ENEGRY TRUST OF OREGON
NET ZERO FELLOWSHIP 2021

Reaching Net Zero In Affordable Housing

By
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Oregon Architecture, Inc.

OREGON ARCHITECTURE INC

Agenda

- Introduction
- Research Team
- Project Study in Brief
- Research Tools
- Research Goals
- Research Strategies
- Research Results
- Research Conclusions & Lessons Learned

Introduction

Concept of Net-Zero

Net zero in energy growth is an effort to make energy production a zero-sum enterprise. The energy requirements of new users is off-set by the reduction in energy use from existing users and new supplemental sources.

Definition of The Term Net-Zero

Net Zero is exactly that – whatever additional energy is required by new construction is off-set by reductions from current users or provided by supplemental sources (i.e., on-site solar panels) so that additional output by power generating sources is not required.

About The Fellowship

The Energy Trust of Oregon annually awards a Fellowship to an entity involved in some way with the production or use of energy to study how or what can be done to reduce the rate of expansion on the power generation systems, hopefully reaching zero at some point in time.

Research Team

DAVID SOMMER

Senior Project Manager at OAI

- Universal Technical Institute, Phoenix, AZ
- Former Director of Facility & Grounds for Ashland Public Schools, OR.

MARK MCKECHNIE, AIA, NCARB

Architect, Principal at OAI

- University of Oregon, Bachelor of Architecture, 1972
- University of Minnesota, Master of Architecture, 1978
- Founding Principal Oregon Architecture, Inc. 2008

NIRANJAN PATIL

Design Project Manager,
Assoc .AIA, LEED Green Assoc. at OAI

- Bachelor of Architecture Chhatrapati Shivaji University, Kolhapur-IN.
- Master of Science in Sustainable Design and
- Master of Science in Construction Management Thomas Jefferson University, Philadelphia- PA.

Project Studies In Brief

- **Project:** Victory Commons and Trail's View multifamily housing projects for the Klamath Housing Authority.
- **Project Location:** Klamath Falls, Oregon
- **Project Size:** Duplexes, 1 Bedroom Units, 630 SF ea.
  Duplexes, 2 Bedroom Units, 810 SF ea.

Research Tools

- BEM is computer-based simulation practice software used to perform detailed analysis of energy usage within a building and its systems
- Energy modeling evaluates the efficiency & performance of the building
- Software/ tools : Sketchup & Sefaira by Trimble
  Revit, AutoCAD & Insight 360 by Autodesk

sefaira®
Sustainability • Performance • Design

SketchUp

AUTODESK® REVIT®

AUTODESK® INSIGHT™

AUTODESK AUTOCAD

Research Goals

- Inform local Housing Authorities on a funding source to pay for additional energy efficient construction.
- Provide information to builders in conventional markets that energy saving strategies can be financed in the conventional mortgage marketplace by utility savings.
- Research to provide the Oregon Housing and Community Services Office with options to modify their standard rent/utility calculations to allow for more energy efficient construction.
- Factor in strategies that recognize while utility costs increase with inflation, construction costs are fixed at the time of project construction.
- Over time utility savings can provide more available funds for mortgage servicing.

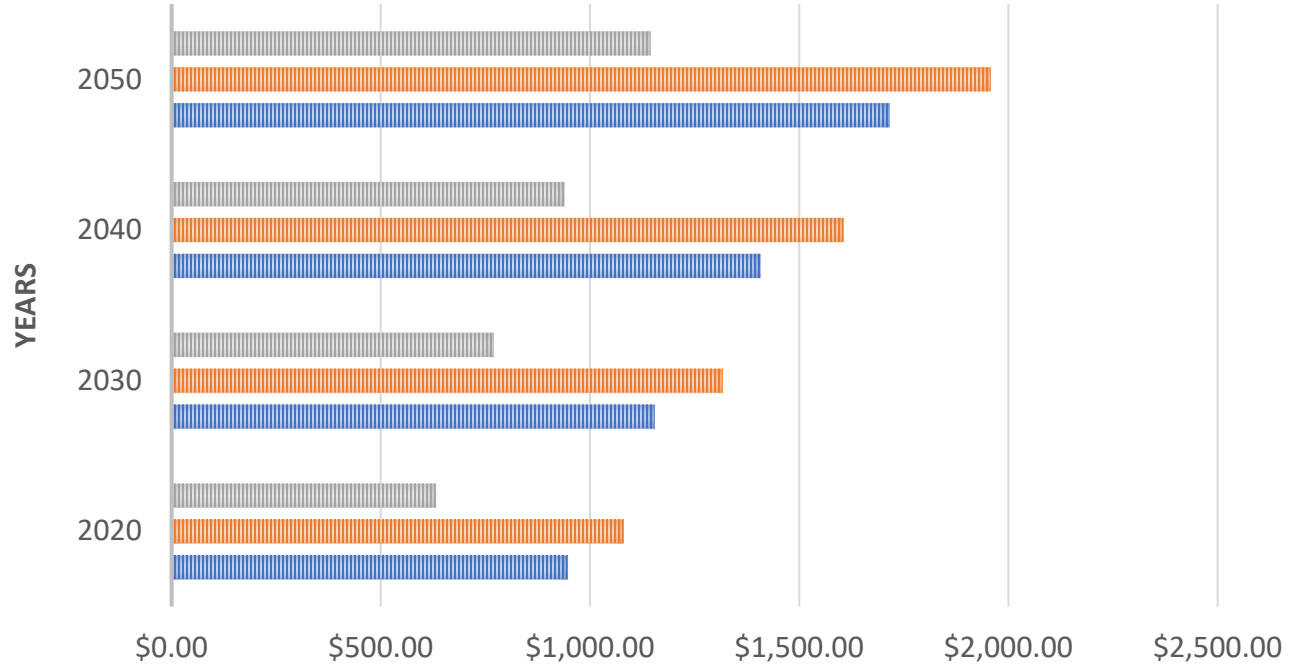
Research Strategies

Energy Usage Data

Properties / Timespan	*Victory Commons 1 BR Unit	*Victory Commons 2 BR Unit	*Trail's View 1 BR Unit
Avg. Per Month	$52.65	$90.05	$78.91
Avg. Per year	$631.77	$1080.61	$946.90
****10 years projection**	$6,917.71	$11,503.90	$10,368.30
****20 years projection**	$15,350.35	$25,527.00	$23,007.18
****30 years projection**	$26,774.00	$44,524.30	$40,129.00

****Note:** Escalation rate for future electricity costs is at a 2% increase per year, based on historical data.

*Baseline units were originally constructed with some efficient energy strategies that went above the minimum Building Code energy requirements at the time of permitting.

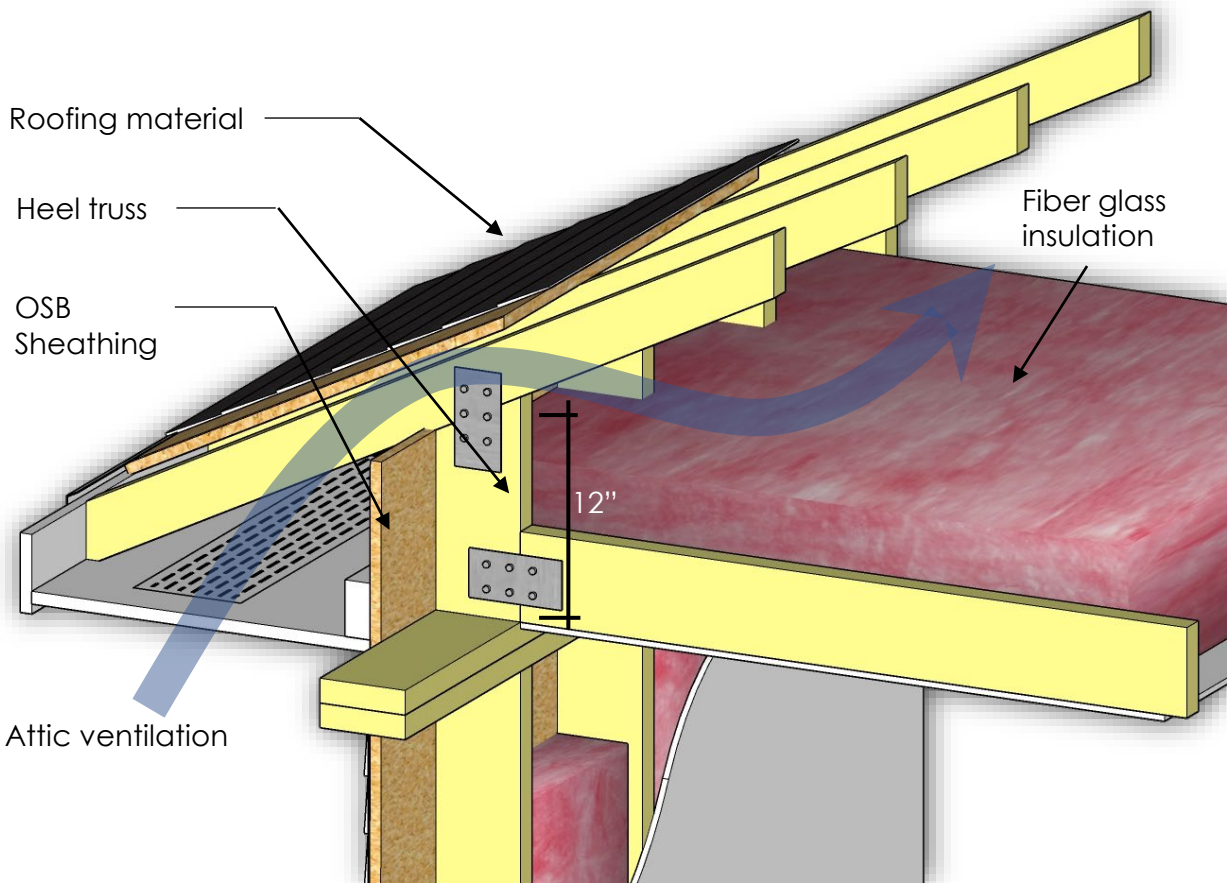


	2020	2030	2040	2050
V.C. 1BED	$631.77	$770.12	$938.78	$1,144.36
V.C. 2BED	$1,080.61	$1,317.26	$1,605.73	$1,957.38
T.V.	$946.90	$1,154.27	$1,407.04	$1,715.18

AVERAGE ELECTRICITY BILL PER YEAR

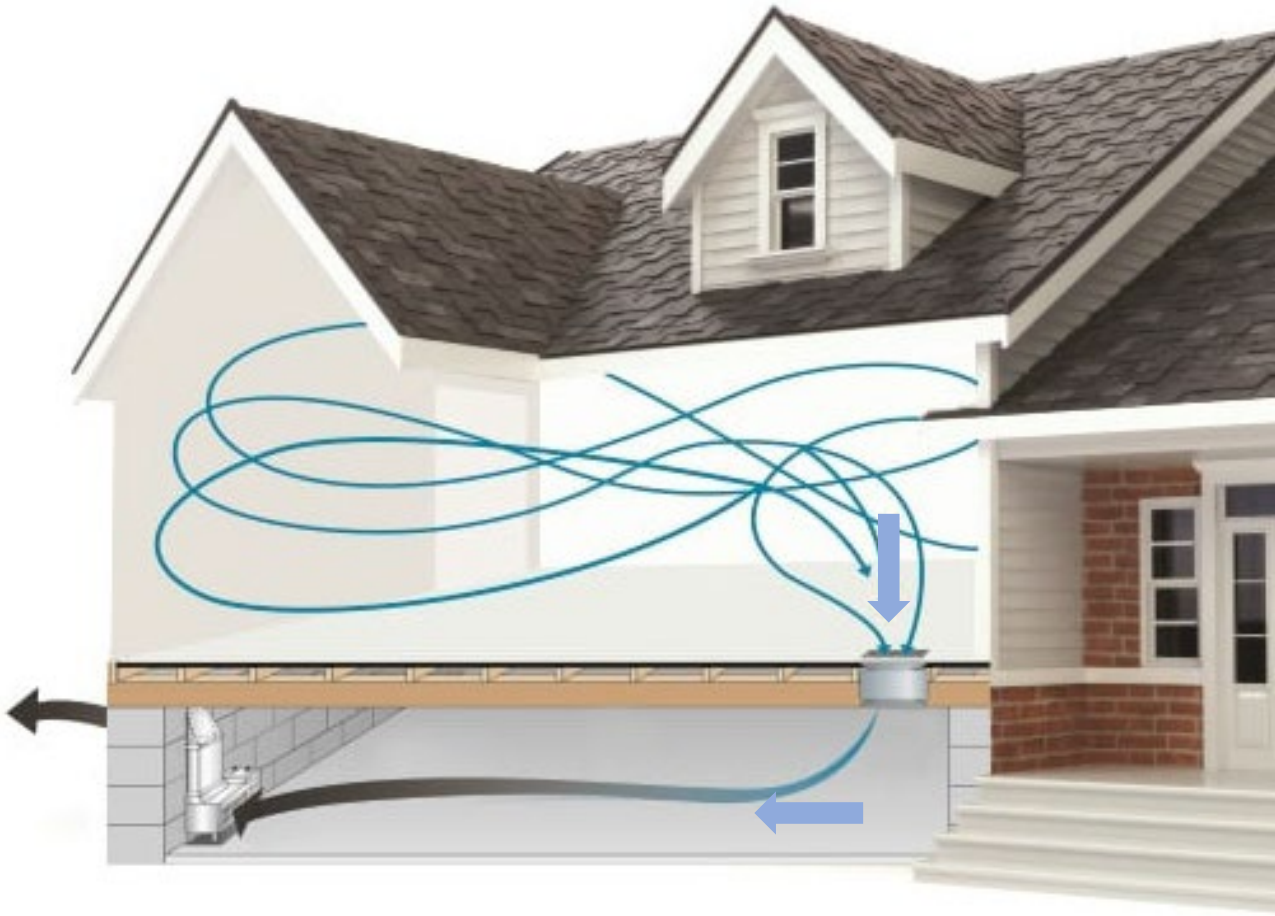
Raised-Heel / Energy Heel Truss

- Efficient use of attic insulation, especially at the narrow part of the truss
- Adequate attic ventilation, thus no mold issues, better control of air infiltration
- More comfortable interior
- Economical method of producing a more resilient building envelope
- No special training required for installation



Mechanically Vented Crawl Space

- Required less energy to keep the living space at comfortable temperature, hence improves indoor air quality
- Helps to remove any moisture saturated with space and walls
- Reduces mold & wood decay on floor joists



Project Strategies

Building Orientation

More energy efficient design, good for daylighting, summer-winter winds, sun & solar tempering.

Passive Design

Design strategies to reduce / eliminate the load on mechanical systems.

Daylighting

Understanding the lighting needed & heat gain for interior spaces, minimize the use of artificial lighting during day time.

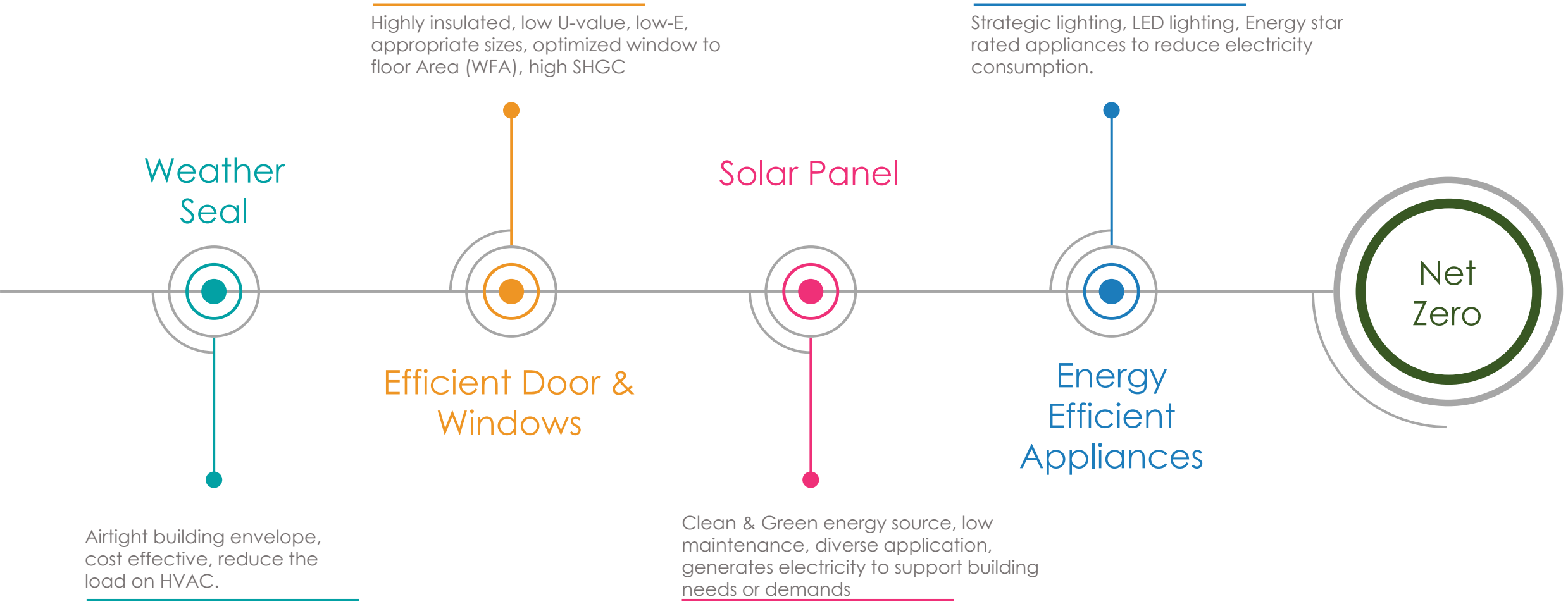
SIP's Panel

Exceptional Thermal Performance, Healthier air quality, faster construction with less labor, design flexibility.

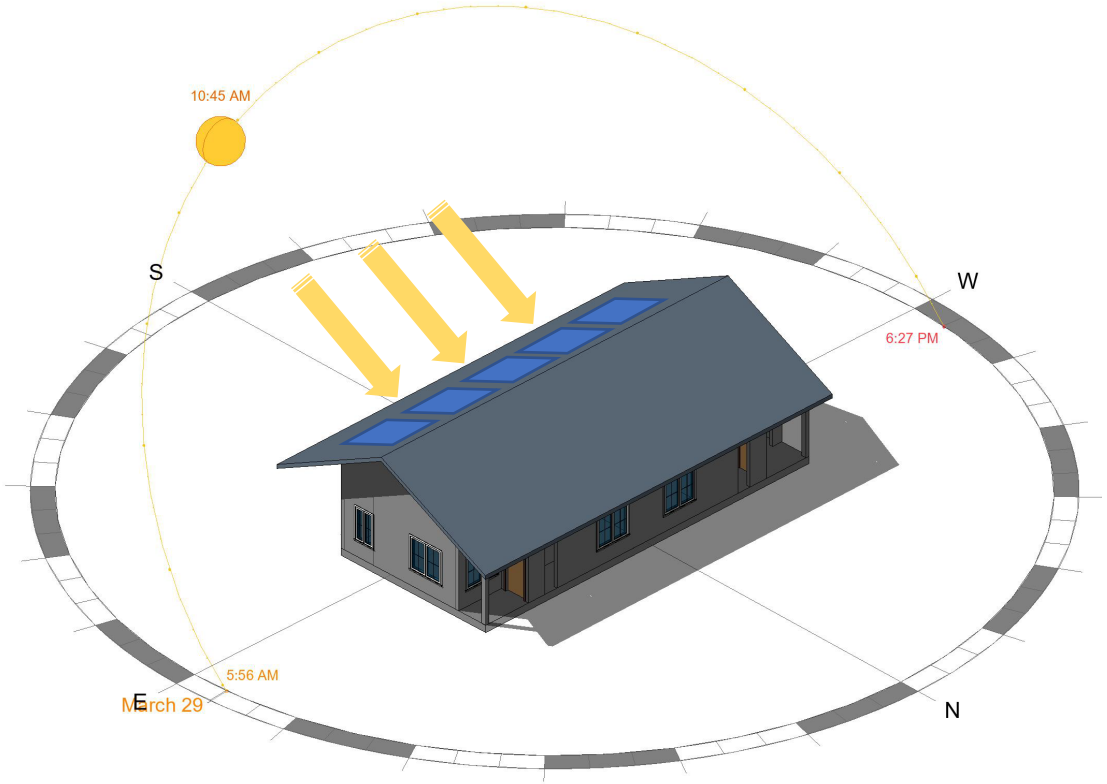
Trombe Wall

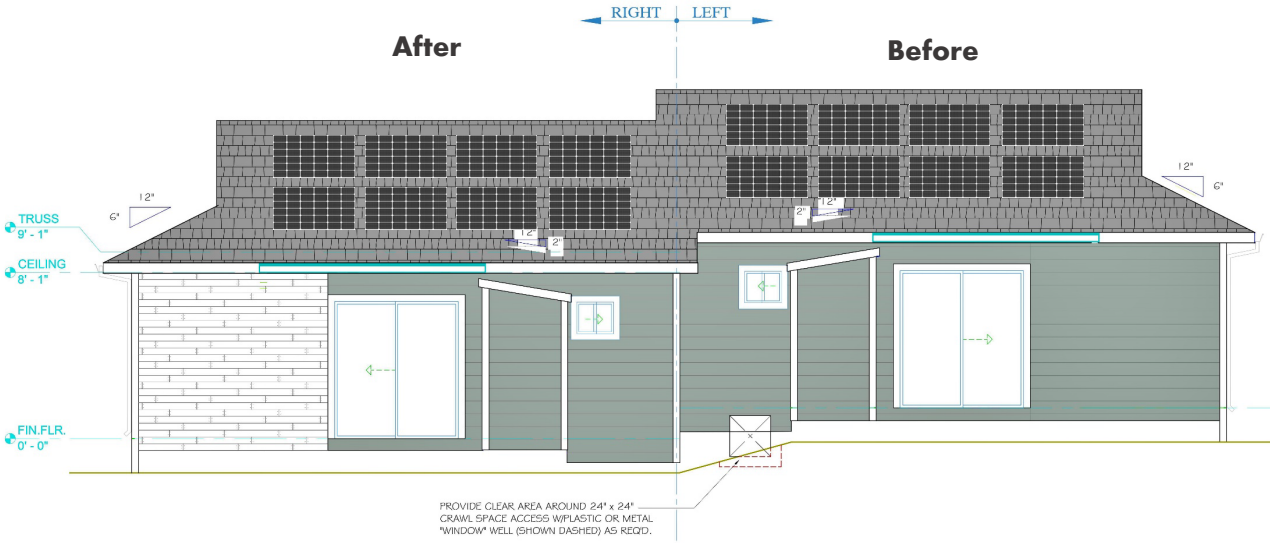
Heat exchange concept. Works in mild climates as well as extreme cold, can be used for cooling or heating the building, aesthetically attractive

Project Strategies

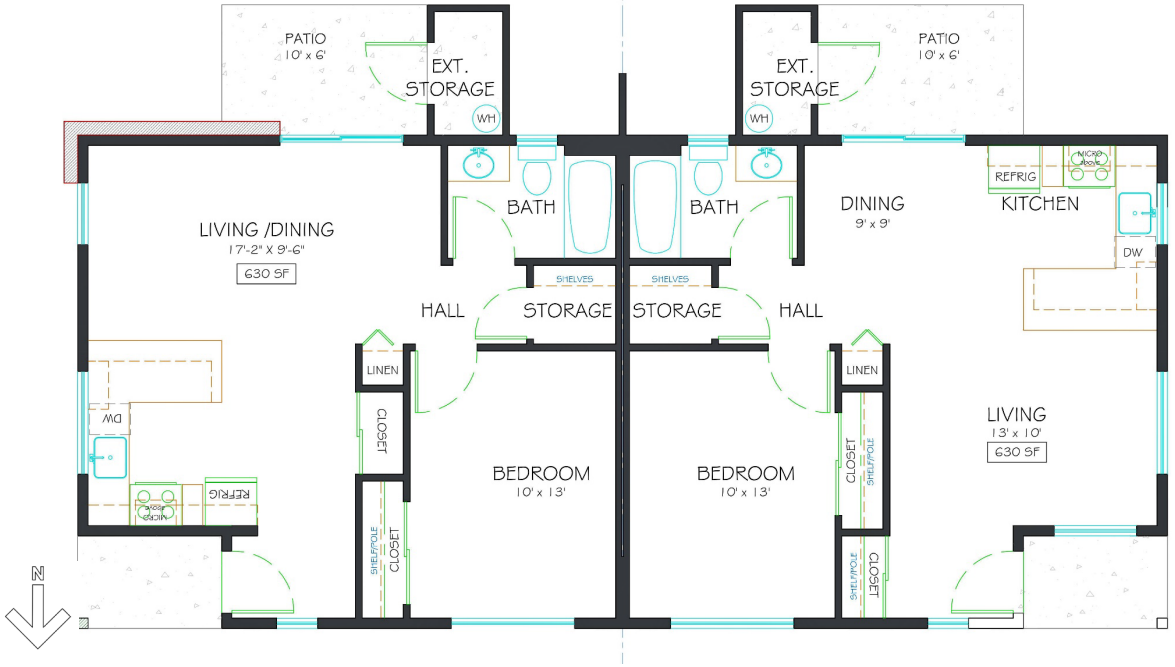


Strategy 1: Building Orientation





SOUTH ELEVATION
Not To Scale

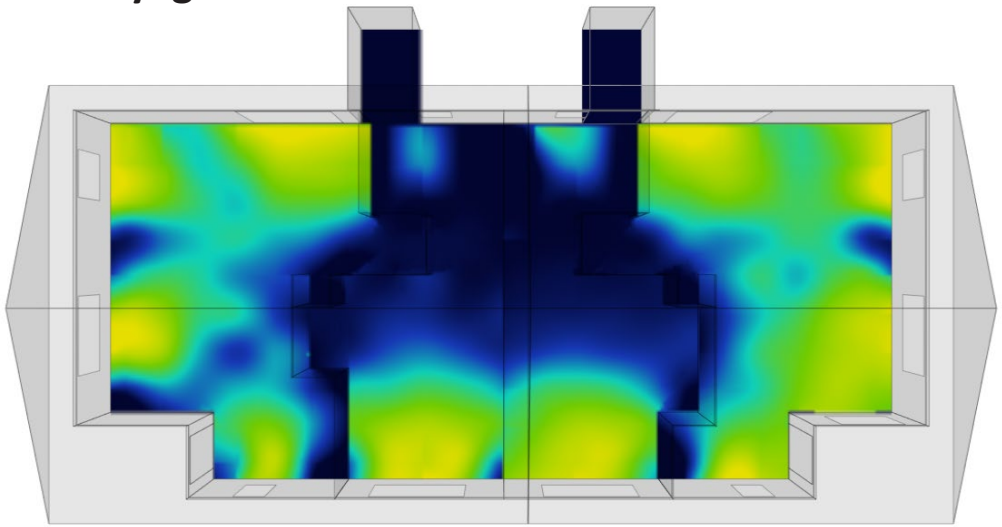


PLAN
Not To Scale

Strategy 2: Daylighting Analysis

- Reduce the need for artificial lighting
- Reduce electricity costs
- Can reduce HVAC costs as well
- Enhanced indoor air quality
- Enhanced thermal comfort
- Improved mental & physical health

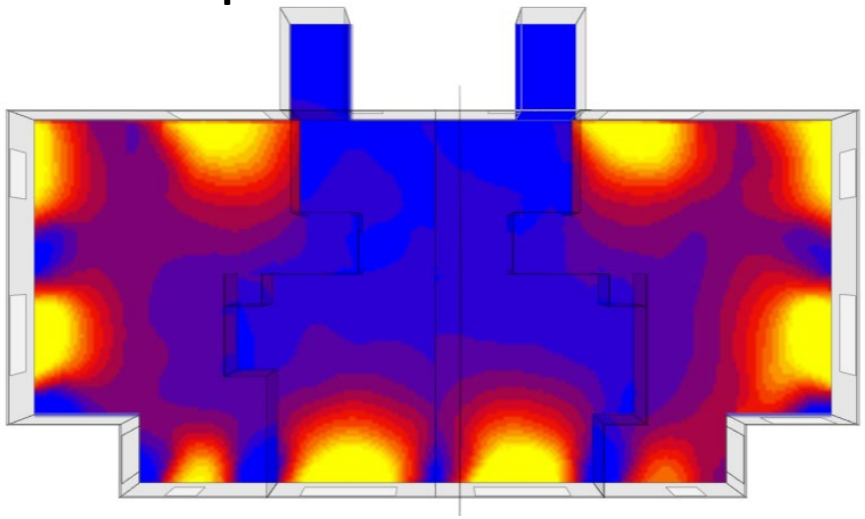
Daylight



e of occupied hours where illuminance is at least 28 footcandles, measured at 3.61 feet above the floor plate.

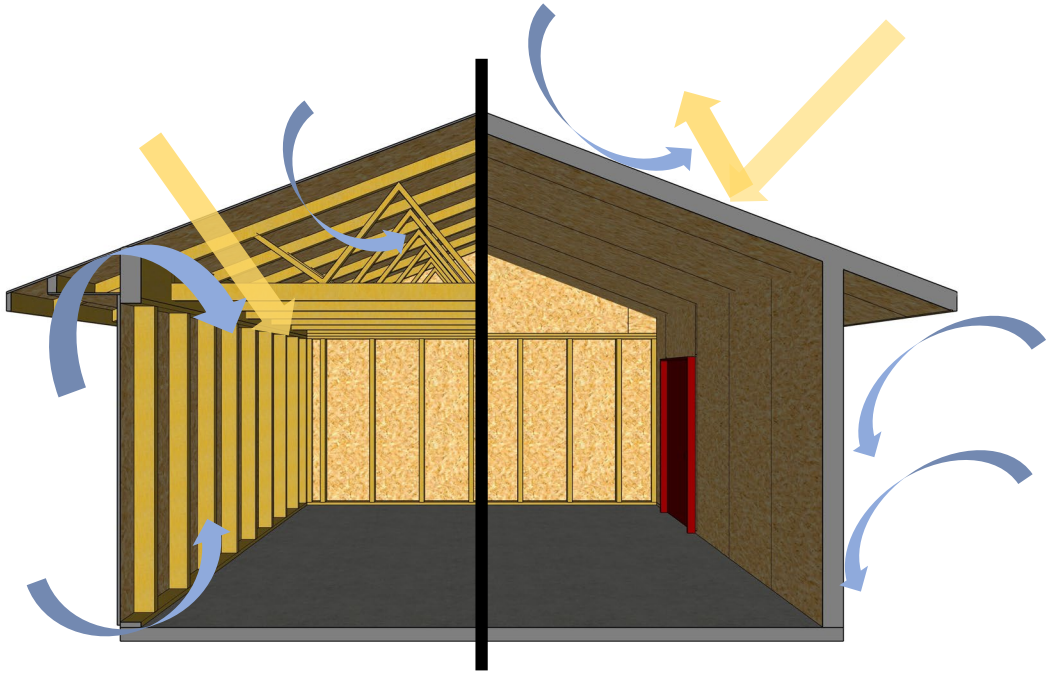
25% 50% 75% 100%

Radiant Temperature



Strategy 3: SIP's Panels

- Exceptional thermal performance
- Healthier air quality
- Faster construction with less labor
- Design flexibility



SIPs Framing VS Stick Framing

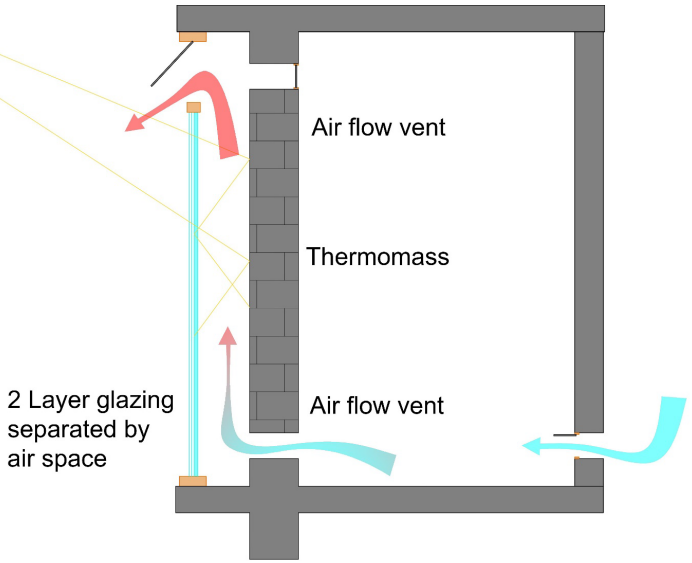
SIPS FRAMING	
Snap Lines	1 Day
Plates	1 Day
Frame	3 Days
Plumb & Line	1 Day
Set Beams	1 Day
Roof Panels	1 Day
Total	8 Days

STICK FRAMING	
Snap Lines	1 Day
Plates	1 Day
Frame	4 Days
Plumb & Line	2 Day
Set Beams	2 Day
Roof Panels	2 Day
Total	12 Days

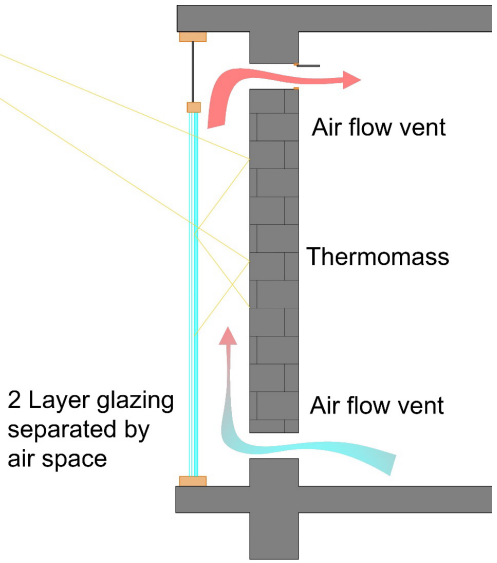
Note: Based on actual production builder's 2,500 SF single homes by Primer Building Systems

Strategy 4: Trombe Wall

- Most flexible solar option
- Can work in mild climates as well as extreme cold
- Provides comfortable heat
- Passive design – no moving parts
- Reduces glare on furniture compared to direct gain design
- Significantly reduces heating bills
- Simple construction
- Aesthetically pleasing



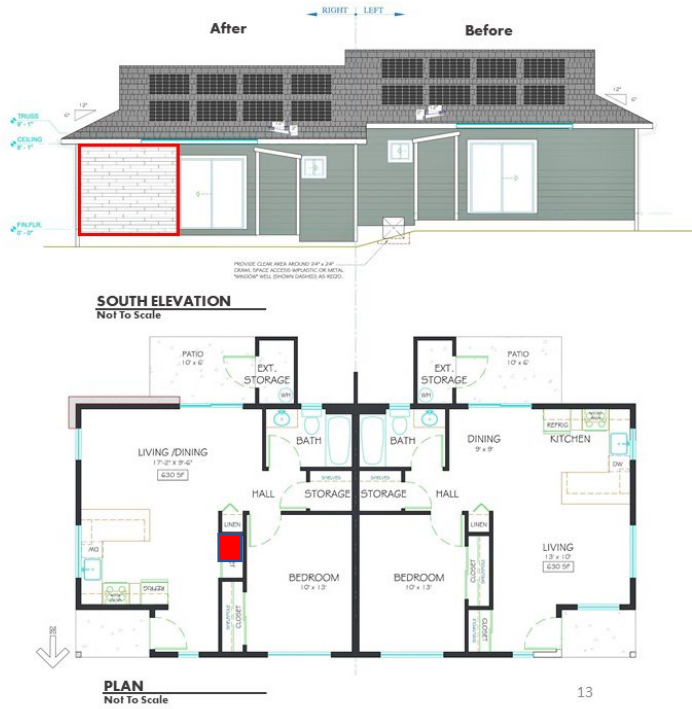
SUMMER



WINTER

Image credit: Egon Vettorazzi, & Pinterest

Image credit: Paul Raff Studio



Strategy 5: Weather Seal

- Exceptional airtightness in Building envelope
- Healthier air quality
- Seals all crack and gaps
- Eliminates leaks that degrade HVAC performance
- Increased design flexibility
- Faster, more reliable and potentially cheaper than air-seal by hand
- Requires positive ventilation

STEP 1

Prep & Setup:
AeroBarrier system & nozzles are setup throughout the house. Designed openings that will not be sealed are protected. (e.g. Windows)

STEP 2

Pressurize & Apply:
The area is pressured with a modified blower door & fan and rest process is controlled by computer.

STEP 3

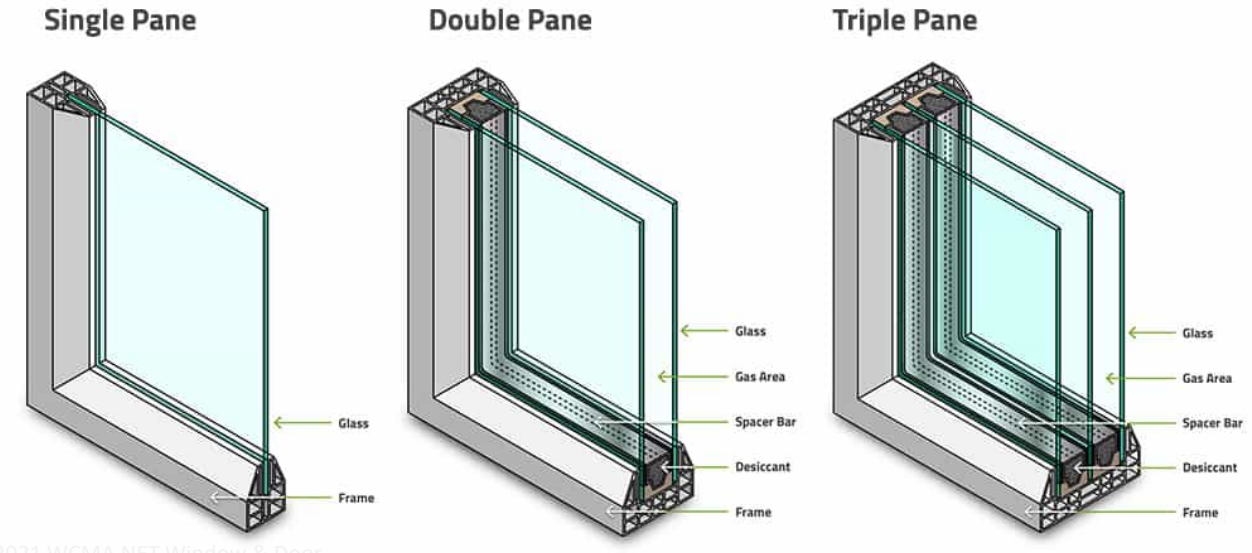
Seal & Monitor:
A final blower door test is run & a report is created, documenting pre & post leakages.

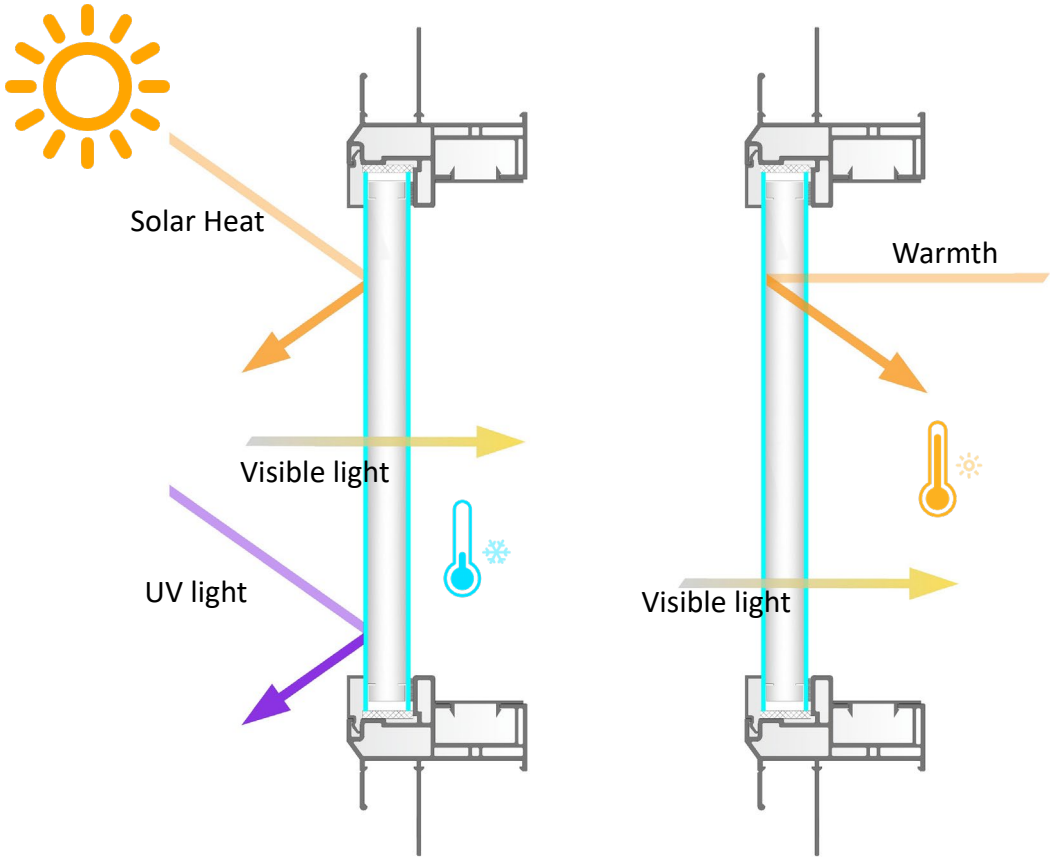
STEP 4

Cleaning:
After the seal is completed, all equipment & prep work is removed. Work can resume in 30 min.

Strategy 6: Efficient Door & Windows

- Better insulation
- Eco- friendly
- Lower HVAC costs
- Less damage to interior
- Sound proof
- Reduced maintenance





SUMMER

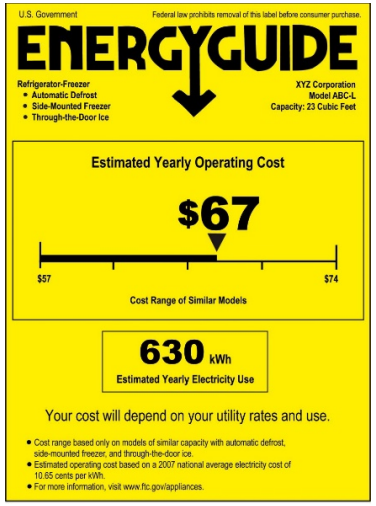
- Low-E Glass reduces heat gain
  From the sun in the summer,
  Keeping you home cooler.

WINTER

- In the winter, Low-E glass lets the warm solar rays in while blocking the heat in your home from getting it out.

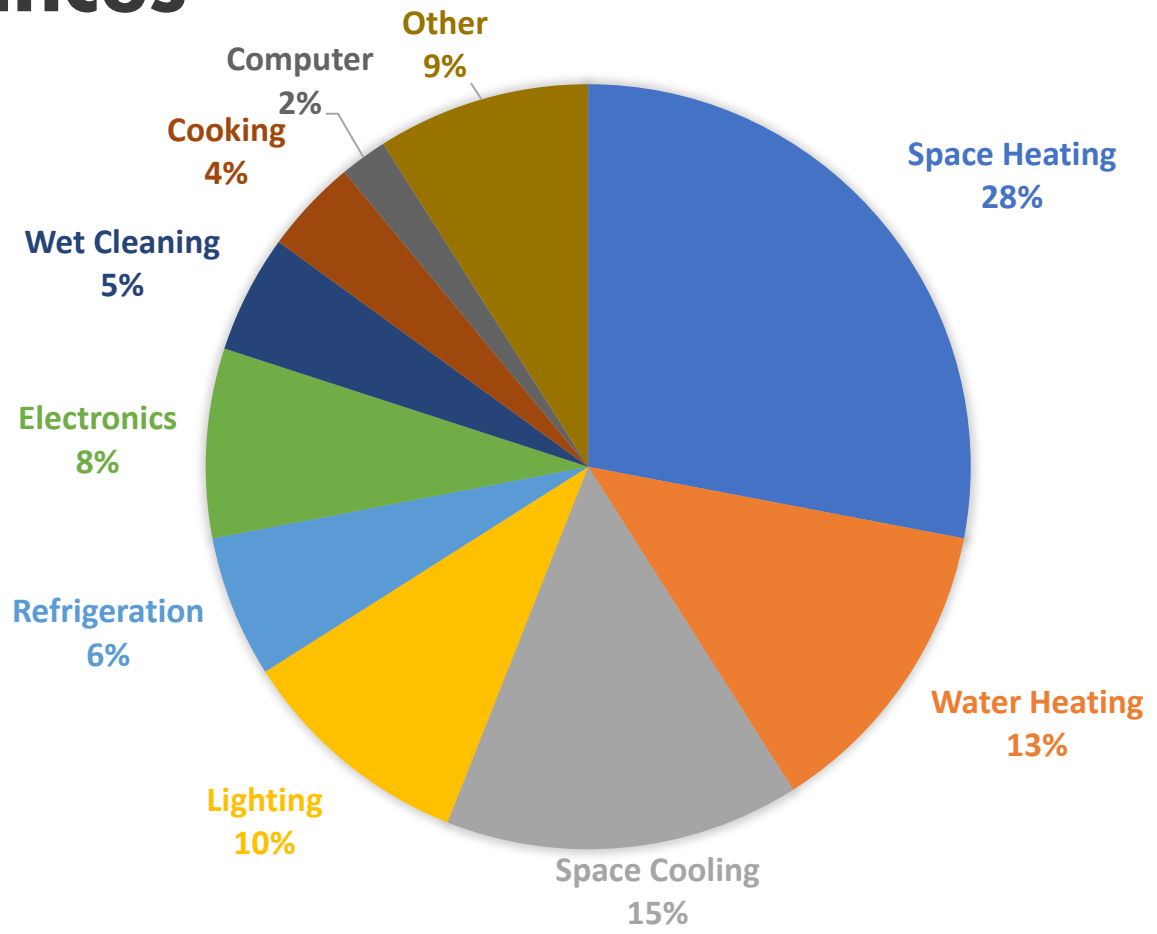
Strategy 7: Efficient Appliances

- Reduces energy consumption
- Reduced carbon footprint & greenhouse gas emissions
- Significantly reduce utility bills
- Earn a great return on your investment as they last longer
- Enhanced quality of life



ENERGY STAR

Source: Environmental & Energy Study Institute



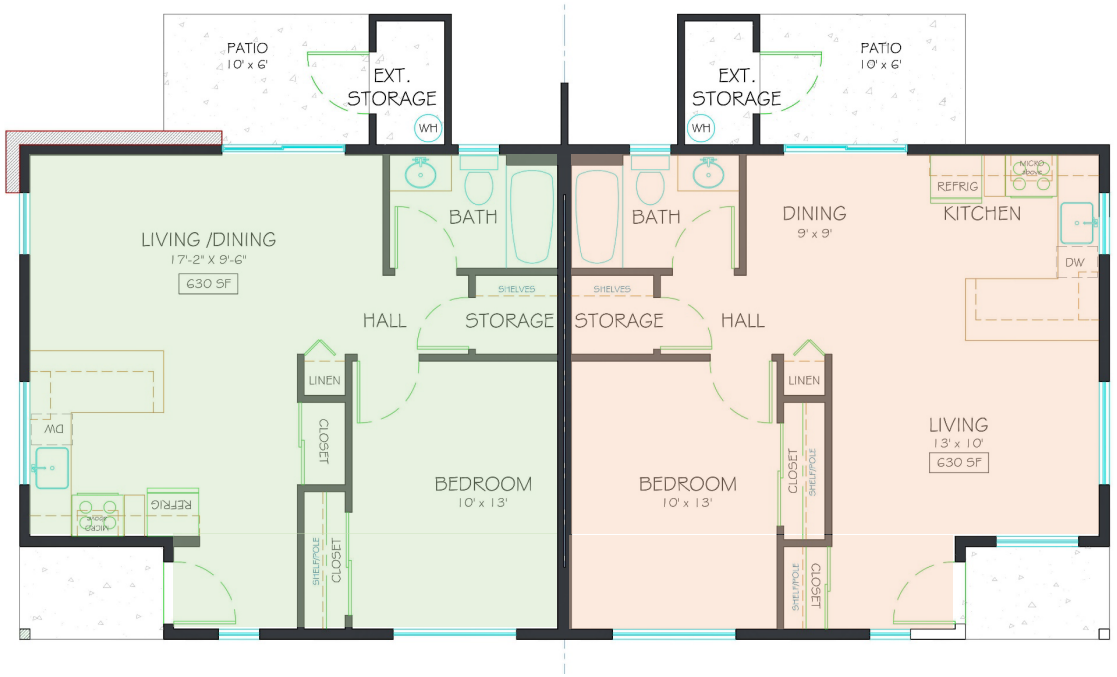
Residential Building Energy Consumption by End Users

Source: Environmental & Energy Study Institute

Building Analysis

Proposed

Baseline



Walls : R-41 SIPs

Windows: U-0.18

Roof: R-41

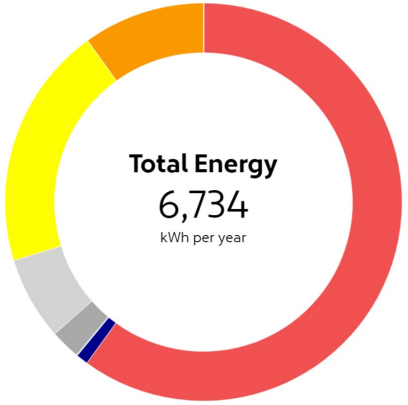
Walls : R-21

Windows: U-0.35

Roof: R-38

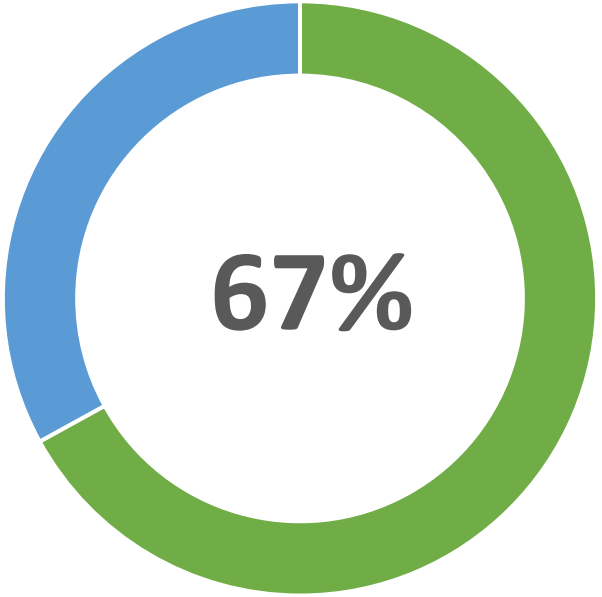
Research Result

Baseline Construction



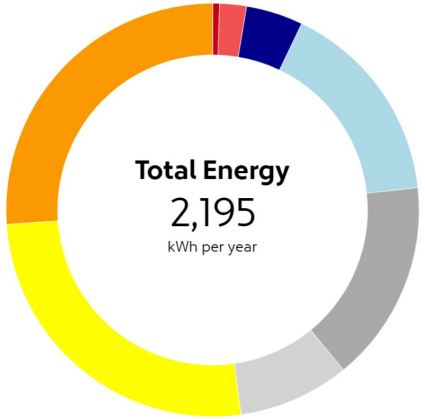
Segment	kWh per year	% of total use
Heating	**4,040**	**60 %**
AHU	3	0 %
Zones	4,037	60 %
Humidification	0	0 %
Cooling	**71**	**1 %**
AHU	66	1 %
Heat Rejection	0	0 %
Zones	5	0 %
Fans	**620**	**9 %**
AHU	164	2 %
Zones	456	7 %
Interior	**2,003**	**30 %**
Lighting	1,335	20 %
Equipment	668	10 %
Pumps	**0**	**0 %**

EUI: 38 kBTU/SF/Yr



Reduction in energy consumption without the addition of solar panels

Net Zero Construction- Without Solar

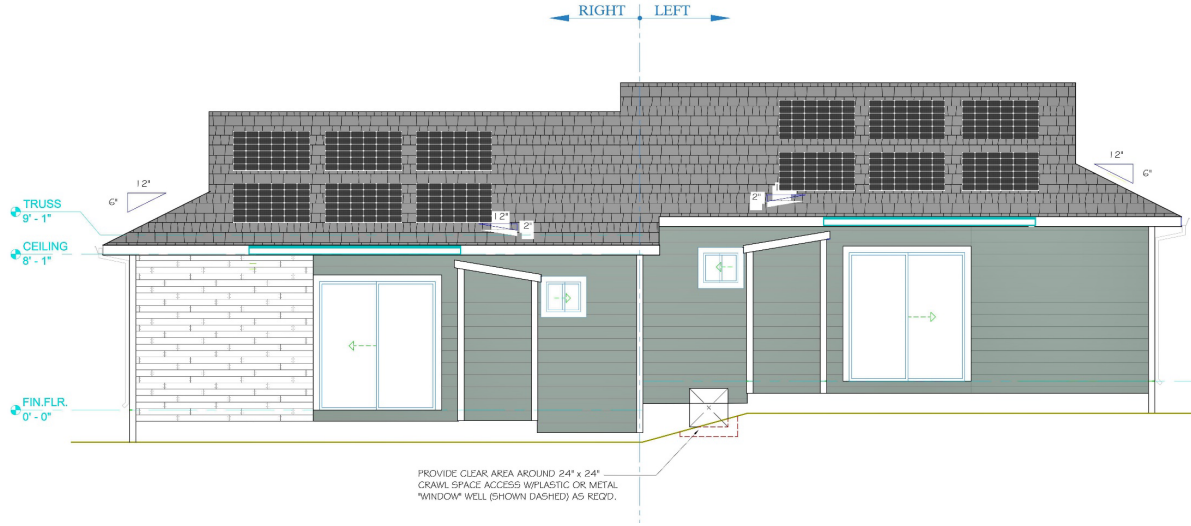


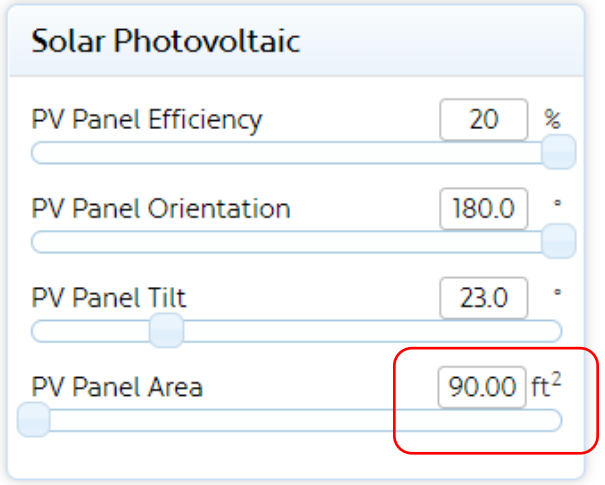
Segment	kWh per year	% of total use
Heating	**58**	**3 %**
AHU	12	1 %
Zones	46	2 %
Humidification	0	0 %
Cooling	**453**	**21 %**
AHU	98	4 %
Heat Rejection	0	0 %
Zones	355	16 %
Fans	**538**	**25 %**
AHU	347	16 %
Zones	191	9 %
Interior	**1,146**	**52 %**
Lighting	573	26 %
Equipment	573	26 %
Pumps	**0**	**0 %**

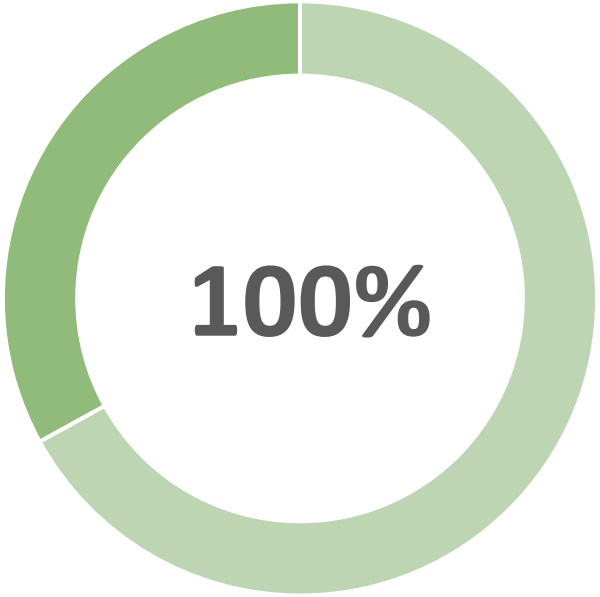
EUI: 18 kBTU/SF/Yr

Solar Energy

Zero Energy Building envelopes are extremely energy efficient, but the residual electrical demand must be provided by renewable energy sources such as solar and wind to make the building truly Net-Zero.







100% reduction of usage of non renewable energy by adding solar panels

Source: Vivint Solar, Unsplash.com

Note: Number of solar panels is dependent on the size and the capacity of each panel

Our Considerations for site demand of 2,196 kWh per year:

Size: 5' X 3'= 15 SF each
Capacity: 280 Watts

Renewable Energy generation on site: 2,269 kWh per year
number of panels: 6 panels

Cost Estimation Tool

Total area of the Building in SF	630
Avg cost of Construction	$ 130.00
Total cost of project	$ 81,900.0
Total cost of project with Net Zero	$ 102,665.7

Properties / Timespan	Victory Commons 1 BR Unit	Victory Commons 2 BR Unit	Trail's View 1 BR Unit
Avg. Per Month	$52.65	$90.05	$78.91
Avg. Per year	$631.77	$1080.61	$946.90
10 Years projection	$6,917.71	$11,503.90	$10,368.30
20 years projection	$15,350.35	$25,527.00	$23,007.18
30 years projection	$26,774.00	$44,524.30	$40,129.00

Total cost of Net Zero construction payback in less than 30 years

Total Cost of Construction	$ 81,900.00
Total Cost of Net Zero Construction	$ 20,765.75
Total cost of Project	$ 102,665.7

	Date	Total area of the Building in SF		630
	6/30/2021	Avg cost of Construction		$ 130.00
Trail's View/ Victory Commons		Total cost of project		$ 81,900.0
Klamath Falls, OR		Total cost of project with Net Zero		$ 102,665.7

	Summery	Avg Cost	Avg Percentage	Net Zero Elements	
1	**DIVISION I**	**$ 16,052.40**	**19.6000%**		
	1.1 Contractor General Conditions/ Soft Costs	$ 8,190.00	10.00%		
	1.1.1 Permits & Fees				
	1.1.2 Impact Fees				
	1.1.3 Water & Sewer Inspection Fees				
	1.1.4 Architecture & Engineering				
	1.2 Overhead	$ 2,457.00	3.00%		
	1.3 Profit	$ 4,095.00	5.00%		
	1.4 CAT Tax	$ 81.90	0.100%		
	1.4 Payments & Performance bond	$ 1,228.50	1.50%		
2	**Site work**	**$ 655.20**	**0.80%**		
3	**Foundations**	**$ 4,914.00**	**6.00%**		
	2.1 Excation, Foundation, Concrete, Retaining wall & backfill	$ 4,750.20	5.80%		
4	**Framing**	**$ 13,513.50**	**16.50%**	**0.00%**	**6.60%**
	3.1 Framing including roof	$ 12,121.20	14.80%		1.00%
	3.2 Trusses	$ 1,228.50	1.50%		0.00%
	3.3 Sheathing	$ 81.90	0.10%		0.30%
	3.4 General Metal and Steel	$ 81.90	0.10%		0.30%
	3.5 Trombe wall			$ 1,638.00	2.00%
	3.6 Sips Panels			$ 2,457.00	3.00%
5	**Exterior Finishes**	**$ 10,647.00**	**13.00%**		
	4.1 Exterior wall finish	$ 5,159.70	6.30%		
	4.2 Roof finish	$ 2,457.00	3.00%		
	4.3 Windows and Doors	$ 3,030.30	3.70%		
	4.5 Triple pane windows (15% addition)			$ 3,484.85	4.26%
6	**MEP**	**$ 10,565.10**	**12.90%**		
	5.1 Plumbing	$ 3,603.60	4.40%		
	5.2 Electrical	$ 3,276.00	4.00%		
	5.3 HVAC	$ 3,685.50	4.50%		
	5.4 Solar Panel			$ 8,190.00	10.00%
	5.5 Heat recovery ventilation			$ 1,638.00	2.00%
	5.6 On-demand hot water			$ 1,228.50	1.50%
7	**Interior Finishes**	**$ 16,707.60**	**20.40%**		
	6.1 Insulation	$ 1,638.00	2.00%		
	6.2 Dry walls	$ 3,439.80	4.20%		
	6.3 Interior trims, door & mirrors	$ 2,702.70	3.30%		
	6.4 Painting	$ 2,293.20	2.80%		
	6.5 Lighting	$ 819.00	1.00%		
	6.6 cabinets and Countertops	$ 1,474.20	1.80%		
	6.7 Appliances	$ 1,064.70	1.30%		
	6.8 Flooring	$ 3,276.00	4.00%		
	6.11 Air sealing			$ 819.00	1.00%
8	**Finish Work**	**$ 4,750.20**	**5.80%**		
	7.1 Landscaping	$ 1,883.70	2.30%		
	7.2 Outdoor Structures (Deck, Patio, Porches)	$ 819.00	1.00%		
	7.3 Driveway	$ 1,392.30	1.70%		
	7.4 Clean Up	$ 655.20	0.80%		
9	**Contingency**	**$ 4,095.00**	**5.00%**		
	Total Cost of Construction	**$ 81,900.00**	**100.00%**	**$ 20,765.75**	**25.36%**
	Total Cost of Net Zero Construction	**$ 20,765.75**			
	Total cost of Project	**$ 102,665.7**			

Cost Estimation Tool Sample

OREGON ARCHITECTURE INC	Date	Total area of the Building in SF		0
	8/2/2021	Avg cost of Construction		0
Project Name		Total cost of project		$ -
Project Address		Total cost of project with Net Zero		$ -

	Summery	Avg Cost	Avg Percentage	Net Zero Elements	
1	**DIVISION I**	**$ -**	**19.6000%**		
	1.1 Contractor General Conditions/ Soft Costs	$ -	10.00%		
	1.1.1 Permits & Fees				
	1.1.2 Impact Fees				
	1.1.3 Water & Sewer Inspection Fees				
	1.1.4 Architecture & Engineering				
	1.2 Overhead	$ -	3.00%		
	1.3 Profit	$ -	5.00%		
	1.4 CAT Tax	$ -	0.100%		
	1.4 Payments & Performance bond	$ -	1.50%		
2	**Site work**	**$ -**	**0.80%**		
3	**Foundations**	**$ -**	**6.00%**		
	2.1 Excavation, Foundation, Concrete, Retaining wall & backfill	$ -	5.80%		
4	**Framing**	**$ -**	**16.50%**	**0.00%**	**6.60%**
	3.1 Framing including roof	$ -	14.80%		1.00%
	3.2 Trusses	$ -	1.50%		0.00%
	3.3 Sheathing	$ -	0.10%		0.30%

Conclusions & Lessons Learned

- We discovered quickly from this exercise that creating a zero energy or near-zero energy building shell is possible with the technology currently available in the marketplace and within a generally reasonable cost.

- However, achieving total zero energy is a bit trickier: we will still need a way to electrically power artificial lighting, refrigeration, cooking, and electrically powered equipment. These tools of modern living are getting more efficient all the time, but no matter how efficient they become, they will still need electric power. At the moment, the only option to provide that energy is through the use of solar panels.

- Our study shows it is possible to trade the purchase of energy over time to the purchase materials to make a dwelling more energy efficient initially. Our interactive cost tool provides a way that allows a person to evaluate the construction cost of an energy upgrade against the potential amount of energy saved in dollars.

That concludes the Presentation.

Thank you.

Are there any questions?