BUILDINGENERGY NYC

Beyond Passive House: Emerging Research from NYSERDA BoE Early Phase Funding

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Curated by Sara Bayer and Crystal Ng

Northeast Sustainable Energy Association (NESEA) | October 24, 2024

Beyond Passive House: Emerging Research from NYSERDA BoE Early Phase Funding

Towards Affordable Decarbonization: Lowering Utility Costs in Fully Electrified Buildings

Case Study: The Beacon

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PAUL A. CASTRUCCI, ARCHITECTS
PASSIVE HOUSE DESIGN FIRM

NYSERDA Buildings of Excellence Early Design Support

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

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castrucciarchitect.com/insights

insights

lowering utility costs in electrified buildings

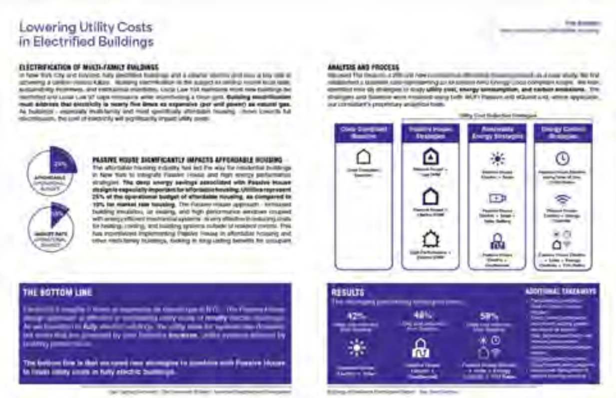
FULL REPORT

Electricity is roughly 5 times as expensive as natural gas in NYC. The Passive House design approach is effective in decreasing utility costs of ***mostly*** electric buildings. As we transition to ***fully*** electric buildings, the utility rates for systems like domestic hot water that are governed by user behavior increase, unlike systems affected by building performance.

The bottom line is that we need new strategies to combine with Passive House to lower utility costs in fully electric buildings.

This report (FULL VERSION) Is a deep dive into strategies on how to reduce the utility costs of fully electrified buildings.

Download



lowering utility costs in electrified buildings

TEAR SHEET

This tear sheet provides a brief overview of the FULL REPORT (see above) on reducing operational costs of fully electric buildings. This resource provides a fast and easy to understand primer on effective strategies in electric buildings, and is intended for use by designers, builders, developers, building owners and policy makers.

Strategies explored in this Tear Sheet and the Full Report include Passive House and High Performance building, renewable energy implementation, advanced building controls and Time of Use energy rates.

Download

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October 24, 2024

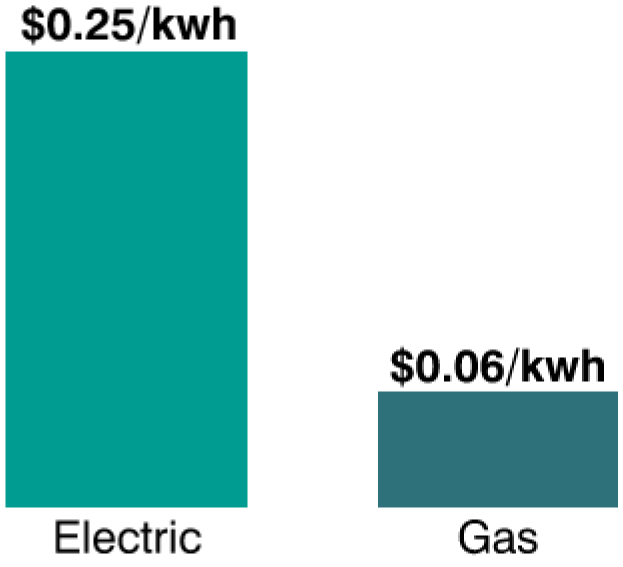

FIGURE 3 The utility gap penalty, where the cost per kWh of electricity is about five times as expensive as gas.

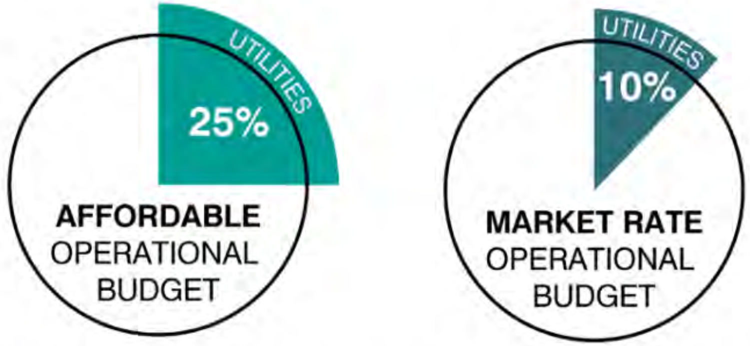

FIGURE 2 Proportion of utility cost to overall operational budget, market rate vs. affordable.

THE *UTILITY GAP PENALTY*

UTILITIES COST AND AFFORDABLE HOUSING

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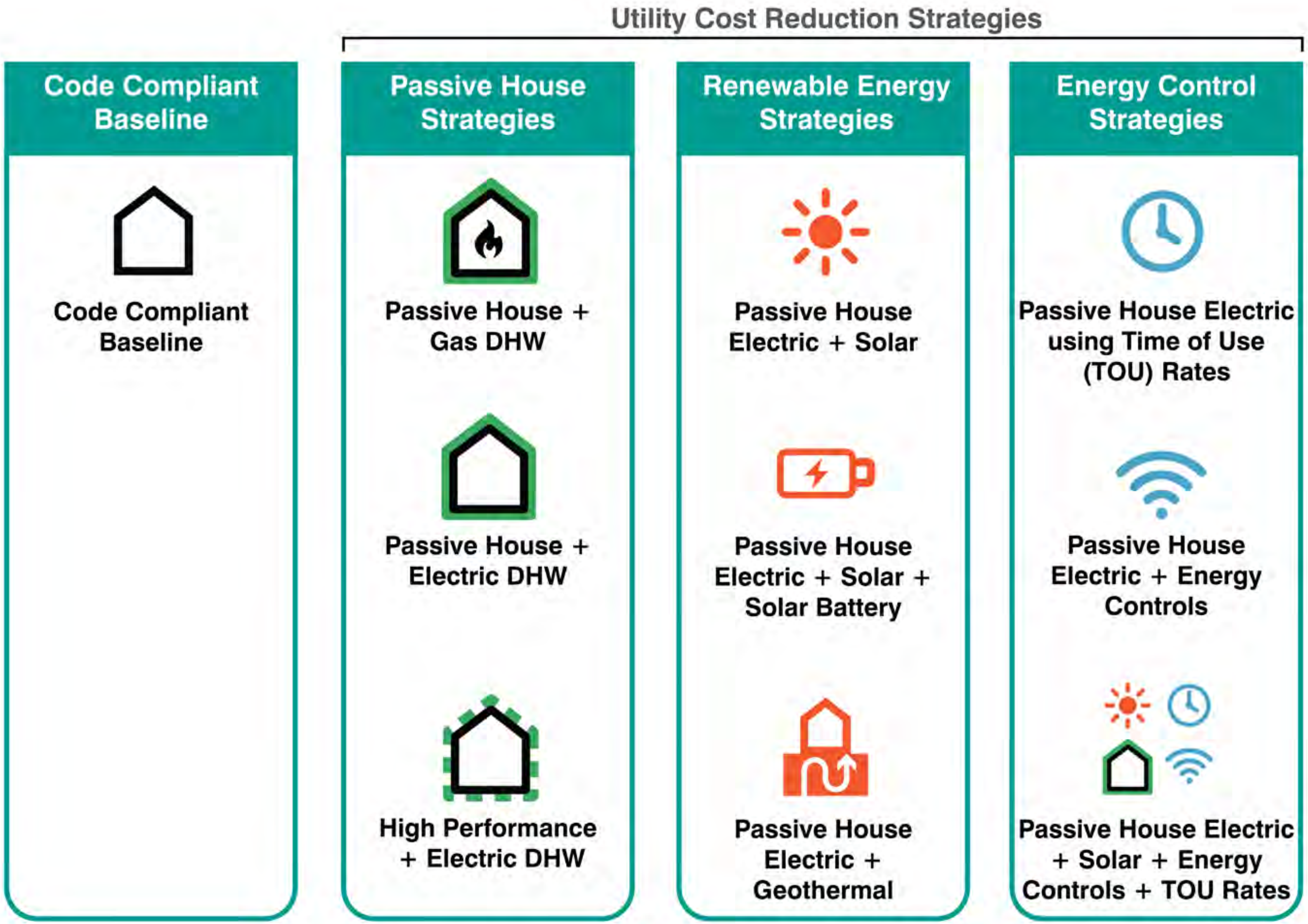
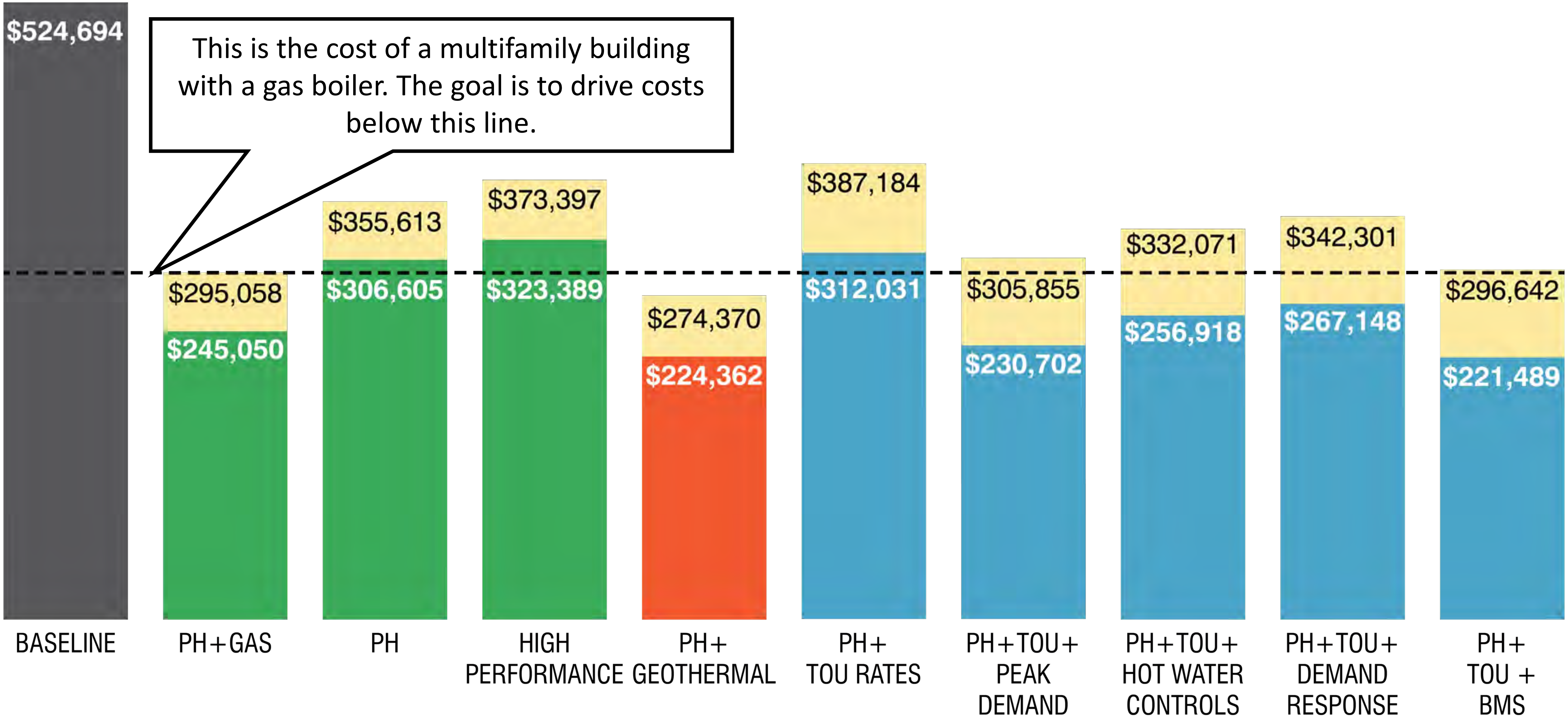
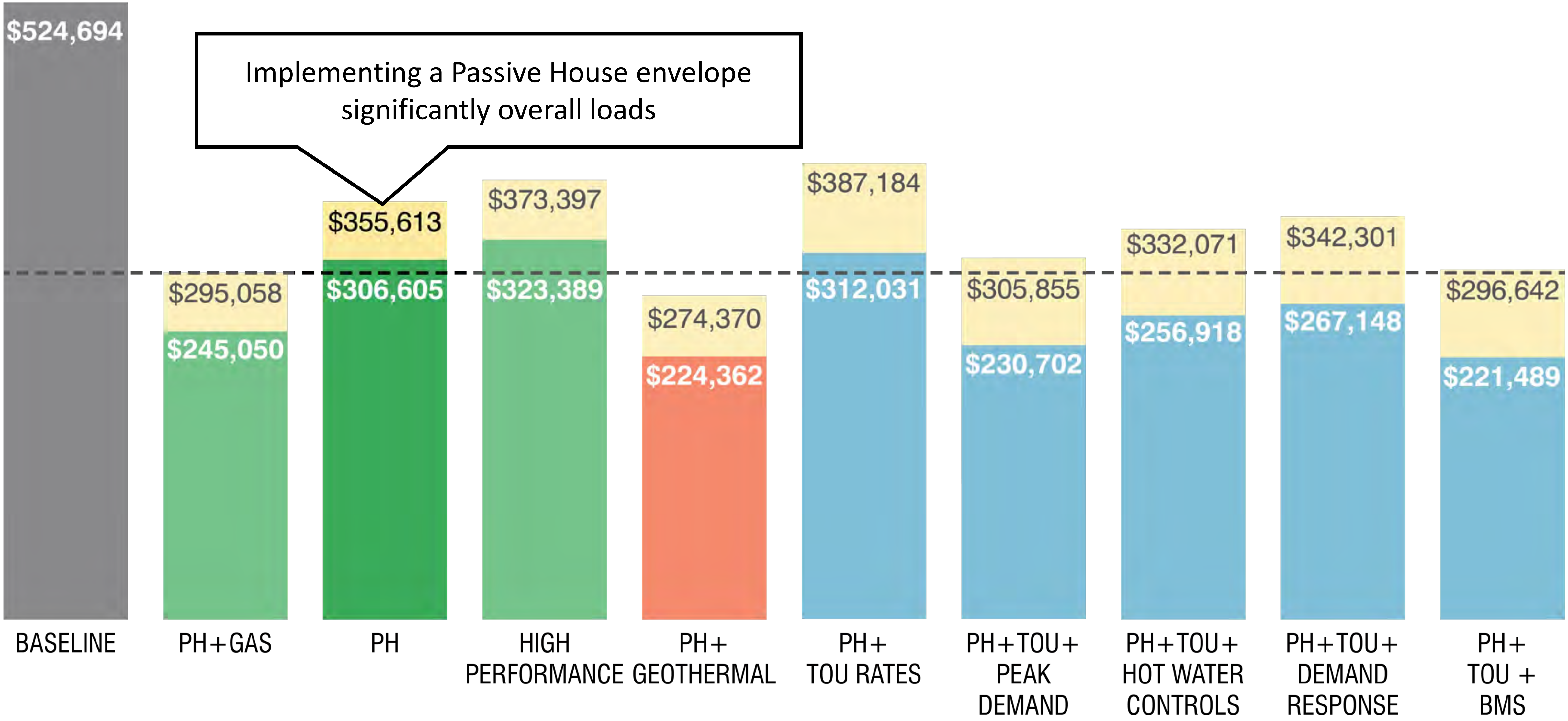

Utility Cost Reduction Strategies
Code Compliant Baseline
Passive House Strategies
Renewable Energy Strategies
Energy Control Strategies
Code Compliant Baseline
Passive House + Gas DHW
Passive House + Electric DHW
High Performance + Electric DHW
Passive House Electric + Solar
Passive House Electric + Solar + Solar Battery
Passive House Electric + Geothermal
Passive House Electric using Time of Use (TOU) Rates
Passive House Electric + Energy Controls
Passive House Electric + Solar + Energy Controls + TOU Rates

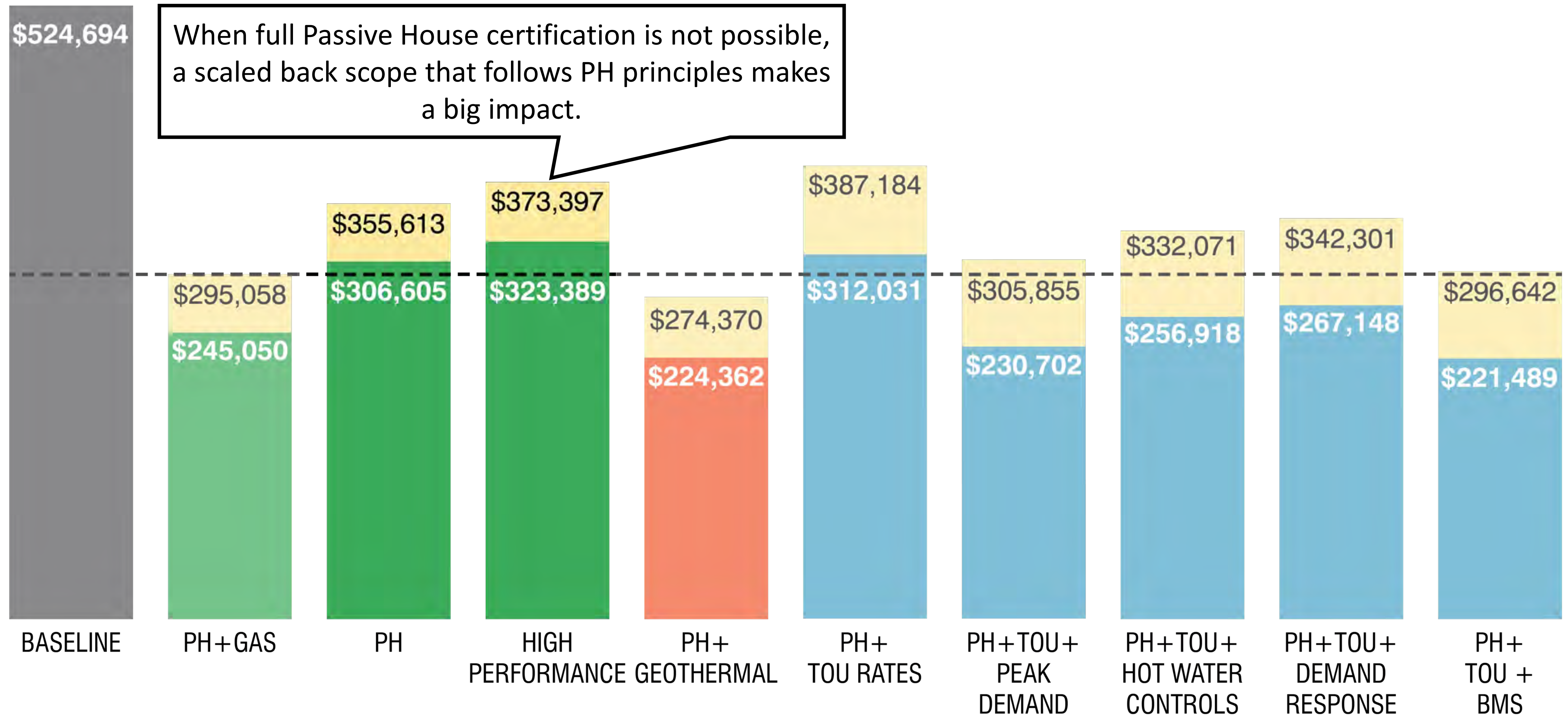
Performance Comparison



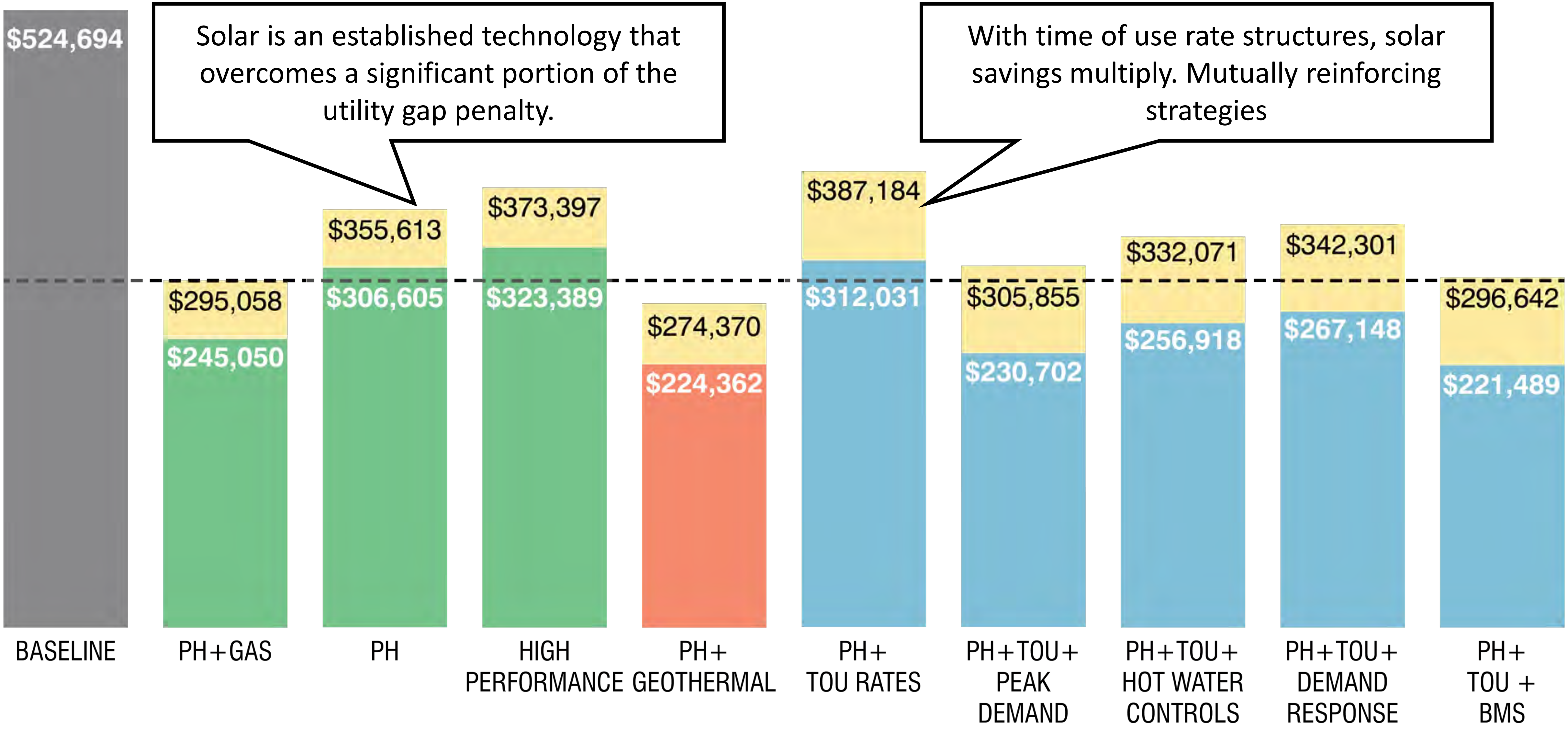
Passive House Envelope



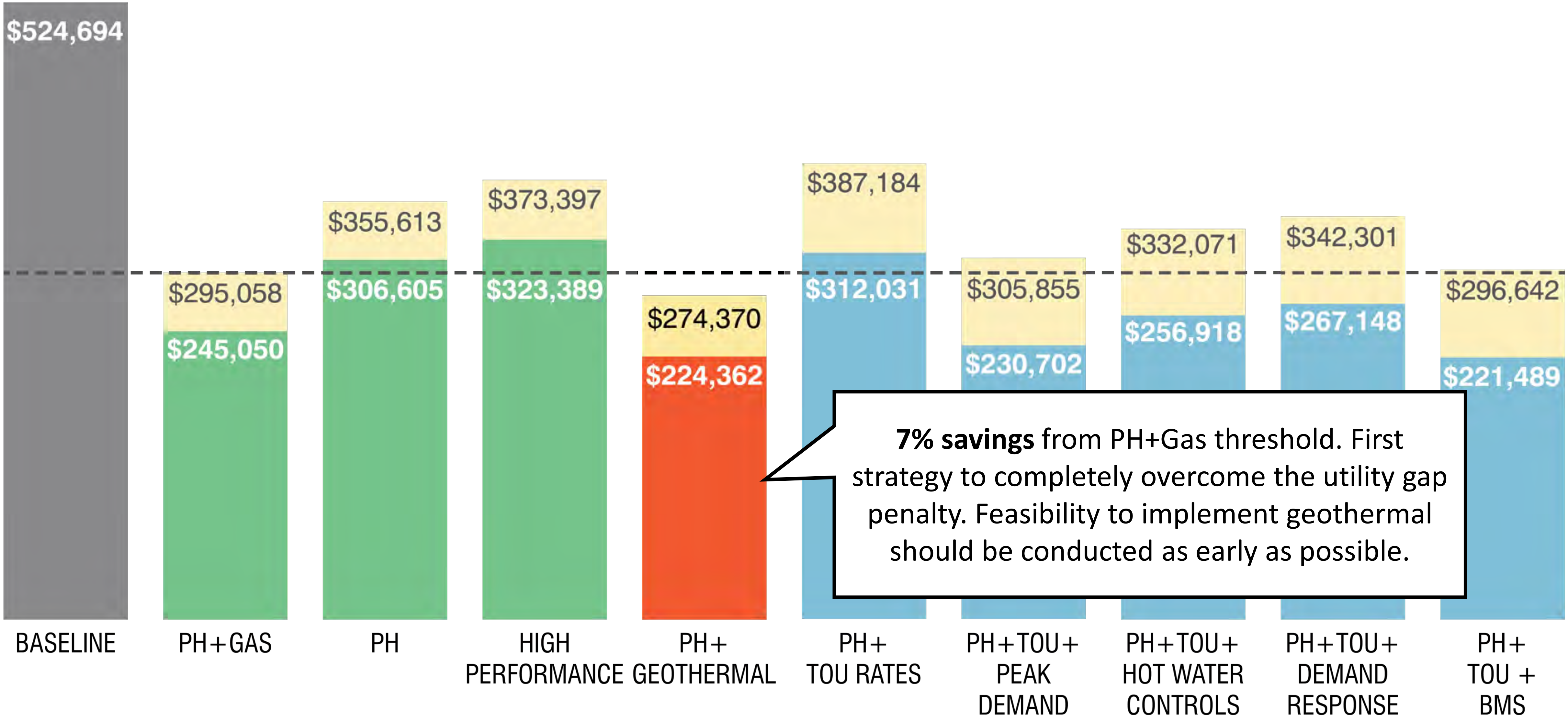
Passive House Envelope



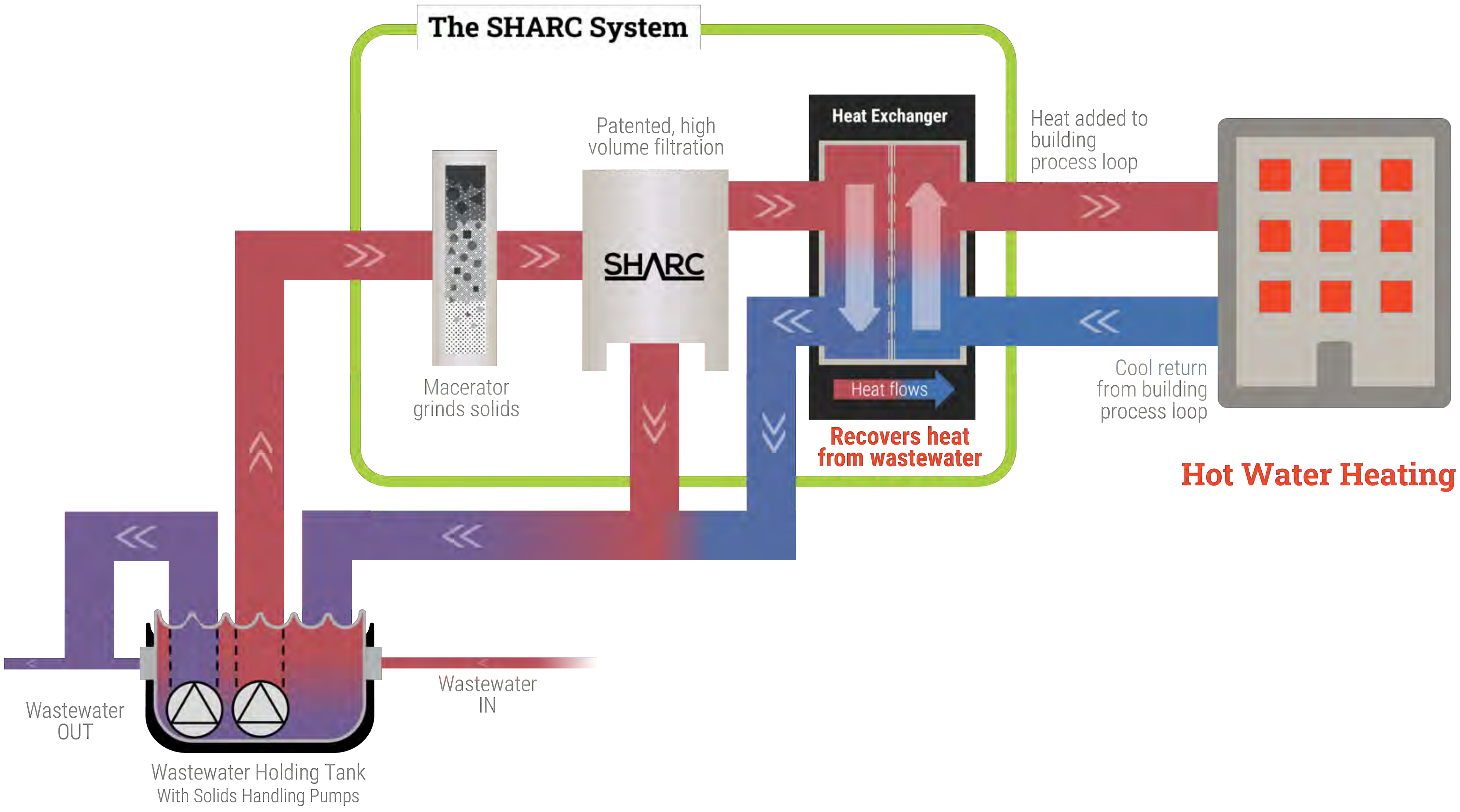
Renewables: Solar



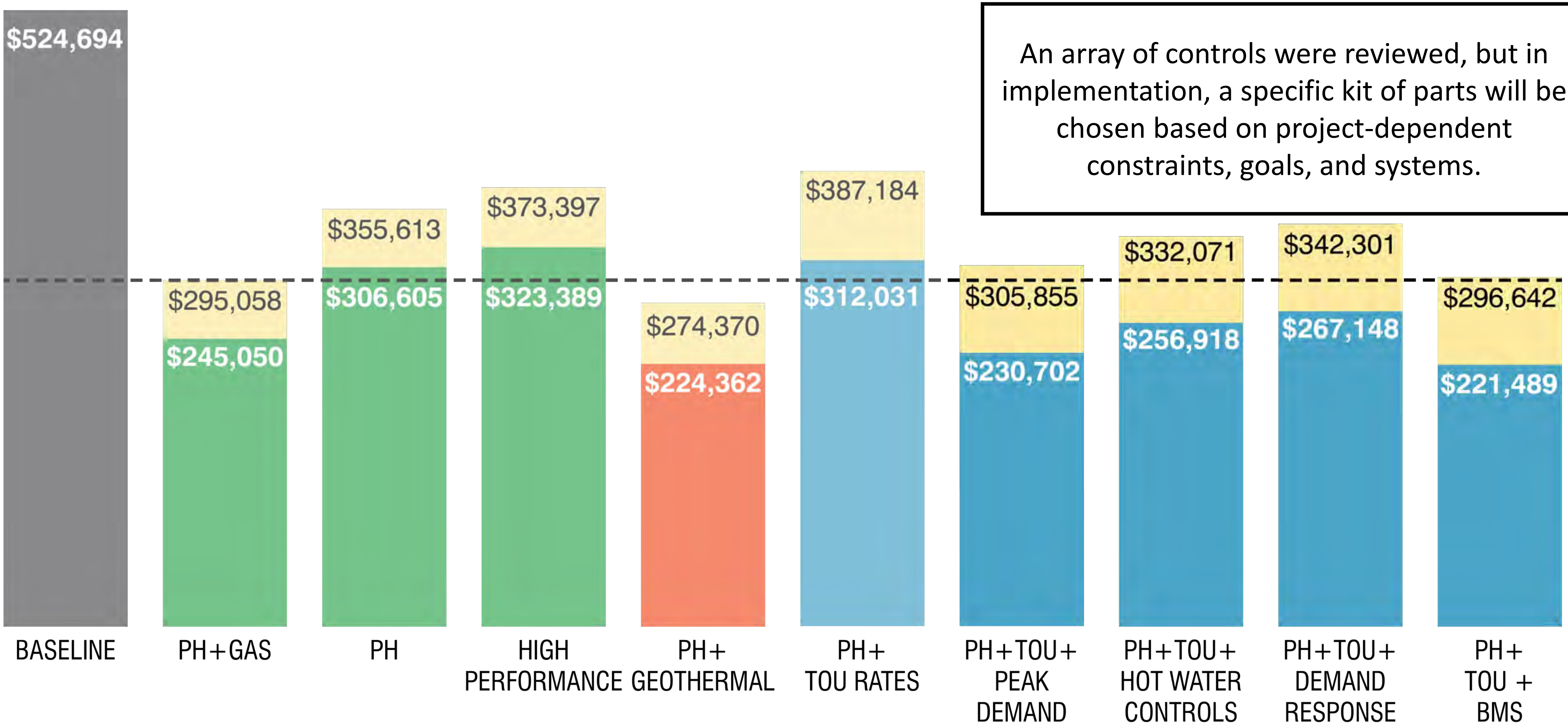
Renewables: Geothermal



Promising Strategy: Wastewater Heat Recovery



Rate Structure and BMS Controls



An array of controls were reviewed, but in implementation, a specific kit of parts will be chosen based on project-dependent constraints, goals, and systems.

Rate Structure and BMS Controls

RATE TYPE	MONTH	HOURS	DEMAND RATE
OFF PEAK	ALL MONTHS	MIDNIGHT - 8AM	$0.018/kWh
WINTER PEAK	OCTOBER - MAY	8AM - MIDNIGHT	$0.098/kWh
SUMMER PEAK	JUNE - SEPTEMBER	8AM - 2-M, 6PM - MIDNIGHT	$0.255/kWh
SUPER PEAK	JUNE - SEPTEMBER	2PM - 6PM	$0.40/kWh *

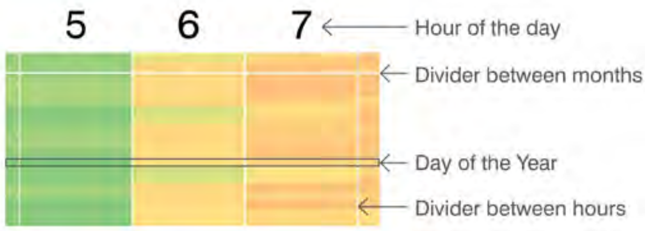
STANDARD	ALL MONTHS	ALL HOURS	$0.12/kWh

* Unknown, assumed $0.40/kWh based on available information.

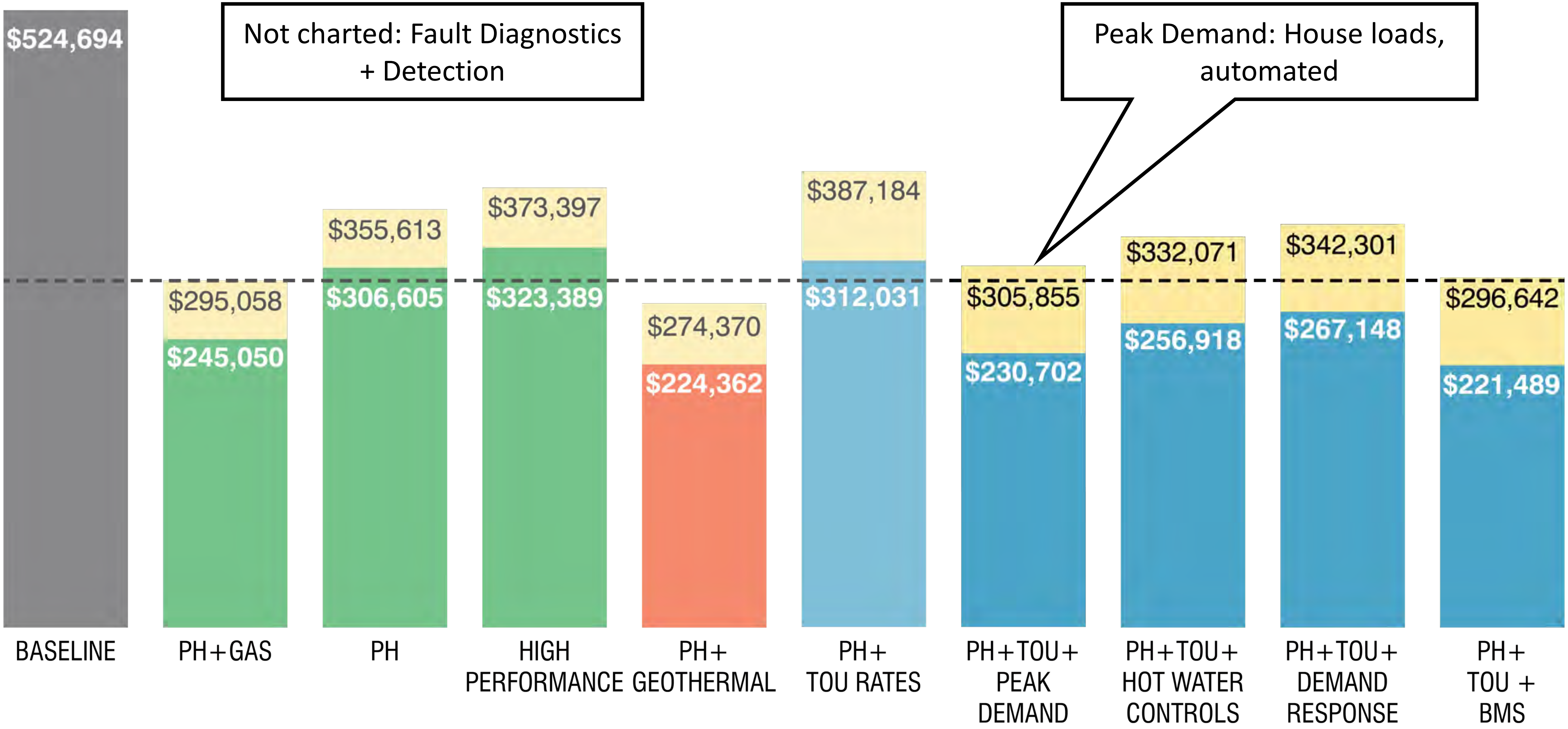
NOTE: Total rate is demand (listed above) + supply ($0.123/kWh)

Rate Structure and BMS Controls

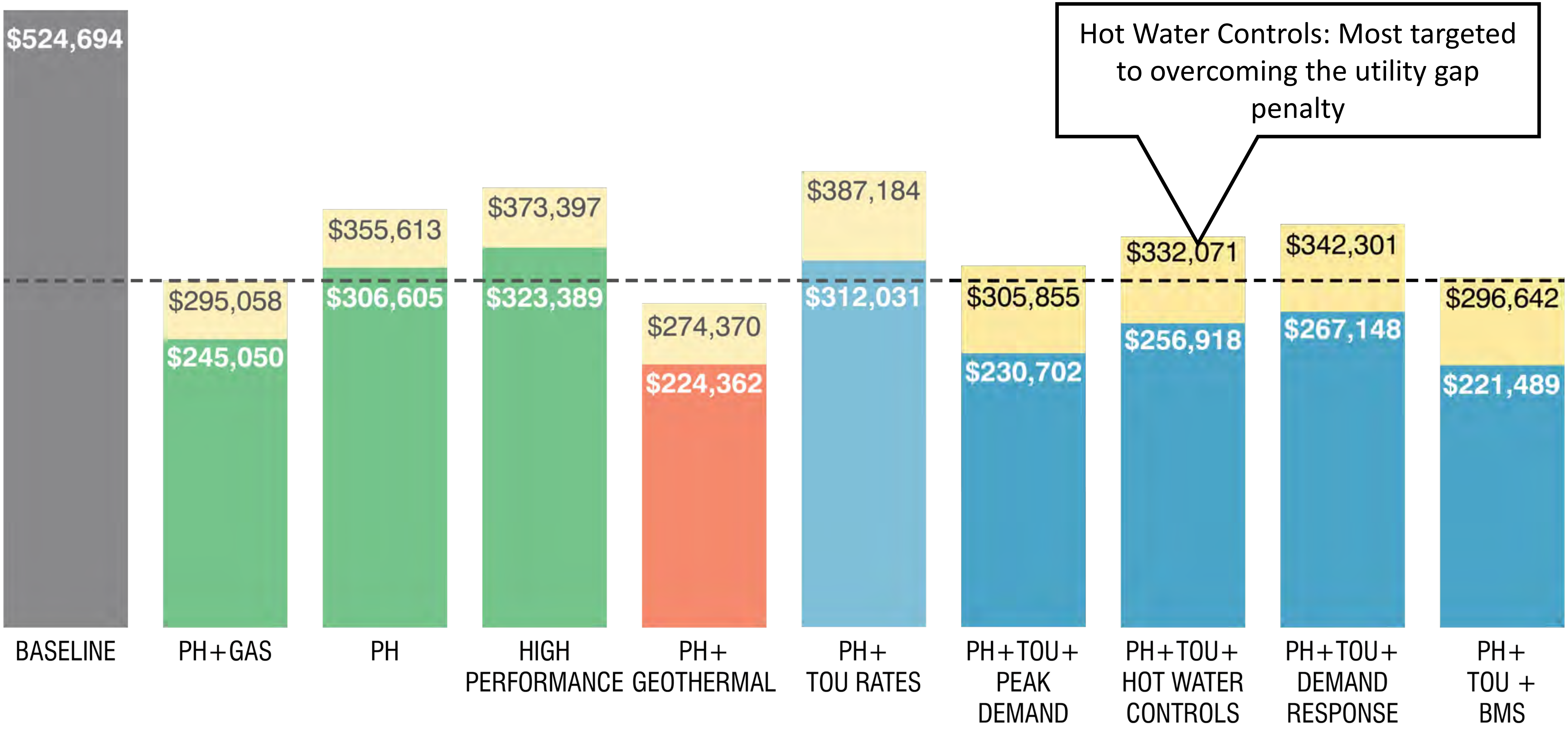
Total energy load



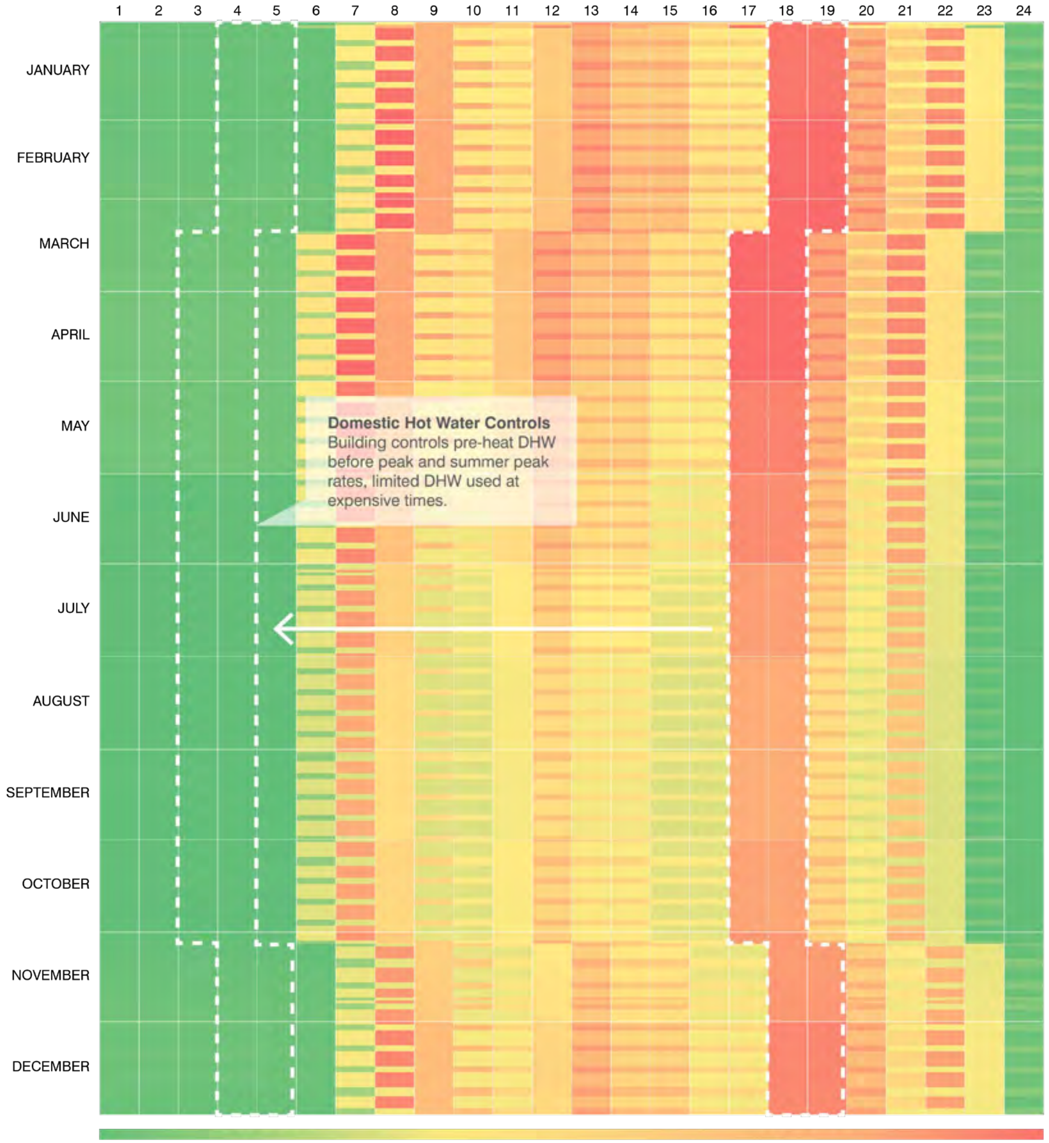
Rate Structure and BMS Controls



Rate Structure and BMS Controls

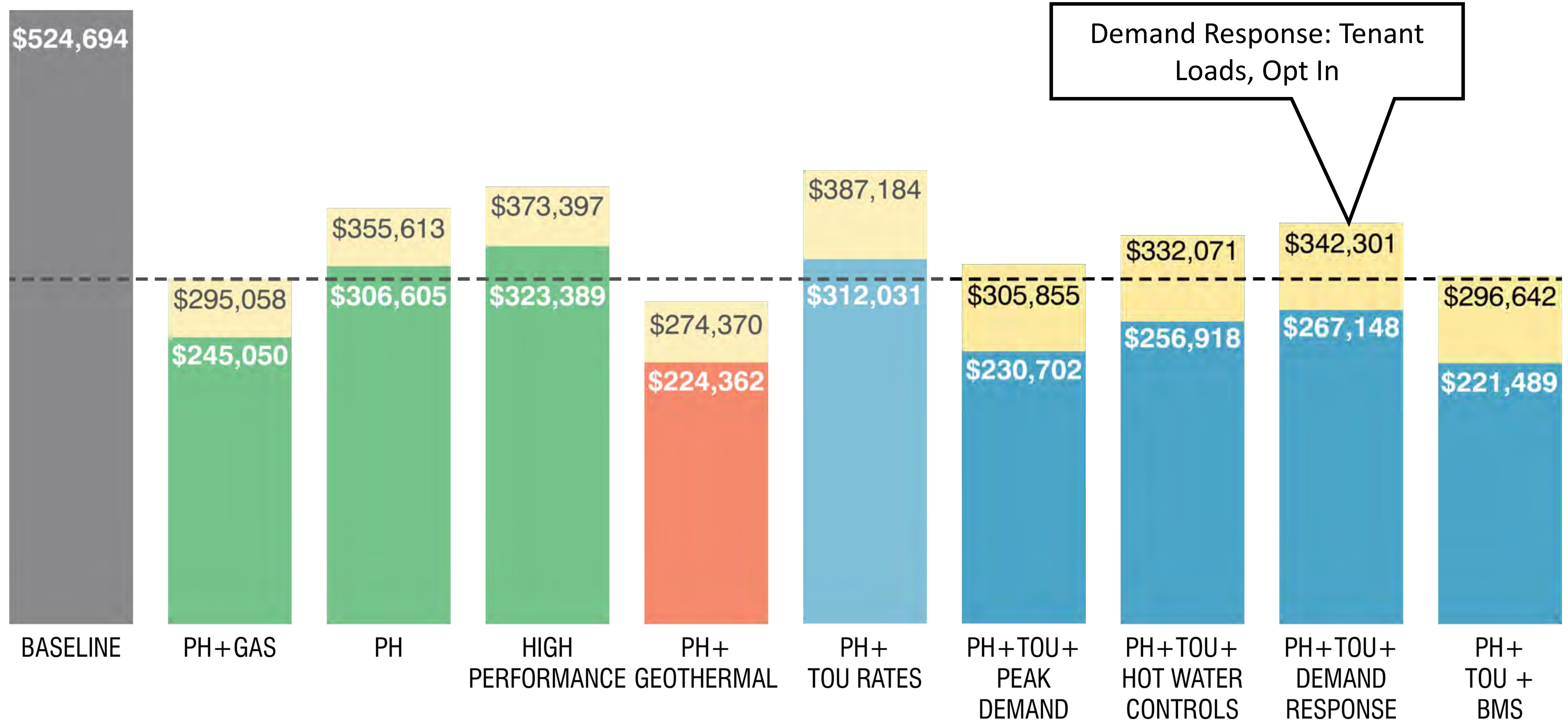


Rate Structure and BMS Controls

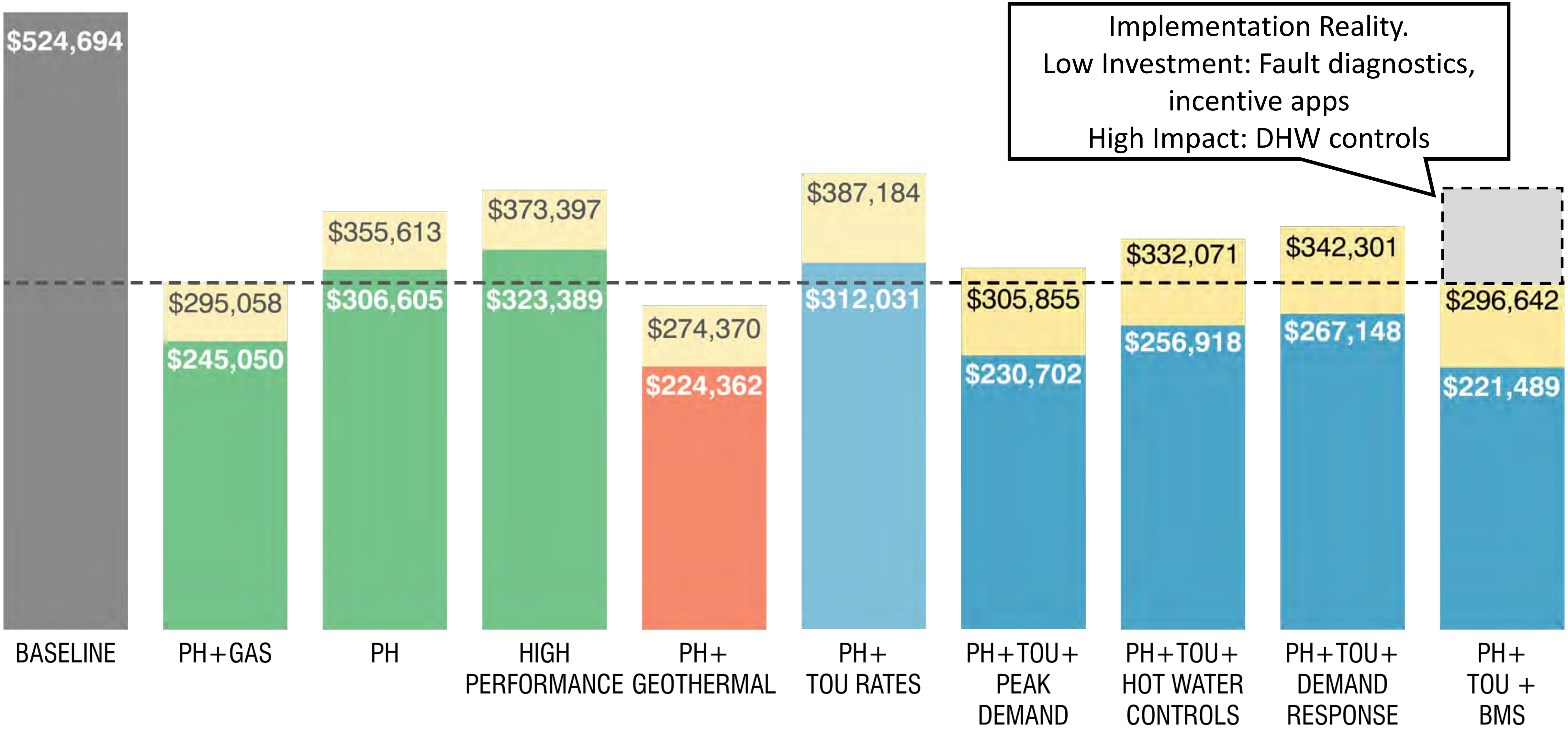


DHW energy load

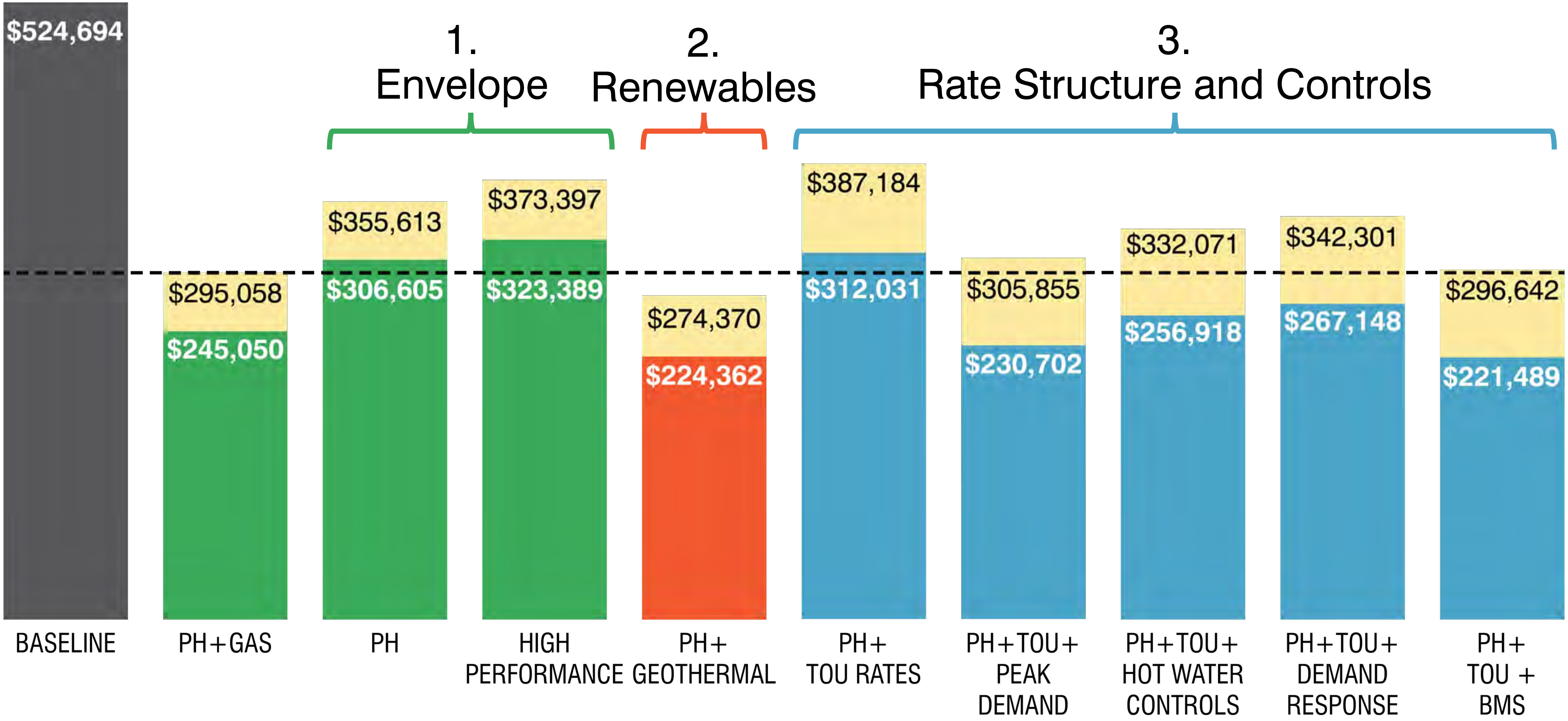
Rate Structure and BMS Controls



Rate Structure and BMS Controls



Implementation Sequence



Next Steps: Resources

ELECTRIFIED	ICON	STRATEGY	DESCRIPTION	ANNUAL PERFORMANCE	COST & SAVINGS		NOTES	
		BASELINE	Fully electric building meeting the 2020 NYC Energy Code	Electric 2,098,776 kWh Gas Carbon 606 tCO2e	ANNUAL UTILITY COST	$524,694	Fully electric buildings that meet code minimum lock the building owner into decades of higher utility costs and subpar energy and carbon performance.	CODE
		PASSIVE HOUSE + GAS DHW	Passive house envelope with high efficiency gas DHW heater	Electric 1,017,400 kWh Gas 2,315,000 kBTU (678,459 kWh) Carbon 417 tCO2e	ANNUAL UTILITY COST Cost Savings from Baseline:	$295,058 $229,636 (44%)	This is the industry standard for affordable Passive House housing and serves as the utility cost threshold to exceed for a fully electric building to be cheaper than a mostly electric building.	PASSIVE HOUSE
		PASSIVE HOUSE + ELECTRIC DHW	Passive house envelope with electric heat pump domestic hot water heater	Electric 1,422,452 kWh Gas Carbon 411 tCO2e	ANNUAL UTILITY COST Cost Savings from Baseline: Cost Increase from PH+Gas:	$355,613 $169,531 (32%) $60,555 (21%)	The standard fully electrified building switches from gas DHW to an electric heat pump hot water heater, reducing savings from the baseline and increasing cost from the gas DHW scope.	PASSIVE HOUSE
		HIGH PERFORMANCE + ELECTRIC DHW	Value-engineered passive house envelope with high performance HPAC window units for heating and cooling	Electric 1,493,587 kWh Gas Carbon 432 tCO2e	ANNUAL UTILITY COST Cost Savings from Baseline: Cost Increase from PH+Gas:	$373,397 $151,297 (29%) $78,339 (27%)	"Pretty Good House" scope locks in 95% of the energy savings of the PH+Electric strategy with considerable installation cost savings. Special consideration is needed for air tightness at the HPAC in this strategy.	PASSIVE HOUSE
		PASSIVE HOUSE + SOLAR	PH + Electric scope with maximized (168 kW) rooftop solar photovoltaic system	Electric 1,222,420 kWh Gas Carbon 353 tCO2e	ANNUAL UTILITY COST Cost Savings from Baseline: Cost Increase from PH+Gas:	$306,605 $218,089 (42%) $11,547 (4%)	Implementing a solar roof photovoltaic system recovers 85% of the cost savings difference lost in the switch from PH+Gas to PH+Electric. Solar savings would be applied to owner meter.	RENEWABLE ENERGY
		SOLAR BATTERIES	Energy batteries to store solar generation. Replaces emergency generator.	Electric Gas - Carbon	ANNUAL UTILITY COST Cost Savings from Baseline: Cost Increase from PH+Gas:	- - -	Significant policy and incentive initiatives are required in order for solar battery installation to be commonplace in NYC.	RENEWABLE ENERGY
		PASSIVE HOUSE + GEOTHERMAL	PH + Electric scope with closed-loop geothermal system for DHW, heating, & cooling	Electric 1,083,224 kWh Gas Carbon 313 tCO2e	ANNUAL UTILITY COST Cost Savings from Baseline: Cost Savings from PH+Gas:	$274,370 $300,332 (57%) $70,696 (24%)	Geothermal outperforms the PH+Gas industry standard. This is the first fully electrified scope to lower utility cost from PH+Gas. Initial site feasibility for geothermal is strongly recommended.	RENEWABLE ENERGY
		PASSIVE HOUSE + TIME OF USE RATES	PH + Electric scope with Con Edison's optional time of use electric rates	Electric 1,422,452 kWh Gas Carbon 411 tCO2e	ANNUAL UTILITY COST Cost Savings from Baseline: Cost Increase from PH+Gas:	$387,184 $137,510 (26%) $92,126 (31%)	Time of Use (TOU) Rates without any strategies to reduce peak demand result in utility cost increase. Solar PV works well with TOU rates, but does not overcome the cost increase.	ENERGY CONTROLS
		PASSIVE HOUSE + TIME OF USE + ENERGY CONTROLS	PH + Electric scope with energy management controls for peak energy, DHW, and demand control	Electric 1,419,018 kWh Gas Carbon 410 tCO2e	ANNUAL UTILITY COST Cost Savings from Baseline: Cost Increase from PH+Gas:	$296,642 $228,052 (43%) $1,584 (<1%)	Energy management controls in conjunction with time of use rates are a key lever to bringing electrified building utility beneath the PH+Gas threshold. No energy generation is included, so PH+Geothermal still outperforms this scope.	ENERGY CONTROLS
		PASSIVE HOUSE + SOLAR + TIME OF USE + ENERGY CONTROLS	PH Electric scope with solar, time of use rates, and energy management controls	Electric 1,023,536 kWh Gas Carbon 296 tCO2e	ANNUAL UTILITY COST Cost Savings from Baseline: Cost Savings from PH+Gas:	$221,489 $303,205 (58%) $73,569 (25%)	PH+Electric scope with TOU rates, energy controls, and solar is the highest performing scope, well below the PH+Gas threshold. Before implementing, Con Edison must clarify TOU rates and a custom control strategy should be designed. Exact interaction of building controls and solar may vary.	ENERGY CONTROLS

Next Steps: Implementation & Demonstration

Thank you!

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October 24, 2024

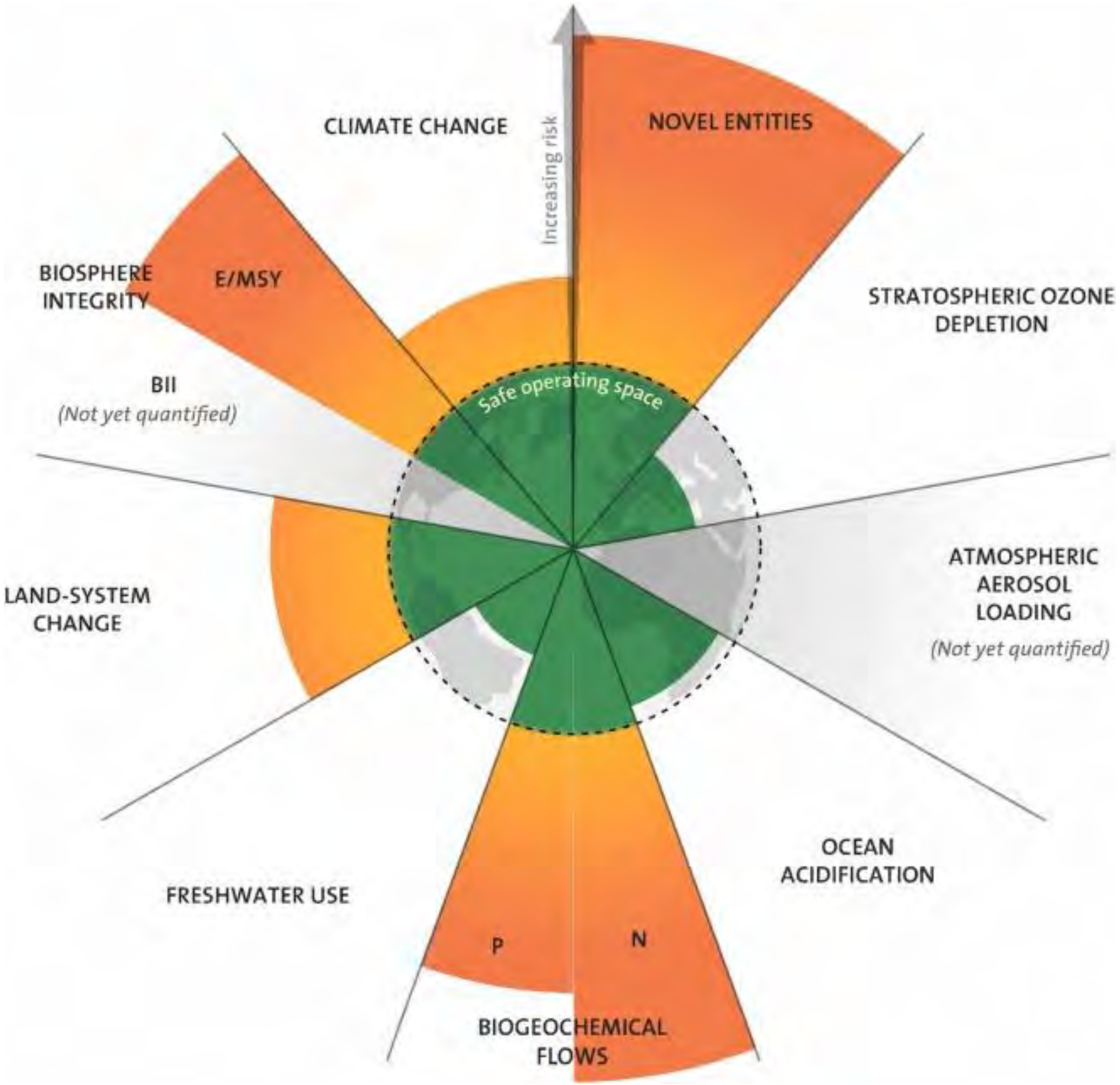

Carmen Villegas Apartments (CVA)
MAP

NEW YORK STATE | Buildings of Excellence
Award Winner

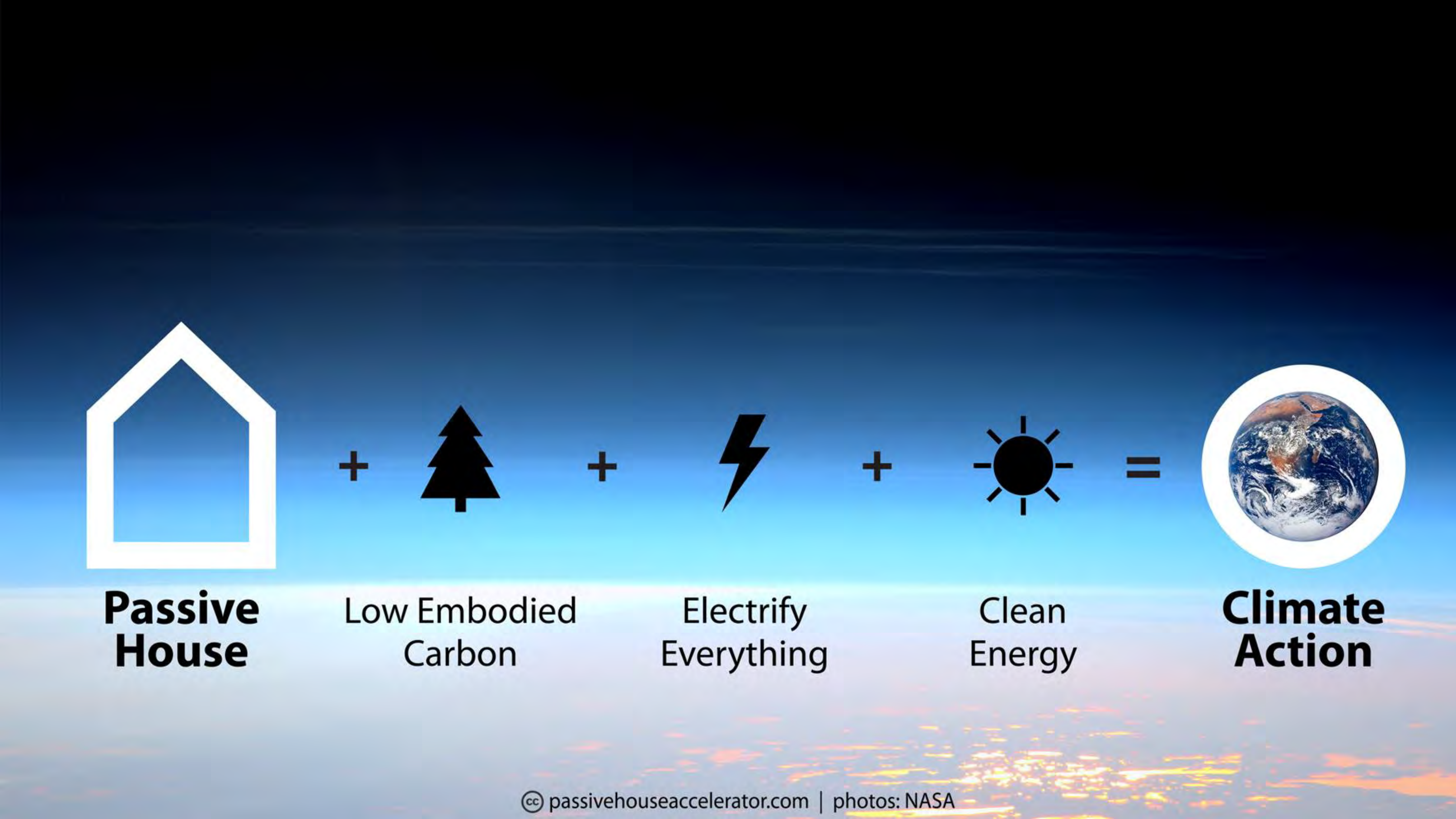
Early Design Support (Round 3)
&
Demonstration Winner (Round 4)

Carmen Villegas Apartments (CVA)

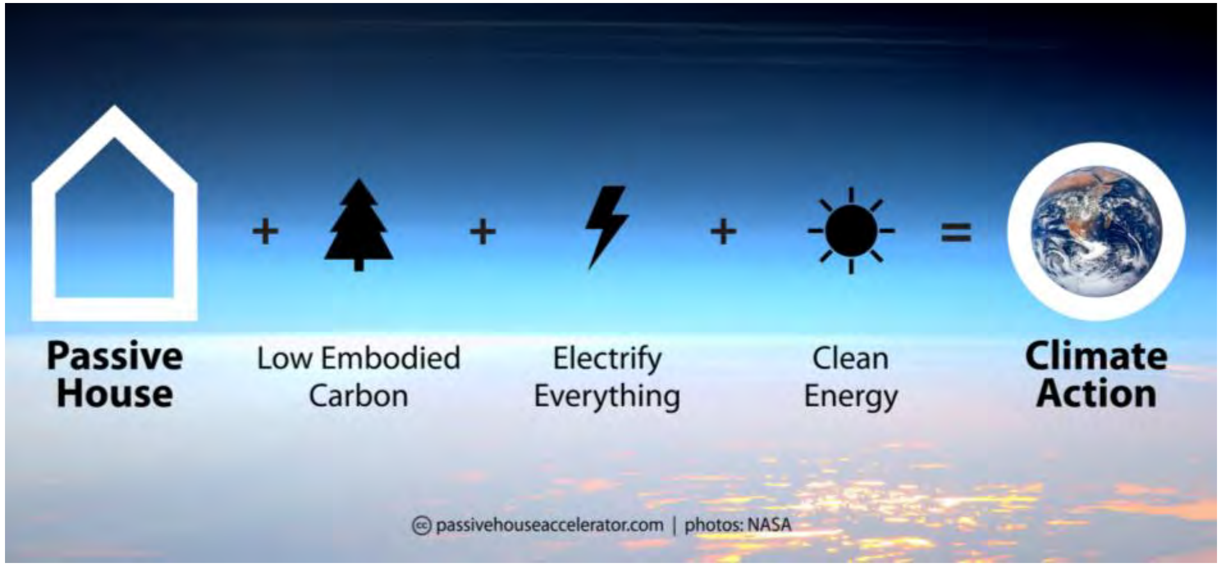
PLANETARY BOUNDARIES

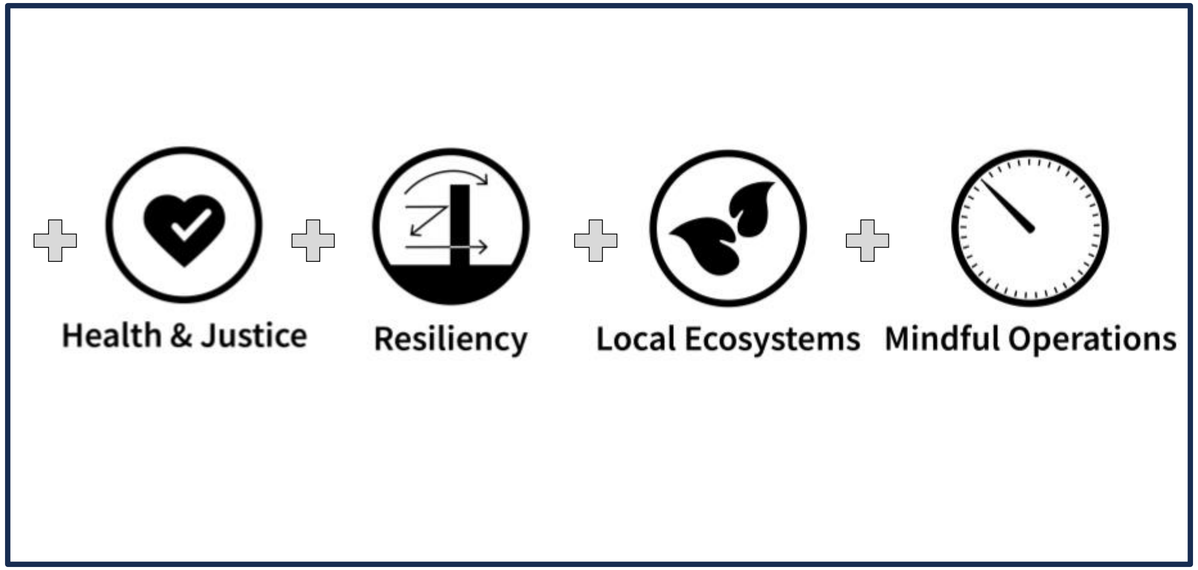


Source Credit: Anna Ferretto, Robin Mathews, Rob Brooker, Pete Smith "Planetary Boundaries and the Doughnut frameworks: A review of their local operability" CC BY 4.0 Credit: "Azote for Stockholm Resilience Centre, based on analysis in [Persson et al. (2022)](#) and [Steffen et al., 2015a](#), [Steffen et al., 2015b](#)". https://www.sciencedirect.com/science/article/pii/S2213305422000285#fig0005


Passive House
+
Low Embodied Carbon
+
Electrify Everything
+
Clean Energy
=
Climate Action
passivehouseaccelerator.com | photos: NASA

TOWARDS REGENERATIVE ARCHITECTURE





Passive House
Embodied Carbon: Measuring & Implement
Prefabricated Facade
Planning for adjacent Renovation
All Electric
Ground Source Heat Pumps
On Site Generation (BIPV + Roof Solar)
ILFI Zero Carbon (includes offsets)

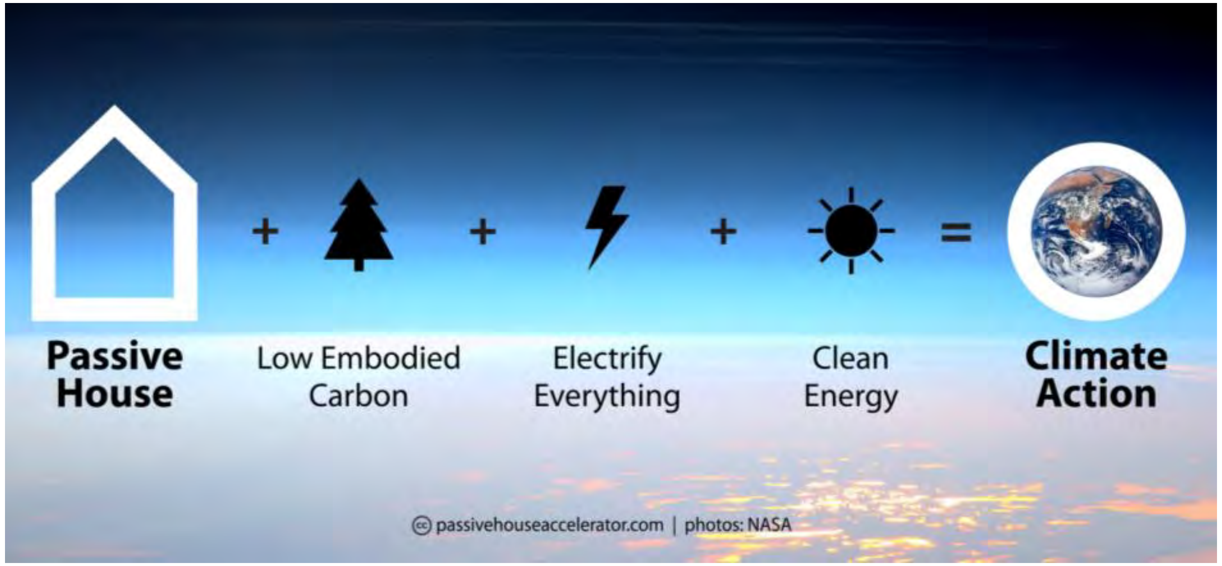
ILFI Red List Free
WELL & RESET
ERV's for IAQ
Native Plants & Biophilia
Natural Light Design
OITC sound control
Active Design
HPD's & Transparency
Design for Freedom

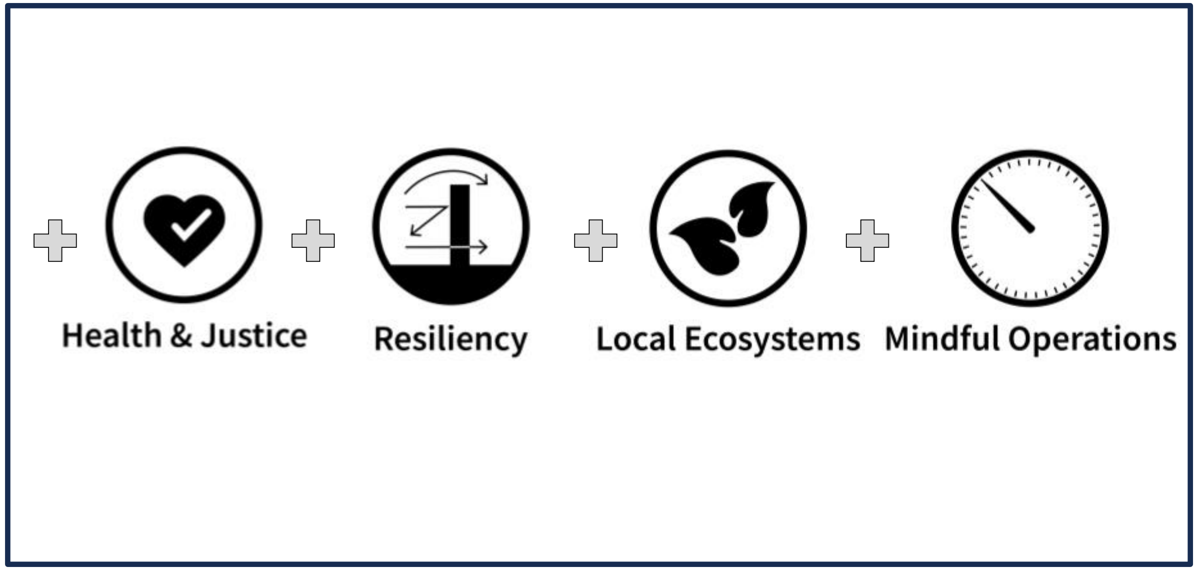
SWPPP: Storm Water
Resiliency from Flooding
Resiliency from Heat Island
Place of Refuge
Backup Power Sizing
Battery Ready

Near Public Trans.
Water saving use
Bird Friendly Glass
Dark Sky lighting
Cultural Celebration
Community Building

Operations & Maintenance
Ongoing Commissioning
Green Cleaning Protocols
Composting & Zero Waste
Tracking Energy Use & Reporting

TOWARDS REGENERATIVE ARCHITECTURE





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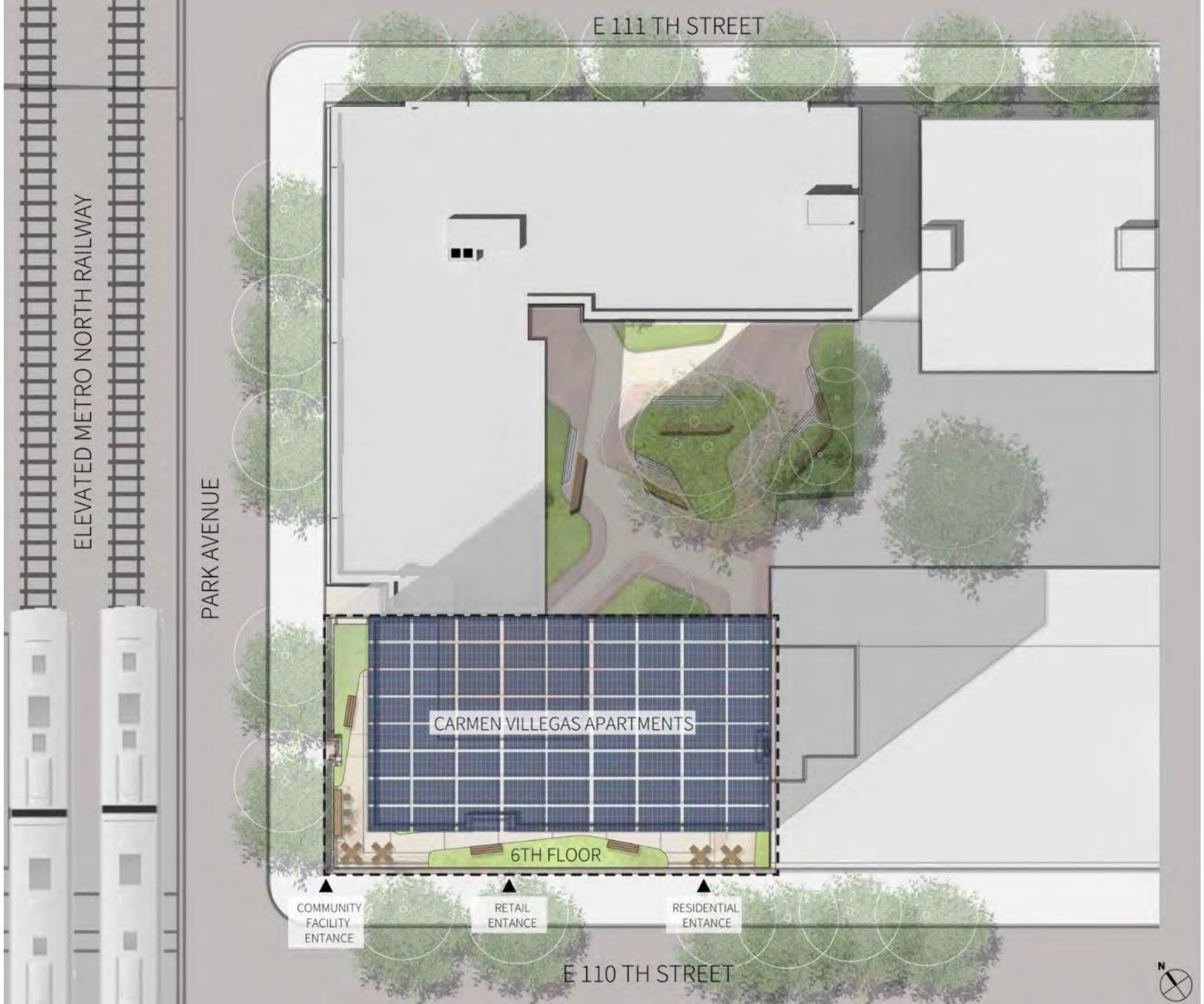


Developers:

Ascendant Neighborhood Development

Urban Builders Collaborative

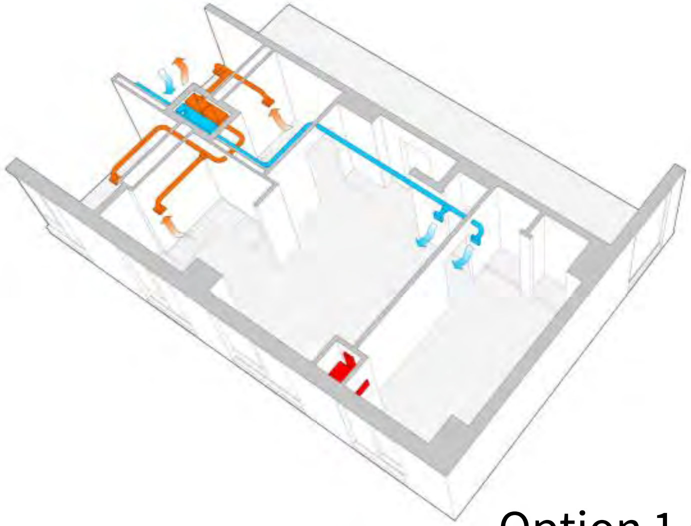
Xylem Projects

Design:
Magnusson Arch & Planning
Bright Power
DeSimone
AMA Group

New Construction
211 Units for Seniors
28 Stories
Community Facility for Seniors
Adjacent to Future Renovation

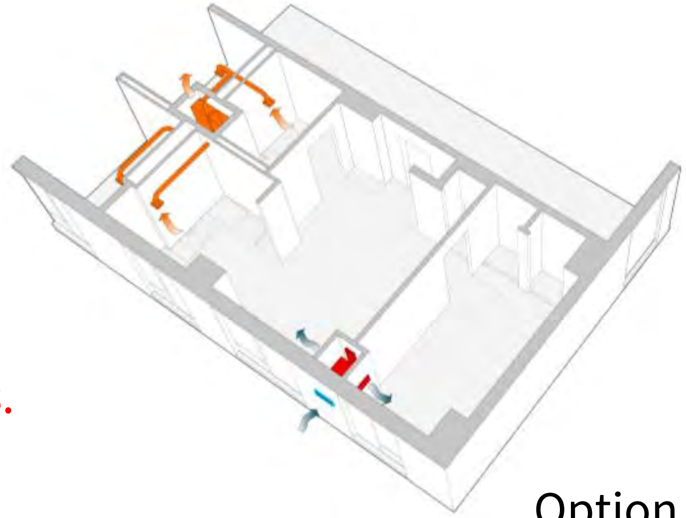
NYSERDA BoE
Early Design Phase Funding & Demonstration Project

PART ONE OF BOE STUDY: PASSIVE HOUSE VENTILATION



Option 1 (PH)

Vs.

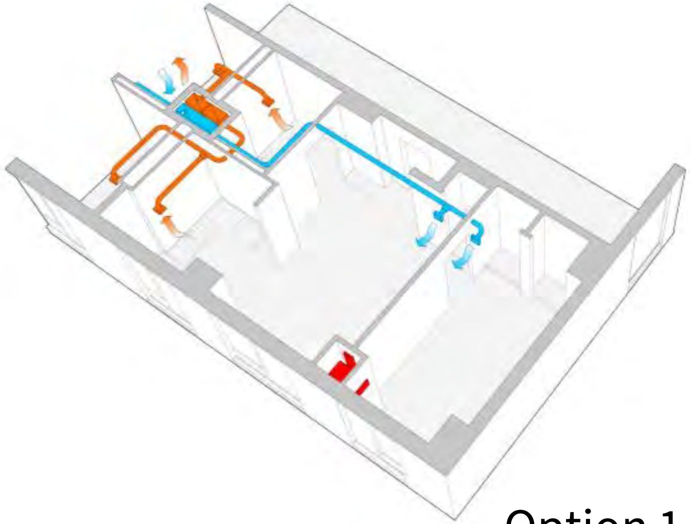


Option 2

<u>ERV vs Project Min</u>
Construction Cost Differential
$587,500

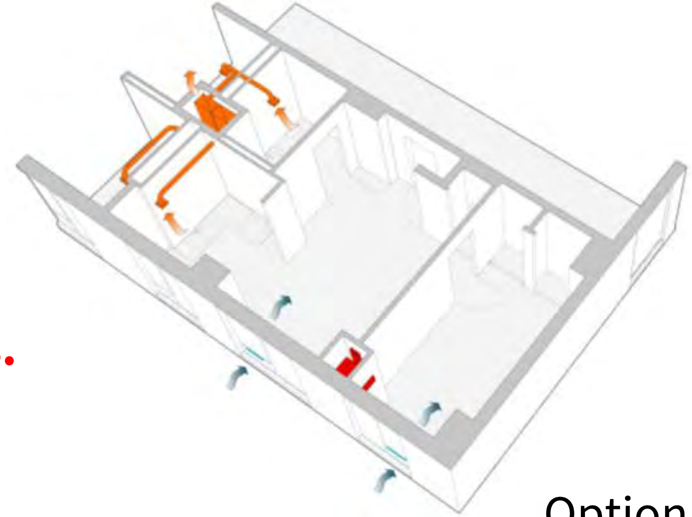
Opt 1 Yearly Energy Savings
$65,900

PAYBACK: 8.9 Years



Option 1 (PH)

Vs.



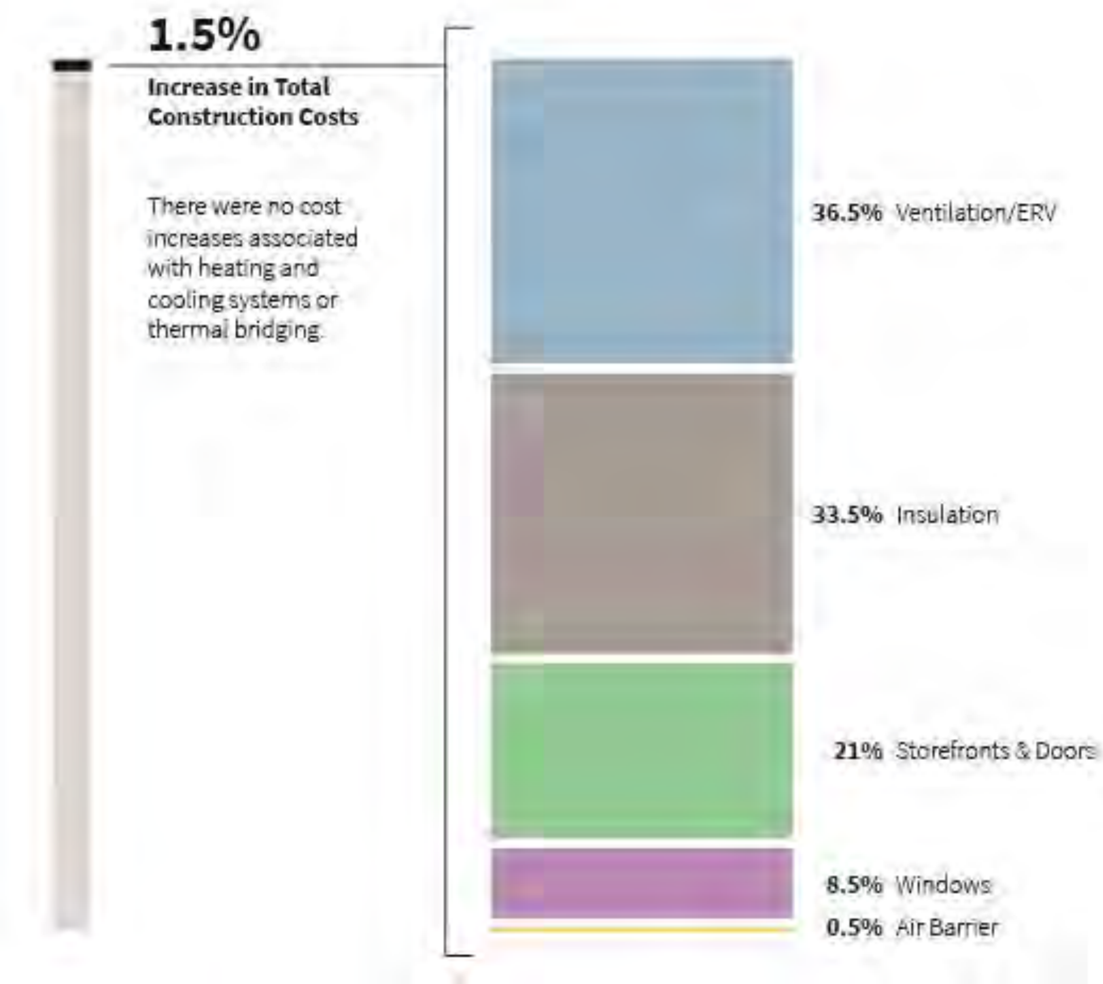
Option 3

<u>ERV vs Code Min w/Trickle Vent.</u>
Construction Cost Differential
$697,970

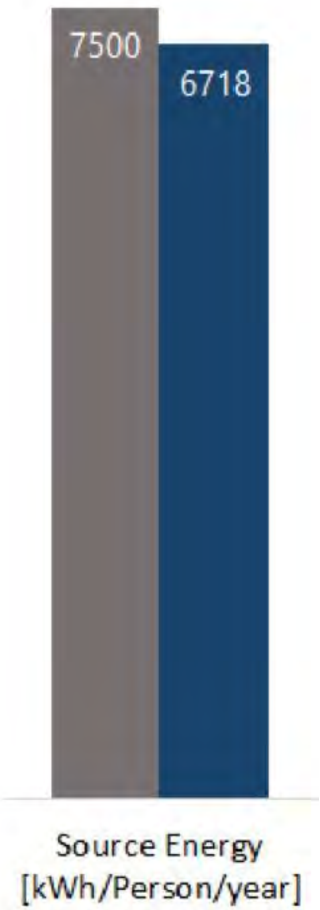
Opt 1 Yearly Energy Savings
$49,300

PAYBACK: 14.2 Years

PART TWO OF BOE STUDY: PASSIVE HOUSE ROI



PH RESULTS: COOLING LOAD DOMINATED



Modeled Result

Phius Maximum Threshold for Compliance

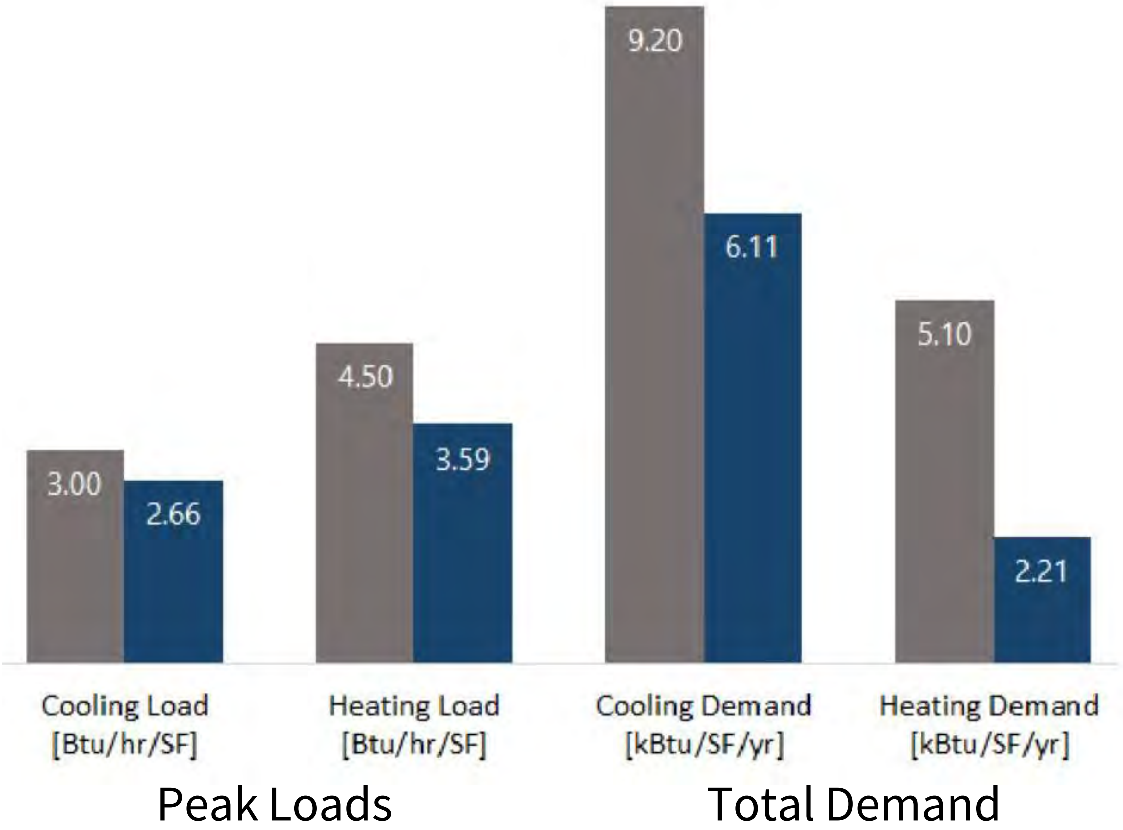
Source Energy: Modeled value within 11% of target

Cooling Load: Modeled value within 11% of target

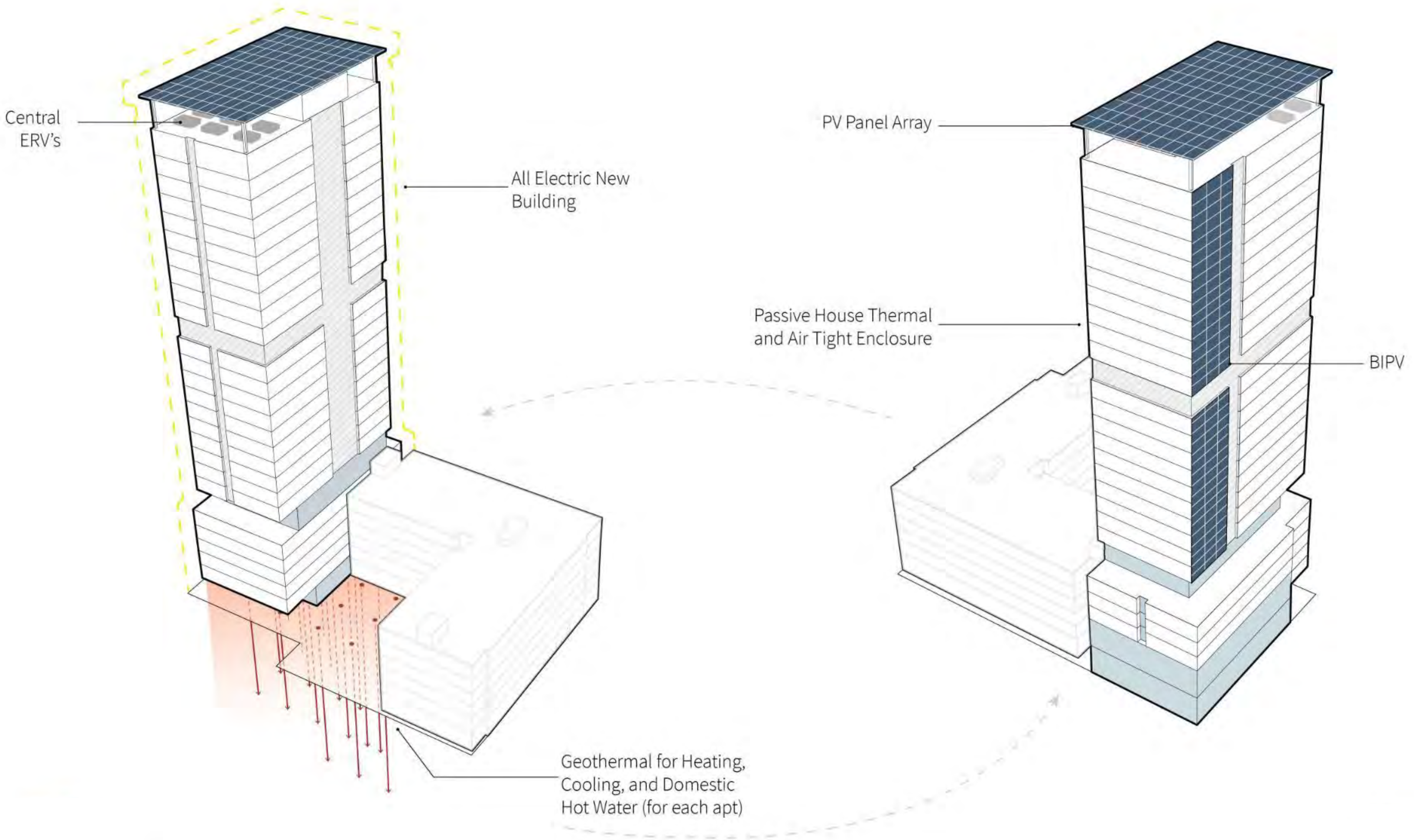
Heating Load: Modeled value within 20% of target

Cooling Demand: Modeled value within 34% of target

Heating Demand: Modeled value within 57% of target



PH: BENEFITS TO THE GROUND SOURCE SYSTEM



PART THREE:
WHAT "ZERO"?

Included
Partial or Encouraged
Ignored

Other Frameworks to Explore:

ASHRAE/ICC 240P
RICS Whole Life Carbon
(Phius Revive)

				ILFI Zero Carbon 1.1	ASHRAE 228	AIA 2030 Zero Code	LEED Zero Carbon 2020
Upfront Carbon	Design Phase	A0	Office Operations				
	Materials	A1	Raw Material Extraction				
		A2	Transport				
		A3	Manufacturer				
			Biogenic Storage				
		A4	Transport to site				
		Upfront Material Scope	Structure				
			Enclosure				
			Interiors				
			FF&E				
			Landscape/Site				
			MEP+Systems				
			Renewables				
	Construction	A5a	Construction Fuel				
		A5w	Construction Waste				

PART THREE:
WHAT “ZERO”?

Legend
Included
Partial or Encouraged
Ignored

Other Frameworks to Explore:

ASHRAE/ICC 240P
RICS Whole Life Carbon
(Phius Revive)

				ILFI Zero Carbon 1.1	ASHRAE 228	2030 Zero Code	LEED Zero Carbon 2020
Operational Carbon	Operational	B1	Site Operational Energy	Included	Included	Included	Included
			Renewables On Site	Included	Included	Included	Included
			Source Energy	Ignored	Included	Ignored	Included
			Refrigerant Leakage	Partial or Encouraged	Included	Ignored	Ignored
			Energy Time of Use	Ignored	Ignored	Ignored	Partial or Encouraged
			Energy Use w/ Future Climate	Ignored	Ignored	Ignored	Ignored
			Occupant Travel to Site	Ignored	Ignored	Ignored	Included
		B2	Maintenance	Ignored	Ignored	Ignored	Ignored
		B3	Repair	Ignored	Ignored	Ignored	Ignored
		B4	Replacement	Ignored	Ignored	Ignored	Ignored
			Landscape Maintenance	Ignored	Included	Ignored	Ignored
			Landscape Sequestration	Ignored	Ignored	Ignored	Ignored
		B5	Refurbishment	Ignored	Ignored	Ignored	Ignored
		B6	Offsite Generation (REC)	Included	Included	Included	Included
			Discounted Renewables Offsite	Ignored	Included	Included	Ignored
			Carbon Offsets	Included	Ignored	Ignored	Included
		B7	Operational Water	Ignored	Ignored	Ignored	Partial or Encouraged
End of Life Carbon	Deconstruction	C1	Deconstruction/Demo	Ignored	Ignored	Ignored	Partial or Encouraged
		C2	Transport	Ignored	Ignored	Ignored	Ignored
		C3	Waste Processing	Ignored	Ignored	Ignored	Ignored
		C4	Disposal	Partial or Encouraged	Ignored	Ignored	Ignored
	Beyond	D	Reuse/Recovery/Recycling	Ignored	Ignored	Ignored	Ignored
All Phases		All	GWP 20 or other shorter metric	Ignored	Ignored	Ignored	Ignored

ILFI FEASIBILITY

ILFI Zero Carbon v1.1 (July 2024)

CVA Project: Affordable Senior Highrise Baseline EGC

Legend	
	Savings
	Cost

		Design Scope	Construction Scope	Operations Scope
Operational Carbon	Energy Modeling & CPHC Consulting			
	No on-site combustion			
	Passive House for low EUI (20% below ASHRAE 90.1 2019, Site Energy)			
	Renewable Energy Procurement 100% (Site) Energy use for 15 years			
	Renewable Energy On Site			
	Maintenance Plan to reduce Refrigerant Leakage			
	Measured energy use for 12 months at full occupancy			
Embodied Carbon	Model Embodied Carbon & Prepare Audit Documents			
	A1-A4: 20% Reduction in EC of Material Procurement (and > 350 kgCO2e/m2)			
	Track A5 During Construction			
	Carbon Offsets (for embodied carbon) from certified Green-e provider			

Project Savings	Energy Savings			
	IRA Incentives (including 45L)			
	BoE Award Funds			
	ConEd Clean Heat			
	Agency Preference/Funding			

ILFI FEASIBILIY: OPERATIONAL ENERGY

SOURCE ENERGY USE INTENSITY (EUI)

(w/o renewables)

Avg NYC Multifamily Bldg:	112 kBtu/sf/yr
Code Building (2020):	89.0 kBtu/sf/yr
PHIUS Primary Energy:	Approx 42.3 kBtu/sf/yr
PHI Primary Energy:	Approx 40 kBtu/sf/yr
LL97- 2024 limit:	6.75 kgCO2/sf
LL97- 2030 limit:	4.07 kgCO2/sf

ILFI EUI Requirement: 20% > ASHRAE 90.1 2019

ZERO Tool (2003 existing data): Site EUI 60

Building As Proposed: **43.60** kBtu/sf/yr

1.37 kgCO2/sf (‘24-’29)

SITE EUI: 21.04 kBtu/sf

Certification: Target **PHIUS 2021 CORE**

ILFI FEASIBILIY: UPFRONT CARBON SCOPE

REPORTED AND OFFSET

Primary Material Assemblies	Substructure	• Foundations • Subgrade Enclosures • Slabs-On-Grade

	Shell	• Superstructure of Floors, Roof, and Stairs
		• Exterior Vertical and Horizontal Enclosures
		  • Cladding
		  • Insulation
		  • Fenestration
		  • Roof Assemblies

Exterior Material Assemblies	Site Materials	• Roads, Paths and Paving • Special Surfacing and Paving

Interior Material Assemblies	Interior Construction	• Interior Partitions
		  • Framing
		  • Insulation
		  • Fenestration

	Interior Finishes	• Wall • Flooring • Ceiling
Other Material Assemblies	*Interior Equipment and Furnishings*	• *Furniture* • *Fixtures* • *Equipment*
	Services	• *Mechanical* • *Electrical + Fire Detection* • *Plumbing + Fire Suppression*
	Sitework	• *Site Preparation* • *Liquid and Gas Site Utilities* • *Electrical Site Improvements*

REPORTED

ILFI Zero Carbon v1.1 (July 2024)

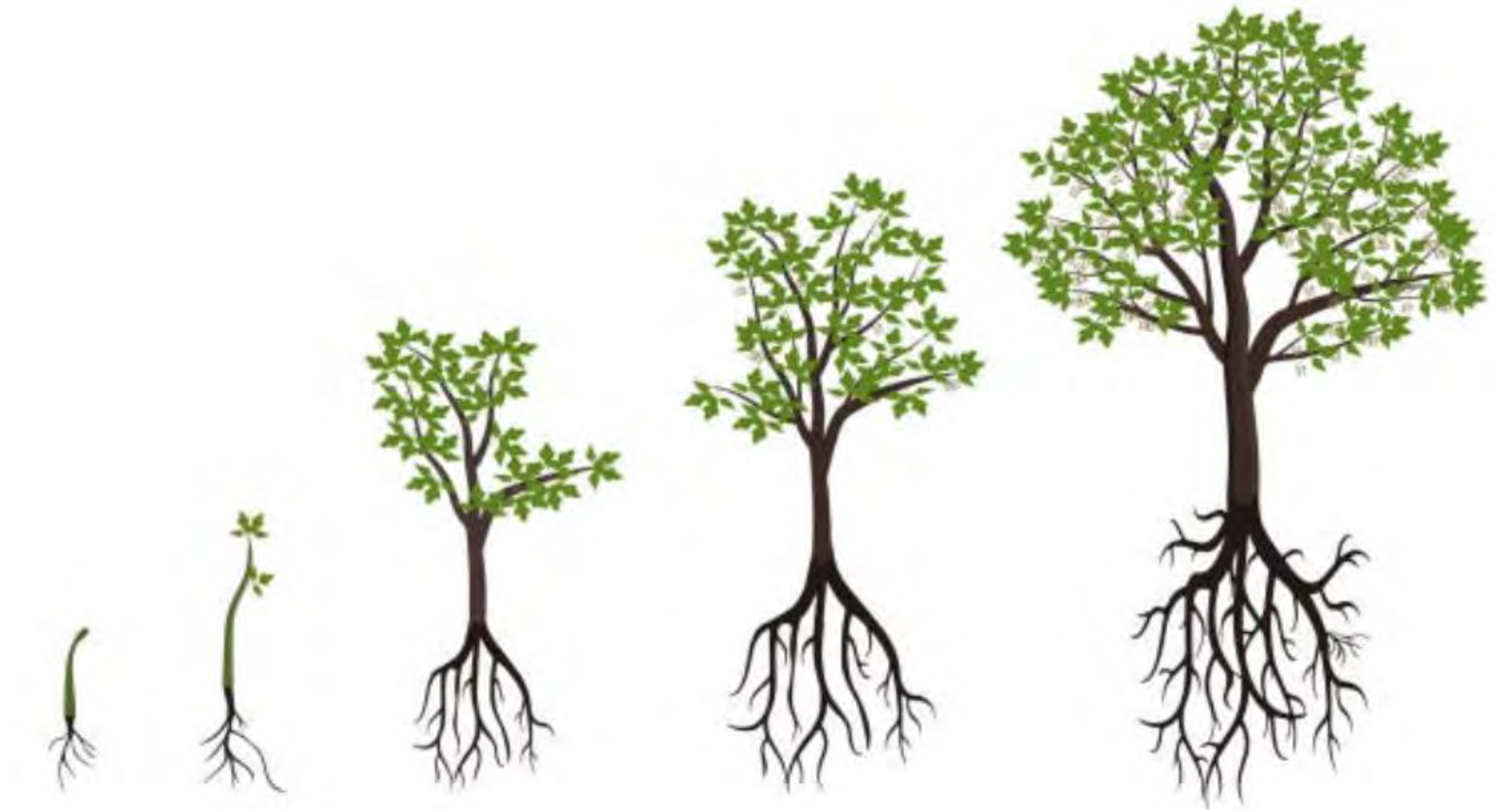
Life Cycle Phases: A1-A5

Primary & Exterior Material Assemblies To Be Min 20% Below Baseline

& Total Project Max 350* kg CO_2 e/m2 (3,767 kg CO_2 e /sqft)
(*Avg 2030 targets of LETI & SBTi)

For Cross Reference
CLF 2023 California Report:
Median Lifetime Embodied Carbon Intensity, Phases A1-A3:
390 kg CO_2e/m^2

UPFRONT CARBON: CARBON REFERNECE



Sapling (5yrs) absorbs
5 kg CO2 yr

Mature (10-20yrs) absorbs
20 kg CO2 yr

Old (40-60+yrs) absorbs
40-50+ kg CO2 yr

ILFI
per square foot limit
3,767 kg CO_2 e
=
188 mature trees absorption rate per year

https://ceepr.mit.edu/wp-content/uploads/2024/03/MIT-CEEPR-WP-2024-04.pdf

UPFRONT CARBON: TOOLS & PROCESS

Select Freeze Point

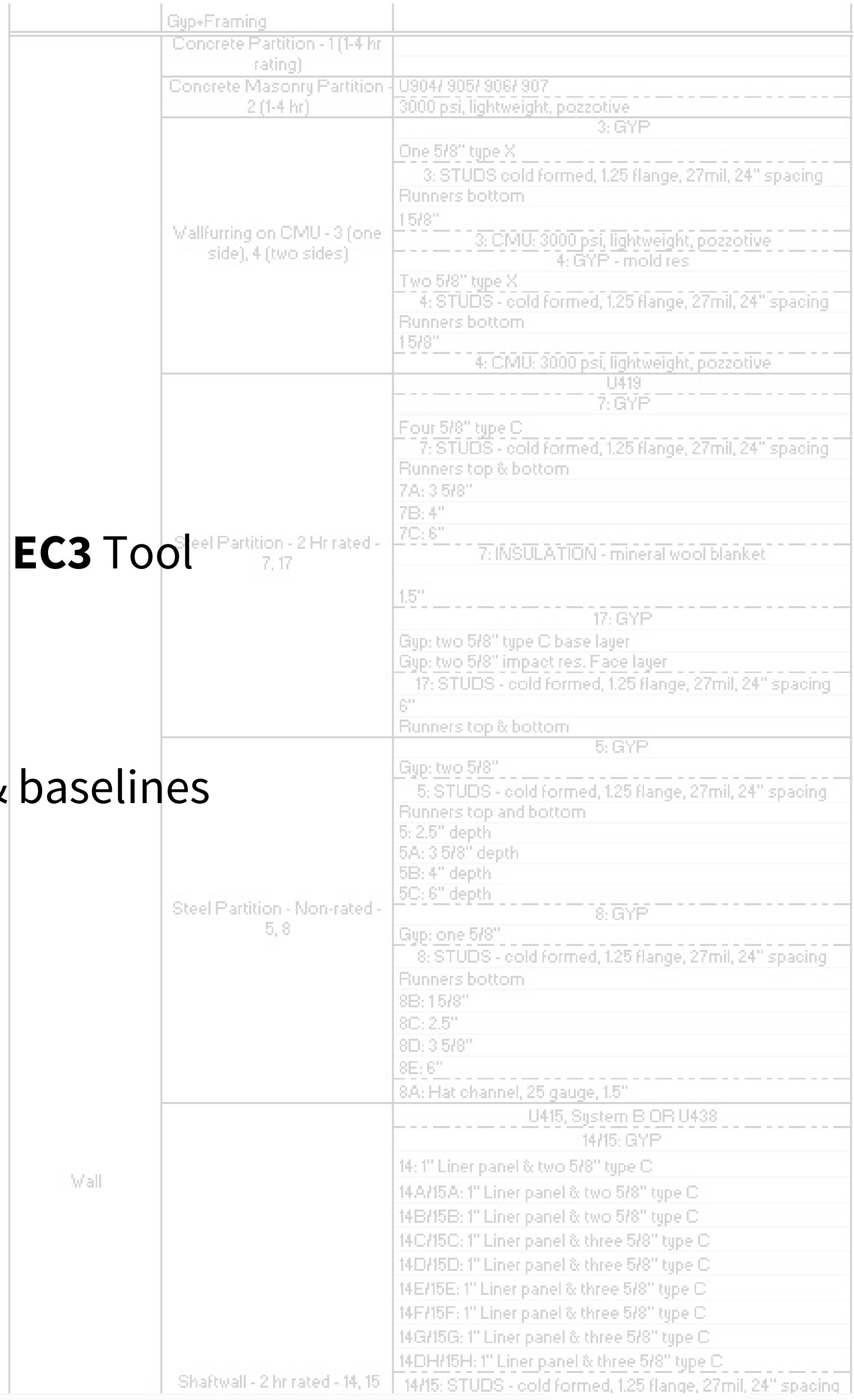
Use **tallyCAT** (Plugin REVIT) to → **EC3** Tool

Organize EC3 into ILFI Categories

Tracking Spreadsheet: materials & baselines

EC3 Tool → GWP Spreadsheet

Final Calculator Spreadsheet



	Gyp+Framing	
	Concrete Partition - 1 (1-4 hr rating)	
	Concrete Masonry Partition - 2 (1-4 hr)	U904/ 905/ 906/ 907 3000 psi, lightweight, pozzotive
	Wallfurring on CMU - 3 (one side), 4 (two sides)	3: GYP One 5/8" type X 3: STUDS cold formed, 1.25 flange, 27mil, 24" spacing Runners bottom 1 5/8" 3: CMU: 3000 psi, lightweight, pozzotive 4: GYP - mold res Two 5/8" type X 4: STUDS - cold formed, 1.25 flange, 27mil, 24" spacing Runners bottom 1 5/8" 4: CMU: 3000 psi, lightweight, pozzotive
	Steel Partition - 2 Hr rated - 7, 17	U419 7: GYP Four 5/8" type C 7: STUDS - cold formed, 1.25 flange, 27mil, 24" spacing Runners top & bottom 7A: 3 5/8" 7B: 4" 7C: 6" 7: INSULATION - mineral wool blanket 1.5" 17: GYP Gyp: two 5/8" type C base layer Gyp: two 5/8" impact res. Face layer 17: STUDS - cold formed, 1.25 flange, 27mil, 24" spacing 6" Runners top & bottom
	Steel Partition - Non-rated - 5, 8	5: GYP Gyp: two 5/8" 5: STUDS - cold formed, 1.25 flange, 27mil, 24" spacing Runners top and bottom 5: 2.5" depth 5A: 3 5/8" depth 5B: 4" depth 5C: 6" depth 8: GYP Gyp: one 5/8" 8: STUDS - cold formed, 1.25 flange, 27mil, 24" spacing Runners bottom 8B: 1 5/8" 8C: 2.5" 8D: 3 5/8" 8E: 6" 8A: Hat channel, 25 gauge, 1.5"
Wall	Shaftwall - 2 hr rated - 14, 15	U415, System B OR U438 14/15: GYP 14: 1" Liner panel & two 5/8" type C 14A/15A: 1" Liner panel & two 5/8" type C 14B/15B: 1" Liner panel & two 5/8" type C 14C/15C: 1" Liner panel & three 5/8" type C 14D/15D: 1" Liner panel & three 5/8" type C 14E/15E: 1" Liner panel & three 5/8" type C 14F/15F: 1" Liner panel & three 5/8" type C 14G/15G: 1" Liner panel & three 5/8" type C 14DH/15H: 1" Liner panel & three 5/8" type C 14/15: STUDS - cold formed, 1.25 flange, 27mil, 24" spacing

UPFRONT CARBON: SETTING THE BASELINE

To demonstrate 20% reduction of materials, it is critical to set a baseline!

Baseline Options:

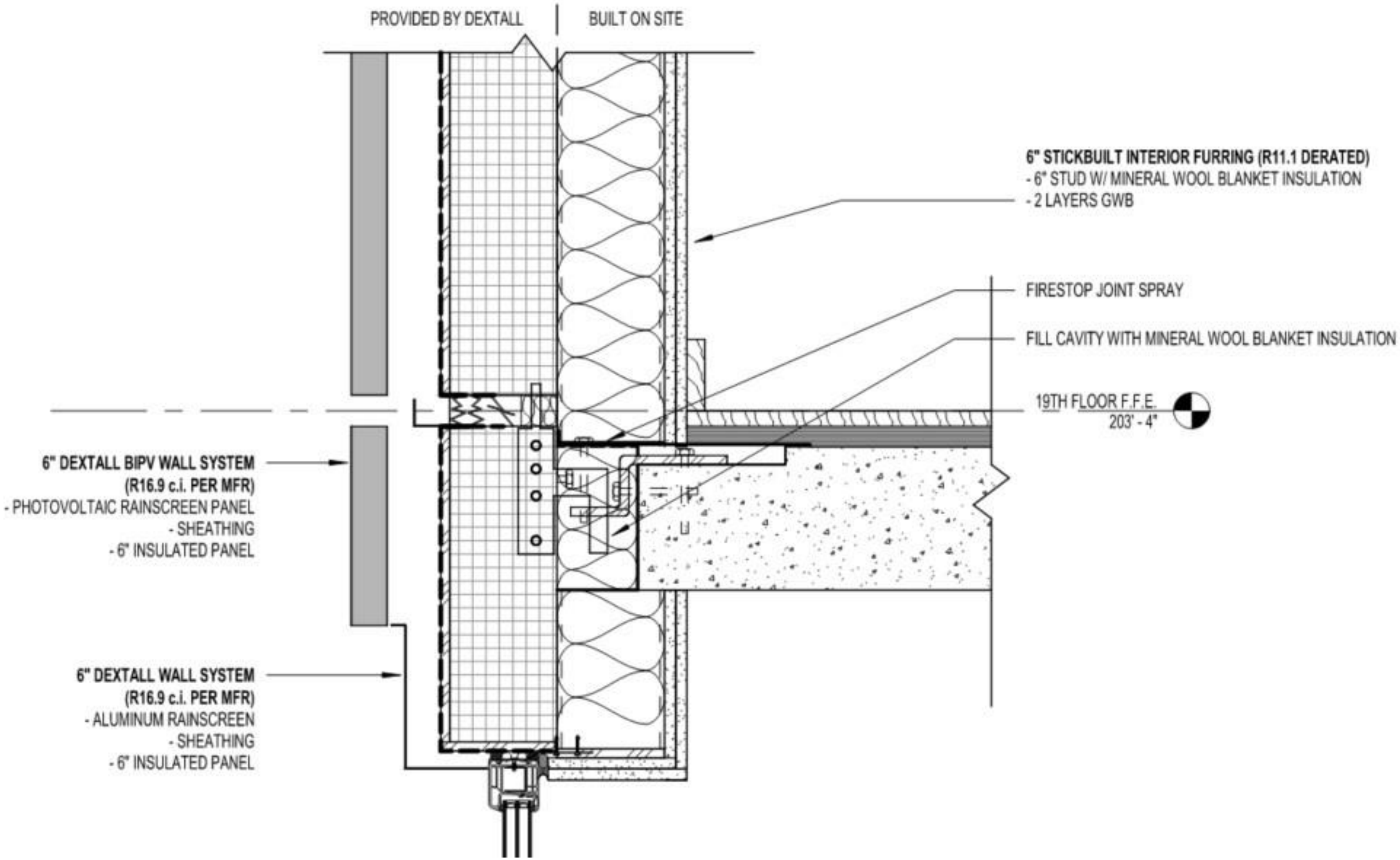
1) Carbon Leadership Forum **(CLF) 2023 Material Baselines**

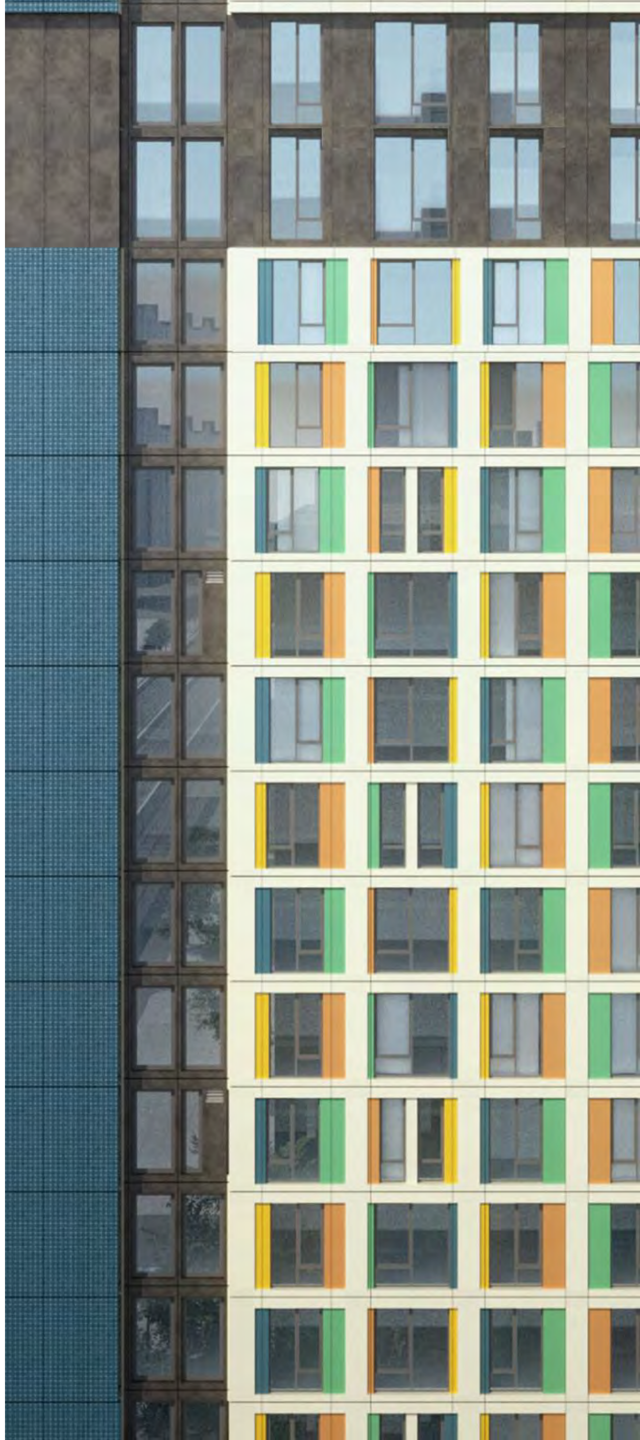
2) Where #1 does not exist, use **Product Industry Average values from EC3**.

3) Interior products clarification: product baselines are currently only specified in the ILFI-approved baseline tools for the following categories: ***Carpet, Ceiling Tile, Gypsum Wallboard***. (But other products still count towards total per sqft requirement)

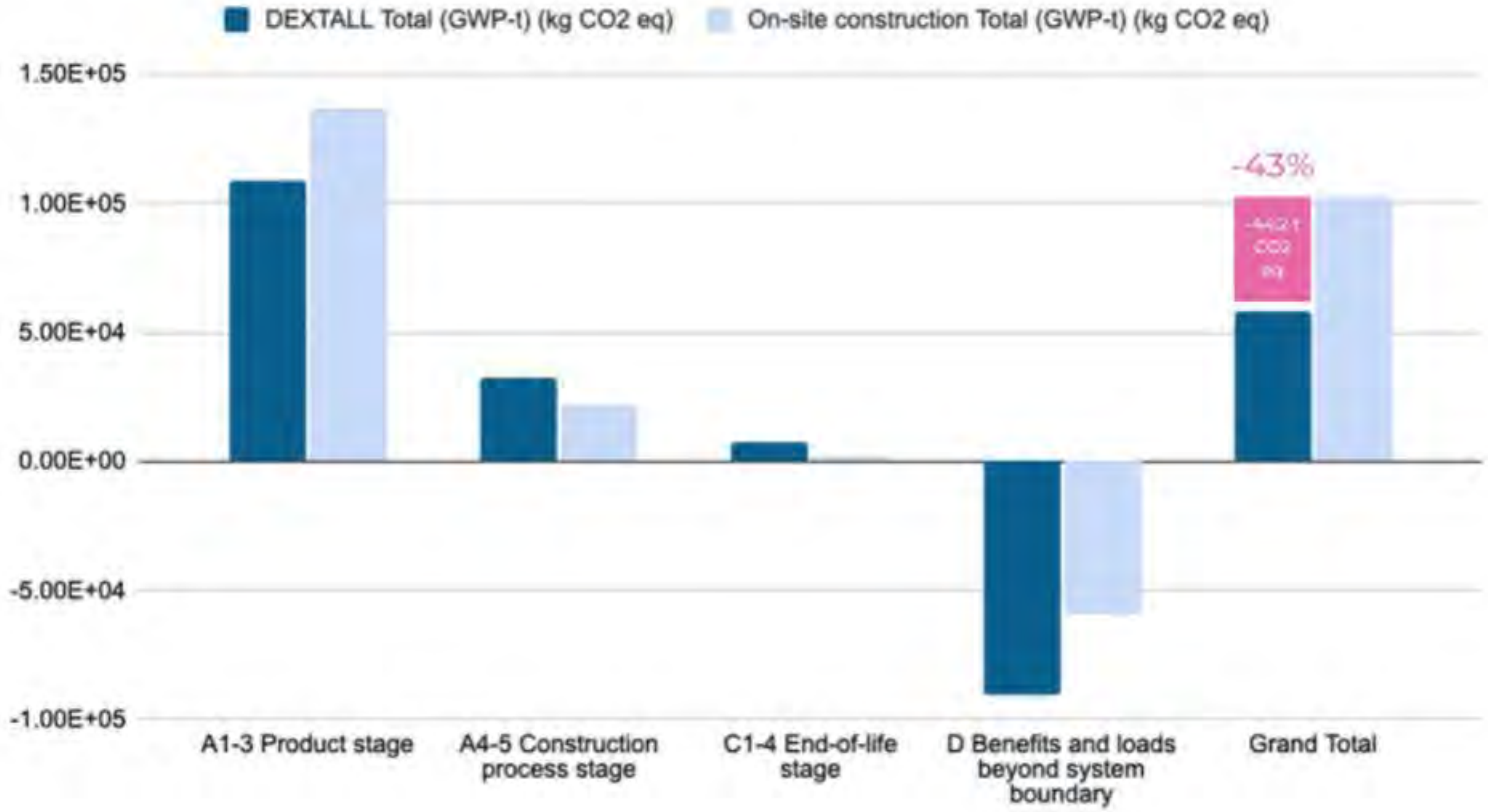
4) Make sure to **search for EPD's by your location**, which will affect your A4 number.

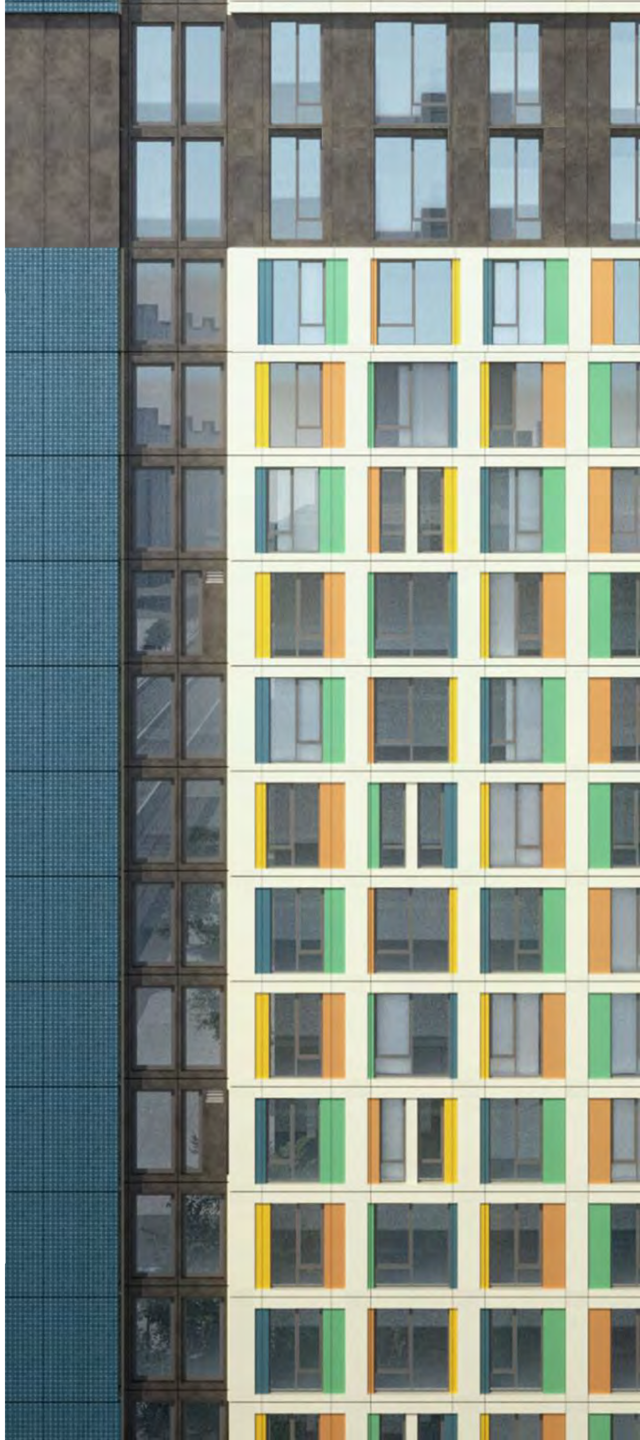
UPFRONT CARBON: DEXTALL "PREFAB OR SITE BUILT"?





UPFRONT CARBON: DEXTALL “PREFAB OR SITE BUILT”?





UPFRONT CABRON & HEALTH: CARBON SEQUESTERING MATERIALS

BioBased Tiles
(Materials: Bacteria
and waste aggregate.
No kiln firing)

Linoleum
(Linseed Oil & Pine Resin)

BioBased Polyurethane
(100% Plant based oils)
Red List & C2C

Vs. LVT: has 1/3rd less EC and
Saves kgCO2e equal to
1 yr. absorption from 2,067 trees

HempWood
(Hemp Stalk
& Carb 2 Binders)

UPFRONT CARBON: ILFI ZERO CARBON RESULTS (CO2e)

	kg C02e Totals					
	Baseline Calcs:		**Realized Calcs:**		**Percent Reduction:**	
A1-A3 Extract. to Manuf.	Foundation:	151,172	Foundation:	**121,598**	Foundation:	**19.56** %
	Substructure:	2,817,827	Substructure:	**2,203,292**	Substructure:	**21.81** %
	Enclosure:	793,323	Enclosure:	**502,199**	Enclosure:	**36.70** %
	Interior:	1,382,740	Interior:	**999,200**	Interior:	**27.74** %
A4 Trasport to Site			Foundation:	**5,376**		
			Substructure:	**260,900**		
			Enclosure:	**216,700**		
			Interior:	**9,676**		
			Total	**492,652**	*A4 is 12.8% of A1-A4*	
A5 Construct: Fuel & Waste			5% of total	227,313		
			20% of total	1,079,735		
			12.5% of total	**616,991**		

Project SF:	**180,352**	ft2
EC Intensity (ft):	**27.37**	
EC Intensity (m):	***294.5899**	**kgCO2e/m2**

*must be less than 350 kgCO2e/m2

Equal to 1 yr. absorption from 5,726,179 trees

UPFRONT CARBON: ILFI ZERO CARBON RESULTS ($)

<u>A1-A4 Estimated Costs for Embodied Carbon for this Project/GC</u>
(Excluding Finishes)

Concrete 28 day GWP max = no added cost
Concrete 56 day GWP max = $325,000 (in labor)
Steel GWP max = no added cost
CMU "Closed Spec" = no added cost
Drywall "Closed Spec" = $159,250
Metal Stud "Closed Spec" = $101,400
Doors "Closed Spec" = $75,000
Insulation = $36,925

Total: $697,575

<u>A5 Estimated Costs (Tracking Fuel) - $90k</u>

Total: $787,575

CLIMATE ACTION: SOLAR'S EMBOIDED CARBON, WORTH IT?

Equal to 1 yr. absorption from 2,622 trees (yearly)

Normative Appendix A Form 4	Annual Greenhouse Gas Emissions (GHG) Net Calculation		
Energy Form	Annual Site energy (Form 2 column 5 kWh/yr	GHG Emission Factor kg CO2e/kWh (Using Table 6+7; Section 7)	Annual GHG Emissions kgCO2e/yr ***(Multiply Site Energy x GHG)***
1a Imported grid electricity	1,109,808.00	0.356	395,091.65
1b Imported specific electricity			0.00
11a Imported transportation vehicle energy			0.00
14 Exported renewable electricity	147,348.00	0.356	52,455.89
19 Exported transportation vehicle energy (EV charged on site)			0.00
20 Qualified off-site renewable Energy			0.00
21 Refrigeration Loss, sum from Form 4A			897.75
	Annual Net GHG Emissions (Sum of 1a-12, minus 13-22 + 21)		343,533.51

Table 5,6+7 Regional Electricity Greenhouse Gas Emission (GHG 100: CO2e/kWh) Factors for US and Canada (Redacted for our typology)		**GHG 100**	**GHG 20 (if req')**
1a Imported grid electricity	NPCC NYC/Westchester	0.356	0.422
	NPCC Upstate NY	0.157	0.183
1b Imported specific electricity	qualified person should determine		
11a Imported transportation vehicle energy	qualified person should determine		
13 (14) Exported renewable electricity	NPCC NYC/Westchester	0.356	
	NPCC Upstate NY	0.157	
19 Exported transportation vehicle energy (EV charged on site)	qualified person should determine		

DEFINITELY YES! NO TRANSITION LOSSES,
AND WE NEED TO BUILD OUR RENEWABLE INFRASTRUCTURE (POINT OF USE IS BEST!)

CLIMATE ACTION: GROUND SOURCE/GEOTHERMAL

Ground Source PROS:

- Greatly reduced refrigerant leakage risk
- More efficient than VRF
- Approx half of upfront cost is covered by incentives. (Considered cost neutral or better, with incentives.)
- Long lasting system with minimal moving parts
- Reduces peak loads on the grid
- No penetrations on the façade (energy, sound, maintenance, & aesthetic benefits)

Ground Source CONS:

- Requires commitment Early in Design
- Embodied Carbon balance not clear yet, needs further study.
- May not be able to cover full loads for non-Passive House building or heating dominated.

	One Year kg CO2e Leakage* ***ASHRAE 228 Leakage Guidance**	
Heat/Cool System	**VRF System**	**Ground Source**
Refrigerant	R410A	R454b (A2L)
Refrigerant GWP kg CO2e	1920	467
Leakage Rate	10%	1%
Refrigerant Charge length	5,586 LF	(hermetic)
Refrigerant Leakage	**821,887**	**898**

Equal to 1 yr. absorption from 41,094 trees

NYC is signatory to **C40 Clean Construction Accelerator:** electrifying construction equipment.

ILFI ZERO CARBON: OFFSET REQUIREMENTS

Operational Energy Offsets

Renewable Energy Credits

Additional
From Allowed Sources
Attributed to the Project
Educational
Identifiable
Metered

Equal to 1 yr. absorption from 284,010 trees

Require: 962 MWh/yr
Cost per MWh/yr = TBD
Estimated Offset Cost = **TBD**

Embodied Carbon Offsets

Carbon Credits

Additional
Leakage prevention
Permanence
Audited Verification

Green-e Climate CERTIFIED

(Only Green-e certified or equal, and Certified Emission Reduction (CER) Verified Emission Reduction (VER)

Require: 4,935,931 kgCO2e
Cost per t CO2e = $4.80
Estimated Offset Cost = **$26,116**

Potential Checklist for Quality Carbon Negative Offsets

1) Verifiable
2) New & Additional
3) Unique
4) Avoid Leakage
5) Environmental Integrity
6) Low Risk
7) Time aligned
8) Third Party Verified
9) Transparent

Credit: LMN Path to Zero Carbon: https://lmnarchitects.com/lmn-research/path-to-zero-carbon-series

Resource: Integrity Council for the Voluntary Carbon Market: https://icvcm.org/

CLIMATE ACTION: ALIGNMENT OPPORTUNITY

How do we drive demand for best practices in other systems?

Construction Industry: Increased Demand for **Biogenic Carbon Storing** Materials → Increased Demand for **Climate Smart Forestry** and **Regenerative Organic Agriculture**

Those other systems are evolving too, how can we align with them?

Climate Smart Forestry

https://www.climatesmartforestry.org/levelsetting

Regenerative Organic Agriculture

https://regenorganic.org/

	(Estimates in Yellow or TBD)	The Cost of ILFI Zero Carbon Certification Scope (w/ Baseline of EGC)		
		Design Scope	Construction Scope	Operations Scope
Operational Carbon	Energy Modeling & CPHC Consulting	$70,000		
	No on-site combustion			
	Passive House for low EUI (20% below ASHRAE 90.1 2019, Site Energy)	$28,000 Verifier + $35,000 Certification	1.5% of Construction Cost	
	Renewable Energy Procurement 100% (Site) Energy use for 15 years			*TBD*
	Renewable Energy On Site	*$15,000*	$525,000 (Façade)+ $450,000 (Pergola)	
	Maintenance Plan to reduce Refrigerant Leakage			*TBD*
	Measured energy use for 12 months at full occupancy			*$5,000 yearly*
Embodied Carbon	Model Embodied Carbon & Prepare Audit Documents	$40,000		
	A1-A4: 20% Reduction in EC of Material Procurement (and > 350 kgCO2e/m2)		$697,675 + *Finshes*	
	Track A5 During Construction		$90,000	
	Carbon Offsets (for embodied carbon) from certified Green-e provider	*+/- $30,000*		

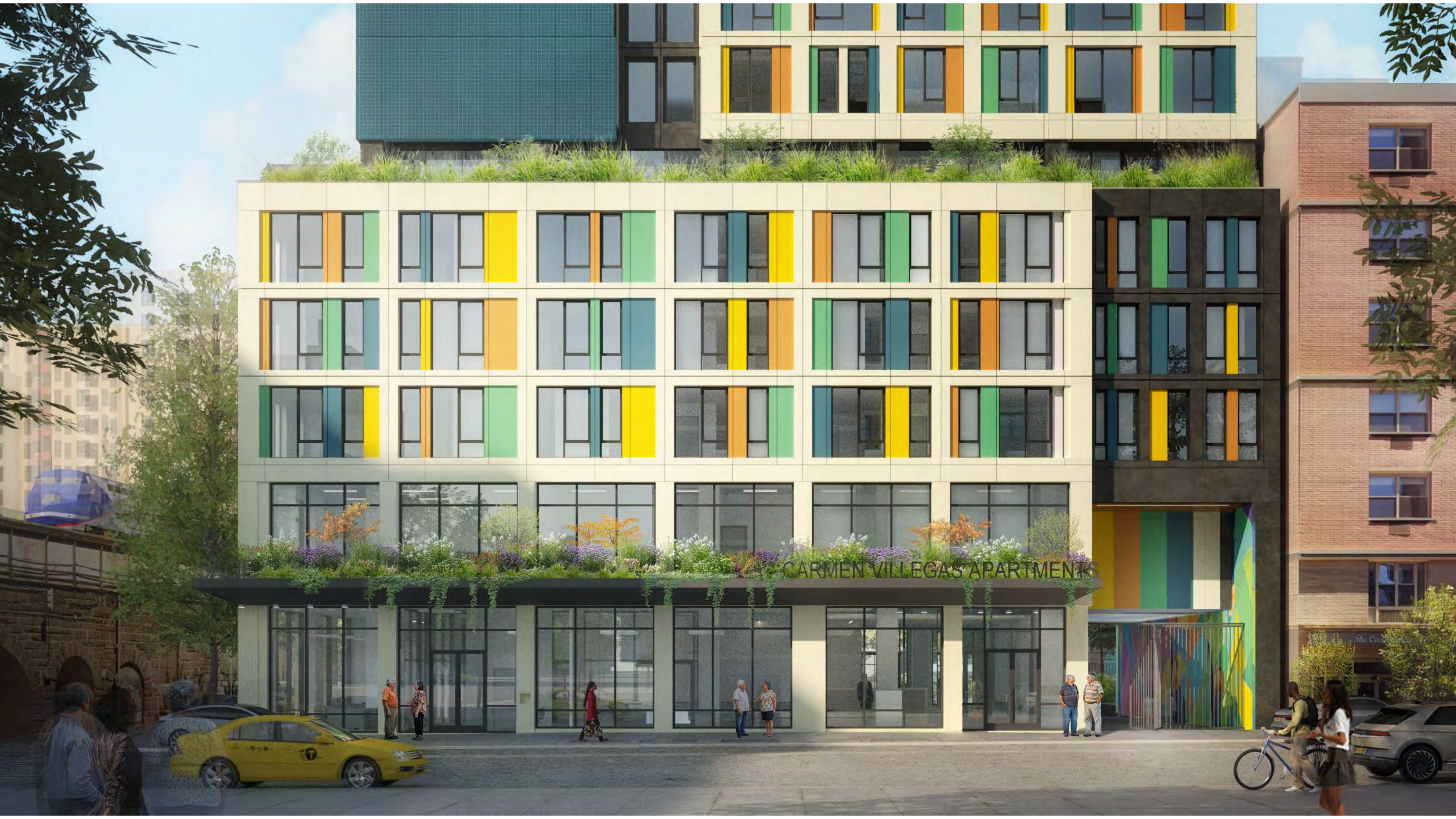
Project Savings	Energy Savings			-$70,000 yrly Savings
	IRA Incentives (including 45L)			
	BoE Award Funds			
	ConEd Clean Heat			
	Agency Preference/Funding			

Total Cost to go "Zero Carbon" (Baseline EGC/NYC)

= Approx 2-3% of construction costs

EPA Social Cost of Carbon, of Embodied & Operational Impacts remaining = $238 tCO2e

= $2,526,642


CARMEN VILLEGAS APARTMENTS

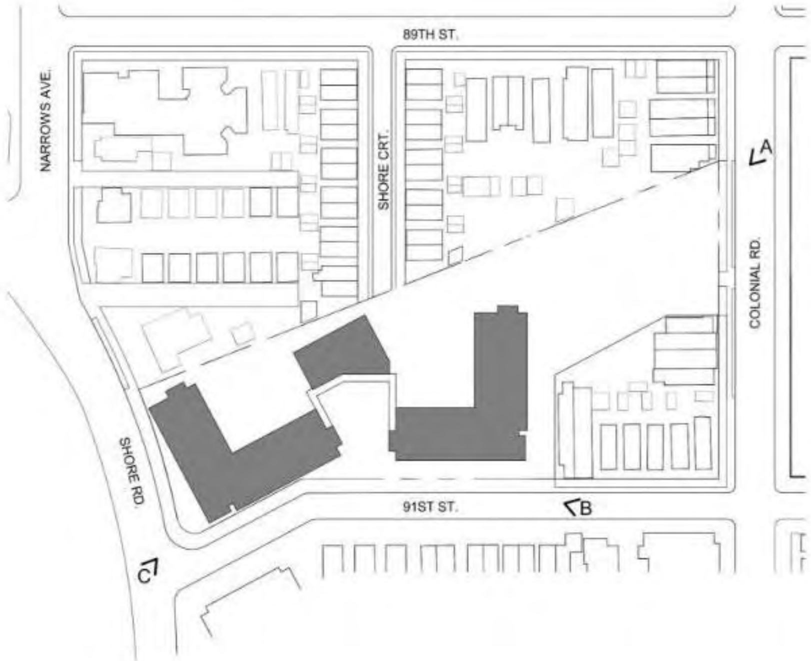
Shore Hills –Embodied Carbon

The Site

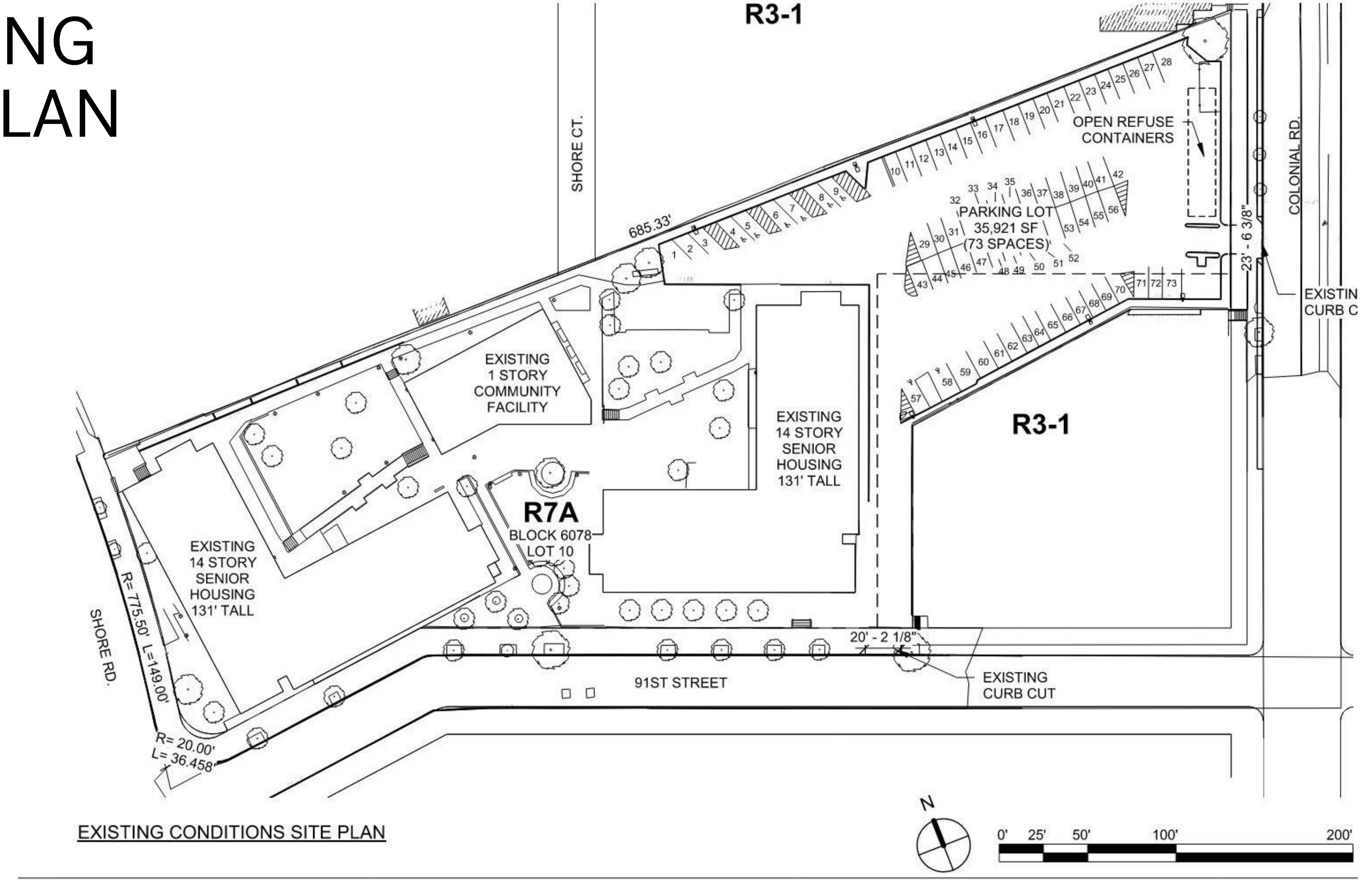
A. VIEW SOUTH-WEST ALONG COLONIAL RD.

B. VIEW WEST ALONG 91ST ST.

C. VIEW NORTH-EAST ALONG 91ST ST. AND SHORE RD.



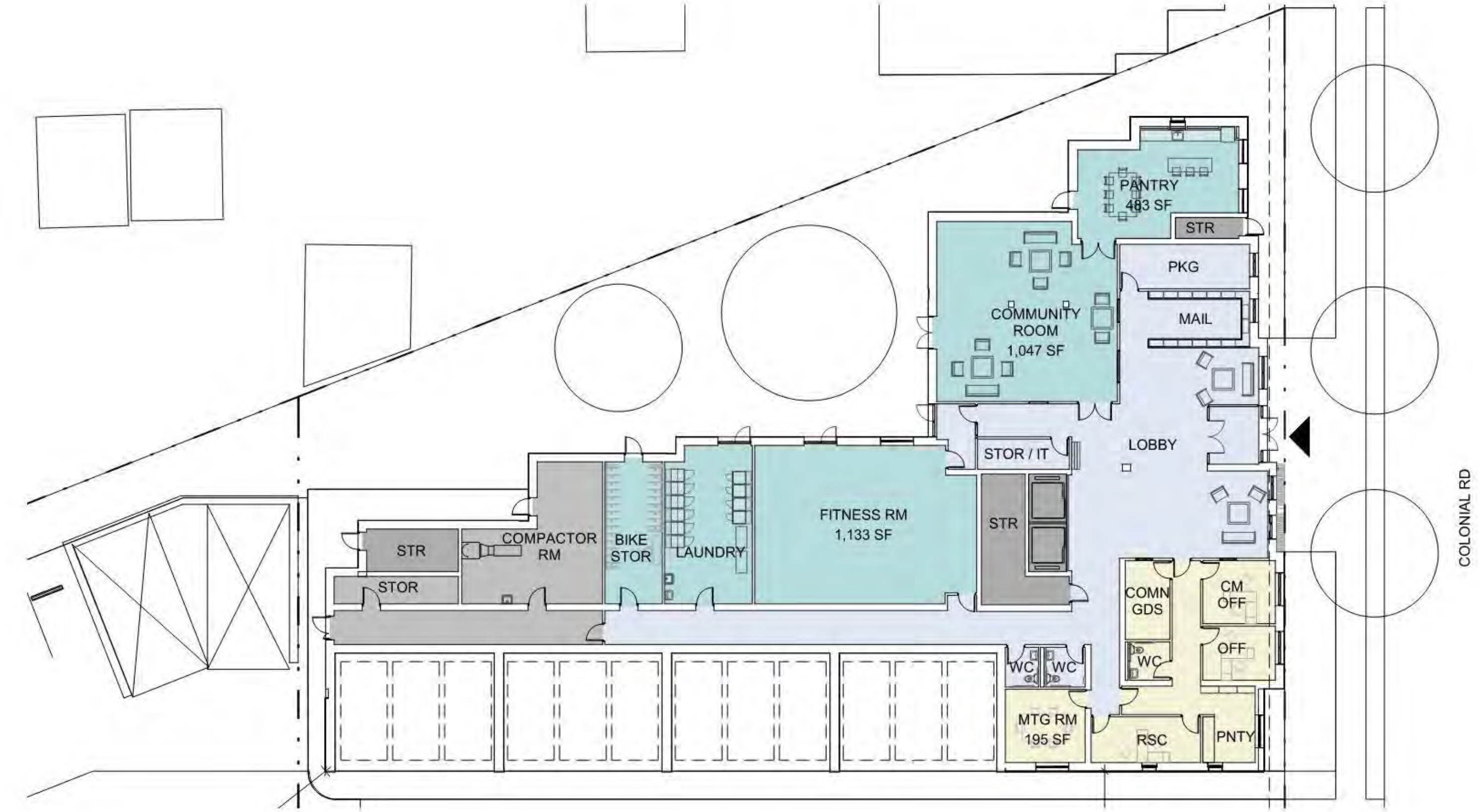
EXISTING SITE PLAN



EXISTING CONDITIONS SITE PLAN

PROPOSED SITE PLAN

FLOOR PLANS


PANTRY
483 SF
STR
PKG
MAIL
COMMUNITY
ROOM
1,047 SF
LOBBY
STOR / IT
FITNESS RM
1,133 SF
STR
LAUNDRY
BIKE
STOR
COMPACTOR
RM
STR
STOR
COMN
GDS
WC
CM
OFF
OFF
WC
WC
MTG RM
195 SF
RSC
PNTY
COLONIAL RD


1 BR
529 SF
0 BR
394 SF
0 BR
395 SF
0 BR
394 SF
0 BR
379 SF
1 BR
526 SF
0 BR
388 SF
0 BR
388 SF
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389 SF
1 BR
527 SF
TR
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393 SF
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0 BR
393 SF
0 BR
393 SF
0 BR
391 SF
0 BR
450 SF

SUSTAINABLE DIAGRAM

LEGEND

RENEWABLE ENERGY

SOLAR ENERGY
Reduce solar heat gain and support energy demands.

ENERGY EFFECIENCY

AIRTIGHTNESS

CONTINUOUS INSULATION
With thermal bridge-free construction.

HIGH PERFORMANCE DOORS AND WINDOWS
Increase thermal and acoustic comfort and energy saving

ERV & APPROPRIATELY SIZED HVAC
Improved air quality and all electric VRF heating and cooling to reduce energy

ALL ELECTRIC BUILDING
LED fixtures and Energy Star Appliances

WATER EFFECIENCY

WATER SAVING & RAINWATER RUNOFF
Low flow fixtures. Green roofs and detention tank to reduce rainwater runoff.

RESPONSIBLE MATERIAL SELECTION

GREEN ROOFS
To promote rain water detention and pollinators

LOW CARBON
Low embodied carbon

LOW OR NO-VOC PAINT / SEALANTS / FLOORING
For healthier air quality.

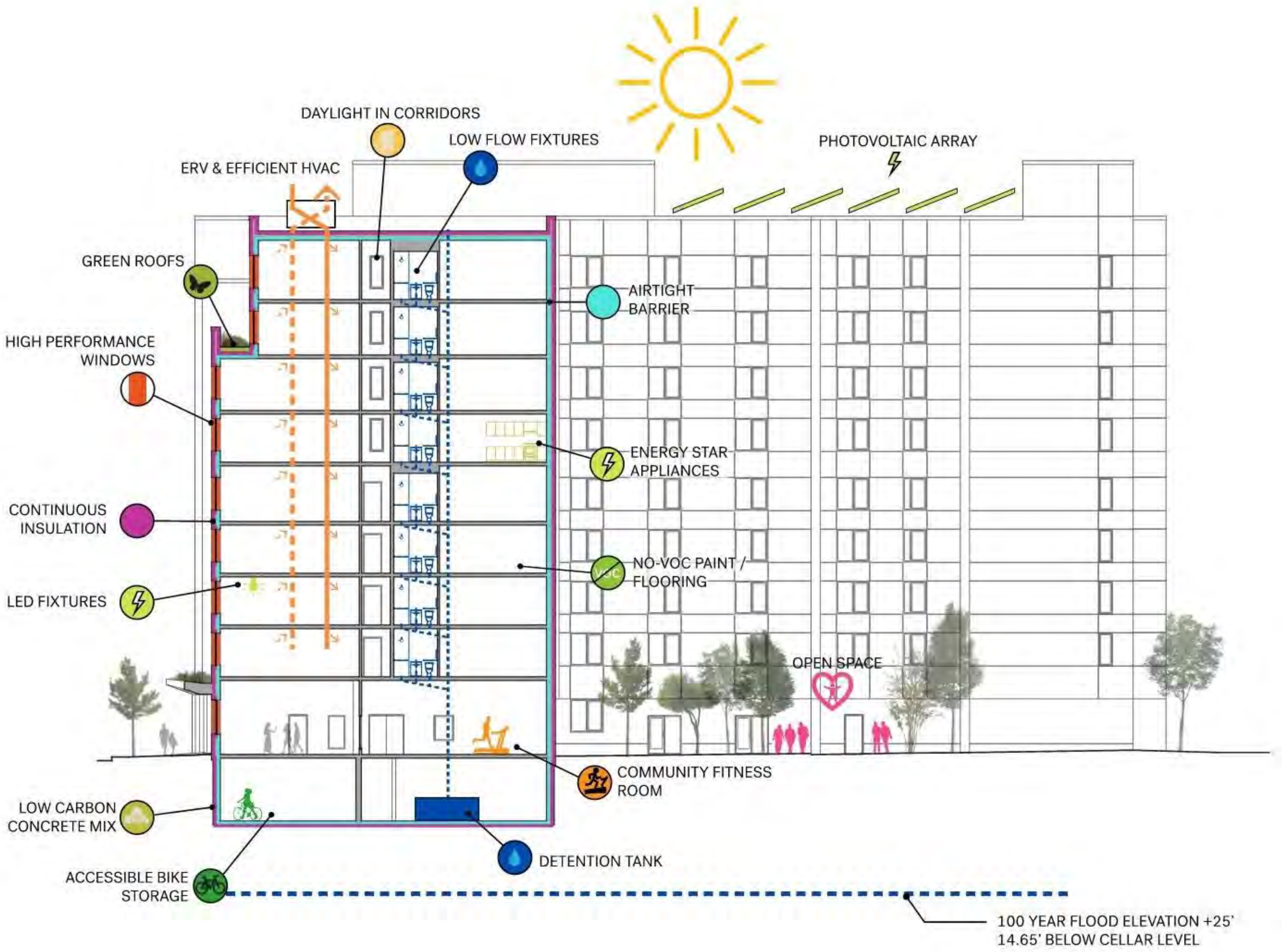
WELLNESS / HEALTHY LIVING

OPEN SPACE
Promote physical activities, improve health and wellness.

ACCESSIBLE BIKE STORAGE

COMMUNITY FITNESS ROOM

DAYLIGHT IN CORRIDORS



EPD, environmental product declaration:

- Limited number of manufacturers have.
- Was it done by a 3rd Party or by the manufacturer?
- One of the hardest things to deal with is the lack of information and good information.

GLENWOOD MASON SUPPLY CO.
ENVIRONMENTAL PRODUCT DECLARATION
CMU: NW PZ 2KPSI • Glenwood Masonry Products Inc. Plant

This Environmental Product Declaration (EPD) reports the impacts for 1 m^3 of concrete formed into manufactured concrete and masonry products meeting the following specifications:

- ASTM C90, Concrete Masonry Unit, Load-Bearing

PRODUCT DESCRIPTION

Normal Weight Pozzotive CMU:
Normal weight, CO2 infused Carbon Cure concrete building blocks made with reduced cement content; 30% of the cement from our conventional mix design is replaced with Pozzotive... a post-consumer recycled glass powder pozzolan. Available in various sizes. Dimensional properties as defined in ASTM C90.

ENVIRONMENTAL IMPACTS

Declared Product:
CMU: NW PZ 2KPSI • Glenwood Masonry Products Inc. Plant
Density Factor: 2082 kg / m^3
Compressive strength: 14 MPa

Declared Unit: 1 m^3 of concrete formed into manufactured concrete masonry product (CMU)

Global Warming Potential (kg CO_2-eq)	193
Acidification Potential (kg SO_2-eq)	1.16
Eutrophication Potential (kg N-eq)	0.26
Smog Creation Potential (kg O_3-eq)	27.1
Ozone Depletion Potential (kg CFC-11-eq)	4.15E-6

Material Composition: Aggregate (crushed), Aggregate (natural), Portland cement, Glass Pozzolan, CarbonCure, Admixture (plasticizing), Batch water

Additional detail and impacts are reported on page five of this EPD

PROGRAM OPERATOR
ASTM International
100 Barr Harbor Drive
West Conshohocken, PA 19428

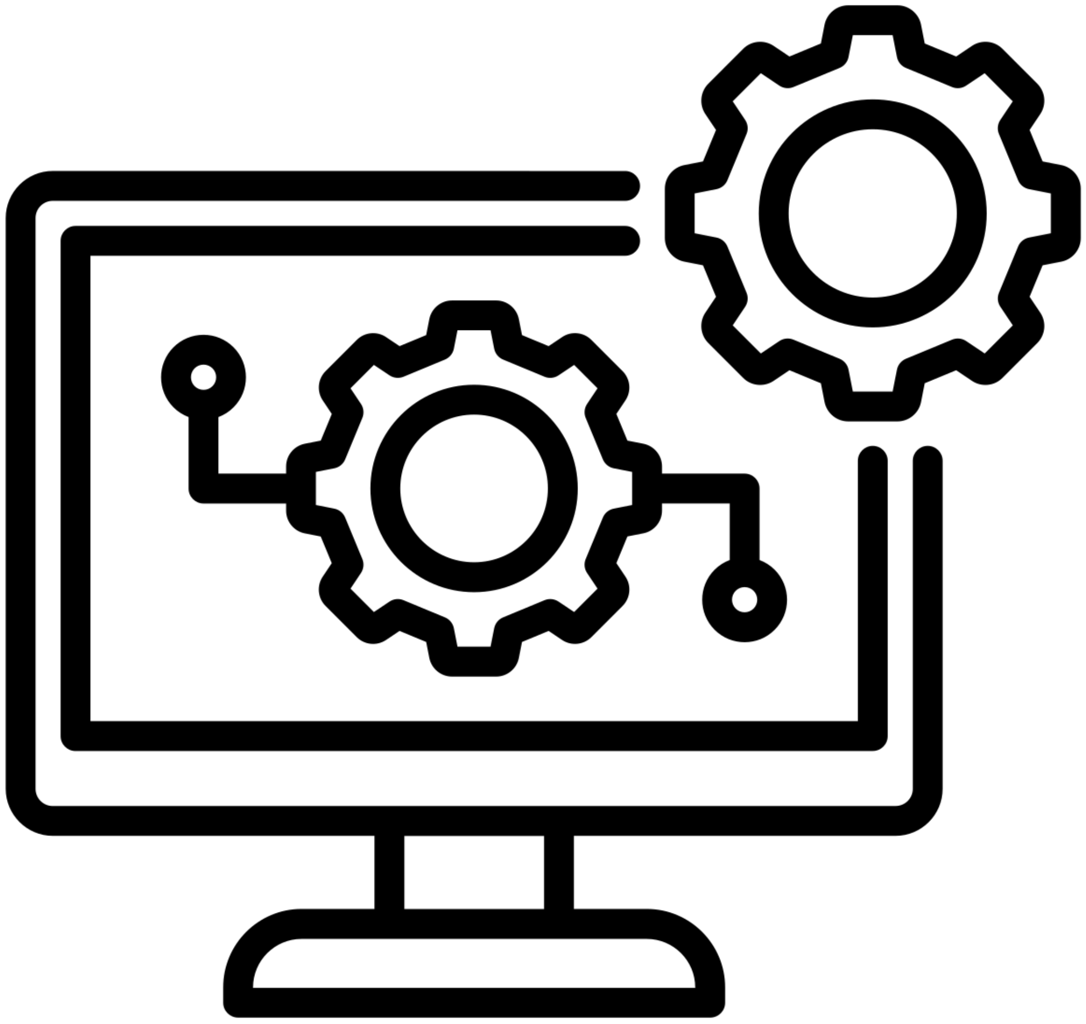
DATE OF ISSUE
07/31/2024 **(valid for 5 years until 07/31/2029)**

GLENWOOD MASON SUPPLY CO.
4100 Glenwood Rd.
Brooklyn, NY 11210
718-859-6500

GLENWOOD MASONRY PRODUCTS INC
761 East 42nd S
Brooklyn, NY 1121
718-859-650

Software

- We use Revit©
- Did at the end of Schematic Design
- Want plug-ins that use Revit© data.
- Software Options
  - EC3 database used by all three below.
  - Cove.tool
  - TallyLCA (Life Cycle Analysis)
  - TallyCAT (Climate Action Tool)

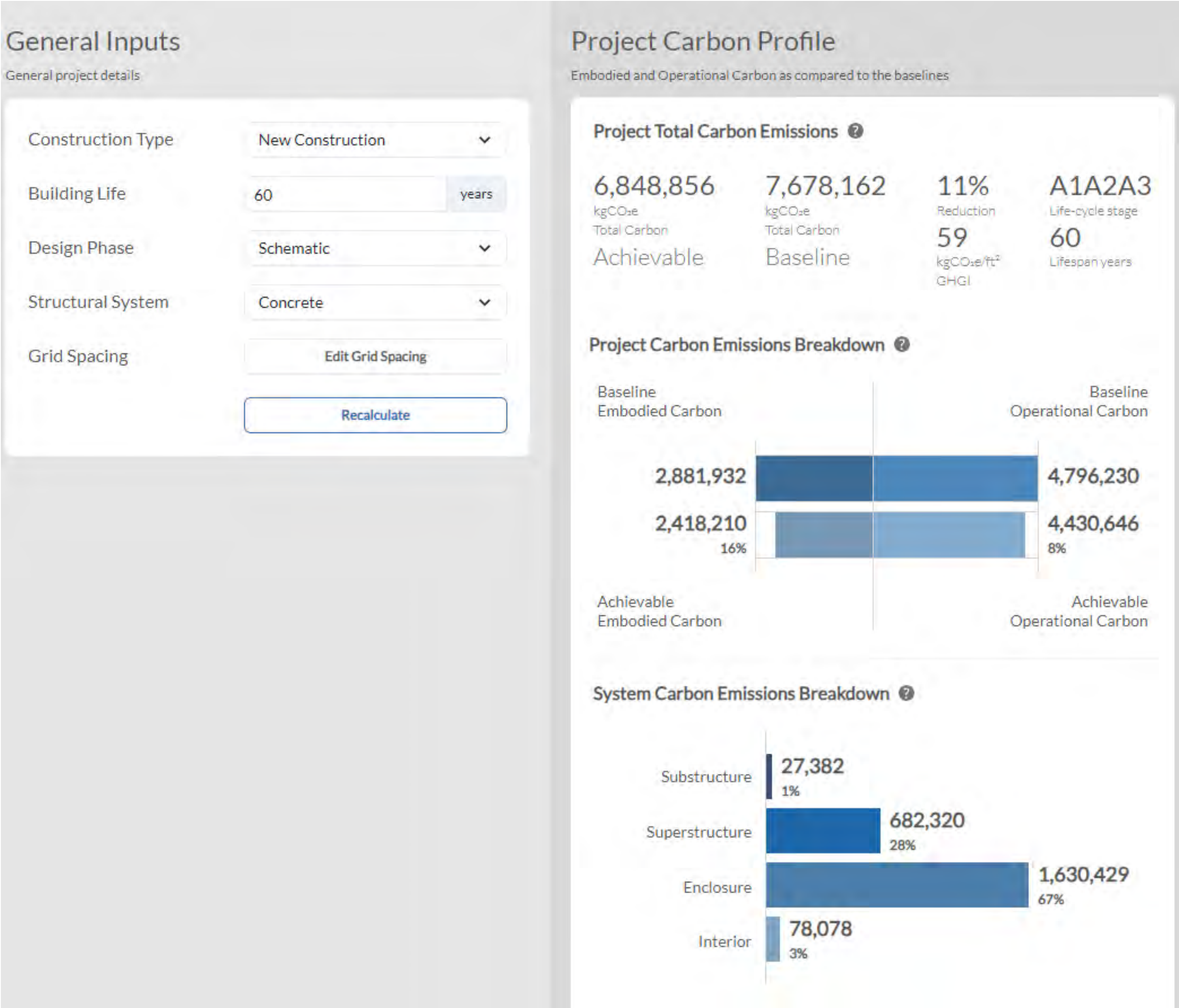


EC3

- EC3 is an open-source software that is developed by Building Transparency, a non-profit organization. It allows users to calculate and compare the embodied carbon emissions associated with construction materials or systems used in building projects, and to also understand the total building embodied carbon footprint. EC3 has industry average EPDS, but it focuses on developing and maintaining a database of product specific EPDs. It collaborates with third-party program operators to digitize EPDs from manufacturers to grow and maintain the database. Architects and engineers do not have the full access to digitize EPDs. Therefore, there is a gap in comparing between products in EC3 and products found outside of EC3 for architects, as the uncertainty that EC3 assigned to the product EPDs cannot be applied to external product EPD pdfs by architects.
- Everything we looked at linked back to this database.
- Can not open Revit model in EC3, need to bring it into Tally

Cove.tool

- Cove.tool's Embodied Carbon tool is dedicated to embodied carbon study and allows users to assign product-specific EPDs to building assemblies. The EPDs come from EC3's database. The tool, which is part of a larger web-based suite, recently launched and is being updated frequently. Cove.tool exports a Revit BIM model
- Currently limited quantities and it automatically uses an energy code minimum assembly.
- Cove.tool's intention is to give a quick idea of the building's carbon footprint based on typical structural systems without defining the assembly of components in the model. Currently, block and plank construction is not an option in the software.

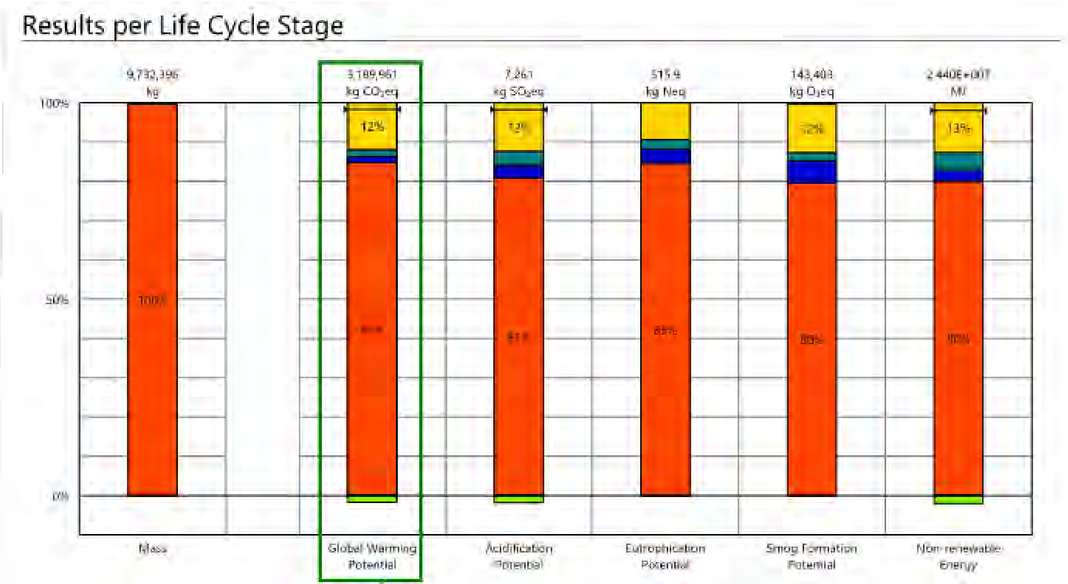


TallyLCA (Life Cycle Analysis)

- TallyLCA is a software add-in for Revit that performs LCAs of building materials for whole building life cycle analysis using model elements in the BIM model by referencing a custom built LCA database. TallyLCA extracts quantities of Revit assembly and its components from the Revit model and maintains the makeup and naming of the Revit families. The same add-in allows a user to manually link Revit material definitions to the custom database for the analysis.

- The TallyLCA database uses information from industry wide EPDs rather than product specific data. This provides an overview, but further analysis is limited because there are no alternatives to the industry average EPDs that one can assign to building components.

- TallyLCA allows the user to export to an EC3 project where specific EPDs can be assigned to building comments.



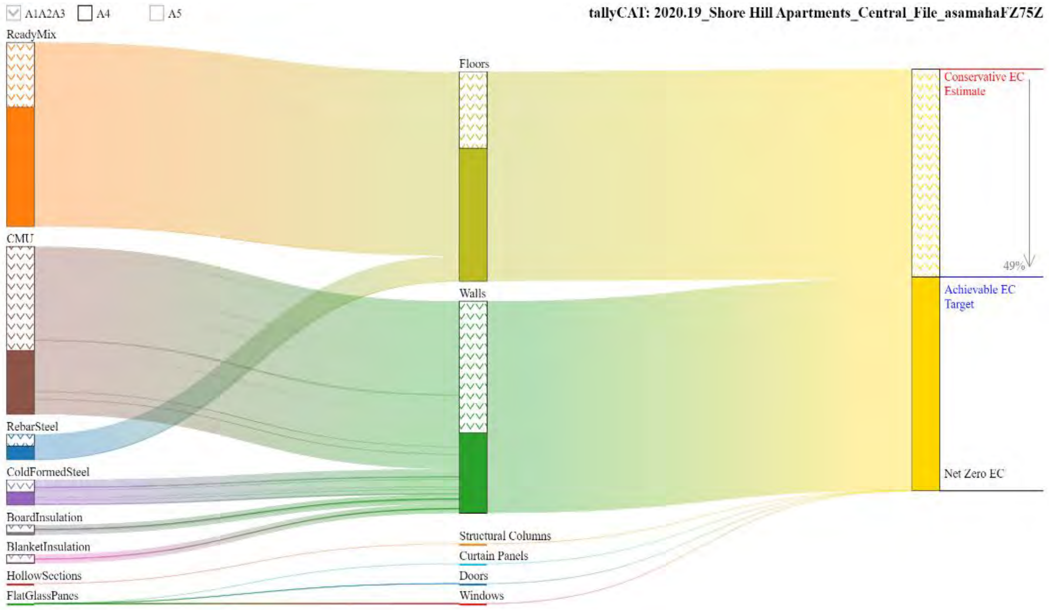
TallyCAT (Climate Action Tool)

- TallyCAT is a development based on TallyLCA with the intention to focus on embodied carbon analysis rather than the full life cycle analysis. Like TallyLCA, TallyCAT extracts quantities of Revit assembly and its components from the Revit model and maintains the makeup and naming of the Revit families. Instead of assigning industry average LCA data to each component in the Revit add-in, it lets users compare GWP data from product specific EPDs in EC3 to generate whole building embodied carbon estimates.
- The baseline whole building embodied carbon is based on EC3's Conservative GWP which is generated from the product specific EPDs in EC3.
- Allows export to EC3

TallyCAT beta (EC3 export)

- TallyCAT exports materials directly from the Revit model families with no overlay or built-in assumptions, so there are fewer categories included in the report. It should also be noted that there were some insistencies in the exports, and multiple exports were performed. This is likely a result of the “beta” nature of this software. Eventually, we anticipate this tool to be extremely valuable and potentially the primary option for embodied carbon analysis using BIM; however, at this point, it is not clear that TallyCAT is the best tool for an SD phase analysis.

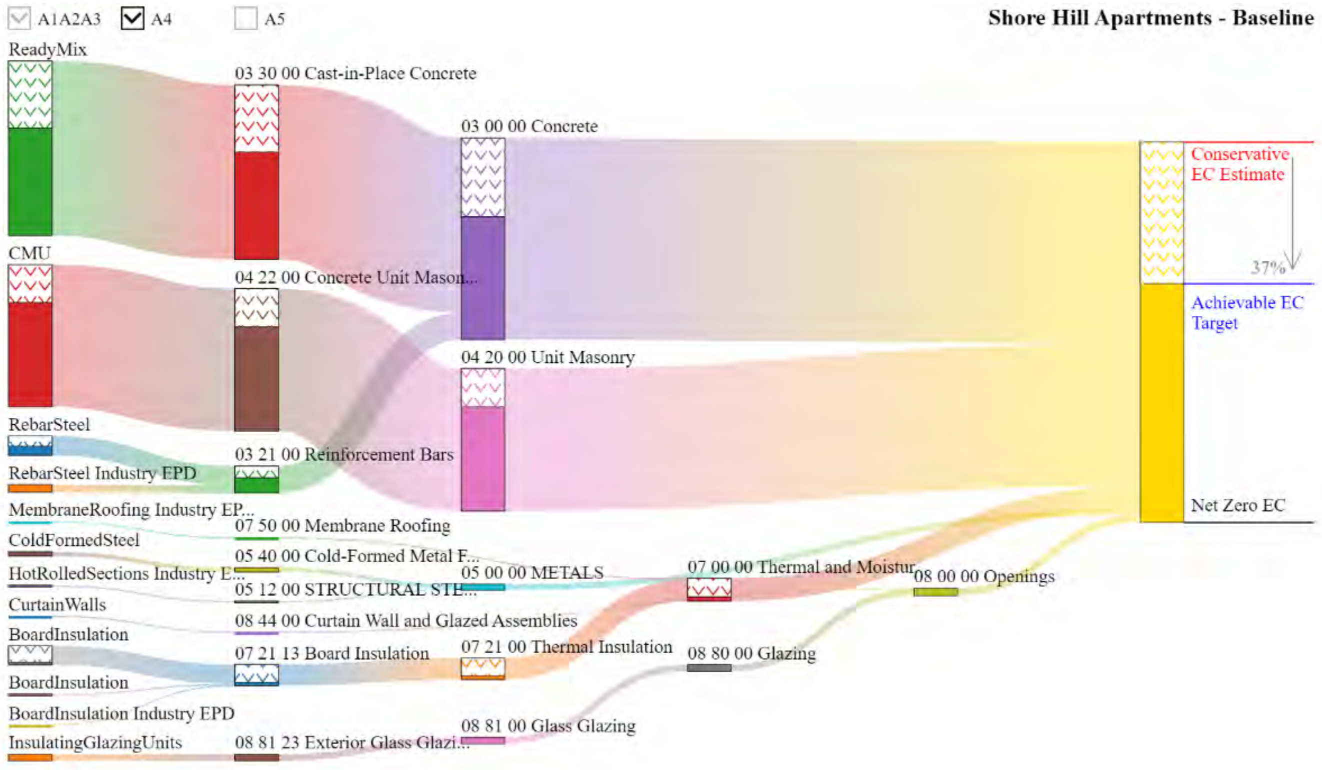
- The whole building baseline embodied carbon in the product stage (stage A1-A3) generated by the TallyCAT beta EC3 export is 2.42 million kgCO2e, in which all materials are set to the “Conservative” value of industry EPDs in EC3. EC3 also estimates that the whole building achievable embodied carbon can be reduced by 49%.



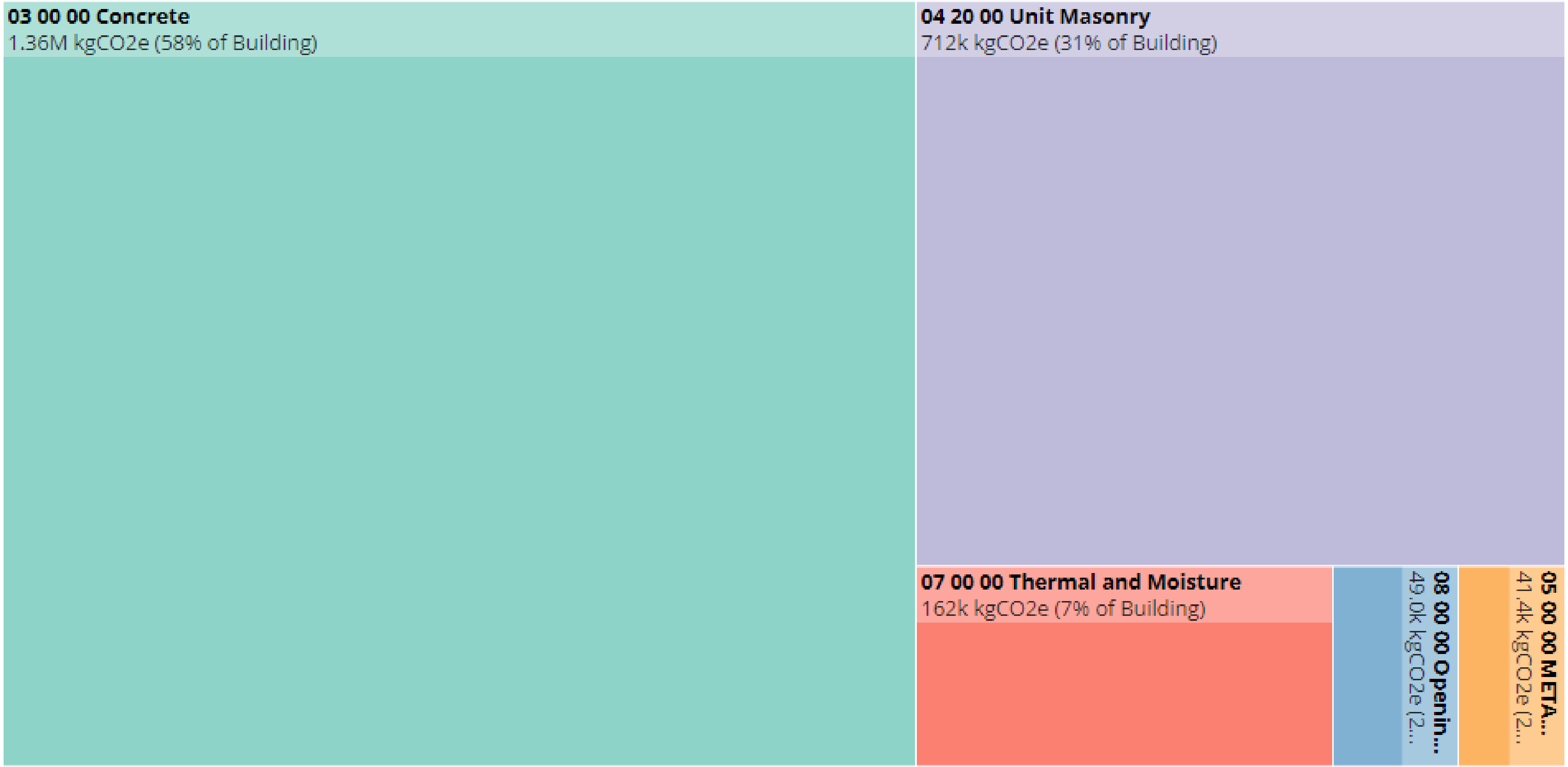
TallyLCA exported into EC3 :

The whole building baseline embodied carbon in product stage (stage A1-A3) generated by the TallyLCA EC3 export is 2.32 million kgCO2e, in which all materials are set to the "Conservative" value of industry EPDs in EC3. EC3 also estimates that the whole building's achievable embodied carbon can be reduced by 44%. The 2.32 million embodied carbon shows 58% coming from concrete, 31% from masonry, and 7% from thermal and moisture protection (insulation).

Preferred, allows to apply information to individual materials.



New Construction Baseline: 2.32M kgCO2e



Study funded by NYSERDA

Concrete

- Efficient design
- CarbonCure.
- Return Concrete Recycling
- Washout Systems allows the recycling of water and surplus concrete
- Pozzotive
- Fly Ash (disappearing)

Carbon Cure

- The injected CO_2 reacts with the concrete mix and becomes a mineral (Calcium Carbonate), increasing the concrete's compressive strength and improving its performance.
- The strength gained enables the reduction of cement content in the concrete mix designs.
- Concrete has a large carbon footprint Every pound of cement produced emits roughly a pound of CO2 emissions.
- The CO2 injected and reduced in the mixes, concrete made with CarbonCure reduces CO2 by an average of 25 pounds per cubic yard. That equals about 200 pounds of CO2 saved per truckload delivered.

Concrete Plank

It is better than poured in place because it is inherently more efficient than poured in place.

Local Manufacturer's (you do not want to ship plank).
Two are enrolled in the North American Precast Concrete Sustainable Plant Program (NAPCSPP) : Oldcastle Precast Building Systems and Coreslab Structures. Through this program, modest reductions in embodied carbon have been achieved.

However, Coreslab Structures does use carbon cure in their Texas plant, and if that was used here, we could see a significant reduction in the embodied

CMU

Data for Manufacturer of CMU

Global Warming Potential (kg CO_2-eq)

2,000 PSI

Baseline	238
With of Pozzotive (30% replacement) and Carbon Cure	193
Reduction	45

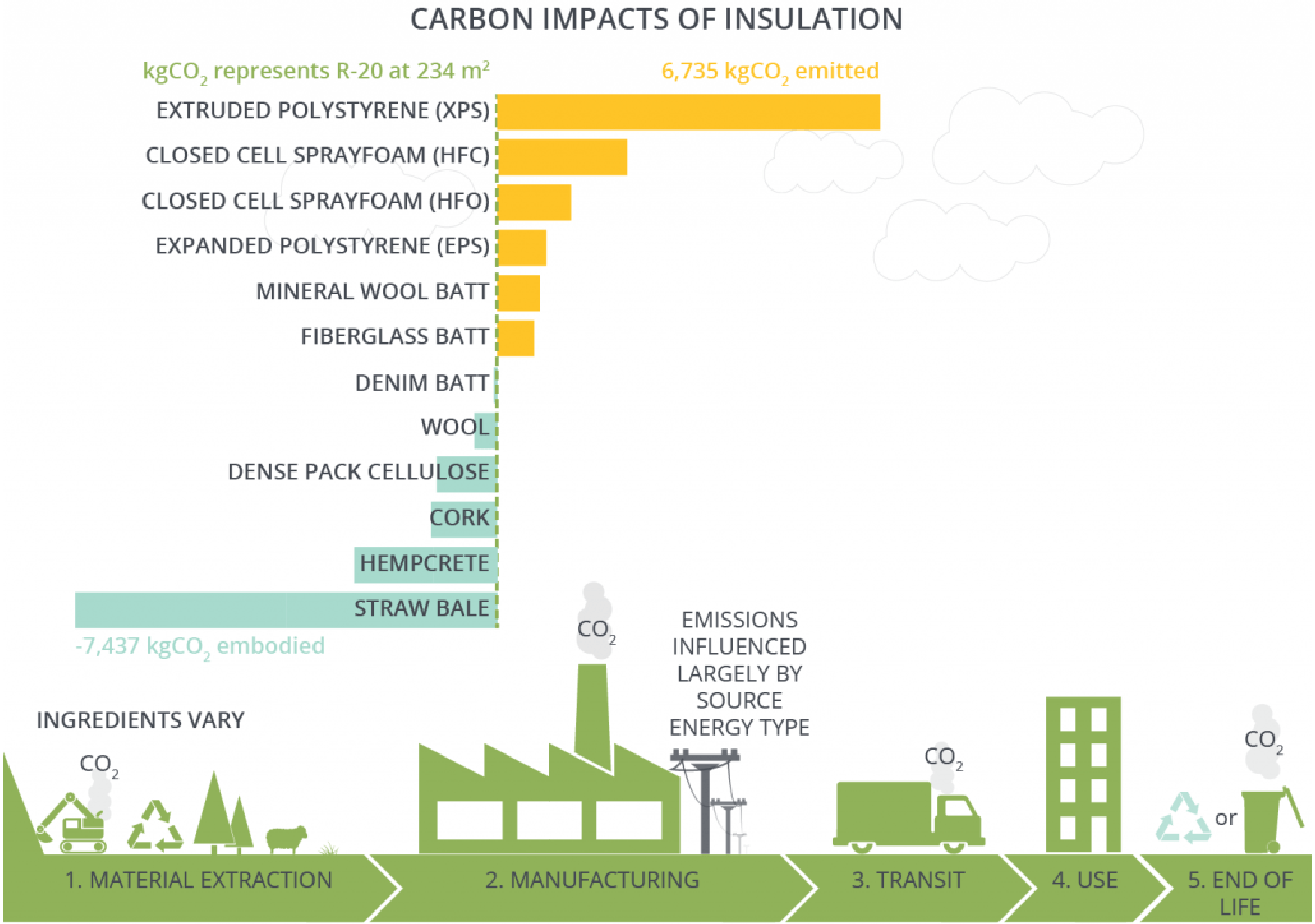
20% Reduction in Green House gas

From Glenwood Masonry

Steel

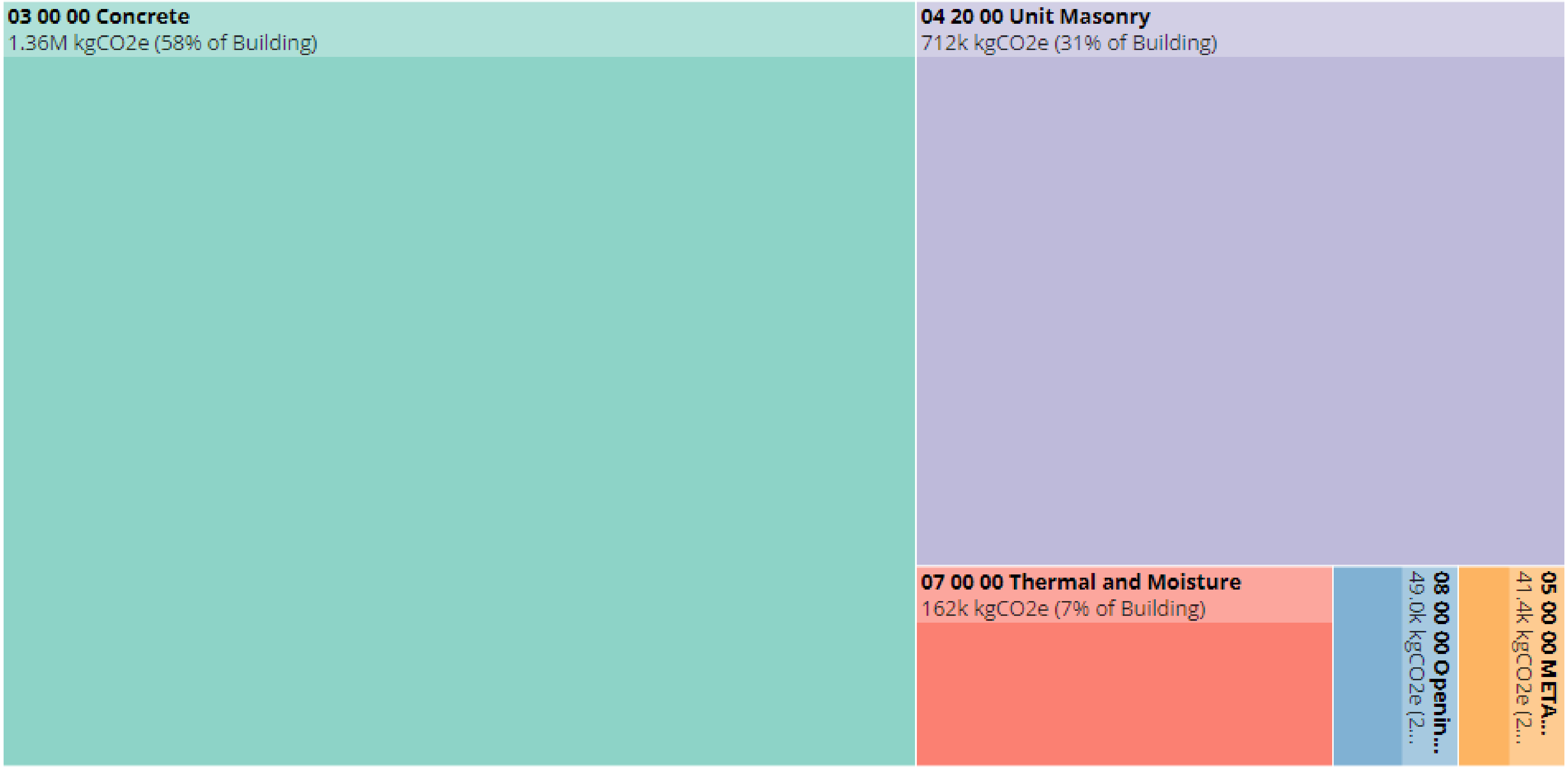
Structural steel is 93% recycled and 100% recyclable. Structural hot-rolled sections produced in North America are made in electric arc furnaces from recycled steel. If your electricity is clean, your steel will be low carbon. Right now, the best way to guarantee this is to purchase steel from Quebec manufacturers who are powered by hydropower.

Insulation



Carbon impacts data source: Builders for Climate Action - 2019 White Paper "Low-Rise Buildings as a Climate Change Solution", Chris Magwood, 2019;

New Construction Baseline: 2.32M kgCO2e



Study funded by NYSERDA

New Construction Enhanced*:

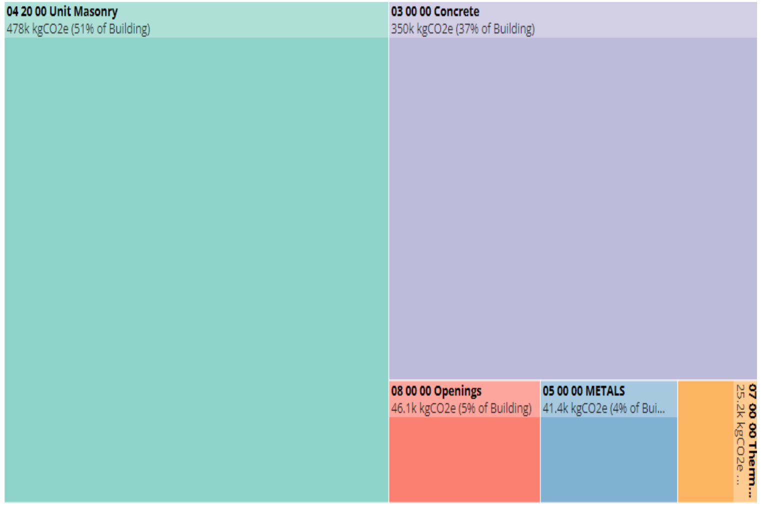
1.6M kgCO2e 27% Reduction

* = Readily available today

Study funded by NYSERDA

New Construction Super Enhanced*:

940K kgCO2e 60% Reduction



⋆ = Readily available today (but not in the Northeast)

Study funded by NYSERDA

How to regulate (change to Policy Considerations)

A clear answer emerges with some initial examples to work from. We think that regulating concrete first and then the other major embodied carbon material in the Building Code is the way to go. This is being studied in Seattle, California, and by the New Buildings Institute (https://newbuildings.org/).

The latest LCA commissioned by the NRMCA (National Ready Mix Concrete Association) to establish average GWP's for ready mix concrete in all regions of the US. https://www.nrmca.org/association-resources/sustainability/

It would be relatively easy to start by regulating concrete and steel's embodied carbon in the Building Code. For example, concrete, at least in NYC, could be a requirement on TR3: Technical Report: Concrete Design Mix.