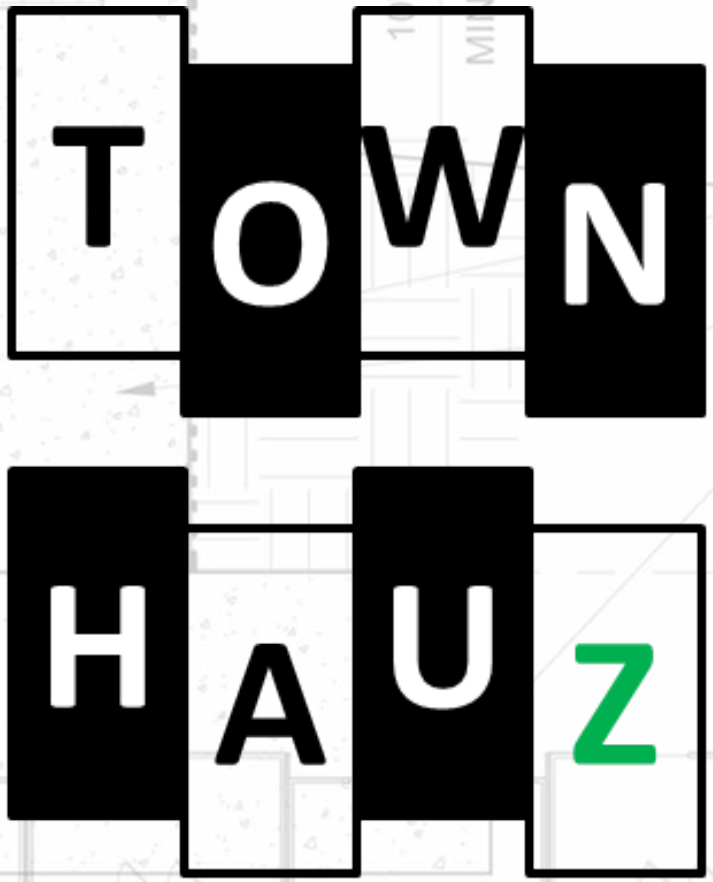


Coming soon to your neighborhood

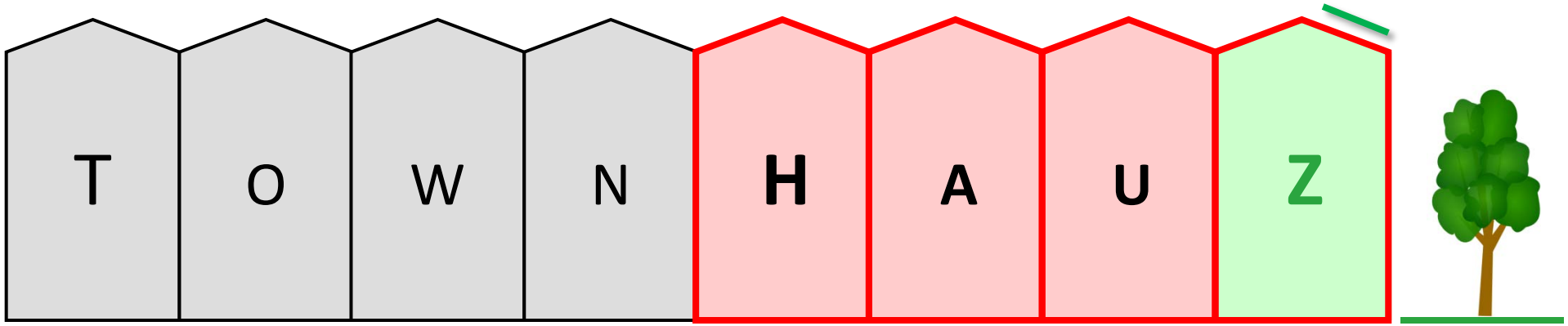
the TownHauZ

by

Team *Invent the Future®*

http://townhauz.bldgsci.net/

A Journey of Discovery and Innovation



Team *Invent the Future®*

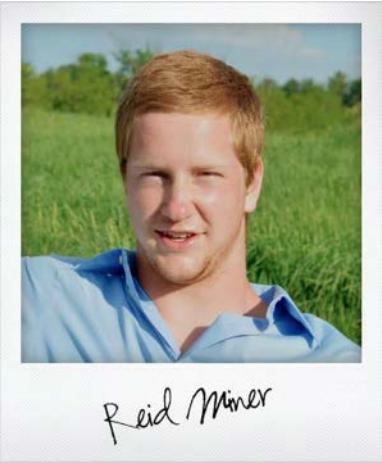
Teni Ladipo
Project Lead
Developer

Susan Maddox
Chief Estimator

Marcelo de Almeida
Simulation Analyst

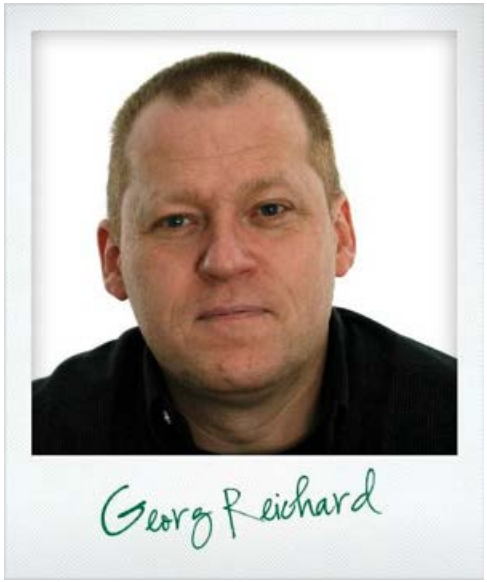
Sarah Scott
Planning &
Development

Greg Polinger
Energy Simulation
Specialist



Reid Miner
Systems Specialist

Team *Invent the Future*®



Georg Reichard
Faculty Advisor

Will Manion
Faculty Advisor in Residence

Industry Advisors

COMMUNITY
HOUSING PARTNERS

The TOWNHAUZ at Admiral's Landing

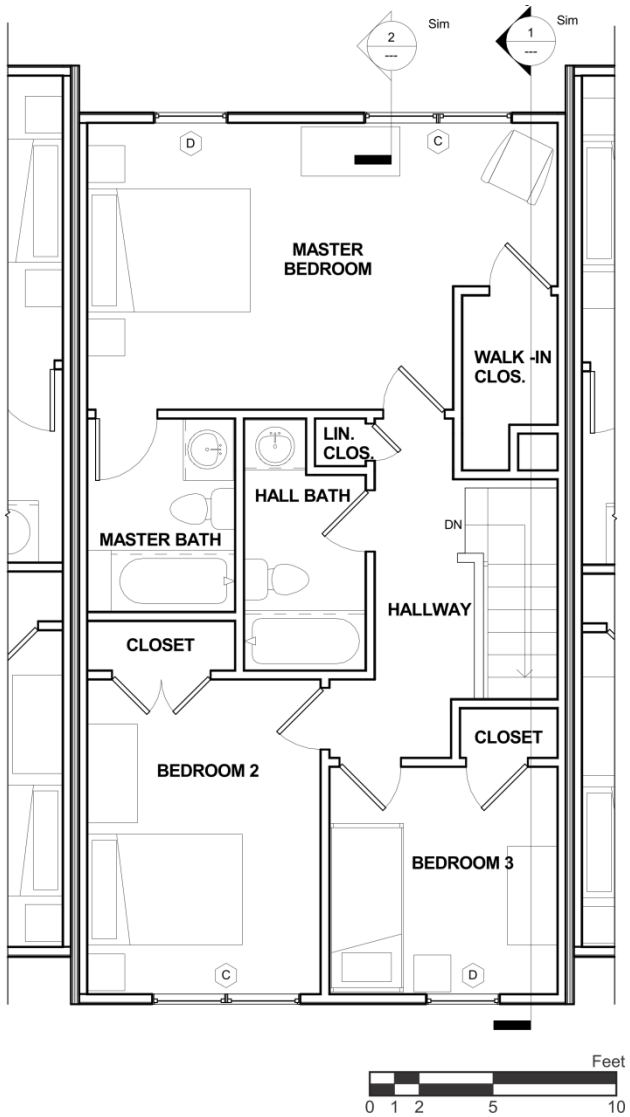
Location:	Dundalk, MD
IECC Climate Zone:	4 (Mixed-Humid)
EPA Radon Zone:	1
Elevation:	154'
Annual Max Temp:	60˚F
Annual Min Temp:	44˚F
Mean Temp:	52 ˚F
Annual Mean Precip:	41"
HDD:	5486
CDD:	795

North Point Village, Dundalk, MD

A neighborhood experiencing revitalization

Current Focus:

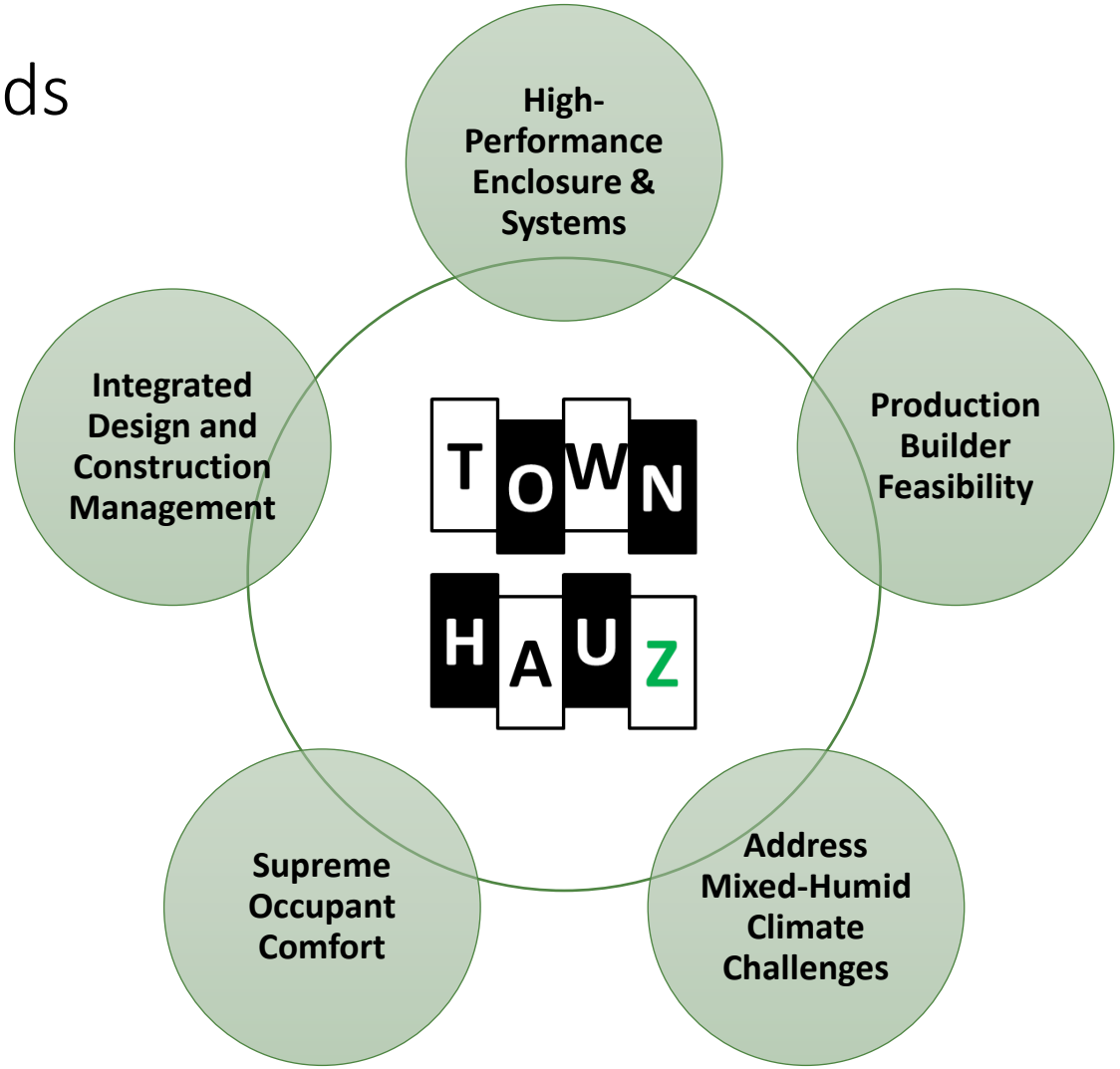
- South oriented units



1690 SF, 3 stories, 3 bedrooms, 2 ½ bath

Design Goals & Key Design Methods

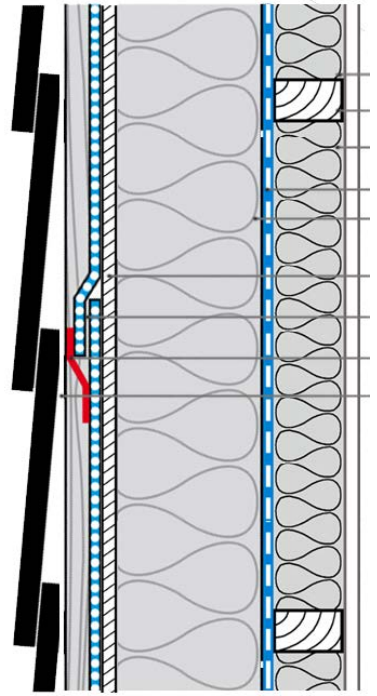
- Thermal Performance Analysis
- Hygrothermal Analysis
- Thermal Bridge Analysis
- Thermal Comfort Analysis
- Energy Simulations
- Financial Analysis
- Construction and Occupant Experience Analysis



Enclosure Design Approach

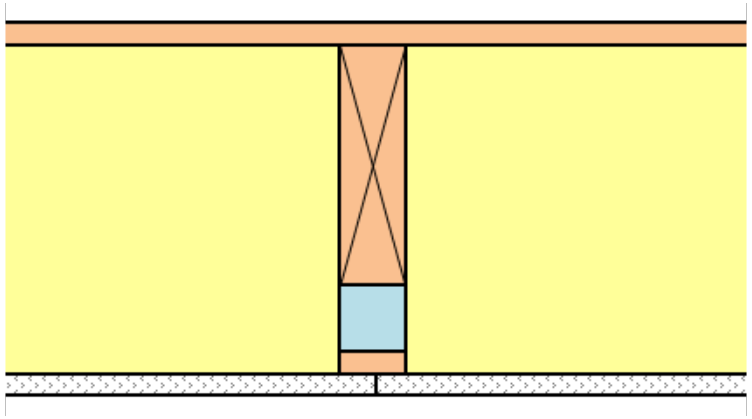
Strategies to improve thermal performance:

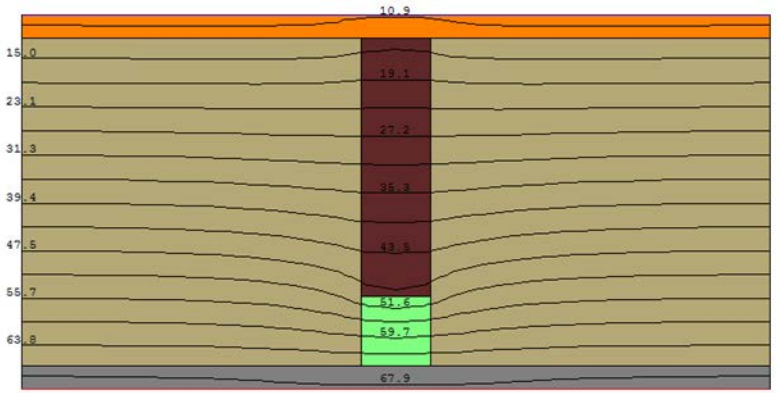
- Increasing cavity by moving to 2x6 wall assemblies
  - Works also for production builder
- Adding exterior rigid insulation
  - Additional step/labor/cost required
- Double stud walls
  - Increased cost, production challenge
- Insulated installation cavity
  - Lowest condensation risk
  - Not production builder friendly



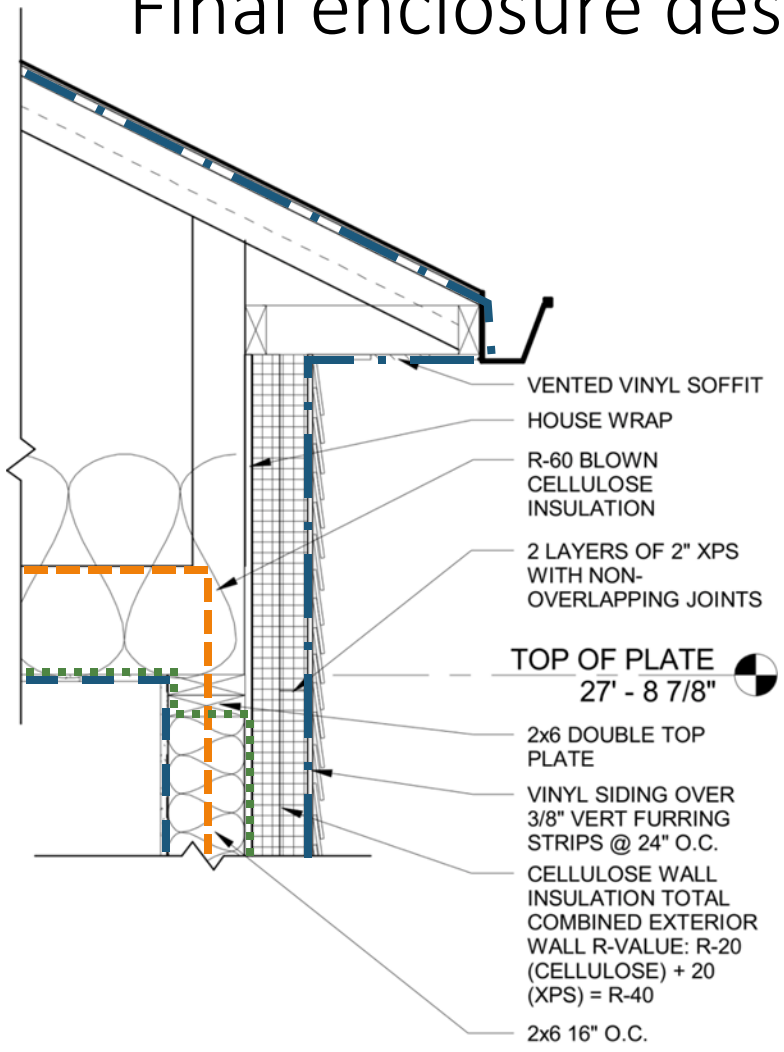
Production friendly hybrid R-25 wall system

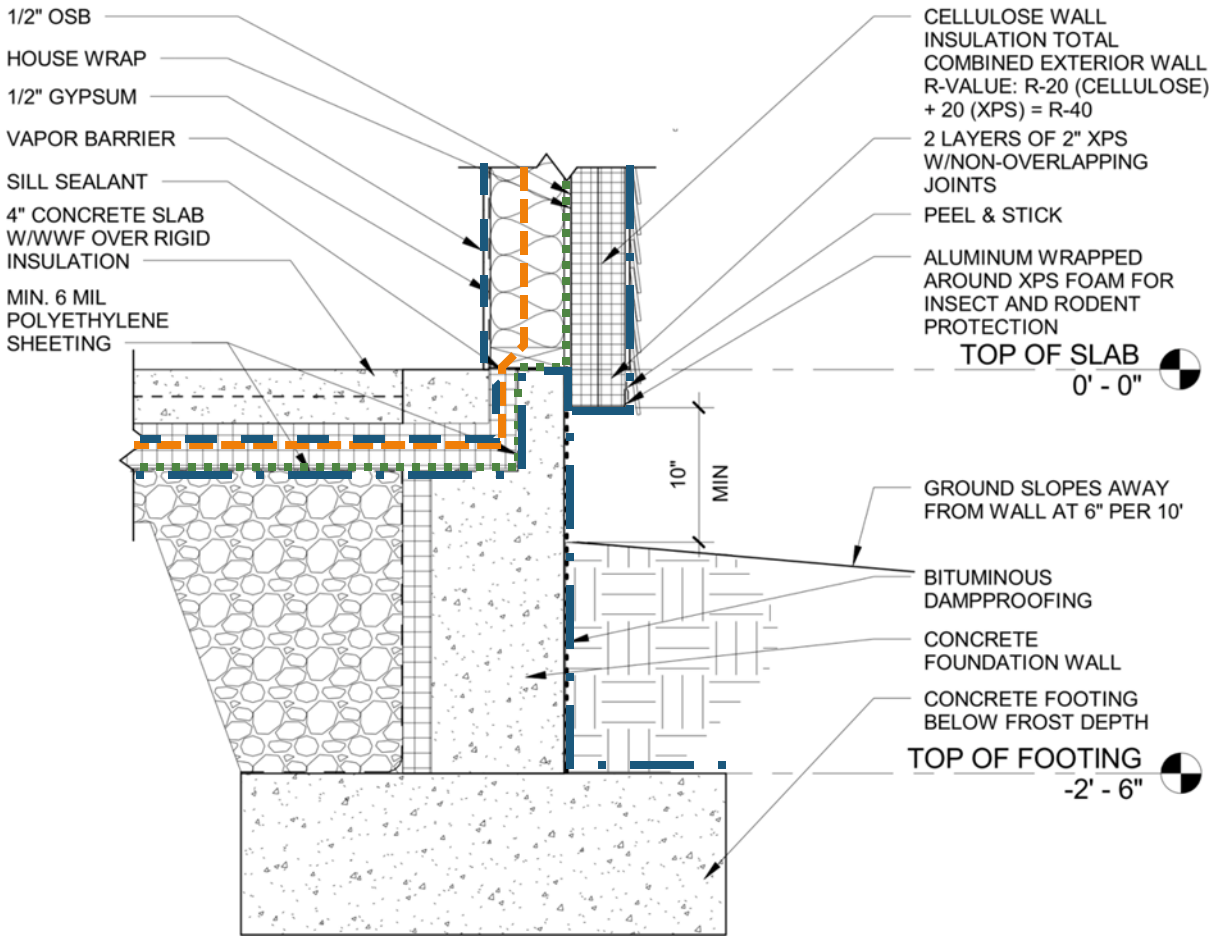
- Core Panels
  - still fit under production bridge
  - can be safely transported
- Blown-in cellulose
  - already used for ceiling
  - cheaper than rigid insulation
- No significant increase in labor
- Rigid SIP (e.g. ZIP system) strips provide
  - additional (scalable) cavity depth
  - thermal break
  - mounting base for drywall





Final enclosure design: Walls R-40; Roof R-60; Windows R-7.6



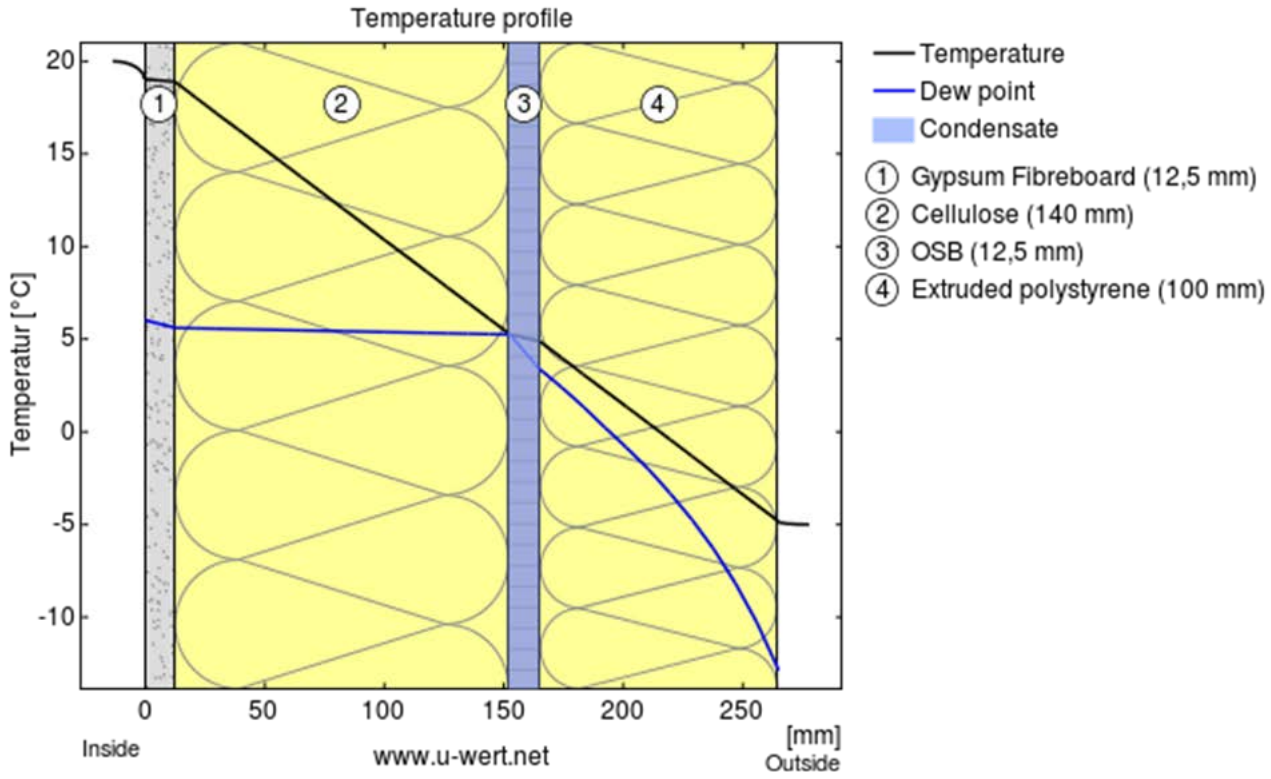


Hygrothermal Analysis – steady state

- Code requirement in many European countries

- E.g. German DIN 4108-3
  - 90 days of exposure to condensation risk condition
  - Interior: 20°C at 50% RH
  - Exterior: 5°C at 80% RH
  - Accumulated moisture must dry out in 90 days in summer

- Without vapor retarding layer
  - Condensation starts around 35% RH int. at -5°C (23°F) ext.



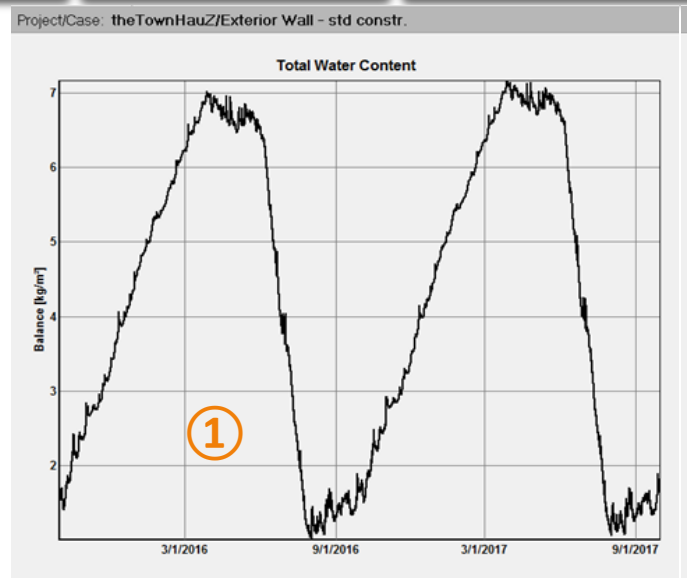
Hygrothermal Analysis

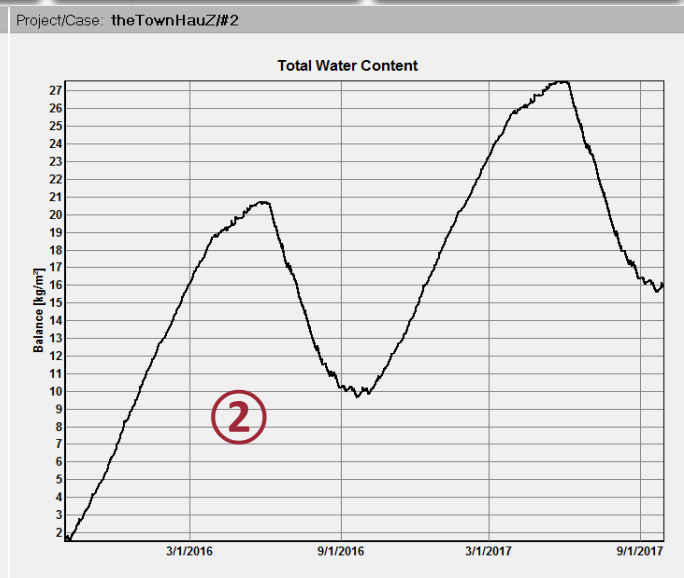
Transient simulation tool WUFI allows for

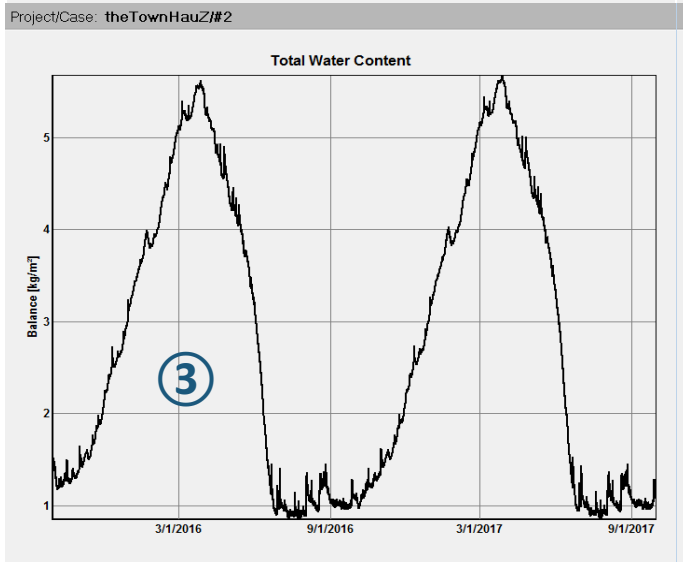
- comparing air tightness of enclosure
- differences in occupancy driven moisture accounted through number of BR
- capturing impact of interior control of relative humidity in summer

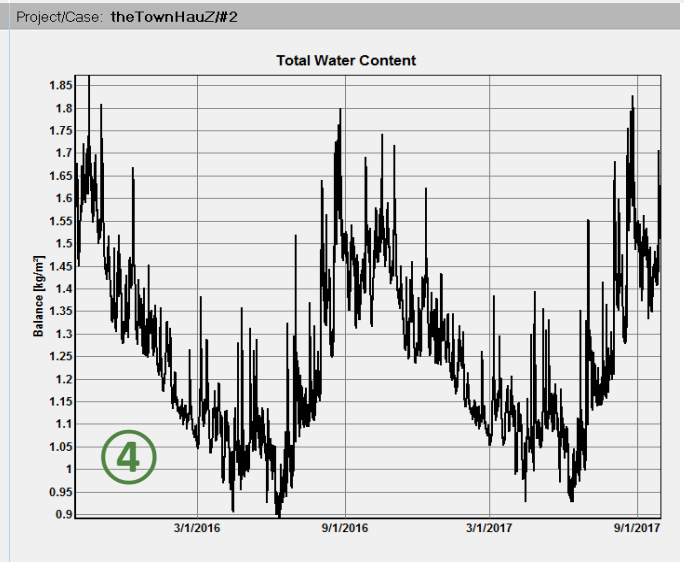
e.g. Standard 2x4 wall in Baltimore, MD climate

- will “work” with lots of moisture moving in/out ①
- with “airtight construction” not so well anymore ②
- can “fix” with interior humidity control ③
- or better with vapor diffusion control layer ④





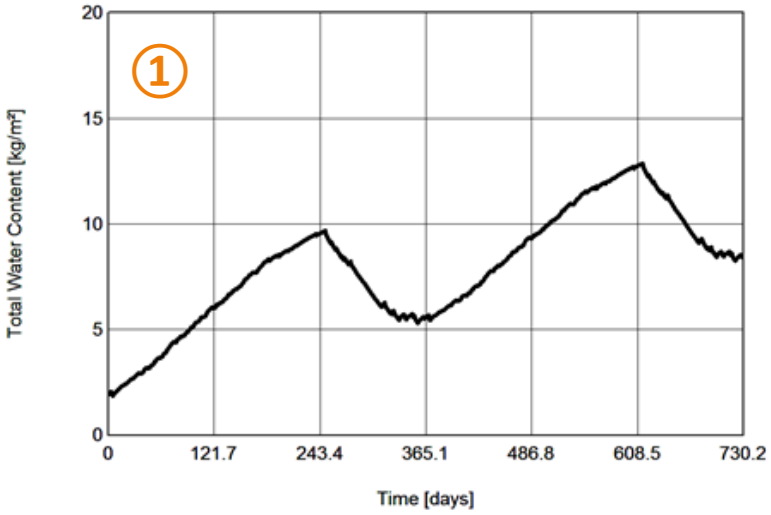


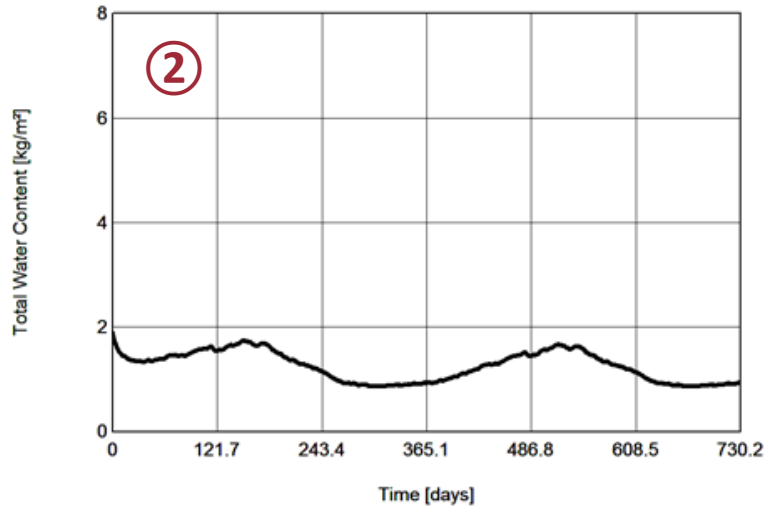


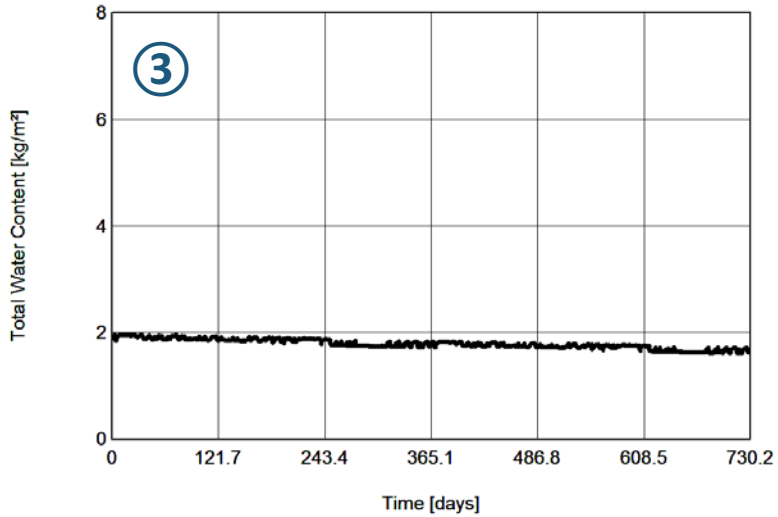
Hygrothermal Analysis

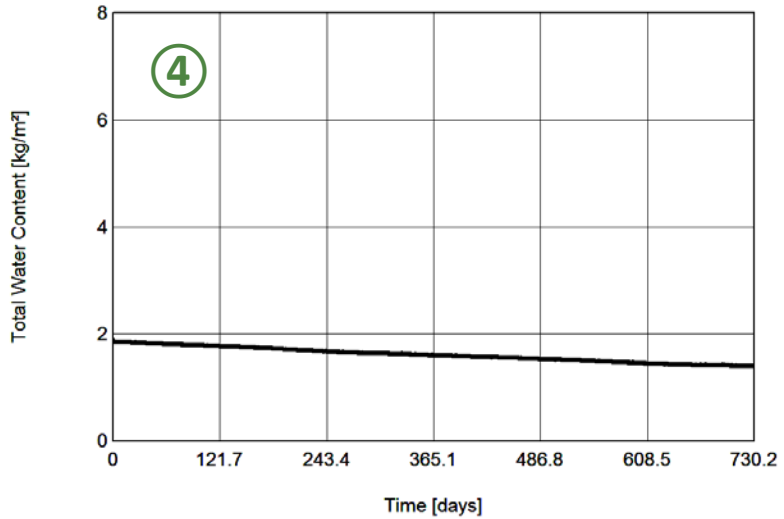
R-40 wall in Baltimore, MD climate:

- will not work since we build air-tight ①
- controlling for interior humidity during summer can prevent issues ②
- vapor retarder on the interior side can do the same without the need of controlled humidity ③
- redundant, combined solution ④
  - prevent issues resulting from local vapor control layer failures
  - can prevent issues resulting from HVAC system failures

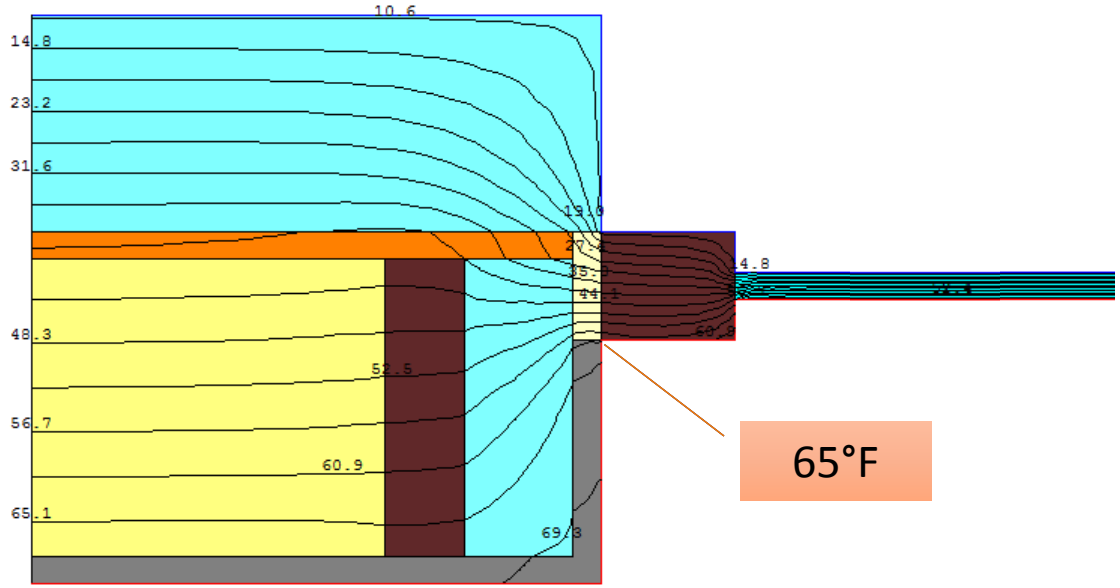


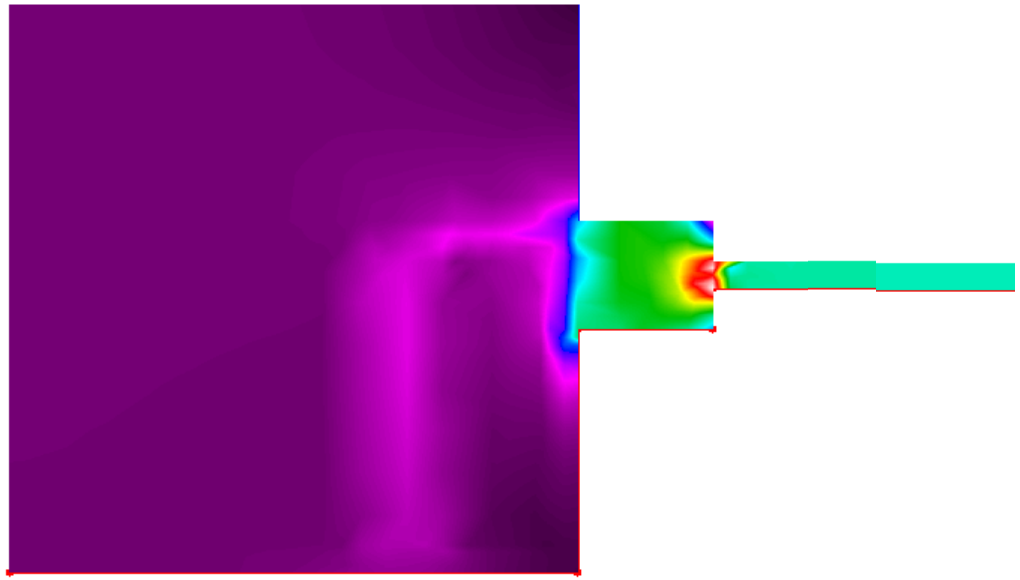


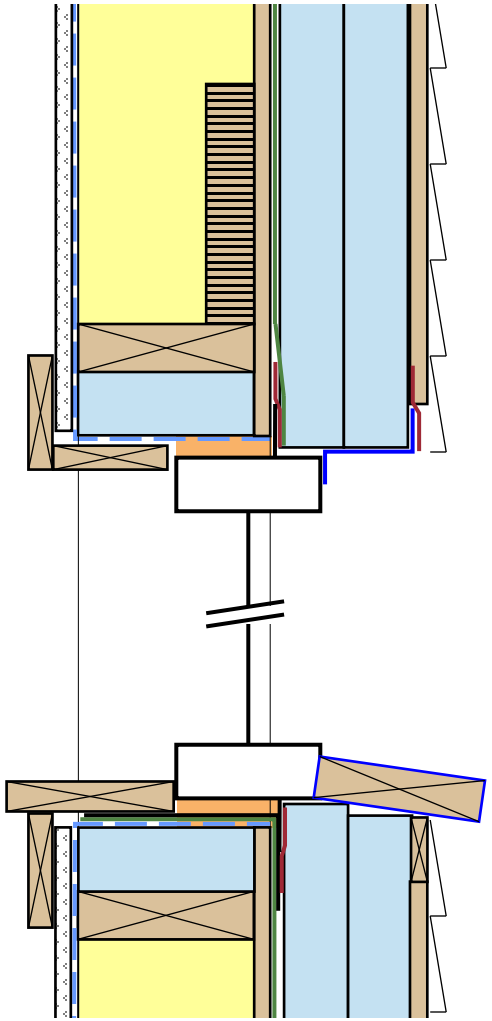


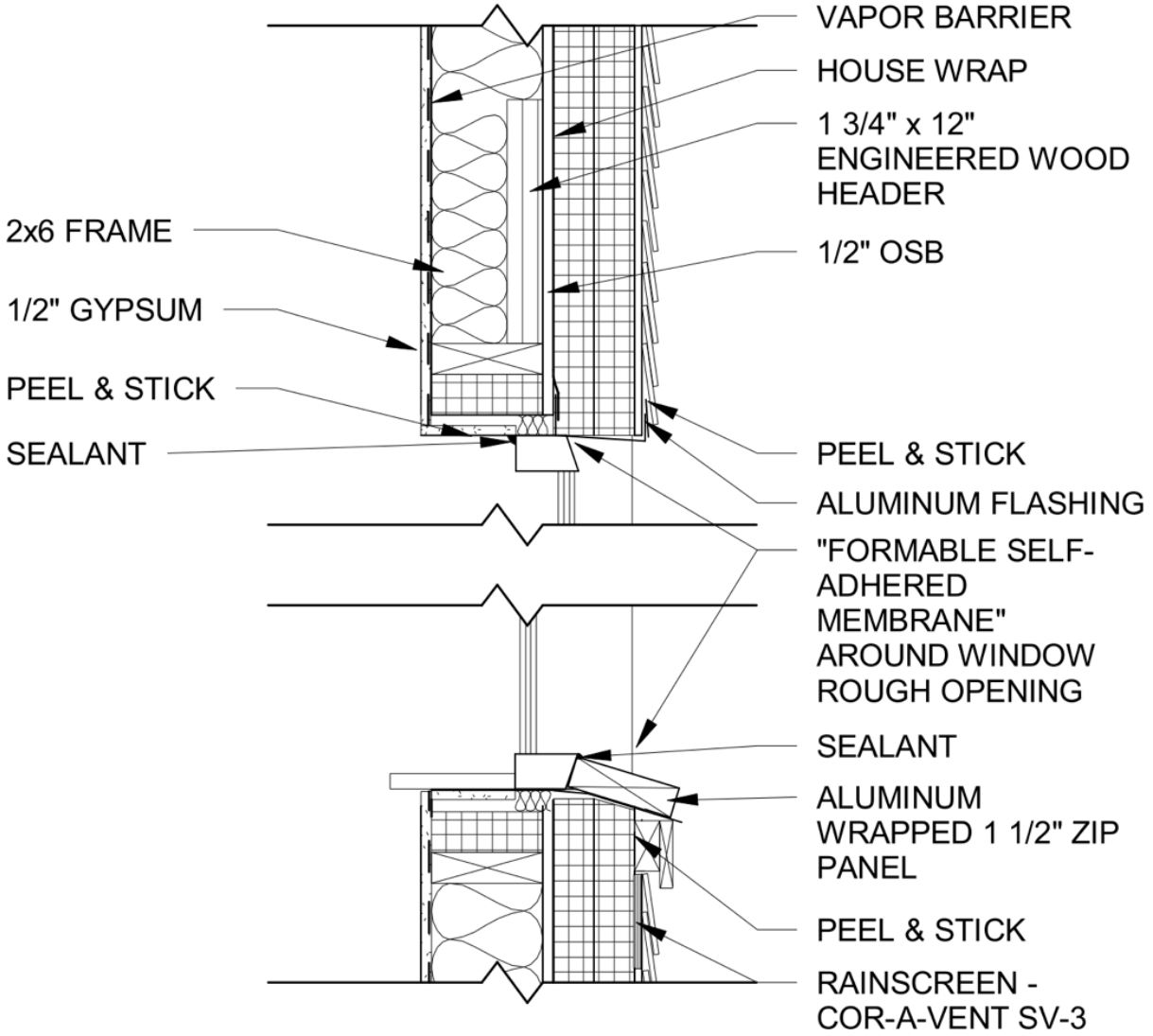


Thermal Bridge Free Details



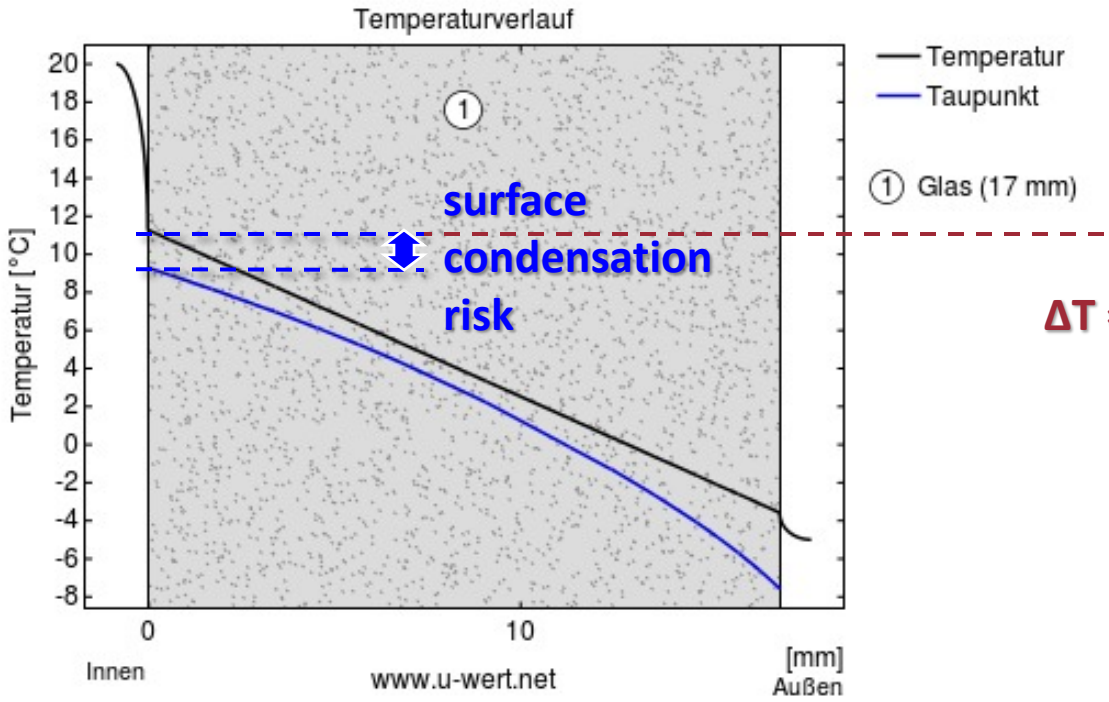




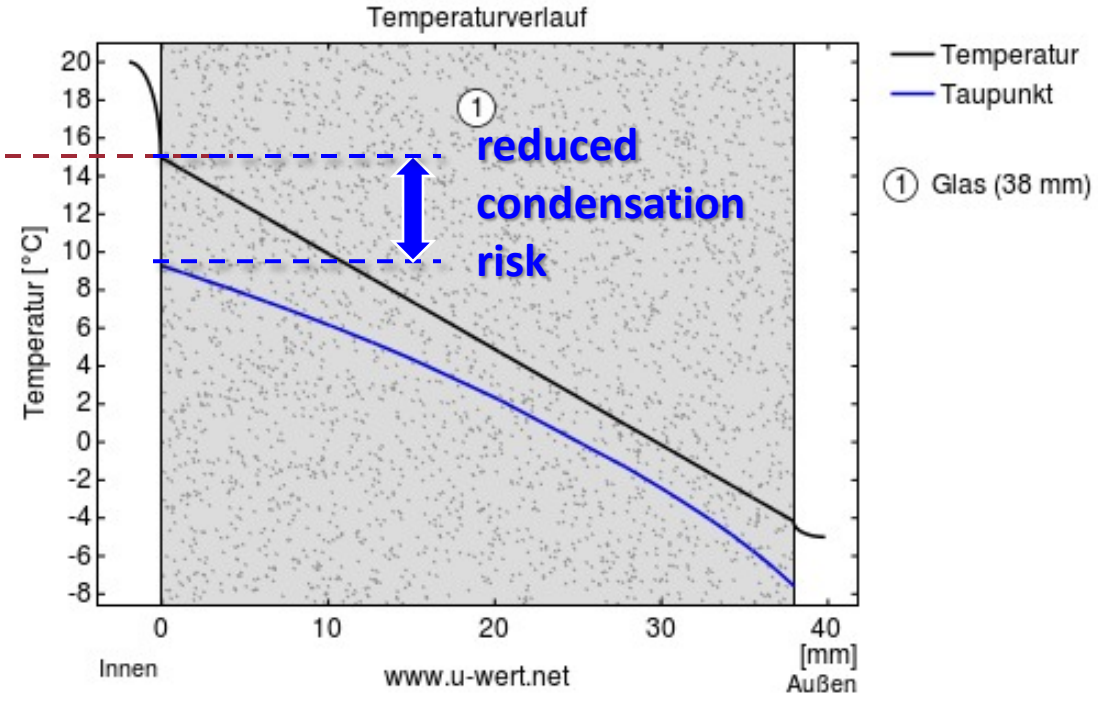

VAPOR BARRIER
HOUSE WRAP
1 3/4" x 12" ENGINEERED WOOD HEADER
2x6 FRAME
1/2" OSB
1/2" GYPSUM
PEEL & STICK
SEALANT
PEEL & STICK
ALUMINUM FLASHING
"FORMABLE SELF-ADHERED MEMBRANE" AROUND WINDOW ROUGH OPENING
SEALANT
ALUMINUM WRAPPED 1 1/2" ZIP PANEL
PEEL & STICK
RAINSCREEN - COR-A-VENT SV-3

Thermal Comfort Analysis

R-3.5 Window



R-7.6 Window (Triple Pane)



ΔT ≈ 8°F

Thermal Comfort Analysis

Median Radiant Temperature Analysis (MRT)

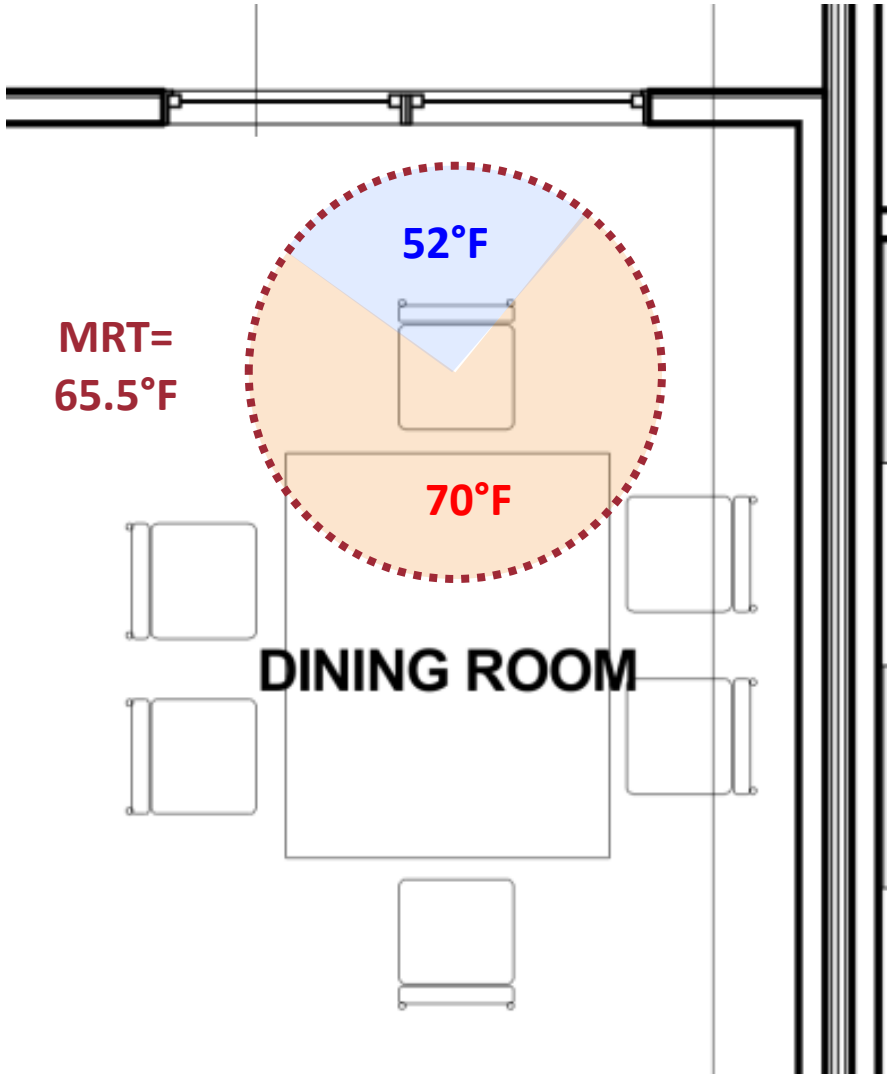
To achieve a target temperature sensation of 70˚F…

Required temp. setpoint for **R-3.5** Windows:

T(set) = 70° + (70°F - 65.5°F) x 1.4 = **76.3°F**

Required temp. setpoint for **R-7.6** Windows:

T(set) = 70° + (70°F - 67.5°F) x 1.4 = **73.5°F**



Indoor Air Quality

Key Ventilation Features:

- Whole-house balanced ductless HRV
- Bathrooms: automatic excess humidity detection
- Kitchens: automatic make-up air
- Ultra quiet operation

Dehumidification:

- Relative humidity control (≤ 50%)

Lunos e² HRV

Ultra-Aire ENERGY STAR 70H Dehumidifier

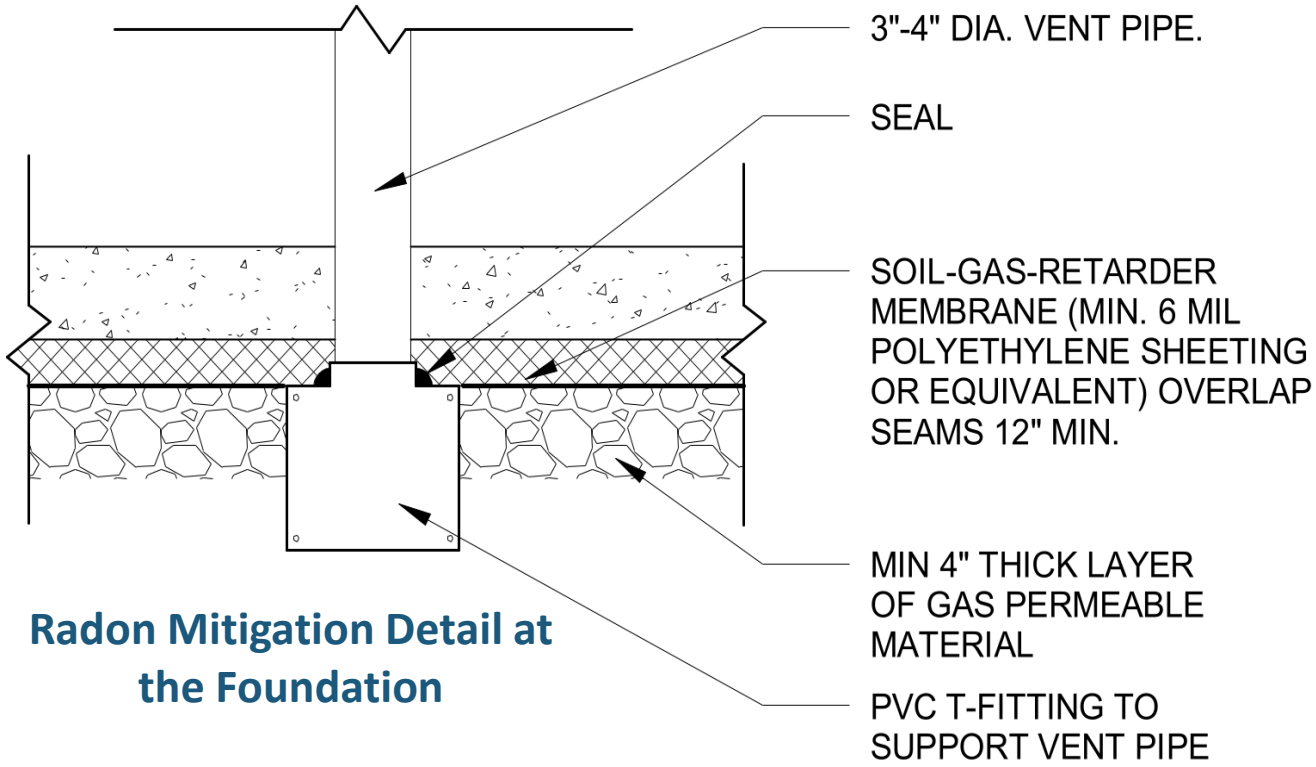
Indoor Air Quality

Key Pollution Control Features:

- High-performance MERV Filters
- Source control
- Radon mitigation

Key IAQ During Construction:

- Low/No VOC materials
- Dust control
- Clean cavities
- Maintain good ventilation



Radon Mitigation Detail at the Foundation

Space Conditioning

Equipment:

- SEER 16, 1.5 ton heat pump
- High-efficiency 2 ton air handler
- Ductwork dampers

Trane XR 15 and Hyperion EXL Units

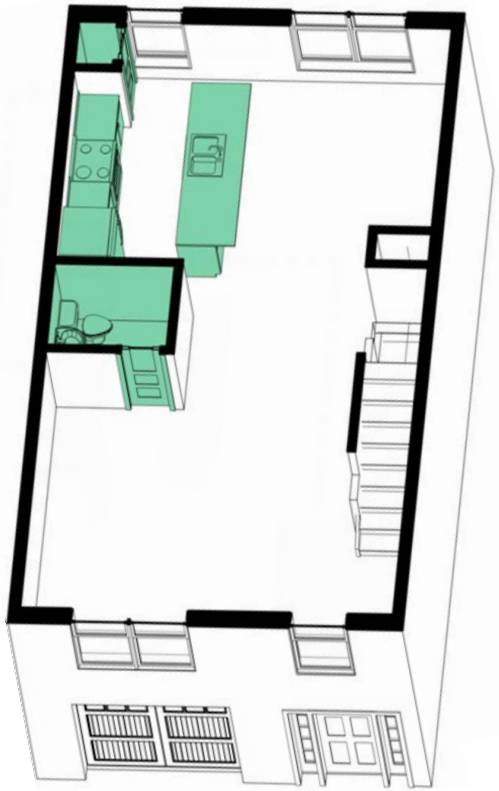
Selection Process:

- Transmission and Ventilation losses

Zonefirst Damper

Bathroom and Kitchen Re-arrangement

Re-arranged Second Floor Layout

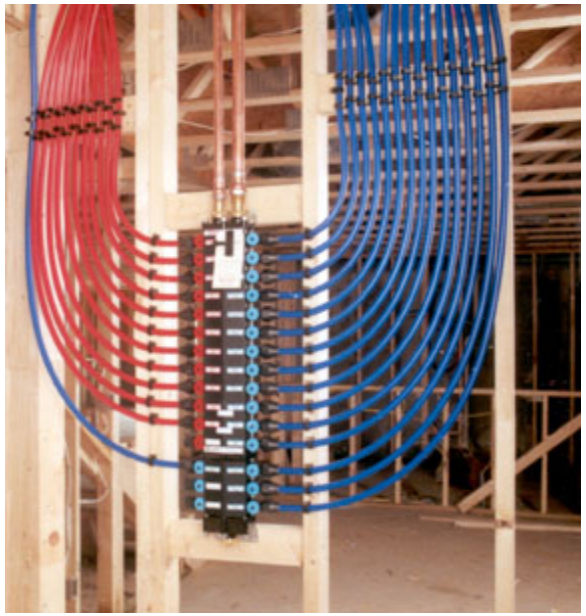


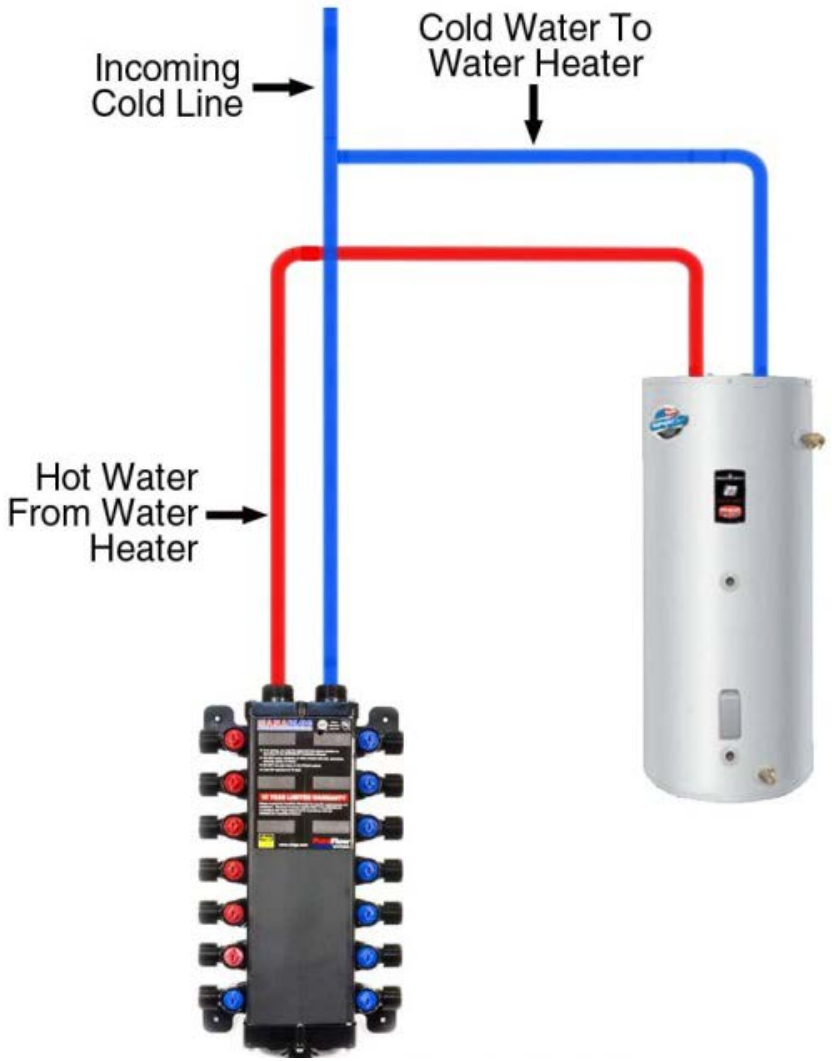
Re-arranged Third Floor Layout

Domestic Hot Water

- PEX lines combined with manifold drastically reduce standby losses

- Energy savings
- Cost savings
- Labor savings





Hybrid Hot Water Heating

GE Geospring
Hybrid Water Heater
EF 2.9

- 10 year savings = **$2,740**
- Payback in 3 years

Lighting and Appliances

LED Bulbs:

- 10 year savings vs. incandescent = **$4,833**
- Reduces energy consumption by **82%**
- Superior to fluorescent

Appliances:

- ENERGY STAR compliant
- Affordable and functional size based on demand

Energy Analysis: Standard Design

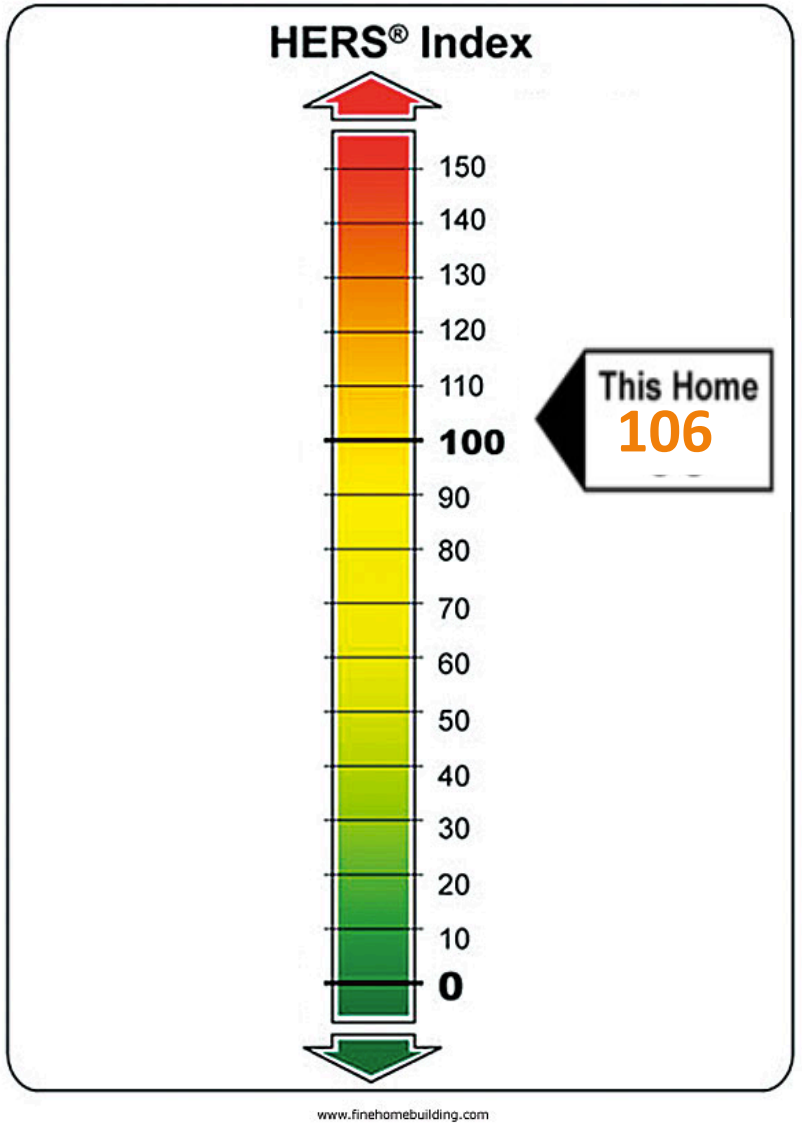
Original townhouse standard design:

Annual Energy Consumption [kBTU/year]					
HERS	Heating	Cooling	Water Heating	Lighting & Appliances	Total
106	31,800	5,100	21,300	24,700	**82,900 kBTU**

Annual Energy Cost [$/year]						
HERS	Heating	Cooling	Water Heating	Lighting & Appliances	Service Charge	Total
106	365	196	224	763	120	**$1,668**

Maryland Residential Standard (EIA)

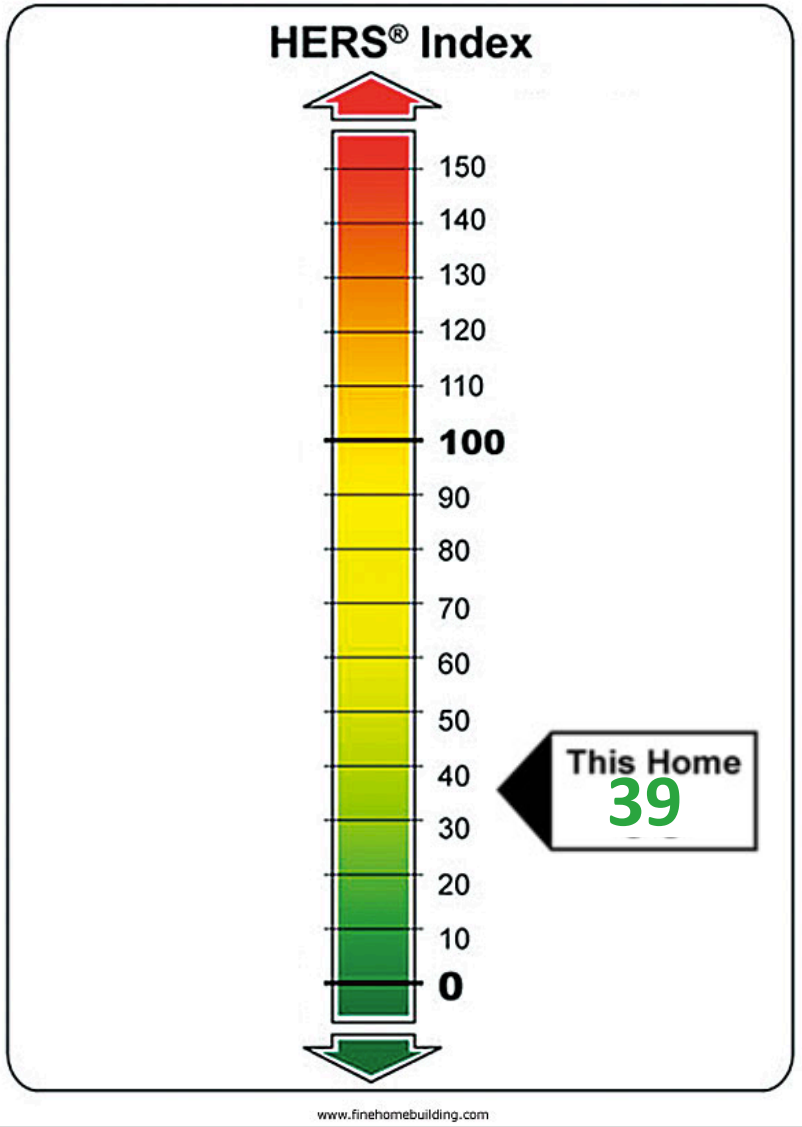
- 88,900 kBTU/year
- $2,313/year



Energy Analysis: New Design

Annual Energy Consumption [kBTU/year]						
	HERS	Heating	Cooling	Water Heating	Lighting & Appliances	Total
End Unit	39	6,200	2,400	4,100	14,900	**27,600**
Middle Unit	39	6,200	2,400	4,100	14,700	**27,400**
Standard Design	106	31,800	5,100	21,300	24,700	**82,900**
MD Standard (EIA)						**89,000**

Annual Energy Cost [$/year]							
	HERS	Heating	Cooling	Water Heating	Lighting & Appliances	Service Charge	Total
End Unit	39	72	92	159	575	120	**1,018**
Middle Unit	39	72	92	159	569	120	**1,012**
Standard Design	106	365	196	224	763	120	**1,668**
MD Standard (EIA)							**2,313**

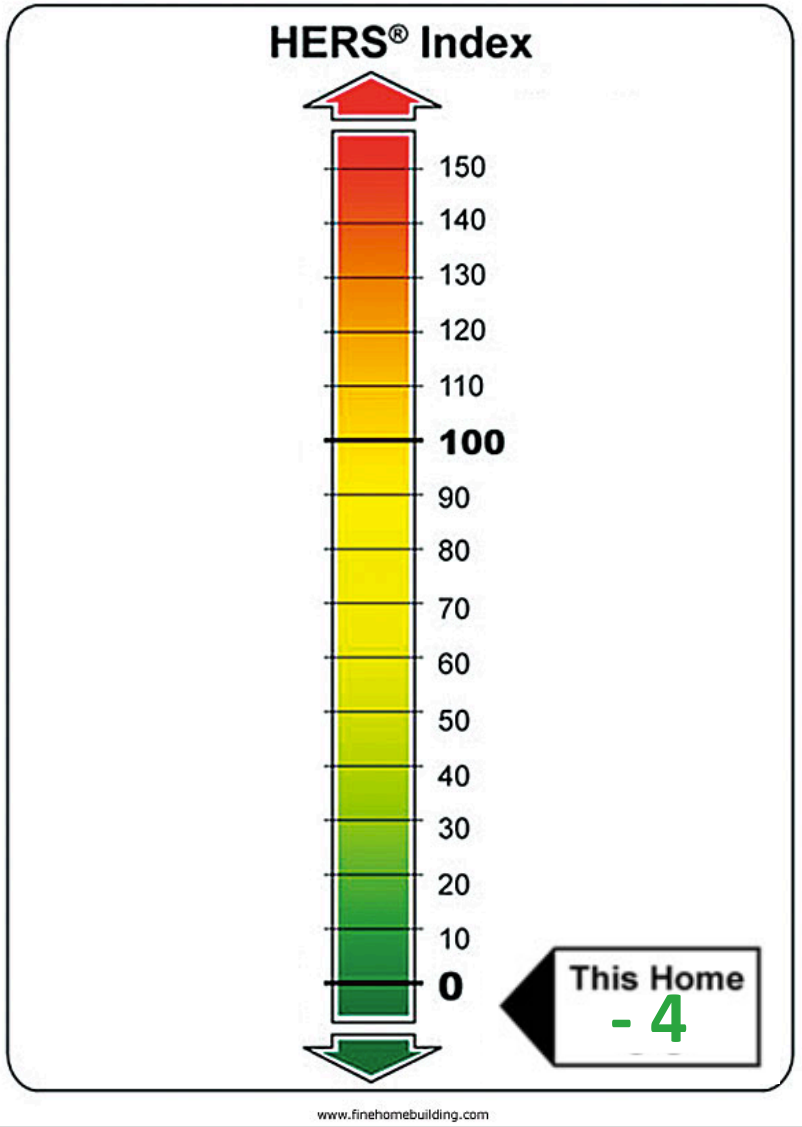


Net Zero Energy

PV System:

- Size: 6kW
- Annual Output: 27,316 kBTU
- Annual Energy Value: $1,041
- Annual Energy Cost: $0 (-$26)
- Estimated System Cost (with applicable grants and tax credits): $12,905

19 PV Panels, 320 Watts Each, South Facing



Financial Analysis

Original KHOV Design Selling Cost	**$235,490**
HVAC Design Changes	$8,580
Plumbing Design Changes	-$336
Electrical Design Changes	$271
Appliances Design Changes	$1,235
Insulation Design Changes	$1,513
Windows Design Changes	$1,157
Total Additional Costs	**$12,420**
Proposed Design Selling Cost	**$265,161**

AFFORDABILITY ANALYSIS (PITIU Analysis)

MFI = $75,000

Down Payment = 20% of Purchase Price = $53,032

Loan Amount = $212,129

Annual Mortgage Payment = $1,074.83

Based on 30 year loan with interest rate of 4.5%

Property Taxes = 2.75% of MFI =$2,063

Insurance = $780

Utilities = $1,012

Debt = 0.5% of MFI =$375

Total Annual Costs = $17,128

This total represents 22.8% of the MFI, less than the recommended maximum of 38%

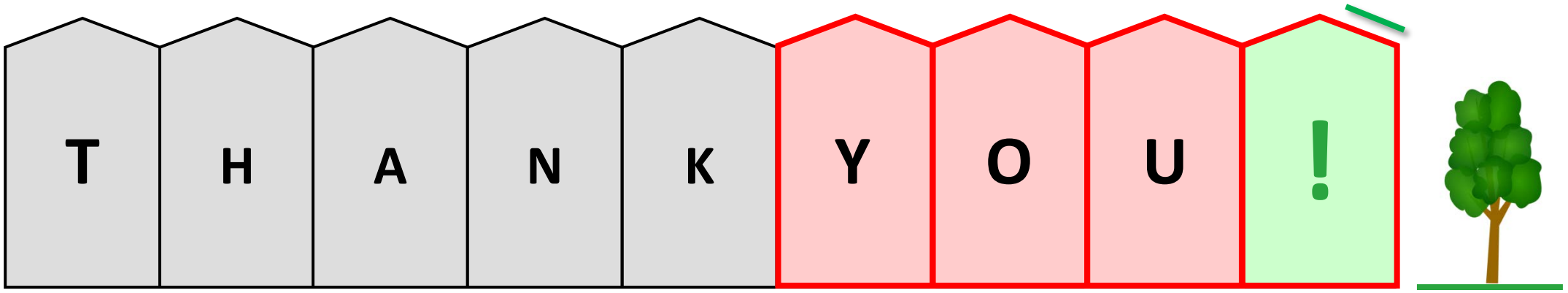
Final Remarks

- Ultimately, we decided on some design solutions that may go beyond the production builder's current strategies

- Why? – to ***Invent the Future*** …

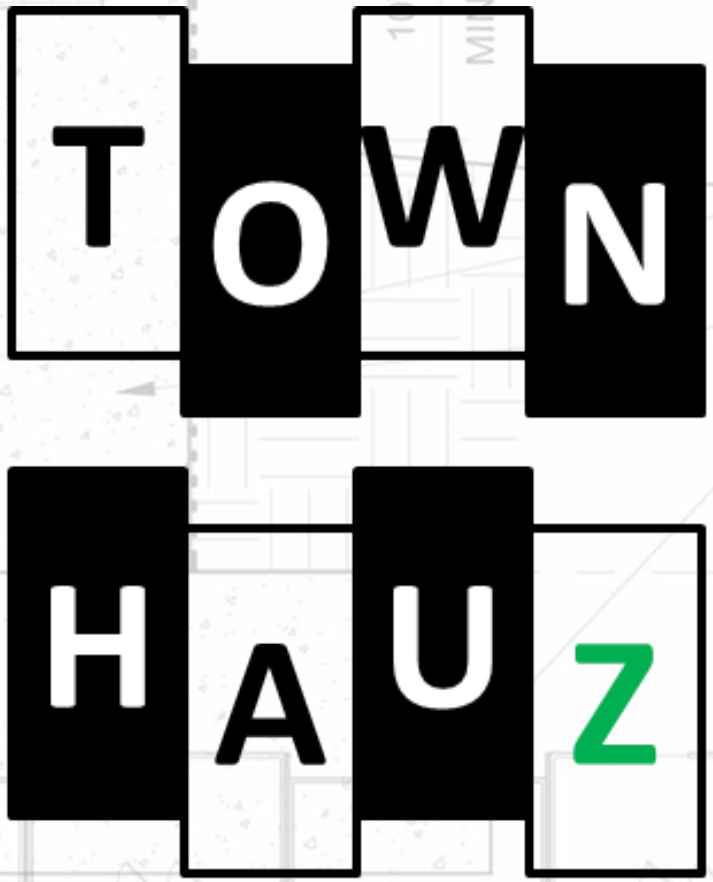
→ **push the envelope in terms of energy performance**

→ **define a new level for occupant comfort**



Take it for a “test-drive” and experience the difference!

http://TownHauZ.bldgsci.net



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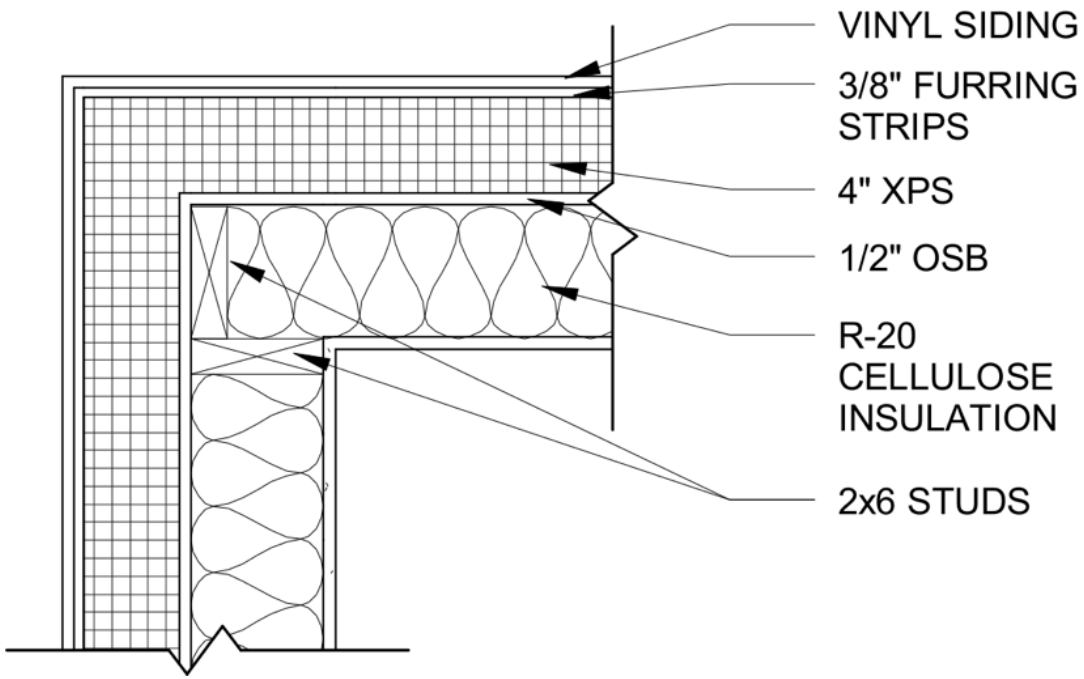
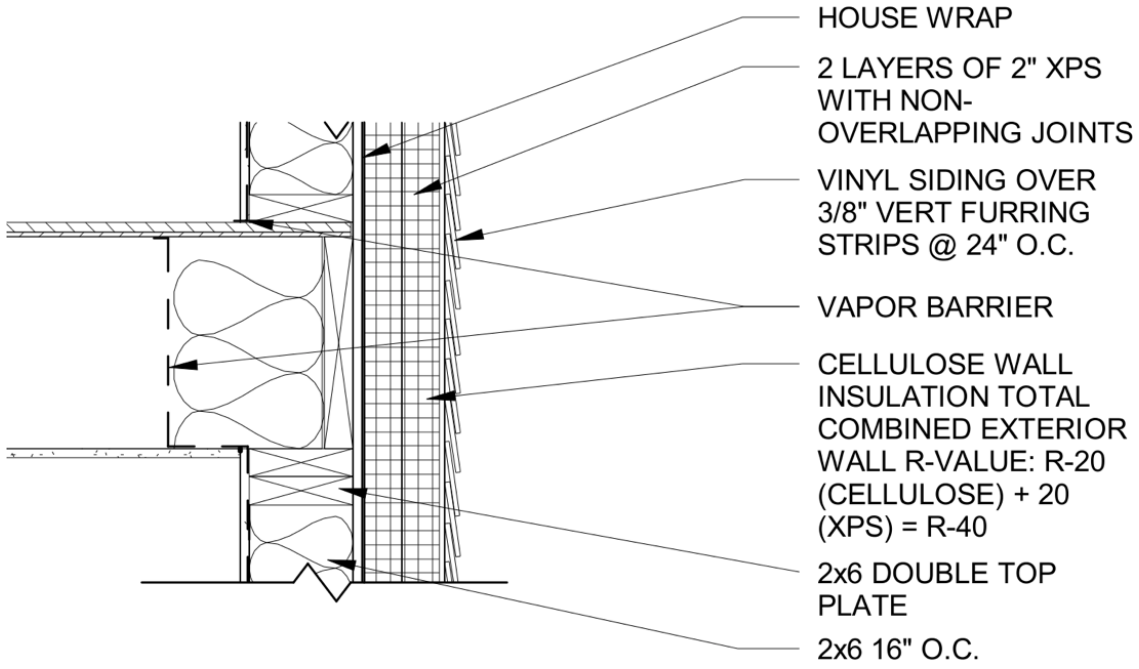
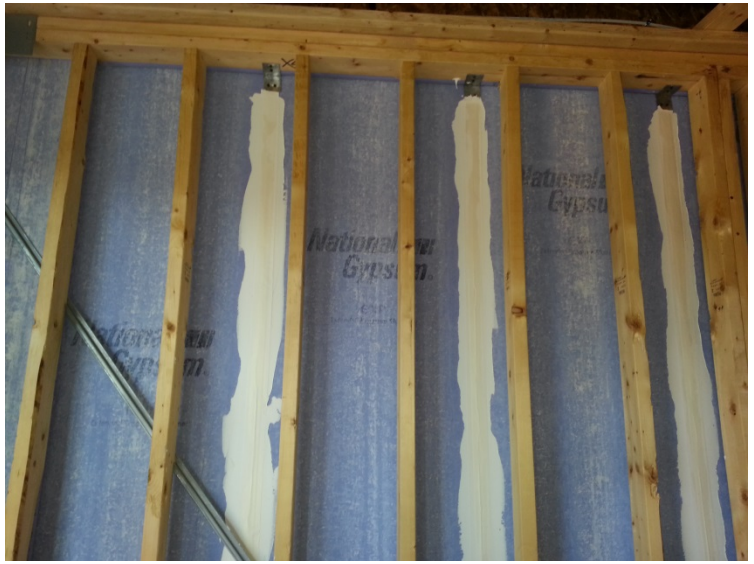
Corner Detail



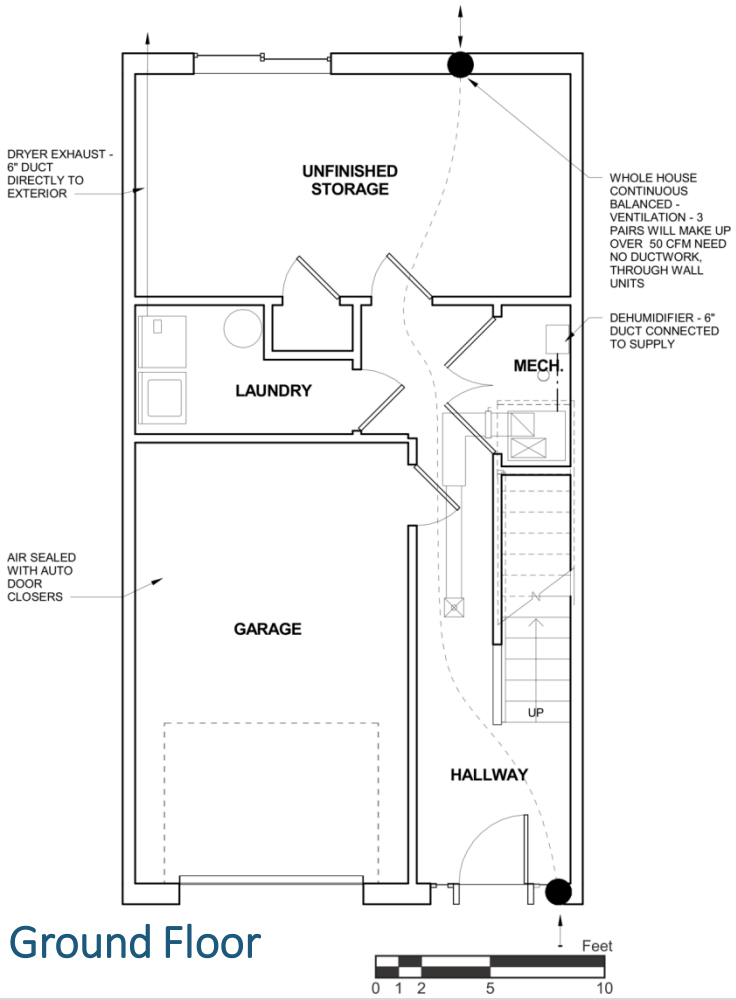
Floor/Ceiling Rim Detail



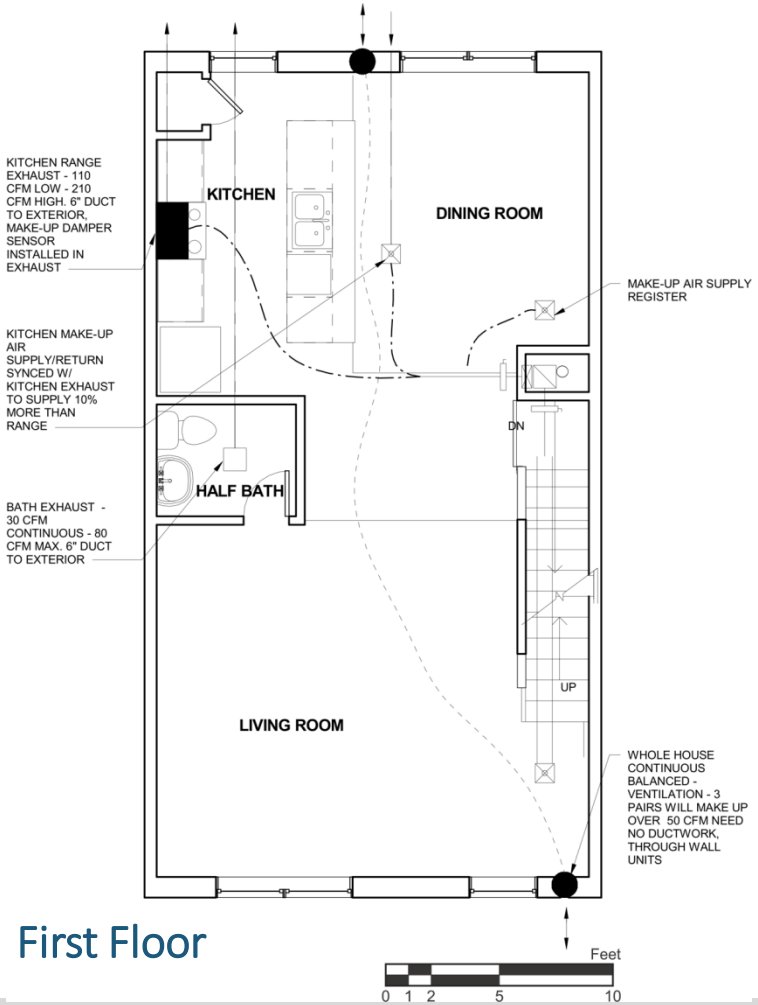
Air Sealing



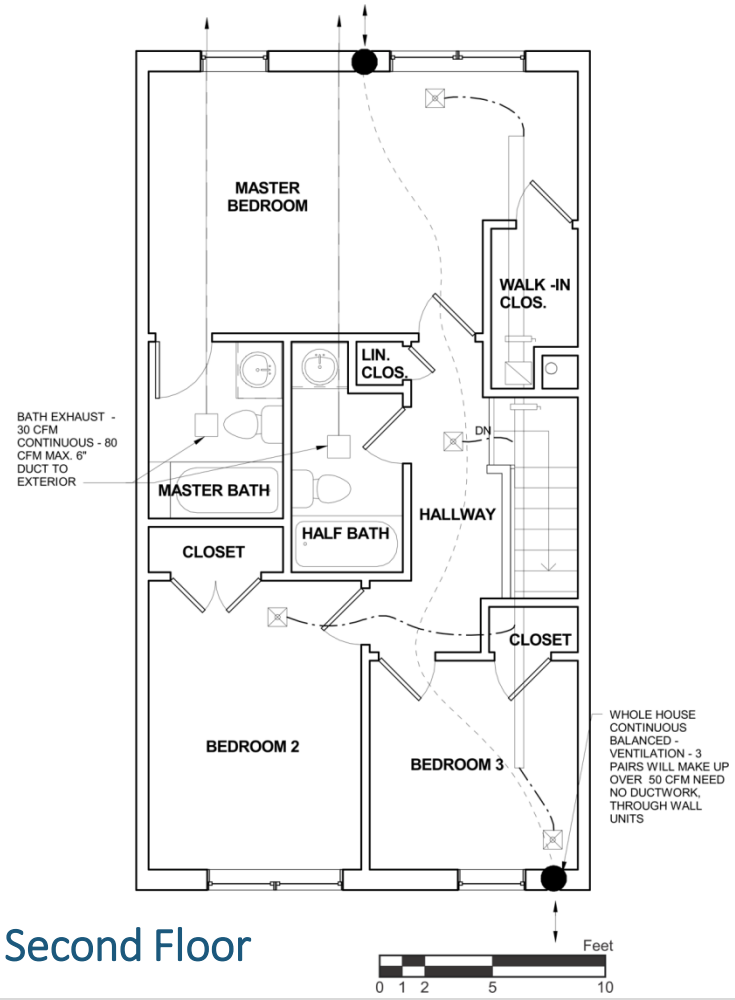
Mechanical Plans



Ground Floor

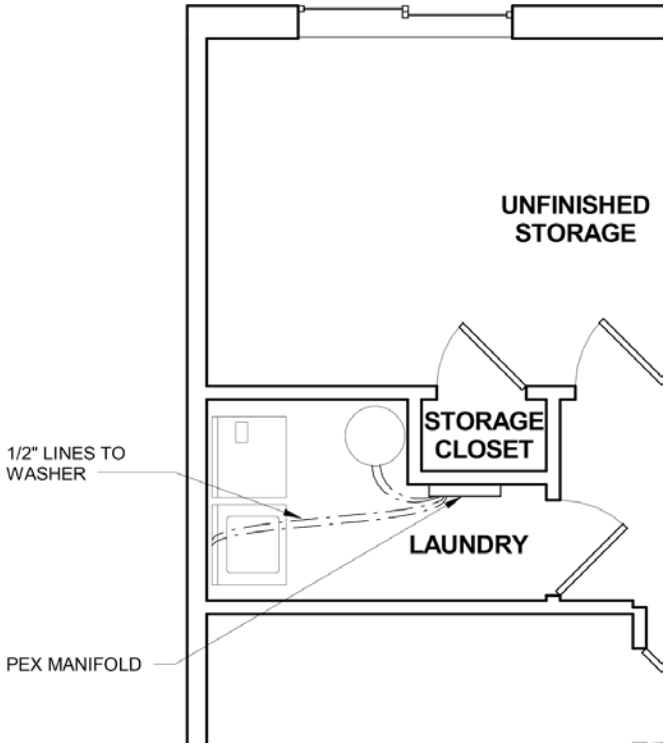


First Floor

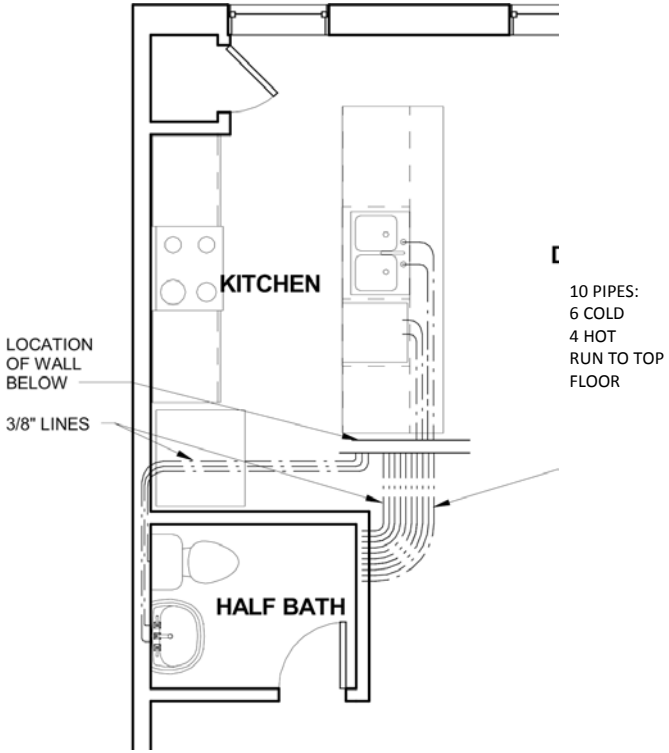


Second Floor

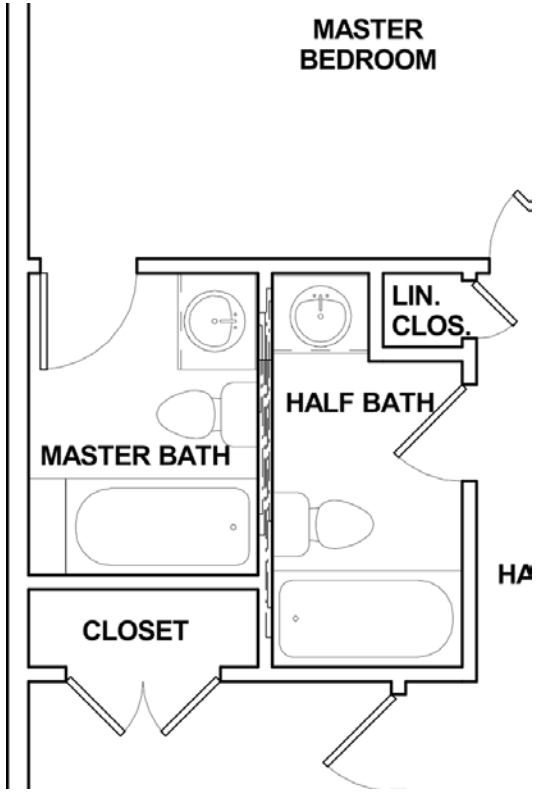
Plumbing Plans



Ground Floor



First Floor



Second Floor