Passive House: A Murder Mystery

The Past, The Present & The Future of Environmental Building Technology

Katrin Klingenberg
Executive Director | Phius (Passive House Institute US)
Summer Camp| July 29-August 2, 2023

Prologue

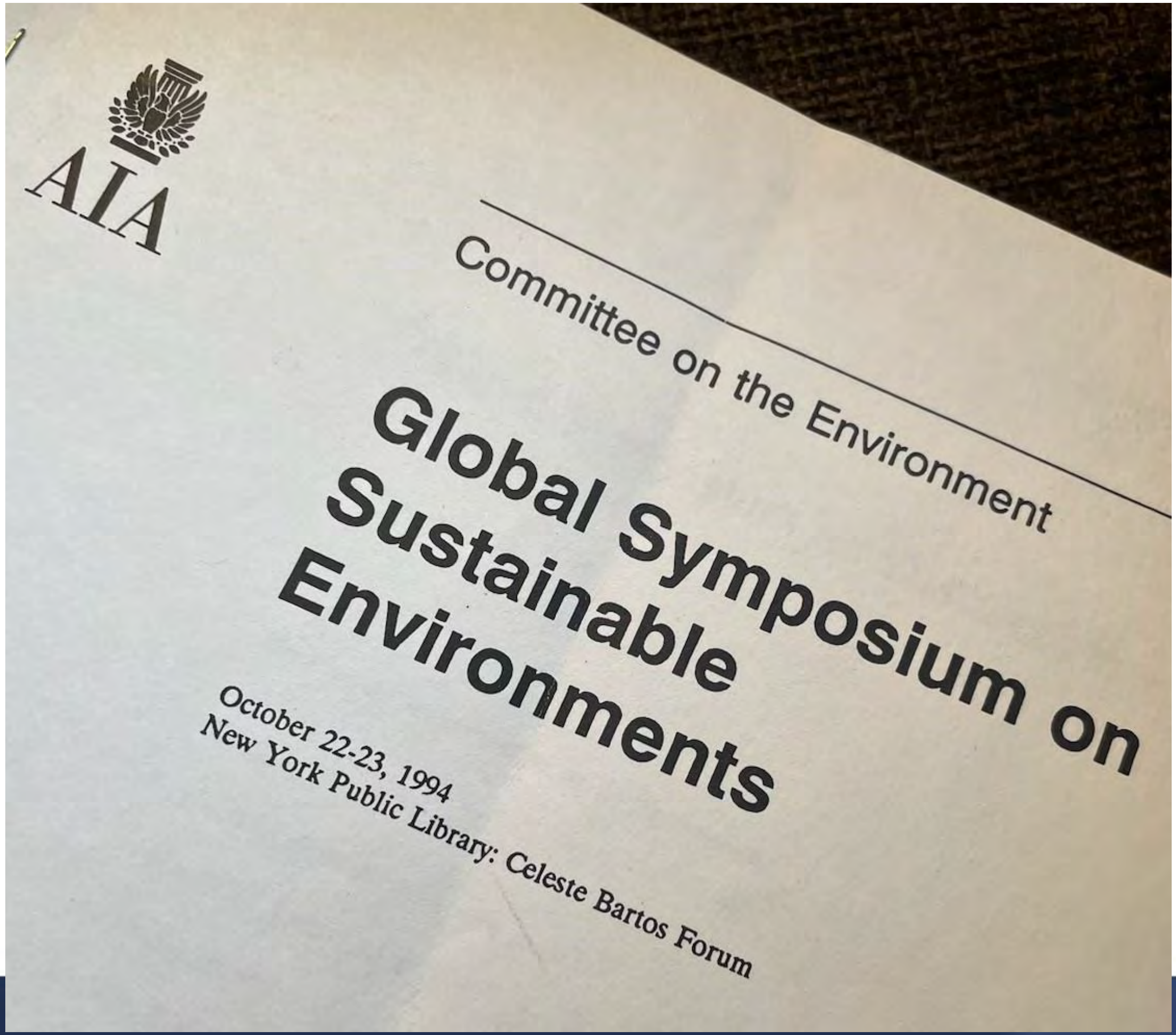
Berlin – November 1989 TU Berlin

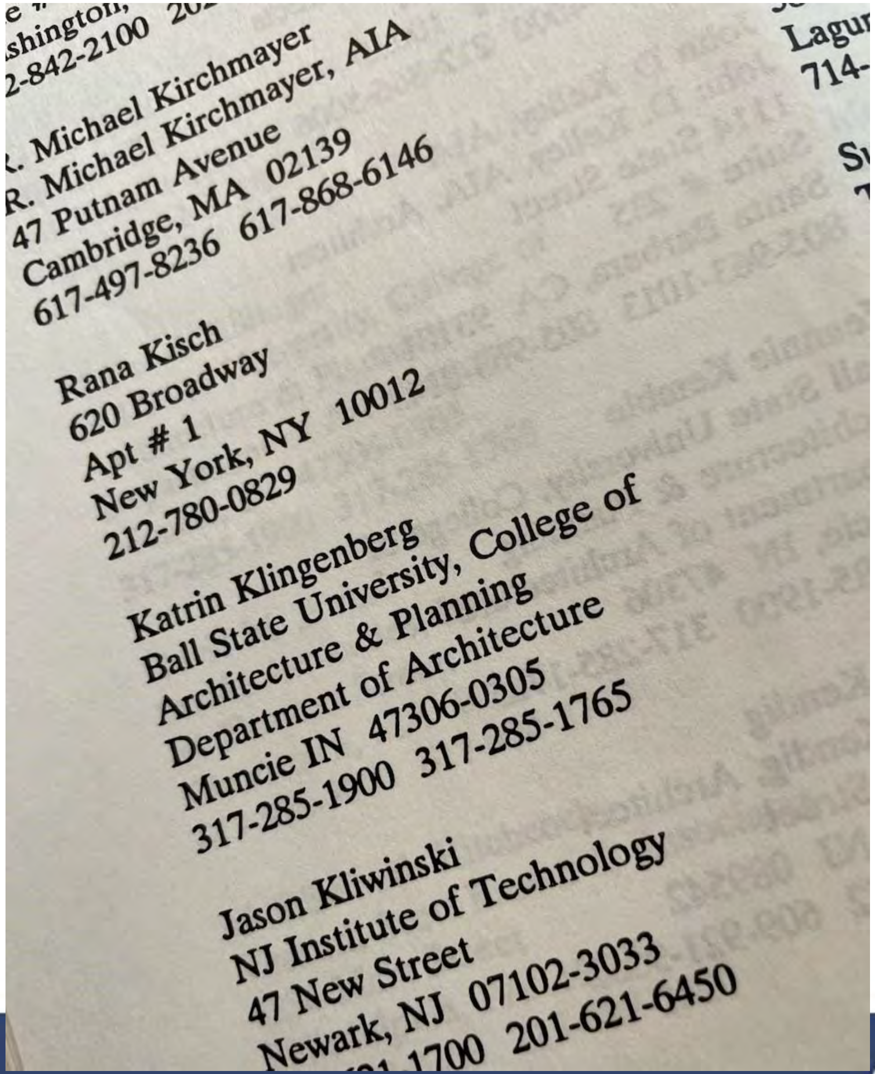
Muncie Indiana – 1994 Ball State University

Center for Energy and Research, Education & Service

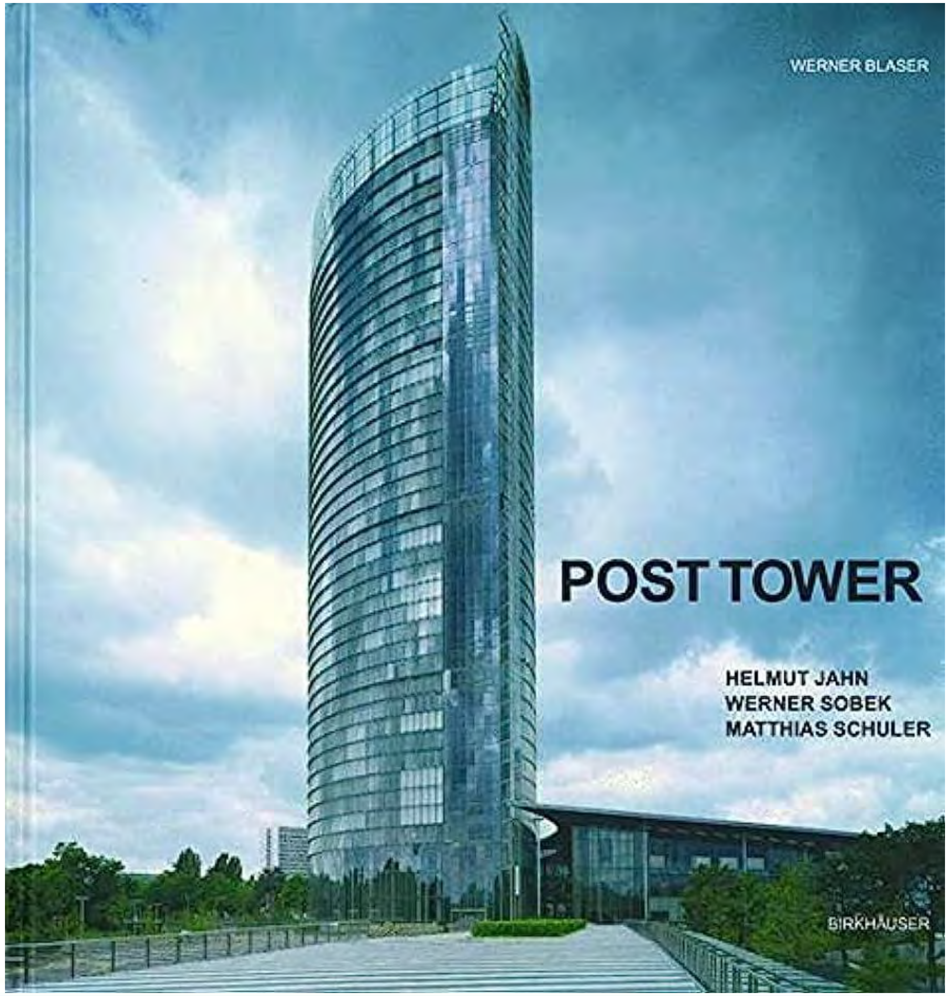
First Generation EFS Leadership
Ball State University's sustainability leadership began with 1979 creation of the university-level ***Center for Energy Research, Education and Service (CERES)*** and its program of ***CERES Research Fellowships*** that triggered BSU's first generation EFS leadership. The 1990 ***Green Committee*** set BSU's sustainability direction and programs to promote sustainability across campus. In 1996, the first ***Greening of the Campus Conference*** was held. The***LandLab*** was proposed at the 2nd Green of the Campus Conference in 1997, as was the ***Cluster of Interdepartmental Minors in Sustainability***. The ***Land Design Institute (LDI)*** was created in 2000.

New York City - October 1994





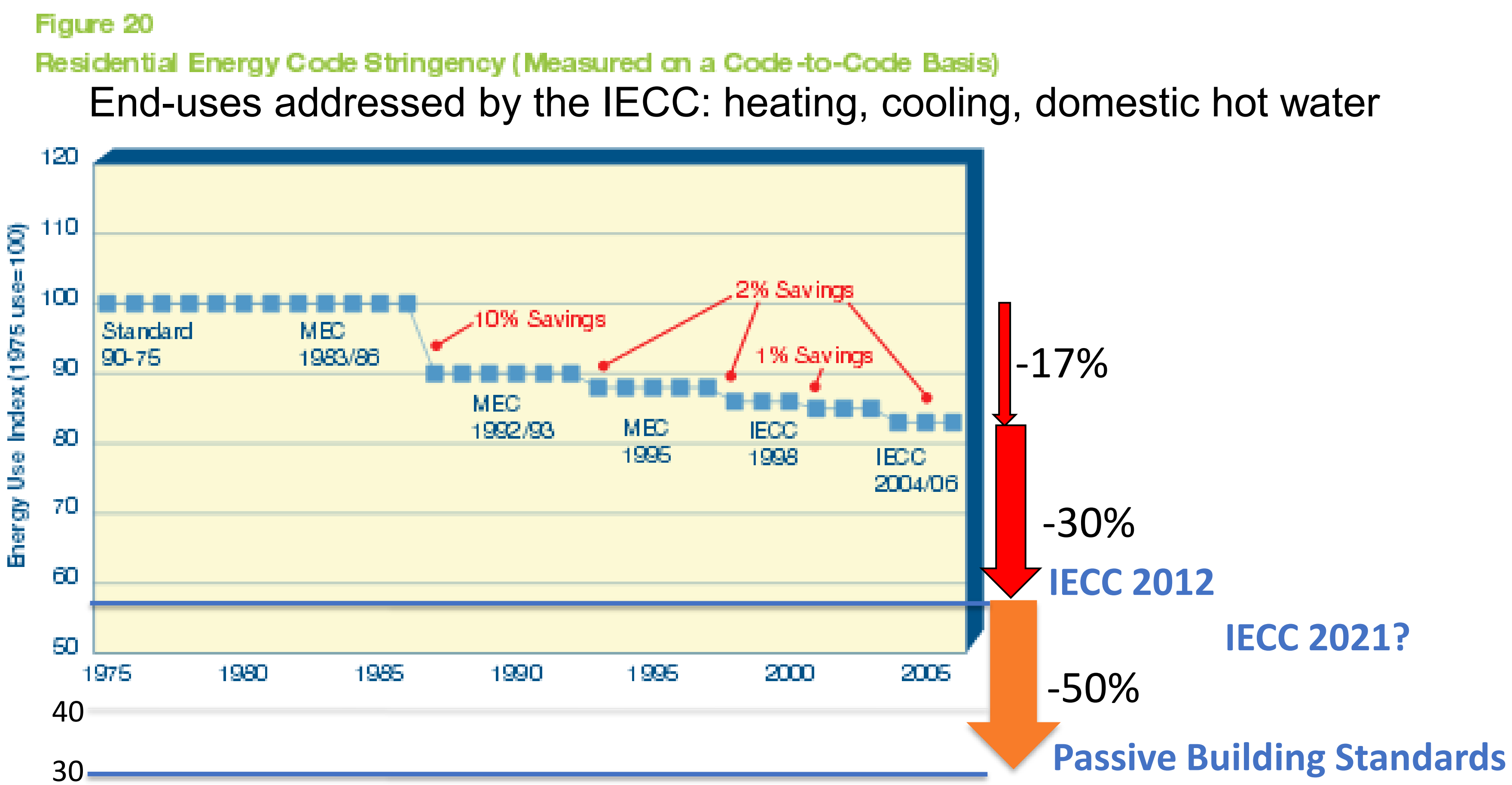
1997 - Murphy/Jahn (Jahn today)



Passive House 1.0 – So it begins...

(taking place in the US, Canada, Scandinavia)

DOE Research Roadmap Develops after 1973 Oil Crisis



(Source : U.S. Department of Energy: Energy Efficiency Trends in Residential and Commercial Buildings)

Superinsulation and Passive Solar Debate

PASSIVE SOLAR

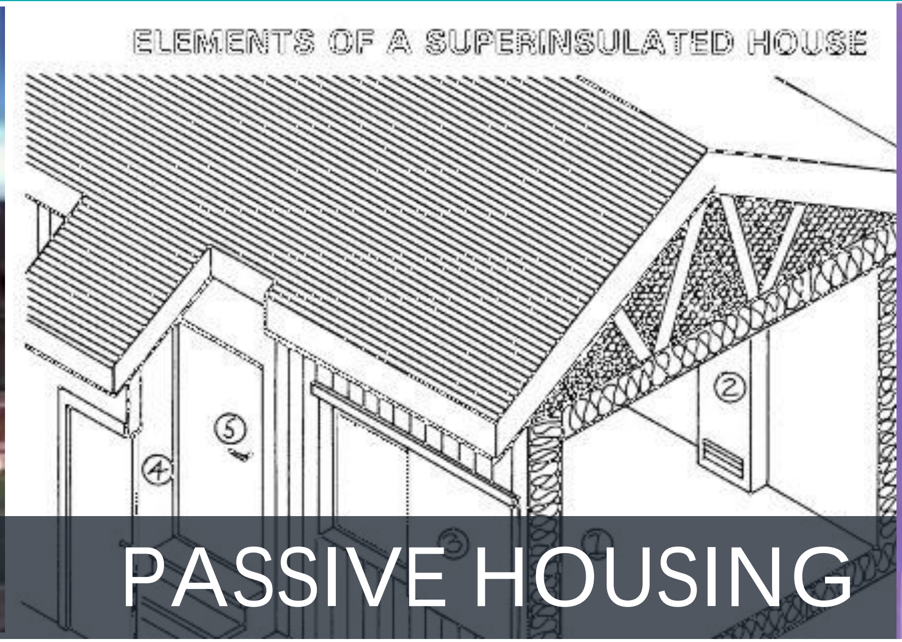
aka Mass & Glass (Doug Balcomb)

Big temperature swings

Net negative windows

Heavy focus on south glazing

Big temperature swings



PASSIVE HOUSING

aka Thick Walls & Tight (Gene Leger)

Slow temp movement

Net positive windows

Moderate south glazing

Balanced ventilation

John Larsen invents the

"stand-off" truss , 1981

Alberta

End of 1985 10k to 30k Homes in US and Canada

4th ANNUAL CONFERENCE SESCI 1978

CANADA, EXCERPT FROM PROCEEDINGS

The term “passive house” or “passive housing” has been in use in the US and Canada since the 70s describing the same concept as today’s passive house!

Proceedings
4th Annual Conf.
SESCI 1978
London, Ontario

8 - 3 - 1

PASSIVE SOLAR HEATING - RESULTS

FROM TWO SASKATCHEWAN RESIDENCES

Robert S. Dumont, Robert W. Besant;
Department of Mechanical Engineering
University of Saskatchewan
Saskatoon S7N 0W0 Canada

Grant Jones, Botting & Associates Ltd.
3337 8th St. E., Saskatoon

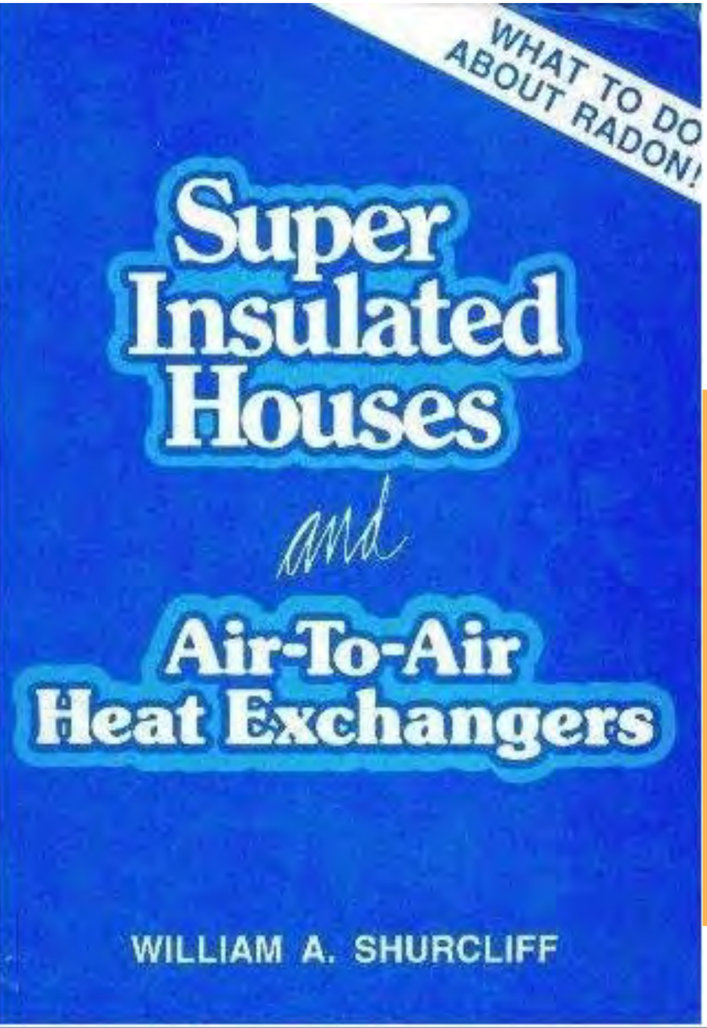
Rod Kyle, Aquitaine of Canada Ltd.
Rainbow Lake, Alberta

8 - 3 - 1

Introduction

Considerable interest has been shown in the use of passive solar heating. Two conferences[1],[2] and numerous papers have dealt with this topic. The pioneering work of Trombe[3], Balcomb[4] and Anderson[5] has led to a greater recognition of the cost-effectiveness of passive solar heating. For Canadian climate conditions little detailed work has been done in this area. A number of recent papers by Cooper[6], Gilpin[7] and Jones and Tymura[8]present theoretical studies on the performance of windows and passive houses in Canadian conditions.

Distilling Passive House & Component Predictions



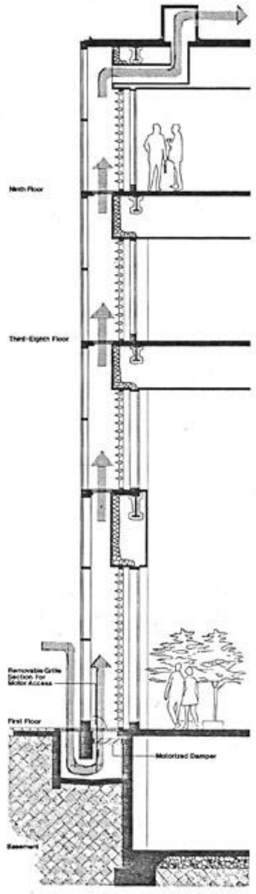
1. ***Not just thick, but clever and thorough.***
2. *…**practically airtight.***
3. ***No provision of extra-large thermal mass.***
4. ***No provision of extra-large south windows.***
5. ***No conventional furnace.***
6. ***No conventional distribution system for such auxiliary heat.***

Are further refinements of design in the offing? Yes. More is being learned year by year about vapor barriers and air-and-water barriers and the best ways of installing them. Better air-to-air heat-exchangers are becoming available; efficiency is being increased, defrosting is being simplified, and costs may decrease. Several groups are working on combination systems that will combine, perhaps in a single package, the functions of ventilation, fresh air supply, heat recovery, domestic hot water heating, auxiliary heat supply, and summertime cooling. Windows with much higher R-values, perhaps as high as 5 to 8, may become widely available. Strategies for accommodating

But there is no need to wait for such refinements. Superinsulation is already a mature and well proven technology.

(Shurcliff, 1988: Super Insulated Houses and Air-To-Air Heat Exchangers)

Richard Levine - Hooker Office Building 1981

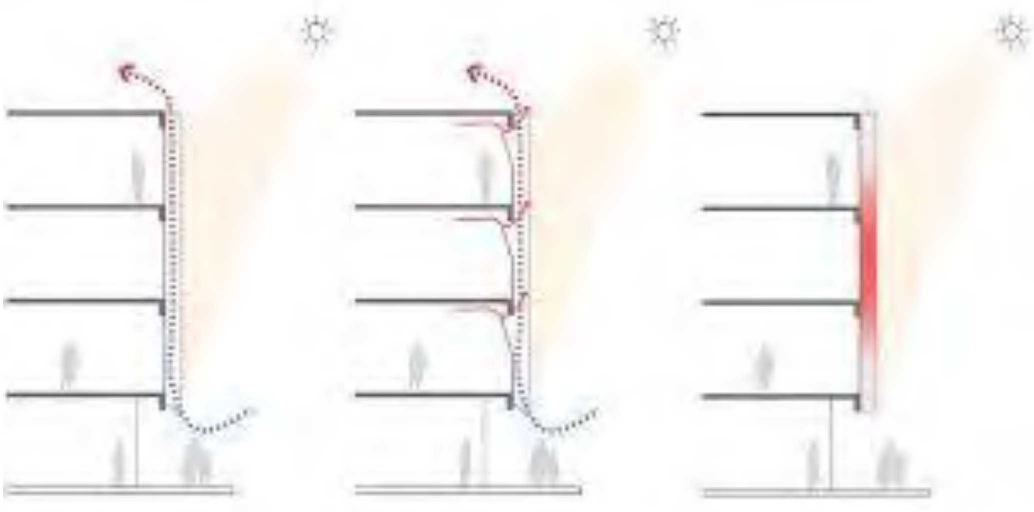


Hooker Office Building,
Niagara Falls, NY

Rainbow's end

At the south end of the famed Rainbow Bridge on the Niagara River, a new focal point is to greet travelers from Canada.

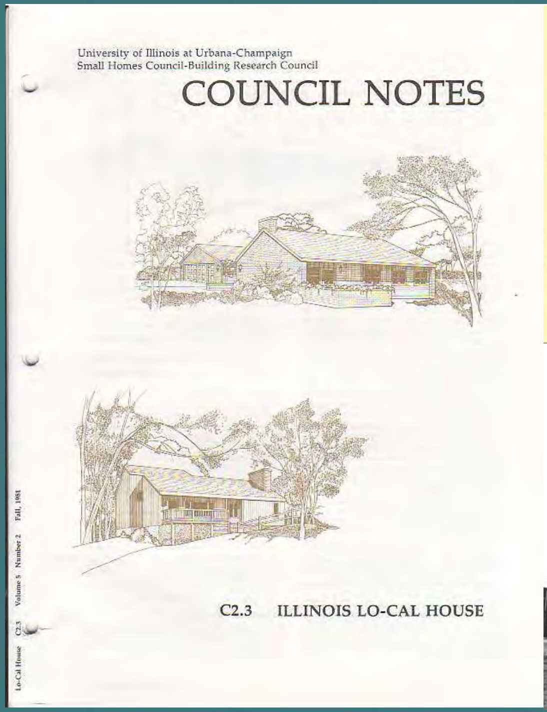
Foster & Partners Duisburg Residential



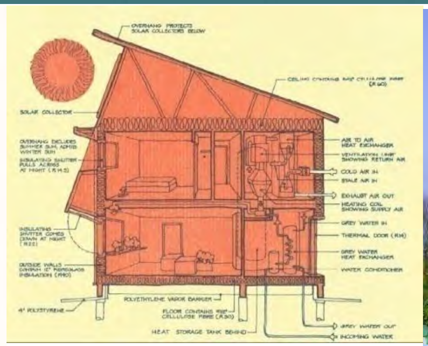
Hooker Building Double Skin Glass Facade

Richard Levine was design and energy consultant for this building, providing the conceptual design for what even today ranks as one of the most energy efficient office buildings ever built This was the first double skinned glass active façade used in an office building. Between the two curtain wall skins, computer-controlled insulated louvers maximized daylighting, minimized heat loss, and provided for passive and active solar heating as well as for ventilation. Twelve years later Norman Foster sent a team of architects and engineers to Niagara Falls to study Hooker and then did a project with a virtually identical system in Duisburg, Germany. Foster's building became the grandaddy of numerous energy conserving commercial buildings in Europe. As part of his consultancy, Levine presented schemes with three levels of performance to the clients who were trying to restore some part of their reputation after being shunned for their role in the Love Canal environmental disaster. Hooker ended up choosing the middle of the three schemes (The top scheme would have resulted in a net positive production of energy.) Progressive Architecture did two articles on Hooker. For the second article they commissioned a prominent energy engineer to assess Hooker's performance. He calculated that Hooker would use just 12% of the energy of a conventional office building in a similar climate. Even today, three decades later, few buildings can equal that level of performance.

Passive House 2.0



1974-76
First experimental Lo-Cal Homes in Urbana Illinois

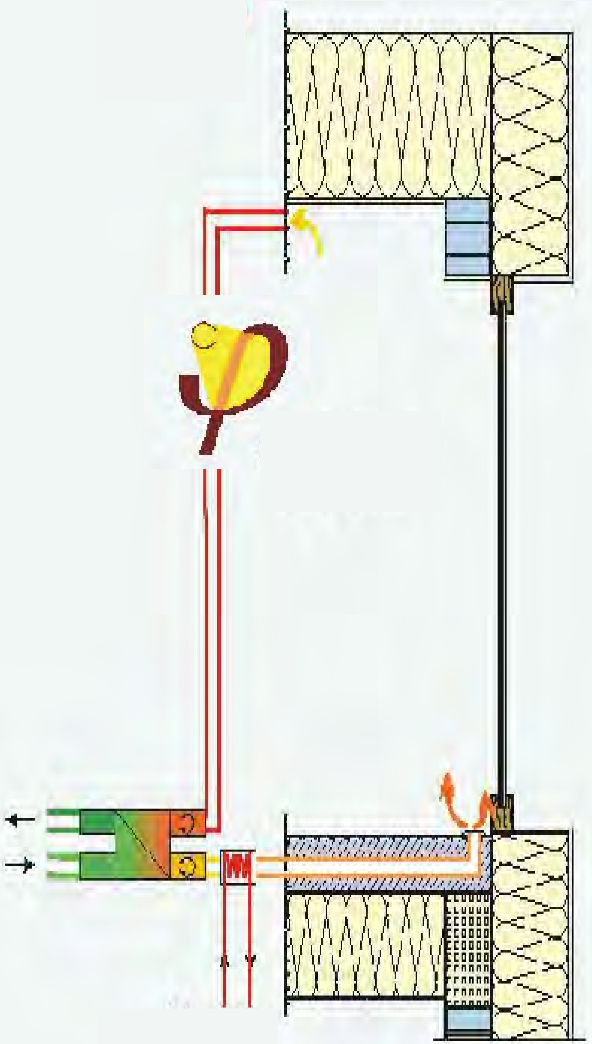


1977-86
Saskatchewan Conservation House

1991 -
Kranichstein Passivhaus developments Germany

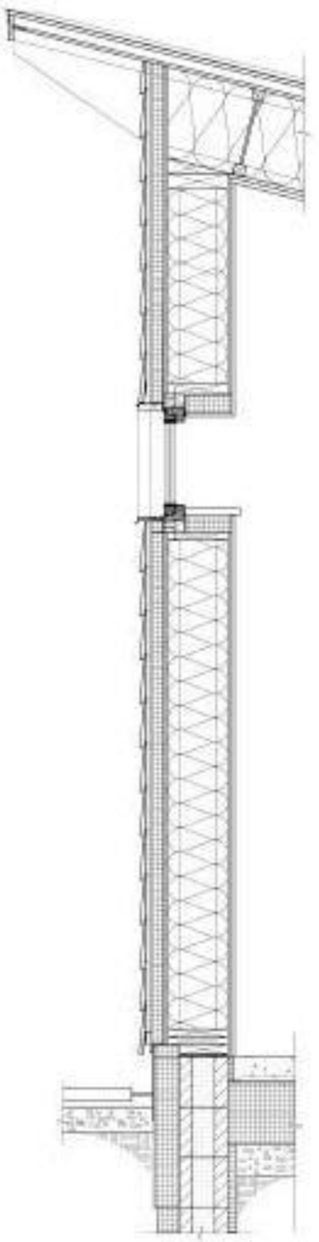
2002, 2006 -
Smith House & BioHaus USA

GERMAN PASSIVHAUS CRITERIA



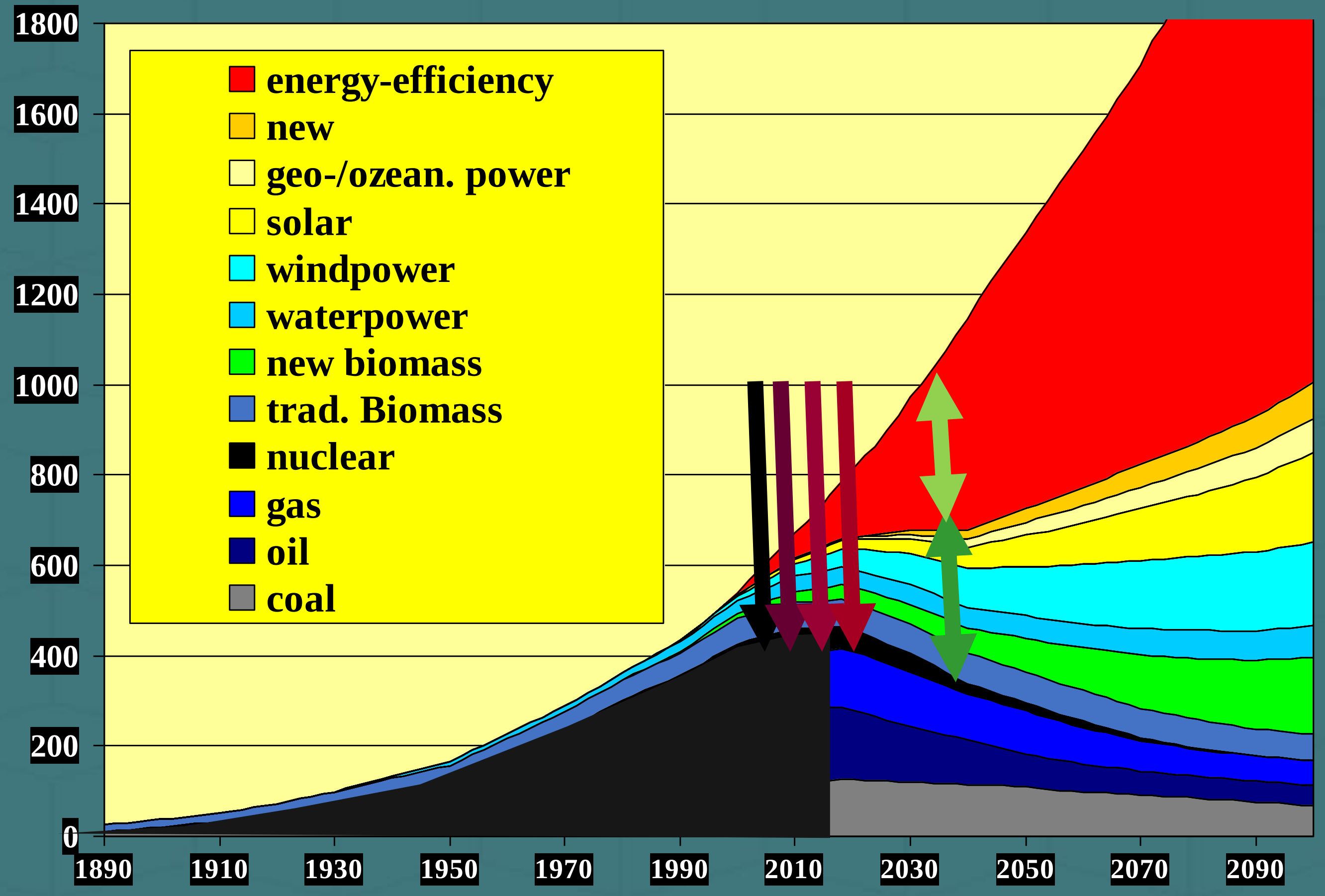
Primary Energy	$kBTU/ft^2/yr$	38
Airtightness	ACH_{50}	0.6
Annual Heat Demand	$kBTU/ft^2/yr$	4.75
Annual Cooling Demand		
Peak Heat Load	$BTU/ft^2.hr$	3.14
Peak Cooling Load		2.54
Ventilation	% efficiency	75%
	W/cfm	≤ 0.76
Thermal Envelope	$hr. ft^2 °F/BTU$	≥ R-38.5
	$BTU/hr. ft^2 °F$	≤ U-0.026
Thermal Bridge Free	BTU/ hr. ft °F	Ψ ≤ 0.006
Windows Installed	$BTU/hr. ft^2 °F$	Uw-install ≤ 0.15
SHGC	%	≈ 0.50 - 0.55


OPTIMA




maxim
CLIMBING ROPES
Products
Activities
Tech Info
MAXIM Team
About Us
MAXIM SIGNATURE SERIES
THE BEST ROPE OF EACH KIND
EXPLORE

FUTURE WORLDWIDE TRANSITION

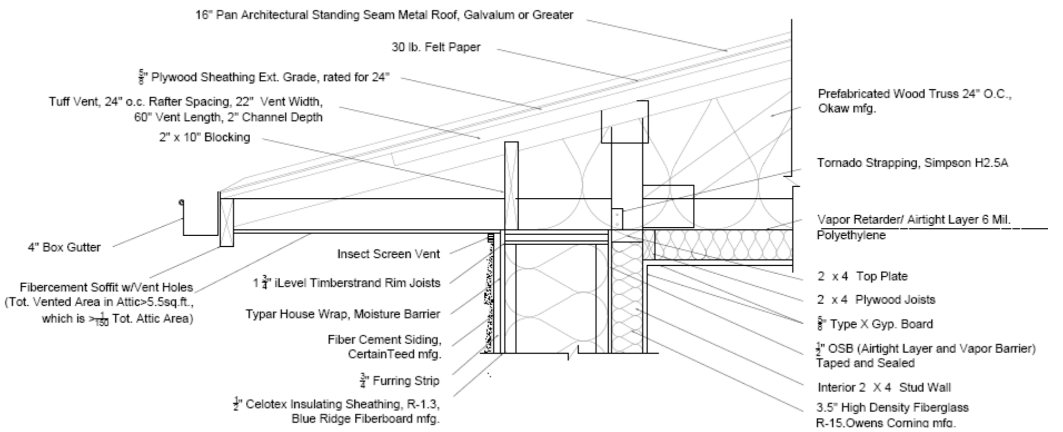


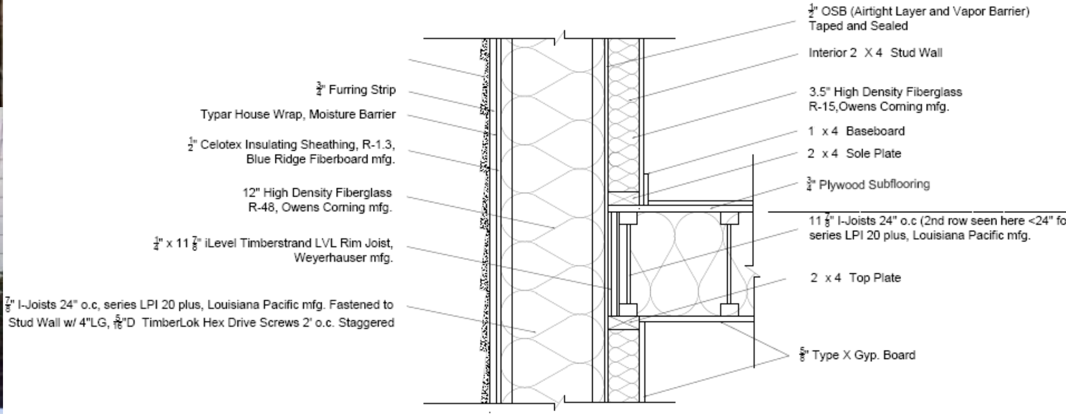
Reference: Shell-Study (2005), Scenario with high efficiency and regenerative usage of energy


OPTIMA

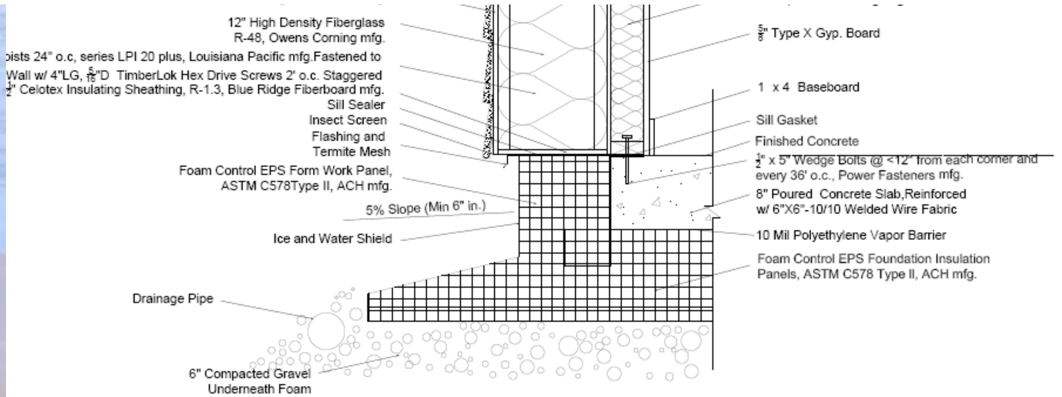

08/20/2008


GRACE VYCOR PLUS





2 DETAIL: FLOOR FRAMING CONNECTION SCALE: 1"= 1'0



Single Family Reality Check PHI Standard & Split

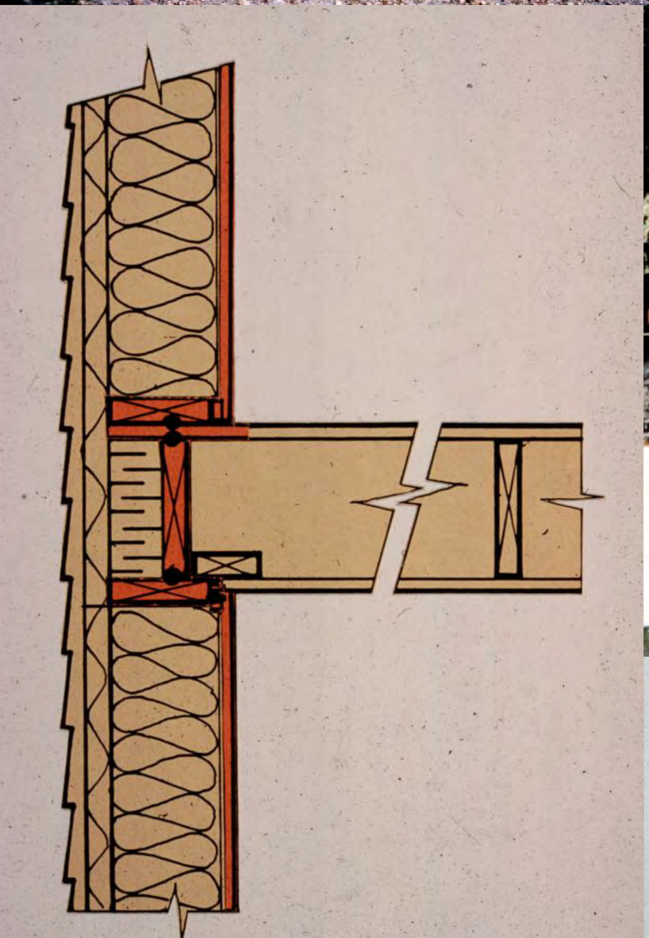
- Urbana home earth tube filled up with water in the humid summer, peak heating load blew the relay on ventilation integrated heating element during the first winter…home was overheating in winter and summer!
- Louisiana Project: boy…did we get our butts handed to ourselves…10% overheating criterion useless, cooling demand simply a mirror of German heating demand? Really?
- California projects: using heating demand in CA climates that have none was like building a fence sized for cows around chickens – lots of savings remained on the table in absence of an appropriately optimized design criterion for that climate
- North-west projects: could not even meet peak heat criterion in that mild climate to allow for ventilation air heat only, heating demand the closet match in the US
- Canadian projects: aced the heating criterion, but focus on passive solar caused overheating issues, made cooling skyrocket in a climate where there really should be none…
- On all PHI projects – measured vs modeled data was off by 25-30%, consistently!

2012 – Joe keynotes 6th NAPHC in Denver CO

- Young Joseph builds passive houses and directs R2000 Program - 1982
- Oliver Drerup's quote, Summer Camp 2011: "If you don't know your past you won't have a future"
- Shurcliff paper from 1988 on Passive Housing mentions Joe's work, I finally put it together.




GLASCLAD
FIBERGLAS CANADA





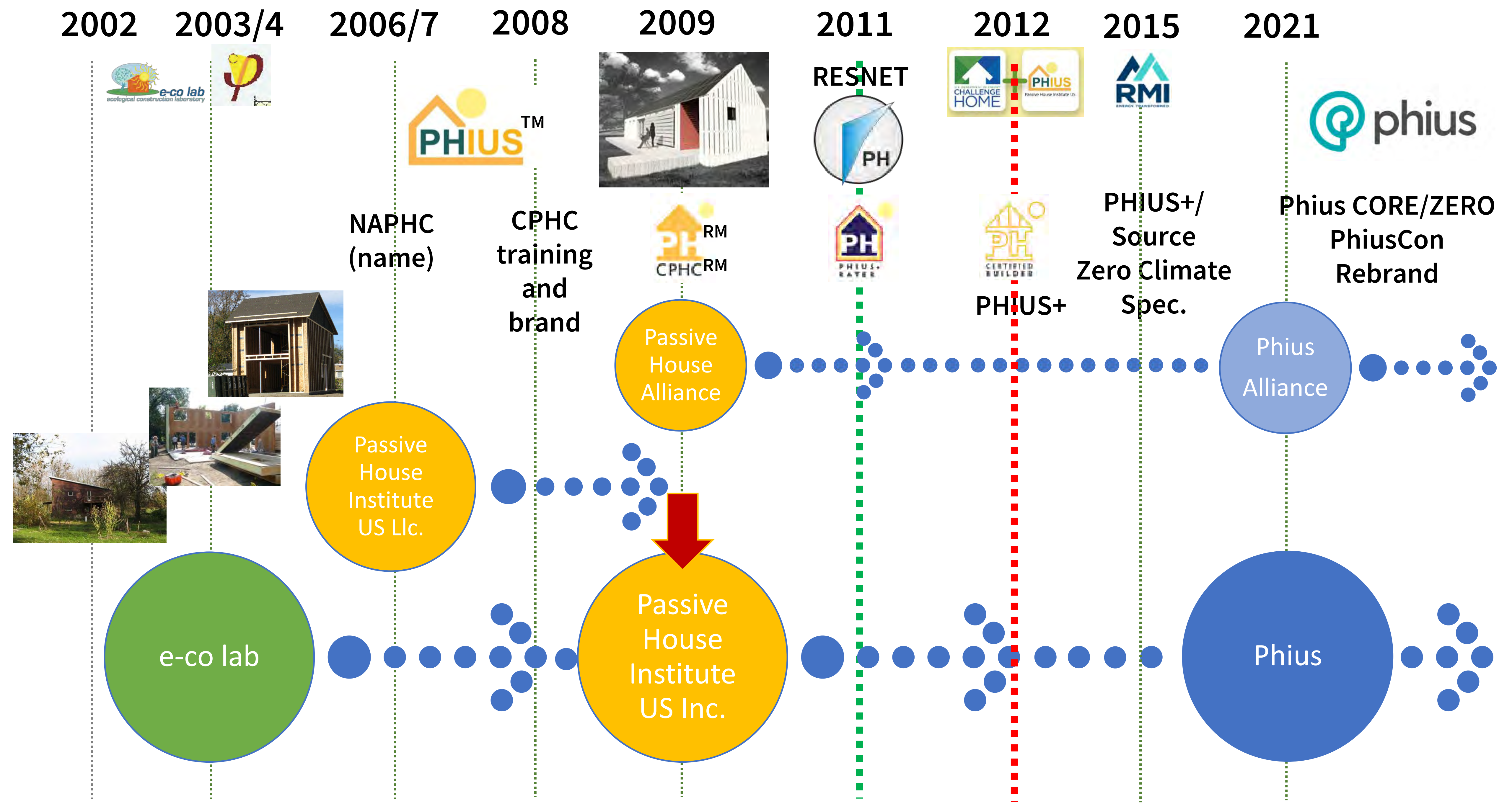
Rocky Mountain Institute

Amory Lovins' Home in Snowmass,
Published the first Paper that talks about Passive Building in 1995

Mentions
Passive Houses in
'Natural Capitalism'

Mentions
Phius in
'Reinventing Fire'

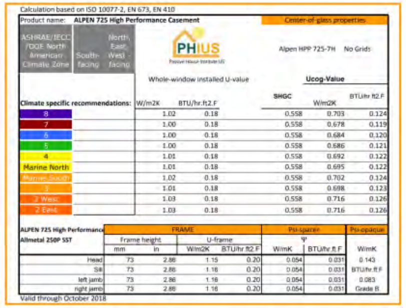
The Present – Passive House 3.0 (Modern Day Passive Building)


2002
2003/4
2006/7
2008
2009
2011
2012
2015
2021
e-co lab
ecological construction laboratory
PHIUS
TM
RESNET
PH
CHALLENGE
HOME
PHIUS
RMI
phius
NAPHC
(name)
CPHC
training
and
brand
RM
CPHC
RM
PHIUS+
RATER
CERTIFIED
BUILDER
PHIUS+
PHIUS+/
Source
Zero Climate
Spec.
Phius CORE/ZERO
PhiusCon
Rebrand
Passive
House
Alliance
Phius
Alliance
Passive
House
Institute
US Llc.
e-co lab
Passive
House
Institute
US Inc.
Phius

What does Phius do?

phius certified consultant

phius certified product



Calculation based on ISO 10077-2, EN 673, EN 410

Product name: ALPEN 725 High Performance Casement

Alpen HPP 725-7H No Grids

ASHRAE/IECC /DOE North American Climate Zone	South-facing	North, East, West - facing	Whole-window installed U-value W/m2K	Whole-window installed U-value BTU/hr.ft2.F	Center-of-glass properties SHGC	Ucog-Value W/m2K	Ucog-Value BTU/hr ft2.F
Climate specific recommendations:							
8			1.02	0.18	0.558	0.703	0.124
7			1.00	0.18	0.558	0.678	0.119
6			1.00	0.18	0.558	0.684	0.120
5			1.00	0.18	0.558	0.686	0.121
4			1.01	0.18	0.558	0.692	0.122
Marine North			1.01	0.18	0.558	0.695	0.122
Marine South			1.02	0.18	0.558	0.702	0.124
3			1.01	0.18	0.558	0.698	0.123
2 West			1.03	0.18	0.558	0.716	0.126
2 East			1.03	0.18	0.558	0.716	0.126

ALPEN 725 High Performance Allmetal 250P SST	FRAME Frame height mm	FRAME Frame height in	FRAME U-frame W/m2K	FRAME U-frame BTU/hr ft2.F	Psi-spacer Ψ W/mK	Psi-spacer Ψ BTU/hr.ft.F	Psi-opaque
							W/mK
Head	73	2.88	1.15	0.20	0.054	0.031	0.143
Sill	73	2.88	1.16	0.20	0.054	0.031	BTU/hr.ft.F
left jamb	73	2.88	1.16	0.20	0.054	0.031	0.083
right jamb	73	2.88	1.16	0.20	0.054	0.031	Grade B

Valid through October 2018

phius ZERO

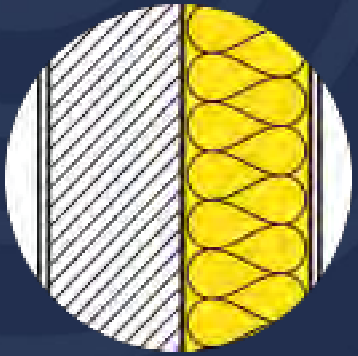
phius alliance CHICAGO

Zero is the goal. Phius is the means.

Passive Building Delivers

Passive Building Principles

THERMAL CONTROL



High Performance Insulation

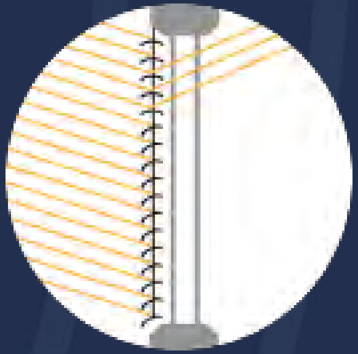
Thermal Bridge Elimination

AIR CONTROL

Air-Tightness

Enthalpy Recovery Ventilation

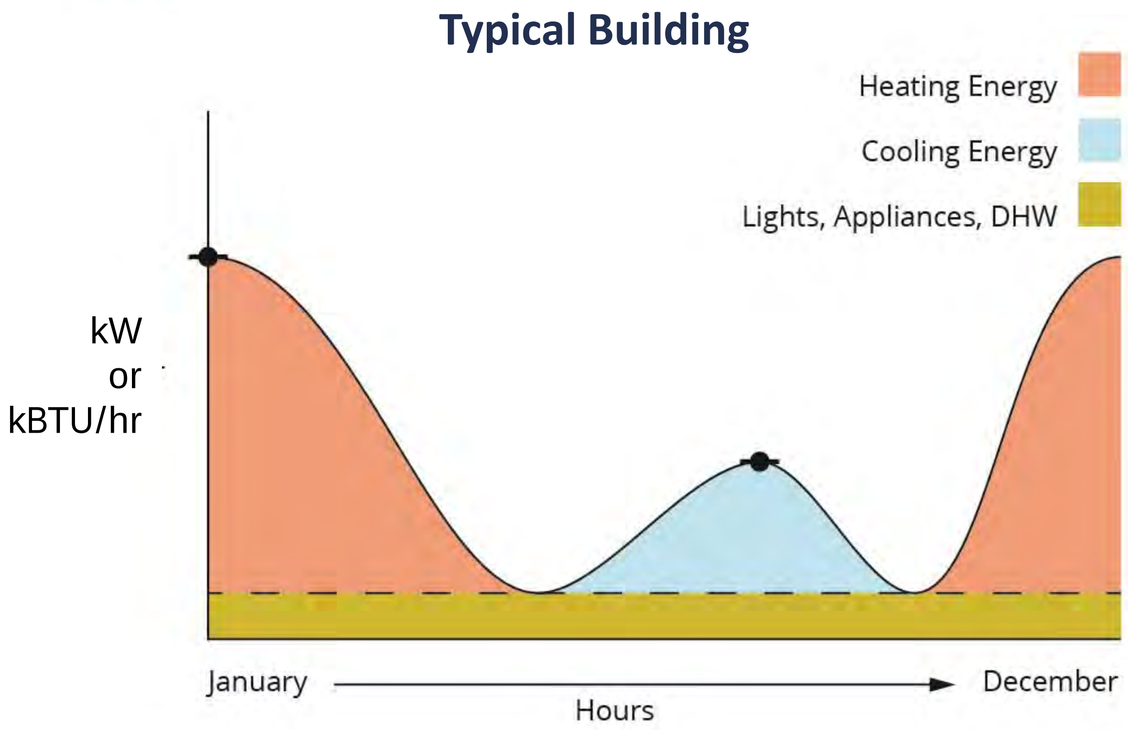
RADIATION CONTROL

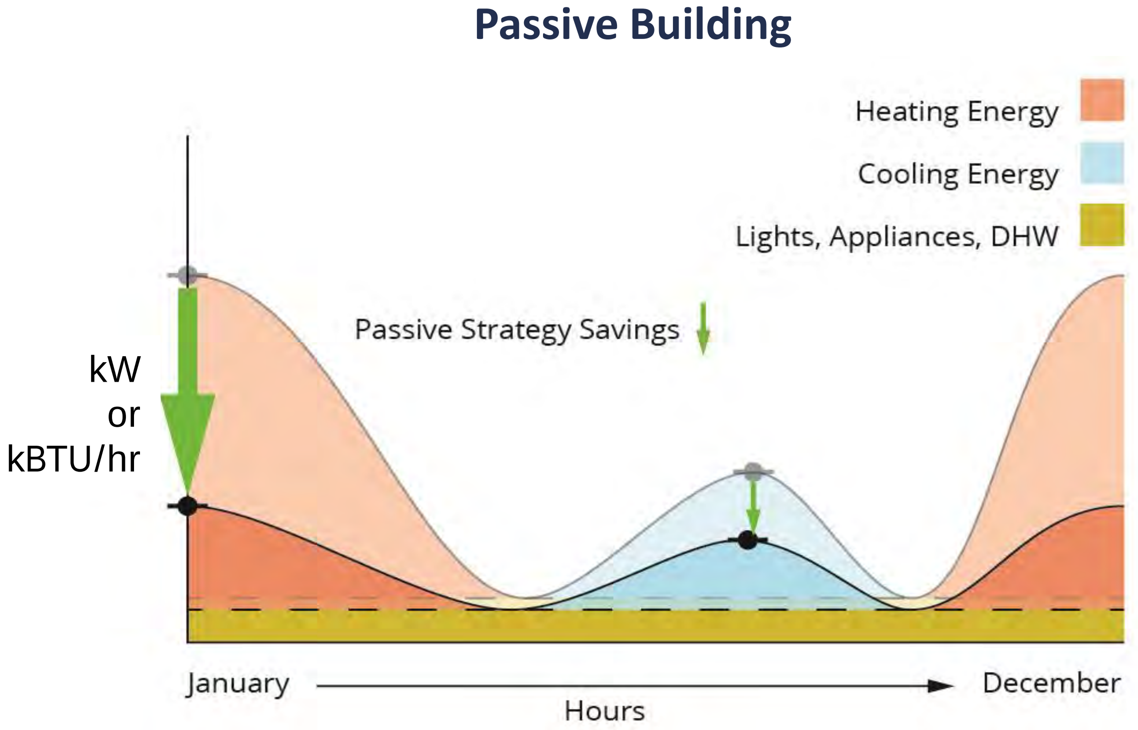


Shading / Daylighting

Climate Appropriate Glazing

Standard Setting / QA QC Process



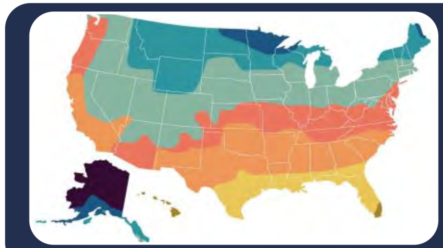


Annual Energy = kWh/yr (or kBTU/yr) → area under the curve

Peak Power = kW (or kBTU/hr) → point at top of curve

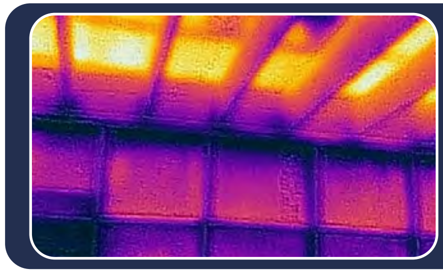
CERTIFICATION FRAMEWORK

REQUEIEMTNS FOR ALL PHIUS CERTIFICATIONS



SPACE CONDITIONING TARGETS

AIR-TIGHTNESS

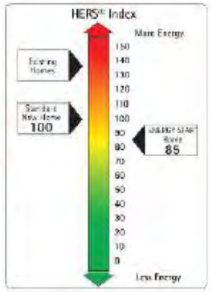


ON-SITE QUALITY ASSURANCE TESTING/INSPECTION

VARIES

NET SOURCE ENERGY TARGET

Partnerships since 2011/12

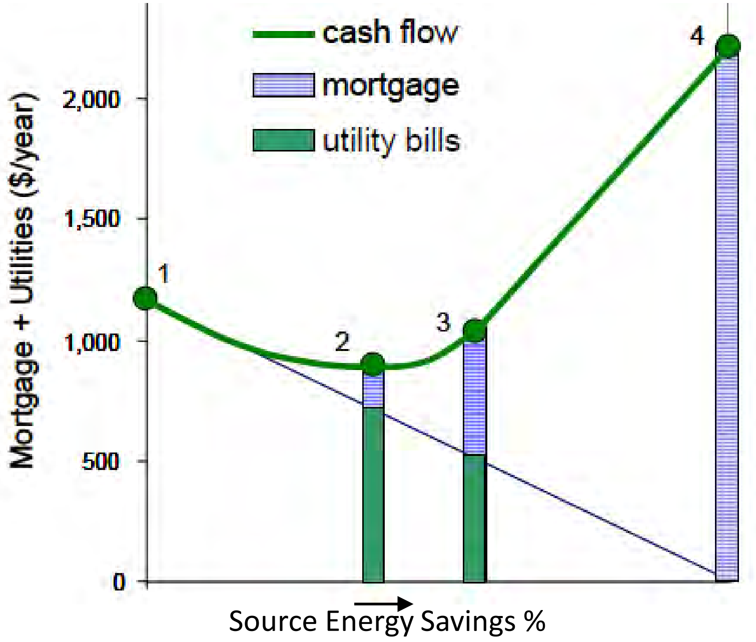



ENERGY
Climate-Specific Passive Building Standards
Graham S. Wright and Katrin Klingenberg
Passive House Institute US
July 2015

IECC 2012	ENERGY STAR v3	ENERGY STAR v3.1	ZERH	phius CORE	phius ZERO
					Renewable Energy to Get to Zero
				Electrification Readiness	No Fossil-Fuel Combustion On-Site
				Electric Vehicle Readiness	Electric Vehicle Readiness
				Balanced Ventilation HRV/ERV	Balanced Ventilation HRV/ERV
			SOLAR READY Depends on climate	SOLAR READY ALWAYS	SOLAR READY ALWAYS
			Eff. Comps. & H2O Distrib	Eff. Comps. & H_2O Distrib	Eff. Comps. & H_2O Distrib
			EPA Indoor airPLUS VI	EPA Indoor airPLUS VI	EPA Indoor airPLUS VI
			Ducts in Condit. Space	Ducts in Condit. Space	Ducts in Condit. Space
	HVAC QI w/WHV	HVAC QI w/WHV	HVAC QI w/WHV	Micro-load HVAC QI	Micro-load HVAC QI
	Water Management	Water Management	Water Management	Water Management	Water Management
	Independent HERS Verification	Independent HERS Verification	Independent HERS Verification	Independent HERS Verification	Independent HERS Verification
IECC 2012 Enclosure	IECC 2012 Enclosure	IECC 2012 Enclosure	IECC 2015/18 Encl./ES Win.	Ultra-Efficient Enclosure	Ultra-Efficient Enclosure
HERS 70-80	HERS 60-70	HERS 50-60	HERS 35-45	HERS 30-40	HERS < 0

Optimization Design Methodology

Setting ***Cost Competitive*** Space Conditioning Targets



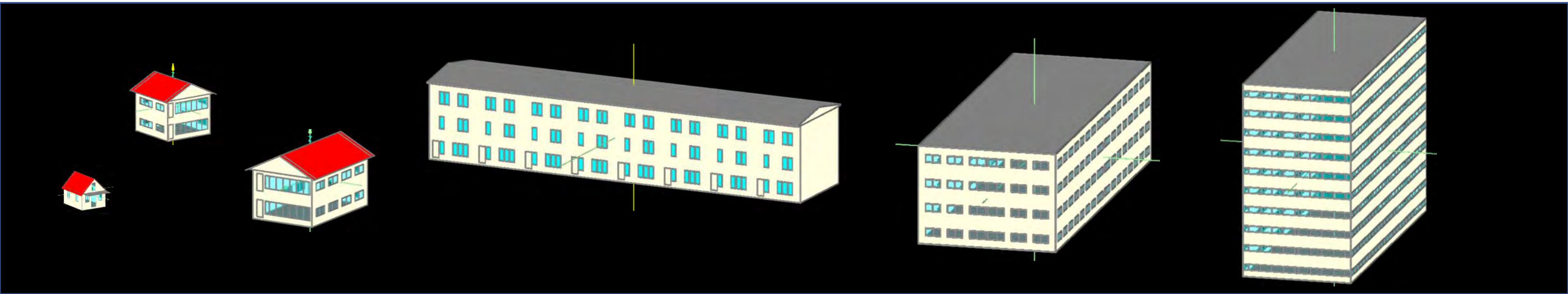
Factors:

Climate

Building Size

Occupant Density

Dwelling Unit Density

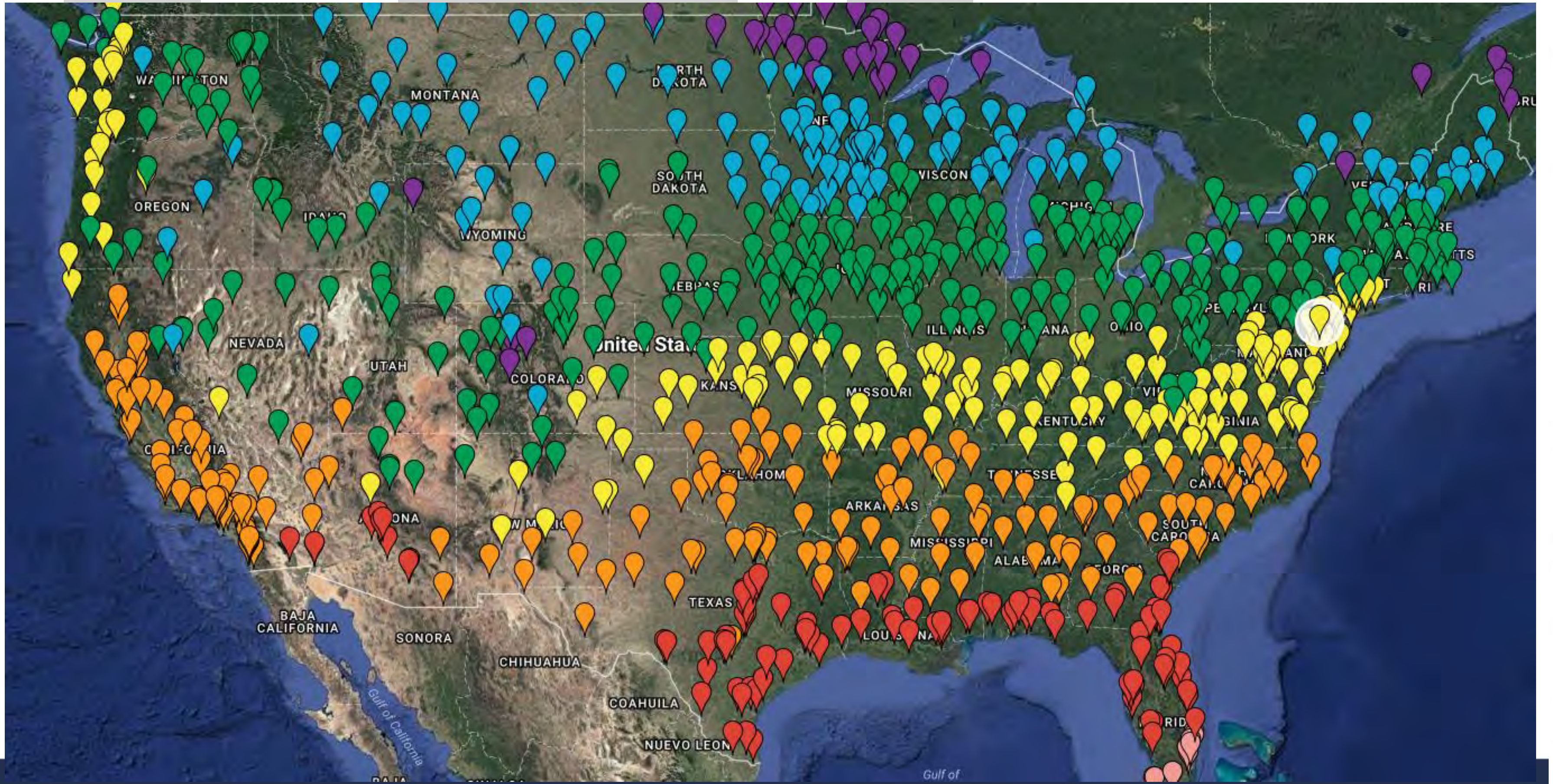


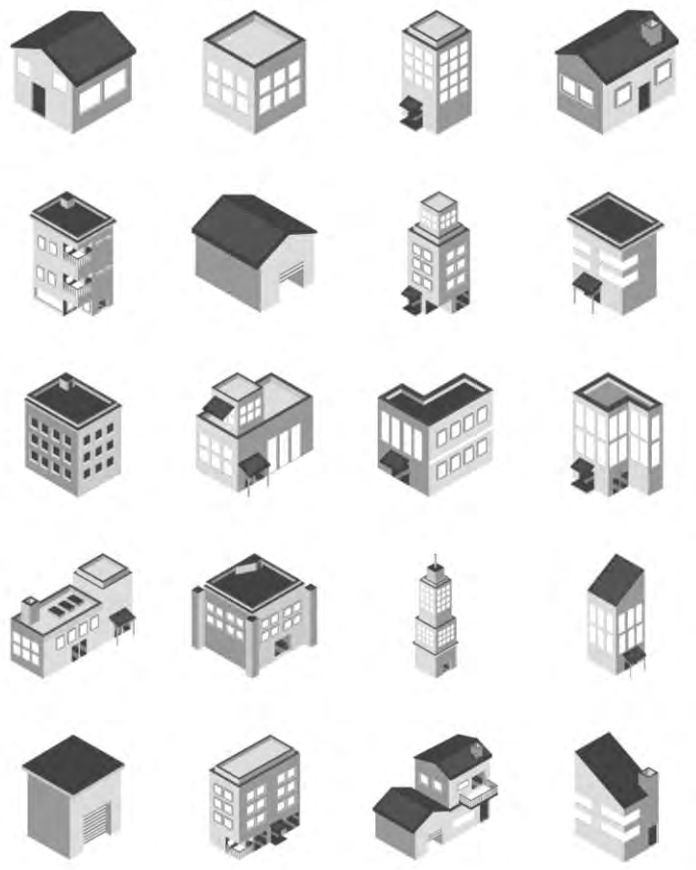
Standard Setting

"Sweet spot"
Based on climate

+

"Sweet spot"
Based on bldg type/size






phius 2021
Performance Criteria Calculator v2
UNITS: IMPERIAL (IP)
BUILDING FUNCTION: NON-RESIDENTIAL
PROJECT TYPE: NEW CONSTRUCTION
STATE/ PROVINCE NEW YORK
CITY NEW YORK J F KENNED'
Envelope Area (ft²) 50,000
iCFA (ft²) 38,000
Design (Max) Occupancy 100
Space Conditioning Criteria
Annual Heating Demand 3.8 kBtu/ft²yr
Annual Cooling Demand 6.9 kBtu/ft²yr
Peak Heating Load 3.3 Btu/ft²hr
Peak Cooling Load 1.9 Btu/ft²hr
Source Energy Criteria
phius CORE 24.5 kBtu/ft²yr
phius ZERO 0 kBtu/ft²yr
phius 2021
Performance Criteria Calculator v2
UNITS: IMPERIAL (IP)
BUILDING FUNCTION: RESIDENTIAL
PROJECT TYPE: NEW CONSTRUCTION
STATE/ PROVINCE ALABAMA
CITY ANNISTON METROPOLIT
Envelope Area (ft²) 3,750
phius 2021
Performance Criteria Calculator v2
UNITS: IMPERIAL (IP)
BUILDING FUNCTION: RESIDENTIAL
PROJECT TYPE: RETROFIT
STATE/ PROVINCE ALABAMA
CITY ANNISTON METROPOLIT
Envelope Area (ft²) 3,750
iCFA (ft²) 1,500
Dwelling Units (Count) 1
Total Bedrooms (Count) 4
Space Conditioning Criteria
Annual Heating Demand 3.7 kBtu/ft²yr
Annual Cooling Demand 10.6 kBtu/ft²yr
Peak Heating Load 4.3 Btu/ft²hr
Peak Cooling Load 2.5 Btu/ft²hr
Same as New Construction + case-by-case allowance for existing structural thermal bridging. See Guidebook Section 1.5.6
Source Energy Criteria
phius CORE REVIVE 3413 kWh/person.yr
phius ZERO REVIVE 0 kWh/person.yr
Phius 2021
PASSIVE BUILDING STANDARD
CERTIFICATION GUIDEBOOK
Version 3.02 | July 2021
phius
53 W. Jackson Blvd. Suite 1462
Chicago, IL 60604 | (312) 561-4588
certification@phius.org
www.phius.org

phius

Certification Process

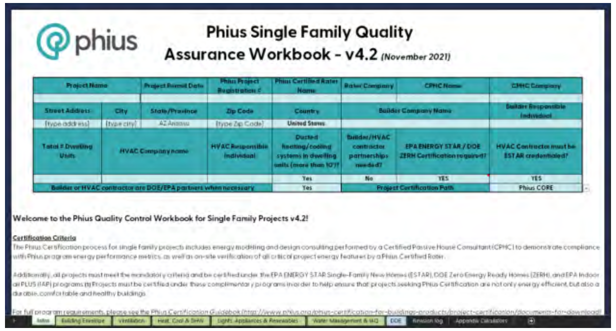
DESIGN CERTIFICATION

- Energy model or checklist to verify compliance
- Review by Phius Certification Team
- Iterative feedback process

WUFI® Passive modeling software

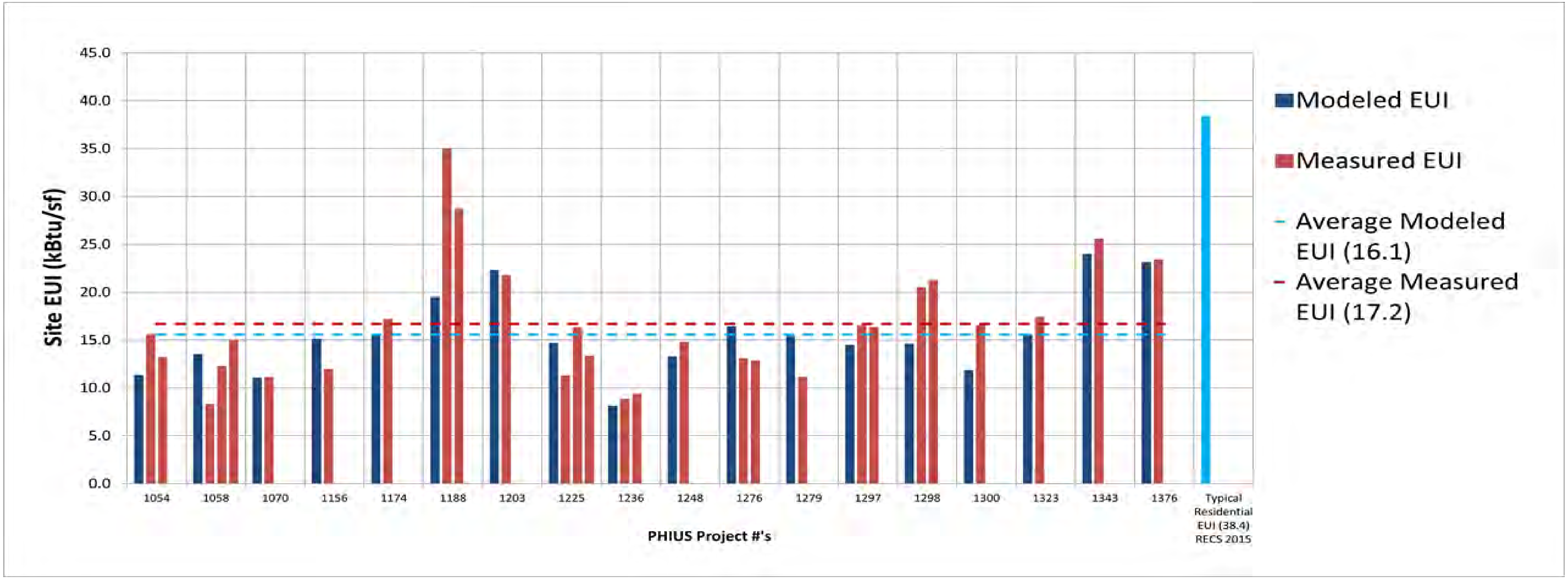
FINAL CERTIFICATION

- Inspection throughout construction by Phius Certified Rater / Verifier (3rd Party)
- Documentation review by Phius Cert Team
- Match energy model to “as-built” conditions



Phius QA/QC workbook

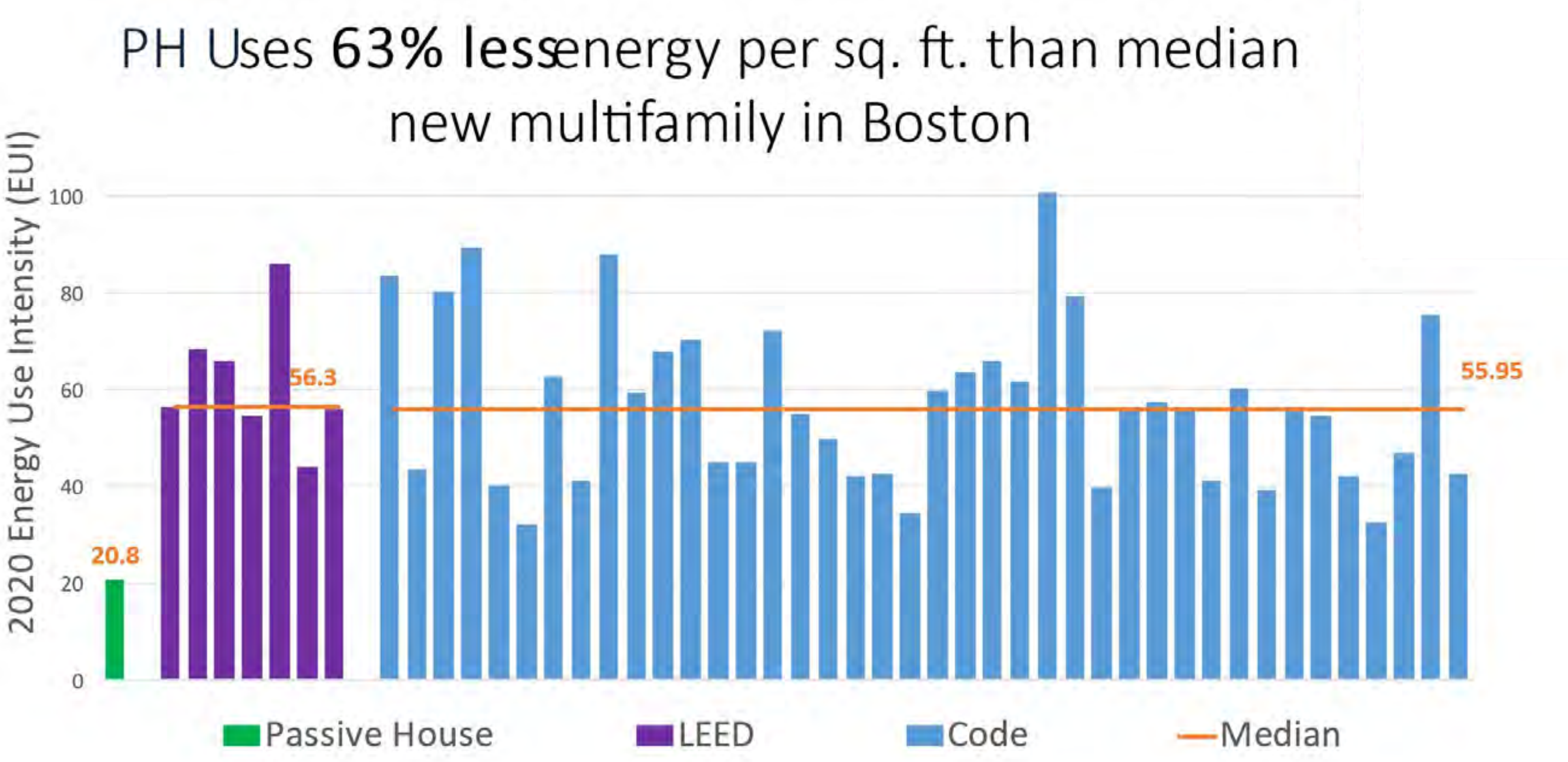
Modeled vs Measured Performance



Verified Performance

Distillery North – South Boston, MA

PHIUS+



Data from Boston Energy Disclosure 2020 sorted for new construction multifamily built since 2008; Cross checked for LEED cer tification; properties with suspected lack of full building energy report are removed.

Passive Buildings as Capacitors of the New Grid

New Construction

phius
CORE

phius
ZERO

Retrofit / Existing Buildings

phius
CORE REVIVE

phius
ZERO REVIVE

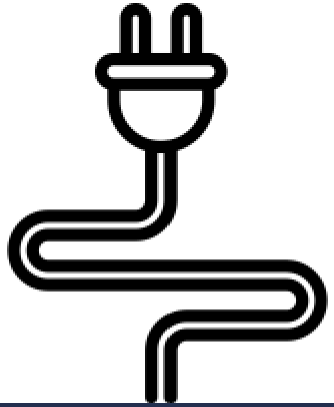
ELECTRIC VEHICLE READINESS

Required for all Residential Phius projects

COMBUSTION AND ELECTRIFICATION

phius CORE

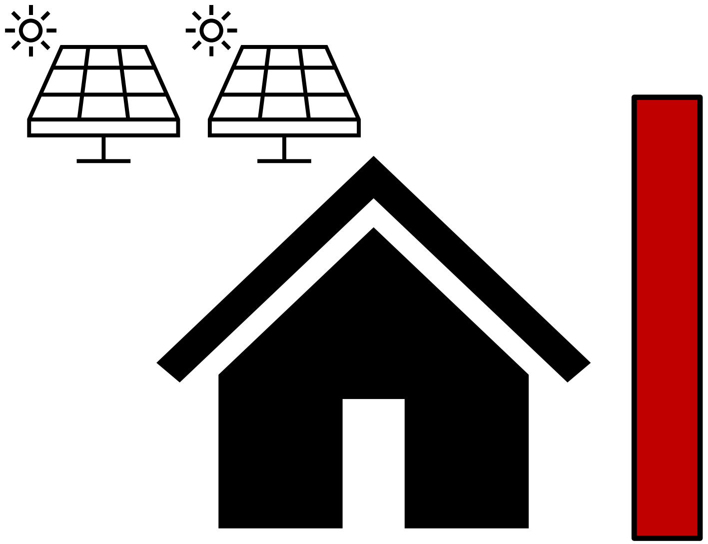
On-Site Combustion OK,
BUT Electrification
Readiness required



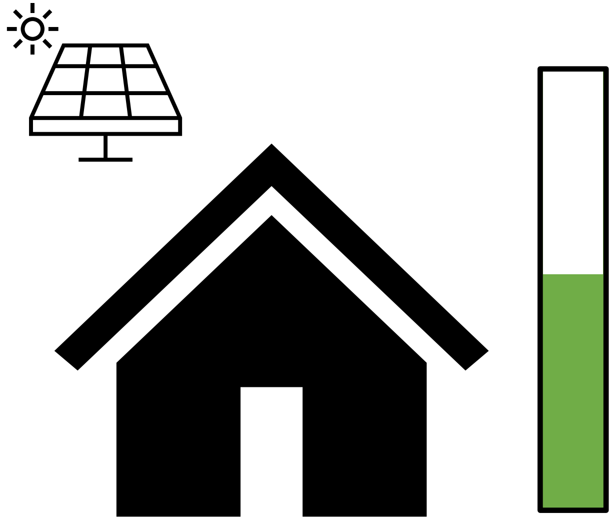
phius CORE Prescriptive & phius ZERO

No fossil fuel combustion allowed

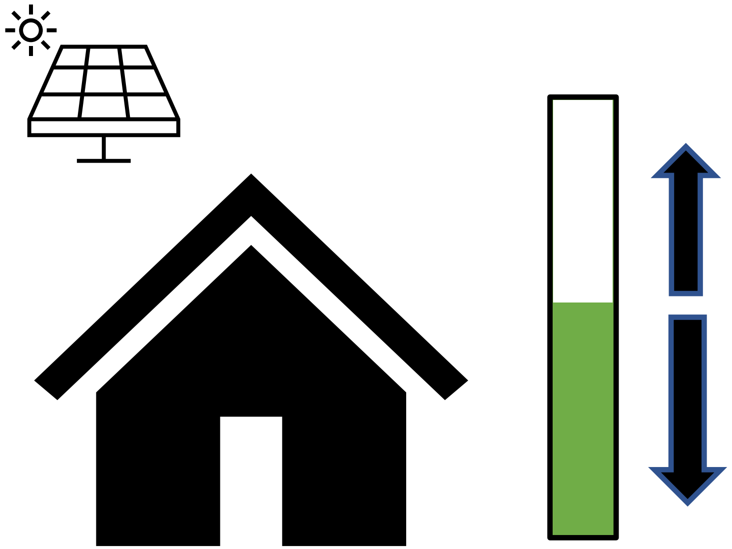
phius



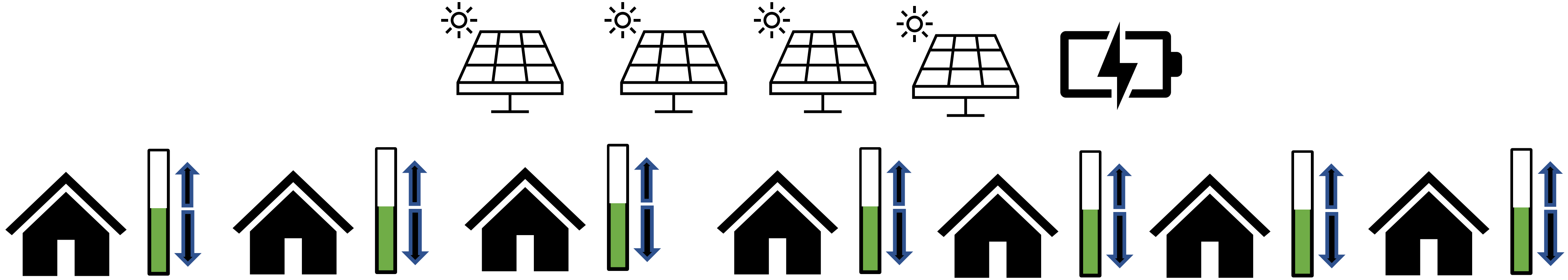
Baseline Net Zero



Phius CORE → ZERO



Phius ZERO + Grid-Interactive Building (GEB)



PhiusGEB Microgrid Community

The Opportunity - PhiusGEB

Phius ZERO + GEB

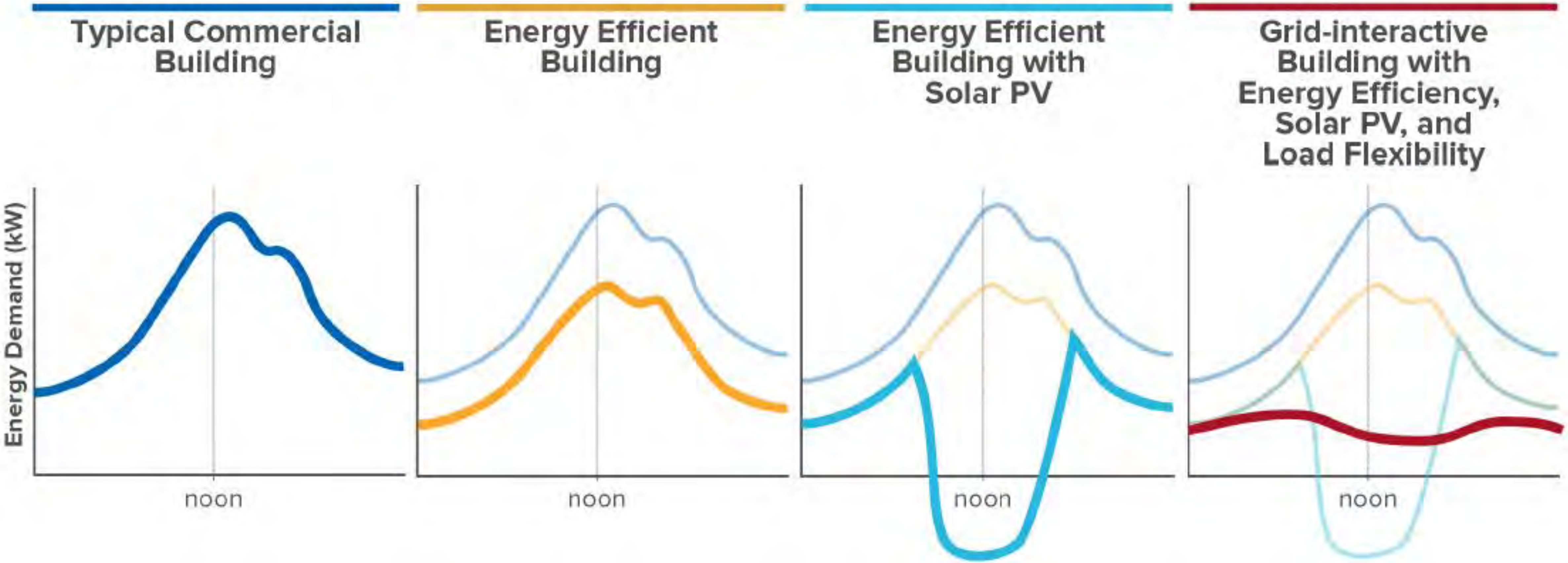


Image Source: RMI/GSA

100% Emissions Reduction

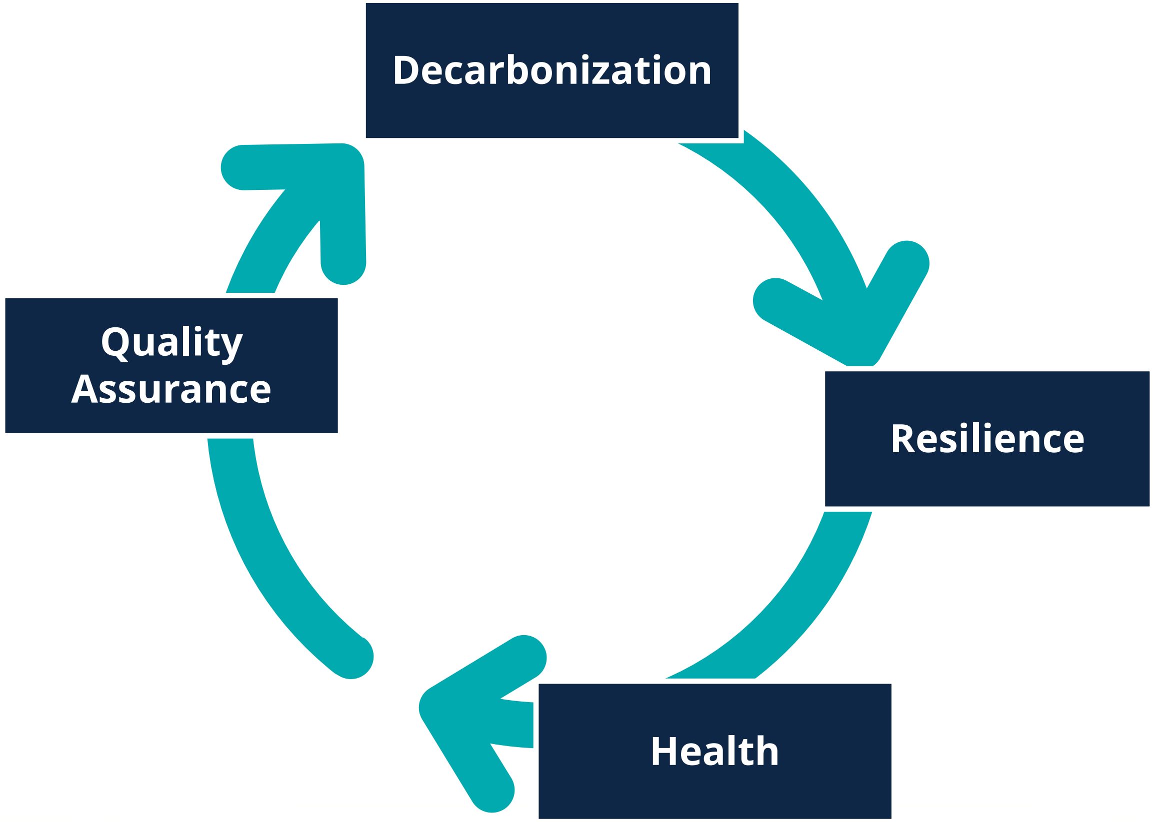
Enclosure Analysis *Results per dwelling unit*

NEIGHBORHOOD

	Existing Enclosure	Code Enclosure	Phius Enclosure
Solar	113 kW	47 kW	25 kW
Battery	866 kWh	358 kWh	126 kWh
Power	32 kW	12 kW	5 kW
Cost	$$$$$$	$$	$

Phius REVIVE 2024

- New Standard-setting Framework optimizing for:
  - Resilience
  - Operational Carbon
  - Embodied Carbon



"…a highly efficient home built to Passive House Institute U.S. (Phius) Standards can maintain temperature within the habitability threshold for the full 7 days, five times as long as the typical existing building. The analysis results also show that increased passive efficiency will save 3.6 and 8.6 lives for the current code and beyond-code cases, respectively."

https://ow.ly/n9WL50PmbqW

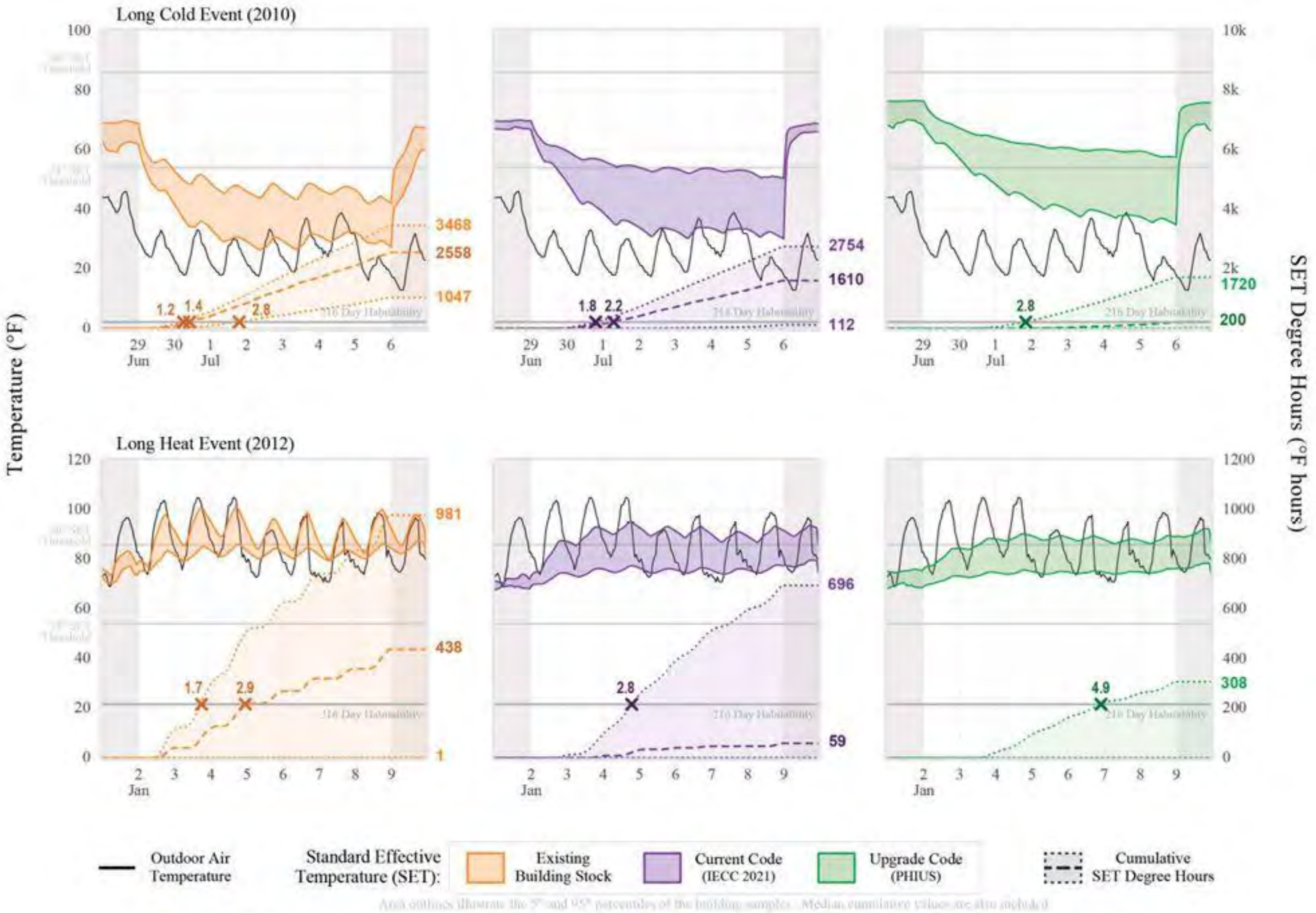
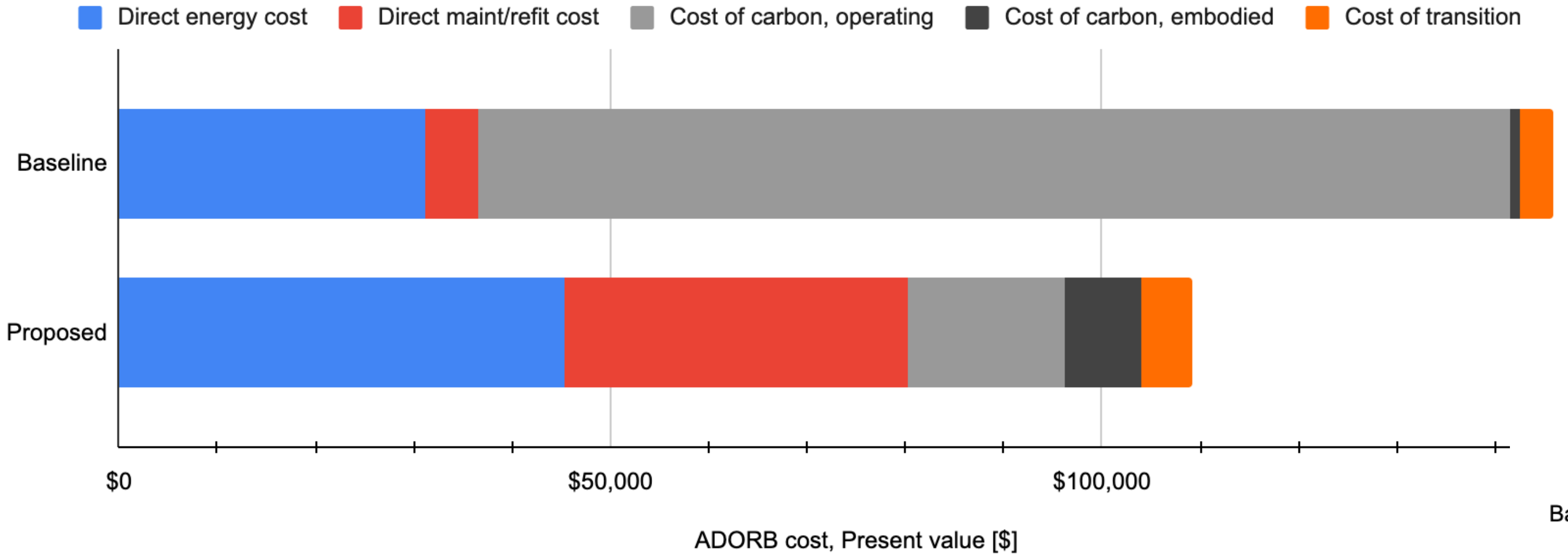
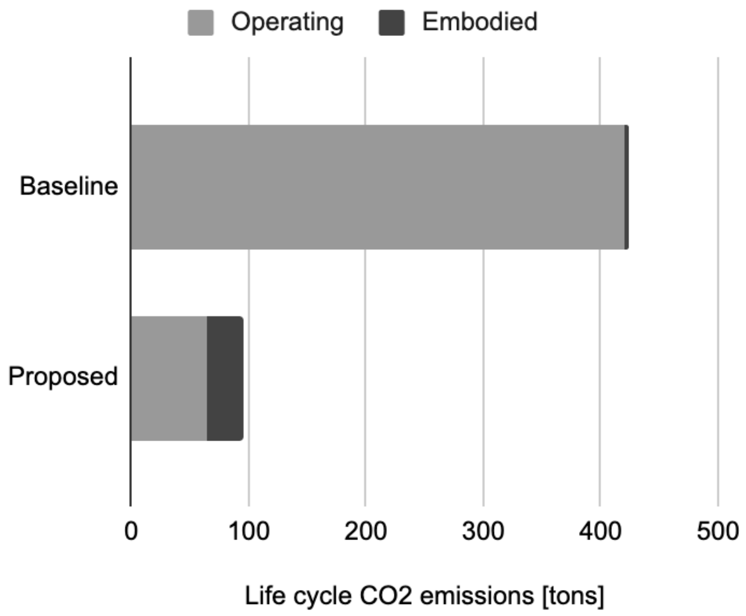


Figure 10. Occupant Exposure over Seven Days for Existing Single-Family Homes in Atlanta, GA (3A)

ADORB Cost Example: Electrification of Apartment in Portland, OR

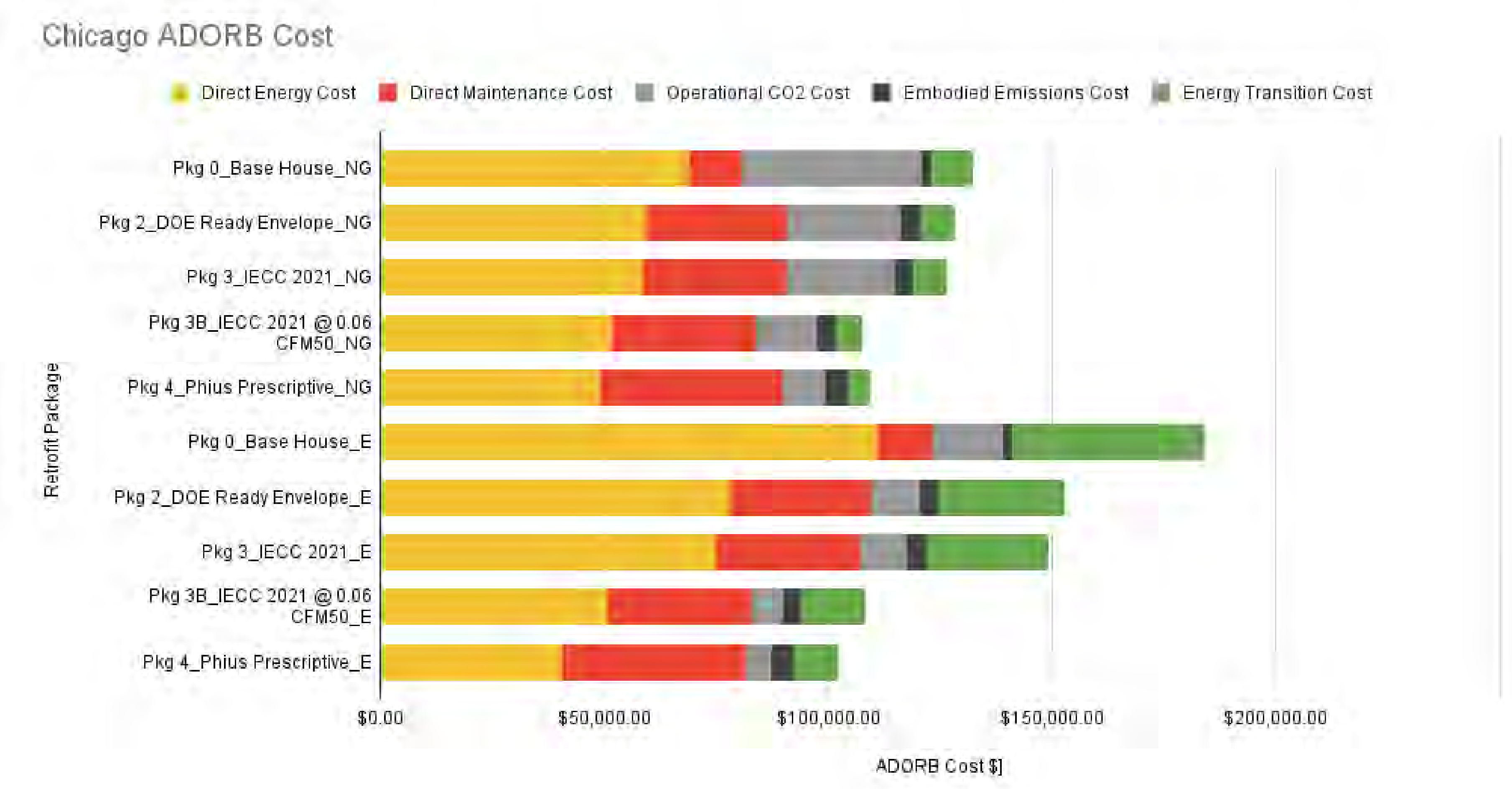


Summary, CO2 emissions [tons]			
	Baseline	Proposed	change
Operating	420	64	-85%
Embodied	4	31	612%
	424	95	-78%



Time horizon [years]	70		
Grid decarb date (1)	2050		
emission factor.			
Summary, present values [$]			
	Baseline	**Proposed**	**change**
Direct energy cost	$31,137	$45,397	46%
Direct maint/refit cost	$5,394	$34,934	548%
Cost of carbon, operating	$104,926	$15,958	-85%
Cost of carbon, embodied	$1,088	$7,743	612%
Cost of transition	$3,310	$5,236	58%
	$145,854	$109,267	-25%

ADORB Results



CERTIFIED WINDOW

ACME Corp Venting Transom Window

ACME Corp

Blue Path Certified (Valid through 2025-06-19)

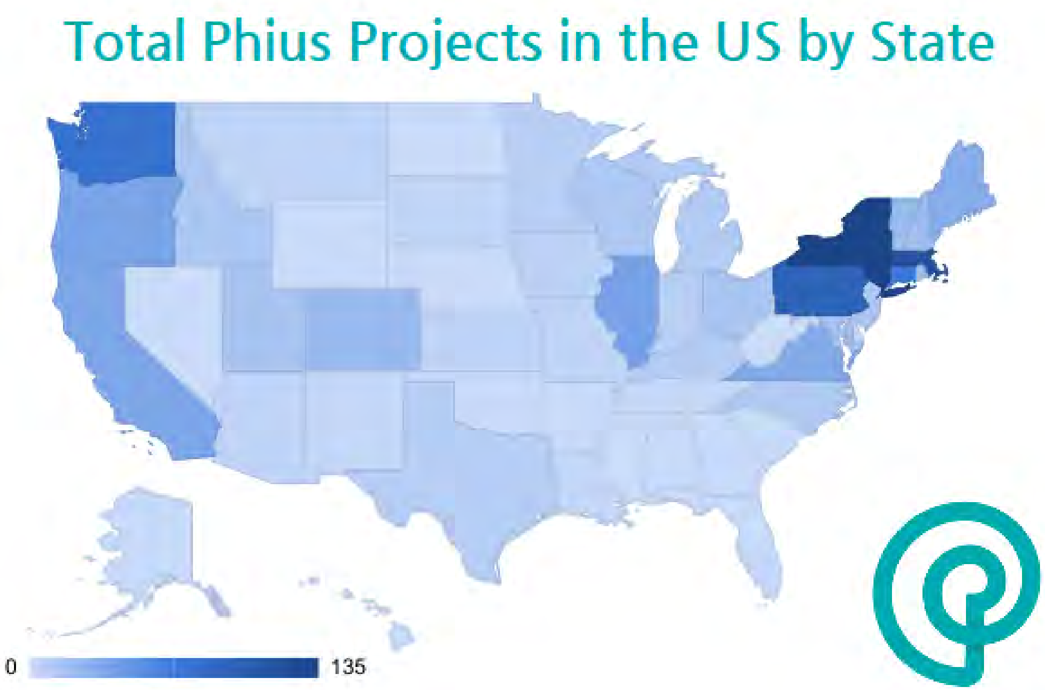
Overview

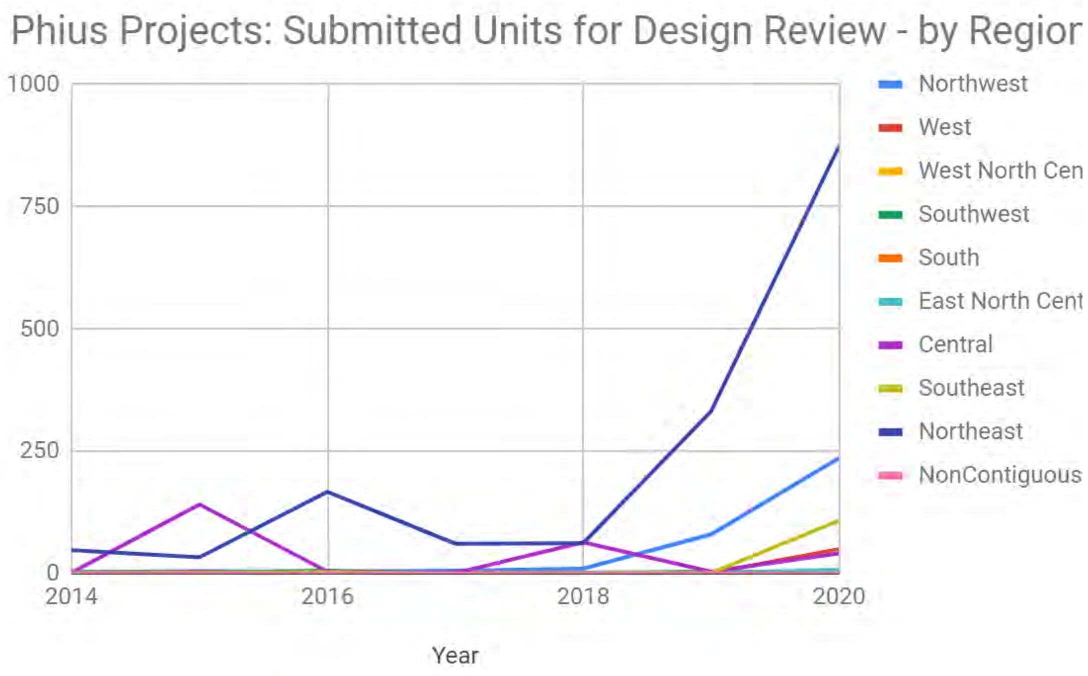
U-VALUE, WHOLE WINDOW	0.20 BTU/hr·ft²·°F 1.12 W/m²K
U-VALUE, CENTER OF GLASS (U-COG)	0.14 BTU/hr·ft²·°F 0.82 W/m²K
SHGC, WHOLE WINDOW	0.157
OPERATION TYPE	Operable
FRAME MATERIAL	Wood
IGU PANES	Triple
GLAZING NAME	ACME LoE Triple Pane Argon
REC. CLIMATE ZONE(S)	1 2 3C 3B 3A 5C 4C

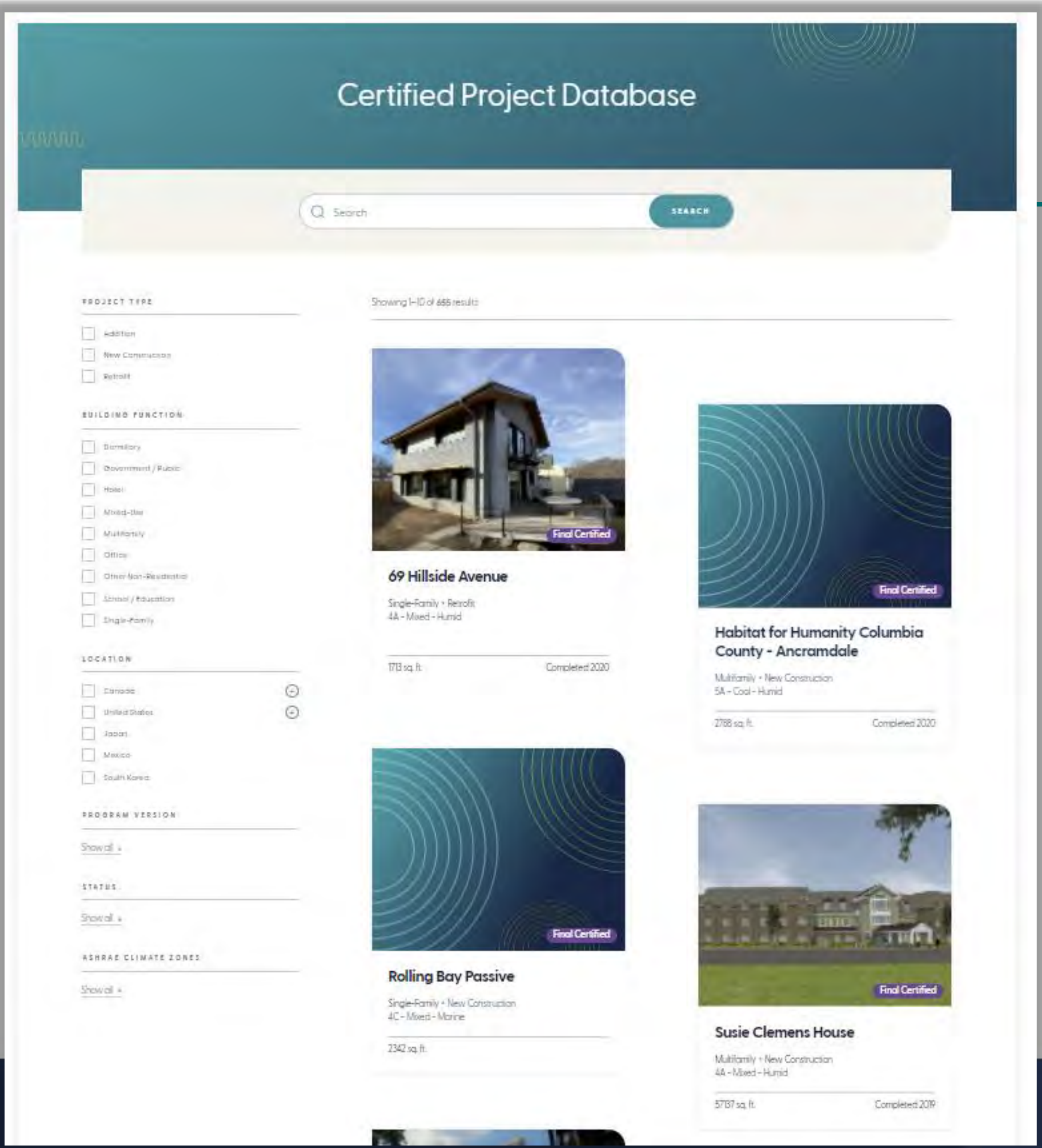
IGU (Glazing) Information

PANES	Triple
GAS FILL	Argon
SPACER	Cardinal XL Edge

Market Demand / Certification Growth





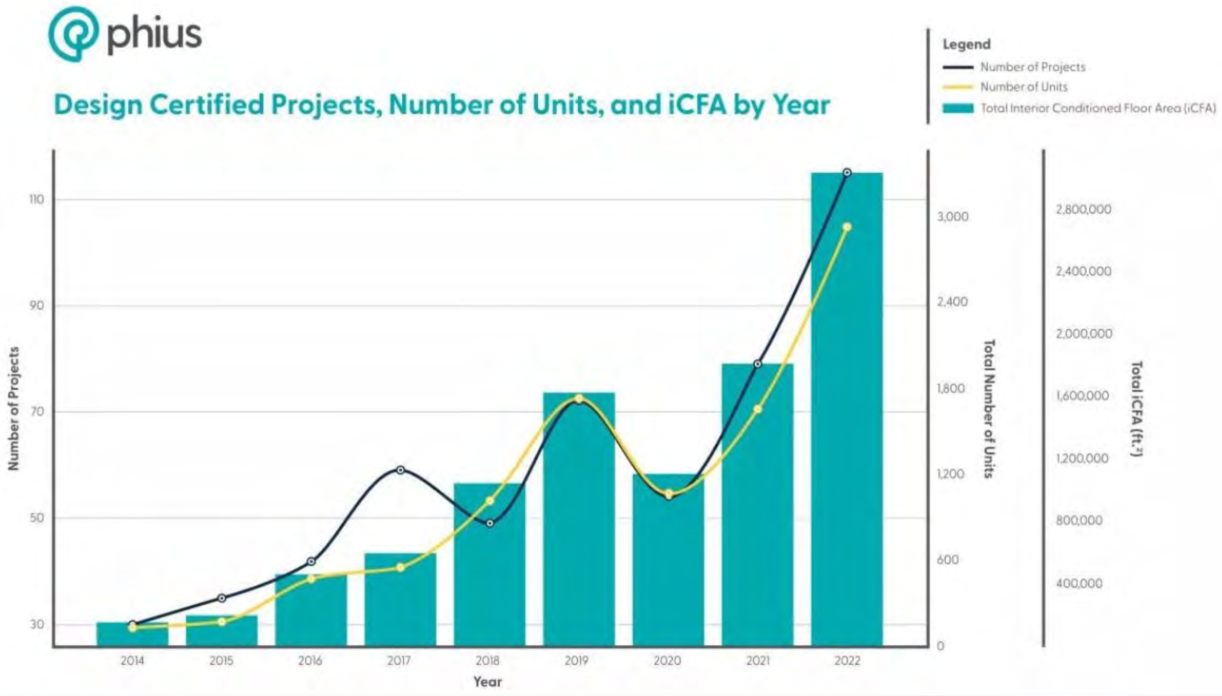


Projects Database

https://www.phius.org/certified-project-database

676 Projects, 11,141 Units Certified

1000+ Projects, xxx Units Submitted



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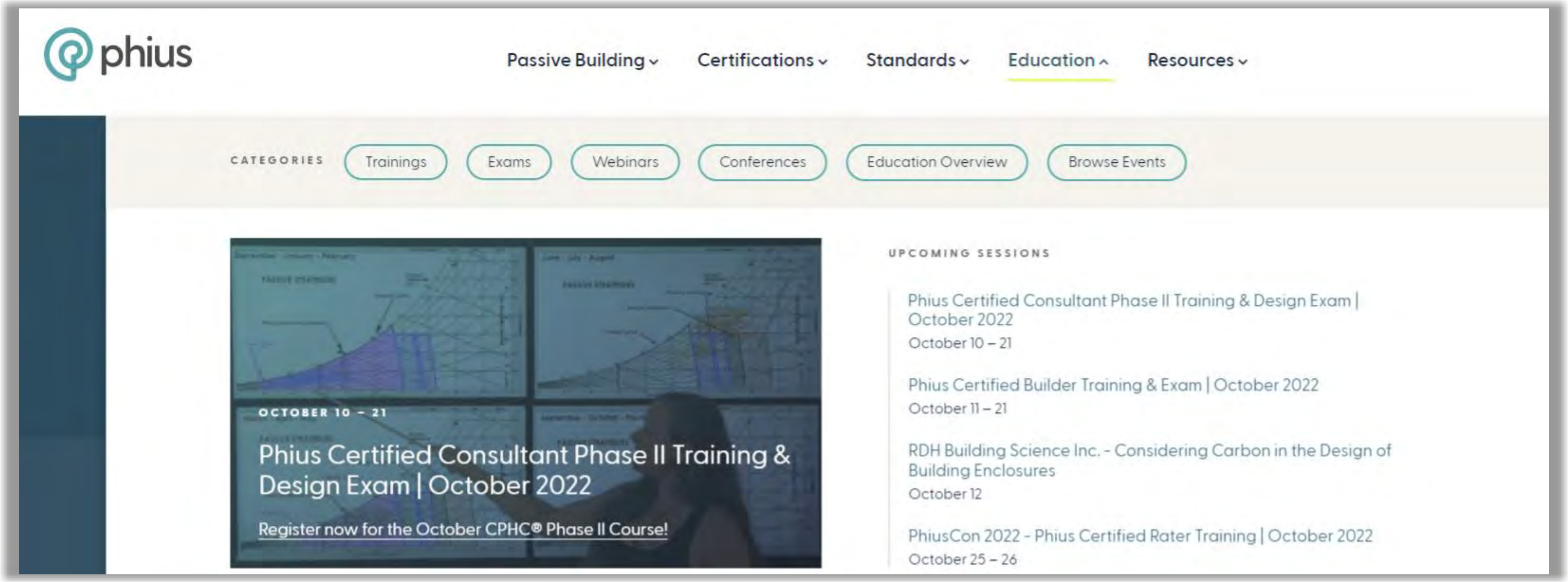
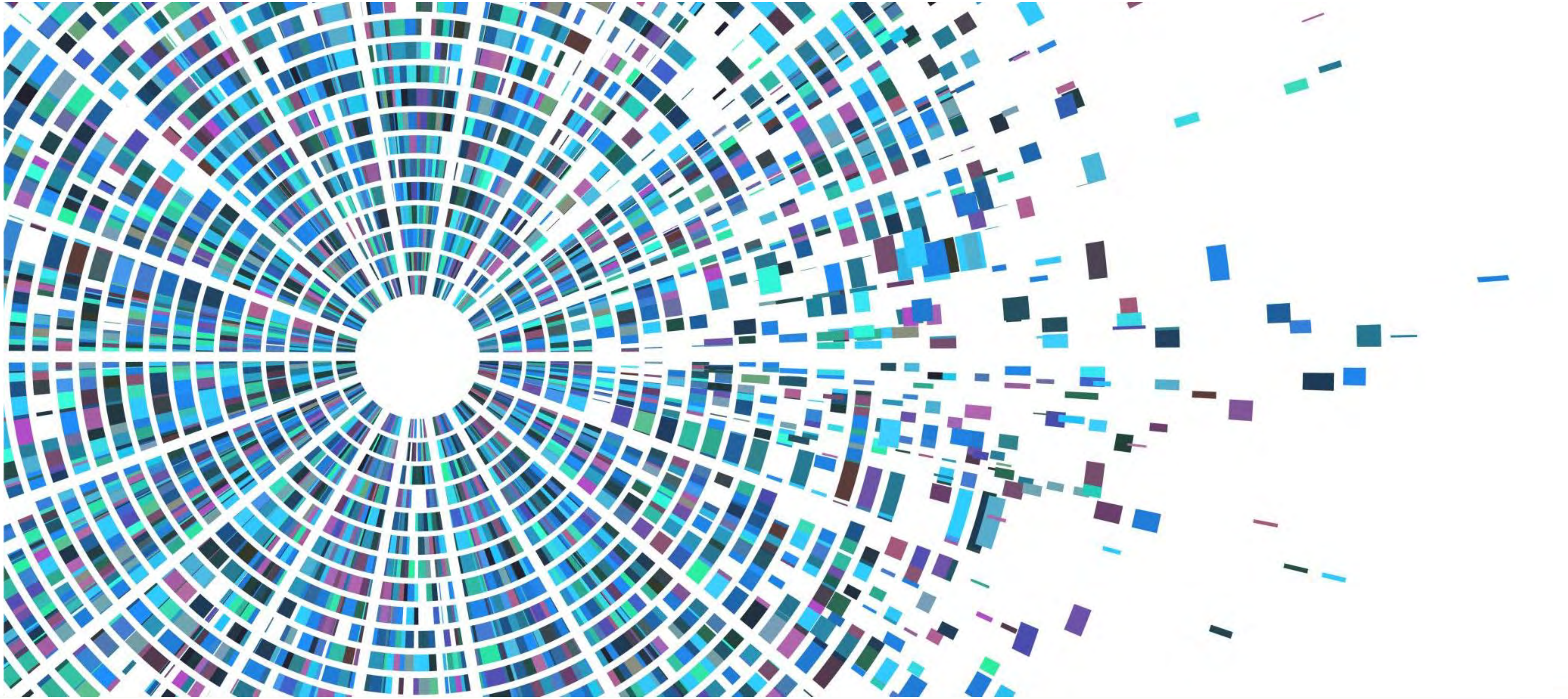
Phius Training / Upcoming Webinars + Events

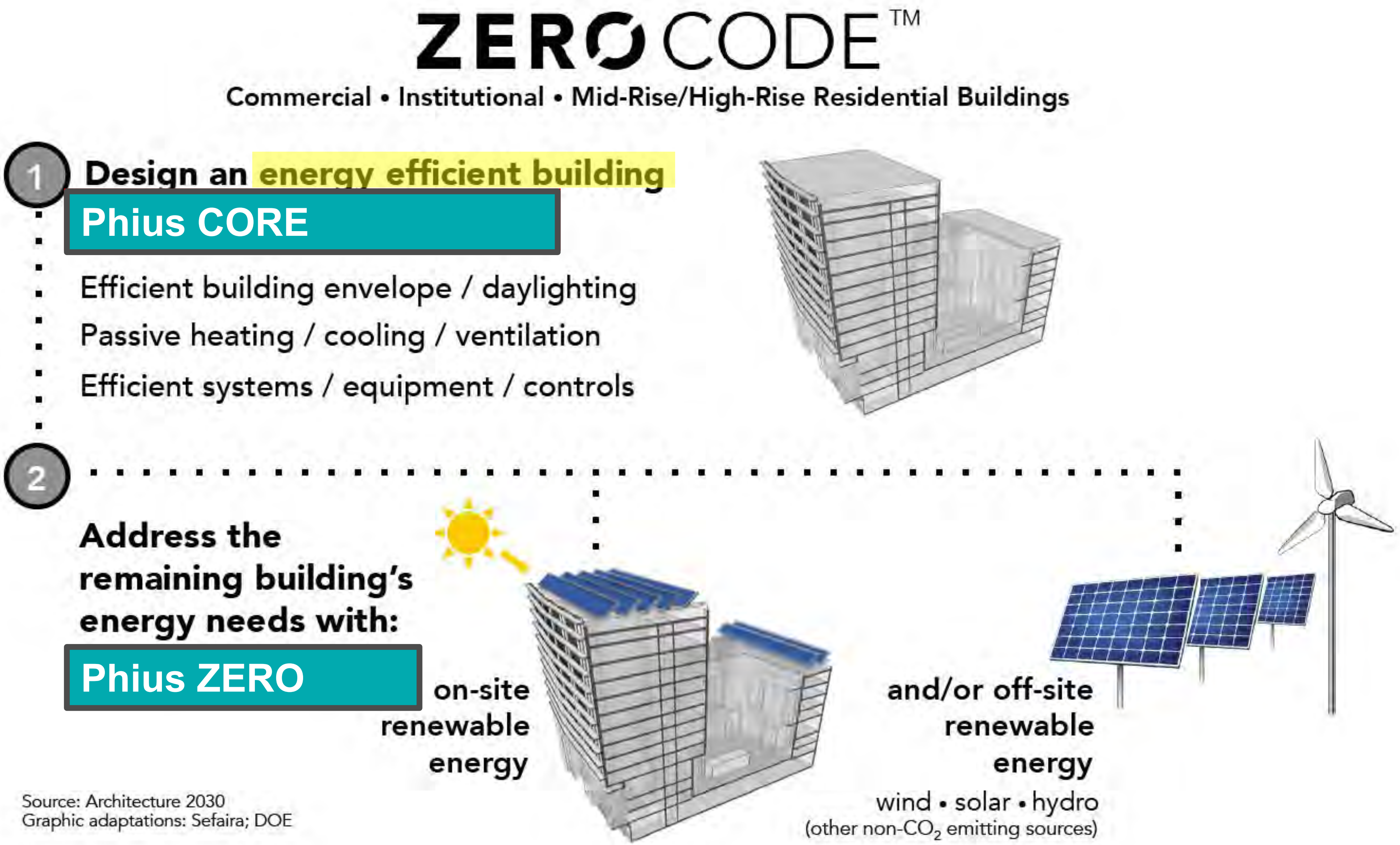
Want to learn more?

https://www.phius.org/browse-all-events



Impact and Future




ZERO CODE™
Commercial • Institutional • Mid-Rise/High-Rise Residential Buildings
1
Design an energy efficient building
Phius CORE
Efficient building envelope / daylighting
Passive heating / cooling / ventilation
Efficient systems / equipment / controls
2
Address the remaining building's energy needs with:
Phius ZERO
on-site renewable energy
and/or off-site renewable energy
wind • solar • hydro
(other non-CO_2 emitting sources)
Source: Architecture 2030
Graphic adaptations: Sefaira; DOE











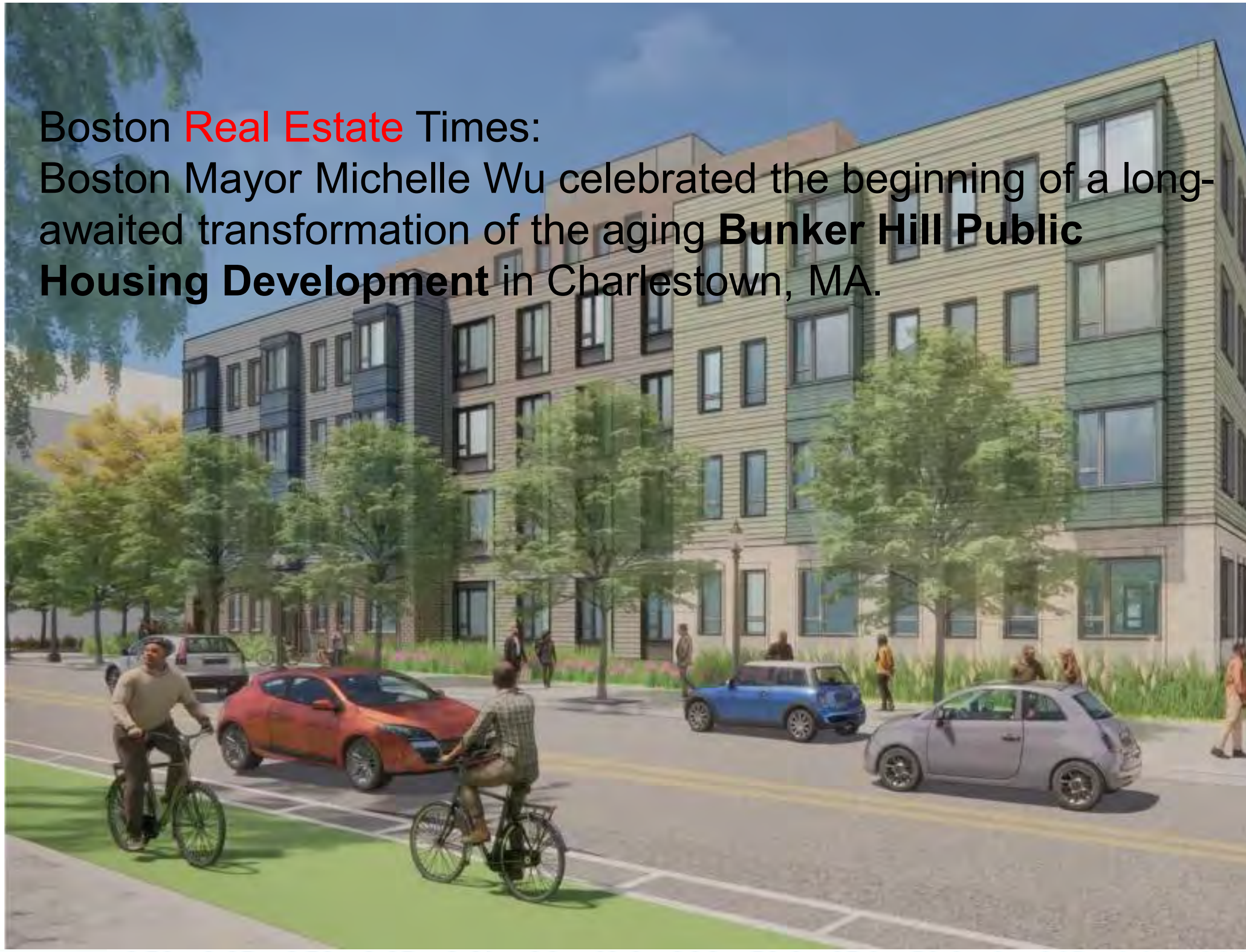

Residential Code Developments

Mass Clean Energy Center Competition - What Does It Cost?

Project	Number of Units	Incremental Cost
Homeowner's Rehab Incs Finch Cambridge	98	1.4% ←
NorthShore Community Development Corporation's Harbor Village	30	1.8%
Preservation for Affordable Housing Mattapan Station	135	2%
Beacon Communities	55	2.8%
North Commons	53	4.3%
Hanson Village	48	4.1%
Kenzi	52	1.0% ←

Opt-in Stretch, QAP, State & Federal Incentives

- New opt-in stretch code requires that any Group R building that is over 12,000 square feet in area must meet Phius or another passive house standard
- Spurs large scale planned Phius re-development Bunker Hill, 2699 units



phius

Federal Incentives

- IRA Phius/ZERH qualify for:
  - 5k Residential Incentive
  - 179D Commercial Buildings Energy-Efficient Tax Deduction
- HUD GRRP Leading Edge Award for Retrofits

Example Applicants

Example 1:

Maple Tree Apartments was last renovated 20 years ago and is still using older equipment dependent on fossil fuel sources. The property owner has already raised funding for a rehab focused on the building envelope and energy efficiency, and now with a Leading Edge Award wants to incorporate full electrification, solar, wind turbines, and Fortified Silver roofing with window upgrades, which will qualify the property for a PHIUS REVIVE certification.

Application Process

Eligibility: HUD-assisted Multifamily properties (see Section 3 of the Leading Edge NOFO for the complete list) that can commit to achieving an advanced green certification

Selection: Eligible properties will be ranked based on the property's current need for utility efficiency improvements, as assessed by the Multifamily Building Efficiency Screening Tool (MBEST)

Additional set-asides: Each HUD region and non-metro areas

Submission: Property applications should include the following:

- Leading Edge application form, including property information, proposed sources and uses and operating proforma, and selected green certification
- Development team credentials and architect/engineer's determination that the selected green certification is achievable
- Submission of Environmental Due Diligence

Key Program Requirements


Triumph

Commercial Code Developments

- ASHRAE 227p (anticipated completion in 2025)
- Opt-In Stretch in Mass TEDI and Phius CORE/ZERO COMM as Alternative Compliance Path

CASE STUDIES – PATH TO ZERO

RMI BASALT INNOVATION CENTER

RMI Headquarters Basalt CO

WUFI PASSIVE RESULTS		
PERFORMANCE CATEGORY	**PHIUS+ 2015 REQUIREMENTS**	**RMI INNOVATION CENTER**
HEATING DEMAND (KBTU/FT2/YR)	6.6	6.2
COOLING DEMAND (KBTU/FT2/YR)	1	0.23
HEATING LOAD (BTU/HR FT2)	5.1	4.96
COOLING LOAD (BTU/HR FT2)	3.6	0
PRIMARY ENERGY (KBTU/FT2/YR)	38.04	33.41
SITE ENERGY (KBTU/FT2/YR)	-	-0.35
AIR TIGHTNESS (ACH50)	0.51	0.36
AIR TIGHTNESS (CFM50/FT2)	0.05	0.04

PRAIRIE RECREATION & ACTIVITY CENTER

Roof: R-60
Walls: R-40
Slab: 4' perimeter (R-20)
Windows: R-6 (U-0.16)
Air-tightness: 0.045 CFM50/ft2 envelope area
Renewable Energy: 215 kW PV Array on-site

OAK PARK CAROLL CENTER RETROFIT & NEW

Location: Oak Park, IL
Roof: R-45
Walls: R-27 (average)
Slab: R-30 (whole slab, average)
Windows: R-7 (U-0.14) average
Renewable Energy: 23.7 kW PV Array on-site
Certification Level: PHIUS+ Source Zero

NORTHBROOK PARK DISTRICT

Location: Northbrook, Illinois
Roof: R-60
Walls: R-34
Slab: R-20
Windows: U-0.196
Air tightness: 0.049
Renewable Energy: 312.28 on-site PV
Certification Level: PHIUS+ 2015 Source Zero

Trinity Mid Bronx Development LLC
425 Grand Concourse

Envelope Performance

COMPONENT	DESIGN	INSTALLED / TESTED
ROOF	R-30	R-30
ABOVE-GRADE WALLS	R-20	R-18.4
BELOW-GRADE WALLS	R-10	R-10
WINDOWS – INSTALLED EFFECTIVE U-VALUE	0.25	0.28 (Frame) 0.21 (Glazing)
GLAZING SHGC	0.27	0.25
FAÇADE AIR TIGHTNESS	0.08 cfm50	0.035 cfm50 (Taped) 0.055 cfm50 (Un-Taped)

425 Grand Concourse

What is the Passive House (Cost) Difference?

A. Envelope

($1,200,000 / 0.7% of TDC)

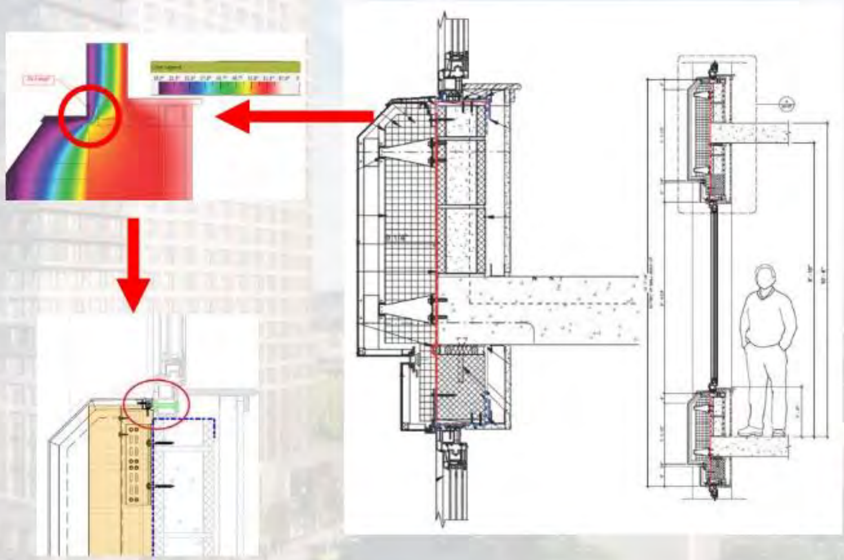
- Added cost for additional sealant.
- Added cost for high-performance windows.
- Added cost for specialty materials to minimize thermal breaks.

What is the Passive House (Cost) Difference?

B. Quality Control / Added Engineering / Testing

($1,150,000 / 0.7% of TDC)

- Added cost for Passive House consultant.
- Added cost for rigorous inspections / commissioning.
- Added cost for blower door pre-testing and testing.



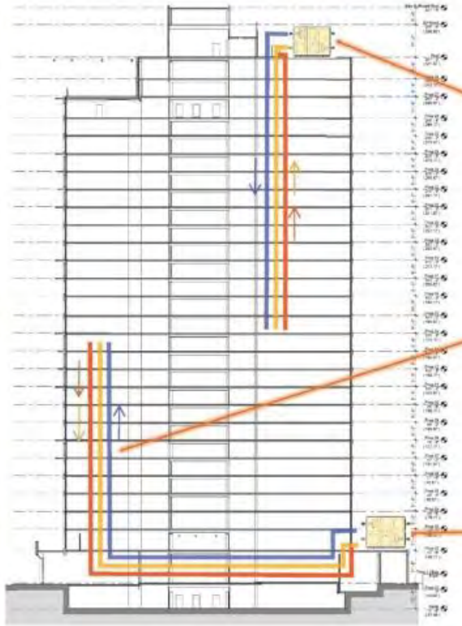
425 Grand Concourse

What is the Passive House (Cost) Difference?

C. HVAC Systems

($1,800,000 / 1.0% of TDC)

- Added cost for supply ductwork for balanced ventilation.
- Added cost for Energy / Heat Recovery Ventilator.
- Added cost for VRF Heating/Cooling.



What are the Energy Savings of a Passive House?

Building Operating Costs			
		Average NYC MF	425 Grand Concourse
Source EUI [kBtu/(sf x a)]		130[1]	73[2]
Space Heating	38%[1]	Gas[1]	Elec
Domestic Hot Water	15%[1]	Gas[1]	Gas
Plug Loads / Misc.	15%[1]	Elec[1]	Elec
Lighting	10%[1]	Elec[1]	Elec
Space Cooling	8%[1]	Elec[1]	Elec
Conveyance	2%[1]	Elec[1]	Elec
Ventilation	2%[1]	Elec[1]	Elec
Process Loads	2%[1]	Elec[1]	Elec
Other	8%[1]	Elec[1]	Elec
Site EUI [kBtu/(sf x a)]		87[2]	30[3]
Site EUI Electric [kBtu/(sf x a)]		66[2]	24[3]
Site EUI Gas [kBtu/(sf x a)]		22[2]	6[3]
2019 Operating Cost[5] [$ / (sf x a)]		**$ 3.64**	**$ 1.30**

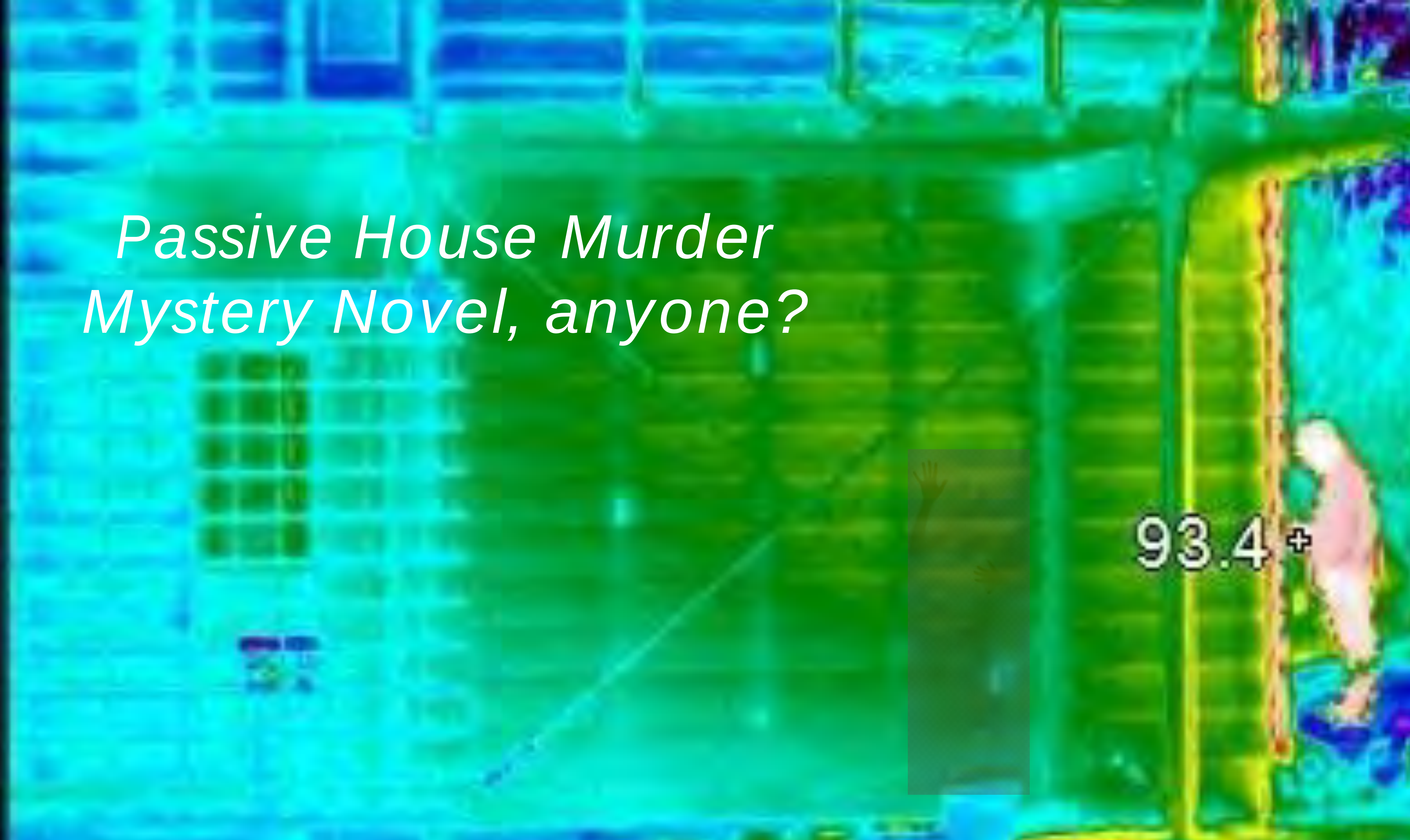
42 BROAD MARKET-RATE, MT VERNON NY

Predictions for Passive House 4.0

- New standard setting framework will become code everywhere
- New more powerful and accurate design & verification cloud-based tools, AI?
- New continual commissioning processes and tools to operate buildings as designed
- Fossil fuels will go out of style
- Revisit passive thermal mass, phase change materials & experiment with new materials (like the whitest paint) to maximize use of 'ambient energy', exergy
- Latest window technologies, thin triples, vacuum glazing, transparent PV will become code & prices will drop dramatically
- Break through in the development of miniature low load heat pump-based space conditioning and hot water appliances
- Mass-retrofitting of existing homes at a rate of 1000+ units per day
- Low load, all electric direct current passive buildings + microgrids will become new best practice for designing communities
- New resilient, decentralized and democratized renewable energy grid emerges with generation from the bottom up & utilities will transform into large scale distribution and backup services
- Buildings will become a central part of the energy generation infrastructure
- New business models will emerge around privately owned ESCOs/developers & consequently housing will be free…

Post Logue - Personal Musings and Observations

Passive House Murder Mystery Novel, anyone?



WASHINGTONIAN

A Real Estate Nightmare on Foxhall Road

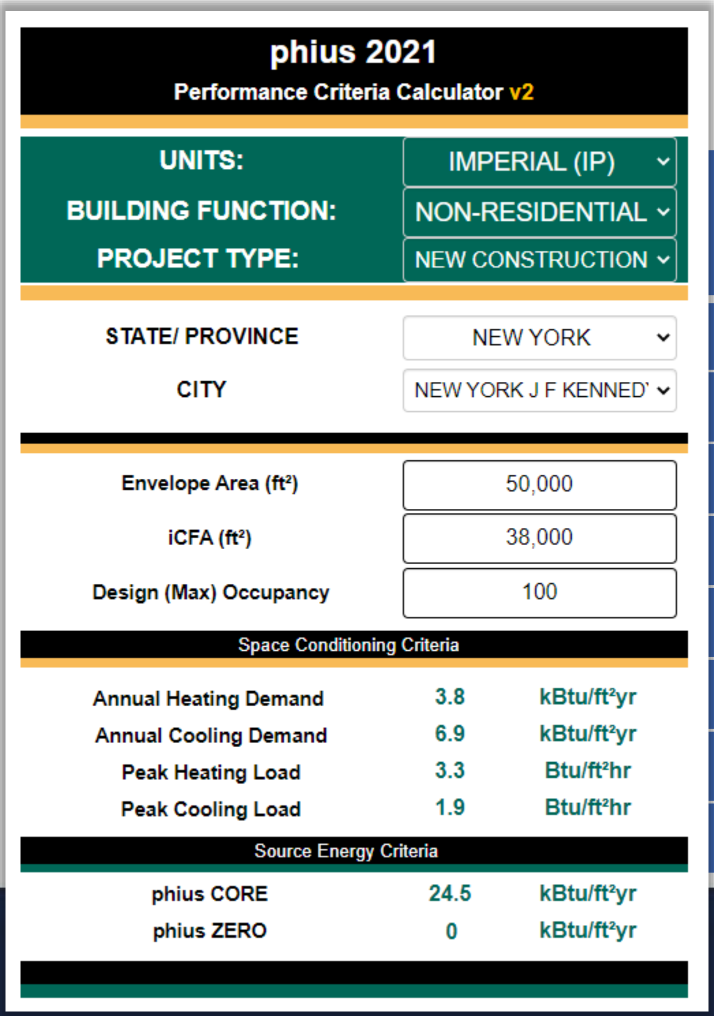
Photograph by Jeff Elkins

A Tale of two TEDIs…

A word on the Mass TEDI…A Comparison

Heating Demand, Cooling Demand and Site EUI for 6 schools designed to the Phius Standard

Note: Climate Zone 4C is the Pacific Northwest Coast (i.e. Vancouver).
Climate Zone 5A is for Massachusetts
Climate Zone 6A is for areas that are colder than Massachusetts



phius 2021
Performance Criteria Calculator v2

UNITS:	IMPERIAL (IP)
BUILDING FUNCTION:	NON-RESIDENTIAL
PROJECT TYPE:	NEW CONSTRUCTION
STATE/ PROVINCE	NEW YORK
CITY	NEW YORK J F KENNED'
Envelope Area (ft²)	50,000
iCFA (ft²)	38,000
Design (Max) Occupancy	100

Space Conditioning Criteria

Annual Heating Demand	3.8	kBtu/ft²yr
Annual Cooling Demand	6.9	kBtu/ft²yr
Peak Heating Load	3.3	Btu/ft²hr
Peak Cooling Load	1.9	Btu/ft²hr

Source Energy Criteria

phius CORE	24.5	kBtu/ft²yr
phius ZERO	0	kBtu/ft²yr

Project	Climate Zone	Type	Heating Demand	Cooling Demand	Site EUI
1	5A	Addition	11.4	1.89	9.3
2	5A	Addition	6.29	2.46	14.17
3	6A	New	5.51	0.78	16.37
4	5A	Retrofit	8.09	1.56	24.03
5	4C	New	3.59	1.19	21.68
6	6A	New	5.45	0.83	12.37
			Kbtu/ft2-yr		Kbtu/ft2-yr
TEDI Limits			2.4	20	

https://www.phius.org/how-performance-targets-shape-building-design-and-why-its-critical-get-them-right

BLOG POST

How Performance Targets Shape Building Design - And Why It's Critical to Get Them Right

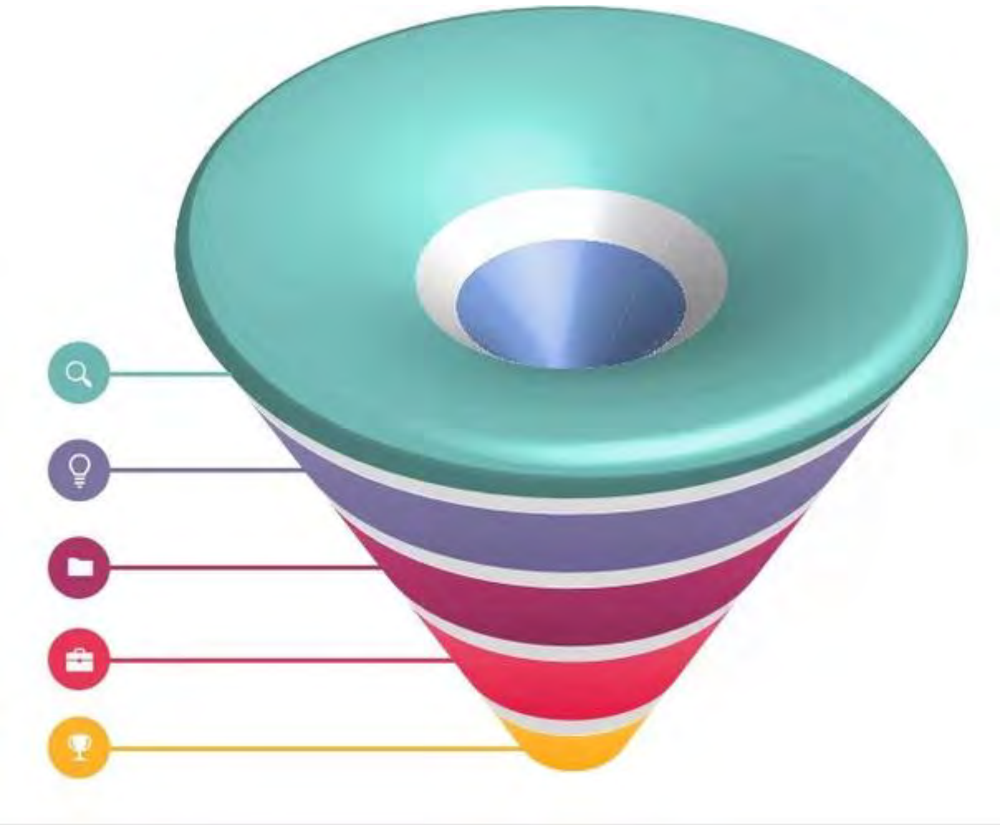
May 13, 2022 By Lisa White

‘In general, we have found that not making targets climate-specific can lead to issues such as overheating and discomfort. They can also guide overinvestment in some measures, which may seem harmless, but directly correlates to additional up-front emissions, and could often be invested in other decarbonization strategies.’

Lisa White

A few personal lessons learned…

- Only two things are certain in life – death and change: the design guidance to manage complexities of environmental building technology will be ever evolving, we are never finished…we learn with every shift in our environment and adapt, the climate is changing, technology is, politics and even economics
- Building Science laws of physics are a constant and a safety rope up the steep mountain of decarbonization we are facing



“Thanks for asking. It is healthy for an old man to face the ever-changing world where everything old is made new again. We spend our young lives contributing to the myths we then invest our time as mature builders, debunking. We move from tool use and personnel management to system understanding, always keen to ensure that nothing has been overlooked or left out. We struggle to be comprehensive and frequently fail to be either graceful or aesthetically pleasing. We are forced to learn over and over and over again that simplicity is key to success. Our desire to accomplish more than one thing simultaneously, by combining systems, appears so seductive when, in truth, decoupling systems make them easy to identify, install and repair.

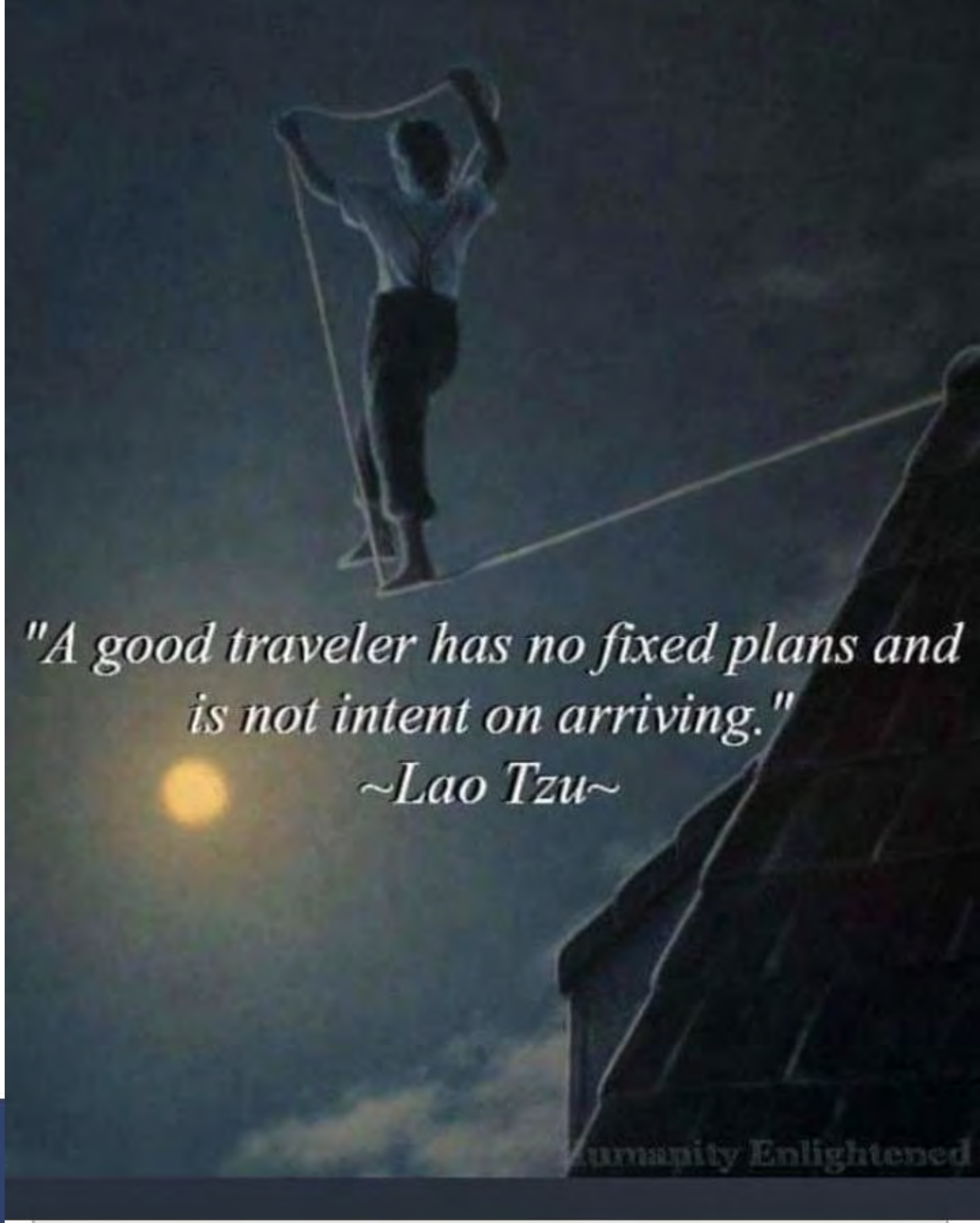
I have been very fortunate. I have virtually never been bored!”

Oliver Drerup

Mark Bomberg

This is the best definition of the environmental aspects of residential building technology of today, I have ever seen. Mark Bomberg

3w Love Reply 2



…NOT OLD (AND WISE) ENOUGH YET TO RETIRE…SEE YOU ON THE DANCE FLOOR

Thanks!
Questions?

Katrin Klingenberg
Executive Director | Phius
Kklingenberg@phius.org