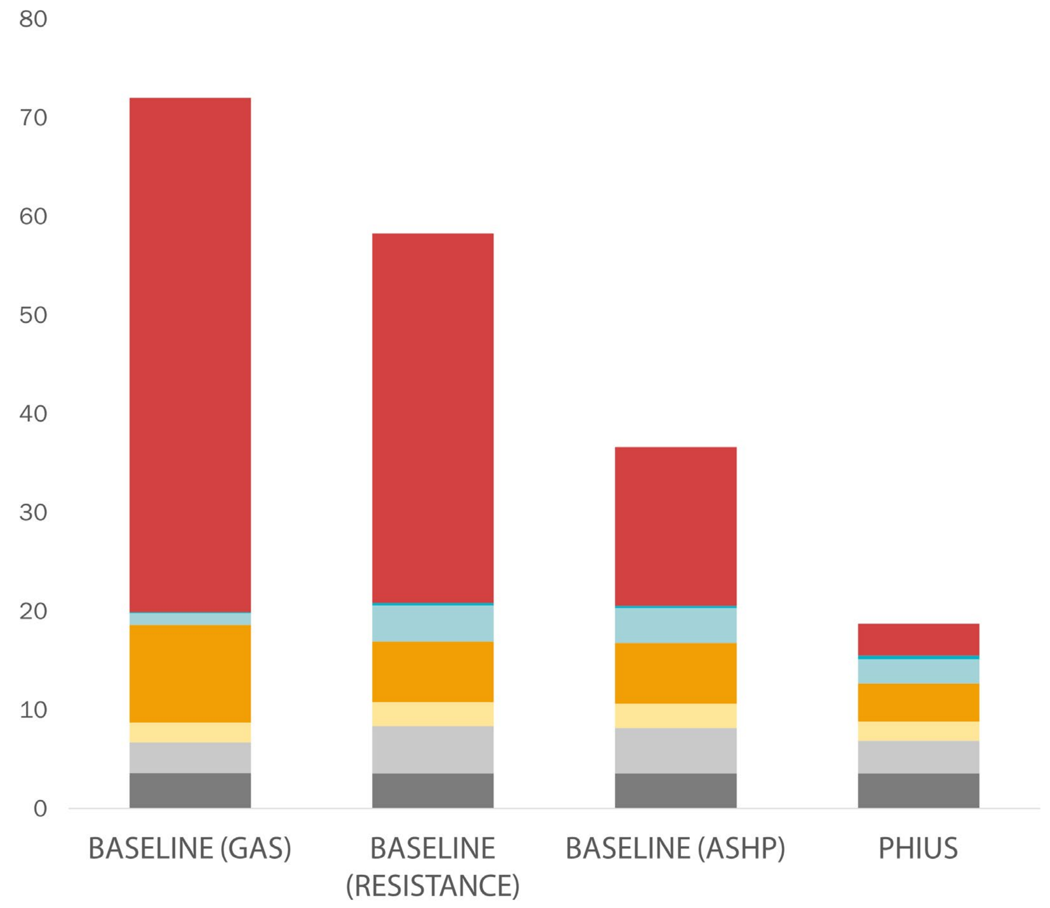
Electric Resistance
Heat Electric AC

Air to Air Heat
Pump
w/ Electric Backup

annual site energy use comparison| small multifamily

BEMIDJI (7A)

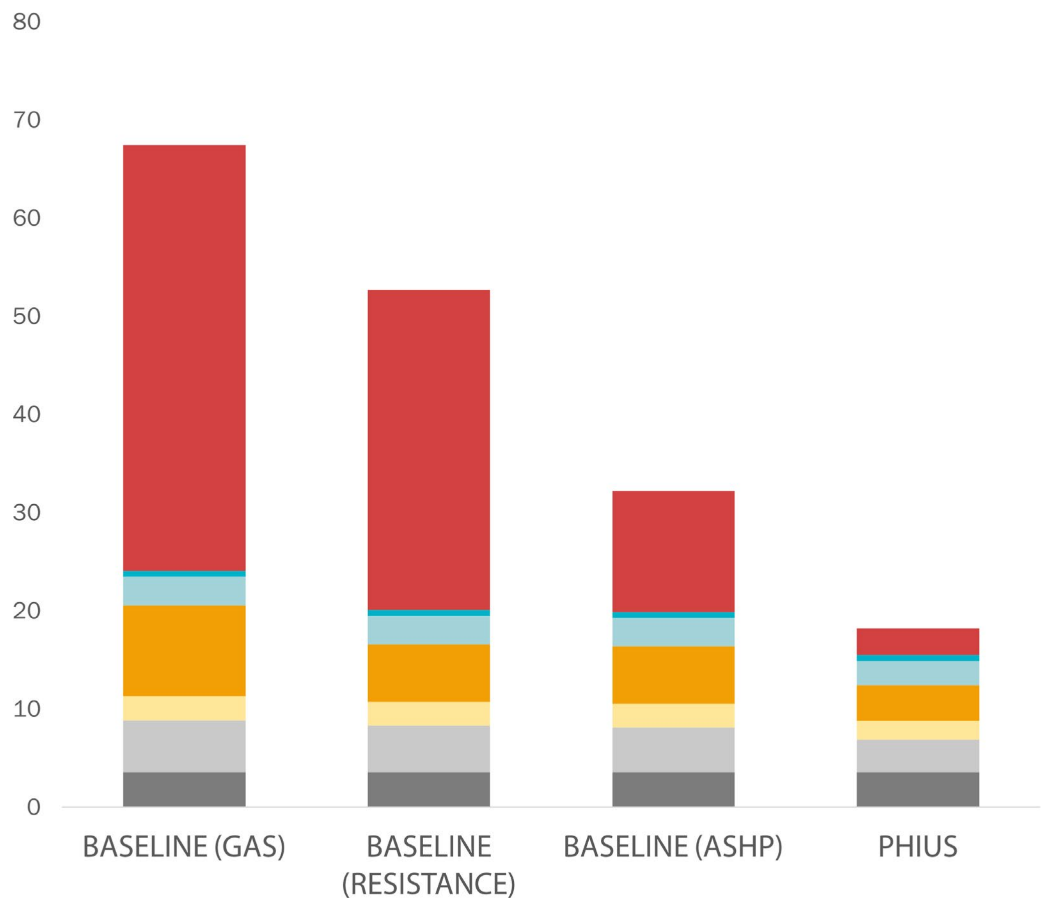
74% - 49% savings



Wall	R16	R65
Roof	R49	R85
Slab	R0.42	R30
Wdws	U0.32	U0.16
Doors	U0.32	U0.29
Solar PV		14,500 kWh/y

MINNEAPOLIS ST PAUL (6A)

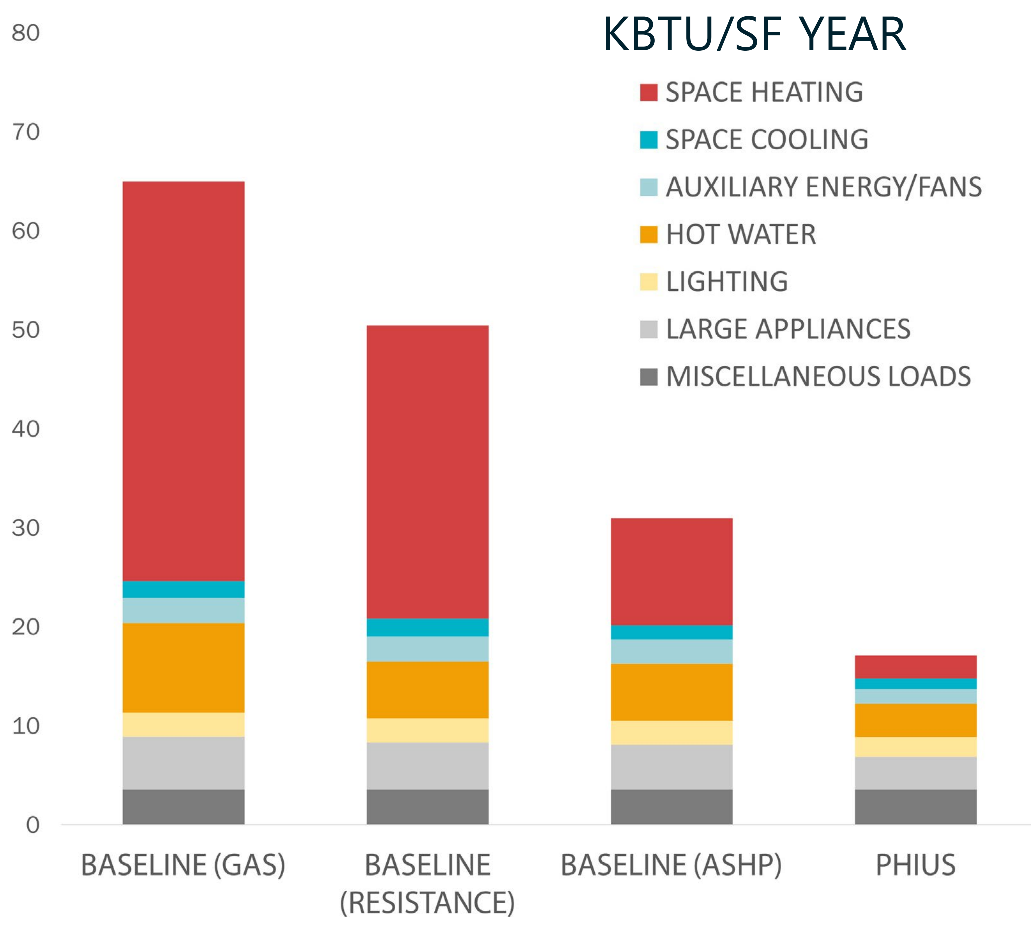
73% - 44% savings



Wall	R16	R40
Roof	R49	R60
Slab	R0.42	R30
Wdws	U0.32	U0.16
Doors	U0.32	U0.29
Solar PV		12,500 kWh/y

ALBERT LEA (6A)

74% - 45% savings

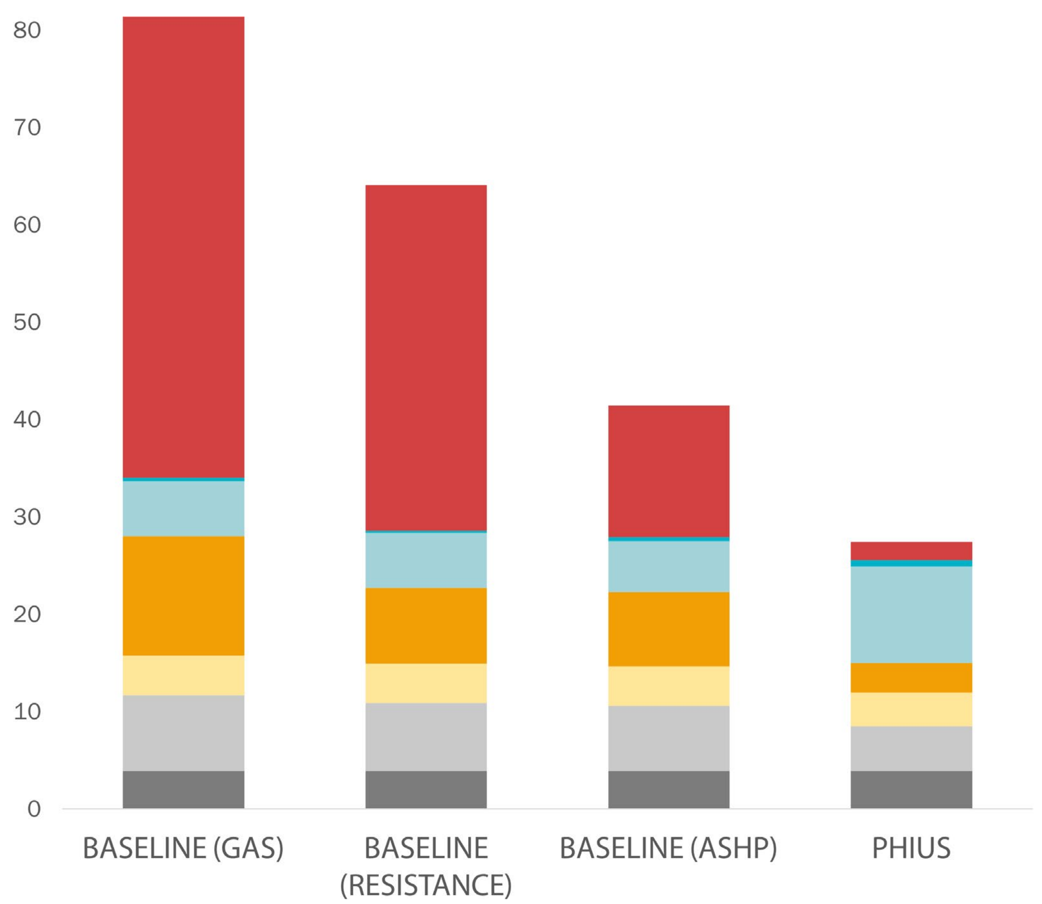


Wall	R16	R40
Roof	R49	R60
Slab	R0.42	R30
Wdws	U0.32	U0.16
Doors	U0.32	U0.16
Solar PV		12,500 kWh/y

annual site energy use comparison| medium multifamily

BEMIDJI (7A)

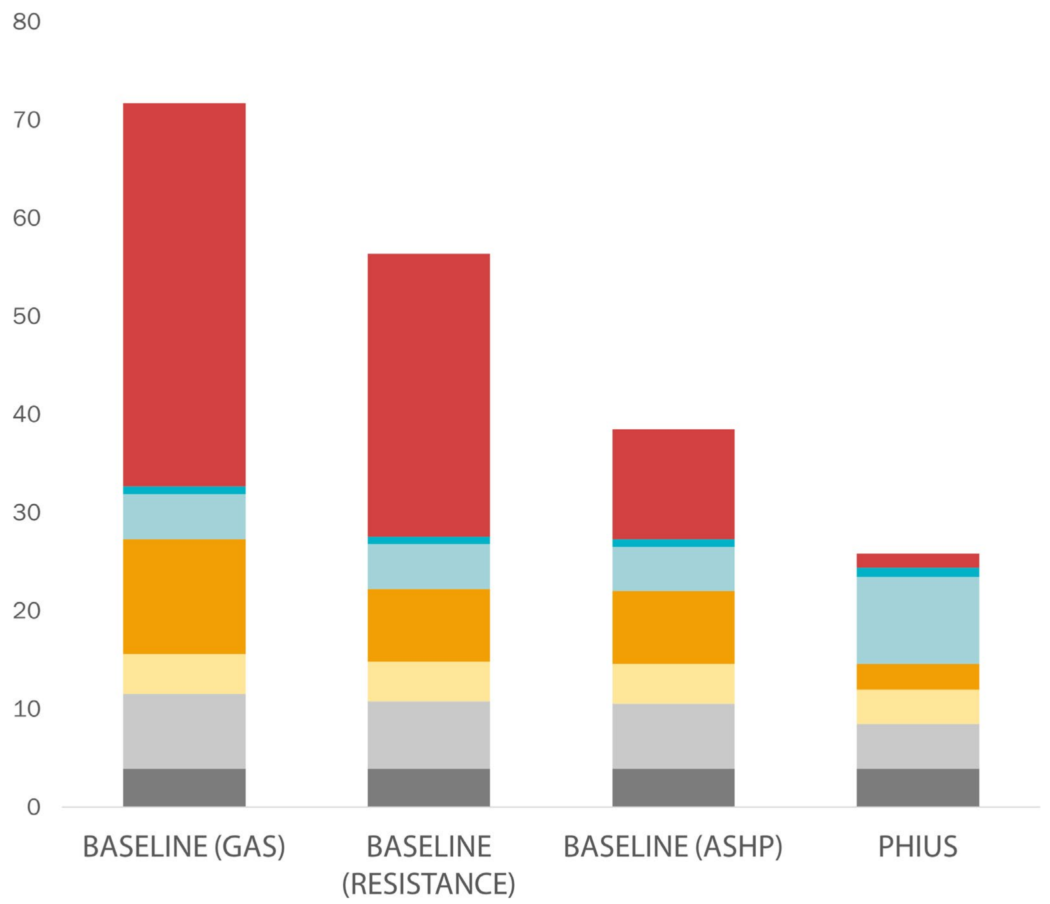
66% - 34% savings



	BASELINE (RESISTANCE)	PHIUS
Wall	R24	R34
Roof	R35	R38
Slab	R0.42	R10
Wdws	U0.32	U0.16
Doors	U0.77	U0.29
Solar PV		2,000 kWh/y

MINNEAPOLIS ST PAUL (6A)

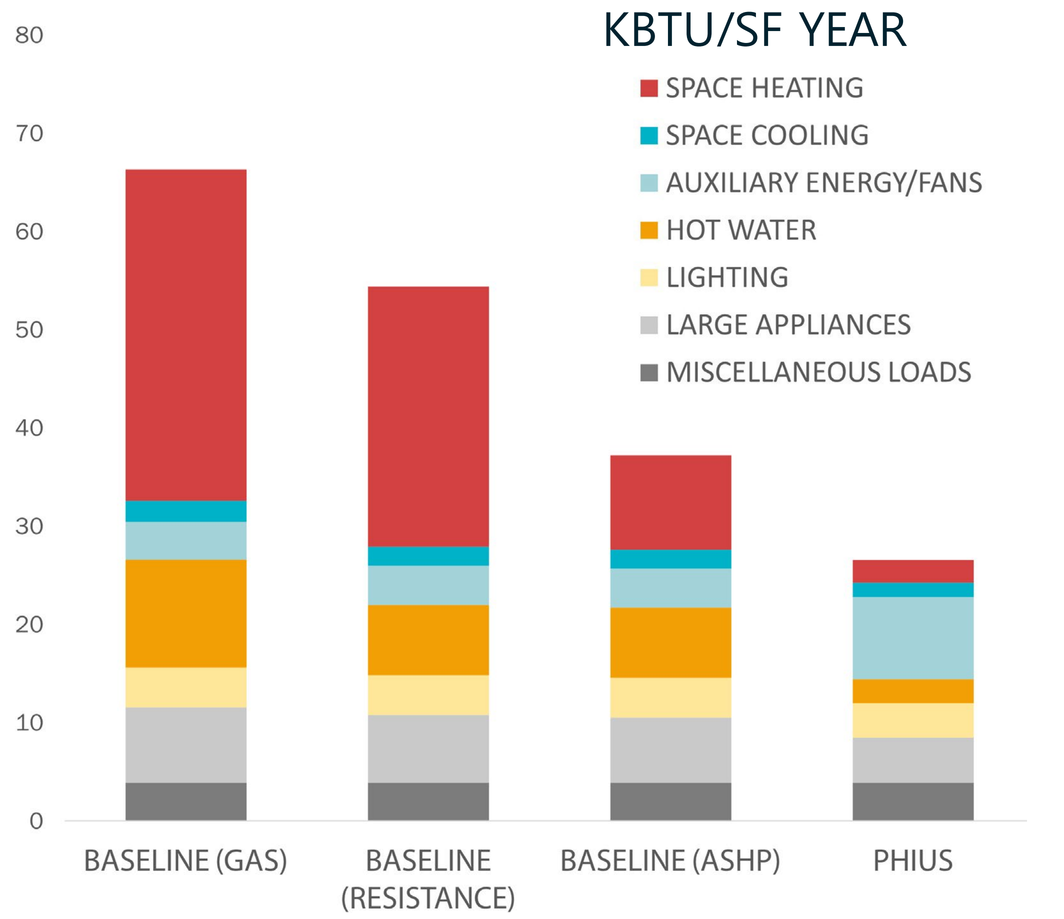
64% - 33% savings



	BASELINE (RESISTANCE)	PHIUS
Wall	R24	R34
Roof	R30	R38
Slab	R0.42	R10
Wdws	U0.32	U0.16
Doors	U0.77	U0.29
Solar PV		none

ALBERT LEA (6A)

60% - 29% savings

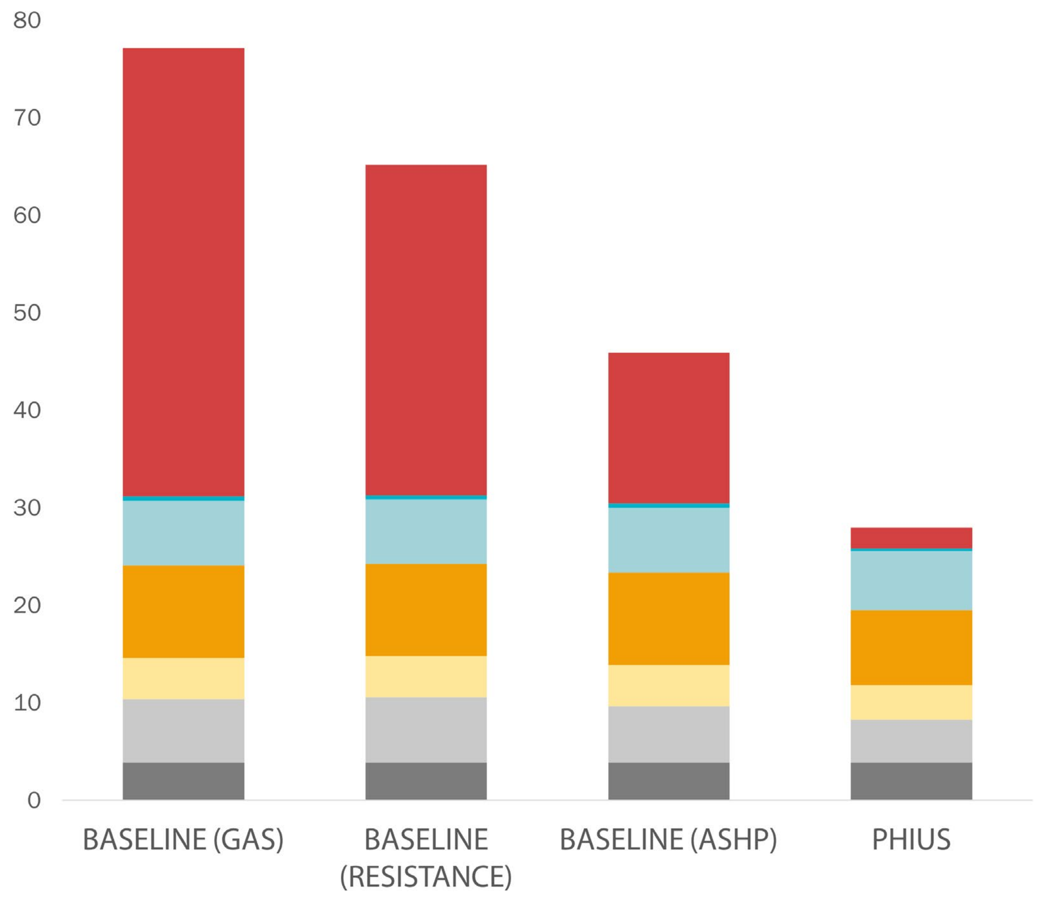


	BASELINE (RESISTANCE)	PHIUS
Wall	R24	R34
Roof	R30	R38
Slab	R0.42	R10
Wdws	U0.32	U0.16
Doors	U0.77	U0.29
Solar PV		2,500 kWh/y

annual site energy use comparison| large multifamily

BEMIDJI (7A)

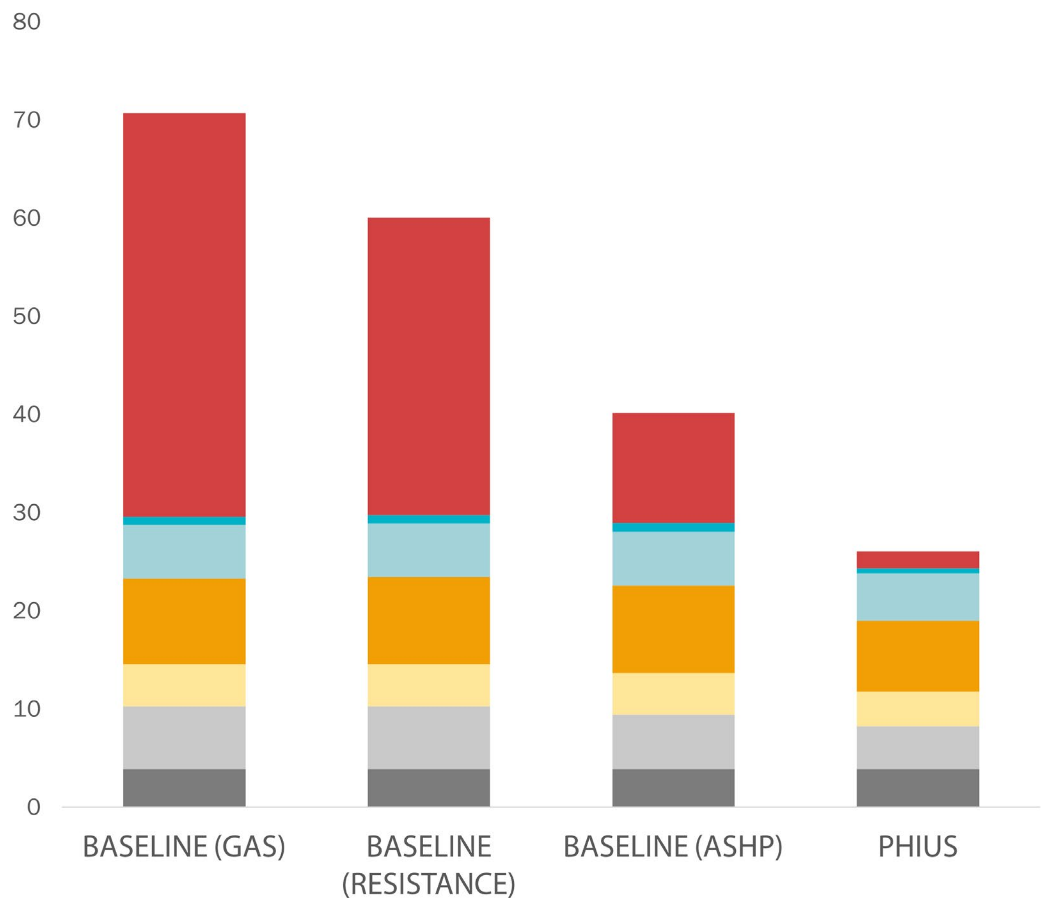
64% - 39% savings



Wall	R16	R26
Roof	R49	R60
Slab	R0.42	R20
Wdws	U0.32	U0.16
Doors	U0.32	U0.29

MINNEAPOLIS ST PAUL (6A)

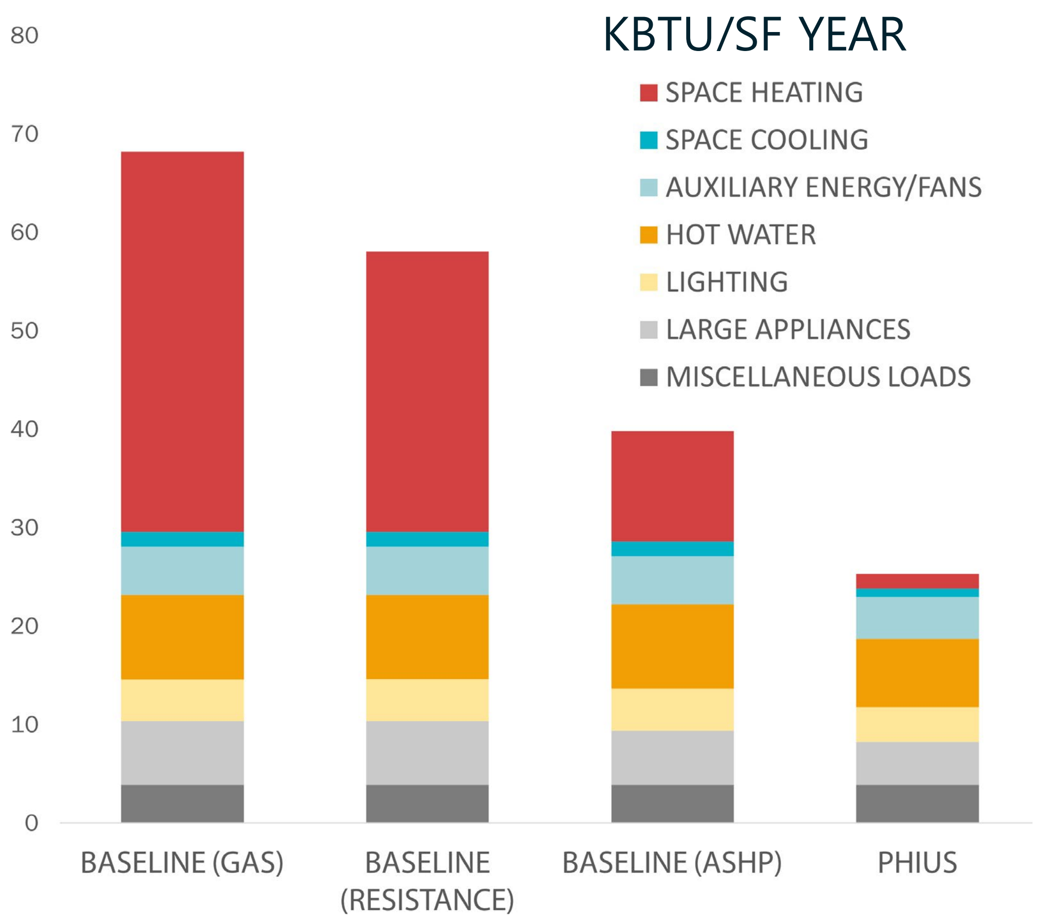
63% - 35% savings



Wall	R16	R26
Roof	R49	R60
Slab	R0.42	R20
Wdws	U0.32	U0.16
Doors	U0.32	U0.29

ALBERT LEA (6A)

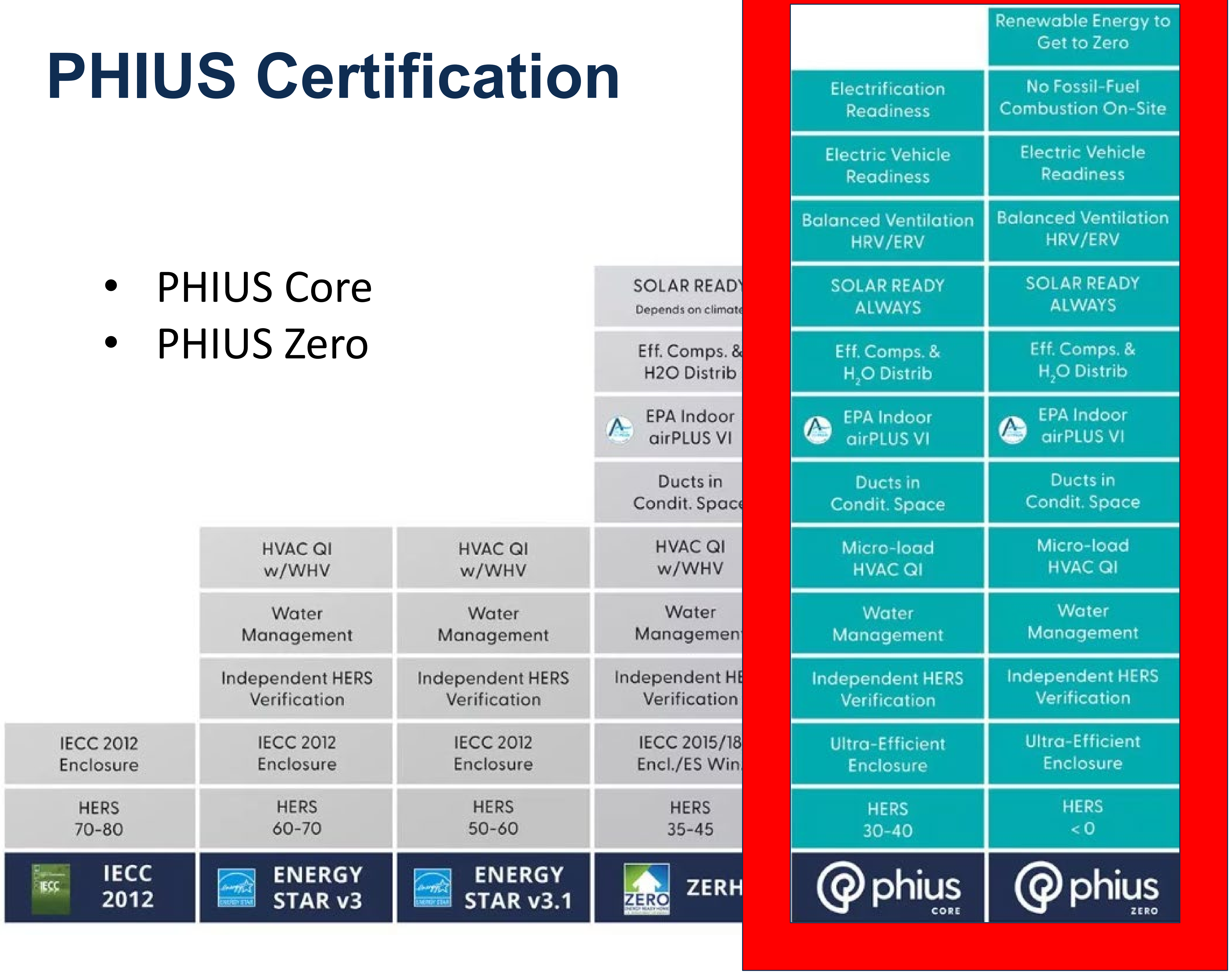
63% - 36% savings



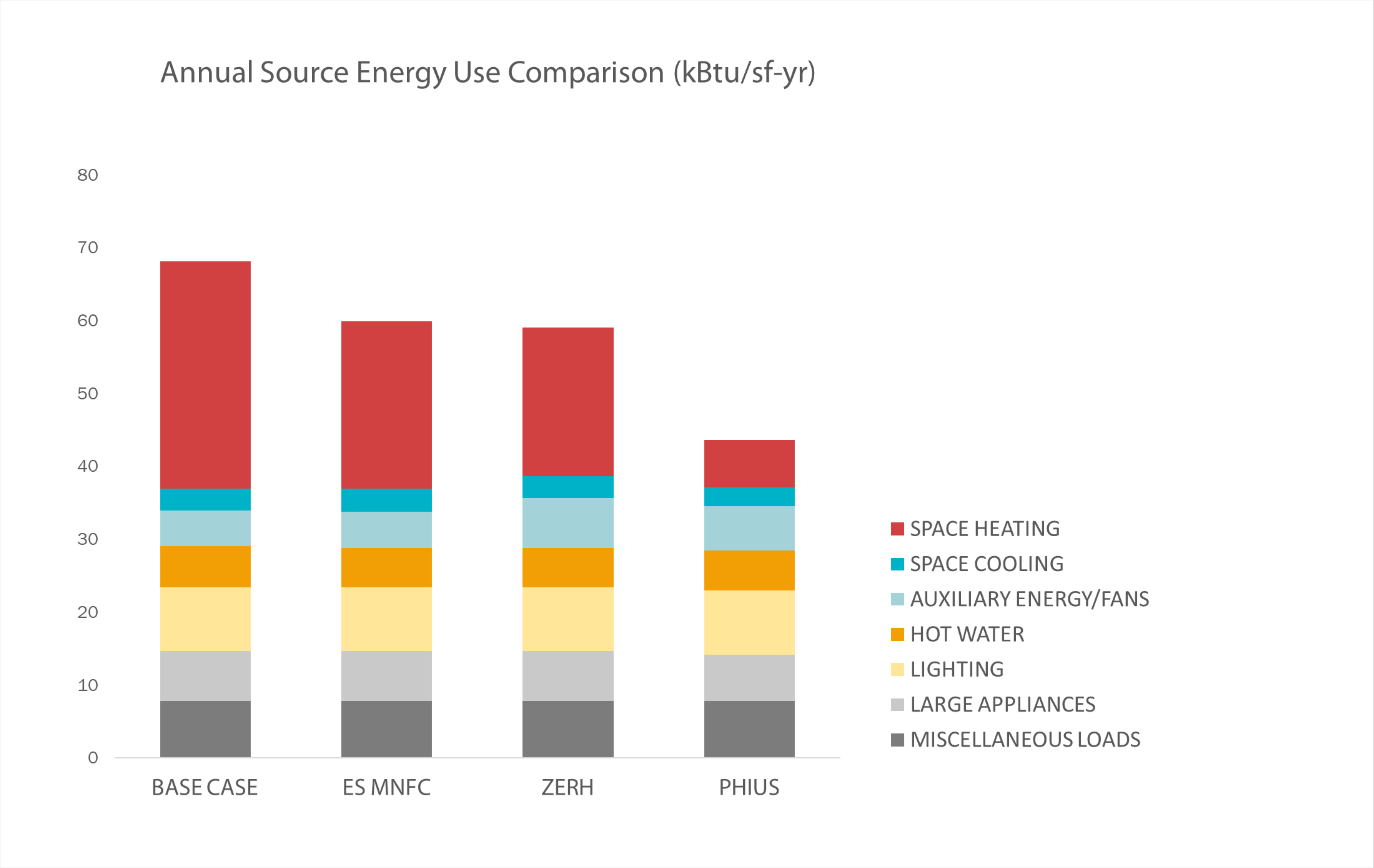
Wall	R16	R26
Roof	R49	R60
Slab	R0.42	R20
Wdws	U0.32	U0.16
Doors	U0.32	U0.16

PHIUS Certification

- PHIUS Core
- PHIUS Zero



Stairstep Energy Use Comparison



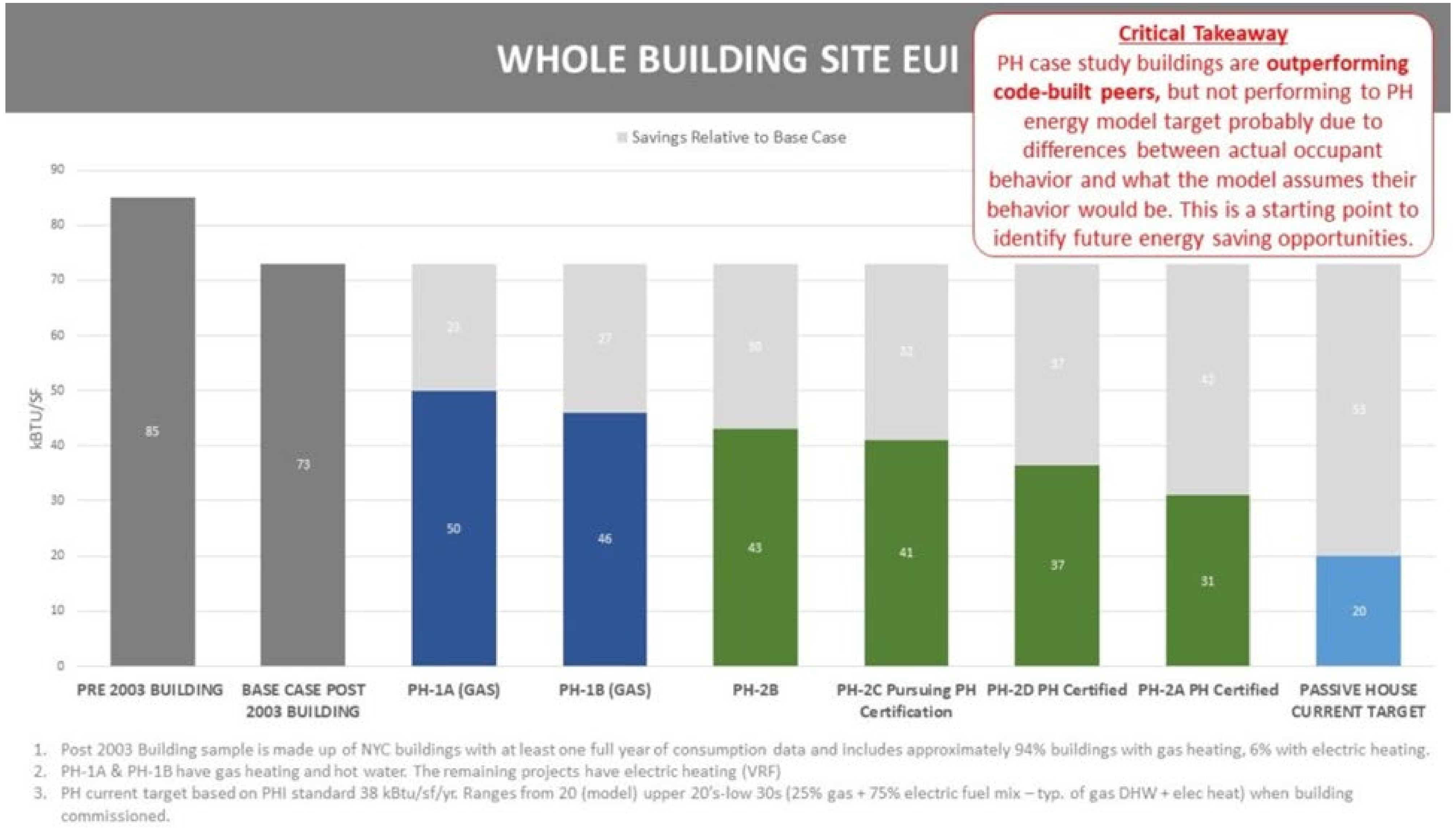
metered and modeled energy consumption

How are passive multifamily buildings performing in the real world?

PHIUS monitoring study in 2019, 6 multifamily building results:

- ❑ Average Modeled vs Actual = 88%
- ❑ Modeling was slightly over-estimating actual efficiency
- ❑ Study included normalization for occupancy, weather, interior setpoints
- ❑ Case studies were in climate zones 4,5

metered and modeled energy consumption



How are passive multifamily buildings performing in the real world?

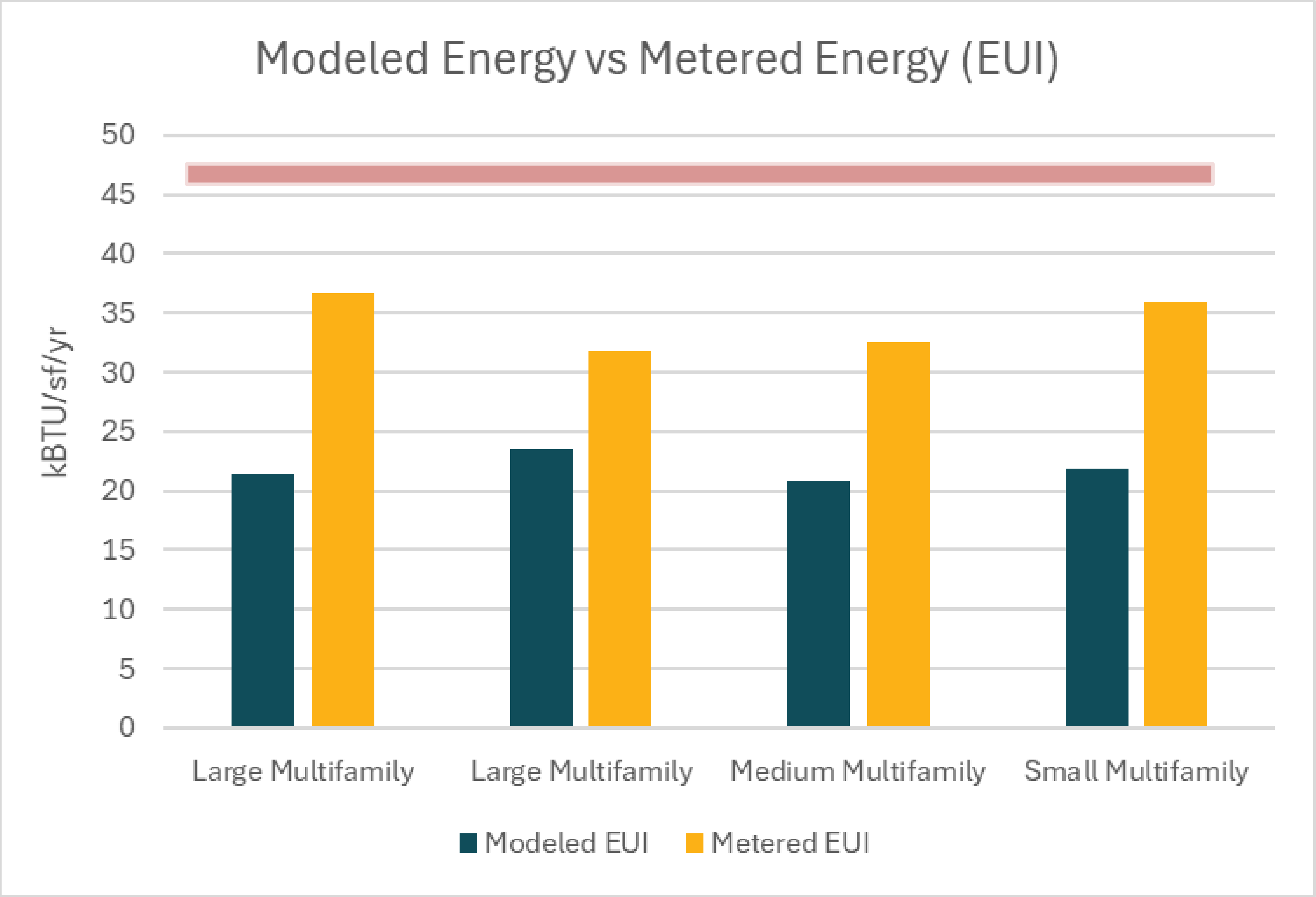
NYSERDA Study

- ❑ Metered performance showed large improvement over conventional construction, but...
- ❑ Projects were again underperforming compared to energy models
- ❑ Study suggested that the main reason for the discrepancy was occupant behavior

metered and modeled energy consumption

How are passive multifamily buildings performing in Climate Zone 6?

- ❑ Outperforming "energy efficient" new construction peers by 10-15 kBTU/sf (energy savings of 25-30%)
- ❑ WUFI Passive energy models estimate energy savings of 50% over peers

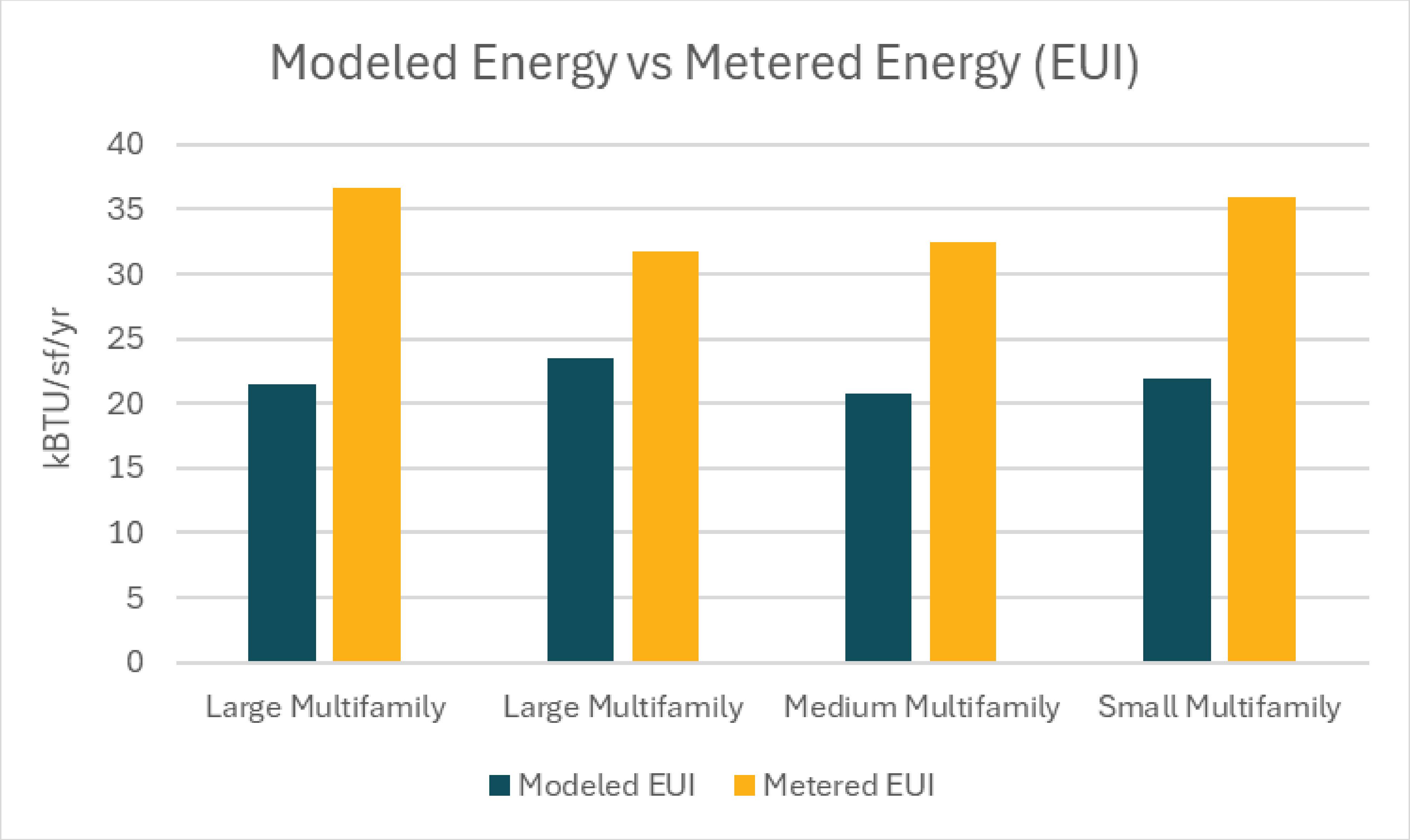


metered and modeled energy consumption

How are passive multifamily buildings performing in Climate Zone 6?

Multifamily buildings are consuming more energy than modeled in WUFI Passive

- ❑ Two of these projects have documented mechanical system issues
- ❑ The data has not been normalized for weather or occupancy, but...
- ❑ Occupancy in at least two of the buildings has been lower than modeled
- ❑ Winter was warmer than average

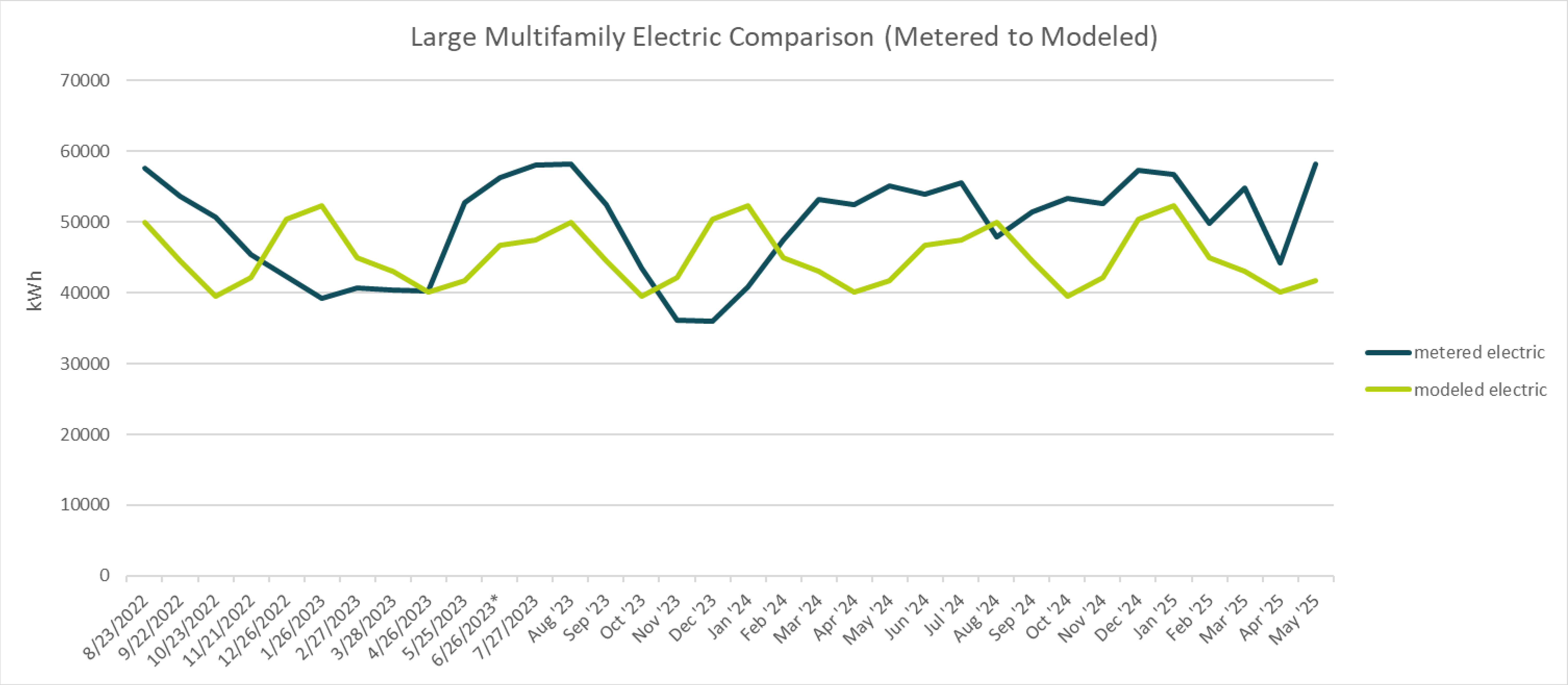


	Large Multifamily	Large Multifamily	Medium Multifamily	Small Multifamily
Modeled EUI	21.44	23.5	20.8	21.9
Metered EUI	36.65	31.8	32.5	35.9
Modeled to Metered (%)	**60%**	**74%**	**64%**	**61%**
Timeframe	April '20 - March '21	June '24 - May '25	June '24 - May '25	July '24 - June '25

metered and modeled energy consumption

Where is the discrepancy coming from? - Look at monthly energy consumption

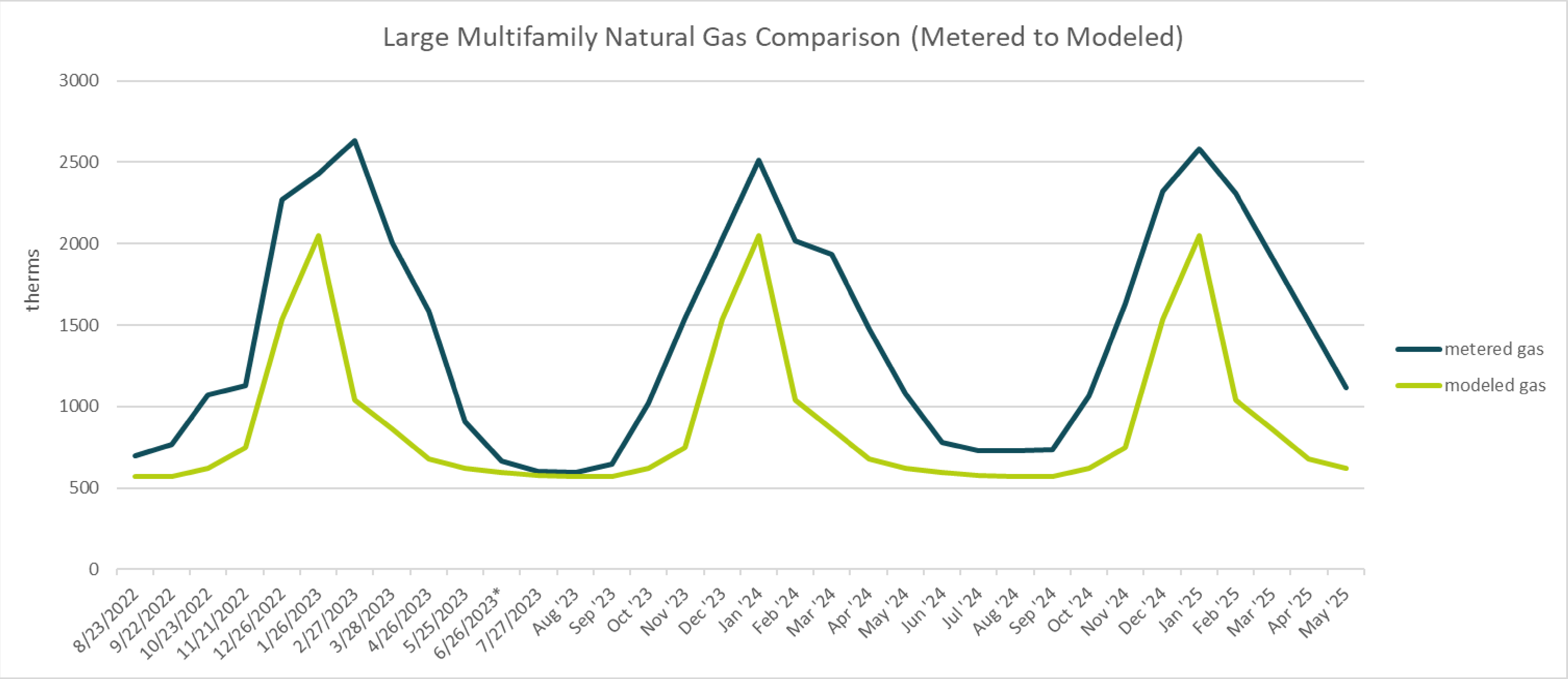
- ❑ Electric usage is a little higher than modeled, but comparable



metered and modeled energy consumption

Where is the discrepancy coming from? - Look at monthly energy consumption

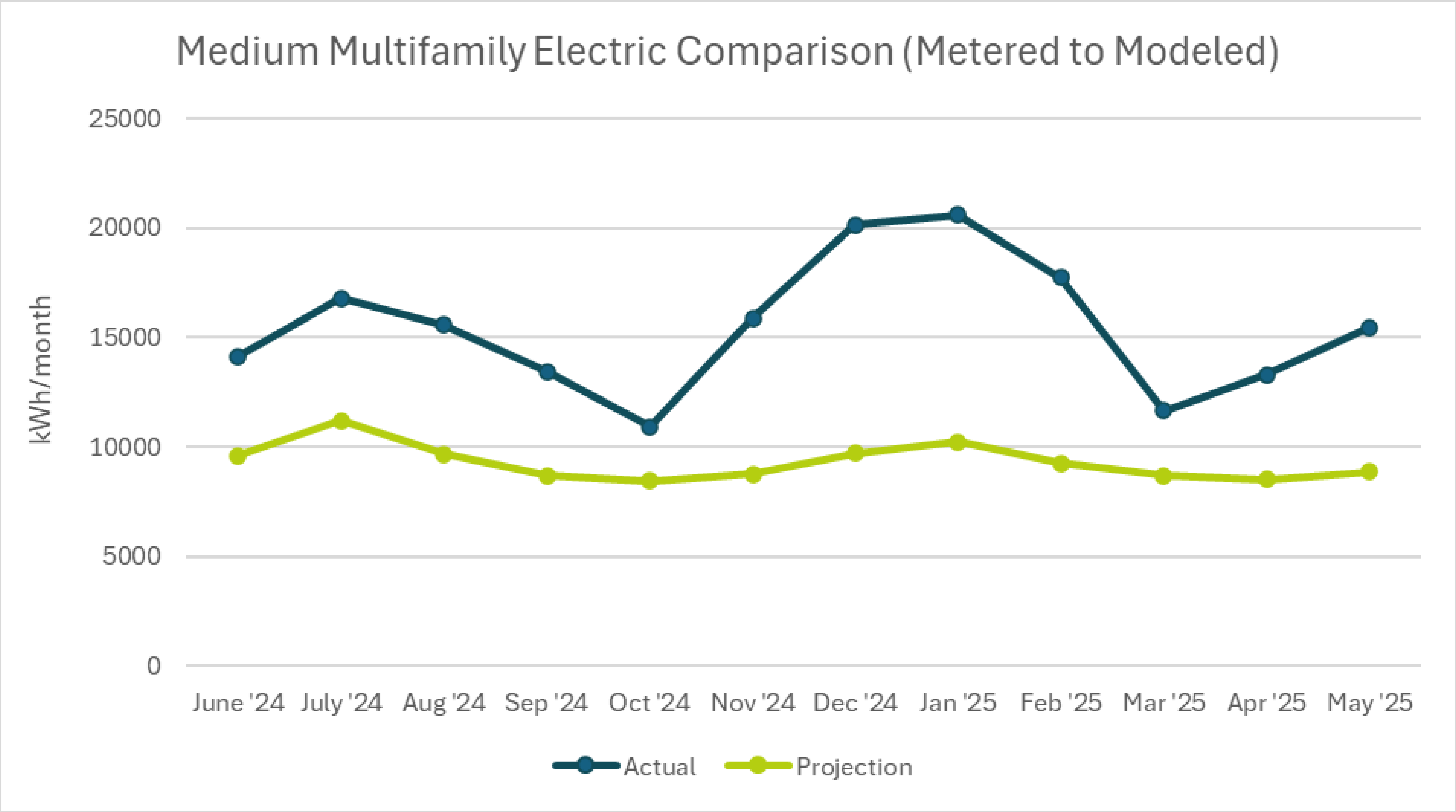
- ❑ A lot more natural gas usage during the winter than modeled



metered and modeled energy consumption

Where is the discrepancy coming from? - Look at monthly energy consumption

- ❑ More heating energy AND more cooling energy
- ❑ Swing seasons are the closest to modeled

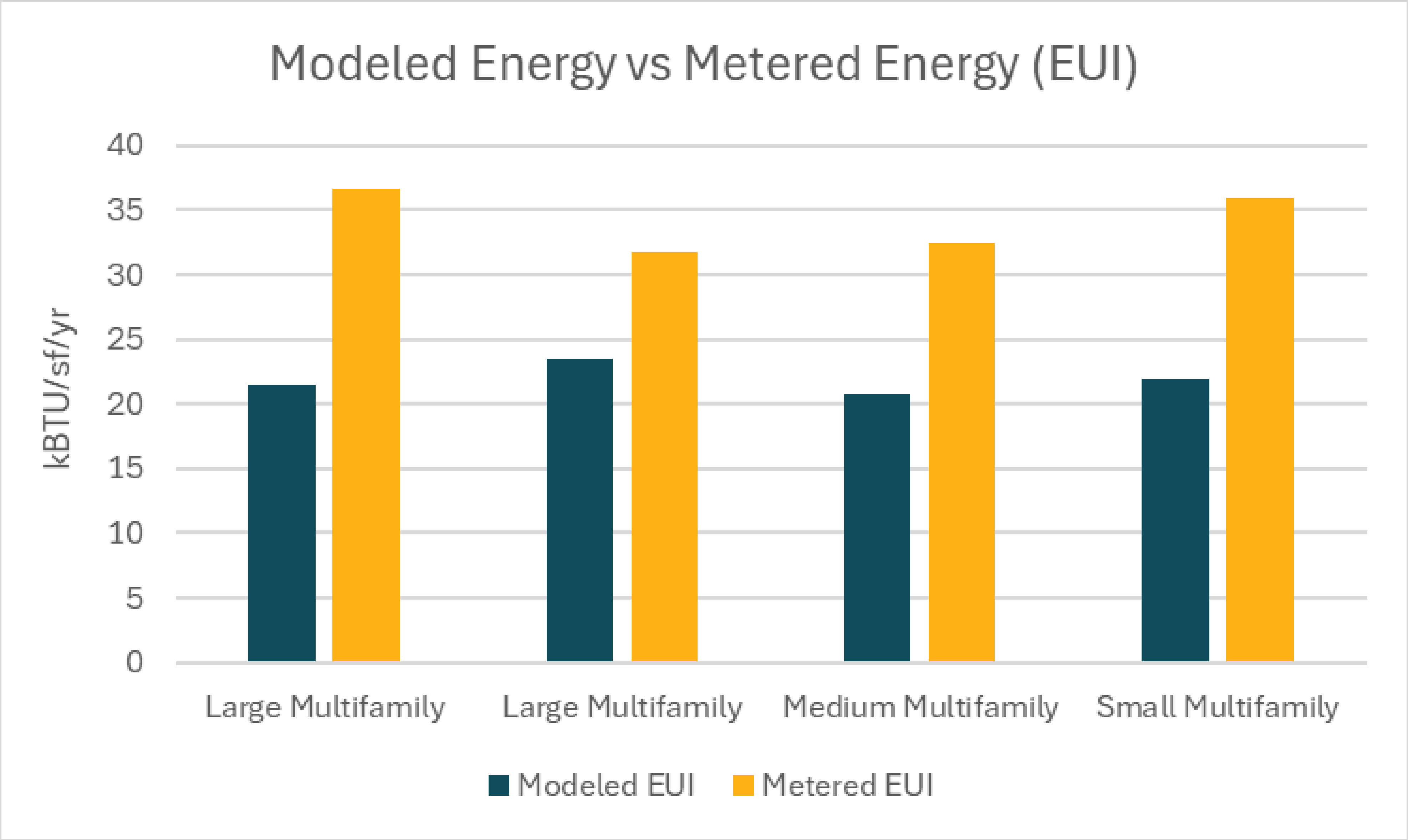


metered and modeled energy consumption

How are passive multifamily buildings performing in Climate Zone 6?

Conclusions

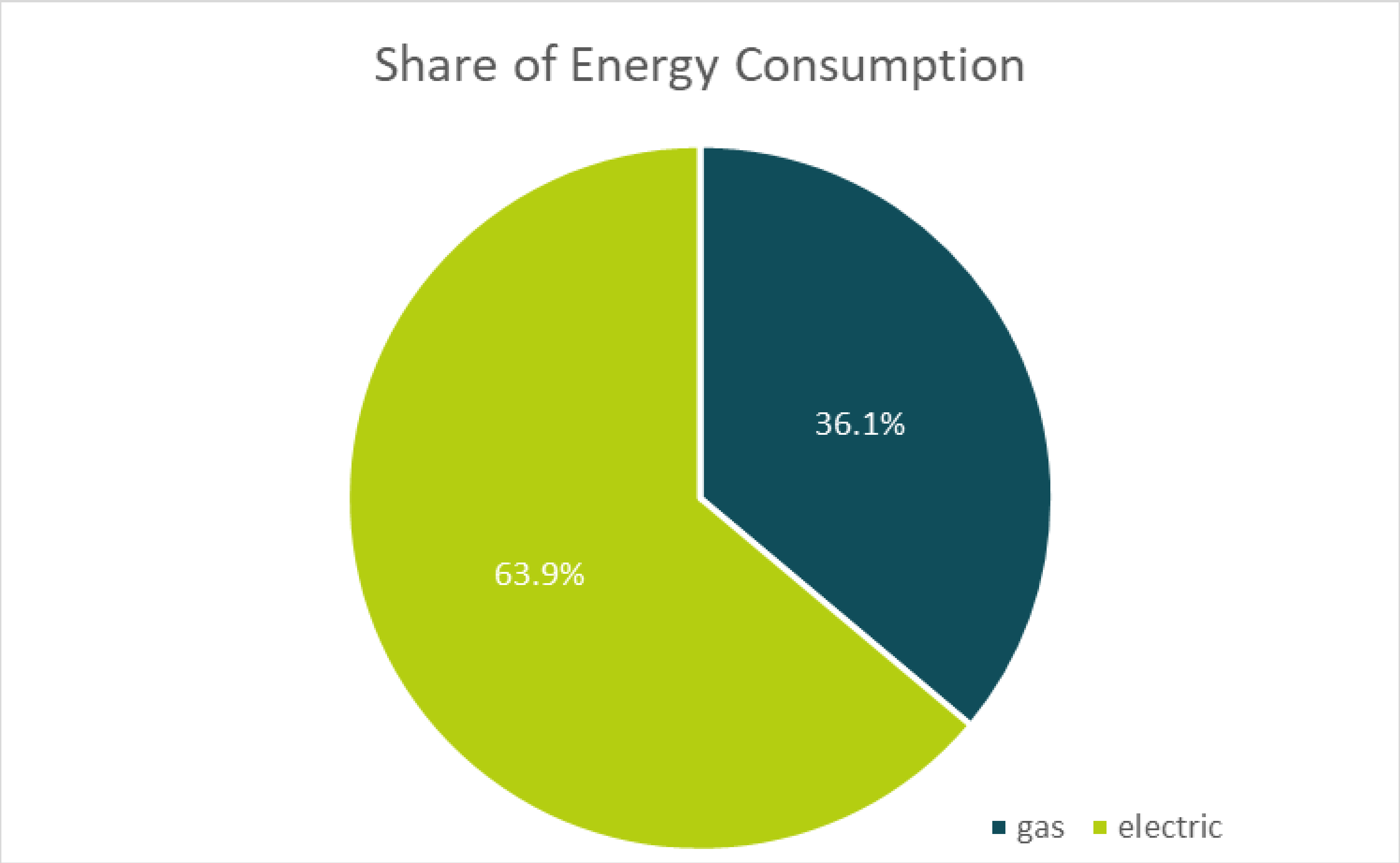
- ❑ In 3 out of 4 of these buildings, additional energy consumption has a lot more to do with mechanical system issues (including ventilation rates and equipment) than it does with user behavior and plug loads.
- ❑ In a developing market, unfamiliarity with new mechanical equipment (on both operations and install sides) can upend expected performance, especially in a very cold climate

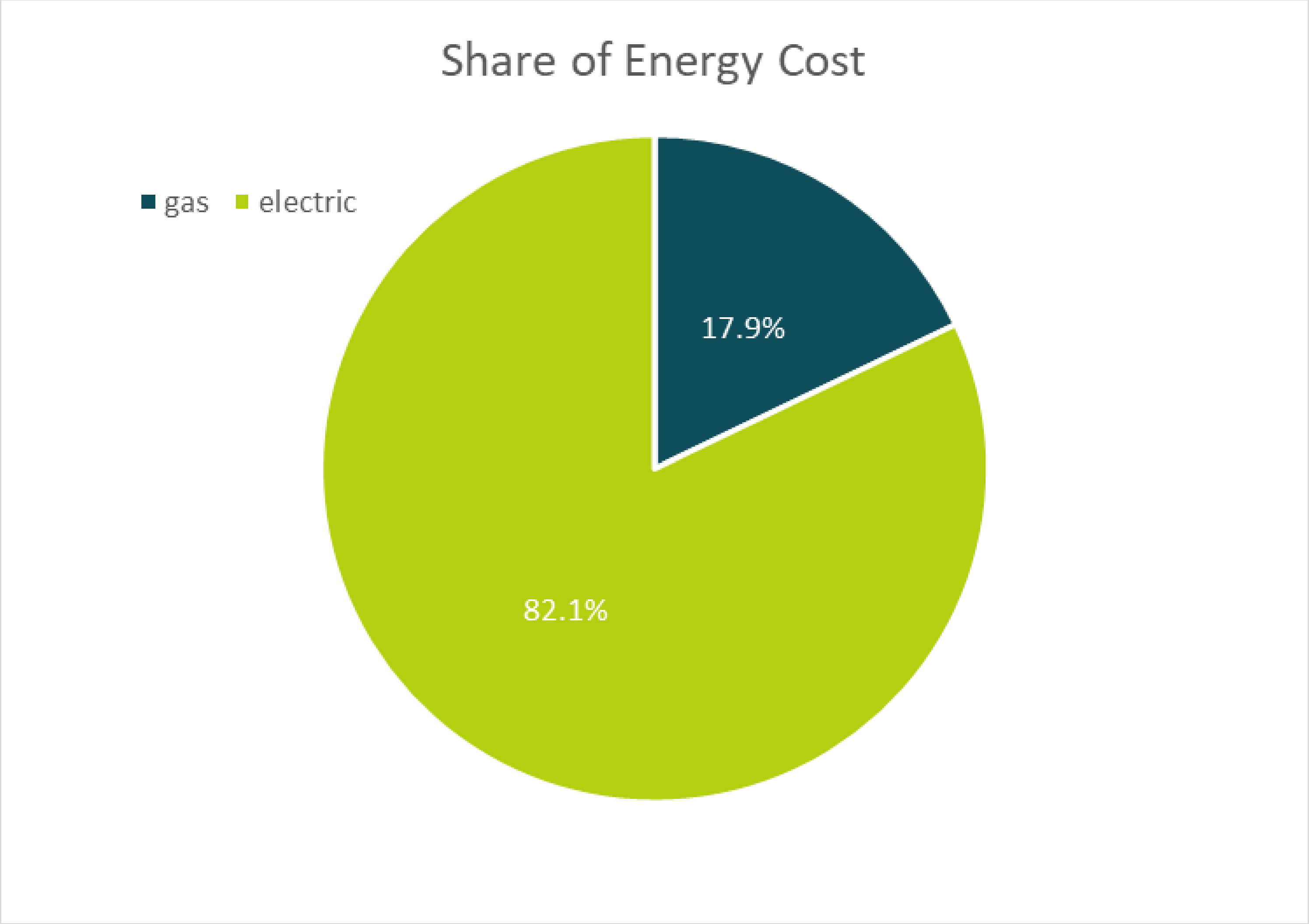


utility costs - large multifamily

Total yearly energy cost for 82 unit building: $83,511 (June '24 – May '25)

- ❑ Since gas is a cheaper energy source and passive multifamily buildings in CZ 6 mostly save gas, we can’t expect 50% energy cost savings to match the 50% reduction in energy consumption.



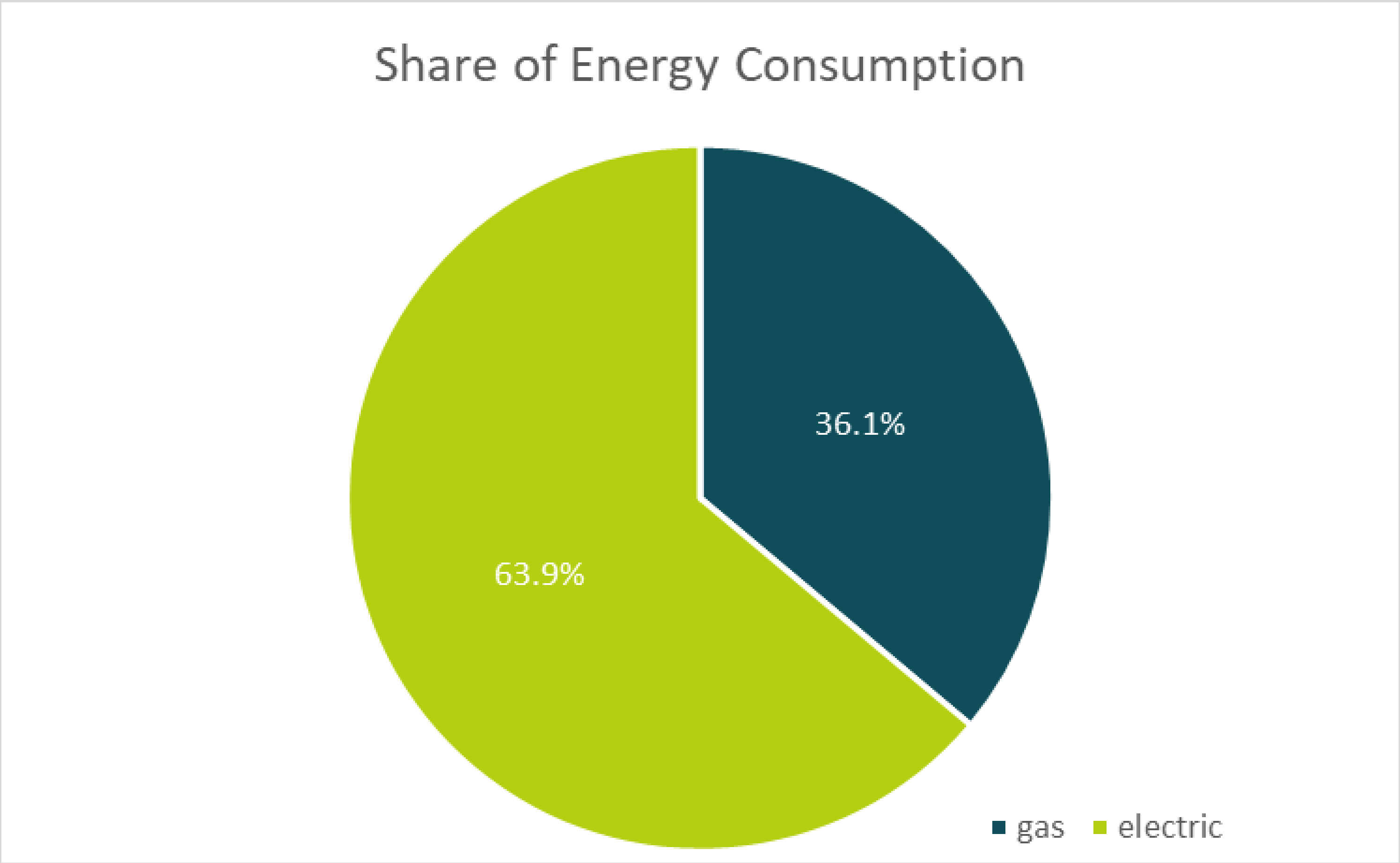


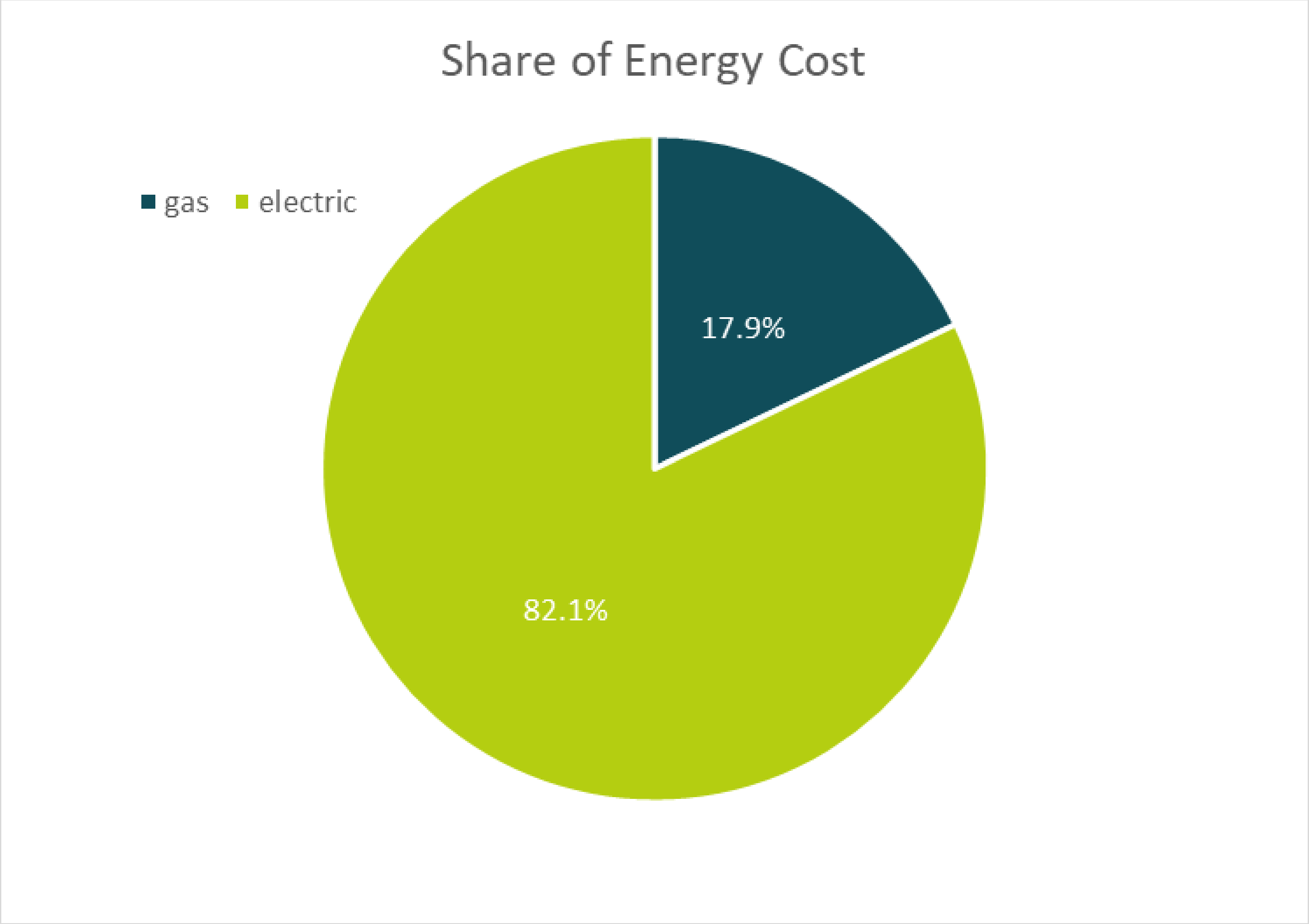
utility costs - large multifamily

Total yearly energy cost for 82 unit building: $83,511 (June '24 – May '25)

- ❑ This building had a 12% incremental cost of construction over Energy Star.
- ❑ With best estimate of energy cost savings - simple payback 26 –36 years

- ❑ With a 6% incremental cost of construction... potential simple payback 13-18 years





TASK 3 COST

construction costs and payback

construction costs – completed minnesota projects

Passive building construction costs in MN (completed projects)

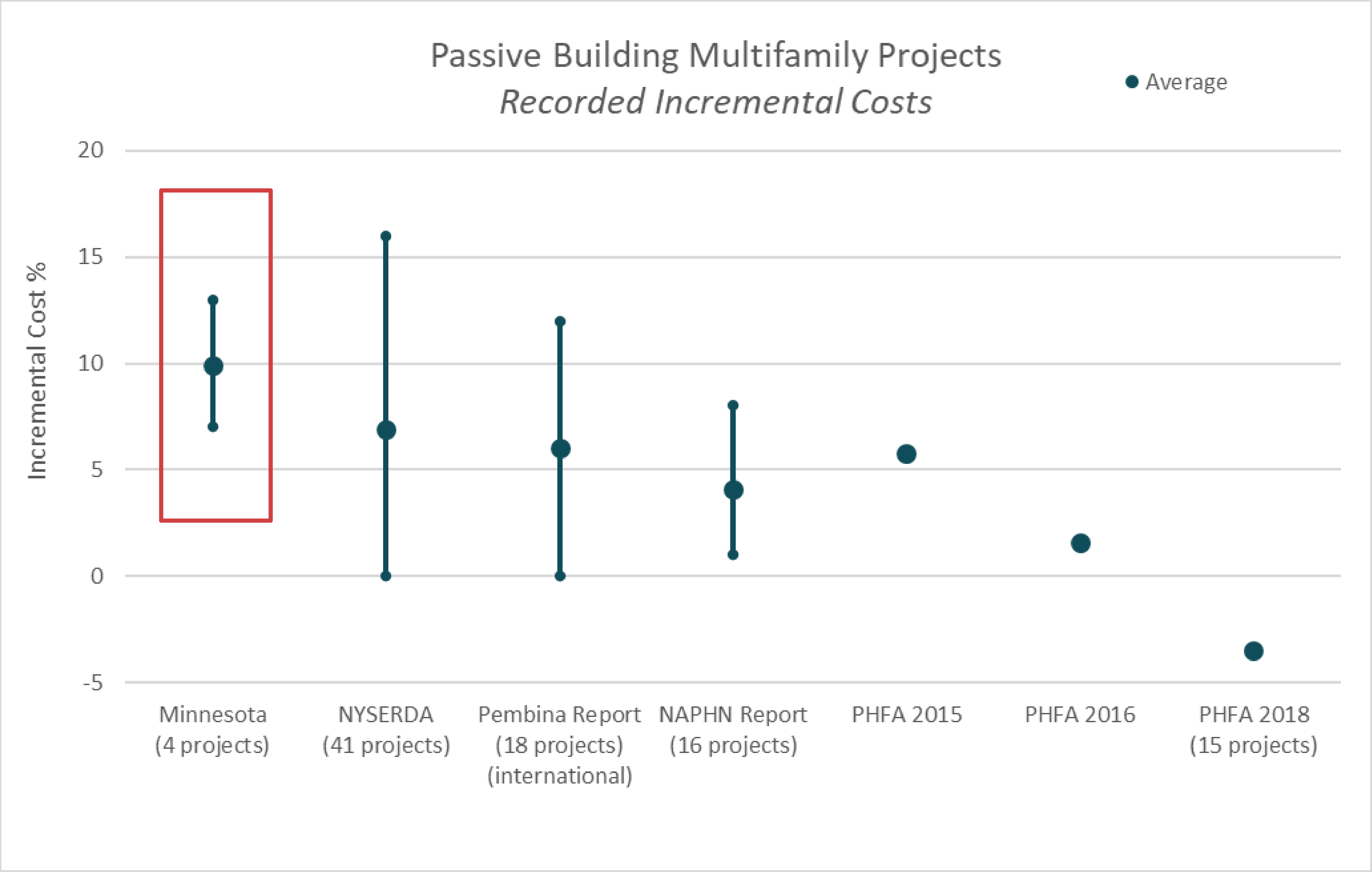
Cost per sf is going up, but incremental cost for passive building is coming down.

Project	# of Units	Cost Year	Cost/sf	Cost/unit	Incremental	Incremental Cost/unit	Cost baseline
Large Multifamily	59	2017	$142	$175,430	**13.0%**	$20,182.00	Energy Star
Large Multifamily	82	2021	$158	$237,276	**12.0%**	$25,422.00	Green Communities
Small Multifamily	17	2022	$230	$239,382	**7.0%**	$15,661.00	Conventional construction
Medium Multifamily	23	2023	$324	$266,870	**7.5%**	$18,619.00	Energy Star
Large Multifamily (study)	43	2025	$252	$258,976	**4.9%**	$12,115.00	Energy Star

5% incremental cost in 2025 study equated to $12,000 additional construction cost per unit

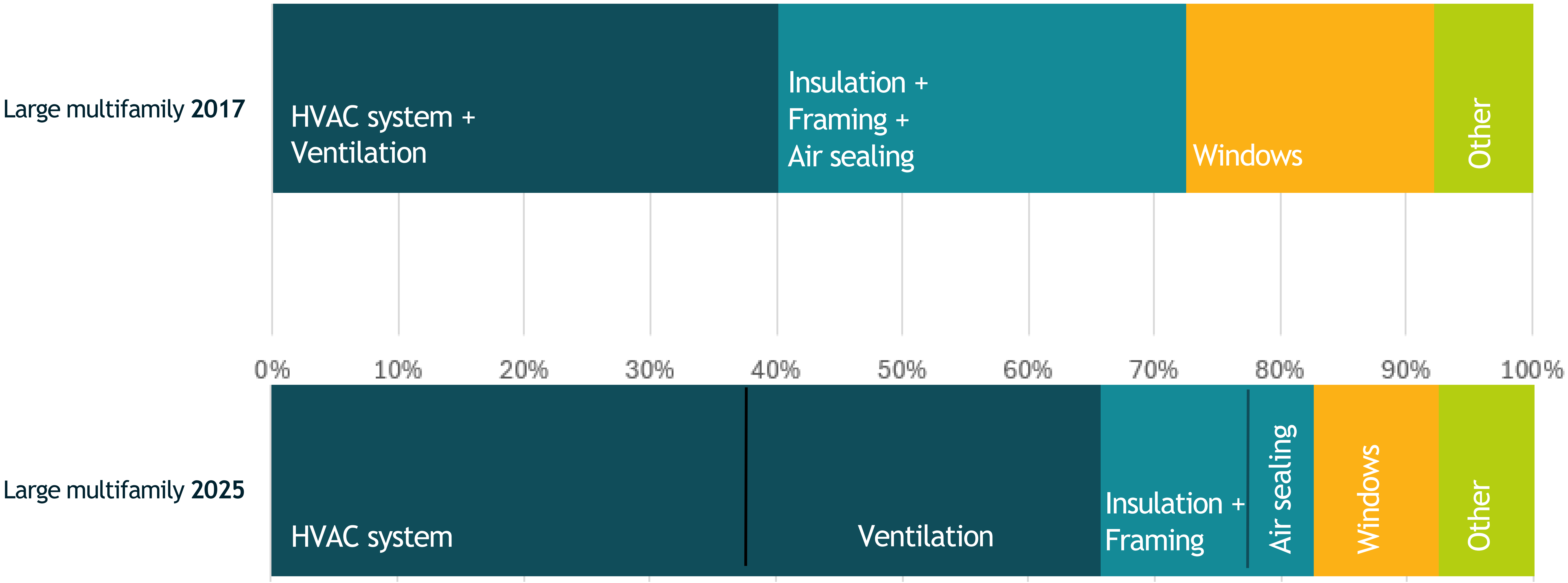
incremental construction costs

In MN - Typical incremental cost: 7-13%, historical average 10%



incremental construction costs

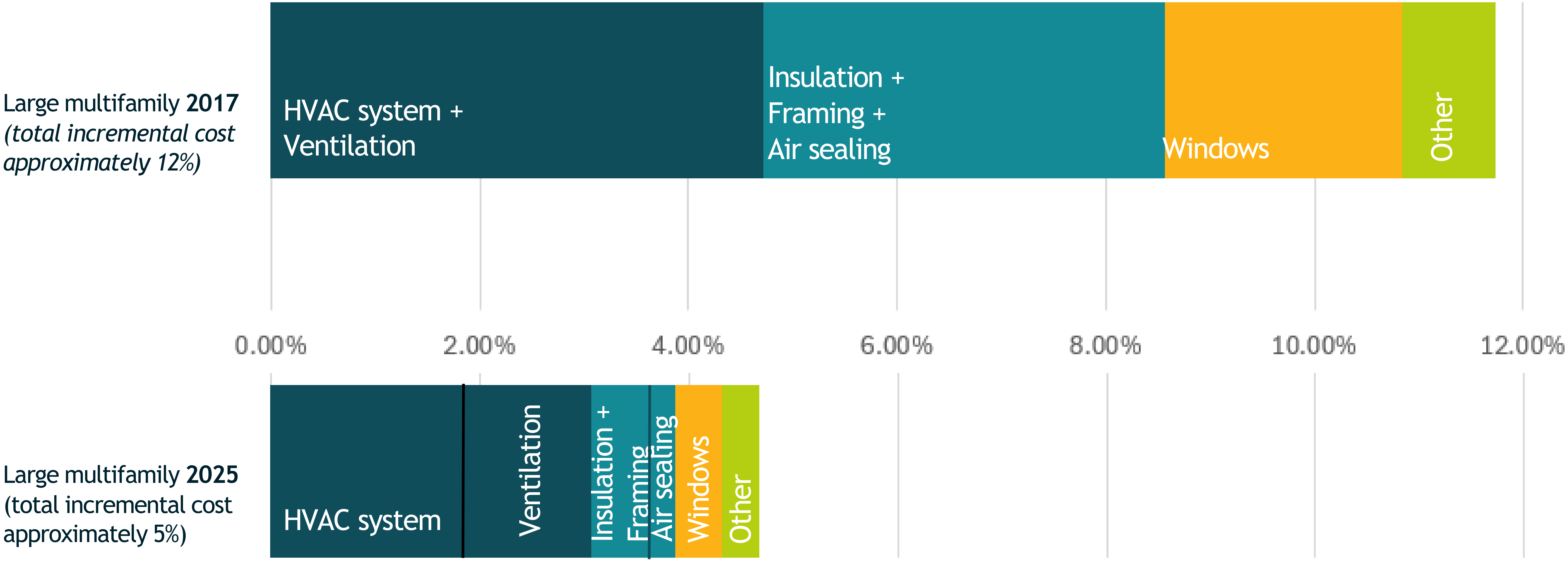
What items make up the incremental cost?



HVAC systems are typically the largest cost increase in this market, but may be a ***cost savings*** *in other markets*

incremental construction costs

Looking at incremental costs as a percentage of total project budget



Cost savings are found in all categories, but especially windows and enclosure items. High performance HVAC and balanced heat recovery ventilation systems are still expensive.

incremental construction costs

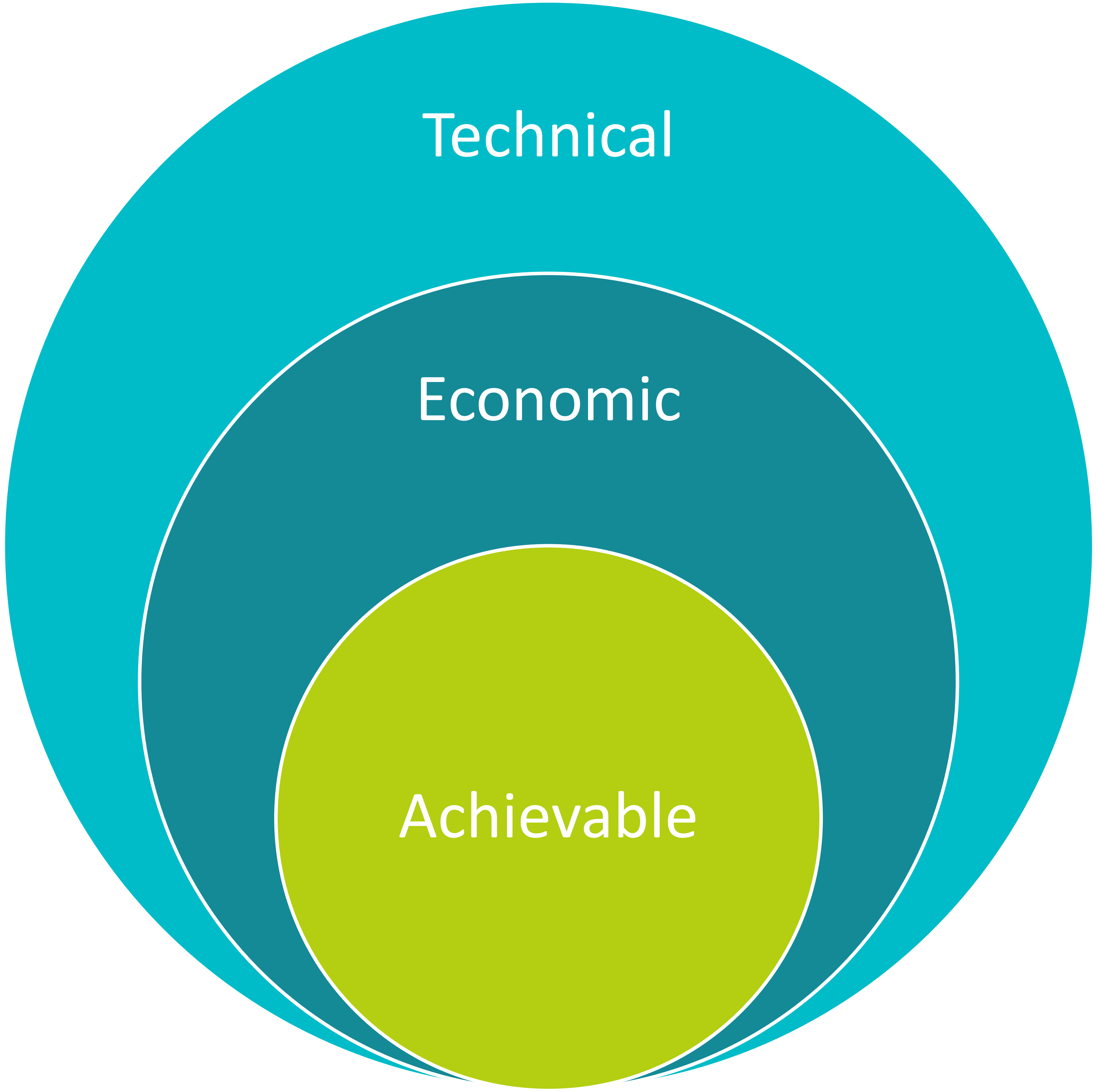
Where can project teams find cost savings compared to standard projects?

- HVAC system downsizing and simplification
- Simplification of building form
- Development model (design/build)
- Space savings (mechanical closets)
- Eliminate gas service + meters

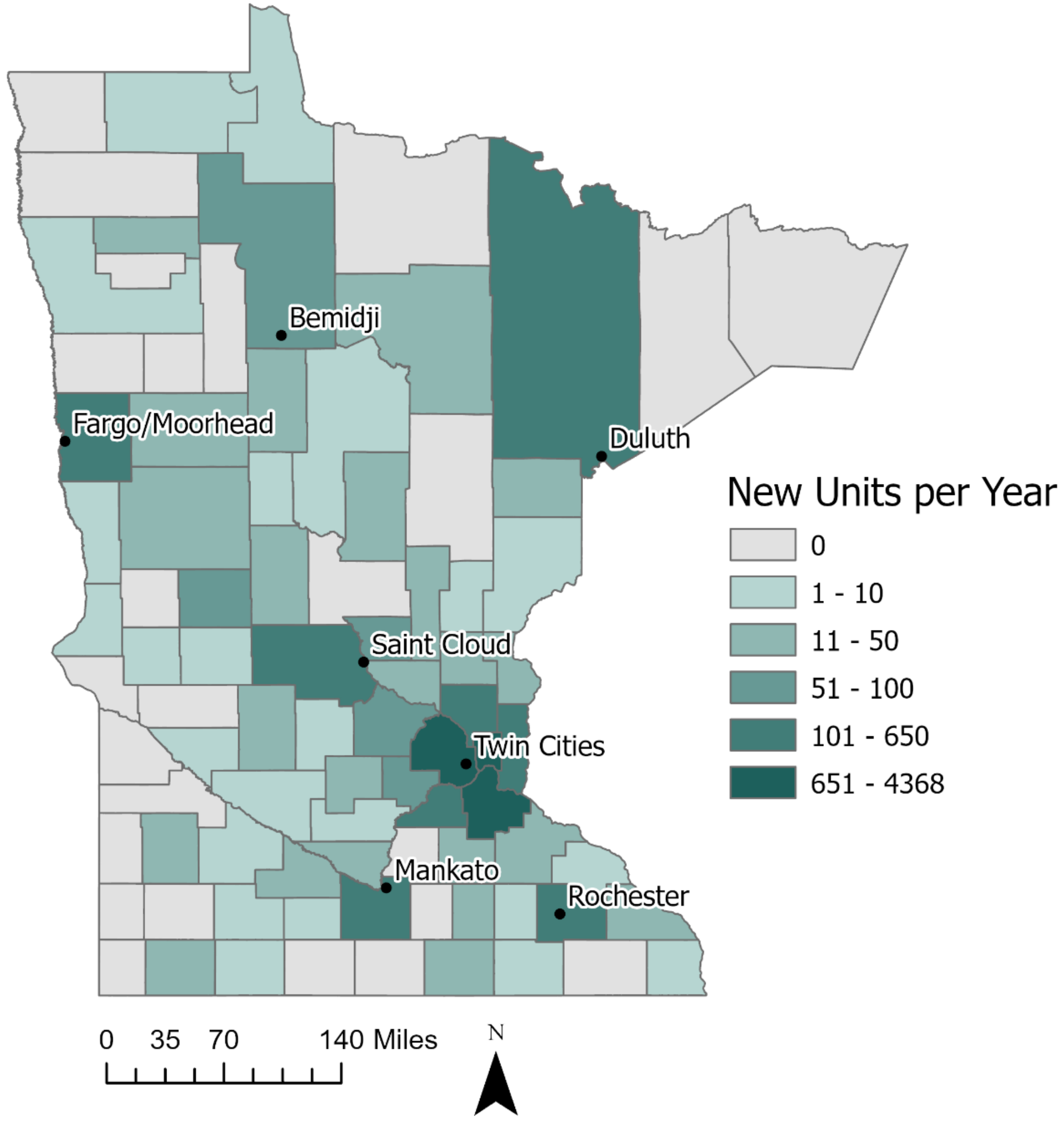
In mature markets, experienced teams can build PH projects for very little incremental cost by taking advantage of these savings

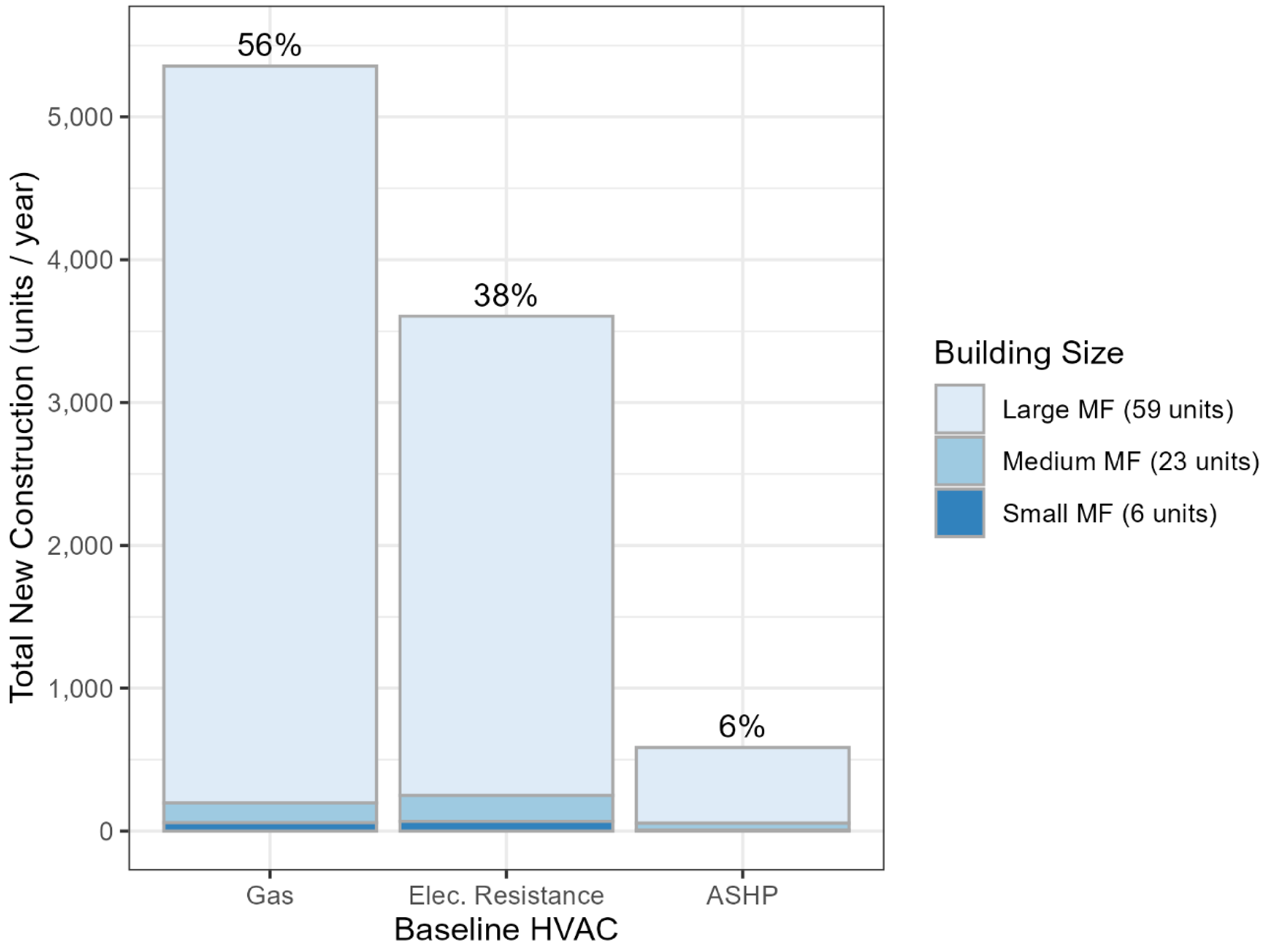
TASK 4 MARKET POTENTIAL

Statewide potential savings



Setting the baseline



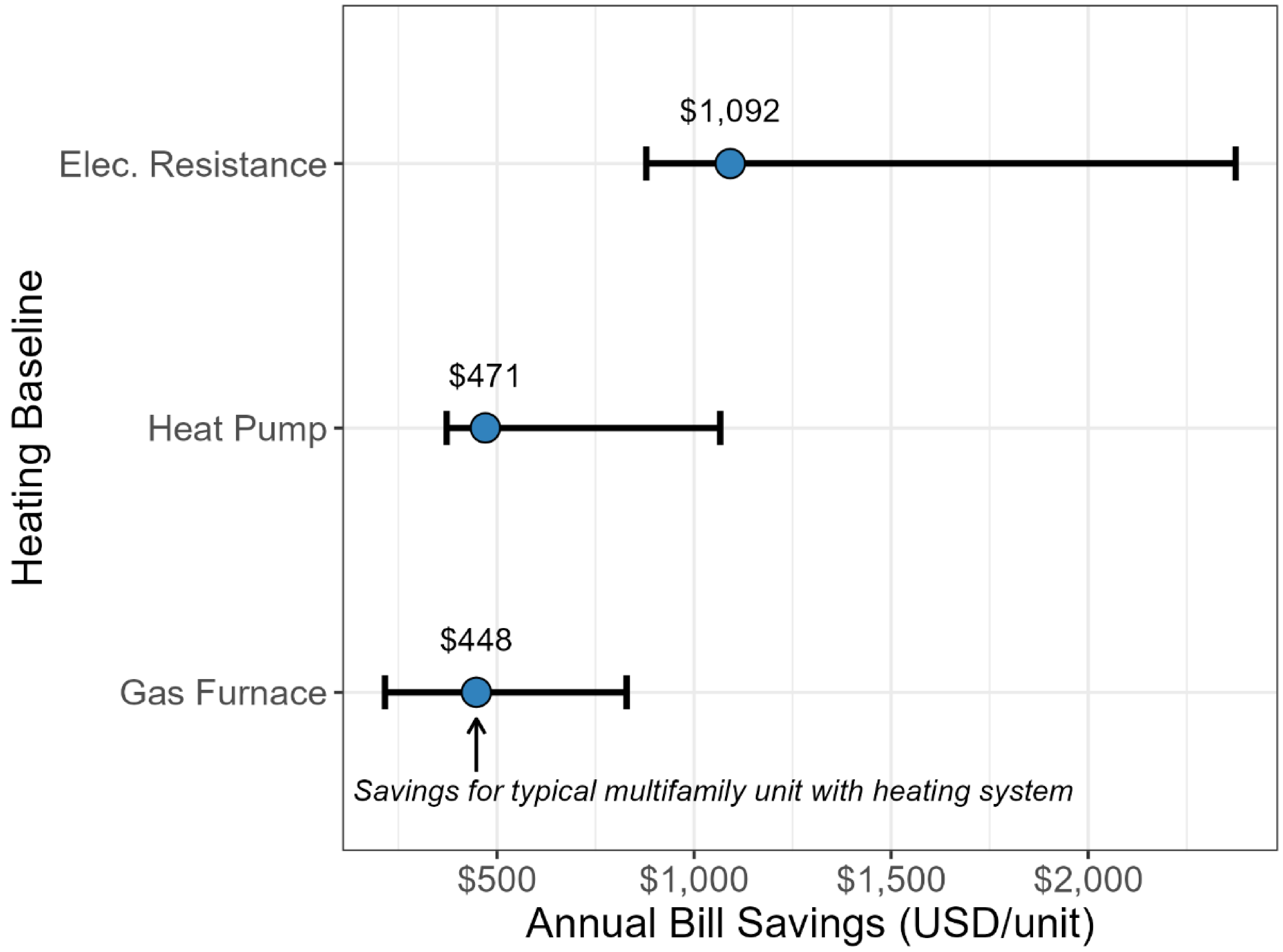


End user savings

Utility bill savings

Dependent on:

- ❑ Baseline system type
- ❑ Climate Zone
- ❑ Unit size and density



Utility/State Potential

Technical Potential

What's possible for the state

- ❑ Significant amount of savings
  - 3% equivalent overall electric savings in 2022
  - 6% equivalent to overall gas savings in 2022
- ❑ Still not enough
  - 0.1% of the commercial building energy consumption in Minnesota

Market Segment	Total Housing Units / Year	Total Electric Savings (MWh/year)	Total Gas Savings (Dth / year)
Market-rate	7,313 (77%)	23,498 (76%)	166,551 (77%)
Affordable	2,233 (23%)	7,316 (24%)	50,365 (23%)
Total	9,546	30,814	216,916

Utility/State potential

Economic Potential

What's realistically affordable

- ❑ High/low construction costs premiums
  - $24,000/unit
  - $12,000/unit
- ❑ Participant cost-effectiveness test
  - PCT > 1 is cost-effective
  - Challenging for market rate
  - Based on annual escalated savings over life-time of equipment
- ❑ Minimum incentive range
  - Value required to make Phius certification cost-effective

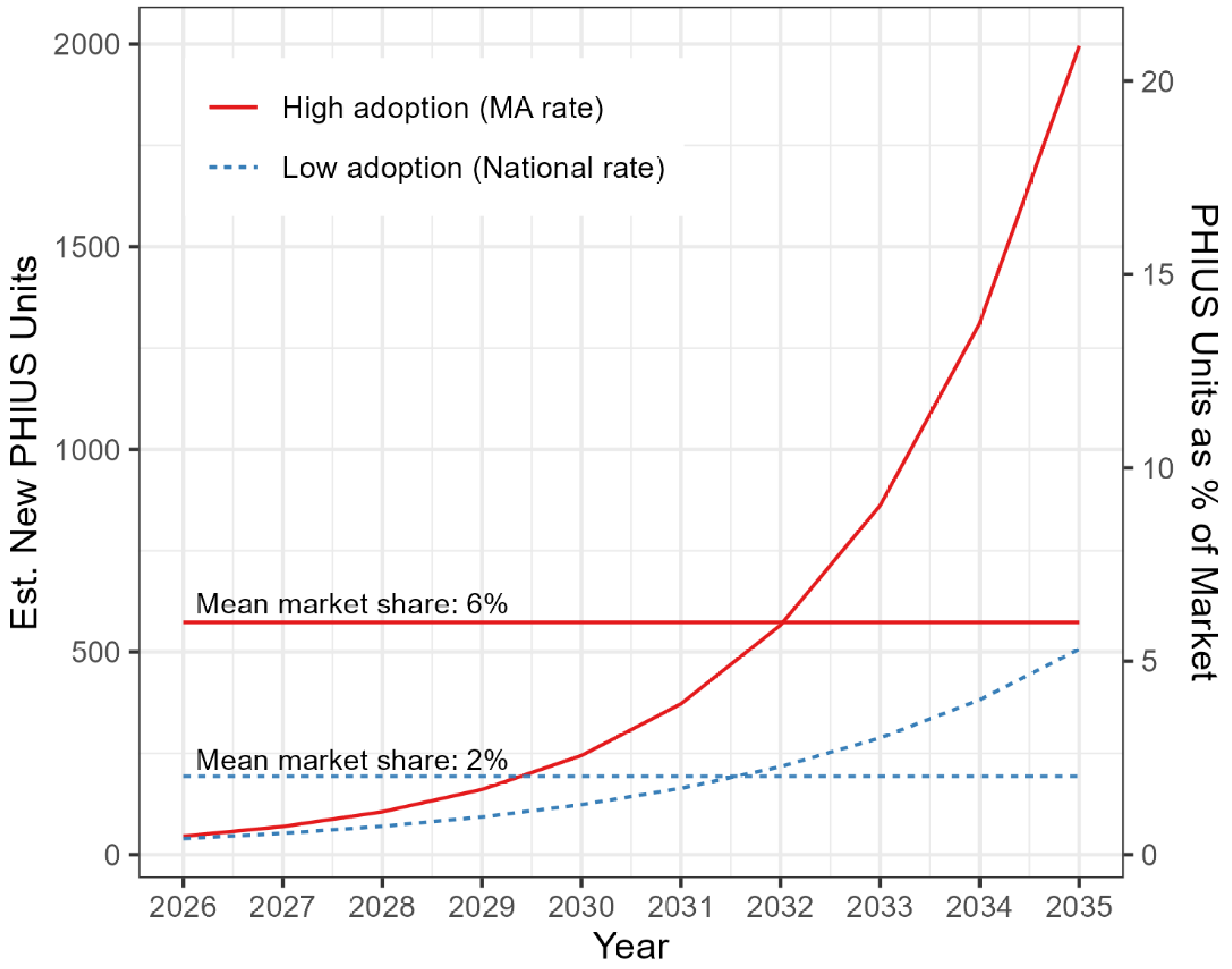
Baseline Heating	Gas Savings (Dth/Year/Unit)	Elec. Savings (kWh/Year/Unit)	PCT Range[1]	Minimum Rebate Range per Unit[2]
Gas	38.8	-42.2	0.36 - 0.71	$3,500 – 15,500
Elec. Resistance	2.3	8,052	0.78 - 1.56	$0 - 5,500
ASHP	1.5	4,510	0.43 - 0.86	$1,750 – 13,750

Utility/State potential

Achievable Potential

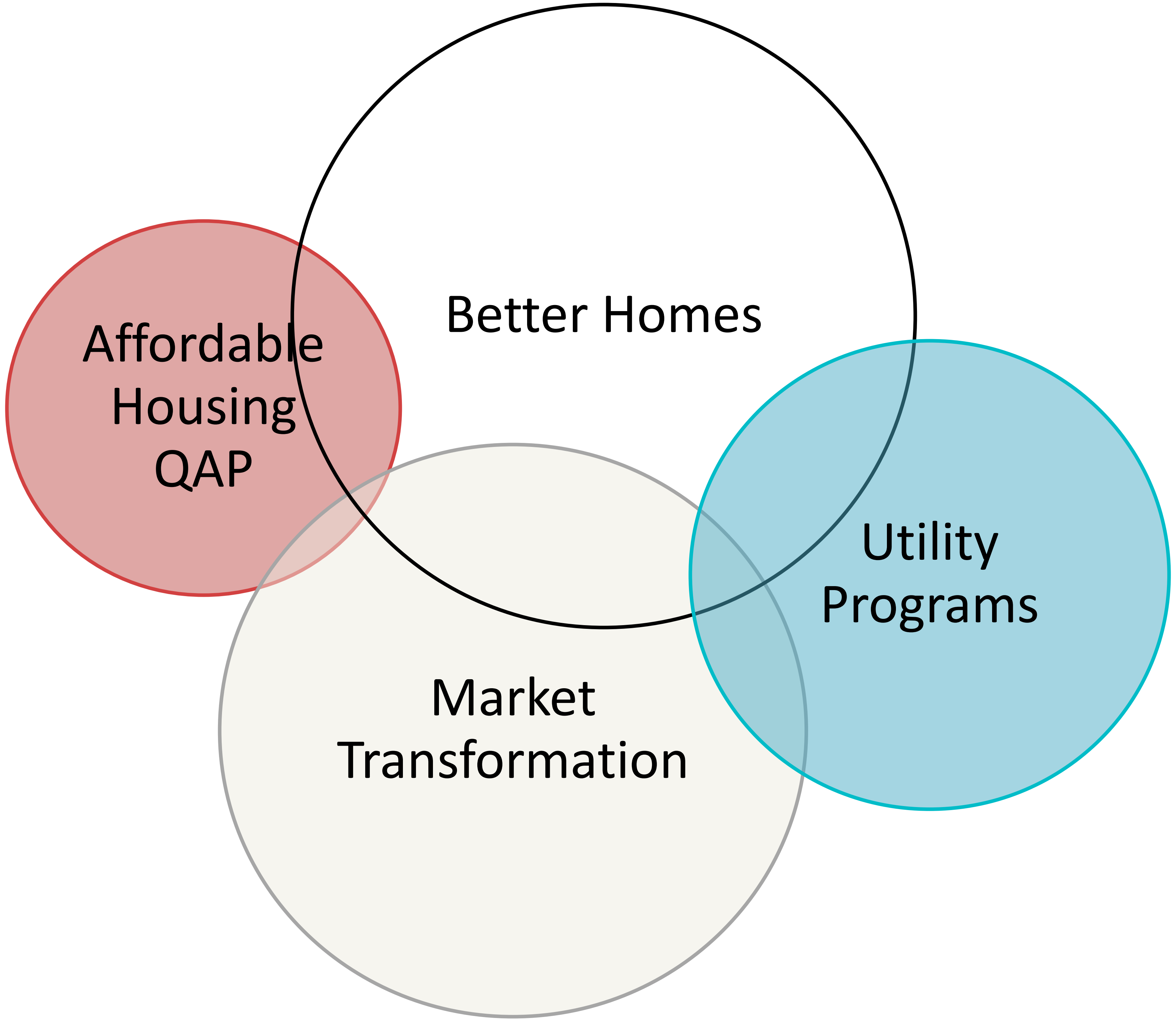
What's realistic for the state

- ❑ High and low market share
  - 6% on average over 10 years
  - 2% on average over 10 years
- ❑ Growth potential
  - High based on MA adoption with strong support
  - Low based on national adoption with mixed support



TASK 5 Program Development

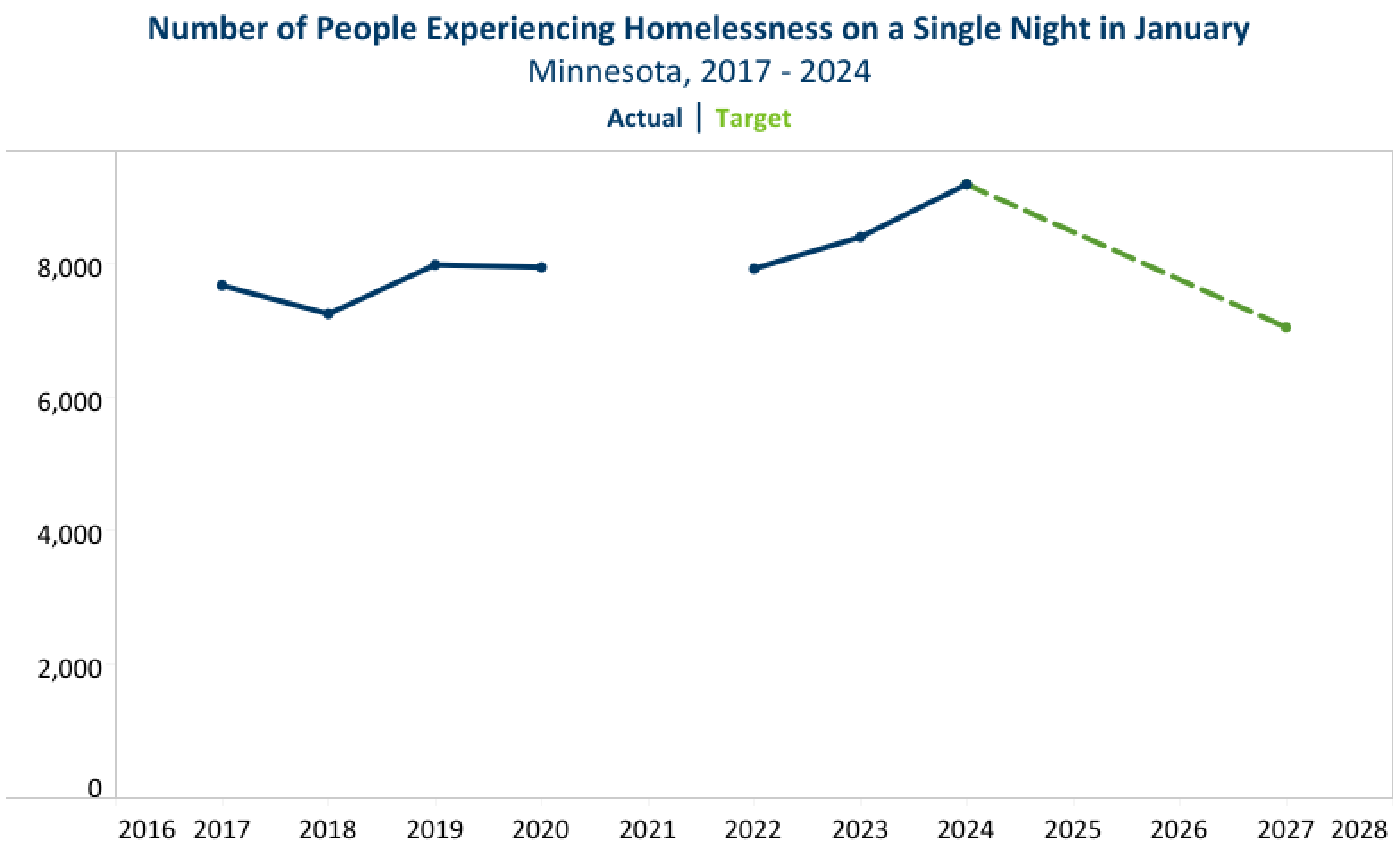
Market transformation drivers



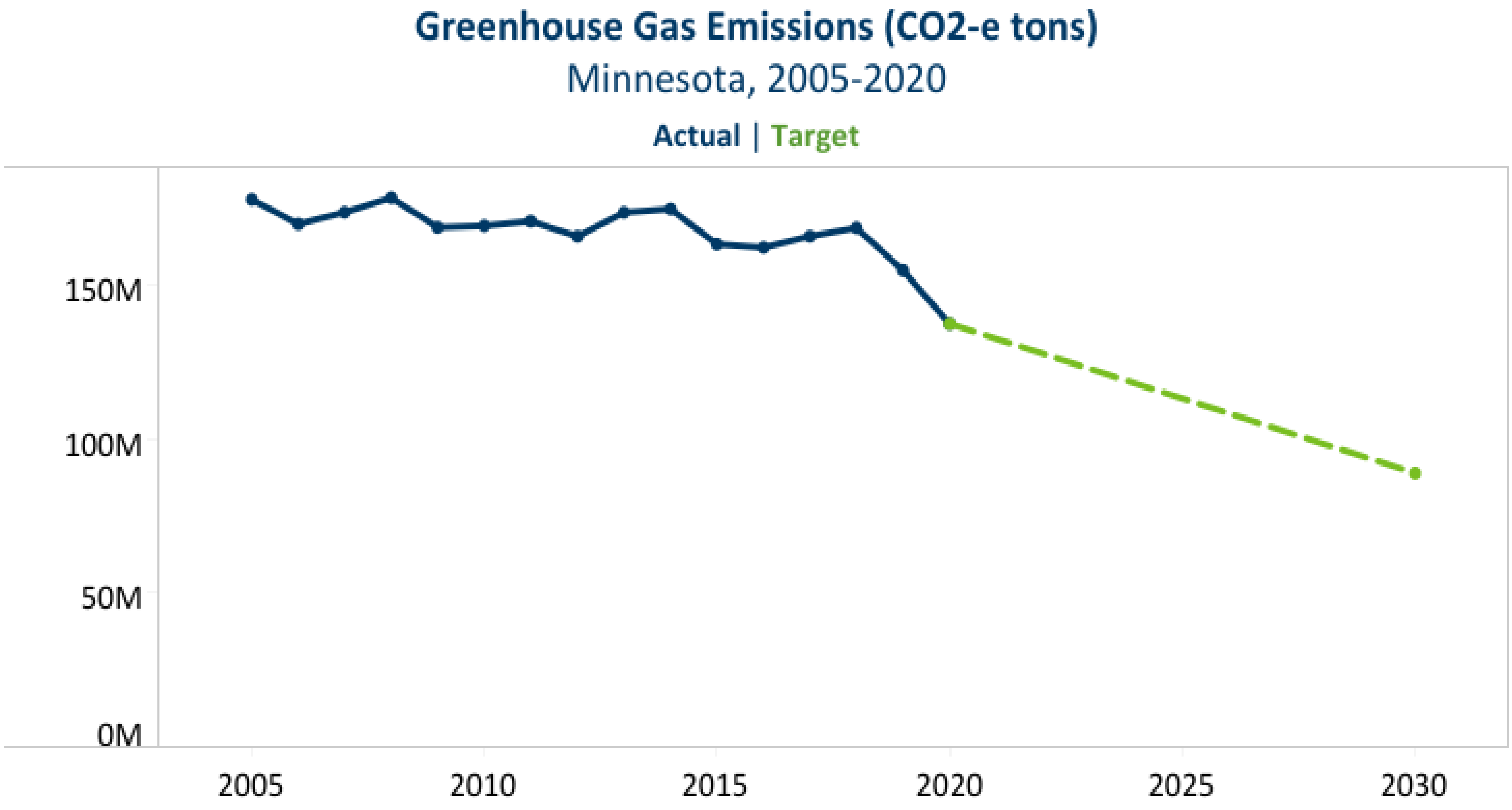
State goals

Which is more important?

Goal: All Minnesotans have housing stability



Goal: Reduce greenhouse gas emissions 50 percent by 2030



Source: One Minnesota Plan
https://mn.gov/mmb/one-mn-plan/measurable-goals/

Current program support

Qualified Allocation Plan

Minnesota Housing's highest scoring energy teir

- ☑ Passive House Institute (PHI) Classic
- ☑ Passive House Institute United States (PHIUS)
- ☑ 2020 Enterprise Green Communities Criteria, Criterion 5.4 Achieving Zero Energy, programs:
  - PHIUS + Source Zero
  - PHI Plus
  - PHI Premium
  - International Living Future Institute's Zero Energy, Carbon Petals
  - Living Building Challenge

Utility Programs

Work in progress

- ❑ Meaningful incentives
- ❑ Clear objectives and outcomes
- ❑ Design Support
- ❑ Market rate pathway

Current program support

Program	Meaningful Incentives	Consistent objectives and predictable outcomes	Upfront Phius design Support	Market rate pathway
Energy Design Assistance (modeling)	✗	✗	✗	✓
TRM Standard/Custom (calculations)	✗	✓	✗	✓
Efficient New Homes Program (4 units and less)	✓	✓	✗	✓

Other passive program examples

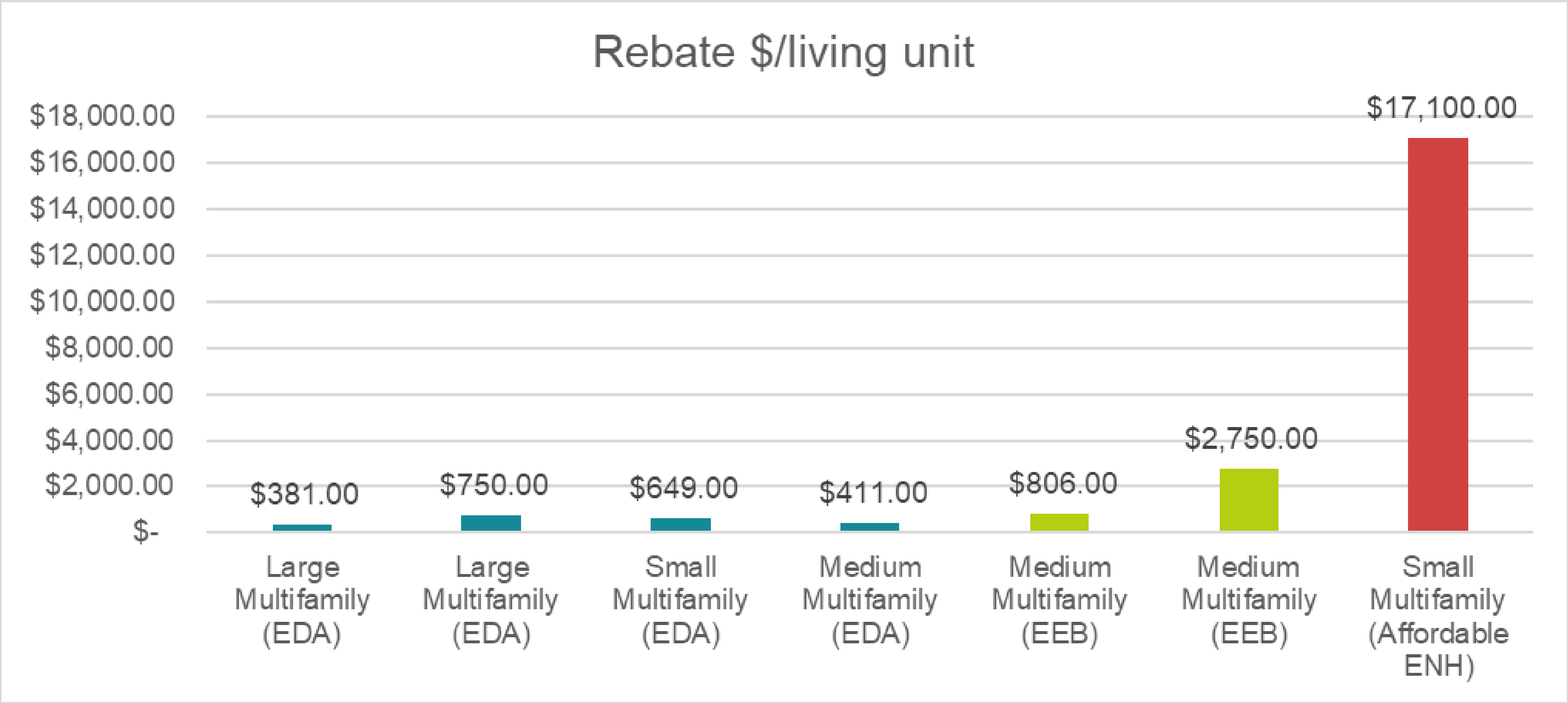
Program	Meaningful Incentives ($/ Unit)	Consistent objectives and predictable outcomes	Upfront Phius design support	Market rate pathway
Mass Save	✓ ($3,750)	✓	✓	✓
ComEd	✓ ($5,000)	✓	✓	✗
Energize CT	✓ ($1,500)	✓	✓	✓

Meaningful incentives

Increase incentives

Right size incentive levels

- ❑ Flat incentive for meeting certification
- ❑ Increase per kW/Therm rates
- ❑ Allow for pathway based on model performance if certification not met

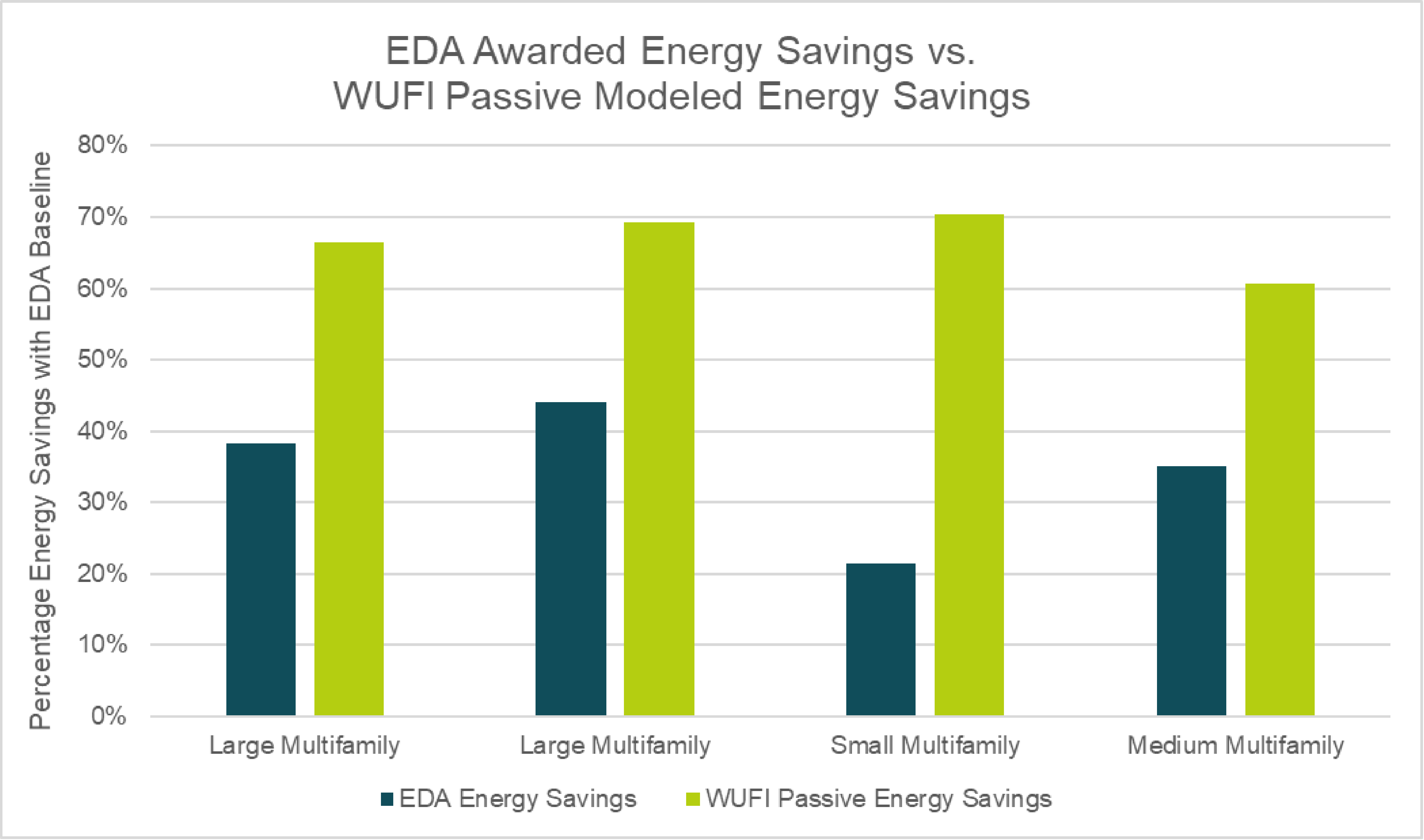


Meaningful incentives

Increase incentives

Right size incentive levels

- ❑ Energy savings is underestimated within the program modeling

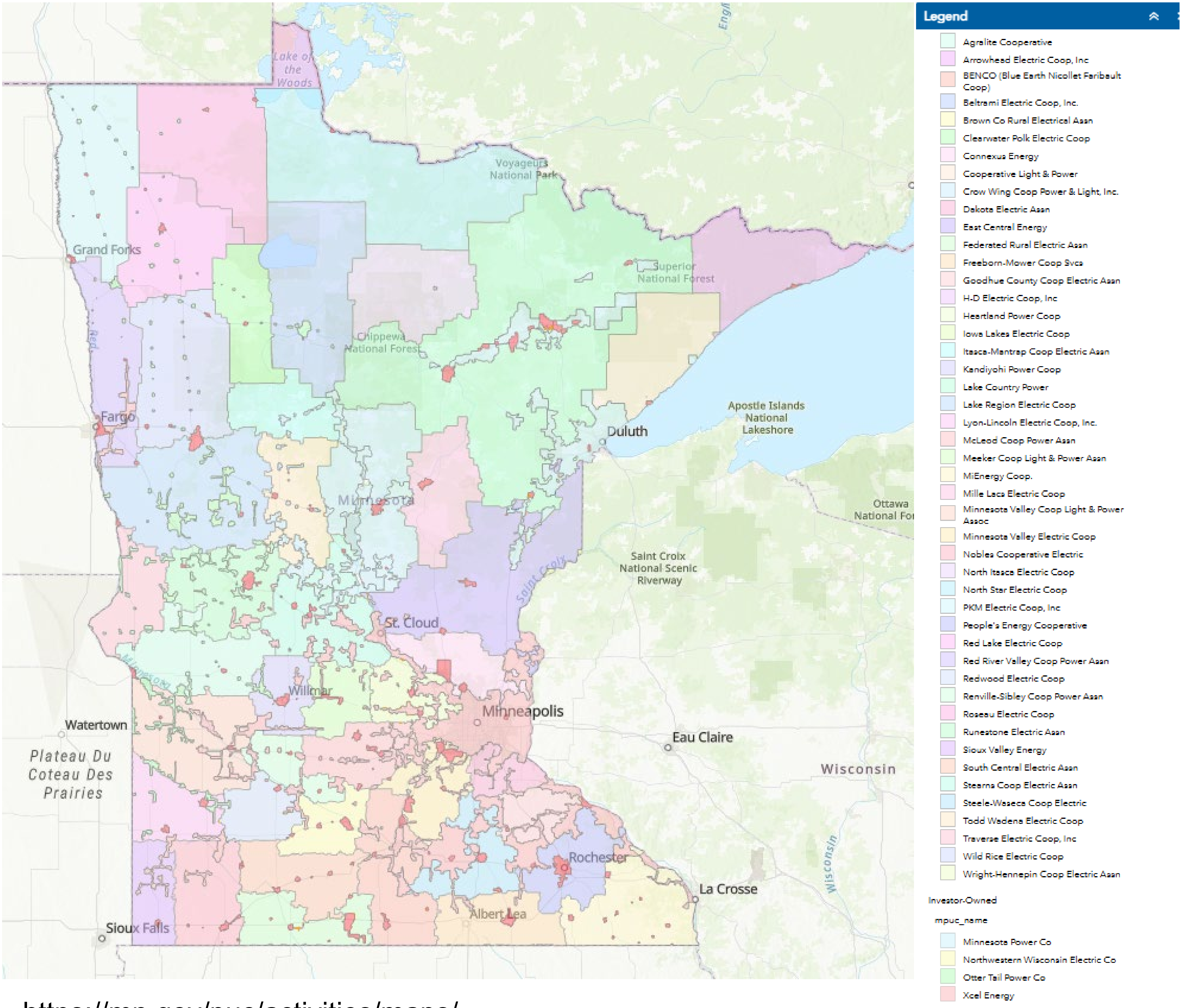


Consistent objectives and predicable outcomes

Consistency

Over 150 utilities across Minnesota

- ❑ Singular offering for entire state
- ❑ Model program that can be adopted
- ❑ Certification overlay for bonus incentives within existing programs



https://mn.gov/puc/activities/maps/

Consistent objectives and predictable outcomes

Predictable outcomes

Allow direct tie to Pro Formas during pre-design

- ❑ Clear if this, then that incentive
- ❑ Upfront incentive agreement
- ❑ Plan for long development timelines and possible unfunded projects

Upfront Phius support

Pre-design studies

Provide incentives or matching for early investigation

- ❑ Flat rate for completing study
- ❑ Set requirements to guide thoughtful consideration
- ❑ Likely third-party, could be existing program provider

Market rate pathway

Expand current multifamily offerings

On-ramp for market rate developments

- ❑ Counter cost-effectiveness challenges with pathways that better account for performance gains and value adds
- ❑ Bonus incentives for verified performance/certification
- ❑ Tiered structure for other performance-based certifications

THANK YOU