TRADITIONAL BUILDING CONFERENCE

Form Follows Energy: Residential Design Before and After Fossil Fuels

AIA Provide T032 Course Number TBCSM2

1 AIA Health/Safety Welfare Learning Unit

CS-021404 1 Hour - Energy (MA CSL)

March 25, 2026

Salem, MA

JB Clancy, AIA; Managing Partner, ART Architects; Boston, MA

AIA Continuing Education Provider

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Course Description

We must find a way to dramatically reduce the amount of energy our buildings consume. How can we design and construct our buildings to meet this challenge? We might look at traditional building forms before the introduction of fossil fuels into our energy economy. Buildings constructed pre-fossil fuels are the original zero net energy/zero carbon structures.

Learning Objectives

- Describe the evolution of home design in America from 1600 to the present and how energy inputs have impacted building form.
- Compare and contrast building envelope design and passive heating strategies, from 1600 to present day.
- Explain different forms of energy and how to measure them.
- Develop different strategies for maximum energy/heating efficiency when building today.

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QUESTIONS AND ANSWERS

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FORM FOLLOWS ENERGY

J.B. Clancy, AIA

ART ARCHITECTS

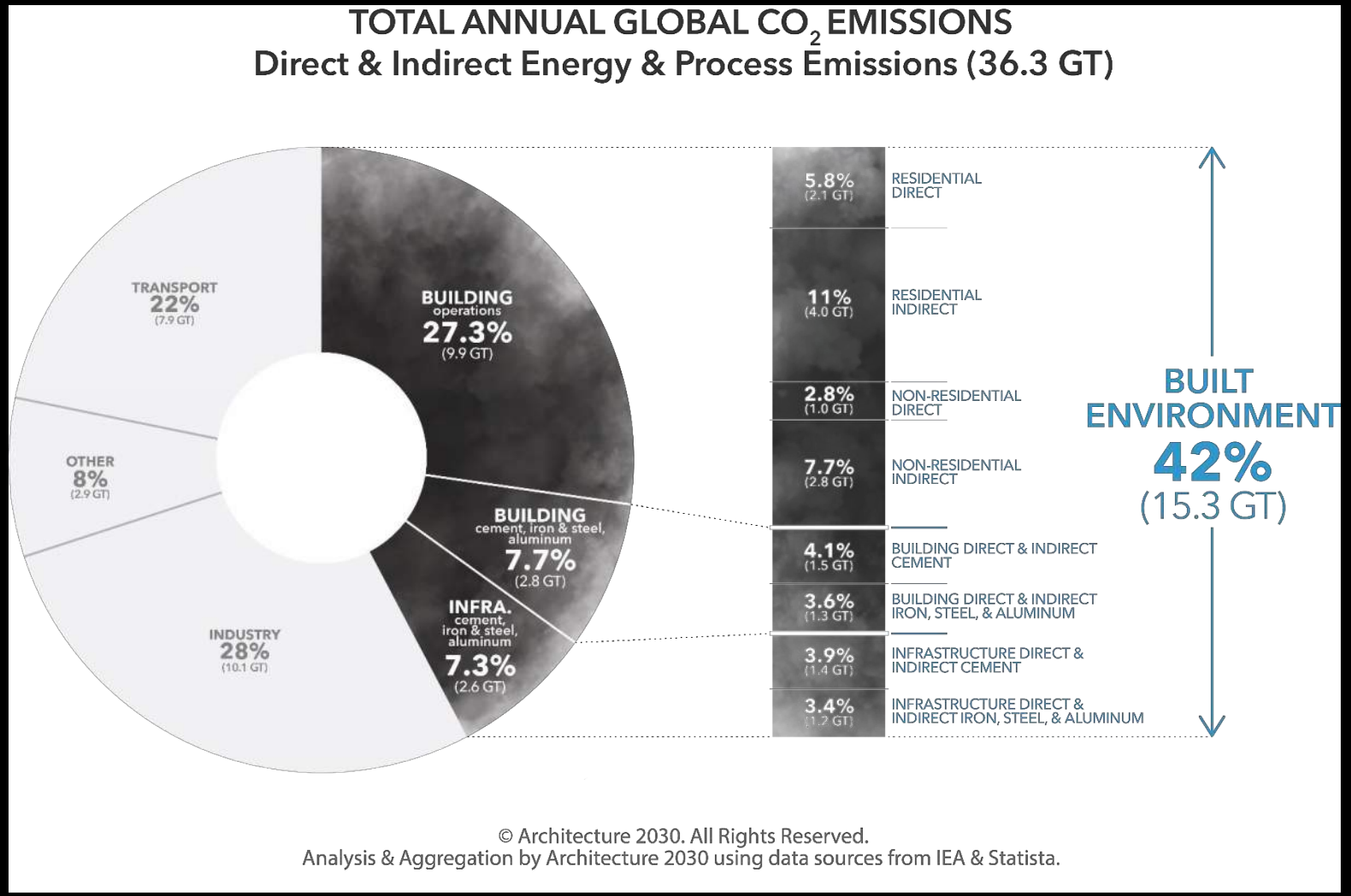
Traditional Building Conference
Salem, MA
March 25, 2026

TRADITIONAL BUILDING CONFERENCE

FORM FOLLOWS ENERGY

Introduction: Context
Chapter 1: Energy 101
Chapter 2: Form Follows Energy Timeline
Chapter 3: A Tale of Three Houses

Introduction: Context

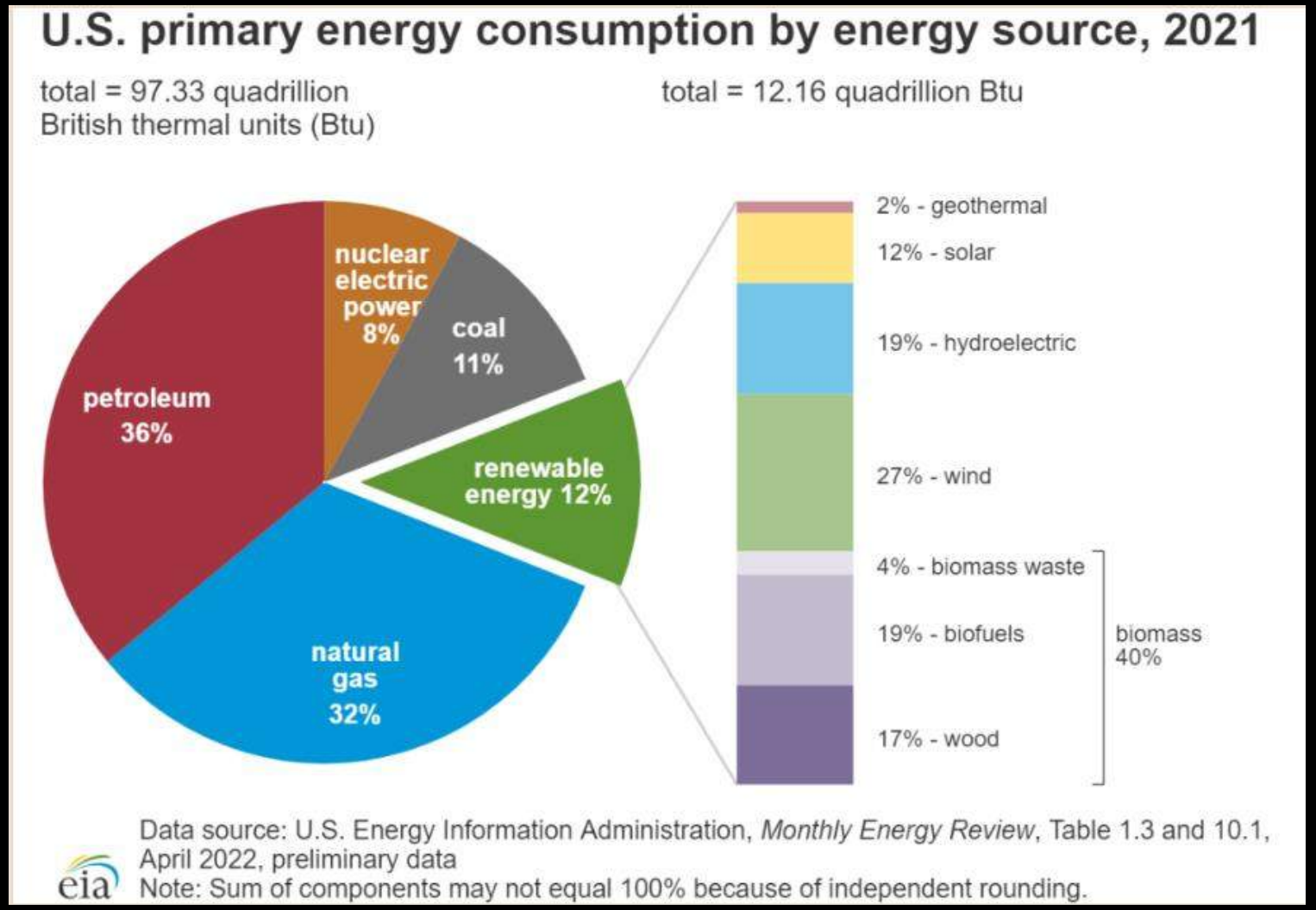


Chapter 1: Energy 101

- Scientists define energy as the ability to do work.
- Modern civilization is possible because people have learned how to change energy from one form to another and then use it to do work.
- We use energy for a variety of things, such as walking and bicycling, moving cars along roads and boats through water, cooking and refrigerating food, lighting our homes and offices, manufacturing products, and even sending astronauts into space.

https://www.eia.gov/energyexplained/what-is-energy/

Energy 101


U.S. primary energy consumption by energy source, 2021
total = 97.33 quadrillion British thermal units (Btu)
total = 12.16 quadrillion Btu
petroleum 36%
nuclear electric power 8%
coal 11%
renewable energy 12%
natural gas 32%
2% - geothermal
12% - solar
19% - hydroelectric
27% - wind
4% - biomass waste
19% - biofuels
17% - wood
biomass 40%
Data source: U.S. Energy Information Administration, Monthly Energy Review, Table 1.3 and 10.1, April 2022, preliminary data
Note: Sum of components may not equal 100% because of independent rounding.
eia

Energy 101 - Electricity

	GIGAWATT-HOURS (GWh)	% OF GENERATION	% OF NEL
Total Generation (a)	111,643	100%	95%
Gas	60,447	55%	51%
Nuclear	27,620	25%	23%
Renewables	14,389	13%	12%
Solar	4,836	4.3%	4.1%
Wind	4,618	4.1%	3.9%
Refuse	2,563	2.3%	2.2%
Wood	2,012	1.8%	1.7%
Landfill Gas	339	0.30%	0.29%
Methane	21	0.019%	0.018%
Steam	0	0.00%	0.00%
Hydro (b)	7,060	6.3%	6.0%
Oil	1,147	1.03%	0.97%
Other (c)	704	0.63%	0.60%
Coal	268	0.24%	0.23%
Price-Responsive Demand	10	0.009%	0.008%

In New England: 55.7% of the energy used to generate electricity comes from fossil fuels. There are very few coal fired power plants left in New England.

https://www.iso-ne.com/about/key-stats/resource-mix

Energy 101

Fossil Fuels & Human Work Capacity

Human Power

75–100 Watts per person

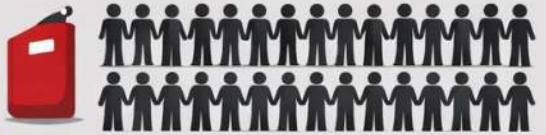
≈ **0.7 kWh** per day of work

1 Person = Limited Power

Fossil Fuel Power

High Energy Density

1 Gallon of Gasoline ≈ **33** kWh of Energy



1 Gallon of Gasoline = **Weeks of Human Labor**

The impact of fossil fuels

Pre-Industrial Era

1–2 Workers per Person

Modern Society

20–100 workers per Person

Energy 101

We need to gain a better perspective on energy

Energy and power have so many units!

- Daily food for a human= 2000 Calories = 2.3 kWh
- Daily food for a horse: 20,000 kcal = 23 kWh
- Daily house Energy = 30 kWh = 30 kWh
- Power per 1 solar panel = 250 W = 1 kWh
- Energy in 1 gallon of gasoline = 114,000 BTU = (33 kWh)
- Engine for an average car= 120 hp = 2200 kWh
- Electricity, USA per capita = 91 kWh = 91 kWh
- Energy, USA per capita = 374 Mj 240 kWh

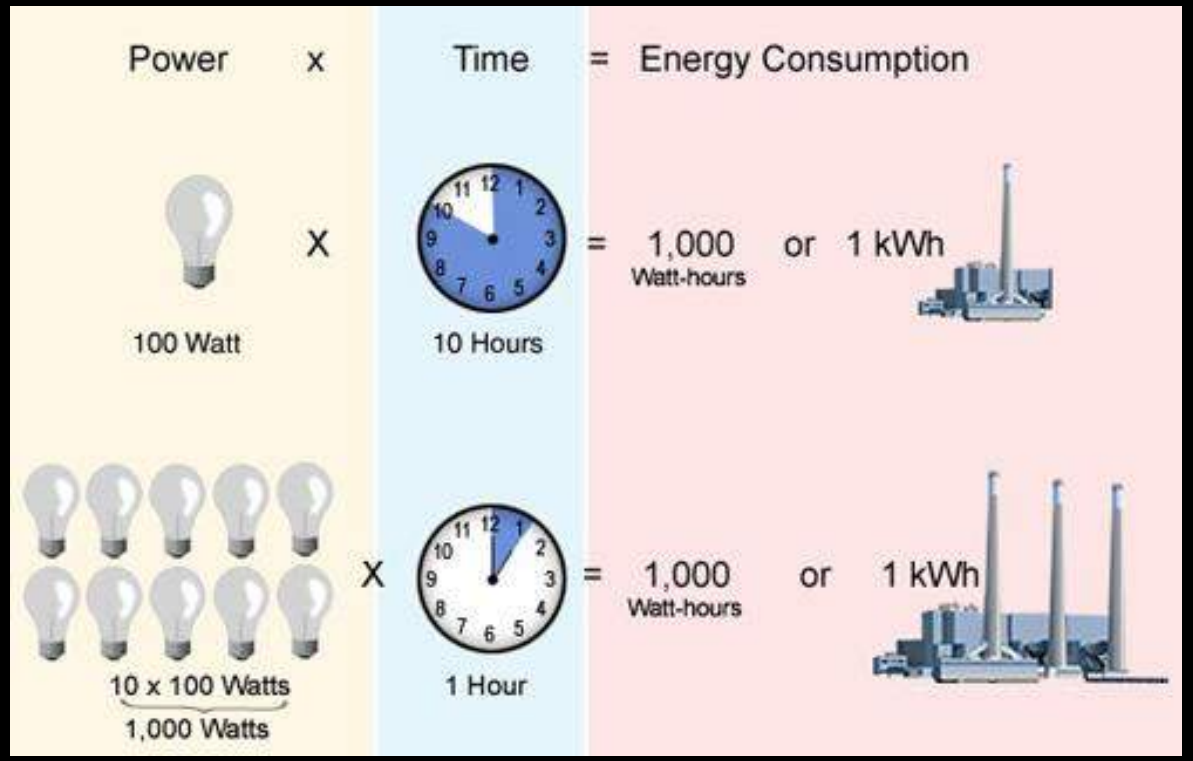
Look at all the energy and power units we see every day!

Can we put this all on the basis of a kWh?

Still too confusing!

PennState

https://courses.ems.psu.edu/egee102/node/1908

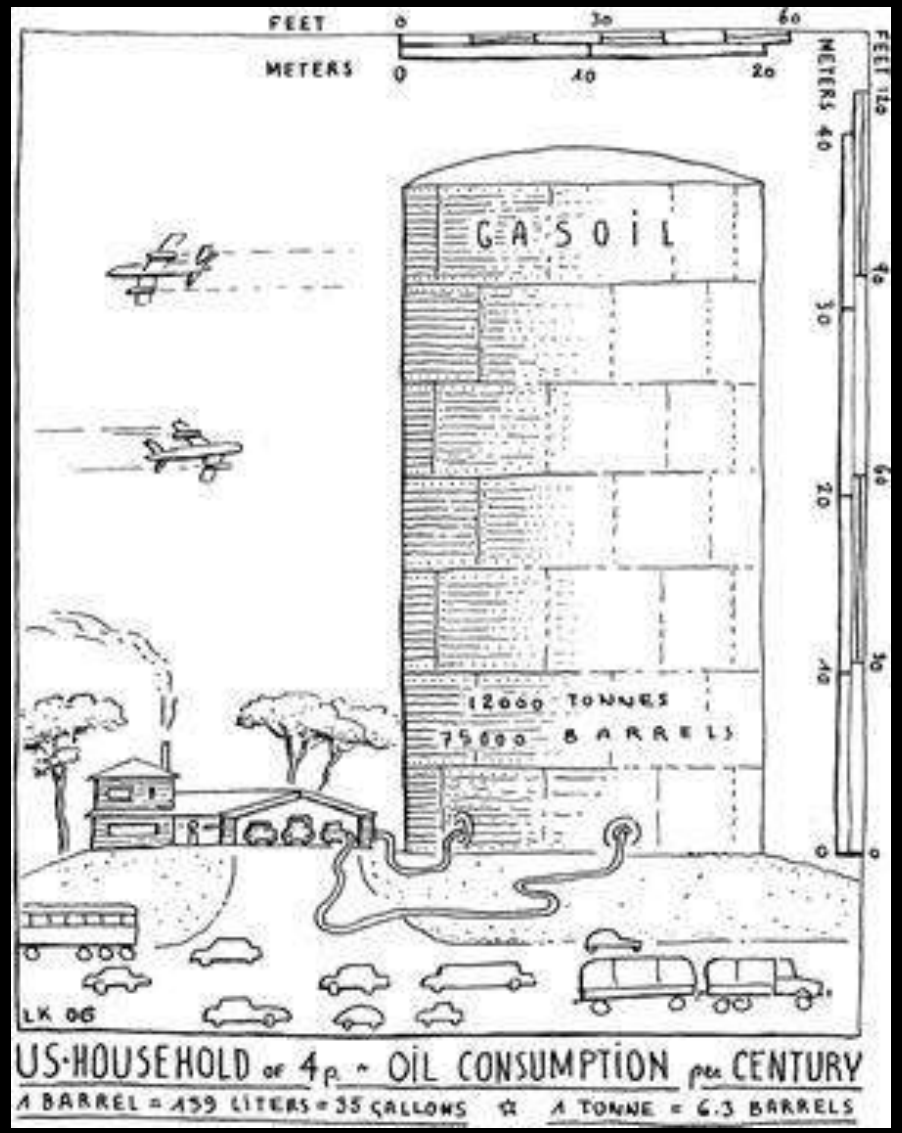


https://www.mariettaga.gov/1503/Power-Water

Energy – Operational

Units:
- **MMBtu**
- **kWh**
- **Therms**

Can be estimated in a HERS model or you can see this in your monthly energy bill



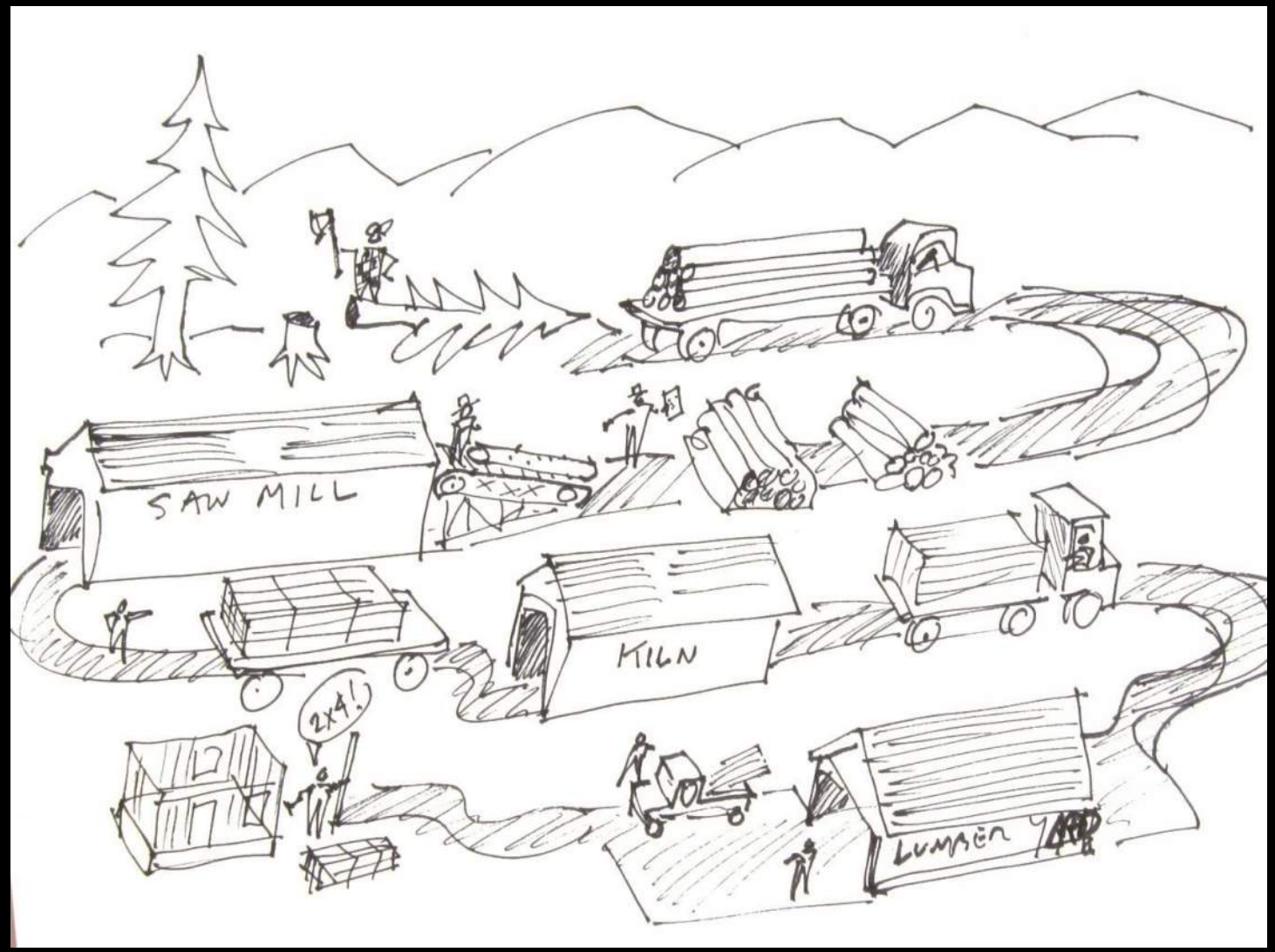
Leon Krier

Energy - Embodied

Units: kg CO2e

For the average passenger vehicle, producing **1,000 kg (1 metric ton) of $CO2$e** is equivalent to driving approximately **2,500 miles**

40,000 kg CO2e is equal to approx. 100k miles driven



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Energy - Embodied

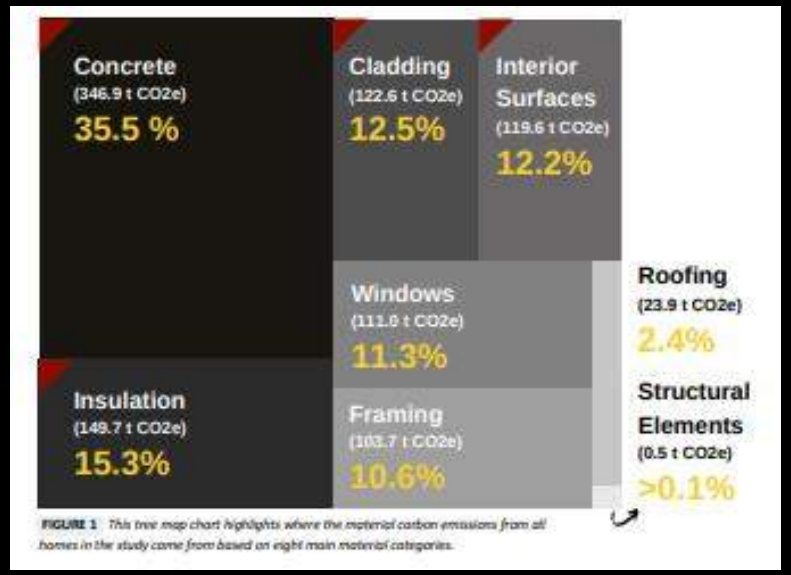
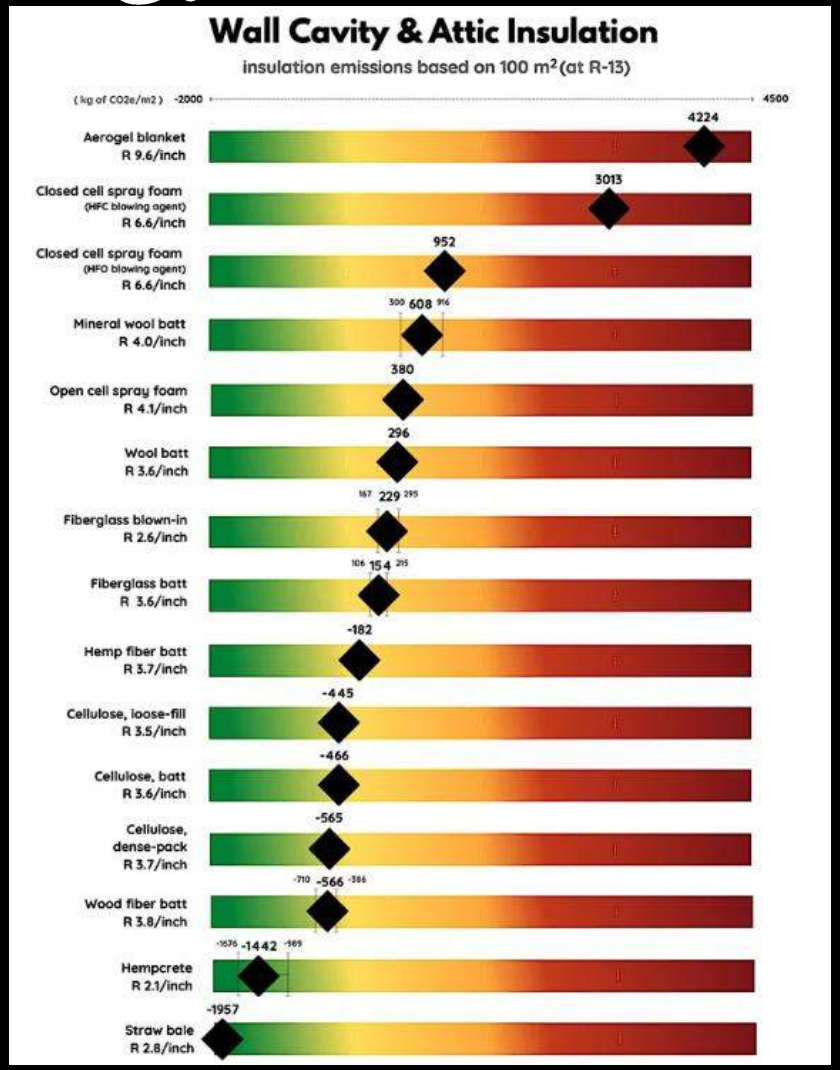
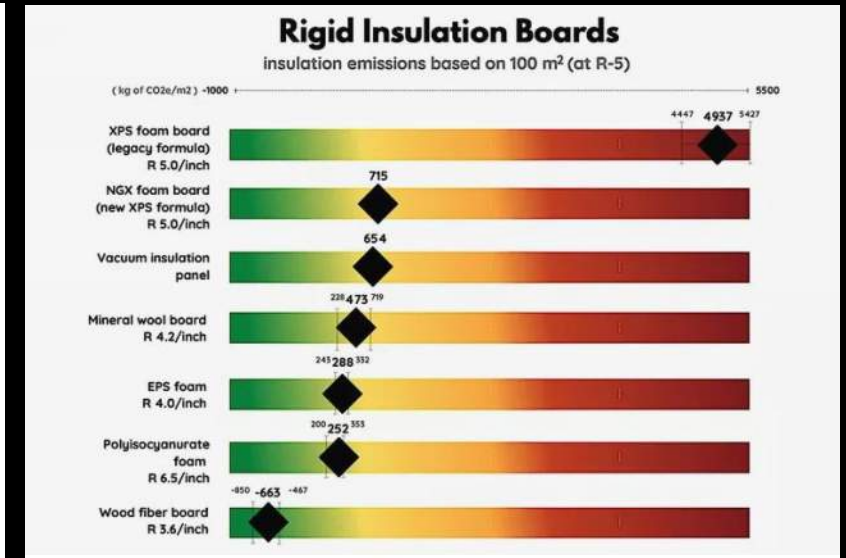
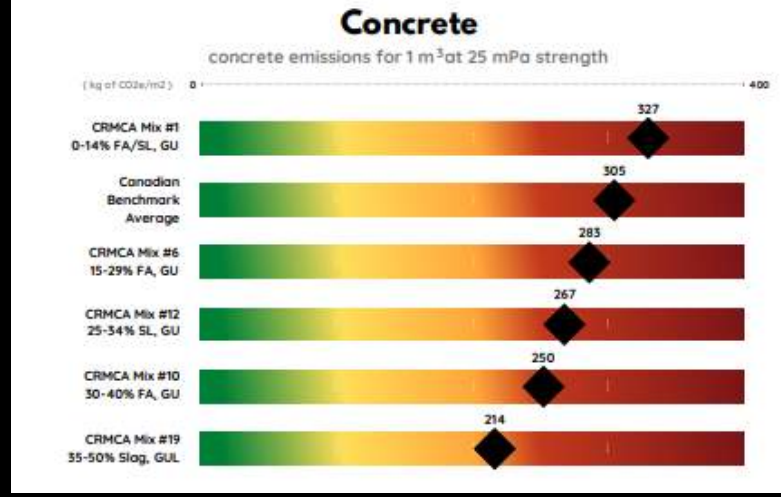


FIGURE 1 This tree map chart highlights where the material carbon emissions from all homes in the study come from based on eight main material categories.

BEAM software can measure the embodied energy of materials.







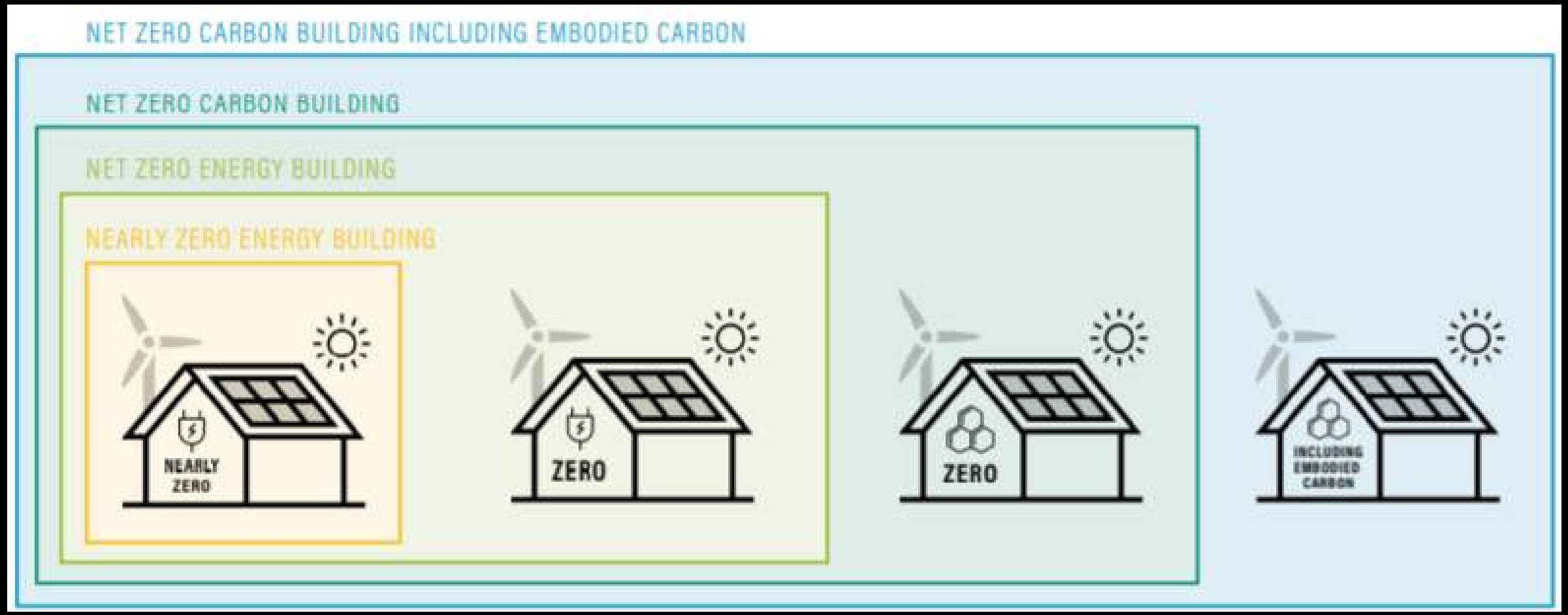
BEAM Guide: https://www.buildersforclimateaction.org/report---nelson-material-carbon-emissions-guide.html

Energy – Lifecycle Analysis

https://theber.com/operational-vs-embodied-carbon/

Whole Life Carbon = Embodied Energy + Operational Energy

Energy – Multiple types of zero

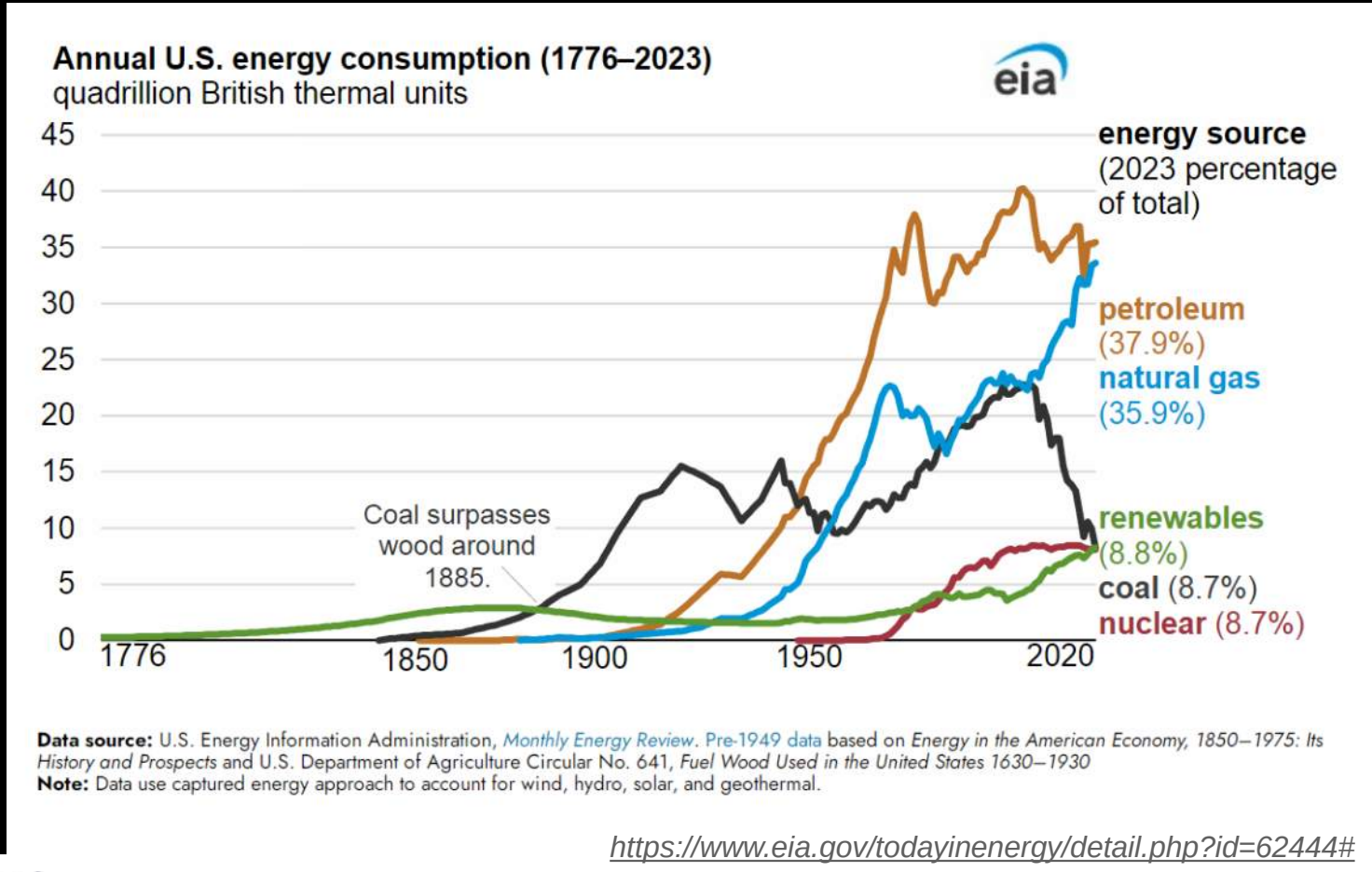


https://www.envirosustain.com/our-stories/the-carbdown-is-on-which-net-zero-scheme-is-the-right-one-for-you/

Chapter 2

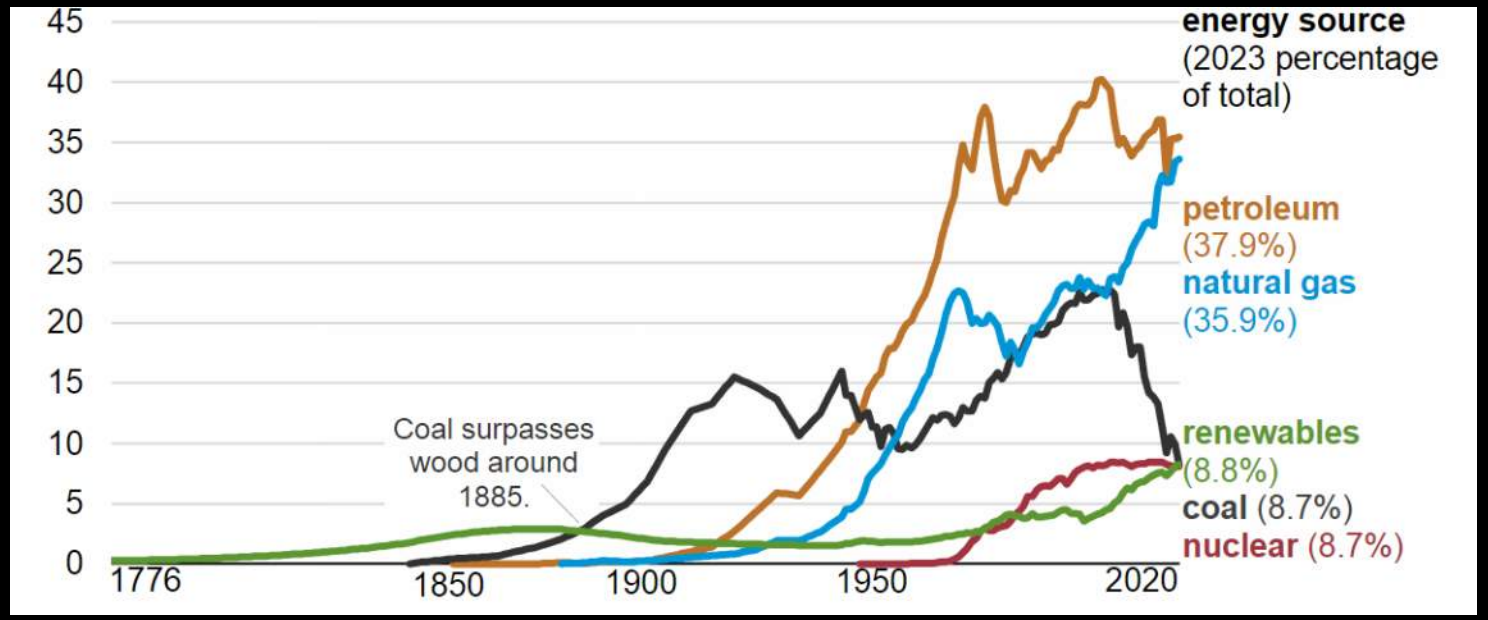
Form Follows Energy Timeline

History of Energy Consumption by Source in USA 1776 to Present



https://www.eia.gov/todayinenergy/detail.php?id=62444#

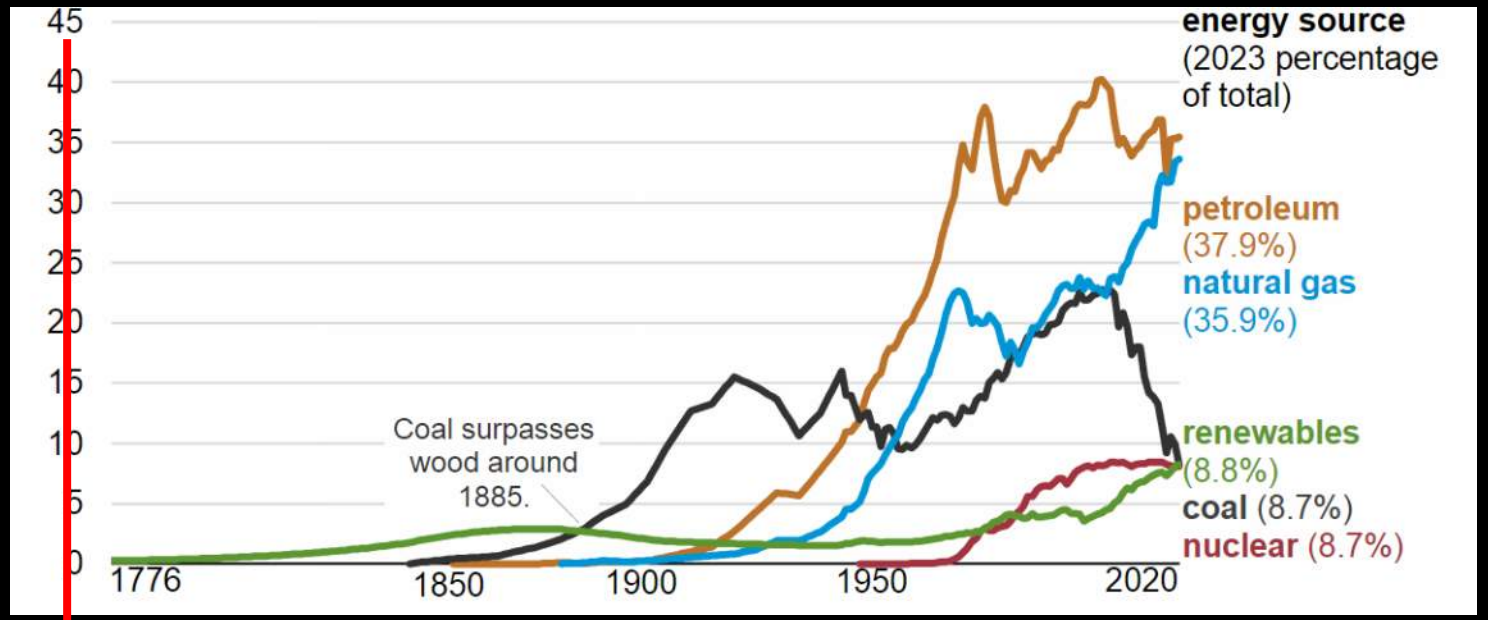
House 1630



- Wood is the primary material, used to build and heat the house.
- Subsistence living, just what is necessary
- Single room or two
- The chimney is the core of the plan
- Rooms cluster around heat
- Compact building form
- Limited manufactured materials, no ornament

George Soule House, Plymouth, MA 1630s

House 1732



- Wood is the primary material, used to build and heat the house.
- The chimney is the core of the plan
- Rooms cluster around heat, they have low ceilings for warmth and material efficiency
- Compact building form
- Limited ornament
- Windows face south, roof faces north

Hartwell Tavern, Concord, MA 1732

ART Architects

House 1732

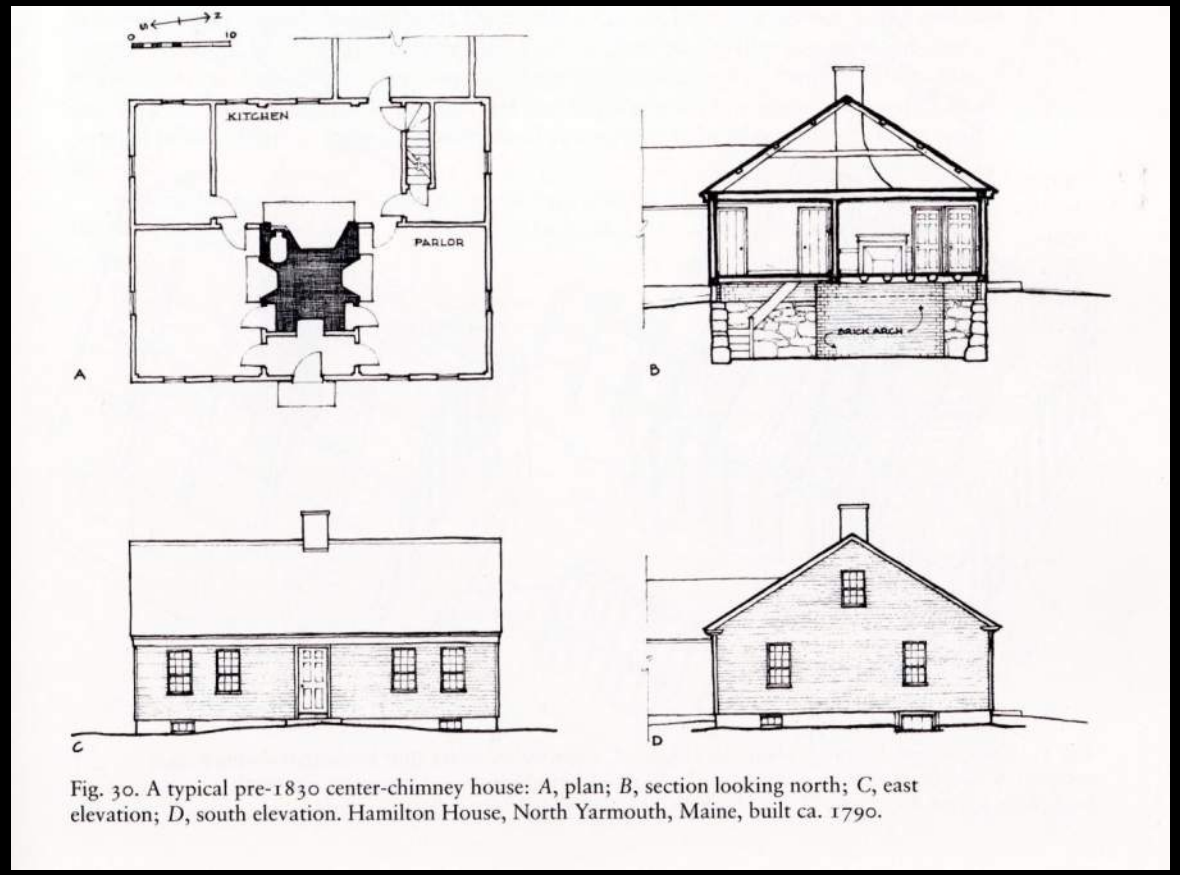
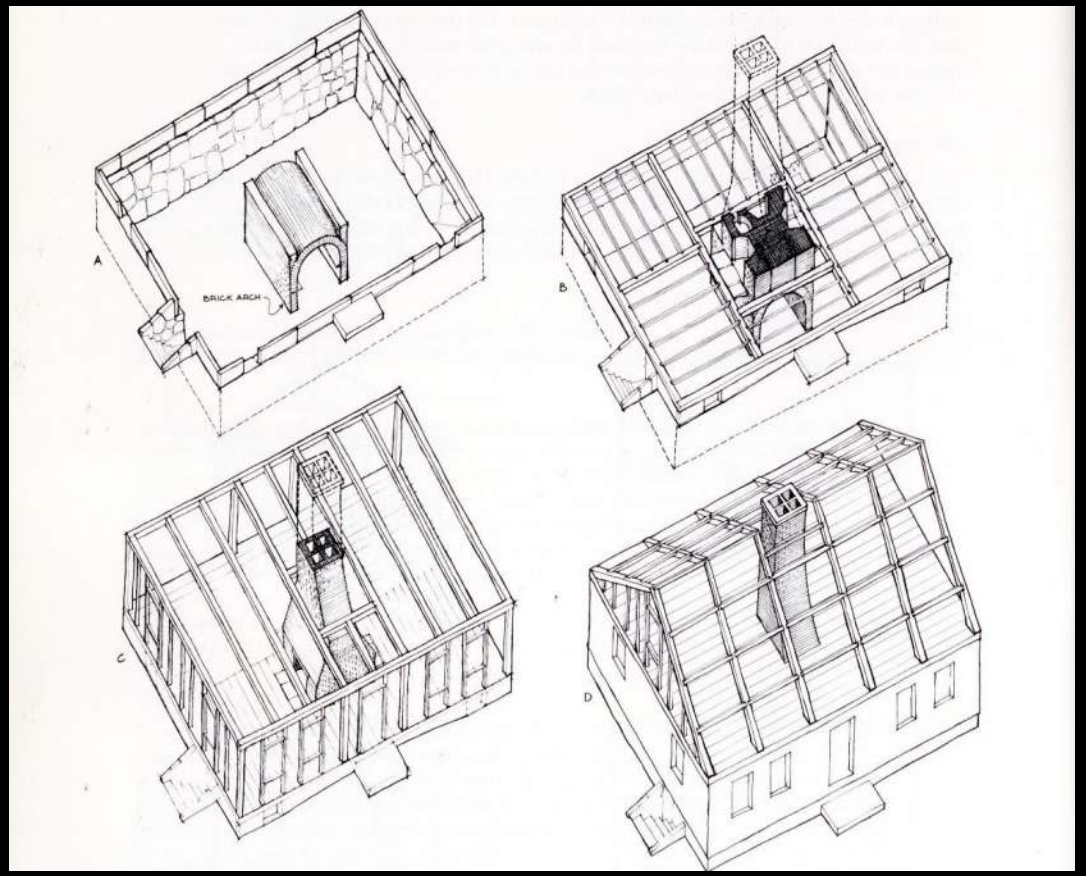


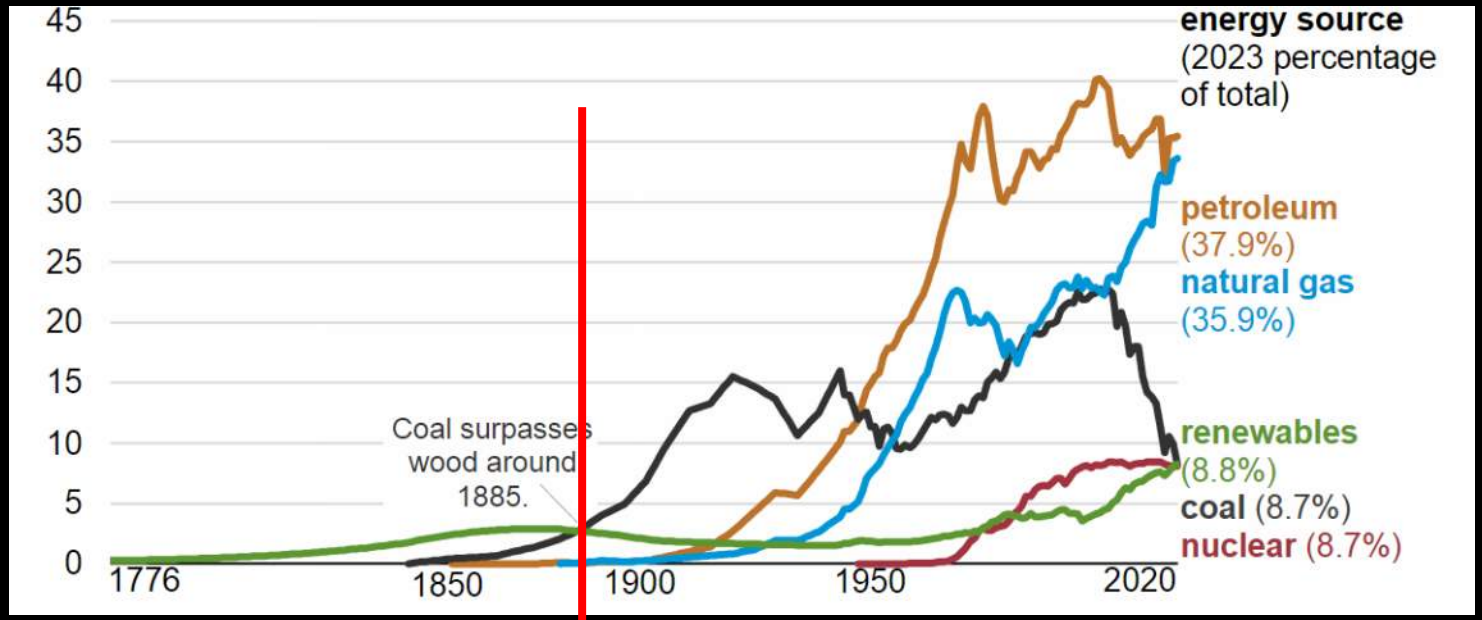
Fig. 30. A typical pre-1830 center-chimney house: *A*, plan; *B*, section looking north; *C*, east elevation; *D*, south elevation. Hamilton House, North Yarmouth, Maine, built ca. 1790.



Hubka, Thomas C. *Big House, Little House, Back House, Barn: The Connected Farm Buildings of New England*. Hanover, NH: University Press of New England, 1984.

18th c Houses - Climate Specific Form

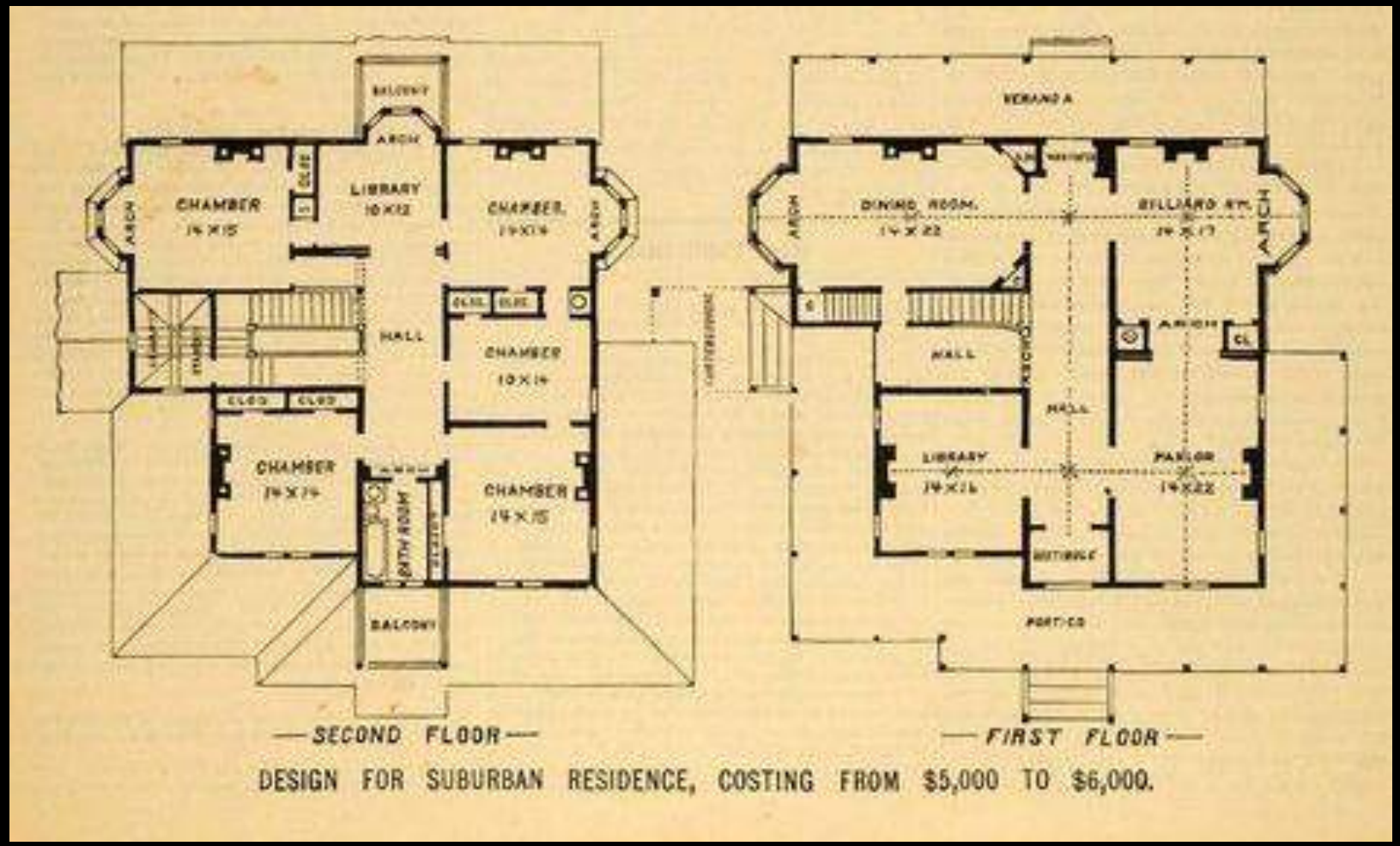
House1881



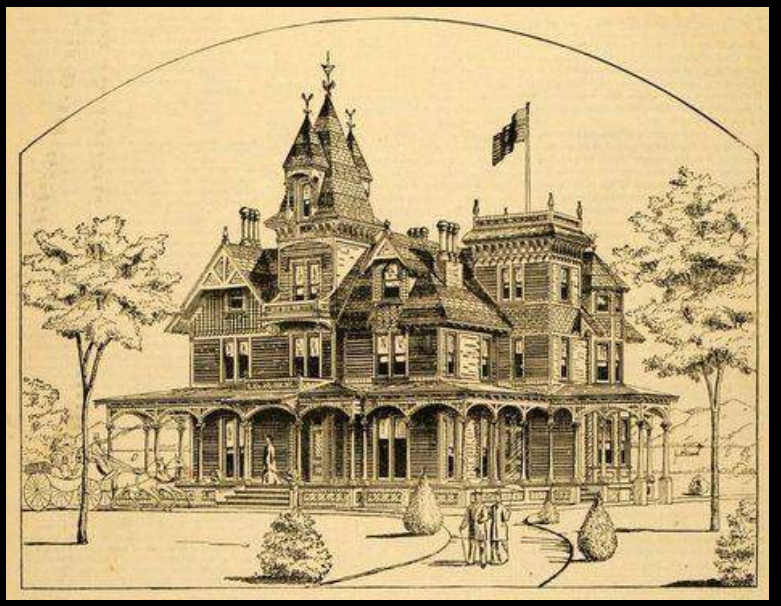
- Plan is no longer a box, complex roof forms
- Made possible by a distributed heating system via a boiler and radiators
- Prolific, highly decorative ornament made in a factory
- Gas lighting
- Large windows and tall ceilings – less regard to conserve heat
- Style not regionally based
- Era of historical revival styles

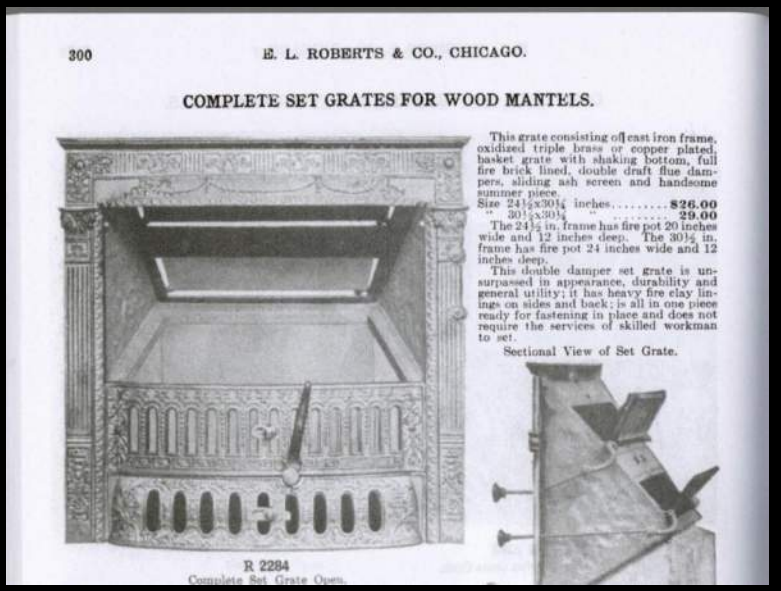
George Drew House, Sandwich, MA 1881

House1881



DESIGN FOR SUBURBAN RESIDENCE, COSTING FROM $5,000 TO $6,000.




300 E. L. ROBERTS & CO., CHICAGO.

COMPLETE SET GRATES FOR WOOD MANTELS.

This grate consisting of cast iron frame, oxidized triple brass or copper plated, basket grate with shaking bottom, full fire brick lined, double draft flue dampers, sliding ash screen and handsome summer piece.

Size 24½x30¼ inches..... $26.00
" 30½x30¼ " 29.00

The 24½ in. frame has fire pot 20 inches wide and 12 inches deep. The 30½ in. frame has fire pot 24 inches wide and 12 inches deep.

This double damper set grate is unsurpassed in appearance, durability and general utility; it has heavy fire clay linings on sides and back; is all in one piece ready for fastening in place and does not require the services of skilled workman to set.

Sectional View of Set Grate.

R 2284
Complete Set Grate Open.

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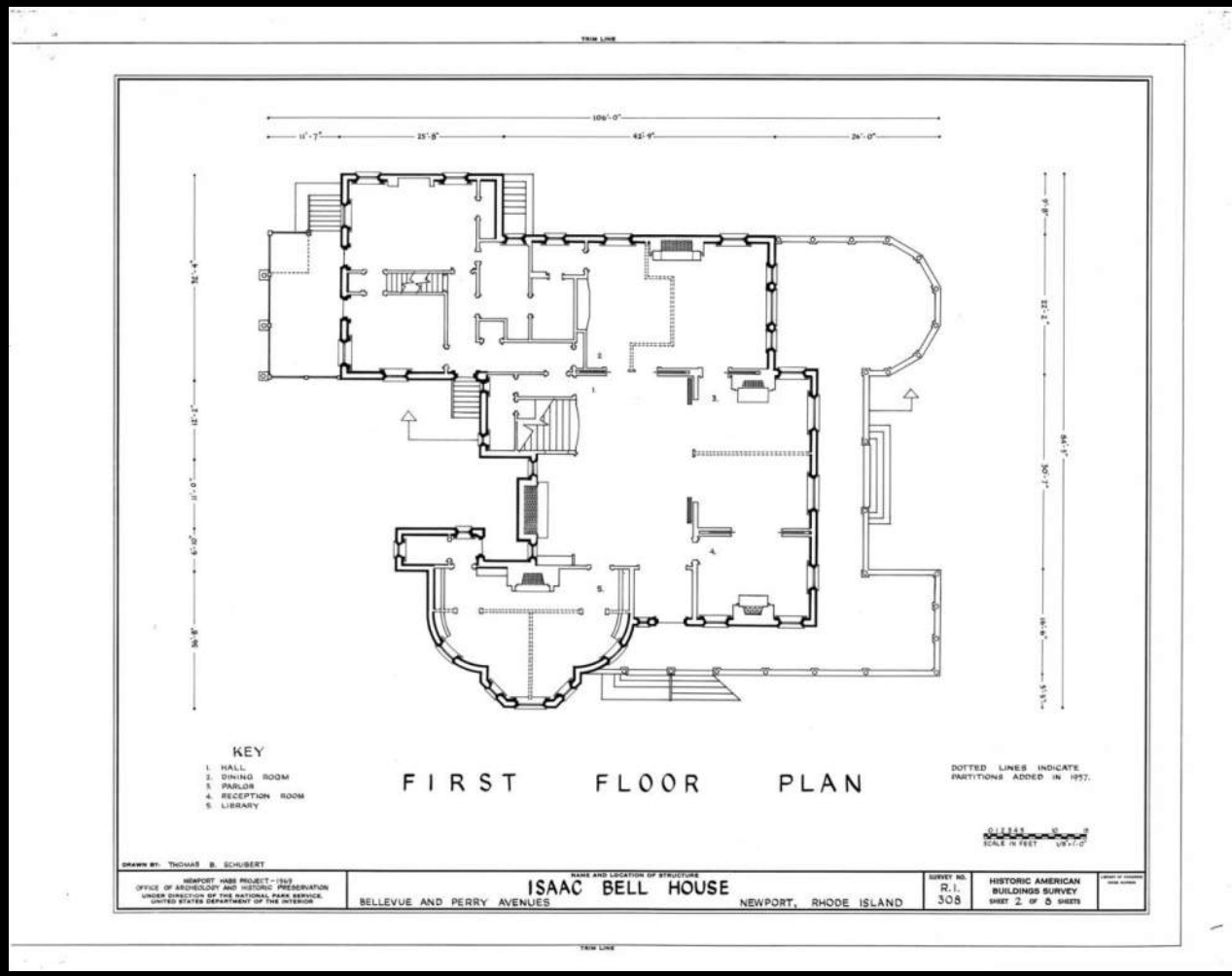
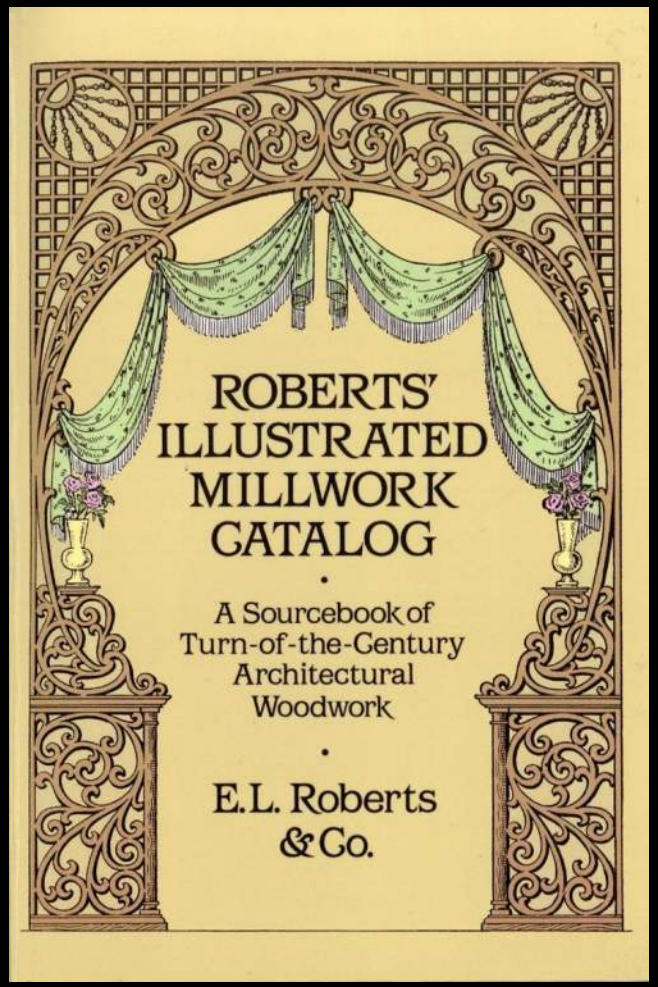
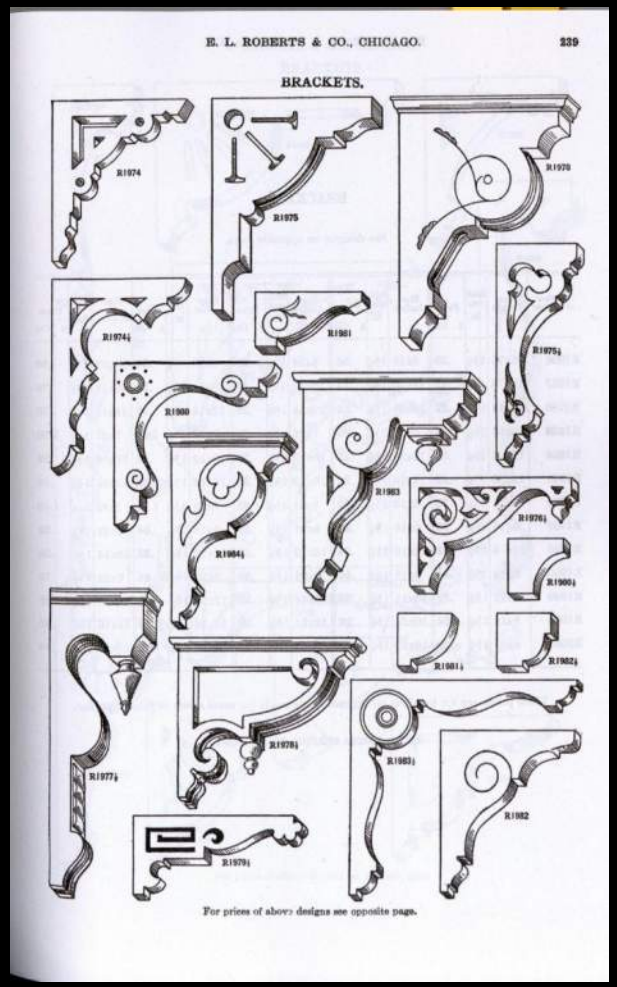
J.B. Clancy

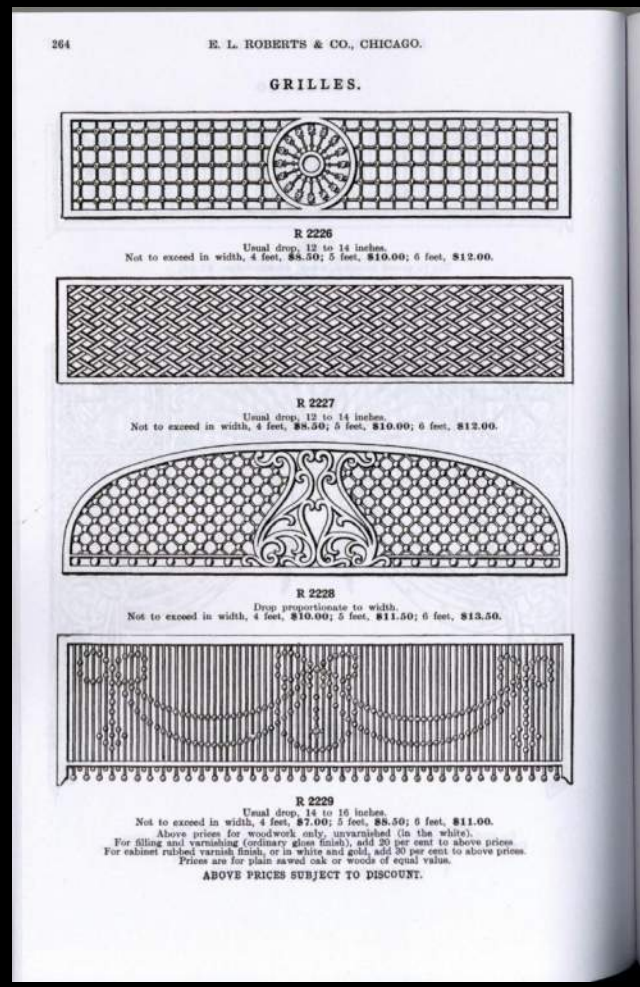


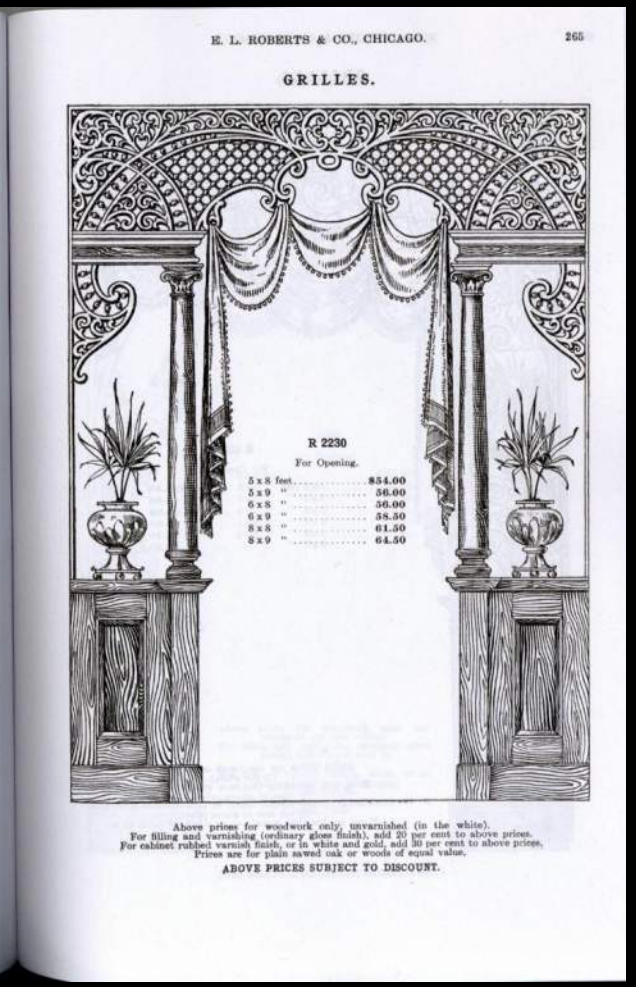
By https://www.loc.gov/pictures/item/ri0034.sheet.00003a, Public Domain,https://commons.wikimedia.org/w/index.php?curid=35080402

House1881









E.L. Roberts & Co. Roberts' Illustrated Millwork Catalog : a Sourcebook of Turn-of-the-Century Architectural Woodwork. New York :Dover Publications, 1988.

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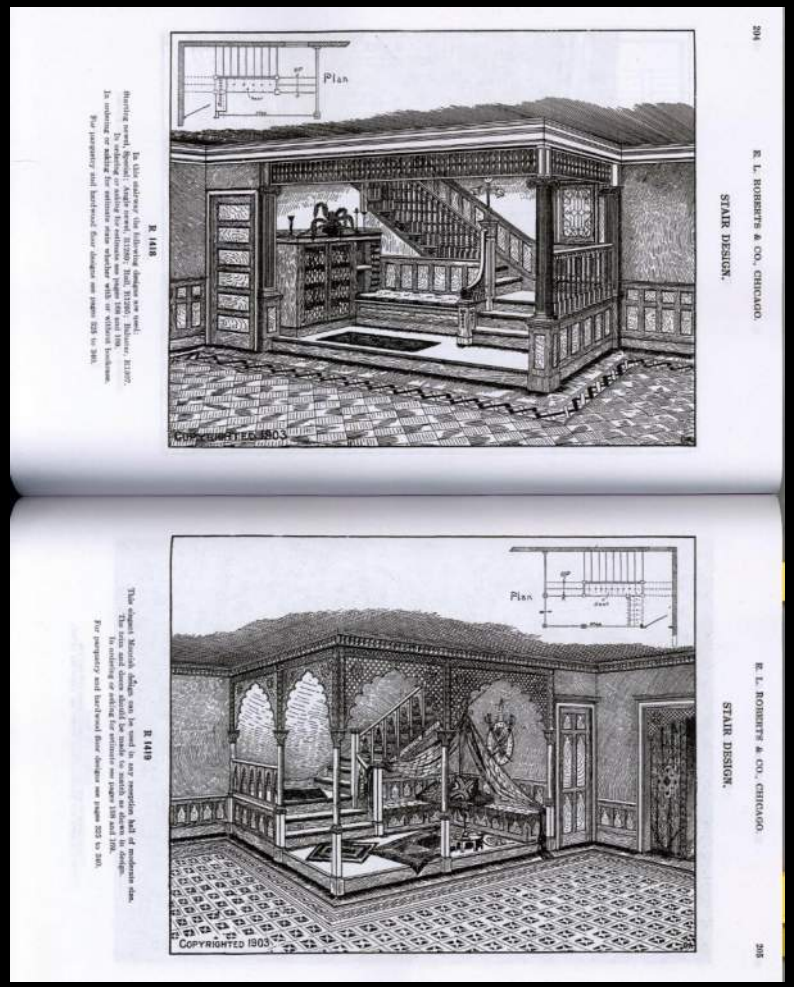
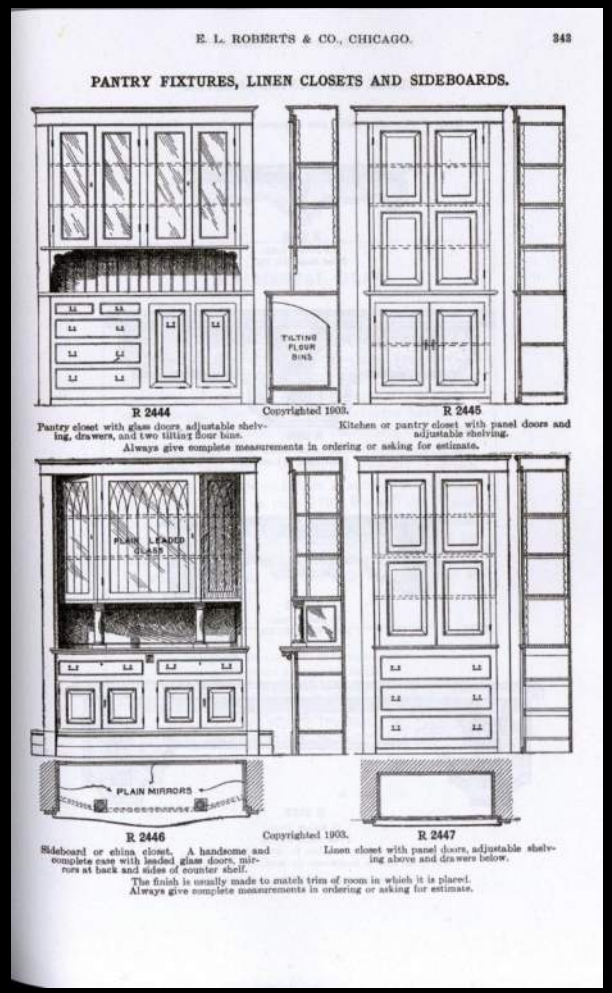


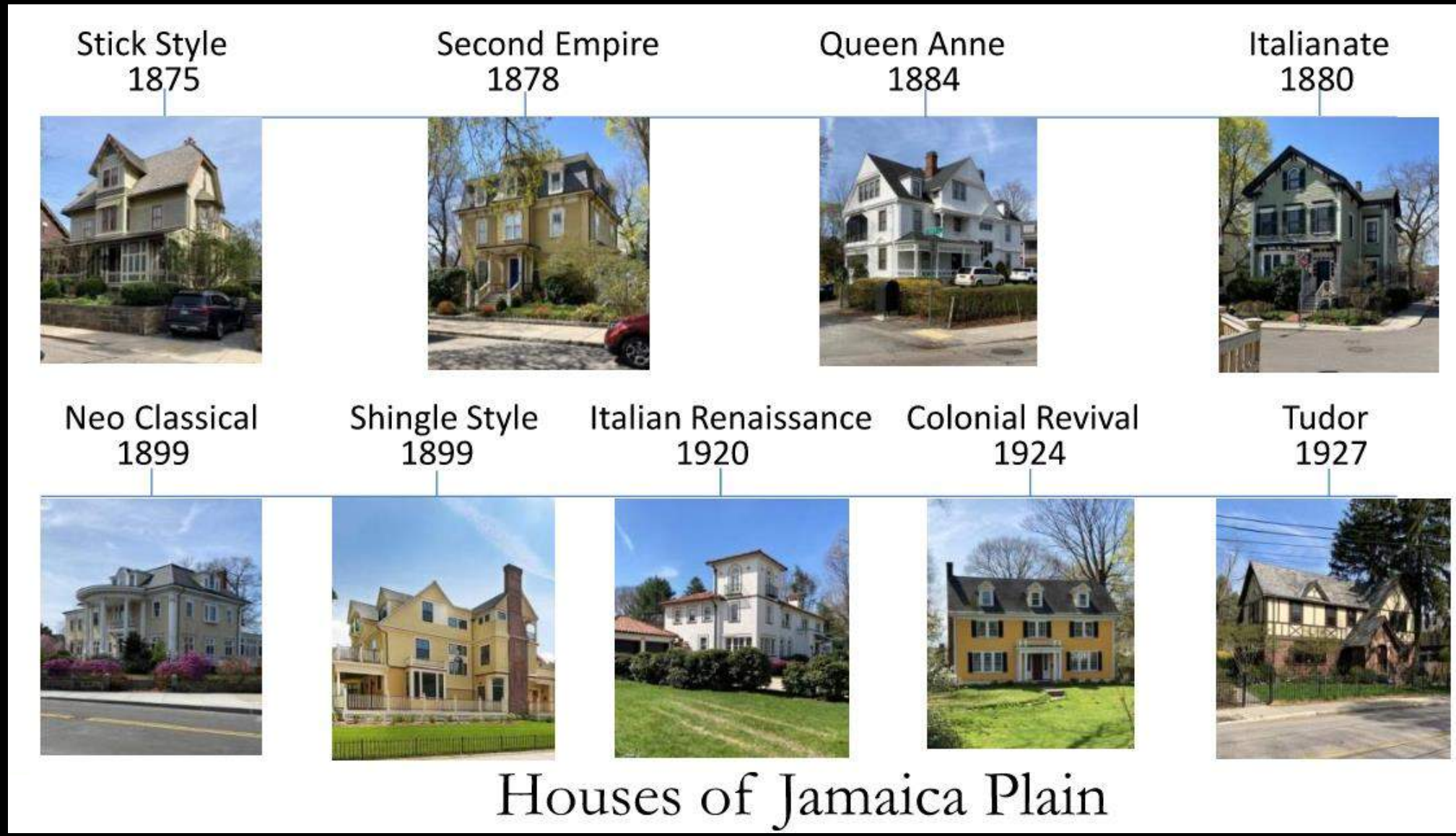


E.L. Roberts & Co. Roberts' Illustrated Millwork Catalog : a Sourcebook of Turn-of-the-Century Architectural Woodwork. New York :Dover Publications, 1988.

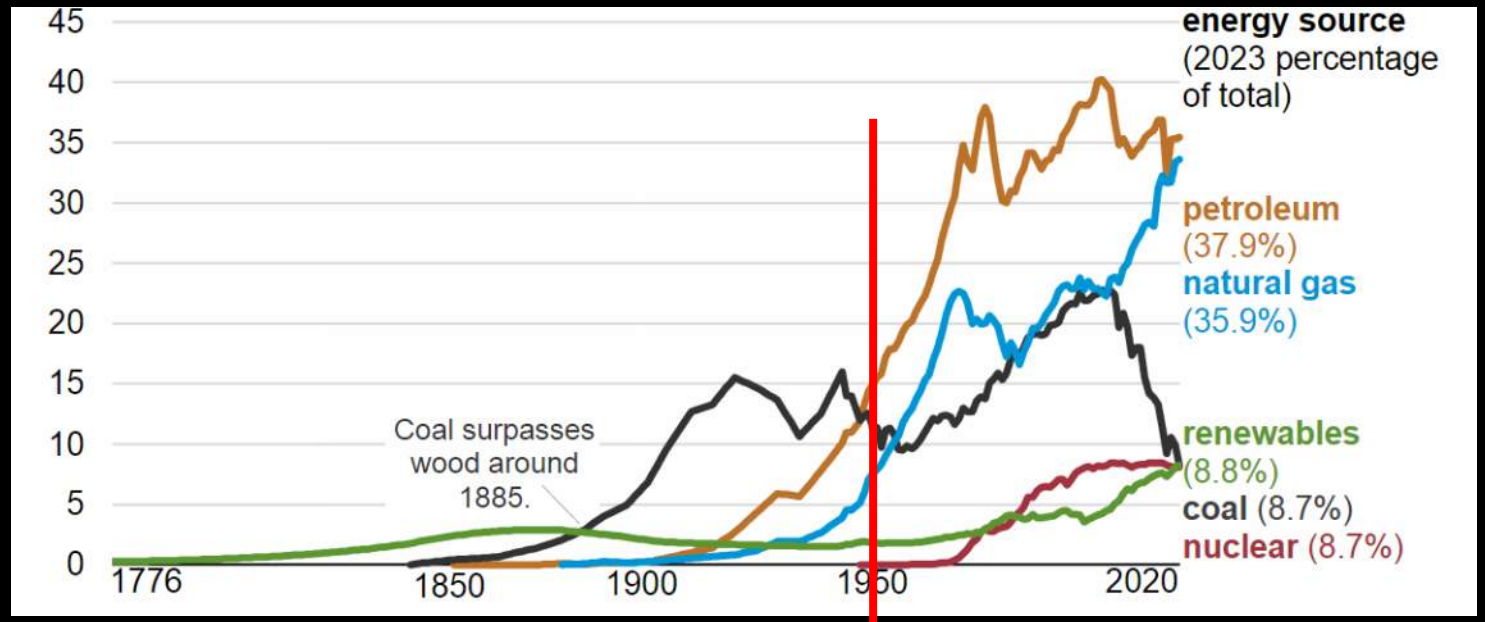
House1881

https://www.architecturaldigest.com/gallery/buildings-that-prove-san-francisco-has-best-victorian-architecture

House1881


Stick Style
1875
Second Empire
1878
Queen Anne
1884
Italianate
1880
Neo Classical
1899
Shingle Style
1899
Italian Renaissance
1920
Colonial Revival
1924
Tudor
1927
Houses of Jamaica Plain

House 1949

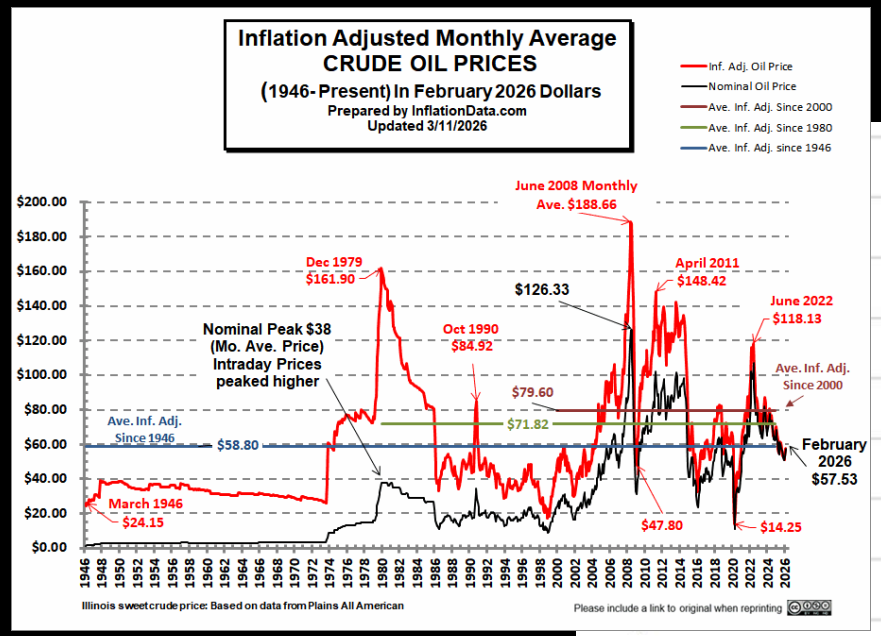


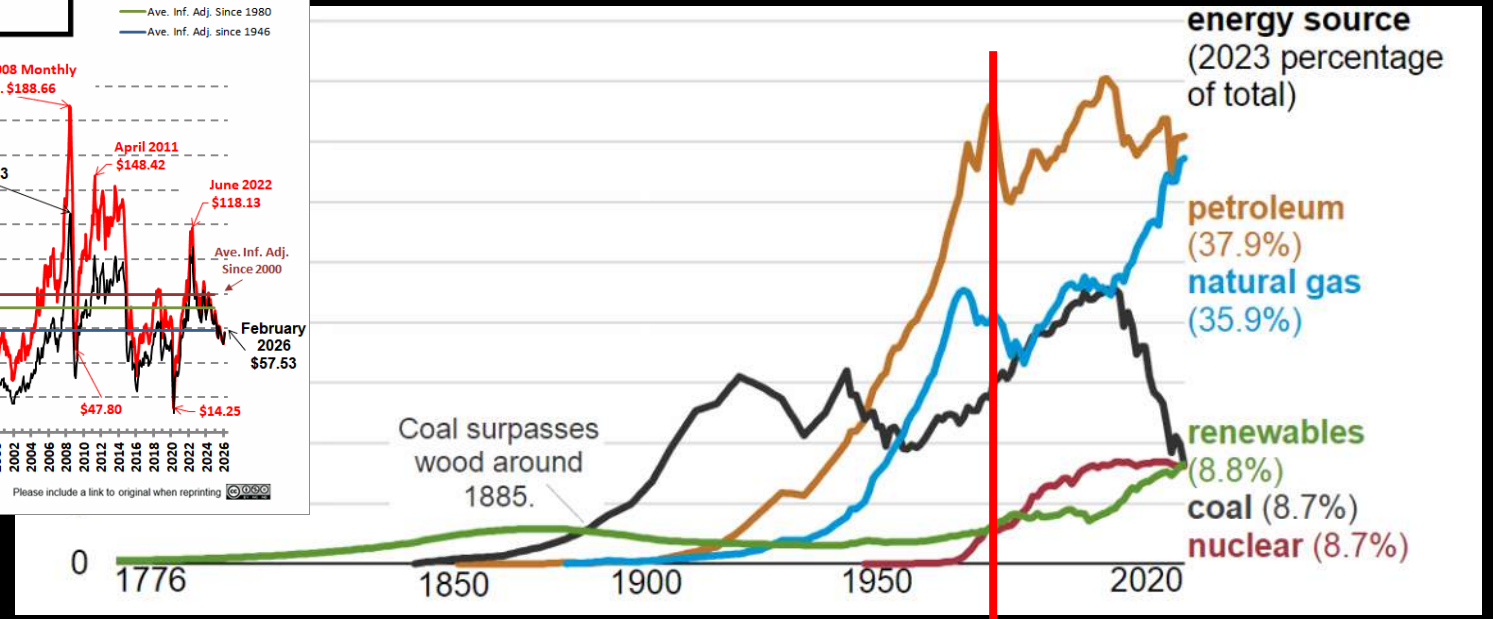
- Built with no concern for the cost of energy
- Uses the highest embodied energy materials: steel, glass, and concrete.
- No regard for orientation, all elevations are the same
- Relies on mechanical systems to manage comfort both in summer and winter
- Seemingly simple and pure, but from an energy perspective, more decadent than Versailles

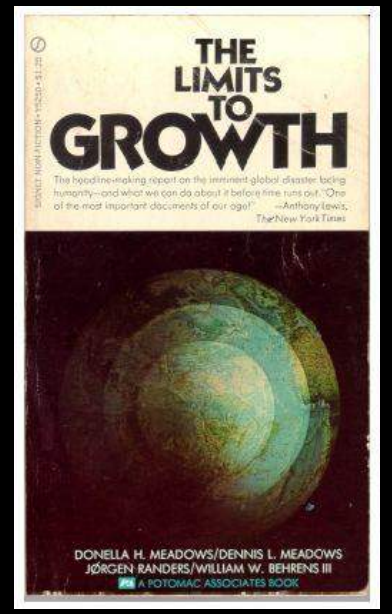
Glass House, New Canaan, CT Philip Johnson, 1949

By Carol M. Highsmith - This image is available from the United States Library of Congress's Prints and Photographs division under the digital ID highsm.04817.

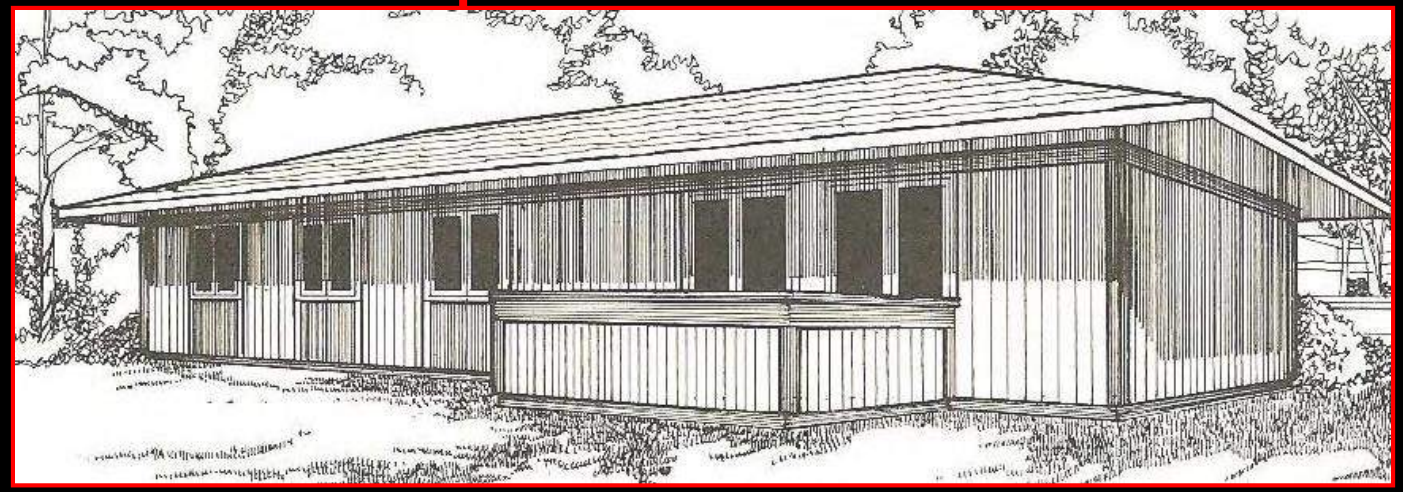
House 1976





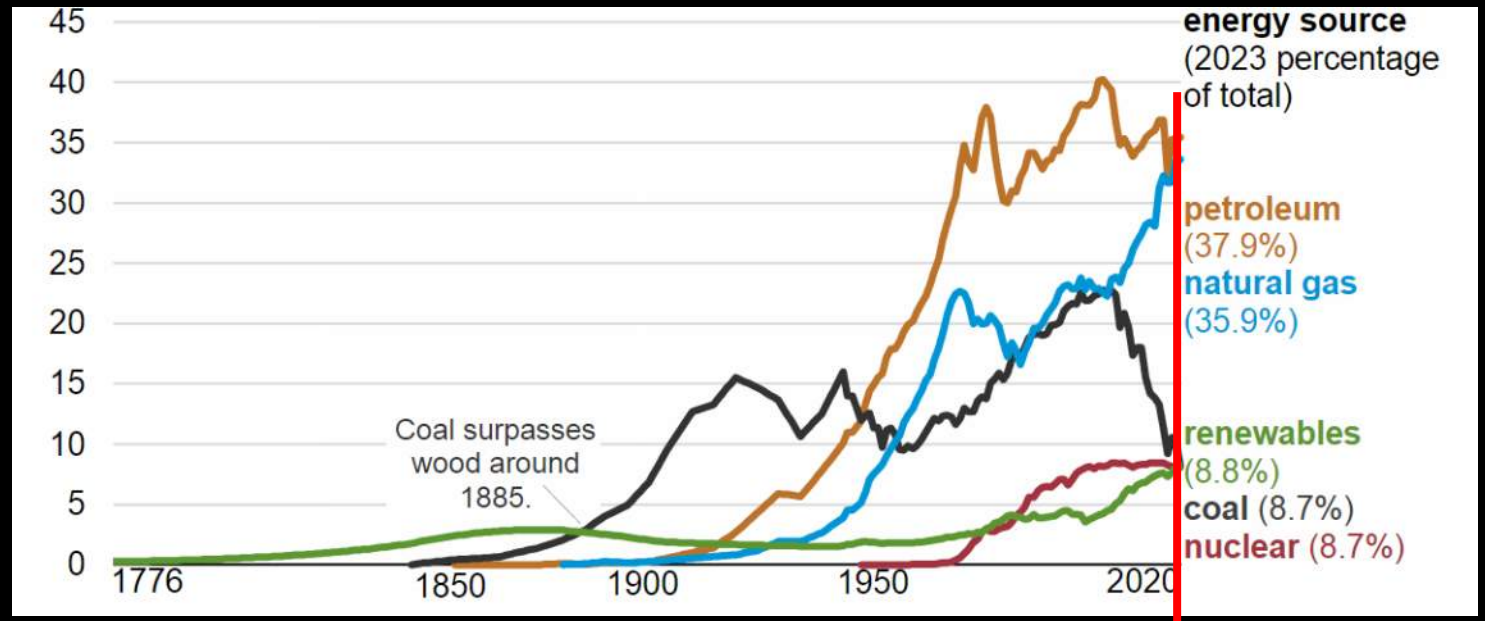


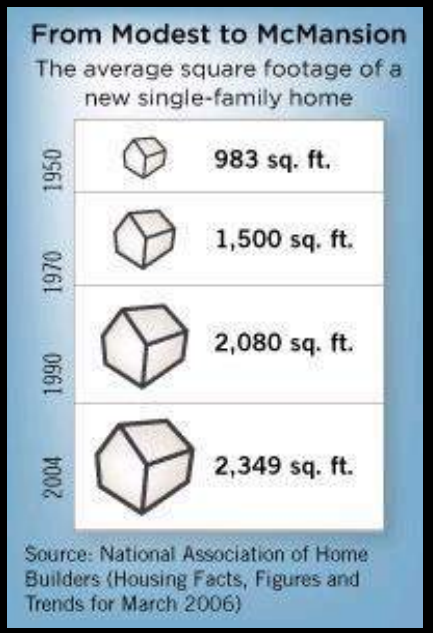
- *Limits of Growth* – published 1972
- OPEC oil embargo – 1973
- With expensive energy and awareness of climate limits, houses begin to adapt
- First super insulated houses built
- Windows oriented to the sun
- Eave projection manages the summer sun



Lo-Cal House, University of Illinois at Urbana-Champaign 1976
Wayne Schick

House Now

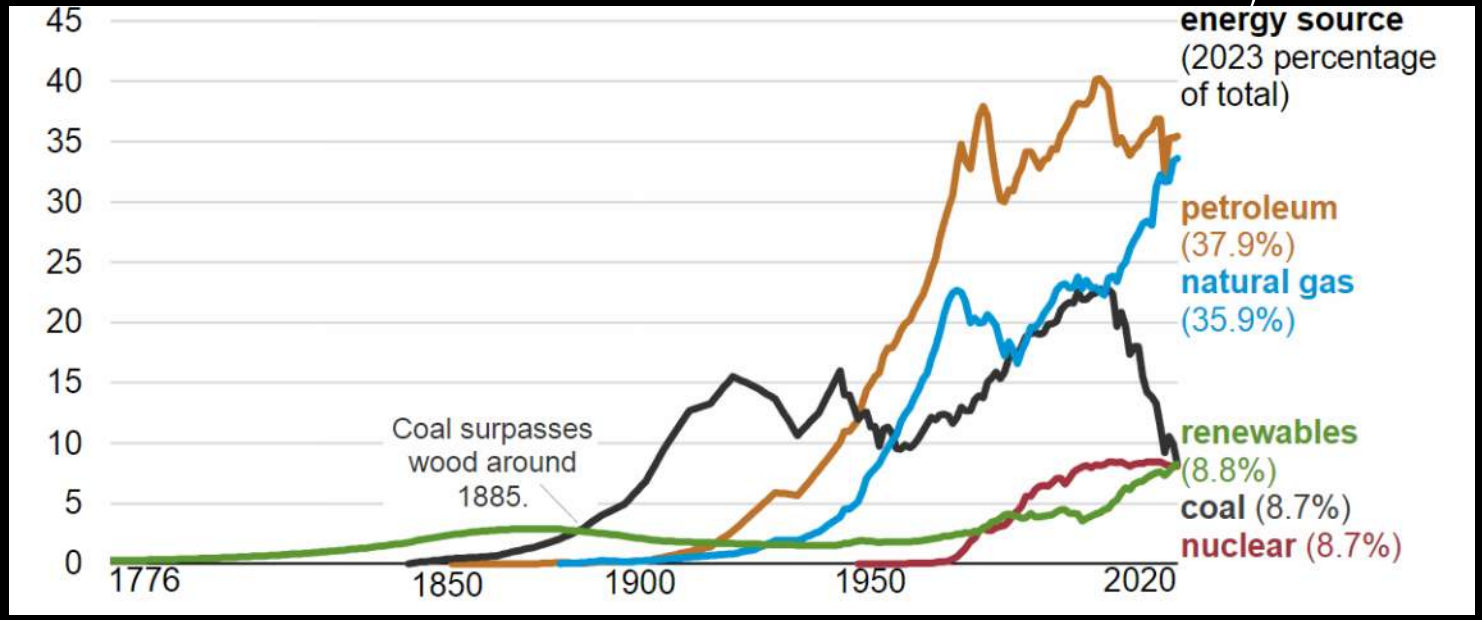


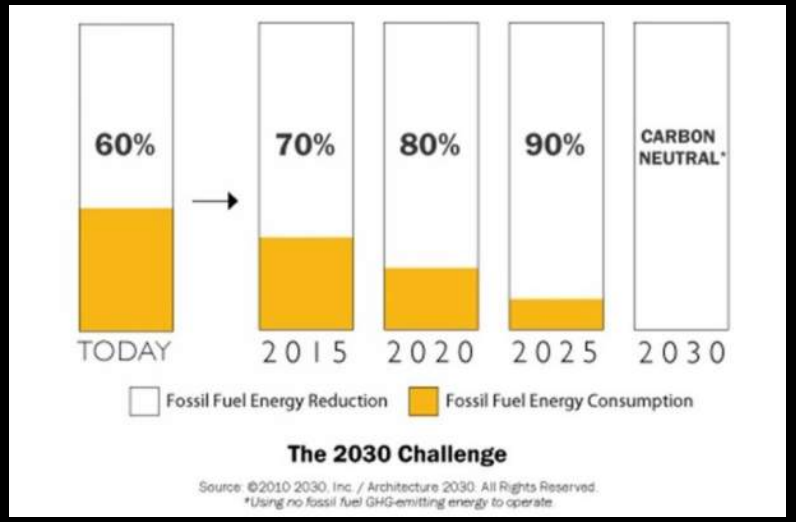


- Built with no concern for the cost of energy
- Bigger than it needs to be
- Uses the high embodied energy materials
- Literally built with oil: vinyl and PVC
- No regard for orientation, all elevations are the same
- Relies on mechanical systems to manage comfort both in summer and winter

Anywhere USA

House 21st Century

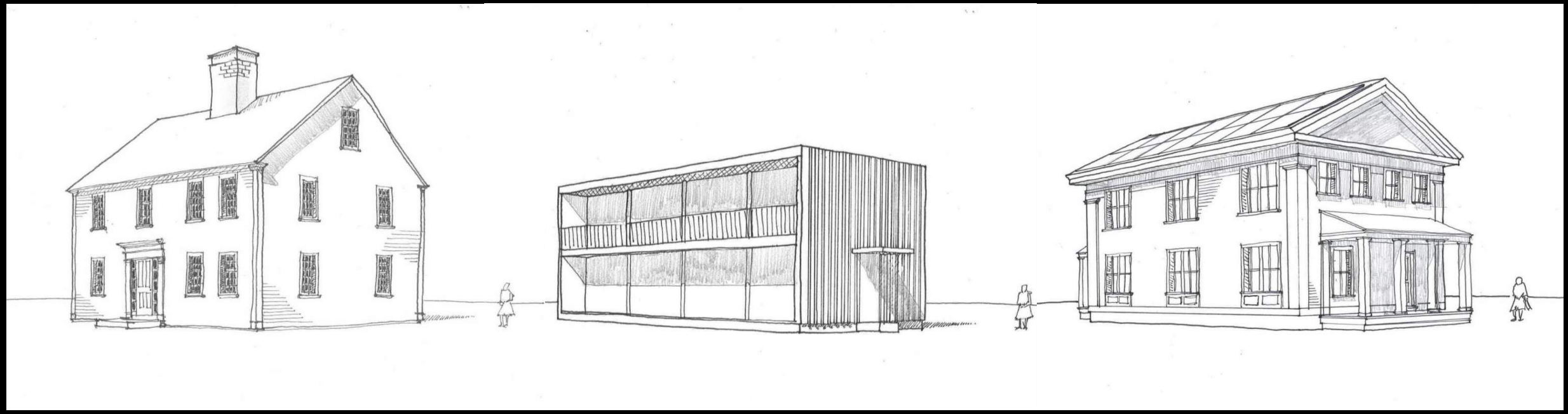




Architecture 2030

Chapter 3

A Tale of Three Houses



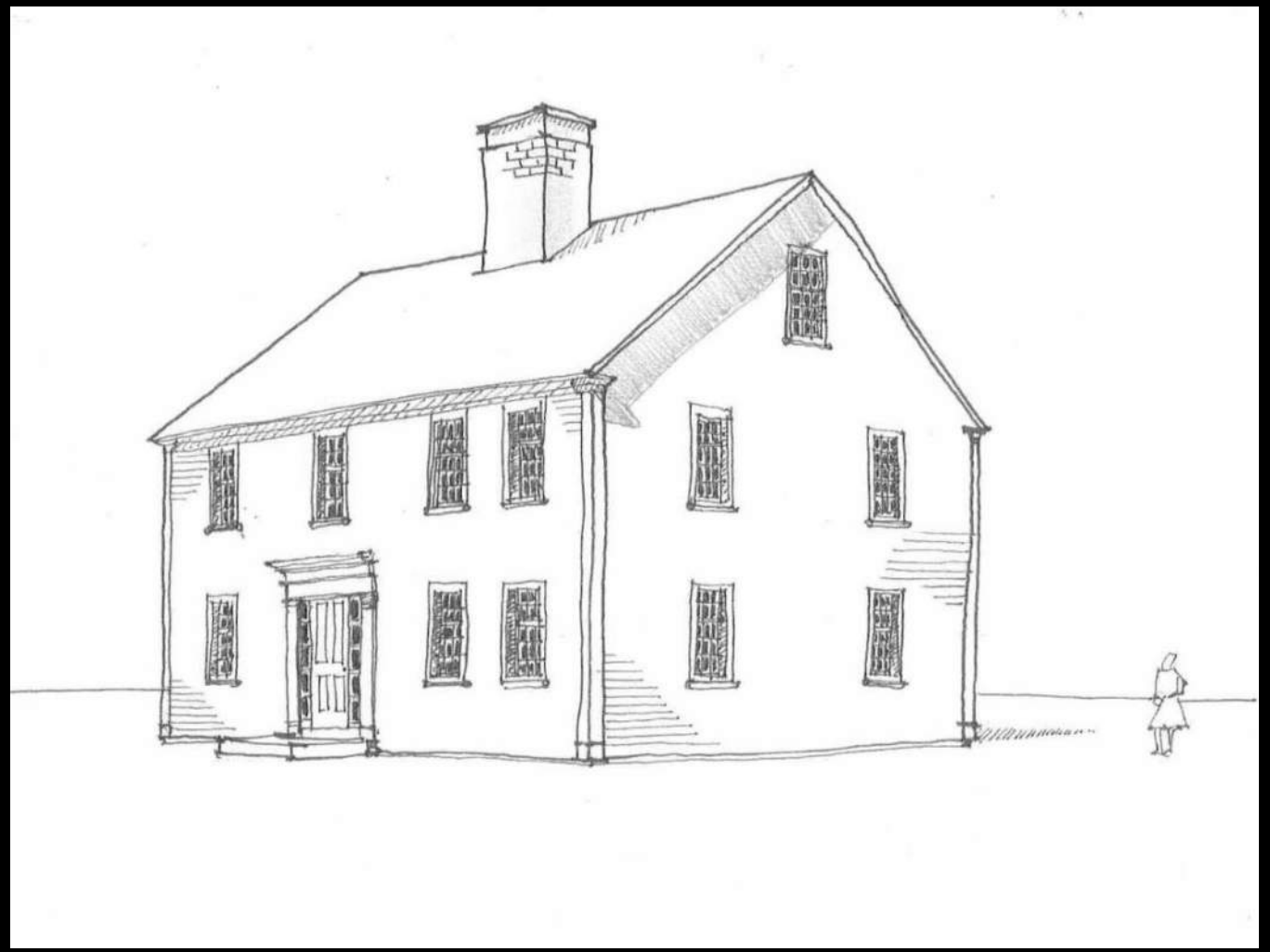
1750

1950

2030

ART Architects

1750 House



TRADITIONAL BUILDING CONFERENCE

ART Architects

1750 House Examples

Hartwell Tavern, Concord, MA 1732

Hamilton House, South Berwick, MA 1785

Bowman House, Dresden, MA 1762

Loring Greenough House, Jamaica Plain, MA 1760

1750 House – Embodied Energy

BEAM

PROJECT NAME: 1750 House
SCENARIO: Baseline
BEAM VERSION: V1.1

SELECTED PROJECT MATERIALS REVIEW

			-79,294	8,900	254	87,940	
SECTION	CATEGORY	MATERIAL	NET EMISSIONS kg CO_2e	GROSS EMISSIONS kg CO_2e	STORAGE Short Cycle kg CO_2	STORAGE Long Cycle kg CO_2	QTY
Footings & Slabs	EARTHEN FLOOR SYSTEMS	Earthen Floor / Cast-in-place / Clay, sand, and straw / 4" (100 mm) [US]	60	314	254	0	981.0 ft²
Foundation Walls	ADD CUSTOM EPD VALUE	Site Field Stone	0	0	0	0	790.0 ft²
Structural Elements	STRUCTURAL TIMBER	Wood / SPF / Lumber by volume / AWC & CWC [Industry Avg | US & CA]	-5,858	531	0	6,389	11.0 yd³
Exterior Walls	LIGHT WOOD FRAME WALLS	Wood / SPF / 2x6 Lumber / AWC & CWC [Industry Avg | US & CA]	-4,407	399	0	4,807	2216.0 ft²
Exterior Walls	STRUCTURAL SHEATHING	Wood / SPF / 3/4" boards / AWC & CWC [Industry Avg | US & CA]	-2,732	248	0	2,979	2216.0 ft²
Cladding	EXTERIOR WALL CLADDING	Cedar Siding / Western Red Cedar Lumber Assn / 1x6 Boards [Industry Avg | CA]	-999	355	0	1,354	2216.0 ft²
Cladding	INTERIOR CLADDING FOR EXTERIOR WALLS	Lime Plaster, NHL 3.5 / Kerakoll / Biocalce Intonaco line @ 2 cm [EU]	2,109	2,109	0	0	2216.0 ft²
Windows	ADDITIONAL MATERIALS	Window - single-glazed / Wood frame / BfCA Study [US & CA]	1,431	1,431	0	0	214.0 ft²
Floors	LIGHT WOOD FLOOR FRAMING	Wood / SPF / 2x8 Lumber / AWC & CWC [Industry Avg | US & CA]	-45,881	200	0	46,080	1962.0 ft²
Floors	SUB FLOORING	Wood / SPF / 3/4" boards / AWC & CWC [Industry Avg | US & CA]	-2,419	219	0	2,638	1962.0 ft²
Floors	FLOORING	Hardwood flooring / Wickham / Solid Hardwood / 3/4"	-2,854	583	0	3,437	1962.0 ft²
Ceilings	CEILING FINISHES	Cedar Siding / Western Red Cedar Lumber Assn / 1x6 Boards [Industry Avg | CA]	-884	314	0	1,199	1962.0 ft²
Ceilings	CEILING FINISHES	Lime Plaster, NHL 3.5 / Kerakoll / Biocalce Intonaco line @ 2 cm [EU]	1,867	1,867	0	0	1962.0 ft²
Ceilings	CEILING STRAPPING	Wood / SPF / 1x4 Lumber / AWC & CWC [Industry Avg | US & CA]	-353	32	0	385	1962.0 ft²
Roof	WOOD ROOF FRAMING	Wood / SPF / 2x6 Lumber / AWC & CWC [Industry Avg | US & CA]	-17,790	89	0	17,878	1324.0 ft²
Roof	ADDITIONAL MATERIALS	Cedar Siding / Western Red Cedar Lumber Assn / 1x6 Boards [Industry Avg | CA]	-586	208	0	794	1300.0 ft²

1750 House – Embodied Energy

1750 House – Operational Energy

Home Energy Rating Certificate

Projected Report
Based on Plans

Rating Date:
Registry ID:
Ekotrope ID: vD7azjMd

HERS® Index Score: 242

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 -$2,112

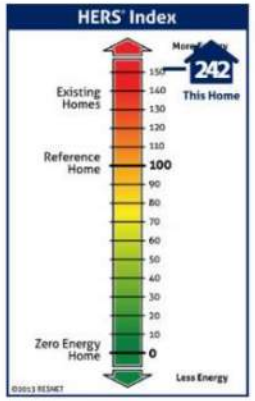
*Relative to an average U.S. home

Home:
0 Main St
Salem, MA 01970

Builder:
ART Architects

Your Home's Estimated Energy Use:

	Use [MBtu]	Annual Cost
Heating	249.3	$5,260
Cooling	0.0	$0
Hot Water	12.5	$262
Lights/Appliances	24.1	$2,071
Service Charges		$240
Generation (e.g. Solar)	0.0	$0
Total:	**285.8**	**$7,833**



Home Feature Summary:

Home Type:	Single family detached
Model:	N/A
Community:	N/A
Conditioned Floor Area:	1,962 ft²
Number of Bedrooms:	3
Primary Heating System:	Boiler • Natural Gas • 79.3 AFUE
Primary Cooling System:	N_A
Primary Water Heating:	Boiler • Natural Gas • 79.3 Thermal Efficiency
House Tightness:	15 ACH50
Ventilation:	None
Duct Leakage to Outside:	Hydronic Delivery (Radiant)
Above Grade Walls:	R-0
Ceiling:	Vented Attic, R-0
Window Type:	U-Value: 0.95, SHGC: 0.8
Foundation Walls:	N/A
Framed Floor:	R-1

This home meets or exceeds the criteria of the following:

83,525 kWh

Rating Completed by:

Energy Rater: Andrew Parneros
RESNET ID: 0890099

Rating Company: Infrared Diagnostic LLC
14 Paxton Rd Framingham, MA 01701
978-440-9900

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

Andrew Parneros, Certified Energy Rater
Date: 3/19/26 at 12:56 PM

ekotrope

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

Ekotrope RATER - Version:5.2.1.3825
The Energy Rating Disclosure for this home is available from the Approved Rating Provider.
This report does not constitute any warranty or guarantee.

Andrew Parneros, Infrared Diagnostics

1750 House – Operational Energy

- Replaced the gas boiler with an air source heat pump
- ERV added for ventilation
- All new energy star appliances
- LED lighting
- Restored the original windows and added storm windows that have a low e coating on the glass,
- Added 12” of insulation to the attic
- Sealed the air leaks up with Aero Barrier, giving us a new air tightness level of 1 ACH 50.

Home Energy Rating Certificate

Projected Report
Based on Plans

Rating Date:
Registry ID:
Ekotrope ID: vD7azjMd

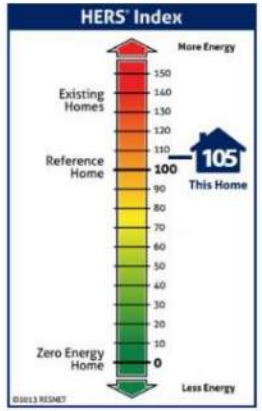
HERS® Index Score: 105
Your home's HERS score is a relative performance score. The lower the number, the more energy efficient the home. To learn more, visit www.hersindex.com

Annual Savings $978
*Relative to an average U.S. home

Home:
0 Main St
Salem, MA 01970
Builder:
ART Architects

Your Home's Estimated Energy Use:

	Use [MBtu]	Annual Cost
Heating	72.0	$6,195
Cooling	1.3	$111
Hot Water	3.1	$263
Lights/Appliances	16.8	$1,445
Service Charges		$120
Generation (e.g. Solar)	0.0	$0
Total:	**93.2**	**$8,135**



Home Feature Summary:

Home Type:	Single family detached
Model:	N/A
Community:	N/A
Conditioned Floor Area:	1,962 ft²
Number of Bedrooms:	3
Primary Heating System:	Air Source Heat Pump • Electric • 11 HSPF2
Primary Cooling System:	Air Source Heat Pump • Electric • 18.5 SEER2
Primary Water Heating:	Residential Water Heater • Electric • 4.32 Energy Factor
House Tightness:	1 ACH50
Ventilation:	95 CFM • 28 Watts • ERV
Duct Leakage to Outside:	Untested Forced Air
Above Grade Walls:	R-0
Ceiling:	Vented Attic, R-44
Window Type:	U-Value: 0.55, SHGC: 0.7
Foundation Walls:	N/A
Framed Floor:	R-1

This home meets or exceeds the criteria of the following:

27,314 kWh

Rating Completed by:

Energy Rater: Andrew Parneros
RESNET ID: 0890099

Rating Company: Infrared Diagnostic LLC
14 Paxton Rd Framingham, MA 01701
978-440-9900

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

Andrew Parneros, Certified Energy Rater
Date: 3/19/26 at 12:57 PM

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

Ekotrope RATER - Version:5.2.1.3825
The Energy Rating Disclosure for this home is available from the Approved Rating Provider.
This report does not constitute any warranty or guarantee.

Andrew Parneros, Infrared Diagnostics

1750 House – Operational Energy

- Replaced the gas boiler with an air source heat pump
- ERV added for ventilation
- All new energy star appliances
- LED lighting
- Restored the original windows and added storm windows that have a low e coating on the glass,
- Added 12” of insulation to the attic
- Sealed the air leaks up with Aero barrier, giving us a new air tightness level of 1 ACH 50.
- 2” of R10 continuous rigid insulation
- 12” of insulation in the floor

Home Energy Rating Certificate

Projected Report
Based on Plans

Rating Date:
Registry ID:
Ekotrope ID: vD7azjMd

HERS® Index Score: 51
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 $5,470
*Relative to an average U.S. home

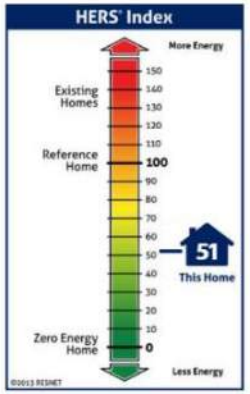
Home:
0 Main St
Salem, MA 01970
Builder:
ART Architects

Your Home's Estimated Energy Use:

	Use [MBtu]	Annual Cost
Heating	18.1	$1,557
Cooling	1.1	$95
Hot Water	5.0	$426
Lights/Appliances	16.8	$1,445
Service Charges		$120
Generation (e.g. Solar)	0.0	$0
Total:	**41.0**	**$3,643**

This home meets or exceeds the criteria of the following:

12,015 kWh



Home Feature Summary:

Home Type:	Single family detached
Model:	N/A
Community:	N/A
Conditioned Floor Area:	1,962 ft²
Number of Bedrooms:	3
Primary Heating System:	Air Source Heat Pump • Electric • 11 HSPF2
Primary Cooling System:	Air Source Heat Pump • Electric • 18.5 SEER2
Primary Water Heating:	Residential Water Heater • Electric • 4.32 Energy Factor
House Tightness:	1 ACH50
Ventilation:	95 CFM • 28 Watts • ERV
Duct Leakage to Outside:	Untested Forced Air
Above Grade Walls:	R-10
Ceiling:	Vented Attic, R-44
Window Type:	U-Value: 0.55, SHGC: 0.7
Foundation Walls:	N/A
Framed Floor:	R-30

Rating Completed by:

Energy Rater: Andrew Parneros
RESNET ID: 0890099

Rating Company: Infrared Diagnostic LLC
14 Paxton Rd Framingham, MA 01701
978-440-9900

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

Andrew Parneros, Certified Energy Rater
Date: 3/19/26 at 12:57 PM

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

Ekotrope RATER - Version:5.2.1.3825
The Energy Rating Disclosure for this home is available from the Approved Rating Provider.
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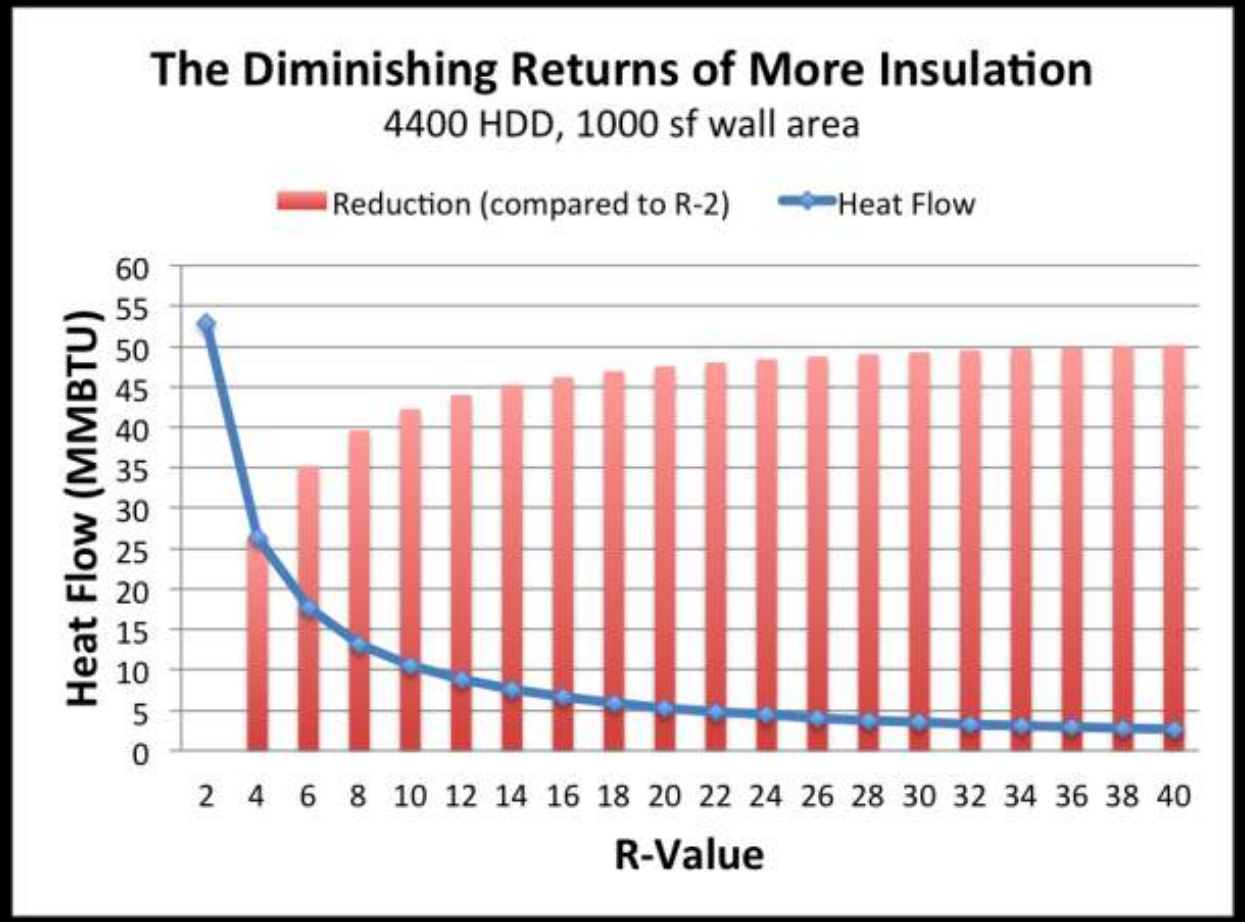
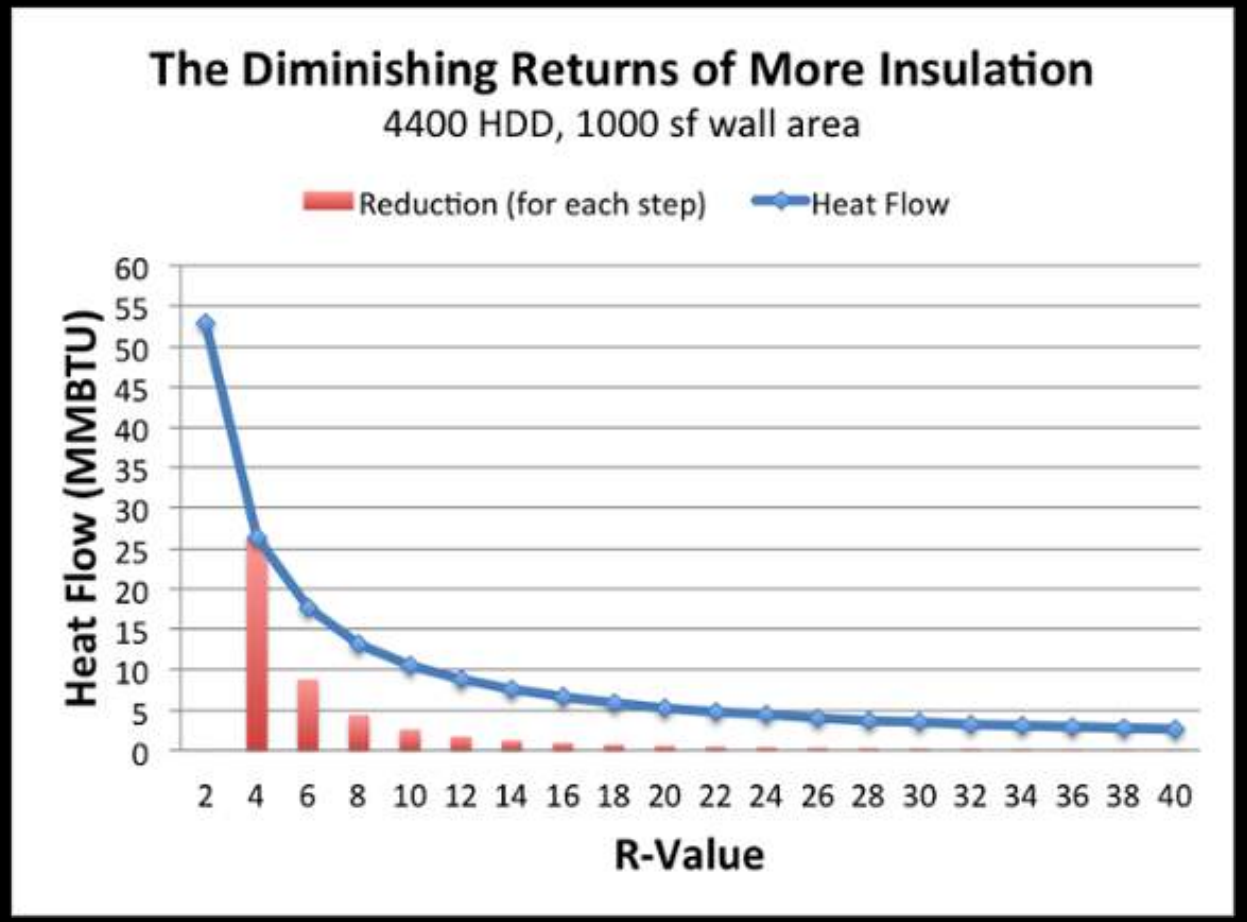
Andrew Parneros, Infrared Diagnostics

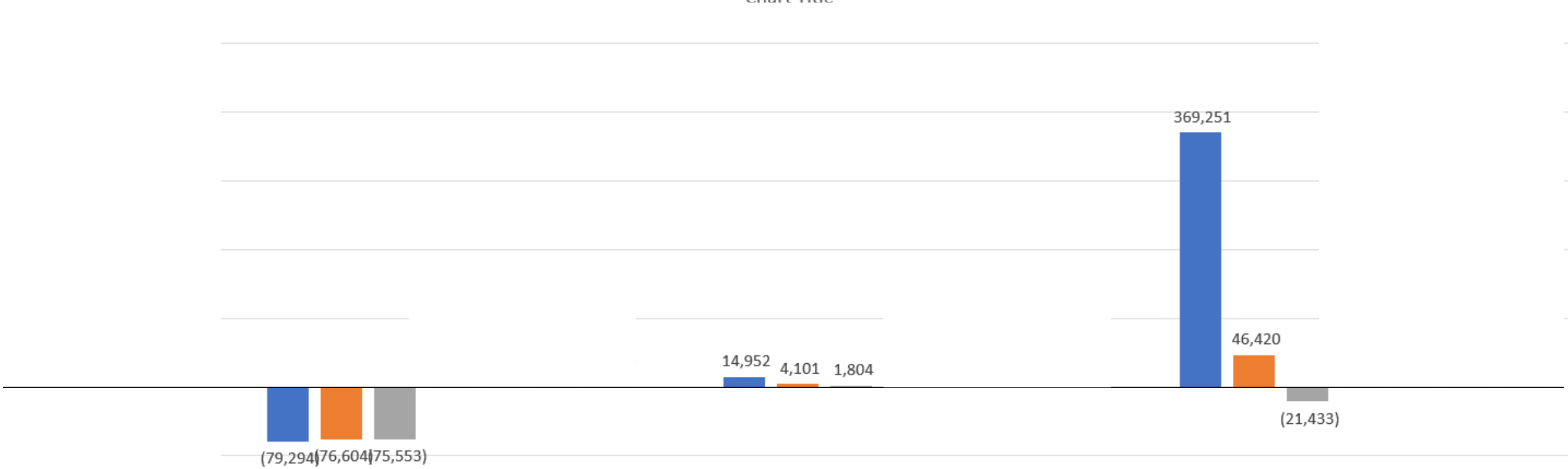
1750 House – Operational Energy





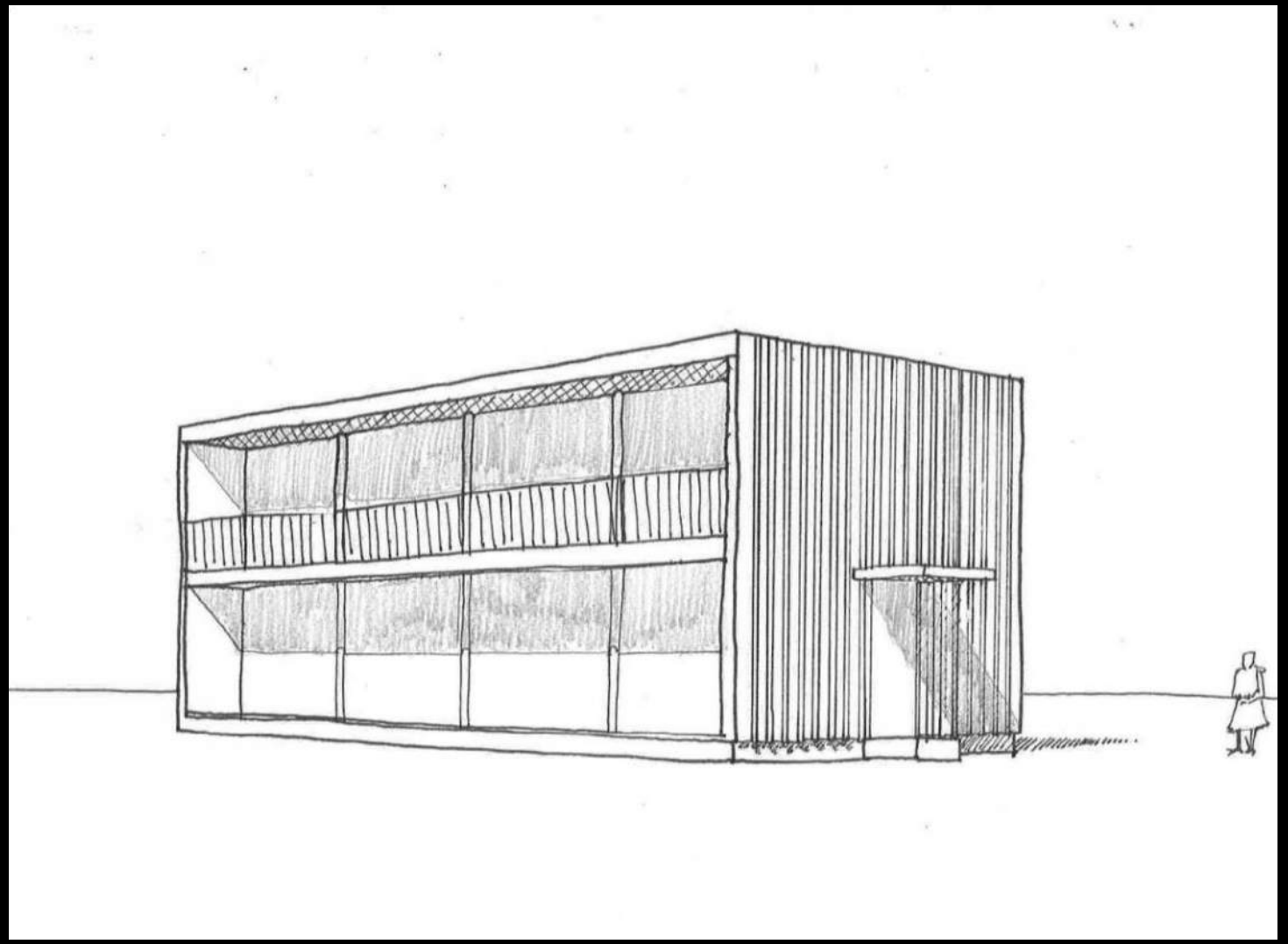
https://www.energyvanguard.com/blog/the-diminishing-returns-of-adding-more-insulation/

1750 House – Whole Life Carbon



	EMBODIED CARBON (kg CO2e)	YEARLY OPERATIONAL CARBON (kg CO2e/Yr)	EMBODIED CARBON + OPERATIONAL CARBON (kg CO2e)
1750s House	(79,294)	14,952	369,251
1750s House - Reno Level 1	(76,604)	4,101	46,420
1750s House - Reno Level 2	(75,553)	1,804	(21,433)

1950 House

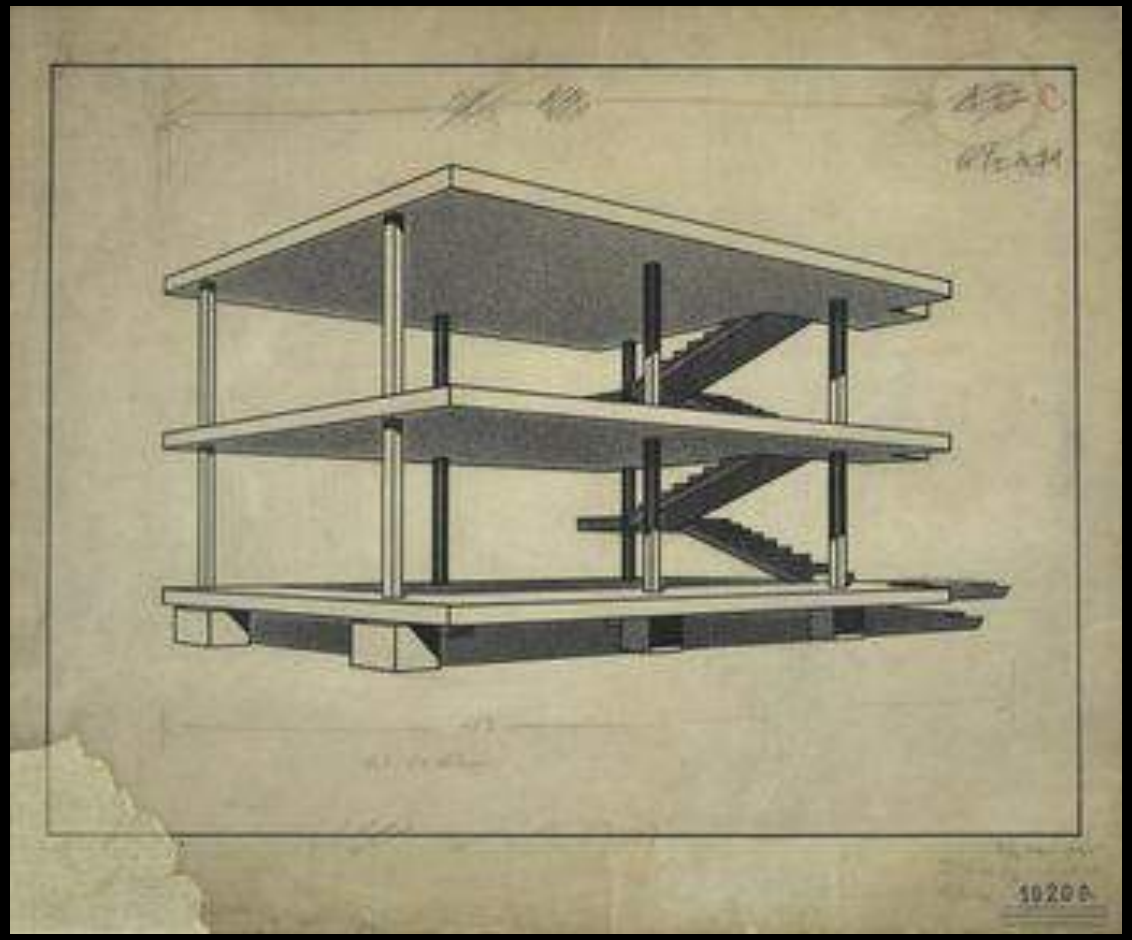


TRADITIONAL BUILDING CONFERENCE

ART Architects

1950 House Examples

Noyes House, Eliot Noyes, New Canaan, CT, 1955



Charles-Édouard Jeanneret (Le Corbusier), 1914-15, Maison Dom-Ino

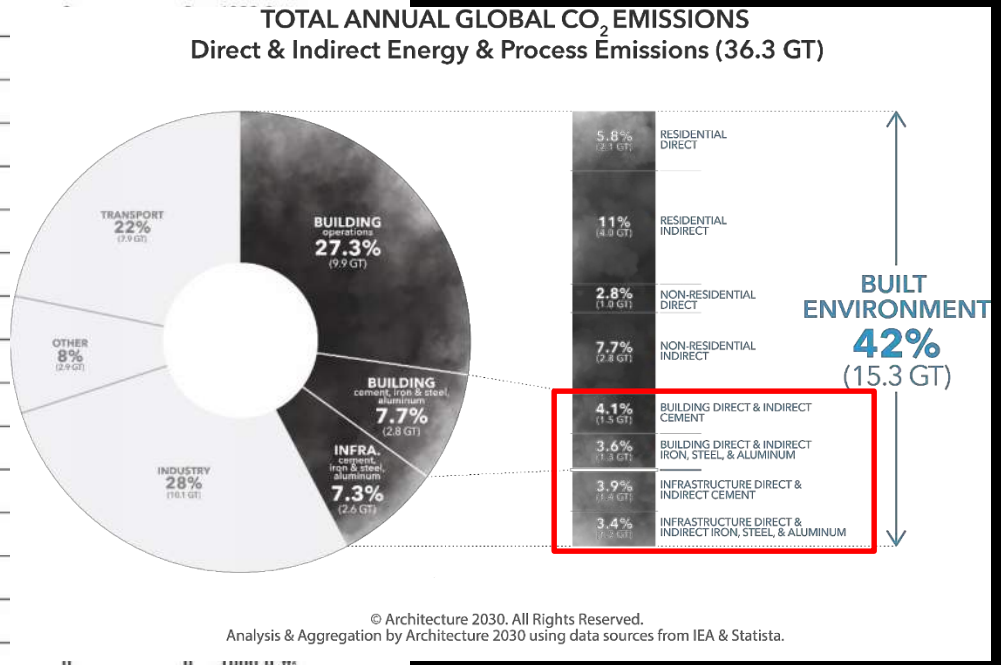
1950 House – Embodied Energy

BEAM

PROJECT NAME: 1950 Breuer House
SCENARIO: Scenario 1
BEAM VERSION: V1.1

SELECTED PROJECT MATERIALS REVIEW

			41,818	41,818	0	0	
SECTION	CATEGORY	MATERIAL	NET EMISSIONS kg CO_2e	GROSS EMISSIONS kg CO_2e	STORAGE Short Cycle kg CO_2	STORAGE Long Cycle kg CO_2	QTY
Footings & Slabs	CONTINUOUS CONCRETE FOOTINGS	Concrete - 3001-4000 psi, >50% SCM mix / NRMCA [Industry Avg | US & CA]	1,856	1,856	0	0	10.2 yd³
Footings & Slabs	CONCRETE SLABS	Concrete - 3001-4000 psi, >50% SCM mix / NRMCA [Industry Avg | US & CA]	2,253	2,253	0	0	1000.0 ft²
Footings & Slabs	BASEMENT FLOORING	Natural stone flooring / Natural Stone Institute / Includes limestone, granite, marble & quartzite / 1/2" thickness / Mortar included / [Industry Avg, US]	2,044	2,044			
Foundation Walls	CONCRETE FOUNDATION WALLS	Concrete - 3001-4000 psi, >50% SCM mix / NRMCA [Industry Avg | US & CA]	2,475	2,475			
Structural Elements	STRUCTURAL STEEL – WIDE FLANGE BEAMS	Structural Steel / Wide Flange / W200x22 (US W8x15) / AISC [Industry Avg | US]	3,012	3,012			
Structural Elements	STRUCTURAL STEEL – OTHER SECTION SHAPES	Structural Steel / Square HSS / 4 x 4 x 1/4"/ AISC [Industry Avg | US]	1,533	1,533			
Exterior Walls	LIGHT WOOD FRAME WALLS	Wood / SPF / 2x4 Lumber / AWC & CWC [Industry Avg | US & CA]	97	97			
Exterior Walls	STRUCTURAL SHEATHING	OSB sheathing / 1/2" / AWC & CWC [Industry Avg | US & CA]	213	213			
Exterior Walls	CAVITY INSULATION	Fiberglass batt / NAIMA / R 4.4-inch [Industry Avg | N.America]	214	214			
Cladding	EXTERIOR WALL CLADDING	Cedar Siding / Western Red Cedar Lumber Assn / 1x6 Boards [Industry Avg | CA]	119	119			
Cladding	INTERIOR CLADDING FOR EXTERIOR WALLS	Drywall 1/2" [BEAM Avg | US & CA]	213	213			
Windows	WINDOWS – DOUBLE-GLAZED	Window, double-glazed, aluminum frame / Arcadia / CV200, T200 / Projected & casement	17,303	17,303			
Floors	LIGHT WOOD FLOOR FRAMING	Wood / SPF / 2x10 Lumber / AWC & CWC [Industry Avg | US & CA]	346	346			
Floors	SUB FLOORING	OSB sheathing / 1/2" / AWC & CWC [Industry Avg | US & CA]	572	572			
Floors	FLOORING	Hardwood flooring / NWFA and Decorative Hardwoods Association / Solid Wood Flooring / 3/4" [Industry Avg | US & CA]	1,820	1,820			
Ceilings	CEILING FINISHES	Drywall 1/2" [BEAM Avg | US & CA]	574	574			
Roof	WOOD ROOF FRAMING	Wood / SPF / 2x10 Lumber / AWC & CWC [Industry Avg | US & CA]	173	173			
Roof	ROOF CAVITY INSULATION	Fiberglass batt / NAIMA / R 4.4-inch [Industry Avg | N.America]	727	727	0	0	1000.0 ft²
Roof	BARRIERS AND MEMBRANES	Roof Deck Liquid Applied Barrier / [BEAM Avg]	629	629	0	0	1000.0 ft²
Roof	ADDITIONAL MATERIALS	Metal Panels - Steel / Metal Construction Assn. / 24 gauge [Industry Avg | US]	1,421	1,421	0	0	1000.0 ft²
Roof	ADDITIONAL MATERIALS	Concrete - 3001-4000 psi, 30-39% FA/SL / NRMCA [Industry Avg | US & CA]	4,224	4,224	0	0	18.5 yd³



1950 House – Operational Energy

Home Energy Rating Certificate

Projected Report
Based on Plans

Rating Date:
Registry ID:
Ekotrope ID: vjgOzK42

HERS® Index Score: 182

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 -$1,833

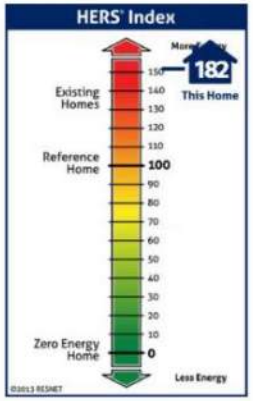
*Relative to an average U.S. home

Home:
0 Main St
Salem, MA 01970

Builder:
ART Architects

Your Home's Estimated Energy Use:

	Use [MBtu]	Annual Cost
Heating	187.4	$5,030
Cooling	8.9	$766
Hot Water	11.9	$317
Lights/Appliances	24.3	$2,092
Service Charges		$120
Generation (e.g. Solar)	0.0	$0
Total:	**232.6**	**$8,325**



Home Feature Summary:

Home Type:	Single family detached
Model:	N/A
Community:	N/A
Conditioned Floor Area:	2,000 ft²
Number of Bedrooms:	3
Primary Heating System:	Boiler • Oil • 84 AFUE
Primary Cooling System:	Air Conditioner • Electric • 14 SEER
Primary Water Heating:	Boiler • Oil • 84 Thermal Efficiency
House Tightness:	7 ACH50
Ventilation:	None
Duct Leakage to Outside:	Untested Forced Air
Above Grade Walls:	R-13
Ceiling:	Vaulted Roof / Exposed Exterior, R-43
Window Type:	U-Value: 0.95, SHGC: 0.8
Foundation Walls:	N/A
Framed Floor:	N/A

This home meets or exceeds the criteria of the following:

68,168 kWh

Rating Completed by:

Energy Rater: Andrew Parneros
RESNET ID: 0890099

Rating Company: Infrared Diagnostic LLC
14 Paxton Rd Framingham, MA 01701
978-440-9900

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

Andrew Parneros, Certified Energy Rater
Date: 3/19/26 at 12:55 PM

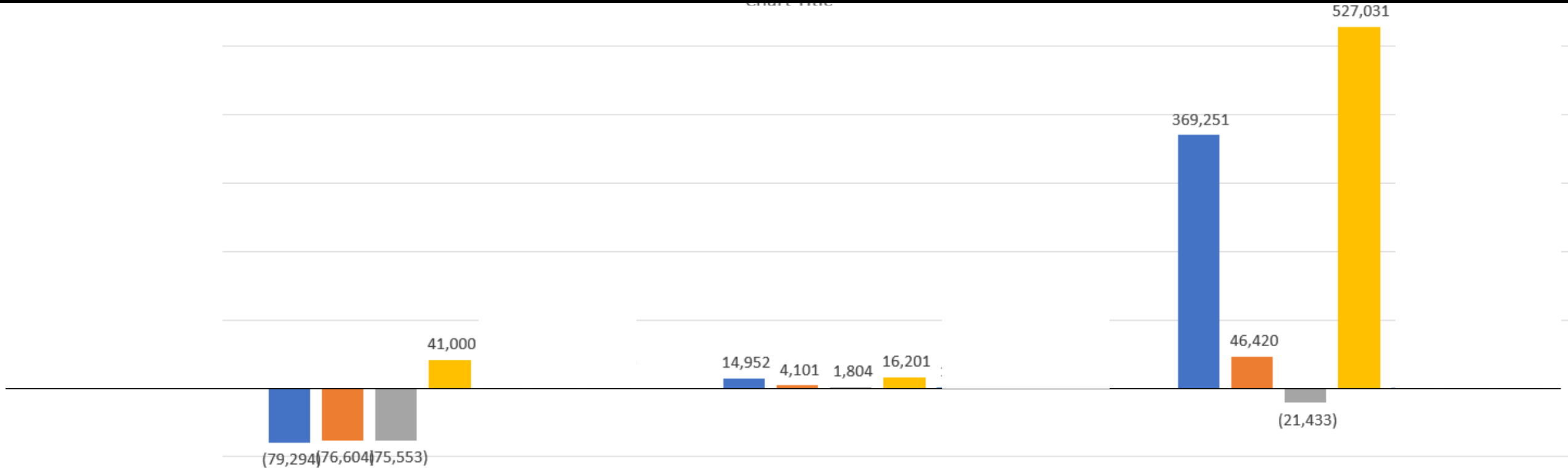
ekotrope

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

Ekotrope RATER - Version:5.2.1.3825
The Energy Rating Disclosure for this home is available from the Approved Rating Provider.
This report does not constitute any warranty or guarantee.

Andrew Parneros, Infrared Diagnostics

1950 House – Whole Life Carbon



	EMBODIED CARBON (kg CO2e)	YEARLY OPERATIONAL CARBON (kg CO2e/Yr)	EMBODIED CARBON + OPERATIONAL CARBON (kg CO2e)
1750s House	(79,294)	14,952	369,251
1750s House - Reno Level 1	(76,604)	4,101	46,420
1750s House - Reno Level 2	(75,553)	1,804	(21,433)
1950s House	41,000	16,201	527,031

2030 House

TRADITIONAL BUILDING CONFERENCE

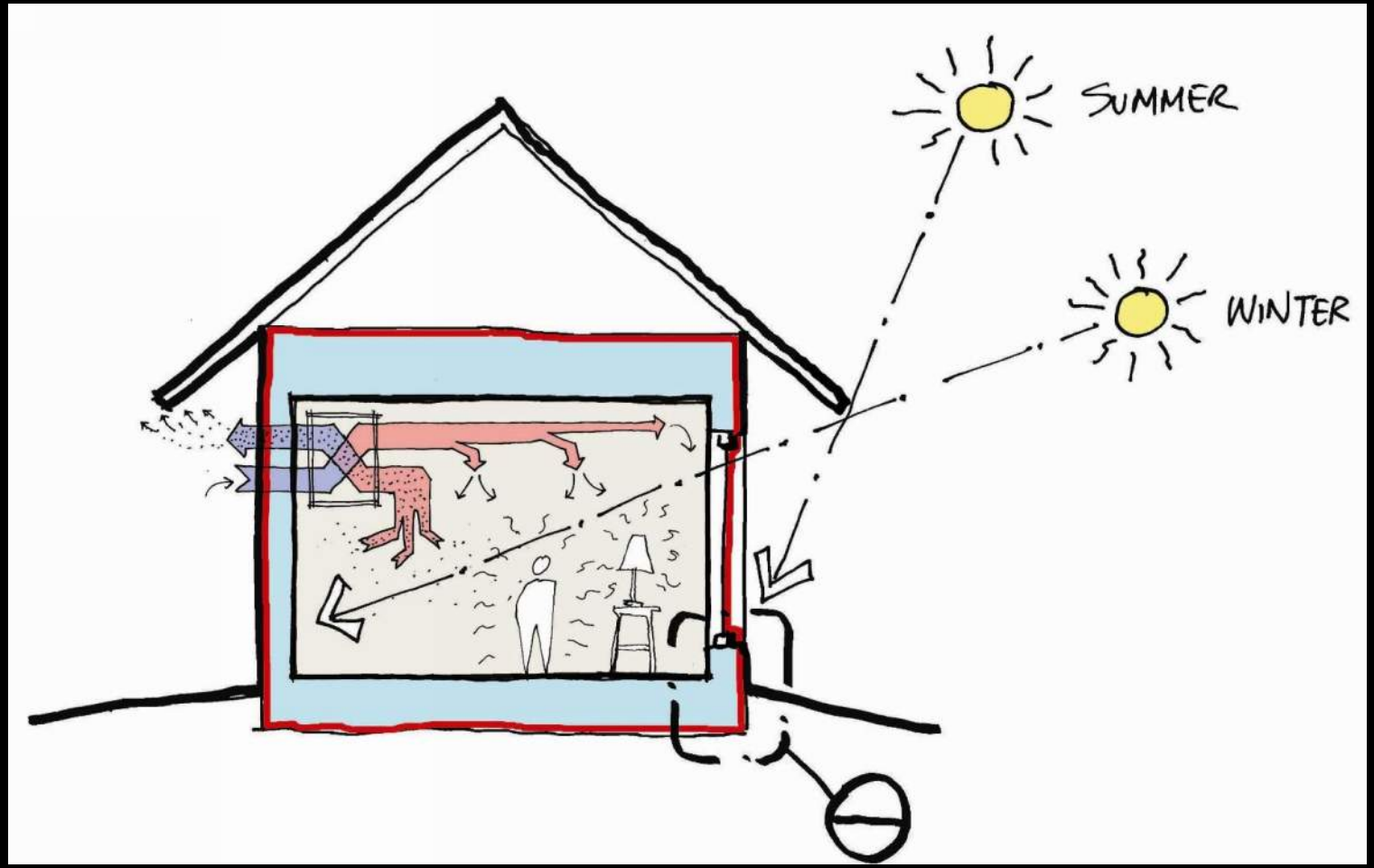
ART Architects

2030 House Examples

ART Architects

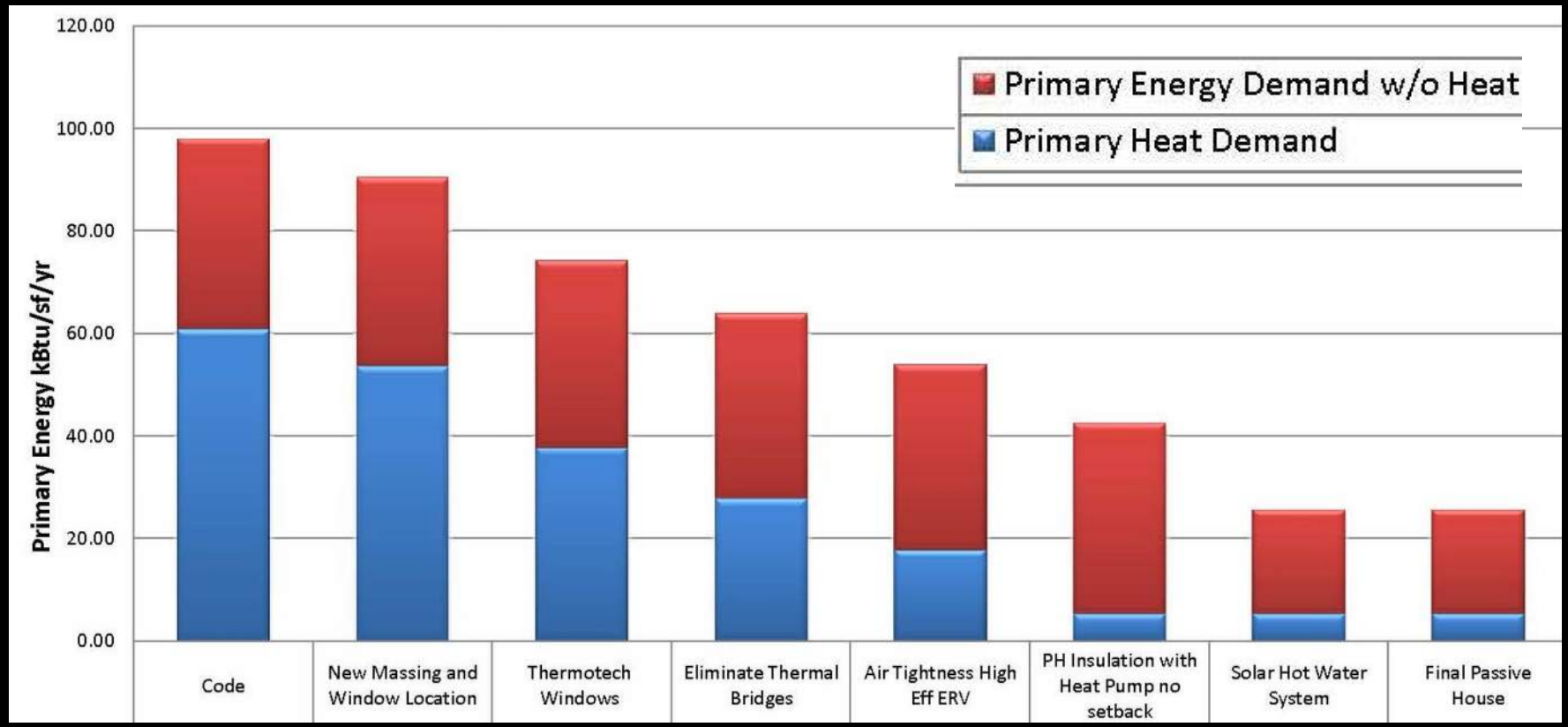
2030 House

“Let the architecture do the work”



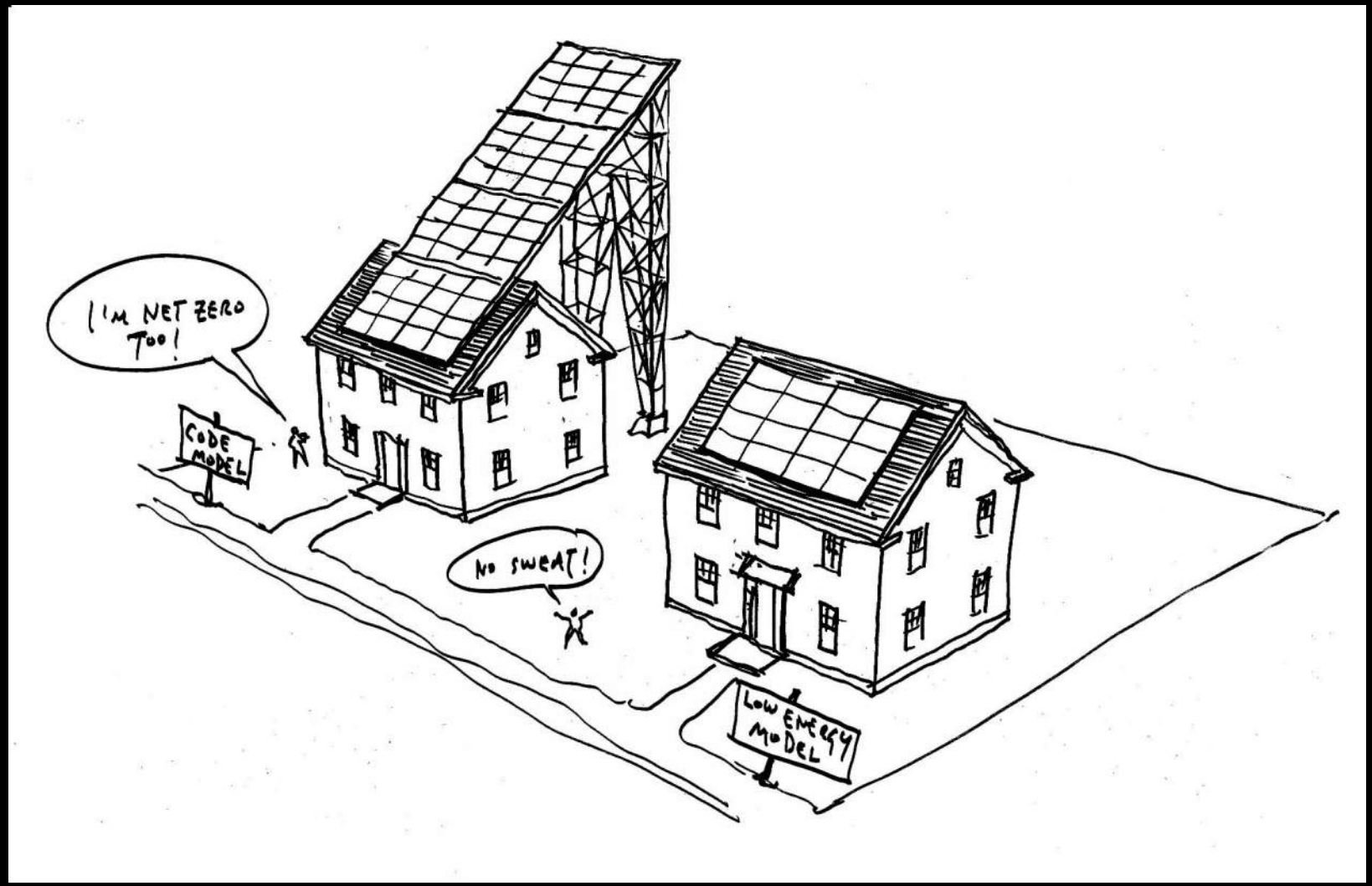
2030 House

TO GET FROM CODE TO PASSIVE HOUSE



INTEGRATED

2030 House



2030 House

ART Architects

2030 House – Embodied Energy

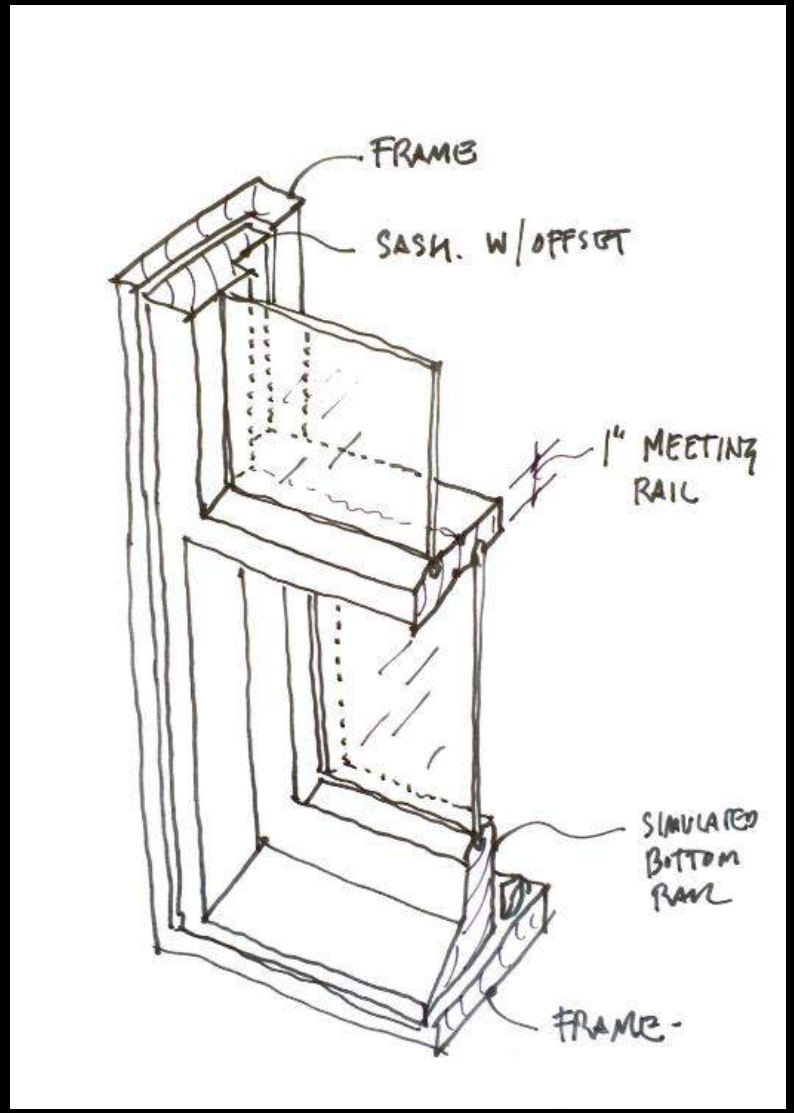
BEAM

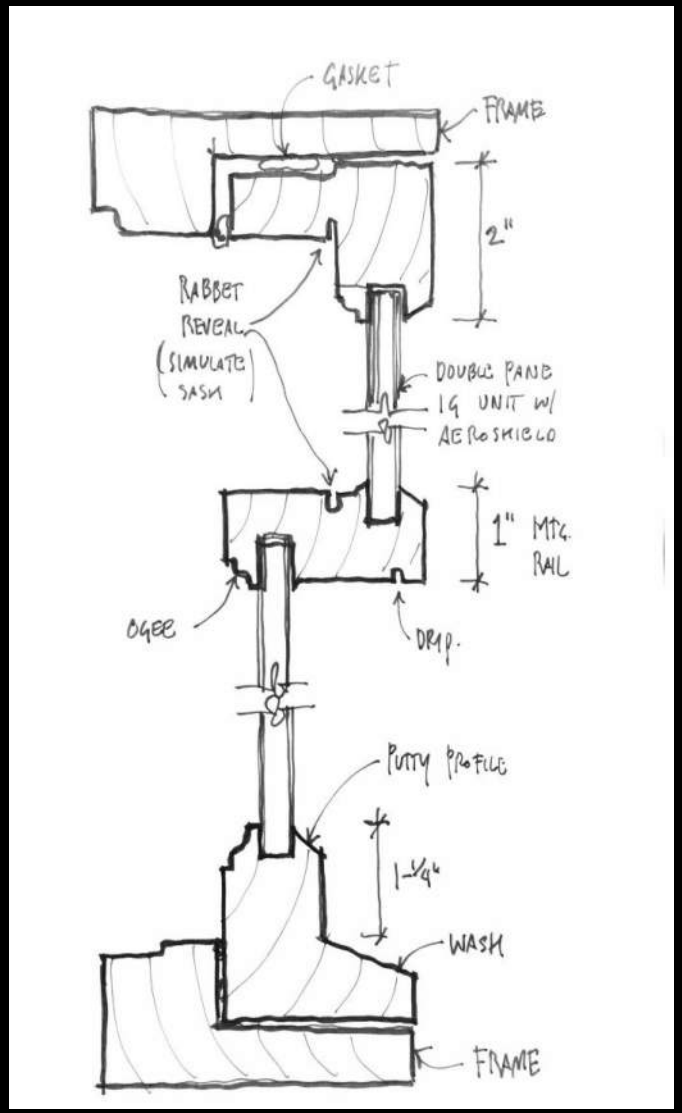
PROJECT NAME: 2050: Passive House
SCENARIO: Scenario 1
BEAM VERSION: V1.1

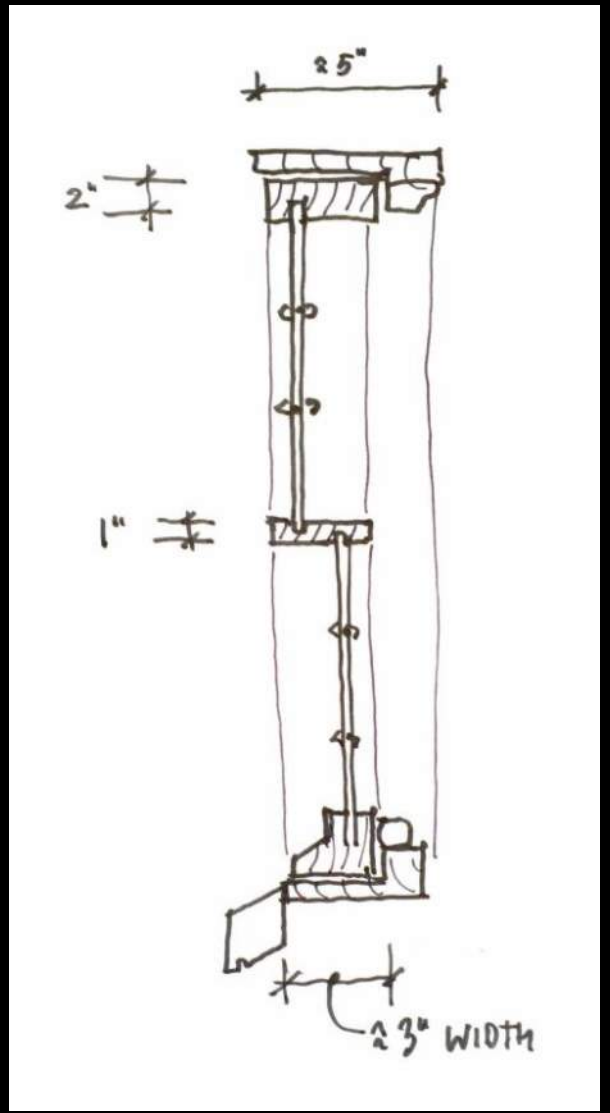
SELECTED PROJECT MATERIALS REVIEW

			6,816	19,656	12,839	0	
SECTION	CATEGORY	MATERIAL	NET EMISSIONS kg CO_2e	GROSS EMISSIONS kg CO_2e	STORAGE Short Cycle kg CO_2	STORAGE Long Cycle kg CO_2	QTY
Footings & Slabs	CONTINUOUS CONCRETE FOOTINGS	Concrete - 3001-4000 psi, >50% SCM mix / NRMCA [Industry Avg | US & CA]	1,785	1,785	0	0	9.8 yd^3
Footings & Slabs	CONCRETE SLABS	Concrete - 3001-4000 psi, >50% SCM mix / NRMCA [Industry Avg | US & CA]	2,361	2,361	0	0	1048.0 ft^2
Footings & Slabs	SUB-SLAB INSULATION	EPS foam board with graphite / BASF / Neopor F 5200 & F 5300 Plus BMB / R 4.7-inch, Type IX, 25 psi (Type 9, 175 kPa)	994	994	0	0	1048.0 ft^2
Footings & Slabs	ADDITIONAL MATERIALS	EPS foam board with graphite / BASF / Neopor F 5200 & F 5300 Plus BMB / R 4.7-inch, Type IX, 25 psi (Type 9, 175 kPa)	19	19	0	0	20.4 ft^2
Exterior Walls	LIGHT WOOD FRAME WALLS	Wood / SPF / 2x6 Lumber / AWC & CWC [Industry Avg | US & CA]	444	444	0	0	2461.4 ft^2
Exterior Walls	STRUCTURAL SHEATHING	OSB sheathing / 1/2" / AWC & CWC [Industry Avg | US & CA]	704	704	0	0	2461.4 ft^2
Exterior Walls	CAVITY INSULATION	Cellulose / dense pack / CIMA / R 3.7-inch / [Industry Avg | US & CA]	-1,623	917	2,540	0	2461.4 ft^2
Exterior Walls	CONTINUOUS INSULATION	Wood fiber board / GUTEX / Multi-Therm / R 3.6-inch, 40-200 mm [EU]	-3,292	1,799	5,091	0	2461.4 ft^2
Cladding	EXTERIOR WALL CLADDING	Cedar Siding / Western Red Cedar Lumber Assn / 1x6 Boards [Industry Avg | CA]	394	394	0	0	2461.4 ft^2
Cladding	INTERIOR CLADDING FOR EXTERIOR WALLS	Drywall 1/2" [BEAM Avg | US & CA]	706	706	0	0	2461.4 ft^2
Windows	WINDOWS – TRIPLE-GLAZED	Window, triple-glazed, PVC-U frame, tilt & turn / [Industry Avg | EU]	2,517	2,517	0	0	284.6 ft^2
Floors	LIGHT WOOD FLOOR FRAMING	Wood / SPF / 2x10 Lumber / AWC & CWC [Industry Avg | US & CA]	362	362	0	0	2096.0 ft^2
Floors	SUB FLOORING	OSB sheathing / 3/4" / AWC & CWC [Industry Avg | US & CA]	900	900	0	0	2096.0 ft^2
Floors	FLOORING	Hardwood flooring / NWFA and Decorative Hardwoods Association / Solid Wood Flooring / 3/4" [Industry Avg | US & CA]	1,907	1,907	0	0	2096.0 ft^2
Ceilings	CEILING FINISHES	Drywall 1/2" [BEAM Avg | US & CA]	601	601	0	0	2096.0 ft^2
Ceilings	CEILING STRAPPING	Wood / SPF / 1x4 Lumber / AWC & CWC [Industry Avg | US & CA]	51	51	0	0	2096.0 ft^2
Roof	WOOD ROOF FRAMING	Wood / SPF / 2x12 Lumber / AWC & CWC [Industry Avg | US & CA]	229	229	0	0	1449.0 ft^2
Roof	ROOF DECKING	OSB sheathing / 5/8" / AWC & CWC [Industry Avg | US & CA]	519	519	0	0	1449.0 ft^2
Roof	ROOFING	Asphalt Shingles / Asphalt Roofing Manufacturers Association / Fiberglass Asphalt Shingles [Industry Avg | US & CA]	590	590	0	0	1449.0 ft^2
Roof	ROOF CAVITY INSULATION	Cellulose / dense pack / CIMA / R 3.7-inch / [Industry Avg | US & CA]	-1,414	798	2,212	0	1048.0 ft^2
Roof	CONTINUOUS ROOF INSULATION	Wood fiber board / GUTEX / Multi-Therm / R 3.6-inch, 40-200 mm [EU]	-1,938	1,059	2,997	0	1449.0 ft^2

2030 House


FRAME
SASH. W/OFFSET
1" MEETING RAIL
SIMULATED BOTTOM RAIL
FRAME


GASKET
FRAME
2"
RABBET REVEAL (SIMULATED SASH)
DOUBLE PANE IG UNIT W/ AEROGEL
1" MTG. RAIL
OGEE
DRIP
PUTTY PROFILE
1-1/4"
WASH
FRAME


2.5"
2"
1"
≈3" WIDTH

2030 House – Embodied Energy

BEAM

PROJECT NAME: 2050: Passive House
SCENARIO: Scenario 2
BEAM VERSION: V1.1

SELECTED PROJECT MATERIALS REVIEW

			30,970	30,970	0	0	
SECTION	CATEGORY	MATERIAL	NET EMISSIONS kg CO_2e	GROSS EMISSIONS kg CO_2e	STORAGE Short Cycle kg CO_2	STORAGE Long Cycle kg CO_2	QTY
Footings & Slabs	CONTINUOUS CONCRETE FOOTINGS	Concrete - 3001-4000 psi, >50% SCM mix / NRMCA [Industry Avg | US & CA]	1,785	1,785	0	0	9.8 yd^3
Footings & Slabs	CONCRETE SLABS	Concrete - 3001-4000 psi, >50% SCM mix / NRMCA [Industry Avg | US & CA]	2,361	2,361	0	0	1048.0 ft^2
Footings & Slabs	SUB-SLAB INSULATION	EPS foam board with graphite / BASF / Neopor F 5200 & F 5300 Plus BMB / R 4.7-inch, Type IX, 25 psi (Type 9, 175 kPa)	994	994	0	0	1048.0 ft^2
Footings & Slabs	ADDITIONAL MATERIALS	EPS foam board with graphite / BASF / Neopor F 5200 & F 5300 Plus BMB / R 4.7-inch, Type IX, 25 psi (Type 9, 175 kPa)	19	19	0	0	20.4 ft^2
Foundation Walls	CONCRETE FOUNDATION WALLS	Concrete - 3001-4000 psi, >50% SCM mix / NRMCA [Industry Avg | US & CA]	5,948	5,948	0	0	1056.0 ft^2
Foundation Walls	CONTINUOUS INSULATION	EPS foam board with graphite / BASF / Neopor F 5200 & F 5300 Plus BMB / R 4.7-inch, Type IX, 25 psi (Type 9, 175 kPa)	1,002	1,002	0	0	1056.0 ft^2
Exterior Walls	LIGHT WOOD FRAME WALLS	Wood / SPF / 2x6 Lumber / AWC & CWC [Industry Avg | US & CA]	504	504	0	0	2461.4 ft^2
Exterior Walls	STRUCTURAL SHEATHING	Plywood / 1/2" / AWC & CWC [Industry Avg | US & CA]	637	637	0	0	2461.4 ft^2
Exterior Walls	BARRIERS AND MEMBRANES	Ext. Wall & Roof Barrier, sheet / Dupont / Tyvek Monolayer 60 / Permeable / EU	64	64	0	0	2461.4 ft^2
Exterior Walls	CAVITY INSULATION	Spray polyurethane foam - Closed Cell (HFO gas) / Carlisle CSFI / SealTite PRO HFO, SealTite One / R 7.0-inch	3,764	3,764	0	0	2461.4 ft^2
Exterior Walls	CONTINUOUS INSULATION	EPS foam board with graphite / BASF / Neopor F 5200 & F 5300 Plus BMB / R 4.7-inch, Type IX, 25 psi (Type 9, 175 kPa)	1,242	1,242	0	0	2461.4 ft^2
Cladding	EXTERIOR WALL CLADDING	Vinyl Siding / Vinyl Siding Institute / 0.040" Double 4.5" [Industry Avg | US & CA]	1,077	1,077	0	0	2461.4 ft^2
Cladding	INTERIOR CLADDING FOR EXTERIOR WALLS	Drywall 1/2" [BEAM Avg | US & CA]	706	706	0	0	2461.4 ft^2
Windows	WINDOWS – TRIPLE-GLAZED	Window - triple pane / Wood frame, aluminum cladding / BfCA Study [US & CA]	2,961	2,961	0	0	284.6 ft^2
Floors	LIGHT WOOD FLOOR FRAMING	Wood / SPF / 2x10 Lumber / AWC & CWC [Industry Avg | US & CA]	362	362	0	0	2096.0 ft^2
Floors	SUB FLOORING	OSB sheathing / 3/4" / AWC & CWC [Industry Avg | US & CA]	900	900	0	0	2096.0 ft^2
Floors	FLOORING	Hardwood flooring / NWFA and Decorative Hardwoods Association / Solid Wood Flooring / 3/4" [Industry Avg | US & CA]	1,907	1,907	0	0	2096.0 ft^2
Ceilings	CEILING FINISHES	Drywall 1/2" [BEAM Avg | US & CA]	601	601	0	0	2096.0 ft^2
Ceilings	CEILING STRAPPING	Wood / SPF / 1x4 Lumber / AWC & CWC [Industry Avg | US & CA]	51	51	0	0	2096.0 ft^2
Roof	WOOD ROOF FRAMING	Wood / SPF / 2x12 Lumber / AWC & CWC [Industry Avg | US & CA]	229	229	0	0	1449.0 ft^2
Roof	ROOF DECKING	OSB sheathing / 5/8" / AWC & CWC [Industry Avg | US & CA]	519	519	0	0	1449.0 ft^2
Roof	ROOFING	Asphalt Shingles / Asphalt Roofing Manufacturers Association / Fiberglass Asphalt Shingles [Industry Avg | US & CA]	590	590	0	0	1449.0 ft^2
Roof	ROOF CAVITY INSULATION	Spray polyurethane foam - Closed Cell (HFO gas) / Carlisle CSFI / SealTite PRO HFO, SealTite One / R 7.0-inch	2,747	2,747	0	0	1048.0 ft^2

2030 House with Spray Foam

BEAM

PROJECT NAME: 1950 Breuer House
SCENARIO: Scenario 1
BEAM VERSION: V1.1

SELECTED PROJECT MATERIALS REVIEW

			41,818	41,818	0	0	
SECTION	CATEGORY	MATERIAL	NET EMISSIONS kg CO_2e	GROSS EMISSIONS kg CO_2e	STORAGE Short Cycle kg CO_2	STORAGE Long Cycle kg CO_2	QTY
Footings & Slabs	CONTINUOUS CONCRETE FOOTINGS	Concrete - 3001-4000 psi, >50% SCM mix / NRMCA [Industry Avg | US & CA]	1,856	1,856	0	0	10.2 yd^3
Footings & Slabs	CONCRETE SLABS	Concrete - 3001-4000 psi, >50% SCM mix / NRMCA [Industry Avg | US & CA]	2,253	2,253	0	0	1000.0 ft^2
Footings & Slabs	BASEMENT FLOORING	Natural stone flooring / Natural Stone Institute / Includes limestone, granite, marble & quartzite / 1/2" thickness / Mortar included / [Industry Avg, US]	2,044	2,044	0	0	1000.0 ft^2
Foundation Walls	CONCRETE FOUNDATION WALLS	Concrete - 3001-4000 psi, >50% SCM mix / NRMCA [Industry Avg | US & CA]	2,475	2,475	0	0	549.2 ft^2
Structural Elements	STRUCTURAL STEEL – WIDE FLANGE BEAMS	Structural Steel / Wide Flange / W200x22 (US W8x15) / AISC [Industry Avg | US]	3,012	3,012	0	0	360.0 ft
Structural Elements	STRUCTURAL STEEL – OTHER SECTION SHAPES	Structural Steel / Square HSS / 4 x 4 x 1/4" / AISC [Industry Avg | US]	1,533	1,533	0	0	128.0 ft
Exterior Walls	LIGHT WOOD FRAME WALLS	Wood / SPF / 2x4 Lumber / AWC & CWC [Industry Avg | US & CA]	97	97	0	0	744.0 ft^2
Exterior Walls	STRUCTURAL SHEATHING	OSB sheathing / 1/2" / AWC & CWC [Industry Avg | US & CA]	213	213	0	0	744.0 ft^2
Exterior Walls	CAVITY INSULATION	Fiberglass batt / NAIMA / R 4.4-inch [Industry Avg | N.America]	214	214	0	0	744.0 ft^2
Cladding	EXTERIOR WALL CLADDING	Cedar Siding / Western Red Cedar Lumber Assn / 1x6 Boards [Industry Avg | CA]	119	119	0	0	744.0 ft^2
Cladding	INTERIOR CLADDING FOR EXTERIOR WALLS	Drywall 1/2" [BEAM Avg | US & CA]	213	213	0	0	744.0 ft^2
Windows	WINDOWS – DOUBLE-GLAZED	Window, double-glazed, aluminum frame / Arcadia / CV200, T200 / Projected & casement	17,303	17,303	0	0	1490.0 ft^2
Floors	LIGHT WOOD FLOOR FRAMING	Wood / SPF / 2x10 Lumber / AWC & CWC [Industry Avg | US & CA]	346	346	0	0	2000.0 ft^2
Floors	SUB FLOORING	OSB sheathing / 1/2" / AWC & CWC [Industry Avg | US & CA]	572	572	0	0	2000.0 ft^2
Floors	FLOORING	Hardwood flooring / NWFA and Decorative Hardwoods Association / Solid Wood Flooring / 3/4" [Industry Avg | US & CA]	1,820	1,820	0	0	2000.0 ft^2
Ceilings	CEILING FINISHES	Drywall 1/2" [BEAM Avg | US & CA]	574	574	0	0	2000.0 ft^2
Roof	WOOD ROOF FRAMING	Wood / SPF / 2x10 Lumber / AWC & CWC [Industry Avg | US & CA]	173	173	0	0	1000.0 ft^2
Roof	ROOF CAVITY INSULATION	Fiberglass batt / NAIMA / R 4.4-inch [Industry Avg | N.America]	727	727	0	0	1000.0 ft^2
Roof	BARRIERS AND MEMBRANES	Roof Deck Liquid Applied Barrier / [BEAM Avg]	629	629	0	0	1000.0 ft^2
Roof	ADDITIONAL MATERIALS	Metal Panels - Steel / Metal Construction Assn. / 24 gauge [Industry Avg | US]	1,421	1,421	0	0	1000.0 ft^2
Roof	ADDITIONAL MATERIALS	Concrete - 3001-4000 psi, 30-39% FA/SL / NRMCA [Industry Avg | US & CA]	4,224	4,224	0	0	18.5 yd^3

1950 House

2030 House – Operational Energy

Home Energy Rating Certificate

Projected Report
Based on Plans

Rating Date:
Registry ID:
Ekotrope ID: LKBaW9e2

HERS® Index Score:

28

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

$7,344

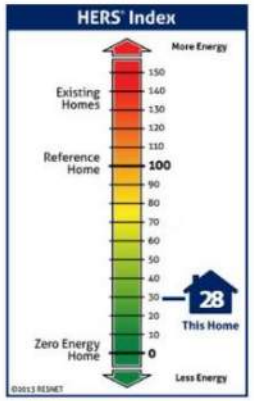
*Relative to an average U.S. home

Home:
0 Main St
Salem, MA 01970

Builder:
ART Architects

Your Home's Estimated Energy Use:

	Use [MBtu]	Annual Cost
Heating	3.8	$326
Cooling	1.7	$149
Hot Water	1.8	$157
Lights/Appliances	17.3	$1,490
Service Charges		$120
Generation (e.g. Solar)	0.0	$0
Total:	**24.7**	**$2,242**



Home Feature Summary:

Home Type:	Single family detached
Model:	N/A
Community:	N/A
Conditioned Floor Area:	2,098 ft²
Number of Bedrooms:	3
Primary Heating System:	Air Source Heat Pump • Electric • 11 HSPF2
Primary Cooling System:	Air Source Heat Pump • Electric • 18.5 SEER2
Primary Water Heating:	Residential Water Heater • Electric • 4.32 Energy Factor
House Tightness:	0.6 ACH50
Ventilation:	95 CFM • 28 Watts • ERV
Duct Leakage to Outside:	Untested Forced Air
Above Grade Walls:	R-36
Ceiling:	Vented Attic, R-89
Window Type:	U-Value: 0.15, SHGC: 0.54
Foundation Walls:	N/A
Framed Floor:	N/A

This home meets or exceeds the criteria of the following:

Massachusetts Stretch Code - New Construction
2021 International Energy Conservation Code

7,238 kWh

Rating Completed by:

Energy Rater: Andrew Parneros
RESNET ID: 0890099

Rating Company: Infrared Diagnostic LLC
14 Paxton Rd Framingham, MA 01701
978-440-9900

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

Andrew Parneros, Certified Energy Rater
Date: 3/19/26 at 12:52 PM

ekotrope

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

Ekotrope RATER - Version:5.2.1.3825
The Energy Rating Disclosure for this home is available from the Approved Rating Provider.
This report does not constitute any warranty or guarantee.

Andrew Parneros, Infrared Diagnostics

2030 House – Operational Energy

Home Energy Rating Certificate

Projected Report
Based on Plans

Rating Date:
Registry ID:
Ekotrope ID: LKBaW9e2

HERS® Index Score:

0 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

$9,466

*Relative to an average U.S. home

Home:
0 Main St
Salem, MA 01970

Builder:
ART Architects

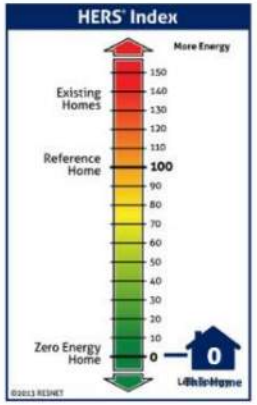
Your Home's Estimated Energy Use:

	Use [MBtu]	Annual Cost
Heating	3.8	$326
Cooling	1.7	$149
Hot Water	1.8	$157
Lights/Appliances	17.3	$1,490
Service Charges		$120
Generation (e.g. Solar)	-25.4	-$2,122
Total:	**-0.8**	**$120**

This home meets or exceeds the criteria of the following:

Massachusetts Stretch Code - New Construction
2021 International Energy Conservation Code

0 net kWh



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Primary Cooling System:	Air Source Heat Pump • Electric • 18.5 SEER2
Primary Water Heating:	Residential Water Heater • Electric • 4.32 Energy Factor
House Tightness:	0.6 ACH50
Ventilation:	95 CFM • 28 Watts • ERV
Duct Leakage to Outside:	Untested Forced Air
Above Grade Walls:	R-36
Ceiling:	Vented Attic, R-89
Window Type:	U-Value: 0.15, SHGC: 0.54
Foundation Walls:	N/A
Framed Floor:	N/A

Rating Completed by:

Energy Rater: Andrew Parneros
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Date: 3/19/26 at 12:53 PM

ekotrope

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

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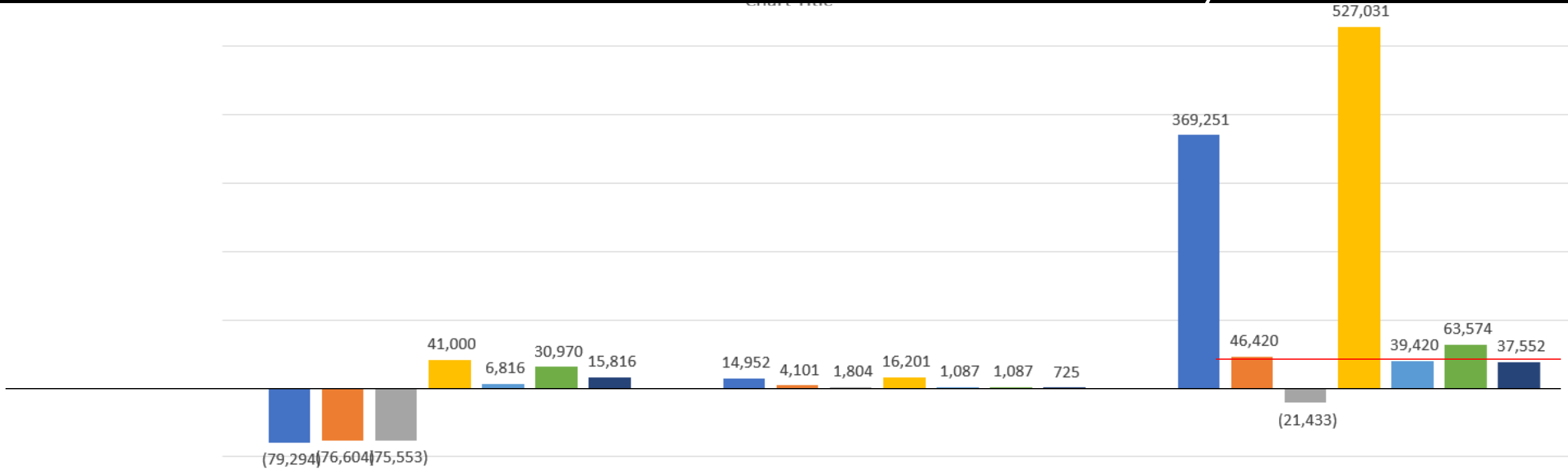
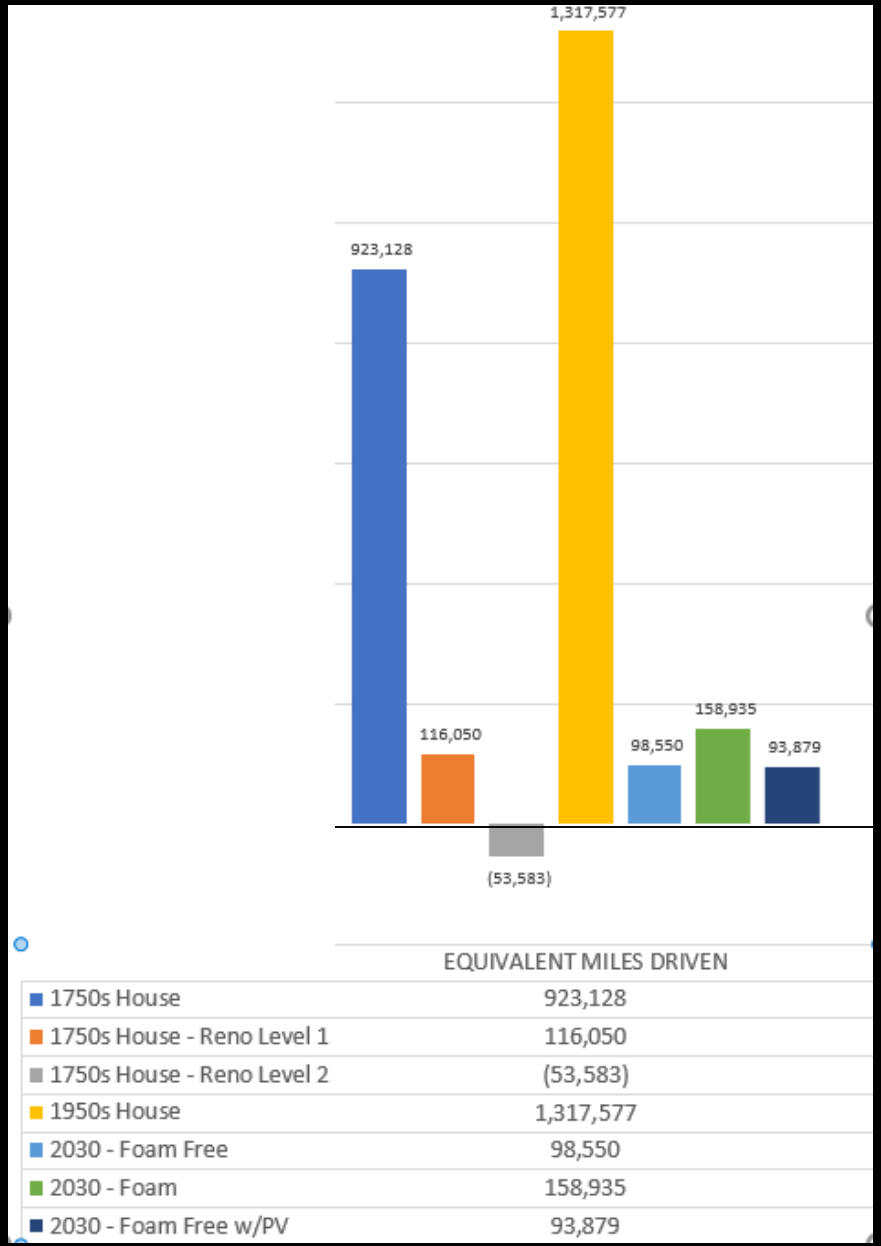
Andrew Parneros, Infrared Diagnostics

Whole Life Carbon Analysis



	EMBODIED CARBON (kg CO2e)	YEARLY OPERATIONAL CARBON (kg CO2e/Yr)	EMBODIED CARBON + OPERATIONAL CARBON (kg CO2e)
1750s House	(79,294)	14,952	369,251
1750s House - Reno Level 1	(76,604)	4,101	46,420
1750s House - Reno Level 2	(75,553)	1,804	(21,433)
1950s House	41,000	16,201	527,031
2030 - Foam Free	6,816	1,087	39,420
2030 - Foam	30,970	1,087	63,574
2030 - Foam Free w/PV	15,816	725	37,552

Whole Life Carbon Analysis



	EQUIVALENT MILES DRIVEN
1750s House	923,128
1750s House - Reno Level 1	116,050
1750s House - Reno Level 2	(53,583)
1950s House	1,317,577
2030 - Foam Free	98,550
2030 - Foam	158,935
2030 - Foam Free w/PV	93,879

Lessons

Traditional architecture is as much about how we building our building as how they look
We can look to these buildings for lessons for our future

- **Form**
  - The envelope and form of the building are the primary environmental control system.
  - Use a systems approach, "Let the architecture do the work."
  - Make the form climate specific, not one size or shape fits all.
  - Use simple forms, don't add unnecessary complexity.
  - Orientation matters. Understand the Site, sun orientation is critical.
  - Right size the plan, multi function spaces, one special room, one special window.
  - Feels timeless – will be loved by generations
  - Beauty –even with limited resources, people made beautiful, lasting buildings, the pre-fossil fuel era was not one of austerity.
- **Materials**
  - Build to last 100 plus years
  - Use low carbon materials
  - Use local materials
  - Use recyclable materials. Use materials that can be repaired and restored.
  - Emphasis – not everything is lux, or maximalist. Might not be able to do "everything" but it will be meaningful and require less energy to create.
  - Does not have to be austere, add ornament or detail if you want.

DESIGN GUIDANCE FROM ARCHITECTURE 2030

2030 PALETTE **THESE ARE ALL "TRADITIONAL" BUILDING PRINCIPLES!**

- *Use or repurpose existing buildings and infrastructure*
- *Use salvaged and/or recycled materials*
- *Optimize systems for material and energy efficiency*
- *Specify materials that naturally sequester carbon*
- *Specify materials manufactured with renewable energy*
- *Design for durability*
- *Choose the right materials for your climate*
- *Get to know the supply chain for your specific project*
- *Understanding your region and source locally*
- *Use low-emissions transportation*
- *Establish emissions targets*

https://www.materialspalette.org/

Architectural Principles in the Age of Sustainability

Harmony

Make it balanced - Use less energy and make the energy you use
Make it balanced with its context and community
Make it last

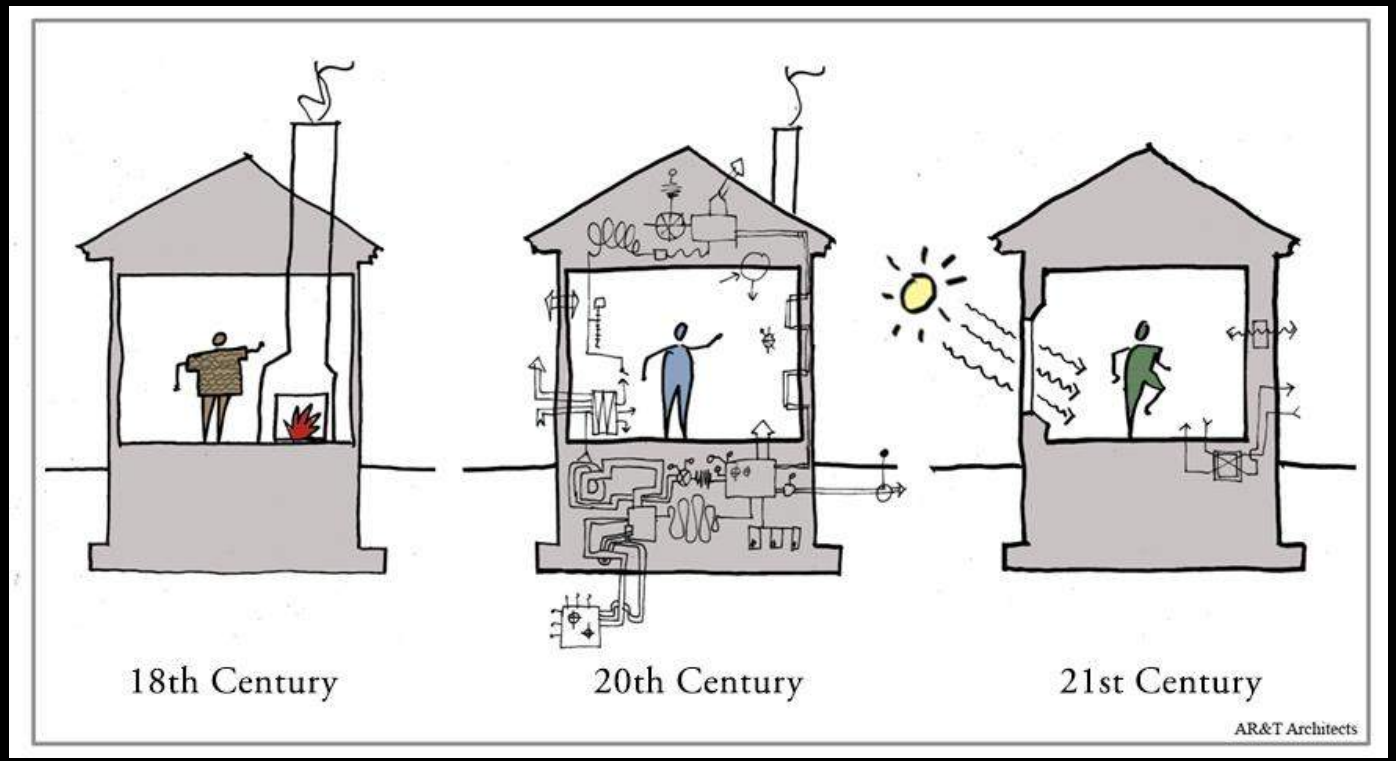
Health

Make it healthy for people
Make it healthy for the planet

Beauty

Make it personal
Make it beautiful

Questions?



Credits

BEAM and WLC Modeling:
- Gabriela Larumbe
- Abby Reed
- Bowen Supple

HERS Energy Modeling:
- Andrew Parneros,

Infrared Diagnostics LLC

Illustrations:
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- Gabriela Larumbe
- John Tittmann