
A COMPENDIUM OF
BETTER RENOVATIONS & RETROFITS
IN THE NORTHEAST



*A proposed initiative of the Northeast Sustainable Energy Association's **BuildingEnergy Online Program***



Worth Preserving Headquarters, Germantown, NY

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North River Electric House, Stone Ridge, NY

PREFACE

The Origin of This Project

In 2019, I attended an MIT symposium called Embodied Carbon in Buildings, where preservation architect Jean Caroon delivered a message that reshaped my thinking. She explained that the construction of even the most energy efficient new buildings creates a carbon debt and it can take thirty years of operation before they break even. Then she exclaimed, “We don’t have thirty years!” The point was clear: the most sustainable buildings are the ones that already exist.

In 2022, I purchased PRETTY GOOD HOUSE: A Guide to Creating Better Homes. I was already aware of the authors’ philosophy and knew I generally aligned with their design and construction approach. On page 5, a small inset titled Pretty Good Renovation caught my attention. It read: “There is no question that buying an existing house is much better for the planet. So why isn’t this book Pretty Good Reno? Mostly because it is much harder to come up with general rules about renovation”.

Those lines stayed with me. In December 2024, I met with one of the authors, Dan Kolbert, to ask if a Pretty Good Reno book was in the works and to express my support for the endeavor. Dan explained that, while the idea had merit, the authors were all too busy with their day jobs to take it on. If the book was ever written, he said it would likely build around case studies of completed renovations.

After some reflection, I realized that I could devote some time and resources to beginning that work. In May of 2025, my colleague Bryn Ablamsky and I started documenting projects that might serve as those case studies.

This compendium is offered both as fieldwork for a future Pretty Good Reno book and as a resource for everyone doing the challenging but essential work of pursuing **better renovations & retrofits**.

— Chris Royer, AIA

ACKNOWLEDGMENT

This project would not exist if it weren't for all the talented and committed contributors who expressed enthusiasm for the endeavor and made time in their very busy schedules to collaborate.

Our heartfelt thanks goes out to all of you.



A COMPENDIUM OF BETTER RENOVATIONS & RETROFITS 2026 COHORT of CONTRIBUTORS

CONNECTICUT

1. **HUDSON VALLEY PRESERVATION:** Mason Lord
2. **WOLFWORKS:** Kyle Cruz, Janet Downey, Connor Musinski

MAINE

3. **LORD BUILDING SOLUTIONS:** Alex Lord

MASSACHUSETTS

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6. **RARE FORMS:** Greg Bossie & Kelley Wagner

NEW HAMPSHIRE

7. **GARLAND MILL:** Ben Southworth

NEW YORK

8. **NORTH RIVER ELECTRIC HOUSE:**
Peter Reynolds, Chris Ruel, Samantha Roesemann
9. **WORTH PRESERVING:** Kate Wood

RHODE ISLAND

10. **CALDWELL & JOHNSON:** Dave Caldwell & Stephen Porder (*home owner*)

VERMONT

11. **CROFTER & GREEN 'DIY':** Steve Crofter & Laurel Green (*owners & builders*)
12. **NEW FRAMEWORKS:** Mike Xenakis, Jacob Deva Racusin
13. **SUSTAINABLE DESIGN:** Alan & Nancy Benoit



Sustainable Design Home & Office Renovation, Dorset, VT

INTRODUCTION

“The built environment is responsible for about 42% of annual global CO2 emissions. Of those total emissions, building operations are responsible for approximately 27% annually...” *Quote from Architecture2030.org website*

If so much of society’s CO2 emissions come from the operation of existing buildings, why isn’t considerably more attention given to their energy efficiency and decarbonization? We cannot tear them all down and replace them with passive house buildings. Their embodied value is far too great, in terms of materials, labor, and cultural meaning.

“The greenest building is the one that is already built.”
Carl Elefante, preservation architect

There are over 85 million existing single family houses in America. Roughly 40 million of them were built before the 1970’s oil crisis and the increased use of insulation and double-pane windows that followed. These old houses comprise the fabric of our neighborhoods, towns, and cities. Most are constructed well. Many have elegant architectural details. These are the places that many of us call home. They are worth preserving.

What are the best practices for stewarding existing homes for the 21st century?

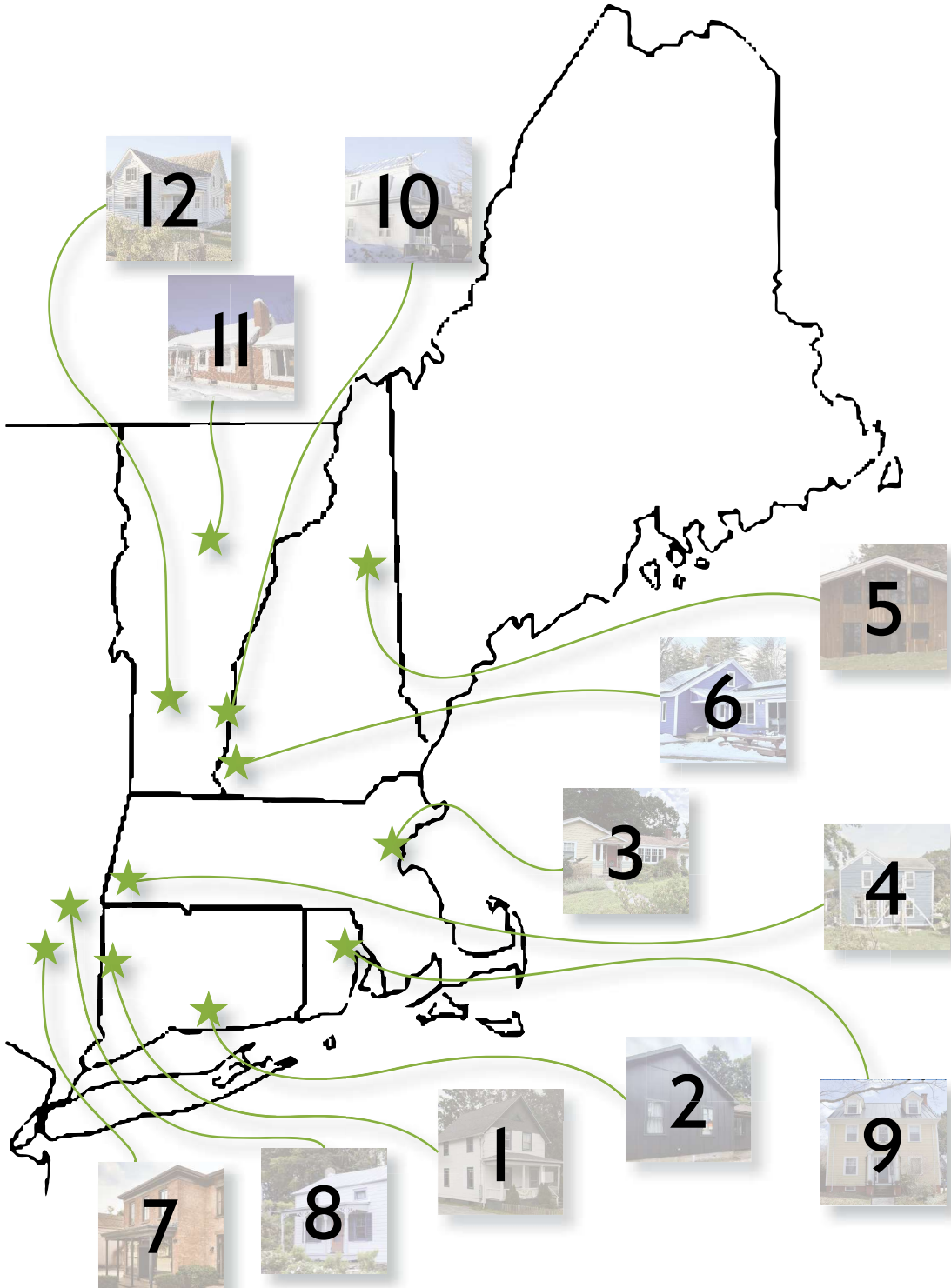
- *How should we prioritize our actions when undertaking a renovation?*
- *How do we strike a balance between the concerns of historical commissions and the new energy codes that are being enacted?*
- *What is the best way to weatherize a damp fieldstone basement?*
- *In the end, how do we know if we have done a good job?*

The geographic scope of this project is limited to the Northeast, in recognition of the fact that house design and construction are regional in nature, through influences of local climate, culture, and building traditions. The Northeast also has some of the oldest buildings that are facing the challenges of a climate that has significantly changed since they were first constructed.



Abisalih Techbuilt Deep Energy Retrofit, Intervale, NH

CASE STUDIES MAP FOR 2026



KEY of PROJECT TYPES

- I ENERGY RETROFIT, *minor renovations to house*
- II LIGHT TO MODERATE RENOVATIONS, *little change to footprint*
- III EXTENSIVE RENOVATIONS, *typically with additions to footprint*
- * HISTORIC LISTING OR IN A HISTORIC DISTRICT

CONNECTICUT

- 1. **Kent** | Hudson Valley Preservation Corp. _____ I
- 2. **Guilford** | Wolfworks, Inc. _____ III

MASSACHUSETTS

- 3. **Medford** | Byggmeister Design Build _____ II
- 4. **Great Barrington** | Rare Forms, Inc. _____ III

NEW HAMPSHIRE

- 5. **Intervale** | Garland Mill Design Build _____ I
- 6. **Chesterfield** | Graphite Studio _____ II

NEW YORK

- 7. **Stone Ridge** | North River _____ III
- 8. **Germantown** | Worth Preserving _____ III*

RHODE ISLAND

- 9. **Providence** | Caldwell & Johnson, Inc. _____ II

VERMONT

- 10. **Bellows Falls** | Crofter & Green DIY _____ III
- 11. **Montpelier** | New Frameworks _____ I
- 12. **Dorset** | Sustainable Design _____ III

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PHOTO CREDITS: Fine Homebuilding

CASE STUDY 1

Project Type I: Energy Retrofit

Kent
CONNECTICUT

2024 AeroBarrier energy retrofit of a Late 19th century National-Style house to serve as Hudson Valley Preservation's new headquarters.

PROJECT TEAM

Designer: HUDSON VALLEY PRESERVATION

Contractor: HUDSON VALLEY PRESERVATION
& LORD BUILDING SOLUTIONS

Energy Consultant: LORD BUILDING SOLUTIONS

PROJECT OVERVIEW (Based on article in Fine Home Building Magazine, Issue 326 - October 2024)

This 1890 wood-framed National-Style house — purchased as the new office for Hudson Valley Preservation—had all the familiar challenges of older Northeast structures: chronic air leakage, drafty rooms, and undersized or disconnected air barriers hidden behind original materials.

“A blower-door test soon quantified the scale of the problem: a staggering 19 ACH50, despite the house having no large visible holes. Infrared scans revealed leakage around doors, windows, band joists, attic access, and ducts.”

The retrofit began with a suite of straightforward, minimally invasive improvements: reglazing and weatherstripping the original windows; sealing ducts and fixing disconnects; insulating the band joist with foil-faced polyiso; tightening basement and attic access points; and addressing abandoned penetrations, door sweeps, and obvious gaps in the enclosure. These interventions alone reduced leakage by about 3 ACH50, but the building still tested above 16 ACH50, confirming deeper leaks within the original board-sheathed walls.

To address what couldn't be accessed without demolition, the team brought in AeroBarrier, a spray-applied sealant that pressurizes the house to force sealant into micro-gaps. Because the building was unoccupied, masking, protection, and equipment staging were manageable, allowing sealing of board-sheathing gaps, sash pockets, register perimeters, duct boots, and other hard-to-reach areas.



Once the AeroBarrier sealing was complete, airtightness improved dramatically to 5.65 ACH50—a transformation that set the stage for better mechanical performance.

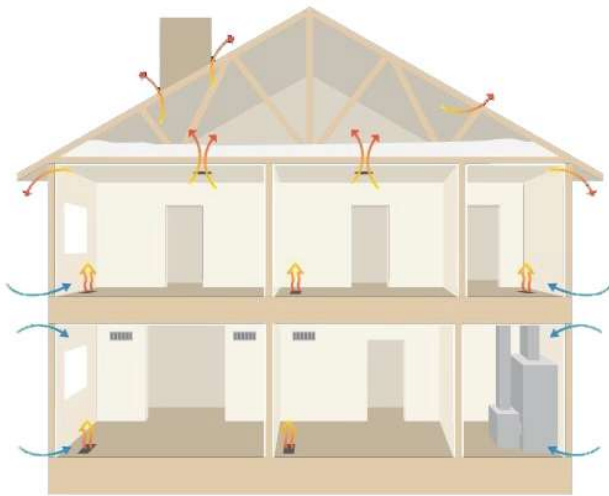
Mechanical upgrades followed: an existing oil-fired furnace was retained for extreme cold. At the same time, a variable-speed heat pump was added to the furnace's blower and ductwork to provide primary heating and cooling. Ductwork was extended to the second floor and later buried in loose-fill cellulose. With the tighter shell, the system now operates more quietly, more efficiently, and with far more stable temperatures. Utility bills have already dropped compared to those of the previously leased smaller office, and the renovated space now reflects the company's commitment to old buildings and thoughtful, incremental upgrades.

AEROBARRIER PROCESS

- Protect Surfaces
- Close Off Mechanical Systems
- Protect Fixtures
- Prep Windows
- Place Spray Heads
- Connect Air Supply
- Turn Up The Heat
- Seal & Monitor

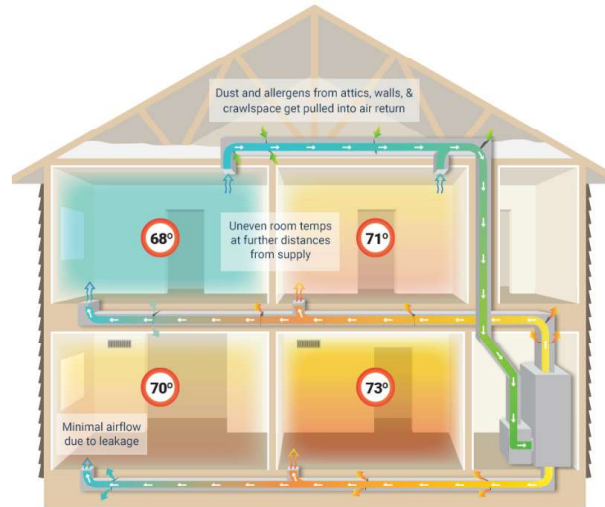


TYPICAL AEROSEAL DIAGRAMS

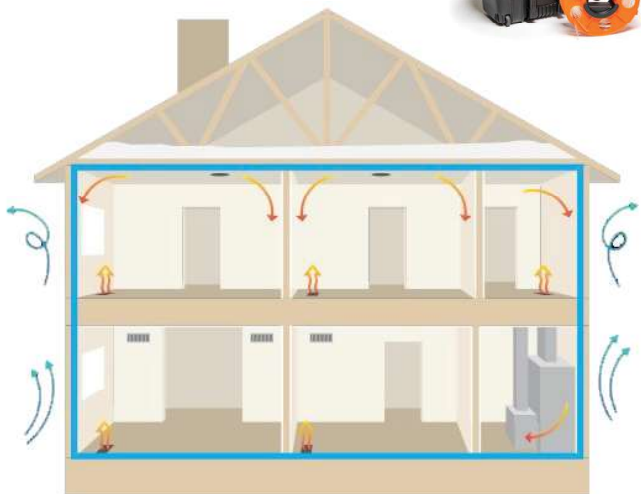


BEFORE | AEROSEAL

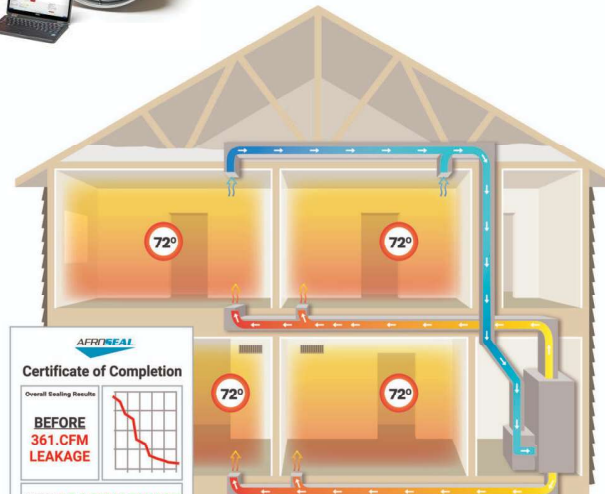
DIAGRAM CREDITS: aeroseal.com



AEROSEAL EQUIPMENT



AFTER | AEROSEAL



PROJECT DATA SUMMARY

- 1 **LOCATION:** Kent, CT
- 2 **IECC CLIMATE ZONE:** 5A
- 3 **YEAR BUILT:** Early 1900s
- 4 **YEAR RENOVATED:** 2023 - 2024
- 5 **LIVING AREA:**
BEFORE: 1,400 SF AFTER: 1,400 SF
- 6 **BEDROOMS/BATHROOMS:**
BEFORE: 3 / 2 AFTER: 3 / 2
- 7 **CONSTRUCTION**
FOUNDATION: Concrete
WALLS: Wood studs
ROOF: Wood rafters
- 8 **INSULATION**
SUBSLAB: None
FOUNDATION: AeroBarrier & foil-faced polyiso at band joist
ABOVE-GRADE WALL: AeroBarrier
ATTIC FLOOR: 24" Loose fill cellulose
- 9 **WINDOWS:** Refurbished wood windows w/aluminum storm windows
- 10 **HVAC:**
BEFORE: Oil
AFTER: Hybrid Oil + Electric Variable Speed Heat Pump
- 11 **MECHANICAL VENTILATION:**
BEFORE: NONE AFTER: NONE
- 12 **DOMESTIC HOT WATER:**
BEFORE: Propane
*AFTER: Electric Heat Pump**
**upon failure of propane heater*
- 13 **PV SYSTEM CAPACITY:**
BEFORE: NONE AFTER: NONE
- 14 **AIR LEAKAGE:**
BEFORE: 19 ACH50 AFTER: 5.65 ACH50

THE BETTER FACTORS

PRESERVATION OVER DEMOLITION

- Stripping the house of original elements goes against our company DNA, which aims to preserve old buildings and original details.
- Cost-conscious, real-world retrofit
- We kept the existing storm windows for reduced noise and increased comfort.

ADDRESS THE ENVELOPE-FIRST

- Used blower door & infrared camera to find and seal envelope leaks.
- Reglazed & weather-stripped windows & doors.
- Sealed ducts.
- The above measures alone reduced air leakage by about 3 ACH50.
- The blower door's fan forces the sealant into leaks, improving its airtightness even more.
- Initially, the building tested at nearly 19 ACH50. After all the improvements, the building tested at 5.65 ACH50.

MECHANICAL COORDINATION

- An evaluation of the HVAC system is a key part of any weatherization or enclosure upgrade. This project had a tight budget, and an entirely new HVAC system was not in the cards.
- The existing Thermo Pride oil-fired, forced-air furnace was retained for heating on the coldest days.
- A variable-speed Trane heat pump was installed for heating on cool days and cooling on hot days.

IMPROVED COMFORT & QUIET

- We spent less on heating oil and electricity than we ever did at our smaller rented office.
- The space is also quieter and more comfortable.

LESSONS LEARNED

As anyone who has spent time working on old houses knows, you're often in uncharted territory when you make upgrades to a house like this. One thing I would do differently in the future is to better coordinate with the HVAC contractor about roughing in ductwork and air-sealing around new ducts... *Let me set the scenario: By the time Alex began sealing with AeroBarrier, the house was nearly ready for occupancy. The conventional air-sealing was done. The windows were out for restoration. The attic was air-sealed and insulated, and the basement had been sealed too.*

Alex started sealing with the spray-applied sealant, but progress was slow. After snooping around with the blower door running and the sealant turned off, he found a pair of 2-in. by 8-in. holes around the duct-work running to the second floor from the basement. These two holes allowed interior air to circulate through the second-floor floor system and the attic; the official building-science name for this is thermal bypass. With the house operating normally, these thermal bypasses would have significantly offset the impact on heating and cooling comfort and efficiency. Once the two holes were plugged, sealing could progress, but that wasn't the only snafu. After Alex had been sealing for about three hours of the four-hour process, the graph tracking the effects of the sealant suddenly showed what looked like a large new hole. The "hole" turned out to be the furnace starting up, because the shutoff switch was broken. This issue created a pressure difference that was detected by the AeroBarrier monitoring system. Combustion equipment is always turned off and ductwork is sealed off before sealing. The pressure of the blower door and sealed ductwork can disrupt system and combustion airflow, potentially damaging equipment. Alex was able to kill the furnace at the breaker, and there was no damage to the equipment.

PROJECT TEAM



MASON LORD
Hudson Valley Preservation
Owner & design-build
contractor



ALEX LORD
Lord Building Solutions
AeroBarrier Contractor

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PHOTO CREDITS: Shannon Downey

CASE STUDY 2

Project Type III: Extensive Renovations & Addition

Guilford
CONNECTICUT

A 2024-25 deep energy renovation & addition to a 1905 camp with detached Accessory Dwelling Unit

PROJECT TEAM

Architect: WOLFWORKS

Contractor: WOLFWORKS

Energy Consultant: WOLFWORKS

PROJECT OVERVIEW

The Guilford project began with the owners weighing a full teardown against a renovation. Ultimately, they chose to work with the existing foundation and shell to create a high-performance, all-electric home that met their goals for comfort, efficiency, and a reduced environmental footprint. A code-minimum ADU built in 2022 already existed on the property, and the design strategy centered on connecting it to the main structure through a new infill addition. This addition extends beneath the two homes and uses only one concrete pier (existing ledge did not allow for a helical pier). This move unified the buildings into a single-level, three-bedroom home with a guest suite and two bathrooms, sized appropriately for the family's needs.

The interior was completely reorganized to improve functionality and building performance. The new layout prioritizes southern exposure, with the living room and primary suite reoriented to maximize solar heat gain and natural light. A new kitchen and bathroom were incorporated into the revised plan, and the existing loft was converted into an insulated mechanical room sized for the home's new systems and future solar readiness.

Upgrading the enclosure was essential. The entire exterior skin was removed and rebuilt with 2.5" ZIP-R continuous exterior insulation, while existing wall cavities were dense-packed with cellulose. New and existing roof assemblies were insulated with closed-cell spray foam to create a continuous air and vapor barrier. A full rainscreen assembly and LP SmartSide board-and-batten siding were installed, and the fenestration package was upgraded to triple-glazed Marvin windows and Velux skylights.



BEFORE | FRONT VIEW



BEFORE | REAR VIEW

The foundation strategy removed the existing basement from the thermal boundary and converted it into a ventilated crawl space. The first-floor framing was dense-packed with cellulose and augmented with continuous 2" of rigid polyiso foam below the joists. A compact insulated mechanical alcove was built in the former basement footprint to house the heat pump water heater, which also serves as the homeowner's craft-beer storage.

The home, including the ADU, was fully electrified. Ducted air-source heat pumps provide space conditioning, a heat pump water heater manages domestic hot water, and a balanced ERV delivers continuous ventilation and improved indoor air quality. The addition roof was oriented for future rooftop solar installation.



AFTER | FRONT VIEW



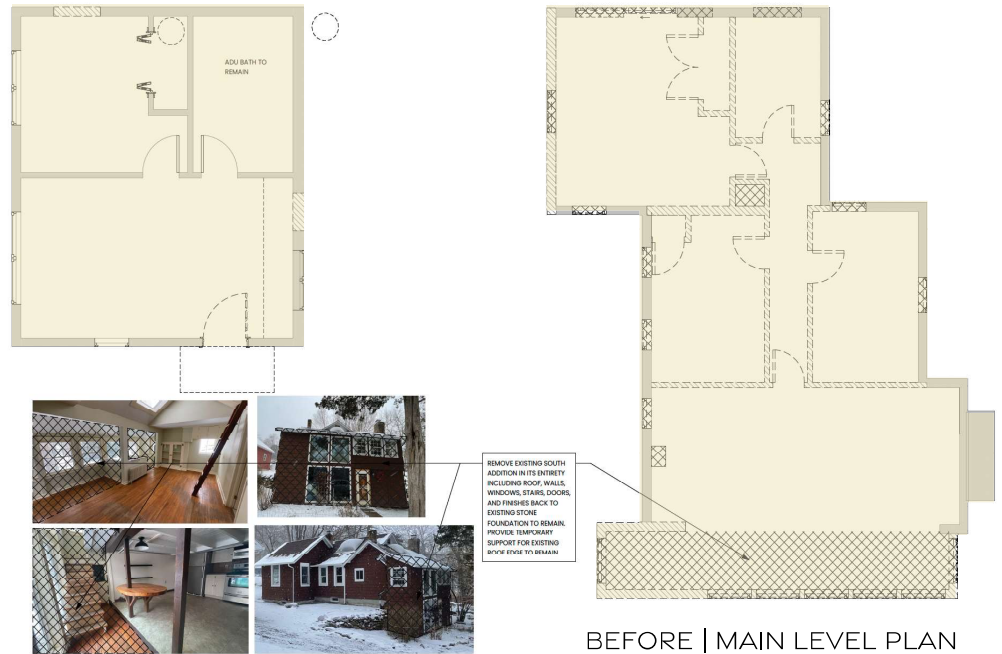
AFTER | REAR VIEW

This project demonstrates how an existing structure can be transformed into a durable, efficient, and right-sized home through strategic enclosure upgrades, electrification, and thoughtful reorganization of space—achieving performance goals aligned with the owners' lifestyle and environmental objectives.

FLOOR PLAN & IMAGES



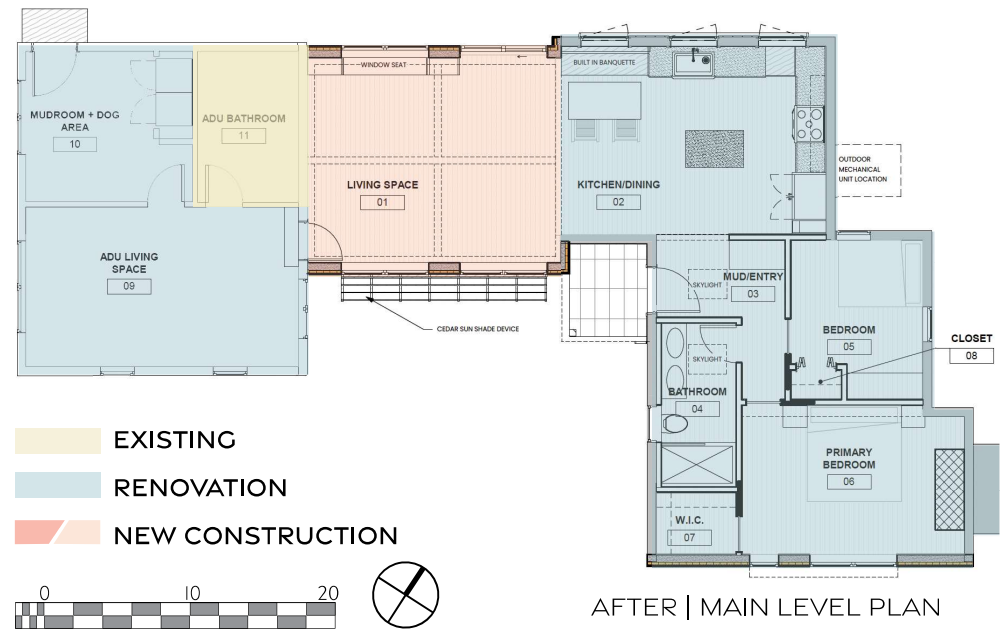
BEFORE | KITCHEN/LIVING



BEFORE | MAIN LEVEL PLAN

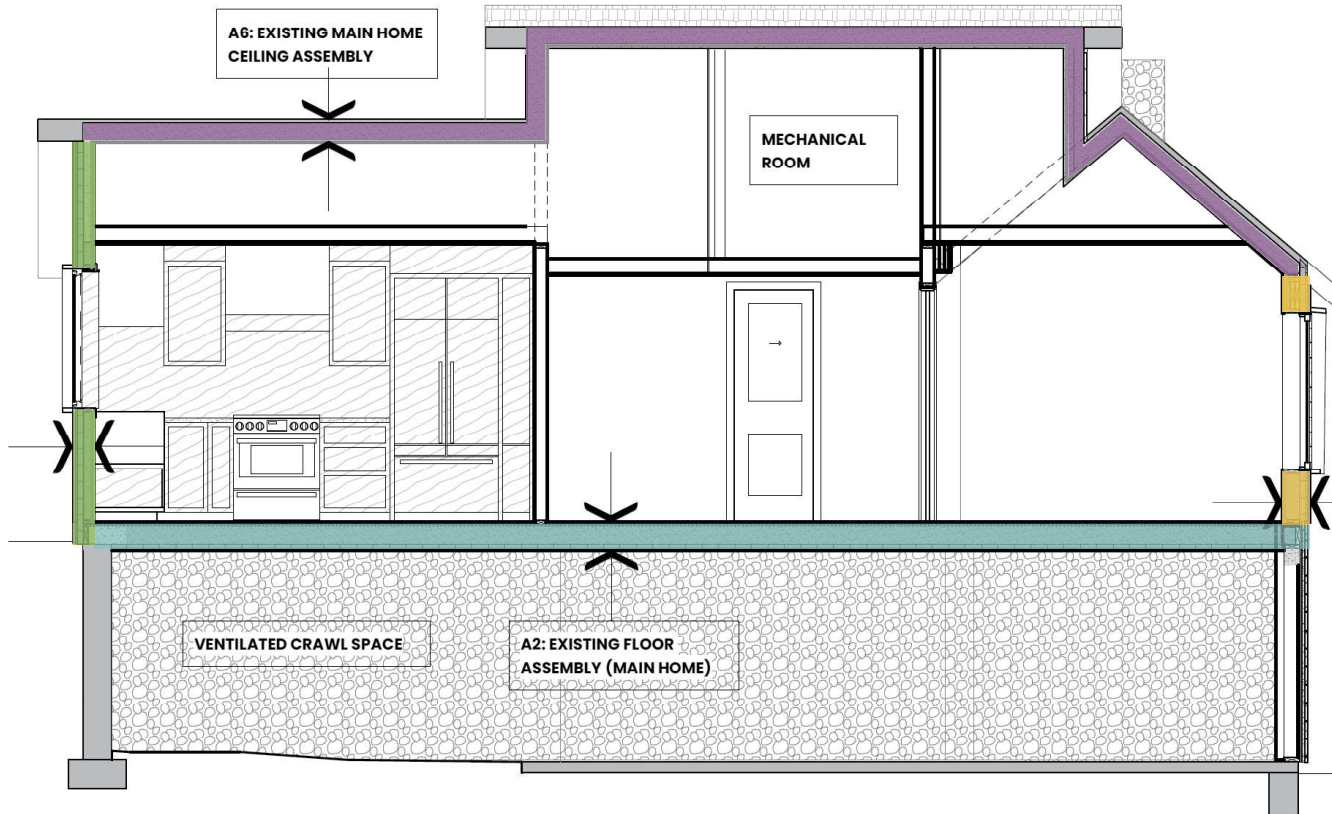


AFTER | KITCHEN/LIVING



AFTER | MAIN LEVEL PLAN

BUILDING SECTIONS



- EXISTING HOME CEILING- (R-49 MIN):**
 - 7" CLOSED-CELL SPRAY FOAM AT UNDERSIDE OF ROOF DECK
- EXISTING FLOOR (MAIN HOME) - (R24+R12CI)**
 - EXISTING 2X6 AND 2X8 JOISTS FILLED WITH DENSEPACK CELLULOSE
 - 2 1/2" ZIP R-INSTALLED TO UNDERSIDE OF FLOOR JOISTS WITH TAPED SEAMS
 - PERIMETER BAND JOIST (4X8 TIMBER ASSUMED).
- EXISTING MAIN HOUSE WALL - (R16+R12CI):**
 - EXISTING 2X4 FRAMING FILLED WITH DENSEPACK CELLULOSE
 - 2 1/2" ZIP R-SHEATHING WITH TAPED SEAMS
 - 1/2" RAINDSCREEN ASSEMBLY
- SOUTH PRIMARY BEDROOM WALL - (R22+R12CI):**
 - 2X6 AT 16" O.C. WITH DENSEPACK CELLULOSE
 - 2 1/2" ZIP R-SHEATHING WITH TAPED SEAMS
 - 1/2" RAINDSCREEN ASSEMBLY (HORIZONTAL CORAVENT OR 1X3 WITH SLICKER MEMBRANE TO BACKSIDE)

PROJECT DATA SUMMARY

- 1 **LOCATION:** Guilford, CT
- 2 **IECC CLIMATE ZONE:** 5A
- 3 **YEAR BUILT:** 1905 - Camp
2022 - ADU
- 4 **YEAR RENOVATED:** 2024-2025
- 5 **LIVING AREA:**
BEFORE: 1,376 SF* AFTER: 1,281 SF
*including basement kitchen
- 6 **BEDROOMS/BATHROOMS:**
BEFORE: 4 / 2 AFTER: 3 / 2
- 7 **CONSTRUCTION**
FOUNDATION: Stone/Rubble
WALLS: 2x6 studs
ROOF: 2x8 studs
- 8 **INSULATION**
CAMP FLOOR: R-24+12ci
CAMP WALL: R-16+12ci
CAMP ROOF: R-49
- 9 **WINDOWS:** Triple glazed Marvin
- 10 **HVAC:**
BEFORE: Oil Boiler
AFTER: Ducted electric heat pump
- 11 **MECHANICAL VENTILATION:**
BEFORE: NONE AFTER: Broan
- 12 **DOMESTIC HOT WATER:**
BEFORE: Oil AFTER: Electric heat pump
- 13 **PV SYSTEM CAPACITY:**
BEFORE: NONE
AFTER: Prepped for future
- 14 **AIR LEAKAGE:**
BEFORE: 12.0 ACH50 AFTER: 1.11 ACH50

THE BETTER FACTORS

CARBON SAVINGS

- Retaining and reusing existing framing and assemblies reduced landfill waste and avoided new embodied carbon of a full rebuild.
- Denspack cellulose and polyiso provided high-R insulation with comparatively lower carbon cost than spray foam.
- T&G pine ceiling added warmth while supporting performance goals.

DURABILITY & MOISTURE MANAGEMENT

- ZIP sheathing with taped seams provided robust air sealing.
- LP SmartSide and rainscreen siding matched the “camp” look with durability.
- Rainscreen assemblies increase drying potential, extending siding life and reducing long-term maintenance.

THERMAL PERFORMANCE

- High-R assemblies across floors, walls, and roofs exceeded code minimums, improving comfort and energy performance.
- Buried ductwork in cellulose insulation reduced distribution losses for heating and cooling.

HEALTHY & EFFICIENT SYSTEMS

- ERV integration improved indoor air quality and balanced pressures across the home.
- Heat pumps offered efficient heating/cooling, while eliminating fossil fuels.

DESIGN FOR RESILIENCE

- The project bridged the old and new with adaptable assemblies that enables for future maintenance and upgrades.
- Raised heel trusses and strategic insulation depths future-proofed the home against rising energy performance standards.

This project highlighted the balance between the homeowners’ budget and schedule goals and the desire to maximize performance and while minimizing environmental impact. Our initial strategy prioritized minimizing the use of closed-cell spray foam and using wood-fiber rigid insulation in place of ZIP-R, with cellulose and a smart vapor barrier in the walls and attic. However, during demolition and the discovery of the existing construction assemblies, we realized that implementing this approach would be time-consuming, costly, and difficult to detail. Additionally, we could not confirm a feasible source of rigid wood fiber insulation. Adapting to these conditions, we chose closed-cell spray foam as both insulation and vapor barrier, which effectively reduced heat loss and air infiltration while accommodating the complexity of the existing form, and used ZIP R as a continuous insulation strategy to the exterior walls.

Projects like this require close collaboration between designers and builders and the flexibility to modify strategies as new information emerges. This project has forced us to consider alternative options for air sealing in existing complex forms. As with any Pretty Good project, every decision is weighed against the budget, asking the central question: Where is the next dollar best spent? The result is a home that achieves high performance while remaining practical and right-sized for the family.

PROJECT TEAM



KYLE CRUZ, AIA, CPHC, LFA
Architect



CONNOR MUSINSKI
Project Manager



JANET DOWNEY, CPHB
Construction Manager

LESSONS LEARNED

- 1. WORKING WITH EXISTING STRUCTURES:** *Irregular joists and framing complicated insulation. Transitions between the old and new assemblies were detail-heavy.*
- 2. AIR SEALING & VAPOR CONTROL:** *Connections between new and old walls/ceilings required significant labor. Continuity of the vapor barrier was difficult in retrofit zones.*
- 3. CARBON-CONSCIOUS DECISION-MAKING:** *Couldn't fully optimize assemblies due to the limits of existing framing. Some embodied carbon is still introduced through rigid insulation.*
- 4. SYSTEM INTEGRATION:** *Duct routing in the existing ceiling required coordination. Mechanical integration added cost and complexity.*
- 5. AESTHETIC & PERFORMANCE ALIGNMENT:** *Balancing character vs. performance required compromises in detailing. Finishes added labor compared to simpler drywall-only approaches.*

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PHOTO CREDITS: Byggmeister

CASE STUDY 3

Project Type II: Moderate Renovations

Medford
MASSACHUSETTS

2024 renovation of a 1960s Ranch-style house, focused on accessibility and home performance for lifelong living.

PROJECT TEAM

Designer: BYGGMEISTER DESIGN | BUILD

Contractor: BYGGMEISTER DESIGN | BUILD

Energy Consultant: BYGGMEISTER DESIGN | BUILD

PROJECT OVERVIEW

The homeowners purchased this 1960s ranch in 2001 with the intention of living there for the rest of their lives. As they aged, they recognized the need for both accessibility improvements and better overall home performance. A previous design study focused exclusively on aging-in-place layouts, but overlooked their primary concerns: comfort, health, and long-term energy efficiency. Discovering Byggmeister's emphasis on building science, electrification, and thoughtful adaptations of older homes aligned perfectly with their goals.

The renovation centered on reorganizing key spaces, improving thermal comfort, and creating a healthier indoor environment. The formerly disconnected kitchen and sunroom were reimagined as a bright, unified cooking and gathering space that opens toward wooded conservation land. Low-use features—like the fireplace, redundant sunroom doors, and a cramped corner shower—were removed, freeing space for more functional storage and improved circulation. Typical 1960s features like the original pink bathroom were retired in favor of a spacious, low-threshold shower, wider doorways, and accessible fixtures.

Performance upgrades were equally important: the roofline was fully insulated; a ducted heat pump and ERV with MERV 13 filtration were added; combustion appliances were eliminated; and both kitchen ventilation and radon mitigation were addressed. Because this was a partial renovation, many air leaks were originally hidden within the existing envelope. The homeowners committed fully and temporarily cleared their home to allow for a whole-house Aerobarrier application. The result: nearly a 90% reduction in air leakage, surpassing today's new construction requirements.



BEFORE | KITCHEN

AFTER | KITCHEN

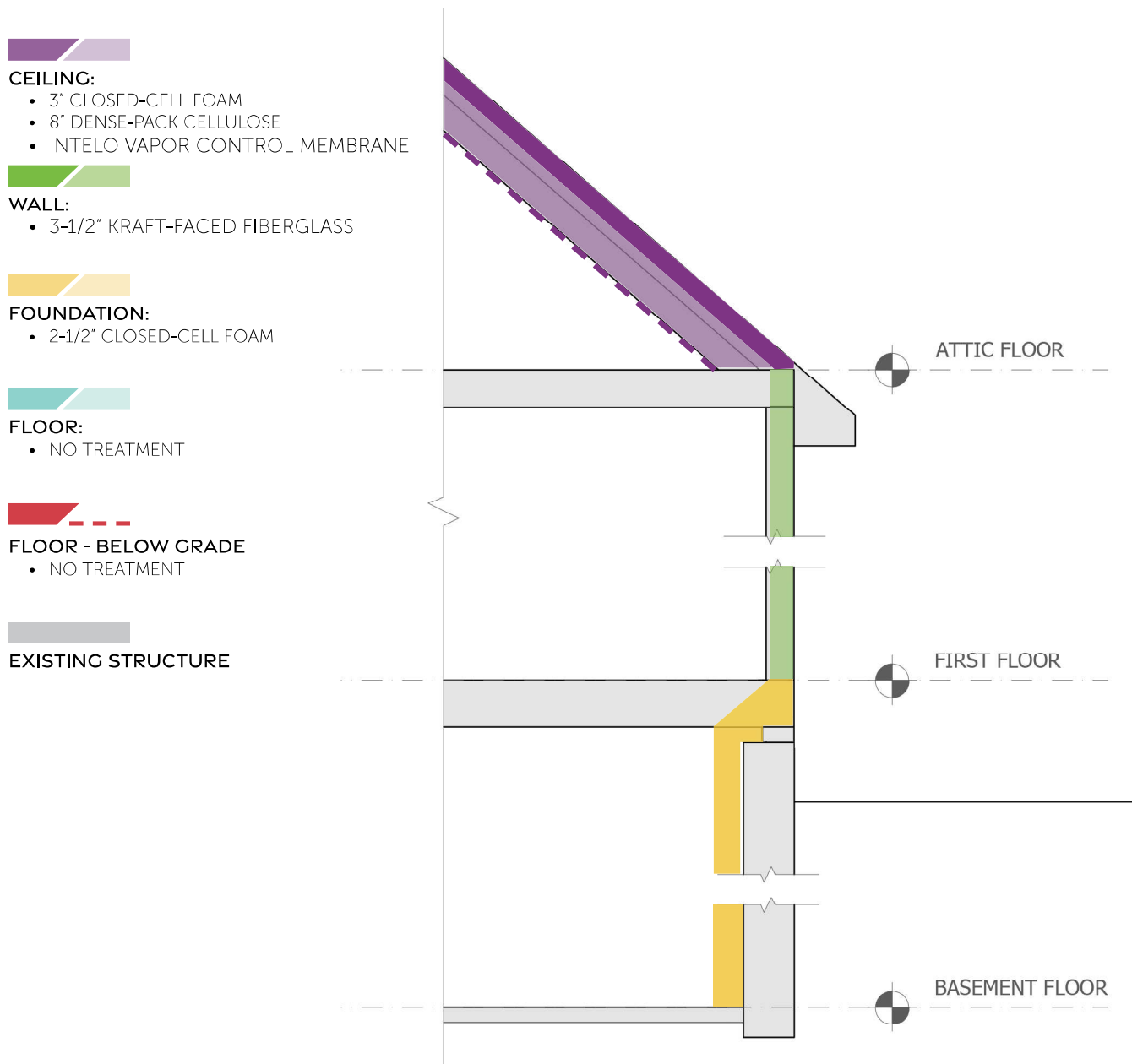
The finished home is quieter, cleaner, and far more comfortable year-round... an all-electric forever home that supports aging gracefully while dramatically cutting energy use.



BEFORE | BATH

AFTER | BATH

TYPICAL WALL SECTION



PROJECT DATA SUMMARY

- 1 **LOCATION:** Medford, MA
- 2 **IECC CLIMATE ZONE:** 5A
- 3 **YEAR BUILT:** 1960
- 4 **YEAR RENOVATED:** 2024
- 5 **LIVING AREA:**
BEFORE: 1,160 SF AFTER: 1,250 SF
- 6 **BEDROOMS/BATHROOMS:**
BEFORE: 2 / 1 AFTER: 2 / 1
- 7 **CONSTRUCTION**
FOUNDATION: Concrete
WALLS: Wood; 2x4 studs
ROOF: Wood; Existing 2x6 rafters built down to 11"
- 8 **INSULATION**
SUBSLAB: None
FOUNDATION: Closed-Cell Spray Foam
ABOVE-GRADE WALL: Fiberglass Batts
ROOF: Closed-cell Foam & Cellulose
- 9 **WINDOWS:**
BEFORE: Single & Double Pane
AFTER: Double & Triple Pane
- 10 **HVAC:**
BEFORE: Gas Boiler AFTER: Electric Air Source Heat Pump
- 11 **MECHANICAL VENTILATION:**
BEFORE: NONE AFTER: Panasonic ERV
- 12 **DOMESTIC HOT WATER:**
BEFORE: Gas AFTER: Electric Heat Pump
- 13 **PV SYSTEM CAPACITY:**
BEFORE: NONE AFTER: NONE
- 14 **AIR LEAKAGE:**
BEFORE: 13.5 ACH50 AFTER: 1.7 ACH50

THE BETTER FACTORS

ALL-ELECTRIC LIVING:

Eliminated all combustion equipment; transitioned HVAC and water heater to heat pumps.

EXCELLENT AIR SEALING:

Aerobarrier created a near-new-construction airtightness level—critical for comfort and indoor air quality.

IMPROVED INDOOR AIR QUALITY:

ERV with high-grade filtration, radon mitigation, and effective kitchen exhaust.

RIGHT-SIZED, THOUGHTFUL UPGRADES:

Targeted thermal improvements at the roofline and strategic removals rather than major layout overhauls.

AGING IN PLACE WITH DIGNITY:

Low-threshold shower, wider doorways, improved circulation, and safer bathroom design.

SPACE REIMAGINED, NOT REBUILT:

Merging the unconditioned sunroom with the kitchen maximized daylight and connection to the outdoors.



BEFORE | AIR & INSULATION

AFTER | AIR & INSULATION



LESSONS LEARNED

Whole-house air sealing using Aerobarrier can be transformative in partial renovations, especially when hidden leakage pathways can't be accessed.

Aging-in-place upgrades pair naturally with performance improvements—wider circulation paths, better ventilation, and improved thermal comfort complement long-term accessibility goals.

Removing low-use or outdated features (fireplace, redundant doors, etc) can free up significant space without costly reconfiguration.

Thorough planning for indoor air quality—including ERV filtration, kitchen ventilation, and radon mitigation—is essential when transitioning to an airtight, all-electric home.

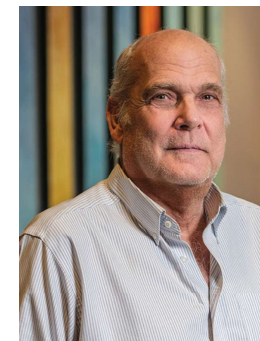
PROJECT TEAM



BRENDAN KAVANAGH
Project & Performance MGR
Byggmeister



ANNIE CHOW
Interior Designer
Byggmeister



MICHAEL GIMBRERE
Lead Carpenter
Byggmeister



RACHEL WHITE
CEO
Byggmeister

A COMPENDIUM OF

BETTER RENOVATIONS & RETROFITS

IN THE NORTHEAST



PHOTO CREDITS: Rare Forms

CASE STUDY 4

Project Type III: Extensive Renovations

Great Barrington
MASSACHUSETTS

2021 - 2025 phased renovation & addition to a drafty 1820s National-style farmhouse transforming it into a tight, all-electric home, using salvaged & low carbon materials.

PROJECT TEAM

Designer: RARE FORMS

Contractor: RARE FORMS

Energy Consultant: Adin Maynard

PROJECT OVERVIEW

This project unfolded over three major phases, each phase building on the previous to create a safer, more comfortable, and significantly more efficient home.

Phase 1 addressed the home's most pressing structural and moisture challenges, including digging out the basement by 18 inches, pouring a new concrete stem wall, and insulating the original rubble foundation with spray foam. These foundational improvements dramatically reduced moisture risk in the existing structure, set clear control layers for future work, and created the conditions for a successful deep energy retrofit.

Phase 1 also included replacing a deteriorated wing of the house with a high performance hempcrete addition and retrofitting the two walls (north and east) of the existing house that were impacted by the addition.

Phase 2 focused on interior improvements, including building out a new basement playroom and reorganizing circulation.

Phase 3 completed the exterior retrofit of the West and South walls of the original farmhouse. This phase included high-performance weather resistant barriers, continuous wood-fiber insulation, rainscreen cladding, new windows, and selective reconfiguration, such as relocating the front entry and converting an underperforming sunporch into a craft room.

Taken together, the three phases outline a practical, incremental roadmap for homeowners looking to improve an older building's performance without the cost and upheaval of being displaced for a single deep-energy overhaul.



BEFORE | SOUTH EAST RENOVATION



AFTER | SOUTH EAST RENOVATION

TYPICAL WALL SECTION

- ROOF OR CEILING:**
- 1" - 2" FLASH COAT CLOSED-CELL SPRAY FOAM
 - 20" CELLULOSE, R-46
 - INSULATION BAFFLE

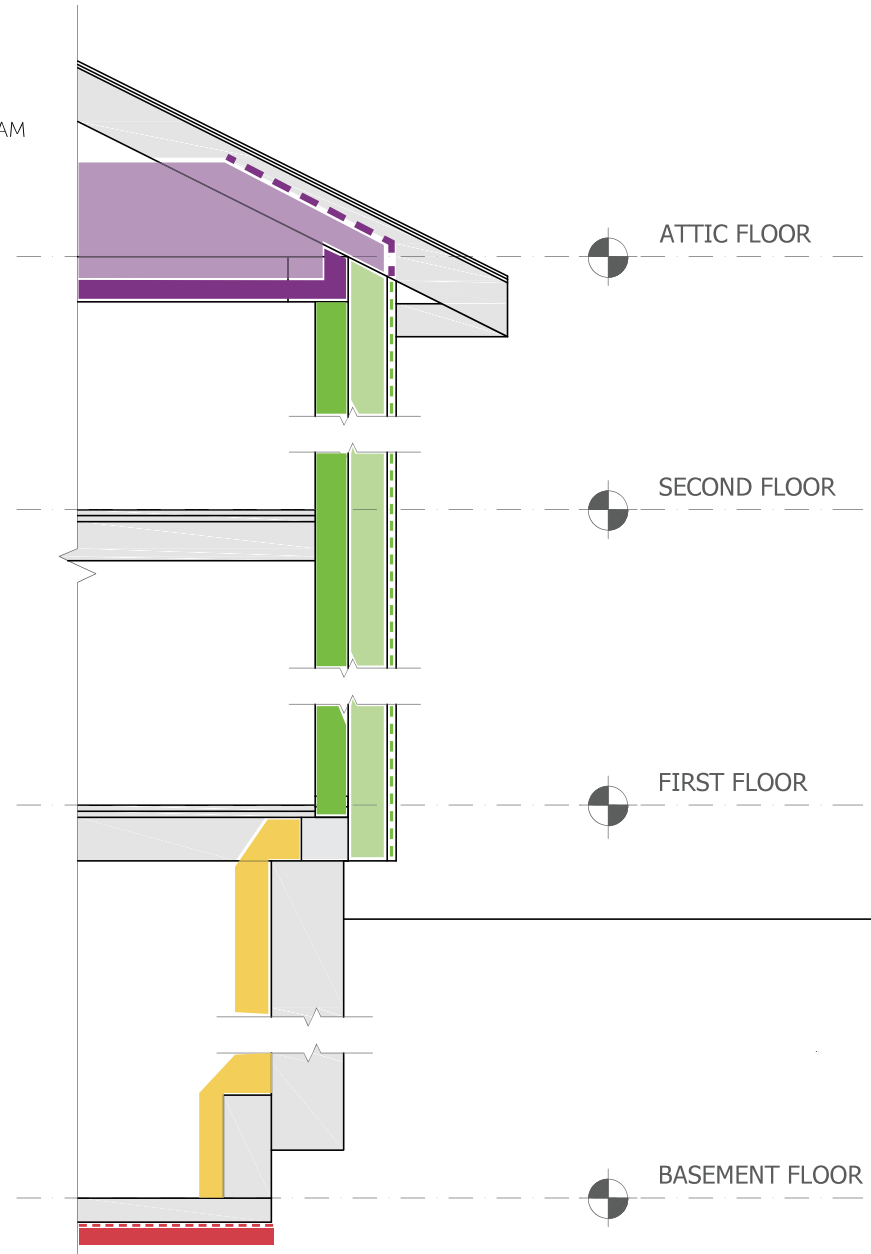
- WALL:**
- DENSE PACKED CELLULOSE
 - 4" WOOD FIBER
 - 1x RAIN SCREEN STRAPPING

- FOUNDATION:**
- 6" CLOSED-CELL SPRAY FOAM

- FLOOR:**
- NO TREATMENT

- FLOOR - BELOW GRADE**
- 4" EPS FOAM
 - 10 MIL VAPOR BARRIER ON TOP

EXISTING STRUCTURE



PROJECT DATA SUMMARY

- LOCATION:** Great Barrington, MA
- IECC CLIMATE ZONE:** 5A
- YEAR BUILT:** 1820s
- YEAR RENOVATED:** 2021 - 2025
- LIVING AREA:**
BEFORE: 1,850 SF AFTER: 1,850 SF
- BEDROOMS/BATHROOMS:**
BEFORE: 4 / 1.5 AFTER: 4 / 1.5
- CONSTRUCTION**
FOUNDATION: Slab on grade
WALLS: Wood; Timber & studs
ROOF: Wood; 2X6 Rafters sistered to original 2x4s
- INSULATION**
SUBSLAB: 4" EPS Foam @ Basement
12" Glavel @ Crawlspace
FOUNDATION: Closed-cell spray foam
ABOVE-GRADE WALL:
Dense packed cellulose & 4" wood fiber
ATTIC FLOOR/ROOF:
Cellulose & closed-cell spray foam
- WINDOWS:** Triple pane Sierra Pacific H3
- HVAC:**
BEFORE: Oil Boiler
AFTER: Electric Air Source Heat Pump
- MECHANICAL VENTILATION:**
BEFORE: NONE AFTER: Zehnder ERV
- DOMESTIC HOT WATER:**
BEFORE: Indirect Oil
AFTER: Electric Heat Pump
- PV SYSTEM CAPACITY:**
BEFORE: NONE AFTER: PV ready
- AIR LEAKAGE:**
BEFORE: not measurable AFTER: 1.52 ACH50

THE BETTER FACTORS

- **PHASED DEEP-ENERGY PATHWAY** that is accessible to typical homeowners.
- **FOUNDATION-FIRST STRATEGY** corrected humidity, air leakage, and structural risks before investing in enclosure upgrades.
- **CONTINUOUS EXTERIOR INSULATION** using low-embodied-energy wood-fiber board.
- **SALVAGED LOW CARBON MATERIALS:** Used salvaged timbers from the house and regionally sourced Hemlock siding.
- **CARBON-CONSCIOUS INSULATION CHOICES** including wood fiber insulation board, hemp-lime plaster, and cellulose.
- **HIGH-PERFORMANCE AIR BARRIER:** Installed Mento weather resistive barrier (WRB), improving durability and comfort.
- **RAINSCREEN FOR LONG-TERM DURABILITY** and reduced maintenance cycles.
- **TRANSITION TO ALL-ELECTRIC HVAC** with zoned air source heat pumps.
- **REPLICABLE AND SCALABLE:** A model for older New England farmhouses that cannot afford one-time deep energy retrofits.



PROJECT TEAM



GREG BOSSIE
Founder / President /
Director of Design
Rare Forms



KELLEY WAGNER
Project Manager
Rare Forms

Not pictured:

CARPENTRY: Matthew Rudnick, Caleb Webb, Audra Ziobro

INSULATION: Cameron McIntosh of American Installations

SITework: Shelby Howland of Village Earthwright

HEAT PUMPS: American Installations

DOORS & WINDOWS: Scenic Windows

LESSONS LEARNED

START WITH THE BASEMENT: The 18" dig-down, stem-wall pour, and rubble-foundation insulation were essential to controlling moisture and creating a durable baseline for later enclosure work.

PHASING WORKS—WHEN PLANNED & DOCUMENTED WELL: Clear control layers, sequencing notes, and detailed as-builts from Phase 1 made the Phase 3 enclosure retrofit far more straightforward.

EXTERIOR INSULATION IS FORGIVING—BUT ONLY WHEN FULLY INTEGRATED: Tying the wood-fiber insulation into the earlier vapor and thermal control layers required careful detailing at the sill, especially where old and new foundations meet.

CONVERSIONS OF WEAK SPACES PAY OFF: The sunporch conversion eliminated a cold, leaky space and created conditioned square footage without increasing the energy burden.

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IN THE NORTHEAST



PHOTO CREDITS: Garland Mill

CASE STUDY 5

Project Type I: Energy Retrofit with minor renovations

Intervale NEW HAMPSHIRE

2024-2025 energy retrofit of a 2-story contemporary-style 1956 Techbuilt pre-fab house

PROJECT TEAM

Designer: GARLAND MILL

Contractor: GARLAND MILL

Design/Energy Consultant: GRAPHITE STUDIO

PROJECT OVERVIEW

Introduced in 1953, the Techbuilt prefabricated house system was the result of decades of research that aimed at meeting the demand for low-cost, high-quality housing in mid-twentieth century America. This Techbuilt house was erected in 1956. When the current owners acquired it, there was little insulation and only single pane windows. When it came time to pass the house to the next generation, the owners wanted to bring the house up to today's high performance standards. The 2025 retrofits included insulation on the exterior of the roof and walls, new windows & exterior doors, new HVAC & ERV systems, and new electric appliances.



BEFORE | FRONT VIEW



BEFORE | SIDE VIEW



BEFORE | REAR VIEW



AFTER | FRONT VIEW



AFTER | SIDE VIEW



AFTER | REAR VIEW

TYPICAL WALL SECTION

- ROOF OR CEILING:**
- 4" RIGID POLYISO FOAM
 - ~R-19 EXISTING

- WALL:**
- 4" RIGID POLYISO FOAM

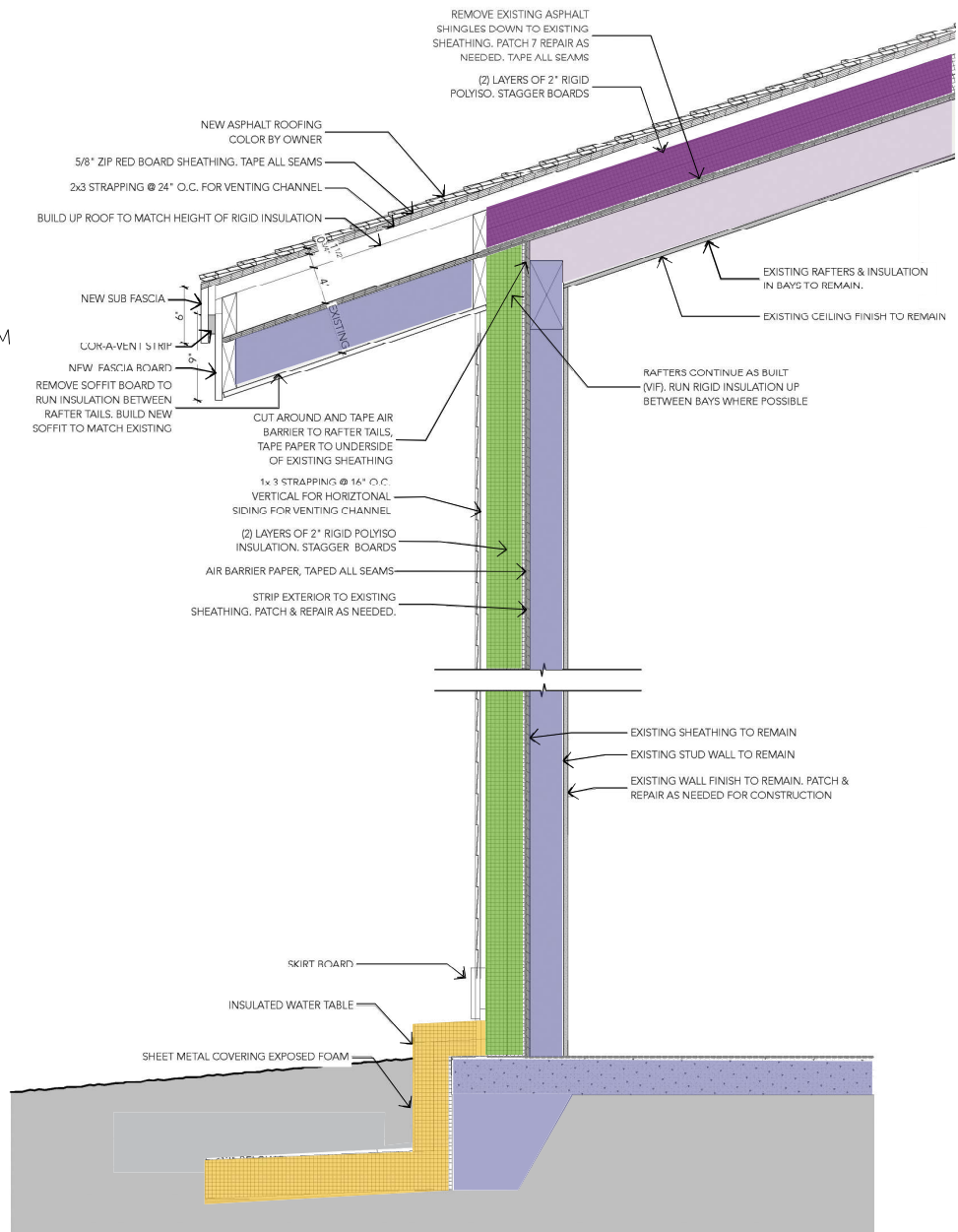
- FOUNDATION:**
- FROST PROTECTED ~R-15 FOAM

- FLOOR:**
- NO TREATMENT

- FLOOR - BELOW GRADE:**
- NO TREATMENT

EXISTING STRUCTURE

NEW STRUCTURE



PROJECT DATA SUMMARY

- 1 **LOCATION:** Intervale, NH
- 2 **IECC CLIMATE ZONE:** 6A
- 3 **YEAR BUILT:** 1956
- 4 **YEAR RENOVATED:** 2024 - 2025
- 5 **LIVING AREA:**
BEFORE: 1,850 SF AFTER: 1,850 SF
- 6 **BEDROOMS/BATHROOMS:**
BEFORE: 4 / 1.5 AFTER: 4 / 1.5
- 7 **CONSTRUCTION**
FOUNDATION: Concrete slab on grade
WALLS: Wood; 2x4 studs
ROOF: Wood; 2x4 rafters
- 8 **INSULATION**
SUBSLAB: None
FOUNDATION: Frost protected ~R-15 foam
ABOVE-GRADE WALL: ~R-26
ATTIC FLOOR/ROOF: ~R-19 existing + ~R-26 new
- 9 **WINDOWS:**
BEFORE: Single glazed
AFTER: Logic Triple glazed
- 10 **HVAC:**
BEFORE: Oil Boiler AFTER: Electric Heat Pump
- 11 **MECHANICAL VENTILATION:**
BEFORE: NONE AFTER: Broan HRV
- 12 **DOMESTIC HOT WATER:**
BEFORE: Indirect Oil AFTER: Electric Heat Pump
- 13 **PV SYSTEM CAPACITY:**
BEFORE: NONE AFTER: PV-ready
- 14 **AIR LEAKAGE:**
BEFORE: 7.7 ACH50 AFTER: 2.3 ACH50

THE BETTER FACTORS

EFFICIENCY

- Exterior insulation and air sealing reduced thermal loads before mechanicals were installed.
- High-performance windows and doors supported energy savings.
- Energy Star appliances and efficient lighting minimized operational energy.
- Solar-ready wiring future-proofs the home for renewable integration.

COMFORT

- Cold-climate heat pump with multiple small zones provided tailored comfort throughout the house.
- A heat pump water heater ensured reliable hot water without using fossil fuels.
- Balanced ventilation system (ERV) delivered continuous fresh air per code, with humidity-responsive bath fan.
- Local wall-mounted controls allowed precise occupant control.

DURABILITY

- Protected and insulated refrigerant line sets, sealed penetrations, and elevated outdoor units improve long-term durability.
- ERV mounted on vibration-isolating dampers; ducts sealed and insulated for long-term performance.
- Careful detailing around envelope penetrations prevents air and water infiltration.

AFFORDABILITY & APPROPRIATENESS

- Uses widely available, cost-effective systems (heat pumps, ERV, Energy Star appliances).
- Kitchen hood limited to <200 CFM to avoid complex makeup air requirements.
- Right-sized mechanicals and practical envelope upgrades balanced performance and cost.

SUSTAINABILITY

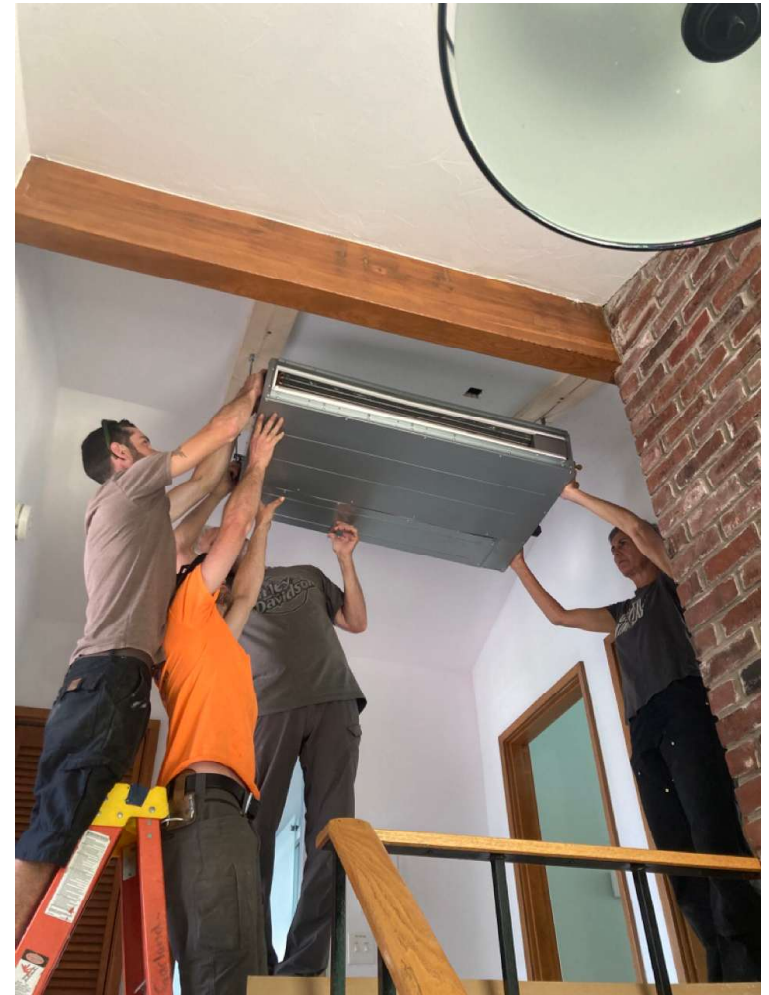
- All-electric target met: heating, water heating, cooking, and EV-ready infrastructure.
- Reduced operational energy and eliminated fossil fuels for a lower carbon footprint.
- System design allows integration of future renewable energy (solar-ready).

SAFETY & CODE COMPLIANCE

- EV-and solar-ready systems installed per the checklist, ensuring safe, future-proof infrastructure.

VERIFICATION

- Blower door testing confirmed airtightness goals.
- Commissioning reports verified refrigerant line pressurization, ERV airflow, and balanced ventilation.
- Written O&M manual and full homeowner demonstration ensured correct use and system longevity.



LESSONS LEARNED

BUILDING ENVELOPE: INSULATION, AIR SEALING, WINDOWS & DOORS

- Detailing penetrations (mechanical, electrical, EV-ready conduit, solar-ready wiring) required extra care.
- Sequencing trades to maintain continuity of insulation and air barrier took additional coordination.

MECHANICAL SYSTEMS: HEATING, COOLING, VENTILATION

- Placement of indoor heads, ERV unit, and duct runs needed early coordination with the architect.
- Ensuring refrigerant piping had no concealed joints and one-pipe/one-hole penetrations added installation complexity.
- Achieving balanced airflow at each ERV register required extra commissioning.

ELECTRICAL & APPLIANCES

- Careful electrical planning was needed to coordinate circuits, breaker space, and solar/EV readiness.
- Extra penetrations and conduit runs required careful air-sealing detailing.

SAFETY & CONTROLS

- Training homeowners on multiple systems (heat pump zones, ERV, safety devices) required extra time.

DURABILITY & RESILIENCE

- Oversight is needed to prevent hidden refrigerant joints.
- Preventing vibration transfer from ERV and ensuring proper condensate management added detailing steps.

COMMISSIONING & QUALITY CONTROL

- Commissioning and documentation added cost and time but proved essential.
- Homeowner training required multiple walkthroughs to ensure comfort with new systems.



PROJECT TEAM



BEN SOUTHWORTH
General Manager
& Designer
Garland Mill



MOLLY MALOY
Architect
& Project Manager
Garland Mill



ANDREW WEBSTER,
CPHC, AIA
Design & Energy Consulting
Graphite Studio

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IN THE NORTHEAST



PHOTO CREDITS: Graphite Studio (except where noted)

CASE STUDY 6

Project Type II: Moderate Renovations

Chesterfield
NEW HAMPSHIRE

2021-2024 “Just Enough” renovation and energy retrofit of an 1800’s one and a half story farmhouse.

PROJECT TEAM

Architect: GRAPHITE STUDIO

Contractor: JONATHAN KLEIN BUILDERS

Energy Consultant: GRAPHITE STUDIO

PROJECT OVERVIEW

The owners originally intended to build a new Passive house in southern NH as a quiet place to retire. But when an early 1800s house, right down the street from a brother, became available, they chose to bring the old home up to modern standards. The original portion (1815) had a rubble foundation and a challenging crawl space. The middle portion, of undetermined age, had a stone foundation and moderate head height, which was attached to an even newer portion (1996) with a full-height poured concrete basement. Each area had its challenges and required individual solutions. **The owners' goals were to modernize the building "just enough"... Just enough to bring down the exorbitant heating costs and address the rattling of windows... Just enough to level the kitchen floor to accept tile... but not to make it perfect.** We worked hard to solve the puzzle of how to retain the charms and history of the existing building while making it comfortable, durable, and affordable to maintain.



BEFORE | EXTERIOR FRONT



AFTER | EXTERIOR FRONT

FLOOR PLANS & IMAGES



BEFORE | KITCHEN
PHOTO CREDIT: By Realtor



BEFORE | LIVING
PHOTO CREDIT: By Realtor



AFTER | KITCHEN



AFTER | LIVING



AFTER | NOOK

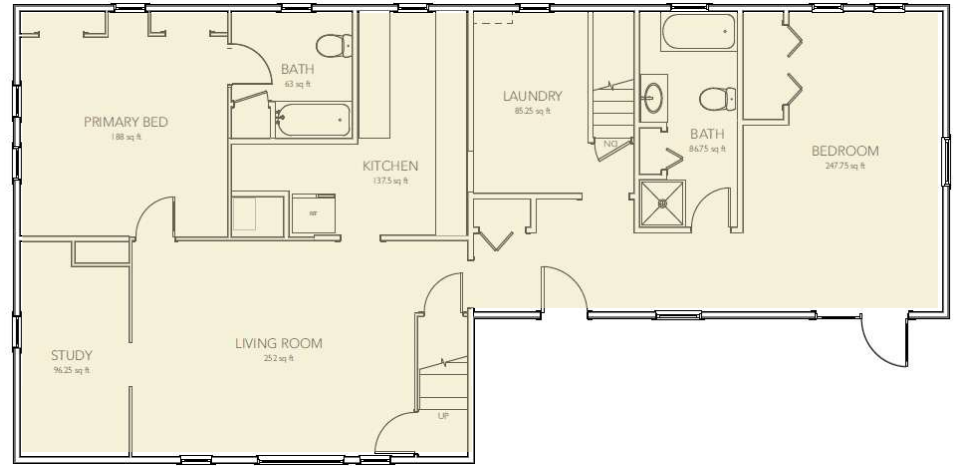


AFTER | LIVING

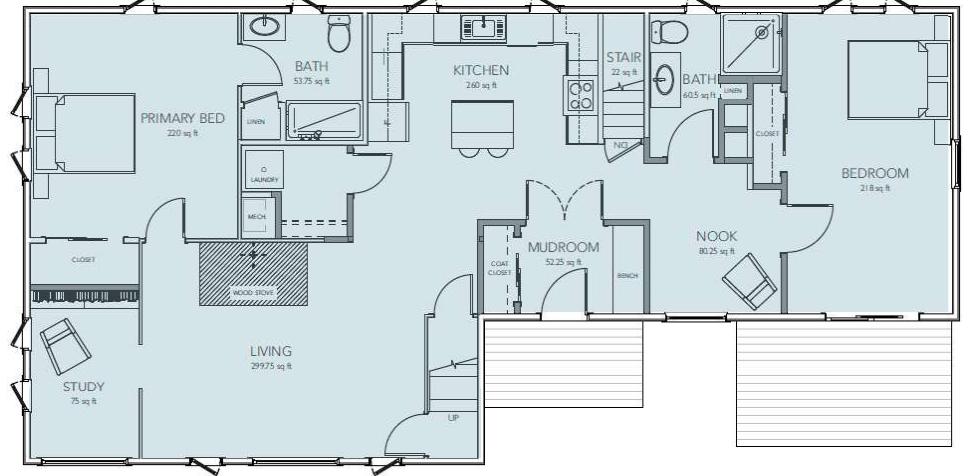


AFTER | STUDY

TOTAL SF
1,487.5 sq ft

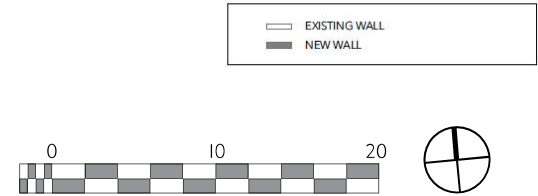


TOTAL SF
1,487.5 sq ft




1 PROPOSED FIRST FLOOR PLAN
SCALE: 1/8" = 1'-0"


- EXISTING
- RENOVATION
- NEW CONSTRUCTION





TYPICAL WALL SECTION


-  **ROOF OR CEILING:**
 - CONTINUOUS R-49 POLYISO RIGID FOAM

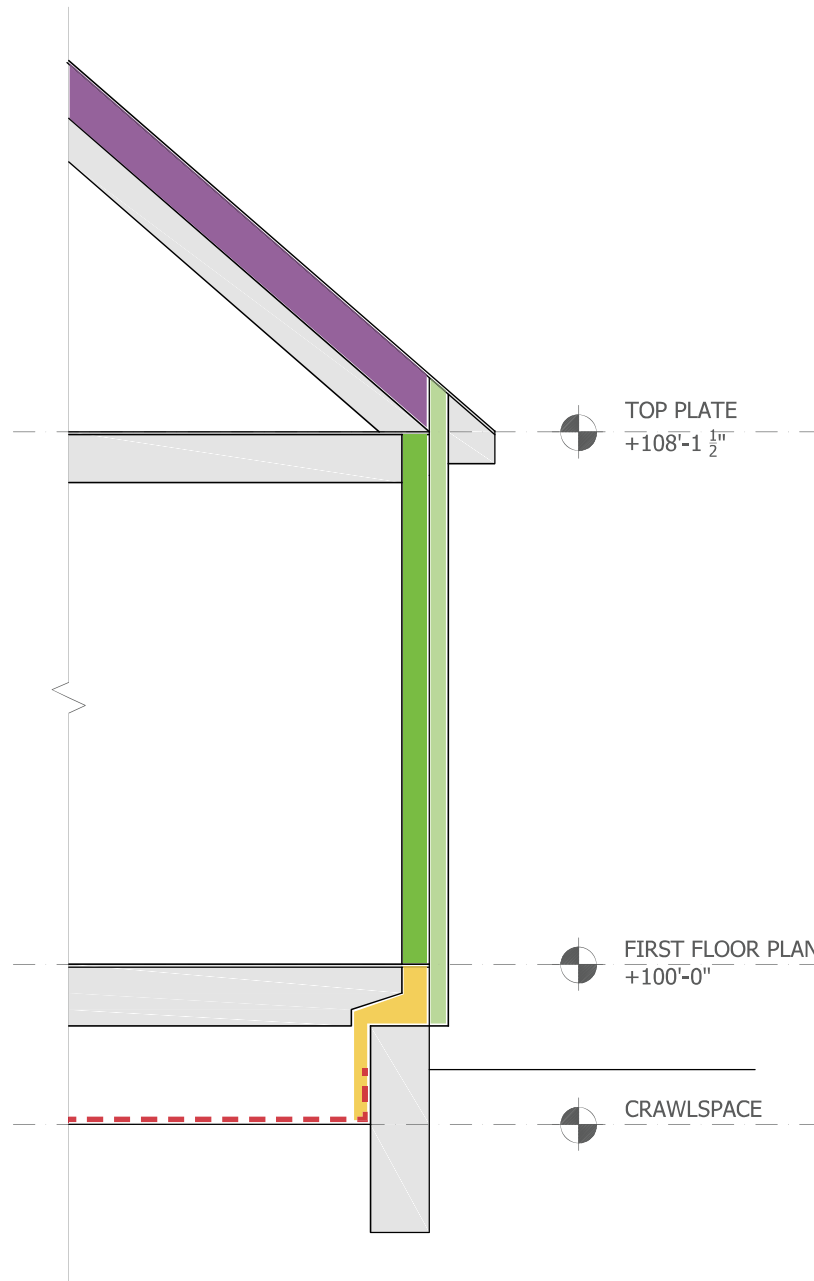
-  **WALL:**
 - CELLULOSE: R-14
 - CONTINUOUS EXTERIOR EPS FOAM: R-12

-  **FOUNDATION:**
 - CLOSED-CELL SPRAY FOAM: R-20

-  **FLOOR:**
 - 3" CLOSED-CELL FOAM ON UNDERSIDE OF FLOOR

-  **FLOOR - BELOW GRADE:**
 - POLY VAPOR BARRIER

-  **EXISTING STRUCTURE**



PROJECT DATA SUMMARY

- 1 **LOCATION:** Chesterfield, NH
- 2 **IECC CLIMATE ZONE:** 5A
- 3 **YEAR BUILT:** 1815, *Unknown** & 1996
- 4 **YEAR RENOVATED:** 2021 - 2024
- 5 **LIVING AREA:**
BEFORE: 1,478 SF AFTER: 1,478 SF
- 6 **BEDROOMS/BATHROOMS:**
BEFORE: 4 / 15 AFTER: 4 / 2
- 7 **CONSTRUCTION**
 - FOUNDATION:** Rubble - 1815
Block Stone*
Concrete- 1996
 - WALLS:** Wood; Timber frame w/4" studs
 - ROOF:** Wood; Variable size rafters
- 8 **INSULATION**
 - SUBSLAB:** None; Added poly vapor barrier
 - FOUNDATION:** R-20 Closed-cell spray foam
 - ABOVE-GRADE WALL:** R-14 Cellulose
R-12 Cont. ext. EPS foam
 - ROOF:** Cont. R-49 rigid foam
- 9 **WINDOWS:** Triple glazed - Marvin Elevate
- 10 **HVAC:**
BEFORE: Oil boiler & Pellet stove
AFTER: Electric heat pump & wood stove
- 11 **MECHANICAL VENTILATION:**
BEFORE: NONE AFTER: Panasonic ERV
- 12 **DOMESTIC HOT WATER:**
BEFORE: Indirect Oil AFTER: Electric heat pump
- 13 **PV SYSTEM CAPACITY:**
BEFORE: NONE AFTER: 9.72 kW
- 14 **AIR LEAKAGE:**
BEFORE: unknown AFTER: 2.6 ACH50

THE BETTER FACTORS

We think doing a better renovation means taking an existing home, just like this, accepting budget constraints, making plenty of compromises and creative solutions. We designed, with the owners, a complete set of compromises for the enclosure.

BELOW GRADE:

For the crawlspace, we applied closed-cell spray foam to the perimeter to keep out drafts and mice. We'd make peace with the uninsulated floor and use rugs to defend against the cold of the earth in the winter. For the half-height cellar, we'd let it be, content that the basement "blanket insulation" system and poly-covered floor were adequate. For the full-height basement, we were confident that the foamed band joist and the basement blanket would do. We had plenty of other places to spend a limited budget. The house had termites, a relative rarity in New England, so we wrapped the lower portions of the wall and sill area in bug-proof mesh and lapped it up the side before installing new insulation.

ABOVE GRADE:

We insulated the walls to the exterior with reclaimed foam over a new air barrier. Over the top of that? A simple weather resistant barrier and new clapboard siding with a rainscreen. New triple glazed windows in the old house helped control drafts and improve the thermal control throughout. A couple of big new windows capitalized on the southern sun, and made statements - in two rooms - about modern glass and expansive views. At the roof, we added control layers and rigid foam above the existing structure to create an R-49 unvented roof assembly, while leaving the existing structure largely in place.

MECHANICALS:

We added electric mini-split heat pumps (wall heads and a floor head) for heating and cooling. We provided a small Panasonic ERV for the areas accessible from the full-height basement, and a bath fan for the less accessible portions of the building. Not perfect, but a lot better than before, and just enough to keep indoor air quality high throughout. A new air source heat pump heater in the full basement also helps with limited dehumidification too.

LIVING SPACES:

All-electric appliances improved indoor air quality. The exposed beams and antique ceiling hardware were retained from the original structure. The old pellet stove was replaced with a new wood stove (perfect for two foresters with a wood lot!), which provided a central focus for the room. A bright sunny plant nook takes advantage of the same southern exposure as the study, but for the benefit of green things, not books.



LESSONS LEARNED

We were surprised by how effective the perimeter control of the crawlspace worked to keep the house warm. What had been a 10" crawlspace with mice and cold winds blowing through (to the detriment of some ducted heating...) now could be relatively easily managed, and the heating system for the old house made much more effective. The builder had done it from above - removing floor boards as required to work down from the first floor with limited spray foam to seal the exteriors and provide an insulated band joist. We recommend the narrative solution for lots of house problems, when certain areas become too costly to address, too thorny to get done to better than 85%. Incorporate them as part of the story of the house, not a problem that we didn't care to solve, but a feature we chose to live with. We didn't choose to lift the house and create a new foundation under the whole thing; we chose to honor the original, to be reminded of 1815 when the floor tends to go a little cool for that week in February. And to spend the money on a new en suite bathroom or a first floor laundry.

Design is about sifting through priorities and making good choices.

To us, better renovations and retrofits are about addressing things head on, making clear, rational decisions about what matters most, rather than trying to make everything perfect all over. Accept imperfection and embrace it, to get what you want most from a home that's all your own.



PROJECT TEAM



ANDREW WEBSTER
CPHC, AIA
Graphite Studio



JONATHAN KLEIN
Jonathan Klein Builders

A COMPENDIUM OF

BETTER RENOVATIONS & RETROFITS

IN THE NORTHEAST



PHOTO CREDITS: Jessica Van-Houten Kenny

CASE STUDY 7

Project Type III: Extensive Renovations

Stone Ridge
NEW YORK

2024 renovation of a 1840s two-story brick masonry building for an architecture & design-build office with co-working & community space.

PROJECT TEAM

Architect: NORTH RIVER ARCHITECTURE & PLANNING

Contractor: NORTH RIVER DESIGN BUILD

Energy Consultant: STEPHANIE BASSLER, FACET ARCHITECTURE

PROJECT OVERVIEW



HISTORICAL | FRONT

The Chancellor Building, as it was originally known, is a 1840s brick building that began as a dry goods store for Stone Ridge before the Civil War. It evolved for uses including a Shell gas station for the earliest Model Ts and a local law office.

In 2024, it was renovated by a Hudson Valley design-build firm using cutting-edge technology and passive house principles.

Much of the original fabric of the building, down to the worn boards in front of the original cash register, was uncovered and preserved by the North River design build team. The redesign and renovation of this local landmark reflect their appreciation of the region's history and dedication to sustainability.

The building is now a solar powered model of electrification and lower carbon footprint education for the region.



AFTER | FRONT

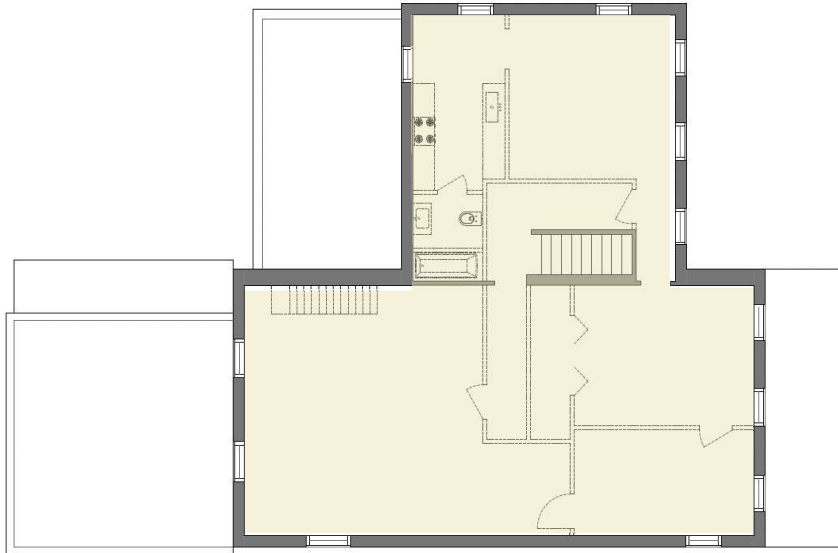


BEFORE | REAR

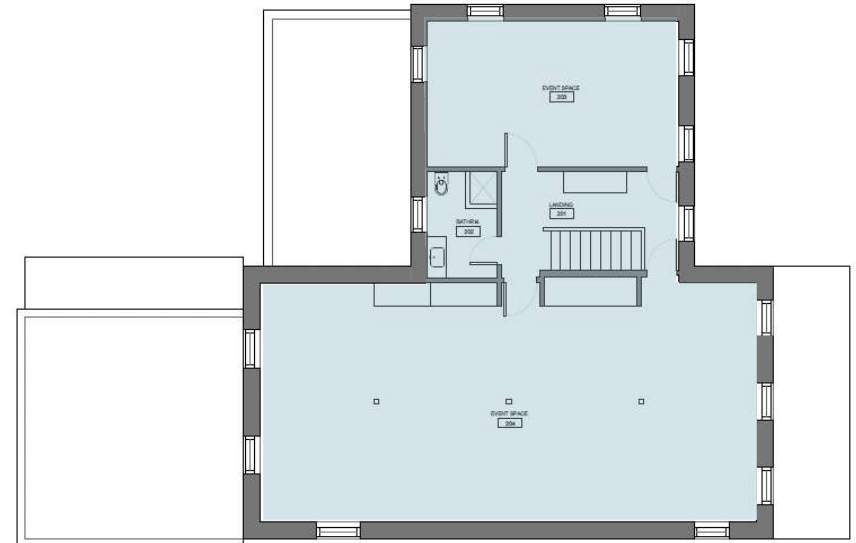


AFTER | REAR

FLOOR PLANS + IMAGES

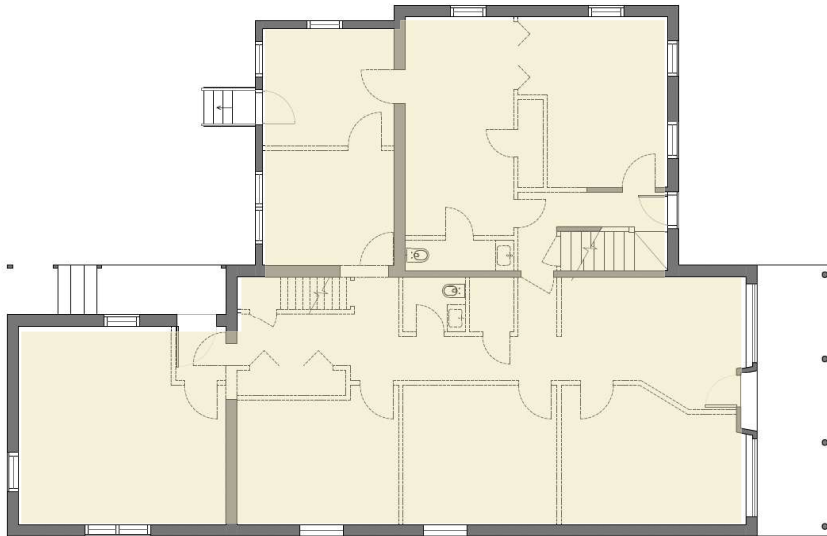
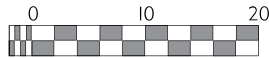


BEFORE | SECOND FLOOR PLAN



AFTER | SECOND FLOOR PLAN

- EXISTING
- RENOVATION
- NEW CONSTRUCTION





BEFORE | FIRST FLOOR PLAN





AFTER | FIRST FLOOR PLAN


TYPICAL WALL SECTION

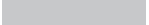
-  **ROOF OR CEILING:**
 - 10" RIGID EPS FOAM ON TOP OF ROOF DECK

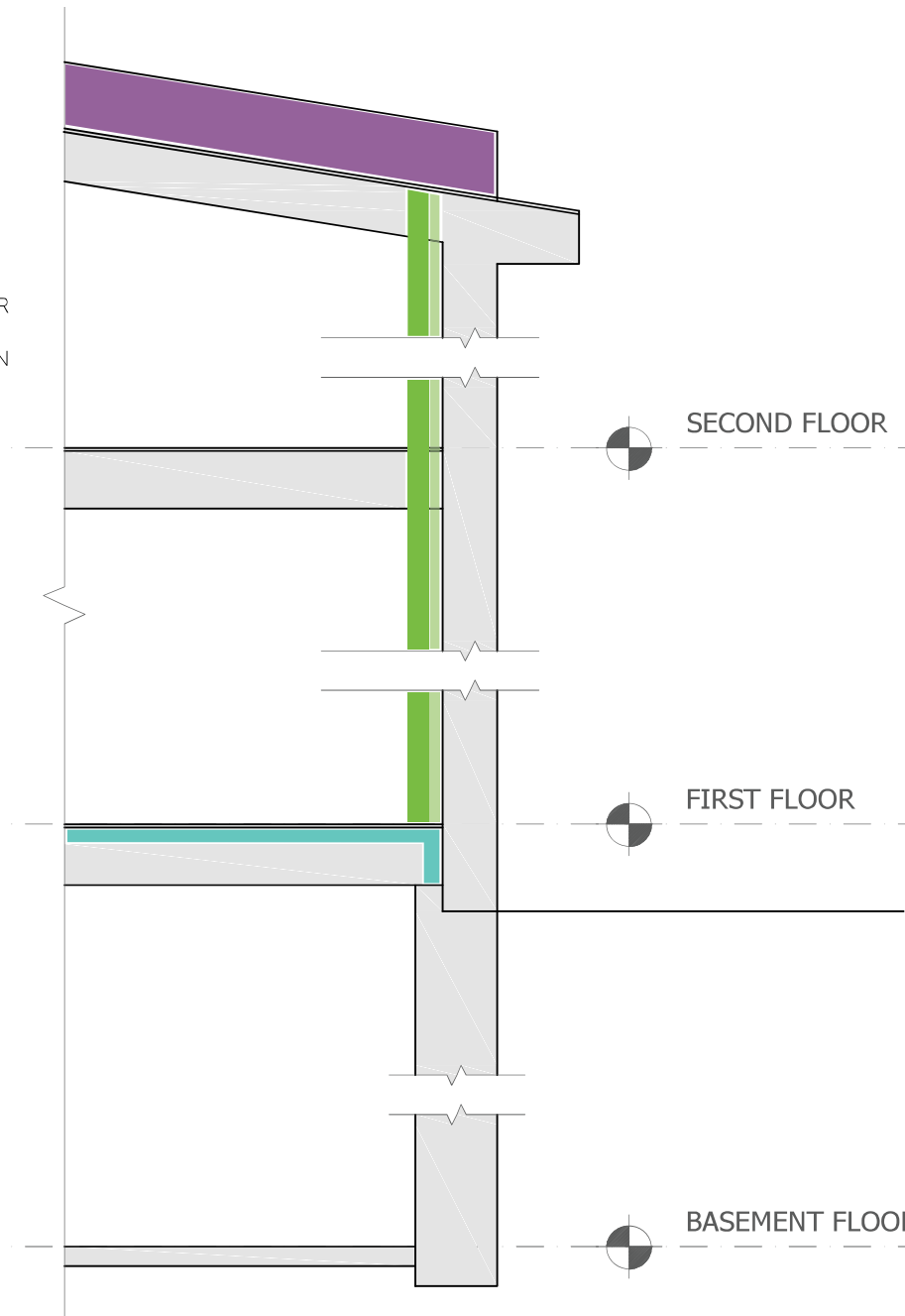
-  **WALL:**
 - 2" CLOSED-CELL SPRAY FOAM ON INTERIOR FACE OF BRICK
 - 3 1/2" DENSE-PACK CELLULOSE INSULATION IN 2X4 FRAMING CAVITY

-  **FOUNDATION:**
 - NO TREATMENT

-  **FLOOR:**
 - 3" CLOSED-CELL FOAM ON UNDERSIDE OF FLOOR

-  **FLOOR - BELOW GRADE**
 - NO TREATMENT

-  **EXISTING STRUCTURE**



PROJECT DATA SUMMARY

- 1 **LOCATION:** Stone Ridge, NY
- 2 **IECC CLIMATE ZONE:** 6B
- 3 **YEAR BUILT:** 1840s
- 4 **YEAR RENOVATED:** 2024
- 5 **LIVING AREA:**
BEFORE: 4,242 SF AFTER: 4,242 SF
- 6 **BEDROOMS-BATHROOMS:**
BEFORE: N/A - 3 AFTER: N/A - 3
- 7 **CONSTRUCTION**
FOUNDATION: Stone
WALLS: Brick
ROOF: Wood Joists & Plank
- 8 **INSULATION**
SUBSLAB: NONE
CEILING OF BASEMENT: ~R-20
FOUNDATION: NONE
ABOVE-GRADE WALL: ~R-26
ROOF: ~R-36
- 9 **WINDOWS:** Wood, Aluminum, & uPVC Triple-pane
- 10 **HVAC:**
BEFORE: Propane Boiler/Furnace
AFTER: Air source heat pump
- 11 **MECHANICAL VENTILATION:**
BEFORE: None *AFTER:* Inline ERV
- 12 **DOMESTIC HOT WATER:**
BEFORE: Propane
AFTER: Electric Heat Pump
- 13 **PV SYSTEM CAPACITY:**
BEFORE: N/A *AFTER:* 17 kW
- 14 **AIR LEAKAGE:**
BEFORE: N/A *AFTER:* N/A

THE BETTER FACTORS

Care was taken to insulate the building in a way that was both sufficient for sustainability goals and respectful of the original building. The walls were insulated as well as possible while still allowing enough heat escape in the winter to dry the brick and prevent failure of the mortar. The roof was insulated from above with EPS panels to preserve the original second floor ceiling. The first floor was insulated from below to preserve the original flooring. All building systems were replaced with new ducted electric air source heat pumps. Solar PV panels were added to the roof.

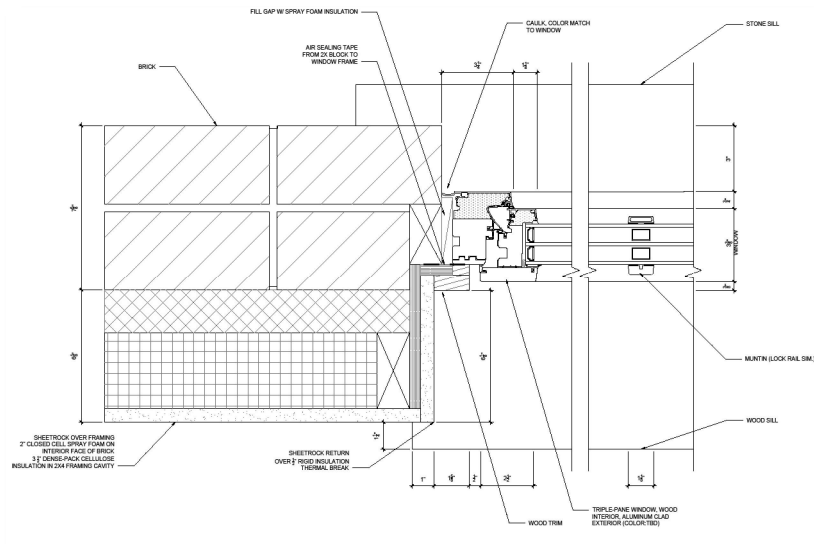


Throughout the design and build process, great lengths were taken to retain the building's original character, both on the exterior and in portions of the interior, to showcase original materials while moving into a sustainable and responsible next phase.



LESSONS LEARNED

As people walk through the building, they fall in love with the blend of respectful restoration and intentional design within a historic building. We've learned that once inside, the comfort performance and mission of the building are qualities that keep them coming back.



JAMB DETAIL | WOOD/CLAD WINDOW



PROJECT TEAM



CHRIS RUEL, AIA
Director of Architecture
North River Architecture



PETER REYNOLDS
Senior Project Development
North River Architecture



SAMANTHA ROSEMANN
Director of Operations
North River Design Build



MILES DANDREW
Director of Construction
North River Design Build

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BETTER RENOVATIONS & RETROFITS

IN THE NORTHEAST



PHOTO CREDITS: Kate Wood (except when noted)

CASE STUDY 8

Project Type III*: Extensive Renovation
of a Nationally-listed Historic House

Germantown
NEW YORK

Full renovation & addition (2017 - 2020) of a circa-1800s highly visible, but sadly neglected historic New World Dutch Vernacular house.

PROJECT TEAM

Architect/Designer: STAYTON WOOD, RA / KATE WOOD

Contractor: NORTHERN BLVD. RESTORATION

Energy Consultant: STEVEN WINTER ASSOCIATES

PROJECT OVERVIEW

This project involved the rehabilitation of a neglected but prominently sited circa-1800 “eyebrow Colonial” near Germantown’s Main Street. Long regarded by locals as “that old place by the cemetery,” the house was later recognized by the New York State Historic Preservation Office as a fine example of New World Dutch Vernacular architecture and subsequently listed on the State and National Registers of Historic Places.



BEFORE | FRONT VIEW



AFTER | FRONT VIEW
PHOTO CREDIT: Tim Hout

Building on experience from earlier preservation work, the team approached the project as both restoration and adaptation—meticulously documenting existing conditions and introducing modern systems with minimal impact on historic fabric. Original plaster, paint, and wood windows were retained wherever possible. A new standing-seam metal roof, new septic system, and discreetly integrated mechanicals brought 21st-century performance to the 200-year-old structure.

A new bedroom and bath addition, designed with clean, modern lines and modest massing, complements and defers to the historic house—creating a renewed dwelling that honors its heritage while ensuring long-term viability as an income-producing property.



BEFORE | REAR VIEW



AFTER | REAR VIEW

TYPICAL BUILDING SECTION



CEILING:

- FIBERGLASS BATTING: R-25
- VENTED ABOVE



WALL:

- 4" DENSE-PACKED CELLULOSE: R-14



FOUNDATION:

- NO TREATMENT



FLOOR:

- RIGID POLYISO FOAM: R-20



FLOOR - BELOW GRADE:

- NO TREATMENT



EXISTING STRUCTURE

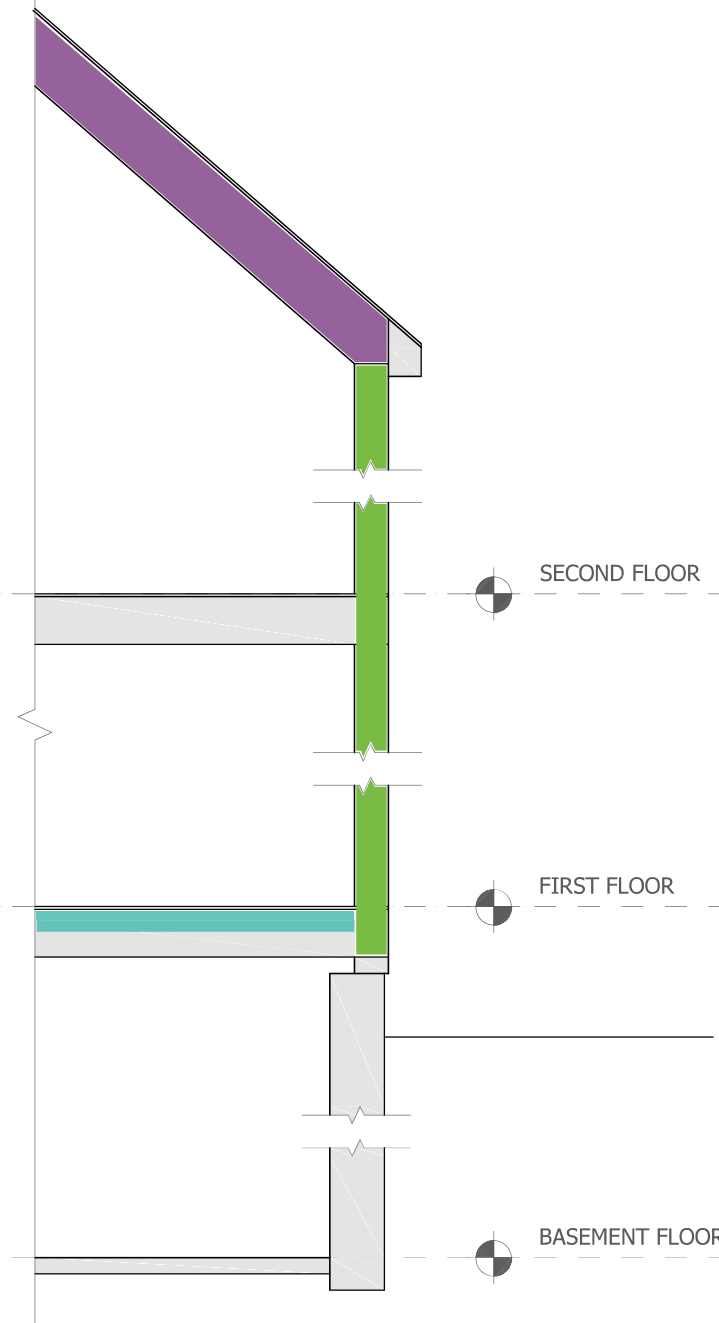


BEFORE | BEDROOM



AFTER | BEDROOM

PHOTO CREDIT: Emma McCann Zauder



PROJECT DATA SUMMARY - HOUSE

- 1 **LOCATION:** Germantown, NY
- 2 **IECC CLIMATE ZONE:** 6A
- 3 **YEAR BUILT:** Ca-1800
- 4 **YEAR RENOVATED:** 2017 - 2020
- 5 **LIVING AREA:**
BEFORE: 1,370 SF AFTER: 1,370 SF
- 6 **BEDROOMS/BATHROOMS:**
BEFORE: 2 / 1 AFTER: 2 / 2
- 7 **CONSTRUCTION**
FOUNDATION: Stone Masonry
WALLS: Wood - Timber; 4" cavity
ROOF: Wood 2x4 rafters; sistered with new 2x8s
- 8 **INSULATION**
SUBSLAB: NONE
FOUNDATION: NONE
FLOOR: Rigid Polyiso Foam
ABOVE-GRADE WALL:
Dense Packed Blown-In Cellulose
ROOF: Fiberglass Batts; vented above
- 9 **WINDOWS:**
BEFORE: Original Wood Single-Pane
AFTER: Original Wood w/ new Wood Storm Windows
- 10 **HVAC:**
BEFORE: Oil-fired boiler
AFTER: Hybrid high efficiency propane boiler & electric mini-splits
- 11 **MECHANICAL VENTILATION:**
BEFORE: NONE AFTER: NONE
- 12 **DOMESTIC HOT WATER:**
BEFORE: Indirect Oil AFTER: Electric heat pump
- 13 **PV SYSTEM CAPACITY:**
BEFORE: NONE AFTER: NONE
- 14 **AIR LEAKAGE:**
BEFORE: N/A AFTER: N/A

THE BETTER FACTORS

This project embodies the spirit of a Better Renovations & Retrofits for an historic house—one that balances energy efficiency, durability, and respect for place—without compromising its historic integrity. **Every intervention was approached with restraint and ingenuity: new mechanical systems, insulation, and a high-performance standing-seam metal roof bring 21st-century comfort and longevity. At the same time, the original plaster, windows, and finishes were carefully preserved to minimize waste and embodied carbon loss.**

- The new addition was designed for efficiency and sensitivity, using modern construction methods and durable materials that quietly support the old house rather than compete with it. The result is a thoughtful blend of preservation and performance—a house that’s not only beautiful and enduring but also energy smart.
- A drainage swale was created around the house to mitigate water in the basement.
- The first floor is heated with a new high-efficiency propane gas boiler and an electric domestic hot water heater. The second floor has wall-mounted Mitsubishi min-split HVAC units.
- We put radiant heat tubing in the ceiling of the existing basement & crawlspace. Rigid board insulation was then installed in each bay, below the tubing.
- We installed dense packed blown-in cellulose insulation through small holes in the preserved original plaster walls on the first floor. On the second floor (where we replaced non-historic drywall), we used new fiberglass batts to insulate the walls and ceiling/attic.
- Existing historic windows & front door were restored, and new wood storm windows were installed.

USED NATIONAL PARK SERVICE'S PRESERVATION BRIEFS AS A REFERENCE

3 PRESERVATION BRIEFS
Improving Energy Efficiency in Historic Buildings
Jo Ellen Hensley and Antonio Aguilar
National Park Service
U.S. Department of the Interior
Technical Preservation Services

24 PRESERVATION BRIEFS
Heating, Ventilating, and Cooling Historic Buildings: Problems and Recommended Approaches

51 PRESERVATION BRIEFS
Building Codes for Historic and Existing Buildings: Planning and Maximizing their Application
Marilyn E. Kaplan, Architect, FAAPT
National Park Service
U.S. Department of the Interior
Technical Preservation Services

Requires Minimal Alteration

- Reduce air leakage.
- Add attic insulation.
- Install storm windows.
- Insulate basements and crawlspaces.
- Seal and insulate ducts and pipes.
- Weather strip doors and add storm doors.
- Add awnings and shading devices where appropriate.

Source: National Park Service Preservation Brief #3
(Improving Energy Efficiency in Historic Buildings)

USED AN INFRARED CAMERA FOR INSULATION DIAGNOSTICS



PHOTO CREDIT: Jeff Parker

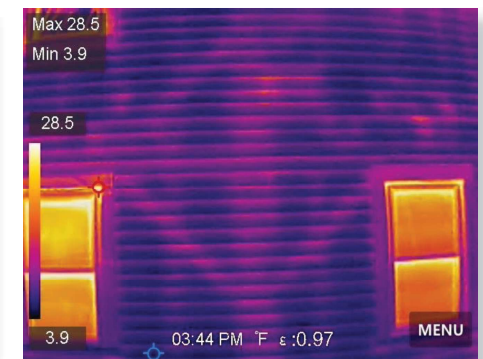


PHOTO CREDIT: Jeff Parker

LESSONS LEARNED

This is a very comfortable, low-cost house to run compared to other properties we manage that rely on oil heat. If I were to do this project over again, **I would take many more photos of the historic framing (just to remind myself now that the walls, floors, and ceilings are closed up and insulated).** I would also have selected a mini-split unit that recesses in the wall or ceiling, for aesthetic reasons.

And I have concerns now about the closed-cell spray foam we used in the addition - now might opt for something like mineral wool or wood-fiber insulation.



BEFORE | LIVING ROOM



AFTER | LIVING ROOM

PHOTO CREDIT: Emma McCann Zander

PROJECT TEAM



KATE WOOD
Historic Renovation
Specialist
Worth Preserving



STAYTON WOOD
Architect
The Dimension Group



ADAM STEENECK
Contractor
Northern Blvd. Restoration

Not pictured:

CARPENTRY: Adam Steeneck, Northern Blvd. Restoration (historic house)
Spectrum Construction & Electric (addition)

PLUMBING AND HEATING: Rich Harkins

ELECTRICAL: Ralph Hinkein

MASONRY: Greg Blum

ROOFS: Gary Arcuri, Greenport Roofing

PLASTER: Claude Carrone

STORM WINDOWS: James Romanchuk & Sons

INSULATION: Earthwise Insulation

LIGHTING: Quittner (custom), Fed-On Lights Antiques (vintage)

VINTAGE BATH FIXTURES: Zaborski Emporium, Fed-On Lights

SHOWER TILE: Heritage Tile

HARDWARE: Van Dyke's Restorers, Classic Accents

PAINTING: Millus Brothers

LANDSCAPE: Rise & Run Permaculture, Visage Construction Corporation,
Pondside Nursery

DEMOLITION AND EXCAVATION: Krapf Excavation

SEPTIC: Royal Flush

FURNISHINGS: Quittner, Richard Fitch (upholstery)

The Antiques Warehouse Hudson (among many others)

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IN THE NORTHEAST



PHOTO CREDITS: Stephen Porder

CASE STUDY 9

Project Type I: Energy Retrofit with minor renovations

Providence

RHODE ISLAND

2014 strategic upgrades & retrofits to a 2 1/2-story
1920 Colonial-style house.

PROJECT TEAM

Designer: OWNER & CONTRACTOR

Contractor: CALDWELL & JOHNSON

Energy Consultant: OWNER

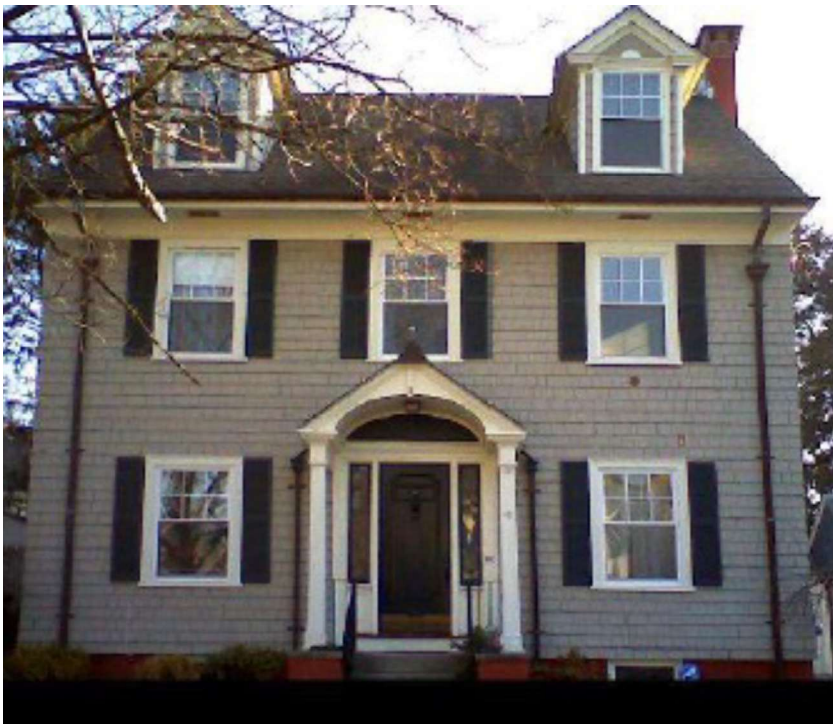
PROJECT OVERVIEW

This renovation demonstrates how a typical older Rhode Island home can dramatically reduce energy use and emissions through strategic insulation upgrades, air-sealing, and a full transition to all-electric heating, cooling, and hot water systems. By electrifying the home and improving its enclosure, the project cuts operating costs in half and emissions by nearly 75%.

illustrating the compounding impact of many small, well-executed improvements.

This project began with a common Northeast condition: an under-insulated, air-leaky, oil-heated house with aging replacement windows and uneven comfort across rooms. The homeowner, an ecologist deeply engaged with climate and sustainability, set out to understand what it would take to convert an average older home into an all-electric, lower-carbon, and more comfortable residence. The approach emphasized cost-effective upgrades that deliver measurable performance improvements—without requiring a full gut renovation.

The retrofit unfolded in two major phases. First came enclosure improvements: targeted air-sealing, upgraded wall, roof, and basement insulation, and a focus on bringing the building envelope closer to modern energy-code performance. With this thermal foundation in place, the fossil-fuel systems were removed and replaced with ductless heat pumps for heating and cooling and a heat-pump water heater for domestic hot water. The result is a home that operates for significantly less money, delivers consistent comfort in every season, and emits roughly one-quarter of the greenhouse gases it once did—demonstrating that incremental, well-chosen upgrades can add up to transformative change.



BEFORE | FRONT VIEW



AFTER | FRONT VIEW

TYPICAL WALL SECTION



ROOF OR CEILING:

- 9" CLOSED-CELL SPRAY FOAM



WALL:

- 3 1/2" CELLULOSE - DENSE-PACK INSULATION
- 1 1/2" CONTINUOUS EXTERIOR RIGID INSULATION



FOUNDATION:

- 5 1/2" MINERAL WOOL @WALL BELOW GRADE
- 3" CLOSED-CELL FOAM ABOVE GRADE



FLOOR:

- NO TREATMENT

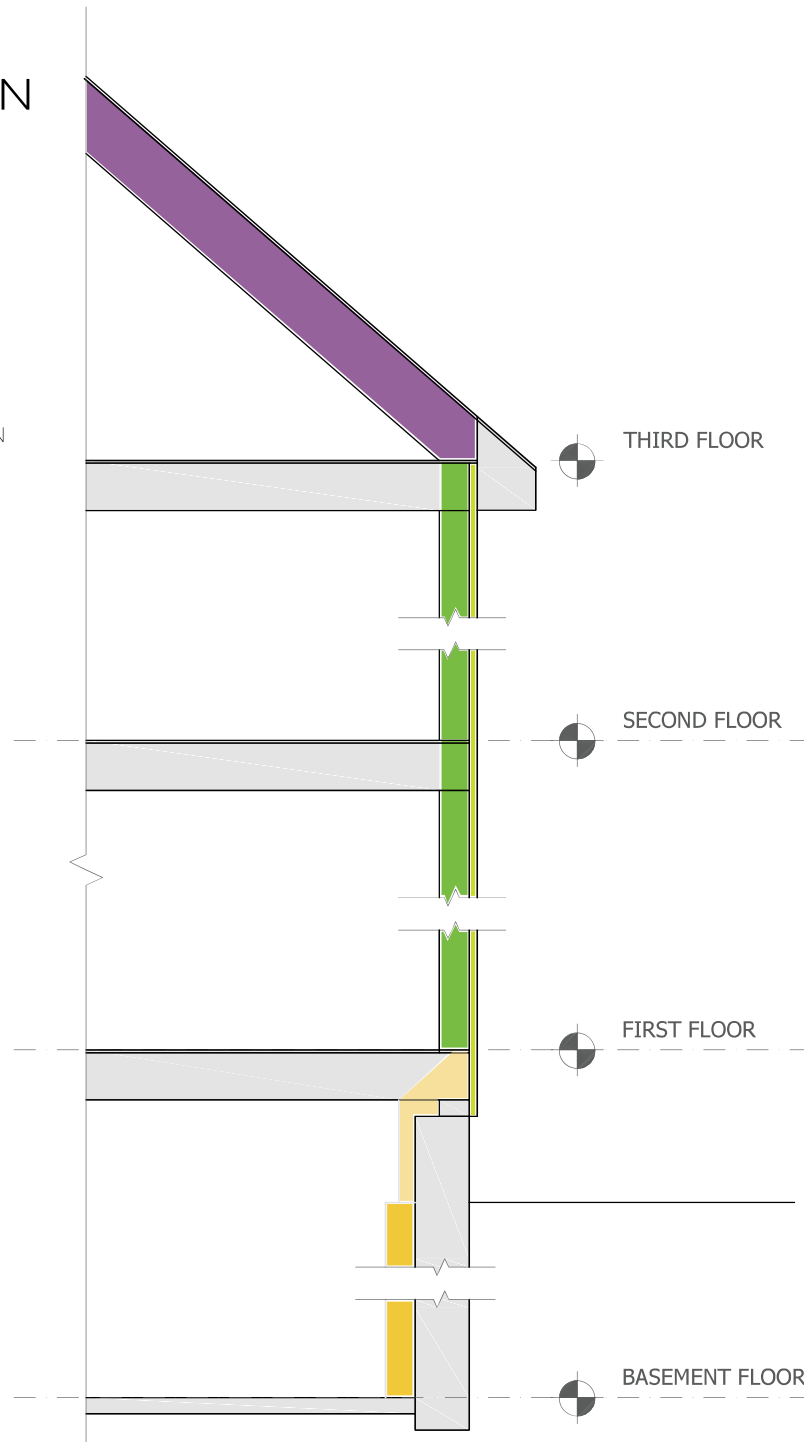


FLOOR - BELOW GRADE:

- NO TREATMENT



EXISTING STRUCTURE



PROJECT DATA SUMMARY

- 1 **LOCATION:** Providence, RI
- 2 **IECC CLIMATE ZONE:** 5A
- 3 **YEAR BUILT:** 1920
- 4 **YEAR RENOVATED:** 2014
- 5 **LIVING AREA:**
BEFORE: 2,500+/- SF AFTER: 2,500+/- SF
- 6 **BEDROOMS/BATHROOMS:**
BEFORE: 5 / 3.5 AFTER: 5 / 3.5
- 7 **CONSTRUCTION**
FOUNDATION: Masonry
WALLS: Wood; 2x4 studs
ROOF: Wood; 2x10 rafters
- 8 **INSULATION**
SUBSLAB: None
FOUNDATION: ~R-20
EXTERIOR WALLS (above grade): ~R-20
ROOF: ~R-60
- 9 **WINDOWS:**
BEFORE: Vinyl Replacements
AFTER: No change
- 10 **HVAC:**
BEFORE: Oil-fired steam (heat only)
AFTER: Electric ductless mini-split heat pumps (heating + cooling)
- 11 **MECHANICAL VENTILATION:**
BEFORE: None
AFTER: HRV for 2nd & 3rd floors
- 12 **DOMESTIC HOT WATER:**
BEFORE: Indirect Oil
AFTER: Electric heat pump
- 13 **PV SYSTEM CAPACITY:**
BEFORE: None AFTER: 10.7 kW
- 14 **AIR LEAKAGE:**
BEFORE: 8.6 ACH50 AFTER: 2.9 ACH50

THE BETTER FACTORS

ELECTRIFICATION ALIGNED WITH ENVELOPE IMPROVEMENTS rather than swapping equipment without addressing heat loss.

SIGNIFICANT AIR-SEALING AND INSULATION UPGRADES that bring an older home toward modern performance standards.

HEAT PUMPS CHOSEN FOR BOTH HEATING AND COOLING, reducing operating costs and carbon emissions simultaneously.

OIL AND COMBUSTION FULLY REMOVED, improving health, safety, and indoor air quality.

FUTURE-PROOFED FOR PV AND GRID DECARBONIZATION—the home will get “cleaner” over time without further major interventions.

PRIORITIZATION OF COMFORT AND USABILITY in real lived spaces—consistent temperatures, improved AC distribution, and quieter operation.

A PRAGMATIC, COST-AWARE RETROFIT APPROACH that can be replicated across similar homes in the Northeast.



BEFORE | THIRD FLOOR



AFTER | THIRD FLOOR

LESSONS LEARNED

THE GOAL IS TO ELECTRIFY EVERYTHING.

ADDRESS THE ENVELOPE FIRST. If cost is an issue, insulation & air sealing upgrades should be made only to the point where full electrification is feasible. Good enough is good enough.

INCREMENTAL UPGRADES CAN BE STRATEGIC. Not every old house requires a deep energy retrofit. Targeted improvements can move a home significantly toward net-zero readiness.

HEAT PUMPS ARE A GAME-CHANGER IN OLDER HOMES. Eliminating combustion equipment delivered quieter, more comfortable rooms and eliminated oil deliveries, odors, and maintenance.

DON'T LET “PERFECT” DELAY “BETTER.” The renovation didn't exceed modern code on every surface, yet it still achieved major reductions in operating costs and emissions.

ALL-ELECTRIC SYSTEMS SIMPLIFY LIFE. Fewer mechanical components, no combustion safety issues, and predictably cleaner energy every year as the grid decarbonizes.

PROJECT TEAM



DAVID CALDWELL
Caldwell & Johnson
Custom Builders



STEPHEN PORDER
Homeowner &
Ecology Professor

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BETTER RENOVATIONS & RETROFITS

IN THE NORTHEAST



PHOTO CREDITS: Laurel Green

CASE STUDY 10

Project Type II: Moderate Renovations

Bellows Falls
VERMONT

Do-it-yourself 2019 - 2021 near Net-Zero renovation of a severely deteriorated 1850s wood-framed home with Victorian Second Empire details.

PROJECT TEAM

Designer: LAUREL GREEN & STEVE CROFTER (*homeowners*)

Contractor: LAUREL GREEN & STEVE CROFTER (*homeowners*)

Energy Consultant: EFFICIENCY VERMONT & ZERO ENERGY NOW

PROJECT OVERVIEW

Laurel Green and Steve Crofter set out to create a home that aligned with their climate values—reducing emissions, using carbon-sequestering materials, and lowering their overall footprint. After searching for a walkable site in Bellows Falls with strong solar access, they purchased a deteriorated salvage house in 2019, they converted the entire lawn area into 14 productive garden beds that also help manage stormwater.

Working with Efficiency Vermont and the ZEN (Zero Energy Now) program, they pursued a deep energy retrofit focused on reusing materials, transitioning entirely to electric systems, and achieving a net zero target. Challenges included rotted sills, water intrusion, and a failing roof. These were resolved through foundation repairs, exterior drainage, a perimeter drain with a sump pump, water barriers, and closed-cell foam insulation (R-30 above grade, R-22 below grade).

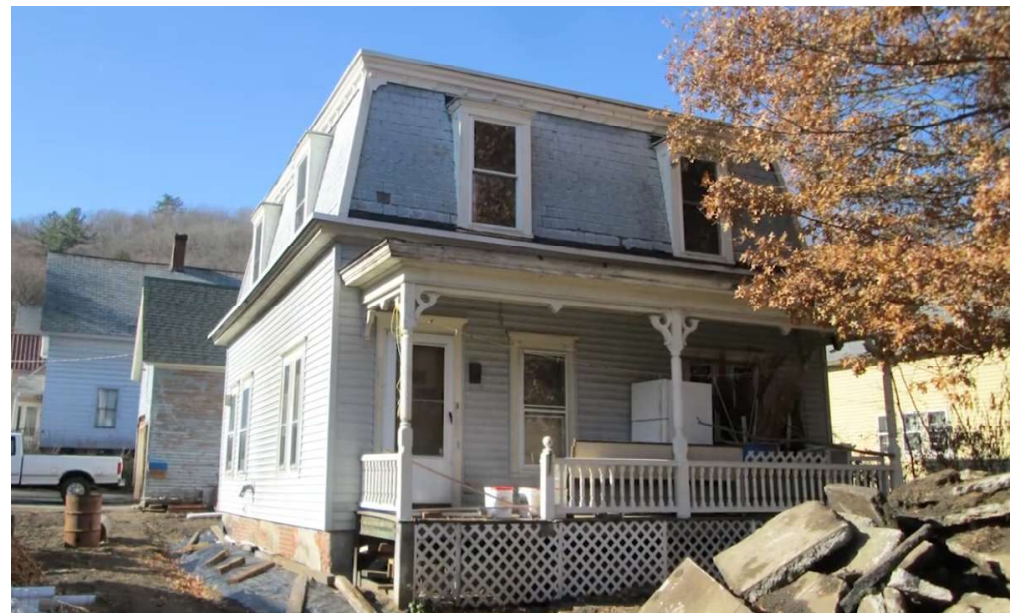
The envelope was rebuilt with 2.5" polyiso and 8.5" dense-pack cellulose (R-40 walls), a lowered second-floor ceiling allowed R-68.5 cellulose at the roof, and AeroBarrier sealing reduced the air leakage to 2.0–2.25 ACH50. First-floor windows were upgraded to fixed triple-pane units. Mechanical systems now include three Mitsubishi heat pumps, a RenewAire ERV, a heat pump water heater, and an induction range. A 7.36 kW rooftop PV system generates roughly 8,500 kWh/year—enough to power the home and charge their electric vehicle.

The couple reused structural lumber, prioritized low-embodied-carbon materials, and redesigned the interior for aging in place.

Completed in 2021, the project resulted in a resilient, all-electric, near net-zero home deeply aligned with their environmental and community values.

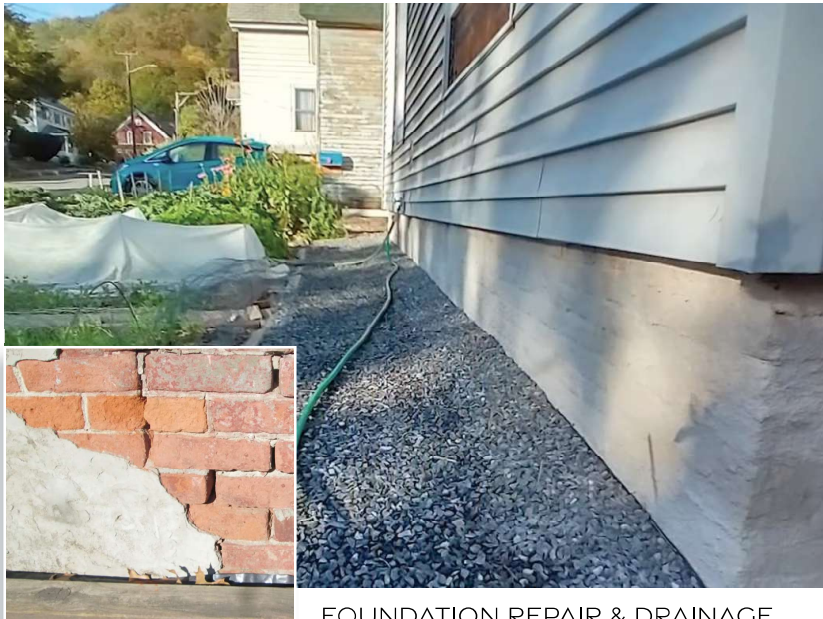


BEFORE | SIDE VIEW



BEFORE | FRONT VIEW

PROGRESS PHOTOS & IMPROVEMENTS



FOUNDATION REPAIR & DRAINAGE



SITE CLEANED & SOIL QUALITY IMPROVED



ELIMINATION OF ALL ON-SITE COMBUSTION

ROOF / CEILING:

- CEILING LOWERED TO CREATE INSULATION CAVITY
- FILLED WITH ~R-68 CELLULOSE
- VENTILATION AIRSPACE WITH SCREENED OPENING @TOP

ABOVE-GRADE WALLS:

- 2.5" POLYISO FOAM
- 8.5" DENSE-PACK CELLULOSE
- EXISTING SHEATHING
- APPROX. 12" TOTAL THICKNESS & R-40
- AEROBARRIER AIR SEALING --> 2.0-2.25 ACH50

BASEMENT:

- PERIMETER DRAIN TO SUMP
- WATERPROOF MEMBRANE ON BASEMENT FLOOR & CRAWLSPACE FLOORS
- CLOSED-CELL FOAM ON WALLS: R-30 ABOVE GRADE / R-22 BELOW GRADE

SUB-SLAB / GROUND CONTROL:

- PERIMETER DRAIN --> SUMP
- WATER-RESISTANT BARRIER (CRAWL/ BASEMENT FLOOR)
- MOISTURE + AIR CONTROL FOUNDATIONAL WORK

EXTERIOR:

- REPAIRED BRICK FOUNDATION & APPLIED PARGE COAT
- BELOW GRADE HORIZONTAL RUBBER MEMBRANE PITCHED 1"/FT
- GRAVEL TOP LAYER

TYPICAL WALL SECTION

ROOF OR CEILING:

- 20" CELLULOSE & VENTILATION AIRSPACE

WALL:

- 2.5" POLYISO
- 8.5" DENSEPACK CELLULOSE

FOUNDATION:

- R-30: CLOSED-CELL FOAM
- R-22: CLOSED-CELL FOAM

FLOOR:

- NO TREATMENT

FLOOR - BELOW GRADE:

- RUBBER MEMBRANE & GRAVEL

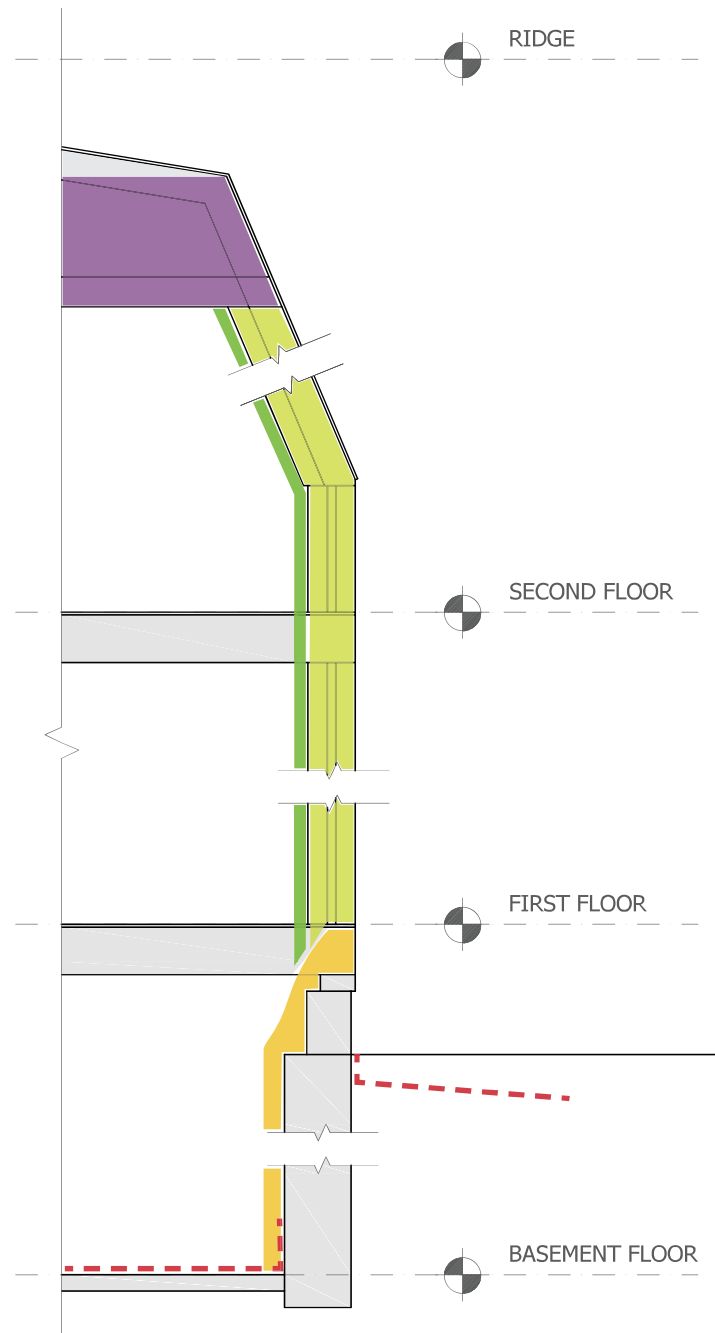
EXISTING STRUCTURE



Window Dressers

COMMUNITY MEMBERS BUILD AFFORDABLE, INSULATING WINDOW INSERTS

INSULATING WINDOW INSERTS
windowdressers.org



PROJECT DATA SUMMARY

- 1 **LOCATION:** Bellows Falls, VT
- 2 **IECC CLIMATE ZONE:** 6A
- 3 **YEAR BUILT:** 1850's
- 4 **YEAR RENOVATED:** 2019 - 2021
- 5 **LIVING AREA:**
BEFORE: 1,424 SF AFTER: 1,424 SF
- 6 **BEDROOMS/BATHROOMS:**
BEFORE: 3 / 2 AFTER: 3 / 2
- 7 **CONSTRUCTION**
FOUNDATION: fieldstone & brick
WALLS: wood; 2x4 studs
ROOF: wood; 2x8 rafters
- 8 **INSULATION**
BASEMENT FLOOR: rubber membrane & gravel
FOUNDATION: closed-cell foam;
R-30 above grade / R-22 below grade
ABOVE-GRADE WALL: R-40
2.5" polyiso / 8.5" densepack cellulose
ATTIC FLOOR/ROOF: R-68.5
cellulose & ventilation airspace
- 9 **WINDOWS:**
BEFORE: Original wood double hung
AFTER: Triple glazed - Mathews Brothers
- 10 **HVAC:**
BEFORE: Oil boiler & pellet stove
AFTER: (4) Mitsubishi single-zone cold climate HP
- 11 **MECHANICAL VENTILATION:**
BEFORE: none AFTER: RenewAire ERV
- 12 **DOMESTIC HOT WATER:**
BEFORE: No functional system
AFTER: Electric heat pump
- 13 **PV SYSTEM CAPACITY:**
BEFORE: none AFTER: 10.44 kW
- 14 **AIR LEAKAGE:**
BEFORE: not measurable
AFTER: 2.0 - 2.25 ACH50

THE BETTER FACTORS

SEAL FIRST, SAVE FOREVER: Comprehensive air-sealing and high-R insulation brought a severely deteriorated 19th-century house up to near-modern performance standards.

ELECTRIFY WHAT MATTERS: A fully electric system. Four cold-climate heat pumps, ERV, and heat-pump water heater eliminated all on-site combustion.

HEALTH STARTS AT ZERO OIL: Removal of the oil boiler, pellet stove, and chimneys improved indoor air quality, safety, and overall building durability.

COMFORT BY DESIGN: Thickened R-40 walls and an R-68.5 roof created stable, comfortable interior temperatures year-round.

AIRTIGHTNESS YOU CAN MEASURE: AeroBarrier reduced leakage by 58%, lowering heating demand and operating costs.

POWERED BY THE SUN, CLEANER EVERY YEAR: A 7.36 kW PV array enables the home to produce its own energy and benefit from grid decarbonization over time.

LOW-CARBON FROM THE INSIDE OUT: Dense-pack cellulose, reused structural lumber, and local pine kept embodied carbon low.

LIFESTYLE AS CLIMATE ACTION: A walkable location, EV charging, and 14 food-producing garden beds compound carbon reductions beyond the envelope.

A MODEL OTHERS CAN FOLLOW: A practical, self-performed, replicable retrofit showing what's possible with committed homeowners and targeted incentives.

LESSONS LEARNED

WATER WINS FIRST: Drainage improvements, foundation repair, and moisture control must precede all envelope upgrades.

REDUCING SPACE IMPROVES PERFORMANCE: Lowering ceilings in an attic-less home made room for higher-R roof insulation.

AIR SEALING THAT SHOWS IT WORKS: AeroBarrier delivered significant, verifiable airtightness gains in an irregular building shell.

FEWER WINDOWS, BETTER PERFORMANCE: Removing unneeded north-facing windows improved efficiency without reducing livability.

REUSE IS A RESOURCE: Reusing lumber and selectively removing hazardous materials managed costs and embodied carbon.

DESIGN FOR TOMORROW TODAY: Early planning for aging in place avoids future alterations and supports long-term occupancy.

STAY THE COURSE: A staged, owner-driven approach succeeded because priorities—dryness, airtightness, insulation, electrification, renewables—remained clear.

NET ZERO IS WITHIN REACH: With aligned envelope upgrades, mechanical systems, and daily practices, older homes can achieve net-zero performance.

PROJECT TEAM



LAUREL GREEN & STEVE CROFTER
Homeowners / Designers / Builders

A COMPENDIUM OF

BETTER RENOVATIONS & RETROFITS

IN THE NORTHEAST

CASE STUDY 11

Project Type I: Energy Retrofit

Montpelier
VERMONT

2021 deep weatherization and electrification project of a 1940s Cape-Style home.

PROJECT TEAM

Designer: NEW FRAMEWORKS & ENERGY BALANCE

Contractor: NEW FRAMEWORKS

Energy Consultant: ENERGY BALANCE



PHOTO CREDITS: Mike Xenakis

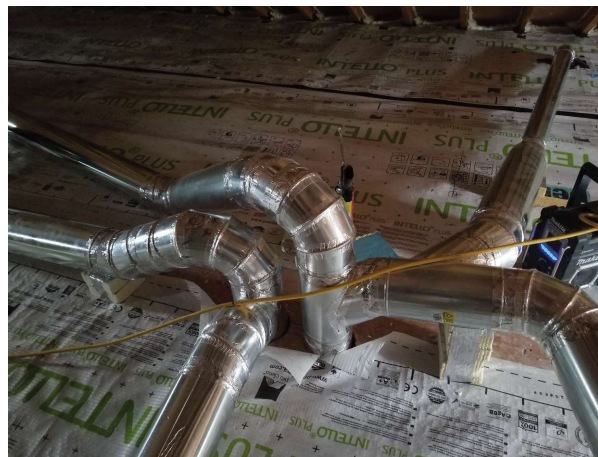
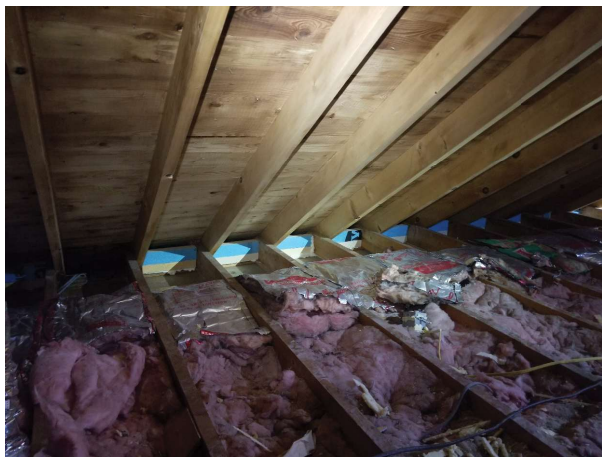
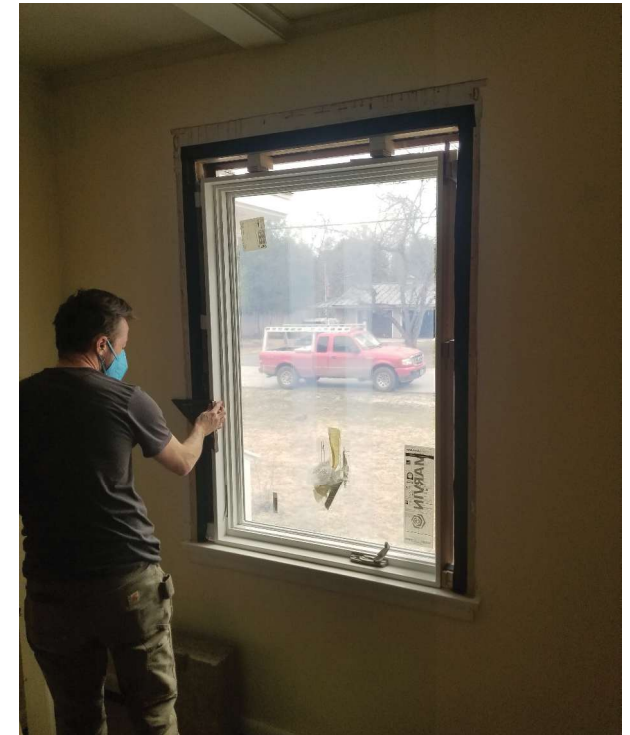
PROJECT OVERVIEW

This retrofit exemplifies how “bread and butter” work—attics, basements, crawlspaces, and mechanical systems—can dramatically transform a mid-century home’s performance without invasive enclosure

rebuids. Guided by tight budgets and a desire to reduce greenhouse gas emissions meaningfully, the team focused on air sealing, moisture management, and strategic electrification, supported by modeling and a whole-house planning approach.

The project addressed multiple long-standing issues: uncontrolled air pathways from the basement and crawlspace, inadequate attic insulation, failing ventilation, and aging mechanicals. Emergent conditions—including rot repair, exterior drainage improvements, vermiculite & asbestos tile remediation—were resolved to create a dry, clean, and safe structure for the performance upgrades that followed.

With a new ERV, a ducted heat pump, and fully sealed and insulated lower assemblies, the house now performs reliably in Vermont’s cold climate. The final blower-door result—under 2.0 ACH50, a 70%+ reduction—demonstrates what’s possible with careful sequencing, experienced trade partners, and a focus on fundamentals rather than wholesale enclosure replacement.



TYPICAL WALL SECTION

- ROOF OR CEILING:**
- CORBELLED PIECES OF 2" SCRAP FOAM
 - 22" LOOSE-FILL CELLULOSE
 - INSULATION BAFFLE

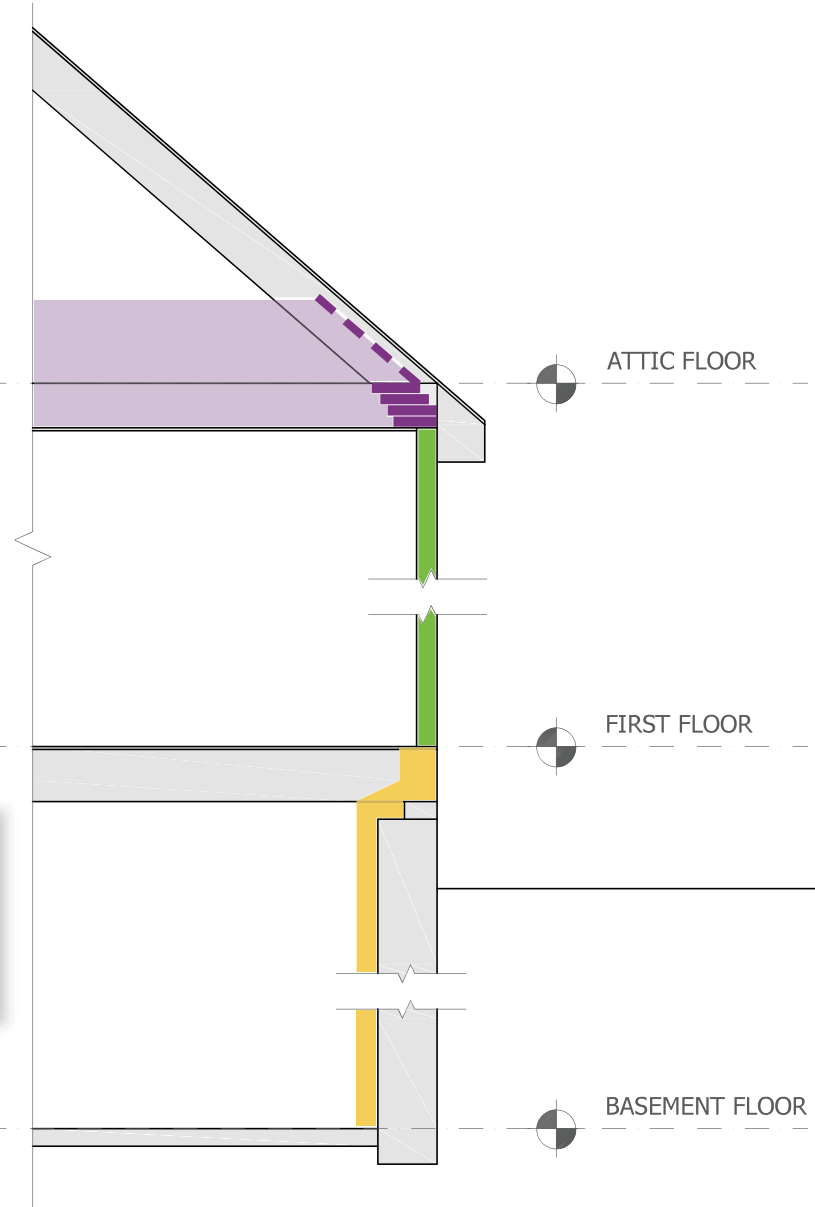
- WALL:**
- ~R-12 EXISTING

- FOUNDATION:**
- 4" FOIL-FACED POLYISO FOAM BOARD

- FLOOR:**
- NO TREATMENT

- FLOOR - BELOW GRADE**
- NO TREATMENT

EXISTING STRUCTURE



PROJECT DATA SUMMARY

- LOCATION:** Montpelier, VT
- IECC CLIMATE ZONE:** 6A
- YEAR BUILT:** 1940s
- YEAR RENOVATED:** 2019 - 2021
- LIVING AREA:**
BEFORE: 1,489 SF AFTER: 1,489 SF
- BEDROOMS/BATHROOMS:**
BEFORE: 2 / 1 AFTER: 2 / 1
- CONSTRUCTION**
FOUNDATION: Concrete
WALLS: Wood; 2x4 studs
ROOF: Wood; 2x8 studs
- INSULATION**
SUBSLAB: None
FOUNDATION: ~R-26
ABOVE-GRADE WALL: ~R-12 (existing)
ATTIC FLOOR/ROOF: ~R-80
- WINDOWS:**
BEFORE: Double pane replacement
AFTER: Marvin Elevate where needed
- HVAC:**
BEFORE: Oil fired boiler
AFTER: Mitsubishi ducted electric air source heat pump with oil-fired boiler back-up
- MECHANICAL VENTILATION:**
BEFORE: NONE AFTER: Broan ERV
- DOMESTIC HOT WATER:**
BEFORE: Indirect Oil
AFTER: Electric heat pump
- PV SYSTEM CAPACITY:**
BEFORE: NONE AFTER: PV ready
- AIR LEAKAGE:**
BEFORE: 7.6 ACH50 AFTER: 2.0 ACH50

THE BETTER FACTORS

SAFETY & IAQ PRIORITIZED. Vermiculite, asbestos tile, and moisture risks were eliminated before mechanical upgrades.

DO THE UNGLAMOROUS PARTS FIRST. Basement, crawlspace, and attic work created a stable, dry, and airtight enclosure.

ELECTRIFICATION PAIRED WITH ENCLOSURE IMPROVEMENTS. Ducted heat pump and ERV were installed after air sealing and moisture management, ensuring durability and performance.

CARBON-CONSCIOUS SEQUENCING. The project avoids unnecessary demolition by strategically improving what mattered most.

EXCEPTIONAL RESULTS FROM TARGETED WORK. A 70%+ air-leakage reduction without invasive wall gutting demonstrates true efficiency both in cost and carbon.

HOLISTIC AND INCREMENTAL. This is the Pretty Good House ethos: sensible, durable, climate-appropriate upgrades that balance cost, comfort, and carbon impact.

LESSONS LEARNED

ADDRESSING LOWER-LEVEL AIR PATHWAYS YIELDS BIG RETURNS. Air sealing basements, crawlspaces, and rim joists fundamentally reshaped the house's performance.

EMERGENT CONDITIONS ARE INEVITABLE—AND CRITICAL TO FIX. Rot, drainage failures, vermiculite, and asbestos remediation were necessary to ensure long-term durability and occupant health.

BUDGETS STRETCH FURTHER WHEN WALLS STAY CLOSED. Achieving sub-2.0 ACH50 without touching walls demonstrates the power of prioritizing basements, attics, and mechanicals.

MECHANICAL UPGRADES MUST BE PAIRED WITH ENCLOSURE WORK. The ducted heat pump and ERV system perform effectively because the house now aligns with their operating needs.

RELATIONSHIP-DRIVEN TEAMS DELIVER BEST ON COMPLEX SCOPES. The project benefited from tight coordination and an experienced crew capable of handling both planned and emergent work.

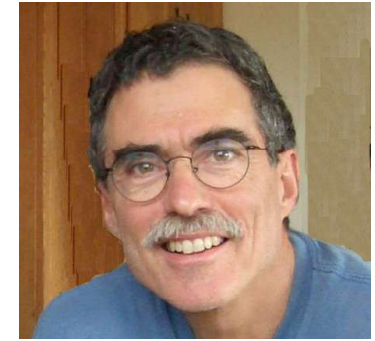
PROJECT TEAM



MIKE XENAKIS
Building Performance
Lead
New Frameworks



JACOB DEVA RACUSIN
Co-Founder, Director of
Sustainability & Building
Science Lead
New Frameworks



ANDY SHAPIRO
Energy Engineer
Energy Balance, Inc.

Not pictured...

CONSTRUCTION:

New Frameworks - *Mike Xenakis, Jackson Mills, Ben Graham, Lily Hammerling, Toño, José, Nacho, Eve, David Runge*
Fly Catcher Farm - *Aeden Scribner*

MANAGEMENT:

HELM - *Sabrina Carpenter*
New Frameworks - *Ace McArleton, Mike Xenakis*

DESIGN:

New Frameworks - *Jacob Deva Racusin, Mike Xenakis*
Energy Balance - *Andy Shapiro*

CONSULTING: Energy Balance - *Andy Shapiro*

ELECTRICAL: Summit Electric - *Jacob Gouge*

PLUMBING: Moorby Plumbing and Heating - *Cam Moorby*

MECHANICALS:

New Frameworks - *distribution*
Vermont Energy - *unit install and controls*

REMEDICATION: *Clay Point & Catamount Environmental*

A COMPENDIUM OF

BETTER RENOVATIONS & RETROFITS

IN THE NORTHEAST



PHOTO CREDITS: Will Russell

CASE STUDY 12

Project Type III: Extensive Renovations & Additions

Dorset
VERMONT

2018 - 2024 wildfire resistant deep energy renovation of a derelict 1860s farmhouse.

PROJECT TEAM

Architect: SUSTAINABLE DESIGN

Contractor: JAMES DYKSTRA

Energy Consultant: SUSTAINABLE DESIGN

PROJECT OVERVIEW

This case study explores the deep energy retrofit of an 1860s Vermont farmhouse, undertaken by Alan and Nancy Benoit of Sustainable Design in Dorset, VT. Once vacant and deteriorating, the house was transformed into a combined residence and office through a phased, five-year process, that included moving the structure onto a new foundation, rebuilding its envelope with airtight and vapor-open assemblies, dramatically improving insulation and air sealing, and installing high-performance windows and mechanical systems. The result is an all-electric, net-zero home powered by Community Solar (from Southshire Community Solar), which demonstrates how... **historic buildings can be “recycled” to meet today’s performance standards while honoring their original character.**



BEFORE | FRONT VIEW
PHOTO CREDITS: Sustainable Design



AFTER | FRONT VIEW
PHOTO CREDITS: Will Russell

FLOOR PLAN



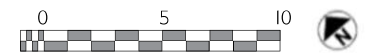
BEFORE | LIVING ROOM
 PHOTO CREDITS: Sustainable Design



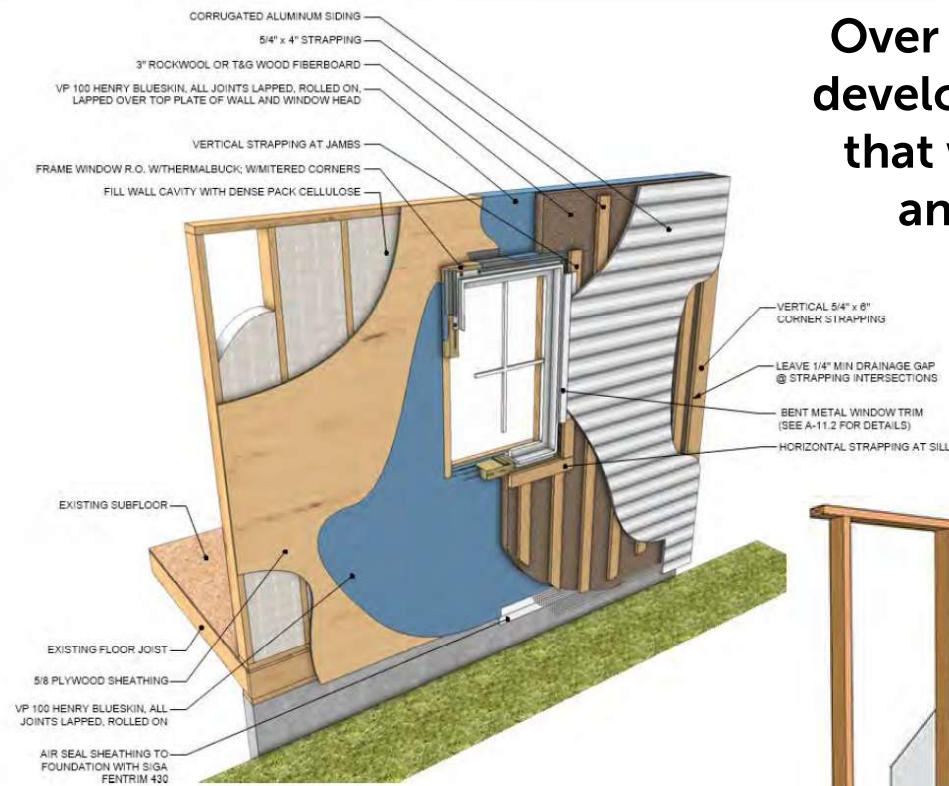
AFTER | LIVING ROOM
 PHOTO CREDITS: Will Russell



- EXISTING
- RENOVATION
- NEW CONSTRUCTION



TYPICAL WALL SECTIONS



SUSTAINABLE DESIGN'S WALL ASSEMBLY

"At first, we had to convince builders and clients of its durability. Shortly afterward, Joe Lstiburek published a paper describing the same assembly, which validated our approach. Since then, new products have made this wall system even easier: Henry VP100 Blueskin self-adhered membrane, ThermalBuck for rough openings, and acrylic tapes for flashing."

Over ten years ago, we developed a wall system that was both airtight and vapor-open.



BUILDING SCIENCE'S WALL ASSEMBLY

Source: buildingscience.com, BSI-091 Flow-Through Assemblies, Figure 5; Used with permission.

PROJECT DATA SUMMARY

- 1 LOCATION: Dorset, VT
- 2 IECC CLIMATE ZONE: 6A
- 3 YEAR BUILT: 1860s
- 4 YEAR RENOVATED: 2018 - 2022
- 5 LIVING AREA:
BEFORE: 2,087 SF AFTER: 2,852 SF
- 6 BEDROOMS/BATHROOMS:
BEFORE: 3 / 2 AFTER: 2 / 1.5
(added 2 offices)
- 7 CONSTRUCTION
FOUNDATION: New Concrete
WALLS: 2x4 wood framing
ROOF: 2x6 rafters, padded down
- 8 INSULATION
SUBSLAB: R-20 Glavel
FOUNDATION: R-33 Recycled insulation
ABOVE-GRADE WALL: R-28 to R-35 cellulose cavity & cont. rockwool
ATTIC FLOOR/ROOF: R-100 (flat), R-50 (sloped)
- 9 WINDOWS:
BEFORE: original wood AFTER: Sierra Pacific H-3 aluminum clad wood
- 10 HVAC:
BEFORE: propane boiler
AFTER: York ground source heat pump
- 11 MECHANICAL VENTILATION:
BEFORE: NONE AFTER: Broan ERV
- 12 DOMESTIC HOT WATER:
BEFORE: propane AFTER: Electric heat pump
- 13 PV SYSTEM CAPACITY:
BEFORE: NONE
AFTER: 8.9 kW via Community Solar
- 14 AIR LEAKAGE:
BEFORE: not measurable AFTER: 0.71 ACH50

THE BETTER FACTORS

ALL-ELECTRIC HOME

- Fully electric: heating, cooling, DHW, cooking, and appliances.
- Ground-source heat pump provides high-efficiency space conditioning.
- Electric heat pump water heater and induction range support all-electric operation.
- EV-ready capacity planned for future needs.
- 8.9kW from Community solar offsets 100% of electric use, enabling net-zero without rooftop PV.
- Slate roof retained—unable to host PV but compatible with Community Solar strategy.

ENCLOSURE

- Recycled insulation on foundation walls (~R-33).
- Dense-packed cellulose walls with 3" exterior Rockwool & Wood fiberboard (R-33+).
- Roof upgraded with closed-cell spray foam (~R-50) at sloped ceilings & cellulose (~R-100) at flat ceilings.
- Triple-pane north-facing windows with ThermalBuck to reduce thermal bridging.
- Fully adhered membrane and taped sheathing create a continuous air barrier.
- Air-sealing strategy achieved a 0.71 ACH50 blower door result.
- Vapor-open, drying-capable assembly improves durability.

EFFICIENCY & PERFORMANCE

- Blower door testing showed an 84% reduction in air leakage.
- Building assemblies designed for both thermal and moisture performance (airtight + vapor open).
- Systems right-sized for reduced loads due to upgraded enclosure.
- Community solar provides 100% renewable electricity, ensuring operational net zero.

WATER & MOISTURE MANAGEMENT

- Airtight and vapor-open wall assembly (validated by building science research).
- Strapping creates a drainage plane behind the siding.
- Continuous exterior insulation reduces condensation risk.
- Waterproofed foundation walls + Gravel under slab for drainage and insulation.
- Landscape swales were created to direct stormwater to rain gardens.

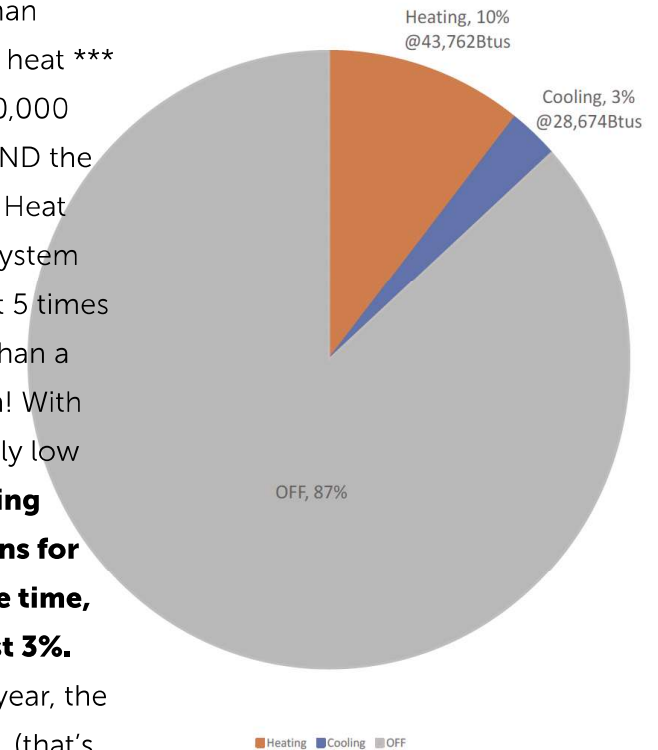
MECHANICAL SYSTEMS & IAQ

- Planned HRV/ERV for ventilation.
- HVAC system sized appropriately for low-load, high-performance enclosure.
- Fully electric design improves indoor air quality by eliminating combustion sources.

MATERIALS & DURABILITY

- "House recycling": deep retrofit rather than demolition and rebuild.
- Gravel sub-slab insulation (locally made from recycled glass).
- Multiple attachment systems tested; long-screw + ribbed-cap method proved most durable.
- Asbestos siding was abated professionally
- Slate roof retained for longevity & fire resistance.
- Corrugated aluminum siding for fire resistance and durability.

"This 2800 sq ft building needs ***less than 35,000 BTUs to heat *** and less than 20,000 BTUs to cool, AND the Ground Source Heat Pump heating system tested at almost 5 times more efficient than a propane system! With these surprisingly low loads, **the heating system only runs for only 10% of the time, and the AC, just 3%.** The rest of the year, the furnace sits idle. (that's 7,620 hours/yr)"



ADAPTABILITY & RESILIENCE

- Relocated house 57 feet back from the road: safer siting, better long-term use.
- Phased five-year retrofit schedule spreads costs and lessons learned.
- Flexible design: combines office + home now, retirement residence later.
- Fire-resistant exterior materials for wildfire resilience.

COST & PRACTICALITY

- Renovation is significantly more affordable than new construction amid rising material costs.
- Homeowner-architects contributed sweat equity (demo, prep work).
- The phased approach eased the financial burden.
- Practical decision-making: triple-pane windows used only where most impactful (NW & NE sides), upgrades added in new construction.

LESSONS LEARNED

“Did we achieve Passive House certification, NO... BUT... If you are familiar with the Pretty Good House movement, **I would consider ours a PRETTY GOOD RENOVATION.** I’ll be the first to admit, that the house isn’t perfect! *Here are a few things we would do differently...*” You will see that many of the changes we would make are is related to moisture management; the **FIRST** is about timing! Do NOT plan a five and a half-year-long renovation... During a GLOBAL PANDEMIC. Availability, lead times, costs, subcontractors, everything was challenging!

SECOND: When you are investing in a well insulated, tight building shell, INSTALL Triple-Pane windows EVERYWHERE. Double-pane windows will need regular wiping at <10 degrees. We used double pane windows on the south face and spent the winter wiping condensation. Even though our AWAIR monitor is tells we have perfect humidity between 40 & 50%, the glass manufacturers (and windows) have a very different idea of what ideal humidity is... that said, this is the first winter that I don’t have eczema or nosebleeds!

The **THIRD** detail I would change: while wood walls cover most of the interior and are a nice touch, there are some areas where another material would be more durable...

FOURTH: We incorporated a greenhouse into our basement. We know a greenhouse should be kept separate from the living space. So, we HAD a door, then removed it to mix the air between the greenhouse and the basement, and finally re-installed a full glass door to contain the humidity in the greenhouse!

FINALLY: We now wish we had built the greenhouse twice as big! Fruiting citrus, avocado & banana trees can be quite large and fill the space quickly. We had pictured ourselves with a cup of tea and sitting in lounge chairs inside the greenhouse in winter. NOT HAPPENING

PROJECT TEAM

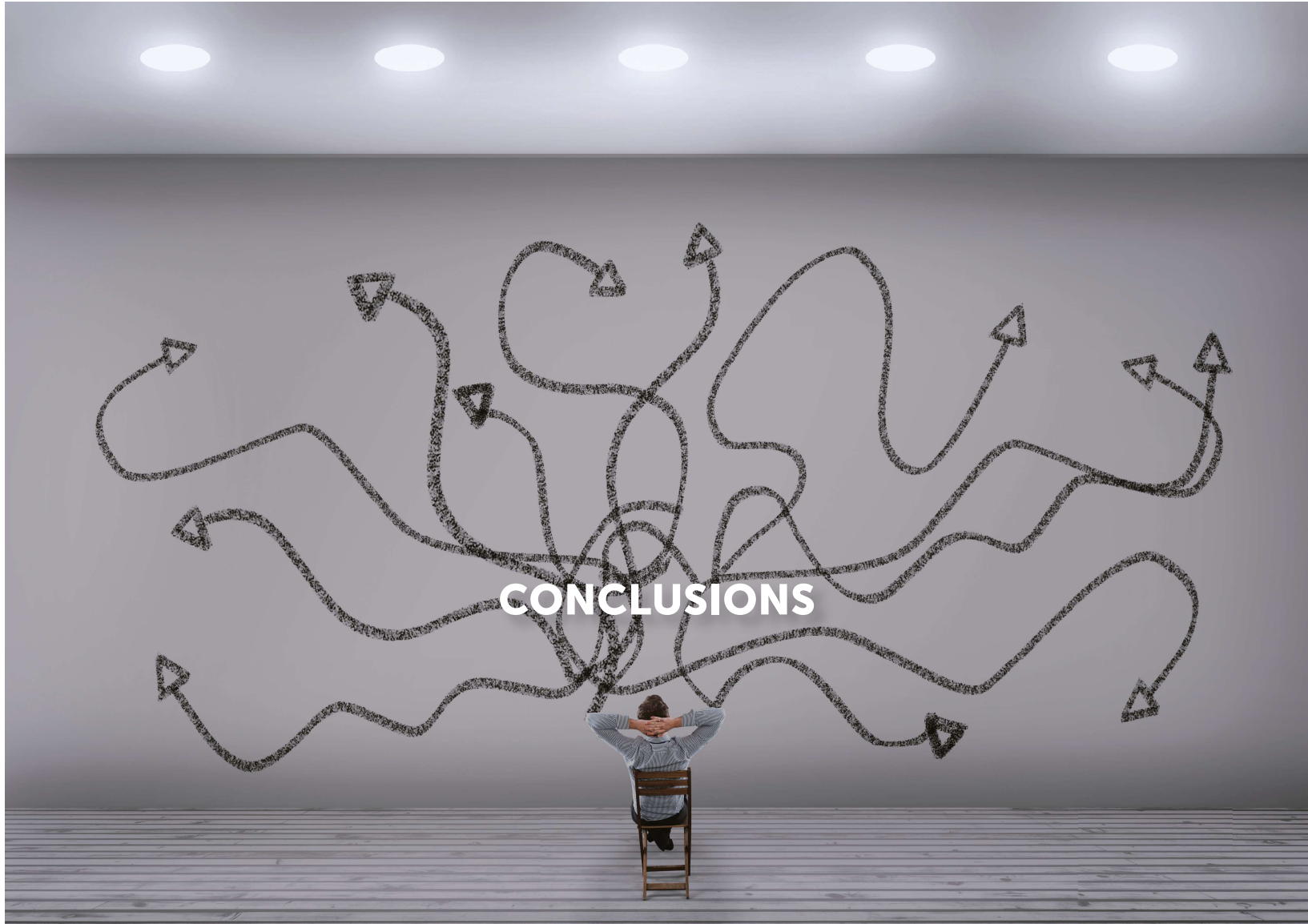


ALAN BENOIT, AIA
Principal Architect
PHOTO CREDITS:

NANCY BENOIT
Senior Designer



PHOTO CREDITS: Sustainable Design



CONCLUSIONS

THE WORK SEQUENCE MATTERS

1. ASSESS EXISTING CONDITIONS

- General building condition
- Site and Drainage
- Mechanical systems
- Electrical system
- Smoke & CO detection system
- Air infiltration & ventilation

2. PERFORM ENCLOSURE UPGRADES

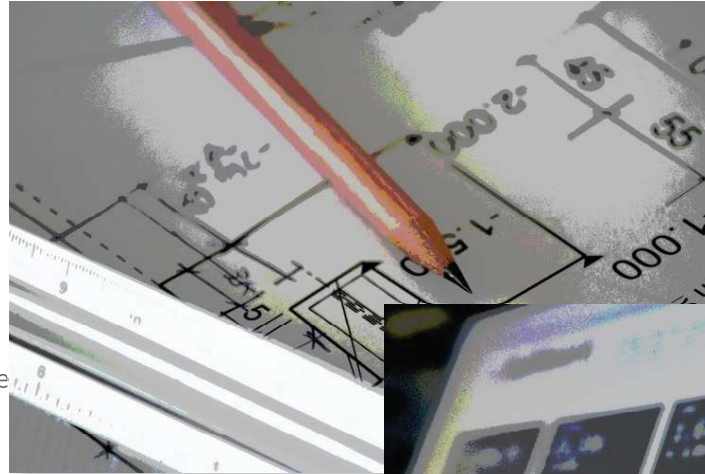
- Air sealing, flashing & water intrusion barriers of the envelope
- Roof & attic insulation
- Wall insulation
- Basement insulation
- Windows & exterior doors

3. PERFORM MECHANICAL UPGRADES

- HVAC: size the system after lowering the loads
- Balanced energy recovery ventilation (ERV), if lower than 3.0 ACH50
- Energy Star electric domestic water heater
- Energy Star electric major appliances

4. SOLAR

- PHOTOVOLTAIC PANELS (PV): *Size the system after lowering the electrical load*
- SOLAR BATTERIES: *If budget permits, install batteries for resilience during a power outage*
- PREPARE FOR THE FUTURE: *If there is no photovoltaic system or electric vehicle initially, make the house PV & EV ready*



PERFORMANCE VERIFICATION IS CRITICAL

- **BLOWER DOOR TESTS:** Perform tests before, during, and after the construction process to measure improvements in air sealing.
- **INFRARED CAMERA SCANS:** Perform infrared scans of the exterior of the house before, during, and after construction to spot weak points in the insulation & air sealing
- **ENERGY BILLS:** Use energy bills to compare before & after energy consumption
- **AIR MONITORS:** Use a home air quality monitor to keep tabs on VOC's, CO2, radon, particulate matter, and humidity during occupancy
- **MOUSTURE SENSORS:** Bury sensors in roof & wall assemblies to monitor moisture conditions

TEN KEY TAKEAWAYS FROM THE CASE STUDIES

1. Electrify everything...heating, cooling, cooking, and water heating

- Insulate, air seal, and select equipment for a fossil-fuel-free, all-electric house
- The 2024 International Energy Conservation Code (IECC) regulations for new construction serve as good guidelines for better renovation projects

2. Affordability can be an obstacle

- Consider a “Deep Weatherization”, as opposed to a “Deep Energy Retrofit”
- Consider phasing the work in a strategic sequence
- Consider redesigning existing space, rather than adding more space
- Conversion of “weak spaces”, such as porches and attics, is money well spent
- Don’t let perfection get in the way of better...good enough is good enough

3. Working on old houses can be a complicated puzzle

- Consider the house as a whole system
- Apply good building science principles
- Relationship-driven teams with good coordination are very important
- Stay the course

4. Do the hard & unglamorous stuff first

- Water, moisture & air leaks
- Basements & attics
- Mechanicals
- Site drainage

5. Hurdles & emergent conditions are inevitable and important to address

- Asbestos in existing materials
- Knob & tube wiring
- Structural rot & insect infestation
- Mold

6. Air sealing is critical

- People need to breathe. Buildings don’t.
- 3.0 ACH50 is a good target for better renovations. It is also the threshold for requiring supplemental mechanical ventilation (ERV).
- AeroBarrier can help achieve better than expected blower door results.

7. Consider the embodied carbon of the existing & new building materials

- Think before demolition. Can existing spaces be redesigned rather than demolished?
- Reuse is a resource. Can materials be salvaged and reused?
- What lower embodied carbon new materials are available? Use more cellulose & wood fiber insulation and less foam.
- Use closed-cell spray foam strategically, and only the type with an HFO, low global warming potential, blowing agent.

8. With historical houses, consider make overs of the existing wood windows rather than installing expensive, historically accurate new windows.

- Remove the pulleys & sash weights. Fill sash weight pockets with insulation & install spring replacement balances.
- Install spring bronze weatherstripping & good quality triple track aluminum storm windows.
- Window Dressers from Maine does “community-build” insulating window insert projects.

9. Consider resilience in the event of a power outage, flooding, or wildfire

- Install extra insulation to hold the heat longer
- Install back-up PV batteries, or a low emission wood stove
- Use fire-resistant siding & roofing
- Keep highly combustible plant materials & accessory structures at least 15 feet away from the house
- Design a good stormwater system for the house & site

10. It’s not all about energy efficiency & decarbonization. If the house isn’t beautiful, comfortable, quiet & healthy, people won’t love it.

OPEN QUESTIONS

- What are the most important metrics for measuring **BETTER?**
- How good is **good enough?** (“Pretty Good Retrofits” versus “Deep Energy Retrofits”)

NEXT STEPS

- **BUILD AN ONLINE COMMUNITY OF PRACTICE:** Establish an online forum for crowdsourcing answers to the above questions and sharing information about our work.
- **DO MORE CASE STUDIES:** For future case studies, gather more strategic and complete metrics to improve their value to practitioners.
- **INCLUDE OTHER BUILDING TYPES:** Expand the scope of the initiative, by partnering with individuals & organizations who are already doing renovation & retrofit case studies of other building types.

RESOURCES

BOOKS

- **PRETTY GOOD HOUSE: A Guide to Creating Better Homes** by Dan Kolbert, Emily Mottram, Michael Maines, & Christopher Briley
- **A HOUSE NEEDS TO BREATHE... OR DOES IT?: An Introduction to Building Science** by Allison A. Bailes III, PhD
- **SUSTAINABLE PRESERVATION: Greening Existing Buildings** by Jean Carroon
- **RENOVATION 5th Edition** by Michael Litchfield & Chip Harley
- **BUILDINGS DON'T LIE: Better Buildings by Understanding Basic Building Science** by Henry Gifford
- **2024 INTERNATIONAL ENERGY CONSERVATION CODE (IECC)** by The International Code Council

WEBSITES

- **GREEN BUILDING ADVISOR** - greenbuildingadvisor.com
- **BUILDING GREEN** - buildinggreen.com
- **FINE HOMEBUILDING** - finehomebuilding.com
- **BUILDING SCIENCE CORPORATION** - buildingscience.com
- **USGBC: LEED FOR OPERATIONS & MAINTENANCE** - usgbc.org/guide/om
- **PHIUS REVIVE** - phi.us.org/phius-revive-2024

ARTICLES & PAPERS

- **NATIONAL PARK SERVICE: Preservation Briefs** | *Link: nps.gov/orgs/1739/preservation-briefs.htm*
- **FINE HOMEBUILDING: Fix Air Leaks in Old Houses** by Mason Lord, Issue 326 - October 2024
Link: finehomebuilding.com/2024/09/10/fix-air-leaks-in-old-houses
- **FINE HOMEBUILDING: Do Deep-Energy Retrofits Make Sense?** by Rachel White, Issue 314 - April / May 2023
Link: finehomebuilding.com/project-guides/energy-retrofit/the-end-of-deep-energy-retrofits
- **FINE HOMEBUILDING: We Need to Keep Doing DERs** by Michael Hindle, Issue 323 - June 2024
Link: finehomebuilding.com/2024/04/16/we-need-to-keep-doing-ders

ORGANIZATIONS

- **NESEA** - Northeast Sustainable Energy Association - nesea.org
- **BPI** - Building Performance Institute - bpi.org
- **NEHERS** - Northeast Home Energy Rating System Alliance - nehers.org
- **USGBC** - US Green Building Council - usgbc.org
- **APTNE** - Association for Preservation Technology Northeast - aptne.org
- **PASSIVHAUS MAINE** - passivhausmaine.org/





AUTHORS

CHRIS ROYER & BRYNYA ABLAMSKY

Architect Chris Royer and interdisciplinary designer Brynya Ablamsky have collaborated for two decades on a range of design projects.

Chris is the founder of Royer Architects, an architecture and landscape design practice dedicated to stewarding homes and gardens for the 21st century. His work focuses on creating high-quality, enduring designs that simplify and enrich everyday life—rooted in a deep understanding of place and craft.

Brynya’s interdisciplinary design practice spans architecture, teaching, visual communication, and operational strategy—*integrating style and culture with form and function to create built environments, narratives, and methods that harmonize the human experience.*

Together, their collaboration reflects the mission of this compendium: to share lessons from the field, celebrate what works, and collectively advance how we renovate and retrofit homes across the Northeast and beyond.