

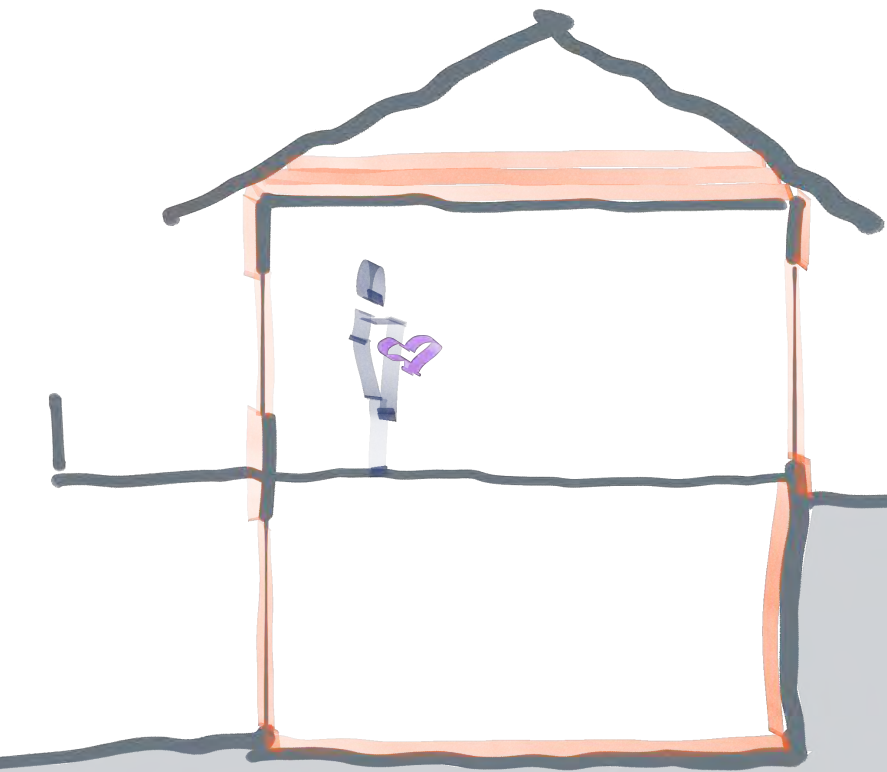
BUILDINGENERGY BOSTON

Deep Energy Retrofits, Round 3: A Holistic Cost Analysis

Michael Hindle, Passive to Positive
Kyle Macht, Macht Architecture

Curated by Brendan Kavanagh and Dave Reilly

Northeast Sustainable Energy Association (NESEA) | March 24, 2026



1. backstory

BUILDING MATTERS

The End of Deep Energy Retrofits?

Learn why one design-build remodeling firm stopped doing these types of renovations in favor of other efficiency improvements and upgrades.

By Rachel White | Issue 314 - April/May 2023



Wednesday Keynote — Why We Stopped Doing Deep Energy Retrofits

After completing many Deep Energy Retrofit projects (DERs) in the late 2000s early 2010s here in Massachusetts, our residential design-build remodeling company's approach to energy retrofit work has shifted towards lighter envelope improvements and a greater focus on getting homes off of an on site fossil fuel consumption. While the DER approach was successful in substantially reducing energy consumption, among other improvements, it often came at a high cost both in terms of our clients investment and the embodied carbon impact of the work itself. In this presentation we will make the case for our current, more moderate approach to energy retrofit work, how we got here, and why we don't expect to be super-insulating many existing homes going forward.

REGISTER
REGISTER

Past Conferences

BuildingEnergy Boston 2024



CEO
Rachel White



PROJECT MANAGER & PERFORMANCE MANAGER
Brendan Kavanagh

keynote Byggmeister

RESPONSE TO THE NESEA BE BOSTON 2023 WEDNESDAY KEYNOTE, “WHY WE STOPPED DOING DEEP ENERGY RETROFITS”



Michael Hindle



interlude: Hindle’s systemic critique

Deep Energy Retrofit Controversy Revisited

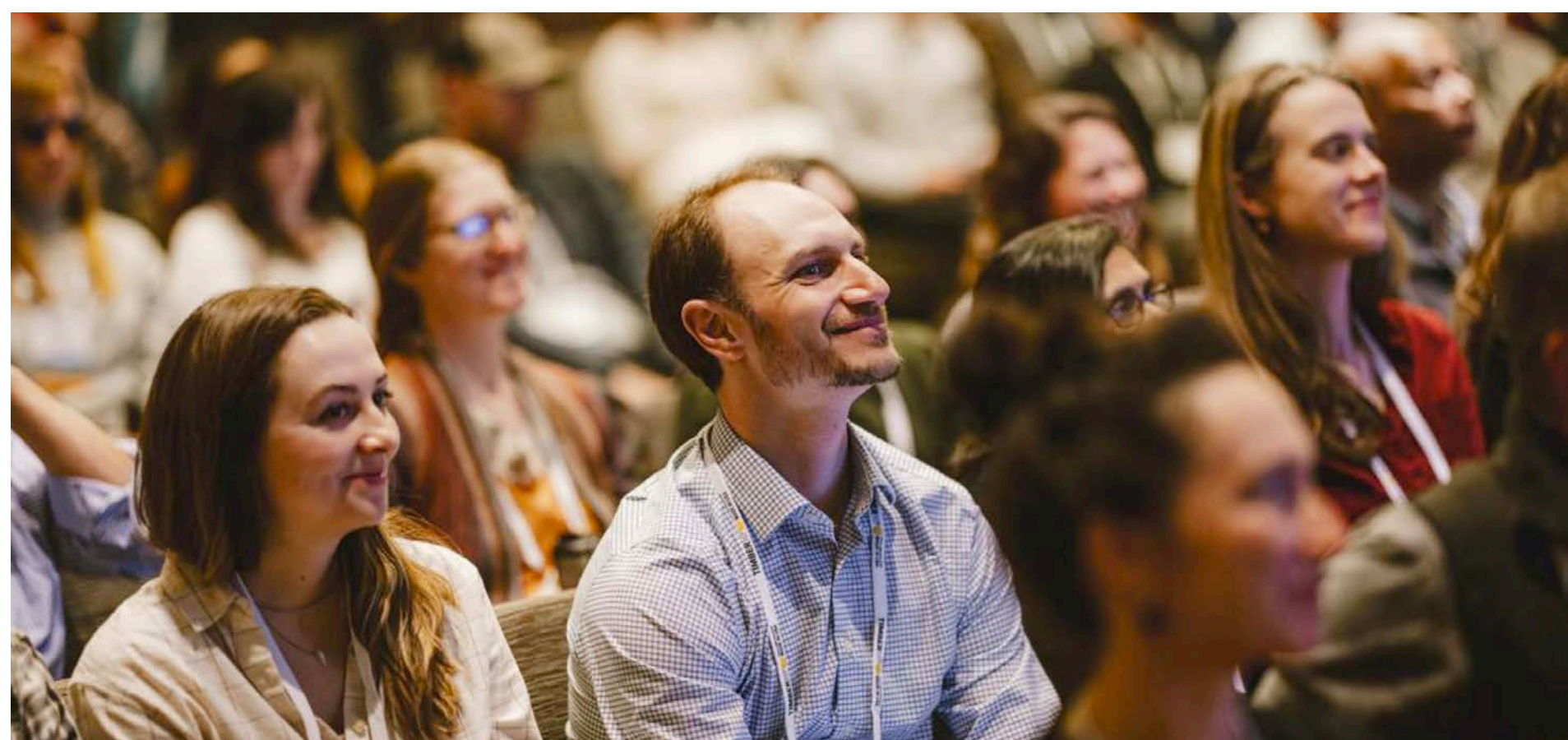


Not actually a controversy at all – (but we thought it might bring in the audience)



Passive to **POSITIVE**
PASSIVE HOUSE AND LOW IMPACT DESIGN

part 2 White and Hindle



kyle's **reflection**



advisors

Brendan Kavanagh - Builder, Byggmeister

Jacob Racusin - Builder, Building Scientist

Mike Maines - Designer, Fine Home Building Editor

Emily Mottram - Architect, E3 Podcast

Ben Bogie - Builder, Building Scientist

Kristof Irwin - Engineer, The Building Science Podcast

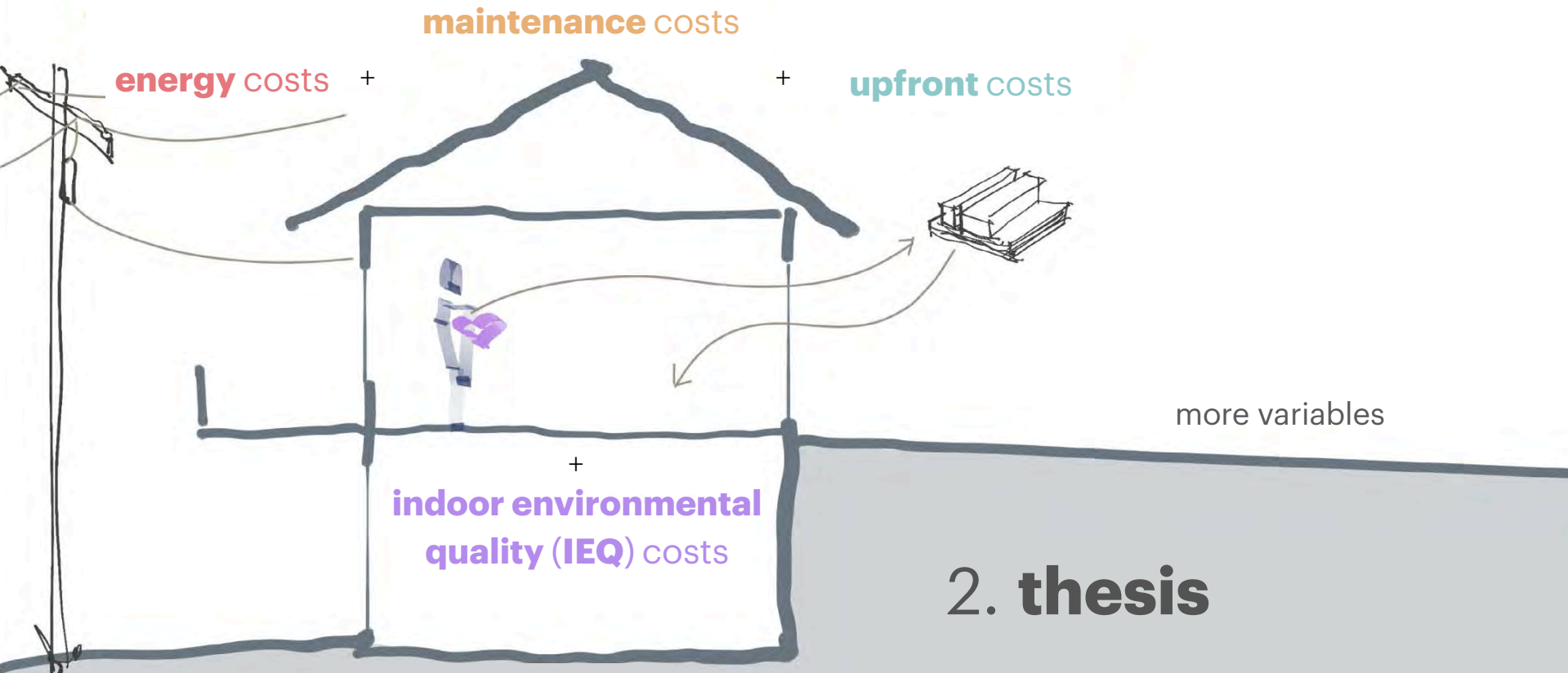
Michael Hindle - Consultant, Passive to Positive

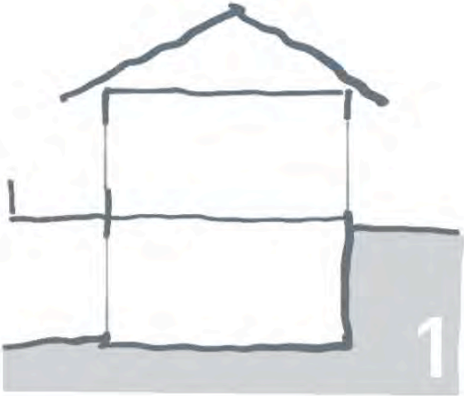
Caroline Blazovsky - America's Healthy Home Expert®

Andy Shapiro - Energy Engineer, Energy Balance, Inc.

Dr. Eva King - Principal Scientist, AURO EnviroScience

Dr. Valerie Maier-Sperdelozzi - Professor of Engineering
Economics, URI

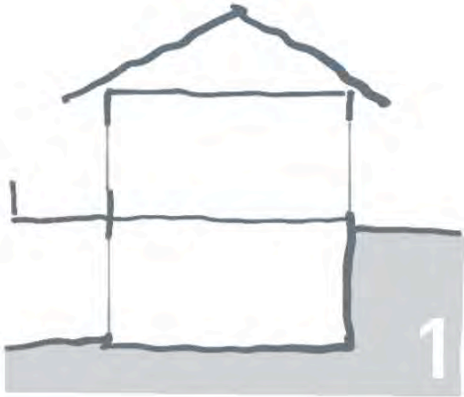




1 Remodel Only

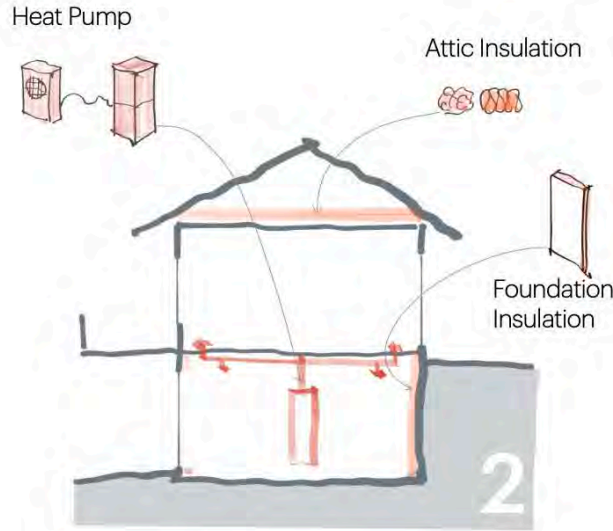
Existing envelope remains
Replace mechanical systems in kind

For all scenarios it will be assumed that the homes interior and exterior will be replaced and will be the same between each version. The main differences will be the buildings envelope and systems.



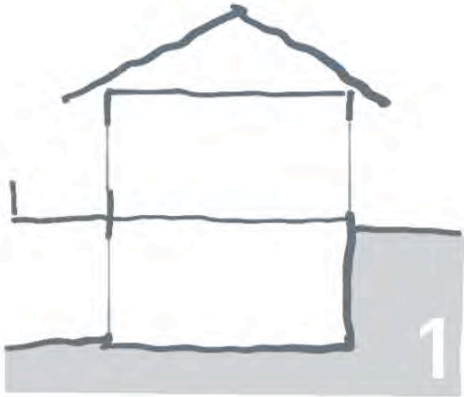
1 Remodel Only

Existing envelope remains
Replace mechanical systems in kind



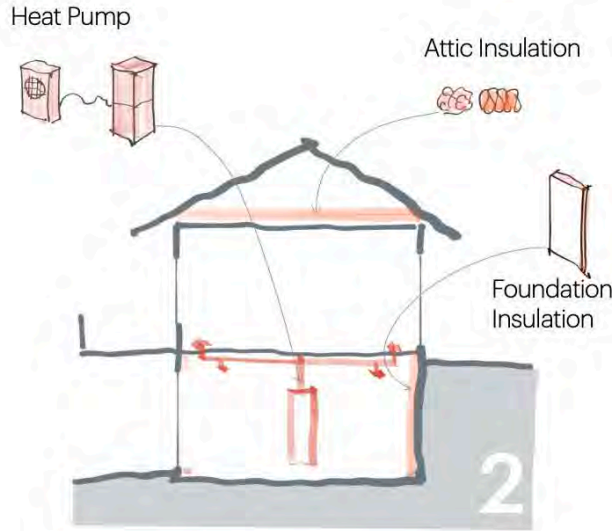
2 Moderate Energy Retrofit

Attic and basement insulation
Replace mechanical systems with
high efficiency heat pump



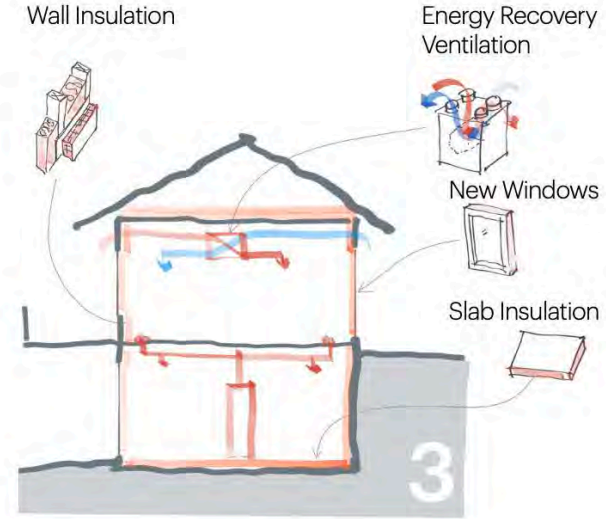
1 Remodel Only

Existing envelope remains
Replace mechanical systems in kind



2 Moderate Energy Retrofit

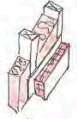
Attic and basement insulation
Replace mechanical systems with high efficiency heat pump



3 Deep Energy Retrofit

Complete upgrade to building envelope to high performance levels
Complete upgrade to high efficiency mechanical systems

Wall Insulation



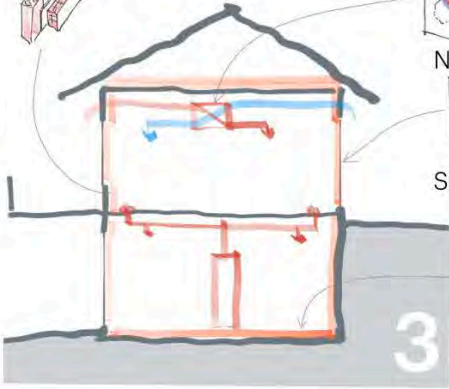
Energy Recovery
Ventilation



New Windows



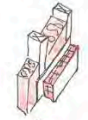
Slab Insulation



3 Deep Energy Retrofit

Complete upgrade to building envelope to high performance levels
Complete upgrade to high efficiency mechanical systems

Wall Insulation



Energy Recovery Ventilation



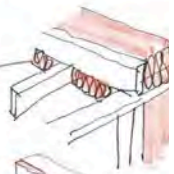
New Windows



Slab Insulation

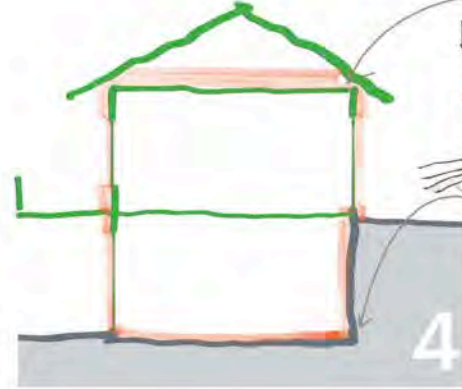
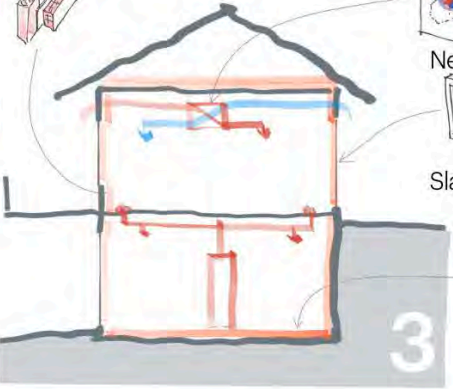


Plus Assemblies



Existing Foundation

4

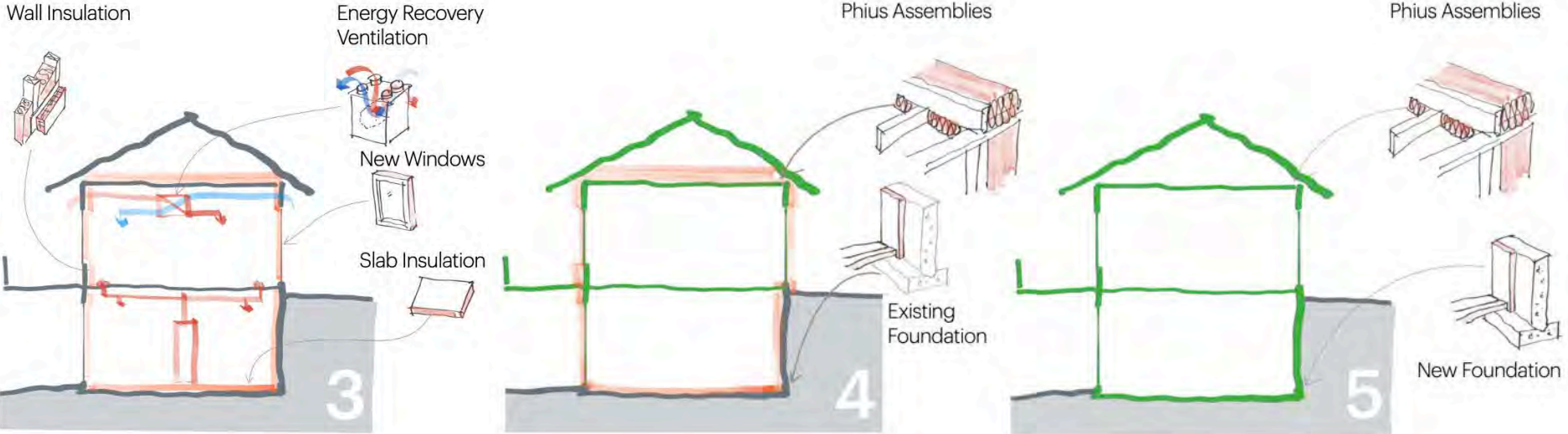


3 Deep Energy Retrofit

Complete upgrade to building envelope to high performance levels
Complete upgrade to high efficiency mechanical systems

4 New Build - Existing Foundation

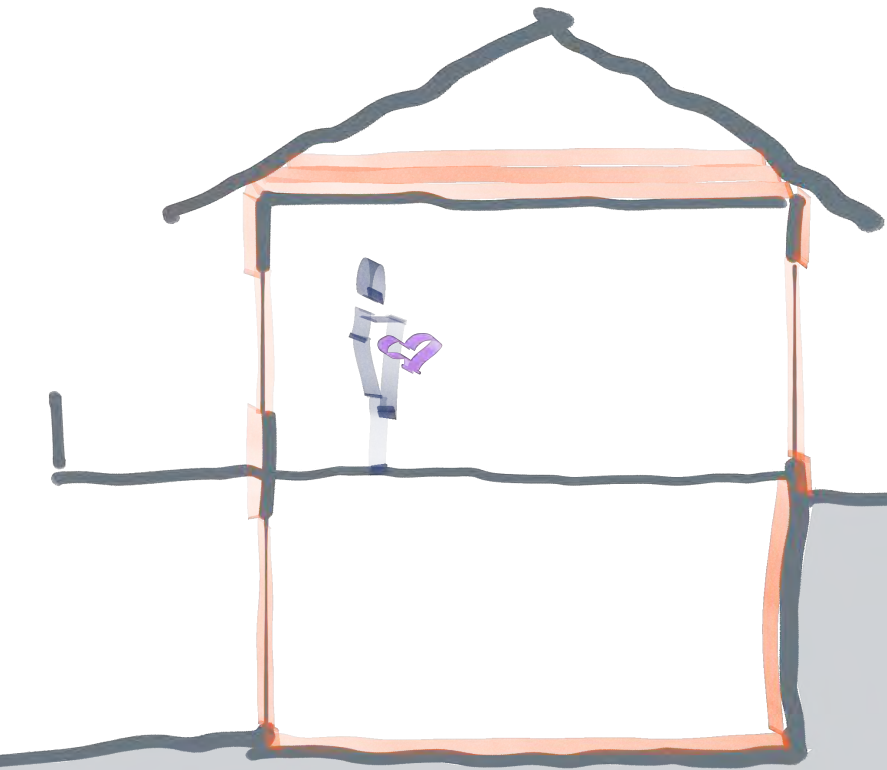
All new home above the existing foundation
Retain the existing foundation to save the embodied carbon



3 Deep Energy Retrofit
 Complete upgrade to building envelope to high performance levels
 Complete upgrade to high efficiency mechanical systems

4 New Build - Existing Foundation
 All new home above the existing foundation
 Retain the existing foundation to save the embodied carbon

5 New Build
 All new building to Pius standards
 Demolish existing home and foundation



3. case **study**

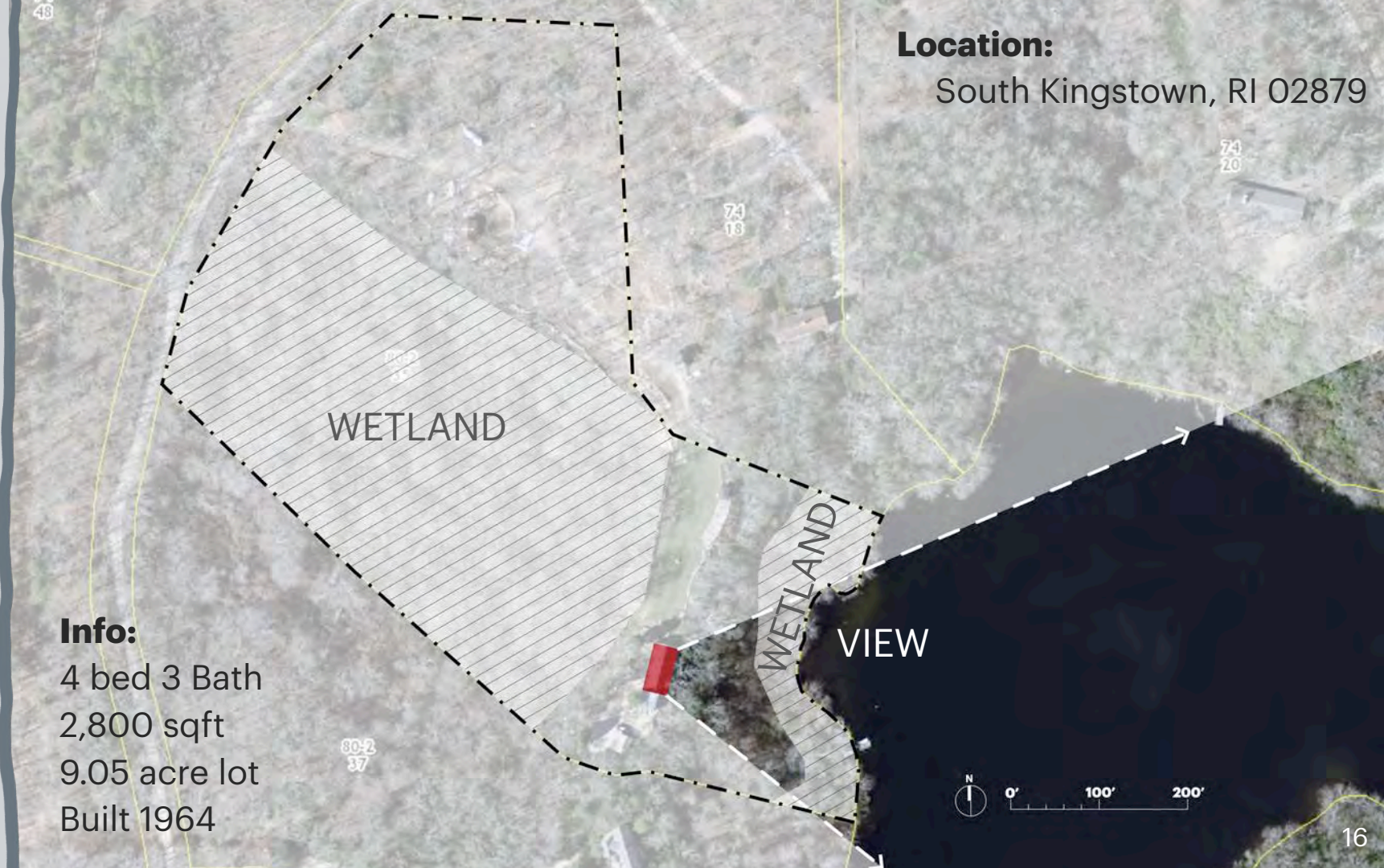
site plan

Info:

4 bed 3 Bath
2,800 sqft
9.05 acre lot
Built 1964

Location:

South Kingstown, RI 02879





South



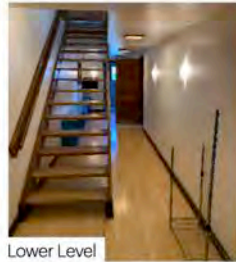
Aerial View



North



Attic



Lower Level



Living Room



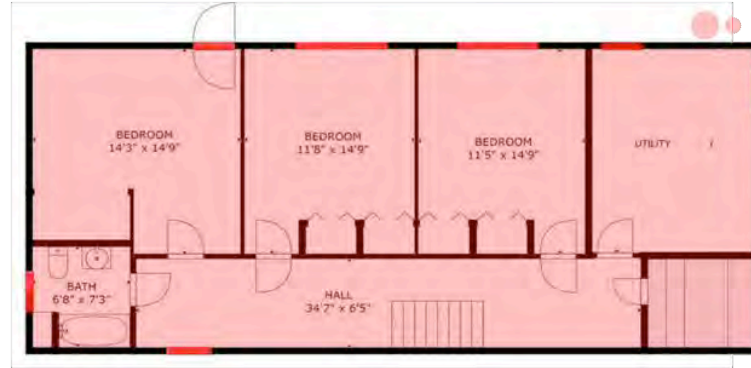
Kitchen

1960s Home
Climate Zone 5, RI

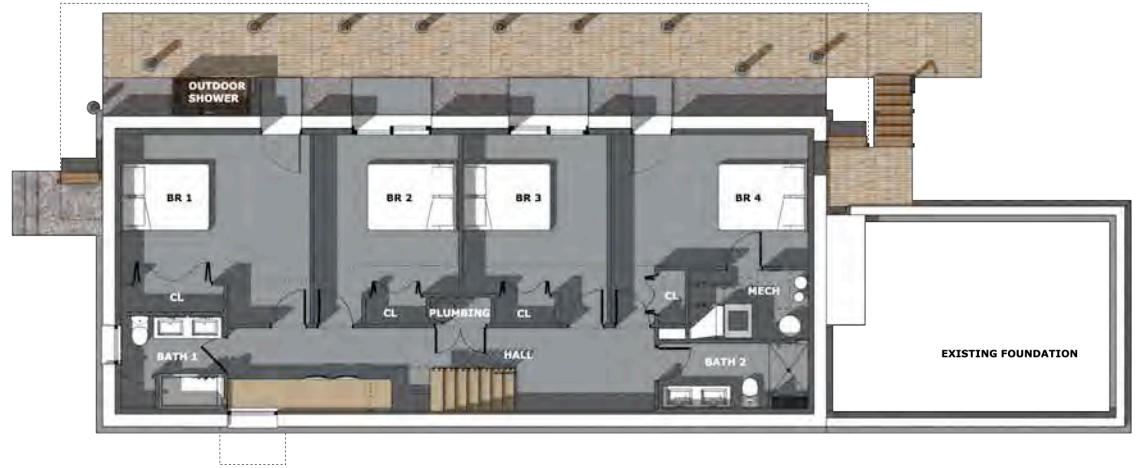
Finishes and systems near the end of their useful life
Assume minor problems with water damage that will need to be repaired

lower level plans

existing



proposed



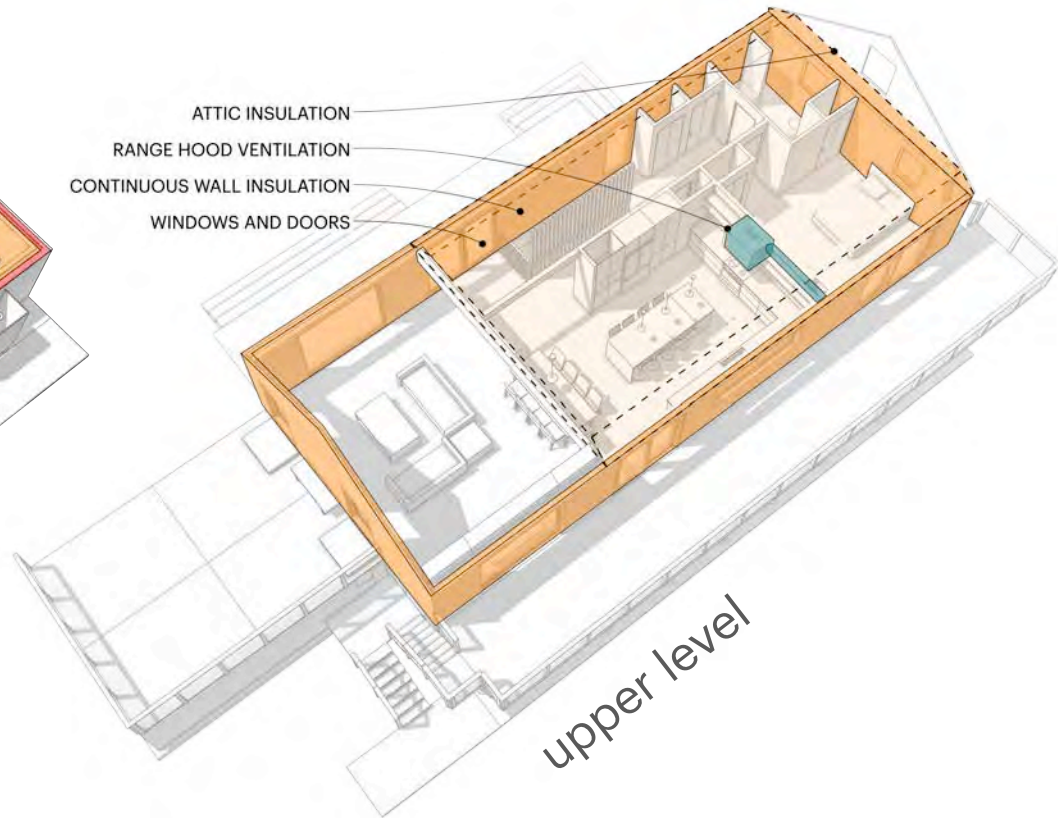
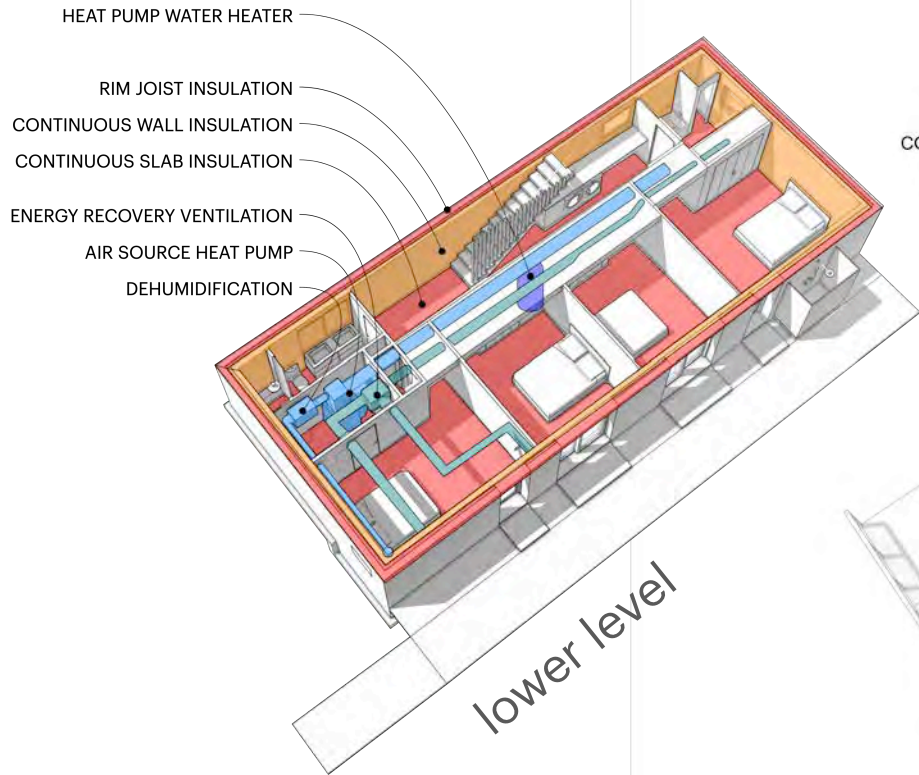
upper level plans

existing



proposed





proposed 3D exterior



North East



South West



North West



South East



Entry



Rear Deck



Lower Level Patio



Entry to the Left

proposed 3D interior



Kitchen



Living Room



Living Room



Lower Level Hall



Lower Level Hall



Bedroom 2



Bedroom 4



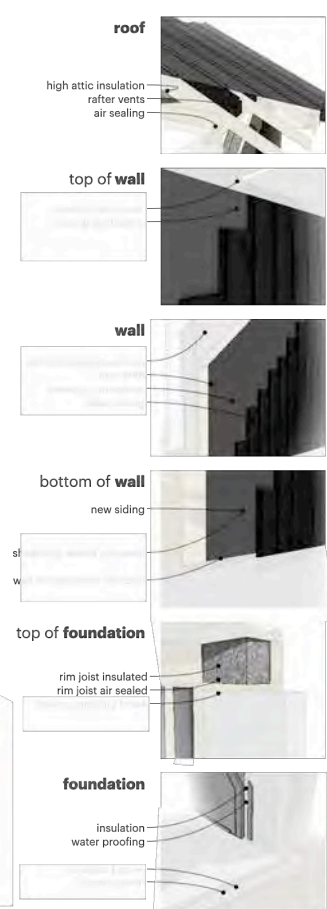
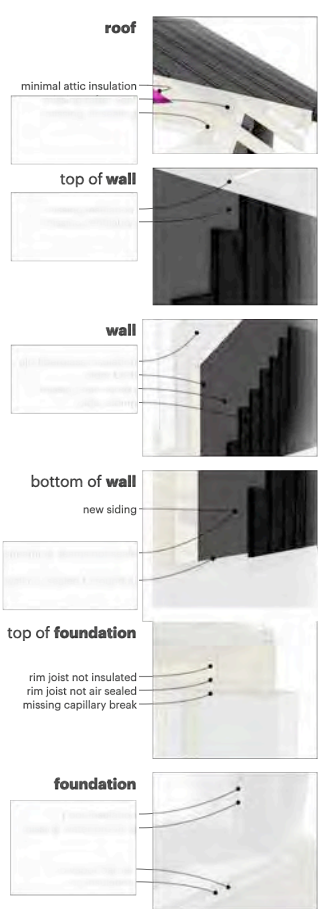
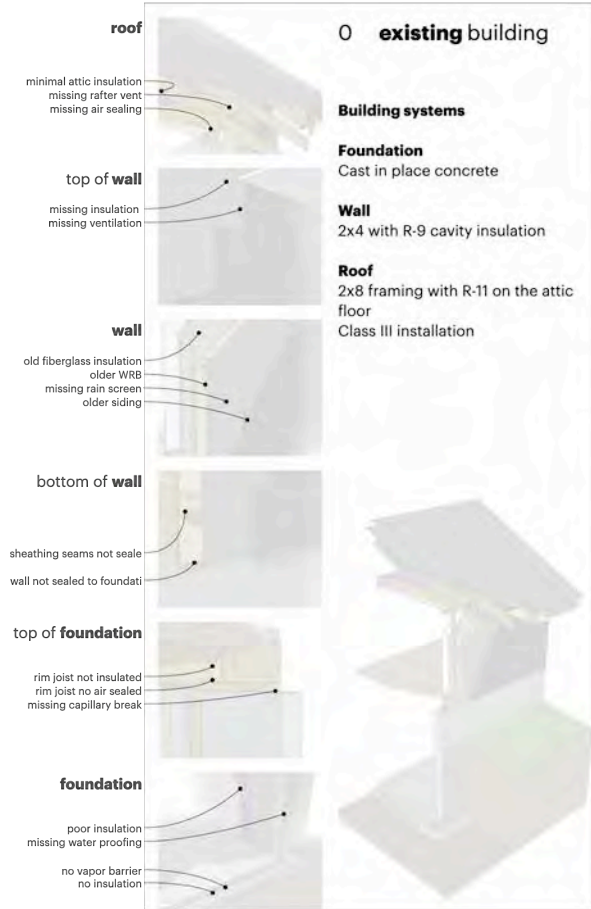
Bath 2



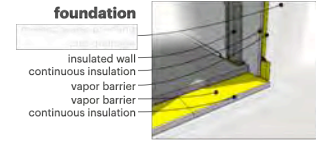
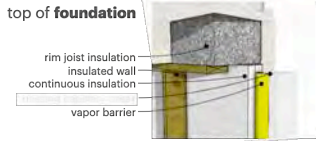
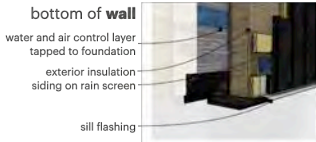
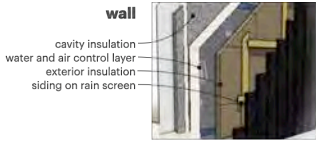
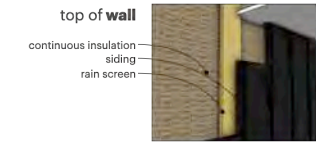
Bath 1

deep energy retrofit results





retrofit envelope details



3 deep energy retrofit

Building Systems

Foundation

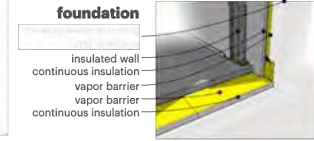
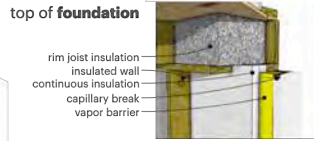
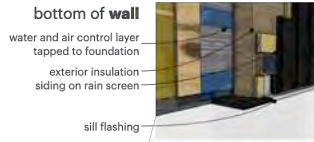
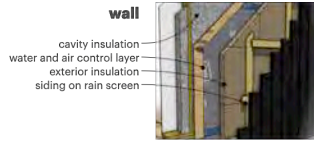
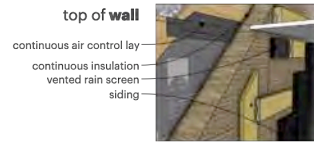
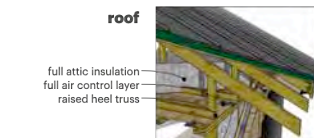
Existing cast in place concrete with an interior vapor barrier, R-9 continuous insulation inside, and a an R-13 insulated service cavity

Wall

Existing 2x4 with R-13 cavity insulation R-12 exterior insulation

Roof

New trusses with R-60 insulation on the attic floor Class I installation



4 new with existing foundation

Building Systems

Foundation

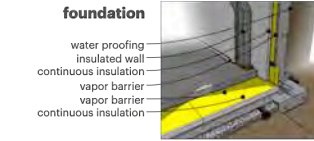
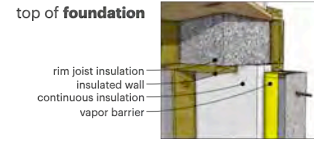
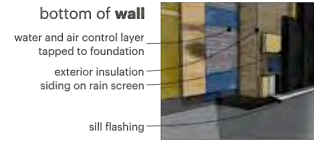
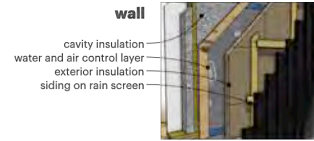
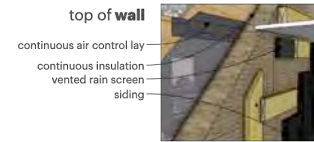
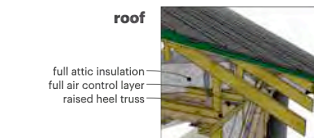
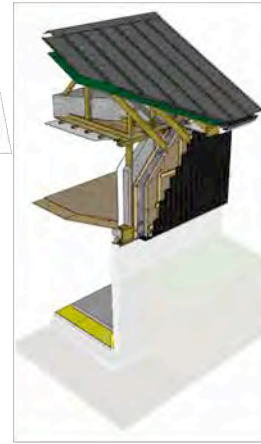
Existing cast in place concrete with an interior vapor barrier, R-9 continuous insulation inside, and a an R-13 insulated service cavity

Wall

2x6 with R-21 cavity insulation with R-12 exterior insulation

Roof

New trusses with R-60 insulation on the attic floor Class I installation



5 new with new foundation

Building Systems

Foundation

New cast in place concrete with drainage, R-9 continuous insulation inside and a an R-13 insulated service cavity

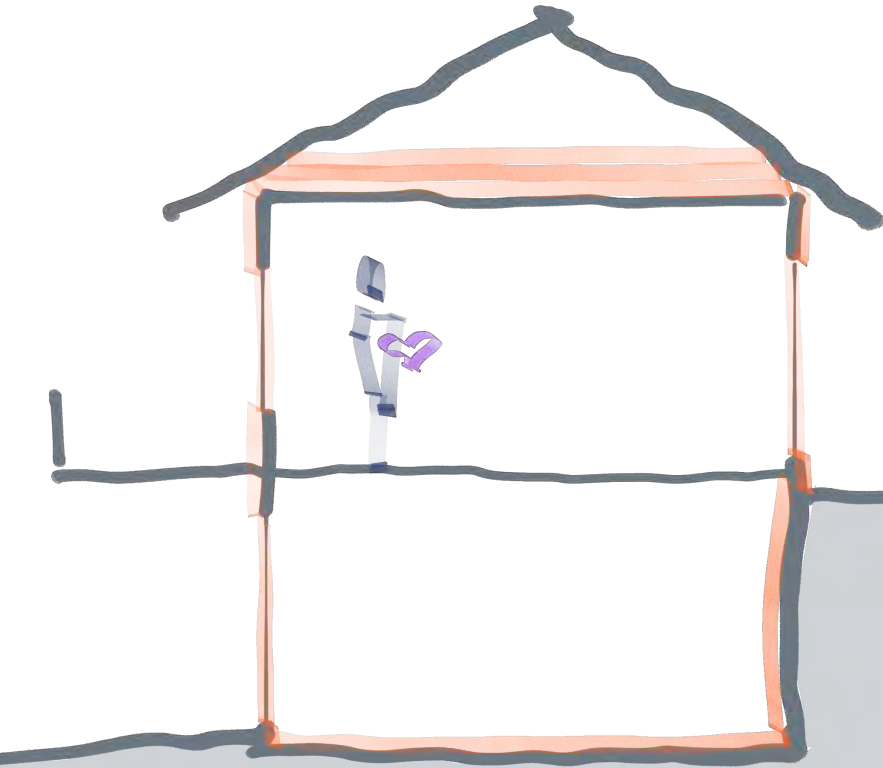
Wall

2x6 with R-21 cavity insulation with R-12 exterior insulation

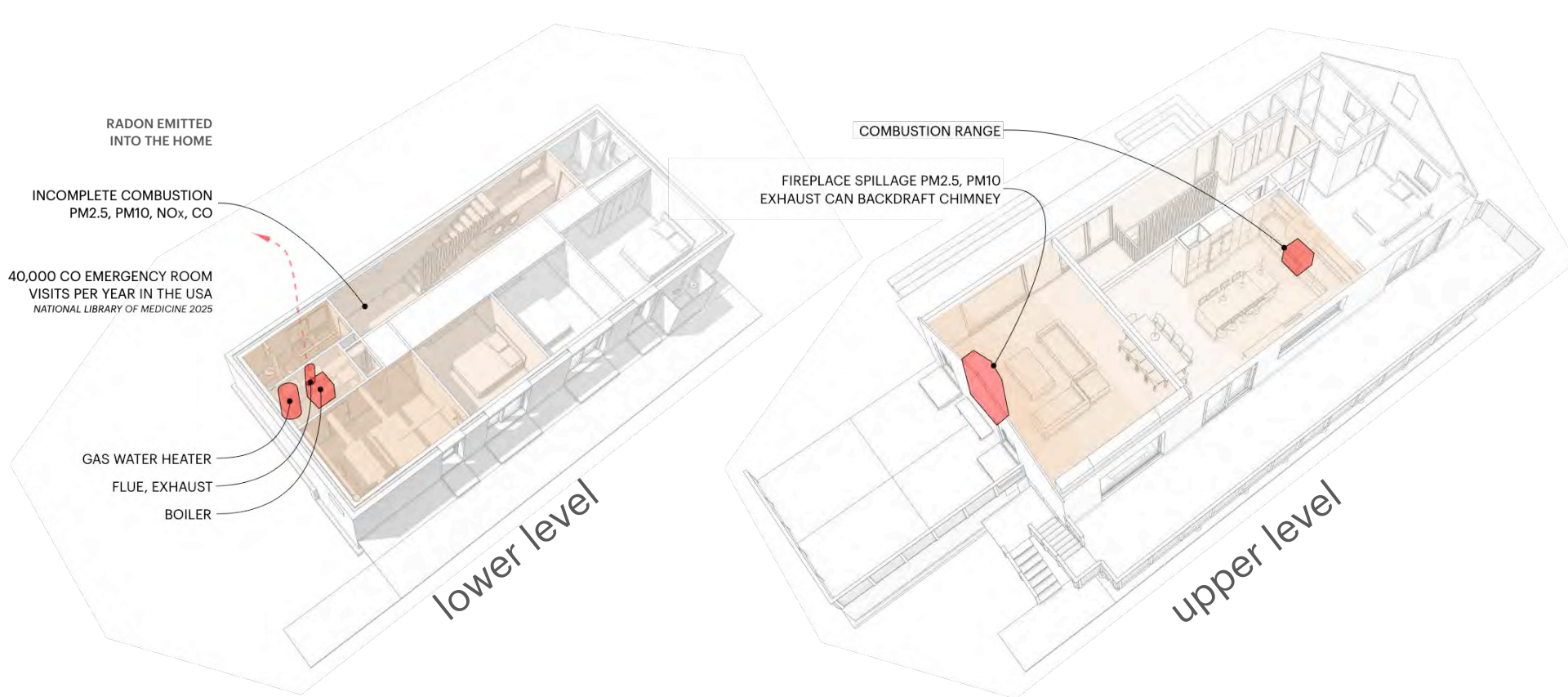
Roof

New trusses with R-60 insulation on the attic floor Class I installation





4. retrofit **risks**



combustion safety

CLOTHING CAN CHANGE THE VAPOR PROFILE OF THE WALL CONDENSATION

SHOWER INCREASED MOISTURE

COLD SURFACE CONDENSATION

EXHAUST, RESULTING IN INFILTRATION

PLUMBING LEAKS OR PIPE CONDENSATION

DAMP SLAB AND FOUNDATION WALLS

lower level

INFILTRATION

BULK WATER LEAKS

DOWNSPOUT CONCENTRATES WATER AT BASE LEADING TO WATER DAMAGE

EXHAUST

SHOWER MOISTURE

CLOTHING CAN CHANGE THE VAPOR PROFILE OF THE WALL CONDENSATION

COOKING MOISTURE

INFILTRATION

CHIMNEY AIR LEAKAGE
FIRE EXHAUST

upper level

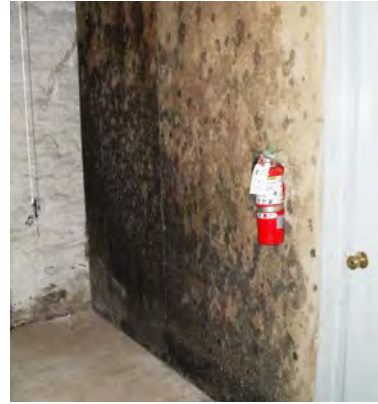
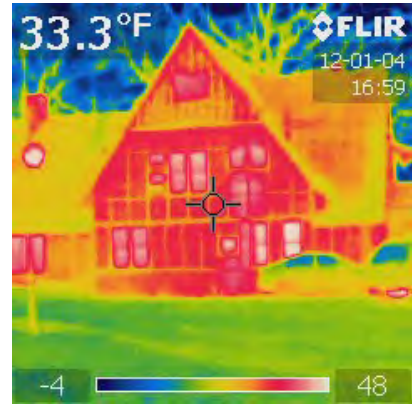
EXHAUST, RESULTING IN INFILTRATION

POOR FLASHING AND DETAILING CAN LEAD TO WATER INTRUSION, RESULTING IN MOLD GROWTH

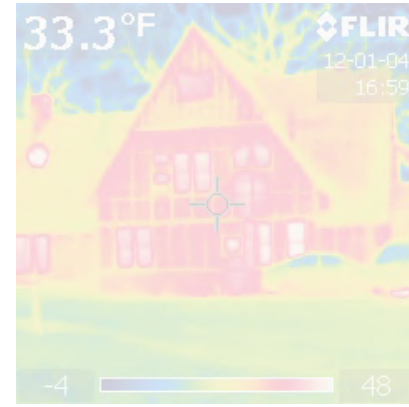
LEAKY DOWNSPOUT CAN CONCENTRATE WATER AT BASE LEADING TO WATER DAMAGE

OLD WINDOWS AND POORLY INSULATED SURFACES ARE COLD IN WINTER LEADING TO CONDENSATION

moisture risk



sick building syndrome



sick building syndrome

from case study 30



INDOOR AIR QUALITY

21/21 pts



THERMAL COMFORT

17/19 pts



WATER AND MOISTURE

15/23 pts

**Ventilation Design
HVAC Filtration and Treatment
Pollution Infiltration Management**

Construction Pollution Management

Combustion Minimization

Air Quality Monitoring

Indoor Air Quality Testing

Radon Risk Mitigation

Electric Vehicle Charging

Smoke-Free Environment

**Thermal Performance and Control
Insulation and Fenestration Efficiency
Humidity Control**

Radiant Heating Systems

Operable Windows

Outdoor Heat Management

Plumbing Design and Sizing

Water Testing

Non-Potable Water Capture and Use

Moisture Management Design

Flow and Temperature Sensing

Water Quality and Plumbing Maintenance



LIGHT

5/5 pts



NOURISHMENT

0/10 pts



SOUND

4/4 pts



MOVEMENT

1/13 pts



MATERIALS

2/7 pts



MIND

5/11 pts



INNOVATION

7+/18 pts



COMMUNITY

8/19 pts



INDOOR AIR QUALITY

21/21 pts



THERMAL COMFORT

17/19 pts



WATER AND MOISTURE

15/23 pts

Ventilation Design
HVAC Filtration and Treatment
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Construction Pollution Management
Combustion Minimization
Air Quality Monitoring
Indoor Air Quality Testing
Radon Risk Mitigation
Electric Vehicle Charging
Smoke-Free Environment

Thermal Performance and Control
Insulation and Fenestration Efficiency
Humidity Control
Radiant Heating Systems
Operable Windows
Outdoor Heat Management

Plumbing Design and Sizing
Water Testing
Non-Potable Water Capture and Use
Moisture Management Design
Flow and Temperature Sensing
Water Quality and Plumbing Maintenance



LIGHT
5/5 pts



NOURISHMENT
0/10 pts



SOUND
4/4 pts



MOVEMENT
1/13 pts



MATERIALS
2/7 pts



MIND
5/11 pts



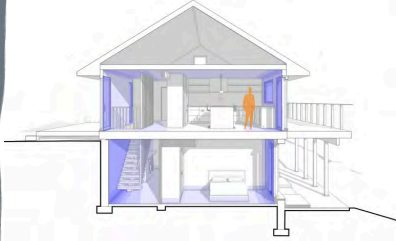
INNOVATION
7+/18 pts



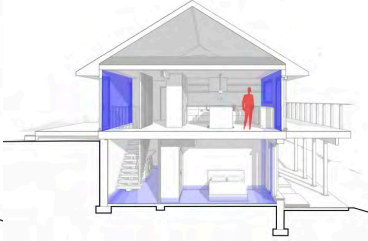
COMMUNITY
8/19 pts

thermal
comfort

1 remodel



2 moderate
energy retrofit



3 deep
energy retrofit

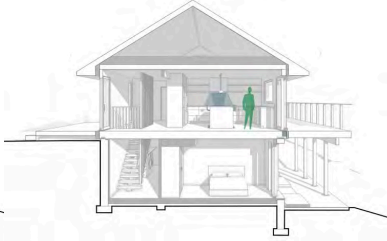
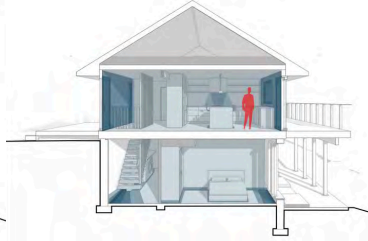
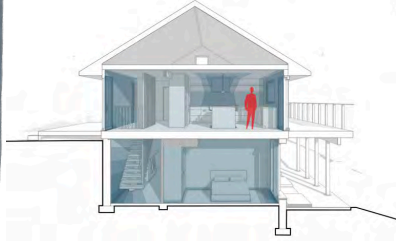


4 and 5
new build



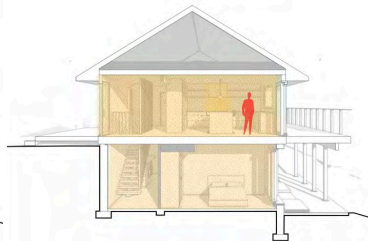
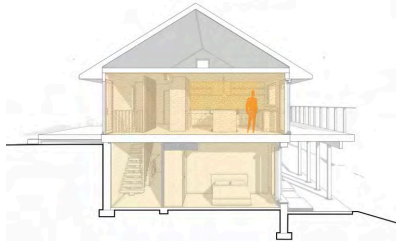
POOR COMFORT  GOOD COMFORT

water and
moisture



HIGH RISK  LOW RISK

indoor air
quality

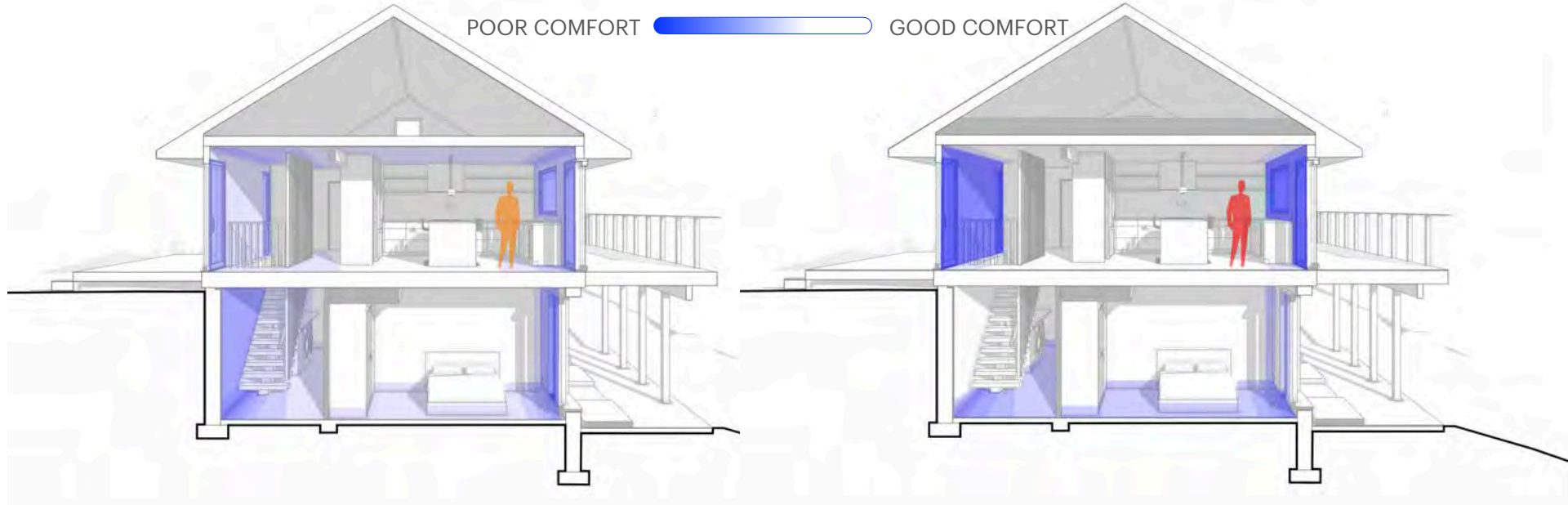


POOR IAQ  GOOD IAQ

1 remodel

2 moderate energy retrofit

POOR COMFORT  GOOD COMFORT



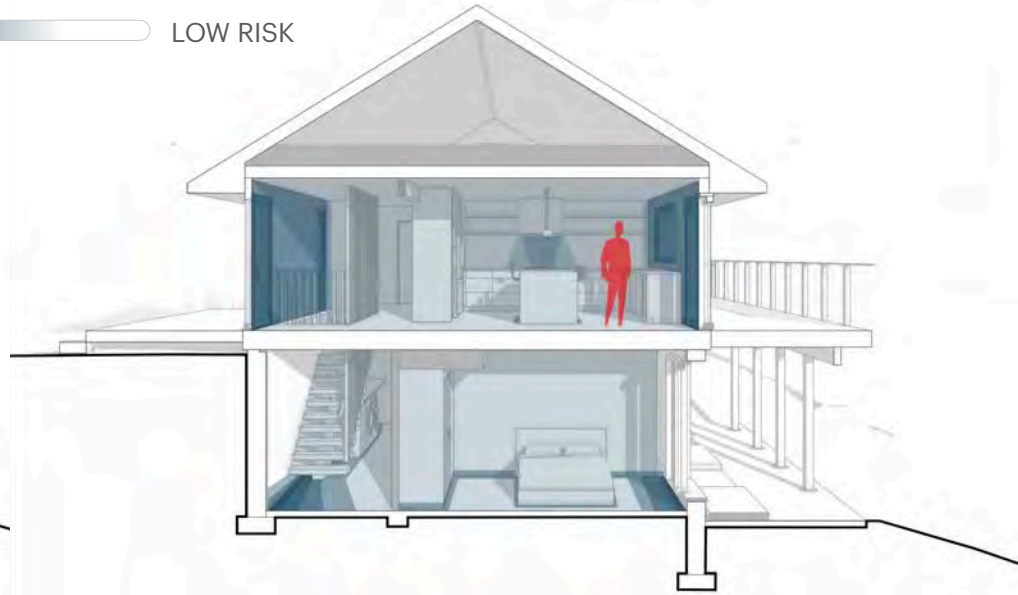
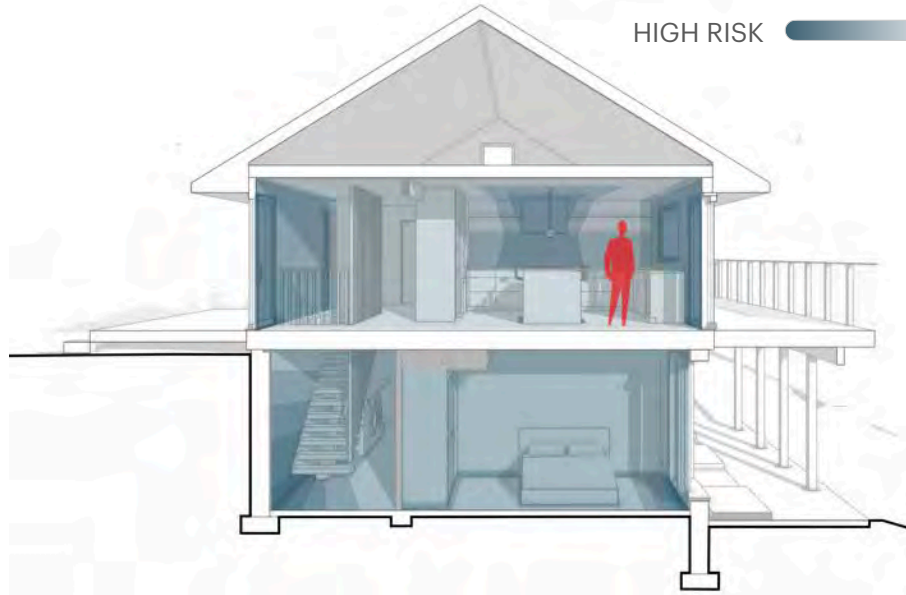
baseboard radiant to forced air leads to colder surfaces

thermal **comfort**

1 remodel

2 moderate
energy retrofit

HIGH RISK  LOW RISK



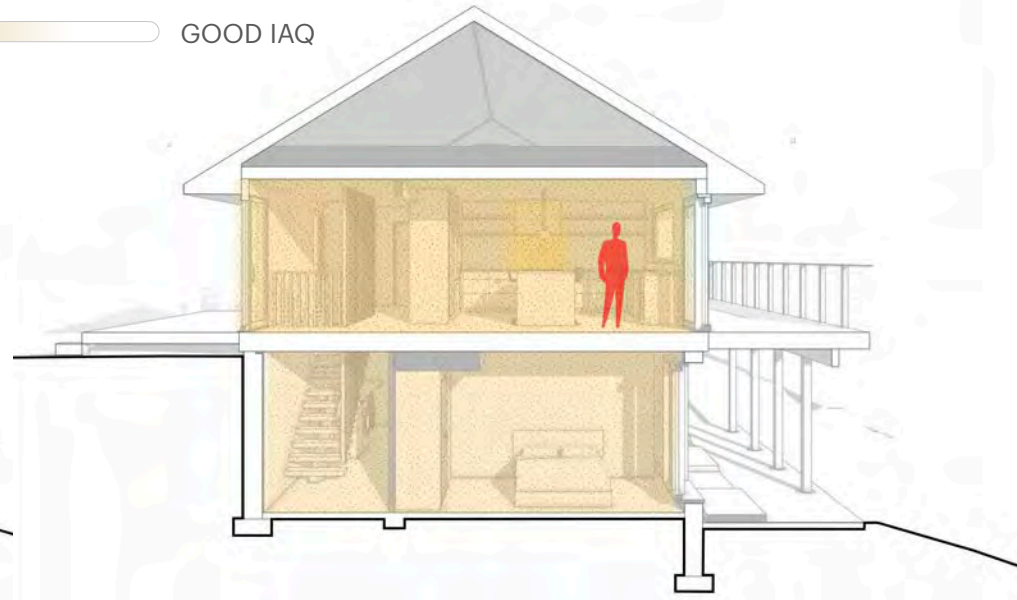
colder surface area increases moisture on those surfaces

water **moisture**

1 remodel

2 moderate
energy retrofit

POOR IAQ  GOOD IAQ

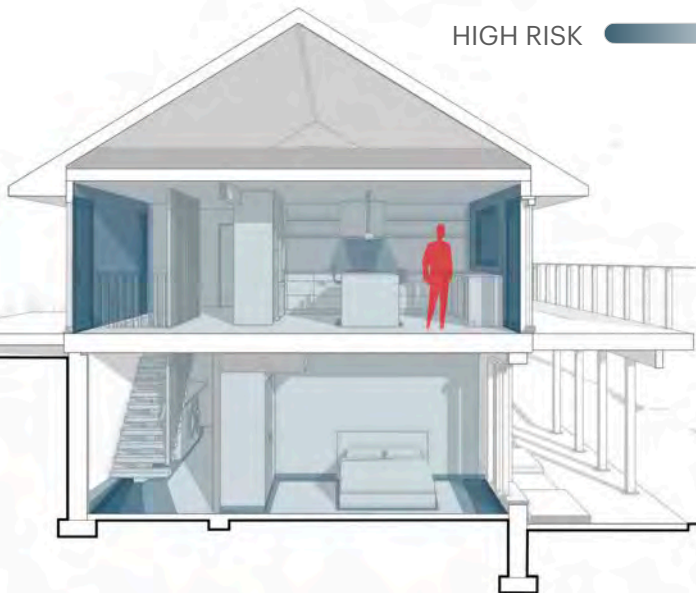


less air leakage means less ventilation

2 moderate energy retrofit

3 deep energy retrofit

HIGH RISK  LOW RISK

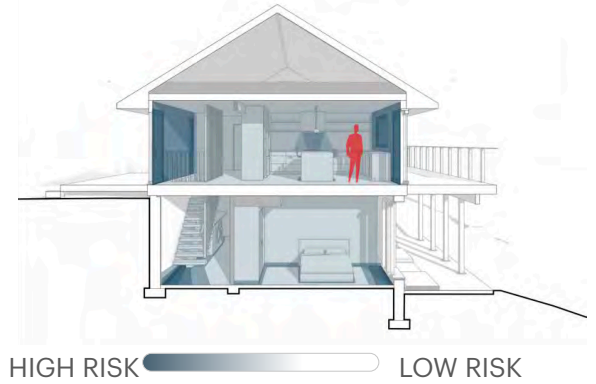


ERV's increase RH, and therefore increase risk of mold in non-optimized envelopes

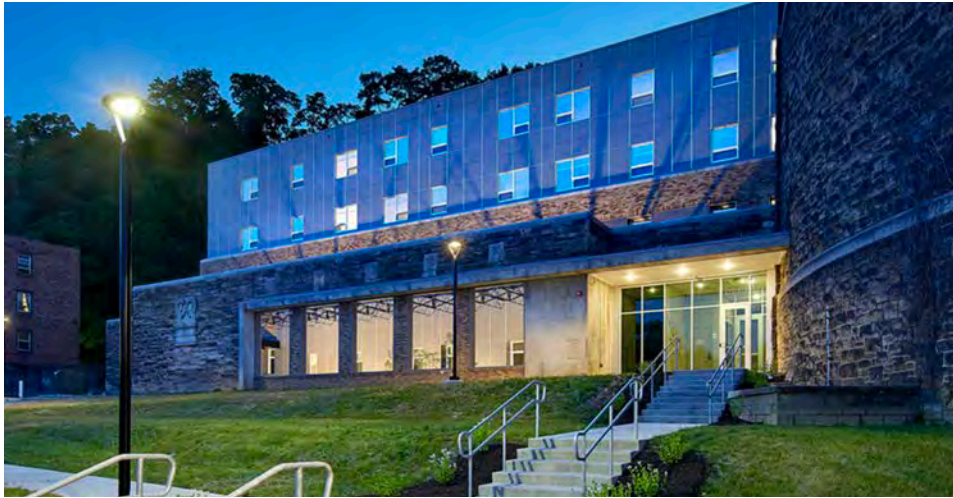
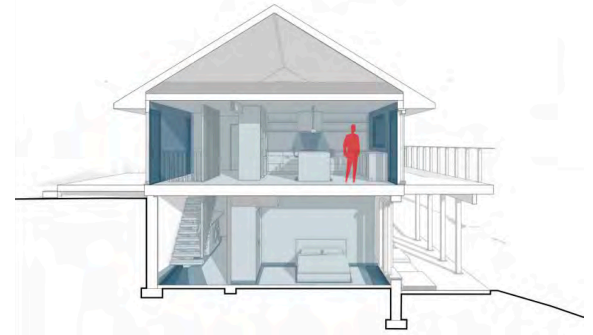
ERV moisture



Heating distribution used to be right at the cold corner - removed the radiators - cold corners more exposed to elevated RH



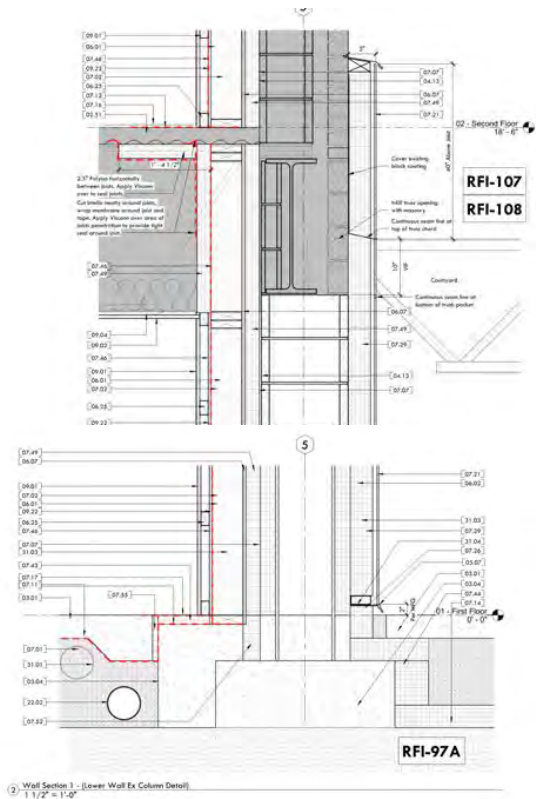
condensation **moisture**



condensation **moisture**

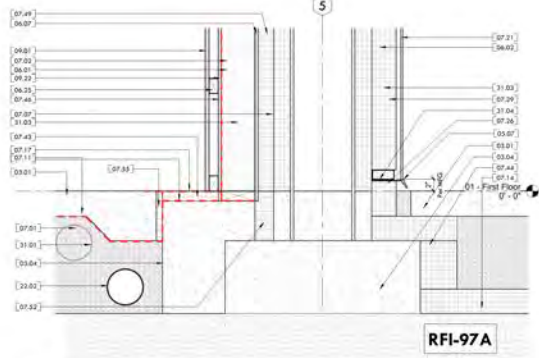
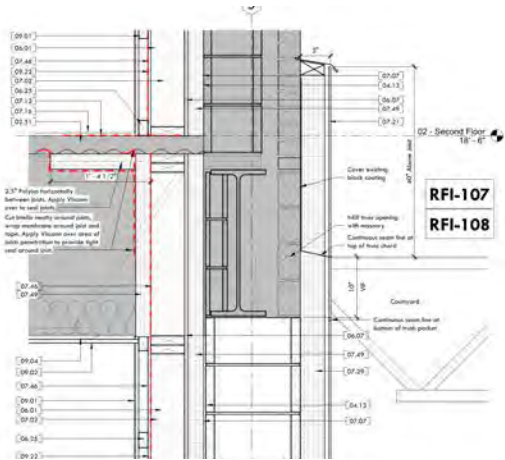


condensation **moisture**

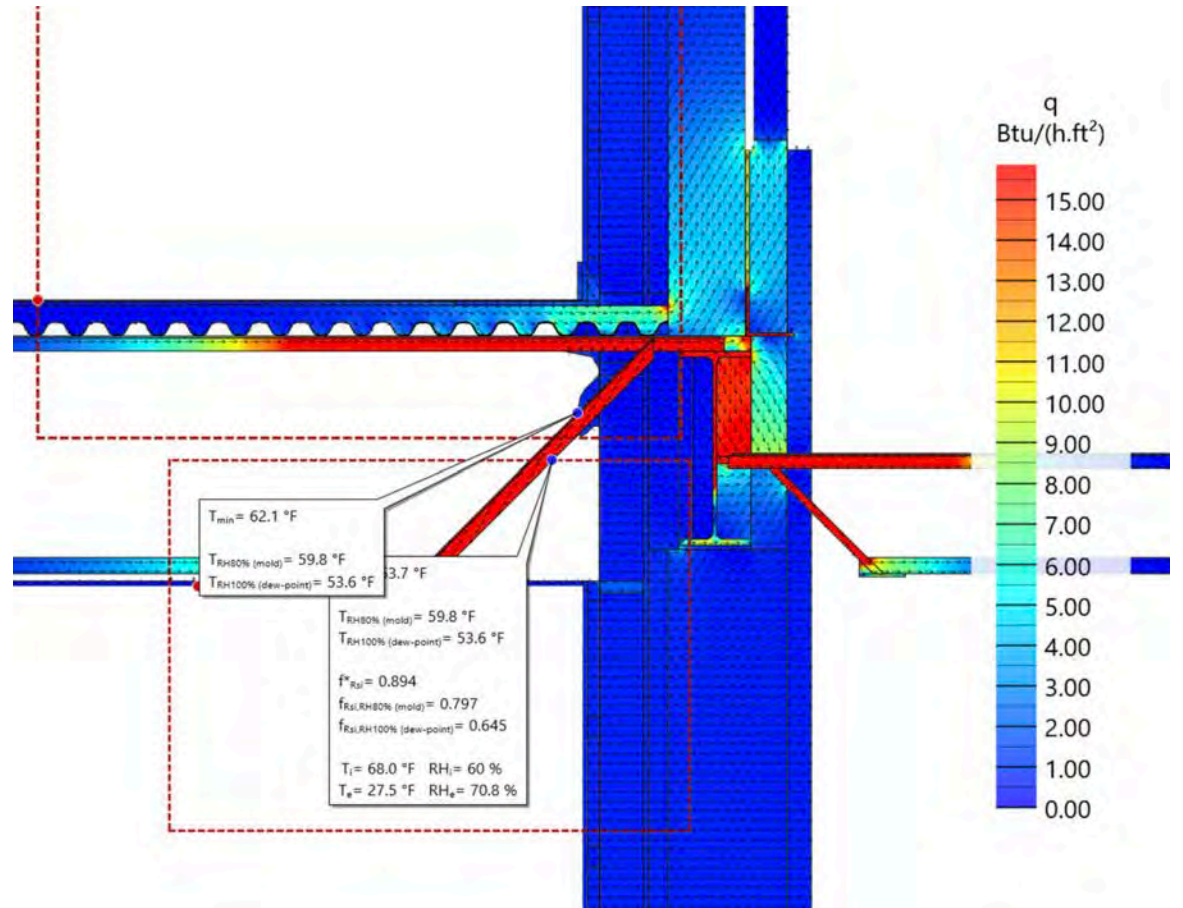


focused cold surface area increases moisture on those cold surfaces

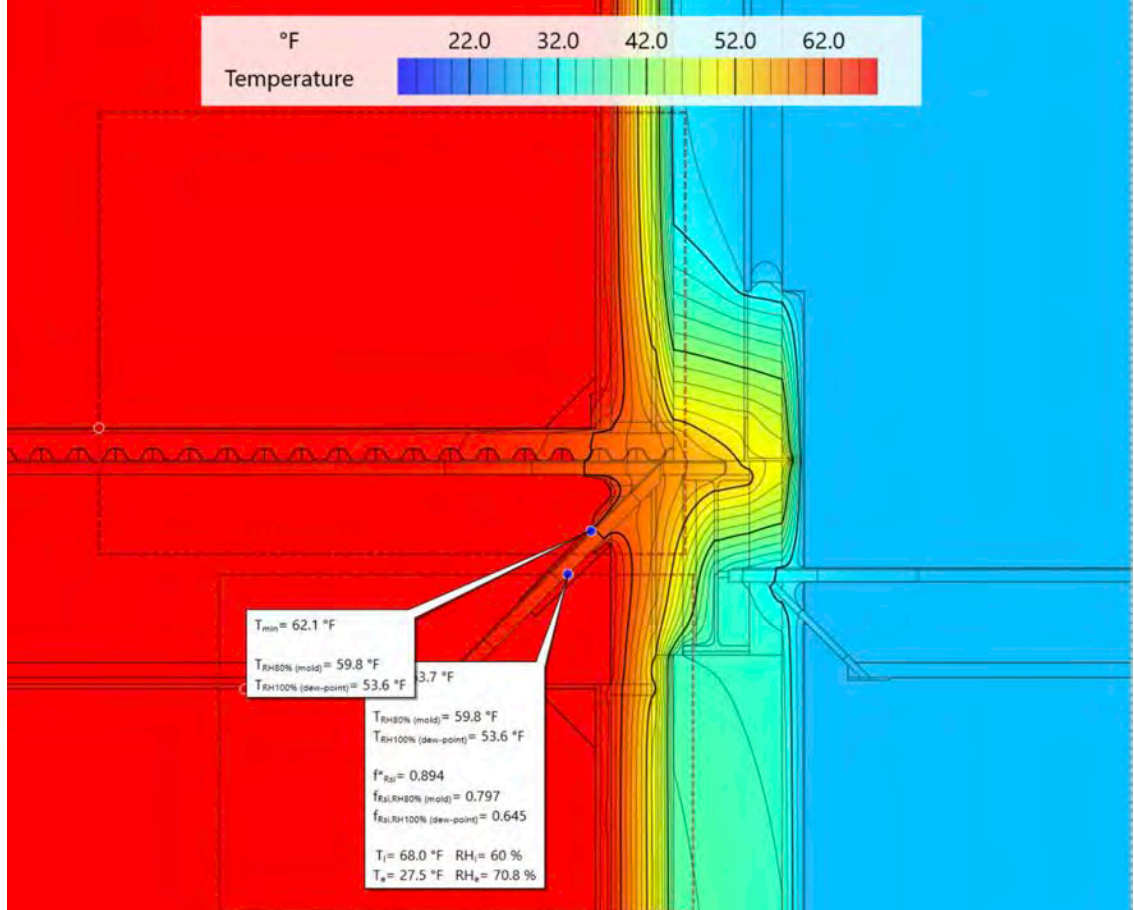
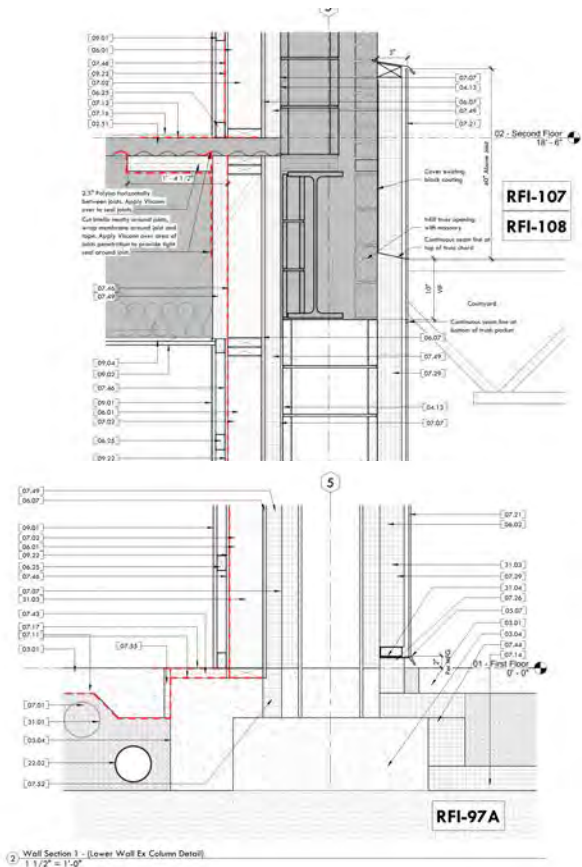
condensation + corrosion **moisture**



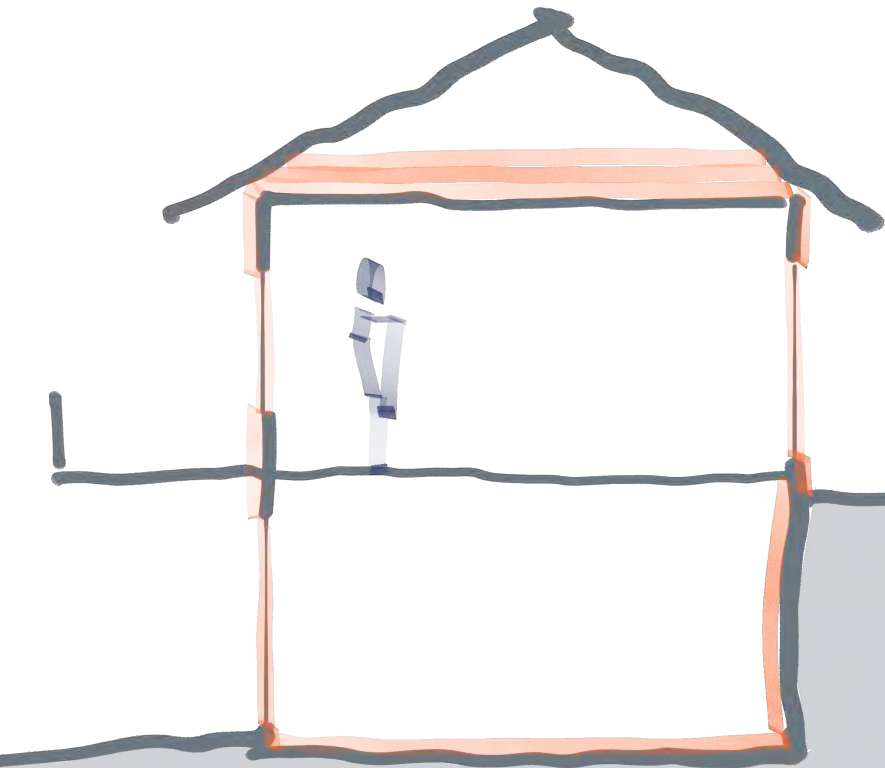
Wall Section 3 - (Lower Wall Ex Column Detail)
1 1/2" = 1'-0"



condensation + corrosion **moisture**



condensation + corrosion **moisture**



upfront costs + **carbon** emissions
maintenance costs + **carbon** emissions
energy costs + **carbon** emissions
indoor environmental quality costs
=
total cost of home

5. calculator

PROJECT NAME: E Existing Home 02/28/2024 BEAM VERSION: V1.1		SELECTED PROJECT MATERIALS REVIEW					
SECTION	CATEGORY	MATERIAL	NET EMISSIONS kg CO ₂ e	GROSS EMISSIONS kg CO ₂ e	STORAGE kg CO ₂ e	STORAGE LONG CYCLE kg CO ₂ e	QTY
Basement Floor	BASEMENT FLOORING	Rigid core vinyl flooring / Resilient Floor Coating (Resilient Industry Avg) (US & CA)	2,048	2,048	0	0	99.9 m ²
Basement Walls	BASEMENT FLOORING	Concrete (US 1 Year Global of North America) 18.8 kg/m ³ (Industry Avg) (US & CA)	157	157	0	0	11.1 m ³

PROJECT NAME: E Existing Home 02/28/2024 BEAM VERSION: V1.1		SELECTED PROJECT MATERIALS REVIEW					
SECTION	CATEGORY	MATERIAL	NET EMISSIONS kg CO ₂ e	GROSS EMISSIONS kg CO ₂ e	STORAGE kg CO ₂ e	STORAGE LONG CYCLE kg CO ₂ e	QTY
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PROJECT NAME: E Existing Home 02/28/2024 BEAM VERSION: V1.1		SELECTED PROJECT MATERIALS REVIEW					
SECTION	CATEGORY	MATERIAL	NET EMISSIONS kg CO ₂ e	GROSS EMISSIONS kg CO ₂ e	STORAGE kg CO ₂ e	STORAGE LONG CYCLE kg CO ₂ e	QTY
Floors	BASEMENT FLOORING	Rigid core vinyl flooring / Resilient Floor Coating (Resilient Industry Avg) (US & CA)	2,048	2,048	0	0	99.9 m ²
Floors	BASEMENT FLOORING	Concrete (US 1 Year Global of North America) 18.8 kg/m ³ (Industry Avg) (US & CA)	157	157	0	0	11.1 m ³

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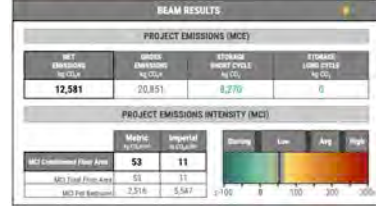
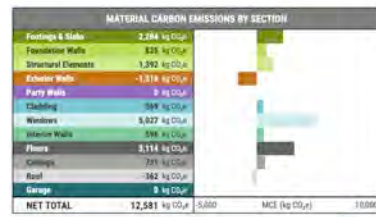
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PROJECT INFORMATION			
Project Name	E Existing Home	Construction Year	2024
Scenario	Scenario 1	Status Above Grade	1
Beam Version	V1.1	Number of Decks	1
Design Firm(s)	Kyle Mastri	CONDITIONED AREA	125 m ²
Engineering Firm(s)		Above Grade	111 m ²
Builder / Developer		Total	236 m ²
Development Project		Below Grade	0 m ²
Street Address		Total	236 m ²
City		Excluding Garage	0 m ²
Country	United States	Gross Area	0 m ²
Province / State	Wash DC	Total	236 m ²
Building Type	Single Detached House	Excluding Garage	0 m ²
Construction Type	Energy Retrofit	Total	236 m ²
Project Stage	Construction Complete		



HIGHEST EMITTING MATERIALS

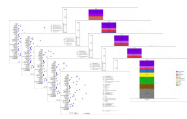
SECTION	kg CO ₂ e	MATERIAL
Windows	5,027	Window, High-Gloss, PVC-U Frame, 81/81/81
Footings & Slabs	2,848	Rigid core vinyl flooring / Resilient Floor Coating Inc
Floors	1,104	Hardwood Flooring / HWFA and Composite Hardwood
Structural Elements	1,094	Laminated veneer lumber (LVL) / AWC & CWC (Insp)
Foundation Walls	1,014	EPS foam board / Type IX / S 4.0-inch, 25 psi / EPS 8
Floors	863	Mineral wool batt / Rockwool / ComfortBatt R 24 (W)
Roof	826	Asphalt Shingles / Asphalt Roofing Manufacturers Assn
Ceilings	785	Drywall 1/2" (BEAM Avg) (US & CA)
Foundation Walls	411	Drywall 1/2" (BEAM Avg) (US & CA)
Clastring	344	Drywall 1/2" (BEAM Avg) (US & CA)

HIGHEST CARBON-STORING MATERIALS

SECTION	kg CO ₂ e	MATERIAL
Roof	-2,358	Cellulose / dense pack / Greenfiber / Sentrylock / Avg
Exterior Walls	-1,238	Wood fiber board / GUTEX / Multi-Term / R 3.6-inch
Foundation Walls	-1,801	Cellulose / dense pack / Greenfiber / Sentrylock / Avg



+

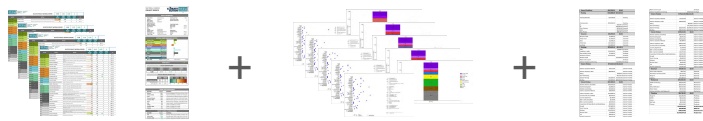


+

► General Conditions				\$150,765.50	\$0.00
▼ Framing				\$153,666.89	\$124,135.36
Framing Materials	\$24,036.89		Framing		
Framing Labor	\$129,630.00		Framing		
LL		\$35,916.72	Framing		
UL		\$20,550.03	Framing		
Floor Framing		\$5,000.00	Framing		
Deck		\$24,251.88	Framing		
Entry Portico		\$38,416.72	Framing		
▼ Concrete				\$35,708.00	\$0.00
Basement Slab	\$7,650.00		Concrete		
Pump Truck	\$1,300.00		Concrete		
Patio	\$5,458.00		Concrete		
Polish Slab	\$10,500.00		Concrete		
Landings	\$10,800.00		Concrete		
▼ Envelope				\$119,843.45	\$61,341.12
WRB		\$8,885.19	Envelope		
Insulation in walls	\$10,000.00		Envelope		
Rim and Band Joists	\$2,280.00		Envelope		
Windows and Door	\$107,563.45		Envelope		
Window Install		\$20,646.34	Envelope		
Water Control Layer			Envelope		
Exterior Insulation and Furring		\$31,809.59	Envelope		
▼ Exterior Finishes				\$171,643.94	\$143,334.35
Exterior Carpentry Material	\$75,527.94		Exterior Finishes		
Exterior Carpentry Labor	\$66,816.00		Exterior Finishes		
Siding		\$67,831.17	Exterior Finishes		
Deck and Railing		\$42,703.18	Exterior Finishes		
Exterior Painting	\$12,800.00	\$12,800.00	Exterior Finishes		
Roofing	\$16,500.00	\$20,000.00	Exterior Finishes		

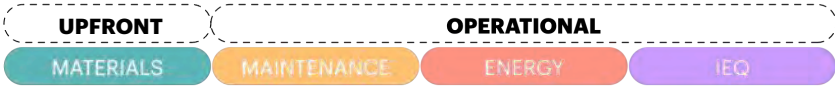
▼ Interior Finishes				\$251,823.93	\$0.00
Kitchen cabinetry (installed)	\$35,000.00		Interior Finishes		
Kitchen Backsplash	\$6,890.00		Interior Finishes		
Kitchen Countertops	\$15,540.00		Interior Finishes		
Interior Carpentry Material	\$21,854.01		Interior Finishes		
Interior Carpentry Labor	\$46,806.00		Interior Finishes		
Laundry built-ins (installed)	\$8,000.00		Interior Finishes		
Laundry Appliances	\$2,199.99		Interior Finishes		
Bath 1 vanity (installed)	\$1,129.99		Interior Finishes		
Bath 2 vanity (installed)	\$3,000.00		Interior Finishes		
Living Room Window Bench and Bookshelves	\$6,000.00		Interior Finishes		
Drywall	\$22,680.00		Interior Finishes		
Patch Flooring	\$6,869.00		Interior Finishes		
Painting	\$24,500.00		Interior Finishes		
Shower Glass	\$3,190.00		Interior Finishes		
Tile	\$28,691.00		Interior Finishes		
Kitchen Appliances	\$19,473.94		Interior Finishes		
▼ Electrical				\$67,361.33	\$0.00
Permit and Inspection	\$800.00		Electrical		
Demolition and temp power	\$4,500.00		Electrical		
Rough In	\$51,570.78		Electrical		
Lighting	\$10,490.55		Electrical		
▼ Mechanical				\$110,000.00	\$0.00
ASHP and Ducting	\$67,500.00		Mechanical		
ERV	\$20,000.00		Mechanical		
Dehumidification	\$10,000.00		Mechanical		
Water Heater	\$8,500.00		Mechanical		
Kitchen Ventilation and Makeup Air	\$4,000.00		Mechanical		
▼ Plumbing				\$54,780.00	\$0.00
Rough In	\$33,280.00		Plumbing		
HPWH	\$8,300.00		Plumbing		
Valves	\$1,300.00		Plumbing		
Well Tank	\$1,900.00		Plumbing		
Fixtures	\$10,000.00		Plumbing		
		\$1115,593.04	Project Subtotal		
		\$73,190.69	Sales Tax		
		\$151,720.65	Contractor Fee		
		\$1,340,504.38	Project Total		

calculator



This is a large, multi-tabbed spreadsheet used for calculating project costs and performance. It includes sections for:

- Inputs:** Material, Maintenance, Energy, IEQ, and other project parameters.
- Calculations:** Detailed breakdowns of costs and performance metrics.
- EQ AVG:** A summary table of EQ values across different categories.
- EQ Values 1-30:** Individual data points for various EQ metrics.
- Project Info:** General project details like location, climate zone, and health goals.
- Market Inflation:** Data on construction and market inflation rates.
- Carbon:** Information on carbon costs and decarbonization rates.
- Fuel Oil Inflation:** Data on fuel oil price increases over time.



Project Info	
Project Location	70 50 South Kingstown RI
Project Climate Zone	5 5
Occupant Health	Average
Lean	10%
Percent Down	20%
Interest Rate	8.25% https://www.freddies.com/prime
Mortgage length (years)	30
HELOC	8.25% https://www.bankrate.com/home-estate/heloc-rates-7ac0de02e79
Percent Down	10% 10%
HELOC length (years)	15 15
Market Inflation	2.80% 2.80% https://www.fis.gov/outlook/red2025/consumer-prices-up-2-8-percent-from-august-2024-to-august-2025-38r
Construction Inflation	4.10% 4.10% https://www.enr.com/2025/02/21/construction-inflation-2025-2-21-25v
Electric Utility Inflation (EUI)	3.50% 3.50% https://www.eia.gov/todayinenergy/detail.php?id=52284
NPV Rate	5.00% 5.00% https://www.investopedia.com/terms/n/npv.asp
Carbon Cost	\$0.1630 per kg CO ₂ e
Compounding Carbon	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/>
Decarbonization Rate Current (1990 - 2022)	3.33% 3.33% https://www.chromestart.com/2024/02/21/decarbonization-rate-current-1990-2022-21-24
Decarbonization Rate Projected (2023 - 2050)	4.81% 4.81% https://www.chromestart.com/2024/02/21/decarbonization-rate-projected-2023-2050-21-24
Fuel Oil Inflation	2.80% 2.80% https://www.eia.gov/energy/fueloil/lastyear.asp?n=PE1&n=WF_EIOPD_IRS_SRL_DPGM-W

assumptions:

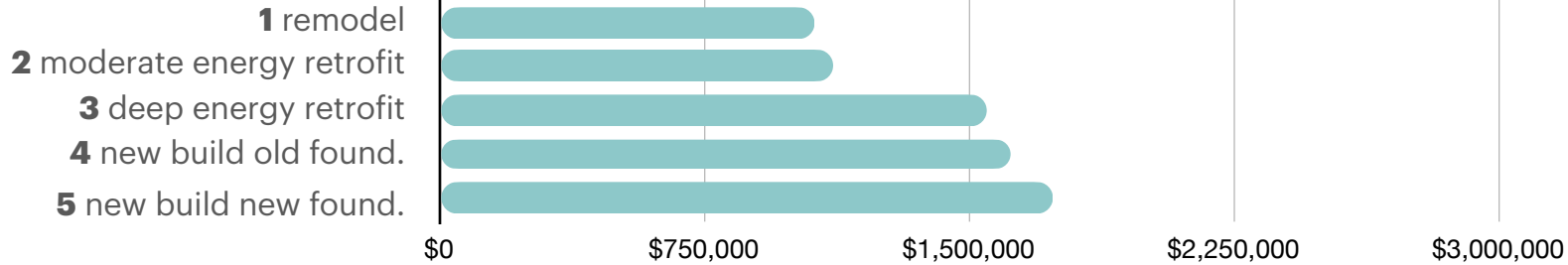
30 year analysis

Mortgage: 10% Down, 6.25% interest

Inflation: Market, Construction

Net Present Value: Convert all costs to today's dollars

owner costs



upfront costs



assumptions:

30 year analysis, years 15-30

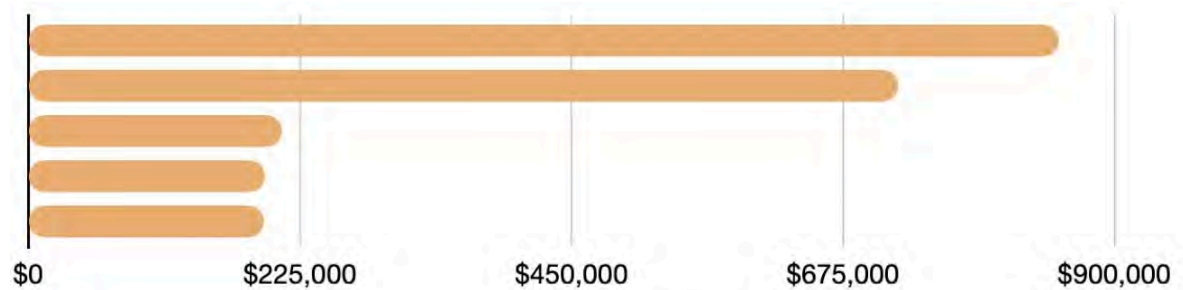
HELOC: 10% Down, 8.25% interest

Inflation: Market, Construction

Net Present Value: Convert all costs to today's dollars

owner costs

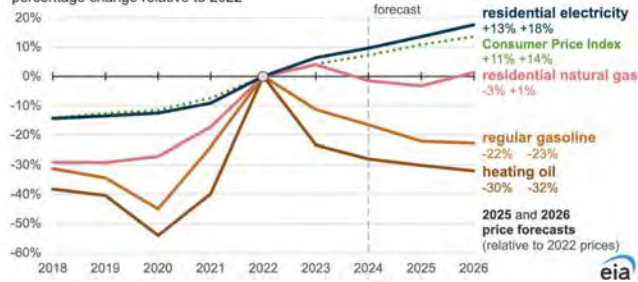
- 1 remodel
- 2 moderate energy retrofit
- 3 deep energy retrofit
- 4 new build old found.
- 5 new build new found.



maintenance costs



Selected retail energy prices and Consumer Price Index (2018–2026)
percentage change relative to 2022



Data source: U.S. Energy Information Administration, Short-Term Energy Outlook, May 2025
Data values: Energy Prices

assumptions:

30 year analysis

Electricity Cost: \$0.2162 per kWh Escalation Rate: 3.2%

Oil Cost: \$3.431 per gal Escalation Rate: 2.98%

Net Present Value: Convert all costs to today's dollars

REM - 7.0 ACH50

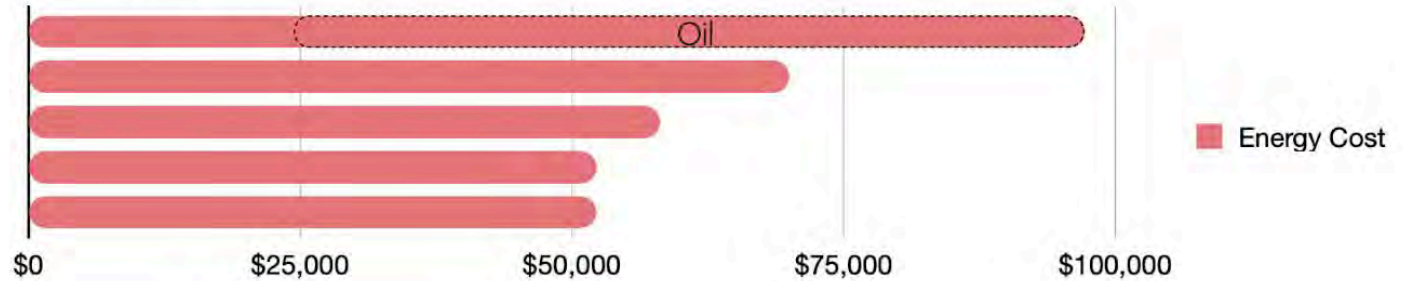
MER - 3.5 ACH50

DER - 1.5 ACH50

NEW - 0.6 ACH50

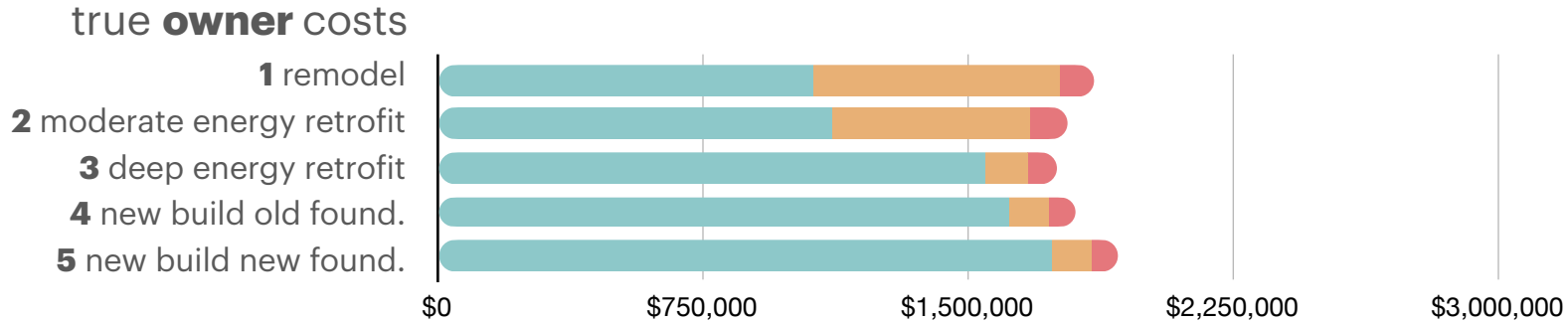
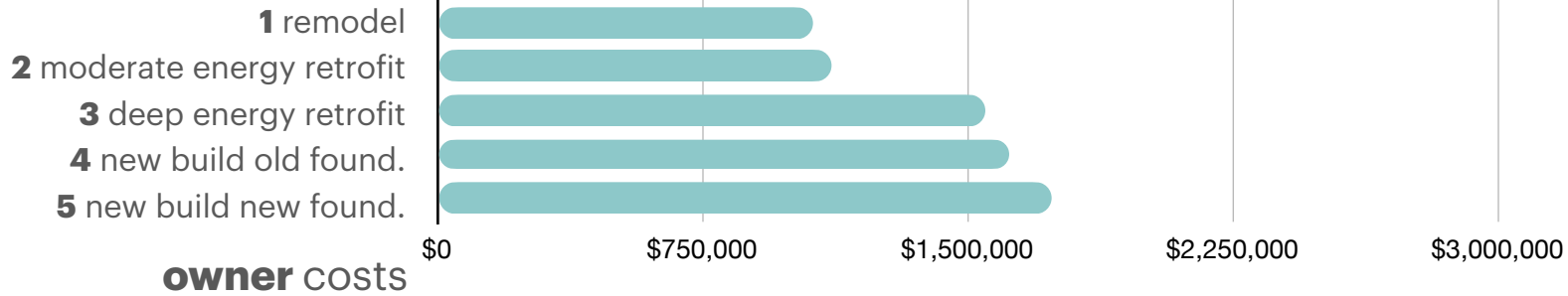
owner costs

- 1 remodel
- 2 moderate energy retrofit
- 3 deep energy retrofit
- 4 new build old found.
- 5 new build new found.



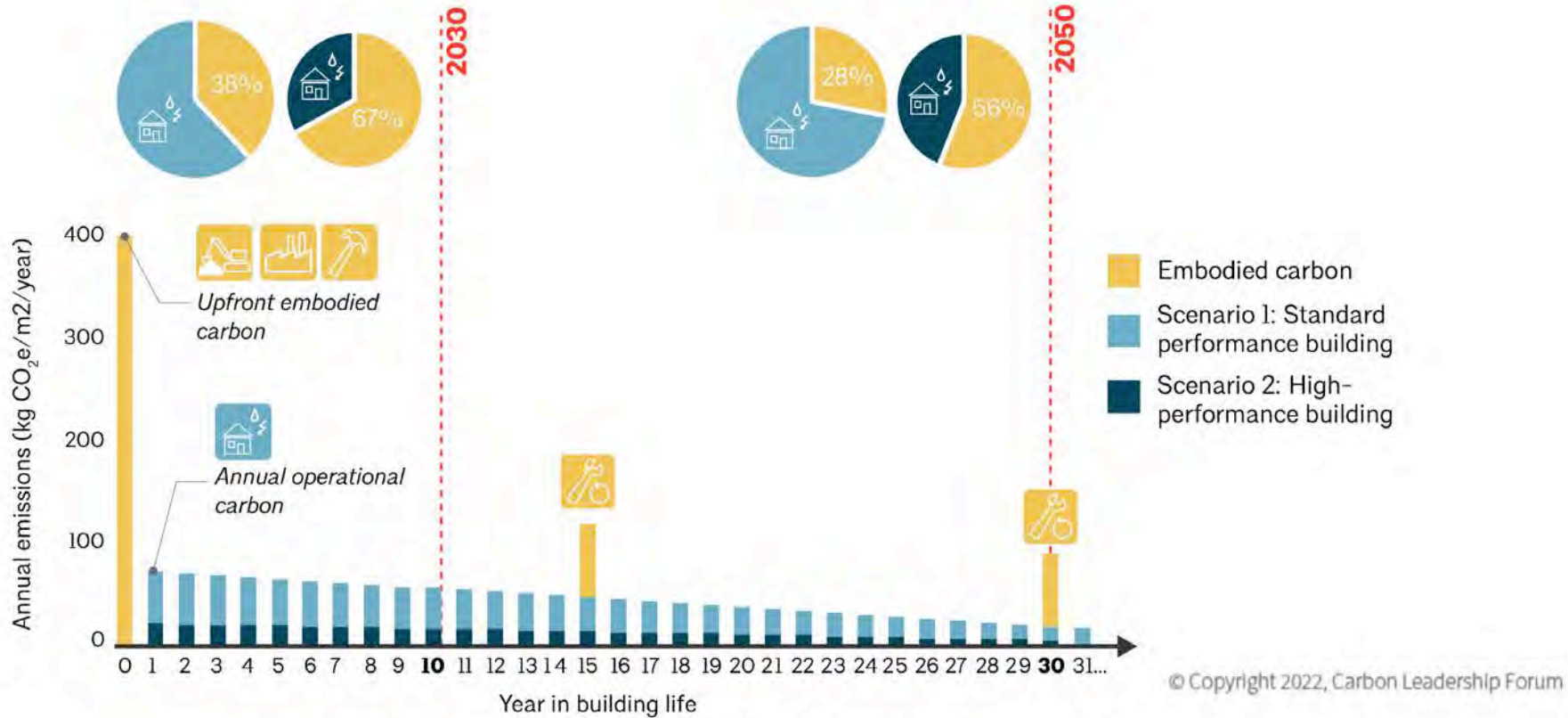
energy costs





true **owner costs**





embodied carbon



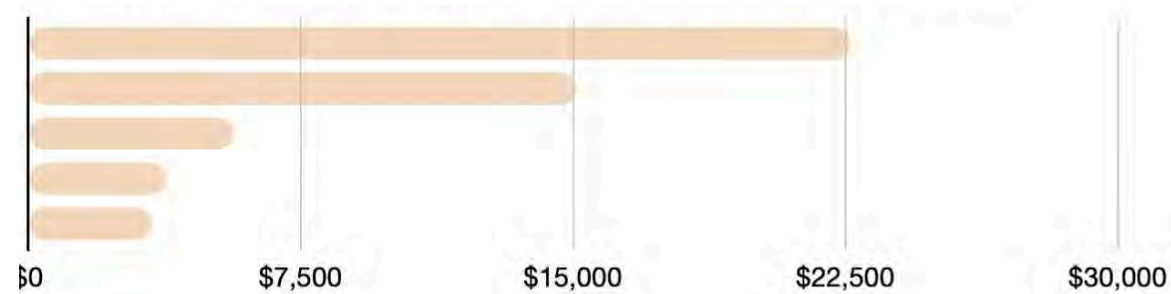
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- 3 deep energy retrofit
- 4 new build old found.
- 5 new build new found.

upfront **carbon**



maintenance **carbon**

- 1 remodel
- 2 moderate energy retrofit
- 3 deep energy retrofit
- 4 new build old found.
- 5 new build new found.



assumptions: \$185 metric ton CO₂e, Rennert et al. (2022)

embodied **carbon**



assumptions:

Energy
RI: 381 tonnes of CO₂e per kWh
Oil: 1,028 tonnes of CO₂e per gallon
(US EPA 2025b)

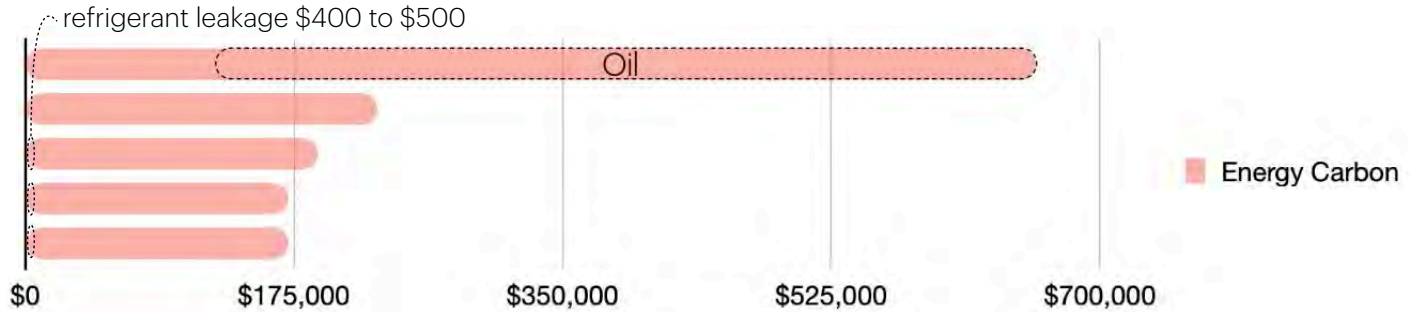
Refrigerant
10% annual leakage rate
R454b: 466 kg CO₂e

\$185 metric ton CO₂e, Rennert et al. (2022) Electricity decarbonization rate: 3.33%

social costs

energy carbon costs

- 1 remodel
- 2 moderate energy retrofit
- 3 deep energy retrofit
- 4 new build old found.
- 5 new build new found.



energy carbon costs



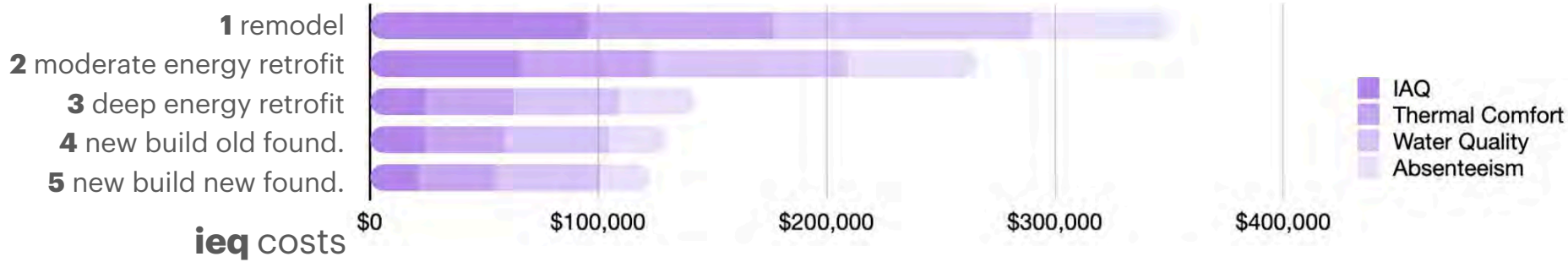


\$2,500 per year due to poor air quality (NRDC 2021)

IAQ House = \$2,500 (poor air quality) x 0.75 (time spent at home)
 x 2.54 (people per household)
 IAQ House = \$4,762.50

IAQ House per point = IAQ House / IAQ Points
 IAQ House per point = \$4762.50 / 21 points = \$226.79 per point

	 AIR (IAQ)	 THERMAL COMFORT	 WATER
WELL pts			
1 Remodel	2/21	3/21	0/21
2 Moderate Energy Retrofit	9.5/21	9/21	7/21
3 Deep Energy Retrofit	20/21	14/21	17/21
4 New Build Exist. Found.	20/21	15/21	17/21
5 New Build New Found.	21/21	15/21	17/21



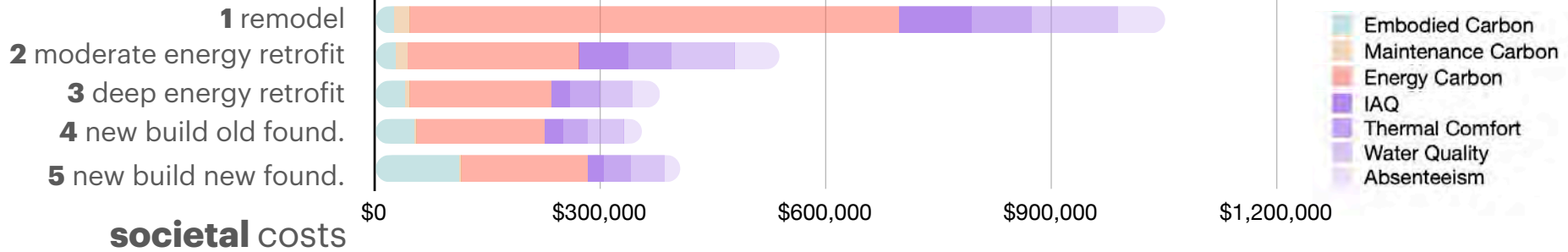
one person with **asthma**



assumptions: There are 61,000 asthma patients in the state of Rhode Island, each costing \$5,603 in healthcare costs (US CDC 2025)

ieq asthma costs





embodied and energy carbon emissions

assumptions: \$185 metric ton CO₂e, *Rennert et al. (2022)*

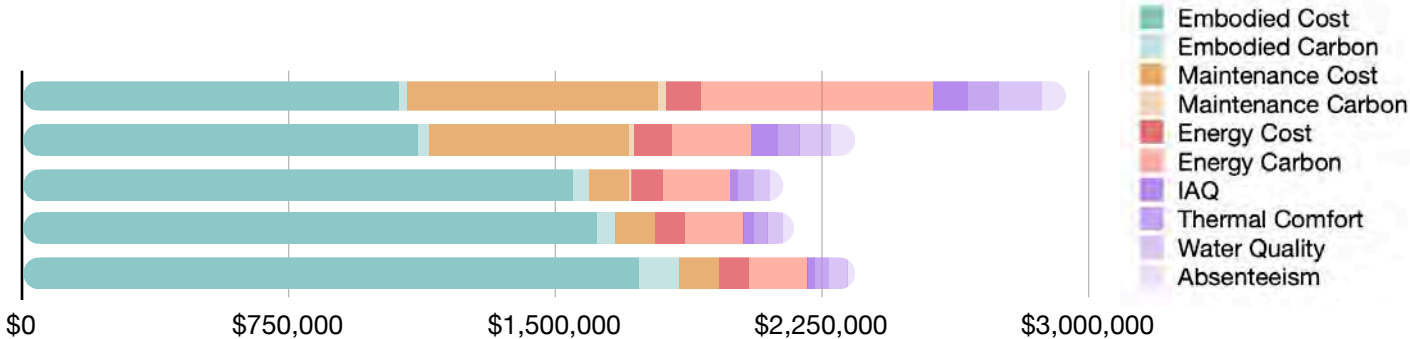
indoor environmental quality - air, thermal, water, absenteeism

social costs



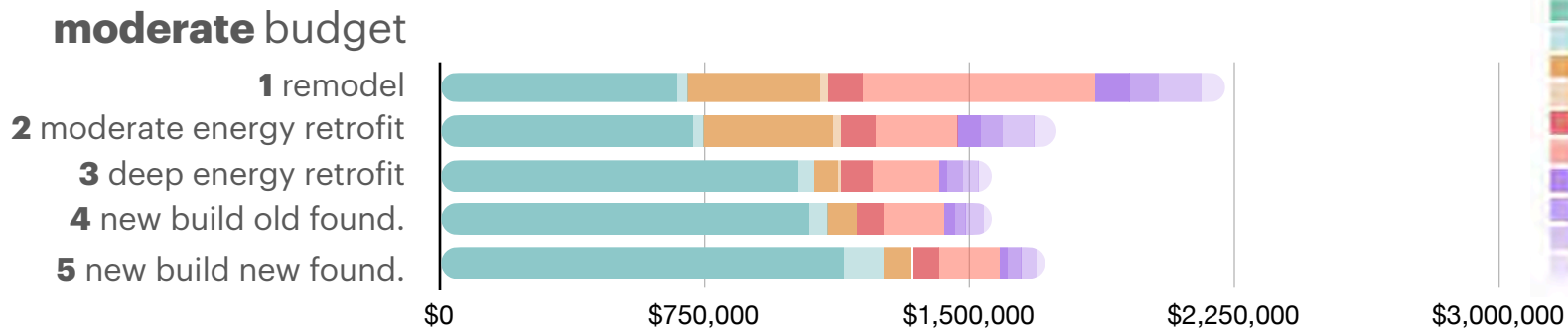
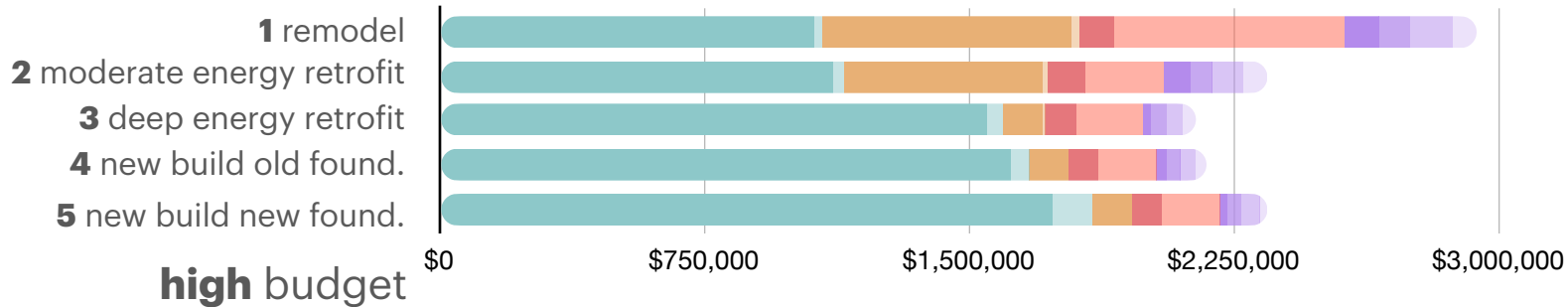
total costs

- 1 remodel
- 2 moderate energy retrofit
- 3 deep energy retrofit
- 4 new build old found.
- 5 new build new found.



total costs





assumptions: same performance but lower cost finishes and builder

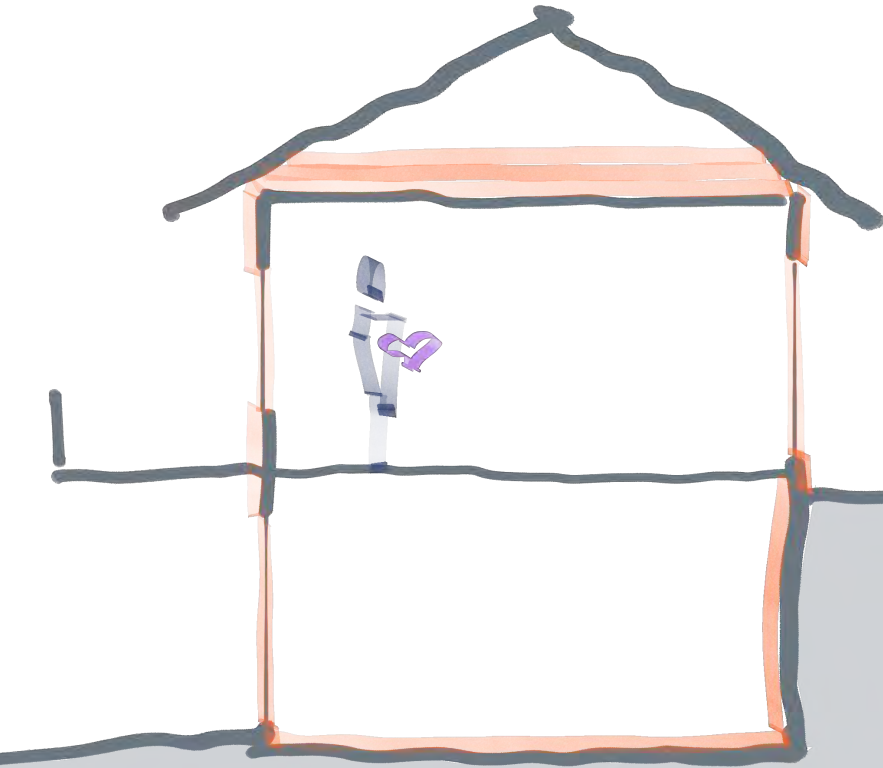
budget options





variations





economic considerations

THERE IS PLENTY OF MONEY, SO IT ISN'T THE CASE THAT THERE IS ANY SIGNIFICANT "SCARCITY" PROBLEM



MONEY IS OLIGARCHIC

WE DELEGATE MONEY CREATION AND CONTROL TO OLIGARCHY

NO DEMOCRATIC CONTROL – NOT BASED ON ANYTHING OTHER THAN PROJECTED PRODUCTIVITY
AND PROFIT

JPM MORGAN CHASE & CO

OBSCENE, SPECULATIVE, ECONOMICS FOR BILLIONAIRES IS COST EFFECTIVE



OPULENCE ONLY FOR A FEW

A large, intense nuclear explosion is shown against a clear sky. A massive, bright yellow and orange fireball rises from the ground, surrounded by a thick cloud of dark smoke and falling debris. The scene is captured from a distance, showing a line of trees and a utility pole in the foreground. The overall atmosphere is one of a catastrophic event.

REVELATION OF MARKET FAILURE

SO, IF THE MARKET SAYS REASONABLE THINGS ARE NOT COST EFFECTIVE, BUT INSANE THINGS ARE COST EFFECTIVE THAT MUST MEAN WE ARE DEFINING COST AND BENEFIT INCORRECTLY.

2018 Nobel Prize: focus on sustainable growth

By Sergei Guriev

11 Oct 2018



The 2018 Nobel Prize in Economics was awarded to William Nordhaus and Paul Romer who have both been expected to get this prize for many years. However, the conventional wisdom was that they would get it separately: Nordhaus for "environmental economics" (probably shared with others) and Romer for "endogenous growth" (also likely to be shared with others). The fact that the Nobel Prize was awarded to Nordhaus and Romer together sends a powerful message: we need economic growth and we can and we should make this growth sustainable.

A composite image featuring a hand holding a small green tree that is growing out of a stack of coins. The background is a lush green forest. Text overlays include 'The Economic Rationale For Green Investments', 'Green Growth Summit 2024', and 'Corporate Leaders Group Europe'. A tagline at the bottom reads: 'A new cycle for climate and competitiveness - Putting the EU on the road to success'.

The Economic Rationale
For Green Investments

Corporate
Leaders Group
Europe

Green
Growth
Summit
2024

A new cycle for climate and competitiveness -
Putting the EU on the road to success

DECOUPLING

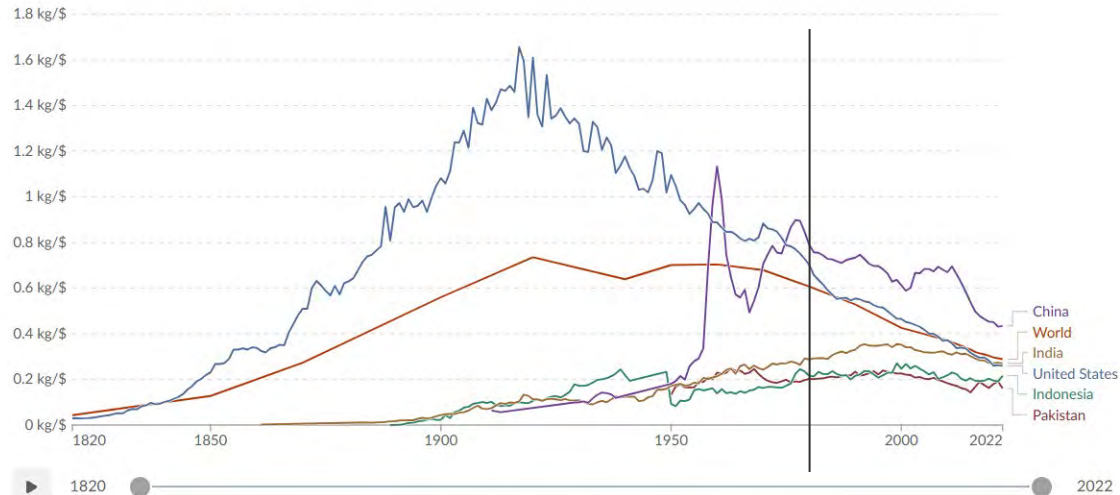
SINCE 1980 WE HAVE CUT OUR CARBON INTENSITY BY 50%!!

Carbon intensity: CO₂ emissions per dollar of GDP

Our World
in Data

Kilograms of CO₂ emitted per dollar of GDP. Fossil fuel and industry emissions are included. Land-use change emissions are not included. GDP data is adjusted for inflation and differences in living costs between countries.

Table Map Line Bar



Data source: Global Carbon Budget (2025); Bolt and van Zanden - Maddison Project Database 2023 - [Learn more about this data](#)

Note: GDP data is expressed in [international-\\$](#) at 2011 prices.

OurWorldinData.org/co2-and-greenhouse-gas-emissions | CC BY



Related: [CO₂ data: sources, methods and FAQs](#)

DECOUPLING IS A MYTH

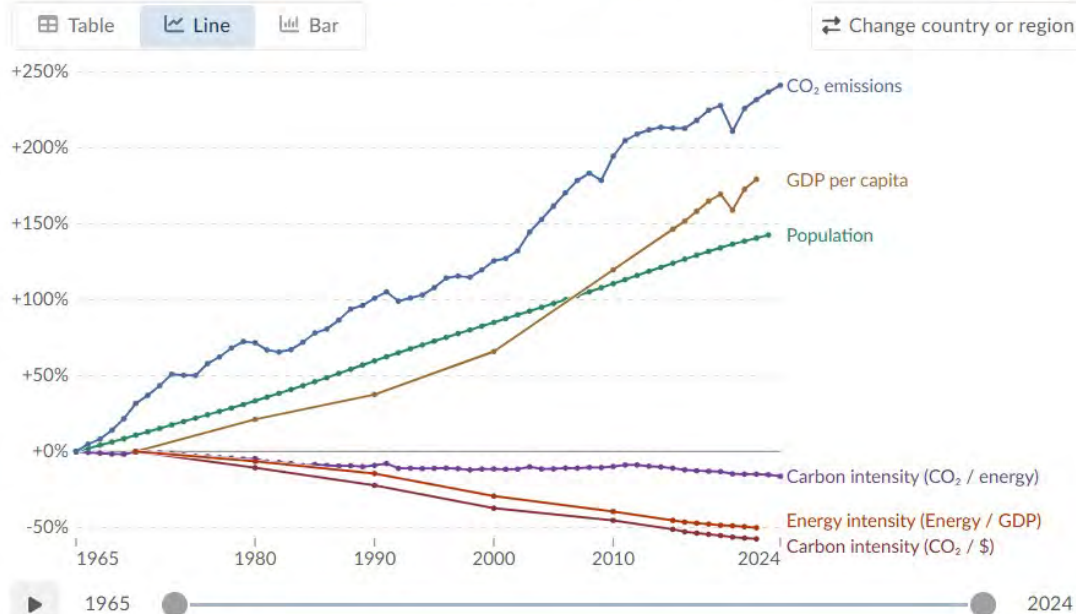
SINCE 1980 WE HAVE CUT OUR CARBON INTENSITY BY 50%!!

DURING THE SAME TIME-FRAME WE HAVE INCREASED OUR CONSUMPTION BY 200%

Kaya identity: drivers of CO₂ emissions, World

Our World in Data

Percentage change in the four parameters of the Kaya Identity, which determine total CO₂ emissions. Emissions from fossil fuels and industry are included. Land-use change emissions are not included.



Data source: Global Carbon Budget (2025) and other sources - [Learn more about this data](#)

Note: GDP per capita is measured in 2011 international-\$ (PPP). This adjusts for inflation and cross-country price differences.

DECOUPLING IS A MYTH

SINCE 1980 WE HAVE CUT OUR CARBON INTENSITY BY 50%!!

DURING THE SAME TIME-FRAME WE HAVE INCREASED OUR CONSUMPTION BY 200%

DON'T LET THE PROMETHIAN SOCIALISTS AND THE TECHNO OPTIMISTS FOOL YOU,
JEVON'S PARADOX IS NOT JUST REAL . . . **IT'S THE HEART OF THE SYSTEM**

GREEN GROWTH MARKET - BASED SOLUTIONS

2018 Nobel Prize: focus on sustainable growth

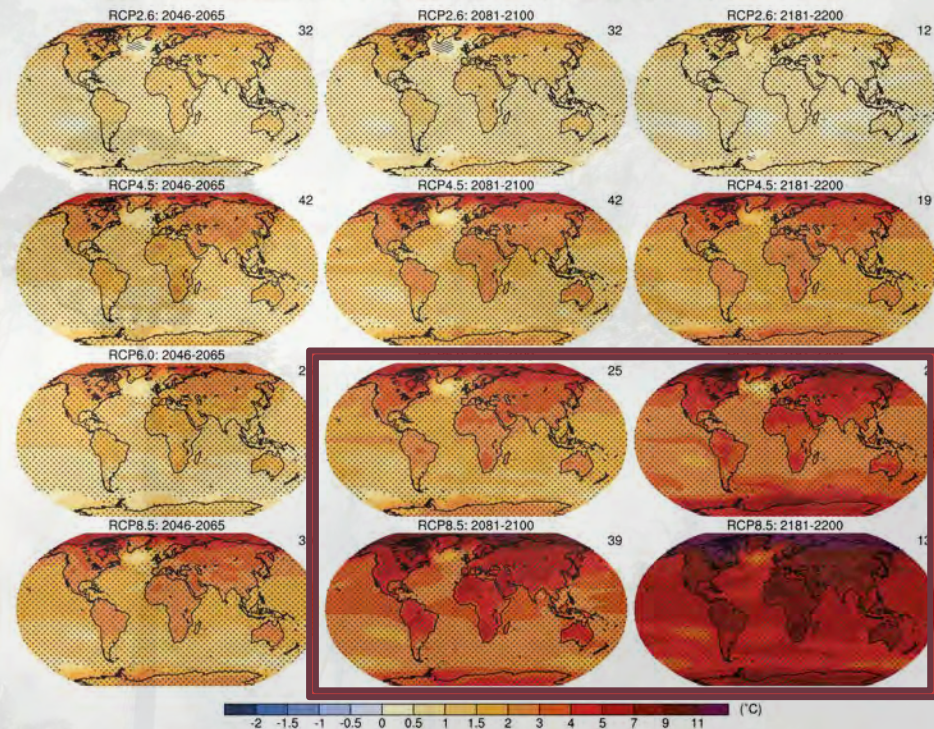
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Annual mean surface air temperature change

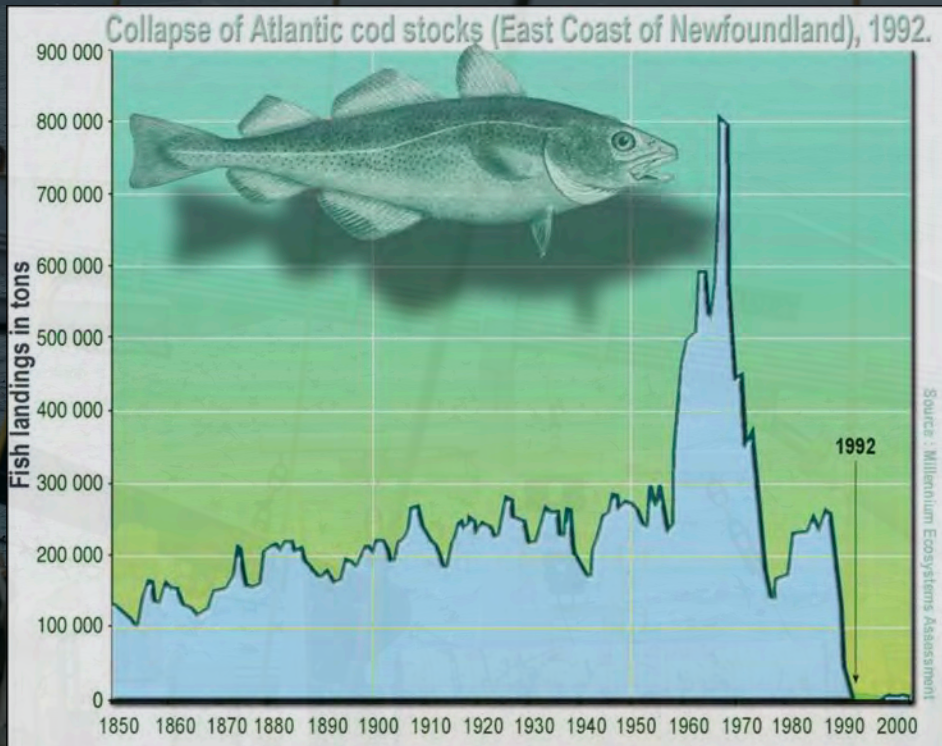


A dense tropical rainforest scene with various types of trees, including palm trees and broad-leafed trees. A prominent tree trunk in the center has a vertical scar or burn mark. The background is hazy and misty, suggesting a humid environment. The overall tone is somewhat somber and atmospheric.

DECOUPLING IS A MYTH

CAPITALISM HAS ONE ALGORITHM – THE EMBEDDED GROWTH OBLIGATION

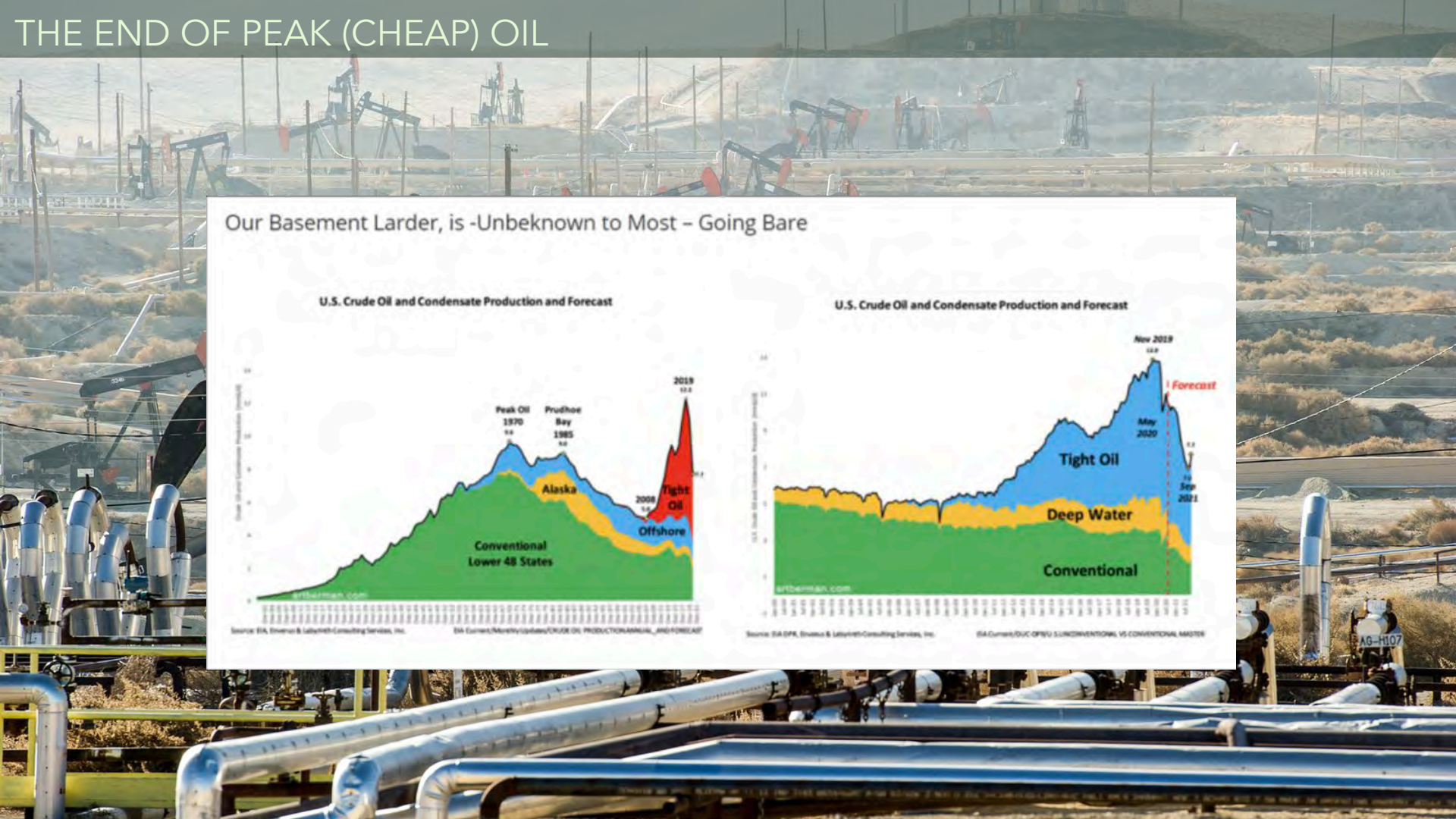
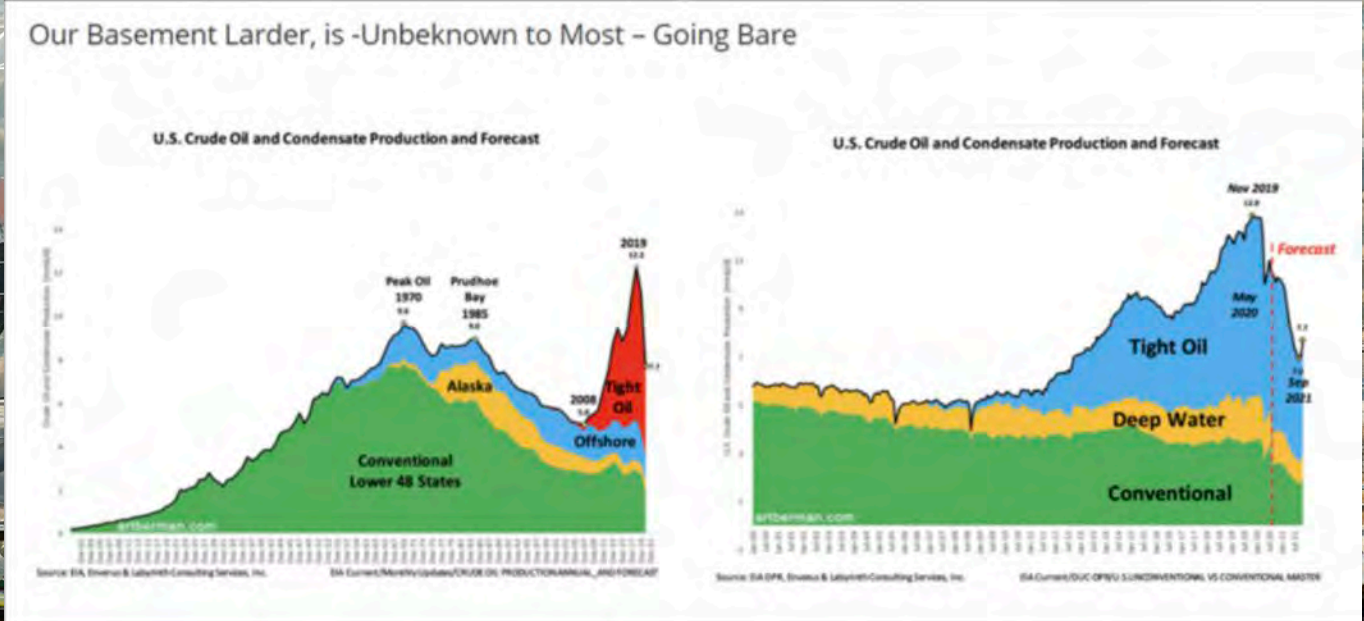
SUPPLY GOES DOWN, PRICE GOES UP, WHICH MAKES INVESTMENT IN MORE TECHNOLOGY AND ENERGY PROFITABLE – SO THE MARKET SURGES FORWARD TOWARDS COLLAPSE



WHICH IS EXACTLY WHAT IS HAPPENING TO OIL

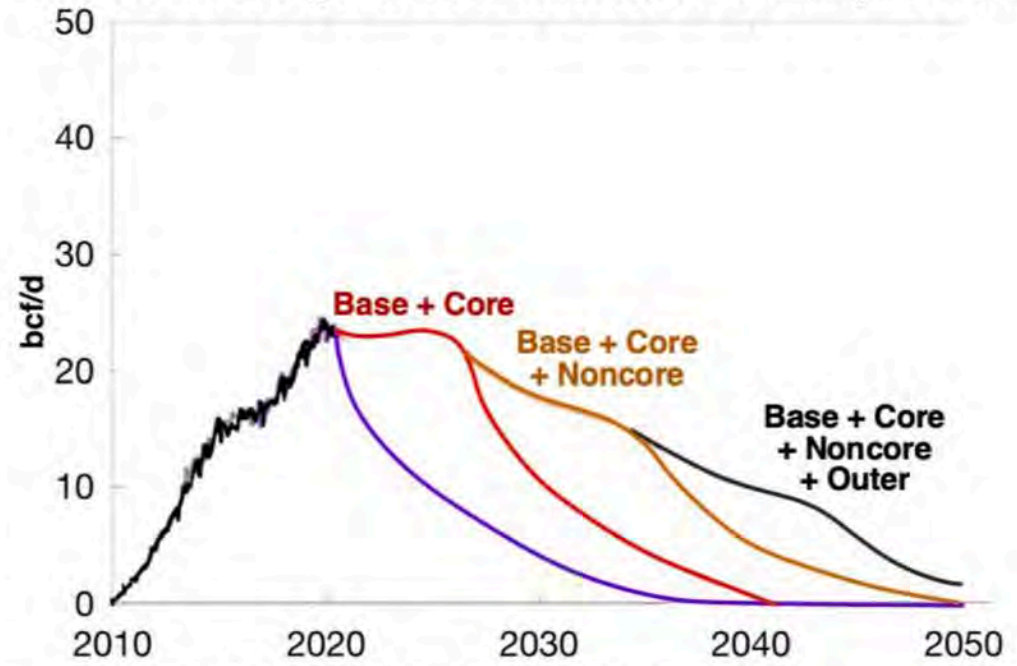


THE END OF PEAK (CHEAP) OIL



THE END OF PEAK (CHEAP) OIL

Most likely Marcellus gas outlook: Plateau through the late-2020s, then sharp decline

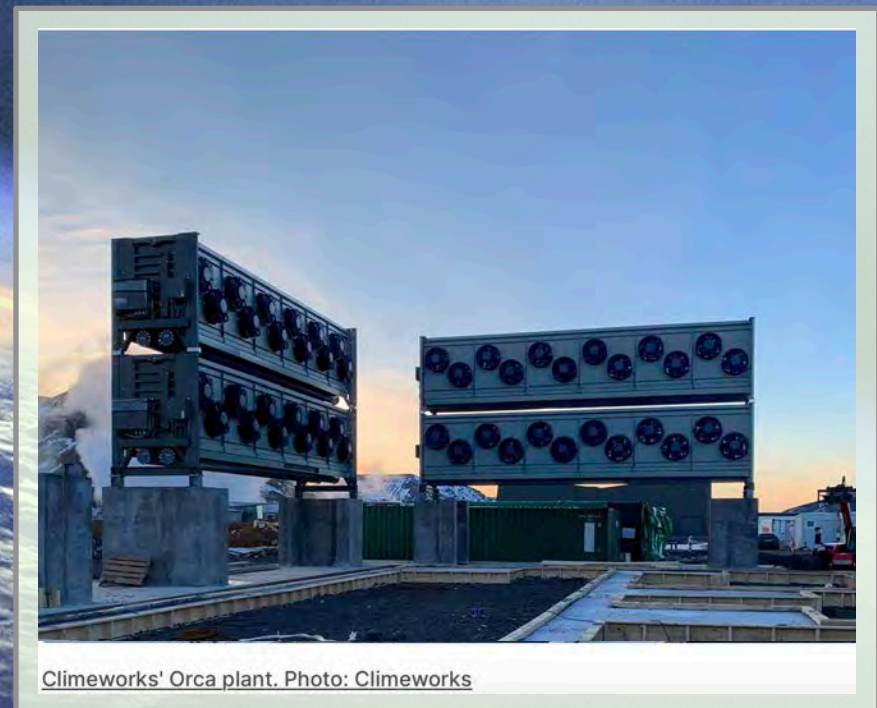
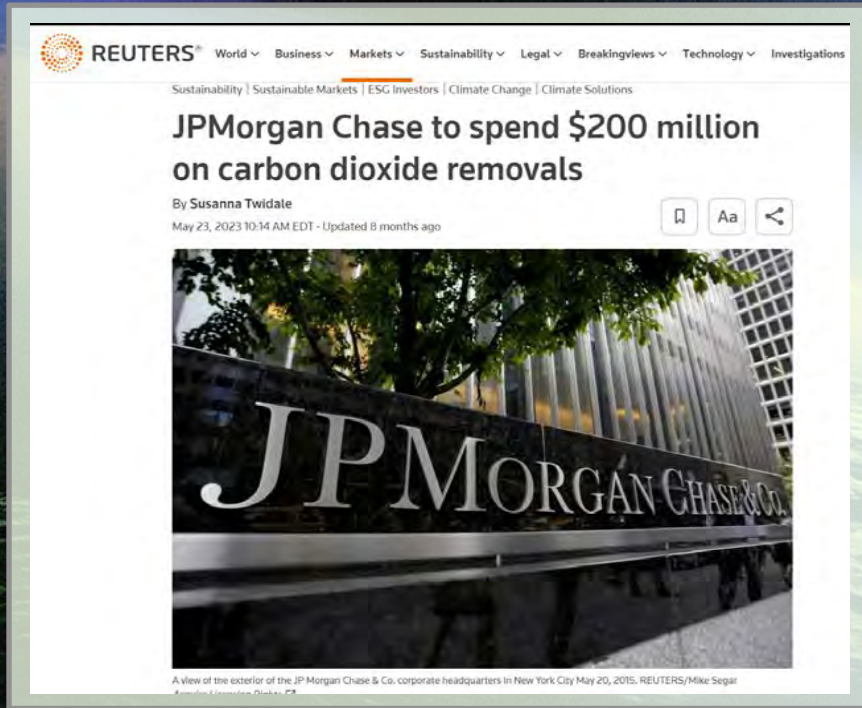


Source: Saputra et al (2021) & Labyrinth Consulting Services, Inc.

Figure 9. Most likely Marcellus gas outlook: Plateau through the late-2020s, then sharp decline.

Source: Saputra et al (2021) & Labyrinth Consulting Services, Inc.

GREEN GROWTH



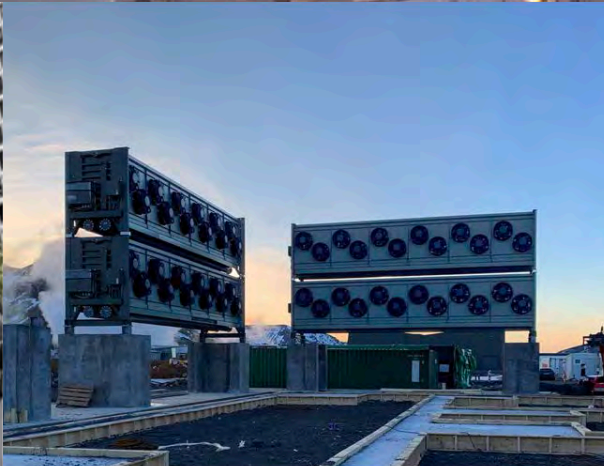
\$200 million on:

- 25,000 tons CO₂ removal by Direct Air Capture over 9 years +
- 28,500 tons from Bio-Oil over 5 years
- = 53,500 and \$3,738/ton

TECHNOLOGY OR CONSERVATION?

EXTERNATILITES

- TECHNOLOGICAL SHIFT
- SPATIAL SHIFT
- TEMPORAL SHIFT



sustainability

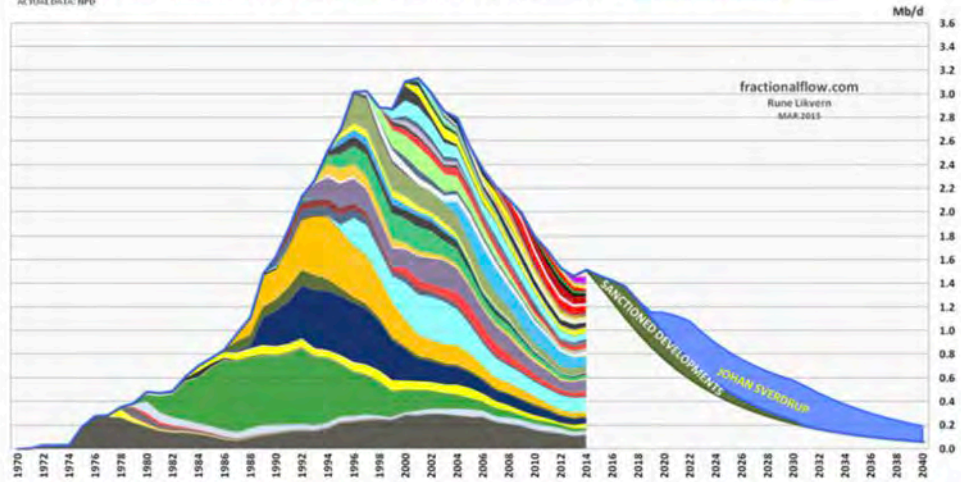
climate

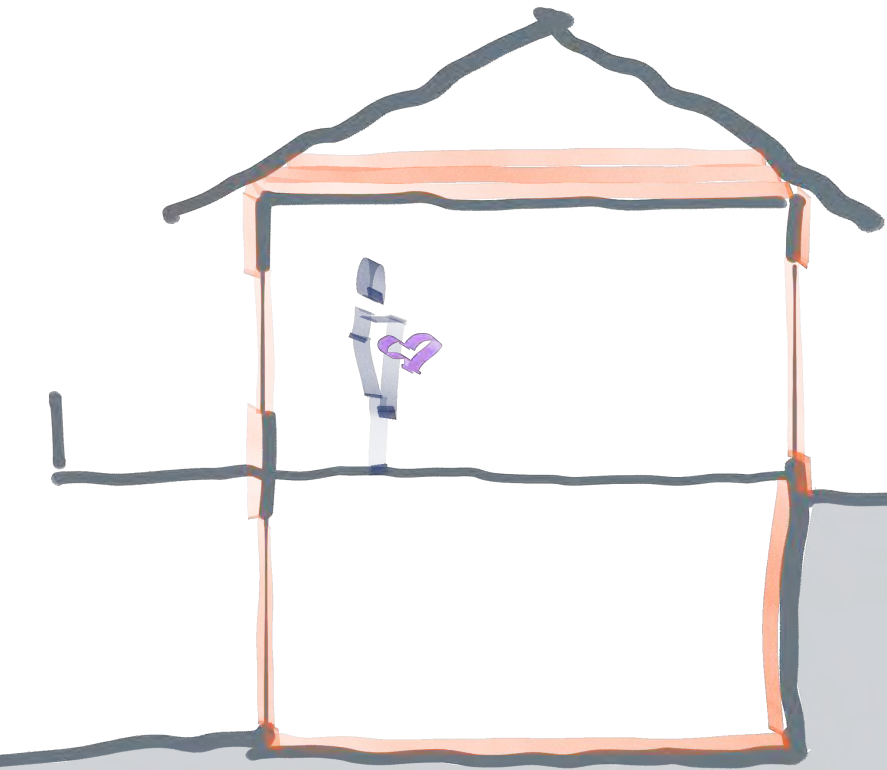
We all have a stake in a reliable, affordable energy system. Our belief that the future is lower carbon drives Chevron's lower carbon ambitions and the actions we take to advance them.



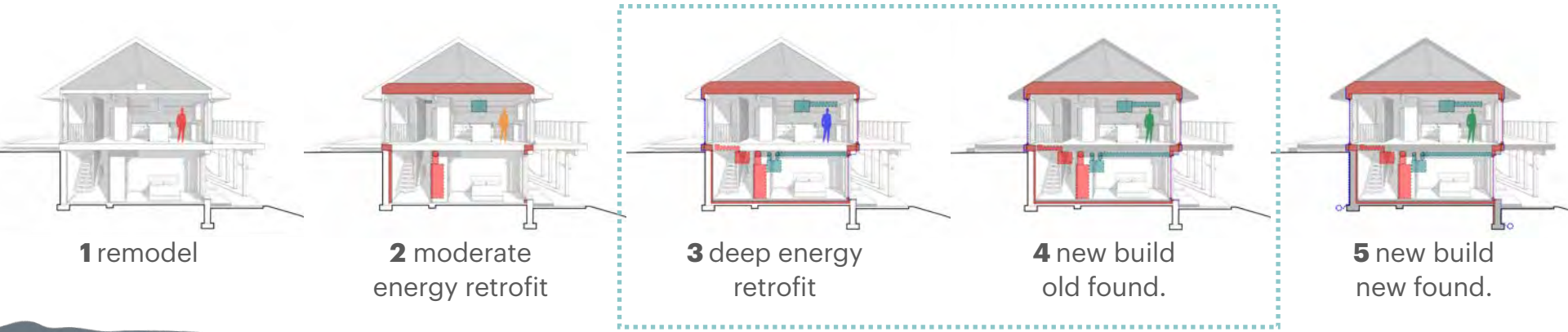
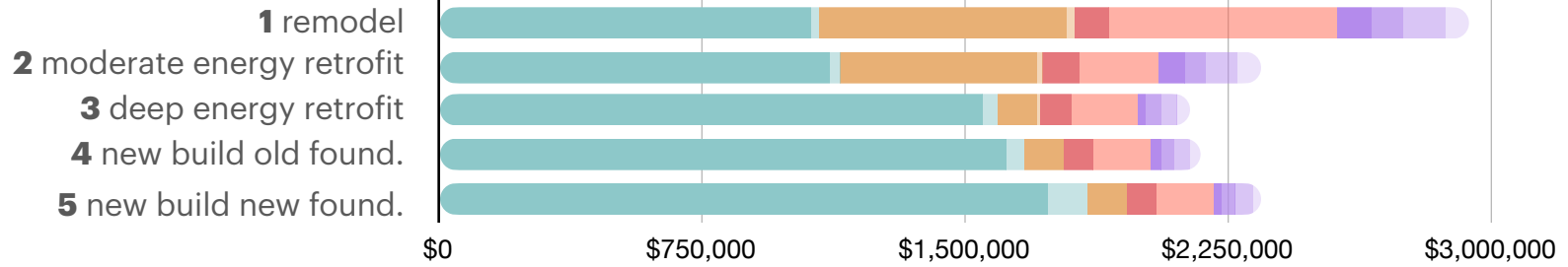
NORWAY, CRUDE OIL EXTRACTION 1970 - 2014
AND A FORECAST TOWARDS 2040 WITH SANCTIONED DEVELOPMENTS AND JOHAN SVERDRUP

ACTUAL DATA: NPQ

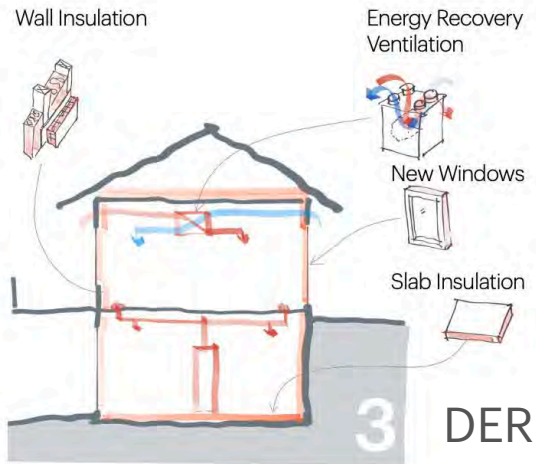




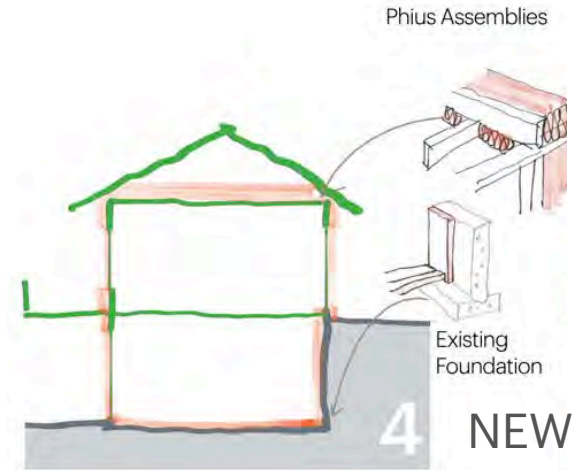
conclusions



most cost effective to do things correctly the first time!



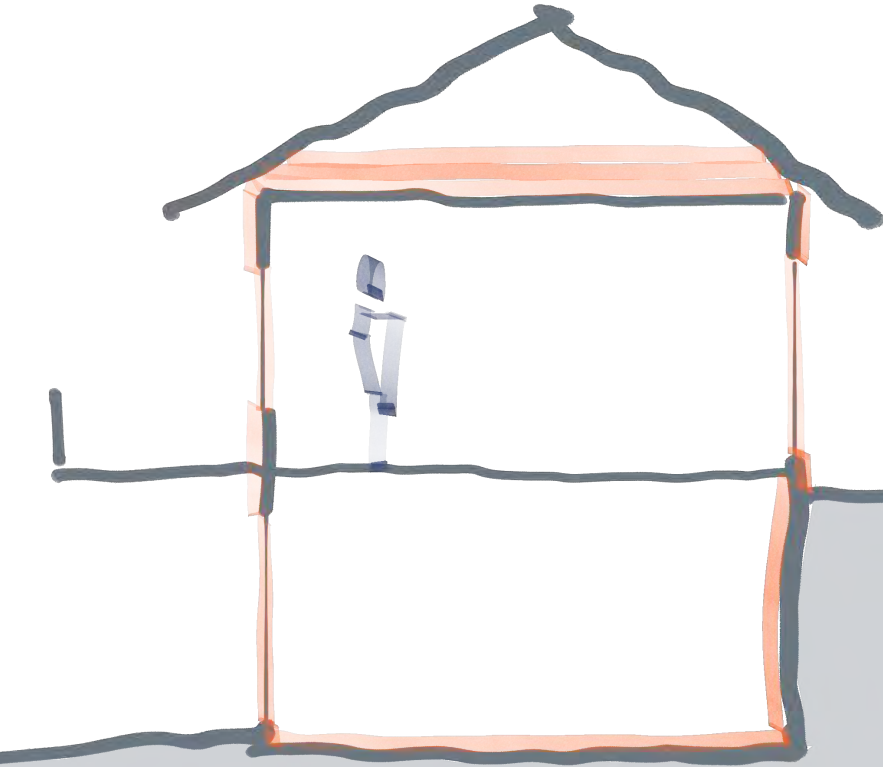
building design stays similar to existing
the structure is in good shape



building design changes significantly
the structure is in bad shape

if the foundation is in bad shape, i.e. structural damage or
poor water management consider replacement

design implications



upfront costs + **carbon** emissions
maintenance costs + **carbon** emissions
energy costs + **carbon** emissions
indoor environmental quality costs
=
total cost of home

5. calculator

BUILDINGENERGY BOSTON

Please fill out an evaluation for this session



or: nesea.org/eval

Northeast Sustainable Energy Association (NESEA) | March 24, 2026