



ENERGY DESIGN
conference & expo



Residential Passive House Retrofit (EnerPHit)

The MinnePHit House

Case Study about the first cold-climate EnerPHit project in the World
Tim Eian, Dipl.-Ing., Certified Passive House Planner & Consultant

In accordance with the Department of Labor and Industry's statute 326.0981, Subd. 11,

“This educational offering is recognized by the Minnesota Department of Labor and Industry as satisfying **1.5 hours** of credit toward **Building Officials and Residential Contractors code/energy** continuing education requirements.”

For additional continuing education approvals, please see your credit tracking card.

Learning Objectives

- **The Passive House building energy standards**
- **Residential Passive House retrofit design**
- **Strategies, materials and systems**
- **Challenges & Opportunities**
- **Certification**

Introduction



The MinnePHit House Minneapolis, MN



before



after



before



after



before



after



Minneapolis
+ EnerPHit

= MinnePHit

The Passive House Standard

Passivhaus - Passive House



“A rigorous, voluntary building energy standard focusing on highest energy efficiency and quality of life at low operating cost.”

Passive House in 90 Seconds



Global Standard



Think globally, build locally.

Global Adoption



Third-Party Certified

Certification Documentation



Category	Value	Target
Heating load	15.0	15.0
Energy demand	120.0	120.0
Air change rate	0.6	0.6
Primary energy demand	120.0	120.0
Indoor air quality	Passive House	Passive House

This building has been awarded the Certified Passive House by the Passive House Institute.



This certification is based solely on the design data and is not a guarantee of the exact characteristics of the building. The Passive House Institute hereby disclaims any liability for the implementation of the building's energy balances and indoor air quality. This certification does not cover quality assurance of the building's construction. The Passive House Institute hereby disclaims any liability for the implementation of the building's energy balances and indoor air quality.



Certificate

The Passive House Institute awards the seal "Certified Passive House" to the following building:

24th Street Passive House #1, 140 24th St. North, La Crosse, WI 54601, USA

Passive House Institute
Dr. Wolfgang Feist
Struwwelpfad 4444
64385 Darmstadt
Germany



Client: Western Technical College
489 7th St. North, La Crosse, WI 54601, USA
Architect: Integrated Planning LLC
501 13rd Ave NE, Minneapolis, MN 55412, USA
Building: Integrated Planning LLC
Services: 991 23rd Ave NE, Minneapolis, MN 55412, USA

This building was designed to meet Passive House criteria as defined by the Passive House Institute. With appropriate on-site implementation, this building will have the following characteristics:

- Excellent thermal insulation and optimized connection details with respect to building envelope. The resulting demand of heating load will be limited to **15 kWh per m² of living area and year** or a heating load of 15 W/m².
- When outdoor temperatures are high, thermal comfort can be ensured with passive means. Minimal energy demand for cooling and dehumidification according to the requirements of ISO 5272, is less than **0.6 kWh per m² of living area and year**.
- A controlled ventilation system with high quality filters, highly efficient heat exchanger, ensuring excellent indoor air quality with low energy consumption. The total primary energy demand for heating, domestic hot water, ventilation and cooling during normal use of less than **120 kWh per m² of living area and year**.

This certificate is to be used only in combination with the associated certification requirements, which describe the exact characteristics of the building.

Passive Houses offer high comfort throughout the year and can be heated or cooled with the same system, for example, by heating/cooling the supply air. Even in times of cold outdoor temperatures, the indoor surface temperatures of a Passive House is evenly warm on the inside and the internal surface temperatures are high. Due to the highly airtight envelope, draughts are eliminated. The controlled ventilation system constantly provides fresh air of excellent quality. Energy demand for heating, cooling and dehumidification is very low. Thanks to this, Passive Houses offer high energy efficiency and future-proof energy efficiency. Moreover, the climate impact of Passive Houses is very low, resulting in the emission of comparatively low levels of CO₂.

Issued:
Darmstadt, 12.11.2014
Wolfgang Feist
Dr. Wolfgang Feist

Certificate-ID: 9019_PHI_PH_20141017_AM

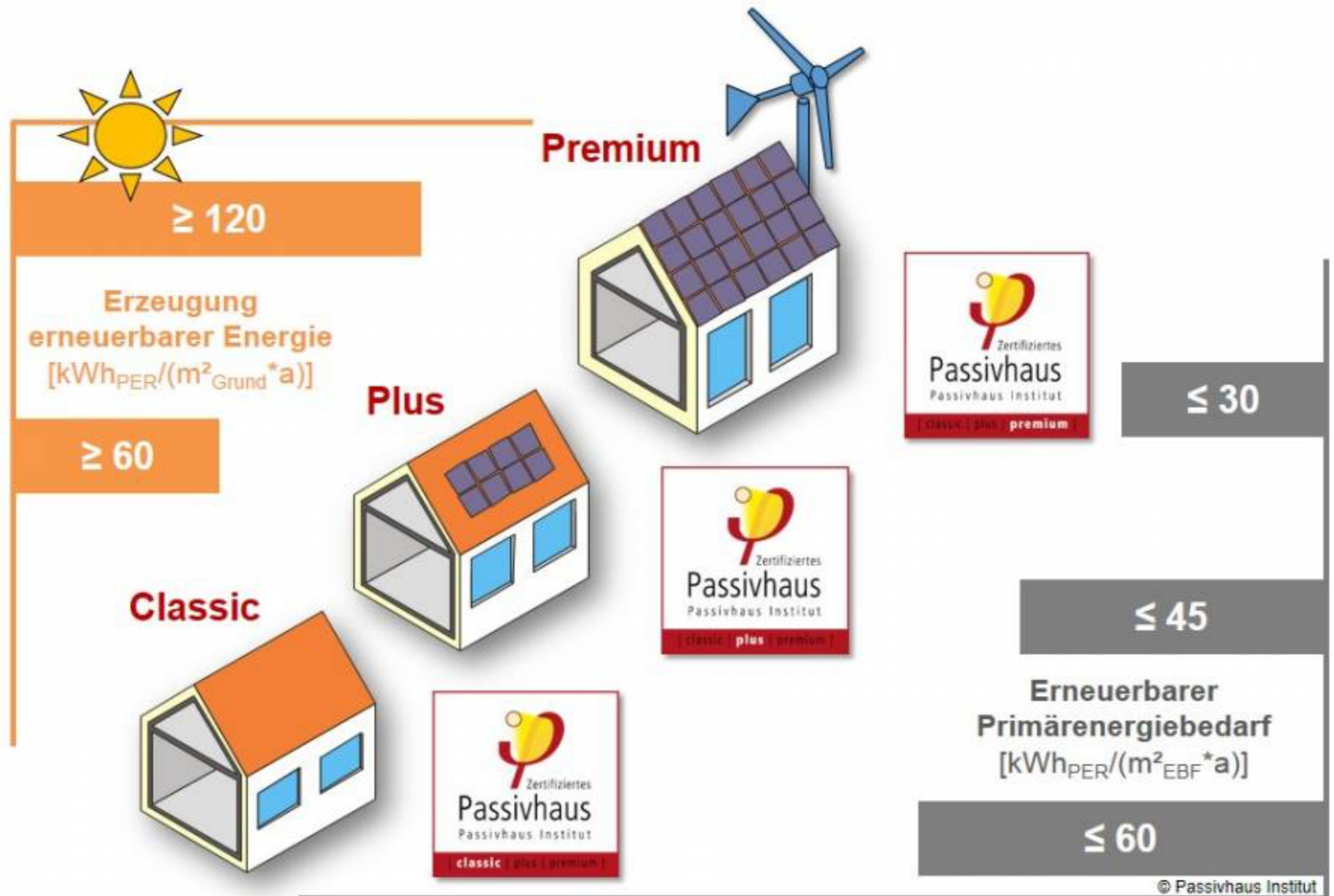


Certified
Passive House
Passive House Institute

Tool



The Path to Ultimate Sustainability



Global Climate Specificity

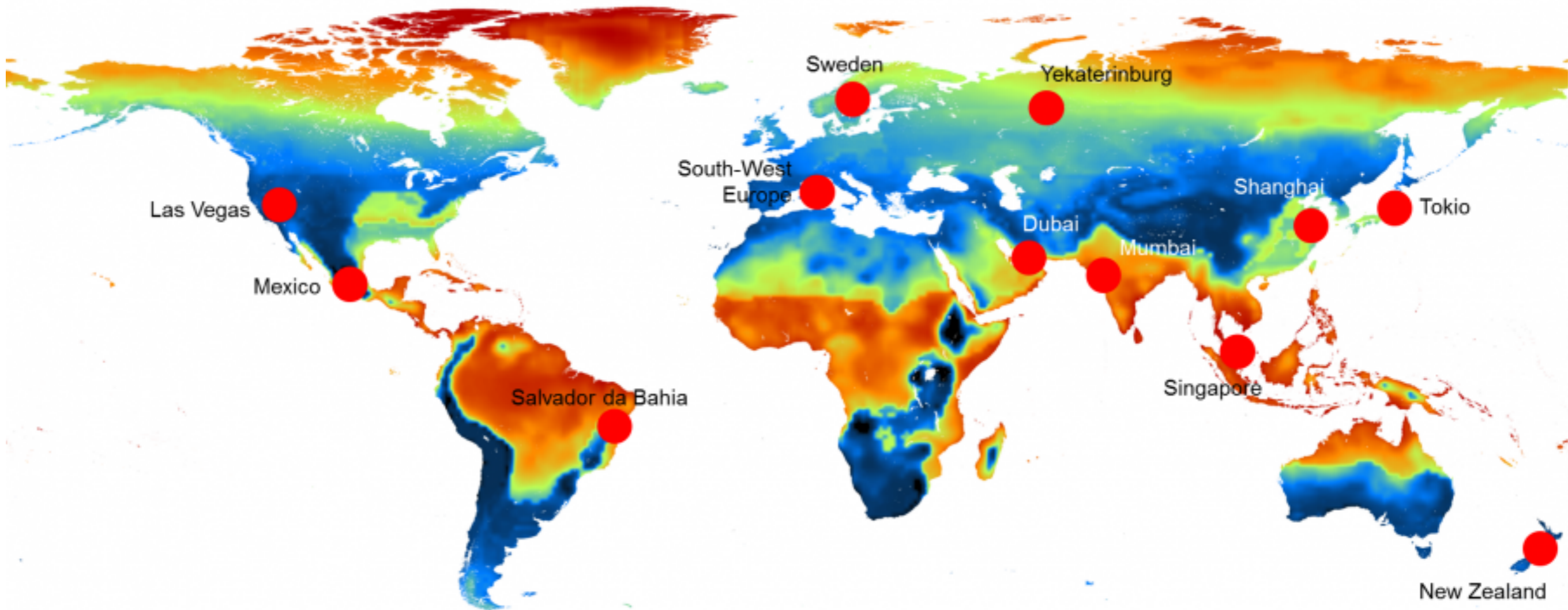





Illustration © Passive House Institute

Climate-Specific Requirements

Climate zone according to PHPP	Opaque envelope ¹ against...				Windows (including exterior doors)				Ventilation		
	...ground	...ambient air			Overall ⁴			Glazing ⁵	Solar load ⁶	Min. heat recovery rate ⁷	Min. humidity recovery rate ⁸
	Insulation	Exterior insulation	Interior Insulation ²	Exterior paint ³	Max. heat transfer coefficient ($U_{D/W,installed}$)			Solar heat gain coefficient (g-value)	Max. specific solar load during cooling period		
	Max. heat transfer coefficient (U-value)			Cool colours						[kWh/m ² a]	%
	[W/(m ² K)]			-	[W/(m ² K)]	-					
											
Arctic	Determined in PHPP from project specific heating and cooling degree days against ground.	0.09	0.25	-	0.45	0.50	0.60	$U_g - g*0.7 \leq 0$	100	80%	-
Cold		0.12	0.30	-	0.65	0.70	0.80	$U_g - g*1.0 \leq 0$		80%	-
Cool-temperate		0.15	0.35	-	0.85	1.00	1.10	$U_g - g*1.6 \leq 0$		75%	-
Warm-temperate		0.30	0.50	-	1.05	1.10	1.20	$U_g - g*2.8 \leq -1$		75%	-
Warm		0.50	0.75	-	1.25	1.30	1.40	-		-	-
Hot		0.50	0.75	Yes	1.25	1.30	1.40	-		-	60 % (humid climate)
Very hot		0.25	0.45	Yes	1.05	1.10	1.20	-		-	60 % (humid climate)

Energy Modeling



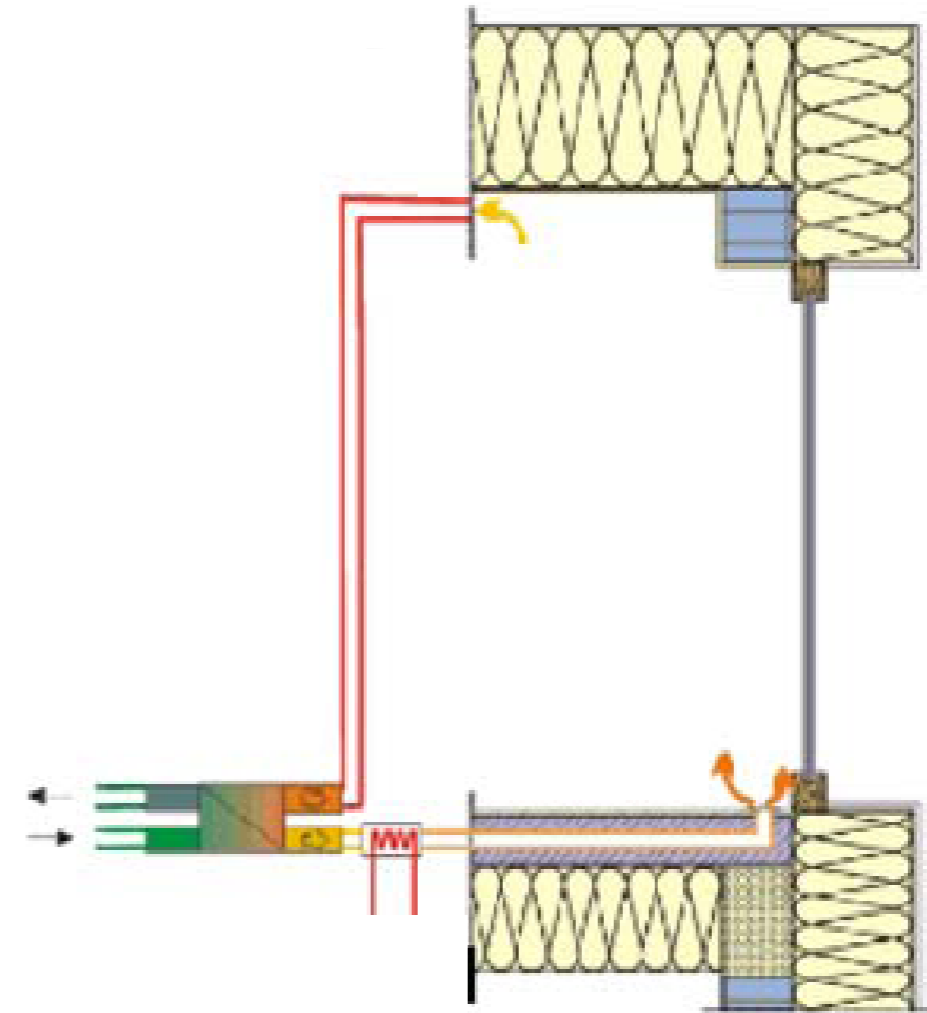
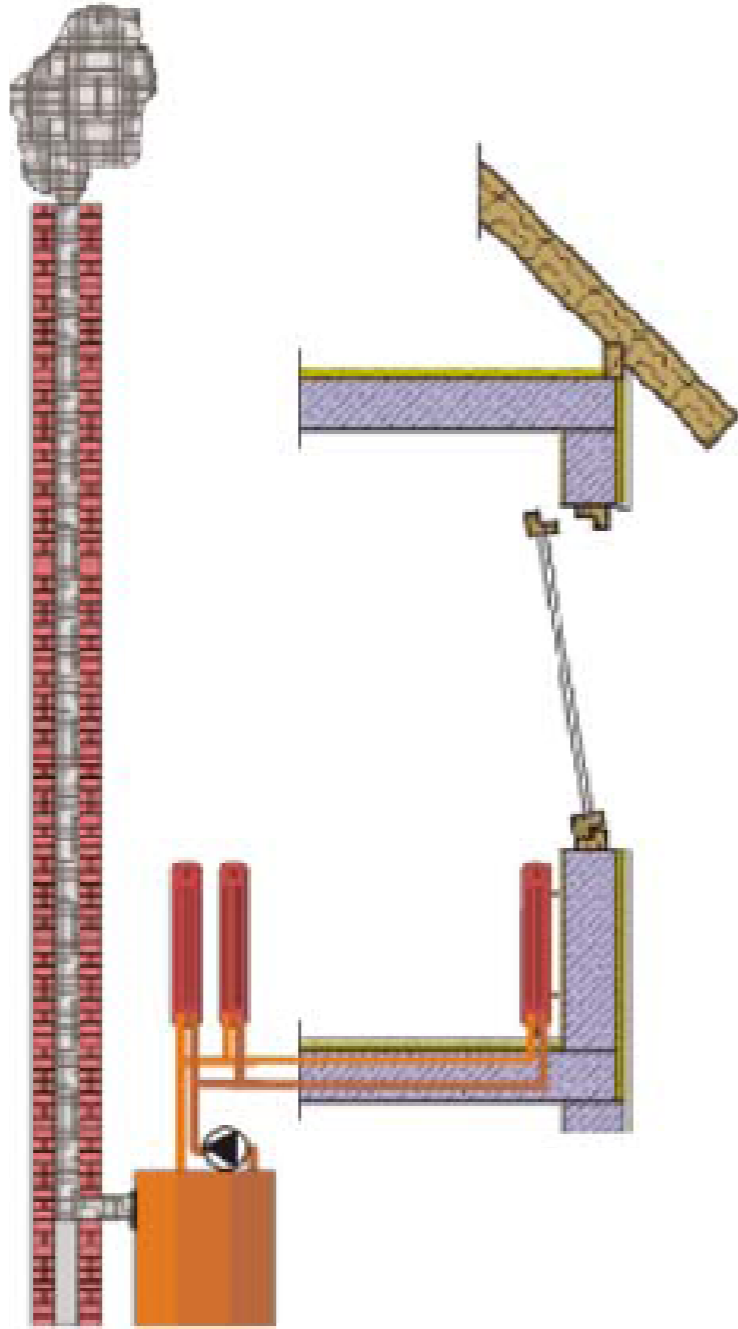
Basic Concept

Conservation first

➔ Minimize losses

➔ Maximize (free) gains

Active vs. Passive



Active: 25-125 kBtu/(sf yr)

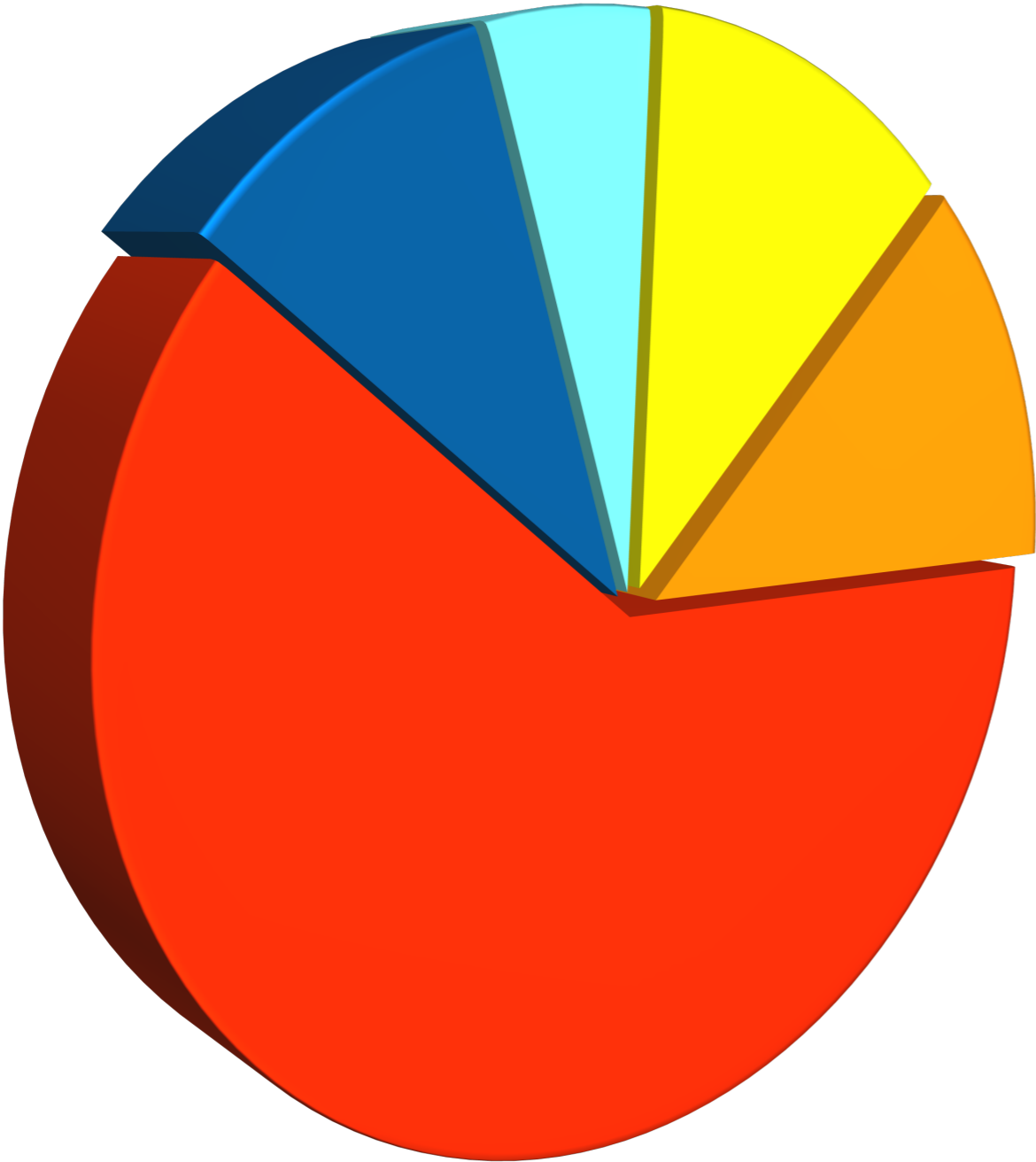
85 - 450 kWh/(m² a), typically found in the U.S.

Passive: 4.75 kBtu/(sf yr)

15kWh/(m² a), maximum target

Energy Footprint

- Heating (active)
- Hot water (active)
- Cooling (active)
- Household Electricity
- Heat & hot water (passive)



Code



Passive House

- ➔ up to 95% less heating energy
- ➔ 50 to 75% less total energy

Metrics

Energy per Square Foot and Year

Gas mileage for buildings.

Space Conditioning Energy Targets



$\leq 4.75 \text{ kBtu}/(\text{sf yr})$

$\leq 15 \text{ kWh}/(\text{m}^2 \text{ a})$



$\leq 9.5 \text{ kBtu}/(\text{sf yr})$

$\leq 30 \text{ kWh}/(\text{m}^2 \text{ a})$



$\leq 7.9 \text{ kBtu}/(\text{sf yr})$

$\leq 25 \text{ kWh}/(\text{m}^2 \text{ a})$

Total energy used to heat or cool a building.

Source Energy Targets



$\leq 38 \text{ kBtu}/(\text{sf yr})$

$\leq 120 \text{ kWh}/(\text{m}^2 \text{ a})$



varies

$\leq 120 \text{ kWh}/(\text{m}^2 \text{ a}) + ((\text{QH} - 15 \text{ kWh}/(\text{m}^2 \text{ a})) * 1.2)$

Total energy used to heat or cool a building.

Heating Load Target (suggested)



$\leq 3.17 \text{ Btu}/(\text{h sf})$

$\leq 10\text{W}/\text{m}^2$

Heating energy can be supplied through ventilation system.

Airtightness Targets



≤ 0.6 ACH₅₀



≤ 1.0 ACH₅₀







Measured with a blower door in the field.

Component Targets

- Maximum U-values
- Minimum R-values
- SHGC requirements
- Minimum heat-recovery rates

EnerPHit offers a Component Track.

Component Targets

Climate zone	Hygiene ¹	Comfort ²			
	Min. temperature factor	Max. thermal transfer coefficient			
	$f_{Rsi}=0.25 \text{ m}^2\text{K/W}$	U-value			
	□	[W/(m ² K)]			
					
Arctic	0.80	0.45	0.50	0.60	0.35
Cold	0.75	0.65	0.70	0.80	0.50
Cool-temperate	0.70	0.85	1.00	1.10	0.65
Warm-temperate	0.60	1.10	1.15	1.25	0.85
Warm	0.55	-	1.30	1.40	-
Hot	-	-	1.30	1.40	-
Very hot	-	-	1.10	1.20	-

Predictable Outcome & Measurable Results

AS (Optwin & 16" SIP).xls

Passive House Planning

REDUCTION FACTOR SOLAR RADIATION, WINDOW U-VALUE

Building: **Applesed House** Annual Heat Demand: **34** kWh/a Heating Degree Hours: **4005**

Climate:	Minneapolis, MN										
Window Area Orientation	Global Radiation (Cardinal Points)	Shading	Dirt	Non-Perpendicular Incident Radiation	Glazing Fraction	g-Value	Reduction Factor for Solar Radiation	Window Area	Window U-Value	Glazing Area	Average Global Radiation
maximum:	W(kWh)	0%	0%	0%	0%	0%	0%	m²	W/(m²)	m²	kWh/(m²)
North	116	0.99	0.95	0.05	0.554	0.51	0.44	3.45	0.79	1.8	116
East	353	0.98	0.95	0.05	0.581	0.51	0.46	4.15	0.77	2.4	351
South	745	0.85	0.95	0.05	0.657	0.51	0.45	15.54	0.79	10.2	745
West	346	0.98	0.95	0.05	0.517	0.51	0.41	5.92	0.94	3.6	346
Horizontal	521	0.75	0.95	0.05	0.000	0.00	0.00	0.00	0.00	0.0	521
Total average value for all windows:						0.51	0.44	38.05	0.90	18.1	

Transmission Losses	Heat Gains Solar Radiation
W(kWh)	W(kWh)
296	90
349	342
1336	2857
0	0
2611	3594

Quantity	Description	Deviation from North	Angle of Inclination from the Horizontal	Orientation	Window Rough Openings		Installed		Glazing		Frame		g-Value	U-Value		Window Frame Dimensions				Installation				U-Value		Window Area
					Width	Height	In Area in the Areas worksheet	No.	Select glazing from the WinType worksheet	No.	Select window from the WinType worksheet	No.		Perpendicular Radiation	Glazing	Frames	Width - Left	Width - Right	Width - Below	Width - Above	Left 1/8"	Right 1/8"	Sill 1/8"	Head 1/8"	U _{Frame}	
24	1	0	90	North	0.308	3.514	North Wall	1	Scenario SIM	30	OPTIMU	94	0.51	0.50	0.95	0.12	0.12	0.13	0.12	1	1	1	1	0.028	-0.001	0.0
24	0	0	90	North	0.000	3.000	North Wall	1	Scenario SIM	30	OPTIMU	94	0.51	0.80	0.95	0.12	0.12	0.13	0.12	1	1	1	1	0.028	-0.001	0.0
25	1	0	90	North	0.818	1.143	North Wall	1	Scenario SIM	30	OPTIMU	94	0.51	0.50	0.95	0.12	0.12	0.13	0.12	1	1	1	1	0.028	-0.001	1.0
26	0	0	90	North	0.000	3.000	North Wall	1	Scenario SIM	30	OPTIMU	94	0.51	0.50	0.95	0.12	0.12	0.13	0.12	1	1	1	1	0.028	-0.001	0.0
27	1	0	90	North	0.308	3.514	North Wall	1	Scenario SIM	30	OPTIMU	94	0.51	0.50	0.95	0.12	0.12	0.13	0.12	1	1	1	1	0.028	-0.001	0.0
28	1	0	90	North	0.818	1.143	North Wall	1	Scenario SIM	30	OPTIMU	94	0.51	0.50	0.95	0.12	0.12	0.13	0.12	1	1	1	1	0.028	-0.001	1.0
29	1	90	90	East	0.818	1.143	East Wall	2	Scenario SIM	30	OPTIMU	94	0.51	0.50	0.95	0.12	0.12	0.13	0.12	1	1	1	1	0.028	-0.001	1.0
30	1	90	90	East	0.308	1.524	East Wall	2	Scenario SIM	30	OPTIMU	94	0.51	0.50	0.95	0.12	0.12	0.13	0.12	1	1	1	1	0.028	-0.001	1.3
31	1	90	90	East	0.818	1.143	East Wall	2	Scenario SIM	30	OPTIMU	94	0.51	0.50	0.95	0.12	0.12	0.13	0.12	1	1	1	1	0.028	-0.001	1.0
32	1	90	90	East	0.818	1.143	East Wall	2	Scenario SIM	30	OPTIMU	94	0.51	0.50	0.95	0.12	0.12	0.13	0.12	1	1	1	1	0.028	-0.001	1.0
44	1	180	90	South	0.308	1.143	South Wall	3	Scenario SIM	30	OPTIMU	94	0.51	0.60	0.95	0.12	0.12	0.13	0.12	1	1	1	1	0.028	-0.001	1.0
34	1	180	90	South	0.308	1.143	South Wall	3	Scenario SIM	30	OPTIMU	94	0.51	0.60	0.95	0.12	0.12	0.13	0.12	1	1	1	1	0.028	-0.001	1.0
35	1	180	90	South	0.818	1.143	South Wall	3	Scenario SIM	30	OPTIMU	94	0.51	0.60	0.95	0.12	0.12	0.13	0.12	0	1	1	1	0.028	-0.001	1.5
36	1	180	90	South	1.329	1.629	South Wall	3	Scenario SIM	30	OPTIMU	94	0.51	0.60	0.95	0.12	0.12	0.13	0.12	1	0	1	1	0.028	-0.001	3.3
47	1	180	90	South	0.308	1.629	South Wall	3	Scenario SIM	30	OPTIMU	94	0.51	0.60	0.95	0.12	0.12	0.13	0.12	0	1	1	1	0.028	-0.001	1.5
38	1	180	90	South	1.329	1.629	South Wall	3	Scenario SIM	30	OPTIMU	94	0.51	0.60	0.95	0.12	0.12	0.13	0.12	1	0	1	1	0.028	-0.001	2.8
49	1	180	90	South	0.818	1.329	South Wall	3	Scenario SIM	30	OPTIMU	94	0.51	0.60	0.95	0.12	0.12	0.13	0.12	1	1	1	1	0.028	-0.001	1.1
40	1	180	90	South	0.308	1.520	South Wall	3	Scenario SIM	30	OPTIMU	94	0.51	0.60	0.95	0.12	0.12	0.13	0.12	1	1	1	1	0.028	-0.001	1.1
41	1	180	90	South	0.308	1.520	South Wall	3	Scenario SIM	30	OPTIMU	94	0.51	0.60	0.95	0.12	0.12	0.13	0.12	1	1	1	1	0.028	-0.001	1.1
42	1	180	90	South	0.818	1.329	West Wall	4	Scenario SIM	30	OPTIMU	94	0.51	0.60	0.95	0.12	0.12	0.13	0.12	1	1	1	1	0.028	-0.001	1.1
43	1	270	90	West	0.818	1.329	West Wall	4	Scenario SIM	30	OPTIMU	94	0.51	0.60	0.95	0.12	0.12	0.13	0.12	0	1	1	1	0.028	-0.001	1.1
44	1	270	90	West	1.329	1.329	West Wall	4	Scenario SIM	30	OPTIMU	94	0.51	0.60	0.95	0.12	0.12	0.13	0.12	1	0	1	1	0.028	-0.001	2.0
45	1	270	90	West	0.818	2.057	West Wall	4	Scenario SIM	30	Fiberglass	9	0.51	0.60	0.75	0.20	0.20	1.00	0.20	1	1	1	1	0.030	0.000	1.9
46	1	270	90	West	0.818	1.143	West Wall	4	Scenario SIM	30	OPTIMU	94	0.51	0.60	0.95	0.12	0.12	0.13	0.12	1	1	1	1	0.028	-0.001	1.0
47	1	270	90	West	0.308	1.143	West Wall	4	Scenario SIM	30	OPTIMU	94	0.51	0.60	0.95	0.12	0.12	0.13	0.12	1	1	1	1	0.028	-0.001	1.0

Passive House Planning Package - PHPP

Key Benefits

Highest Comfort



Superior Indoor Environmental Quality



Ecology and Resource Efficiency



Cheapest Life Cycle Cost



The MinnePHit Project

Where are we?

what we got



1935













- 2 stories + basement
- 1,200 finished SF
- 2 bedrooms
- 1 bath
- 5 people

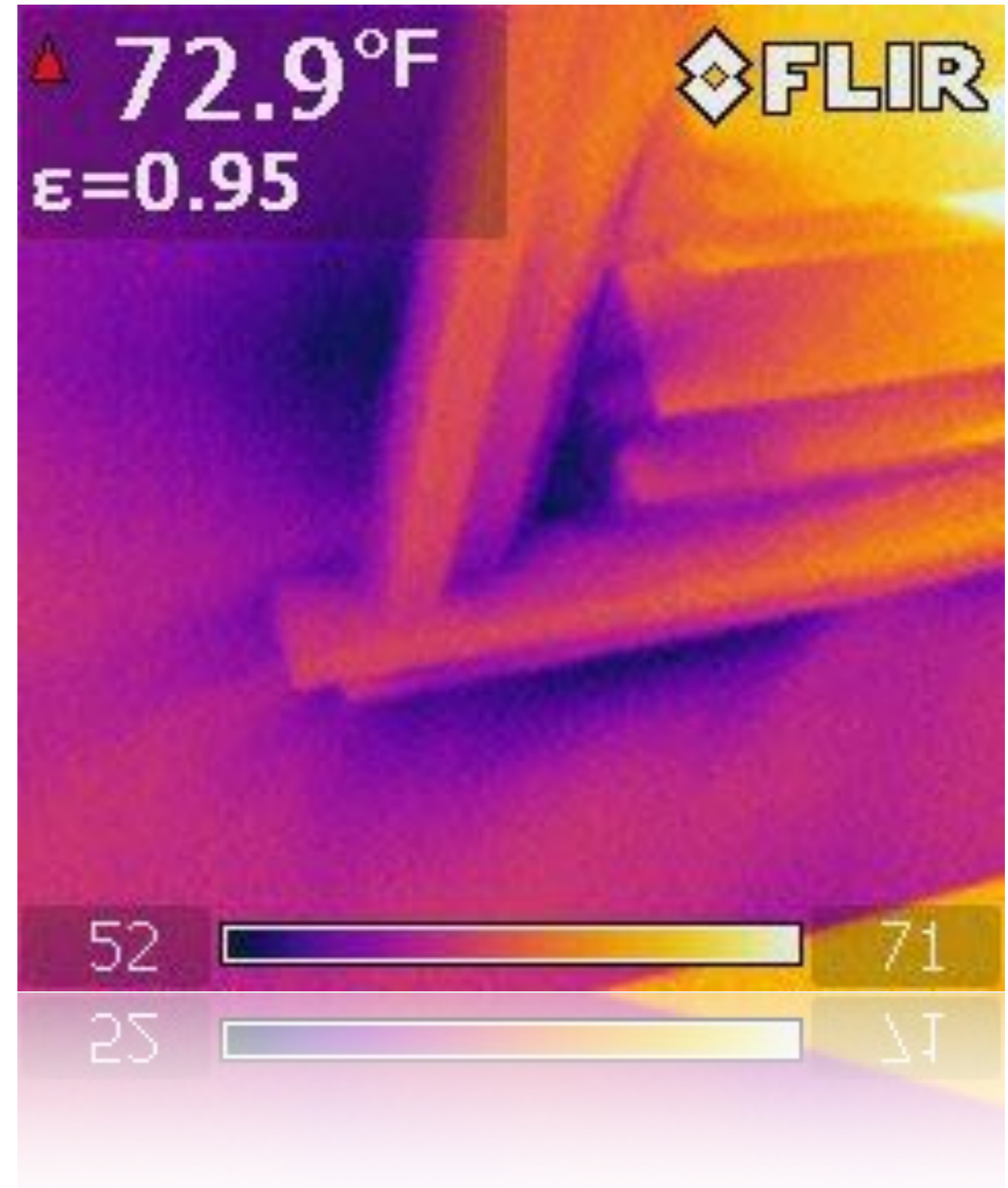
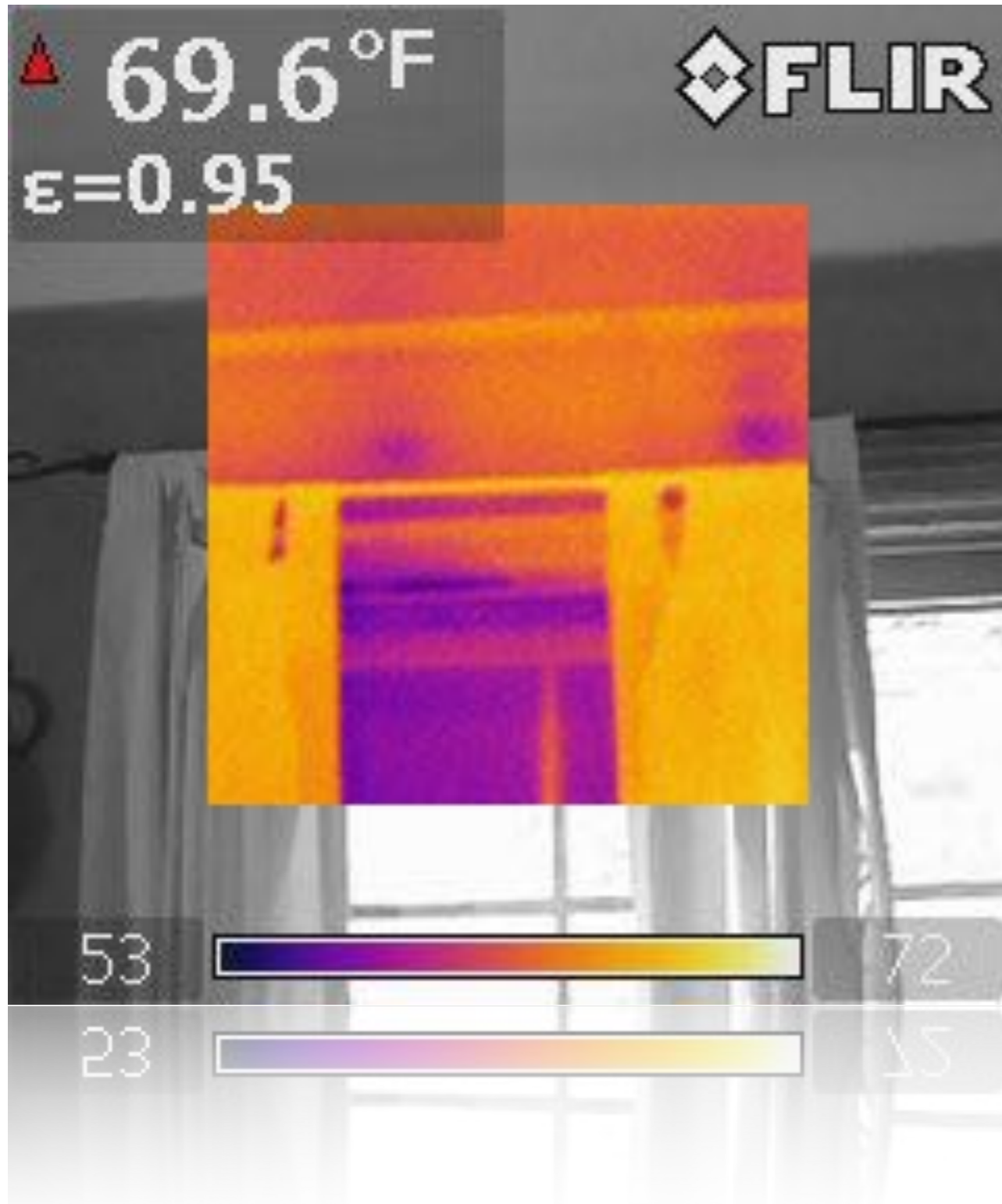




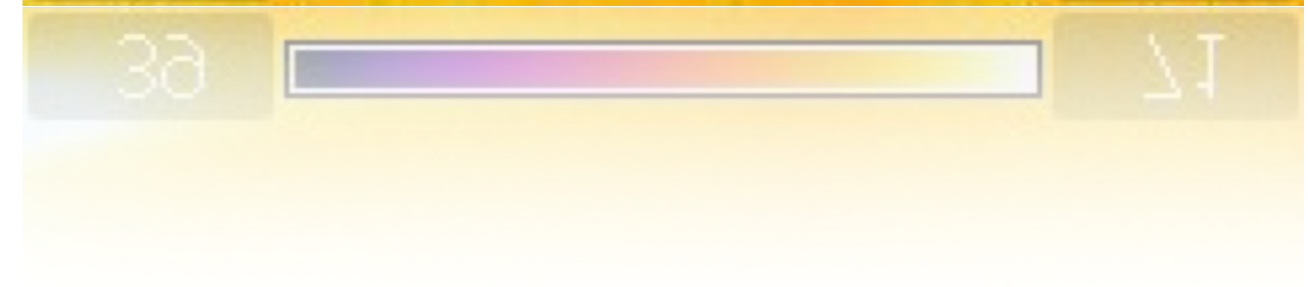
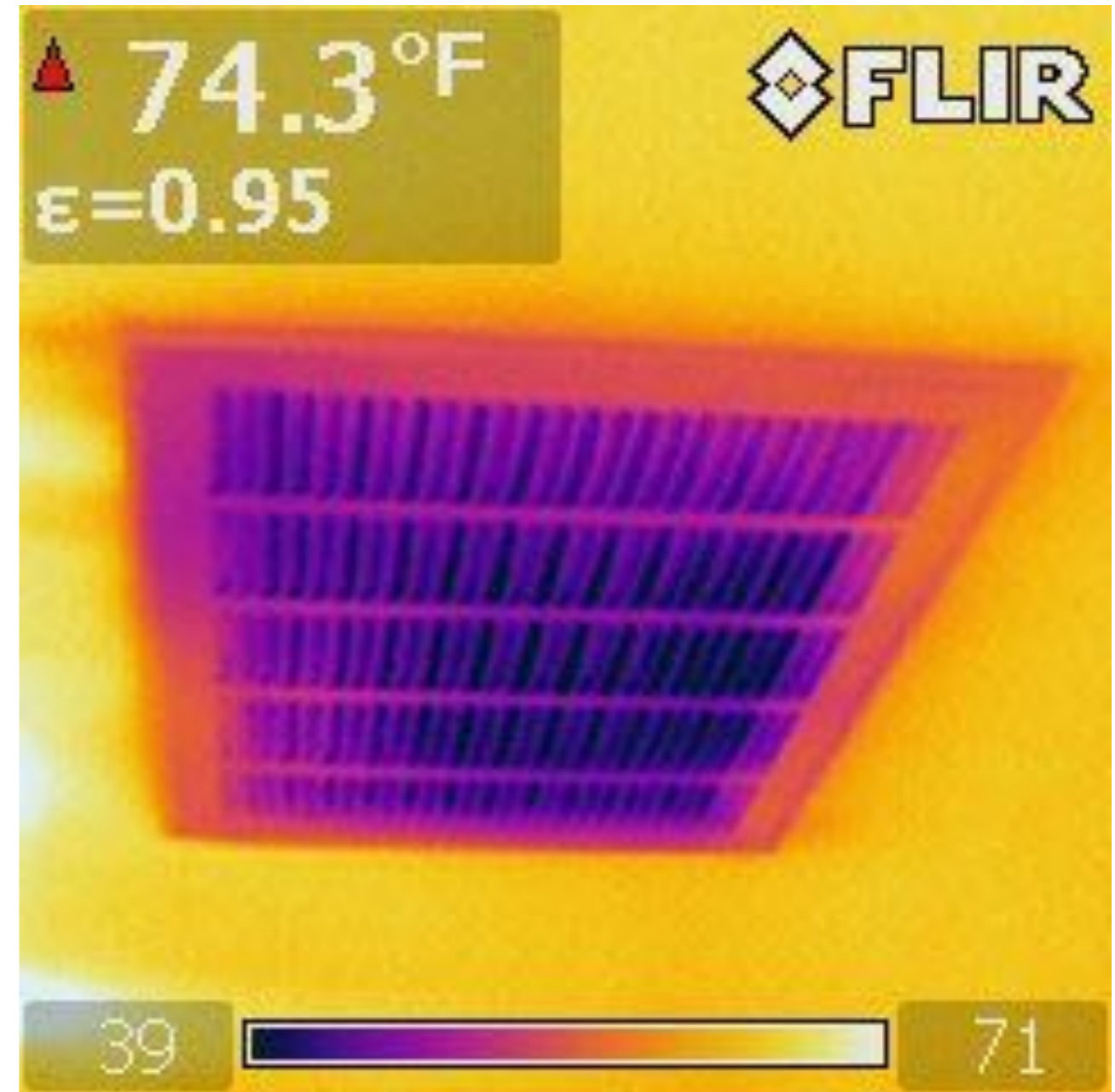
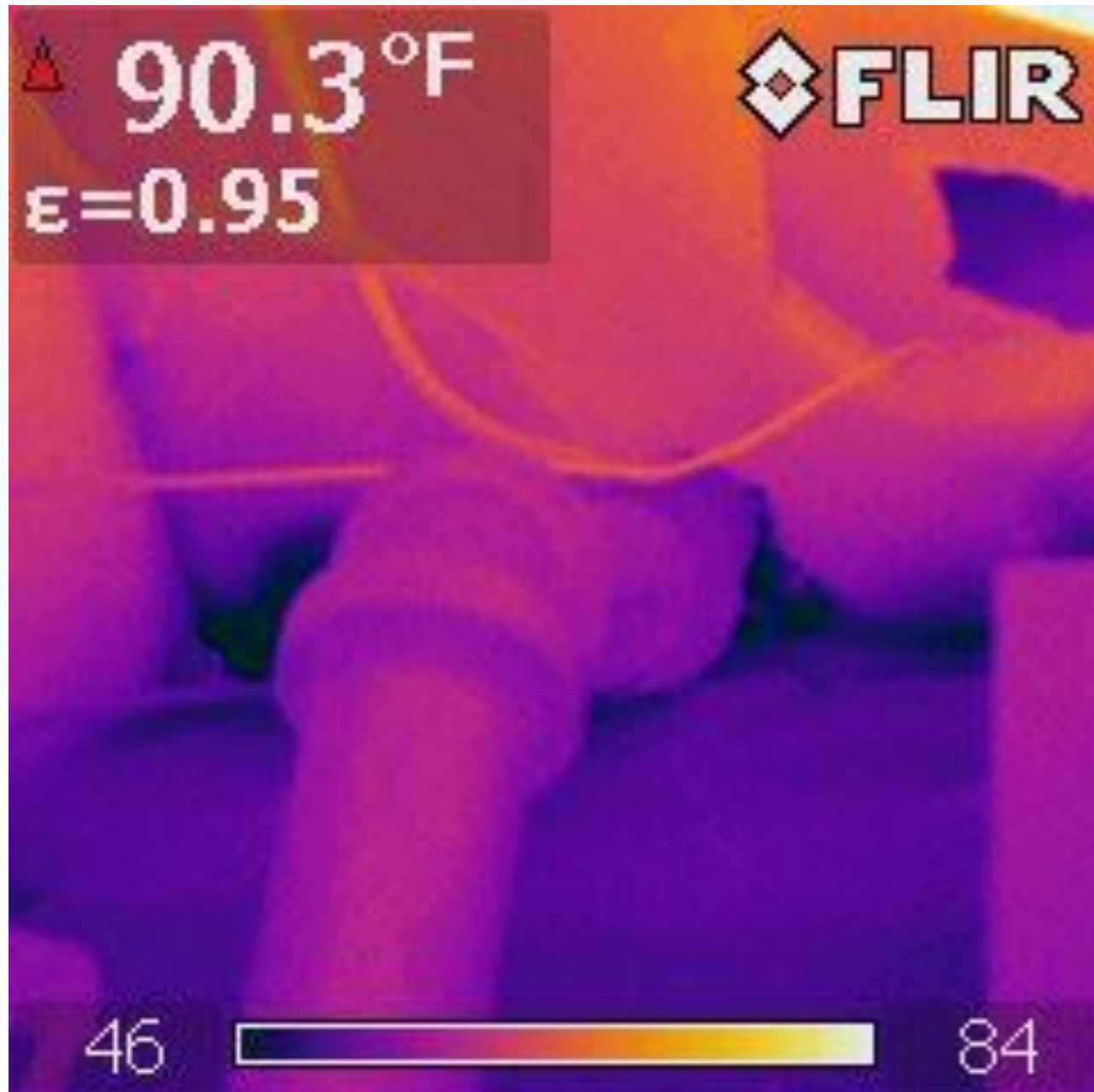
Prior Airport Noise Retrofit



Windows with Storms



Mechanicals



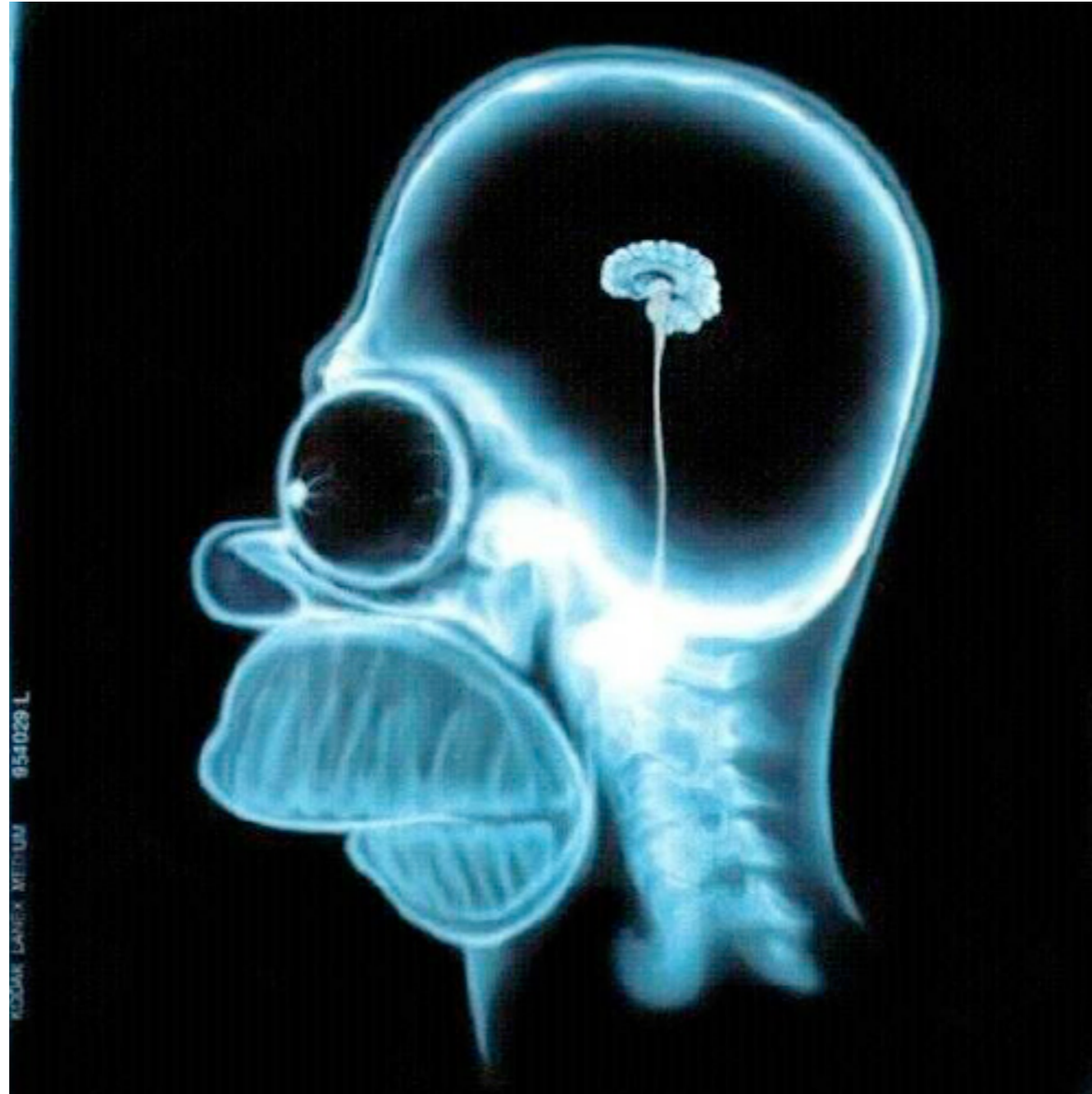


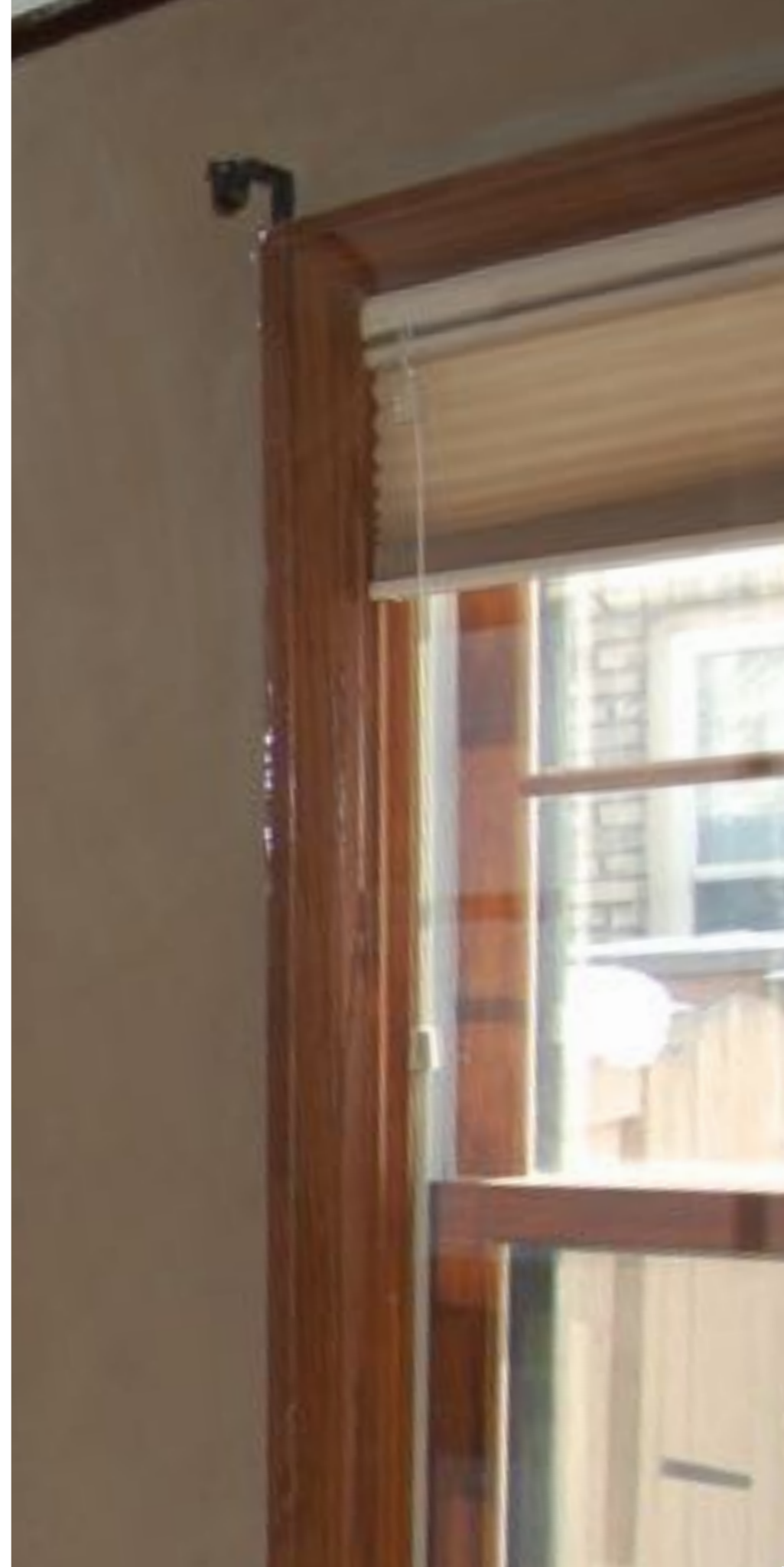
Airtightness

Initial Test

8.5 ACH₅₀ [2,100 CFM₅₀]

Pre-Existing Conditions





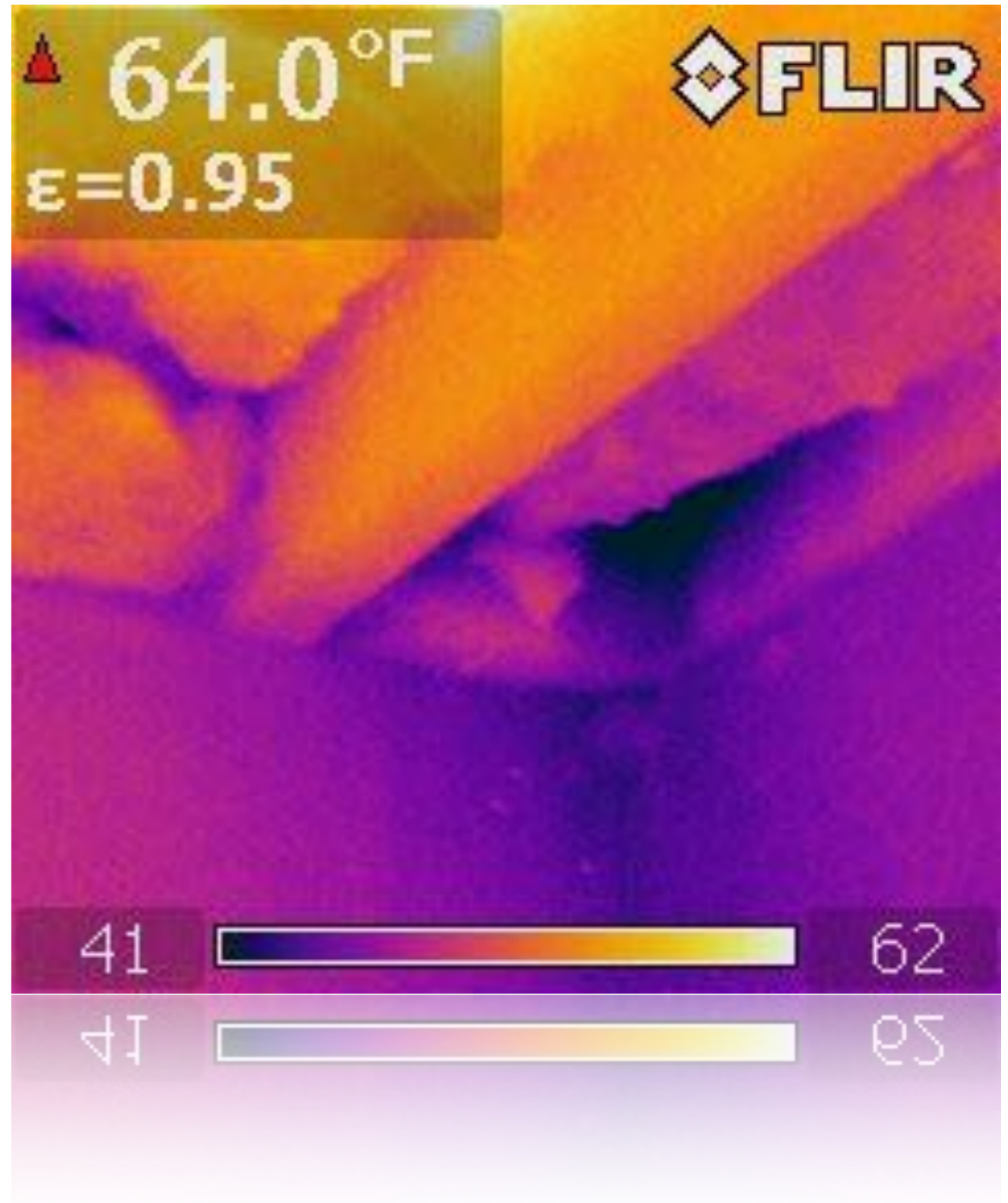
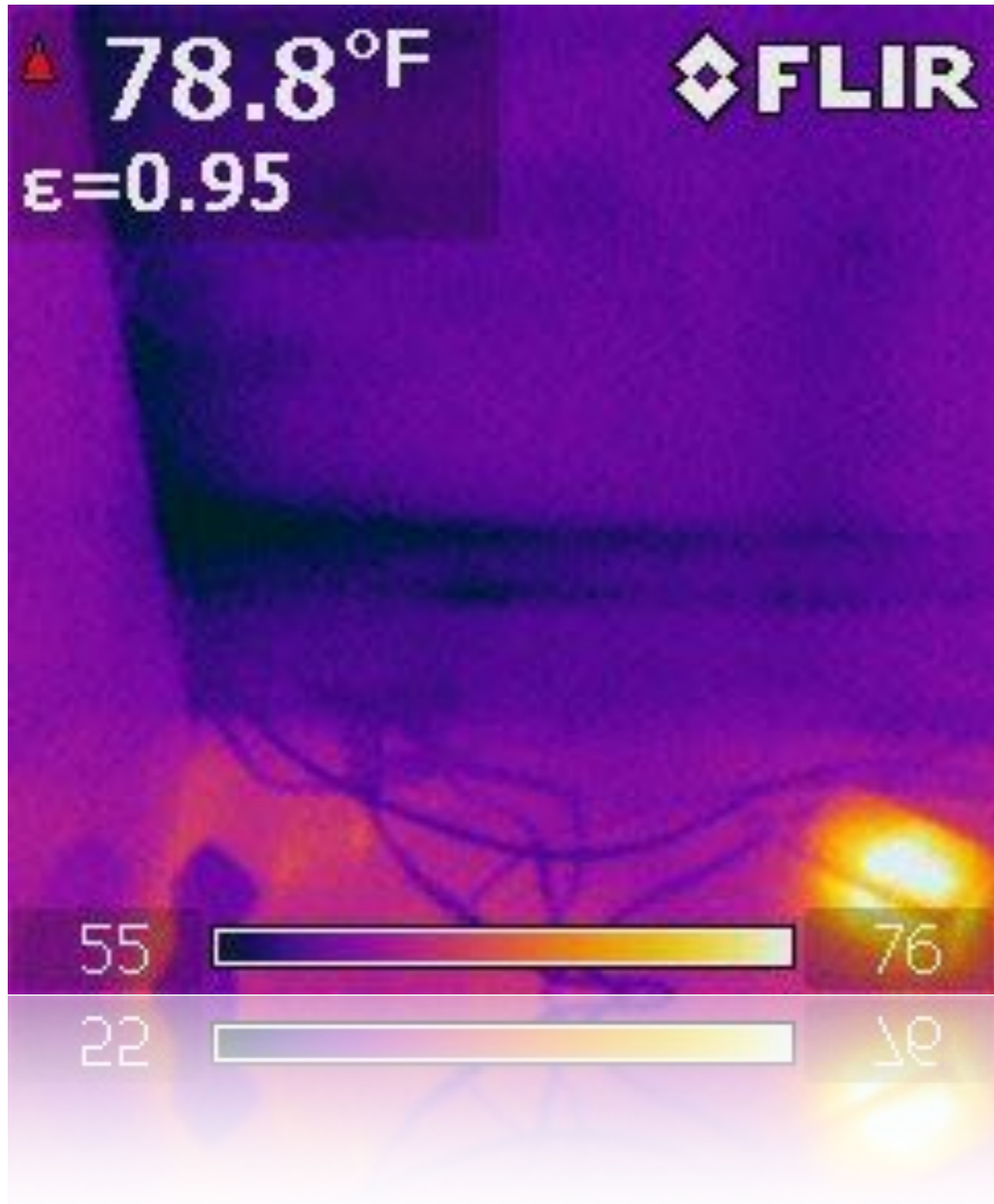


Goal \$1500
Total
5 - \$582.5
G - \$944
\$1526.50

War is a Force
That Gives Us
Meaning







So, Where Are We?

- Structure ✓
- Weather Barrier?
- Insulation ✗
- Airtightness ✗
- Moisture Management ✓
- Ventilation/ Air Quality ✗
- Comfort ✗ ✗
- Daylight ✗
- Durability (30 years?)
- Design (Sign of the Times)

Where do we go?

what we need



Image Source: Wikipedia

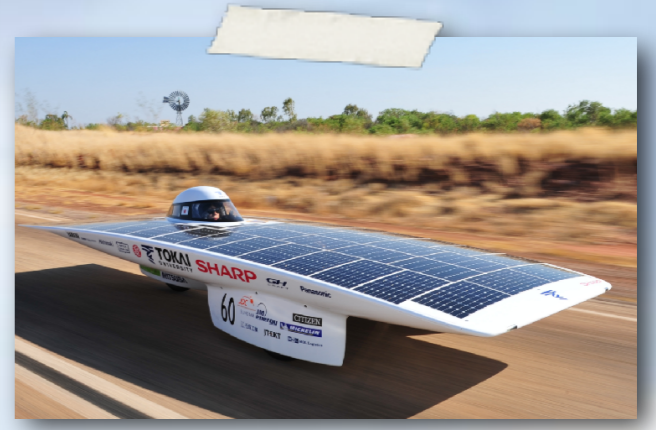
The List

- + 3 Bedrooms
- + 2 Baths
- + Mudroom
- Better kitchen
- Better living areas
- Homeschool room
- Safe stairs
- Weather-tight envelope
- Durable structure
- Healthy interiors
- Comfort & daylight
- Low operating cost
- **Energy performance**



Quality-Approved
Energy Retrofit with
Passive House Components
Dr. Wolfgang Feist

Dr. Wolfgang Feist
Passive House Components
Energy Retrofit with
Quality-Approved





Passive House Institute
Dr. Wolfgang Feist
Rheinstraße 44/46
64283 Darmstadt
Germany
www.passivehouse.com

EnerPHit and EnerPHit⁺

Certification Criteria for Energy Retrofits with Passive House Components

If an energy retrofit of an existing building meets Passive House criteria (for new builds), it, too, can be certified as a Certified Passive House.

It is, however, often difficult to feasibly achieve the Passive House Standard in older buildings for a variety of reasons. Passive House technology for relevant building components in such buildings does, nevertheless, lead to considerable improvements with respect to thermal comfort, structural longevity, cost-effectiveness over the building lifecycle and energy use.

Buildings that have been retrofitted with Passive House components and, to a great extent, with exterior wall insulation can achieve EnerPHit certification as evidence of both building quality and fulfilment of specific energy values. The EnerPHit⁺ designation is applied if more than 25 % of the opaque exterior wall surface has interior insulation.

How do we get there?



Holistic Energy Reduction Retrofit
≠
Weatherization



Sports car?

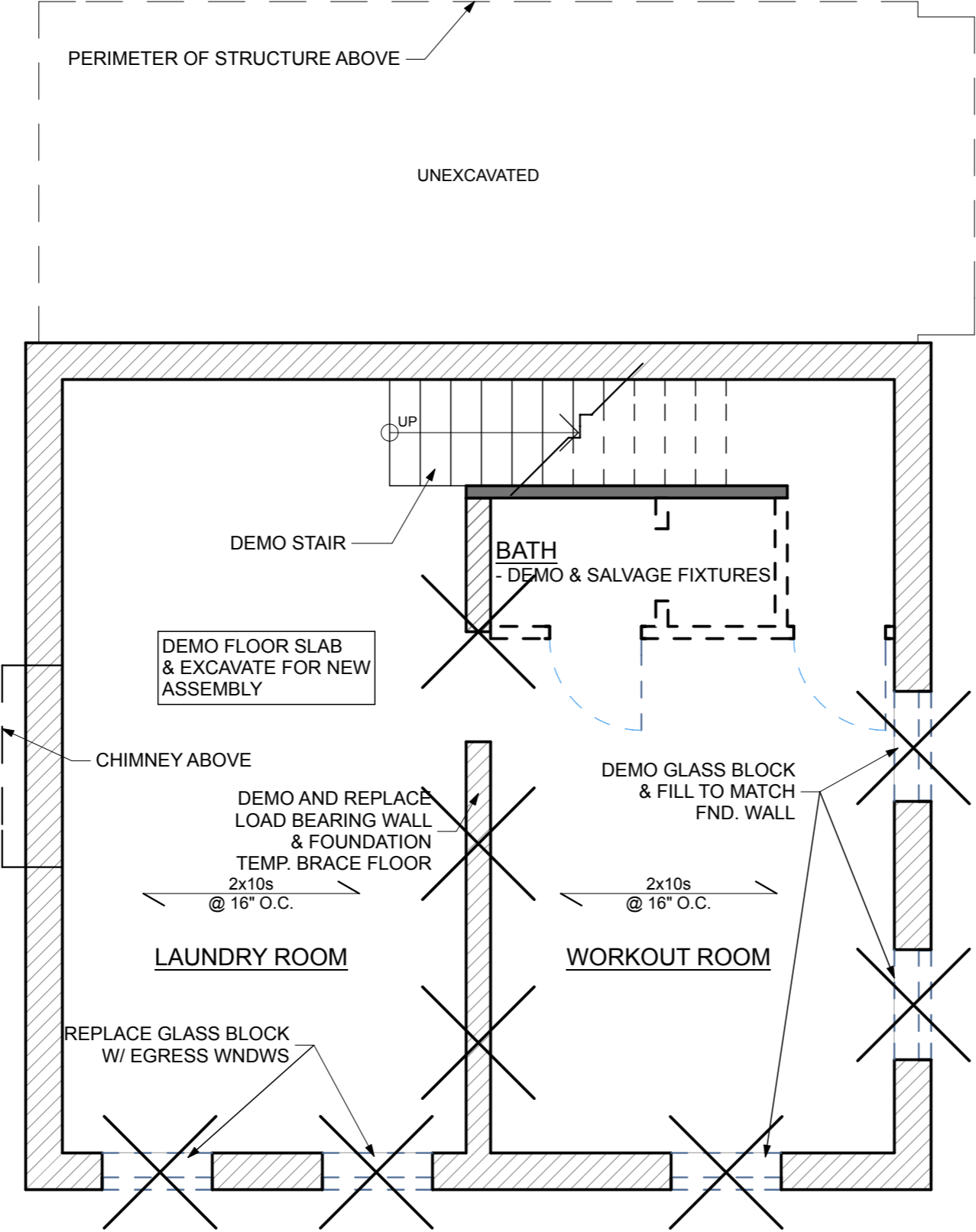
The Plan for Success

- Set goals for performance and design
- Overlay architectural program
- Make the home safe for people (code compliance)
- Control temperature, air, and moisture
- Add ventilation
- Make the envelope air- and weather-tight
- Add continuous insulation to meet the energy goals
- Assess moisture transfer through shell
- Implement robust climate zone-appropriate assemblies
- Reduce energy demand by 2/3 and air-leakage 10X to meet Passive House retrofit standard (EnerPHit)

The Concept



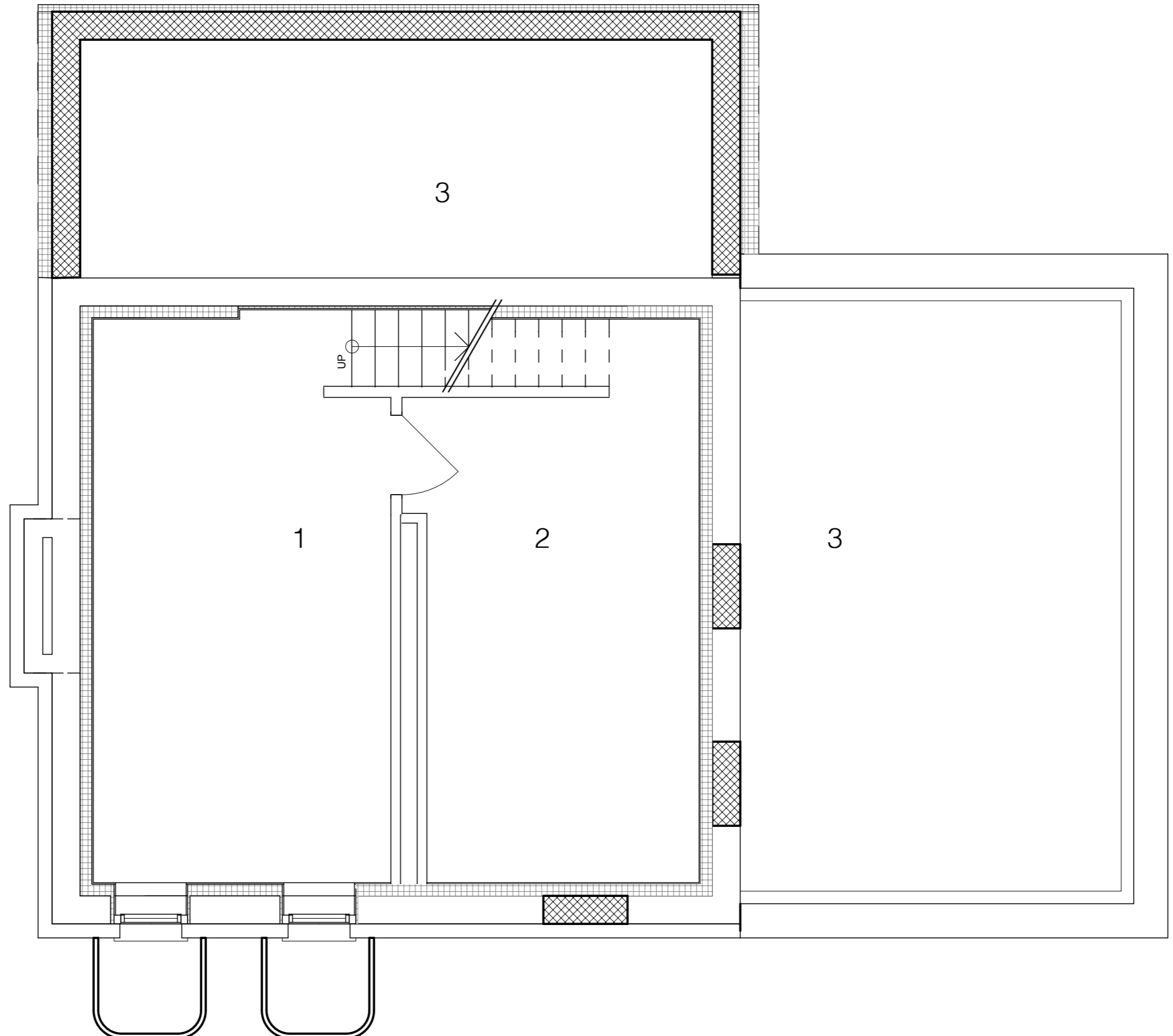
Basement



Basement



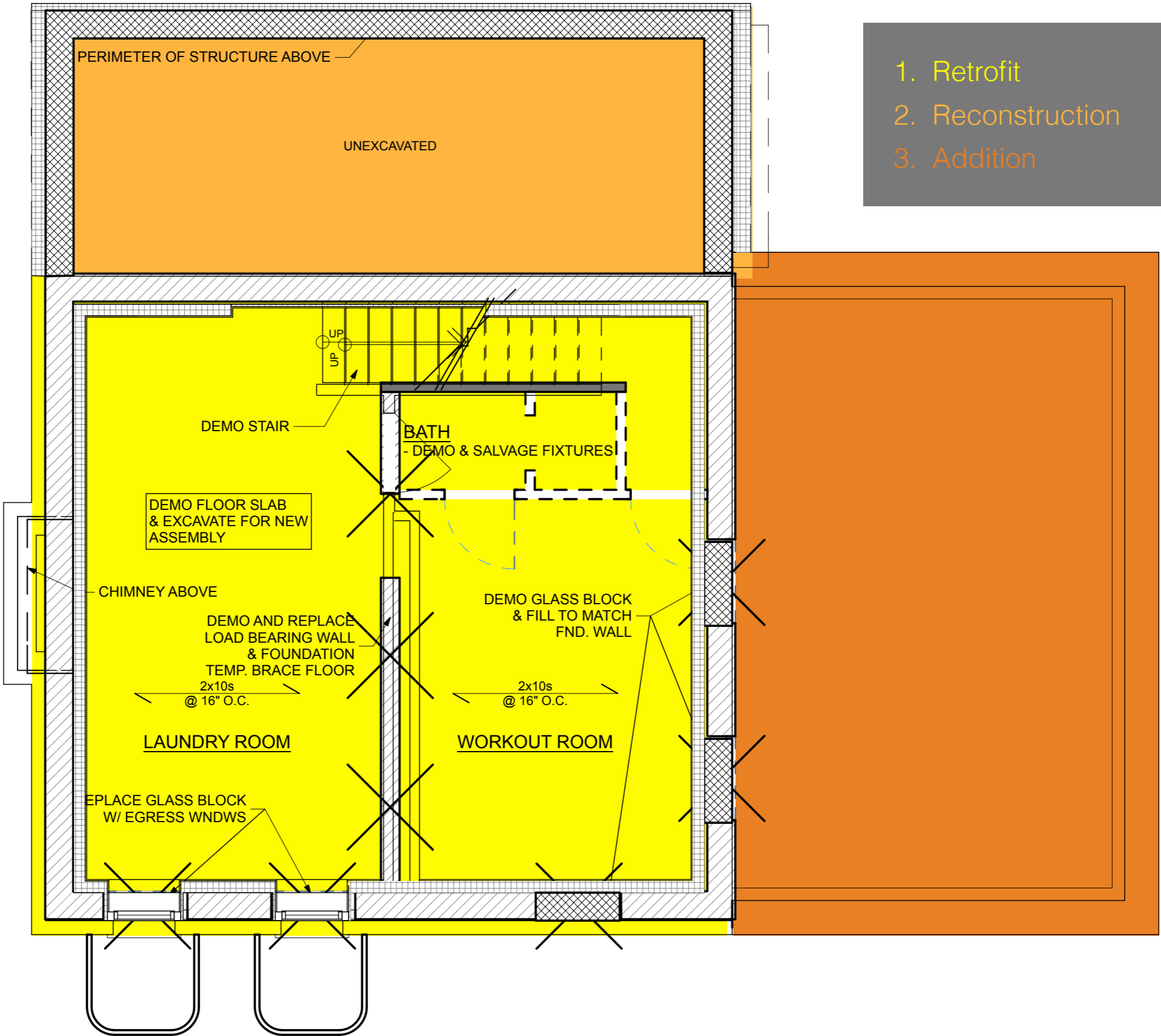
- 1. Homeschool Room
- 2. Mechanical
- 3. Unexcavated



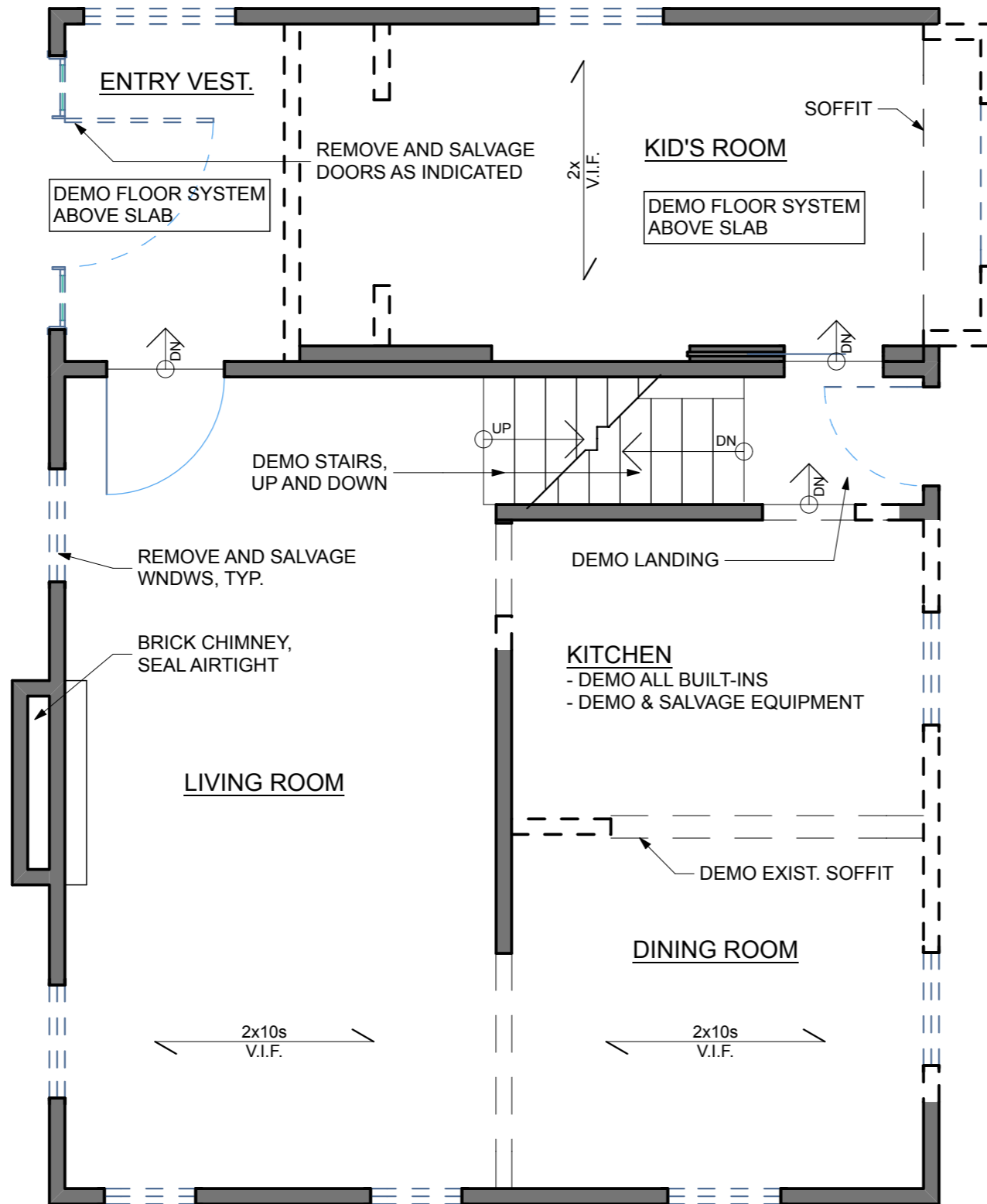
Basement



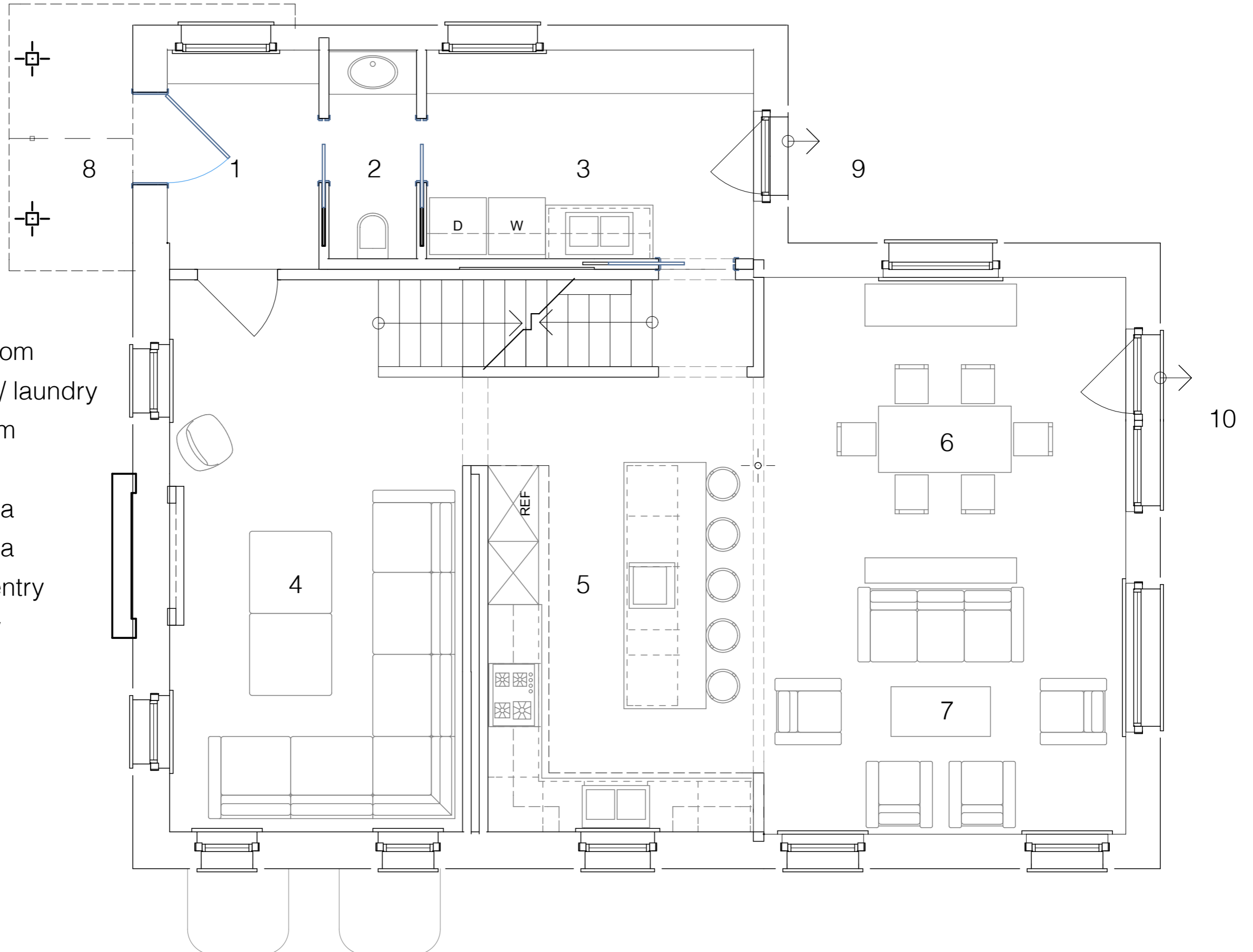
- 1. Retrofit
- 2. Reconstruction
- 3. Addition



First Floor

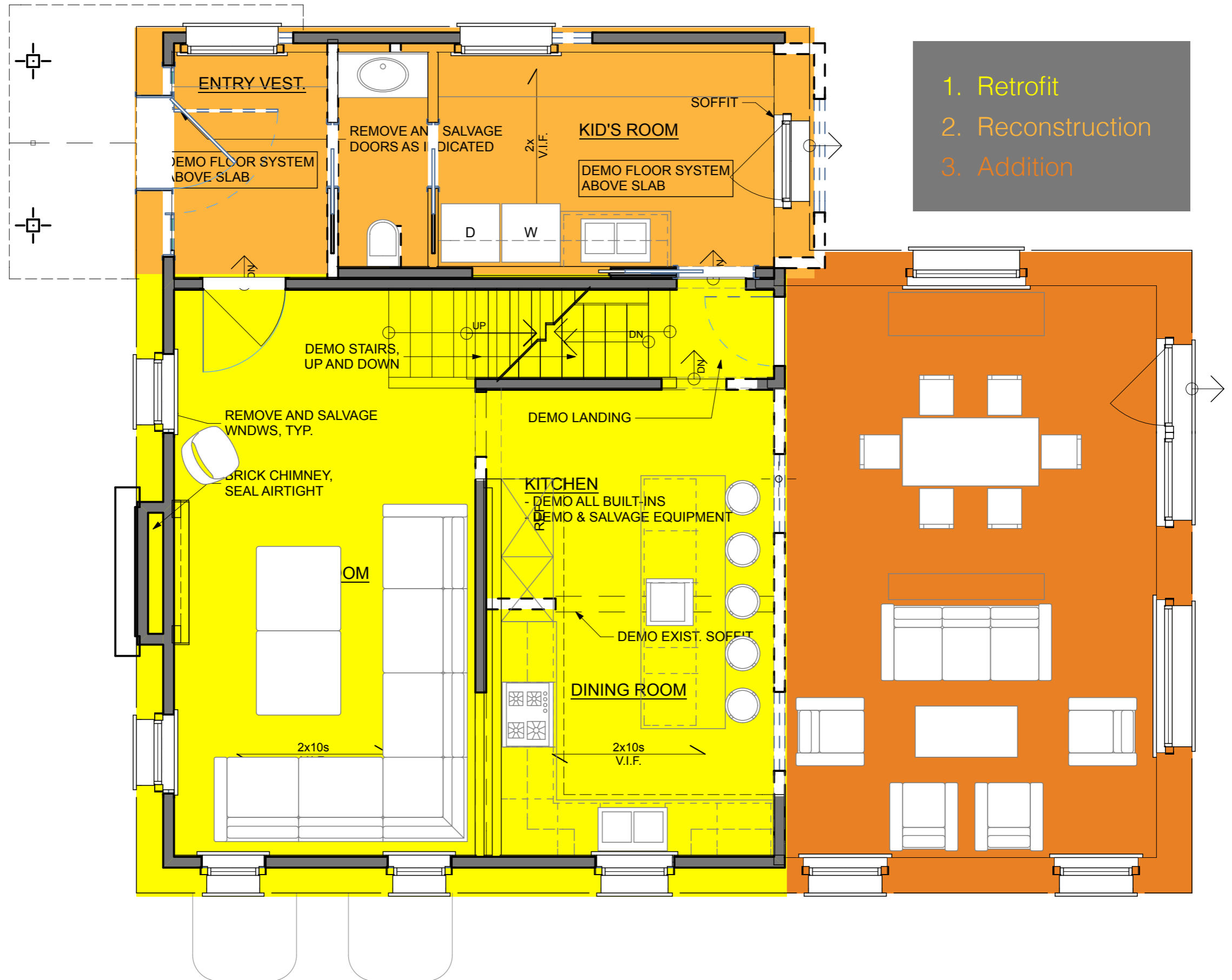


First Floor

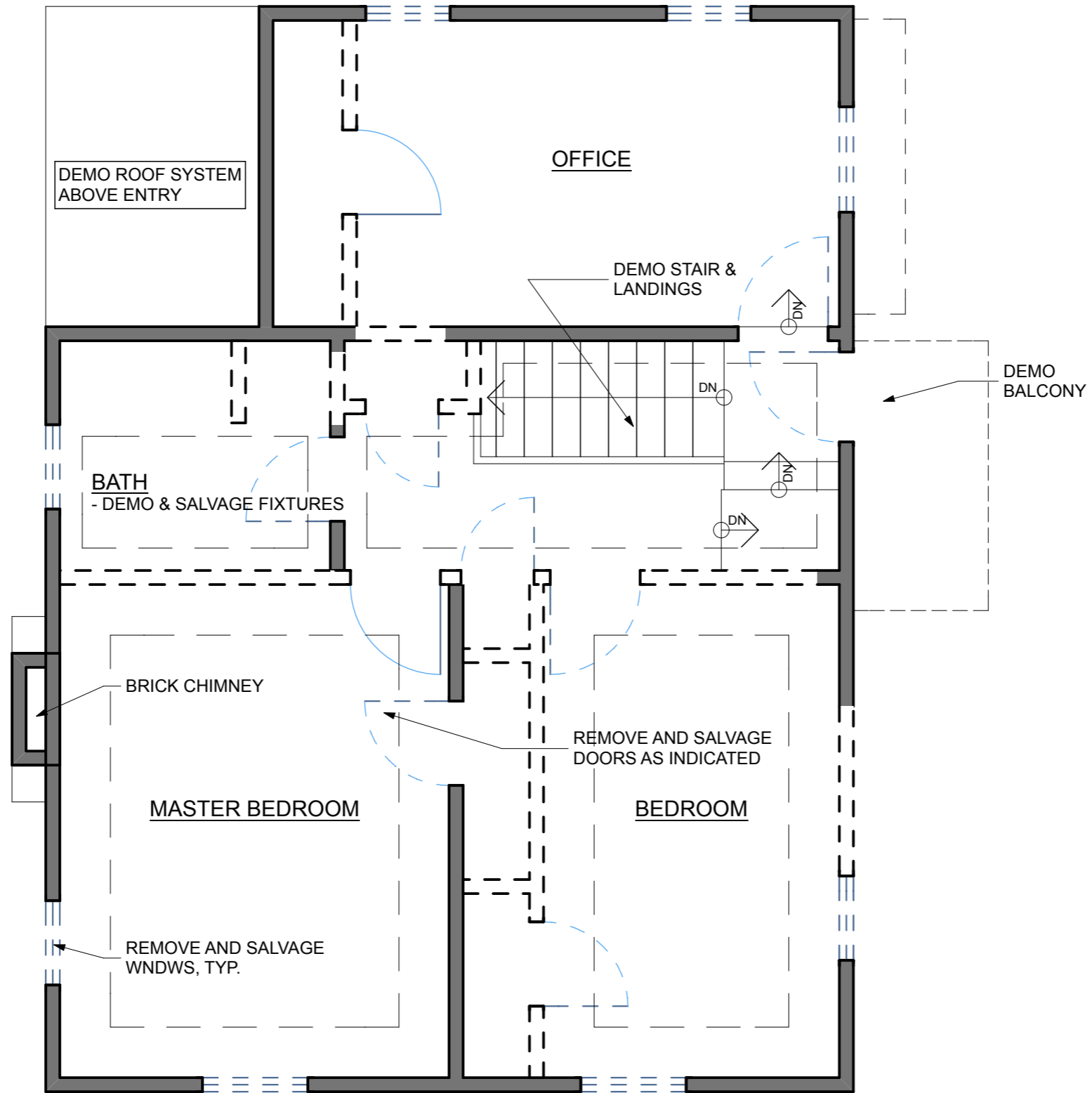


- 1. Entry
- 2. Powder room
- 3. Mud room/ laundry
- 4. Living room
- 5. Kitchen
- 6. Dining area
- 7. Family area
- 8. Covered entry
- 9. Rear entry
- 10. Patio

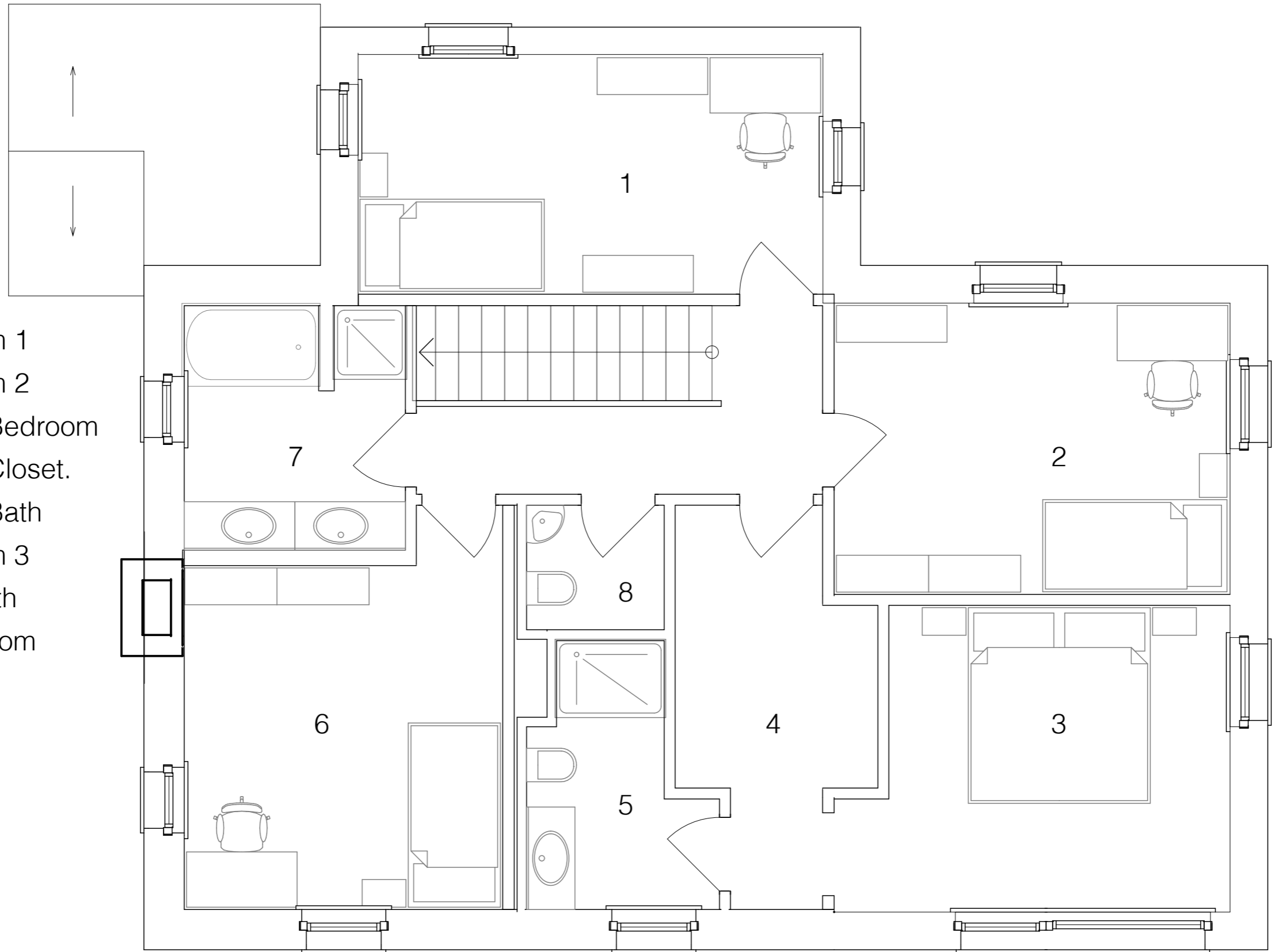
First Floor



Second Floor

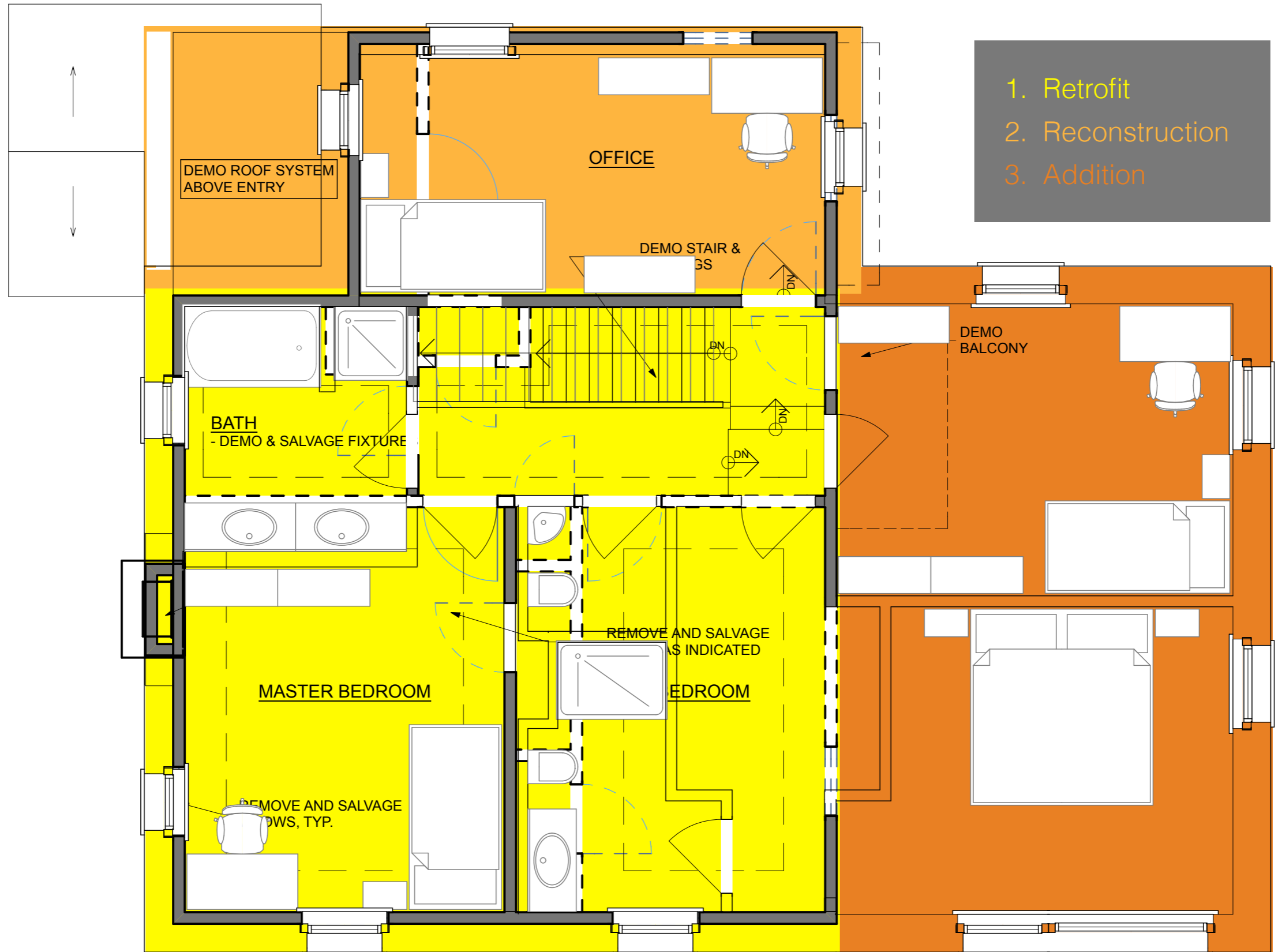


Second Floor



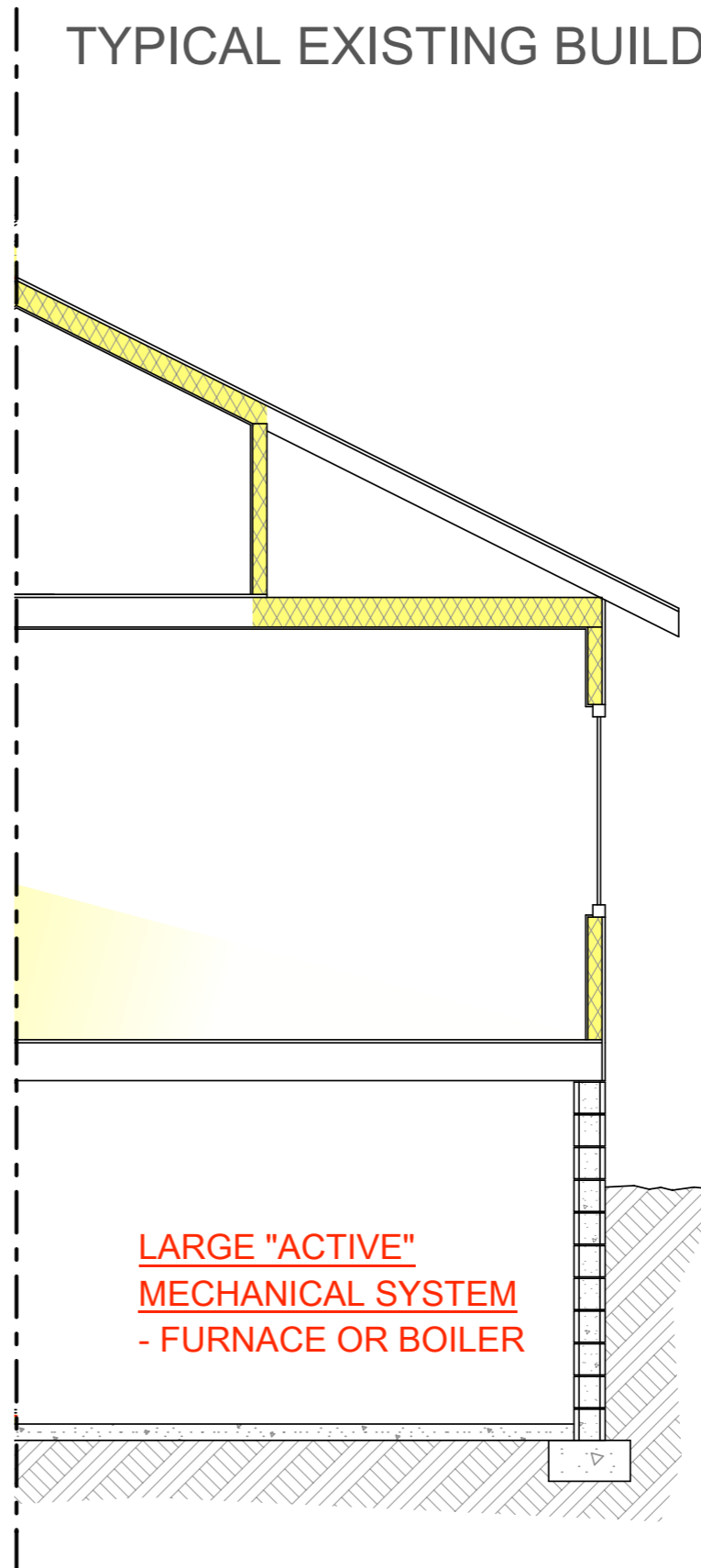
1. Bedroom 1
2. Bedroom 2
3. Master Bedroom
4. Master Closet.
5. Master Bath
6. Bedroom 3
7. Kid's Bath
8. Toilet Room

Second Floor



Retrofit Concept

TYPICAL EXISTING BUILDING (BEFORE)



EXISTING CONDITION

- INSUFFICIENT INSULATION
- LOW-PERFORMANCE WINDOWS AND DOORS
- AIR LEAKAGE
- NO VENTILATION

EXISTING CONDITION

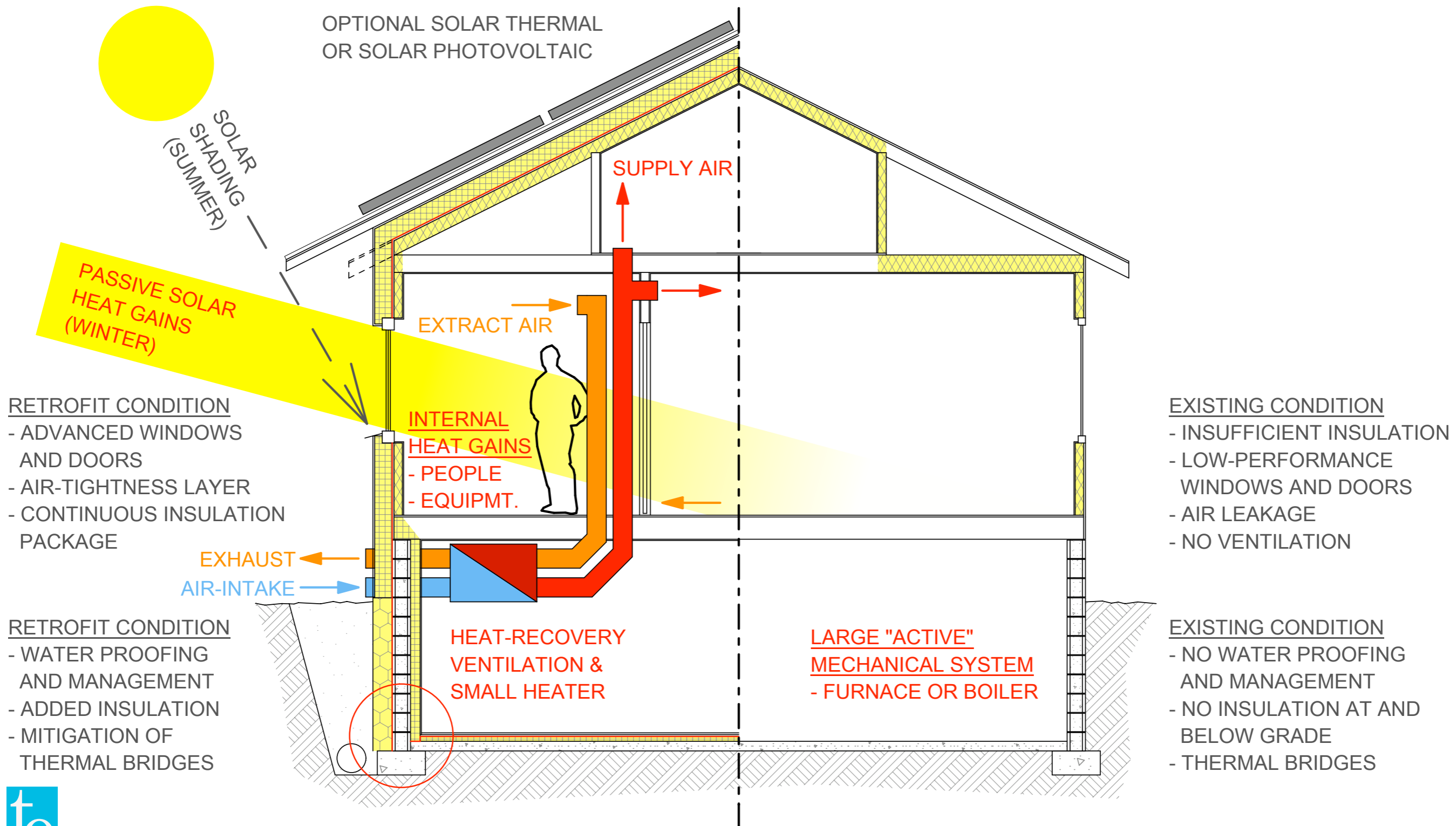
- NO WATER PROOFING AND MANAGEMENT
- NO INSULATION AT AND BELOW GRADE
- THERMAL BRIDGES

LARGE "ACTIVE"
MECHANICAL SYSTEM
- FURNACE OR BOILER

Retrofit Concept

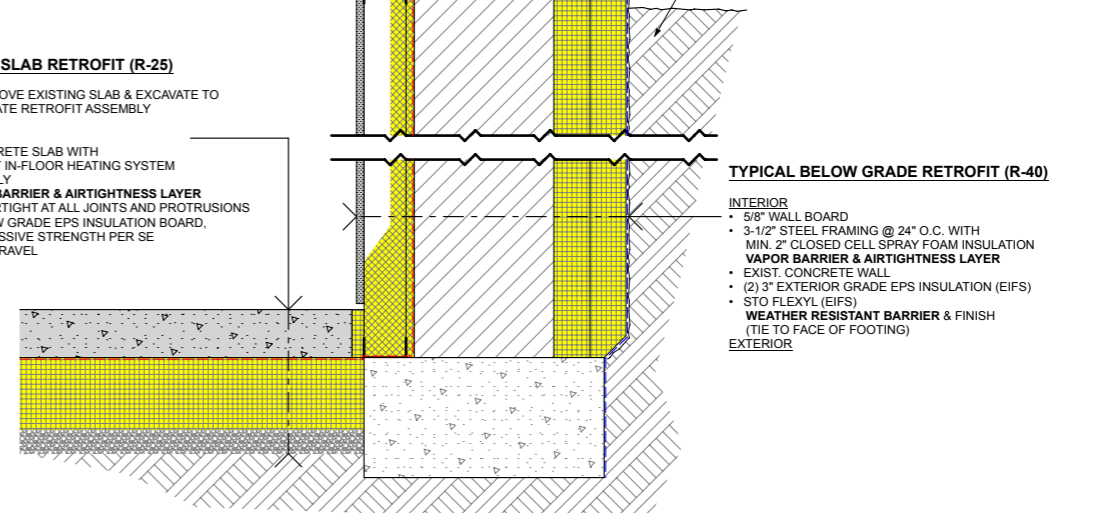
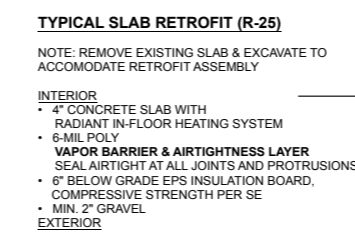
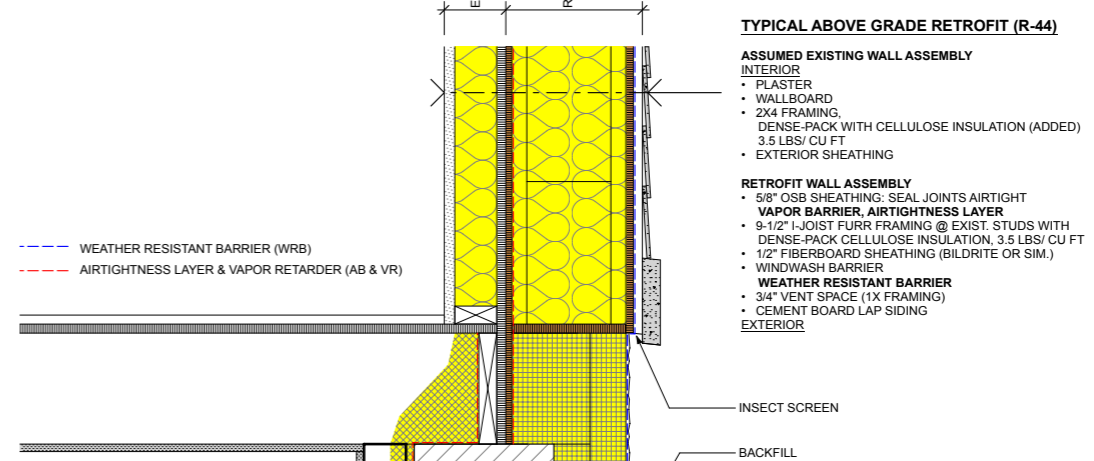
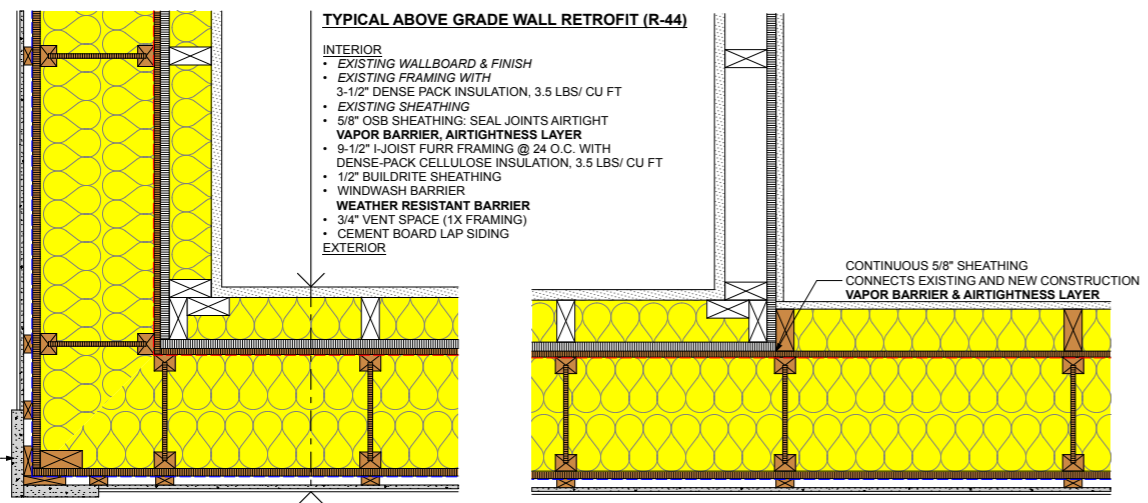
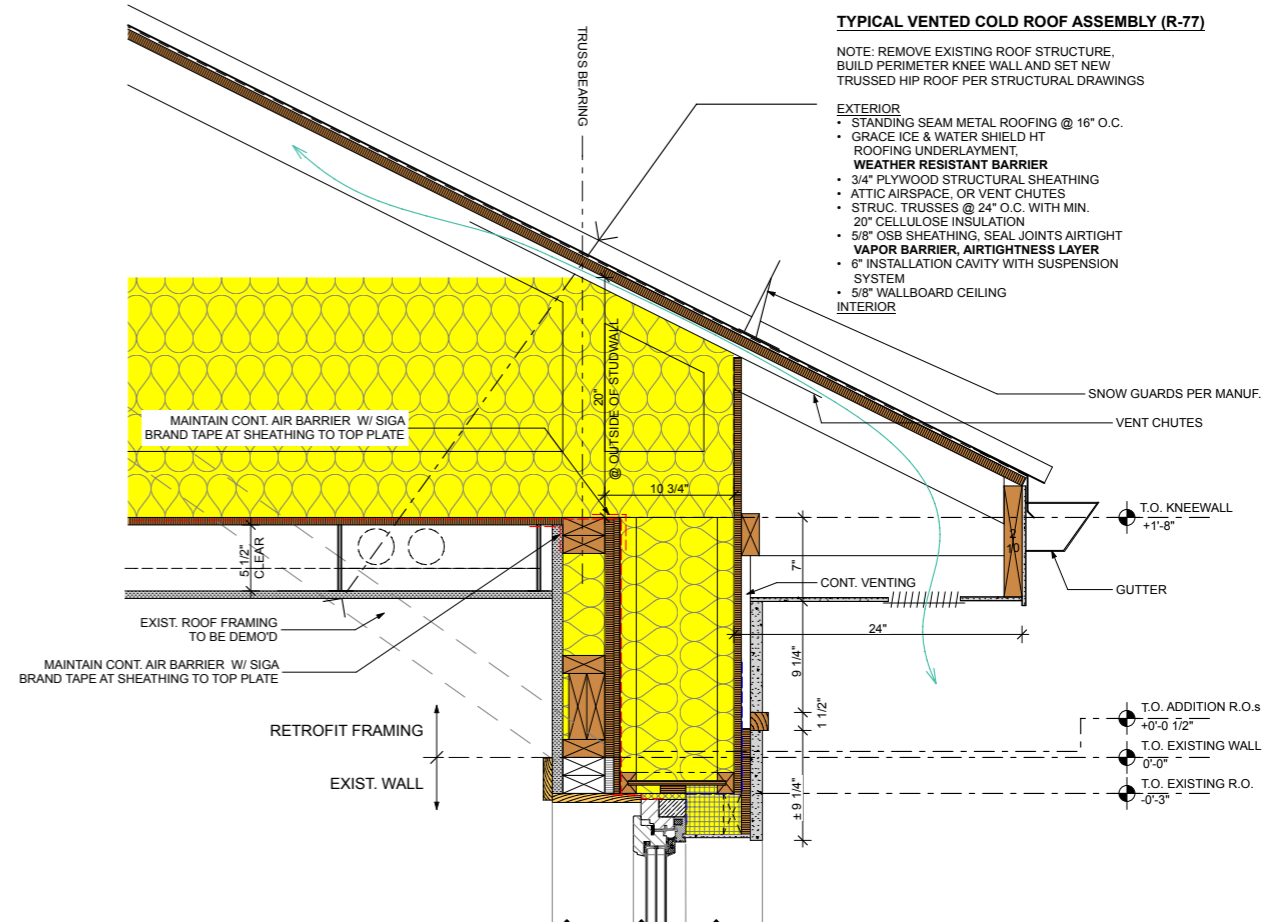
DEEP ENERGY REDUCTION RETROFIT (AFTER)

TYPICAL EXISTING BUILDING (BEFORE)



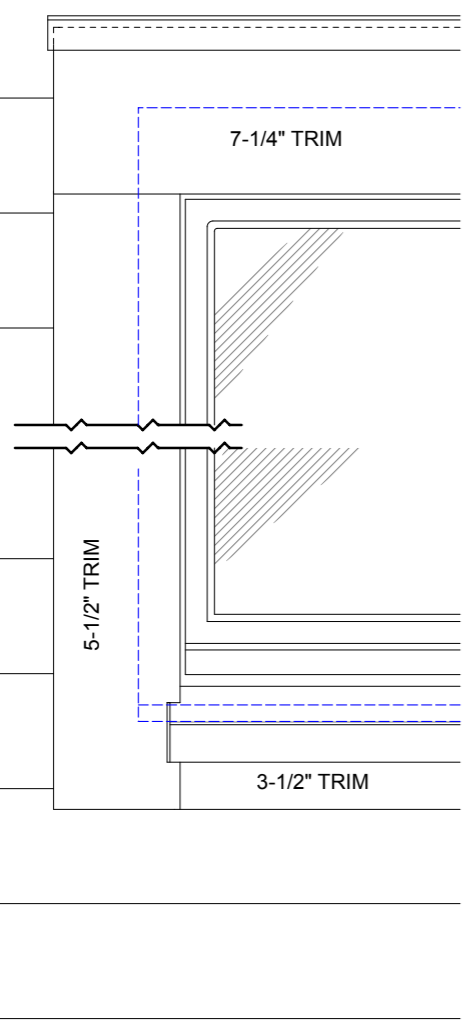
Assemblies

- Walls a/ grade: R-10 to R-44
- Walls b/ grade: R-1 to R-30+
- Roof: R-20 to R-77
- Slab: R-1 to R-25

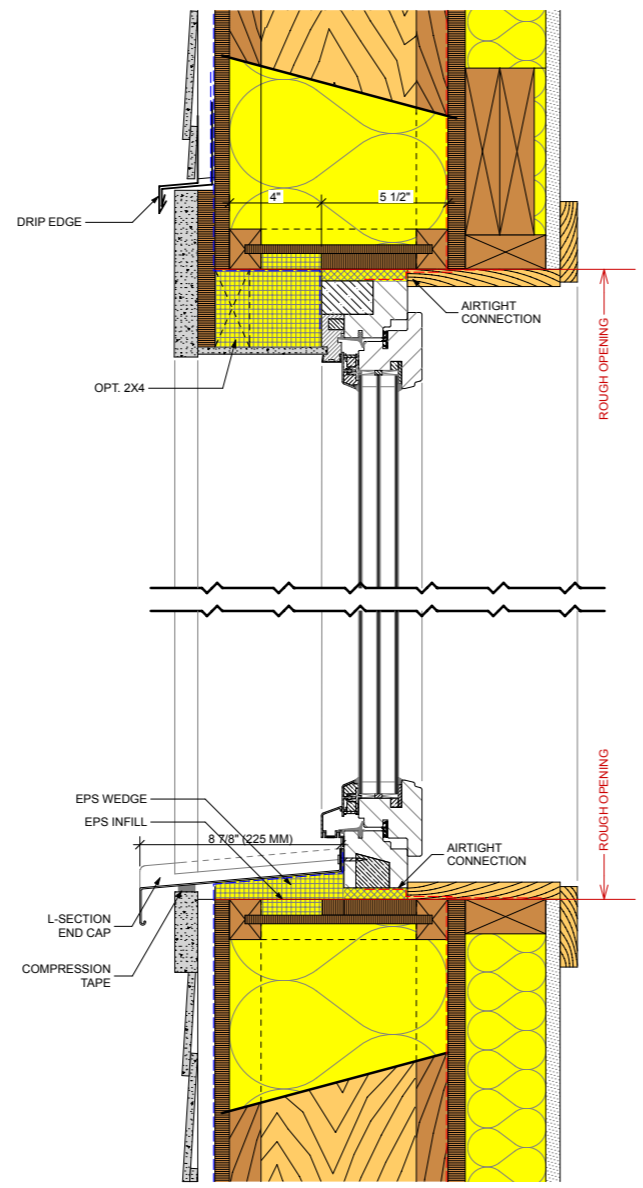


--- WEATHER RESISTANT BARRIER (WRB)
 --- AIRTIGHTNESS LAYER & VAPOR RETARDER (AB & VR)

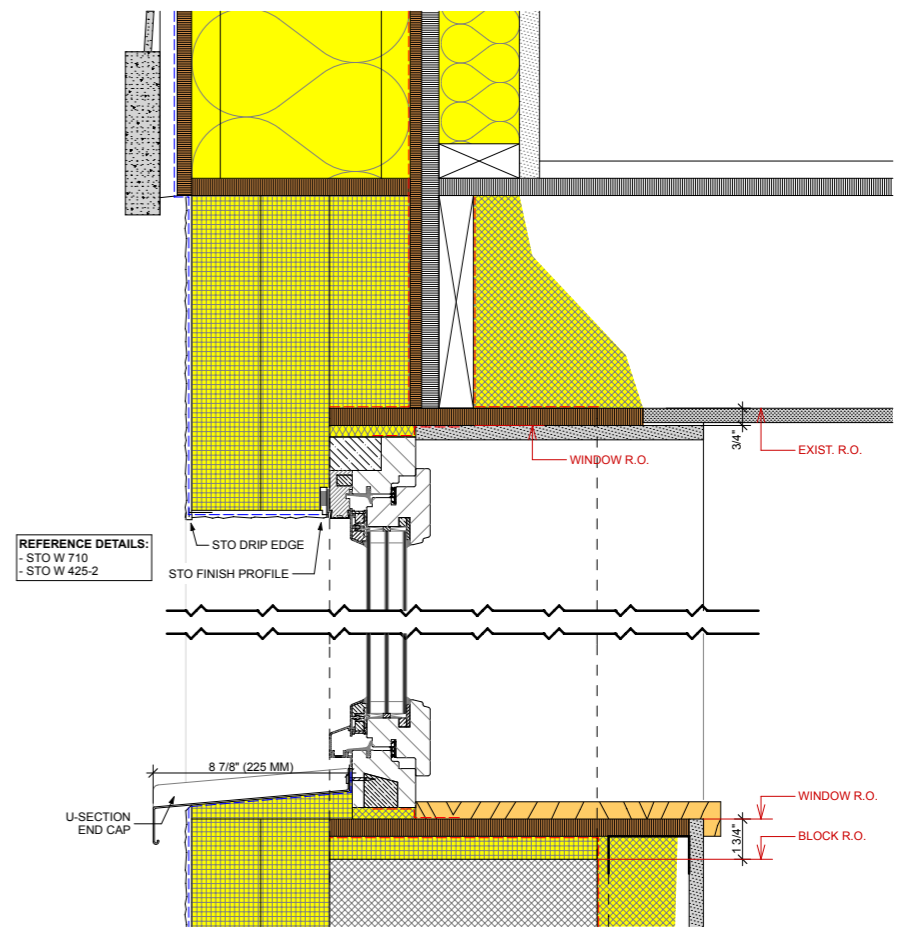
Details



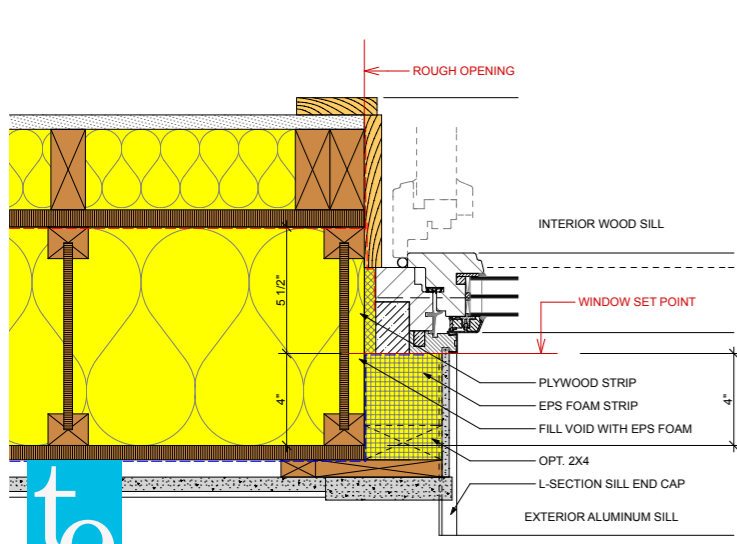
1 TYPICAL EXTERIOR WINDOW ELEVATION
 SCALE: 3" = 1'-0"



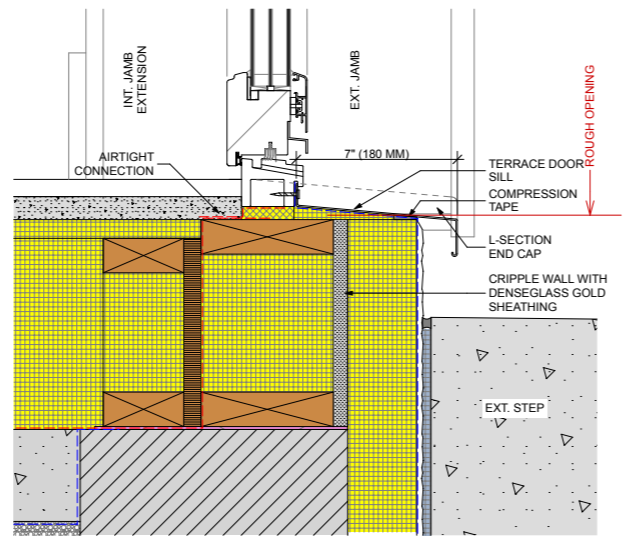
2 TYPICAL WINDOW HEAD & SILL
 SCALE: 3" = 1'-0"



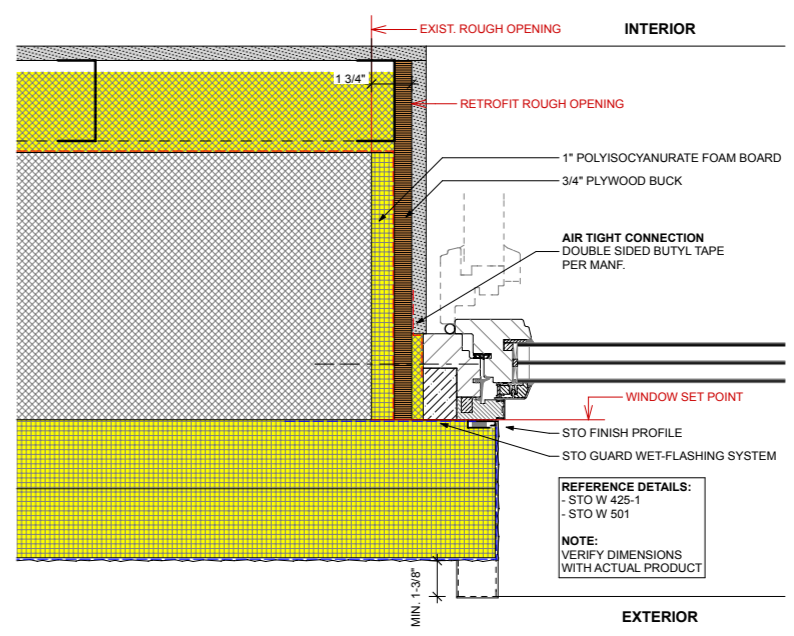
5 TYPICAL WINDOW HEAD & SILL, BASEMENT
 SCALE: 3" = 1'-0"



3 TYPICAL WINDOW JAMB
 SCALE: 3" = 1'-0"



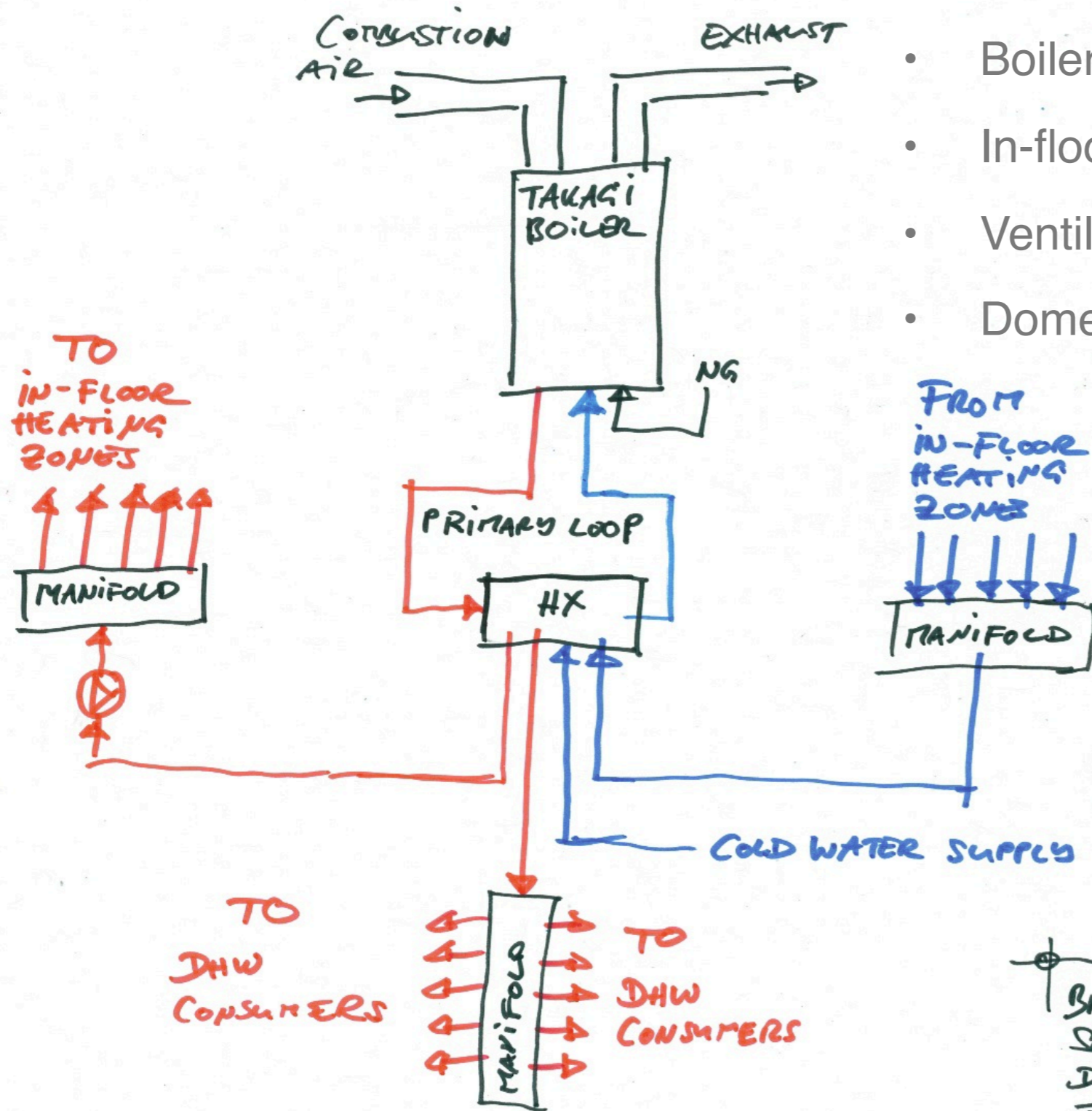
4 TYP. TERRACE DOOR SILL
 SCALE: 3" = 1'-0"



6 TYPICAL WINDOW JAMB, BASEMENT
 SCALE: 3" = 1'-0"




MEP Systems



- Boiler (existing, replaced)
- In-floor heat (existing, reused and expanded)
- Ventilation system (new)
- Domestic hot water system (new plumbing)




 BRAZELTON RESIDENCE
 SCHEMATIC HEATING &
 DHW SYSTEM.
 TDE/TE STUDIO, LTD.

Construction Project





PC75UU
KOMATSU

VEIT

S208054

S208054

PLEASE
RECYCLE
CONTAINER









































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TESTUDIO.COM

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STEGORA INC
CUSTOM HOMES & REMODELING
612-889-8277
EST. 1988

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The MinnePhit House
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SIGA-WH
SIGA



















≤ 1.0

Airtightness

Rough-In Test

0.87 ACH₅₀ [267 CFM₅₀]

























SI-Majves
Wsigach



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Whole House Heat Recovery Ventilation





Insulated Tubes



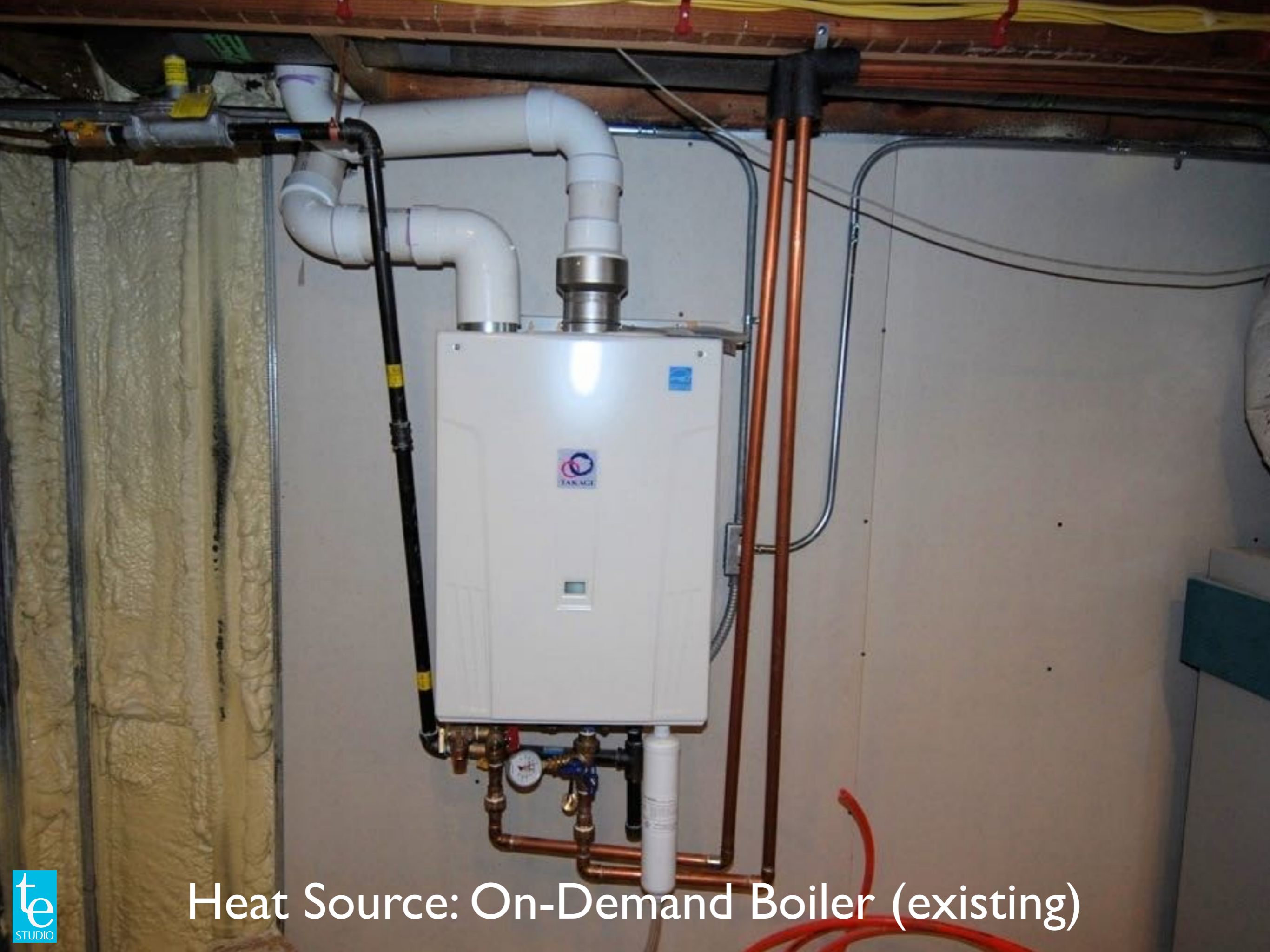
Home-Run Distribution with Tubes



Installation/Service Cavities



Registers: Plug & Play



Heat Source: On-Demand Boiler (existing)



Unique Feature: Water Tree



Minisplit AC

The Result

LIVING WELL IN THE TWIN CITIES

spaces

AUGUST/SEPTEMBER 2013

ECO-CHIC ISSUE

5605

NEW GROUND

Minneapolis
boasts its first
Passivhaus
super-efficient
home

PLUS

- * Green
inside & out
- * Testing
tech cleaning
gadgets

IN EVERY ISSUE

GREAT
PLACES
TO EAT
SHOP PLAY









es a
bbage
hile
rvises.





Homeowners Paul and Desiree Brazelton whip up a fresh egg breakfast. All their eggs come from a brood of hens cooped in the back yard.











Penelope, 7, Amelie, 9, and Madeline, 5, jump for joy (with special permission) in the master bedroom.

> **Bedding and curtain,** westelm.com

Photos: Spaces Magazine



Photos: Spaces Magazine



Photos: Spaces Magazine



Speed racer Madeline is all about pink.

- > **Bedding**, target.com
- > **Rug and curtain**, ikea.com

The upstairs hallway is the perfect spot

Certified Performance

≤ 1.0

Airtightness

Final Test

0.65 ACH₅₀ [195 CFM₅₀]



Passive House Performance

Component Approach

Minimum R-values throughout

Heating Load

20 W/m² [6.3 Btu/h/ft²]

4.1 kW [14 kBtu/h]

Cooling Load

2.6 kW

[0.74 tons, 8.8 kBtu/h]

Airtightness

0.65 ACH₅₀ [196 CFM₅₀]

≤ 1.0

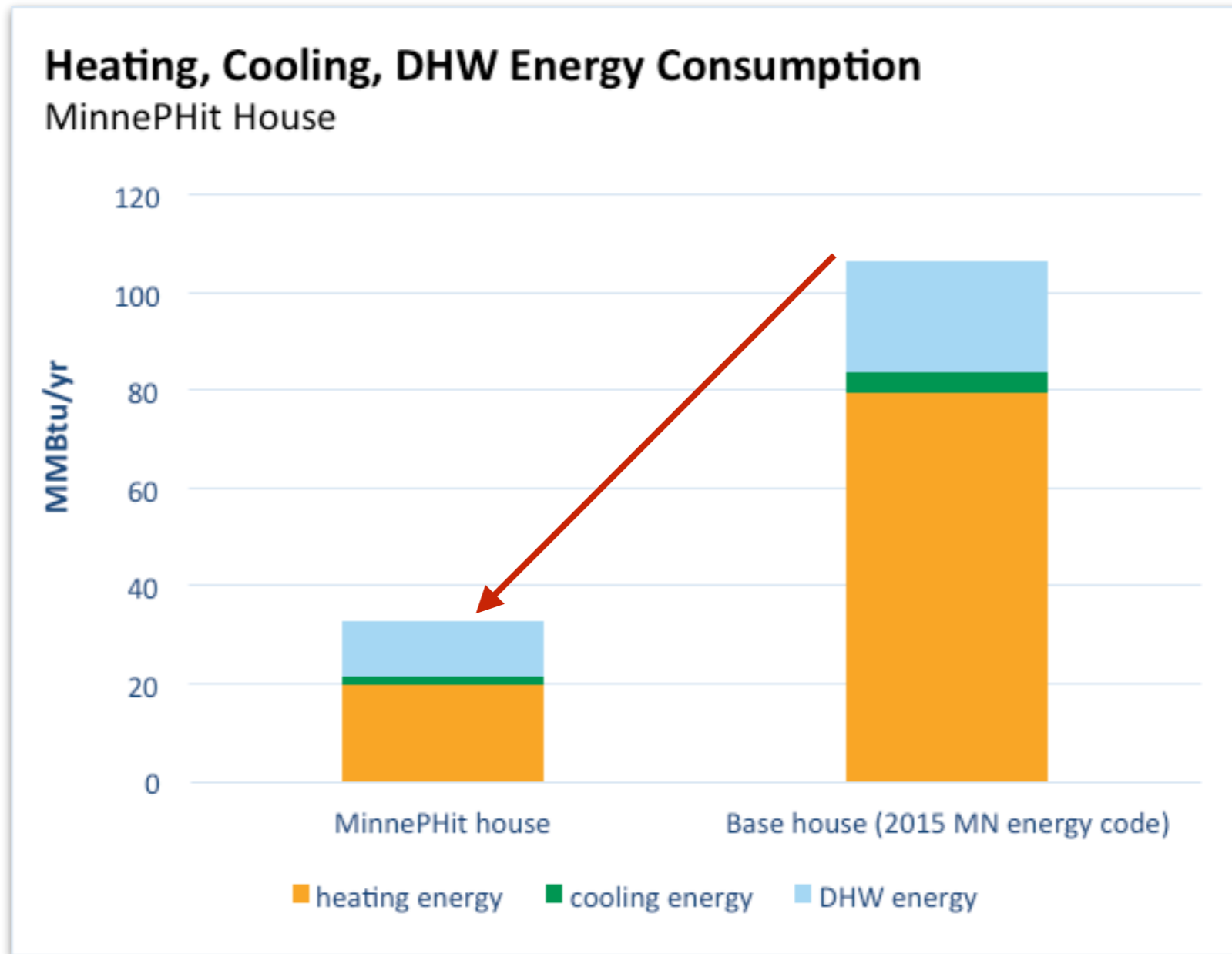
Specific Primary Energy Demand

112 kWh/m² a [35.5 kBtu/ft² a]

≤ 30

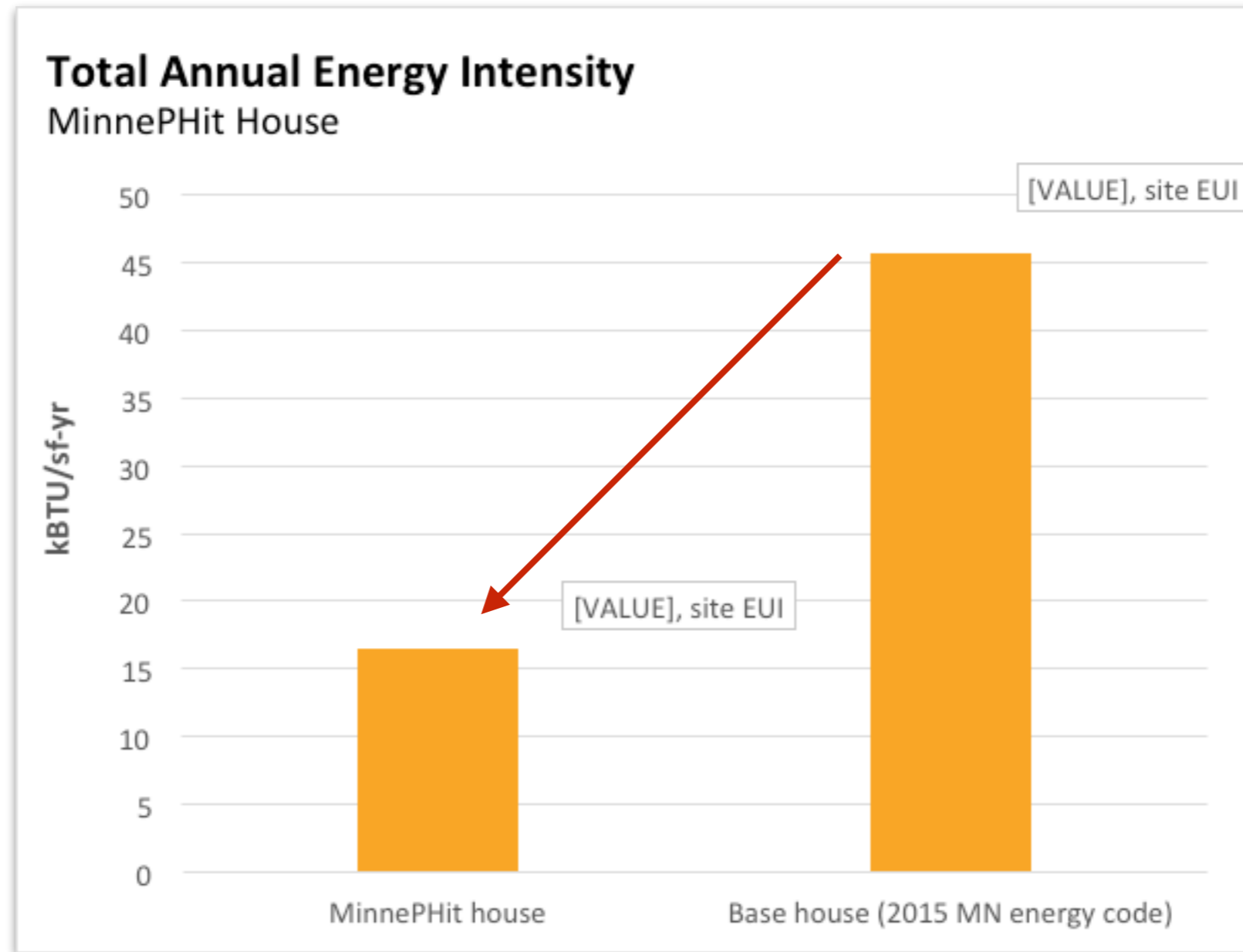
$$QP \leq 120 \text{ kWh/m}^2\text{a} + ((QH - 15 \text{ kWh}/(\text{m}^2\text{a})) * 1.2)$$

Passive House Comparison



Heat loss is dramatically reduced by more than 66% over current new construction in Minnesota.

Passive House Comparison



Annual energy intensity was calculated at 16.5 kBTU/(sf yr).

This is a savings of 64% compared to a similarly-sized house meeting MN 2015 residential energy code—modeled at 45.7 kBTU/(sf yr).

Passive House Certification

Certificate

Certificate ID: 5583_PHI_EP-Pilot_20130110_STh

Passive House Institute
Dr. Wolfgang Feist
Rheinstraße 44/46
64283 Darmstadt, Germany



The Passive House Institute hereby awards the EnerPHit Pilot Project certificate to the following building:

EnerPHit Pilot Project in Minneapolis, 5605 Bloomington Avenue S., MN 55417 Minneapolis, USA



Client:	Paul&Desiree Brazelton 5605 Bloomington Avenue S., MN 55417 Minneapolis, USA
Architecture:	Tim Eian - TE Studio, Ltd. 212 2nd St.SE #222, MN 55414 Minneapolis, USA
Building Services:	TE Studio, Zehnder USA, Paul Brazelton

This building was designed to meet the Passive House component energy retrofit criteria as defined by the Passive House Institute Darmstadt. Given appropriate on-site implementation, this building has the following characteristics:

Building characteristics:	Achieved	Required	
Annual specific space heating demand	27 kWh/(m ² a)	= 25 kWh/(m ² a)	- ¹
Annual specific primary energy demand ² for heating, DHW, ventilation and all other electric appliances for standard use	120 kWh/(m ² a)	= 134 kWh/(m ² a)	✓
Airtightness of building envelope n_{50} as per test result	0.7 h ⁻¹	= 1.0 h ⁻¹	✓
Mean value of individual building component thermal protection :			
Exterior insulation to ambient Thermal transmittance (U-value)	0.11 W/(m ² K)		✓
Exterior insulation to ground Thermal transmittance (U-value)	0.17 W/(m ² K)		-
Interior insulation to ground Thermal transmittance (U-value)	0.17 W/(m ² K)		✓
Thermal bridges Δ_U Building envelope (window installation excluded)	0.01 W/(m ² K)	No limiting value	
Windows Thermal transmittance $U_{w,installed}$	0.77 W/(m ² K)		✓ ²
Exterior doors Thermal transmittance $U_{w,installed}$	0.79 W/(m ² K)		✓
Ventilation unit Effective efficiency of heat recovery	89 %		✓

¹Limiting value is not relevant. ²Improved windows ($U_{w,installed} = 0.65$ W/(m²K)) are recommended in order to meet comfort criteria in winter conditions as optimal thermal comfort directly near window areas cannot currently be guaranteed. Thick curtains or use of floor heating is thus recommended.

Certification criteria met? Selection of the evaluation method	Space heating demand	
	Component quality	✓

issued:
Darmstadt, 10.01.2013

Wolfgang Feist
Dr. Wolfgang Feist

Mission Accomplished!

- Structure ✓
- Weather Barrier ✓
- Insulation ✓
- Airtightness ✓
- Moisture Management ✓
- Ventilation/ Air Quality ✓
- Comfort ✓
- Daylight ✓
- Durability (50-100 years) ✓
- Design ✓
- Lifecycle Cost ✓
- Environmental Impact ✓
- Deconstructability ✓



**HOLISTIC
DESIGN**



Resources



passivehouse.com

passipedia.org

passivehouse-international.org



Thank you!

testudio.com