Net Zero Energy Homes

High Performance Building Design

Do it Smart, Do it Right

Green Needham

Net Zero Energy Homes and the Real Estate Market

Craig Foley

LAER Realty Partners

Chief Sustainability Officer

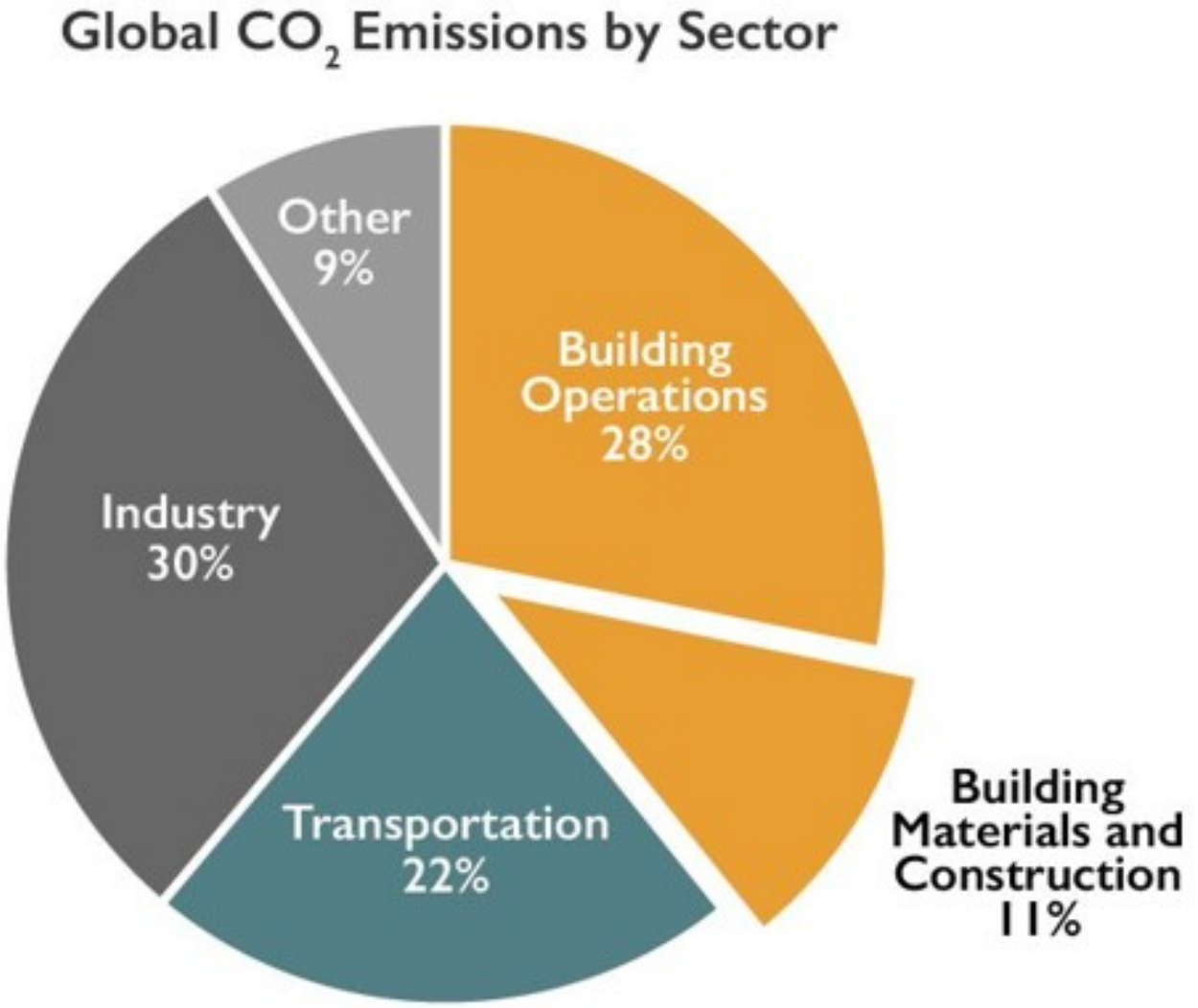
craig.rhg@gmail.com

- Craig Foley is a leading national voice on sustainability in the real estate industry. Craig's combination of real estate and energy management skills give him a unique perspective about sustainable energy solutions and subject matter expertise on greening the MLS, high-performance home valuation and marketing, and the impact of climate change on the real estate industry. He is a LEED Green Associate and the chief sustainability officer for LAER Realty Partners. As a real estate broker, he has sold several high-performance projects in and around Greater Boston. He is also the team co-founder of REthink39 Group. REthink39 is devoted to lowering the 39% of U.S. energy consumption attributed to the built environment and believes they can be part of a solution with every transaction closed.

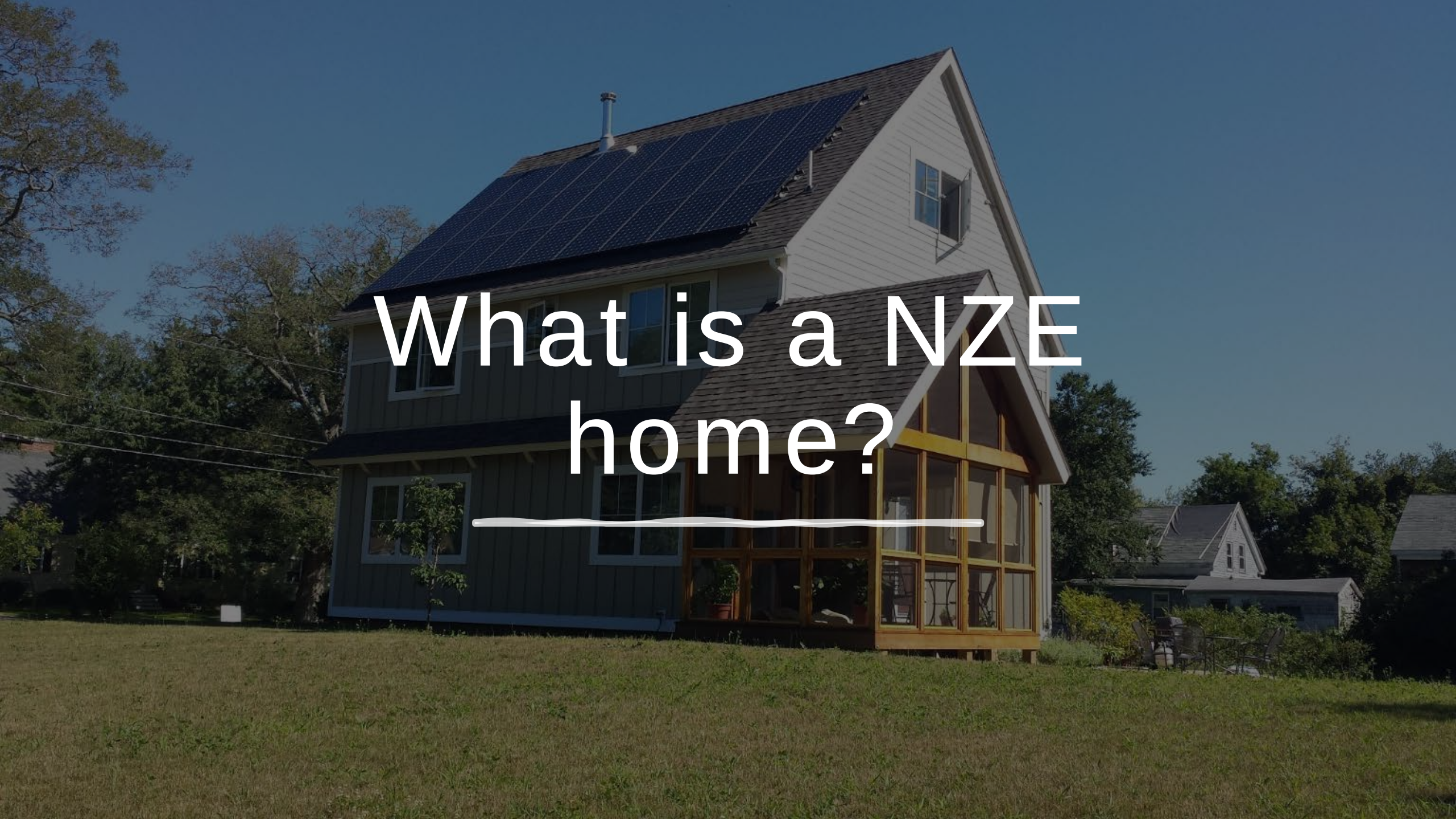
REthink39
LAER REALTY PARTNERS

The Two Sides of the Utility Meter

The built environment and GHG emissions



H3750	An Act authorizing the town of Arlington to adopt and enforce local regulations restricting the use of fossil fuels in certain construction	Rep. Sean Garballey
H3893	An Act authorizing the town of Lexington to adopt and enforce local regulations restricting new fossil fuel infrastructure in certain construction	Rep. Michelle L. Ciccolo
H4117	An Act authorizing the town of Concord to adopt and enforce local regulations restricting new fossil fuel infrastructure in certain construction	Rep. Tami L. Gouveia
H602	An Act to promote energy and economic resilience through clean energy education and job pathway programs	Rep. Thomas A. Golden, Jr.
S1333	An Act to reduce greenhouse gas emissions by permitting local option all-electric buildings and homes ordinances	Sen. James B. Eldridge
S2473	An Act authorizing the town of Brookline to adopt and enforce local regulations restricting new fossil fuel infrastructure in certain construction	Sen. Cynthia Stone Creem
S2515	An Act authorizing the town of Acton to adopt and enforce local regulations restricting new fossil fuel infrastructure in certain construction	Sen. James B. Eldridge


What is a NZE home?

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1. A home built to high-performance standards (building envelop above code)

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1. **A home built to high-performance standards (building envelop above code)**

2. **A home that supplies power with renewable energy**

What is a NZE home?

1. **A home built to high-performance standards (building envelop above code)**
2. **A home that supplies power with renewable energy**
3. **A home that produces as much energy as it uses on an annual basis**

Do the math…

How much $ did you spend heating your home this last year?

$_____

Do the math…

How much $ did you spend heating your home this last year?
$_____

How much $ did you spend for electricity this last year?
$_____

Do the math…

How much $ did you spend heating your home this last year? $_____

How much $ did you spend for electricity this last year? $_____

How much $ did you spend for gas for your car this last year $_____

Do the math…

How much $ did you spend heating your home this last year? $_____

How much $ did you spend for electricity this last year? $_____

How much $ did you spend for gas for your car this last year $_____

What does it add up to?
$_____

What is a NZE home?

- **These homeowners spent *$434 for the year* for heating, lighting, hot water, powering all their gadgets and appliances and running one EV**

Are these cost savings recognized in the market? You betcha they are, IF

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- https://www.buildingenergymagazine-digital.com/eneb/0218_fall_2018/MobilePagedArticle.action?articleId=1422004#articleId1422004

Are these cost savings recognized in the market? You betcha they are, IF

- https://ai.appraisalinstitute.org/eweb/Dynamicpage.aspx?webcode=AIPDPDirectory&key=428cdb90-9814-47e4-9256-a4113c815862

Are these cost savings recognized in the market? You betcha they are, IF

AI Reports®
Form 820.03*

Client File #:		Appraisal File #:	

Residential Green and Energy Efficient Addendum

Client:		
Subject Property:		
City:	State:	Zip:

Additional resources to aid in the valuation of green properties and the completion of this form can be found at
http://www.appraisalinstitute.org/education/green_energy_addendum.aspx

ENERGY SENSE FINANCE™
EiVALUE® • PvVALUE®

https://www.pvvalue.com/

It’s Time for a War on Climate

Some resources…

The Process of High-Performance Home Valuation, BuildingEnergy Magazine Spring 2018
https://www.buildingenergymagazine-digital.com/eneb/0218_fall_2018/MobilePagedArticle.action?articleId=1422004

Selling the Sun, MA CE class that addresses solar in residential real estate transaction,
https://ma.keepmecertified.com/selling-the-sun

Complimentary supporting video for using the PV Value Tool
https://www.youtube.com/watch?v=6FJ1ZDeC_ZM&t=5s

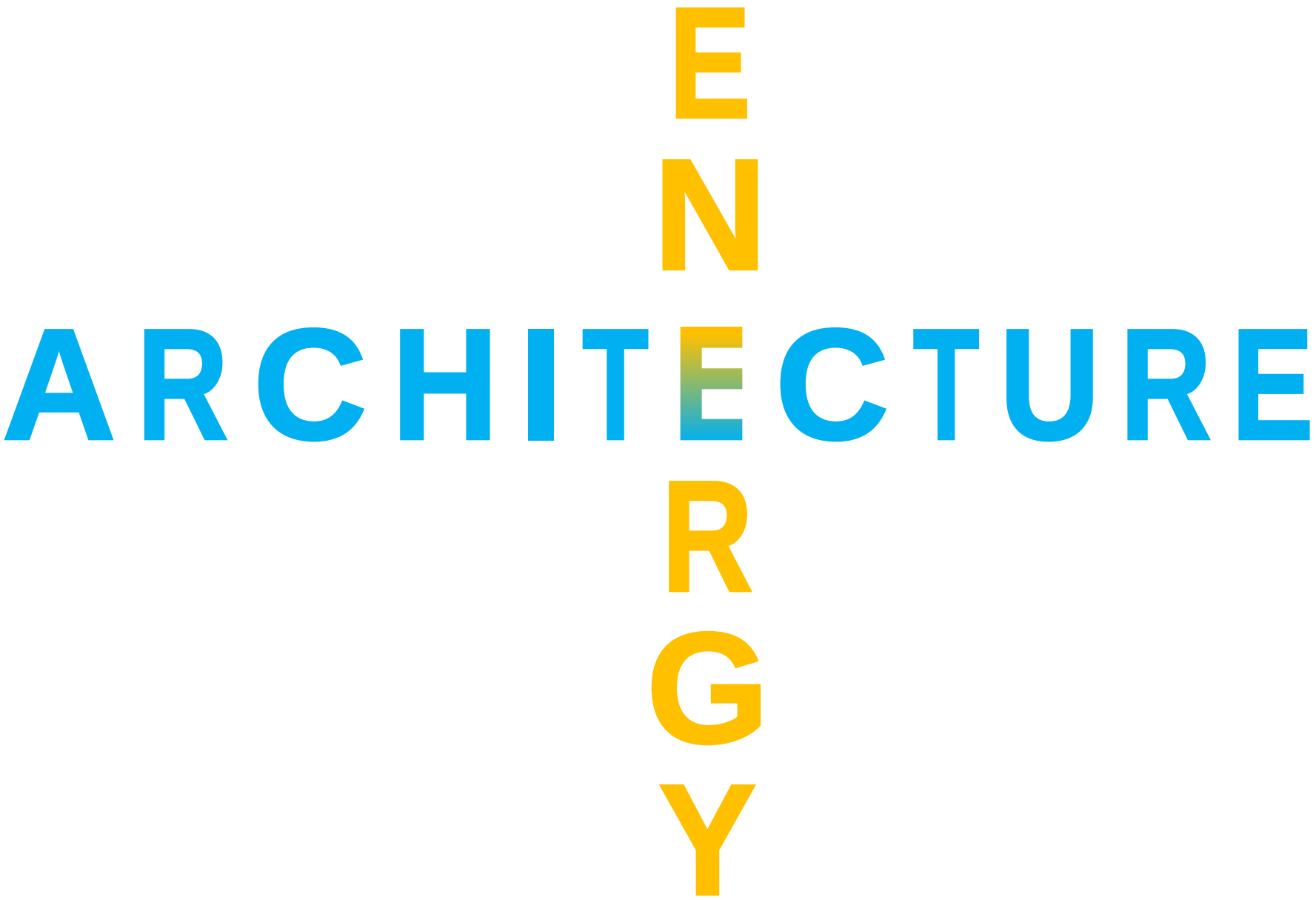
NAR link to letter to request a qualified appraiser, https://green.realtor/green-resources/guide-appraisals

Appraisal Institutes Registry of Valuation of Sustainable Buildings appraisers
https://ai.appraisalinstitute.org/eweb/Dynamicpage.aspx?webcode=AIPDPDirectory&key=428cdb90-9814-47e4-9256-a4113c815862

LAER Sustainability Report, download at https://www.laerrealty.com/2021LSR

ARCHITECTURAL SOLUTIONS

PRESENTED BY: STEPHANIE HOROWITZ



ZEROENERGY DESIGN

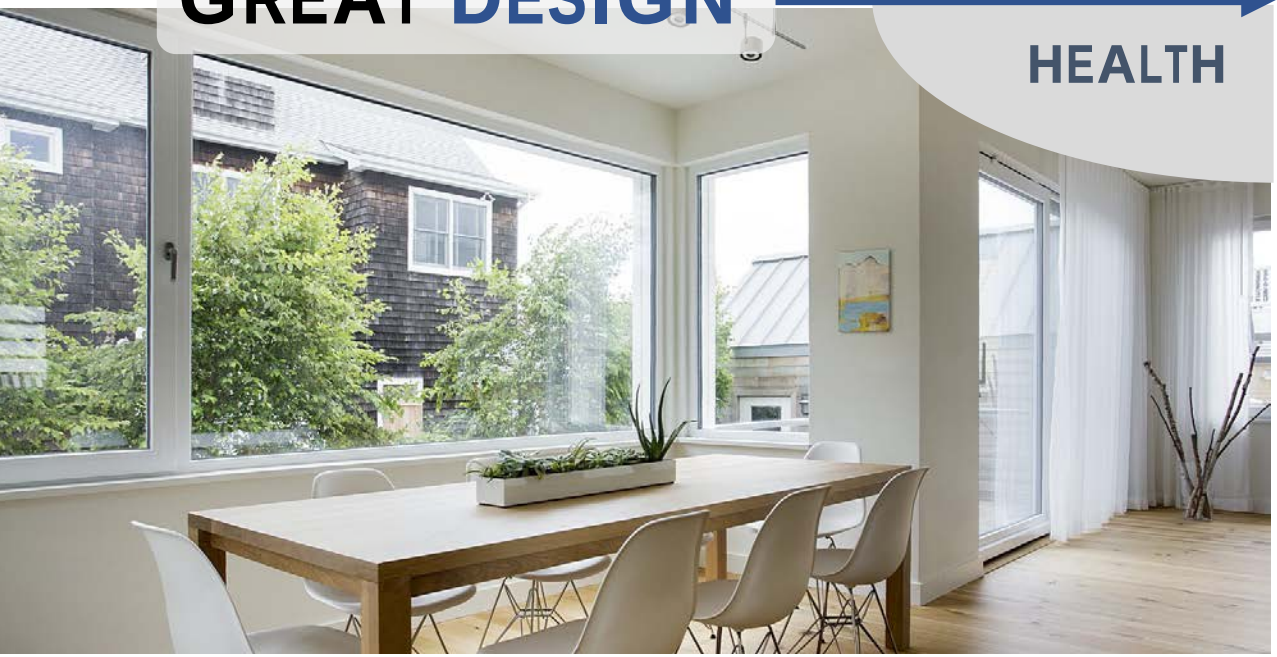
GREAT DESIGN

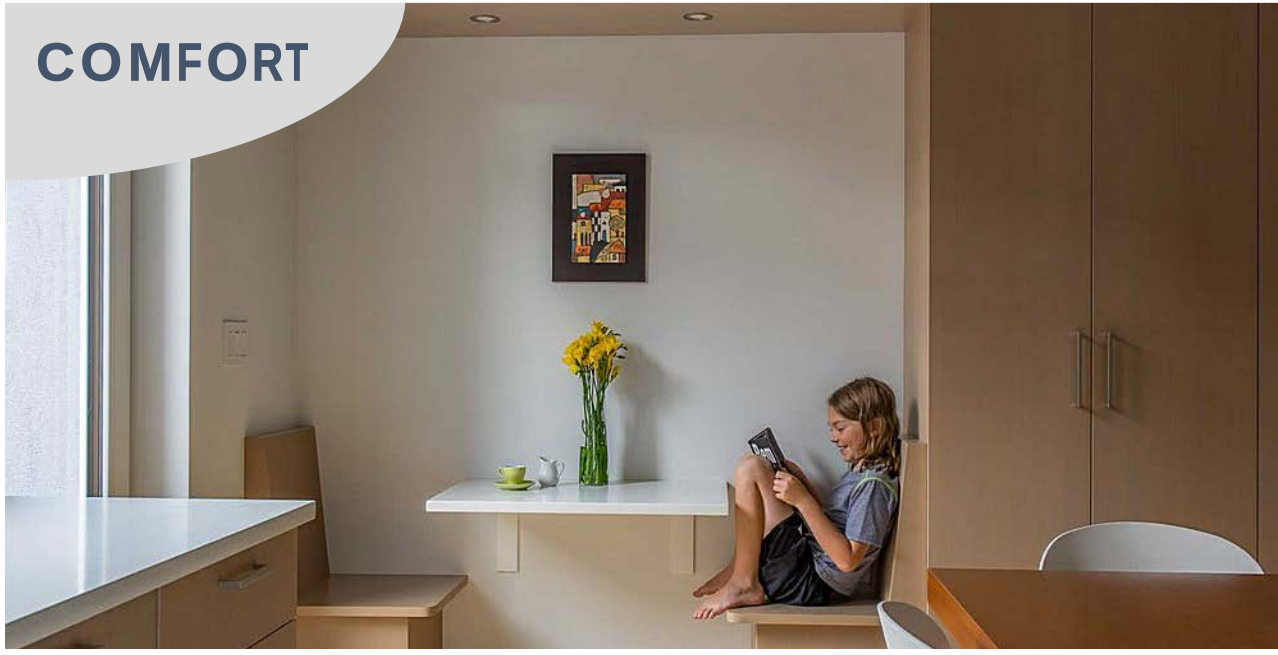
ENERGY

DURABILITY

HEALTH

COMFORT





CHANGE THE CONVERSATION

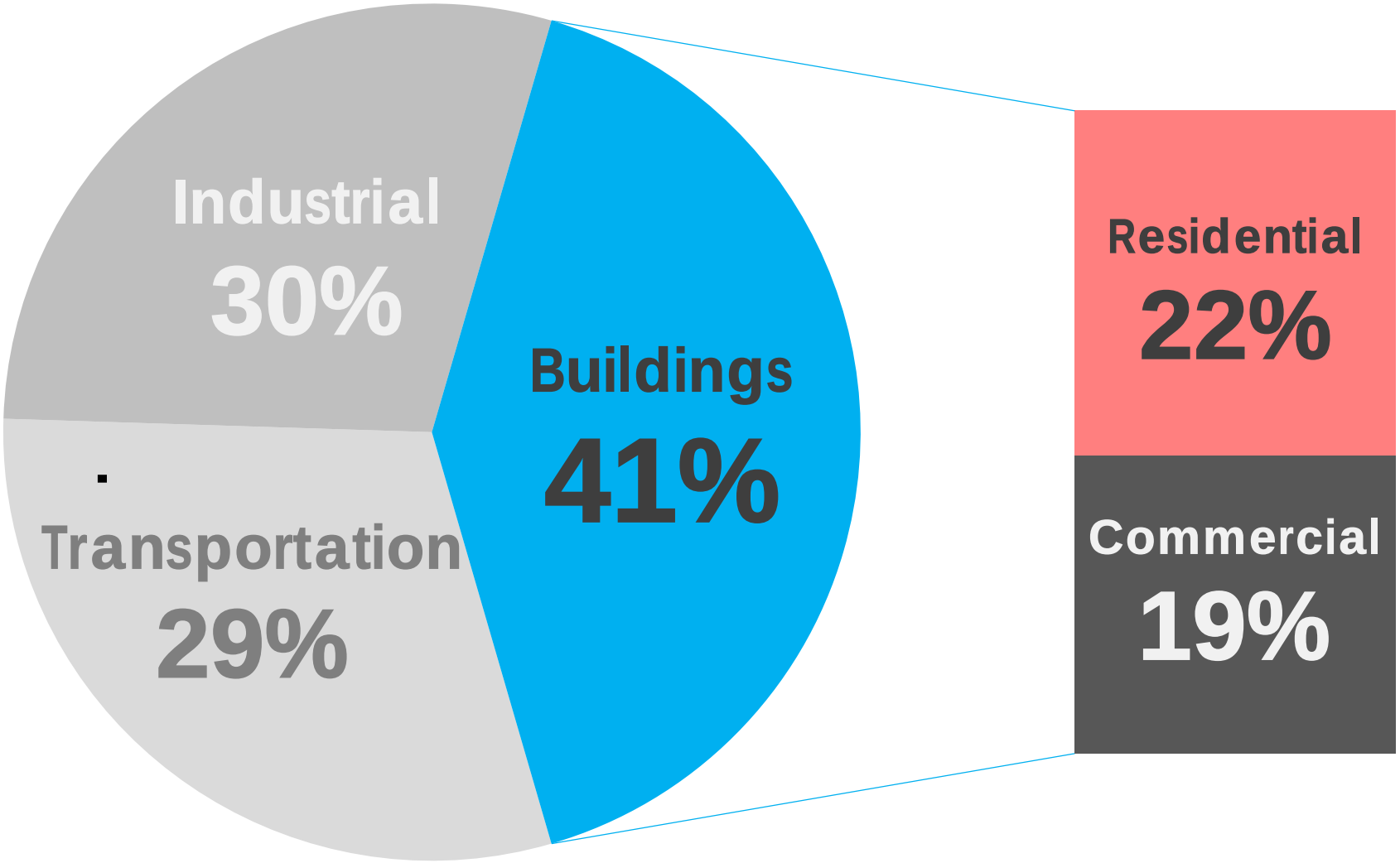
PORTFOLIO | ARCHITECTURE

CHANGE THE CONVERSATION

PORTFOLIO | ARCHITECTURE

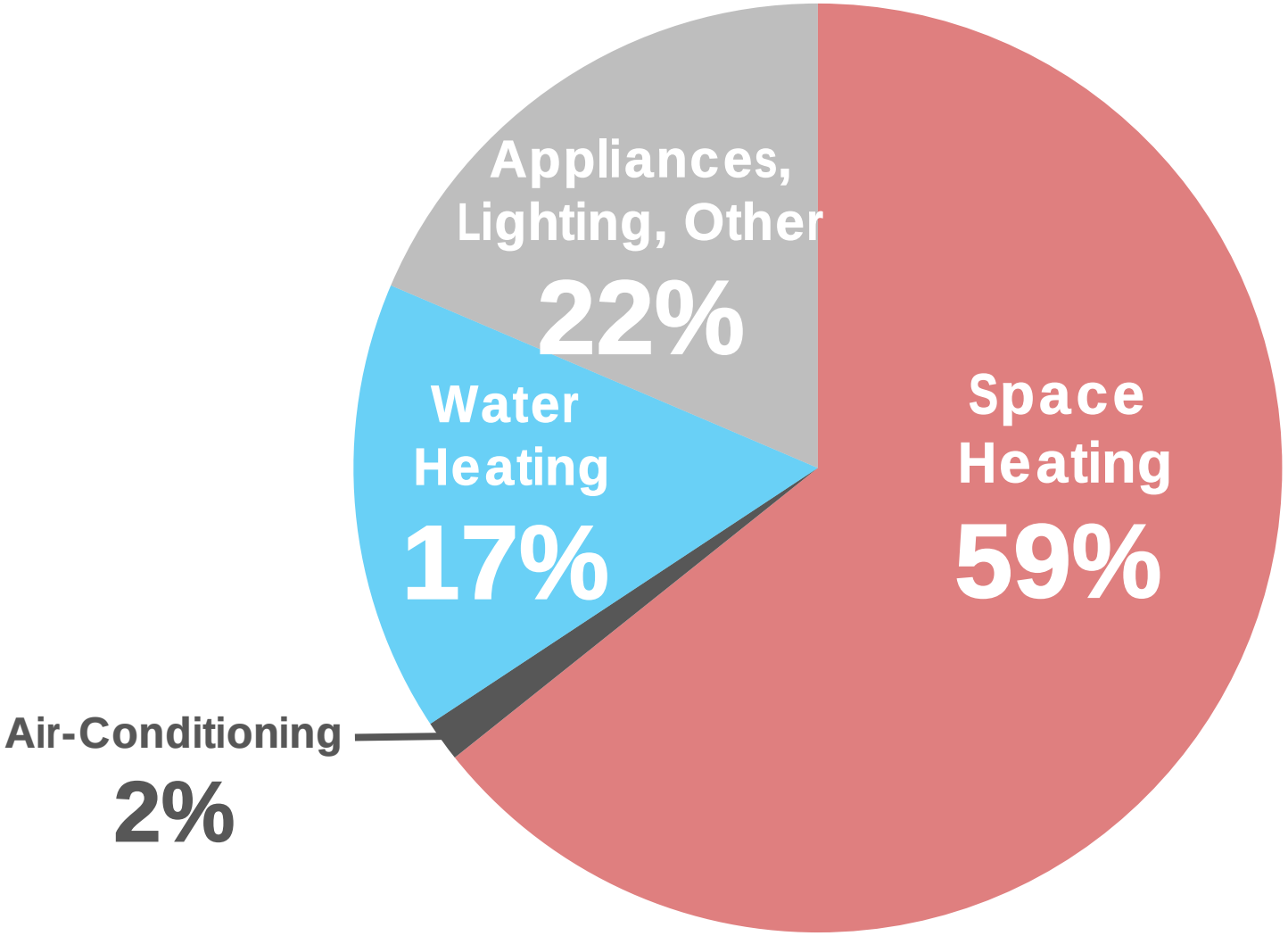
WHERE DOES OUR ENERGY GO?

US ENERGY USE



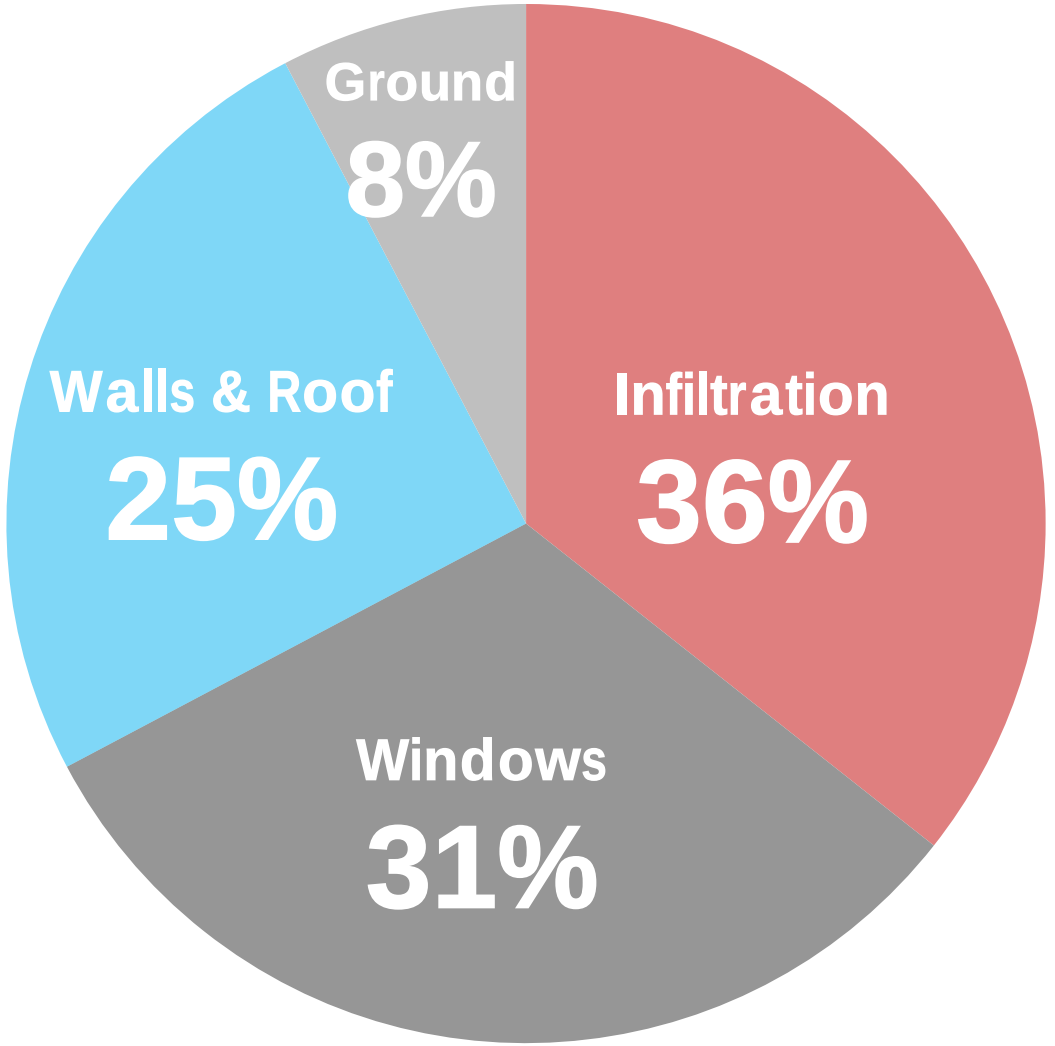
SOURCE: US DEPARTMENT OF ENERGY, 2011

NE ENERGY CONSUMPTION BY END USE



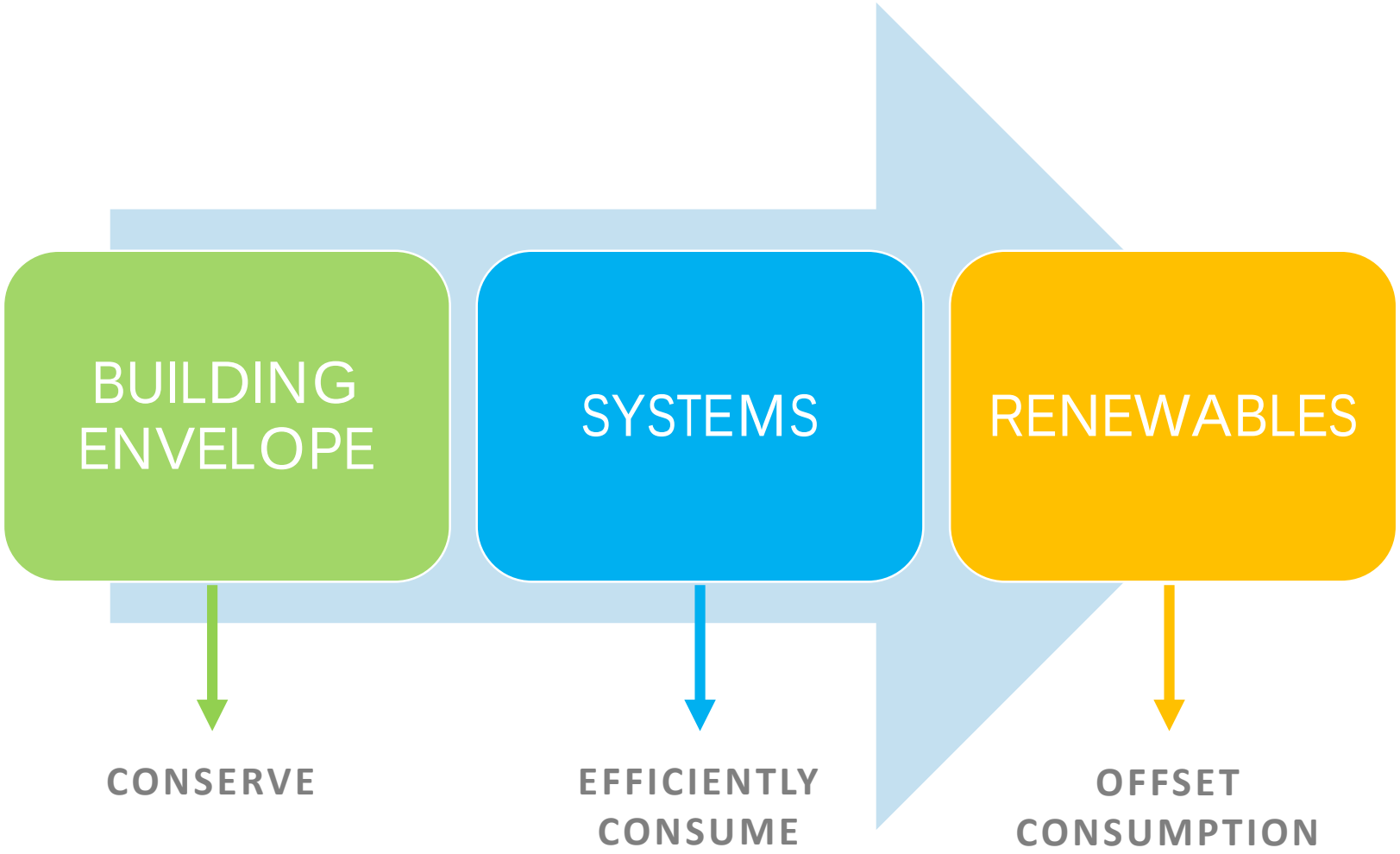
SOURCE: Source: US Energy Information Agency Residential Energy Consumption Survey, 2015

TYPICAL HEAT LOSS BY BUILDING COMPONENTS



SOURCE: ZeroEnergy DESIGN

DESIGN & FOLLOW THE PATH TO ZERO



BENEFITS

- Increased comfort
- Improved indoor air quality
- Quieter
- Improved durability
- Lower and predictable utility costs
- Smaller carbon footprint

SITE RESPONSIVE DESIGN

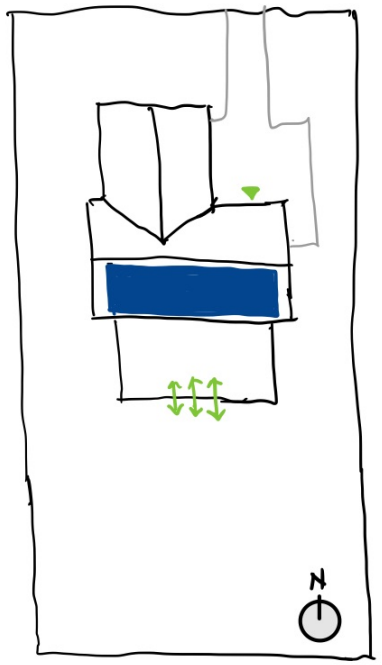
LINCOLN FARMHOUSE

South / Front

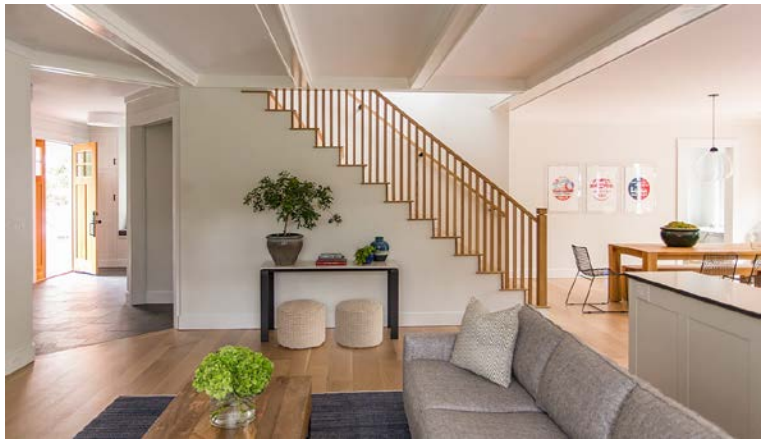
North / Rear

SITE RESPONSIVE DESIGN

WELLESLEY GREEN HOME



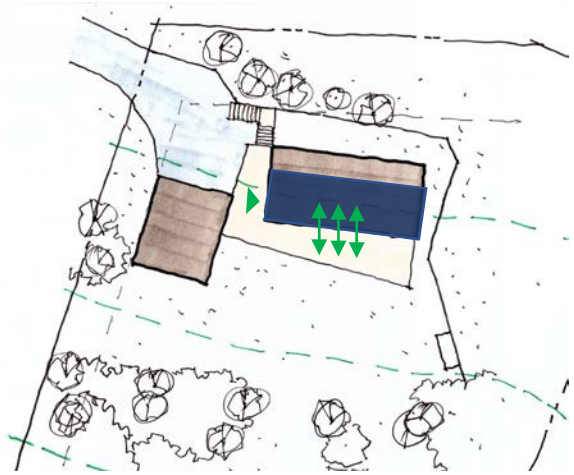
South / Rear



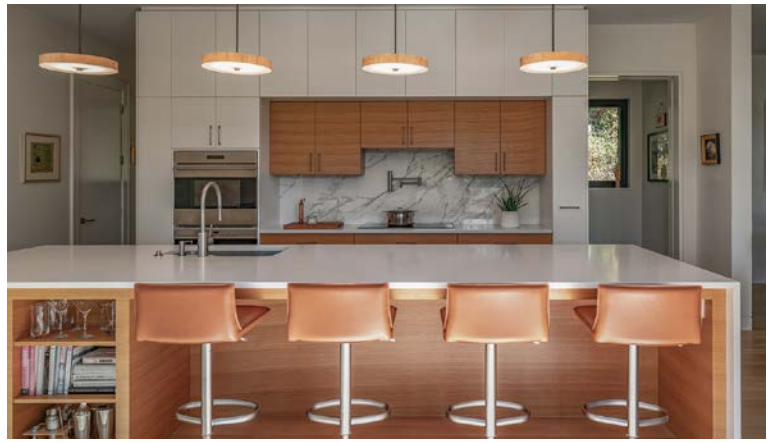
East / Side

SITE RESPONSIVE DESIGN

HINGHAM MARSHFRONT



South / Side



North/Side

BRIGHT LIVING SPACES

STRATEGIES THAT WE LIKE

- Start with design
- Continuous air barriers
- Continuous insulation
- Insulation with low GWP
- Triple-glazed windows
- Air-source heat pumps
- Continuous ventilation w/ energy recovery
- Renewables

CONTINUOUS AIR BARRIER

CONTINUOUS INSULATION

LOW GWP INSULATION

TRIPLE GLAZED WINDOWS

AIR SOURCE HEAT PUMPS

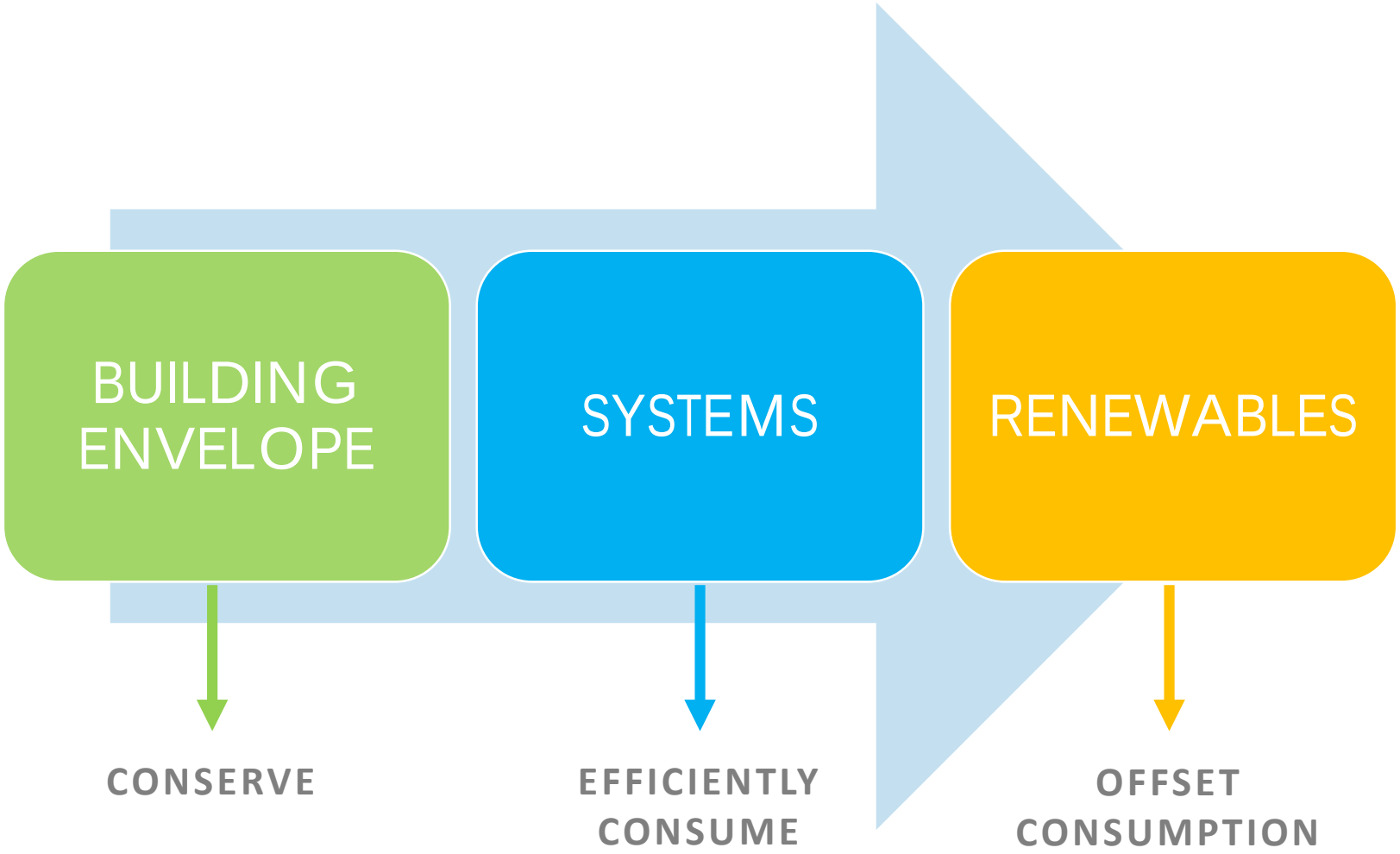
CONTINUOUS VENTILATION

RENEWABLES

RENEWABLES

RENEWABLES

DESIGN & FOLLOW THE PATH TO ZERO




THANKS!


info@ZeroEnergy.com

Net Zero Energy Homes
Builder Experiences

Jonathan Kantar

Sage Builders LLC
Founder / Principal
jonathan@sagebuilders.com

A Solution for the Future

- Provide a functional, attractive, comfortable, affordable, healthy, and durable home that optimizes energy use, embodied carbon, and both investment and operational costs.

- All Electric (remove existing natural gas service)
- “Easy to build”
- Focus on the air barrier: 0.6 ACH50 target

New roofs oriented for solar PV panels

- Demo and protection
- Immediately, establishing the air barrier w/ pressure activated self-adhesive WRB/Air Barrier
- Focus: continuous air, vapor, and thermal barriers: 0.6 ACH50 target;
  - Planning penetrations; sequencing and use of products
  - Tape, tape, and more tape!

- 2” Zip R9 Sheathing, 2x6 @ 16oc (should have done 24”oc) ext. wall
- Performance in a small package –
  - R9 continuous insulation;
  - WRB
  - Air Barrier w/ Zip Tape
  - Compact

- Opportunistic: easy assembly in a process we needed to do anyway
- Constructability
- Readily available

- Focus on CONTINUOUS air sealing:

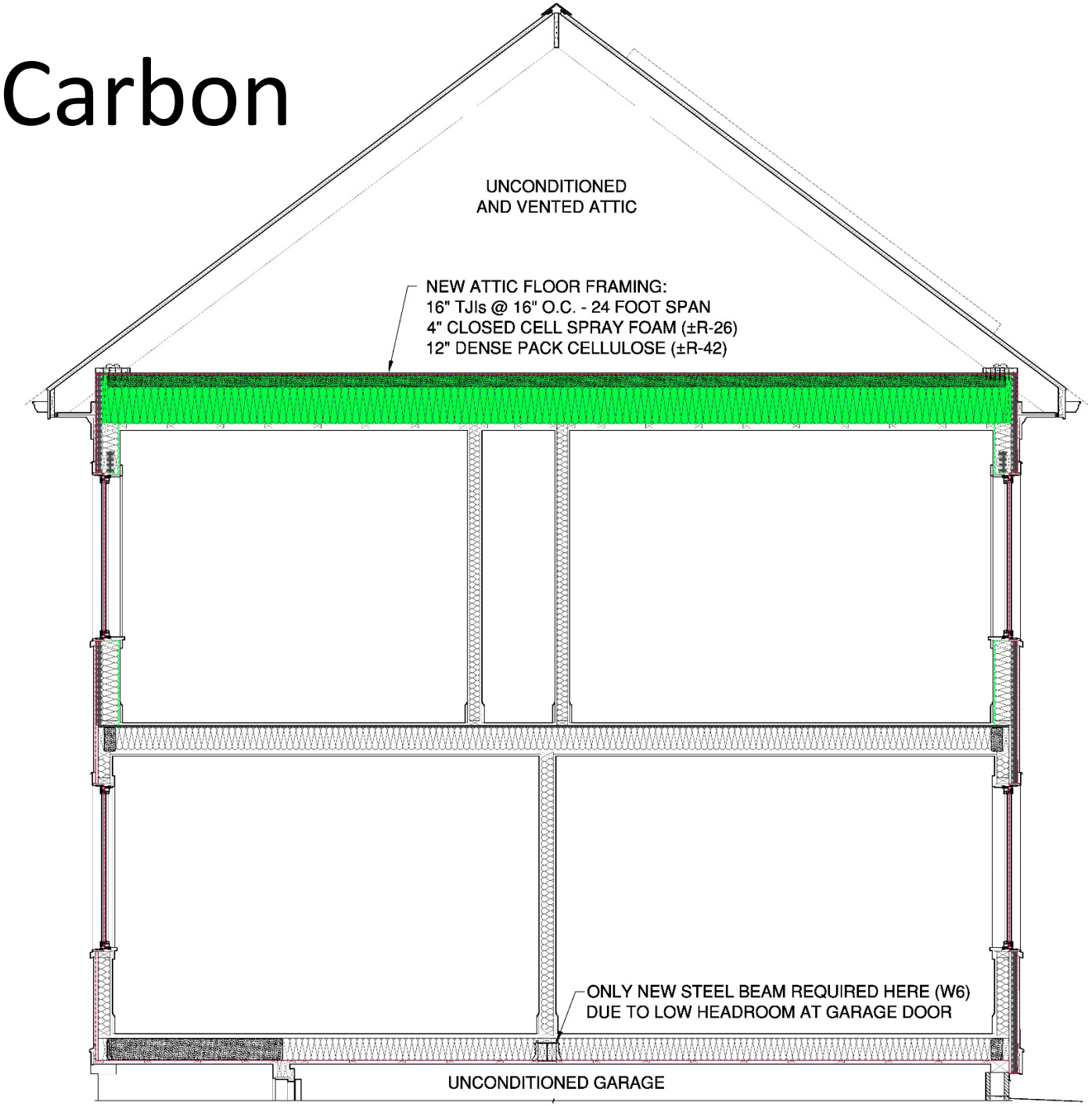
- Zip system – tape all seams
- Openings: tape zip assembly to framing
- Doors/windows/penetrations: tape/foam units to exterior air barrier and interior air barrier….continuity inside and out
- ROs 1” larger than needed for shimming and spray foam

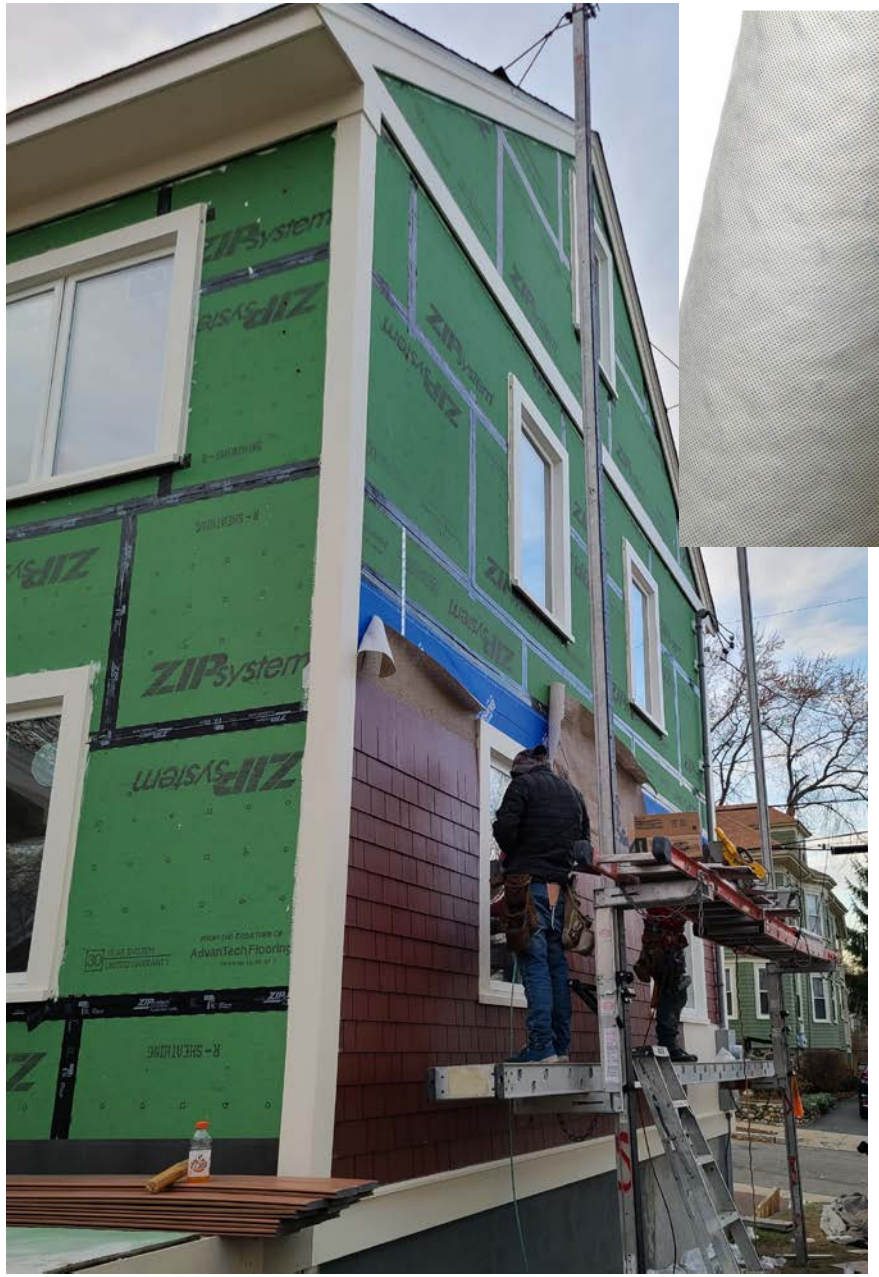
Goal: Reduce Embodied Carbon

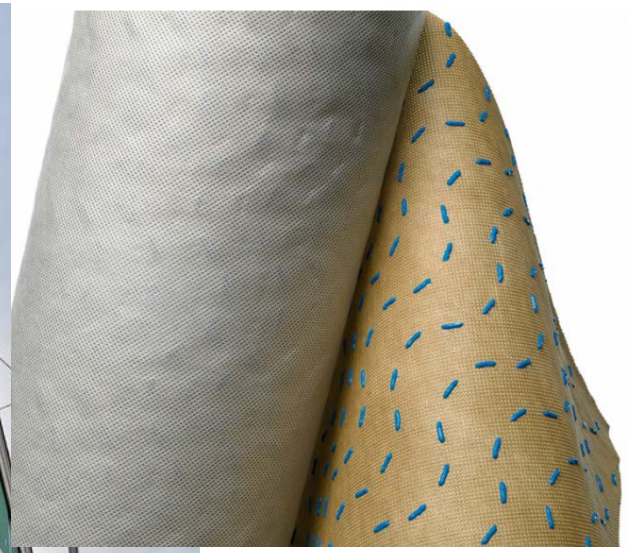
- Reuse much of existing structure
- Minimize new concrete and structural steel (rear addition on piers)
- Minimize use of closed cell spray foam
- Wood framing and dense pack cellulose insulation where feasible
- Boral Exterior Trim (instead of PVC

Reduce Embodied Carbon

- 16” attic floor joists
- Reduce need for new structural steel
- Extra insulation depth (R-68)
- Compensate for underperforming exterior walls

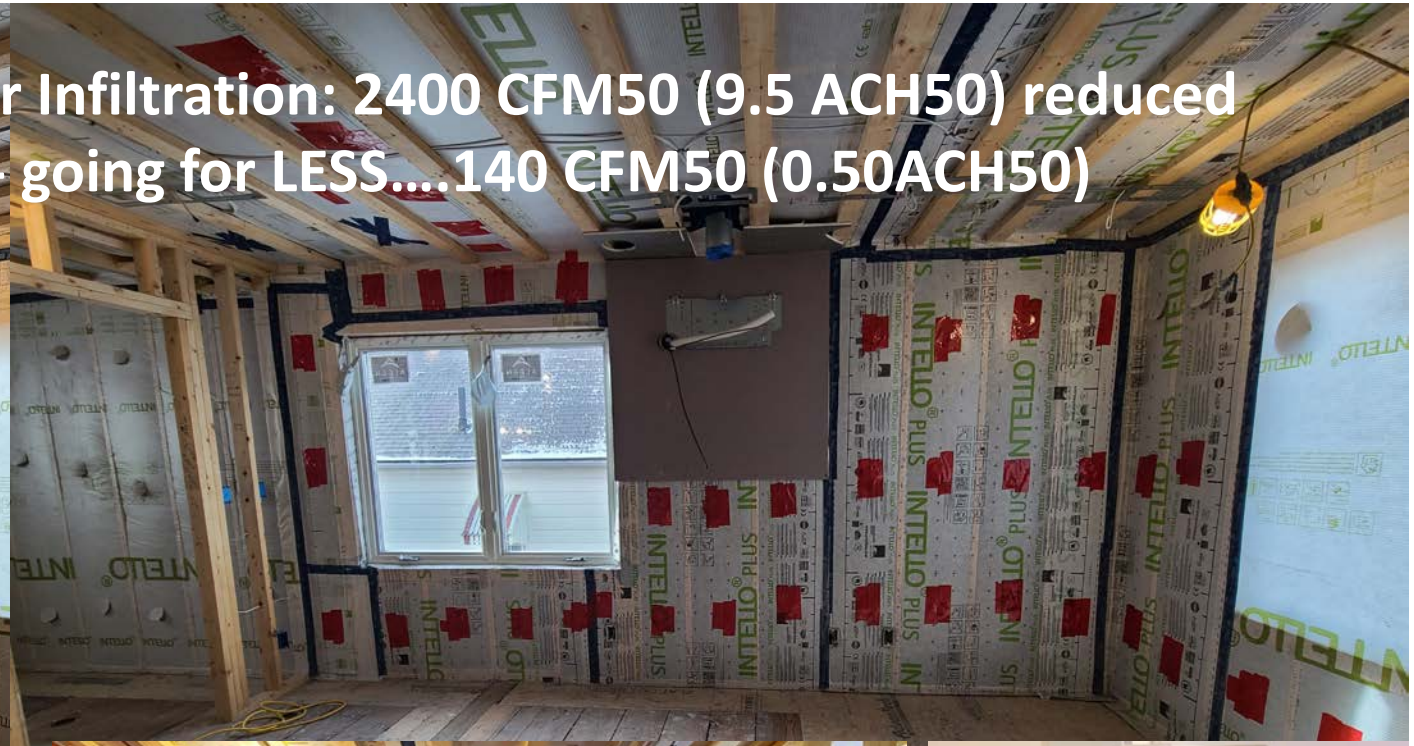


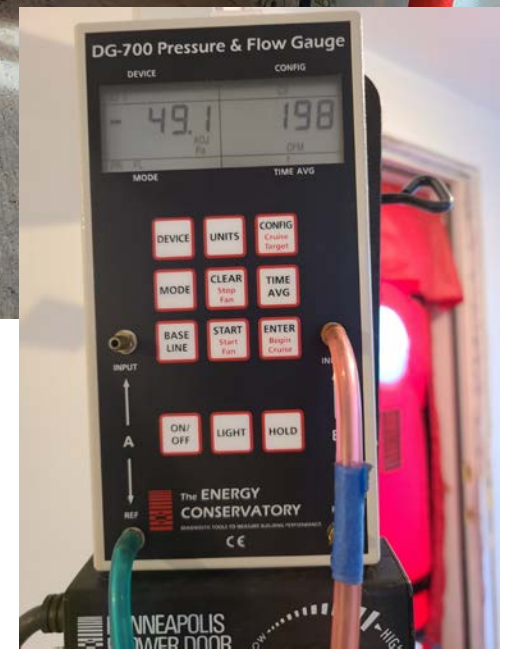




The exterior - looking for durability, efficiency, economy with no compromises: **** R8+ Windows ****

- Boral Exterior Trim for durability and environmentally friendly;
- Trim pre-assembled w/ pocket holes, rabbeted out for window flange
- 3 dimensional WRB for air gap
- Prefinished, cementitious panel shingle siding – quick installation, durable, fire protection, handsome
- Stop the water! Flash head casing, flash horizontal blocks, trim



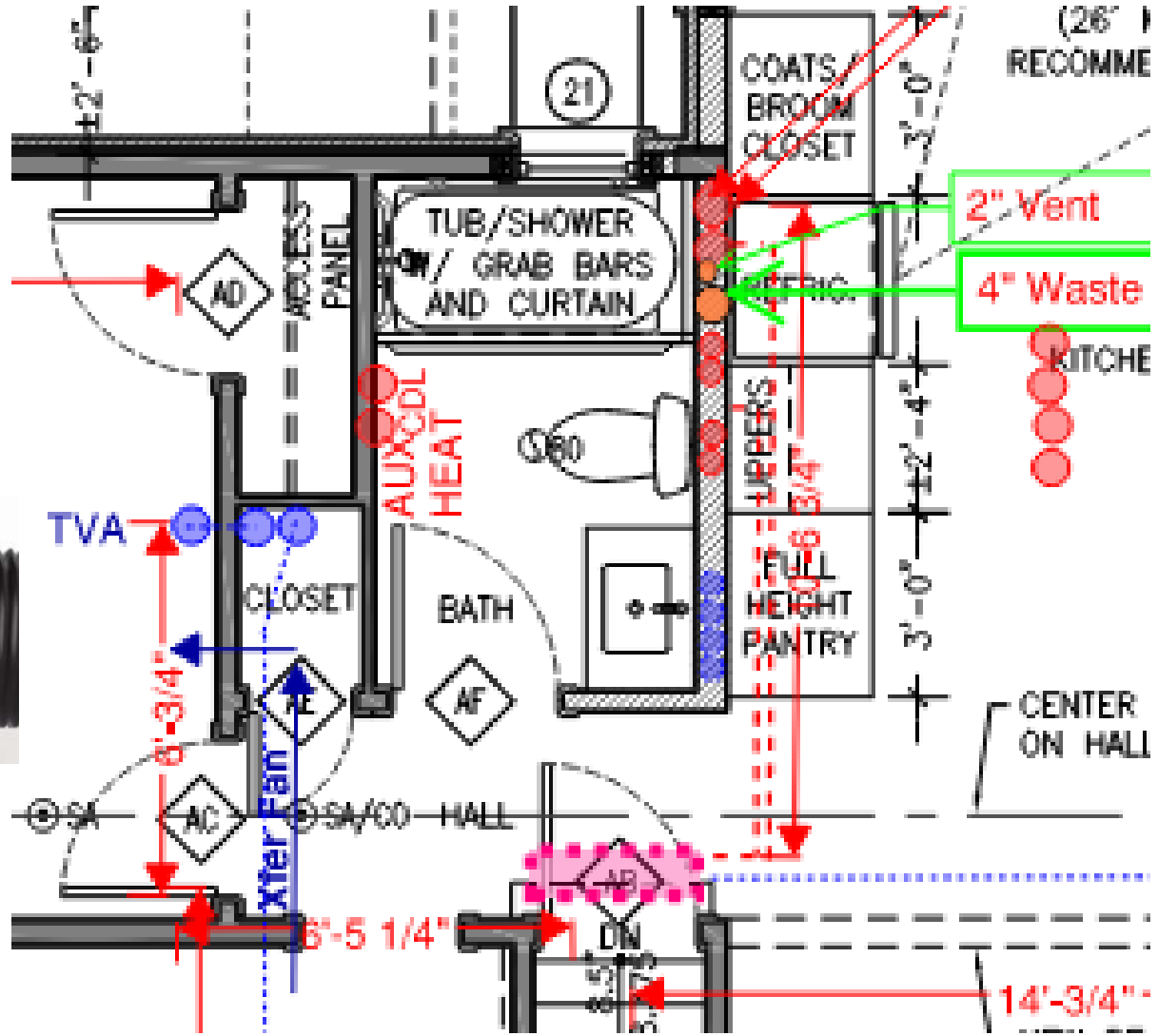


- Dense packed cellulose and TAPING – many hours ($$$$) and tons of tape ($$$)
- Missed: blower door 1) before interior air barrier, 2) after air barrier, 3) after insulation, 4) after taping.

- Where to put all the pipes and tubes ??
- Worked w/ vendor to size systems – ended up oversizing both….but still within efficient oper. Ranges
- Air transfer fans for distribution

Heating, A/C and Ventilation

- Critical aspect of the project
- Must do thorough, careful energy modeling
- Consider layout and distribution



Net Zero to Boot !!

Boucher Energy Systems, Inc.

World Class HVAC

www.boucherenergy.com

Since 1981

New Air Source Heat Pump Home

- Traditional New England style homes
- 6” spray foam exterior
- Wrapped with foam under sheathing R-10 for no thermal bridge

New Air Source Heat Pump Home

- Large solar array powers most of home's needs
- No flue pipes through side walls or roof
- No fossil fuels

Air Handlers

- Replaces traditional gas hot air furnace
- Can be stacked in tight spaces (since there are no gas lines or flue pipes)

Ceiling recessed unit

- Functions just like the more traditional wall head style units, yet sits flush in a ceiling for a cleaner look
- Can be used in areas where ductwork is impractical OR to reduce costs and create zoning

Fresh Air Ventilation

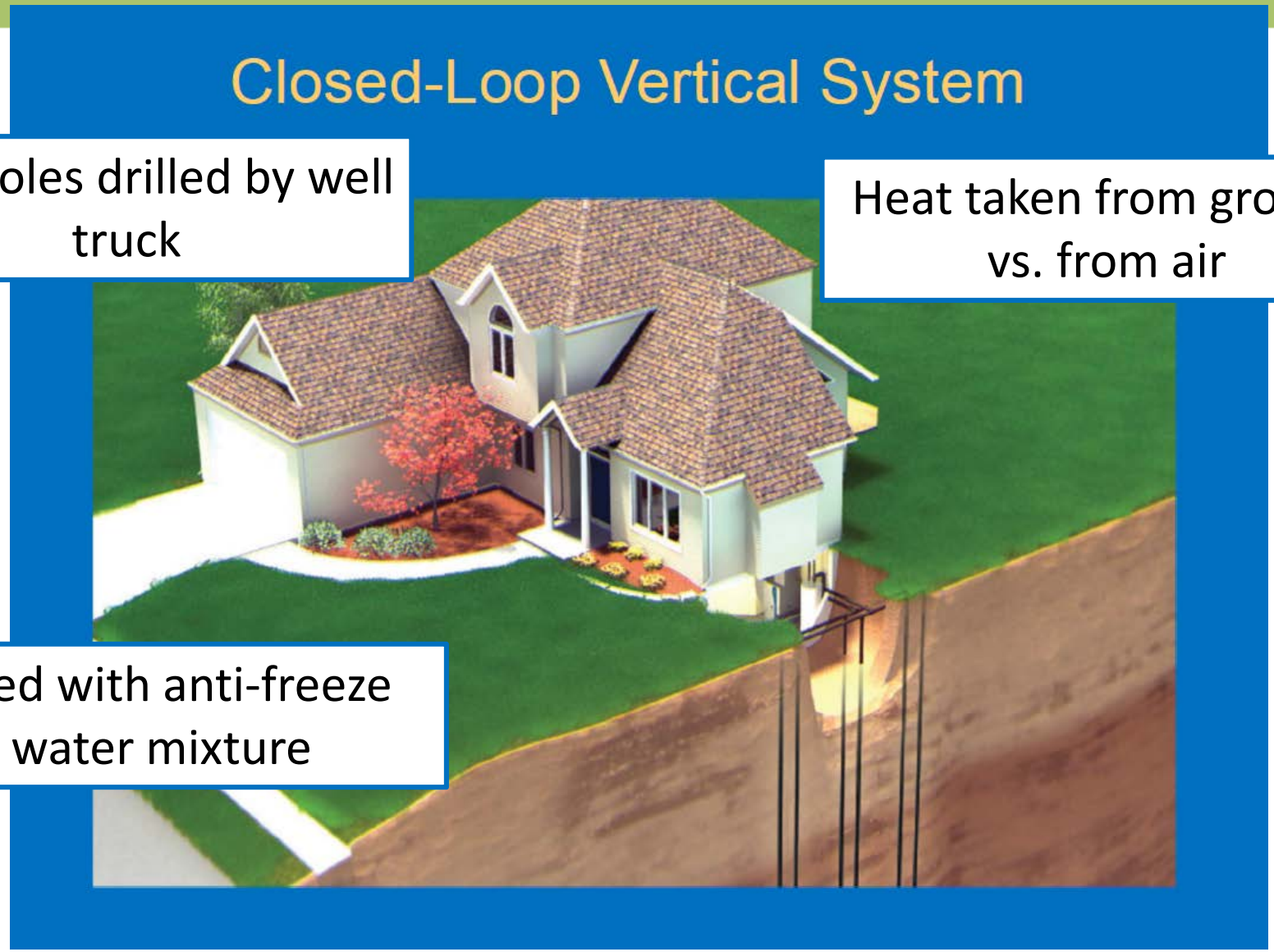
- Zehnder ERV (energy recovery ventilator)
- Tighter new homes require fresh air ventilation for occupant health and comfort

Condensing Units

- Variable speed enhances efficiency
- Very quiet condenser, reduces noise complaints from own neighbors
- Extremely long line lengths

Geothermal: Unveiling the mystery….

Geothermal: Not a mystery, not magic 😊



New Geothermal Home (Front)

- Benson Wood post and beam
- Exterior walls 9.5” TGI with high density cellulose
- Factory assembled wall systems, including windows
- Foundation walls insulated to R-15
- Air tightness at >1 ACH50

New Geothermal Home (Back)

- Large open porch areas
- Eliminates A/C condenser clutter on exteriors
- Eliminates noise near outdoor living spaces
- Eliminates wall penetrations, ugly flue pipes

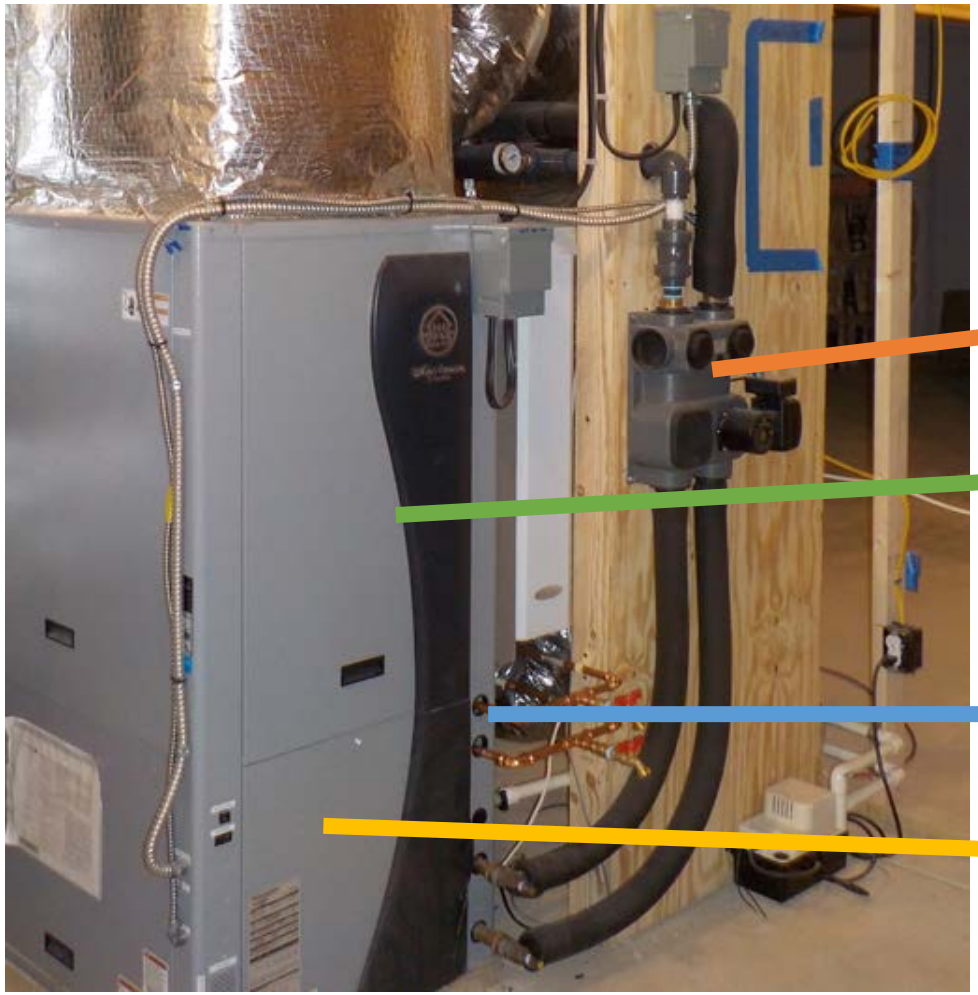
New Geothermal Home (interior)

- No indoor units hanging on walls
- Traditional floor mounted grills like any other system

New Geothermal Home (equipment room)

- Two units, one per floor
- 2 in 1 system: an air handler AND condensing unit

New Geothermal Home (components)



Pump Station

Blower section

Desuperheater (Supplements water heater)

Condenser section

New Geothermal Home (components)

What's missing?

Look at what you don’t need…

New Geothermal Home (duct work)

- Sized larger than traditional hot air ductwork
- Radiused corners for less resistance
- R-8 fiberglass wrap
- Sealed beyond minimum code

Would you drive your car with the emergency brake on?

One great tip to improve efficiency in ANY home on ANY HVAC system…

=

Boucher Energy Systems, Inc.

World Class HVAC

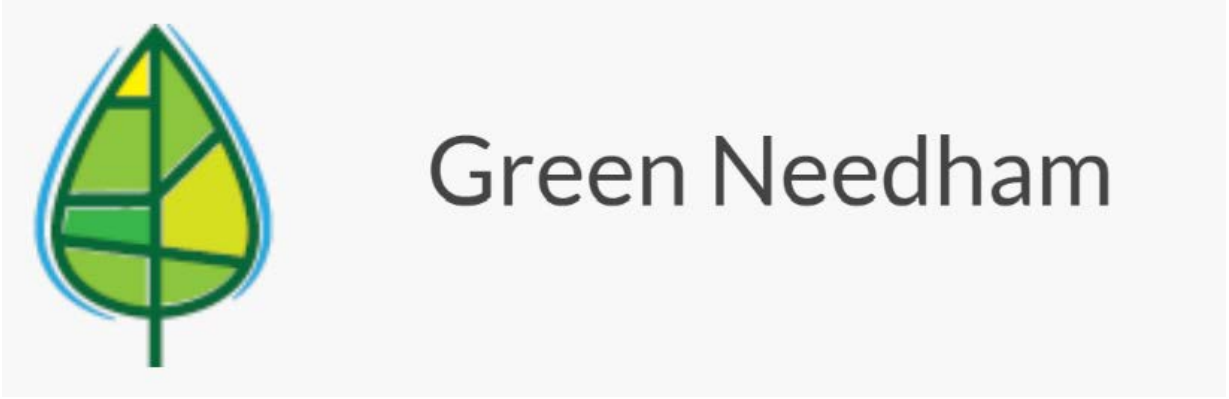
www.boucherenergy.com

Since 1981

Thank You

Net Zero Energy Homes
Heat Pump Energy Modeling

Ed Quinlan
Green Needham Collaborative
Engineered Solutions Inc.
Founder/Principal/Retired
ed@btuchaser.com

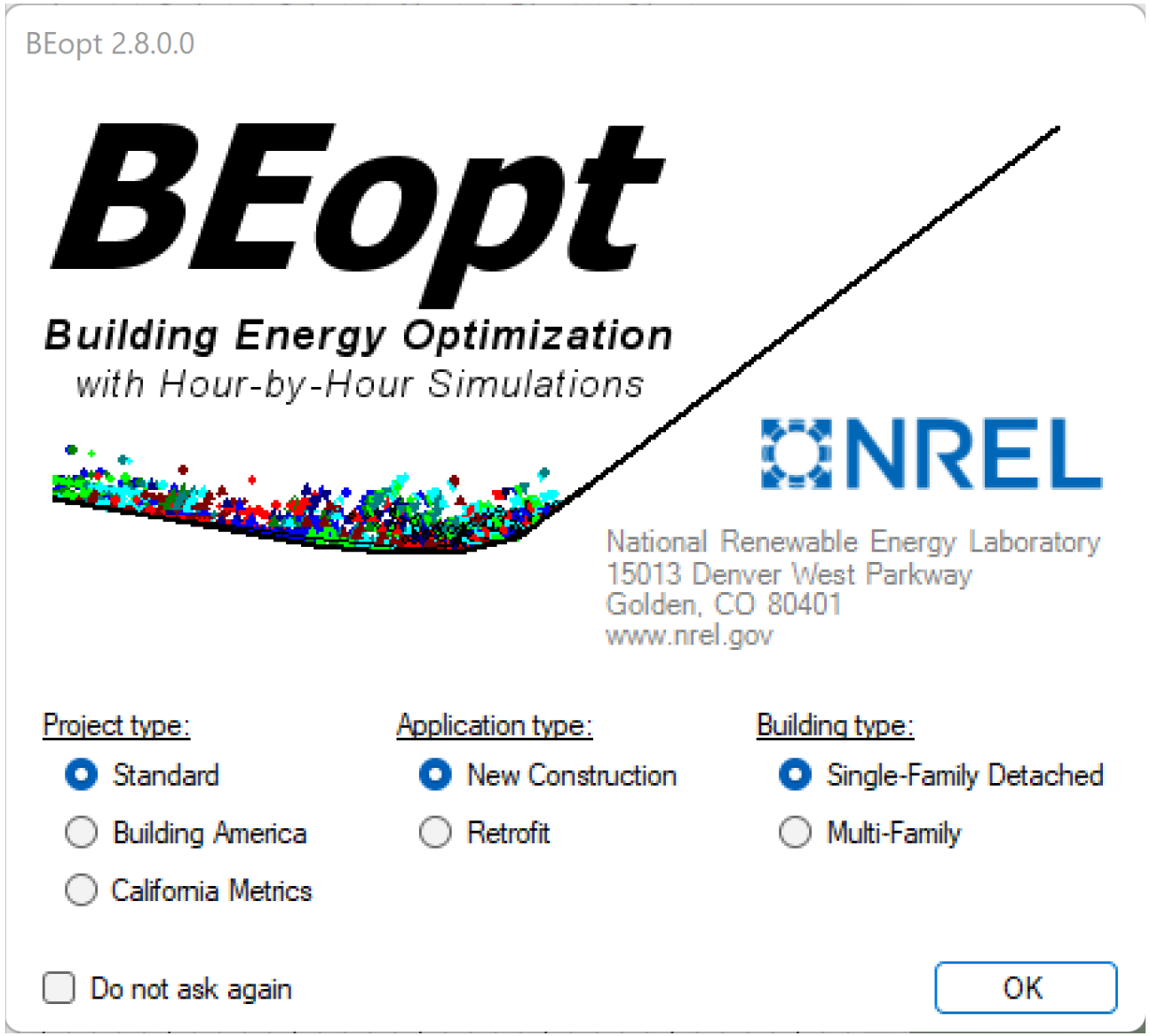


Energy Plus for Building Energy Analysis

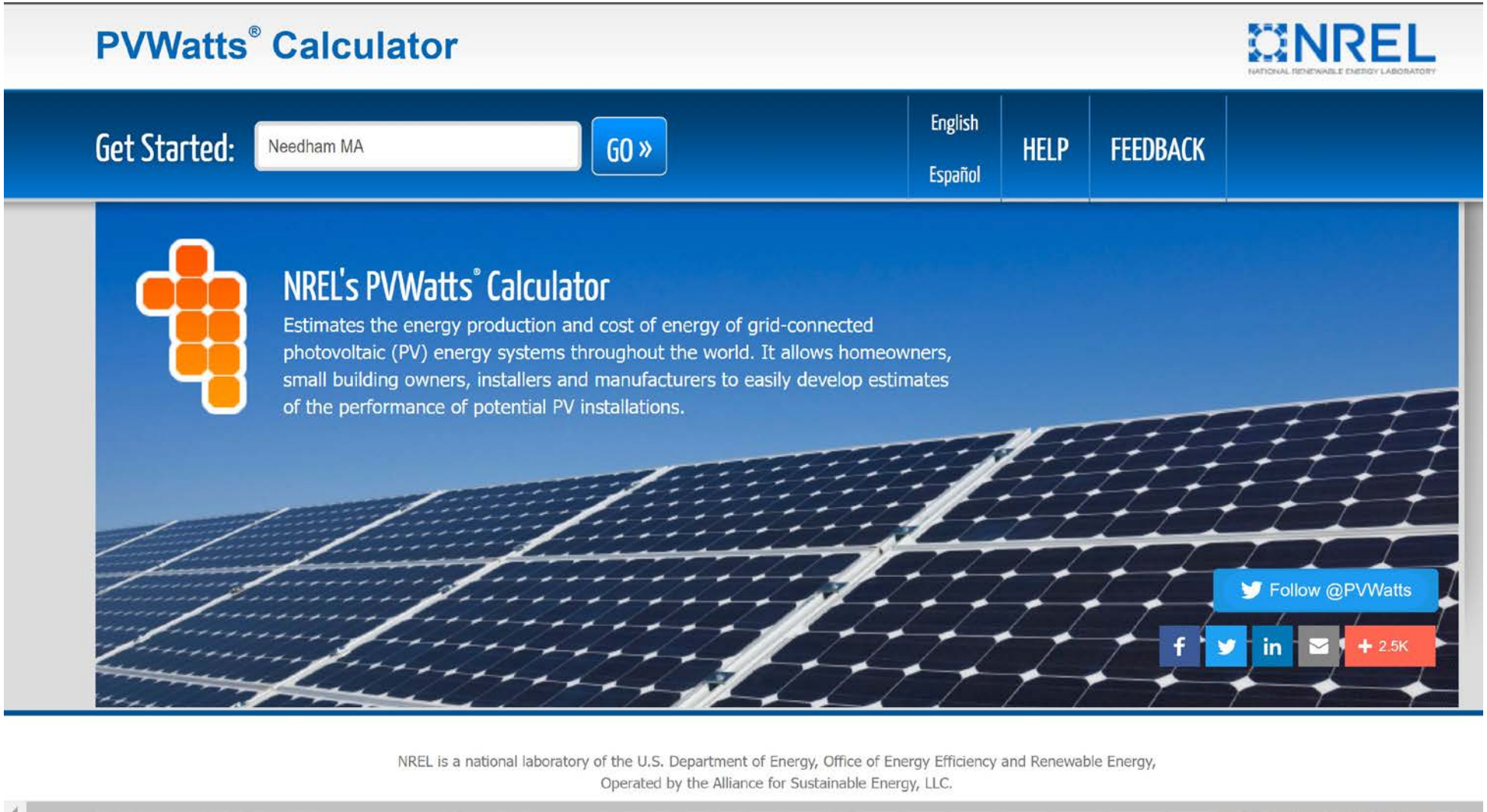
Graphical User Interfaces:

* **BEopt**
* Sketch Up
* Open Studio

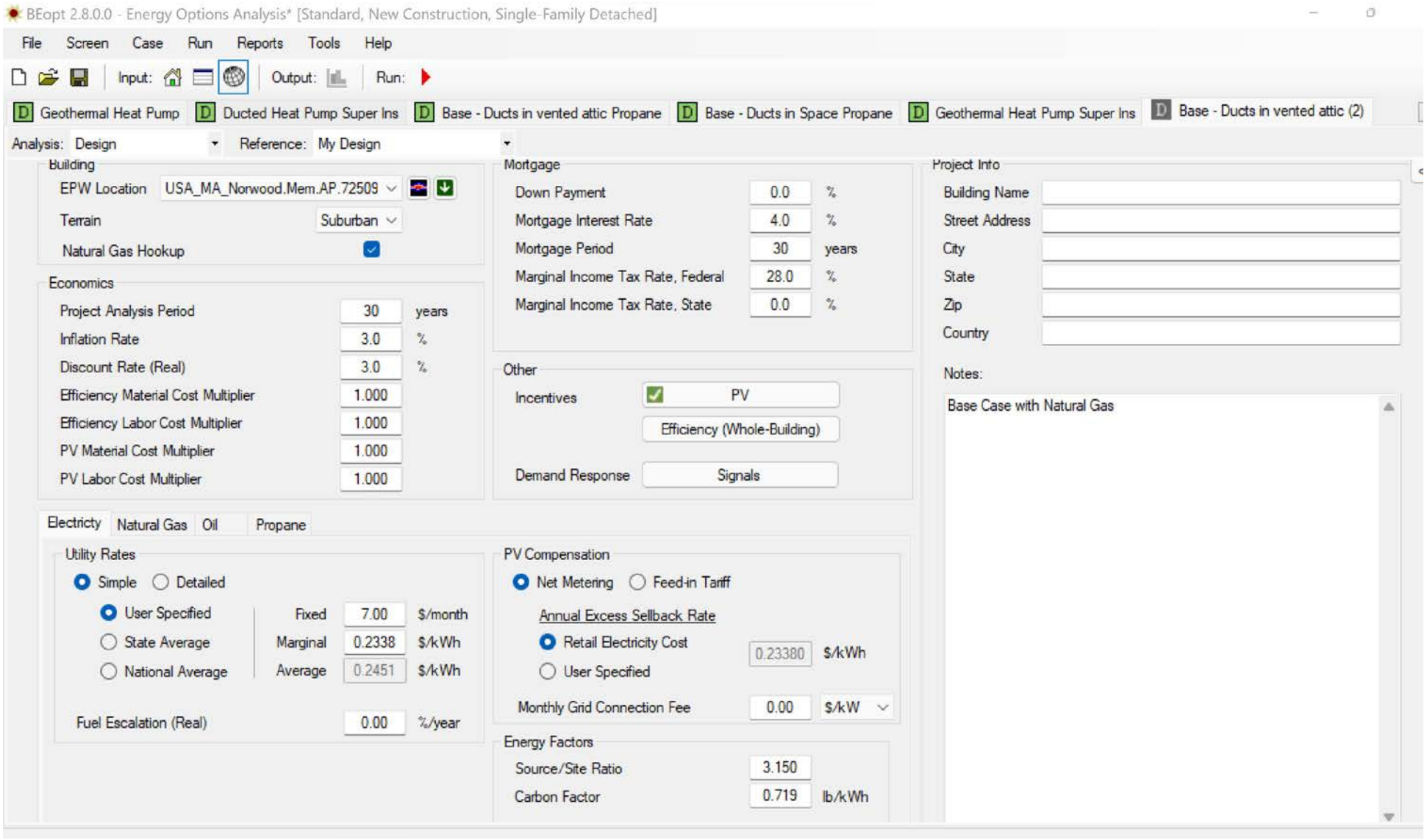
BEopt – Building Energy Optimization



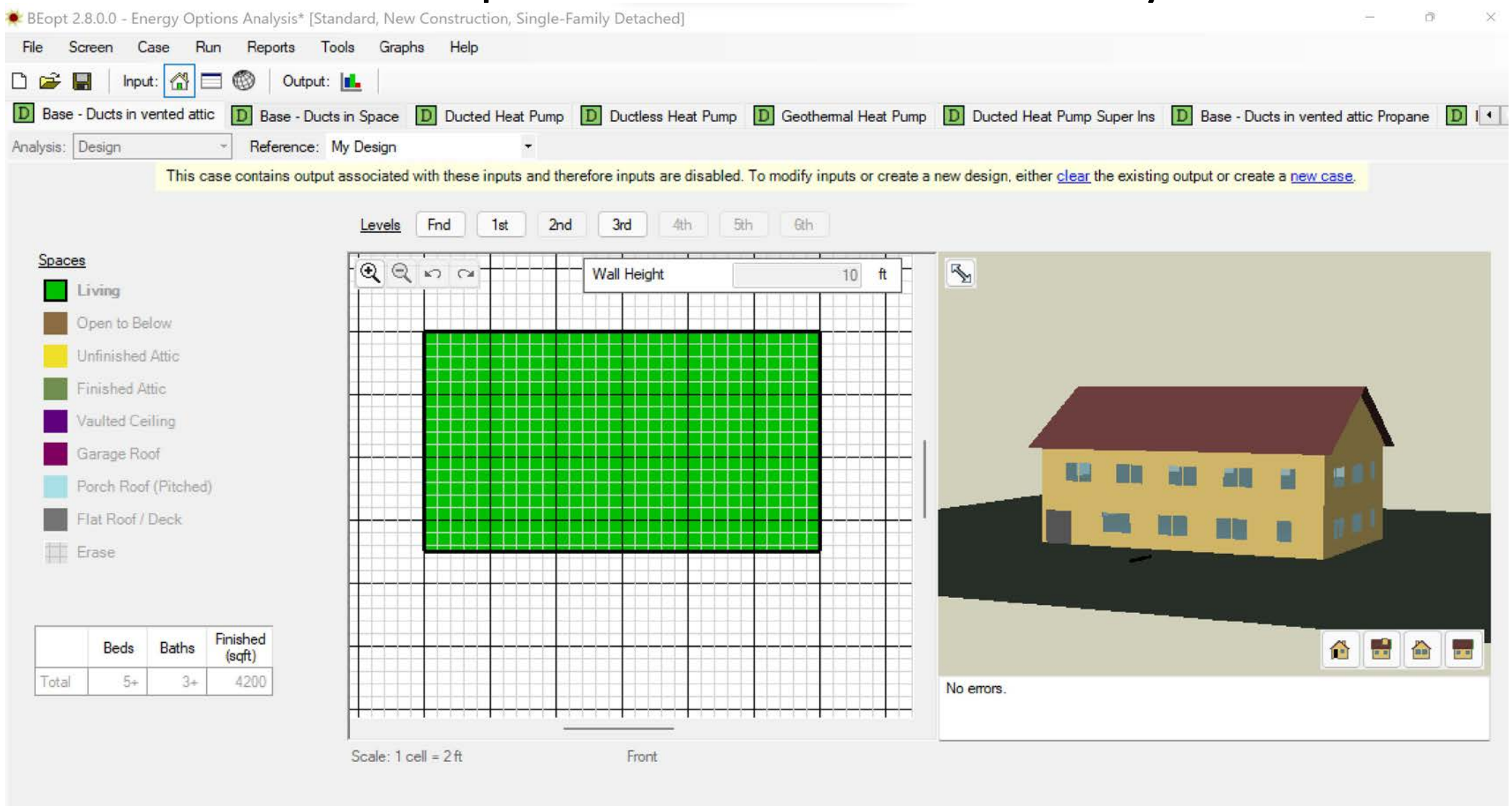
PV Watts – Solar PV Analysis



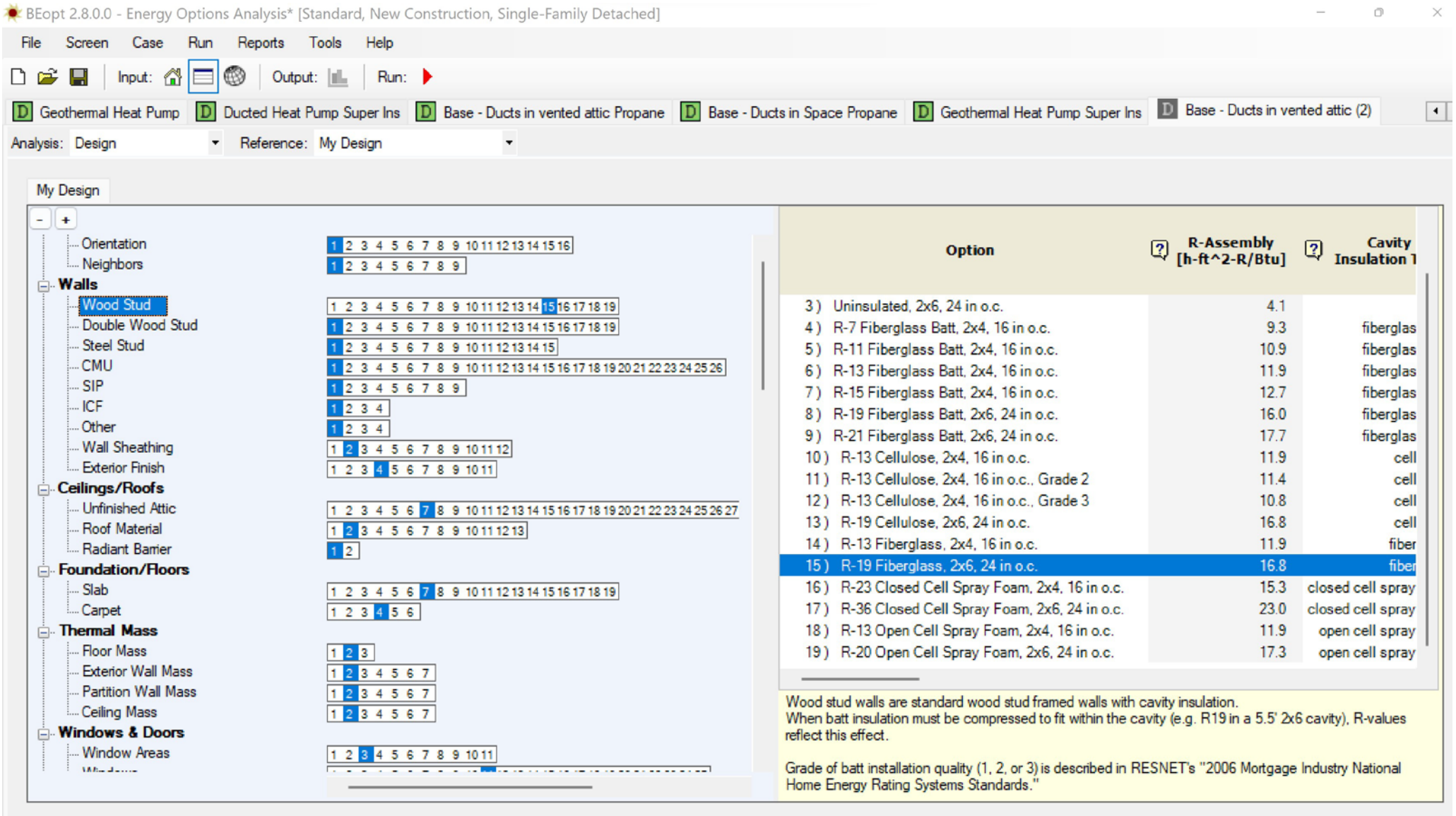
BEopt Energy Input Parameters



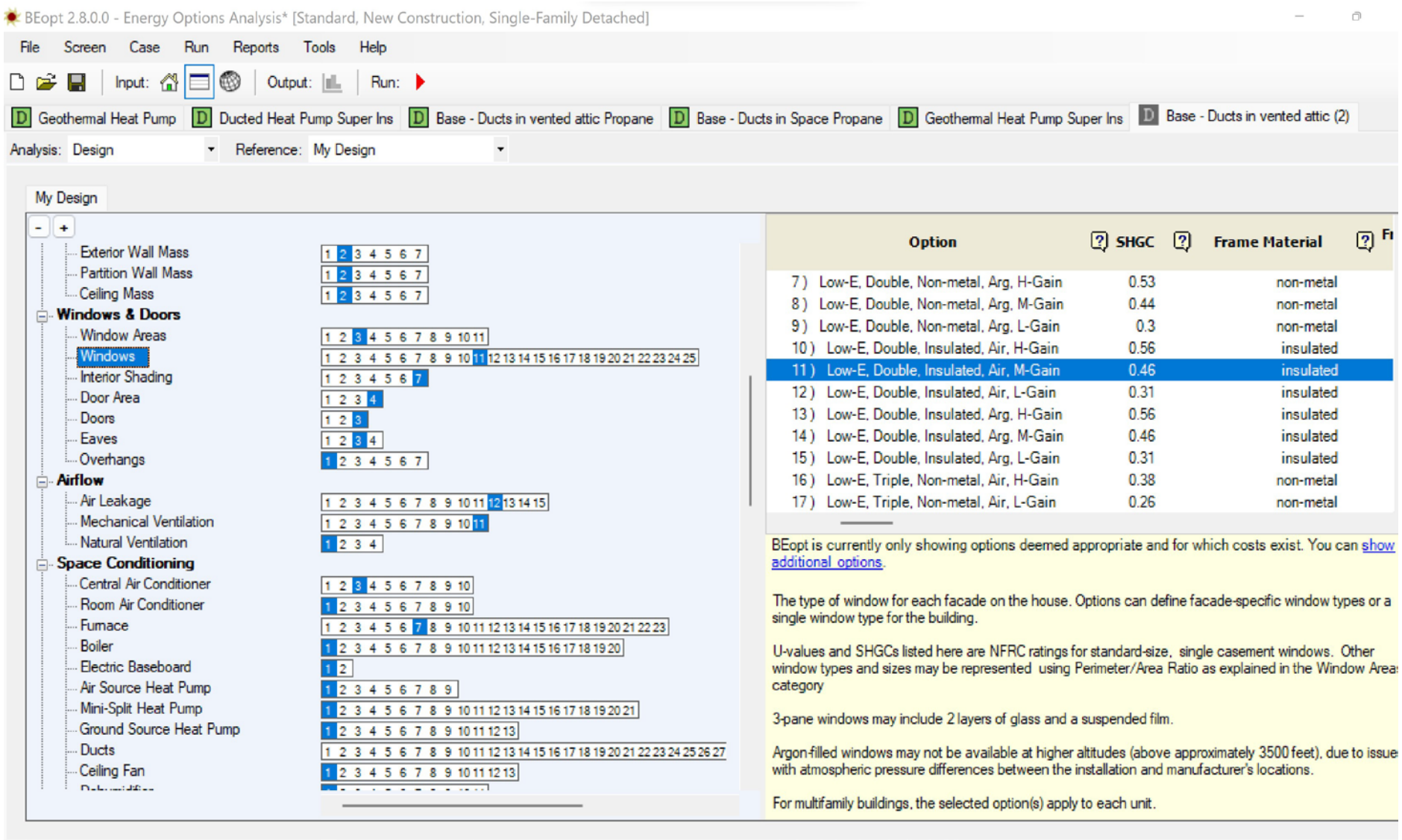
BEopt – House Geometry



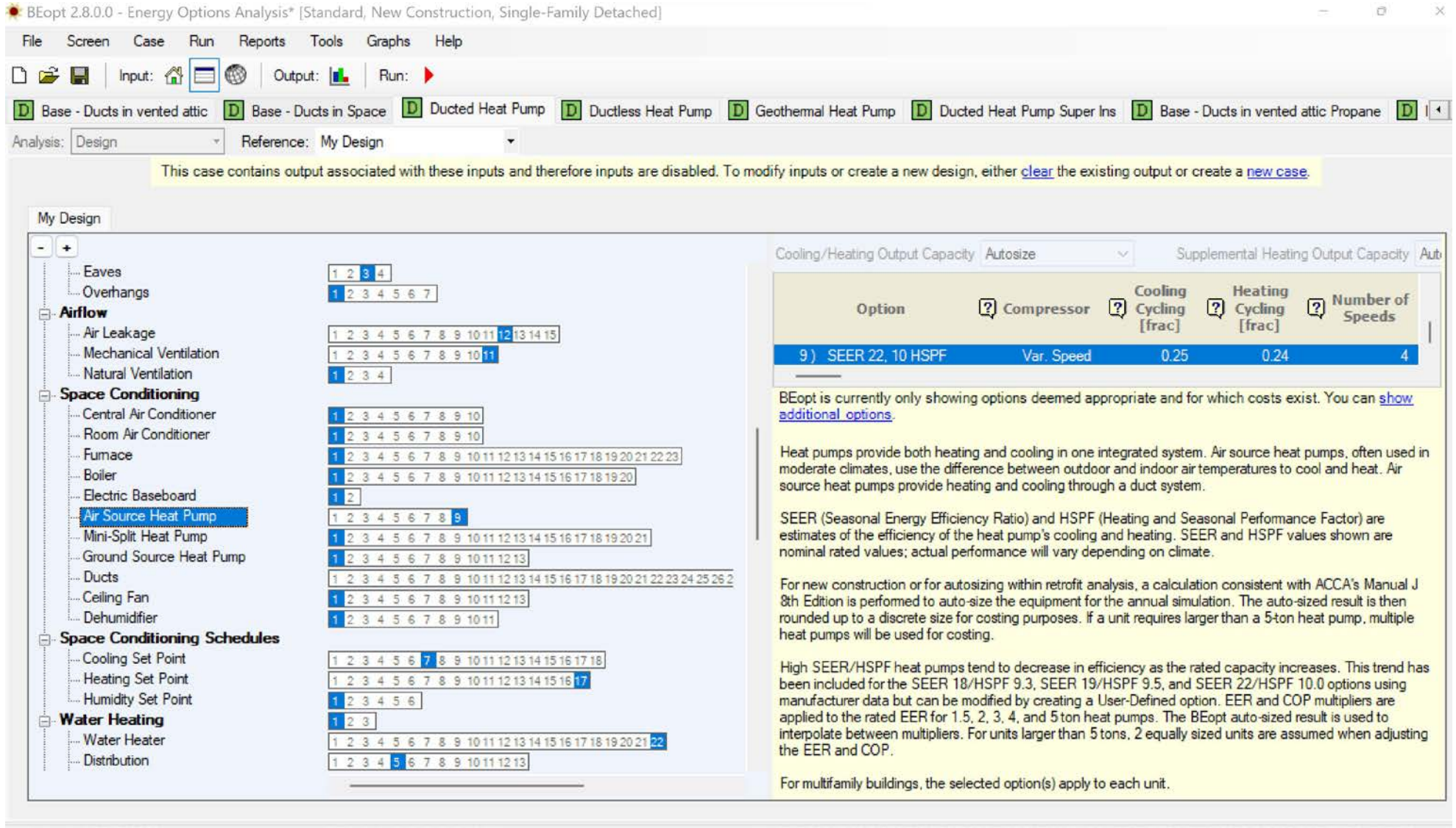
BEopt Input – Wall Construction



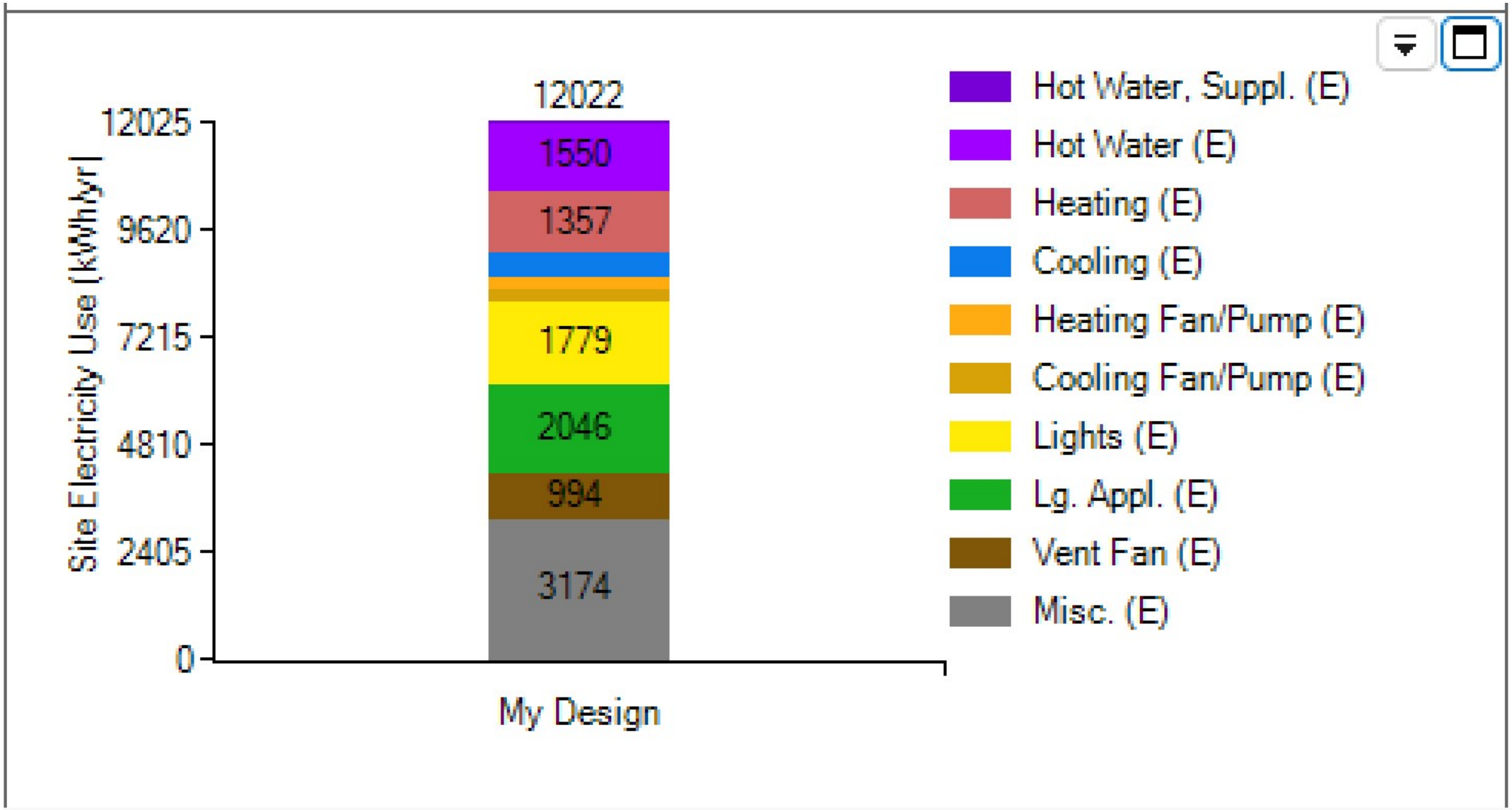
BEopt Input – Window Type



BEopt Input – Mechanical System Options



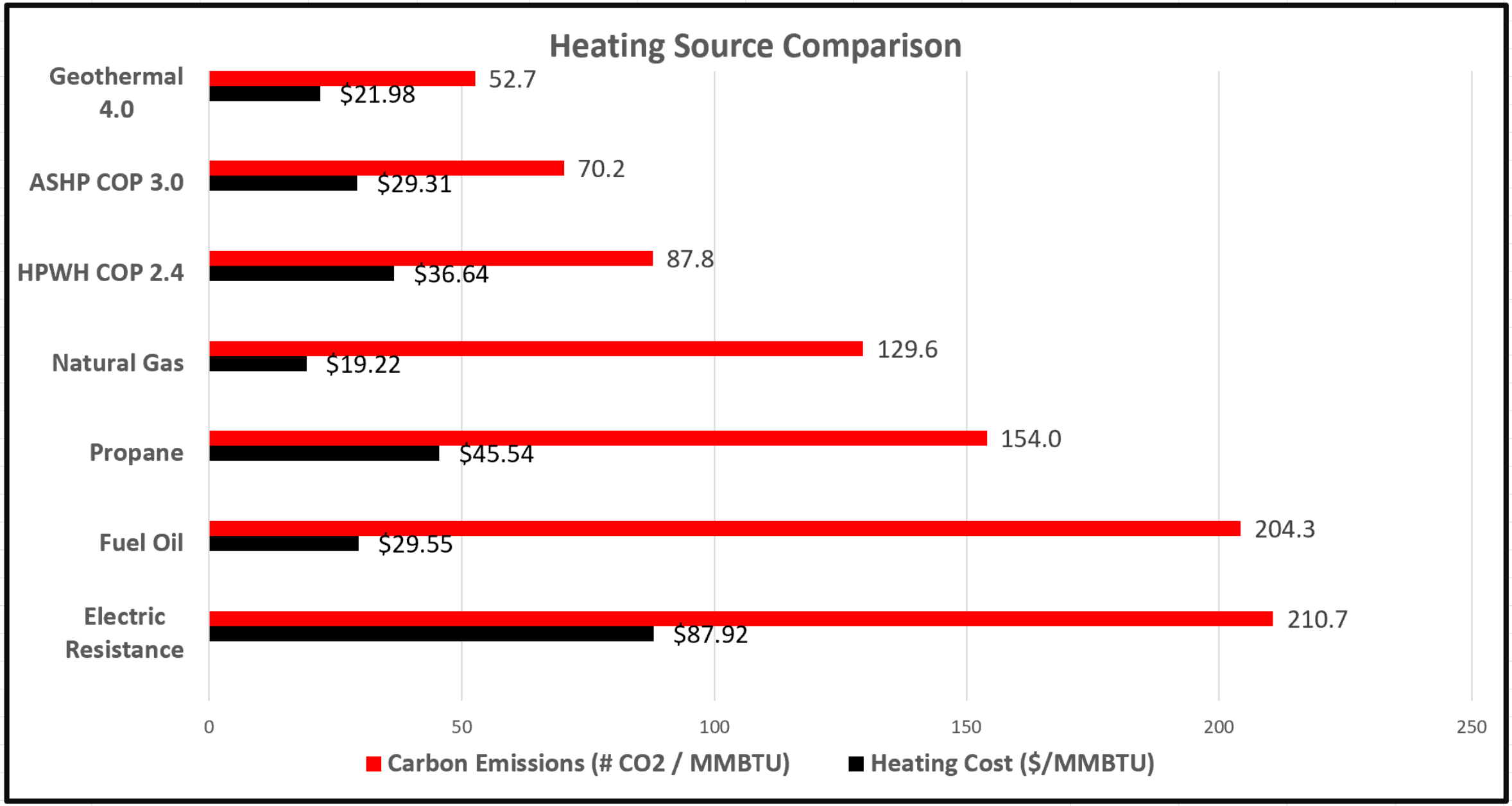
BEopt Output - Energy Consumption by End Use



BEopt/Energy Plus Energy Model

House Description: 2 Story Colonial, 5 BdRm, 4 BathRm, 4,200 SF Finished Space

Item Description	Base Case Gas Furnace, Split DX AC	Option 1 Ducted ASHP	Option 2 Ductless ASHP	Option 3 Geo Heat Pump	Option 4 Ducted ASHP w/ Super Ins.	Option 5 Geo Heat Pump w/ Super Insul
Heat Fuel	Gas / Propane	All Electric	All Electric	All Electric	All Electric	All Electric
Orientation	N/S	N/S	N/S	N/S	N/S	N/S
Wall Construction	2x6, 24" o.c., R-19, FiberGlass	Base	Base	Base	2x6, 24" o.c., R-19, Dense Pack Cellulose	2x6, 24" o.c., R-19, Dense Pack Cellulose
Wall Sheathing	1/2" OSB	Base	Base	Base	1/2" OSB, R-10 XPS	1/2" OSB, R-10 XPS
Attic Floor Insulation	R-49 FiberGlass	Base	Base	Base	R-60, Foam/Cellulose	R-60, Foam/Cellulose
Slab	4 Ft Perim R10	Base	Base	Base	100% Slab R-30	100% Slab R-30
Windows Qty	15% N/S/E/W	Base	Base	Base	30% S, 10% N/E/W	30% S, 10% N/E/W
Window U Value	0.30	Base	Base	Base	0.18	0.18
Window SHGF	0.46	Base	Base	Base	0.40	0.40
Infiltration	3 ACH50	Base	Base	Base	1 ACH 50	1 ACH 50
Mech Vent	ERV 70%	Base	Base	Base	Base	Base
AC	SEER 14	SEER 22	SEER 26	EER 20.2	SEER 22	EER 20.2
Heat	Furnace 95% AFUE	10 HSPF	10.7 HSPF	COP 4.2	10 HSPF	COP 4.2
Supplemental Heat	None	Yes, Electric	Yes, Electric	None	Yes, Electric	None
Ductwork	In Conditioned Space	Base	None	Base	Base	Base
Cooling Setpoint	74F	Base	Base	Base	Base	Base
Heating Setpoint	70F / 62F	Base	Base	Base	Base	Base
Water Heater	Gas / Propane, Hi-eff	HPWH	HPWH	HPWH	HPWH	HPWH
Lighting	100% LED	Base	Base	Base	Base	Base
Stove	Gas / Propane	Induction El.	Induction El.	Induction El.	Induction El.	Induction El.
Clothes Dryer	Gas / Propane	Electric	Electric	Electric	Electric	Electric
Plug Loads	National Ave	Base	Base	Base	Base	Base
Heating Equip Capacity	60 MBH	60 MBH	60 MBH	60 MBH	30 MBH	30 MBH
Cooling Equip Capacity	4.5 Tons	4.5 tons	4.5 tons	4.5 tons	3 tons	3 tons
	Yellow Blocks Indicate Options that Vary from Base Case					



Based on Utility Rates as of Jan 31, 2022 for Eversource Electric and Gas, Default Service

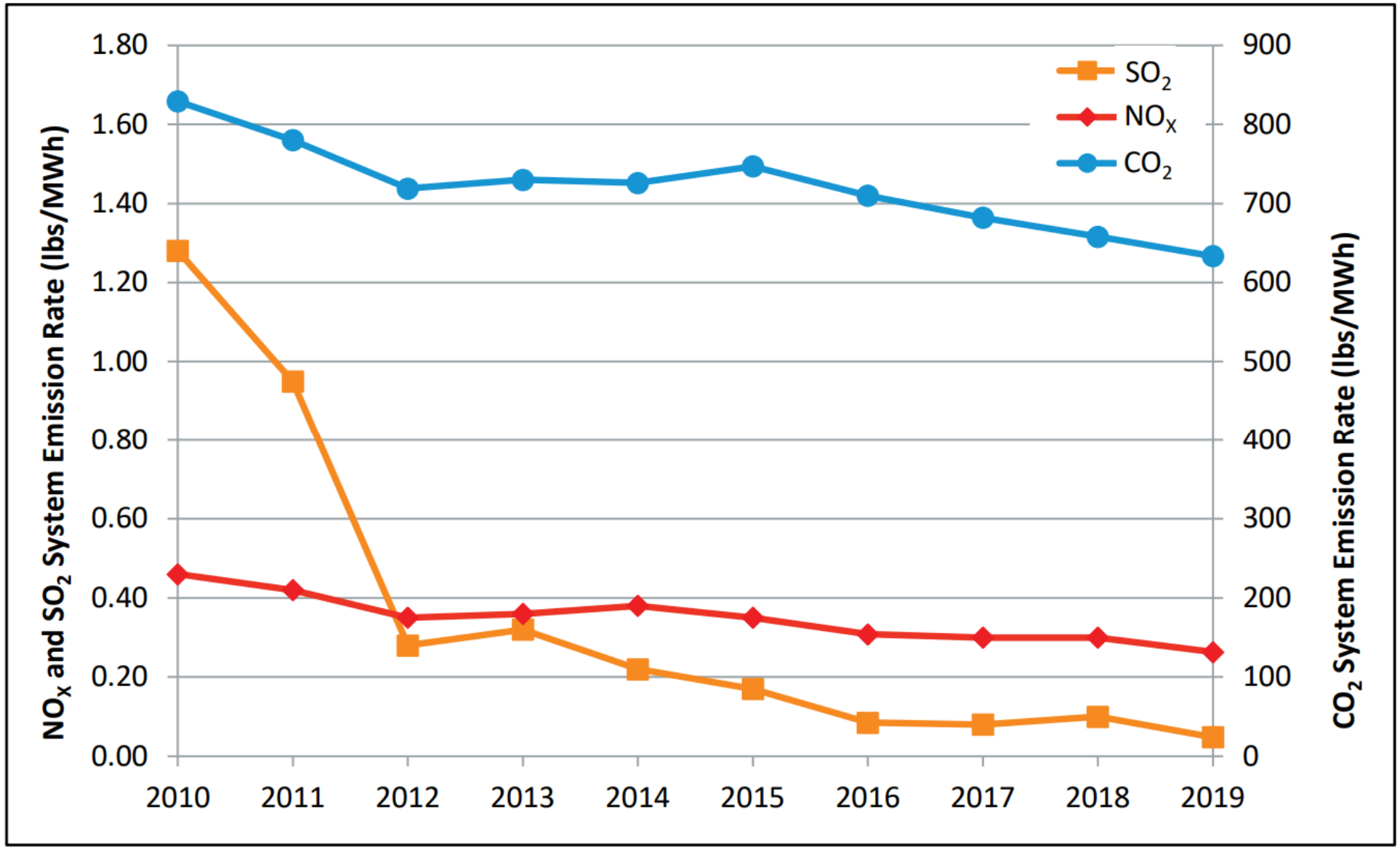
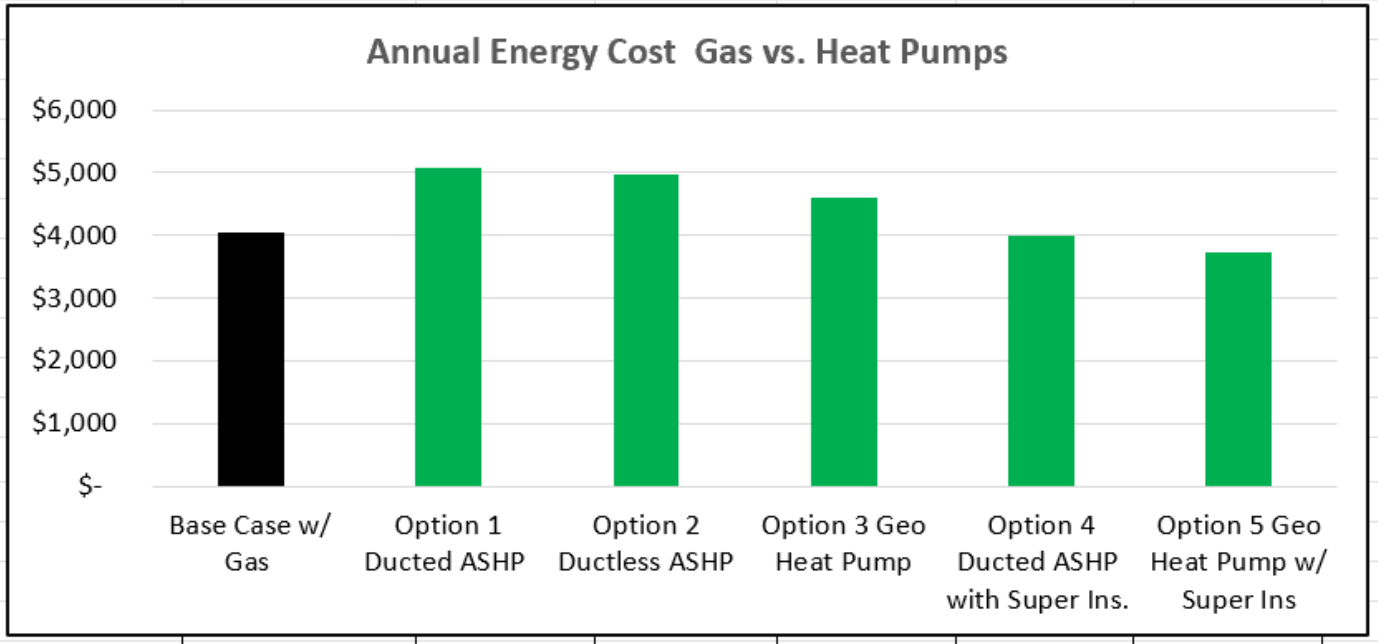


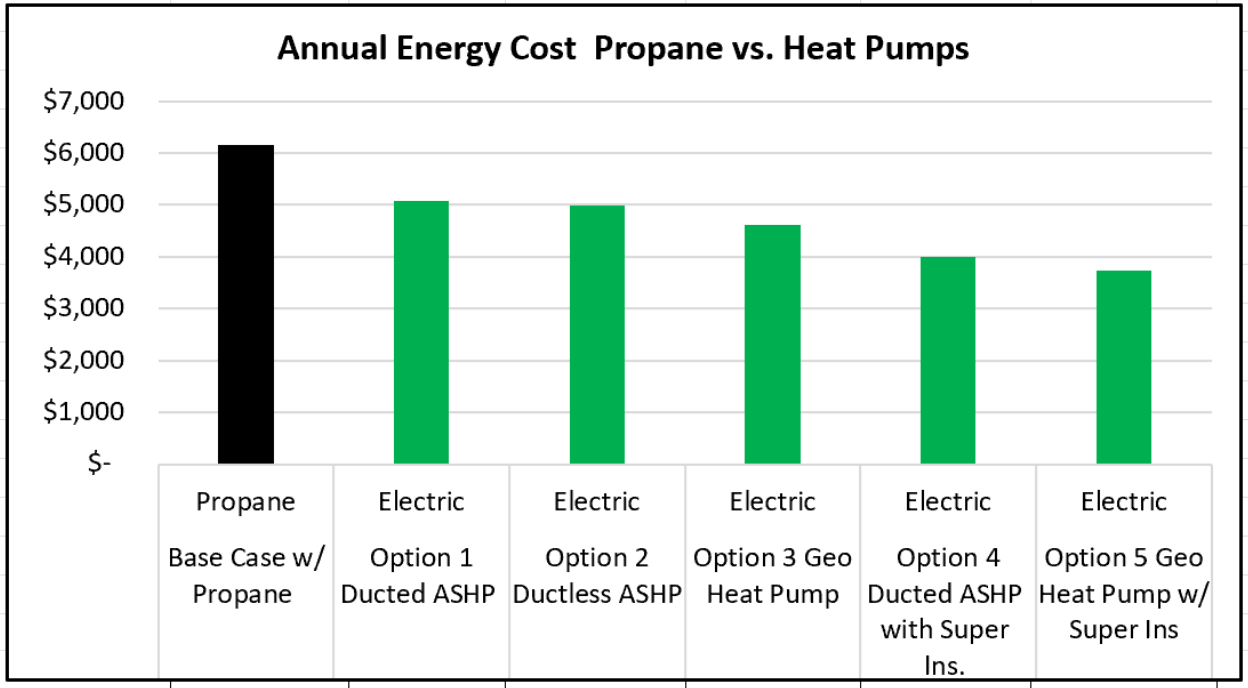
Figure 5-4: ISO New England system annual average generator emission rates, 2010 to 2019 (lbs/MWh).

New Construction Base Case = Gas Heat



Add Heat Pump	Cooling Capacity (Tons)	4.5	4.5	4.5	4.5	3	3
	Heating Capacity (MBH)	60	60	60	60	30	30
	Annual Energy Cost w/o Solar ($/Yr)	$ 4,039	$ 5,067	$ 4,977	$ 4,613	$ 3,995	$ 3,740
	Annual Energy Savings w/o solar ($/Yr)	NA	$ (1,028)	$ (938)	$ (574)	$ 44	$ 299
	Construction Cost Change ($)	NA	$ -	$ (5,000)	$ 15,000	$ 35,000	$ 50,000
	Carbon Reduction w/o solar (%)	0%	25%	27%	32%	42%	45%
Add Solar	Solar System Capacity (KW)	5.9	13.0	12.8	11.8	10.2	9.6
	Solar Array Area (SF) 1200 SF Available	295	651	639	592	511	478
	Solar Installed Cost (after Incentives)	$ 14,299	$ 32,716	$ 32,102	$ 29,644	$ 25,452	$ 23,735
	Total Net Project Costs (Solar + Heat Pump)	$ 14,299	$ 32,716	$ 27,102	$ 44,644	$ 60,452	$ 73,735
	Annual Energy Cost ($/Yr)	$ 1,473	$ -	$ -	$ -	$ -	$ -
	Annual Energy Savings ($/Yr)	$ 2,566	$ 4,039	$ 4,039	$ 4,039	$ 4,039	$ 4,039
	Carbon Reduction with solar (%)	34%	100%	100%	100%	100%	100%

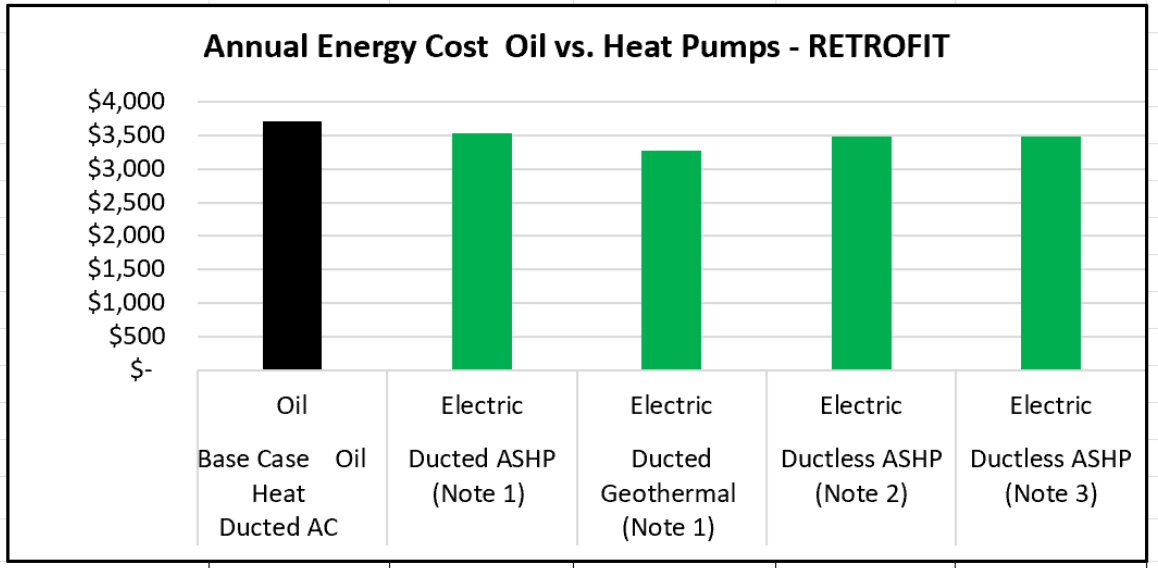
New Construction Base Case = Propane Heat



Add Heat Pump	Cooling Capacity (Tons)	4.5	4.5	4.5	4.5	3	3
	Heating Capacity (MBH)	60	60	60	60	30	30
	Annual Energy Cost w/o Solar ($/Yr)	$ 6,146	$ 5,067	$ 4,977	$ 4,613	$ 3,995	$ 3,740
	Annual Energy Savings w/o solar ($/Yr)	NA	$ 1,079	$ 1,169	$ 1,533	$ 2,151	$ 2,406
	Construction Cost Change ($)	NA	$ -	$ (5,000)	$ 15,000	$ 35,000	$ 50,000
	MASS Save Incentive ($)	$ -	$ 10,000	$ 10,000	$ 15,000	$ 10,000	$ 15,000
	Net Construction Cost ($)	NA	$ (10,000)	$ (15,000)	$ -	$ 25,000	$ 35,000
	Carbon Reduction w/o solar (%)	0%	34%	35%	40%	48%	52%
Add Solar	Solar System Capacity (KW)	5.9	13.0	12.8	11.8	10.2	9.6
	Solar Array Area (SF) 1200 SF Available	294	651	639	592	511	478
	Solar Installed Cost (after Rebate)	$ 14,239	$ 32,716	$ 32,102	$ 29,644	$ 25,452	$ 23,735
	Total Net Project Costs	$ 14,239	$ 22,716	$ 17,102	$ 29,644	$ 50,452	$ 58,735
	Annual Energy Cost ($/Yr)	$ 3,581	$ -	$ -	$ -	$ -	$ -
	Annual Energy Savings	$ 2,565	$ 6,146	$ 6,146	$ 6,146	$ 6,146	$ 6,146
	Carbon Reduction with solar (%)	30%	100%	100%	100%	100%	100%

Retrofit

Base Case = Oil Heat



Add Heat Pump	Cooling Capacity (Tons)	3 tons	3 tons	3 tons	3 tons	3 tons
	Heating Capacity (MBH)	45.0	45.0	45.0	45.0	45.0
	Annual Energy Cost w/o Solar ($/Yr)	$ 3,711	$ 3,538	$ 3,270	$ 3,493	$ 3,493
	Annual Energy Savings w/o solar ($/Yr)	NA	$ 173	$ 441	$ 218	$ 218
	Added Construction Cost ($)	NA	$ 5,000	$ 20,000	$ 5,000	$ (8,000)
	MASS Save Incentive ($)	$ -	$ 10,000	$ 15,000	$ 10,000	$ 10,000
	Net Construction Cost ($)	-	$ (5,000)	$ 5,000	$ (5,000)	$ (18,000)
	Carbon Reduction w/o solar (%)	$ -	54%	57%	54%	54%
Add Solar	Solar System Capacity (KW)	4.0	9.0	8.3	8.9	8.9
	Solar Array Area (SF) 1000 SF Available	201	451	416	445	445
	Solar Installed Cost (after Rebate)	$ 9,428	$ 22,362	$ 20,553	$ 22,053	$ 22,053
	Total Net Project Costs	$ 9,428	$ 17,362	$ 25,553	$ 17,053	$ 4,053
	Annual Energy Savings	$ 1,760	$ 3,711	$ 3,711	$ 3,711	$ 3,711
	Carbon Reduction with solar (%)	21%	100%	100%	100%	100%

Note 1: Construction cost assumes ducted AC system needs to be replaced so Cost is the incremental cost of Heat Pump vs Split DX AC

Note 2: Construction cost for ductless Heat Pump option assumes house had no AC and Owner was going to install ductless AC (not heat pump)

Note 3: Same as Note 1, plus credit for cost of boiler replacement avoided

Summary Table 1 - Stretch Code Compliant house. Heat Pump & Solar in lieu of fossil fuel heat

	Item	Compared to Gas	Compared to Propane	Comment
Add Heat Pump	Annual House Total Energy Cost with ASHP	25% Higher	18% Lower	Approx $1,028/Yr higher compared to gas, and approximately $1,079/Yr lower compared to propane
	Cost of Construction for ASHP	~ Same or Less than Gas	~ At Least $10,000 Less than Propane	Higher cost of high efficiency heat pumps is offset by elimination of gas furnace, all gas piping, combustion and flue piping. **See Note 1 Below**
	Carbon Emissions (Before adding solar)	25% Reduction	34% Reduction	If site is not compatible for Solar, House will benefit from lower carbon emissions over time as electric grid provides more renewable power
Add Solar PV	Solar PV Capacity	13 KW		No Shading, +/- 30 Deg due South, 100% of annual energy needed
	Roof Area Req'd	651 SF		1,200 SF Available in Modeled House
	Solar PV System Cost	$32,716	$32,716	$3.50/Watt, Includes Tax Credits
	Net Cost Heat Pump & Solar PV	$32,716	$32,716	Net Project Cost includes all incentives/credits availabe
	Annual House Total Energy Savings	$4,039	$6,146	Savings based on Base Case energy cost avoided
	Carbon Emissions	100% Reduction		House achieves Net Zero Energy target

Note 1: MASS Save Incentive of $10,000/$15,000 available for Installation of Air Source Heat Pump/Geothermal Heat Pump in Lieu of Propane

Summary Table 2 - Super-Insulated house. Heat Pump & Solar in lieu of fossil fuel heat

	Item	Compared to Gas	Compared to Propane	Comment
Add Heat Pump	Annual House Total Energy Cost with ASHP	2% Lower	35% Lower	Approx $44 Lower compared to gas, and approximately $2,151 lower compared to propane
	Added Cost of Higher Efficiency Envelope	$35,000 Higher (est.)	$25,000 Higher (est)	See Slide with Table showing insulation changes. Includes savings for smaller HVAC equipment capacity and $10,000 Incentive for Heat Pump (propane only)
	Carbon Emissions (Before adding solar)	42% Reduction	48% Reduction	If site is not compatible for Solar, House will benefit from lower carbon emissions over time as electric grid provides more renewable power
Add Solar PV	Solar PV Capacity	10.2 KW		No Shading, +/- 30 Deg due South, 100% of annual energy needed
	Roof Area Req'd	511 SF		1,200 SF Available in Modeled House
	Solar PV System Cost	$25,452		$3.50/Watt, Includes Tax Credits
	Net Cost Heat Pump & Solar PV	$60,452	$50,452	Net Project Cost includes all incentives/credits availabe
	Annual Energy Savings	$4,039	$6,146	Savings based on Base Case energy cost avoided
	Carbon Emissions	100% Reduction		House achieves Net Zero Energy target

Note 1: MASS Save Incentive of $10,000/$15,000 available for Installation of Air Source Heat Pump/Geothermal Heat Pump in Lieu of Propane

Note 2: Additional savings available for house designs that can meet a lower HERS rating. Review this with your HERS consultant

Summary Table 3 - Super-Insulated house. Geothermal Heat Pump in lieu of fossil fuel heat

	Item	Compared to Gas	Compared to Propane	Comment
Add Heat Pump	Annual House Energy Cost with Geothermal	8% Lower	40% Lower	Approx $660 Lower compared to gas, and approximately $2,800 lower compared to propane
	Added Cost of Higher Efficiency Envelope & Geothermal System	$50,000	$35,000	See Slide with Table showing insulation changes. Includes savings for smaller HVAC equipment capacity. Includes MASS Save Incentive for Geo HP. Federal Tax Credit for Geothermal systems includes cost of entire HVAC system (propane only)
	Carbon Emissions (Before adding solar)	45% Reduction	52% Reduction	If site is not compatible for Solar, House will benefit from lower carbon emissions over time as electric grid provides more renewable power
Add Solar PV	Solar PV Capacity	9.6 KW		No Shading, +/- 30 Deg due South, 100% of annual energy needed
	Roof Area Req'd	478		1,200 SF Available in Modeled House
	Solar PV System Cost	$23,735		$3.50/Watt, Includes Tax Credits
	Net Cost Heat Pump & Solar PV	$73,735	$58,735	Net Project Cost includes all incentives/credits availabe
	Annual Energy Savings	$4,039	$6,146	Savings based on Base Case energy cost avoided
	Carbon Emissions	100% Reduction		House achieves Net Zero Energy target

Note 1: MASS Save Incentive of $10,000/$15,000 available for Installation of Air Source Heat Pump/Geothermal Heat Pump in Lieu of Propane

Note 2: Additional savings available for house designs with HERS rating <35.

Summary Table 4 - Retrofit 2,600 SF Existing House with Oil Heat to Heat Pump

(After Mass Save Weatherization)

	Item	Convert to Ducted ASHP (Note 1)	Convert to Ducted or Ductless ASHP (Note 2)	Comment
Add Heat Pump	Annual House Energy Cost with ASHP	4% Lower	13% Lower	Approx $150 Lower with Ducted ASHP, $400 lower cwith Ductless ASHP
	Net Cost of Conversion including incentives and avoided cost	($5,000)	($18,000)	Red Values are negative costs. Includes Incentives and avoided costs (see notes 1,2 below)
	Carbon Emissions (Before adding solar)	54% Reduction	54% Reduction	If site is not compatible for Solar, House will benefit from lower carbon emissions over time as electric grid provides more renewable power
Add Solar PV	Solar PV Capacity	9 KW		No Shading, +/- 30 Deg due South, 100% of annual energy needed
	Roof Area Req'd	451 SF		1,000 SF Available in Modeled House
	Solar PV System Cost	$22,362		$3.50/Watt, Includes Tax Credits
	Net Cost Heat Pump & Solar PV	$17,362	$4,362	Cost of Solar + Net Cost of HVAC Upgrade
	Annual Energy Savings	$3,711		Savings based on fuel cost avoided
	Carbon Emissions	100% Reduction		House achieves Net Zero Energy target

Note 1: Cost of conversion assumes AC system needs to be replaced, so the Cost is the incremental cost of Heat Pump system vs Split DX

Note 2: Same as Note 1, plus the Boiler needs to be replaced, so the Cost is the incremental cost of Heat Pump system vs Split DX and new boiler

Summary

- If you are building a new home, build with a cold-climate electric heat pump system for your heating/cooling.
- This is not the “old” heat pump technology of 20+ years ago. It is built to be efficient in a New England environment
- Install an air-source heat pump for Domestic HW and an induction stove for cooking
- The construction cost is less than or equal to a conventional fossil fuel house.
- In many cases, this will also reduce your monthly utility bills.
- You will improve the comfort and indoor air quality of your home
- Work with your architect and HERS rater to explore options for increasing the efficiency of your new home with enhanced insulation levels and air tightness beyond the code requirement.
- Add solar PV to your roof if you have a good exposure.
- Make sure your roof lines are designed to accommodate the installation of the solar PV array.
- With electric heat pumps and solar PV, you can make your new house a “Net Zero Energy” (NZE) home without radically changing the look of the house
- Even if your house doesn’t lend itself to a solar PV system, with heat pumps you will be building with the future in mind, where our electric grid is becoming more carbon neutral with renewable energy sources.
- An all-electric home (especially a NZE home) will have increasing re-sale value over similar sized fossil-fueled homes.
- Check for Federal, State, and Utility Company credits and incentives to lower the cost of your clean energy investments.
- When you build a home, you are building something that will be around for 50-100 years.
- Do it Smart, Do it Right……now is the opportunity.

High Performance Building Design

Do it Smart, Do it Right

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