BUILDINGENERGY BOSTON

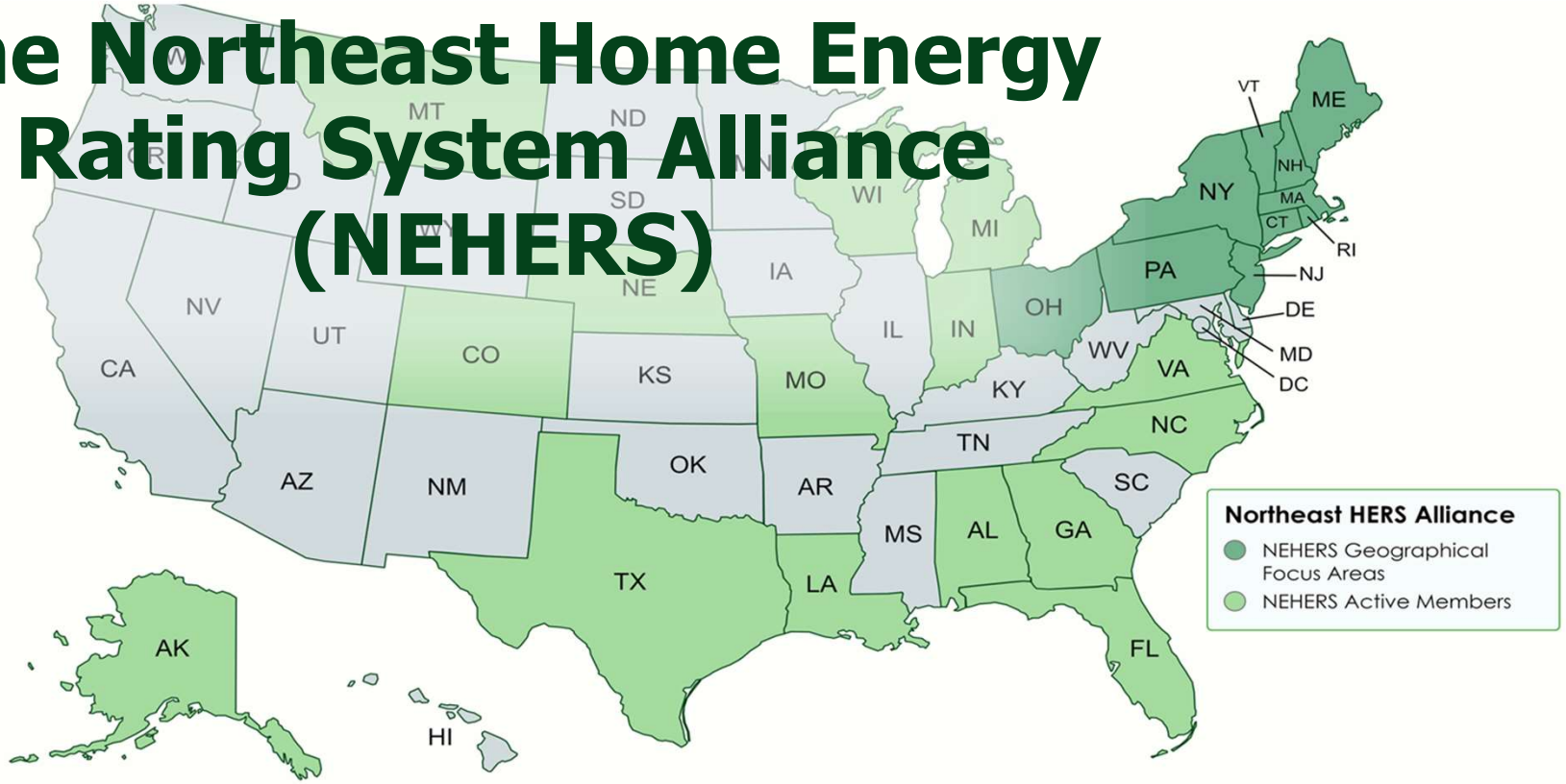
The RESNET Carbon Trifecta: HERS Index + CO2 Index + Embodied Carbon

Andy Buccino (Stephens and Company)
Nicole Burger (Innova)
Jacob Racusin (New Frameworks)

Curated by Christopher Nielson (Bruner/Cott) and Alex Guerrieri (Steven Winter Associates)

Northeast Sustainable Energy Association (NESEA) | March 20, 2024

The Northeast Home Energy Rating System Alliance (NEHERS)



www.nehers.org

Speakers:

Nicole Burger
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and Senior Energy Consultant
Innova Building Advisors
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Stephens and Company
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Jacob Deva Racusin
Director of Building Science
and Sustainability
New Frameworks
Jacob@newframeworks.com

AGENDA

Introductions

Part 1: HERS Index

Part 2: CO2 Index

Part 3: Embodied Carbon

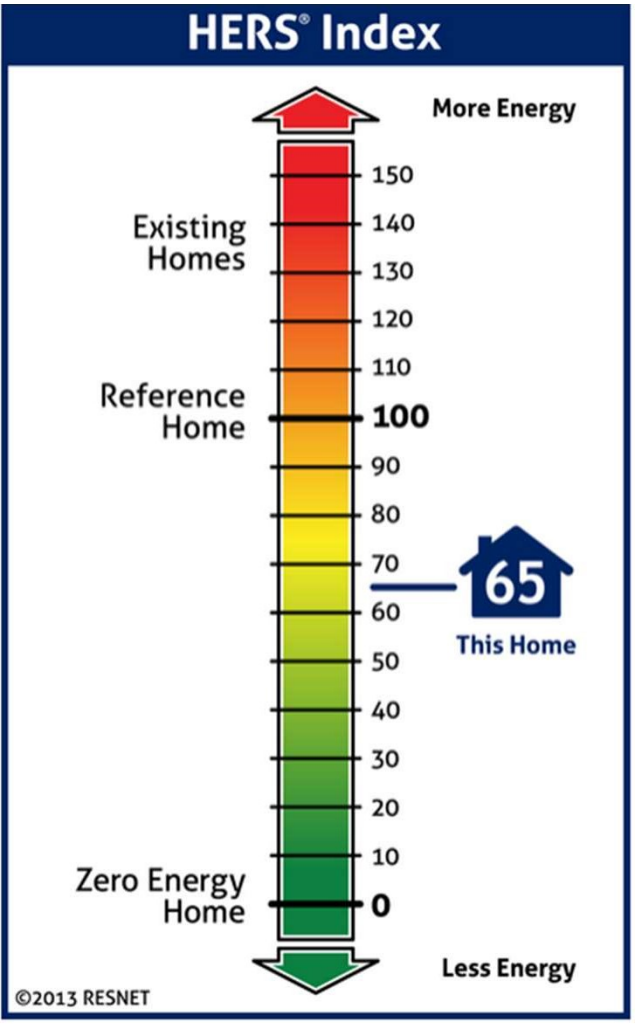
Part 4: Emergent Methodologies

Part 5: Environmental Justice and Resiliency

Part I: The HERS Index

RESNET

https://www.resnet.us/



What is the HERS Index?

HERS® Activity by IECC Climate Zone

IECC Climate Zone	Homes HERS® Rated in 2023	Average HERS Index Score in 2023
1A	895	47
1B	55	85
2A	92,006	57
2B	29,241	52
3A	69,126	58
3B	15,031	45
3C	84	28
4A	60,077	62
4B	3,655	54
4C	2,218	52
5A	48,312	58
5B	25,510	57
6A	10,722	51
6B	1,028	56
7B	297	45

https://www.resnet.us/wp-content/uploads/2022-HERS-Activity-by-climate-zone.pdf

HERS® Activity by State

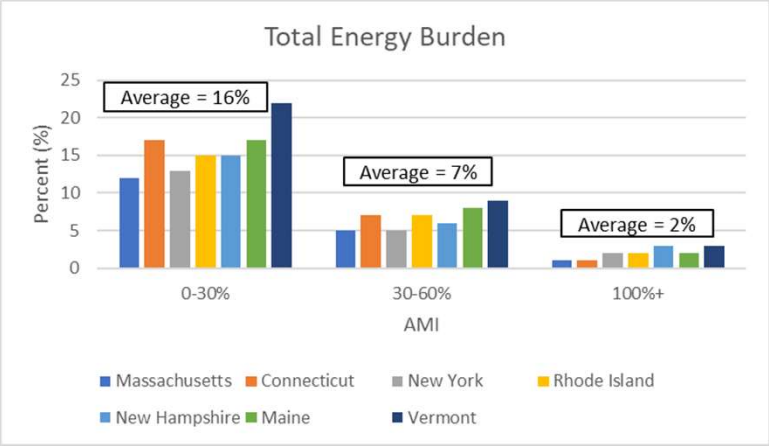
FOR THE CALENDAR YEAR OF 2023		
State	**HERS Rated Homes**	**Average HERS Index Score**
Connecticut	2019	51
Maine	128	44
Massachusetts	9531	50
New Hampshire	1320	52
New Jersey	4339	54
New York	4296	48
Ohio	7450	61
Pennsylvania	7421	59
Rhode Island	181	57
Vermont	253	40

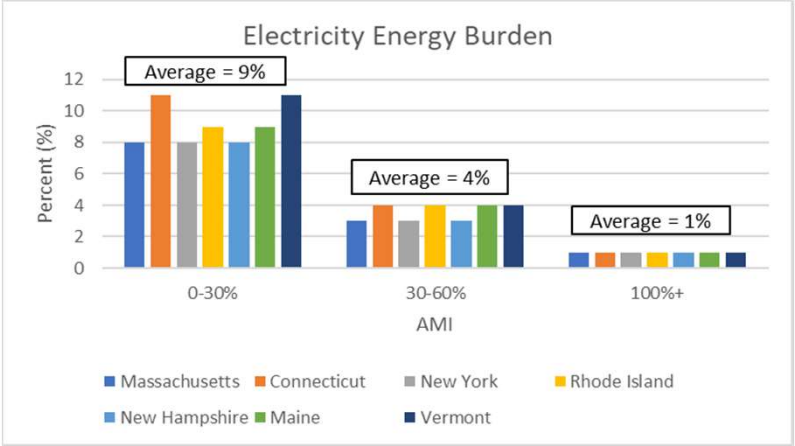
https://www.resnet.us/wp-content/uploads/2022-HERS-Activity-by-State.pdf

How a HERS Rating Can Assist Renters & Home Buyers:

- Transparency & Information
- Identifying Energy Efficient Units
- Understanding Energy Costs
- Advocating for improvements
- Supporting Sustainable Living
- Enhancing Quality of Life

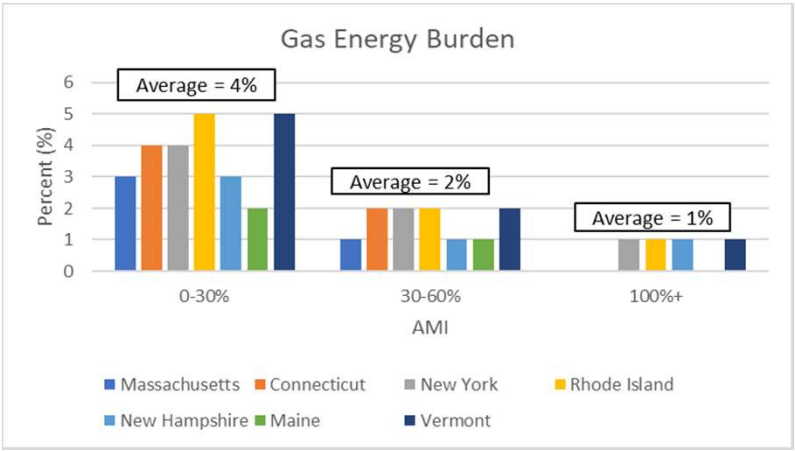
Why Energy Labeling Is Important





1 in 7 Families Live in Energy Poverty

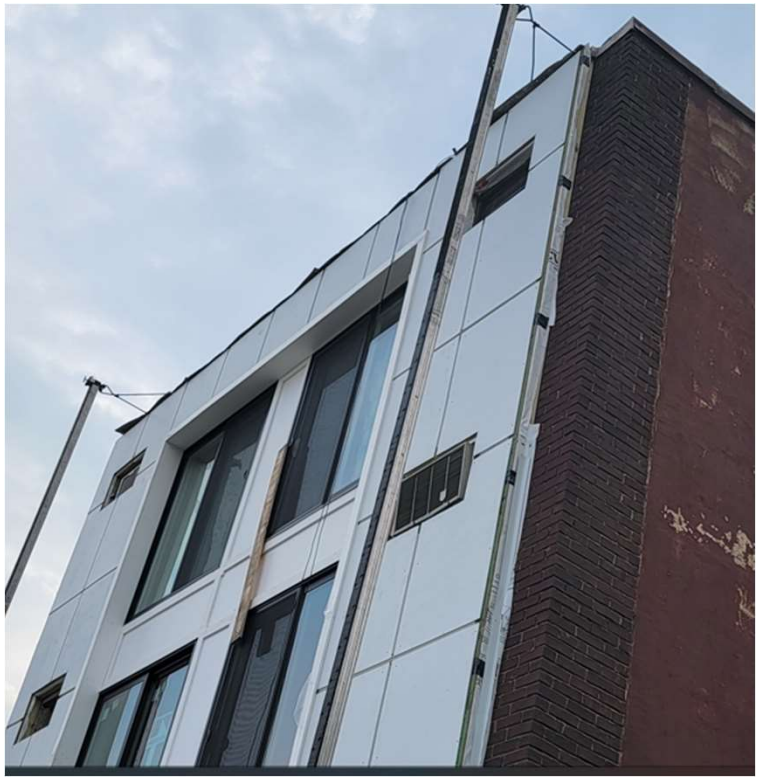
Across Every state, extremely low-income households bear disproportionately high energy burdens
https://rmi.org/1-in-7-families-live-in-energy-poverty-states-can-ease-that-burden/

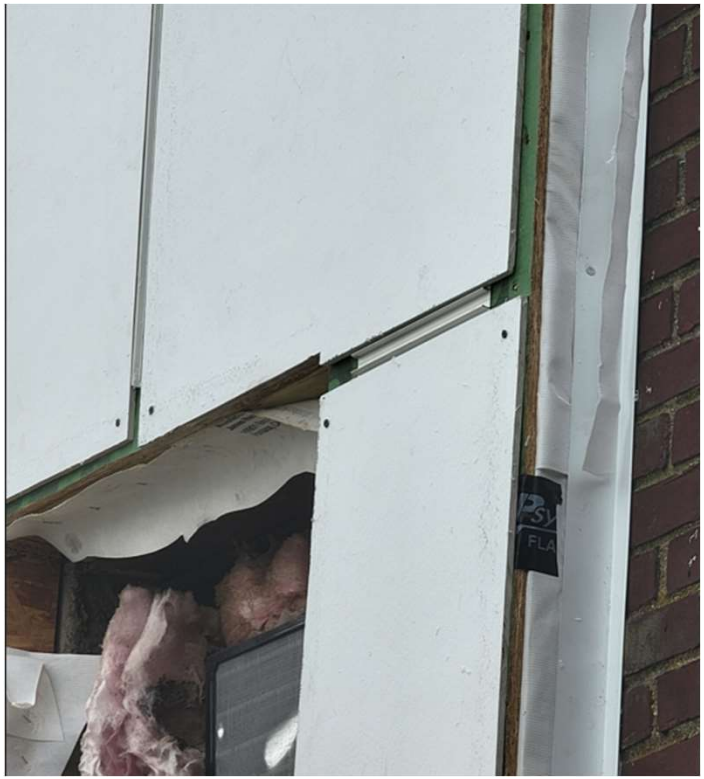


https://www.energy.gov/scep/slsc/low-income-energy-affordability-data-lead-tool

Aesthetics Versus Thermal Efficiency

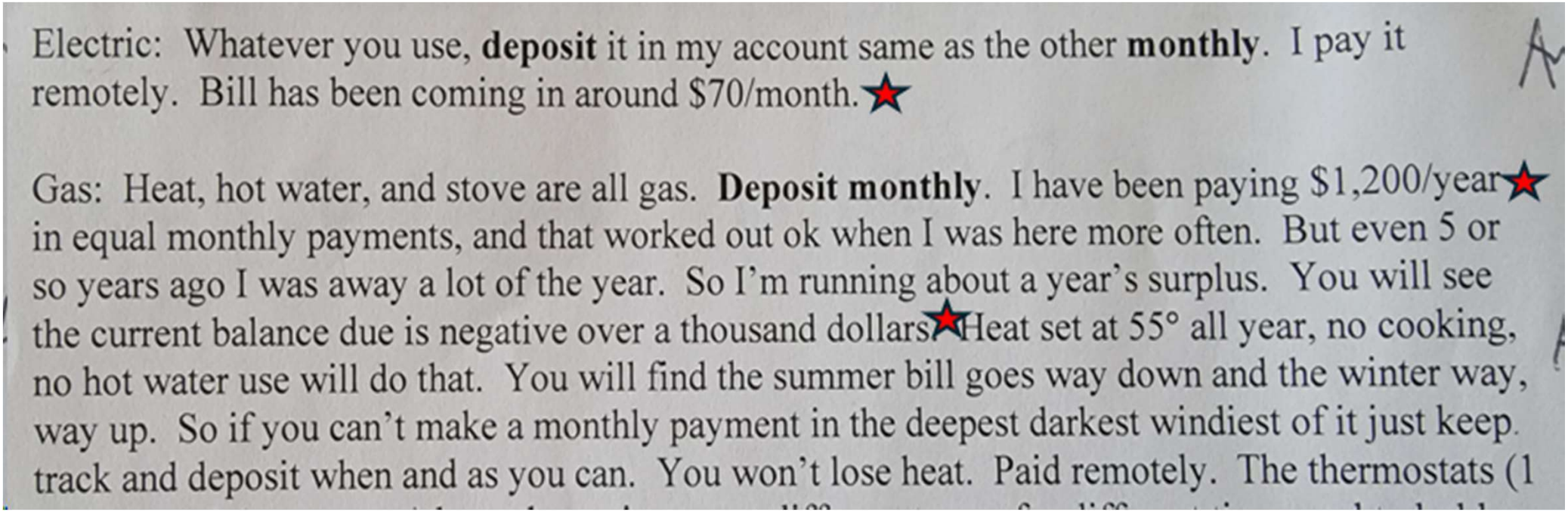
… What's Under the Façade?






Help Is On
The Way Dear

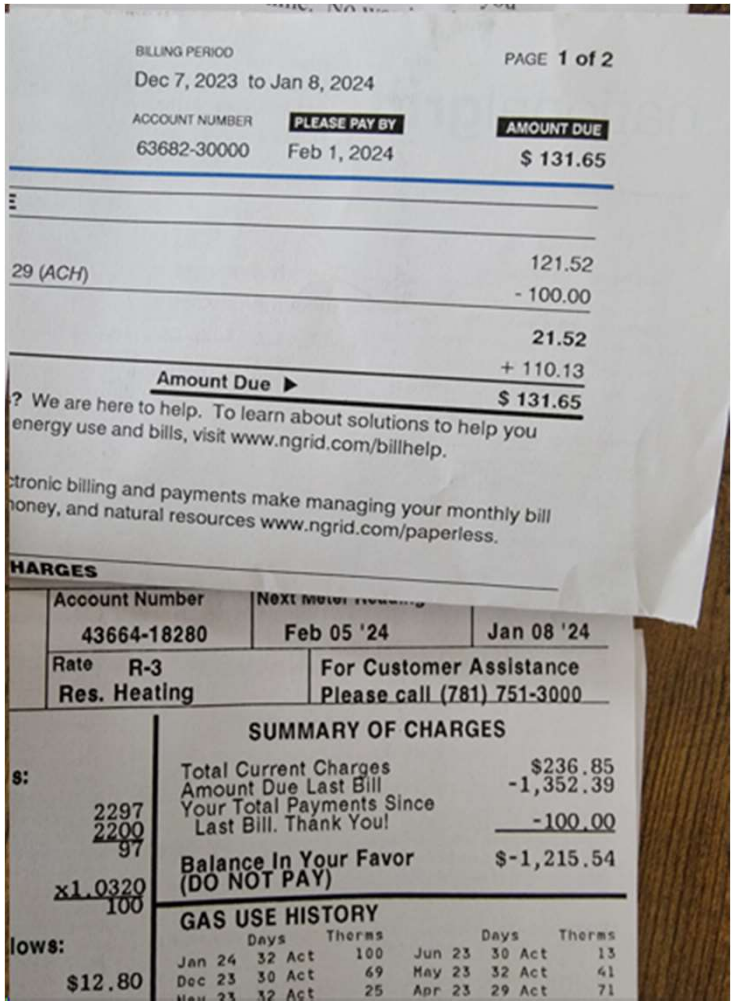
Energy Transparency



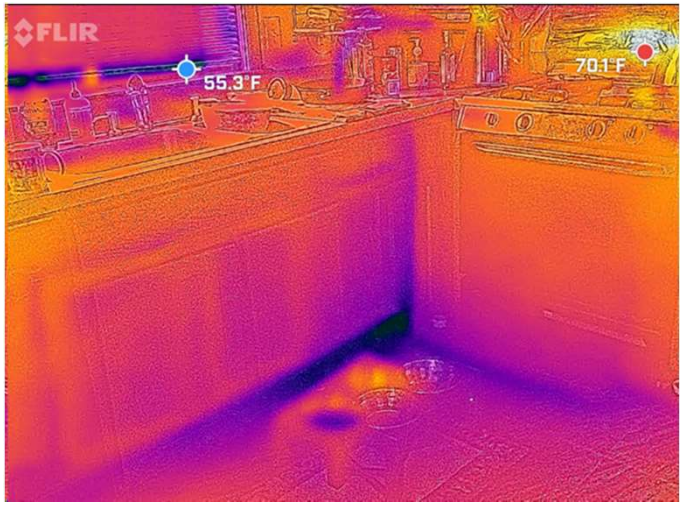
Electric: Whatever you use, **deposit** it in my account same as the other **monthly**. I pay it remotely. Bill has been coming in around $70/month.

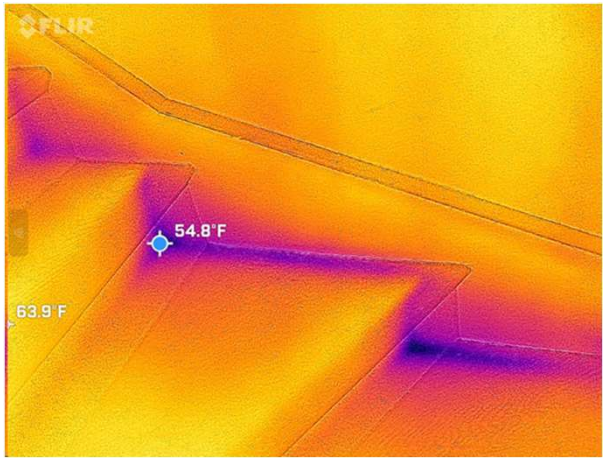
Gas: Heat, hot water, and stove are all gas. **Deposit monthly**. I have been paying $1,200/year in equal monthly payments, and that worked out ok when I was here more often. But even 5 or so years ago I was away a lot of the year. So I'm running about a year's surplus. You will see the current balance due is negative over a thousand dollars. Heat set at 55° all year, no cooking, no hot water use will do that. You will find the summer bill goes way down and the winter way, way up. So if you can't make a monthly payment in the deepest darkest windiest of it just keep track and deposit when and as you can. You won't lose heat. Paid remotely. The thermostats (1

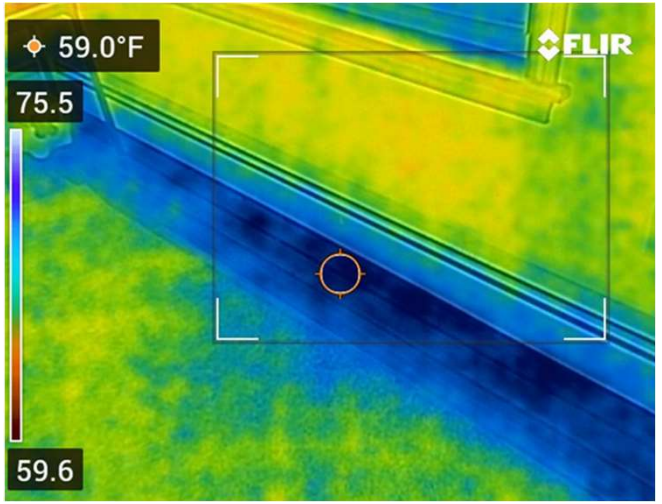
Actual Utility Bills


BILLING PERIOD
Dec 7, 2023 to Jan 8, 2024
PAGE 1 of 2
ACCOUNT NUMBER
63682-30000
PLEASE PAY BY
Feb 1, 2024
AMOUNT DUE
$ 131.65
29 (ACH)
121.52
- 100.00
21.52
+ 110.13
Amount Due ▶
$ 131.65
? We are here to help. To learn about solutions to help you
energy use and bills, visit www.ngrid.com/billhelp.
ctronic billing and payments make managing your monthly bill
honey, and natural resources www.ngrid.com/paperless.
HARGES
Account Number
43664-18280
Feb 05 '24
Jan 08 '24
Rate R-3
Res. Heating
For Customer Assistance
Please call (781) 751-3000
SUMMARY OF CHARGES
Total Current Charges $236.85
Amount Due Last Bill -1,352.39
Your Total Payments Since Last Bill. Thank You! -100.00
Balance In Your Favor (DO NOT PAY) $-1,215.54
s:
2297
2200
97
x1.0320
100
lows:
$12.80
GAS USE HISTORY
Days Therms
Jan 24 32 Act 100
Dec 23 30 Act 69
Jun 23 30 Act 13
May 23 32 Act 41
Apr 23 29 Act 71

Thermal Imaging







Energy Modeling

Home Energy Rating Certificate

Projected Report
Based on Plans

Rating Date:
Registry ID:
Ekotrope ID: LK5XgJgv

innova BUILDING ADVISORS

HERS® Index Score: 121

Your home's HERS score is a relative performance score. The lower the number, the more energy efficient the home. To learn more, visit www.hersindex.com

Annual Savings* $452

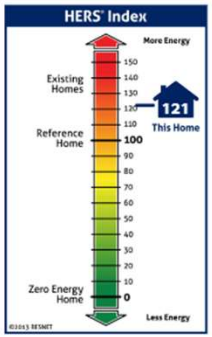
*Relative to an average U.S. home

Home:
Revere, MA 02151
Builder:

Your Home's Estimated Energy Use:

	Use [MBtu]	Annual Cost
Heating	102.3	$583
Cooling	0.0	$0
Hot Water	9.1	$426
Lights/Appliances	19.7	$925
Service Charges		$144
Generation (e.g. Solar)	0.0	$0
Total:	**131.2**	**$2,078**

This home meets or exceeds the criteria of the following:



Home Feature Summary:

Home Type:	Single family detached
Model:	N/A
Community:	N/A
Conditioned Floor Area:	1,500 ft²
Number of Bedrooms:	2
Primary Heating System:	Boiler • Natural Gas • 85 AFUE
Primary Cooling System:	N_A
Primary Water Heating:	Residential Water Heater • Electric • 0.95 Energy Factor
House Tightness:	10 ACH50
Ventilation:	None
Duct Leakage to Outside:	Hydronic Delivery (Radiant)
Above Grade Walls:	R-34
Ceiling:	Attic, R-30
Window Type:	U-Value: 0.3, SHGC: 0.4
Foundation Walls:	R-0
Framed Floor:	R-0

Rating Completed by:

Energy Rater: Nicole Burger
RESNET ID: 5841944

Rating Company: Innova Building Advisors, LLC
1548 South 16th Street Philadelphia PA 19146
2154469945

Rating Provider: Performance Systems Development
950 Danby Rd, Ste 201P, Ithaca NY 14850
607-277-6240

Nicole Burger, Certified Energy Rater
Date: 3/6/24 at 3:57 PM

ekotrope

Energy savings calculated without modifications to the energy model. (As Modeled)

Ekotrope RATER - Version:4.0.2.3352
The Energy Rating Disclosure for this home is available from the Approved Rating Provider.
This report does not constitute any warranty or guarantee.

Case Comparison

Reference	Unit	Type	Floor	Annual Heating Cost	Annual Cooling Cost	Annual Water Heating	Annual Lighting/ Appliances/ Other	Annual Service Charges	Total Annual Cost
TB Aluminum Frame Window	A	1BR Mid Inner	3	$426	$26	$214	$472	$84	$1,222
uPVC Frame Window	B	1 BR Mid Inner	3	$275	$25	$214	$472	$84	$1070

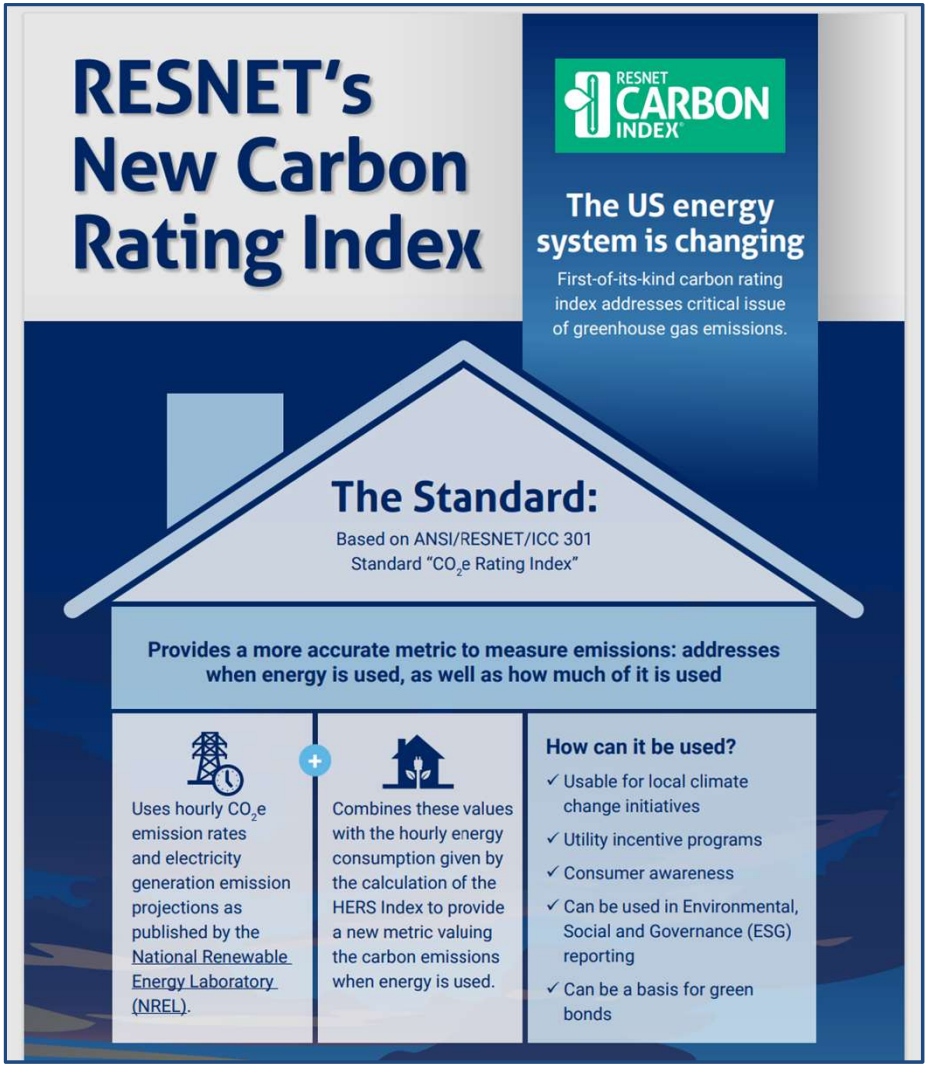
Reference	Unit	HERS Energy Rating Index Score	Operational Carbon Index	Annual Energy Use Electric	Energy Use MBtu Heating	Energy Use MBtu Cooling	Energy Use MBtu Hot Water	Energy Use MBtu Lights/ Appliances	Total Use MBtu
Existing Historic Building	A	63	63	7,113 KWh	9.1	0.6	4.6	10.1	24.3
New Construction Addition	B	49	50	6,163 KWh	5.9	0.5	4.6	10.1	17.6

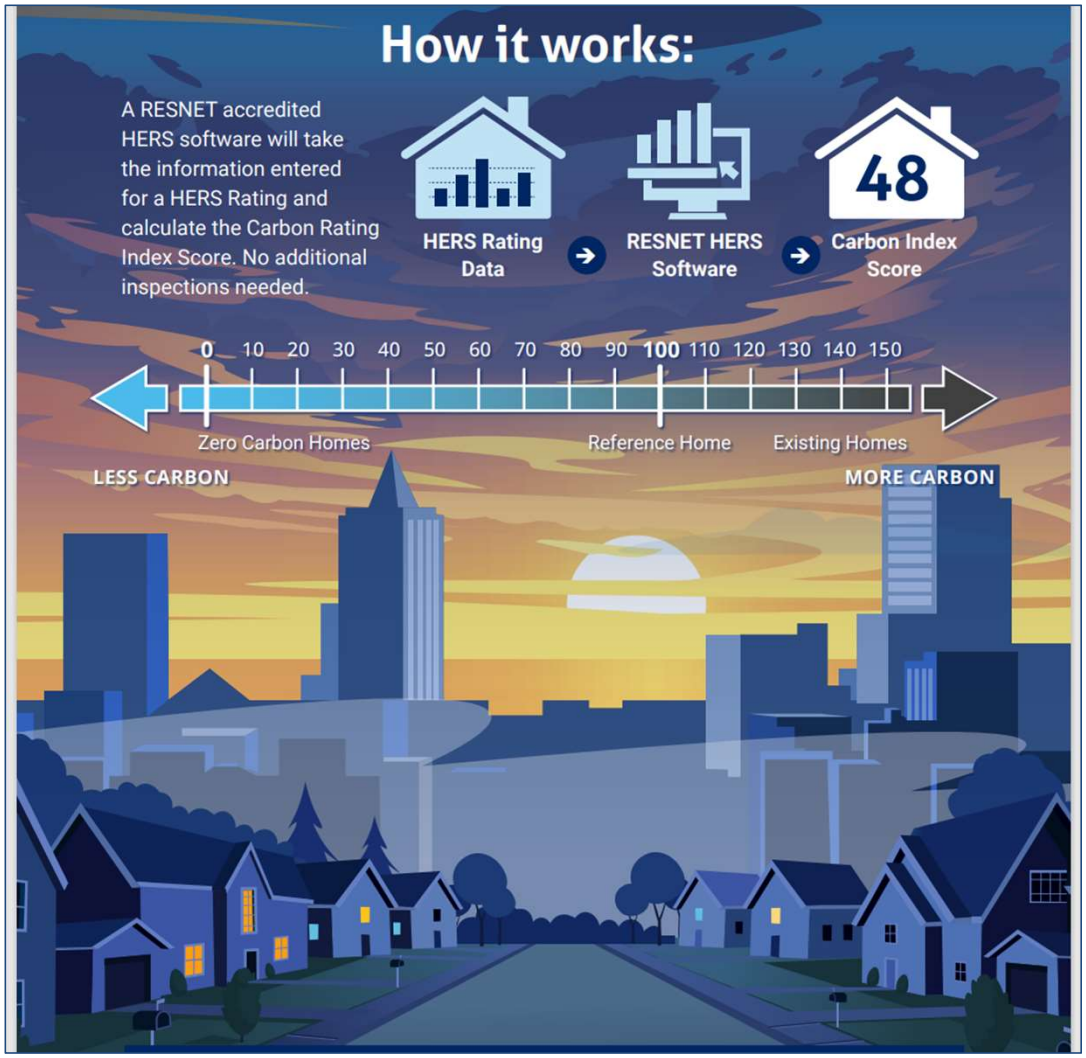
Local and Federal Funding Opportunities:

- Inflation Reduction Act (IRA)
- 45L Tax Credits
- DOE Homes
- DOE HEEHRA
- Green and Resilient Retrofit Program (GRRP)
- DOE 48 Solar
- Bipartisan Infrastructure Law (BIL)
- Utility Program Rebates & Incentives

Part II: The CO2 Index

The CO2 Index: Why and How



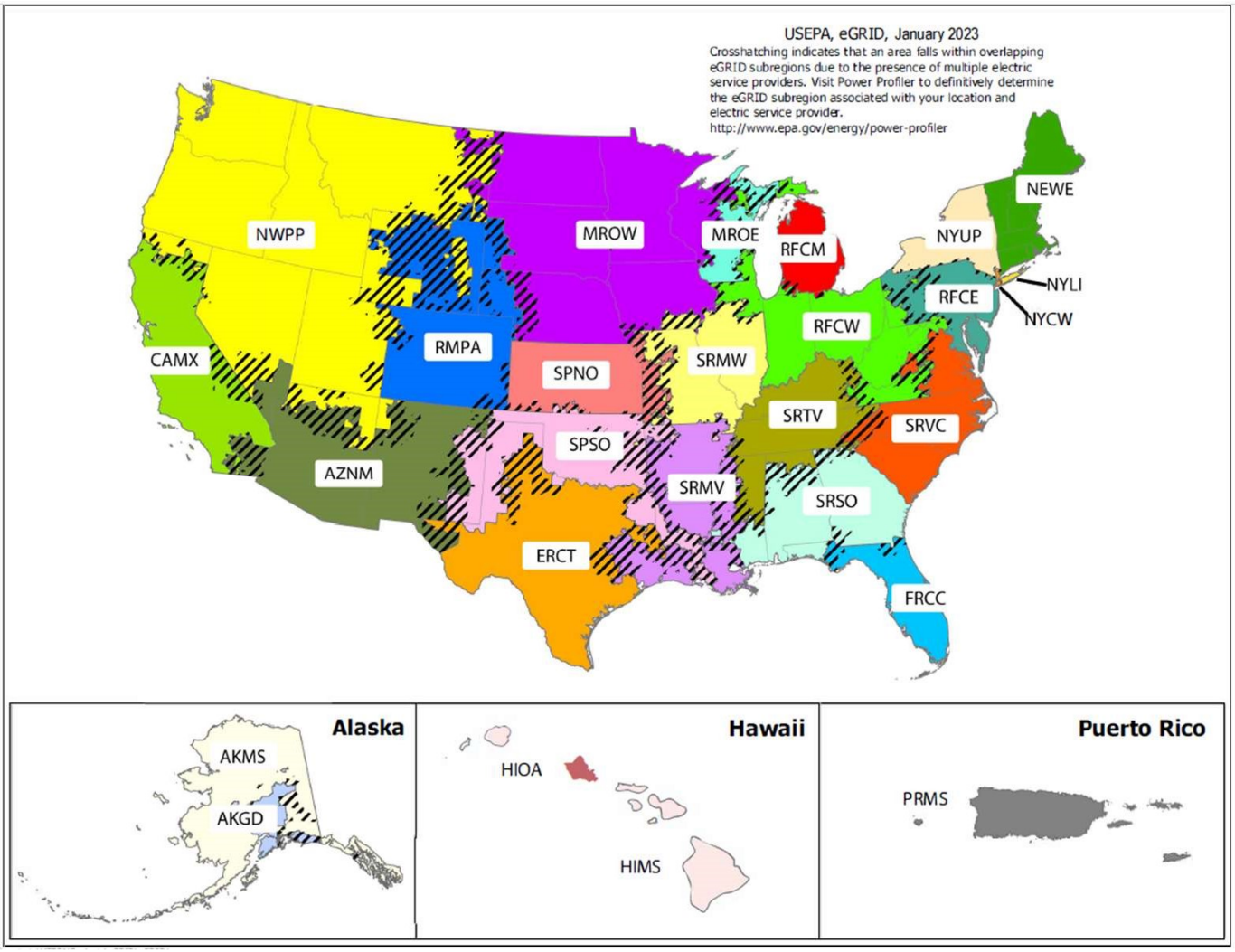


RESNET CARBON INDEX®

- CO2 100 indicates that the rated home incurs the same total emissions as a similar, all-electric home built to 2006 efficiency standards

- CO2 0 = the rated home incurs net-zero emissions over the course of the year - a more difficult scenario than a HERS 0 Score unless the home is generating on-site renewable energy at times when the grid is carbon-intensive

Spoiler: HERS 0 and CO2 0 are NOT the same thing! A HERS 0 home is still a burden on the grid overnight when renewables are not plentiful.



The Cambium Database

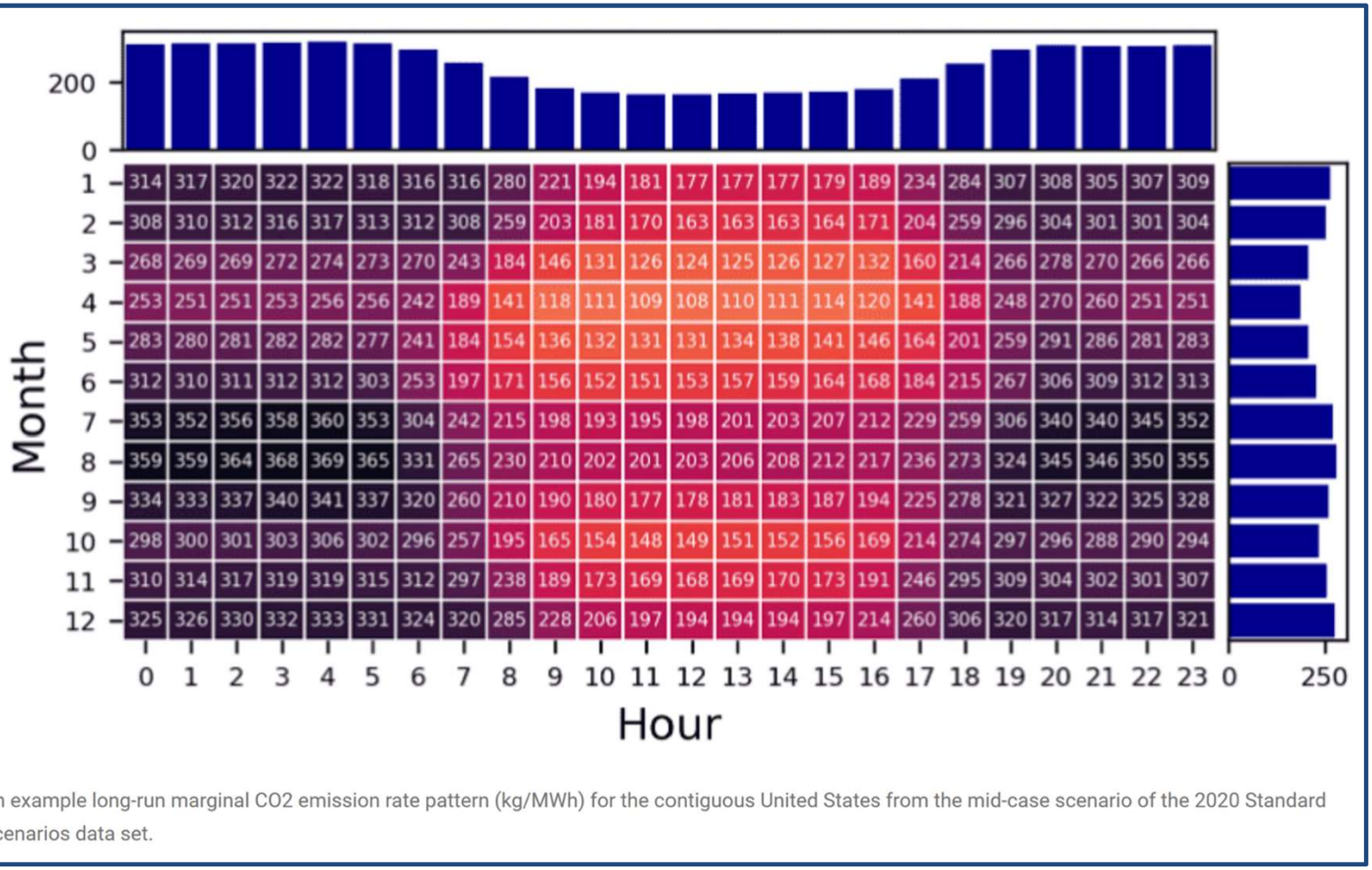
- Grid Forecasting Tool Released in 2020

- Based on the USEPA eGRID regions

- Models 10 Different Grid Impact Scenarios

- Leading Grid Analysis Tool

Time of Use



An example long-run marginal CO2 emission rate pattern (kg/MWh) for the contiguous United States from the mid-case scenario of the 2020 Standard Scenarios data set.

NREL

The Cambium database analyzes hourly results, showing emission rate patterns in kg/MWh of production

Low Renewables Cost Scenario —

Highest Market Share of Renewable Energy Levelized from 2025-2050

Levelized Long-run Marginal Emission Rates (Annual)

Units: kg of CO2 per MWh at the point of end-use

AZNMc	CAMXc	ERCTc	FRCCc	MROEc	MROWc	NEWEc	NWPPc	NYSTc	RFCEc	RFCMc	RFCWc	RMPAc	SPNOc	SPSOc	SRMVc	SRMWc	SRSOc	SRTVc	SRVCc
137.9	44.6	83.5	204.8	200.7	134.6	196.4	102.9	75.8	280.2	343.0	311.1	162.6	141.5	160.0	305.5	210.4	305.1	360.1	179.8

Levelized Long-run Marginal Emission Rates (Time-of-day)

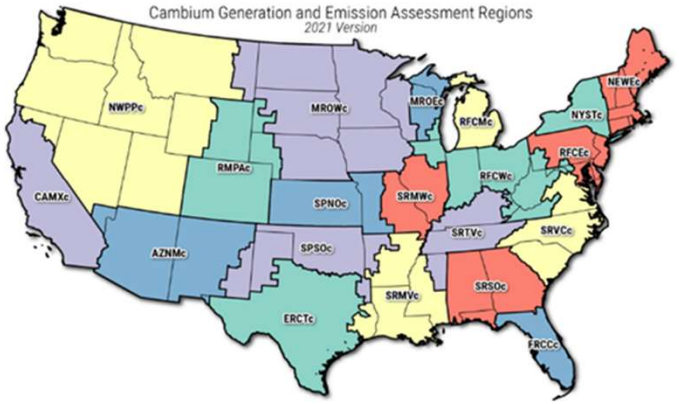
Units: kg of CO2 per MWh at the point of end-use

Hour of the day	AZNMc	CAMXc	ERCTc	FRCCc	MROEc	MROWc	NEWEc	NWPPc	NYSTc	RFCEc	RFCMc	RFCWc	RMPAc	SPNOc	SPSOc	SRMVc	SRMWc	SRSOc	SRTVc	SRVCc
0	176.6	79.8	90.7	374.6	302.3	184.7	231.0	132.3	98.6	366.4	378.0	396.9	207.9	177.0	182.5	373.3	274.3	441.0	485.1	324.9
1	181.8	85.9	90.6	392.4	300.9	187.2	228.5	133.3	96.9	362.0	374.9	392.2	210.6	177.5	182.0	370.8	276.7	446.4	485.7	331.8
2	186.1	88.8	90.7	399.6	302.5	186.8	227.5	133.9	95.7	359.4	373.5	390.7	212.8	178.8	184.2	371.1	279.0	446.9	486.3	334.3
3	188.7	88.6	90.5	394.5	303.1	189.2	226.6	133.2	95.6	358.4	374.0	391.4	211.0	181.9	186.7	371.4	281.3	446.8	486.0	334.0
4	187.9	84.1	91.3	377.7	280.0	184.6	222.0	129.6	94.4	358.3	375.5	393.0	205.0	181.8	190.1	368.4	277.0	442.6	468.8	328.6
5	183.1	62.3	90.3	333.3	220.5	154.0	204.0	118.6	84.7	335.0	370.6	384.3	195.0	163.6	182.3	336.2	232.8	420.5	390.2	281.9
6	157.0	39.7	76.7	216.0	174.7	129.7	181.5	96.4	70.2	284.3	348.1	335.5	174.1	137.3	162.1	280.1	190.4	333.0	308.4	193.7
7	125.0	17.6	63.1	120.5	123.1	107.0	161.8	75.7	56.8	228.2	325.4	276.1	144.9	119.5	136.4	226.6	151.2	244.5	246.7	115.7
8	99.6	12.1	58.0	90.9	96.5	88.1	146.9	68.4	47.5	178.8	299.7	215.9	120.9	102.8	118.6	203.8	134.6	187.1	229.0	67.2
9	94.5	11.6	58.6	88.1	91.5	84.2	143.3	67.4	44.6	166.3	290.8	196.5	112.1	99.0	113.7	198.4	129.2	172.5	225.2	58.2
10	93.1	11.4	61.7	86.9	89.4	82.8	142.4	67.6	44.3	163.5	291.2	193.8	109.6	98.7	112.8	194.8	126.9	166.7	223.5	54.9
11	93.4	11.6	65.4	85.4	89.9	82.1	143.1	68.0	44.8	162.1	290.9	193.0	111.1	98.6	110.5	194.2	125.7	163.9	221.3	53.7
12	93.2	11.6	67.8	87.2	89.1	81.3	143.6	67.9	45.0	161.0	291.6	193.4	111.9	97.7	109.5	193.3	125.8	162.5	221.0	52.7
13	93.1	12.2	67.0	89.4	90.1	81.8	143.8	68.4	45.0	161.5	291.0	192.5	110.3	96.8	111.5	194.7	127.4	163.4	224.0	53.6
14	93.0	13.0	66.8	93.7	94.7	82.7	148.7	71.1	46.9	164.1	291.8	194.6	112.2	98.3	113.4	203.3	131.7	168.4	232.7	56.7
15	94.4	22.9	68.9	100.4	131.5	94.0	166.2	84.4	53.1	182.4	298.7	208.6	120.8	109.9	123.3	247.0	157.8	176.0	286.9	67.4
16	112.1	41.9	81.2	140.5	188.5	122.0	195.4	108.5	69.1	249.4	326.4	266.0	140.4	134.6	153.5	320.0	215.0	225.5	373.1	128.8
17	139.6	53.6	110.8	215.7	248.7	150.4	230.5	122.0	88.5	330.6	360.1	336.4	170.8	160.7	193.1	411.0	261.1	316.3	444.6	188.3
18	157.8	62.4	126.5	279.8	287.5	170.5	255.2	126.6	110.2	386.4	395.0	393.4	186.8	181.0	224.5	420.1	284.4	398.0	468.0	233.6
19	167.3	57.2	111.8	274.8	289.3	169.5	249.3	124.9	108.2	387.6	399.4	414.8	194.1	171.5	209.7	401.8	266.7	413.8	450.5	241.2
20	161.0	56.2	98.2	258.9	284.1	167.0	238.4	124.8	99.7	373.2	392.1	405.3	189.0	168.0	201.9	384.2	263.0	396.1	443.7	236.2
21	159.6	61.6	91.4	258.1	297.1	172.7	235.9	126.8	98.6	368.2	381.9	399.5	189.3	170.7	192.7	378.9	273.6	389.6	461.8	245.5
22	164.9	65.3	90.7	289.1	305.6	176.0	235.8	129.3	100.9	375.6	382.1	405.9	196.8	172.7	190.3	380.0	277.1	406.6	478.9	282.8
23	170.0	73.0	94.7	335.2	306.4	182.0	234.1	130.6	102.1	376.2	380.2	405.9	201.6	176.3	186.7	376.0	274.7	430.6	484.1	313.0

For mappings of ZIP codes and counties to GEA regions, see the County Mapping and ZIP Mapping tabs.
For the time zone that each GEA region is reported in, see the Timezones tab.

Levelization weight calculations

2024	2026	2028	2030	2035	2040	2045	2050
1.00	1.91	1.80	1.70	3.84	3.31	1.76	0.00



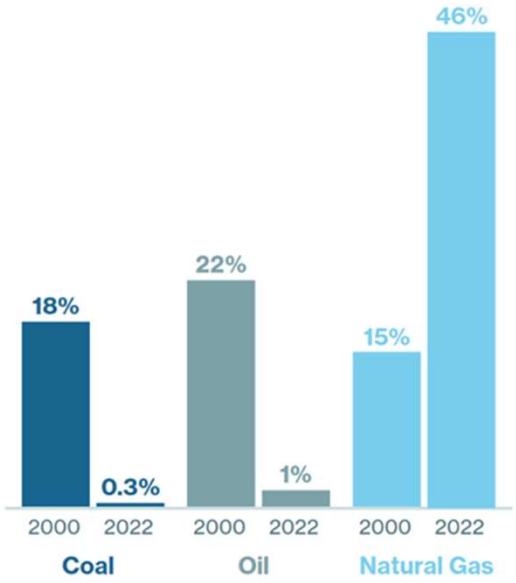
A Major Energy Transformation Is Underway

New England has shifted away from older coal- and oil-fired generation to cleaner burning natural gas.

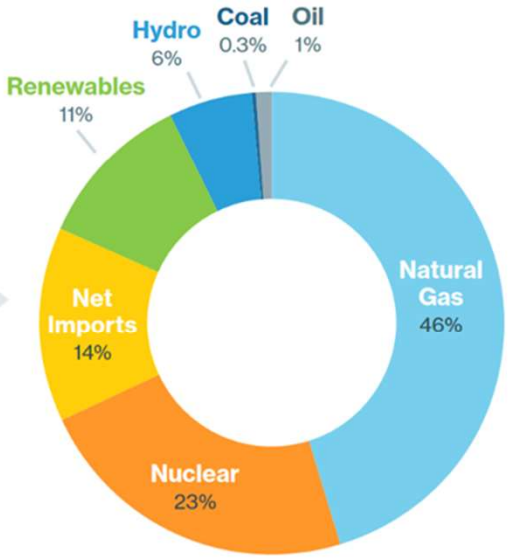
Most of today's electricity comes from lower-emitting energy resources.

The region is transitioning to large-scale clean and renewable energy.

YESTERDAY VS. TODAY



2022 ENERGY RESOURCES



The amount of electricity produced by generators in New England and imported from other regions to satisfy all residential, commercial, and industrial customer demand in New England. This is called Net Energy for Load (NEL).

LOOKING TO THE FUTURE

- Wind power dominates new resource proposals: nearly 16,000 MW
- Solar power is growing rapidly: ISO-NE forecasts nearly 12,000 MW within a decade
- Battery storage technologies are emerging at the customer and grid level: more than 11,000 MW proposed
- New transmission proposals would provide access to additional clean or renewable energy in New England or Eastern Canada

Courtesy ISO-ne.com

Carbon Index Emissions Comparison

STEPHENS & COMPANY, INC.
NANTUCKET, MASSACHUSETTS

Property
41 Wauwinet Rd
Nantucket, MA 02554

Wauwinet Rd 41 - 5dYEqVnd
41 Wauwinet Rd

Organization
Stephens and Company, I
Andrew Buccino
508-280-6542

Builder
Adam Ross

Inspection Status
2023-10-17
Rater ID (RTIN): 2223008
RESNET Registered
(Confirmed)

Carbon Dioxide Equivalent (CO_2e) [tons/yr]	Carbon Ref.	Rated Home	Savings	% Saved
Heating Total	5.64	1.16	4.48	79.41%
Cooling Total	0.04	0.01	0.04	82.34%
Hot Water Total	1.14	0.30	0.84	73.61%
Lights & Appliances Total	4.23	2.95	1.27	30.13%
Emissions Savings from Onsite Generation	-0.00	-0.00	0.00	
TOTAL	11.05	4.42	6.62	59.97%

Carbon Rating & HERS® Certificate

Projected Report
Based on Plans

Rating Date: 2021-10-07
Registry ID:
Ekotrope ID: 6LAXOWZ2

STEPHENS & COMPANY, INC.
NANTUCKET, MASSACHUSETTS

Carbon Index **41**

HERS® Index **40**

About these ratings:
Both ratings are relative performance scores. A lower Carbon Rating Index means fewer carbon emissions for a home. The lower the HERS Rating, the more energy efficient the home. For more Info:
www.resnet.us/about/resnet-carbon-rating-index
www.hers.com

Home:
31 Fairgrounds Rd Building 1 Unit B
Nantucket, MA 02554

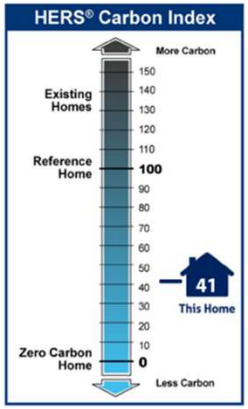
Builder:
Fairgrounds Common

	CO_2e Emissions [tons/yr]	Annual Cost
Heating	0.3	$251
Cooling	0.0	$2
Hot Water	0.1	$129
Lights/Appliances	0.9	$844
Service Charges		$2
Generation (e.g. Solar)	0.0	$0
Total:	**1.3**	**$1,228**

Annual Savings*
2.7 Tons CO_2e
$2,443
*Relative to an average U.S. home

This home meets or exceeds the criteria of the following:

2018 International Energy Conservation Code



Home Feature Summary:

Home Type:	Apartment, end unit
Model:	N/A
Community:	N/A
Conditioned Floor Area:	1,003 ft^2
Number of Bedrooms:	2
Primary Heating System:	Air Source Heat Pump • Electric • 10.9 HSPF
Primary Cooling System:	Air Source Heat Pump • Electric • 21.4 SEER
Primary Water Heating:	Residential Water Heater • Electric • 3.75 Energy Factor
House Tightness:	1.3 ACH50 (Adjusted Infiltration: 1.30 ACH50)
Ventilation:	54 CFM • 39 Watts • ERV
Duct Leakage to Outside:	Forced Air Ductless
Above Grade Walls:	R-32
Ceiling:	Vaulted Roof, R-37
Window Type:	U-Value: 0.29, SHGC: 0.26
Foundation Walls:	N/A
Framed Floor:	R-37

Rating Completed by:

Energy Rater: Andrew Buccino
RESNET ID: 2223008

Rating Company: Stephens and Company, Inc
61 Old South Rd PMB 119 Nantucket, MA 02554
508-325-5736

Rating Provider: Building Efficiency Resources
PO Box 1769 Brevard, NC 28712
800-399-9620

Andrew Buccino, Certified Energy Rater
Date: 11/10/23 at 11:28 AM

This home was modeled to Base Code, HERS 45 All-Electric, and HERS 42 – Propane

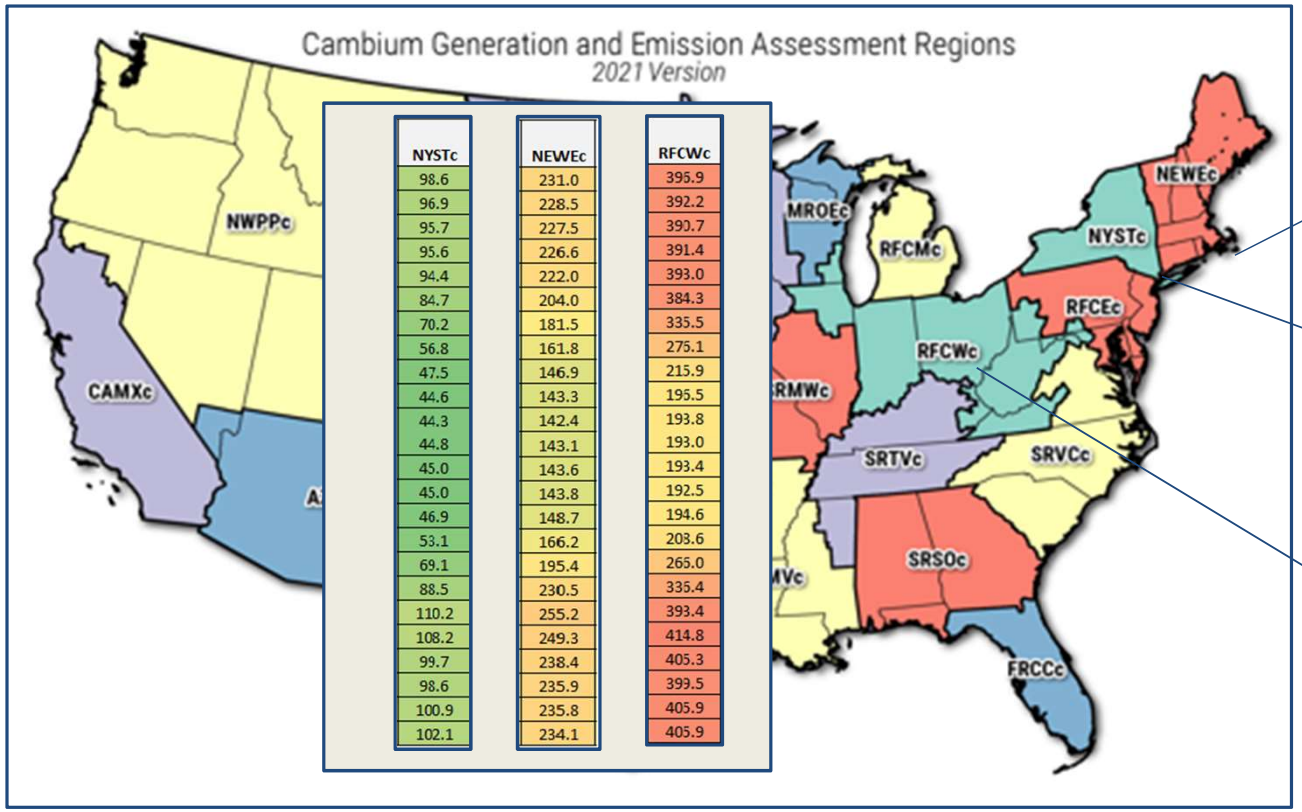
Insulation R-values were kept at Base Code levels across all 3 models

Stretch Code Job Comparison			
Address:	Base Code	All Electric - HERS 45	Propane - HERS 42
18 Beach Grass	HERS 59	HERS 45	HERS 42
3200 sq ft 3Beds			
Insulation Package	Base Code Minimum	Base code minimum	Base Code minimum
Windows	U:.30 / SHGC:.27	U:.30 / SHGC:.27	U:.30 / SHGC:.27
House Tightness	3 Air Changes	1.25 Air Changes	1.0 Air Changes
Heating	Heat pump w/Propane backup	Heat Pump HSPF2-10; SEER2-18.8	98% efficient furnace
Cooling	SEER-17.5	SEER2-18.8	SEER-18
Hot Water	95% efficient On Demand	Heat Pump 3.93 EF	96% efficient On Demand
ERV	60% efficient	82%	85%
Operational Cost	$3,865	$2,774	$3,815
Op. Cost 25 yr	$96,625	$69,350	$95,375
Tons Carbon / YR	4.42	3.01	4.97
25-Year Horizon	110.5	75.25	124.25

Operating cost is an estimate
25-year horizon does not account for inflation

Air Changes have a significant impact on Energy performance

Comparing the Same Development Across Three Grids



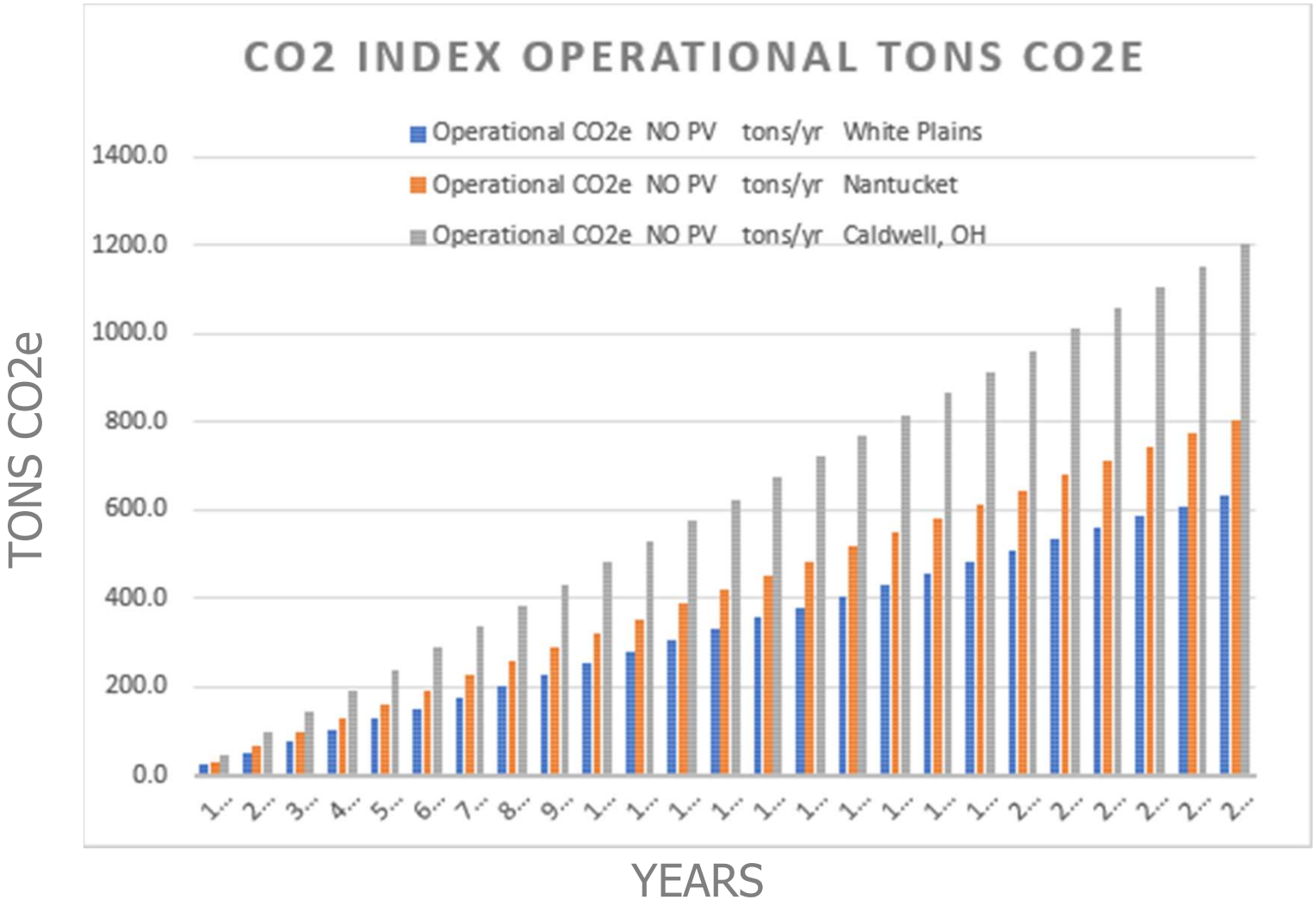
NYSTc	NEWEc	RFCWc
98.6	231.0	395.9
96.9	228.5	392.2
95.7	227.5	390.7
95.6	226.6	391.4
94.4	222.0	393.0
84.7	204.0	384.3
70.2	181.5	335.5
56.8	161.8	275.1
47.5	146.9	215.9
44.6	143.3	195.5
44.3	142.4	193.8
44.8	143.1	193.0
45.0	143.6	193.4
45.0	143.8	192.5
46.9	148.7	194.6
53.1	166.2	203.6
69.1	195.4	265.0
88.5	230.5	335.4
110.2	255.2	393.4
108.2	249.3	414.8
99.7	238.4	405.3
98.6	235.9	399.5
100.9	235.8	405.9
102.1	234.1	405.9

3 Cambium GEA Scenarios

Nantucket, MA 02554
NEWEc - NPCC New England

White Plains, NY 10601
NYSTc - NPCC
NYC/Westchester/Long Island/ Upstate

Caldwell, OH 43724
RFCWc - RFC West

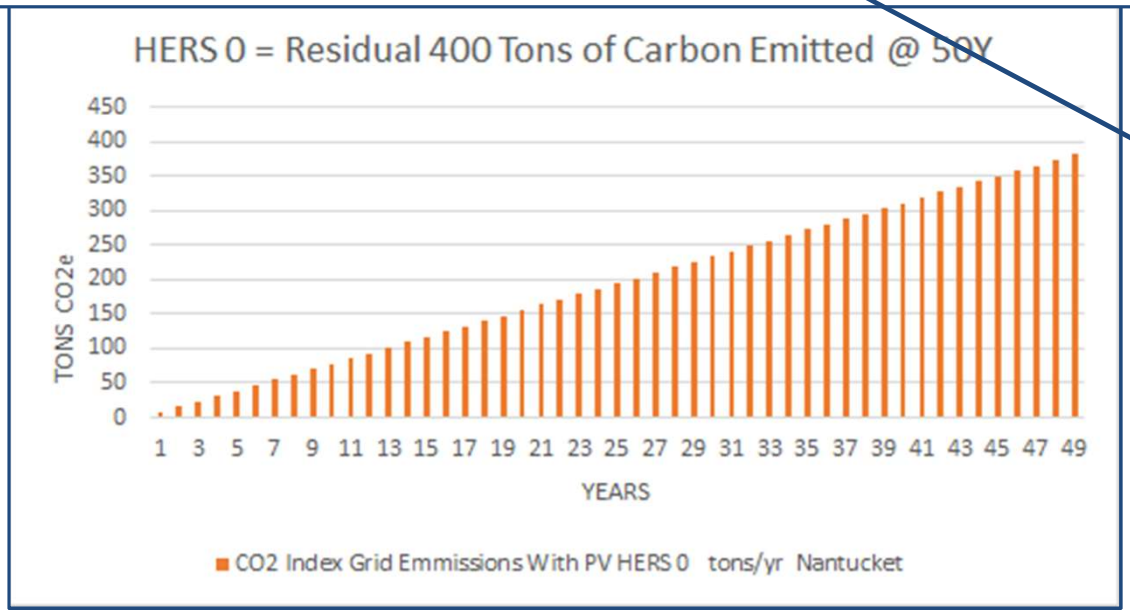

CO2 INDEX OPERATIONAL TONS CO2E
Operational CO2e NO PV tons/yr White Plains
Operational CO2e NO PV tons/yr Nantucket
Operational CO2e NO PV tons/yr Caldwell, OH
1400.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
TONS CO2e
YEARS

Carbon Dioxide Equivalent (CO_2e) [tons/yr]	Carbon Ref.	Rated Home	Savings	% Saved
Heating Total	0.92	0.29	0.63	68.51%
Cooling Total	0.01	0.00	0.01	82.58%
Hot Water Total	0.72	0.13	0.59	81.58%
Lights & Appliances Total	1.42	0.90	0.51	36.35%
Emissions Savings from Onsite Generation	-0.00	-0.98	0.98	
TOTAL	3.06	0.34	2.72	88.79%

HERS 0

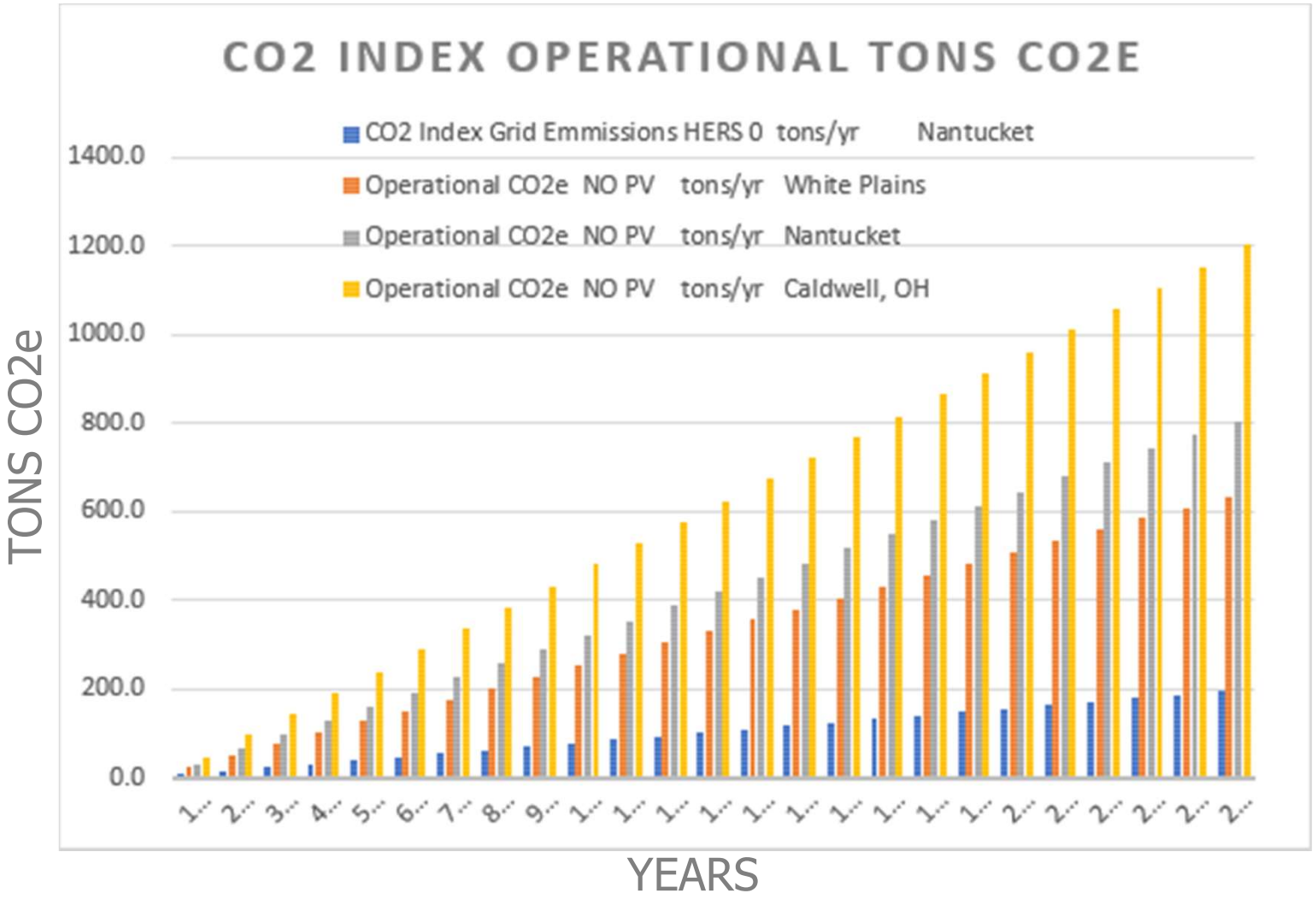
≠

CO2 0



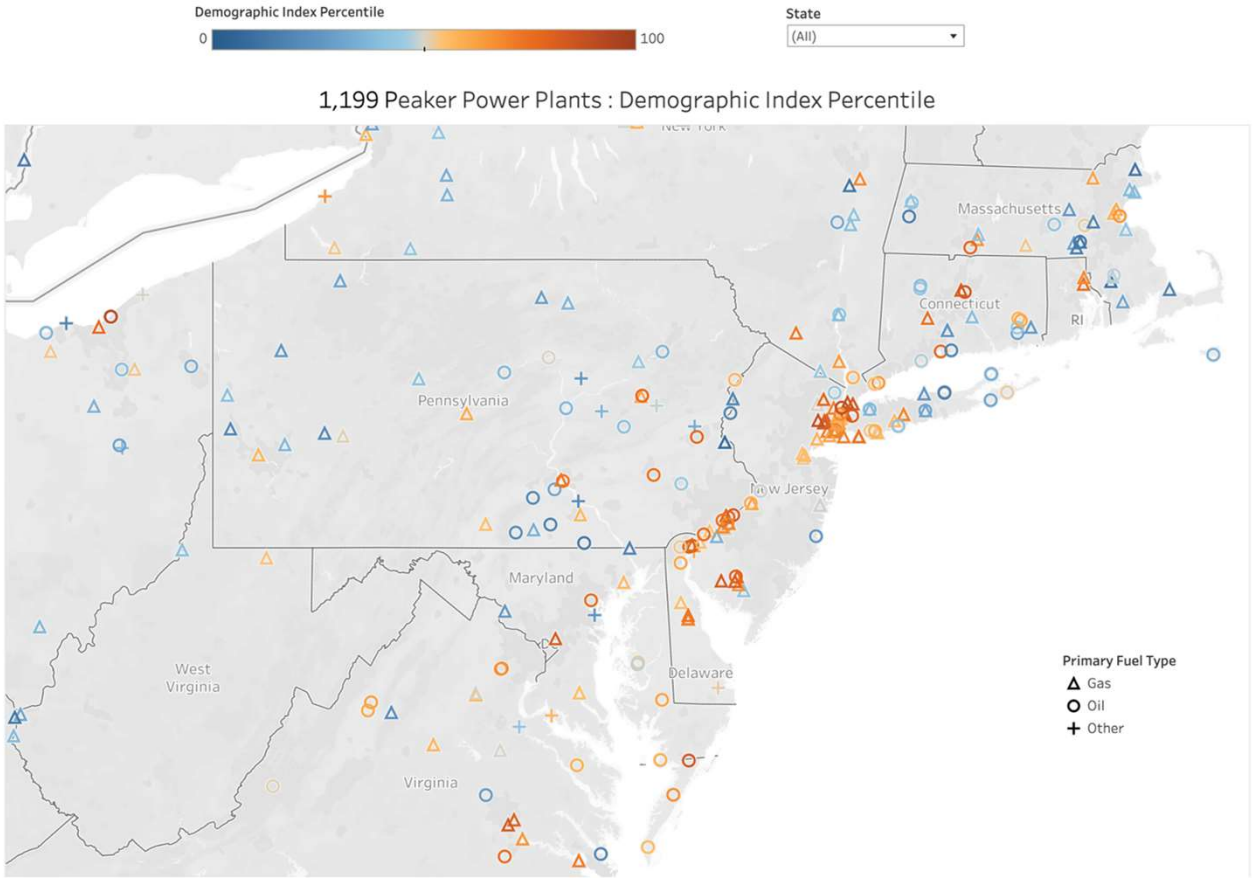
Even after adding all that PV, we still are emitting carbon at the grid scale

PV doesn't produce at night!

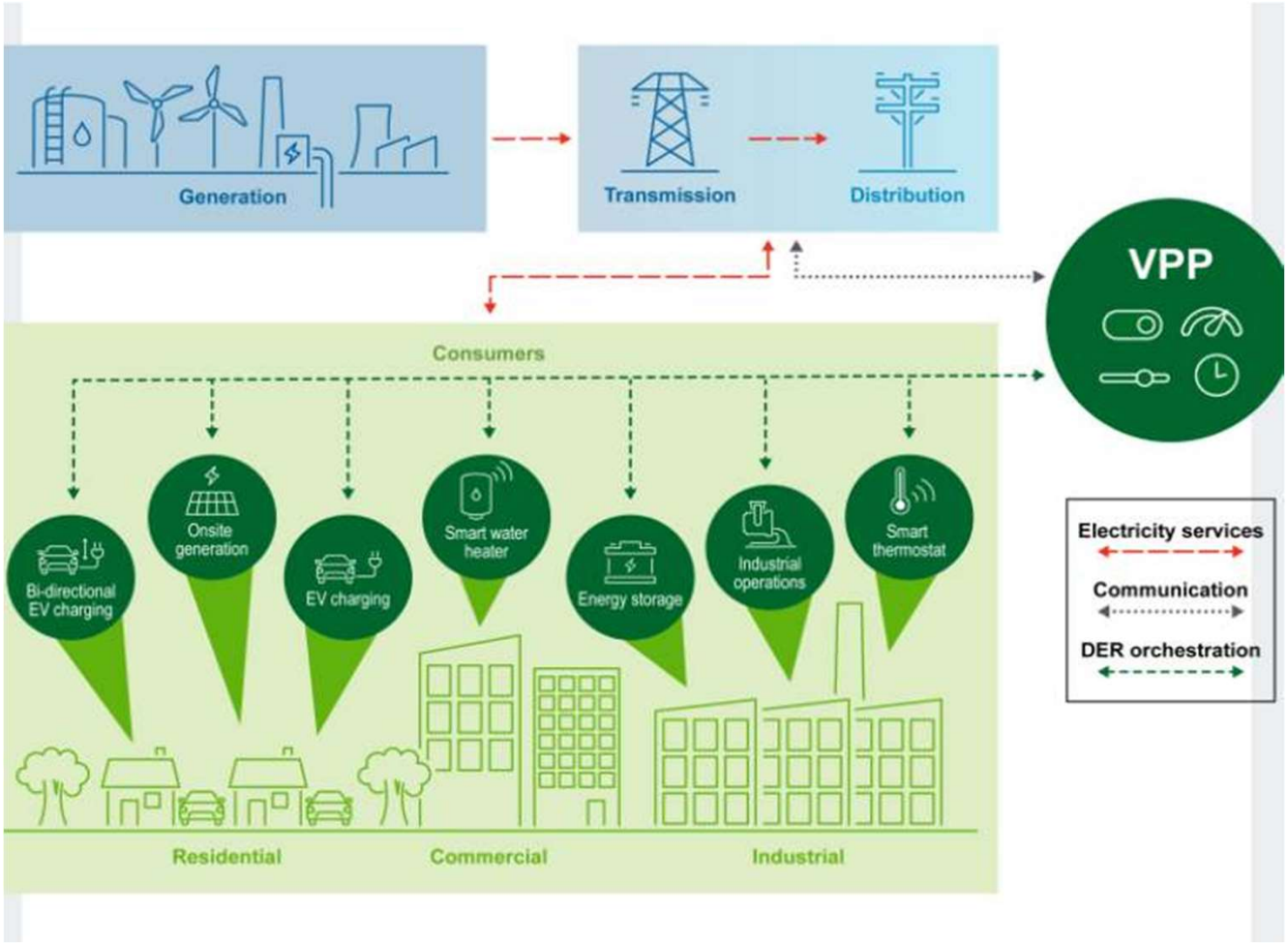

CO2 INDEX OPERATIONAL TONS CO2E
CO2 Index Grid Emmissions HERS 0 tons/yr Nantucket
Operational CO2e NO PV tons/yr White Plains
Operational CO2e NO PV tons/yr Nantucket
Operational CO2e NO PV tons/yr Caldwell, OH
1400.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
TONS CO2e
YEARS

Environmental Justice and CO2

Large numbers of "peaker" plants in New England are located in areas with densely populated EJ Communities



Source: US EPA data visualized at https://www.cleanegroup.org/initiatives/phase-out-peakers/maps/



What is a Virtual Power Plant?

Leveraging of installed communications tech to deliver demand responsiveness

Let's consider a microgrid and a VPP

> We can't have a microgrid without connecting to a primary grid's Peak Load capacity in case that microgrid goes down.

if a microgrid is supported by VPP responsiveness, it can eliminate itself from the peak load equation.

38

All Of These Are Now Supported and Are Interconnected:

On-Site Battery Storage/ Micro-Grids
Heat Pump Water Heaters
Electric Variable capacity HVAC Systems
Connected Thermostats
Clothes Washers
Clothes Dryers
Refrigerators
Electric Vehicles

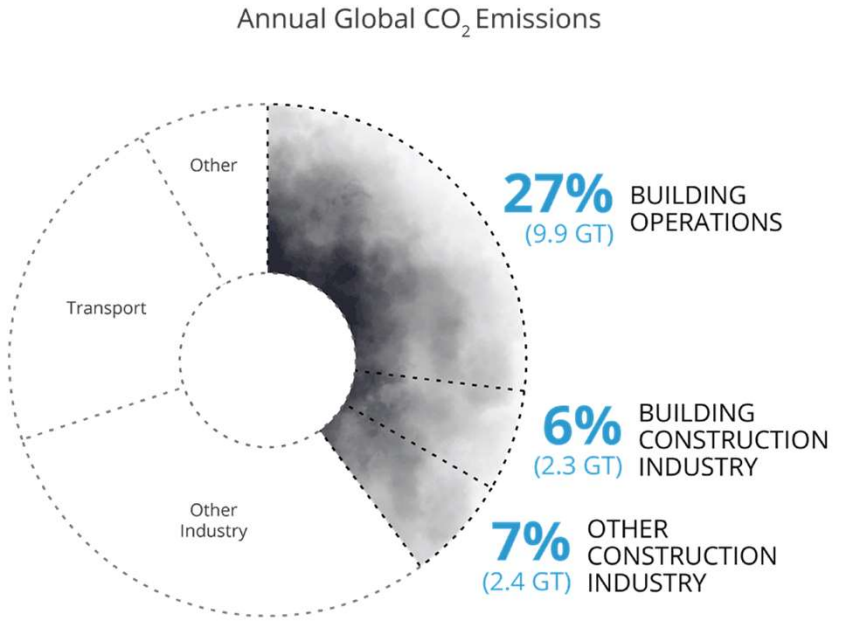
Part III: Embodied Carbon

Buildings and Carbon: Operational and Embodied Emissions

Total global fossil fuel emissions by sector, 2022

The built environment is responsible for 40% of annual global CO_2 emissions

Concrete, steel, and aluminum for buildings & infrastructure are responsible for 13% of annual global CO_2 emissions



Building Construction Industry and Other Construction Industry represent emissions from concrete, steel, and aluminum for buildings and infrastructure respectively.

Residential Construction Impact

(Average of 800 new homes from BfCA studies)

235 million m²
(2.5 billion ft²)
new low-rise residential
in US (2017)

~50-55 million tonnes
annual emissions

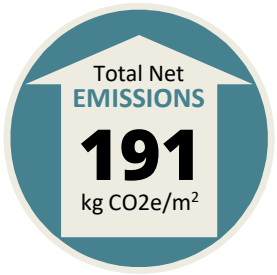
Finland	46.846
Bulgaria	49.568
Hungary	50.856
Sweden	50.874
Norway	52.492
Singapore	55.018
Peru	55.931
Portugal	56.771

Residential Construction Material Emission Baselines

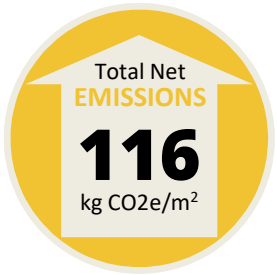
EMBARC Study (Toronto region)
503 as-built homes

HIGHEST RESULT

AVERAGE RESULT

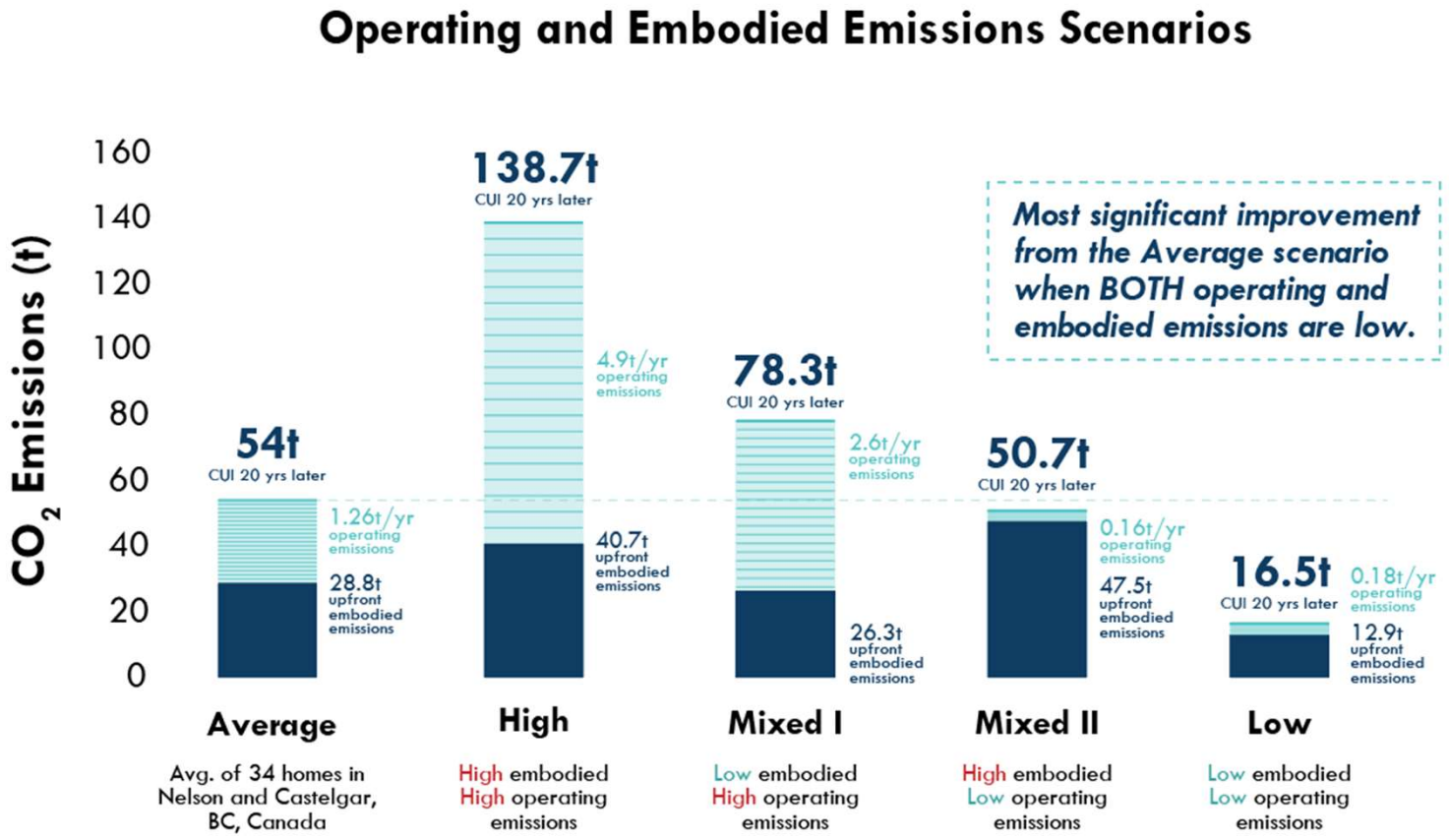


LOWEST RESULT



https://www.buildersforclimateaction.org/report---embarc-report.html

Carbon Use Intensity - Nelson, B.C.



New Way to Define Building Performance

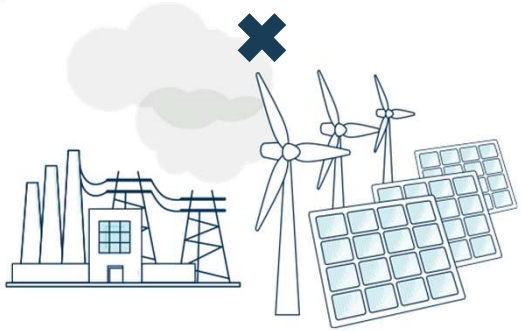
Up-Front Embodied Carbon Emissions

+

Operational Carbon Emissions

ENERGY USE INTENSITY

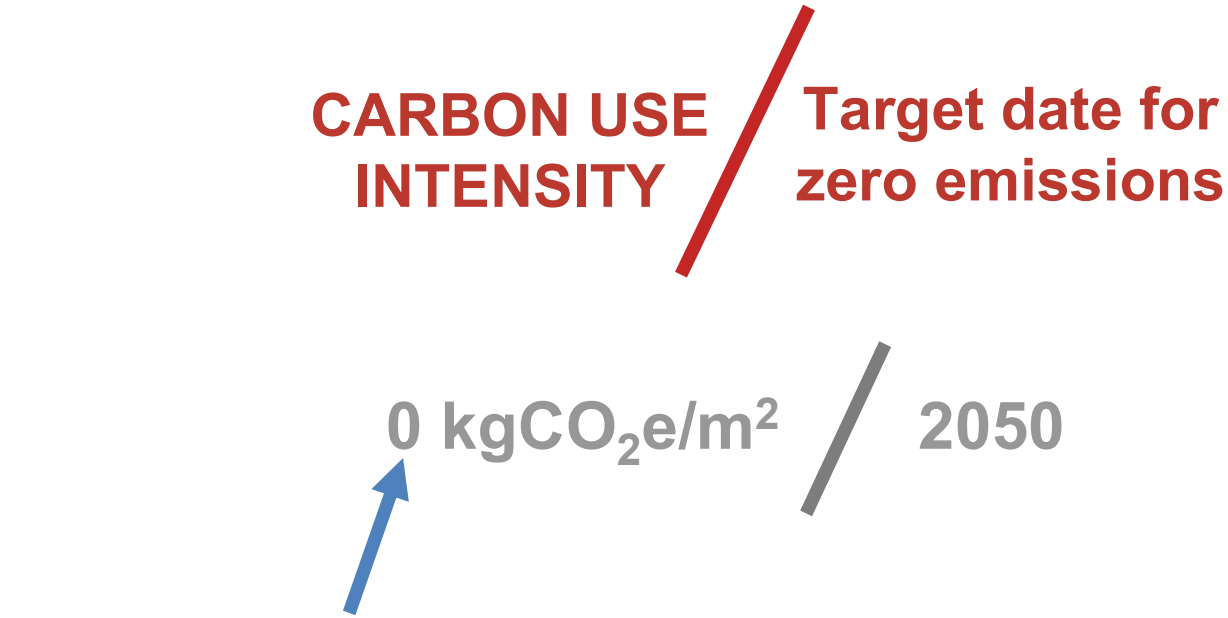
×



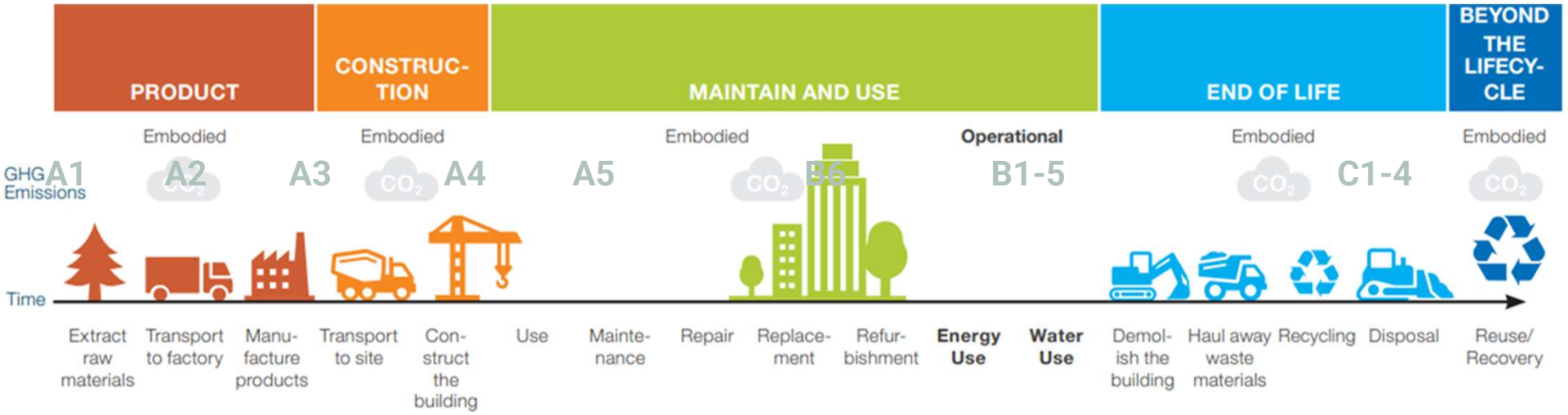
ENERGY SOURCE EMISSIONS

= CARBON USE INTENSITY

New Way to Meet Emission Reduction Targets



Life Cycle of a Building



Source: New Buildings Institute https://newbuildings.org/code_policy/embodied-carbon/

Material Carbon Emission Analysis

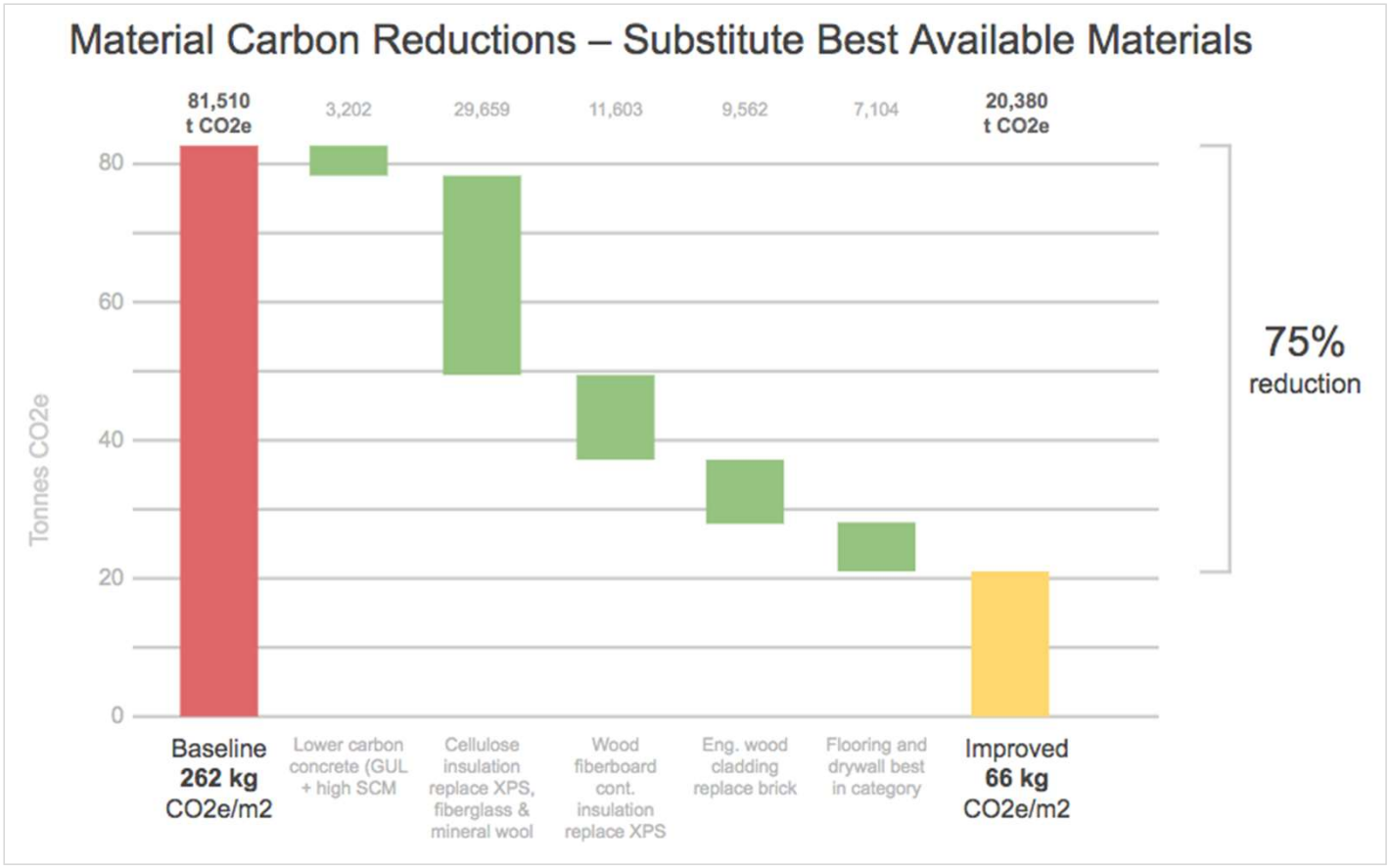
EXTERIOR WALLS

SECTION COMPLETE? ☐

SUBTOTAL (kg CO_2e): -5,576

CATEGORY	MATERIAL	QUANTITY	UNITS	%	SELECT	NET EMISSIONS (kg CO_2e)	EMISSIONS (kg CO_2e)	STORAGE (kg CO_2e)	FOOTNOTE
	Fiberglass batt / Owens Corning / EcoTouch Pink batt and roll / R 3.6/inch	4,101.0	ft²	100%	☐	374	374	0	
HEMP FIBER WOOL INSULATION									
	Hemp fiber batt / NaturFibre / Hemp Wool / R 3.7/inch	4,101.0	ft²	100%	☐	-438	1,398	1,836	
CELLULOSE INSULATION									
	Cellulose / loose fill / R 3.7/inch / CIMA [Industry Avg | US & CA]	4,101.0	ft²	100%	☐	-856	392	1,248	
	Cellulose / batt / CMS / EcoCell / R 3.6/inch	4,101.0	ft²	100%	☐	-1,436	392	1,828	
	Cellulose / spray applied / R 3.75/inch / International Cellulose Corp. / K-13, ThermoCon	4,101.0	ft²	100%	☐	-1,692	262	1,954	
	Cellulose / dense pack / R 3.7/inch / CIMA [Industry Avg | US & CA]	4,101.0	ft²	100%	☐	-1,711	784	2,495	
WOOD FIBER INSULATION									
	Wood fiber loose fill / GUTEX / ThermoFiber / R 3.6/inch	4,101.0	ft²	100%	☐	-1,172	486	1,658	Expired 2020
	Wood fiber batt / GUTEX / ThermoFlex / R 4/inch [EU]	4,101.0	ft²	100%	☐	-1,731	302	2,033	
	Wood fiber batt / Steico / SteicoFlex / R 3.8/inch [EU]	4,101.0	ft²	100%	☐	-1,897	352	2,249	Expired 2021
	Wood fiber batt / [BEAM Avg | EU]	4,101.0	ft²	100%	☐	-1,956	235	2,191	
	Wood fiber batt / Pavatex / Pavaflex / R 3.8/inch [EU]	4,101.0	ft²	100%	☐	-2,241	50	2,291	Expired 2019
HEMPCRETE INSULATION									
	Hempcrete / Cast in-situ / USA / R 2.1/inch, Avg. mix using NHL & PHL	4,101.0	ft²	100%	☐	-2,417	7,133	9,551	Peer-reviewed LCA, 2020
	Hempcrete / Cast in-situ / Europe / R 2.1/inch, Avg. of 9 mixes	4,101.0	ft²	100%	☐	-4,199	10,548	14,747	Peer-reviewed LCA, 2017
	Hempcrete / Cast in-situ / IsoHemp / Europe / R 2.1/inch	4,101.0	ft²	100%	☐	-4,832	4,719	9,551	LCA, 2018
STRAW BALE INSULATION									
	Straw Bale / Wheat & barley straw / SNaB (UK) / R 2.8/inch	4,101.0	ft²	100%	☐	-4,319	542	4,861	
	Straw Bale / Wheat & rye straw / (Germany) / R 2.8/inch	4,101.0	ft²	100%	☑	-6,162	326	6,488	Expired 2019

Simple Substitution Strategy: Immediate Action



Part IV: Emergent Methodologies

Emergent Methodology: Combining RESNET Indices for Equity

HERS Index

This year, RESNET will introduce its 4,000,000th HERS Rated Home into its registry!

CO2 Index

Currently established: accounts for **time of use** emissions and coordinates with the new embodied carbon standard. EPDs could use the CO2 Index to allow for consistency across the industrial sector in product manufacturing.

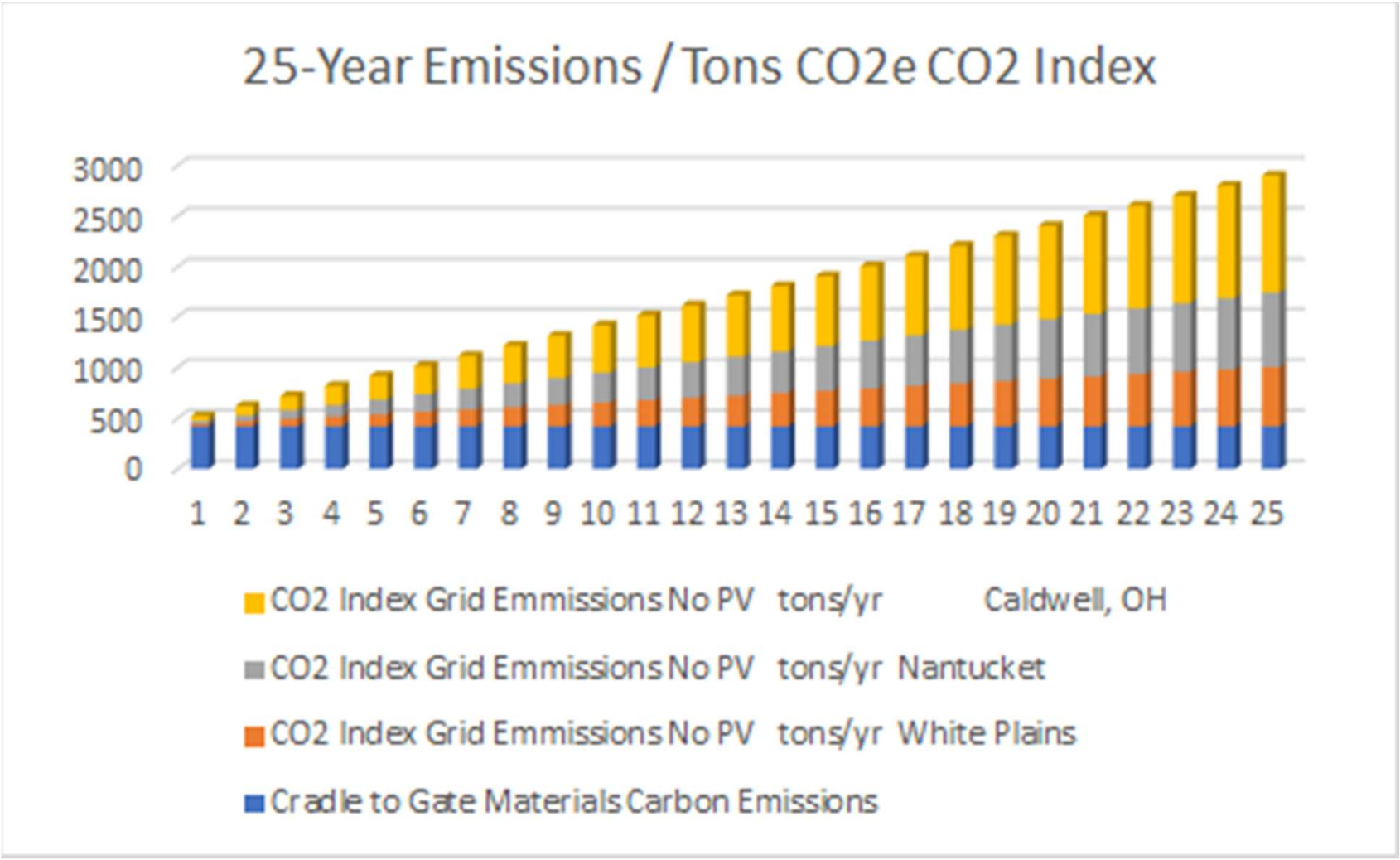
Embodied Carbon Measurement Standard

Currently in development: Technical Advisory Task Group is working out the details and the Standard Development Committee has been officially appointed.

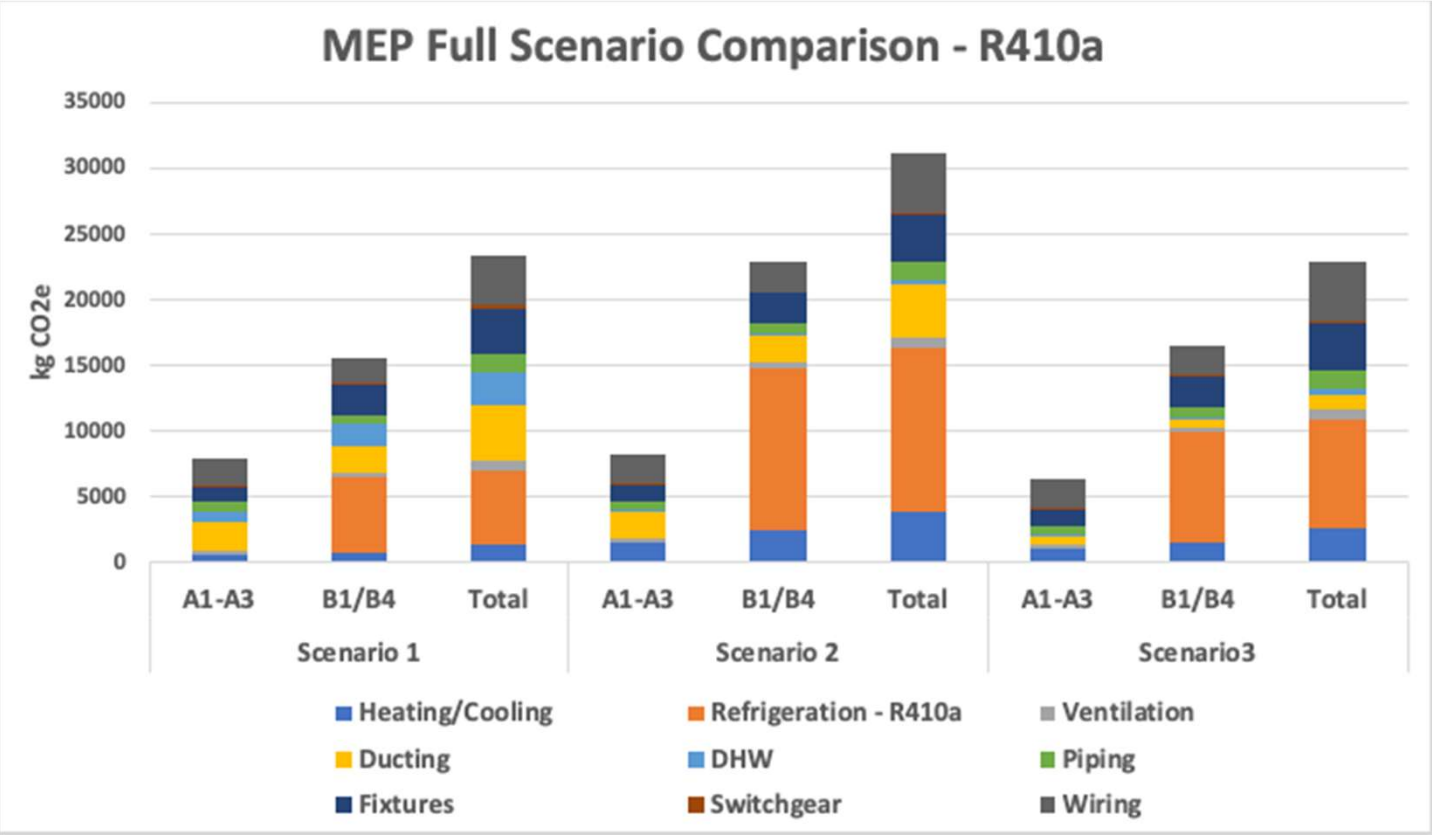
HERS H_2O

RESNET's Water Efficiency Rating System

- **HERS H20 Water Index** is currently established: opportunity to coordinate with other indices as it relates to carbon and/or ecological impact.
- **HERS H2O** was rolled out in 2021: over 6000 homes have used this index in the West and Southwest. This is in alignment with WaterSense certification from the EPA.
- According to the EPA, Electricity Generation is responsible for **41% of our water** consumption in the US!
- Reducing our Grid Intensity reduces our Water Intensity!!


25-Year Emissions / Tons CO2e CO2 Index
3000
2500
2000
1500
1000
500
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
CO2 Index Grid Emmissions No PV tons/yr Caldwell, OH
CO2 Index Grid Emmissions No PV tons/yr Nantucket
CO2 Index Grid Emmissions No PV tons/yr White Plains
Cradle to Gate Materials Carbon Emissions

Emergent Methodology: M/E/P



54

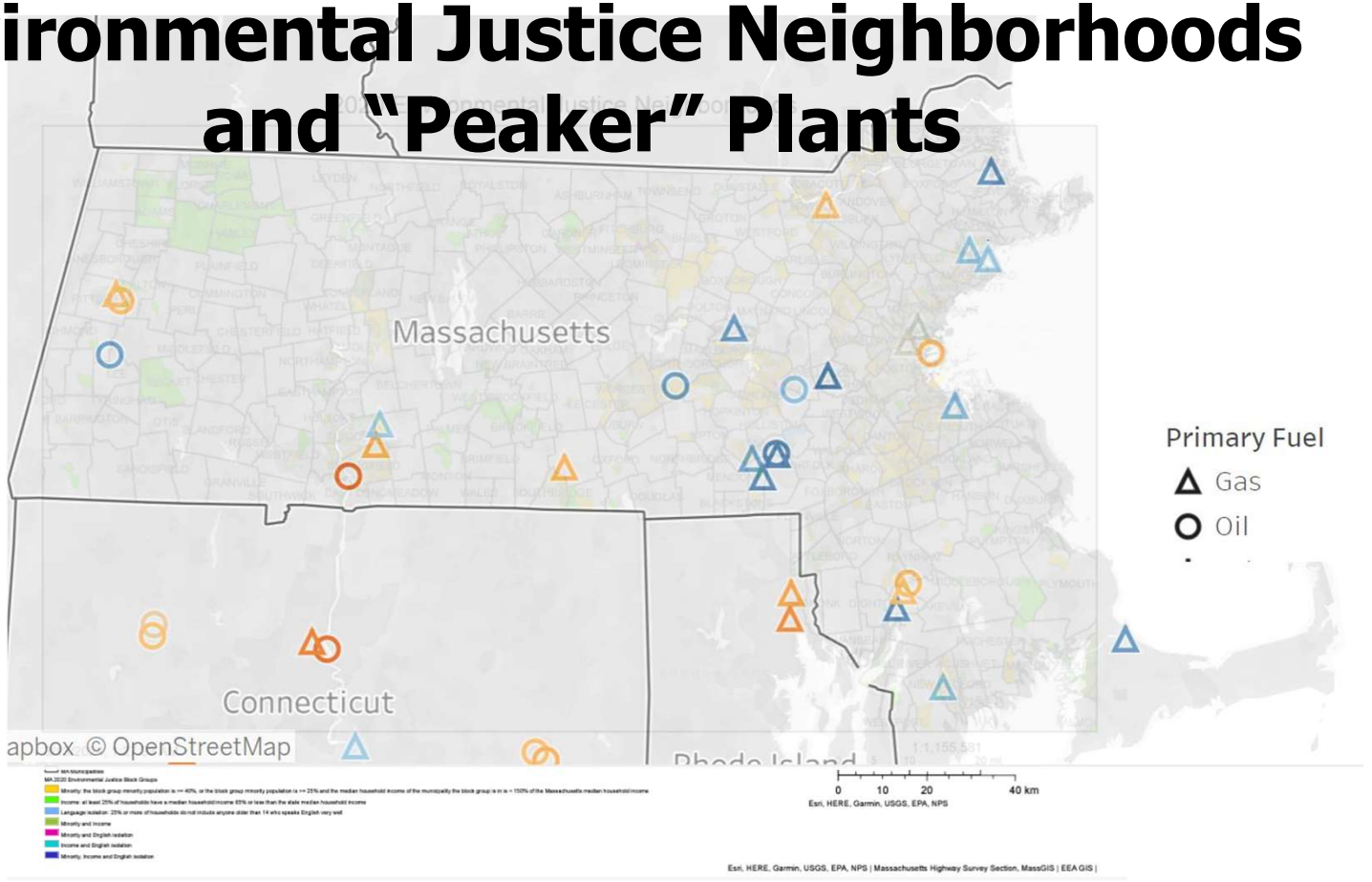
Emergent Methodology: M/E/P

- **Include MEP** in embodied carbon (EC) standard; **25% of total EC** emissions (CISBE 2021)
- **Utilize CISBE-NA TM65** as data basis (ASHRAE in process), or EU EPD data
- **Include refrigerant impacts** - major potential impact during use (B) stage
- **Sensitivity Analysis** on residential-scale EC totals in process
- **Coordinate with RESNET Workflows and Indices** to inform data collection and analysis

Part V: Environmental Justice and Resiliency

56

Environmental Justice Neighborhoods and "Peaker" Plants



https://mass-eoeea.maps.arcgis.com/apps/webappviewer/index.html?id=1d6f63e7762a48e5930de84ed4849212

Source: US EPA data visualized at https://www.cleanegroup.org/initiatives/phase-out-peakers/maps/

57

So Let’s Reduce the Load

58

So Let's Transition to Renewables

59

Unequal Consequences

60

Indigenous Knowledge Leading the Way

"5% of world's population exist of indigenous people, and their way of life has preserved 80% of the world's biodiversity."

– Raki of West Papua

https://sustainingalllife.org/resources/frontline-voices-video/

61

Extraction

RAW MATERIALS → PRODUCTS → WASTE

62

Regeneration

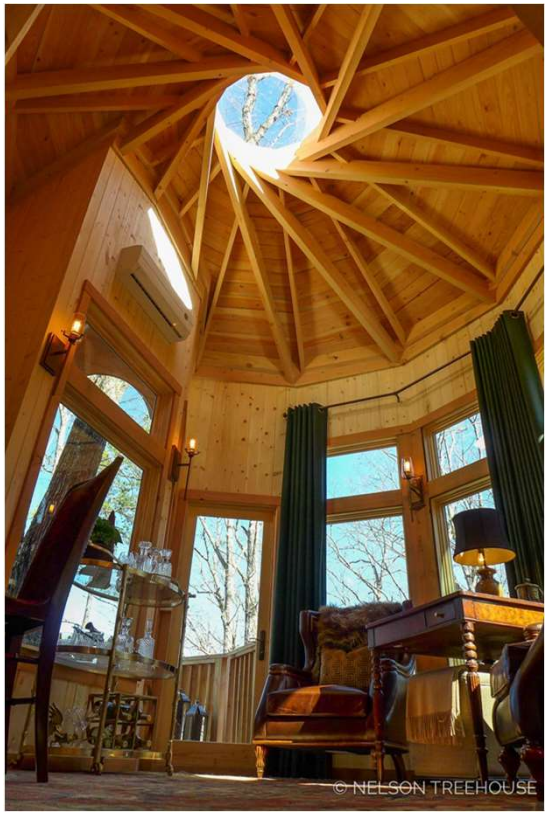
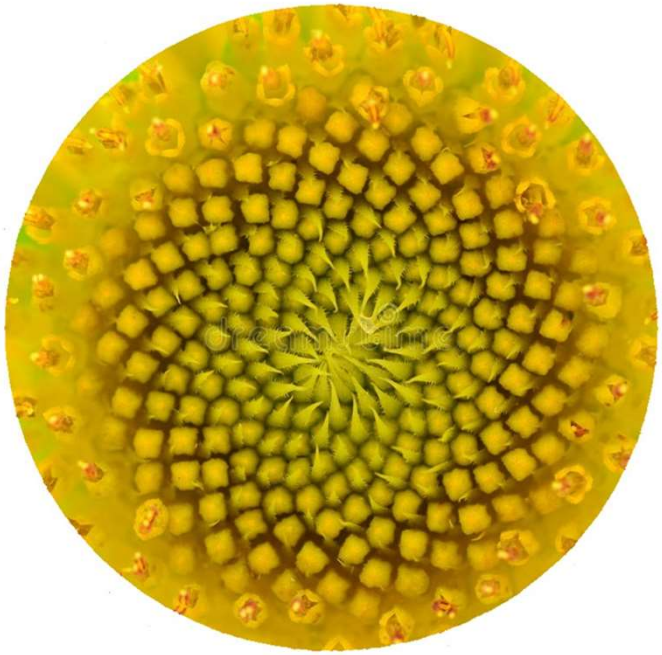


Photo by Nelson Treehouse and Supply



63

Bio-Based =
Supports Local Industry =
Carbon Sequestering =
Non-Toxic…

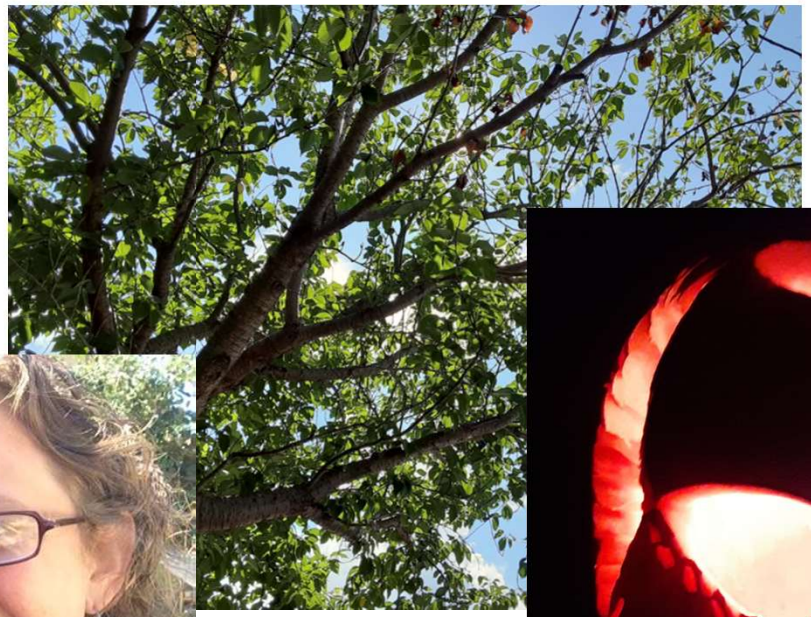

Eve, Elio, Marina, José, and Nacho at the Gryphon Straw Panel fabrication shop at New Frameworks

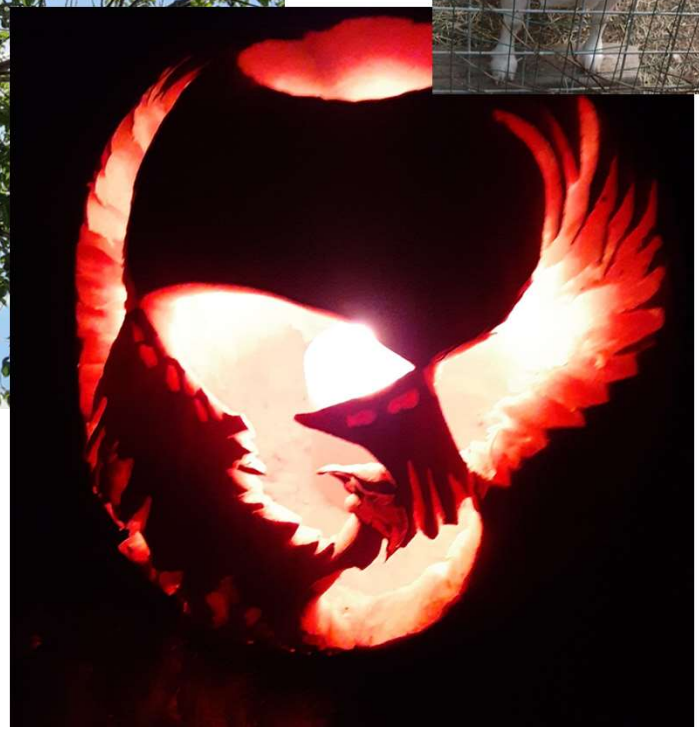
TIMBERHP
by GO LAB
INSULATE BETTER. LIVE BETTER.™

PROCESS:

64

Getting to Be Human





65

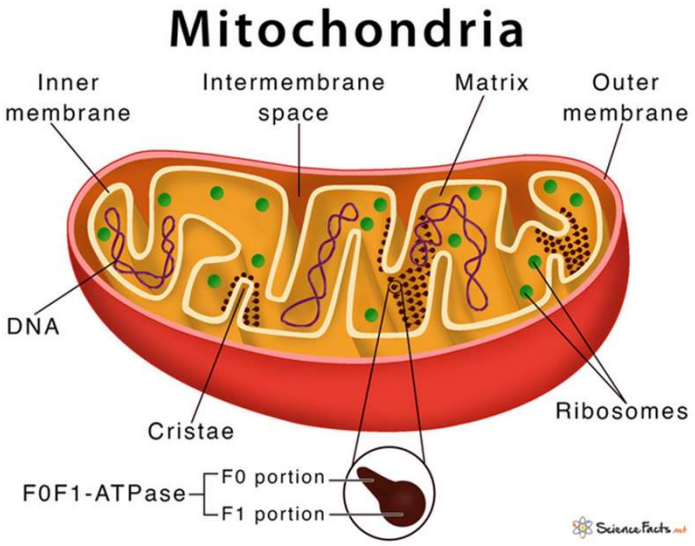
Where Does Value Lie?

66

Resiliency

https://nextcity.org/features/grassroots-movement-puerto-ricos-first-community-owned-solar-microgrid

Energy Is Everything



68

Questions:

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nburger@innovaservices.com

Andy Buccino
Manager - Energy Division
Stephens and Company
AndyB@stephensandcoinc.com

Jacob Deva Racusin
Director of Building Science
and Sustainability
New Frameworks
Jacob@newframeworks.com

Thank You!