



# ENERGY DESIGN

conference & expo



## Residential New Construction Passive House **The Northeast Nest**

Case Study

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 standard**
- **Residential Passive House design**
- **Strategies, materials and systems**
- **Challenges & Opportunities**
- **Performance**

# 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
CO <sub>2</sub> emissions	1.0	1.0

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 actual performance of the building. The Passive House Institute hereby disclaims any liability for the implementation of the building's energy balance and the above.

Certificate-ID: 9019\_PHI\_PH\_20141017\_AM



## 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  
Struwweg 4046  
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 m<sup>2</sup> of living area and year** or a heating load of 15 W/m<sup>2</sup>.
- 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 ASHRAE 55-2010 is achieved.
- A highly airtight building envelope, which eliminates draughts and reduces the heat loss. The air change rate through the envelope at a 50 Pa static pressure difference, as verified according to EN 13827, is less than **0.6 air changes per hour with respect to the building envelope**.
- A controlled ventilation system with high quality filters, highly efficient heat exchanger, ensuring excellent indoor air quality with low energy consumption.
- A total primary energy demand for heating, domestic hot water, ventilation and electricity during normal use of less than **120 kWh per m<sup>2</sup> 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 stable. Due to the highly airtight envelope, draughts are eliminated. The controlled ventilation system constantly provides fresh air of excellent quality. Energy demand for heating, domestic hot water, ventilation and electricity during normal use of a Passive House are very low. Thanks to this, Passive Houses offer a high level of energy efficiency and future-proof energy prices. Moreover, the climate impact of Passive Houses is very low, resulting in the emission of comparatively low levels of CO<sub>2</sub> and air pollutants.

Issued:  
Darmstadt, 12.10.2014  
*Wolfgang Feist*  
Dr. Wolfgang Feist

Certificate-ID: 9019\_PHI\_PH\_20141017\_AM



## Certified Passive House

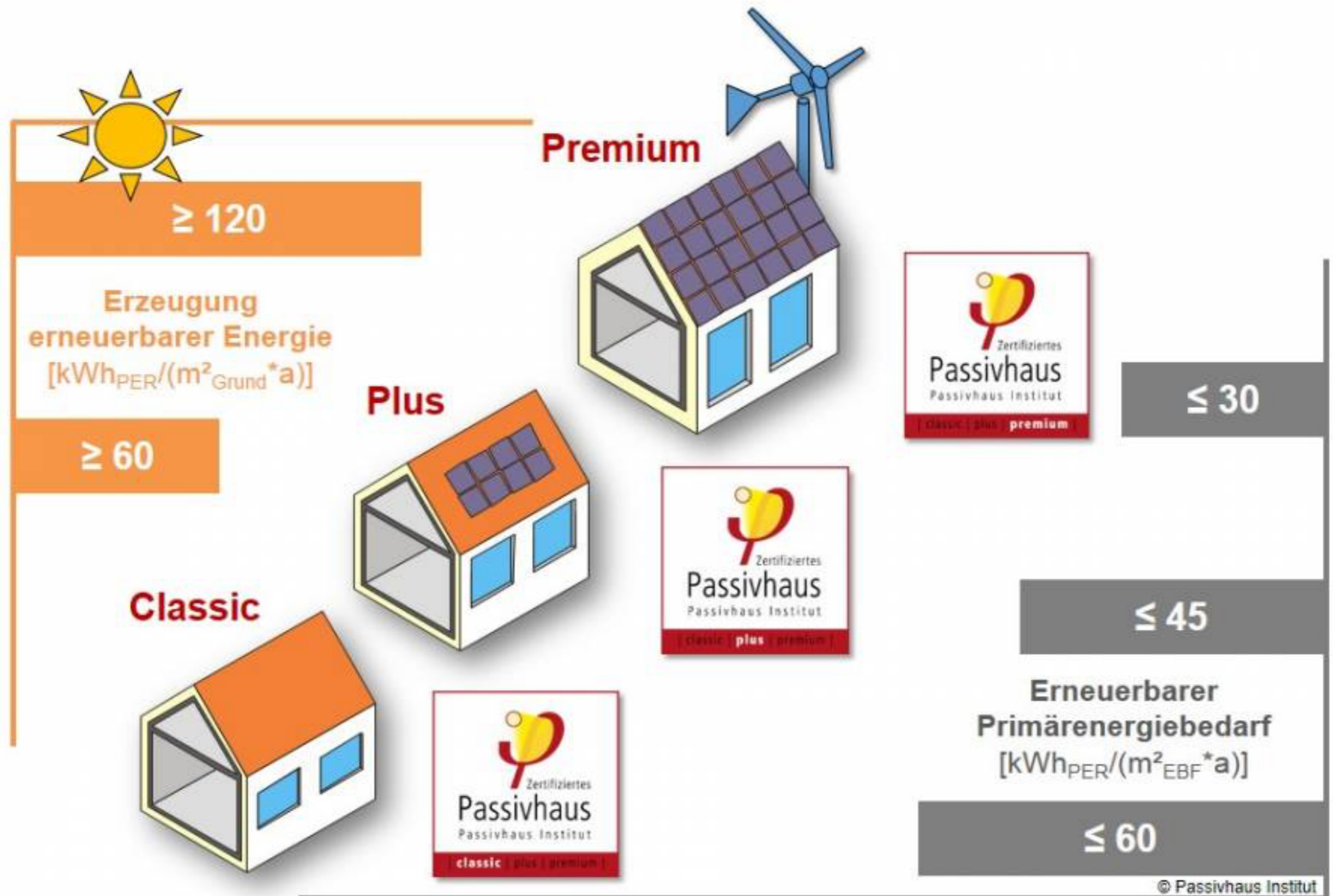
### Passive House Institute



# Tool



# The Path to Ultimate Sustainability



# Global Climate Specificity

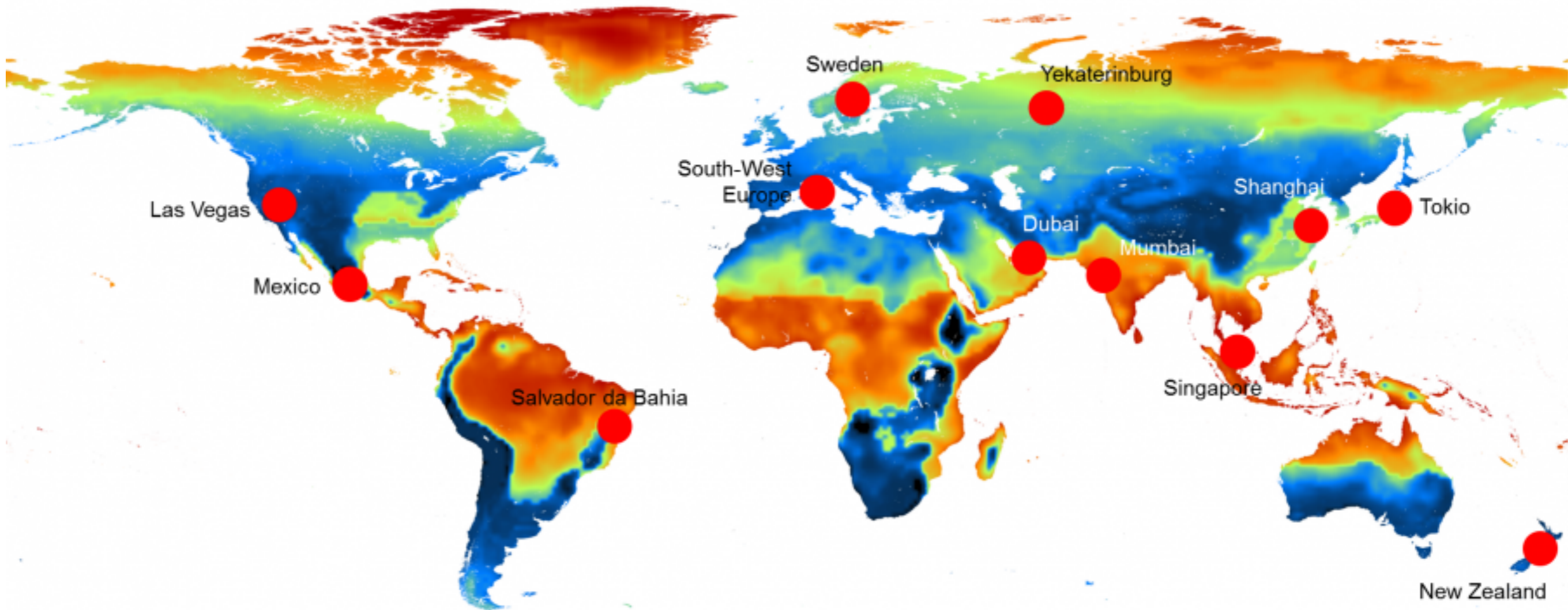



Illustration © Passive House Institute

# Climate-Specific Requirements

Climate zone according to PHPP	Opaque envelope <sup>1</sup> against...				Windows (including exterior doors)				Ventilation		
	...ground	...ambient air			Overall <sup>4</sup>			Glazing <sup>5</sup>	Solar load <sup>6</sup>	Min. heat recovery rate <sup>7</sup>	Min. humidity recovery rate <sup>8</sup>
	Insulation	Exterior insulation	Interior Insulation <sup>2</sup>	Exterior paint <sup>3</sup>	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 <sup>2</sup> a]	%
	[W/(m <sup>2</sup> K)]			-	[W/(m <sup>2</sup> 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



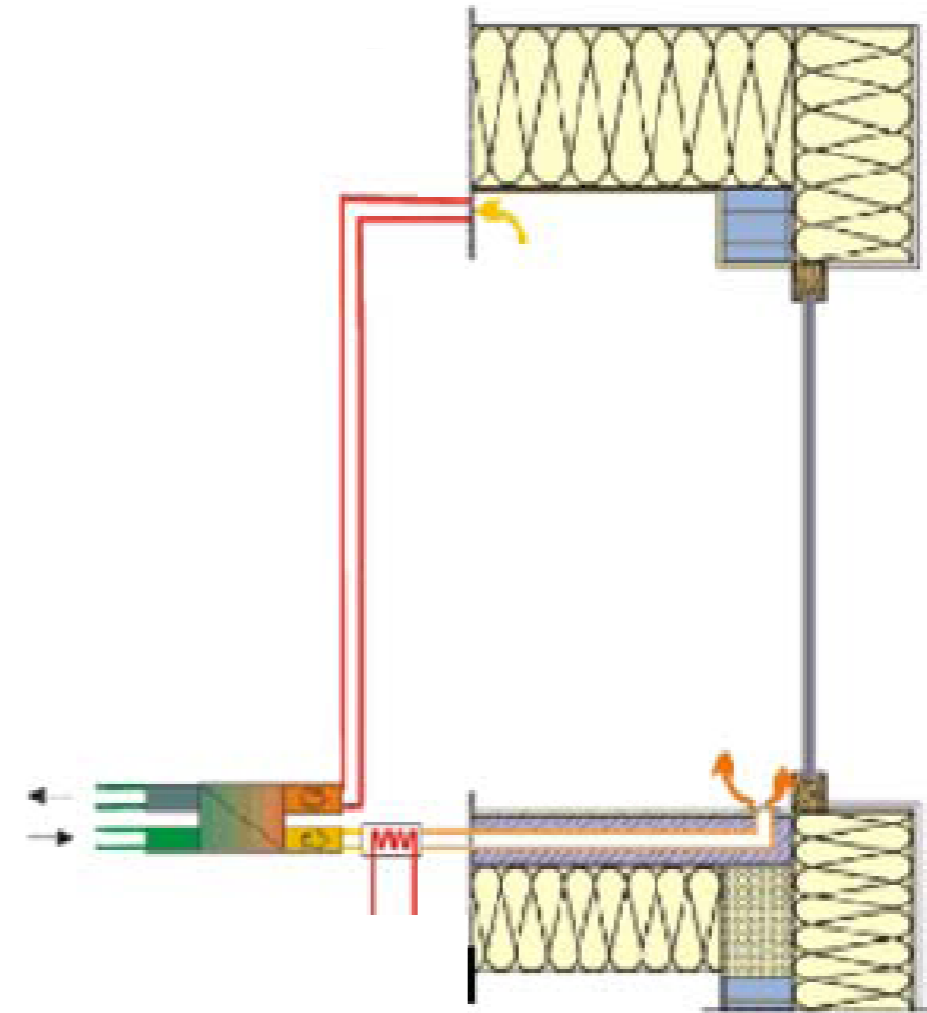
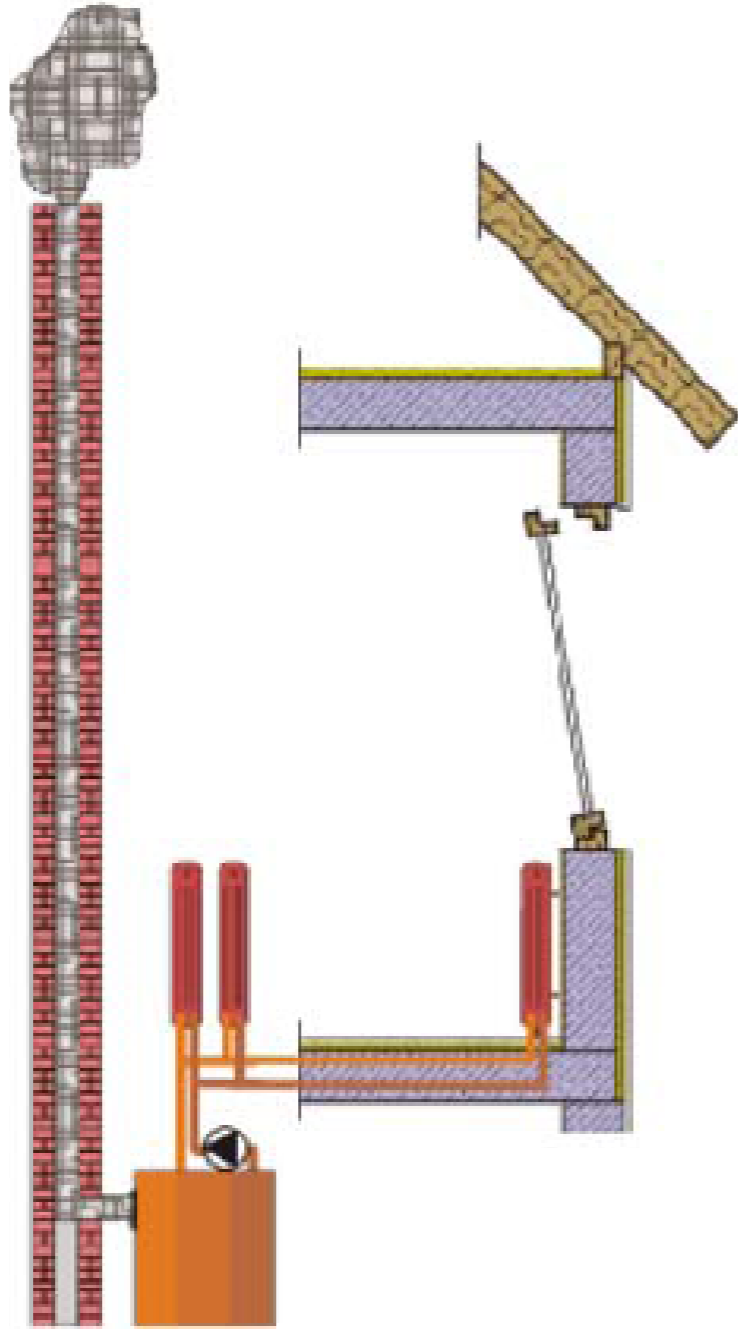
# Basic Concept

Conservation first

➔ Minimize losses

➔ Maximize (free) gains

# Active vs. Passive



**Active: 25-125 kBtu/(sf yr)**

85 - 450 kWh/(m<sup>2</sup> a), typically found in the U.S.

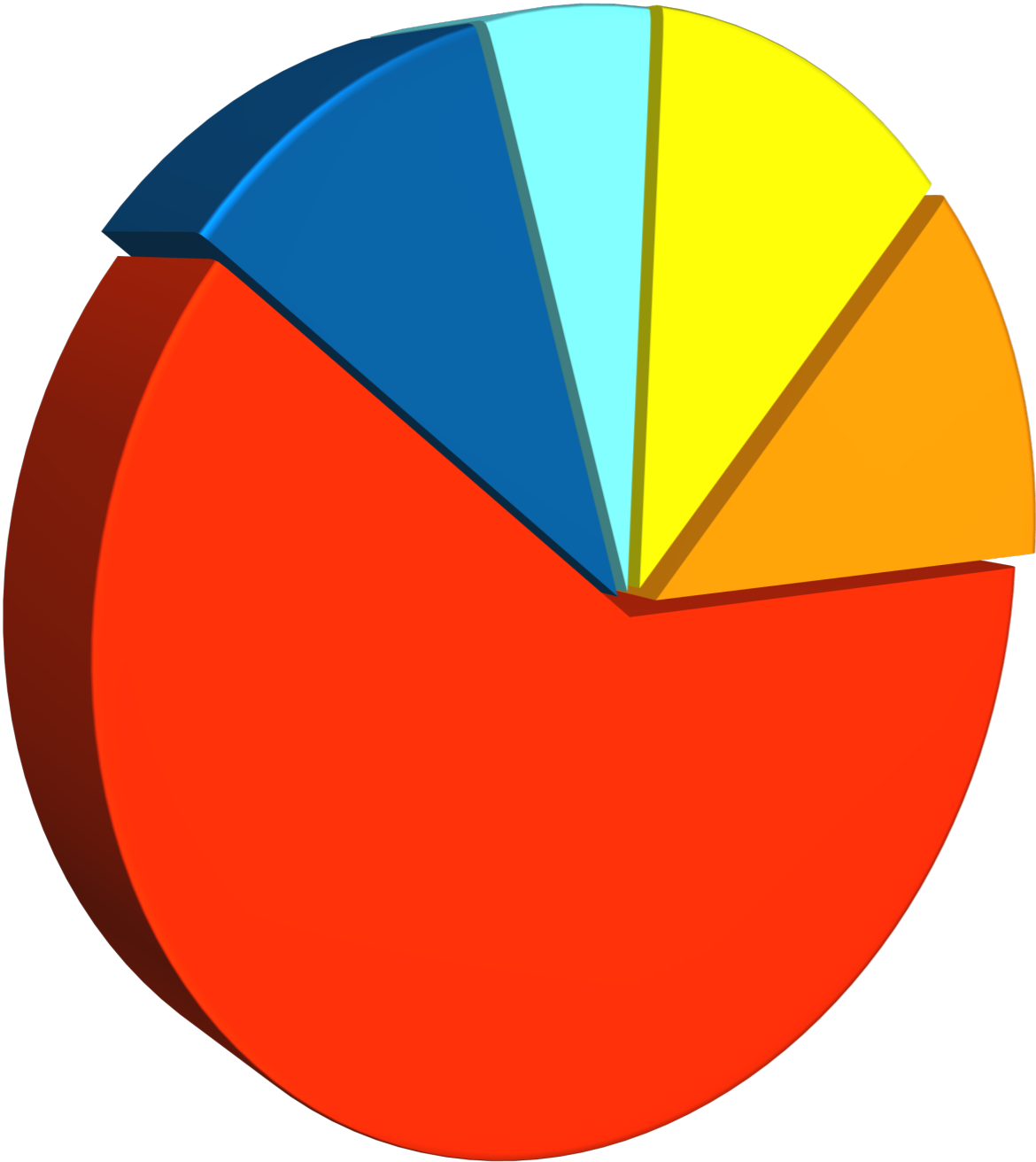
**Passive: 4.75 kBtu/(sf yr)**

15kWh/(m<sup>2</sup> 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



$\leq 0.6$  ACH<sub>50</sub>



$\leq 1.0$  ACH<sub>50</sub>







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 <sup>1</sup>	Comfort <sup>2</sup>			
	Min. temperature factor	Max. thermal transfer coefficient			
	$f_{Rsi}=0.25 \text{ m}^2\text{K/W}$	U-value			
	□	[W/(m <sup>2</sup> 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/m<sup>2</sup>      Heating Degree Hours: **466.6**

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/m <sup>2</sup> h	0%	0%	0%	0%	0%	0%	m <sup>2</sup>	W/m <sup>2</sup>	m <sup>2</sup>	kWh/m <sup>2</sup>
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	523	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
296	90
349	342
1336	2857
0	0
2611	3994

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 <sub>Frame</sub>	
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

Ready      Sun=100      OSCRL      CAPS      NLM

## Passive House Planning Package - PHPP



# Key Benefits

# Highest Comfort



# Superior Indoor Environmental Quality



# Ecology and Resource Efficiency



# Cheapest Life Cycle Cost



# The Project

# Northeast Nest





































# Home Energy Rating Certificate



2335 McKinley St NE  
MPLS, MN 55418



5 Stars Plus  
Confirmed

HERS Index: 32

Efficient Home Comparison: 68% Better

Registry ID 420377360  
Rating Number 2014-1  
Certified Energy Rater Patrick O'Malley  
Rating Date 11/26/14  
Rating Ordered For Julie & Tarel Alkatout

## Estimated Annual Energy Cost

Use	MMBtu	Cost	Percent
Heating	12.3	\$256	21%
Cooling	2.5	\$80	6%
Hot Water	13.4	\$104	8%
Lights/Appliances	24.4	\$692	55%
Photovoltaics	-0.0	\$-0	-0%
Service Charges		\$116	9%
<b>Total</b>	<b>52.7</b>	<b>\$1249</b>	<b>100%</b>

## Criteria

This home meets or exceeds the minimum criteria for the following:  
2006 International Energy Conservation Code  
2009 International Energy Conservation Code  
2012 International Energy Conservation Code

## General Information

Conditioned Area	2964 sq. ft.	House Type	Single-family detached
Conditioned Volume	26676 cubic ft.	Foundation	Conditioned basement
Bedrooms	3		

## Mechanical Systems Features

Heating:	Fuel-fired air distribution, Natural gas, 90.0 AFUE.
Air-source heat pump:	Electric, Htg: 9.5 HSPF, Clg: 18.0 SEER.
Water Heating:	Instant water heater, Natural gas, 0.93 EF, 0.0 Gal.
Duct Leakage to Outside	RESNET/HERS default
Ventilation System	Balanced: ERV, 75 cfm, 120.0 watts.
Programmable Thermostat	Heat=Yes; Cool=Yes

## Building Shell Features

Ceiling Flat	R-90.0	Slab	R-30.0 Edge, R-30.0 Under
Sealed Attic	NA	Exposed Floor	NA
Vaulted Ceiling	NA	Window Type	U-Value: 0.140, SHGC: 0.500
Above Grade Walls	R-60.0	Infiltration Rate	Htg: 133 Clg: 133 CFM50
Foundation Walls	R-25.0	Method	Blower door test

## Lights and Appliance Features

Percent Interior Lighting	100.00	Range/Oven Fuel	Electric
Percent Garage Lighting	98.00	Clothes Dryer Fuel	Electric
Refrigerator (kWh/yr)	300.00	Clothes Dryer EF	3.01
Dishwasher Energy Factor	0.46	Ceiling Fan (cfm/Watt)	0.00

Building Knowledge, Inc.  
PO Box 1376  
Burnsville MN 55337  
952-944-5605  
[www.buildingknowledge.com](http://www.buildingknowledge.com)

REM/Rate - Residential Energy Analysis and Rating Software v14.5.1

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The Home Energy Rating Standard Disclosure for this home is available from the rating provider.





# “Northeast Nest”

## Building Envelope Specifications

### Window Frames

Optiwin, Alu2Wood

Timber window frame with insulation and exterior aluminum cladding

$U_w$ -Value = 0.84 W/(m<sup>2</sup>K) [ $U_{IP}$  = 0.148 Btu/(h ft<sup>2</sup> F)]

### Glazing

Glas Trösch

SILVERSTAR glaCE

EUROFLOAT

4:/18/4/18/:4

Argon filled

$U_g$ -Value = 0.54 W/(m<sup>2</sup>K) [ $U_{IP}$  = 0.095 Btu/(h ft<sup>2</sup> F)]

g-Value (SHGC) = 53 %

### Entry Doors

Doors of Distinction

Custom made entry door. Wood frame, wood finish, polyisocyanurate foam insulation core

$U_d$ -Value = 0.79 W/(m<sup>2</sup>K) [ $U_{IP}$  = 0.139 Btu/(h ft<sup>2</sup> F)]

# Design Concept



# Built Project



# “Northeast Nest”

## Building Envelope Specifications

### Exterior Walls

Below-grade exterior walls: U-value: 0,146 W/(m<sup>2</sup>K); R-39

- 5/8 "[16mm] drywall
- 11" [280mm] insulated concrete forms (ICF)  
[2.5" EPS (035) - 6" concrete - 2.5" EPS (035)]
- 4" [102mm] EPS insulation (035)
- Sto Flexyl

Above-grade exterior walls: U-value: 0,111 W/(m<sup>2</sup>K); R-51

- 5/8 "[16mm] drywall
- 2X6 Studs [140mm] with mineral wool batt insulation (040)
- 3/4" OSB [19mm] structural sheathing, air barrier, vapor retarder
- 12" I-Joist [305mm] with dense-pack cellulose insulation (039)
- 1/2" [12mm] wood fiberboard sheathing (068)
- Ventilated wood composite siding

# “Northeast Nest”

## Building Envelope Specifications

### Slab

Insulated concrete slab (and footings): U-Value = 0.219 W/(m<sup>2</sup>K); R-26

- 4" [102 mm] concrete slab
- 6" [152 mm] EPS insulation (035)

### Roof

Cold roof, insulated second floor ceiling: U-Value = 0.081 W/(m<sup>2</sup>K); R-70

- 5/8 "[16mm] drywall
- 2X6 [140mm] framing; service cavity (086)
- 3/4 "[19 mm] OSB air barrier, vapor retarder
- 20 "[508] loose-fill cellulose (042)
- Vented attic

# Construction Process

# Before













BuildBlock

BuildBlock



**BuildBlock**  
4000 BuildBlock.com  
800 322 3300





RJ  
STEGORA INC  
612-889-8277

PROJECT DESIGNED BY  
te  
STUDIO  
612-203-1629  
TESTUDIO.COM













**Airtightness 0.36 ACH<sub>50</sub>**

































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# HVAC Systems

# “Northeast Nest” HVAC Systems

## Ventilation

Zehnder, ComfoAir 350 (84% efficiency)

Zehnder distribution system

Effective heat recovery efficiency = 76%

## Heating, Cooling, Dehumidification

2 recirculating Fujitsu split air-to-air heat pump systems (first floor and second floor) with electric resistance backup post heater; system also provides cooling and dehumidification; sheet metal ductwork

Mantis gas fireplace; direct vent; modulating: can augment heating on coldest days of the year; will be used throughout the winter for enjoyment.

Electric resistance panel heaters (basement)

## Domestic Hot Water

Boiler, IntelliHot i-200P tankless on-demand gas hot water heater with continuously insulated PEX tube distribution

# Energy Recovery Ventilation









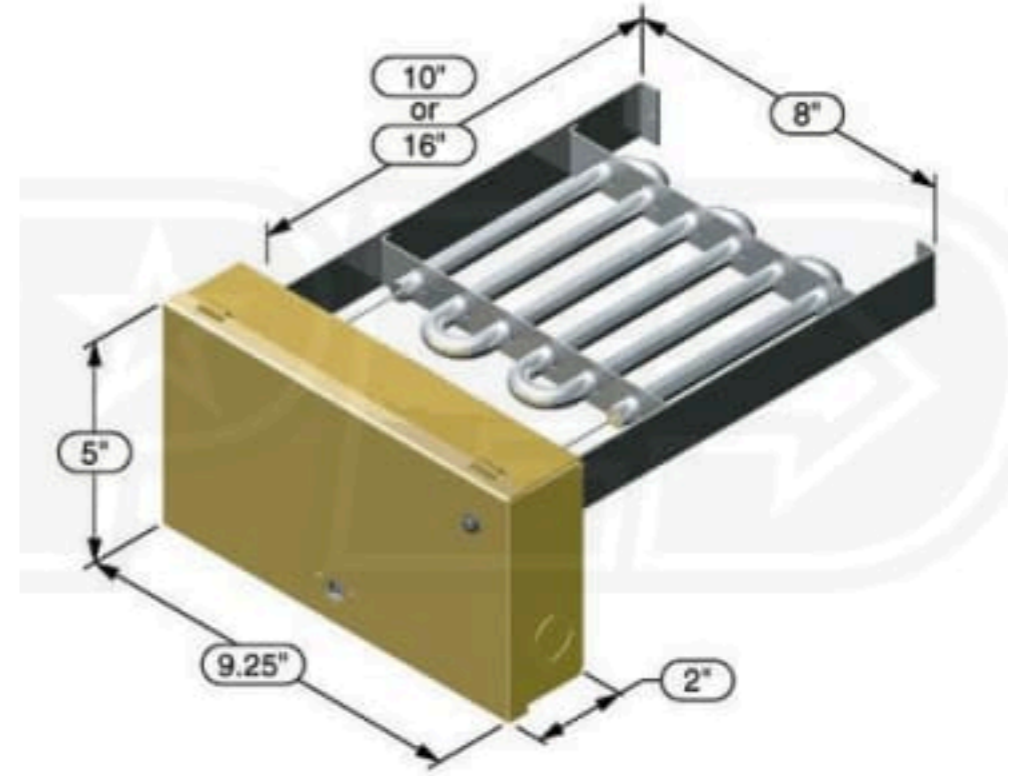
Clean  
fresh air



# Domestic Hot Water Heater

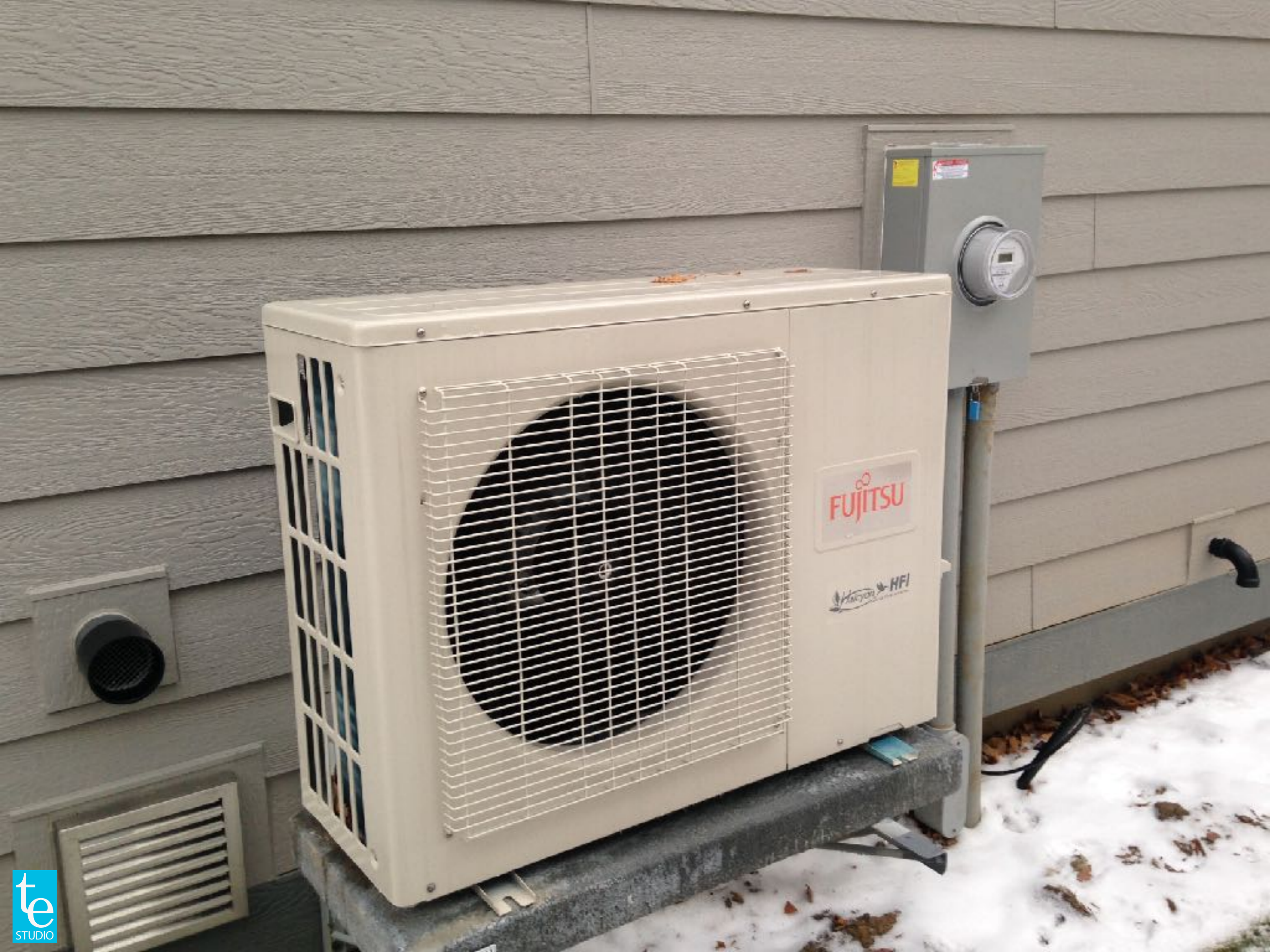


# HAC Equipment



# HVAC Distribution





FUJITSU

Mini-Split HFI



# HVAC Distribution

Ventilation

HAC



# Performance

# “Northeast Nest”

## Modeled Performance

### Annual Heating Demand

27 kWh / (m<sup>2</sup>a ) [8.5 kBTU / (sf yr)]

### Heat Load

17 W/m<sup>2</sup> [5.4 Btu/h/ft<sup>2</sup>]

### Design Heat Load

3.8 KW [13.1 kBTU/h]

### Source Energy Demand

104 kWh / (m<sup>2</sup>a ) [33 kBTU / (sf yr)] for Heating, Domestic Hot Water, Auxiliary- and Plug Loads  
Will be much less in reality as electricity is sourced from wind power.

Calculated with the PHPP



# Verification

## PHI Low Energy Building Verification



<b>Building:</b>	"Nordeast Nest" - Alkatout Residence	
Street:	2335 McKinley St. NE	
Postcode/City:	55418	Minneapolis
Province/Country:	Minnesota	US-United States of America
Building type:		
Climate data set:	US0040a-Minneapolis	
Climate zone:	2: Cold	Altitude of location: 285.332424 m
<b>Home owner / Client:</b>	Julie and Tarek Alkatout	
Street:	2335 McKinley St. NE	
Postcode/City:	55418	Minneapolis
Province/Country:	Minnesota	US-United States of America
<b>Mechanical system:</b>	TE Studio, Ltd.	
Street:	901 23rd Ave NE	
Postcode/City:	55418	Minneapolis
Province/Country:	Minnesota	US-United States of America
<b>Certification:</b>	Passivhaus Institut	
Street:	Rheinstr. 44/46	
Postcode/City:	64283	Darmstadt
Province/Country:	DE-Germany	
Year of construction:	2014	Interior temperature winter [°C]: 20.0
No. of dwelling units:	1	Interior temp. summer [°C]: 25.0
No. of occupants:	3.1	Internal heat gains (IHG) heating case [W/m²]: 2.3
		Specific capacity [Wh/K per m² TFA]: 84
		IHG cooling case [W/m²]: 2.3
		Mechanical cooling: x

### Specific building characteristics with reference to the treated floor area

Characteristic	Value	Comparison	Criteria		Fullfilled? <sup>2</sup>	
			Criteria	Alternative criteria		
Space heating	Treated floor area m <sup>2</sup>	226.4				
	Heating demand kWh/(m <sup>2</sup> a)	27	≤	30	-	yes
	Heating load W/m <sup>2</sup>	17	≤	-	-	yes
Space cooling	Cooling & dehum. demand kWh/(m <sup>2</sup> a)	8	≤	30	-	yes
	Cooling load W/m <sup>2</sup>	8	≤	-	-	yes
	Frequency of overheating (> 25 °C) %	-	≤	-	-	-
	Frequency excessively high humidity (> 12 g/kg) %	0	≤	10	-	yes
Airtightness	Pressurization test result n <sub>50</sub> 1/h	0.4	≤	1.0	-	yes
Non-renewable Primary Energy (PE)	PE demand kWh/(m <sup>2</sup> a)	104	≤	120	-	yes
Primary Energy Renewable (PER)	PER demand kWh/(m <sup>2</sup> a)	62	≤	-	-	-
	Generation of renewable energy (in relation to projected building) kWh/(m <sup>2</sup> a)		≥	-	-	-

<sup>2</sup> Empty field: Data missing; '-': No requirement

I confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The PHPP calculations are attached to this verification.

Task: 1-Designer First name: Tim Surname: Eian  
 Issued on: City:

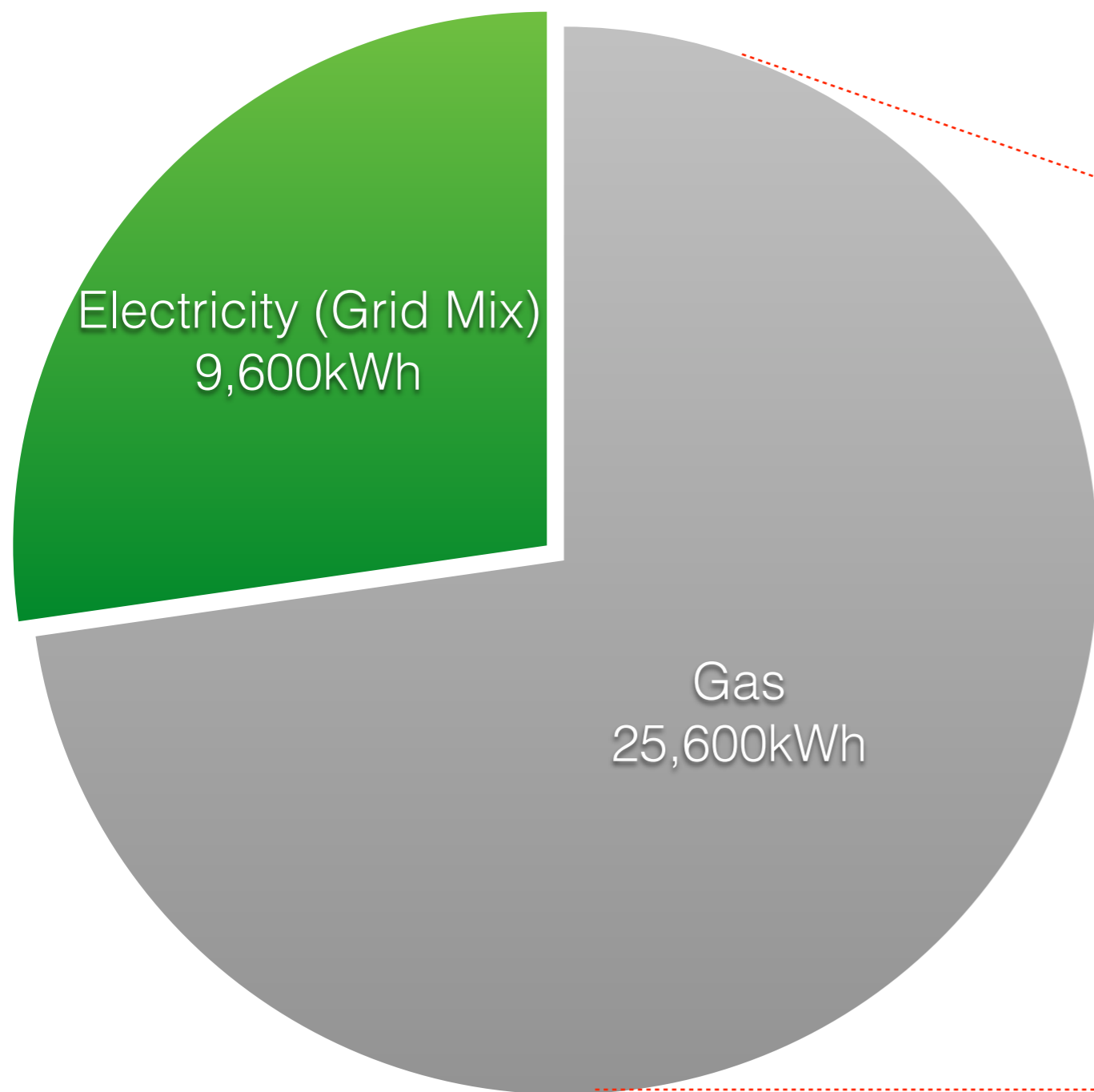
PHI Low Energy Building?

yes

Signature:

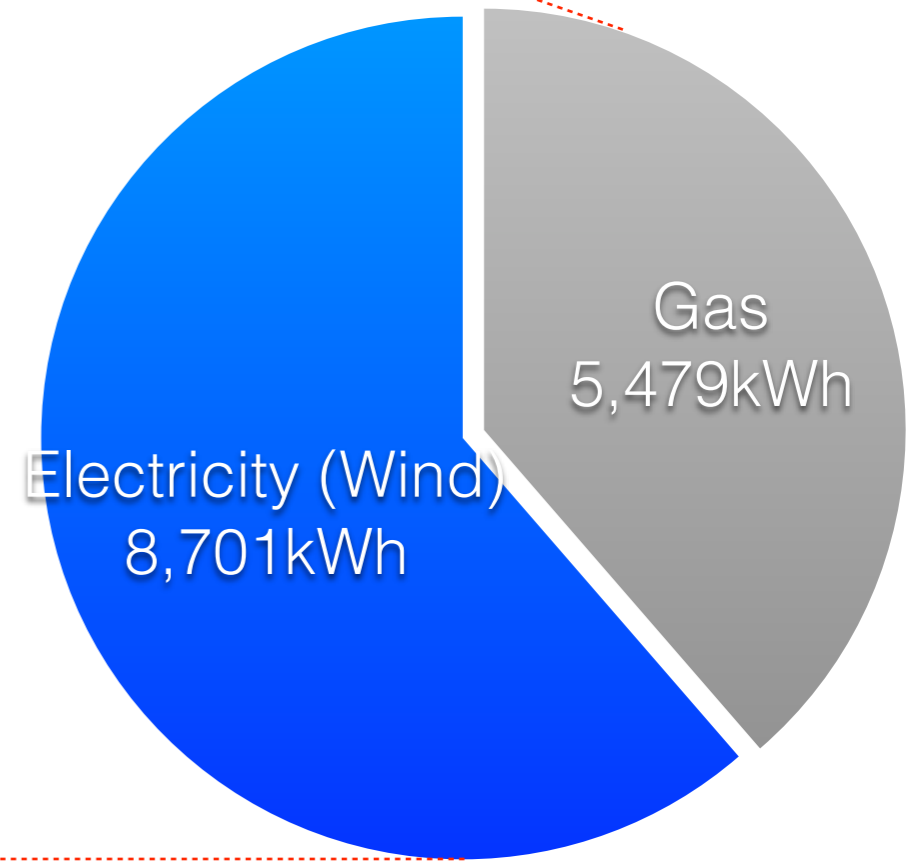
# Energy Footprint (Northeast Nest)

Average MN Home



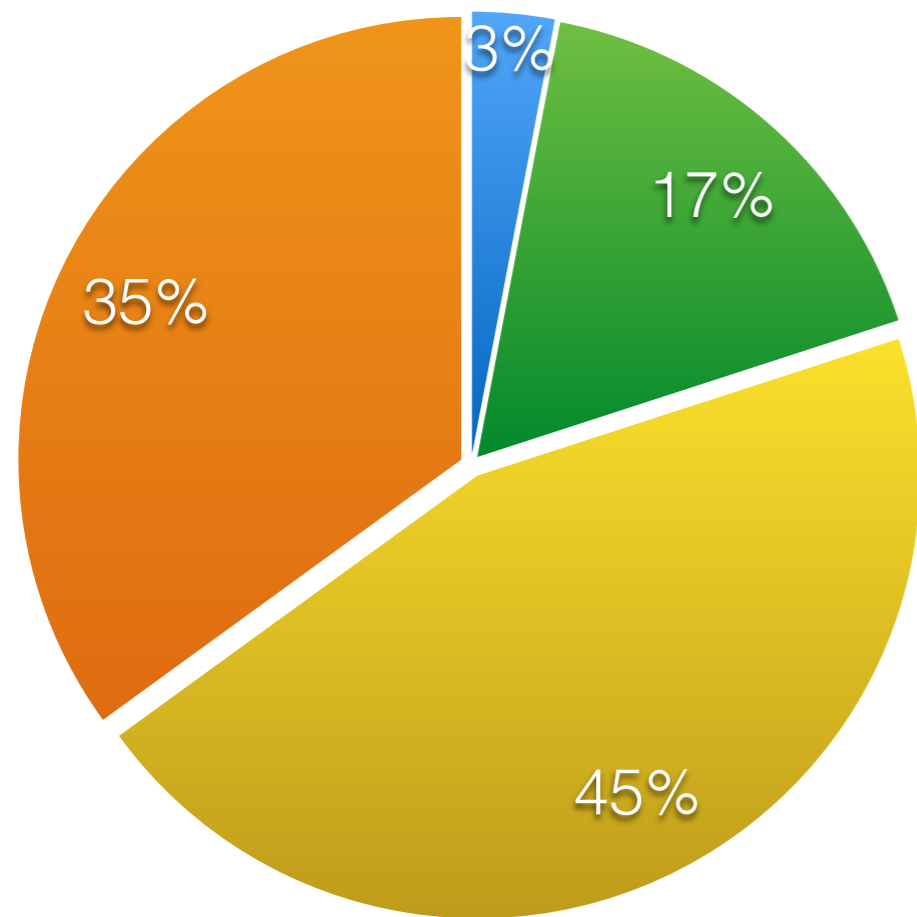
**60% less energy**

Northeast Nest

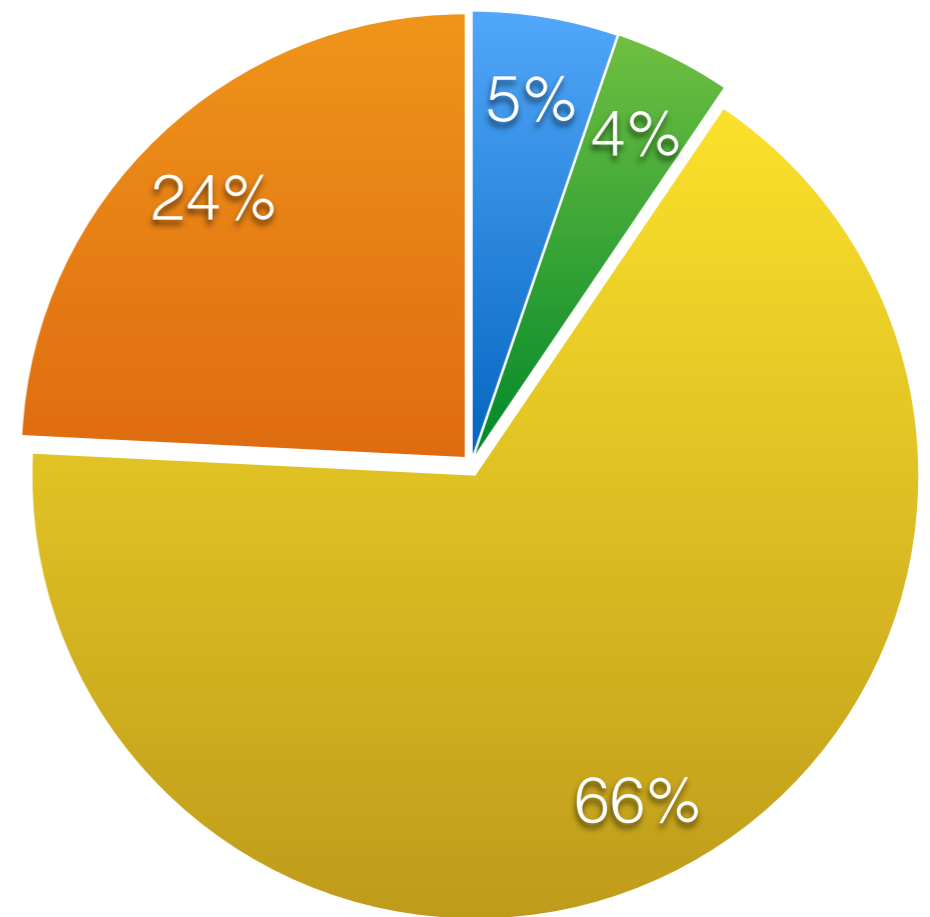


# Energy Consumption and Cost

Energy Consumption



Energy Cost

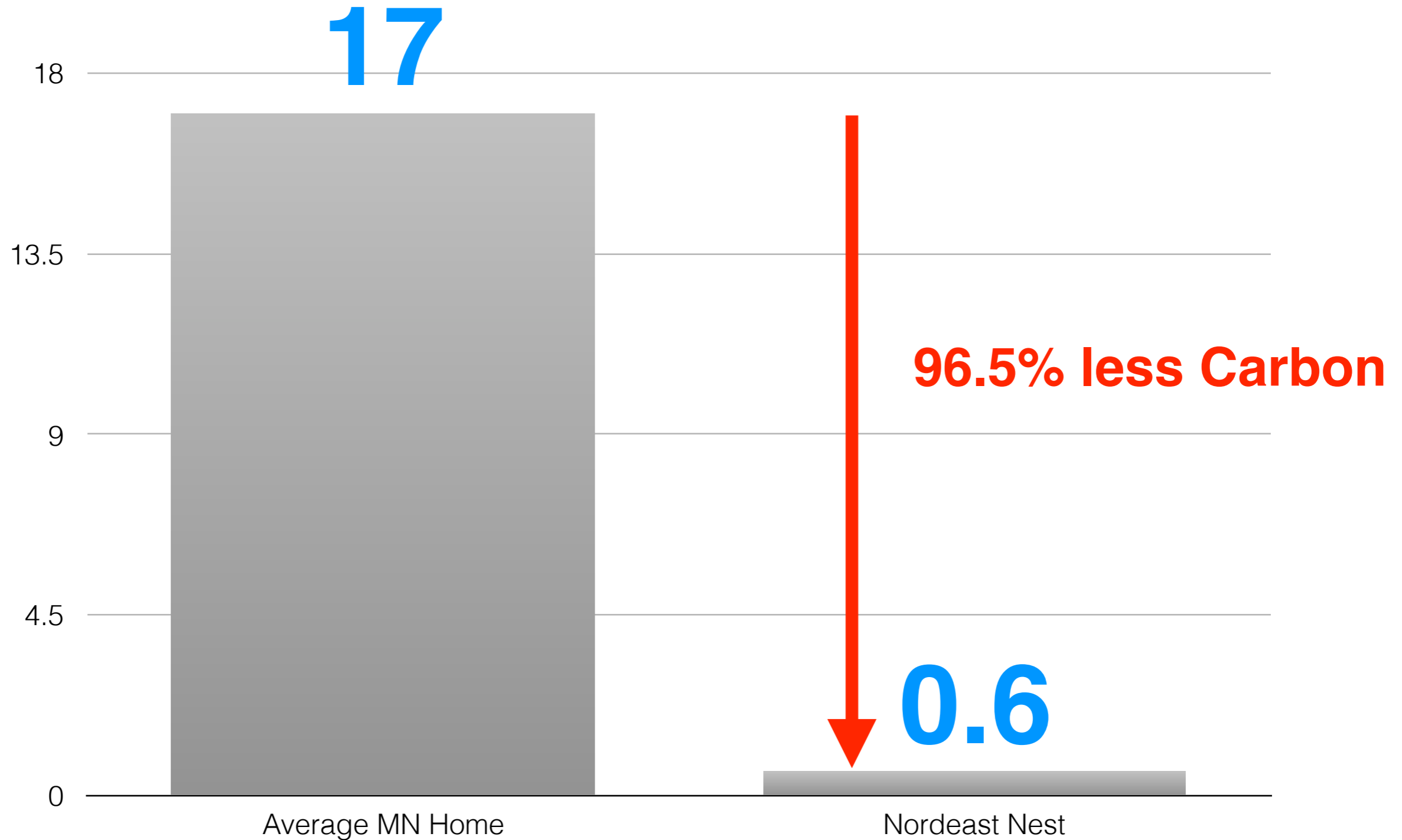


● Cooling ● DHW ● Household ● Heating

● Cooling ● DHW ● Household ● Heating

# Carbon Footprint

■ Carbon Footprint in metric tonnes



# Transportation





[northeastnest.com](http://northeastnest.com)

# Resources



[passivehouse.com](http://passivehouse.com)

[passipedia.org](http://passipedia.org)

[passivehouse-international.org](http://passivehouse-international.org)



# Thank You!



High Performance Architecture

[testudio.com](http://testudio.com)