PASSIVE HOUSE MULTIFAMILY

MN CARD grant

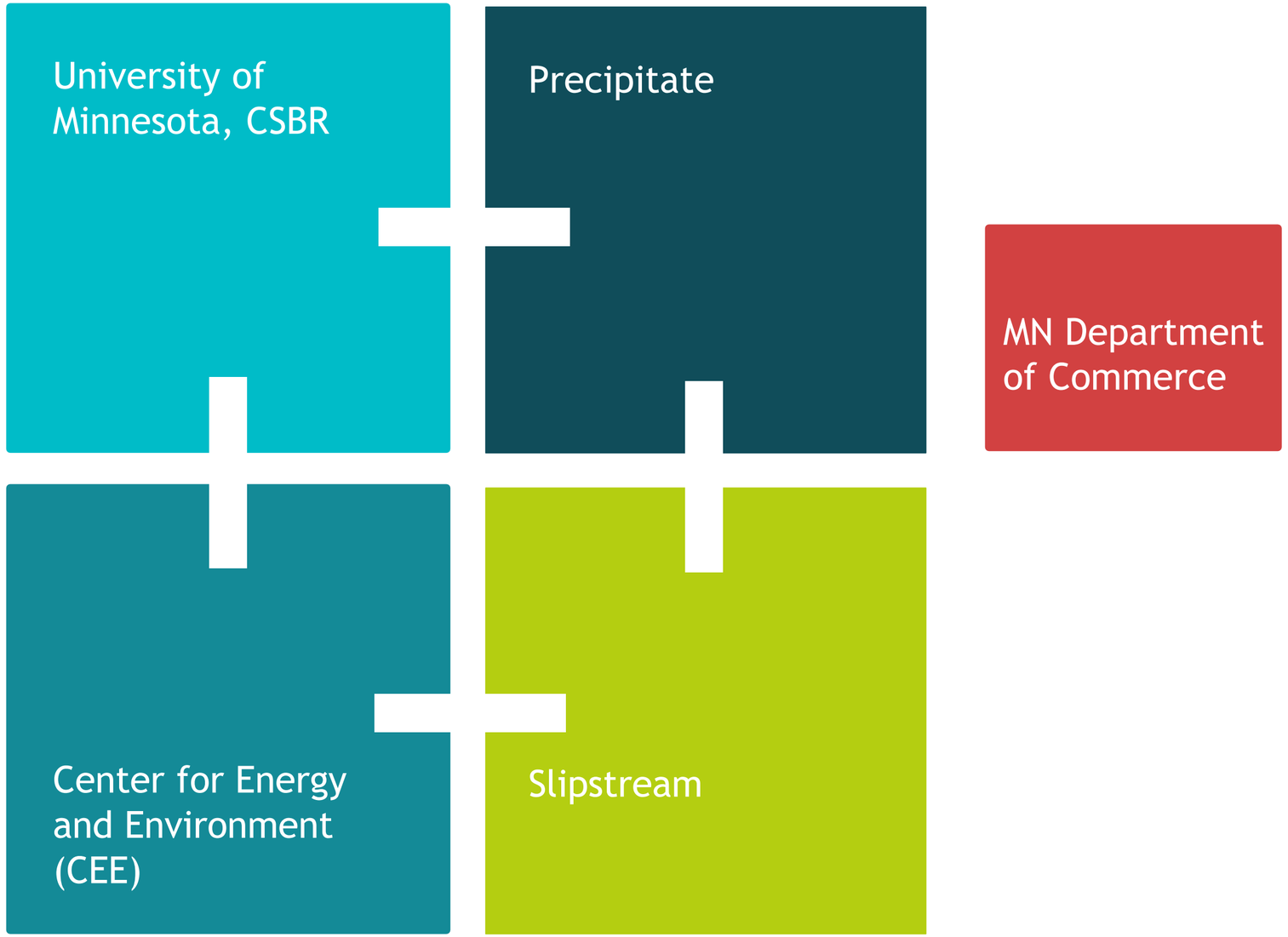
1| DISCOVERY
2| ENERGY
3| COST
4| MARKET STUDY
5| INCENTIVES

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.

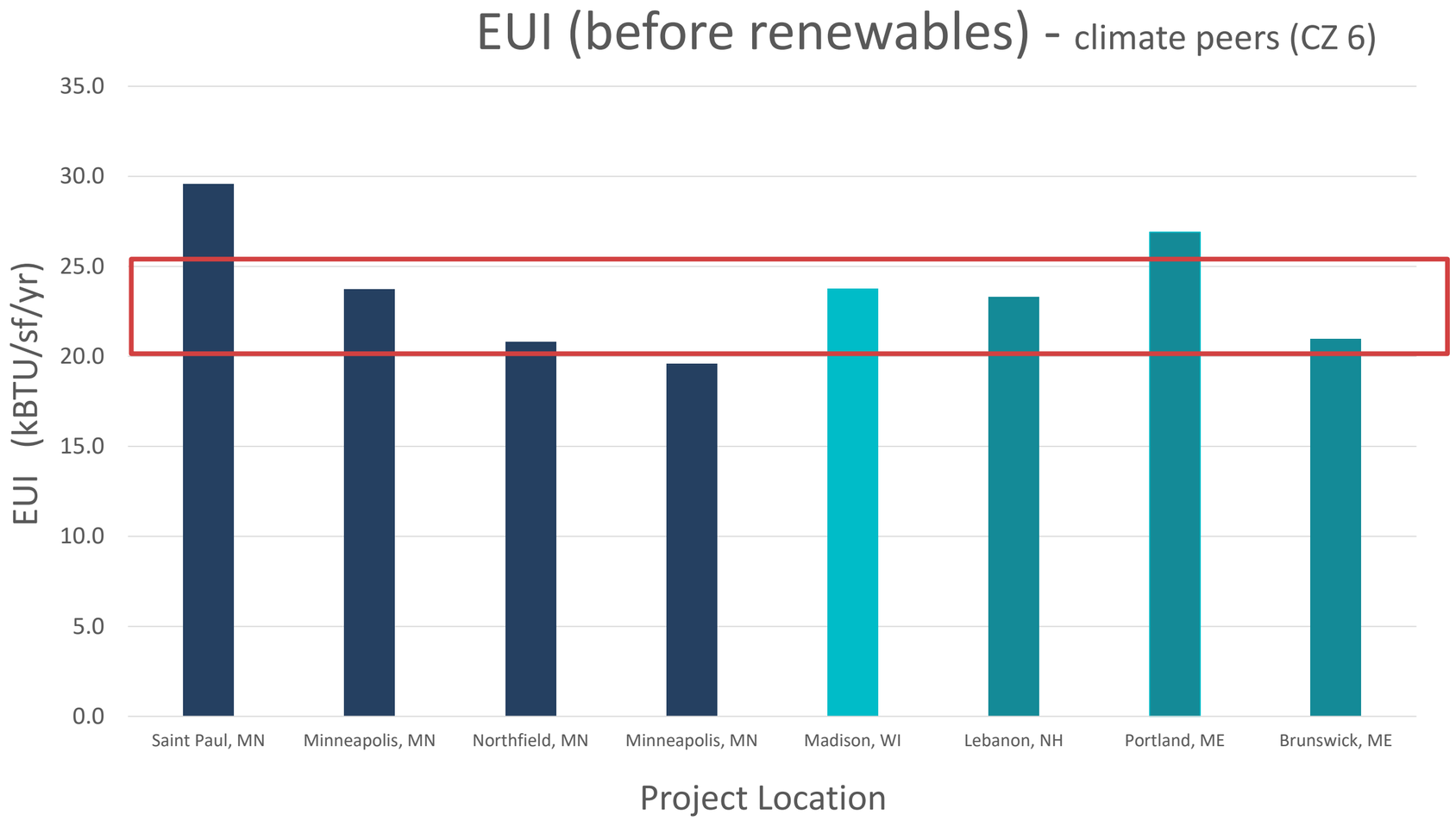
- *Determine cost effectiveness and energy savings potential*
- *Develop understanding of the drivers and barriers related to adoption of Passive House-certified multifamily buildings*
- *Provide guidance on how to structure future, improved CIPs (targeted at PH-certified MF buildings) to maximize market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

Image credit – Mike Kane - Bloomberg

TASK 1 DISCOVERY

peer group

current multifamily phius in minnesota



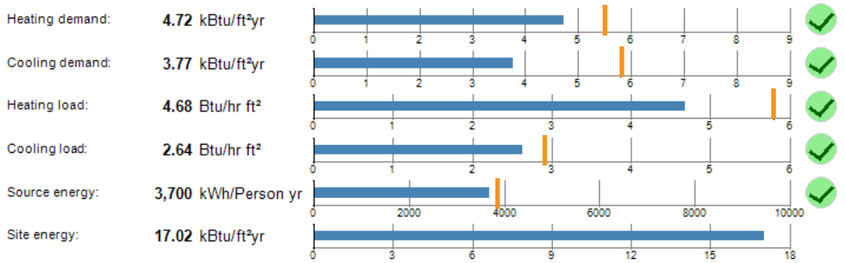
Typical EUI:
20-25 kBTU/sf/yr

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

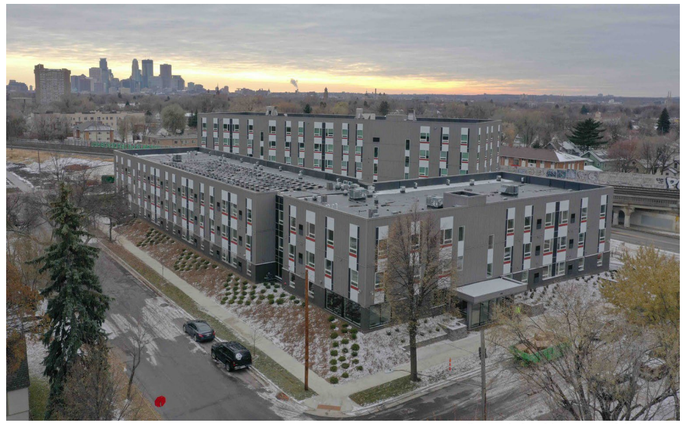
current multifamily phius in minnesota

image courtesy - Kaas Wilson

VERDANT PHIUS+ 2018 CERTIFIED

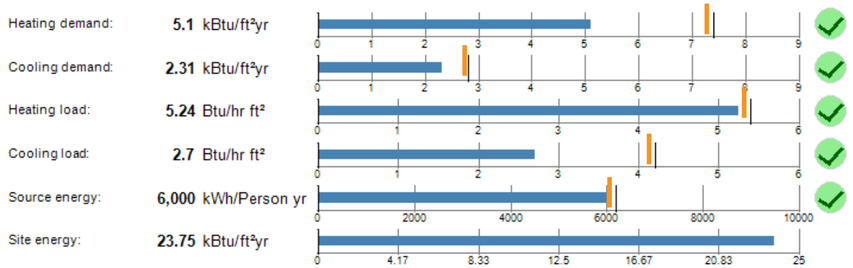


Developer: Sherman Associates
Architect: Kaas Wilson
Contractor: Frana
CPHC: Precipitate



Copyright Newport Midwest

HOOK & LADDER PHIUS+ 2015 CERTIFIED

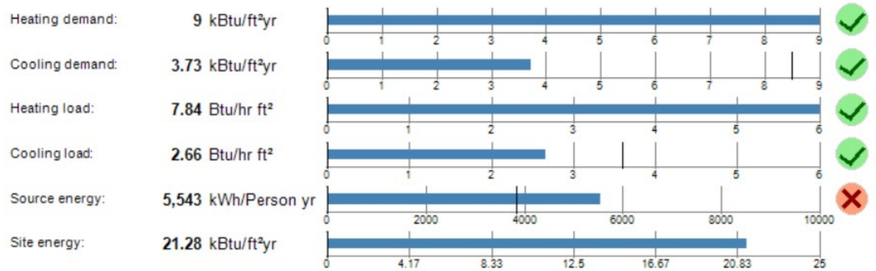


Developer: Newport Midwest
Architect: LHB
Contractor: Frerichs
CPHC: Precipitate

current multifamily phius in minnesota

Image courtesy Precipitate

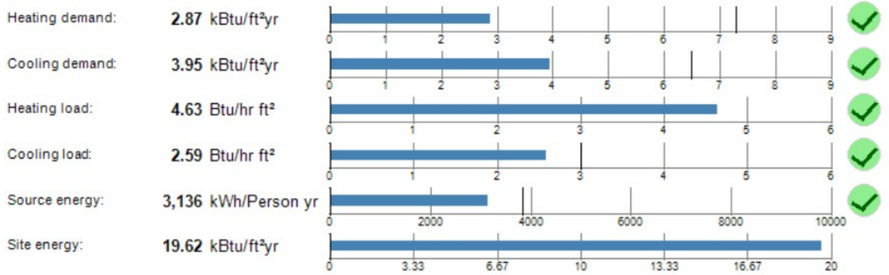
HILLCREST VILLAGE PHIUS+ 2018 MODELED



Developer: Northfield CDC
Designer: Sweetgrass
Contractor: Multiple
CPHC: Precipitate (CSBR support)

Image courtesy Precipitate

SOLSTICE APARTMENTS PHIUS CORE 2021 DESIGN CERTIFIED



Developer: Footprint Development
Architect: Precipitate
Contractor: Copeland
CPHC: Precipitate

FOOTPRINT DEVELOPMENT

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

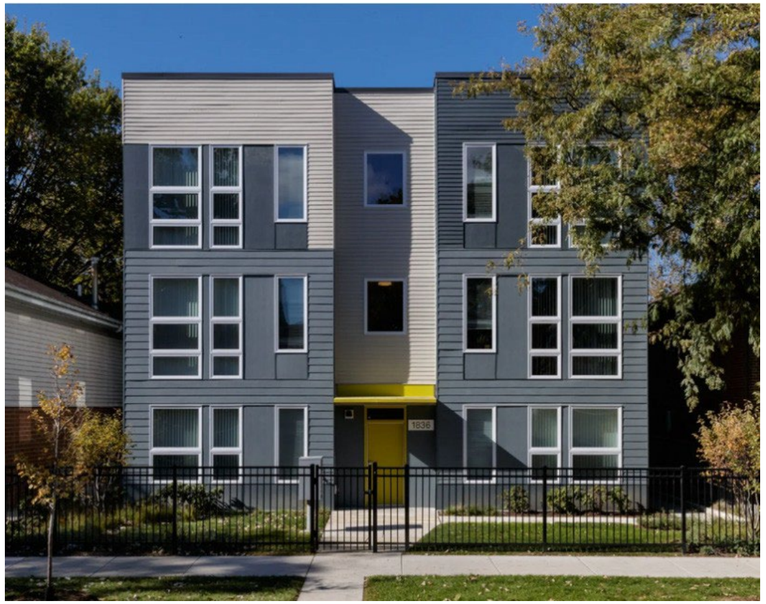


Image courtesy Phius

A. SMALL MULTIFAMILY

TIERRA LINDA

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

Image courtesy Precipitate

B. MEDIUM MULTIFAMILY

SOLSTICE APARTMENTS

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

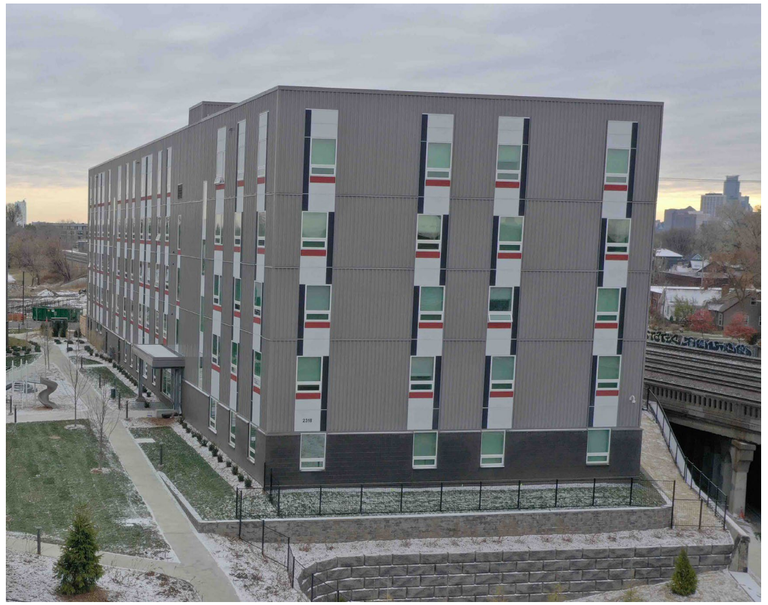


Image courtesy Newport Midwest

C. LARGE MULTIFAMILY

HOOK & LADDER

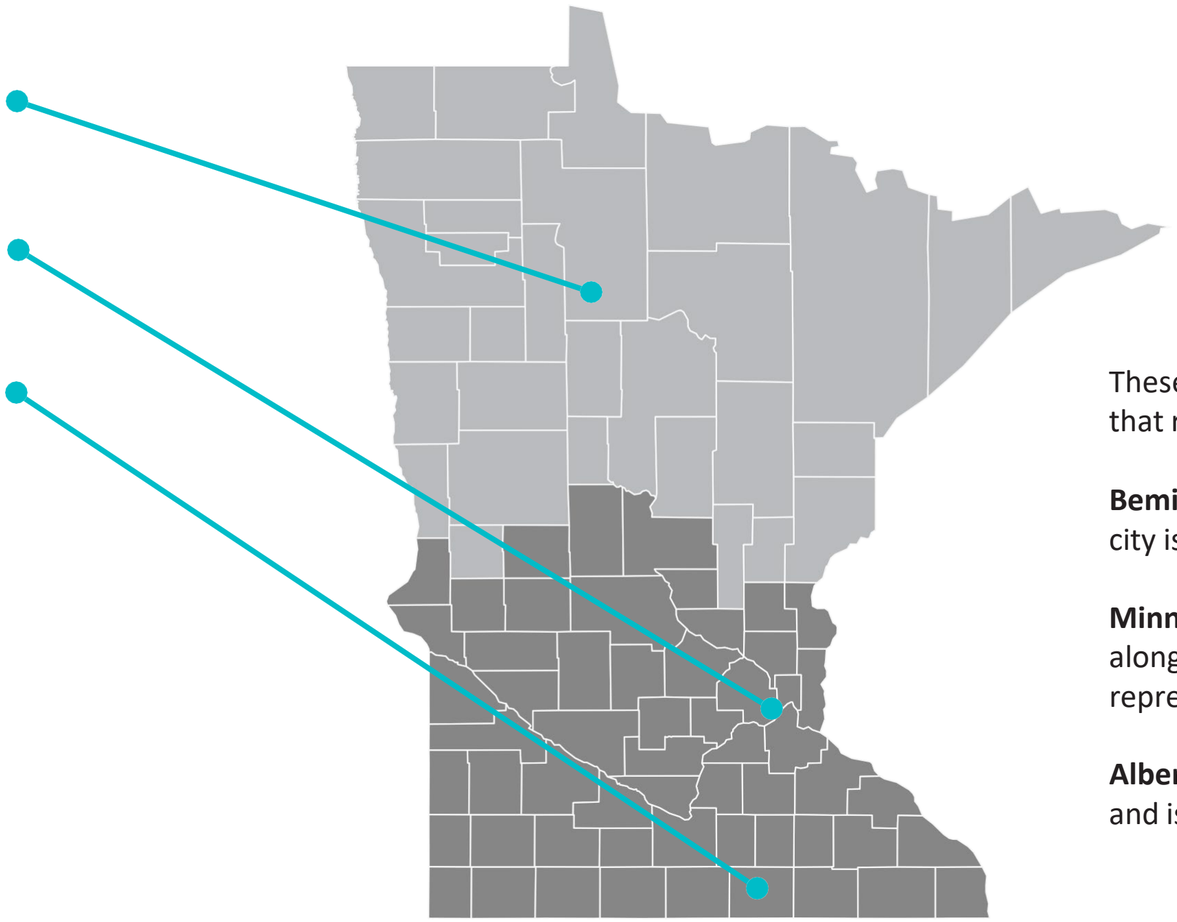
Envelope Area	56,200
iCFA	53,167
Dwelling Units	59
Bedrooms	97

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.

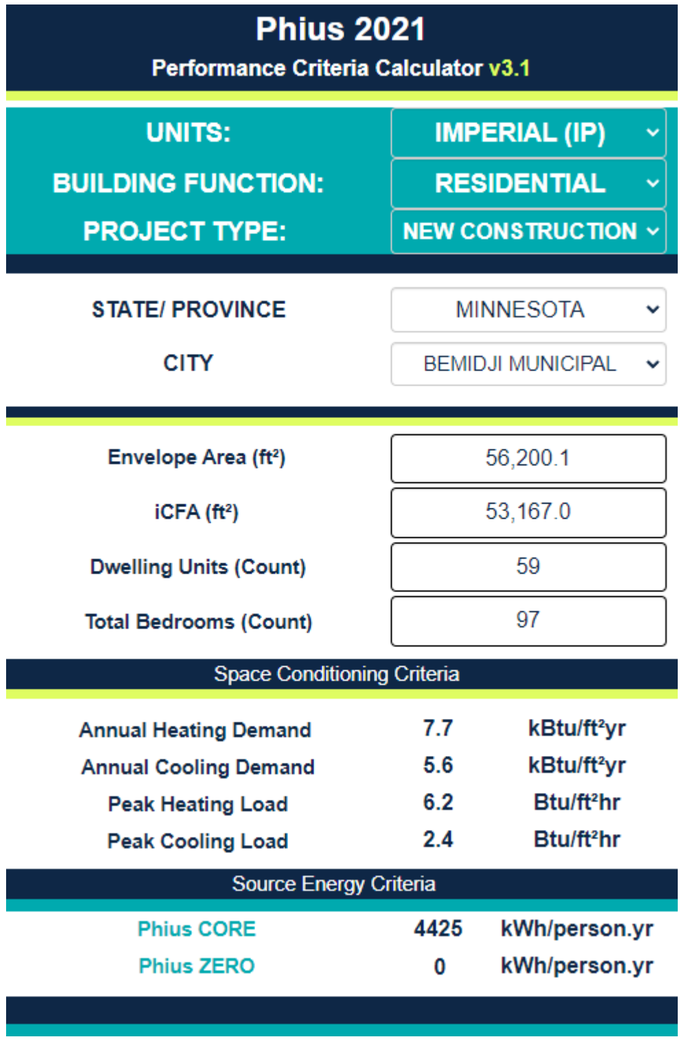
Bemidji in the north, is located in climate zone 7, and the city is surrounded by lakes and forestland.

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



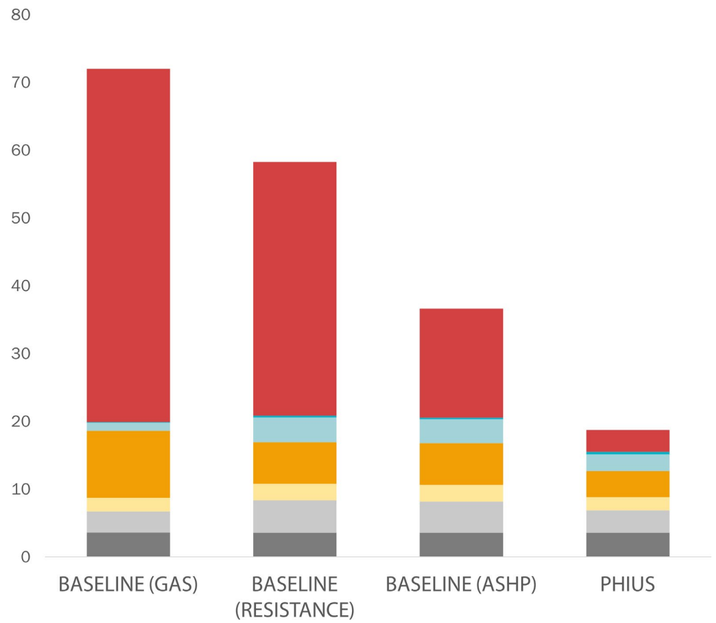
images from PHIUS online calculator

model assumptions for small multifamily

	BASELINE RESIDENTIAL CODE 2012 IECC W/MN AMENDMENTS			PASSIVE HOUSE
	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			

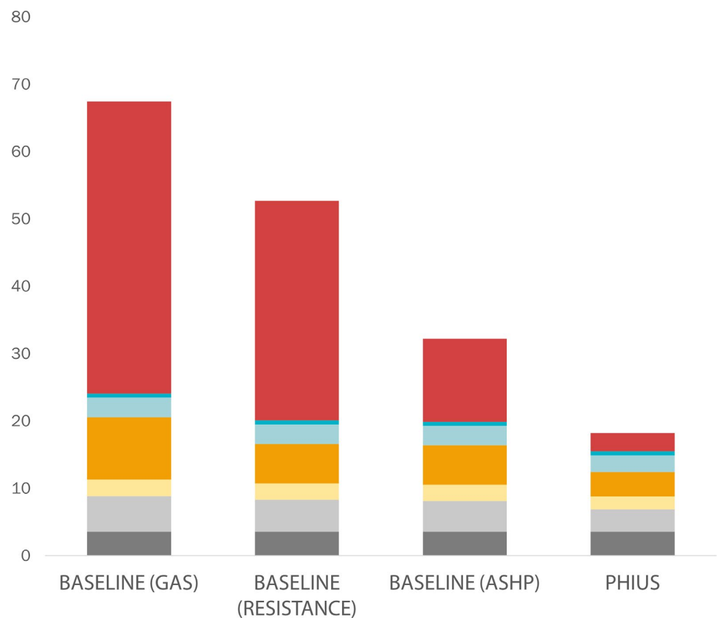
annual site energy use comparison | small multifamily

BEMIDJI (7A)



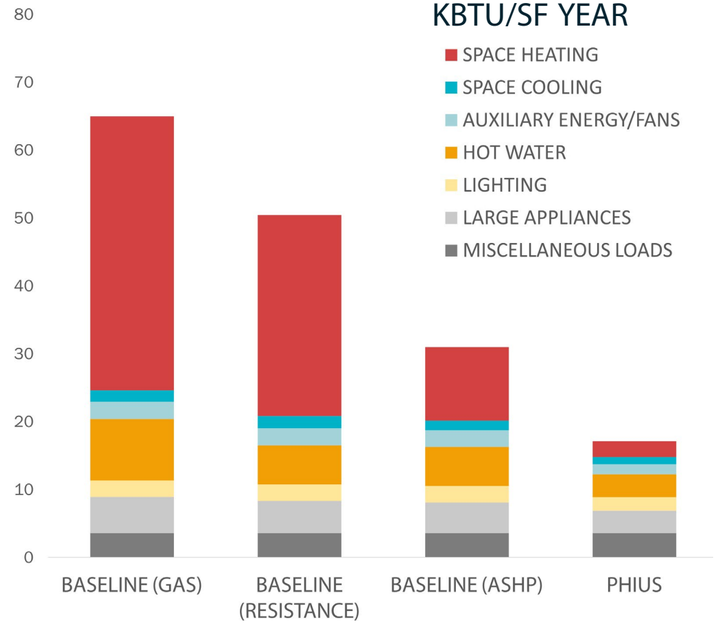
Wall	R16	R65
Roof	R49	R85
Slab	R0.42	R30
Wdws	U0.32	U0.16
Doors	U0.32	U0.29
Solar PV		14,500 kWh/y

MINNEAPOLIS ST PAUL (6A)



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)



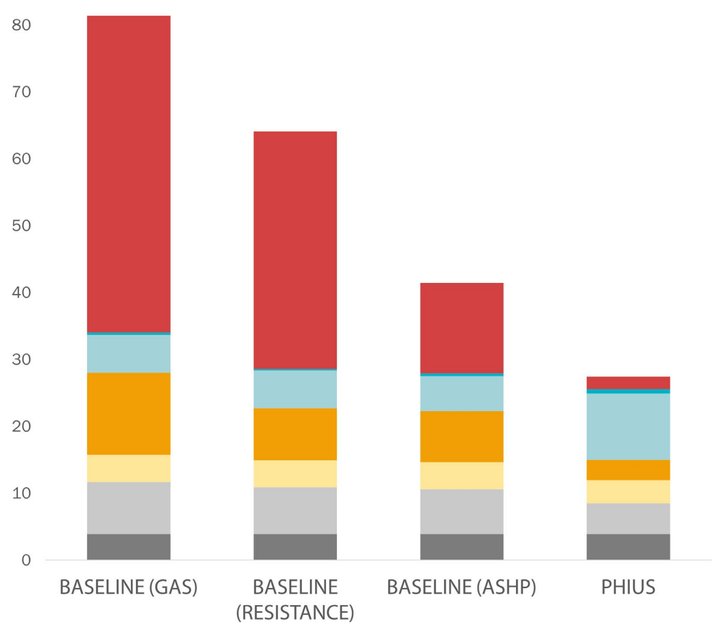
Wall	R16	R40
Roof	R49	R60
Slab	R0.42	R30
Wdws	U0.32	U0.16
Doors	U0.32	U0.16
Solar PV		12,500 kWh/y

model assumptions for medium multifamily

	BASELINE COMMERCIAL CODE ASHRAE 90.1 2019 W/MN AMENDMENTS			PASSIVE HOUSE
	GAS	ELECTRIC RESISTANCE	ELECTRIC ASHP	PHIUS+ 2021
Roof	R30 Zone6, R35 Zone7			PERFORMANCE BASED (VARIES)
(whole wall) Wall	R20 + 3.8ci			
Slab	R7.9 (slab on grade w/48" R25)			
Windows	U-0.43/0.37 (operable), U-0.36/0.29 (fixed) site & summer shading 0.75, no interior blinds			
Doors	Uw-0.77 (R1.3)			
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 3.17 @ 47F / 2.47@ 17F
Cooling	Electric AC 13 SEER / 11.38 EER		Air Source Heat Pump 14 SEER / 12.25 EER	Air to Air Heat Pump 18,000 BTU/h 20 SEER
Ventilation	Balanced, No Recovery 1 W/cfm Fan Efficiency			Energy Recovery Ventilator SRE 1 / LRE 0 / 1.5 W/cfm
DHW	Standard Natural Gas 0.69 Ef R3.3 Pipe Insulation	Electric 0.92 UEF R3.3 Pipe Insulation		Electric Heat Pump 4.07 UEF 72 ga. tank
Lighting & Power	75% LED, Utility Baseline Appliances			100% LED, Median Energy Star Apps.
Thermal Bridging	Not Included in Baseline Models			

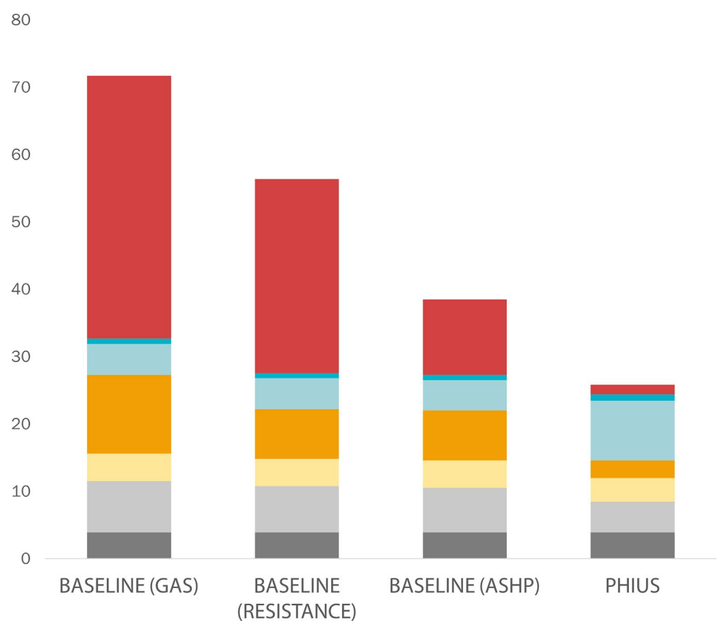
annual site energy use comparison | medium multifamily

BEMIDJI (7A)



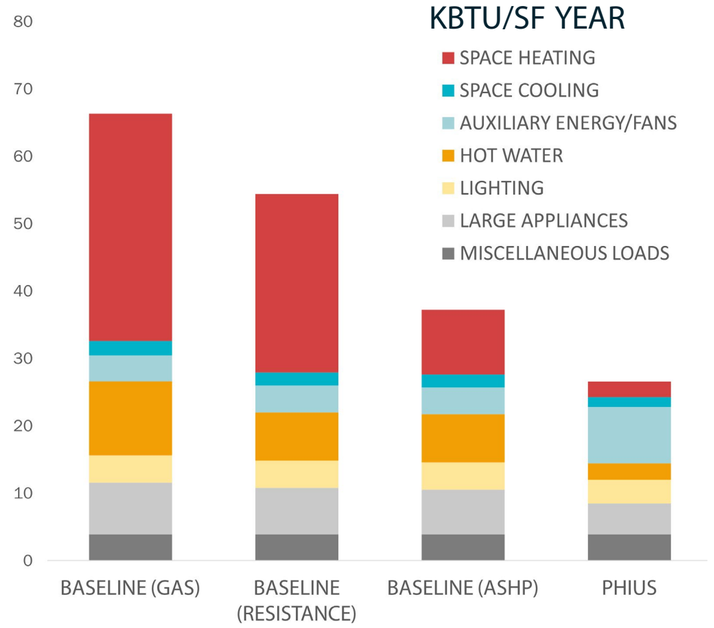
Wall	R24		R34
Roof	R35		R38
Slab	R0.42		R10
Wdws	U0.32		U0.16
Doors	U0.77		U0.29
Solar PV			2,000 kWh/y

MINNEAPOLIS ST PAUL (6A)



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)



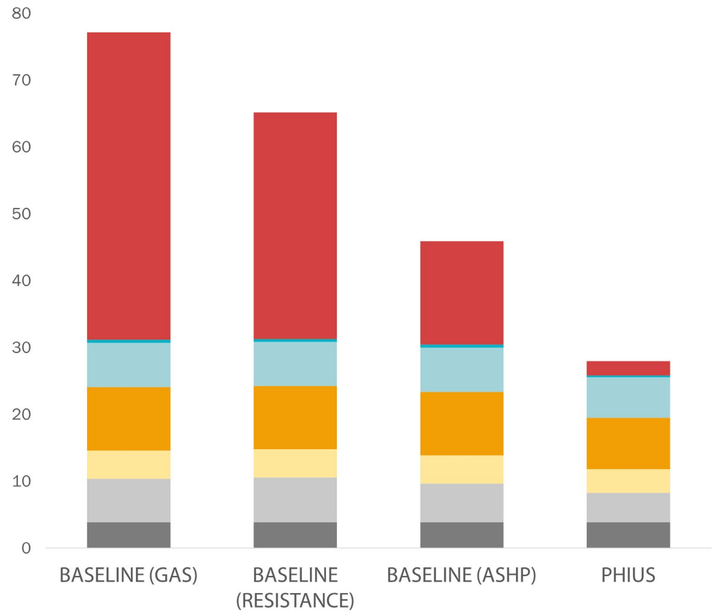
Wall	R24		R34
Roof	R30		R38
Slab	R0.42		R10
Wdws	U0.32		U0.16
Doors	U0.77		U0.29
Solar PV			2,500 kWh/y

model assumptions for large multifamily

	BASELINE COMMERCIAL CODE ASHRAE 90.1 2019 W/MN AMENDMENTS			PASSIVE HOUSE
	GAS	ELECTRIC RESISTANCE	ELECTRIC ASHP	PHIUS+ 2021
Roof	R30 Zone6, R35 Zone7			PERFORMANCE BASED (VARIES)
(whole wall) Wall	R20 + 3.8ci			
Slab	R7.9 (slab on grade w/48" R25)			
Windows	U-0.43/0.37 (operable), U-0.36/0.29 (fixed) site & summer shading 0.75, no interior blinds			
Doors	Uw-0.37 (R2.7)			
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 3.2 @ 47F / 2.05 @ 17F	VRF SYSTEM 20,000 BTU/h Heat.COP 3.87 @ 47F / 2.41@ -12.6F
Cooling	Electric AC 13 SEER / 11.38 EER		Air Source Heat Pump 13 SEER / 11.38 EER	Air to Air Heat Pump 641,000 BTU/h 25 SEER
Ventilation	Balanced, No Recovery 1 W/cfm Fan Efficiency			Energy Recovery Ventilator SRE 0.79 / LRE 0.694 / .79 W/cfm
DHW	Standard Natural Gas 0.8 EF R3.3 Pipe Insulation			Natural Gas 96% efficient 72 ga. tank
Lighting & Power	75% LED, Utility Baseline Appliances			100% LED, Median Energy Star Apps.
Thermal Bridging	Not Included in Baseline Models			

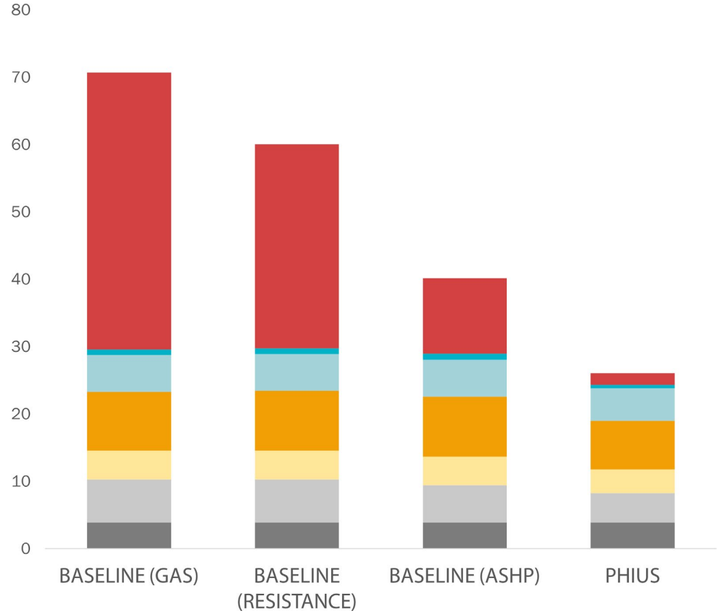
annual site energy use comparison | large multifamily

BEMIDJI (7A)



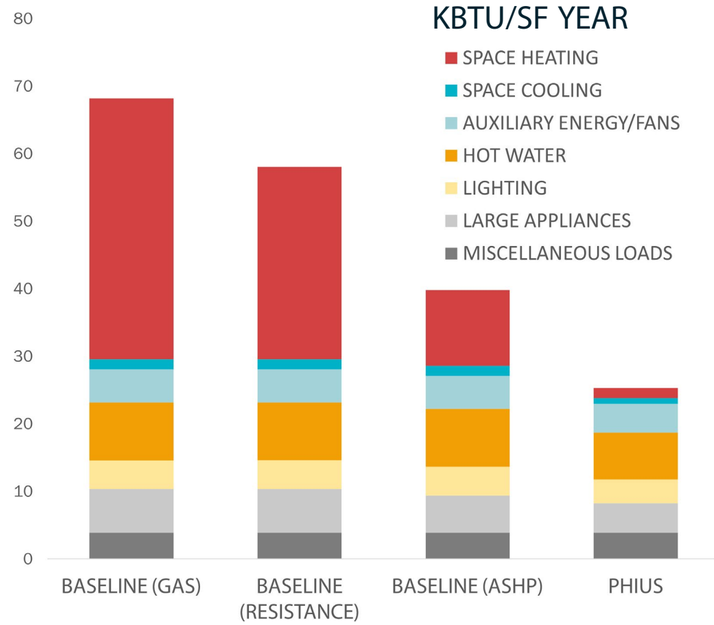
Wall	R16	R26
Roof	R49	R60
Slab	R0.42	R20
Wdws	U0.32	U0.16
Doors	U0.32	U0.29

MINNEAPOLIS ST PAUL (6A)



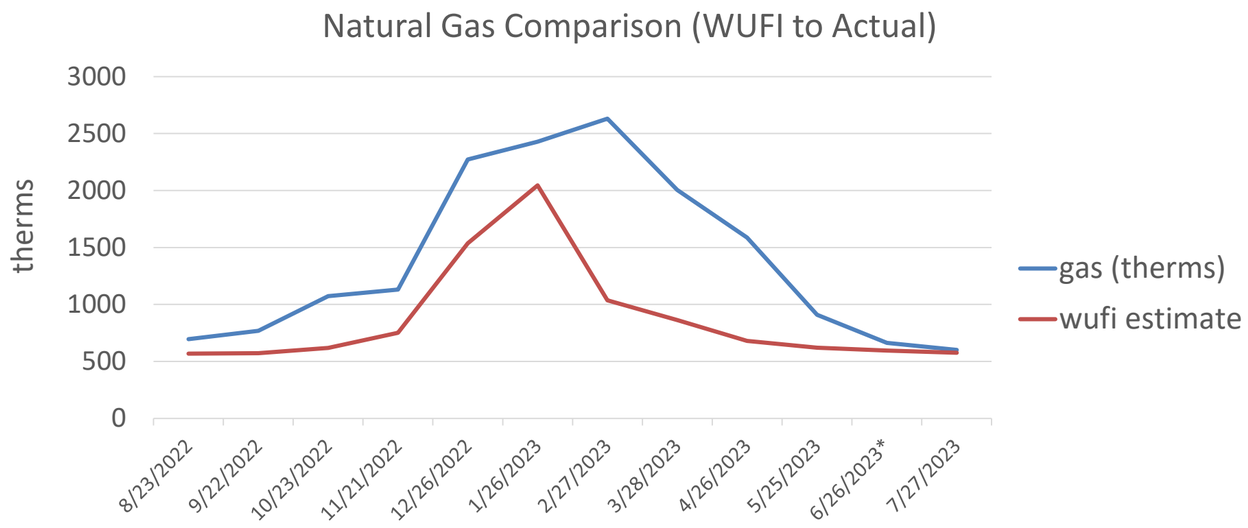
Wall	R16	R26
Roof	R49	R60
Slab	R0.42	R20
Wdws	U0.32	U0.16
Doors	U0.32	U0.29

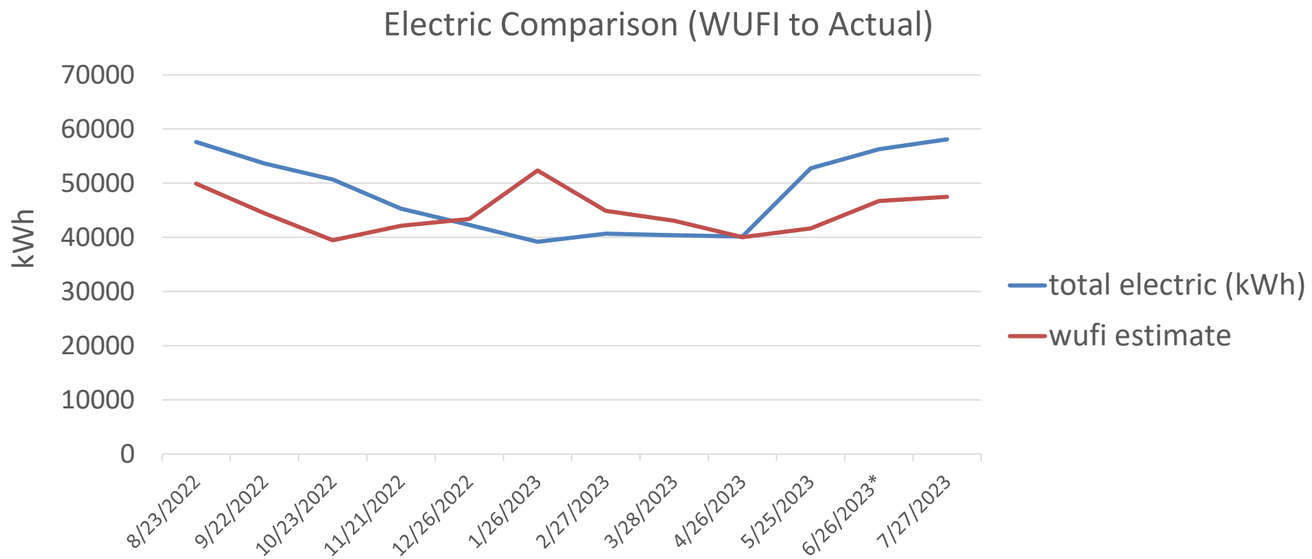
ALBERT LEA (6A)



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

modeled to actual consumption - verdant





WUFI EUI (with parking garage): 25.3 kBTU/sf/yr

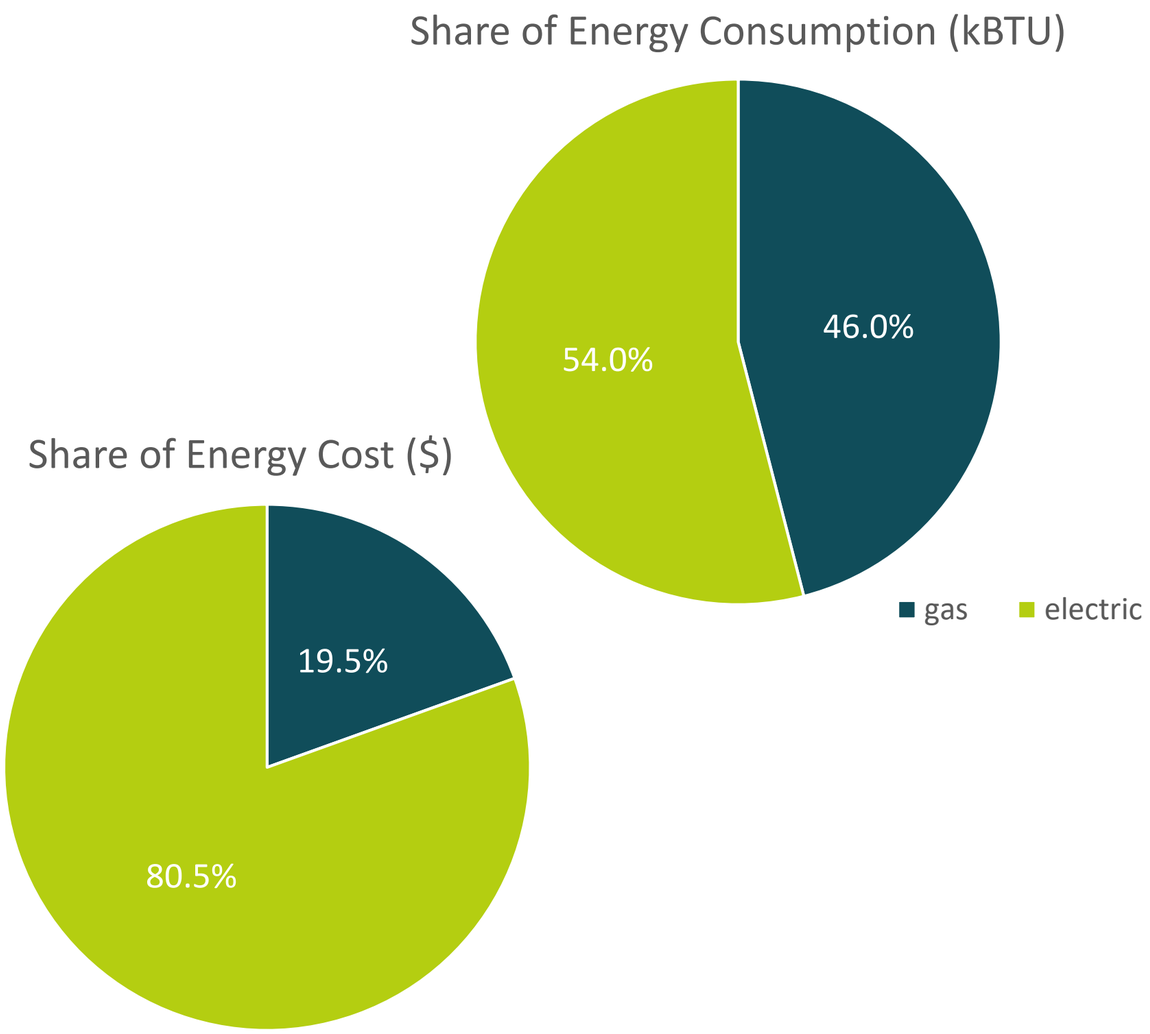
Measured EUI (with parking garage): 29.6 kBTU/sf/yr

(Measured data is most recent 12 months, but has not been weather-normalized yet)

utility bills - verdant

yearly total = $98,980

Since gas is a cheaper energy source and PH buildings mostly save gas, we can't expect 50% energy cost savings to match the 50% reduction in energy consumption.



TASK 3 COST

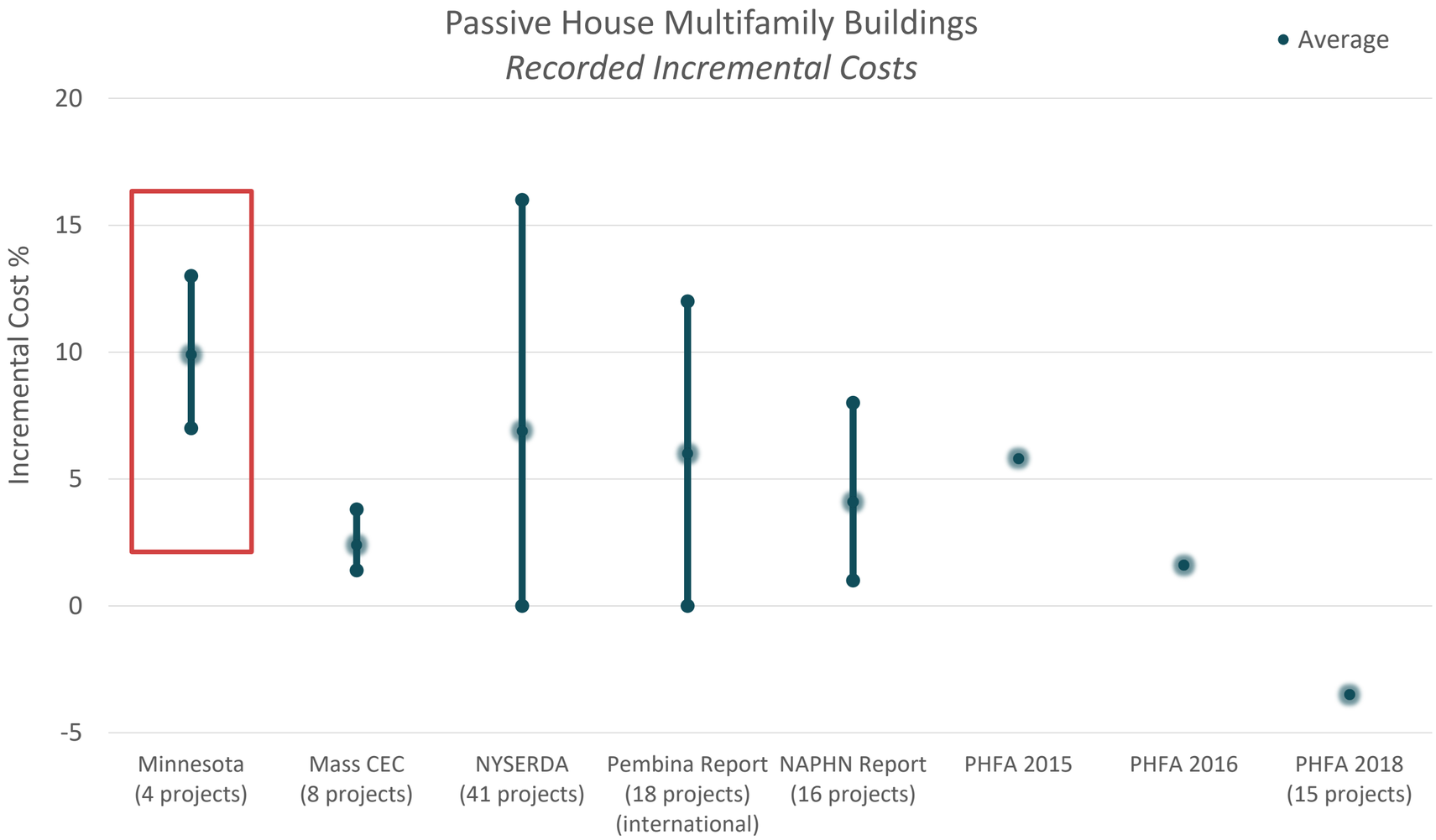
construction costs and payback

construction costs – minnesota projects

Project	Location	# Units	Floor Area (gross)	Construction Cost	Cost year	Cost/sf	Cost/unit	Incremental	Incremental above…
Hook & Ladder	Minneapolis, MN	59	73,000	$ 10,350,360	2017	$ 142	$ 175,430	13.0%	Energy Star
Verdant	Saint Paul, MN	82	123,137	$ 19,456,650	2021	$ 158	$ 237,276	12.0%	Green Communities
Hillcrest Village	Northfield, MN	17	17,674	$ 4,069,500	2022	$ 230	$ 239,382	7.0%	Standard construction
Solstice	Minneapolis, MN	23	18,960	$ 6,138,000	2023	$ 324	$ 266,870	7.5%	Energy Star

incremental construction costs

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



TASK 4 MARKET STUDY

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.

interview synthesis – lessons learned

Controlling Costs

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 in multifamily buildings, but finding an engineer willing to do this can be hard.

If the "green premium" is getting high, develop relationships with manufacturers and get direct pricing. Especially for windows.

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

interview synthesis – lessons learned

Management and Operations

Complex mechanical and control systems that are unfamiliar in the market can lead to serious operational failures.

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

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.

3rd party utility billing companies – if they are necessary, be aware they can increase miscommunication and misunderstandings between residents and management.

interview synthesis – lessons learned

Construction & Process

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

CPHCs should remain involved during Construction Administration to ensure PH-related items are installed as specified.

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

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

TASK 5 INCENTIVES

multifamily PH

current incentives for passive house multifamily

45L Tax Credits (IRS - 2023)

DOE ZERH-certified units in multifamily buildings	***$1000** per unit*
DOE ZERH-certified units in MF buildings built with prevailing wage	***$5000** per unit*

Xcel Energy

Energy Design Assistance (EDA) and Enhanced EDA (energy models with bundled ECMs compared to utility baseline)	***$500** per kW peak reduction* ***$0.04** per kWh/yr* ***$5** per Dth/yr*

Centerpoint Energy

PH-certified residential	***$1500 - $2000+** towards certification costs*

future incentives for passive house multifamily

Image credit – Getty Images, Creator - x-reflexnaja

Utility incentives offered for:

- *whole-building energy savings, not based on a measure-by-measure approach*
- *incentive amounts commensurate with energy savings*
- *additional incentives for PH-certified* ***affordable*** *housing*
- *grant funding available for feasibility studies and pre-certification work*