CODES & QAPS

collaboration with allies

finding allies

Phius
Alliance MN

Passive
House MN
(NAPHN)

Midwest Building
Decarbonization
Coalition & Coalition

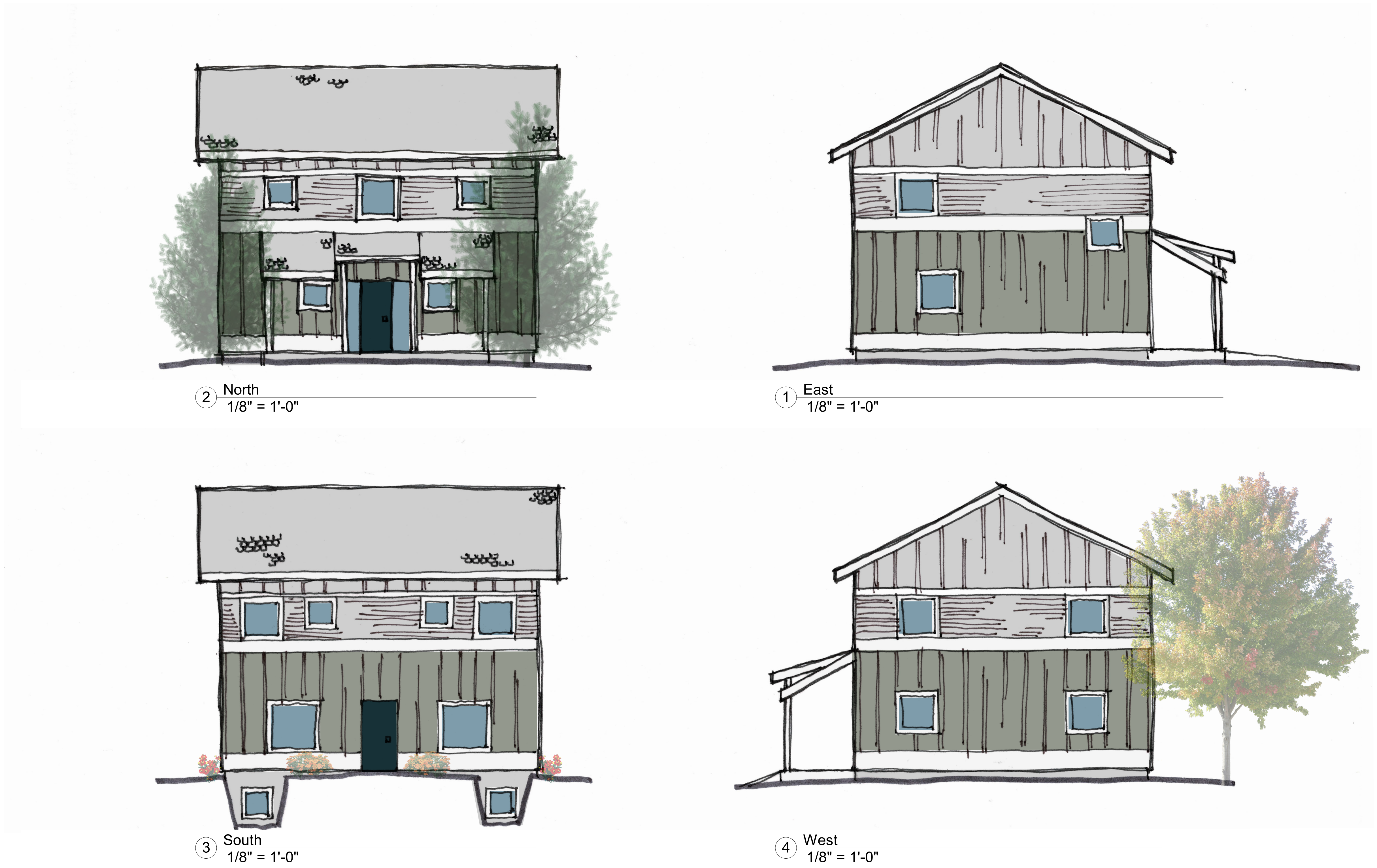
AIA MN
Government
Affairs

volunteering for
Technical Advisory
Committee

INCENTIVES

minneapolis homes

incentivizing phius, phi, & net zero energy ready homes + solar



$90,000
incentive

MARKET ANALYSIS

phius level construction

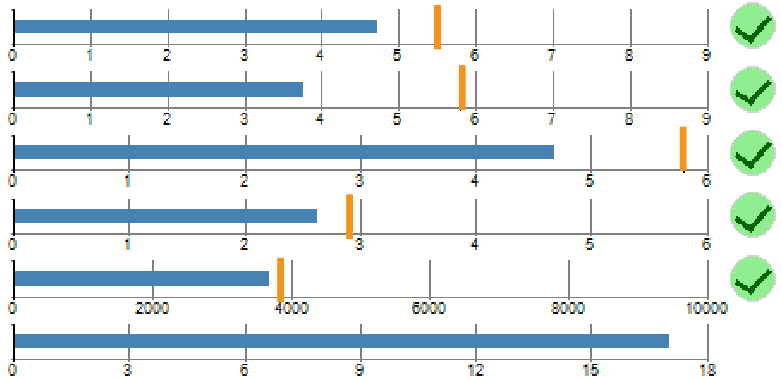
research sponsored through a MN Department of Commerce CARD grant

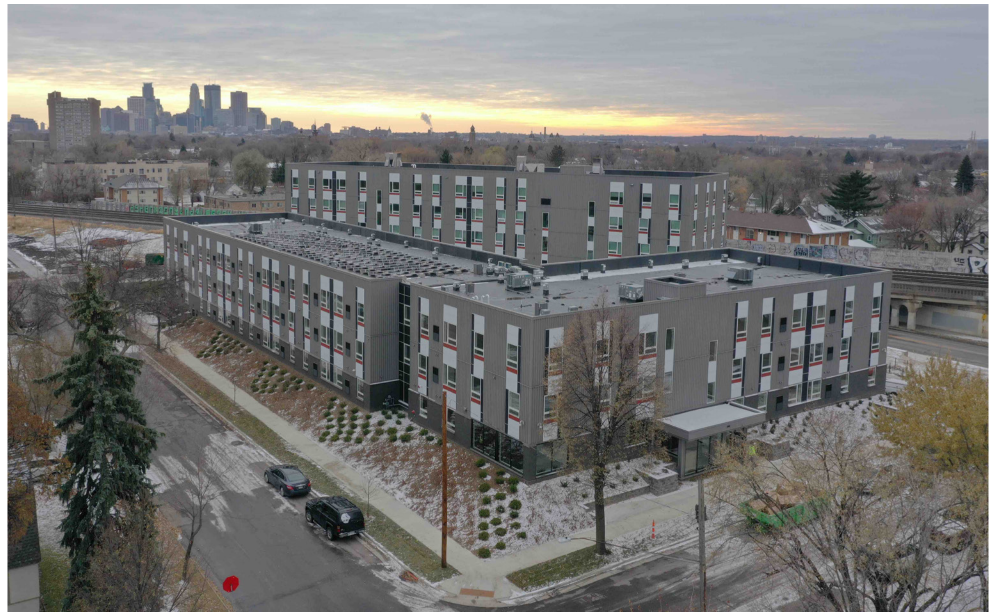
current multifamily phius in minnesota

image courtesy Kaas Wilson

VERDANT PHIUS+ 2018 PRE-CERTIFIED

Heating demand:	**4.72**	kBtu/ft²yr
Cooling demand:	**3.77**	kBtu/ft²yr
Heating load:	**4.68**	Btu/hr ft²
Cooling load:	**2.64**	Btu/hr ft²
Source energy:	**3,700**	kWh/Person yr
Site energy:	**17.02**	kBtu/ft²yr

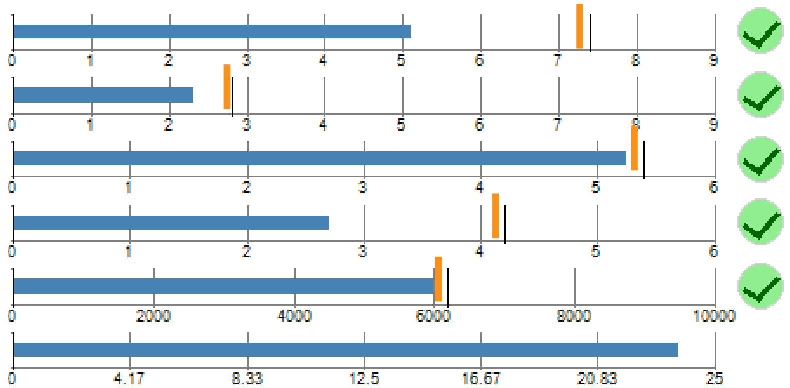




copyright Newport Midwest

HOOK & LADDER PHIUS+ 2015 CERTIFIED

Heating demand:	**5.1**	kBtu/ft²yr
Cooling demand:	**2.31**	kBtu/ft²yr
Heating load:	**5.24**	Btu/hr ft²
Cooling load:	**2.7**	Btu/hr ft²
Source energy:	**6,000**	kWh/Person yr
Site energy:	**23.75**	kBtu/ft²yr



interview synthesis

Distribution of Interviewees

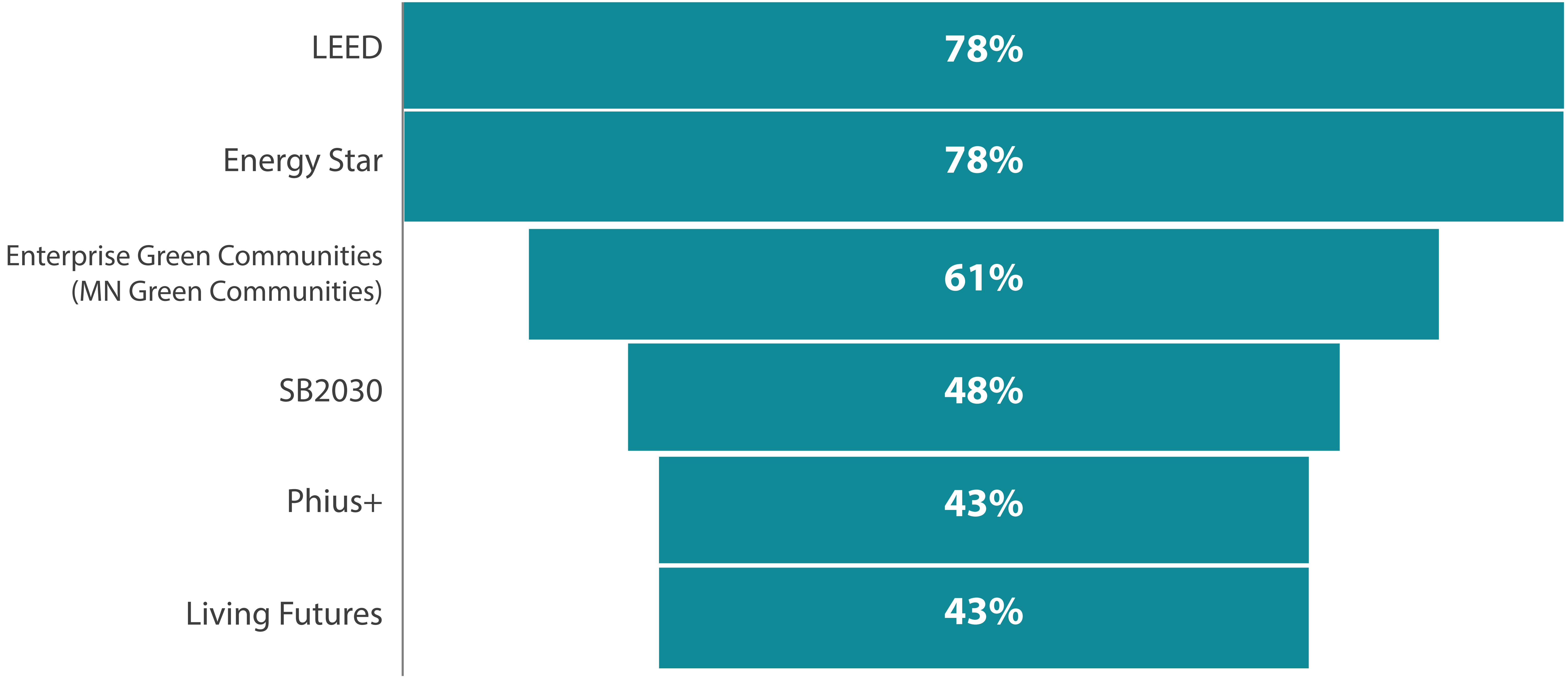
Initial outreach was conducted to 59 unique stakeholders across the building design, development, and construction community as well as local housing authorities and municipal entities. Out of that original pool of candidates we carried out structured phone interviews with 29 people.

questions

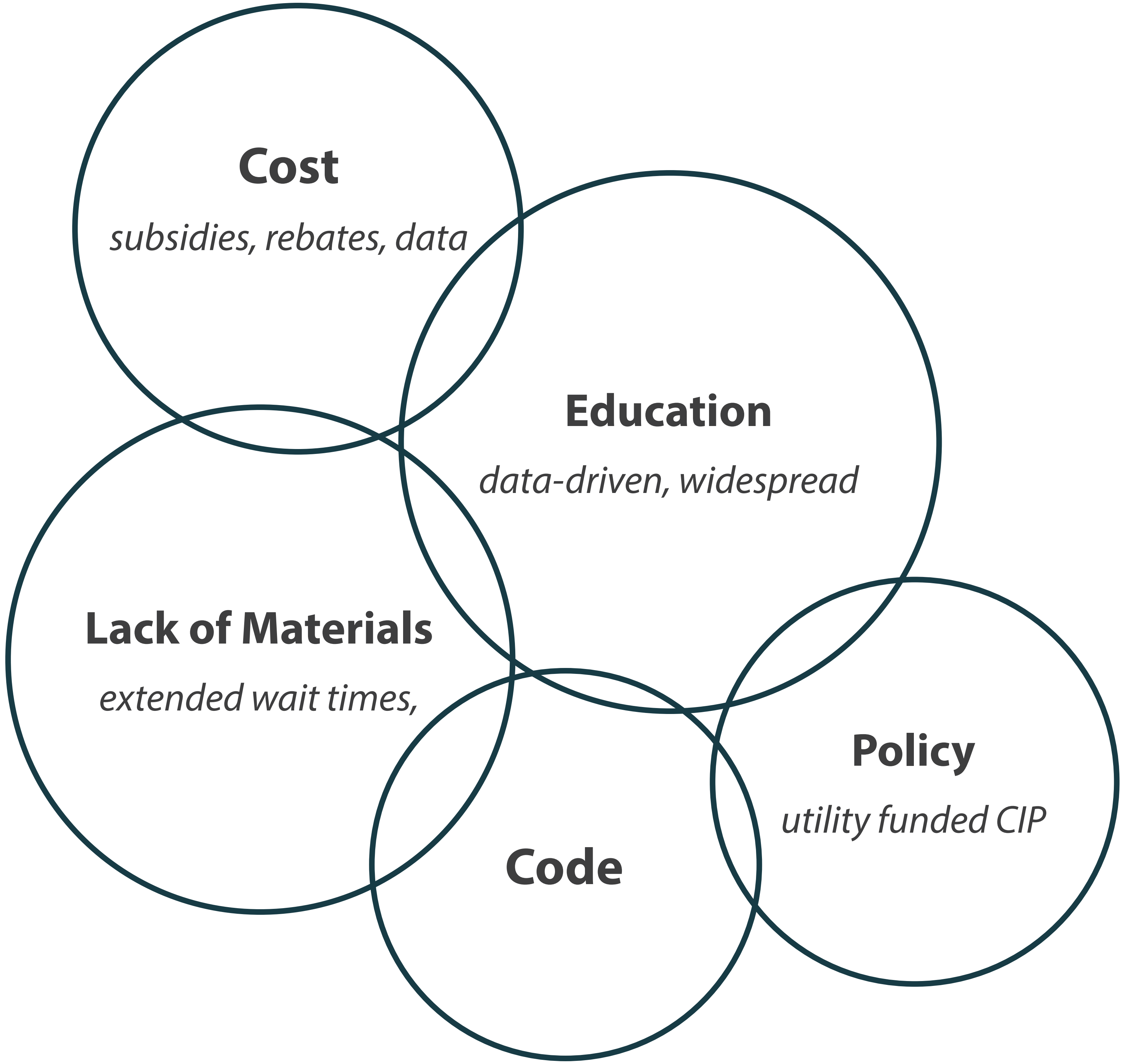
Interviewees were asked a series of questions on both their general awareness and perceptions of Passive buildings.

Specific questions based on industry sectors were also administered for feedback and considerations to help move the market towards increased adoption.

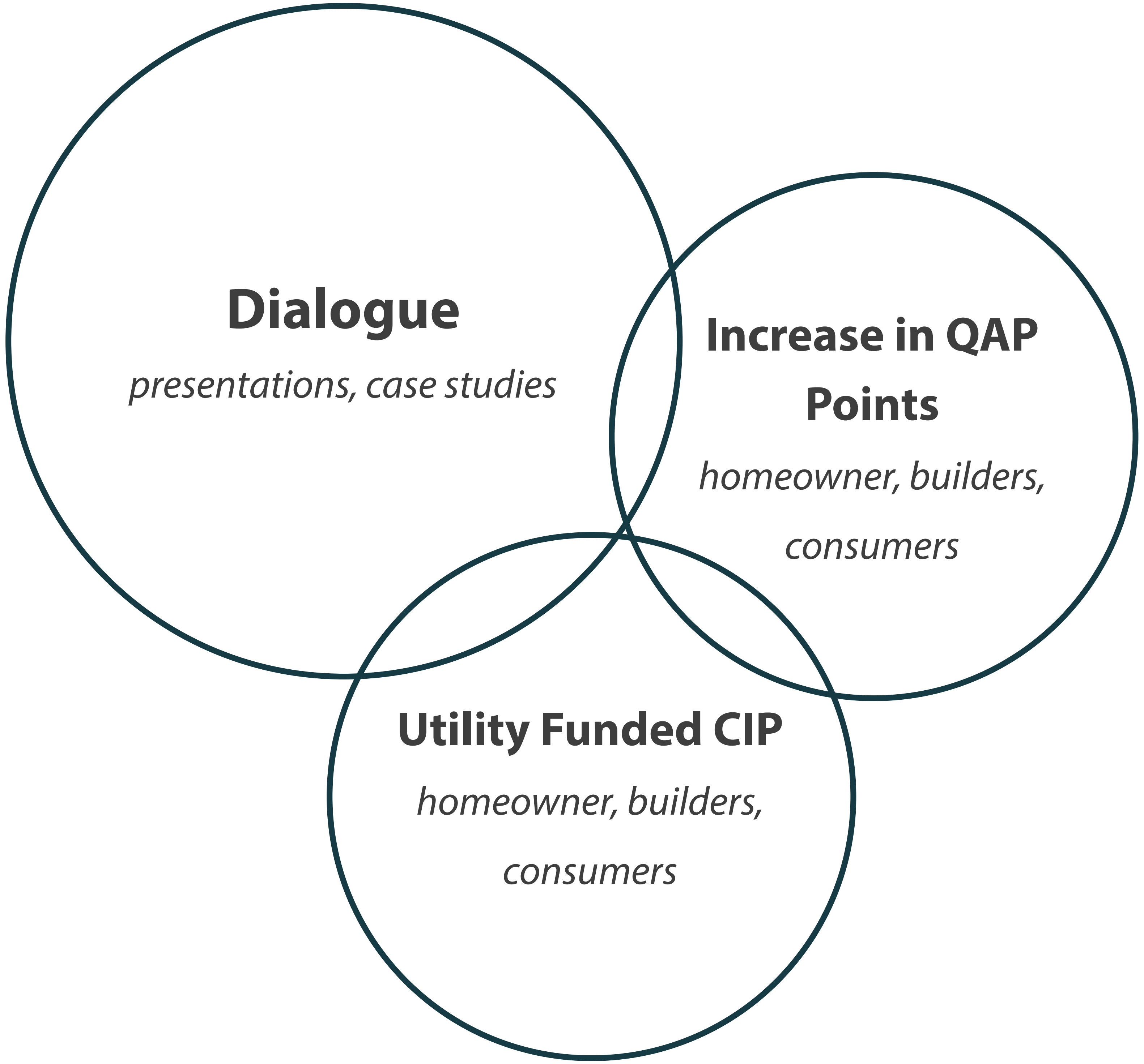
familiarity with green standards



opportunities



possible solutions



Research will be made available in a public report and webinar

ENERGY MODELING

estimating the impact

estimating phius impact - setting the base case

Minnesota Climate Zones		*Climate Zone*	7		7	6A Central		6A	6A South	
		Weather Station	Bemidji Municipal Airport		Duluth Intl Airport	Minneapolis-St. Paul Intl Airport		Rochester Intl Airport	Albert Lea (AWOS)	
		Elevation	1377.95 ft/420 m			833.33 ft/254 m			1256.56/383 m	
Study Buildings										
A. Small Multifamily			*Target*	*Modeled*		*Target*	*Modeled*		*Target*	*Modeled*
Envelope Area	*14,107.5*	Heating Demand	8.5		8.2	7.3		7.6	7.6	
iCFA	*8,595.8*	Cooling Demand	4.3		4	5.5		5	5.2	
Dwelling Units	*6*	Heating Load	5.9		5.4	6.3		6.9	5.4	
Bedrooms	*18*	Cooling Load	1.9		2.1	2.6		2.1	2.5	
		Airtightness								
		Source Energy	3850		3850	3850		3850	3850	
		Site Energy	-							
B. Mid-Size Multifamily										
Envelope Area	*17,749.3*	Heating Demand	7.8		7.7	7.1		7.3	7.4	
iCFA	*17,918.8*	Cooling Demand	5.6		5.2	6.9		6.4	7.2	
Dwelling Units	*23*	Heating Load	6.3		5.8	6.8		7.4	5.8	
Bedrooms	*23*	Cooling Load	2.5		2.7	3.1		2.7	3	
		Airtightness								
		Source Energy	5175		5175	5175		5175	5175	
		Site Energy	-							
C. Large Multifamily										
Envelope Area	*56,200.1*	Heating Demand	7.7		7.6	6.9		7.1	7.2	
iCFA	*53,167.0*	Cooling Demand	5.6		5.2	6.8		6.3	7	
Dwelling Units	*59*	Heating Load	6.2		5.7	6.6		7.2	5.7	
Bedrooms	*97*	Cooling Load	2.4		2.6	3		2.6	2.9	
		Airtightness								
		Source Energy	4425		4425	4425		4425	4425	
		Site Energy	-							

Phius 2021 Criteria Calculator v3.1 (spreadsheethosting.com)

CASE STUDY

affordable net-zero townhomes

hillcrest village | community action center of northfield

NET-ZERO TOWNHOMES

TYPOLOGY	Residential/2-Unit Townhomes
CLIENT	Community Action Center of Northfield
YEAR	Design 2020
LOCATION	Northfield, Minnesota
AREA	2,521 GSF

PROJECT TEAM

DESIGN	Sweetgrass Design Studio
CONTRACTOR	Steve Schmitt
CPHC	Precipitate
RESEARCH	CSBR @ University of Minnesota

PERFORMANCE DATA

CLIMATE	ZONE 6
iCFA	2,222 SF

Space Conditioning Criteria		
Annual Heating Demand	**10.4**	**kBTU/ft²yr**
Annual Cooling Demand	**8.5**	**kBTU/ft²yr**
Peak Heating Load	**8.4**	**BTU/ft²hr**
Peak Cooling Load	**3.6**	**BTU/ft²hr**

CONSTRUCTION COST DATA

Standard Design (GOOD)	$405,000 - $161/GSF
Passive House Level (OPTIMIZED)	$425,000 - $169/GSF (5% INCREASE)

northfield climate action plan

OUR GOALS

The City of Northfield is committed to:

- 100% carbon-free electricity by 2030 and
- Being a 100% carbon-free community by 2040.

The plan includes strategies to enhance the resilience of the community as it adapts to the impacts of a changing climate.

GREAT PLAINS INSTITUTE

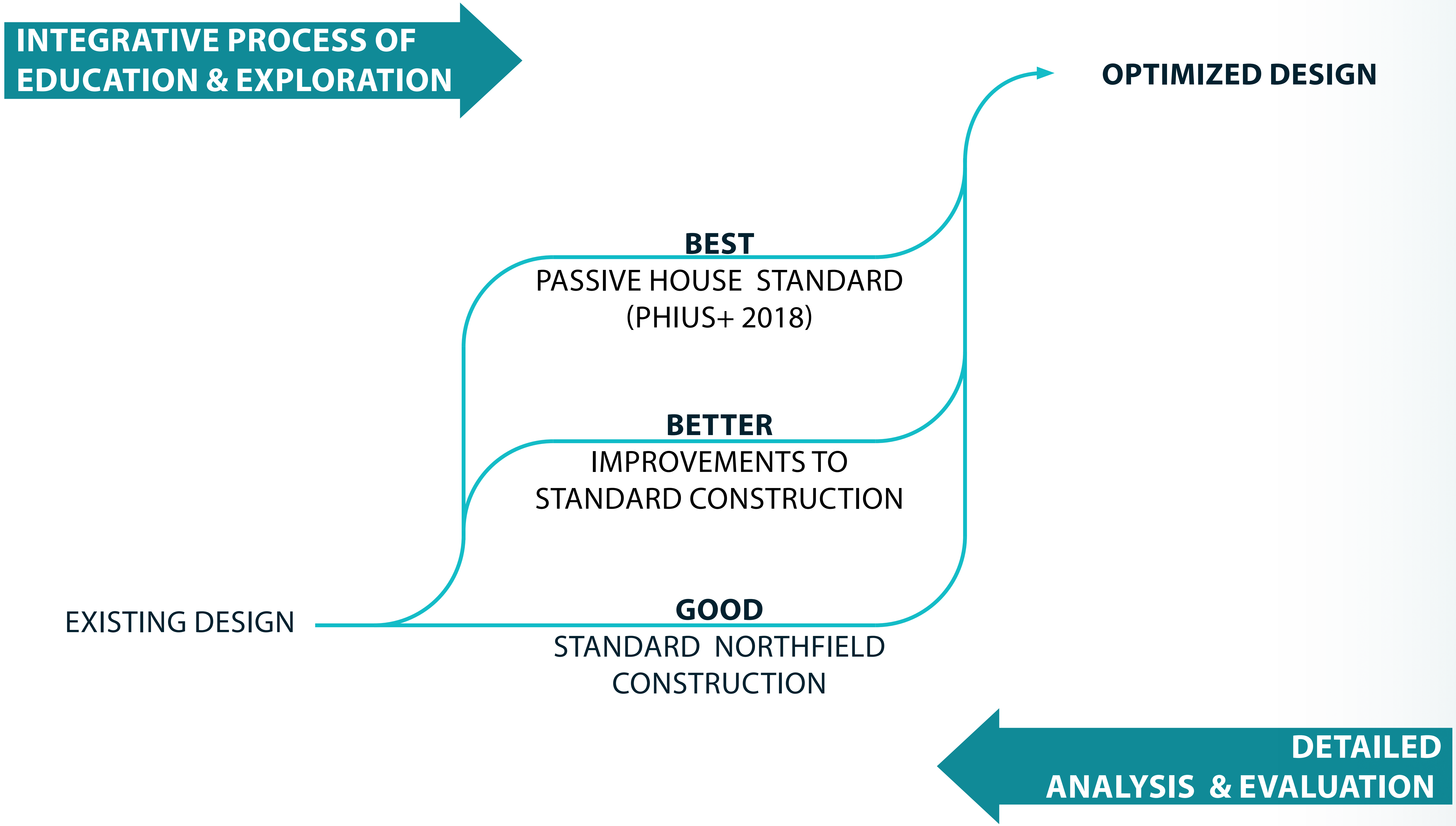
ci.northfield.mn.us/Sustainability

project goals

- **Everyone feels at home in the neighborhood:** Center every aspect of the project around community, safety, dignity, and privacy to fit the needs of all residents.
- **Flexible for all:** Provide a diverse and mixed-use type of housing to fit the needs of all residents to be cost-neutral for the CAC. Provide an environment that integrates emergency and transitional housing with "real affordable housing".
- **Prioritize People:** Minimize displacement of current residents as well as support measures that enhance community
- **Planning for the future:** Design homes that minimize environmental impacts, both in construction & in daily operations.
- **Community Pride:** Engage, fund, build, and operate through the joy and commitment of the full Northfield community.

Illustration Credit Michael Joyce

Community Action Center OF NORTHFIELD

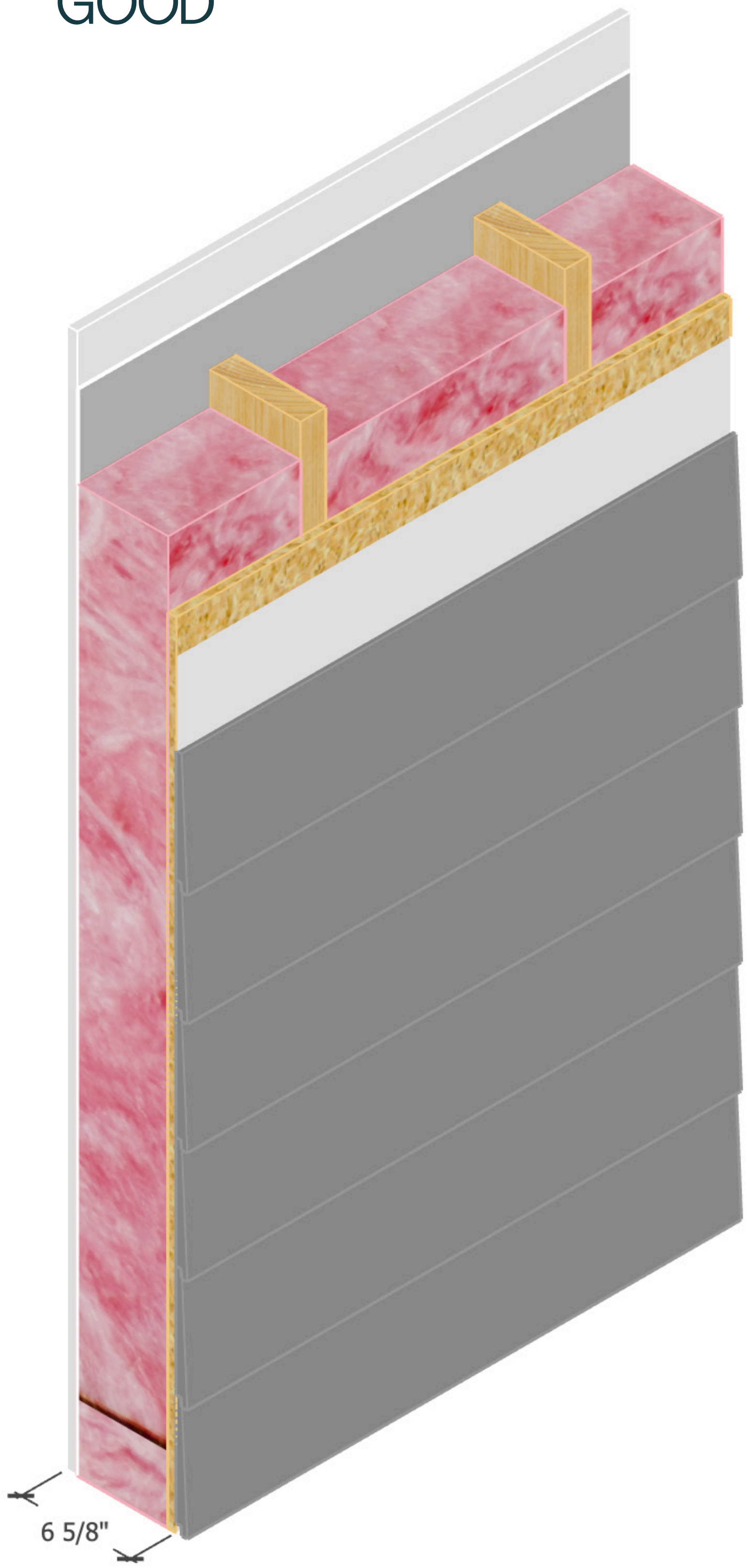

INTEGRATIVE PROCESS OF
EDUCATION & EXPLORATION
OPTIMIZED DESIGN
BEST
PASSIVE HOUSE STANDARD
(PHIUS+ 2018)
BETTER
IMPROVEMENTS TO
STANDARD CONSTRUCTION
EXISTING DESIGN
GOOD
STANDARD NORTHFIELD
CONSTRUCTION
DETAILED
ANALYSIS & EVALUATION

model assumptions

	GOOD STANDARD	**BETTER** IMPROVED STANDARD	**BEST** PHIUS+ 2018
(whole wall) Wall	R16.9	“B” R39.6	R36.3
Roof	R50 (R52)	R50 (R52)	R60 (R61.5)
Slab	R10	R15	R25
Windows	Code Baseline Uw-0.32, SHGC 0.26	Pella 350 Natural Sun Uw-0.199, SHGC 0.56	Alpen Triple Glazed Uw-0.179, SHGC 0.582
Doors	R13	R13	R13
Air Sealing	0.945 cfm/SF @50 Pa (2 ACH50)	.0708 cfm/SF @50 Pa (1.5 ACH50)	.05 cfm/SF @50 Pa (1.18 ACH50)
Heating	90 AFUE Gas Furnace	Air to Air Heat Pump 7800 BTU/h Heating COP 3.9 @ 47F / 2.09 @ 5F	Air to Air Heat Pump 7800 BTU/h Heating COP 3.9 @ 47F / 2.09 @ 5F
Cooling	13 SEER Electric AC	Air to Air Heat Pump 12000 BTU/h Cooling COP 4.89, Dehumid. COP 2	Air to Air Heat Pump 12000 BTU/h Cooling COP 4.89, Dehumid. COP 2
Geothermal Option		Ground Source Heat Pump Heating 3.0 COP, Cooling 5.0 COP DHW 2.8 COP	Ground Source Heat Pump Heating 3.0 COP, Cooling 5.0 COP DHW 2.8 COP
Ventilation	Energy Recovery Ventilator Lifebreath 170 ERVD SRE 0.82 / LRE 0.63 / 0.94 W/cfm	Energy Recovery Ventilator Lifebreath 170 ERVD SRE 0.82 / LRE 0.63 / 0.94 W/cfm	Energy Recovery Ventilator Zehnder Q350 ComfortAir ERV SRE 0.86 / LRE 0.73 / 0.37 W/cfm
DHW	Standard Natural Gas 0.67 EF / 50 ga. tank	Condensing Natural Gas 0.90 EF / 50 ga. tank	Electric Heat Pump 3.93 EF (3.75 UEF) / 50 ga. tank COP 1.7325
Lighting & Power	100% LED	100% LED	100% LED
Thermal Bridging	6091 kBTU/year	4902 kBTU/year	468 kBTU/year

wall assemblies

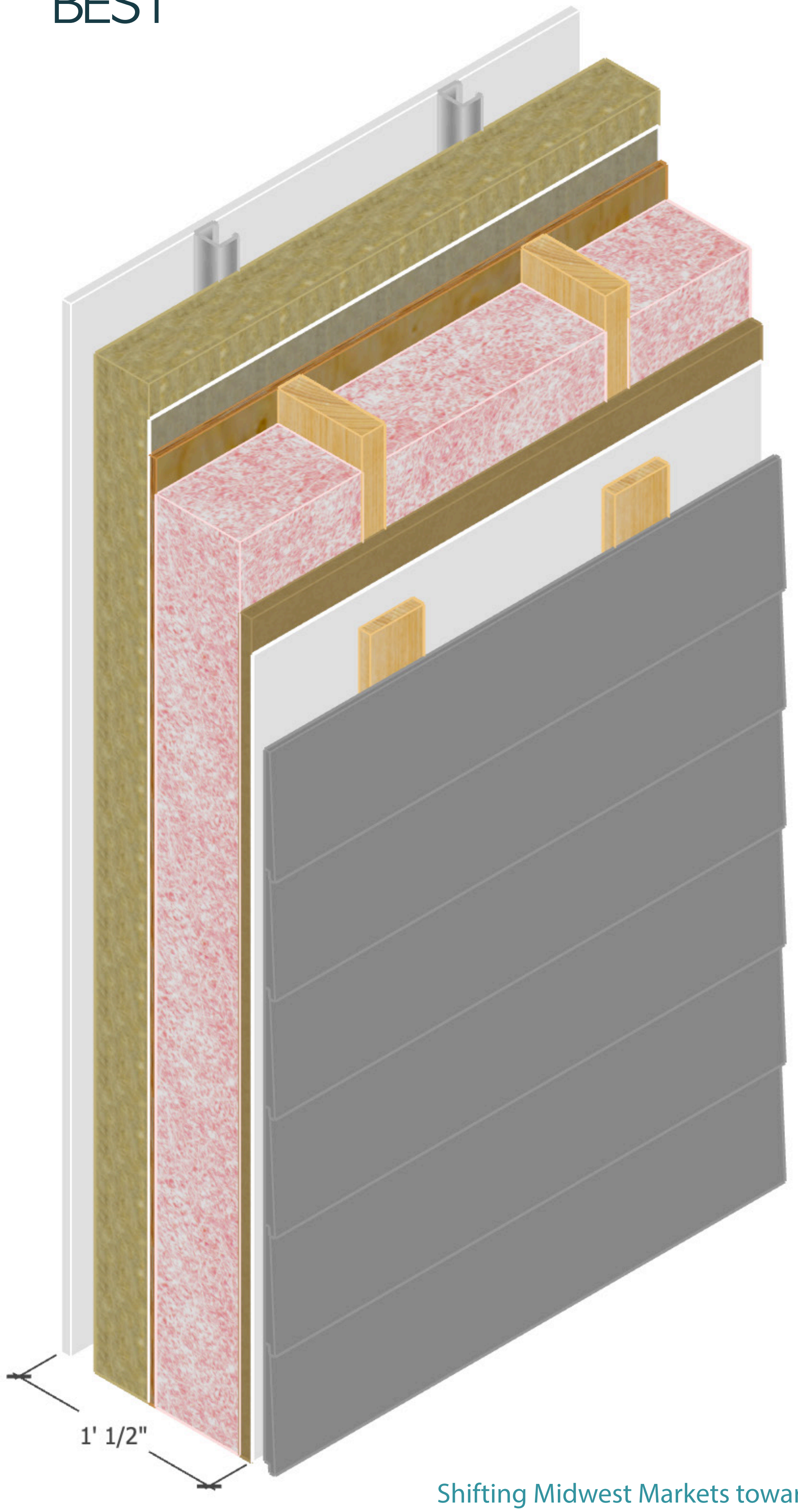
GOOD



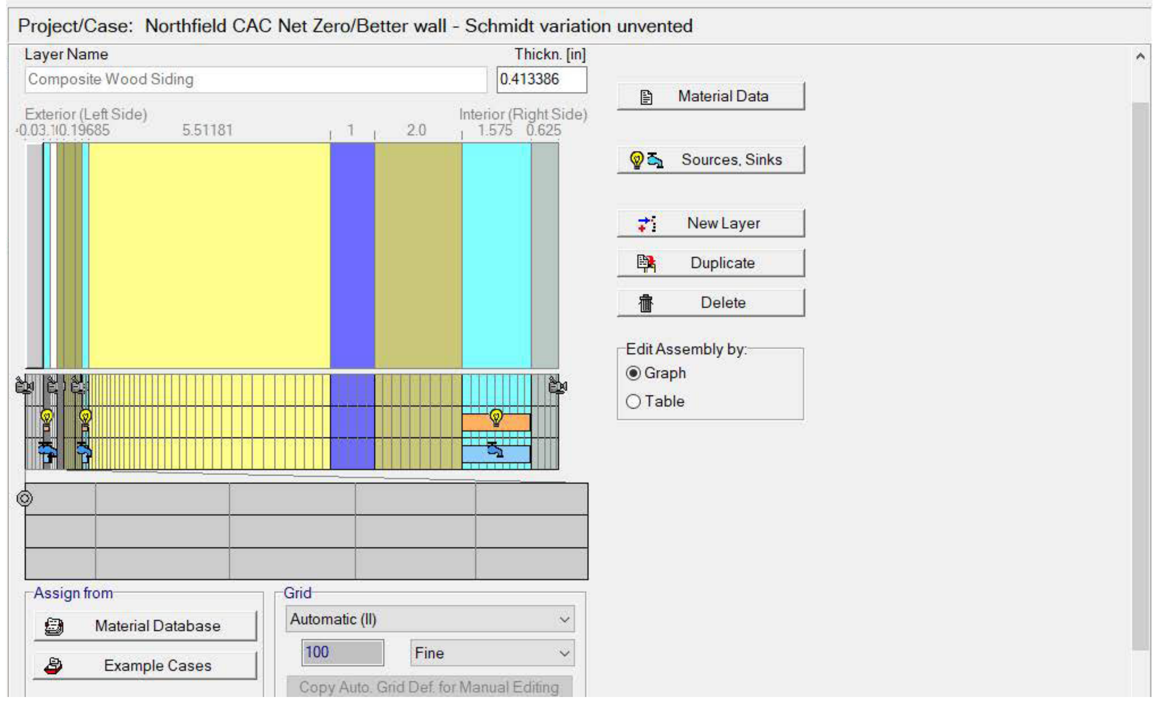
N

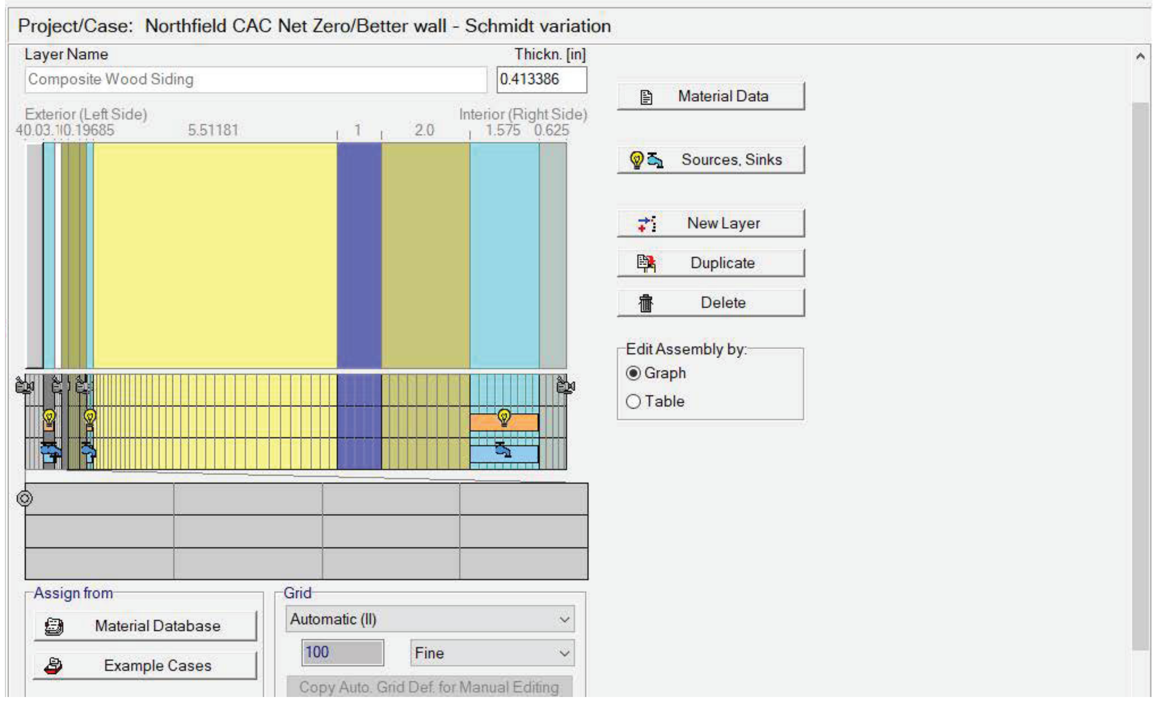
BETTER

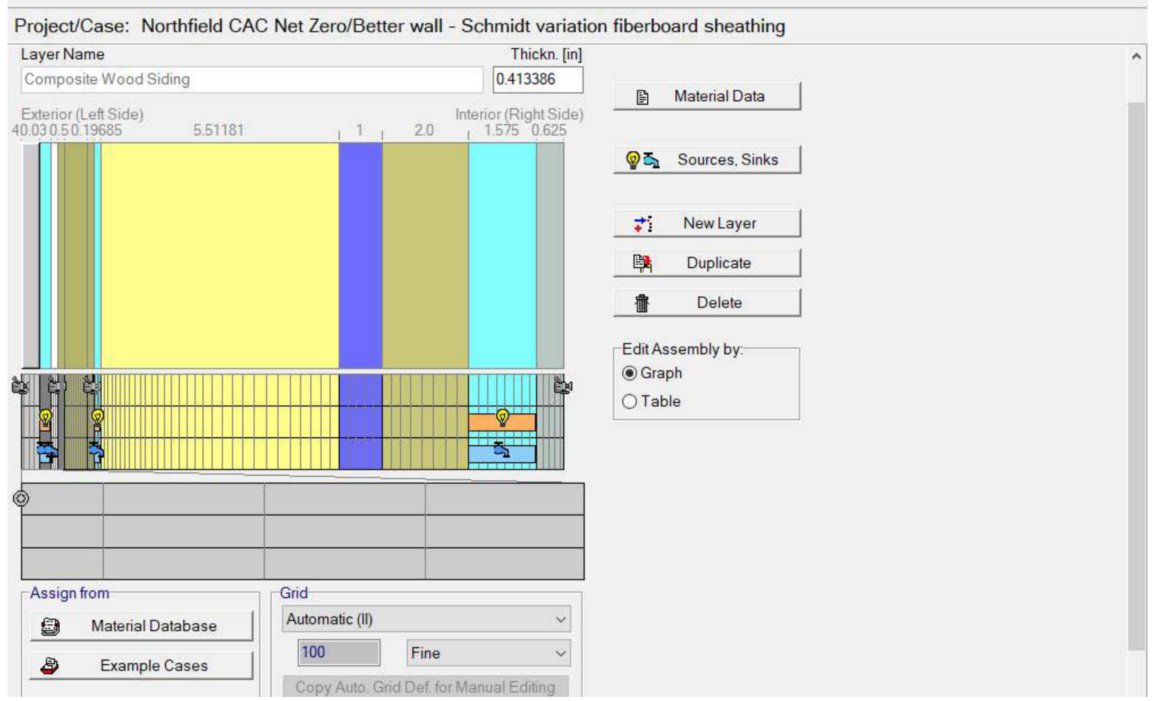
BEST

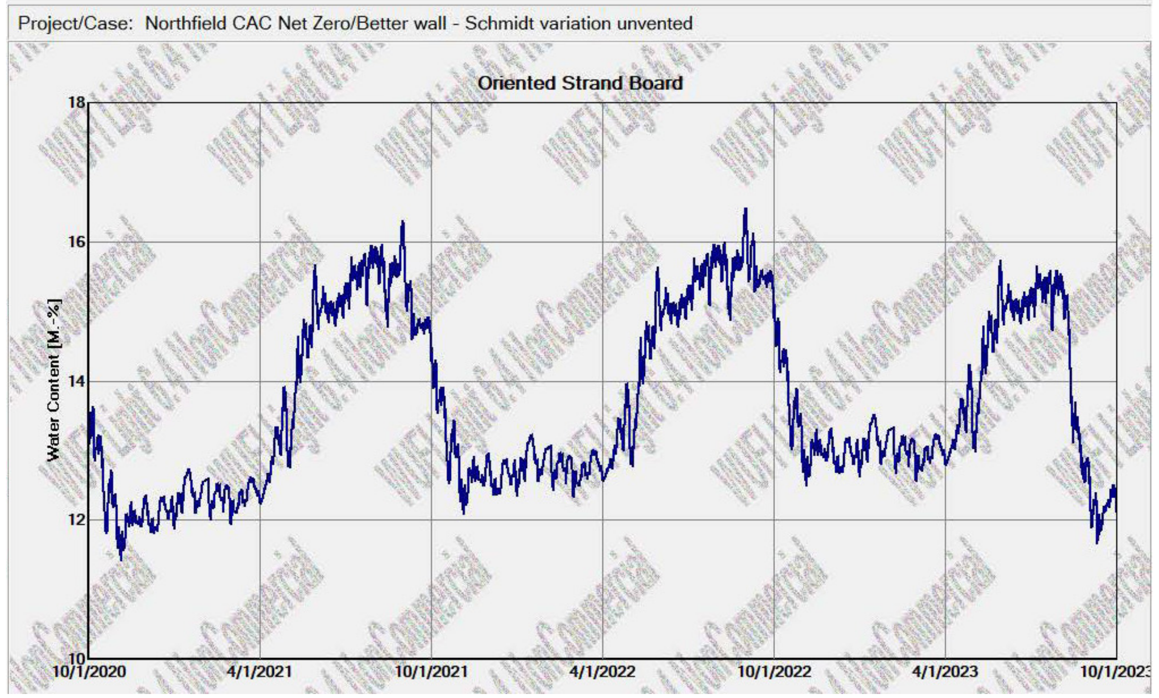


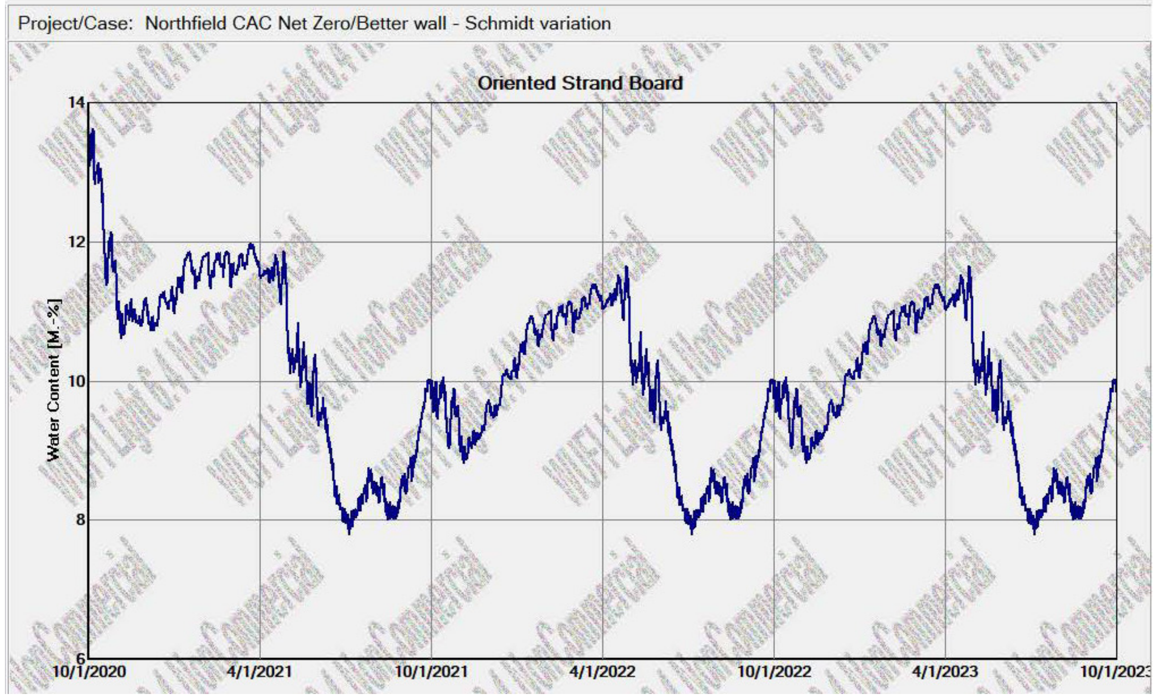
hygrothermal analysis

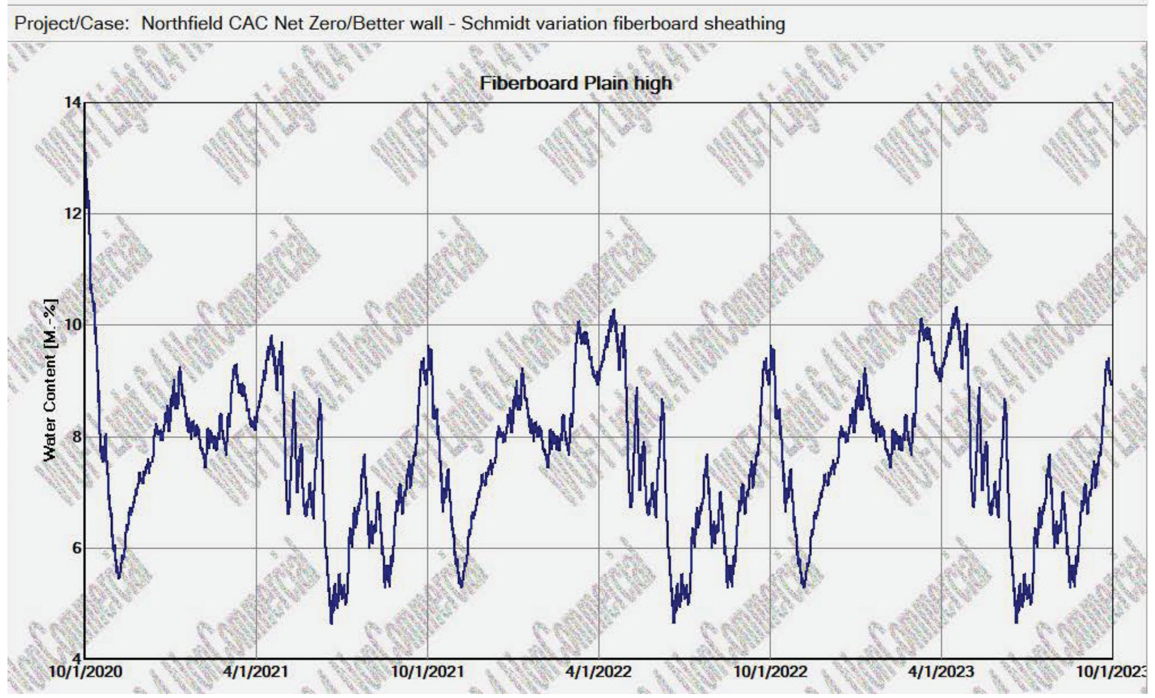




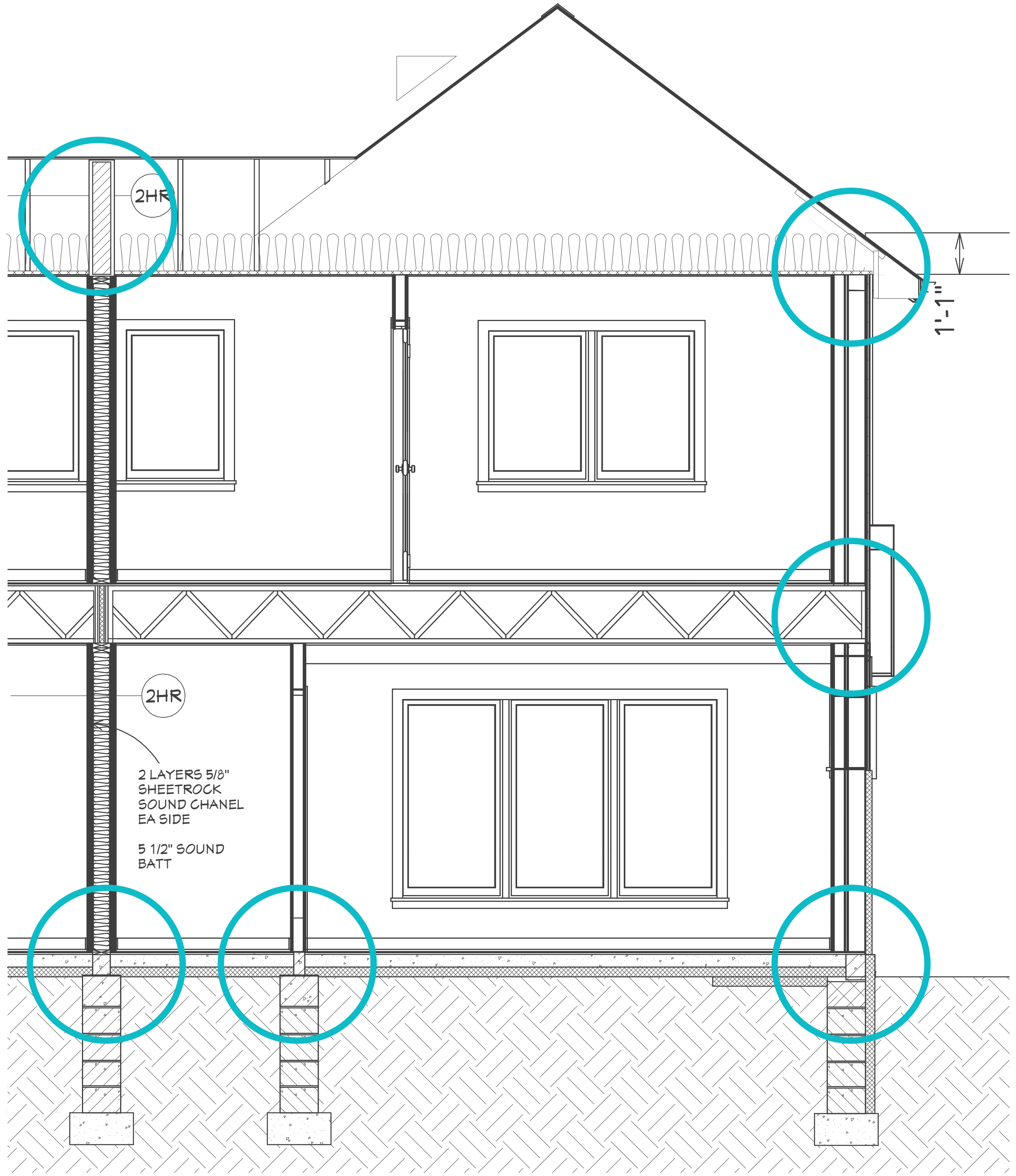








thermal bridge analysis

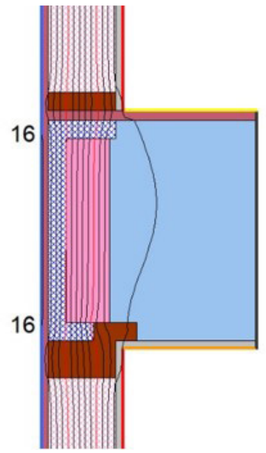


drawings copyright SWEETGRASS DESIGN STUDIO

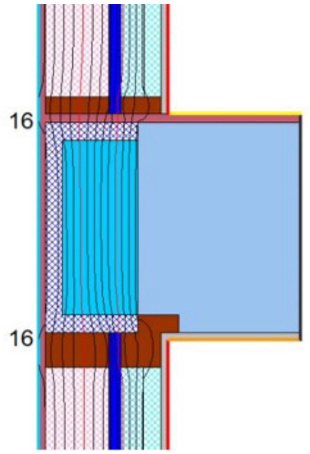
6091 KBTU/YEAR VS 468 KBTU/YEAR

RIM JOIST DETAIL

TB (>0.006) 0.018 BTU/hr-ft-F

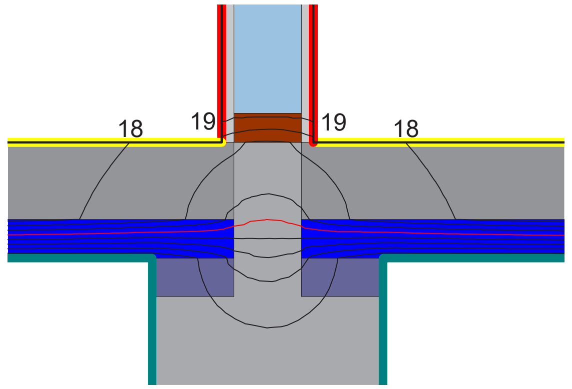


TB-FREE (<0.006) 0.003 BTU/hr-ft-F

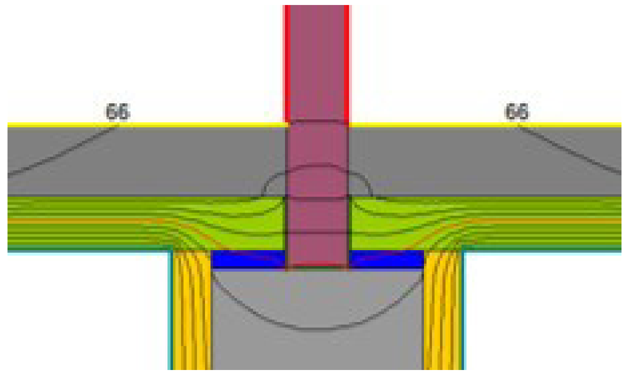


BEARING WALL DETAIL

TB 0.341 BTU/hr-ft-F

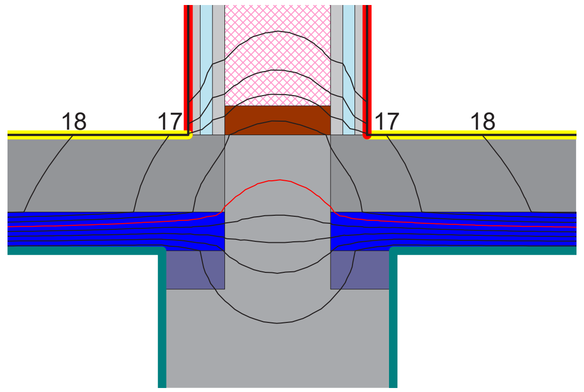


ADEQUATE 0.127 BTU/hr-ft-F

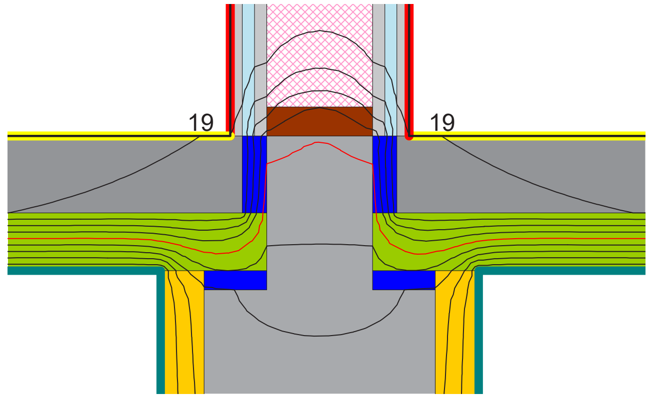


DEMISING WALL DETAIL

TB 0.380 BTU/hr-ft-F



ADEQUATE 0.062 BTU/hr-ft-F



domestic hot water

GOOD
Conventional Natural Gas

Energy Star-certified
0.67 EF / 50 ga. tank

BETTER
Condensing Natural Gas

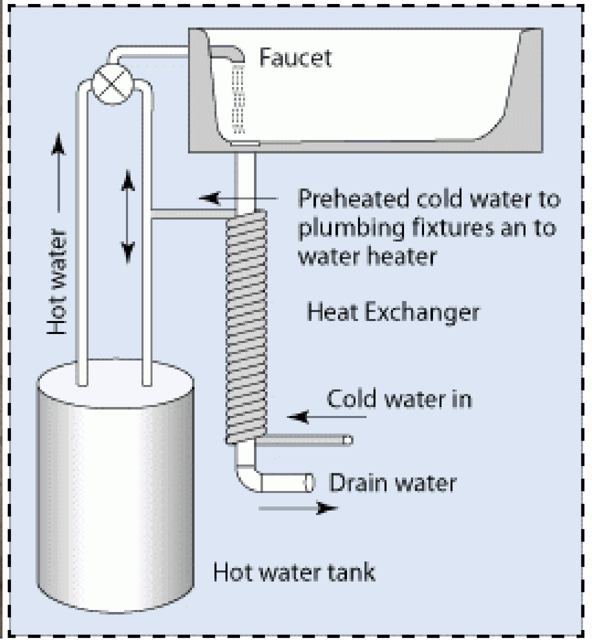
AO Smith Vertex
0.90 EF / 50 ga. tank
67Hx22Dia

BEST
Electric Heat Pump
w/ Drainwater Heat Recovery

Rheem ProTerra
3.93 EF (2.7 Effective)/ 50 ga. tank
62Hx22Dia

DRAIN WATER HEAT RECOVERY

Simple copper water coil recovers heat from shower/tub drain, increasing the temperature of water coming in to the hot water tank. This makes it easier for electric heat pump water heaters to keep up with high demand.

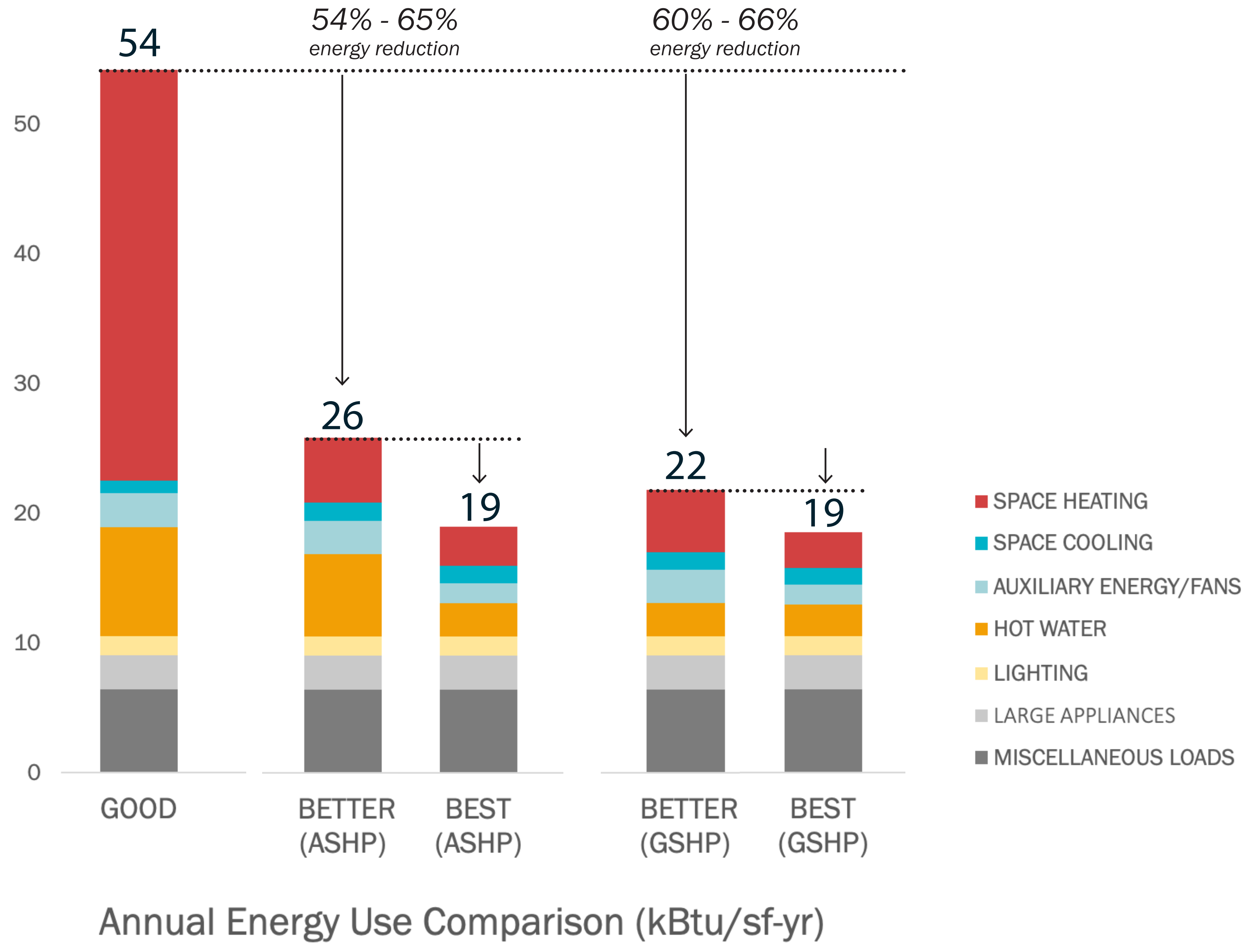


http://renewability.com/wp-content/uploads/2017/09/KB-Homes3.jpg

https://www.energy.gov/sites/prod/files/styles/borealis_photo_gallery_large_respondxl/public/drainwater_heat_recover.gif?itok=FNJ2jrO0

Images from respective manufacturers' websites

annual site energy use comparison



While moving to a Ground Source Heat Pump does make a difference in total Energy Use Intensity for the Better case, much of this is due to the switch from a natural gas condensing water heater to a heat pump water heater.

Since the loads were already so reduced, the team did not consider the small efficiency improvement offered by the GSHP over the ASHP to be worth the extra expense and complexity.

northfield optimized hybrid

	GOOD STANDARD	**BETTER** IMPROVED STANDARD	**BEST** PHIUS+ 2018
(whole wall) Wall	R16.9	"B" R39.6	R36.3
Roof	R50 (R52)	R50 (R52)	R60 (R61.5)
Slab	R10	R15	R25 --> R28
Windows	Code Baseline Uw-0.32, SHGC 0.26	Pella 350 Natural Sun Uw-0.199, SHGC 0.56	Alpen Triple Glazed Uw-0.179, SHGC 0.582
Doors	R13	R13	R13
Air Sealing	0.945 cfm/SF @50 Pa (2 ACH50)	.0708 cfm/SF @50 Pa (1.5 ACH50)	.05 cfm/SF @50 Pa (1.18 ACH50) --> .047 cfm/SF @50 Pa (1 ACH50)
Heating	90 AFUE Gas Furnace	Air to Air Heat Pump 7800 BTU/h Heating COP 3.9 @ 47F / 2.09 @ 5F	Air to Air Heat Pump 7800 BTU/h Heating COP 3.9 @ 47F / 2.09 @ 5F
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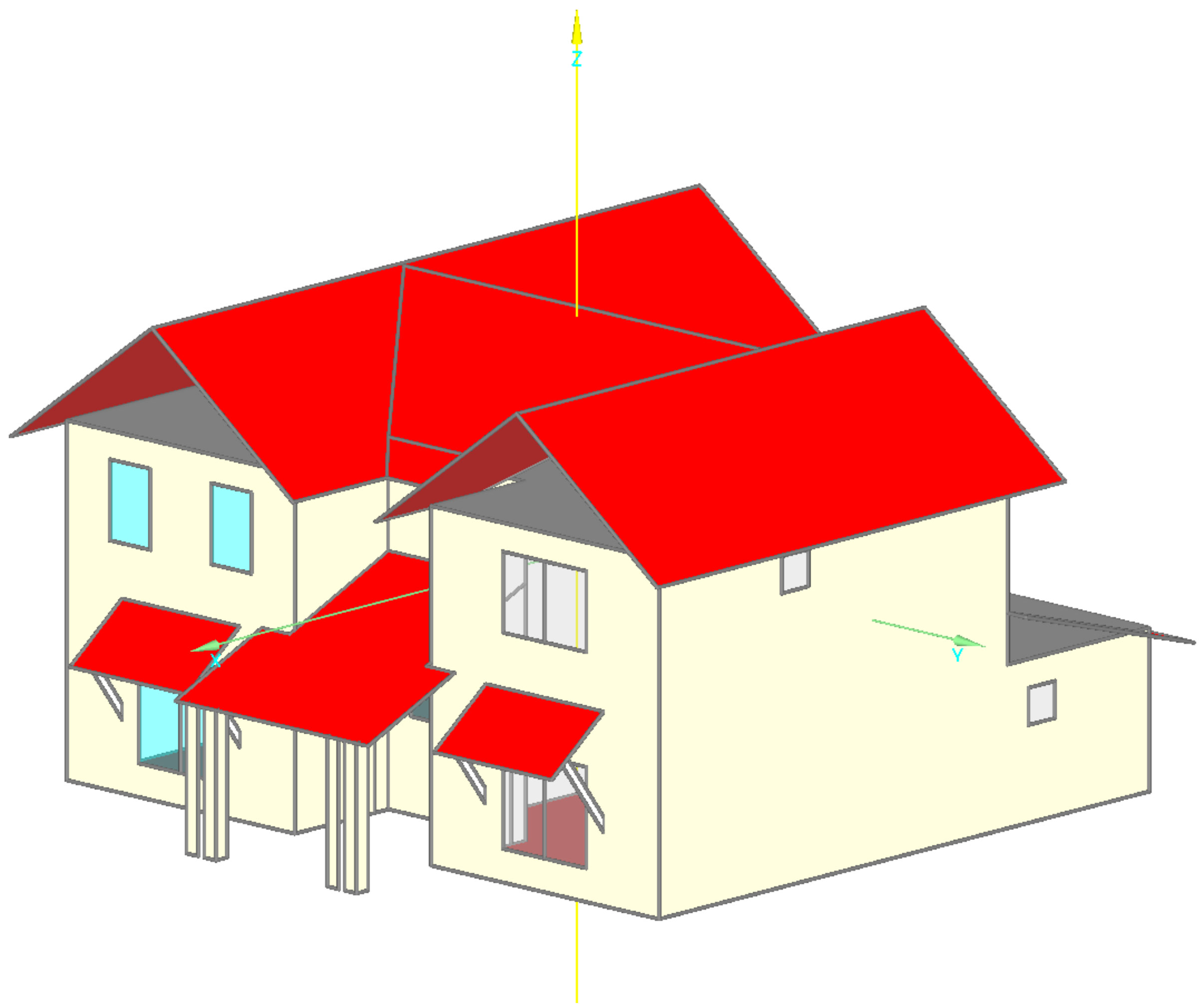
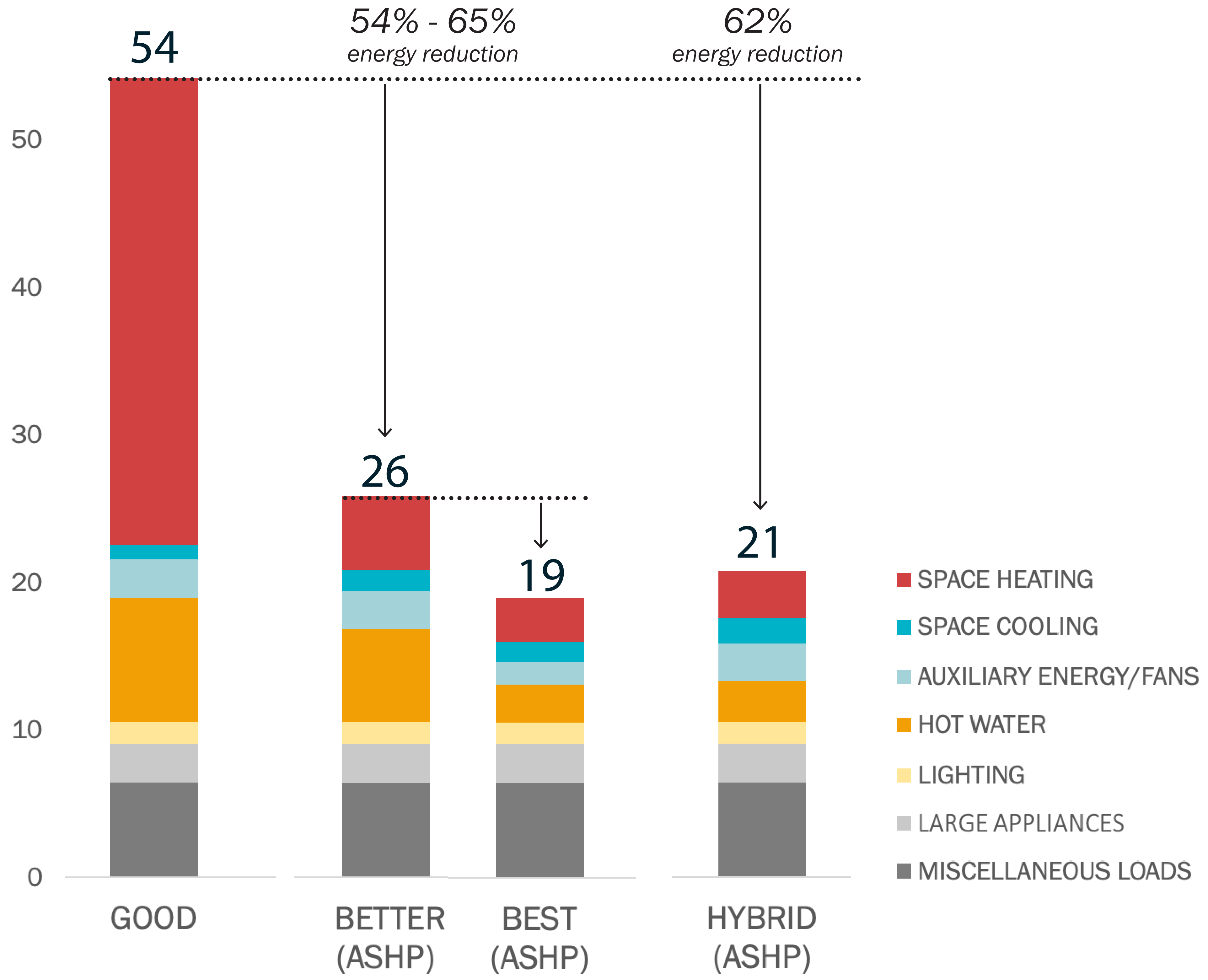
Ventilation	Energy Recovery Ventilator Lifebreath 170 ERVD SRE 0.82 / LRE 0.63 / 0.94 W/cfm	Energy Recovery Ventilator Lifebreath 170 ERVD SRE 0.82 / LRE 0.63 / 0.94 W/cfm	Energy Recovery Ventilator Zehnder Q350 ComfortAir ERV SRE 0.86 / LRE 0.73 / 0.37 W/cfm
DHW	Standard Natural Gas 0.67 EF / 50 ga. tank	Condensing Natural Gas 0.90 EF / 50 ga. tank	Electric Heat Pump 3.93 EF (3.75 UEF) / 50 ga. tank COP 1.7325
Lighting & Power	100% LED	100% LED	100% LED
Thermal Bridging	6091 kBTU/year	4902 kBTU/year	468 kBTU/year

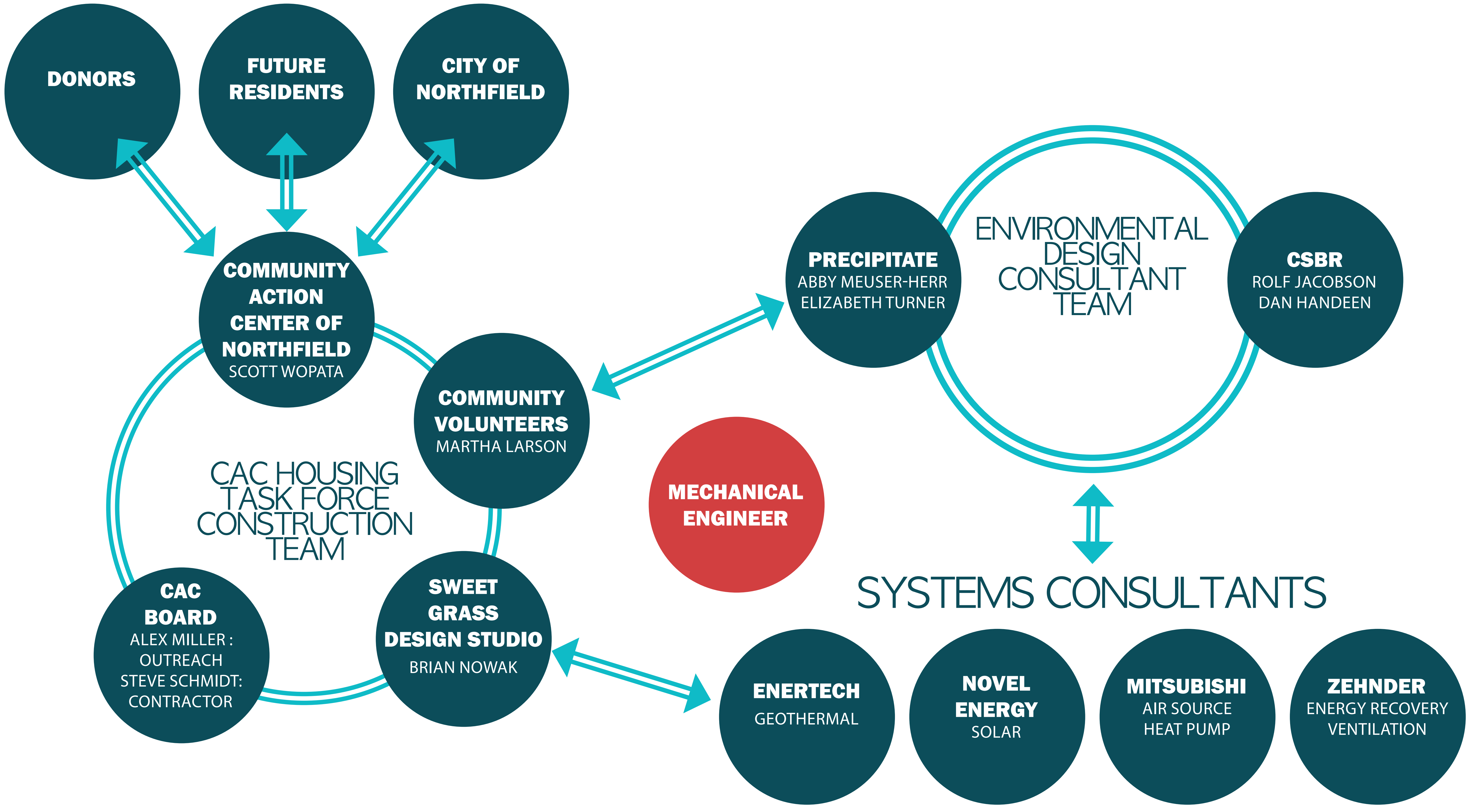
annual site energy use comparison



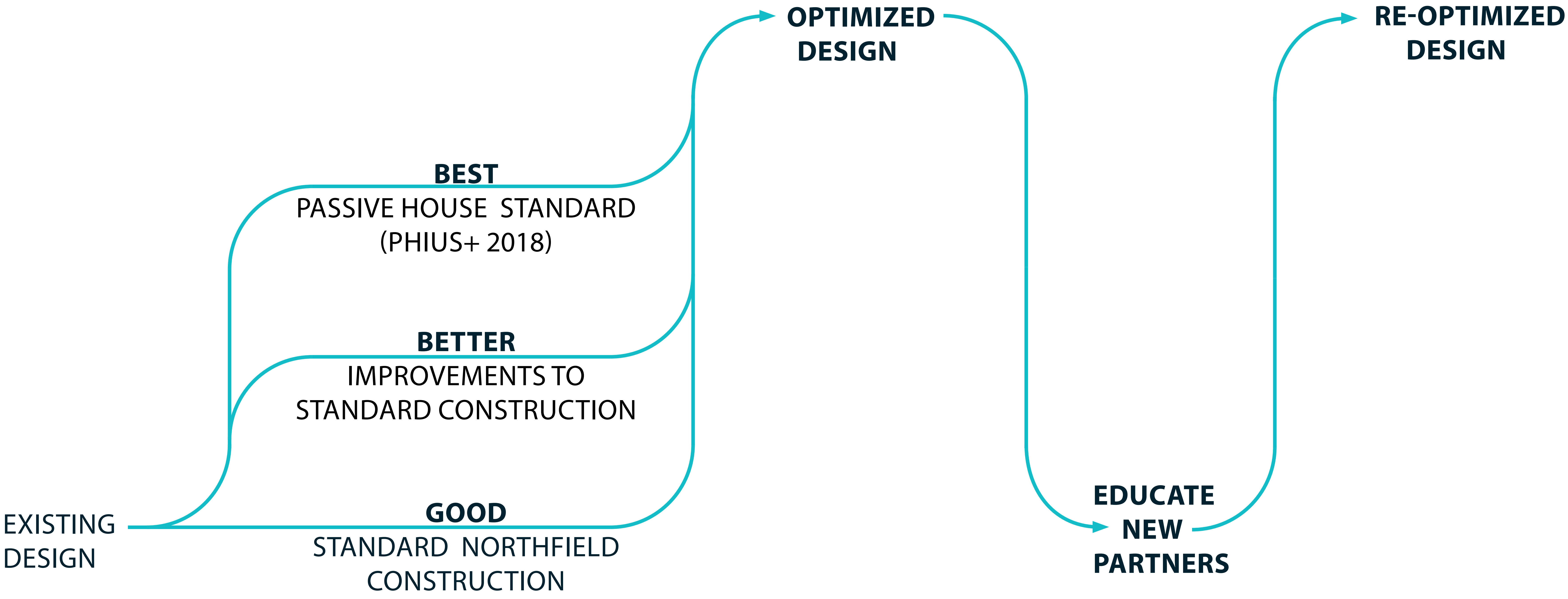


ANNUAL SITE ENERGY USE COMPARISON (kBTU/sf-yr)

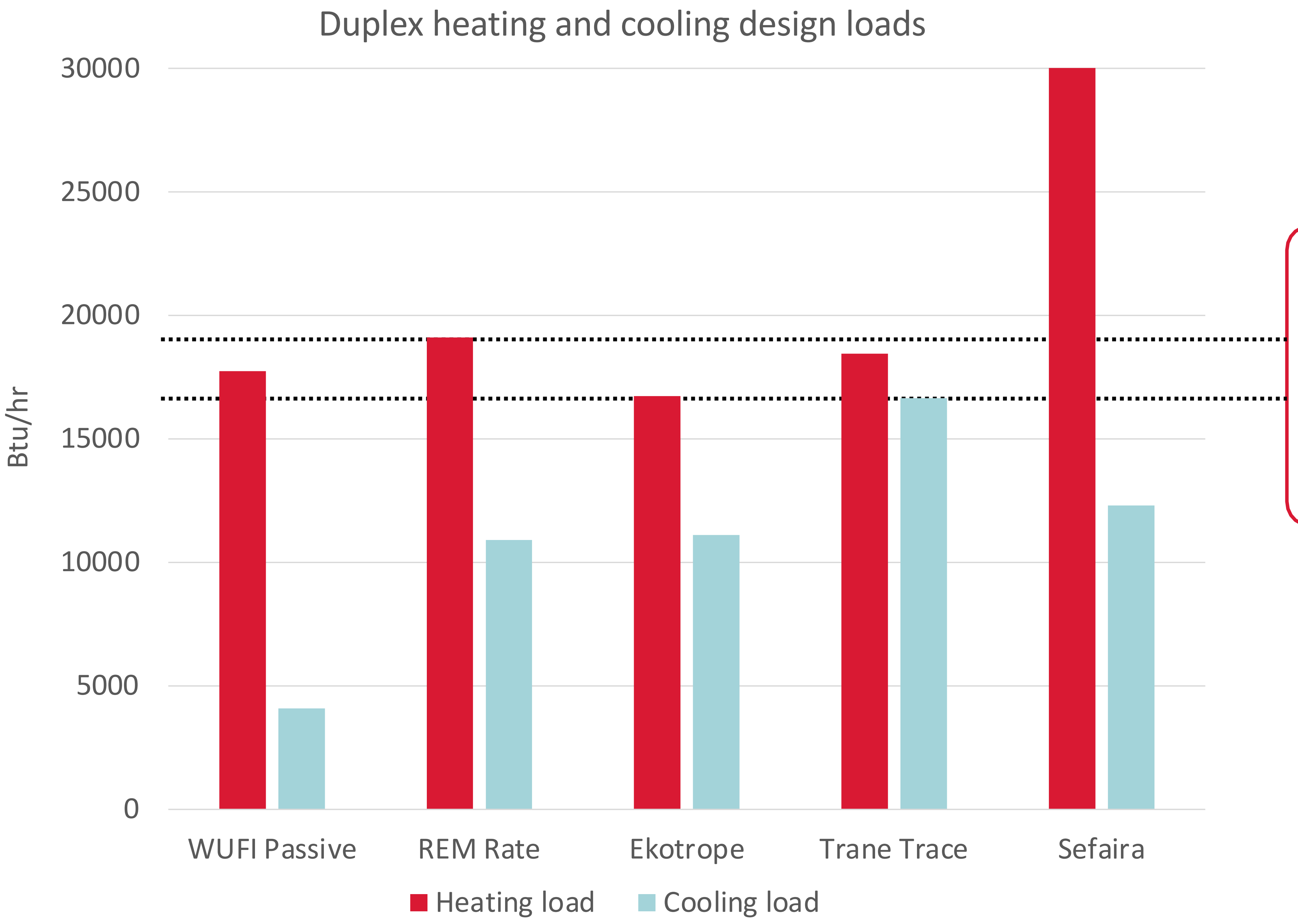
new partners



multiple iterations

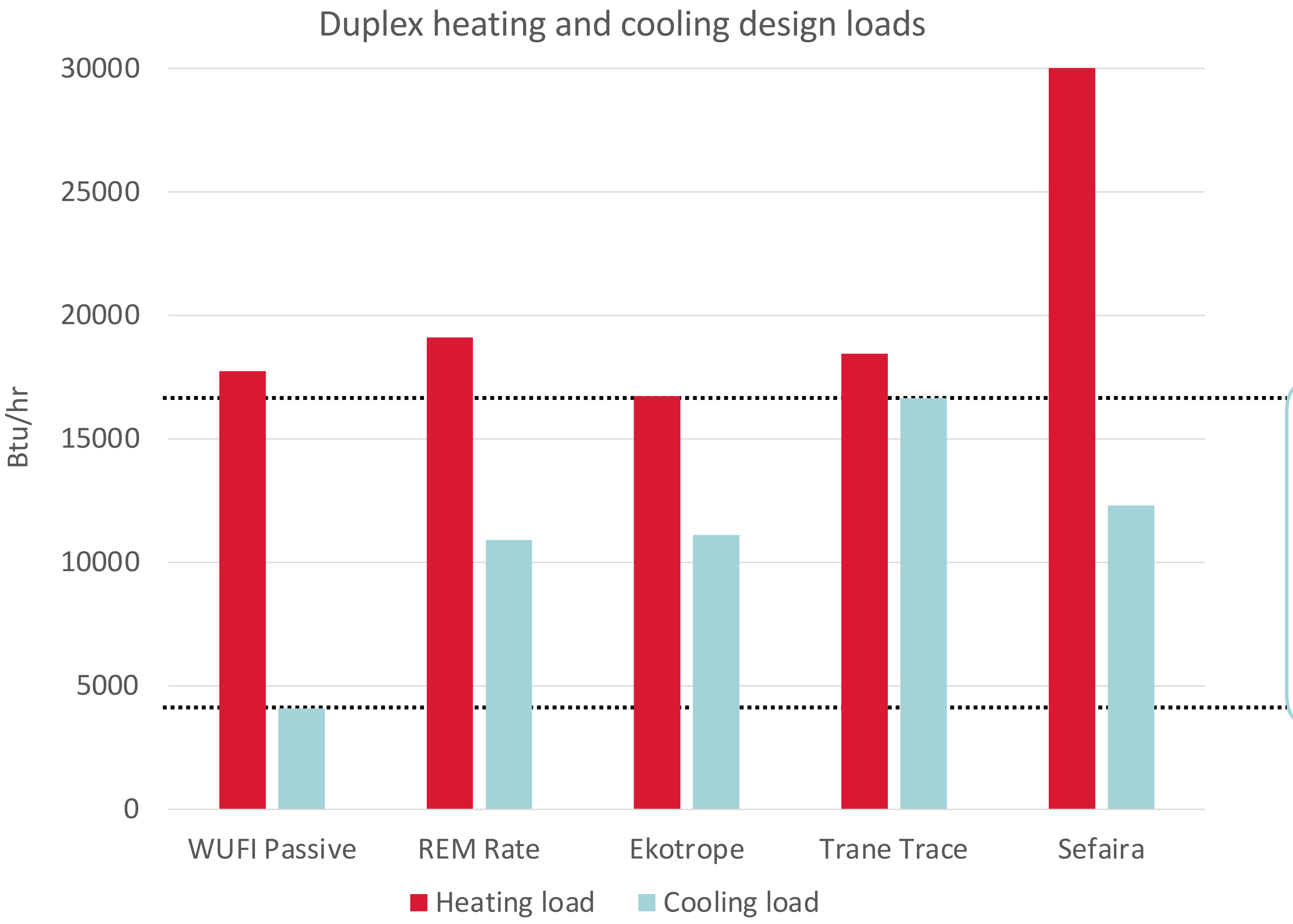


energy modeling software comparison



DESIGN HEATING LOADS
Appear consistent across software type (with one exception). This is not too surprising since design heat loads are fairly straight forward to calculate using primarily surface areas and the temperature difference between inside and outside. (Ventilation rate and infiltration are also factored in.)

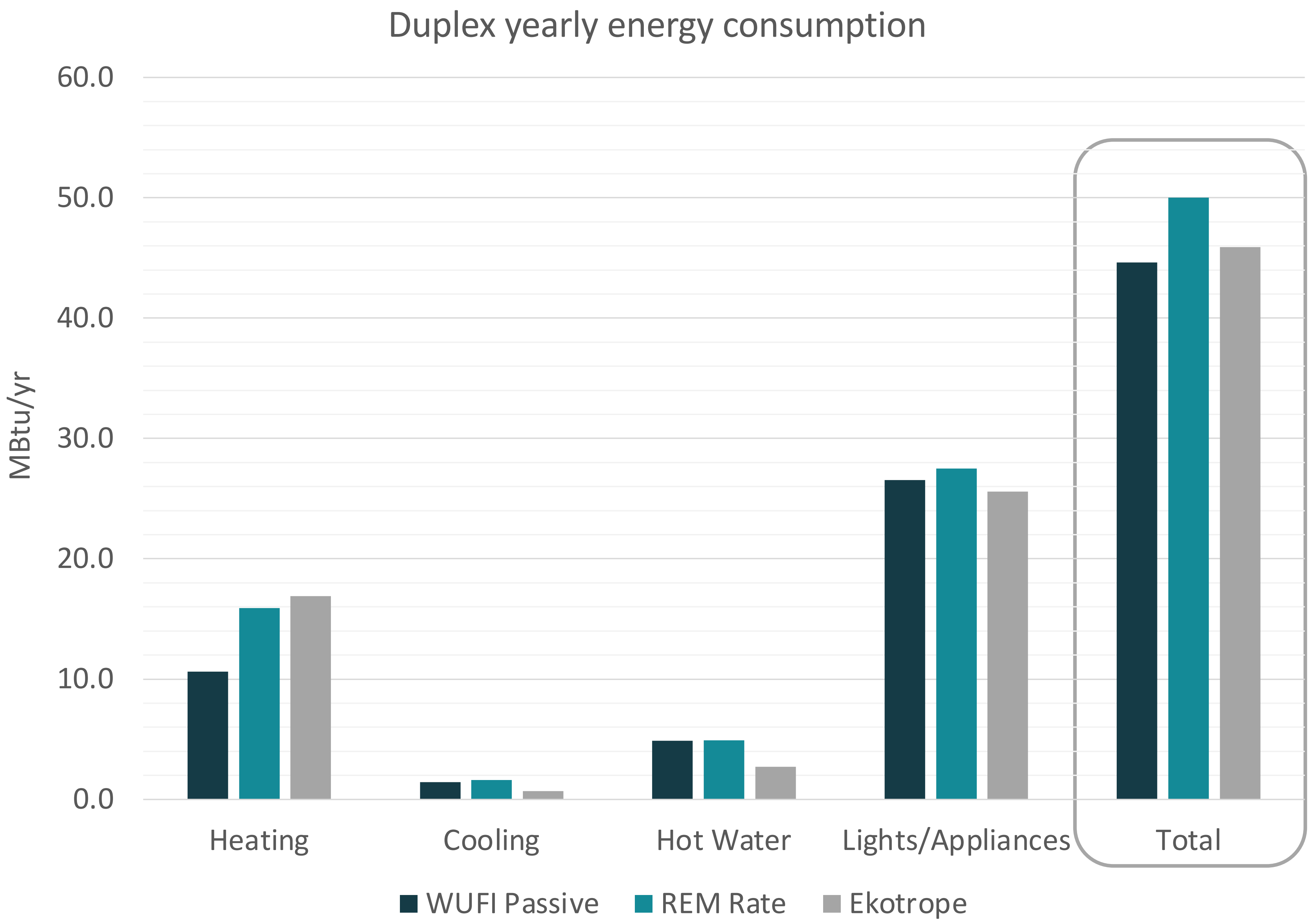
energy modeling software comparison



DESIGN COOLING LOADS

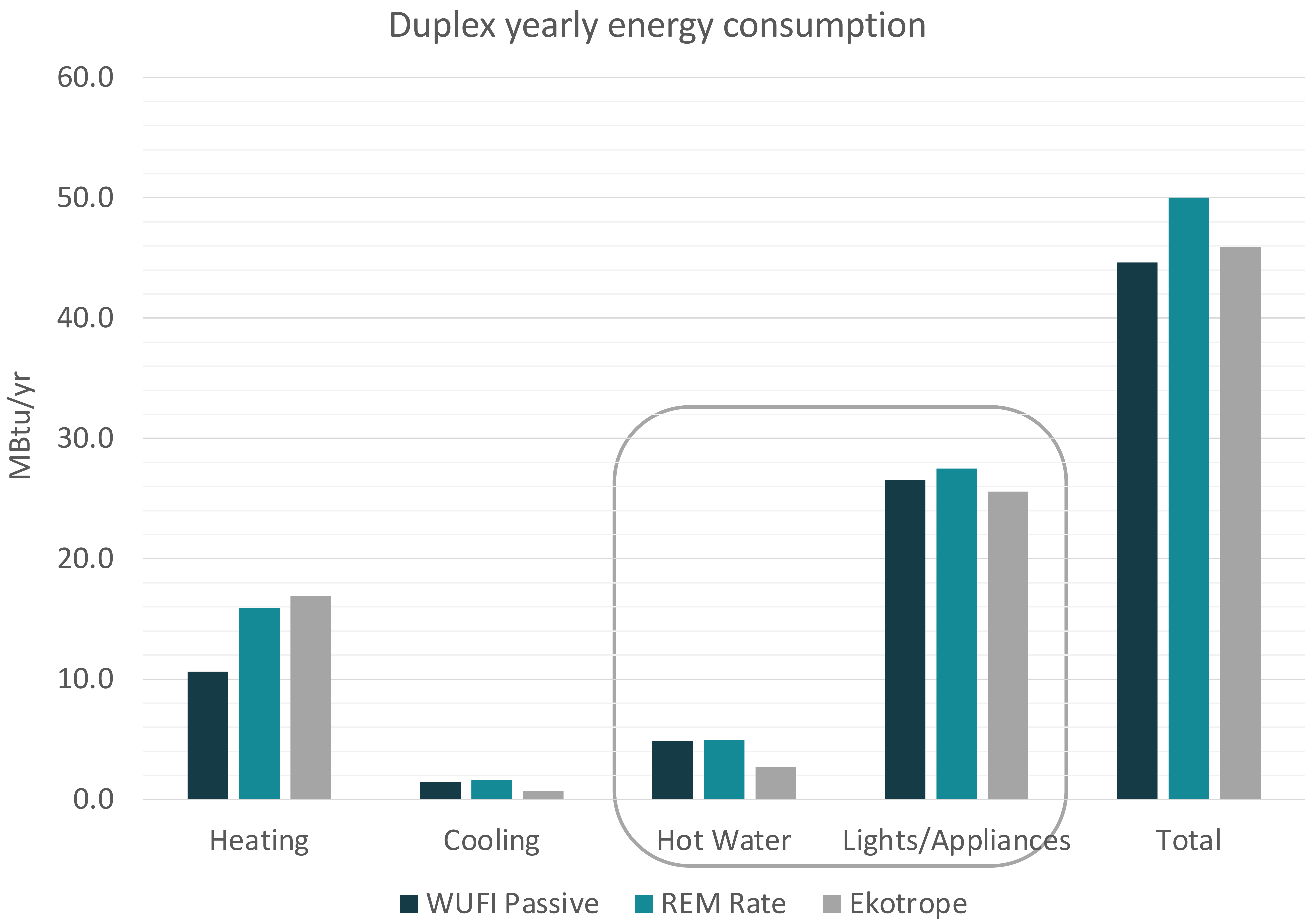
Much less consistent. Cooling loads are harder to calculate and include critical assumptions about solar heat gains, window shading, and internal heat gains, in addition to ventilation, infiltration, and surface areas X temperature difference.

energy modeling software comparison



Total estimated yearly energy consumption appears reasonably consistent. However, looking at the inconsistencies in individual energy uses, some of this may be due simply to luck.

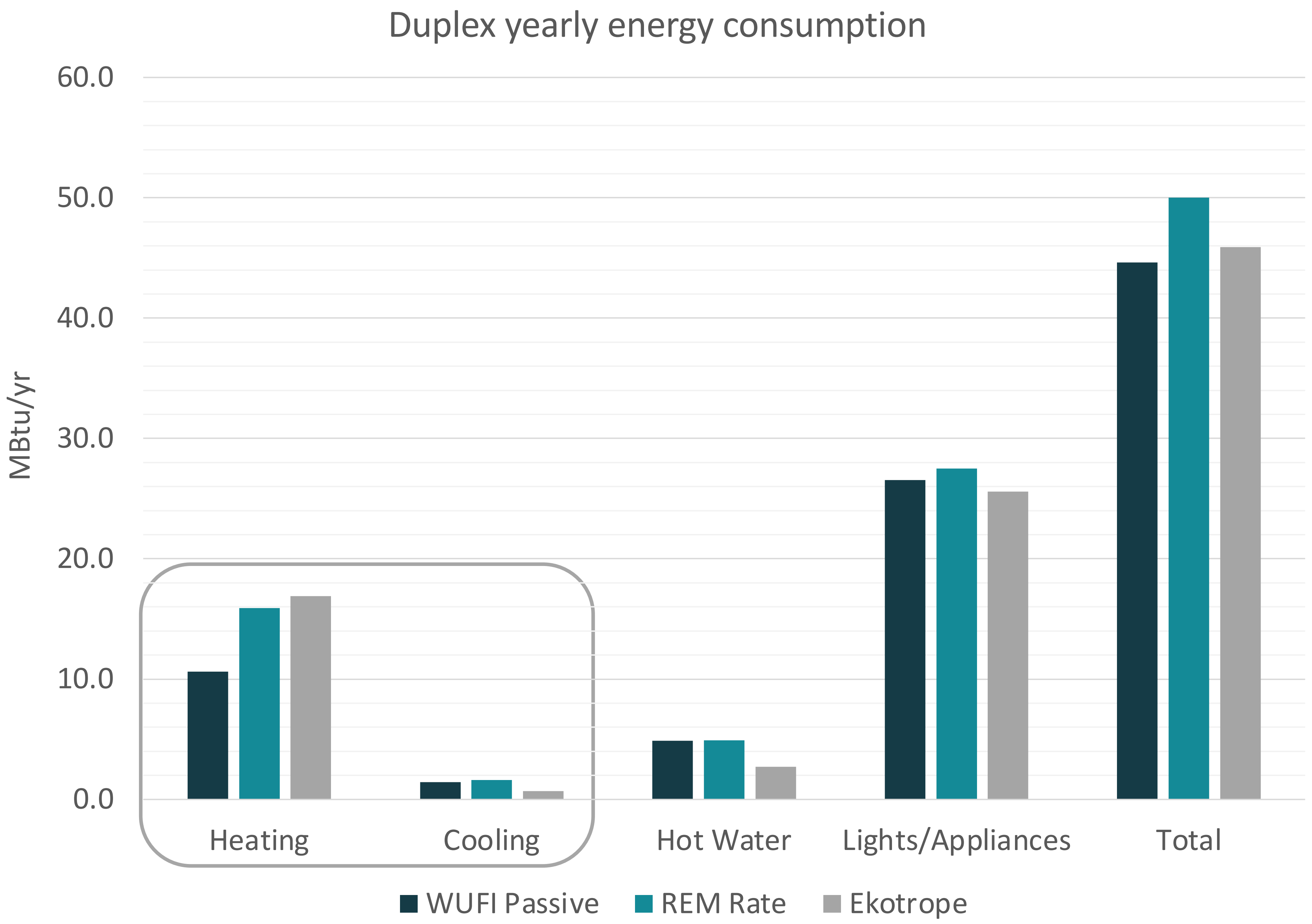
energy modeling software comparison



Lights and appliances make up a very large share of total yearly energy consumption, since heat loss/gain through the enclosure has been reduced so dramatically.

DHW energy consumption may be lower in the Ekotrope because low flow fixtures were specified, although WUFI Passive also assumes quite a small DHW consumption per person (6.6 gpd/person @140F).

energy modeling software comparison

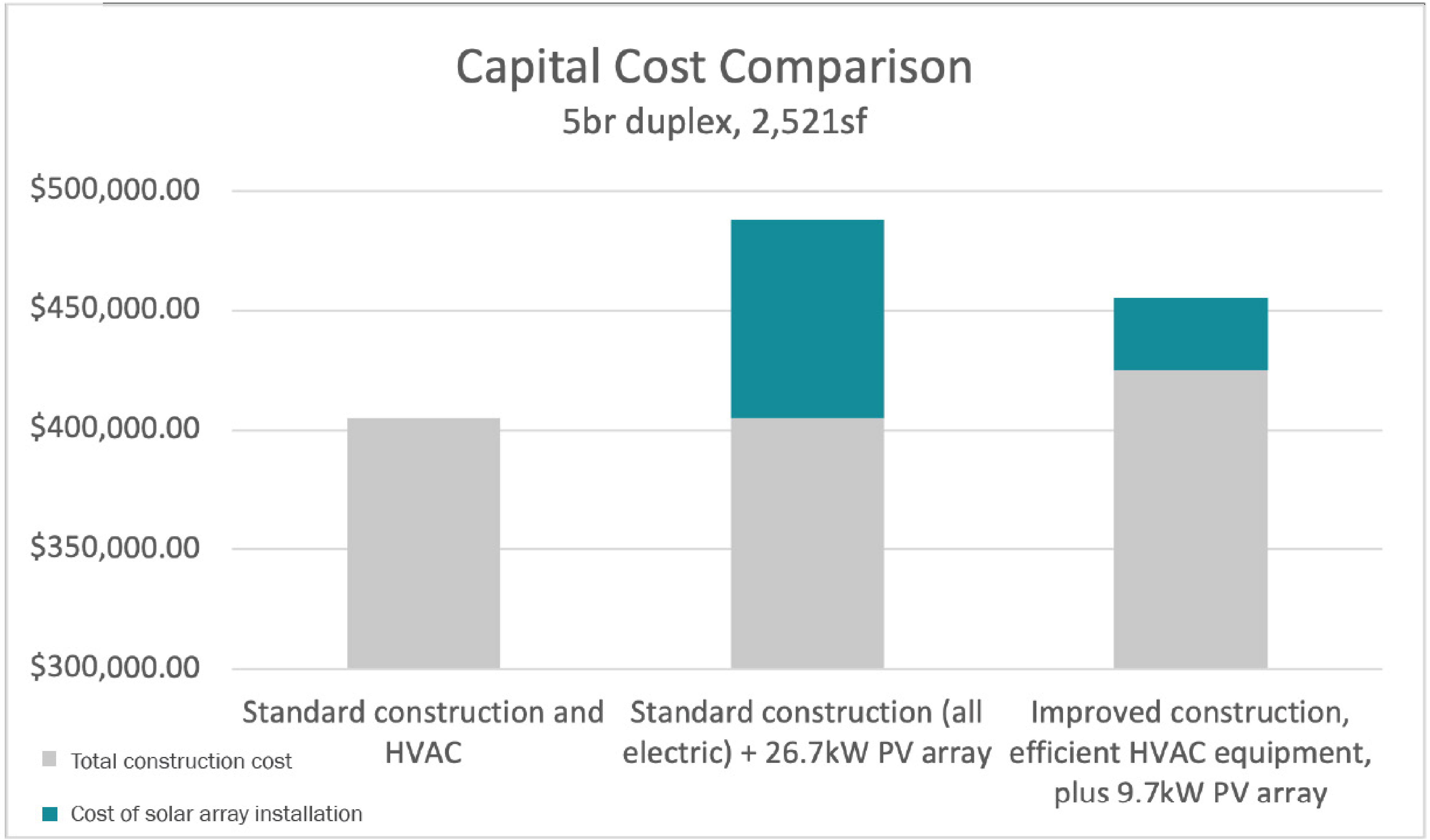


Cooling energy consumption is small relative to other items. The consistency in predicted annual energy use is surprising given the large difference in predicted peak loads.

Heating energy consumption is variable. WUFI Passive estimates 2/3 of the consumption predicted by REM Rate and Ekotrope. Energy modeling software designed for more conventional construction may tend to overestimate heating energy for super-insulated, passive homes.

construction cost comparison

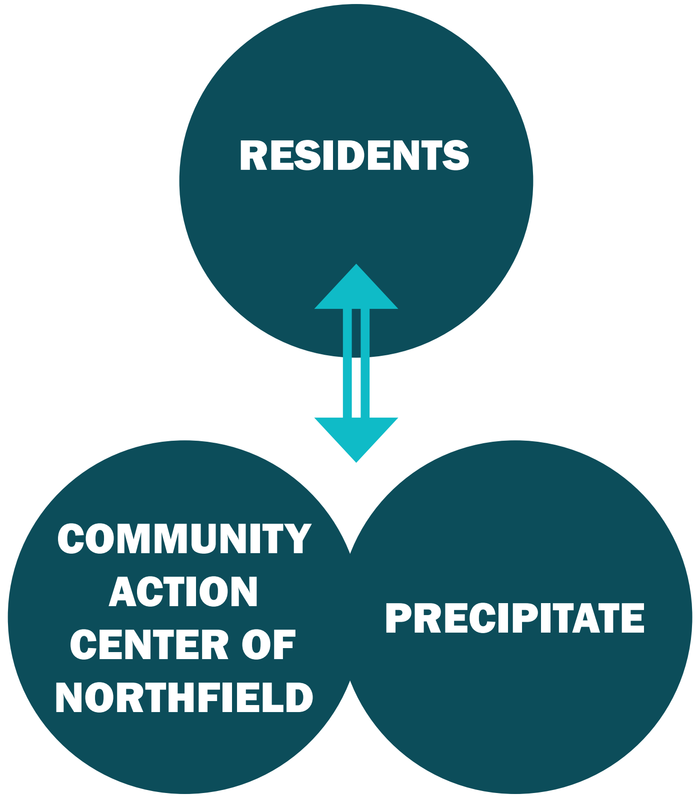
Adding PV to the standard construction adds an estimated 20.4% to the construction cost.
The optimized construction and equipment plus PV represents an estimated 12.4% increase over standard construction.



it's happening!

photo courtesy Scott Wopota, CAC of Northfield

FEEDBACK LOOP - CERTS GRANT



Proposed Presentation Title Shifting Midwest Markets toward Phius Adoption (through research and utility program development)

Commercial-scale passive building development is starting to gain traction in the Midwest. With a handful of local buildings completed, key stakeholders in the design and development community as well as utility and government entities are beginning to solidify their confidence in Passive House certification. This presentation will showcase some of the efforts and key findings in Minnesota and Illinois to further accelerate the adoption of Passive House certification for utility programs and qualified allocation plans for affordable housing, and break down market barriers. Speakers will share findings and insights on two Midwest multifamily program initiatives. The first is the development of a Passive building pathway for the ComEd New Construction Affordable Housing Utility Program. This initiative kicked off with a robust feasibility study leading to the 2021 launch of a utility program focused on accelerating Phius development in northern IL. The second is an on-going market study in Minnesota funded by CARD, looking to characterize the state of multifamily Passive House construction with a goal to outline recommendations for new utility programs targeting passive multifamily projects. Speakers will provide perspective from a research organization and utility program implementer on best practices and important considerations for constructing multifamily buildings to the Phius standard, including aligning the requirements of the standard with utility program needs, support of local development practices, and finding and training design teams and contractors with the knowledge and experience to meet the Phius standard requirements. We will outline the market research including over 50 stakeholder interviews between the two initiatives. We will provide results on actual vs modelled performance through a combination of bill review and in-depth monitoring initiatives. We will include cost comparisons for first-cost and operational cost between conventional, code-compliant projects and Phius projects. The presentation will conclude with the speakers sharing how this standard is being integrated into an affordable new construction program to address key needs of the income eligible multifamily market. These needs include improved long-term affordability through decreased energy consumption and better ventilation, and improved comfort and resilient building design.

Learning Objective #1 1 increased awareness of stakeholder needs when it comes to reducing barriers, encouraging development, and assisting with funding of passive multifamily buildings in the Midwest.

Learning Objective #2 Expand the understanding of energy performance comparisons between modelled and actual energy usage.

Learning Objective #3 Provide insights on cost differentials between business as usual and Phius construction in emerging markets such as the Midwest.

Learning Objective #4 Understanding of basic steps and needs for a Phius based energy efficiency program