Better Buildings Residential Network Peer Exchange Call Series:

Zero Energy Goals and Residential Energy Efficiency: How Are They Fitting Together?

October 22, 2020

Agenda and Ground Rules

- Agenda Review and Ground Rules
- Opening Poll
- Residential Network Overview and Upcoming Call Schedule
- Featured Speakers:
  - **Sam Rashkin** U.S. Department of Energy
  - **Karla Butterfield**, Steven Winter Associates
  - **Paul Torcellini**, National Renewable Energy Laboratory
- Open Discussion
- Closing Poll and Announcements

Ground Rules:

1. **Sales of services and commercial messages are not appropriate** during Peer Exchange Calls.
2. Calls are a safe place for discussion; **please do not attribute information to individuals** on the call.

The views expressed by speakers are their own, and do not reflect those of the Dept. of Energy.

Better Buildings Residential Network

Join the Network

Member Benefits:

- Recognition in media and publications
- Speaking opportunities
- Updates on latest trends
- Voluntary member initiatives
- One-on-One brainstorming conversations

Commitment:

- Members only need to provide *one number*: their organization's number of residential energy upgrades per year, or equivalent.

Upcoming Calls (2nd & 4th Thursdays):

- Nov 12: Conversations with Utility Commissions, Efficiency Programs, and Homeowners – Translating Building Science to the Real World
- Dec 10: A Review of the Historic Past Year in Energy Efficiency

Peer Exchange Call summaries are posted on the Better Buildings website a few weeks after the call

For more information or to join, for no cost, email bbresidentialnetwork@ee.doe.gov, or go to energy.gov/eere/bbrn & click Join

Sam Rashkin

U.S. Department of Energy

U.S. DEPARTMENT OF ENERGY

DOE Zero Energy Ready Home

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Accelerating the Zero Buildings Imperative

SAM RASHKIN

Chief Architect
Building Technologies Office

The Zero Buildings Imperative

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Buildings Share of Total U.S. Energy Use: **40%**

Buildings Share of Total U.S. Electricity Use: **70%**

Fossil Fuel Share of Total U.S. Electricity: **63%**

U.S. Share of Global Population: **4%**

U.S. Share of Global CO2 Emissions: **14% (3.5X)**

Zero Energy Ready Home

Why, What, and How

Why Zero Energy Ready Home?

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Leverage Proven Innovations from DOE Research that can Transform Market to Zero Buildings by 2030	
Homeowners	• Better User Experience • Lower Ownership Cost
Builders	• Superior Customer Satisfaction • Reduced Liability • Market Differentiation
Our Nation	• ~$150 Billion Utility Savings into Economy • ~1 Million Job-Years Employment • ~1+ MMTe Avoided Carbon Emissions • More Resilient Electric Grid

What is Zero Energy Ready Home?

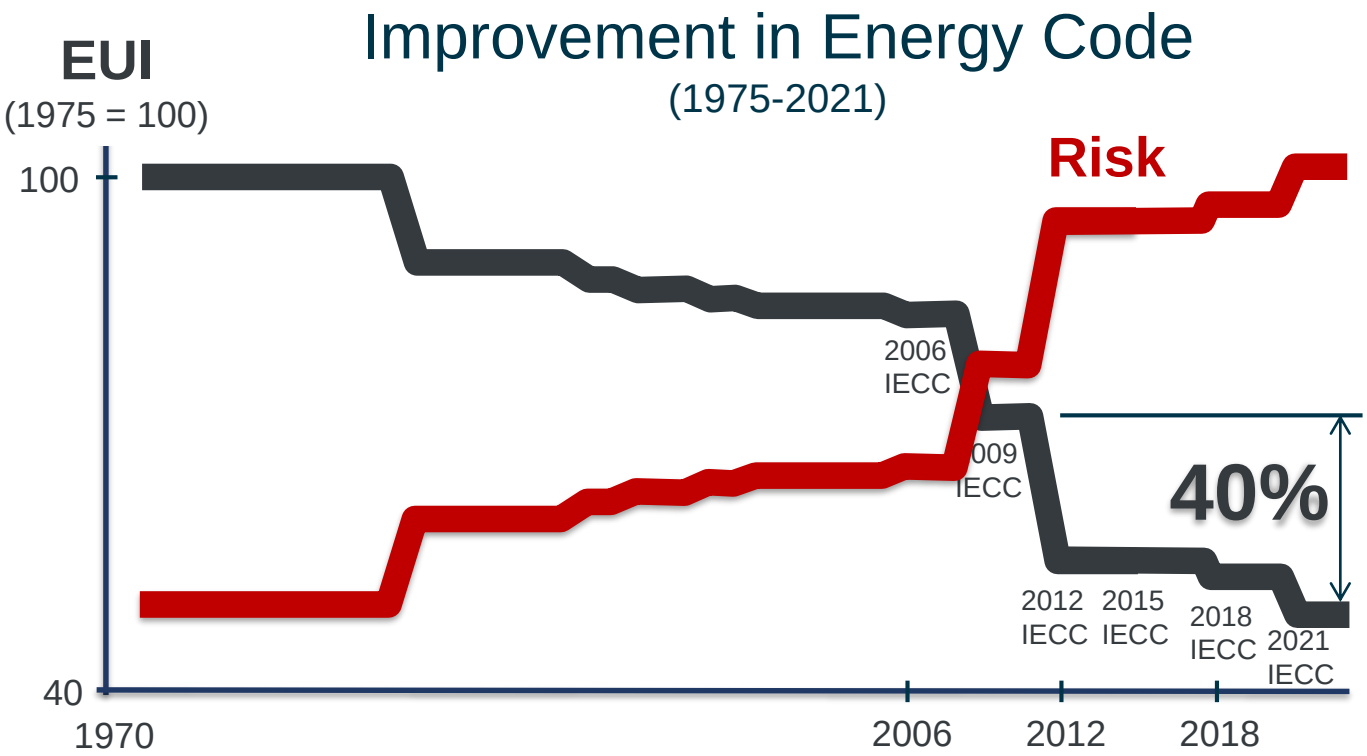


Image Basis: Building Energy Codes Program: National Benefits Assessment, 1992-2040, https://www.energycodes.gov/sites/default/files/documents/BenefitsReport_Final_March20142.pdf

What is Zero Energy Ready Home?

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

A home certification program that optimizes energy efficiency, manages related risks, and help ensure future readiness.

Step One: **Optimize Efficiency**	Step Two: **Do No Harm**	Step Three: **Ensure Future Ready**
Enclosure	**Water Protection**	**Solar Ready**
Equipment	**Ensured Comfort**	**Forthcoming Codes**
Appliances/Lighting	**Indoor Air Quality**	**Resilience** [Future]

ZERO ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY

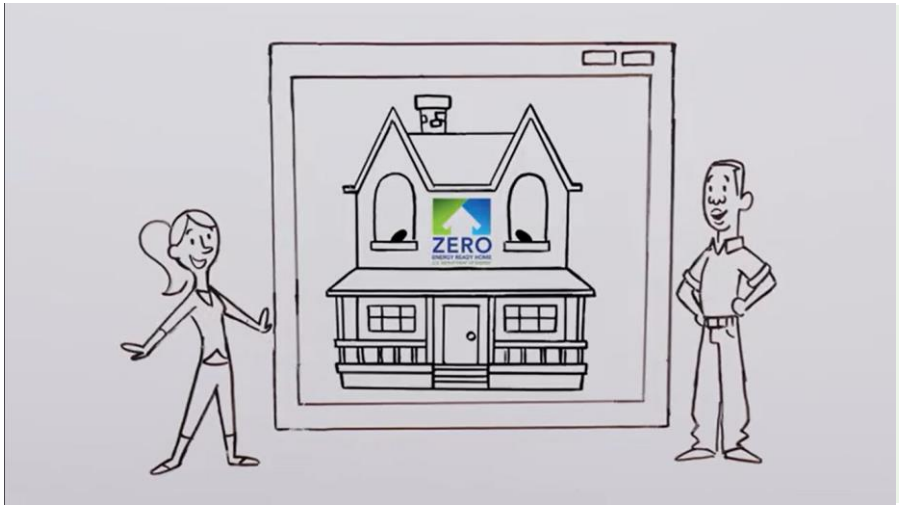
How Zero Energy Ready Home?

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Build Upon Existing Infrastructure:

- Verification
- Labeling

How Zero Energy Ready Home?

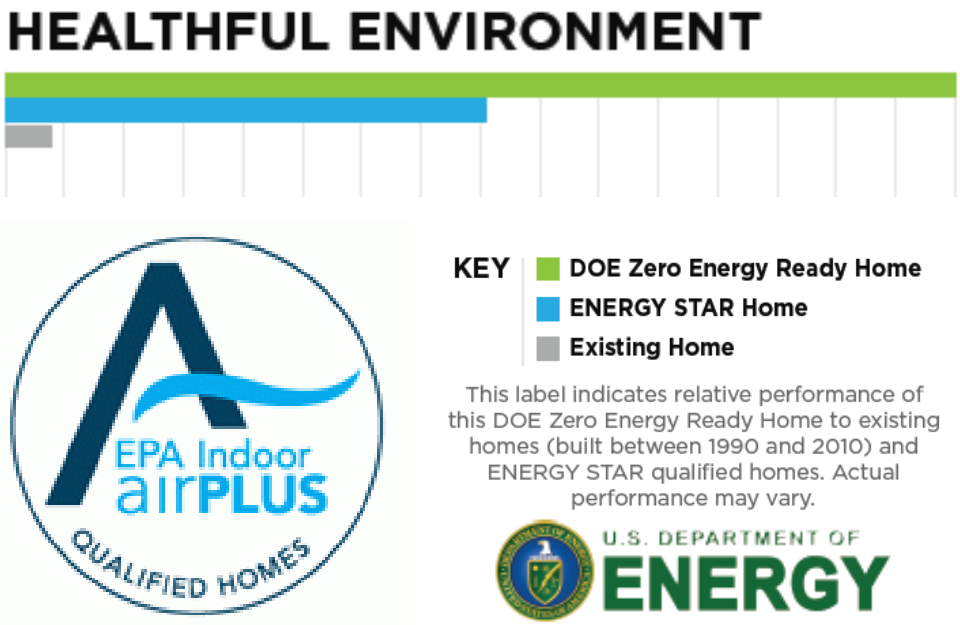


Communicate ‘Why’:

- Live Better
- Live Healthy
- Live Future Ready

How Zero Energy Ready Home?

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy



Clarify 'Why':

- Contrast
- Simple

How Zero Energy Ready Home?

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

DOE Tour of Zero: Eco2 by BrightLeaf Homes

"We threw away our kids inhalers…Priceless!"

Prove 'Why':

- Showcase
- Testimonials

How Zero Energy Ready Home?

Trust 'Why':

- Certification
- DOE

Zero Energy Ready Home

Path to Zero Carbon

Path to Zero Carbon: Key Concept

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

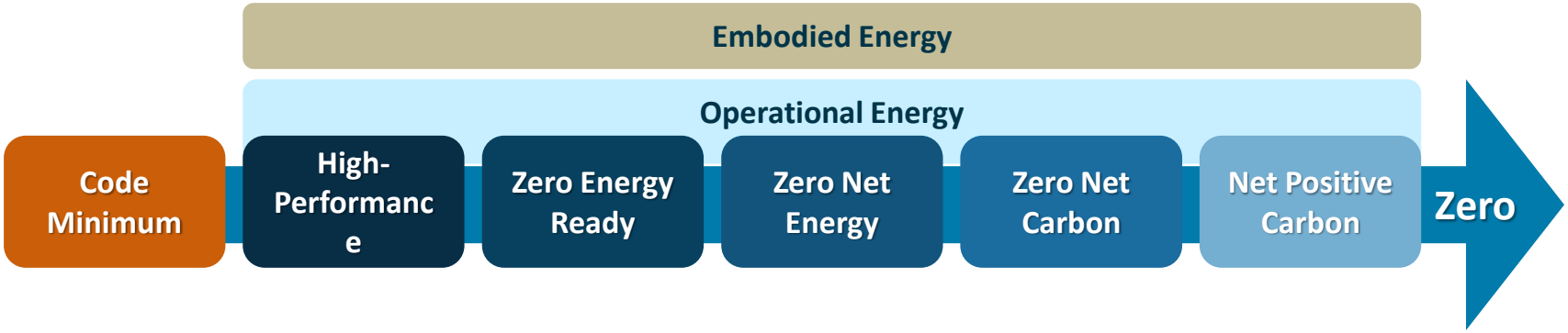
Zero is a Journey

Path to Zero Carbon: Key Factors

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

High-Performance	• Building Science • Indoor Air Quality • Water Conservation • Grid-Interactive • Resilience
Annual Energy Consumption	• Electricity with Fossil Fuel • All-Electric
Renewable Energy	• On-Site • Micro-Grid • Utility • Offsets
Embodied Energy	• Extraction • Production • Transportation • Installation • Maintenance • End-of-Life

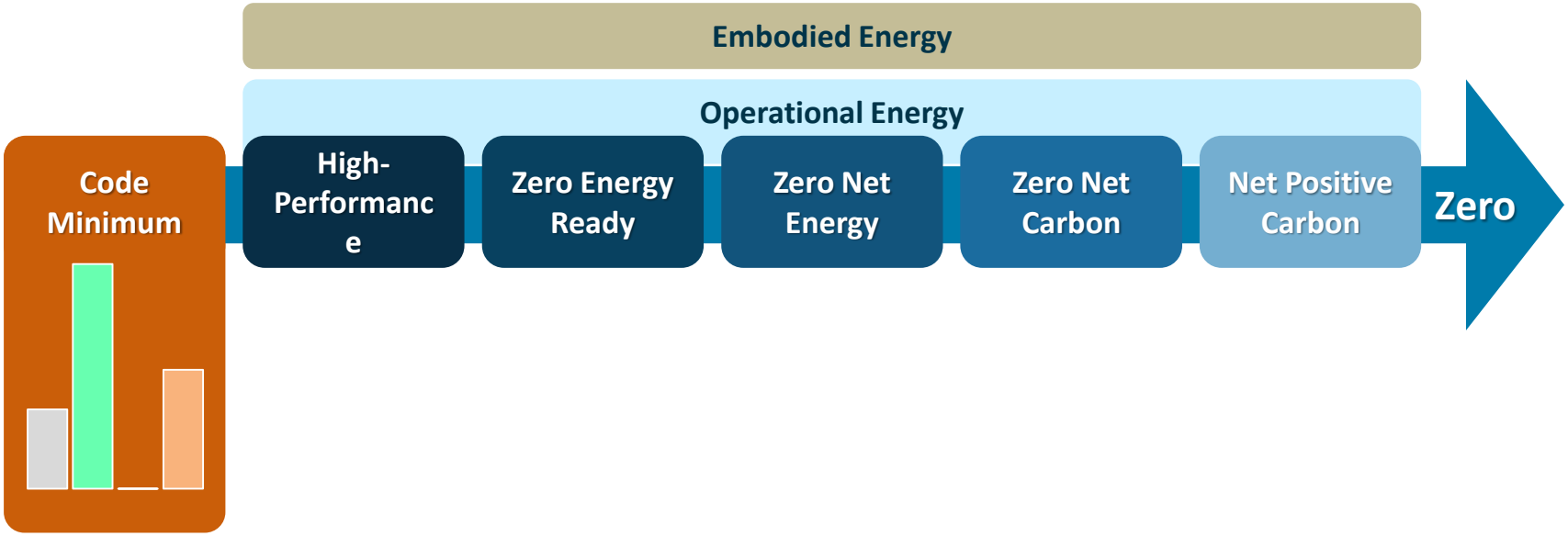
Path to Zero Carbon: Zero Steps



Key

High-Performance | Annual Energy w/Fossil Fuel | Annual Energy w/o Fossil Fuel | Renewable Energy | Embodied Energy

Path to Zero Carbon: Key Steps



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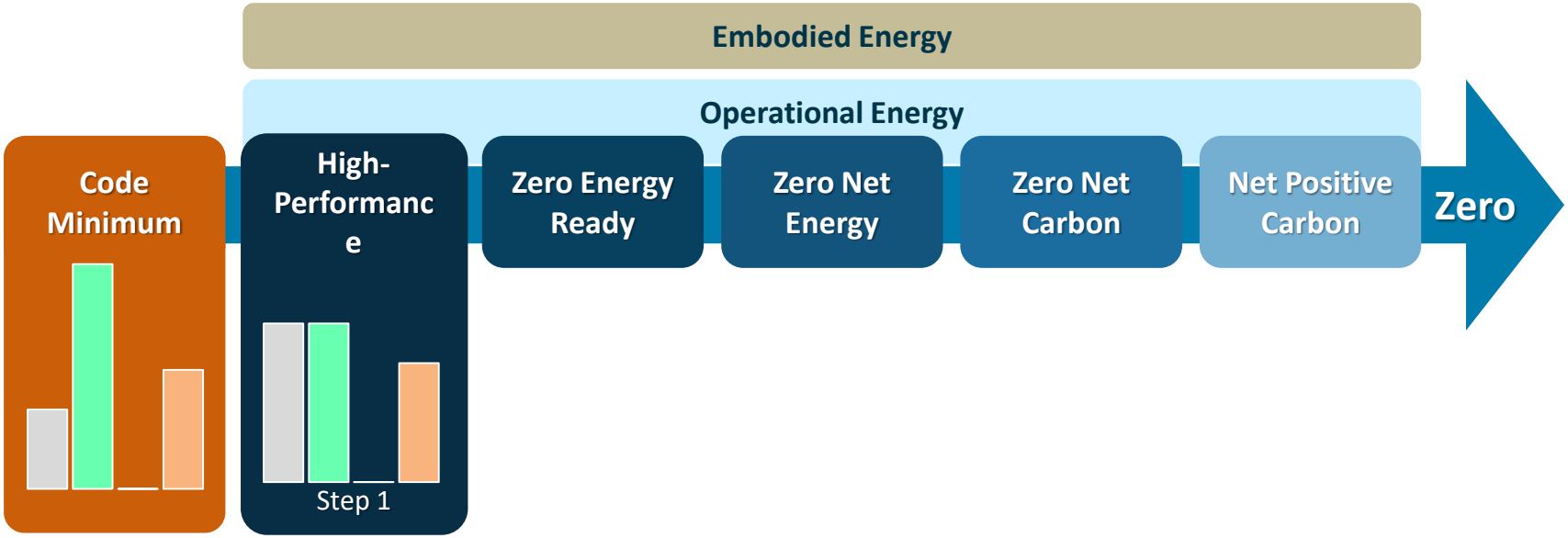

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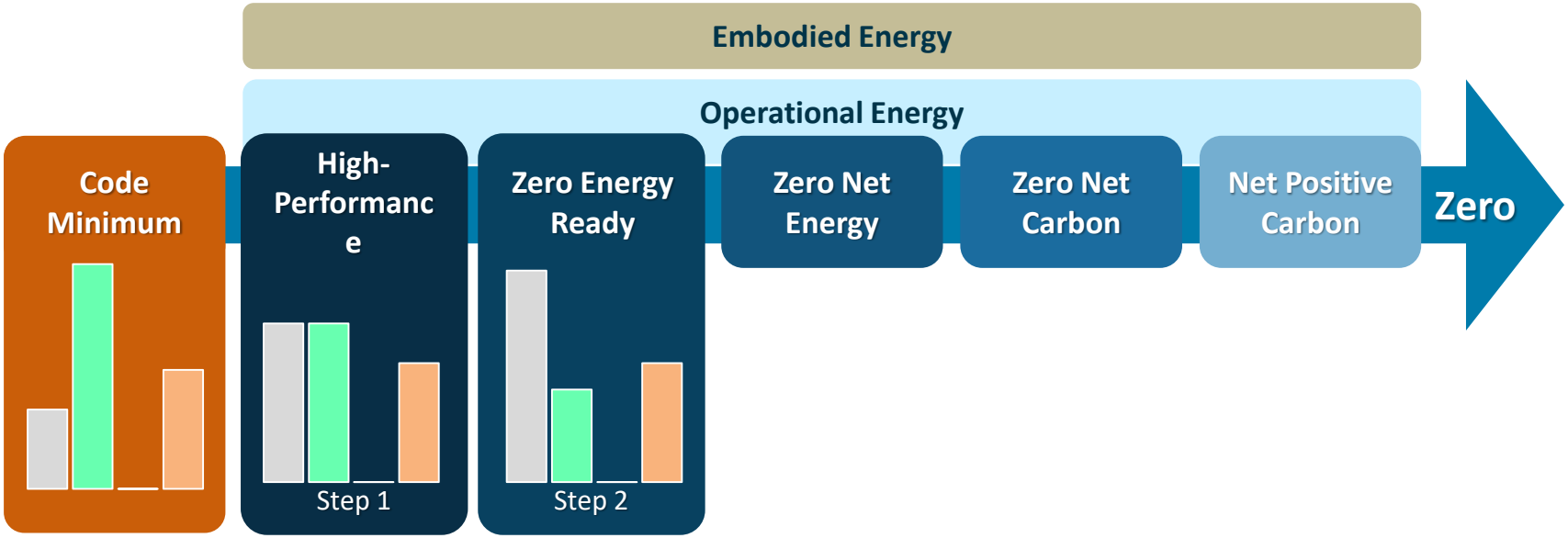
Path to Zero Carbon: Key Steps



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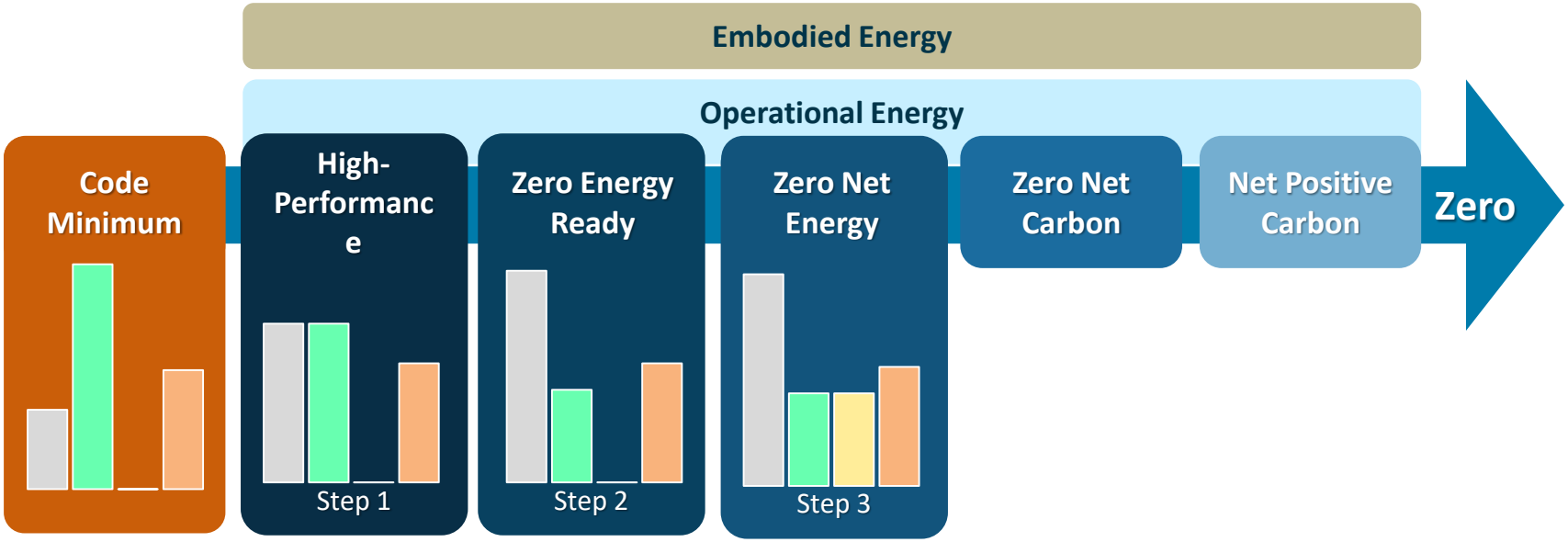
Path to Zero Carbon: Key Steps



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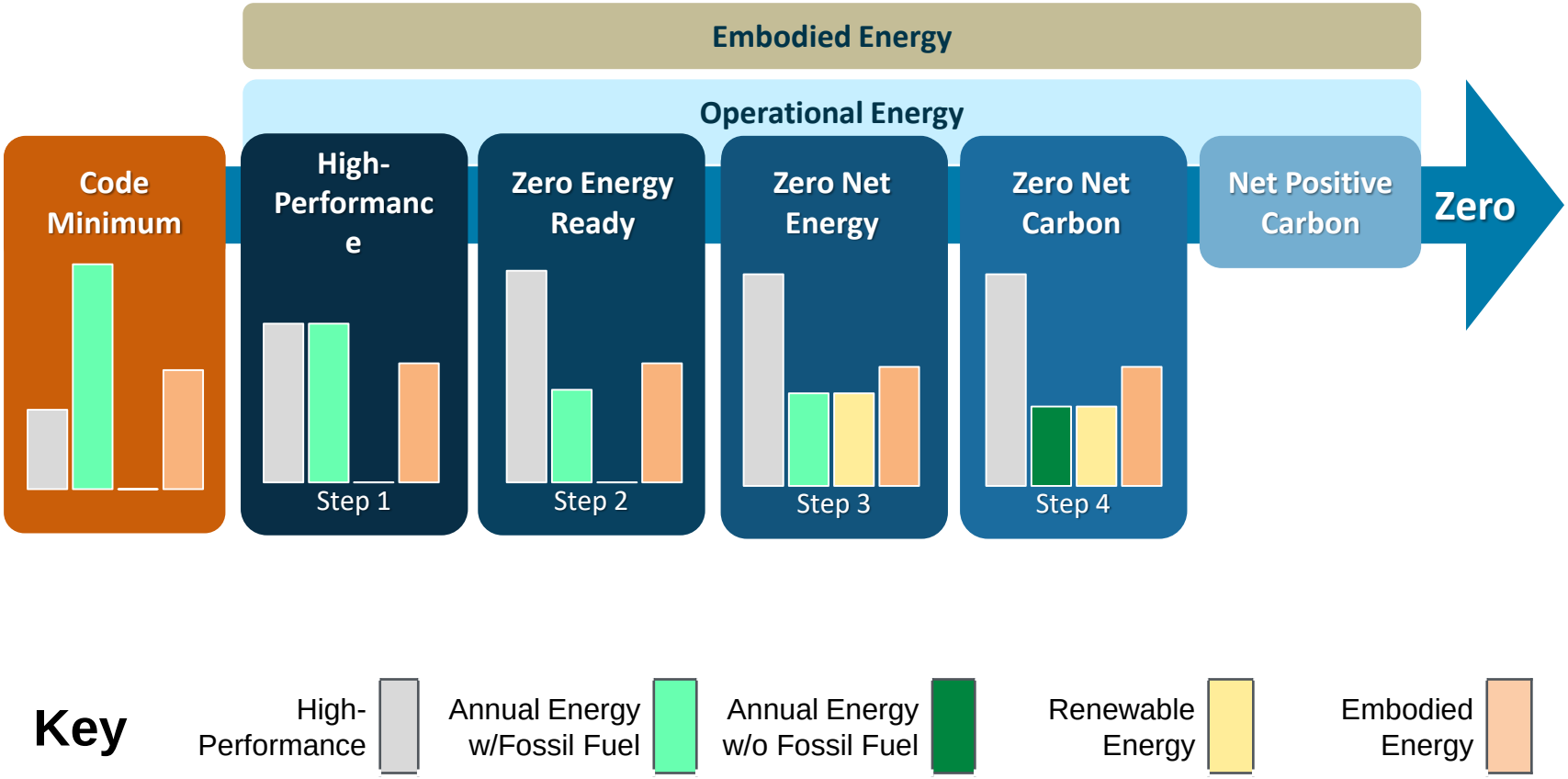
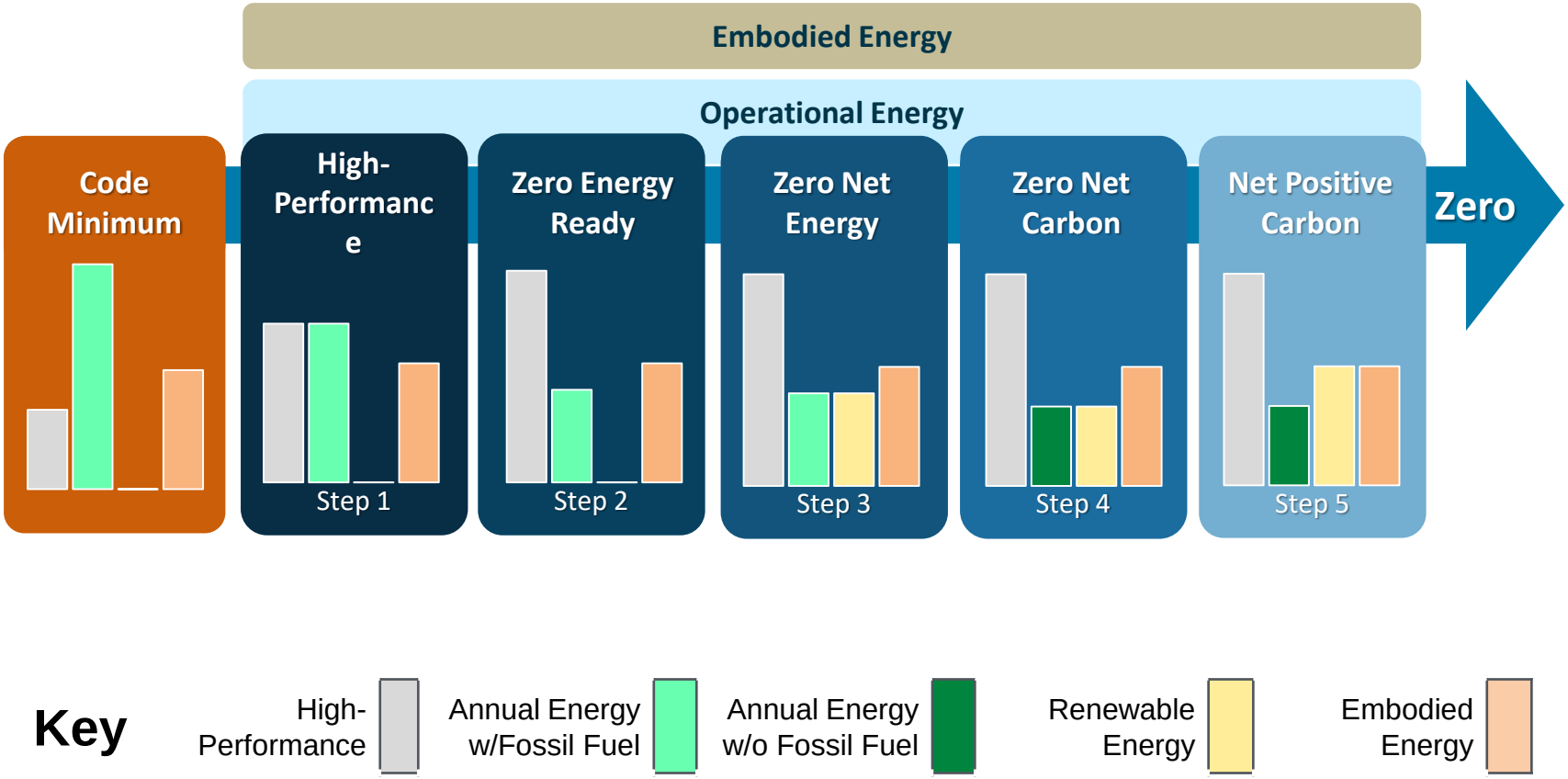
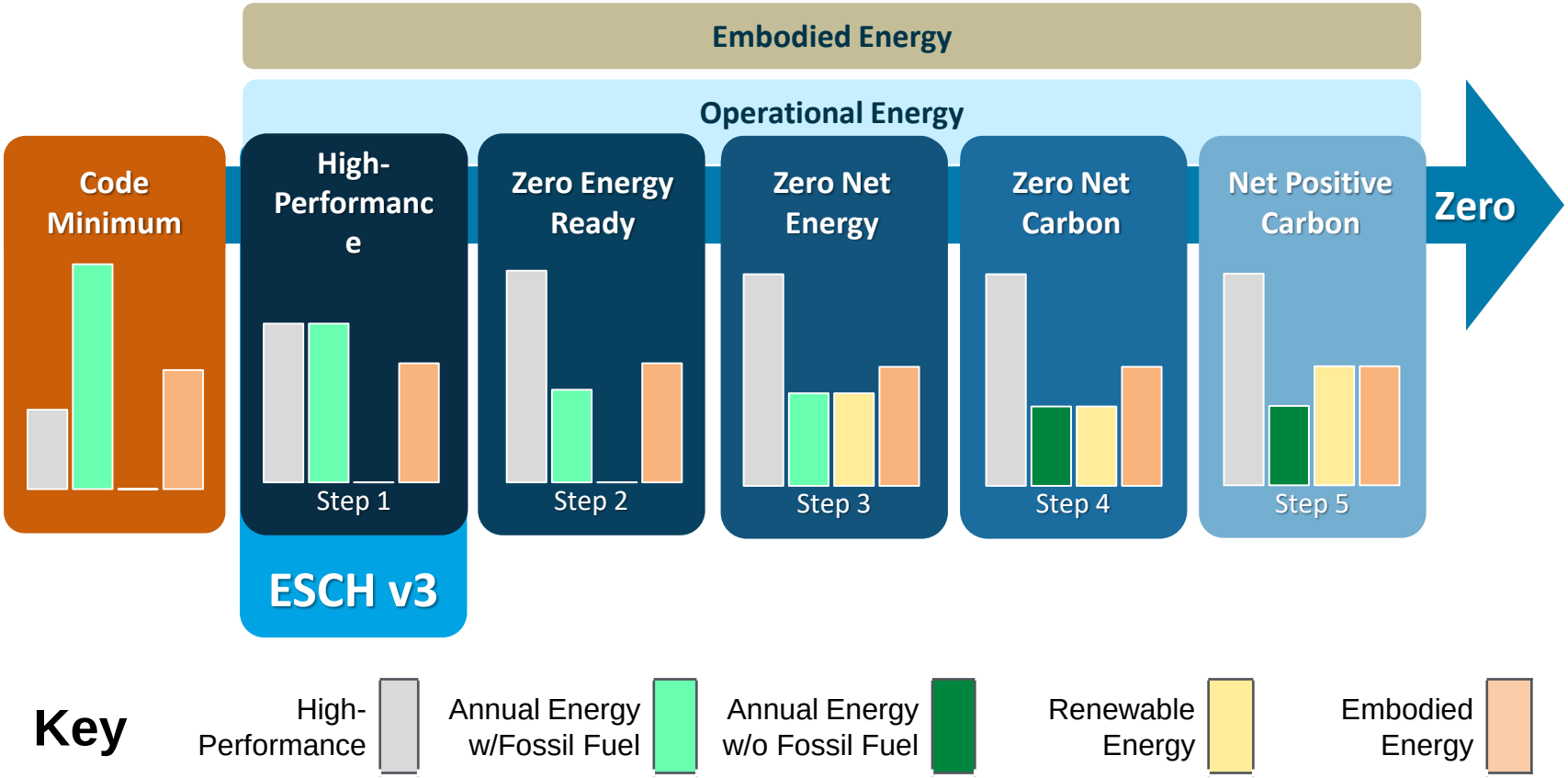
Path to Zero Carbon: Key Steps



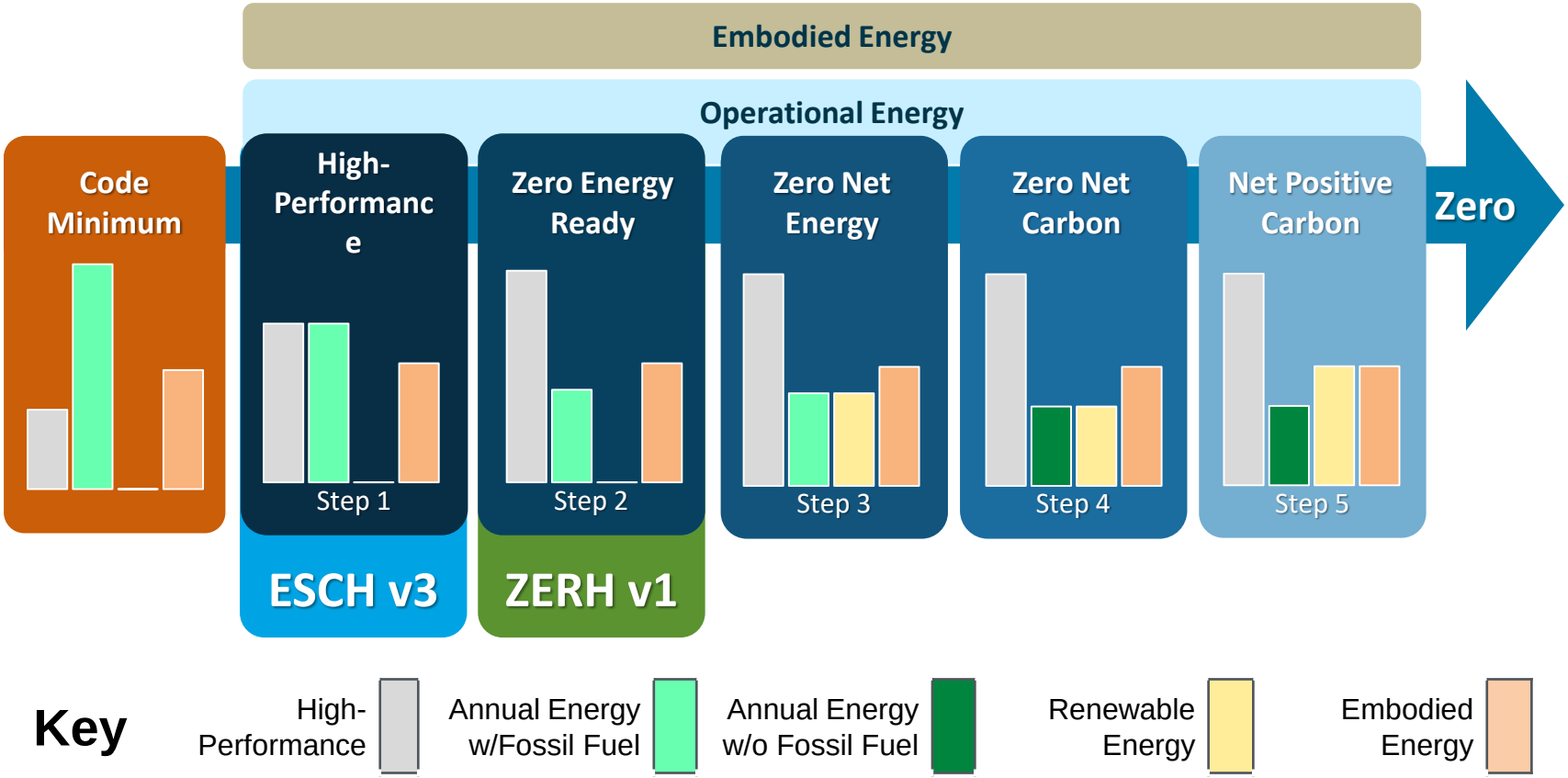
Path to Zero Carbon: Key Steps



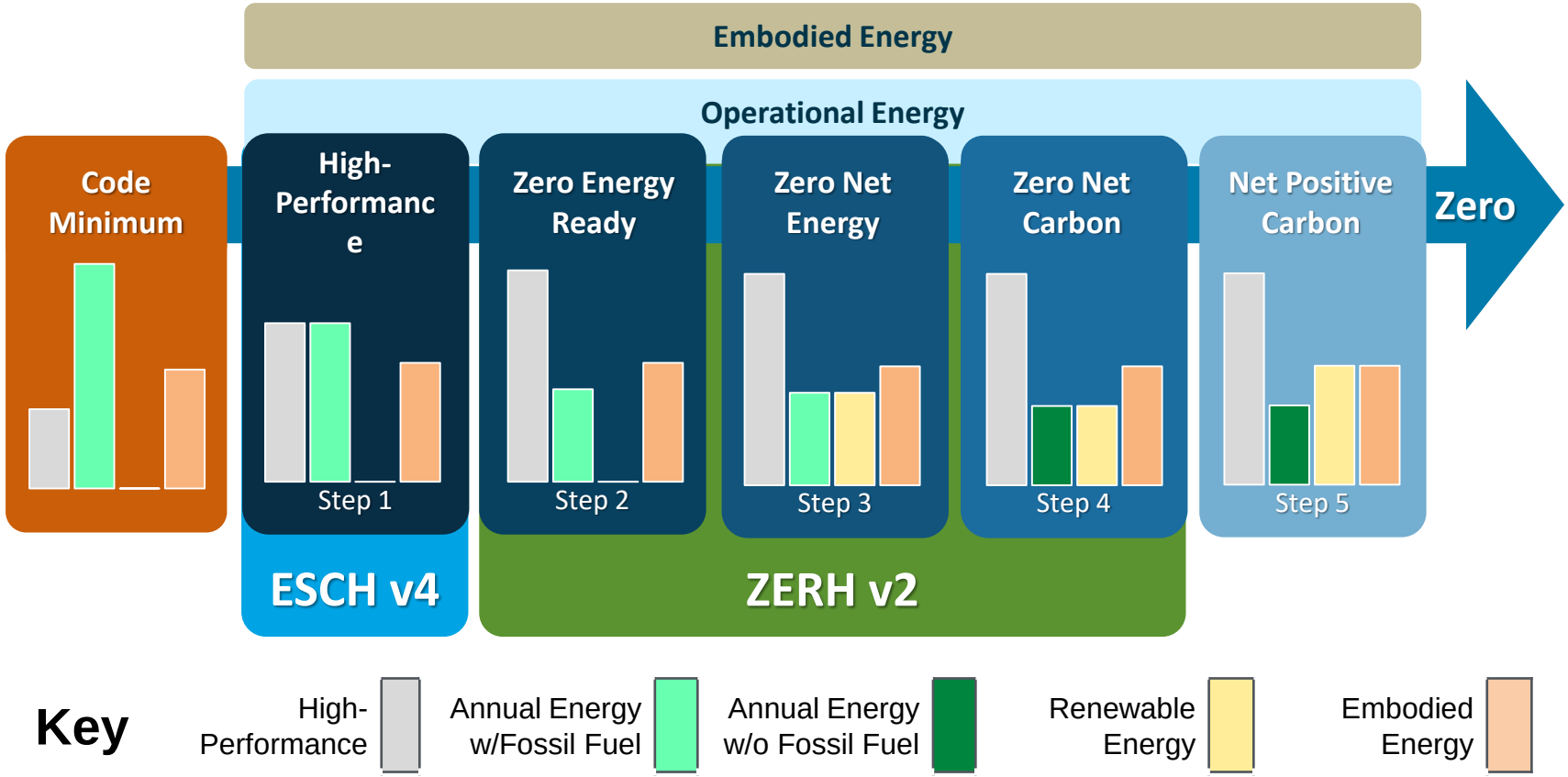
Path to Zero Carbon: Key Steps



Path to Zero Carbon: Key Steps



Path to Zero Carbon: ZERH v2 Concept



Path to Zero Carbon: ZERH v2 Concept

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

ZERH v1

ZERO
ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY

ZERH v2

ZERH v1
+ U.S. DOE Brand
+ 2021 IECC
+ Targeted Innovations

U.S. DOE ZERO READY HOME

+ **Zero Energy**

U.S. DOE ZERO ENERGY HOME

+ **All-Electric**

U.S. ZERO CARBON HOME

www.buildings.energy.gov/zero/

- Become a Partner
- Program Specs
- DOE Tour of Zero
- 24+ Recorded Webinars
- Marketing Took Kit

ZERO
ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY

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Karla Butterfield
Steven Winter Associates

U.S. DEPARTMENT OF ENERGY

Zero Energy Goals & Residential Energy Efficiency

Steven Winter Associates, Inc.

Since 1972, Steven Winter Associates, Inc. has been providing research, consulting, and advisory services to improve the built environment for private and public sector clients.

Our services include:

- Energy Conservation and Management
- Sustainability Consulting
- Green Building Certification
- Accessibility Consulting

We have over 125 staff across four office locations:
New York, NY | Washington, DC | Norwalk, CT | Boston, MA
AND WE'RE HIRING

For more information, visit
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Daniels Lane

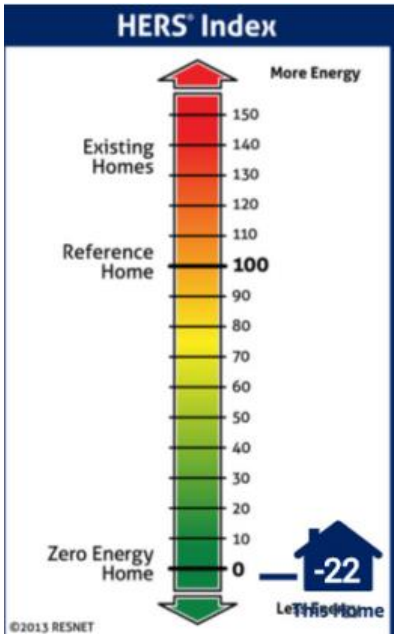
Thermal Envelope

- R20 Slab on Grade
- R34 SIPS Walls
- R45 SIPS Roof
- U 0.18 & 0.29 SHGC Windows

Mechanicals & Appliances

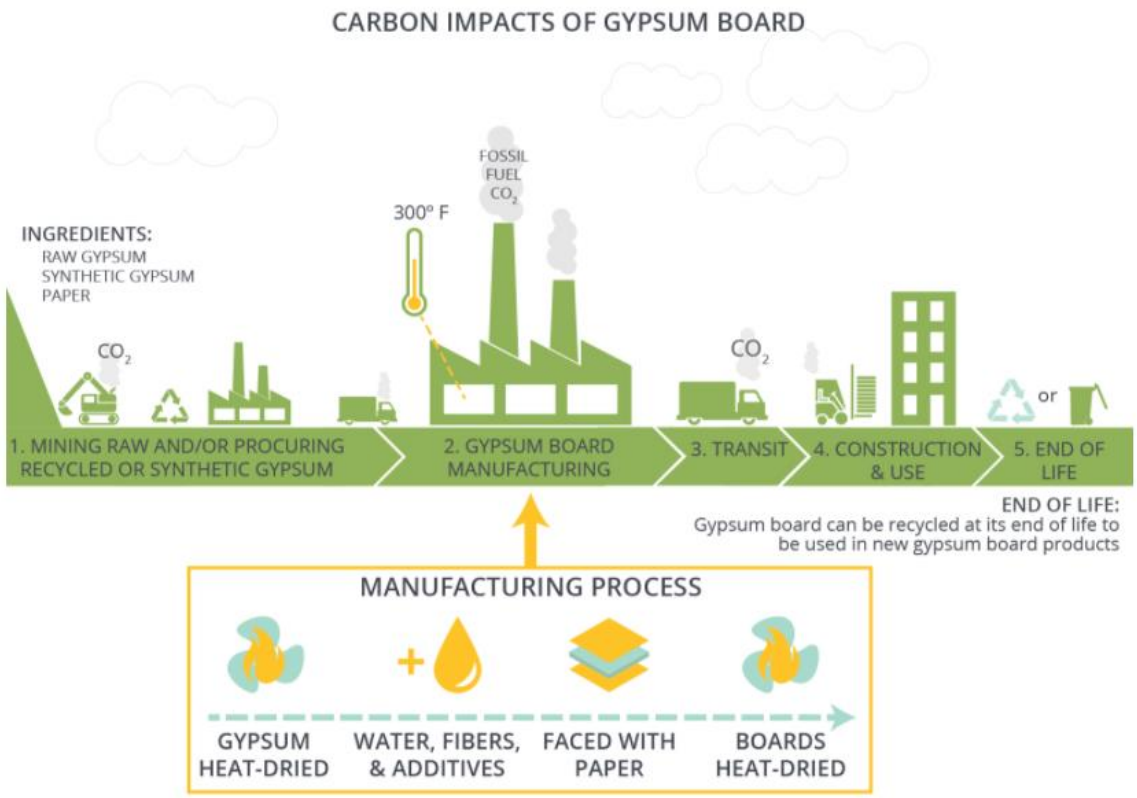
All Electric and Achieving Zero

	Use [MBtu]	Annual Cost
Heating	9.4	$497
Cooling	0.8	$41
Hot Water	2.6	$137
Lights/Appliances	15.3	$807
Service Charges		$240
Generation (e.g. Solar)	44.3	-$1,482
Total:	**28.1**	**$240**



Embodied Carbon Reduction

Embodied Carbon Reduction



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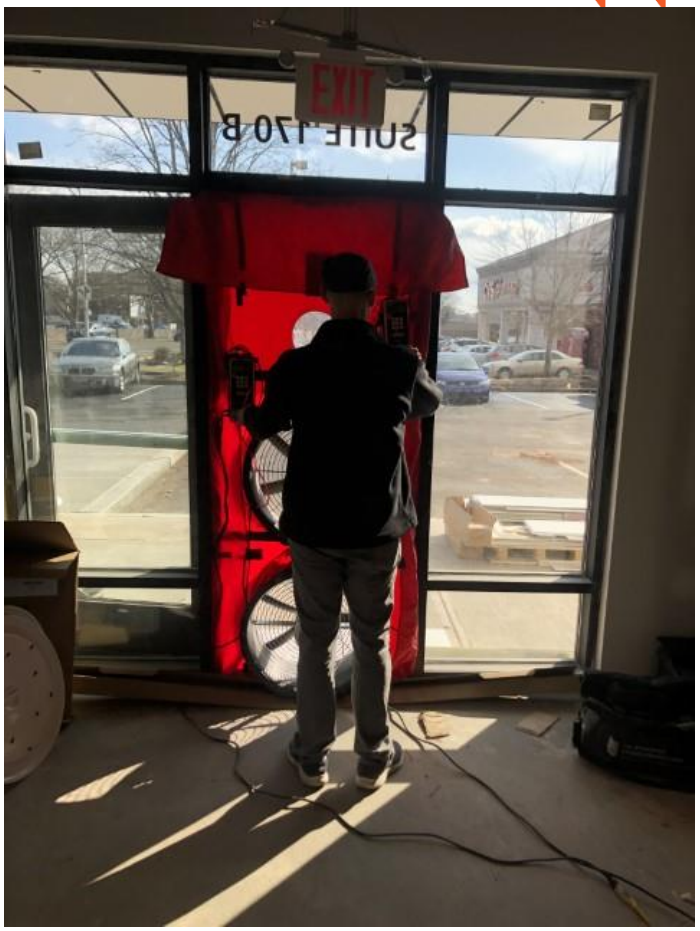
Thermal Envelope

Thermal Envelope

- R21 Cavity + R13 CI Walls
- R31 CI Roof (insulated drains)
- U 0.20 & 0.22 SHGC Windows

Mechanicals & Appliances

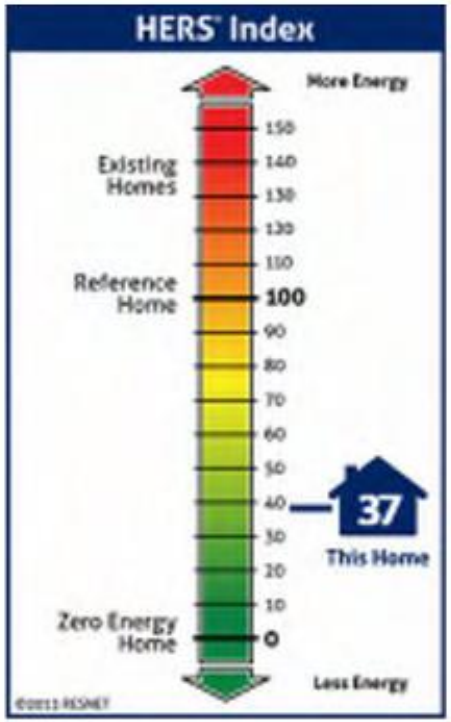
Mechanicals & Envelope



Reaching Zero

	Use [MBtu]	Annual Cost
Heating	2.3	$147
Cooling	0.4	$27
Hot Water	5.8	$84
Lights/Appliances	11.1	$712
Service Charges		$477
Generation (e.g. Solar)	0.0	$0
Total:	**19.6**	**$1,446**

Total Tenant Cost $113.50/mo



The Renovation of the Cargill Falls Mill
Putnam, CT

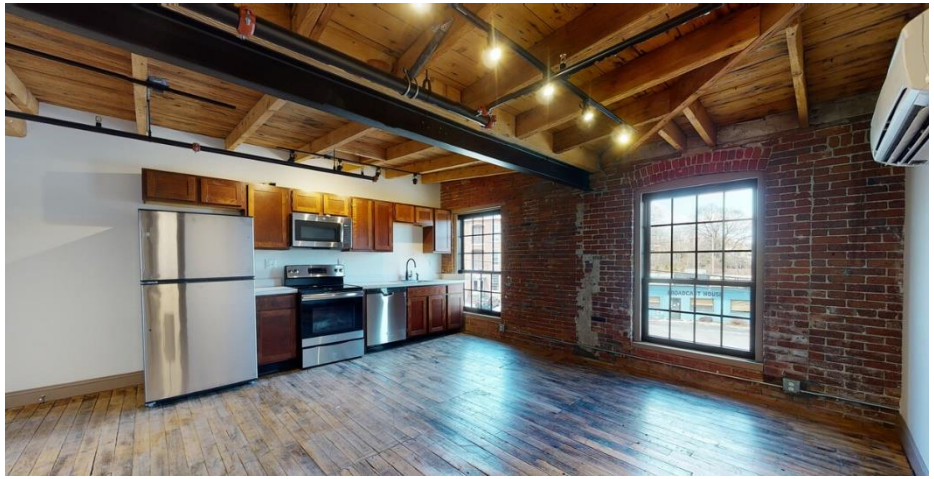
Aka, The Wilkinson Mill

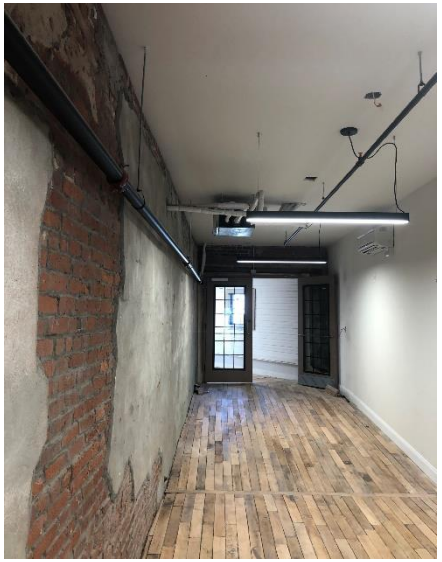
- Textile Mill, est.1806
- In 1850 the early stone mills contained 4,260 spindles & 105 looms
- Worked by 60 men & 45 women
- Expanded & modified in the mid 19th century to a twenty-building complex
- Representing more than 178 years of mill architecture

The Lofts Cargill Falls Mill

- Bldg 7, 21, 22 – 3 story – 36 units
- Bldg 4, 5, 6 – 4 story – 28 units
- Bldg 3– 5 story – 14 units
- Bldg 16– 5 story – 3 units

105,863 sf of meandering buildings with 83 residential units and commercial space

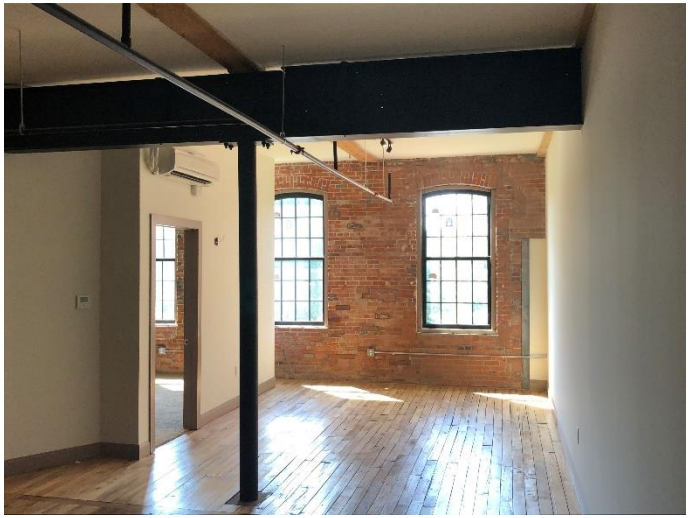




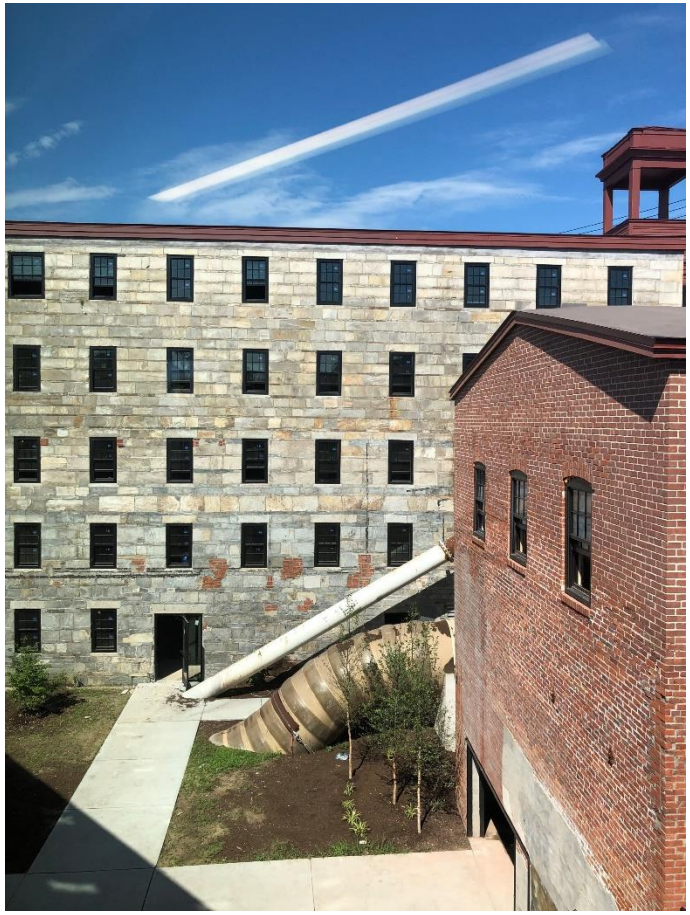
THE RENOVATION OF CARGILL FALLS MILL

- All Electric
  - DHW – Heat Pump Water Heaters
  - VRV Heating & Cooling
  - In-unit Heat Pump Dryers
  - Putnam Green Power, LLC
    - 2 refurbished hydroelectric turbines generate

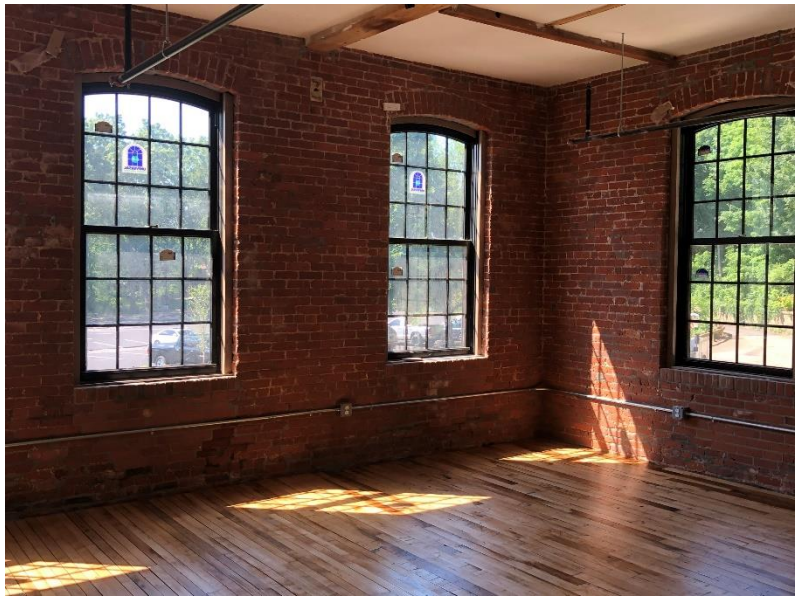
    2,550,000 -3,000,000 kWh/yr



Challenges



- SHPO (State Historic Preservation Office)
  - Insulation
  - Air Sealing (limited penetrations)
    - Central ERVs
    - Heat Pump Dryers
  - Windows



Zero Energy Goals

- Water Savings from Baseline ~50%

Interior Water Usage		BEFORE Remodel				AFTER Remodel			
	Fixture	# of uses per week	flow rate (gpm/gpf)	gallons per use		# of uses per week	flow rate (gpm/gpf)	gallons per use	
Kitchen	Sink faucet	196	2.6	2.6	509.6 gal.	196	1.6	1.6	313.6 gal.
	Dishwasher	5	3.5	3.5	17.5 gal.	5	6.0	6.0	30.0 gal.
Bathroom #1	toilet	42	1.6	1.6	67.2 gal.	42	1.3	1.3	53.8 gal.
	shower	28	2.5	17.6	492.8 gal.	28	2.2	14.0	392.0 gal.
	sink #1	56	2.2	3.3	184.8 gal.	56	1.2	1.5	84.0 gal.

- Energy Savings from Baseline ~ 67.7%
  - HPWH 3.24 EF vs. Electric Tank .93 UEF
  - VRF 4COP, 25 SEER vs. 7.5HSPF,10SEER
  - ERV vs. Exhaust Only
  - Infiltration – no credit taken

- Annual Cost without Hydro ~ $1824
- Annual Cost with Hydro ~ $1274

Zero Energy Goals & Residential Energy Efficiency

- Thermal Envelope First
- All Electric When Possible
- Don’t Forget Filtration, MERV 13 is the Goal
- Address Embodied Carbon in Building Materials

Paul Torcellini
National Renewable Energy Laboratory

U.S. DEPARTMENT OF
ENERGY

NATIONAL RENEWABLE ENERGY LABORATORY

Living at Zero—Experiences in moving towards an all renewable energy lifestyle

DOE Better Buildings Residential Network

Paul A. Torcellini, Ph.D., P.E.
Principal Engineer, NREL
Paul.Torcellini@nrel.gov

Advanced Energy Design Guides

Six 30% Guides published
(2004-2008)
Highway Lodging, K-12 Schools, Small Hospitals and Healthcare Facilities, Small Office Buildings, Small Retail Buildings, Small Warehouses and Self Storage

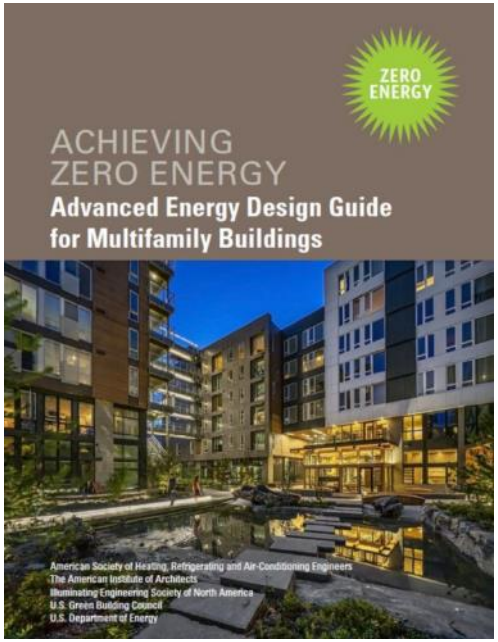
Five 50% Guides published
(2009-2013)
Grocery Stores, K-12 Schools, Large Hospitals, Small to Medium Office Buildings, Medium to Big Box Retail Buildings

Two Zero Energy Guides Published
(2018-current)
K-12 Schools
Small/Medium Offices
Multifamily (expected late Fall 2020)

As of October 4, 2020

All versions (13 total)
657,412 downloaded
26,582 distributed in print
683,994 total
171,029 registrants account for free AEDG downloads

ZE
K-12: 11,119 copies (January 2018)
SMO: 5,411 copies (June 2019)



- Industry partnership with top professional organizations and DOE, with oversight and constant validation process with industry experts
- Specialized volunteer experts on the Project Committee for each guide, representing the different professional organizations
- Supported by and leveraging DOE's national laboratory research, energy simulation, and technical analysis

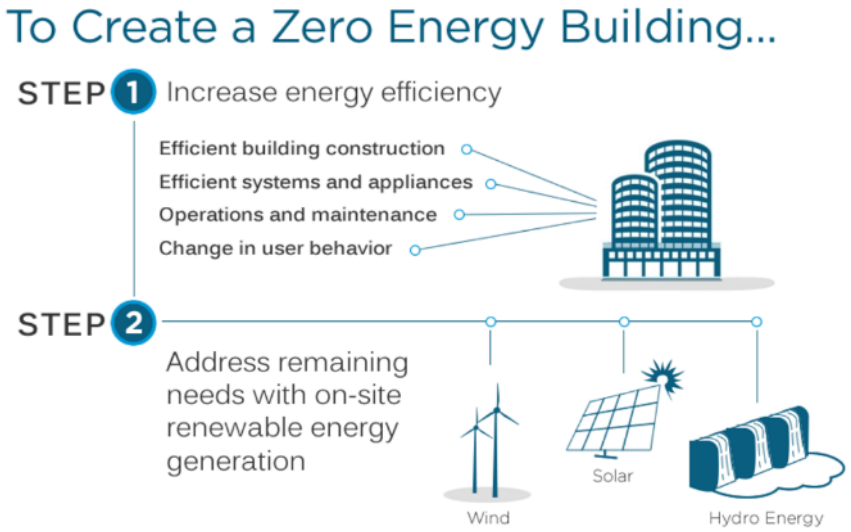
www.ashrae.org/aedg

Changing Buildings

From Consumers to Producers…

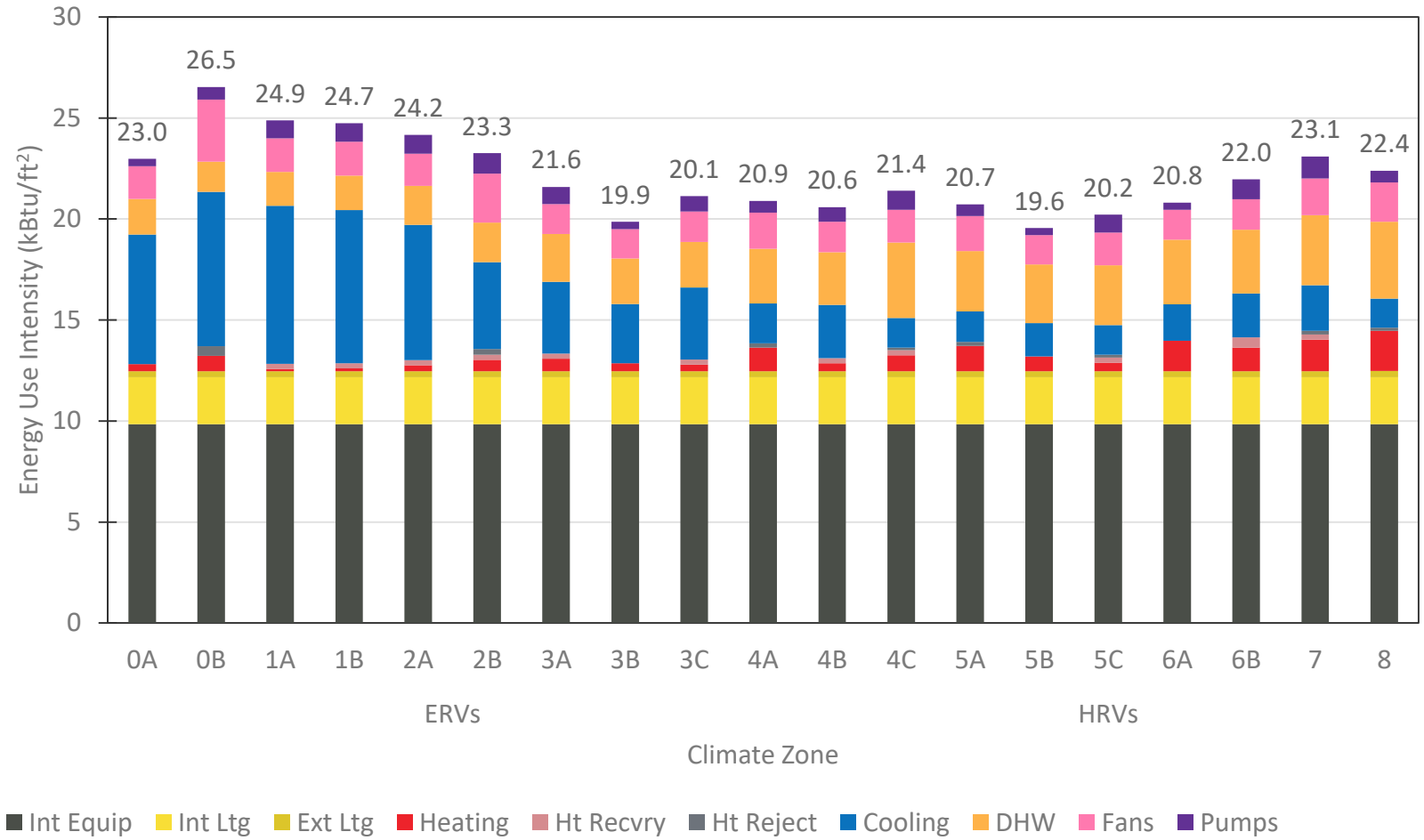
An energy-efficient building, where on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy.

Zero Energy Buildings



Optimization of EUI reduction through efficiency and PV system capacity

Site EUI Targets by Climate Zone



Making Decisions

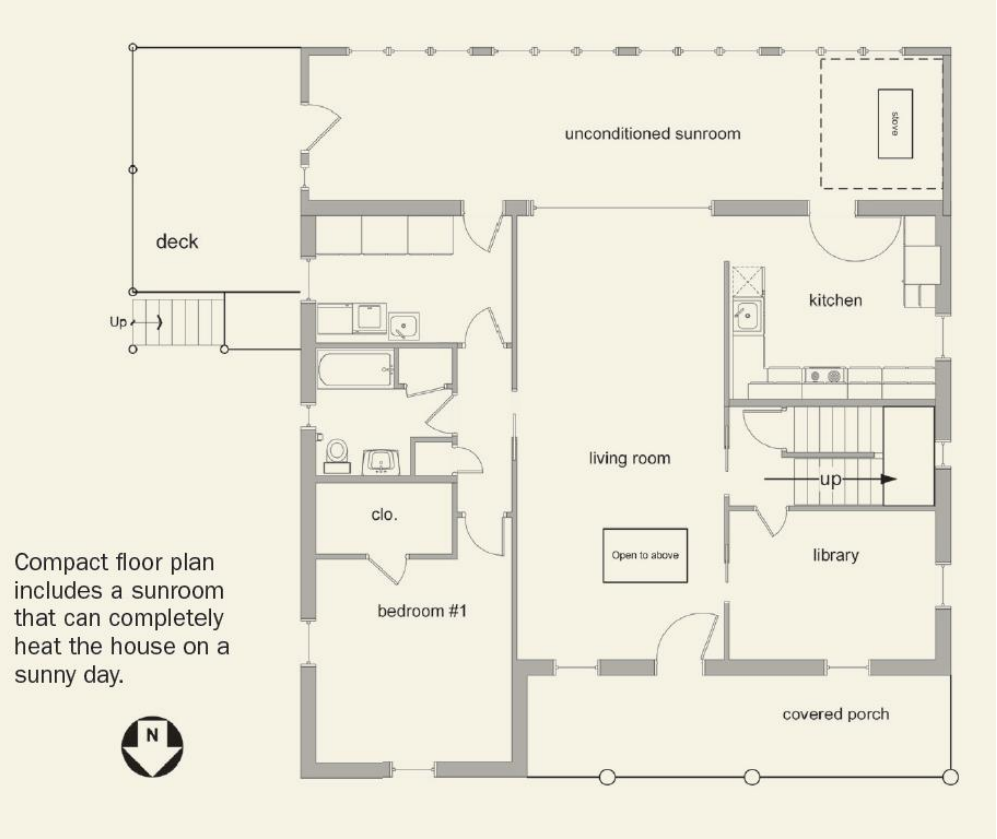
- How do we make decisions?
- What is the cost and value of making those decisions?
- How broadly can we look at making those decisions?
- How willing are we to change?

- Walking the talk—the discussion changes when it is your own money!

Torcellini Residence

- Northeastern Connecticut
- HERS rating of 2
- Part of the Eversource Zero Energy Challenge

Floor Plan



Compact floor plan includes a sunroom that can completely heat the house on a sunny day.

Framing

Insulation

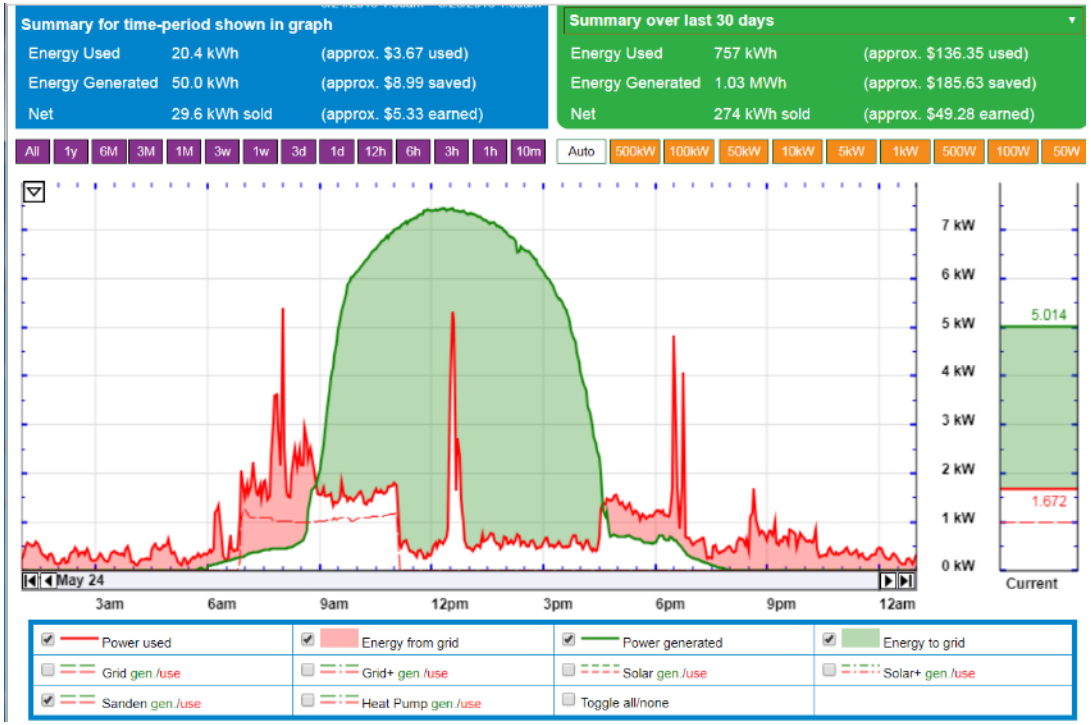
HVAC

- A/A heat exchanger
- Ductwork
- Humidity

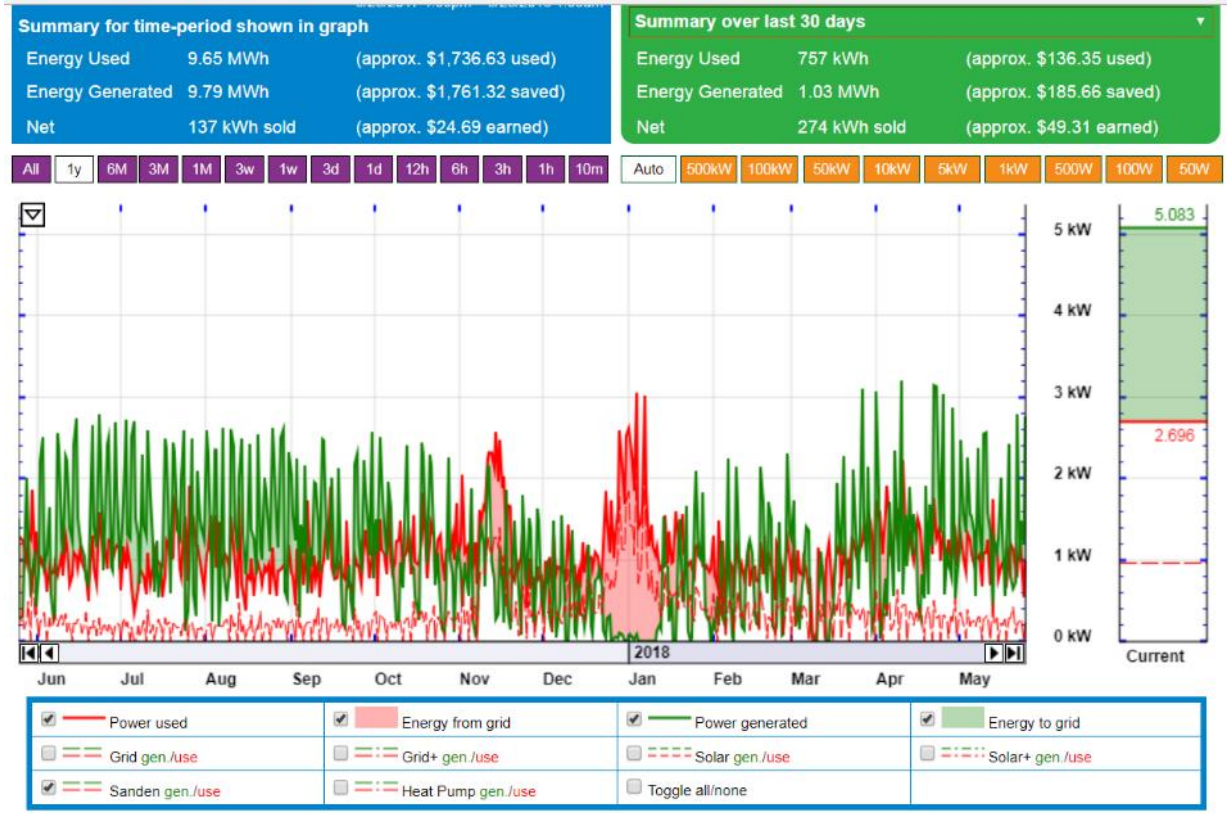
Non-energy Aspects

PV and the Roof System

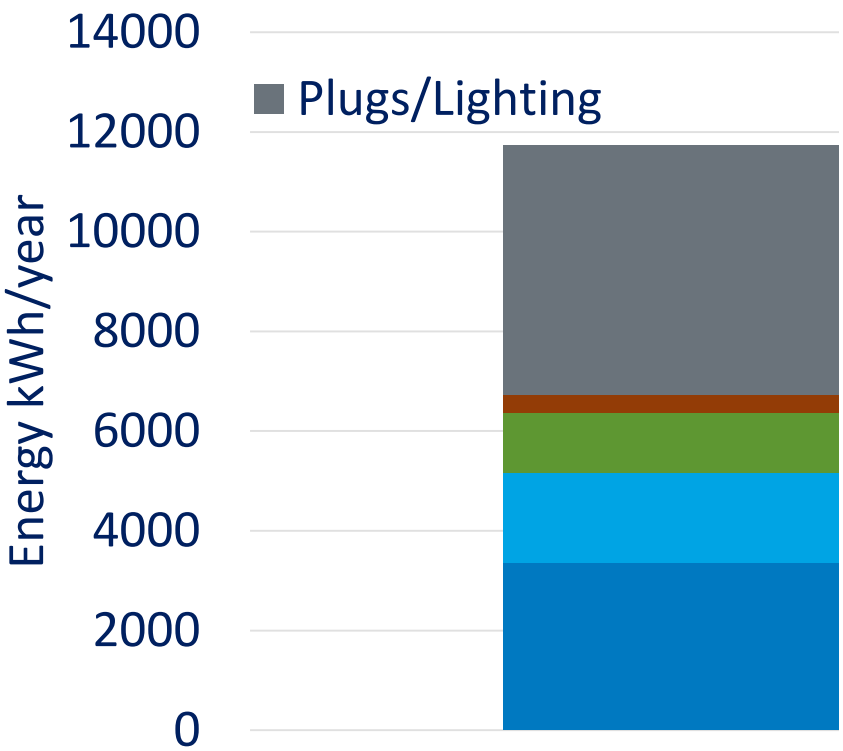
Energy Monitoring



Energy Monitoring



2017 Energy Totals



End Use	2017 Totals (kWh)	Estimate from HERS (kWh)
Heating/Hot Water	5,161	6,272
Cooling	0	1,172
Plug Loads	6,573	7,562
Total	**11,734**	**15,006**
PV	9,896	12,368

Using the conditioned area, the EUI is 11.1 kBtu/ft^2·yr on a site basis and 35.1 kBtu/ft^2·yr on a source basis.

Big Lessons

- Set the budget, set the energy goals (such as zero)
- Envelope, envelope, envelope
- Envelope testing
- HVAC to match—should be minimal
- Overlap value wherever possible
- Hold people accountable for their performance (select the right contractors)
- Have measured data to prove results

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www.nrel.gov

This work was authored in part by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Building Technologies Office. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

New Virtual Sessions from Solar Decathlon on Innovative Homes and Energy Careers

The Solar Decathlon announced a new webinar series starting in September that will include virtual tours of innovatively designed homes and address a variety of topics from the rise in zero energy homes to clean energy careers.

U.S. DEPARTMENT OF ENERGY
SOLAR DECATHLON

Upcoming DOE Solar Decathlon Virtual Sessions

Register for Upcoming Sessions and Watch Prior Sessions at solardecathlon.gov/virtual_sessions.html

- **A Virtual Hands-On Energy Workshop for Families**
  Wednesday, November 18, 2020, 1–2 p.m. E.T.

- **Solar Student Leaders of Tomorrow Showcase**
  Wednesday, December 16, 2020, 1–2 p.m. E.T.

- **Resilient Home 411: Strategies to Weather and Recover from Natural Disasters**
  Wednesday, January 20, 2021, 1–2 p.m. E.T.

- **Zero Energy Ready Homes: New and Growing Fast**
  Wednesday, February 17, 2021, 1–2 p.m. E.T.

- **The Future of Solar: A Tour of Cutting-Edge Solar Research with the U.S. Department of Energy**
  Wednesday, March 17, 2021, 1–2 p.m. E.T.

- **Solar Decathlon Build Challenge Team House Tour**
  Friday, April 16, 2021, 1–2 p.m. E.T.

- **Winning Solar Home - The DOE Solar Decathlon Build Challenge Winners**
  Wednesday, May 19, 2021, 1-2 p.m. E.T.

Apply Today – DOE Announces $80 Million 2020 BENEFIT Funding Opportunity

The U.S. Department of Energy released the Buildings Energy Efficiency Frontiers & Innovation Technologies (BENEFIT) 2020 Funding Opportunity Announcement (FOA). This funding opportunity will provide up to $80 million for projects that enhance energy demand flexibility across buildings and the grid, enabling greater affordability, increased energy productivity, and improved occupant comfort.

The FOA includes topic areas on advanced building construction, workforce development, and a variety of building technologies, including advanced lighting, HVAC, and thermal energy storage, among others.

How to Apply

More information, submittal requirements, and instructions for applying to this FOA (DE-FOA-0002196) can be found on the EERE Exchange. To be eligible for consideration, a concept paper must be submitted no later than November 5, 2020 by 5:00 p.m. ET.

Questions about this FOA may be submitted to DE-FOA-0002196@netl.doe.gov no later than three business days before the application deadline.

STEM
RISING
U.S. DEPARTMENT OF ENERGY
ENERGY.GOV/STEMRISING

Explore the Residential Program Solution Center

Resources to help improve your program and reach energy efficiency targets:

- Handbooks - explain *why* and *how* to implement specific stages of a program.
- Quick Answers - provide answers and resources for common questions.
- Proven Practices posts - include lessons learned, examples, and helpful tips from successful programs.
- Technology Solutions NEW! - present resources on advanced technologies, **HVAC** & **Heat Pump Water Heaters**, including installation guidance, marketing strategies, & potential savings.

https://rpsc.energy.gov

Thank You!

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Please send any follow-up questions or future call topic ideas to:
bbresidentialnetwork@ee.doe.gov