LOW ENERGY BUILDING DESIGN MORPHOLOGY

Process and case studies

Richard Pedranti, AIA

RPA

Richard Pedranti Architect

September 21, 2018

AIA

PH CPHC®

PH CERTIFIED BUILDER

PH PHIUS+ RATER

PH

PASSIVE HOUSE ALLIANCE UNITED STATES

PHIUS

LOW ENERGY BUILDING DESIGN MORPHOLOGY

Process and case studies

PRESENTATION OUTLINE

1. CLIMATE BASED DESIGN TIMELINE
2. DESIGN METHOD AND PARAMETERS
3. CASE STUDIES

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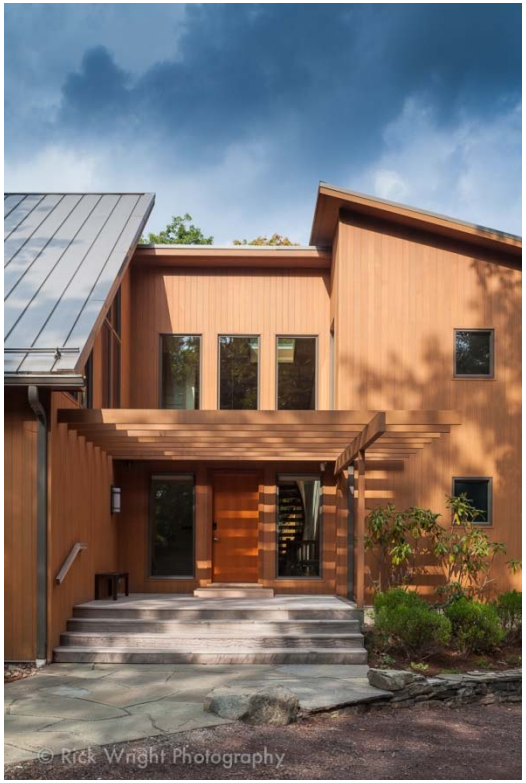
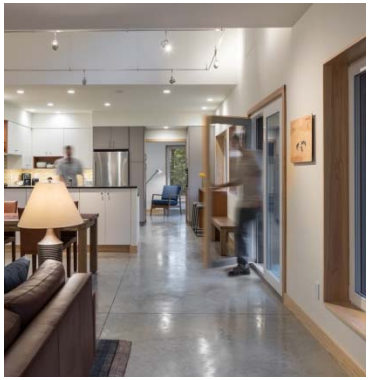
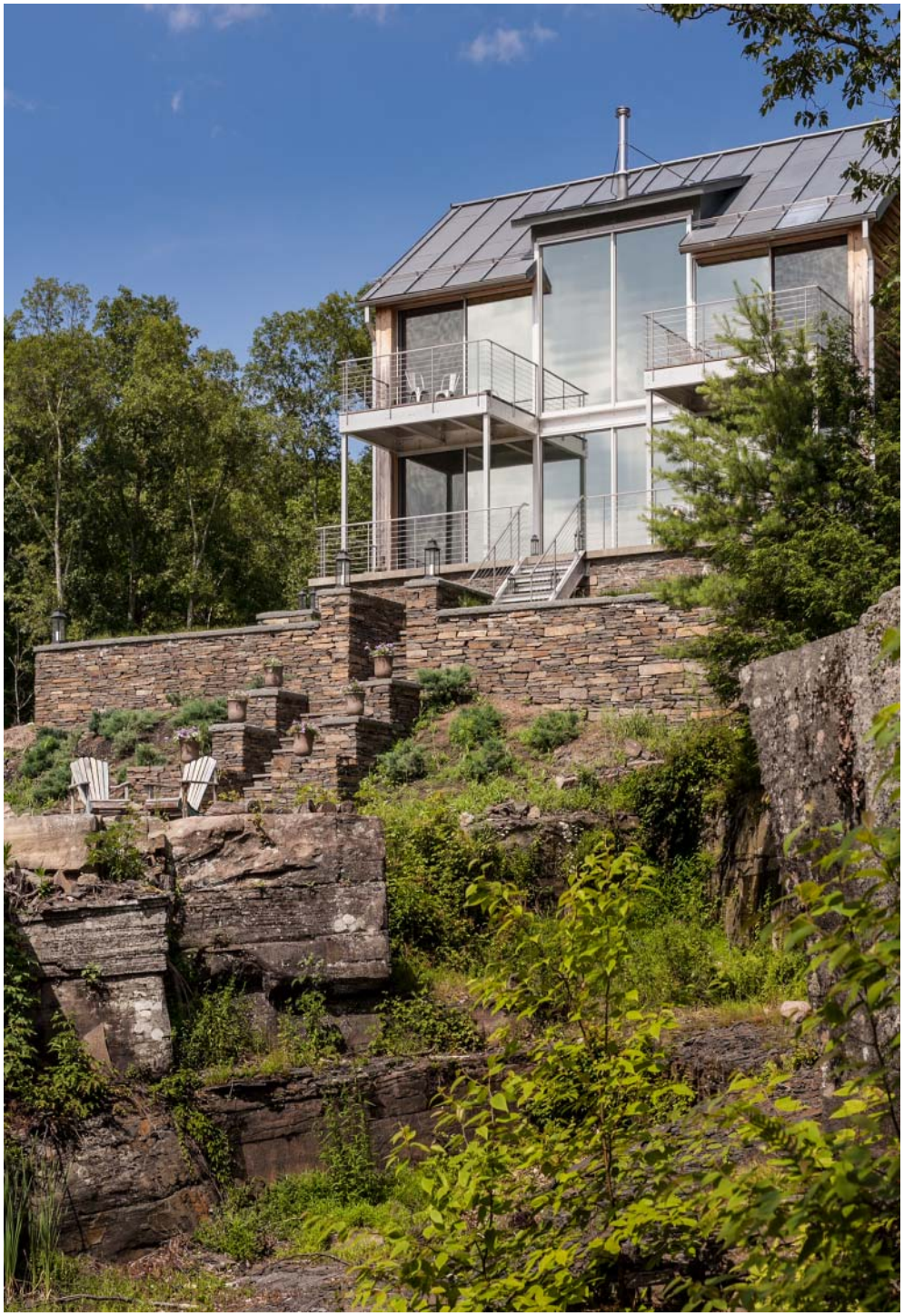
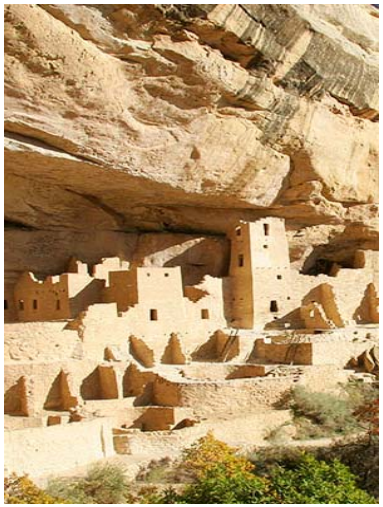






TIMELINE OF CLIMATE BASED DESIGN



1300

1500

1700

1900

1200

1400

1600

1800

2018

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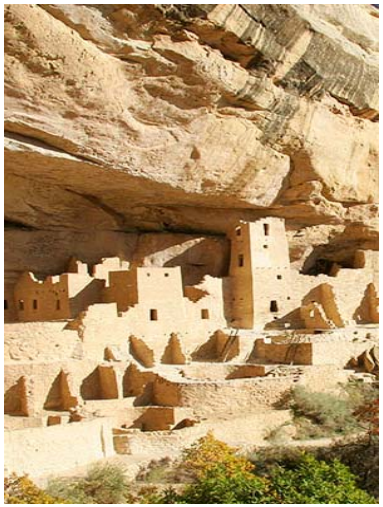
TIMELINE OF CLIMATE BASED DESIGN



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2018

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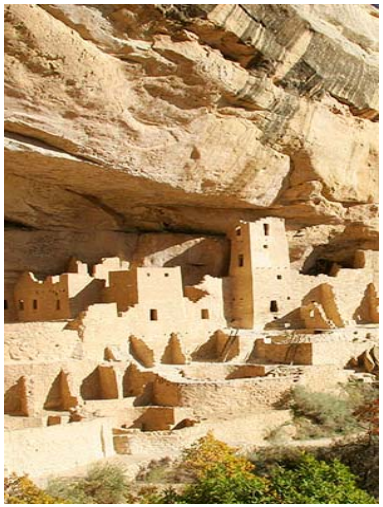
TIMELINE OF CLIMATE BASED DESIGN



1300

1500

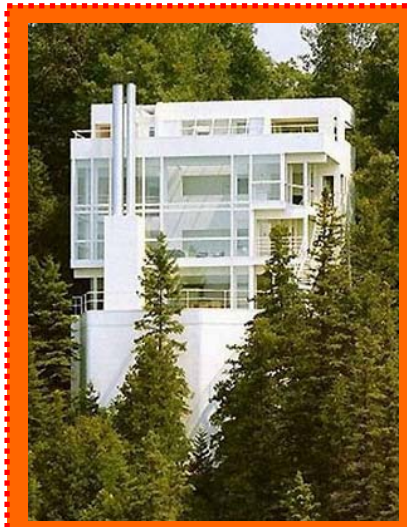
1700

1900

1200

1400

1600



1800

2018

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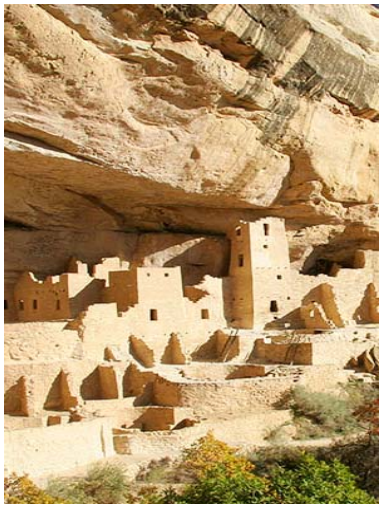
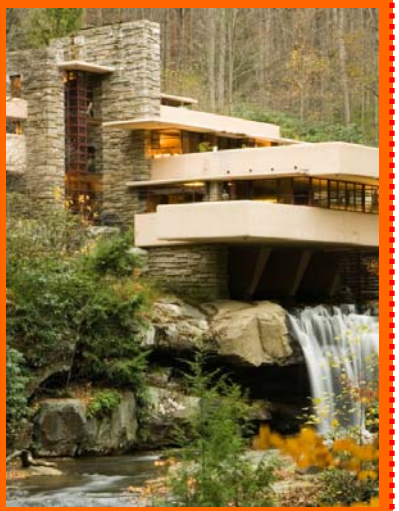
TIMELINE OF CLIMATE BASED DESIGN



1300 1500 1700 1900

1200 1400 1600 1800 2018



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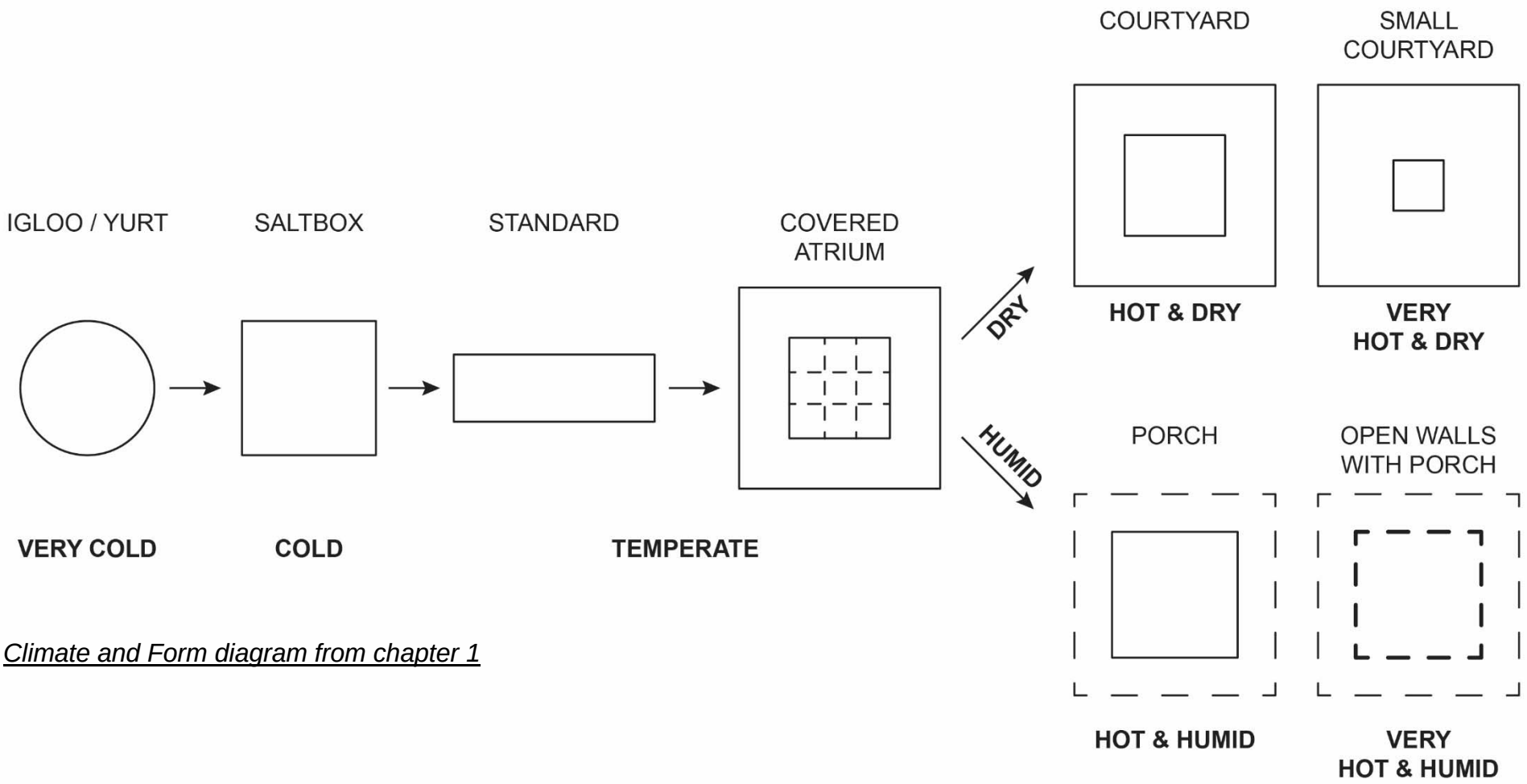
CLIMATE AND FORM



Climate and Form diagram from chapter 1

Heating, Cooling, and Lighting as Form Givers in Architecture

Norbert Lechner
2015
Heating, Colling, Lighting : sustainable design methods for architects

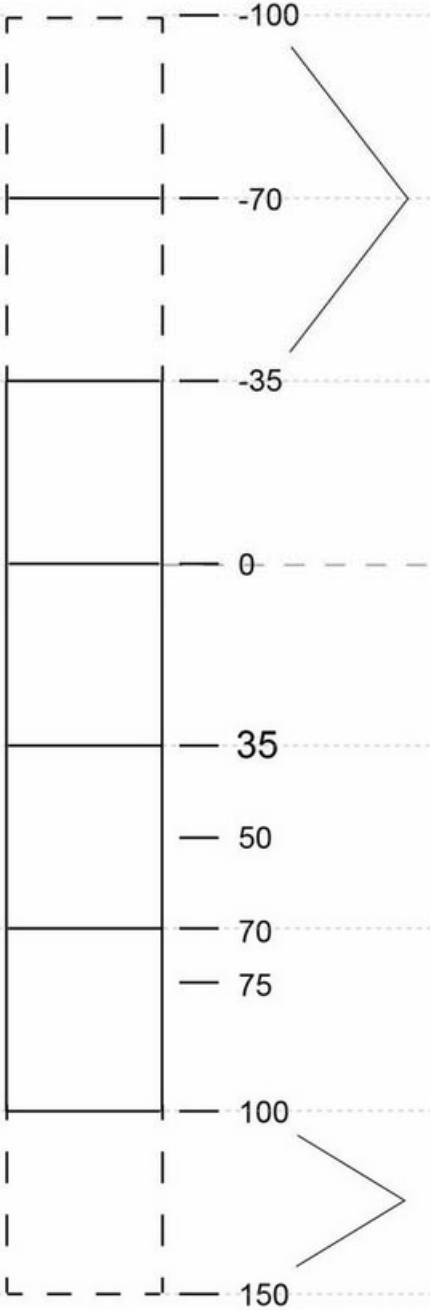
RPA BUILDING ENERGY MATRIX

"Using building science to create beautiful, healthy, comfortable, durable, and energy efficient buildings." - RPA

CLIMATE ZONE 5

RPA DESIGN METHODOLOGY

BUILDING ENERGY PYRAMID



HERS

BUILDING STANDARDS

RPA BUILDING ENERGY MATRIX

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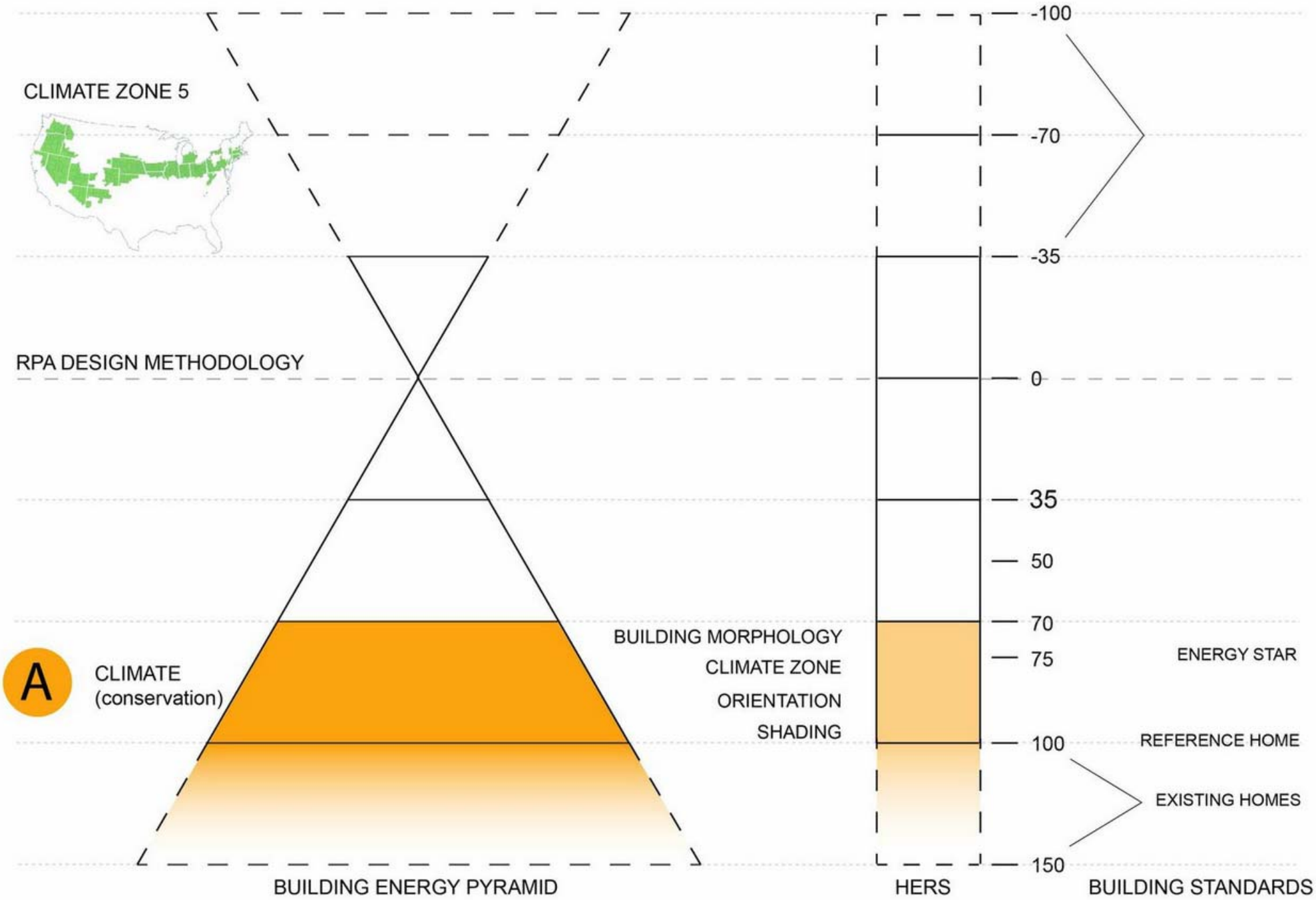

RPA

RPA BUILDING ENERGY MATRIX

"Using building science to create beautiful, healthy, comfortable, durable, and energy efficient buildings." - RPA

CLIMATE ZONE 5

RPA DESIGN METHODOLOGY

B ENCLOSURE (efficency)

A CLIMATE (conservation)

INSULATION
AIR SEALING
WINDOWS
THERMAL BRIDGE FREE
BUILDING MORPHOLOGY
CLIMATE ZONE
ORIENTATION
SHADING

-100
-70
-35
0
35
50
70
75
100
150

ZERH
ENERGY STAR
REFERENCE HOME
EXISTING HOMES

BUILDING ENERGY PYRAMID
HERS
BUILDING STANDARDS

RPA

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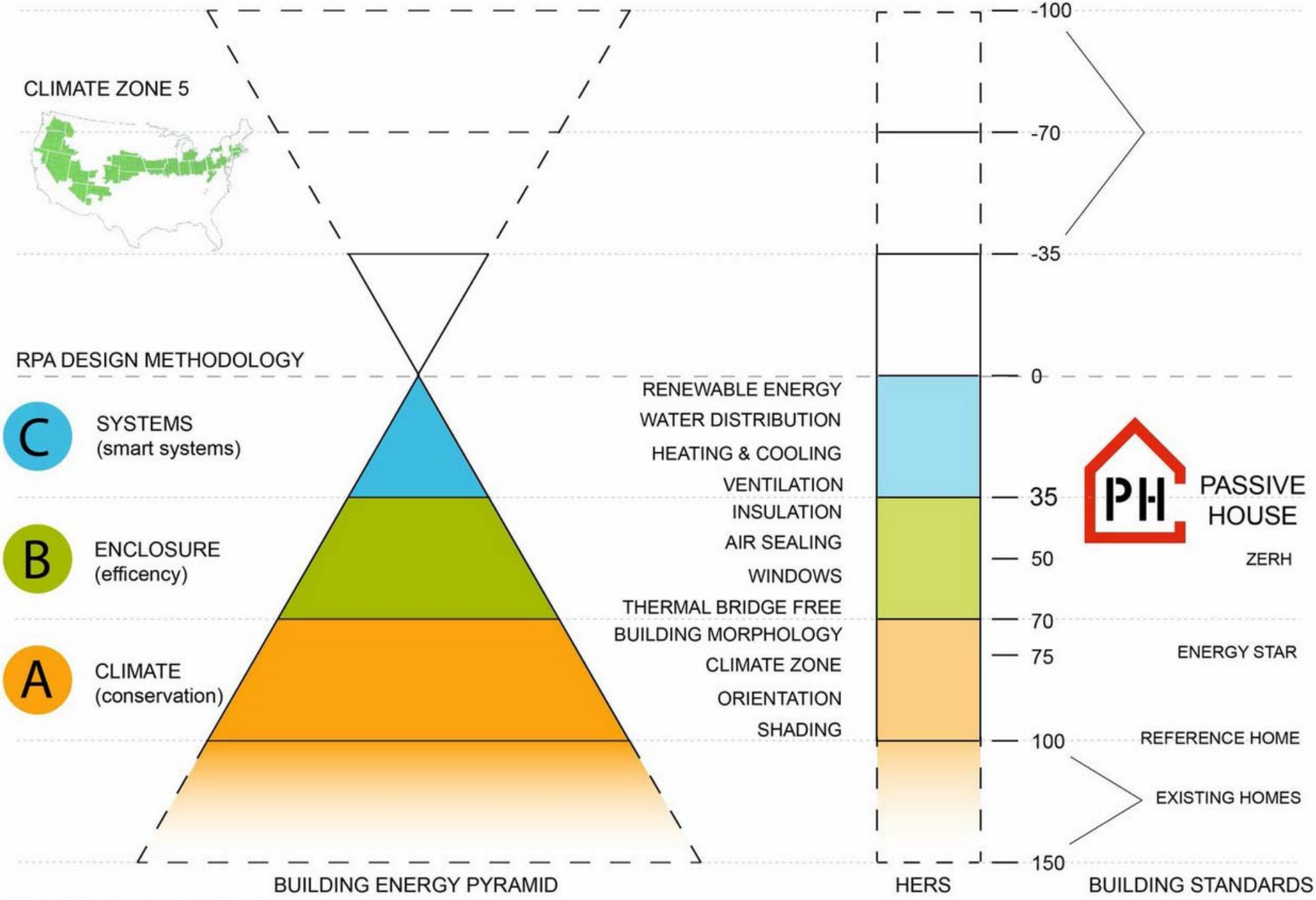

RPA

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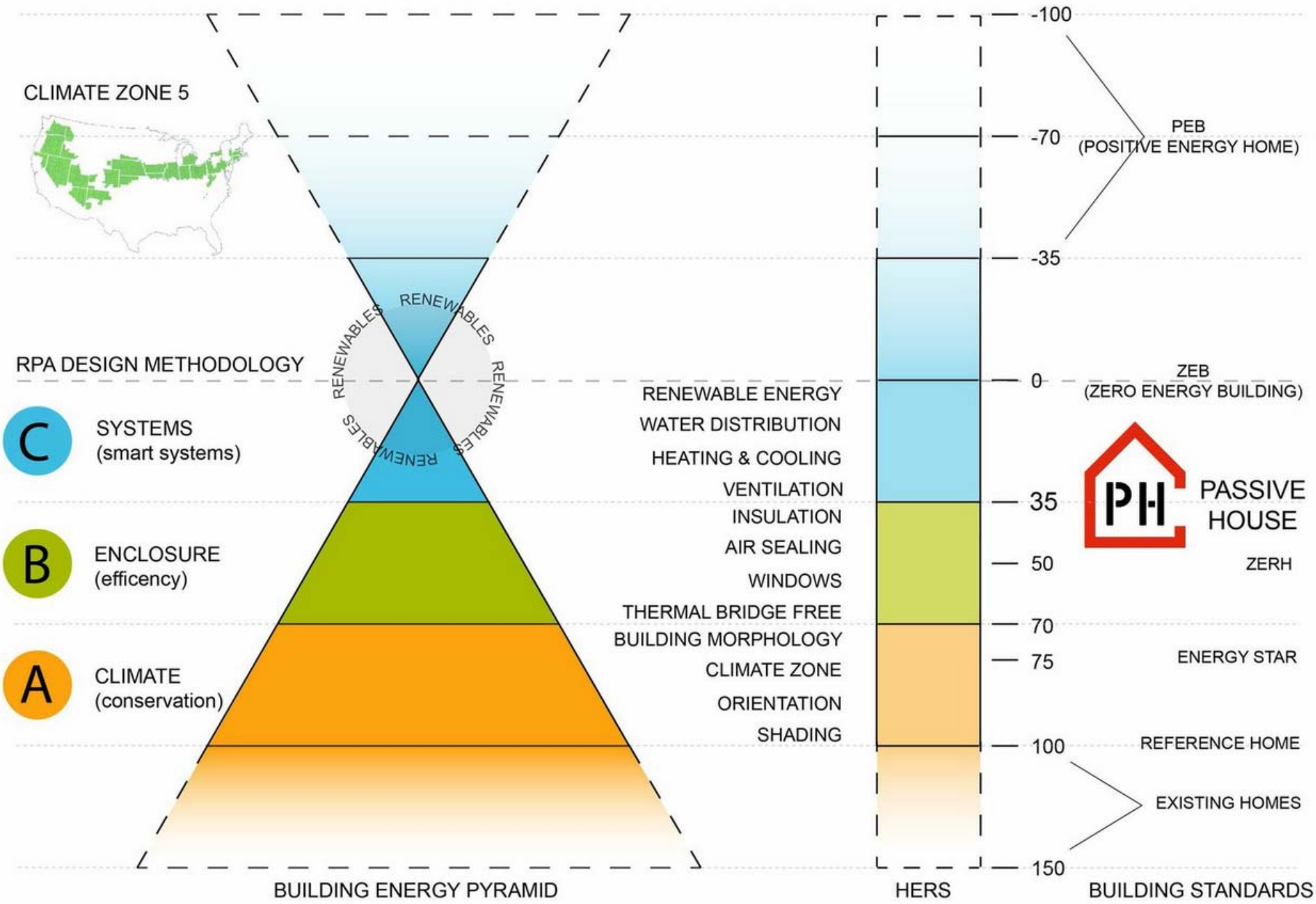
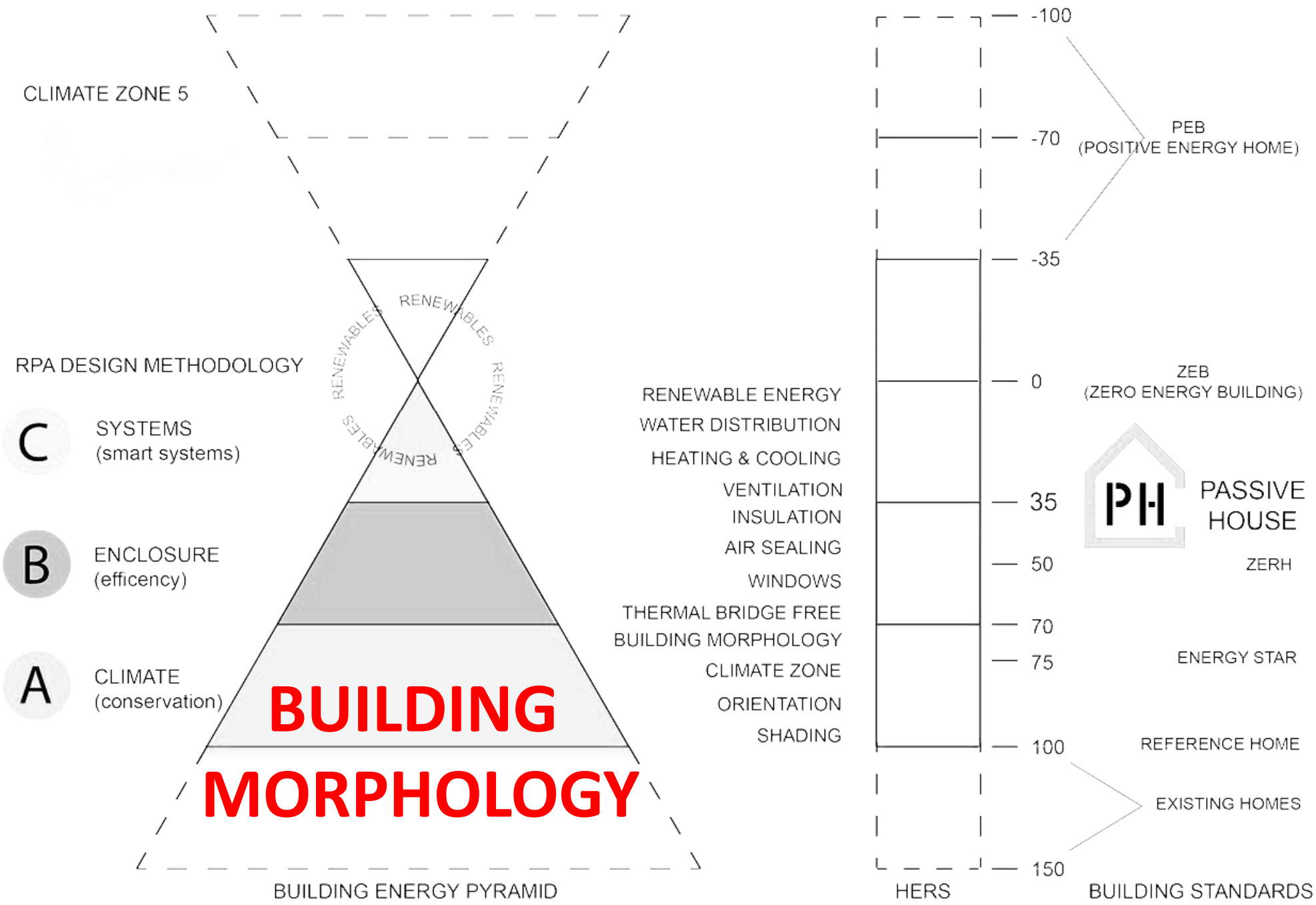


RPA

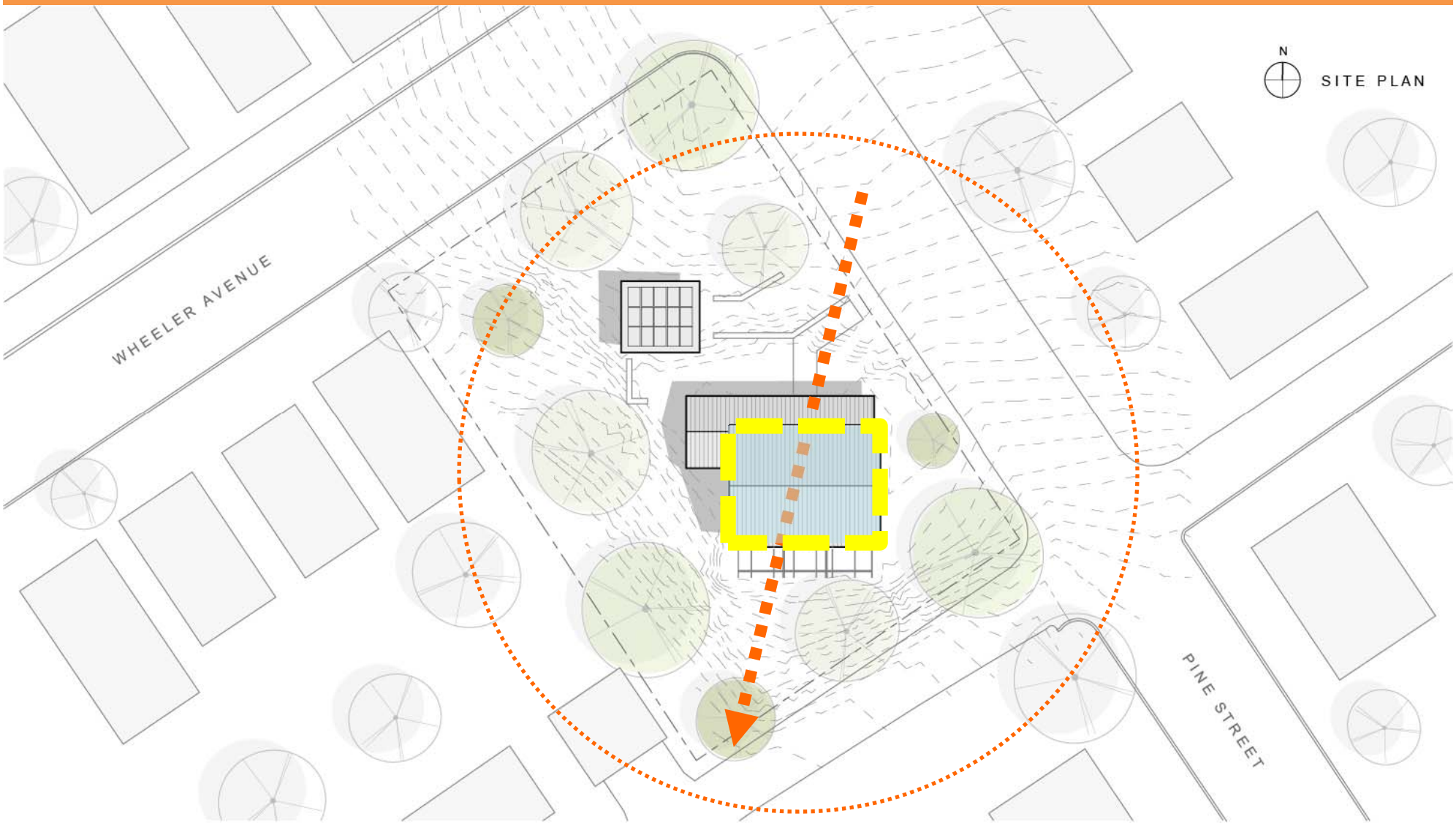
RPA BUILDING ENERGY MATRIX

"Using building science to create beautiful, healthy, comfortable, durable, and energy efficient buildings." - RPA



Case Study 1

SCRANTON PASSIVE HOUSE



Site: Urban neighborhood

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SCRANTON PASSIVE HOUSE

Site: Urban neighborhood

PHIUS

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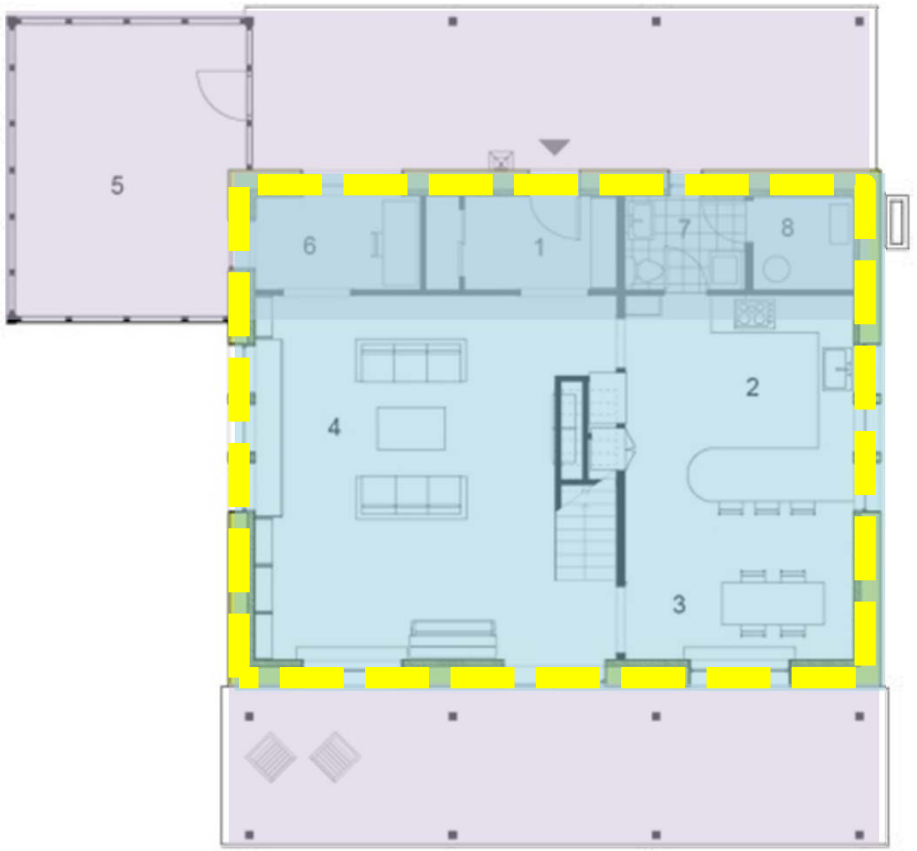
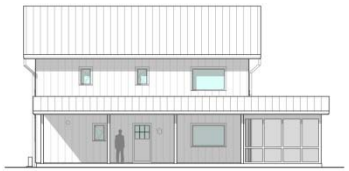
SCRANTON PASSIVE HOUSE





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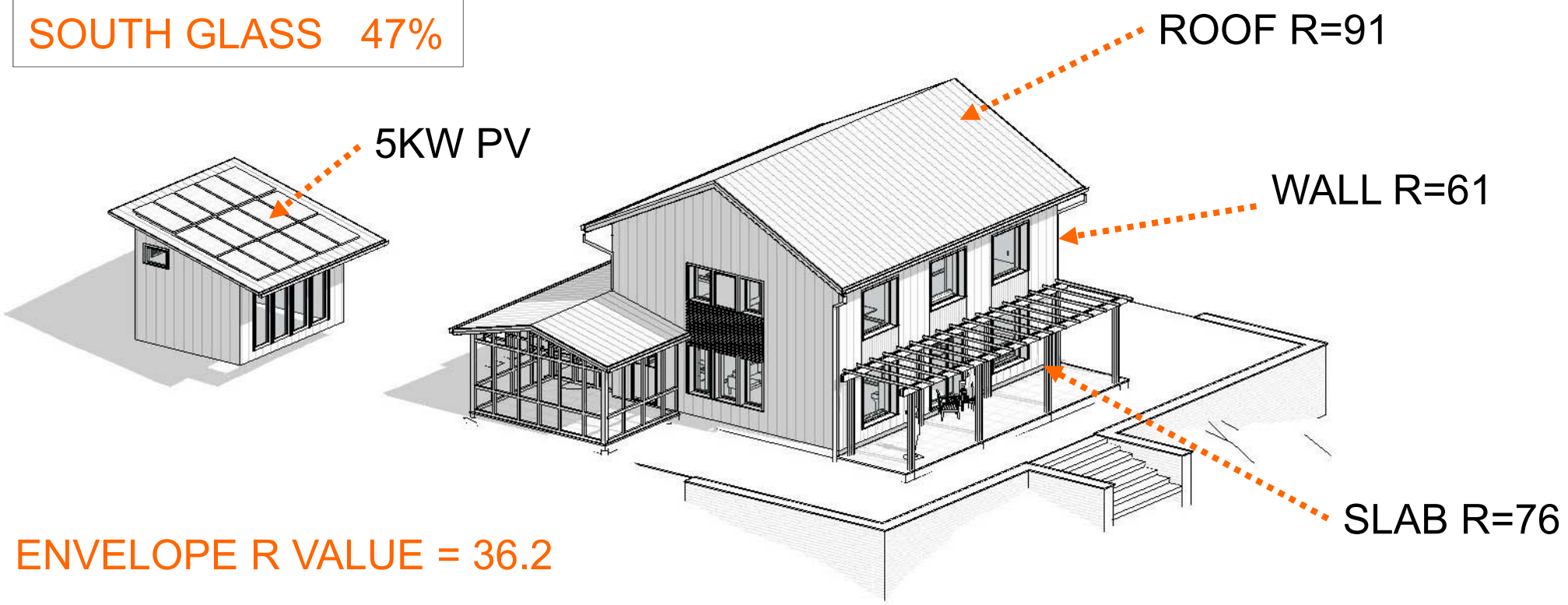
SCRANTON PASSIVE HOUSE

SVR	0.32
GLASS	14%
SOUTH GLASS	47%

MORPHOLOGY



ENVELOPE R VALUE = 36.2

GENERAL INFO
SCRANTON, PA
2,153 SQFT
CLIMATE ZONE 5/6
HERS 28
PV TO ZERO 5KW

MECHANICAL

BALANCED VENTILATION	RENEWAIRE ERV
HEAT / COOL	MITSUBISHI ASHP
HOT WATER	GE HWHP
WINDOWS	INTUS EFORTE

PASSIVE HOUSE METRICS

ANNUAL HEAT DEMAND	4.52 KBTU/(FT2YR)
HEAT LOAD	2.75 KBTU/(FT2YR)
PRIMARY ENERGY	31.5 KBTU/(FT2YR)
AIR TIGHTNESS	0.47ACH@50PA
TREATED FLOOR AREA	1,750 SQFT.

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SCRANTON PASSIVE HOUSE

PHIUS

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SCRANTON PASSIVE HOUSE

PHIUS

RPA

SCRANTON PASSIVE HOUSE

PHIUS

RPA

SCRANTON PASSIVE HOUSE

PHIUS

RPA

SCRANTON PASSIVE HOUSE

“It is beautifully designed, warm/cool, cheap to run, silent, and comfy.”

Declan Mulhall, Homeowner

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SCRANTON PASSIVE HOUSE

PHIUS

RPA

SCRANTON PASSIVE HOUSE

PHIUS

RPA

SCRANTON PASSIVE HOUSE

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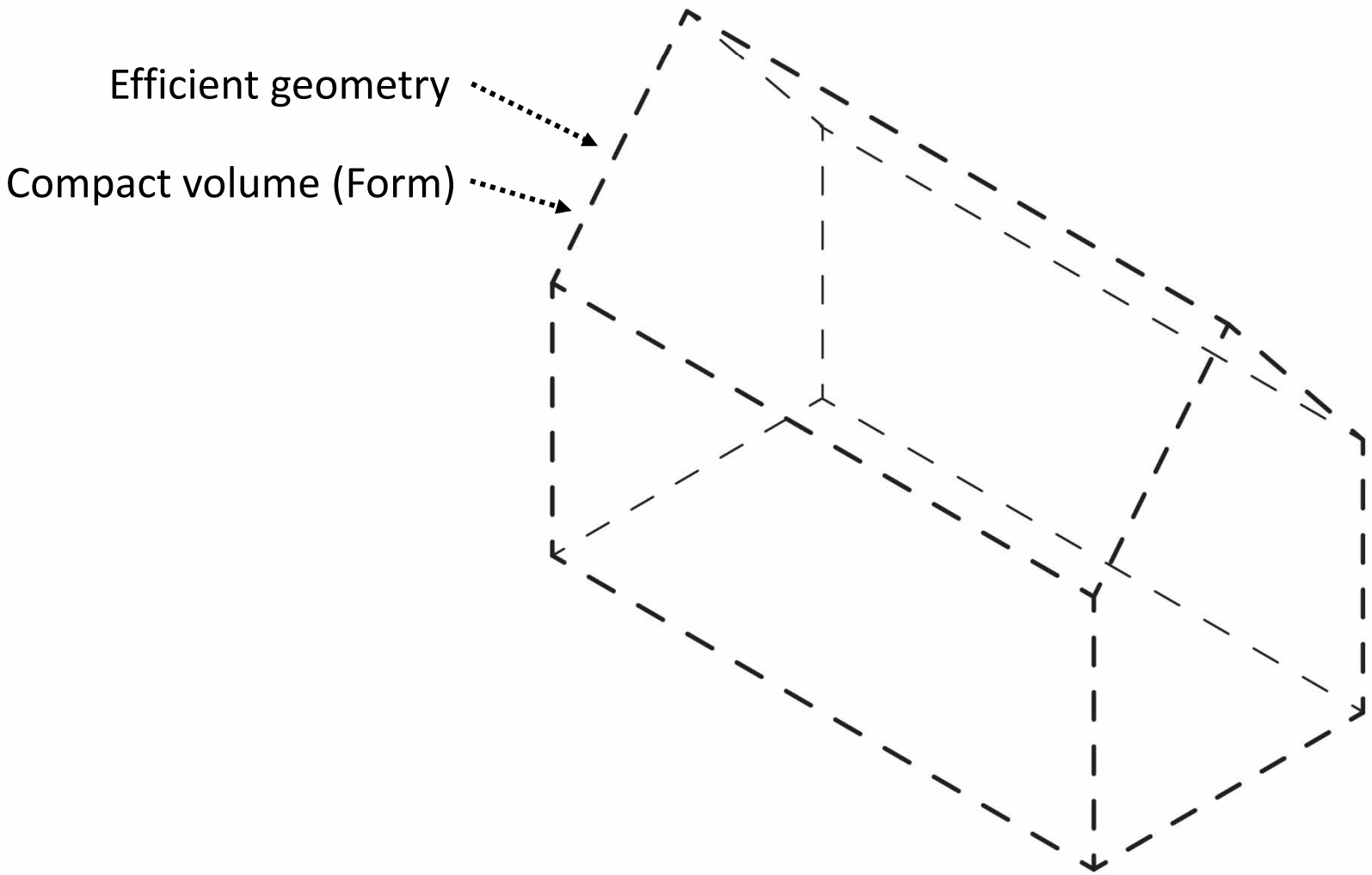
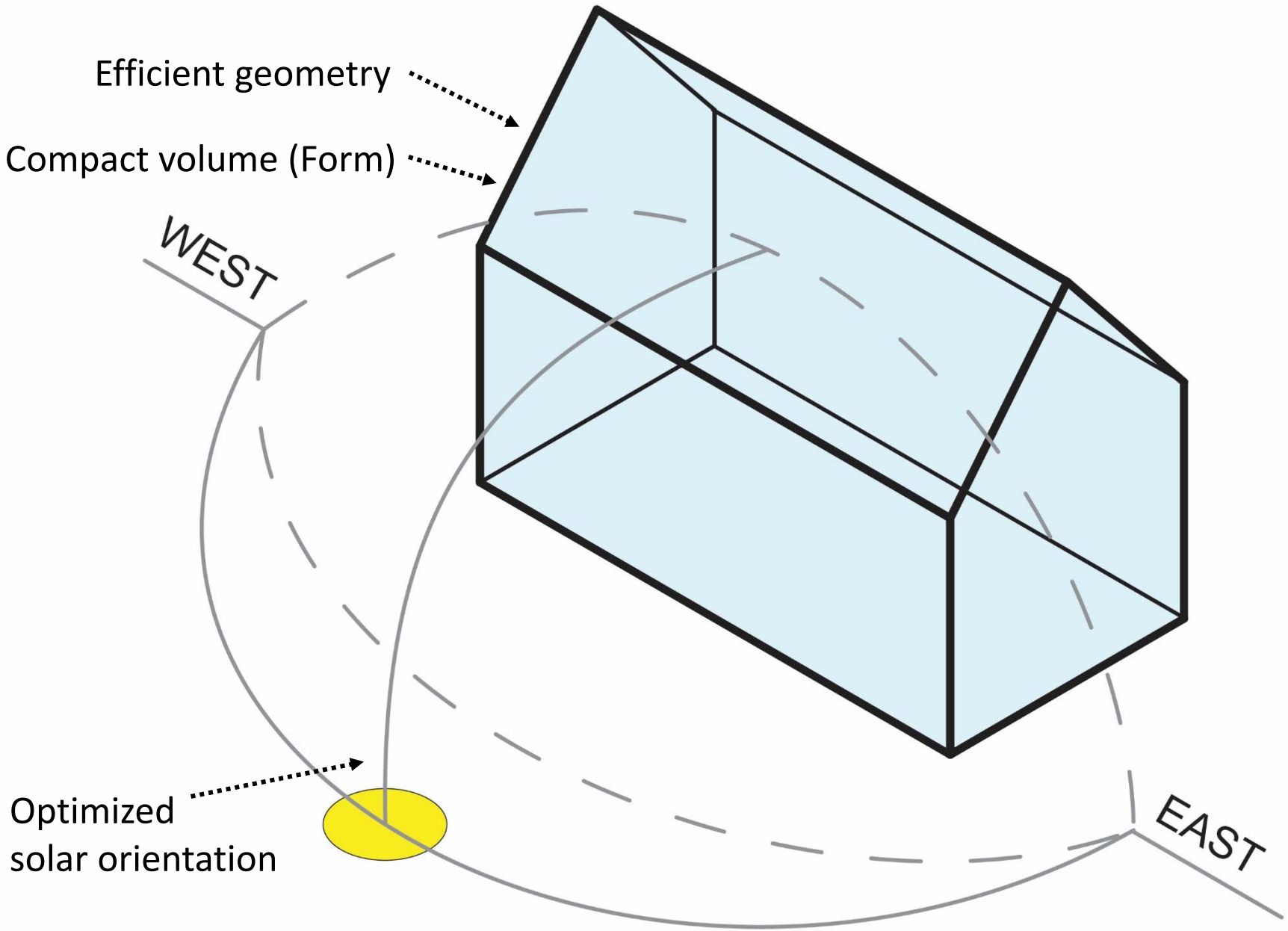
OPTIMIZED BUILDING MORPHOLOGY



OPTIMIZED BUILDING MORPHOLOGY



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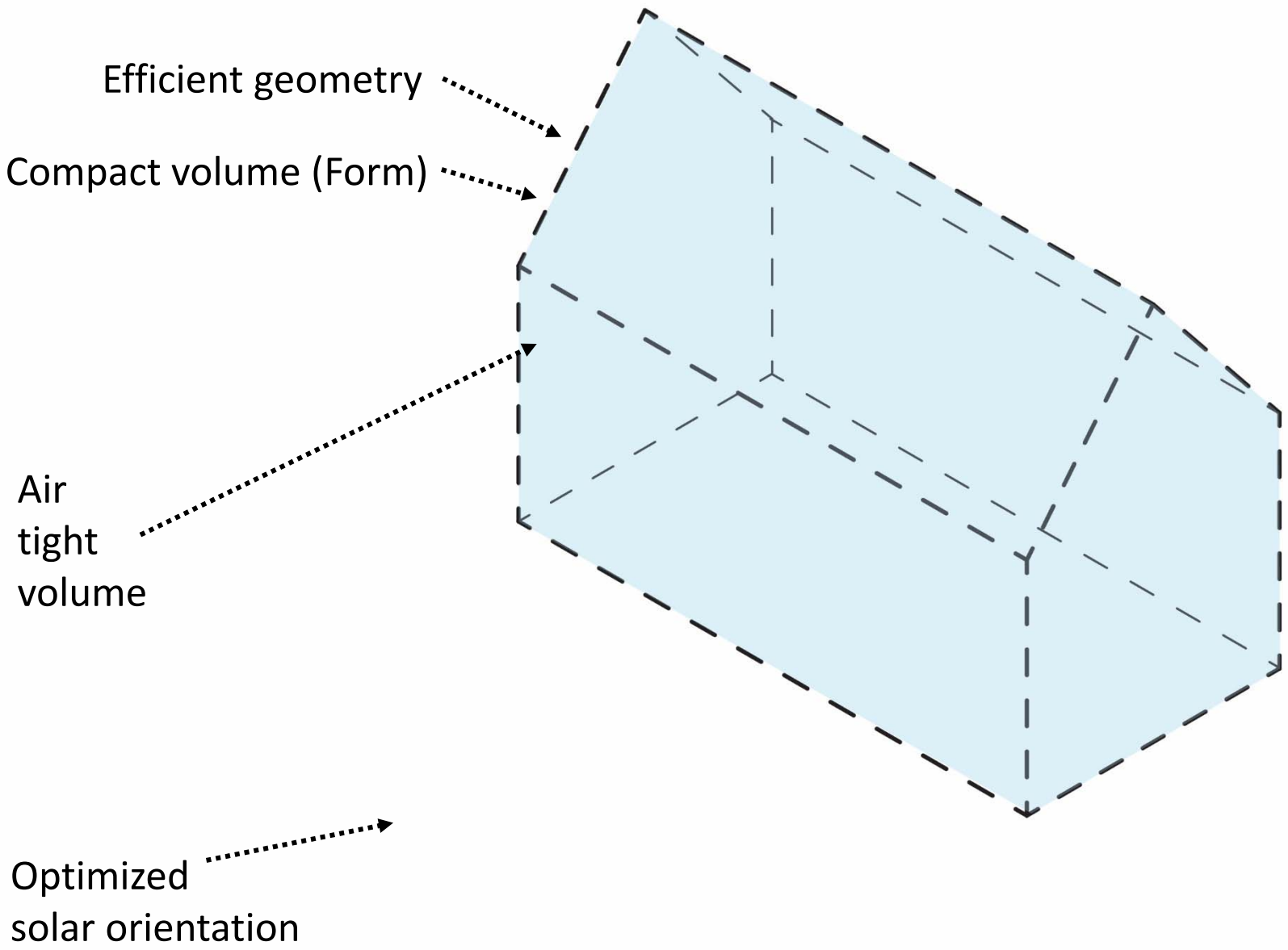
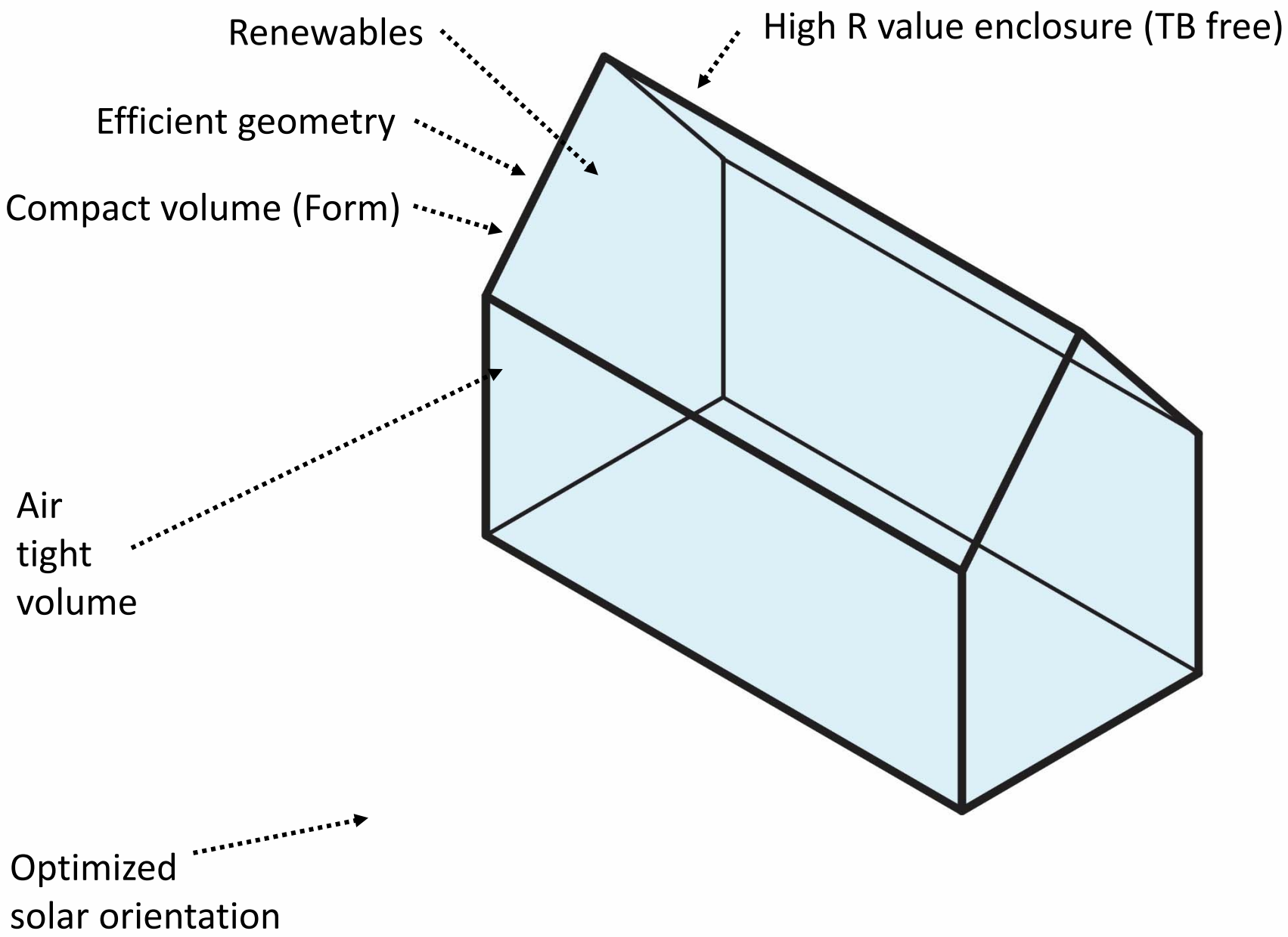
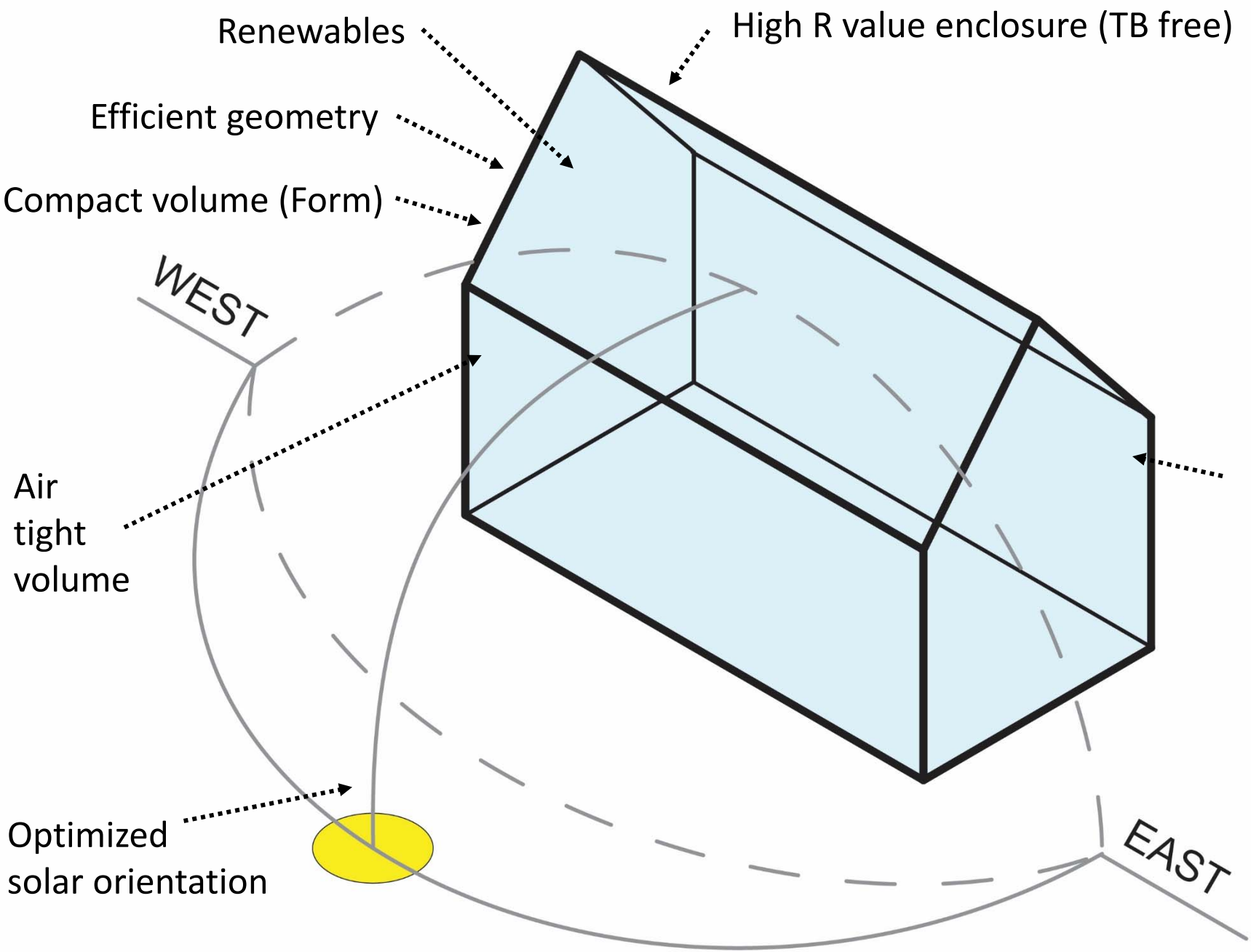


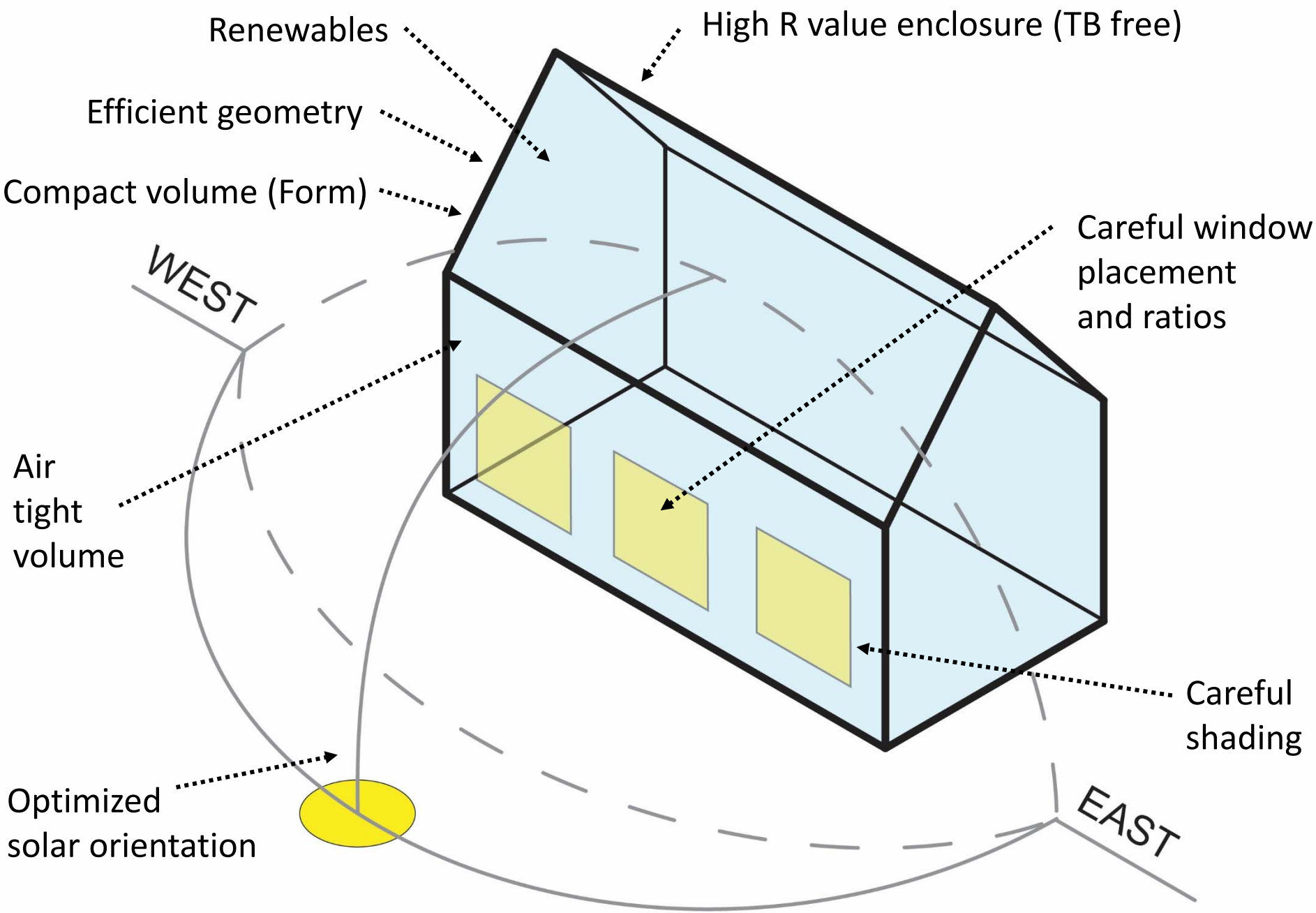
OPTIMIZED BUILDING MORPHOLOGY



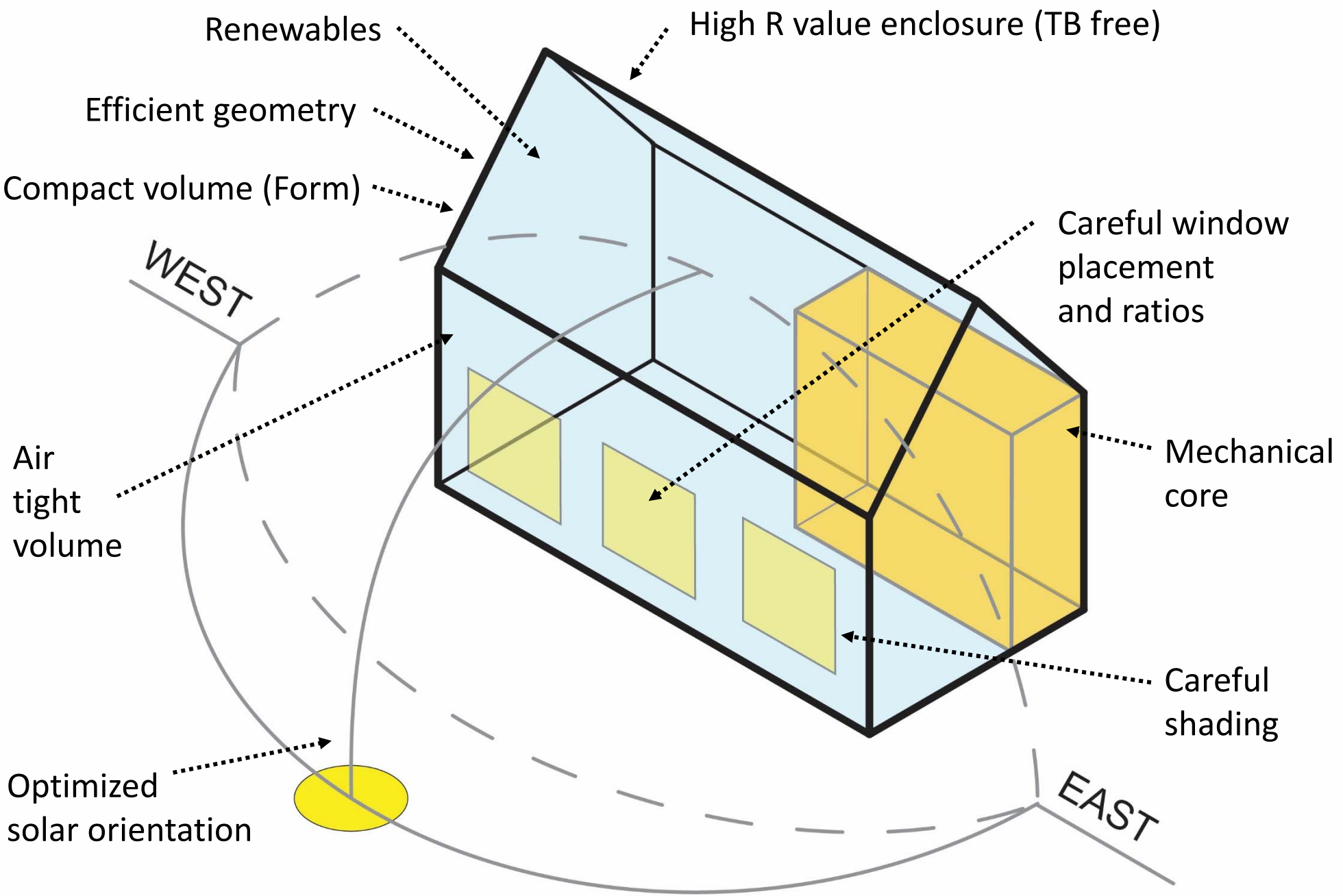
OPTIMIZED BUILDING MORPHOLOGY



OPTIMIZED BUILDING MORPHOLOGY



OPTIMIZED BUILDING MORPHOLOGY



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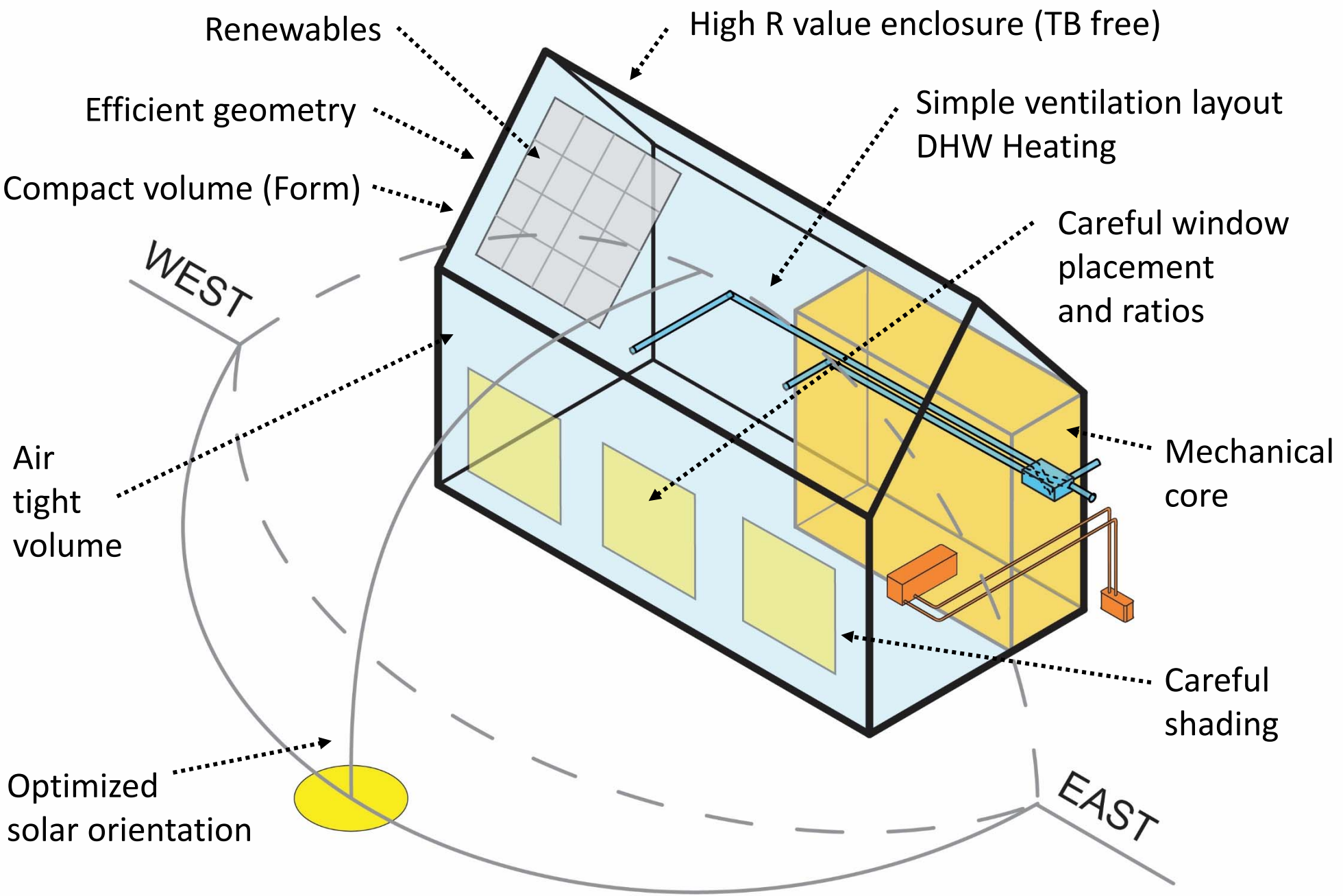
OPTIMIZED BUILDING MORPHOLOGY



DESIGN PARAMETERS

A Science / Quantitative

Orientation

Compact volume (Form)

Efficient geometry (SVR)

R value

Glazing placement

Glazing ratios

Shading

Thermal bridging

Air tightness

Ventilation

Water management

Vapor management

System design

Equipment efficiency

Renewables

DESIGN PARAMETERS

A Science / Quantitative

Orientation
Compact volume (Form)
Efficient geometry (SVR)
R value
Glazing placement
Glazing ratios
Shading
Thermal bridging
Air tightness
Ventilation
Water management
Vapor management
System design
Equipment efficiency
Renewables

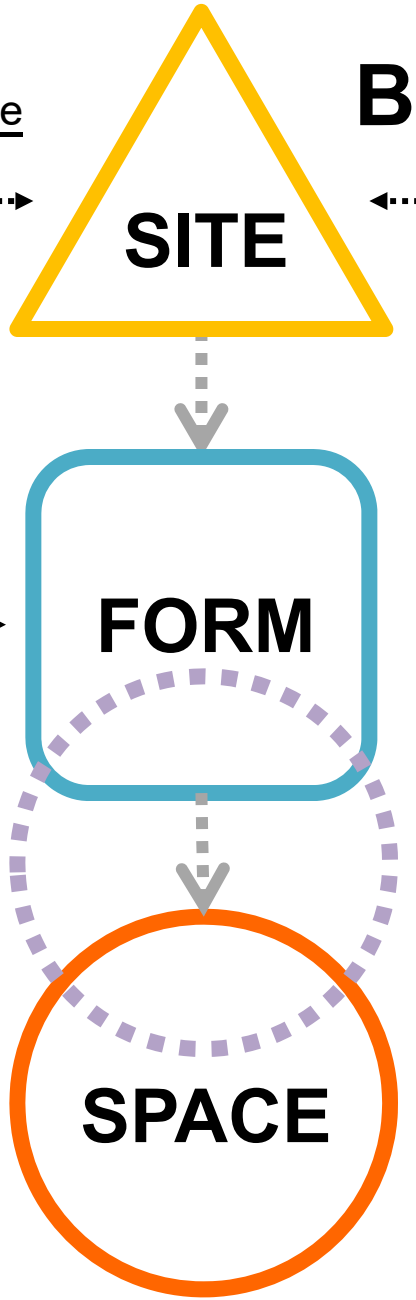
B Architecture / Qualitative

Place
Landscape
Aesthetics
Order
Technology
Social patterns
Culture
Structure
Materials
Experience
Comfort
Health
Light
Sound
Space

LOW ENERGY BUILDING DESIGN MAP

A Science / Quantitative

- Orientation
- Compact volume (Form)
- Efficient geometry (SVR)
- R value
- Glazing placement
- Glazing ratios
- Shading
- Thermal bridging
- Air tightness
- Ventilation
- Water management
- Vapor management
- System design
- Equipment efficiency
- Renewables



B Architecture / Qualitative

- Place
- Landscape
- Aesthetics
- Order
- Technology
- Social patterns
- Culture
- Structure
- Materials
- Experience
- Comfort
- Health
- Light
- Sound
- Space

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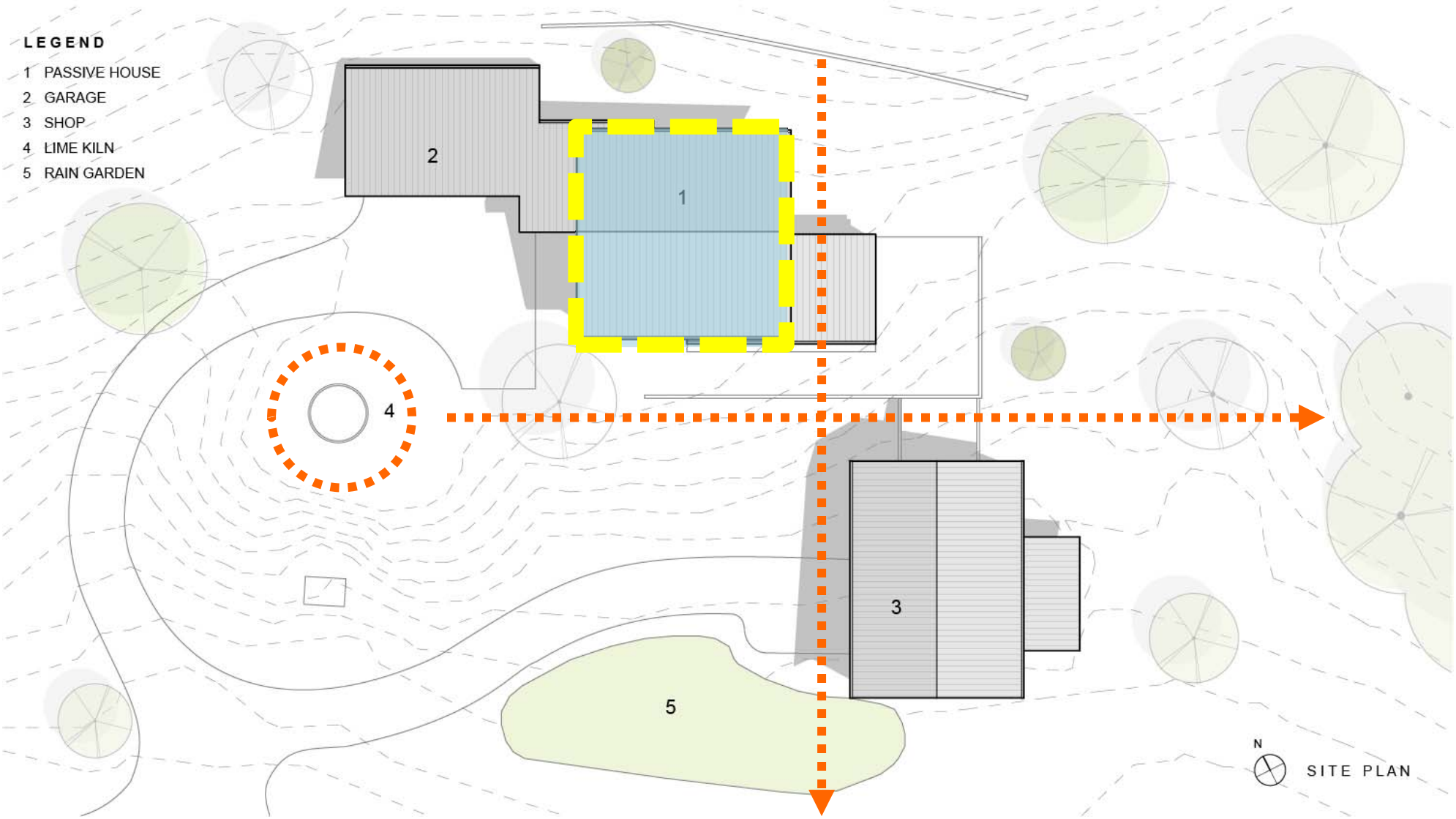
Case Study 2

SOEDER PASSIVE HOUSE



Site: Rural farm country with views

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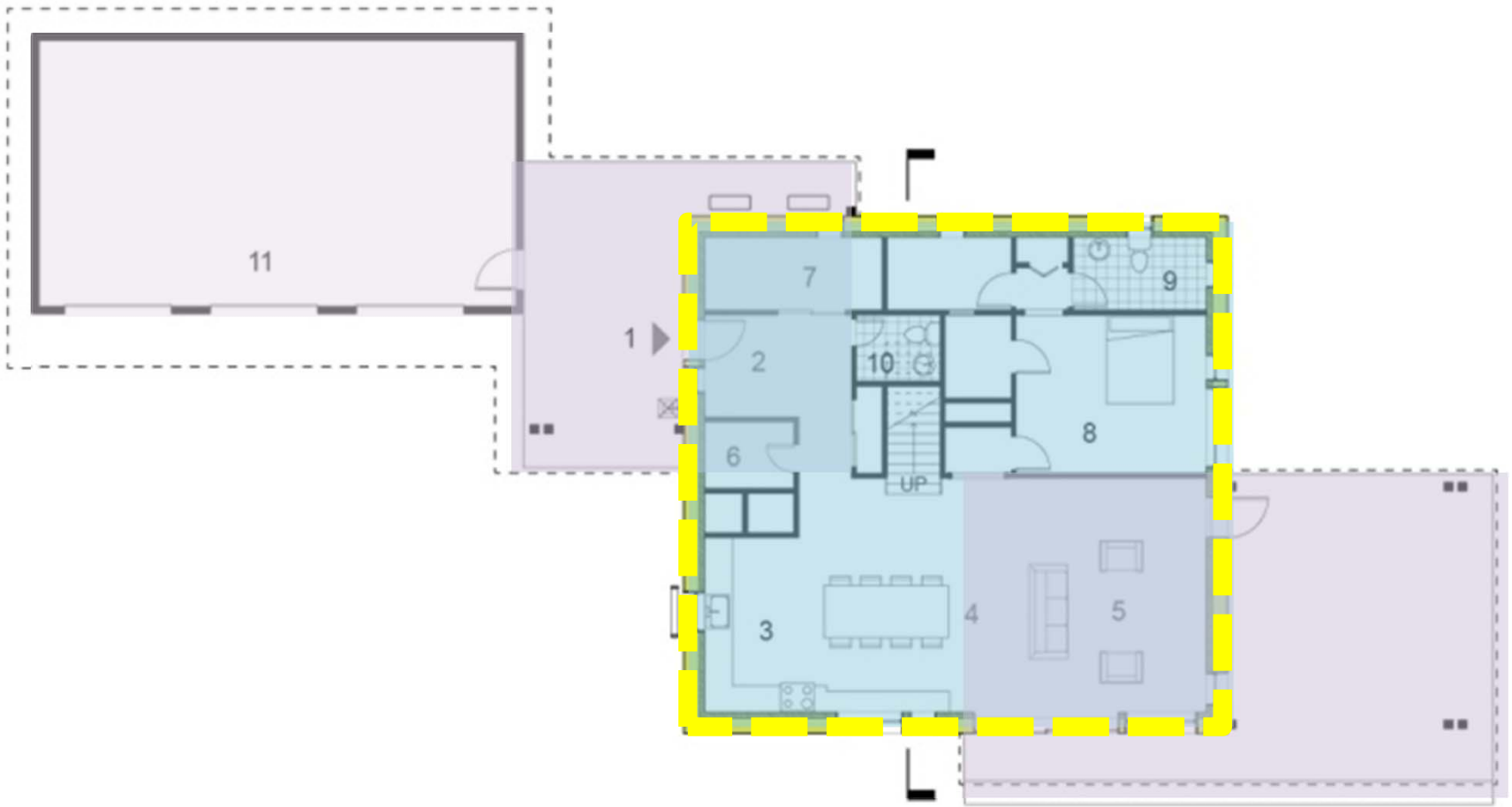
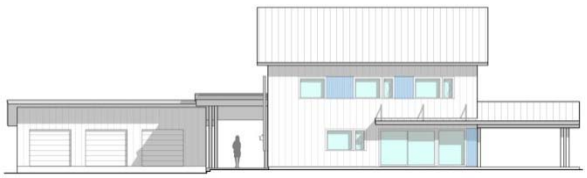
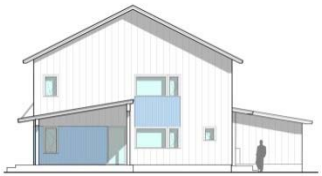
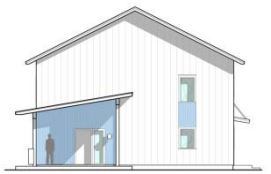
SOEDER PASSIVE HOUSE





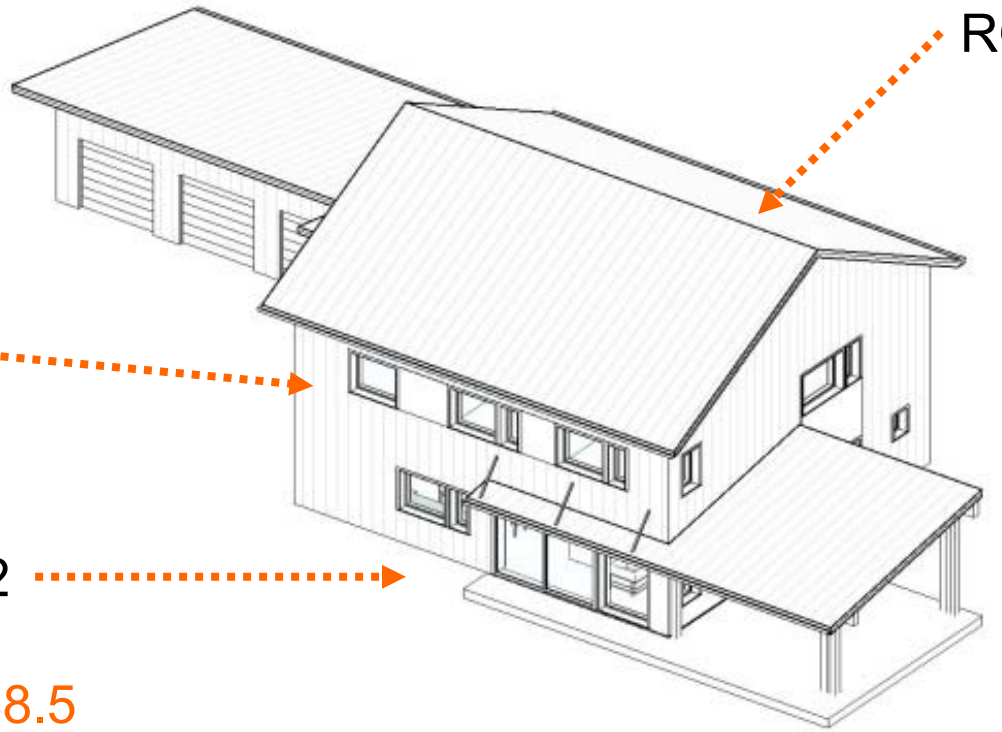




SOEDER PASSIVE HOUSE

SVR	0.32
GLASS	14%
SOUTH GLASS	51%

MORPHOLOGY



ENVELOPE R VALUE = 38.5

GENERAL INFO

BECHTELSVILLE, PA
2,600 SQFT
CLIMATE ZONE 5/6
HERS 30
PV TO ZERO 6KW

MECHANICAL

BALANCED VENTILATION	ZEHNDER 350
HEAT / COOL	MITSUBISHI ASHP
HOT WATER	GE HWHP
WINDOWS	INTUS EFORTE

PASSIVE HOUSE METRICS

ANNUAL HEAT DEMAND	4.75 KBTU/(FT2YR)
HEAT LOAD	2.84 KBTU/(FT2YR)
PRIMARY ENERGY	34.5 KBTU/(FT2YR)
AIR TIGHTNESS	0.22 ACH@50PA
TREATED FLOOR AREA	2,440 SQFT.

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SOEDER PASSIVE HOUSE

PHIUS

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SOEDER PASSIVE HOUSE

"My favorite thing is the **peace of mind** that comes with a high performance building, **knowing that we didn't compromise when it comes to the environmental impact.**

Shawn Soeder

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SOEDER PASSIVE HOUSE

PHIUS

RPA

SOEDER PASSIVE HOUSE

”Our house has been extremely comfortable! Both my wife and I feel the main living spaces tend to be the right temperature and humidity through all the seasons. We do have one upstairs bedroom that tends to be too warm at times, and that takes some attention (door open during the day, sometimes use a fan).”
Shawn Soeder

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SOEDER PASSIVE HOUSE

SOEDER PASSIVE HOUSE

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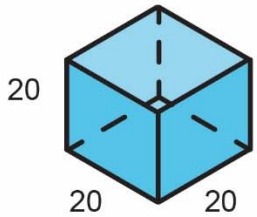
SVR STUDY

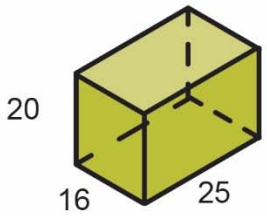
A1



SOUTH
400 SF

SFA : 2400 / VOL : 8000 = **.300**

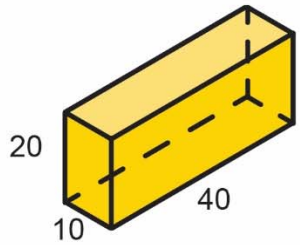
A2



SOUTH
500 SF

SFA : 2440 / VOL : 8000 = **.305**

A3

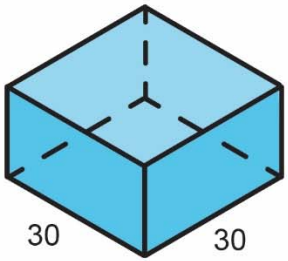


SOUTH
800 SF

SQFT = 800

SFA : 2600 / VOL : 8000 = **.325**

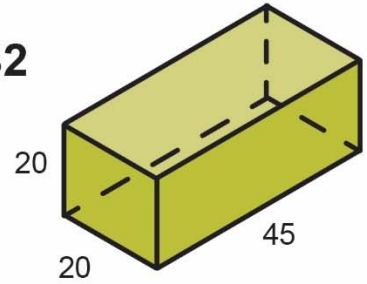
B1



SOUTH
600 SF

SFA : 4200 / VOL : 18000 = **.233**

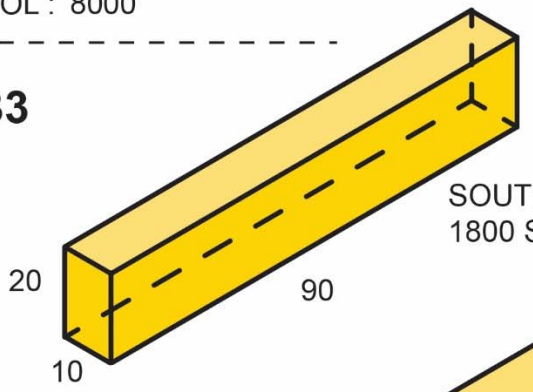
B2



SOUTH
900 SF

SFA : 4400 / VOL : 18000 = **.244**

B3

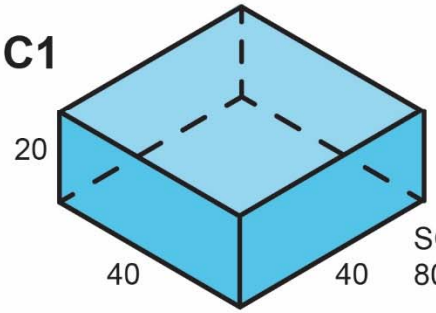


SOUTH
1800 SF

SQFT = 1800

SFA : 5800 / VOL : 18000 = **.322**

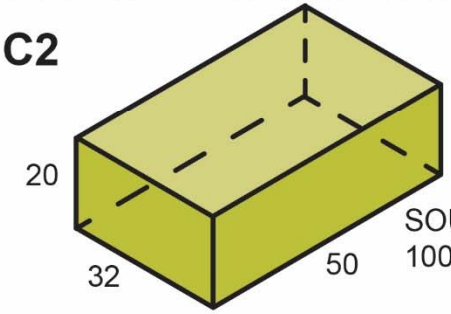
C1



SOUTH
800 SF

SFA : 6400 / VOL : 32000 = **.200**

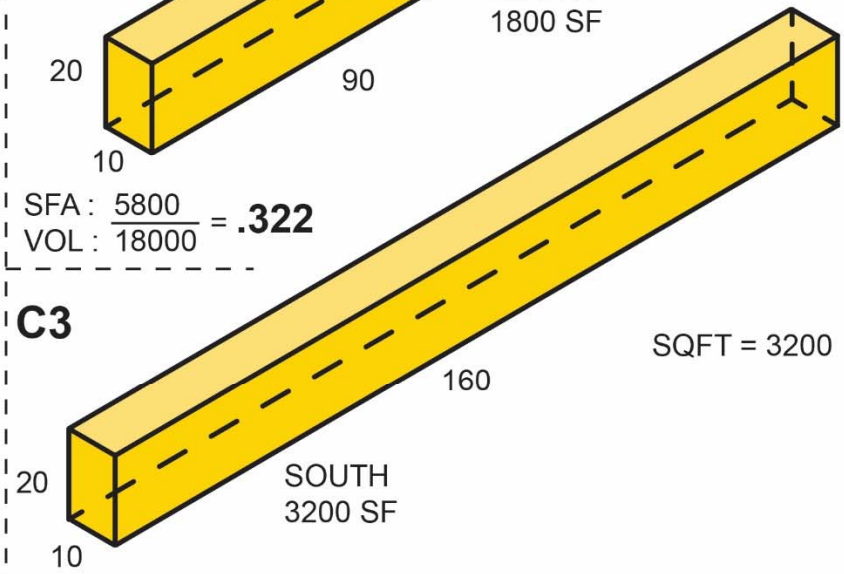
C2



SOUTH
1000 SF

SFA : 6480 / VOL : 32000 = **.203**

C3



SOUTH
3200 SF

SQFT = 3200

SFA : 10000 / VOL : 32000 = **.313**

PHIUS

RPA

800	ft²		Requirements		Fulfilled?*
5.20	kBTU/(ft²yr)	88% of	5.90	kBTU/(ft²yr)	yes
4.41	BTU/(hr.ft²)	96% of	4.60	BTU/(hr.ft²)	yes
0.92	kBTU/(ft²yr)	37% of	2.50	kBTU/(ft²yr)	yes
2.23	BTU/(hr.ft²)	54% of	4.10	BTU/(hr.ft²)	yes
	%		-		-
53.9	kBTU/(ft²yr)	101% of	53.2	kBTU/(ft²yr)	no
15.3	kBTU/(ft²yr)		-		-
	kBTU/(ft²yr)		-		-
0.6	1/h		0.6	1/h	yes

* empty field: data missing; '-': no requirement

no

800	ft²		Requirements		Fulfilled?*
5.74	kBTU/(ft²yr)	97% of	5.90	kBTU/(ft²yr)	yes
4.68	BTU/(hr.ft²)	102% of	4.60	BTU/(hr.ft²)	-
1.00	kBTU/(ft²yr)	40% of	2.50	kBTU/(ft²yr)	yes
2.31	BTU/(hr.ft²)	56% of	4.10	BTU/(hr.ft²)	yes
	%		-		-
56.4	kBTU/(ft²yr)	106% of	53.2	kBTU/(ft²yr)	no
16.2	kBTU/(ft²yr)		-		-
	kBTU/(ft²yr)		-		-
0.6	1/h		0.6	1/h	yes

* empty field: data missing; '-': no requirement

no

800	ft²		Requirements		Fulfilled?*
6.61	kBTU/(ft²yr)	112% of	5.90	kBTU/(ft²yr)	no
5.03	BTU/(hr.ft²)	109% of	4.60	BTU/(hr.ft²)	no
0.93	kBTU/(ft²yr)	37% of	2.50	kBTU/(ft²yr)	yes
2.27	BTU/(hr.ft²)	55% of	4.10	BTU/(hr.ft²)	yes
	%		-		-
55.1	kBTU/(ft²yr)	104% of	53.2	kBTU/(ft²yr)	no
16.5	kBTU/(ft²yr)		-		-
	kBTU/(ft²yr)		-		-
0.6	1/h		0.6	1/h	yes

* empty field: data missing; '-': no requirement

no

1800	ft²		Requirements		Fulfilled?*
4.08	kBTU/(ft²yr)	69% of	5.90	kBTU/(ft²yr)	yes
3.67	BTU/(hr.ft²)	80% of	4.60	BTU/(hr.ft²)	yes
0.14	kBTU/(ft²yr)	6% of	2.50	kBTU/(ft²yr)	yes
0.98	BTU/(hr.ft²)	24% of	4.10	BTU/(hr.ft²)	yes
	%		-		-
25.7	kBTU/(ft²yr)	48% of	53.2	kBTU/(ft²yr)	yes
8.8	kBTU/(ft²yr)		-		-
	kBTU/(ft²yr)		-		-
0.6	1/h		0.6	1/h	yes

* empty field: data missing; '-': no requirement

yes

1800	ft²		Requirements		Fulfilled?*
5.49	kBTU/(ft²yr)	93% of	5.90	kBTU/(ft²yr)	yes
4.42	BTU/(hr.ft²)	96% of	4.60	BTU/(hr.ft²)	yes
0.11	kBTU/(ft²yr)	4% of	2.50	kBTU/(ft²yr)	yes
1.11	BTU/(hr.ft²)	27% of	4.10	BTU/(hr.ft²)	yes
	%		-		-
31.8	kBTU/(ft²yr)	60% of	53.2	kBTU/(ft²yr)	yes
14.8	kBTU/(ft²yr)		-		-
	kBTU/(ft²yr)		-		-
0.6	1/h		0.6	1/h	yes

* empty field: data missing; '-': no requirement

yes

1800	ft²		Requirements		Fulfilled?*
6.79	kBTU/(ft²yr)	115% of	5.90	kBTU/(ft²yr)	no
4.78	BTU/(hr.ft²)	104% of	4.60	BTU/(hr.ft²)	no
0.16	kBTU/(ft²yr)	6% of	2.50	kBTU/(ft²yr)	yes
1.09	BTU/(hr.ft²)	27% of	4.10	BTU/(hr.ft²)	yes
	%		-		-
28.1	kBTU/(ft²yr)	53% of	53.2	kBTU/(ft²yr)	yes
11.1	kBTU/(ft²yr)		-		-
	kBTU/(ft²yr)		-		-
0.6	1/h		0.6	1/h	yes

* empty field: data missing; '-': no requirement

no

3200	ft²		Requirements		Fulfilled?*
2.58	kBTU/(ft²yr)	44% of	5.90	kBTU/(ft²yr)	yes
3.25	BTU/(hr.ft²)	71% of	4.60	BTU/(hr.ft²)	yes
0.06	kBTU/(ft²yr)	2% of	2.50	kBTU/(ft²yr)	yes
0.64	BTU/(hr.ft²)	16% of	4.10	BTU/(hr.ft²)	yes
	%		-		-
16.2	kBTU/(ft²yr)	30% of	53.2	kBTU/(ft²yr)	yes
6.6	kBTU/(ft²yr)		-		-
	kBTU/(ft²yr)		-		-
0.6	1/h		0.6	1/h	yes

* empty field: data missing; '-': no requirement

yes

3200	ft²		Requirements		Fulfilled?*
51.11	kBTU/(ft²yr)	866% of	5.90	kBTU/(ft²yr)	no
27.00	BTU/(hr.ft²)	587% of	4.60	BTU/(hr.ft²)	no
5.11	kBTU/(ft²yr)	204% of	2.50	kBTU/(ft²yr)	no
5.37	BTU/(hr.ft²)	131% of	4.10	BTU/(hr.ft²)	no
	%		-		-
148.7	kBTU/(ft²yr)	280% of	53.2	kBTU/(ft²yr)	no
66.7	kBTU/(ft²yr)		-		-
	kBTU/(ft²yr)		-		-
0.6	1/h		0.6	1/h	yes

* empty field: data missing; '-': no requirement

no

3200	ft²		Requirements		Fulfilled?*
5.87	kBTU/(ft²yr)	99% of	5.90	kBTU/(ft²yr)	no
4.66	BTU/(hr.ft²)	101% of	4.60	BTU/(hr.ft²)	no
0.07	kBTU/(ft²yr)	3% of	2.50	kBTU/(ft²yr)	yes
0.79	BTU/(hr.ft²)	19% of	4.10	BTU/(hr.ft²)	yes
	%		-		-
19.0	kBTU/(ft²yr)	36% of	53.2	kBTU/(ft²yr)	yes
9.5	kBTU/(ft²yr)		-		-
	kBTU/(ft²yr)		-		-
0.6	1/h		0.6	1/h	yes

* empty field: data missing; '-': no requirement

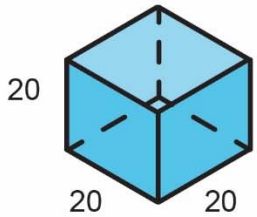
no

PHIUS

RPA

SVR STUDY

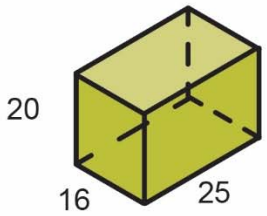
A1



SOUTH
400 SF

SFA : 2400 / VOL : 8000 = **.300**

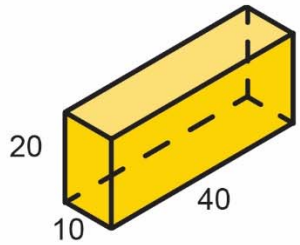
A2



SOUTH
500 SF

SFA : 2440 / VOL : 8000 = **.305**

A3

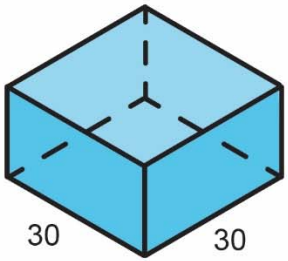


SOUTH
800 SF

SQFT = 800

SFA : 2600 / VOL : 8000 = **.325**

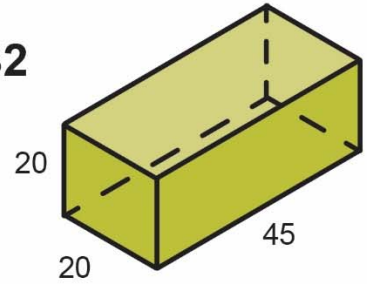
B1



SOUTH
600 SF

SFA : 4200 / VOL : 18000 = **.233**

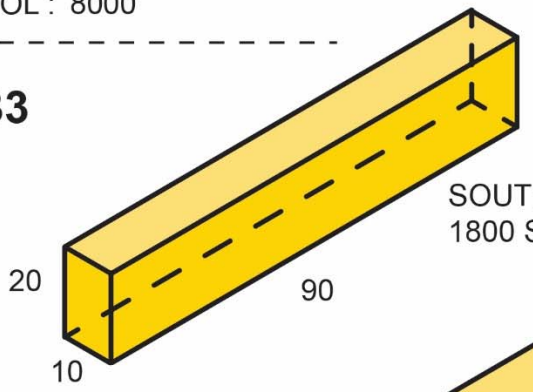
B2



SOUTH
900 SF

SFA : 4400 / VOL : 18000 = **.244**

B3

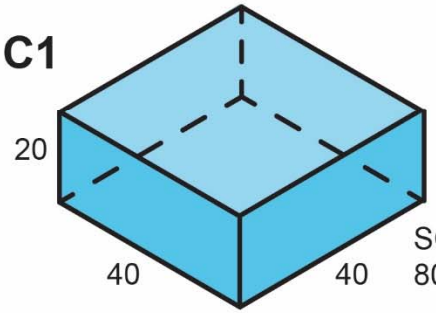


SOUTH
1800 SF

SQFT = 1800

SFA : 5800 / VOL : 18000 = **.322**

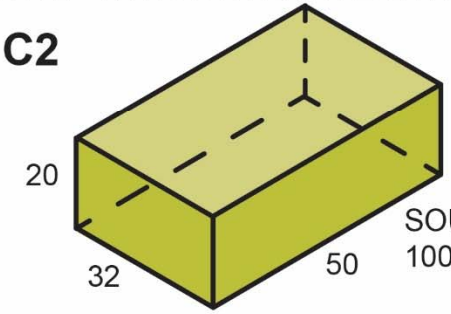
C1



SOUTH
800 SF

SFA : 6400 / VOL : 32000 = **.200**

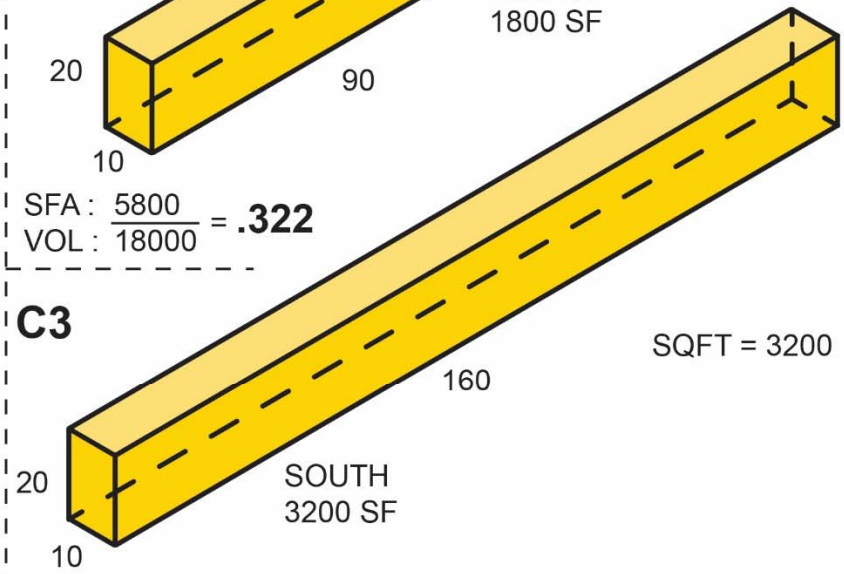
C2



SOUTH
1000 SF

SFA : 6480 / VOL : 32000 = **.203**

C3



SOUTH
3200 SF

SQFT = 3200

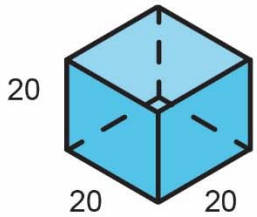
SFA : 10000 / VOL : 32000 = **.313**

PHIUS

RPA

SVR STUDY

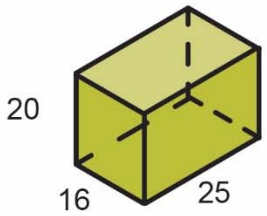
A1



SOUTH
400 SF

SFA : 2400 / VOL : 8000 = **.300**

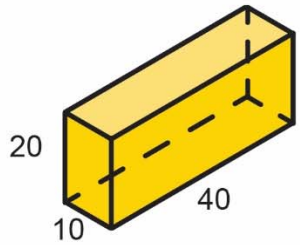
A2



SOUTH
500 SF

SFA : 2440 / VOL : 8000 = **.305**

A3

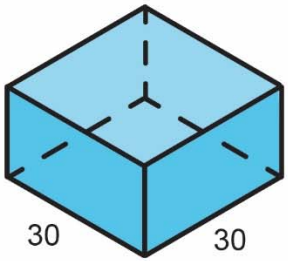


SOUTH
800 SF

SQFT = 800

SFA : 2600 / VOL : 8000 = **.325**

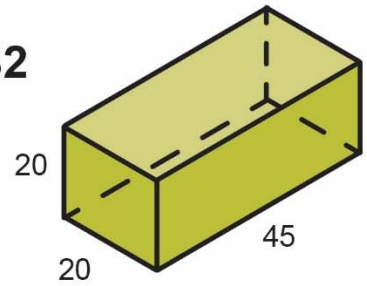
B1



SOUTH
600 SF

SFA : 4200 / VOL : 18000 = **.233**

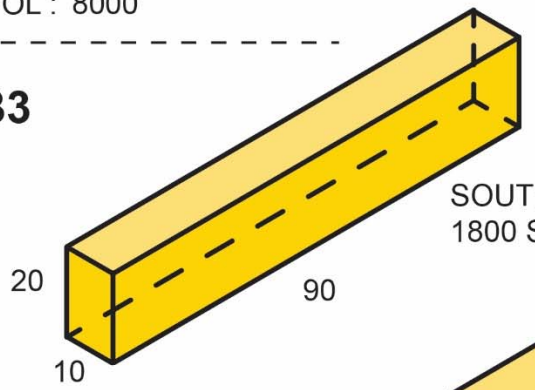
B2



SOUTH
900 SF

SFA : 4400 / VOL : 18000 = **.244**

B3

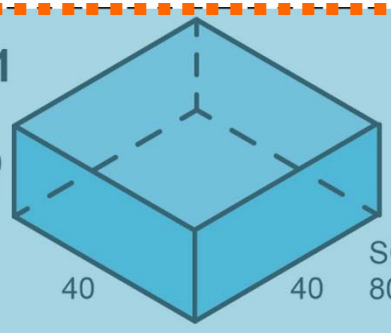


SOUTH
1800 SF

SQFT = 1800

SFA : 5800 / VOL : 18000 = **.322**

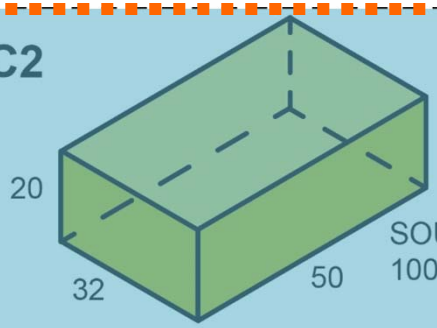
C1



SOUTH
800 SF

SFA : 6400 / VOL : 32000 = **.200**

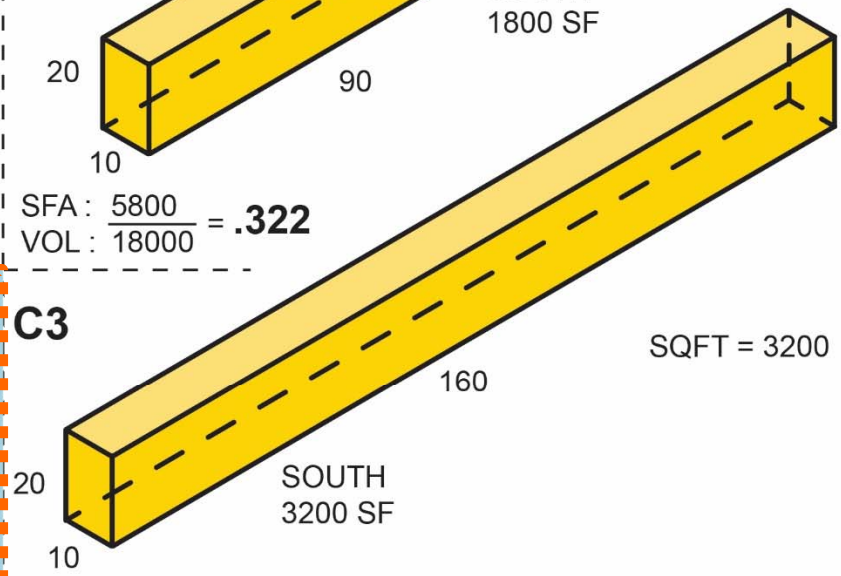
C2



SOUTH
1000 SF

SFA : 6480 / VOL : 32000 = **.203**

C3



SOUTH
3200 SF

SQFT = 3200

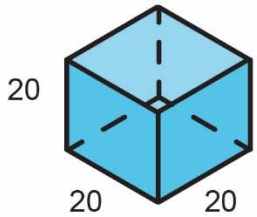
SFA : 10000 / VOL : 32000 = **.313**

PHIUS

RPA

SVR STUDY

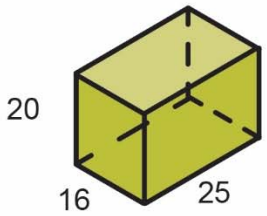
A1



SOUTH
400 SF

SFA : 2400 / VOL : 8000 = **.300**

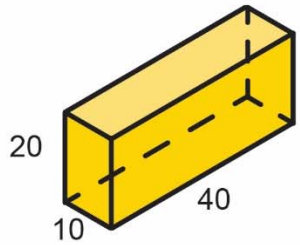
A2



SOUTH
500 SF

SFA : 2440 / VOL : 8000 = **.305**

A3

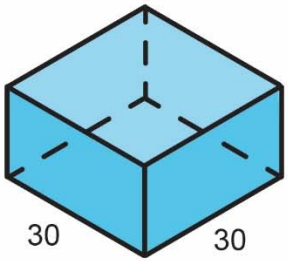


SOUTH
800 SF

SQFT = 800

SFA : 2600 / VOL : 8000 = **.325**

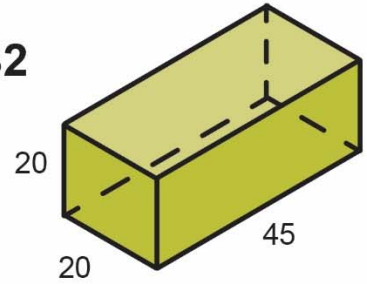
B1



SOUTH
600 SF

SFA : 4200 / VOL : 18000 = **.233**

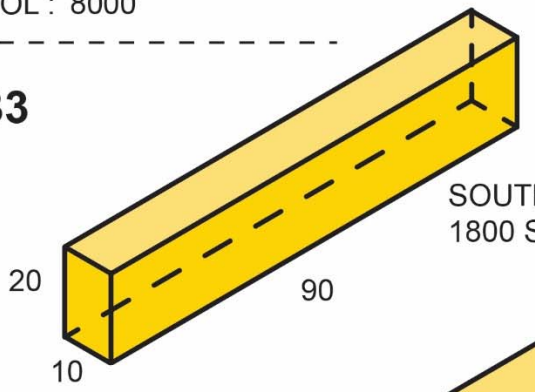
B2



SOUTH
900 SF

SFA : 4400 / VOL : 18000 = **.244**

B3

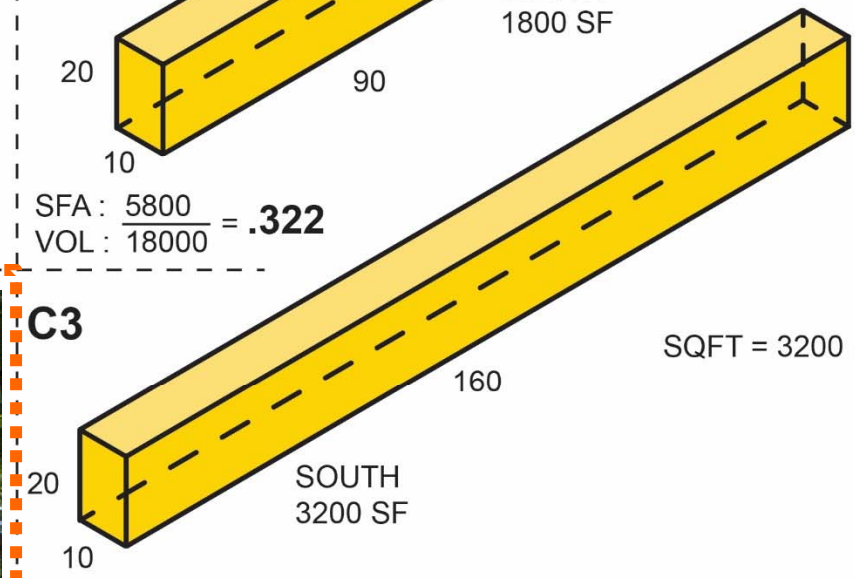


SOUTH
1800 SF

SQFT = 1800

SFA : 5800 / VOL : 18000 = **.322**

C3



SOUTH
3200 SF

SQFT = 3200

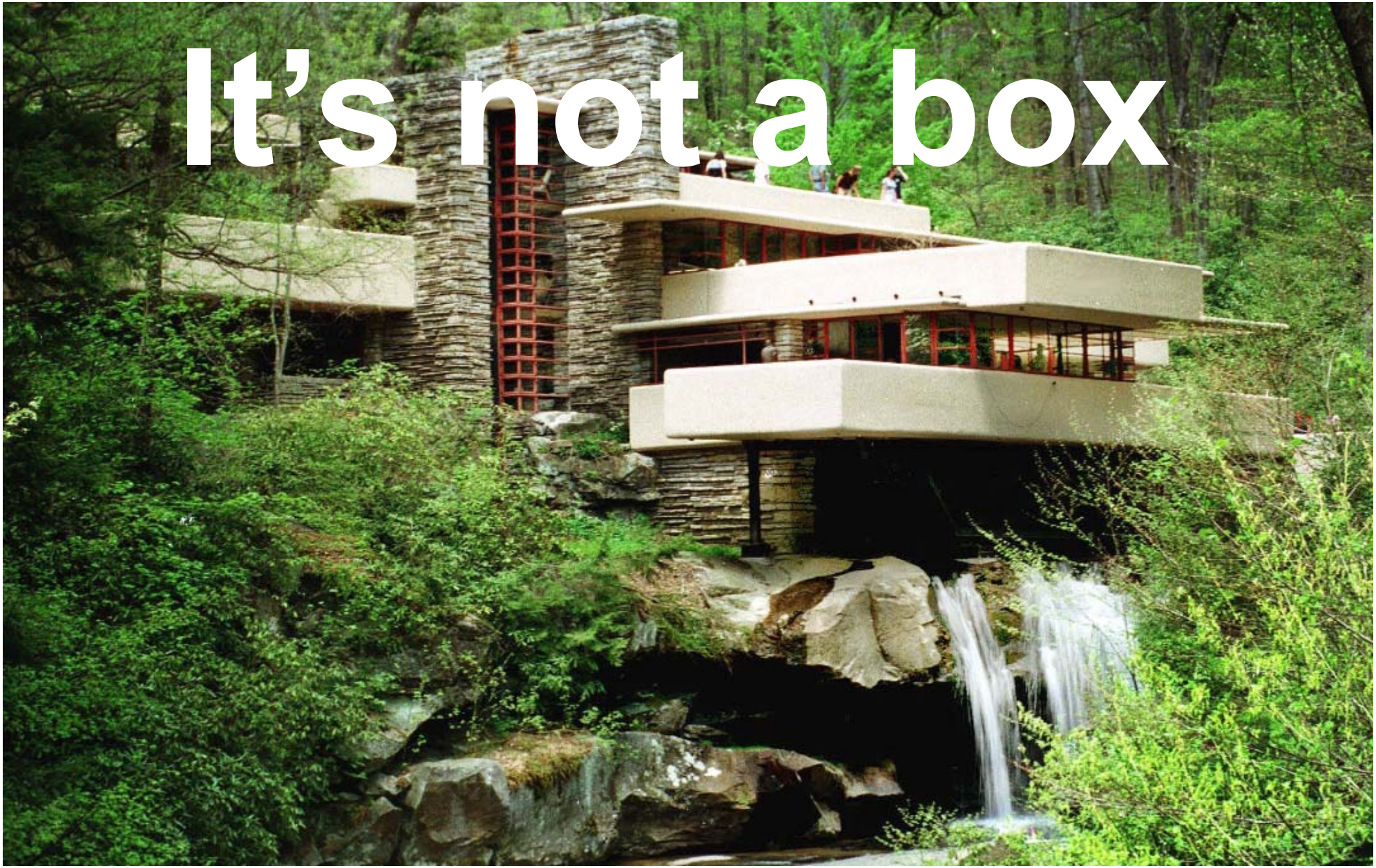
SFA : 10000 / VOL : 32000 = **.313**

PHIUS

RPA

It’s a box

It’s not a box



PHIUS

RPA

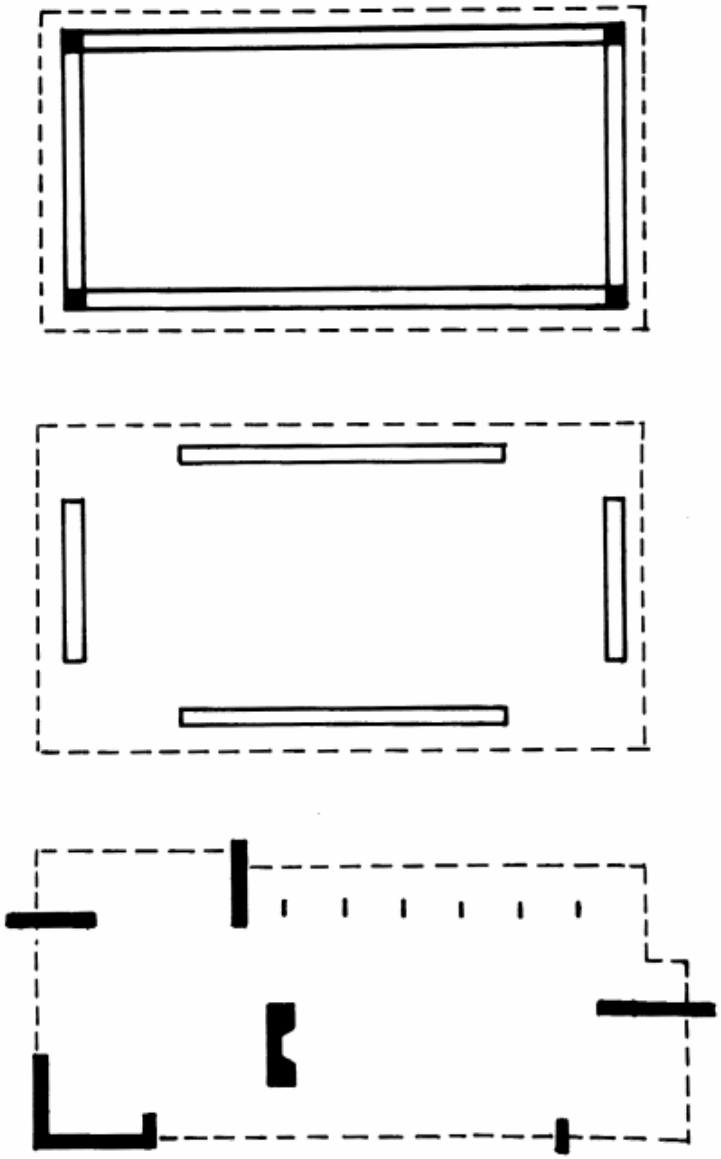
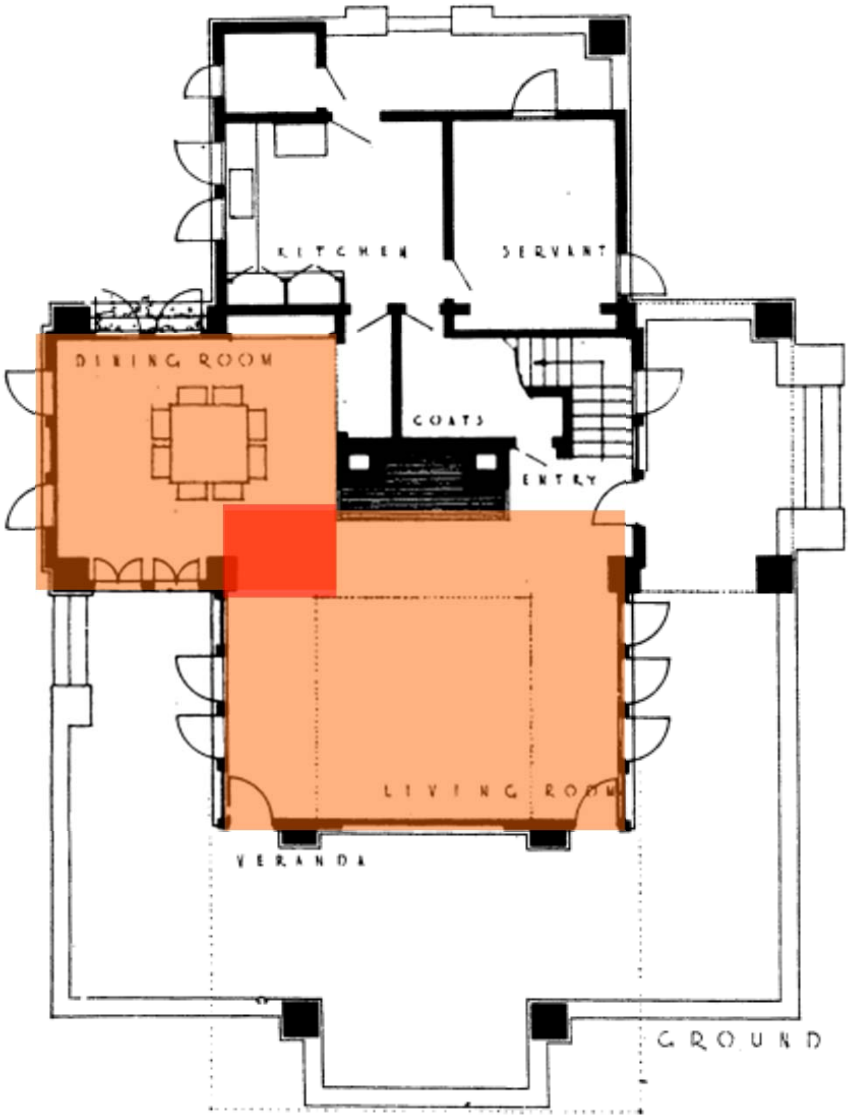
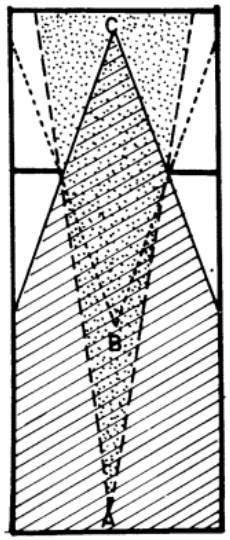
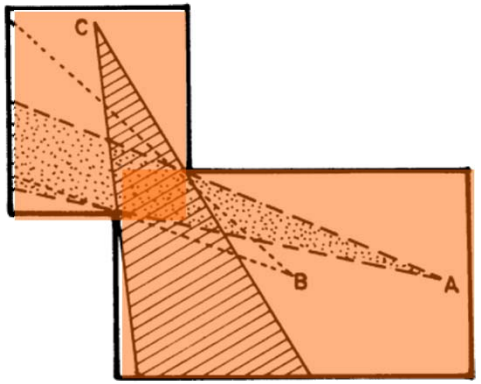
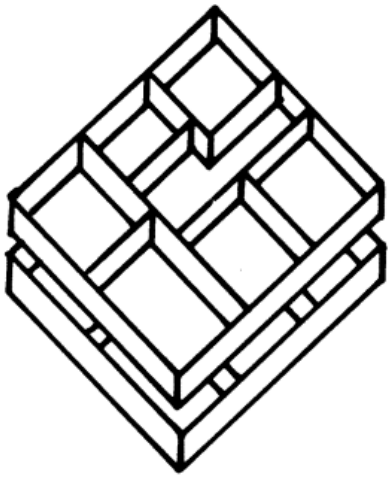


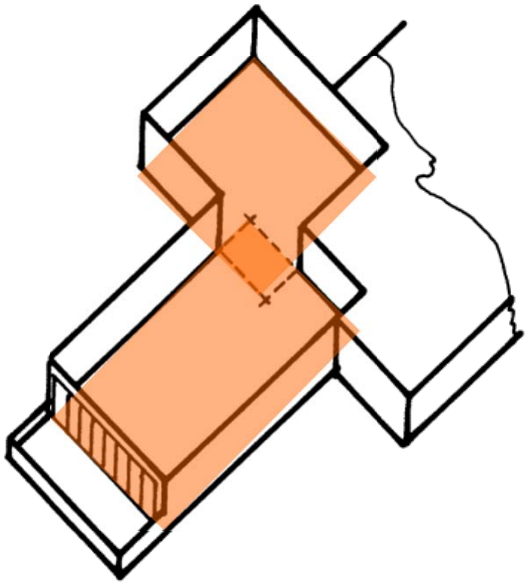
Fig. 10. A: typical room with walls joined at four corners. B: Wright's first step: eliminate the corners, thus turning the walls into freestanding, movable slabs. C: Wright's second step: define, by reassembling segments of these slabs, a new spatial context that integrates the former functions of the demolished rooms; this is the schematic plan of a Usonian house (author after Wright).





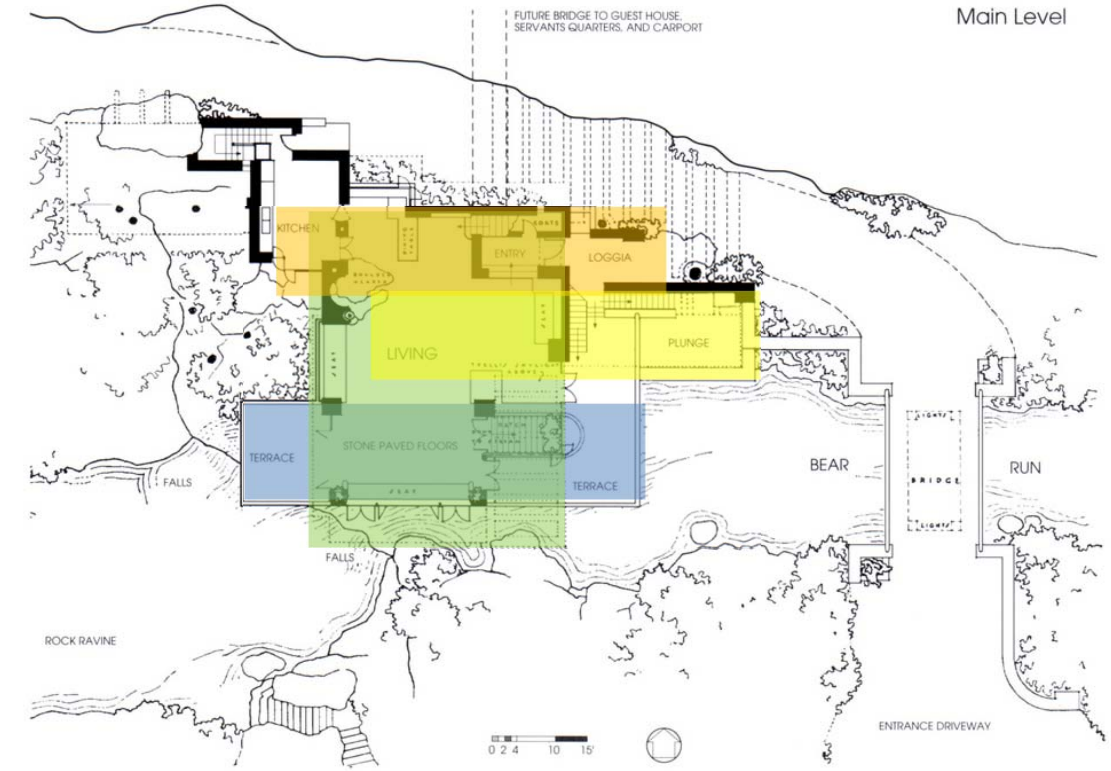




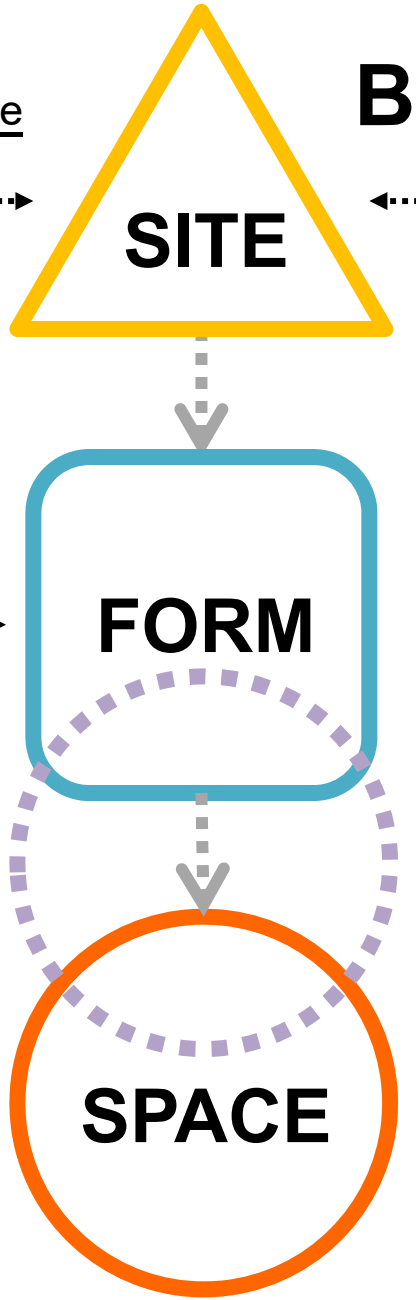


Frank Lloyd Wright and the Destruction of the Box

H. Allen Brooks
March 1979
Journal of the Society of Architectural Historians



DESIGN PARAMETERS



A Science / Quantitative

- Orientation
- Compact volume (Form)
- Efficient geometry (SVR)
- R value
- Glazing placement
- Glazing ratios
- Shading
- Thermal bridging
- Air tightness
- Ventilation
- Water management
- Vapor management
- System design
- Equipment efficiency
- Renewables

B Architecture / Qualitative

- Place
- Landscape
- Aesthetics
- Order
- Technology
- Social patterns
- Culture
- Structure
- Materials
- Experience
- Comfort
- Health
- Light
- Sound
- Space

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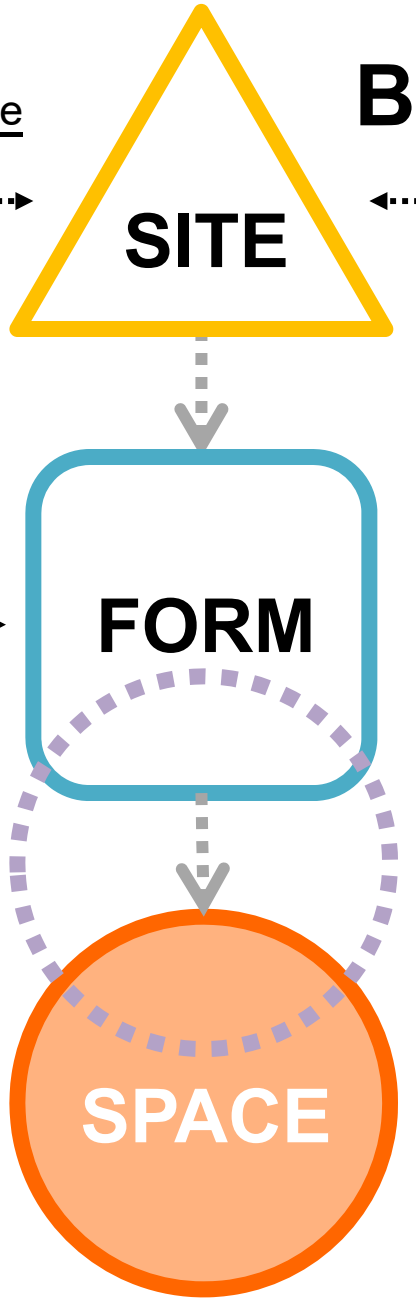
DESIGN PARAMETERS

A Science / Quantitative

- Orientation
- Compact volume (Form)
- Efficient geometry (SVR)
- R value
- Glazing placement
- Glazing ratios
- Shading
- Thermal bridging
- Air tightness
- Ventilation
- Water management
- Vapor management
- System design
- Equipment efficiency
- Renewables



B Architecture / Qualitative

- Place
- Landscape
- Aesthetics
- Order
- Technology
- Social patterns
- Culture
- Structure
- Materials
- Experience
- Comfort
- Health
- Light
- Sound
- Space

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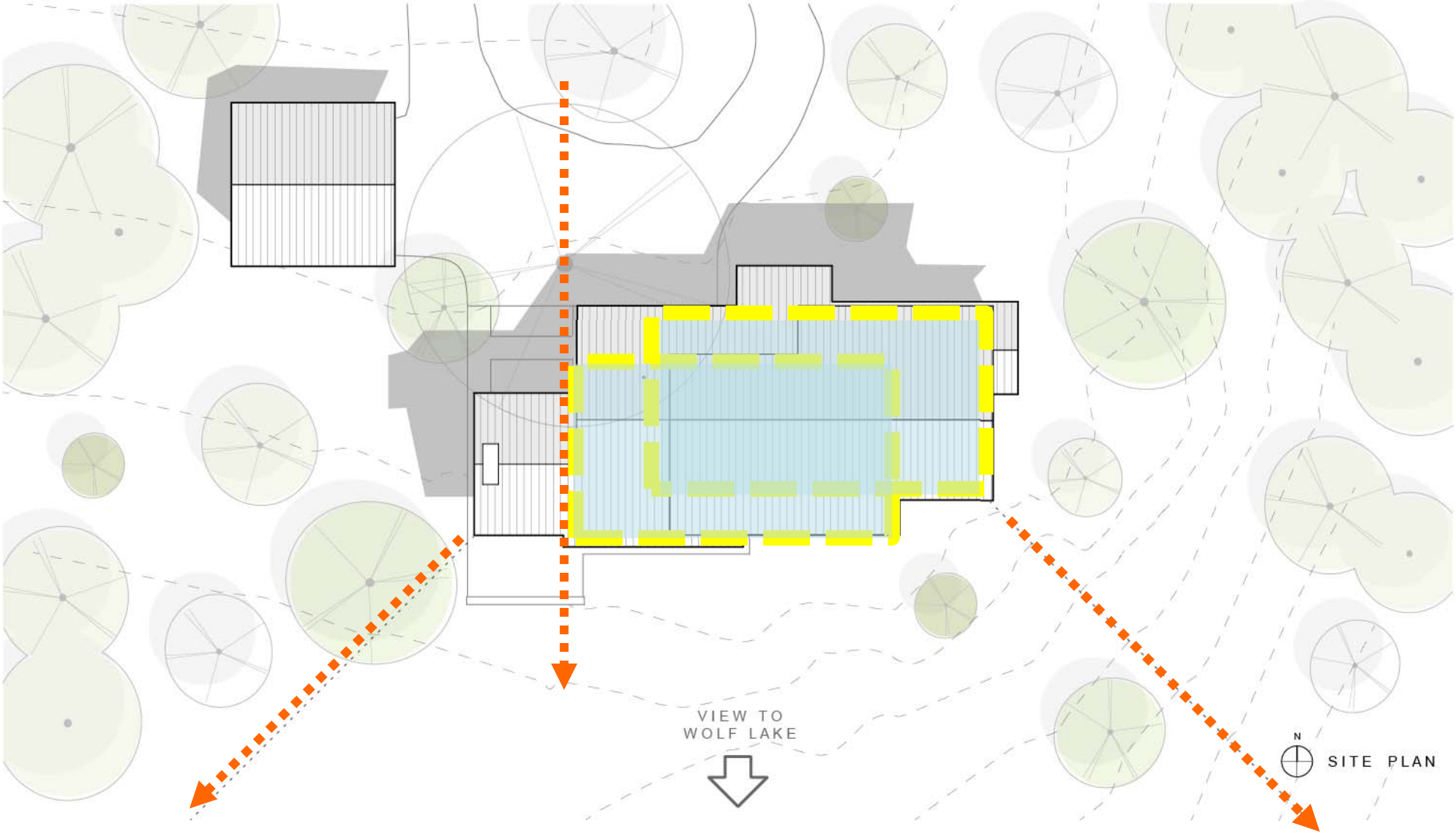
Case Study 3

KEFFER PASSIVE HOUSE



Site: In a forest on a lake

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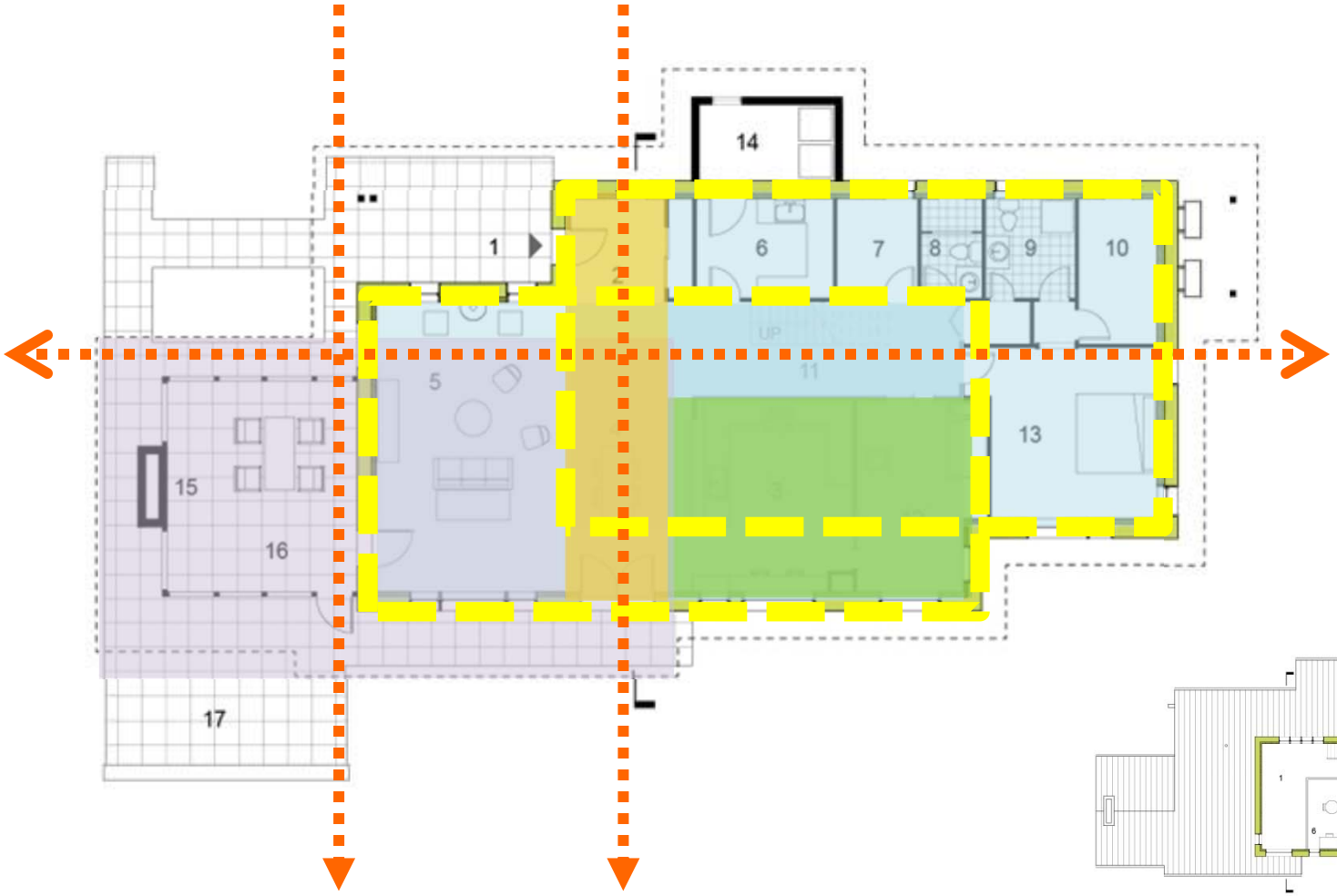
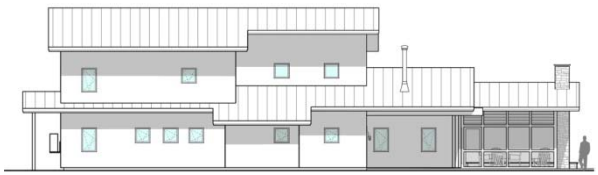
KEFFER PASSIVE HOUSE





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KEFFER PASSIVE HOUSE

SVR	0.34
GLASS	15%
SOUTH GLASS	67%

MORPHOLOGY

ENVELOPE R VALUE = 38.5

GENERAL INFO

HAWLEY, PA
2,900 SQFT
CLIMATE ZONE 5
HERS 32
PV TO ZERO 7KW

MECHANICAL

BALANCED VENTILATION	ZEHNDER 350
HEAT / COOL	MITSUBISHI ASHP
HOT WATER	NYLES GEYSER
WINDOWS	INTUS EFORTE

PASSIVE HOUSE METRICS

ANNUAL HEAT DEMAND	4.65 KBTU/(FT2YR)
HEAT LOAD	2.93 KBTU/(FT2YR)
PRIMARY ENERGY	27.3 KBTU/(FT2YR)
AIR TIGHTNESS	0.29 ACH@50PA
TREATED FLOOR AREA	2,304 SQFT.

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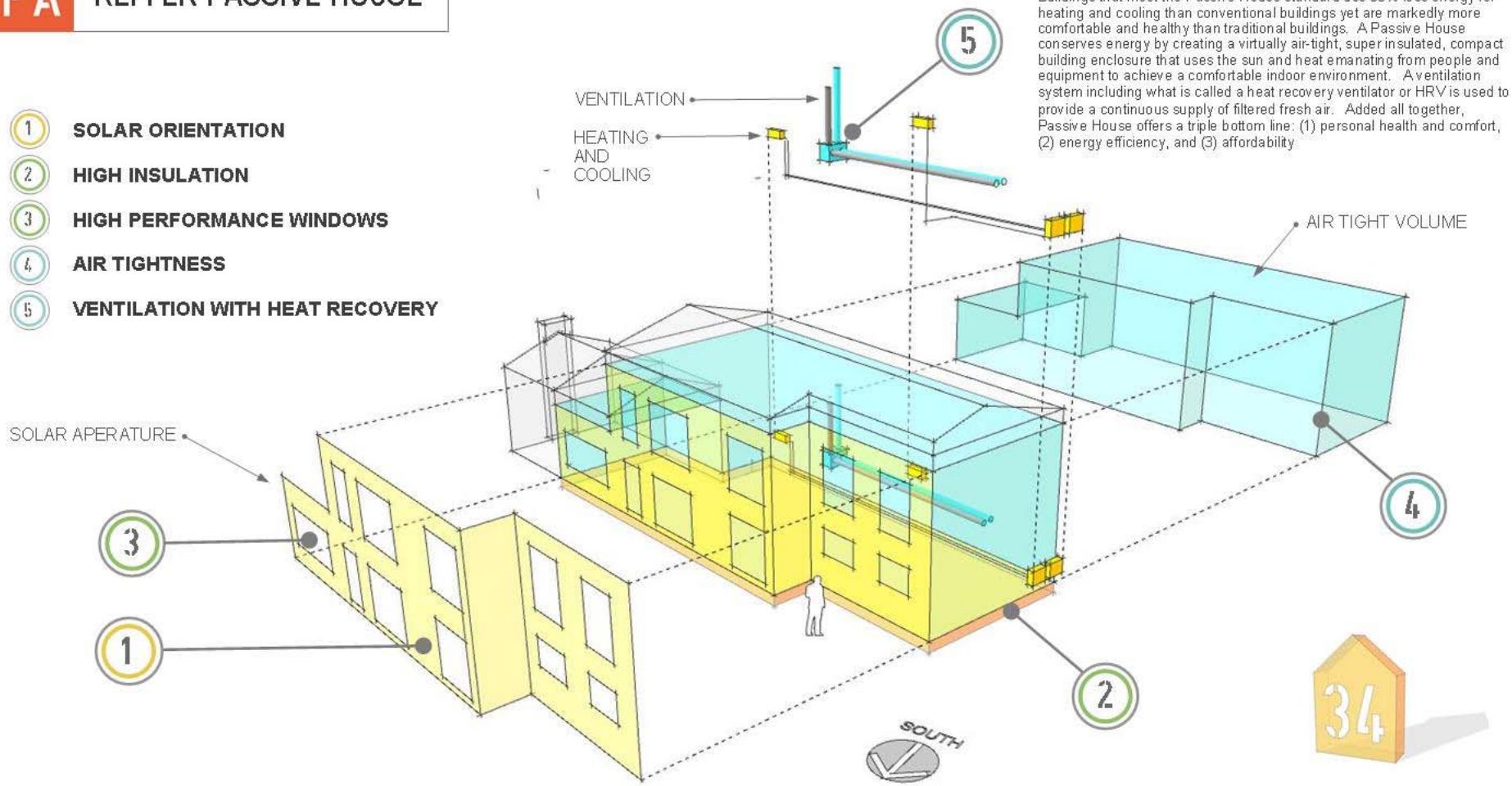
RPA KEFFER PASSIVE HOUSE

"Passive House" is today's most energy efficient building standard. Buildings that meet the Passive House standard use 80% less energy for heating and cooling than conventional buildings yet are markedly more comfortable and healthy than traditional buildings. A Passive House conserves energy by creating a virtually air-tight, super insulated, compact building enclosure that uses the sun and heat emanating from people and equipment to achieve a comfortable indoor environment. A ventilation system including what is called a heat recovery ventilator or HRV is used to provide a continuous supply of filtered fresh air. Added all together, Passive House offers a triple bottom line: (1) personal health and comfort, (2) energy efficiency, and (3) affordability

1. **SOLAR ORIENTATION**
2. **HIGH INSULATION**
3. **HIGH PERFORMANCE WINDOWS**
4. **AIR TIGHTNESS**
5. **VENTILATION WITH HEAT RECOVERY**



KEFFER PASSIVE HOUSE

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KEFFER PASSIVE HOUSE

“Whenever we arrive the inside air feels fresh, without musty odors.”

Lynn Keffer

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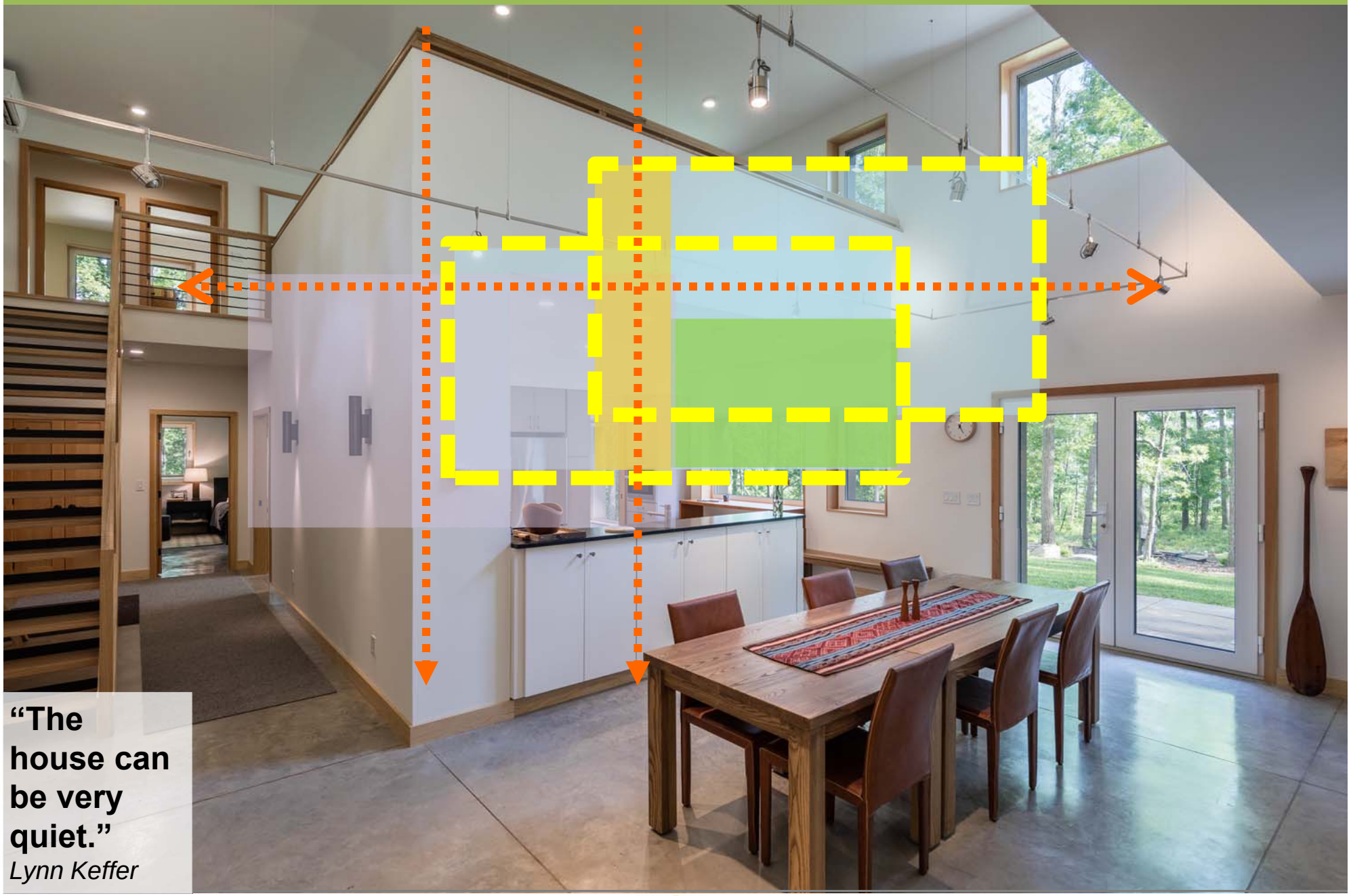
KEFFER PASSIVE HOUSE



“The house can be very quiet.”
Lynn Keffer

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KEFFER PASSIVE HOUSE

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PHIUS

RPA

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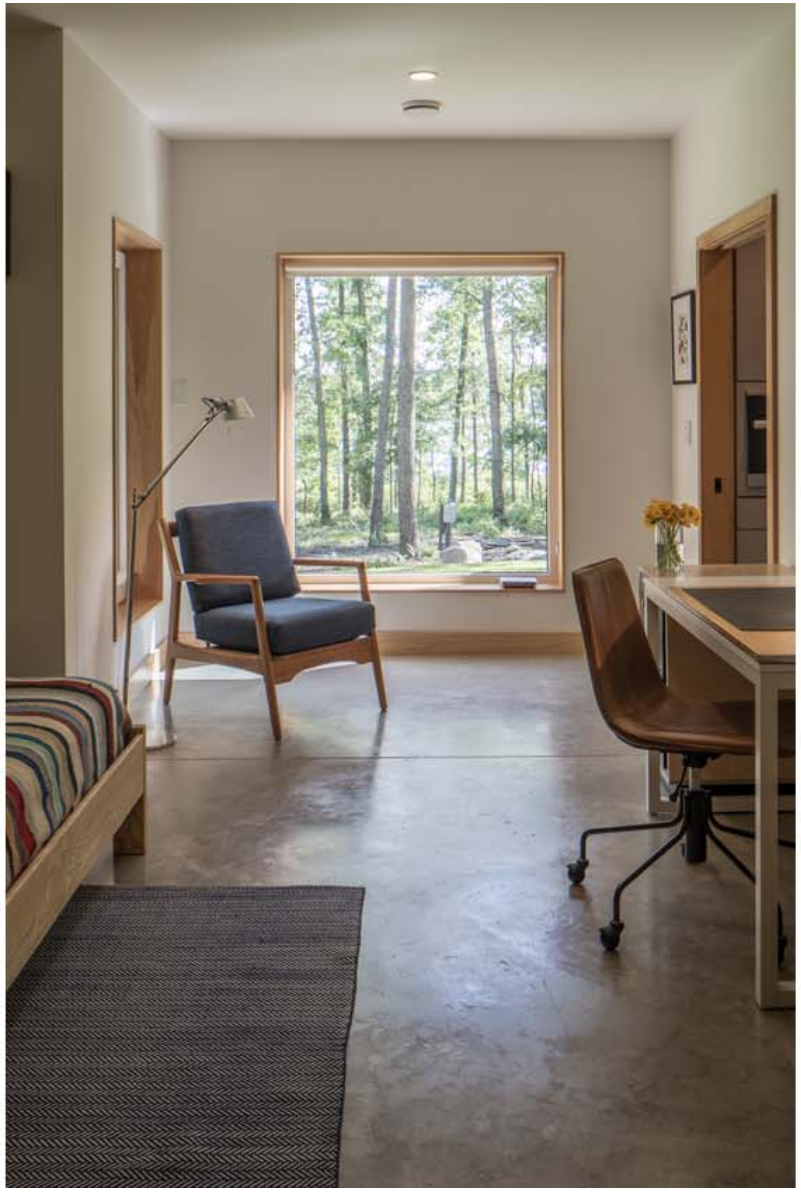
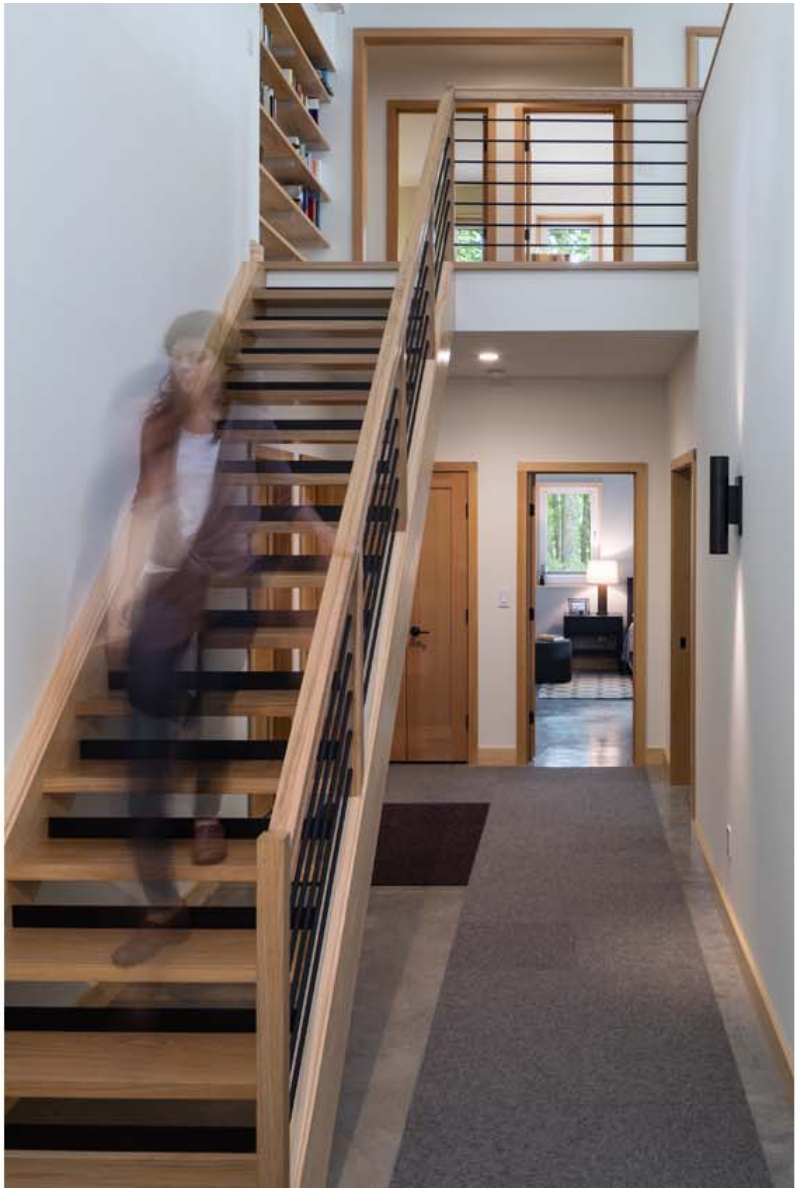
RPA

KEFFER PASSIVE HOUSE





KEFFER PASSIVE HOUSE

PHIUS

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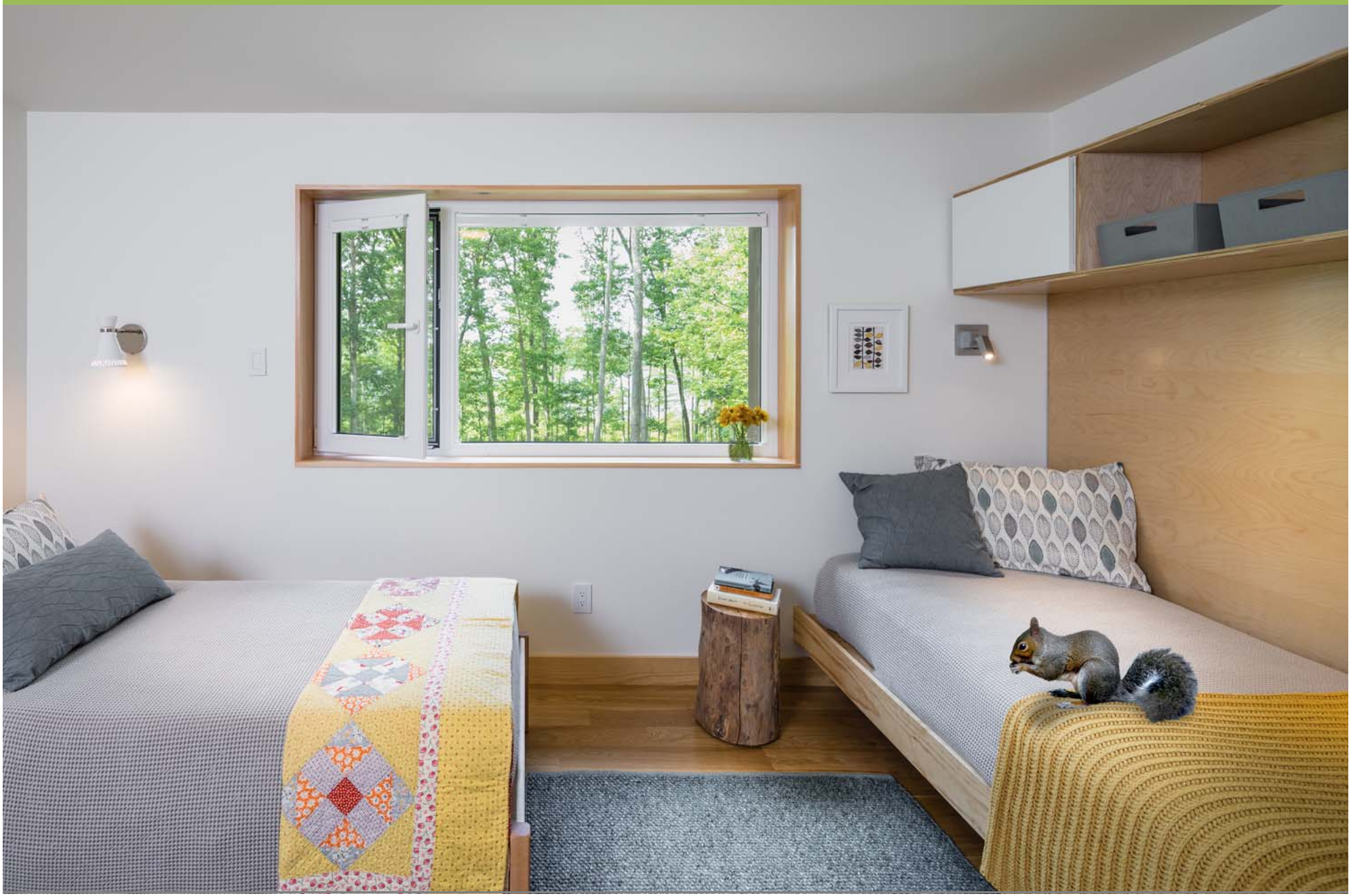
KEFFER PASSIVE HOUSE



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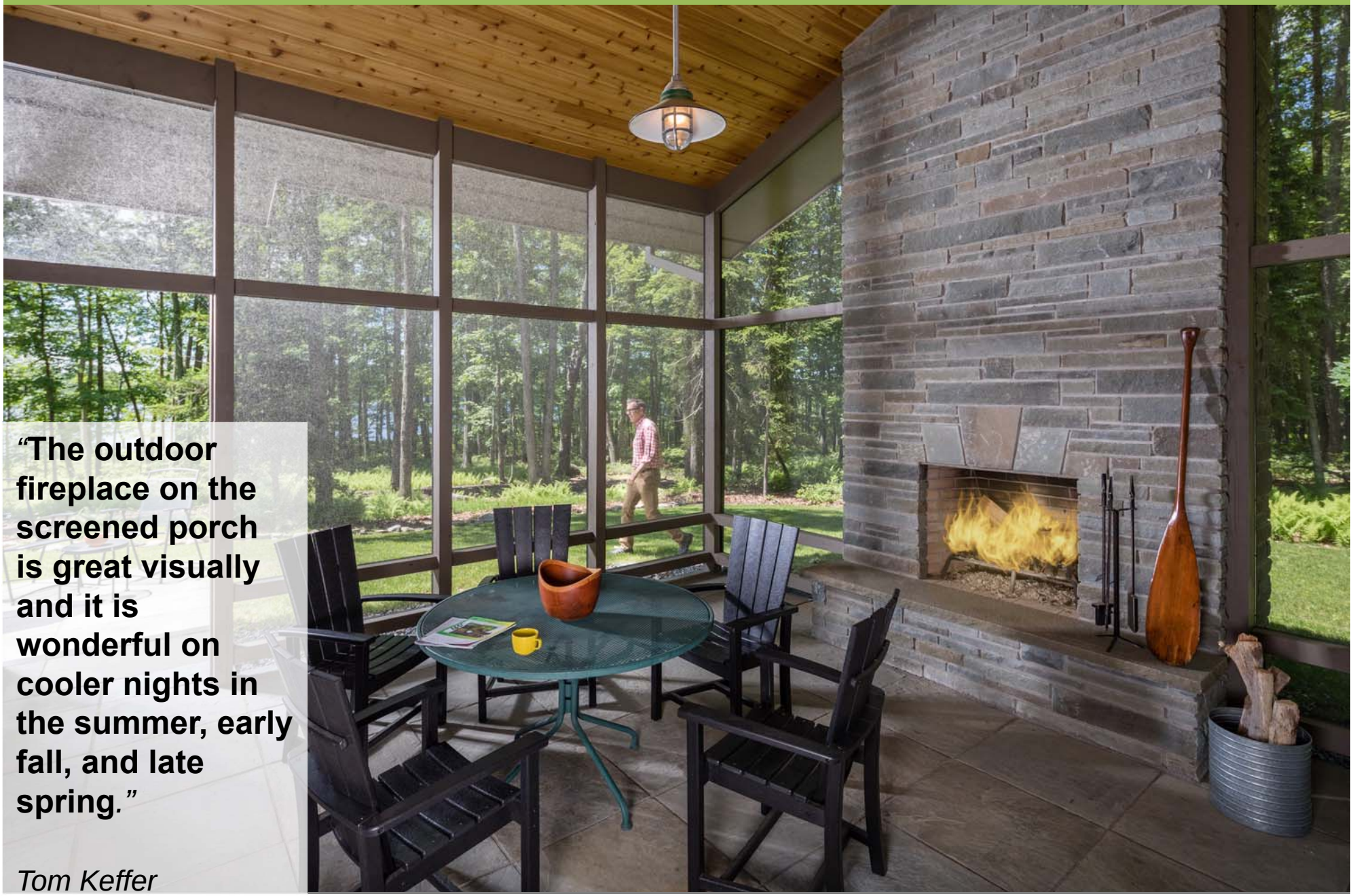

“The outdoor fireplace on the screened porch is great visually and it is wonderful on cooler nights in the summer, early fall, and late spring.”

Tom Keffer

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KEFFER PASSIVE HOUSE

“The passive house structure’s large south-facing windows provide lots of natural light.”

Lynn Keffer

PHIUS

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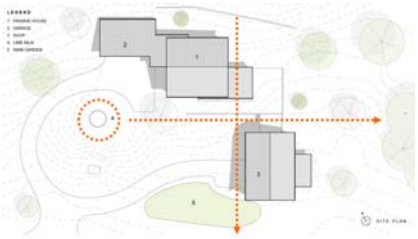
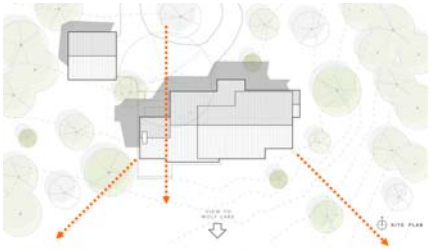
LESSONS LEARNED

1. SITE

Site: Urban neighborhood



Site: Rural farm country with views



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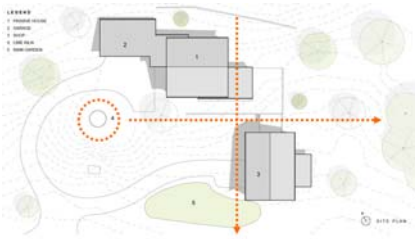

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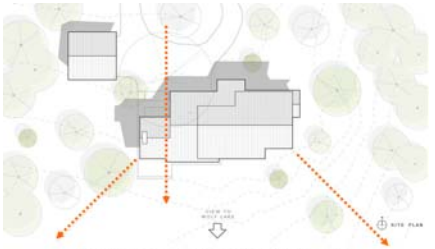

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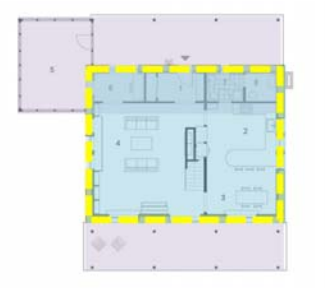
2. FORM



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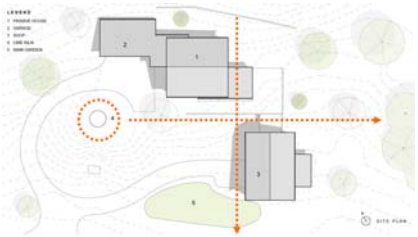
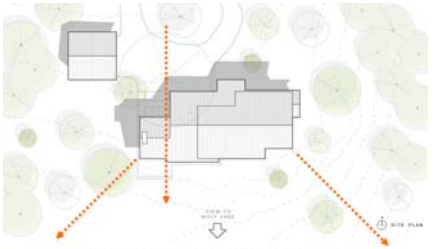


Site: Rural farm country with views



Site: In a forest on a lake

2. FORM

3. SPACE

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RESOURCES

Heating, Cooling, Lighting

Sustainable Design Methods for Architects

Norbert Lechner
Wiley
2015

Frank Lloyd Wright and the Destruction of the Box

H. Allen Brooks
Journal of the Society of Architectural Historians
1979

Design With Climate

Biolclimatic approach to architectural regionalism

Victor Olgyay
Princeton University Press
1963

Transparency: Literal and Phenomenal

Colin Rowe and Robert Slutzky
Perspecta, Volume 8
1963