Resilient Home
Regenerative Home
Zero Energy Home
Water Home
Renewable Home
Right-Size Home
Responsible Home
Adaptive Home
Long-Lasting Home
Safe Home
Urban Home
Grow Home
Expandable Home
Diversity Home
Innovation Home
Restorative Home
Ecological Home
Dream Home
My Home
OptiMN Home

Bassett Creek **ReGen Homes**

Team OptiMN
University of Minnesota

April 22, 2017

United States
Department of Energy
2017 Race to Zero Competition

optiMN
ReGen Homes

University of Minnesota
Team OptiMN
introduces

Bassett Creek
ReGen Homes

Healthy
Lasting
Cost-Effective
Zero Energy Ready

Team OptiMN Profile

BS Building Science & Technology
Matt Dries (Team Leader)
Sorelle Checkam

BSAS Construction Management
Nelson Hull

BD Architecture
Katerina Grengs

M Architecture
Lindsey Kieffaber
Chris Laabs
Rodrigo Lozada

MS Sustainable Design
Parul Jain
George Liu
Tim Markoe

PhD Bioproducts and Biosystems Engineering
Maria Fernanda Laguarda - Mallo

MS Business Marketing
Aaron Hanson

M Landscape Architecture
Luke Nichols

Faculty Advisors: Pat Huelman, Jim Lutz, Peter Hilger

OptiMN Partners

Habitat for Humanity Twin Cities
Nonprofit Builder

Residential Sciences Resources
Home Performance Testing

Simple Energy Testing
Home Performance Testing

Mississippi Watershed Management Organization
Watershed Organization

Aeon
Nonprofit Developer

MSR
Architect

Harrison Neighborhood Association
Neighborhood Association

Meet Your Presenters

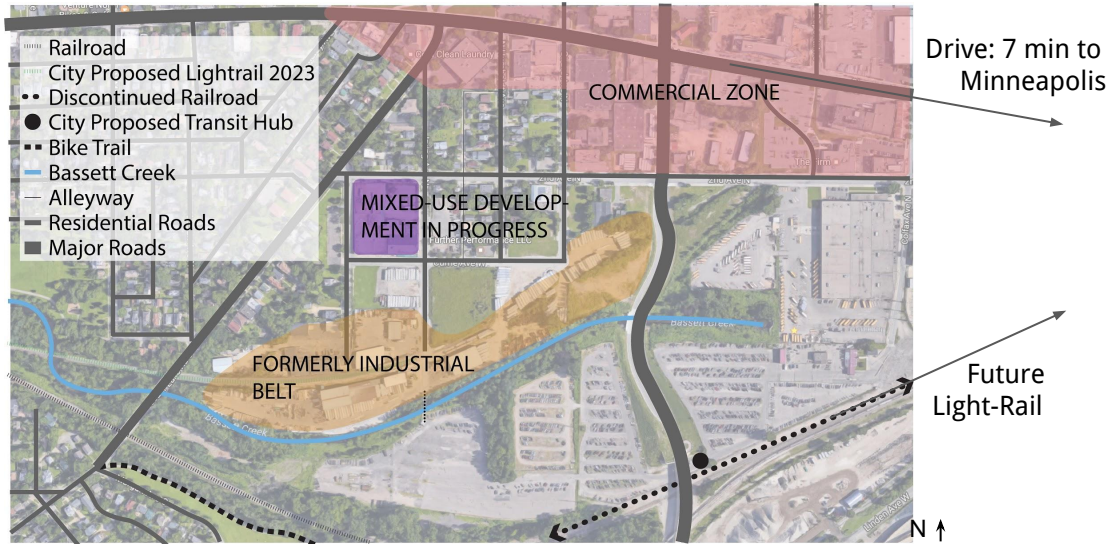
Matt Dries
BS Building Sciences

Maria Fernanda Laguarda - Mallo
PhD Bioproducts and Biosystems Engineering

Lindsey Kieffaber
M Architecture

Chris Laabs
M Architecture

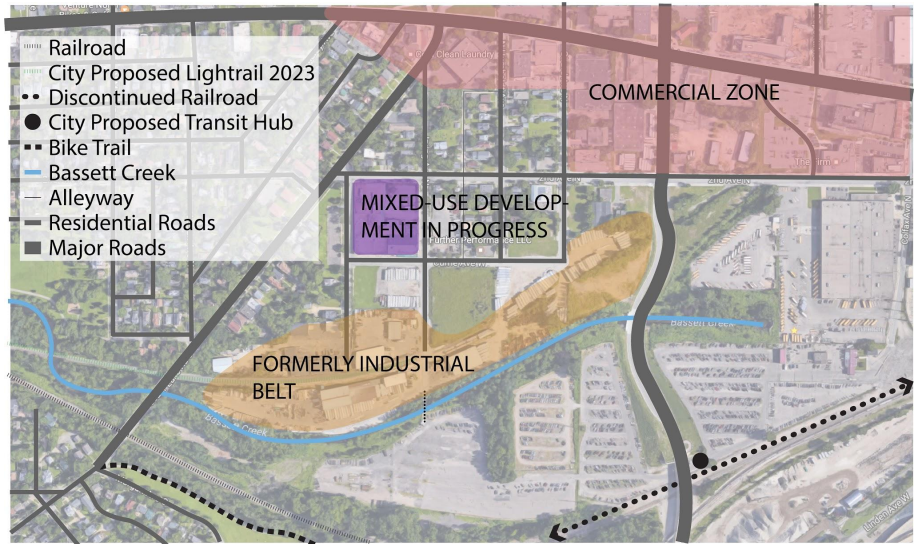
Master Plan

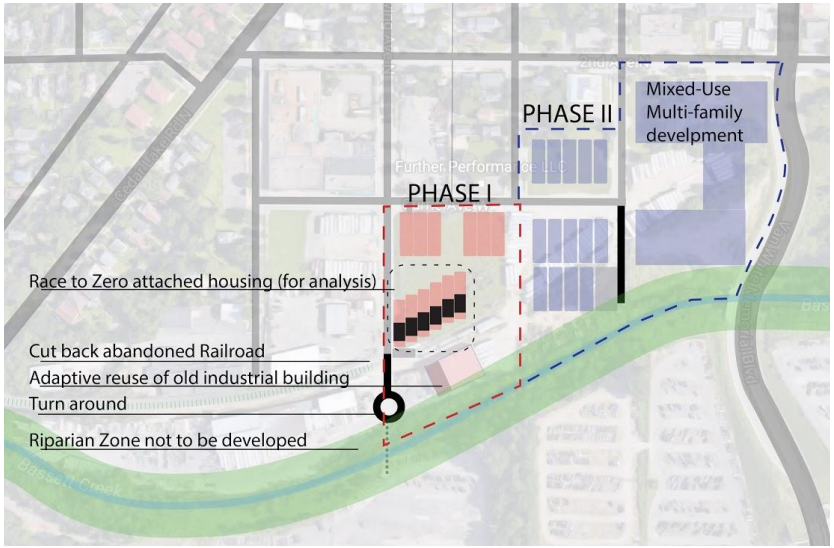


Area Attributes Contributing to Site Selection

- Neglected industrial area
- Proximity to nature/recreation
- Mixture of housing types & densities
- Future light-rail infrastructure

Master Plan





Area Attributes Contributing to Site Selection

- Neglected industrial area
- Proximity to nature/recreation
- Mixture of housing types & densities
- Future light-rail infrastructure

Masterplan Exercise

- Mixed-use, multi-family development
- Sensitivity to surrounding context
- Strategically located RTZ townhomes

Social Responsibility

- Sized for the Harrison Neighborhood demographics and family structure
- Priced for a typical Habitat for Humanity homeowner
- ADA visitable units
- Environmentally-responsive to site
- Lasting design and structure

Site Plan

- Appropriate fit to Harrison Neighborhood and site context
- Effectively serve needs of Habitat for Humanity homeowners
- Walkable and ADA visitable
- Unit & community garden spaces
- Aggressive stormwater management plan to protect Bassett Creek

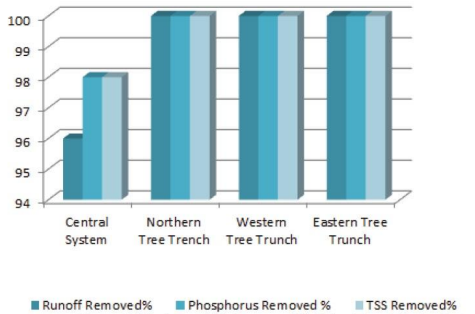


Figure 11B: Annual Volume and Pollutant Load Reductions Based on BMP's

Landscape Design

Stormwater Management

- Bioswales for large storm events
- Underground cistern for gardens

Landscape Selections

- Low-maintenance
- MN native species
- Disease resiliency
- Pear trees: Golden Spice & Summer Crisp
- Serviceberry trees
- Raised beds for herbs
- Green screen wall: wild grape or hops

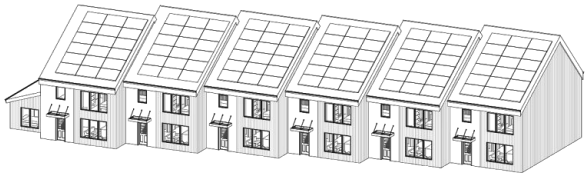
Landscape Design

Overall Design Goals

Healthy - Lasting - Cost-Effective - Zero Energy Ready Home

Six Attached Units for Six Families

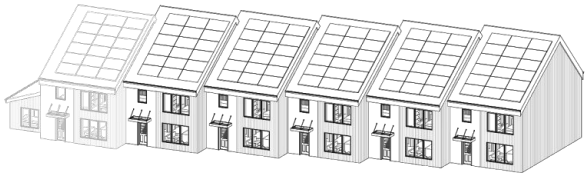
- Culturally rich and accommodating
- Aesthetically pleasing
- Flexible and expandable
- Optimized to be Zero Energy Ready



Standard Units

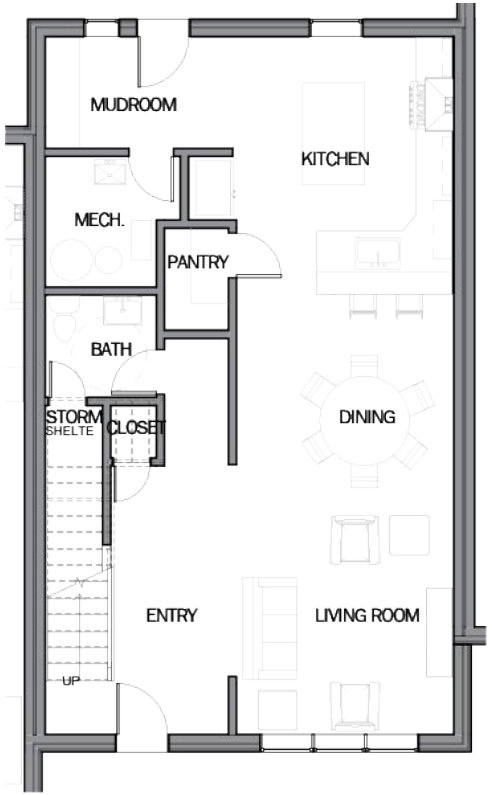
5 Units

- ADA Visitable
- Three bedrooms
  - expands to four with “unbasement”
- 1844 square feet on two floors
  - plus 448 square feet for expansion



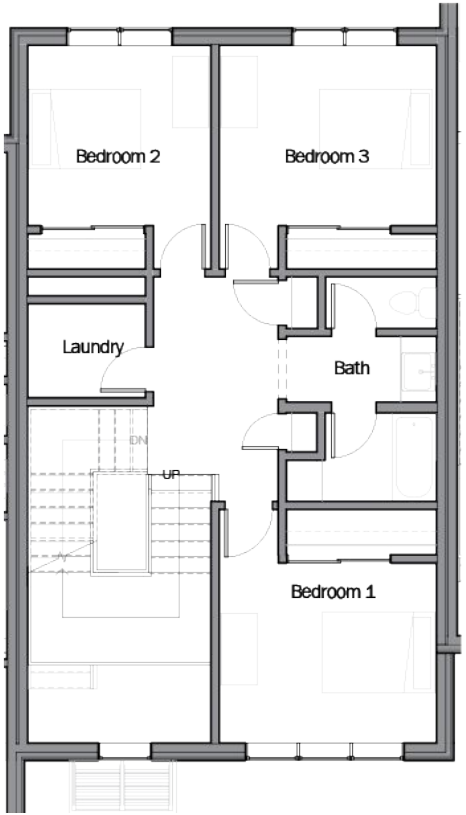
Level One

- Open plan connects front and back yards
- ADA visitable bath
- Designated storm shelter
- Optimizing storage space



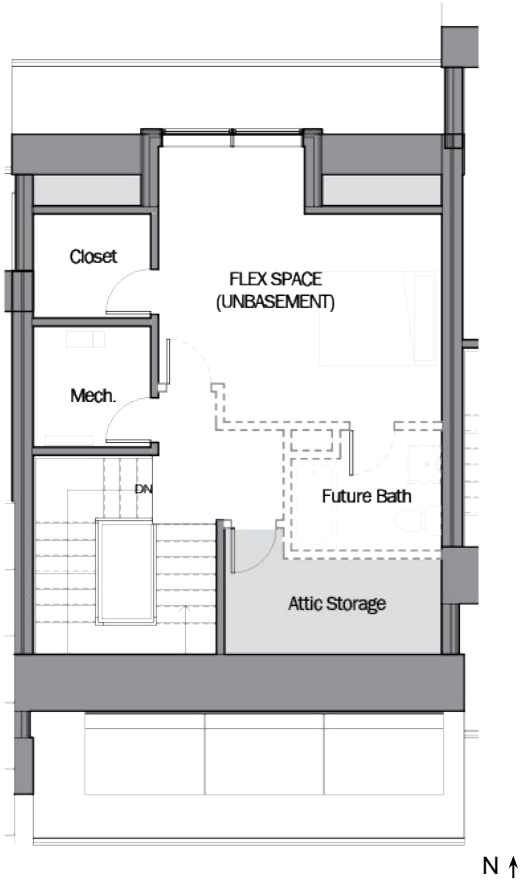
Level Two

- Three sizable bedrooms
- Fully partitioned bathroom
- In-unit laundry



The “Unbasement”

- Location for utilities and storage
- Attic is transformed to conditioned space
- Flexible unfinished space for today
- Quality expansion space for tomorrow
    - without typical basement comfort and indoor air quality concerns



Interiors

- Light-filled spaces
- Connection to exterior
- Warm finishes
- Opportunities for customization
- Preference for recycled and recyclable materials
- Durable surfaces for floors, kitchens, baths

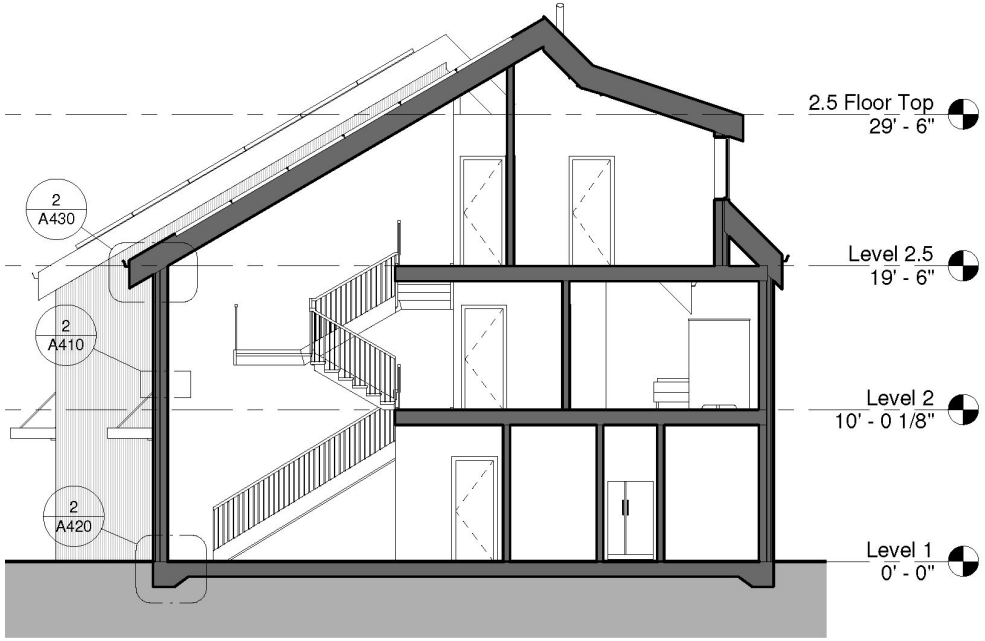
Landscaped Rooms

- Extension of the living spaces
- Personal identity of each home
- Private gardens
- Social gathering space

N

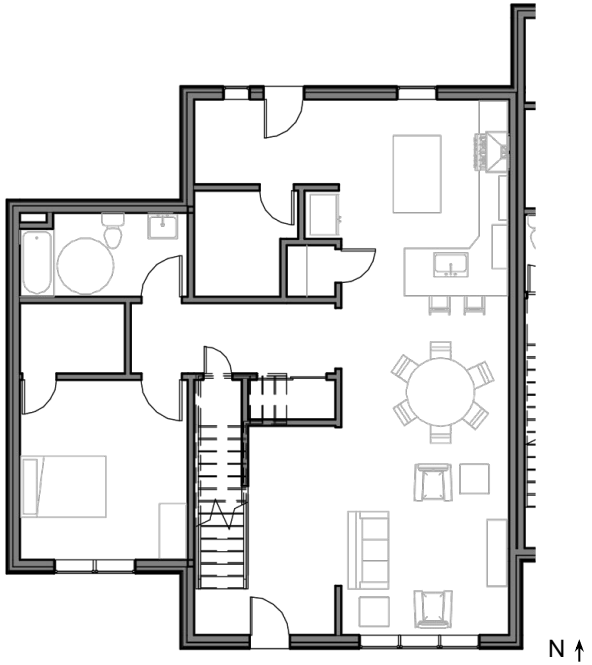
Section

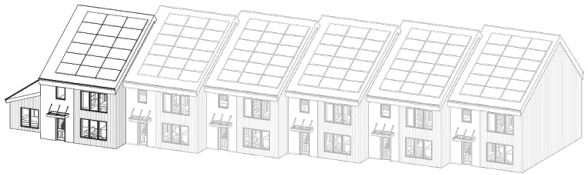
- Dynamic design both in plan and section



Extended Unit

- Four bedrooms; one ADA
- First floor laundry
- Fully accessible bathroom
- Provides disabled family members freedom to perform tasks in the home



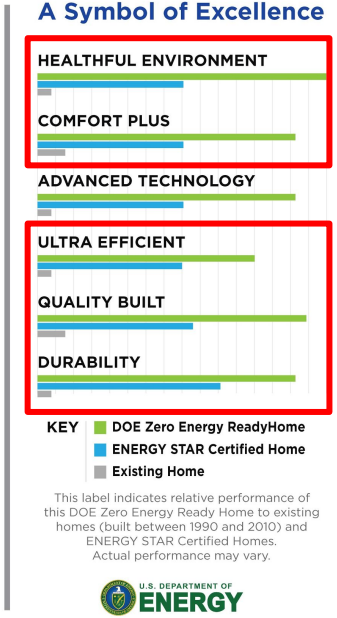


Enclosure Goals

Healthy - Lasting - Cost-Effective - Zero Energy Ready Home

- An ultra-efficient enclosure
- Highly insulated
- Carefully considered air sealing
- Ensure moisture control
- Provides maximum durability

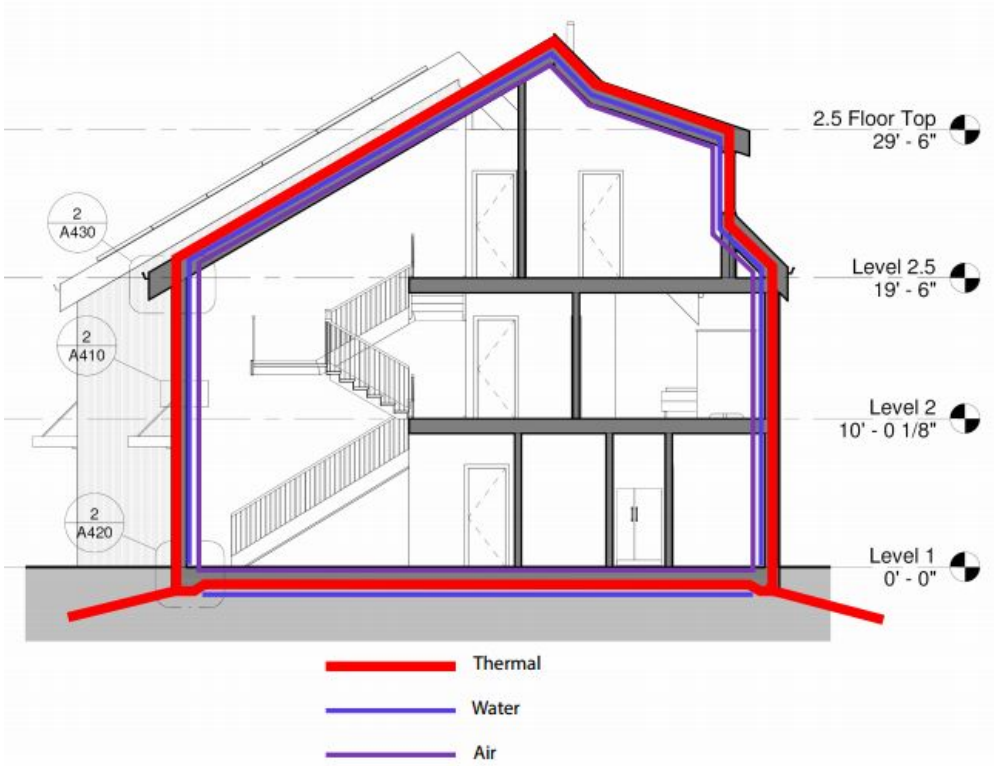
ZERO ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY



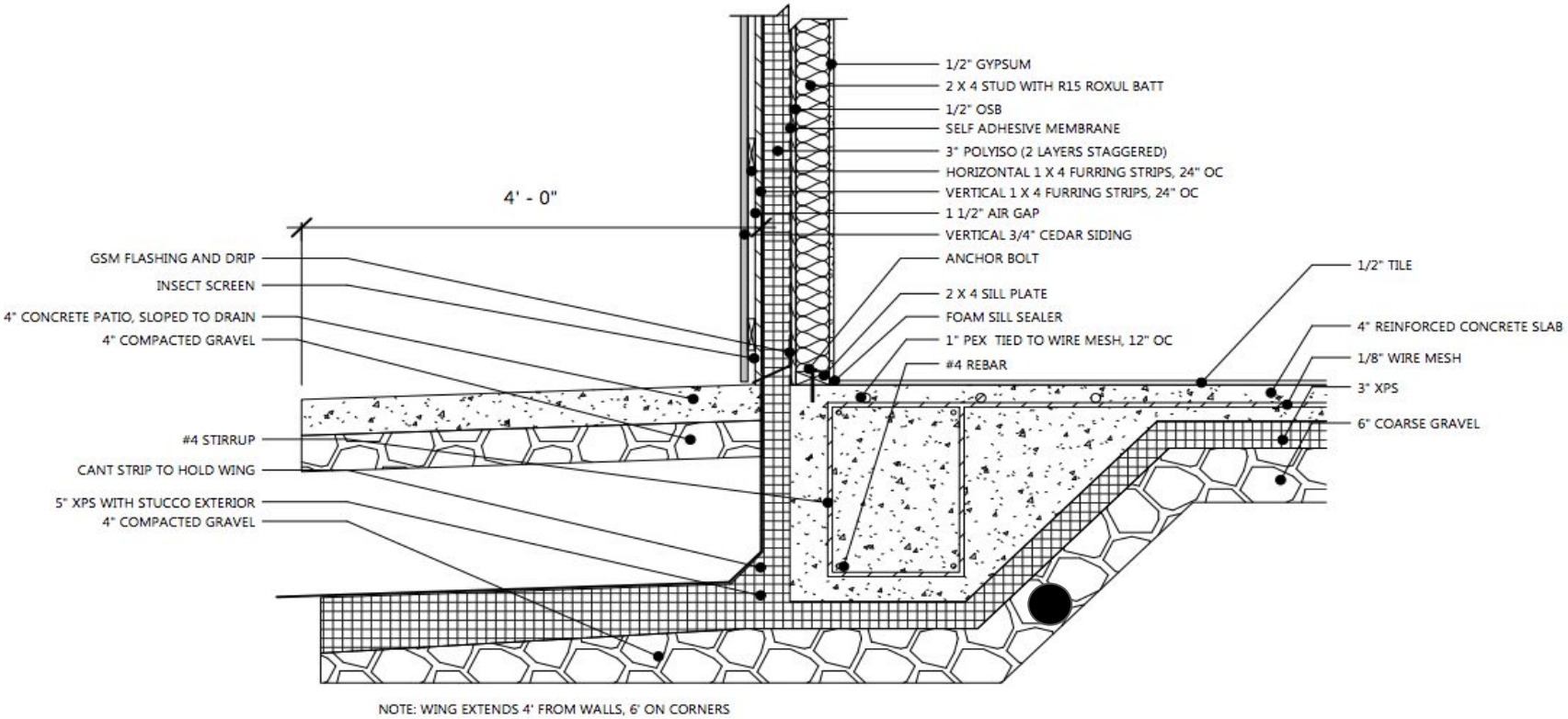
Enclosure Overview

Key Features

- Frost Protected Shallow Foundation
- OptiMN Hybrid Wall
- OptiMN Hybrid Roof
- Ultra-efficient windows
  - North: triple pane, U-0.20
  - South: double pane, U-0.24



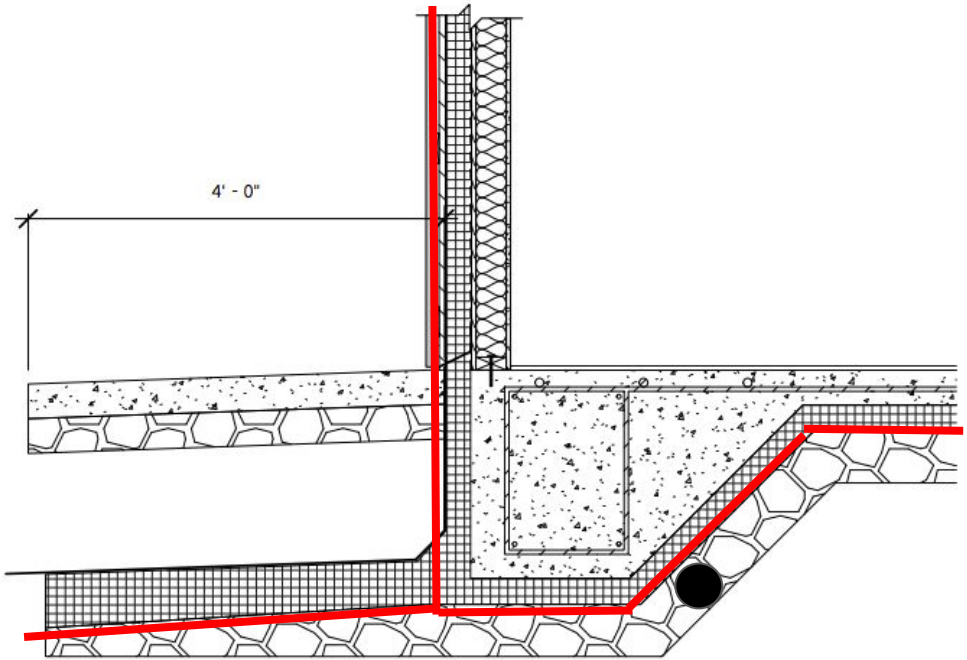
Frost Protected Shallow Foundation



Foundation: Thermal Control

Thermal Control Layer

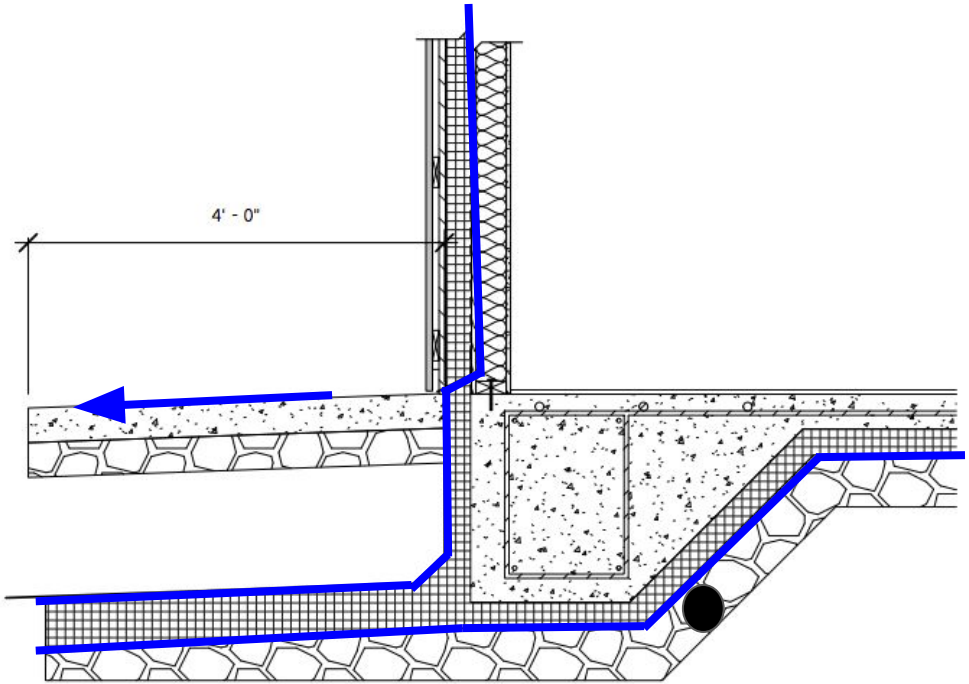
- Insulation serves as formwork for cast-in-place concrete
- Wing insulation: 5” XPS (R25)
- Under slab & footing: 3” depth compressive strength XPS (R15) under slab and footing
- Slab perimeter: 3” XPS (R15) with stucco finish



Foundation: Moisture Control

Moisture Control Layers

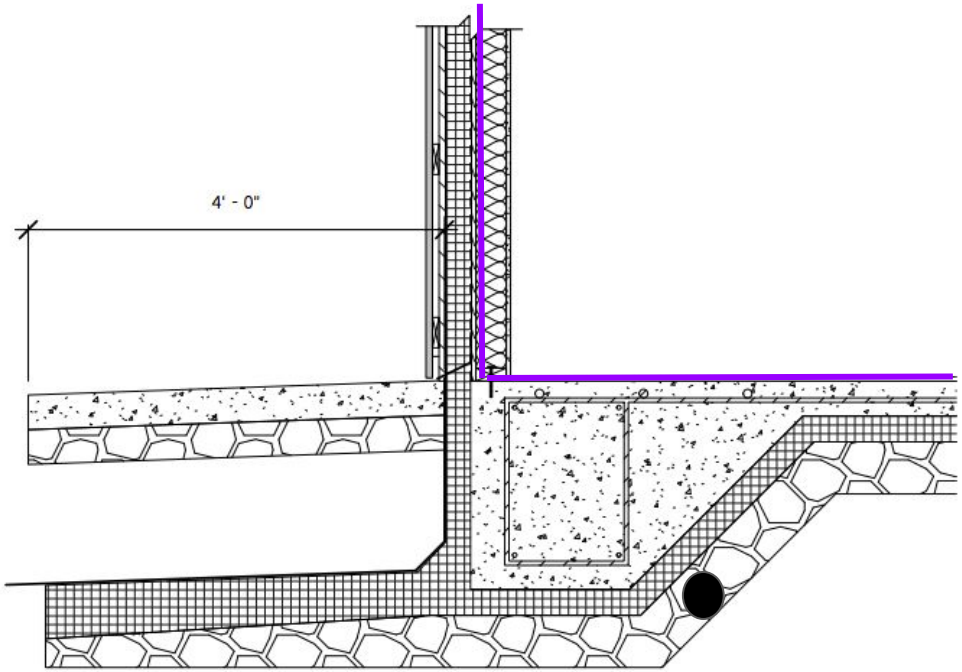
- XPS with stucco surface deflects water away from concrete.
- 6” of large aggregate under entire foundation.
- 4” of large aggregate under wing insulation
- Drain tile inside footing & sump
- XPS provides below-grade vapor control



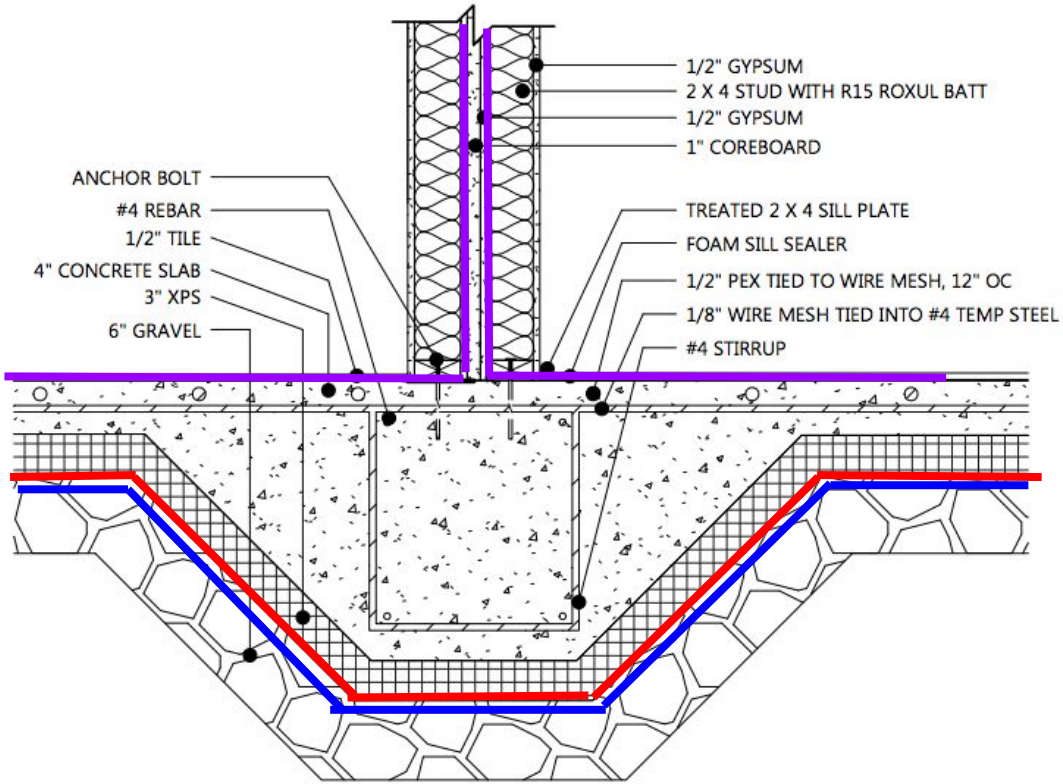
Foundation: Air Control

Air Control Layer

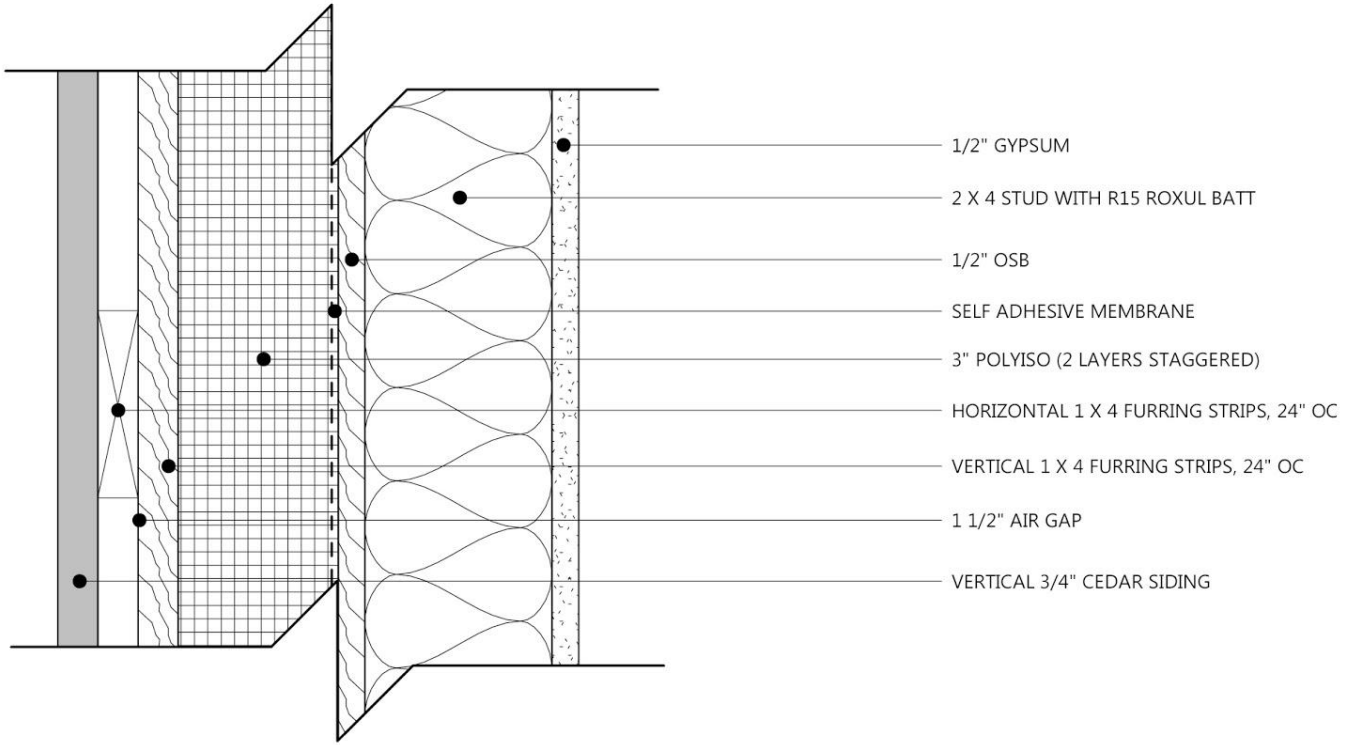
- Concrete with sealed control joints
- Sill sealer and pan flashing between concrete and sill plate



Party Foundation: Control Layers



OptiMN Hybrid Wall

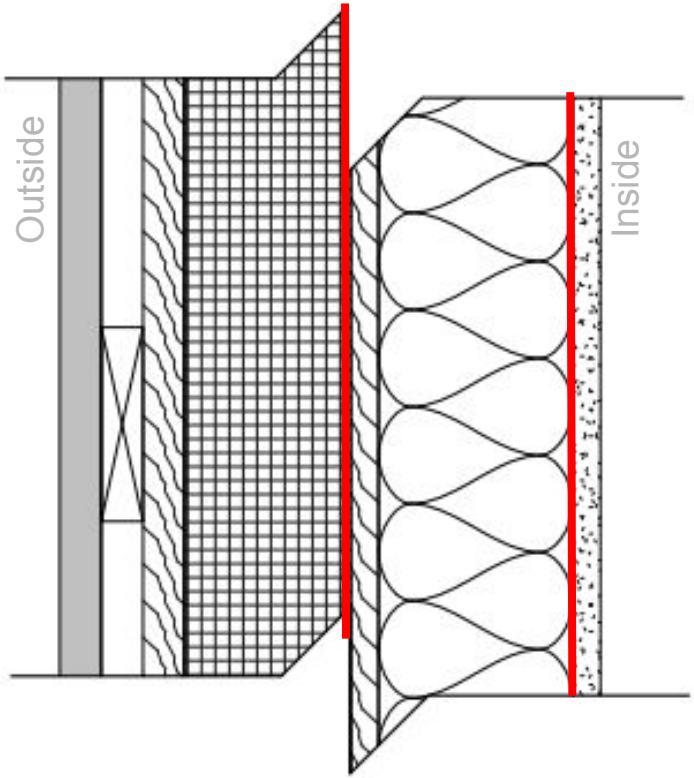


OptiMN Hybrid Wall: Thermal Control

Thermal Control: R35 Assembly

- Exterior: continuous 3” polyiso
- Cavity: 3.5” rock wool batt
- Exterior/Interior Ratio: 60/40

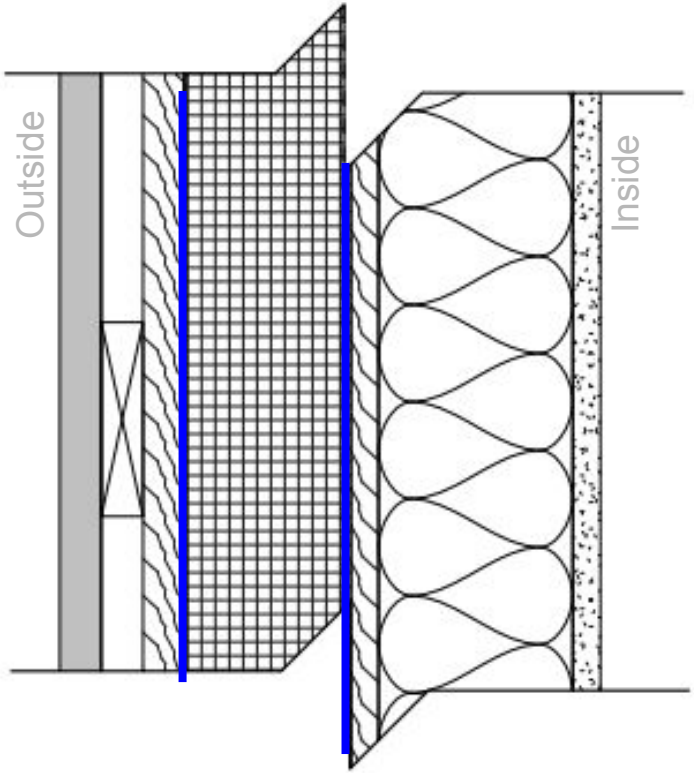
Wall- Insulation			Wall- Framing		
Material	Thickness	R value	Material	Thickness	R value
Interior Airfilm	-	0.68	Interior Airfilm	-	0.68
1/2" Gypsum Board w/ Latex	0.5	0.55	1/2" Gypsum Board w/ Latex	0.5	0.55
3.5" Rock Wool	3.5	15	2x4 Wood Stud	3.5	3.3
1/2" OSB Sheathing	0.5	0.62	1/2" OSB Sheathing	0.5	0.62
Peel and Stick Membrane	0.1	0.12	Peel and Stick Membrane	0.1	0.12
1" Air Gap	1	1.5	1" Furring Strips (Vert and Horiz)	1	0.94
3" Polyiso	3	18	3" Polyiso	3	18
Wood Siding	0.75	0.59	Wood Siding	0.75	0.59
Exterior Airfilm	-	0.17	Exterior Airfilm	-	0.17
Total:	9.35	37.2	Total:	9.35	24.97
Composite U-value		0.0269	**Composite U-value**		0.040
Percentage of Total		0.85	**Percentage of Total**		0.15
Wall Insulation U Component		0.0228	**Wall Framing U Component**		0.0060
Total U			***Total R***		
0.0288			35		



OptiMN Hybrid Wall: Water Control

Water Control Layers

- Self-adhered membrane on OSB
- XPS and furring strips
  - Drained and vented rain screen
  - XPS with taped seams



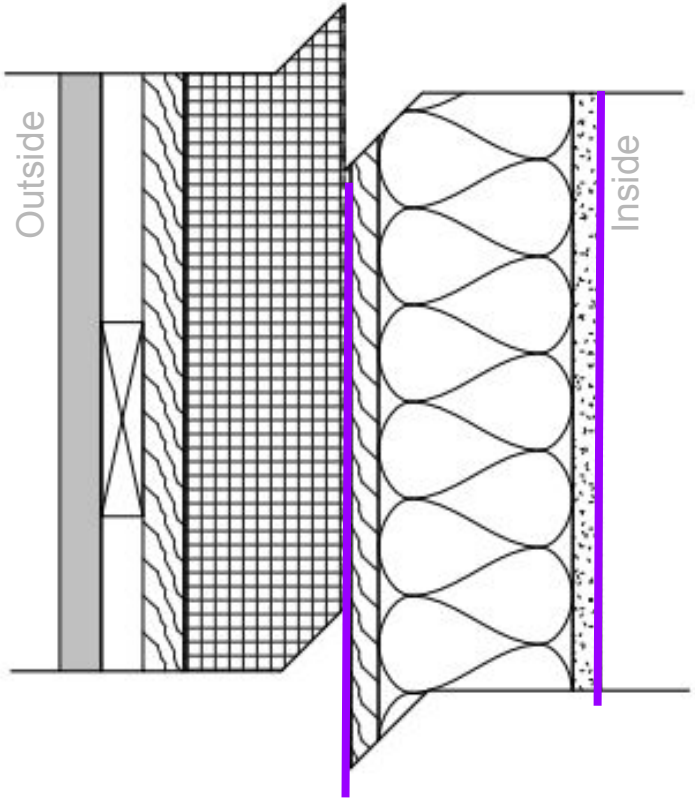
OptiMN Hybrid Wall: Air & Vapor Control

Air Control Layer

- Self-adhered membrane over OSB

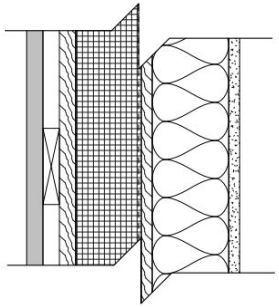
Vapor Control Strategy

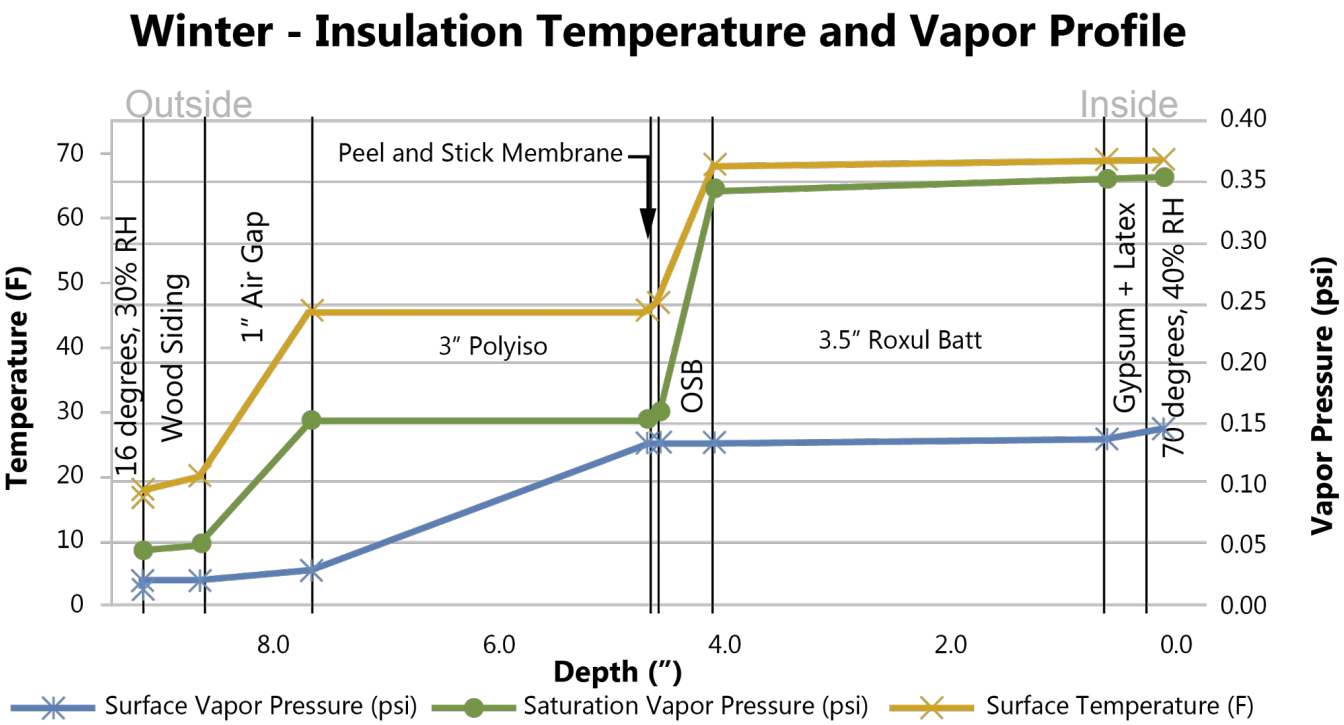
- Self-adhered membrane
- Class III vapor retarder latex paint on gypsum for inward drying
- Furring strips for air and vapor drying



OptiMN Hybrid Wall: Winter Hygrothermal Analysis

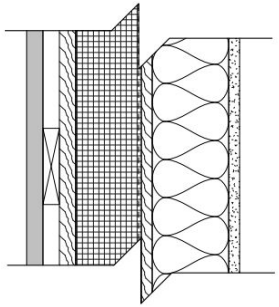
- 16 degrees, 30% RH outside
- 70 degrees, 40% RH inside
- Condensation plane of concern
  - OSB
- 85% RH on OSB

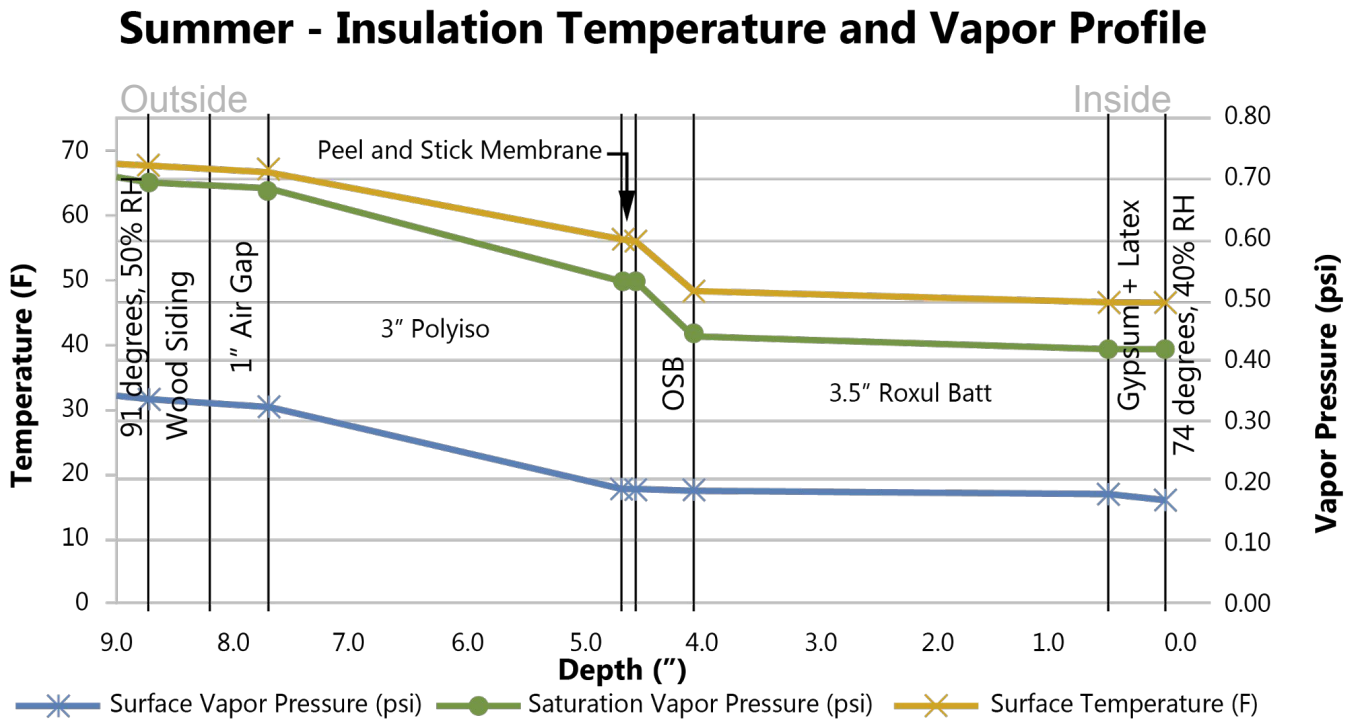




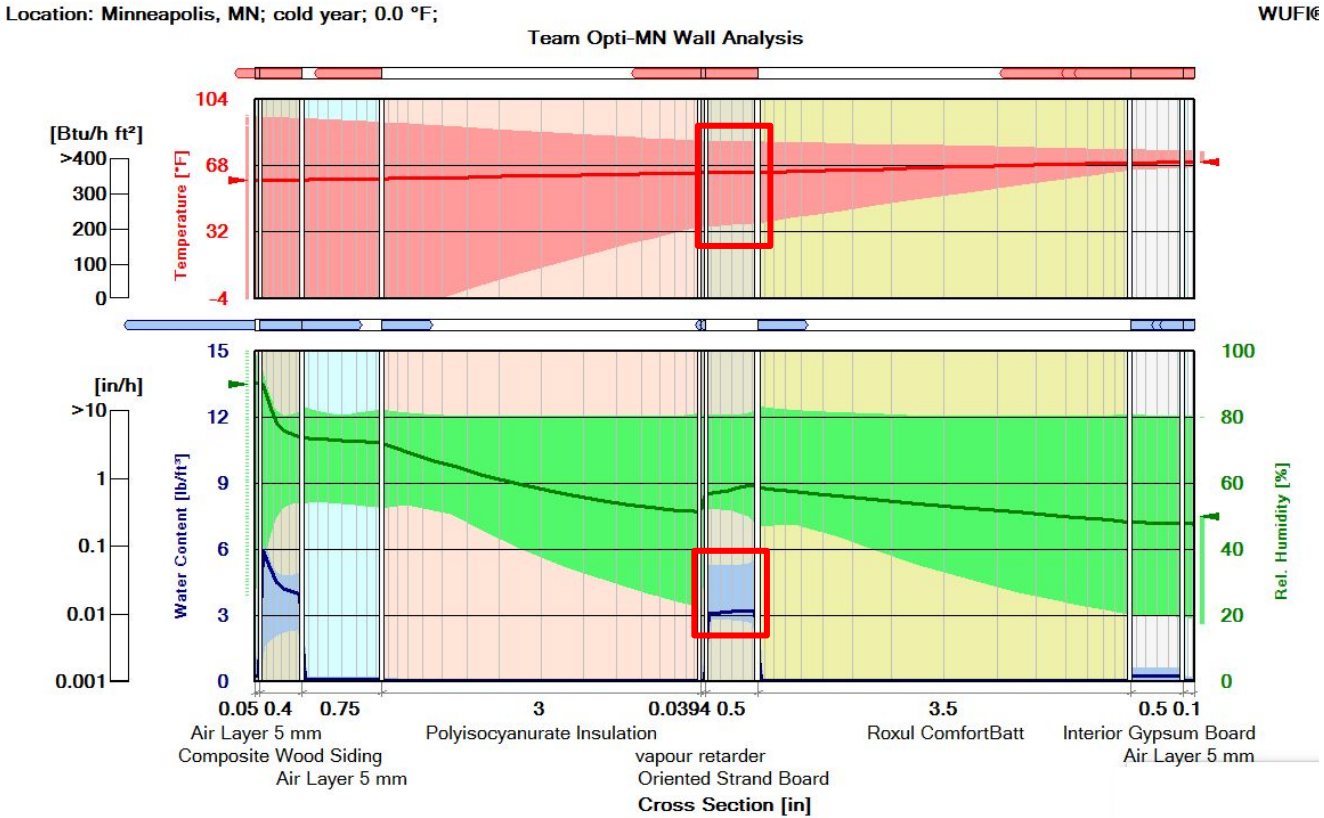
OptiMN Hybrid Wall: Summer Hygrothermal Analysis

- 91 degrees, 50% RH outside
- 74 degrees, 40% RH inside
- Condensation plane of concern
  - OSB
- 35% RH on OSB



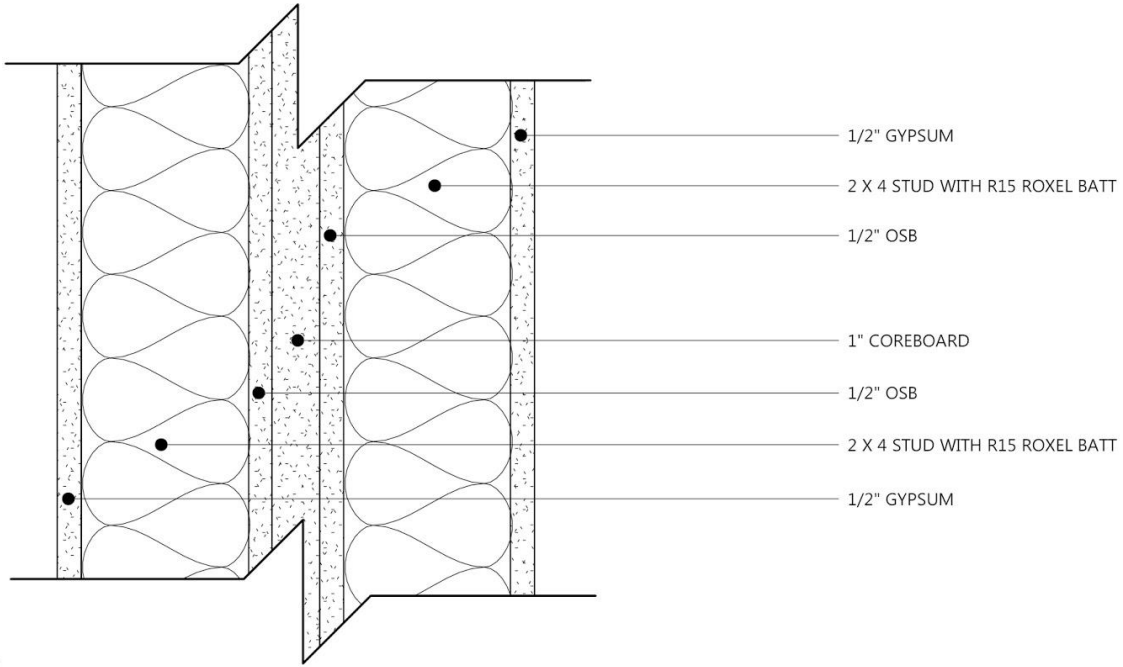


OptiMN Hybrid Wall: WUFI Analysis



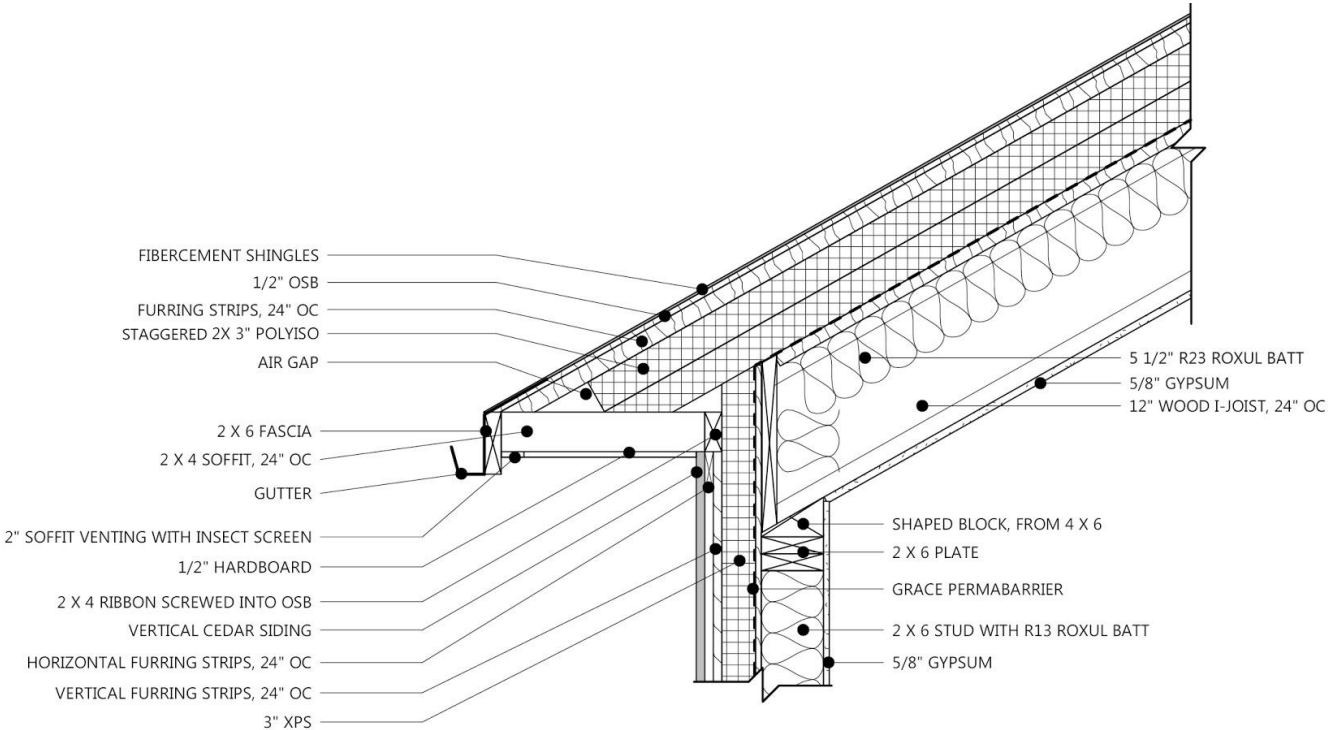
Party Wall

- 2x4 walls with OSB for shear strength
- Rock wool batt staggered for fire and sound control
- 1” Coreboard for fire and sound control



1: Party Wall
Scale: 3”=1’

OptiMN Hybrid Roof



2: Roof Detail
Scale: 3/4"=1'

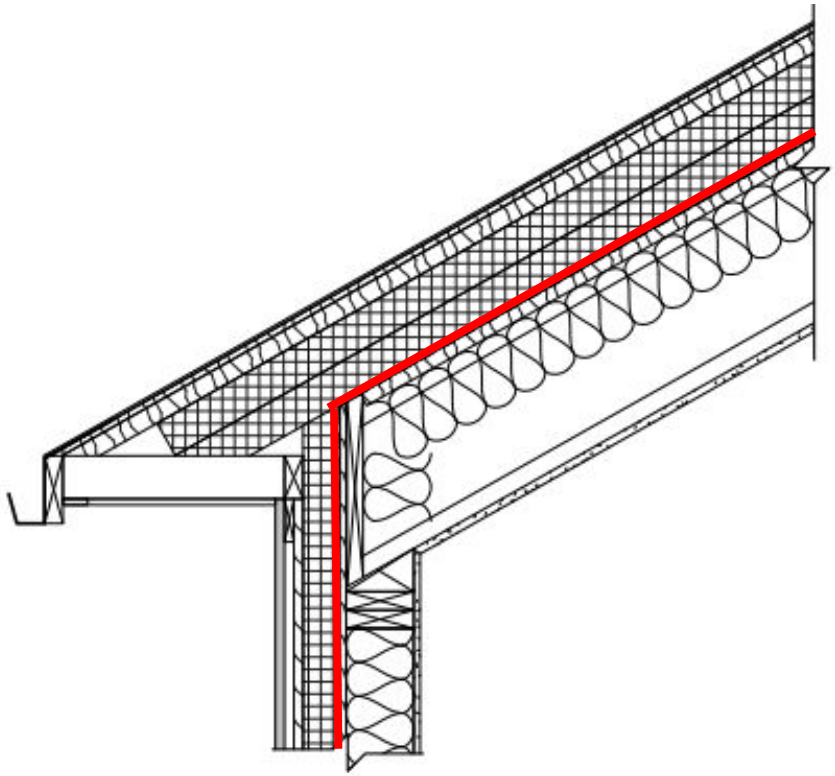
OptiMN Hybrid Roof: Thermal Control

Thermal Control: R57 Assembly

- Exterior: continuous 6” polyiso
- Cavity: 5.5” rock wool batt
- Exterior/Interior Ratio: 65/35

Roof- Insulation		
Material	**Thickness**	**R value**
Interior Airspace	-	0.68
1/2" Gypsum Board	0.5	0.55
2x6 Roxul ComfortBatt	5.5	15
Air Gap in Rafter Cavity	5.75	1.82
1 1/18" OSB	1.125	1.45
Grace Perm-a-Barrier	0.01	0.06
6" Polyisocyurenate	6	36
1/2" OSB Sheathing	0.5	0.62
Asphalt Paper	0.1	0.12
1/2" Airspace (furring strip)	0.75	0.9
Fiber cement Shingles	0.75	0.44
Exterior Airspace	-	0.17
Total:	20.985	57.8
Composite U-value		0.0173
Percentage of Total		0.85
Wall Insulation U Component		0.0147
Total U		
0.0176		

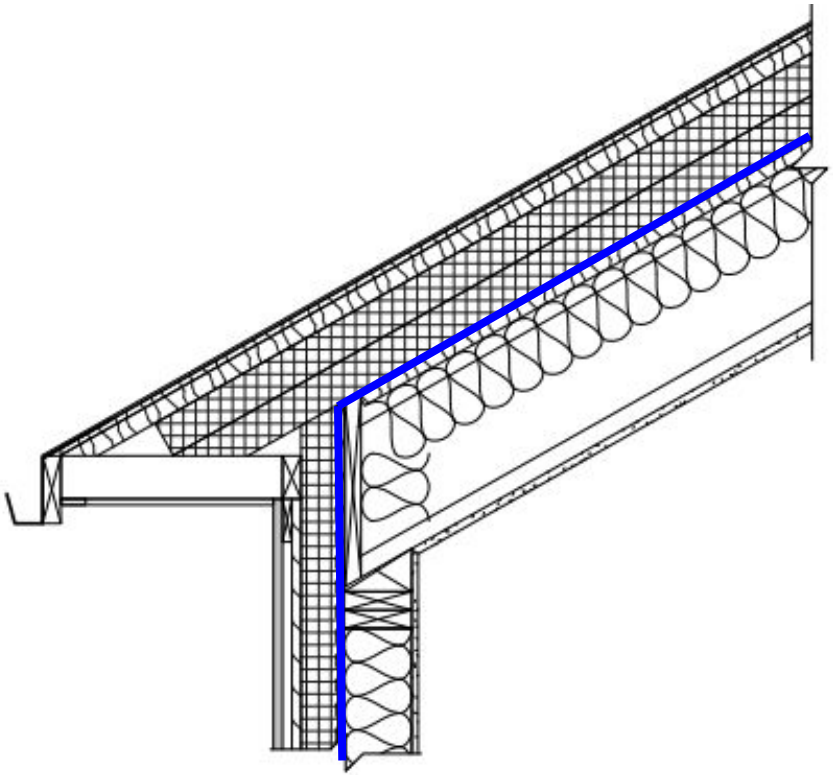
Roof- Framing		
Material	**Thickness**	**R value**
Interior Airspace	-	0.68
1/2" Gypsum Board	0.5	0.55
2 x 12 Roof Joists	11.25	10.5
1 1/18" OSB	1.125	1.45
Grace Perm-a-Barrier	0.01	0.06
6" Polyiso	6	36
1/2" OSB Sheathing	0.5	0.62
Asphalt Paper	0.1	0.12
1/2" Airspace (furring strip)	0.75	0.9
Fiber cement Shingles	0.75	0.59
Exterior Airspace	-	0.17
Total:	20.985	51.64
Composite U-value		0.019
Percentage of Total		0.15
Wall Framing U Component		0.0029
Total R		
57		



OptiMN Hybrid Roof: Water Control

Water Control Layers

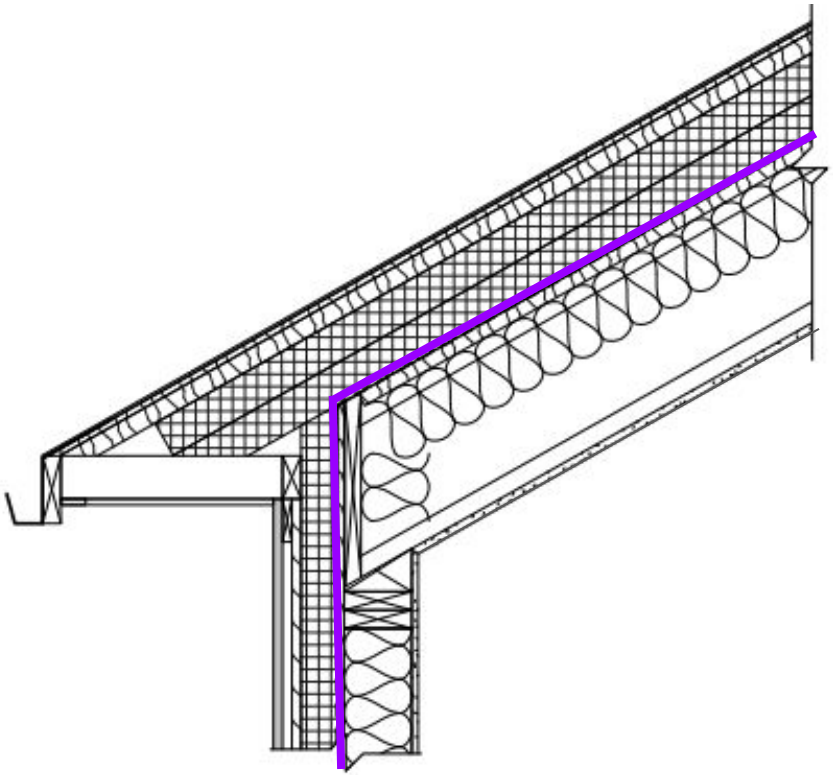
- Self-adhered membrane over structural OSB
- Asphalt building paper between OSB roof sheathing and shingles



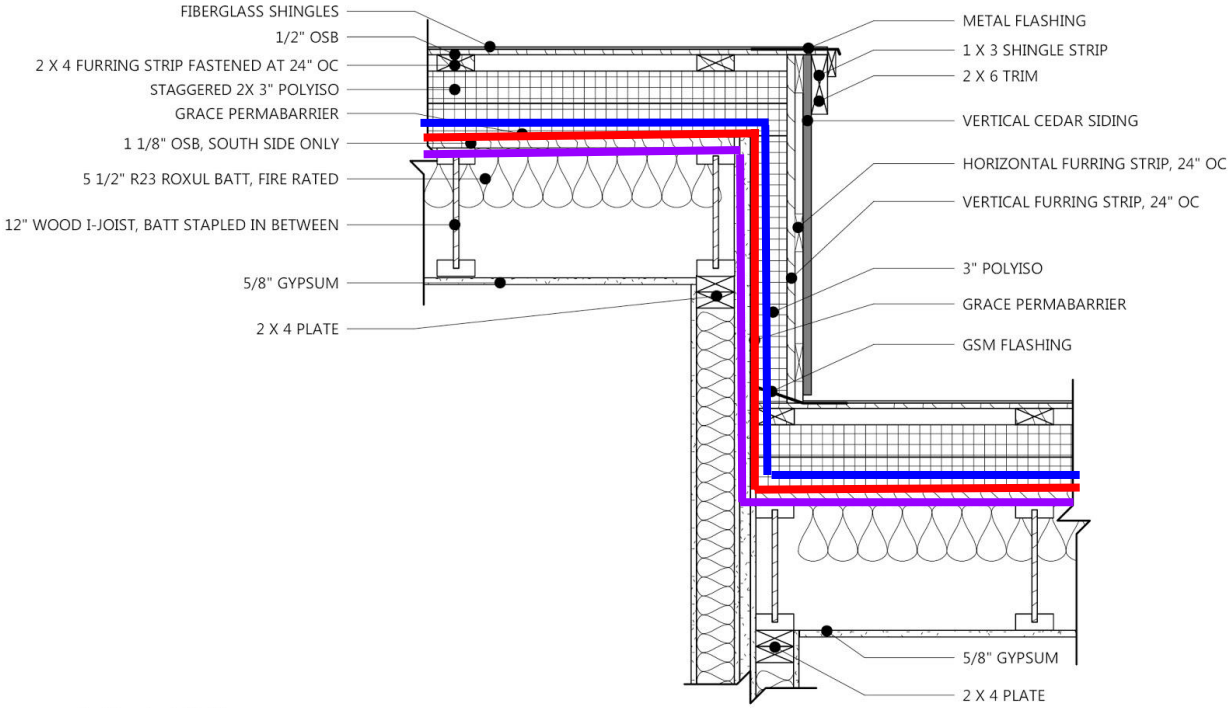
OptiMN Hybrid Roof: Air and Vapor Control

Air and Vapor Control

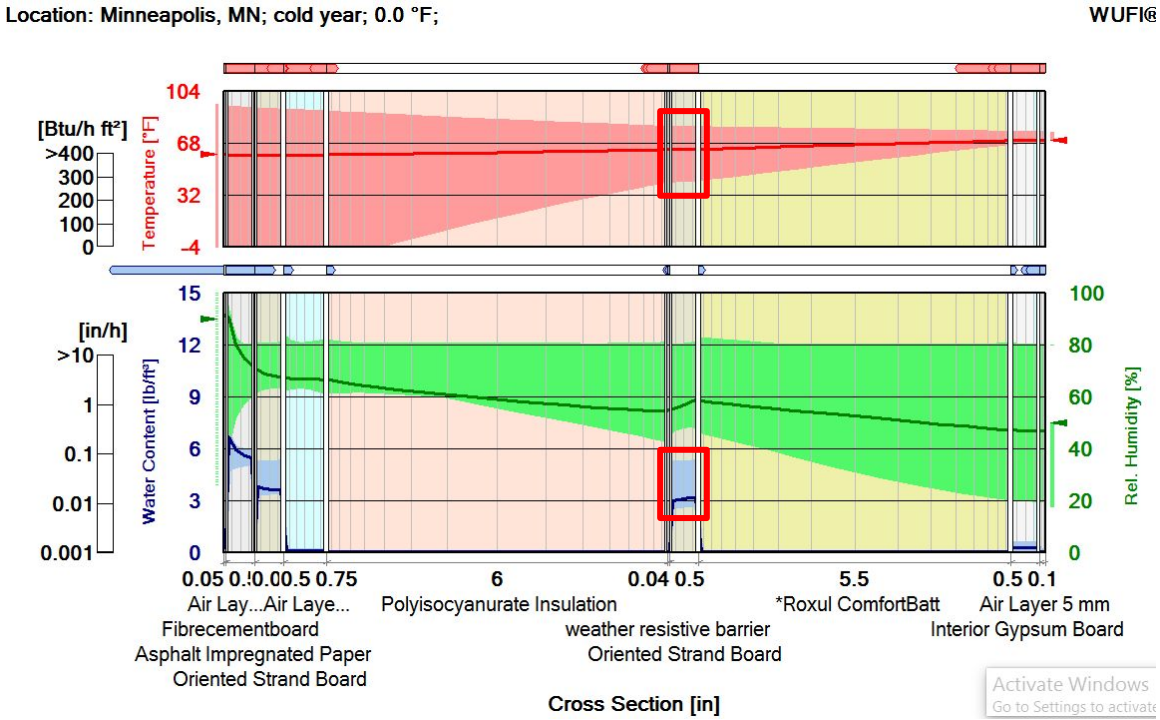
- Self-adhered membrane over OSB
- Class III latex paint on gypsum for inward drying
- Furring strips under shingles and OSB provides air and vapor drying



Roof and Party Wall Connection



OptiMN Hybrid Roof: WUFI Analysis

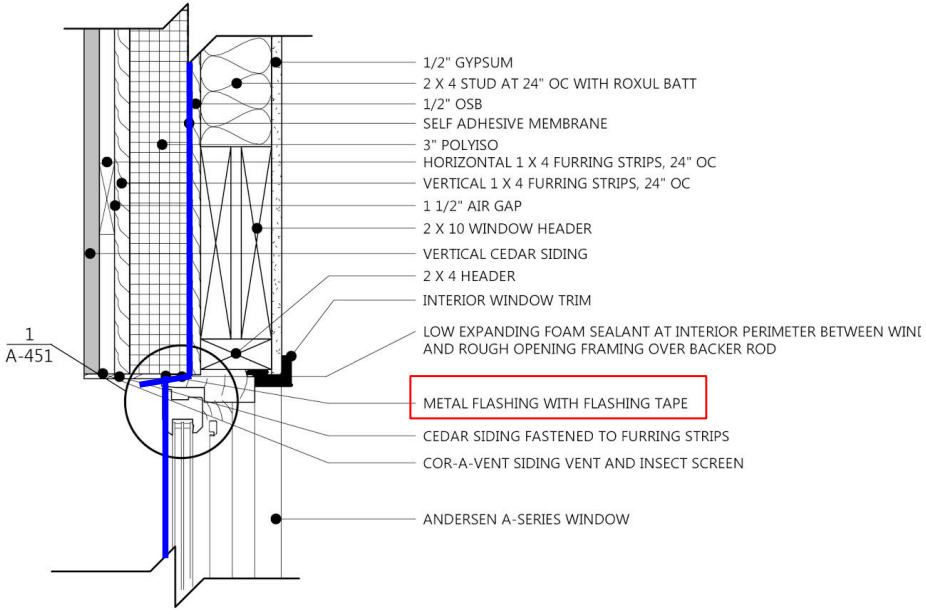


Windows: Specifications

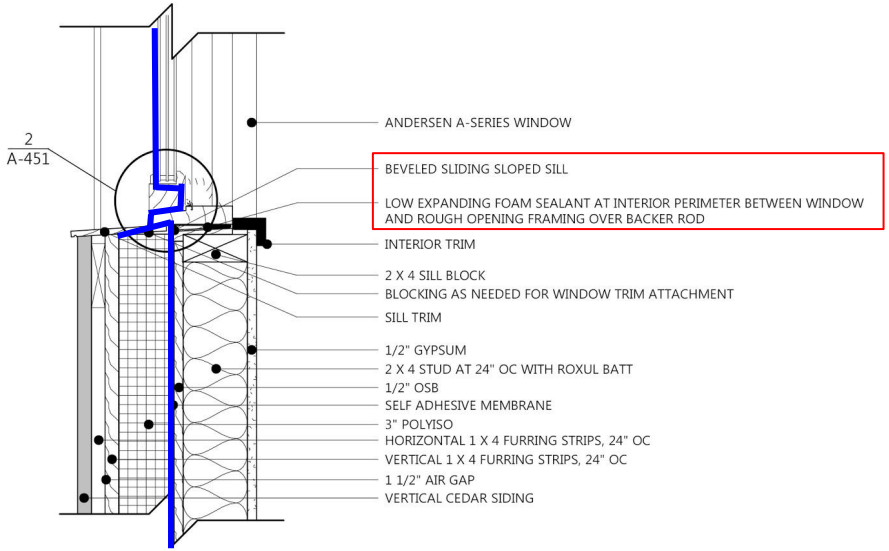
Andersen A-Series

- MN window manufacturer
- Fibrex frame: wood fiber and PVC polymer composite
- North: Low-e triple pane with Heatlock
  - U-Factor- 0.20
  - SHGC- 0.21
- South: Low-e double pane; PassiveSun with Heatlock
  - U-factor-0.24
  - SHGC- 0.36

Windows: Head and Sill Details



1: Window Head Detail
Scale: 1-1/2"=1'



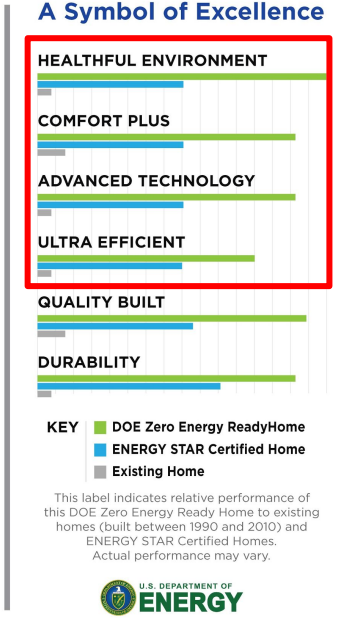
2: Window Seal Detail
Scale: 1-1/2=1'

Systems Goals

Healthy - Lasting - Cost-Effective - Zero Energy Ready Home

- Select high-efficiency equipment
- Proper design, sizing, and layout
- Minimize duct and pipe lengths
- Easily and efficiently distribute fresh air to all rooms

ZERO ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY



Energy Loads

Heating and cooling loads were calculated by entering enclosure areas, insulation values, air tightness, ventilation rates, solar, and internal gains into both ACCA Manual J and REMRate.

	Manual J	REM Rate
Heating Load (KBtu/Hr)	13.9	13
Cooling Load (KBtu/Hr)	7.5	9.3

Ultra Efficient Loads

- Extremely low heating design load < 15 kBtu/hr
- Very small cooling design load < 12 kBtu/hr (1 ton)

Heating and Cooling System

Compact Combi Boiler

Energy Kinetics Accel CS EK1C90

Hot Water
Bathrooms / Kitchen

Space Conditioning

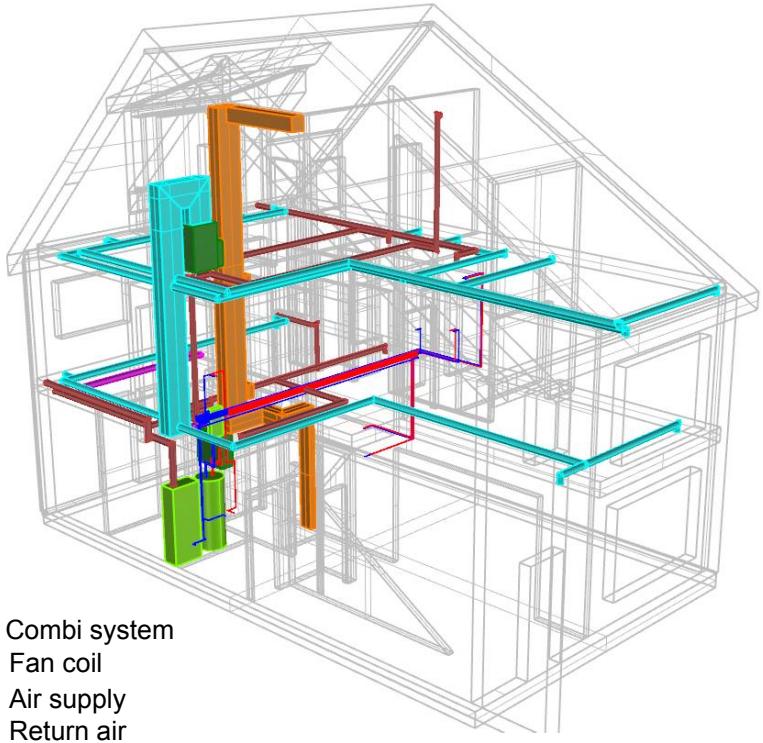
Radiant Heat

Fan coil w/ ECM

Enerzone Convertible

Air conditioner

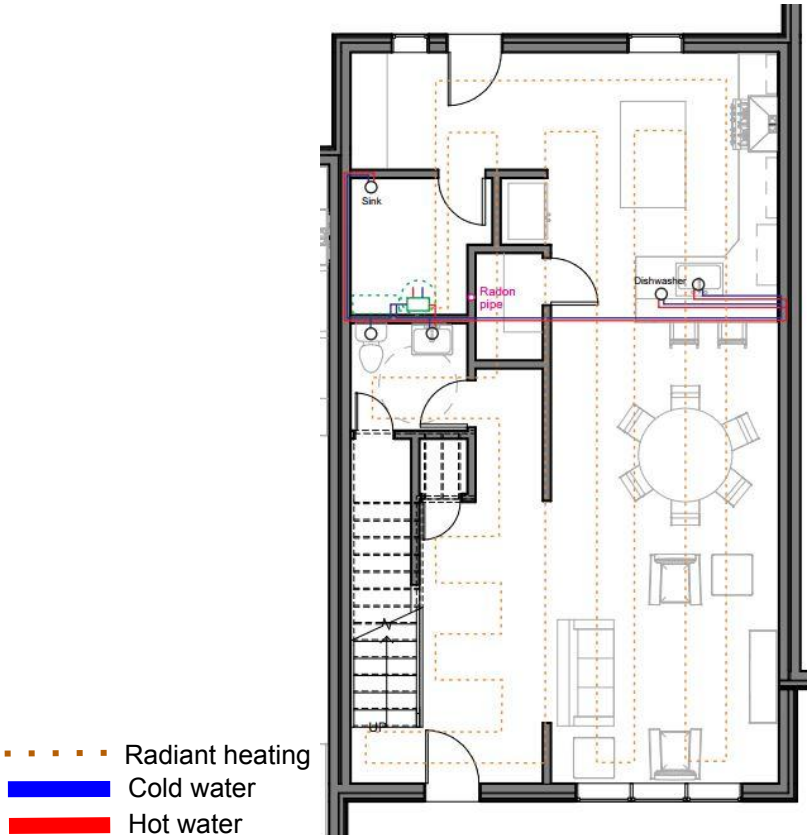
Lennox XC21



Combi system
Fan coil
Air supply
Return air
Exhaust

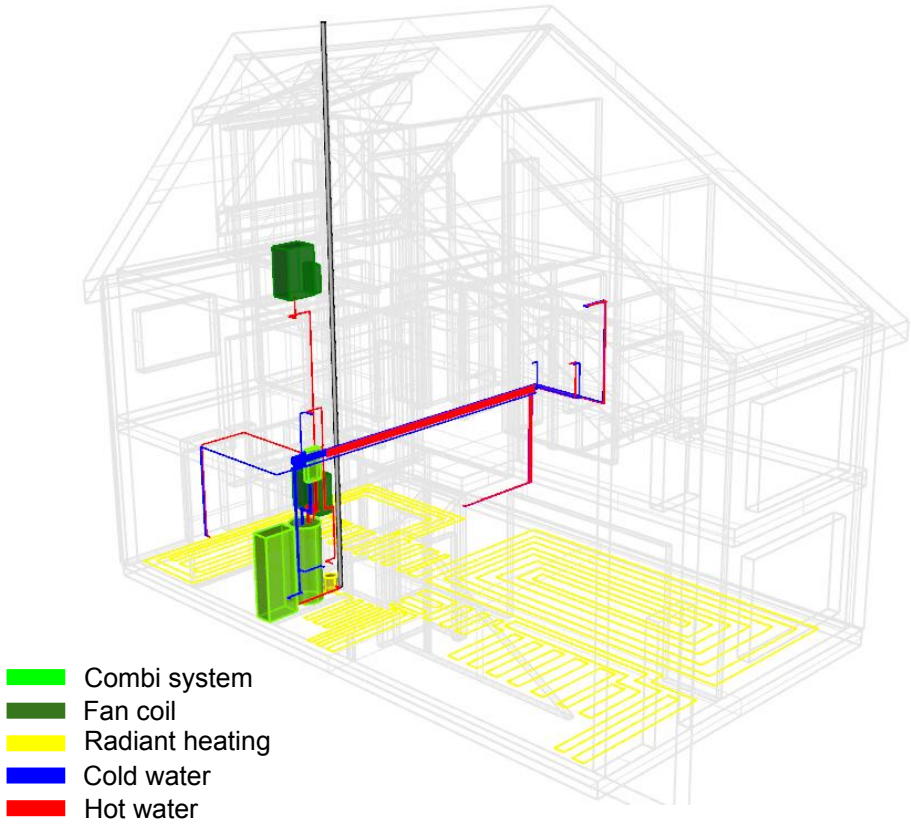
Radiant In-Floor Heating

- More efficient heating
- Reduced spread of allergens
- Consistent and comfortable temperatures
- Reduced energy use



Domestic Hot Water

- High-efficiency water heater
- Proper system sizing
- Efficient distribution layout
- WaterSense certified fixtures



Appliances

Washing Machine		Whirlpool - Energy Star 4.3-cu.ft High- Efficiency Top Load Washer
Dryer		Beko - Energy Star, Ventless, Electric 4.1 cu.ft Front Loader
Refrigerator		Whirlpool - Energy Star, 20.5 cu.ft Top-Freezer Refrigerator
Stove		Whirlpool - Energy Star, 4-burner 5 cu.ft Slide-in Gas Range
Dishwasher		Whirlpool - Energy Star, Gold 51-decibel Built-in Dishwasher

Indoor Air Quality Goals

Healthy - Lasting - Cost-Effective - Zero Energy Ready Home

- Manage contaminants
- Filter particulates
- Provide fresh outside air
- Manage intakes and exhausts

→

- Sealed combustion equipment
- Radon mitigation w/ASD
- Reduced VOCs
- Hard surface flooring

Indoor Air Quality Goals

Healthy - Lasting - Cost-Effective - Zero Energy Ready Home

- Manage contaminants
- Filter particulates
- Provide fresh outside air
- Manage intakes and exhausts

→

- High-efficiency MERV 12 air filter for circulation system
- MERV 8 filter for ERV intake

Indoor Air Quality Goals

Healthy - Lasting - Cost-Effective - Zero Energy Ready Home

- Manage contaminants
- Filter particulates
- Provide fresh outside air
- Manage intakes and exhausts

→

- ERV (filtered and tempered air)
- Source point exhaust intakes
- Timed air circulation/distribution

Indoor Air Quality Goals

Healthy - Lasting - Cost-Effective - Zero Energy Ready Home

- Manage contaminants
- Filter particulates
- Provide fresh outside air
- Manage intakes and exhausts →
  - Elevated fresh air intakes
  - Separated intakes and exhausts
  - Exhaust clearances to openings

Ventilation Rates

Energy Recovery Ventilator (ERV) EC15 ECM
with MERV 12 Filter

- Minnesota Code = (0.02 cfm/sf x 2298 sf) + (15 cfm/br x (3br+1) = **106 cfm**
  - 1/2 of this must be continuous meeting ASHRAE 62.2-2010 = **53 cfm**
- Continuous ventilation rate = **80 cfm**
  - 1st floor half-bath = 20 cfm
  - 2nd floor bathroom (toilet room) = 20 cfm
  - 3rd floor future bathroom = 20 cfm
  - 1st floor kitchen area = 10 cfm
  - 2nd floor laundry = 10 cfm
- Total ventilation rate = **120 cfm** (high speed)

Dedicated Exhaust Fans

2nd Floor Bathroom (shower room)

Panasonic WhisperGreen FV-05-11VK1
50 cfm hard-wired to light

Kitchen Range Hood

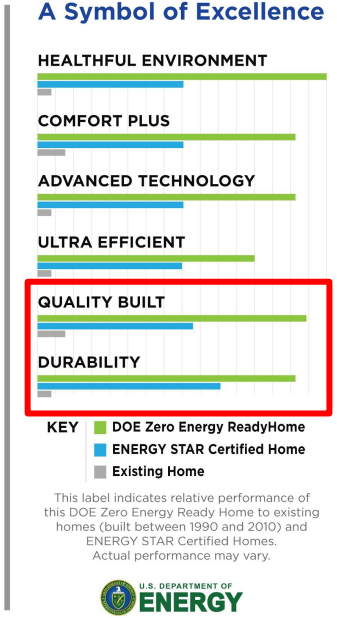
Broan Elite RME50305SS
135 cfm normal; 290 cfm boost

Constructability Goals

Healthy - Lasting - Cost-Effective - Zero Energy Ready Home

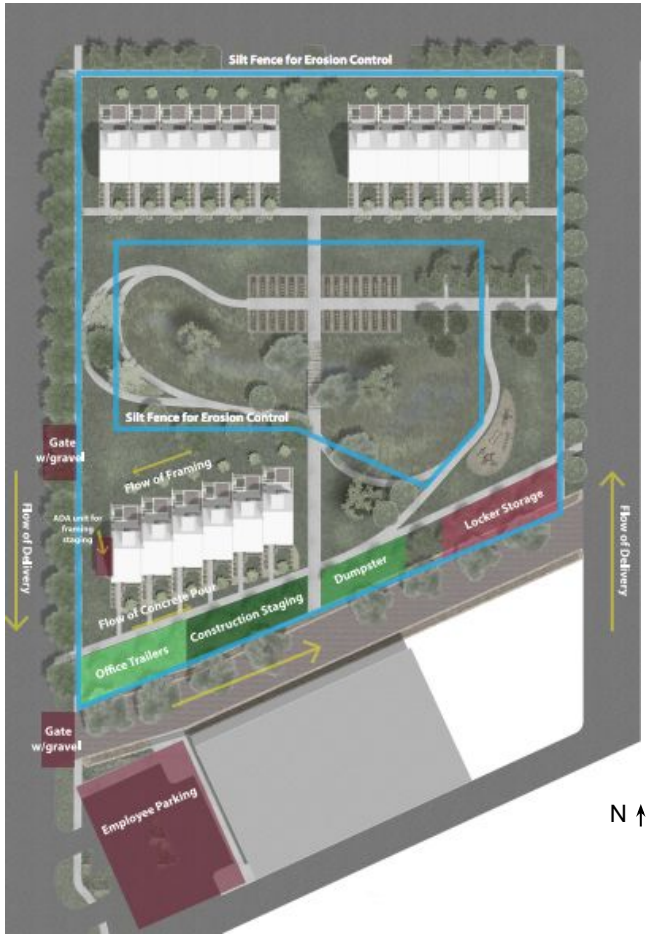
- Ensure a quality-built house
- Minimize environmental impact from construction
- Use of readily available materials and common practices for ease of construction and cost reduction

ZERO ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY



Site Logistics

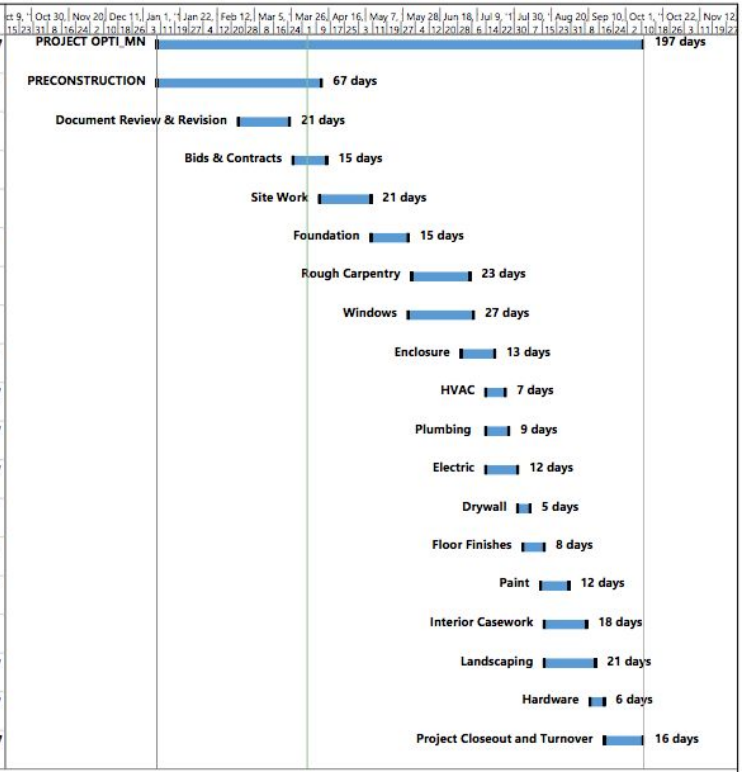
- Properly installed and maintained silt fences for erosion control
- High level of visibility from office trailers
- West end (ADA) unit provides staging for other units
- Pour concrete from east to west
- Frame from east to west
- Ensure site safety and security with perimeter fence and gated entries



Constructability: Construction Schedule

- Employ “waterfall technique” for efficient sequencing
- Start excavation
  - 11 April
- Weathertight
  - 28 July
- Project Completion
  - 10 October
- Total Project Cycle
  - 10 Months

ID	Task Mode	Task Name	Duration	Start	Finish
1		PROJECT OPTI_MN	197 days	Mon 1/9/17	Tue 10/10/17
2		PRECONSTRUCTION	67 days	Mon 1/9/17	Tue 4/11/17
26		Document Review & Revision	21 days	Fri 2/24/17	Fri 3/24/17
33		Bids & Contracts	15 days	Mon 3/27/17	Fri 4/14/17
37		Site Work	21 days	Tue 4/11/17	Tue 5/9/17
53		Foundation	15 days	Wed 5/10/17	Tue 5/30/17
63		Rough Carpentry	23 days	Fri 6/2/17	Tue 7/4/17
100		Windows	27 days	Wed 5/31/17	Thu 7/6/17
114		Enclosure	13 days	Fri 6/30/17	Tue 7/18/17
148		HVAC	7 days	Fri 7/14/17	Mon 7/24/17
152		Plumbing	9 days	Fri 7/14/17	Wed 7/26/17
158		Electric	12 days	Fri 7/14/17	Mon 7/31/17
177		Drywall	5 days	Tue 8/1/17	Mon 8/7/17
190		Floor Finishes	8 days	Fri 8/4/17	Tue 8/15/17
221		Paint	12 days	Mon 8/14/17	Tue 8/29/17
234		Interior Casework	18 days	Wed 8/16/17	Fri 9/8/17
253		Landscaping	21 days	Wed 8/16/17	Wed 9/13/17
261		Hardware	6 days	Mon 9/11/17	Mon 9/18/17
265		Project Closeout and Turnover	16 days	Tue 9/19/17	Tue 10/10/17



Construction Management: Best Practices

Construction Management

- Quality assurance plan to ensure quality for each stage of construction

Construction Quality Assurance	
Preconstruction	Constant communication between general contractor and architects will ensure high-quality execution and a high-perfromance building. A complete set of detailed construction drawings will assure that all materials specified are correct and amounts specified are appropriate.
	Consulations with building science and certification professionals to ensure energy efficiency and high performance across all elements
Site Work	A geological survey preempts site work, and alerts us to conflicting existing conditions.
	Soil contamination is a great residential concern, and remediation work may be required.
	Soil has structural considerations as well, so well graded, inorganic gavel and sand is ideal.
	Proper compaction of the soil must begin prior to laying and compactive gravel.
	Slopes of the foundation are designed to be 45 degree angles for easy workability.
Foundation	Filter fabric is installed between earth and gravel to prevent compaction into soil.
	Proper gravel compaction must occur before rigid insulation is used for formwork.
	Minimize gaps between XPS insulation and install temporary support for vertical XPS.
	Stagger underslab XPS into two layers, 1" and 2"
	Use stucco coated XPS for exterior rigid insulation and wing insulation to protect the insulation from breaking.
	Use high compressive strength XPS (40 psi) for under footing insulation
	Install drain tile in gravel underneath slab and slope towards sump pump.
	Exterior drainage layer must slope away from foundation.
	Sump pump opening in slab must be air sealed
	Install flashing between walls and foundation and sill sealer beneath the sill plate for capillary break and wall drainage.
Rough Carpentry	Gaps between framing and sheathing must be minimized by using graded 2x4 studs, selected specifically for straightness and structural capacity.
	OSB sheathing must be weatherproofed with continuous peel and stick membrane soon to prevent warping or swelling.
	FSC certified wood must be used
	Framing inspection for gaps between sheathing and framing by HERS Rater
Windows	Oversize window rough opening to allow for sloped sill and expanding foam sealant between window and rough opening.
	Peel and stick membrane, and flashing must be established prior to window installation.
	The sides of the peel and stick membrane will be flashed in, and there will be a pan flash must be installed.
	Sealant between trim and cladding to minimize water penetration.
	Use beveled siding to create slope sill and flashing installed under window and integrated with peel and stick membrane
Weatherproofing	Furring strips are installed over the rigid installation to provide back ventilation of siding.
	Roof rigid installation installed in 2 layers and staggered to minimize thermal bridging.
	Install furring strips over rigid insulation to provide ventilation for shingles.
Cavity Insulation	Install cavity insulation without compression or voids
	Insulation Inspection by HERS Rater
HVAC	Assure all ducts are properly sealed with mastic during installation.
	Inspection of HVAC appliances occur after rough ins.
Plumbing	Plumbing rough inspection and final inspection for proper pressure and flow
Electrical	Electrical inspection rough in and final inspection for proper wiring and fire stops
Landscaping	Exterior perimeter of site surrounded by silt fence, and bioswale in middle of site surrounded by silt fence
Final Approval & Certification	*Blower door test and infrared analysis for infiltration levels by HERS Rater*
	Duct Blaster test for duct leakage assessment by HERS Rater
	Ventilation flow verification by HERS Rater
	Hot water test- no more than 0.5 gal to achieve a 10 degree rise by HERS Rater

Construction Management: Best Practices

Construction Management

- Quality assurance plan to ensure quality for each stage of construction
- 3rd party verification at three crucial points of construction to ensure performance

Construction Quality Assurance	
Preconstruction	Constant communication between general contractor and architects will ensure high-quality execution and a high-perfromance building. A complete set of detailed construction drawings will assure that all materials specified are correct and amounts specified are appropriate.
	Consulations with building science and certification professionals to ensure energy efficiency and high performance across all elements
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	Soil contamination is a great residential concern, and remediation work may be required.
	Soil has structural considerations as well, so well graded, inorganic gavel and sand is ideal.
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	Minimize gaps between XPS insulation and install temporary support for vertical XPS.
	Stagger underslab XPS into two layers, 1" and 2"
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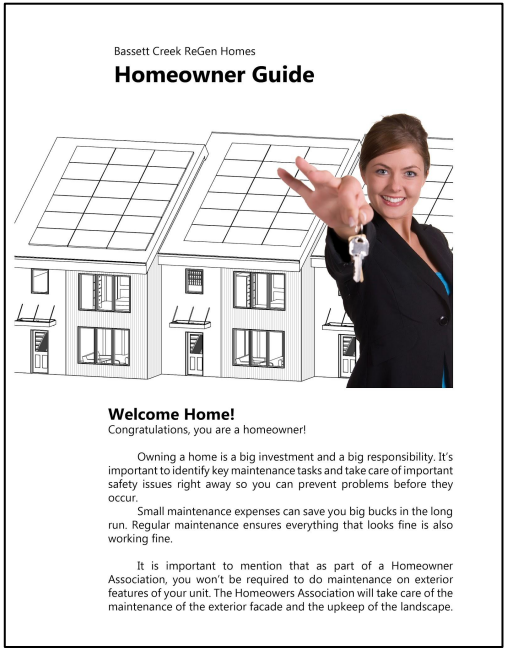
	Hot water test- no more than 0.5 gal to achieve a 10 degree rise by HERS Rater

Homeownership: Best Practices

- Best practices don't end when construction is completed
- Homeowner guide includes:
  - Schedule for routine maintenance
  - Home systems explanation
  - Safety items
  - Diagrams with locations of system access



Bassett Creek ReGen Homes

Homeowner Guide

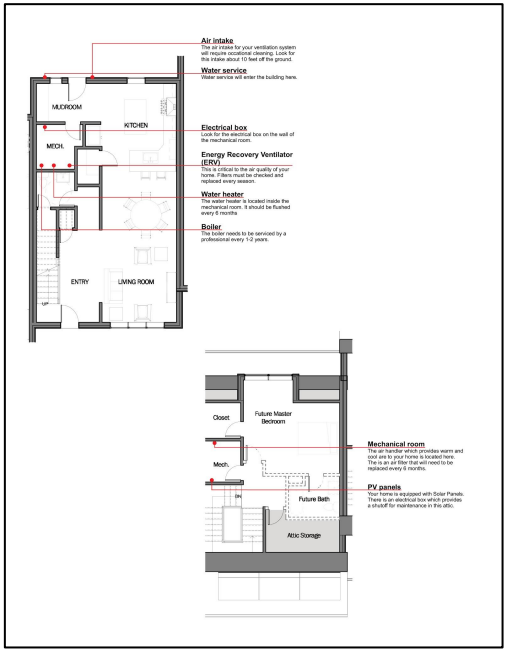
Welcome Home!

Congratulations, you are a homeowner!

Owning a home is a big investment and a big responsibility. It's important to identify key maintenance tasks and take care of important safety issues right away so you can prevent problems before they occur.

Small maintenance expenses can save you big bucks in the long run. Regular maintenance ensures everything that looks fine is also working fine.

It is important to mention that as part of a Homeowner Association, you won't be required to do maintenance on exterior features of your unit. The Homeowers Association will take care of the maintenance of the exterior facade and the upkeep of the landscape.



Financial Summary

- Overall ReGen construction costs less than NAHB baseline
- Foundation cost includes in-floor heating
- Advanced framing techniques decrease framing costs

Team Name: Team Opti-MN (University of Minnesota)
Contest Category: Attached Housing

Construction Cost Summary

	Baseline Design	Team Design
Site Work	$ 14,831	$ 14,831
Foundations	$ 20,627	$ 29,699
Framing	$ 41,461	$ 24,668
Exterior Finishes	$ 31,268	$ 31,034
Major Systems Rough-ins	$ 29,052	$ 23,147
Interior Finishes	$ 63,678	$ 73,073
Final Steps	$ 14,327	$ 5,009
Other	$ 1,997	$ -
Total Construction Costs	$ 217,243	$ 201,459

Sales Price Summary and Cost of Living

	Baseline Design	Team Design
Total Sales Price	$ 352,177	$ 336,394
Monthly Household Debt (0.5% MFI)	$ 261	$ 240
Operations and Maintenance Costs	$ 196	$ 120
Monthly Utility Costs	$ 160	$ 78
Property Tax	$ 332	$ 377
Insurance	$ 79	$ 79
Mortagage	$ 1,405	$ 1,193
Total	**$ 2,433**	**$ 2,087**
Estimated Target Family Income	$ 52,250	$ 48,000
Debt to Income Ratio	56%	52%

Financial Analysis

Home Cost	Default Estimate	Value	Justification/Notes
Construction Costs		$ 201,459	
Total Home Costs		$ 336,394	
Property Tax			
Property Tax Rate	1.15%	1.35%	Current Hennepin County Property Tax
Annual Property Tax	$ 3,986	$ 4,524	
Financing			
Annual Interest Rate	4.50%	4.50%	
Years		30 years	
Payments per Year		12	
Number of Payments		360	
			30% of Home Cost with Habitat for Humanity
Down payment	$ 69,316	$ 67,279	Assistance
Principle Amount		$ 269,115	
Monthly Payment		$ (1,364)	
Affordability			
			Based on ESRI and Harrison Neighborhood
Estimated Target Family Income	$ 52,250	$ 48,000	Association Data
Monthly Utility Costs			
Electricity	$ 111	$ 23	REM/Rate Analysis for ReGen Homes
Natural Gas	$ 31	$ 43	REM/Rate Analysis for ReGen Homes
			Low flow fixtures in house reduce water
Water	$ 18	$ 12	consumption
Other	$ -	$ -	
Total	$ 160	$ 78	
Debt to Income Ratio			
Monthly Household Debt (0.5% MFI)	$ 261	$ 240	
Operations and Maintenance Costs	$ 196	$ 120	
Monthly Utility Costs	$ 160	$ 78	
Property Tax	$ 332	$ 377	
Insurance	$ 79	$ 79	
Mortgage Payment	$ 1,405	$ 1,193	
Calculated Debt to Income Ratio	56%	52%	Homeownership Affordability Target is 38%

- MFI for Harrison Neighborhood: $48,000
- Property tax: 1.345%
- Inflation rate: 3.2%
- Interest rate: 4.5%
- Overall development cost: $1.2 Million
- Construction cost per unit: $201,459
- Unit sales price: $336,394
- Cost per square foot: $146

Construction Estimate: UPDATE

Home Cost	Default Estimate	Value
Construction Costs	$246,454	$201,459
Total Home Costs	$399,532	$336,394
Property Tax		
Property Tax Rate	1.15%	1.35%
Annual Property Tax	$ 3,986	$ 4,524
Financing		
Annual Interest Rate	4.50%	4.50%
Years		30 years
Payments per Year		12
Number of Payments		360
Down payment	$ 69,316	$ 67,279
Principle Amount		$ 269,115
Monthly Payment		$ (1,364)
Affordability		
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Monthly Utility Costs		
Electricity	$ 111	$ 23
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Calculated Debt to Income Ratio	56%	52%

-$416 Anderson Windows: 10% Discount

-$2,974 Whirlpool: Refrigerator & Range

-$10,987 DOW Chemical Company: Rigid Insulation

0% Interest

Construction Estimate: UPDATE

Home Cost	Default Estimate	Value	Habitat Model
Construction Costs	$246,454	$201,459	$187,782
Total Home Costs	$399,532	$336,394	$304,418
Property Tax			
Property Tax Rate	1.15%	1.35%	1.35%
Annual Property Tax	$ 3,986	$ 4,524	$ 4,524
Financing			
Annual Interest Rate	4.50%	4.50%	0.00%
Years		30 years	30 years
Payments per Year		12	12
Number of Payments		360	360
Down payment	$ 69,316	$ 67,279	$ 60,884
Principle Amount		$ 269,115	$ 243,534
Monthly Payment		$ (1,364)	$ (676)
Affordability			
Estimated Target Family Income	$ 52,250	$ 48,000	$ 48,000
Monthly Utility Costs			
Electricity	$ 111	$ 23	$ 23
Natural Gas	$ 31	$ 43	$ 43
Water	$ 18	$ 12	$ 12
Other	$ -	$ -	$ -
Total	$ 160	$ 78	$ 78
Debt to Income Ratio			
Monthly Household Debt (0.5% MFI)	$ 261	$ 240	$ 240
Operations and Maintenance Costs	$ 196	$ 120	$ 120
Monthly Utility Costs	$ 160	$ 78	$ 78
Property Tax	$ 332	$ 377	$ 377
Insurance	$ 79	$ 79	$ 79
Mortgage Payment	$ 1,405	$ 1,193	$ 676
Calculated Debt to Income Ratio	56%	52%	38%

-$416 Anderson Windows: 10% Discount

-$2,974 Whirlpool: Fridge & Range

-$10,987 DOW Chemical Company: Rigid Insulation

0% Interest

Habitat specific savings: $13,676

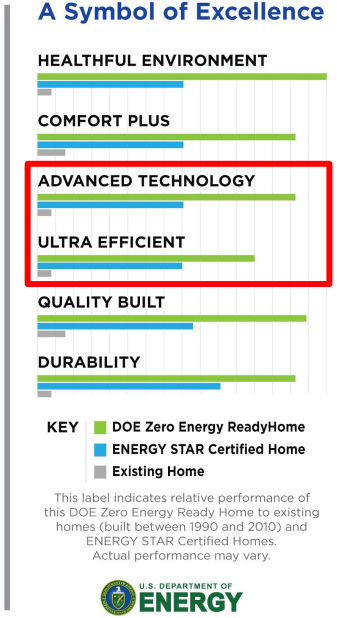
Achieve 38% Homeownership affordability target

Energy Performance Goals

Healthy - Lasting - Cost-Effective - Zero Energy Ready Home

- Optimize site energy use
- Provide ultra-efficiency
- Minimize energy bills without PV
- Eliminate energy bills with PV
- Optimize southern roof exposure
- PV payback less than 10 years

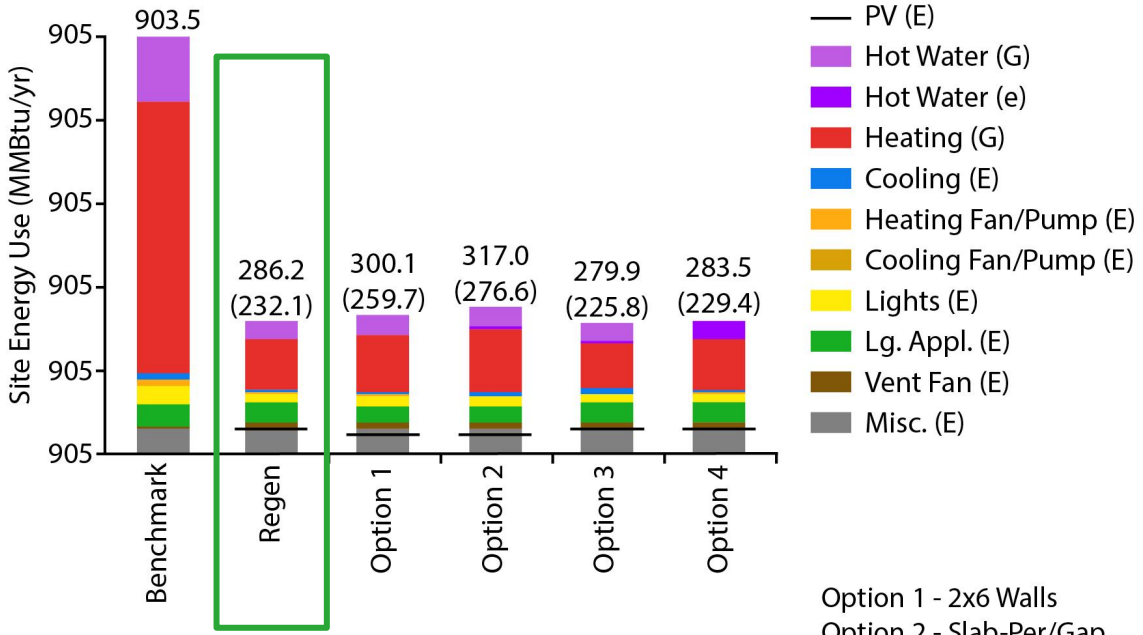
ZERO ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY



BeOpt Design Comparison

Analysis Confirmed

- Reduced energy consumption with triple pane windows
- 2x4 walls with exterior insulation better than 2x6
- No need to increase slab insulation



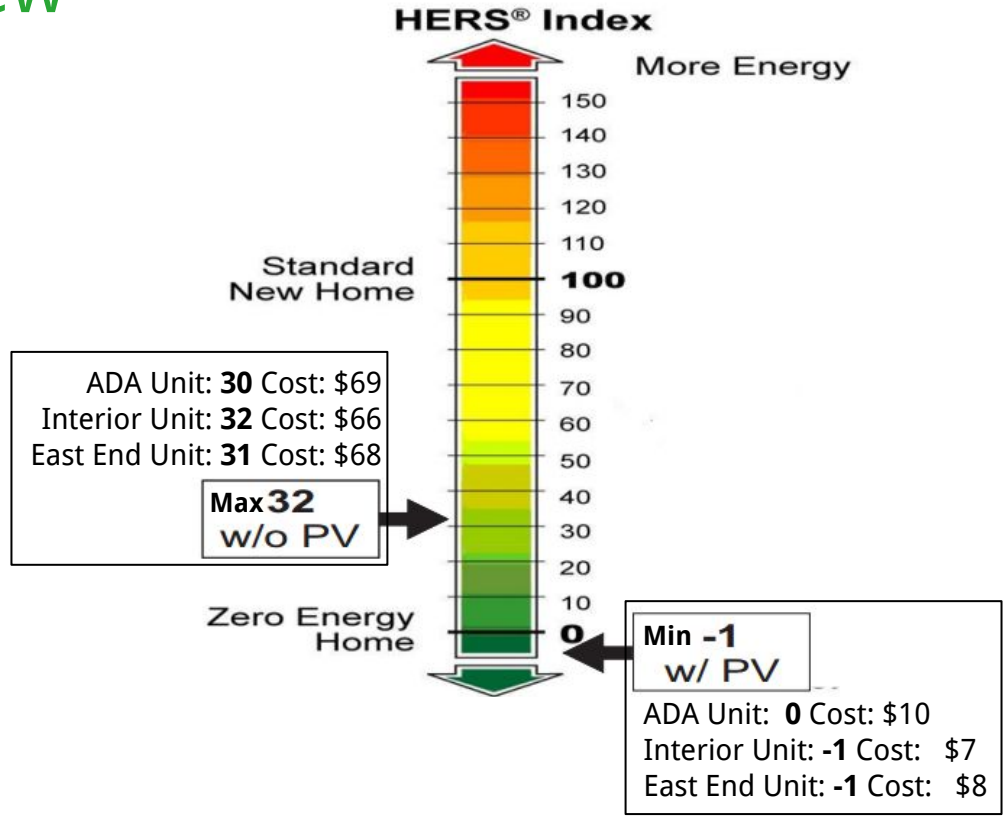
Option 1 - 2x6 Walls
Option 2 - Slab-Per/Gap
Option 3 - Triple Pane
Option 4 - Electric WH

Lighting: Electricity Consumption

	LED Lights					Incandescent Lights	
Room	Units	Total Watts (W	Usage (Hrs/Day)	Total Watts/Day	Total KWh/Yr	Watts/Unit	Total KWh/Yr
Dining	2	21	10	210	76.65	40	292
Kitchen	7	48	10	480	175.20	40	1022
Living Room	6	69	15	1035	377.78	40	1314
Bedroom 3	3	28.5	10	285	104.03	40	438
Bedroom 2	3	28.5	10	285	104.03	40	438
Master Bedroom	3	28.5	10	285	104.03	40	438
Hallway (1st floor)	2	21	15	315	114.98	40	438
Bathroom (1st floor)	1	10.5	5	52.5	19.16	40	73
Bathroom (2nd floor	1	10.5	5	52.5	19.16	40	73
Toilet	1	10.5	5	52.5	19.16	40	73
Sink	1	10.5	5	52.5	19.16	40	73
Washroom	1	10.5	5	52.5	19.16	40	73
Storage	1	10.5	5	52.5	19.16	40	73
Hallway (2nd floor)	2	10.5	15	157.5	57.49	40	438
Mech Room	1	10.5	2	21	7.67	40	29.2
Mudroom	1	10.5	10	105	38.33	40	146
Closet	1	10.5	2	21	7.67	40	29.2
Storm Shelter	1	10.5	0	0	0.00	40	0
				Total KWh/Year	**1283**		**5460**
				Energy Cost ($/KWh)	**$0.11**		**$0.11**
				Cost/Year	**$ 141.11**		**$ 600.64**
				Total Annual Savings	$ 460.00		

Performance Overview

- Superior energy efficiency compared to standard new home
- Affordable operational costs
- PV system completely offsets all energy related costs
  - remaining monthly cost is utility service charge



Performance: ReGen Homes w/o PV

- Meets DOE Zero Energy Ready Homes
- Energy Star Certified
- HERS Score
  - Interior Units: **32**
  - End Unit: **31**
  - ADA Unit: **30**
- Annual Energy Cost: $831
- Monthly Energy Cost: $69

Annual Load	MMBtu/ yr
Heating	13.9
Cooling	12.3
Water Heating	9.8
Annual Consumption	**MMBtu/yr**
Heating	14.9
Cooling	2.7
Water Heating	10.7
Lights and Appliances	23.3
Photovoltaics	0
Total	51.6
Annual Energy Cost	**$/yr**
Heating	165
Cooling	59
Water Heating	78
Lights and Appliances	397
Photovoltaics	0
Service Charges	132
Total	831
Design Loads	**Kbtu/hr**
Space Heating	13
Space Cooling	9.3

Performance: ReGen Homes w/ PV

- Meets DOE Zero Energy Ready Homes
- Energy Star Certified
- HERS Score
  - Interior Units: **-1**
  - End Unit: **-1**
  - ADA Unit: **0**
- Annual Energy Cost: $73
- Monthly Energy Cost: $7

ENERGY STAR

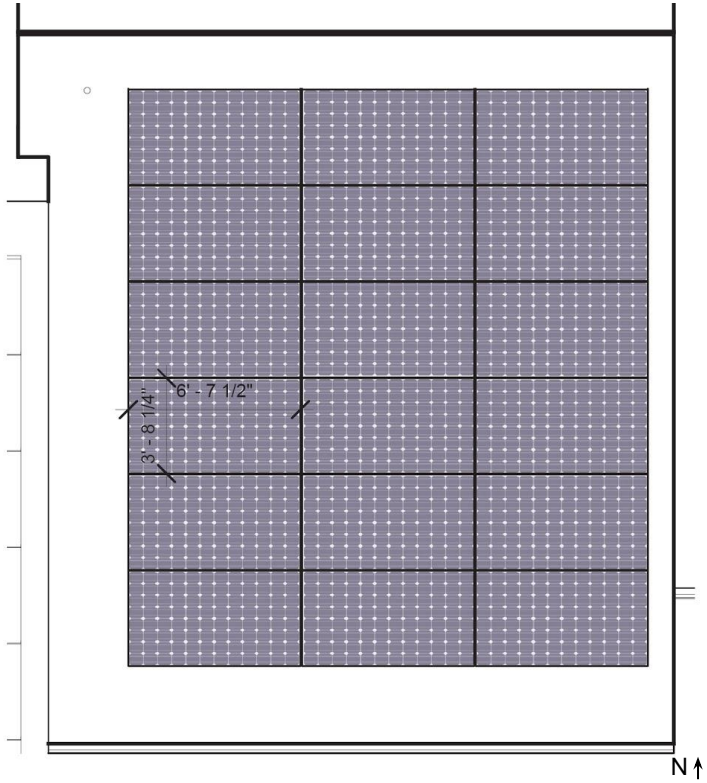
ZERO ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY

Annual Load	MMBtu/ yr
Heating	13.9
Cooling	12.3
Water Heating	9.8
Annual Consumption	**MMBtu/yr**
Heating	14.9
Cooling	2.7
Water Heating	10.7
Lights and Appliances	23.3
Photovoltaics	-35
Total	16.7
Annual Energy Cost	**$/yr**
Heating	115
Cooling	56
Water Heating	70
Lights and Appliances	408
Photovoltaics	-717
Service Charges	132
Total	73
Design Loads	**Kbtu/hr**
Space Heating	13
Space Cooling	9.3

Photovoltaic System Overview

Optimized Southern Roof

- Maximize energy generation
- Southern Roof Area: 701 sq ft
- Total Array Area: 508 square feet
- Inclination Angle: 30.3 degrees
- Azimuth Angle: 180 degrees



Photovoltaic System: Solar Array Analysis

tenK Solar

- Headquartered in Minneapolis, MN
- APEX 440W model
  - Monocrystalline array
  - 96% efficient inverter
  - 16.8% module efficiency
  - 28.2 square feet per panel
- Eighteen 440W Panels
- 7.92 KW peak production
- 11,260 KWh annual production

ten K SOLAR

Photovoltaic Array: Cost and Payback

- Cost at $5/Watt = 7920W * $5/W = $39,600
- Federal Renewable Energy Tax Credit (30%)
  - $39,600 - $11,880 = $27,720 sales price
- Made in MN rebate of about $1600 per year ($0.14/KWh)
- Annual energy savings of $1,239 to $1,645
- Payback for array is approximately 9 years

Solar Array Payback Calculations

Year	KWh Produced	MiM Rebate	Electricity Costs (3.2% Escalation)	Annual PV Savings ($)	Total Annual Savings ($)	Accruing Savings	Payback
0	11260	$1,576	$0.11	$1,239	$2,815	$2,815	-$24,905
1	11260	$1,576	$0.11	$1,278	$2,855	$5,670	-$22,050
2	11260	$1,576	$0.12	$1,319	$2,896	$8,566	-$19,154
3	11260	$1,576	$0.12	$1,361	$2,938	$11,503	-$16,217
4	11260	$1,576	$0.12	$1,405	$2,981	$14,485	-$13,235
5	11260	$1,576	$0.13	$1,450	$3,026	$17,511	-$10,209
6	11260	$1,576	$0.13	$1,496	$3,073	$20,584	-$7,136
7	11260	$1,576	$0.14	$1,544	$3,121	$23,705	-$4,015
8	11260	$1,576	$0.14	$1,594	$3,170	$26,875	-$845
Payback Year-9	11260	$1,576	$0.15	$1,645	$3,221	$30,096	$2,376

Conclusion

- Flexible Right-Sized Townhomes
  - All units ADA visitable
  - 1 unit ADA compliant
  - 1844 square feet
  - plus 448 sf “unbasement”
- High-Performance Robust Enclosure
  - Slab-on-grade using FPSF
  - R35 OptiMN Hybrid Wall
  - R57 OptiMN Hybrid Roof
- High-Efficiency Optimized Systems
  - Combi space & water heating
  - Radiant in-floor heating
- Healthy Indoor Environment
  - Energy recovery ventilator
- Superior Whole House Performance
  - DOE Zero Energy Ready
  - HERS 32 w/o PV; $69/month
  - HERS -1 w/ PV; $7/month
  - 9 year payback for PV
- Cost-Effective and Affordable
  - $336,394 sales price
  - $146 per square foot