

Passive House as a Roadmap for Low-Carbon Affordable Housing

James Moriarty
Sustainable Comfort

Michelle Tinner
Sustainable Comfort

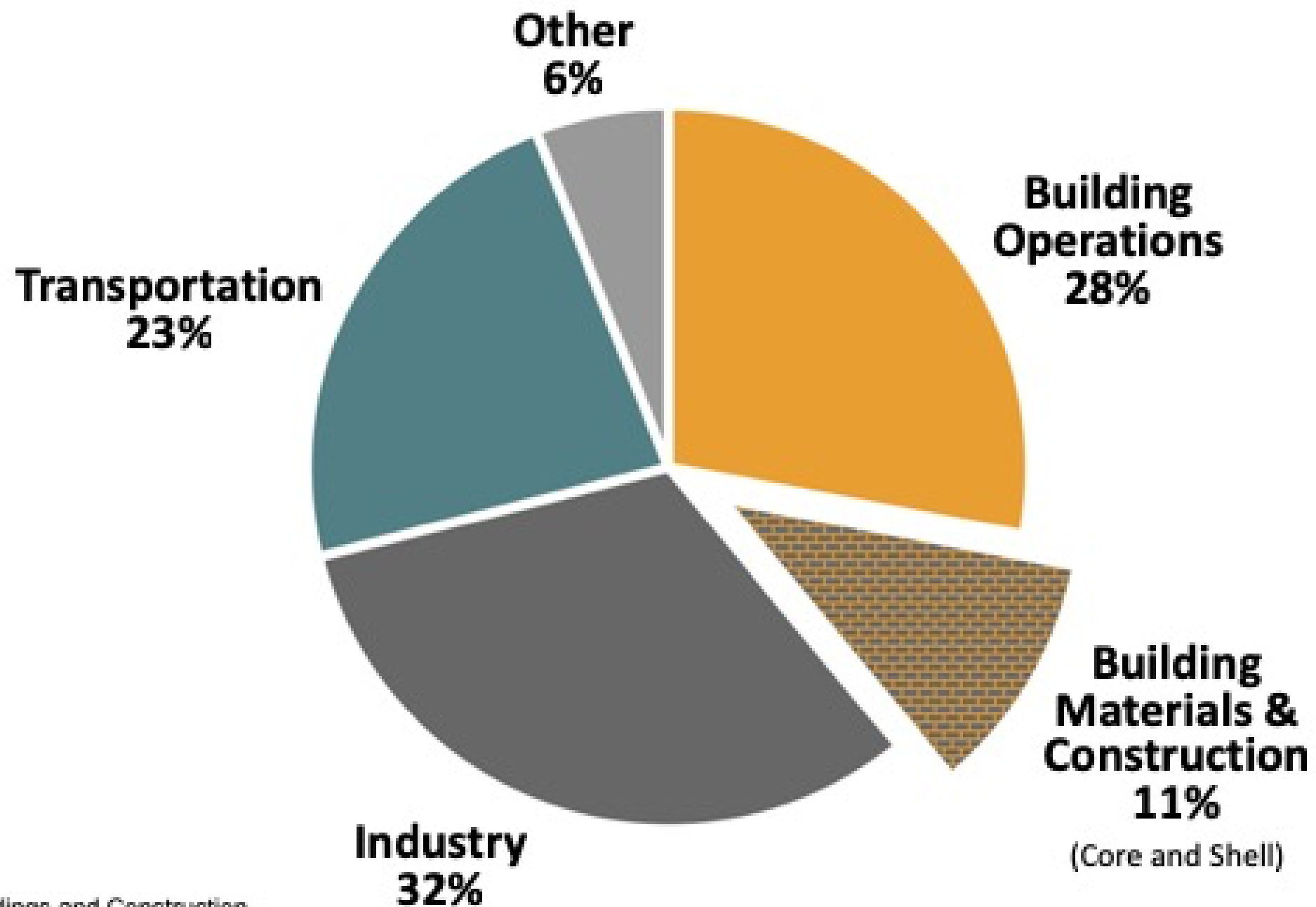


Agenda

- What is Low Carbon Housing and Electrification
- Case Study: Baird Road Apartments – Early Design
- Case Study: West Side Homes – Late Design
- Case Study: CreekView Apartments – PHIUS Certified



Global CO₂ Emissions by Sector

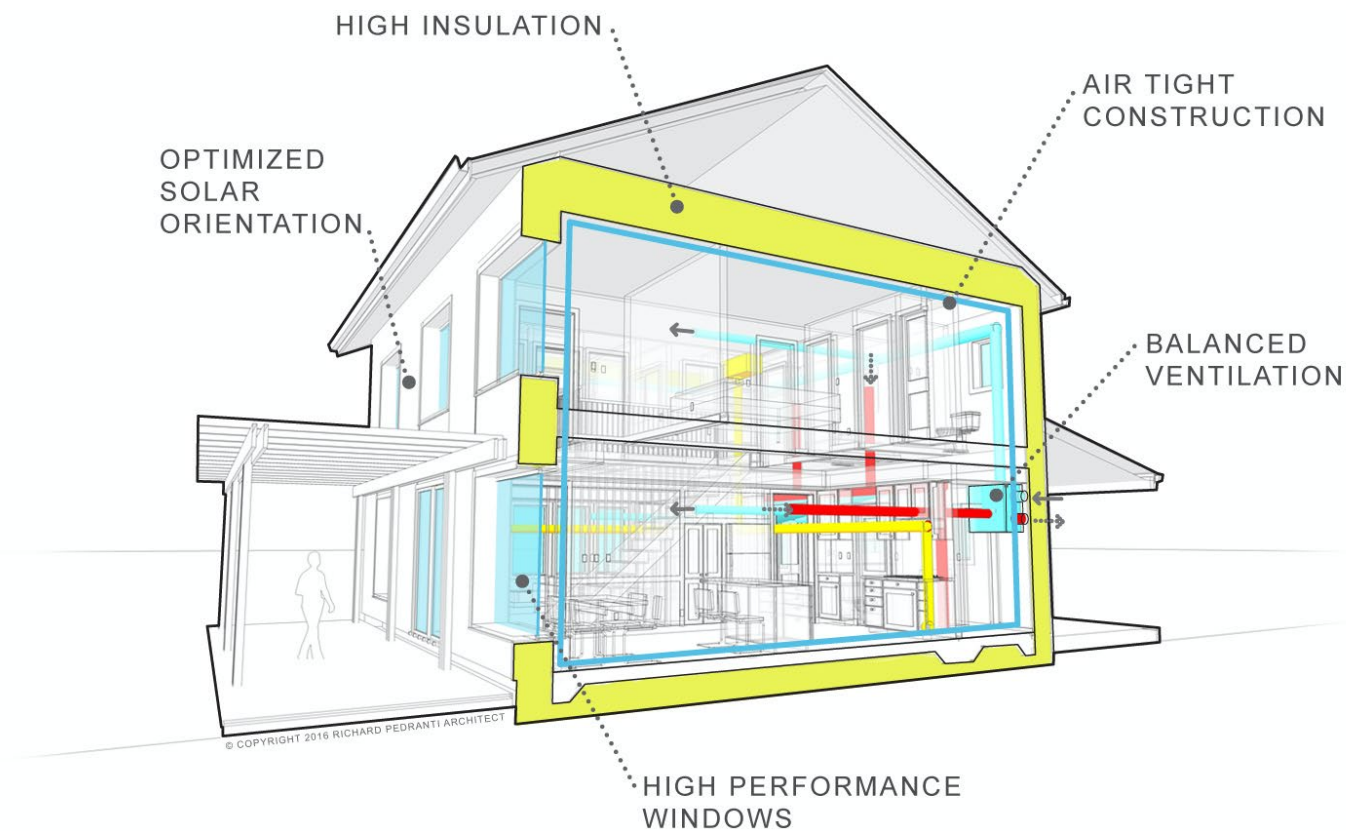


Source:
Global Alliance for Buildings and Construction.
2018 GLOBAL STATUS REPORT.



How is Low Carbon Achieved?

By combining efficient all *electric* building technologies with low-embodied carbon high performance building envelopes, renewables, energy storage, a clean grid, and deliberate utility integration.



Electrification

Moving away from fossil fuel systems to highly efficient electric systems while simultaneously making the grid more efficient and cleaner.



Why is Electrification Important?



- Carbon dioxide emissions
- Aging gas infrastructure and foreign oil
- Renewable energy integration with the proper control strategies.
- Current and rising energy demands
- Climate Leadership and Community Protection Act (CLCPA)



Benefits of Electrification

Social Benefits:

Improved air quality, mitigation of climate change.

Utility Benefits:

Reduced burden on aging gas infrastructure.

Valuable synergies with electric vehicles, demand response, and distributed generation and energy storage.

Consumer Benefits:

No combustion appliances in the home

Reduced fuel price risks

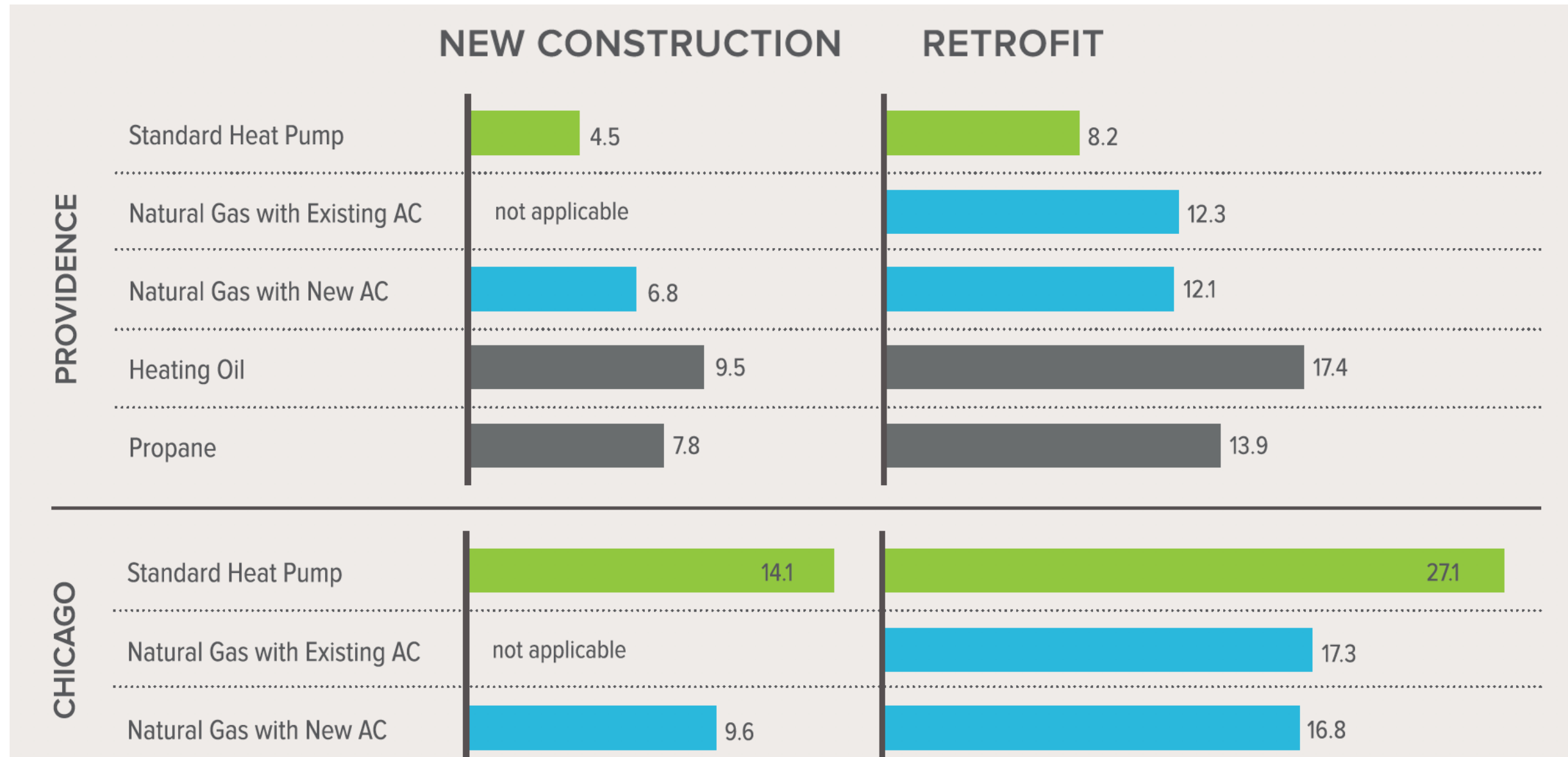
Reduce consumers' costs in some applications

Reduce demand charge risks

Less infrastructure required in new construction scenario



Annual Carbon Emissions by Scenario (1000lb CO2)

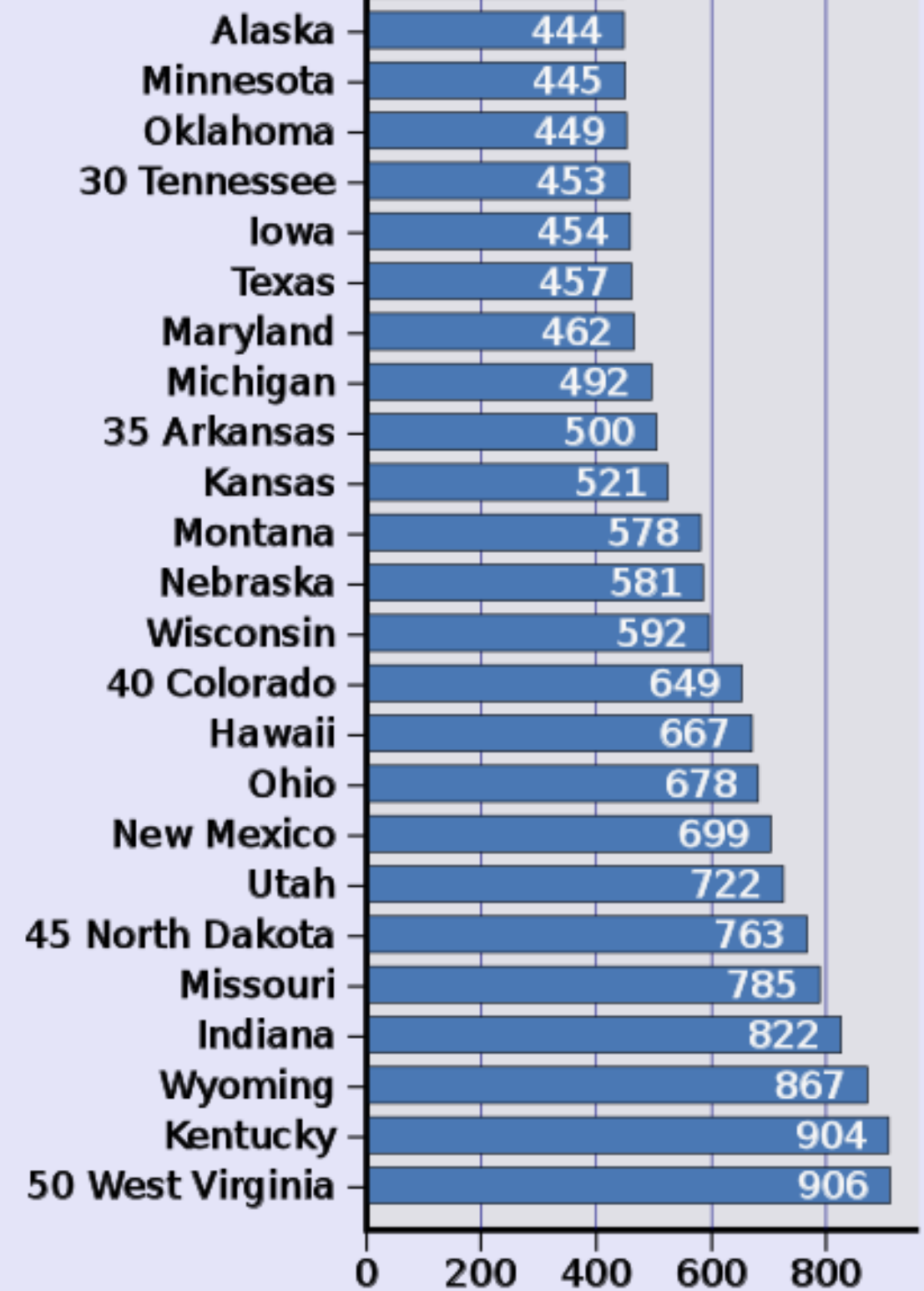
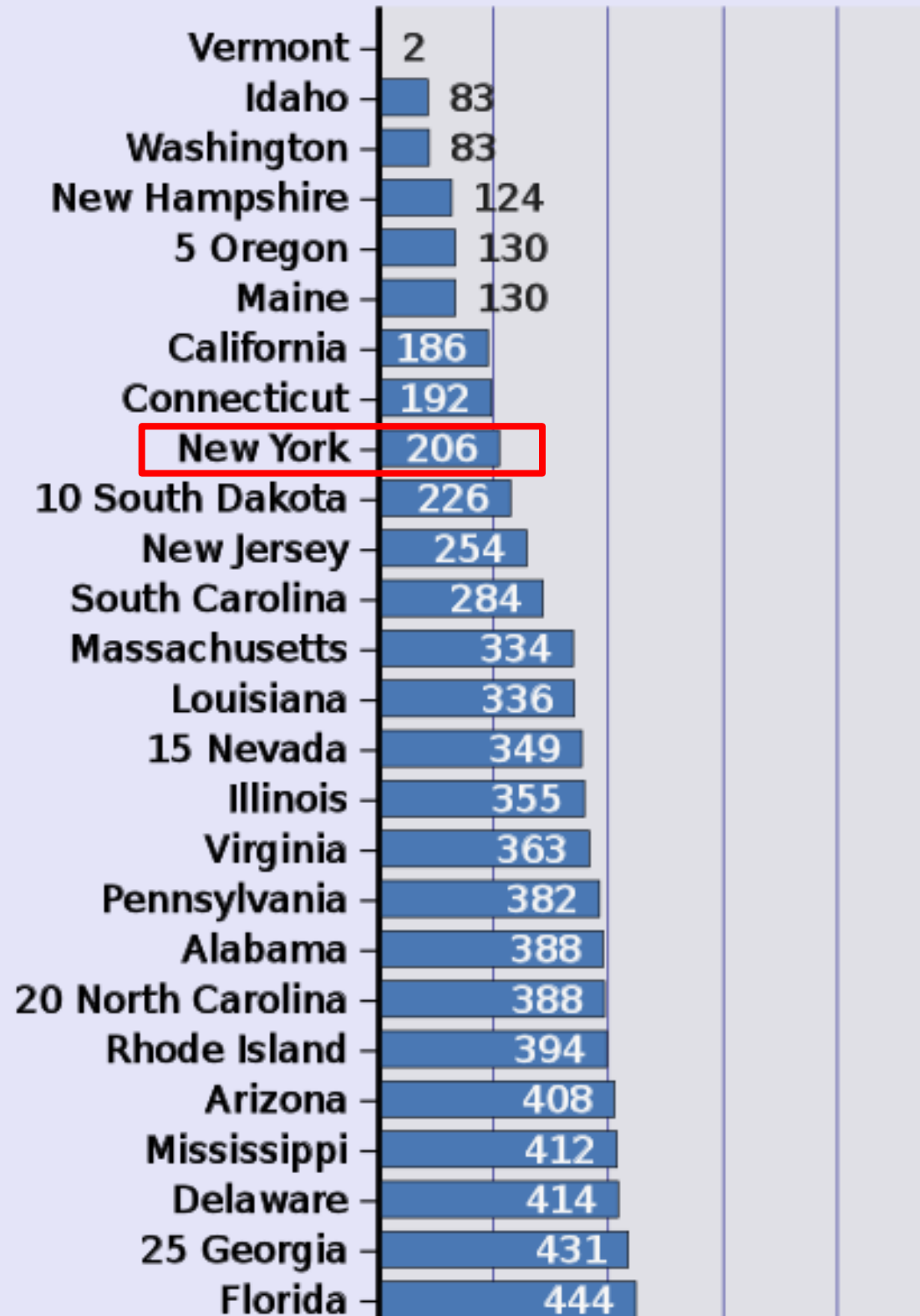


Source: Rocky Mountain Institute: The Economics of Electrifying Buildings



2016 Carbon Intensity of Electricity

Co2 Emissions (gm/kWh) by state



Source: U.S. Energy Information Administration
2016 State CO2 Emissions from Electricity Generation
2016 Electricity Generation from Electricity Data Browser

Affordable Passive House Projects

Baird Road Apartments, Perinton, NY

Schematic Design Phase

Waiting on HCR Funding Award

West Side Homes – Buffalo, NY

Funded LIHTC 9% Round 2020

In Pre-Certification Phase

Creekview Apartments – Canandaigua, NY

First Upstate NY PHIUS project funded through HCR. Phase 2 Concept in Design

Baird Road Apartments
Perinton, NY



West Side Homes
Buffalo, NY



Creekview Apartments
Canandaigua, NY





Baird Road Apartments, Perinton, NY

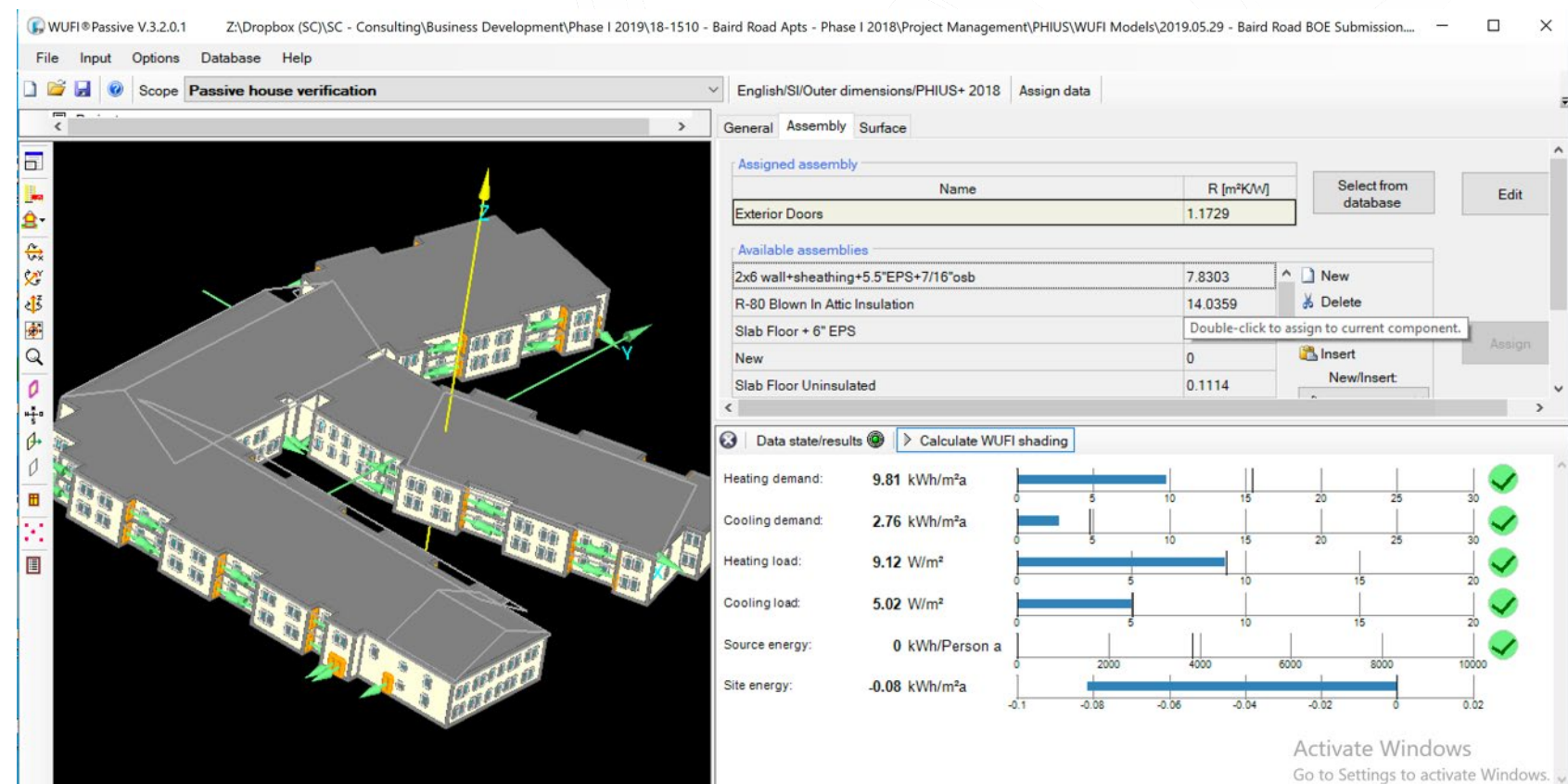
Owner: PathStone | Design Team Lead: Sustainable Comfort, Inc.



Passive House Modeling

Modeling Benefits

- Utility Cost Comparisons
- Insulation Optimization
- PHIUS+ Certification
- Early Stage Feasibility Study



Baird Road

Low Carbon Technologies

- Heat Pump Hot Water Heating
Shared among 4 apartments
- Air Source Heat Pumps
1 per apartment
- Energy Recovery Ventilation
Shared among 2 apartments

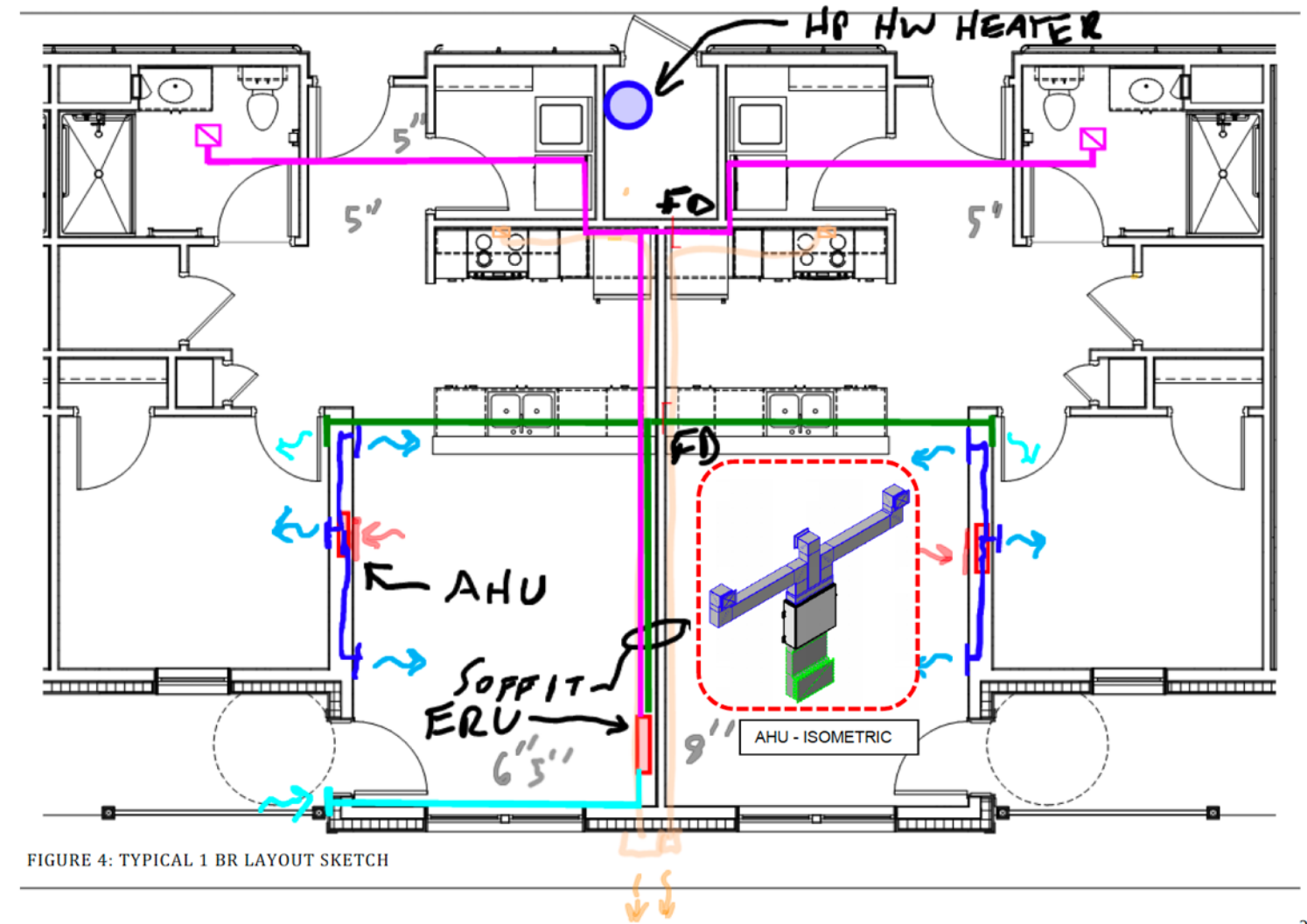


FIGURE 4: TYPICAL 1 BR LAYOUT SKETCH

Baird Road

High Performance Systems

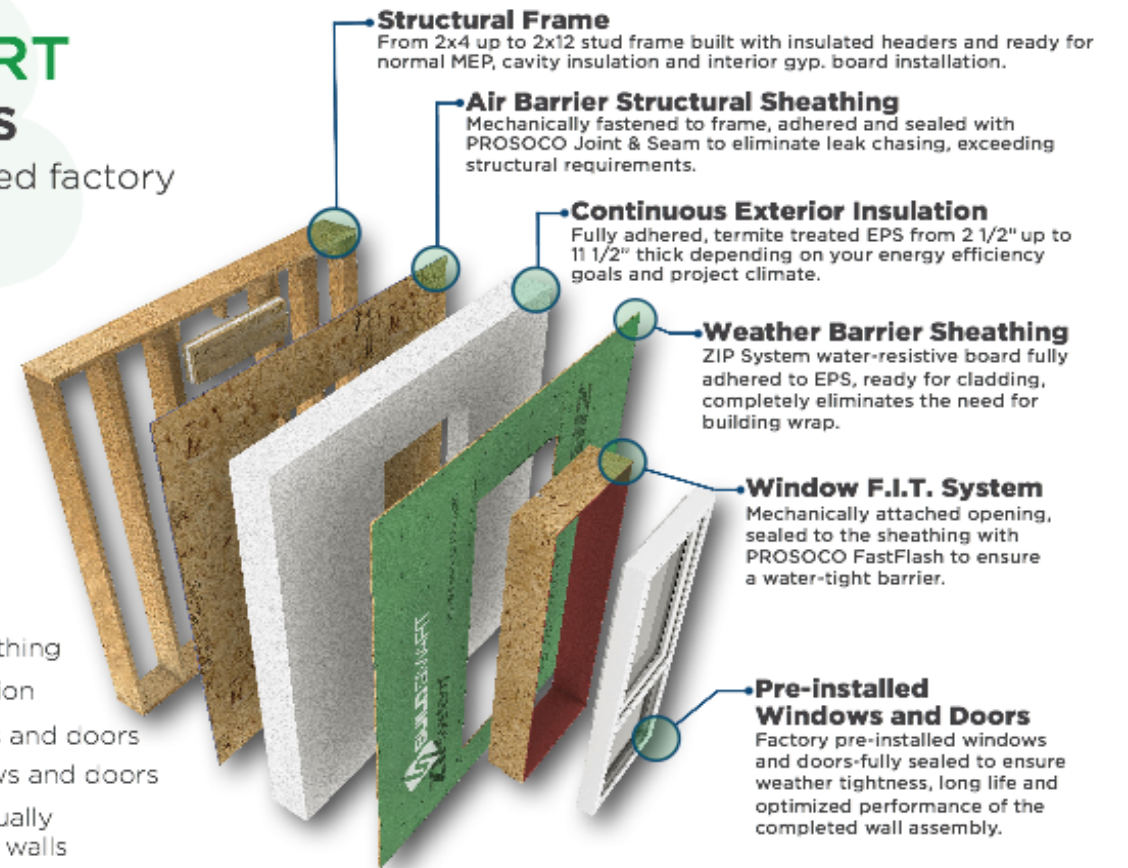
- PHIUS 2018 Insulation Levels
- Panelized Pre-Insulated Walls
- Triple pane windows

Build SMART Wall Panels

from our mechanized factory
to your job site
Certified by Passive House

Single-source responsibility:

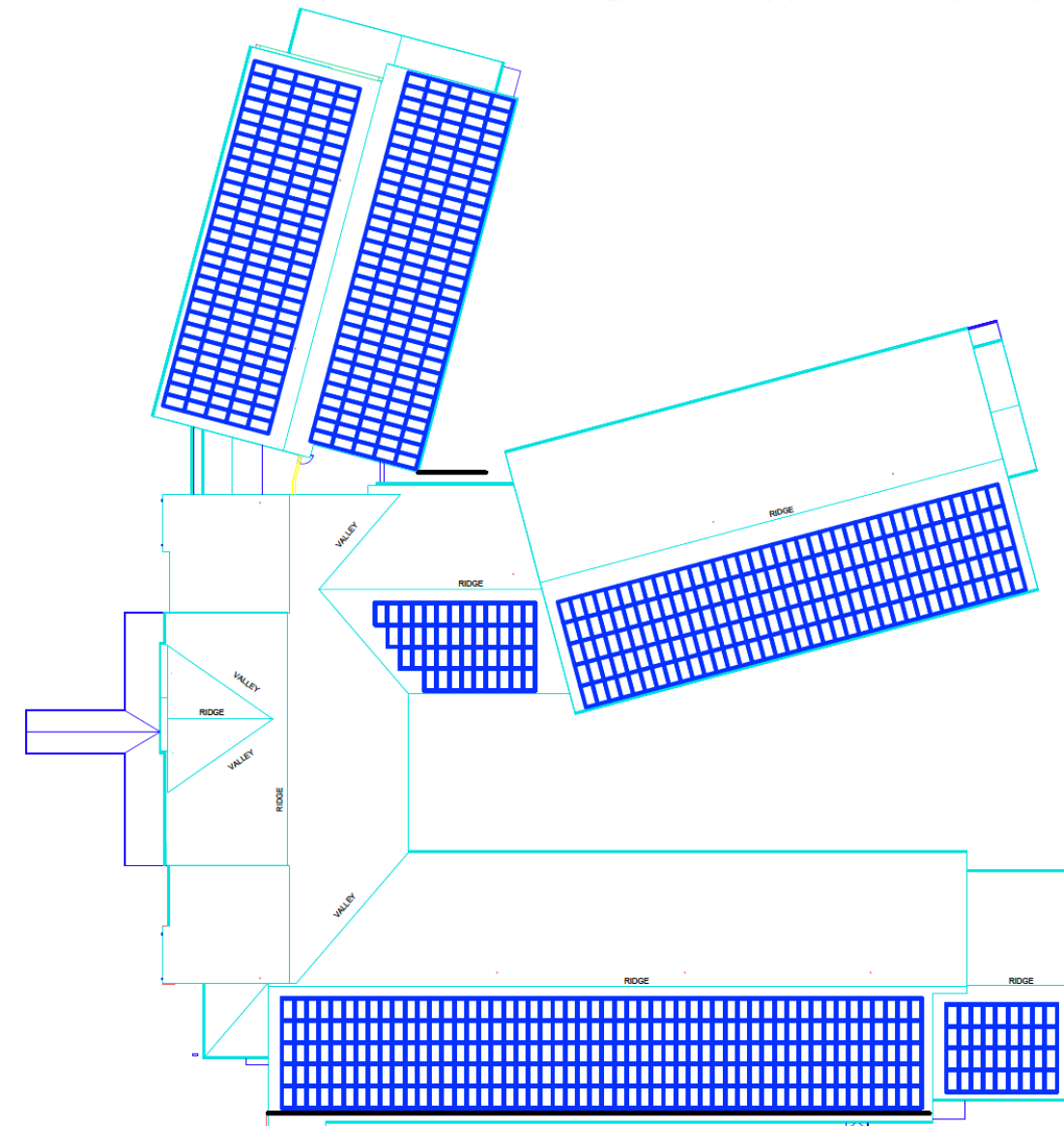
- Structural wall framing
- Air barrier structural sheathing
- Continuous exterior insulation
- Factory installed windows and doors
- Factory air-sealed windows and doors
- Extreme air-tightness virtually eliminates leak-chasing at walls
- Complete single-source warranty



Baird Road

Net Zero Performance

- Rooftop Solar PV
- Electric Vehicle Car Charging
- Battery Storage



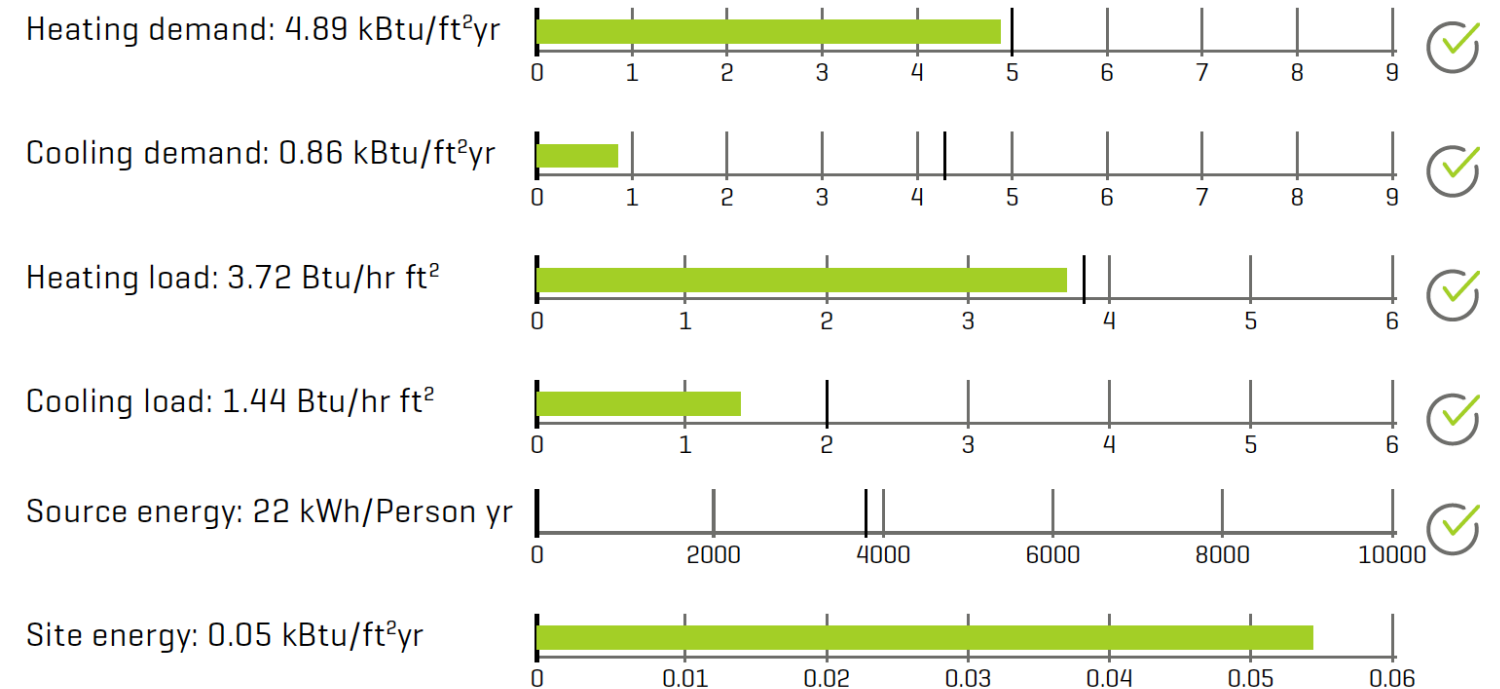
Baird Road Apartments

Technical Details

Walls	R-8.4 continuous EPS rigid insulation and 2x6 wood studs with R-21 cellulose cavity insulation using the Build SMART panelized wall assemblies.
Windows	Alpen Triple Pane Tilt/Turn Windows
Air Barrier	Build SMART exterior wall panels which feature an air tight layer sealed with Prosoco Joint and Seam Filler, and taped exterior ZIP weather barrier.
Roof	R-60 Blown in Cellulose
Slab	Build SMART J-Form shallow frost foundation system with R-10 slab edge insulation.
Heating/Cooling	Ducted split air source heat pump systems per apartment, Carrier Systems with 23 SEER, 10 HSPF
Ventilation	Energy Recovery Ventilation Systems serving apartments, shared between 2 apartments, Panasonic with 84% recovery efficiency.
Hot Water	Heat pump water heaters located in hallway closets with a single heat pump serving 4 apartments in compact distribution.
Solar Electric	Roof mounted solar PV panels with an estimated generation of 364,000 kWh/yr. Will offset the full usage of the building to achieve net-zero energy.
Additional Features	EV Charging Stations, battery backup system, low carbon materials selection such as cellulose insulation and shallow frost foundation.



Energy Modeling Results [WUFI Passive]





West Side Homes, Buffalo, NY

Owner: Buffalo Neighborhood Stabilization Company, Inc.

Design Team Lead: Sustainable Comfort, Inc.



West Side Homes



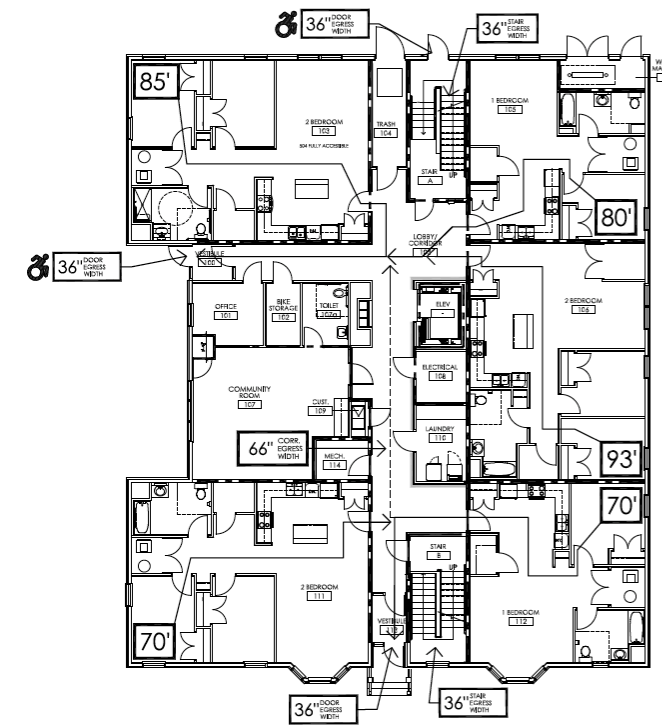
Buildings of Excellence
Award Winner

Project Description

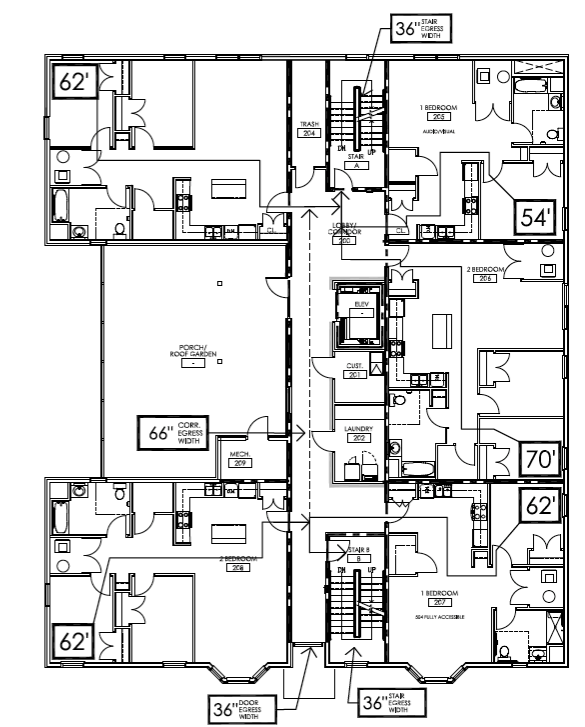
The Buffalo Neighborhood Stabilization Company Inc (BNSC), the housing development arm of PUSH Buffalo, proposes to develop 15 units of housing on Buffalo’s West Side that is targeting certification with Passive House Institute US (PHIUS), and pursuing NYSERDA, 2020 Enterprise Green Communities, and WELL Building Certification. By coordinating housing and sustainability work, West Side Homes addresses both human and ecosystem health, creates a resilient project that addresses future heat, precipitation, and drought events, and uses renewable energy sources to avoid increased greenhouse gas emissions.

Project Information

Location	Buffalo, NY
Climate Zones	5A
Average HERS Index	<50 pre PV, <10 post PV
Square Footage	18,131 sf
No. of Units	15 Multifamily Units
Year Built	Anticipate 2021 Start



FIRST FLOOR PLAN
SCALE: 1/8" = 1'-0"

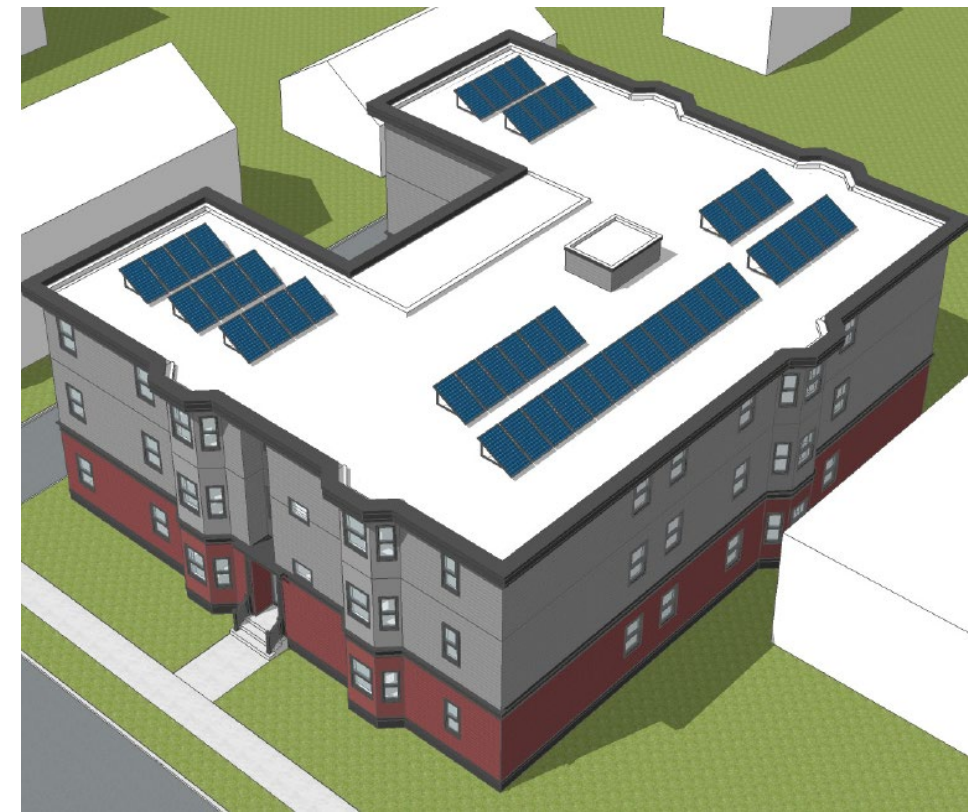


SECOND/THIRD FLOOR PLAN
SCALE: 1/8" = 1'-0"

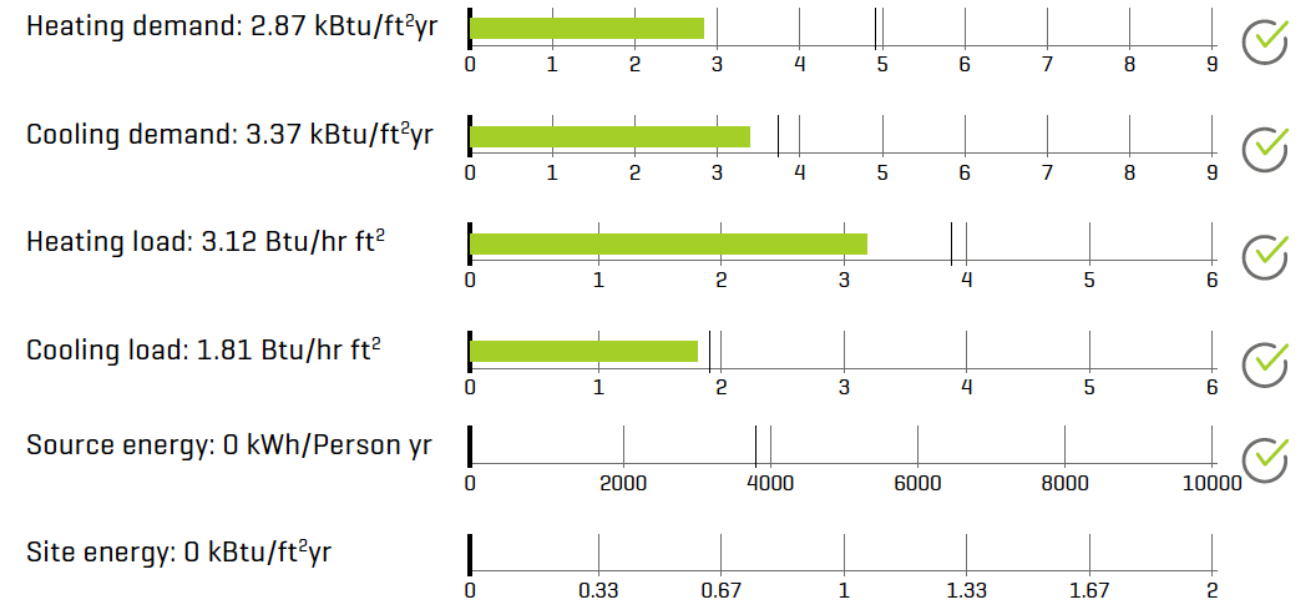
West Side Homes

Technical Details

Walls	Wood panelized construction, 2X6 cavity with R-20 dense pack cellulose. Utilizing 2.5" zip panels creating R-12.6 of continuous insulation totaling R-33 exterior wall, finished with LP Smartside.
Windows	Alpen Tyrol Triple Pane Casement Windows
Air Barrier	The exterior ZIP sheathing will create an enhanced air, water, moisture and thermal barrier.
Roof	R-30+ continuous insulation
Slab	Continuous EPS perimeter and under-slab insulation
Heating/Cooling	Ground Source Heat Pump
Ventilation	The ERV ventilation system has monitoring capabilities allowing tenants to track some aspects of indoor air quality.
Hot Water	Geothermal electric hot water with desuperheaters
Solar Electric	Roof-mounted Solar Photovoltaic systems owned by BNSC will produce an estimated 30,755 kWh/yr
Materials	Low carbon materials such as insulation and foam were considered during material selection process.



Energy Modeling Results [WUFI Passive]



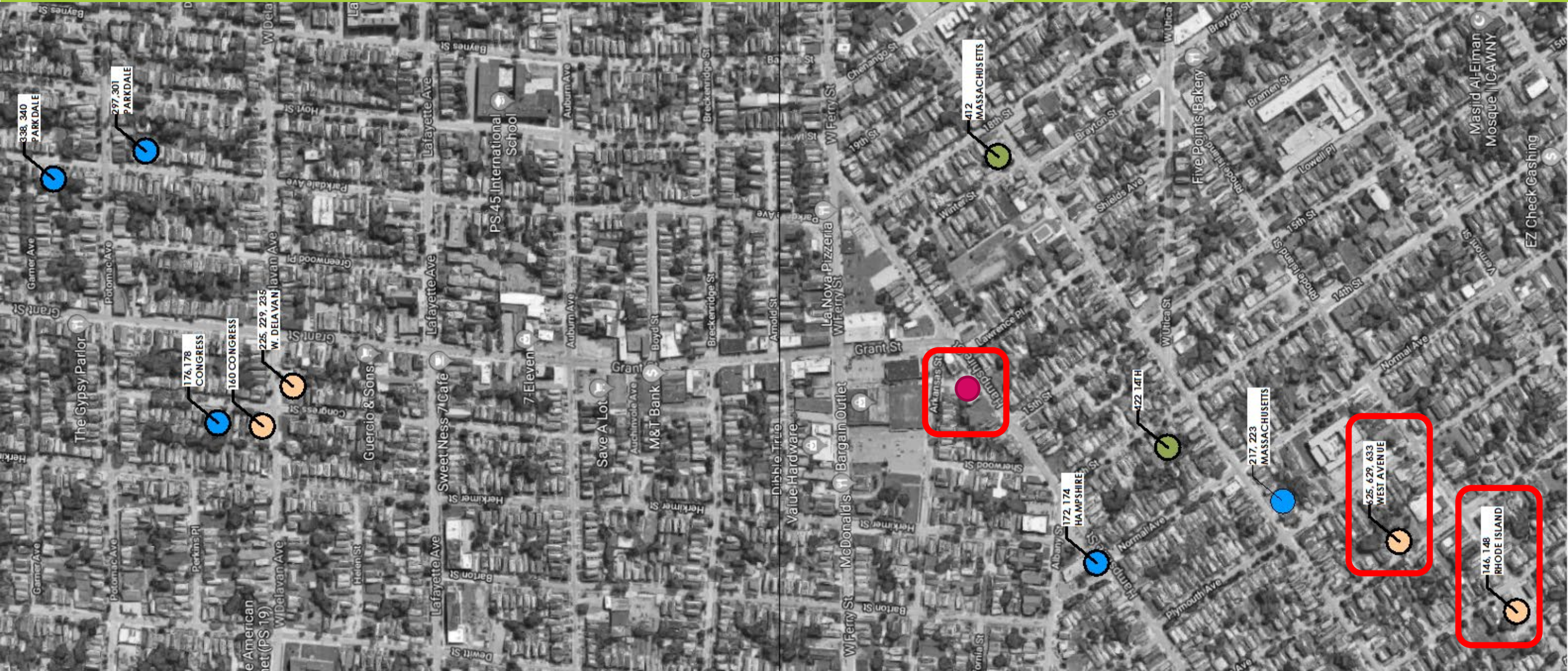
West Side Homes

Low Carbon Technologies

- West: Unitary Geothermal Heat Pumps for Space Conditioning and DHW
- Rhode Island: Air Source Heat Pumps and Heat Pump Hot Water Heating, 1 per apartment
- Unitary Energy Recovery Ventilation



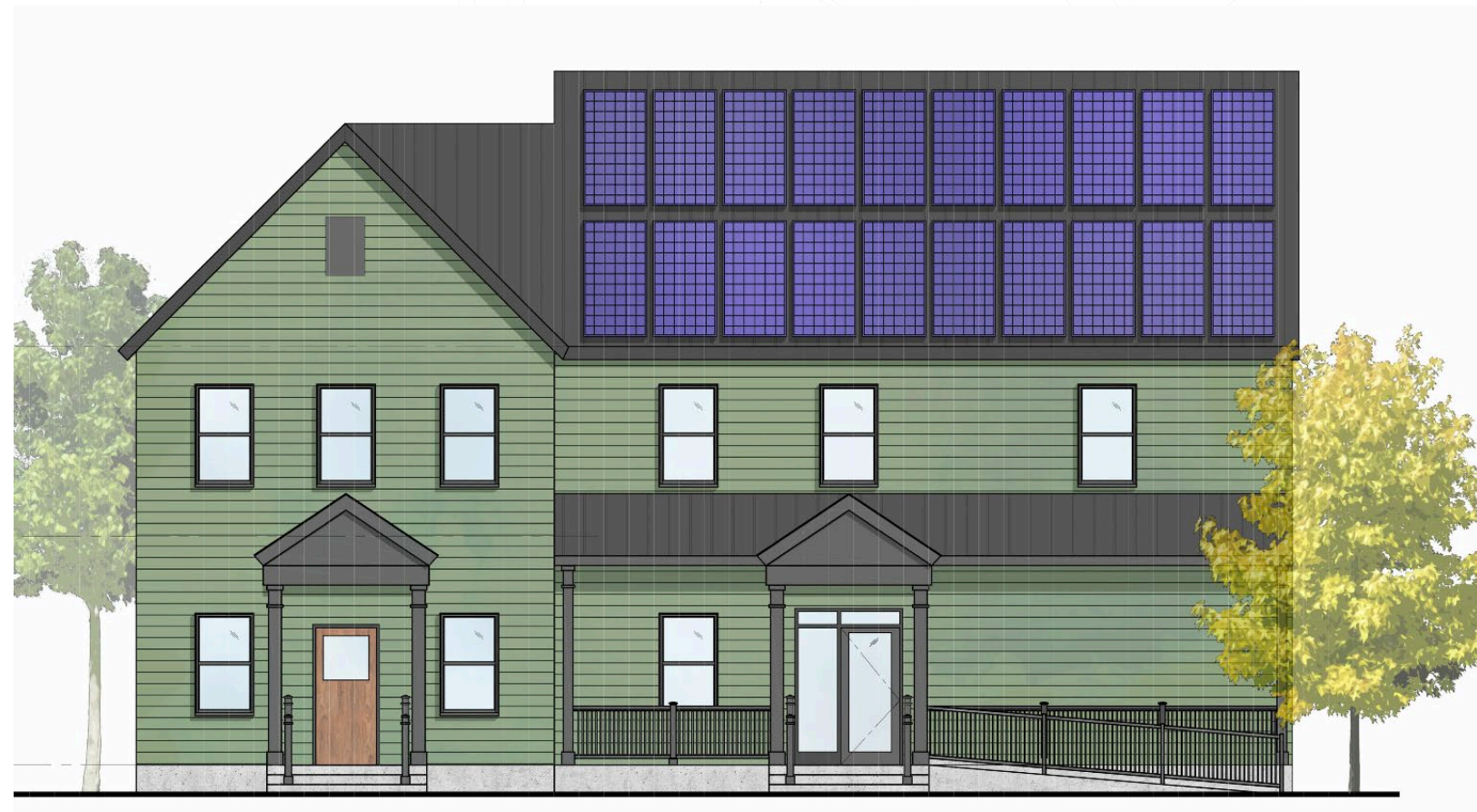
West Side Homes



West Side Homes

Whole Systems Approach:

- Site-built construction using local workforce
- Fits with the local vernacular
- Community engagement
- Energy Modeling for optimization
- Resilient / Supportive





CreekView Apartments at Woodland Park Phase II, Canandaigua, NY

Owner: Baldwin Real Estate Corp. | Design Team Lead: Sustainable Comfort, Inc.



Glasow Architecture



Creekview Apartments



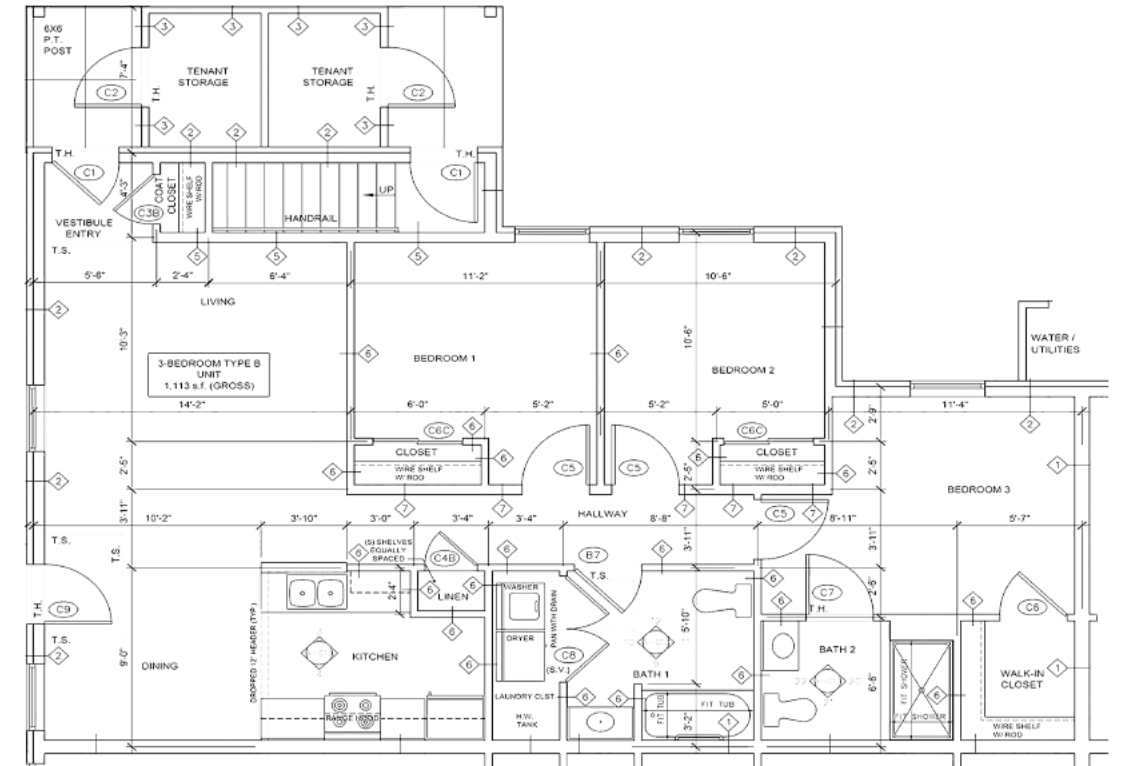
Buildings of Excellence
Award Winner

Project Description

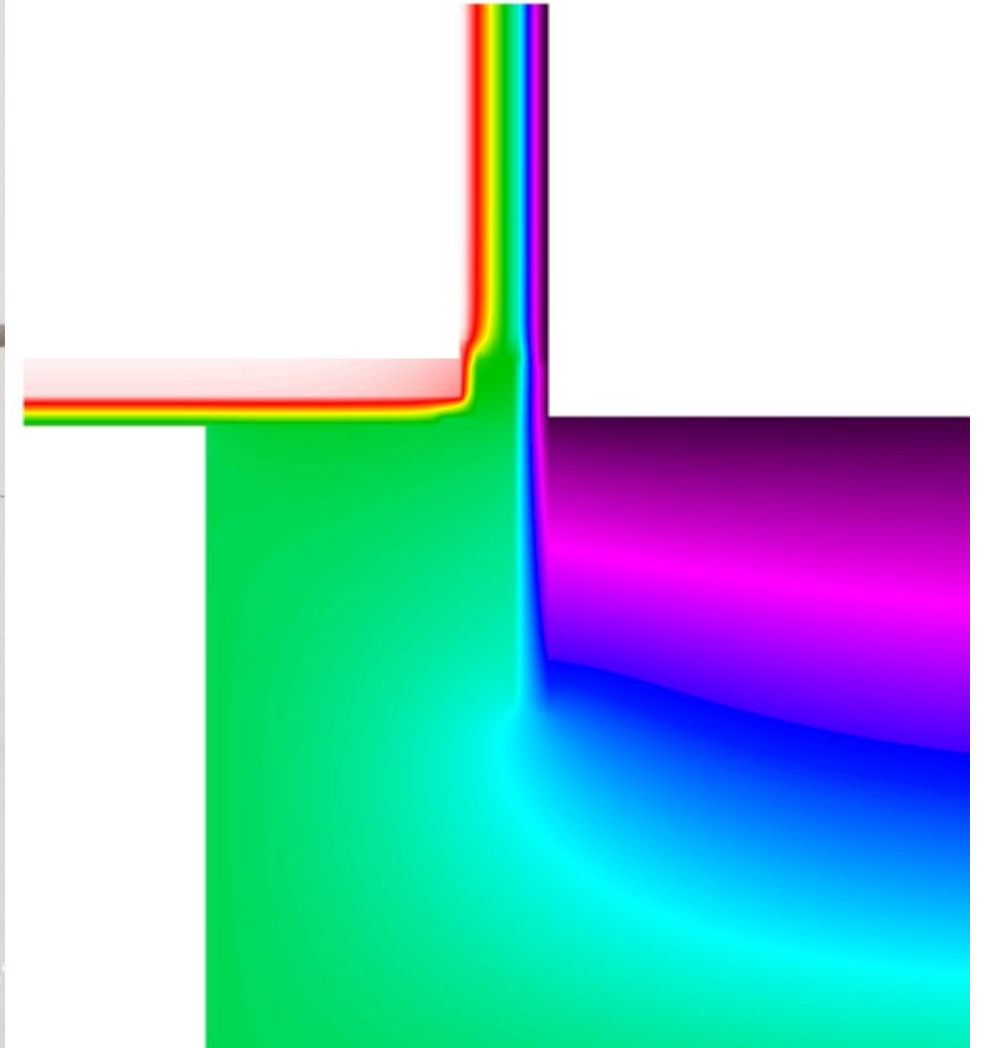
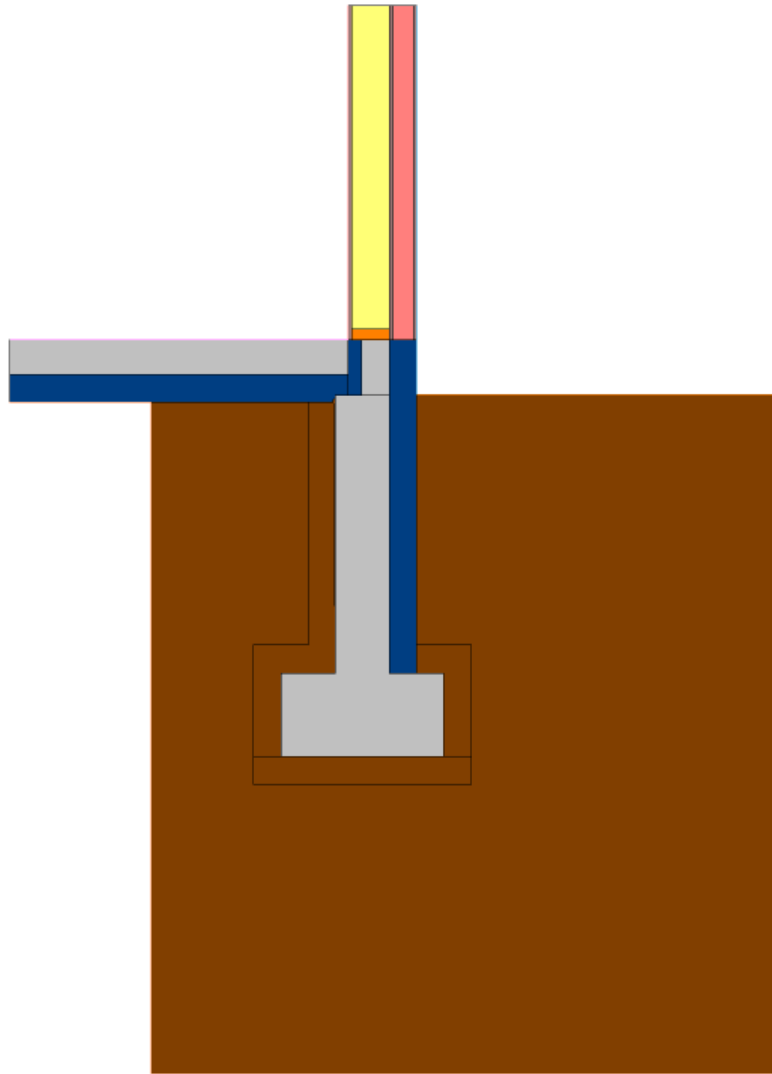
CreekView Apartments Phase II is the continuation of a high-performance passive house community in Canandaigua. Building up on the efforts of the PHIUS+ 2015 Phase I, CreekView Phase II will reach to Net-Zero energy, continuing to drive the cost effectiveness of high-performance building. Phase II consists of 96 apartments in 12 buildings which will be Net-Zero, with triple pane windows, energy recovery ventilation, highly insulated slab; walls; and roof, as well as solar PV. The buildings will use all electric systems including ground source heat pumps tied to VRF systems for heating, cooling, plus a ground source water to water heat pump for hot water heating with roof mounted solar PV to offset the use of the buildings.

Project Information

Location	Canandaigua, NY
Climate Zones	5
Heating Degree Days	6,621
Average HERS Index	Pre-PV 35, Post-PV 6
Square Footage	93,668 sf

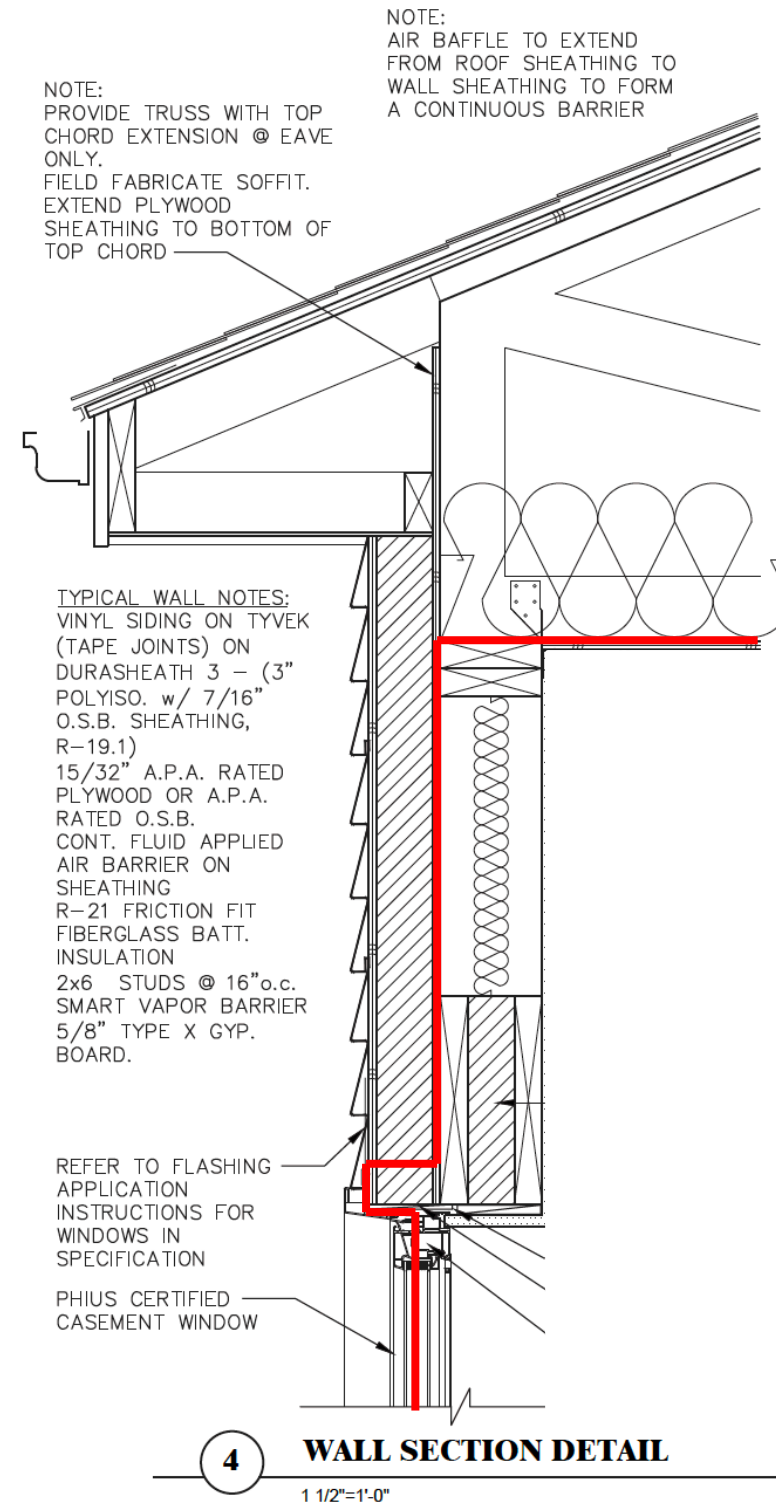


Foundation Insulation Connections



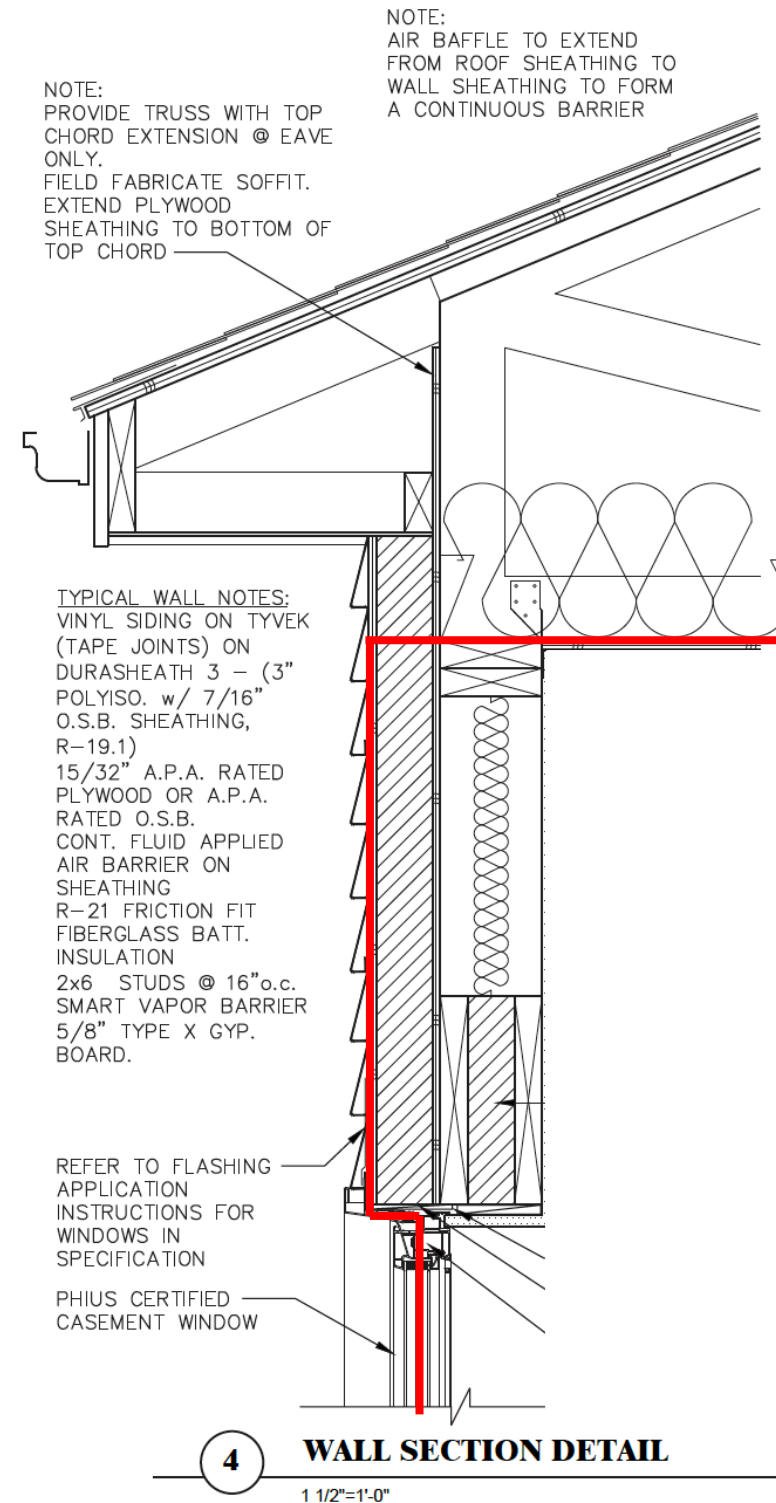
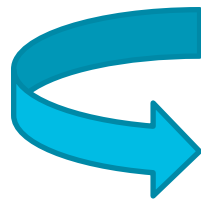
Wall Insulation Phase 1

- R-37 Wall
 - 2x6 Wood Studs - R-21 Batt
 - OSB Sheathing
 - Fluid Applied Air Barrier
 - 3.5" Exterior Panel R-19 (Polyiso + Osb)
 - Tyvek weather barrier
 - Vinyl Siding



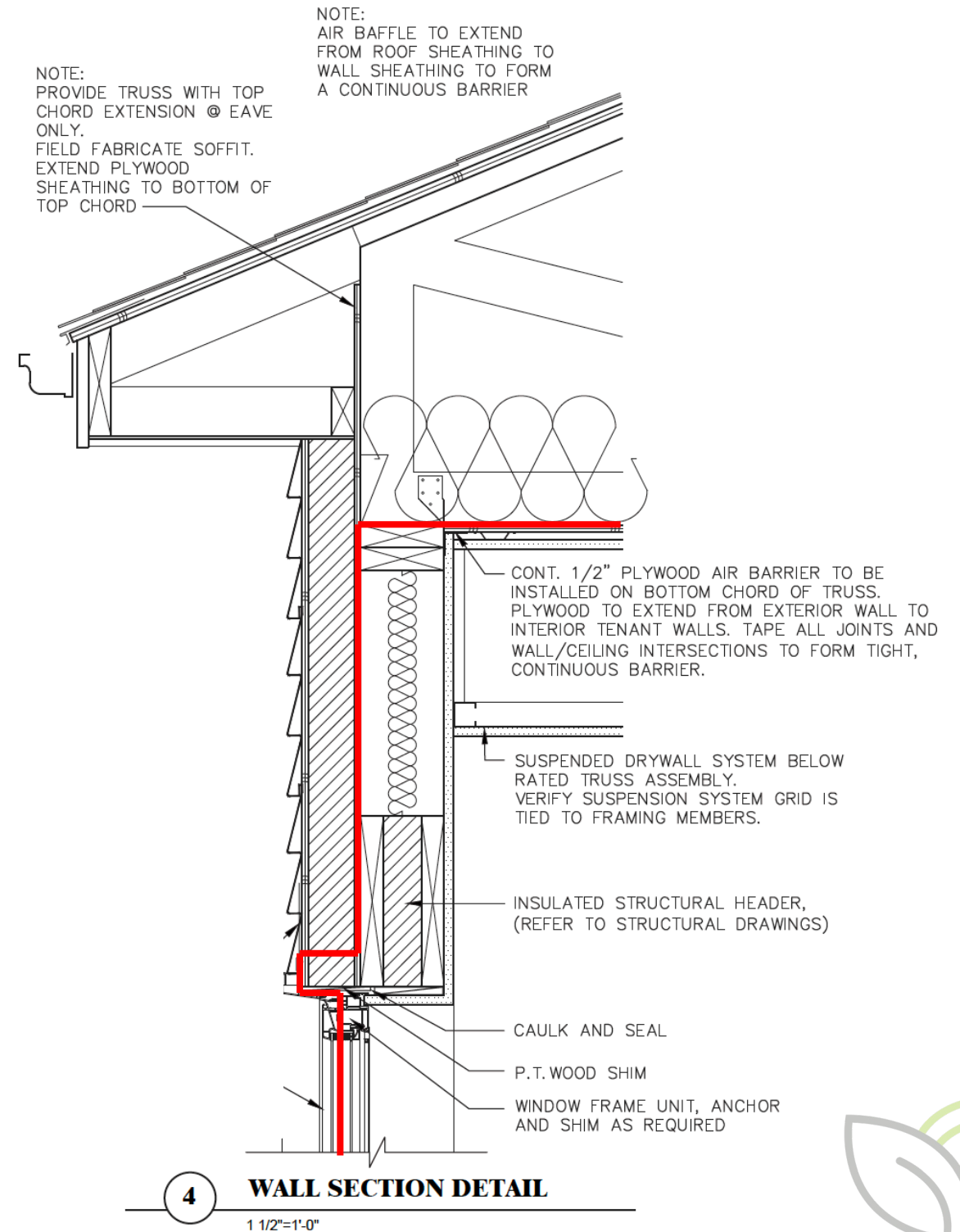
Creekview Phase 2 Concept

- R-37 Wall
 - 2x6 Wood Studs - R-21 Batt
 - OSB Sheathing
 - 3.5" Exterior Panel R-19 (Polyiso + Osb)
 - Fluid Applied Weather Barrier
 - ~~Tyvek Weather Barrier~~
 - Vinyl Siding



Ceiling Assembly Phase 1

- Blown in Insulation
- OSB Taped Continuous Air Barrier
- Resilient Channel
- Drywall
- 1' Space to run Mechanicals
- Suspended Drywall



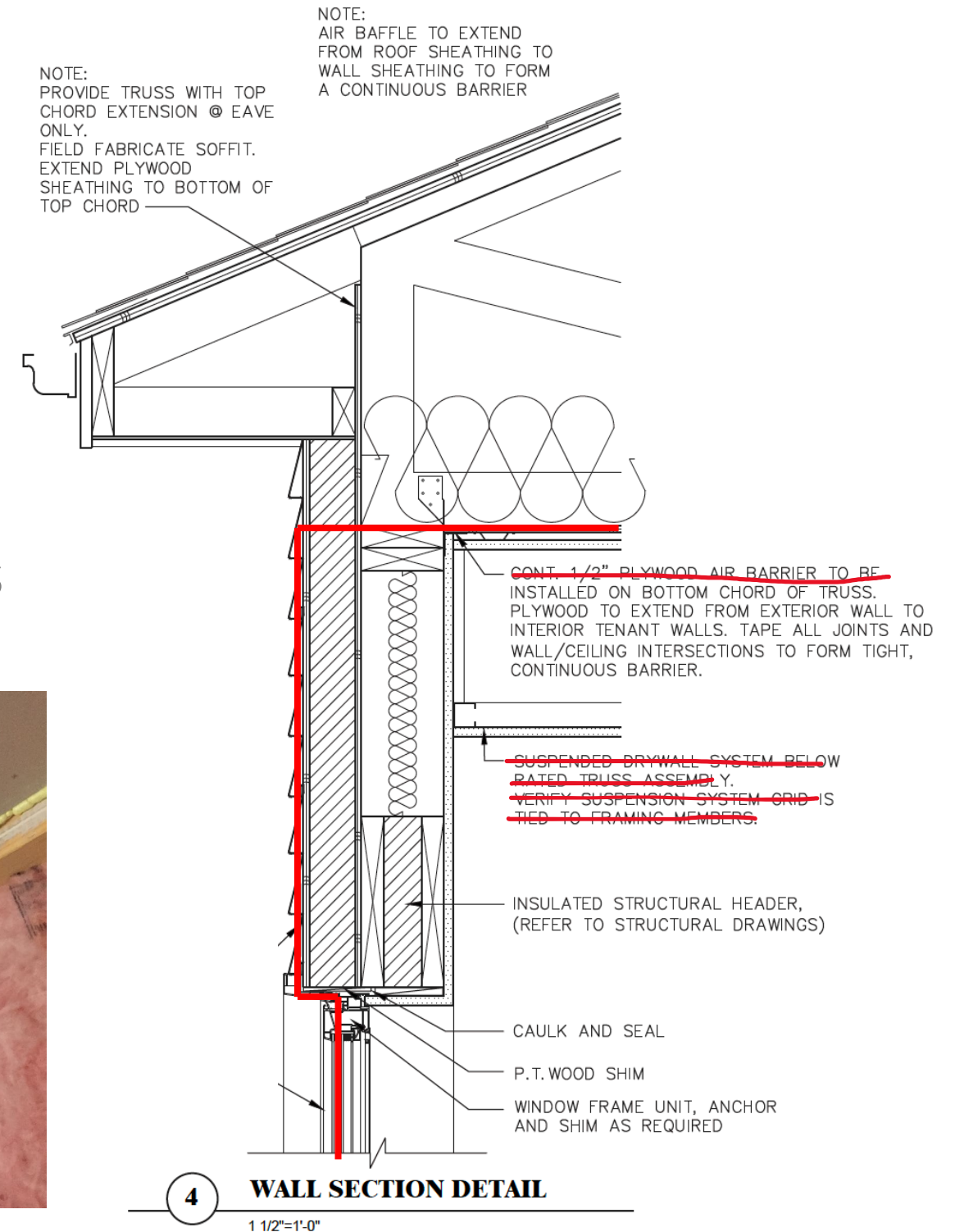
Creekview Phase 2 Concept

Blown In Insulation

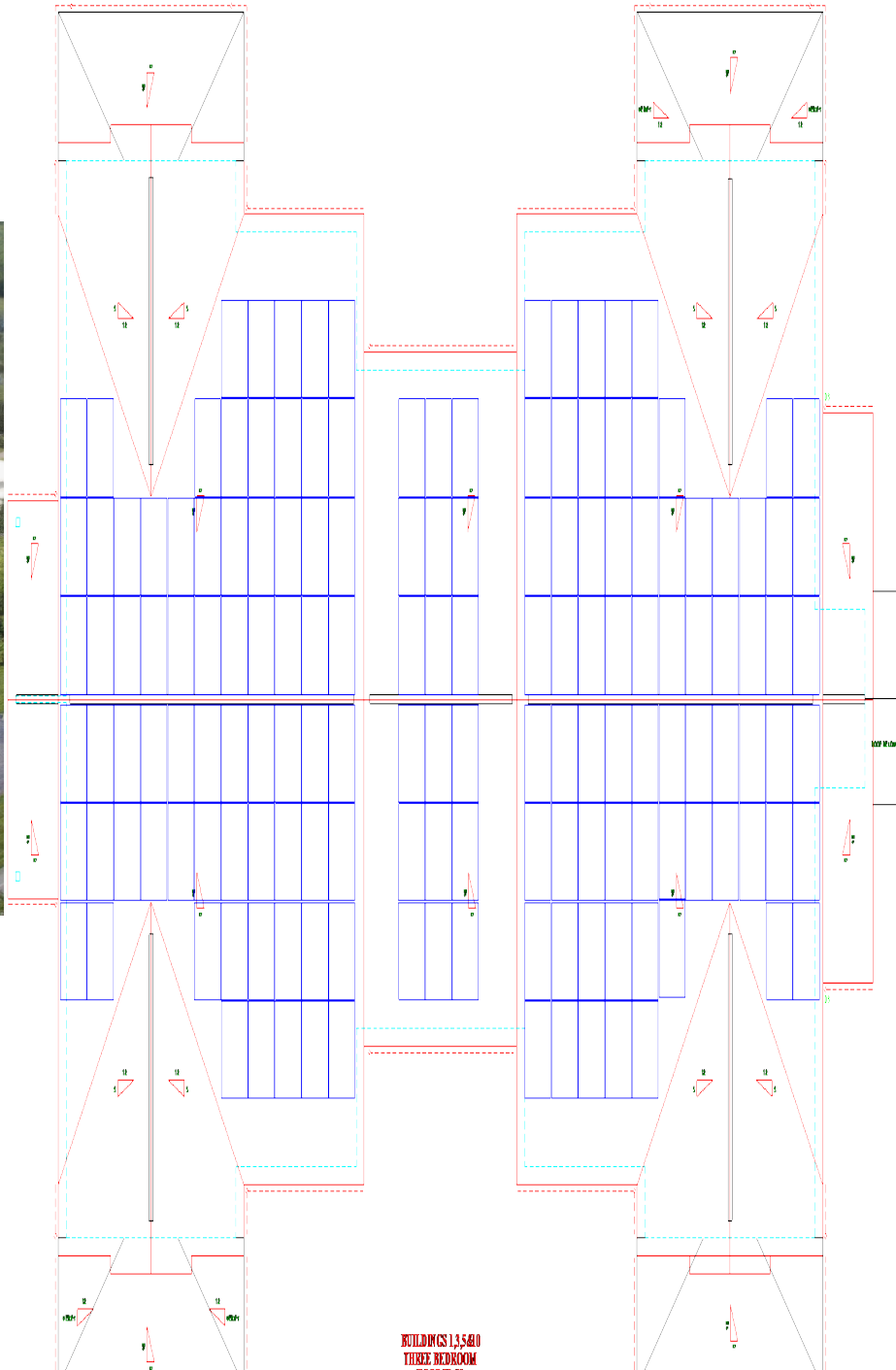
Drywall

Air Sealing:

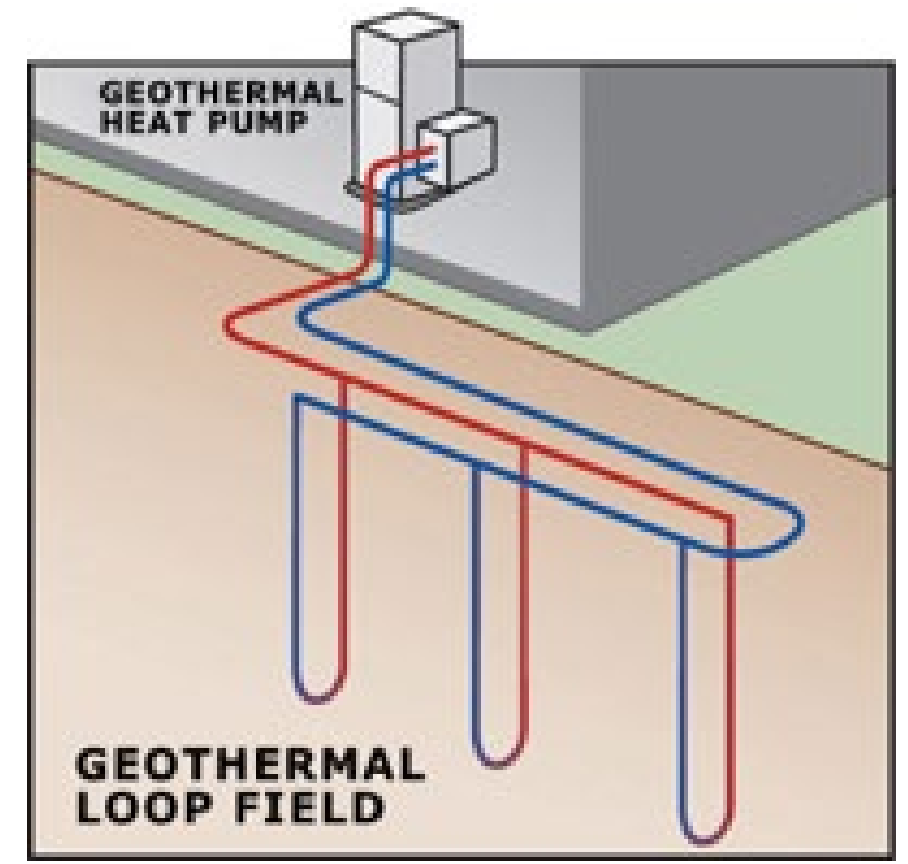
1. Seal penetrations from inside
2. Seal ceiling drywall to top plates
3. Spray foam from above all top plates



Creekview Phase 2 Concept



BUILDINGS 1,550
THREE BEDROOM



1/16
04/16/2024
SJT
1/16
AM
D1
10:00
10:00
10:00

Creekview Phase 2 Concept

		ENERGY USE				ENERGY COST	
PROJECT	HERS INDEX	SITE ENERGY USE [KBTU]	SITE EUI [KBTU/SF]	SOURCE EUI [KBTU/SF]	SOURCE ENERGY SAVINGS	TOTAL COST	COST SAVINGS
RIVERKNOLL III	64	4,700,640	50	79	-	106,488	-
CREEKVIEW I	46	2,606,956	26	71	10%	102,912	\$ 3,576
CREEKVIEW II	7	1,850,150	19	21	74%	34,952	\$ 71,536





CreekView Apartments Phase 2

How to get a PHIUS Project to Net Zero?

- Size of roof now dictates source energy, how to reduce building loads to fit in budget of roof produced solar.
- Geothermal heating/cooling/DHW central per building
- Central ERV systems to reduce construction and maintenance cost
- Solar PV – Owner paid remote net metering
 - Owner pays all utilities for the project
 - 108 Individual Electric Meters – 1 apt meter + 1 blg meter
 - Solar PV on each building tied into 1 owner meter

CreekView Apartments
Canandaigua, NY

Early Design
\$1 Million Award



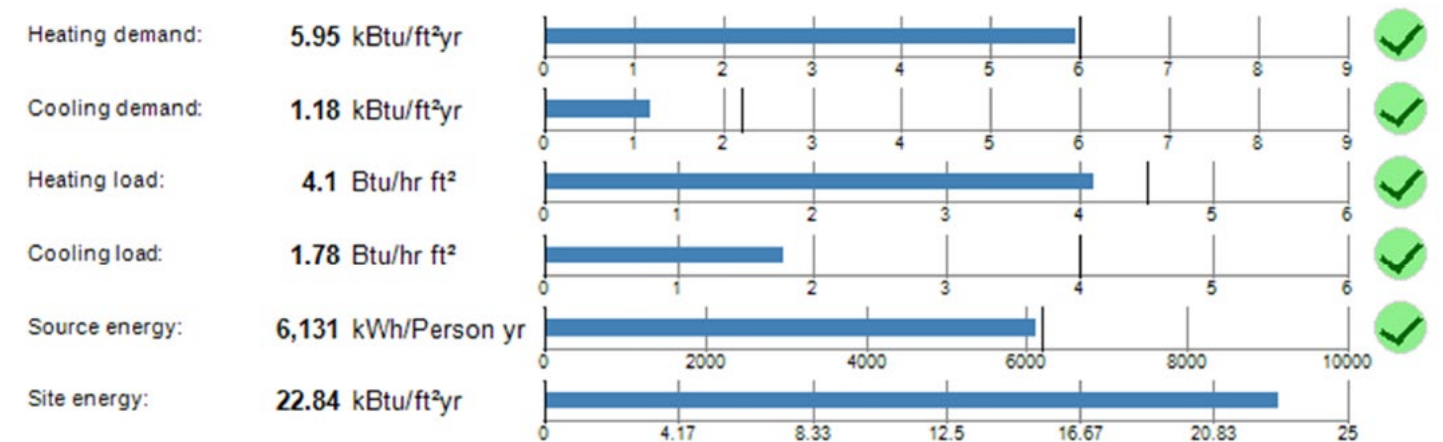
CreekView Apartments Phase 2

Technical Details

Walls	R-37 Total: 2x6 wood studs with R-21 batt, exterior XCI Hunter Panels R-19.1 continuous polyiso insulation, vinyl siding
Windows	Kohltech Supreme triple-pane operable casement window over fixed window, Whole window U-0.15, 0.33 SHGC
Air Barrier	Prosoco FastFlash and Joint & Seam Filler
Roof	R-60- R-80 blown in cellulose insulation depending on building type
Slab	3" Foam Control Plus insulation beneath entire slab, foundation wall insulated as well as 2" slab edge thermal break.
Heating/Cooling	Geothermal loop per building serving Samsung VRF based Ground Source Heat Pumps, internal distribution through slim duct system
Ventilation	Central Energy Recover Ventilation Systems.
Hot Water	Ground Source Heat Pump Water-to-Water Heat Pump per building
Solar Electric	Roof mounted PV estimated at 30 kW, 40kW, 48kW, systems for the 1,2,3 bedroom buildings respectively

Energy Modeling Results [HERS Rating]

Unit Type	Modeled Pre-PV HERS Index	Modeled Post-PV HERS Index	Energy Star V3.1 Reference Index
1 Bed	36	6	63
1 Bed 2 nd	34	8	62
2 Bed	35	4	64
2 Bed 2 nd	35	6	63
3 Bed	36	5	63
3 Bed 2 nd	36	7	62



How Much does Housing Matter?



Housing in Context of Sustainability



Source: Project Drawdown

Rank	Solution	Sector	TOTAL ATMOSPHERIC CO2-EQ REDUCTION (GT)
1	Refrigerant Management	Materials	89.74
2	Wind Turbines (Onshore)	Electricity Generation	84.60
3	Reduced Food Waste	Food	70.53
4	Plant-Rich Diet	Food	66.11
5	Tropical Forests	Land Use	61.23
6	Educating Girls	Women and Girls	51.48
7	Family Planning	Women and Girls	51.48
8	Solar Farms	Electricity Generation	36.90
9	Silvopasture	Food	31.19
10	Rooftop Solar	Electricity Generation	24.60
11	Regenerative Agriculture	Food	23.15
12	Temperate Forests	Land Use	22.61
13	Peatlands	Land Use	21.57
14	Tropical Staple Trees	Food	20.19
15	Afforestation	Land Use	18.06
16	Conservation Agriculture	Food	17.35
17	Tree Intercropping	Food	17.20
18	Geothermal	Electricity Generation	16.60

What About Buildings?



Rank	Solution	Sector	TOTAL ATMOSPHERIC CO2-EQ REDUCTION (GT)
27	District Heating	Buildings and Cities	9.38
31	Insulation	Buildings and Cities	8.27
33	LED Lighting (Household)	Buildings and Cities	7.81
42	Heat Pumps	Buildings and Cities	5.20
44	LED Lighting (Commercial)	Buildings and Cities	5.04
45	Building Automation	Buildings and Cities	4.62
54	Walkable Cities	Buildings and Cities	2.92
57	Smart Thermostats	Buildings and Cities	2.62
58	Landfill Methane	Buildings and Cities	2.50
59	Bike Infrastructure	Buildings and Cities	2.31
61	Smart Glass	Buildings and Cities	2.19
71	Water Distribution	Buildings and Cities	0.87
73	Green Roofs	Buildings and Cities	0.77
79	Net Zero Buildings	Buildings and Cities	N/A
80	Retrofitting	Buildings and Cities	N/A

What else should be considered?

Peak Load Reduction: Shift burden off of grid

Embodied Carbon: The materials used and their source matter

Historic Rehabs: Community revitalization critical

Financial Superiority: Demonstrate the project can succeed without incentives/subsidy.

Agriculture/Soil Restoration: Carbon highly retained in forests, soils, and regenerative agriculture. How to tie into community.



Questions?

James Moriarty

james@greenrater.com

413-262-7390

Michelle Tinner

michelle@greenrater.com

239-682-2462

